Climate Limited-area Modelling Community

January 2025

Newsletter

No. 24

Content

See YOU at the

ICCARUS 2025

10 – 14 March 2025

Offenbach, Germany

Dear Colleagues,

Welcome to the 24th CLM Community Newsletter.

We wish you a Happy New Year and all the best for 2025!

With the first recommended release and configuration of ICON-CLM in 2024, we have truly achieved a great goal. It ensures that community members will have a state-of-the-art modelling system for their work and research in the future, and once again demonstrates that together we can achieve much more than any of us could do alone. Thank you to everyone who has contributed to the development and testing over the last few years.

The new modelling system is already used in production. The downscaling of global CMIP6 simulations has started in the UDAG project and several other intuitions of the community. Many historical and scenario simulations will be produced during the year.

This issue of the newsletter contains an interview with Daniel Rieger from DWD, a short report on the new naming conventions for climate simulations in the CLM community, some information on the release of the FPS convection data and a contribution about the first recommended version and configuration for ICON-CLM. We also look back at the last CLM Community Assembly in Oberpfaffenhofen and give an outlook on ICCARUS 2025. The research notes are provided by Günther Heinemann from the University of Trier on the evaluation of CCLM for the Arctic during MOSAiC and by Sven Karsten from the Leibnitz Institute for Baltic Sea Research Warnemünde on a flux coupling approach on an exchange grid for the IOW Earth System Model of the Baltic Sea region.

Enjoy reading!

Five questions to…. Daniel Rieger

Deutscher Wetterdienst

Daniel Rieger works as scientists in the Numerical Models group of DWD's Research and Development department. He studied meteorology in Karlsruhe from 2006 to 2012.

Already during his PhD at KIT from 2013 to 2016 , he was a user and developer of the ICON(-ART) model. In 2017, Daniel started a new position at DWD which, among several other tasks, included leading a project to support and organize the transition from the COSMO to the ICON model for DWD's partner weather services and the CLM community. This project was successfully concluded in 2022. With over 10 years of experience with the ICON model, Daniel is also one of the ICON-NWP gatekeepers. His scientific focus is on aerosols and their interaction with radiation and clouds.

1. *Daniel, you work at DWD in the Research and Development Department. Can you please tell us something about DWD in general, the work of your department and your tasks there?*

Deutscher Wetterdienst (DWD) is Germany's national meteorological service. As such, DWD provides guidance for aeronautical as well as maritime traffic, official severe weather warnings for the general public but also climate monitoring and projecting climate change. The task of the Research and Development department is the continued development and the application of the numerical weather prediction (NWP). This includes data assimilation, model development, ensemble generation and verification. Thus, our research tasks are targeted at application in NWP.
Part of my tasks is to monitor and assess the developments of our partners doing research using our numerical model ICON and coordinate these with our research efforts. These partners are the COSMO national weather services, the CLM Community as well as the academic sector. I am part of the organization teams of the ICON/COSMO/CLM/ART User Seminar (ICCARUS) and the ICON Training Course. Both of these events are targeted to foster the collaboration between DWD and researchers at these partner institutions.
Being one of the ICON-NWP gatekeepers is one aspect of the assessment of partner developments.
Last but not least, my scientific focus is on aerosols and radiation. Part of my work at DWD was to introduce the radiation scheme ecRad into ICON and to synchronize our ecRad developments with ECMWF.

2. *You are the COSMO contact person in the CLM Community. What is your role in this context?*

There has always been a close collaboration between the COSMO national weather services and the CLM Community in development and scientific exchange of the limited area model COSMO. With the COSMO to ICON transition project C2I that I was leading, this collaboration continued for the ICON model with these two communities being the main users of ICON's limited area-mode. Since I am part of the majority of meetings of both communities, I identify topics where a collaboration may result in a mutual benefit for scientists in both communities. In such a case, I try to set up the contacts. Furthermore, I am also the CLM Community's first contact person in DWD's Research & Development department. This means that community members can contact me with their scientific and technical questions on the ICON model. Since I am one the ICON-NWP gatekeepers, I also provide support in planning and reviewing code contributions from the CLM Community.

3. *You were involved in the development of the new community interface in ICON (ComIn). It provides many opportunities for users, especially for coupling of external components. Can you please explain briefly how the interface works and what opportunities it opens up?*

With ICON being a core component of the German national earth system modelling strategy and being internationally recognized as one of the leading NWP models, the number of ICON users has grown vastly over the last years. Many of these users want to extent the model for their applications, e.g. air quality or hydrological models. ComIn aims to provide an interface to connect such applications ('third party plugins') to ICON by organizing data exchange and simulation events. The third-party plugin can get access to all global fields of ICON and tell ICON at which entry point to call certain functions of the third-party plugin.
A specific highlights of ComIn is certainly these interfaces are not only provided for Fortran, but also for C and Python.

The latter allows for a completely new range of applications, for example rapid prototyping in ICON without compilation or making use of the vast amount of available Python libraries. For example, I created a python plugin that performs a grid point search utilizing SciPy's KDTree. Another example is machine learning where Python libraries are nowadays defacto standard. ComIn can also be combined with the YAC coupler, for example to run third party plugins on a different grid than ICON.
Finally, we have extensive documentation, user guide and many examples being part of the whole ComIn package which should ease the usage.

