Global Change Abstracts
The Swiss Contribution
11.1
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Concept and Methods

Global Change Abstracts: The Swiss Contribution (GCA) is a compendium of abstracts for papers on the topic of global environmental change. The abstracts are written or co-authored by Swiss scientists and other experts working in Switzerland. The papers are published in one of the 6000 journals covered by the databases Science Citation Index® and Social Sciences Citation Index®, which are compiled by the Institute for Scientific Information®.

A total of 363 papers that were published during the period August–November 2010 are included in this issue. These papers are classified according to the following categories, which are also used to order the abstracts in GCA (refer to the Table of Contents):

1 Earth system process studies and methodologies
   1.1 Atmosphere
   1.2 Terrestrial Ecosystems
   1.3 Soil and Lithosphere
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2 Past Global Changes
3 Human Dimensions
4 Mitigation and Adaptation Technologies
5 General Topics

The papers are also referenced by an alphabetical list of authors and by scientific discipline (as preassigned by the Institute for Scientific Information®).

We use three different searches to identify the papers in GCA, namely: (i) a search in both databases mentioned above for the names of the principal investigators and their coworkers contained in the ProClim- Infosystem (about 800 names) or for projects with Switzerland as a country of origin; (ii) a search for additional Swiss papers that have been published in a selection of journals chosen from the Science Citation Index® based on the themes they cover (using “journal category codes” assigned by the database producer); (iii) a search in the database Social Sciences Citation Index® for Swiss papers in the social sciences that contain one of over 50 keywords on the topic of global change. ProClim-staff then scan these selected papers to determine which are relevant for inclusion in GCA.

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If you think a paper should be published in an issue of GCA, you can send it to ProClim- and we will consider including it in a future issue. We hope that Global Change Abstracts: The Swiss Contribution will facilitate the exchange of information and with it the interdisciplinarity among the global change research community.
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1.1 Atmosphere

11.1-1 Chemistry-climate model simulations of spring Antarctic ozone


USA, Sweden, Canada, Japan, Germany, France, New Zealand, England, Italy, Switzerland

Meteorology & Atmospheric Sciences, Modelling

Coupled chemistry-climate model simulations covering the recent past and continuing throughout the 21st century have been completed with a range of different models. Common forcings are used for the halogen amounts and greenhouse gas concentrations, as expected under the Montreal Protocol (with amendments) and Intergovernmental Panel on Climate Change A1b Scenario. The simulations of the Antarctic ozone hole are compared using commonly used diagnostics: the minimum ozone, the maximum area of ozone below 220 DU, and the ozone mass deficit below 220 DU. Despite the fact that the processes responsible for ozone depletion are reasonably well understood, a wide range of results is obtained. Comparisons with observations indicate that one of the reasons for the model underprediction in ozone hole area is the tendency for models to underpredict, by up to 35%, the area of low temperatures responsible for polar stratospheric cloud formation. Models also typically have species gradients that are too weak at the edge of the polar vortex, suggesting that there is too much mixing of air across the vortex edge. Other models show a high bias in total column ozone which restricts the size of the ozone hole (defined by a 220 DU threshold). The results of those models which agree best with observations are examined in more detail. For several models the ozone hole does not disappear this century but a small ozone hole of up to three million square kilometers continues to occur in most springs even after 2070.


11.1-2 An evaluation of the estimation of road traffic emission factors from tracer studies

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Switzerland, France, Germany

Energy & Fuels, Meteorology & Atmospheric Sciences, Modelling, Urban Studies

Road traffic emission factors (EFs) are one of the main sources of uncertainties in emission inventories; it is necessary to develop methods to reduce these uncertainties to manage air quality more efficiently. Recently an alternative method has been proposed to estimate the EFs. In that work the emission factors were estimated from a long term tracer study developed in Ho Chi Minh City (HCMC) Vietnam. A passive tracer was continuously emitted from a finite line source placed in one side of an urban street canyon. Simultaneously, the resulting tracer concentrations were monitored at the other side of the street. The results of this experiment were used to calculate the dispersion factors and afterwards, these dispersion factors were used to estimate the EFs. In this paper we use the Computational Fluids Dynamics (CFD) model WinMISKAM to critically evaluate the proposed methodology. In a first step, we use the results of the tracer study to validate the CFD model. Results show that the model is able to simulate quite well the tracer dispersion in most of the cases. The model is then used to evaluate the effect of varying the source configuration and to correct the EFs. A comparison with available studies shows that the corrected EFs are within the range of the EFs reported in other studies. Finally, the CFD model is used to find a source configuration that better represents the vehicle emissions and that may be used in future studies to estimate the EFs more accurately. Results show that a 200 m line placed in the center of the street would represent very well the vehicle emissions. This work shows that it is possible to accurately estimate the EFs from tracer studies.

11.1-3
Atmospheric Brown Clouds in the Himalayas: first two years of continuous observations at the Nepal Climate Observatory-Pyramid (5079 m)
Italy, France, Switzerland, USA
Meteorology & Atmospheric Sciences
This paper provides a detailed description of the atmospheric conditions characterizing the high Himalayas, thanks to continuous observations begun in March 2006 at the Nepal Climate Observatory- Pyramid (NCO-P) located at 5079 m a.s.l. on the southern foothills of Mt. Everest, in the framework of ABC-UNEP and SHARE-Ev-K2-CNR projects. The work presents a characterization of meteorological conditions and air-mass circulation at NCO-P during the first two years of activity. The mean values of atmospheric pressure, temperature and wind speed recorded at the site were: 551 hPa, -3.0 degrees C, 4.7 m s(-1), respectively. The highest seasonal values of temperature (1.7 degrees C) and relative humidity (94%) were registered during the monsoon season, which was also characterized by thick clouds, present in about 80% of the afternoon hours, and by a frequency of cloud-free sky of less than 10%. The lowest temperature and relative humidity seasonal values were registered during winter, -6.3 degrees C and 22%, respectively, the season being characterised by mainly cloud-free sky conditions and rare thick clouds. The summer monsoon influenced rain precipitation (seasonal mean: 237 mm), while wind was dominated by flows from the bottom of the valley (S-SW) and upper mountain (N-NE). The atmospheric composition at NCO-P has been studied thanks to measurements of black carbon (BC), aerosol scattering coefficient, PM1, coarse particles and ozone. The annual behaviour of the measured parameters shows the highest seasonal values during the pre-monsoon (BC: 316.9 ng m(-3), PM1: 3.9µg m(-3), scattering coefficient: 11.9 Mm(-1), coarse particles: 0.37 cm(-3) and O3: 60.9 ppbv), while the lowest concentrations occurred during the monsoon (BC: 49.6 ng m(-3), PM1: 0.6µg m(-3), scattering coefficient: 2.2 Mm(-1), and O3: 38.9 ppbv) and, for coarse particles, during the post-monsoon (0.07 cm(-3)). At NCO-P, the synoptic-scale circulation regimes present three principal contributions: Westerly, South-Westerly and Regional, as shown by the analysis of in-situ meteorological parameters and 5-day LAGRANTO back-trajectories. The influence of the brown cloud (AOD>0.4) extending over Indo- Gangetic Plains up to the Himalayan foothills has been evaluated by analysing the in-situ concentrations of the ABC constituents. This analysis revealed that brown cloud hot spots mainly influence the South Himalayas during the pre-monsoon, in the presence of very high levels of atmospheric compounds (BC: 1974.1 ng m(-3), PM1: 23.5µg m(-3), scattering coefficient: 57.7 Mm(-1), coarse particles: 0.64 cm(-3), O3: 69.2 ppbv, respectively). During this season 20% of the days were characterised by a strong brown cloud influence during the afternoon, leading to a 5-fold increased in the BC and PM1 values, in comparison with seasonal means. Our investigations provide clear evidence that, especially during the pre-monsoon, the southern side of the high Himalayan valleys represent a “direct channel” able to transport brown cloud pollutants up to 5000 m a.s.l., where the pristine atmospheric composition can be strongly influenced.
Atmospheric Chemistry and Physics, 2010, V10, N15, pp 7515-7531 DOI: http://dx.doi.org/10.5194/acp-10-7515-2010.

11.1-4
New particle formation and ultrafine charged aerosol climatology at a high altitude site in the Alps (Jungfraujoch, 3580 m a.s.l., Switzerland)
France, Switzerland
Meteorology & Atmospheric Sciences
We investigate the formation and growth of charged aerosols at Jungfraujoch, in the Swiss Alps (3580 m a.s.l.), the highest altitude site of the European EU-CAARI project intensive campaign. Charged particles and clusters (0.5 - 1.8 nm) were measured from April 2008 to April 2009 and allowed the detection of nucleation events in this very specific environment (presence of free tropospheric air and clouds). We found that the naturally charged aerosol concentrations, which are dominated by the cluster size class, shows a strong diurnal pattern likely linked to valley breezes transporting surface layer ion precursors, presumably radon. Cosmic rays were found not to be the major ion source at the measurement site. However, at night, when air masses are more representative of free tropospheric conditions, we found that the cluster concentrations are still high. The charged aerosol size distribution and concentration are strongly influenced by the presence of clouds at the station. Clouds should be taken into account
when deriving high altitude nucleation statistics. New particle formation occurs on average 17.5% of the measurement period and shows a weak seasonality with a minimum of frequency during winter, but this seasonality is enhanced when the data set is screened for periods when the atmospheric station is out of clouds. The role of ions in the nucleation process was investigated and we found that the ion-mediated nucleation explains 22.3% of the particle formation. The NPF events frequency is correlated with UV radiation but not with calculated H$_2$SO$_4$ concentrations, suggesting that other compounds such as organic vapors are involved in the nucleation and subsequently growth process. In fact, NPF events frequency also surprisingly increases with the condensational sink (CS), suggesting that at Jungfraujoch, the presence of condensing vapours probably coupled with high CS are driving the occurrence of NPF events. A strong link to the air mass path was also pointed out and events were observed to be frequently occurring in Eastern European air masses, which present the highest condensational sink. In these air masses, pre-existing cluster concentrations are more than three time larger than in other air masses during event days, and no new clusters formation is observed, contrarily to what is happening in other air mass types. Atmospheric Chemistry and Physics, 2010, V10, N19, pp 9333-9349 DOI: http://dx.doi.org/10.5194/acp-10-9333-2010.

11.1-5
Three centuries of Slovakian drought dynamics
Buettgen U, Brazdil R, Frank D, Esper J
Switzerland, Czech Republic
Meteorology & Atmospheric Sciences, Forestry, Hydrology, Modelling
Tree-ring data from Slovakia are used to reconstruct decadal-scale fluctuations of the self-calibrated Palmer Drought Severity Index (sc PDSI) over 1744-2006. The ring width chronology correlates at 0.58 (annual) and 0.88 (decadal) with regional-scale (48-50°A degrees N and 18-20°A degrees E) summer (June-August) scPDSI variations (1901-2002). Driest and wettest years common to the tree-ring and target data are 1947, 1948, 1964, and 1916, 1927, 1938, 1941, respectively. The model indicates decadal-scale drought similar to 1780-1810, 1850-1870, 1940-1960, and during the late twentieth century. The wettest period occurred similar to 1745-1775. Instrumental measurements and documentary evidence allow the reconstructed drought extremes to be verified and also provide additional insights on associated synoptic drivers and socioeconomic impacts. Comparison of anomalous dry conditions with European-scale fields of 500 hPa geopotential height retains positive pressure anomalies centered over Central Europe leading to atmospheric stability, subsidence and dry conditions. Negative mid-tropospheric geopotential height anomalies over Western Europe are connected with anomalous wet conditions over Slovakia. Nine existing, annually resolved hydroclimatic reconstructions from Central Europe, which were herein considered for comparison with the Slovakian findings, reveal significant high- to low-frequency coherency among the majority of records. Differences between the Slovakian and the other reconstructions are most evident at the end of the nineteenth century. Climate Dynamics, 2010, V35, N2-3, AUG, pp 315-329 DOI: http://dx.doi.org/10.1007/s00382-009-0563-2.

11.1-6
Agrometeorological conditions on the Swiss Plateau from 1864 to 2050
Calanca P, Holzkämper A
Switzerland
Meteorology & Atmospheric Sciences, Agriculture, Plant Sciences
Agrometeorological conditions on the Swiss Plateau from 1864 to 2050 Climate change will affect the agrometeorological conditions for crop and forage farming also in Switzerland. This can improve agricultural production but also increase weather-related risks. In this context, agrometeorological indices can help to better understand the interactions between crops and climate and thus serve as a basis for the development of adaptation strategies. This study investigates two important aspects of crop production, namely the length of vegetation period and drought risks. Our investigation relies on homogenized data series for temperature and precipitation spanning the period 1864-2009 and the latest climate scenarios from the European research project ENSEMBLES. Concerning the length of vegetation period, our results are consistent with the findings of earlier studies. For the Plateau, they suggest by 2050 an extension of about 40 days relative to the reference in the 1970s. Regarding drought risks the picture is less dramatic than previously assumed. This can be explained by the fact that for the first half of the 21st century the ENSEMBLES scenarios show on average only a small tendency toward reduced summer precipitation. On this aspect, however, even the new scenarios are fraught with uncertainty. Agrarforschung Schweiz, 2010, V1, N9, SEP, pp 320-325.
11.1-7
The potential to narrow uncertainty in projections of stratospheric ozone over the 21st century
England, Germany, South Africa, USA, Japan, France, Italy, New Zealand, Canada, Switzerland
Meteorology & Atmospheric Sciences, Modelling
Future stratospheric ozone concentrations will be determined both by changes in the concentration of ozone depleting substances (ODSs) and by changes in stratospheric and tropospheric climate, including those caused by changes in anthropogenic greenhouse gases (GHGs). Since future economic development pathways and resultant emissions of GHGs are uncertain, anthropogenic climate change could be a significant source of uncertainty for future projections of stratospheric ozone. In this pilot study, using an “ensemble of opportunity” of chemistry-climate model (CCM) simulations, the contribution of scenario uncertainty from different plausible emissions pathways for ODSs and GHGs to future ozone projections is quantified relative to the contribution from model uncertainty and internal variability of the chemistry-climate system. For both the global, annual mean ozone concentration and for ozone in specific geographical regions, differences between CCMs are the dominant source of uncertainty for the first two-thirds of the 21st century, up to and after the time when ozone concentrations return to 1980 values. In the last third of the 21st century, dependent upon the set of greenhouse gas scenarios used, scenario uncertainty can be the dominant contributor. This result suggests that investment in chemistry-climate modelling is likely to continue to refine projections of stratospheric ozone and estimates of the return of stratospheric ozone concentrations to pre-1980 levels.
Atmospheric Chemistry and Physics, 2010, V10, N19, pp 9473-9486 DOI: http://dx.doi.org/10.5194/acp-10-9473-2010.

11.1-8
CO₂ surface fluxes at grid point scale estimated from a global 21 year reanalysis of atmospheric measurements
France, USA, Finland, South Africa, Italy, Japan, Austria, New Zealand, Spain, Hungary, Australia, Switzerland, Netherlands, Canada
Meteorology & Atmospheric Sciences, Modelling
This paper documents a global Bayesian variational inversion of CO₂ surface fluxes during the period 1988-2008. Weekly fluxes are estimated on a 3.75 degrees x 2.5 degrees (longitude-latitude) grid throughout the 21 years. The assimilated observations include 128 station records from three large data sets of surface CO₂ mixing ratio measurements. A Monte Carlo approach rigorously quantifies the theoretical uncertainty of the inverted fluxes at various space and time scales, which is particularly important for proper interpretation of the inverted fluxes. Fluxes are evaluated indirectly against two independent CO₂ vertical profile data sets constructed from aircraft measurements in the boundary layer and in the free troposphere. The skill of the inversion is evaluated by the improvement brought over a simple benchmark flux estimation based on the observed atmospheric growth rate. Our error analysis indicates that the carbon budget from the inversion should be more accurate than the a priori carbon budget by 20% to 60% for terrestrial fluxes aggregated at the scale of subcontinental regions in the Northern Hemisphere and over a year, but the inversion cannot clearly distinguish between the regional carbon budgets within a continent. On the basis of the independent observations, the inversion is seen to improve the fluxes compared to the benchmark: the atmospheric simulation of CO₂ with the Bayesian inversion method is better by about 1 ppm than the benchmark in the free troposphere, despite possible systematic transport errors. The inversion achieves this improvement by changing the regional fluxes over land at the seasonal and at the interannual time scales.
11.1-9

Tropospheric ozone variations at the Nepal Climate Observatory- Pyramid (Himalayas, 5079 m a.s.l.) and influence of deep stratospheric intrusion events

Italy, France, Switzerland

Meteorology & Atmospheric Sciences

The paper presents the first 2 years of continuous surface ozone (O₃) observations and systematic assessment of the influence of stratospheric intrusions (SI) at the Nepal Climate Observatory at Pyramid (NCO-P; 27 degrees 57'N, 86 degrees 48'E), located in the southern Himalayas at 5079 m a.s.l.. Continuous O₃ monitoring has been carried out at this GAW-WMO station in the framework of the EvK2-CNR SHARE and UNEP ABC projects since March 2006. Over the period March 2006-February 2008, an average O₃ value of 49 +/- 12 ppbv (+/- 1 delta) was recorded, with a large annual cycle characterized by a maximum during the pre-monsoon (61 +/- 9 ppbv) and a minimum during the monsoon (39 +/- 10 ppbv). In general, the average O₃ diurnal cycles had different shapes in the different seasons, suggesting an important interaction between the synoptic-scale circulation and the local mountain wind regime. Short-term O₃ behaviour in the middle/lower troposphere (e.g. at the altitude level of NCO-P) can be significantly affected by deep SI which, representing one of the most important natural input for tropospheric O₃, can also influence the regional atmosphere radiative forcing. To identify days possibly influenced by SI at the NCO-P, a specially designed statistical methodology was applied to the time series of observed and modelled stratospheric tracers. On this basis, during the 2-year investigation, 14.1% of analysed days were found to be affected by SI. The SI frequency showed a clear seasonal cycle, with minimum during the summer monsoon (1.2%) and higher values during the rest of the year (21.5%). As suggested by back-trajectory analysis, the position of the subtropical jet stream could play an important role in determining the occurrence of deep SI transport on the southern Himalayas. We estimated the fraction of O₃ due to SI at NCO-P. This analysis led to the conclusion that during SI O₃ significantly increased by 27.1% (+13 ppbv) with respect to periods not affected by such events. Moreover, the integral contribution of SI (O₃SI) to O₃ at the NCO-P was also calculated, showing that up to 13.7% of O₃ recorded at the measurement site could be possibly attributed to SI. On a seasonal basis, the lowest SI contributions were found during the summer monsoon (less than 0.1%), while the highest were found during the winter period (up to 24.2%). Even considering the rather large uncertainty associated with these estimates, the obtained results indicated that, during non-monsoon periods, high O₃ levels could affect NCO-P during SI, thus influencing the variability of tropospheric O₃ over the southern Himalayas.

Atmospheric Chemistry and Physics, 2010, V10, N14, pp 6537-6549 DOI: http://dx.doi.org/10.5194/acp-10-6537-2010.

11.1-10

Phenological retrospective 2009

Defila C
Switzerland

Meteorology & Atmospheric Sciences, Plant Sciences

Phenological retrospective 2009 In 2009, average temperatures above the norm, and especially the extremely warm months of April, May and August, significantly influenced the development of vegetation in Switzerland. In contrast, the drought that prevailed temporarily did not influence this development. The growing season began in normal time or slightly delayed with hazel flowering in March and coltsfoot late March-early April. Few weeks later, last spring phenological phases were early, in particular the daisy flowering. A warm April and unusually high temperatures in May are responsible for this turnaround. The early arrival of phenological summer was truly exceptional, with some new record dates. Thus, in summer 2009, due to the heat in May and August, an advance of vegetation development from two to three weeks compared to the standard was temporarily observed. Grape harvesting and Autumn crocus flowering took place at a very early date. In contrast, the fall of 2009 showed a clear trend to the late occurrence of autumnal phenological phases like leaf colouring and leaf fall.


11.1-11

PM10 remote sensing from geostationary SEVIRI and polar-orbiting MODIS sensors over the complex terrain of the European Alpine region

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Remote Sensing, Meteorology & Atmospheric Sciences, Energy & Fuels, Modelling

The subject of this study is to investigate the capability of spaceborne remote sensing data to predict ground concentrations of PM10 over the European
Alpine region using satellite derived Aerosol Optical Depth (AOD) from the geostationary Spinning Enhanced Visible and InfraRed Imager (SEVIRI) and the polar-orbiting MODerate resolution Imaging Spectroradiometer (MODIS). The spatial and temporal resolutions of these aerosol products (10 km and 2 measurements per day for MODIS, similar to 25 km and observation intervals of 15 min for SEVIRI) permit an evaluation of PM estimation from space at different spatial and temporal scales. Different empirical linear relationships between coincident AOD and PM10 observations are evaluated at 13 ground-based PM measurement sites, with the assumption that aerosols are vertically homogeneously distributed below the planetary Boundary Layer Height (BLH). The BLH and Relative Humidity (RH) variability are assessed, as well as their impact on the parameterization. The BLH has a strong influence on the correlation of daily and hourly time series, whilst RH effects are less clear and smaller in magnitude. Despite its lower spatial resolution and AOD accuracy, SEVIRI shows higher correlations than MODIS ($r(\text{SEV}) \approx 0.7$, $r(\text{MOD}) \approx 0.6$) with regard to daily averaged PM10. Advantages from MODIS arise only at hourly time scales in mountainous locations but lower correlations were found for both sensors at this time scale ($r \approx 0.45$). Moreover, the fraction of days in 2008 with at least one satellite observation was 27% for SEVIRI and 17% for MODIS. These results suggest that the frequency of observations plays an important role in PM monitoring, while higher spatial resolution does not generally improve the PM estimation. Ground-based Sun Photometer (SP) measurements are used to validate the satellite-based AOD in the study region and to discuss the impact of aerosols’ micro-physical properties in the empirical models. A lower error limit of 30 to 60% in the PM10 assessment from space is estimated in the study area as a result of AOD uncertainties, variability of aerosols properties and the heterogeneity of ground measurement sites. It is concluded that SEVIRI has a similar capacity to map PM as sensors on board polar-orbiting platforms, with the advantage of a higher number of observations. However, the accuracy represents a serious limitation to the applicability of satellites for ground PM mapping, especially in mountainous areas.

**11.1-12**

**Spatial Predictions of Extreme Wind Speeds over Switzerland Using Generalized Additive Models**

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*Switzerland, Spain*

Meteorology & Atmospheric Sciences, Modelling

The purpose of this work is to present a methodology aimed at predicting extreme wind speeds over Switzerland. Generalized additive models are used to regionalize wind statistics for Swiss weather stations using a number of variables that describe the main physiographical features of the country. This procedure enables one to present the results for Switzerland in the form of a map that provides the 98th percentiles of daily maximum wind speeds (W98) at a 10-m anemometer height for cells with a 50-m grid interval. This investigation comprises three major steps. First, meteorological data recorded by the weather stations was gathered to build local wind statistics at each station. Then, data describing the topographic and landscape characteristics of the country were prepared using geographic information systems (GIS). Third, appropriate regression models were selected to make spatially explicit predictions of extreme wind speeds in Switzerland. The predictions undertaken in this study provide realistic values of the W98. The effects of topography on the results are particularly conspicuous. Wind speeds increase with altitude and are greatest on mountain peaks in the Alps, as would be intuitively expected. Relative errors between observations and model results calculated for the meteorological stations do not exceed 30%, and only 12 out of 70 stations exhibit errors that exceed 20%. The combination of GIS techniques and statistical models used to predict a highly uncertain variable, such as extreme wind speed, yields interesting results that can be extended to other fields, such as the assessment of storm damage on infrastructures.

11.1-13

Multi-model assessment of stratospheric ozone return dates and ozone recovery in CCMVal-2 models


Germany, South Africa, England, USA, Canada, Japan, France, Italy, Switzerland, New Zealand

Meteorology & Atmospheric Sciences, Modelling

Projections of stratospheric ozone from a suite of chemistry-climate models (CCMs) have been analyzyed. In addition to a reference simulation where anthropogenic halogenated ozone-depleting substances (ODSs) and greenhouse gases (GHGs) vary with time, sensitivity simulations with either ODS or GHG concentrations fixed at 1960 levels were performed to disaggregate the drivers of projected ozone changes. These simulations were also used to assess the two distinct milestones of ozone returning to historical values (ozone return dates) and ozone no longer being influenced by ODSs (full ozone recovery). The date of ozone returning to historical values does not indicate complete recovery from ODSs in most cases, because GHG-induced changes accelerate or decelerate ozone changes in many regions. In the upper stratosphere where CO₂-induced stratospheric cooling increases ozone, full ozone recovery is projected to not likely have occurred by 2100 even though ozone returns to its 1980 or even 1960 levels well before (similar to 2025 and 2040, respectively). In contrast, in the tropical lower stratosphere ozone decreases continuously from 1960 to 2100 due to projected increases in tropical upwelling, while by around 2040 it is already very likely that full ozone recovery is reached by the end of the 21st century in this region. Arctic total column ozone is projected to return to 1980 levels well before polar stratospheric halogen loading does so (similar to 2025-2030 for total column ozone, cf. 2050-2070 for Cl₂ +60xBr(y)) and it is likely that full recovery of total column ozone from the effects of ODSs has occurred by similar to 2035. In contrast to the Antarctic, by 2100 Arctic total column ozone is projected to be above 1960 levels, but not in the fixed GHG simulation, indicating that climate change plays a significant role.

Atmospheric Chemistry and Physics, 2010, V10, N19, pp 9451-9472 DOI: http://dx.doi.org/10.5194/acp-10-9451-2010.

11.1-14

Light scattering enhancement factors in the marine boundary layer (Mace Head, Ireland)


Switzerland, Ireland

Meteorology & Atmospheric Sciences

Direct climate aerosol radiative forcing is influenced by the light scattering of atmospheric aerosols. The chemical composition, the size distribution, and the ambient relative humidity (RH) determine the amount of visible light scattered by aerosols. We measured the aerosol light scattering coefficients at RH varying from 30% to 90% of the marine atmosphere at the Mace Head Atmospheric Research Station on the west coast of Ireland. At this site, two major air mass types can be distinguished: clean marine and polluted air. In this paper, we present measurements of light scattering enhancement factors f(RH) = sigma(sp)(RH)/sigma(sp)(dry) from a month long field campaign (January-February 2009). At this site in winter, the mean f(RH = 85%) (standard deviation) for marine air masses at the wavelength of 550 nm was 2.22 (+/- 0.17) and 1.77 (+/- 0.31) for polluted air. Measured sigma(sp)(RH) and f(RH) agreed well with calculations from Mie theory using measurements of the size distribution and hygroscopic diameter growth factors as input. In addition, we investigated the RH influence on additional intensive optical properties: the backscatter fraction and the single scattering albedo. The backscatter fraction decreased by about 20%, and the single scattering albedo increased on average by 1%-5% at 85% RH compared to dry conditions.

11.1-15
Quantification of sources of PCBs to the atmosphere in urban areas: A comparison of cities in North America, Western Europe and former Yugoslavia
Switzerland, Czech Republic, Bosnia & Herceg, Germany, Norway
Meteorology & Atmospheric Sciences, Urban Studies, Modelling
We present estimated emission source strengths of seven polychlorinated biphenyl (PCB) congeners for Banja Luka, a city that was affected by the civil war in Bosnia and Hercegovina (former Yugoslavia) in the 1990s. These emission estimates are compared to PCB emission rates estimated for the cities of Zurich, Switzerland, and Chicago, USA using an approach that combines multimedia mass balance modeling and measurement data. Our modeled per-capita emission estimates for Banja Luka are lower by a factor of ten than those for Zurich and Chicago, which are similar. This indicates that the sources of PCB emissions in Banja Luka are likely to be weaker than in the Western European and North American cities which show relatively high PCB emissions. Our emission rates from the three cities agree within a factor of ten with emission estimates from a global PCB emission inventory derived from production and usage estimates and emission factors. Environmental Pollution, 2010, V158, N10, OCT, pp 3230-3235 DOI: http://dx.doi.org/10.1016/j.envpol.2010.07.011.

11.1-16
Assessing the impact of weather events at mid-latitudes on the atmospheric transport of chemical pollutants using a 2-dimensional multimedia meteorological model
Gasic B, Macleod M, Scheringer M, Hungerbühler K
Switzerland
Meteorology & Atmospheric Sciences, Modelling
We investigate the long-range transport potential (LRTP) of five different classes of hypothetical chemical pollutants (volatile, multimedia, semivolatile, particle-associated and hydrophilic) during a low pressure weather event using a novel 2 (x- and z-axis)-Dimensional Multi-Media Meteorological Model (2D4M). The atmosphere (z-axis) is described by three atmospheric layers, where two layers constitute the boundary layer and the third layer the free troposphere. The 2D4M can describe distinct weather events on a regional scale and calculate the LRTP of chemicals as a function of time during these events. Four weather factors are used to model weather events and their influence on the atmospheric transport of chemicals: (1) temperature, (2) wind speed and mixing dynamics of the troposphere, (3) hydroxyl radical concentrations and (4) precipitation. We have modeled the impact of variability in each of these factors on LRTP of pollutants during a front event associated with a low pressure period that interrupts a dominant high pressure system. The physico-chemical properties of the pollutant determine which specific weather factors contribute most to variability in transport potential during the event. Volatile and multimedia chemicals are mainly affected by changing atmospheric mixing conditions, wind speeds and OH radical concentrations, while semivolatile substances are also affected by temperature. Low-vapor-pressure pollutants that are particle-associated, and water-soluble pollutants are most strongly affected by precipitation. Some chemical pollutants are efficiently transported from the boundary layer into the upper troposphere during the modeled low pressure event and are transported by much higher wind speeds than in the boundary layer. Our model experiments show that the transport potential of volatile, multimedia and semivolatile compounds is significantly increased during a front event as a result of efficient tropospheric mixing and fast wind speeds in the upper troposphere, whereas low-volatility and hydrophilic chemicals are largely scavenged from the atmosphere. In future LRTP assessment of chemical contaminants as required by the Stockholm Convention and the convention on long-range transboundary air pollution, it is therefore advised to prioritize volatile, multimedia and semivolatile chemicals that are identified in initial screening. Atmospheric Environment, 2010, V44, N35, NOV, pp 4489-4496 DOI: http://dx.doi.org/10.1016/j.atmosenv.2010.07.016.

11.1-17
Stratosphere-troposphere coupling and annular mode variability in chemistry-climate models
USA, Japan, France, England, Germany, Finland, New Zealand, Switzerland, Canada
Meteorology & Atmospheric Sciences, Modelling
The internal variability and coupling between the stratosphere and troposphere in CCMVal-2 chemistry-climate models are evaluated through analysis of the annular mode patterns of variability. Computation of the annular modes in long data sets with secular trends requires refinement of the standard definition of the annular mode, and a more robust procedure that allows for slowly varying trends is established and verified. The spatial and temporal structure of the models’ annular modes is then compared with that of reanalyses. As a whole, the models capture the key features of observed intraseasonal variability, including the sharp vertical gradients in structure between stratosphere and troposphere, the asymmetries in the seasonal cycle between the Northern and Southern hemispheres, and the coupling between the polar stratospheric vortices and tropospheric midlatitude jets. It is also found that the annular mode variability changes little in time throughout simulations of the 21st century. There are, however, both common biases and significant differences in performance in the models. In the troposphere, the annular mode in models is generally too persistent, particularly in the Southern Hemisphere summer, a bias similar to that found in CMIP3 coupled climate models. In the stratosphere, the periods of peak variance and coupling with the troposphere are delayed by about a month in both hemispheres. The relationship between increased variability of the stratosphere and increased persistence in the troposphere suggests that some tropospheric biases may be related to stratospheric biases and that a well-simulated stratosphere can improve simulation of tropospheric intraseasonal variability.


11.1-18

Multimodel assessment of the upper troposphere and lower stratosphere: Tropics and global trends


USA, Canada, Japan, Germany, Spain, France, England, Italy, New Zealand, Switzerland

Meteorology & Atmospheric Sciences, Modelling

The performance of 18 coupled Chemistry Climate Models (CCMs) in the Tropical Tropopause Layer (TTL) is evaluated using qualitative and quantitative diagnostics. Trends in tropopause quantities in the tropics and the extratropical Upper Troposphere and Lower Stratosphere (UTLS) are analyzed. A quantitative grading methodology for evaluating CCMs is extended to include variability and used to develop four different grades for tropical tropopause temperature and pressure, water vapor and ozone. Four of the 18 models and the multi-model mean meet quantitative and qualitative standards for reproducing key processes in the TTL. Several diagnostics are performed on a subset of the models analyzing the Tropopause Inversion Layer (TIL), Lagrangian cold point and TTL transit time. Historical decreases in tropical tropopause pressure and decreases in water vapor are simulated, lending confidence to future projections. The models simulate continued decreases in tropopause pressure in the 21st century, along with similar to 1K increases per century in cold point tropopause temperature and 0.5-1 ppmv per century increases in water vapor above the tropical tropopause. TTL water vapor increases below the cold point. In two models, these trends are associated with 35% increases in TTL cloud fraction. These changes indicate significant perturbations to TTL processes, specifically to deep convective heating and humidity transport. Ozone in the extratropical lowermost stratosphere has significant and hemispheric asymmetric trends. O-3 is projected to increase by nearly 30% due to ozone recovery in the Southern Hemisphere (SH) and due to enhancements in the stratospheric circulation. These UTLS ozone trends may have significant effects in the TTL and the troposphere.


11.1-19

Diurnal Fluctuations in Polybrominated Diphenyl Ether Concentrations During and After a Severe Dust Storm Episode in Kuwait City, Kuwait

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Meteorology & Atmospheric Sciences, Urban Studies

Concentrations of polybrominated diphenyl ethers (PBDEs) were quantified in four-hour integrated air samples obtained serially over a five day period in May 2007 in Kuwait City during and after a severe dust storm. The Sigma PBDE concentrations ranged from 51 to 1307 pg m(-3) for the first two days of...
sampling and 20 to 148 pg m m (-3) for the rest of the sampling period. The first two days of sampling occurred during a severe dust storm episode when the total suspended particulates (TSP) in air exceeded 10000 pg/m(3) with concentrations peaking during the day and decreasing at night. During this dust episode, the peak nighttime PBDE concentration was 30 times higher than the minimum daytime concentration. Although Sigma PBDE concentrations peaked at night during the first two sampling days, the fluctuations in the BDE 47:99 ratio tracked changes in ambient temperature remarkably well, following a clear diurnal pattern. The fraction of congeners in the gas phase varied inversely with solar flux and was lower on days with a high number of hours of sunshine, suggesting that photolytic degradation of gas-phase PBDEs was occurring.


11.1-20

**What can be learned about carbon cycle climate feedbacks from the CO2 airborne fraction?**

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*Meteorology & Atmospheric Sciences, Modelling, Energy & Fuels*

The ratio of CO2 accumulating in the atmosphere to the CO2 flux into the atmosphere due to human activity, the airborne fraction AF, is central to predict changes in earth’s surface temperature due to greenhouse gas induced warming. This ratio has remained remarkably constant in the past five decades, but recent studies have reported an apparent increasing trend and interpreted it as an indication for a decrease in the efficiency of the combined sinks by the ocean and terrestrial biosphere. We investigate here whether this interpretation is correct by analyzing the processes that control long-term trends and decadal-scale variations in the AF. To this end, we used simplified linear models for describing the processes that control long-term trends and interpreted it as an indication for a decreasing long-term trend in the carbon sink efficiency over the last few decades are currently not supported by atmospheric CO2 data and anthropogenic emissions estimates.

*Atmospheric Chemistry and Physics, 2010, V10, N16, pp 7739-7751 DOI: http://dx.doi.org/10.5194/acp-10-7739-2010.*

11.1-21

**Airborne Particles in the Urban Environment**

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Switzerland, Germany, France

*Meteorology & Atmospheric Sciences, Energy & Fuels, Urban Studies, Human & Public Health*

Particulate matter is an important constituent of our atmosphere and has a critical impact on natural processes and human health. Although they are a minor component of the average global mass flux, anthropogenic particles are abundant in the urban environment, where they contribute substantially to air pollution. Particulate matter is routinely monitored in urban areas, but different particle types can be distinguished only by combining single-particle chemical analysis with bulk analysis of trace elements and measurement of isotope ratios. Such chemical tracers also allow for source identification and thus for targeted mitigation of anthropogenic particle pollution.

*Elements, 2010, V6, N4, AUG, pp 229-234 DOI: http://dx.doi.org/10.2113/gselements.6.4.229.*

11.1-22

**EC-Earth A Seamless Earth-System Prediction Approach in Action**


Netherlands, Ireland, England, Denmark, Sweden, Portugal, Spain, France, Switzerland, Belgium

Multimodel assessment of the upper troposphere and lower stratosphere: Extratropics


Canada, Japan, Spain, USA, Germany, France, England, Italy, New Zealand, Switzerland

Meteorology & Atmospheric Sciences, Modelling

A multimodel assessment of the performance of chemistry-climate models (CCMs) in the extratropical upper troposphere/lower stratosphere (UTLS) is conducted for the first time. Process-oriented diagnostics are used to validate dynamical and transport characteristics of 18 CCMs using meteorological analyses and aircraft and satellite observations. The main dynamical and chemical climatological characteristics of the extratropical UTLS are generally well represented by the models, despite the limited horizontal and vertical resolution. The seasonal cycle of lowermost stratospheric mass is realistic, however with a wide spread in its mean value. A tropopause inversion layer is present in most models, although the maximum in static stability is located too high above the tropopause and is somewhat too weak, as expected from limited model resolution. Similar comments apply to the extratropical tropopause transition layer. The seasonality in lower stratospheric chemical tracers is consistent with the seasonality in the Brewer-Dobson circulation. Both vertical and meridional tracer gradients are of similar strength to those found in observations. Models that perform less well tend to use a semi-Lagrangian transport scheme and/or have a very low resolution. Two models, and the multimodel mean, score consistently well on all diagnostics, while seven other models score well on all diagnostics except the seasonal cycle of water vapor. Only four of the models are consistently below average. The lack of tropospheric chemistry in most models limits their evaluation in the upper troposphere. Finally, the UTLS is relatively sparsely sampled by observations, limiting our ability to quantitatively evaluate many aspects of model performance.


Influence of a future climate on the micro- and optical properties of orographic cirrus clouds in ECHAM5

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Meteorology & Atmospheric Sciences, Modelling

The European Centre/Hamburg 5 (ECHAM5) general circulation model is used in order to investigate the influence of a warmer climate on the microphysical and optical properties of orographic cirrus clouds. The main goal of this study is to highlight the variety of processes influencing the formation of orographic cirrus and to emphasize the importance of coupling dynamics and cloud microphysics in order to provide realistic predictions of the influence of a future climate on cloud microphysical and radiative properties. Therefore, a coupling of gravity wave dynamics and cloud microphysics is implemented in the model. The influence of additional moisture on the propagation of gravity waves is investigated by using the dry and moist Brunt-Väisälä frequency in the calculation of the gravity wave-induced vertical velocity in two different simulations. In both simulations, the vertical velocities increase in the warmer climate. The additional moisture decreases the Brunt-Väisälä frequencies leading to less flow blocking and thus higher effective mountain heights. As this effect dominates over the decrease of the gravity wave amplitude due to more moisture, higher vertical velocities occur in a future climate. The opposite effect of a decreased vertical velocity in a future climate can be seen over the dry regions. From the present to the future climate, the ice crystal number concentration decreases despite the increased vertical velocities. Higher temperatures lead to a faster growth of the ice crystals, and the supersaturation is depleted faster such that no new crystals can be formed. The ice water content increases as more water vapor is available in a warmer climate. The net effect of a decreased ice crystal number concentration and an increased ice content is an increased optical depth in a future climate. This result is in good agreement with recent cloud resolving studies. The effect of orographic cirrus clouds on the radiation is given by an increased short- and long-wave cloud forcing, whereas the latter dominates. However, from the present to the future climate, no changes in orographic cloud cover and cloud forcing over mountains can be seen.

11.1-25
A high-resolution mass spectrometer to measure atmospheric ion composition
Finland, Switzerland, USA
Meteorology & Atmospheric Sciences
In this paper we present recent achievements on developing and testing a tool to detect the composition of ambient ions in the mass /charge range up to 2000 Th. The instrument is an Atmospheric Pressure Interface Time-of-Flight Mass Spectrometer (APi-TOF, Tofwerk AG). Its mass accuracy is better than 0.002%, and the mass resolving power is 3000 Th/Th. In the data analysis, a new efficient Matlab based set of programs (tofTools) were developed, tested and used. The APi-TOF was tested both in laboratory conditions and applied to outdoor air sampling in Helsinki at the SMEAR III station. Transmission efficiency calibrations showed a throughput of 0.1-0.5% in the range 100-1300 Th for positive ions, and linearity over 3 orders of magnitude in concentration was determined. In the laboratory tests the APi-TOF detected sulphuric acid-ammonia clusters in high concentration from a nebulised sample illustrating the potential of the instrument in revealing the role of sulphuric acid clusters in atmospheric new particle formation. The APi-TOF features a high enough accuracy, resolution and sensitivity for the determination of the composition of atmospheric small ions although the total concentration of those ions is typically only 400-2000 cm$^{-3}$. The atmospheric ions were identified based on their exact masses, utilizing Kendrick analysis and correlograms as well as narrowing down the potential candidates based on their proton affinities as well isotopic patterns. In Helsinki during daytime the main negative ambient small ions were inorganic acids and their clusters. The positive ions were more complex, the main compounds were (poly) alkyl pyridines and - amines. The APi-TOF provides a near universal interface for atmospheric pressure sampling, and this key feature will be utilized in future laboratory and field studies.

11.1-26
Measured and modelled cloud condensation nuclei number concentration at the high alpine site Jungfraujoch
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Switzerland
Meteorology & Atmospheric Sciences
Atmospheric aerosol particles are able to act as cloud condensation nuclei (CCN) and are therefore important for the climate and the hydrological cycle, but their properties are not fully understood. Total CCN number concentrations at 10 different supersaturations in the range of SS=0.12-1.18% were measured in May 2008 at the remote high alpine research station, Jungfraujoch, Switzerland (3580 m a.s.l.). In this paper, we present a closure study between measured and predicted CCN number concentrations. CCN predictions were done using dry number size distribution (scanning particle mobility sizer, SMPS) and bulk chemical composition data (aerosol mass spectrometer, AMS, and multi-angle absorption photometer, MAAP) in a simplified Kohler theory. The predicted and the measured CCN number concentrations agree very well and are highly correlated. A sensitivity study showed that the temporal variability of the chemical composition at the Jungfraujoch can be neglected for a reliable CCN prediction, whereas it is important to know the mean chemical composition. The exact bias introduced by using a too low or too high hygroscopicity parameter for CCN prediction was further quantified and shown to be substantial for the lowest supersaturation. Despite the high average organic mass fraction (similar to 45%) in the fine mode, there was no indication that the surface tension was substantially reduced at the point of CCN activation. A comparison between hygroscopicity tandem differential mobility analyzer (HTDMA), AMS/MAAP, and CCN derived kappa values showed that HTDMA measurements can be used to determine particle hygroscopicity required for CCN predictions if no suitable chemical composition data are available.
Atmospheric Chemistry and Physics, 2010, V10, N16, pp 7891-7906 DOI: http://dx.doi.org/10.5194/acp-10-7891-2010.
11.1-27
Chemical composition of ambient aerosol, ice residues and cloud droplet residues in mixed-phase clouds: single particle analysis during the Cloud and Aerosol Characterization Experiment (CLACE 6)

Germany, Switzerland
Meteorology & Atmospheric Sciences, Remote Sensing

Two different single particle mass spectrometers were operated in parallel at the Swiss High Alpine Research Station Jungfraujoch (JFJ, 3580 m a.s.l.) during the Cloud and Aerosol Characterization Experiment (CLACE 6) in February and March 2007. During mixed phase cloud events ice crystals from 5-20µm were separated from larger ice aggregates, non-activated, interstitial aerosol particles and supercooled droplets using an Ice-Countercflow Virtual Impactor (Ice-CVI). During one cloud period supercooled droplets were additionally sampled and analyzed by changing the Ice-CVI setup. The small ice particles and droplets were evaporated by injection into dry air inside the Ice-CVI. The resulting ice and droplet residues (IR and DR) were analyzed for size and composition by the two single particle mass spectrometers: a custom-built Single Particle Laser-Ablation Time-of-Flight Mass Spectrometer (SPLAT) and a commercial Aerosol Time-of-Flight Mass Spectrometer (ATOFMS, TSI Model 3800). During CLACE 6 the SPLAT instrument characterized 335 individual IR that produced a mass spectrum for at least one polarity and the ATOFMS measured 152 IR. The mass spectra were binned in classes, based on the combination of dominating substances, such as mineral dust, sulfate, potassium and elemental carbon or organic material. The derived chemical information from the ice residues is compared to the JFJ ambient aerosol that was sampled while the measurement station was out of clouds (several thousand particles analyzed by SPLAT and ATOFMS) and to the composition of the residues of supercooled cloud droplets (SPLAT: 162 cloud droplet residues analyzed, ATOFMS: 1094). The measurements showed that mineral dust was strongly enhanced in the ice particle residues. Close to all of the SPLAT spectra from ice residues did contain signatures from mineral compounds, albeit connected with varying amounts of soluble compounds. Similarly, close to all of the ATOFMS IR spectra show a mineral or metallic component. Pure sulfate and nitrate containing particles were depleted in the ice residues. Sulfate and nitrate was found to dominate the droplet residues (similar to 90% of the particles). The results from the two different single particle mass spectrometers were generally in agreement. Differences in the results originate from several causes, such as the different wavelength of the desorption and ionisation lasers and different size-dependent particle detection efficiencies.

Atmospheric Chemistry and Physics, 2010, V10, N16, pp 8077-8095 DOI: http://dx.doi.org/10.5194/acp-10-8077-2010.

11.1-28
The effect of the global UV irradiance measurement accuracy on the single scattering albedo retrieval

Kazadzis S, Gröbner J, Arola A, Amiridis V
Greece, Switzerland, Finland
Meteorology & Atmospheric Sciences, Modelling, Remote Sensing

The possibility of measuring aerosol optical absorption properties in the UV spectral range such as single scattering albedo (SSA), using remote sensing techniques, is currently an open scientific issue. We investigate the limitations in calculating column average SSA using a combination of global UV spectral measurements (that are common in various UV monitoring stations worldwide) with radiative transfer modeling. To point out the difficulties in such a retrieval we have used the travelling reference spectroradiometer QASUME (Quality Assurance of Spectral Ultraviolet Measurements in Europe) results from 27 visits to UV monitoring stations around Europe. We have used the QASUME instrument as relative reference, analyzing absolute differences and also temporal and spectral deviations of UV irradiances, that are used as basic input for the SSA retrieval. The results comparing the mean SSA derived by all instruments, measuring synchronous UV spectra, showed that 5 were within +/-0.02 difference from the SSA calculated from the QASUME instrument, while 17 were within +/-0.04, for the Solar zenith angle of 60 degrees. As for the uncertainty that has been calculated using the 2 sigma standard deviation of the spectral measurements, a mean 0.072 and 0.10 (2 degrees). As for the uncertainty that has been calculated for 60 degrees and 30 degrees, respectively. Based on the fact that additional uncertainties would be introduced in the SSA retrieval from AOD model input accuracy, asymmetry parameter assumptions, we show that only very few instruments could be able to detect long term SSA changes. However, such measurements/results ar useful in order to retrieve SSA at UV wavelengths, a product needed for various applications such as, inputs for modeling radiative forcing studies and satellite retrieval algorithms.

11.1-29
The inter-comparison of major satellite aerosol retrieval algorithms using simulated intensity and polarization characteristics of reflected light


Germany, France, USA, England, Wales, Byelarus, Switzerland, Japan

Meteorology & Atmospheric Sciences, Remote Sensing, Modelling

Remote sensing of aerosol from space is a challenging and typically underdetermined retrieval task, requiring many assumptions to be made with respect to the aerosol and surface models. Therefore, the quality of a priori information plays a central role in any retrieval process (apart from the cloud screening procedure and the forward radiative transfer model, which to be most accurate should include the treatment of light polarization and molecular-aerosol coupling). In this paper the performance of various algorithms with respect to the of spectral aerosol optical thickness determination from optical spaceborne measurements is studied. The algorithms are based on various types of measurements (spectral, angular, polarization, or some combination of these). It is confirmed that multangular spectropolarimetric measurements provide more powerful constraints compared to spectral intensity measurements alone, particularly those acquired at a single view angle and which rely on a priori assumptions regarding the particle phase function in the retrieval process.


11.1-30 Impact of Manaus City on the Amazon Green Ocean atmosphere: ozone production, precursor sensitivity and aerosol load


Germany, Italy, England, Brazil, Zimbabwe, Switzerland

Meteorology & Atmospheric Sciences, Urban Studies, Energy & Fuels, Modelling

As a contribution to the Large-Scale Biosphere-Atmosphere Experiment in Amazonia - Cooperative LBA Airborne Regional Experiment (LBA-CLAIRE-2001) field campaign in the heart of the Amazon Basin, we analyzed the temporal and spatial dynamics of the urban plume of Manaus City during the wet-to-dry season transition period in July 2001. During the flights, we performed vertical stacks of crosswind transects in the urban outflow downwind of Manaus City, measuring a comprehensive set of trace constituents including O-3, NO, NO2, CO, VOC, CO2, and H2O. Aerosol loads were characterized by concentrations of total aerosol number (CN) and cloud condensation nuclei (CCN), and by light scattering properties. Measurements over pristine rainforest areas during the campaign showed low levels of pollution from biomass burning or industrial emissions, representative of wet season background conditions. The urban plume of Manaus City was found to be joined by plumes from power plants south of the city, all showing evidence of very strong photochemical ozone formation. One episode is discussed in detail, where a threefold increase in ozone mixing ratios within the atmospheric boundary layer occurred within a 100 km travel distance downwind of Manaus. Observation-based estimates of the ozone production rates in the plume reached 15 ppb h(-1). Within the plume core, aerosol concentrations were strongly enhanced, with Delta CN/Delta CO ratios about one order of magnitude higher than observed in Amazon biomass burning plumes. Delta CN/Delta CO ratios tended to decrease with increasing transport time, indicative of a significant reduction in particle number by coagulation, and without substantial new particle nucleation occurring within the time-space observed. While in the background atmosphere a large fraction of the total particle number served as CCN (about 60-80% at 0.6% supersaturation), the CCN/CN ratios within the plume indicated that only a small fraction (16 +/- 12 %) of the plume particles were CCN. The fresh plume aerosols showed relatively weak light scattering efficiency. The CO-normalized CCN concentrations and light scattering coefficients increased with plume age in most cases, suggesting particle growth by condensation of soluble organic or inorganic species. We used a Single Column Chemistry and Transport Model (SCM) to infer the urban pollution emission fluxes of Manaus City, implying observed mixing ratios of CO, NOx and VOC. The model can reproduce the temporal/spatial distribution of ozone enhancements in the Manaus plume, both with and without accounting for the distinct (high NOx) contribution by the power plants; this way examining the sensitivity of ozone production to changes in the emission rates of NOx. The VOC reactivity in the Manaus region was dominated by a
high burden of biogenic isoprene from the background rainforest atmosphere, and therefore NOx control is assumed to be the most effective ozone abatement strategy. Both observations and models show that the agglomeration of NOx emission sources, like power plants, in a well-arranged area can decrease the ozone production efficiency in the near field of the urban populated cores. But on the other hand remote areas downwind of the city then bear the brunt, being exposed to increased ozone production and N-deposition. The simulated maximum stomatal ozone uptake fluxes were 4 nmol m(-2) s(-1) close to Manaus, and decreased only to about 2 nmol m(-2) s(-1) within a travel distance >1500 km downwind from Manaus, clearly exceeding the critical threshold level for broad-leaf trees. Likewise, the simulated N deposition close to Manaus was similar to 70 kg N ha(-1) a(-1) decreasing only to about 30 kg N ha(-1) a(-1) after three days of simulation. Atmospheric Chemistry and Physics, 2010, V10, N19, pp 9251-9282 DOI: http://dx.doi.org/10.5194/acp-10-9251-2010.

11.1-31 Impact of Surface Flux Formulations and Geostrophic Forcing on Large- Eddy Simulations of Diurnal Atmospheric Boundary Layer Flow Kumar V, Svensson G, Holtslag A A M, Meneveau C, Parlange M B USA, Sweden, Netherlands, Switzerland Meteorology & Atmospheric Sciences, Modelling The impact of surface flux boundary conditions and geostrophic forcing on multiday evolution of flow in the atmospheric boundary layer (ABL) was assessed using large-eddy simulations (LES). The LES investigations included several combinations of surface boundary conditions (temperature and heat flux) and geostrophic forcing (constant, time varying, time and height varying). The setup was based on ABL characteristics observed during a selected period of the Cooperative Atmosphere-Surface Exchange Study-1999 (CASES-99) campaign. The LES cases driven by a constant geostrophic wind achieved the best agreement with the CASES-99 observations specifically in terms of daytime surface fluxes and daytime and nighttime profiles. However, the nighttime fluxes were significantly overestimated. The LES cases with the surface temperature boundary condition and driven by a time- and height- varying geostrophic forcing showed improved agreement with the observed nighttime fluxes, but there was less agreement with other observations (e.g., daytime profiles). In terms of the surface boundary condition, the LES cases driven by either surface temperature or heat fluxes produced similar trends in terms of the daytime profiles and comparisons with data from soundings. However, in reproducing the fluxes and nighttime profiles, the agreement was better with imposed temperature because of its ability to interact dynamically with the air temperature field. Therefore, it is concluded that surface temperature boundary condition is better suited for simulations of temporally evolving ABL flow as in the diurnal evolution of the ABL. Journal of Applied Meteorology and Climatology, 2010, V49, N7, JUL, pp 1496-1516 DOI: http://dx.doi.org/10.1175/2010JAMC2145.1.

11.1-32 Cloud albedo increase from carbonaceous aerosol Leaitch W R, Lohmann U, Russell L M, Garrett T, Shantz N C, Toom Sauntry D, Strapp J W, Hayden K L, Marshall J, Wolde M, Worsnop D R, Jayne J T Canada, Switzerland, USA, Germany Meteorology & Atmospheric Sciences, Modelling Airborne measurements from two consecutive days, analysed with the aid of an aerosol-adiabatic cloud parcel model, are used to study the effect of carbonaceous aerosol particles on the reflectivity of sunlight by water clouds. The measurements, including aerosol chemistry, aerosol microphysics, cloud microphysics, cloud gust velocities and cloud light extinction, were made below, in and above stratocumulus over the northwest Atlantic Ocean. On the first day, the history of the below-cloud fine particle aerosol was marine and the fine particle sulphate and organic carbon mass concentrations measured at cloud base were 2.4µg m(-3) and 0.9µg m(-3) respectively. On the second day, the below-cloud aerosol was continually influenced and the fine particle sulphate and organic carbon mass concentrations were 2.3µg m(-3) and 2.6µg m(-3) respectively. Over the range 0.06-0.8µm diameter, the shapes of the below-cloud size distributions were similar on both days and the number concentrations were approximately a factor of two higher on the second day. The cloud droplet number concentrations (CDNC) on the second day were approximately three times higher than the CDNC measured on the first day. Using the parcel model to separate the influence of the differences in gust velocities, we estimate from the vertically integrated cloud light scattering measurements a 6% increase in the cloud albedo principally due to the increase in the carbonaceous components on the second day. Assuming no additional absorption by this aerosol, a 6% albedo increase translates to a local daytime radiative cooling of similar to 12 W m(-2). This result provides observational evidence.
that the role of anthropogenic carbonaceous components in the cloud albedo effect can be much larger than that of anthropogenic sulphate, as some global simulations have indicated. Atmospheric Chemistry and Physics, 2010, V10, N16, pp 7669-7684 DOI: http://dx.doi.org/10.5194/acp-10-7669-2010.

11.1-33
Single particle characterization of black carbon aerosols at a tropospheric alpine site in Switzerland
England, Switzerland, Germany
Meteorology & Atmospheric Sciences

The refractory black carbon (rBC) mass, size distribution (190-720 nm) and mixing state in sub-micron aerosols were characterized from late February to March 2007 using a single particle incandescence method at the high alpine research station Jungfraujoch (JFJ), Switzerland (46.33 degrees N, 7.59 degrees E, 3580 m a.s.l.). JFJ is a ground based location, which is at times exposed to continental free tropospheric air. A median mass absorption coefficient (MAC) of 10.2±3.2 m(2) g(-1) at gamma = 630 nm was derived by comparing single particle incandescence measurements of black carbon mass with continuous measurements of absorption coefficient. This value is comparable with other estimates at this location. The aerosols measured at the site were mostly well mixed and aged during transportation via the free troposphere. Pollutant sources were traced by air mass back trajectories, trace gases concentrations and the mass loading of rBC. In southeasterly wind directions, mixed or convective weather types provided the potential to vent polluted boundary layer air from the southern Alpine area and industrial northern Italy, delivering enhanced rBC mass loading and CN concentrations to the JFJ. The aerosol loadings at this site were also significantly influenced by precipitation, which led to the removal of rBC from the atmosphere. Precipitation events were shown to remove about 65% of the rBC mass from the free tropospheric background reducing the mean loading from 13±5 ng m(-3) to 6±2 ng m(-3) (corrected to standard temperature and pressure). Overall, 40±15% of the observed rBC particles within the detectable size range were mixed with large amounts of non-refractory materials present as a thick coating. The growth of particle size into the accumulation mode was positively linked with the degree of rBC mixing, suggesting the important role of condensable materials in increasing particle size and leading to enhanced internal mixing of these materials with rBC. It is the first time that BC mass, size distribution and mixing state are reported in the free troposphere over Europe. These ground based measurements also provide the first temporal study of rBC in the European free troposphere quantitatively measured by single particle methods. At the present time there is only limited information of BC and its mixing state in the free troposphere, especially above Europe. The results reported in this paper provide an important constraint on modelled representation of BC. Atmospheric Chemistry and Physics, 2010, V10, N15, pp 7389-7407 DOI: http://dx.doi.org/10.5194/acp-10-7389-2010.

11.1-34
Regional climate change patterns identified by cluster analysis
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Switzerland
Meteorology & Atmospheric Sciences, Modelling

Climate change caused by anthropogenic greenhouse emissions leads to impacts on a global and a regional scale. A quantitative picture of the projected changes on a regional scale can help to decide on appropriate mitigation and adaptation measures. In the past, regional climate change results have often been presented on rectangular areas. But climate is not bound to a rectangular shape and each climate variable shows a distinct pattern of change. Therefore, the regions over which the simulated climate change results are aggregated should be based on the variable(s) of interest, on current mean climate as well as on the projected future changes. A cluster analysis algorithm is used here to define regions encompassing a similar mean climate and similar projected changes. The number and the size of the regions depend on the variable(s) of interest, the local climate pattern and on the uncertainty introduced by model disagreement. The new regions defined by the cluster analysis algorithm include information about regional climatic features which can be of a rather small scale. Comparing the regions used so far for large scale regional climate change studies and the new regions it can be shown that the spatial uncertainty of the projected changes of different climate variables is reduced significantly, i.e. both the mean climate and the expected changes are more consistent within one region and therefore more representative for local impacts. Climate Dynamics, 2010, V35, N4, SEP, pp 587-600 DOI: http://dx.doi.org/10.1007/s00382-009-0654-0.
11.1-35  
**Effect of radar-rainfall uncertainties on the spatial characterization of rainfall events**  
Mandapaka P V, Villarini G, Seo B C, Krajewski W F  
USA, Switzerland  
Hydrology, Meteorology & Atmospheric Sciences, Remote Sensing, Modelling  
Remotely sensed precipitation products, due to their large areal coverage and high resolution, have been widely used to provide information on the spatiotemporal structure of rainfall. However, it is well known that these precipitation products also suffer from large uncertainties that originate from various sources. In this study, we selected radar-rainfall (RR) data corresponding to 10 warm season events over a 256 x 256 km² domain with a data resolution of 4 x 4 km² in space and 1 h in time. We characterized their spatial structure using correlation function, power spectrum, and moment scaling function. We then employed a recently developed RR error model and rainfall generator to obtain an ensemble of probable rainfall fields that are consistent with the RR estimation error structure. We parameterized the spatial correlation functions with a two-parameter power exponential function, the Fourier spectra with a power law function, and the moment scaling functions with the universal multifractal model. The parameters estimated from the ensemble were compared with those obtained from the RR products to quantify the impact of radar-rainfall estimation errors on the spatial characterization of rainfall events. From the spatial correlation and power spectrum analyses, we observed that RR estimation uncertainties introduce spurious correlations with greater impact for the smaller scales. The RR errors also significantly bias the estimation of the moment scaling functions.  

11.1-36  
**EUCAARI ion spectrometer measurements at 12 European sites - analysis of new particle formation events**  
Finland, Estonia, Germany, Hungary, Netherlands, Greece, Ireland, Sweden, Italy, France, Switzerland  
Meteorology & Atmospheric Sciences  
We present comprehensive results on continuous atmospheric cluster and particle measurements in the size range similar to 1-42 nm within the European Integrated project on Aerosol Cloud Climate and Air Quality interactions (EUCAARI) project. We focused on characterizing the spatial and temporal variation of new particle formation events and relevant particle formation parameters across Europe. Different types of air ion and cluster mobility spectrometers were deployed at 12 field sites across Europe from March 2008 to May 2009. The measurements were conducted in a wide variety of environments, including coastal and continental locations as well as sites at different altitudes (both in the boundary layer and the free troposphere). New particle formation events were detected at all of the 12 field sites during the year-long measurement period. From the data, nucleation and growth rates of newly formed particles were determined for each environment. In a case of parallel ion and neutral cluster measurements, we could also estimate the relative contribution of ion-induced and neutral nucleation to the total particle formation. The formation rates of charged particles at 2 nm accounted for 1-30% of the corresponding total particle formation rates. As a significant new result, we found out that the total particle formation rate varied much more between the different sites than the formation rate of charged particles. This work presents, so far, the most comprehensive effort to experimentally characterize nucleation and growth of atmospheric molecular clusters and nanoparticles at ground-based observation sites on a continental scale.  
*Atmospheric Chemistry and Physics, 2010, V10, N16, pp 7907-7927 DOI: http://dx.doi.org/10.5194/acp-10-7907-2010.*

11.1-37  
**A liquid nitrogen-free preconcentration unit for measurements of ambient N₂O isotopomers by QCLAS**  
Switzerland, Japan  
Meteorology & Atmospheric Sciences  
Important information about the biogeochemical cycle of nitrous oxide (N₂O) can be obtained by measuring its three main isotopic species, 14N15N16O, 15N14N16O, and 14N14N16O, and
the respective site-specific relative isotope ratio differences \( \delta_{15N}(\alpha) \) and \( \delta_{15N}(\beta) \). Absorption laser spectroscopy in the mid-infrared is a direct method for the analysis of the 15N isotopic composition of \( N_2O \), yet not sensitive enough for atmospheric \( N_2O \) mixing ratios (320 ppb). To enable a fully-automated high precision analysis of \( N_2O \) isotopic species at ambient mixing ratios, we built and optimized a liquid nitrogen-free pre-concentration unit to be coupled to a quantum cascade laser (QCL) based spectrometer. During standard operation 10 l of ambient air are preconcentrated on a HayeSep D trap and desorbed in 50 ml of synthetic air. Rigorous tests were conducted, using FTIR, quantum cascade laser absorption spectroscopy (QCLAS), GC-FID and component-specific ozone and oxygen analysers to investigate recovery rates, conservation of isotopic signatures and spectral interferences after preconcentration. We achieve quantitative \( N_2O \) recovery of \( >99\% \) with only minor, statistically not significant isotopic fractionation and no relevant spectral interferences from other atmospheric constituents. The developed preconcentration unit also has the potential to be applied to other trace gases and their isotopic composition.


