Climate Limited-area Modelling Community
CLM-Community Newsletter
DWD

No. 6 January 2016

Content

Happy New Year 2016…

… and enjoy the 6th CLM Newsletter!!!

An interesting year passed by with some very successful milestones achieved by the CLM-Community. Thanks to the initiative COPAT, a project group with the aim to perform a COordinated Parameter Testing, the new model version COSMO5.0-CLM6 was evaluated. This initiative is a very good example for a successful community effort since it was a very intense collaboration of several institutions distributing the work load over many of us. The CLM-Community accepted the new model version as our new recommended CLM-Community version at our annual CLM Assembly which was held in Luxembourg in October last year.

Another important result of our community effort are the big steps we made towards the CLM test suite. A first version of the technical test suite and a draft version of the meteorological test suite are already finished. Having this test suite completed facilitates us to develop the model decentralized since the performance of the model can be tested from every member in the same objective way. Many thanks to everyone who is involved in this development!

I am also very happy about the increasing number of successful COSMO-CLM applications for convection permitting climate simulations. The ability to solve the non-hydrostatic equations of motion singles COSMO-CLM out compared to other regional climate models. Thanks to the increasing computing power and efficiency of modern high performance computers these kind of simulations are becoming more feasible and, thus, more attractive.

Looking forward to 2016, there will be many more new challenges in which the CLM-Community should get involved. One of them is related to the planning and preparing of the upcoming IPCC AR6 report (see section IPCC activities for further reading). These initial ideas will surely be consolidated at the ICRC-CORDEX conference in Stockholm, Sweden, 17 – 20 May 2016. We, as a community, have a chance to contribute to many of the planned issues, e.g., the flag ship pilot studies and the atlas type product. In doing so we could make an important contribution to the IPCC AR6 report. I am really looking forward to these new challenges!

Yours sincerely, Barbara Früh

CLM Assembly

2006	Langen, Germany, 09-10.03.2006
2007	Langen, Germany, 07.-09.03.2007
2008	Langen, Germany, 05.-07.03.2008
2009	Karlsruhe, Germany, 14.-16.09.2009
2010	Berlin, Germany, 01.-03.09.2010
2011	Cava de' Tirreni, Italy, 30.08.-02.09.2011
2012	Leuven, Belgium, 17.-20.09.2012
2013	Zürich, Switzerland, 27.-30.08.2013
2014	Frankfurt, Germany, 02.-05.09.2014
2015	Belvaux, Luxembourg, 29.09.-02.10.2015

Save the date!!!!

2016 **Lüneburg, Germany**
20. – 23. September 2016

2017 Graz, Austria

Five questions to Ivonne Anders, ZAMG

1. Which is your main research focus when using COSMO-CLM?

Beside other issues, the Climate Research group at ZAMG is focusing on the changes of glaciers and on extreme events like dry periods and extreme precipitation events in the South and East of Europe but also in high mountain regions in general. I am interested in how well the RCMs and especially the CCLM are able to reproduce certain events. I do mainly sensitivity studies and try to tune, but also improve the model to get the results closer to the observations. As I am working at a weather service, the task of climate services is playing an important role in my day-to-day business. Improving the model results leads to better products we can offer to the customers. The applications are often very interesting and so I am able to work together with people dealing with energy potential, risk management, wildlife changes or odor transmission. There are so many issues to be able to focus on and I have many ideas. Up to now working with CCLM is still a one-(wo)man-show at ZAMG and financial basement is often a problem. But as I learned from my time at HZG, the most interesting research is the one you do beside the stuff you are paid for, the hidden research, ☺. Now I try to establish a small group dealing with the model and to extend “official research”.

2. What was your motivation to join the CLM Community and to take over the lead for the working group EVAL?

When I started working with the model in the beginning of 2005, the community was very small with 19 members only. There was no question about not to join the community. I think that a community really can push the development and the application of a model forward, which actually happened in the last 10 years. Another reason, I was very new in regional climate modelling and I really learned a lot from discussions within the community. During my PhD and later at ZAMG the focus of my research was on evaluation of model results and identifying deficiencies in the model. I usually joined the WG-EVAL meetings because everybody is dealing with model evaluation in some way. Before the CCLM-Assembly in Leuven in 2012 I was asked to take over the lead of the group and was finally elected. This was a great and interesting opportunity for many reasons. Meanwhile the WG-group has grown to a strong group working on tasks together across different institutions. My job in sending invitations, minutes from the meetings and leading the workshops is small against the effort most of the WG-members put into the working group.

3. What are your expectations to the CLM-Community?

From my daily work, I know about other limited area models used for climate applications and the connected user and developer groups. The most successful models and communities are the well-organized ones containing weather services on one hand but also research centers and universities on the other hand. In this way the application and development covers a very broad range of topics and issues. The exchange between the community members is important, bringing together people working on similar issues, the same as helping in case of problems, bugs etc. Especially the active work in the different working groups strengthens the community to the outside.

We should really push forward the idea of the community to develop the model together to continue the very fruitful exchange of ideas and discussions during our regular meetings.