4. *You are also the main organizer of the ICON – COSMO – CLM – ART User Seminar. How do you see the role of ICCARUS in bringing the different ICON user communities together in the coming years?*

For the CLM Community, the COSMO national weather services and for large parts of DWD's academic partners, ICCARUS was already very well established as the exchange platform around the COSMO model. In recent years, we have seen a steady increase in the number of ICON presentations. The ICON community on the other hand lacked such a large scientific conference targeting only at ICON as well as the associated working group meetings. Thus, we reached out to the ICON partners inviting them to join ICCARUS for key-note presentations and we pushed towards opening up the COSMO/CLM working groups to the wider ICON community.
We have surely not reached a final point in this transition process, but I think that all the ingredients are prepared now, such that ICCARUS can play a similar key role in the whole ICON community. Especially the working group meetings allowing for extensive discussions should be able to bring all the ICON scientists together in their efforts of better understanding and forecasting the earth system.

5. *In your opinion, what are the decisive foundations for a successful ICON Community?*

To answer this question, I think it makes perfectly sense to take one step back and ask ourselves 'What was the foundation of the successful COSMO Community'? In my opinion, the COSMO Community (NWP, CLM, Academia, …) can answer this question with quite some self-confidence.

Four ingredients come into my mind:

- *Free Distribution*: The COSMO model was free for scientific usage.
- *Documentation:* The model was provided with regularly updated, extensive documentation of the physics and a user guide. For new versions, a thorough list of changes was created.
- *Data:* The CLM community provided easy access to input data needed for research in the caf file format on several platforms. The WebPep made it easy to start simulations for a new domain.
- *Support infrastructure*: There were dedicated mailing lists for COSMO and the Redmine for CLM where users could post their questions to the more experienced community members. In combination with the starter package, this eased the first steps tremendously.

The success of a large cooperating ICON community will be strongly coupled to these aspects. While the recent open source release put us into a good position for the first point mentioned, I think there is some space left for improvements in the other aspects and I would like to encourage every ICON community member to contribute to this endeavor.

Thank you very much for the interview!

CORDEX activities

Model data from the CORDEX-FPS-Convection

By Susanne Brienen (Deutscher Wetterdienst)

The "Flagship Pilot Study (FPS) on Convective phenomena at high resolution over Europe and the Mediterranean" (https://cordex.org/strategic-activities/flagship-pilot-studies/endorsed-cordex-flagship-pilote-studies/europe-mediterranean-convective-phenomena-at-high-resolution-over-europe-and-the-mediterranean/) was a CORDEX initiative that ran mainly in the period 2016-2020, bringing together colleagues from many different institutions in Europe with the interest of producing a first ensemble of convection-allowing climate simulations with a grid spacing of less than 4 km for Central Europe. A common framework was established and a large number of simulations with different regional climate models were performed and analysed. The CLM Community also participated with COSMO-CLM and other RCMs.

Since a few months some of the model data are available for download from the ESGF, see e.g. https://esgf-metagrid.cloud.dkrz.de/search under the project ID "CORDEX-FPSCONV". A data descriptor paper with all related meta-information is in preparation.

Naming Conventions for Climate Simulations in the CLM Community

By Christian Steger (Deutscher Wetterdienst)

The production of CORDEX simulations with CMIP6 boundary conditions has started. It was therefore necessary to update the "Naming Convention Document" for simulations produced by the CLM Community and to adapt it to the CORDEX-CMIP6 conventions. In addition to the updates for CORDEX-CMIP6, the document now includes the necessary information for ICON-CLM, in addition to the COSMO-CLM information that was already part of the previous version of the document.
The document contains information about the elements to be used in the path and file names and in the attributes that are part of the metadata in the netCDF files. This information is necessary for the standardisation process (CMOR) that the data must undergo before publication.
For the CMIP5 downscaling, it was already decided that the information about the institutions performing the simulations within CORDEX should be visible in the CORDEX directory structure and file names, as these credits are important for the institutions to defend the use of funding.
People from different institutions contributed to the production of the document and helped with their expertise to identify and correct errors and to make the document consistent and coherent. Many thanks to all!
The updated version of the document is available on the CLM Community portal in the section "Community" -> "Terms and Conditions":
https://www.clm-community.eu/community/terms-and-conditions/

Review CLM Community Assembly 2024

By Susanne Brienen (Deutscher Wetterdienst)

The 2024 CLM Community Meeting took place from 22-25 October at the German Aerospace Centre (DLR) in Oberpfaffenhofen near Munich, Germany.
There was a total of 23 talks in 6 oral sessions and a very active poster session with 17 posters. As usual, the working groups also took the opportunity to share their latest results and ideas in dedicated working group sessions. The invited lecture was given by Dr. Alexandra Schneider, Deputy Director of the Institute of Epidemiology and Head of the Research Group "Environmental Risks" at the Helmholtz Zentrum München. She provided many interesting insights into the impact of climate and climate change, particularly in relation to heat, on the human body and health.
One of the highlights of the Community Meeting on Friday was the adoption of the first recommended version and configuration of the ICON-CLM, following the great work of the COPAT2 initiative of WG EVAL - see related article in this issue of the Newsletter. Other aspects discussed at this meeting, such as an update of the COSMO-CLM 6.0 recommendations and a possible contribution to CORDEX-CORE-2, can be assessed in detail in the minutes (and related material), which can be found here: https://www.clm-ommunity.eu/uploads/media/material/b3baa81b-b51c-499d-b201-7613b436e597/20241025_CLM-CommunityMeeting_Minutes.pdf (or follow the steps from the programme at https://www.clm-community.eu/events/clm-community-assembly-2024/programme, clicking on the "CLM Community Meeting" block and then on "Session Material" in the new window). You can also have a look at the highlights of the different working groups, "20251025_CLMcomReportWGs.pdf", or directly at the minutes of the different working group meetings.
The social programme included a very interesting guided tour through the city centre of Munich and two joint dinner reservations, with plenty of opportunity for chatting and networking. Many thanks to the DLR team for organizing a very pleasant meeting!
As usual, abstracts, presentations and working group materials are available on the CLM community website: https://www.clm-community.eu/events/clm-community-assembly-2024/
The 20th CLM Community Meeting is planned to take place in September 2025 at the Wegener Centre in Graz, Austria. We are looking forward to it!

