Climate Limited-area Modelling Community

July 2023

Newsletter

No. 21

Content

See YOU at the

CLM Assembly

18 – 22 September 2023

Leuven, Belgium

Announcement:

ICCARUS 2024

04 – 07 March 2024
Offenbach, Germany (hybrid)

Dear colleagues,

Welcome to the 21st CLM-Community Newsletter!

After three years with online Assemblies, we will finally meet again in person in Leuven (Belgium) from 18 – 22 September. The last in person Assembly took place in Paestum (Italy) in 2019 (see picture).

We are really looking forward to meeting many of you in Leuven and we have already compiled a very interesting program with a good combination of talks, working group meetings and social events. You can find more information about the assembly in the newsletter.

In parallel to the preparations for the Assembly, the transition to ICON-CLM continues. We have organized the first ICON-CLM training course this year and the COPAT2 activities for ICON-CLM have also started. You can find reports about both topics in this issue of the newsletter.

In addition, the newsletter contains an interview with Marianna Adinolfi from CMCC, a short information about the migration of the webpage to the community portal, a review of ICCARUS 2023 and two research notes. The first contribution is from Angelo Campanale (CMCC) and describes the implementation of TERRA_URB in ICON. The second report by Julia Mömken (KIT) is about the "Recurrence of Drought Events over Iberia. Future Changes Using Regional Climate Projections".

Enjoy reading!

Yours sincerely,
Susanne Brienen, Anja Thomas and Christian Steger

Five questions to….
Marianna Adinolfi

Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)

Marianna Adinolfi graduated with honours in Environmental Engineering. She got the Ph. Doctor Europaeus in "Energy Science and Engineering" developing coupled numerical models and collaborating with the École Polytechnique Fédérale de Lausanne in Switzerland. Since 2018, she is a researcher at CMCC (Euro-Mediterranean Centre on Climate Change), carrying out research activities in the field of climate change with a focus on regional climate models with urban parameterization and convection-permitting modes. She studies the current and projected climate at local scale over complex domains. She is involved in the post-processing activities of the climate data to make them available to the scientific community through the publication on ESGF nodes. She also conducted researches supporting adaptation and mitigation actions and promoting climate resilient infrastructures (as energy geo-structures). She is authors of several peer-reviewed papers and participates in national and international conferences. She is involved in several European projects in the field of climate change (as H2020 EUCP, AGORA) also supporting the coordination activities and proposal conceptualization. Moreover, she is part of international communities (as the CLM Community) and initiatives (as EURO-CORDEX and CORDEX Flagship pilot study on Convection, on Land Use and Urban context).

1. *Marianna, you work at the CMCC Foundation in Italy. Can you please tell us something about CMCC in general and also about your tasks there?*

The Centro Euro-Mediterraneo sui cambiamenti climatici (CMCC) has been established in 2005 with the financial support of the Italian Ministry of Education, University and Research, and the Ministry of the Environment, Land and Sea and in 2015 the Centre became a Foundation. CMCC mission is to investigate the climate system and its interactions with society. It is organized in the form of a network distributed throughout the country with locations in Lecce, Bologna, Caserta, Milano, Sassari, Venezia, and Viterbo. The network connects universities and research institutes in a strongly interdisciplinary collaboration with experienced scientists, economists, and technicians, which work together in order to provide full analyses of climate impacts on various systems such as, but not limited to, agriculture, ecosystems, coasts, water resources, health, and economics. I work at the "Regional models and geo-hydrological impacts" (REMHI) division, located in Caserta.

The division conducts researches and provides services related to local climate change and impact assessment, as well as support for defining adaptation actions and climate risk management. The pillar of REMHI is the unit developing and using regional climate models (REM), in which I'm mainly involved. The unit is participating in international programs to constantly improve knowledge on expected climate change condition at the local level and in urban environments. The studies that we conduct can support the scientific community on the evaluation of the impact of climate change on various sectors and aid adaptation strategies.

2. *What is your experience with the CLM-Community? What are, in your opinion the strength and the weaknesses of the CLM Community?*

I am member of the Climate Limited-area Modelling Community (CLM Community) since 2018 and I started my research activities at CMCC with the regional climate model COSMO-CLM, currently moving to ICON-CLM. I was impressed by the collaboration of the members - always eager to assist and open to new suggestions -, the activities of the working groups, the wide range of applications of the results, and the development of tools to support modelling activities that are continuously shared and updated. In addition, the platform is comprehensive and provides a lot of useful information. I believe that these aspects are the most relevant strengths of the CLM community.

3. *How do you contribute to CLM Community activities?*

I actively participate, to the annual CLM Assembly and specific meetings of the CLM Community, showing advancements in the modelling strategies, specific applications, sensitivity tests and results achieved at CMCC. Moreover, I'm involved in several working groups also with other colleagues of REMHI division, as the Soil and Vegetation (SOILVEG), the Climate projections (CP) and the Convection Resolving Climate Simulations (CRCS) ones. Specifically, I am the point of contact between the CRCS working group and the Flagship Pilot Study on Convection, endorsed by CORDEX initiative.

4. *In which context do you use COSMO-CLM?*

The COSMO-CLM model is used by CMCC since 2008 for the activities of dynamical downscaling in the context of several national and international projects and research activities. We use COSMO-CLM for the coordinated activities of the CORDEX initiative and dedicated Flagship pilot studies. Our main areas of interest are the Alpine domain, the whole Italian peninsula, the European cities as well as small islands. Of course, we have interest in the EURO-CORDEX domain in the perspective of the dynamical downscaling of CMIP6 scenarios.