4. Ivonne, what are, in your opinion, the strengths and the weaknesses of the CLM-Community?

As I mentioned before our strength is that the community includes weather services, research centers and universities connecting research and application. All together, we develop and apply the model in a broad range of tasks and topics. In this way and due to the simulations carried out for the IPCC-reports within the ENSEMBLES- and the CORDEX-framework, the COSMO-CLM has been established to a strong model among the other state-of-the-art RCMs. The structure of our community with working and project groups give all members the opportunity to find themselves in there and to exchange ideas. The model documentation and the technical support are great and in case of problems or bugs, there is quick response and hints for solutions. In my opinion, it is a big advantage to have the core member institutions in the community. They are able to constantly support the community with manpower etc. This brings me to a weakness of the community: Except perhaps for the core institutions, the size of research groups working with the model strongly depend on related projects and financial support in most other institutions. In this way, the number of active community members differs from year to year. This can also be seen in the number of participants in the annual meetings.

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

Good question… working in science is always a fight for money and within the last three years my main task was writing proposals not only CCLM-related but also on impact analysis, data homogenization etc. If I decide to stay in research, I would like to work in or set up a group of researchers working in the same direction dealing with and improving the model with respect to impact modelers needs. There are many things which could be done. Additionally beside my fulltime job at ZAMG, I started teaching at the University one year ago. I like it a lot working with people. To keep a combination of both would be nice.

Thank you very much for the interview!

IPCC activities

IPCC Workshop on Regional Climate Projections and their Use in Impacts and Risk Analysis Studies, Brazil, 2015

By Alessandro Dosio From 15 to 18 September 2015, 110 experts from 52 countries, including world leading experts in the areas of regional climate projections and impacts and risk analysis studies, gathered at the Instituto Nacional de Pesquisas Espaciais (INPE) in São José dos Campos, Brazil, to discuss and review the status of the science and to strengthen the link between the assessment of regional projections and the assessment of the projected impacts and risks, with the goal to enhance the information the IPCC can provide to its users and stakeholders in its Sixth Assessment Report.

The goals of the meeting were to

- Critically reflect on the assessment of regional climate change projections and of regional projections of climate change impacts and risks, and their limitations, in the IPCC AR5;
- Collect views and perspectives on how IPCC assessment of regional projections of climate, impacts and risks could be better supported/improved;
- Discuss the latest, post IPCC AR5 results from regional climate modelling and downscaling efforts;
- Obtain an overview of the status of information currently available and expected on a time scale relevant for the next assessment cycle for all regions of the world;
- Explore ways how the IPCC could facilitate the collaboration and exchange between the climate modelling and impact and risk communities, including ensuring an effective flow and quality control of information and data;
- Identify numerical data requirements (climate variables, derived quantities, proxies, and statistics) by the impacts and risk communities from the climate modelling community that could help facilitate the IPCC assessment process in the future

The main goal of the Workshop was to arrive at a set of recommendations to a range of addressees: to the IPCC, the IPCC Working Group's for the AR6, as well as the scientific community and the decision/policymakers.

A short list of high level recommendations and priorities in view of the incoming AR6 process is provided below:

General Recommendations for the IPCC

- Engage in a dialogue with the World Climate Research Programme (WCRP), with its Coordinated Model Intercomparison Project (CMIP) and with CORDEX (Coordinated Regional Climate Downscaling Experiment), for fostering research on distilling across multi-model multi-method ensemble data, in particular the further evolution of Atlas products.

- Engage in a dialogue with the Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) and Future Earth for fostering coordinated quantitative research on projections of vulnerability, impacts and risks, in particular the design of Atlas products.
- Engage in a dialogue with the Global Framework on Climate Services (GFCS) and related climate services partnerships for issues of communication and user needs
- Consider options to contribute to or facilitate the development of scientific guidance on national or regional climate assessments.

Edificio do Banespa der Banco do Estado, Sao Paulo (Photo: Heike Hübener).

General Recommendations for the IPCC AR6 Cycle

- Rethink the approach to present regional information in the assessment reports. The goal should be to enhance regionalization of the assessment throughout, not to add more separate regional chapters to one or more WG Reports.
- Support the integration of the assessment across WGs by dealing with topics of high-regional relevance in a coordinated manner.
- Make use of IPCC Expert Meetings and Workshops that are cross-WG organized, to activate the research communities for the assessment and foster coordination across WGs
- Prepare IPCC Guidance Documents, e.g., Good Practice Guidance Papers on important cross-WG themes and topics to help the assessment process in AR6.

Specific Recommendations for the IPCC AR6 Scoping Process

- Prepare an AR6 WGI Atlas of Global and Regional Climate Projections.
- Prepare an AR6 WGII Atlas of Global and Regional Climate Impacts and Risks.
- Assess the uncertainty in climate projections in a comprehensive, end – to - end manner in the AR6 and in particular in the proposed WGI and WGII Atlases.

