Climate Limited-area Modelling Community

January 2022

Newsletter

No. 18

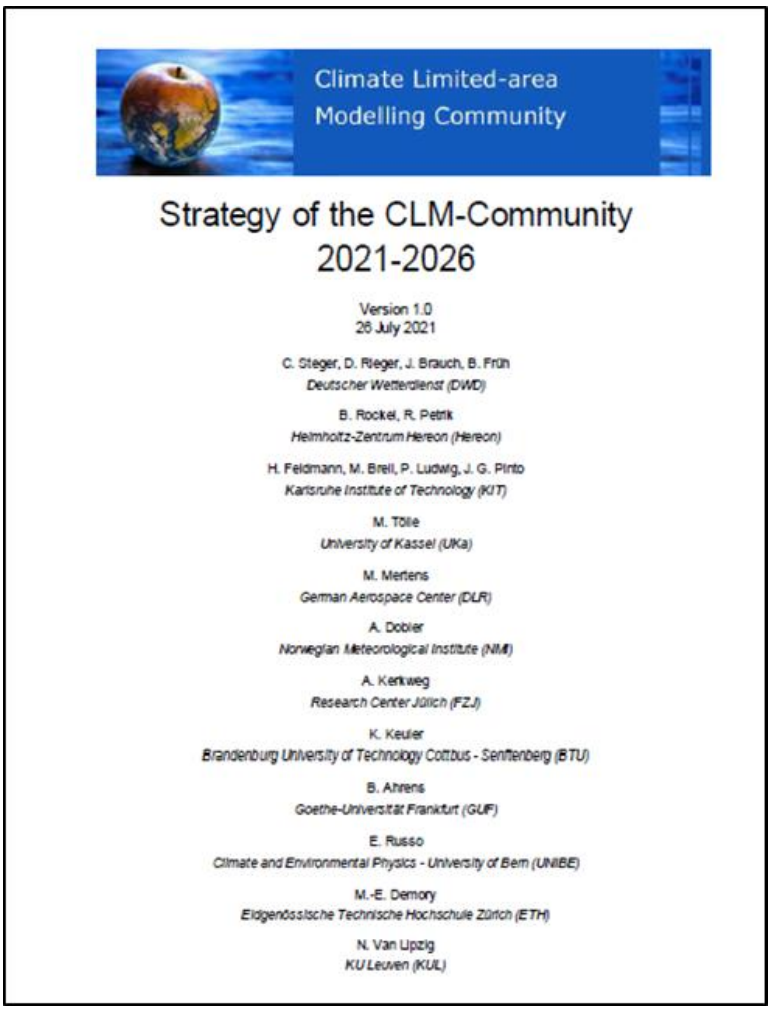
Content

See YOU at
ICCARUS 2022
07 – 11 March 2022
Virtual Meeting
www.dwd.de/iccarus

Announcement:
CLM-Community Assembly 2022
19 – 23 September 2022
Berlin, Germany or virtual meeting

Dear colleagues,

Happy new year and welcome to the 18th CLM-Community Newsletter! The CLM-Community has a new Science Plan for the upcoming years! After many discussions about the character and content of the document in the last years, the CLM-Community members accepted the new strategy document in the CLM-Community meeting at the Assembly 2021. You can find more details about the document and the creation process in the report in the CLM-Community issues of this newsletter.


Climate Limited-area Modelling Community

Strategy of the CLM-Community 2021-2026

Version 1.0
26 July 2021

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Furthermore, this issue of the CLM-Community newsletter includes an interview with Mariano Mertens from the German Aerospace Center, an update on the CORDEX activities, a review of the CLM-Community Assembly 2021 and an outlook to ICCARUS 2022. The research notes include a review about the COSMO-CLM regional climate simulations in the Coordinated Regional Climate Downscaling Experiment (CORDEX) framework by Silje Sørland and a study about evaluation and expected changes of summer precipitation at convection permitting scale with COSMO-CLM over Alpine space by Marianna Adinolfi.

Enjoy reading!

Yours sincerely,

Susanne Brienen, Anja Thomas and Christian Steger

Five questions to…. Mariano Mertens

German Aerospace Center

Mariano Mertens is a PostDoc at the Institute of Atmospheric Physics of the German Aerospace Center in Oberpfaffenhofen. In his work, he investigates the impact of transportation emissions on climate and air quality. He studied Geophysics in Münster and moved to Oberpfaffenhofen in 2013. 2017 he received his PhD from the Ludwig-Maximilians-Universität Munich.

1. *Mariano, you work at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt (DLR)). Can you please tell us something about DLR in general and about your tasks there?*

The DLR is a large German research institution in the fields of Aerospace, Space, Energy, Transport, Security and Digitalization. Currently, we have 55 institutes and more than 10.000 employees. I work at the Institute of Atmospheric Physics where we investigate the physics and chemistry of the global atmosphere from the Earth's surface up to the upper boundary of the middle atmosphere. In this context my main task is the investigation of impacts of transport emissions on climate and air quality as well as the assessment of possible mitigation options. For this, I develop and apply our global chemistry-climate model (CCM) EMAC and the global-regional CCM MECO(n), which couples EMAC with COSMO-CLM/MESSy. In the future, also ICON(-CLM)/MESSy shall be used and I am involved in this transition.