11.1.38 The Modulation of the Subtropical and Extratropical Atmosphere in the Pacific Basin in Response to the Madden-Julian Oscillation

Moore R W, Martius O, Spengler T
Switzerland
Meteorology & Atmospheric Sciences, Modelling

The 40-yr ECMWF Re-Analysis (ERA-40) data are combined with a number of novel climatologies to conduct a comprehensive examination of the response of the subtropical and extratropical atmosphere over the Pacific basin to an evolving Madden-Julian oscillation (MJO) event. The adopted approach constitutes a symbiosis of a climatological analysis during the Northern Hemisphere winter from 1979 to 2002 and a case study analysis of a distinct MJO event that occurred in January-February 1993. The former is designed to obtain the general characteristics observed during a composite MJO life cycle, while the latter is used to provide insight into the instantaneous mechanisms responsible for the observed composite evolution. A primary component of the study involves the diagnosis of anomalous wave breaking activity in response to MJO forcing in the form of tropical convection and/or upper-level divergence. Wave breaking events are separated by their characteristic life cycles: LC1 (anticyclonic) and LC2 (cyclonic) events. Statistically significant anomalies in wave breaking activity are found to be prevalent during the composite MJO event. Furthermore, the dynamical distinction between LC1 and LC2 wave breaking is useful in that the two different characteristic life cycles exhibit significantly different anomalous behavior during the MJO. Statistically significant variability is also identified in both the subtropical and extratropical flow and atmospheric blocking and surface cyclone frequency. These data, taken in conjunction with the observed evolution of the 1993 MJO event, provide a relatively coherent picture of the response of the atmosphere to MJO forcing. A schematic representation of the evolution is presented.


11.1.39 Review of the formulation of present-generation stratospheric chemistry-climate models and associated external forcings

New Zealand, Germany, Japan, USA, Canada, France, England, Italy, Switzerland
Meteorology & Atmospheric Sciences, Modelling

The goal of the Chemistry-Climate Model Validation (CCMVal) activity is to improve understanding of chemistry-climate models (CCMs) through process-oriented evaluation and to provide reliable projections of stratospheric ozone and its impact on climate. An appreciation of the details of model formulations is essential for understanding how models respond to the changing external forcings of greenhouse gases and ozone-depleting substances, and hence for understanding the ozone and climate forecasts produced by the models participating in this activity. Here we introduce and review the models used for the second round (CCMVal-2) of this intercomparison, regarding the implementation of chemical, transport, radiative, and dynamical processes in these models. In particular, we review the advantages and problems associated with approaches used to model pro-
Increasing aerosol number concentrations is hypothesized to retard the cloud droplet coalescence and the riming in mixed-phase clouds, thereby decreasing orographic precipitation. This study presents results from a model intercomparison of 2-D simulations of aerosol-cloud-precipitation interactions in stratiform orographic mixed-phase clouds. The sensitivity of orographic precipitation to changes in the aerosol number concentrations is analysed and compared for various dynamical and thermodynamical situations. Furthermore, the sensitivities of microphysical processes such as coalescence, aggregation, riming and diffusional growth to changes in the aerosol number concentrations are evaluated and compared. The participating numerical models are the model from the Consortium for Small-Scale Modeling (COSMO) with bulk microphysics, the Weather Research and Forecasting (WRF) model with bin microphysics and the University of Wisconsin modeling system (UWMMS) with a spectral ice habit prediction microphysics scheme. All models are operated on a cloud-resolving scale with 2 km horizontal grid spacing. The results of the model intercomparison suggest that the sensitivity of orographic precipitation to aerosol modifications varies greatly from case to case and from model to model. Neither a precipitation decrease nor a precipitation increase is found robustly in all simulations. Qualitative robust results can only be found for a subset of the simulations but even then quantitative agreement is scarce. Estimates of the aerosol effect on orographic precipitation are found to range from -19% to 0% depending on the simulated case and the model. Similarly, riming is shown to decrease in some cases and models whereas it increases in others, which implies that a decrease in riming with increasing aerosol load is not a robust result. Furthermore, it is found that neither a decrease in cloud droplet coalescence nor a decrease in riming necessarily implies a decrease in precipitation due to compensation effects by other microphysical pathways. The simulations suggest that mixed-phase conditions play an important role in buffering the effect of aerosol perturbations on cloud microphysics and reducing the overall susceptibility of clouds and precipitation to changes in the aerosol number concentrations. As a consequence the aerosol effect on precipitation is suggested to be less pronounced or even inverted in regions with high terrain (e.g., the Alps or Rocky Mountains) or in regions where mixed-phase microphysics is important for the climatology of orographic precipitation.

Enhanced ozone over western North America from biomass burning in Eurasia during April 2008 as seen in surface and profile observations

USA, Canada, Switzerland
Meteorology & Atmospheric Sciences, Plant Sciences

During April 2008, as part of the International Polar Year (IPY), a number of ground-based and aircraft campaigns were carried out in the North American Arctic region (e.g., ARCTAS, ARCPAC). The widespread presence during this period of biomass burning effluent, both gaseous and particulate, has been reported. Unusually high ozone readings for this time of year were recorded at surface ozone monitoring sites from northern Alaska to northern California. At Barrow, Alaska, the northernmost point in the United States, the highest April ozone readings recorded at the...
surface (hourly average values >55 ppbv) in 37 years of observation were measured on April 19, 2008. At Denali National Park in central Alaska, an hourly average of 79 ppbv was recorded during an 8-h period in which the average was over 75 ppbv, exceeding the ozone ambient air quality standard threshold value in the U.S. Elevated ozone (>60 ppbv) persisted almost continuously from April 19-23 at the monitoring site during this event. At a coastal site in northern California (Trinidad Head), hourly ozone readings were >50 ppbv almost continuously for a 35-h period from April 18-20. At several sites in northern California, located to the east of Trinidad Head, numerous occurrences of ozone readings exceeding 60 ppbv were recorded during April 2008. Ozone profiles from an extensive series of balloon soundings showed lower tropospheric features at similar to 1-6 km with enhanced ozone during the times of elevated ozone amounts at surface sites in western Canada and the U.S. Based on extensive trajectory calculations, biomass burning in regions of southern Russia was identified as the likely source of the observed ozone enhancements. Ancillary measurements of atmospheric constituents and optical properties (aerosol optical thickness) supported the presence of a burning plume at several locations. At two coastal sites (Trinidad Head and Vancouver Island), profiles of a large suite of gases were measured from airborne flask samples taken during probable encounters with burning plumes. These profiles aided in characterizing the vertical thickness of the plumes, as well as confirming that the plumes reaching the west coast of North America were associated with biomass burning events.


11.1-42

Cost733cat-A database of weather and circulation type classifications


Meteorology & Atmospheric Sciences

A new database of weather and circulation type catalogs is presented comprising 17 automated classification methods and five subjective classifications. It was compiled within COST Action 733 “Harmonisation and Applications of Weather Type Classifications for European regions” in order to evaluate different methods for weather and circulation type classification. This paper gives a technical description of the included methods using a new conceptual categorization for classification methods reflecting the strategy for the definition of types. Methods using predefined types include manual and threshold based classifications while methods producing types derived from the input data include those based on eigenvector techniques, leader algorithms and optimization algorithms. In order to allow direct comparisons between the methods, the circulation input data and the methods’ configuration were harmonized for producing a subset of standard catalogs of the automated methods. The harmonization includes the data source, the climatic parameters used, the classification period as well as the spatial domain and the number of types. Frequency based characteristics of the resulting catalogs are presented, including variation of class sizes, persistence, seasonal and inter-annual variability as well as trends of the annual frequency time series. The methodological concept of the classifications is partly reflected by these properties of the resulting catalogs. It is shown that the types of subjective classifications compared to automated methods show higher persistence, inter-annual variation and long-term trends. Among the automated classifications optimization methods show a tendency for longer persistence and higher seasonal variation. However, it is also concluded that the distance metric used and the data preprocessing play at least an equally important role for the properties of the resulting classification compared to the algorithm used for type definition and assignment.


11.1-43

The Finokalia Aerosol Measurement Experiment-2008 (FAME-08): an overview


Meteorology & Atmospheric Sciences, Modelling A month (4 May to 8 June 2008) of ambient aerosol, air and gas phase sampling (Finokalia Aerosol Measurement Experiment 2008, FAME-08) was conducted at Finokalia, on the island of Crete, Greece. The purpose of the study was to character-
ize the physical and chemical properties of aged aerosol and to investigate new particle formation. Measurements included aerosol and air ion size distributions, size-resolved chemical composition, organic aerosol thermal volatility, water uptake and particle optical properties (light scattering and absorption). Statistical analysis of the aerosol mass concentration variations revealed the absence of diurnal patterns suggesting the lack of strong local sources. Sulfates accounted for approximately half of the particulate matter less than 1 micrometer in diameter (PM1) and organics for 28%. The PM1 organic aerosol fraction was highly oxidized with 80% water soluble. The supermicrometer PM10 organic aerosol fraction was highly oxidized and correlated with ozone measurements but with a one-day lag. The average OC/EC ratio for the study period was equal to 5.4. For three days air masses from North Africa resulted in a 6-fold increase of particulate matter less than 10 micrometers in diameter (PM10) and a decrease of the OC/EC ratio by a factor of 2. Back trajectory analysis, based on FLEXPART footprint plots, identified five source regions (Athens, Greece, Africa, other continental and marine), each of which influenced the PM1 aerosol composition and properties. Marine air masses had the lowest PM1 concentrations and air masses from the Balkans, Turkey and Eastern Europe the highest.

Atmospheric Chemistry and Physics, 2010, V10, N14, pp 6793-6806 DOI: http://dx.doi.org/10.5194/acp-10-6793-2010.

11.1-45 Evidence for changes in stratospheric transport and mixing over the past three decades based on multiple data sets and tropical leaky pipe analysis
Meteorology & Atmospheric Sciences, Modelling

Variability in the strength of the stratospheric Lagrangian mean meridional or Brewer-Dobson circulation and horizontal mixing into the tropics over the past three decades are examined using observations of stratospheric mean age of air and ozone. We use a simple representation of the stratosphere, the tropical leaky pipe (TLP) model, guided by mean meridional circulation and horizontal mixing changes in several reanalyses data sets and chemistry climate model (CCM) simulations, to help elucidate reasons for the observed changes in stratospheric mean age and ozone. We find that the TLP model is able to accurately simulate multiyear variability in ozone following recent major volcanic eruptions and the early 2000s sea surface temperature changes, as well as the lasting impact on mean age of relatively short-term circulation perturbations. We also find that the best quantitative agreement with the observed mean age and ozone trends over the past three decades is found assuming a small strengthening of the mean circulation in the lower stratosphere, a moderate weakening of the mean circulation in the middle and upper stratosphere,
and a moderate increase in the horizontal mixing into the tropics. The mean age trends are strongly sensitive to trends in the horizontal mixing into the tropics, and the uncertainty in the mixing trends causes uncertainty in the mean circulation trends. Comparisons of the mean circulation and mixing changes suggested by the measurements with those from a recent suite of CCM runs reveal significant differences that may have important implications on the accurate simulation of future stratospheric climate.


**11.1-46**

Quantitative sampling and analysis of trace elements in atmospheric aerosols: impactor characterization and Synchrotron-XRF mass calibration


Switzerland, Spain, Germany

Meteorology & Atmospheric Sciences

Identification of trace elements in ambient air can add substantial information to pollution source apportionment studies, although they do not contribute significantly to emissions in terms of mass. A method for quantitative size and time-resolved trace element evaluation in ambient aerosols with a rotating drum impactor and synchrotron radiation based X-ray fluorescence is presented. The impactor collection efficiency curves and size segregation characteristics were investigated in an experiment with oil and salt particles. Cutoff diameters were determined through the ratio of size distributions measured with two particle sizers. Furthermore, an external calibration technique to empirically link fluorescence intensities to ambient concentrations was developed. Solutions of elemental standards were applied with an ink-jet printer on thin films and area concentrations were subsequently evaluated with external wet chemical methods. These customized and reusable reference standards enable quantification of different data sets analyzed under varying experimental conditions.


**11.1-47**

Extreme events in total ozone over Arosa - Part 1: Application of extreme value theory


Switzerland, Austria

Meteorology & Atmospheric Sciences

In this study ideas from extreme value theory are for the first time applied in the field of stratospheric ozone research, because statistical analysis showed that previously used concepts assuming a Gaussian distribution (e.g. fixed deviations from mean values) of total ozone data do not adequately address the structure of the extremes. We show that statistical extreme value methods are appropriate to identify ozone extremes and to describe the tails of the Arosa (Switzerland) total ozone time series. In order to accommodate the seasonal cycle in total ozone, a daily moving threshold was determined and used, with tools from extreme value theory, to analyse the frequency of days with extreme low (termed ELOs) and high (termed EHOs) total ozone at Arosa. The analysis shows that the Generalized Pareto Distribution (GPD) provides an appropriate model for the frequency distribution of total ozone above or below a mathematically well-defined threshold, thus providing a statistical description of ELOs and EHOs. The results show an increase in ELOs and a decrease in EHOs during the last decades. The fitted model represents the tails of the total ozone data set with high accuracy over the entire range (including absolute monthly minima and maxima), and enables a precise computation of the frequency distribution of ozone mini-holes (using constant thresholds). Analyzing the tails instead of a small fraction of days below constant thresholds provides deeper insight into the time series properties. Fingerprints of dynamical (e.g. ENSO, NAO) and chemical features (e.g. strong polar vortex ozone loss), and major volcanic eruptions, can be identified in the observed frequency of extreme events throughout the time series. Overall the new approach to analysis of extremes provides more information on time series properties and variability than previous approaches that use only monthly averages and/or mini-holes and mini-highs.

*Atmospheric Chemistry and Physics, 2010, V10, N20, pp 10021-10031 DOI: http://dx.doi.org/10.5194/acp-10-10021-2010.*
11.1-48
Extreme events in total ozone over Arosa - Part 2: Fingerprints of atmospheric dynamics and chemistry and effects on mean values and long-term changes
Switzerland, Austria
Meteorology & Atmospheric Sciences
In this study the frequency of days with extreme low (termed ELOs) and extreme high (termed EHOs) total ozone values and their influence on mean values and trends are analyzed for the world’s longest total ozone record (Arosa, Switzerland). The results show (i) an increase in ELOs and (ii) a decrease in EHOs during the last decades and (iii) that the overall trend during the 1970s and 1980s in total ozone is strongly dominated by changes in these extreme events. After removing the extremes, the time series shows a strongly reduced trend (reduction by a factor of 2.5 for trend in annual mean). Excursions in the frequency of extreme events reveal “fingerprints” of dynamical factors such as ENSO or NAO, and chemical factors, such as cold Arctic vortex ozone losses, as well as major volcanic eruptions of the 20th century (Gunung Agung, El Chichon, Mt. Pinatubo). Furthermore, atmospheric loading of ozone depleting substances leads to a continuous modification of column ozone in the Northern Hemisphere also with respect to extreme values (partly again in connection with polar vortex contributions). Application of extreme value theory allows the identification of many more such “fingerprints” than conventional time series analysis of annual and seasonal mean values. The analysis shows in particular the strong influence of dynamics, revealing that even moderate ENSO and NAO events have a discernible effect on total ozone. Overall the approach to extremal modelling provides new information on time series properties, variability, trends and the influence of dynamics and chemistry, complementing earlier analyses focusing only on monthly (or annual) mean values.
Atmospheric Chemistry and Physics, 2010, V10, N20, pp 10033-10045 DOI: http://dx.doi.org/10.5194/acp-10-10033-2010.

11.1-49
Validation of a modified AVHRR aerosol optical depth retrieval algorithm over Central Europe
Riffler M, Popp C, Hauser A, Fontana F, Wunderle S
Switzerland, Germany
Meteorology & Atmospheric Sciences, Remote Sensing
The Advanced Very High Resolution Radiometer (AVHRR) carried on board the National Oceanic and Atmospheric Administration (NOAA) and the Meteorological Operational Satellite (MetOp) polar orbiting satellites is the only instrument offering more than 25 years of satellite data to analyze aerosols on a daily basis. The present study assessed a modified AVHRR aerosol optical depth tau(a) retrieval over land for Europe. The algorithm might also be applied to other parts of the world with similar surface characteristics like Europe, only the aerosol properties would have to be adapted to a new region. The initial approach used a relationship between Sun photometer measurements from the Aerosol Robotic Network (AERONET) and the satellite data to post-process the retrieved tau(a). Herein a quasi-stand-alone procedure, which is more suitable for the pre-AERONET era, is presented. In addition, the estimation of surface reflectance, the aerosol model, and other processing steps have been adapted. The method’s cross-platform applicability was tested by validating tau(a) from NOAA-17 and NOAA-18 AVHRR at 15 AERONET sites in Central Europe (40.5 degrees N-50 degrees N, 0 degrees E-17 degrees E) from August 2005 to December 2007. Furthermore, the accuracy of the AVHRR retrieval was related to products from two newer instruments, the Medium Resolution Imaging Spectrometer (MERIS) on board the Environmental Satellite (ENVISAT) and the Moderate Resolution Imaging Spectroradiometer (MODIS) on board Aqua/Terra. Considering the linear correlation coefficient R, the AVHRR results were similar to those of MERIS with even lower root mean square error RMSE. Not surprisingly, MODIS, with its high spectral coverage, gave the highest R and lowest RMSE. Regarding monthly averaged tau(a), the results were ambiguous. Focusing on small-scale structures, R was reduced for all sensors, whereas the RMSE solely for MERIS substantially increased. Regarding larger areas like Central Europe, the error statistics were similar to the individual match-ups. This was mainly explained with sampling issues. With the successful validation of AVHRR we are now able to concentrate on our large data archive dating back to 1985. This is a unique opportunity for both climate and air pollution studies over land surfaces.
11.1-50
How to quantify the resolution of surface climate by circulation types: An example for Alpine precipitation
Schiemann R, Frei C
Switzerland
Meteorology & Atmospheric Sciences, Hydrology
A novel approach is presented for the evaluation of circulation type classifications (CTCs) in terms of their capability to predict surface climate variations. The approach is analogous to that for probabilistic meteorological forecasts and is based on the Brier skill score. This score is shown to take a particularly simple form in the context of CTCs and to quantify the resolution of a climate variable by the classifications. The sampling uncertainty of the skill can be estimated by means of nonparametric bootstrap resampling. The evaluation approach is applied for a systematic intercomparison of 71 CTCs (objective and manual, from COST Action 733) with respect to their ability to resolve daily precipitation in the Alpine region. For essentially all CTCs, the Brier skill score is found to be higher for weak and moderate compared to intense precipitation, for winter compared to summer, and over the north and west of the Alps compared to the south and east. Moreover, CTCs with a higher number of types exhibit better skill than CTCs with few types. Among CTCs with comparable type number, the best automatic classifications are found to outperform the best manual classifications. It is not possible to single out one ‘best’ classification for Alpine precipitation, but there is a small group showing particularly high skill.

11.1-51
Mechanisms of Along-Valley Winds and Heat Exchange over Mountainous Terrain
Schmidl J, Rotunno R
Switzerland, USA
Meteorology & Atmospheric Sciences, Modelling
The physical mechanisms leading to the formation of diurnal along-valley winds are investigated over idealized three-dimensional topography. The topography used in this study consists of a valley with a horizontal floor enclosed by two isolated mountain ridges on a horizontal plain. A diagnostic equation for the along-valley pressure gradient is developed and used in combination with numerical model simulations to clarify the relative role of various forcing mechanisms such as the valley volume effect, subsidence heating, and surface sensible heat flux effects. The full diurnal cycle is simulated using comprehensive model physics including radiation transfer, land surface processes, and dynamic surface atmosphere interactions. The authors find that the basic assumption of the valley volume argument of no heat exchange with the free atmosphere seldom holds. Typically, advective and turbulent heat transport reduce the heating of the valley during the day and the cooling of the valley during the night. In addition, dynamically induced valley plain contrasts in the surface sensible heat flux can play an important role. Nevertheless, the present analysis confirms the importance of the valley volume effect for the formation of the diurnal along-valley winds but also clarifies the role of subsidence heating and the limitations of the valley volume effect argument. In summary, the analysis brings together different ideas of the valley wind into a unified picture.

11.1-52
Fast and simple model for atmospheric radiative transfer
Seidel F C, Kokhanovsky A A, Schaepman M E
Switzerland, Germany
Meteorology & Atmospheric Sciences, Modelling, Remote Sensing
Radiative transfer models (RTMs) are of utmost importance for quantitative remote sensing, especially for compensating atmospheric perturbation. A persistent trade-off exists between approaches that prefer accuracy at the cost of computational complexity, versus those favouring simplicity at the cost of reduced accuracy. We propose an approach in the latter category, using analytical equations, parameterizations and a correction factor to efficiently estimate the effect of molecular multiple scattering. We discuss the approximations together with an analysis of the resulting performance and accuracy. The proposed Simple Model for Atmospheric Radiative Transfer (SMART) decreases the calculation time by a factor of more than 25 in comparison to the benchmark RTM 6S on the same infrastructure. The relative difference between SMART and 6S is about 5% for spaceborne and about 10% for airborne computations of the atmospheric reflectance function. The combination of a large solar zenith angle (SZA) with high aerosol optical depth (AOD) at low wavelengths lead to relative differences of up to 15%. SMART can be used to simulate the hemispherical conical reflectance factor (HCRF) for spaceborne
and airborne sensors, as well as for the retrieval of columnar AOD. 


11.1-53

An Earth-System Prediction Initiative for the Twenty-First Century


USA, Norway, Canada, Brazil, Switzerland, Germany, France, Sweden, Australia, Japan, England, Iceland

Meteorology & Atmospheric Sciences, Modelling

The necessity and benefits for establishing the international Earth-system Prediction Initiative (EPI) are discussed by scientists associated with the World Meteorological Organization (WMO) World Weather Research Programme (WWRP), World Climate Research Programme (WCRP), International Geosphere–Biosphere Programme (IGBP), Global Climate Observing System (GCOS), and natural-hazards and socioeconomic communities. The proposed initiative will provide research and services to accelerate advances in weather, climate, and Earth system prediction and the use of this information by global societies. It will build upon the WMO, the Group on Earth Observations (GEO), the Global Earth Observation System of Systems (GEOSS) and the International Council for Science (ICSU) to coordinate the effort across the weather, climate, Earth system, natural-hazards, and socioeconomic disciplines. It will require (i) advanced high-performance computing facilities, supporting a worldwide network of research and operational modeling centers, and early warning systems; (ii) science, technology, and education projects to enhance knowledge, awareness, and utilization of weather, climate, environmental, and socioeconomic information; (iii) investments in maintaining existing and developing new observational capabilities; and (iv) infrastructure to transition achievements into operational products and services.


11.1-54

Impact of stratospheric ozone on Southern Hemisphere circulation change: A multimodel assessment


Canada, Japan, USA, Germany, France, England, Italy, Switzerland, South Korea, New Zealand

Meteorology & Atmospheric Sciences, Modelling

The impact of stratospheric ozone on the tropospheric general circulation of the Southern Hemisphere (SH) is examined with a set of chemistry-climate models participating in the Stratospheric Processes and their Role in Climate (SPARC)/Chemistry-Climate Model Validation project phase 2 (CCMVal-2). Model integrations of both the past and future climates reveal the crucial role of stratospheric ozone in driving SH circulation change: stronger ozone depletion in late spring generally leads to greater poleward displacement and intensification of the tropospheric midlatitude jet, and greater expansion of the SH Hadley cell in the summer. These circulation changes are systematic as poleward displacement of the jet is typically accompanied by intensification of the jet and expansion of the Hadley cell. Overall results are compared with coupled models participating in the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4), and possible mechanisms are discussed. While the tropospheric circulation response appears quasi-linearly related to stratospheric ozone changes, the quantitative response to a given forcing varies considerably from one model to another. This scatter partly results from differences in model climate. It is shown that poleward intensification of the westerly jet is generally stronger in models whose climatological jet is biased toward lower latitudes. This result is discussed in the context of quasi-geostrophic zonal mean dynamics.

11.1-55 Impact of heterogeneous ice nuclei on homogeneous freezing events in cirrus clouds
Spichtinger P, Cziczo DJ
Switzerland
Meteorology & Atmospheric Sciences, Modelling
The influence of initial heterogeneous nucleation on subsequent homogeneous nucleation events in cirrus clouds is investigated using a box model which includes the explicit impact of aerosols on the nucleation of ice crystals and a new sedimentation scheme. Different effects are discussed, namely the impact of external versus internal mixtures of heterogeneous ice nuclei and the influence of size-dependent freezing thresholds. Several idealized experiments are carried out, which show that the treatment of external mixtures of ice nuclei can strongly change subsequent homogeneous nucleation events (i.e., the ice crystal number densities) over a large variety of environmental conditions relevant for the upper troposphere. In most cases a strong reduction in ice crystal number concentrations formed in subsequent homogeneous freezing events is observed. The use of size-dependent freezing thresholds can change cloud properties when compared to more simple parameterizations and is most important at largest ice nuclei concentrations.

11.1-56 MIAWARA-C, a new ground based water vapor radiometer for measurement campaigns
Straub C, Murk A, Kämpfer N
Switzerland
Meteorology & Atmospheric Sciences, Modelling
In this paper a new 22GHz water vapor spectroradiometer which has been specifically designed for profile measurement campaigns of the middle atmosphere is presented. The instrument is of a compact design and has a simple set up procedure. It can be operated as a standalone instrument as it maintains its own weather station and a calibration scheme that does not rely on other instruments or the use of liquid nitrogen. The optical system of MIAWARA-C combines a choked gaussian horn antenna with a parabolic mirror which reduces the size of the instrument in comparison with currently existing radiometers. For the data acquisition a correlation receiver is used together with a digital cross correlating spectrometer. The complete backend section, including the computer, is located in the same housing as the instrument. The receiver section is temperature stabilized to minimize gain fluctuations. Calibration of the instrument is achieved through a balancing scheme with the sky used as the cold load and the tropospheric properties are determined by performing regular tipping curves. Since MIAWARA-C is used in measurement campaigns it is important to be able to determine the elevation pointing in a simple manner as this is a crucial parameter in the calibration process. Here we present two different methods; scanning the sky and the Sun. Finally, we report on the first spectra and retrieved water vapor profiles acquired during the Lap-biat campaign at the Finnish Meteorological Institute Arctic Research Centre in Sodankyla, Finland. The performance of MIAWARA-C is validated here by comparison of the presented profiles against the equivalent profiles from the Microwave Limb Sounder on the EOS/Aura satellite.

11.1-57 Contrasting response of European forest and grassland energy exchange to heatwaves
Switzerland, Netherlands, Germany, France, Denmark, Italy, Belgium, Austria
Meteorology & Atmospheric Sciences, Plant Sciences, Forestry, Hydrology
Recent European heatwaves have raised interest in the impact of land cover conditions on temperature extremes. At present, it is believed that such extremes are enhanced by stronger surface heating of the atmosphere, when soil moisture content is below average. However, the impact of land cover on the exchange of water and energy and the interaction of this exchange with the soil water balance during heatwaves is largely unknown. Here we analyse observations from an extensive network of flux towers in Europe that reveal a difference between the temporal responses of forest and grassland ecosystems during heatwaves. We find that initially, surface heating is twice as high over forest than over grassland. Over grass, heating is suppressed by increased evaporation in response to increased solar radiation and temperature. Ultimately, however, this process accelerates soil moisture depletion and induces a critical shift in the regional climate system that leads to increased heating. We propose that this mechanism may explain the extreme temperatures in August
2003. We conclude that the conservative water use of forest contributes to increased temperatures in the short term, but mitigates the impact of the most extreme heat and/or long-lasting events. Nature Geoscience, 2010, V3, N10, OCT, pp 722-727 DOI: http://dx.doi.org/10.1038/NGEO950.

11.1-58
A Novel Method for the Homogenization of Daily Temperature Series and Its Relevance for Climate Change Analysis
Toreti A, Kuglitsch F G, Xoplaki E, Luterbacher J, Wanner H
Italy, Switzerland, Cyprus, Germany
Meteorology & Atmospheric Sciences
Instrumental daily series of temperature are often affected by inhomogeneities. Several methods are available for their correction at monthly and annual scales, whereas few exist for daily data. Here, an improved version of the higher-order moments (HOM) method, the higher-order moments for autocorrelated data (HOMAD), is proposed. HOMAD addresses the main weaknesses of HOM, namely, data autocorrelation and the subjective choice of regression parameters. Simulated series are used for the comparison of both methodologies. The results highlight and reveal that HOMAD outperforms HOM for small samples. Additionally, three daily temperature time series from stations in the eastern Mediterranean are used to show the impact of homogenization procedures on trend estimation and the assessment of extremes. HOMAD provides an improved correction of daily temperature time series prior to climate change assessment. Journal of Climate, 2010, V23, N19, OCT, pp 5325-5331 DOI: http://dx.doi.org/10.1175/2010JCLI3499.1.

11.1-59
Observation-based estimates of fossil fuel-derived CO₂ emissions in the Netherlands using Delta 14C, CO and 222Radon
Netherlands, Germany
Meteorology & Atmospheric Sciences, Energy & Fuels, Modelling
Surface emissions of CO₂ from fossil fuel combustion (phi FFCO₂) are estimated for the Netherlands for the period of May 2006-June 2009 using ambient atmospheric observations taken at station Lutjewad in the Netherlands (6 degrees 21'E, 53 degrees 24'N, 1 m. a.s.l.). Measurements of delta 14C on 2-weekly integrations of CO₂ and CO mixing ratios are combined to construct a quasi-continuous proxy record (FFCO₂*) from which surface fluxes (phi FFCO₂*) are determined using the 222Rn flux method. The trajectories of the air masses are analysed to determine emissions, which are representative for the Netherlands. We compared our observationally based estimates to the national inventories and we evaluated our methodology using the regional atmospheric transport model REMO. Based on 3 yr of observations we find annual mean phi FFCO₂* emissions of (4.7 +/- 1.6) kt km⁻² a⁻¹ which is in very good agreement with the Dutch inventories of (4.5 +/- 0.2) kt km⁻² a⁻¹ (average of 2006-2008). Tellus Series B Chemical and Physical Meteorology, 2010, V62, N5, SI, NOV, pp 389-402 DOI: http://dx.doi.org/10.1111/j.1600-0889.2010.00493.x.

11.1-60
Remoteness from Emission Sources Explains the Fractionation Pattern of Polychlorinated Biphenyls in the Northern Hemisphere
von Waldow H, Macleod M, Jones K, Scheringer M, Hungerbühler K
Switzerland
Meteorology & Atmospheric Sciences, Modelling
The global distillation hypothesis states that fractionation patterns of persistent semivolatile chemicals in the environment are determined by the effect of spatially varying environmental temperature on the temperature-dependent phase partitioning coefficients of chemicals. Here, we use a model experiment and an analysis of monitoring data for polychlorinated biphenyls (PCBs) to explore an alternative hypothesis, the differential removal hypothesis, which proposes that fractionation results from different loss rates from the atmosphere, acting along a gradient of remoteness from emission sources. Model calculations for a range of PCB congeners demonstrate that fractionation occurs with distance from sources, regardless of the temperature gradient. We have assembled two independent data sets of PCB concentrations in European air that show fractionation, and quantified the remoteness of monitoring sites from PCB sources using the remoteness index, RI. Regression analysis of these empirical data against RI and temperature demonstrates that RI determines fractionation patterns. Based on this result, we calculate empirical effective residence times in air for a set of PCB congeners from the relationship between measured concentrations and RI. These empirical effective residence times agree well with values calculated by a multimedia mass balance model. Our conclusion from the model experiment and analysis of monitoring

**Wang K, Dickinson R E, Wild M, Liang S**
USA, Switzerland, Peoples R China

Meteorology & Atmospheric Sciences, Hydrology, Modelling, Plant Sciences, Remote Sensing

Estimating interannual to decadal variability of terrestrial evapotranspiration (ET) requires use of standard meteorological data complemented with some high-resolution satellite data. A semiempirical expression for this purpose is developed and validated with data from 2000 to 2007. These data were collected at 64 globally distributed sites, including the continuous measurements collected by the Atmospheric Radiation Measurement (ARM) and FLUXNET projects, and are the longest available, with continuous worldwide multisite measurements of ET, and a total of 274 site years. The sites are mainly located in North America and Asia, with the exception of three sites in Australia, two in Europe, and one in Africa. The climates of the sites vary from tropical to subarctic and from arid to humid. The land cover types of the sites vary from desert, croplands, grasslands, and shrub land to forests. On average, the 16 day average daily ET can be estimated with an error (standard deviation) of 17 W m\(^{-2}\) (25% in relative value), and with an average correlation coefficient of 0.94. The standard deviation of the comparison between measured and predicted site-averaged daily ET is 9 W m\(^{-2}\) (14%), with a correlation coefficient of 0.93. The model is also satisfactory in reproducing the interannual variability at sites with 5 years of data in both humid and arid regions. The correlation coefficient between measured and predicted annual ET anomalies is 0.85. This simple but accurate method permits us to investigate decadal variation in global ET over the land as will be demonstrated in part two of this paper series.


**Wang K, Dickinson R E, Wild M, Liang S**
USA, Switzerland, Peoples R China

Meteorology & Atmospheric Sciences, Hydrology, Modelling, Plant Sciences

Terrestrial evapotranspiration (ET) cools the surface and moistens the atmosphere near the Earth’s surface. Variations in this important climate factor have major environmental and socio-economic impacts. How terrestrial ET has varied in the past and what caused the variations, however, have remained quite uncertain. These issues are addressed by calculating monthly global ET from 1982 to 2002 at 1120 globally distributed stations, using a modified Penman-Monteith method that was developed in the first part of the two-part paper. Our analyses show that ET has a significant decadal variation (similar to 10%) regionally and globally. Over the period analyzed ET for global land increased by 0.6 W m\(^{-2}\) per decade equal to 1.2 W m\(^{-2}\) (about 2.2% in relative value) or 15 mm yr\(^{-1}\) in water flux during the study period. We show that long-term variations of ET in humid areas such as the tropics, Europe, and humid areas of Asia are primarily controlled by variations in incident solar radiation \(R_s\) connected to changes in cloudiness and aerosols. However, soil water supply, estimated here by RH, and connected to precipitation, is the dominant factor in controlling long-term variations of ET in arid areas. A correlation analysis demonstrates that the dependence of ET on \(R_s\) switches to negative in dry regions. Furthermore, its dependence on relative humidity switches from negative in moist regions to positive in dry regions. Its dependence on normalized difference vegetation index is uniformly positive.


11.1-63 Risks of Model Weighting in Multimodel Climate Projections

**Weigel A P, Knutti R, Liniger M A, Appenzeller C**
Switzerland

Meteorology & Atmospheric Sciences, Modelling

Multimodel combination is a pragmatic approach to estimating model uncertainties and to making climate projections more reliable. The simplest way of constructing a multimodel is to give one vote to each model (“equal weighting”), while more sophisticated approaches suggest applying model weights according to some measure of performance (“opti-
mum weighting”). In this study, a simple conceptual model of climate change projections is introduced and applied to discuss the effects of model weighting in more generic terms. The results confirm that equally weighted multimodels on average outperform the single models, and that prediction errors can in principle be further reduced by optimum weighting. However, this not only requires accurate knowledge of the single model skill, but the relative contributions of the joint model error and unpredictable noise also need to be known to avoid biased weights. If weights are applied that do not appropriately represent the true underlying uncertainties, weighted multimodels perform on average worse than equally weighted ones, which is a scenario that is not unlikely, given that at present there is no consensus on how skill-based weights can be obtained. Particularly when internal variability is large, more information may be lost by inappropriate weighting than could potentially be gained by optimum weighting. These results indicate that for many applications equal weighting may be the safer and more transparent way to combine models. However, also within the presented framework eliminating models from an ensemble can be justified if they are known to lack key mechanisms that are indispensable for meaningful climate projections. Journal of Climate, 2010, V23, N15, AUG 1, pp 4175-4191 DOI: http://dx.doi.org/10.1175/2010JCLI3594.1.

11.1-64 Three methods for quantifying proximity of air sampling sites to spatially resolved emissions of semi-volatile organic contaminants Westgate J N, Shunthirasingham C, Oyiliagu C E, von Waldow H, Wania F Canada, Switzerland
Meteorology & Atmospheric Sciences
Passive air samplers have made it possible to measure long-term average air concentrations of semi-volatile organic contaminants (SVOCs) at a large number of sampling sites. In order to use the results of such measurement networks in the derivation of empirical measures of long-range transport, a method is required that quantitatively expresses the proximity of air sampling sites to spatially distributed emissions. We propose three increasingly sophisticated tiers for quantifying proximity to emissions. The ‘static’ method assumes that a sampling site is only influenced by emission taking place in the same 1 degrees of latitude by 1 degrees of longitude cell in which it is located. The ‘dispersion’ method additionally accounts for the influence of emissions in neighboring cells by adding the emissions into each cell weighted by the distance between the cell’s center and the center of the cell containing the sampling site. The ‘airshed’ method quantifies proximity to emissions by combining the emissions in each cell with the probability that air arriving at the sampling site passed through each cell. The probability is calculated for each sampling site by aggregating a large number of air mass backtrajectories. These new proximity gauges were contrasted against the remoteness index RI, which is derived from global atmospheric tracer transport modeling. The four methods were used to quantify the proximity of the sampling sites of the Global Atmospheric Passive Sampling (GAPS) study to global Polycyclic Aromatic Hydrocarbon (PAH) emissions. The proximity gauges produce markedly different results primarily for sites located near steep gradients in population, such as occur in coastal areas or at the feet of mountain ranges. The dispersion method produces quite similar results to the airshed method using drastically less computational power and input data, but application of the airshed method may be necessary where winds are strongly directional. Atmospheric Environment, 2010, V44, N35, NOV, pp 4380-4387 DOI: http://dx.doi.org/10.1016/j.atmosenv.2010.07.051.

Meteorology & Atmospheric Sciences, Modelling
High-resolution numerical weather prediction (NWP) models produce more detailed precipitation structures but the real benefit is probably the more realistic statistics gained with the higher resolution and not the information on the specific grid point. By evaluating three model pairs, each consisting of a high-resolution NWP system resolving convection explicitly and its low-resolution-driving model with parameterized convection, on different spatial scales and for different thresholds, this paper addresses the question of whether high-resolution models really perform better than their driving lower-resolution counterparts. The model pairs are evaluated by means of two fuzzy verification methods: upscaling (UP) and fractions skill score (FSS)-for the 6 months of the D-PHASE Operations Period and in a highly complex terrain. Observations are provided by the Swiss radar composite and the evaluation is restricted to the area covered by the Swiss radar stations. The high-resolution models outperform or equal the performance of their respective lower-resolution driving models. The differences between the models are
significant and robust against small changes in the verification settings. An evaluation based on individual months shows that high-resolution models give better results, particularly with regard to convective, more localized precipitation events. 


11.1-66

A gridded hourly precipitation dataset for Switzerland using rain-gauge analysis and radar-based disaggregation

Wüest M, Frei C, Altenhoff A, Hagen M, Litschi M, Schär C 
Switzerland, Germany

Meteorology & Atmospheric Sciences, Hydrology, Modelling

Rain gauges and weather radars both constitute important devices for operational precipitation monitoring. Gauges provide accurate yet spotty precipitation estimates, while radars offer high temporal and spatial resolution yet at a limited absolute accuracy. We propose a simple methodology to combine radar and daily rain-gauge data to build up a precipitation dataset with hourly resolution covering a climatological time period. The methodology starts from a daily precipitation analysis, derived from a dense rain-gauge network. A sequence of hourly radar analyses is then used to disaggregate the daily analyses. The disaggregation is applied such as to retain the daily precipitation totals of the rain-gauge analysis, in order to reduce the impact of quantitative radar biases. Hence, only the radar’s advantage in terms of temporal resolution is exploited. In this article the disaggregation method is applied to derive a 15-year gridded precipitation dataset at hourly resolution for Switzerland at a spatial resolution of 2 km. Validation of this dataset indicates that errors in hourly intensity and frequency are lower than 25% on average over the Swiss Plateau. In Alpine valleys, however, errors are typically larger due to shielding effects of the radar and the corresponding underestimation of precipitation periods by the disaggregation. For the flatland areas of the Swiss Plateau, the new dataset offers an interesting quantitative description of high-frequency precipitation variations suitable for climatological analyses or heavy events, the evaluation of numerical weather forecasting models and the calibration/operation of hydrological runoff models. 


11.1-67

Climate control of terrestrial carbon exchange across biomes and continents

USA, Sweden, Switzerland, Canada, Brazil, Belgium, Finland, Hungary, France, Australia, Germany, Netherlands, England, Scotland, Denmark, Italy, Peoples R China, Austria, Portugal, Ireland, Czech Republic, Zambia, Japan, Spain

Meteorology & Atmospheric Sciences, Plant Sciences, Forestry, Hydrology

Understanding the relationships between climate and carbon exchange by terrestrial ecosystems is critical to predict future levels of atmospheric carbon dioxide because of the potential accelerating effects of positive climate-carbon cycle feedbacks. However, directly observed relationships between climate and terrestrial CO₂ exchange with the atmosphere across biomes and continents are lacking. Here we present data describing the relationships between net ecosystem exchange of carbon (NEE) and climate factors as measured using the eddy covariance method at 125 unique sites in various ecosystems over six continents with a total of 559 site-years. We find that NEE observed at eddy covariance sites is (1) a strong function of mean annual temperature at mid-and high-latitudes, (2) a strong function of dryness at mid-and low-latitudes, and (3) a function of both temperature and dryness around the mid-latitudinal belt (45 degrees N). The sensitivity of NEE to mean annual temperature breaks down at similar to 16 degrees C (a threshold value of mean annual temperature), above which no further increase of CO₂ uptake with temperature was observed and dryness influence overrides temperature influence. 


11.1-68

Analysis of 3-year observations of CFC-11, CFC-12 and CFC-113 from a semi-rural site in China

Peoples R China, Switzerland, England, Norway, Italy

Meteorology & Atmospheric Sciences, International Relations

In-situ measurements of atmospheric chlorofluorocarbons (CFCs) can be used to the assess their global and regional emissions and to check for compliance with phase-out schedules under Montreal protocol and its amendments. The at-
mospheric mixing ratios of CFC-11 (CCl3F), CFC-12 (CCl2F2) and CFC-113 (CCl2F-CClF2) have been measured by an automated in-situ GC-ECDs system at the regional Chinese Global Atmosphere Watch (GAW) station Shangdianzi (SDZ), from November 2006 to October 2009. The time series for these three principal CFCs showed large episodic events and background conditions occurred for approximately 30% (CFC-11), 52% (CFC-12) and 56% (CFC-113) of the measurements. The mean background mixing ratios for CFC-11, CFC-12 and CFC-113 were 244.8 ppt (parts per trillion, 10^-12, molar) 539.6 ppt and 76.8 ppt, respectively, for 2006-2009. The enhanced CFC mixing ratios compared to AGAGE sites such as Trinidad Head (THD), US and Mace Head (MHD), Ireland suggest regional influences even during background conditions at SDZ, which is much closer to highly-populated areas. Between 2006 and 2009 background CFCs exhibited downward trends at rates of 2.0 ppt yr^-1 (for CFC-11), 2.5 ppt yr^-1 (for CFC-12) and 0.7 ppt yr^-1 (for CFC-113). De-trended 3-year average background seasonal cycles displayed small fluctuations with peak-to-trough amplitudes of 1.0 +/- 0.02 ppt (0.4%) for background CFC-11, 1.3 +/- 2.1 ppt (0.3%) for CFC-12 and 0.2 +/- 0.4 ppt (0.3%) for CFC-113. On the other hand, during pollution periods these CFCs showed much larger seasonal cycles of 11.2 +/- 10.7 ppt (5%) for CFC-11, 7.5 +/- 6.5 ppt (2%) for CFC-12 and 1.0 +/- 1.2 ppt (1.2%) for CFC-113, with apparent winter minima and early summer maxima. This enhancement was attributed to prevailing wind directions from urban regions in summer and to enhanced anthropogenic sources during the warm season. In general, horizontal winds from northeast showed negative contribution to atmospheric CFCs loading, whereas South Western advection (urban sector: Beijing) had positive contributions.  


11.1-69  
Accounting for surface reflectance anisotropy in satellite retrievals of tropospheric NO2  
Switzerland, USA, Netherlands  
Meteorology & Atmospheric Sciences, Remote Sensing, Modelling  
Surface reflectance is a key parameter in satellite trace gas retrievals in the UV/visible range and in particular for the retrieval of nitrogen dioxide (NO2) vertical tropospheric columns (VTCs). Current operational retrievals rely on coarse-resolution reflectance data and do not account for the generally anisotropic properties of surface reflectance. Here we present a NO2 VTC retrieval that uses MODIS bidirectional reflectance distribution function (BRDF) data at high temporal (8 days) and spatial (1 km x 1 km) resolution in combination with the LIDORT radiative transfer model to account for the dependence of surface reflectance on viewing and illumination geometry. The method was applied to two years of NO2 NO(2) observations from the Ozone Monitoring Instrument (OMI) over Europe. Due to its wide swath, OMI is particularly sensitive to BRDF effects. Using representative BRDF parameters for various land surfaces, we found that in July (low solar zenith angles) and November (high solar zenith angles) and for typical viewing geometries of OMI, differences between MODIS black-sky albedos and surface bidirectional reflectances are of the order of 0-10% and 0-40%, respectively, depending on the position of the OMI pixel within the swath. In the retrieval, black-sky albedo was treated as a Lambertian (isotropic) reflectance, while for BRDF effects we used the kernel-based approach in the MODIS BRDF product. Air Mass Factors were computed using the LIDORT radiative transfer model based on these surface reflectance conditions. Differences in NO2 VTCs based on the Lambertian and BRDF approaches were found to be of the order of 0-3% in July and 0-20% in November with the extreme values found at large viewing angles. The much larger differences in November are mainly due to stronger BRDF effects at higher solar zenith angles. To a smaller extent, they are also caused by the typically more pronounced maximum of the NO2 a priori profiles in the boundary layer during the cold season, which make the retrieval more sensitive to radiation changes near the surface. However, BRDF impacts vary considerably across Europe due to differences in land surface type and increasing solar zenith angles at higher latitude. Finally, we compare BRDF-based NO2 VTCs with those retrieved using the GOME/TOMS Lambertian equivalent reflectance (LER) data set. The relative differences are mostly below 15% in July but in November the NO2 VTCs from TOMS/GOME are lower by 20-60%. Our results indicate that the specific choice of albedo data set is even more important than accounting for surface BRDF effects, and this again demonstrates the strong requirement for more accurate surface reflectance data sets.  

1.2 Terrestrial Ecosystems

11.1-70
Plant-pollinator network assembly along the chronosequence of a glacier foreland
Albrecht M, Riesen M, Schmid B
Switzerland
Plant Sciences, Zoology, Ecology, Biodiversity
Forelands of retreating glaciers offer an ideal model system to study community assembly processes during primary succession. As plants colonize the area that is freed from ice they should be accompanied by their pollinators to successfully reproduce and spread. However, little is known about the assembly of plant-pollinator networks. We therefore used quantitative network analysis to study the structure of plant-pollinator interactions at seven sites representing a chronosequence from 8 to 130 years since deglaciation on the foreland of the Morteratsch glacier (southeastern Switzerland). At these sites, individual visits of plant flowers by insects were recorded throughout the flowering season. Species richness of insect-pollinated plants and plant-pollinating insects, together with measures of interaction diversity and evenness, increased along the chronosequence at least for the first 80 years after deglaciation. Bees were the most frequent flower visitors at the two youngest sites, whereas flies dominated in mature communities. Pollinator generalization (the number of visited plant species weighted by interaction strength), but not plant generalization, strongly increased during the primary succession. This was reflected in a pronounced decline in network level specialization (measured as Blüthgen’s H²) and interaction strength asymmetry during the first 60 years along the chronosequence, while nestedness increased along the chronosequence. Thus, our findings contradict niche-theoretical predictions of increasing specialization of pollination systems during succession, but are in agreement with expectations from optimal foraging theory, predicting an increase in pollinator generalization with higher plant diversity but similar flower abundance, and an increase in diet breadth at higher pollinator densities during primary succession.


11.1-71
Genetic differences in the elevational limits of native and introduced Lactuca serriola populations
Alexander J M
Switzerland
Plant Sciences, Ecology, Biodiversity
Differences in phenological timing might explain why populations of the annual Lactuca serriola reach higher elevational limits in a part of its introduced range than in its native range. I investigated (1) whether this difference in elevational limits has a genetic basis, (2) the importance of clinal genetic differentiation and phenotypic plasticity in phenology as responses to elevation in L. serriola, and whether these responses differ between regions, and (3) whether the realized temperature niche of L. serriola differs between the two regions. Plant material was collected in Canton Valais, Switzerland (native range) and the Wallowa Mountains, Oregon, USA (introduced range). The field experiment was conducted in Canton Grisons, Switzerland. Plants from 20 populations collected along elevational gradients were grown in eight common gardens established at 200-m elevational intervals (600-2000 m a.s.l.). The timing of phenological transitions was monitored and analysed with mixed-effects models to determine differences in (1) elevational limits, and (2) clinal genetic differentiation and phenotypic plasticity as responses to elevation for plants from each region. The limits of the species along five temperature gradients were derived from generalized linear models using published occurrence data to quantify regional differences in the realized temperature niche. The limit of seed set (1400 m a.s.l.) was the same for plants of both regions. However, the limit of flowering, probably a better reflection of elevational limits in this study, was 400 m higher for plants from the introduced region due to their faster development. Native populations showed clines in development time with elevation consistent with expectations. However, these were weaker in introduced populations, the responses of which were rather characterized by phenotypic plasticity. Thus, although introduced populations grow at considerably cooler sites than in the native region, this is unlikely to have resulted from direct selection for tolerance of high-elevation conditions. This study supports a genetic basis for differences in the elevational limits of L. serriola populations between two parts of its native and introduced range. Although it is not yet clear whether these differences evolved in the introduced range, these findings highlight the potential of alien species for gaining insights into niche evolution.

11.1-72
Limits to the niche and range margins of alien species
Alexander J M, Edwards P J
Switzerland
Biodiversity , Ecology
We discuss the apparent paradox that while introduced populations often adapt rapidly to conditions in the new range, it is normally assumed that the species’ niche remains unchanged. Focusing on plants, we argue that studies of the niche dynamics of alien species are useful for understanding the constraints acting on species in their native ranges, and vice versa. Most hypotheses about species ecological range margins are more consistent with there being a niche shift than niche stasis in the new range. After reviewing the evidence for niche shifts in alien species, we suggest that the probability of a shift occurring depends primarily upon the ecological and genetic processes limiting the species in its native range. For example, a fundamental niche shift might occur if introduced individuals are released from maladaptive gene flow from central populations, or if genetic diversity is increased by the mixing of individuals from different sources. In addition, other factors such as species characteristics, introduction history and conditions in the new range may also influence whether a niche shift occurs. Based on these considerations, we propose conditions under which niche shifts are most likely. Such understanding is important for predicting and mitigating current and future anthropogenic impacts on species ranges.
Oikos, 2010, V119, N9, SEP, pp 1377-1386

11.1-73
Variation in delta 13C among species and sexes in the family Restionaceae along a fine-scale hydrological gradient
England, Switzerland, South Africa
Plant Sciences , Hydrology , Ecology
Consistent, repeatable segregation of plant species along hydrological gradients is an established phenomenon that must in some way reflect a trade-off between plants’ abilities to tolerate the opposing constraints of drought and waterlogging. In C3 species tissue carbon isotope discrimination (delta 13C) is known to vary sensitively in response to stomatal behaviour, reflecting stomatal limitation of photosynthesis during the period of active growth. However, this has not been studied at fine-spatial scale in natural communities. We tested how delta 13C varied between species and sexes of individuals in the family Restionaceae growing along a monitored hydrological gradient. Twenty Restionaceae species were investigated using species-level phylogeny at two sites in the Cape Floristic Region, a biodiversity hotspot. A spatial overlap analysis showed the Restionaceae species segregated significantly (P < 0.001) at both sites. Moreover, there were significant differences in delta 13C values among the Restionaceae species (P < 0.001) and between male and female individuals of each species (P < 0.01). However, after accounting for phylogeny, species delta 13C values did not show any significant correlation with the hydrological gradient. We suggest that some other variable (e.g. plant phenology) could be responsible for masking a simple response to water availability.

11.1-74
Impact of weather and climate variation on Hoopoe reproductive ecology and population growth
Arlettaz R, Schaad M, Reichlin T S, Schaub M
Switzerland, Australia
Ecology , Zoology , Biodiversity
Preserving peripheral populations is a key conservation issue because of the adaptive potential to environmental change they provide for the species as a whole. Yet, peripheral populations are often small and isolated, i.e. more vulnerable to stochastic events and prone to extinction. We studied a peripheral population of Hoopoe (Upupa epops), a rare insectivorous farmland bird, in the Swiss Alps. We first investigated the effect of weather variation on food provisioning to chicks by Hoopoe parents. Second, while accounting for density-dependence, we tested the extent to which breeding success is governed by weather circumstances and assessed the possible consequences of climate variation on population growth. Provisioning rate and provisioned prey biomass were negatively affected by adverse weather (cool, rainy days), were higher in males and also increased with brood size. Much smaller proportions of molecrickets (Gryllotalpa gryllotalpa; the most profitable prey locally, constituting 93% of chicks’ food biomass) were provisioned on days with adverse weather, irrespective of brood size. Rainfall prior to hatching and during the first days of chick life had a negative impact on their survival, and there was a positive effect of temperature on chick survival just before fledging. Reproductive output was
negatively affected by precipitation during the hatching period, but was enhanced by warm temperature just before hatching and in the last days before fledging. Our model showed that the variable reproductive output has a strong impact on the population growth: a succession of adverse, rainy springs would cause a rapid decline of the population. This case study confirms that conservation efforts may be obliterated if risks linked to increasing climate variability are not properly accounted for in the management of small peripheral populations.


11.1-75

**Sustained enhancement of photosynthesis in mature deciduous forest trees after 8 years of free air CO₂ enrichment**

*Bader M K F, Siegwolf R, Körner C*

Switzerland

Forestry, Plant Sciences, Meteorology & Atmospheric Sciences

Carbon uptake by forests constitutes half of the planet’s terrestrial net primary production; therefore, photosynthetic responses of trees to rising atmospheric CO₂ are critical to understanding the future global carbon cycle. At the Swiss Canopy Crane, we investigated gas exchange characteristics and leaf traits in five deciduous tree species during their eighth growing season under free air carbon dioxide enrichment in a 35 m tall, ca. 100-year-old mixed forest. Net photosynthesis of upper-canopy foliage was 48% (July) and 42% (September) higher in CO₂-enriched trees and showed no sign of down-regulation. Elevated CO₂ had no effect on carboxylation efficiency (V_cmax) or maximal electron transport (J_max) driving ribulose-1,5-bisphosphate (RuBP) regeneration. CO₂ enrichment improved nitrogen use efficiency, but did not affect leaf nitrogen (N) concentration, leaf thickness or specific leaf area except for one species. Non-structural carbohydrates accumulated more strongly in leaves grown under elevated CO₂ (largely driven by Quercus). Because leaf area index did not change, the CO₂-driven stimulation of photosynthesis in these trees may persist in the upper canopy under future atmospheric CO₂ concentrations without reductions in photosynthetic capacity. However, given the lack of growth stimulation, the fate of the additionally assimilated carbon remains uncertain.


11.1-76

**Effects of habitat amount and isolation on biodiversity in fragmented traditional orchards**


Switzerland

Biodiversity, Zoology, Ecology, Agriculture, Modelling

1. Habitat fragmentation is a major threat to biodiversity and can lead to the loss of both species and ecosystem services, but fragmentation effects vary greatly between studies and studied organisms. Understanding the distinct effects of habitat amount and isolation at the patch and landscape scale may account for some of this variation. 2. We studied biodiversity in 30 traditional orchards that were selected for independent variation in habitat amount and habitat isolation at the patch and landscape scale. We analysed species richness and abundance of snails, beetles, true bugs, spiders and breeding birds that avoid open farmland but occur in woody vegetation types. Additionally, the abundances of nine single species were analysed using specific habitat definitions. 3. Surprisingly, the effects of habitat isolation were more important than the effects of habitat amount. Effects at the patch scale were more frequent than landscape-scale effects. 4. Spider species richness decreased with increasing patch-scale habitat amount. Abundance of the weevil Phyllobius oblongus increased with landscapescale habitat amount. Negative effects of patch isolation were greater for predatory birds and spiders, while the predominately herbivorous beetles, true bugs and snails were less affected. Species richness of birds, spiders and beetles, and abundance of birds, Cyanistes caerules, Parus major and Fringilla coelebs, decreased with increasing patch-scale habitat isolation. In contrast, species richness of spiders and beetles increased with increasing landscape-scale habitat isolation. 5. Synthesis and applications. The effects of habitat fragmentation differed between taxonomic groups, with stronger and more consistent responses in birds than invertebrates. Our understanding of fragmentation effects may be biased due to the dominance of bird studies in the literature, and further invertebrate studies are encouraged. Landscape management to improve biodiversity or ecosystem services requires a group-specific approach and coordinated priority setting. High habitat connectivity benefited wood-preferring birds, spiders and beetles, lending support to national initiatives for increased habitat connectedness. The negative effects of patch isolation were greater for natural pest regulators, birds and spiders than for herbivorous beetles and bugs.

11.1-77
North American gross primary productivity: regional characterization and interannual variability
Baker I T, Denning A S, Stöckli R
USA, Switzerland
Plant Sciences, Meteorology & Atmospheric Sciences, Modelling, Remote Sensing
Seasonality and interannual variability in North American photosynthetic activity reflect potential patterns of climate variability. We simulate 24 yr (1983-2006) and evaluate regional and seasonal contribution to annual mean gross primary productivity (GPP) as well as its interannual variability. The highest productivity occurs in Mexico, the southeast United States and the Pacific Northwest. Annual variability is largest in tropical Mexico, the desert Southwest and the Midwestern corridor. We find that no single region or season consistently determines continental annual GPP anomaly. GPP variability is dependent upon soil moisture availability in low- and mid-latitudes, and temperature in the north. Soil moisture is a better predictor than precipitation as it integrates precipitation events temporally. The springtime anomaly is the most frequent seasonal contributor to the annual GPP variability. No climate mode (i.e. ENSO, NAM) can be associated with annual or seasonal variability over the entire continent. We define a region extending from the Northeast United States through the midwest and into the southwestern United States and northern Mexico that explains a significant fraction of the variability in springtime GPP. We cannot correlate this region to a single mechanism (i.e. temperature, precipitation or soil moisture) or mode of climate variability.

11.1-78
Shrub expansion may reduce summer permafrost thaw in Siberian tundra
Blok D, Heijmans M M P D, Schaeppman Strub G, Kononov A V, Maximov T C, Berendse F
The Netherlands, Switzerland, Russian Federation
Plant Sciences
Climate change is expected to cause extensive vegetation changes in the Arctic: deciduous shrubs are already expanding, in response to climate warming. The results from transect studies suggest that increasing shrub cover will impact significantly on the surface energy balance. However, little is known about the direct effects of shrub cover on permafrost thaw during summer. We experimentally quantified the influence of Betula nana cover on permafrost thaw in a moist tundra site in northeast Siberia with continuous permafrost. We measured the thaw depth of the soil, also called the active layer thickness (ALT), ground heat flux and net radiation in 10m diameter plots with natural B. nana cover (control plots) and in plots in which B. nana was removed (removal plots). Removal of B. nana increased ALT by 9% on average late in the growing season, compared with control plots. Differences in ALT correlated well with differences in ground heat flux between the control plots and B. nana removal plots. In the undisturbed control plots, we found an inverse correlation between B. nana cover and late growing season ALT. These results suggest that the expected expansion of deciduous shrubs in the Arctic region, triggered by climate warming, may reduce summer permafrost thaw. Increased shrub growth may thus partially offset further permafrost degradation by future temperature increases. Permafrost models need to include a dynamic vegetation component to accurately predict future permafrost thaw.

11.1-79
Seasonal variation in nitrogen isotopic composition of bog plant litter during 3 years of field decomposition
Bragazza L, Iacumin P, Siffi C, Gerdol R
Italy, Switzerland
Plant Sciences, Pedology, Forestry
In this study, we describe the seasonal variation in N-15 abundance in the litter of two Sphagnum species and four vascular plant species during 3 years of field decomposition in an Italian Alpine bog. Litter bags were periodically retrieved at the end of summer and winter periods, and the delta N-15 in residual litter was related to mass loss, litter chemistry, and climatic conditions. In Sphagnum litter, higher rates of decomposition during summer months were associated with an increase of delta N-15 probably due to the incorporation of microbial organic compounds rich in N-15. The litter of Eriophorum vaginatum and Carex rostrata was characterized by a decrease of delta N-15, so that the final signature was significantly lower than in initial litter. On the other hand, the residual litter of Potentilla erecta and Calluna vulgaris was characterized by a final delta N-15 higher than in initial litter. Our data reported a seasonality of N-15 abundance in the residual litter of Sphagnum species, but not in that of vascular plant species, thus highlighting the role of differences in litter chemistry. Biology and Fertility of Soils, 2010, V46, N8, OCT, pp 877-881 DOI: http://dx.doi.org/10.1007/s00374-010-0483-7.
Use of sap flow measurements to validate stomatal functions for mature beech (Fagus sylvatica) in view of ozone uptake calculations

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Switzerland
Forestry, Plant Sciences, Modelling

For a quantitative estimate of the ozone effect on vegetation reliable models for ozone uptake through the stomata are needed. Because of the analogy of ozone uptake and transpiration it is possible to utilize measurements of water loss such as sap flow for quantification of ozone uptake. This technique was applied in three beech (Fagus sylvatica) stands in Switzerland. A canopy conductance was calculated from sap flow velocity and normalized to values between 0 and 1. It represents mainly stomatal conductance as the boundary layer resistance in forests is usually small. Based on this relative conductance, stomatal functions to describe the dependence on light, temperature, vapour pressure deficit and soil moisture were derived using multivariate non-linear regression. These functions were validated by comparison with conductance values directly estimated from sap flow. The results corroborate the current flux parameterization for beech used in the DO3SE model.

Environmental Pollution, 2010, V158, N9, SEP, pp 2954-2963 DOI: http://dx.doi.org/10.1016/j.envpol.2010.05.028.

Modelling functional landscape connectivity from genetic population structure: a new spatially explicit approach

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Ecology, Landscape Studies, Modelling

Functional connectivity between spatially disjoint habitat patches is a key factor for the persistence of species in fragmented landscapes. Modelling landscape connectivity to identify potential dispersal corridors requires information about landscape features affecting dispersal. Here we present a new approach using spatial and genetic data of a highly fragmented population of capercaillie (Tetrao urogallus) in the Black Forest, Germany, to investigate effects of landscape structure on gene flow and to parameterize a spatially explicit corridor model for conservation purposes. Mantel tests and multiple regressions on distance matrices were employed to detect and quantify the effect of different landscape features on relatedness among individuals, while controlling for the effect of geographic distance. We extrapolated the results to an area-wide landscape permeability map and developed a new corridor model that incorporates stochasticity in simulating animal movement. The model was evaluated using both a partition of the data previously set apart and independent observation data of dispersing birds. Most land cover variables (such as coniferous forest, forest edges, agricultural land, roads, settlements) and one topographic variable (topographic exposure) were significantly correlated with gene flow. Although inter-individual relatedness inherently varies greatly and the variance explained by geographic distance and landscape structure was low, the permeability map and the corridor model significantly explained relatedness in the validation data and the spatial distribution of dispersing birds. Thus, landscape structure measurably affected within-population gene flow in the study area. By converting these effects into spatially explicit information our model enables localizing priority areas for the preservation or restoration of metapopulation connectivity.


Reconciling biodiversity conservation and food security: scientific challenges for a new agriculture

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Biodiversity, Agriculture, Ecology

Production ecology and conservation biology have long focused on providing the knowledge base for intensive food production and biodiversity conservation, respectively. With increasing global food insecurity and continuing biodiversity decline, we show that the largely separate development of these fields is counterproductive. Scenario analyses suggest that feeding the world is possible without further encroachment of agriculture into natural ecosystems. Without ignoring the necessary demographic, socio-economic, institutional and governance requirements, we make the case for a science that develops the best ecological means to produce food in a way that has substantially less negative effects on biodiversity and associated ecosystem services and, indeed, should be able to contribute to their persistence and enhancement. Recent developments in trait-based ecology should soon make it possible to adapt and (re-)design agroecosystems to meet both goals of biodiversity conservation and food security. However, there are real tensions between, on the one hand, the oppor-
tunity costs of biodiversity conservation (for direct use and for conversion to agriculture) and on the other hand, the ecosystem service values and option values associated with biodiversity. We elaborate the management of plant genetic resources as a metaphor of the tensions between such values of biodiversity and ecosystem services in general. We conclude that significant changes in policies, institutions and practices are necessary to make advances in ecology work for reconciling biodiversity conservation and food security.