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

My main goal, as the one of the whole scientific community, is to study, investigate, analyse and model our climate system and its impacts to provide increasingly reliable, rigorous and timely scientific results to protect the environment and develop science-based adaptation and mitigation policies in a changing climate.

Thank you very much for the interview!

Centro Euro-Mediterraneo sui Cambiamenti Climatici

CLM-Community issues

Assembly 2023

By Susanne Brienen (Deutscher Wetterdienst)

The CLM-Community Assembly 2023 will take place at the KU Leuven in Belgium from 18 - 22 September. This is the first time after the COVID-19 pandemic that we will meet in person. We are looking forward to seeing many community members again and to have many interesting discussions.

28 abstracts have been submitted and will be presented as oral presentations throughout the week. The topics include updates on the status of the different model components and script environments, coupling activities, model evaluation techniques and results, convection-permitting modelling activities, climate change studies and more. In between the scientific presentations, the different working groups will meet in the usual way as has been done before the pandemic. Finally, a community meeting will take place where important aspects of the community will be discussed and necessary decisions on the future collaboration will be made. The agenda of the community meeting will be distributed several weeks in advance. The full program is available on the community portal:
https://www.clm-community.eu/events/clmcommunity-assembly-2023/programme

Some social activities are planned for the evenings: an icebreaker on Tuesday, a conference dinner on Wednesday and a guided tour through the city center of Leuven on Thursday.

Practical information for the participants can be found on the meeting webpage of KU Leuven: https://ees.kuleuven.be/en/clm2023/index.html

We thank the group of Nicole van Lipzig at the KU Leuven for organizing this event and hope to meet many community members in September in Leuven!

KU LEUVEN

ICCARUS 2023

By Christian Steger (Deutscher Wetterdienst)

ICCARUS (ICON/COSMO/CLM/ART User Seminar) is an international conference that brings together users and developers of the COSMO and ICON numerical models. Over the last two decades ICCARUS has become a hub for the exchange of information on model development, physical parameterizations, data assimilation, ensemble generation, verification and applications of the model systems. As such, it provides an important link between COSMO, the CLM Community, and ICON and ART developers.

The 24th edition of ICCARUS took place from 6 - 9 March 2023 at the DWD headquarters in Offenbach, Germany. The conference was planned and executed for the first time as a hybrid event by the organization team consisting of Anja Thomas, Daniel Egerer, Bernd Kress, Daniel Rieger, and Christian Steger. For this, the well established tools Webex, Gather.Town and Nextcloud could be used.

After greetings by DWD President Prof. Gerhard Adrian and the head of DWD's research and development business unit, Prof. Sarah Jones, the first three days of the conference featured scientific presentations in plenary sessions. These could be followed and given on-site as well as online. The poster session then took place entirely online on Thursday 9 March. There was the possibility to present the posters in short presentations in the plenum on Monday and Tuesday. The working group meetings of COSMO, the CLM and the ICON community, which used to be held during the ICCARUS week in Offenbach as well, were now held as virtual meetings in the weeks before and after. The only element of the conference which was exclusively reserved for on-site participants was the Icebreaker event, which took place following the scientific program on Tuesday evening.

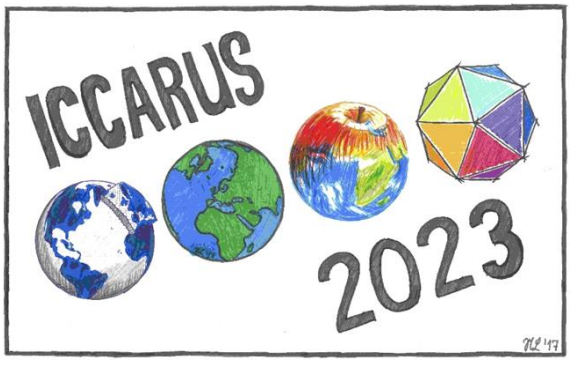

***Figure 1**: ICCARUS 2023 Logo (Source: Nora Leps)*

A total of 286 people were registered for ICCARUS 2023, of which 110 were registered for on-site participation. Participants submitted 88 contributions, of which 42 were oral presentations and 46 were poster presentations. The plenary presentations were organized into a total of 14 thematic sections. These included "Aerosol and Clouds", "Coupled Simulations", "Predictabilty", "Boundary Layer and Soil", "Data Assimilation", "Clouds and Convection", "SINFONY", "Model Development", "Radiation", "Dynamics and Numerics", "Aerosol", "Evaluation", "Dynamic and Gravity Waves" and "Clouds". For the division of the thematic blocks, the keyword system introduced in the previous year again proved helpful for the submission of contributions.

The program also included 5 keynote talks, including an invited talk by Stephanie Johnson (ECMWF) on ECMWF's seasonal forecasting system. The other four keynote talks dealt with various aspects of the ICON model system. Roland Potthast gave a general overview of ongoing work and plans with ICON. Jan Keller presented the regional re-analysis generated by DWD in more detail. Günther Zängl explained the major updates in ICON for weather forecasting, as well as the related plans for 2023. Barbara Früh provided information on the work for using ICON on climate time scales.

Next year ICCARUS will celebrate its 25th anniversary and will be held during the week 4-9 March 2024.

