Climate Limited-area Modelling Community

July 2022

Newsletter

No. 19

Content

See YOU at the

CLM-Community Assembly

19 – 23 September 2022

Virtual Meeting

Announcement:

ICCARUS 2023

06 – 10 March 2023
Offenbach, Germany / hybrid meeting

Dear colleagues,

Welcome to the 19th CLM-Community Newsletter!

The CLM-Community is in the middle of the COordinated PArameter Testing (COPAT2) activity for COSMO-CLM 6.0 and the first recommended version of ICON-CLM. Many test simulations for COSMO-CLM have already been conducted and are currently analyzed to figure out which settings are beneficial. Once the tests for COSMO-CLM are completed, the same exercise will be repeated for ICON-CLM.

The careful analysis of different model settings is the basis for recommended model versions, which are expected to produce trustworthy simulations and provide high quality simulation data. This is an important requirement for any research application and the planned contributions of the CLM-Community to CORDEX, the second overarching community activity that will take place in the next years.

If you want to use COSMO-CLM or ICON-CLM for your research, please consider to contribute to COPAT2 and help to optimize the model setups for our community models (contact the coordination office).

This issue of the newsletter contains an interview with Leenes Uzan from Israel Meteorological Service, a report about the EURO-CORDEX activities and a very interesting depiction of Alessandro Dosio (JRC) about his work as lead author for the IPCC 6th assessment report. Furthermore, we have a retrospection of ICCARUS 2022, an outlook to the CLM-Community Assembly in September and short report from Philipp Sommer (Hereon) about the new event management functionality in the CLM-Community management tool. The research notes are this time about "The impact of greening on the urban heat island effect – sensitivity studies for Vienna" from Johann Züger (AIT) and the "Sensitivity of Convection Permitting Simulations to Lateral Boundary Conditions in Idealised Experiments" from Nora Leps (DWD) and Bodo Ahrens (GUF).
Enjoy reading!

Yours sincerely,
Susanne Brienen, Anja Thomas and Christian Steger

Five questions to…. Leenes Uzan

Israel Meteorological Service (IMS).

Leenes works as a researcher in numerical modelling in the Israeli meteorological service (IMS) R&D department. In 2001, she received her first degree in Environmental Engineering at the Technion Israel Institute of Technology. She served as the head of the Air Quality Branch in the Association of Towns for Environmental Protection in Israel for over a decade. Over the course of the years, she continued her studies in the field of atmospheric sciences and received her Master's degree (2007) and PhD (2021) in Geophysics in the faculty of Exact Sciences at the Tel Aviv University. Her research focused on the evaluation of the planetary boundary layer by combining remote sensing measurements and numerical weather prediction models.

1. *Leenes, you work at the Israel Meteorological Service (IMS). Can you please tell us something about IMS in general and also about your tasks there?*

The IMS provides forecasts and warnings for a variety of economic sectors: transportation, agriculture, water management, energy, environmental protection and more. We operate and maintain a national network of meteorological stations - synoptic, climatological, agrometeorological and solar, and produce routine climate reports. The R&D department, where I work, focuses on the development of weather prediction models to improve regional medium and long-term forecasts through collaboration with the COSMO consortium, ECMWF and other organizations. My tasks are to calibrate ICON-CLM for the Eastern Mediterranean region and perform long-term climate projections in different scenarios.

2. *IMS is a long-term member of and very active in COSMO (Consortium for Small-scale Modeling), but it also becomes more and more active in the field of climate modeling. Can you please give us some insights in the activities at IMS and the medium to long-term goals in the field of climate modeling / climate research?*

About Seven years ago, the IMS ran COSMO-CLM version 5 between 1950-2100 for scenario RCP 4.5 on CORDEX MENA domain with 0.44° resolution and boundaries from ECHAM model. Nowadays, we joined the CLM-Community efforts to calibrate ICON-CLM using the SPICE package.

Our goals are to achieve a tuned convection parametrizing (~12 km) version over the CORDEX domain (MED or MENA) and a tuned convection-permitting (~3 km) version over the Eastern Mediterranean. Currently, we perform the ICON-CLM test runs on the Cyprus Institute HPC as part of an Israel-Cyprus collaboration project. In the coming months, we intend to continue the test runs on our recently purchased medium-size HPC. Moreover, the IMS director has been investing great efforts to establish a national computer center to enable IMS, ministerial and academic research institutions perform high-resolution ensemble runs. In the long term, these climate projections will serve as a tool for regulators and decision makers in respect to climate change predictions.

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

The CLM-Community is very cooperative, keen to assist and open to new suggestions.

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

To keep on updating on developments and sharing difficulties encountered through the research process for the benefit of all. Frankly, on my behalf, I hope I'll gradually but surely achieve the expertise of my fellow colleagues in the CLM-Community.

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

My main goal is to contribute to the development of ICON-CLM in the Eastern Mediterranean in order to provide a reliable tool for region-wide climate change adaptation.

Thank you very much for the interview! ■

CORDEX activities

Update (EURO-)CORDEX and CMIP6 downscaling

By Christian Steger (Deutscher Wetterdienst)

In the previous issues of the newsletter, we provided some information about the CMIP6 downscaling activities within the framework of CORDEX. The main information for CORDEX, the experiment design for dynamical downscaling and the variable list were published in May and September 2021, respectively.

Meanwhile, also the coordination for the activities in EURO-CORDEX made progress and the variable list for simulations on the European domain has been further specified. In addition, the draft of the EURO-CORDEX CMIP6 protocol was published on 25 May 2022 and the document was open for comments until 10 June 2022 (please see: https://docs.google.com/document/d/1meBrMiHRJNhqvTTd0c5C97vALGoxdBmiFPF8jQc9qKw/edit#heading=h.6lg2b5ulfxrj).

