CLM Community

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CLM ASSEMBLY

CLM COMMUNITY
14TH GENERAL ASSEMBLY

FROM 16 TO 20 SEPTEMBER, 2019
PAESTUM – ITALY

ORGANIZING SECRETARY mtn

BOOK OF ABSTRACTS

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TUESDAY
morning

Recent developments of the COSMO-CLM system

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An overview of the recent modifications in the COSMO-CLM system will be given. This concerns the recommended versions of COSMO5.00_clm15 (at the assembly in Karlsruhe 2018 it was COSMO5.00_clm10) and int2lm2.5_clm1 (at the assembly in Karlsruhe 2018 it was int2lm2.0_clm4).
New developments in pre-processing and starter package will also be given.
Finally, the current status on the way to the next (and last) re-unification of the weather forecast version and the climate version of COSMO into version 6.0 will be given.

Experiences with ICON-CLM and its starter package

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Over the last year a small group of people developed a first version of ICON-CLM from the ICON-NWP version. The main work at the source code was performed at the German Weather Service and a GIT repository was created at the MPI Hamburg where also other ICON branches are stored. Until an official source code administrator is found the repository is maintained by the German Weather Service.
In this presentation experiences gathered during the process of setting up the ICON-CLM on a different computer than those at the German Weather Service. Here on the mistral super computer at the German Climate Compute Centre (DKRZ) in Hamburg.
After compiling and running a first test version the next task was to put the ICON-CLM into a framework that allows for splitting long term simulations into monthly pieces. A chain similar to the one that already exists in the starter package for the COSMO-CLM was implemented for ICON-CLM. This will be included in the starter package for ICON-CLM. A short introduction to this package will be given.
An overview of what is available and what is missing in comparison to the COSMO-CLM system will be presented.

Online diagnostics for the CLM-Community

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Long-term and/or high resolution simulations with geoscientific models become more and more limited by storage space. Therefore, on-line diagnostic tools calculating the target variables directly during the model simulation become increasingly important. One option is to use the MESSy-fied versions of the CLM-Community models. MESSy provides a huge range of on-line diagnostic tools, e.g.
1. simple statistics w.r.t. time, such as monthly mean, standard deviation, minimum, maximum or event counting,
2. the output on distinct surfaces (e.g., pressure levels, potential vorticity iso-surfaces),
3. output of data along sun-synchronous satellite orbits or radiosonde tracks,
4. the renaming of variables, as e.g. required by the CMOR standard,
5. redirection of a set of variables into specific output _les, etc.,
6. diagnostics for tracers (such as hydrological variables),
7. tendency diagnostics.
Further, the modular MESSy infrastructure gives the possibility to integrate tailormade on-line diagnostics to the model without modifying the COSMO-CLM code itself. COSMO-CLM/MESSy is already provided to the CLM-community members and a trainings course is offered late October this year. Further, implementation of the MESSy interface in ICON-CLM has started.
In our presentation we will provide a general overview of the features of the diagnostic capabilities of the MESSy-fied CLM-Community models.

Evaluation of an ERA-Interim steered EURO-CORDEX simulation with the regional ocean-atmosphere model ROAM1.0 and first steps in the direction of ROAM2.0

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In the pilot project ProWaS (Projektionsdienst für Wasserstraßen und Schifffahrt, engl. climate projection service for waterways and shipping) several German federal agencies cooperate to determine the effects of climate change on waterways and on shipping in the region of the German Bight and the rivers Elbe and Rhine. Possible effects of climate change are an increasing number of draughts, which could cause low level situations in Rhine and Elbe and would highly restrain the shipping.
In this project, meteorological and oceanographical datasets of high resolution climate projections, which are produced by coupling the COSMO-CLM model with the ocean

model NEMO-Nordic via the OASIS3-MCT coupler, were provided. COSMO-CLM has a resolution of approx. 24 km and covers the EURO-CORDEX domain while NEMO-Nordic simulates the North- and Baltic Sea with a grid size of approx. 3 km. These simulations are intended to drive impact models for the rivers and the estuaries to advise decision makers in these areas on possible climate change effects.
Prior to performing the climate projection run forced by a CMIP5 global model with the RCP8.5 scenario until 2100, an evaluation simulation steered by ERA-Interim was carried out with the coupled model. This run was evaluated by comparing different meteorological fields like 2 m air temperature, precipitation and sea-surface temperature to observations and uncoupled (standalone) simulations from the two models.
First results reveal a good agreement of the modeled 2 m air temperature with the observations for central Europe. It can be seen that precipitation is overestimated in the Alps and underestimated in the Central German Uplands.
In the long run, it is planned to switch from COSMO-CLM to ICON-CLM as regional atmosphere model as the base of ROAM2.

TUESDAY
afternoon

Computational Performance of Higher Order Numerical Schemes in COSMO model

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Performance modeling results of higher order numerical symmetric schemes (HOS) in the COSMO-CLM 5 show that the increased stencil width associated with higher order numerical schemes has insignificant impact on the computational costs of climate simulations. This is because the computing time of advection is small in comparison to the time for communication of the boundary values between the cores. The computing time of the HOS model equations is however affected by additional operations necessary for the symmetric conservative fourth order scheme. The results show that there is about fifty percent increase in computing time for the fourth order symmetric schemes compared to the traditional COSMO 3rd order upwind scheme (CU3) but without significant effect on the total run time. We show that the symmetric property of these schemes make it possible to design efficient algorithms with minimal communications of overlapping domains between the processors resulting in no increase of computing time for boundary exchange in HOS in comparison with CU3 thus making them practical for high resolution geophysical modeling using the current and future supercomputers. The overall efficiency of HOS coupled with the numerical conservative properties makes it appropriate for current and future generations Earth System Models.