***Figure 2:** Group picture (Source: DWD)*

Migration of Website to the Community Portal

By Christian Steger (Deutscher Wetterdienst)

In the last issue of the newsletter, we reported about the migration of the RedC Wiki pages to the CLM Community Portal. Meanwhile, also the CLM Community Webpage has been transferred to the Community Portal and the generic address of the Webpage (www.clm-community.eu) points to the new pages now.

This is a major step in the migration process, because the membership and topic administration, event organization, wiki and webpage are now organized via one system for the first time. Having everything in one system simplifies the administration and maintenance as well as the update of content and cross references between different sections.

Special thanks go to Philipp Sommer for implementing all the additional functionality in the last months and to Beate Geyer for leading, coordinating and doing a lot of the work during the migration process. Thank you very much!

In addition to the technical changes that were necessary to integrate all functionalities in one system and the migration of the content, there is still work to do to optimize the structure of the new system and adjust, update and homogenize the content of the different sections. The task team will work on this in the upcoming months.

If you spot any errors, inconsistencies our outdated content in the Community Portal, if you have suggestions for improving the structure or if you want to contribute to the remaining tasks, please contact the coordination office (clm.coordination@dwd.de). ■

Please Remember!

Part of your scientific success relies on the work of the colleagues who provide the reference configurations of the models, the runtime environments and other tools and maintain the code. It would be more than a sign of courtesy to offer them co-authorship in publications once in a while.

Please do not forget to state that you use the "COSMO model in Climate Mode (COSMO-CLM)" or the "Climate Lmited-area Mode of ICON (ICON-CLM)".

Thank you very much!

Updates on the Coordinated Parameter Testing (COPAT2) Initiative of the CLM-Community

By Emmanuele Russo (ETH Zurich)

In the COordinated PArameter Testing 2 (COPAT2) project, several members of the CLM Community join forces with the goal of testing and providing recommended configurations of the latest release versions of COSMO-CLM 6.0 and ICON-CLM (ICON 2.6.6) for the European CORDEX domain.

The calibration of each model is divided into four main phases. In a first stage (Phase 0), the procedure to follow for determining an optimal model configuration is carefully discussed. This includes the selection of the model parameters and configuration options to be tested, the setup of the model runtime environment on the supercomputer of the German Climate Computing Center (DKRZ) and the selection of the metrics and observational datasets to be used for the evaluation of model results. Then, in a second phase (Phase 1), starting from a reference simulation, a series of short-term experiments are performed for the period 1979-1985, for parameters and configurations selected during Phase 0. Changes in the model configuration combining the most sensitive options of the Phase 1 are then tested in a third phase (Phase 2). The most promising experiments in terms of agreement against observations are further extended over a total period of 12 years (1979-1990), as well as tested over a more recent period of time (2002-2008), in Phase 3: a recommended configuration is finally determined based on the analysis of these results.

All COPAT2 simulations are conducted at a horizontal resolution of approximately 12 km over Europe (EURO-CORDEX domain), on the regular rotated grid EUR-11 for COSMO-CLM and on the R13B05 grid for ICON. The experiments use ERA5 reanalysis data as boundary conditions and are performed on the high-performance computing system LEVANTE at DKRZ.

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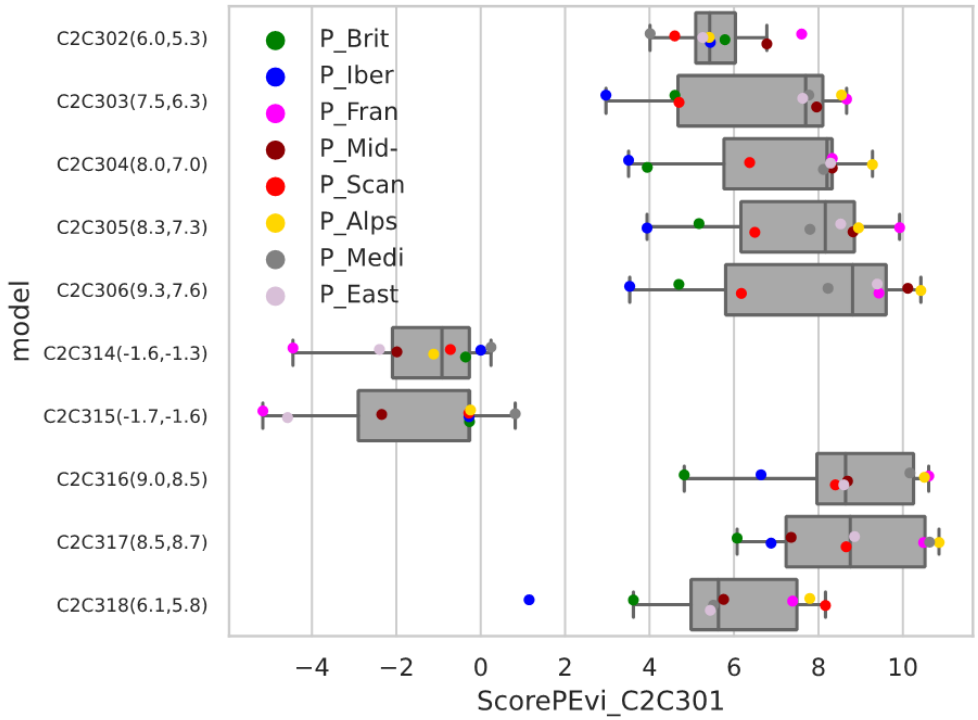