Current Opinion in Environmental Sustainability, 2010, V2, N1-2, MAY, pp 34-42 DOI: http://dx.doi.org/10.1016/j.cosust.2010.03.007.

11.1-83 Plant succession and soil development on the foreland of the Morteratsch glacier (Pontresina, Switzerland): Straight forward or chaotic?
As study area we selected the glacier foreland of Morteratsch (approx. 1900-2100m a.s.l.) near Pontresina northwest of the Bernina pass, Upper Engadine, Grisons (Switzerland). The aim of this study is a multimethodological approach using floristic inventories, vegetation and soil mapping of the pro-glacial area in order to detect crucial parameters controlling plant resettlement in recently deglaciated areas as related to time, local micro-topography and soil development. The following methodological approaches were included in this study: (i) floristic relevés along a chronosequence covering 134 years (1857-1990); (ii) dendrocronological data on tree establishment, collected on a grid with a mesh width of 40 m in the area, which became ice-free between 1857 and 1980; (iii) vegetation mapping; (iv) soil analyses including physical and chemical properties of 11 typical profiles; (v) soil mapping and (vi) data evaluation using GIS. Retreating glaciers successively expose mineral substrates that are colonised within a few years by vascular plants, mosses, lichens and soil biota. With increasing plant cover, also the abundance of soil organic matter increases. At first sight, the large-scale patterns of vegetation and soil seem to be driven by the time since deglaciation, whereas the small scale patterns may appear chaotic since they depend on local site conditions, which may change dramatically over short distances. The large-scale pattern seems to develop as follows. About 7 years after deglaciation the first pioneer plants establish themselves and form after an additional 20 years period the Epilobietum fleischerei community, which today dominates the recently deglaciated areas, but may be found in patches more or less on the whole pro-glacial area. By contrast, the first elements of the short living Oxyrietum digynae community appear approximately 10 years after deglaciation and persist for only about 30 years. Dendrochronology showed that the first European larch and Swiss stone pine trees established themselves 15 and 31 years, respectively, after deglaciation. Surprisingly, on the study area, Swiss stone pine is about twice as frequent as the typical pioneer species European larch (88 stems per ha vs. 45 stems per ha), despite the fact that larch starts earlier and grows faster than Swiss stone pine (annual height increment: 21 cm vs. 8 cm). Up-to-now, however, nowhere in the 150-year-old glacier foreland a near-to-mature larch-Swiss stone pine forest can be found. Besides large-scale factors such as time since deglaciation, topography and disturbance (floods, rockfalls, avalanches), also small-scale factors such as grain size and water content of the substrate, micro-relief and micro-climate seem to be crucial for the development of both vegetation and soil. Time since deglaciation and a straightforward single-pathway succession model are clearly not sufficient for understanding the small-scale patterns of succession. A non-linear succession model with different starting points and different pathways of potential primary successions for the different ecological niches is more promising for describing accurately the spatio-temporal vegetation dynamics of the pro-glacial area of Morteratsch.

11.1-84 Evaluating a Forest Conservation Plan with Historical Vegetation Data – A Transdisciplinary Case Study from the Swiss Lowlands
Bürgi M, Steck C, Bertiller R Switzerland, Germany Forestry, Plant Sciences, Biodiversity
Forest types shaped by humans host a specific set of plant species that may disappear subsequent to the abandonment of traditional uses of the forest. To improve the effectiveness of conservation management for plant species associated with traditionally managed forests, information on historical forest conditions and plant occurrence is vital. In the Swiss Canton Zurich, an action plan to promote light forests has been initiated by the state office for nature protection. This action plan has defined a set of 172 target species for light forests. In order to evaluate in which forest types
these species occurred historically, we combined a vegetation survey from 1907 from the wooded mountain range of Lägern (Switzerland) with information on forest structure in the early 20th century based on forest management plans. For 21 target species, 181 locations were determined and linked to historical forest structures. We recommend enhancing the effectiveness of the action plan for light forests by recreating coppice-with-standard forest on productive soils, considering the role of non-timber forest uses for ecosystem development, and engaging private forest owners to assist in the creation of light forest reserves. 


11.1-85

Community development along a proglacial chronosequence: are above-ground and below-ground community structure controlled more by biotic than abiotic factors?

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Switzerland, USA, France

*Plant Sciences, Pedology, Microbiology, Ecology, Biodiversity*

1. We studied vascular plant and soil-dwelling testate amoeba communities in deglaciated sites across a range of substrate ages in Kenai Fjords, Alaska, USA to test four hypotheses. (i) Patterns of community assembly are similar for vascular plants and testate amoebae. (ii) Vascular plant and testate amoeba communities are more strongly correlated to abiotic variables than to each other, since these communities are not directly linked trophically. (iii) Plant community structure becomes less associated with abiotic condition in succession relative to testate amoeba, as species replacement is believed to be more common for plants than testate amoebae. (iv) Above- and below-ground communities become more strongly linked over the succession, due a shift from predominantly allogenic to autogenic forces. 2. We assessed relationships among biotic communities and abiotic site variables across the chronosequence using multiple factor analysis, redundancy analysis (RDA) and a moving-window analysis. 3. The diversity patterns and the communities’ response to site and soil variables differed between groups. The composition of both communities was significantly explained by bedrock type and moisture regime. The vascular plant community, however, was more influenced by distance from the glacier. 4. Testate amoeba and vascular plant community patterns were significantly linked to each other and to location and physical conditions. The moving-window RDA indicates the variation explained by the physical and chemical environment tended to slightly decrease through the chronosequence for testate amoebae, while a bell-shape response was evidenced for vascular plants. The variation of the microbial community explained by the plant community was very low in the early stages of the succession and became higher than the variation explained by the environmental variables later in the chronosequence. 5. Synthesis. These results suggest that vascular plants and testate amoebae are as linked or more in ecosystem development than either community is to changes in site condition. Furthermore, the strength of interactions varies along the succession. Thus, ecological links may be more important than macro-scale abiotic site condition is to community development, even between communities without direct trophic interactions.


11.1-86

Why the inaction on biodiversity?

Chapron G, Arlettaz R, Boitani L

Sweden, Switzerland, Italy

*Biodiversity, Ecology*

11.1-87

Restoring degraded ecosystems in the Sahel


Switzerland, Burkina Faso

Ecology, Forestry

The prolonged period of water stress experienced by the Sahel since the 1970s and the gradual sedimentation of nomadic tribes have caused local degradation and over-exploitation of the region’s fragile ecosystems, especially shrub savannah. Ecosystems are assessed as degraded when they lose their resilience as a result of changes that can only be reversed with difficulty, if at all. Degraded ecosystems are characterised by increasing scarcity or complete loss of woody and herbaceous flora, reduced biological soil activity and increased surface run-off and erosion. Restoring plant cover on degraded surfaces is critical to controlling and halting desertification. This article describes the results of a six-year programme to monitor the recovery of degraded ecosystems in northern Burkina Faso (Oudatan province). The results show the value, when restoring even the most degraded Sahelian landscapes, of the approach involving the creation of semicircular depressions to collect rainwater. The areas treated in this way showed
sustained production of herbaceous biomass (about 1 000 to 1 200 kilograms of dry matter per hectare and per year, on average) and significant forest cover (about 350 trees per hectare), with trees capable of spontaneous growth even under pressure from traditional extensive grazing and years of water stress.


11.1-88
Effects of multi-species swards on dry matter production and the incidence of unsown species at three Irish sites
Connolly J, Finn J A, Black A D, Kirwan L, Brophy C, Lüscher A
Ireland, Switzerland, New Zealand
Plant Sciences, Biodiversity, Ecology, Agriculture
Recent ecological research provides evidence that an increased number of plant species in natural grasslands is associated with increased biomass productivity, and provides a wide range of other ecosystem benefits. This suggests that increases in species diversity in agricultural ecosystems may similarly lead to increased benefits. The work reported below was part of the COST 852 Agrodiversity experiment, carried out at 34 sites across Europe. In Ireland, the effects of four-species grass-clover mixtures on herbage production, species persistence and unsown species suppression at three sites over multiple years, were investigated under growing conditions that were intensive relative to unfertilised natural grassland systems. The design included a range of four-species mixtures and monocultures of perennial ryegrass, timothy, cocksfoot, white clover, red clover and Caucasian clover. Several harvests were taken at each site for two or three years. Species diversity had a strong, persistent and positive effect on overall yield and the yield of sown species, and enhanced resistance to the growth of unsown species. Mixtures generally yielded well when compared with the best monoculture, and sometimes out yielded it. These effects on total yield declined over time but were still important at the end of the experiments. The diversity effects on sown species yield and on resistance to unsown species increased with time. Diversity effects were robust to changes in species composition, and persisted for the duration of the experiments across mixtures and over time. Virtually every mixture had a higher yield, and suppressed unsown species better, than monocultures of perennial ryegrass. These patterns were broadly consistent across sites. The persistence of species varied widely and was not consistent across sites.


11.1-89
Food or nesting place? Identifying factors limiting Wryneck populations
Coudrain V, Arlettaz R, Schaub M
Switzerland
Zoology, Ecology, Biodiversity, Agriculture
In recent decades, farmland bird populations have declined strongly as a consequence of agriculture intensification. Birds may have lost breeding sites, food supply or other crucial resources, with the role of multiple factors often remaining unclear. The ant-eating and cavity-breeding Wryneck (Jynx torquilla) may be limited by the availability of cavities, the number of ants or their accessibility. By comparing occupied and unoccupied breeding territories, we investigated the relative role of these factors in the decline of Wrynecks. We compared the characteristics of known Wryneck breeding territories (availability of breeding cavities, food abundance and ground vegetation structure) with randomly selected, fictitious territories (n = 154) in Western Switzerland. We also studied environmental factors that may affect ant nest density. The probability of territory occupancy strongly increased with both nestbox availability and ant abundance. In addition, this probability peaked around 50% of bare ground cover. Habitat types that harbour low ant abundance such as cropland and grassland were avoided. Ant nest density decreased with increasing amounts of bare ground, and it was particularly high in vineyards. Our results showed that breeding cavities, food availability and its accessibility all limit Wryneck distribution. The maintenance and restoration of ant rich grassland, interspersed with patches of bare ground and with hollow trees or dedicated nestboxes in the surroundings, are essential to preserve Wryneck populations. Such a habitat structure could be achieved even in intensively farmed habitats, such as in vineyards or fruit tree plantations.


11.1-90
Improving indicator species analysis by combining groups of sites
de Caceres M, Legendre P, Moretti M
Canada, Switzerland
Biodiversity, Ecology
Indicator species are species that are used as ecological indicators of community or habitat types, environmental conditions, or environmental changes. In order to determine indicator species, the characteristic to be predicted is represented
in the form of a classification of the sites, which is compared to the patterns of distribution of the species found at the sites. Indicator species analysis should take into account the fact that species have different niche breadths: if a species is related to the conditions prevailing in two or more groups of sites, an indicator species analysis undertaken on individual groups of sites may fail to reveal this association. In this paper, we suggest improving indicator species analysis by considering all possible combinations of groups of sites and selecting the combination for which the species can be best used as indicator. When using a correlation index, such as the point-biserial correlation, the method yields the combination where the difference between the observed and expected abundance/frequency of the species is the largest. When an indicator value index (IndVal) is used, the method provides the set of site-groups that best matches the observed distribution pattern of the species. We illustrate the advantages of the method in three different examples. Consideration of combinations of groups of sites provides an extra flexibility to qualitatively model the habitat preferences of the species of interest. The method also allows users to cross multiple classifications of the same sites, increasing the amount of information resulting from the analysis. When applied to community types, it allows one to distinguish those species that characterize individual types from those that characterize the relationships between them. This distinction is useful to determine the number of types that maximizes the number of indicator species.

**Tree-ring Delta C-13 reveals the impact of past forest management on water-use efficiency in a Mediterranean oak coppice in Tuscany (Italy)**

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**Italy, Switzerland**

**Forestry , Plant Sciences**

The effects of thinning and heavy stand density reduction was investigated in Turkey oak (Quercus cerris L.) forests of central Italy, to evaluate the physiological responses and the growth status of trees that survived a past coppice cut and thinning to convert the stand to high-forest. The working hypothesis was that a strong decrease in stand density would cause a decreasing in canopy-intrinsic water-use efficiency (measured as the ratio of CO$_2$ assimilation to stomatal conductance, $A/g$), thus an increase in tree-ring carbon isotopic discrimination (Delta C-13). The tree-ring Delta C-13 of the remaining trees ("survivors") was found to have significantly ($P < 0.05$) raised between year two and year seven since the coppice stand was thinned (high-forest conversion thinnings). This effect was mostly caused by a large decrease in tree-rings Delta C-13 at control site which was characterized by high density and competition by trees. An increase in survivors tree-rings Delta C-13 probably indicates an improved water availability, possibly induced by a decrease in competition and in stand density or a decrease in the precipitation intercepted by the canopy (i.e., a stronger increase in $g$ over $A$ since a decrease in $A$ is highly unlikely). A change in foliar nitrogen, foliar Delta C-13 and content in chlorophylls was also recorded seven years after thinning. Thinnings carried out to convert old abandoned coppices into high-forest stands induce short-term stimulation of Turkey oak growth by increasing light and water availability. We were able to make a detailed reconstruction of the impact of past silvicultural treatment on the stand using a tree-ring wood Delta C-13 time-series.

**Annals of Forest Science, 2010, V67, N5, JUL-AUG**

**ARTN: 510, DOI: http://dx.doi.org/10.1051/for-est/2010012.**

**11.1-92**

**Biodiversity in forest carbon sequestration initiatives: not just a side benefit**

Diaz S, Hector A, Wardle D A

**Argentina, Switzerland, Sweden**

**Biodiversity , Forestry , Plant Sciences , Ecology**

One way of mitigating global climate change is protecting and enhancing biosphere carbon stocks. The success of mitigation initiatives depends on the long-term net balance between carbon gains and losses. The biodiversity of ecological communities, including composition and variability of traits of plants and soil organisms, can alter this balance in several ways. This influence can be direct, through determining the magnitude, turnover rate, and longevity of carbon stocks in soil and vegetation. It can also be indirect through influencing the value and therefore the protection that societies give to ecosystems and their carbon stocks. Biodiversity of forested ecosystems has important consequences for long-term carbon storage, and thus warrants incorporation into the design, implementation, and regulatory framework of mitigation initiatives.

**Current Opinion in Environmental Sustainability, 2009, V1, N1, OCT, pp 55-60 DOI: http://dx.doi. org/10.1016/j.cosust.2009.08.001.**
11.1-93
Interesting saxicolous lichens at Tossen near Schimbrigbad in the UNESCO Biosphere Entlebuch (Canton of Lucerne, Central Switzerland)

Dietrich M, Bürgi Meyer K
Switzerland

Plant Sciences, Biodiversity, Ecology

The description of the interesting lichen flora of the rock habitat at Tossen complements the knowledge of saxicolous species in the UNESCO Biosphere Entlebuch. At an altitude of 1480m 61 lichen species were observed inhabiting the rock. Caloplaca dichroa, C. pusilla and Fulgensia klementii are mentioned for the first time from Switzerland. Acrocordia conoidea, Diplomemma alboatrum, Fulgensia bracteata subsp. deformis, Lecanora agardhiana, Pyxidula byssophila, Synalissa symphorea and Thelidium minimum are mentioned for the first time from the canton of Lucerne. Further species, until now only rarely registered in Switzerland, are mentioned specially, among them Lecanora reuteri, Naetrocymbe saxicola and Squamarina lamarkii. The documented lichen flora is very similar to comparable places at Mount Pilatus, from where the occurrence of Dacampia hookeri, Lecanora admontensis and Leucocarpia biatorella is mentioned for the first time from the canton of Lucerne.

Herzogia, 2010, V23, N1, pp 75-84.

11.1-94
Nitrogen balances in farmers fields under alternative uses of a cover crop legume: a case study from Nicaragua

Douxchamps S, Humbert F L, van der Hoek R, Mena M, Bernasconi S M, Schmidt A, Rao I, Frossard E, Oberson A
Switzerland, Nicaragua, Colombia

Agriculture, Plant Sciences, Pedology

Canavalia brasiliensis (canavalia), a drought tolerant legume, was introduced into the smallholder traditional crop-livestock production system of the Nicaraguan hillsides as green manure to improve soil fertility or as forage during the dry season for improving milk production. Since nitrogen (N) is considered the most limiting nutrient for agricultural production in the target area, the objective of this study was to quantify the soil surface N budgets at plot level in farmers fields over two cropping years for the traditional maize/bean rotation and the alternative maize/canavalia rotation. Mineral fertilizer N, seed N and symbiotically fixed N were summed up as N input to the system. Symbiotic N2 fixation was assessed using the N15 natural abundance method. Nitrogen output was quantified as N export via harvested products. Canavalia derived in average 69% of its N from the atmosphere. The amount of N fixed per hectare varied highly according to the biomass production, which ranged from 0 to 5,700 kg ha(-1). When used as green manure, canavalia increased the N balance of the maize/canavalia rotation but had no effect on the N uptake of the following maize crop. When used as forage, it bears the risk of a soil N depletion up to 41 kg N ha(-1) unless N would be recycled to the plot by animal manure. Without N mineral fertilizer application, the N budget remains negative even if canavalia was used as green manure. Therefore, the replenishment of soil N stocks by using canavalia may need a few years, during which the application of mineral N fertilizer needs to be maintained to sustain agricultural production.


11.1-95
Agricultural legacy, climate, and soil influence the restoration and carbon potential of woody regrowth in Australia

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Australia, Switzerland

Forestry, Plant Sciences, Pedology, Modelling, Agriculture, Landscape Studies

Opportunities for dual restoration and carbon benefits from naturally regenerating woody ecosystems in agricultural landscapes have been highlighted recently. The restoration capacity of woody ecosystems depends on the magnitude and duration of ecosystem modification, i.e., the “agricultural legacy.” However, this legacy may not influence carbon sequestration in the same way as restoration because carbon potential depends primarily on biomass accumulation, with little consideration of other attributes and functions of the ecosystem. Our present study simultaneously assesses the restoration and carbon potential of Acacia harpophylla regrowth, an extensive regrowth ecosystem in northeastern Australia. We used a landscape-scale survey of A. harpophylla regrowth to test the following hypotheses: (1) management history, in combination with climatic and edaphic factors, has long-term effects on stem densities, and (2) higher-density stands have lower restoration and carbon potential, which is also influenced by climatic and edaphic factors. We focused on the restoration of forest structure, which was characterized using stem density, aboveground biomass, stem heights, and stem diameters. Data were analyzed using multilevel models within the hierarchical Bayesian model (HBM) framework.
found strong support for both hypotheses. Repeated attempts at clearing Brigalow (A. harpophylla ecosystem) regrowth increases stem densities, and these densities remain high over the long term, particularly in high-rainfall areas and on gilgai, high-clay soils (hypothesis 1). In models testing hypothesis 2, interactions between stem density and stand age indicate that higher-density stands have slower biomass accumulation and structural development in the long term. After accounting for stem density and stand age, annual rainfall had a positive effect on biomass accumulation and structural development. Other climate and soil variables were retained in the various models but had weaker effects. Spatial extrapolations of the HBMs indicated that the central and eastern parts of the study region are most suitable for biomass accumulation; however, these may not correspond to the areas that historically supported the highest biomass Brigalow forests. We conclude that carbon and restoration goals are largely congruent within areas of similar climate. At the regional scale, however, spatial prioritization of restoration and carbon projects may only be aligned where carbon benefits will be high.


11.1-96
Contribution of multi-source remote sensing data to predictive mapping of plant-indicator gradients within Swiss mire habitats

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Switzerland
Plant Sciences, Remote Sensing, Ecology

Remotesensing plays an important role in wetland monitoring on the regional and global scale. In this study we assessed the potential of different optical sensors to map floristic indicator gradients across complex mire habitats at the stand level. We compared traditional CIR photographs from RC30 cameras with modern digital ADS40 data and SPOT5 satellite images as well as finescale topo-structure derived from LIDAR data. We derived about 70 spectral and 30 topo-structural variables and evaluated their ability to predict the mean ecological indicator values of the vegetation across a sample of 7 mire objects. The airborne images (RC30, ADS40) and the LIDAR data were found to have a high potential for use in vegetation mapping; they explained on average 50% of the variation in observed ecological indicator values. The RC30 data slightly outperformed the less optimally collected ADS40 data. The LIDAR topo-structural variables showed equal overall predictive power as the airborne images, but they performed clearly better in predicting soil moisture, soil dispersion and light. Combining both airborne images and topo-structural data improved the predictions of all indicator values considerably. The combined use of these data sources is therefore recommended for use in fine-scale monitoring of priority habitats in nature conservation.

Botanica Helvetica, 2010, V120, N1, JUL, pp 29-42
DOI: http://dx.doi.org/10.1007/s00035-010-0070-4.

11.1-97
Contribution of advection to the carbon budget measured by eddy covariance at a steep mountain slope forest in Switzerland

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Switzerland
Forestry, Plant Sciences, Meteorology & Atmospheric Sciences

We calculated the contribution of advection to the C budget measured by the eddy covariance (EC) technique for a steep and forested mountain site (CarboEurope site CH-Lae, Lageren, Switzerland) during the growing season 2007 (May to August). Thereby we followed two approaches: (1) the physical correction of the EC data for directly measured advection terms and (2) the u(*) filter approach that replaces periods with u(*) below a site-specific threshold with empirically modelled fluxes. We found good agreement between the two approaches in terms of daily (linear regression slope: 0.78 +/- 0.04, intercept: 0.68 +/- 0.29 µmol m(-2) s(-1), adj. R2=0.78) and seasonal sums of gross fluxes (difference < 12%), when using a u(*) threshold of 0.3 m s(-1) and correcting EC for horizontal advection only. Incorporating also vertical advection into the mass balance equation resulted in unrealistic and highly erratic fluxes. However, on a daily basis vertical advection cancelled out to nearly zero. The u(*) filter seems to account primarily for respiration fluxes, which are mainly affected by horizontal advection. We could confirm our corrections by a cross-validation with independent approaches, such as soil respiration chamber measurements, light curves and energy budget closure. Our results show that flux measurements on steep sites with complex topography are possible. Actually, sloping sites seem to have the advantage over flat sites that advection measurements can be reduced to a simplified two-dimensional measurement approach due to the two-dimensional characteristics of the wind field at those sites.

11.1-98
Ecosystem services: an evolutionary perspective on the links between biodiversity and human well-being
Faith D P, Magallon S, Hendry A P, Conti E, Yahara T, Donoghue M J
Australia, Mexico, Canada, Switzerland, Japan, USA
Biodiversity, Ecology
A framework for exploring regional-scale trade-offs among ecosystem services and biodiversity protection has been established for some time, and it is clear that optimizing these trade-offs provides a strategy to address targets for a reduced rate of biodiversity loss. Recent trade-off studies have highlighted the need for better biodiversity measures, to complement measures of ecosystem services. Biodiversity typically has been linked in this context to existence and other non-use values. We argue that biodiversity will have a stronger role in such trade-off analyses if measures of biodiversity better reflect additional current and future services. These ‘evosystem services’ have been, and, if we are careful, can continue to be provided by the evolutionary process. Some services have been provided through evolution operating in the past, and a phylogenetic diversity measure can help us to quantify these current and potential future benefits derived from the tree of life. Furthermore, a variety of evosystem services are delivered through ongoing contemporary evolution, and value should therefore be placed on the maintenance of healthy evosystems. We argue that the concept of evosystem services could be useful as a complement to the traditional concept of ecosystem services. Together, these reflect a fuller range of the services supported by biodiversity, and thereby provide a sounder basis for conservation planning and decision-making. Current Opinion in Environmental Sustainability, 2010, V2, N1-2, MAY, pp 66-74 DOI: http://dx.doi.org/10.1016/j.cosust.2010.04.002.

11.1-99
Adaptation and extinction in experimentally fragmented landscapes
Fakheran S, Paul Victor C, Heichinger C, Schmid B, Grossniklaus U, Turnbull L A
Switzerland
Landscape Studies, Ecology, Plant Sciences
Competition and disturbance are potent ecological forces that shape evolutionary trajectories. These forces typically work in opposition: when disturbance is infrequent, densities are high and competition is intense. In contrast, frequent disturbance creates a low-density environment in which competition is weak and good dispersal essential. We exploited recent advances in genomic research to quantify the response to selection by these powerful ecological forces at the phenotypic and molecular genetic level in experimental landscapes. We grew the annual plant Arabidopsis thaliana in discrete patches embedded in a hostile matrix and varied the number and size of patches and the intensity of disturbance, by creating both static and dynamic landscapes. In static landscapes all patches were undisturbed, whereas in dynamic landscapes all patches were destroyed in each generation, forcing seeds to disperse to new locations. We measured the resulting changes in phenotypic, genetic, and genotypic diversity after five generations of selection. Simulations revealed that the observed loss of genetic diversity dwarfed that expected under drift, with dramatic diversity loss, particularly from dynamic landscapes. In line with ecological theory, static landscapes favored good competitors; however, competitive ability was linked to growth rate and not, as expected, to seed mass. In dynamic landscapes, there was strong selection for increased dispersal ability in the form of increased inflorescence height and reduced seed mass. The most competitive genotypes were almost eliminated from highly disturbed landscapes, raising concern over the impact of increased levels of human-induced disturbance in natural landscapes.

11.1-100
Allelochemicals of the invasive neophyte Polygonum cuspidatum Sieb. & Zucc. (Polygonaceae)
Fan P, Hostettmann K, Lou H
Peoples R China, Switzerland
Biodiversity, Plant Sciences, Ecology
Polygonum cuspidatum Sieb. and Zucc., a traditional Chinese medicine is now a wide-spread invasive neophyte in Europe and America. The novel weapon hypothesis states that some invasive weed species owe part of their success as invaders to allelopathy mediated by some allelochemicals. Previous HPLC/UV/ESI-MS analysis showed that the constituents of the roots of P. cuspidatum from China were obviously different from the species collected in Switzerland (present as an invasive neophyte) with respect to piceatannol glucoside, resveratrolsides and some proanthocyanidin. This work isolated these special constituents from the invasive plant and studied their allelopathy effect, as well as the related structures by the seedling
and growing model of Lepidium sativum (garden cress, Brassicaceae). The results revealed that stilbenes as piceatannol glucoside, resveratrol glucoside and proanthocyanidins as catechin, epicatechin from this plant were comparatively stronger allelochemicals than the reported allelochemical (-)-catechin, which may partly explain the invasive behavior of this plant in Europe.

Chemocoeology, 2010, V20, N3, SEP, pp. 223-227
DOI: http://dx.doi.org/10.1007/s00049-010-0052-4.

11.1-101
Implementing large-scale and long-term functional biodiversity research: The Biodiversity Exploratories
Switzerland, Germany
Biodiversity , Ecology , Plant Sciences
Functional biodiversity research explores drivers and functional consequences of biodiversity changes. Land use change is a major driver of changes of biodiversity and of biogeochemical and biological ecosystem processes and services. However, land use effects on genetic and species diversity are well documented only for a few taxa and trophic networks. We hardly know how different components of biodiversity and their responses to land use change are interrelated and very little about the simultaneous, and interacting, effects of land use on multiple ecosystem processes and services. Moreover, we do not know to what extent land use effects on ecosystem processes and services are mediated by biodiversity change. Thus, overall goals are on the one hand to understand the effects of land use on biodiversity, and on the other to understand the modifying role of biodiversity change for land-use effects on ecosystem processes, including biogeochemical cycles. To comprehensively address these important questions, we recently established a new large-scale and long-term project for functional biodiversity, the Biodiversity Exploratories (www.biodiversity-exploratories.de). They comprise a hierarchical set of standardized field plots in three different regions of Germany covering manifold management types and intensities in grasslands and forests. They serve as a joint research platform for currently 40 projects involving over 300 people studying various aspects of the relationships between land use, biodiversity and ecosystem processes through monitoring, comparative observation and experiments. We introduce guiding questions, concept and design of the

Biodiversity Exploratories - including main aspects of selection and implementation of field plots and project structure - and we discuss the significance of this approach for further functional biodiversity research. This includes the crucial relevance of a common study design encompassing variation in both drivers and outcomes of biodiversity change and ecosystem processes, the interdisciplinary integration of biodiversity and ecosystem researchers, the training of a new generation of integrative biodiversity researchers, and the stimulation of functional biodiversity research in real landscape contexts, in Germany and elsewhere.

DOI: http://dx.doi.org/10.1016/j.baae.2010.07.009.

11.1-102
Responses of wood anatomy and carbon isotope composition of Quercus pubescent saplings subjected to two consecutive years of summer drought
Switzerland, Spain, Germany
Forestry , Plant Sciences
To withstand and to recover from severe summer drought is crucial for trees, as dry periods are predicted to occur more frequently over the coming decades. In order to better understand growth-related tree responses to drought, wood formation, vessel characteristics and stable carbon isotope composition (delta C-13) in tree rings of Quercus pubescens saplings imposed to two consecutive summer droughts were compared with regularly watered control trees. In both years, photosynthetic activity was strongly inhibited during the drought periods of five to seven weeks but quickly restored after re-watering, reinitiating wood formation. Stress caused more than a 20% reduction in ring width, a 0.5 parts per thousand increase in latewood delta C-13 and changes in vessels characteristics in both the current year latewood and the next year earlywood. The latewood displayed up to 90% increased hydraulic conductivity than control trees, likely to compensate for a cavitation-induced reduction of water transport. The earlywood after the first drought year was characterized by more but smaller vessels suggesting the attempt of restoring conductivity while minimizing the risk of hydraulic failure. However, after the second year, the reduction of hydraulic conductivity and the increased delta C-13 values indicate a structural adjustment towards a reduced growth induced by exhaustion of carbon reserves.

Annals of Forest Science, 2010, V67, N8, DEC
ARTN: 809, DOI: http://dx.doi.org/10.1051/forest/2010045.
A Recount of Tropical Tree Species
Ghazoul J
Switzerland
Forestry, Plant Sciences

Long-term dynamics of aboveground fungal communities in a subalpine Norway spruce forest under elevated nitrogen input
Gillet F, Peter M, Ayer F, Büttler R, Egli S
France, Switzerland
Ecology, Plant Sciences, Forestry, Pedology
As anthropogenic N deposition has been suspected to be the main reason for the decline of macromycetous sporocarp production in forest ecosystems, various N-fertilization experiments were started in the mid 1990s. The dynamics of ectomycorrhizal (root-inhabiting) and terricolous saprobic (litter-inhabiting) fungal communities were studied by exhaustive sporocarp inventories in a substitution Norway spruce (Picea abies) forest in two 256-m² plots sampled for periods of 1 week at 1-m² resolution between 1994 and 2007. N was added to the soil twice per year in one plot from the fourth year onwards. The effects of N input and time on aboveground fungal communities were assessed using redundancy analysis, principal response curves and non-parametric multivariate ANOVA. Results of this long-term experiment revealed that both ectomycorrhizal and saprobic fungal communities responded to an increase in soil N input. The ectomycorrhizal community reacted by a fast decrease in sporocarp production and in species richness, whereas the saprobic community was less affected. The response was highly species specific, especially for the saprobic community. The difference in species composition between control and fertilized plots was significant after 1 year of N addition for ectomycorrhizal fungi and only after 3 years for saprobic fungi. An aging effect affected sporocarp production in the whole area. For both communities, this unidirectional drift in species composition was as important as the treatment effect. This result highlights the importance of considering the respective role of treatment and year effects in long-term field experiments on fungal communities.

Land-use and climate change effects in forest compositional trajectories in a dry Central-Alpine valley
Gimmi U, Wohlgemuth T, Rigling A, Hoffmann C W, Bürgi M
Switzerland
Forestry, Plant Sciences, Biodiversity
Increased mortality of Scots pine (Pinus sylvestris L) and spreading of deciduous trees are observed in the Swiss Rhone valley. Previous research identified climate change effects as main drivers of this trend. On the local scale, we hypothesize that legacies from past anthropogenic disturbances are superimposed on climate effects. We reconstructed land-use history and quantified changes in tree species composition from 1930 to 1994 on 9468 ha of forested land. The aim was to analyze the contribution of anthropogenic disturbances to the observed changes and to disentangle human impact from climate change effects. At altitudes below 1200 m a.s.l. we found a shift from pine (+11.4%) to deciduous trees (+11%) with significantly lower increase of deciduous trees in stands formerly used for grazing and/or litter collecting. Conversely, pine decrease was not correlated with former anthropogenic disturbances. We interpret pine mortality as an effect of increased drought stress due to climate change while spread of deciduous trees is driven by land-use change. Grazing and litter collecting hindered deciduous tree regeneration and it was not until their abandonment a few decades ago that forest composition started to change. At higher elevations the shift from Norway spruce (Picea abies; -8.5%) to European larch (Larix decidua; +8.2%) corresponds to silvicultural management schemes, aimed at promoting larch recruitment. Our study illustrates the importance of disentangling climate from land-use change effects for understanding shifts in forest composition. The findings are relevant for other regions in the European Alps where forests undergo comparable environmental changes.

The future of the global food system
England, Switzerland, Scotland
Agriculture
Although food prices in major world markets are at or near a historical low, there is increasing con-
cern about food security—the ability of the world to provide healthy and environmentally sustainable diets for all its peoples. This article is an introduction to a collection of reviews whose authors were asked to explore the major drivers affecting the food system between now and 2050. A first set of papers explores the main factors affecting the demand for food (population growth, changes in consumption patterns, the effects on the food system of urbanization and the importance of understanding income distributions) with a second examining trends in future food supply (crops, livestock, fisheries and aquaculture, and ‘wild food’). A third set explores exogenous factors affecting the food system (climate change, competition for water, energy and land, and how agriculture depends on and provides ecosystem services), while the final set explores cross-cutting themes (food system economics, food wastage and links with health). Two of the clearest conclusions that emerge from the collected papers are that major advances in sustainable food production and availability can be achieved with the concerted application of current technologies (given sufficient political will), and the importance of investing in research sooner rather than later to enable the food system to cope with both known and unknown challenges in the coming decades.

**11.1-107 Five-year changes in Swiss mire vegetation**
Graf U, Wildi O, Küchler M, Ecker K
Switzerland
Ecology, Biodiversity, Plant Sciences, Marine & Freshwater Biology

To assess whether short-term changes in mire vegetation can be detected using the phytosociological approach, paired vegetation relevés from two surveys of 112 mire sites of Switzerland were assigned to phytosociological alliances through a numerical approach. About 30% of the plots were assigned to different alliances in the two surveys. These transitions were analysed based on species frequencies and interpreted ecologically using Landolt’s indicator values. Transitions between different alliances were more frequently related to the appearance of new species rather than to the disappearance of species. Transitions from fen to peat bog communities were frequent. Many plots with fen vegetation were transformed into other wetland types. Fen-grassland increased in abundance, mainly at the cost of small-sedge fens. To re-establish the function of the Swiss mires as peat producers, we recommend to raise the mean summer water table to a maximum depth of 10 cm.

**11.1-108 Anthropogenic NOx emissions alter the intrinsic water-use efficiency (WUEi) for Quercus cerris stands under Mediterranean climate conditions**
Guerrieri R, Siegwolf R, Saurer M, Ripullone F, Menicucci M, Borghetti M
Italy, Switzerland, Scotland
Forestry, Plant Sciences, Energy & Fuels, Hydrology

We investigated the effect of N deposition (Ndep) on intrinsic water-use efficiency (WUEi), the ratio of photosynthesis (A) to stomatal conductance (gs), for two Quercus cerris stands at different distances to an oil refinery in Southern Italy. We used delta C-13 in tree rings for assessing changes in WUEi; while the influence of climate and NOx emission was explored through delta O-18 and delta N-15, respectively. Differences in WUEi between the two sites were significant, with trees exposed to different degrees of NOx emissions showing an abrupt increase with the onset of pollution. Assuming similar gs at the two sites, as inferred through delta O-18, the higher N availability at the polluted site caused the shift of the A/gs ratio in favour of A. Overall, our result suggests that an increase of Ndep may enhance tree WUE under a scenario of reduction of precipitation predicted for Mediterranean area.

**11.1-109 Mosses as biomonitor of atmospheric heavy metal deposition: Spatial patterns and temporal trends in Europe**
Wales, Norway, Finland, Italy, Byelarus, Ukraine, Turkey, Denmark, Belgium, Spain, Latvia, Russia, Poland, Slovenia, Serbia, Lithuania, France, Estonia, Iceland, Slovakia, Germany, Croatia, Czech Repub-
In recent decades, mosses have been used successfully as biomonitor s of atmospheric deposition of heavy metals. Since 1990, the European moss survey has been repeated at five-yearly intervals. Although spatial patterns were metalspecific, in 2005 the lowest concentrations of metals in mosses were generally found in Scandinavia, the Baltic States and northern parts of the UK: the highest concentrations were generally found in Belgium and south-eastern Europe. The recent decline in emission and subsequent deposition of heavy metals across Europe has resulted in a decrease in the heavy metal concentration in mosses for the majority of metals. Since 1990, the concentration in mosses has declined the most for arsenic, cadmium, iron, lead and vanadium (52-72%), followed by copper, nickel and zinc (20-30%), with no significant reduction being observed for mercury (12% since 1995) and chromium (2%). However, temporal trends were country-specific with sometimes increases being found.

Environmental Pollution, 2010, V158, N10, OCT, pp 3144-3156 DOI: http://dx.doi.org/10.1016/j.envpol.2010.06.039.

11.1-110

General stabilizing effects of plant diversity on grassland productivity through population asynchrony and overyielding


Insurance effects of biodiversity can stabilize the functioning of multispecies ecosystems against environmental variability when differential species’ responses lead to asynchronous population dynamics. When responses are not perfectly positively correlated, declines in some populations are compensated by increases in others, smoothing variability in ecosystem productivity. This variance reduction effect of biodiversity is analogous to the risk-spreading benefits of diverse investment portfolios in financial markets. We use data from the BIODEPTH network of grassland biodiversity experiments to perform a general test for stabilizing effects of plant diversity on the temporal variability of individual species, functional groups, and aggregate communities. We tested three potential mechanisms: reduction of temporal variability through population asynchrony; enhancement of long-term average performance through positive selection effects; and increases in the temporal mean due to overyielding. Our results support a stabilizing effect of diversity on the temporal variability of grassland aboveground annual net primary production through two mechanisms. Two-species communities with greater population asynchrony were more stable in their average production over time due to compensatory fluctuations. Overyielding also stabilized productivity by increasing levels of average biomass production relative to temporal variability. However, there was no evidence for a performance-enhancing effect on the temporal mean through positive selection effects. In combination with previous work, our results suggest that stabilizing effects of diversity on community productivity through population asynchrony and overyielding appear to be general in grassland ecosystems.


11.1-111

Spiders associated with the meadow and tree canopies of orchards respond differently to habitat fragmentation

Herrmann J D, Bailey D, Hofer G, Herzog F, Schmidt Entling M H Switzerland

Zoology, Ecology, Agriculture, Forestry

The response of animal communities to habitat quality and fragmentation may vary depending on microhabitat associations of species. For example, sensitivity of species to woody habitat fragmentation should increase with their degree of association with woody plants. We investigated effects of local and landscape factors on spider communities in different microhabitats within Swiss apple orchards. We expected a stronger negative effect of woody habitat fragmentation on spiders inhabiting tree canopies compared to spiders living in the meadow. The 30 orchards that we sampled varied in woody habitat amount and isolation at landscape and patch scales. Local factors included management intensity and plant diversity. Spiders associated with meadow were affected by plant diversity, but not by fragmentation. In contrast, spiders associated with canopies responded to isolation from other woody habitats. Surprisingly, we found both positive and negative effects of habitat isolation on local abundance. This indicates that differences in dispersal and/or biotic interactions shape the specific response to habitat isolation.
The relative importance of local and landscape factors was in accordance with the microhabitat of the spiders. Thus, considering microhabitat associations can be important for identifying processes that would be overlooked if sampling were pooled for the whole habitat. Landscape Ecology, 2010, V25, N9, NOV, pp 1375-1384 DOI: http://dx.doi.org/10.1007/s10980-010-9518-6.

11.1-112
The genetic effects of roads: A review of empirical evidence
Holderegger R, Di Giulio M
Switzerland
Ecology , Biodiversity , Zoology
Roads exert various effects of conservation concern. They cause road mortality of wildlife, change the behaviour of animals and lead to habitat fragmentation. Roads also have genetic effects, as they restrict animal movement and increase the functional isolation of populations. We first formulate theoretical expectations on the genetic effects of roads with respect to a decrease in genetic diversity and an increase in genetic differentiation or distance of populations or individuals. We then review the empirical evidence on the genetic effects of roads based on the available literature. We found that roads often, but not always, decrease the genetic diversity of affected populations due to reduced population size and genetic drift. Whether the reduction in genetic diversity influences the long-term fitness of affected populations is, however, not yet clear. Roads, especially fenced highways, also act as barriers to movement, migration and gene flow. Roads therefore often decrease functional connectivity and increase the genetic differentiation of populations or the genetic distance of individuals. Nevertheless, roads and highways rarely act as complete barriers as shown by genetic studies assessing contemporary migration across roads (by using assignment tests). Some studies also showed that road verges act as dispersal corridors for native and exotic plants and animals. Genetic methods are well suited to retrospectively trace such migration pathways. Most roads and highways have only recently been built. Although only few generations might thus have passed since road construction, our literature survey showed that many studies found negative effects of roads on genetic diversity and genetic differentiation in animal species, especially for larger mammals and amphibians. Roads may thus rapidly cause genetic effects. This result stresses the importance of defragmentation measures such as over- and underpasses or wildlife bridges across roads.

11.1-113
First thorough identification of factors associated with Cd, Hg and Pb concentrations in mosses sampled in the European Surveys 1990, 1995, 2000 and 2005
Germany, Wales, Russia, Italy, Byelarus, Ukraine, Turkey, Denmark, Belgium, Portugal, Latvia, Spain, Poland, Slovenia, Serbia, Finland, Lithuania, France, Estonia, Iceland, Slovakia, Romania, Norway, Czech Republic, Switzerland, Hungary, Macedonia, Netherlands, Bulgaria, Austria
Plant Sciences , Meteorology & Atmospheric Sciences , Geochemistry & Geophysics , Modelling
The aim of this study was, for the first time ever, to thoroughly identify the factors influencing Cd, Hg and Pb concentrations in mosses sampled within the framework of the European Heavy Metals in Mosses Surveys 1990-2005. These investigations can be seen as a follow up of a previous study where only the moss data recorded in the survey 2005 was included in the analysis (Schroder et al. 2010). The analyses of this investigation give a complete overview on the statistical association of Cd, Hg and Pb concentrations in mosses sampled within the framework of the European Heavy Metals in Mosses Surveys 1990-2005. As exemplary case studies revealed that other factors besides atmospheric deposition of metals influence the element concentrations in mosses, the moss datasets of the above mentioned surveys were analysed by means of bivariate statistics and decision tree analysis in order to identify factors influencing metal bioaccumulation. In the analyses we used the metadata
recorded during the sampling as well as additional geodata on, e.g., depositions, emissions and land use. Bivariate Spearman correlation analyses showed the highest correlations between Cd and Pb concentrations in mosses and EMEP modelled total deposition data (0.62 a parts per thousand currency signaEuro parts per thousand r(s) a parts per thousand currency signaEuro parts per thousand 0.73). For Hg the correlations with all the tested factors were considerably lower (e.g. total deposition r(s) a parts per thousand currency signaEuro parts per thousand 0.24). Decision tree analyses by means of Classification and Regression Trees (CART) identified the total deposition as the statistically most significant factor for the Cd and Pb concentrations in the mosses in all four monitoring campaigns. For Hg, the most significant factor in 1990 as identified by CART was the distance to the nearest Hg source recorded in the European Pollutant Emission Register, in 1995 and 2000 it was the analytical method, and in 2005 it was the sampled moss species. The strong correlations between the Cd and Pb concentrations in the mosses and the total deposition can be used to calculate deposition maps with a regression kriging approach on the basis of surface maps on the element concentrations in the mosses.


11.1-114
What is the speed of link between aboveground and belowground processes?

11.1-115
Predicting species distributions from checklist data using site-occupancy models
Kery M, Gardner B, Monnerat C Switzerland, USA Biodiversity , Modelling , Ecology
Aim: (1) To increase awareness of the challenges induced by imperfect detection, which is a fundamental issue in species distribution modelling; (2) to emphasize the value of replicate observations for species distribution modelling; and (3) to show how ‘cheap’ checklist data in faunal/floral databases may be used for the rigorous modelling of distributions by site-occupancy models. Location: Switzerland. Methods: We used checklist data collected by volunteers during 1999 and 2000 to analyse the distribution of the blue hawker, Aeshna cyanea (Odonata, Aeshnidae), a common dragonfly in Switzerland. We used data from repeated visits to 1-ha pixels to derive ‘detection histories’ and apply site-occupancy models to estimate the ‘true’ species distribution, i.e. corrected for imperfect detection. We modelled blue hawker distribution as a function of elevation and year and its detection probability of elevation, year and season. Results: The best model contained cubic polynomial elevation effects for distribution and quadratic effects of elevation and season for detectability. We compared the site-occupancy model with a conventional distribution model based on a generalized linear model, which assumes perfect detectability (p = 1). The conventional distribution map looked very different from the distribution map obtained using site-occupancy models that accounted for the imperfect detection. The conventional model underestimated the species distribution by 60%, and the slope parameters of the occurrence-elevation relationship were also underestimated when assuming p = 1. Elevation was not only an important predictor of blue hawker occurrence, but also of the detection probability, with a bell-shaped relationship. Furthermore, detectability increased over the season. The average detection probability was estimated at only 0.19 per survey. Main conclusions: Conventional species distribution models do not model species distributions per se but rather the apparent distribution, i.e. an unknown proportion of species distributions. That unknown proportion is equivalent to detectability. Imperfect detection in conventional species distribution models yields underestimates of the extent of distributions and covariate effects that are biased towards zero. In addition, patterns in detectability will erroneously be ascribed to species distributions. In contrast, site-occupancy models applied to replicated detection/non-detection data offer a powerful framework for making inferences about species distributions corrected for imperfect detection. The use of ‘cheap’ checklist data greatly enhances the scope of applications of this useful class of models.


11.1-116
Site-Occupancy Distribution Modeling to Correct Population-Trend Estimates Derived from Opportunistic Observations
Species’ assessments must frequently be derived from opportunistic observations made by volunteers (i.e., citizen scientists). Interpretation of the resulting data to estimate population trends is plagued with problems, including teasing apart genuine population trends from variations in observation effort. We devised a way to correct for annual variation in effort when estimating trends in occupancy (species distribution) from faunal or floral databases of opportunistic observations. First, for all surveyed sites, detection histories (i.e., strings of detection-nondetection records) are generated. Within-season replicate surveys provide information on the detectability of an occupied site. Detectability directly represents observation effort; hence, estimating detectability means correcting for observation effort. Second, site-occupancy models are applied directly to the detection-history data set (i.e., without aggregation by site and year) to estimate detectability and species distribution (occupancy, i.e., the true proportion of sites where a species occurs). Site-occupancy models also provide unbiased estimators of components of distributional change (i.e., colonization and extinction rates). We illustrate our method with data from a large citizen-science project in Switzerland in which field ornithologists record opportunistic observations. We analyzed data collected on four species: the widespread Kingfisher (Alcedo atthis) and Sparrowhawk (Accipiter nisus) and the scarce Rock Thrush (Monticola saxatilis) and Wallcreeper (Tichodroma muraria). Our method requires that all observed species are recorded. Detectability was < 1 and varied over the years. Simulations suggested some robustness, but we advocate recording complete species lists (checklists), rather than recording individual records of single species. The representation of observation effort with its effect on detectability provides a solution to the problem of differences in effort encountered when extracting trend information from haphazard observations. We expect our method is widely applicable for global biodiversity monitoring and modeling of species distributions.


11.1-117
Effects of population size on plant reproduction and pollinator abundance in a specialized pollination system
Klank C, Pluess A R, Ghazoul J
Switzerland
Plant Sciences, Ecology
1. Many plant species are currently experiencing negative consequences of habitat fragmentation as a result of reductions in population size and disruptions in pollination services. Plants in specialized pollination systems might be especially vulnerable to changes in plant population size and density resulting from land-use changes. 2. Representing such a system, we chose the globe-flower Trollius europaeus L. with its pollinating fly Chiastocheta, which also acts as a seed predator at its larval stage, to investigate the effects of small plant population size on reproductive success and pollinator abundance. 3. Reproductive output of T. europaeus declined with increasing plant population size, while Chiastocheta abundance within T. europaeus flowers was independent of plant population size. However, at the local level, Chiastocheta numbers within flowers were inversely correlated to local T. europaeus flower density. We further found that increasing floral densities increased plant reproductive success at the population level. 4. Chiastocheta abundance was the main driver of reproductive output of T. europaeus through its dual role as an obligate pollinator and seed predator: at least some Chiastocheta flies were needed to secure pollination, but a continued increase in Chiastocheta flies within a flower incurred seed predation costs that greatly reduced reproductive success. Thus, high local flower density contributed positively to per capita reproductive output by diluting Chiastocheta abundance within flowers independently of overall population size. 5. Synthesis. Our findings highlight that plant population size is not always the main determinant of reproductive success for populations, but that other factors such as plant density and the specific ecology of a pollinator and its interplay with other population parameters can be more important in determining the fate of a population. Furthermore, the effects of plant population size and floral density on pollinator visitation in T. europaeus vary across scales, with implications for plant fitness. It is therefore important not to focus solely on pure plant population size in determining population viability. Thus, from a conservation perspective, even small and isolated T. europaeus populations may be viable and resistant to pollination-associated vulnerabilities depending on plant density at local (sub-population) scales.

11.1-118
Effect of the age and season of fattening period on carbon dioxide emissions from broiler housing
Slovakia, Switzerland, Germany
Zoology, Agriculture, Meteorology & Atmospheric Sciences
The quantification of emissions of greenhouse gases from human activities is of prime importance for determining the importance of their effect on the environment. The aim of this study was to test a hypothesis that the interior concentration and emission of carbon dioxide in chicken housing is impacted by the age of animals and season of fattening period. Carbon dioxide (CO₂) concentrations and emissions were assessed over six fattening periods in total. The major part of CO₂ seemed to have its origin in bird respiration with assumed production of approx. 147 kg of CO₂/h. CO₂ emission was most affected by chickens towards the end of the grow-out period (P < 0.001) taking dominance over the process of natural gas burning by heaters. The mean CO₂ emission from the chicken house ranged between 120 and 247 kg/h in the first quarter of periods and between 325 and 459 kg/h in the last ones. The heaters could be theoretically a possible source of approx. 39 kg each hour if they worked continuously. CO₂ emissions were considerably more affected by ventilation rate (P < 0.001) than by CO₂ concentration in the indoor air.

11.1-119
A Matrix-Calibrated Species-Area Model for Predicting Biodiversity Losses Due to Land-Use Change
Koh L P, Lee T M, Sodhi N S, Ghazoul J
Switzerland, USA, Singapore
Biodiversity, Modelling, Plant Sciences, Zoology, Landscape Studies
Application of island biogeography theory to prediction of species extinctions resulting from habitat loss is based on the assumption that the transformed landscape matrix is completely inhospitable to the taxa considered, despite evidence demonstrating the nontrivial influence of matrix on populations within habitat remnants. The island biogeography paradigm therefore needs refining to account for specific responses of taxa to the area of habitat “islands” and to the quality of the surrounding matrix. We incorporated matrix effects into island theory by partitioning the slope (z value) of species-area relationships into two components: gamma, a constant, and sigma, a measure of taxon-specific responses to each component of a heterogeneous matrix. We used our matrix-calibrated model to predict extinction and endangerment of bird species resulting from land-use change in 20 biodiversity hotspots and compared these predictions with observed numbers of extinct and threatened bird species. We repeated this analysis with the conventional species-area model and the countryside species-area model, considering alternative z values of 0.35 (island) or 0.22 (continental). We evaluated the relative strength of support for each of the five candidate models with Akaike’s information criterion (AIC). The matrix-calibrated model had the highest AIC weight (w(1) = 89.21%), which means the weight of evidence in support of this model was the optimal model given the set of candidate models and the data. In addition to being a valuable heuristic tool for assessing extinction risk, our matrix-calibrated model also allows quantitative assessment of biodiversity benefits (and trade-offs) of land-management options in human-dominated landscapes. Given that processes of secondary regeneration have become more widespread across tropical regions and are predicted to increase, our matrix-calibrated model will be increasingly appropriate for practical conservation in tropical landscapes.

11.1-120
An overhaul of the species-area approach for predicting biodiversity loss: incorporating matrix and edge effects
Koh L P, Lee T M, Sodhi N S, Ghazoul J
Switzerland, USA, Singapore
Biodiversity, Ecology, Modelling, Zoology
1. Species-area (SA) models have often been used to predict biodiversity loss resulting from habitat loss. This application of SA models hinges on two fundamental assumptions: the resultant landscape matrix is inhospitable to the taxa of interest; and edge effects do not factor into extinction risks. Despite growing consensus that these assumptions are unrealistic, the SA approach continues to be used in assessments of biodiversity decline and conservation planning. 2. We propose an overhaul of the SA approach by accounting for taxon-specific responses to landscape-specific matrix quality and deleterious effects of habitat edges. We pitted nine variants of an improved SA model (calibrated for edge and/or matrix) against two variants of the conventional model (calibrated...
We assessed the taxonomic uniqueness of the two northern and southern temperate zone mammals. conservation status, threats and range sizes to compare the Red List of Threatened Species to characterize continental temperate region (with the exception of Antarctica) and continental temperate regions. Location: Land surfaces of all continents impacting their conservation differ across hemispheres. Aim: To examine the taxonomic uniqueness, range sizes, endemism and conservation status in the southern temperate zone mammals and how factors impacting their conservation differ across hemispheres. Location: Land surfaces of all continents (with the exception of Antarctica) and continental islands with an emphasis on the southern temperate hemisphere (land south of the Tropic of Capricorn). Methods: We used data from the 2008 IUCN Red List of Threatened Species to characterize conservation status, threats and range sizes to compare northern and southern temperate zone mammals. We assessed the taxonomic uniqueness of the two regions as derived from the EDGE programme. We also conducted a gap analysis by overlapping mammal ranges with protected area coverages for temperate regions. Results: Southern temperate species are phylogenetically more unique than in the Northern Hemisphere. The endemics have significantly smaller range sizes and are at a significantly greater risk of extinction (about 50% greater, with 24.7% of species being threatened versus 15.6% in the Northern Hemisphere). Finally, southern temperate endemics are significantly more likely to exist outside protected areas (13.38% versus 3.65%). Main conclusions: The southern temperate zone harbours a unique fauna, attributed to the long isolation from the northern temperate zone. Temperate regions are heavily exploited for human activities, especially grazing and agriculture. The Southern Hemisphere is particularly susceptible to disturbance, given the small range sizes of its species and the low degree of protected area coverage. The scenario now is one of regions with numerous endemics under high threat from human activities.

**11.1-122** Organic Farming and Soil Carbon Sequestration: What Do We Really Know About the Benefits?

**Leifeld J, Fuhrer J**

**Switzerland**

**Agriculture, Pedology, Plant Sciences**

Organic farming is believed to improve soil fertility by enhancing soil organic matter (SOM) contents. An important co-benefit would be the sequestration of carbon from atmospheric CO₂. Such a positive effect has been suggested based on data from field experiments though many studies were not designed to address the issue of carbon sequestration. The aim of our study was to examine published data in order to identify possible flaws such as missing a proper baseline, carbon mass measurements, or lack of a clear distinction between conventional and organic farming practices, thereby attributing effects of specific practices to organic farming, which are not uniquely organic. A total of 68 data sets were analyzed from 32 peer-reviewed publications aiming to compare conventional with organic farming. The analysis revealed that after conversion, soil C content (SOC) did not change significantly. The majority of publications reported SOC concentrations rather than amounts thus neglecting possible changes in soil.
bulk density. 34 out of 68 data sets missed a true control with well-defined starting conditions. In 37 out of 50 cases, the amount of organic fertilizer in the organic system exceeded that applied in the compared conventional system, and in half of the cases crop rotations differed between systems. In the few studies where crop rotation and organic fertilization were comparable in both systems no consistent difference in SOC was found. From this data analysis, we conclude that the claim for beneficial effects of organic farming on SOC is premature and that reported advantages of organic farming for SOC are largely determined by higher and often disproportionate application of organic fertilizer compared to conventional farming. Ambio, 2010, V39, N8, DEC, pp 585-599 DOI: http://dx.doi.org/10.1007/s13280-010-0082-8.

11.1-123
Gradual speciation in a global hotspot of plant diversity
Linder H P
Switzerland
Plant Sciences, Biodiversity, Ecology

11.1-124
Biotic diversity in the Southern African winter-rainfall region
Switzerland, South Africa, England
Biodiversity, Plant Sciences, Ecology
The outstanding diversity of biota of the Cape region is expressed differently in major groups: flowering plants and bees show high species richness in few clades combined with high endemism and remarkable functional adaptations; mammals and reptiles have a rich diversity of distinct intraspecific genetic lineages; and fresh-water fish are characterized by a high level of endemism but a low local species richness. Diversification has been promoted by the physical complexity of the Cape environment, as well as biotic interactions, such as those between bees and flowering plants. Endemism has been promoted by the uniqueness of local climate and soils, and, in the case of fishes, by the history of connections between the short Cape river systems. Maintenance of Cape biodiversity requires that key environmental factors that promote diversification are identified and retained. Current Opinion in Environmental Sustainability, 2010, V2, N1-2, MAY, pp 109-116 DOI: http://dx.doi.org/10.1016/j.cosust.2010.02.001.

11.1-125
Overcoming the rare species modelling paradox: A novel hierarchical framework applied to an Iberian endemic plant
Lomba A, Pellissier L, Randin C, Vicente J, Moreira F, Honrado J, Guisan A
Portugal, Switzerland
Biodiversity, Plant Sciences, Modelling, Ecology
Rare species have restricted geographic ranges, habitat specialization, and/or small population sizes. Datasets on rare species distribution usually have few observations, limited spatial accuracy and lack of valid absences; conversely they provide comprehensive views of species distributions allowing to realistically capture most of their realized environmental niche. Rare species are the most in need of predictive distribution modelling but also the most difficult to model. We refer to this contrast as the “rare species modelling paradox” and propose as a solution developing modelling approaches that deal with a sufficiently large set of predictors, ensuring that statistical models are not over-fitted. Our novel approach fulfils this condition by fitting a large number of bivariate models and averaging them with a weighted ensemble approach. We further propose that this ensemble forecasting is conducted within a hierarchical multi-scale framework. We present two ensemble models for a test species, one at regional and one at local scale, each based on the combination of 630 models. In both cases, we obtained excellent spatial projections, unusual when modelling rare species. Model results highlight, from a statistically sound approach, the effects of multiple drivers in a same modelling framework and at two distinct scales. From this added information, regional models can support accurate forecasts of range dynamics under climate change scenarios, whereas local models allow the assessment of isolated or synergistic impacts of changes in multiple predictors. This novel framework provides a baseline for adaptive conservation, management and monitoring of rare species at distinct spatial and temporal scales. Biological Conservation, 2010, V143, N11, NOV, pp 2647-2657 DOI: http://dx.doi.org/10.1016/j.biocon.2010.07.007.

11.1-126
Global Convergence in the Temperature Sensitivity of Respiration at Ecosystem Level
Germany, Switzerland, Portugal, Norway, USA,
Canada, Italy, Belgium
Forestry, Plant Sciences, Meteorology & Atmospheric Sciences, Modelling

The respiratory release of carbon dioxide (CO₂) from the land surface is a major flux in the global carbon cycle, antipodal to photosynthetic CO₂ uptake. Understanding the sensitivity of respiratory processes to temperature is central for quantifying the climate-carbon cycle feedback. We approximated the sensitivity of terrestrial ecosystem respiration to air temperature (Q(10)) across 60 FLUXNET sites with the use of a methodology that circumvents confounding effects. Contrary to previous findings, our results suggest that Q(10) is independent of mean annual temperature, does not differ among biomes, and is confined to values around 1.4 ±/− 0.1. The strong relation between photosynthesis and respiration, by contrast, is highly variable among sites. The results may partly explain a less pronounced climate-carbon cycle feedback than suggested by current carbon cycle climate models.

11.1-127
Common factors drive adaptive genetic variation at different spatial scales in Arabis alpina
Manel S, Poncet B N, Legendre P, Gugerli F, Holderegger R
France, Canada, Switzerland
Plant Sciences, Biodiversity, Ecology, Modelling

A major challenge facing landscape geneticists studying adaptive variation is to include all the environmental variables that might be correlated with allele frequencies across the genome. One way of identifying loci that are possibly under selection is to see which ones are associated with environmental gradient or heterogeneity. Since it is difficult to measure all environmental variables, one may take advantage of the spatial nature of environmental filters to incorporate the effect of unaccounted environmental variables in the analysis. Assuming that the spatial signature of these variables is broad-scaled, broad-scale Moran’s eigenvector maps (MEM) can be included as explanatory variables in the analysis as proxies for unmeasured environmental variables. We applied this approach to two data sets of the alpine plant Arabis alpina. The first consisted of 140 AFLP loci sampled at 130 sites across the European Alps (large scale). The second one consisted of 712 AFLP loci sampled at 93 sites (regional scale) in three mountain massifs (local scale) of the French Alps. For each scale, we regressed the frequencies of each AFLP allele on a set of eco-climatic and MEM variables as predictors. Twelve (large scale) and 11% (regional scale) of all loci were detected as significantly correlated to at least one of the predictors (R² adj > 0.5), and, except for one massif, 17% at the local scale. After accounting for spatial effects, temperature and precipitation were the two major determinants of allele distributions. Our study shows how MEM models can account for unmeasured environmental variation in landscape genetics models.


11.1-128
Plant species selection by free-ranging cattle in southern Bolivian tropical montane forests
Switzerland, Bolivia
Plant Sciences, Forestry, Biodiversity, Agriculture, Zoology

The frequency of selection of functional groups and plant species by free-ranging cattle foraging in a diverse environment and its changes during the dry and the following prehumid seasons were investigated using direct observations and bite counting. The study was conducted at two sites in the Bolivian-Tucuman montane forests in southern Bolivia, by including datasets of a total of 16 animals. Across both study sites and the entire observation period (May to October/November), the cattle were found to select a broad spectrum of plant species from different functional groups. However, just a limited number of species made up a considerable contribution to overall plant selection. The functional group of the graminoids was selected most frequently, but their contribution to plant selection decreased significantly from 63.5% of total bites in May to 15.9% in September/October, in accordance with a decrease in availability. Selection of woody plants (shrubs and tree parts, the latter mainly in the form of leaf litter and fruits) increased with time, reaching its peak at the beginning of the prehumid season, while the herbs showed a curvilinear pattern of selection which was highest in August. Plant species belonging to the functional groups of ferns, climbers and epiphytes were also selected by the cattle, but generally at low relative proportions. Plant selection might be influenced by temporal differences in nutritional quality and availability of the preferred plant species and functional groups. Sampling behaviour seems to be the most likely reason for the inclusion of a broad range of plant species with overall low contribution to plant selection.

11.1-129

Spatial genetic analysis of the grass snake, Natrix natrix (Squamata: Colubridae), in an intensively used agricultural landscape
Meister B, Hofer U, Ursenbacher S, Baur B
Switzerland
Agriculture, Zoology, Ecology, Biodiversity
Both the conversion of natural habitats to farmland and efforts at increasing the yield of existing crops contribute to a decline in biodiversity. As a consequence of land conversion, specialised species are restricted to remnants of original habitat patches, which are frequently isolated. This may lead to a genetic differentiation of the subpopulations. We used seven microsatellite markers to examine the genetic population structure of the grass snake, Natrix natrix (Linnaeus, 1758), sampled in remnants of pristine habitat embedded in an intensively used agricultural landscape in north-western Switzerland. The study area, a former wetland, has been drained and gradually converted into an agricultural plain in the last century, reducing the pristine habitat to approximately 1% of the entire area. The grass snake feeds almost entirely on amphibians, and is therefore associated with wetlands. In Central Europe, the species shows severe decline, most probably as a result of wetland drainage and decrease of amphibian populations. We found no genetically distinct grass snake populations in the study area covering 90 km². This implies that there is an exchange of individuals between small remnants of original habitat. Thus, gene flow may prevent any genetic differentiation of subpopulations distributed over a relatively large area. Our results show that a specialized snake species can persist in an intensively used agricultural landscape, provided that suitable habitat patches are interconnected.