Results of statistical downscaling of COSMO-CLM convection-permitting simulations with PCA-derived weather patterns

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The climate change is not only a global issue but also important on the local scale for countries like Germany. The knowledge about frequencies and intensities of extreme events of the local climate is one of the key issues in the project “Network of experts - Adapting transport infrastructure to climate change and extreme weather events”, launched in 2016 by the German Federal Ministry of Transport

and Digital Infrastructure. Several federal agencies are working closely together to develop strategies for dealing with challenges of future traffic infrastructure. For the assessment of the vulnerability and possible adaptation strategies for transport infrastructure on a local scale, climate information is needed on the same scale, as they are one of the main factors.
Thus, we perform convection-permitting climate projections with COSMO-CLM on 2.8 km grid width using the RCP 8.5 scenario, dynamically downscaled two-fold from MIROC5 global model data. The simulations were done continuously from 1971 to 2100 with focus periods for the past (1971-2000) and for the future (2031-2060 and 2071-2100). An additional evaluation run was performed using the reanalyses of ERA-40 and ERA-Interim as driving data sets.
In order to estimate the robustness of our climate projections we developed a high-resolution climate multi-model ensemble using a combination of statistical and dynamical downscaling. We applied a statistical downscaling technique ensemble by linking high-resolution dynamical simulation at 2.8 km grid width to the simulations at 12 km grid width. For this procedure we used principal component analysis (PCA) derived weather patterns. The optimal configuration has been tested for a 30 year period of climate projections driven with MIROC5. We used the Bias-adjusted reduced ensemble of 8 EURO-CORDEX members which has been developed in the framework of the Network of Experts.
Comparisons of dynamically and statistically downscaled simulations show overall good agreement. Compared to gridded observations, it turns out that the COSMO-CLM simulations produce too much precipitation over the Alps and too less over the northern parts of Germany.
The ensemble data show no significant future change of mean annual precipitation but an increase of heavy precipitation. More results of the dynamical and statistical downscaling will be presented.

Analysis of convection-resolving COSMO-CLM simulations for Germany

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The influence of climate change on the transport infrastructure is addressed in the German research project “Network of Experts - Adapting transport and infrastructure to climate change and extreme weather events”. Temperature, precipitation and wind are key parameters. As information are required locally and the transport infrastructure is specifically vulnerable to extreme events, climate model output at high spatial and temporal resolution is needed. For this, we ran simulations with the regional climate model COSMO-CLM at 2.8 km grid spacing (convection permitting) for the area of Germany and for the time period 1971-2100. The COSMO-CLM simulations were nested in 12km EURO-CORDEX runs with COSMO-CLM driven by ERA40/ERA-Interim and MIROC5 (RCP8.5 scenario). These high resolution simulations are further applied in the project to a statistical downscaling technique to generate a high resolution climate projection ensemble.

We analyze the RCM simulations regarding average and extreme conditions and with an additional focus on the added value compared to the forcing simulations at lower resolution. The area of interest is Germany and related river catchments and we use the HYRAS observational data sets, which are further developed in another part of the project, for evaluation.

Effects of shallow convection schemes in perennial convection-permitting simulations with CCLM and WRF

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Shallow convection can have significant impacts on weather and climate. For instance, it may affect the net radiation characteristics of the atmosphere and/or modify the timing and location of deep convection initialisation. In convection-permitting simulations, deep convection parameterisations are generally switched off. However, there is an ongoing debate about the usage of shallow convection parameterisations in climate modelling applications.
Within the framework of the “Flag Ship Pilot Study on convective phenomena over Europe and the Mediterranean” (CORDEX-FPS), two re-analysis-driven WRF twin simulations have been conducted in a convection-permitting modelling domain (3 km grid spacing) covering the Alpine region: one makes use of the shallow convection scheme of the Global/Regional Integrated Model system (GRIMs) while the other one does not employ any shallow convection scheme. CCLM has also been used in a similar convection-permitting setting for two times: with and without the Tiedke shallow convection scheme.
In the presented study, the simulations with CCLM and WRF are compared to the analysis fields from the Integrated Nowcasting through Comprehensive Analysis (INCA) system that is operationally used at the Austrian Central Department for Meteorology and Geodynamics (ZAMG). INCA combines in-situ measurements of precipitation from a high-density stations network (more than 300 stations in the Austrian territory and its near surroundings) with remote sensing data (5 weather radar stations distributed over the country) and provides gridded (1 km grid spacing) precipitation fields with a temporal resolution of 15 minutes. In this work, simulated precipitation of June, July, and August from 2006 to 2009 is compared with INCA in Austria on an hourly basis. The analysis focuses on how the shallow convection parameterisations affect size and intensity of summertime precipitation along its diurnal cycle in the two models, CCLM and WRF.

Evaluation of very high resolution ERA-Interim driven COSMO-CLM simulation over the period 2000-2010

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Regional climate models (RCMs) at few kilometers of resolution are powerful tools currently available for understanding the evolution of the climate system at local level, in response to the changing of greenhouse gases concentrations, seeking to represent in an improved way the local-scale atmospheric phenomena.
Currently, climate simulations exploiting finer grid spacing are computationally very demanding and it is not yet evident their added value, often depending on the geographical context and variables. An increasing capability in representing local climate is expected by the convection permitting model COSMO-CLM. In this work, a very high resolution COSMO-CLM simulation, including the urban parameterization TERRA-URB, over the period 2000-2010 is presented. It is driven by ERA-Interim Reanalysis, first dynamically downscaled at the intermediate resolution of 0.11° (~ 12 km) over the EURO-CORDEX domain, and then further downscaled at the resolution of 0.0275° (~ 3 km) over Greater Alpine Region and South West Europe domains, according to H2020 EUCP Project protocol. The focus of this work is a detailed evaluation of the simulation, using fine gridded observations available over the considered domains and using specific tools such as Taylor diagrams. Model response has been analyzed in terms of two-meter temperature and total precipitation.

