

Abstracts of the 6th CLM-Community Assembly

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– Amalfi Coast –

Contents

1	Session: AIO	4
1.1	Brauch and Dobler.....plenary	4
1.2	Cavicchia and Storch plenary	5
1.3	Ho et al.	6
2	Session: CCAR	7
2.1	Ferrone et al.plenary	7
2.2	Ferrone et al.poster	8
2.3	Kerkweg and Jöckel poster	9
2.4	Metzger et al.	10
3	Session: CRCS	11
3.1	Gutjahr and Heinemann	11
4	Session: DYNNUM	13
4.1	Ogaja and Will	13
4.2	Ogaja and Will	15
4.3	Will and Panitz	16
5	Session: EVAL	17
5.1	Becker et al.poster	17
5.2	Bellprat et al..... plenary	18
5.3	Bucchignani et al.	19
5.4	Haslinger et al. poster	21
5.5	Klehmet and Rockel	22
5.6	Lorenz et al.poster	23
5.7	Mercogliano et al.poster	24
5.8	Montesarchio et al.	26
5.9	Nolan and Lynch poster	28
5.10	Schiano et al..... plenary	29
5.11	Wang et al. poster	30
5.12	Zuvela-Aloise et al.	31
6	Session: IPCC-AR5	32
6.1	Keuler and Radtke	32
6.2	Polonsky et al.poster	33
6.3	Sarr..... plenary	35
7	Session: SOILVEG	36
7.1	Ahrens et al.	36
7.2	Akkermans et al.	37

7.3	Lorenz et al..... plenary	38
7.4	Ludwig et al..... plenary	39
7.5	Volkholz poster	40
7.6	Wouters et al. plenary	41
8	Session: SUPTECH	42
8.1	Brauch et al.	42
8.2	Dobler et al.	43
8.3	Legutke	44
8.4	Lüthi et al. plenary	45
8.5	Roches and Fuhrer	47
8.6	Will and Blahak	48

1 Session: AIO

1.1 Coupling COSMO/CLM and NEMO for the Mediterranean Sea

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Presentation: plenary oral

At BiK-F and the Goethe-University of Frankfurt, a coupled system of the COSMO-CLM and the NEMO ocean model via the OASIS coupling framework is developed. It currently focusses on the Mediterranean area using the NEMO-MED12 system in collaboration with the SiMED project. This presentation shows the current status of our coupling efforts and some preliminary results of first coupled runs.

1.2 Medicanes simulation in CLM

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Presentation: plenary oral

Medicanes, strong mesoscale cyclones with tropical-like features (axis-symmetry, a warm core, a cloud-free eye surrounded by a cloud cover with spiral shape, winds up to the hurricane speed), are known to develop occasionally over the Mediterranean Sea.

Due to the scarcity of observations over sea and the coarse resolution of the long-term reanalysis datasets, it is difficult to study systematically the statistical and dynamical properties of Medicanes.

Our goal is to assess the Medicanes long-term variability and trends, performing the dynamical downscaling of the NCEP/NCAR reanalysis data for the 1960-2010 period in order to obtain a long-term climatology, and then replying the same procedure on GCM projections for future climate scenarios.

In order to prove the robustness of the method outlined above and to investigate the value added by the use of the CLM model to the study of Medicanes, we performed several high resolution (0.22° and 0.09°) simulations for a number of test cases studied in the literature, and we tested on a five-years model run different algorithms tailored to optimize automatic Medicanes detection in long-term simulations. We present results on the CLM ability to reproduce Medicanes test cases and to catch their dynamical characterization. We then discuss the performance of tracking and detection algorithms.

1.3 Coupling Atmosphere and Ocean Models for climate simulation over Baltic Sea and North Sea Regions

Ha Ho¹, Burkhardt Rockel¹, Hartmut Kapitza¹,
Beate Geyer¹, Elke Meyer¹ and Sophie Valcke¹

¹ Helmholtz-Zentrum Geesthacht

Presentation: WG oral

In this study the regional climate model COSMO-CLM (CONsortium for SMall scale MOdelling model in CLimate Mode) is coupled with the regional ocean model TRIM-NP (the nested and parallel model which was developed in Helmholtz-Zentrum Geesthacht, Germany, on the basis of TRIM3D model developed at the University of Trento, Italy) by the OASIS (Ocean-Atmospheric-SeaIce-Soil) coupler version 3 of CERFACS (France). The atmospheric model component COSMO-CLM is setup with a horizontal grid mesh size of 50km and 32 vertical levels. The initial and boundary conditions are from six hourly ERA-interim reanalysis data. The regional ocean model TRIM-NP is setup with a horizontal grid mesh size of 12.8km and 50 vertical levels. In a two-way coupling mode, COSMO-CLM is linked to TRIM-NP through sea surface temperature SST as the lower boundary condition and TRIM-NP is driven by standard atmospheric variables from COSMO-CLM. Since the integration domain of TRIM-NP is smaller than that of COSMO-CLM the SST data beyond the outer area of TRIM-NP is taken from ERA-interim. The coupled model is applied in a study for winter months of 1997 over Baltic Sea and North Sea regions. Despite the cold bias, the regional ocean model TRIM-NP captures quite well the daily variation of SST over the Baltic Sea and along eastern coastline of the North Sea. Over the Baltic Sea, the monthly averaged SST of TRIM-NP is much closer to that of OISST (NOAA Optimum Interpolation Sea Surface Temperature) and observation (from Bundesamt für Seeschifffahrt und Hydrographie) than the reanalysis data ERA-interim due to the higher resolution of the regional ocean model. The air-sea interaction and feedback implemented in coupling process lead to more consistent heat fluxes and precipitation of CCLM over the considered region.

2 Session: CCAR

2.1 Towards climate simulations with COSMO-ART: The heat-wave of 2003

Andrew Ferrone¹, Bernhard Vogel¹, Heike Vogel¹ and
Christoph Kottmeier¹

¹ IMK-TRO, KIT Karlsruhe

Presentation: plenary oral

The year 2003 was marked by a strong heat-wave in June, July, and August (JJA). During this period a synoptic blocking situation and unusual clear skies caused a drying-out of the soil. The combinations of these factors induced unusually high surface temperatures, up and above 40° C in Mid-Europe. From this unusual situation resulted an extremely high photolysis activity, which led to very high levels of ozone. At the same time, the larger number of wild-fires together with the blocking situation of air-masses led also to unusual high concentration of aerosols in Europe. All these aspects qualify this situation as a particular test for air-quality models.

The COSMO-ART (Aerosols and Reactive Trace gases) model system is based on the operational COSMO model. The physical processes like transport, turbulent diffusion, and dry and wet deposition are treated together with photochemistry and aerosol dynamics using the modal approach. The system can represent the impact of aerosol particles on photolysis on radiation and clouds thus allowing feedback between natural and anthropogenic aerosol particles and the atmospheric variables.

The model system has proven to yield valuable results in a number of case studies, but has not been applied to longer time series yet. As an intermediate step of developing a climate version CLM-ART, simulations of the heat wave in JJA 2003 have been performed. The COSMO-EU region was chosen as a model domain with a resolution of approx. 14km, and the model was driven by ERA-Interim data for the considered period.

The model system will be used in this situation to estimate the impact of feedback mechanisms between the aerosols and the meteorological parameters. Therefore two simulations have been performed in which the impact of aerosols on the radiation is or is not taken into account. The feedbacks on clouds are not considered in the present study, as they seem of minor importance due to the exceptionally clear skies in this period.

2.2 Accelerating COSMO-ART: CPU and GPU opportunities

Andrew Ferrone¹, Hartwig Anzt² and Bernhard Vogel¹

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Presentation: poster

The interaction of aerosol particles with clouds is still one of the largest sources of uncertainties in modern climate studies. They have been extensively studied by cloud resolving model. Unfortunately their impact on the global scale is difficult to assess due to the coarse resolution of global climate models. The regional model system COSMO-ART (Aerosols and Reactive Trace gases) could be able to fill the gap between these two modeling approaches.

The COSMO-ART model system is based on the operational COSMO model, and includes an explicit representation of trace-gases and chemistry, including their chemical reactions and transport. The impact on radiation and clouds is also treated in the model, and thus, feedbacks between natural and anthropogenic aerosol particles and the atmospheric variables can be represented.

