Program and Abstracts
CLM-Assembly 2020

Organisation Team

August 3, 2020

Contents

1 Program

1.1 Tuesday 9:00 - 10:30

Assembly opening

9^{30} **Recent developments of the COSMO-CLM system**

Burkhardt Rockel [see 7.3 (Page 42)]

9^{50} **News from COSMO and ICON**

Daniel Rieger, Ulrich Schättler and Günther Zängl [see 7.2 (Page 41)]

10^{10} **Assessment of CORDEX simulations performed with COSMO-CLM over multiple domains**

Silje Lund Sørland, Roman Brogli, Praveen Kumar, Emmanuele Russo, Jonas Van de Walle, Ivonne Anders, Edoardo Bucchignan, Marie-Estelle Demory, Alessandro Dosio, Hendrik Feldman, Barbara Früh, Beate Geyer, Klaus Keuler, Donghyun Lee, Delei Li, Nicole van Lipzig, Seung-Ki Min, Hans-Jürgen Paniz, Burkhardt Rockel, Christoph Schär, Christian Steger, and Wim Thiery [see 3.3 (Page 12)]

1.2 Tuesday 11:00 - 12:40

11^{00} **Evaluation of hindcast COSMO-CLM simulation over Central Europe and Spain**

H. Zhang and M. H. Tölle [see 6.5 (Page 37)]

11^{20} **The reduction of systematic summertime warm biases in the soil-moisture limited regions of Southern Europe by stochastic root depth variation**

M. Breil and G. Schädler [see 6.1 (Page 33)]

11^{40} **Impact of urban canopy parametrization from TERRA_URB on air quality in urban regions in Germany**

Joachim Fallmann, Marc Barra and Holger Tost [see 6.2 (Page 34)]

12^{00} **On the influence of density and morphology on the Urban Heat Island intensity**

Yunfei Li, Sebastian Schubert, Jürgen P. Kropp and Diego Rybski [see 6.3 (Page 35)]

12^{20} **High-resolution urban climate simulations for Moscow megacity with TERRA_URB scheme: the recent developments and new challenges**

M. Varentsov, T. Samsonov, M. Demuzere, I. Rozinkina, G. Rivin and V. Vasenev [see 6.6 (Page 38)]

1.3 Wednesday 13:30 - 16:00 - Postersession

13^{30} **Evaluation of a coupled ERA-Interim simulation with 0.22deg resolution for the EURO-CORDEX region**

J. Brauch and B. Früh [see 2.1 (Page 8)]

13^{45} **User-relevant climate change information from regional climate predictions and projections**

H. Feldmann, H. Schipper and J. Moemken [see 3.2 (Page 11)]

14^{00} **A classification algorithm for selective dynamical downscaling of precipitation extremes**

Edmund P Meredith, Uwe Ulbrich and Henning W Rust [see 4.8 (Page 22)]

14^{15} **Sub-daily precipitation characteristics in convection-permitting COSMO-CLM simulations for Germany**

S. Brienen, M. Haller and B. Früh [see 4.2 (Page 15)]

14^{30} **Subhourly rainfall in a convection-permitting model**

Edmund P Meredith, Uwe Ulbrich and Henning W Rust [see 5.3 (Page 26)]

14^{45} **Use of COSMO CLM Model for Climate Simulations in Brazil Applied to Environment and Hydroelectric Energy**

Reinaldo.B. Silveira, Christopher T. Blum, Flavio A. C. Deppe, Amanda K. Marcon, Gabriel H. A. Pereira and Clovis Cechim Jr. [see 5.7 (Page 31)]

15^{00} **Simulation of present and expected future runoff in a complex terrain Alpine catchment with EURO-CORDEX data**

Gerhard Smiatek [see 5.8 (Page 32)]

15^{15} **Regional modelling of the aerosol impact on the West African Monsoon system**

Imoleayo Ezekiel Gbode and Bernd Heinold [see 5.1 (Page 23)]

15^{30} **COSMO-BEP-Tree: a coupled urban climate model with explicit representation of street trees**

Gianluca Mussetti, Edouard L. Davin, Juan A. Acero, Dominik Brunner, Scott E. Krayenhoff, Jan Carmeliet and Sonia I. Seneviratne [see 6.4 (Page 36)]

15^{45} **MESSy on-line diagnostics in COSMO-CLM and ICON-CLM**

Astrid Kerkweg, Mariano Mertens, Patrick Jöckel, Christiane Hofmann and Bastian Kern [see 7.1 (Page 40)]

1.4 Thursday 9:00 - 10:20

9^{00} **Assessing climate change and extreme events in Germany simulated by COSMO-CLM on convection-permitting scale**

M. Haller, J. Brauch, S. Brienen and B. Früh [see 4.5 (Page 19)]

9^{20} **Potential of Convection-permitting Decadal Simulations for the Representation of Extremes in the Western and Eastern Mediterranean**

S. Helgert [see 4.6 (Page 20)]

9^{40} **The Diurnal Nature of Future Extreme Precipitation Intensification**

Edmund P Meredith, Uwe Ulbrich and Henning W Rust [see 4.7 (Page 21)]

10^{00} **Scale dependency of most extreme precipitation. Evaluation of COSMO- CLM long-term simulations in the German-Alpine region**

A. Caldas-Alvarez, H. Feldmann, J. Pinto and Ch. Kottmeier [see 4.3 (Page 16)]

1.5 Thursday 10:50 - 12:10

10^{50} **Precipitation patterns for different circulation types over Svalbard and possible future changes**

Andreas Dobler, Julia Lutz and Oskar Landgren [see 4.4 (Page 18)]

11^{10} **Mesoscale resolving high-resolution simulation of wind farms in COSMO-CLM 5**

Naveed Akhtar and Burkhardt Rockel [see 4.1 (Page 14)]

11^{30} **Analysis of precipitation at convection permitting scale with COSMO-CLM over Alpine space**

Adinolfi M., Raffa M., Bucchignani E., Montesarchio M. and Mercogliano P. [see 3.1 (Page 10)]

11^{50} **Changes of storm intensities in the Lake Victoria basin, projected by a convection-permitting model**

Jonas Van de Walle, Wim Thiery, Roman Brogli, Oscar Brousse, Matthias Demuzere and Nicole P.M. van Lipzig [see 3.4 (Page 13)]

1.6 Thursday 13:10 - 14:50

13^{10} **Internal model variability in the regional coupled system model GCOAST-AHOI**

H.T.M. Ho-Hagemann, S. Hagemann, S. Grayek, R. Petrik, B. Rockel, J. Staneva, F. Feser and C. Schrum [see 2.2 (Page 9)]

13^{30} **A sensitivity study with COSMO-CLM driven by ERA5 Reanalysis over central Europe**

