Climate Limited-area Modelling Community

February 2018

Newsletter

No. 10

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See YOU at

ICCARUS 2018

26.02 – 02.03.2018

Offenbach, Germany

Announcement:

CLM Assembly 2018

18. 09– 21. 09.2018

Karlsruhe Germany

Invited speaker:

Thomas Stocker

http://clm2018.imk.kit.edu

We wish you a happy new year 2018!

Welcome to the 1st CLM Community Newsletter... These were the first words of the very first CLM Newsletter published in August 2013. Since then, a newsletter has been published regularly every six month. The introduction section of the first newsletter mentioned, that the newsletter wants "to inform the community about new projects, articles just published, and community activities" as well as "attract the interest of scientists outside our community working on similar issues". We hope that we could achieve this goals during the last five years and the following issues. Furthermore we hope that we could give you some interesting insights in international activities outside the CLM-Community, give you some background information on community members with the section "Five question to..." and last but not least some fun while reading the newsletter. We want to take the opportunity and thank all the community members who contributed to the newsletter in the past. Thank you very much.

The current issue of the newsletter presents an interview with Heimo Truhetz from University of Graz, reports on the 46th session of the IPCC, COP 23 and the CMIP6 timeline, a review to the CLM-Community Assembly 2017 in Graz and an outlook to ICCARUS 2018 in Offenbach. In addition the newsletter contains two research articles by Hendrik Wouters et al. and Anika Obermann et al.

10th issue of the CLM Newsletter. Happy birthday.
Photo by LIST

Enjoy reading the Newsletter

Yours sincerely,
Barbara Früh and Christian Steger

Five questions to … Heimo Truhetz

Wegener Center, Graz

Heimo Truhetz is senior scientist at the University of Graz. He finished studies on Environmental System Sciences in 2000. After a period of self-employment he started a PhD thesis and received the degree in 2010. Since then he is also the vice head of the Regional Climate Modelling and Analysis (Reloclim) research group at the Wegener Center.

1. Heimo, you work at the Wegener Center in Graz. Can you please tell us something about this institution and your tasks there?

The Wegener Center in Graz is an interdisciplinary institute of the University of Graz. There are four research groups (~55 persons in total) that are covering the areas of climate monitoring, climate change and its human dimension, and environmental sciences. We are well established in the Austrian scene. But it was not always like that: in the beginning (2007), the Wegener Center started as a research facility with a special status. In practice, this was sort of a testing phase and the Wegener Center's further existence was not guaranteed. But we successfully passed these days and now the Wegener Center is a regular institute, a visible commitment of the University of Graz on climate sciences.

My heart lies in regional climate modelling and in all what is necessary for doing it. Before the Wegener Center existed, I was already doing regional climate modelling in my garage – even without having heard anything about regional climate models before. As being now a fresh senior scientist, I can continue with that on a professional basis. In addition to many open scientific questions I would love to find an answer on. My responsibilities also include the acquisition of research projects and HPC resources, (co-)advising of PhD and master students and postdocs. Teaching is also receiving increasing attention.

2. In which context do you use COSMO-CLM?

As a regional climate model, clearly. But I also want to better understand the climate system, especially in the Alpine region, and I am trying to do this by means of regional climate models. CCLM is one of them. Another indispensable ingredient is observational data. Observations are giving us a verifiable picture of the climate system – unfortunately, they are quite sparse. The combination of both, models and observations gives a more complete imagination. But one has to be careful not to mix up facts and speculations.

3. You are a member of the CLM-Community for quite a long time now. What are, in your opinion the strength and the weaknesses of the CLM-Community?

When I was a student, I was representing my colleagues at the Austrian Student Union. What we had in common was our curriculum that had no regular status. Then I entered the Wegener Center and all we had in common was a vague idea about interdisciplinary climate research. Then I entered the CLM-Community and again there was something all members had in common, a regional climate model. Meanwhile the curriculum became regular and it is now one of the most popular ones at the University of Graz; the Wegener Center became a regular institute and the CLM-Community is preparing for the next generation of climate projections. So, what is the strength of the CLM-Community? I don't know any better words to express this than a sentence of Andreas Will: "If you want to be fast, go alone; if you want to go far, go together."

