# Climate Limited-area Modelling Community

July 2021

# Newsletter

No. 17

## Content



**See YOU at the**

**CLM-Community Assembly 2021**

**20 – 24 September 2021**

**Virtual Meeting**

**Announcement:**

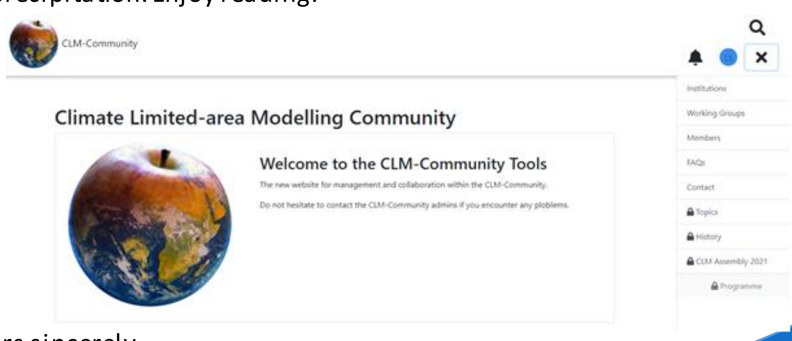
**ICCARUS 2022**

**07 – 11 March 2022**

**On-site or virtual to be decided.**

Dear colleagues,

Welcome to the 17th CLM-Community Newsletter.
The CLM-Community is a large community with a clear focus on research, model development and application. To be able to work and collaborate effectively, some organisation and administration is required, especially against the background that the community has 230 members from 75 research institutions all over the world. Most of the administrative work usually happens in the background, unrecognized by most of the members.
In order to improve the management of the community members, institutions, topics, working and project groups and to simplify the application process for membership and the organisation of the CLM-Community Assembly, we introduced a new management tool in April this year. Many of you have already used it to update their membership information, the membership in working and project groups, or for the registration and abstract submission for the CLM-Community Assembly 2021. Everybody who did not have a look at the new tool so far, is invited to do so and update his/her profile information and report problems and inconsistencies to the coordination office.
Special thanks go to our colleagues from Helmholtz-Zentrum Hereon, Beate Geyer, Burkhardt Rockel and especially Philipp Sommer, who developed the system, tested it and adjusted it according to our needs. Thank you very much for that. You can find a more detailed description of the tool in the CLM-Community Issues.
In addition, this issue contains an interview with Nadja Samtleben from BTU Cottbus, an update on the downscaling activities for CMIP6 within CORDEX, a review of ICCARUS 2021, an outlook to the CLM-Community Assembly 2021 and as usual two research notes. One from Marcus Breil about the reduction of systematic temperature biases in soil moisture-limited regimes by stochastic root depth variations and a second one by Michael Haller on the influence of graupel in COSMO-CLM simulations with focus on the annual and diurnal cycle of precipitation. Enjoy reading!




Yours sincerely,
Susanne Brienen, Anja Thomas and Christian Steger

# Five questions to…. Nadja Samtleben

Brandenburg University of Technology Cottbus - Senftenberg

Photo by N. Samtleben

Nadja Samtleben studied Meteorology at Universität Leipzig and worked as Student Research Assistant at Leibniz Institute for Tropospheric Research (Department: Experimental Aerosol and Cloud Microphysics). In 2017 she started her PhD at Universität Leipzig and is about to finalize her dissertation dealing with the effects of stratospheric gravity wave hotspots on the circulation in the middle atmosphere. Currently, she works as Research Scientist at Brandenburg University of Technology Cottbus – Senftenberg.

1. *Nadja, you work at BTU in the project RegIKlim. Can you please tell us something about the project in general and especially about your tasks?*

RegIKlim is a joint project focusing on (i) the comprehensive coverage of climate change on regional scale in Germany and (ii) the systematic determination of preventive measures to reduce economical, infrastructural and social damages induced by the effects of climate change. To achieve these goals, this project was separated into 3 different working groups. The first working group consists of 6 subprojects (WAKOS, IAWAK-EE, KlimaKonform, R2K-Klim+, KARE, ISAP) investigating potential impacts and successful adaptation measures of climate change in selected model regions across Germany. These projects require high-resolution climate simulations, which are performed and provided by the partners involved in the project NUKLEUS, the second working group. To create a small multi-model ensemble of high-resolution regional climate scenario simulations, three different models are used: COSMO-CLM, REMO and ICON-CLM. The third working group WIRKsam is responsible for the scientific coordination and supports the exchange of information and a close collaboration of all partners.
I am part of the NUKLEUS project and will create climate scenario simulations for Europe (EURO-CORDEX domain) and Germany with a horizontal resolution of 12 km and 3 km, respectively. In close collaboration with the partners from HZH (Helmholtz-Zentrum Hereon), GERICS (Climate Service Centre Germany) and KIT (Karlsruhe Institute of Technology) a common simulation protocol was arranged for all three models.

In consultation with the model regions we try to meet their expectations and provide the datasets they urgently need.

2. *Do you work with COSMO-CLM or ICON-CLM and in which context do you use the model?*

Within the project NUKLEUS I belong to a subproject called NUKLEUS-KONKRET concentrating on the preparation and accomplishment of convection-permitting regional climate simulations. Thus, it supports the fundamental objectives of the RegIKlim/NUKLEUS project including the provision of climate information. To perform regional climate simulations, different nesting methods will be tested to achieve the requested resolution. The different approaches will be evaluated by examining e.g. mean annual cycles of specific parameters. Later on, climate scenario simulations will be performed, which (i) will be driven by specific GCM outputs from the CMIP6 database for chosen RCPs and (ii) will cover time slices of 30 years derived from specific temperature increases in relation to pre-industrial conditions. I will analyze the resulting climate data with respect to extreme weather events and their related temporal and spatial distribution. Especially, I will focus on events with high precipitation with special emphasis on the model regions involved in RegIKlim.

3. *As a rather new member, what is your experience with the CLM-Community so far?*

I am part of the CLM-Community for more than six months and I have to admit that I was a bit disoriented in the beginning. It is a large community consisting of numerous working groups with many institutions involved and a platform providing a lot of information. But once I got used to the whole structure and got in touch with the community members contributing to the development of the ICON-CLM, everything was clear to me.
The main advantage of the CLM-Community are the regular meetings of the different working groups. All kind of problems and pending tasks can be discussed so that they can be promptly solved. As they say: Many hands make light work. Therefore, the community strongly profits from the close collaboration with the colleagues from the DWD also being part of the CLM-Community and participating in the meetings. This is something I really appreciate.

*4. What are your expectations to the CLM-Community?*

The community benefits from a lot of experts from different institutions and different fields, which may push the model development forward. The communication is well coordinated within the community so that the members would be able to make good progress. Nevertheless, it is only possible if each member of the CLM-Community contributes to the model development, takes the initiative and also performs common community simulations. On behalf of many CLM-Community members, an operating ICON-CLM version shall be provided as soon as possible. Therefore, each member who intends to benefit from the new climate model should contribute to its development as much as possible. We have to closely work together to achieve our goals.