A few further topics that have not made it to the "high level recommendations"

By Heike Hübener In addition to the information provided by Alessandro Dosio, I would like to highlight a few further topics that have not made it to the "high level recommendations". Below you find a (non-exhaustive) list of issues that I find interesting (and possibly relevant to the CLM-Community):

- What is regional? In the IPCC context, regions are usually continents or sub-continents. For vulnerability and impact assessment as well as for decision support the scale is on the national or even sub-national level. Thus, higher resolution modeling (RCMs and empirical statistical downscaling methods) and assessment are necessary.
- National or regional assessments, carried out by government agencies and academic institutions could become a valuable resource of regional information that hitherto has not found its way into IPCC assessments.
- High risk – low probability events: more research is needed on the causes of these events in the current climate to develop more reliable future projections of them. Experts from all three WGs should

collaborate to develop historical records of such events and their impacts.

- Further research is needed on emerging risks such as possible tipping points leading to abrupt changes.
- For impact assessment and decision support it might be necessary to have high resolution simulations for RCPs 2.6 (the 2°C-scenario for policy makers as baseline against which costs of climate impacts could be calculated) and 6.0 (as scenario comparable to the SRES A1B which was used most often so far).
- Urban structures and air-quality issues should be better represented in the simulations to make the results more relevant to urban stakeholders. Thus, the inclusion of urban sub-models is encouraged. (CORDEX modelers could design a set of pilot studies to model the effects of processes such as urban heat islands and/or air quality in developing country megacities.)
- Attribution of past impacts to anthropogenic climate change – when possible – can be extremely powerful for communicating climate change and possible impacts.
- Bias correction: AR6 should provide definitions of “bias” and “bias correction” (or bias adjustment or bias reduction) and a best practice guideline for users.
- The pure scientific climate change information is often insufficient for decision support, since important socio-economic or cultural aspects are missing. However, these aspects may well decide whether or not a certain physical change or event is dangerous or not. Thus, a much closer collaboration between WG I and WG II (and preferably also WG III) was called for. This should start well before the scoping of the AR6.
- One breakout group clearly requested IPCC to “stop messing around with scenarios and reference periods” to keep results comparable to earlier research results.
- Complex climate information needs to be distilled, packaged and shared in a way that is meaningful and useful for multiple users, each with specific needs. This might include communicating climate change information in the form of narratives or storylines.

Further reading:

The full, final version of the workshop report is available here:
https://www.ipcc-wg1.unibe.ch/meetings/region/RPW_WorkshopReport.pdf

New IPCC bureau elected in Dubrovnik

By Andrew Ferrone At its 42nd session, held from 5-9 October 2015 in Dubrovnik, Croatia, the IPCC elected the bureau for its 6th Assessment cycle. The elections started with the most prominent position, the chair of the IPCC. Five candidates presented themselves for this position: Ogunlade Davidson (Sierra Leone), Hoesung Lee, (Republic of Korea), Chris Field (United States), Nebojsa Nakicenovic (Austria and Montenegro), Jean-Pascal van Ypersele (Belgium) and Thomas Stocker (Switzerland).

During the first round, the votes of the 135 countries resulted in the following: Davidson, 1; Lee, 45; Field, 19; Nakicenovic, 8; van Ypersele, 32; Stocker, 30 votes. The election rules of the IPCC prescribe that if none of the candidates reaches a simple majority in the first round, a second round between the two candidates with the most votes in the first round is to be held, which were Lee and van Ypersele in this case. The second vote resulted in 56 votes for van Ypersele and 78 votes for Lee. This implied that Hoesung Lee has been elected as new IPCC Chair. All other candidates decided not to run for another position in the IPCC bureau.

The IPCC proceeded with the election of the bureau, which resulted in the following composition (only members of the Executive Committee listed here):

- Vice-Chairs of the IPCC:
  - Ko Barrett (United States),
  - Thelma Krug (Brazil),
  - Youba Sokona (Mali)
- Co-Chairs of WG I:
  - Valérie Masson-Delmotte (France)
  - Panmao Zhai (China)
- Co-Chairs of WG II:
  - Hans-Otto Pörtner (Germany),
  - Debra Roberts (South Africa)
- Co-Chairs of WG III:
  - Jim Skea (United Kingdom),
  - Priyadarshi R. Shukla (India)
- Co-Chairs of the Task Force Bureau:

- Kiyoto Tanabe (Japan),
- Eduardo Calvo Buendía (Peru)

Despite the fact, that none of the European candidates were elected as Chair of the IPCC, all three working group Co-Chairs are from the European Union, supported by co-chairs from key developing countries, thus giving the bureau the possibility to strive for a better geographical balance for the 6th Assessment Cycle.

Further reading:

Complete bureau composition:
https://www.ipcc.ch/nominations/results.shtml

Full election results of the bureau:
http://www.iisd.ca/download/pdf/enb12645e.pdf

Can regional climate modelling contribute to the outcome of the Paris agreement?

By Andrew Ferrone The Paris agreement has been adopted on 12th December 2015 by 196 parties after several days and nights of tense negotiations. It is the first global agreement that sets the framework for a peak of greenhouse gas emissions followed by a decline. The agreement is generally seen as historic and its ambition is

PARIS2015
CONFÉRENCE DES NATIONS UNIES SUR LES CHANGEMENTS CLIMATIQUES
COP21·CMP11

Snapshot from the COP21 in Paris, 2015. From left to right: Sarah Honour (United Kingdom), Frank McGovern (Ireland) and Andrew Ferrone (Luxembourg) during a contact group on the 2013-15 Review. Photo by IISD/Kiara Worth (<http://www.iisd.ca/climate/cop21/enb/3dec.html) Day #5 – (3K1A8712)

higher than most people expected. This high ambition is due to an exemplary French presidency of the 21st Conference of the Parties (COP21), but was also caused by a strong push by the European Union.