***Figure 1**: Score points of evidence based on the differences in the mean BIAS between the observations and different model realizations against the ones of the reference simulation C2C301. The coloured dots indicate the different PRUDENCE regions. The numbers given on the left, on the y-axis, are weighted means of all regions. First weight considers the area of a region. Second weight considers the distance to Mid-Europe. Positive (Negative) values of the Score points of evidence indicate a better (worse) agreement to observations with respect to the reference run. Considering all of the conducted analysis, the simulation C2C316 is the one leading to best performance in the comparison against observations.*

For COSMO-CLM 6.0, the evaluation has been concluded in February 2023. The results show that configuration changes in model dynamics (such as the Bott 2nd order finite-volume scheme with deformational correction and local time stepping, and a new scheme for the treatment of fast waves), and in the representation of surface processes (in particular the use of a new explicit calculation of a skin surface energy budget and an improved representation of bare soil evaporation (after Schulz and Vogel 2020)) lead to important improvements in model performance with respect to the recommended model configuration of the previous model version 5.0 (see Fig. 1), that resulted from the COPAT1 initiative. A documentation on the work conducted for the configuration of COSMO-CLM 6.0 is currently in preparation and will be made available to the members of the CLM-Community during summer 2023. The recommended configuration will be made available through the CLM Community namelist-tool (https://tools.clm-community.eu/NLT/ (log in required)).

For ICON-CLM, the calibration of the model is currently on-going. Phase 0 is almost concluded, and it is now clear which experiments to conduct during Phase 1 of the ICON-CLM calibration. However, some work is still required for the configuration of the SPICE runtime environment of the model on the supercomputer at DKRZ. The selected tests to be performed in Phase1 will include experiments with different aerosol climatological datasets, changes in the number and depth of soil hydrologically active layers, the use of a new formulation for skin temperature, the consideration of stochastic differential equations for the shallow convection scheme, a different cloud cover scheme for radiation and a new urban parameterisation. These tests will be followed by experiments with changes in selected tuning parameters of the different physical schemes. Then, the plan is to follow the same procedure used for the calibration of COSMO-CLM 6.0, conducting combined tests of the most promising configuration options of the model in Phase 2 and Phase 3 of the project. For the ICON-CLM experiments, the evaluation will be based on the comparison against gridded observational datasets and reanalysis products, as well as on radiosondes measurements.

Numerical Model Training Course 2023

By Christian Steger (DWD)

Last The Numerical Model Training Course 2023 for the ICON model took place from 27-31 March. The training was organized by DWD in collaboration with the COSMO partner weather services and the CLM Community.

The application areas of the ICON model range from numerical weather prediction (NWP) and regional climate simulations (CLM - Climate Limited Area Model) to the prediction of trace substance dispersion with ICON-ART. Therefore, national meteorological services, universities and research institutions are among the ICON users and the target groups of the training course. Each morning, lectures on the physical basics of the ICON model, data output of the DWD and technical details of ICON were scheduled. In the afternoon, practical exercises allowed participants to learn how to run ICON simulations.

The practical exercises were split into three parts, that were tailored to the needs of the different groups of participants. NWP for universities (Academia), regional climate simulations (CLM) and NWP for national weather services (MetServices). The CLM part of the course was designed and conducted delivered by the CLM Community. Beate Geyer (Hereon), Christian Steger (DWD), Ha Hagemann (Hereon), Merja Tölle (University Kassel), Prashant Singh (University Frankfurt), Patrick Ludwig (KIT), Ronny Petrik (German Navy) and Susanne Brienen (DWD) contributed to the preparation and realisation of the ICON-CLM course on-site.

The CLM part of the course covered the ICON model for the first time and provided an introduction to ICON-CLM and the Starter Package for ICON-CLM Experiments (SPICE). SPICE is a runtime environment for performing regional climate simulations with ICON-CLM which was developed within the CLM community. Participants learned how to install and configure SPICE and how to use it to run simulations.

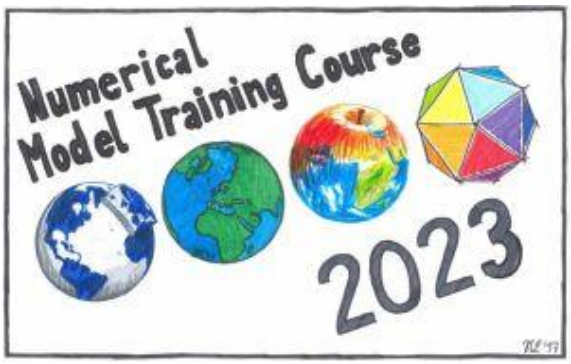

***Figure 1**: Logo Numerical Model Training Course 2023 (Source: Nora Leps)*

In special exercises the participants learned which steps are necessary to perform a simulation for a different time period, a different area and with different boundary conditions. Furthermore, it was explained how to create a simulation with convection permitting resolution. Boundary data were provided by a previously created experiment with coarser resolution. Analysing the results with the evaluation tool EvaSuite included in SPICE has been explained as well. In the final exercise, participants were able to begin configuring the model for their target region and use case.

In total, the organizers welcomed 71 participants in Offenbach (see Fig. 1). The fact that WMO supported several African national meteorological services resulted in an international course with participants from Austria, Brazil, Burkina Faso, France, Germany, Israel, Italy, Kenya, Mauritius, Mozambique, Niger, Oman, Seychelles, South Africa, Switzerland, Tanzania, United Arab Emirates and Zimbabwe.