The GCM selection process for Europe also made some steps ahead and combined with the plans, interests and commitments of the RCM groups, a first set of GCMs for the downscaling was selected. For the moment, the "balanced" matrix includes EC-Earth3-Veg, MPI-ESM1-2-HR, CNRM-ESM2-1, NorESM2-MM, MIROC6 and CMCC-CM2-SR5. Each of these GCMs will be downscaled with several RCMs for the scenarios SSP126 and SSP370. This should guarantee the availability of a homogenous and balanced set of simulations that allows for assessment and comparison of the two scenarios. Simulations driven by other GCMs or for other scenarios and model set-ups that include more components of the earth system than the standard atmosphere-land combination (e.g. ocean, dynamic vegetation, lakes, urban parameterization or sea-ice) are explicitly welcome and will complement the runs of the balanced matrix.

The CLM-Community groups interested in downscaling of CMIP6 simulations discussed and coordinated their contribution in the last months.

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According to the plans, the CLM-Community will use COSMO-CLM and ICON-CLM for the downscaling and contribute to the balanced matrix with simulations driven by MPI-ESM1-2-HR, EC-Earth3-Veg, MIROC6 and CMCC-CM2-SR5 (see "Europe (EUR) – balanced matrix" here: https://docs.google.com/spreadsheets/d/1ucEdjdygFBJS_WLvbNis1rywmptSZcutqRkWaZI1SVY/edit#gid=328539360). Furthermore, some groups plan to run simulations with coupled systems that include ocean or runoff models (see the tab "Europe (EUR) – other" of the same document).

The production of the simulations will certainly take some time, but the first runs (mainly conducted by the project NUKLEUS with contributions from BTU, Hereon and KIT) will likely become available at the end of this year or at the beginning of 2023. If you are interested to contribute to the CMIP6 downscaling and add simulations that are not included yet, please contact Hendrik Feldmann, the coordinator of WG Climate Projections, or the coordination office.

IPCC activities

Assessing science to support policy making: the IPCC WGI report from an 'insider' point of view.

By Alessandro Dosio (European Commission, Joint Research Centre (JRC))

Working on the Working Group I (WGI) 6th Assessment Report (AR6) published in August 2021 was my first experience as Lead Author of the Intergovernmental Panel on Climate Change (IPCC). It was three years of hard work, but at the same time exceptionally rewarding. In this article, I will describe how the report is produced, distilling policy relevant information (the 40-page Summary for Policy Maker) through the assessment of the available scientific literature (14000+ scientific publications) and I will share my experience about what the work of IPCC scientists looks like, from the process of Authors selection to the line-by-line approval of the SPM.

What's the IPCC and why it matters?

The Intergovernmental Panel on Climate Change (IPCC) is the UN body with the specific role to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information

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relevant to understanding the scientific basis of human-induced climate change (WGI) its potential impacts and options for adaptation (WGII) and mitigation (WGIII). The WGI report addresses the most updated physical understanding of our past, present and future climate combining multiple lines of evidence from paleoclimate, observations, process understanding, global and regional climate simulations, etc. In particular, the report highlights our improved understanding of the human influence on a wider range of climate characteristics, including for instance extreme events.

The IPCC reports inform governments in the development of climate policy as well as guiding the international climate change negotiations. Every IPCC report was linked to a major step in international negotiations, from the creation of the UNFCCC (First Assessment Report, 1990), the Kyoto protocol (Second Assessment report, 1995), to the Paris Agreement (Fifth Assessment Report).

The WGI report: the structure and novelty.

The AR6 WGI report contains 12 chapters, plus a regional atlas. Compared to previous reports where topics were discussed in specific separated chapters (assessment of models, observational evidence, paleo-climate records etc.), AR6 follows a broader, cross-chapter structure: large-scale information (chapters 2-4), process understanding (chapters 5-9), regional information (chapters 10-12 + Atlas). Indeed, there is a far greater emphasis on regional climate and factors relevant for risk assessment with nearly one third of the report specifically dedicated to regional climate. Chapter 10 (Linking global to regional climate change) is a new chapter connecting the global to the local, and highly relevant to the needs of local policymakers.

Who writes the report and how is it done?

The IPCC reports are written by a large and diverse community of scientists who decided to voluntarily give up their evenings, weekends and holidays to work on something they strongly believe in. Authors are selected following a call to governments and IPCC observer organizations for nominations. Authors are individually cherry picked solely on the basis of their knowledge, scientific expertise and background. They are not selected because they work for specific organizations and/or lobbies etc. They work on voluntary basis, meaning that IPCC work often comes on top of (or at least in parallel to) their day to day job.

Author teams include a mix of authors from different regions and from developed and developing countries. The IPCC also seeks a balance of men and women, as well as between those experienced with working on IPCC reports and those new to the process, including younger scientists.

AR6 WGI Author Team included 234 authors from 65 countries (28% women), 30% new to the IPCC.

Different kind of 'authors' have different responsibilities: Coordinating Leading Authors, Leading Authors, Contributing Authors, Review Editors, etc..

Chapter 10 author team during the First Lead Author Meeting in Guangzhou (China), June 2018. You may recognize a couple of familiar faces… (Photo by F. Doblas-Reyes)

In my case, Chapter 10 author team was made of around 15 people from all over the world, ranging from the US to Argentina, Jamaica, Europe (most of us), West and South Africa, Saudi Arabia, China, South Korea and Japan. This was a wonderful experience in terms of sharing cultural differences and personal enrichment, but it also created some problems with communications, and practicalities. For instance, during the most intense phases of the writing process, we had weekly virtual meetings. Given the time differences, colleagues from the US and Japan had to work at early morning or late evening hours. I have a great respect and gratitude for their dedication.