11.1-130

Fire-induced taxonomic and functional changes in saproxylic beetle communities in fire sensitive regions
Switzerland, Canada
Zoology, Biodiversity, Ecology
It is often suggested that fire acts as an environmental filter that selects species and functional traits, and reduces trait variability within communities, affecting ecosystem function and underlying services. This may be particularly important in fire-sensitive ecosystems, such as the central European Alps, where fires are scarce. According to climate and land use change scenarios in Europe, fire risk will increase during the next decades, raising important questions about the maintenance of ecological and functional resilience in these regions. We used two families of saproxylic beetles (i.e. Cerambycidae and Buprestidae) as model group to test the combined effect of fire and altitude on species and trait composition in the central Alps of Switzerland. Trait response was based on weighted means and variation of 15 traits over the communities. Our results showed an overall positive effect of fire on taxonomic and functional diversity, while indicator species and community analyses revealed that the response to fire was also modulated by altitude. The positive effect of fire and the presence of large populations of pyrophilous species suggest co-evolution with fire and adaptation to disturbance in the Alps. Biodiversity in the central Alps might thus be more resilient to fire than expected. In the light of climatic and land use changes, forest management and species conservation in the central Alps have to consider fire one of the major disruptive factors that have shaped and will shape species composition and ecosystem services.

11.1-131

Urban growth along motorways in Switzerland
Müller K, Steinmeier C, Küchler M
Switzerland
Landscape Studies, Urban Studies
Urban growth is a key concern for planners as it has considerable ecological impact. In both Switzerland and the European Union this growth has mostly proceeded at the expense of agricultural land. It is not yet, however, well understood what drives this extensive land-use change. This study assesses the influence of proximity to motorway exits on urban growth and analyses urban growth along some of the main motorways in Switzerland. The analysis is based on two data collection campaigns from the Land Use Statistics with a time difference of 12 years. Proximity is measured as the distance from a motorway exit, which we related to changes in the entire urban areas and their subclasses ‘Building areas’, ‘Industrial areas’ and ‘Transportation areas’. Linear regression revealed a significant distance trend whereby the closer an area lies to a motorway exit, the higher the rate of urban growth. Industrial areas show the strongest distance trend. Further, variance partitioning revealed the exclusive explanatory power.

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of distance from a motorway exit by partiailling out two further potential predictors, the previous urban area and the local relief. We found significant effects of distance, e.g. on industrial areas in the Central Plateau and on building areas in the Central Alps. There, we can assume a causal relationship between proximity to motorway exits and urban growth. Regarding ecoregions or urban subclasses, no uniform picture emerged. We thus recommend discussing urban sprawl separately for different areas and subcategories of urban land.


11.1-132
The emission factor of volatile isoprenoids: stress, acclimation, and developmental responses

Ninemets U, Arneth A, Kuhn U, Monson R K, Penuelas J, Staudt M
Estonia, Sweden, Switzerland, USA, Spain, France
Plant Sciences, Forestry, Meteorology & Atmospheric Sciences, Modelling

The rate of constitutive isoprenoid emissions from plants is driven by plant emission capacity under specified environmental conditions (E-S, the emission factor) and by responsiveness of the emissions to instantaneous variations in environment. In models of isoprenoid emission, E-S has been often considered as intrinsic species-specific constant variable in time and space. Here we analyze the variations in species-specific values of E-S under field conditions focusing on abiotic stresses, past environmental conditions and developmental processes. The reviewed studies highlight strong stress-driven, adaptive (previous temperature and light environment and growth CO₂ concentration) and developmental (leaf age) variations in E-S values operating at medium to long time scales. These biological factors can alter species-specific E-S values by more than an order of magnitude. While the majority of models based on early concepts still ignore these important sources of variation, recent models are including some of the medium- to long-term controls. However, conceptually different strategies are being used for incorporation of these longer-term controls with important practical implications for parameterization and application of these models. This analysis emphasizes the need to include more biological realism in the isoprenoid emission models and also highlights the gaps in knowledge that require further experimental work to reduce the model uncertainties associated with biological sources of variation.


11.1-133
Recruitment limitation after mast-seeding in two African rain forest trees

Norghauer J M, Newbery D M
Switzerland
Forestry, Plant Sciences, Ecology

Seed and establishment limitation can have a major role in determining plant species’ abundances and distributions in communities. Their relative importance, however, remains uncertain and controversial, especially for trees in forests where density-dependent mortality of seeds and seedlings may be common. In a primary African rain forest, we directly tested the strength of each limitation by using seeds of the tree species Microberlinia bisulcata and Tetraberlinia bifoliolata at eight addition levels and by following establishment over six weeks. Local background seed rain was also measured. Seedling recruitment was higher in seed-addition quadrats than in control quadrats, indicating seed limitation in both species. However, fitting the Beverton-Holt model indicated that establishment limitation was consistently 2-4 times stronger than seed limitation for Microberlinia, whereas seed limitation greatly exceeded establishment limitation for Tetraberlinia. Strong density dependence was operating in the short seed-to-seedling transition for Microberlinia, whereas it was almost negligible for Tetraberlinia. Although early postdispersal mortality was very high for both species (>80%), they may achieve local codominance as a result of differing strengths of seed limitation vs. establishment limitation. Assessing the importance of seed limitation for tree populations requires a knowledge of species-specific seed rain as well as a reliable recruitment function. The outcome of early establishment processes also needs to be seen in the context of later stages of tree dynamics.


11.1-134
Plant health and global change - some implications for landscape management

England, Switzerland
Plant Sciences, Biodiversity, Ecology, Landscape Studies

Global change (climate change together with other worldwide anthropogenic processes such as increasing trade, air pollution and urbanization) will affect plant health at the genetic, individual, population and landscape level. Direct effects include ecosystem stress due to natural resources
shortage or imbalance. Indirect effects include (i) an increased frequency of natural detrimental phenomena, (ii) an increased pressure due to already present pests and diseases, (iii) the introduction of new invasive species either as a result of an improved suitability of the climatic conditions or as a result of increased trade, and (iv) the human response to global change. In this review, we provide an overview of recent studies on terrestrial plant health in the presence of global change factors. We summarize the links between climate change and some key issues in plant health, including tree mortality, changes in wildfire regimes, biological invasions and the role of genetic diversity for ecosystem resilience. Prediction and management of global change effects are complicated by interactions between globalization, climate and invasive plants and/or pathogens. We summarize practical guidelines for landscape management and draw general conclusions from an expanding body of literature.


11.1-135
Plant traits co-vary with altitude in grasslands and forests in the European Alps
Pellissier L, Fournier B, Guisan A, Vittoz P
Switzerland
Plant Sciences, Forestry, Ecology
Biological traits that are advantageous under specific ecological conditions should be present in a large proportion of the species within an ecosystem, where those specific conditions prevail. As climatic conditions change, the frequency of certain traits in plant communities is expected to change with increasing altitude. We examined patterns of change for 13 traits in 120 exhaustive inventories of plants along five altitudinal transects (520-3,100 m a.s.l.) in grasslands and in forests in western Switzerland. The traits selected for study represented the occupation of space, photosynthesis, reproduction and dispersal. For each plot, the mean trait values or the proportions of the trait states were weighted by species cover and examined in relation to the first axis of a PCA based on local climatic conditions. With increasing altitude in grasslands, we observed a decrease in anemophily and an increase in entomophily complemented by possible selfing; a decrease in diaspores with appendages adapted to ectozoochory, linked to a decrease in achenes and an increase in capsules. In lowlands, pollination and dispersal are ensured by wind and animals. However, with increasing altitude, insects are mostly responsible for pollination, and wind becomes the main natural dispersal vector. Some traits showed a particularly marked change in the alpine belt (e.g. the increase of capsules and the decrease of achenes), confirming that this belt concentrates particularly stressful conditions to plant growth and reproduction (e.g. cold, short growing season) that constrain plants to a limited number of strategies. One adaptation to this stress is to limit investment in dispersal by producing capsules with numerous, tiny seeds that have appendages limited to narrow wings. Forests displayed many of the trends observed in grasslands but with a reduced variability that is likely due to a shorter altitudinal gradient.


11.1-136
Spatial pattern of floral morphology: possible insight into the effects of pollinators on plant distributions
Pellissier L, Pottier J, Vittoz P, Dubuis A, Guisan A
Switzerland
Plant Sciences, Biodiversity, Modelling, Ecology
Pollination syndromes involve convergent evolution towards phenotypes composed of specific scents, colours or floral morphologies that attract or restrict pollinator access to reward. How these traits might influence the distributions of plant species in interaction with pollinators has rarely been investigated. We sampled 870 vegetation plots in the western Swiss Alps and classified the plant species into seven blossom types according to their floral morphology (wind, disk, funnel, tube, bilabiate, head or brush). We investigated the environmental features of plots with functional diversity (FD) lower than expected by chance alone to detect potential pollination filtering and related the proportions of the seven blossom types to a combination of environmental descriptors. From these results, we inferred the potential effect of the pollinator on the spatial distribution of plant species. The vegetation plots with significantly lower FD of blossom types than expected by chance were found at higher altitudes, and the proportions of blossom types were strongly patterned along the same gradient. These results support a biotic filtering effect on plant species assemblages through pollination: disk blossoms became dominant at higher altitudes, resulting in a lower FD. In harsh conditions at high altitudes, pollinators usually decrease in activity, and the openness of the disk blossom grants access to any available pollinator. Inversely, bilabiate blossoms, which are mostly pollinated by bees, were more abundant at lower elevations, which are characterised by greater abundance and
diversity of bees. Generalisation through openness of the blossom could be advantageous at high elevations, while specialisation could be a successful alternative strategy at lower elevations. The approach used in this study is purely correlative, and further investigations should be conducted to infer the nature of the causal relationship between plant and pollinator distributions.


11.1-137

**Plant Species Loss Affects Life-History Traits of Aphids and Their Parasitoids**


Switzerland, Germany

*Plant Sciences, Biodiversity, Ecology*

The consequences of plant species loss are rarely assessed in a multi-trophic context and especially effects on life-history traits of organisms at higher trophic levels have remained largely unstudied. We used a grassland biodiversity experiment and measured the effects of two components of plant diversity, plant species richness and the presence of nitrogen-fixing legumes, on several life-history traits of naturally colonizing aphids and their primary and secondary parasitoids in the field. We found that, irrespective of aphid species identity, the proportion of winged aphid morphs decreased with increasing plant species richness, which was correlated with decreasing host plant biomass. Similarly, emergence proportions of parasitoids decreased with increasing plant species richness. Both, emergence proportions and proportions of female parasitoids were lower in plots with legumes, where host plants had increased nitrogen concentrations. This effect of legume presence could indicate that aphids were better defended against parasitoids in high-nitrogen environments. Body mass of emerged individuals of the two most abundant primary parasitoid species was, however, higher in plots with legumes, suggesting that once parasitoids could overcome aphid defenses, they could profit from larger or more nutritious hosts. Our study demonstrates that cascading effects of plant species loss on higher trophic levels such as aphids, parasitoids and secondary parasitoids begin with changed life-history traits of these insects. Thus, life-history traits of organisms at higher trophic levels may be useful indicators of bottom-up effects of plant diversity on the biodiversity of consumers.


11.1-138

**Robust dynamics of Amazon dieback to climate change with perturbed ecosystem model parameters**


Switzerland, Germany, England, USA

*Forestry, Plant Sciences, Ecology, Modelling*

Climate change science is increasingly concerned with methods for managing and integrating sources of uncertainty from emission storylines, climate model projections, and ecosystem model parameterizations. In tropical ecosystems, regional climate projections and modeled ecosystem responses vary greatly, leading to a significant source of uncertainty in global biogeochemical accounting and possible future climate feedbacks. Here, we combine an ensemble of IPCC-AR4 climate change projections for the Amazon Basin (eight general circulation models) with alternative ecosystem parameter sets for the dynamic global vegetation model, LPJmL. We evaluate LPJmL simulations of carbon stocks and fluxes against flux tower and aboveground biomass datasets for individual sites and the entire basin. Variability in LPJmL model sensitivity to future climate change is primarily related to light and water limitations through biochemical and water-balance-related parameters. Temperature-dependent parameters related to plant respiration and photosynthesis appear to be less important than vegetation dynamics (and their parameters) for determining the magnitude of ecosystem response to climate change. Variance partitioning approaches reveal that relationships between uncertainty from ecosystem dynamics and climate projections are dependent on geographic location and the targeted ecosystem process. Parameter uncertainty from the LPJmL model does not affect the trajectory of ecosystem response for a given climate change scenario and the primary source of uncertainty for Amazon ‘dieback’ results from the uncertainty among climate projections. Our approach for describing uncertainty is applicable for informing and prioritizing policy options related to mitigation and adaptation where long-term investments are required.

11.1-139
Diversity Promotes Temporal Stability across Levels of Ecosystem Organization in Experimental Grasslands


Germany, Switzerland, Estonia, England, France

Biodiversity , Plant Sciences , Ecology

The diversity-stability hypothesis states that current losses of biodiversity can impair the ability of an ecosystem to dampen the effect of environmental perturbations on its functioning. Using data from a long-term and comprehensive biodiversity experiment, we quantified the temporal stability of 42 variables characterizing twelve ecological functions in managed grassland plots varying in plant species richness. We demonstrate that diversity increases stability i) across trophic levels (producer, consumer), ii) at both the system (community, ecosystem) and the component levels (population, functional group, phylogenetic clade), and iii) primarily for abovementground rather than belowground processes. Temporal synchronization across studied variables was mostly unaffected with increasing species richness. This study provides the strongest empirical support so far that diversity promotes stability across different ecological functions and levels of ecosystem organization in grasslands.


11.1-140
Distribution and decline of Dwarf Bulrush (Typha minima) in the Alps

Prunier P, Garraud L, Köhler C, Lambelet Haueter C, Selvaggi A, Werner P

Switzerland, France, Italy

Plant Sciences , Biodiversity

Dwarf Bulrush (Typha minima Hoppe) is an alluvial species that used to colonize most major rivers of the prealpine foothills. Since the beginning of the nineteenth century, it has been declining due to river diking as well as plugging and drainage of the floodplains. However, the magnitude of this decline is not yet precisely known. This paper quantifies the decline of Typha minima since the nineteenth century by comparing its present and past distributions. Based on information in literature and herbarium data, two distribution maps (past and present) were compiled and used to calculate the total length of colonized river banks. This resulted in a distribution of about 3,170 km of river banks during the nineteenth century but only 480 km currently (1995-2010). The overall decline thus amounted to 85%. However, there were considerable regional differences: The decline was as high as 98% in the northern and central Alps but only about 50% in France, where strategies of flood mitigation that allowed for wide river beds proved to be favourable to the conservation of Typha minima.


11.1-141
Soil-vegetation patterns in secondary slash and burn successions in Central Menabe, Madagascar


Switzerland, France, Madagascar

Agriculture , Forestry , Plant Sciences , Pedology

Slash and burn agriculture is a traditional and predominant land use practice in Madagascar and its relevance in the context of forest preservation is significant. At the end of a cycle of culture, the fields become mostly weed covered and the soil fertility starts to drop. As a consequence, these fields are abandoned (they are called “monka”) and the farmers, in the best case, re-use old surfaces where the vegetation has recovered to some extent. Nevertheless, some of the farmers continue to extend part of their cultures into the natural forest. In order to decrease deforestation, the paper focuses on the potential for agricultural re-use of monkas. To do so, we present the soil-vegetation pattern along a slash and burn successional gradient from newly cultivated surfaces to surfaces abandoned for 40 years. Vegetation releves were carried out on 61 plots sampled on yellow and red soils, and soil variables such as loss of ignition, pH, total carbon content and total nitrogen content were measured. Results show that: (1) by the 10th year of abandonment woody species are increasing, and after 21-30 years herbaceous plants become less dominant, (2) the species richness increases with age of abandonment, but flattens out by 40 years, (3) by 20 years of fallow, the loss of ignition, total carbon and total nitrogen show similar values or even higher values than in cultivated surfaces, (4) the yellow soils are related to higher pH more than the red soils and are preferred for cultivation, but
the higher pH of yellow soils is not associated with higher species richness. Given these results, we conclude that fields older than 20 years have recovered sufficient fertility to be reused as agricultural land. This reuse would decrease impacts on natural forests. But beyond the nutrient perspective, critical problems remain, including the growing demand for arable land and the need for cultivation to control invasive weeds.


**11.1-142**

_Environmental determinants of lightning- v. human-induced forest fire ignitions differ in a temperate mountain region of Switzerland_

_Reineking B, Weibel P, Conedera M, Bugmann H_

_Switzerland, Germany_

_Forestry, Plant Sciences, Modelling, Landscape Studies_

Understanding the environmental and human determinants of forest fire ignitions is crucial for landscape management. In this study, we consider lightning- and human-induced fires separately and evaluate the relative importance of weather, forest composition and human activities on the occurrence of forest fire ignitions in the most fire-prone region of Switzerland, the Canton Ticino. Independent variables included 14 drought and fire weather indices, forest composition and human influences. Logistic regression models were used to relate these independent variables to records of forest fires over a 37-year period (1969-2005). We found large differences in the importance of environmental and human controls on forest fire ignitions between lightning- and human-induced events: lightning-induced fires occurred in a small range of weather conditions well captured by the Angstrom and the Fosberg Fire Weather Index, mainly in deciduous forests, and strongly depending on proximity to human infrastructure. We conclude that the suitability of fire indices can vary dramatically between ignition sources, suggesting that some of these indices are useful within certain regions and fire types only. The ignition source is an important factor that needs to be taken into account by fire managers and when developing models of forest fire occurrence.


**11.1-143**

_Grubbing by wild boars (Sus scrofa L.) and its impact on hardwood forest soil carbon dioxide emissions in Switzerland_

_Risch A C, Wirthner S, Busse M D, Page Dumroese D S, Schütz M_

_Switzerland, USA_

_Forestry, Zoology, Pedology, Plant Sciences, Modelling_

_Interest in soil C storage and release has increased in recent years. In addition to factors such as climate/land-use change, vertebrate animals can have a considerable impact on soil CO2 emissions. To date, most research has considered herbivores, while the impact of omnivorous animals has rarely been investigated. Our goal was to determine how European wild boars (Sus scrofa L.), large omnivores that consume soil-inhabiting animals and belowground plant parts by grubbing in the soil, affect soil C dynamics. We measured soil respiration (CO2), temperature, and moisture on paired grubbed and non-grubbed plots in six hardwood forest stands for a 3-year period and sampled fine root and microbial biomass at the beginning and after 2 years of the study. We also measured the percentage of freshly disturbed forest soil within the larger surroundings of each stand and used this information together with hunting statistics and forest cover data to model the total amount of CO2 released from Swiss forest soils due to grubbing during 1 year. Soil CO2 emissions were significantly higher on grubbed compared to non-grubbed plots during the study. On average 23.1% more CO2 was released from these plots, which we associated with potential alterations in CO2 diffusion rates, incorporation of litter into the mineral soil and higher fine root/microbial biomass. Thus, wild boars considerably increased the small-scale heterogeneity of soil properties. Roughly 1% of Switzerland’s surface area is similar to our sites (boar density/forest cover). Given the range of forest soil disturbance of 27-54% at our sites, the geographic information system model predicted that boar grubbing would lead to the release of an additional 49,731.10-98,454.74 t CO2 year(-1). These values are relatively small compared to total soil emissions estimated for Swiss hardwood forests and suggest that boars will have little effect on large-scale emissions unless their numbers increase and their range expands dramatically._

Spider, bee, and bird communities in cities are shaped by environmental control and high stochasticity
Sattler T, Borcard D, Arlettaz R, Bontadina F, Legendre P, Obrist M K, Moretti M
Switzerland, Canada
Zoology, Ecology, Biodiversity, Urban Studies
Spatially organized distribution patterns of species and communities are shaped by both autogenic processes (neutral mechanism theory) and exogenous processes (niche theory). In the latter, environmental variables that are themselves spatially organized induce spatial structure in the response variables. The relative importance of these processes has not yet been investigated in urban habitats. We compared the variance explained by purely spatial, spatially structured environmental, and purely environmental components for the community composition of spiders (Araneae), bees (Apidae), and birds (Aves) at 96 locations in three Swiss cities. Environmental variables (topography, climate, land cover, urban green management) were measured on four different radii around sampling points (<10 m, 50 m, 250 m, 1000 m), while Moran’s eigenvector maps (MEMs) acted as spatial variables. All three taxonomic groups showed weak spatial structure. Spider communities reacted to very fine-scaled environmental changes of lawn and meadow management and climate. Bird community composition was determined by woody plants as well as solar radiation at all radii, the scale of the influence varying among species. Bee communities were weakly explained by isolated variables only. Our results suggest that the anthropogenic structuring of urban areas has disrupted the spatial organization of environmental variables and inhibited the development of biotic spatial processes. The near absence of spatial structure may therefore be a feature typical of urban species assemblages, resulting in urban community composition mainly influenced by local environmental variables. Urban environments represent a close-knit mosaic of habitats that are regularly disturbed. Species communities in urban areas are far from equilibrium. Our analysis also suggests that urban communities need to be considered as being in constant change to adapt to disturbances and changes imposed by human activities.


Invasion of Solidago gigantea in contrasting experimental plant communities: effects on soil microbes, nutrients and plant-soil feedbacks
Scharfy D, Güsewell S, Gessner M O, Venterink H O
Switzerland
Plant Sciences, Biodiversity, Ecology, Pedology, Microbiology
1. Plant-soil feedbacks can influence the success of non-native plant invasions. We investigated if these feedbacks and the underlying invasion effects on soil microbes and nutrients depend on the species composition of the invaded vegetation, and whether these effects are related to differences in the invasibility of native plant communities. 2. We carried out a mesocosm experiment simulating the invasion of Solidago gigantea into three wetland plant communities (Molinion, Magnocaricion and Filipendulion), each composed of five plant species but differing in productivity. To study plant-soil feedbacks, we used different soil inoculum types from invaded and non-invaded field sites of the corresponding communities and a reference site. Invasion success was assessed by measuring the biomass of S. gigantea after three growing seasons and by analysing soil properties several times during the experiment. 3. Invasion success varied significantly among communities and soil inoculum types. Solidago gigantea produced more biomass in the Molinion than in the two more productive communities. In all three communities, it exhibited a negative feedback upon itself, producing 31-46% less biomass when the substrate was inoculated with soil from a stand invaded with S. gigantea. 4. The presence of S. gigantea did not influence total biomass in any community nor N and P availability in soil. However, it led to a decrease in soil bacterial and an increase in soil fungal biomasses. These changes were similar in the three communities and unrelated to the biomass of S. gigantea biomass in the invaded communities. 5. Synthesis. The experimental comparison between effects of an invasive plant species on soil properties in different native communities showed similar effects despite pronounced differences in the ability of the invasive species to grow in the different communities. In this system, plant-soil interactions may thus affect invasion, but not explain differences in the invasibility of different communities. The invasive species increased soil fungal biomass, particularly in its own soil, compared to native species and experienced a negative feedback, suggesting that the course of its invasion might be affected by species-specific soil pathogens.

11.1-146

Patches of Bare Ground as a Staple Commodity for Declining Ground-Foraging Insectivorous Farmland Birds

Switzerland
Zoology, Agriculture, Ecology, Landscape Studies

Conceived to combat widespread biodiversity erosion in farmland, agri-environment schemes have largely failed to deliver their promises despite massive financial support. While several common species have shown to react positively to existing measures, rare species have continued to decline in most European countries. Of particular concern is the status of insectivorous farmland birds that forage on the ground. We modelled the foraging habitat preferences of four declining insectivorous bird species (hoopoe, wryneck, woodlark, common redstart) inhabiting fruit tree plantations, orchards and vineyards. All species preferred foraging in habitat mosaics consisting of patches of grass and bare ground, with an optimal, species-specific bare ground coverage of 30-70% at the foraging patch scale. In the study areas, birds thrived in intensively cultivated farmland where such ground vegetation mosaics existed. Not promoted by conventional agri-environment schemes until now, patches of bare ground should be implemented throughout grassland in order to prevent further decline of insectivorous farmland birds.


11.1-147

Genotypic and environmental variation in specific leaf area in a widespread Alpine plant after transplantation to different altitudes

Scheepens J F, Frei E S, Stöcklin J
Switzerland
Plant Sciences, Ecology

Specific leaf area (SLA) is an important plant functional trait as it is an indicator of ecophysiological characteristics like relative growth rate, stress tolerance and leaf longevity. Substantial intraspecific variation in SLA is common and usually correlates with environmental conditions. For instance, SLA decreases with increasing altitude, which is understood as adjustment to temperature. It is generally assumed that intraspecific variation is mostly the result of environmentally induced phenotypic plasticity, but genetic effects may also be present, due to local adaptation or genetic drift. In this study, genotypic and environmental effects on SLA were experimentally separated for the widespread Alpine bell flower Campanula thyrsoides by transplanting plants to three common gardens at contrasting altitudes (600, 1,235 and 1,850 m a.s.l.). Seeds were sampled from 18 populations in four phylogeographic regions within the European Alps. A strong plastic response was observed: SLA decreased with increasing altitude of the common gardens (22.0% of variation). The phylogeographic regions were differentiated in SLA in the common gardens (10.1% of variation), indicating that SLA is at least partly genetically determined. Plants from the six easternmost populations experienced a submediterranean climate and showed decreased SLA values in the three common gardens compared to populations to the west, which may be explained as adaptation to drought. Within these submediterranean populations, SLA decreased with altitude of origin in two out of three common gardens. Concluding, SLA shows strong phenotypic plasticity as well as substantial genetic effects, the latter probably being the result of adaptation to local conditions rather than genetic drift.


11.1-148

Infra-red thermometry of alpine landscapes challenges climatic warming projections

Scherrer D, Körner C
Switzerland
Plant Sciences, Landscape Studies, Meteorology & Atmospheric Sciences

Rough mountain terrain offers climatic conditions (niches) to plants and animals poorly represented by conventional climate station data. However, the extent to which actual temperatures deviate from those of the freely circulating atmosphere had never been assessed at a landscape level. Here, we quantify thermal life conditions across topographically rich mountain terrain by using a combination of thermal (IR) imagery of surface temperature with data from a large number of miniature data loggers buried at 3 cm soil depth. The data obtained from six alpine (Alps) and arctic-alpine slopes (Norway, Sweden, Svalbard) evidence persistent root zone temperatures of 2-4 K above air temperature during summer. Surface temperatures show strong positive (2-9 K) and negative (3-8 K) deviations from air temperature on bright days and clear nights, respectively. As to be expected, south oriented slopes are warmer than west and north slopes but microclimatic variation on clear sky days was strong within all slopes, with 8.4 +/- 2.5 K
(mean ± SD) surface temperature differences persisting over several hours per day along horizontal (i.e., equal elevation) transects. Life conditions of alpine organisms are thus strongly decoupled from conditions in the free atmosphere and cannot reliably be inferred from climate station data in both, temperate and arctic latitudes. Microtopography can mimic temperature differences of large elevational (or latitudinal) gradients over very short horizontal distances. This is important in the context of climate change because it shows that species do not necessarily need to climb several hundred meters in elevation to escape the warmth. Quite often, few meters of horizontal shift will do. For plants unable to, or too slow to adapt to a warmer climate, thermal microhabitat mosaics offer both refuge habitats as well as stepping stones as atmospheric temperatures rise. Global Change Biology, 2010, V16, N9, SEP, pp 2602-2613 DOI: http://dx.doi.org/10.1111/j.1365-2486.2009.02122.x.

11.1-149
Plant community diversity and composition affect individual plant performance
Schmidtke A, Rottstock T, Gaedke U, Fischer M
Germany, Switzerland
Plant Sciences, Biodiversity, Ecology
Effects of plant community diversity on ecosystem processes have recently received major attention. In contrast, effects of species richness and functional richness on individual plant performance, and their magnitude relative to effects of community composition, have been largely neglected. Therefore, we examined height, aboveground biomass, and inflorescence production of individual plants of all species present in 82 large plots of the Jena Experiment, a large grassland biodiversity experiment in Germany. These plots differed in species richness (1-60), functional richness (1-4), and community composition. On average, in more species-rich communities, plant individuals grew taller, but weighed less, were less likely to flower, and had fewer inflorescences. In plots containing legumes, non-legumes were higher and weighed more than in plots without legumes. In plots containing grasses, non-grasses were less likely to flower than in plots without grasses. This indicates that legumes positively and grasses negatively affected the performance of other species. Species richness and functional richness effects differed systematically between functional groups. The magnitude of the increase in plant height with increasing species richness was greatest in grasses and was progressively smaller in legumes, small herbs, and tall herbs. Individual aboveground biomass responses to increasing species richness also differed among functional groups and were positive for legumes, less pronouncedly positive for grasses, negative for small herbs, and more pronouncedly negative for tall herbs. Moreover, these effects of species richness differed strongly between species within these functional groups. We conclude that individual plant performance largely depends on the diversity of the surrounding community, and that the direction and magnitude of the effects of species richness and functional richness differ largely between species. Our study suggests that diversity of the surrounding community needs to be taken into account when interpreting drivers of the performance of individual plants. Oecologia, 2010, V164, N3, NOV, pp 665-677 DOI: http://dx.doi.org/10.1007/s00442-010-1688-z.

11.1-150
Counterbalancing effects of competition for resources and facilitation against grazing in alpine snowbed communities
Schöb C, Kammer P M, Kikvidze Z, Choler P, von Felten S, Veit H
Switzerland, Japan, France
Plant Sciences, Biodiversity, Cryology / Glaciology, Modelling, Ecology
Alpine snowbeds are habitats where the major limiting factors for plant growth are herbivory and a small time window for growth due to late snowmelt. Despite these limitations, snowbed vegetation usually forms a dense carpet of palatable plants due to favourable abiotic conditions for plant growth within the short growing season. These environmental characteristics make snowbeds particularly interesting to study the interplay of facilitation and competition. We hypothesised an interplay between resource competition and facilitation against herbivory. Further, we investigated whether these predicted neighbour effects were species-specific and/or dependent on ontogeny, and whether the balance of positive and negative plant-plant interactions shifted along a snowmelt gradient. We determined the neighbour effects by means of neighbour removal experiments along the snowmelt gradient, and linear mixed model analyses. The results showed that the effects of neighbour removal were weak but generally consistent among species and snowmelt dates, and depended on whether biomass production or survival was considered. Higher total biomass and increased fruiting in removal plots indicated that plants competed for nutrients, water, and light, thereby supporting the hypothesis of prevailing competition for resources in snowbeds. However, the presence of neighbours reduced herbivory and...
and Regression Trees (CART) were applied. The
man rank correlation analysis and Classification
concentrations and the chosen predictors. Spear-
ments between moss tissue total N
compass various N compounds. In order to as-
modelled deposition and concentration data
range Transboundary Air Pollution (CLRTAP).
Programme (EMEP) of the Convention on Long-
data were calculated using the Unified EMEP Mod-
atmospheric N deposition and air concentration
Vegetation and Crops (ICP Vegetation). Modelled
programme on Effects of Air Pollution on Natural
was coordinated by the International Cooperative
work of the European moss survey 2005/6, which
from 2781 sites across Europe within the frame-
analyses included data from mosses collected
best the total N concentration in mosses on the
site-specific and regional factors which explain
factors best explaining the total nitrogen
concentration in mosses
Schröder W, Holy M, Pesch R, Harmens H, Fagerli
Alber R, Coskun M, de Temmerman L, Frolova
M, Gonzalez Miqueo L, Jeran Z, Kubin E, Leblond
S, Liv S, Mankovska B, Piispanen J, Santamaria
J M, Simonie J, Suchara I, Yurukova L, Thöni L,
Zechmeister H G
Germany, Wales, Norway, Italy, Turkey, Belgium,
Latvia, Spain, Slovenia, Finland, France, Estonia,
Slovakia, Bulgaria, Switzerland, Austria
Plant Sciences, Meteorology & Atmospheric
sciences
In this study, the indicative value of mosses as
biomonitors of atmospheric nitrogen (N) deposi-
tions and air concentrations on the one hand and
site-specific and regional factors which explain
best the total N concentration in mosses on the
other hand were investigated for the first time at
a European scale using correlation analyses. The
analyses included data from mosses collected
from 2781 sites across Europe within the frame-
work of the European moss survey 2005/6, which
was coordinated by the International Cooperative
Programme on Effects of Air Pollution on Natural
Vegetation and Crops (ICP Vegetation). Modelled
atmospheric N deposition and air concentration
data were calculated using the Unified EMEP Mod-
el of the European Monitoring and Evaluation
Programme (EMEP) of the Convention on Long-
rage Transboundary Air Pollution (CLRTAP).
The modelled deposition and concentration data
encompass various N compounds. In order to as-
ss the correlations between moss tissue total N
concentrations and the chosen predictors. Spear-
man rank correlation analysis and Classification
and Regression Trees (CART) were applied. The
Spearman rank correlation analysis showed that
the total N concentration in mosses and modelled
N depositions and air concentrations are signifi-
cantly correlated ($0.53 \leq r(s) < 0.68$, $p < 0.001$).
Correlations with other predictors were lower
than 0.55. The CART analysis indicated that the
variation in the total N concentration in mosses
was best explained by the variation in NH4+ con-
centrations in air, followed by NO2 concentrations
in air, sampled moss species and total dry N depo-
position. The total N concentrations in mosses mir-
ror land use-related atmospheric concentrations
and depositions of N across Europe. In addition
to already proven associations to measured N de-
position on a local scale the study at hand gives
a scientific prove on the association of N concen-
tration in mosses and modelled deposition at the
European scale.

11.1-151
First Europe-wide correlation analysis identify-
ing factors best explaining the total nitrogen
concentration in mosses
Schweiger O, Biesmeijer J C, Bommarco R, Hickler
T, Hulme P E, Klotz S, Kühn I, Moora M, Nielsen A,
Ohlemüller R, Petanidou T, Potts S G, Pysek P, Stout
J C, Sykes M T, Tscheulin T, Vila M, Walther G R,
Westphal C, Winter M, Zobel M, Settele J
Germany, England, Sweden, New Zealand, Estonia,
Greece, Czech Republic, Ireland, Spain, Switzerland
Biodiversity , Ecology , Plant Sciences
Global change may substantially affect biodiver-
sity and ecosystem functioning but little is known
about its effects on essential biotic interactions.
Since different environmental drivers rarely act
in isolation it is important to consider interactive
effects. Here, we focus on how two key drivers of
anthropogenic environmental change, climate
change and the introduction of alien species, af-
fect plant-pollinator interactions. Based on a lit-
ature survey we identify climatically sensitive
aspects of species interactions, assess potential
effects of climate change on these mechanisms,
and derive hypotheses that may form the basis of
future research. We find that both climate change
and alien species will ultimately lead to the cre-
ation of novel communities. In these communities
certain interactions may no longer occur while
there will also be potential for the emergence of
new relationships. Alien species can both partly
compensate for the often negative effects of cli-
mate change but also amplify them in some cases.
Since potential positive effects are often restricted
to generalist interactions among species, climate change and alien species in combination can result in significant threats to more specialist interactions involving native species.


### 11.1-153

**Concealment from predators drives foraging habitat selection in brood-rearing Alpine black grouse Tetrao tetrix hens: habitat management implications**

Signorell N, Wirthner S, Patthey P, Schranz R, Rotelli L, Arlettaz R

Switzerland, Italy, Australia

Zoology, Ecology, Biodiversity

Declines of Alpine black grouse Tetrao tetrix populations have been linked to increasing disturbance by recreation and degradation of breeding habitat due to changes in land-use, especially abandonment of traditional farming practices. Appropriate forest, shrubland and grassland management may mitigate the negative effects of land abandonment. The habitat associations and trophic requirements of brood-rearing Alpine black grouse hens were appraised to inform effective habitat management policies. We measured the abundance, biomass and phenology of arthropods, a key food source for grouse chicks, in eight timberline habitat categories and performed a habitat selection analysis based on radio-tracking data collected from eight brood-rearing hens in the Swiss and Italian Alps. Arthropod biomass differed significantly between habitat categories and peaked in early summer due to a sharp increase of orthopterans (Saltatoria), an essential food source for Alpine black grouse chicks. Open grassland and grassy shrubland yielded the highest arthropod biomass, with Saltatoria dominating the sample. Yet, brood-rearing hens avoided open grassland, opting for a mosaic of grassy shrubland with scattered trees. Chick-rearing hens apparently traded-off food abundance for reduced predation risk, i.e. habitats offering cover for concealment and escape from predators. These specific black arouse breeding habitat requirements inform about habitat management within Alpine timberline ecosystems. Managers should not restore extensive, homogeneous pastures. Instead, a complex heterogeneous habitat mosaic, consisting of patches of grassland and shrubland interspersed with scattered coniferous trees should be promoted.


### 11.1-154

**Conserving Southeast Asian forest biodiversity in human-modified landscapes**


Singapore, Switzerland, Malaysia, Australia, England, Germany, USA

Biodiversity, Forestry, Plant Sciences, Landscape Studies, Ecology

Southeast Asia experiences one of the highest rates of deforestation in the tropics due to agricultural expansion, logging, habitat fragmentation and urbanization, which are expected to result in species declines and extinctions. In particular, growing global demands for food, biofuel and other commodities are driving the rapid expansion of oil palm and paper-and-pulp industries at the expense of lowland dipterocarp forests, further jeopardizing Southeast Asian forest biotas. We synthesize recent findings on the effects of land-use changes on plants, invertebrates, vertebrates and ecosystem functioning/services in Southeast Asia. We find that species richness and abundance/density of forest-dependent taxa generally declined in disturbed compared to mature forests. Species with restricted ranges and those with habitat and foraging specialization were particularly vulnerable. Forest loss also disrupted vital ecosystem services (e.g. crop pollination). Long-term studies are needed to understand biotic sustainability in regenerating and degraded forests, particularly in the context of the synergistic or additive effects of multiple agents of biodiversity loss (e.g. invasive species and climate change). The preservation of large tracts of mature forests should remain the principal conservation strategy in the tropics. In addition, reforestation and reintroductions of native species, as well as improved connectivity among forest patches could enhance the conservation value of forest remnants in human-dominated landscapes.


### 11.1-155

**Landscape genetics: where are we now?**

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USA, Switzerland

Landscape Studies, Ecology, Zoology

Landscape genetics has seen rapid growth in number of publications since the term was coined in 2003. An extensive literature search from 1998 to 2008 using keywords associated with landscape...
Litterfall production, decomposition and nutrient use efficiency varies with tropical forest types in Xishuangbanna, SW China: a 10-year study

Tang J W, Cao M, Zhang J H, Li M H
Peoples R China, Switzerland
Plant Sciences, Forestry, Pedology

Litterfall production, decomposition and nutrient use efficiency in three different tropical forest ecosystems in SW China were studied for 10 years. Annual mean litterfall production in tropical seasonal forest (TSF) (9.47 +/- 1.65 Mg ha(-1)) was similar to that in man-made tropical forest (MTF) (9.23 +/- 1.29 Mg ha(-1)) (P > 0.05) but both were significantly lower than that in secondary tropical forest (STF) (12.96 +/- 1.71 Mg ha(-1)) (P < 0.05). The annual variation of litterfall was greater in TSF (17.4%, P < 0.05) than in MTF (14.0%) or STF (13.2%). The annual mean decomposition rate of litterfall increased followed the order of MTF (2.72) < TSF (3.15) < STF (3.50) (P < 0.05), which was not correlated with annual precipitation or annual mean temperature, but was rather related to litter quality. The nutrient use efficiency was found to be element-dependent and to vary significantly among the three forest types (P < 0.05). These results indicate that litterfall production and decomposition rates in different tropical forest systems are related to plant species composition and are influenced strongly by coexisting species and their life stage (age) but less so by the species richness. Constructing multi-species and multistory man-made tropical forest is an effective way to enhance biological productivity and maintain soil nutrients on degraded tropical land. Funding acknowledgement: This project was supported by Chinese Ecosystem Research Network (CERN) (Grants: KZ951-A1-301, KZ95T-04). Ministry of Science and Technology of China (Grant: 2001CCB00600) and Chinese Academy of Sciences (Grant: KZCX2-406). We thank staff members of Xishuangbanna Tropical Rainforest Ecosystem Station for their assistance in the field work and Biogeochromy Lab of Xishuangbanna Tropical Botanical Garden.

11.1-157
No adaptation to altitude in the invasive plant Erigeron annuus in the Swiss Alps

Trtikova M, Edwards P J, Güsewell S
Switzerland
Plant Sciences, Biodiversity, Ecology

The altitudinal distribution of plants is restricted by various environmental factors, with climatic conditions being one of the primary constraints. Here, we investigate what limits the altitudinal range of the introduced species Erigeron annuus in the Swiss Alps. We planted offspring of E. annuus plants originating from different altitudes into two common gardens, one located at an al-
titude representing the main area of distribution (400 m) and the other close to the current altitudinal limit of E. annuus in Switzerland (1000 m). In both common gardens all established plants survived and grew vigorously during the growing season. However, there was high winter mortality of seedlings at 1000 m. Furthermore, plant phenology was delayed and reproductive output was reduced at 1000 m, although the seeds produced were larger. The general lack of adaptation to altitude and only moderate levels of plasticity suggest that there is little potential for E. annuus to persist beyond its current altitudinal limit in the Swiss Alps. However, climate warming might promote the upward range expansion of E. annuus by reducing winter mortality and by increasing the chance of producing seeds within the growing season.


11.1-158
Functional traits as indicators of biodiversity response to land use changes across ecosystems and organisms

Rigorous and widely applicable indicators of biodiversity are needed to monitor the responses of ecosystems to global change and design effective conservation schemes. Among the potential indicators of biodiversity, those based on the functional traits of species and communities are interesting because they can be generalized to similar habitats and can be assessed by relatively rapid field assessment across eco-regions. Functional traits, however, have as yet been rarely considered in current common monitoring schemes. Moreover, standardized procedures of trait measurement and analyses have almost exclusively been developed for plants but different approaches have been used for different groups of organisms. Here we review approaches using functional traits as biodiversity indicators focussing not on plants as usual but particularly on animal groups that are commonly considered in different biodiversity monitoring schemes (benthic invertebrates, collembolans, above ground insects and birds).

Further, we introduce a new framework based on functional traits indices and illustrate it using case studies where the traits of these organisms can help monitoring the response of biodiversity to different land use change drivers. We propose and test standard procedures to integrate different components of functional traits into biodiversity monitoring schemes across trophic levels and disciplines. We suggest that the development of indicators using functional traits could complement, rather than replace, the existing biodiversity monitoring. In this way, the comparison of the effect of land use changes on biodiversity is facilitated and is expected to positively influence conservation management practices.


11.1-159
Reproducibility of species lists, visual cover estimates and frequency methods for recording high-mountain vegetation

Question: When multiple observers record the same spatial units of alpine vegetation, how much variation is there in the records and what are the consequences of this variation for monitoring schemes to detect changes? Location: One test summit in Switzerland (Alps) and one test summit in Scotland (Cairngorm Mountains). Method: Eight observers used the GLORIA protocols for species composition and visual cover estimates and frequency methods for recording high-mountain vegetation. Conclusions: Statistical power calculations indicated that unless large numbers of plots were used, changes in cover or frequency were only likely to be detected for abundant species (exceeding 10% cover) or if relative changes were large (50% or more). Lower variation could be reached with the point method and with larger numbers of small quadrats (1 m2). Results: The multiple records from the same spatial unit for species composition and species cover showed considerable variation in the two countries. Estimates of pseudo-turnover of composition and coefficients of variation of cover estimates for vascular plant species in 1 m x 1-m quadrats showed less variation than in previously published reports, whereas our results in larger sections were broadly in line with previous reports. In Scotland, estimates for bryophytes and lichens were more variable than for vascular plants.
plots. However, as summits often strongly differ from each other, supplementary summits cannot be considered as a way of increasing statistical power without introducing a supplementary component of variance into the analysis and hence into the power calculations.


11.1-160
Evolution in heterogeneous populations: From migration models to fixation probabilities
Vuilleumier S, Goudet J, Perrin N Switzerland
Ecology, Biodiversity, Modelling
Although dispersal is recognized as a key issue in several fields of population biology (such as behavioral ecology, population genetics, metapopulation dynamics or evolutionary modeling), these disciplines focus on different aspects of the concept and often make different implicit assumptions regarding migration models. Using simulations, we investigate how such assumptions translate into effective gene flow and fixation probability of selected alleles. Assumptions regarding migration type (e.g. source-sink, resident pre-emption, or balanced dispersal) and patterns (e.g. stepping-stone versus island dispersal) have large impacts when demes differ in sizes or selective pressures. The effects of fragmentation, as well as the spatial localization of newly arising mutations, also strongly depend on migration type and patterns. Migration rate also matters: depending on the migration type, fixation probabilities at an intermediate migration rate may lie outside the range defined by the low- and high-migration limits when demes differ in sizes. Given the extreme sensitivity of fixation probability to characteristics of dispersal, we underline the importance of making explicit (and documenting empirically) the crucial ecological/behavioral assumptions underlying migration models.


11.1-161
Incorporating 2D tree-ring data in 3D laser scans of coarse-root systems
Wagner B, Gärtner H, Ingensand H, Santini S Switzerland
Plant Sciences, Forestry, Modelling, Pedology
In times of global change biomass calculations and the carbon cycle is gaining in importance. Forests act as carbon sinks and hence, play a crucial role in worlds and forests carbon budgets. Unfortunately, growth models and biomass calculations existing so far mainly concentrate on the above-ground part of trees. For this reason, the aim of the present study is to develop an annually resolved 3D growth model for tree roots, which allows for reliable biomass calculations and can later be combined with above-ground models. A FARO scan arm was used to measure the surface of a tree-root segment. In addition, ring-width measurements were performed manually on sampled cross sections using WinDENDRO. The main goal of this study is to model root growth on an annual scale by combining these data sets. In particular, a laser scan arm was tested as a device for the realistic reproduction of tree-root architecture, although the first evaluation has been performed for a root segment rather than for an entire root system. Deviations in volume calculations differed between 5% and 7% from the actual volume and varied depending on the used modeling technique. The model with the smallest deviations represented the structure of the root segment in a realistic way and distances and diameter of cross sections were acceptable approximations of the real values. However, the volume calculations varied depending on object complexity, modeling technique and order of modeling steps. In addition, it was possible to merge tree-ring borders as coordinates into the surface model and receive age information in connection with the spatial allocation. The scan arm was evaluated as an innovative and applicable device with high potential for root modeling. Nevertheless, there are still many problems connected with the scanning technique which have an influence on the accuracy of the model but are expected to improve with technical progress.


11.1-162
Conserving biodiversity in production landscapes
Wilson K A, Meijaard E, Drummond S, Grantham H S, Boitani L, Catullo G, Christie L, Dennis R, Dutton I, Falcucci A, Maiorano L, Possingham H P, Rondinini C, Turner W R, Venter O, Watts M Australia, Indonesia, Italy, USA, Switzerland Biodiversity, Forestry, Ecology, Plant Sciences Alternative land uses make different contributions to the conservation of biodiversity and have different implementation and management costs. Conservation planning analyses to date have generally assumed that land is either protected or unprotected and that the unprotected portion does not con-
1.3 Soil and Lithosphere

11.1-163  
No overall stimulation of soil respiration under mature deciduous forest trees after 7 years of CO₂ enrichment

Bader M K F, Körner C  
Switzerland  
Pedology, Plant Sciences, Forestry, Meteorology & Atmospheric Sciences

The anthropogenic rise in atmospheric CO₂ is expected to impact carbon (C) fluxes not only at ecosystem level but also at the global scale by altering C cycle processes in soils. At the Swiss Canopy Crane (SCC), we examined how 7 years of free air CO₂ enrichment (FACE) affected soil CO₂ dynamics in a ca. 100-year-old mixed deciduous forest. The use of 13C-depleted CO₂ for canopy enrichment allowed us to trace the flow of recently fixed C. In the 7th year of growth at similar to 550 ppm CO₂, soil respiratory CO₂ consisted of 39% labelled C. During the growing season, soil air CO₂ concentration was significantly enhanced under CO₂-exposed trees. However, elevated CO₂ failed to stimulate cumulative soil respiration (Rs) over the growing season. We found periodic reductions as well as increases in instantaneous rates of Rs over the growing season. We found periodic reductions as well as increases in instantaneous rates of Rs in response to elevated CO₂, depending on soil temperature and soil volumetric water content (VWC; significant three-way interaction). During wet periods, soil water savings under CO₂-enriched trees led to excessive VWC (> 45%) that suppressed Rs. Elevated CO₂ stimulated Rs only when VWC was < 40% and concurrent soil temperature was high (> 15 degrees C). Seasonal Q(10) estimates of Rs were significantly lower under elevated (Q(10)=3.30) compared with ambient CO₂ (Q(10)=3.97). However, this effect disappeared when three consecutive sampling dates of extremely high VWC were disregarded. This suggests that elevated CO₂ affected Q(10) mainly indirectly through changes in VWC. Fine root respiration did not differ significantly between treatments but soil microbial biomass (C-mic) increased by 14% under elevated CO₂ (marginally significant). Our findings do not indicate enhanced soil C emissions in such stands under future atmospheric CO₂. It remains to be shown whether C losses via leaching of dissolved organic or inorganic C (DOC, DIC) help to balance the C budget in this forest.


11.1-164  
Polycyclic aromatic hydrocarbons (PAHs) and their oxygen-containing derivatives (OPAHs) in soils from the Angren industrial area, Uzbekistan

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Switzerland, Germany, Uzbekistan  
Geochemistry & Geophysics, Pedology, Energy & Fuels

We measured the concentrations and depth distribution (0-10, 10-20 cm) of 31 PAHs and 12 OPAHs in soils at eleven equidistant sampling points along a 20-km transect in the Angren industrial region (coal mine, power plant, rubber factory,
gold mine), Uzbekistan to gain an insight into their concentrations, sources, and fate. Concentrations of all compounds were mostly much higher in the 0-10 cm than in the 10-20 cm layer except in disturbed soil close to the coal mine. Proximity to one of the industrial emitters was the main determinant of PAH and OPAH concentrations. The Sigma 31PAHs concentrations correlated positively with the Sigma 7 carbonyl-OPAH ($r = 0.98$, $p < 0.01$), Sigma 5 hydroxyl-OPAH ($r = 0.72$, $p < 0.05$), and with industrially emitted trace metals in the topsoil, identifying industrial emissions as their common source. Concentrations of several OPAHs were higher than their parent PAHs, but their vertical distribution in soil suggested only little higher mobility of OPAHs than their corresponding parent PAHs.

*Environmental Pollution, 2010, V158, N9, SEP, pp 2888-2899 DOI: http://dx.doi.org/10.1016/j.envpol.2010.06.012.*

**11.1-166**

**Evaluation of soil compaction effects on soil biota and soil biological processes in soils**

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Germany, Switzerland  
Pedology, Biodiversity, Microbiology  
Investigations on soil compaction focused mainly on effects on soil physical parameters and on plant growth. Nevertheless, a substantial number of papers deal with effects of soil compaction on soil organisms (soil fauna, soil microorganisms) and biologically driven processes in soils (e.g., macropore formation, respiration rates, N-mineralisation). In view of soil and soil functions protection, there is an essential need to identify soil compaction threshold values with respect to soil biota and soil biological processes. No such values are currently available. Thus the aim of our study was to evaluate literature on the effects of soil compaction mainly in agricultural soils on soil organisms and soil biological processes (e.g., respiration, nitrification); to identify relevant parameters which are helpful for assessing soil compaction from the soil biological point of view; and to find out whether threshold values of soil structure parameters proposed by soil physicists correspond to harmful impacts on soil organisms and biological processes in soils. Our literature review showed that due to the high variability of experimental situations and conditions in the evaluated papers, especially in papers describing field investigations, no general effect of soil compaction was found. Negative and positive effects occurred with slight compaction as well as with strong compaction. A verification of the thresholds published to date for soil compaction was not possible based on the data evaluated. However, the fact that above an effective bulk density of 1.7 g cm$^{-3}$, only negative effects on microbial biomass and C-mineralisation were found confirms this value, proposed by soil physicists, also from the soil biological point of view. In order to provide a scientifically meaningful database for the assessment of soil compaction, effects on soil biodiversity, related functions and processes, we recommend considering the following site and soil properties as essentials: land use, climate, soil type, texture, bulk density; soil organic matter content; pH value; soil moisture (water content/water tension); pore volume; macroporosity and air and/or water conductivity.  

*Soil Tillage Research, 2010, V109, N2, AUG, pp 133-143 DOI: http://dx.doi.org/10.1016/j.still.2010.05.010.*

**11.1-165**

**Rill development and soil erosion: a laboratory study of slope and rainfall intensity**

Berger C, Schulze M, Rieke Zapp D, Schlunegger F  
Switzerland  
Pedology, Geomorphology, Hydrology, Modelling  
A total of 15 rainfall simulation experiments were conducted in a 1 m by 2 m box varying slope (10, 20, 30%) and rainfall intensity (60, 90, 120 mm h$^{-1}$). The experiments were performed to study how rill networks initiate and evolve over time under controlled conditions with regard to the treatment variables considered, and to allow for input in a computer simulation model. Runoff and sediment yield samples were collected. Digital elevation models were calculated by means of photogrammetry for several time steps of most experiments. The soil used in the experiments was a basal till derived Cambisol typical for the Swiss Plateau. While significant differences were found for sediment yield, runoff did not vary significantly with treatment combinations. Increasing rainfall intensity had a larger effect on sediment yield than increasing slope. Rill density and energy expenditure decreased with time, suggesting that energy expenditure was a useful parameter to describe the emergence of rill network at the laboratory scale.

11.1-167

Effect of the endogeic earthworm Pontoscolex corethrurus on the microbial structure and activity related to CO₂ and N₂O fluxes from a tropical soil (Madagascar)
Madagascar, France, Switzerland
Pedology, Microbiology, Zoology

The objective of this laboratory study was to determine the influence of a tropical endogeic earthworm, Pontoscolex corethrurus, on CO₂ and N₂O fluxes from a tropical Ferralsol and microorganisms potentially involved in these gases emissions. CO₂ and N₂O fluxes were measured during 35 days from soil mesocosms with and without earthworms. At the end of the incubation, 7% of soil was egested as cast in the earthworm treatment. Then, casts which may be aged from few hours to 35 days old were isolated from non-ingested soil. Different descriptive parameters (activity, density, and structure) of the microbial communities were investigated in the control, the non-ingested soils, and the casts. Quantitative PCR of denitrification genes encoding the nitrite (nirK) and nitrous oxide (nosZ) reductases was used to study denitrifier density in the earthworm casts. The presence of P. corethrurus induced a significant increase in CO₂ emissions but did not affect N₂O fluxes when measured at mesocosm level. Despite the absence of significant differences in C and N contents between soils and casts, the near infra-red spectra analysis clearly underlined a specific organic signature for the casts. Fungal and bacterial biomass significantly decreased (similar to 2-fold) in casts compared to parent soil, but the fungal-to-bacterial ratio was not modified by the earthworm casting activity. Data suggested that bacterial communities, especially denitrifiers, were modified in casts. The relative abundance of nirK and nosZ genes increased in the casts while the genetic structures of total bacteria and denitrifying communities were slightly modified in the casts. This study highlighted the importance of earthworm casts as a specific soil habitat where a subset of soil functional bacterial communities (such as denitrifiers) found favourable condition for their growth. However the effect of P. corethrurus was less evident when up-scaling from casts to mesocosm level.


11.1-168

Preservation of fire-derived carbon compounds and sorptive stabilisation promote the accumulation of organic matter in black soils of the Southern Alps
Eckmeier E, Egli M, Schmidt M W I, Schlumpf N, Nötzli M, Minikus Stary N, Hagedorn F
Germany, Switzerland
Pedology, Geochemistry & Geophysics, Forestry
Cryptopodzols are black soils that occur under forests dominated by chestnut trees (Castanea sativa) in Southern Switzerland. Their soil organic carbon (SOC) stocks reach an average of 150 t C ha⁻¹ and are thus among the highest of European forest soils. We investigated the processes leading to the accumulation and stabilisation of SOC in these soils by analysing three Cryptopodzols and one Cambisol for charred organic matter content (macrocharcoal and BPCA), the amounts of Fe and Al, and the colour and SOC content in bulk soil and density fractions. The results showed that charred organic matter produced by frequent fires in the area for more than 10,000 years is highly abundant in Cryptopodzols: the stocks of macrocharcoal and BPCA-C amount to up to 31 t ha⁻¹ and 17 t ha⁻¹, respectively. These high amounts of charred organic matter are responsible for the dark soil colour and high SOC concentrations that are, however, also closely related to Fe and Al concentrations. We concluded that the occurrence of charcoal across the whole profiles of Cryptopodzols seems to be the dominating factor, although both the formation of organo-metallic or organo-mineral complexes in the subsoil and the high abundance and stability of charred organic matter are responsible for the high SOC stocks in Cryptopodzols.


11.1-169

Soil organic matter formation along a chronosequence in the Morteratsch proglacial area (Upper Engadine, Switzerland)

Egli M, Mavris C, Mirabella A, Giaccai D
Switzerland, Italy
Pedology, Plant Sciences, Geochemistry & Geophysics

Global warming leads to the melting of ice caps and glaciers and, consequently, the exposure of new areas of land to the atmosphere and weathering. These areas usually have a high reactivity to both biotic and abiotic changes. Proglacial ar-
areas in the Alps usually have a deglaciation time span of around 150 years (time since the end of the “Little Ice Age” in the 1850’s). We investigated a chronosequence of very young soils in the proglacial area Morteratsch (Swiss Alps) to derive time-trends of soil organic matter accumulation and evolution. Total organic C and N contents, C and N contents of the various organic matter (OM) density fractions and of the labile (oxidised by \text{H}_2\text{O}_2\) and stable (\text{H}_2\text{O}_2\-resistant) fractions were measured. Further characterisation of OM and the various fractions was performed using Diffuse Reflection Infrared Fourier Transform (DRIFT).

Soil organic matter has been accumulated over 150 years at very high rates, values lay between 7 and 368 C/(m²)/year. This led to a soil organic matter abundance of about 1-5.5 kg C/(m²) after 140 years. Even at the start of soil formation, a very stable fraction of soil organic matter was detectable. Stable organic matter (resistant to the \text{H}_2\text{O}_2\ treatment) comprised about 6% of the total soil organic carbon and 10% of the total nitrogen. At the start of soil formation, a very high proportion of soil organic matter was present in the density fractions <1.6 g/cm(3). After about 140 years, 15% of soil organic carbon and 35-40% of the nitrogen was already present in the highest density fraction (>2 g/cm(3)). With time, the quality of soil organic matter changed: a decrease of hydrophobicity, an increase in aromatic compounds in the bulk soil and a decrease in phenolic functional groups in the heaviest density fraction were detectable with increasing age. In general, stable organic matter as well as the density fraction >2 g/cm(3) had a low C/N ratio and were enriched in proteinaceous materials. The adsorption of proteinaceous materials points to a strong organomineral association. This process has existed since the very beginning of soil formation.

Catena, 2010, V82, N2, AUG 15, pp 61-69 DOI: http://dx.doi.org/10.1016/j.catena.2010.05.001.

11.1-170
Predicting Threshold Exceedance by Local Block Means in Soil Pollution Surveys
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Switzerland

Pedology, Geochemistry & Geophysics, Modelling

Soil contamination by heavy metals and organic pollutants around industrial premises is a problem in many countries around the world. Delineating zones where pollutants exceed tolerable levels is a necessity for successfully mitigating related health risks. Predictions of pollutants are usually required for blocks because remediation or regulatory decisions are imposed for entire parcels. Parcel areas typically exceed the observation support, but are smaller than the survey domain. Mapping soil pollution therefore involves a local change of support. The goal of this work is to find a simple, robust, and precise method for predicting block means (linear predictions) and threshold exceedance by block means (nonlinear predictions) from data observed at points that show a spatial trend. By simulations, we compared the performance of universal block kriging (UK), Gaussian conditional simulations (CS), constrained (CK), and covariance-matching constrained kriging (CMCK), for linear and nonlinear local change of support prediction problems. We considered Gaussian and positively skewed spatial processes with a nonstationary mean function and various scenarios for the autocorrelated error. The linear predictions were assessed by bias and mean square prediction error and the nonlinear predictions by bias and Peirce skill scores. For Gaussian data and blocks with locally dense sampling, all four methods performed well, both for linear and nonlinear predictions. When sampling was sparse CK and CMCK gave less precise linear predictions, but outperformed UK for nonlinear predictions, irrespective of the data distribution. CK and CMCK were only outperformed by CS in the Gaussian case when threshold exceedance was predicted by the conditional quantiles. However, CS was strongly biased for the skewed data whereas CK and CMCK still provided unbiased and quite precise nonlinear predictions. CMCK did not show any advantages over CK. CK is as simple to compute as UK. We recommend therefore this method to predict block means and nonlinear transforms thereof because it offers a good compromise between robustness, simplicity, and precision. Funding acknowledgement: Mathematical Geosciences, 2010, V42, N6, AUG, pp 631-656 DOI: http://dx.doi.org/10.1007/s11004-010-9287-4.

11.1-171
Applying erosion damage mapping to assess and quantify off-site effects of soil erosion in Switzerland
Ledermann T, Herweg K, Liniger H P, Schneider F, Hurni H, Prasuhn V
Switzerland

Pedology, Hydrology

In order to fill existing knowledge gaps in the temporal and spatial distribution of soil erosion, its sources and causes, as well as in relation to its off-site impacts, erosion damage mapping of all visible erosion features was carried out at three study sites in Switzerland. The data illustrate that
about one-quarter of the cultivated land was affected by water erosion. Observed mean annual soil loss rates are considered rather low (0.7-2.3 t ha\(^{-1}\) y\(^{-1}\)) compared to other European countries. However, substantial losses of >70 t ha\(^{-1}\) were recorded on individual plots. The analyses illustrate that the sites differ considerably in average soil loss rates, but show similar patterns of off-site effects. In about one-third of the damaged plots an external source of surface runoff upslope contributed to the damage (run-on). Similarly, more than 50 per cent of the soil eroded on arable land deposited downslope on adjacent plots, roads, public/private infrastructure, etc., and 20 per cent of it reached open water bodies. Large amounts of eroded soil which deposit off-site, often related to slope depressions, are considered muddy floods and were frequently observed in Switzerland. Mapping, in conclusion, helps to shed light on some of the important challenges of today, in particular: to comprehensively assess socioeconomic and ecological off-site effects of soil erosion, to attribute off-site impacts to on-site causes, and to raise awareness of all stakeholders involved, in order to improve ongoing discussions on policy formulation and implementation at the national and international levels.


11.1-172
Molecular evidence for widespread occurrence of Foraminifera in soils
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Switzerland, France
Pedology , Biodiversity , Microbiology , Ecology
Environmental SSU rDNA-based surveys are contributing to the dramatic revision of eukaryotic high-level diversity and phylogeny as the number of sequence data increases. This ongoing revolution gives the opportunity to test for the presence of some eukaryotic taxa in environments where they have not been found using classical microscopic observations. Here, we test whether the foraminifera, a group of single-celled eukaryotes, considered generally as typical for the marine ecosystems are present in soil. We performed foraminiferal-specific nested PCR on 20 soil DNA samples collected in contrasted environments. Unexpectedly, we found that the majority of the samples contain foraminiferal SSU rDNA sequences. In total, we obtained 49 sequences from 17 localities. Phylogenetic analysis clusters them in four groups branching among the radiation of early foraminiferal lineages. Three of these groups also include sequences originated from previous freshwater surveys, suggesting that there were up to four independent colonization events of terrestrial and/or freshwater ecosystems by ancestral foraminifera. As shown by our data, foraminifera are a widespread and diverse component of soil microbial communities. Yet, identification of terrestrial foraminiferal species and understanding of their ecological role represent an exciting challenge for future research.