For the first time, the training was held at the DWD headquarter in Offenbach, with exercises in the conference areas Blue and Green as well as in the Gartensaal. The lectures were streamed from conference area Blue to the other rooms.

The participants had to bring their own notebooks for the exercises. The Academia and CLM course were performed on the HPC Levante at the German Climate Computing Center (DKRZ), while the MetService course was run on ECMWF's ATOS system. We want to thank DKRZ and ECMWF for the resources and their support.

In the scope of the training course, the ICON Tutorial was also revised and published. The ICON Tutorial is updated with each training course and is now the most comprehensive model documentation available for the ICON model. It is available for download on https://doi.org/10.5676/DWD_pub/nwv/icon_tutorial2023

***Figure 2**: Group photo ICON Training 2023 (Source: DWD)*

Research notes

Implementation of TERRA_URB in ICON: first results over Italy

Angelo Campanale, Marianna Adinolfi*, Mario Raffa*, Paola Mercogliano*, Jan-Peter Schulz***

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See also:
Campanale, A., Adinolfi, M., Raffa, M., Mercogliano, P., and Schulz, J.-P.: A new urban parameterization for the ICON atmospheric model: first results over Italy, EMS Annual Meeting 2023, Bratislava, Slovakia, 4–8 Sep 2023, EMS2023-461, https://doi.org/10.5194/ems2023-461, 2023

Introduction

Research activities and high-performance computing architectures are permitting increasing the resolution of atmospheric models for numerical weather prediction and climate simulations, allowing for a more accurate description of the physical processes at urban scale.

Furthermore, a common trend is occurring in most countries: the number of people living in towns and, therefore, the number of built surfaces keep on increasing remarkably. For this reason, one of the most investigated phenomena, with a significant impact on atmospheric flow and meteorological processes, is the Urban Heat Island (UHI) effect, which occurs when a city experiences much warmer temperatures than its surrounding rural area [1, 2].

Indeed, many studies have already documented that UHIs and other urban-induced climate feedbacks may amplify heat stress and urban flooding under climate change, leading to additional deterioration of the human thermal comfort, amplification of heat-stress hazards, and even increase of heat-related mortality in the cities [3, 4]. Therefore, an adequate representation of urban areas in atmospheric models is essential to correctly forecast not only air temperature and UHI phenomena, but also to support assessment of the related impact as human heat stress. Additionally, it is expected to improve the representation of localized high impact weather events such as thunderstorms [5], which may be triggered or modified by urban-induced effects.

Implementation of TERRA_URB in ICON

In all this scenario, the interest in proper modelling the physical processes in urban areas has gained wide attention from the research community. In particular, the convection-permitting atmospheric models [6-10], associated with urban parameterizations [10, 11], are able to resolve the heterogeneity of cities with applications for heat stress assessment and the development of urban climate adaptation and mitigation strategies. In this perspective, a bulk urban canopy parameterization, TERRA_URB (TU) [12-14], has been developed for the COSMO regional atmospheric model [15]. Due to the computational efficiency of the TU scheme, its simplicity and its encouraging evaluation results [16, 17], the CLM Community decided to select it as the default urban parameterization for the official COSMO code version. Thus, in the framework of the transition from the COSMO model to the new Icosahedral Nonhydrostatic (ICON) Weather and Climate regional model, TU needs to be implemented in ICON [18].
Therefore, in this context, the Priority Project CITTA' was designed, with the precise purpose of addressing the "City Induced Temperature change Through A'dvanced modelling". CITTA' is one of the priority projects of the COSMO Consortium and involves several institutes and research centers of the Consortium. The activity is composed basically by an implementation phase of the ICON source code for several physics that compose TU, adapted to the urban canopy, and then a compilation and testing phase, in particular with short simulations over the Italy domain at 2 km of grid spacing.

The steps taken so far concern the adaptation of the heat capacity and thermal conductivity for the urban canopy, the implementation of the Brutsaert-Kanda model for the turbulence, which defines the roughness length and roughness sublayers for the urban canopy, the modification of the albedo for the urban canopy, the implementation of the anthropogenic heat flux (AHF) as heat energy due to human activity, and finally the modification of the hydrology for urban areas, where the infiltration and bare soil evaporation at impervious surface areas is set to zero, and instead a re-evaporation of water puddles over impervious surface areas is introduced. The next steps will basically regard the coupling with the ECOCLIMAP-Second Generation land cover dataset [19], instead of the current GlobCover land cover dataset [20], which offers a poor representation of urban land cover and, finally, sensitivity tests, in order to properly tune some TU parameters.

Results and conclusions

Our Here we present the results related to 5 simulated days, from 01 August 2017 to 05 August 2017, of ICON with TU activated and TU deactivated (the reference case) over Italy at 2 km resolution. Both simulations are forced with ECMWF IFS analysis every 6 hours.

Figure 1 reveals the difference of 2-m temperature between the two simulations averaged for the entire simulated period over the Italian domain. The 2-m temperature is shown during nighttime and daytime and compared with the so called fr_paved (fraction paved) variable, which provides information about the percentage of impervious area. The results show a nighttime with hotspots near several cities and also a good spatial matching between the temperature pattern and impervious area pattern. These hotspots over cities would be impossible to observe with ICON standalone, furthermore the characteristic of urban centers to exhibit a nighttime warmer then daytime has been widely confirmed in the literature.