The development of the model system was mainly focused on the implementation of relevant processes and the correction of already existing parts of the model, leading to 150 additional prognostic three-dimensional fields (60 gas and 80 aerosol species). The CPU time of the present version is 20 to 30 times higher than the COSMO model, and climate runs are thus difficult to perform.

A profiling of COSMO-ART done with the Scalasca tool has shown that the additional parts of the code takes around 70% are used by the chemical integrator (RADMKKA), and 15% (ISOROPIA). This model run has been performed with a time-step of 40 seconds, and the chemical solver is called at every time-step.

In order to reduce the overall CPU needs, some tests will be performed with longer time-steps and we will investigate if the chemical solver needs to be called at every time-step. Currently the code is optimized towards vector machines and compiler options have been implemented to optimize the code for large parallel applications. Moreover, the number of messages that need to be exchanged will be reduced while increasing their size.

Also the possibility of using accelerator technology like graphic processing units (GPUs) will be evaluated. These offer excellent parallel performance, and could trigger considerable acceleration of the chemical solver. The challenge in this field is to adapt the algorithm to coprocessor architectures, and to enable the code of being processed by GPUs.

2.3 MECO(n): a global - regional chemistry climate model

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Presentation: poster

Within the DFG funded project MACCHIATO the on-line coupled model chain MECO(n) (MESSy-fied ECHAM and COSMOS nested n times, previously named ECHAM5/MESSy(-; COSMO/MESSy)ⁿ) was developed aiming at consistent chemistry simulations on a wide range of spatial and temporal scales. After the successful meteorological evaluation of the on-line coupling between ECHAM/MESSy and COSMO/MESSy, now the MESSy sub-models required for chemistry calculations are adapted for COSMO/MESSy. We present the current state of this development and show that processes like convective tracer transport, dry deposition or emission calculations work well within COSMO/MESSy.

2.4 Aerosol hygroscopic growth parameterization based on a solute specific coefficient

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Presentation: WG oral

Water is a main component of atmospheric aerosols and its amount depends on the particle chemical composition. We introduce a new parameterization for the aerosol hygroscopic growth factor (HGF), based on an empirical relation between water activity (a_w) and solute molality (μ_s) through a single solute specific coefficient ν_i . Three main advantages are: (1) wide applicability, (2) simplicity and (3) analytical nature. (1) Our approach considers the Kelvin effect and covers ideal solutions at large relative humidity (RH), including CCN activation, as well as concentrated solutions with high ionic strength at low RH such as the relative humidity of deliquescence (RHD). (2) A single ν_i coefficient suffices to parameterize the HGF for a wide range of particle sizes, from nanometer nucleation mode to micrometer coarse mode particles. (3) In contrast to previous methods, our analytical a_w parameterization depends not only on a linear correction factor for the solute molality, instead ν_i also appears in the exponent in form $x \cdot a^x$. According to our findings, ν_i can be assumed constant for the entire a_w range (0-1). Thus, the ν_i based method is computationally efficient. In this work we focus on single solute solutions, where ν_i is pre-determined with the bisection method from our analytical equations using RHD measurements and the saturation molality μ_s^{sat} . The computed aerosol HGF and supersaturation (Köhler-theory) compare well with the results of the reference model E-AIM.

3 Session: CRCS

3.1 Parametric bias correction of high resolution CCLM precipitation with a focus on extreme values and climate change signal.

Oliver Gutjahr¹ and Günther Heinemann¹

¹ University of Trier

Preferred presentation: poster

Regional climate models are advancing at a remarkable speed considering the horizontal resolution. The current state-of-the-art CCLM approaches to the 1-5km scale. Impact studies, like hydrological or species distribution models, benefit from such high resolution climate model output. However, model output is often biased, especially precipitation, and cannot be used directly as input data. This bias affects the whole distribution, not only the mean values. Extreme values are crucial for impact studies, since they may cause floods or distinction of a local species population. Therefore an accurate method for bias correcting the core of the distribution and the extremes has to be applied. The influence of the bias correction on the climate change signal is the second investigation carried out. At this step, the research area is the Nahe catchment (Rhineland Palatinate, Western Germany) but will be enlarged to whole Rhineland Palatinate and the Saar-Lor-Lux region. Within the Global Change Project (<http://www.uni-trier.de/index.php?id=40193&L=2>) the daily, heavily wet biased precipitation fields of two CCLM runs (C20: 1991-2000, A1B: 2091-2100) with a horizontal resolution of about 5km (CCLM5) are bias corrected with special treatment of the extreme values and the impact on the climate change signal is investigated. The bias correction is carried out by fitting a parametric gamma distribution to observed and modeled precipitation values smaller than the 95th percentile to the extremes greater or equal the threshold of the 95th percentile. The probability of a dry day is corrected separately by setting all CCLM5 precipitation values lower than a threshold to zero. This threshold is optimized so that the number of dry days equals the observed number. Afterwards, a quantile matching is used to construct the transfer functions which create the new precipitation time series. Since there are only 39 precipitation stations available with no missing values, a linear interpolation of the three nearest transfer functions is implemented to correct all grid boxes. Local U-tests are used at every grid box to detect a climate change signal and a False Discovery Rate (FDR) analysis is applied to control the falsely rejection of true H₀-hypothesis due to the multiplicity problem. FDR is also used as a global field significance test. The signal is investigated for the hydrological summer (May-Nov.) and winter (Oct.-Apr.) separately. The corrected precipitation fields show a significant improvement considering the mean values and the core of the distribution. The correction of the extreme values is satisfying in most cases, but sometimes causes unrealistic high precipitation values. Without and with the bias correction

the climate change signal is significant in the hydrological summer. In the hydrological winter only a small region (the Mainzer Bucht) is significant in the uncorrected data but nearly half of the region is significant after the correction. The method of combining a gamma distribution and a GPD is potentially appropriate for bias correcting precipitation fields, although there are some unresolved drawbacks. This is caused by violating the assumptions of the extreme value theory by using a fixed threshold and neglecting autocorrelation of the extremes, but mainly by the interpolation method. In further studies, the fitting of a dynamical mixture model of a gamma distribution and GPD, where the threshold is a parameter to be optimized, will be investigated to derive an unsupervised threshold. After a sufficient method is found, extreme value analysis will be carried out and the same procedure will be repeated for very high resolution runs with a resolution of about 1.3km.

4 Session: DYNNUM

4.1 Steps towards implementation of higher order spatial schemes in the COSMO model

Jack Ogaja¹ and Andreas Will¹

¹ BTU Cottbus

Presentation: WG oral

The horizontal discretization schemes available with the Runge Kutta dynamical core of COSMO model are the standard 2nd order central difference scheme and further approximations of the advection term of the dynamical variables u, v, w, T and p . Interpolations to grid positions of other dynamical variables and dealising by a smoothing operator are also done in the model.

A study on the convergence properties of these spatial schemes has been done by conducting a 2d hydrostatic linear mountain flow test case according to Baldauf, 2008. L0, L1, L2 norms were then calculated to determine the order of convergence for the 2nd, 3rd, 4th, 5th, and 6th order advection schemes. Since the approximations of other derivatives in the system of equation of the model are 2nd order accurate, the convergence of spatial schemes are expected to be 2nd order. However, all the advection schemes revealed order of convergences lower than 2. It was evident that the test case results are dominated by other sources of error apart from error due to spatial discretization.

We analysed other higher order schemes suggested. Wicker and Skamarock (2002) suggested 2nd, 4th, 6th order central difference and 3rd and 5th order upwind schemes for the discretization of the flux divergence term. The convergence properties of these schemes have been demonstrated to be of higher order by a one-dimensional advection test. However, a theoretical analysis showed a second order accuracy only for the 2d mountain flow equations. Morinishi et al (1998) investigated the conservation properties of higher order spatial schemes taking into account different formulations of the nonlinear term. They suggested a method of discretisation for the momentum advection which preserves global conserved quantities. Higher order discretisation and interpolation was shown to be a prerequisite of higher order convergence. Higher order interpolation has been implemented for advection in the COSMO model and the results will be discussed.