2. *You are one of the main developers of MESSy. Can you please explain a bit about MESSy, esp. what benefit users can get from it, and about the status of MESSy with respect to ICON?*

MESSy is a software package. It consists of infrastructure components and several so called submodels which describe individual physical (e.g. convection) or chemical (e.g. dry deposition) processes and diagnostics. MESSy facilitates the creation of new numerical earth system models or the extension of existing (e.g. legacy) models.

Once a legacy model, for example COSMO, is equipped with the MESSy infrastructure additional physical or chemical processes or diagnostics can be added to the model via well-defined interfaces without modifications of the COSMO code.

For the user several benefits arise. Firstly, MESSy allows to define model set-ups which are tailor-made for specific research questions. As example, simulations can either be performed with complex atmospheric chemistry including aerosols, with a simplified chemistry or purely diagnostically with climatologies of the radiatively active substances. Secondly, the large amount of available diagnostics and online-statistics allows tailor-made model output without the need of expensive post processing which is very important considering the increasing amounts of model data due to increasing resolution. Thirdly, the model development is eased in many ways due to the well-defined interfaces. These interfaces allow for parallel developments at many different parts of the model. Further, even without detailed knowledge of the legacy model new processes/diagnostics can be implemented easily. Finally, as the individual code parts of the processes/diagnostics are formulated independently from the legacy model the same code can be used for all legacy models.

With respect to ICON this means that everything which is available in COSMO-CLM/MESSy or EMAC will also be available in ICON(-CLM)/MESSy. We have now expanded the infrastructure of MESSy in a way that it is capable of the nested domains in ICON. This work is complete. In the special case of ICON also the submodels need to be adapted to the nested domains. This work is ready for the diagnostic submodels and in progress for the chemistry submodels. The current status allows that for instance gridded data can be directly imported and mapped onto the ICON grids (incl. the nested domains) at runtime, chemical components (tracers) defined by MESSy submodels are transported by the ICON physics (turbulence, convection, large scale advection). ICON variables are "seen" by the MESSy submodels, and so forth.

3. *You are also one of the ICON-CLM gatekeepers. Can you please give us some information about the ICON development workflow in general and your tasks as gatekeeper in the process?*

The CLM-Community has a development partnership with the DWD, which allows all members to contribute further developments to ICON. Anyone who wants to contribute to the development of ICON-CLM should contact the CLM-Community coordinator with a short summary of the planned work. When the proposal for this development is accepted, the member gets developer access to the ICON-project on GIT. The CLM-Community offers a lot of documentation about the ICON and GIT workflow in detail and the developers should make themselves familiar with this. Once the developers thinks that the development is ready, they should ask either the ICON-CLM gatekeepers or other developers of the CLM-Community for a code review. Once this review is accomplished the ICON-CLM gatekeepers will perform a final code review and hand the feature branch over to the COSMO contact person, who will finally perform the backmerge to ICON. Besides the last points our role as gatekeepers (currently Ingo Kirchner and myself) is to accompany the development process and coordinate it, where necessary. Therefore, it is very important that the ICON-CLM gatekeepers are informed about all developments.

4. *You are a member of the CLM-Community for quite a long time now. What are, in your opinion, the advantages of the CLM-Community and where do you see room for improvements?*

The complexity of climate and earth system models is continuously increasing. Partly, due to additional physical processes, but also due to the requirements of a largely changing HPC-infrastructure. The development and maintenance of the model, but also the procedure to find optimal configurations (e.g. for specific geographical regions) is so demanding that no institution on its own is really able to manage it. Here, I see the large advantage of the CLM-Community: scientists dealing with a lot of different specific scientific questions join their forces w.r.t. development, maintenance of the used models and of the required infrastructure (e.g. subchain / SPICE), etc. At this point, however, I see the largest room for improvements. Clearly, a community does only work if all members contribute to the community tasks actively. In the last years, however, less and less active members invest time in important community issues.

On the long term this is a drawback for everyone applying the models. Therefore, it is to my opinion very important that everyone should contribute a little bit of time to the tasks of the CLM-Community.

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

Globally, the transportation sector is a very important emission source. The transition from fossil fuels to alternative fuels or the electrification of the transport sector is a main challenge of the next decades. I want to contribute with my work to this major challenge and help to reduce climate and air quality impacts of the transportation sector. For me, an important part of this work is the communication of key results to stakeholders and the public and of course the education of the next generation of climate scientists.

Thank you very much for the interview!

DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

CORDEX activities

Update CMIP6 downscaling activities

By Christian Steger (Deutscher Wetterdienst)

In the previous newsletter, we reported about the status of the preparations for the CMIP6 downscaling activities within the framework of CORDEX. An important step was the publication of the CORDEX experiment design for dynamical downscaling on 24 May 2021 (https://cordex.org/experiment-guidelines/cordex-cmip6/experiment-protocol-rcms/).