Atmospheric Moisture Effects on Deep Convection in the Western Mediterranean

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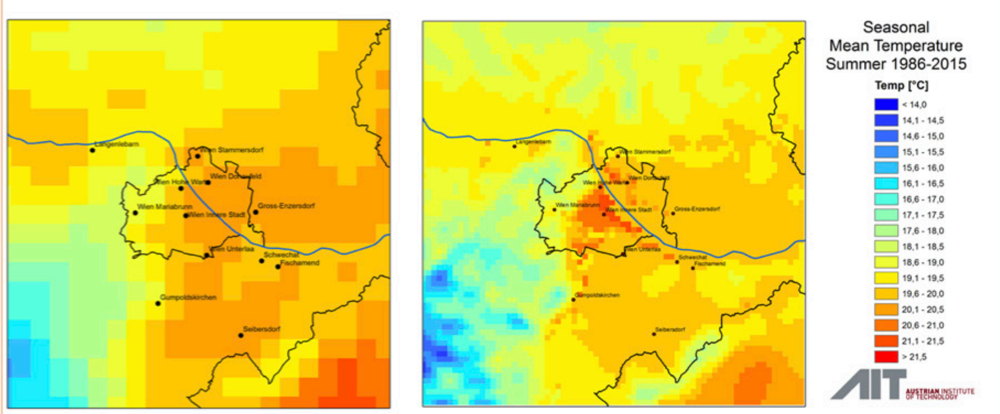
The costliest weather hazard in the Western Mediterranean (WMed) is heavy precipitation and flooding, occurring mainly by autumn due to the phenomenon of deep moist convection (EEA, 2016; Llasat et al., 2010). Forecasting exactly where and when this phenomenon will take place is still a challenge given the manifold mechanisms that interact across several weather scales. Regarding this problem, one of the identified sources of error, in current atmospheric models is the misrepresentation of the atmospheric moisture spatial distribution (Chazette et al., 2015; Khodayar et al., 2016). A well-established technique to overcome this issue is the Data Assimilation (DA) of observations (Wulfmeyer et al., 2015; Guerova et al., 2016). The recent advancements in remote sensing techniques open new prospects for DA of humidity measurements with a high spatio-temporal resolution. In particular, measurements of the Zenith Total Delay (ZTD) obtained by Global Positioning Systems

(GPS) are especially outstanding given their high accuracy, their sub-hourly temporal frequency (minutes), and the large coverage over European countries. Still, few studies exist so far on the impact of correcting the atmospheric moisture fields at such high temporal resolution. Especially relevant is gaining knowledge on what would be the different responses of current atmospheric models depending on their model horizontal resolution.

The presented work is an assessment of the relevance of high-resolution modelling of atmospheric moisture for the improvement of the seasonal and event-scale predictability of heavy precipitation in the WMed.

To this end, we performd DA sensitivity experiments using the nudging scheme to correct the simulated atmospheric moisture fields toward GPS-ZTD observations. The used GPS-ZTD data set is unique given it has a very high temporal frequency of 10 minutes and that it merges measurements from 25 different European networks (Bock et al., 2016). We analysed the impact in an across-scale approach performing simulations of a complete autumn period using the Climate Mode of the COSMO model (COSMO-CLM), coinciding the HyMeX Special Observation Period 1 (SOP1), as well as a selected case study within. We performed the GPS-ZTD nudging sensitivity experiments on different horizontal grid-spacings (7 km, 2.8 km and 500m) to study the impact of the moisture variations in convection-parameterized as well as a convection-permitting set-ups.

The results show, that the two most affected processes by the moisture correction are atmospheric instability, due to changes of low-level moisture, and mixing in the rising updrafts due to variations of the lower free-tropospheric moisture. The moisture corrections invariably affect these two processes, entailing a large impact on the total represented precipitation. In the representation of the seasonal conditions in the WMed, the GPS-ZTD nudging corrected seasonal biases up to 5mm, entailing a large reduction of extreme precipitation. This aspect turned out most beneficial in the convection-permitting simulation (2.8 km), as a better agreement with the observational frequency of extreme precipitation was gained. For the selected case study, we carried out a supplementary experiment combining the high-resolution GPS-ZTD data set with operational soundings. The results showed that knowledge on



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WEDNESDAY
morning

High Resolution Urban Climate Modelling

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Regional Climate Models usually work at resolutions of app. 10km. This is insufficient for addressing the micro-scale effects generated in urban environments. For that reason high resolution model runs based on results from the project reclip:century were carried out at the Austrian Institute of Technology. This was achieved with 4 nesting steps at 50km, 10km, 4km, and 1km horizontal resolution. The first 3 runs were performed with the standard Regional Climate Model Cosmo-CLM (cosmo_4.8_19), for the 1km run special urban extensions provided by Hendrik Wouters were applied. Therefor two additional input fields are needed: the urban fraction (URBAN) and annual-averaged anthropogenic heat (AHF, AHE). The high resolution model domain represents a 100x100 km2 square of the Greater Vienna Region. The model was evaluated against 13 measurement stations in and around Vienna using ERA40/ ERAInterim forcing data from 1960 to 2015. Model runs for the future climate are based on data from the Global Climate Model HadCM3 using the IPCC SRES scenario A1B. Although the Regional Climate Model Cosmo-CLM has a distinct cold bias the temperature profiles are significantly enhanced and very close to measurements. Compared to the 4km run 1km results show a significant gain in accuracy especially in representing urban heat island effects.

Fig. 1: Temperature map from 4-km standard run (left) and 1-km urban run (right)

Further on sensitivity tests have been carried out using different anthropogenic heat emission sources and modifying input for urban fabric, soil sealing, plant cover and leave area index with data derived from Urban Standard Topology (UST) maps.

In addition, first runs with the latest version of TERRA-URB (v2.3) and CLM-v5.0 were conducted. Differences compared to the base run and troubles during model execution will be highlighted.