In reference to the above schemes, we present and discuss steps towards implementation of higher order spatial schemes in the COSMO model. The dealising method will be discussed too.

Since the investigation of the convergence properties of the COSMO spatial schemes also reveals convergence of order lower than two due to other sources of error, we also discuss different requirements in this investigation. These includes a systematic study of instationarity to asses the validity of this assumption of the test case, of the properties of both Rayleigh damping layer and relaxation at the lateral boundaries to further re-

duce wave reflection and development of disturbances near the boundaries (also discussed extensively in another presentation, Ogaja and Will), and a study different vertical grid resolutions. Different 'simple' methods have been developed for investigating the different error sources, like instationarity, lateral boundary relaxation and Rayleigh damping.

Results with stretched vertical grid of 500 levels revealed consistent results for both u and w with improved accuracy in both. The optimized damping strength showed a reduction of reflection and disturbances developments at the boundaries of one order of magnitude (see Ogaja and Will: Boundary conditions and convergence properties of the COSMO model). A new improved damping coefficient function is being tested.

The investigation of the development of instationarity showed an independence of the norm development on the time step but on the simulation time with a convergence slope of higher than 2 for w . Further investigations revealed that after a sufficiently long simulation time other sources of error dominate the instationarity of the field.

Based on the results of these investigations, we defined a new reference configuration, and the results revealed a significantly higher consistency of convergence results, in particular for w . The order of convergence was close to 2 for u and w using the 250m solution as reference. Several aspects, in particular the vertical structure of the errors is investigated further. Other ongoing work will also be presented.

4.2 Investigation of effects of different boundary conditions on the convergence properties of spatial schemes of the COSMO model

Jack Ogaja¹ and Andreas Will¹

¹ BTU Cottbus

Presentation: WG oral

We investigated the Rayleigh damping (Doms and Shaettler, 2002, sec.6.4, eq.6.23) at the upper boundary and the Davis explicit lateral boundary relaxation (no scientific documentation at the moment) which is based on an exponential function.

The work is motivated by investigations of differences between the results of 2D stationary mountain flow test case runs for different model configurations. The analytical solution of the test case (Baldauf, 2008) is assuming an unbounded domain in the horizontal and unlimited atmosphere. This assumption can not be fulfilled in numerical simulations due to need for limited domain. It became evident that the differences between the test case results are dominated by disturbances developing at the lateral boundaries and propagating into the computational domain and wave reflections at the upper boundary. It's amplitude was 3.3×10^{-4} of the waves amplitude. The disturbances are associated by strong vertical motion within the relaxation zone resulting from the continuity equation.

An important aim of the Rayleigh damping function at the upper boundary and of the relaxation at the lateral boundaries is to prevent reflection of waves propagating out of the domain. However the standard $\cos^2(x/x_0)$ Rayleigh damping function and $\exp(-6x/x_0)$ relaxation functions of the COSMO model exhibit reflections and disturbances at both boundaries for different reasons. The cosine function which has an advantage of zero slopes for $x=1$ and $x=0$ but strong slopes within the damping zone. The $\exp(-6x/x_0)$ function has a very good behaviour within the relaxation but a non-zero value at $x=x_0$ resulting in a step-function.

We derived optimal coefficients for the functions used at the boundaries which minimize reflections and developments of the disturbances. Furthermore we derived a new function combining the advantages of the cosine and of the exponential function. The promising tests of the new function are ongoing. We aim to present a detailed investigation of the profiles of the damping coefficients and of their influence on the 2d stationary mountain flow test case results. In dependence on the progress of regional climate simulations the relevance for real case applications will be discussed too.

4.3 Climatological relevance of constant fast wave time steps

Andreas Will¹ and Hans-Jürgen Panitz²

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Presentation: WG oral

The standard version of the COSMO-CLM Runge-Kutta dynamics allows different fast wave time steps \mathbf{dts} for different Runge-Kutta substeps in order to save computing time. This however is not consistent with theory. A constant fast wave time step for all Runge-Kutte substeps was implemented and its climatological relevance was investigated for the Africa domain.

No significant differences have been found for climatological means. However, the behaviour of strong vortices was found to be modified. The results and the computational costs will be discussed.

5 Session: EVAL

5.1 Mediterranean wind speeds at different resolutions

Nico Becker¹, Gregor C. Leckebusch², Uwe Ulbrich¹ and
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Preferred presentation: poster

The influence of meso-scale horizontal model grid resolution on the simulation 10m wind speeds in the Mediterranean region is analysed. The mean wind fields are compared in contrast to extreme wind events. The study is based on a systematic series of simulations with the regional climate model COSMO-CLM at four different horizontal model grid resolutions between 7 to 49 km.

In general, the mean wind fields show increasing wind speeds with increasing model resolution. The size and location of the largest differences change depending on the compared resolutions.

The Adriatic Bora, a regional extreme wind event, is analysed, regarding the frequency of its occurrence and spatial characteristics. Regional winds like the Adriatic Bora are often induced by orographic effects and therefore exhibit a particular sensitivity to the shape of the model topography. The formation of bora related low level jets is enhanced and the number of Bora days per year is increasing at higher resolutions.

5.2 Perturbed physics ensembles and objective calibration of the regional climate model CCLM

Omar Bellprat¹, Daniel Lüthi¹, Sven Kotlarski¹ and
Christoph Schär¹

¹ IAC-ETH Zürich

Presentation: plenary oral

Evaluation of climate model uncertainties has received much attention in recent years, as it represents a key element of climate change assessment. Typically uncertainties are assessed using multi-model ensembles and single-model perturbed physics ensembles (PPE). Past projects have provided estimates for the uncertainty of climate sensitivity and parametric uncertainty in current state-of-the-art climate model. However, studies using PPEs have so far mainly been using global climate models, and little work has been conducted with regional models.

Commonly the inherent parametric uncertainty of climate models is constrained using observations, a procedure which is often referred as tuning or calibration. However, since the calibration of climate models is generally based on expert judgment, the efforts of model calibration are often concealed. In particular, the tuning and calibration efforts of physically-based global and regional climate models are in general poorly documented and characterized by a lack of transparency.

In this study we present an analysis of the parameter uncertainty of the regional climate model COSMO-CLM with several PPEs for present-day climate over Europe. The PPEs consist of 40 simulations for the period 1990-2000, 150 simulations for the year 1990, and 20 simulations for the period 1994-1998 with combined parameter experiments, driven by ERA-40 and ERA-interim re-analysis.

The PPE with combined parameter perturbations is used to apply an objective model calibration scheme, which allows to derive an optimized model configuration using a quadratic meta-model (Neelin et al. 2011). The optimization is based on a new skill metric (an extension of the climate prediction index CPI, Murphy 2004), which takes into account observational uncertainty and natural variability.