M. Raffa, M. Adinolfi, M. Montesarchio, E. Bucchignani and P. Mercogliano [see 5.4 (Page 27)]

13^{50} **Structural Behaviour of the COSMO-CLMUnder Different Forcings**

Emmanuele Russo [see 5.5 (Page 28)]

14^{10} **Low-level circulation, Moisture Convergence and Precipitation Biases in Regional Climate Simulations for Central America with COSMO-CLM**

Emmanuele Russo, Stephan Pfahl and Alejandro Martinez [see 5.6 (Page 29)]

14^{30} **An evaluation of the surface climatology over the Totten region (Antarctica) using COSMO-CLM2**

Samuel Helsen, Sam Vanden Broucke, Alexandra Gossart, Niels Souverijns and Nicole P. M. van Lipzig [see 5.2 (Page 24)]

2 WG AIO

2.1 Evaluation of a coupled ERA-Interim simulation with 0.22deg resolution for the EURO-CORDEX region

Presentation type : poster

Authors : J. Brauch and B. Früh
Deutscher Wetterdienst

In the newly established service DAS Basisdienst climate & water several German federal agencies under the governance of the ministry for transportation (BMVI) working together to determine the effects of climate change on waterways and shipping in Germany. Possible effects of climate change are an increasing number of droughts, which could cause low level situations in Rhine and Elbe and would highly restrain the shipping. Meteorological and oceanographical climate projection will be provided, which are produced by coupling the COSMO-CLM model with the ocean model NEMO-Nordic via the OASIS3-MCT coupler, are 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 rivers and estuaries to advise decision makers on possible climate change effects in these areas. 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 2m 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.

2.2 Internal model variability in the regional coupled system model GCOAST-AHOI

Presentation type : oral

Authors : H.T.M. Ho-Hagemann (1), S. Hagemann (1), S. Grayek (1), R. Petrik (1), B. Rockel (1), J. Staneva (1), F. Feser (1) and C. Schrum (1,2)

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Simulations of a Regional Climate Model (RCM) driven by identical lateral boundary conditions but initialized at different times exhibit the phenomenon of so-called internal model variability (or in short, Internal VariabilityIV), which is defined as the inter-member spread between members in an ensemble of simulations. Our study investigates the effects of air-sea coupling on IV of the regional atmospheric model COSMO-CLM (CCLM) of the new regional coupled system model GCOAST-AHOI (Geesthacht Coupled cOAstal model SysTem: Atmosphere, Hydrology, Ocean and Sea Ice). We specifically address physical processes parameterized in CCLM, which may cause a large IV during an extreme event, and where this IV is affected by the air-sea coupling. Two six-member ensemble simulations were conducted with GCOAST-AHOI and the stand-alone CCLM (CCLM_ctr) for a period of 1 September31 December 2013 over Europe. IV is expressed by spreads within the two sets of ensembles. Analyses focus on specific events during this period, especially on the storm Christian occurring from 27 to 29 October 2013 in northern Europe. Results show that simulations of CCLM_ctr vary largely amongst ensemble members during the storm. By analyzing two members of CCLM_ctr with opposite behaviors, we found that the large uncertainty in CCLM_ctr is caused by a combination of two factors (1) uncertainty in parameterization of cloud-radiation interaction in the atmospheric model. and (2) lack of an active two-way air-sea interaction. When CCLM is two-way coupled with the ocean model, the ensemble means of GCOAST-AHOI and CCLM_ctr are relatively similar, but the spread is reduced remarkably in GCOAST-AHOI, not only over the ocean where the coupling is done but also over land due to the land-sea interactions.

3 WG CP

3.1 Analysis of precipitation at convection permitting scale with COSMO-CLM over Alpine space

Presentation type : oral

Authors : Adinolfi M. (1), Raffa M. (1), Bucchignani E. (1,2), Montesarchio M. (1,2) and Mercogliano P. (1)

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With recent advances in computing power, an increasing number of studies show improvements in regional climate model performances when the grid spacing is increased to 1-kilometer scale and the parametrization of deep convection is switched off (i.e. convection-permitting). The aim of this work is the analysis of the COSMO-CLM model results in terms of precipitation over the Alpine space when a very high resolution is employed. More specifically, the driving data provided by the GCM EC EARTH are downscaled first at an intermediate resolution (12km) over the Euro-CORDEX domain. Then, a further downscaling at 3 km, nested into the previous one, is performed over the Alpine domain in order to exploit the results over a complex orography context. An historical period (1996-2005) and a far future one (2090-2099) under IPCC RCP8.5 scenario have been considered. Some indices, such as mean daily precipitation, frequency, intensity and heavy precipitation are employed in daily and hourly analyses. Results highlight significant differences of the convection permitting simulations (3 km) with respect to its driving one (12 km), especially at hourly time scale. The future projections (2090-2099) indicate that the convection permitting simulation refines and enhances the projected patterns, compared with the coarser resolution one, also modifying the signal in some cases. Moreover, both simulations agree in projecting a general decrease of the mean precipitation in summer and an increase of the intensity and of the heavy precipitation in autumn. Although 10 years-long simulations do not represent a sufficiently long period to identify climatologic trends, the present findings could provide preliminary indications about the expected changes in future precipitation projections.

3.2 User-relevant climate change information from regional climate predictions and projections

Presentation type : poster

Authors : H. Feldmann, H. Schipper and J. Moemken

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Local and regional stakeholders from administration, agriculture, forestry or economy require tailored climate information to develop adaptation measures at different planning intervals. However, changes of 30-year mean temperature and precipitation are often not suitable. The Expert Team on Climate Change Detection and Indices (ETCCDI, https://www.wcrp-climate.org/data-etccdi) developed a set of indices relevant for various applications. Schipper et al. (2019) and Hackenbruch et al. (2017) developed and applied a set of custom-tailored climate change indices in collaboration with communal practitioners for the region of Baden-Wrttemberg. Mmken et al. (2020) used regional climate predictions to assess the potential of deriving reliable forecasts for up to ten years ahead. This work will assess the climate change signals and the associated uncertainties for decadal predictions from MiKlip (e.g. Mid-term climate prediction) as well as near term climate projections from EURO-CORDEX. Different types of indices from single or multiple basic meteorological parameters are examined. This includes climatological means, extremes, threshold or integral indices and parameters indicating changes in the annual cycle or the climate variability. The regional MiKlip ensemble consists of about 15000 simulation years of initialized decadal hindcasts with CCLM for the period 1960 2029. Here we focus on the decadal predictability of user relevant variables. Good predictive skill is found especially for temperature-derived indices such as summer days or growing degree days. From EURO-CORDEX an ensemble of five RCMs (CCLM, REMO, RACMO, HIRHAM and RCA4) downscaling five GCMs (MPI-ESM, CNRM-CM5, EC EARTH, HadGEM and NorESM) has been generated. Here a focus is on the contributions of GCMs and RCMs to the ensemble spread and the climate sensitivity of the various indices, which differ for different types of indices and with the season.