A Comprehensive Study of the COSMO-CLM Performance over Central Asia

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Due to its extension, geography and the presence of under-developed or developing economies, Central Asia constitutes a very important case study for the application of Regional Climate Models (RCMs). In fact, on one hand, its vulnerability to the possible harmful effects of climate change requires information with a high spatial resolution to develop adequate adaptation and mitigation studies. On the other hand, the region is characterized by a variety of climatic conditions, which makes it a very useful test case for the evaluation of model performance. Despite its importance, this region has rarely received appropriate attention from the RCM community. In this study, the performance of COSMO-CLM 5.0 for the CORDEX Central Asia domain is evaluated, with the goal of investigating main model uncertainties and limitations, determining at the same time an optimal model configuration. Additionally, the problem of model configuration transferability is addressed by comparing the results with the configuration and model performance for Europe.
Results show that the model presents particularly pronounced biases over the region, with warm temperature biases up to 15. While it seems possible to generally improve model performance by changing different physical parameterizations and parameter values, some biases are particularly resistant, indicating limitations in the model formulation, especially over areas characterized by extremely cold winters. For the entire area, the model seems to be mainly sensitive to parameters characterizing the interaction between soil and atmosphere, with some exceptions for speci c sub-domains. Parameters perturbation allows to isolate six most sensitive model parameters, on which an objective calibration using a multivariate quadratic metamodel is performed, leading to an optimal configuration for the region. Finally, a comparison of the results with the ones obtained for Europe highlights the necessity of conducting a model calibration when applying the COSMO-CLM to different domains of study.

Implementation of blowing snow and improvement of albedo and surface mass balance in COSMO-CLM^2 over Antarctica

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Surface mass balance (SMB) strongly controls spatial and temporal variations in the Antarctic Ice Sheet (AIS) and its contribution to sea level rise. The current scarcity of observational data and the challenges of climate modeling over the ice sheet limit our understanding of the processes controlling AIS SMB. Particularly, the impact of blowing snow on local SMB is not yet constrained and is subject to large uncertainties. Drifting snow is crucial for ice sheet mass balance through the displacement and relocation of snow particles but also through drifting snow sublimation. We implement the simple bulk model from Déry and Yau (2001) for blowing snow in the regional atmospheric COSMO-CLM model coupled to the land component of CESM, the Community Land Model. The coupled COSMO-CLM^2 model was adapted to accurately represent the Antarctic conditions and includes snowpack adaptations for a better representation of perennial snow surface and mass balance representation over the ice sheets and glaciers. As such, we optimized the representation of albedo in the model, by adapting the albedo parameterization scheme to the conditions over the AIS, compliant to the MODIS albedo product. A realistic representation of albedo is of large importance, as variations in the ice albedo can have a large influence on melt through melt-albedo feedback processes.

Analysis of heat-related hazard reducing actions during heatwaves in Berlin – with an urbanized regional climate model COSMO-CLM/DCEP-BEM

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A building energy model (BEM) coupled with the urban Double Canyon Effect Parameterization scheme (DCEP) is designed for explicit computation of anthropogenic heat production within buildings. When coupled with an urbanized climate model, it allows for detailed calculations of heat flux transfer between buildings and the atmosphere and an estimation of the impact of human activities on the urban climate.
In this study, we investigate the feedback of actions for reducing heat-related hazard focusing on different cooling technologies, e.g. air conditioning systems, vegetation cover, building structures, etc., at the urban scale. To this end, several simulations with the COSMOCLM/DCEP-BEM at a spatial grid spacing of 1 km are carried out for an extreme heatwave period in 2018 for Berlin (Germany). The urban canopy parameters are derived from a 3D building model of the city. We put emphasis on the interactions

of extensive indoor air conditioning with the urban atmosphere and the cooling potential of urban vegetation. In addition, the effectiveness of heat-related hazard reducing measures are studied by analyzing the energy demand under different scenarios.

Modelling the impact of urban climate on vector borne malaria in Sub-Saharan Africa using COSMO-CLM – The example of Kampala, Uganda.

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As 90% of all malaria deaths worldwide are occurring on the African continent, the mitigation of mortality due to malaria is among the top priorities for the 2030 horizon (United Nations 2015). Malaria is mostly considered to be a rural disease. However, some studies documented its presence in urban areas (Robert et al. 2003, Hay et al. 2005, Castro et al. 2009, Machault et al. 2010) and Sub-Saharan Africa has been experiencing unprecedented rates of urban growth in the last decades (Seto et al. 2012). It is therefore necessary to better understand the impact of rapidly growing African cities on the local urban climate and thereby on climate-dependent diseases. In this work, we quantify the impact of urban climate on the presence of the malaria mosquito in the city of Kampala using the framework proposed by Brousse et al. (2019), which has proven to adequately address local data scarcity and allow for modelling the urban climate in Sub-Saharan Africa.
To this end, we extracted the Local Climate Zones (Stewart and Oke 2012) urban land cover classification following the WUDAPT framework (Ching et al. 2018) and fed them into the urban canopy model TERRA-URB (Wouters et al. 2016, Brousse et al. 2019) embedded in the COSMO-CLM model. The COSMO-CLM v5 model is then run at a convection permitting scale of 2.8 km horizontal resolution, forced by ERA5 reanalysis data, before dynamically downscaling at 1 km over Kampala. Model outputs are evaluated against cloud-free land surface temperature measurements from MODIS and CM-SAF SUMET products and 3-hourly precipitation satellite observations from MSWEP and TRMM 3B42 for the period 2010-2015.
After evaluating the model's performance, we first calculate the dynamic temperature suitability index (TSI) proposed by Gething et al. (2011) to capture the temporal and seasonal evolution of the TSI. Brousse et al. (2019) already demonstrated using the static TSI – which doesn't account for the temporal variability – that the urbanization of Kampala could lead to a 30% increase of the TSI in the city. In fact, this measure calculates the vectorial capacity of an environment for the development of malaria-infected mosquitoes out of air temperature. Thereby, hotter urban areas could have higher vectorial capacities. Hence, we also compute the effect of relative humidity on

the survival of mosquitoes following Yamana and Eltahir (2013) in order to see how the dryer city may also influence the TSI. Both results of the suitability modelling are compared temporally and spatially.