The role of Coordinating Lead Authors (CLA) is particularly stressful. They have the responsibility for the entire structure of the chapter, the liaison with the WGI Bureau and co-chairs, and the interaction with other chapters etc. Since one of the major deadline (delivery of one of the report draft) was set just after Christmas, I am sure our CLAs spent their entire holidays working on the IPCC report. I am glad I wasn't a CLA.

Why does it take so long?

The writing process itself lasts around three years, although the scoping of the report and the approval of its structure is done even before the authors' selection.
The report is written in multiple stages, which includes three drafts and a thorough, open and transparent review process.
The First Order Draft, prepared by the authors based on scientific literature (mostly) published after the 5th assessment report (in our case after 2013) is then reviewed by experts. After the expert comments have been considered, author teams prepare a Second Order Draft and a first draft of the report's Summary for Policymakers (SPM). These are subject to simultaneous review by experts and governments. Following receipt of the review comments, author teams then prepare final drafts of the full report and SPM. The final draft of the report is distributed to governments for a final round of written comments on the SPM, before governments meet in plenary session to approve the SPM line by line and accept the underlying report.
AR6 WGI report received more than 78,000 comments, with 46 Countries commented on the Final Government Draft.
Authors are committed to answer every single comment (but they are not necessarily obliged to accept all of them). Comments and answers are made public after the publication of the report.

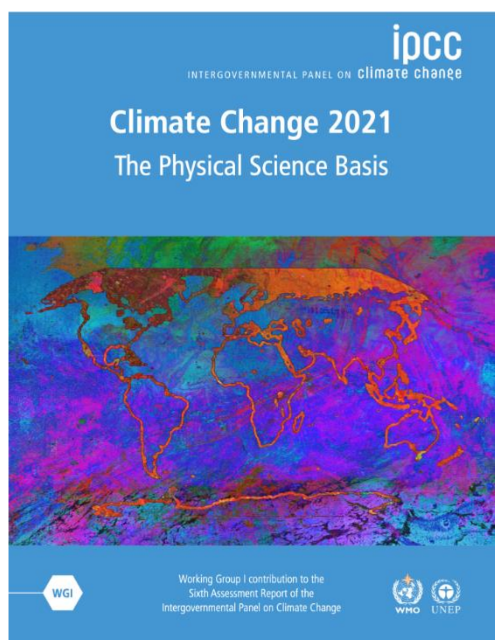
Is that all?

As if the thousands of pages of the full report (and the 40 pages of the SPM), were not enough, the WGI AR6 contains other products than are tailored to the needs of different user communities.
The Technical Summary (TS) is designed to bridge between the comprehensive assessment of the WGI Chapters and its SPM. It is primarily built from the Executive Summaries of the individual chapters and atlas and provides a synthesis of key findings based on multiple lines of evidence. It is written using a less technical language than the chapters.
The Regional Fact Sheets are a 2-page summary of the most relevant information for a specific region including observed and projected trends, and confidence level.
Similarly, the Sectoral Fact Sheets contains the most relevant information for specific sectors like City, buildings and transport, Energy, Tourism, Agriculture & Livestock, Marine & Fisheries, Terrestrial Ecosystems & Forestry, Water, and Insurance sector.
The Summary for Actuaries based on the IPCC Sixth Assessment Report, tailored to the actuarial community while the need for emphasis on some risks.

The interactive Atlas is a tool for flexible spatial and temporal analyses of much of the observed and projected climate change information underpinning the WGI report.

Was it worth it?

This was my first time as IPCC author and for me it was an incredible and exceptionally rewarding experience. I learned really a lot during the three-year process for the writing of the AR6 report. As my specific chapter involved many different and diverse topics, many of which were not at the core of my field of expertise, I feel I have greatly expanded my knowledge, thanks to the close collaboration with truly great specialists. Despite the amount of work involved, the stress of discovering that hundreds of answers to reviewers' comments had mysteriously disappeared from the excel table hours before the deadline, the love-hate relationship with the reference manager Mendeley and the constant fight to correctly insert hundreds of references in the document, and many other things like these, I will always remember the relief and satisfaction at the moment (minutes before the deadline, a Saturday midnight) when we delivered the final draft of our chapter. I will be more than happy to start it over again tomorrow.



CLM-Community issues

ICCARUS 2022 - Review

By Christian Steger (Deutscher Wetterdienst)

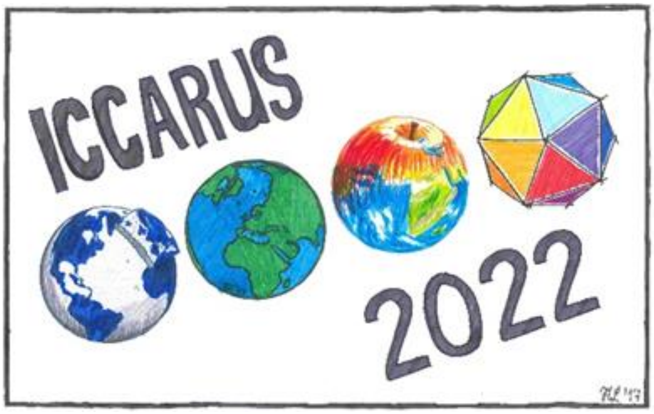
In 2022, ICCARUS was organized as virtual conference for the second time after the premiere of this format in the previous year. The organization team decided to go back to the "classic" format of one week, with plenary sessions on 07 – 09 March and working group meetings on 10 and 11 March. In 2021 the plenary and poster sessions and the working group meetings were distributed over two weeks. 369 persons were registered for the conference and at the maximum, about 250 of them were present at the same time. The average size of the audience across all sessions was about 150 people.