Meanwhile, on 30 September 2021, the draft of the second important document, the CORDEX-CMIP6 variable list, has been published (https://cordex.org/2021/09/30/we-invite-you-to-comment-on-the-cordex-cmip6-variable-list/). It was possible to provide comments and suggestions for the variable list until 14 October. On 20 January 2022, the CORDEX SAT distributed the Second Order Draft of the variable list. It is again possible to provide comments and suggestion for changes until 01 February 2022 via the following link: https://docs.google.com/forms/d/e/1FAIpQLSea07hkYRnavd-LplclgbCTg8YDsuPnNwm50EzvdVILXGNcgw/viewform

Meetings of the GCM selection group of EURO-CORDEX took place on 01 October 2021 and on 05 January 2022. A tool for the evaluation of the CMIP6 GCMs is now in place and an overview document with a lot of information about the models from literature but also from direct assessments is now available. Based on this, a suggestion for "recommended" GCMs for the boundary conditions of the regional models has been created. The document includes some considerations and background information about the selection process and additional explanations.

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A first version of the document should also be published on Zenodo as soon as possible, to share the information with other modelling groups and help them to make decisions and get started. In the medium-term, the goal is to write a publication about the process and the outcome.

The document has also been be distributed in the EURO-CORDEX community in January and will build the basis of the discussions and decisions at the EURO-CORDEX General Assembly. This discussion will also include the complete matrix design for EURO-CORDEX for CMIP6. In the draft of the agenda for the General Assembly, the sessions "GCM evaluation and selection" and "Matrix design" are scheduled for Tuesday, 25 January 2022. Further sessions are "EURO-CORDEX in the broader context" and "Aerosol and land use forcing in CMIP6-CORDEX simulations and prioritization of the use of SSPs" on Monday, "Variable list" on Wednesday and "Final discussion and decisions" on Thursday.

If time permits, there will be an additional session about the strategy for convection permitting simulations on Thursday. The discussions on this important topic, which builds on the work in the CORDEX-FPS Convection, has already started and a first meeting took place on 08. October 2021.

Review CLM-Community Assembly 2021

By Susanne Brienen (Deutscher Wetterdienst)

For the second time now, it was only possible to meet for the CLM Assembly virtually. The meeting took place in the week 20 – 24 September 2021. Although we are all now much more used to this type of communication, and experienced only little technical difficulties, the possibilities of exchange and networking are still limited. Nevertheless, it was a successful meeting with 65 registered participants from 11 countries.

As usual, many community members took the opportunity to present their current work in 24 oral presentations. Uli Schättler (DWD) started the plenary sessions with a very interesting and entertaining overview of the history of the COSMO model, which now reaches the end of its lifetime. The poster session has been skipped this time, as there were enough time slots for oral presentations available. The different CLM-Community working and project groups met as well in order to discuss the current status and open issues for the different aspects of model development and community tasks. In the community meeting, the new strategy document for the next 5 years was presented and approved, and the plans for ICON-Seamless (preparation of ICON-NWP for use for climate simulations) were introduced.

Some of the presentations and the minutes of the community meeting can be found on the CLM-Community webpage: https://wiki.coast.hereon.de/clmcom/assembly-98599085.html. The minutes of the different working group meetings should be available on the specific working group website or RedC pages.

Currently, the preparations for the next Assembly, which is planned for the week 19 – 23 September 2022, have been started. It is not clear yet if the conference can be conducted as in-person-meeting in Berlin (finally) or needs to be hosted as virtual meeting again. In any case, we hope to see again many community members in September.

Outlook ICCARUS 2022

By Christian Steger (Deutscher Wetterdienst)

ICCARUS (ICON/COSMO/CLM/ART USER SEMINAR) 2021 was organized as virtual conference, because the Covid-19 situation did not allow for an in-person meeting in March last year. The situation is still very unstable und uncertain and it is not possible to make any prediction how the situation will look like for some months in advance. Therefore, the organisation team decided already in fall last year that ICCARUS will again take place in a virtual format in 2022.

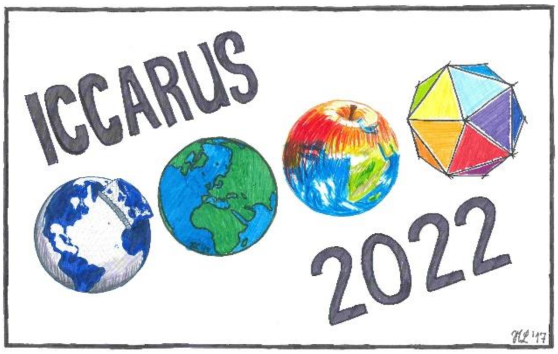
ICCARUS 2022 will have the classical one-week format. The plenary sessions of ICCARUS 2022 are scheduled for 07 – 09 March, 09:00 – 17:00 CET each day, and 10/11 March are reserved for working and project group meetings of COSMO, CLM-Community and ICON.

The abstract submission procedure has slightly changed this year. In the past, the author could select a session for his/her contribution. This led to a very unequal distribution of the talks in the different sessions in recent years. Therefore, the organisers decided to change the procedure and provide some key words that the authors can select for their abstract during the submission process. Based on the selected key words, the program committee will group the contributions and assign them to different thematic sessions.

The number and structure of the invited and solicited talks will also change for ICCARUS 2022. With the inclusion of ICON some years ago, the number of solicited talks grew steadily over the last years and against the background of some new and overarching projects like ICON consolidated and ICON seamless, it seemed reasonable to restructure the number and topics of the solicited talks. In the future, there will only be one invited talk. The invited talk at ICCARUS 2022 will be given by Johannes Flemming (ECMWF) about "Prognostic aerosols in the radiation scheme of ECMWF's Integrated Forecasting System - experiences with the global CAMS system".