4. You organized the last CLM Assembly in Graz (Thank you very much!). Can you share your experience on that with us and maybe give some valuable hints?

Yes, we had the CLM Assembly in Graz in 2017 (thank you very much for coming) and it was a double premier: (1) it took place for the first time in Austria and (2) it was the first time for me to organize such a big event. In order to give some hints, I would like to do a short comparison: organizing the CLM Assembly is like riding a snowboard off the track – there are lots of things you can control, but there also lots of things you cannot and cause surprises. So, reaching apres ski safely requires a mix of skill and improvisation. The most important factor is "time". For instance, it does not matter, "when" the ice breaker is ordered – if something goes wrong, do you still have enough time to develop an alternative? At that point, the problem-solving skill of the organizing team as a whole determines the outcome of the Assembly. I whish the IMK-KIT team all the best for 2018. May they circumvent the pitfalls, we were stepping into.

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

My overarching personal goal on the long-term is to pave the way for young scientists. Of course, there are personal scientific questions and I am also deep in HPC computing, but my position has changed. Maybe it will take some more time to get familiar with this new situation, but finally my task is to support young scientists in finding answers to questions about climate change, especially in the Alpine region.

Thank you very much for the interview!

IPCC activities

IPCC 46th session

by Andrew Ferrone

The Intergovernmental Panel on Climate Change (IPCC) met from 6th to 10th September in Montreal, Canada. In this session, the IPCC decided on the outlines of the contributions of its three working groups (WGs) to the 5th Assessment Report. As a novelty, the three reports are not aligned along scientific specialities, but along topics that were deemed relevant. This will put a particular challenge for the co-chair as a strong inter-chapter coordination is needed. The co-chairs also assured the plenary that they already started to work in a cross-WG style for the Special Reports that are currently under preparation and want to keep up this momentum.

Andrew at the 46th IPCC session in Montreal.
Photo by IISD/Mike Muzurakis (enb.iisd.org/climate/ipcc46/6sep.html

WGI (The Physical Science Basis) will focus on the current state of the climate system, human influence on observed changes and future projections, on global climate processes, biogeochemical cycles, water cycle and sea level, regional climate change, and extremes in a changing climate.
WGII (Climate Change Impacts, Adaptation and Vulnerability) will deal with risks, adaptation and sustainability for systems impacted by climate change, and include seven regional chapters (e.g. Europe, Africa) and seven 'papers' on individual natural and human region types (e.g. Polar regions, cities by the sea) and sustainable development pathways.
WG3 will provide information on emission trends, drivers and pathways encompassing the Paris Agreement temperature goal (and higher pathways), near/mid-term mitigation paths and demand-side aspects, individual sectors (energy, AFOLU (Agriculture, Forestry and Land Use), cities & settlements, buildings, transport and industry) and cross-sectoral interactions, policy and governance at various scales (national, regional etc.), finance and innovation.
The contributions of all three WGs will be approved in 2021. The scope of the Synthesis report was only discussed in broad lines and its scope will be approved in 2020, but it was highlighted that it should contain relevant information for the Global Stocktake under the Paris Agreement.
A detailed outline of the reports, as well as the time lines of the production of these reports can be found on the following page:
WGI:
http://ipcc.ch/meetings/session46/AR6_WGI_outlines_P46.pdf
WGII:
http://ipcc.ch/meetings/session46/AR6_WGII_outlines_P46.pdf
WGIII:
http://ipcc.ch/meetings/session46/AR6_WGIII_outlines_P46.pdf

COP23/CMP13/CMA1-2

by Andrew Ferrone

Under the United Nations Framework Convention on Climate Change (UNFCCC) the 23rd Conference of the Parties (COP23), the 13th Conference of the Parties serving as Meeting of the Parties under the Kyoto protocol (CMP13) and the second part of the first Conference of the Parties serving as meeting under the Paris Agreement (CMA1-2) took place from 6th to 17th November 2017 in Bonn, Germany. It was the first time in the history of the UNFCCC that they were presided by a small island state, namely Fiji.
Furthermore progress was achieved on all items related to the elaboration of the work program of the Paris Agreement, which will allow to put the Agreement into practice and is expected to be approved at COP24 in December 2018, in Katowice, Poland.
Under the Subsidiary Body for Scientific and Technological Advice (SBSTA) two agenda items related to scientific issues were considered.