The program included short welcome speeches of Prof. Dr. Gerhardt Adrian for DWD and Prof. Dr. Corinna Hoose from KIT on behalf of the ICON consortium, 39 talks in the plenary and 42 posters in two poster sessions. For the poster sessions on Tuesday afternoon and evening the video conference tool Gather.town was used and it proofed to be very suitable for this purpose. Furthermore, several invited talks were part of the program. The program committee decided to change the structure and reduce the number of these keynotes a bit since their number had grown continuously in the last years due to the inclusion of the ICON consortium. There was only one invited talk from an external scientist. Johannes Flemming (ECMWF) gave a very interesting presentation about "Prognostic aerosols in the radiation scheme of ECMWF's Integrated Forecasting System - experiences with the global CAMS system". Beside that, there were four keynotes covering different aspects of the ICON forecasting system: Roland Potthast gave a talk about the strategic developments for ICON, Barbara Früh gave an overview of ICON for climate applications, Stefanie Hollborn presented the news about the data assimilation component and Günther Zängl provided insights in the upcoming innovations for the forecasting system at DWD.

The talks in the plenary were organised in the sessions „Climate Model Application", „Aerosol and Chemistry", „Radiation and Clouds", „ICON-Seamless", „Coupled Model Applications", „SINFONY: Seamless Integrated FOrecastiNg sYstem", „Data Assimilation" „Large-Eddy Model Applications", „NWP model development and applications" and „Numerics and Model Infrastructure".

The arrangement of the sessions was simplified by allowing the authors to select keywords for their contribution during the submission process instead of assigning the abstract to a fixed thematic session. This allowed for a more flexible and balanced distribution of the contributions to the sessions.

After ICCAURS has now been organized successfully as virtual conference for the second time, the organizational form of the meeting for the future will be discussed in the next months. The opinions of all partners involved in ICCARUS will be heard and collected and the organization team will present a suggestion how the meeting could look like in the post-COVID-19 era. Anyhow, the date for ICCARUS 2023 has already been fixed. In the next year, the meeting will take place from 06 – 10 March.



CLM Community Assembly 2022 - Outlook

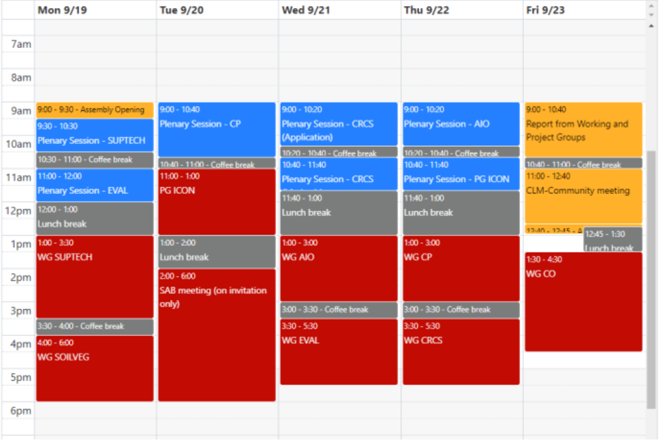
By Susanne Brienen (Deutscher Wetterdienst)

As the pandemic situation is still uncertain for autumn this year, we face another Community Assembly as complete virtual meeting. It takes place in the week 19 to 23 September 2022 and is organized in a similar way as last year, which seemed to have worked out quite well.

The programme, abstracts and all further information are available on the webpage of the event: https://hcdc.hereon.de/clm-community/events/clmcommunity-assembly-2022/
Registration is open until 11 September.

As usual, there will be plenary sessions for the presentation of the submitted abstracts, dedicated working group meetings and a community meeting for the discussion of general community topics.

We strongly invite all community members to take part in this meeting. The gain for everybody's own work and for the common goals of a reliable regional climate model and suitable infrastructure can best be achieved with joined forces. Also new members and early-career scientists are very welcome. It is also possible to participate in working group meetings if you have not been a member before.



Event management via the Community Website

By Philipp Sommer (Hereon)

The CLM-Community-Website includes now an event management functionality that each community member can use to organize events within the community. This event management has already been used for the CLM-Assembly last year and it is now open to everyone. You can create your own events at https://hcdc.hereon.de/clm-community/events or test the feature in our playground at https://hcdc.hereon.de/clm-playground/events.

Events can range from small working group meetings (with the single session mode) to large community events such as the CLM-Assembly. It features abstract submission, registration, view permissions, organization teams, session management, meeting rooms, calendar interfaces for agendas and much more. The documentation is still lacking but you are kindly invited to test the new features and provide feedback or ask questions to philipp.sommer@hereon.de.

The technology behind our website is now open-source at
https://gitlab.hzdr.de/hcdc/django/clm-community/django-academic-community.

The documentation is also still lacking, but we are working on funding possibilities to improve the situation. Our aim is to provide a software that can be adapted by different communities that have an organization comparable to the CLM-Community. You are kindly invited to open issues and discuss in the Gitlab repository.

Currently we are working on a chat system that will replace (and improve) https://redc.clm-community.eu, and we aim for integrating the current website at https://www.clm-community.eu. Our aim is to provide a single website for all the necessary functionalities and topics related to the CLM-Community.