The number of solicited talks will be reduced from six to four. One solicited talk will be about strategic developments in ICON, one about major changes and updates in ICON and the ICON releases of the last year as well as the influence on the performance and verification scores, a third one about the other components of the prediction system including data assimilation, ensembles and verification, and another one will cover climate related topics, including information from ICON seamless and the CLM-Community.

The registration for ICCARUS 2022 and the abstract submission for posters is still open. For registration and further information, please visit: https://dwd.de/iccarus
We hope that many of you will participate in the conference and the working and project group meetings and we are looking forward to an interesting conference.



New CLM-Community strategy for 2021 - 2026

By Christian Steger (Deutscher Wetterdienst)

After the previous science plan expired in 2018, it was necessary to development a new strategy for the CLM-Community for the upcoming years. The discussions for a new science plan started already at the end of 2018, but it took some time to agree on the character and the content of the document.
The new document should define the strategy and goals of the CLM-Community for the period 2021-2026. It starts with the basic idea of the CLM-Community as a platform for scientific exchange and collaboration. The main purpose of the community is the joint development and application of the community models (COSMO-CLM and ICON-CLM). The collaboration in the community supports the work of the members, reduces the efforts for model development and maintenance for each institution and helps the members to achieve their goals.
The community hereby relies on voluntary contributions of its members and operates without direct funding. As a whole, the community does not work directly on scientific questions. It builds the framework and provides a network and the tools for the members to do so. Consequently, the new strategy does not outline scientific questions that will be addressed by the community in the future, but focuses on overall goals and tasks.

Building on the previous discussions, the coordination started to gather plans and goals from the core institutions in 2020 and combined this information with input from external sources like e.g. CORDEX and different ICON related projects to get an overview of the "Demands on the CLM-Community and the community model(s)." This part forms the first chapter of the new strategy.

Based on this, the document defines community activities and model development tasks that support the attainment of these goals and ensure the availability of a state-of-the-art modelling system to enable the institutions to conduct their research and achieve their goals. These goals are outlined and described in more detail in part two of the document. The "Goals of the CLM-Community" are grouped in three categories, "Quality assurance and support", "Model development" and "Applications". While the first category focuses on overall community tasks like the transition to ICON, provision of recommended model setups and runtime environments as well as the training course, the focus of the second part is on the improvement and extension of ICON-CLM to produce better simulations results. Amongst others, it includes goals like a better representation and treatment of aerosol, a better representation of land cover and land use change and the coupling of an ocean model. These features should in the end ideally be combined in a regional earth system model. The main application on which many groups of the community will work together in the next years is the downscaling of the CMIP6 simulations in CORDEX.

The goals that should be included in the new strategy were first discussed and structured by the coordination group and each goal was described in more detail with about half a page of text. Afterwards, the document was consolidated and homogenized in May last year and the review from the coordination group took place in May and beginning of June. From mid of June to mid of July 2021, the members of the Scientific Advisory Board had the chance to review the text and provide suggestions for changes. Afterwards, the document was finalized and the final version was shared with the community members on 26 July 2021. In the community meeting at the Assembly 2021, the members voted on the new document and accepted it as new strategy for the CLM-Community for the period 2021 – 2026.

The document is now part of the community agreement (Annex H) and available on the CLM-Community webpage: https://wiki.coast.hereon.de/clmcom/terms-conditions-98599061.html

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Evaluation and expected changes of summer precipitation at convection permitting scale with COSMO-CLM over Alpine space

Adinolfi, M.[1], Raffa M.[1], Reder A.[1], Mercogliano P.[1]

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More details can be found in:

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

Introduction

Extreme precipitation events represent the main cause for different hazards (e.g., floods). Therefore, the need of providing climate information at properly temporal (preferably hourly) and spatial (preferably ~1-3 km) scales is suggested for current climate as for future projections. In the last decade, different activities report about significant improvement by the use of Regional Climate Models (RCMs) at kilometre-scales resolution, so-called convection-permitting (CP-RCMs), to dynamically downscale General Circulation Models (GCMs) or RCMs at lower resolutions information [1-6]. The characteristics defining such a strategy are to explicitly resolve convection by turning off the deep convection parameterizations and to run climate simulations at resolutions below 4 km with hourly outputs. The added value of kilometre-scale modelling is revealed by several publications [7-14], and also, there are further benefits such as e.g., a more accurate representation of interactions with complex topography and urban effects, which play a key role in forcing or triggering convection. The complex orographic context of the Alpine area, often affected by heavy precipitation events that are likely to be significantly impacted in the future, represents a promising hot-spot to investigate the benefits of CP-RCMs. An objective assessment of the summer precipitation over the Alpine space with a proper quantification of uncertainties is proposed in the following, supported by statistical analyses and metrics, addressing the impact of model temporal and spatial resolution on the actual values. The same approach is used to investigate the expected changes of the summer precipitation using the CP-RCMs climate projections and the results, although not presented here, are described in detail in the original publication.