The first one concerned the use of greenhouse gas metrics for the accounting of emissions. Parties decided to stick with the IPCC Global Warming Potential with a time horizon of 100 years (GWP-100) for the moment and continue discussion of it in early 2019 after the work program related to the Paris Agreement has been approved.

Impression from COP23.
Photo by IISD/Kiara Worth (enb.iisd.org/climate/cop23/enb/9nov.html

Furthermore, the SBSTA considers in its winter session an agenda item of systematic observations. Under this agenda item, Parties noted the effort of Global Climate Observing System (GCOS) and others in developing climate indicators and essential climate variable inventory and noting with appreciation the information on the Global Framework for Climate Service (GFCS) and the challenges on sustaining systematic observation, particularly in developing countries, in particular observations related to the oceans and ocean-related climate indicators. Parties also noted with concern the findings of the World Meteorological Organization (WMO) report on the State of the Global Climate 2017.

Impression from COP23.
Photo by IISD/Kiara Worth (enb.iisd.org/climate/cop23/enb/15nov.html

The CMIP6 timeline

By Christian Steger

The 6th phase of the Coupled Model Intercomparison Project (CMIP6) is under way. Time to provide a short overview of the CMIP6 timeline. As for the past phases of CMIP, the main product of this phase will be the Assessment Report (AR6). The report consists of three volumes, one for each working group, and a comprehensive synthesis report. It will be published in 2021/22, but the preparation for the next report has already started five years ago with the planning and the preparation of the input data for the simulations.

The production of the data, which forms the basis for the Assessment Report, has started mid of last year with the so called DECK experiments (Diagnostic, Evaluation and Characterization of Klima). The ScenarioMIP simulations, with different future emission pathways will start in 2018. Beside these projects, CMIP6 contains numerous other subprojects, so called MIPs (Model Intercomparison Projects), which deal with other aspects of models or the earth system. CORDEX is one of them. In total, there are 21 endorsed MIPs, more than in any CMIP phase before.

In addition to AR6, the IPCC will produce three special reports until 2019. There will be a special report on the 1.5 degree target, which was appointed by representatives from 195 countries in the context of the 21st conference or the parties (COP21) in Paris in 2015. In addition there will be special report on aspects of land use and terrestrial ecosystems and a third one on Oceans and Cryosphere.

More information about CMIP6 can be found on the webpage of the World Climate Research Programme (https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6). Information about the Special and Assessment Reports is provided by IPCC (http://ipcc.ch/).

CLM-Community issues

Review - CLM Assembly 2017

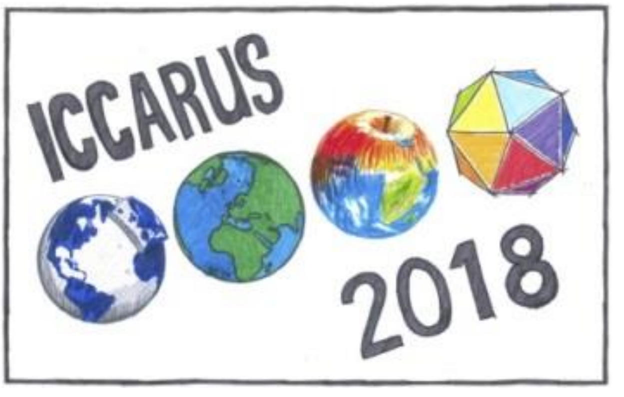
The 12th CLM Assembly took place at the Wegener Centre, University of Graz in Austria from 19th to 22nd of September 2017. About 60 participants discussed scientific topics related to COSMO-CLM. Twenty-four talks were given in the six oral sessions from Tuesday to Thursday. Mathias Rotach (University of Innsbruck) and Bruce Hewitson (University of Cape Town), the two invited speaker, talked about "Simulation of turbulence in alpine valleys" and "The intersection of downscaling, information, uncertainty, and psychology". The slides of all talks are available online (https://wegcwww.uni-graz.at/clm2017/public/gallery/clm2017/html/default.html). The oral session were supplemented by two poster sessions.