Research notes

The impact of greening on the urban heat island effect – sensitivity studies for Vienna

Johann Züger[1], Marianne Bügelmayer-Blaschek[1], Tanja Tötzer[1]

[1] Austrian Institute of Technology, Giefinggasse 4, 1210 Vienna, Austria

Introduction

Climate change is already taking place and especially cities suffer from the rising temperatures in summer. The increase in built environment is linked to effects like higher absorption of solar radiation, higher heat storage characteristics of the materials and decreased ventilation. Additionally, the inflow of people to cities causes more anthropogenic heat flux (AHF). So, there is a growing need to find suitable measurements to mitigate the UHI effect. One possible measure are nature-based solutions (NbS), e.g., extensive greening within the cities. Its strong impact is caused by cooling due to evaporation and shading. Further, the unsealing needed to implement NbS decreases areas covered by materials of high thermal conductivity, high heat storage capacity and low albedo, which absorb and store large quantities of solar radiation and release it as 'sensible' heat at night [1]. For the smaller scale (meters) micro or urban scale models are used, but to investigate the effect on a whole city (km scale), mesoscale climate models are needed [2]. In this study, we use the COSMO-CLM model [3-4] version 4.8_19 with the land surface models TERRA and TERRA_URB [5-8].

Data and Method

The simulations are based on ERA-Interim reanalysis data from ECMWF [9]. A period from 2001 to 2017 was chosen with special focus on 2003, where Vienna was hit by extremely hot summer temperatures. Three nesting steps were performed with the standard TERRA version for domains at 50, 10, and 4km. The 1km domain covering Vienna was computed with the TERRA_URB. Additional input data for the anthropogenic heat flux (AHF) by Flanner [10] and soil sealing (ISA) from WebPEP [11] were used for the base run. As shown in figure 1 there is no UHI effect in the 4km standard run, but it is clearly visible at 1km with urban extensions switched on.

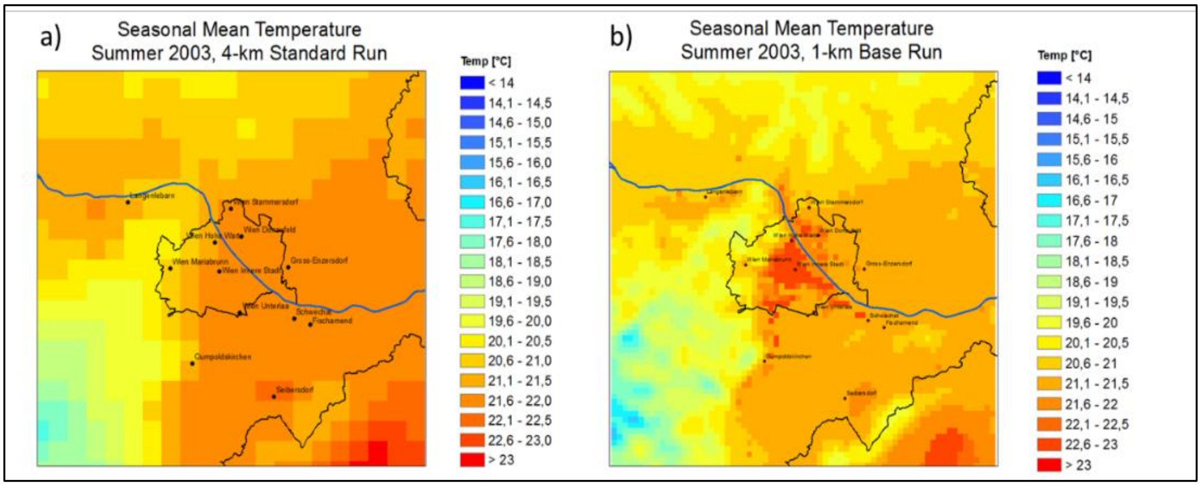


***Figure 1:** Temperature map from 4-km standard run (left) and 1-km urban run (right)*

To evaluate the impact of large-scale greening or sealing on the observed UHI effect in Vienna, four scenarios were computed. The applied AHF was the same for all scenarios, but the fraction of soil sealing, plant cover and area of deciduous forest varied between the simulations. For a high resolution and realistic information about sealed and open areas and their potential for additional green infrastructure a map of Urban Standard Typologies (USTs) developed by Green4Cities [12] was used. On this basis a "Status Quo (STQ)" and 3 scenarios for Vienna were defined (Figure 2) – "Moderate Greening (MOD)", "Maximum Greening (MAX)" and a "Worst Case (WOC)" which means complete sealing.

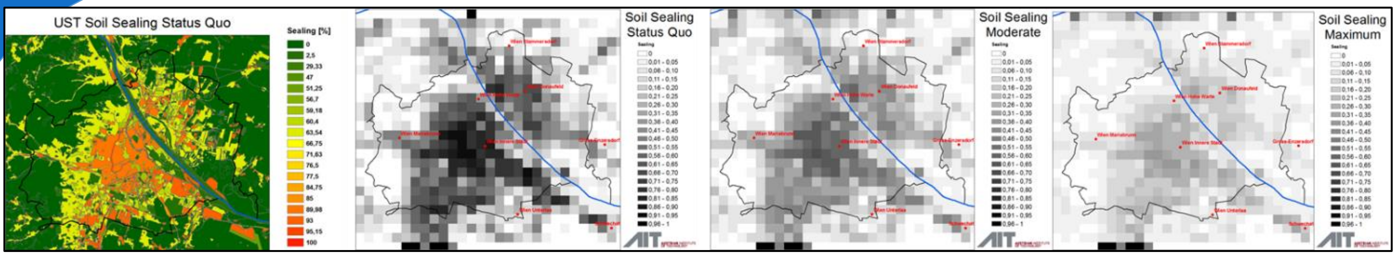


***Figure 2**: Map for soil sealing based on Urban Standard Topologies and CLM input for Status Quo, Moderate and Maximum Greening Scenario (from left to right)*

Results

Summer 2003 was extremely hot, and Vienna had to cope with a seasonal mean temperature of more than 23°C. With moderate greening this temperature could have been lowered by almost 1°C and up to 1.5°C in the MAX scenario (Figure 3, left). Even more pronounced is the impact of greening on the occurrence of tropical nights. There are ~30 nights simulated for STQ. This amount is reduced to ~20 within the MOD and to ~10 days in the MAX scenario (Figure 3, right). The highest changes occur in the city center. In outer districts the current green fraction is already high and thus the numbers do not change strongly.