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First recommended version and configuration for ICON-CLM CLM

By Christian Steger (Deutscher Wetterdienst)

On 25 October 2024, the CLM Community members decided at the community meeting in Oberpfaffenhofen that the ICON release icon-2024.07 and the configuration C2I301c will be the first recommended ver-sion and configuration for ICON-CLM in the CLM Community. The final decision is the result of a long devel-opment and testing process in which many community members have participated over the last few years.

The development of ICON started more than 20 years ago at DWD and MPI-M. From the beginning, the goal was to develop a unified modelling framework for all temporal and spatial scales. On 20 January 2015, ICON replaced GME (Global Model) for operational global weather prediction at DWD. In 2016 and 2021, ICON replaced the COSMO model for high-resolution NWP for the European and German domain at DWD.

The foreseeable end of the COSMO model also led to the need to develop a new ICON-based regional climate model for the CLM Community. Activities started already in 2014, when the ICON project group was established to coordinate the ICON-CLM development. It took several years before a first version of ICON-CLM was available (Pham et al., 2021). This was the basis for further additions to the climate-limited area mode of ICON and, in particular, for extensive testing of an optimised setup for the European domain.

These tests were carried out by members of the Working Group EVAL as part of COPAT2 (Coordinated Parameter Testing - Phase 2) project. The testing procedure included many single and combined parameter tests, including new external parameters, transient aerosols and an urban parameterisation to better represent cities. The search for an optimal configuration was aided by the use of a linear meta-model to estimate the best values for the tuning parameters. Taking all aspects into account, the C2I301c configuration gave the best results and was proposed as the first recommended configuration for ICON-CLM for the European domain.

The necessary changes and adjustments into the ICON code could be brought back to the main version in time for the open source release of ICON in July 2024. As a result, this open source release (icon-2024.07) is the first recommended version for ICON-CLM. The code is available from the ICON website (www.icon-model.org).

The development of a new regional climate model based on ICON and the release of a recommended version and configuration is a very big and important step for the CLM community. It provides community members with access to a new and well-tested regional climate model for their research and ensures the availability of a state-of-the-art modelling framework that is actively developed by many leading institutions in NWP and climate research in Europe for the future.

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

ICON Logo (Source: DWD)

Outlook ICCARUS 2025

By Christian Steger (Deutscher Wetterdienst)

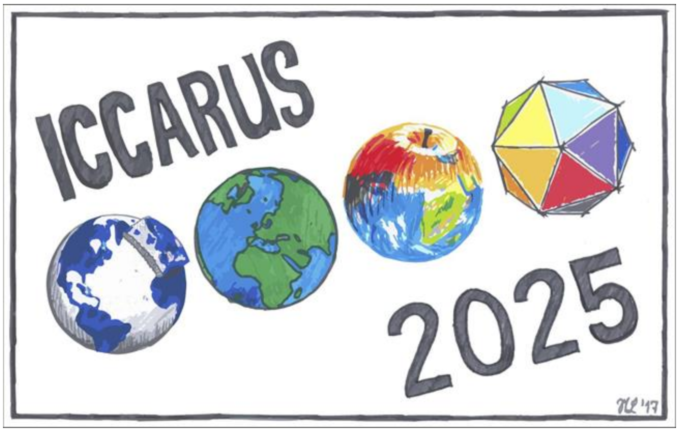
The ICCARUS (ICON/COSMO/CLM/ART User Seminar) 2025 will take place from 10 to 14 March 2025 at the DWD headquarters in Offenbach, Germany. The conference will be largely organised as a hybrid meeting. Only the poster sessions will be offered for on-site participants only.

ICCARUS brings together developers and users of the non-hydrostatic COSMO and ICON models, which are used in numerical weather prediction as well as in climate simulations and modelling of air quality and its feedback to the atmosphere. The seminar will provide a forum for COSMO and ICON groups to exchange information on model development, physics parameterisation, data assimilation, ensemble generation, verification and applications.

The first three days, from 10 to 12 March, are dedicated to plenary sessions. Plenary sessions can be attended online or in person, poster sessions will be held in person only. This will be followed by face-to-face or hybrid working group meetings on Thursday and Friday, 13 and 14 March. The working group meetings will deal with overarching topics like ICON Infrastructure, Earth System Modelling and Soil, Vegetation and Land Surface and try to bring people from the different communities together.

The programme will be available in early February. It is not yet known which sessions will be offered. However, past experience suggests that there will amongst others be sessions on data assimilation, case studies, clouds and radiation, boundary layer and turbulence, aerosol and chemistry.

The four keynote talks and the invited talk are already known. Günther Zängl (DWD) will present the latest developments and plans for NWP. Ali Hoshyaripour (KIT) will give an update on ICON-ART and present news from the ICON steering committee (ICON-C5). The Warmworld project and porting ICON code to C++ will be the subject of a talk by Claudia Frauen from DKRZ and Xavier Lapillonne (MeteoSwiss) will present the Exclaim project. The invited talk will be given by Charlotte Debus from KIT on AI models.
More information on ICCARUS 2025 is available at www.dwd.de/iccarus.



