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10. Meteorology and Climatology +
11. Greenhouse Gases: Linkages between Biosphere and Climate

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10. Meteorology and Climatology +
11. Greenhouse Gases: Linkages between Biosphere and Climate

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Swiss Meteorological Society,
Commission on Atmospheric Chemistry and Physics,
ProClim–,
Swiss Committee of IGBP

TALKS:

POSTER:

10.1

Numerical simulations of short-crested surface waves for a pre-Alpine lake using the SWAN wave model

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The spectral wave model SWAN (Simulation Waves Nearshore) was applied for Lake Zurich, a narrow pre-Alpine lake in Switzerland. It is able to simulate short-crested wind-generated surface waves. The model was forced by a dynamic wind field taken from the numerical weather prediction model COSMO-2. The winds are available in 1-h time steps. Model simulations were compared with measured wave data at one near-shore site during three different time periods dominated by: 1) low winds, 2) transient foehn winds, and 3) strong on-shore winds. The results suggest that the quality of the wave simulation highly depends on the accuracy of the input wind fields and varies strongly for different wind situations.

The influence of the temporal wind resolution is further studied with two sensitivity experiments. The first one considers a low-pass filtered wind field, based on a 2-h running mean of COSMO-2 output, and the second experiment uses a simple synthetic gust simulation, which is implemented into the SWAN model and takes into account short-term fluctuations of wind speed at 1 sec resolution. The wave field significantly differs for the 1-h and 2-h simulations, but is only negligibly affected by the gust simulation.

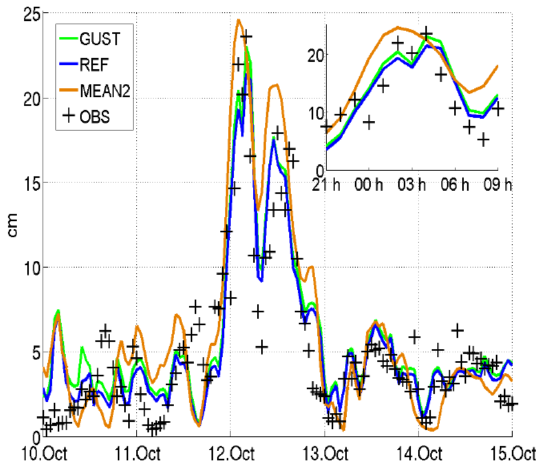

Figure 1: Time series of the significant wave height [cm] near Meilen. Grey crosses are in-situ measurements in Meilen. The solid lines are model outputs of the SWAN. The time resolution of the input winds for SWAN is given by one of the following three scenarios: (a) 1-hour resolution COSMO-2 data (REF); (b) 2-hour COSMO-2 running means (MEAN2); and (c) high-resolution (1 sec) synthetic wind speeds that take gustiness into account.

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10.2

Regional scale methane emissions derived from concentration gradient measurements along the Reuss Valley, Switzerland

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Today's greenhouse gas inventories are typically based on bottom-up estimates, but comparisons to atmospheric measurements are scarce and can disagree by a factor of two or more (Nisbet & Weiss, 2010). Therefore, top-down assessments to verify the commonly used emission factors are needed. In Switzerland, 83% of the anthropogenic methane emissions are attributed to the agricultural sector (FOEN, 2010). To validate emission inventory estimates from this most relevant source in Switzerland, we performed aircraft measurements along part of the Reuss Valley, a pre-alpine valley dominated by agriculture.

Flight legs were mostly chosen to follow the terrain at constant heights of 50–400 m above ground surface. These transects showed distinct patterns in CH_4 concentrations depending on local changes in CH_4 source strength in combination with dynamic changes of atmospheric conditions. During periods with a steady valley wind system, a CH_4 concentration gradient was observed along the valley axis, with increasing concentrations along the direction of the prevailing wind. During these conditions it was possible to use a simple box model approach to calculate regional-scale fluxes. Additionally, fluxes were calculated with the help of the eddy covariance (EC) method. A spatially highly resolved CH_4 inventory allowed comparing aircraft-based regional scale flux estimates with fluxes based on default emission factors used for the Swiss national inventory report (FOEN, 2010).