The FINO database and its applicability for model evaluation

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In-situ measurements are one of the main sources to detect and understand deficits in numerical models, and to put forward model development. Over land the spatial coverage of observations is far from perfect, but over the ocean only a few reliable observational sites exist. These sites are not only of major importance for the modeling community but also for the calibration of remote-sensing systems. Over the last years the Seewetteramt (Deutscher Wetterdienst), the data providers from the three platforms FINO1, FINO2 and FINO3 and the HZG performed a detailed revision of the measurement data. The revision includes quality of the sensors, long-term persistence of the sensors, shifts in measurement techniques and handling of data gaps. The implications regarding model evaluation are presented in our contribution, e. g. the analysis of temperature reveals physically inconsistent gradients. Moreover, we aim at understanding the quality of the COSMO-CLM model under different assimilation setups. Therefore, a simulation with perfect boundaries is compared against simulations with nudging of large-scales and the reanalyses products from COSMO-REA and UERRA. It is shown to which extend the elaborated assimilation of observations improves the model performance for single events and on a climatological scale. The classification of James is used to distinguish between different weather regimes. Finally, we will discuss the deficits inherent in the COSMO-CLM model.

Regional climate and process studies in South Asia CORDEX: An information theory perspective

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Regional climate models (RCMs) are used to dynamically downscale Global Climate Models (GCMs) to obtain high-resolution climate information over a region of interest, and these data are extensively used by the international community for adaptation and impact assessment. The Coordinated Regional Climate Downscaling Experiment (CORDEX) is coordinating this downscaling effort, which consists of 14 different domains globally. Here, we downscale three different GCMs (MPI-ESM-LR, NorESM, EC-EARTH) with the regional climate model COSMO-crCLIM (the GPU-version of the COSMO-CLM model) for a historical period (1970-2010) and also two different representative Concentration Pathways (RCPs), RCP2.6 and RCP8.5, over the South Asia domain at a horizontal resolution of 25km. The experiments follow the simulation framework initiated through CORDEX Coordinated Output for Regional Evaluations (CORDEX-CORE). The goal of the framework is to provide regional climate data that can support the next IPCC Assessment Report (AR6). Moreover, with increasing need to understand the dynamics of various process, we use concepts from information theory: the axiomatically proposed transfer entropy and the first principle based information flow to detect and quantify interactions. Through this study, we demonstrate how these information theory methods could be used to quantify information transfer among sub-process at various timescales, which assists to better understand the dynamics. Furthermore, to build a better understanding of the differences in dynamics, we compare information transfer in the downscaled RCM simulations from three GCMs under various scenarios and historical periods.

Influence of horizontal resolution on simulations of extreme precipitation episodes

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The analysis compares two regional climate simulations with different horizontal resolutions of three extreme precipitation episodes with high-resolution reference data. The first simulation is a standard evaluation run of COSMO-CLM 5.0 on the Euro-CORDEX domain with 0.11° resolution driven by ERA-Interim reanalysis data. The second simulation is executed with the same model but with a 10-times higher, convection permitting, horizontal resolution on a much smaller model domain covering southern Germany and the Alpine area, is dynamically nested into the coarser-resolved Euro-CORDEX simulation and runs without the parameterization for deep convection. The reference data represent daily precipitation values on a 1 km grid based on the HYRAS data of the German Meteorological Service (DWD). The simulated episodes include the three most intense multi-day precipitation events in southern Germany since 1979, leading each to a severe flooding of the Danube.
The daily precipitation data are analyzed over the Danube catchment area before the discharge gauge Passau at the German-Austrian border, collecting the precipitation over large parts of southern Germany and the adjacent Alpine area north of the main ridge of the Austrian-Swiss Alps. Three main characteristics of the precipitation fields are evaluated: the spatial distribution of daily precipitation, the temporal sequence of the total daily precipitation inputs into the catchment area and the frequency distribution of daily precipitation amounts during the days with intensive precipitation. Both simulations generally show a comparable chronological sequence of the three precipitation episodes according to the development in the reference data. But the higher resolved simulation shows, as expected, a much more detailed and better spatial structure of the daily precipitation fields together with higher and more local maximum amounts. Deviations from the reference data occur in both simulations in the spatial coverage as well as in the temporal development, characterized by weak shifts in the onset or duration of extreme precipitation days. In total, the temporal development in the convection permitting simulation is more synchronous to its driving simulation than to the reference data and seems to be mainly controlled by phase shifts in the larger scale run on the much greater European domain. The overall precipitation is underestimated in both simulations and not significantly improved by the 10 times higher resolution. But the intensity distribution of daily precipitation is better represented in the high-resolution simulations of all three episodes by shifting precipitation amounts from low to medium and high intensities and by the generation of intensive events that do not occur at all in the coarser simulations. The results are promising but also demonstrate the necessity for further improvements, which must result in a substantial rise of simulated precipitation in the peak events.

Long-term variability of European climate extremes

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Often time-series of climate extreme indices exhibit (multi-)decadal variability or trends. To attribute these signals either to climate change or natural climate variability is uncertain. Since the natural variability within the climate system overlays the climate trends, it affects the climate change signals derived from model simulations even if they are generated over climatological (e.g. 30 year) periods.
The historical period covered by reliable observations on the European scale or by CMIP/CORDEX type historical climate simulations usually just covers the second half of the 20th century, at best. But, this period is already affected by the climate trend. Furthermore, the periods are shorter than that of the leading multi-decadal variability indices, like the Atlantic Multi-decadal Variability (AMV), which is calculated from de-trended sea-surface temperatures of the North Atlantic. An extension of the examination period could provide valuable information on the attribution.
Several regional experiments with CCLM for Europe have been performed covering the whole 20th century (simulation period 1901 – 2010) by using boundary conditions from ERA20C and several members of the NOAA-ESRL 20CR re-analysis. These simulations improve the coverage of different phases of the AMV and other climate variability pattern.
Within this study teleconnection pattern are examined, which affect European extremes. Furthermore, the quality of these long-term simulations to reconstruct the 20th-century climate variability is examined. The results indicate that the frequency and intensity of precipitation extremes are increased, in case of a warm phase of the North-Atlantic sea-surface temperature.