ICCARUS Logo (Source: N. Leps (DWD))

Evaluation of CCLM for the Arctic during MOSAiC

Günther Heinemann (University of Trier), Lukas Schefczyk (State Environment Agency Rhineland-Palatinate), Rolf Zentek (German Meteorological Service)

The ship-based experiment MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate) was carried out during a full year (2019/2020) in the Arctic and yielded an excellent data set for the atmospheric boundary layer (ABL), which can be used to test the parameterizations of ocean/sea-ice/atmosphere interaction processes in regional climate models (RCMs) for the Arctic. Parameterization of the stable boundary layer (SBL) and sub-grid processes such as leads are major challenges for atmospheric models in polar regions. Fig.1b shows an example of the distribution of leads for 23 January 2020. Leads are ubiquitous in the inner pack ice, and some leads extend over distances of 200 km and more in length, but their width is on a kilometer scale or less. In most state-of-the-art RCMs, leads are not realistically represented. Sea ice is considered as a mean concentration over a model grid box, and surface fluxes are computed according to the fractions of water and ice. Most uncoupled RCMs assume open water for the water fraction, which is unrealistic during winter, where leads and polynyas are almost totally covered with thin ice.

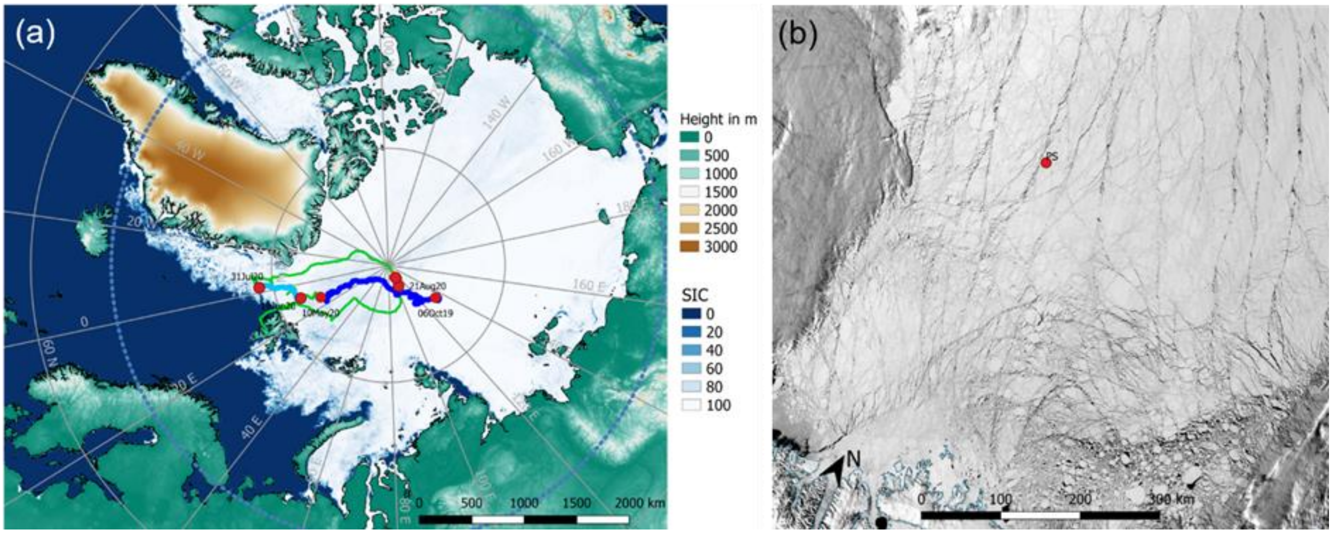


Figure 1: *(a) CCLM model domain with 14 km resolution (Arctic circle as blue dashed line) with topography and AMSR2 sea ice concentration for 23 April 2020. The green line shows the entire track of Polarstern, and the three drift phases are marked in blue, light blue, and orange. Dates of ship positions at the start and end of the drift phases are marked. (b) MODIS VIS image with Polarstern position (PS) on 23 April 2020.*

The main objective of the project MISLAM (**M**odelling the **i**mpact of **s**ea-ice **l**eads on the **A**BL during **M**OSAiC, funded by BMBF grant 03F0887A) was to investigate the impact of sea-ice leads on the atmospheric boundary layer and to develop methods to include these processes in RCMs. In the MISLAM project, simulations were performed using the CCLM adapted for polar conditions with 14 km resolution for the whole Arctic, with 5 km resolution for the complete area of the MOSAiC drift and with 1 km resolution for sub-areas of the drift. For the present study, we focus on runs with 14 km resolution (Fig.1a) for the winter period (Nov. 2019-April 2020). CCLM is used in a forecast mode (nested in ERA5) with different configurations of sea ice data. These include the standard sea ice concentration (SIC) from passive microwave data with around 6 km resolution (AMSR run) and sea ice data from Moderate Resolution Imaging Spectroradiometer (MODIS) thermal infrared data with about 1 km resolution (MOD run). The adaptions of CCLM to polar conditions include the implementation of a two-layer sea ice model (sea ice and snow layer) and a tile approach for sea ice (Heinemann et al. 2022). The tile approach has a parameterization of the subgrid-scale ice thickness (thin ice in leads and polynyas), a parameterization of the sea ice form drag and parameterizations for the roughness length of heat. The roughness length and snow layer depth for thick ice depends on the ice thickness. The Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS) ice thickness was taken for the grid-scale sea ice, and the sub-grid thin ice thickness was computed by thermodynamic growth during the daily initialization of the sea ice model.

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The sea ice model includes parameterizations for the albedo, penetration of solar radiation into the snow and ice layers, and non-linear temperature gradients in ice and snow layers. Other adaptions were necessary for the SBL, e.g. a variable asymptotic mixing length depending on turbulent kinetic energy (TKE) and stability as well as lowering the minimum value of the diffusion coefficients (Heinemann et al. 2022).