*5. What are your personal goals with respect to your scientific career?*

For the moment I just want to finish my dissertation and want to focus on the NUKLEUS project. I don't really have further personal goals for my scientific career. For me it is important that (i) I am enjoying my work to be fully absorbed by the interesting topic/project and (ii) I am enlarging my knowledge and get a deep insight into new fields.

*Thank you very much for the interview!*

b-tu
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## CMIP6 downscaling

*By Christian Steger (Deutscher Wetterdienst)*

The Coupled Model Intercomparison Project is currently in the sixth phase (CMIP6) and many of the global modelling groups have already published most of their historical and ScenarioMIP simulations on the ESGF. The CORDEX community currently discusses and organizes the framework for the coordinated downscaling.

An important step was the publication of the CORDEX experiment design for dynamical downscaling of CMIP6 on 24 May 2021 (https://cordex.org/experiment-guidelines/cordex-cmip6/experiment-protocol-rcms). The first order draft of the experiment protocol was already distributed in June 2020, followed by the second order draft in February 2021. The community had again the possibility to review the document and provide feedback. The comments from the CORDEX community on the second order draft and the replies from the CORDEX SAT are available here: https://cordex.org/wp-content/uploads/2021/05/CORDEX_CMIP6_exp_design_response_SOD.pdf. The final version of the protocol was released in May 2021.

Overall, the protocol for CMIP6 is very similar to the protocol for CMIP5, but there are some important changes that should be mentioned. In terms of grid-spacing, the primary targets are now 25 km and 12.5 km and a resolution in-between can also be used if necessary. The community of each specific domain can take the final decision, but it is recommended that only one grid spacing is used per domain to avoid a wide range of resolutions for the same domain.

As for CMIP5, dynamical downscaling for CMIP6 should be done at least with regional atmosphere and land surface models. But the protocol suggests, that "increased efforts towards regional earth system models (RESMs), which include additional model components to represent other processes (e.g. ocean, sea ice, snow, urban lakes, vegetation/agriculture, land hydrology, glaciers, aerosols and chemistry), are encouraged."

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In addition, a static aerosol dataset is considered as a minimum requirement, but it is strongly encouraged that for the evaluation experiment, the modeling groups should apply up-to-date regional or global aerosol datasets with realistic variability in time and space. These statements have also strong implications for the model development activities within the CLM-Community in the next years and are taken into account in the new strategy document of the community that will be distributed to the CLM-Community members in July and voted on at the CLM-Community Assembly 2021 in September.

The evaluation experiment should now be done with boundary conditions from ERA5 for the period 1979-2020. The historical experiments have to cover at least the period 1960-2014 such that the WMO recommendation for the standard static reference period for long-term climate change assessment (1961-1990) is included. If possible, the entire period 1950-2014 should be used. For the scenario experiments, the main change compared to CMIP5 is that the mandatory scenarios are now SSP1-2.6 and SSP3-7.0 instead of RCP-2.6 and RCP-8.5. It is recommended to do SSP2-4.5 and/or SSP5-8.5 after the downscaling of SSP1-2.6 and SSP3-7.0 has been completed.

The CORDEX Data Request details (output list of variables and their frequencies) is not available yet, but is expected to be published in the next weeks. The decision about the GCMs that provide the boundary conditions for the downscaling is left to the communities of each domain. In EURO-CORDEX, a group has been established that should provide recommendations and guidelines for the GCM selection. This group has met several times in the last year, gathered information about model evaluation and performance and summarized everything in a white paper (Euro-CORDEX _CMIP6_GCMSelection_CommunityDraft - Google Docs) that should build the basis for the GCM selection in EURO-CORDEX.

A workshop of the whole EURO-CORDEX community took place on 28 June in which the suggestions/recommendations from the task force were discussed and some decisions taken. There should be 8-10 GCMs in the whole EURO-CORDEX ensemble to account for inter-model variability. It is important to mention, that this is the number that should be achieved by all groups together and it does not mean that every group has to downscale 8-10 GCMs. The first priority for the scenarios are SSP1-2.6 and SSP3-7.0, followed by SSP2-4.5 and SSP5-8.5, following the recommendations of the global CORDEX community. Criteria on observational constraints will be included in the selection process, but also one or two models that fall outside the observationally constrained range but are otherwise well performing will be included, e.g. for worst case risk assessment. The decision if several realizations of the GCMs should be downscaled to account for intra-model variability was less clear. In general, this is considered to be important, but it also requires a lot of resources, which might then be missing for the downscaling of more GCMs and/or scenarios. It was decided that a few models with multiple realizations should be included (e.g. EC-Earth, IPSL, MPI-ESM) to have the possibility to address this question.

Some more work by the task force is now necessary to put the decisions into practice and assess all the models that are currently available. The task force will try to provide a list of recommended GCMs by the end of summer. The CLM-Community will continue the discussion about the contributions of the member institutions and the coordination of the work as soon as all decisions in EURO-CORDEX have been taken.

## Review ICCARUS 2021

*By Christian Steger (Deutscher Wetterdienst)*

About 200 developers and users of COSMO and ICON usually meet at ICCARUS at the DWD headquarter in Offenbach. Last year, the meeting had to be cancelled on very short notice, because the COVID-19 pandemic started to spread across Europe. For ICCARUS 2021, the organization team had more time to prepare the meeting as an online event and ICCARUS could take place as virtual conference from 08 – 19 March. In the first week, the focus was on the scientific presentations in the plenary, while the second week was reserved for working and project group meetings. Due to the online format, more participants than usually could take part in the meeting and the number of registrations reached an all-time high with 342.

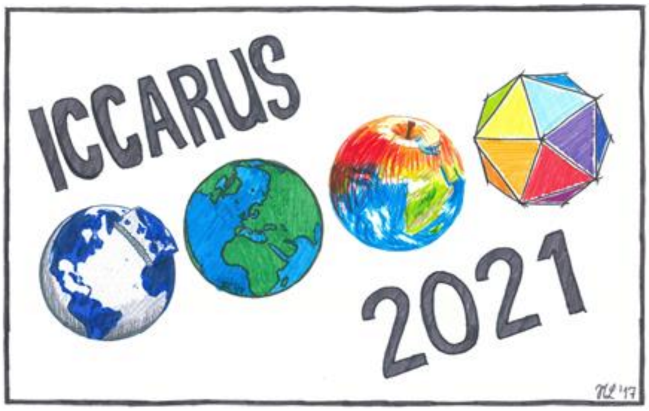
Ninety-four abstracts were submitted for ICCARUS 2021. Sixty-one of them were presented as an oral presentation in the plenary and the remaining 33 as a "poster" in the poster sessions. Classical poster sessions are difficult to realize in an online event. Therefore, the poster sessions were organized as parallel sessions where the authors could present their work to the audience with enough time for discussions afterwards.