FRIDAY
morning

Producing regional climate projections for Europe through the PRINCIPLES project

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The assessment of regional climate change is usually based on complex model chains, obtained from global and regional climate models (GCMs and RCMs). RCMs dynamically downscale GCMs to obtain higher resolution climate data over a region of interest. This effort is coordinated through the Coordinated Regional Climate Downscaling Experiment (CORDEX).
Over Europe, the EURO-CORDEX initiative has in the past provided simulations at two spatial resolutions (12 km and 50 km), with a large number of RCMs, which have downscaled multiple GCMs for three emission scenarios (Representative Concentration Pathways, RCPs).
While the CORDEX ensemble over Europe is unique in terms of its number of members, the 3-D matrix of available simulations is still insufficient to span the uncertainty dimensions from RCPs, GCMs and RCMs. The goal of the PRINCIPLES project is to produce well-coordinated RCM simulations for the European domain at 12km horizontal resolution, which are intended to serve the international climate adaptation and impact community, consistent with the overarching goals of Copernicus (https://climate.copernicus.eu/climate-projections). These new simulations will supply the already existing 3-D matrix from EURO-CORDEX, with the objective to better capture the spread of uncertainty in European climate projections. There are 9 partners with 9 different regional climate models. At the end of the project, the existing RCM simulations for EUR-11 will have doubled. Here, we present the objectives and current status of the project, and report about how we contribute to the project by using COSMOcrCLIM, a GPU version of the COSMO/COSMO-CLM model.

Sensitivity of mid-latitude temperature to albedo parameterization in the regional climate model COSMO-CLM linked to extreme land use changes

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In the framework of CORDEX FPS LUCAS multi-model studies are uncertain about the biophysical impact of afforestation in the northern hemisphere mid-latitude summers, and show either a cooling or warming. The magnitude and direction is still uncertain with implications to the surface energy balance and temperature response. In this study, the effect of three different albedo parameterizations in the regional climate model COSMO-CLM (v5.09) is examined performing de-/afforestation experiments at 0.44° horizontal resolution across the EURO-CORDEX domain during 1986-2015. Idealized de- and af-forestation simulations are compared to a simulation with no land cover change. Emphasis is put on the impact of changes in radiation and turbulent fluxes. A clear latitudinal pattern is found, which results partly due to the strong land cover conversion from forest- to grassland in the high latitudes and open land to forest conversion in mid-latitudes. Afforestation warms the climate in winter, and strongest in mid-latitudes. Results are indifferent in summer owing to opposing albedo and evapotranspiration effects of comparable size but different sign. Thus, the net effect is small for summer. Depending on the albedo parameterization in the model, the temperature effect can turn from cooling to warming in mid-latitude summers. The summer warming due to deforestation to grassland is up to 3 °C higher than due to afforestation. The cooling by grass or warming by forest is in magnitude comparable and small in winter. The magnitude of individual biophysical changes together with the specific climate conditions result in the described near-surface temperature changes.
Considering albedos of different vegetation types is more important than soil moisture dependent albedos only. This is important information for model development.

Influence of spectral nudging on convection permitting simulations

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Recent projects focusing on high resoluiton regional climate simulations (3 km and below) have opened a new field of research within the regional climate modelling (RCM) community. The convection permitting scales have been of particular interest for many research groups, as convection remains an important phenomenon still not correctly represented in models even at such high resolutions.
Coppola et. al. 2018 suggest that in climate simulations the large scale fields departs significantly from the driving re-analysis even after a month. In former investigations on coarser resolutions at e.g. 25km or 10km we found that applying spectral nudging (Storch et al. 2008) significantly improved the representation of the observed large scale fields the same as for the resulting precipitation and near surface temperature. the model results. Besides the conventional forcing of the regional climate model at its lateral boundaries, applying the spectral nudging technique means that inside the model area the model is forced to accept the analysis for large scales whereas it has no effect on the small scales.
Within the framework of CORDEX-FPS on convection a large number of European

institution carry out regional climate model simulations for the past and the future covering the Alpine Region (as the mandatory domain) at very high spatial resolution of 3km. In the evaluation run (1999-2014) we applied spectral nudging in the first nesting step from the global reanalysis ERAinterim to 0.11° (~12 km) European domain. In the second nesting step from the forcing at 0.11° to the final resolution of 0.0275° (~3 km) for the Alpine Region we did not applied the nudging. In a second simulation chain we didn't use spectral nudging for the first nest neither the second nesting step. We will show simulation results for six special convective precipitation events in the past (between 2000-2018) investigating the different nesting strategies mentioned above in short simulations. Two dimensional and three dimensional analysis is presented by comparing synoptic situation with the ERA-Interim and INCA (Integrated Nowcasting through comprehensive Analysis) dataset. A synopsis of synoptic situation as seen by ERA interim and each simulation with and without spectral nudging along with in depth analysis of dynamic and prognostic variables suggest that application of the Spectral Nudging is very useful on both (11 km, 3 km) scales. Spectral Nudging changes the atmospheric circulation and plays a vital role in manifestation and development of extreme convective events on 3 km scale.

CORDEX-FPS ELVIC: a convection-permitting model ensemble over the Lake Victoria region

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The Lake Victoria basin (East-Africa) is very vulnerable to extreme weather events. Hazardous over-lake thunderstorms fatally affect fishermen, while heavy precipitation, heat waves and long droughts pose threat to life, livelihood and infrastructure in the lake region. The COordinated Regional Climate Downscaling EXperiment Flagship Pilot Study (CORDEX-FPS) “ELVIC – climate Extremes in the Lake VICtoria basin” is an internationally coordinated initiative bringing together different research groups that perform simulations with multiple high-resolution, convection-permitting regional climate models. Via an intermediate-resolution domain (~12 km), the convection-permitting models (~2.8 km) are nested in ERA-Interim. This work provides an answer to ELVIC's first research questions: What is the added value of high resolution in Equatorial East-Africa? And do convection-permitting models (CPMs) better represent deep convective systems compared to models that rely on a convection parameterization? Beside the project itself, the first evaluation of the control simulations for all different models is presented. This evaluation focuses on the model performance of precipitation and top-of-atmosphere radiation. In addition, the comparison between the intermediate
resolution with the convection-permitting simulations provides an answer to the research question. Moreover, some sensitivity tests investigate the effect of one-step nesting in ERA5.