Despite the historic nature of the agreement many points remain to be clarified they become effective. Some decisions, explicitly mention that they should be based on the *"best available science"*. For the climate modelling community, in particular the long term global goal of the Agreement pointed out in Article 2 is of interest:

"Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change".

On the same line, in the decisions taken by COP21 (which are not part of the Paris agreement), paragraph 21 *"invites the Intergovernmental Panel on Climate Change to provide a special report in 2018 on the impacts of global warming of 1.5 °C above pre-industrial levels".* At its next session in April 2016 the IPCC will have to decide on the feasibility and the timing of such a report.

For this reason I would like to invite the CLM Community to **discuss the feasibility of RCM runs that limit global temperature increases to 1.5°C**, as those results will be very relevant for impact studies as requested by the COP21. These runs do represent a series of challenges (availability of forcing data, signal-to-noise ratio, and very sparse scientific literature), but could be very policy-relevant and contribute to the potential special report of the IPCC.

Further reading:

Decisions taken by COP21, including the Paris agreement:
http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

CLM-Community issues

CLM Assembly 2015

The 10th Assembly of the CLM-Community was hosted at the Luxembourg Institute of Science and Technology (LIST) in Belvaux, Luxembourg from 29th September to 2nd October 2015.

The assembly had a very good mix of interesting talks and discussions as well as social events. A great help was the possibility to or-

Birthday cake for the 10th anniversary of CLM Assembly (photo: LIST)

der lunch bags. The participants had a great guided walk through Luxembourg and the conference dinner was held on a boot trip on the river Moselle. As a special surprise we had a birthday cake for the 10th anniversary of our assembly!

It was a great evening in a very successful and interesting Assembly. The preparation of the perfect organization by the local committee is very much appreciated.

The Assembly consisted of a stringing together of inspiring presentations followed by interesting discussions. The highlights of this year's program include three solicited talks: by Hendrik Feldmann (KIT)

on regional decadal forecast, by Nicole van Lipzig (KU Leuven) on convection permitting climate simulations, and by Hans-Jürgen Panitz (KIT) on the impact of aerosol to the climate. In addition we were happy to have an evening keynote by Filippo Giorgi (ICTP) speaking about CORDEX and the plans for IPCC AR6 (see also section IPCC Workshop on Regional Climate Projections and their Use in Impacts and Risk Analysis Studies, Brazil, 2015).

For the second time we awarded the best poster presentation. This year it was won by Nico Kröner (ETHZ) for his poster on "*The influence of large-scale lapse-rate changes on the European summer climate: A CCLM surrogate experiment*".

A. Ferrone (LIST) hands over the poster award to Nico Kröner, ETHZ (photo: LIST).

New member institutions

Pohang University of Science and Technology

(http://www.postech.ac.kr/)

Projection and uncertainty analysis of fine-scale climate change over CORDEX-East Asia and Korean Peninsula using COSMO-CLM based on RCP scenarios. The model domain includes East Asia, including China, Korea and Japan with horizontal resolution 25 km.

Contact: Donghyun Lee

(donhyunlee[at]postech.ac.kr)

Lund University

(http://www.lunduniversity.lu.se/)

Studying land-atmosphere interactions in the midlatitude water cycle using stable water isotopes as naturally available tracers to obtain detailed insights into land surface exchange fluxes of water. Sensitivity studies with the isotope-enabled version of the COSMO model (COSMO-ISO) will be performed to assess the impact of different isotope fractionation parametrisations on the isotopic signature of land surface evaporation.

Contact: Franziska Aemisegger

(franziska.aemisegger[at]usys.ethz.ch)

National Meteorological Office, Algeria

(http://www.meteo.dz/index.php)

Performing regional climate simulations to develop a monitoring and alert mechanism based on forest fire management indices and on meteorological parameters. Second, climate projections will be analysed for longer term studies of the northern Algeria and to identify areas and species (cedar, cork, ...) effected by forest fires.

Contact: Halimi Lofti

(lotfi.halimi@gmail.com)

Norwegian Meteorological Institute

(http://met.no/English/)

COSMO-CLM will be applied over a domain covering parts of northern Europe which are outside the EURO-CORDEX domain, e.g., Svalbard. The results will be compared to those of the recently established climate branch of the HARMONIE forecast model.