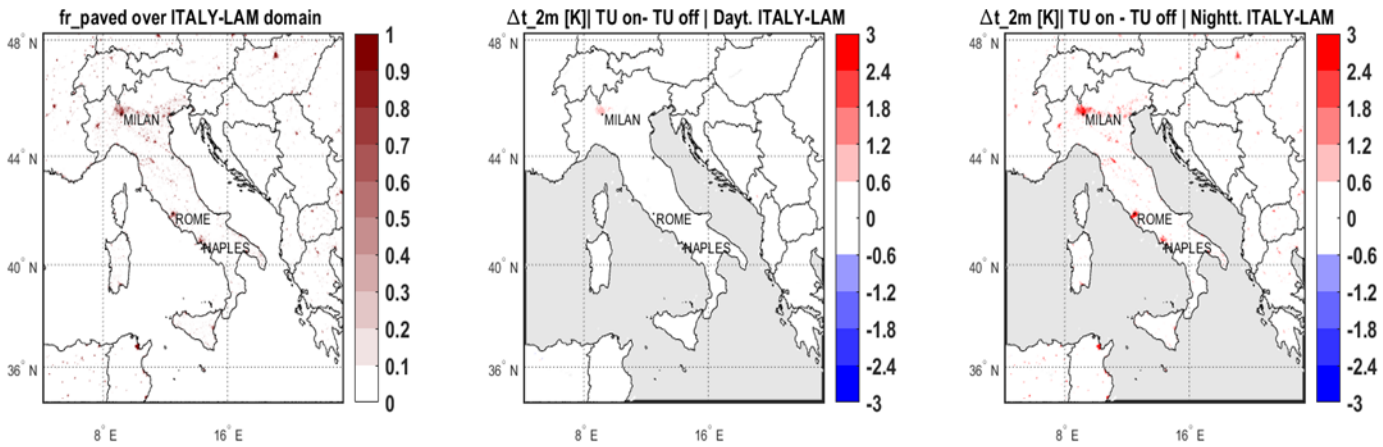

Figure 1: *Differences between ICON+TU and ICON standalone of air temperature at 2 m during daytime and nighttime, respectively center panel and right panel, against the impervious surface areas (fr_paved variable) over Italy.*

In order to properly assess the implementation of TU, in Figure 2 the comparison of UHI for Rome with observations is shown. The observations are obtained from urban and rural point stations, whose coordinates are depicted in the right panel of Figure 2. ICON without TU is not capable to see the increment of temperature of the urban soil during nighttime. Instead, there is a satisfactory comparison between ICON+TU and observations, especially during nighttime.

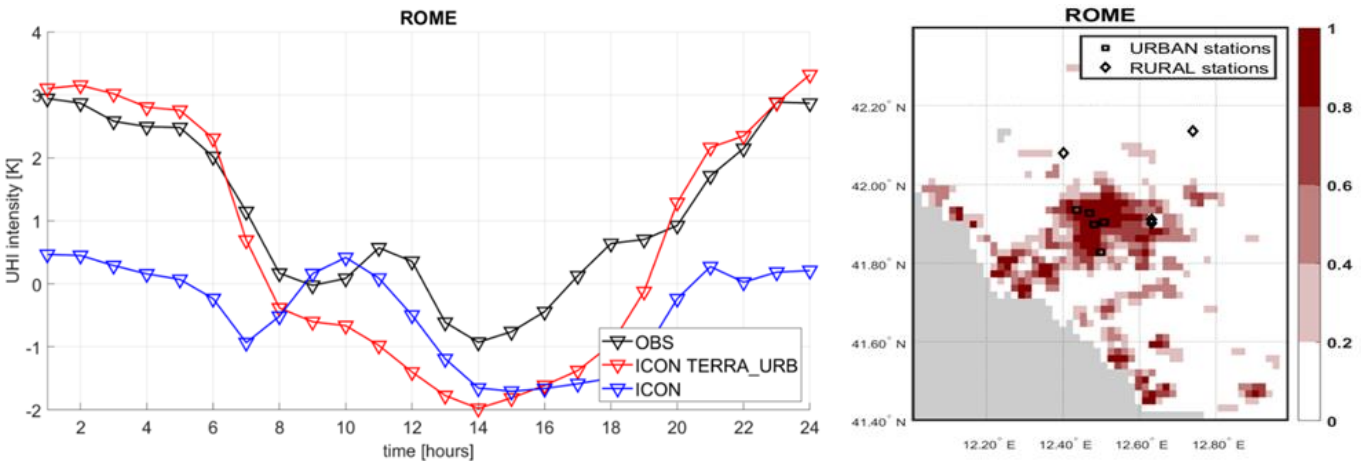

Figure 2: *UHI for Rome with OBS (black curve), ICON+TU (red curve) and ICON standalone (blue curve). The UHIs are obtained through the difference between average of temperature urban signals (square markers in the right panel) and average of temperature rural signals (diamond markers in the right panel).*

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Recurrence of Drought Events over Iberia. Part II: Future Changes Using Regional Climate Projections

Julia Moemken, Benjamin Koerner, Florian Ehmele, Hendrik Feldmann, Joaquim G. Pinto (Karlsruhe Institute of Technology)

Seasonal droughts are a common feature of the Iberian (Mediterranean) climate. They can severely affect both natural and human life – especially, when recurring in consecutive years. In this study, we investigate the potential impacts of climate change on recurrent drought events in the Iberian Peninsula (IP). With this aim, we apply the new set of indices introduced in Moemken and Pinto (2022), namely the Recurrent Dry Year Index (RDYI) and the Consecutive Drought Year (CDY) Index, to regional climate projections. The projections are taken from a large EURO-CORDEX multi-model ensemble comprising 25 different global-to-regional model (GCM-RCM) chains with 12 km horizontal resolution. The ensemble is spanned from 5 RCMs (including COSMO-CLM) each driven by the same 5 GCMs. We analyse climate change information for different global warming levels (GWLs): +2°C and +3°C. The future climate projections were carried out under the RCP8.5 scenario. A drizzle correction and a simple multiplicative approach are used to bias adjust the daily precipitation sums.