3.3 Assessment of CORDEX simulations performed with COSMO-CLM over multiple domains

Presentation type : oral

Authors : Silje Lund Sørland (1), Roman Brogli (1), Praveen Kumar (2), Emmanuele Russo (3), Jonas Van de Walle (4), Ivonne Anders (5), Edoardo Bucchignan (6), Marie-Estelle Demory (1), Alessandro Dosio (7), Hendrik Feldman (8), Barbara Früh (9), Beate Geyer (10), Klaus Keuler (11), Donghyun Lee (12), Delei Li (13), Nicole van Lipzig (4), Seung-Ki Min (12), Hans-Jürgen Paniz (8), Burkhardt Rockel (10), Christoph Schär (1), Christian Steger (9), and Wim Thiery (14)

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Through the Coordinated Regional Climate Downscaling Experiment (CORDEX), the CLMCommunity has the last years contributed with an extensive set of regional climate simulation for different domains, with the community model COMSO-CLM. ERA-Interim and 8 different CMIP5 GCMs have been dynamically downscaled with various versions of COSMOCLM at a horizontal resolution of 0.44 (˜50km), 0.22 (˜25km) or 0.11 (˜12km) for the domains Europe, South Asia, East Asia, Australia and Africa. This is resulting in 80 simulation which are published on the ESGF-node, available for impact studies and to produce climate scenario assessment. Such a contribution would not have been possible without the community effort from the CLM-members. A systematically evaluating the model versions, model configurations, horizontal resolution for all the domains is presented.

3.4 Changes of storm intensities in the Lake Victoria basin, projected by a convection-permitting model.

Presentation type : oral

Authors : Jonas Van de Walle (1), Wim Thiery (2), Roman Brogli (3), Oscar Brousse (1), Matthias Demuzere (4) and Nicole P.M. van Lipzig (1)

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Extreme weather is posing a constant threat to more than 30 million people in the region surrounding Lake Victoria. Thousands of fishermen die every year on the lake by severe thunderstorms, strong wind gusts and associated waves and water currents. Moreover, intense precipitation events largely affect people living inland, continuously facing flood risks. Both wind gust and heavy precipitation hazards call for better understanding of climate extremes over the region. Climate models are a useful tool to gain insight in the complex behaviour of thunderstorms, especially when simulated at convection-permitting resolution. Such simulations, explicitly resolving deep convection at fine resolutions, have been shown to improve the representation of extreme events in many parts of the world, including equatorial East-Africa. At this stage, future climate projections at convection-permitting scales are desirable to assess the impact of anthropogenic climate change on extreme weather in the region. Therefore, a surrogate global warming approach has been applied to a convection-permitting COSMO-CLM simulation. In this approach, the lateral boundary conditions from the ERA 5 reanalysis are perturbed in accordance with the recent CMIP 6 ensemble-mean end-of-century SSP5 8.5 scenario. This approach confers three major advantages over the more conventional methods. First, by perturbing with the ensemble-mean, it averages out uncertainties of driving Earth system models without the need for a time and computational intensive high resolution ensemble approach. Second, it avoids including present-day circulation biases. Third, no intermediate nesting steps are necessary, as the perturbed ERA5 allows a direct downscaling to the convection-permitting climate projection. Besides the methodology, results for the Lake Victoria basin will be presented. Changes in wind and precipitation extremes are investigated from a statistical point of view, making use of multivariate Extreme Value Theory. Furthermore, the intensity of both present-day and future extreme events are related to their preceding (thermo)dynamic atmospheric conditions to explain the changes.

4 WG CRCS

4.1 Mesoscale resolving high-resolution simulation of wind farms in COSMO-CLM 5

Presentation type : oral

Authors : Naveed Akhtar and Burkhardt Rockel
Institute for Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht

The rapid development of offshore wind farms has raised concerns about the local environment and ecosystem. Wind farms influence the local meteorology by extracting kinetic energy from the wind field and by generating a large wake. The North Sea is one of the main regions of the world where the growth of offshore wind farms is rapidly increasing. In this study, we analyze the impact of large-scale offshore wind farms in the North Sea on local meteorology using regional climate model COSMO-CLM. For this purpose, the parametrization for wind turbine driven by Fitch et al. (2012) and Blahak et al. (2010), previously implemented in COSMO-CLM v 4.8 at KU-Leuven (Chatterjee et al. 2016), has been implemented in the latest version 5 of COSMO-CLM. Here we present the first results of COSMO-CLM long-term simulations with and without wind farms using mesoscale resolving high-resolution horizontal atmospheric grid spacing (˜2km).

4.2 Sub-daily precipitation characteristics in convection-permitting COSMO-CLM simulations for Germany

Presentation type : poster
Authors : S. Brienen, M. Haller and B. Früh
Deutscher Wetterdienst, Offenbach, Germany

The focus of the German research project 'Network of Experts - Adapting transport and infrastructure to climate change and extreme weather events' is the provision of high-resolution climate information in order to make the national transport infrastructure resilient to extreme weather and climate change. Precipitation is one of the key parameters and the project partners are interested in information on high temporal and spatial scales. Therefore, we aim at the analysis of sub-daily precipitation characteristics, coming out of convection-permitting simulations. The sub-daily characteristics include the daily cycle of hourly precipitation as well as hourly and 5-minute precipitation extremes. We perform and investigate simulations with the regional climate model COSMO-CLM at about 3 km. One simulation was nested in 12km EURO-CORDEX runs with COSMO-CLM driven by ERA40/ERA-Interim and MIROC5 (RCP8.5 scenario), performed during the first phase of the project. Secondly, a COSMO-CLM simulation driven by HadGEM2-ES, which was run in the context of the CORDEX-FPS Convection initiative, is analyzed. Currently, a new evaluation simulation with a direct nesting in ERA5 is running, as well as historical and scenario simulations forced by MIROC5-CCLM with a newer model version. The outcome of these runs will also be included in the comparison. For the evaluation of hourly precipitation, we use the RADKLIM observational data set from DWD for overlapping time periods. These are combined radar and rain gauge measurements for Germany, covering nearly 20 years.