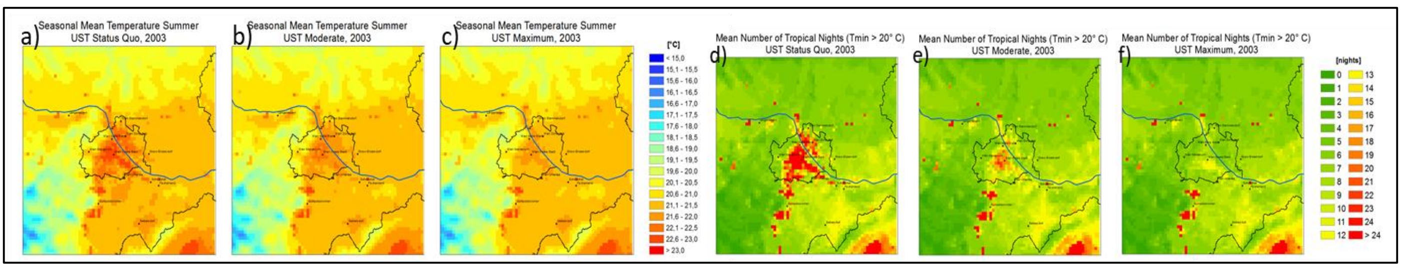


***Figure 3**: Mean summer temperature (a-c) and number of tropical nights (d-f) for STQ (left), MOD (center) and MAX (right)*

The mean diurnal cycle of days with maximum temperatures of 36°C is similar in all experiments and the maximum temperature is almost identical. Yet, the effect of the greening is clearly visible in the morning and evening hours, where the green scenarios display the decreased heat storage. The scenario without any greening measures (whole city sealed) displays up to 6°C higher temperatures in the evening, night, and morning hours due to increased heat storage (figure 4).

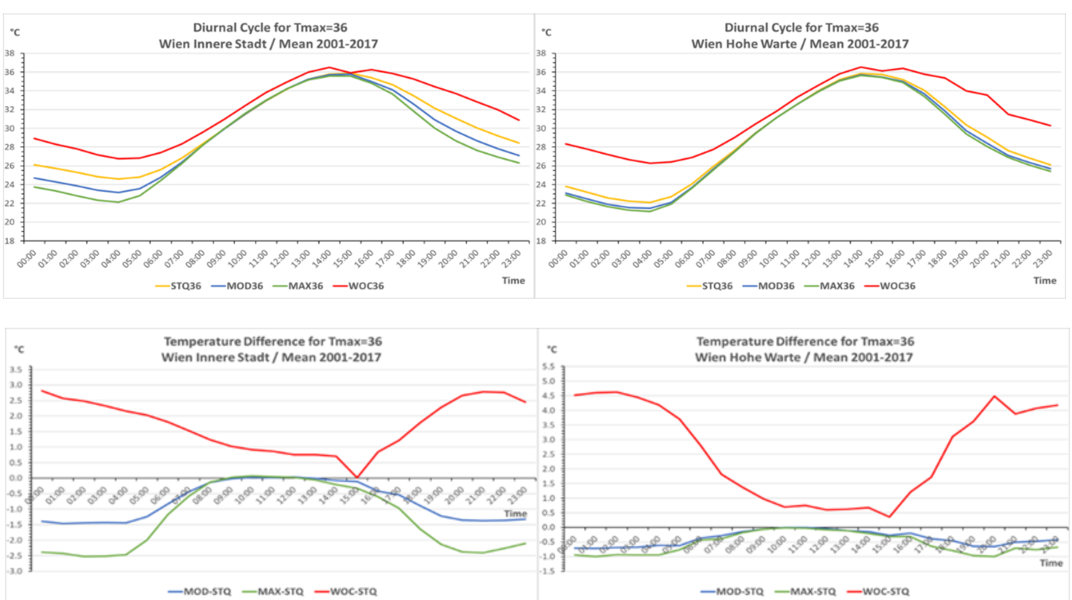


***Figure 4**: Mean diurnal cycles (top) and differences compared to Status Quo (bottom) for city center (left) and a suburban area (right): Status Quo in gold, Moderate Greening in blue, Maximum Greening in green and Worst Case in red.*

As the effects are mainly visible in the night temperatures, we further analyzed the changes during nighttime with respect to daily maximum temperatures (Figure 5). Although night temperatures in general increase with higher daily maximum, the cooling effect is getting more efficient. At the city center (Innere Stadt) we find reductions from 1.5°C at 21°C daily maximum up to 3°C at 40°C maximum. Sealing would worsen the situation in the same range. In suburban areas (Hohe Warte) the cooling effects are smaller and reach from 0.5°C to 1.5°C, but soil sealing worsens the situation dramatically and increase may go up to 6°C compared to Status Quo.