CCLM simulations showed a good agreement with the near-surface measurements (Heinemann et al. 2022). The reference run using AMSR SIC had a relatively large negative bias, which was partly caused by a too large ice thickness used by CCLM for November and December 2019 (Fig.2a). The consideration of sea ice leads in the sub-grid parameterization in CCLM yields improved results for the near-surface temperature. Both runs showed a good representation of the daily temparature amplitude. ERA5 data showed a large warm bias of about 2.5°C and a large underestimation of the temperature variability. One main reason is that ERA5 used sea ice with fixed ice thickness and without a snow layer.

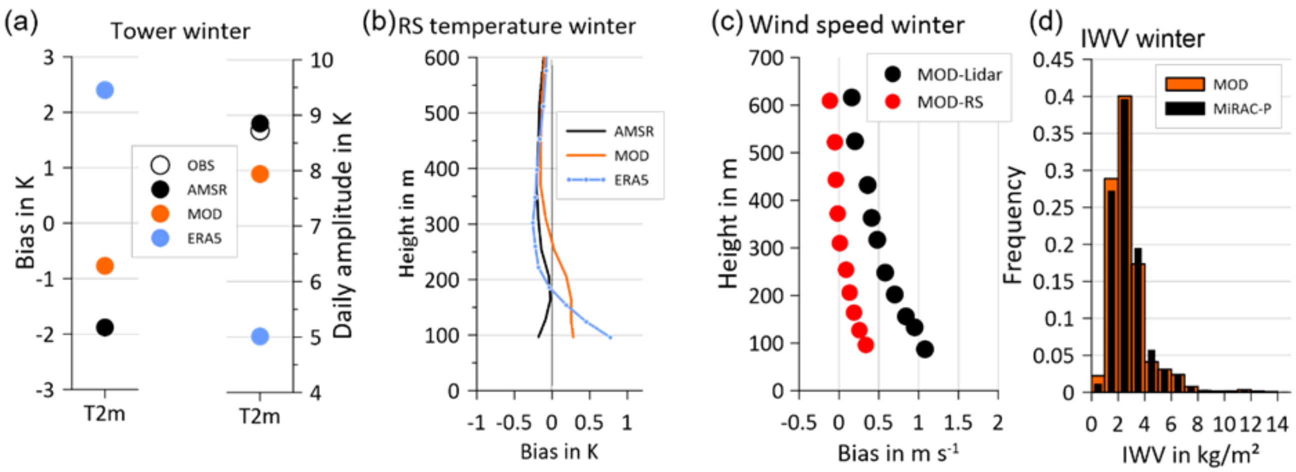

***Figure 1:** CCLM evaluation (AMSR: reference run with AMSR SIC, MOD: run with sea ice leads from MODIS) against different MOSAiC data sets for the winter period (1 h values). (a) 2m-temperature at the tower at the ice camp MetCity (bias and daily temperature amplitude). (b) Temperature for the 100 to 600m against radiosondes. (c) Wind speed of the MOD run against radiosondes and wind lidar data. (d) Frequency distributions of integrated water vapour from MiRAC-P and the MOD run. Results for ERA5 data are shown in (a) and (b).*

The model was evaluated using radiosonde data and data of different profiling systems (Heinemann et al. 2023). The comparison with radiosonde data (only above about 100 m) showed very good agreement for temperature, humidity, and wind. A cold bias was present in the ABL for the AMSR run, while the MOD run showed a slight warm bias (Fig.2b). The effects of different sea ice parameterizations were limited to heights below 300 m. High-resolution lidar wind profiles as well as temperature and integrated water vapor (IWV) data from microwave radiometers were used for the comparison with CCLM. The comparison with Lidar wind profiles showed a slight overestimation of the wind speed by CCLM of up to about 1 m/s (Fig.2c), while the comparison to radiosonde wind data was even smaller. Comparisons with IWV and temperature data of microwave radiometers showed very good agreement (Fig.2d). Overall, the results of the project show that the parameterization of sea ice, particularly the consideration of leads, is of utmost importance for the representation of the ABL in RCMs in the Arctic.

Reference:

Heinemann, G., Schefczyk, L., Willmes, S., Shupe, M., 2022: Evaluation of simulations of near-surface variables using the regional climate model CCLM for the MOSAiC winter period. Elem. Sci. Anth., 10 (1). DOI: 10.1525/elementa.2022.00033.

Heinemann, G., Schefczyk, L., Zentek, R., Brooks, I., Dahlke, S., Walbröl, A., 2023: Evaluation of vertical profiles and atmospheric boundary layer structure using the regional climate model CCLM during MOSAiC. Meteorology 2, 257–275, doi: 10.3390/meteorology2020016.

Flux coupling approach on an exchange grid for the IOW Earth System Model (version 1.04.00) of the Baltic Sea region

Sven Karsten[1], Hagen Radtke[1], Matthias Gröger[1], Ha T. M. Ho-Hagemann[2], Hossein Mashayekh[1], Thomas Neumann[1], and H. E. Markus Meier[1]

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Geoscientific Model Development Discussions 2023 (2023): 1-24. https://gmd.copernicus.org/articles/17/1689/2024/

This article introduces the development of a high-resolution Earth System Model (ESM) tailored to the Baltic Sea region. Unlike conventional methods, this model incorporates a technical component known as the flux calculator, which computes fluxes between model components using a shared exchange grid. This technique ensures the conservation of exchanged quantities, provides local consistency in flux handling, and facilitates straightforward component interchangeability (see Figure 1).