5.3 Climate Projections for the Greater Alpine Region with COSMO-CLM

Edoardo Bucchignani¹, Paola Mercogliano¹ and Myriam Montesarchio²

¹ CIRA/CMCC

² CMCC

Presentation: WG oral

ADAPTALP is a European project in which CMCC-CIRA participates as subcontractor of MATMM (Italian Ministry of Environment, Land and Sea). The aim of this project is the development of an improved climate data set for the Alpine Space, whose orography is very complex, for the description of the precipitation patterns expected in the next century in small size (10-200 km²) Alpine river catchment to help the decision-makers in planning the adaptation strategies. The IPCC SRES A1B emission scenario is used for the climate projections of the XXI century. It has studied the area (2-20E; 40-52 N). Three sets of simulations have been performed employing for the time integration a Runge-Kutta 2-time level HE-VI scheme: clmsxg-14km: Periods 1901-2000 and 2001-2100, spatial resolution 14 km, time step 150 sec, computational grid with 118 x 116 nodes and 40 vertical levels. Boundary conditions obtained from the global model SINTEX-G, whose atmospheric component is ECHAM4 (T106 120 km spatial resolution, 12 h time resolution). clmera-14km: Period 1971-2000, spatial resolution 14 km, time step 150 sec, computational grid with 118 x 116 nodes and 40 vertical levels. Boundary conditions obtained from the ECMWF ERA40 re-analysis (120 km spatial resolution). clmcm-8km: Period 1965-2035, spatial resolution 8 km, time step 40 sec, computational grid with 207 x 211 nodes and 40 vertical levels. Boundary conditions obtained from the global model CMCC-MED, whose atmospheric component is ECHAM5 (T159 80 km spatial resolution, 6 h time resolution). A validation activity has been performed, in terms of 2-metre temperature and daily precipitation, making a comparison with the observational dataset MOBS-GAR (50 km of resolution). With both the spatial resolutions (14 and 8 km) the 2m temperature is well reproduced, with a slight underestimation, in particular in winter. Concerning the precipitation, the simulation at 14 km underestimates the winter values in the central and eastern region, while overestimates their in the north of Alps; in summer, instead, there is a strong underestimation of precipitation over the entire domain. This is due to the fact that, in the winter period, the precipitation is related to large-scale systems and the simulation can benefit from higher resolution; on the other side, the summer precipitation is mainly due to convection and the underestimation proves that the resolution is not fine enough. This last reason explain why the results obtained with simulation at 8 km are better. Moreover, the seasonal cycle of 2m temperature and total precipitation for the period 1971-2000 for four selected sub regions have been analyzed: the observed seasonal trend of 2m temperature is very well caught by COSMO-CLM, with a slight underestimation in winter, while in summer there is a better agreement,

especially in the southern domains. The seasonal cycle of precipitation is well captured, with a strong underestimation in summer for both the configuration; in winter, with the resolution of 8 km, the differences between the simulation and the observations are smaller. For what concerns the climate projections in the XXI century, the results show a general increase of temperature, up to 5° C in 2071-2100. For the precipitation, instead, they show that at the end of the XXI century, it is expected a general increase in winter, while in summer there is a very irregular change distribution.

5.4 EVACLIM - a process-orientated evaluation of climate simulations for Europe and the Greater Alpine Region

Klaus Haslinger¹, Ivonne Anders¹, Maja Zuvella-Aloise¹ and
Michael Hofstätter¹

¹ ZAMG, Central Institute for Meteorology and Geodynamics

Presentation: poster

The ZAMGs project EVACLIM is a one year project with focus on the evaluation of the ERA40 hindcast simulations for the time period 1961-2000 for Europe (50km) and for the Greater Alpine Region (GAR, 10km). With this project we have the possibility to extend a basic evaluation to more observational data sets and more sophisticated methods. The datasets encompass global and European domain datasets like CRU, GPCC4 and E-OBS which were used for the analysis of the 50km run, as well as higher resolution datasets for the 10km run covering the GAR like e.g. the new gridded HISTALP dataset for temperature and precipitation. The evaluation focussed mainly on the 10km run, investigating the skill of the regional climate model COSMO-CLM by calculating mean biases, correlation, representation of the annual cycle, inter annual variability etc. The model domain is located mainly over very complex terrain of the Alpine Ridge, resulting in a model topography reaching beyond 3000m altitude. Apart from basic evaluation results we will show results of our analyses of the height dependence of certain skill scores like bias, correlation, etc and additionally the representation of linear trends in model compared to other observational datasets. Compared to the CRU dataset CCLM shows a cold bias of annual mean temperature of 0.61 K whereas precipitation sums are generally overestimated by 15in space and season. Correlation of seasonal temperature exceeds values of 0.8 in winter (DJF) in lowland areas and values of 0.6 in summer (JJA). With higher altitudes correlation is decreasing in winter and increasing in summer. Linear trends of precipitation are fairly good represented in the model simulations, whereas the trends of temperature contradict the signals from observations, e.g. HISTALP, showing negative trends in summer and autumn which are in contrast to HISTALP.

5.5 A model setup of COSMO-CLM for Siberia - ongoing efforts

Katharina Klehmet¹ and Burkhardt Rockel¹

¹ Helmholtz-Zentrum Geesthacht

Presentation: WG oral

Siberia, a vast landmass extending from the arctic, subarctic to temperate northern latitudes of Russia, is largely underlain by permafrost and characterised by one of the most continental climates on earth. Furthermore, climatic changes across Northern Eurasia are among the largest of the globe. However, the paucity of consistent long-term observation data hampers the distinction between climate variability and climate change. To complement existing data at high spatial and temporal resolution and to provide information of climate and terrestrial parameters for which no measurements have been taken we aim to produce a climate reconstruction for the period 1950-2010 using COSMO-CLM (CCLM). This requires a suitable model setup with additional adjustments for these specific regional needs. Therefore, test simulations using different model versions (CCLM 4.8, 4.14 and 4.16) and different configurations are performed at a horizontal resolution of about 50 km for the period 1990-1999. Additionally, the sensitivity of the model is analysed with respect to changes in the turbulence parameterization and in the prescribed temperature field at the lowest boundary of the soil layer. Boundary forcing is taken from the NCEP1 reanalysis. The model domain of the Siberian Region stretches of approximately 45° N - 85N and 50E - 150E. In order to take vertical temperature changes in the frozen ground better into account we use the multi-layer soil model with additional layers up to total soil depth of 92m. The focus of the model evaluation concentrates on the annual cycle of the area-averaged monthly mean 2m temperature calculated for different subregions in comparison to ERA-40 reanalysis and station data (NSIDC). This near-surface variable is of special interest since CCLM reveals a strong winter warm bias in a standard setup especially for the eastern parts of the Siberian Region up to 8K compared to ERA-40 reanalysis. This bias could be reduced to 5K in winter using the integrated multi-layer snow model. The assumption that the temperature of the deepest soil layer which is prescribed by the climatological 2m temperature might be unrealistic for permafrost regions and therefore produce too high air temperatures cannot be confirmed. Changes in the lowest soil temperature have only little effect on the near-surface temperature. In order that CCLM can better reproduce the low temperatures during winter time, which occur in association with the Siberian High, we reduce the minimal diffusion coefficient for heat. This adjustment decreases the winter warm bias for eastern parts of Siberia to 6K. Up to now technical problems came up in the model version of 4.14 and 4.16 when trying to combine this changed setting for heat diffusion with the multi-layer snow model.

5.6 Extreme event diagnosis by means of dynamical downscaling with CCLM: Simulations focusing on European winter storm events

Philip Lorenz¹, Gregor C. Leckebusch², Daniel Befort¹,
Tobias Pardowitz¹ and Uwe Ulbrich¹

¹ Freie Universität Berlin

² University of Birmingham

Presentation: poster

Extreme events like European winter storms cause significant socio-economic impacts. For many kinds of extreme event analyses, output from global model is still too coarse in terms of spatial and temporal resolutions, nor do the model physics capture extreme values of specific parameters well, due to the nature of its implementation. Further on, as extreme events resemble exceptional states of the atmosphere, their downscaling by e.g. with statistical methods is challenging. Therefore here a dynamical approach is chosen and regional climate models like the COSMO-CLM (CCLM) are important tools for those activities.

One example for needed high spatial and temporal resolutions is the modelling of a special subset of European winter storms, which are causing storm surges at the German North Sea coast. Major storm surges develop under a specific sequence of near surface wind speeds and directions within the area of the North Sea. Within a joint project with the German Federal Maritime and Hydrographic Agency (BSH) the CCLM, forced by ERA40 Reanalysis data, is used for dynamical downscaling of observed historic storm surge events. The used spatial resolution of approximately 18 km will lead to an adequate assessment of storm surge characteristics and their temporal evolution. The CCLM output will be used to provide meteorological boundary data for a downstream water level modelling of these events by BSH.

In terms of property damage, studies focussing on regional differentiated losses are highly relevant. While damages on e.g. a federal-state-scale are simulated quite well in an accumulated perspective, regional aspects could not be covered by coarsely resolved global simulations. With CCLM simulations for specific relevant storms over e.g. Germany, a loss-function is trained regionally and applied to potentially changed future conditions.