Contact: Andreas Dobler

(andreas.dobler@met.no)

Research notes

Sensitivity analysis with the regional climate model COSMO-CLM over the CORDEX-MENA domain

E. Bucchignani[1,2], L. Cattaneo[1], H.-J. Panitz[3], P. Mercogliano[1,2]

[1]Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC)
[2]Centro Italiano Ricerche Aerospaziali (CIRA)
[3]Institut für Meteorologie & Klimaforschung, KIT

More details and additional references can be found in:

Bucchignani, E., L. Cattaneo, H.-J. Panitz, P. Mercogliani (2015): Sensitivity analysis with the regional climate model COSMO-CLM over the CORDEX-MENA domain. *Meteorol. Atmos. Phys.*, DOI: 10.1007/s00703-015-0403-3

In this paper, the results of a sensitivity work based on ERA-Interim driven COSMO-CLM simulations over the Middle East-North Africa domain (CORDEX-MENA) are presented. The CORDEX-MENA domain (27W - 76E, 7S - 45N), which includes North Africa, southern Europe and the whole Arabian peninsula, offers considerable challenges for assessing and understanding climate change due to its large size and complex topography. It includes highland areas (e.g., Atlas Mountains, Ethiopian Highlands, and Iranian and Anatolian plateaus), wide coastal areas and desert areas (Sahara in Africa and Rub Al-Khali in the Arabian Peninsula), shortage and crop failure.

High-resolution climate projections within this domain are driven by several needs, such as the assessment of impacts on water resources in the Arab region. The importance is confirmed by the establishment of the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR), coordinated by the United Nations Economic and Social Commission for Western Asia (UN-ESCWA).

Several studies have shown that, in general, the configuration of a regional model cannot be transferred directly to other climatic areas, but specific modifications are necessary in each case. In particular, COSMO-CLM has been evaluated in different regions worldwide, showing that the standard set-up (the one used in Europe) should be applied only to those regions that have climate characteristics similar to those of Europe. For other climate zones, especially the tropics, a modified set-up is necessary. Generally speaking, in order to generate downscaled climate projections that can be used for reasonable assessments of future impacts of climate change at regional scales, a sensitivity analysis is claimed to find the optimal configuration for the analysed area.

In this work, different configurations were defined starting from a reference one, by varying initially one parameter at a time and subsequently a combination of parameters. The effects of soil albedo are examined by replacing the default dataset with a new one, derived from the Moderate Resolution Imaging Spectroradiometer (MODIS), which better reproduces the reflectivity of the Earth's surface over arid zones. The sensitivity to aerosol effects, which are represented by distributions of Aerosol Optical Depth (AOD), is also analysed considering the NASA-GISS AOD distributions. The sensitivity analysis to tuning parameters was performed by selecting those that were shown to play an important role in determining model. These tuning parameters are mainly related to surface, convection, radiation and cloud parameterizations.

The gauge network over the CORDEX-MENA domain is highly irregular, with areas where almost no data are available, such as the Sahara desert in Africa and over the Rub Al-Khali desert of Saudi Arabia. For this reason, model assessment was performed by using a combination of available ground observations, satellite products and reanalysis.

Sensitivity simulations were performed employing a 0.44° spatial resolution, as specified in the CORDEX protocol. The model was integrated over a six-year period from January 1979 through December 1984. The first year of the simulation (1979) was removed in the validation phase to reduce spin-up effects. This remaining five-year time period is long enough to capture the temporal dyna-

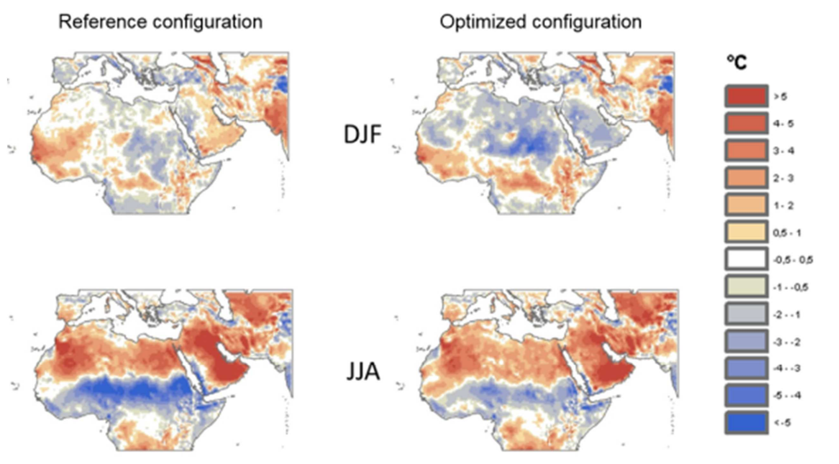

Figure 1 Bias of temperature (°C) against CRU obtained with the reference and the optimized configurations.

mics and interannual variability of climate processes.