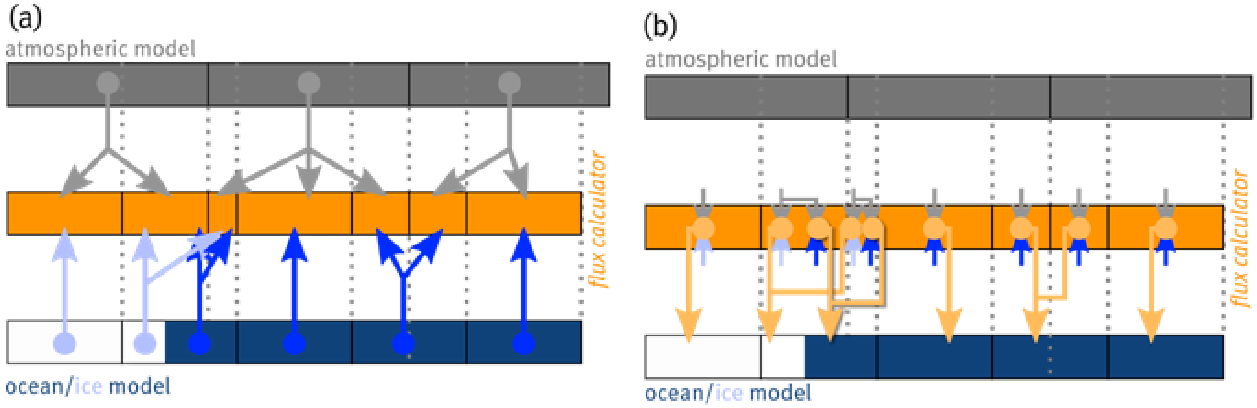

***Figure 1 (a):** Coupling the models via the exchange grid and the flux calculator.*

Panel (a): State variables, calculated in the respective models (marked by the filled circles), are communicated to the flux calculator (as visualized by the arrows) without averaging. Panel (b): Fluxes are calculated on the exchange grid and subsequently communicated to the bottom model.

The primary aim of the model is to downscale global reanalysis or climate model data for the Baltic Sea region, addressing the limitations of global model grids, which are often too coarse to resolve regional dynamics effectively. The ESM integrates the Modular Ocean Model 5 (MOM5) for ocean dynamics and the COSMO model in Climate Mode (CCLM, version 5.0_clm3) for atmospheric simulations. The bidirectional coupling between the ocean and atmosphere allows for realistic air-sea feedbacks, surpassing the performance of uncoupled models typically employed under the EURO-CORDEX protocol. Additionally, to address marine environmental issues such as eutrophication and oxygen depletion, the ocean model incorporates the marine biogeochemistry model ERGOM, configured specifically for the hydrographic conditions of the Baltic Sea.

The model's versatility allows it to address various scientific questions, including climate sensitivity experiments, reconstructions of ocean dynamics, investigations of past climates and natural variability, and studies of ocean-atmosphere interactions. This capability supports attribution experiments aimed at linking observed changes to their mechanistic causes, enhancing the understanding of natural processes.

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The capabilities of the developed framework are demonstrated through simulations based on various exchange grid configurations. The most intuitive option for the exchange grid is the one formed by the intersections of the grids of the models involved, referred to as the intersection grid. However, two apparent alternative exchange grids can then be either the atmospheric model grid or the ocean model grid itself. Typically, in a coupled model setup, the atmospheric grid has a coarser resolution than the oceanic grid. As a result, these two alternative exchange grids can differ significantly from each other and from the intersection grid. Regardless, both alternatives inherently possess a lower resolution compared to the intersection-type exchange grid.

When the atmospheric model grid was used as the exchange grid, inconsistencies were observed at boundaries between different surface types (e.g., ice-water or water-land), leading to model instability by the second year of simulation (see Figure 2). This was attributed to evaporation fluxes being calculated on the coarse atmospheric grid, causing errors at ice-covered ocean cells near ice-free regions. While future updates to CCLM version 6.0 or the ICON model may address this issue, it highlights limitations of this approach in the current configuration.