Group photo at the CLM Assembly 2017
Photo by Annina Thaller, University Graz

The meetings of the working groups and the CLM-Community meeting are traditionally the second important pillar of the Assembly. The community decided among other things, that the CLM assembly 2019 will take place in Italy. If you are interested in the topic of one or several working groups or if want to get involved, please visit the CLM webpage for more information or contact the particular coordinator of the working group directly.

Outlook - ICCARUS 2018

The next ICCARUS is almost there! The joint meeting of COSMO, CLM, ICON and ART Communities is organized by DWD and takes traditionally place at the DWD headquarters in Offenbach. This year, the meeting occurs under its new name for the first time. A new name was necessary because the partners working on the ICON development took part in the meeting last year. As a consequence the name of the seminar should have changed to cumbersome **I**CON/**C**OSMO/**C**LM/**AR**T **U**ser **S**eminar. The better sounding name was found in a contest. Since 8 participants suggested "ICCARUS", this name won clearly.



New logo drawn by Nora Leps (GUF, DWD)

This year, we can look forward to an interesting meeting with about 200 participants from all over the world, 38 talks organised in 10 sessions, and three poster sessions with more than 60 poster in total. As usual, the sessions cover all relevant topics of the communities involved, from data assimilation and model input data to dynamics and numeric, cloud microphysics, aerosol and radiation, planetary boundary layer, soil, vegetation and ocean, verification and evaluation, predictability and ensemble systems, as well as NWP and RCM applications and process studies.

In addition to the talks in the oral sessions, there will be two invited and four solicited talks. The invited speakers are Robin Hogan from ECMWF, Reading, UK, who will talk about "Radiation in NWP: recent advances and future challenges" and Martin Losch from Alfred-Wegener-Institute in Bremerhaven, Germany. He will present his work on sea ice dynamics at high resolution.

Obituary of
Daniel Lüthi
12.09.1962 – 20.01.2018

Photo by LIST

Dani Lüthi passed away on the 20th of January 2018 at the age of 55 years, after suffering from a serious disease for a little more than two years. We grieve for a very likeable and cooperative colleague and a very competent scientist.

Dani was a pioneer in the area of weather and climate modeling, and a long term member of the CLM Community. He grew up in Solothurn, Switzerland and got a degree in Physics from ETH Zurich in 1987. He joined the Institute for Atmospheric and Climate Science at ETH when he did his diploma and PhD theses with Huw Davies. His PhD was about the forcing of atmospheric mesoscale circulations. During his PhD, he has been among the first in Switzerland to use a full atmospheric numerical model, long before numerical modeling was to become a key element of current weather and climate research.

Following his PhD, Dani continued to work at ETH in atmospheric mesoscale modeling, and became the head of the institute's first IT administration. Soon Dani started to shape the modeling environment and IT infrastructure at the institute, and decisively contributed to making it as sophisticated and convenient as it is still today.

In 1993 Dani joined the group of Christoph Schär to work on regional climate modeling. As a member of the CLM core group, he contributed strongly to a significant number of code developments in the COSMO model and its predecessors and served as EXTPAR source code administrator for many years. He was involved in a number of international committees, interacted with the modeling communities at the Swiss and German Weather Services and made wide-ranging contributions to CORDEX.

One of his professional highlights was the Mesoscale Alpine Programme (MAP). During the field phase in 1999, he stayed at the operations center in Innsbruck and was the main responsible for running the first kilometer-scale numerical weather prediction model in real-time mode. Such models are now operational at many weather services around the world.

Dani was a hard-working, quiet and very selfless individual and did always put himself behind his services to the community, the institute, and his colleagues. He supervised and supported generations of master, PhD and post-doctoral students. We are grateful that we had the pleasure to work with him. Dani leaves behind his wife Pierrette, their children Lara and Timon, his parents, and many additional family members. Our thoughts are with him and his family.