Results reveal a general tendency towards more severe drought conditions in IP under different global warming levels (GWLs) – caused by an overall decrease in precipitation and soil water content, and a slightly increased net evapotranspiration. Moreover, recurrent drought events are projected to occur more frequent and last longer (Figure 1). While the ensemble mean responses are only moderate for a GWL of +2°C (compared to the pre-industrial average; Figure 1b), recurrent drought conditions are strongly enhanced for the +3°C GWL (Figure 1c). Changes are mostly robust (in the sense that at least 68% of the ensemble members agree on the sign of change), but the magnitude of projected changes shows some sensitivity on the choice of index and model.

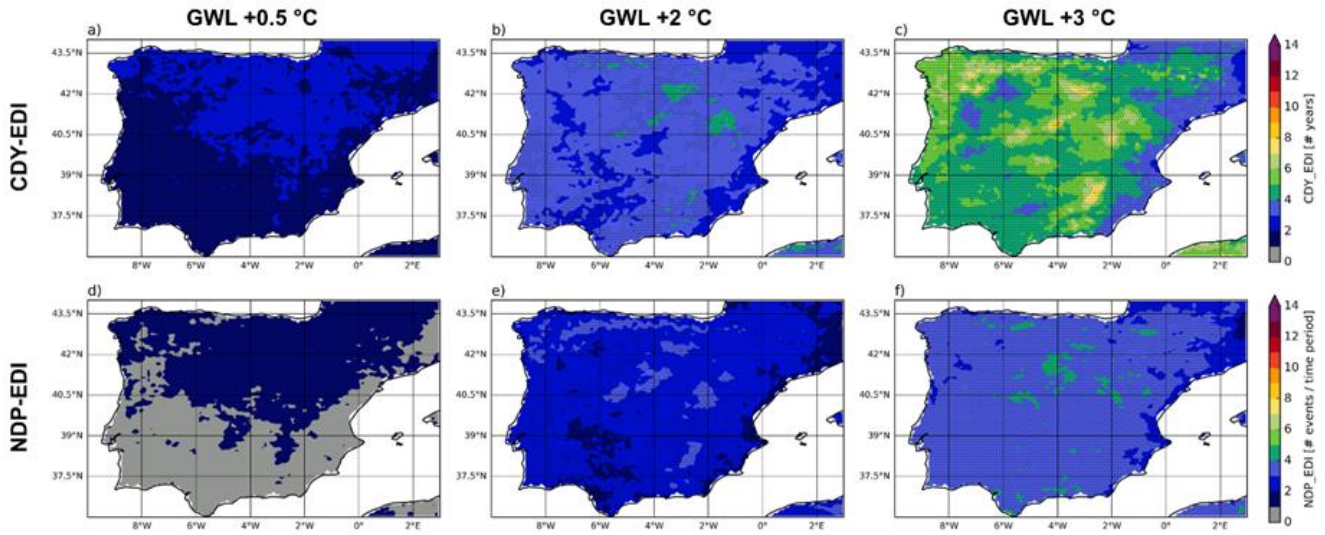

Figure 1: *Consecutive drought year index based on EDI (CDY-EDI; top row) and corresponding number of drought periods (NDP-EDI; bottom row) derived from the ensemble mean for a GWL of +0.5°C (historical reference; a, d), +2°C (b, e), and +3°C (c, f). For future GWLs, black dots indicate robust climate change signals, meaning that 17 or more ensemble members (corresponds to 68%) agree on the sign of change. Source: Moemken et al. (2022, Tellus A), their Figure 8.*