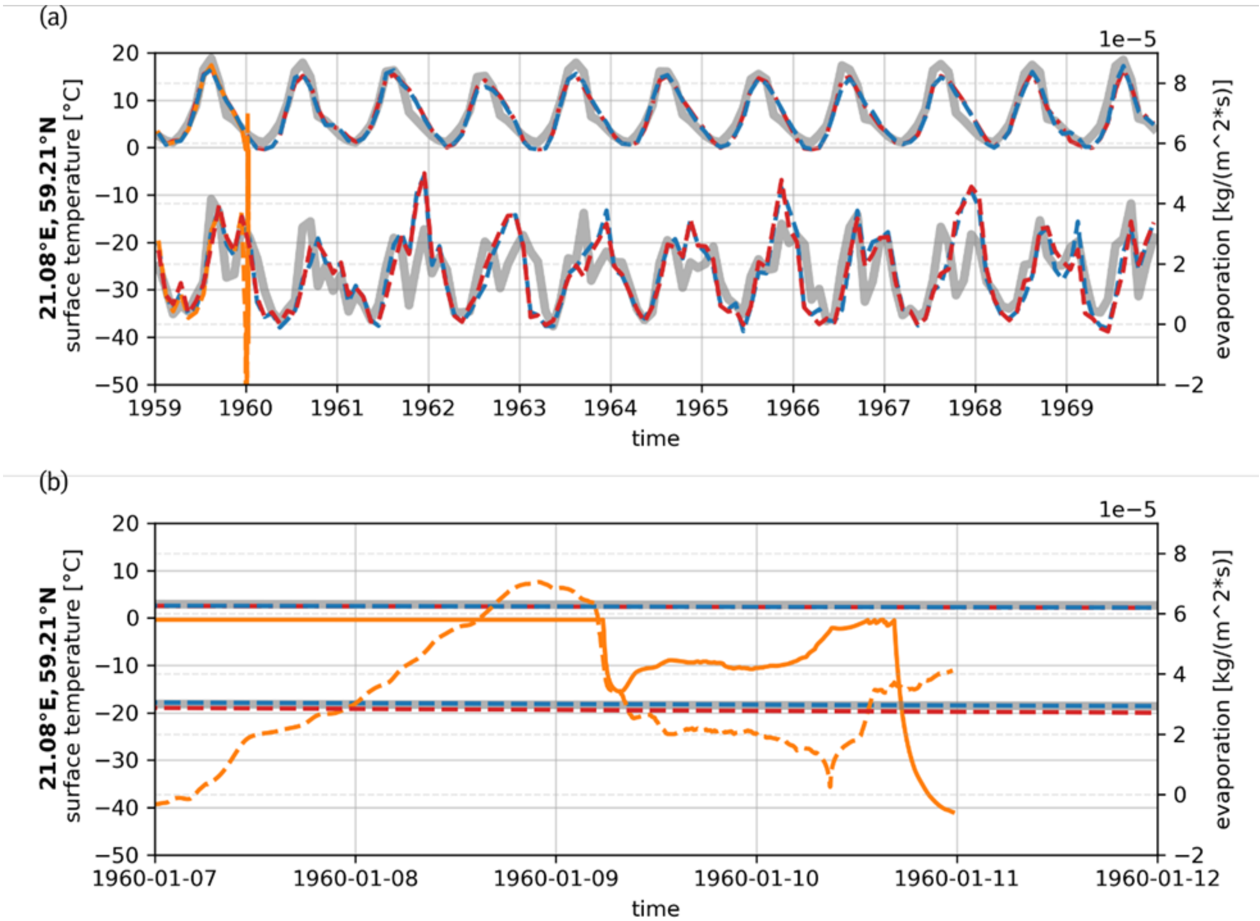

Figure 2: *Time series of the ocean's surface temperature and evaporation flux at 21.08 E and 59.20 N. The colours represent the different exchange grid types, where blue stands for the intersection grid, red for the ocean model's grid and orange for the atmospheric grid. The light grey curves depict the ERA5 reference data. The upper curves in the upper panel (a) account for the surface temperature (left y-axis) whereas the lower curves represent the evaporation (right y-axis). The lower panel (b) shows the time evolution when the model using the atmospheric grid gets instable. The solid orange curve shows the surface temperature (left y-axis) simulated with the atmospheric exchange grid. The dashed orange line depicts the corresponding evaporation flux (right y-axis).*

By contrast, the other configurations, namely the intersection grid and the ocean model grid, maintained stability throughout the 1959-1999 integration period (see Figure 2). Seasonal mean sea surface temperatures (SSTs) from these configurations showed minimal differences, but greater discrepancies were noted in the 95th percentile SSTs, with the spatial distribution of these differences tied to inconsistencies in grid mapping when using the oceanic exchange grid. The intersection grid configuration naturally avoided these issues, ensuring consistency. Whether such differences influence the representation of extreme events remains an open question for future research.

Using the intersection grid as the exchange grid provides a robust, consistent framework for coupling in climate simulations. For the Baltic Sea setup examined, this approach demonstrated superior consistency compared to the standard practice of flux calculation on the atmospheric grid. While mean SSTs were comparable to those from fluxes calculated on the oceanic grid, the differences in extreme SSTs warrant further investigation to assess their impact on simulating extreme events.

In conclusion, the presented framework offers a flexible, efficient coupling methodology for integrating diverse Earth system components, paving the way for robust dynamical downscaling of global climate models to the Baltic Sea region. This advancement holds potential for addressing a wide array of scientific and environmental challenges in regional climate modelling.

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Recent publications

2020

Kranenburg, W., M. Tiessen, J. Veenstra, R. de Graaff, R. Uittenbogaard, D. Bouffard, G. Sakindi, A. Umutoni, J. Van de Walle, W. Thiery, N. van Lipzig (2020): 3D-modelling of Lake Kivu: Horizontal and vertical flow and temperature structure under spatially variable atmospheric forcing. J. of Great Lakes Research, 46 (4) 947-960, doi: https://doi.org/10.1016/j.jglr.2020.05.012

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Mottram, R., N. Hansen, C. Kittel, J.M. van Wessem, C. Agosta, C. Amory, F. Boberg, W.J. van de Berg, X. Fettweis, A. Gossart, N.P.M. van Lipzig, E. van Meijgaard, A. Orr, T. Phillips, S. Webster, S.B. Simonsen, N. Souverijns (2021): What is the surface mass balance of Antarctica? An intercomparison of regional climate model estimates. The Cryosphere, 15 (8), 3751–3784, 2021, doi: https://doi.org/10.5194/tc-15-3751-2021

Van de Vyver, H., B. Van Schaeybroeck, R. De Troch, L. De Cruz, R. Hamdi, C. Villanueva-Birriel, P. Marbaix,J.-P. van Ypersele, H. Wouters, S. Vanden Broucke, N.P.M. van Lipzig, S. Doutreloup, C. Wyard, C. Scholzen, X. Fettweis, S. Caluwaerts, P. Termonia (2021): Evaluation Framework for Subdaily Rainfall Extremes Simulated by Regional Climate Models. J. of Applied Meteorology and Climatology, 60 (10), 1423-1442. doi: 10.1175/JAMC-D-21-0004.1

Van de Walle, J., W. Thiery, R. Brogli, O. Martius, J. Zscheischler, N.P.M. van Lipzig (2021): Future intensification of precipitation and wind gust associated thunderstorms over Lake Victoria. Weather and Climate Extremes, 34, Art.No. 100391. doi: 10.1016/j.wace.2021.100391