4.3 Scale dependency of most extreme precipitation. Evaluation of COSMO- CLM long-term simulations in the German-Alpine region

Presentation type : oral

Authors : A. Caldas-Alvarez, H. Feldmann, J. Pinto and Ch. Kottmeier

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Most Extreme Precipitation Events (MEPEs) are a challenging atmospheric phenomenon with a high impact on human lives and infrastructures. Given their rareness, the available observational records and model simulations are too short to reliably estimate their very large return periods (¿100 years). This is why very large model ensembles like the one provided by the Decadal Climate Predictions (MiKlip) project with over 10.000 years of simulations are of great value. The resolution of 25km is relatively coarse to study the processes affecting extreme precipitation events. It is therefore intended to do a further downscaling for a set of MEPEs. As a first step, we validate two COSMO-CLM long-term simulations aiming at the assessment of the scale dependency of the relevant processes for the German-Alpine region. In particular, we focus on two model resolutions. The first one, 25 km, typical of Global Circulation Models (GCMs), needs the parameterization of all processes occurring at the sub-grid scale and suffers from a coarse description of the orography and surface processes. The second, in the convection-permitting scale (3 km), circumvents these deficiencies at the expense of being computationally very expensive. Given the coexistence of both model scales in regional climate simulations there is a need to address what are the implications of using different horizontal resolutions for extreme precipitation representation. Our work is carried out in the framework of the recently started project ClimXtreme, a multidisciplinary research initiative from six German Institutions aiming at the quantification and understanding of extreme weather events in the context of a changing climate. We validate and compare two COSMO-CLM v.5 simulations during the period 1971 to 2015. The first, has a resolution of 25 km and is forced by ERA40 until 1979 and by ERA-interim afterwards. The second, has a resolution of 3 km (convection-permitting) and is composed by two sub-periods, the first one between 1971 and 1999, forced by ERA40, and the second between 2000 and 2015, forced by ERA-interim. The latter sub-simulation belongs to the CORDEX-FPS convection project. We validate the simulations against E-OBS (25 km) and the unique HYdrologische RASterdatenstze (HYRAS) precipitation data set, which has a spatial resolution of 5 km and covers Germany and the most relevant surrounding river catchments. In the methodology, the MEPEs are identified using a Precipitation

Severity Index (PSI) adapted from extreme wind detection (Leckebusch et al., 2008; Pinto et al., 2012). The main advantage of the PSI is its ability to account for extreme grid point precipitation as well as spatial coverage and event duration. We provide a catalogue of the MEPES in the period, which will be selected in the future for further model downscaling and process understanding. The first results show a large dependency of extreme precipitation intensity with model resolution. Differences of 240 mmd-1 exist for the most extreme events between the 25 km and the 3 km resolutions. The comparison against HYRAS reveals that the 25 km simulations perform well for intensities up to 110 mmd-1 but that such coarse resolution is unable to represent a realistic probability distribution.

4.4 Precipitation patterns for different circulation types over Svalbard and possible future changes

Presentation type : oral
Authors : Andreas Dobler, Julia Lutz and Oskar Landgren
Norwegian Meteorological Institute

Observations on Svalbard suggest that the general weather situation favouring heavy precipitation events is a strong south-southwesterly flow with advection of water vapour from warmer areas. This is often linked to atmospheric river-like features in the precipitable water anomaly field. Earlier results have shown that the COSMO-CLM at high-resolution (2.5km) can reproduce these heavy precipitation events and their seasonal distribution. Future projections at the same resolution show an increase in the heaviest precipitation amounts, with more of the events happening in autumn and summer and less during winter and spring. In this study, we want to show 1) how the high-resolution COSMO-CLM simulation reproduces the observed circulation type statistics and the associated precipitation patterns over Svalbard, and 2) how the distribution of circulation types and precipitation patterns are changing in an MPI-ESM-LR driven future projection, following the RCP8.5 greenhouse-gas scenario.

4.5 Assessing climate change and extreme events in Germany simulated by COSMO-CLM on convection-permitting scale

Presentation type : oral
Authors : M. Haller, J. Brauch, S. Brienen and B. Früh
Deutscher Wetterdienst

The climate change is evident on all spacial scales, including the local areas, and provides large challenges for most countries, including 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 resilience strengthening of the 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. Thus, we perform convection-permitting climate simulations with COSMO-CLM using the RCP 8.5 scenario, dynamically downscaled two-fold from CMIP5 MIROC5 global model data. The simulations were run 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 the second project phase, which started in January 2020, we re-run the COSMO-CLM with a newer model version but only for the focus periods. For the analyses of our simulations, we are interested especially in the characteristics of extreme events such as heat waves, heavy rainfall and storm events. We compare our simulation results with gridded observational data sets for Germany (HYRAS, RADKLIM) and provide the data to our project partners.

4.6 Potential of Convection-permitting Decadal Simulations for the Representation of Extremes in the Western and Eastern Mediterranean

Presentation type : oral
Authors : S. Helgert
Karlsruher Institute of Technology (KIT)

The Mediterranean region is one of the hot spots of climate change with an increase in the frequency and intensity of extreme weather phenomena. This region is prone to extreme weather events due to its complex terrain which is characterized by strong ocean-land-atmosphere interactions. Current climate models cannot adequately represent such processes on regional-to-local scales and are therefore subject to model uncertainties. The improvement of the understanding of physical processes and the reduction of uncertainties in the representation of extremes seems to be promising by using the resolution of convection-permitting models. The aim of this study is to analyze the added value of convection-permitting simulations for the representation of high-impact weather on seasonal-to-decadal scales. For this purpose we carried out convection-resolving COSMO-CLM simulations (˜3km) over the Iberian Peninsula (1999-2018) and in the Levant region (eastern Mediterranean) in the period 2006 to 2018. These simulations are dynamically downscaled from a 7 km simulation domain and the regional model is driven by hourly global ERA-5 data (˜28km). We profit from an exceptional high temporal resolution of an hour to study weather extremes in terms of temperature, precipitation and wind on several time scales, analyzing the variability of diurnal to interannual cycles. A spatial resolution comparison between the resolution of the convection-parameterized (7 km) and the convection-permitting model is performed to demonstrate the improvements of high-resolution modeling in the representation of extremes. The model results are evaluated with observations from E-OBS (V20 0.1) as well as other state-of-the-art data sets (e.g. precipitation data set Iberia01). With the knowledge gained, we discuss the potential and limits of convection-permitting climate simulations at such high temporal and spatial resolutions, assessing their viability with respect to their computational effort.

4.7 The Diurnal Nature of Future Extreme Precipitation Intensification

Presentation type : oral
Authors : Edmund P Meredith, Uwe Ulbrich and Henning W Rust
Institut für Meteorologie, Freie Universität Berlin

Short-duration, high-impact precipitation events in the extratropics are invariably convective in nature, typically occur during the summer, and are projected to intensify under climate change. The occurrence of convective precipitation is strongly regulated by the diurnal convective cycle, peaking in the late afternoon. Here we perform regional CPM simulations to study the scaling of extreme precipitation under climate change across the diurnal cycle. We show that the future intensification of extreme precipitation may have a strong diurnal signal and that intraday scaling far in excess of overall scaling, and indeed thermodynamic expectations, is possible. We additionally show that, under a strong climate change scenario, the probability maximum for the occurrence of heavy to extreme precipitation may shift from late afternoon to the overnight/morning period. We further identify the thermodynamic and dynamic mechanisms which modify future extreme environments, explaining both the future scaling's diurnal signal and departure from thermodynamic expectations. We furthermore compare our CPM results with those obtained from the 0.11 EURO-CORDEX ensemble.