POSTER
session

Climate modeling with a multi-grid approach

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The Icosahedral nonhydrostatic (ICON) model is a joint development of Deutscher Wetterdienst (DWD) and of Max-Planck-Insitute for Meteorology. The numerical-weather-prediction version of ICON has been running operationally at DWD for more than three years now using a multi-grid approach, i.e. with a horizontally higher resolved domain over Europe connected to a global domain via 2-way nesting.
In the first part of our project, we transferred the multi-grid approach of the ICON model to the atmospheric part of ICON-ESM with the aim of producing high-resolution climate projections for Europe. The targeted resolution is 10-20 km. In the second part, we investigate the influence of higher horizontal resolution on (1) extreme events over Europe such as heat waves and heavy precipitation using the atmospheric part of ICON-ESM and on (2) model biases such as the northern-hemisphere summer warm bias, which has already been present in MPI-ESM and seems to persist in ICON-ESM.

Status of the CORDEX CORE Africa Simulation

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To contribute to the CORDEX CORE Atlas new simulations have been performed for the CORDEX Africa domain. Several adaptations have been made compared to the previous Africa simulation: The CLM version 5.0.15 has been used instead of CLM 4.8 in the older studies. The horizontal resolution is now 0.22° in line with the CORDEX CORE specifications compared to 0.44° in the old simulations. The vertical resolution has been increased as well, now using 57 layers.
The simulations include an evaluation experiment with ERAInterim forcing from 1979-2016. Three CMIP5 GCMs were used for the downscaling: MPI_ESM-LR, HadGEM2-ES and NorESM. For all three boundary forcings a historical simulation (1950-2005) and two scenario simulations with rcp2.6 and rcp8.5 are conducted (2006-2100).
The presentation will be dedicated to the status and analysis of these simulations and a comparison with the previous CORDEX Africa experiments.

Precipitation changes over Southern Africa, simulated with a high-resolution hindcast CCLM simulation

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We investigate the impact of the Agulhas Current on the regional climate in Southern Africa, in particular on hydroclimate events, droughts and floods. This investigation is part of the project CASISAC "Changes in the Agulhas System and its impacts on Southern African Coasts" within the "SPACES Program - Science Partnerships for the Adaptation of Complex Processes in the Earth System in the Region Southern Africa" in the BMBF Framework Program "Research for Sustainable Development" (FONA3). We simulate precipitation changes in a CCLM hindcast simulation driven by JRA-55 for the period1958-2019 with the aim to detect variations and trends on timescales from interannual to decadal, and identify their drivers. A special focus lies on the impact of the Agulhas Current, a warm and salty current along the east and south coast of Southern Africa transporting Indian Ocean water towards and into the South Atlantic. The Agulhas Current causes near-coastal convection and is, thus, a key driver of precipitation in the southernmost eastern part of the African continent. Changes in the Southern Hemisphere westerlies drive changes in the position of the Agulhas Current. This, in turn, might cause precipitation changes by modulating the atmospheric humidity and temperature over the coastal region of south-eastern Africa. The spatial high resolution of our simulation (16 km) enables us to study local precipitation changes. In addition, the hourly resolution helps to investigate certain extreme events in wind and precipitation, like the recent cyclones Idai and Kenneth with torrential rains and flooding especially in Mozambique.
Here, we present a validation of this hindcast simulation by comparing our data to the driving reanalysis data set as well as to observational data sets. Furthermore, first results of our analysis regarding the impact of the Agulhas Current on precipitation, precipitation trends and variations, and the analysis of a flooding event will be shown.

Climate Change's Influence on June 2009 Extreme Precipitation Event Over Southeast Austria

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During 22-24 June 2009, Austria witnessed a rampant rainfall spell that spread across populated areas of the country. High intensity rainfall caused 3000+ landslides in Feldbach, and property damages worth €10,000,000 in Styria itself. Numerous synoptic scale studies indicated the presence of a cut-off low over central Europe and excessive moisture convergence behind the extreme event. In a warmer climate change

scenario, such an extreme precipitation event may become more intense due to higher water holding capacity of air with increased temperatures, but this reasoning may not be so straightforward considering the complex physics of precipitation.
Precipitation, as a natural atmospheric phenomenon, is dependent upon the dynamic and thermodynamic characteristics of the atmosphere. While it is safe to say that the thermodynamic characteristics of the atmosphere is relatively easier to simulate with confidence using available global models, the same cannot be said about the dynamics. This can be blamed on the chaotic non-linear behavior of the atmosphere and problem in resolving sub-grid scale processes that reduce the model accuracy for longer spatial scales.
Following up on existing modeling studies, we will be using CCLM regional model to simulate this one particular event for a warmer future. To this end, two documented approaches include using the larger EURO-CORDEX domain (25km resolution) and the smaller CCLM domain (3km resolution) in nested form, or using CCLM domain in standalone. Due to possible uncertainties in the accurate determination of large-scale dynamics in the larger domain, the first approach fails to capture the event for the future. However, the event is captured for the past and the present with the accumulated rainfall figure in the past case (cooler) being lesser compared to the present. To solve the problem of future case simulation, in the second approach the standalone CCLM domain is used. Therein factors such as relative humidity and atmospheric lapse rate are idealized to capture the event in future. The changes in the boundary conditions are derived from GCMs.
We understand that to improve the accuracy of our future simulations, we will need GCM derived inputs for parameters such as the relative humidity or the lapse rate, instead of using idealized values for the same (as in second approach). We will be building on the storyline approach for its utility in approximately separating dynamical and thermodynamic uncertainties and allowing higher resolution model runs.