11.1-173
How effective are ‘Effective microorganisms (R) (EM)? Results from a field study in temperate climate
Mayer J, Scheid S, Widmer F, Flissbach A, Oberholzer H R
Switzerland
Pedology , Plant Sciences , Microbiology , Biodiversity , Agriculture
Effective microorganisms (R) (EM) is a microbial inoculant promoted to stimulate plant growth and soil fertility in agriculture. In our study we investigated the effects of EM on crop yields and soil microbial parameters in a 4-year field experiment under organic management (2003-2006) in Zurich, Switzerland. Treatments of the EM preparations (i) the spraying agent EMA, (ii) EMA with the EM enriched organic substrate Bokashi and (iii) EMA with Bokashi and farmyard manure were applied in each year. As controls to treatments (i) (ii) (iii) the same treatments were included with sterilised EM preparations and a control without EM application. Crop yields in each year and the soil microbiological parameters soil respiration, microbial biomass (SIR, CFE), dehydrogenase activity and microbial community structure (RISA, CLSU) were determined in spring and autumn 2005 and spring 2006. In laboratory incubation experiments cellulose degradation, N mineralisation potential and N mineralisation from added substrate were determined. The EMA application as spraying agent alone (treatment (i)) showed no significant differences to the untreated control (treatment without EM application) for any of the investigated parameters. Significant differences to the untreated control for crop yields and soil microbial parameters were found if Bokashi was applied in addition to EMA (ii) and (iii). However,
11.1-174
Diffusive fractionation complicates isotopic partitioning of autotrophic and heterotrophic sources of soil respiration

Moyes A B, Gaines S J, Siegwolf R T W, Bowling D R
USA, Switzerland
Pedology, Geochemistry & Geophysics, Plant Sciences, Forestry

Carbon isotope ratios (δ13C) of heterotrophic and rhizospheric sources of soil respiration under deciduous trees were evaluated over two growing seasons. Fluxes and δ13C of soil respiratory CO2 on trenched and untrenched plots were calculated from closed chambers, profiles of soil CO2 mole fraction and δ13C and continuous open chambers. δ13C of respired CO2 and bulk carbon were measured from excised leaves and roots and sieved soil cores. Large diel variations (> 5 parts per thousand) in δ13C of soil respiration were observed when diel flux variability was large relative to average daily fluxes, independent of trenching. Soil gas transport modelling supported the conclusion that diel surface flux δ13C variation was driven by non-steady state gas transport effects. Active roots were associated with high summertime soil respiration rates and around 1 parts per thousand enrichment in the daily average δ13C of the soil surface CO2 flux. Seasonal δ13C variability of about 4 parts per thousand (most enriched in summer) was observed on all plots and attributed to the heterotrophic CO2 source.


11.1-175
Fresh and residual phosphorus uptake by ryegrass from soils with different fertilization histories

Oberson A, Tagmann H U, Langmeier M, Dubois D, Mäder P, Frossard E
Switzerland
Pedology, Agriculture, Plant Sciences

Organic farming largely depends on animal manure as a source of phosphorus (P) and the recycling of animal manure globally is becoming increasingly important. In a pot experiment, using radioactive P labeling techniques, we studied ryegrass uptake of P applied with animal manure and water soluble mineral fertilizer to soils that had been cropped for 22 years according to organic or conventional farming practices. The soils differed in P status and microbial activity. Labeling soil-available P also allowed assessing the uptake from residual P that remained in the soils because of their different fertilization histories. On each soil, recovery of fresh manure P in four harvests of ryegrass shoots was lower than recovery of mineral P. It ranged from 24% to 35% for manure P and from 37% to 43% for mineral P. Recovery of fresh manure P was affected by soil-available P contents. It was lower at a higher available P in a conventional soil. Different levels in microbial activity among soils were of lesser importance for the recovery of fresh manure P in plants. The recovery of residual P ranged from 9% to 15%. Residual P contained in organic cropped soils contributed less to P nutrition of ryegrass than the residual P contained in conventional cropped soils, probably due to their lower residual P contents being composed of stable P forms. The indirect isotope dilution technique is useful in assessing manure P uptake by plants, but attention must be given to added P interactions, i.e., the potential impact of organic amendments on P uptake from non-labeled soil and residual P.


11.1-176
The benzene polycarboxylic acid (BPCA) pattern of wood pyrolyzed between 200 degrees C and 1000 degrees C

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Switzerland
Geochemistry & Geophysics, Energy & Fuels, Forestry, Plant Sciences

Environmental charcoals represent a poorly defined part of the black carbon (BC) combustion continuum and may differ widely in their chemi-
The method was then used to qualitatively characterize sources of analytical uncertainty. The improved tools in this study were to identify and improve potential processes behind the subtle differences in methods. The objectives of this study were to determine and improve potential sources of analytical uncertainty. The improved method was then used to qualitatively characterize wood charred at 200-1000 degrees C. One significant improvement of the BPCA method was to replace citric acid with phthalic acid as an internal standard, which is more stable in acidic solutions and more similar to the target compounds. Also, including a soil reference material as a quality control in each analysis proved to be a robust tool to detect for variations in reproducibility. For the thermosequence, elemental O/C and H/C ratios typically decreased with temperature to \( < 0.03 \) at 1000 degrees C, whereas BPCA concentrations peaked at 700 degrees C. With temperature B6CA proportions increased consistently (6-98%), except for a plateau at 250-500 degrees C. Thus, relative contributions of B6CA reflected the pyrolysis temperature and probably also the degree of condensation of the charcoals we investigated. Future work will show if our results can be directly related to charcoal produced under oxygen limited conditions, including charcoal formed at wildfires or so called biochar for agricultural use.

### 11.1-177 Testate Amoebae and Nutrient Cycling with Particular Reference to Soils

**Wilkinson D M, Mitchell E A D**  
England, Switzerland  
*Microbiology, Pedology, Ecology*

We asked the following question: Is the lack of attention given to testate amoebae, and other protists, in studies of nutrient cycling justified by their relative unimportance or are we ignoring key players in nutrient cycling and other ecological processes? We review various aspects of the ecology of testates relevant to their role in nutrient cycling. These include their food sources, their population sizes and production ecology, the rate of test breakdown (and hence recycling of material from testates to other organisms) and non-feeding interactions with other organisms (e.g., mycorrhizae). Much of the relevant published literature dates from the late 1960s to the early 1980s, presumably due to the interest in production ecology and other aspects of ecosystem ecology at this time. There was a reduction in relevant research during the 1980s and 1990s, but there has recently been signs of renewed interest in this area. In addition to reviewing the past literature we suggest new speculations about the role of the evolution of grasses and the rise of the euglyphid testates-mediated by the silica cycle. Our main conclusion is that we currently do not know enough to answer our question about their potential importance! However, there are hints in these data which suggest that testates may be important and should be targeted by future research. Some of the main questions that should be targeted are outlined.

**Geomicrobiology Journal, 2010, V27, N6-7, pp 520-533 DOI: http://dx.doi.org/10.1080/01490451003702925.**

### 11.1-178 Asymmetric response to disturbance and recovery: Changes of soil permeability under forest-pasture-forest transitions

**Zimmermann B, Papritz A, Elsenbeer H**  
Panama, Germany, Switzerland  
*Pedology, Geochemistry & Geophysics, Hydrology, Forestry, Agriculture*

In the humid tropics, continuing high deforestation rates are seen alongside an increasing expansion of secondary forests. In order to understand and model the consequences of these dynamic land-use changes for regional water cycles, the response of soil hydraulic properties to forest disturbance and recovery has to be quantified. At a site in the Brazilian Amazonia, we annually monitored soil infiltration and saturated hydraulic conductivity (Ks) at 12.5, 20 cm, and 50 cm soil depth after manual forest conversion to pasture (year zero to four after pasture establishment), and during secondary succession after pasture abandonment (year zero to seven after pasture abandonment). We evaluated the hydrological consequences of the detected changes by comparing the soil hydraulic properties with site-specific rainfall intensities and hydrometric observations. Within one year after grazing started, infiltration and Ks at 12.5 and 20 cm depth decreased by up to one order of magnitude to levels which are typical for 20-year-old pasture. In the three subsequent monitoring years, infiltration and Ks remained stable. Land use did not impact on subsoil permeability. Whereas infiltration values are large enough to allow all rainwater to infiltrate even after the conversion, the sudden decline of near-surface Ks is of hydrological relevance as perched water tables and overland flow occur more often on pastures.
than in forests at our study site. After pasture abandonment and during secondary succession, seven years of recovery did not suffice to significantly increase infiltrability and Ks at 12.5 depth although a slight recovery is obvious. At 20 cm soil depth, we detected a positive linear increase within the seven-year time frame but annual means did not differ significantly. Although more than a doubling of infiltrability and Ks is still required to achieve pre-disturbance levels, which will presumably take more than a decade, the observed slight increases of Ks might already decrease the probability of perched water table generation and overland flow development well before complete recovery.


1.4 Cryosphere

11.1-179
A glacier inventory for the western Nyainqentanglha Range and the Nam Co Basin, Tibet, and glacier changes 1976-2009
Bolch T, Yao T, Kang S, Buchroithner M F, Scherer D, Maussion F, Huntjies E, Schneider C
Germany, Peoples R China, Switzerland
Cryology / Glaciology, Remote Sensing, Meteorology & Atmospheric Sciences
The western Nyainqentanglha Range is located in the south-eastern centre of the Tibetan Plateau. Its northwestern slopes drain into Lake Nam Co. The region is of special interest for glacio-climatological research as it is influenced by both the continental climate of Central Asia and the Indian Monsoon system, and situated at the transition zone between temperate and subcontinental glaciers. A glacier inventory for the whole mountain range was generated for the year around 2001 using automated remote sensing and GIS techniques based on Landsat ETM+ and SRTM3 DEM data. Glacier change analysis was based on data from Hexagon KH-9 and Landsat MSS (both 1976), Metric Camera (1984), and Landsat TM/ETM+ (1991, 2001, 2005, 2009). Manual adjustment was especially necessary for delineating the debris-covered glaciers and the glaciers on the panchromatic Hexagon data. In the years around 2001 the whole mountain range contained about 960 glaciers covering an area of 795.6 +/- 22.3 km(2) while the ice in the drainage basin of Nam Co covered 198.1 +/- 5.6 km(2). The median elevation of the glaciers was about 5800 m with the majority terminating around 5600 m. Five glaciers with debris-covered tongues terminated lower than 5200 m. The glacier area decreased by -6.1 +/- 3% between 1976 and 2001. This is less than reported in previous studies based on the 1970s topographic maps and Landsat data from 2000. Glaciers continued to shrink during the period 2001-2009. No advancing glaciers were detected. Detailed length measurements for five glaciers indicated a retreat of around 10 m per year (1976-2009). Ice cover is higher south-east of the mountain ridge which reflects the windward direction to the monsoon. The temperature increase during the ablation period was probably the main driver of glacier wastage, but the complex glacier-climate interactions need further investigation.


11.1-180
Spatio-temporal reconstruction of snow avalanche activity using tree rings: Pierres Jean Jeanne avalanche talus, Massif de l’Oisans, France
Corona C, Rovera G, Lopez Saez J, Stoffel M, Perfettini P
France, Switzerland
Cryology / Glaciology, Geomorphology, Forestry, Plant Sciences, Hydrology
Snow avalanches are a major threat in many parts of the Alps, where they periodically damage infrastructure, disrupt transportation corridors or even cause loss of life. Nonetheless, the spatial behavior of past avalanche activity and the analysis of areas affected during particular events remain often imprecise. It was therefore the purpose of this study to reconstruct spatio-temporal patterns of past avalanche activity on a forested avalanche talus in the French Alps (Pierres Jean Jeanne talus, Massif de l’Oisans, France). A total of 232 European larches (Larix decidua Mill.) with clear signs of snow wasting events was analyzed and growth disturbances (GD) related to avalanche activity was assessed, such as tangential rows of traumatic resin ducts, the onset of compression wood or abrupt growth suppression and release. In total, 901 GD were identified in the tree-ring samples, indicating that 20 high-magnitude avalanches occurred between AD 1919 and 1994. The mean
return period of snow avalanches was similar to 4 years with a similar to 26% probability that an avalanche occurs in any particular year. Interpolated maps allowed for explicit spatial estimates of return periods throughout the talus, showing a rapid increase of return frequency from 2.5 to 50 years with increasing distance from the talus apex. The distribution of avalanche years seems to be quite homogeneous in time with a gap between 1951 and 1959 and since 1994. Snowfall from a nearby meteorological station (Saint-Christophe en Oisans; 10 km from the study site) indicated that the five most recent high-magnitude events on record occurred due to above-average snowfall anomalies in December and January associated with abnormally low air temperatures. Findings suggest that a strong snow metamorphism under high temperature gradients in January could explain the occurrence of high-magnitude snow avalanches.

An Improved Snow Scheme for the ECMWF Land Surface Model: Description and Offline Validation

Portugal, Switzerland, England, USA
Cryology / Glaciology, Meteorology & Atmospheric Sciences, Hydrology, Modelling

A new snow scheme for the European Centre for Medium-Range Weather Forecasts (ECMWF) land surface model has been tested and validated. The scheme includes a new parameterization of snow density, incorporating a liquid water reservoir, and revised formulations for the subgrid snow cover fraction and snow albedo. Offline validation (covering a wide range of spatial and temporal scales) includes simulations for several observation sites from the Snow Models Intercomparison Project-2 (SnowMIP2) and global simulations driven by the meteorological forcing from the Global Soil Wetness Project-2 (GSWP2) and by ECMWF Re-Analysis ERA-Interim. The new scheme reduces the end of season ablation biases from 10 to 2 days in open areas and from 21 to 13 days in forest areas. Global GSWP2 results are compared against basin-scale runoff and terrestrial water storage. The new snow density parameterization increases the snow thermal insulation, reducing soil freezing and leading to an improved hydrological cycle. Simulated snow cover fraction is compared against NOAA/National Environmental Satellite, Data, and Information Service (NESDIS) with a reduction of the negative bias of snow-covered area of the original snow scheme. The original snow scheme had a systematic negative bias in surface albedo when compared against Moderate Resolution Imaging Spectroradiometer (MODIS) remote sensing data. The new scheme reduces the albedo bias, consequently reducing the spatial- and time-averaged surface net shortwave radiation bias by 5.2 W m⁻² in 14% of the Northern Hemisphere land. The new snow scheme described in this paper was introduced in the ECMWF operational forecast system in September 2009 (cycle 35R3).


A virtual network for estimating daily new snow water equivalent and snow depth in the Swiss Alps

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Switzerland
Cryology / Glaciology, Modelling, Hydrology

Daily new snow water equivalent (HNW) and snow depth (HS) are of significant practical importance in cryospheric sciences such as snow hydrology and avalanche formation. In this study we present a virtual network (VN) for estimating HNW and HS on a regular mesh over Switzerland with a grid size of 7 km. The method is based on the HNW output data of the numerical weather prediction model COSMO-7, driving an external accumulation/melting routine. The verification of the VN shows that, on average, HNW can be estimated with a mean systematic bias close to 0 and an averaged absolute accuracy of 4.01 mm. The results are equivalent to the performance observed when comparing different automatic HNW point estimations with manual reference measurements. However, at the local scale, HS derived by the VN may significantly deviate from corresponding point measurements. We argue that the VN presented here may introduce promising cost-effective options as input for spatially distributed snow hydrological and avalanche risk management applications in the Swiss Alps.


Influence of atmospheric forcing parameters on modelled mountain permafrost evolution

Engelhard M, Hauck C, Salzmann N
Norway, Germany, Switzerland
Cryology / Glaciology, Modelling, Meteorology & Atmospheric Sciences
To evaluate the sensitivity of mountain permafrost to atmospheric forcing, the dominant meteorological variables such as temperature, precipitation and timing and duration of snow cover have to be considered. Simulations with a one-dimensional coupled heat and mass transfer model (Coup Model) are used to investigate the interactions between the atmosphere and the ground focusing on ground temperature evolution and the temporal variability of the depth of the unfrozen top layer in summer (active layer depth). Idealised and observed atmospheric forcing data sets are used to determine the meteorological conditions, which show the largest impact on the permafrost regime. Borehole temperature and energy balance data from the permafrost station Schilthom (2900 m asl, Berner Oberland) are used for verification. The results for the Schilthom site show the largest impact due to summer temperatures changes during the snow free period and to a lesser extent winter precipitation which influence the duration of the snow cover. Similarly important is the timing of the first snow event in autumn which leads to a sufficiently large snow cover to isolate the ground from atmospheric forcing. Simulations with different data sets from Regional Climate Model (RCM) simulations derived from an ensemble of models and scenarios show that the differences in changes of active layer depth between different RCMs are on the same order than between different scenarios. Meteorologische Zeitschrift, 2010, V19, N5, SI, OCT, pp 491-500 DOI: http://dx.doi.org/10.1127/0941-2948/2010/0476.

11.1-185
Assessment of periglacial slope stability for the 1988 Tschiera rock avalanche (Piz Morteratsch, Switzerland)
Fischer L, Amann F, Moore J R, Huggel C
Switzerland
Cryology / Glaciology, Geology, Geochemistry & Geophysics
The Tschiera rock avalanche occurred on October 29, 1988 in the area of the Piz Morteratsch, Switzerland. Releasing a total volume of similar to 300,000 m³, the avalanche ran out over 1 km destroying a hiking trail before stopping on the Tschiera Glacier. We analyze the setting of this periglacial slope failure, combining geomechanical and cryosphere investigations to identify the primary factors contributing to the rock avalanche. An approach to slope stability assessment is presented that copes with existing data limitations in an inaccessible alpine terrain. Results from the analyses of morphology, geology, glaciation history, permafrost, hydrology, and meteorological data allowed preliminary inferences to be made regarding the influence of these factors on slope stability. Conceptual kinematic and numerical slope stability modeling critically analyzed the role of kinematic degrees of freedom, glacier retreat, and water infiltration from above the detachment zone. Results highlight the strong influence of discontinuity orientation with respect to the slope face, the role of a fault zone with increased joint density, and long-term progressive development of persistent discontinuities induced by glacier retreat and groundwater loading cycles in leading to the rock avalanche. The role of permafrost could not be clearly assessed, however observations and analyses indicate that permafrost had no dominant influence on the slope failure. Extraordinary precipitation prior to the event is suggested to...
have played a role in triggering the rock avalanche, especially in combination with observed superficial ice that could have sealed the rock face generating high water pressures. Our results emphasize the importance of analyzing multiple contributing factors when assessing alpine rock slope failures, with careful consideration of data limitations prevailing in such areas.


11.1-186

**Perennial snow and ice variations (2000-2008) in the Arctic circumpolar land area from satellite observations**


Switzerland, USA, Canada

Cryology / Glaciology, Remote Sensing, Modelling

Perennial snow and ice (PSI) extent is an important parameter of mountain environments with regard to its involvement in the hydrological cycle and the surface energy budget. We investigated interannual variations of PSI in nine mountain regions of interest (ROI) between 2000 and 2008. For that purpose, a novel MODIS data set processed at the Canada Centre for Remote Sensing at 250 m spatial resolution was utilized. The extent of PSI exhibited significant interannual variations, with coefficients of variation ranging from 5% to 81% depending on the ROI. A strong negative relationship was found between PSI and positive degree-days (threshold 0 degrees C) during the summer months in most ROIs, with linear correlation coefficients ($r$) being as low as $r = -0.90$. In the European Alps and Scandinavia, PSI extent was significantly correlated with annual net glacier mass balances, with $r = 0.91$ and $r = 0.85$, respectively, suggesting that MODIS-derived PSI extent may be used as an indicator of net glacier mass balances. Validation of PSI extent in two land surface classifications for the years 2000 and 2005, GLC-2000 and Globcover, revealed significant discrepancies of up to 129% for both classifications. With regard to the importance of such classifications for land surface parameterizations in climate and land surface process models, this is a potential source of error to be investigated in future studies.

The results presented here provide an interesting insight into variations of PSI in several ROIs and are instrumental for our understanding of sensitive mountain regions in the context of global climate change assessment.


11.1-187

**Geometry and drainage of a retreating glacier overlying and recharging a karst aquifer, Tsanfleuron-Sanetsch, Swiss Alps**

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Switzerland, Germany

Cryology / Glaciology, Geochemistry & Geophysics, Geology, Hydrology

Alpine glaciers store large amounts of freshwater contributing to groundwater recharge during warmer periods, but the interactions between glaciers and aquifers have rarely been investigated in detail. The Tsanfleuron-Sanetsch area, Switzerland, is an ideal test site to study glacier-aquifer interactions. It consists of a rapidly retreating glacier (2.8 km(2)) overlying a karst aquifer drained by a spring (mean discharge 600-700 L/s) used for drinking water supply and irrigation. The geometry and structure of the glacier were assessed by means of geophysical surveys, using radiomagnetotellurics (RMT). The estimated ice volume is 1.0 x 10(8) m(3) (0.92 x 10(8) m (3) water equivalent), but the glacier currently loses 1.5 m ice thickness per year. Field observations, flow measurements and tracer tests allowed characterisation of glacier drainage and aquifer recharge. Three recharge pathways have been identified: 1) The main glacial stream sinks into the aquifer via swallow holes 3 km downstream of the glacier mouth; 2) Numerous small meltwater streams sink underground shortly below the glacier front; 3) Subglacial meltwaters and supraglacial streams sink into the glacier via moulins and contribute to aquifer recharge through fractures and swallow holes underneath the glacier. Recharge and spring discharge display strong diurnal and seasonal variability, with a general high-flow period during snow and glacier melt from spring to autumn. Preliminary predictions of the future availability of spring water after disappearance of the glacier suggest that the discharge may decrease by 20-30%. Nearly all of this loss will occur in summer and autumn, presumably resulting in temporary water shortage.


11.1-188

**Time-lapse refraction seismic tomography for the detection of ground ice degradation**

Hilbich C

Germany, Switzerland

Cryology / Glaciology, Geochemistry & Geophysics

The ice content of the subsurface is a major factor controlling the natural hazard potential of permafrost degradation in alpine terrain. Monitoring of changes in ice content is therefore similarly important as temperature monitoring in moun-
tain permafrost. Although electrical resistivity tomography monitoring (ERTM) proved to be a valuable tool for the observation of ice degradation, results are often ambiguous or contaminated by inversion artefacts. In theory, the sensitivity of P-wave velocity of seismic waves to phase changes between unfrozen water and ice is similar to the sensitivity of electric resistivity. Provided that the general conditions (lithology, stratigraphy, state of weathering, pore space) remain unchanged over the observation period, temporal changes in the observed travel times of repeated seismic measurements should indicate changes in the ice and water content within the pores and fractures of the subsurface material. In this paper, a time-lapse refraction seismic tomography (TLST) approach is applied as an independent method to ERTM at two test sites in the Swiss Alps. The approach was tested and validated based on a) the comparison of time-lapse seismograms and analysis of reproducibility of the seismic signal, b) the analysis of time-lapse travel time curves with respect to shifts in travel times and changes in P-wave velocities, and c) the comparison of inverted tomograms including the quantification of velocity changes. Results show a high potential of the TLST approach concerning the detection of altered subsurface conditions caused by freezing and thawing processes. For velocity changes on the order of 3000 m/s even an unambiguous identification of significant ice loss is possible. Cryosphere, 2010, V4, N3, pp 243-259 DOI: http://dx.doi.org/10.5194/tc-4-243-2010.

11.1-189
Glacier Mass Balance in the South-Eastern Swiss Alps since 1900 and Perspectives for the Future
Huss M, Usselmann S, Farinotti D, Bauder A
Switzerland
Cryology / Glaciology , Modelling , Remote Sensing
In this study, we analyzed the 20th century ice volume changes for 20 glaciers in the south-eastern Swiss Alps. Our sample included different glacier geometries, sizes and exposures and allowed us to investigate glacier response to climate change. Using a distributed accumulation and temperature-index melt model, we derived mass balance time series in seasonal resolution from 1900. The model was calibrated using ice volume changes obtained from differentiating digital elevation models based on (i) terrestrial topographic surveys, (ii) the Shuttle Radar Topographic Mission (SRTM), and (iii) aerial photogrammetry. In-situ point measurements of annual mass balance and winter accumulation were available for some glaciers, and long-term discharge records were used for model validation. The rate of mass loss between 1900 to 2008 strongly differed between adjacent glaciers. Whereas large valley glaciers (e.g. Vadrec del For-no) showed average mass balances of up to -0.60m w.e. a(-1), smaller and steeper glaciers (e.g. Vadret da Palu) exhibited slower mass loss in the order of -0.20m we. a(-1). Over the last century, the regional ice volume decreased by 47%, with strong differences between individual glaciers (30-75%). Using a combined model for 3D glacier evolution and stream-flow runoff driven by regional climate scenarios, we generated perspectives for the 21st century. We determined a decrease in glacier area of 63% until 2050 and an increase in annual discharge over the next three decades for catchments with high glacierization. By 2100, the model results indicated a shift in the hydrological regime and a 23% decrease in annual runoff attributed to increased evapotranspiration and strongly reduced glacier melt contribution.
Erdkunde, 2010, V64, N2, APR-JUN, pp 119-140 DOI: http://dx.doi.org/10.3112/erd-kunde.2010.02.02.

11.1-190
Reanalysis of multi-temporal aerial images of Storglaciaren, Sweden (1959-99) - Part 1: Determination of length, area, and volume changes
Switzerland, Sweden
Cryology / Glaciology , Remote Sensing , Modelling
Storglaciaren, located in the Kebnekaise massif in northern Sweden, has a long history of glaciological research. Early photo documentations date back to the late 19th century. Measurements of front position variations and distributed mass balance have been carried out since 1910 and 1945/46, respectively. In addition to these in-situ measurements, aerial photographs have been taken at decadal intervals since the beginning of the mass balance monitoring program and were used to produce topographic glacier maps. Inaccuracies in the maps were a challenge to early attempts to derive glacier volume changes and resulted in major differences when compared to the direct glaciological mass balances. In this study, we reanalyzed dia-positives of the original aerial photographs of 1959, 1969, 1980, 1990 and 1999 based on consistent photogrammetric processing. From the resulting digital elevation models and orthophotos, changes in length, area, and volume of Storglaciaren were computed between the survey years, including an assessment of related er-
rors. Between 1959 and 1999, Storglaciaren lost an ice volume of 19x10(6) m(3), which corresponds to a cumulative ice thickness loss of 5.69 m and a mean annual loss of 0.14 m. This ice loss resulted largely from a strong volume loss during the period 1959-80 and was partly compensated during the period 1980-99. As a consequence, the glacier shows a strong retreat in the 1960s, a slowing in the 1970s, and pseudo-stationary conditions in the 1980s and 1990s.


11.1-191
Isotopic evolution of snowmelt: A new model incorporating mobile and immobile water
Lee J, Feng X, Faia A, Posmentier E, Osterhuber R, Kirchner J
USA, Switzerland
Cryology / Glaciology, Hydrology, Modelling
Isotopic variations of snowmelt provide important information for understanding snowmelt processes and the timing and contribution of snowmelt to catchments in spring. We report a new model for simulating the isotopic evolution of snowmelt. The model includes a hydraulic exchange between mobile and immobile water, and an isotopic exchange between liquid water (mobile and immobile water) and ice within a snowpack. Since this model is based on the mobile-immobile water conceptualization, which is widely used for describing chemical tracer transport in snow, it allows simultaneous simulations of chemical as well as isotopic variations in snowpack discharge. We also report temporal variations of isotopic composition of a snowpack and snowmelt during artificial rain-on-snow experiments and diel snowmelt cycles observed in spring 2003 at the Central Sierra Snow Laboratory, California. These observations are used to test the newly developed model and to understand physical processes in a seasonal snowpack. Our model simulates the isotopic variations reasonably well, and suggests that exchanges of ice with both mobile and immobile water are important for determining the isotopic composition of the discharge.

11.1-192
A numerical study of glacier advance over deforming till
Leysinger Vieli G J M C, Gudmundsson G H
Switzerland, England
Cryology / Glaciology, Modelling, Geomorphology
The advance of a glacier over a deforming sediment layer is analysed numerically. We treat this problem as a contact problem involving two slowly-deforming viscous bodies. The surface evolution of the two bodies, and of the contact interface between them, is followed through time. Using various different non-linear till rheologies, we show how the mode of advance depends on the relative effective viscosities of ice and till. Three modes of advances are observed: (1) overriding, where the glacier advances through ice deformation only and without deforming the sediment; (2) plug-flow, where the sediment is strongly deformed, the ice moves forward as a block and a bulge is built in front of the glacier; and (3) mixed-flow, where the glacier advances through both ice and sediment deformation. For the cases of both overriding and mixed-flow, an inverse depth-age relationship within the ice is obtained. A series of model experiments show the contrast in effective viscosity between ice and till to be the single most important model parameter defining the mode of advance and the resulting thickness distribution of the till. Our model experiments indicate that the thickness of the deforming till layer is greatest close to the glacier front. Measurements of till thickness taken in such locations may not be representative of deforming till thickness elsewhere. Given sufficiently large contrast in effective viscosity between ice and till, a sediment bulge is formed in front of the glacier. During glacier advance, the bulge quickly reaches a steady state form strongly resembling single-crested push moraines. Inspection of particle paths within the sediment bulge, shows that particles within the till travel at a different speed from the bulge itself, and the push moraine to advance as a form-conserving non-linear wave.

11.1-193
Rock-glacier dynamics and magnitude-frequency relations of debris flows in a high-elevation watershed: Ritigraben, Swiss Alps
Lugon R, Stoffel M
Switzerland
Cryology / Glaciology, Hydrology, Geomorphology
A widespread risk in high mountains is related to the accumulation of loose sediments on steep slopes, which represent potential sources of different types of geomorphic processes including debris flows. This paper combines data on 50 yr of permafrost creep at the Ritigraben rock glacier (Valais, Swiss Alps) with magnitude-frequency (M-F) relationships of debris flows recorded in the
Ritigraben torrent originating at the rock-glacier front. Debris production and volumetric changes at the rock-glacier front are compared with debris-flow activity recorded on the cone and potential couplings and feedbacks between debris sources, channel processes and debris sinks. The dataset existing for the Ritigraben rock glacier and its debris-flow system is unique and allows prime insights into controls and dynamics of permafrost processes and related debris-flow activity in a constantly changing and warming high-altitude environment. Acceleration in rock-glacier movement rates is observed in the 1950s and 1960s, followed by a decrease in flow rates by the 1970s, before movements increase again after the early 1990s. At a decadal scale, measured changes in rock-glacier movements at Ritigraben are in concert with changes in atmospheric temperatures in the Alps. Geodetic data indicates displacement rates in the frontal part of the rock glacier of up to 0.6-0.9 m yr⁻¹ since the beginning of systematic measurements in 1995. While the Ritigraben rock glacier has always formed a sediment reservoir for the associated debris-flow system, annual horizontal displacement rates of the rock-glacier body have remained quite small and are in the order of decimeters under current climatic conditions. Sediment delivery from the rock-glacier front alone could not therefore be sufficient to support the 16 debris flows reconstructed on the cone since 1958. On the contrary, debris accumulated at the foot of the rock glacier, landslide and rockfall activity as well as the partial collapse of oversteepened channel walls have to be seen as important sediment sources of debris flows at Ritigraben and would represent 65-90% of the material arriving on the Ritigraben cone. There does not seem to exist a direct coupling between displacement rates of and sediment delivery by the rock-glacier body and the frequency of small- and medium-magnitude debris flows. In contrast, a direct link between source and sink processes clearly exists in the case of active-layer failures. In this case, failure processes at the rock-glacier snout and debris-flow events in the channel occur simultaneously and are both triggered by the rainfall event.

11.1-194
Assessing high altitude glacier thickness, volume and area changes using field, GIS and remote sensing techniques: the case of Nevado Coropuna (Peru)
Peduzzi P, Herold C, Silverio W Switzerland
Cryology / Glaciology, Remote Sensing, Hydrology
Higher temperatures and changes in precipitation patterns have induced an acute decrease in Andean glaciers, thus leading to additional stress on water supply. To adapt to climate changes, local governments need information on the rate of glacier area and volume losses and on current ice thickness. Remote sensing analyses of Coropuna glacier (Peru) delineate an acute glaciated area decline between 1955 and 2008. We tested how volume changes can be estimated with remote sensing and GIS techniques using digital elevation models derived from both topographic maps and satellite images. Ice thickness was measured in 2004 using a Ground Penetrating Radar coupled with a Ground Positioning System during a field expedition. It provided profiles of ice thickness on different slopes, orientations and altitudes. These were used to model the current glacier volume using Geographical Information System and statistical multiple regression techniques. The results revealed a significant glacier volume loss; however the uncertainty is higher than the measured volume loss. We also provided an estimate of the remaining volume. The field study provided the scientific evidence needed by COPASA, a local Peruvian NGO, and GTZ, the German international cooperation agency, in order to alert local governments and communities and guide them in adopting new climate change adaptation policies.

11.1-195
Effect of glaciers on streamflow trends in the Swiss Alps
Pellicciotti F, Bauder A, Parola M Switzerland
Hydrology, Modelling, Cryology / Glaciology
Daily streamflow from stations close to five Swiss glaciers is analyzed for trends with the Mann-Kendall test. We consider a common period of record (1974-2004) and longer periods based on data availability. The trend statistical significance is tested on annual and seasonal bases. We also examine changes in precipitation, temperature, and snow cover characteristics. Highly glacierized basins show statistically significant positive trends in annual streamflow caused by increasing streamflow in spring and summer. Trends are more numerous.
and stronger at lower and mid than at the upper quantiles. The basin characterized by lower glacier coverage, conversely, does not exhibit consistently statistically significant trends. Changes in precipitation are not sufficient to explain the observed streamflow trends. Air temperature sees an increase in mean, minimum, and maximum values at all sites. Variations in the seasonal snow accumulation and ablation process are evident. Solid precipitation is decreasing at all sites and trends may be due to a shift from snowfall into rainfall. Mean snow depth is also decreasing, and its duration is getting shorter because of a decrease in solid precipitation and enhanced melting. Trend magnitude attenuates with longer time series. Contrasting trends are detected for different subperiods in the last 70 years: statistically significant negative trends are observed in the periods 1944-1974 and 1954-1984 for Aletschgletscher, in contrast with the results for the common period. These trends are explained by different rates of ice volume changes, and the sign of trends is clearly related to phases of positive or negative glacier mass balance.


### 11.1-196

**The influence of the presence and drainage of an ice-marginal lake on the flow of Gornergletscher, Switzerland**

Riesen P, Sugiyama S, Funk M  
Switzerland, Japan  
Cryology / Glaciology, Limnology, Modelling, Hydrology

Gornergletscher, Switzerland, is located adjacent to the marginal lake Gornersee, which periodically drains. We measured glacier ice-flow velocities during two drainage events of the lake, in 2004 and 2006. The common feature of these events was that, during both, Gornersee filled to its maximum level and then overflowed. The events differed in that in 2004 Gornersee rapidly drained via a sudden subglacial connection, whereas in 2006 the lake water continued to overflow and slowly discharged into a nearby moulin. We analysed the changes in ice-flow velocities in the vicinity of Gornersee during the two drainage events, using a three-dimensional ice-flow model which is able to (1) simulate locally variable enhanced basal motion of the ice and (2) account for the load and release of water pressure exerted on the ice margin. We demonstrate that the key features of the observed flow changes can be reproduced adequately in the numerical model by considering these two effects as the main mechanisms. We interpret the 2006 flow changes to be dominated by the release of lake water pressure acting on the ice during the lake drainage. The 2004 ice-flow changes can be explained by enhanced basal motion, and the impact of the lake water pressure provides certain clues to some observations insufficiently explained by enhanced basal motion.


### 11.1-197

**Surface ice motion deviating toward the margins during speed-up events at Gornergletscher, Switzerland**

Sugiyama S, Bauder A, Riesen P, Funk M  
Japan, Switzerland  
Cryology / Glaciology

High frequency ice flow measurements during speed-up events in Gornergletscher, Switzerland, revealed intriguing ice motion which has never been reported in detail before. During the summer 2005, more than a 100% flow speed increase was observed three times at four GPS stations installed across Gornergletscher. The speed-ups were accompanied by a decimeter scale surface uplift. Two of the events were triggered by intensive surface melt and rainfall, while the third one was due to the outburst of Gornersee, a glacier-dammed lake located 2 km upglacier. An interesting observation was ice motion deviating toward the side margins during the events. As the glacier accelerated, a transverse (cross glacier) velocity component was generated, turning the flow direction away from the central flow line toward the margins. When the glacier decelerated, the transverse velocity component reversed so that the ice flowed back to the azimuth of the initial flow direction. In the most significant case, the trajectory of the survey stake deviated from the original track by 0.2 m in the transverse direction. We hypothesize that the observed lateral ice motion was caused by locally elevated subglacial water pressure. When the ice sole decoupled from the bed at a part of the glacier, a point source of vertical displacement was transmitted to the surface through viscous ice. This caused the transverse as well as vertical surface motion, as observed in ground motion during magma intrusion. The hypothesis was tested with a two-dimensional ice flow model applied to the transverse glacier cross section. The model confirmed that the surface ice would move toward the margins as observed in Gornergletscher, if subglacial water pressure exceeded the ice overburden pressure over a limited part of the bed.

11.1-198
Short term variations of tracer transit speed on alpine glaciers
Werder M A, Schuler T V, Funk M
Switzerland, Norway
Cryology / Glaciology, Hydrology, Modelling, Limnology
We first present the results of a series of tracer experiments conducted on an alpine glacier (Gornergletscher, Switzerland) over a diurnal discharge cycle. For these injections, a moulin was used into which an ice marginal lake was draining, providing a relatively constant discharge. The measured tracer transit speeds show two diurnal maxima and minima. These findings are qualitatively different to existing observations from two series of injections conducted at Unteraargletscher (Switzerland) using a moulin fed by supraglacial meltwater having a high diurnal variability, which displayed one diurnal maximum and minimum. We then develop and use a simple two-component model of the glacier drainage system, comprising a moulin and a channel element, to simulate the measured transit speeds for all three injection series. The model successfully reproduces all the observations and shows that the same underlying processes can produce the qualitatively different behaviour depending on the different moulin input discharge regimes. Using the model, we assess the relative importance of the different measurement quantities, show that frequent measurements of moulin input discharge are indispensable and propose an experiment design to monitor the development of the drainage system over several weeks.

11.1-199
An introduction to mountain glaciers as climate indicators with spatial and temporal diversity
Winkler S, Chinn T, Gärtner Roer I, Nussbaumer S U, Zemp M, Zumbühl H J
New Zealand, Switzerland
Cryology / Glaciology
This article gives an introduction to the spatial and temporal diversity of mountain glaciers as climate indicators. Alongside some information about the present extent of mountain glaciation and available databases, some specific problems with the interpretation of mountain glacier changes are highlighted.
Erdkunde, 2010, V64, N2, APR-JUN, pp 97-118 DOI: http://dx.doi.org/10.3112/erdkunde.2010.02.01.

11.1-200
Reanalysis of multi-temporal aerial images of Storglaciaren, Sweden (1959-99) - Part 2: Comparison of glaciological and volumetric mass balances
Switzerland, Sweden
Cryology / Glaciology, Remote Sensing
Seasonal glaciological mass balances have been measured on Storglaciaren without interruption since 1945/46. In addition, aerial surveys have been carried out on a decadal basis since the beginning of the observation program. Early studies had used the resulting aerial photographs to produce topographic glacier maps with which the in-situ observations could be verified. However, these maps as well as the derived volume changes are subject to errors which resulted in major differences between the derived volumetric and the glaciological mass balance. As a consequence, the original photographs were re-processed using uniform photogrammetric methods, which resulted in new volumetric mass balances for 1959-69, 1969-80, 1980-90, and 1990-99. We compared these new volumetric mass balances with mass balances obtained by standard glaciological methods including an uncertainty assessment considering all related previous studies. The absolute differences between volumetric and the glaciological mass balances are 0.8 m w.e. for the period of 1959-69 and 0.3 m w.e. or less for the other survey periods. These deviations are slightly reduced when considering corrections for systematic uncertainties due to differences in survey dates, reference areas, and internal ablation, whereas internal accumulation systematically increases the mismatch. However, the mean annual differences between glaciological and volumetric mass balance are less than the uncertainty of the in-situ stake reading and stochastic error bars of both data series overlap. Hence, no adjustment of the glaciological data series to the volumetric one is required.
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stability. In the last two decades, many boreholes for thermal permafrost monitoring have been drilled in Alpine regions. Factors such as snow or scree cover, hydrology, or topography strongly affect the ground thermal regime and make trend estimation very difficult. Furthermore, ground temperature series exhibit a pronounced annual cycle and are strongly temporally correlated. For the sake of simplicity, often only annual values are analyzed for trend estimation, which is usually not robust for short measurement periods. This study intends to model time series with annual cycles and a daily database. A family of nine different models for trend estimation is proposed. The models are able to fit both overall trends and trends in the annual cycle amplitudes and therefore allow more robust and accurate trend estimation than when annual values only are used. Evaluation and comparison of the models is demonstrated using short-range (less than two decades, 1996-2008) permafrost temperature series from two adjacent boreholes in the Muot da Barba Peider ridge (Eastern Swiss Alps). The results suggest an increase in cycle amplitudes for near-surface coarse-blocky ground layers and an overall warming trend for deeper bedrock layers where the annual cycles are less pronounced. Journal of Geophysical Research Earth Surface, 2010, V115, OCT 16 ARTN: F04009, DOI: http://dx.doi.org/10.1029/2009JF001648.

11.1-202
The effects of alterations in temperature and flow regime on organic carbon dynamics in Mediterranean river networks
Acuna V, Tockner K
Switzerland, Spain, Germany
Hydrology, Modelling, Ecology
It is only recently that freshwaters have been identified as important quantitative components of the carbon (C) cycle at global and regional scales. To date there are no studies that quantitatively predict the effects of alterations in temperature and flow regimes, individually, or in concert, on organic C dynamics in streams. To address this need, we applied a mechanistic model to simulate organic C dynamics in Mediterranean river networks under 27 different scenarios of altered temperature and flow regimes. We predict that the organic C dynamics in freshwaters in the Mediterranean, as well as in other semiarid regions, will be highly sensitive to global climate change owing to major increases in the degree of intermittency as well as in flood frequency and magnitude. Results indicate that flow regime alterations increase C export rates, whereas temperature alterations increase instream metabolism of organic C. However, flow regime alterations exhibit a much greater influence on C dynamics than do changes in the temperature regime. Reservoirs partly counteract the effects of flow extremes on C export rates, and their role in the C dynamics increases with increasing flow variability. The present study is one of the first studies to quantify the complex interactions between the flow and the temperature regime on C dynamics, emphasizing the key role of extreme events such as dry periods and floods, compared with overall trend effects. This information is pivotal in understanding the impact of future climate change on global C dynamics. Global Change Biology, 2010, V16, N9, SEP, pp 2638-2650 DOI: http://dx.doi.org/10.1111/j.1365-2486.2010.02170.x.

11.1-203
Adaptive groundwater management in urban areas. Effect of surface water-groundwater interaction using the example of artificial groundwater recharge and in- and exfiltration of the river Birs (Switzerland)
Affolter A, Huggenberger P, Scheidler S, Epting J
Switzerland
Hydrology, Water Resources, Urban Studies
Groundwater resources in urban areas are under increasing pressure. The purpose of this manuscript is to demonstrate how adaptive groundwater management techniques can establish conditions for sustainable use of groundwater resources. To illustrate this, a representative transient dataset from the Lower Birs Valley (Switzerland) was investigated. The main focus of this work was to evaluate effects of river-groundwater interaction and artificial groundwater recharge. Results showed that the evaluation of a hundred year flood significantly contributed to the understanding of the transient character of river-groundwater interaction. An extended period without artificial recharge in the study area provided insights into the impact of planned changes in groundwater management. This investigation contributes to the better understanding of recharge processes

1.5 Oceans and Fresh Water Systems

11.1-204 Populations in small, ephemeral habitat patches may drive dynamics in a Daphnia magna metapopulation
Alternatt F, Ebert D
Switzerland, Finland, USA
Marine & Freshwater Biology, Zoology, Biodiversity, Modelling
Migration is the key process to understand the dynamics and persistence of a metapopulation. Many metapopulation models assume a positive correlation between habitat patch size or stability and the number of emigrants. However, few empirical data exist, and habitat patch size and habitat stability may affect dispersal differently than they affect local persistence. Here, we studied the production of the migration stage (i.e., resting eggs called ephippia) of the cladoceran Daphnia magna in a metapopulation consisting of 530 rock pool habitat patches over 25 years. Earlier, the functioning of this metapopulation was explained with a Levins-type metapopulation model or with a mainland-island metapopulation model, based on local extinction and colonization data or time series data, respectively. We used pool volume, hydroperiod length, and number of desiccation events to calculate per-pool production of ephippia (i.e., migration stages). We estimated that populations in small and ephemeral habitat patches produced more than half of the 250,000 to 1 million ephippia that were produced in the metapopulation as a whole per year between 1982 and 2006. Furthermore, these small populations contributed similar to 90% of the ephippia exposed during desiccation events, while the contribution of the long-lived populations in large pools was minimal. We term this an “inverse mainland-island” type metapopulation and propose that populations in small, ephemeral habitat patches may also be the driving force for metapopulation dynamics in other systems. Ecology, 2010, V91, N10, OCT, pp 2975-2982.

11.1-205 Is point uncertain rainfall likely to have a great impact on distributed complex hydrological modeling?
Balin D, Lee H, Rode M
Germany, Switzerland
Hydrology, Modelling
Uncertainty analysis has become an important topic in environmental research. Uncertainty in hydrological modeling, in general, has been studied by investigating mainly the influence of the parameter uncertainty on the uncertainty of the simulated outputs. This paper focuses essentially on the impact of point input uncertainty on fully distributed hydrological modeling and proposes an integrated approach to cope with input and parameter uncertainty. The approach uses Bayesian theory in two steps: first, to compute the uncertainty in input forcing data, and second, to compute the hydrological parameter uncertainty and the uncertainties of a lumped-error term that include other sources of errors: response errors and model error. The method is applied with a fully distributed model: WaSIM-ETH. The results show that the methodology proposed here is a valuable tool to assess different sources of uncertainty in hydrological modeling and show the effects of uncertainty in the input forcing when a fully distributed, physically based hydrological model is used. Water Resources Research, 2010, V46, NOV 11 ARTN: W11520, DOI: http://dx.doi.org/10.1029/2009WR007848.

11.1-206 Changes and trends in debris-flow frequency since AD 1850: Results from the Swiss Alps
Bollschweiler M, Staffel M
Switzerland
Geomorphology, Hydrology, Forestry, Plant Sciences
Although studies have repeatedly focused on feedbacks and impacts of climate change on mass movements in the past, the inter-relations between climatic variables and debris-flow occurrence remain widely unclear and ambiguous to date. Most studies on past debris-flow occurrence remained rather isolated reconstructions for single torrents or they were restricted to short time periods. It is therefore the aim of this study to provide a regional chronology of past debris-flow events for the Zermatt Valley (Swiss Alps) and to go beyond the simple dating of events. Based on tree-ring reconstructed debris-flow histories of eight torrents, we shed light on changes and trends in debris-flow occurrence, climatic conditions prevailing during events and on potential evolutions in a future climate. Based on the analysis of tree-ring records of 2467 conifers (mainly Larix decidua and Picea abies), 417 events between ad 1600 and 2009 were assessed. Decadal frequencies suggest peaks in debris-flow activity after the end of the ‘Little Ice Age’ and for the period 1920-1929. In contrast, activity was rather low during the most recent part
of the record (2000-2009), which is in concert with the observed decrease in the number of triggering rainfall events. Long-term trends in debris-flow occurrence were analysed for three time intervals of the period 1850-2009 with Student’s t-tests. For the debris-flow frequency of the entire valley, no significant trends can be observed over the last 150 years. We conclude that the occurrence of debris flows would depend on short-term changes in triggering rainfall rather than on long-term climatic changes.


11.1-207
Tree rings and debris flows: Recent developments, future directions
Bollschweiler M, Stoffel M
Switzerland
Geomorphology, Hydrology, Forestry, Plant Sciences
The sudden and unpredictable occurrence of debris flows poses major problems in many mountain areas in the world. For a realistic hazard assessment, knowledge of past events is of crucial importance. As archival data is generally fragmentary, additional information sources are needed for an appraisal of past and contemporary events as well as for the prediction of potential future events. Tree rings represent a very valuable natural archive on past debris-flow occurrence as they may record the impact of events in their tree-ring series. In the past few years, dendrogeomorphology has evolved from a pure dating tool to a broad range of applications. Besides the reconstruction of frequencies, tree rings allow - if coupled with spatial positioning methods - the determination of spread and reach of past events. Similarly, the wide field of applications includes the identification of magnitudes and triggers of debris-flow events. Besides demonstrating recent developments in the use of tree rings for debris-flow research, this contribution also provides a short overview on the application of tree rings for other mass-movement processes and highlights further possibilities of the method. Established techniques can be applied to related processes such as debris floods, flash floods or lahars. Data obtained can also be used to calibrate modeling approaches. The impact of past and future climatic changes on debris-flow occurrence is furthermore an important aspect where tree rings can be of help.

11.1-208
Variations in debris-flow occurrence in an Alpine catchment - A reconstruction based on tree rings
Bollschweiler M, Stoffel M
Switzerland
Hydrology, Geomorphology, Forestry
Past debris-flow activity in the Birchbach torrent (Swiss Alps) was assessed using tree-ring data. Based on the analysis of 210 Larix decidua and Picea abies, 50 events were reconstructed for the period AD 1752-2006. On average, 3.2 events per decade occurred in the torrent during the last century with distinct differences between the decades and a considerable decrease in the number of events during the last decade. Comparison with debris-flow reconstructions in neighboring catchments provided more insight in the similarities and differences in debris-flow occurrence. The recurrent debris-now activity and current geomorphic settings suggest that the occurrence of debris flows in the torrent is rather transport-limited than supply-limited. Therefore, future investigations on debris-flow occurrence in transport-limited basins should focus on triggering rainfall events.

11.1-209
Stochastic modeling of nutrient losses in streams: Interactions of climatic, hydrologic, and biogeochemical controls
Botter G, Basu N B, Zanardo S, Rao P S C, Rinaldo A
Italy, USA, Switzerland
Hydrology, Water Resources, Modelling
We present an analytical, stochastic approach for quantifying intra-annual fluctuations of in-stream nutrient losses induced by naturally variable hydrologic conditions. The relevance of the problem we address lies in the growing concern for the major environmental impacts of increasing nutrient loads from watersheds to freshwater bodies and coastal waters. Here we express the first-order nutrient loss rate constant, k(e), as a function of key biogeochemical and hydrologic controls, in particular the stream depth (h). The stage h modulates the impact of natural streamflow temporal fluctuations (induced by intermittent rainfall forcings) on the underlying biogeochemical processes and thus represents the major driver of at-a-site fluctuations of k(e). Novel expressions for the probability distribution function (pdf) of h and k(e) are derived as a function of a few eco-hydrologic, morphologic and biogeochemical param-
eters. The shape of such pdf's chiefly depends on the following attributes: (1) the average frequency of streamflow-producing rainfall events, lambda; (2) the inverse of mean catchment residence time, k; and (3) a stream channel shape factor, identified through the discharge rating curve exponent b. For lambda/(kb) > 1, h and k(e) have lower intra-annual variability and lower sensitivity to climatic and morphologic controls, leading to improved predictability and ease of measurement of these attributes. Moment analyses suggest that the variability of k(e), relative to that of h, is attenuated for lambda/(kb) > 1. Thus, the interplay between climate-landscape parameters and the stream shape factor b controls the temporal variability induced by stochastic rainfall forcings on stream stages and nutrient removal rates.


**11.1-210**

**Inter-comparison of hydro-climatic regimes across northern catchments: synchronicity, resistance and resilience**


Canada, Scotland, Switzerland, Sweden, USA

*Hydrology, Water Resources, Cryology / Glaciology*

The higher mid-latitudes of the Northern Hemisphere are particularly sensitive to climate change as small differences in temperature determine frozen ground status, precipitation phase, and the magnitude and timing of snow accumulation and melt. An international inter-catchment comparison program, North-Watch, seeks to improve our understanding of the sensitivity of northern catchments to climate change by examining their hydrological and biogeochemical responses. The catchments are located in Sweden (Krycklan), Scotland (Mharcaidh, Girnock and Strontian), the United States (Sleepers River, Hubbard Brook and HJ Andrews) and Canada (Catamaran, Dorset and Wolf Creek). This briefing presents the initial stage of the North-Watch program, which focuses on how these catchments collect, store and release water and identify ‘types’ of hydro-climatic catchment response. At most sites, a 10-year data of daily precipitation, discharge and temperature were compiled and evaporation and storage were calculated. Inter-annual and seasonal patterns of hydrological processes were assessed via normalized fluxes and standard flow metrics. At the annual scale, relations between temperature, precipitation and discharge were compared, highlighting the role of seasonality, wetness and snow/frozen ground. The seasonal pattern and synchronicity of fluxes at the monthly scale provided insight into system memory and the role of storage. We identified types of catchments that rapidly translate precipitation into runoff and others that more readily store water for delayed release. Synchronicity and variance of rainfall-runoff patterns were characterized by the coefficient of variation (cv) of monthly fluxes and correlation coefficients. Principal component analysis (PCA) revealed clustering among like catchments in terms of functioning, largely controlled by two components that (i) reflect temperature and precipitation gradients and the correlation of monthly precipitation and discharge and (ii) the seasonality of precipitation and storage. By advancing the ecological concepts of resistance and resilience for catchment functioning, results provided a conceptual framework for understanding susceptibility to hydrological change across northern catchments.


**11.1-211**

**Comparative study of ecohydrological streamflow probability distributions**

Ceola S, Botter G, Bertuzzo E, Porporato A, Rodriguez Iturbe I, Rinaldo A

Switzerland, Italy, USA

*Hydrology, Modelling, Water Resources*

We run a comparative study of ecohydrological models of streamflow probability distributions (pdfs), p(Q), derived by Botter et al. (2007a, 2009), against field data gathered in different hydrological contexts. Streamflows measured in several catchments across various climatic regions of northeastern Italy and the United States are employed. The relevance of the work stems from the implied analytical predictability of hydrologic variability, whose role on stream and riparian ecological processes and large-scale management schemes is fundamental. The tools employed are analytical models of p(Q) and of the related flow duration curve, D(Q) derived by coupling suitable storage-discharge relations with a stochastic description of streamflow production through soil moisture dynamics, and are expressed as a function of few macroscopic rainfall, soil, vegetation and geomorphological parameters. In this work we compare the performances of a recent version of the model (which includes the effects of nonlinear subsurface storage-discharge relations) to those provided by the linear version through the
application of the models to 13 test catchments belonging to various climatic and geomorphic contexts. A general agreement between predicted and observed daily streamflows pdfs is shown, though differences emerge between the linear and the nonlinear approaches. In particular, by including the effects of a nonlinear storage-discharge relation the model accuracy is shown to increase with respect to the linear scheme in most examined cases. We show that this is not simply attributable to the added parameter but corresponds to a proper likelihood increase. The nonlinear model is shown to exhibit three basic forms for \( p(Q) \) (monotonically decreasing with an atom of probability in \( Q = 0 \), bell-shaped with the mode close to zero, bell-shaped with the mode close to the mean), corresponding to different hydrologic regimes which are clearly detectable in field data. Inferences on the nonlinear character of the relation between subsurface storage and discharge from observed \( p(Q) \) are finally drawn.


11.1-212
Temporal discontinuity of nutrient limitation in plankton communities
Davies J M, Nowlin W H, Matthews B, Mazumder A
Canada, USA, Switzerland
Limnology, Marine & Freshwater Biology, Microbiology, Plant Sciences
Ideas on how various measures of nutrient limitation relate to plankton biomass and species composition are re-examined. While long-term and multi-lake studies typically focus on determining overall biomass, seasonal studies are more focused toward understanding species composition. We use physiological assays to assess short-term nutrient deficiency of nitrogen and phosphorus in two moderately fertile lakes. While biomass in the lakes was considered to ultimately be limited by total phosphorus, nutrient assays were variable in time. Nutrient ratios (TN:TP, PN:PP, PC:PP and PC:PN) did not predict short-term deficiencies, notably that nitrogen deficiency occurred in these phosphorus-limited lakes. In one of our study lakes, there was a relaxation of phosphorus deficiency despite phosphate concentrations occurring below traditional detection limits. Following this period, there was an autumn bloom of Anophidizomenon flos-aquae. This relationship corresponds with other studies that have found A. flos-aquae to be a poor competitor for phosphorus. In contrast, phosphorus deficiency remained high prior to the autumn diatom bloom in our other study lake. Deficiency measures remain an excellent means of assessing physiological status of plankton communities and provide greater insight into species compositional changes, especially when other potential indicators like dissolved nutrient concentrations are inconclusive. Regardless of the nutrient limitation indicator used for a given study, it is critical to consider the appropriate scale of the measure.

Aquatic Sciences, 2010, V72, N4, SEP, pp 393-402 DOI: http://dx.doi.org/10.1007/s00027-010-0143-x.

11.1-213
Spatio-temporal scaling of biodiversity and the species-time relationship in a stream fish assemblage
Eros T, Schmera D
Hungary, Switzerland
Marine & Freshwater Biology, Biodiversity, Zoology, Ecology
1. The increase of species richness with the area of the habitat sampled, that is the species-area relationship, and its temporal analogue, the species-time relationship (STR), are among the few general laws in ecology with strong conservation implications. However, these two scale-dependent phenomena have rarely been considered together in biodiversity assessment, especially in freshwater systems. 2. We examined how the spatial scale of sampling influences STRs for a Central-European stream fish assemblage (second-order Bernecei stream, Hungary) using field survey data in two simulation-based experiments. 3. In experiment one, we examined how increasing the number of channel units, such as riffs and pools (13 altogether), and the number of field surveys involved in the analyses (12 sampling occasions during 3 years), influence species richness. Complete nested curves were constructed to quantify how many species one observes in the community on average for a given number of sampling occasions at a given spatial scale. 4. In experiment two, we examined STRs for the Bernecei fish assemblage from a landscape perspective. Here, we evaluated a 10-year reach level data set (2000-09) for the Bernecei stream and its recipient watercourse (third-order Kemence stream) to complement results on experiment one and to explore the mechanisms behind the observed patterns in more detail. 5. Experiment one indicated the strong influence of the spatial scale of sampling on the accumulation of species richness, although time clearly had an additional effect. The simulation methodology advocated here helped to estimate the number of species in a diverse combination of spatial and temporal scale and, therefore, to determine how
In mountains, environmental gradients are steep in both terrestrial and aquatic systems, and climate change is causing upward shifts of physical and biological features of these gradients. Glacial streams are an interesting system to evaluate such shifts both because streams have a linear nature (for simplicity of analysis), and because the stream habitat will at least temporarily lengthen as it follows receding glaciers upward. The Tschirerva Glacier, Swiss Alps, receded 482 m upstream as it follows receding glaciers upward. The Tschireresa Lake-outlet tributary upon which glacial influence was diminished between 1997 and 2007/2008. These results suggest that upward-shifting gradients in glacial streams can involve complex interactions with other landscape elements and that local-scale climate response can progress even more rapidly than the rate of glacial recession. 


11.1-214
Physical and biological changes to a lengthening stream gradient following a decade of rapid glacial recession
Finn D S, Räätänen K, Robinson C T
Switzerland
Marine & Freshwater Biology, Hydrology , Zoology , Ecology
In mountains, environmental gradients are steep in both terrestrial and aquatic systems, and climate change is causing upward shifts of physical and biological features of these gradients. Glacial streams are an interesting system to evaluate such shifts both because streams have a linear nature (for simplicity of analysis), and because the stream habitat will at least temporarily lengthen as it follows receding glaciers upward. The Tschirerva Glacier, Swiss Alps, receded 482 m upstream from 1997 to 2008. We tested the null hypothesis that the physical and biological stream gradient below this glacier maintained the same structure during these time periods, but simply shifted upward following the glacial source. We compared longitudinal patterns of water temperature and zoobenthic community structure in 1997 and 2007-2008 during three seasons (spring, summer, fall) along the uppermost ca. 5 stream km. Upward shifts were evident, including colonization of the newly exposed stream reaches by cold-adapted taxa, and the appearance in 2007/2008 of four lower-altitude species that were previously absent. Overall, however, results rejected the null hypothesis, instead revealing significant changes in gradient structures. These included a more steeply increasing temperature profile downstream of the glacier and increased amplitude of seasonal community turnover in 2007/2008 vs. 1997. Long-term (1955-2007) flow records revealed increasing short-term and seasonal hydrologic variability, which might have influenced the increased intra-annual community variability. The steepening of the temperature gradient was likely caused by a warming lake-outlet tributary upon which glacial influence was diminished between 1997 and 2007/2008.

groups. The results stress the need to take into account the limits of the working range and the occurrence of extreme events, when testing and applying bioindicator systems.


11.1-216
Application of detection probabilities to the design of amphibian monitoring programs in temporary ponds
Gomez Rodriguez C, Guisan A, Diaz Paniagua C, Bustamante J
Spain, Switzerland
Marine & Freshwater Biology, Biodiversity, Zoology, Modelling
Failure to detect a species in an area where it is present is a major source of error in biological surveys. We assessed whether it is possible to optimize single-visit biological monitoring surveys of highly dynamic freshwater ecosystems by framing them a priori within a particular period of time. Alternatively, we also searched for the optimal number of visits and when they should be conducted. We developed single-species occupancy models to estimate the monthly probability of detection of pond-breeding amphibians during a four-year monitoring program. Our results revealed that detection probability was species-specific and changed among sampling visits within a breeding season and also among breeding seasons. Thereby, the optimization of biological surveys with minimal survey effort (a single visit) is not feasible as it proves impossible to select a priori an adequate sampling period that remains robust across years. Alternatively, a two-survey combination at the beginning of the sampling season yielded optimal results and constituted an acceptable compromise between sampling efficacy and survey effort. Our study provides evidence of the variability and uncertainty that likely affects the efficacy of monitoring surveys, highlighting the need of repeated sampling in both ecological studies and conservation management.


11.1-217
Bridge Pier Scour under Flood Waves
Hager W H, Unger J
Germany, Switzerland
Hydrology, Engineering
The effect of a single-peaked flood wave on pier scour is investigated both theoretically and experimentally. The conditions considered involve clear-water scour of a cohesionless material of given median sediment size and sediment nonuniformity, an approach flow characterized by a flow depth and velocity, a circular-shaped cylindrical bridge pier, and a flood hydrograph defined by its time to peak and peak discharge. A previously proposed formula for scour advance under a constant discharge was applied to the unsteady approach flow. The generalized temporal scour development along with the end scour depth are presented in terms of mainly the densimetric particle Froude number based on the maximum approach flow velocity and the median sediment size. The effect of the remaining parameters on the end scour depth is discussed and predictions are demonstrated to be essentially in agreement with model observations.


11.1-218
Chemical and Physical Environmental Conditions Underneath Mat- and Canopy-Forming Macroseaweed, and Their Effects on Understorey Corals
Hauri C, Fabricius K E, Schaffleke B, Humphrey C
Switzerland, Australia
Oceanography, Marine & Freshwater Biology, Plant Sciences
Disturbed coral reefs are often dominated by dense mat- or canopy-forming assemblages of macroalgae. This study investigated how such dense macroalgal assemblages change the chemical and physical microenvironment for understorey corals, and how the altered environmental conditions affect the physiological performance of corals. Field measurements were conducted on macroalgal-dominated inshore reefs in the Great Barrier Reef in quadrats with macroalgal biomass ranging from 235 to 1029 g DW m(-2) dry weight. Underneath mat-forming assemblages, the mean concentration of dissolved oxygen was reduced by 26% and irradiance by 96% compared with conditions above the mat, while concentrations of dissolved inorganic carbon and alkalinity increased with increasing algal biomass underneath mat-forming but not under canopy-forming assemblages. The responses of corals to conditions similar to those found underneath algal assemblages were investigated in an aquarium experiment. Coral nubbins of the
species Acropora millepora showed reduced photosynthetic yields and increased RNA/DNA ratios when exposed to conditions simulating those underneath assemblages (pre-incubating seawater with macroalgae, and shading). The magnitude of these stress responses increased with increasing proportion of pre-incubated algal water. Our study shows that mat-forming and, to a lesser extent, canopy-forming macroalgal assemblages alter the physical and chemical microenvironment sufficiently to directly and detrimentally affect the metabolism of corals, potentially impeding reef recovery from algal to coral-dominated states after disturbance. Macroalgal dominance on coral reefs therefore simultaneously represents a consequence and cause of coral reef degradation. *Plos One*, 2010, V5, N9, SEP 13 ARTN: e12685, DOI: http://dx.doi.org/10.1371/journal.pone.0012685.