5.7 Prediction of shallow landslides in pyroclastic soils due to climatic changes in the Mediterranean area

Paola Mercogliano¹, Edoardo Bucchignani¹, Myriam Montesarchio² and
Emila Damiano²

¹ CIRA/CMCC

² CMCC

Presentation: poster

The aim of this paper is to show the results obtained by research activity of the CMCC work group 2: “Impacts on territory monitoring activity and hydrological risk prevention” of the Division “Impact on soil and coast” (ISC). The ISC Division studies the impact of climate changes on ecosystems (of earth and sea) and on the coastal zones, and it studies the hydrogeological risk related to climate conditions too. The work reports the results of numerical simulations aimed to the individuation of a simple and rational procedure to investigate the effects of climate change on the behaviour of slopes in unsaturated pyroclastic soils affected by rainfall-induced landslides. The analysis of the response of the Cervinara slope has been conducted, which was interested in a killer flowslide during 1999 and was monitored since 2002. The study have been performed using the hand-made code I-MOD3D for the study of seepage processes in unsaturated medium and stability analysis using as climatic boundary conditions data coming COSMO-CLM model. Predicting impacts of potential climate change on slope stability is complex. Impacts could be both negative and positive for warming climate scenarios, depending on storm pattern changes which are uncertain. The proposed approach requires three main steps: - the individuation of the main climate factors which influences the behaviour of the slope; - the validation of both climatic and hydrological models used to evaluate the future trend of rainfall and mean temperature and, in cascade, the future response of the investigated slope; - the forecasting of the slope behaviour on the base of the future climatologic scenario. The first step has been pursued on the base of literature case histories similar to the analyzed one and on detailed study of the slope response, which reveal that the controlling factors of rapid shallow landslides in pyroclastic granular soils are essentially the heavy rainfall events and the antecedent 30days precipitation together with evapotranspiration which strongly affect the initial soil-moisture conditions. To face the second step is essential to have a good and long series of experimental data in order to validate the climatologic model COSMO-CLM. The comparison between the results of analysis and experimental data for a 30-years long period (1996-2006) highlights that the model is able to capture the mean monthly temperature but heavily underestimates the annual precipitation, the most intense rainfall heights and the number of rainy days: thus, this step reveals that an appropriate statistical correction of numerical data is necessary. On the contrary, the validation of I-MOD3D code used for the analysis of infiltration process (made on the base of a 14 months-long period during 2006-2007 where experimental data

from in situ monitoring were available) reveals that a fair agreement between numerical and monitored suction has been reached: this suggests that the code can be used as a tool for the assessment of the behaviour of the slope. At least, an evaluation of the long-term behaviour of the investigated slope in the 2060 has been done considering the climate scenario furnished by COSMO-CLM, which indicates an increase in temperature, a decrease in annual precipitation and a substantial similar distribution of most intense rainfall events. The combined effect of an increasing temperature, which will promote a stronger evaporation, and of a decreasing rainfall will lead to a reduction of net infiltration. This fact can affect the initial soil-moisture conditions increasing the mean values of suction and, hence, since no variation seems to be attended in terms of intense rainfall events, the stability condition of the slope will globally increase over the years. However, this assessment of future scenario is strongly affected by the hypothesis done and has to be considered only as an attempt to utilize a procedure for predicting impacts of potential climate change on slope stability of shallow pyroclastic soil deposits.

5.8 Performance evaluation on Sub-Saharan Africa region from high resolution simulations with COSMO-CLM

Myriam Montesarchio¹, Edoardo Bucchignani² and Paola Mercogliano²

¹ CMCC

² CIRA/CMCC

Presentation: WG oral

The EC-CLUVA project aims to develop methods and knowledge to be applied to selected African cities, to manage climate risks, to reduce vulnerabilities and to improve their coping capacity and resilience towards climate change. The objective is to set up methods and work out probabilistic scenarios of climate change affected hazards having a resolution that fits for regional and urban systems and relates uncertainties. The CMCC-CIRA is involved in the production of downscaled regional climate projections at high resolution (about 8 km), using the IPCC scenarios (A1B, RCP4.5 and RCP8.5), for selected areas surrounding the African cities of interest. Three limited domains have been defined: a west domain (18W-15.17E; 3.3-16.8N with 465x190 grid points) that includes St.Louis, Ouagadougou and Douala; a lower east domain (34.54-41.26E; 11.8-2.2S with 95x135 grid points) centred on Dar Es Salaam and an upper east domain (34.45-43.03E; 6.16-12.59N with 120x90 grid points) centred on Addis Abeba. All the COSMO-CLM simulations have been performed forced by the global model CMCC-MED, whose atmospheric component is ECHAM5 (horizontal resolution of 80 km). The time step used for the time resolution is 50 sec, the numerical scheme is Runge-Kutta with a HE-VI integration at 2 time levels. The simulations have been performed on a cluster of 30 IBM P575 nodes, installed at CMCC-Lecce. A first preliminary simulation has been performed on the west domain for the period 1970-2065 with the A1B scenario. Further simulations have been performed on all three domains for the period 1950-2050 with the new IPCC scenarios. In general, a very good capability of the model to simulate localized climate effects has been registered. A comparison with observed data has been done in terms of 2-metre temperature and total precipitation averaged on the period 1971-2000. Overall, there is a good agreement between the values of COSMO-CLM and the CRU dataset (60 km of horizontal resolution): a little underestimation of temperature winter has seen, especially in the north east zone, while for the summer there is a higher overestimation. About the precipitation, the comparison shows higher differences on the coastal area, even if in summer the differences are higher in the whole domain, while in winter there is a general good agreement. A comparison with precipitation data provided by AMRA (Italy) on Ouagadougou for the period 1973-1985 shows similar trends (little differences, except for an overestimation in summer). A comparison with observed data over Nigeria (period 1976-2005) shows that the seasonal cycle of precipitation and temperature are well captured. Moreover, a projection of temperature and precipitation values up to 2065 shows an increase of the temperature (approximately 3.5 degrees), up to an average of 30 de-

grees. Indeed, the precipitation values remain enough unchanged (on an average of 3.3 mm/day).

5.9 Simulating Climate Change in Ireland

Paul Nolan¹ and Peter Lynch¹

¹ University College Dublin

Presentation: poster

At the Meteorology & Climate Centre at University College Dublin, we are using the CLM-Community's COSMO-CLM Regional Climate Model (RCM) and the WRF RCM (developed at NCAR) to simulate the climate of Ireland at high spatial resolution.

To address the issue of model uncertainty, a Multi-Model Ensemble (MME) approach is used. The ensemble method uses different RCMs, driven by several Global Climate Models (GCMs), to simulate climate change. Through the MME approach, the uncertainty in the RCM projections is quantified, enabling us to estimate the probability density function of predicted changes, and providing a measure of confidence in the predictions.

The RCMs were validated by performing a 20-year simulation of the Irish climate (1981-2000), driven by ECMWF ERA-40 global re-analysis data, and comparing the output to observations. Results confirm that the output of the RCMs exhibit reasonable and realistic features as documented in the historical data record.

Projections for the future Irish climate were generated by downscaling the Max Planck Institute's ECHAM5 GCM, the UK Met Office HadGEM2-ES GCM and the CGCM3.1 GCM from the Canadian Centre for Climate Modelling. To add to the number of ensembles, different realizations of the ECHAM5 forcing data were used to drive the models. Simulations were run for a reference period 1961-2000 and future period 2021-2060. The future climate was simulated using the A1B, A2, B1 and the new AR5 RCP greenhouse gas emission scenarios.

Preliminary results for the downscaled simulations show a substantial overall increase in precipitation and wind speed for the future winter months and a decrease during the summer months. The predicted annual change in temperature is approximately 1.1C over Ireland. To date, all RCM projections are in general agreement, thus increasing our confidence in the robustness of the results.

Results will be presented on the validation of the RCMs and the projected changes in the Irish climate.

5.10 Assessment of temperature and precipitation change projections over Italy and Mediterranean Area with COSMO-CLM

Pasquale Schiano¹, Edoardo Bucchignani¹, Myriam Montesarchio² and
Paola Mercogliano²

¹ CIRA/CMCC

² CMCC

Presentation: plenary oral

We present an assessment of climate change projections over the Italian peninsula and the Mediterranean area for the 21st century, considering the A1B emission scenario.