Analyses have been carried out considering six sub-regions to cover varieties of climatic conditions, complex topography and land surface heterogeneities. Model evaluation focuses on two-meter temperature, total precipitation, and mean sea level pressure, since they are the key variables of a climate system and a good representation of their values is a precondition for further analysis. Cloud cover was also considered, since it plays an important role in the interaction among these variables and is one of the major sources of uncertainty in climate modelling. Wind field was also considered, since it is an important parameter related to moisture transportation, which plays an important role in the formation of convection

The present investigation revealed that COSMO-CLM shows a great sensitivity to changes related to the physical parameterizations of soil and surface, convection, radiation and clouds. We found that the optimal configuration is characterized by the new parameterization of albedo, which more realistically describes the Earth's surface reflectivity (especially over dry areas) and of a more realistic distribution of AOD, namely the NASA-GISS AOD distributions. Both schemes gave a significant contribution to the improvement of model performances. An increase in the value of the parameter controlling the vertical variation of critical humidity for sub-grid cloud formation also provides a positive effect on precipitation. With regard to the effects of cloud representation and parameterization schemes, it turned out that the optimal configuration selected is characterized by the default values of the corresponding tuning parameters. With this configuration, COSMO-CLM is relatively well able to improve the simulated main climate features of this very complex area. Indeed, the Mean Absolute Error values are of about 1.2°C for temperature, about 15 mm/month for precipitation, about 9% for total cloud cover, and about 0.6 hPa for mean sea level pressure. It must be taken into account that non-negligible values of bias are found in the maps. These biases are partially due to low accuracy of observational datasets, but partially due to shortcomings of the model in simulating some climate features, such as the West African Monsoon.

Systematic large-scale secondary circulations in a regional climate model

Nico Becker[1], Uwe Ulbrich[1], Rupert Klein[2]

[1]Freie Universität Berlin, Institut für Meteorologie

[2]Freie Universität Berlin, Institut für Mathematik

More details about this work can be found in:

Becker N., U. Ulbrich, R. Klein, 2015: Systematic large-scale secondary circulations in a regional climate model. *Geophys. Res. Lett.*, **42**, 4142–4149. doi: 10.1002/2015GL063955.

Introduction

The most common approach used in RCMs is the one-way nesting technique, where coarser resolved data are prescribed at the lateral boundaries of a finer resolved RCM with the aim of adding the effects of smaller scales, which are not resolved by the driving model. However, an RCM does not solely add smaller scales, but it is also capable of deviating from the driving model data on larger scales within its domain. It is often questioned whether these large-scale deviations represent an added-value or erroneous behaviour of the RCM (Diaconescu and Laprise, 2013). In this study we investigate the deviations of an RCM simulation from the driving global climate model (GCM) simulation with respect to the large-scale flow pattern prescribed by the GCM, in order to study the impacts of the topography on these deviations.

Data

We analyse an RCM simulation over Europe, which is part of the "consortial simulations" performed with the COSMO-CLM (Hollweg et al., 2008). The horizontal resolution is 0.165°, and the analysed period covers 41 years with present-day climate forcing conditions. An ECHAM5/MPIOM simulation with a horizontal resolution of T63 (1.875°) was used to provide the lateral boundary conditions. For the analysis the 6-hourly model output of COSMO-CLM and ECHAM5 was used.

Results

The basic idea of our approach is a splitting of the horizontal wind fields of the RCM into a "primary circulation" (PC) and a "secondary circulation" (SC). The PC is defined to be equivalent to the GCM wind vector fields, interpolated to the RCM grid. Thus, the SC is equal to the wind vector difference between the RCM and the GCM wind fields, representing the modifications of the PC by the RCM. The term "secondary" hereafter refers to features found in the SC.

The climatological mean of the SC at 500 hPa, calculated from the 41 years of simulations, shows an anticyclonic vortex in the south-eastern part of the RCM domain (not shown here). This secondary vortex has a diameter of roughly 3000 km and wind speeds of up to 1 m/s, which is locally more than 10% of the speed of the PC. The vortex is associated with a positive geopotential height (GPH) anomaly. That implies that the secondary vortex is approximately geostrophically balanced.

A clustering algorithm is applied to the time series of the GCM GPH fields at 500 hPa in DJF in order to analyse the SC patterns that result from different large-scale flow patterns in the PC. The resulting SC fields of 13 clusters are displayed in descending order according to the average intensity of the SC within each cluster (Figure 2). The main characteristics of the different SC patterns are summarized as follows:

Prominent anticyclonic secondary vortices occur adjacent to the Alps, somewhat downstream of the Alpine region. Dipole or tripole structures occur in the GPH anomalies, which are composed of positive and negative GPH anomalies associated with anticyclonic and cyclonic vortices in the SC, respectively. If the PC within the Alpine region is relatively low, either due to an extended ridge (cluster *j* and *m*) or a deep trough (cluster *l*), the SC is comparatively weak. In contrast, the clusters with the strongest SC (*a*–*d*) show strong GPH gradients and high wind speeds in the Alpine region. Strong boundary-parallel flows are visible in the SC along the eastern and northern RCM boundaries (e.g., clusters *a, d*, and *g*).