The program included thematic sessions on "Data Assimilation", "Dynamics and Numerics", "Climate Model Application", "NWP Model Applications and Case Studies", "Planetary Boundary Layer", "Verification (NWP) and Evaluation (Climate)", "Predictability and Ensemble Systems", "Clouds, Chemistry, Aerosol and Radiation", "Soil, Vegetation and Ocean" and "Model infrastructure and data processing". Furthermore, there was a session about "ICON-Seamless", to inform the COSMO and ICON communities about this new project. The goal of "ICON-Seamless" is to prepare the NWP physics branch of ICON for use on all temporal and spatial scales, including seasonal and decadal predictions and climate projections.

Besides the presentations of the participants, there were also two invited talks by Steve Derbyshire (UK Met Office) and Reiner Schnur (MPI-M). Steve gave an overview of the state of knowledge on atmospheric waves and Reiner informed the audience about further developments with the land surface model JSBACH and the planned integration into ICON-Seamless.

In addition to the two invited talks, several of the ICON and COSMO core developers informed the participants about recent developments and future plans. This included talks by Ulrich Schättler (DWD) about the last release of the COSMO model (COSMO Version 6.0), Günther Zängl (DWD) about the operational start of the high-resolution model configuration ICON-D2, Marco Giorgetta (MPI-M) about the representation of the Quasi Biennial Oscillation (QBO) in simulations with high spatial resolutions, Bernhard Vogel (KIT) about the latest development of ICON-ART, Roland Potthast (DWD) about recent developments in the data assimilation and Panagiotis Adamidis (DKRZ), who presented the role of DKRZ as the main developer of the ICON model infrastructure.

Overall, ICCARUS 2021 was a successful event, even if it was organized as a pure online meeting. Whether ICCARUS 2022 will be organized as on-site meeting, again as virtual conference or something in between has not been decided yet. The organization committee will distribute the information as soon as a decision is taken.



# The new CLM-Community Management tool – easy access to CLM-Community information and easy management of your information

*By P. Sommer and B. Geyer (Helmholtz-Zentrum Hereon)*

In April this year, a new management tool for the CLM-Community has been introduced. All pages with information about the CLM-Community have been restructured in a smart way. They provide both overviews and details of member institutions, persons, working/project groups and topics – the fields where members contribute to the success of the CLM-Community. A distinction is made between open access and protected content.
The latter is only accessible for CLM-Community members. Filters can be used on all pages to reduce the amount of information that is shown or to find specific details.
Although the usage of the new tool is easy, the underlying system is very complex and replaces the old 3-step procedure for content updates with emails to the coordination office, consistency check and Access database plus transfer to the mySQL database with display on the website.
With the new tool all members have editing permission to their own profile and information on their topics on the webpage. Additional permissions are given according to their role in the CLM-Community. Wherever you find the edit icon you are allowed to change or update the content. When you find outdated or misleading content and have no permission to update, please contact the coordination office (clm.coordination[at]dwd.de).
The updated content is immediately visible for self-checking. Afterwards, the coordination office checks each new/updated entry for formal correctness. The basic rule is: Content belonging to the CLM-Community may not be deleted, but must be terminated or deactivated. This means:

For Working/Project Groups: All members should contribute to the work of the CLM-Community. The easiest way is to participate in the working and project groups. Everyone can manage his own membership. The working/project group leaders are informed of your decision and will manage the mailing list accordingly. The leaders have the permission to edit the content of the respective group page.

For institutions: When an institutions is no longer represented in the CLM-Community the institution is no longer active and is listed afterwards as 'former member institution' to acknowledge their contribution to the CLM-Community in the past. If you enter an institution, which is not yet part of the CLM-Community you have to introduce it with the 'add' button on the institutions page.

For topics: The topic browser is a community-internal mirror of the work in the CLM-Community on both model development and application. To keep the overview on work already done, the finished topics are listed as such including publication lists. Start and end dates are given. To start a new topic you can use the 'add' function on the topics page.

For members: The membership is connected to the affiliation and ends when the member leaves the institution. This is done by editing the member profile and choosing "Finish this membership" in the section Academic Membership. This action implies a decision on your topics:

- if you are not the leader of a topic and do not proceed your contribution from a new institution:
  - end only your work in the topic by choosing 'End this membership' in the 'Edit and approve the topic members' modus of the topic page.
- if you are the leader, you can
  - end only your work in the topic and hand it over to a new leader (via pull down menu 'Leader') or
  - close the topic by setting 'Topic is finished'
- when further work on that topic is planned at the new institution: clone the closed topic by using the button 'clone this topic' and change the lead institution to your new affiliation.
- As the tool is not self-explanatory everywhere, we have created an https://hcdc.hereon.de/clm-community/faqs section and, in addition, the FAQs belonging to the current webpage are listed on top of the page. If you have any questions, please do not hesitate to contact the CLM-Community coordination office. The tool is still new and we are keen to improve, document and simplify the workflows as much as we can.

## CLM Community Assembly 2021 – Outlook

*By Susanne Brienen (Deutscher Wetterdienst)*

As the COVID-29 pandemic is still influencing our lives, the CO working group has decided to organize this year's Community Assembly again as a virtual meeting. Although a face-to-face meeting would certainly be preferable, the good experience from last year's Assembly gives hope that again a virtual meeting can nonetheless be fruitful for the exchange of results and discussions of next steps and maybe even formation of new cooperation. All members are invited to join the meeting on 20 – 24 September 2021. Registration is still open: https://hcdc.hereon.de/clm-community/clm-assembly-21/

The structure of the meeting will remain in principle the same as last year, but all 30 contributions that have been submitted will be presented as talks in the plenary sessions this time, because classical poster sessions are difficult to realize in an online meeting. In addition, working and project group meetings will take place and community issues will be discussed in the community meeting on 24 September. The SAB will meet at the Assembly as well. One subject of the community meeting will be the new strategy document for the next years, which is currently in the process of being finalized and will be distributed to the community members before the meeting.
More information can be found on the Assembly webpage: https://wiki.coast.hereon.de/clmcom/assembly-98599085.html.


## Overwhelming attention for paper

*By N. Akhtar and B. Geyer (Helmholtz-Zentrum Hereon)*

Beginning of June we published a paper about "Accelerating deployment of offshore wind energy alter wind climate and reduce future power generation potentials" in Nature scientific reports. The paper summarized the concentrated work on the model itself, on the setup of the simulations, the cost intensive simulations and the analysis and visualization.


scientific reports

Check for updates

OPEN Accelerating deployment of offshore wind energy alter wind climate and reduce future power generation potentials

Naveed Akhtar, Beate Geyer, Burkhardt Rockel, Philipp S. Sommer & Corinna Schrum

The echo on this article was louder than the actual call (please see article metrics https://www.nature.com/articles/s41598-021-91283-3/metrics). Since everyone knows what a wind turbine looks like and usually has a position pro or contra wind energy or renewable energy in general, the press release for this article got a lot of attention in social media. Our influence on how the findings of our study are now used in public debates is minor and we hope that it is of greater use for the energy transition to renewables. The public interest helps us on the other hand to get in contact with scientists of other communities for discussion of the findings and the way forward.