■

Research notes

Heat-stress increase under climate change twice as large in cities as in rural areas: a study for a densely populated mid-latitude maritime region

Hendrik Wouters[1,2], Koen De Ridder[3], Lien Poelmans[3], Patrick Willems[4], Johan Brouwers[5], Parisa Hosseinzadehtalaei[4], Hossein Tabari[4], Sam Vanden Broucke[1], Nicole P.M. van Lipzig[1], Matthias Demuzere[1,2]

[1]Department of Earth and Environmental Sciences, KU Leuven, Heverlee, Belgium, [2]Laboratory of Hydrology and Water Management, Ghent University, Ghent, Belgium, [3]Environmental Modelling Unit, Flemish Institute for Technological Research, Mol, Belgium, [4]Department of Civil Engineering, KU Leuven, Heverlee, Belgium, [5]Flanders Environment Agency, Aalst, Belgium

More details and additional references can be found in:
Wouters, H., K. De Ridder, L. Poelmans, P. Willems, J. Brouwers, P. Hosseinzadehtalaei, H. Tabari, S. Vanden Broucke, N.P.M. van Lipzig, M. Demuzere (2017): Heat stress increase under climate change twice as large in cities as in rural areas: A study for a densely populated midlatitude maritime region. Geophys. Res. Lett., 44, 1–11, doi:10.1002/2017GL074889.

Introduction

Greenhouse gas emissions and land-use changes both lead to more intense, more frequent and longer lasting heatwaves. Recent studies have been using ensemble general circulation models and regional climate models to address the future (heatwave-related) risks of climate change around the globe including the role of urbanization. However, all of these studies use climate information on a scale (size of grid cells > 50x50 km^2) that is too coarse to resolve the inter-urban variability of the cities. In order to capture the urban-atmospheric feedbacks contrasting with the rural surroundings and the consequential urban-induced circulations, one requires to resolve at least the scale of the cities themselves (< 10x10 km^2).

Here, we project temperature-based urban heat-stress for Belgium under global warming with a unique combination of convection-permitting climate downscaling, socio-demographic urban land-use change modeling, and ensemble information from general circulation models. Therefore, long-term (35-year) urban-climate model integrations with the COSMO-CLM model (Rockel et al., 2014; Schulz et al., 2016) coupled to the urban land-surface scheme TERRA_URB (Wouters et al., 2016) resolving the convection-permitting scale at 2.8km resolution (Brisson et al., 2016) are performed.

The heat stress is quantified for a historical (1980-2014) and a future (2040-2074) period. Two local land-use scenarios are considered, namely a scenario for historical urbanization (year 2000) and a scenario for future business-as-usual urbanization (year 2060). Three global emission scenarios are constructed from the CMIP5 ensemble by taking the 5th (best-case), 50th (median) and 95th (worst-case) percentile values of changes in temperature distributions, respectively. The heat-stress indicator from the Flanders Environment Agency is applied that sums the exceedances above the daily temperature alarm levels (29.6°C for maximum temperature; 18.2°C for minimum temperature) for each heat-wave day, expressed in heatwave degree days on an annual basis [°C·day]. More details on the heat-stress indicator, the urban-climate model setup and evaluation, and scenarios can be found in Wouters et al. (2017).

Results

The heat-stress increase towards the mid-21st century is twice as large for the city centers as for the natural surroundings. Particularly, the cities experience an increase of the annual heat stress from 17°C·day for the present-day to 25/70/253°C·day by the mid-21st century (best-case/median/worst-case emission scenario), and become more intense away from the coastline (see Figure 1). For the rural areas, the absolute increase is much smaller from 2.6 to 6.4/25/145°C·day. Remarkably, the heat stress for the rural areas in the future climate is higher than for the urban hot spots of today. On average over the different city centers, the heat stress in the urban centers is multiplied by a factor between 1.5 and 15 depending on the emission scenario, considering the business-as-usual land-use change scenario. These increase factors become slightly smaller when the land-use change is not taken into account (between 1.4 and 14). Clearly, the role of the global emission scenarios is larger than the role of local land-use change scenarios in terms of the overall heat-stress increase under global warming and its spread for Belgium. Still, new emerging urban areas experience strong impacts as their future heat stress becomes more similar to existing urbanization.

The presented scenarios allow for a decomposition of the different climatic drivers of heat-stress increase under climate change occurring at the different scales and are explained below by means of Figure 2. In accordance to earlier studies, a substantial part of the heat-stress increase already stems from global-warming trends in the general circulation models.