4.8 A classification algorithm for selective dynamical downscaling of precipitation extremes

Presentation type : poster

Authors : Edmund P Meredith, Uwe Ulbrich and Henning W Rust
Institut für Meteorologie, Freie Universität Berlin

Climate data at convection-permitting resolution can be of great value to both hydrological modellers and end users. Its added value, however, can often not be realized due to the prohibitive computational expense. Here we present a novel and flexible classification algorithm for discriminating between days with an elevated potential for extreme precipitation over a catchment and days without, so that dynamical downscaling to convection-permitting resolution can be selectively performed on high-risk days only, drastically reducing total computational expense compared to continuous simulations; the classification method can be applied to climate model data or reanalyses. Using observed precipitation and the corresponding synoptic-scale circulation patterns from reanalysis, characteristic extremal circulation patterns are identified for the catchment via a clustering algorithm. These extremal patterns serve as references against which days can be classified as potentially extreme, subject to additional tests of relevant meteorological predictors in the vicinity of the catchment. Here we present an evaluation of the classification algorithm's performance and compare the resulting precipitation statistics with observartions.

5 WG EVAL

5.1 Regional modelling of the aerosol impact on the West African Monsoon system

Presentation type : poster
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Over West Africa, there is a unique mixture of aerosol: biomass burning smoke (predominately black carbon, BC) from agricultural waste burning, air pollution particles from industrial, transportation and domestic emissions of a fast-growing population along the Gulf of Guinea, and desert dust from the Saharan Desert and Sahel. These aerosol particles influence the West African Monsoon (WAM) system via aerosol-radiation and aerosol-cloud interactions, depending on their optical, microphysical and chemical properties. This can have an impact on the West African weather and climate, with potentially important implications for the living conditions of hundreds of millions in this region. The aim of the project ACCLIMATE (Aerosol-radiation and aerosol-cloud effects on the West African Monsoon system in a changing climate) in the framework of the DAAD program Climate Research for Alumni and Postdocs in Africa (CLAP Africa) is to investigate the aerosol impact on the WAM system. The research is based on interactive experiments with the regional chemistry-transport model COSMO-MUSCAT. Here, we provide an overview of the project and show first initial results of the model evaluation using the extensive field observations in this region during recent years, including the DACCIWA experiment, as well as satellite and AERONET sun photometer observations.

5.2 An evaluation of the surface climatology over the Totten region (Antarctica) using COSMO-CLM2

Presentation type : oral
Authors : Samuel Helsen (1), Sam Vanden Broucke (1), Alexandra Gossart (1,2), Niels Souverijns (1,3) and Nicole P. M. van Lipzig (1)
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(3) Flemish Institute for Technological Research (VITO)

The Totten glacier is a highly dynamic outlet glacier, situated in E-Antarctica, that contains a potential sea level rise of about 3.5 meters. During recent years, this area has been influenced by sub-shelf intrusion of warm ocean currents, contributing to higher basal melt rates. Moreover, most of the ice over this area is grounded below sea level, which makes the ice shelf potentially vulnerable to the marine ice sheet instability mechanism. It is expected that, as a result of climate change, the latter mechanisms may contribute to significant ice losses in this region within the next decades, thereby contributing to future sea level rise. Up to now, most studies have been focusing on sub-shelf melt rates and the influence of the ocean, with much less attention for atmospheric processes (often ignored), which also play a key-role in determining the climatic conditions over this region. For example: surface melt is important because it contributes to hydrofracturing, a process that may lead to ice cliff instabilities. Also precipitation is an important atmospheric process, since it determines the input of mass to the ice sheet and contributes directly to the surface mass balance. In order to perform detailed studies on these processes, we need a well-evaluated climate model that represents all these processes well. Recently, the COSMO-CLM2 (CCLM2) model was adapted to the climatological conditions over Antarctica. The model was evaluated by comparing a 30 year Antarctic-wide hindcast run (1986-2016) at 25 km resolution with meteorological observational products (Souverijns et al., 2019). It was shown that the model performance is comparable to other state-of-the-art regional climate models over the Antarctic region. We now applied the CCLM2 model in a regional configuration over the Totten glacier area (E-Antarctica) at 5 km resolution and evaluated its performance over this region by comparing it to climatological observations from different stations. We show that the performance for temperature in the high resolution run is comparable to the performance of the Antarctic-wide run. Wind speed is overestimated in some places, which is solved by increasing the surface roughness. This research frames in the context of the PARAMOUR project (http://www.climate.be/php/users/klein/PARAMOUR/index.html). Within PARAMOUR, CCLM2 is currently being coupled to an ocean model (NEMO) and an ice sheet model (f.ETISh/BISICLES) in order to understand decadal predictability over this region.

5.3 Subhourly rainfall in a convection-permitting model

Presentation type : poster

Authors : Edmund P Meredith, Uwe Ulbrich and Henning W Rust

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Convection-permitting models (CPMs) have been shown to greatly improve the representation of subdaily and hourly precipitation, in particular for extreme rainfall. Intense precipitation events, however, often occur on subhourly timescales. The distribution of subhourly precipitation, extreme or otherwise, during a rain event can furthermore have important knock-on effects on hydrological processes. Little is known about how well CPMs represent precipitation at the subhourly timescale, compared to the hourly. Here we perform multi-decadal CPM simulations centred over Catalonia and, comparing with a high temporal-resolution gauge network, find that the CPM simulates subhourly precipitation at least as well as hourly precipitation is simulated. While the CPM inherits a dry bias found in its parent model, across a range of diagnostics and aggregation times (5, 15, 30 and 60 min) we find no consistent evidence that the CPM precipitation bias worsens with shortening temporal aggregation. We furthermore show that the CPM excels in its representation of subhourly extremes, extending previous findings at the hourly timescale. Our findings support the use of CPMs for modelling subhourly rainfall and add confidence to CPM-based climate projections of future changes in subhourly precipitation, particularly for extremes.