The second paper, on the influence of the energy reduction through wind farms on other meteorological variables has been submitted and is currently under review.

## Research notes

# The reduction of systematic temperature biases in soil moisture-limited regimes by stochastic root depth variations

*M. Breil* [1], *G. Schädler*[1]

[1] *Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology, Karlsruhe, Germany*

**More details can be found in:**

Breil, M., & Schädler, G. (2021). The reduction of systematic temperature biases in soil moisture-limited regimes by stochastic root depth variations, Journal of Hydrometeorology (published online ahead of print 2021). https://doi.org/10.1175/JHM-D-20-0265.1.

**Introduction**

In soil moisture-limited evapotranspiration regimes, near-surface temperatures are strongly affected by the available amount of soil water for evapotranspiration. An adequate estimation of the soil water supply for evapotranspiration is therefore essential to simulate the near-surface climate conditions in such regimes correctly.

In general, it is a challenging task to quantify the available soil water amount for evapotranspiration. It is a quantity that depends on two uncertain factors, the soil water content itself and the capability of plants to extract this water from the soil. The first factor, the actual soil water content, is generally unknown, because an exact simulation of the water input into the soil (i.e. of precipitation) and its distribution in the soil is very difficult. The second factor, the capability of the plants to extract this water from the soil, is mainly determined by the plants access to the stored soil water, which in turn strongly depends on the root depths. However, only limited observational data exists regarding the depth and density of root systems in the soils (e.g. Schenk & Jackson, 2003). Thus, the simulation of the soil water supply for evapotranspiration is highly uncertain, leading inevitably to biases in the simulated near-surface temperatures for soil moisture-limited regimes.

The physical reasons for such soil moisture induced temperature biases can differ from region to region and model to model (errors in precipitation rates, soil water transport, water extraction by roots, etc.). Thus, a lot of different model developments would be needed to get rid of such biases without having the certainty that all model deficiencies can be redressed. Therefore, a method that systematically reduces these biases, irrespective of which physical process caused the modeled soil water deficiencies, would be of great advantage.

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Evapotranspiration processes in other regions and periods should not be negatively affected. Therefore, the goal of the presented study is to develop a method which fulfills these requirements. For this purpose, a new modelling approach is introduced, by which the available amount of soil water for evapotranspiration is stochastically varied by randomly changing the root depths.

**Method**

By using a random number generator, uniformly distributed numbers between -1.0 and 1.0 are created for each model grid box. For positive random numbers, the whole root density profile over all soil layers is proportionally shifted downward in the soil column. The new root density in a soil layer is therefore a linear combination of the actual root density and the one of the overlying soil layer. For the maximum perturbation of 1.0, the complete root profile (and thus the root depth) is displaced by one soil layer. For negative random numbers, an upward layer displacement is performed. In this way, the vegetation specific shape of the density distribution is preserved, but the depth from which water can be extracted is changed. Since the stochastic root profile variation is uniformly distributed over the whole model domain and performed for each model grid box separately, the root depths are increased for 50 % of the grid boxes in the model domain and reduced for the other 50 %. This is approximately also the case for the available amount of soil water for evapotranspiration.

The root depth values are varied yearly. Due to these yearly stochastic variations, a physically consistent development of the soil conditions is guaranteed for a whole vegetation period. In this way, a seasonal soil moisture memory is preserved, which is essential to consistently simulate the development of the soil conditions during a year (Dirmeyer & Halder, 2017).

These stochastic root depth variations are implemented in regional climate simulations with COSMO-CLM coupled to the Land-Surface Model VEG3D (CCLM-VEG3D, Breil et al., 2019). In a first step, a reference simulation is performed with the default root depths used in the CCLM-VEG3D model system. In a second step, three stochastic simulations with perturbed root depths are performed. All simulations are driven by ERA-Interim reanalyses (Dee et al., 2011). The simulation period is 1986-2015, with a spin-up of seven years. The model domain is identical to the Coordinated Downscaling Experiment-European Domain (EURO-CORDEX; Jacob et al., 2014). The spatial horizontal resolution is 0.44°, the time step is 300s.

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## Expected Effects

The expected effects of a stochastic root depths variation on energy-limited and soil moisture-limited evapotranspiration regimes are conceptually described in Figure 1. In energy-limited regimes, where soil moisture just slightly affects the near-surface temperatures, the turbulent heat flux partitioning should not be affected (Figure 1a). Since the radiative energy input is generally small in these regions, the low evaporative demand should still be covered after slight variations of the available soil water amount for evapotranspiration.

But in moisture-limited regimes, the method should have an asymmetric effect on evapotranspiration (Figure 1b). A uniformly distributed stochastic root depth variation increases the water supply for evapotranspiration in 50 % of the grid-boxes in the model domain and reduces it in the other 50 %. In the case that the available soil water amount for evapotranspiration is realistically estimated in a climate model, the yearly varying negative and positive moisture perturbations should counteract each other and the near-surface conditions should spatially and temporally not be affected on the climatological mean. In the case of an overestimated soil water supply for evapotranspiration, a further increase of the soil water availability in 50 % of the model grid-boxes by increased root depths should not additionally enhance the already overestimated evapotranspiration rates. But for the other 50 % of the model grid boxes, the root depth reduction should reduce the soil water availability, resulting in a reduction of the overestimated evapotranspiration rates. Since such a root depth reduction is not constant over the simulation and occurs every year in another model grid box, near-surface climate conditions should in mean be improved in all grid boxes located in soil moisture-limited regimes. In the case of an underestimated soil water supply for evapotranspiration, a further reduction of the root depths in 50 % of the model grid-boxes should not additionally reduce the already existing water limitations for evapotranspiration. But an increase in the other 50 % of the model grid-boxes should increase the soil water availability and thus the evapotranspiration rates. This should lead in mean to a reduced bias in the near-surface climate conditions in soil moisture-limited regimes.

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## Results and Discussion

As expected, in the energy-limited evapotranspiration regimes of Northern Europe and of the mountain areas in Central and Eastern Europe (Alps and Carpathian Mountains), evapotranspiration is not affected by the stochastic root depth variation (Figure 2a). But for the summertime soil moisture-limited regimes in Central and Southern Europe in CCLM-VEG3D, the latent heat fluxes are considerably increased. According to this, sensible heat fluxes are reduced (Figure 2b) and lower near-surface temperatures are simulated. As a result, the soil moisture induced warm bias in these regions (Figure 2c) is significantly reduced (Figure 2d).