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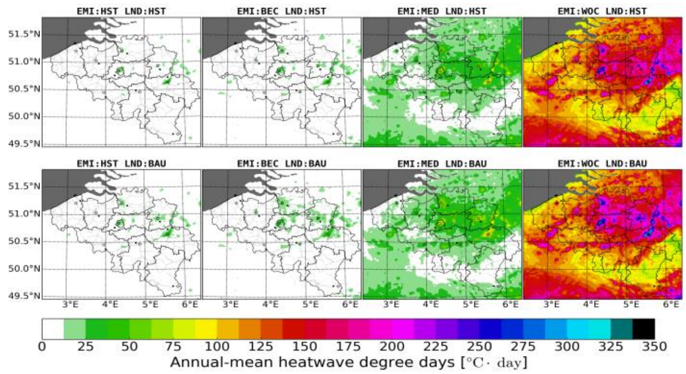

Figure 1. *Climate downscaling hindcast (1980-2014) and projections (2040-2074) of annual-mean heat stress based on the global emission scenarios (historical: EMI:HST / best-case: EMI:BEC / median: EMI:MED / worst-case: EMI:WOC) and local land-use change scenarios (historical: LND:HST / business-as-usual LND:BAU) over Belgium. The heat stress is expressed in heatwave degree days according to the heat-stress indicator considering a pointwise multiplication of heat-wave days and the intensity.*

Herein, both the monthly-mean change (BASE) and the shifting probability distribution (SPD) of the daily temperatures are important. The latter reflects an excessive increase of high extremes in daily temperatures in comparison to the average temperature increase. We further reveal a profound exacerbation of urban heat stress increase with the convection-permitting climate downscaling with the COSMO-CLM model, especially in the city centers. The exacerbation is driven by the urban heat island itself (CPM_M), the excessive urban heat island intensities during heatwaves (CPM_TD), and urban expansion (CPM_LUC). Those excesses under climate change are explained by the nonlinear response of the heat-stress to increasing temperatures. The last term CPM_LUC stemming from local land-use change mostly affects the peri-urban areas where the urban expansion typically takes place. However, it also makes the hot spots at the city centers more intense: at night, the air flow in the direction of the urban centers accumulates more heat (or is cooled less) because an additional amount of heat is stored in the cities' periphery. This eventually leads to a higher temperature in the centers.

Conclusions and outlook

The applied framework that combines climate and land-use models acting on the different scales offers novel insights in the relation between heatwave-related problems, urbanization and climate change for Belgium.

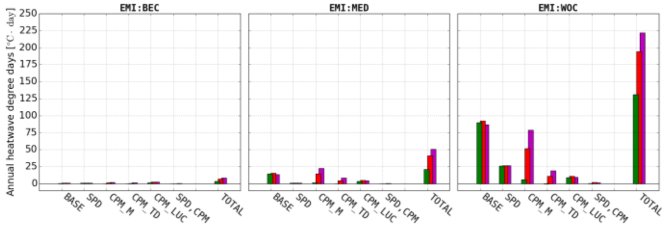

Figure 2. *Total heat-stress change (TOTAL) and its climatic drivers according to a Stein and Alpert (1993) decomposition under the three global emission scenarios (historical: EMI:HST / best-case: EMI:BEC / median: EMI:MED / worst-case: EMI:WOC), expressed in future change in annual heatwave degree days [°C·day]. Results are averaged for different levels of impervious surface area fractions, ie., urban centers (purple; Impervious Surface Area (ISA) for the surrounding 100 km^2 ≥ 50%), peri-urban areas (red; 25% ≤ ISA(100 km^2) < 50%) and rural areas (green; ISA(100 km^2 < 25%). The baseline term (BASE) indicates the change according to the ensemble global emission scenarios by changing the monthly-mean temperatures of the coarse-scale historical record of gridded observations by E-OBS. The Shifting Probability Distribution term (SPD) refers to the additional heat-stress increase when also taking into account the differential change between the monthly 10-category quantiles of the daily temperature distribution. The contribution of urban heat-stress increase related to the urban convection-permitting downscaling is quantified by subsequently adding the monthly-mean temperature deviation from the above coarse-scale observational record (CPM_MD), the inclusion of the day-to-day time-dependency of those temperatures (CPM_TD), and the inclusion of the future local land-use change under a business-as-usual scenario (CPM_LUC). Finally, the additional covariance term (SPD,CPM) arises from simultaneously providing the information about the shifting probability distribution and the downscaling.*