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Data and method

Climate simulations run at different spatial scales (~12 km against ~3 km) and covering different 10 year-long periods following the evaluation experiment (on the time horizon 2000-2009 for evaluation initialized with ERA-Interim reanalysis) are presented. The simulations have been integrated with the COSMO-CLM (COnsortium for Small- Scale MOdeling in Climate Mode) model [15]. The choice for running 10 year-long simulations is adopted in some European projects and initiatives (e.g., H2020 EUCP, CORDEX-FPS convection) in order to save computational resources, although climate data on 10 years-long periods provide only preliminary indications and deserve further study on sufficiently long periods (e.g. 30 years-long) to identify climatologic trends. The domains are presented as "EUR-11" and "ALP-3": the simulations referring to the latter domain are nested into the previous one. High-resolution observational precipitation datasets available over different regions at daily and sub-daily scale are considered to evaluate the reliability of climate simulations for the evaluation experiment (EURO4M-APGD, GRIPHO and COMEPHORE). The characteristics of precipitation and extremes are investigated at hourly and daily scales as considering evaluation experiments with respect to observations. The indicators assumed for the analysis in hand are mean precipitation, wet-day/hour frequency, and wet-day/hour intensity, while the extreme precipitation events are investigated through the amount of daily and hourly precipitation above a fixed percentile (the 99th percentile is adopted for daily data while the 99.9th percentile for hourly data) computed from all data (wet and dry events). All indicators, first analysed in terms of spatial distributions through maps, are computed for simulated precipitation over 10-year long periods for summer season (JJA = June–July–August). Moreover, some metrics widely adopted for performance evaluation have been assessed as the root-mean-square error (RMSE) and the standard deviation (STD). Then, a more focused statistical analysis is performed considering the spatial cumulative distribution functions (CDF) and probability density functions (PDF). Moreover, in order to test the goodness-of-fit statistics, the Anderson-Darling test and the distribution added value (DAV) are assessed.

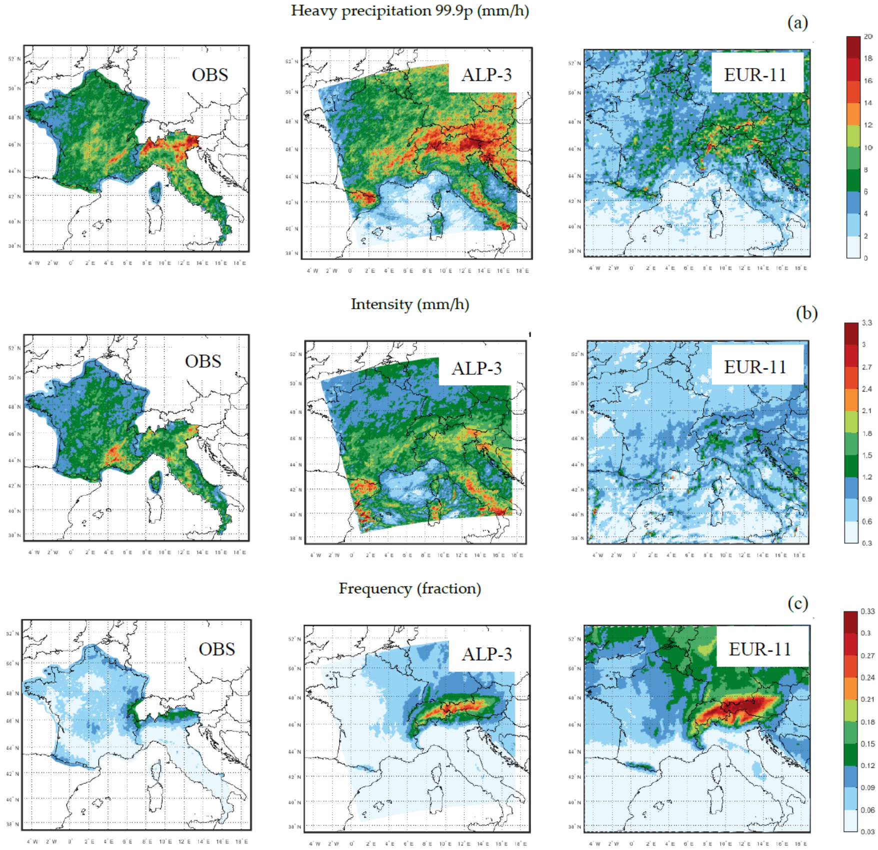

Figure 1:
Spatial distribution at hourly scale of heavy precipitation 99.9p (a), intensity, (b) and frequency, (c) for observations OBS, ALP-3, and EUR-11 (evaluation experiments) over summer (JJA) 2001-2005. For OBS, observations over France derived from COMPHORE dataset, and over Italy, derived from GRIPHO dataset are used.