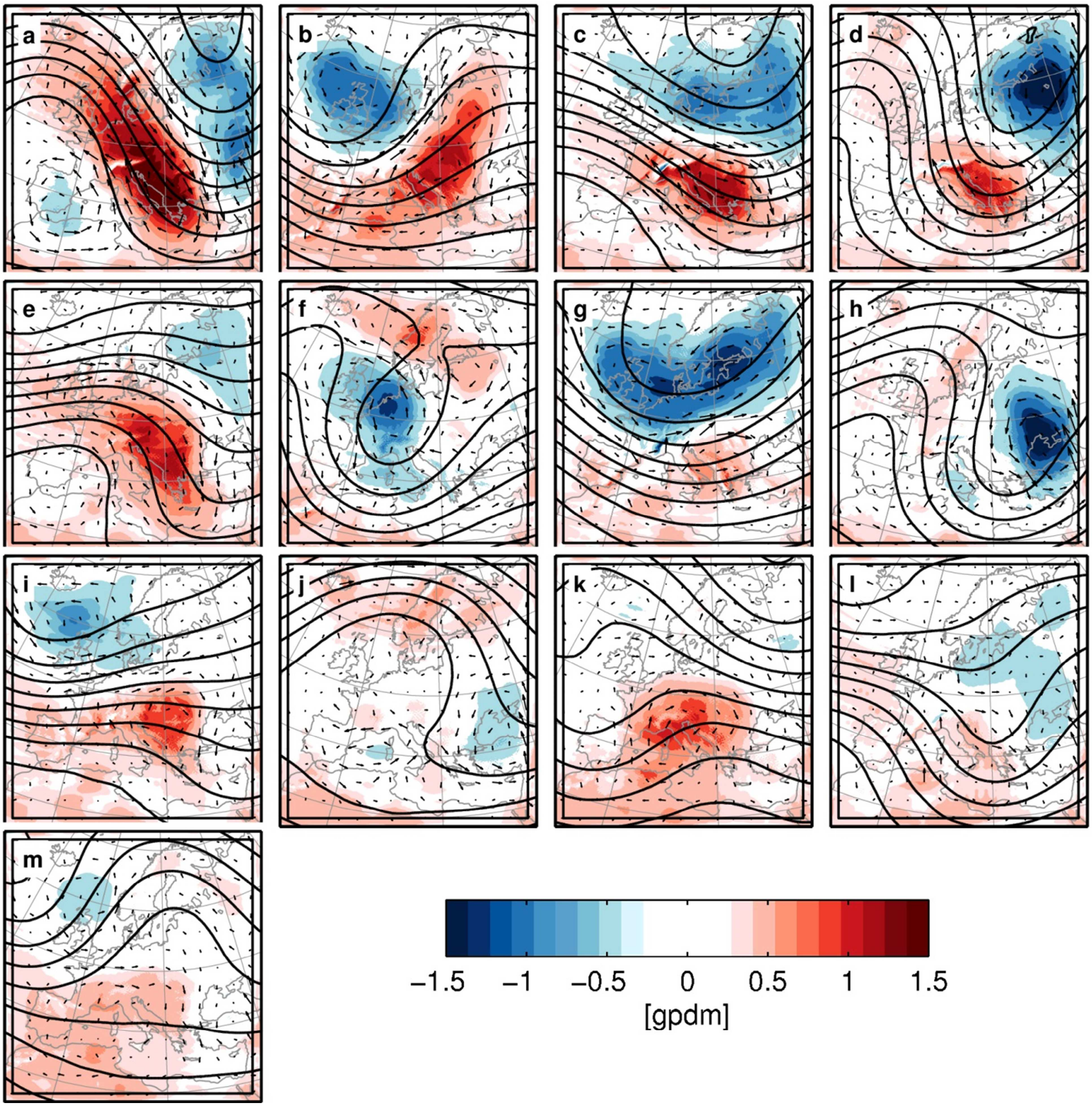

Figure 2: (a–m) Clusters of the PC and the associated SCs at 500 hPa in winter (DJF). The GCM GPH fields (contours), the wind vector differences (arrows), and GPH differences between RCM and GCM (shading) of each cluster are displayed in descending order according to the SC intensity.