11.1-219
Leaf-litter breakdown in pasture and deciduous woodland streams: a comparison among three European regions
England, Ireland, Switzerland, Romania
Marine & Freshwater Biology, Agriculture, Hydrology, Ecology, Zoology, Microbiology

1. Human land-use has altered catchments on a large scale in most parts of the world, with one of the most profound changes relevant for streams and rivers being the widespread clearance of woody riparian vegetation to make way for livestock grazing pasture. Increasingly, environmental legislation, such as the EU Water Framework Directive (EU WFD), calls for bioassessment tools that can detect such anthropogenic impacts on ecosystem functioning. 2. We conducted a large-scale field experiment in 30 European streams to quantify leaf-litter breakdown, a key ecosystem process, in streams whose riparian zones and catchments had been cleared for pasture compared with those in native deciduous woodland. The study encompassed a west-east gradient, from Ireland to Switzerland to Romania, with each of the three countries representing a distinct region. We used coarse-mesh and fine-mesh litter bags (10 and 0.5 mm, respectively) to assess total, microbial and, by difference, macroinvertebrate-mediated breakdown. 3. Overall, total breakdown rates did not differ between land-use categories, but in some regions macroinvertebrate-mediated breakdown was higher in deciduous woodland streams, whereas microbial breakdown was higher in pasture streams. This result suggests that overall ecosystem functioning is maintained by compensatory increases in microbial activity in pasture streams. 4. We suggest that simple coefficients of breakdown rates on their own often might not be powerful enough as a bioassessment tool for detecting differences related to land-use such as riparian vegetation removal. However, shifts in the relative contributions to breakdown by microbial decomposers versus invertebrate detritivores, as revealed by the ratios of their associated breakdown rate coefficients, showed clear responses to land-use. *Freshwater Biology*, 2010, V55, N9, SEP, pp 1916-1929 DOI: http://dx.doi.org/10.1111/j.1365-2427.2010.02426.x.

11.1-220
Balancing between retention and flushing in river networks - optimizing nutrient management to improve trophic state
Honti M, Istvanovics V, Kovacs A S
Hungary, Austria, Switzerland
Hydrology, Marine & Freshwater Biology, Water Resources, Modelling

River basin management can frequently involve decisive situations, when conflicting interests must be resolved. In the Zala River catchment (Western Hungary) local efforts to improve water quality by reducing algal biomass are not always harmonized with the requirement of sustaining the same objective in its recipient, Lake Balaton. The PhosFate catchment model is a GIS tool designed to estimate the spatial variability and fate of diffuse phosphorus emission during transport. Besides diffuse pollution, a simplified annual hydrologic balance is also calculated. A new module was added to PhosFate that tracked the development of entrained algae during their travel downstream. The extended model was used to simulate the current average algal concentrations in the river network. The numerous small reservoirs and impoundments on the tributaries of the Zala River were identified as the key elements in determining algal biomass, since they fundamentally increase the water residence time (WRT) in the system. Without reservoirs, the short WRT in the drainage network would successfully prevent the development of suspended algal biomass despite the fairly high SRP concentrations. However, the removal of such standing waters is impossible for socio-economic reasons and reducing the overall P load to Lake Balaton would also require increasing WRT in the system. As a resolution to these conflicting interests, a hybrid management strategy was designed to simultaneously reach both goals:
(i) switching from WRT to P limitation in reservoirs responsible for most of algal growth, and (ii) optimized deployment of buffer zones and the introduction of best agricultural practices on the remaining majority of the catchment to reduce the overall P load. The suggested management approach could be applied in other river catchments too, due to the extensive presence of reservoirs and impoundments in many stream networks. Science of the Total Environment, 2010, V408, N20, SEP 15, pp 4712-4721 DOI: http://dx.doi.org/10.1016/j.scitotenv.2010.06.054.

11.1-221
Recent decline in the global land evapotranspiration trend due to limited moisture supply
Germany, France, Switzerland, USA, Italy, Netherlands
Hydrology, Meteorology & Atmospheric Sciences, Modelling

More than half of the solar energy absorbed by land surfaces is currently used to evaporate water(1). Climate change is expected to intensify the hydrological cycle(2) and to alter evapotranspiration, with implications for ecosystem services and feedback to regional and global climate. Evapotranspiration changes may already be under way, but direct observational constraints are lacking at the global scale. Until such evidence is available, changes in the water cycle on land - a key diagnostic criterion of the effects of climate change and variability - remain uncertain. Here we provide a data-driven estimate of global land evapotranspiration from 1982 to 2008, compiled using a global monitoring network(3), meteorological and remote-sensing observations, and a machine-learning algorithm(4). In addition, we have assessed evapotranspiration variations over the same time period using an ensemble of process-based land-surface-models. Our results suggest that global annual evapotranspiration increased on average by 7.1 +/- 1.0 millimetres per year per decade from 1982 to 1997. After that, coincident with the last major El Nino event in 1998, the global evapotranspiration increase seems to have ceased until 2008. This change was driven primarily by moisture limitation in the Southern Hemisphere, particularly Africa and Australia. In these regions, microwave satellite observations indicate that soil moisture decreased from 1998 to 2008. Hence, increasing soil-moisture limitations on evapotranspiration largely explain the recent decline of the global land-evapotranspiration trend. Whether the changing behaviour of evapotranspiration is representative of natural climate variability or reflects a more permanent reorganization of the land water cycle is a key question for earth system science. Nature, 2010, V467, N7318, OCT 21, pp 951-954 DOI: http://dx.doi.org/10.1038/nature09396.

11.1-222
Impact of lake level change on deep-water renewal and oxic conditions in deep saline Lake Van, Turkey
Kaden H, Peeters F, Lorke A, Kipfer R, Tomonaga Y, Karabiyikoglou M
Germany, Turkey, Switzerland
Limnology, Hydrology

Changes in the hydrological regime of the saline closed basin Lake Van, a large, deep lake in eastern Turkey, resulted in a lake level increase by about 2 m between 1988 and 1995, followed by a 1.5 m decrease until 2003 and a relatively constant lake level thereafter. Based on measurements of transient tracers (sulfur hexafluoride, CFC-12, H-3, He-3, He-4, Ne), dissolved oxygen, light transmission, conductivity-temperature-depth profiles, and thermistor data, we investigate the implications associated with lake level fluctuations for deep-water renewal and oxygenation. Our data suggest that deep-water renewal was significantly reduced in Lake Van between 1990 and 2005. This change in mixing conditions resulted in the formation of a more than 100 m thick anoxic deep-water body below 325 m depth. Apparently, the freshwater inflows responsible for the lake level rise between 1988 and 1995 decreased the salinity of the surface water sufficiently that the generation of density plumes during winter cooling was substantially reduced compared to that in the years before the lake level rise. Significant renewal and oxygenation of the deep water did not occur until at least 2005, although by 2003 the lake level was back to almost the same level as in 1988. This study suggests that short-term changes in the hydrological regime, resulting in lake level changes of a couple of meters, can lead to significant and long-lasting changes in deep-water renewal and oxic conditions in deep saline lakes. Water Resources Research, 2010, V46, NOV 3 ARTN: W11508, DOI: http://dx.doi.org/10.1029/2009WR008555.
11.1-223
Increasing water temperature and disease risks in aquatic systems: Climate change increases the risk of some, but not all, diseases
Karvonen A, Rintamäki P, Jokela J, Valtonen E T
Finland, Switzerland
Medicine, Marine & Freshwater Biology, Zoology, Hydrology, Ecology
Global warming may impose severe risks for aquatic animal health if increasing water temperature leads to an increase in the incidence of parasitic diseases. Essentially, this could take place through a temperature-driven effect on the epidemiology of the disease. For example, higher temperature may boost the rate of disease spread through positive effects on parasite fitness in a weakened host. Increased temperature may also lengthen the transmission season leading to higher total prevalence of infection and more widespread epidemics. However, to date, general understanding of these relationships is limited due to scarcity of long-term empirical data. Here, we present one of the first long-term multi-pathogen data sets on the occurrence of pathogenic bacterial and parasitic infections in relation to increasing temperatures in aquatic systems. We analyse a time-series of disease dynamics on two fish farms in northern Finland from 1986 to 2006. We first demonstrate that the annual mean water temperature increased significantly on both farms over the study period and that the increase was most pronounced in the late summer (July-September). Second, we show that the prevalence of infection (i.e. proportion of fish tanks infected each year) increased with temperature. Interestingly, this pattern was observed in some of the diseases (Ichthyophthirius multifiliis, Flavobacterium columnare), whereas in the other diseases, the pattern was the opposite (Ichthyobodo necator) or absent (Chilodonella spp.). These results demonstrate the effect of increasing water temperature on aquatic disease dynamics, but also emphasise the importance of the biology of each disease, as well as the role of local conditions, in determining the direction and magnitude of these effects.


11.1-224
Potential impacts of precipitation change on large-scale patterns of tree diversity
USA, Switzerland, Italy
Hydrology, Modelling, Biodiversity, Forestry, Water Resources
Forests are globally important ecosystems host to outstanding biological diversity. Widespread efforts have addressed the impacts of climate change on biodiversity in these ecosystems. We show that a metacommunity model founded on basic ecological processes offers direct linkage from large-scale forcing, such as precipitation, to tree diversity patterns of the Mississippi-Missouri River System and its subregions. We quantify changes in tree diversity patterns under various projected precipitation patterns, resulting in a range of responses. Uncertainties accompanying global climate models necessitate the use of scenarios of biodiversity. Here we present results from scenarios with the largest losses and gains in tree diversity. Our results suggest that species losses under scenarios with the most dramatic contractions tend to be greater in magnitude, spatial extent, and statistical significance than gains under alternative scenarios. These findings are expected to have important implications for conservation policy and resource management.


11.1-225
Hypolimnetic oxygen consumption by sediment-based reduced substances in former eutrophic lakes
Matzinger A, Müller B, Niederhauser P, Schmid M, Wüest A
Germany, Switzerland
Limnology, Hydrology, Geochemistry & Geophysics
We quantified the areal hypolimnetic mineralization rate (AHM; total areal hypolimnetic oxygen depletion including the formation of reduced substances) in two formerly eutrophic lakes based on 20 yr of water-column data collected during oligotrophication. The upward diffusion of reduced substances originating from the decomposition of organic matter in the sediment was determined from pore-water profiles and related to the time of deposition. More than 80% of AHM was due to degradation of organic matter in the water column (including sediment surface) and diffusion of reduced substances from sediment layers younger
than 10 yr. Sediments older than 10 yr, including the eutrophic past, accounted for similar to 15% of AHM. This “old” contribution corresponds to a 20-43% fraction of the total sediment-based AHM. The contribution from old sediment layers to AHM is expected to be even lower in lakes with deeper hypolimnias (> 12 m). In summary, oxygen consumption in stratified hypolimnias is controlled mainly by the present lake productivity. As a result, technical lake management measures, such as oxygenation, artificial mixing, or sediment dredging, cannot efficiently decrease the flux of reduced substances from the sediment.


11.1-226 Accounting for subgrid scale topographic variations in flood propagation modeling using MODFLOW
Milzow C, Kinzelbach W
Denmark, Switzerland
Hydrology, Water Resources, Modelling
To be computationally viable, grid-based spatially distributed hydrological models of large wetlands or floodplains must be set up using relatively large cells (order of hundreds of meters to kilometers). Computational costs are especially high when considering the numerous model runs or model time steps necessary in calibration and long-term simulation. To parameterize such models, upscaling procedures are required in furnishing equivalent hydrological model parameters on the grid scale. Here we investigate the effect of a new upscaling technique for hydrological flow parameters dependent upon the small-scale terrain elevation distribution, namely, resistance to flow, infiltration, and depression storage volume. In the new procedure, these hydrological model parameters on the grid scale become functions of the water table elevation. These functions are established by preparatory, nonrecurring, simulations using the highest available topographic data as input. In this way, the variability and spatial correlation of elevation data on the subscale is preserved on the model scale, at least to some extent. The MODFLOW-based hydrological model of the Okavango Wetlands is used as a study case. The effectiveness of the new upscaling technique is judged on the basis of comparison of computed flooding patterns with and without implementation of the new technique. It is shown that model results are considerably influenced by this new more flexible parameterization. The partitioning of flows toward the different distributary systems of the Okavango Wetlands is improved by the new technique.

11.1-227 HYPROM hydrology surface-runoff prognostic model
Nickovic S, Pejanovic G, Djurdjevic V, Roskar J, Vujadinovic M
Switzerland, Serbia, Slovenia
Hydrology, Water Resources, Modelling
The major objective of this study was to develop a hydrology model (HYPROM) to simulate overland watershed processes based on advanced numerical and parameterization methods. The resulting model, HYPROM, was designed for real-time watershed prediction. The model solves grid point-based shallow water equations with numerical approaches that include an efficient explicit time-differencing scheme for the gravity wave components and a physically based and numerically stable implicit scheme for the friction slope terms. The model dynamics (advection, diffusion, and height gradient force) are explicitly represented, whereas the model physics (e.g., friction slope) are parameterized, i.e., subgrid effects are expressed in terms of the model grid point variables. The fact that the modeling governing equations for momentum and mass are all prognostic makes HYPROM distinct to most other prognostic hydrology systems. The model uses real topography, river routing, and land cover data to represent surface influences. The HYPROM calculations can be executed offline (i.e., independent of a driving atmospheric model) or online as a callable routine of a driving atmospheric model. The model is applicable across a broad range of spatial scales ranging from local to regional and global scales. The model can be set up over different geographic domains and can run efficiently on conventional computer platforms. Finally, the model can be used either for hydrologic forecasts or climate studies if embedded as a component of an atmospheric climate model.

11.1-228 Abrupt onset of carbonate deposition in Lake Kivu during the 1960s: response to recent environmental changes
This study interprets the recent history of Lake Kivu, a tropical lake in the East African Rift Valley. The current gross sedimentation was characterized from a moored sediment trap array deployed over 2 years. The past net sedimentation was investigated with three short cores from two different basins. Diatom assemblages from cores were interpreted as reflecting changes in mixing depth, surface salinity and nutrient availability. The contemporary sediment trap data indicate seasonal variability, governed by diatom blooms during the annual mixing in the dry season, similar to Lakes Malawi and Tanganyika. The ratio of settling fluxes to net sediment accumulation rates implies mineralization rates of 80-90% at the sediment-water interface. The sediment cores revealed an abrupt change similar to 40 years ago, when carbonate precipitation started. Since the 1960s, deep-water methane concentrations, nutrient fluxes and soil mineral inputs have increased considerably and diatom assemblages have altered. These modifications probably resulted from a combination of three factors, commonly altering lake systems: the introduction of a non-native fish species, eutrophication, and hydrological changes inducing greater upwelling. Both the fish introduction and increased rainfall occurred at the time when the onset of carbonate precipitation was observed, whereas catchment population growth accompanied by intensified land use increased the flux of soil minerals already since the early twentieth century due to more intense erosion. 


11.1-229
On the reproducibility and repeatability of laser absorption spectroscopy measurements for delta H-2 and delta O-18 isotopic analysis
Italy, Czech Republic, Luxembourg, Netherlands, Switzerland
Hydrology
The aim of this study was to analyse the reproducibility of off-axis integrated cavity output spectroscopy (OA-ICOS)-derived delta H-2 and delta O-18 measurements on a set of 35 water samples by comparing the performance of four laser spectrometers with the performance of a conventional mass spectrometer under typical laboratory conditions. All samples were analysed using three different schemes of standard/sample combinations and related data processing to assess the improvement of results compared with mass spectrometry. The repeatability of the four OA-ICOS instruments was further investigated by multiple analyses of a sample subset to evaluate the stability of delta H-2 and delta O-18 measurements. Results demonstrated an overall agreement between OA-ICOS-based and mass spectrometry-based measurements for the entire dataset. However, a certain degree of variability existed in precision and accuracy between the four instruments. There was no evident bias or systematic deviations from the mass spectrometer values, but random errors, which were apparently not related to external factors, significantly affected the final results. Our investigation revealed that analytical precision ranged +/- 0.56 parts per thousand to +/- 1.80 parts per thousand for delta H-2 and from +/- 0.10 parts per thousand to +/- 0.27 parts per thousand for delta O-18 measurements, with a marked variability among the four instruments. The overall capability of laser instruments to reproduce stable results with repeated measurements of the same sample was acceptable, and there were general differences within the range of the analytical precision for each spectroscope. Hence, averaging the measurements of three identical samples led to a higher degree of accuracy and eliminated the potential for random deviations.


11.1-230
Switzerland, Germany
Limnology , Hydrology , Modelling
The European winter of 2006-2007 was unusually mild, with record high mean winter air temperatures comparable with those predicted to become the norm by the end of the current century as a result of climate warming. In Lake Zurich and Greifensee, two neighboring Swiss perialpine lakes with several decades of data, mean lake temperatures for this winter were the highest ever recorded, as was thermal stability. Associated with the high thermal stability, mean winter oxygen concentrations in Lake Zurich were unusually high in the epilimnion and metalimnion, but normal in
the hypolimnion. In Greifensee, however, which is much shallower, mean winter oxygen concentrations did not deviate substantially from the norm anywhere in the water column. From 17-19 January 2007, an unusually severe cyclonic storm, “Kyrill,” traversed Europe. Monthly oxygen profiles suggest that the stabilizing effect of the mild winter on the two lakes was greatest before the occurrence of the storm, and that wind mixing resulted in a deepening of the mixed layer in both lakes. The mixing was able to encompass the entire water column of Greifensee, but not of Lake Zurich. These results, supported by more limited data from two other neighboring lakes, suggest that climate warming will likely inhibit complete mixing of some deep, temperate, normally monomictic lakes in winter even when extremely intense cyclonic storms occur. In shallower lakes, however, complete mixing is unlikely to be inhibited. 


11.1-231 New challenges in integrated water quality modelling

There is an increasing pressure for development of integrated water quality models that effectively couple catchment and in-stream biogeochemical processes. This need stems from increasing legislative requirements and emerging demands related to contemporary climate and land use changes. Modelling water quality and nutrient transport is challenging due a number of serious constraints associated with the input data as well as existing knowledge gaps related to the mathematical description of landscape and in-stream biogeochemical processes. The present paper summarizes the discussions held during the workshop on ‘Integrated water quality modelling: future demands and perspectives’ (Magdeburg, Germany, 23-24 June 2008). Our primary focus is placed on the current limitations and future challenges in water quality modelling. In particular, we evaluate the current state of integrated water quality modelling, we highlight major research needs to assess and reduce model uncertainties, and we examine opportunities to enhance model predictive capacity. To better account for the need of upscaling process knowledge, we advocate the adoption of combined process-oriented field and modelling studies at representative sites. In-stream nutrient metabolism investigations at the entire range of stream and river scales will enable the improvement of the mathematical representation of these processes and therefore the articulation level of coupled watershed-receiving waterbody models. Keeping the complexity of integrated water quality models in mind, the development of novel uncertainty analysis techniques for rigorous assessing parameter identification and model credibility is essential. In this regard, we recommend the use of Bayesian calibration frameworks that explicitly accommodate measurement errors, parameter uncertainties, and model structure errors. The Bayesian inferences can be used to quantify the information the data contain about model inputs, to offer insights into the covariance structure among parameter estimates, to obtain predictions along with credible intervals for model outputs, and to effectively address the ‘change of support’ problems.


11.1-232 Reduced space optimal interpolation of daily rain gauge precipitation in Switzerland
Schiemann R, Liniger M A, Frei C Switzerland Meteorology & Atmospheric Sciences, Hydrology

The coarse spacing of automatic rain gauges complicates near-real-time spatial analyses of precipitation. We test the possibility of improving such analyses by considering, in addition to the in situ measurements, the spatial covariance structure inferred from past observations with a denser network. To this end, a statistical reconstruction technique, reduced space optimal interpolation (RSOI), is applied over Switzerland, a region of complex topography. RSOI consists of two main parts. First, principal component analysis (PCA) is applied to obtain a reduced space representation of gridded high-resolution precipitation fields available for a multiyear calibration period in the past. Second, sparse real-time rain gauge observations are used to estimate the principal component scores and to reconstruct the precipitation field. In this way, climatological information at higher resolution than the near-real-time measurements is incorporated into the spatial analysis. PCA is found to efficiently reduce the dimensionality of the calibration fields, and RSOI is successful despite the difficulties associated with the statistical distribution of daily precipitation (skewness, dry days). Examples and a systematic evaluation show substantial added value over a simple interpolation.
technique that uses near-real-time observations only. The benefit is particularly strong for larger-scale precipitation and prominent topographic effects. Small-scale precipitation features are reconstructed at a skill comparable to that of the simple technique. Stratifying the reconstruction method by the types of weather type classifications yields little added skill. Apart from application in near real time, RSOI may also be valuable for enhancing instrumental precipitation analyses for the historic past when direct observations were sparse. *Journal of Geophysical Research Atmospheres, 2010, V115, JUL 22* ARTN: D14109, DOI: http://dx.doi.org/10.1029/2009JD013047.

11.1-233 Oxidation and emission of methane in a monomictic lake (Rotsee, Switzerland)


Limnology, Hydrology, Microbiology, Marine & Freshwater Biology

The build-up of methane in the hypolimnion of the eutrophic Lake Rotsee (Lucerne, Switzerland) was monitored over a full year. Sources and sinks of methane in the water column were characterized by measuring concentrations and carbon isotopic composition. In fall, high methane concentrations (up to 1 mM) were measured in the anoxic water layer. In the oxic layer, methane concentrations were much lower and the isotopic composition shifted towards heavy carbon isotopes. Methane oxidation rates peaked at the interface between oxic and anoxic water layers at around 8-10 m depth. The electron balance between the oxidants oxygen, sulphate, and nitrate, and the reductants methane, sulphide and ammonium, matched very well in the chemocline during the stratified season. The profile of carbon isotopic composition of methane showed strong indications for methane oxidation at the chemocline (including the oxycline). Aerobic methane oxidizing bacteria were detected at the interface using fluorescence in situ hybridization. Sequencing the responsible organisms from DGGE bands revealed that aerobic methanotrophs type I closely related to Methylomonas were present. Sulphate consumption occurred at the sediment surface and, only towards the end of the stagnation period, matched with a zone of methane consumption. In any case, the flux of sulphate below the chemocline was not sufficient to oxidize all the methane and other oxidants like nitrate, iron or manganese are necessary for the observed methane oxidation. Although most of the methane was oxidized either aerobically or anaerobically, Lake Rotsee was still a source of methane to the atmosphere with emission rates between 0.2 mg CH₄ m(-2) day(-1) in February and 7 mg CH₄ m(-2) day (-1) in November. *Aquatic Sciences, 2010, V72, N4, SEP, pp 455-466* DOI: http://dx.doi.org/10.1007/s00027-010-0148-5.

11.1-234 Effects of wildfire on catchment runoff response: a modelling approach to detect changes in snow-dominated forested catchments

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Hydrology, Modelling, Forestry

Wildfire is an important disturbance affecting hydrological processes through alteration of vegetation cover and soil characteristics. The effects of fire on hydrological systems at the catchment scale are not well known, largely because site specific data from both before and after wildfire are rare. In this study a modelling approach was employed for change detection analyses of one such dataset to quantify effects of wildfire on catchment hydrology. Data from the Entiat Experimental Forest (Washington State, US) were used, a conceptual runoff model was applied for pre- and post-fire periods and changes were analyzed in three different ways: reconstruction of runoff series, comparison of model parameters and comparison of simulations using parameter sets calibrated to the two different periods. On average, observed post-fire peak flows were 120% higher than those modelled based on pre-fire conditions. For the post-fire period, parameter values for the snow routine indicated deeper snow packs and earlier and more rapid snowmelt. The net effect of the changes in all parameters was largely increased post-fire peak flows. Overall, the analyses show that change detection modelling provides a viable alternative to the paired-watershed approach for analyzing wildfire disturbance effects on runoff dynamics and supports discussions on changes in hydrological processes. *Hydrology Research, 2010, V41, N5, pp 378-390* DOI: http://dx.doi.org/10.2166/nh.2010.036.

11.1-235 Thermo-evaporative fluxes from heterogeneous porous surfaces resolved by infrared thermography

Shahraeeni E, Or D Switzerland

Hydrology, Meteorology & Atmospheric Sciences

Variations in evaporative fluxes from heterogeneous wet terrestrial surfaces may induce a dis-
distinct and spatially variable thermal signature detectable by modern infrared thermography (IRT) methods. Combining measured temperature distribution for an evaporative surface with surface energy balance offers a means for extraction of spatial and temporal distributions of evaporative flux as a function of surface temperature. Recent advances in IRT technology offer spatially resolved thermal images at unprecedented sensitivity for in situ estimation of surface evaporation flux distribution currently unobservable by other methods. We studied evaporation patterns from surfaces of initially saturated sand columns containing sharp vertical textural contrasts (fine-sand inclusion in coarse-sand background) to evaluate the performance of the proposed method. We examined several algorithms for model validation. Spatial and temporal IRT data are numerically inverted to obtain evaporation flux values that are compared with rates of mass loss from direct weighing of the samples. Analytical solutions of some special cases are also compared with the experimental data. We introduce a convenient approximation based on mean surface temperatures of similar textural regions to resolve spatial evaporative fluxes. Estimates are in good agreement with experimental results. Our results also confirm the occurrence of lateral capillary flows from coarse to fine sand in the presence of sharp heterogeneity during evaporation. The proposed method could under certain conditions be used to convert highly resolved temperature fields to deduce drying patterns of interest in various fields from hydrology to food processing and other engineering applications.


11.1-236
Debris-flow activity along a torrent in the Swiss Alps: Minimum frequency of events and implications for forest dynamics
Sorg A, Bugmann H, Bollschweiler M, Stoffel M
Switzerland
Geomorphology, Hydrology, Forestry, Plant Sciences
This study reports on a tree-ring-based reconstruction of geomorphic activity and illustrates impacts of such processes on tree germination along a debris-flow torrent in the Swiss Alps. Analysis included the identification of growth disturbances and the assessment of germination dates for 28 trees along the channel of the Geisstrifbach torrent (Valais, Swiss Alps). Provided that recolonizing trees indicate the minimum time elapsed since the last deposition, germination dates suggest that a devastating debris-flow event in the 1880s had cleared the surface and scoured the currently active channel. This interpretation is supported by two topographic maps showing a dislocation of the channel. Analyzing the age structure of trees along the channel in more detail, we observe higher tree ages with increasing distance from the cone apex. In addition, dendrogeomorphic methods allowed for the reconstruction of 13 debris-flow events between AD 1913 and 2006. In combination with geomorphic mapping, the spatial distribution of trees affected by individual events was assessed and a minimum frequency of previous debris-flow events reconstructed. Although the present study was based on a limited set of tree-ring records, it illustrates that tree-ring analysis in combination with cartographic methods holds much promise for dating minimum ages of surfaces cleared by destructive events as well as for determining the spatio-temporal impacts of past debris-flow activity.


11.1-237
Explicit simulations of stream networks to guide hydrological modelling in ungauged basins
Stoll S, Weiler M
Germany, Switzerland
Hydrology, Modelling
Rainfall-runoff modelling in ungauged basins is still one of the greatest challenges in hydrological research. The lack of discharge data necessitates the establishment of new innovative approaches to guide hydrological modelling in ungauged basins. Besides the transfer of calibrated parameters from similar gauged catchments, the application of distributed data as a hydrological response in addition to discharge seems to be promising. A new approach to guide hydrological modelling based on explicit simulation of the spatial stream network was tested in four different catchments in Germany. In a first step we used a simplified version of the process-based model Hill-Vi together with regional climate normals to simulate stream networks. The calculation of gravity driven lateral subsurface and groundwater flow is used to identify patterns of stream cells, which were compared to reference stream networks and their degree of spatial agreement was evaluated. Significant differences between good and poor simulations could be distinguished and the corresponding parameter sets relate well with the hydrogeological properties of the catchments. The optimized pa-
Parameters were subsequently used to simulate daily discharge using an observed time series of precipitation and air temperature. The performance was evaluated against observed discharge and water balance. This approach shows some promising results but also some limitations. Although the model’s parsimonious model structure could be further improved regarding discharge recession and evapotranspiration, the performance was similar to regionalisation methods. Stream network modelling, which has minimal data requirements, seems to be a reasonable alternative for model development and parameter evaluation in ungauged basins. 


11.1-238
Thermal Heterogeneity in River Floodplains
Tonolla D, Acuna V, Uehlinger U, Frank T, Tockner K
Germany, Switzerland, Spain
Hydrology, Remote Sensing, Ecology
River floodplains are composed of a shifting mosaic of aquatic and terrestrial habitats. Each habitat type exhibits distinct environmental and ecological properties. Temperature is a key property driving ecological processes and controlling the composition and distribution of biota. However, given the size and complexity of floodplains, ground surveys based on point measurements are spatially limited.

In this study, we applied thermal infrared (IR) imagery to quantify surface temperature patterns at 12-15 min intervals over 24 h cycles in two near-natural Alpine river floodplains (Roseg, Tagliamento). Furthermore, vertical temperature distribution was measured at 3-5 min intervals in unsaturated gravel sediment deposits (at 1 cm distances; 0-29 cm depth). Each habitat type exhibited a distinct thermal signature creating a complex thermal mosaic. The diel temperature pulse and maximum daily temperature were the main thermal components that differentiated habitat types. In both floodplains, exposed gravel sediments exhibited the highest diel pulse (up to 23A degrees C), whereas in aquatic habitats the pulse was as low as 11A degrees C (main channel in the Roseg floodplain). In the unsaturated gravel sediment deposits, the maximum diel kinetic temperature pulse ranged from 40.4A degrees C (sediment surface) to 2.7A degrees C (29 cm sediment depth). Vertically, the spatiotemporal variation of temperature was about as high as horizontally across the entire floodplain surface. This study emphasized that remotely sensed thermal IR imagery provides a powerful non-invasive method to quantitatively assess thermal heterogeneity of complex aquatic and terrestrial ecosystems at a resolution required to understand ecosystem processes and the distribution of biota.


11.1-239
The physico-chemical habitat template for periphyton in alpine glacial streams under a changing climate
Uehlinger U, Robinson C T, Hieber M, Zah R
Switzerland
Hydrology, Marine & Freshwater Biology, Zoology, Plant Sciences
The physico-chemical habitat template of glacial streams in the Alps is characterized by distinct and predictable changes between harsh and relatively benign periods. Spring and autumn were thought to be windows of favorable environmental conditions conducive for periphyton development. Periphyton biomass (measured as chlorophyll a and ash-free dry mass) was quantified in five glacial and three non-glacial streams over an annual cycle. One glacial stream was an outlet stream of a proglacial lake. In all glacial streams, seasonal patterns in periphyton were characterized by low biomass during summer high flow when high turbidity and transport of coarse sediment prevailed. With the end of icemelt in autumn, environmental conditions became more favorable and periphyton biomass increased. Biomass peaked between late September and January. In spring, low flow, low turbidity, and a lack of coarse sediment transport were not paralleled by an increase in periphyton biomass. In the non-glacial streams, seasonal periphyton patterns were similar to those of glacial streams, but biomass was significantly higher. Glacier recession from climate change may shift water sources in glacier streams and attenuate the glacial flow pulse. These changes could alter predicted periods of optimal periphyton development. The window of opportunity for periphyton accrual will shift earlier and extend into autumn in channels that retain surface flows.

Hydrobiologia, 2010, V657, N1, DEC, pp 107-121 DOI: http://dx.doi.org/10.1007/s10750-010-9963-x.

11.1-240
Flood risk mapping in Europe, experiences and best practices
van Alphen J, Martini F, Loat R, Slomp R, Passchier R
Netherlands, Switzerland
Hydrology, Water Resources, International Relations
Within the context of the European Flood Risk Management Directive, adopted in 2007, the Euro-
ean countries are required to prepare flood hazard and flood risk maps before 2014. The Exchange Circle on Flood Mapping (EXCIMAP) has made an inventory of flood mapping practices in Europe. This inventory has resulted in a ‘Handbook on Good Practices for flood mapping in Europe’ and an ‘Atlas of Flood maps containing examples from 19 European countries, Japan and USA’. This paper highlights the main conclusions of the EXCIMAP Handbook and Atlas, regarding the most appropriate ways to present flood-related information. Distinction is made between different types of use and users, such as land-use planning, emergency planning, flood risk management, reinsurance and the general public. Many countries disseminate flood maps (mainly flood extent maps) and flood hazard maps (depth or depth-velocity combinations) already via Internet. Many European rivers are part of transboundary water systems. Therefore, uniform approaches in flood (risk) assessments, map legend and presentation are urgently needed.


11.1-242
Shift of Spawning Season and Effects of Climate Warming on Developmental Stages of a Grayling (Salmonidae)
Wedekind C, Küng C
Switzerland
Marine & Freshwater Biology, Zoology, Biodiversity, Ecology
River-dwelling fish, such as European graylings (Thymallus thymallus), are susceptible to changes in climate because they can often not avoid sub-optimal temperatures, especially during early developmental stages. We analyzed data collected in a 62-year-long (1948-2009) population monitoring program. Male and female graylings were sampled about three times/week during the yearly spawning season in order to follow the development of the population. The occurrence of females bearing ripe eggs was used to approximate the timing of each spawning season. In the last years of the study, spawning season was more than 3 weeks earlier than in the first years. This shift was linked to increasing water temperatures as recorded over the last 39 years with a temperature logger at the spawning site. In early spring water temperatures rose more slowly than in later spring. Thus, embryos and larvae were exposed to increasingly colder water at a stage that is critical for sex determination and pathogen resistance in other salmonids. In summer, however, fry were exposed to increasingly warmer temperatures. The changes in water temperatures that we found embryos, larvae, and fry were exposed to could be contributing to the decline in abundance that has occurred over the last 30-40 years.


11.1-243
Water scarcity in inner-Alpine regions - options for sustainable water use in the region Crans-Montana-Sierre (Valais canton)
Switzerland
Water Resources, Hydrology
11.1-244
Impact of climate change on irrigation requirements in terms of groundwater resources
Zhou Y, Zwahlen F, Wang Y, Li Y
Switzerland, Peoples R China
Hydrology, Water Resources, Modelling, Agriculture
Climate change affects not only water resources but also water demand for irrigation. A large proportion of the world’s agriculture depends on groundwater, especially in arid and semi-arid regions. In several regions, aquifer resources face depletion. Groundwater recharge has been viewed as a by-product of irrigation return flow, and with climate change, aquifer storage of such flow will be vital. A general review, for a broad-based audience, is given of work on global warming and groundwater resources, summarizing the methods used to analyze the climate change scenarios and the influence of these predicted changes on groundwater resources around the world (especially the impact on regional groundwater resources and irrigation requirements). Future challenges of adapting to climate change are also discussed. Such challenges include water-resources depletion, increasing irrigation demand, reduced crop yield, and groundwater salinization. The adaptation to and mitigation of these effects is also reported, including useful information for water-resources managers and the development of sustainable groundwater irrigation methods. Rescheduling irrigation according to the season, coordinating the groundwater resources and irrigation demand, developing more accurate and complete modeling prediction methods, and managing the irrigation facilities in different ways would all be considered, based on the particular cases.


11.1-245
Consistency of global satellite-derived aerosol and cloud data sets with recent brightening observations
Cermak J, Wild M, Knutti R, Mishchenko M I, Heidinger A K
Switzerland, USA
Meteorology & Atmospheric Sciences
Solar radiation at the Earth surface has increased over land and ocean since about 1990 (‘global brightening’). An analysis of various global (ocean only) aerosol and (global) cloud data sets from geostationary and polar orbiting satellites is performed to determine whether changes in these quantities have occurred in accordance with ‘global brightening’, and to analyse the global distribution of these changes. Change-point detection and trend analysis are employed in the analysis. In a period from the mid-1980s to the mid-2000s, aerosol optical depth is found to have started declining in the early 1990s, while cloud data sets do not agree on trends. Angstrom exponent data seem to suggest changes in pollution.


1.6 Energy Balance

11.1-246
Verification of CM-SAF and MeteoSwiss satellite-based retrievals of surface shortwave irradiance over the Alpine region
Dürr B, Zelenka A, Müller R, Philipona R
Switzerland, Germany
Meteorology & Atmospheric Sciences, Remote Sensing
Verification results from different satellite-based surface shortwave irradiance retrievals and sensitivity runs for key input parameters are presented for the Alpine region. Overall the uncertainty of the hourly retrievals at the Federal Office of Meteorology and Climatology (MeteoSwiss) validated with high-quality surface measurements is comparable with results from the standard Heliosat-3 model, but clearly improved for situations with snow-cover. The sensitivity study reveals that it is recommended to precisely georeference the High Resolution Visible (HRV) and the Spinning Enhanced Visible and Infrared Imager (SEVIRI) channels of the Meteosat Second Generation (MSG) satellites to obtain accurate surface shortwave irradiance estimates. They also confirm the benefit of terrain corrections for sites located in deep Alpine valleys. Monthly mean shortwave irradiance
retrievals provided by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) Satellite Application Facility on Climate Monitoring (CM-SAF) are verified with the MeteoSwiss products. For the National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR)-based product about 60% of all satellite 15 km x 15 km grid cells match the MeteoSwiss product, if locally dependent 90% confidence intervals are applied. This percentage decreases to 52%, if the standard CM-SAF 90% confidence interval of 20 Wm-2 is used. Taking the local spatial variability of the shortwave irradiance field into account therefore allows obtaining more realistic verification results over heterogeneous terrain such as the Alpine region.


11.1-247
Solar influences on climate
England, Switzerland, Germany, USA, Netherlands
Meteorology & Atmospheric Sciences
Understanding the influence of solar variability on the Earth’s climate requires knowledge of solar variability, solar-terrestrial interactions, and the mechanisms determining the response of the Earth’s climate system. We provide a summary of our current understanding in each of these three areas. Observations and mechanisms for the Sun’s variability are described, including solar irradiance variations on both decadal and centennial time scales and their relation to galactic cosmic rays. Corresponding observations of variations in ozone, temperatures, winds, clouds, precipitation, and regional modes of variability such as the monsoons and the North Atlantic Oscillation. A discussion of the available solar and climate proxies is provided. Mechanisms proposed to explain these climate observations are described, including the effects of variations in solar irradiance and of charged particles. Finally, the contributions of solar variations to recent observations of global climate change are discussed.

11.1-248
Explicit validation of a surface shortwave radiation balance model over snow-covered complex terrain
Helbig N, Löwe H, Mayer B, Lehning M
Switzerland, Germany
Meteorology & Atmospheric Sciences, Modelling, Cryology / Glaciology
A model that computes the surface radiation balance for all sky conditions in complex terrain is presented. The spatial distribution of direct and diffuse sky radiation is determined from observations of incident global radiation, air temperature, and relative humidity at a single measurement location. Incident radiation under cloudless sky is spatially derived from a parameterization of the atmospheric transmittance. Direct and diffuse sky radiation for all sky conditions are obtained by decomposing the measured global radiation value. Spatial incident radiation values under all atmospheric conditions are computed by adjusting the spatial radiation values obtained from the parametric model with the radiation components obtained from the decomposition model at the measurement site. Incident radiation under cloudless sky is spatially derived from a parameterization of the atmospheric transmittance. Direct and diffuse sky radiation for all sky conditions are obtained by decomposing the measured global radiation value. Spatial incident radiation values under all atmospheric conditions are computed by adjusting the spatial radiation values obtained from the parametric model with the radiation components obtained from the decomposition model at the measurement site.

11.1-249
Review on Estimation of Land Surface Radiation and Energy Budgets From Ground Measurement, Remote Sensing and Model Simulations
USA, Peoples R China, Switzerland
Meteorology & Atmospheric Sciences, Remote Sensing, Modelling
Land surface radiation and energy budgets are critical components of any land surface models
that characterize hydrological, ecological and biogeochemical processes. The estimates of their components generated from remote sensing data or simulations from numerical models have large uncertainties. This paper provides a comprehensive review of recent advances in estimating insolation, albedo, clear-sky longwave downward and upwelling radiation, all-wave net radiation and evapotranspiration from ground measurements, remote sensing algorithms and products, as well as numerical model simulations. The decadal variations of these components are also discussed.

Relationship between high daily erythemal UV doses, total ozone, surface albedo and cloudiness: An analysis of 30 years of data from Switzerland and Austria


Switzerland, Austria, Finland

Meteorology & Atmospheric Sciences

This work investigates the occurrence frequency of days with high erythemal UV doses at three stations in Switzerland and Austria (Davos, Hoher Sonnblick and Vienna) for the time period 1974-2003. While several earlier studies have reported on increases in erythemal UV dose up to 10% during the last decades, this study focuses on days with high erythemal UV dose, which is defined as a daily dose at least 15% higher than for 1950s clear-sky conditions (which represent preindustrial conditions with respect to anthropogenic chlorine). Furthermore, the influence of low column ozone, clear-sky/partly cloudy conditions and surface albedo on UV irradiance has been analyzed on annual and seasonal basis. The results of this study show that in the Central Alpine Region the number of days with high UV dose increased strongly in the early 1990s. A large fraction of all days with high UV dose occurring in the period 1974-2003 was found especially during the years 1994-2003, namely 40% at Davos, 54% at Hoher Sonnblick and 65% at Vienna. The importance of total ozone, clear-sky/partly cloudy conditions and surface albedo (e.g. in dependence of snow cover) varies strongly among the seasons. However, overall the interplay of low total ozone and clear-sky/partly cloudy conditions led to the largest fraction of days showing high erythemal UV dose. Furthermore, an analysis of the synoptic weather situation showed that days with high erythemal UV dose, low total ozone and high relative sunshine duration occur at all three stations more frequently during situations with low pressure gradients or southerly advection.

Comparison of surface UV irradiance in mountainous regions derived from satellite observations and model calculations with ground-based measurements


Austria, Italy, Finland, England, Switzerland

Meteorology & Atmospheric Sciences, Modelling

Several UV data products derived from satellite measurements, 1-D and 3-D radiative transfer modeler are compared with high-quality ground-based measurements. Data products include the UV index, erythemally weighted daily dose and spectrally resolved UV irradiances at 305, 310, 324 and 380 nm. The study focuses on the UV radiation climate in mountainous terrain under cloud-free conditions. The results show, that overall the 3-D- and the 1-D-model agree best with the measurements (average ratio 1.10 and 1.13, range 0.88-1.6). It is also found that snow and local topography have a rather minor impact on ground UV-irradiance, while altitude plays a significant role >5%). Satellite-retrieved values significantly underestimate irradiance for most of our stations due to erroneous cloud correction (average ratio 0.89, range 0.6-1.35). However, if one compares the uncorrected (cloud-free) satellite-retrieved values to the measurements, the ratios are only slightly larger (average ratio 1.14, range 0.8 - 1.6) than for the 1-D- and 3-D-model. The main deficiencies arise in determining the correct surface height and albedo within the satellite-retrieval algorithm.
1.7 Coupled Systems and Cycles

11.1-252
Past, Present, and Future Controls on Levels of Persistent Organic Pollutants in the Global Environment
Norway, England, Switzerland, Spain, Italy, Denmark, Sweden, Germany, USA, Peoples R China
Geochemistry & Geophysics, Meteorology & Atmospheric Sciences, Pedology, Limnology

11.1-253
Statistical Analyses of Land-Atmosphere Feedbacks and Their Possible Pitfalls
Orlowsky B, Seneviratne S I
Switzerland
Meteorology & Atmospheric Sciences, Pedology, Hydrology, Modelling
In some regions of the world, soil moisture has a typical memory for atmospheric processes and can also feed back to the latter. Thus, a better understanding of feedbacks between soil moisture and the atmosphere could provide promising perspectives for increased seasonal predictability. Besides numerical simulations, statistical analysis of existing GCM simulations or observational data has been used to study such feedbacks. By referring to a recent statistical analysis of soil moisture-precipitation feedbacks in GCM simulations, the authors illustrate potential pitfalls of statistical approaches in this context: (i) most importantly, apparent soil moisture-precipitation feedbacks can often as well or even better be attributed to the influence of sea surface temperatures (SSTs) on precipitation and (ii) the discrepancy between different GCMs is large, which makes the aggregation of individual model results difficult. These aspects need to be carefully evaluated in statistical analyses of land-atmosphere coupling. Results for soil moisture-temperature feedbacks complement the precipitation analysis.

11.1-254
Trends and regional distributions of land and ocean carbon sinks
USA, England, Switzerland
Forestry, Oceanography, Meteorology & Atmospheric Sciences, Energy & Fuels
We show here an updated estimate of the net land carbon sink (NLS) as a function of time from 1960 to 2007 calculated from the difference between fossil fuel emissions, the observed atmospheric growth rate, and the ocean uptake obtained by recent ocean model simulations forced with reanalysis wind stress and heat and water fluxes. Except for interannual variability, the net land carbon sink appears to have been relatively constant at a mean value of -0.27 Pg C yr(-1) between 1960 and 1988, at which time it increased abruptly by -0.88 (-0.77 to -1.04) Pg C yr(-1) to a new relatively constant mean of -1.15 Pg C yr(-1) between 1989 and 2003/7 (the sign convention is negative out of the atmosphere). This result is detectable at the 99% level using a t-test. The land use source (LU) is relatively constant over this entire time interval. While the LU estimate is highly uncertain, this does imply that most of the change in the net land carbon sink must be due to an abrupt increase in the land sink, LS = NLS - LU, in response to some as yet unknown combination of biogeochemical and climate forcing. A regional synthesis and assessment of the land carbon sources and sinks over the post 1988/1989 period reveals broad agreement that the Northern Hemisphere land is a major sink of atmospheric CO2, but there remain major discrepancies with regard to the sign and magnitude of the net flux to and from tropical land.

11.1-255
Calcium isotope ratios in the world's largest rivers: A constraint on the maximum imbalance of oceanic calcium fluxes
Tipper E T, Gaillardet J, Galy A, Louvat P, Bickle M J, Capmas F
France, Switzerland, England
Hydrology, Oceanography, Geochemistry & Geophysics
The oceanic mass balance of calcium (Ca) is defined by a balance between the inputs (rivers and hydrothermal) and outputs (bulk carbonate) of Ca. Large rivers were analyzed for Ca isotope ratios (Ca-44/Ca-42, expressed as delta(44/42) Ca) to investigate the source and cycling of riverine Ca,
and to add an isotopic mass balance constraint to the oceanic budget of Ca. The new data account for approximately one-third of the total Ca supplied to the oceans by rivers. Intersample and seasonal variability was assessed by analyzing more than one sample for many rivers. The range in the delta(44/42) Ca of large rivers at high water stand is extremely narrow at 0.27%. Variations in delta(44/42) Ca do not correlate with proxies for carbonate, silicate or evaporite derived Ca, and are more likely related either to inherent variability in the lithological sources of Ca or to process related fractionation. The spread in riverine delta(44/42) Ca overlaps with the spread in marine limestone delta(44/42) Ca consistent with most riverine Ca coming from the recycling of limestones. The Ca isotope composition of continental runoff has an average delta(44/42) Ca value of 0.38 +/- 0.04%, identical to recent (5 M.yr) bulk carbonate ooze (0.33 +/- 0.13%, 2S.D.). Isotopic mass balance constrains that the input and output fluxes of Ca to and from the oceans, are balanced to within 15% over time-scales similar to the residence time of Ca in the oceans (1 M.yr). A greater imbalance between the fluxes would result in a detectable difference between the delta(44/42) Ca value of bulk carbonate and the riverine input at the current level of uncertainty. The input and output fluxes could be imbalanced over much shorter time-scales (such as glacial-interglacial cycles), in which case the ocean-carbonate system will not yet have responded, because of the long residence time of Ca. The maximum current flux imbalance of 15% would be sufficient to account for the total variations in Ca concentration over the Tertiary. Such an interpretation is not unique, but is the simplest interpretation given the similarity between the input and output isotopic compositions, and rules out hypotheses of extreme imbalance in the recent global biogeochemical cycle of Ca.


2 Past Global Changes

11.1-256
El Niño forcing on Be-10-based surface denudation rates in the northwestern Peruvian Andes?
Switzerland, Sweden, U Arab Emirates
Paleontology, Geomorphology, Hydrology, Meteorology & Atmospheric Sciences, Geochemistry & Geophysics, Landscape Studies
High magnitude precipitation events provide large contributions to landscape formation and surface denudation in arid environments. Here, we quantify the precipitation-dependent geomorphic processes within the Rio Piura drainage basin located on the Western Escarpment of the northern Peruvian Andes at 5 degrees S latitude. In this region, monsoonal easterly winds bring precipitation to the >3000 m asl high headwaters, from where the annual amount of precipitation decreases downstream toward the Pacific coast. Denudation rates are highest in the knickzones near the headwaters, similar to 200-300 mm ky(-1), and sediment discharge is limited by the transport capacity of the channel network. Every few years, this situation is perturbed by westerly, wind-driven heavy precipitation during El Niño events and results in supply-limited sediment discharge as indicated by bedrock channels. The detailed analysis of the stream-long profiles of two river basins within the Rio Piura catchment reveals a distinct knickzone in the transition zone between the easterly and westerly climatic influences, suggesting an El Nino forcing on the longitudinal channel profiles over at least Holocene timescales. Measured trunk stream catchment-wide denudation rates are up to ca. 300 mm ky(-1) and decrease successively downstream along the river profiles. Denudation rates of tributary rivers are ca. 200 mm ky(-1) near the plateau and show a stronger downstream decreasing trend than trunk stream rates. This suggests that the landscape is in a transient stage of local relief growth, which is driven by fluvial incision. This corroborates the results of paleoclimate studies that point towards higher El Nino frequencies during the past ca. 3000 years, leading to higher runoff and more erosion in the trunk channel compared to the hillslopes and thus growth of local relief. Downstream increases in channel gradient spatially coincide with the reaches of highest precipitation rates during El Nino events, we therefore interpret that Holocene landscape evolution has largely been controlled by climate. The ky-timescale of the Be-10 data together with
the transience of the landscape implies that El Nino events in northwestern Peru have occurred since at least the Holocene, and that adjustment to channel incision is still taking place. *Geomorphology, 2010, V123, N3-4, NOV 15, pp 257-268* DOI: http://dx.doi.org/10.1016/j.geomorph.2010.07.017.

11.1-257

Lake-level changes in central Patagonia (Argentina): crossing environmental thresholds for Lastglacial and Holocene human occupation

Switzerland, Argentina, USA
Paleontology, Limnology, Geochemistry & Geophysics, Hydrology

The role and extent of climate as a cause of the expansion and decline of human cultures is still debatable. It is clear, however, that human environment interactions are enhanced and interplay more closely in climatically sensitive areas such as around hydrologically closed basins. Lago Cardiel is located at 49 degrees S in the very arid rain shadow east of the Andes, providing an exceptionally receptive system to changes in hydrological balance. Results of a geophysical survey combined with sedimentological and geochemical studies provide a continuous Lastglacial-Holocene record of substantial water-level changes. These variations, combined with archaeological results from the catchment area, offer a unique possibility to explore the pattern of peopling within this remote area of the globe and its possible relation to climate change. Human occupation in Patagonia is well documented towards the Andes throughout the entire Holocene. Archiological data from the Lago Cardiel basin, however, show an apparent lack of human activity during the first part of this period, which coincides with well-constrained high lake levels. Our results show an intriguing coincidence between low lake level and increasing human occupation, suggesting that the Lago Cardiel basin has focused human use during intervals with relatively lower effective moisture such as during the Late Pleistocene, but its evidence may have been submerged. This interpretation is confirmed by archiological remains from Lago Strobel, another perennial lake with a comparable catchment located in the same climatic region and thus sharing the same climatic history as Lago Cardiel. *Journal of Quaternary Science, 2010, V25, N5, OCT, pp 711-721* DOI: http://dx.doi.org/10.1177/0959683609358912.

11.1-258

Effect of climatic and palaeoenvironmental changes on the occurrence of Holocene bats in the Swiss Alps

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Switzerland
Paleontology, Zoology, Ecology

A large-scale palaeozoological study compared 45 C-14-dated bat remains from the southern and northern Swiss Alps with palaeovegetational and paleoclimatic data. Four thermophilous (warm-demanding) and four psychrophilous (cold-tolerant) bat species, mainly forest dwellers, were selected for the study. Myotis blythii is the oldest bat species recorded in the Alps, i.e. on the southern side, going back to the early Holocene at 10 500 cal. BP. Our study showed that thermophilous species (e.g. Myotis bechsteinii and Rhinolophus hipposideros) were most abundant during the Holocene climatic optimum in Central Europe (10 000-4000 cal. BP), when warm-demanding mixed forests were dominant. Psychrophilous species such as Myotis brandtii also occurred during the climatic optimum, but most of the samples fall into the onset of the late Holocene (Sub-Atlantic period), when summer temperatures were already declining. These species declined in the southern Alps after 4000 cal. BP, when fire was intensively used by humans to convert portions of the forest into open land. This fire practice modified forest species composition and structure, with effects on forest-dwelling bat communities. We conclude that during the early and mid Holocene bat community compositions mainly depended on climate and related vegetation and forest structure dynamics. With increasing land use during the mid and late Holocene, anthropogenic changes of forest composition and creation of open habitats increasingly co-determined bat-population dynamics in the Alps. These Swiss findings are in agreement with previous results from eastern Central Europe. *Holocene, 2010, V20, N5, AUG, pp 711-721* DOI: http://dx.doi.org/10.1177/0959683609358912.

11.1-259

A 40 ka record of temperature and permafrost conditions in northwestern Europe from noble gases in the Ledo-Paniselian Aquifer (Belgium)

Switzerland, Belgium, Germany
Paleontology, Hydrology, Cryology / Glaciology, Meteorology & Atmospheric Sciences

The Ledo-Paniselian Aquifer in Belgium offers unique opportunities to study periglacial ground-
water recharge during the Last Glacial Maximum (LGM), as it was located close to the southern boundary of the ice sheets at that time. Groundwater residence times determined by C-14 and He-4 reveal a sequence of Holocene and Pleistocene groundwater and a gap between about 14 and 21 ka, indicating permafrost conditions which inhibited groundwater recharge. In this paper, a dataset of noble gas measurements is used to study the climatic evolution of the region. The derived recharge temperatures indicate that soil temperatures in the periods just before and after the recharge gap were only slightly above freezing, supporting the hypothesis that permafrost caused the recharge gap. The inferred glacial cooling of 9.5 degrees C is the largest found so far by the noble gas method. Yet, compared to other paleoclimatic reconstructions for the region, recharge temperatures deduced from noble gases for the cold periods tend to be rather high. Most likely, this is due to soil temperatures being several degrees higher than air temperatures during periods with extended snow cover. Thus the noble gas-derived glacial cooling of 9.5 degrees C is only a lower limit of the maximum cooling during the LGM. Some samples younger than the recharge gap are affected by degassing, possibly related to gas production during recharge in part of the recharge area, especially during times of melting permafrost. The findings of this study, such as the occurrence of a recharge gap and degassing related to permafrost and its melting, are significant for groundwater dynamics and geochemistry in periglacial areas.


11.1-260
Lake Malawi sediment and pore water chemistry: Proposition of a conceptual model for stratification intensification since the end of the Little Ice Age
Branchu P, Bergonzini L, Pons Branchu E, Violier E, Dittrich M, Massault M, Ghaleb B
Canada, France, Switzerland
Paleontology, Limnology, Hydrology, Geochemistry & Geophysics, Modelling

Sedimentary records of salinity indicators are largely used to reconstruct past climatic changes in lacustrine systems where chemistry is sensitive to hydroclimatic conditions. In large fresh lakes of the East African Rift such as Lakes Tanganyika and Malawi, salinity is often considered constant and other paleoclimatological proxy data are used. However, a relation between lake surface chloride concentration and hydroclimatic regime was previously demonstrated at the century scale in Lake Tanganyika. This relation is transposed to Lake Malawi on the basis of similarity between hydrochemical budgets of both lakes that are computed for the whole lake and epilimnion. Whereas numerous physico-chemical difficulties make generally debatable use of lake pore water chemistry, as illustrated here by diffusion modelling, the dissolved chloride concentration profile from a core sampled in northern Lake Malawi is considered as a potential indicator of limnological-hydroclimatic condition changes for the last 200 years. A decrease in pore water chloride concentration between 1840 AD and present situation is directly associated to a metalimnetic water salinity decrease. The chronology of this event is synchronous with diatom productivity change demonstrated by Johnson et al. (2001) at the end of the Little Ice Age (LIA). A conceptual model of Lake Malawi, based on salinity, organic carbon and its “dead” watershed contribution, lake-level and productivity changes since the mid 19th century is presented. A new scenario is proposed, based on thermal stratification reinforcement at the end of the LIA. Lake productivity and chemistry depend on stratification strength, water column mixing rate and on climatic variability. During the LIA, nutrient distribution profiles were more homogeneous with depth due to the climatically (colder and drier climatic conditions than today) induced desaturation of the mixing barrier. The productive system is then auto-supplied and does not require external silicon supply while chloride concentration is higher due to closure of the basin. Stratification has become more stable since the end of the LIA, as in nearby Lake Tanganyika where it is linked to air temperature global increase. Results demonstrated that chloride is a suitable indicator of the present and past hydroclimatic and hydrodynamic regimes. This work shows that in Lake Malawi, assessment of “dead” carbon (or old “refractive watershed carbon”) contribution to the TOC is a key parameter to set chronological frame from C-14 ages.


11.1-261
Smithian (Early Triassic) ammonoids from Tulong, South Tibet
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Paleontology, Zoology, Biodiversity, Marine & Freshwater Biology
Intensive sampling of the Tulong Formation in South Tibet has facilitated the construction of a highly-resolved middle and late Smithian ammonoid succession. The new biostratigraphical sequence comprises the middle Smithian Brayardites compressus beds, Nammalites pilatoides beds, and the Nyalamites angustecostatus beds followed by the late Smithian Wasatchites distractus beds and Glyphophyceras sinuatum beds. This faunal succession correlates very well with that of other Tethyan sequences such as the Salt Range (Pakistan), Spiti (India), Oman and South China. The Smithian faunal sequence from Tulong contains several taxa with broad geographic distribution (e.g., Owenites, Paranannites spathi, Shigetaceras, Wasatchites), thus enabling correlation with faunal successions from areas outside the Tethys (e.g., USA, British Columbia, Arctic Canada, South Primorye, Siberia). Early Smithian ammonoid faunas are almost absent in Tulong because of a preservation bias (absence of carbonate rocks). Five new ammonoid genera (Brayardites, Nammalites, Nyalamites, Shigetaceras, Tulongites) and six new species (Brayardites crassus, Brayardites compressus, Prionites involutus, Subflemingites compressus, Tulongites xiaoqiaoi, Urdyceras tulongensis) are described.


11.1-262

Glacial/interglacial changes in nutrient supply and stratification in the western subarctic North Pacific since the penultimate glacial maximum
USA, Switzerland, Germany
Paleontology, Oceanography, Geochemistry & Geophysics
In piston cores from the open subarctic Pacific and the Okhotsk Sea, diatom-bound delta N-15 (delta N-15(db)), biogenic opal, calcium carbonate, and barium were measured from coretop to the previous glacial maximum (MIS 6). Glacial intervals are generally characterized by high delta N-15(db) (similar to 8 parts per thousand) and low productivity, whereas interglacial intervals have a lower delta N-15(db) (5.7-6.3 parts per thousand) and indicate high biogenic productivity. These data extend the regional swath of evidence for nearly complete surface nutrient utilization during glacial maxima, consistent with stronger upper water column stratification throughout the subarctic region during colder intervals. An early deglacial decline in delta N-15(db) of 2 parts per thousand at similar to 17.5 ka, previously observed in the Bering Sea, is found here in the open subarctic Pacific record and arguably also in the Okhotsk, and a case can be made that a similar decrease in delta N-15(db) occurred in both regions at the previous deglaciation as well. The early deglacial delta N-15(db) decrease, best explained by a decrease in surface nutrient utilization, appears synchronous with southern hemisphere-associated deglacial changes and with the Heinrich 1 event in the North Atlantic. This delta N-15(db) decrease may signal the initial deglacial weakening in subarctic North Pacific stratification and/or a deglacial increase in shallow subsurface nitrate concentration. If the former, it would be the North Pacific analogue to the increase in vertical exchange inferred for the Southern Ocean at the time of Heinrich Event 1. In either case, the lack of any clear change in palaeoproductivity proxies during this interval would seem to require an early deglacial decrease in the iron-to-nitrate ratio of subsurface nutrient supply or the predominance of light limitation of phytoplankton growth during the deglaciation prior to Bolling-Allerod warming.


11.1-263

Environmental change without climate change?
Buentgen U, Schweingruber F H
Switzerland
Ecology, Plant Sciences, Forestry, Meteorology & Atmospheric Sciences

11.1-264

Reconstruction of global Be-10 production over the past 250 ka from highly accumulating Atlantic drift sediments
Christl M, Lippold J, Steinhalber F, Bernsdorff F, Mangini A
Switzerland, Germany
Paleontology, Geology, Geochemistry & Geophysics, Oceanography
In this study we present a reconstruction of the global Be-10 production rate over the past 250,000 years from three marine sediment cores located in high accumulation environments in the North-, northwest-, and South Atlantic Ocean (ODP Sites 983, 1063 and 1089). The Be-10 records are corrected for oceanic transport processes and Principal
Component Analysis (PCA) is used to extract the common signal from the three records, which we interpreted as variations of the global Be-10 production rate. The reconstruction presented here may serve as (i) a record of past flux of Galactic Cosmic Rays (GCR), (ii) a proxy for past geomagnetic dipole strength, and (iii) as a global matching tool to synchronize marine archives with ice cores and terrestrial records.  


11.1-265
Six millennia of summer temperature variation based on midge analysis of lake sediments from Alaska

USA, Canada, Switzerland

Paleontology , Limnology , Meteorology & Atmospheric Sciences , Geology , Marine & Freshwater Biology

Despite their importance for evaluating anthropogenic climatic change, quantitative temperature reconstructions of the Holocene remain scarce from northern high-latitude regions. We conducted high resolution midge analysis on the sediments of the past 6000 years from a lake in south-central Alaska. Results were used to estimate mean July air temperature (TJuly) variations on the basis of a midge temperature transfer function. The TJuly estimates from the near-surface samples are broadly consistent with instrumental and treering-based temperature data. Together with previous studies, these results suggest that midge assemblages are more sensitive to small shifts in summer temperature (similar to 0.5 °C) than indicated by the typical error range of midge temperature transfer functions (similar to 1.5 °C). A piecewise linear regression analysis identifies a significant change point at ca 4000 years before present (cal BP) in our TJuly record, with a decreasing trend after this point. Episodic TJuly peaks (similar to 14.5 °C) between 5500 and 4200 cal BP and the subsequent climatic cooling may have resulted from decreasing summer insolation associated with the precessional cycle. Centennial-scale climatic cooling of up to 1 °C occurred around 4000, 3300, 1800-1300, 600, and 230 cal BP. These cooling events were more pronounced and lasted longer during the last two millennia than between 2000 and 4000 cal BP. Some of these events have counterparts in climatic records from elsewhere in Alaska and other regions of the Northern Hemisphere, including several roughly synchronous with known grand minima in solar irradiance. Over the past 2000 years, our TJuly record displays patterns similar to those inferred from a wide variety of temperature proxy indicators at other sites in Alaska, including fluctuations coeval with the Little Ice Age, the Medieval Climate Anomaly, and the First Millennial Cooling (centered around 1400 cal BP). To our knowledge, this study offers the first high-resolution, quantitative record of summer temperature variation that spans longer than the past 2000 years from the high-latitude regions around the North Pacific.  