Two COSMO-CLM simulations have been performed, both forced by the global model CMCC-MED, whose atmospheric component is ECHAM5 (horizontal resolution of 80 km). The simulation over Italy has been performed at a spatial resolution of 8 km, considering the domain (4 -23 E; 35-51N) with 184 x 230 grid points and 40 vertical levels. The time step used for the time resolution is 50 sec, while the period considered is 1965-2100. The simulation over the Mediterranean Area has been performed in the frame of the EC project FUME (Forest fires in the context of climate and social changes), in which CMCC is involved in the production of downscaled regional climate projections at high resolution. The spatial resolution has been set equal to 14 km, considering the domain (13W - 40 E; 29-50N) with 380 x 190 grid points and 40 vertical levels. The time step used for the time resolution is 80 sec. Both the simulations have been performed on a cluster of 30 IBM P575 nodes, installed at CMCC-Lecce, employing as numerical scheme the Runge-Kutta with a HE-VI integration at 2 time levels and the Tiedtke scheme for the moist convection: Comparisons, in terms of 2-metre temperature and precipitation, with CRU data averaged on the period 1971-2000 will be shown and discussed, in order to analyze the capabilities of the Limited Area Model COSMO-CLM in simulating the main features of the observed climate over an area characterized by complex orography. Comparisons with data provided by Italian Regional Environmental Agencies will be also performed. Finally, climate projections in the XXI century will be analyzed, comparing the average values over the periods 1971-2000 and 2071-2100.

5.11 Regional climate modelling for the two catchments in China – some results from evaluation runs

Dinan Wang¹, Christian Ohlwein¹ and Clemens Simmer¹

¹ Meteorological Institute, University of Bonn

Presentation: poster

The work presented here is a follow-up of the presentation at CLM-Assembly 2010, which now is in the second year of three-year-project "Land Use and Water Resources Management under Changing Environmental Conditions", co-funded by DFG and NSFC. The work has so far focused on the evaluation run driven by ERA40 and ECHAM520C based on the configuration tuned for East Asia domain (Cordex Project). The parameter configuration test runs are cooperated with Christoph Menz from PIK, whose project simulation domain also lies within China. So far CCLM has rarely been applied for the East Asian Summer Monsoon (EASM) region. Therefore the author attempted to examine the capability of CCLM to capture the basic dynamics of EASM based on the evaluation results. The 2M temperature and total precipitation comparison against the CRU and APHRODITE are also presented, respectively.

5.12 Evaluation of the COSMO-CLM hindcast simulation intended for the forest modelling in Austria

Maja Zuvela-Aloise¹, Ivonne Anders¹, Klaus Haslinger¹,
Michael Hofstätter¹, Christoph Matulla¹ and Manfred Josef Lexer²

¹ ZAMG, Central Institute for Meteorology and Geodynamics

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Presentation: WG oral

In order to provide a long-term high resolution climate dataset for the modeling of biotic disturbances and wind damages in Austrian forests, we use a one-way triple nesting approach to downscale ERA40 reanalysis to the grid of the Austrian National Forest Inventory. In the first step the European domain with a spatial resolution of about 50 km is used. Within this simulation the Greater Alpine Region domain is nested having a resolution of about 10 km and in the final step the COSMO-CLM simulation of about 4 km spatial resolution is set. We perform basic analysis of climatic parameters derived from the 4 km resolution simulation to evaluate the added value from the dynamical downscaling and the applicability of the modeling results for climate impact research. We compared the mean daily bias and the seasonal distribution of temperature as well as precipitation between the simulations of 10 km and 4 km resolution for the period 1961-2000. The COSMO-CLM results are compared against STARTCLIM (ZAMG) 1 km gridded daily temperature and precipitation datasets. For the modeling of forest wind damages, we evaluate the performance of the COSMO-CLM model to simulate the wind field in the complex terrain of Austria. We compared the spatial patterns of wind speed maxima (number of exceedances over threshold) in COSMO-CLM simulation with the output of the weather forecast and analysis system INCA-ZAMG. Additionally, the model values of daily maximum wind speed and the wind speed distribution have been compared with observational timeseries from approximately 15 monitoring stations in Austria.

6 Session: IPCC-AR5

6.1 CCLM simulations for Europe in the context of CORDEX

Klaus Keuler¹ and Kai Radtke¹

¹ BTU Cottbus

Presentation: WG oral

Several climate simulations of the Euro-Cordex domain with CCLM are planned and partly prepared at a high horizontal resolution of 0.11 degree. The evaluation run for the period 1989 - 2008 using ERA-Interim reanalysis as lateral boundary conditions had already been completed. Selected results for different climate quantities are presented, i.e. 2m temperature, precipitation, daily minimum and maximum temperature, total cloud cover, mean sea level pressure. Three different configurations had been used including two different initializations of the soil water content, a modified albedo data set for dry and moist conditions and a modified (corrected) external data set describing elementary soil and land surface conditions. The climatological effects of these modifications are analysed. Finally the first results of a reference climate simulation starting in 12/1949 and driven by MPI-ESM-LR (ECHAM6 forcing) historical run are presented. The climatological means of the first decade of this run are compared with corresponding reference data (ECAD, CRU). The differences of this historical GCM driven climate evaluation with the ERA-Interim driven evaluation are discussed. The presentation is intended to initiate a discussion in the PG meeting about how to proceed with the scenario simulations for the Euro-Cordex and Africa domain, in particular how to select appropriate GCM runs for the further climate downscaling experiments.

6.2 XXI century projections of wind-wave conditions and sea-level rise in the Black sea

Alexander Polonsky¹, Anton Garmashov¹, Vladimir Fomin²,
Nikolay Valchev³ and Ekaterina Trifonova³

¹ Marine Hydrophysical Institute

² Marine department of Ukrainian Hydrometeorological Institute

³ Institute of Oceanology

Presentation: poster

Projection of regional climate changes for XXI century is one of the priorities of EC environmental programme. Potential worsening of the waves' statistics, sea level rise and extreme surges are the principal negative consequences of the climate change for marine environment. That is why the main purpose of this presentation is to discuss the above issue for the Black sea region (with a strong focus to the south-west subregion because the maximum heights of waves exceeding 10 m occur just here) using output of several global coupled models (GCM) for XXI century, wave simulation, long-term observations of sea level and statistical techniques. First of all we tried to choose the best coupled model (s) simulated the Black sea climate change and variability using the control experiments for 20 century (20-3). The principal result is as follows. There is not one model which is simulating adequately even one atmospheric parameter for all seasons. Therefore we considered (for the climate projection) different outputs from various models. When it was possible we calculated also the ensemble mean projection for the selected model (s) and emission scenarios. To calculate the wave projection we used the output of SWAN model forced by the GCM wind projections for 2010 to 2100. To estimate the sea level rise in XXI century and future surges statistics we extrapolate the observed sea level rise tendencies, statistical relation between wave heights and sea level and wave scenarios. Results show that in general, the climate change in XXI century doesn't lead to the catastrophic change of the Black sea wind-wave statistics including the extreme waves in the S-W Black sea. The typical atmospheric pattern leading to the intense storm in the S-W Black sea is characterized by the persistent anticyclonic area to the North of the Black sea and cyclonic conditions in the Southern Black sea region. Such pressure pattern causes persistent and strong eastern or north-eastern wind which generates the high waves in the S-E Black sea. The climate projections show that the frequency of such atmospheric pattern will not principally increase. The recent probability of the extreme wave height (exceeding 8 to 10 m) in the S-W Black sea (1 occurrence per 10 years) will not be much worse in XXI century. Similar conclusion is true for the storm surges along the Bulgarian coastline. Expected sea level rise in the Black sea basin for XXI century due to regional climate changes is about 2 mm per year (50 bay) are characterized by fivefold sea level rise because of the local land subsidence. So, this geomorphologic effect is the

most dangerous local consequence for the sustainable development and management of the coastal zone in such subregions.

6.3 An Overview of Preliminary Assessment Results of Cordex-Africa Regional Climate Model Simulation over West Africa Sahel.