Results

Figure 1 compares the spatial distributions at hourly scale of heavy precipitation (Figure 1a), intensity (Figure 1b) and frequency (Figure 1c), derived from the evaluation experiments ALP-3 and EUR-11, with respect to the corresponding plots carried out assuming the gridded datasets at sub-daily resolution (GRIPHO and COMPHORE) as reference observations. Due to the availability of hourly datasets, the simulation results plotted in Figure 1 are for the common period 2001-2005, shared by both evaluation experiments (i.e., 2000-2009) and sub-daily observation datasets (i.e., 1997-2005 for COMPHORE and 2001-2016 for GRIPHO). ALP-3 tends to produce more intense precipitation than its driving coarse resolution model EUR-11 (Figure 1b). Thus, the coarse-resolution RCM simulation underestimates heavy precipitation over high orography and lower ground (Figure 1a). Moreover, EUR-11 largely overestimates the wet-hour frequency (Figure 1c), especially over mountains, and intensity is strongly underestimated. In other words, the analysis highlights that the EUR-11 provides too light but very frequent precipitation compared to the observations, confirming the results of previous studies [2, 4]. The ALP-3 reduces such differences returning higher intensity and lower frequency of precipitation much closer to the observations than EUR-11. This analysis gives indication on *t*he differences between CP-RCM and RCM and on the improvements of the former with respect to the latter, particularly for the hourly-scale analyses and localized over mountains. The comparison addressed by the maps of Figure 1 is complemented by statistically comparing the spatial cumulative distribution functions (CDF) and probability density functions (PDF) related to the heavy precipitation 99.9p, calculated in summer from hourly observations, ALP-3 and EUR-11 models in Figure 2.

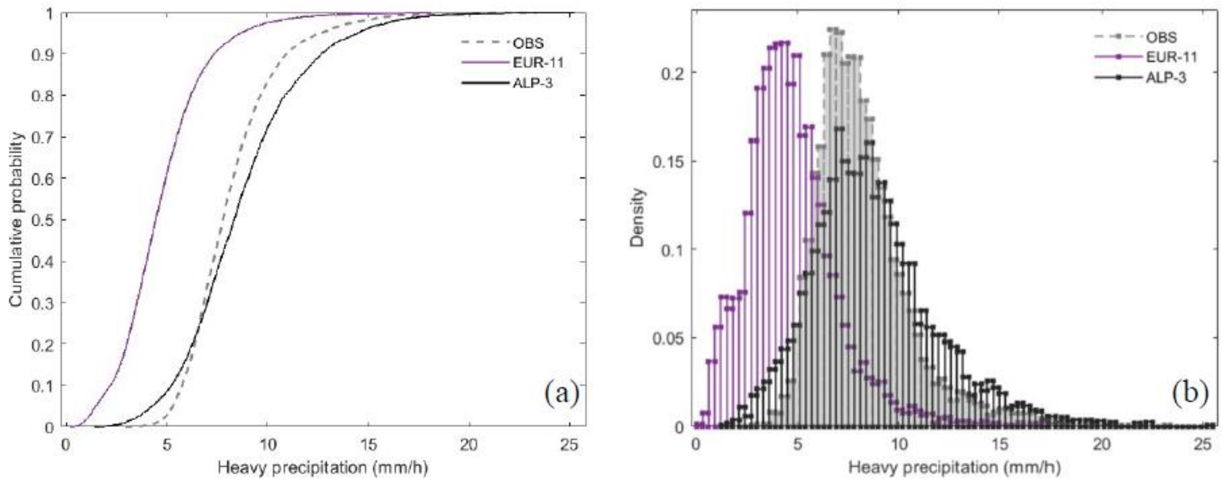

Figure 2

The empirical cumulative distribution functions (a) and probability density functions, (b) related to heavy precipitation 99.9p from hourly data. The observations are filled with a grey area.

To make the data comparable, the ALP-3 and EUR-11 simulations refer to a common domain (the one of observations) and are regridded to the EUR-11 grid [3, 5]. Figure 2a presents the empirical CDFs of heavy precipitation 99.9p, assessed in summer over the period 2001-2005 from observations (GRIPHO and COMPHORE), ALP-3 and EUR-11 simulations. For ease of interpretation these functions are differentiated to obtain the corresponding PDFs in Figure 2b. The ALP-3 distribution shows a very good agreement with the observed statistical distribution, except for slight underestimations for values of heavy precipitation 99.9p lower than 6 mm/h and overestimations for values of heavy precipitation 99.9p higher than 6 mm/h. In any case, the mean value of heavy precipitation 99.9p for ALP-3 distribution is very similar to the one of the observations as are the shapes of both distributions. This is due to a sort of compensation effect of CP-RCMs in which intense values are overrepresented and medium events underrepresented. The shift of EUR-11 distribution toward low values of heavy precipitation 99.9p confirms the underestimations of such distribution compared with the one of observations. Moreover, the mean value of heavy precipitation 99.9p for EUR-11 distribution differs of around 3 mm/h from the one of observations and the whole distribution of data is shifted towards low values of heavy precipitation 99.9p. The DAV highlights that the added value gained by the use of high resolution is 129.5%.

Conclusion

This work aims at contributing to the scientific activities currently ongoing in the climate community showing the limitations and benefits returned by running CP–RCMs. On one hand, the improvements of high-resolution simulations in spatial representation, heavy precipitation, frequency, and intensity of precipitation, are pronounced compared to coarser resolution counterparts at sub-daily scale. On the other hand, the climate change projections (exploited within the original work but not presented here) show very little difference, raising the question of whether the additional computational cost is justified. Further studies are needed to understand the actual benefits of CP-RCMs, and if they are due to a better resolution of topography or to the explicit simulation of convection. The proposed results underline, supported by an ad-hoc quantification of the uncertainties, that convection-resolving climate models are attractive tools to investigate the precipitation climate and its sensitivity to climate change, especially over a hot-spot area (Alpine space) affected by complex precipitation regimes as for current climate as for future projections.