Therefore, the stochastic root depth variation constitutes a method to systematically reduce biases in summertime soil moisture-limited evaporation regimes, without causing negative side-effects in energy-limited regimes. In this context, the physical reason for the spuriously simulated soil water supply for evapotranspiration (over- or underestimation of precipitation, root depth, etc.) is irrelevant, since the method does not improve the simulated soil water supply itself. Only the negative effects of these model deficiencies on the near-surface climate conditions are compensated. In this way, the initially stated requirements for an adequate method are fulfilled. This stochastic root depth variation should be applicable in any regional or global climate model.

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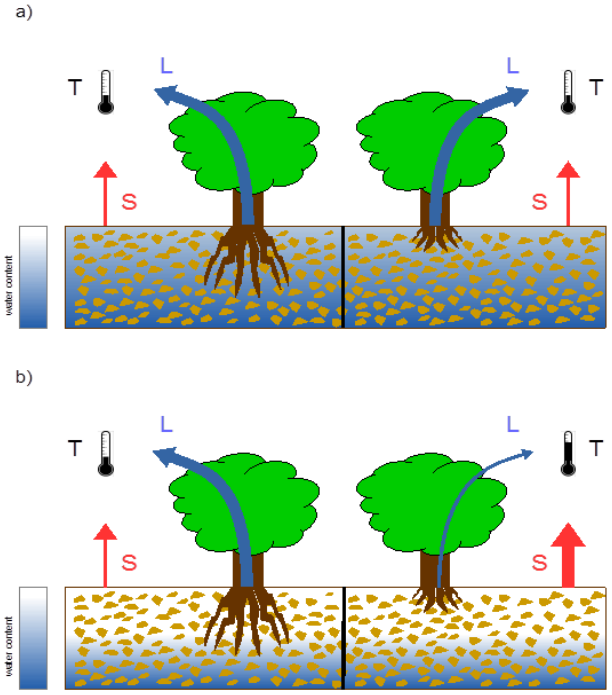


***Figure 1:** expected effects of a stochastic root depth variation in different grid boxes (left: increased root depth, right: reduced root depth) on (a) energy-limited and (b) soil moisture-limited evapotranspiration regimes. The black line indicates the root depth in the reference run. Latent heat fluxes (L) are drawn in blue and sensible heat fluxes (S) in red. (T) represents the near-surface temperatures.*

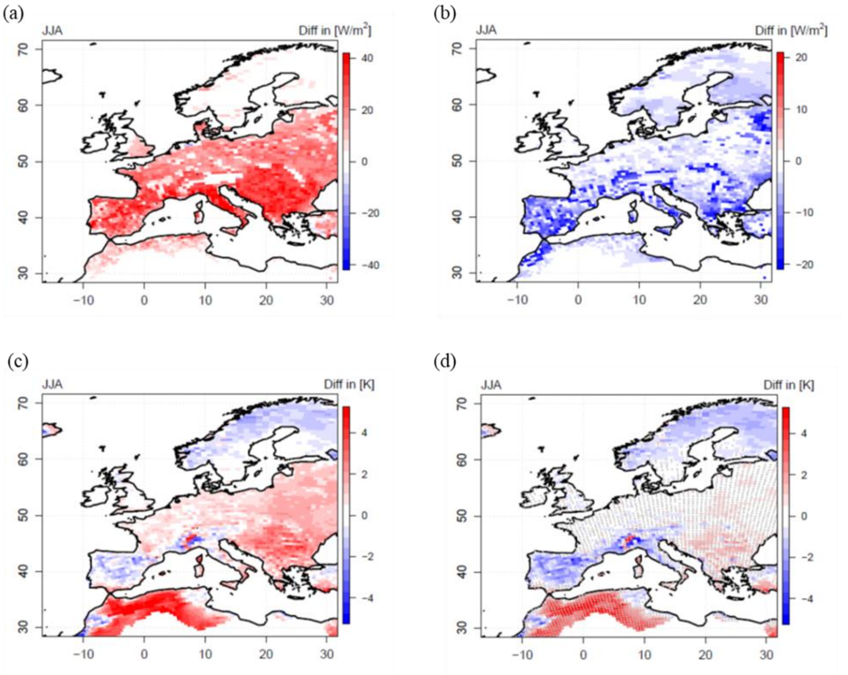


***Figure 2:** Differences in the simulated seasonal mean (a) latent and (b) sensible heat fluxes in [W/m²] for the summer season between the CCLM-VEG3D stochastic ensemble mean and the reference run for the evaluation period 1986-2015. (c) Differences in the simulated seasonal mean 2 m temperatures [K] between the CCLM-VEG3D reference run and the E-OBS observational data set in summer for the evaluation period 1986-2015. (d) Differences in the simulated seasonal mean 2 m temperatures [K] between the CCLM-VEG3D stochastic ensemble mean and the E-OBS observational data set in summer for the evaluation period 1986-2015. The grey lines indicate grid boxes in which the reductions of the squared errors of the mean monthly 2 m temperatures, over the whole simulation period of all three stochastic ensemble member, are significant at a 95 % level in a Wilcoxon-Rank-Sum-Test in comparison to the reference run.*

Research notes

# On the influence of graupel in COSMO-CLM simulations in regard to the annual and diurnal cycle of precipitation

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**Introduction**

In the first phase of the project „Expertennetzwerk (Network of Experts)“ (2016-2019), funded by the German Ministry of Transport and Digital Infrastructure (BMVI), climate projections with the COSMO-CLM4-8-18 have been conducted on a convection-permitting scale. In these simulations, driven with MIROC-MIROC5, we covered 130 years in a transient run from 1971 until the year 2100 in the RCP 8.5 scenario. The knowledge about frequencies and intensities of extreme events, as well as their alteration triggered by climate change is one of the key issues in the project. In general, adaptation to climate change and associated changes of extreme events is necessary in many fields of action. The Network of Experts is specifically investigating the vulnerability of traffic and transport infrastructure in Germany. For the assessment of this vulnerability and possible adaptation strategies for transport infrastructure on local scale, climate information is needed on the same scale.
In the analysis of our climate simulation, we found deficiencies especially in the representation of the diurnal cycle of precipitation when compared to observational data. Previous studies have shown that convection-permitting simulations are able to reproduce well the precipitation peak in the afternoon according to observations, which is most pronounced in the summer months. Global or coarser resolved models do not simulate the afternoon peak, instead they show a precipitation peak around noon associated often with too high precipitation values (see e.g. BAN et al., 2014; PREIN et al., 2015). In our case, precipitation is decreasing during the day and increasing in the evening (see Figure 1, left). Having a closer look at our model setup, we realized we did not deploy the graupel parametrization (which would be itype_gscp=4) to save simulation time, which makes a substantial difference when simulating a time period covering 130 years. However, we lost an important part of the microphysics scheme on this horizontal scale. As the graupel seems to be a trigger for earlier rainfall in convective events, we missed this part of the microphysics scheme.