11.1-266
Bentho-planktonic evidence from the Austrian Alps for a decline in sea-surface carbonate production at the end of the Triassic

France, Switzerland

Paleontology , Oceanography , Marine & Freshwater Biology, Geology, Geochemistry & Geophysics

A high-resolution micropalaeontological study, combined with geochemical and sedimentological analyses was performed on the Tiefengraben, Schlossgraben and Eiberg sections (Austrian Alps) in order to characterize sea-surface carbonate production during the end-Triassic crisis. At the end-Rhaetian, the dominant calcareous nannofossil Priniosphaera triassica shows a decrease in abundance and size and this is correlated with an increase in delta O-18 and a gradual decline in delta C-13(carb) values. Simultaneously, benthic foraminiferal assemblages show a decrease in diversity and abundance of calcareous taxa and a dominance of infaunal agglutinated taxa. The smaller size of calcareous nannofossils disturbed the vertical export balance of the biological carbon pump towards the sea-bottom, resulting in changes in feeding strategies within the benthic foraminiferal assemblages from deposit feeders to detritus feeders and bacterial scavengers. These micropalaeontological data combined with geochemical proxies suggest that changes in seawater chemistry and/or cooling episodes might have occurred in the latest Triassic, leading to a marked decrease of carbonate production. This in turn culminated in the quasi-absence of calcareous nannofossils and benthic foraminifers in the latest Triassic. The aftermath (latest Triassic earliest Jurassic) was characterised by abundance peaks of “disaster” epifaunal agglutinated foraminifera Trochammina on the sea-floor. Central Atlantic
Species responses to fire, climate and human impact at tree line in the Alps as evidenced by palaeoenvironmental records and a dynamic simulation model

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Switzerland
Paleontology, Forestry, Plant Sciences, Modelling, Geology

1. We use high-resolution records of macroscopic charcoal and plant remains from sediments of a lake in the Swiss Alps (Gouille Rion, 2343 m a.s.l.) to reconstruct local fire variability and vegetation dynamics over the last 12 000 years. 2. Species response to fire variability and to summer temperature was obtained by combining regression analyses between contiguous series of plant macrofossils, macroscopic charcoal and an available reconstruction of past summer temperature. 3. With a dynamic landscape vegetation model (LandClim), we simulated fire regimes using two levels of ignition frequency and moisture availability to disentangle the role of climate vs. humans on fire occurrence. The simulation results show that human disturbance was relevant in controlling the fire variability and are in agreement with pollen evidence of human impact from previous studies from Gouille Rion. 4. Our results show that fire is a natural disturbance agent in the tree line ecotone. Biomass availability controlled the fire regime until increased land use and anthropogenic fire during the past 4000 years changed species composition and vegetation structure close to the tree line. 5. Important species at the tree line ecotone such as Pinus cembra greatly benefitted from periods with temperature above the modern mean July temperature, if anthropogenic fire disturbance was not too severe, such as during the Bronze Age (c. 4000 cal. years bp). 6. When mean July temperatures were lower than modern mean July values, Juniperus nana and Larix decidua were at an advantage over P. cembra. With increasing anthropogenic fire, open lands with J. nana replaced L. decidua and P. cembra forest stands. 7. Synthesis. Fire activity was low to moderate during the early and mid-Holocene. Intensified land use coupled with fire occurrence since the Bronze Age (c. 4000 cal. years bp) had a larger impact on species composition near the tree line than climate change. Although climate change will alter vegetation composition, future dynamics of mountain forests will be co-determined by anthropogenic fire. For example, high fire variability may impede upslope establishment of forests in response to climatic warming as expected for this century, with serious implications for forest diversity.


Indian Summer Monsoon variations could have affected the early-Holocene woodland expansion in the Near East

Paleontology, Forestry, Plant Sciences, Meteorology & Atmospheric Sciences

Postglacial expansion of deciduous oak woodlands of the Zagros-Anti-Taurus Mountains, a major biome of the Near East, was delayed until the middle Holocene at similar to 6300 cal yr BP. The current hypotheses explain this delay as a consequence of a regional aridity during the early Holocene, slow migration rates of forest trees, and/or a long history of land use and agro-pastoralism in this region. In the present paper, support is given to a hypothesis that suggests different precipitation seasonalities during the early Holocene compared with the late Holocene. The oak species of the Zagros-Anti-Taurus Mts, particularly Quercus brantii Lindl., are strongly dependent on spring precipitation for regeneration and are sensitive to a long dry season. Detailed analysis of modern atmospheric circulation patterns in SW Asia during the late spring suggests that the Indian Summer Monsoon (ISM) intensification can modify the amount of late spring and/or early summer rainfall in western/northwestern Iran and eastern Anatolia, which could in turn have controlled the development of the Zagros-Anti-Taurus deciduous oak woodlands. During the early Holocene, the northwestward shift of the InterTropical Convergence Zone (ITCZ) could have displaced the subtropical anticyclonic belt or associated high pres...
sure ridges to the northwest. The latter could, in turn, have prevented the southeastward penetration of low pressure systems originating from the North Atlantic and Black Sea regions. Such atmospheric configuration could have reduced or eliminated the spring precipitation creating a typical Mediterranean continental climate characterized by winter-dominated precipitation. This scenario highlights the complexity of biome response to climate system interactions in transitional climatic and biogeographical regions.


11.1-269
Holocene land-cover reconstructions for studies on land cover-climate feedbacks
Sweden, Estonia, France, Switzerland, Denmark, Germany, England, Finland, Lithuania, Norway, Latvia, Poland
Paleontology, Forestry, Plant Sciences, Modelling, Landscape Studies
The major objectives of this paper are: (1) to review the pros and cons of the scenarios of past anthropogenic land cover change (ALCC) developed during the last ten years, (2) to discuss issues related to pollen-based reconstruction of the past land cover and introduce a new method, REVEALS (Regional Estimates of V(E)getation Abundance from Large Sites), to infer long-term records of past land-cover from pollen data, (3) to present a new project (LANDCLIM: LAND cover - CLIMate interactions in NW Europe during the Holocene) currently underway, and show preliminary results of REVEALS reconstructions of the regional land-cover in the Czech Republic for five selected time windows of the Holocene, and (4) to discuss the implications and future directions in climate and vegetation/land-cover modeling, and in the assessment of the effects of human-induced changes in land-cover on the regional climate through altered feedbacks. The existing ALCC scenarios show large discrepancies between them, and few cover time periods older than AD 800. When these scenarios are used to assess the impact of human land-use on climate, contrasting results are obtained. It emphasizes the need for methods such as the REVEALS model-based land-cover reconstructions. They might help to fine-tune descriptions of past land-cover and lead to a better understanding of how long-term changes in ALCC might have influenced climate. The REVEALS model is demonstrated to provide better estimates of the regional vegetation/land-cover changes than the traditional use of pollen percentages. This will achieve a robust assessment of land cover at regional- to continental-spatial scale throughout the Holocene. We present maps of REVEALS estimates for the percentage cover of 10 plant functional types (PFTs) at 200 BP and 6000 BP, and of the two open-land PFTs ‘grassland’ and ‘agricultural land’ at five time-windows from 6000 BP to recent time. The LANDCLIM results are expected to provide crucial data to reassess ALCC estimates for a better understanding of the land surface-atmosphere interactions.

11.1-270
Middle and late Cenomanian oceanic anoxic events in shallow and deeper shelf environments of western Morocco
USA, Switzerland, Egypt, Germany, Netherlands
Paleontology, Oceanography, Geology
The response of shallow-water sequences to oceanic anoxic event 2 and mid-Cenomanian events 1a and 1b was investigated along the west African margin of Morocco north of Agadir (Azazoul) and correlated with the deep-water sequence of the Tarfaya Basin (Mohammed Beach) based on biostratigraphy, mineralogy, phosphorus and stable isotopes. In the deeper Mohammed Beach section results show double peaks in delta 13C for mid-Cenomanian events 1a and 1b (Rotalipora ritchelii biozone, lower CC10a biozone), the characteristic oceanic anoxic event 2 delta 13C excursion (Rotalipora cushmani extinction, top of CC10a biozone) and laminated (anoxic) black shale. In the shallow environment north of Agadir, a fluctuating sea-level associated with dysoxic, brackish and mesotrophic conditions prevailed during the middle to late Cenomanian, as indicated by oyster biostromes, nannofossils, planktonic and benthonic foraminiferal assemblages. Anoxic conditions characteristic of oceanic anoxic event 2 (for example, laminated black shales) did not reach into shallow-water environments until the maximum transgression of the early Turonian. Climate conditions decoupled along the western margin of Morocco between mid-Cenomanian event 1b and
the Cenomanian-Turonian boundary, as also observed in eastern Tethys. North of Agadir alternating humid and dry seasonal conditions prevailed, whereas in the Tarfaya Basin the climate was dry and seasonal. This climatic decoupling can be attributed to variations in the Intertropical Convergence Zone and in the intensity of the north-east trade winds in tropical areas. *Sedimentology, 2010, V57, N6, OCT, pp 1430-1462 DOI: http://dx.doi.org/10.1111/j.1365-3091.2010.01151.x.*

### 11.1-271

**From early pollen trapping experiments to the Pollen Monitoring Programme**

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*Paleontology, Plant Sciences, Forestry*

Pollen monitoring has become a standard investigation method for researchers in several disciplines; among them are Quaternary palynologists, who conduct experiments in order to gain insights that will help to interpret the content of pollen in sediments. A review of the literature shows how these experiments diversified during the 1920s and 1930s with an array of different research questions, ranging from pollination biology to hay fever studies. Quaternary palynologists gained renewed interest with the possibility of radiocarbon dating late Quaternary sediments and obtaining accumulation rates. Also, the comprehensive model of pollen deposition and the pollen budget studies by H. Tauber encouraged researchers to conduct similar experiments using the same type of pollen trap, which became the main trapping device for Quaternary palynologists. The high precipitation in the tropics inspired the development of alternative designs. The equipment used to assess the pollen content in the air has evolved from simple gravity devices to different types of apparatus using a vacuum pump or revolving rods that collect the pollen on impact. Silicone impregnated filters exposed perpendicularly to the wind can also yield a volumetric assessment and have proven useful in areas with a low content of pollen in the air. The literature review is followed by a brief account of the developments which established the basis for the formation of a group of scientists monitoring the pollen deposition at a network of sites using standard pollen traps, the Pollen Monitoring Programme (PMP). Over the last 15 years the network has collected a large dataset, which is now available to answer a number of research questions. A summary of selected regions and environments, for which pollen monitoring results are available, is provided to serve as a complement to the investigations mentioned above and to provide an overview that may stimulate new research. *Vegetation History and Archaeobotany, 2010, V19, N4, SI, AUG, pp 247-258 DOI: http://dx.doi.org/10.1007/s00334-010-0261-3.*

### 11.1-272

**Towards quantitative palynology: using pollen accumulation rates and models of pollen dispersal**

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*Paleontology, Plant Sciences, Forestry*

Pollen monitoring has become a standard investigation method for researchers in several disciplines. In our record, reduced mixing with northern-source water (NSW) mass like modern NADW at the deeper part of Blake Ridge at any time between 45 and 35 ka. This is fundamentally different from the hydrographic situation during the Holocene where NADW extends below 4500 m at this location. The epsilon(Nd) of past seawater derived from authigenic Fe-Mn oxyhydroxides recovered from drift sediments on the Blake Ridge in the deep western North Atlantic (ODP Leg 172, Site 1060, 3481 m water depth). The data cover the period from 45 to 35 ka BP, tracing circulation changes during major Heinrich iceberg discharge event 4 (H1, similar to 40-39 ka BP). The Nd isotope record suggests that there was no northern-source water (NSW) mass like modern NADW at the deeper part of Blake Ridge at any time between 45 and 35 ka. This is fundamentally different from the hydrographic situation during the Holocene where NADW extends below 4500 m at this location. The epsilon(Nd) of past deep water recorded in the Blake Ridge sediments was least radiogenic during Dansgaard/Oeschger (D/O) Interstadial (IS) 8 (epsilon(Nd) = -11.3) and most radiogenic immediately preceding IS 9 (epsilon(Nd) = -9.8). More radiogenic compositions were also recorded during H1 (epsilon(Nd) <= -9.9). The Nd isotope variability in MIS 3 matches that of a physical bottom current strength reconstruction from the same location. Neither record follows the pattern of Northern Hemisphere D/O climatic cycles. In our record, reduced mixing with north-
ern source waters started in stadial 12 and lasted until after H 4 in stadial 9, followed by a rapid increase in NSW contribution thereafter. This major change in the Nd isotope record predates the iceberg discharge event Heinrich 4 by more than 3 ka indicating a shallowing of the water mass boundary between Glacial North Atlantic Intermediate Water and Southern Source Water beneath. This early change in bottom water properties at the deep Blake Ridge suggests that North Atlantic deep water advection may already have decreased several thousand years before the actual iceberg discharge event and associated freshening of the surface waters in the North Atlantic. The change can thus not be attributed to climatic events in the North Atlantic but may be related to changes in flux of deep water from the South.


11.1-274
Interhemispheric coupling, the West Antarctic Ice Sheet and warm Antarctic interglacials
England, Switzerland
Paleontology, Meteorology & Atmospheric Sciences, Cryology / Glaciology, Modelling, Oceanography
Ice core evidence indicates that even though atmospheric CO₂ concentrations did not exceed similar to 300 ppm at any point during the last 800 000 years, East Antarctica was at least similar to 3-4 °C warmer than preindustrial (CO₂ similar to 280 ppm) in each of the last four interglacials. During the previous three interglacials, this anomalous warming was short lived (similar to 3000 years) and apparently occurred before the completion of Northern Hemisphere deglaciation. Hereafter, we refer to these periods as ‘Warmer than Present Transients’ (WPTs). We present a series of experiments to investigate the impact of deglacial meltwater on the Atlantic Meridional Overturning Circulation (AMOC) and Antarctic temperature. It is well known that a slowed AMOC would increase southern sea surface temperature (SST) through the bipolar seesaw and observational data suggests that the AMOC remained weak throughout the terminations preceding WPTs, strengthening rapidly at a time which coincides closely with peak Antarctic temperature. We present two 800 kyr transient simulations using the Intermediate Complexity model GENIE-I which demonstrate that meltwater forcing generates transient southern warming that is consistent with the timing of WPTs, but is not sufficient (in this single parameterisation) to reproduce the magnitude of observed warmth. In order to investigate model and boundary condition uncertainty, we present three ensembles of transient GENIE-I simulations across Termination II (135 000 to 124 000 BP) and three snapshot HadCM3 simulations at 130 000 BP. Only with consideration of the possible feedback of West Antarctic Ice Sheet (WAIS) retreat does it become possible to simulate the magnitude of observed warming.

11.1-275
Amazonia Through Time: Andean Uplift, Climate Change, Landscape Evolution, and Biodiversity
Netherlands, Venezuela, Colombia, Spain, Brazil, Panama, USA, Switzerland, England
Paleontology, Forestry, Landscape Studies, Geology, Biodiversity
The Amazonian rainforest is arguably the most species-rich terrestrial ecosystem in the world, yet the timing of the origin and evolutionary causes of this diversity are a matter of debate. We review the geologic and phylogenetic evidence from Amazonia and compare it with uplift records from the Andes. This uplift and its effect on regional climate fundamentally changed the Amazonian landscape by reconfiguring drainage patterns and creating a vast influx of sediments into the basin. On this “Andean” substrate, a region-wide edaphic mosaic developed that became extremely rich in species, particularly in Western Amazonia. We show that Andean uplift was crucial for the evolution of Amazonian landscapes and ecosystems, and that current biodiversity patterns are rooted deep in the pre-Quaternary.

11.1-276
Vegetation and fire history of the Euganean Hills (Colli Euganei) as recorded by Lateglacial and Holocene sedimentary series from Lago della Costa (northeastern Italy)
Kaltenrieder P, Procacci G, Vanniere B, Tinner W
Switzerland, Italy, France
Paleontology, Limnology, Geology, Plant Sciences, Forestry
We reconstruct the vegetation and fire history of the Colli Euganei and northeastern Po Plain from c. 16 500 cal. BP to the present using AMS-dated sedimentary pollen, microscopic and macroscopic charcoal records. Our study site, Lago della Costa, is the only natural water basin with an undisturbed late-Quaternary sediment accumulation in the northeastern Po Plain. Mixed coniferous-deciduous forests occurred since at latest 14 500 cal. BP. Gradual expansion of e.g. Alnus glutinosa and Carpinus betulus is documented after c. 11 000 cal. BP. A further expansion of Abies alba and Alnus at 9200 cal. BP coincided with a population buildup of these species in the Insular region c. 200 km northwest of our site. A further increase of Alnus about 6400 cal. BP was accompanied by an expansion of Castanea sativa and Juglans regia as well as meadow and field plants. This vegetational change was contemporaneous with a huge increase of regional and local fire activity. Our data suggest that fire disturbance favoured strong and moderate re-sprouters, e.g. Alnus, Carpinus and Castanea, whereas fire-sensitive taxa, e.g. Tilia and Abies were disadvantaged. The close link between crops, weeds and fire activity suggests human impact as the main source of changes in Neolithic vegetation and fire regime. To our knowledge these are the oldest palaeobotanical data suggesting the cultivation of Castanea and Juglans in Europe and elsewhere. Our pollen and charcoal records document the subsequent cultivation of Castanea, Juglans, Olea and Cerealia t. during the Bronze Age (4150-2750 cal. BP). Subsequently, intensification of land use continued during the Iron and Roman Age and Medieval times. In contrast with other northern Italian sites vegetation around our site was always rather open with a substantial proportion covered by grassland. We explain this peculiarity of the site by its location near river banks and floodlands.


11.1-277
 Modeling the epidemiological history of plague in Central Asia: Palaeoclimatic forcing on a disease system over the past millennium

Norway, England, Germany, Switzerland, Belgium, Denmark, Peoples R China
Paleontology, Human & Public Health, Medicine, Meteorology & Atmospheric Sciences, Microbiology, Zoology

Background: Human cases of plague (Yersinia pestis) infection originate, ultimately, in the bacterium’s wildlife host populations. The epidemiological dynamics of the wildlife reservoir therefore determine the abundance, distribution and evolution of the pathogen, which in turn shape the frequency, distribution and virulence of human cases. Earlier studies have shown clear evidence of climatic forcing on contemporary plague abundance in rodents and humans. Results: We find that high-resolution palaeoclimatic indices correlate with plague prevalence and population density in a major plague host species, the great gerbil (Rhombomys opimus), over 1949-1995. Climate-driven models trained on these data predict independent data on human plague cases in early 20th-century Kazakhstan from 1904-1948, suggesting a consistent impact of climate on large-scale wildlife reservoir dynamics influencing human epidemics. Extending the models further back in time, we also find correspondence between their predictions and qualitative records of plague epidemics over the past 1500 years. Conclusions: Central Asian climate fluctuations appear to have had significant influences on regional human plague frequency in the first part of the 20th century, and probably over the past 1500 years. This first attempt at ecoepidemiological reconstruction of historical disease activity may shed some light on how long-term plague epidemiology interacts with human activity. As plague activity in Central Asia seems to have followed climate fluctuations over the past centuries, we may expect global warming to have an impact upon future plague epidemiology, probably sustaining or increasing plague activity in the region, at least in the rodent reservoirs, in the coming decades.


11.1-278
Ammonium concentration in ice cores: A new proxy for regional temperature reconstruction

Kellerhals T, Bruetsch S, Sigl M, Knuesel S, Gaeggeler H W, Schwikowski M
Switzerland
Paleontology, Cryology / Glaciology, Meteorology & Atmospheric Sciences, Hydrology

We present a reconstruction of tropical South American temperature anomalies over the last similar to 1600 years. The reconstruction is based on a highly resolved and carefully dated ammonium record from an ice core that was drilled in 1999 on Nevado Illimani in the eastern Bolivian Andes. Concerning the relevant processes governing the observed correlation between ammonium concentrations and temperature anomalies, we discuss anthropogenic emissions, biomass burn-
ing, and precipitation changes but clearly favor a temperature-dependent source strength of the vegetation in the Amazon Basin. That given, the reconstruction reveals that Medieval Warm Period- and Little Ice Age-type episodes are distinguishable in tropical South America, a region for which until now only very limited temperature proxy data have been available. For the time period from about 1050 to 1300 AD, our reconstruction shows relatively warm conditions that are followed by cooler conditions from the 15th to the 18th century, when temperatures dropped by up to 0.6 degrees C below the 1961-1990 average. The last decades of the past millennium are characterized again by warm temperatures that seem to be unprecedented in the context of the last similar to 1600 years.


11.1-279
CO2 and O-2/N-2 variations in and just below the bubble-clathrate transformation zone of Antarctic ice cores
Switzerland, Germany, France
Paleontology, Cryology / Glaciology, Meteorology & Atmospheric Sciences
CO2 measurements on the EPICA (European Project for Ice Coring in Antarctica) DML ice core in depth levels just below the bubble ice-clathrate ice transformation zone (1230-2240 m depth) were performed. In the youngest part (1230-1600 m), they reveal variations of up to 25 ppmv around the mean atmospheric concentration within centimetres, corresponding to a snow deposition interval of a few years. Similar results are found at corresponding depth regions of the Dome C and the Tabs Dome ice cores. Since we can exclude all hitherto known processes altering the concentration of CO2 in ice cores, we present a hypothesis about spatial fractionation of air components related to episodically increasing clathrate formation followed by diffusion processes from bubbles to clathrates. This hypothesis is supported by optical line-scan observations and by O-2/N-2 measurements at the same depth where strong CO2 variations are detected. Below the clathrate formation zone, this small-scale fractionation process is slowly smoothed out, most likely by diffusion, regaining the initial mean atmospheric concentration. Although this process compromises the representativeness of a single CO2 measurement on small ice samples in the clathrate formation zone of an ice core, it does not affect the mean atmospheric CO2 concentration if CO2 values are averaged over a sufficiently long depth scale (>10 cm in case of the EPICA DML ice core).


11.1-280
Climatic cycles recorded in the Middle Eocene hemipelagites from a Dinaric foreland basin of Istria (Croatia)
Luzar Oberiter B, Hochuli P A, Babic L, Glumac B, Tibiljas D
Croatia, Switzerland, USA
Paleontology, Geology, Oceanography, Geochemistry & Geophysics
Middle Eocene hemipelagic marls from the Pazin-Trieste Basin, a foreland basin of the Croatian Dinarides, display repetitive alternations of two types of marls with different resistance to weathering. This study focuses on the chemical composition, stable isotopes, and palynomorph content of these marls in order to better understand the nature of their cyclic deposition and to identify possible paleoenvironmental drivers responsible for their formation. The less resistant marls (LRM) have consistently lower carbonate content, lower delta O-18 and delta C-13 values, and more abundant dinoflagellate cysts than the more resistant marls (MRM). We interpret these differences between the two marl types to be a result of climatic variations, likely related to Milankovitch oscillations. Periods with wetter climate, associated with increased continental runoff, detrital and nutrient influx produced the LRM. Higher nutrient supply sparked higher dinoflagellate productivity during these times, while reduced salinity and stratification of the water column may have hampered the productivity of calcareous nannoplankton and/or planktonic foraminifera. In contrast, the MRM formed during dryer periods which favoured higher carbonate accumulation rates. This study provides new insight into the sedimentary record of short-scale climate variations reflected in wet-dry cycles during an overall warm, greenhouse Earth.

11.1-281
Reconstruction of the recent history of a large deep prealpine lake (Lake Bourget, France) using subfossil chironomids, diatoms, and organic matter analysis: towards the definition of a lake-specific reference state
Millet L, Giquet Covex C, Verneaux V, Druart J C, Adatte T, Arnaud F
France, Switzerland
Paleontology, Limnology, Marine & Freshwater Biology, Geology
This paper presents the recent history of a large prealpine lake (Lake Bourget) using chironomids, diatoms and organic matter analysis, and deals with the ability of paleolimnological approach to define an ecological reference state for the lake in the sense of the European Framework Directive. The study at low resolution of subfossil chironomids in a 4-m-long core shows the remarkable stability over the last 2.5 kyrs of the profundal community dominated by a Micropsectra-association until the beginning of the twentieth century, when oxyphilous taxa disappeared. Focusing on this key recent period, a high resolution and multiproxy study of two short cores reveals a progressive evolution of the lake's ecological state. Until AD 1880, Lake Bourget showed low organic matter content in the deep sediments (TOC less than 1%) and a well-oxygenated hypolimnion that allowed the development of a profundal oxyphilous chironomid fauna (Micropsectra-association). Diatom communities were characteristic of oligotrophic conditions. Around AD 1880, a slight increase in the TOC was the first sign of changes in lake conditions. This was followed by a first limited decline in oligotrophic diatom taxa and the disappearance of two oxyphilous chironomid taxa at the beginning of the twentieth century. The 1940s were a major turning point in recent lake history. Diatom assemblages and accumulation of well preserved planktonic organic matter in the sediment provide evidence of strong eutrophication. The absence of profound chironomid communities reveals permanent hypolimnetic anoxia. From AD 1995 to 2006, the diatom assemblages suggest a reduction in nutrients, and a return to mesotrophic conditions, a result of improved wastewater management. However, no change in hypolimnion benthic conditions has been shown by either the organic matter or the subfossil chironomid profundal community. Our results emphasize the relevance of the paleolimnological approach for the assessment of reference conditions for modern lakes. Before AD 1900, the profound Micropsectra-association and the Cyclotella dominated diatom community can be considered as the Lake Bourget reference community, which reflects the reference ecological state of the lake. Journal of Paleolimnology, 2010, V44, N4, DEC, pp 963-978 DOI: http://dx.doi.org/10.1007/s10933-010-9467-8.

11.1-282
Middle to Late Pleistocene palaeoenvironmental evolution of the southeastern Alpine Valeriano Creek succession (northeastern Italy)
Monegato G, Lowick S E, Ravazzi C, Banino R, Donegana M, Preusser F
Italy, Switzerland
Paleontology, Hydrology, Geomorphology, Landscape Studies, Plant Sciences, Geology
The Middle Late Pleistocene alluvial and lacustrine succession of Valerian Creek (southeastern Alpine foothills, 190 m a.s.l.) documents the environmental evolution of the piedmont plain before the onset of the Last Glacial Maximum (LGM). The sedimentary record was investigated by multidisciplinary stratigraphical and sedimentological studies coupled with petrographic and palaeobotanical analysis. A chronology has been provided by luminescence, radiocarbon dating and pollen biochronology. The succession developed at the valley mouth of a small catchment and is confined in the piedmont plain by the alluvial fans of major rivers. The oldest deposits were formed during a cold phase during the late Middle Pleistocene. This part of the piedmont plain was generally stable until Termination II, when it was trenched more than 15 m deep by watercourses. The infillng succession of the trench, mostly by low-energy alluvial sediments interbedded with mire and peat deposits, documents, for the first time on the southern side of the Alps, the relationships between fluvial activity, vegetation and climate change at the foothills piedmont plain during late Marine Isotope Stage (MIS) 5. The stadial-interstadial climate forcing implies a local reorganisation of fluvial dynamics and of forest composition, although substantial plant cover persisted even during cooler stadia's. In accordance with coeval alluvial and speleothem records from the northern side of the Alps, this environmental evolution supports a very restricted Alpine glaciation of the main fluvial catchments of the southeastern Alps during MIS 5a-d. Journal of Quaternary Science, 2010, V25, N5, JUL, pp 617-632 DOI: http://dx.doi.org/10.1002/jqs.1321.
11.1-283  
Late Pliocene changes in the North Atlantic Current
Naafs B D A, Stein R, Hefter J, Khelifi N, de Schepper S, Haug G H
Germany, Switzerland
Paleontology, Oceanography, Meteorology & Atmospheric Sciences

During the late Pliocene global climate changed drastically as the Northern Hemisphere glaciation (NHG) intensified. It remains poorly understood how the North Atlantic Current (NAC) changed in strength and position during this time interval. Such changes may alter the amount of northward heat transport and therefore have a large impact on climate in the circum-North Atlantic region and the growth of Northern Hemisphere ice sheets. Using the alkenone biomarker we reconstructed orbitally resolved sea surface temperature (SST) and productivity records at Integrated Ocean Drilling Project (IODP) Expedition 306 Site U1313 during the late Pliocene and early Pleistocene, 3.68-2.45 million years ago (Ma). Before 3.1 Ma, SSTs in the mid-latitude North Atlantic were up to 6 °C higher than the present and surface water productivity was low, indicating that an intense NAC transported warm, nutrient-poor surface waters northwards. Starting at 3.1 Ma, surface water characteristics changed drastically as the NHG intensified. During glacial periods at the end of the late Pliocene and beginning of the Pleistocene, SSTs decreased and surface water productivity in the mid-latitude North Atlantic increased, reflecting a weakened influence of the NAC at our site. At the same time the increase in surface productivity suggests that the Arctic Front (AF) reached down into the mid-latitudes. We propose that during the intensification of the NHG the NAC had an almost pure west to east flow direction in glacials and did not penetrate into the higher latitudes. The diminished northward heat transport would have led to a cooling of the higher latitudes, which may have encouraged the growth of large continental ice sheets in the Northern Hemisphere.


11.1-284  
Multi-centennial summer and winter precipitation variability in southern South America
Switzerland, Germany, Argentina, USA, England
Paleontology, Hydrology, Meteorology & Atmospheric Sciences

We present the first spatially and temporally highly resolved gridded reconstruction of multi-centennial precipitation variability for southern South America (SSA). A novel reconstruction approach of deriving 10,000 ensemble members based on varying predictor networks and methodological settings allows the identification of spatiotemporal changes in SSA precipitation and associated uncertainties. The summer and winter reconstructions back to AD 1498 and AD 1590, respectively, provide new evidence for multi-centennial increase in summer precipitation and an opposing decrease in winter precipitation into the 20th century. The drying in winter is significant over large parts of SSA, whereas the patterns for summer, possibly representing convective rainfall, have displayed high spatial variability. The fact that such long-term seasonal and spatial changes have occurred in the past, underlines the complex form that hydroclimatic variability might have in the future. This emphasizes the need for careful adaptation strategies as governments become attuned to the realities of climate change.


11.1-285  
The science and strategy of the Past Global Changes (PAGES) project
Newman L, Kiefer T, Otto Bliesner B, Wanner H
Switzerland
Paleontology

The Past Global Changes (PAGES) project was founded in 1991 with the mission to address past changes in the Earth System in a quantitative and process-oriented way in order to improve projections of future climate and environment, and inform strategies for sustainability. Toward this goal, PAGES has identified four sets of questions aimed at developing a better understanding of climate-environment sensitivity, regional variability, global system behavior and human interaction with climate and environment. These questions are addressed by scientific Working Groups that hold workshops and other activities, toward the production of syntheses and products. Furthermore, PAGES supports the international paleoscience community by fostering collaboration and communication, and ensuring access to and dissemination of results, data, and other relevant information.

Comparing pollen spectra from modified Tauber traps and moss samples: examples from a selection of woodlands across Europe


Wales, Germany, Switzerland, Czech Republic, Rep Of Georgia, Greece, Poland, Bulgaria, Latvia

Plant Sciences , Forestry , Ecology

This paper compares pollen spectra derived from modified Tauber traps and moss samples from a selection of woodland types from Bulgaria, the Czech Republic, Georgia, Greece, Poland, Switzerland and Wales. The study examines the representation of individual taxa in the two sampling media and aims to ascertain the duration of pollen deposition captured by a moss. The latter aim was pursued through the calculation of dissimilarity indexes to assess how many years of pollen deposited in a pollen trap yield percentage values that are most similar to those obtained from the moss. The results are broadly scattered; the majority of moss samples being most similar to several years of pollen deposition in the adjacent trap. For a selection of samples, a comparison of the pollen accumulation rate in pollen traps with the pollen concentration in the moss per unit surface indicates that the entrapment and/or preservation of individual pollen types in the moss differ from that in the pollen trap. A comparison of the proportion of different taxa in the moss with the pollen spectrum of 2 years of pollen deposition in the trap also revealed large differences. There is a tendency for bisaccate grains such as Pinus and Picea to have a higher representation in moss than in traps but there is considerable regional variation. The results indicate that pollen proportions from moss samples often represent the pollen deposition of one area over several years. However, bisaccate pollen grains tend to be over-represented in moss samples compared to both pollen traps and, potentially, lake sediments.

Variation in annual pollen accumulation rates of Fagus along a N-S transect in Europe based on pollen traps


Poland, Czech Republic, Switzerland, Bulgaria, Estonia, Germany

Plant Sciences , Forestry , Ecology

Annual pollen-accumulation rates (PAR) of Fagus (beech) obtained within the framework of the Pollen Monitoring Programme (PMP) were analyzed in pollen traps along a N-S transect from the Baltic Sea to the Black Sea in different European vegetation units. The study regions are situated in the lowlands of northern Poland, the uplands of SE Poland, the Czech Krkonoe Mts, the Czech umava Mts, the Swiss Jura Mts, the Swiss Alps, the Bulgarian Rila Mts and the Bulgarian Strandzha Mts. Most time series are 10 or 11 years long, some are 5-16 years long. Inter-annual fluctuations in Fagus PAR were analyzed and compared with seed mast years. Years with high Fagus PAR and others with low Fagus PAR occurred most frequently in parallel within each region and often in two neighbouring regions. 2006 was exceptional as it had a very high Fagus sylvatica pollen deposition in all study regions and it was also a mast year. In Bulgaria, the trend in the 5 years of Fagus orientalis PAR in the Strandzha Mts differed from that of F. sylvatica PAR in the Rila Mts. Aiming at establishing the relationship between average Fagus PAR and tree cover, differences in Fagus PAR (averaged per pollen trap) were related in each region to the proportion of beech trees in the vegetation within 2 km of the pollen traps, the distance to the nearest pollinating Fagus tree, regional or local presence of beech forests, the degree of landscape openness, and the size of forest opening in which a trap is situated. Average Fagus PAR was found to track the regional abundance of beech trees in the vegetation, not the distance of the nearest Fagus tree. Regional occurrence of beech- dominated forests was reflected by a Fagus PAR of ca. 1,400 grains cm (-2) year(-1), local abundance very close to pollen traps by ca. 2,400 grains, small patches.
of forest with admixture of Fagus by ca. 170-220 grains, and scarcity or absence of Fagus by ca. 40 grains or less.

Vegetation History and Archeobotany, 2010, V19, N4, SI, AUG, pp 259-270 DOI: http://dx.doi.org/10.1007/s00334-010-0248-0.

11.1-288 Holocene soils and sediments around Ma’rib Oasis, Yemen: Further Sabaean treasures?


Germany, Switzerland

Paleontology, Pedology, Geology, Geochemistry & Geophysics, Landscape Studies

The ancient cultures of Southern Arabia are increasingly recognised as playing as major a role in the heritage of mankind as the early cultures of Egypt, Mesopotamia or the Indus Valley. The beginning of the widely known Sabaean culture dates back to the end of the second millennium BC. Whereas, undoubtedly, its wealth came mainly from the trade along the Incense Road, the backbone of its economy was irrigated agriculture. Since agriculture is based on soil and water resources and, hence, land availability, the buried soils and sediments of the area surrounding the Ma’rib Oasis have been investigated, both as an archive of Holocene soil development in Pre-Sabaean times and as ‘natural treasures’, as, for example, ores or alabaster are defined. The natural buried Holocene soils around Ma’rib are rich in phosphate, organic material and volcanic ashes. In a few places they demonstrate cultivation before the Great Dam of Ma’rib was built in the first millennium BC. Most important are those soils that formed during the Neolithic between 8000 and 3000 BC, a time before the permanent settlement of humans in the Bronze Age, and before the arrival of those of the early Sabaean period at the Ar-Rub’ Al-Khali desert margin. Since the area surrounding the oasis shows a huge variety of landscapes, such as dune belts, volcanic fields with archaeological structures and different soils, it is worth accentuating the significance of Holocene soils as an important record or archive of land use. As well as classical soil analysis, AMS-C-14 datings, the results of phytolith analysis and geochemistry, including XRF data, have been taken into consideration.


11.1-289 New MIS 19 EPICA Dome C high resolution deuterium data: Hints for a problematic preservation of climate variability at sub-millennial scale in the “oldest ice”


France, Denmark, Switzerland, Italy

Paleontology, Cryology / Glaciology, Meteorology & Atmospheric Sciences

Marine Isotope Stage 19 (MIS 19) is the oldest interglacial period archived in the EPICA Dome C ice core (similar to 780 ky BP) and the closest “orbital analogue” to the Holocene - albeit with a different obliquity amplitude and phase with precession. New detailed deuterium measurements have been conducted with a depth resolution of 11 cm (corresponding time resolution of similar to 130 years). They confirm our earlier low resolution profile (55 cm), showing a relatively smooth shape over the MIS 20 to MIS 18 time period with a lack of sub-millennial climate variability, first thought to be due to this low resolution. The MIS 19 high resolution profile actually reveals a strong isotopic diffusion process leading to a diffusion length of at least similar to 40 cm erasing sub-millennial climate variability. We suggest that this diffusion is caused by water veins associated with large ice crystals at temperatures above -10 degrees C, temperature conditions in which the MIS 19 ice has spent more than 200 Icy. This result has implications for the selection of the future “oldest ice” drilling site.


11.1-290 Glacier advance in southern middle-latitudes during the Antarctic Cold Reversal


USA, New Zealand, Norway, France, Switzerland

Paleontology, Cryology / Glaciology, Geology, Geochemistry & Geophysics

During the last deglaciation, warming over Antarctica was interrupted by a return to colder conditions from about 14,540 to 12,760 yr ago. This period, known as the Antarctic Cold Reversal, is well documented in Antarctic ice cores(1), but the geographic extent of the cooling throughout the Southern Hemisphere remains unclear(2). Here we use Be-10 surface-exposure ages from two glacial moraine sets from the Southern Alps, New
Zealand, to assess whether the glacier advance was associated with the Antarctic Cold Reversal. We find that widespread glacier resurgence culminated 13,000 years ago, at the peak of Antarctic cooling. Subsequent glacier retreat in the Southern Alps coincided with warming in Antarctica. We conclude that the climate deterioration associated with the Antarctic Cold Reversal extended into the southern mid-latitudes of the southwestern Pacific Ocean. We suggest that the extensive cooling was caused by northward migration of the southern Subtropical Front, and concomitant northward expansion of cold Southern Ocean waters.


11.1-291
Climate and tectonic controls on Pleistocene sequence development and river evolution in the Southern Vienna Basin (Austria)
Salcher B C, Wagreich M
Switzerland, Austria
Paleontology, Landscape Studies, Geomorphology, Hydrology, Geology
The impact of climate and tectonism on sedimentation and lithofacies development is demonstrated for Austria’s largest Pleistocene sedimentary basin situated within the Vienna Basin. The coarse grained, massive facies is associated with high-energetic flood events reflecting a distinct seasonality effect of discharge during glacial times. In contrast, fine grained, well stratified sediments mark periods of rather high discharge to sediment supply ratios during warmer periods. Preservation of depositional sequences was facilitated by subsidence rates of approx 05-1 mm/a. High subsidence rates in the basin preserve a relatively large record of sequences compared to fluvial terraces which reflect mainly sediments deposited during and shortly after glacials C-14 and relative ages demonstrate the strong impact of oscillations in climate on fluvial stratigraphy covering times from the upper period of MIS 3 to MIS 1. Abundant sediment supply and the associated increase in accumulation space as well as tectonic factors affect not only the sequence development but also the geomorphology of two mountain front alluvial fans which toe out into the Mitterndorf Basin. High discharge to sediment supply ratios leads to fan incision and to abandonment of fan surfaces. During phases of reduced sediment supply the effect of subsidence results in headcut erosion, and, if sufficient time is available, may lead to complete through trenching. Abandoned fan surfaces are exposed to widespread soil formation which mark sequence boundaries to the following coarse grained, massive facies reflecting high sediment supply to discharge ratios.


11.1-292
Sedimentology-based reconstructions of paleoclimate changes in the Central Andes in response to the uplift of the Andes, Arica region between 19 and 21 degrees S latitude, northern Chile
Schlunegger F, Kober F, Zeilinger G, von Rotz R
Switzerland, Germany, Namibia
Paleontology, Geology, Meteorology & Atmospheric Sciences
We focus on the sedimentological record of the Middle Miocene to modern deposits in the Andes of northern Chile between 19 and 21 degrees S. These sediments, deposited at the Western Escarpment of the Central Depression, indicate successively more moisture on the western margin of the Altiplano and the Western Cordillera where the sources are. At the Pacific Coast, 20-Ma-old exposure ages and salic gypsisols reflect an existing and ongoing hyperarid climate. We interpret the increased divergence of climates between the Coast and the Altiplano as consequence of the Andean rise to elevations higher than approximately 2,500 m a.s.l., when the topography of the Altiplano was sufficiently high and areally extensive to attract Atlantic moisture. Accordingly, the inferred general increase in run-off was closely coupled with the uplift of the Andes if the steady rise model applies. In case that the rapid rise model for Andean uplift is correct, the inferred changes in sediment transport would have occurred independently of uplift, requiring an alternative, yet unknown driver.


11.1-293
Changes in flood frequencies in Switzerland since 1500
Schmocker Fackel P, Naef F
Switzerland
Hydrology, Meteorology & Atmospheric Sciences
In northern Switzerland, an accumulation of large flood events has occurred since the 1970s, preceded by a prolonged period with few floods (Schmocker-Fackel and Naef, 2010). How have Swiss flood frequencies changed over the past 500 years? And how does the recent increase in
flood frequencies compare with other periods in this half millennium? We collected historical flood data for 14 Swiss catchments dating back to 1500 AC. All catchments experienced marked fluctuations in flood frequencies, and we were able to identify four periods of frequent flooding in northern Switzerland, lasting between 30 and 100 years (1560-1590, 1740-1790, 1820-1940 and since 1970). The current period of increased flood frequencies has not yet exceeded those observed in the past. We tested whether the flood frequency fluctuation could be explained with generalised climatic indices like solar activity or the NAO. The first three periods of low flood frequency in Switzerland correspond to periods of low solar activity. However, after 1810 no relationship between solar activity and flood frequency was found, nor could a relationship be established between reconstructed NAO indices or reconstructed Swiss temperatures. We found re-occurring spatial patterns of flood frequencies on a European scale, with the Swiss periods of frequent flooding often in phase with those in the Czech Republic, Italy and Spain and less often with those in Germany. The pattern of flooding in northern Switzerland and the Czech Republic seem to be rather similar, although the individual flood events do not match. This comparison of flooding patterns in different European countries suggests that changes in large scale atmospheric circulation are responsible for the flood frequency fluctuations.


11.1-294

Fungus, not comet or catastrophe, accounts for carbonaceous spherules in the Younger Dryas “impact layer”


England, USA, Switzerland

Paleontology, Geology, Ecology

A claim attributes the onset of the Younger Dryas climate interval and a range of other effects similar to 12,900 years ago to a comet airburst and/or impact event. One key aspect of this claim centers on the origin of carbonaceous spherules that purportedly formed during intense, impact-ignited wildfires. Samples from Pleistocene-Holocene sedimentary sequences in the California Channel Islands and other sites show that carbon spherules and elongate forms are common in samples dating to before, during, and well after the 12,900-year time horizon, including from modern samples. Microscopic studies show that carbon spherules have morphologies and internal structures identical to fungal sclerotia (such as Sclerotium and Cenococcum). Experimental charring of fungal sclerotia shows that their reflectance increases with temperature. Reflectance measurements of modern and late Pleistocene spherules show that the latter indicate, at most, low-intensity burning. These data cast further doubt upon the evidence suggesting a catastrophic Younger Dryas impact event.


11.1-295

Relationships between Local Climate and Hydrology in Sphagnum Mire: Implications for Palaeohydrological Studies and Ecosystem Management

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Poland, Switzerland

Paleontology, Hydrology, Plant Sciences, Meteorology & Atmospheric Sciences

We investigated: a) the hydrology of a small Sphagnum mire located in a transitional climate in Eastern Europe, and b) the relationships between the local climate and hydrology of the mire. We hypothesized that temperature is the most important factor determining water table changes in this type of peatland in an exceptional biogeographic setting. Research on the Linje mire revealed that the groundwater table was predominantly influenced by air temperature, which determines the rate of evapotranspiration, particularly in summer. Another important physical factor that significantly influences the variation in groundwater table of the mire is the permeability of the surface deposits. Moreover, the vegetation (especially Sphagnum) also has a modifying influence. Our study is the first of this kind in the young glacial area of Poland as well as in Eastern Europe. There is a need to improve precision of the study by installing automatic data loggers, as well as to intensify monitoring of the mire and its surroundings in order to obtain a better picture of the relationships between the mire and forest management in its vicinity. Furthermore, in the future we plan to extend the monitoring to hydrochemistry and microbial indicators (e.g. testate-amoebeae and bacteria) to use the ecosystem approach in management of this valuable site.

11.1-296

Spatio-temporal variability in debris-flow activity: a tree-ring study at Geisstriftbach (Swiss Alps) extending back to AD 1736
Stoffel M, Bollschweiler M, Widmer S, Sorg A
Switzerland
Forestry, Plant Sciences, Geomorphology, Hydrology
Past debris-flow activity on the forested cone of the Geisstriftbach torrent (St. Niklaus, Valais, Swiss Alps) was assessed from growth disturbances in old conifer trees, providing a much improved record of past events. The study of 633 tree-ring sequences sampled from 252 European larch (Larix decidua Mill.), Norway spruce (Picea abies (L.) Karst.) and Silver birch (Betula pendula Roth.) trees allowed reconstruction of 53 debris-flow events since AD 1736. The spatial analysis of trees affected during particular events on the geomorphic map allowed for a spatial representation of individual events and a reconstruction of four flow patterns. Based on our results and Siegfried maps, we believe that before the formation of a dogleg near the cone apex in the late 1890s, debris flows preferentially used the channels located in the west-southwestern part of the Geisstriftbach cone. This study contributes to our understanding of debris-flow processes on cones and provides an example of how dendrogeomorphic techniques may help in the reconstruction and understanding of debris flows in Alpine areas.

11.1-297

Updating historical tree-ring records for climate reconstruction
Tegel W, Vanmoerkerke J, Buentgen U
Switzerland, Germany, France
Paleontology, Forestry, Plant Sciences, Meteorology & Atmospheric Sciences
Over the past three decades, numerous Late Holocene-long tree-ring (TR) chronologies have been developed for different parts of Europe that allow archaeological, historical and cultural wood remains to be dated with annual precision. Ironically, palaeoclimatic evidence inherent in such composites is limited as modern updates essential for calibration/verification with instrumental measurements are often inappropriate, incomplete or even missing. Here we propose a novel approach to updating historical TR records while preventing statistical over-fit with the target data and advocate ‘horizontal’ splitting between historical (early) and recent (modern) TR samples prior to their standardization (detrending). This split-technique will help to overcoming unprecedented effects of increased atmospheric greenhouse-gas, biospheric fertilization, forest management, sample replication, age-structure and chronology development associated with modern proxy updates.

11.1-298

Combining charcoal and elemental black carbon analysis in sedimentary archives: Implications for past fire regimes, the pyrogenic carbon cycle, and the human-climate interactions
Thevenon F, Williamson D, Bard E, Anselmetti F S, Beaufort L, Cachier H
Switzerland, France
Paleontology, Geochemistry & Geophysics, Geology, Limnology, Forestry
This paper addresses the quantification of combustion-derived products in oceanic and continental sediments by optical and chemical approaches, and the interest of combining such methods for reconstructing past biomass burning activity and the pyrogenic carbon cycle. In such context, the dark particles >0.2µm(2) remaining after the partial digestion of organic matter are optically counted by automated image analysis and defined as charcoal, while the elemental carbon remaining after thermal and chemical oxidative treatments is quantified as black carbon (BC). The obtained pyrogenic carbon records from three sediment core-based case studies, (i) the Late Pleistocene equatorial Pacific Ocean, (ii) the mid-Holocene European Lake Lucerne, and (iii) the Late Holocene African Lake Masoko, are interpreted as proxy records of regional transportation mechanisms and biomass burning activities. The results show that the burial of dark carbon-rich particles in the 360 kyr-long record from the west equatorial Pacific is controlled by the combination of sea-level changes and low-latitude atmospheric circulation patterns (summer monsoon dynamics). However, the three fold increases in charcoal and BC sediment influxes between 53-43 and 12-10 kyr BP suggest that major shifts in fire activity occur synchronously with human colonization in the Indo/Pacific region. The coarse charcoal distribution from a 7.2 kyr record from Lake Lucerne in Switzerland closely matches the regional timing of major technical, land-use, and socio-economic changes during the Neolithic (between ca. 5.7 and 5.2 kyr BP and 4.9-4.5 kyr BP), the Bronze and Iron Ages (at ca. 3.3 and 2.4 kyr BP, respectively), and
the industrialization (after AD 1838), pointing to the key impact of human activities on the sources, transportation processes and reservoirs of refractory carbon during the Holocene. In the tropical Masoko maar lake in Tanzania, where charcoal and BC records are highly sensitive to the local climate and environment, surface runoffs from forested areas and/or aerial transportation over short distances are also important sources for detrital charred particles. However, this 4.3 kyr-long record exhibits a major increase in charcoal and BC sediment influxes between 1.8 and 0.6 kyr BP, synchronously with the regional extent of Late Iron Age and agricultural innovations. Therefore, in both marine and terrestrial depositional environments, the climate- and vegetation-controlled fire regimes appear to be strongly associated to societal changes, or directly affected by human practices. In fact, the anthropogenic effect associated to past human activities (e.g. settlement, agriculture, and metallurgy) has temporally at least tripled the emissions of pyrogenic carbon in the environment. However, the data from the three Late Pleistocene to Holocene sequences also show that the redistribution of fossil particles by run-off and erosion processes is a significant source of pyrogenic carbon that should be understood as a prerequisite for interpreting sedimentary records of biomass burning.


11.1-299
Quantitative summer temperature reconstruction derived from a combined biogenic Si and chironomid record from varved sediments of Lake Silvaplana (south-eastern Swiss Alps) back to AD 1177
Trachsel M, Grosjean M, Larocque Tobler I, Schwikowski M, Blass A, Sturm M
Switzerland, Canada
Paleontology, Limnology, Geology, Meteorology & Atmospheric Sciences, Modelling
High-resolution quantitative temperature records are needed for placing the recent warming into the context of long-term natural climate variability. In this study we present a quantitative high-resolution (9-year) summer (June-August) temperature reconstruction back to AD 1177 for the south-eastern Swiss Alps. This region is a good predictor for summer temperatures in large parts of western and central Europe. Our reconstruction is based on a combination of the high-frequency component of annually resolved biogenic silica (bSi flux) data and the low-frequency component of decadal chironomid-inferred temperatures from annually laminated well dated sediments (varves) from proglacial Lake Silvaplana, eastern Swiss Alps. For the calibration (period AD 1760-1949) we assess systematically the effects of six different regression methods (Type I regressions: Inverse Regression IR, Inverse Prediction IP, Generalised Least Squares GLS; Type II regressions: Major Axis MA, Ranged Major Axis RMA and Standard Major Axis SMA) with regard to the predicted amplitude and the calibration statistics such as root-mean-square error of prediction (RMSEP), reduction of error (RE) and coefficient of efficiency (CE). We found a trade-off in the regression model choice between a good representation of the amplitude and good calibration statistics. The band-pass filtered bSi flux record is in close agreement both in the structure and the amplitude with two fully independent reconstructions spanning back to AD 1500 and AD 1177, respectively. All known pulses of negative volcanic forcing are represented as cold anomalies in the bSi flux record. Volcanic pulses combined with low solar activity (Sporer and Maunder Minimum) are seen as particularly cold episodes around AD 1460 and AD 1690. The combined chironomid and bSi flux temperature record (RMSEP = 0.57 degrees C) is in good agreement with the glacier history of the Alps. The warmest (AD 1190) and coldest decades (17th century; 1680-1700) of our reconstruction coincide with the largest anomalies in the Alpine tree-ring based reconstruction; both records show in the decadal variability an amplitude of 2.8 degrees C between AD 1180 and 1950, which is substantially higher than the amplitude of hemispheric reconstructions. Our record suggests that the current decade is slightly warmer than the warmest decade in the pre-industrial time of the past 800 years.

11.1-300
Scanning reflectance spectroscopy (380-730 nm): a novel method for quantitative high-resolution climate reconstructions from minerogenic lake sediments
Trachsel M, Grosjean M, Schnyder D, Kamenik C, Rein B
Switzerland, Germany
Paleontology, Limnology, Geology, Modelling
High-resolution (annual to sub-decadal) quantitative reconstructions of climate variables are needed from a variety of paleo-decadal climate change...
in the context of long-term natural climate variability. Rapid, high-resolution, non-destructive scanning techniques are required to produce such high-resolution records from lake sediments. In this study we explored the potential of scanning reflectance spectroscopy (VIS-RS; 380-730 nm) to produce quantitative summer temperature reconstructions from minerogenic sediments of proglacial, annually laminated Lake Silvaplana, in the eastern Swiss Alps. The scanning resolution was 2 mm, which corresponded to sediment deposition over 1-2 years. We found correlations up to \( r = 0.84 \) (p < 0.05) for the calibration period 1864-1950, between six reflectance-dependent variables and summer (JJA) temperature. These reflectance-dependent variables (e.g. slope of the reflectance 570/630 nm, indicative of illite, biotite and chlorite; minimum reflectance at 690 nm indicative of chlorite) indicate the mineralogical composition of the clastic sediments, which is, in turn, related to climate in the catchment of this particular proglacial lake. We used multiple linear regression (MLR) to establish a calibration model that explains 84% of the variance of summer (JJA) temperature during the calibration period 1864-1950. We then applied the calibration model downcore to develop a quantitative summer temperature reconstruction extending back to AD 1177. This temperature reconstruction is in good agreement with two independent temperature reconstructions based on documentary data that extend back to AD 1500 and tree ring data that extend back to AD 1177. This study confirms the great potential of in situ scanning reflectance spectroscopy as a novel non-destructive technique to rapidly acquire high-resolution quantitative paleoclimate information from minerogenic lake sediments. 


11.1-301 Multi-century variability in the Pacific North American circulation pattern reconstructed from tree rings

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Paleontology, Meteorology & Atmospheric Sciences, Forestry, Plant Sciences

We here present a reconstruction (1725-1999) of the winter Pacific North American (PNA) pattern based on three winter climate sensitive tree ring records from the western USA. Positive PNA phases in our record are associated with warm phases of ENSO and PDO and the reorganization of the PNA pattern towards a positive mode is strongest when ENSO and PDO are in phase. Regime shifts in our PNA record correspond to climatic shifts in other proxies of Pacific climate variability, including two well-documented shifts in the instrumental period (1976 and 1923). The correspondence breaks down in the early 19th century, when our record shows a prolonged period of positive PNA, with a peak in 1800-1820. This period corresponds to a period of low solar activity (Dalton Minimum), suggesting a ‘positive PNA like’ response to decreased solar irradiance. The distinct 30-year periodicity that dominates the PNA reconstruction in the 18th century and again from 1875 onwards is disrupted during this period.


11.1-302 Annual pollen traps reveal the complexity of climatic control on pollen productivity in Europe and the Caucasus

Switzerland, Czech Republic, Poland, Rep Of Georgia, Germany, Latvia, Wales

Plant Sciences, Forestry, Meteorology & Atmospheric Sciences

Annual PAR (pollen accumulation rates; grains cm\(^{-2}\) year\(^{-1}\)) were studied with modified Tauber traps situated in ten regions, in Poland (Roztocze), the Czech Republic (two regions in Krkonoe, two in umava), Switzerland (4 regions in the Alps), and Georgia (Lagodekhi). The time-series are 10-16 years long, all ending in 2007. We calculated correlations between pollen data and climate. Pollen data are PAR summarized per region (4-7 traps selected per region) for each pollen type (9-14 per region) using log-transformed, detrended medians. Climate data are monthly temperature and precipitation measured at nearby stations, and their averages over all possible 2- to 6-month windows falling within the 20-month window ending with August, just prior to the yearly pollen-trap collection. Most PAR/climate relationships were found to differ both among pollen types and among regions, the latter probably due to differences among the study regions in the habitats of plant populations. Results shared by a number of regions can be summarized as follows. Summer warmth was found to enhance the following year’s PAR of Picea, Pinus non-cembra, Larix and Fagus. Cool summers, in contrast, increase the PAR of Abies, Alnus viridis and Gramineae in the
following year, while wet summers promote PAR of Quercus and Gramineae. Wetness and warmth in general were found to enhance PAR of Salix. Precipitation was found to be more important for PAR of Alnus glutinosa-type than temperature. Weather did not have an impact on the PAR of Gramineae, and possibly of Cyperaceae in the same year. Care is advised when extrapolating our results to PAR in pollen sequences, because there are large errors associated with PAR from sediments, due to the effects of taphonomy and sedimentation and high uncertainty in dating. In addition, in pollen sequences that have decadal to centennial rather than near-annual resolution, plant-interaction effects may easily out-weigh the weather signal.


11.1-303
Chironomid delta O-18 as a proxy for past lake water delta O-18: a Lateglacial record from Rotsee (Switzerland)
Verbruggen F, Heiri O, Reichart G J, Lotter A F Netherlands, Switzerland
Paleontology, Limnology, Hydrology, Geology
We explored whether the stable oxygen isotope composition (delta O-18) of fossil chironomid remains can be used to reconstruct past variations in lake water delta O-18 from Lateglacial and early Holocene sediments from Rotsee (Switzerland). A sediment core from the former littoral zone of the lake was examined since it contained both high concentrations of chironomid remains and abundant authigenic carbonates and therefore allowed a direct comparison of chironomid delta O-18 with values measured on bulk carbonates. Since carbonate particles adhering to chironomid remains potentially affect O-18 measurements we tested two methods to chemically remove residual carbonates. Trials with isotopically heavy and light acetic acid solutions indicated that treatment with hydrochloric acid promoted oxygen exchange between chironomid remains and the water used during pretreatment. In contrast, a buffered 2 M ammonium chloride (NH4Cl) solution did not seem to affect the chironomid delta O-18 signature. Samples pretreated with NH4Cl correlated well with bulk carbonate delta O-18 (r(2) = 0.67) and successfully tracked the well-known Lateglacial changes in delta O-18. Chironomid delta O-18 indicated depleted lake water delta O-18 during the Oldest Dryas period, the Aegelsee and Gerzensee Oscillations, and the Younger Dryas, whereas enriched delta O-18 values were associated with sediments deposited during the Lateglacial interstadial and the early Holocene. Differences in the amplitude of variations in bulk carbonate and chironomid delta O-18 are attributed to differential temperature effects on oxygen isotope fractionation during the formation of carbonates and chironomid head capsules or seasonal changes of lake water delta O-18, potentially affecting delta O-18 of these two substances to a different extent. Our results indicate that chironomid delta O-18 can successfully reconstruct centennial to millennial-scale changes in lake water delta O-18 and that the method can be applied to carbonate-rich records provided that care is taken to eliminate carbonate contamination from the samples.


11.1-304
Holocene climatic fluctuations and positioning of the Southern Hemisphere westerlies in Tierra del Fuego (54 degrees S), Patagonia
Waldmann N, Ariztegui D, Anselmetti F S, Austin J A Jr, Moy C M, Stern C, Recasens C, Dunbar R B Switzerland, USA
Paleontology, Meteorology & Atmospheric Sciences, Limnology, Geology, Geochemistry & Geophysics
Recent advances in the chronology and the palaeoclimatic understanding of Antarctic ice core records point towards a larger heterogeneity of latitudinal climate fluctuations than previously thought. Thus, realistic palaeoclimate reconstructions rely in the development of a tight array of well-constrained records with a dense latitudinal coverage. Climatic records from southernmost South America are critical cornerstones to link these Antarctic palaeoclimatic archives with their South American counterparts. At 54 degrees S on the Island of Tierra del Fuego, Lago Fagnano is located in one of the most substantially and extensively glaciated regions of southernmost South America during the Late Pleistocene. This elongated lake is the largest (similar to 110 km long) and non-ice covered lake at high southern latitudes. A multi-proxy study of selected cores allows the characterisation of a Holocene sedimentary record. Detailed petrophysical, sedimentological
11.1-305 Response of testate amoeba assemblages to environmental and climatic changes during the Lateglacial-Holocene transition at Lake Lautrey (Jura Mountains, eastern France)

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France, Switzerland

Paleontology, Limnology, Marine & Freshwater Biology, Ecology, Meteorology & Atmospheric Sciences

We tested the response of lacustrine testate amoebae (thecamoebians) to climate and environmental changes for the Lateglacial-Holocene transition. The palaeoenvironmental history of the study site (Lake Lautrey, Jura Mountains, eastern France) was previously established based on high-resolution multi-proxy studies of the same core. The present study is characterised by a high taxonomic resolution (54 taxa), inclusion of small species (clown to 25µm) and high total counts (>500 individuals per sample on average). Changes in the composition of testate amoeba assemblages (dominant species and assemblage structure), as well as in the accumulation rate (tests cm⁻² a⁻¹), corresponded to major climatic phases (i.e. Oldest Dryas, Bolling-Allerod Interstadial, Younger Dryas, Preboreal) as well as changes in organic matter inputs. Furthermore, decreases in the accumulation rate characterised minor short-lived cooling events, such as Older Dryas event or Gerzensee oscillation. However, the Preboreal oscillation, which was well registered by other proxies at Lake Lautrey, could not be recognised in the testate amoeba record. This work demonstrates that lacustrine testate amoebae can be used for palaeoclimatic and palaeoecological reconstructions. Nevertheless, a better understanding of the relation between climate, organic matter and lacustrine testate amoebae requires further high-resolution studies based on multi-proxy approaches and the development of appropriate modern analogues.


11.1-306 The impact of Pleistocene glaciation across the range of a widespread European coastal species

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Switzerland

Paleontology, Marine & Freshwater Biology, Zoology, Biodiversity, Ecology

There is a growing consensus that much of the contemporary phylogeography of northern hemisphere coastal taxa reflects the impact of Pleistocene glaciation, when glaciers covered much of the coastline at higher latitudes and sea levels dropped by as much as 150 m. The genetic signature of postglacial recolonization has been detected in many marine species, but the effects of coastal glaciation are not ubiquitous, leading to suggestions that species may intrinsically differ in their ability to respond to the environmental change associated with glacial cycles. Such variation may indeed have a biological basis, but apparent differences in population structure among taxa may also stem from our heavy reliance on individual mitochondrial loci, which are strongly influenced by stochasticity during coalescence. We investigated the contemporary population genetics of Syngnathus typhle, one of the most widespread European coastal fish species, using a multilocus data set to investigate the influence of Pleistocene glaciation and reduced sea levels on its phylogeography. A strong signal of postglacial recolonization was detected at both the northern and eastern ends of the species' distribution, while southern populations appear to have been relatively unaffected by the last glacial cycle. Patterns of population variation and differentiation at nuclear and mitochondrial loci differ significantly, but simulations indicate that these differences can be explained by the stochastic nature of the coalescent process. These results demonstrate the strength of a multilocus approach to phylogeography and suggest that an overdependence on mitochondrial loci may provide a misleading picture of population-level processes.

3 Human Dimensions

11.1-307
The environmental paradox in generation: How South America is gradually becoming more dependent on thermal generation
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Switzerland, Colombia
Energy & Fuels, Economics, Political Sciences
There has been an increasing focus on global warming, emission of greenhouse gases (GHG), and the problems this might create. In this article, we review the trend in sustainable and renewable electricity generation in South America, where the generation portfolio increasingly depends on thermal generation, in particular gas. South America is a region that has relatively low emissions, but the current development is not desirable in environmental terms. We analyze the underlying reasons for this development, which is related to security of supply, deregulation, and the cost of renewable energy. We review and discuss the policies to promote renewables in the region. We analyze the potential advantages and drawbacks of different types of market interventions, such as direct subsidies that create potentially strong market distortions, more sophisticated market interventions that might be less intrusive but not necessarily as effective as, e.g., firm energy markets. We also review market-based solutions such as the Clean Market Mechanism and its potential, and the use of renewable electricity in non-interconnected zones, which might be one of the most economically attractive applications of renewables. However, without a stronger and more aggressive intervention from the governments in the region it is unlikely that the increase in thermal generation can be stopped.


11.1-308
MRV under the UN climate regime: paper tiger or catalyst for continual improvement?
Arquit Niederberger A, Kimble M
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International Relations, Political Sciences, Economics
One of the most contentious issues at the 2009 UN Climate Summit in Copenhagen, and one which has persisted in the successive rounds of negotiation since then, is, in diplomatic lingo, ‘MRV’ (monitoring, reporting and verification). Expanding the MRV regime to include mitigation actions is an opportunity to support, rather than burden, developing countries in their efforts to improve their climate performance over time, consistent with sustainable development - if done in a sensible way. The article reviews the essence of this debate and suggests one pragmatic approach to ensure that national actions are indeed measurable, reportable and verifiable, namely adopting a certification scheme for national climate management systems (NCMS, which would require countries to establish a climate policy, set national goals and timetables, secure resources to implement related national actions and track their progress over time). Based on the high level of agreement among Parties to the United Nations Framework Convention on Climate Change (UNFCCC) on the need for comprehensive frameworks to facilitate forestry and energy sector mitigation by developing countries, supported by financial resources, technology and capacity building, an NCMS certification scheme is well suited to add value to the existing MRV regime both for developed and developing countries.