Van de Walle, J., O. Brousse, L. Arnalsteen, D. Byarugaba, D.S. Ddumba, M. Demuzere, S. Lwasa, G. Nsangi, H. Sseviiri, W. Thiery, R. Vanhaeren, H. Wouters, N.P.M. van Lipzig (2021): Can local fieldwork help to represent intra-urban variability of canopy parameters relevant for tropical African climate studies? Theoretical and Applied Climatology , 146 (1-2), 457–474, doi: 10.1007/s00704-021-03733-7

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Van de Walle, J., O. Brousse, L. Arnalsteen, C. Brimicombe, D. Byarugaba, M. Demuzere, E. Jjemba, S. Lwasa, H. Misiani, G. Nsangi, F. Soetewey, H. Sseviiri, W. Thiery, R. Vanhaeren, B.F. Zaitchik, N.P.M van Lipzig (2022): Lack of vegetation exacerbates exposure to dangerous heat in dense settlements in a tropical African city. Environmental Research Letters, 17 (2), Art.No. 024004, doi: 10.1088/1748-9326/ac47c3

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Goosse, H., S. Allende Contador, C.M. Bitz, E. Blanchard-Wrigglesworth, C. Eayrs, T. Fichefet, K. Himmich, P.-V. Huot, F. Klein, S. Marchi, F. Massonnet, B. Mezzina, C. Pelletier, L. Roach, M. Vancoppenolle, N.P.M. van Lipzig (2023): Modulation of the seasonal cycle of the Antarctic sea ice extent by sea ice processes and feedbacks with the ocean and the atmosphere. The Cryosphere, 17 (1), doi: https://doi.org/10.5194/tc-17-407-2023

Stulic, L., R. Timmermann, S. Paul, R. Zentek, G. Heinemann, T. Kanzow (2023): Southern Weddell Sea surface freshwater flux modulated by icescape and atmospheric forcing. Ocean Sci., 19, 1791–1808, 2023 https://doi.org/10.5194/os-19-1791-2023

Van Lipzig, N.P.M, J. Van de Walle, D. Belušić, S. Berthou, E. Coppola, M. Demuzere, A.H. Fink, D.L. Finney, R. Glazer, P. Ludwig, J.H. Marsham, G. Nikulin, J.G. Pinto, D.P. Rowell, M. Wu, W. Thiery (2023): Representation of precipitation and top-of-atmosphere radiation in a multi-model convection-permitting ensemble for the Lake Victoria Basin (East-Africa). Clim. Dyn., 60, 4033–4054, doi: https://doi.org/10.1007/s00382-022-06541-5

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Breil, M., V.K.M. Schneider, J.G. Pinto (2024): The effect of forest cover changes on the regional climate conditions in Europe during the period 1986–2015. Biogeosciences, 21, 811–824, 2024, https://doi.org/10.5194/bg-21-811-202

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Landshuter, N, F. Aemisegger, T. Mölg (2024): Stable Water Isotope Signals and Their Relation to Stratiform and Convective Precipitation in the Tropical Andes. J. of Geophysical Research: Atmospheres,129, e2023JD040630. https://doi.org/10.1029/2023JD040630Received

Langendijk, G.S., T. Halenka, P. Hoffmann, M. Adinolfi, A.A. Campino, O. Asselin, S. Bastin, B. Bechtel, M. Belda, A. Bushenkova, A. Campanale, K. Pan Chun, K. Constantinidou, E. Coppola, M. Demuzere, Q.-V. Doan, J. Evans, H. Feldmann, J. Fernandez, L. Fita, J. Yuan, P. Hadjinicolaou, R. Hamdi, M. Hundhausen, D. Grawe, F. Johannsen, J. Milovac, E. Katragkou, N. El Islam Kerroumi, S. Kotlarski, B. Le Roy, A. Lemonsu, C. Lennard, M. Lipson, S. Mandal, L.E. Muñoz Pabón, V. Pavlidis, J.-P. Pietikäinen, M. Raffa, E. Raluy-López, D. Rechid, R. Ito, J.-P. Schulz, P.M.M. Soares, Y. Takane, C. Teichmann, M. Thatcher, S. Top, B. Van Schaeybroeck, F. Wang, J. Yuan (2024): Towards better understanding the urban environment and its interactions with regional climate change - The WCRP CORDEX Flagship Pilot Study URB-RCC. Urban Climate, 58, Art.-Nr.: 102165. doi:10.1016/j.uclim.2024.102165

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Russo, E., B. Geyer, P. Petrik, K. Keuler, M. Adinol, H. Feldmann, K. Goergen, A. Kerkweg, P. Khain, P. Ludwig, M. Mertens, P. Pothapakula, M. Raffa, B. Rockel, J.-P. Schulz, M. Sulis, H.T.M. Ho-Hagemann, H. Truhetz, L. Uzan, U. Voggenberger, C. Steger: (2024): CLM Community WG EVAL, COordinated Parameter Testing project 2 (COPAT2): COSMO-CLM 6.0 clm1 recommended model configuration. COSMO Technical Reports, No. 51, https://doi.org/10.5676/DWD_pub/nwv/cosmo-tr_51, 2024

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Welcome to new Members

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(https://www.iusspavia.it/en)

Contact: Sobia Ayub

Upcoming events

2025

March 10 – 14: ICCARUS (ICON/COSMO/CLM/ART USER Seminar) , Offenbach, Germany

May 12 – 16: Numerical Model Training Course 2025, Offenbach, Germany

September 22 – 26: CLM Community Assembly 2025, Graz, Austria

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