Without graupel, BRISSON et al. (2016) reported that rimed snow flakes are the main hydrometeors in the ice phase. They have a smaller falling speed, which in turn leads to less precipitation reaching the ground.
Thus, we decided to repeat our simulations in the second phase of the project Network of Experts that started January 2020. This time, we used COSMO-CLM5-0-16 with active graupel parametrization.
The two main aspects of the comparison between the simulations were, first, the differences in precipitation and, secondly, the influence of the graupel parametrization on other variables like temperature and wind. We name here the simulation with COSMO-CLM4-8-18 “Sim1”, the one using COSMO-CLM5-0-16 “Sim2”.

**Data and Methods**

We used different model configurations in our climate projections for Network of Experts phase 1 and phase 2. The most important differences were, first, the different model versions. In phase 1, we applied the model version COSMO-CLM4-8-18 (Sim1), while in phase 2 we switched to COSMO-CLM5-0-16 (Sim2). Second, we switched on the graupel parametrization in Sim2. For the Sim2 simulation, further adaptions of the setup were taken from the CLM community´s FPS-convection contribution from the year 2019, including a change in wind gust parametrization and usage of the FLake parametrization.
We only present results here of the comparison of precipitation, 2m-temperature and 10m-wind for the historical period of 1971-2000. In an additional test run for one year using the Sim1 setup, we only switched the graupel parametrization on and off, leaving all other options unchanged. Thus, we could examine the pure effect of the graupel parametrization. We compared these results to RADKLIM radar observations (WINTERRATH et al., 2019).

**Results**

First, we addressed the question to which extent the effect of graupel is seen in our simulations. The most important difference between both simulations appears in the diurnal cycle of precipitation (Figure 1, left). The new simulation Sim2 produced results similar as in previous studies e.g. in BAN et al. (2014) with the precipitation peak during the afternoon. As seen in our additional test simulation for one year (Figure 1, right), this effect is associated with the influence of the graupel parametrization. It can be seen here that the agreement of the diurnal cycle for the simulation with activated graupel parametrization to RADKLIM is much better. Figure 2 shows the annual cycle of precipitation. Here it is obvious that the effect of graupel is most pronounced in the summer months, when convective precipitation is more frequent.

However, in the other months, Sim1 produced less precipitation than Sim2 as well.

In Figure 3, the differences of mean annual precipitation for 30 years (1971-2000) of both simulations are shown. Red colours indicate higher precipitation in Sim1; blue colours show higher precipitation in Sim2. Two main features are discernible. There is much more precipitation in Sim2 than in Sim1 in most regions of the domain (blue colours). In Germany, it is restricted to the North and the southwest of Germany and the highest differences reach values of around 200 mm in mountainous areas (e.g. Black Forest, Sauerland). At the western boundary of the domain, very high negative differences are found (> 250 mm), which may be a result of boundary effects. In the southeastern part of Germany, differences are low or positive, especially near the Alps, where precipitation is reduced in Sim2 compared to Sim1 (red colours). In the Alpine region, large differences of more than 300 mm are found, which means the amount of precipitation is higher in Sim1 compared to Sim2. Overall, Sim2 produces more convective precipitation than Sim1, which is mostly due to the graupel parametrization. Graupel particles have a higher sink velocity than snowflakes. Without graupel, less precipitation reaches the ground, leading to lower precipitation rates and to a shift towards later hours.

Summed up over the year, it builds a difference between simulations with or without graupel parametrization. The absolute value of the difference may vary from year to year depending on the convective activity over the year.

For the second part of our analysis, we examined the effect of graupel on the 2m temperature and the mean wind speed. We see an effect of the different model setup on the 2m temperature (Figure 4 left), showing generally higher temperatures up to 1 K in Sim1 for Germany. In the Alpine region, temperature differences tend to be negative, i.e. Sim1 temperatures are lower than in Sim2. Higher differences occur over some large lakes in the vicinity of the Alps (e.g. Lake Geneva, Lake Constance). This is probably due to the utilization of the FLake parametrization in Sim2. The differences of 2m temperatures for the one-year experiment range only between ± 0.2 K, where we conclude that the usage of the graupel parametrization has only a small effect on the 2m temperature.

Differences of the mean 10m-wind speed, shown in Figure 4 (right), show values of around ± 0.5 m/s for Germany (with a mean value of 0.01 m/s). In the Alpine region, however, differences are larger, accounting up to 1 m/s. This is also the case for the wind speed in 850 hPa height. Diurnal and seasonal cycles show a good agreement to each other. Overall, the results for wind speed give the impression that the influence of graupel on the wind speed is rather small.

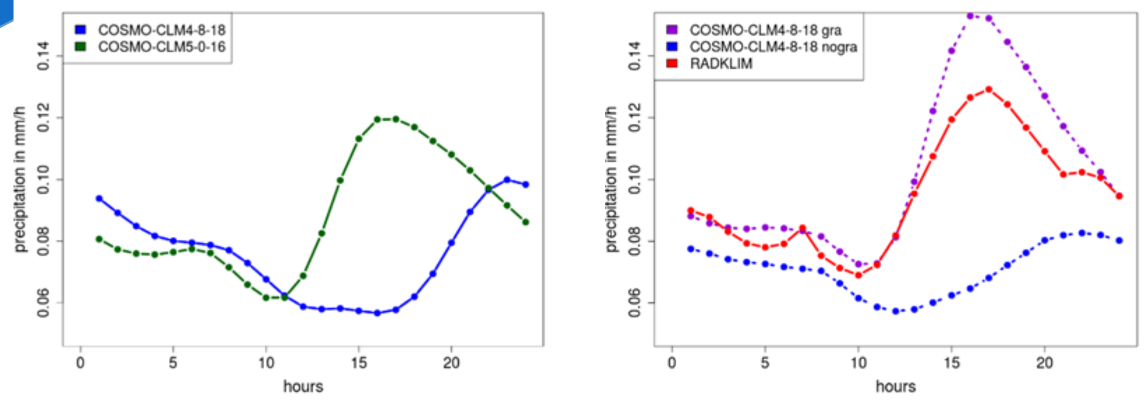


***Figure 1 left:** Mean diurnal cycle of precipitation of historical simulations (1971-2000) with COSMO-CLM of Sim1 (COSMO-CLM4-8-18) and Sim2 (COSMO-CLM5-0-16). Right: Mean diurnal cycle of precipitation for the year 2001 of COSMO-CLM4-8-18 simulation with activated ("gra") and deactivated ("nogra") graupel parametrization. Both figures are for summer months (JJA) only.*

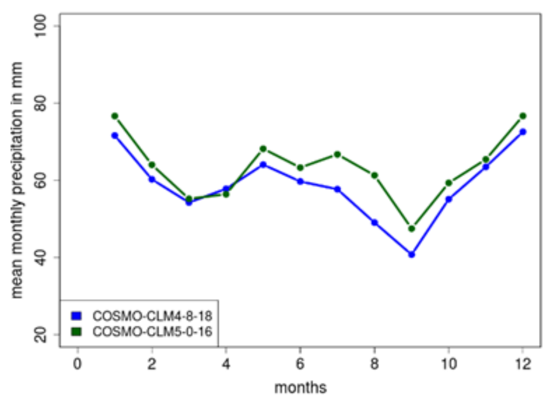


***Figure 2:** Mean annual cycle of precipitation of historical simulation (1971-2000) for Sim1 (COSMO-CLM4-8-18) and Sim2 (COSMO-CLM5-0-16).*