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COSMO-CLM regional climate simulations in the Coordinated Regional Climate Downscaling Experiment (CORDEX) framework: a review

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Introduction

In the last decade, the Climate Limited-area Modelling (CLM) Community has contributed to the Coordinated Regional Climate Downscaling Experiment (CORDEX) with an extensive set of regional climate simulations. Using several versions of the COSMO-CLM community model, ERA-Interim reanalysis and eight Global Climate Models from phase 5 of the Coupled Model Intercomparison Project (CMIP5) were dynamically downscaled with horizontal grid spacings of 0.44° (~50 km), 0.22° (~25 km) and 0.11° (~12 km) over the CORDEX domains Europe, South Asia, East Asia, Australasia and Africa.

This major effort resulted in 80 regional climate simulations publicly available through the Earth System Grid Federation (ESGF) web portals for use in impact studies and climate scenario assessments. Here we review the production of these simulations and assess their results in terms of mean near-surface temperature and precipitation to aid the future design of the COSMO-CLM model simulations.

Method

We present COSMO-CLM simulations performed by the CLM-Community that are following the CORDEX framework (Giorgi et al. 2009; Gutowski et al. 2016), for the domains Europe, Africa, Australasia, East Asia and South Asia. We focus on the simulations that have performed an evaluation simulation driven by the ERA-Interim reanalysis and downscaled one or more of the GCMs CanESM2, CNRM-CM5, EC-EARTH, HadGEM2-ES, HadGEM-AO, MIROC5, MPI-ESM-LR or NorESM1-M. All simulations are evaluated against a number of global observation datasets, allowing for a fair comparison between the different domains. The main focus is on the performance of near-surface temperature and precipitation, and to allow an easy comparison of the model performance across domains, we summarize the spatial deviations of the climatological means by Taylor diagrams, which combine the spatial pattern correlation with the ratio of spatial variances.

Results

Figure 1 compares the model performance in terms of spatial variability for precipitation and temperature for the summer and winter seasons, between the five domains, displayed in Taylor diagrams for all the ERA-Interim driven simulations (12 in total). The COSMO-CLM simulations over Europe tend to have the best performance of the spatial variability, which is expected since most of the model development for COSMO-CLM is done on the European domain. When considering the different seasons and variables, it is not evident that increasing the horizontal resolution has a positive impact on model performance. In contrast, a clear improvement can be found for a newer model version, as seen for instance in the precipitation performance for Africa and Europe. Another element to notice from Figure 1 is that the individual model performance for the simulations for Africa and Europe is not so different, but the same cannot be said for East Asia and Australasia.

The model configurations for Africa and Europe only differ in terms of changing the tuning parameters, aerosol climatology, horizontal or vertical resolution (see Table S1 in the supplementary material of the original publication for an overview over the model configurations). The simulations for Australasia and East Asia differ more in their configurations, resulting in larger differences in the performance score shown by the Taylor diagram, especially seen for the precipitation. The AUS-44 is coupled to the Community Land Model CLM, and this simulation has a better DJF precipitation performance in terms of spatial pattern correlation, but underestimates the spatial variability. The configuration used for AUS-22 is closer to the standard COSMO-CLM configuration. Over East Asia, the EAS-22 simulation is using spectral nudging, which is not used in EAS-44, and this seems to also improve performance, in particular for summer monsoon precipitation. Note that the benefit of using spectral nudging has a strong dependency on the forcing data.