In general, the regional scale fluxes derived by box and EC methods were comparable, but slightly higher than those suggested by the inventory. The scattering of fluxes based on the box model was larger than that based on the EC fluxes. However, biases are potentially present in both our estimates and the inventory. Aircraft measurements were only taken during the warm season at daytime, whereas the inventory represents mean annual flux estimates. A recent publication (Klevenhusen et al., 2010) further suggests 25% higher CH_4 emission factors for ruminants than used in the national inventory. This affects the most dominant CH_4 source in our study area. In addition, the inventory only accounts for the major anthropogenic CH_4 emissions (about 90%) and does not include natural fluxes, e.g. wetland emissions. Considering all the uncertainties, a good agreement between inventory and measurement based fluxes was found.

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10.3

New balloon sounding technic used to investigate the radiation error on radiosonde temperature measurements

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Radiosondes are usually fixed with a single string of about 30 meters below a weather balloon. Analysis of video recordings and GPS data from several different flights showed that small gusts can lead to intense wobbling of the sonde. To get a smoother ascending, two balloons with a special triangle were attached to stabilize the whole radiosonde. This two balloon flight system allows releasing the carrier balloon with a controlling device inside the triangle once the sonde reached a given preset altitude. The second or parachute balloon is inflated such that the payload descents to the ground with the same speed as during ascent which leads to a much more predictable flight than before. With such a construction we were able to get rid of the wobbling which was a key element to our experiment were we need a stable platform for investigating the radiation error on radiosonde temperature measurements. The measurement of atmospheric temperature by radiosonde instruments is affected by heating from sources other than the air itself. Solar and infrared radiation, heat conduction to the temperature sensor from its attachment points, and infrared radiation emitted by the sensor are heat sources or sinks that make the temperature of the sensor different from that of the air in which it is embedded. Further we show experiments using special techniques that allow flying temperature sensors in shaded and unshaded conditions to investigate direct solar radiation effects on sensors. Results from first flights and the relation between measured radiative fluxes and the radiation effect on temperature sensors are presented.

10.4

Heavy precipitation events in Europe and their connection to an upper-level stratospheric intrusion

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Floods and landslides caused by heavy precipitation (HP) events are an increasing threat to population and infrastructure. Massacand et al. (1998) and Schlemmer et al. (2010) show that along the Alpine south-side, HP events can be triggered by meridionally elongated and zonally narrow positive potential vorticity (PV) anomalies located at tropopause level over western Europe. These positive upper-level PV anomalies are filaments of stratospheric air intruding into the troposphere. In a climatological analysis, Martius et al. (2006) found that for HP events in the Alpine region upper-level PV anomalies "over western Europe occur in 73% of all HP days". The question is wether or not this mechanism is also relevant for other areas in Europe.

Global climate models are widely used to estimate possible amplitudes, trends and impacts of future HP patterns, thus a correct representation of their link to the large-scale forcing is essential. Béguin (2009) assessed the capability of the global circulation model ECHAM5.5 to simulate upper-level PV anomalies for different model resolutions. For resolution T63 and T106 Béguin (2009) found good agreement between simulations and reanalysis data. However, regionally significant biases in the frequency of upper-level PV anomalies exist also in these high resolution simulations.

In this study we applied the methodology of Martius et al. (2006) to other areas in Europe using the ERA-40 reanalysis data set and data from the ECHAM5 global circulation model. A spatiall confined, meridionally elongated frequency pattern of upper-level PV anomalies is observed on HP events in other European areas such as Eastern Europe (figure 1). The associated rain pattern is mostly limited to mountainous areas which suggests a close link between orographic lifting and the large-scale flow induced by the upper-level PV anomaly. ECHAM5 shows ambivalent performance in representing these upper-level PV anomalies. While the frequency pattern is well represented in areas with well resolved large scale mountain ranges (T63 and T106) it is mostly absent in areas with smaller orographic features.

The assessment reveals distinct large-scale flow situations leading to HP events in various regions in Europe. With the event based ECHAM5 verification we provide an approach to study the large-scale flow patterns associated with precipitation extremes in a future climate.