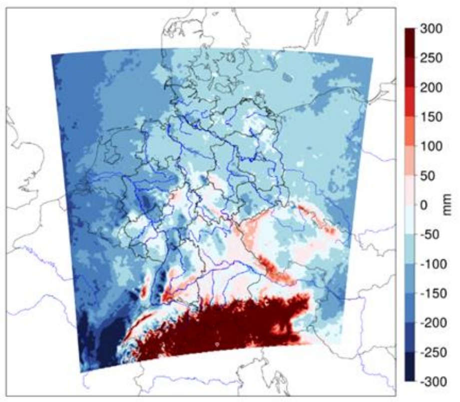


***Figure 3:** Differences of mean annual precipitation of COSMO-CLM Sim1 minus Sim2 for the years 1971-2000.*

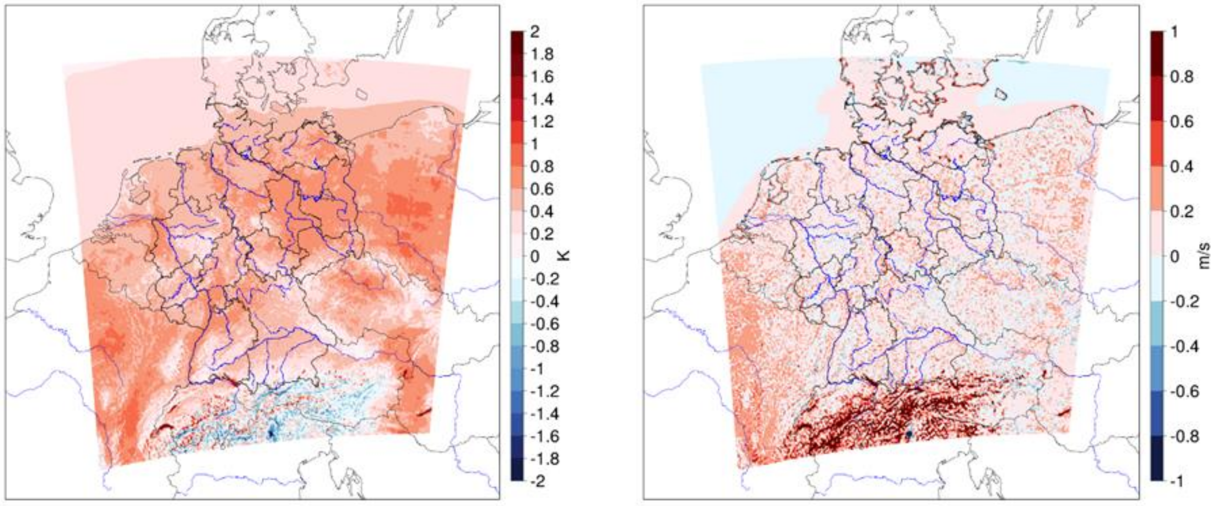


***Figure 4:** Differences of mean 2m-temperature in K (left) and 10m wind speed in m/s (right) of COSMO-CLM Sim1 minus Sim2 for the historical period 1971-2000.*

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**Conclusions**

In the presented study, we evaluated the differences of two COSMO-CLM simulations, covering the historical period of 1971-2000. Besides the different model versions and some other minor changes in the configuration of the simulations, the main difference is the usage of the graupel parametrization. Additionally, we performed an experiment covering one year with the same COSMO-CLM version, keeping the setup constant except for the graupel parametrization. In our simulations, the different setup of the graupel parametrization has a tremendous effect on the precipitation in terms of mean annual sum as well as the diurnal cycle. For a realistic representation of the diurnal and annual cycle of precipitation, the graupel parametrization is essential. For other variables, the effect of the different model versions is larger than the differences from using graupel parametrization or not. This holds for 2m temperature as well as for wind speed and other variables.

**References:**


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## Recent publications

**Please** send all information on new publications related to COSMO-CLM (peer-reviewed, reports, theses, etc.) with corresponding links to clm.coordination[at]dwd.de. Please do not forget to name the project in the topic browser to which the publication is related.

**2020**

Conte, D., S. Gualdi, P. Lionello (2020): Effect of Model Resolution on Intense and Extreme Precipitation in the Mediterranean Region. Atmosphere 2020, 11(7), 699; https://doi.org/10.3390/atmos11070699

Levi, Y.,Y. Mann (2020): COSMO-CLM Performance and Projection of Daily and Hourly Temperatures Reaching 50 °C or Higher in Southern Iraq. Atmosphere 2020, 11(11), 1155; https://doi.org/10.3390/atmos11111155

Platonov, V., A. Kislov (2020): High-Resolution COSMO-CLM Modeling and an Assessment of Mesoscale Features Caused by Coastal Parameters at Near-Shore Arctic Zones (Kara Sea). Atmosphere 2020, 11(10), 1062; https://doi.org/10.3390/atmos11101062

Ramon, D., K. Allacker, F. De Troyer, H. Wouters, N.P. van Lipzig (2020): Future heating and cooling degree days for Belgium under a high-end climate change scenario. Energy and Buildings, 216, 109935, https://doi.org/10.1016/j.enbuild.2020.109935

**2021**

Adinolfi, M. M. Raffa, A. Reder, P. Mercogliano (2021): Evaluation and Expected Changes of Summer Precipitation at Convection Permitting Scale with COSMO-CLM over Alpine Space. Atmosphere 2021, 12(1), 54; https://doi.org/10.3390/atmos12010054

Ban, N., C. Caillaud, E.Coppola, E. Pichelli, S. Sobolowski, M. Adinolfi, B. Ahrens, A. Alias, I. Anders, S. Bastin, D. Belušić, S. Berthou, E. Brisson, R.M. Cardoso, S.C. Chan, O.B. Christensen, J.Fernández, L. Fita, T. Frisius, G. Gašparac, F. Giorgi, K. Goergen, J.E. Haugen, Ø. Hodnebrog, S. Kartsios, E. Katragkou, E.J. Kendon, K. Keuler, A. Lavin-Gullon, G. Lenderink, D. Leutwyler, T. Lorenz, D. Maraun, P. Mercogliano, J. Milovac, H.-J. Panitz, M. Raffa, A..Reca Remedio, C. Schär, P.M.M. Soares, L. Srnec, B.M. Steensen, Paolo Stocchi, M.H. Tölle, H. Truhetz, J. Vergara-Temprado, H. de Vries, K.irsten Warrach-Sagi, V. Wulfmeyer, M.J. Zander (2021): The first multi-model ensemble of regional climate simulations at kilometer-scale resolution, part I: evaluation of precipitation. Clim Dyn. (2021). https://doi.org/10.1007/s00382-021-05708-w