It exemplifies that such a framework - particularly featuring the convection-permitting climate downscaling with the COSMO-CLM model - is indispensable for comprehensive climate-change assessment in heterogeneous regions. As such, methodology holds great promise for other regions and other risks related to urban climate change as well. Especially, the (sub-)tropic developing regions need to be considered for which urban expansion and population vulnerability are much larger than in mid-latitude developed regions. Finally, our quantification of the different drivers of urban heat stress under climate change demonstrate that adaptation strategies (decreasing of urban heat load with urban green infrastructure) and mitigation strategies (avoiding greenhouse gas emissions with renewable energy and compact low-carbon city design) should come together for countering the increase in heat-wave problems especially in the urban areas. In that respect, interdisciplinary research needs to pursue optimal pathways for future urbanization, for which heat-reducing strategies apply to the multiple scales of climate change on the one hand and of policy-making on the other hand. It is clear from our study that urban convection-permitting models should serve as a key tool. ■

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Wouters, H., M. Demuzere, U. Blahak, K. Fortuniak, B. Maiheu, J. Camps, D. Tielemans, and N. P. M. van Lipzig (2016), The efficient urban canopy dependency parametrization (SURY) v1.0 for atmospheric modelling: description and application with the COSMO-CLM model for a Belgian summer, Geoscientific Model Development, 9(9), 3027–3054, doi:10.5194/gmd-9-3027-2016.

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Influence of Sea Surface Roughness Length Parameterization on Mistral and Tramontane Simulations

Anika Obermann-Hellhund, Benedikt Edelmann, Bodo Ahrens

Institut für Atmosphäre und Umwelt, Goethe Universität Frankfurt, Altenhöferallee 1, 60438 Frankfurt am Main, Germany

More details and additional references can be found in:
Obermann, A.; B. Edelmann, B. Ahrens (2016): Influence of sea surface roughness length parameterization on Mistral and Tramontane simulations. Advances in Science and Research, 13, 107-112, doi: 10.5194/asr-13-107-2016

Introduction

The Mistral and Tramontane are winds in southern France, which are channeled through the Rhône and Aude Valleys. They often occur at the same time and play a crucial role in deep-water formation in the Gulf of Lion and for the understanding of the Mediterranean Sea circulation. On Mistral and Tramontane days, simulations with the regional climate model COSMO-CLM (CCLM) with 0.088° grid spacing were found to be able to simulate Mistral and Tramontane wind patterns slightly overestimating 10-m wind speed compared to satellite and buoy observations (Obermann2016). This sensitivity study investigates the influence of the sea surface roughness length parameterization on the patterns of Mistral and Tramontane wind speeds and wind directions above the Mediterranean Sea in CCLM simulations.

Methods

The simulations of this study were performed using the model version CCLM 5-0-2 on a domain of 1140 times 800 km^2 encompassing Southern France and a large part of the western Mediterranean Sea. The simulations are nested into a CCLM simulation from the MedCORDEX framework (Ruti et al., 2015) and cover the year 2005. Horizontal grid spacing for both domains is 0.088° (Edelmann, 2015).

The roughness length z_0 depends on the properties of ocean waves and, therefore, on wind speeds over the sea surface. A classical parameterization of sea surface roughness was introduced by Charnock (1955) and is implemented in CCLM as $z_0 = \frac{\alpha}{g} \cdot max(u_*^2, w_*^2)$. Here, α denotes the Charnock parameter, g the gravity constant, u_* the friction velocity, and w_* the free convection scaling velocity. In the standard configuration, CCLM uses α =0.0123 (the reference simulation). Two larger values of α, 0.025 and 0.05, are tested.

Results

Figure 1a shows the mean sea level pressure during the Mistral days in 2005 from the reference simulation. Figure 1b shows the mean 10-m wind speeds during the same days.