Alternative Sources of Input Data for COSMO-CLM model: Vegetation Cover Information

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We present an alternative method to provide input data for COSMO-CLM regional climate simulation model, with a specific focus on provision of vegetation land cover and vegetation density information. In this regard, we focus on the application potential of remote sensing and high-resolution satellite imagery for conducting comprehensive spatial analysis. The considered alternative solution is evaluated based on results computed for distinct extent of urban standard typologies (USTs)1 for the city of Vienna, Austria.

The effect of the urban parametrization scheme into a very high resolution ERA-Interim driven COSMO-CLM simulation

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Cities are experiencing a significant alteration in climate patterns compared to their surroundings, posing tough challenges (cities warming, poor air quality and increased impacts of extreme weather and climate events such as heat waves, floods, droughts, storms) to the urban populations. Vulnerability analysis and risk assessment, supported by regional climate models (RCMs) at very high resolution to capture urban dynamics, are key elements to the development and implementation of effective local adaptation measures to make climate-resilient and more sustainable cities.
In this work, we present a climate simulation performed with COSMO-CLM including the urban parametrization TERRA-URB over the period from 2000 to 2010. ERA-Interim Reanalysis are first dynamically downscaled at the intermediate resolution of 0.11° (~ 12 km) over the EURO-CORDEX domain, and then at the resolution of 0.0275° (~ 3 km) over the Greater Alpine Region (GAR).
The main results refer to the urban environment within the GAR domain and to the capability of the RCM in reproducing the variations in temperature and energy fluxes occurring between cities and surrounding areas. Results provide encouraging findings, suggesting that the very high resolution model has an added value, especially in specific context (such as urban and complex orography areas), with respect to simulations at lower resolution.

Improved processes in the land surface model TERRA: Bare soil evaporation and skin temperature

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Land surface processes have a significant impact on near-surface atmospheric phenomena. They determine, among others, near-surface sensible and latent heat fluxes and the radiation budget, and thus influence atmosphere and land characteristics, such as temperature and humidity, the structure of the planetary boundary layer, and even cloud formation processes. It is therefore important to simulate the land surface processes in atmospheric models as realistically as possible.

Verifications have shown that the bare soil evaporation simulated by the land surface scheme TERRA of the COSMO atmospheric model is systematically overestimated under wet conditions. Furthermore, it turned out that the amplitude of the diurnal cycle of the surface temperature is systematically underestimated. In contrast, the

diurnal cycles of the temperatures in the soil are overestimated, instead. This means that the other components of the surface energy and water balances are biased as well, for instance, the surface turbulent heat fluxes as well as the soil water content.

Data from the Meteorological Observatory Lindenberg of the German Meteorological Service were used to analyse this model behaviour. The erroneous formulation of bare soil evaporation was replaced by a scheme based on a resistance formulation, which efficiently reduces the simulated vapour flux. In the standard model configuration of TERRA, there is no representation of the vegetation in the surface energy balance. This means, there is no energy budget including a temperature for the vegetation layer. Furthermore, the insulating effects by the vegetation at the sub-canopy level are missing as well. In this work, a scheme providing both of these missing model characteristics was implemented in TERRA, the so-called skin temperature formulation. As a result, the simulated diurnal amplitude of the surface temperature is increased and the one of the soil temperature is reduced.

Both developments of the model, in particular their combination, lead to better agreements with the measurements. These improvements are found in TERRA in offline mode, using Lindenberg observations, as well as in coupled mode in the atmospheric model.

Impact of numerical Diffusion, grid resolution and convection parameterisation on precipitation in regional Climate simulation with COSMO-CLM: diagnostics and mechanisms

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We present a separation of the impact of numerical Diffusion, grid resolution and convection parameterisation on climate simulations and quantify the individual impacts on precipitation and related quantities. It was found that the numerical diffusion is increasing the precipitation by approximately 10-20 %, deep convection parameterisation is reducing the precipitation by 10-20% and a doubling of grid resolution is reducing the precipitaiton by approximately 5%. However, the spatial distribution, the annual and diurnal cycle of the impacts of the three model changes are different resulting in a much more complex response to the combined model changes.
The three model changes have been separated by investigating a systematic series of double nested simulation driven by ERA interim with 50km, 11km, 5km and 3km grid resolution of the COSMO-CLM for dissipative and non-dissipative numerics and for different convection parameterisations.

It can be shown, that each of these model changes has a significant impact on the vertical velocity and related to that on the vertical distribution of clouds, which can

be regarded as a key quantities for model evaluation, in particular at convection permitting scales.

Temperature dependent phenology for the COSMO-CLM model

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The energy and water cycle of the regional climate is influenced by the phenological development of the vegetation through albedo, sensible and latent heat flux changes. This influences near surface temperature, precipitation and other parameters. The phenological stages in turn depend on temperature, net primary productivity, day length and water availability variations. Therefore, vegetation should play an important role in climate simulations. The current implementation of the seasonal vegetation development in the regional climate model COSMO-CLM (CCLM, COSMO 5.0 clm15), represented in the model by the leaf area index (LAI), the root depth or plant coverage, assumes a static, annually recurring cycle. This is very imprecise because it varies from year to year depending on the environment. Particularly supposing climate change to modify the environment, the phenology will also change. Therefore, we implement the approach of Knorr et al. 2010 to improve the representation of the phenology in CCLM by temperature. Here, the tuning parameters for the growth rate of grass from Schulz et al. 2015 are used for single column simulations over the Lindenberg Meteorological Observatory. Evaluation of LAI results from 1999 to 2013 in spring reveals comparable agreement to remote sensing LAI observations. The variation in LAI and fraction of land cover also lead to an improvement of the latent heat flux in the model compared to observations. Further work will add the influence of day length, water availability and net primary productivity.

Literature:
Knorr, W. et al., 2010. Carbon cycle data assimilation with a generic phenology model. Journal of Geophysical Research: Biogeosciences, 115(G4).
Schulz, J.-P., Vogel, G. & Ahrens, B., 2015. A new leaf phenology for the land surface scheme TERRA of the COSMO atmospheric model. COSMO Newsletter No. 15.

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