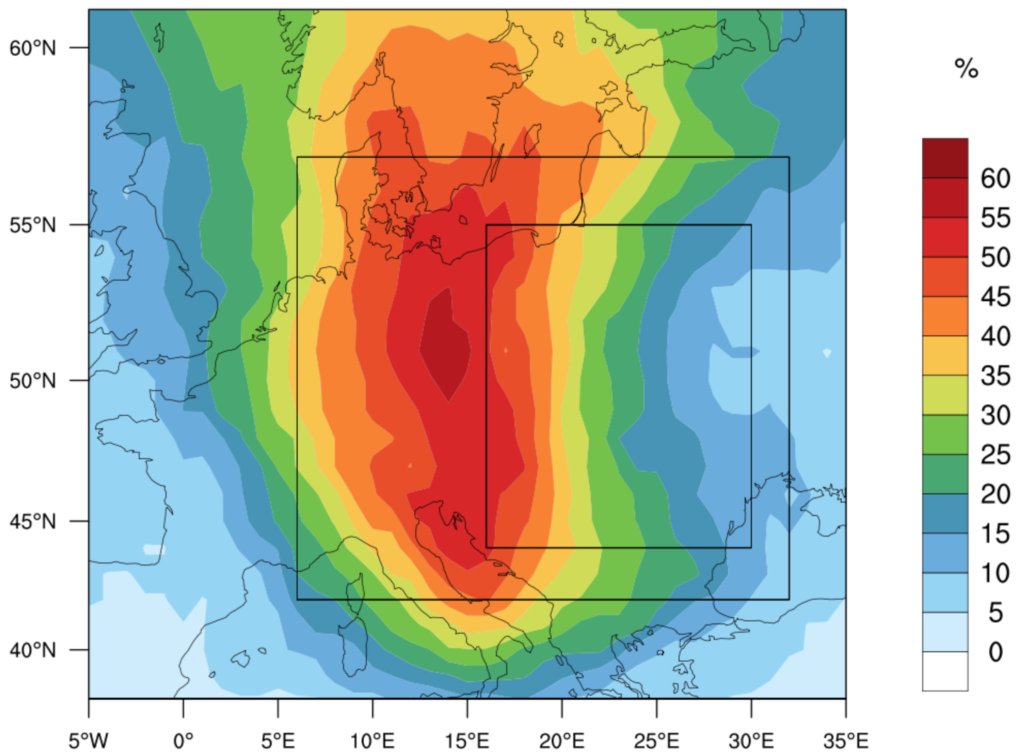

Figure 1. Frequency of upper-level PV anomalies touching the large box on days with a HP event over eastern Europe (small box).

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10.5

Radiation errors and uncertainty on radiosonde upper air temperature measurements

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Atmospheric temperature profiles are long since important for meteorological purposes, but climate change issues now strongly enhanced interest in reference upper air observations. To improve radiosonde temperature measurements a new approach has been taken to determine the radiation errors on thermocouples. On the one hand shortwave solar and longwave thermal radiation was accurately measured during radiosonde ascents. On the other hand air temperature was measured with several thermocouples on the same sonde under sun shaded and unshaded conditions, which allowed isolating heating effects of direct solar radiation. The experiments show that the very thin thermocouples (Ø 0.05 mm) used, experience solar radiation errors of only +0.1K at 1 km a.s.l. linearly increasing to +0.6K at 30 km. With thermal radiation being five to ten times lower than solar radiation, thermal radiative effects on thin thermocouples are negligible on day- and night measurements. Intercomparisons with other sondes however, revealed considerable larger day corrections on other sensor types. Our experiments suggest that remaining discrepancies on upper air temperature are most likely still due to large and ill corrected radiation errors.

10.6

The response of the hydrological cycle to different forcing agents

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This study investigates the response of the energy and water cycles to different forcing agents in global climate models.
Human activities affect the climate system in several ways: greenhouse gases warm the oceans and the atmosphere by blocking outgoing longwave radiation, while aerosols have a predominantly cooling effect by scattering incoming shortwave radiation. Both forcings alter the energy budget of the Earth, which triggers responses through complex feedback mechanisms in order to reach a new equilibrium state. Among all these mechanisms, the ones modifying the processes leading to precipitation formation are of particular interest because human societies as well as ecosystems will likely have difficulties to adapt to changing precipitation patterns.