5.4 A sensitivity study with COSMO-CLM driven by ERA5 Reanalysis over central Europe

Presentation type : oral

Authors : M. Raffa (1), M. Adinolfi (1), M. Montesarchio (1,2), E. Bucchignani (1,2) and P. Mercogliano (1)

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(2) CIRA Centro Italiano Ricerche Aerospaziali, Italy

ERA5 is the latest climate reanalysis produced by ECMWF, replacing the ERA-Interim reanalysis, which stopped being produced on 31 August 2019. ERA5 is available on regular latitude-longitude grids at 0.25 x 0.25 resolution, with atmospheric parameters on 37 pressure levels. Compared to ERA-Interim, ERA5 has a higher spatial and temporal resolution, improving the representation of troposphere and tropical cyclones, with better global balance of precipitation and evaporation. Further, there are many additional differences to the computation of individual atmospheric parameters, due to the change in the assimilation systems. At this stage, it is therefore necessary to perform sensitivity studies and evaluate the performance of COSMO-CLM experiment driven by this latest reanalysis to asset the optimal experimental setup, even in the frame of future climate studies. In this work, we present a sensitivity analysis with COSMO-CLM at convection permitting scale, driven by ERA5. More specifically, we have investigated the sensitivity of the model to the double nesting, performing both a direct downscaling to 2.2 km grid spacing and an intermediate downscaling to 12 km. Moreover, a sensitivity to the number of vertical levels has been investigated. The simulations have been performed over central Europe, including the main cities in Germany such as Koln, Frankfurt am Main, up to Copenhagen in Denmark and the experiment covers the period from 2006 to 2010. The evaluation is carried out in terms of temperature and precipitation, comparing COSMO-CLM output with gridded observational datasets, EOBS and RADKLIM, and with the results of other simulations forced by ERA-Interim Reanalysis. Comparison has been performed mainly considering the extreme precipitation and the ability of the model to catch some events of heavy precipitation occurred from May to June 2008. Preliminary results highlight that ERA5 directly downscaled with CCLM at 2.2 km shows good performance in the most of analysis, especially to capture heavy precipitation events and extremes with respect to the double nesting downscaling.

5.5 Structural Behaviour of the COSMO-CLMUnder Different Forcings

Presentation type : oral
Authors : Emmanuele Russo (1,2)
(1) Climate and Environmental Physics, Physics Institute, University of Bern
(2) Oeschger Centre for Climate Change Research, University of Bern

In this study the COSMO-CLM sensitivity to parameters perturbation is investigated under different climate forcings. The main aim of this work is to understand how the uncertainty of the model propagates in different climate regimes and whether the model presents structural stability when different forcings are considered. For this purpose, two Physically Perturbed Ensembles(PPEs) are produced, each one composed of 30 realizations, at two different periods of the past: the Mid-Holocene, 6000 years ago, and the Pre-industrial period. The two periods present significant differences in the seasonal values of incoming insolation due to changes in the Earths orbital configuration.The effects of these changes on the Earths radiative balance, at least when considering seasonal values, are of the same magnitude of the changes due to GHGs emissions of the worst case Representative Concentration Pathway scenario (RCP8.5). Preliminary analyses reveal that the model, for some variables such as near surface temperature, presents a stable behaviour in the two periods,with no particular changes in the distribution of the considered variables (when considering climate mean statistics), for all tested parameters. On the other hand, some larger changes in the behaviour of the model are present for other variables, such as precipitation or cloud cover. In these cases the model sensitivity to parameters perturbation is particularly noisy and noticeable changes in the distribution of model results are evident between the two periods, for several parameters. These results suggest that, due to the evinced changes in the model parameter sensitivity for different climate regimes, when investigating future or past climate changes Physically Perturbed Ensemble (PPE) approaches have to be preferred to single model realizations based on a model calibration conducted for present-day conditions.

5.6 Low-level circulation, Moisture Convergence and Precipitation Biases in Regional Climate Simulations for Central America with COSMO-CLM

Presentation type : oral

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The Intra-Americas region, defined here as the land between the southern United States and northern South America, and the surrounding seas, is home to a large population, which is strongly dependent on natural resources and particularly vulnerable to weather and climate variations. This region contains what has been denoted as one of the Climate Change Hot Spots (Diffenbaugh and Giorgi 2012). Reliable climate model projections are indispensable for the development of adequate and effective adaptation and mitigation strategies for the area. However, regional weather and climate modeling is challenging for the Intra-Americas region, because the typical atmospheric phenomena include a wide range of scales, from regional-scale circulation features such as the Caribbean Low-Level Jet (CLLJ, Hidalgo et al. 2015) and the Choco Jet (CJ, Poveda et al. 2011), to smaller mesoscale tropical convection (Sherwood et al. 1999) and orographic effects flows around the Andes and other mountain ranges (Insel et al. 2010). In particular, regional climate modeling has produced mixed results in terms of skill and biases in the simulation of the Essential Climate Variables (ECVs) precipitation and near-surface temperature (Fuentes-Franco et al. 2014, Diro et al. 2012, Taylor et al. 2013, Martinez et al., Martinez-Castro et al. 2006, Martinez-Castro et al. 2016). This current state of affairs demonstrates the need for additional studies focused on the region. Here we present the results of a series of simulations with the COSMO-CLM, aiming to better understand and quantify the added value and challenges of regional climate modeling for the Coordinated Regional climate Downscaling Experiment (CORDEX, Giorgi et al. 2009) Central America (CAM) domain. Model performances of a reference simulation with the same model configuration used for the CORDEX South America domain (Lange et al. 2014), are firstly evaluated with respect to the mean state climatology and interannual variability of several ECVs, including precipitation and temperature. Successively, in order to better understand the dependence of the results on parameterization schemes and parameter values, a set of experiments with changes inherent to the parameterization of cumulus convection, orographic drag and boundary layer turbulence are considered. For these, associated structural changes in the representation of low-level circulation patterns, convergence zones and associated precipitation biases are investigated at the regional scale. Preliminary analyses indicate that the model reproduces the considered mean statistics considerably well, with model results within the range of the ones obtained for other CORDEX domains. Additionally, significant changes in model performances with the different tested configuration options are evident for different areas of the region.

5.7 Use of COSMO CLM Model for Climate Simulations in Brazil Applied to Environment and Hydroelectric Energy

Presentation type : poster

Authors : Reinaldo.B. Silveira (1), Christopher T. Blum (2) , Flavio A. C. Deppe (1), Amanda K. Marcon (2), Gabriel H. A. Pereira(1) and Clovis Cechim Jr. (1)

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The Paran Electric Energy Company, COPEL GeT, is running the research and development project PD-06491-0405/2015 with the Department of Forest Sciences of Federal University of Paran and Simepar, under the COPEL research and development unit and sponsored by the National Agency of Electric Energy (ANEEL), through its program of scientific development of electrical energy applications. In this project, the COSMO model is being used for regional simulations on climate in Brazil and with more detail on Paran state. The model is initiated with the boundaries of ERA-5 for a domain covering Central and South of Brazil, with 7km grid mesh. The goal of such study is to investigate the impact on climate and native forest, due to hydroelectric operations in the Iguau River for production of electric energy. Thus, as a first step, the climate over Parana state is investigate through the evaluation of the change on climate parameters from past 40 years to now. Environment satellite data have also been used to classify vegetation and land use over the years. In a second phase, regional climatic aspects and their influence on forest attributes, such as the growth of tree rings, will be studied. The results so far have shown changes on temperature, humidity and rainfall in Parana state, that can be related to land use and variation on vegetation.