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Bucchignani, E. P. Mercogliano (2021): Performance Evaluation of High-Resolution Simulations with COSMO over South Italy. Atmosphere 2021, 12(1), 45; https://doi.org/10.3390/atmos12010045

Garbero, V., M. Milelli, E. Bucchignani, P. Mercogliano, M. Varentsov, I. Rozinkina, G. Rivin, D. Blinov, H. Wouters, J.-P. Schulz, U. Schättler, F. Bassani, M. Demuzere, F. Repola (2021): Evaluating the Urban Canopy Scheme TERRA_URB in the COSMO Model for Selected European Cities. Atmosphere, 12, 237. https://doi.org/10.3390/atmos12020237

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Krug, A., P. Pothapakula, C. Primo, B. Ahrens (2021): Heavy Vb-cyclone precipitation: a transfer entropy application showcase. Met. Z., DOI: 10.1127/metz/2021/1071

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Meredith, E.P., U. Ulbrich, H.W. Rust, H. Truhetz (2021): Present and future diurnal hourly precipitation in 0.11° EURO-CORDEX models and at convection-permitting resolution. Environ. Res. Commun., 3 (2021) 055002 https://doi.org/10.1088/2515-7620/abf15e

Pichelli, E., Coppola, E., Sobolowski, S., Ban, N., Giorgi, F., Stocchi, P., Alias, A., Belušić, D., Berthou, S., Caillaud, C., Cardoso, R. M., Chan, S., Christensen, O. B., Dobler, A., de Vries, H., Goergen, K., Kendon, E. J., Keuler, K., Lenderink, G., Lorenz, T., Mishra, A. N, H.-J. Panitz, C. Schär, P.M.M. Soares, H. Truhetz, J. Vergara-Temprado (2021): The first multi-model ensemble of regional climate simulations at kilometer-scale resolution part 2: historical and future simulations of precipitation. Clim Dyn (2021). https://doi.org/10.1007/s00382-021-05657-4

Platonov, V., M. Varentsov (2021): Introducing a new detailed long-term cosmo-clm hindcast for the russian arctic and the first results of its evaluation. Atmosphere 2021, 12(3), 350; https://doi.org/10.3390/atmos12030350

Purr, C., E. Brisson, B. Ahrens (2021): Convective rain cell characteristics and scaling in climate projections for Germany. Int. J. Climatol. 2021; 1-12, https://doi.org/10.1002/joc.7012

Raffa, M., A. Reder, M. Adinolfi, P. Mercogliano (2021): A Comparison between One-Step and Two-Step Nesting Strategy in the Dynamical Downscaling of Regional Climate Model COSMO-CLM at 2.2 km Driven by ERA5 Reanalysis. Atmosphere 2021, 12(2), 260; https://doi.org/10.3390/atmos12020260

Revokatova, A., M. Nikitin, G. Rivin, I. Rozinkina, A. Nikitin, E. Tatarinovich (2021): High-Resolution Simulation of Polar Lows over Norwegian and Barents Seas Using the COSMO-CLM and ICON Models for the 2019–2020 Cold Season. Atmosphere 2021, 12(2), 137; https://doi.org/10.3390/atmos12020137

Van Pham, T., C. Steger, B. Rockel, K. Keuler, I. Kirchner, M. Mertens, D. Rieger, G. Zängl, B. Früh (2021): ICON in Climate Limited-area Mode (ICON release version 2.6.1): a new regional climate model. Geosci. Model Dev., 14, 985–1005, 2021 https://doi.org/10.5194/gmd-14-985-2021

Vasenev, V., M. Varentsov, P. Konstantinov, O. Romzaykina, I. Kanareykina, Y. Dvornikov, V. Manukyan (2021): Projecting urban heat island effect on the spatial-temporal variation of microbial respiration in urban soils of Moscow megalopolis. Science of The Total Environment, Vol. 786, https://doi.org/10.1016/j.scitotenv.2021.147457

## Remember!

... part of your scientific success relies on the work of those people providing the reference model setup, maintain the codes, etc. Therefore, it would be more than a sign of courtesy to offer them co-authorships once in a while.

Please, do not forget to state that you used the "COSMO model in Climate Mode (COSMO-CLM)" and, please, also include the statement "COSMO-CLM is the community model of the German regional climate research community jointly further developed by the CLM-Community" in each publication.

## Welcome to new Members

**University of Eswatini**
**Swasiland**

(http://www.uneswa.ac.sz/)

*Topic:* *Climate change scenario and risk assessment reduction of surface temperatures for the assessment*

*Contact:* *Samkele Tfwala*

**University of Bern**
**Switzerland**

(https://www.unibe.ch/)

*Contact:* *Emmanuele Russo*

**National Observatory of Athens**
**Greece**

(https://www.noa.gr/en/)

*Topic:* *Dust electrification and climate Ecuador*

*Contact:* *Stergios Misios*

## Upcoming events 2021

**2021**

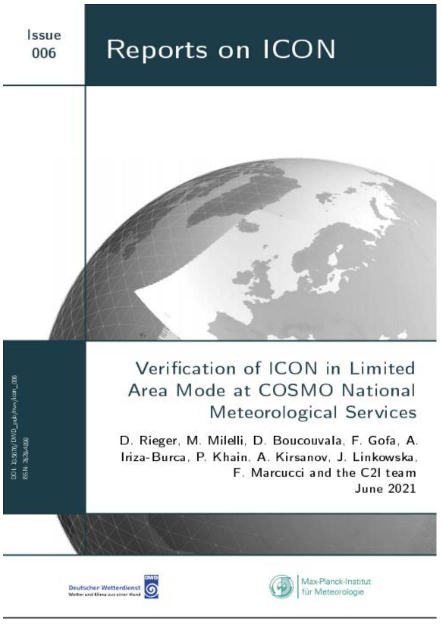
September 06 - 10: EMS Annual Meeting, Historical University of Barcelona, Spain
September 13 - 17: COSMO General Meeting, virtual meeting
September 20 – 24: CLM-Community Assembly, Virtual Meeting

**2022**

March 07 - 11: ICCARUS 2022, t.b.d.
September 05 – 09: EMS Annual Meeting, University of Bonn, Germany
September 12 - 16: COSMO General Meeting, Greece, t.b.c.

**2023**

19 - 23 June 19-23: ICAM 2023, St. Gallen, Switzerland


Issue 006

Reports on ICON

Verification of ICON in Limited Area Mode at COSMO National Meteorological Services

D. Rieger, M. Milelli, D. Boucouvala, F. Gofa, A. Iriza-Burca, P. Khain, A. Kirsanov, J. Linkowska, F. Marcucci and the C2I team
June 2021

All Reports on ICON are available here:
https://www.dwd.de/DE/leistungen/reports_on_icon/reports_on_icon.html

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