Abdoulaye Sarr¹

¹ ANAMS

Presentation: plenary oral

It was noted during IPCC AR4 of WG1, that most of the projections over Sub-Saharan Africa were mainly done based on General Circulation Models (GCMs) with coarse resolution and very high uncertainty. To reduce this issue in the next IPCC AR5 report, all regional modeling centers are asked to perform, over a uniform Africa domain, high resolution simulations for the present time and projections for the future in the framework of the Coordinated Regional Downscaling Experiment (CORDEX). This so-called Cordex-Africa experiment, with the support of WCRP and START is comforting an Africa Analysis Team to work on these RCMs outputs in their respective regions. The first component of the experiment consists of forcing the involved RCMs with ERA-INTERIM data as IC&LBCs, for the period 1989 to 2008. This paper presents mainly the evaluation process of the different RCMs, over a highly vulnerable region of West Africa known as Sahel. This region has experienced the longest and most devastating drought during the last century. The validation is carried out against different reference datasets (CRU, GPCP, CMAP etc) as preliminary results of the Sahel Group (SAH-G) of the Cordex-Africa Analysis Team. The Cosmo Climate model (CLM) is a member of the RCMs used in this international effort to support high resolution downscaling over Africa for IAV studies and capacity building. The performance of different RCMs forced by ERA-INTERIM is investigated at regional and sub regional scale over West Africa Sahel with a special emphasis on key parameters like precipitation and temperature. Weaknesses and strengths of RCMs in simulating the mean climate and selected key features over the region of investigation are highlighted. The next phase of the process will be the use of simulations by these RCMs forced by CMIP5 GCMs.

7 Session: SOILVEG

7.1 A modification of the mixed form of Richards equation and its application in vertically inhomogeneous soils

Bodo Ahrens¹, Frank Kalinka¹ and Eva Gerstner¹

¹ Goethe University

Presentation: WG oral

Recently, new soil data maps were developed, which include vertical soil properties like soil type. Implementing those into a multilayer Soil-Vegetation-Atmosphere-Transfer (SVAT) scheme, discontinuities in the water content occur at the interface between dissimilar soils. Therefore, care must be taken in solving the Richards equation for calculating vertical soil water fluxes. We solve a modified form of the mixed (soil water and soil matric potential based) Richards equation by subtracting the equilibrium state of soil matrix potential \mathcal{E} from the hydraulic potential \langle . The sensitivity of the modified equation is tested under idealized conditions. The paper will show that the modified equation can handle with discontinuities in soil water content at the interface of layered soils.

7.2 The added value of the Community Land Model in simulations for tropical Africa.

Tom Akkermans¹, Dirk Lauwaet¹ and Nicole Van Lipzig¹

¹ Katholieke Universiteit Leuven

Presentation: WG oral

The default Soil-Vegetation-Atmosphere-Transfer (SVAT) scheme of COSMO-CLM is called TERRA-ML and can be replaced by the more complex Community Land Model. In a preceding “offline” evaluation study (Akkermans et al, 2011) it became obvious that the latter is better performing compared to TERRA-ML when both schemes were uncoupled from their respective atmospheric models and ran in standalone mode. This study aims to quantify the added value for tropical simulations of coupling the Community Land Model to COSMO-CLM, hereafter called COSMO-CLM² “online” model runs. The model (COSMO v4.0) is run with 0.22° (25km) horizontal resolution and 210x180 gridpoints for the period 2001-2002, from which only the second year is evaluated. Two model runs are done, differing only in the type of SVAT, hence differences in model output are also strictly due to this modification. Analyses are mainly done for the Congo Basin area. The energy balance and hence near-surface temperature is simulated significantly better over the Congo Basin (cold bias decreased by +1K), at root caused by a better partitioning of the surface turbulent fluxes (H and LE). Despite the older atmospheric model core (v4.0), COSMO-CLM² still performs better than the newer COSMO version (v4.8) which uses the default TERRA SVAT. Finally a 20-year present-day reference run (1989-2009) is presented using COSMO-CLM with ERA-interim boundary conditions. The results are briefly discussed. Besides surface temperature (CRU, GHCN) also energy balance (GEWEX-SRB), cloud cover (SRB, FRESCO) and precipitation (TRMM) are evaluated.

7.3 Investigating land-vegetation-climate coupling with COSMO-CLM²

Ruth Lorenz¹, Edouard L. Davin¹ and Sonia I. Seneviratne¹

¹ ETH Zürich

Presentation: plenary oral

Processes acting at the interface between the land surface and the atmosphere have a strong impact on the European summer climate, particularly on extreme events. We investigate the role of land-vegetation-climate coupling in Europe using simulations with COSMO-CLM², a new version of the COSMO-CLM regional climate model coupled to NCAR's Community Land Model. COSMO-CLM² allows for a detailed representation of vegetation-climate interactions due to the representation of plant physiological processes. The set of experiments consists of a control run (CTL) with interactive soil moisture driven by ERA-*Interim* data and different sensitivity experiments. We conduct two experiments with extreme soil moisture (dry and wet) conditions as well as an experiment with soil moisture prescribed to the mean seasonal cycle from CTL. In addition, we perform an experiment with leaf area index prescribed by using a global reanalysis of vegetation phenology. We analyze to which extent soil moisture-atmosphere interactions are reproduced in COSMO-CLM² by comparing it to the standard version. Using the model run with prescribed leaf area index we investigate soil moisture- versus phenology-climate interactions and study the impacts of phenology on climate. The results highlight the importance of the correct representation of vegetation processes and soil hydrology for land-atmosphere feedbacks in a regional climate model.

7.4 Northern Germany- what could happen to its climate due to dramatic land-use change?

Anja Ludwig¹, Burkhardt Rockel¹, Insa Meinke¹ and
Felix Ament²

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² University of Hamburg

Presentation: plenary oral

Land cover is continuously modified both by natural as well as anthropogenic factors. These modifications show impacts on climate especially on the regional scale. Until now, this degree of interactions was mainly examined by global climate models with coarse horizontal resolutions. Here, land-atmosphere interactions in the convection resolving scale of 2.8km horizontal resolution with COSMO-CLM are presented. CCLM simulations with three different horizontal resolutions are performed: 25 km, 7 km and finally 2.8 km. Land-atmosphere processes are parameterized by the soil and vegetation atmosphere transfer model TERRA_ML. The focus is on the northern part of Germany which is predominantly characterised by the adjacency of the Baltic Sea and the North Sea and comparable smooth orography.

The study is divided into two parts: Firstly, a sensitivity study is performed for the period of 2002 and 2003 forced by ERA-interim reanalyses with three extreme cases of simplified land-use change, namely mixed forest only, continuous urban fabric only and non-irrigated arable land only are defined as land-use types in all simulations. Most pronounced impacts for urban land-use occur in summer whereas mixed forest leads to clear impacts in spring. These direct effects on near surface temperature and humidity as well as indirect effects on precipitation formation and general atmospheric circulation patterns are analysed.

Secondly, first results of long-term simulations forced by ECHAM5 reanalyses will be shown for the last decade of this century. More realistic land-use change scenarios for Northern Germany will highlight possible impacts due to land-use change next to CO₂-emissions on regional climate.

7.5 River Routing in CCLM

Jan Volkholz¹

¹ PIK Potsdam

Presentation: poster

In order to enable CCLM to simulate lateral stream flow the "Muskingum" river routing scheme was implemented in TERRA-ML. This scheme takes the surface and subsurface runoffs and simulates their flow towards the sea. In particular, the Elbe basin was modeled. Results of the simulation of the years 1959 to 1975 will be presented.

7.6 Results of offline runs over rural and urban terrains with TERRA-ML standalone upgraded with new stability functions for momentum and heat

Hendrik Wouters², Nicole P.M. van Lipzig¹, Koen De Ridder² and
Gerd Vogel³

¹ K.U.Leuven

² VITO N.V.

³ DWD

Presentation: plenary oral

A new analytical bulk parametrization for surface-layer transfer coefficients for momentum and heat are presented and tested with TERRA-ML in standalone mode. These transfer relations are applicable for both very large roughness lengths for momentum and extremely small thermal roughness lengths, and includes effects of the roughness sublayer. As a consequence, it is suitable for every surface type, including urban surfaces, in global and mesoscale meteorological models. This is not the case for earlier analytical approaches like the Louis-type currently implemented in COSMO_CLM. The new transfer relations are now being tested with TERRA-ML in offline mode for both urban and rural land-cover types. For the meteorological forcing and validation, we use measurements from both the Falkenberg site for grassland and the ESCOMPTE campaign in the city center of Marseille. On the one hand, a similar and even slightly better performance is achieved over grassland when using the new transfer relations compared to the Louis-type approach. On the other hand, the results improve dramatically for the urban site regarding the blocking effect on the sensible heat due to extremely small thermal roughness lengths.