Figure 5: *Night temperatures (left) and changes compared to Status Quo (right) depending on daily maximum temperatures for city center (top) and suburban area (bottom)*

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Sensitivity of Convection Permitting Simulations to Lateral Boundary Conditions in Idealized Experiments

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More details can be found in:

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Introduction

Limited-area convection-permitting climate models (CPMs) with horizontal grid spacing less than 4 km, that partly resolve deep convection and typically don't use deep convection parameterisations, are being used more and more frequently for climate studies. These models represent small-scale features such as deep convection and in consequence extreme precipitation better than coarser regional climate models (RCMs). As these, CPMs are also subject to limitations and challenges.

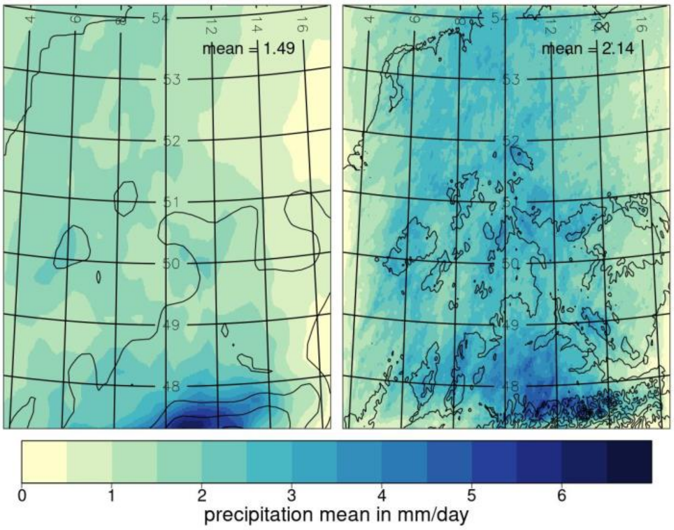

***Figure 1**: mean daily precipitation (mm/d) of 309 convective days from climate simulations with an RCM (left) and a nested CPM (right) in a domain over Germany in the period 1983-2015. Contours show coastlines and orography (contour interval 400m).*

One of these are the domain size, spatial and temporal resolution jumps between the driving data and the CPM, and formulation of the LBCs. In a spatial spin-up zone at the primary inflow boundary of the CPM domain, precipitation amounts are underestimated (Brisson et al, 2016). Figure 1 shows this effect that the paper investigates systematically. The simulated precipitation amounts shown here were discussed in Purr et al. (2019). The CPM (COSMO-CLM with 0.02° grid spacing driven by ERA-Interim with 0.22° grid spacing) simulates about 40% more precipitation on the investigated 309 convectively active days. We investigate how the extend of the spin-up zone depends on the resolution jumps between driving RCM and driven CPM and the characteristics of the orography in the domain. For this, idealised experiments following the Big-Brother-Experiment (BBE) approach (Denis et al. 2002) have been conducted, in an adapted version already used in Leps et al. (2019).

Method, Model and Experiments

An idealised convection-permitting simulation with COSMO5.0-CLM7 with grid spacing of 0.022° was performed over a large domain, the so-called Big-Brother (BB) simulation. Inside this domain, artificial gaussian hills were placed to trigger convection. This data is used as a reference and driving data for two nested domains (Little Brothers, LB); one situated over the hills (orographic LB) and one downwind (inflow LB), see figure 2.

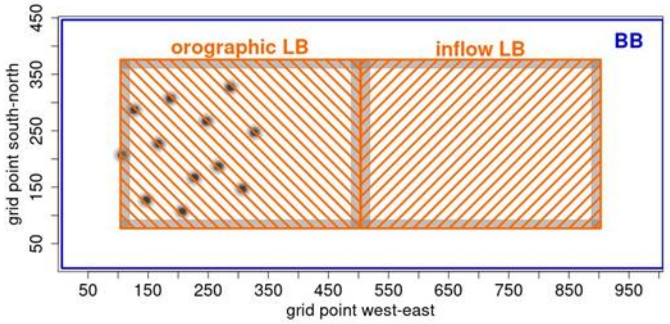

Figure 2: *Domain of the BB (blue) and two nested LB (orange) simulations. Black dots indicate the locations of the Gaussian hills.*

The simulations ran over 24 hours and BB is used as reference and as input data for the LB simulations. As additional input data, Coarse Brother (CB) simulations were performed, that covered the same domain as the BB but on a coarser scale, to mimic realistic coarser input data for the LB nested simulations. These CB simulations were performed with the deep convection parameterisation (CP) switched on or off. The LB simulations were driven by BB and CB in order to quantify the impact of the scale jumps J between driving and nested simulation, and the update frequency U (frequency of lateral boundary data applied to LB per day). Typical driving frequencies of U ϵ {96, 24, 8, 4}/day and spatial jumps of J ϵ {1, 2, 5, 10, 20} were tested.

The simulations were evaluated using precipitation sum and transient-eddy standard deviation ratios (see publication for details) in comparison to the BB simulations (sumr and tsdr, respectively) to get simple statistics for each simulation. The evaluation was always done over the two LB domains, excluding a sponge zone at the boundary. For more details about the calculation, see the publication.

Results and Discussion

In a first step, the results of the CB simulations were compared to the BB simulations. In the BB simulations, precipitation was triggered orographically by the Gaussian hills and moved through the orographic and the inflow LB domain areas. For the two CB simulations with CP switched off (J=2 and J=5), the precipitation pattern is similar to the reference, but a bit coarser. If the CB was simulated with CP switched on, the variability and sum of precipitation was strongly reduced in comparison to BB. Both the variability and sum varied depending on the resolution, values of sumr and tsdr can be found in the publication.

Figure 3 shows, next to the quality of the driving data, also the quality of the LB simulations driven by BB and CB with different update frequencies U and resolution jumps J.