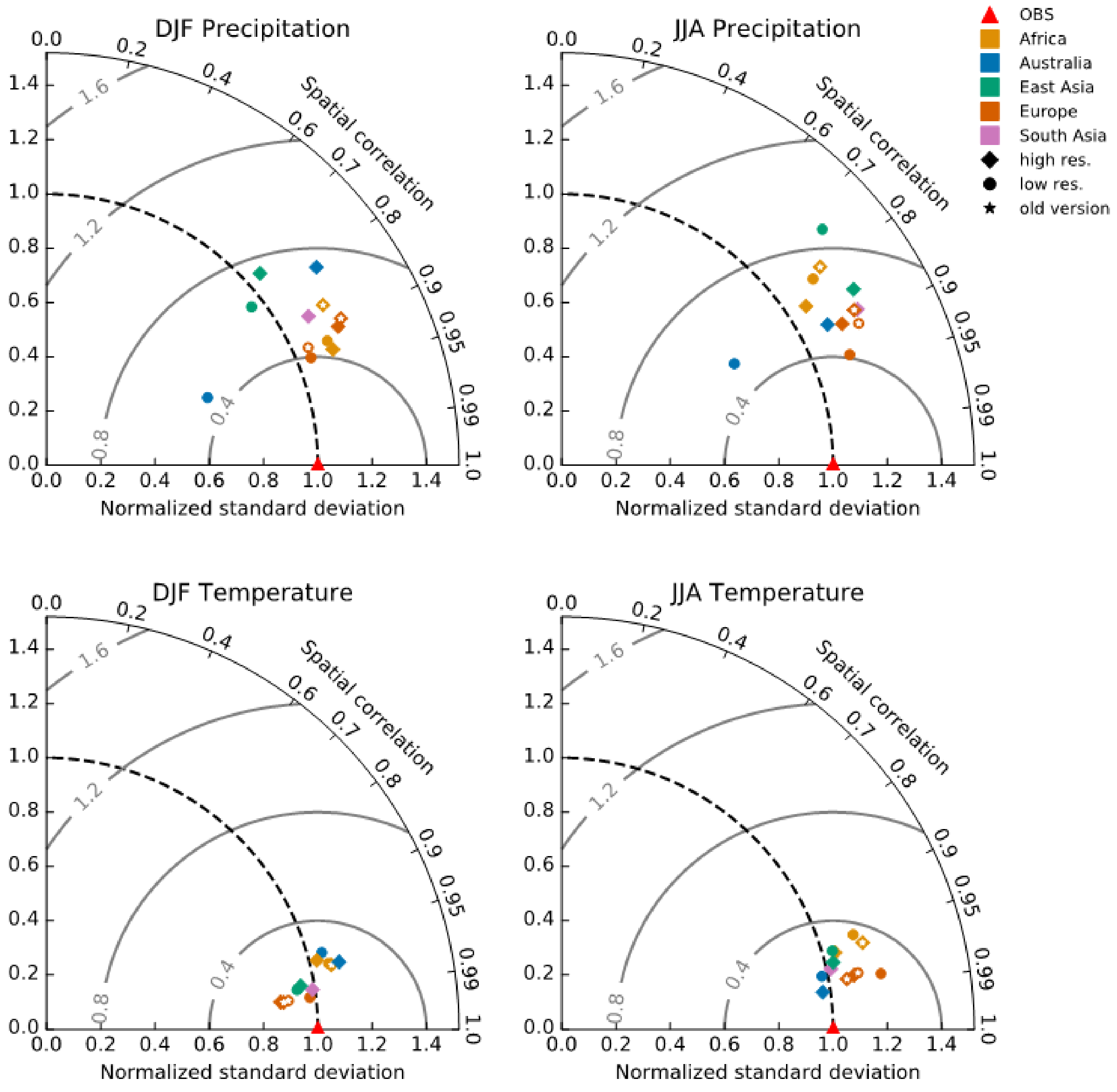

Figure 1: Spatial Taylor diagram exploring the model performance for JJA and DJF for precipitation and 2 m air temperature for each domain (labelled with colours) by considering the ERA-Interim-driven simulations. The diamonds are the 12 km or 25 km simulations, the circles are the 50 km simulations. The older model version is marked with a white star inside the symbols. The triangle is the mean of all observations.

Conclusion

During the decade of CORDEX, the COSMO-CLM results were influenced by several model upgrades, developments or bug fixes, and model tuning such as parameter testing and objective calibration, and all these advancements had an impact on the model performance. At the same time, as more computing power became available, modelling groups were able to run their model at a higher horizontal resolution, resulting in the CORDEX framework also recommending the RCMs to be run with a horizontal grid spacing of 25 km (12 km for Europe) instead of 50 km, which was initially suggested by Giorgi et al. (2009).

We have presented regional climate simulations performed with COSMO-CLM following the CORDEX framework (Giorgi et al., 2009). The results suggest that a domain-specific parameter tuning is beneficial, while increasing horizontal model resolution (from 50 to 25 or 12 km grid spacing) alone does not always improve the performance of the simulation. The COSMO-CLM performance depends on the driving data. This is generally more important than the dependence on horizontal resolution, model version and configuration. Our results emphasize the importance of performing regional climate projections in a coordinated way, where guidance from both the global (GCM) and regional (RCM) climate modelling communities is needed to increase the reliability of the GCM-RCM modelling chain.

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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

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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.

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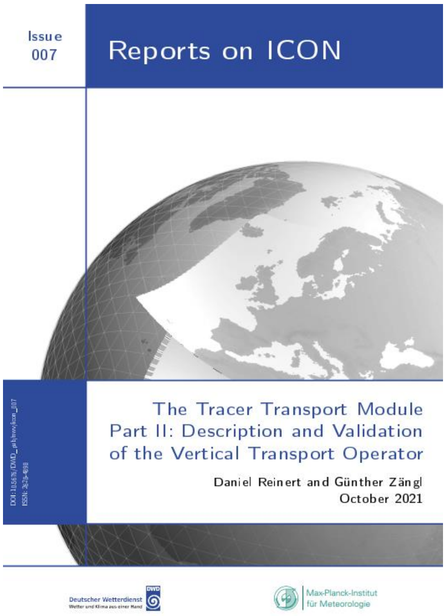
Beihang University

(https://www.china-admissions.com/beihang-university/)

Contact: *Xiaoyan Liu*



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Upcoming events

2022

January 24 - 27: EURO-CORDEX General Assembly, virtual meeting

March 07 - 11: ICCARUS 2022, virtual meeting

March 21-25: D-A-CH Meteorology Conference, Leipzig, Germany

April 03 - 08: EGU General Assembly 2022, Vienna, Austria and online

September 05 - 09: EMS Annual Meeting, University of Bonn, Germany

September 07 - 09: Convection-Permitting Climate Modelling Workshop, Buenos Aires and online

September 12 - 16: COSMO General Meeting, Greece, t.b.c.

September 19 - 23: CLM Assembly, Berlin, Germany or virtual meeting

2023

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

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