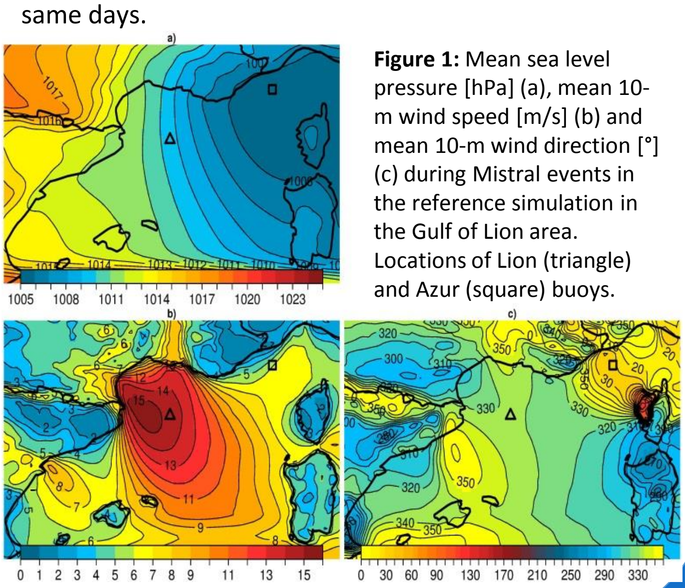

Figure 1: Mean sea level pressure [hPa] (a), mean 10-m wind speed [m/s] (b) and mean 10-m wind direction [°] (c) during Mistral events in the reference simulation in the Gulf of Lion area. Locations of Lion (triangle) and Azur (square) buoys.

Figure 2 shows the bias of the simulation runs compared to the reference run. A decrease in wind speeds is observed for increasing α in large parts of the modeling domain. The strongest decrease in wind speed for increasing α occurs in areas with high absolute wind speeds in the reference run. With increasing α the wind direction changes to a more counterclockwise rotated direction south of the Balearic Islands, between the Alps and Corsica, as well as from Corsica to the northern Apennines.

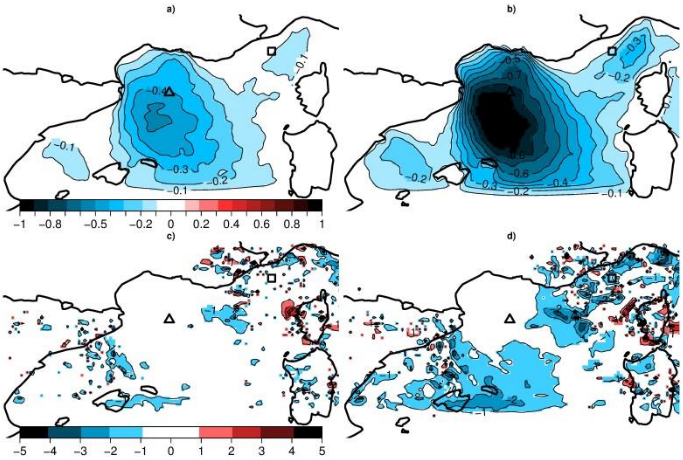

Figure 2: 10-m wind speed bias [m/s] (a and b) and 10-m wind direction bias [°] (c and d) for α =0.025 (a and c) and α =0.05 (b and d) with respect to reference.

Discussion

From the wind speed dependence of the Coriolis force, one would expect that slower winds come from a more counterclockwise rotated direction. Consequently, this effect should be stronger where the wind speed change is larger, but this is not present in the simulations. Indeed, the change of wind speed and wind direction do not occur at the same time and location. The counterclockwise rotation at the borders of the main flow could be due to the flow becoming more ageostrophic with decreasing wind speed. The Coanda effect counteracts the clockwise rotation of Mistral and Tramontane due to the Coriolis force (Giles, 1977). The increased α values could potentially result in a broadened Mistral and Tramontane flow, which would extend further to the east. A consequence of which would be a smaller bias in wind speed and a counter-clockwise rotated wind between Alps and Corsica.

Conclusions

Three values for the Charnock parameter α have been tested. Higher values of α lead to lower wind speeds in the main Mistral flow. The overestimation of wind speeds in the reference simulation was reduced. A counterclockwise rotation of the wind on the left-hand border of the flow is observed for higher values of α. This could be due to a change in the balance between the wind speed dependent Coriolis force and pressure gradient force as well as corner effects as the so-called Coanda effect, which causes a flow to stay close to nearby mountain ranges. Further studies are needed to test these assumptions and to study the sensitivity to roughness length changes due to other phenomena (e.g., ocean currents and waves).

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CLM-Community Coordination Office
Dr. Christian Steger, Dr. Barbara Früh, Anja Thomas
Deutscher Wetterdienst
Frankfurter Str. 135
63067 Offenbach, Germany
clm.coordination@dwd.de

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