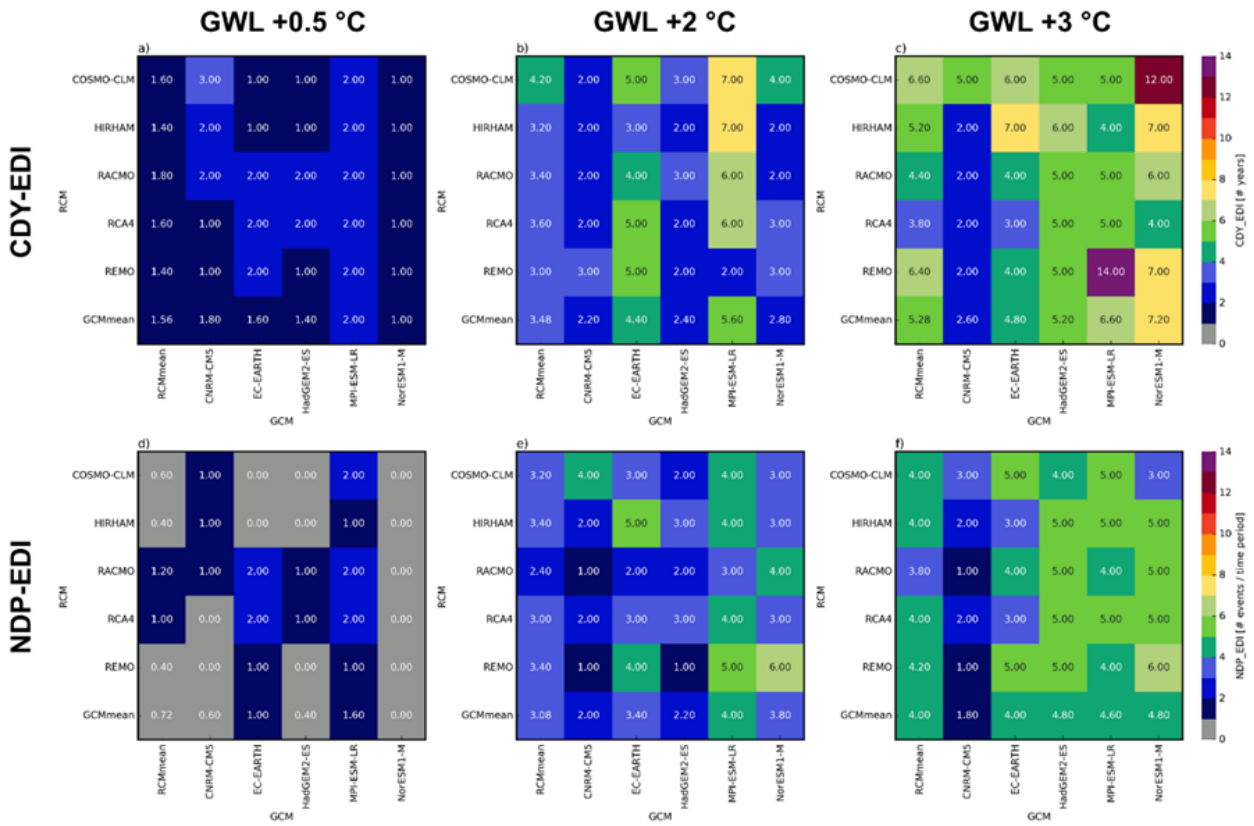

Figure 2: *Consecutive drought year index based on EDI (CDY-EDI; top row) and corresponding number of drought periods (NDP-EDI; bottom row) for the individual ensemble members derived for whole IP for a GWL of +0.5°C (historical reference; a, d), +2°C (b, e), and +3°C (c, f). For each matrix, rows represent RCMs and columns GCMs, while the RCM (GCM) mean is depicted in the first column (last row). Source: Moemken et al. (2022, Tellus A), their Figure 7.*

Typically, changes are more pronounced for indices based on the effective drought index (EDI) and show a larger spread for the individual GCMs than for the various RCMs (Figure 2). Nevertheless, the climate change signals are robust for most of IP and all indices, with a larger model agreement for the +3°C GWL (Figure 2c).

We conclude that the Iberian Peninsula is confronted with a drastic increase in the risk of both longer and more frequent recurrent drought events with ongoing climate change. If global warming should exceed the +3°C threshold, the majority of models projects an almost permanent state of drought – which could result in severe implications for the Iberian population and ecosystems. The results could support stakeholders and decision makers in developing and implementing mitigation and adaptation strategies to secure water supply in future decades.

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2023

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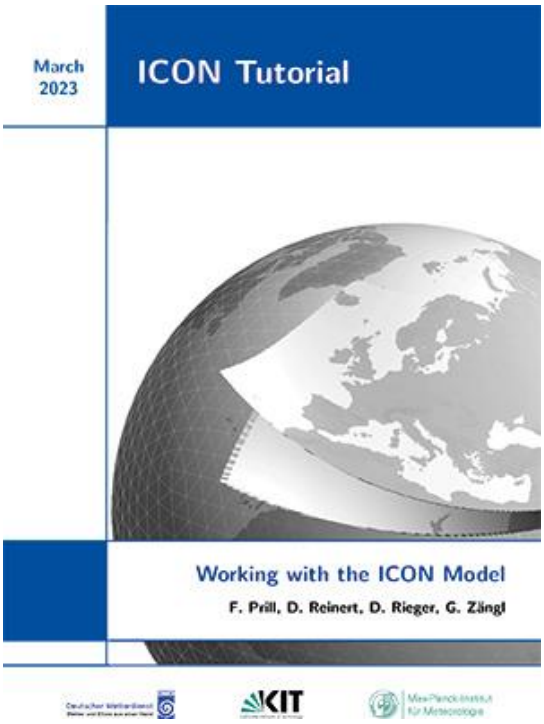

Upcoming events

2023

August 28 – 31: CORDEX 7th Convection Permitting Modelling Workshop, Bergen, Norway
September 11 – 15: COSMO General Meeting, Gdansk/Sopot/Gdynia, Poland
September 18 – 22: CLM Community Assembly, Leuven, Belgium
September 25 – 29: CORDEX conference, Trieste, Italy
October 23 – 27: WCRP Open Science Conference 2023, Kigali, Ruanda

2024

March 04 – 07: ICCARUS 2024, Offenbach, Germany
June 10 – 14: ICON Training Course, Offenbach, Germany
October 07 – 11: CLM Community Assembly 2024, Oberpfaffenhofen, Germany

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