5.8 Simulation of present and expected future runoff in a complex terrain Alpine catchment with EURO-CORDEX data

Presentation type : poster

Authors : Gerhard Smiatek

Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research (IMK-IFU), Garmisch-Partenkirchen, Germany

Data from seven regional climate models, run within the Coordinated Regional Climate Downscaling Experiments (EURO-CORDEX) experiments are applied to evaluate the reproduction of observed runoff and access its expected future changes of a mesoscale Alpine river by applying the distributed hydrological simulation model WaSiM. The modeling domain covers the complex terrain of the Ammer catchment located in the German Alps. Its size is round 600 km2 and the elevation ranges from 500 to 2000 m. The hydrology model is operated with a spatial resolution of 100 m and with a daily time step with temperature, precipitation, wind, relative humidity and shortwave radiation input. The investigated periods are 1981-2008 for the data from CORDEX evaluation runs, 1975 - 2005 for the historical runs and 2050 - 2100 for RCP4.5 scenario runs. The contribution investigates the bias present in the CORDEX precipitation data and discusses the necessity and approaches of a bias correction for all variables. Finally, present and future river discharge based on simulated flow duration curves (FDCs) is analysed. Obtained results show an increase in high flows in the future. Flow return periods obtained from a larger sample of highest flows over 50 years reveal for 2050 - 2100 lower return periods for high runoff values compared to 1955 - 2005.

6 WG SOILVEG

6.1 The reduction of systematic summertime warm biases in the soil-moisture limited regions of Southern Europe by stochastic root depth variation

Presentation type : oral

Authors : M. Breil and G. Schädler
Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology

The intensity of latent heat fluxes strongly depends on the available soil water amount for evapotranspiration, i.e. the water amount stored within the rooted soil depth. But the determination of the root depth itself, and consequently also of the water supply for evapotranspiration, is associated with large uncertainties, especially on the sub-grid scale. The evapotranspiration rates are therefore in many cases spuriously simulated, leading to temperature biases especially in soil-moisture limited evapotranspiration regimes like Southern Europe. To take these uncertainties into account, a new method is introduced, in which the root depths within a Regional Climate Model are stochastically varied within a sensible range. For this, the root depths in each model grid-box are perturbed by uniformly distributed random numbers. The study reveals that during the winter season, evapotranspiration is virtually not affected by the stochastic root depth perturbation. Changes are only caused by indirectly induced chaotic changes in the atmospheric circulation. But in summer, the latent heat fluxes are considerably increased all over Southern Europe, due to an asymmetric effect of the stochastic perturbation on the soil water supply for evapotranspiration. The evapotranspiration rates are only affected by stochastically increased root depths, but not by reduced ones. Soil warming is consequently reduced and lower near-surface temperatures are simulated for the whole Mediterranean region. These lower temperatures reduce an existing warm bias in South-Eastern Europe. Therefore, stochastic root depth modelling constitutes a simple method to mitigate systematic warm biases and thus, potentially improving model performance in soil-moisture limited evapotranspiration regimes.

6.2 Impact of urban canopy parametrization from TERRA_URB on air quality in urban regions in Germany

Presentation type : oral

Authors : Joachim Fallmann, Marc Barra and Holger Tost
Institute of Atmospheric Physics, University Mainz

In urban areas, chemical reactions and aerosol formation processes are altered not only due to enhanced pollution levels but also because of increased temperature, reduced humidity and wind speed as well as modified urban-rural trace substance mixture. Turbulent mixing within the urban boundary layer thus governs transport processes of air pollutants. Urban-rural circulation patterns driven by the strength of the urban heat island (UHI) promote the dispersion of pollutants into the rural vicinity, being able to modify local and regional air chemistry and meteorology. This study uses a state-of-the-art chemical transport model coupled to a sophisticated urban canopy parametrization in order to analyze the interaction of dynamical features and air quality for two large industrial regions in western Germany. For evaluating the benefit of using the TERRA_URB canopy parametrization for air quality simulations, we use the global chemistry climate model EMAC and its regional nested version MECO(n), with chemistry coming from the Modular Earth Submodel System (MESSy) and meteorology being calculated by COSMO-CLM. Comparing modelling results for summer and winter 2018 with surface observations for the Rhine-Main area, we find an improved representation of urban air quality and meteorology when TERRA_URB is included. We further used data from a passive microwave radiometer proofing an enhanced representation of the vertical temperature profile within the urban boundary layer. With this model setup, we designed a case study, analyzing the impact of projected future densification of urban areas concluding that denser urban structures always have to be accompanied with urban greening efforts in order maintain thermal comfort in the urban area. We further state that a reduction of air pollution levels can only be achieved by reduction of actual emissions, rather than by urban design. We summarize that linking chemical and local meteorological features in chemical transport models is crucial to account for combined effects of weather and air quality in urban regions. Findings from these model systems can be an important asset for science tools for cities in the framework of climate change adaption and mitigation strategies.

6.3 On the influence of density and morphology on the Urban Heat Island intensity

Presentation type : oral

Authors : Yunfei Li (1,2), Sebastian Schubert (1,3), Jürgen P. Kropp (1,2) and Diego Rybski (1,4)

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The canopy layer urban heat island (UHI) effect, as manifested by elevated near-surface air temperatures in urban areas, exposes urban dwellers to additional heat stress in many cities, especially during heat waves. We simulate the urban climate of various generated cities under the same weather conditions. For mono-centric cities, we propose a linear combination of logarithmic city area and logarithmic gross building volume, which also captures the influence of building density. By studying various city shapes, we generalise and propose a reduced form to estimate UHI intensities based only on the structure of urban sites, as well as their relative distances. We conclude that in addition to the size, the UHI intensity of a city is directly related to the density and an amplifying effect that urban sites have on each other. Our approach can serve as a UHI rule of thumb for the comparison of urban development scenarios.