In order to better understand the sensitivity of the energy and hydrological cycles to different forcing agents, a set of idealised transient simulations with a fully coupled ocean has been performed with the NCAR CCSM3.5 climate model. First, the model is run with a transient increase of CO_2 from 355 ppm up to 710 ppm. Then the solar constant is transiently increased to reach a radiative forcing that corresponds to a doubling of CO_2 (i.e. 3.7 W/m^2). In addition, simulations are also performed for CO_2 and solar forcings of doubled intensity along with a simulation combining both forcings. This allows for the investigation of the linear additivity in the response to forcings. Each simulation consists of 5 100-year runs intended to quantify the model internal variability. In a second step, ramp down simulations (CO_2 concentration is brought transiently back to 355 ppm) are run to assess if the system returns to its initial state or if it behaves non-linearly.

First results show that the temperature response to CO_2 and solar forcing of the same amplitude is significantly different, which indicates limitations in the definition of radiative forcing. The hydrological sensitivity is also found to be larger for solar forcing compared to CO_2 forcing in the global average in agreement with previous studies. Further, the response of most variables does not scale linearly with the forcing for several decades after stabilization. These results have important implications for the scaling of climate change patterns based on simple energy balance models.

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10.7
NCCR Climate related research at MeteoSwiss - The Swiss climate of today and tomorrow

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Switzerland as an Alpine country is particularly sensitive to climate change. There is a demand and a social responsibility to present information about specific changes and possible adaptations. MeteoSwiss supports the public, research and decision makers in business and government by providing high quality climate information on the past, current and future climate conditions on different scales. This climate information and support with its interpretation and use is described as climate services (WMO, 2011).

MeteoSwiss is developing the scientific basis making high quality climate services possible bundling resources from different external fundings and a substantial internal contribution. MeteoSwiss is an active member of the C2SM (Center for Climate Systems Modeling) and participant of various research projects, in particular of the SNF NCCR Climate (Swiss National Center of Competence In Research – Climate), COST-Actions and projects funded by the European Union (FP7). MeteoSwiss coordinates the CH2011 Initiative, an update of climate scenarios for Switzerland within the framework of C2SM and NCCR Climate. The Swiss Climate Change Scenarios CH2011 will be published on September 28th.

The research project at MeteoSwiss runs from 2009 until 2012 and is divided into four subprojects: Preclim, BiotoP, CombiPrecip and EURO4M. According to the key areas defined by the Stern Review (Stern et al., 2006), it is our goal to provide high resolution climate data (EURO4M, CombiPrecip) and to refine climate scenarios for user needs (BiotoP, PreClim) in order to link the scientific community with real world applications.

Preclim provides climate scenarios for Switzerland for the current century based on regional climate models (Fischer et al., submitted; Weigel et al., 2010). BiotoP links climate change scenario data to plant pest models, in order to investigate the potential threat of plant diseases under conditions of a changing climate. First results for codling moth (a key pest in apple plantations) for Northern Switzerland show a shift of important life phases towards earlier dates and a risk of an additional generation in the future (Hirschi et al., submitted). CombiPrecip combines information from the two classical rainfall measurements – radar and rain gauges – with statistical methods for climatological and near-real time applications such as hydrology (Erdin et al., submitted; Schiemann et al., 2010). EURO4M will provide a new high-resolution daily gridded Alpine wide precipitation data set over the last 40 years based on rain gauge observations.

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P 10.1

A simple statistical model for estimating exceedance probabilities in a future climate

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There is increasing confidence that certain types of climatic extremes will become more frequent and/or more intense under increased atmospheric greenhouse-gas concentrations. Not only the physical climate science community but also the climate impact community is interested in future trends of extreme events given their high potential impacts on infrastructure, society and ecosystems. Unfortunately, climate simulations are not available for all emission scenarios, time periods or spatial areas of interest. This raises the question whether reasonable estimations of expected changes for such cases are possible without simulating the missing information.

We here develop a simple statistical model for estimating changes in the exceedance probabilities for various percentile-related thresholds in a future climate given the expected change in the location and/or scale parameter. The applicability of this approach is investigated for a set of percentile-based temperature-related extreme indices. The underlying temperature distributions are the result of transient simulations for the SRES A1B scenario conducted by one-way nested regional climate models in the framework of the European ENSEMBLES project. First, the applicability of this simple model is evaluated for standardized temperature variables under the assumption of a constant scale parameter. In this context, the associated question is how reasonable this assumption is. Second, the complexity of this statistical model will be increased taking into account changes in the scale parameter because there is evidence that climate change affects not only the location parameter but also the variability. Finally, the skewness is taken into account using, for instance, skew-normal distributions since over parts of southern Europe the daily temperature distributions are often skewed.