Figure 4 shows the simulated precipitation sum for a selection of the LB simulations nested in different driving simulations.

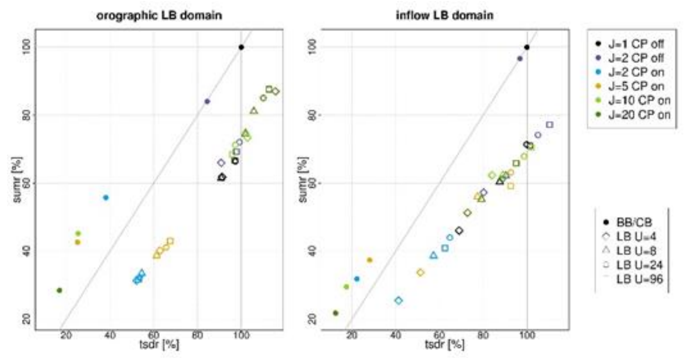

Figure 3*: Scatter plots of the BB, CB and LB simulations relative precipitation sums (sumr) versus relative transient-eddy standard deviations (tsdr) in the two evaluation areas in the orographic (left) and inflow (right) LB domain.*

The quality of the LB simulations driven by BB data is decreased in comparison to the BB simulation, sumr was always underestimated, and tsdr in most cases. Increasing the update frequency U generally improved the results. The LB results were less sensitive to U in the orographic domain than in the inflow domain, orographic precipitation was triggered by the hills in the former and not well inherited from the BB simulation in the latter. A spin-up zone of about 80-100 grid points can be seen. Next to the spin-up zone, the inflow-domain simulations show too much precipitation near the eastern outflow boundary.

Nesting into the CB with grid spacing of 4.9 km with deep convection parameterisation switched off gave relatively good results, in contrast to driving with the CB of the same resolution but with the parameterisation switched on, which gave the overall worst results.

Also, in the simulations driven by CB, sensitivity to the update frequency is small in the orographic domain compared to the inflow domain. The LB simulations nested into the CB domain with 12 km grid-spacing (J=5) did not add value to the average precipitation amount in the orographic domain (large spin-up zone). The results with CB J=10 are better in average. However, that may be because the effects of the spin-up zone are compensated by an overestimation deeper into the domain.

In the orographic domain, the LB nested into the coarsest CB surprisingly gave the best average results. But again, looking at the pattern of precipitation (figure 4), the patterns are not represented the best, with the spin-up zone being compensated by an overestimation further into the domain.

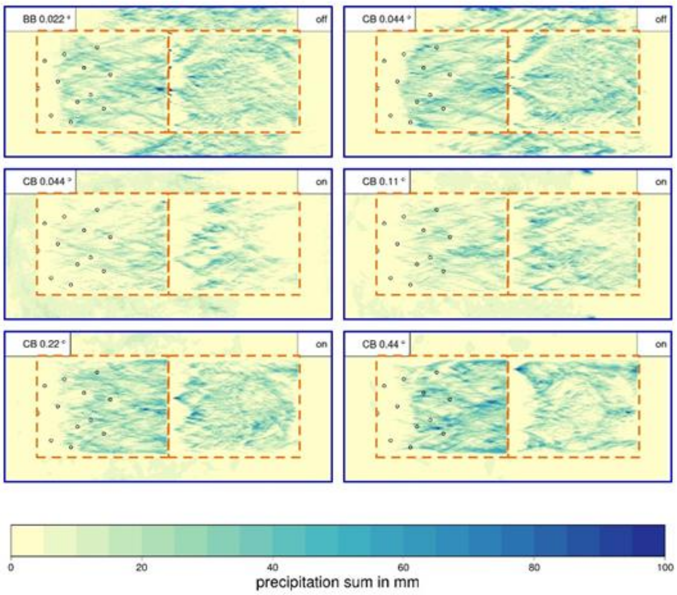

***Figure 4**: Simulated precipitation sum (mm) by the LB simulations in the two LB domains (orange dashed lines) using different driving simulations. All show update frequency U=24 (hourly) and the driving simulation is indicated in the left upper corner. In the right upper corner is written, if the deep convection parameterisation was switched on or off.*

Conclusion

Different simulations on a large domain have been used to drive convection permitting simulations on two smaller domains, one including hilly orography triggering convection, and one where convective cells were advected into through the lateral inflow boundary. The resolution of the driving simulation (BB or CB), as well as the resolution jump to the driven LB domains the temporal update frequency had a strong impact on the representation of precipitation in the LB.

Our results suggest that a buffer zone of about 100 grid points has to be accepted at the lateral boundaries to account for spin-up effects.

The update frequency at the boundaries should be at least 3-hourly. We didn't see an overall impact of using different lateral boundary schemes in the model, however investigating this further might help to reduce some inconsistencies at the lateral boundaries.

The large-domain CB simulation with grid-spacing of 4.9km and the convection parametrisation switched off performed better than all LB simulations. This grid spacing is coarser than usually suggested for CPMs, but on the other hand this simulation is computationally much cheaper than higher resolved LB simulations.

Our results suggest that a larger domain with ca. 5km grid-spacing is advisable, however the optimal compromise between resolution and domain size will be dependent on the model and the application.

We expect that in real world examples with additional forcings results of nested simulations would be better compared to the BB simulations.

It is recommended to use a driving model with grid-spacing not too deep in the grey zone of convection parametrization. The depth of the spin-up zone might be decreased by developing methods for better preconditioning of convective activity at the CPM domain's inflow boundary.

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2022

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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, Athens, Greece

September 19 - 23: CLM Assembly, Virtual Meeting

2023

March 06 – 10: ICCARUS 2023, t.b.d.

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

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