8 Session: SUPTECH

8.1 Coding Standards (CS) for the COSMO-CLM

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Presentation: WG oral

The first draft version of the Coding Standards (CS) for the COSMO and COSMO-CLM model versions is available online on the assembly webpage as part of the materials. The CLM SUPTECH subgroup on coding standards (J. Brauch, S. Brien and A. Will) participated in the preparation of the document. The CLM-Community is asked to accept the document. If this will be the case, it has to be taken into account with future model developments which shall become part of a CLM-Community model version.

The document shall be discussed at the SUPTECH WG meeting as specified in the time schedule for the meeting. All members interested in this discussion are invited to join the meeting or to make suggestions before the meeting by email to the CS topic group of SUPTECH (jennifer.brauch@senckenberg.de).

The document “COSMO Standards for Source Code Development” contains regulations of mandatory aspects for further source code development:

- coding rules and implementation issues ,
- documentation standards,
- code maintenance issues and
- quality control requirements.

These regulations aim to improve the overall quality and usability of new model versions and to facilitate a systematic further model development by the community. The main intended advantages for all members are the availability of an up to date documentation and a reduction of model bugs. An important issue for the CLM-Community is the definition of responsibilities of the scientists providing the code developments and of the community interested in the further model development. The latter become community tasks.

The main aspects of the current version and the consequences for the CLM-Community and for the code developers will be presented. The suggested responsibilities for controlling of the quality of the code developments, for the conduction of the tests and for the evaluation runs necessary will be discussed and the resulting rules for source code distribution will be highlighted. Last but not least the work packages for the WG SUPTECH will be presented.

8.2 C3Grid application: Diagnostic workflows for climate data

Andreas Dobler¹, Ingo Kirchner¹, Thomas Schartner¹ and
Uwe Ulbrich¹

¹ Freie Universität Berlin

Presentation: WG oral

The aim of the C3Grid project is to create a grid-based working environment for earth system research. Within the project, a user web-portal has been developed where different climate workflows (WFs) can be applied on a range of data sets. The currently implemented WF's include a storm tracking algorithm, the calculation of humidity transport, convective available potential energy, and some CDO ensemble statistics. The C3Grid portal also provides a quick-view visualisation and the ability to download the data. Future WF's will include multi model multi ensembles, IPCCAR5 data browsing and access, and the evaluation of RCM runs and inter comparison of model runs in terms of specific processes.

Currently, also the implementation of a WF to prepare initial and boundary conditions for the COSMO-CLM is carried out at FU-Berlin. For this WF, different global int2lm-ready data sets (e.g., NCEP and ERA re-analyses, ECHAM5, CMIP5-GCMs) will be made available in the C3Grid, and a GUI based interface to the int2lm program will be implemented. This presentation gives a short overview on the current status and features of the C3Grid portal and an outlook on the WF to prepare initial and boundary conditions for the COSMO-CLM.

8.3 Activities with CCLM at DKRZ

Stephanie Legutke¹

¹ DKRZ

Presentation: WG oral

DKRZ has been charged with the organisation and performance of the CMIP5 Earth system model simulations with MPI-ESM (ECHAM6/JSBACH/MPIOM/HAMOCC). The CMIP5 experiments create the data base for the next IPCC/AR5. Computing resources for this activity are available at DKRZ because the experiments will be/are run in the so-called 'consortial mode' in the interest of the German climate scientific community in general. In the same DKRZ project (ID 555) some of the global CMIP5 experiments, i.e. parts of the 'historical' experiment (1850-2005) and the new scenario experiments will be downscaled over some of the CORDEX domains (Africa, Europe) with CCLM as well as with REMO. An overview on the plans and activities is given.

Data access to the global data is provided through the ESG (Earth System Grid) data archive federation. Data contained in this archive must strictly comply to data format standards agreed on in the CMIP5 project. CORDEX has recently agreed to a similar standard. Data format and access are explained for both, the CMIP5 and CORDEX results.

Finally the general activities at DKRZ related to CCLM is summarized.

8.4 Alternative external data-sets for the COSMO-CLM

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Presentation: plenary oral

There still remain biases in the simulated mean temperature, precipitation and cloud cover fields for simulations with recent configurations and versions of the COSMO-CLM for resolutions in the range of 50-12km over the European continent even though the work of the “cold bias project” has made quite some improvements. In this contribution we investigate to what extent some alternative datasets for external parameters can influence these biases. All investigations are based on the unofficial CCLM-Version cosmo1.14_clm1 which already allows for prescribed aerosol fields and consist of ERA40 driven simulations for the period 1990-1995. In the original COSMO-CLM soil albedo is directly related to the soil type and leads to maximum albedo values of 30we apply a procedure adopted from the Community Land Model which prescribes the soil albedo via soil color fields that were derived from MODIS satellite measurements(Lawrence and Chase, 2007). Further the plant albedo is kept as a constant in the original model code irrespective of the plant functional type. We try instead spatially variable plant albedo fields based on ISLSCP II gridded plant functional type distributions and MODIS derived albedo values for these plant types (Houldcroft et al., 2009). Newer Versions of the COSMO model code allow also the use of externally prescribed emissivity fields. Datasets of the long- wave emissivity show lower than standard values over Northern Africa. The impact of this is also shown. Zubler et al. (2011) showed that the aerosol optical depths over Europe are poorly represented by the Tanré climatology which is the standard in the COSMO-CLM model. We extended the COSMO code to allow also for time varying prescribed aerosol fields and used the monthly climatologies of Tegen(1997) and Aerocom (Kinne et al., 2006) for a transient prescription of the aerosol fields. Results of these simulations are also shown. Finally external fields for leaf area index (LAI), fractional plant cover and rooting depths derived from the ISLSCP II project are applied and their impact is investigated.

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8.5 Implementation of a general treatment of tracers in COSMO

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Presentation: WG oral

An implementation of submodules for atmospheric processes such as microphysics, atmospheric chemistry or pollen transport requires a consistent treatment of passive scalars (tracers) throughout a regional climate or numerical weather prediction model. In the current COSMO code, tracers are handled as individual variables. For example, water vapor is declared as the variable `qv` and treated throughout the code using an explicit reference to this field. This treatment leads to massive code redundancy, making it difficult to understand, maintain and further develop. Furthermore, an in-depth knowledge of the code is required from anyone wanting to implement a new prognostic variable. In other atmospheric models (e.g. ECHAM, WRF), a general tracer mechanism is available, enabling a uniform, consistent and more convenient tracer treatment. We propose to tackle this issue by implementing a new module which provides a general treatment of tracers that can be leveraged by submodules which require this functionality (clients). The tracer module provides a clean interface as well as standard functionalities to all tracer clients.

This talk will give an overview of the functionalities provided by the tracer module and demonstrate its use with a practical example. The main functionalities currently provided are the definition of a new tracer (specification of the name, actions to be performed, etc.), its initialization, the associated memory management, I/O and treatment of the initial and boundary conditions, its advection, turbulent mixing and artificial diffusion. Introducing a new tracer (prognostic variable) into the COSMO model is reduced to a simple call of one single subroutine with the adequate arguments. Flexibility for future changes is maintained by hiding the implementation details for the user.

8.6 Consistent COSMO-CLM configuration for different horizontal resolutions and time steps

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Presentation: WG oral

The COSMO-CLM provides a wide range of different configurations specified by more than 150 namelist parameters affecting the data assimilation, the model domain and its physical properties, the model physics, dynamics and the model output. Several of these parameters are not independent. A detailed knowledge of the namelist parameters is necessary for a consistent modification of the configuration.

One of the typical applications is the modification of the models horizontal spatial resolution (dlam, dphi) and/or slow mode time step (dt). However several parameters affecting the model physics depend on dlam, dphi and/or dt.

We analyzed the dependencies between dlam,dphi,dt and the other namelist parameters. An overview will be presented and discussed. A recommendation for a consistent modification of the configuration will be made.