6.4 COSMO-BEP-Tree: a coupled urban climate model with explicit representation of street trees

Presentation type : poster

Authors : Gianluca Mussetti (1), Edouard L. Davin (1), Juan A. Acero (2), Dominik Brunner (3), Scott E. Krayenhoff (4), Jan Carmeliet (5) and Sonia I. Seneviratne (1)

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Street trees are more and more regarded as a potential measure to mitigate the excessive heat in urban areas resulting from climate change and the urban heat island. Nevertheless, our understanding of their cooling potential relies on micro-scale studies while potential interactions at the city-scale are yet to be understood. Traditional urban climate models only represent vegetation outside the street canyon, neglecting important effects such as shading and sheltering. In order to explicitly represent street trees in coupled urban climate simulation, the multi-layer urban canopy model BEP-Tree was coupled with the regional weather and climate model COSMO-CLM (Mussetti et al., 2020). The coupled model, named COSMO-BEP-Tree, enable simulating the radiative, flow and energy interactions between street trees, canyon surfaces and the atmosphere during weather and climate simulations. Owing to its fully-physical and multi-layer representation of the urban canopy, COSMO-BEP-Tree enables modelling the outdoor thermal comfort through the index UTCI. A Python interface has been developed to ingest the most common urban morphology datasets, including building geometries and urban tree inventories. The model applicability is demonstrated in two contrasting urban environments: Basel and Singapore. The impact of street trees on the urban climate of the two cities is explored in terms of air temperature and outdoor thermal comfort. Preliminary insights regarding the climate-dependent effectiveness of street trees for heat mitigation are presented. Directions for further developments and applications are finally discussed. Mussetti, Gianluca, et al. 'COSMO-BEP-Tree v1. 0: a coupled urban climate model with explicit representation of street trees.' Geoscientific Model Development 13.3 (2020): 1685-1710. https://doi.org/10.5194/gmd-13-1685-2020

6.5 Evaluation of hindcast COSMO-CLM simulation over Central Europe and Spain

Presentation type : oral
Authors : H. Zhang and M. H. Tölle
Center for Environmental Systems Research, University of Kassel, Kassel, Germany

In the framework of climate and land use changes, MAPPY aims to study quantitatively the feedback processes linking pollinators, plant diversity and crop yields. To support this project, our group produces spatio-temporal high-resolution (~3km) climatic scenarios by dynamically downscaling MPI-ESM-LR projections for scenario RCP8.5 up to year 2070 over the studied regions, which mainly covering central Europe and Spain. We employ COSMO5.0-CLM9 model and configure it using COSMO-DE settings with a few modifications. For the model evaluation, the Hindcast simulations with 0.0275 resolution are driven by ERA5 (C3S 2013) with 0.25 spatial and one hourly temporal resolution for the period 1980-2019 with spin-up starting 1979. The land-use classes are described by ECOCLIMAP (Champeaux et al. 2005), and the soil type and depth by HWSD (v1.2) (FAO 2012). We compare the simulated variables like temperature and rainfall with HYRAS dataset (Frick et al. 2014) over central Europe and find good agreements. Yield and water use for a range of field crops are effected by extreme events like heat, drought, heavy rains, flooding, and spring frost (Pagani et al. 2017). Therefore, we also analyze variations of extreme weather indices in simulations and compare them with the observed ones.

6.6 High-resolution urban climate simulations for Moscow megacity with TERRA_URB scheme: the recent developments and new challenges

Presentation type : oral

Authors : M. Varentsov (1-4), T. Samsonov (1,2), M. Demuzere (5), I. Rozinkina (1,2), G. Rivin (1,2) and V. Vasenev (4)

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For the last years, Moscow megacity serves as a test-bed for the high-resolution weather and climate simulations with COSMO model and a TERRA_URB urban canopy scheme (Wouters et al., 2016). The COSMO model with TERRA_URB scheme was previously successfully used for Moscow for the regional climate simulations (Varentsov et al., 2018), and since 2018 serves as a core of the high-resolution weather forecast system (Rivin et al., 2019). In the current study, we present our recent developments, aimed at the further improvement of the model quality and detail. In particular, we present the results obtained with a newer COSMO version 5.05urb, which has been developed within the framework of AEVUS PTs. The new model version includes the updated physical parameterizations from ICON and extended options for configuration and calibration of the TERRA_URB scheme. We further consider the experience of high-resolution simulations with 500 m horizontal grid step and the challenges, related to the behaviors of physical parameterizations under so high resolution. One of the key challenges for high-resolution modeling for urban areas is related with obtaining the urban canopy parameters, which are needed for TERRA_URB scheme, with sufficient quality and resolution. The global data sets, used by the model by default, have too coarse resolution and poor quality for our study area. We compare two different methods to obtain more detailed and reliable urban canopy parameters. The first one is based on a combined use of OpenStreetMap data, the Copernicus Global Land Cover data set and Sentinel-2 satellite images. The second is based on a classification of the Local Climate Zones according to WUDAPT methodology (hing et al., 2018). Additional attempts are also performed in order to improve the external parameters for surrounding rural areas, firstly the soil map. We use various observations in Moscow region in order to evaluate the model quality and its changes due to the discussed developments, including the meteorological observations on a dense ground-based networks and ABL profile measurements. Acknowledges: The research was supported by the Grant for the implementation of activities on the development of the system for monitoring and forecasting

of, as well as warning against severe and adverse weather events in Moscow city (the Resolution of the Government of Moscow No. 257-PP, April 3, 2018), by Russian Science Foundation (project 19-77-30012) and Russian Foundation for Basic Research (project No.18-35-20052).
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7 WG SUPTECH

7.1 MESSy on-line diagnostics in COSMO-CLM and ICON-CLM

Presentation type : poster

Authors : Astrid Kerkweg (1), Mariano Mertens (2), Patrick Jöckel (2), Christiane Hofmann (3) and Bastian Kern (2)

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Long-term and/or high resolution simulations with geoscientic 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 files, etc., 6) diagnostics for tracers (such as hydrological variables), 7) tendency diagnostics. Further, the modular MESSy infrastructure gives the possibility to integrate tailor-made on-line diagnostics into the model without modifying the COSMO-CLM / ICON-CLM code itself. COSMOCLM/ MESSy is already provided to the CLM-community members. The diagnostic tools are implemented in ICON/MESSy. Here we provide a general overview of the features of the diagnostic capabilities of the MESSy-fied CLM-Community models. www.messy-interface.org Example

7.2 News from COSMO and ICON

Presentation type : oral
Authors : Daniel Rieger, Ulrich Schättler and Günther Zängl
Deutscher Wetterdienst

The presentation will provide a broad overview on the most important changes, development and research activities with the COSMO and ICON community. A particular focus is set on the COSMO-6.0/int2lm-3.0 reunification. Furthermore, development and research activities in the scope of COSMO priority projects and priority tasks are summarized. With the first CLM contributions already integrated into official ICON releases, this talk will also provide insight into the latest ICON developments.

7.3 Recent developments of the COSMO-CLM system

Presentation type : oral

Authors : Burkhardt Rockel ...
Helmholtz-Zentrum Geesthacht

An overview of the recent modifications in the COSMO-CLM model system will be presented. The main focus lies on the status of the next and last re-unification of the weather forecast version and the climate version of COSMO into version 6.0. This is a major update and will contain a restructuring of a large part of the code to adopt the physics subroutines to those implemented in ICON. New developments in pre-processing (INT2LM) and starter package will also be given.