Greenhouse Gas Measurement and Management, 2010, V1, N1, FEB, pp 47-54

11.1-309
A Comparison of International and Domestic Sources of Global Governance Dynamics
Bernauer T, Kalbhenn A, Koubi V, Spilker G
Switzerland
Political Sciences, International Relations, Modelling
Existing empirical models of international co-operation emphasize domestic determinants, although virtually all theories of international relations focus on interdependencies between countries. This article examines how much states’ linkages with the international system, relative to domestic factors, such as income and democracy, influence the dynamics of global governance efforts. To this end, we study the ratification behaviour of 180 countries vis-à-vis 255 global environmental treaties. Except for integration into the world economy, which affects co-operative behaviour negatively, our results show that international factors have a stronger and more positive impact on co-operative behaviour than domestic factors. This implies that Gallon’s advice not to examine the effects of internal and external variables in isolation is also useful in the study of international politics.

11.1-310
Consistency and comparability of estimation and accounting of removal by sinks in afforestation/reforestation activities
Blujdea V, Bird D N, Robledo C
Italy, Austria, Switzerland
Forestry, International Relations, Economics
The Kyoto Protocol accounting system and its market mechanisms, Clean Development Mechanism (CDM) and Joint Implementation (JI), are built on the key principle that emission and emission reduction units generated by afforestation/reforestation activities under national systems and projects are fully comparable, no matter their origin. Lack of consistency in the quality of emission and emission reduction units can undermine the environmental integrity of the climate stabilization actions. Therefore, it is the ambition that units generated in the land-use, land-use change and forestry (LULUCF) sector are of similar quality with those from non-LULUCF sectors. In this paper, the authors pose the question of whether there is full estimation and accounting consistency between Annex I Party’s national GHG systems and CDM projects methodologies in the LULUCF sector, in terms accuracy, completeness, levels of uncertainty and permanence risk. We focus on methodological aspects related to the applicability and practicability of using approved afforestation/reforestation CDM methodologies; estimation, reporting and accounting rules; the small pools and sources issue, uncertainty of removal estimate; leakage and handling of non-permanence risk. We conclude that there is significant scope for improving the consistency of greenhouse gas emission accounting from land use activities in the post-2012 climate change agreement, between Annex I domestic and project activities. As well, we conclude that the preparation and implementation of project activities has to be made simpler by a project framework guideline, which is then adapted to any project circumstances.

11.1-311
Market Design for Emission Trading Schemes
Carmona R, Fehr M, Hinz J, Porchet A
USA, Switzerland, Singapore, France
Economics, Modelling, International Relations, Energy & Fuels
This paper is concerned with the mathematical analysis of emissions markets. We review the existing quantitative analyses on the subject and introduce some of the mathematical challenges posed by the implementation of the new phase of the European Union Emissions Trading Scheme as well as the cap-and-trade schemes touted by the U.S., Canada, Australia, and Japan. From a practical point of view, the main thrust of the paper is the design and numerical analysis of new cap-and-trade schemes for the control and reduction of atmospheric pollution. We develop tools intended to help policy makers and regulators understand the pros and cons of the emissions markets. We propose a model for an economy where risk neutral firms produce goods to satisfy an inelastic demand and are endowed with permits in order to offset their pollution at compliance time and avoid having to pay a penalty. Firms that can easily reduce emissions do so, while those for which it is harder buy permits from firms that anticipate they will not need all their permits, creating a financial market for pollution credits. Our equilibrium model elucidates the joint price formation for goods and pollution allowances, capturing most of the features of the first phase of the European Union Emissions Trading Scheme. We show existence of an equilibrium and uniqueness of emissions credit prices. We also characterize the equilibrium prices of goods and the optimal production and trading strategies of the firms. We use the electricity market in Texas to numerically illustrate the qualitative properties of these cap-and-trade schemes. Comparing the numerical implications of cap-and-trade schemes to the business-as-usual benchmark, we show that our numerical results match those observed during the implementation of the first phase of the European Union cap-and-trade CO₂ emissions scheme. In particular, we confirm the presence of windfall profits criticized by the opponents of these markets. We also demonstrate the shortcomings of tax and subsidy alternatives. Finally we introduce a relative allocation scheme which, while easy to implement, leads to smaller windfall profits than the standard scheme.

11.1-312
Democratic smog? An empirical study on the correlation between social class and environmental pollution
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Switzerland
Meteorology & Atmospheric Sciences, Energy & Fuels, Social Sciences
For years the public and scientific debate about Environmental Justice was mostly confined to the U.S. Only recently, the question about the existence and strength of the “social gradient” of en-
Environmental pollution has entered the European debate. Earlier research simply records subjective perceptions of pollution and correlates them with indicators of social status. Objective measures of environmental quality are seldom used, and even then only in studies of small geographic areas. In contrast, the present study uses various objective measures of air pollution (nitrogen dioxide, particulate matter, ozone) and road traffic noise (day, night) and assigns them to the respondents of the Swiss Environmental Survey 2007 (N = 3 369) using a geographic information system (GIS). The combination of objective GIS coded data with subjective measures allows for a new approach in Environmental Sociology that takes spatial context into account, which is often neglected in sociological studies. Using bivariate and multivariate statistical methods this objective data on pollution is related to indicators of social stratification such as income, education and nationality as well as the subjective perception of pollution. Subjective and objective measures of pollution are positively correlated with the interesting exception of ozone. Surprisingly, and contrary to the expectations, income is not significantly correlated with the pollutants considered and there is even a significant and positive correlation with education. In the multivariate analysis, however, a significant and negative correlation with income is observed, although this effect is fairly weak. Also, foreigners from Non-Western countries suffer from a higher burden of environmental pollution. However, in comparison to social and minority status differences in environmental impact between urban areas and the countryside are much more pronounced. We suppose that problems of environmental justice may be more accentuated in countries with a higher degree of segregation than in the Swiss population.


11.1-313

Analysis of intra-country virtual water trade strategy to alleviate water scarcity in Iran
Faramarzi M, Yang H, Mousavi J, Schulin R, Binder C R, Abbaspour K C
Switzerland, Iran, Austria
Economics, Hydrology, Modelling, Water Resources, Agriculture
Increasing water scarcity has posed a major constraint to sustain food production in many parts of the world. To study the situation at the regional level, we took Iran as an example and analyzed how an intra-country 'virtual water trade strategy' (VWTS) may help improve cereal production as well as alleviate the water scarcity problem. This strategy calls, in part, for the adjustment of the structure of cropping pattern (ASCP) and interregional food trade where crop yield and crop water productivity as well as local economic and social conditions are taken into account. We constructed a systematic framework to assess ASCP at the provincial level under various driving forces and constraints. A mixed-integer, multi-objective, linear optimization model was developed and solved by linear programming. Data from 1990-2004 were used to account for yearly fluctuations of water availability and food production. Five scenarios were designed aimed at maximizing the national cereal production while meeting certain levels of wheat self-sufficiency under various water and land constraints in individual provinces. The results show that under the baseline scenario, which assumes a continuation of the existing water use and food policy at the national level, some ASCP scenarios could produce more wheat with less water. Based on different scenarios in ASCP, we calculated that 31% to 100% of the total wheat shortage in the deficit provinces could be supplied by the wheat surplus provinces. As a result, wheat deficit provinces would receive 3.5 billion m$^3$ to 5.5 billion m$^3$ of virtual water by importing wheat from surplus provinces.


11.1-314

Towards an improved understanding of farmers’ behaviour: The integrative agent-centred (IAC) framework
Feola G, Binder C R
Switzerland, Austria
Social Sciences, Agriculture, Modelling, Ecology
Art effective approach to research on farmers’ behaviour is based on: i) an explicit and well-motivated behavioural theory; ii) an integrative approach; and iii) understanding feedback processes and dynamics. While current approaches may effectively tackle some of them, they often fail to combine them together. The paper presents the integrative agent-centred (IAC) framework, which aims at filling this gap. It functions in accordance with these three pillars and provides a conceptual structure to understand farmers’ behaviour in agricultural systems. The IAC framework is agent-centred and supports the understanding of farmers’ behavior consistently with the perspective of agricultural systems as complex social-ecological systems. It combines different behavioural drivers, bridges...
between micro and macro levels, and depicts a potentially varied model of human agency. The use of the framework in practice is illustrated through two studies on pesticide use among smallholders in Colombia. The examples show how the framework can be implemented to derive policy implications to foster a transition towards more sustainable agricultural practices. The paper finally suggests that the framework can support different research designs for the study of agents’ behaviour in agricultural and social-ecological systems.


11.1-315
What determines UN approval of greenhouse gas emission reduction projects in developing countries?

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Switzerland
Political Sciences, International Relations, Energy & Fuels, Economics
The Clean Development Mechanism (CDM), established by the Kyoto protocol, can generate substantial rents for project participants via the sale of Certified Emission Reductions. For this reason, supposedly technical decisions about the approval of CDM methodologies and about the registration of projects may be driven by benefits to specific countries or interest groups. Our econometric analysis of data for about 250 methodologies and about 1000 projects discussed by the CDM Executive Board (EB) so far, suggests that indeed, along with formal quality criteria, political-economic variables determine the final EB decision.


11.1-316
On integration of plug-in hybrid electric vehicles into existing power system structures

Galus M D, Zima M, Anderson G
Switzerland
Energy & Fuels, Political Sciences, Economics
Plug-in hybrid electric vehicles (PHEVs) represent one option for the electrification of private mobility. In order to efficiently integrate PHEVs into power systems, existing organizational structures need to be considered. Based on procedures of power systems planning and operation, actors are identified whose operational activities will be affected by PHEV integration. Potential changes and challenges in the actors’ long- and short term planning activities are discussed. Further, a PHEV operation state description is developed which defines vehicle operation states from the power system point of view integrating uncontrolled, controlled recharging and vehicle to grid (V2G) utilization in one single framework. Future PHEV managing entities, such as aggregators, can use this framework for planning and operation activities including load management and V2G. This operational state description could provide a solution for future short term planning challenges of PHEVs and an aegis for various routes of current research, which to date have been weakly linked to each other.


11.1-317
International legal status of the use of shallow geothermal energy

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Germany, Switzerland
Energy & Fuels, Hydrology, International Relations, Political Sciences
Shallow geothermal energy (< 400 m depth) is used in many countries worldwide, with a rising number of installations over the last decades. The use of ground source heat pump (GSPH) and groundwater heat pump (GWHP) systems results in local temperature anomalies (cold or heat plumes). Since groundwater is used in many countries as source for drinking water a balance between its use and protection has to be found. Therefore, to avoid detrimental environmental impacts it is necessary to define groundwater temperature limits for heating and cooling and minimum distances between such geothermal systems. The aim of the present study is to provide a comprehensive overview of the current international legal status for the use of shallow geothermal energy. Therefore, an international survey was performed using a questionnaire, which was sent to more than 60 countries worldwide. The questionnaire requested information on the corresponding national legislation, temperature limits and minimum distances for GSHP and GWHP systems. The answers to the inquiry showed an extremely heterogeneous outcome. Until now national and legally binding regulations only exist in few countries such as Denmark or Sweden. However, all existing regulations show a wide range for minimum distances (5-300 m) and temperature limits for groundwater.

The highest inconsistency was observed for the acceptable temperature change with 3 K in Switzerland to 11 K in France. However, most countries have no legally binding regulations or even guidelines, which highlight the urgent need for further

11.1-318
The Effects of Rent Seeking over Tradable Pollution Permits
Hanley N, Mackenzie I A
Scotland, Switzerland
Economics, Energy & Fuels, Modelling
The establishment of a tradable permit market requires the regulator to select a level of aggregate emissions and then distribute the associated permits to specific groups. Both these decisions create opportunities for rent seeking. In this paper, we use a contest model to analyse the incentives to rent seek for pollution permits and to analyse the consequences for social welfare. We find differences in firms’ rent-seeking choices compared to a conventional rent-seeking contest. We see that a fundamental aspect of firms’ incentives to rent seek depends on the market value of the permits, that is, the value of the ex post reallocated rents. This impact depends on the responsiveness of the regulator to aggregate rent-seeking effort. The responsiveness, in some cases, may improve welfare by reducing the per-unit value of permits, which may lower the rent-seeking effort more than it increases the damages experienced from the additional emissions.

11.1-319
Greening Goliaths versus emerging Davids - Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship
Hockerts K, Wüstenhagen R
Denmark, Switzerland
Economics, Modelling
This paper proposes a model of how incumbents and new entrants engage in sustainable entrepreneurship. We suggest that in the early stages of an industry’s sustainability transformation, new entrants (‘Emerging Davids’) are more likely than incumbents to pursue sustainability-related opportunities. Incumbents react to the activities of new entrants by engaging in corporate sustainable entrepreneurship activities. While these ‘Greening Goliaths’ are often less ambitious in their environmental and social goals, they may have a broader reach due to their established market presence. This paper analyses the interplay between ‘Greening Goliaths’ and ‘Emerging Davids’ and theorizes about how it is their compounded impact that promotes the sustainable transformation of industries.

11.1-320
Livelihood and Conservation Aspects of Non-wood Forest Product Collection in the Shaxi Valley, Southwest China
Huber F K, Ineichen R, Yang Y, Weckerle C S
Switzerland, Peoples R China
Economics, Forestry, Social Sciences, Plant Sciences
The Shaxi Valley in Yunnan Province, P.R. China, is inhabited by Tibeto-Burman ethnic groups. We found a clear dichotomy between household strategies in the valley bottom and the mountain areas, with significantly lower household income in the mountains. The majority Bai people live predominantly in the fertile valley floor and cultivate rice, keep livestock, and commonly pursue off-farm work. Other ethnic groups live in more remote mountainous areas of the Shaxi Valley, where the collection of non-wood forest products, especially wild mushrooms, plays an important role in securing livelihoods. However, only households in the valley’s central villages engage in the profitable non-wood forest product trade. Mushroom populations appear to be less vulnerable to commercial harvest than the rapidly declining wild medicinal plant populations. Due to this decline, local farmers have gained interest in cultivating medicinal plants, but only if risks are low and if financial and technical support is provided. Encouraging the cultivation of medicinal plants appears to be an appropriate means of sustainable community development.

11.1-321
Why and how much are firms willing to invest in ecosystem services from tropical forests?
A comparison of international and Costa Rican firms
Köllner T, Sell J, Navarro G
Germany, Switzerland, Costa Rica
Economics, Ecology
In recent years, schemes for payment for ecosystem services PES have emerged in tropical countries. Besides public demand, the private demand offers the opportunity to develop PES. The goal of this paper is to investigate the potential demand by firms for four ecosystem services from tropical
forests: biodiversity conservation, carbon sequestration, scenic beauty, and watershed protection. Those are the four granted in the forest legislation and rewarded for in the PES scheme in Costa Rica. To explain stated willingness to invest WTI, we assess influential factors: expectations with respect to financial and non-financial benefits of investing in ecosystem services; experience with forest ecosystem services; firm attributes, like origin, sector membership, and size; and finally, perceived behavioral control. We sent a questionnaire to over 900 international and Costa Rican firms from different sectors. The low response rate of the survey of over 6% can be explained by - in a business context - rather new topic of ecosystem services from tropical forests. The analysis showed that a firm’s willingness to invest (WTI) depends on the origin of the firm. International firms are interested in buying certificates mainly for carbon sequestration; Costa Rican firms, for all four ecosystem services in the following order: watershed protection, biodiversity conservation, carbon sequestration, and scenic beauty. Indirect and non-financial benefits are surprisingly important and can impede the development of ecosystem service markets. At the same time, the activities of intrinsically motivated green entrepreneurs in a financially oriented firm setting might be a prerequisite within a firm context for bringing such innovative topics as ecosystem services from tropical forests to the table.

Introduction: International Migration and Global Governance
Koser K
Switzerland, USA
Social Sciences, Political Sciences, International Relations
This article serves as the introduction for this special issue of Global Governance on international migration. It presents some of the key facts, figures, concepts, and debates on international migration that appear in the articles that follow, and outlines their main arguments. Five arguments in support of greater international cooperation and more formal processes of global governance on international migration are presented here. First, contemporary international migration is now occurring at unprecedented levels and has a truly global reach. Second, international migration can no longer effectively be managed or controlled by national migration policies, and greater international cooperation is required to achieve national goals in international migration. Third, there are growing numbers of migrants around the world who are vulnerable and exploited, and insufficiently protected by either states or international institutions. Fourth, emerging structural features in the global economy, alongside the effects of climate change, are likely to significantly increase the scale of international migration worldwide, and present new management and protection challenges. Finally, momentum for change is slowly developing.

Lofgren A, Müller A
Sweden, Switzerland
Economics, Energy & Fuels
This study undertakes a decomposition analysis to identify the drivers of carbon dioxide emissions change in the Swedish business and industry sectors 1993-2006. On aggregate, energy intensity decreased, but this does not seem to have been very important for reducing emissions. Rather, fuel substitution seems to have been more important, which is in line with findings from the decomposition literature on Sweden. However, at the sectoral level, we find no clear pattern of the effect of fuel substitution and energy intensity on emissions. We also draw some methodological conclusions: decomposition analysis should be undertaken at the most disaggregate level possible; assessing decomposition results by summing results over several time periods leads to biased results; and decomposition analysis should not be based only on some initial and final years of a long time period. Furthermore, we address the problem of double counting energy flows in decomposition analysis of aggregate effects when the energy sector is included, and point out potential problems related to output measured in monetary terms.

Small-Town Sustainability: Prospects in the Second Modernity
Mayer H, Knox P
Switzerland, USA
Economics, Social Sciences, Urban Studies
Small towns account for a significant fraction of the total population in many regions, but there...
has been a relative lack of research into small towns, with researchers’ attention being drawn more to the effects of globalization and technological change on large cities and city regions. Yet, as the effects of globalization have become increasingly imprinted on small towns, transnational grassroots movements have emerged to address the needs, challenges and opportunities of small-town communities. Many of these movements involve partnerships and networks linking the local and international levels. They are often framed in terms of sustainability of their community, with an emphasis on liveability and quality of life. This article places the emergence of cross-border collaborations between small towns in the broader context of shifts from the “first” to the “second modernity”. Through in-depth case studies of movements such as Italy’s Slow Food and Slow City movement, Sweden’s eco-cities, economic gardening in the US and the creative cities project in Albania, we highlight four sensibilities that have emerged: local, organic and slow food; environmentalism; entrepreneurship and creativity.


11.1-325

The economic impact of tourism in six German national parks

Mayer M, Müller M, Woltering M, Arnegger J, Job H

Germany, Switzerland

Economics, Ecology, Landscape Studies

Tourism in protected areas can create considerable income for adjacent communities. Based on face-to-face visitor surveys, the present study measures the structure, size and economic impact of tourist expenditure in the six German national parks Niedersachsisches Wattenmeer, Bayerischer Wald, Eifel, Muritz, Hainich and Kellerwald-Edersee. We find that mean daily expenditure per person of national park visitors is considerably below the national averages for tourists in Germany: day-trippers spend between EUR 7 and 13 per day (national average: EUR 28), whereas overnight visitors spend between EUR 37 and 57 (national average: EUR 120). The proportion of visitors with high national park affinity varies between a maximum of almost 46% in Bayerischer Wald and a minimum of nearly 11% in Niedersachsisches Wattenmeer. Between 49% and 51% of tourist expenditure is captured as direct and indirect income. The total impact of tourism ranges between EUR 525 million in Niedersachsisches Wattenmeer and EUR 1.9 million in Kellerwald-Edersee, reflecting the national parks’ distinct trajectories as tourist destinations. In order to increase the economic benefits accruing from national parks regional policy could aim at a qualitative upgrading of tourist services, increased marketing of the unique national park label and the promotion of a diverse regional supply base.


11.1-326

Sea-level rise impact models and environmental conservation: A review of models and their applications

Mcleod E, Poulter B, Hinkel J, Reyes E, Salm R

USA, Germany, Switzerland

Modelling, Oceanography, Political Sciences

Conservation managers and policy makers need tools to identify coastal habitats and human communities that are vulnerable to sea-level rise. Coastal impact models can help determine the vulnerability of areas and populations to changes in sea level. Model outputs may be used to guide decisions about the location and design of future protected areas and development, and to prioritize adaptation of existing protected area investments. This paper reviews state-of-the-art coastal impact models that determine sea-level rise vulnerability and provides guidance to help managers and policy makers determine the appropriateness of various models at local, regional, and global scales. There are a variety of models, each with strengths and weaknesses, that are suited for different management objectives. We find important trade-offs exist regarding the cost and capacity needed to run and interpret the models, the range of impacts they cover, and regarding the spatial scale that each operates which may overstate impacts at one end and underestimate impacts at the other. Understanding these differences is critical for managers and policy makers to make informed decisions about which model to use and how to interpret and apply the results.

11.1-327
Landscape, Landscape Awareness, and Landscape Identity as Potentials for Regional Development - An Empirical Case Study in Southern Glarus, Switzerland
Meter C, Bucher A, Hagenbuch R
Switzerland
Landscape Studies, Social Sciences
A transdisciplinary understanding of landscape - as a geographical space and as a cultural concept - offers a new approach for sustainable landscape development. This case study of a peripheral mountain region in Switzerland empirically investigates physical landscape as well as landscape awareness and landscape identity on the part of the local population. It seeks to make both aspects of landscape useful for sustainable regional development. Physical landscape was described by cultural-geographical methods; landscape awareness and identity were investigated by a quantitative-qualitative survey. The results show great affinity and a positive attitude of the residents towards their landscape. It was also revealed that the population seems to differentiate between “typical” rural landscapes associated with nature and cultural development, and “normal” landscapes associated with settlements and infrastructure. Landscape is thus shown to be both a functional space and an important part of regional identity. Consequently, landscape has the potential to be relevant for sustainable development.

11.1-328
Are the affluent prepared to pay for the planet? Explaining willingness to pay for public and quasi-private environmental goods in Switzerland
Meyer R, Liebe U
Switzerland, Germany
Economics, Agriculture, Forestry, Plant Sciences, Biodiversity
A large number of ‘environmental justice’ studies show that wealthier people are less affected by environmental burdens and also consume more resources than poorer people. Given this double inequity, we ask, to what extent are affluent people prepared to pay to protect the environment? The analyses are couched within the compensation / affluence hypothesis, which states that wealthier persons are able to spend more for environmental protection than their poorer counterparts. Further, we take into account various competing economic, psychological and sociological determinants of individuals’ willingness to pay (WTP) for both public environmental goods (e.g., general environmental protection) and quasi-private environmental goods (e.g., CO₂-neutral cars). Such a comprehensive approach contrasts with most other studies in this field that focus on a limited number of determinants and goods. Multivariate analyses are based on a general population survey in Switzerland (N = 3,369). Although income has a positive and significant effect on WTP supporting the compensation hypothesis, determinants such as generalized interpersonal trust that is assumed to be positively associated with civic engagement and environmental concern prove to be equally important. Moreover, we demonstrate for the first time that time preferences can considerably influence survey-based WTP for environmental goods; since investments in the environment typically pay off in the distant future, persons with a high subjective discount rate are less likely to commit.

11.1-329
Economic trade-offs between carbon sequestration, timber production, and crop pollination in tropical forested landscapes
Olschewski R, Klein A M, Tscharntke T
Switzerland, Germany
Economics, Agriculture, Forestry, Plant Sciences, Biodiversity
The Millennium Ecosystem Assessment distinguishes between supporting, regulating, provisioning, and cultural ecosystem services. We focus on three services, namely the provision of timber, the regulation of atmospheric carbon dioxide, and the supporting service of bee pollination for coffee production. Possible trade-offs between the different ecosystem services might result in a reduced attractiveness of afforestation projects when taking pollination services into account. We found that economic losses due to a limited reduction of tree density of a Cordia alliodora plantation can be overcompensated by generating pollination services to adjacent coffee agroforest systems. Thus, for moderate silvicultural interventions such trade-offs do not necessarily occur. Including additional ecosystem services such as biological pest control or seed dispersal, which are also associated with the enhanced functional biodiversity in less dense tree plantations, might further emphasize the hump-shaped relationship between tree density and forest revenues.
11.1-330

International regime formation revisited: Explaining ratification behaviour with respect to long-range transboundary air pollution agreements in Europe

Perrin S, Bernauer T
Switzerland
International Relations, Political Sciences, Social Sciences

We draw on the policy diffusion literature to shed more light on the determinants of treaty ratification, a crucial step in the formation of international regimes. Our hypotheses stipulate that a country’s ratification behaviour is influenced by the ratification choices of other countries in general, or of specific types of other countries. The underlying argument is that the ratification behaviour of (specific) other countries sends particular signals - for instance signals about implementation costs, competitiveness effects or reputation costs - to the country in question. The empirical testing is done on data for ratification of the UN Economic Commission for Europe’s agreements on long-range transboundary air pollution. The results show that international factors are as important in influencing ratification choices as domestic factors. This result raises interesting questions about the relative importance of international and domestic determinants in different policy areas and at different stages of international regime formation.


11.1-331

CDM potential of SPV lighting systems in India

Purohit P, Michaelowa A
Germany, Switzerland
Energy & Fuels, Engineering, Economics, International Relations

In view of the increasing interest in the development and dissemination of technologies for harnessing new and renewable sources of energy in India, there have also been some efforts towards their use in the domestic lighting sector. However, the cumulative number of Solar Photovoltaic (SPV) lighting systems such as SPV lanterns and solar home lighting systems in India is far below their theoretical potential despite government subsidy programmes. One of the major barriers is the high capital investment in these systems. The Clean Development Mechanism (CDM) provides industrialized countries with an incentive to invest in emission reduction projects in developing countries to achieve a reduction in CO2 emissions at lowest cost that also promotes sustainable development in the host country. SPV lanterns and solar home lighting systems could be of interest under the CDM because they directly displace greenhouse gas emissions while contributing to sustainable rural development. However, only two SPV projects have been submitted under the CDM so far. This study assesses the maximum theoretical as well as the realistically achievable CDM potential of SPV lanterns and solar home lighting systems in India. The SPV lantern project is financially viable at a certified emissions reductions (CER) price of 34 (sic) whereas the solar home lighting project is financially viable at a CER price of 46 (sic). While the maximum mitigation volume is about 35 million tonne CO2 on an annual basis, an estimate of achievable CER levels is done using the past diffusion trends of SPV systems. We find that annual CER volumes could reach 0.8 to 2.4 million by 2012 and 5.6 to 13.6 million by 2020. This would require that the government sets the subsidy level for SPV lighting systems at a level that allows them to become viable with the CER revenue. From a macroeconomic point of view this makes sense if the sustainability benefits are deemed sufficiently high to warrant promotion of this type of project.


11.1-332

The impact of changing agricultural policies on jointly used rough pastures in the Bavarian Pre-Alps: An economic and ecological scenario approach

Roeder N, Lederbogen D, Trautner J, Bergamini A, Stofer S, Scheidegger C
Germany, Switzerland
Political Sciences, Agriculture, Economics, Ecology, Modelling, Biodiversity

The paper assesses the impact of different policy options on the land use and associated biodiversity values of jointly organised low-intensity grazing systems (’Allmende’) in Bavaria. We use an integrated economic and ecological modelling approach to compare three scenarios with the situation in 2003/05. We base the economic sub-model on single farms, which alter their land use in response to economic stimuli. Within the economic part, factors like the farm’s endowment with machinery and quota are regarded. Within the rule-based ecological sub-model we analyse: area of protected habitats according to the EC Habitats Directive: biodiversity for selected taxonomic groups and habitat quality for different target species. An overall evaluation of the scenarios indicates that
decoupling has a limited effect, because higher direct payments compensate the effect of lower product prices. If all payments are strictly targeted to agri-environmental measures and set to a level which guarantees a low-input management of the grassland, the public costs could be reduced and additional habitats for the target species could be provided. Regarding all indicators but the extent of protected habitats and the public costs, a scenario with a cessation of public payments and market liberalisation performs the worst.


**11.1-334**

**Modelling European winter wind storm losses in current and future climate**

_Schweizer C, Köllner Heck P, Zenklusen Mutter E, Bresch D N, Vidale P L, Wild M, Schär C_

_Switzerland_  

Ecological Economics, Meteorology & Atmospheric Sciences, Modelling

Severe wind storms are one of the major natural hazards in the extratropics and inflict substantial economic damages and even casualties. Insured storm-related losses depend on (i) the frequency, nature and dynamics of storms, (ii) the vulnerability of the values at risk, (iii) the geographical distribution of these values, and (iv) the particular conditions of the risk transfer. It is thus of great importance to assess the impact of climate change on future storm losses. To this end, the current study employs-to our knowledge for the first time—a coupled approach, using output from high-resolution regional climate model scenarios for the European sector to drive an operational insurance loss model. An ensemble of coupled climate-damage scenarios is used to provide an estimate of the inherent uncertainties. Output of two state-of-the-art global climate models (HadAM3, ECHAM5) is used for present (1961-1990) and future climates (2071-2100, SRES A2 scenario). These serve as boundary data for two nested regional climate models with a sophisticated gust parametrization (CLM, CHRM). For validation and calibration purposes, an additional simulation is undertaken with the CHRM driven by the ERA40 reanalysis. The operational insurance model (Swiss Re) uses a European-wide damage function, an average vulnerability curve for all risk types, and contains the actual value distribution of a complete European market portfolio. The coupling between climate and damage models is based on daily maxima of 10 m gust winds, and the strategy adopted consists of three main steps: (i) development and application of a pragmatic selection criterion to retrieve significant storm events, (ii) generation of a probabilistic event set using a Monte-Carlo approach in the hazard module of the insurance model, and (iii) calibration of the simulated annual expected losses with a historic loss data base. The climate models considered agree regarding an increase in the intensity of extreme storms in a band across central Europe (stretching from southern UK and northern France to Denmark, northern Germany into eastern Europe). This effect increases with event strength, and rare storms show the largest climate change sensitivity, but are also beset with the largest uncertainties. Wind gusts decrease over northern Scandinavia and Southern Europe.
Highest intra-ensemble variability is simulated for Ireland, the UK, the Mediterranean, and parts of Eastern Europe. The resulting changes on European-wide losses over the 110-year period are positive for all layers and all model runs considered and amount to 44% (annual expected loss), 23% (10 years loss), 50% (30 years loss), and 104% (100 years loss). There is a disproportionate increase in losses for rare high-impact events. The changes result from increases in both severity and frequency of wind gusts. Considerable geographical variability of the expected losses exists, with Denmark and Germany experiencing the largest loss increases (116% and 114%, respectively). All countries considered except for Ireland (-22%) experience some loss increases. Some ramifications of these results for the socio-economic sector are discussed, and future avenues for research are highlighted. The technique introduced in this study and its application to realistic market portfolios offer exciting prospects for future research on the impact of climate change that is relevant for policy makers, scientists and economists.


11.1-336
Managing a hydro-energy reservoir: A policy approach
van Ackere A, Ochoa P
Switzerland
Energy & Fuels , Political Sciences , Economics
Liberalisation and privatisation have increased the need to gain more understanding into the management of hydro storage (HS) plants. We analyse what types of reservoir management policies enable an owner or a public authority to achieve their respective objectives. By “policy” we understand simple, easily applicable decision rules, which enable a decision maker to decide when and how much to produce based on currently available information. We use a stylised deterministic simulation model of a hydro-power producer (HP) who behaves strategically. We study a non-liberalised market, where the authorities aim to minimise the total electricity cost for customers and a liberalised market where the HP attempts to maximise his contribution. This enables us to evaluate the impact of the liberalisation of HS production decisions on production volumes and electricity prices. We conclude that imposing rigid policies with the aim of limiting the potential for strategic behaviour can create incentives to produce only at very high prices throughout the year. This can lead to very high total costs, especially when the producer has most flexibility (large reservoirs combined with large turbine capacity). More surprisingly, we observe lower total production in a non-liberalised market.

Energy Policy, 2010, V38, N1, NOV, pp 7299-7311 DOI: http://dx.doi.org/10.1016/j.enpol.2010.08.005.
Results confirm findings from previous qualitative studies and show a quantification of a variety of widespread intuitive concepts that laypeople hold about storage mechanisms as well as about leakage and socioeconomic issues, which all appeared to influence risk perception and benefit perception. The perception of an overpressurized reservoir and concerns about diffuse impacts furthermore amplified risk perception. Appropriate images about storage mechanisms and climate change awareness were increasing the perception of benefits. Knowledge about CO\textsubscript{2} seemed to lower both perceived benefits and perceived risks. Implications for risk communication and management are discussed.


11.1-339
Measuring the economic effects of sea level rise on shore fishing
Whitehead J C, Poulter B, Dumas C F, Bin O
USA, Switzerland
Economics, Oceanography
In this paper we develop estimates of the economic effects of sea level rise on marine recreational shore fishing in North Carolina, USA. The relationship between angler behavior and spatial differences in beach width is estimated using the Marine Recreational Fishing Statistics Survey and geospatial data. We exploit the empirical relationship between beach width and fishing site choice by simulating the effects of sea level rise on angler site choice. We find that reductions in beach width negatively affect the quality and number of fishing trips even as anglers adapt by using piers and bridges. Welfare losses are potentially substantial, ranging up 39\% of the total value of marine shore fishing in North Carolina.

11.1-340
The Regional Network for Asian Schistosomiasis and Other Helminth Zoonoses (RNAS(+)): Target Diseases in Face of Climate Change
Peoples R China, Switzerland, Sweden
Medicine, Human & Public Health, Zoology, Modelling
Climate change—according to conventional wisdom—will result in an expansion of tropical parasitic diseases in terms of latitude and altitude, with vector-borne diseases particularly prone to change. However, although a significant rise in temperature occurred over the past century, there is little empirical evidence whether climate change has indeed favoured infectious diseases. This might be explained by the complex relationship between climate change and the frequency and the transmission dynamics of infectious diseases, which is characterised by nonlinear associations and countless other complex factors governing the distribution of infectious diseases. Here, we explore whether and how climate change might impact on diseases targeted by the Regional Network for Asian Schistosomiasis and Other Helminth Zoonoses (RNAS(+)). We start our review with a short summary of the current evidence-base how climate change affects the distribution of infectious diseases. Next, we introduce biology-based models for predicting the distribution of infectious diseases in a future, warmer world. Two case studies are presented: the classical RNAS(+) disease schistosomiasis and an emerging disease, angiostrongyliasis, focussing on their occurrences in the People’s Republic of China. Strengths and limitations of current models for predicting the impact of climate change on infectious diseases are discussed, and we propose model extensions to include social and ecological factors. Finally, we recommend that mitigation and adaptation strategies to diminish potential negative effects of climate change need to be developed in concert with key stakeholders so that surveillance and early-warning systems can be strengthened and the most vulnerable population groups protected.
Advances in Parasitology, 2010, V73, pp 101-135 DOI: http://dx.doi.org/10.1016/S0065-308X(10)73005-0.
4 Mitigation and Adaptation Technologies

11.1-341
Effect of hybrid system battery performance on determining CO₂ emissions of hybrid electric vehicles in real-world conditions
Alvarez R, Schlienger P, Weilenmann M
Switzerland
Energy & Fuels, Meteorology & Atmospheric Sciences, Engineering
Hybrid electric vehicles (HEVs) can potentially reduce vehicle CO₂ emissions by using recuperated kinetic vehicle energy stored as electric energy in a hybrid system battery (HSB). HSB performance affects the individual net HEV CO₂ emissions for a given driving system battery (HSB). HSB performance affects the vehicle energy stored as electric energy in a hybrid system battery by approximately 13% in real-world conditions of one HEV by approximately 13% in real-world driving patterns. The main observation is that the selected HEVs can only use 67-80% of the charge provided to the HSB, which distorts the outcomes of the statutory correction procedure that does not consider such irreversibility. CO₂ emissions corrected according to this procedure underestimate the true net CO₂ emissions of one HEV by approximately 13% in real-world urban driving. The correct CO₂ emissions are only reproduced when considering the HSB performance in this driving pattern. The statutory procedure for correcting HEV CO₂ emissions should, therefore, be adapted.


11.1-342
Scenario Analysis Exploring the Macroeconomic Impacts of Information and Communication Technologies on Greenhouse Gas Emissions
Erdmann L, Hilty L M
Germany, Switzerland
Energy & Fuels, Economics
During the past decade, several macroeconomic studies on the potentials of information and communication technology (ICT) to reduce greenhouse gas (GHG) emissions have been published. The mitigation potentials identified in them vary to a high degree, mainly because they are not consistently defined and diverse methodologies are applied. The characteristics of ICT-exceptional dynamics of innovation and diffusion, social embedment and cross-sector applications, diverse and complex impact patterns-are a challenge for macroeconomic studies that quantify ICT impacts on GHG emissions. This article first reviews principal macroeconomic studies on ICT and GHG emissions. In the second part, we reconsider our own study on this topic and present an in-depth scenario analysis of the future impacts of ICT applications on GHG emissions. We conclude that forthcoming macroeconomic studies could strengthen the state of the art in environmental ICT impact modeling (1) by accounting for the dynamics of new ICT applications and their first-, second-, and third-order effects on a global scale, (2) by reflecting the error margins resulting from data uncertainty in the final results, and (3) by using scenario techniques to explore future uncertainty and its impacts on the results.


11.1-343
Evaluation of the particle measurement programme (PMP) protocol to remove the vehicles’ exhaust aerosol volatile phase
Italy, Switzerland
Energy & Fuels, Engineering, Meteorology & Atmospheric Sciences
European regulation for Euro 5/6 light duty emissions introduced the measurement of non-volatile particles with diameter >23 nm. The volatile phase is removed by using a heated dilution stage (150 degrees C) and a heated tube (at 300-400 degrees C). We investigated experimentally the removal efficiency for volatile species of the specific protocol by conducting measurements with two Euro 3 diesel light duty vehicles, a Euro 2 moped, and a Euro III heavy duty vehicle with the system’s heaters on and off. The particle number distributions were measured with a Scanning Mobility Particle Sizer (SMPS) and a Fast Mobility Particle Sizer (FMPS). An Aerosol Mass Spectrometer (AMS) was used to identify the non-refractory chemical composition of the particles. A Multi-Angle Absorption Photometer (MAAP) was used to measure the black carbon concentration. The results showed that the condensed material in the accumulation mode (defined here as particles in the diameter range of similar to 50-500 nm) was removed with an efficiency of 50-90%. The volatile nucleation mode was also completely evaporated or was decreased to sizes <23 nm; thus, these particles wouldn’t be counted from the particle counter, indicating the robustness of the protocol.

11.1-344
Exhaust-Stream and In-Cylinder Measurements and Analysis of the Soot Emissions From a Common Rail Diesel Engine Using Two Fuels
Kirchen P, Obrecht P, Boulouchos K, Bertola A
Switzerland
Energy & Fuels , Engineering
The operation and emissions of a four cylinder, passenger car common- rail diesel engine operating with two different fuels was investigated on the basis of exhaust-stream and in-cylinder soot measurements, as well as a thermodynamic analysis of the combustion process. The two fuels considered were a standard diesel fuel and a synthetic diesel (fuel two) with a lower aromatic content, evaporation temperature, and cetane number than the standard diesel. The exhaust-stream soot emissions, measured using a filter smoke number system, as well as a photo-acoustic soot sensor (AVL Micro Soot Sensor), were lower with the second fuel throughout the entire engine operating map. To elucidate the cause of the reduced exhaust- stream soot emissions, the in-cylinder soot temperature and the KL factor (proportional to concentration) were measured using miniature, three-color pyrometers mounted in the glow plug bores. Using the maximum KL factor value to quantify the soot formation process, it was seen that for all operating points, less soot was formed in the combustion chamber using the second fuel. The oxidation of the soot, however, was not strongly influenced by the fuel, as the relative oxidized soot fraction was not significantly different for the two fuels. The reduced soot formation of fuel two was attributed to the lower aromatic content of the fuel. The soot cloud temperatures for operation with the two fuels were not seen to differ significantly. Similar correlations between the cylinder-out soot emissions, characterized using the pyrometers, and the exhaust-stream soot emissions were seen for both fuels. The combustion process itself was only seen to differ between the two fuels to a much lesser degree than the soot formation process. The predominant differences were seen as higher maximum fuel conversion rates during premixed combustion at several operating points, when fuel two was used. This was attributed to the lower evaporation temperatures and longer, ignition delays (characterized by the lower cetane number) leading to larger premixed combustion fractions.

11.1-345
Eawag Forum Chriesbach-Simulation and measurement of energy performance and comfort in a sustainable office building
Lehmann B, Güttinger H, Dorer V, van Velsen S, Thiemann A, Frank Th
Switzerland
Energy & Fuels , Engineering , Economics
The Eawag’s new headquarters “Forum Chriesbach” is an exemplary illustration of a ‘sustainable’ construction design for office buildings. With a unique combination of architectural and technical elements the building reaches a very low 88 kWh/m(2) overall primary energy consumption, which is significantly lower than the Swiss Passive House standard, Minergie-P. A monitoring and evaluation project shows that the building is heated mainly by using the sun and internal heat gains from lighting, electrical appliances and occupants, resulting in an extremely low space heating demand. Cooling is provided by natural night time ventilation and the earth- coupled air intake, which pre-cools supply air and provides free cooling for computer servers. However, values for embodied energy and electricity consumption remain significant, even with partial on-site electricity production using photovoltaics. TRNSYS computer simulations show the contributions of individual building services to the overall energy balance and indicate that the building is resilient towards changes in parameters such as climate or occupancy density. Measurements confirm comfortable room temperatures below 26 degrees C, even during an extremely hot summer period, and 20-23 degrees C in the winter season. An economic analysis reveals additional costs of only 5% compared to a conventionally constructed building and a payback time of 13 years.

11.1-346
Power and cogeneration technology enviro-nomic performance typification in the context of CO₂ abatement part II: Combined heat and power cogeneration
Li H, Marechal F, Favrat D
Switzerland
Energy & Fuels , Engineering , Economics , Modeling
This is the second of a series of two articles, dealing with a new approach of enviro-nomic (ther-modynamic, economic and environmental) performance Typification and optimization of power generation technologies. This part treats specifi-
cally of combined heat and power (CHP) cogeneration technologies in the context of CO₂ abatement and provides a methodology for a flexible and fast project based CHP system design evaluation. One of the aspect of the approach is the post-optimization integration of the operating and capital costs, in order to effectively deal with the uncertainty of the project specific design and operation conditions (fuel, electricity and heat selling prices, project financial conditions such as investment amortization periods, annual operating hours, etc). In addition the approach also allows to efficiently evaluate the influence of the external cost such as the CO₂ tax level under a tax scheme or the CO₂ permit price in the emission trading market. Application examples, including gas turbine and combined cycles are treated with the proposed methodology, by using superstructure based generic enironomic models and a multi-objective optimizer.


11.1-347
Characterization of particulate matter deposited in diesel particulate filters: Visual and analytical approach in macro-, micro- and nano-scales
Liati A, Dimopoulos Eggenschwiler P
Switzerland
Energy & Fuels , Engineering
Multi-scale analytical investigations of particulate matter (soot and ash) of two loaded diesel particulate filters (DPF) from (a) a truck (DPF1) and (b) a passenger car (DPF2) reveal the following: in DPF1 (without fuel-borne additives), soot aggregates form an approximately 130-270µm thick, homogeneous porous cake with pronounced orientation. Soot aggregates consist of 15-30 nm large individual particles exhibiting relatively mature internal nanostructures, however, far from being graphite. Ash aggregates largely accumulate at the outlet part of DPF1, while minor amounts are deposited directly on the channel walls all along the filter length. They consist of crystalline phases with individual particles of sizes down to the nanoscale range. Chemically, the ash mainly of Mg, S, Ca, Zn and P, elements encountered in lubricating oil additives. In the passenger car DPF2 (with fuel-borne additives), soot aggregates form an approximately 200-500µm thick, inhomogeneous porous cake consisting of several superposed layers corresponding to different soot generations. The largest part of the soot cake is composed of unburned, oriented soot aggregates left behind despite repeated regenerations, while a small part constitutes a loose layer with randomly oriented aggregates, which was deposited last and has not seen any regeneration. Fe-oxide particles of micro- to nano-scale sizes, originating from the fuel-borne additive, are often dispersed within the part of the soot cake composed of the unburned soot leftovers. The individual soot nanoparticles in DPF2 are approximately 15-40 nm large and generally less mature than in the truck DPF1. The presence of soot leftovers in DPF2 indicates that the addition of fuel-borne material does not fully compensate for the temperatures needed for complete soot removal. Ash in DPF2 is filling up more than half of the filter volume (at the downstream part) and is dominated by Fe-oxide aggregates, due to the Fe-based fuel-borne additive, but otherwise its chemical composition reflects compounds of lubricating oil additives.


11.1-348
Oxidative Potential of Logwood and Pellet Burning Particles Assessed by a Novel Proflourescent Nitroxide Probe
Australia, Switzerland
Energy & Fuels , Engineering , Meteorology & Atmospheric Sciences , Toxicology
This study reports the potential toxicological impact of particles produced during biomass combustion by an automatic pellet boiler and a traditional logwood stove under various combustion conditions using a novel proflourescent nitroxide probe, BPEAnit. This probe is weakly fluorescent but yields strong fluorescence emission upon radical trapping or redox activity. Samples were collected by bubbling aerosol through an impinger containing BPEAnit solution, followed by fluorescence measurement. The fluorescence of BPEAnit was measured for particles produced during various combustion phases: at the beginning of burning (cold start), stable combustion after refilling with the fuel (warm start), and poor burning conditions. For particles produced by the logwood stove under cold-start conditions, significantly higher amounts of reactive species per unit of particulate mass were observed compared to emissions produced during a warm start. In addition, sampling of logwood burning emissions after passing through a thermodenuder at 250 degrees C resulted in an 80-100% reduction of the fluorescent...
cence signal of the BPEAnit probe, indicating that the majority of reactive species were semivolatile. Moreover, the amount of reactive species showed a strong correlation with the amount of particulate organic material. This indicates the importance of semivolatile organics in particle-related toxicity. Particle emissions from the pellet boiler, although of similar mass concentration, were not observed to lead to an increase in fluorescence signal during any of the combustion phases. *Environmental Science Technology, 2010, V44, N17, SEP 1, pp 6601-6607 DOI: http://dx.doi.org/10.1021/es100963y.*

11.1-349
**Contribution of Li-Ion Batteries to the Environmental Impact of Electric Vehicles**
Switzerland

Battery-powered electric cars (BEVs) play a key role in future mobility scenarios. However, little is known about the environmental impacts of the production, use and disposal of the lithium ion (Li-ion) battery. This makes it difficult to compare the environmental impacts of BEVs with those of internal combustion engine cars (ICEVs). Consequently, a detailed lifecycle inventory of a Li-ion battery and a rough LCA of BEV based mobility were compiled. The study shows that the environmental burdens of mobility are dominated by the operation phase regardless of whether a gasoline-fueled ICEV or a European electricity fueled BEV is used. The share of the total environmental impact of E-mobility caused by the battery (measured in Ecoindicator 99 points) is 15%. The impact caused by the extraction of lithium for the components of the Li-ion battery is less than 2.3% (Ecoindicator 99 points). The major contributor to the environmental burden caused by the battery is the supply of copper and aluminum for the production of the anode and the cathode, plus the required cables or the battery management system. This study provides a sound basis for more detailed environmental assessments of battery based E-mobility. *Environmental Science Technology, 2010, V44, N17, SEP 1, pp 6550-6556 DOI: http://dx.doi.org/10.1021/es903729a.*

11.1-350
**Efficient formation of stratospheric aerosol for climate engineering by emission of condensible vapor from aircraft**
Pierce J R, Weisenstein D K, Heckendorn P, Peter T, Keith D W
Canada, USA, Switzerland

Recent analysis suggests that the effectiveness of stratospheric aerosol climate engineering through emission of non-condensable vapors such as SO2 is limited because the slow conversion to H2SO4 tends to produce aerosol particles that are too large; SO2 injection may be so inefficient that it is difficult to counteract the radiative forcing due to a CO2 doubling. Here we describe an alternate method in which aerosol is formed rapidly in the plume following injection of H2SO4, a condensable vapor, from an aircraft. This method gives better control of particle size and can produce larger radiative forcing with lower sulfur loadings than SO2 injection. Relative to SO2 injection, it may reduce some of the adverse effects of geoengineering such as radiative heating of the lower stratosphere. This method does not, however, alter the fact that such a geoengineered radiative forcing can, at best, only partially compensate for the climate changes produced by CO2.


11.1-351
**Bioenergy in Switzerland: Assessing the domestic sustainable biomass potential**
Steubing B, Zah R, Waeger P, Ludwig C
Switzerland

This paper analyzes the sustainable domestic biomass potential for bioenergy in Switzerland. Relevant biomass resources were selected based on expert interviews and literature analyses. A definition of technical and sustainable biomass potentials was developed. The technical and sustainable biomass potentials were then assessed based on technical and sustainability constraints. The sustainable potentials were further subdivided into the already energetically-used potential and the remaining biomass potential. Data was collected
from the literature and supplementary interviews with field experts. Finally, the primary energy potential from biomass was calculated and compared to the current Swiss energy demand. We show that there is currently no sustainable potential for agricultural biomass, such as energy crops, crop residues and grass. On the other hand, there is a substantial potential from woody biomass, manure and waste biomass. The main constraints that limit the sustainable biomass potential are competing material utilizations, economic factors as well as the Swiss biofuels policy. Currently, 3.6% of Switzerland’s energy demand is met by biomass resources, whereas the remaining potential could provide an additional 3.3%. Hence, with respect to a sustainable energy supply, bioenergy in Switzerland could cover a total share of 7%.


5 General Topics

11.1-352
From Publications to Public Actions: When Conservation Biologists Bridge the Gap between Research and Implementation
Switzerland, Australia
Biodiversity, Ecology, Social Sciences
There is a vigorous debate about the capacity of conservation biology, as a scientific discipline, to effectively contribute to actions that preserve and restore biodiversity. Various factors may be responsible for the current great divide that exists between conservation research and action. Part of the problem may be a lack of involvement by conservation scientists in actually conducting or helping implement concrete conservation actions, yet scientists’ involvement can be decisive for successful implementation, as illustrated here by the rapid recovery of an endangered hoopoe population in the Swiss Alps after researchers decided to implement the corrective measures they were proposing themselves. We argue that a conceptual paradigm shift should take place in the academic conservation discipline toward more commitment on the part of researchers to turn conservation science into conservation action. Practical implementation should be regarded as an integrated part of scientific conservation activity as it actually constitutes the ultimate assessment of the effectiveness of the recommended conservation guidelines, and should be rewarded as such.

Bioscience, 2010, V60, N10, NOV, pp 835-842 DOI: http://dx.doi.org/10.1525/bio.2010.60.10.10.

11.1-353
A methodology to assess the influence of local wind conditions and building orientation on the convective heat transfer at building surfaces
Defraeye T, Carmeliet J
Belgium, Switzerland
Engineering, Modelling, Meteorology & Atmospheric Sciences, Urban Studies, Energy & Fuels
Information on the statistical mean convective heat transfer coefficient (CHTCSM) for a building surface, which represents the temporally-averaged CHTC over a long time span (e.g. the lifetime of the building), could be useful for example for the optimisation of the performance of solar collectors and ventilated photovoltaic arrays or for preservation analysis of cultural heritage sites. A methodology is proposed to estimate the CHTCSM for a building surface, by combining local wind climate information and information on the CHTC, namely CHTC-U-10 correlations, where U-10 is the mean wind speed at a height of 10 m above the ground. This methodology is applied to a cubic building for a specific wind climate, where the CHTC-U-10 correlations are obtained by means of CFD simulations (CFD code Fluent 6.3, realizable k-epsilon turbulence model). It is shown that the CHTCSM varied significantly with the orientation of the building surface due to the rather anisotropic wind conditions, where high values are found for surfaces oriented towards the prevailing wind directions, thus for windward conditions. Moreover, the evaluation of the CHTCSM for other wind climates clearly shows that the local wind
conditions also can have a significant impact on the overall magnitude of the CHTCSM, where differences up to a factor 4 are found in this study. Different levels of complexity for determining the CHTCSM value are also evaluated and it is found that the required number of CFD simulations can be reduced significantly by using more simplified methods to calculate the CHTCSM, without compromising its accuracy. The applicability of the proposed methodology for other building-related applications is also discussed, for example to assess statistical mean pressure coefficients, wind-driven ventilation rates or convective mass transfer coefficients.


11.1-354 LCI modelling approaches applied on recycling of materials in view of environmental sustainability, risk perception and eco-efficiency

Frischknecht R
Switzerland
Energy & Fuels, Modelling, Economics

Two ISO-compliant approaches on modelling the recycling of plastics and metals are frequently applied in life cycle assessment case studies and intensively debated: the recycled content or cutoff approach and the end of life recycling or avoided burden approach. This paper discusses the two approaches from three different perspectives: (1) the kind of sustainability concept served, (2) the risk perception involved and (3) the eco-efficiency indicators resulting from the two approaches. The analysis shows that the recycled content approach serves the strong sustainability concept. It is based on a risk-averse attitude and results in higher eco-efficiency of metal scrap recycling as compared to primary metal manufacture. The end of life recycling approach serves the weak sustainability concept (losses in natural capital can be compensated by man-made capital). It corresponds to a risk-seeking attitude and results in higher eco-efficiency of primary metal manufacture as compared to secondary metal production. It is concluded that a harmonisation of the approaches is hardly possible due to the value choices involved. It is the task of (private and public) life cycle assessment commissioners to decide on the appropriate modelling approach. National authorities may have a rather long-term and risk-averse perspective, whilst industries may prefer a short-term perspective leading them to select the recycled content and end of life recycling approach, respectively. Life cycle inventory databases need to be flexible to serve such opposing perspectives and to enable practitioners to adapt the modelling approaches according to the needs of the commissioner. International Journal of Life Cycle Assessment, 2010, V15, N7, AUG, pp 666-671 DOI: http://dx.doi.org/10.1007/s11367-010-0201-6.

11.1-355 Scope-dependent modelling of electricity supply in life cycle assessments

Frischknecht R, Stucki M
Switzerland
Energy & Fuels, Modelling, Economics

Electricity use or substitution is one of the key parameters with regard to life cycle assessment (LCA) results. At the same time, it is often used as an illustrative example to highlight the modelling differences between decision-oriented and descriptive LCA. Three basically different models exist in life cycle inventory analysis: the attributional, the consequential and the decisional model. This paper proposes criteria that help to classify typical LCA questions regarding real business cases and find the most appropriate life cycle inventory (LCI) model. The framework is applied to a case study of an LCA of electricity use and supply within the international operations of an environmental service company with headquarters in France. Individual decision with comparatively small consequences can be modelled under ceteris paribus (other things being equal) conditions. Decision situations with medium to large potential consequences should be modelled under the conditions of mutatis mutandis (the necessary changes being made). The key question is how to distinguish between small, medium and large consequences. We recommend using the relative economic size to classify objects of investigation and the LCA goals related to them into three groups to which the most appropriate LCI models are assigned. The attributional approach is sensible for environmental reporting and product labelling and declaration where the relative economic size of the object of investigation is small. The decisional approach is sensible for LCAs of product and process development, as well as site and supplier evaluation carried out by private companies in case the relative economic size of the object of investigation is medium. The consequential approach is of relevance for policy support of governments and international organisations as well as for strategic decisions of companies, where the relative economic size of the object of investigation is large. The consequential approach is also sensible in product or service comparisons by companies, if they offer products or services that are in line or help to comply with
large-scale government policy measures (like for instance promotings renewable fuels). The French attributional and decisional electricity supply mix causes greenhouse gas emissions of 98 and 225 g CO$_2$-eq./kWh, respectively, whereas the European attributional and decisional electricity supply mix causes greenhouse gas emissions of 554 and 473 g CO$_2$-eq./kWh, respectively. The volumes of high radioactive waste generated with the French and EU-27 electricity mixes amount to 11 and 3.5 mm(3)/kWh for the attributional mixes as well as 3.8 and 0.034 mm(3)/kWh for the decisional mixes. The criterion "relative economic size" helps to better decide on the appropriate LCI model to be applied in specific LCA case studies supporting any kind of decisions. Being quantitative, the "relative economic size" criterion is comparable to the criteria used to delimitate the product system (cut-off criteria mass, energy and environmental impact). The delimitation values proposed are still preliminary and still show a certain degree of ambiguity. Nevertheless, it proves to be both a practical and potentially relevant criterion. The case study of the French and European electricity mixes shows that a distinction of different decision contexts is required and feasible. Using official statistical information and published forecasts issued by the relevant industrial associations or governmental bodies significantly reduces the potential bias related to the determination of possible change-oriented electricity mixes. The relative economic size of the object of investigation is a quantified criterion to decide on the most appropriate modelling approach in life cycle inventory. It is recommended to apply the criterion in the goal and scope phase of any LCA and to apply it on the production volume on the one hand and on purchase volumes on the other. Production and purchase volumes can be expressed in either economic or physical quantities and be related to the totals of economic sectors or political entities such as nations or international organisations. The current paper deals with the appropriate modelling approach illustrated with the electricity mix. The electricity sector is only one of many sectors where the choice of the modelling approach may reveal important differences in the overall environmental impacts. Thus, it is worthwhile to extend the concept presented in this paper to other economic sectors such as agriculture, mining or paper and pulp. This would help to better substantiate or to adjust the delimitation values and to gain more experience with the threshold criteria proposed.

**11.1-356**

**Exploring research issues in selected forest journals 1979-2008**

Kaen nel Dobbertin M, Nobis M P
Switzerland
For estry, Plant Sciences
Forest science and policy have experienced significant changes under the pressure of global change. Assuming that scientific publications mirror contemporary issues, our objective was to verify whether titles of articles show a temporal trend, and whether it coincides with the new agenda set by sustainable forest management. We used ISI Web of Science to collect articles published 1979-2008 in 6 peer-reviewed forest(ry) journals (n = 20 677). We split titles into strings and processed them to increase the homogeneity of our sample. We applied principal components analysis (PCA) as an indirect gradient analysis. We also searched titles for words related to the social, political and economic components of forestry. The PCA ordination revealed a dominant and distinct time gradient in the use of title words in our corpus. A few words have disappeared, but those with a positive trend clearly dominate, reflecting an opening of forest science towards more process-oriented research, especially in ecology and environmental and climate change. However, socio-economic aspects are still underrepresented. In our study, titles of forest(ry) publications increasingly include topics from neighboring natural sciences, but still very few from socio-economic disciplines.

*Annals of Forest Science, 2010, V67, N8, DEC 11.1-357*

**Developing a common strategy for integrative global environmental change research and outreach: the Earth System Science Partnership (ESSP) Strategy paper**

Netherlands, Switzerland, USA, Australia, England, France, Brazil, India, Germany, Sweden
Biodiversity, Geochemistry & Geophysics, Social Sciences, Meteorology & Atmospheric Sciences
The Earth System Science Partnership (ESSP) was established in 2001 by four global environmental change (GEC) research programmes: DIVERSEAS, IGBP, IHDP and WCRP. ESSP facilitates the study of the Earth’s environment as an integrated system in order to understand how and why it is changing, and to explore the implications of these
changes for global and regional sustainability. Joint research projects on carbon dynamics, food, water and health have been established. As a result of an independent review, the ESSP developed a new strategy that will provide an internationally coordinated and holistic approach to Earth system science. The approach integrates natural and social sciences from regional to the global scale. The mainstay of the ESSP is to identify and define Earth system science challenges, enable integrative research to address these challenges, and build scientific capacity. The GEC research community also faces an increasing challenge to present research results in more accessible and informative ways to stakeholders, especially to policy-makers. In response, the ESSP is developing new services that include knowledge products, Earth system science fora, a synthesis journal and interdisciplinary collaborative research. Coping with GEC is an enormous challenge and one the world must respond to successfully. Our common goal is, therefore, to develop the essential knowledge base needed to respond effectively and quickly to the great challenge of GEC.

11.1-358
The State of Multimedia Mass-Balance Modeling in Environmental Science and Decision-Making
MacLeod M, Scheringer M, Mckone T E, Hungerbühler K
Switzerland, USA

11.1-359
Scientists - take action for access to biodiversity
Martinez S I, Biber Klemm S
Switzerland
Biodiversity, Political Sciences, Economics
Biodiversity research generates critically important knowledge for the implementation of the Convention on Biological Diversity (CBD)’s goals. However, academic noncommercial scientists intending to study biodiversity experience obstacles caused by restrictive access conditions legislated by the countries that provide access to their genetic resources. Currently, a legally binding protocol on Access and Benefit Sharing (ABS) is being negotiated within the CBD without adequate involvement of the academic community. The ABS regulations were originally designed for commercial uses that generate monetary benefits from the utilization of genetic resources. Noncommercial research should expeditiously assert its interests and state its needs in the ABS negotiations. Academia has failed to market to policy makers its special dual role as user of genetic resources and as generator of essential knowledge for the benefit of the CBD and society at large.

Current Opinion in Environmental Sustainability, 2010, V2, N1-2, MAY, pp 27-33 DOI: http://dx.doi.org/10.1016/j.cosust.2010.03.004.

11.1-360
Sharing the benefits of biodiversity: some perspectives from the recent history of conservation
Mcneely J A
Switzerland
Biodiversity, International Relations, Ecology

11.1-361
Access and benefit sharing and the ethical sourcing of biodiversity
Oliva M
Switzerland
Biodiversity, Economics

11.1-362
MEXALCA: a modular method for the extrapolation of crop LCA
Roches A, Nemecek T, Gaillard G, Plassmann K, Sim S, King H, Mia I Canals L
Switzerland, England
Agriculture, Energy & Fuels, Modelling
Life cycle assessment (LCA) is widely used for the environmental assessment of food products, but difficulties arise when evaluating large portfolios of food products or when faced with a diversity of sources of ingredients and/or frequent changes of suppliers. In such situations, a specific, in-depth assessment of each ingredient is not feasible, and screening approaches using a few LCIA (Life Cycle Impact Assessment) results are not recommended. The goal of this paper is to propose an intermediate solution between a screening assessment using limited data and specific LCA for all products considering all sources of ingredients. The extrapolation method presented here (Modular EXtrapolation of Agricultural LCA (MEXALCA)) allows deriving LCIA results for a crop in a specific (target) country using the LCIA data of the same
crop in another (original) country. The existing crop inventory (LCI) is split into nine modules corresponding to the main on-field and post-harvest activities, each associated to its key farming input. This approach reduces the complexity of the inventories, and data collection is focused on nine inputs in the target country. Additionally, data can be approximated by means of statistical estimators if necessary. Impacts per unit of farming input are calculated for each module in the original country and combined with the quantity of farming inputs in the target countries in order to determine the impacts in the latter. Combining MEXALCA with available national statistics provides the means for a rapid evaluation of environmental impacts of a given crop for all producing countries globally and the determination of their statistical distribution. The range of the impacts for a number of crops was determined, and a sensitivity analysis with values derived from national statistics was conducted. Validation of the method showed a good performance for the evaluation of energy demand, ozone formation, and global warming potential. The method was inaccurate for eutrophication and acidification and not suitable for toxicity impact categories. Extrapolation of agricultural LCIs using statistical data and existing inventories is feasible. Compared with many streamlined LCA approaches, it does not discard processes nor jeopardise the understanding of the production system. MEXALCA shows benefits in terms of the amount of data and time required and allows for data generation on a multi-country scale. It appears promising for an assessment of products from various origins and may also be useful for the extrapolation of one product to another. The method is suitable for environmental assessments at the regional or global scale and to fill data gaps in traditional LCAs. However, extrapolation should not replace a conventional LCA for the assessment of a specific product, and particular caution should be exercised for spatially dependent impact categories such as eutrophication or acidification.


11.1-363
Modeling carbon footprints across the supply chain
Sundarakani B, de Souza R, Goh M, Wagner S M, Manikandan S
U Arab Emirates, Singapore, Australia, Switzerland
Energy & Fuels, Economics, Modelling
Environmental consciousness has become critical in the design and operation of globally integrated supply chain networks. This research examines the carbon footprint across supply chains and thus contributes to the knowledge and practice of green supply chain management. The analytical model uses the long-range Lagrangian and the Eulerian transport methods. Analytical and finite difference methods are used to approximate the three-dimensional infinite footprint model. A simplified numerical example validates and illustrates the proposed approach. The results show that carbon emissions across stages in a supply chain can constitute a significant threat that warrants careful attention in the design phase of supply chains.

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