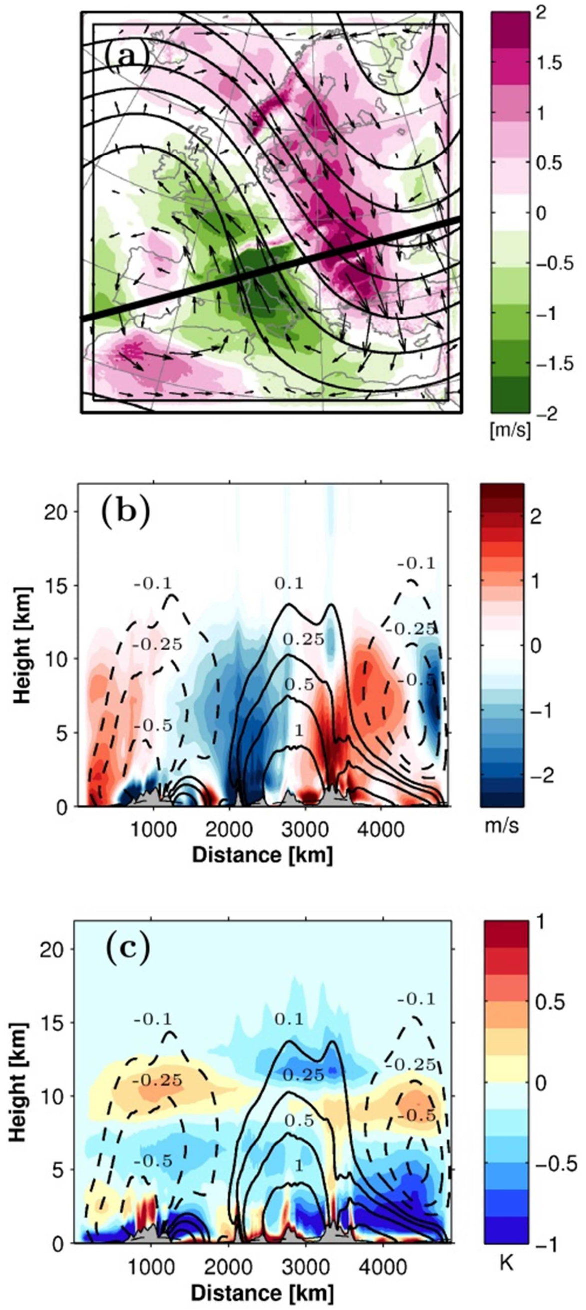

Figure 3 Cross section through cluster a. *(a) As in Figure 2a but with wind speed difference between RCM and GCM (shading). Along the cross section (solid line in Figure 2a), (b) the component of the SC orthogonal to the cross section (shading, with positive and negative values indicating a southward directed flow and northward directed flow, respectively) and (c) temperature differences between RCM and GCM (shading) are shown. The pressure differences (hPa) between RCM and GCM (contours) are displayed in Figure 2b and c.*

Cluster *a* exhibits the most intense SC of all clusters. The PC of cluster *a* is characterized by a north-westerly jet over central Europe, which crosses the full length of the Alpine mountain range. A reduction of the RCM wind speeds of more than 2 m/s, compared to the GCM, is found downstream of the Alps. (Figure 3a). This reduction is consistent with the SC pointing north-eastward, in opposite direction of the PC. The wind speed reduction is balanced by increased wind speeds of a similar magnitude, which occur farther eastward of the Alps.

Vertically, the SC affects the whole troposphere (Figure 3b). This is shown by the pressure differences between RCM and GCM and by the component of the SC vectors orthogonal to the cross section. The SC also affects the temperature profile (Figure 3c). Along the cross section, consistent temperature anomalies occur between heights of 8 and 14 km. A temperature reduction (increase) of 0.5 K is observed, which is related to the positive (negative) pressure anomalies and to the anticyclonic (cyclonic) secondary vortices.

An analysis of the Froude number of the flow approaching the Alps shows that the intensity and shape of the SC vortices depends strongly on the characteristics of the flow passing the Alps (not shown here).

Discussion

In previous studies a connection between orographic effects, large-scale RCM anomalies, and the RCM boundary was indicated (Miguez-Macho et al., 2004), but until now there has been little research addressing this relationship. In general, mountains are known to affect the atmospheric flow on different spatial scales (Schär and Smith, 1993). Our results suggest that in the RCM the influence of the meso-scale orography of the Alps on the large-scale flow is much more pronounced than in the GCM. This leads to modifications of the large-scale RCM flow relative to the GCM. For example, cluster *a* showed that a north-westerly jet crossing the Alps is decelerated in the RCM due to orographic drag effects. However, a deceleration has to be balanced by an acceleration elsewhere in the RCM domain, because at the RCM boundaries the mass fluxes into and out of the domain are exactly specified. Therefore, a modification of the flow within the RCM, as observed in the SC fields, cannot exit the domain. Instead, a closed secondary circulation develops relative to the prescribed driving GCM data, which is necessary to balance the mass fluxes.

The spatial extent of the SC is artificially restricted by the existence of the RCM boundary. This can lead to artificial flows, which align parallel to the RCM boundary. It can be expected that gradually shifting the individual boundaries inward and outward could significantly affect the structure of the SC patterns. We are going to address this issue in a future study.

We only considered one specific RCM; however, the underlying mechanisms suggest that the SC can be regarded a common feature of one-way nested RCMs with prescribed inflow and outflow conditions. Due to the impact on other atmospheric variables like pressure and temperature the SC has the potential to produce large scale systematic errors in RCMs.

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References

Diaconescu E. P., R. Laprise, 2013: Can added value be expected in RCM-simulated large scales? *Clim. Dyn.*, **41**(7-8), 1769–1800.

Hollweg H. et al., 2008: Ensemble simulations over Europe with the regional climate model CLM forced with IPCC AR4 global scenarios. *M & D Tech. Rep.*, **3**, Max-Planck Institut für Meteorologie, Hamburg, Germany.

Miguez-Macho G., G. L. Stenchikov, A. Robock, 2004: Spectral nudging to eliminate the effects of domain position and geometry in regional climate model simulations. *J. Geophys. Res.*, **109**, D13104.

Schär C., R. B. Smith, 1993: Shallow-water flow past isolated topography: Part II. Transition to vortex shedding. *J. Atmos. Sci.*, **50**(10), 1401–1412.

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Brunner, D., N. Savag, O. Jorba, B. Eder, L. Giordano, A. Badia, A. Balzarini, R. Baro, R. Bianconi, C. Chemel, G. Curci, R. Forkel, P. Jimenez-Guerrero, M. Hirtl, A. Hodzic, L. Honzak, U. Im, C. Knote, P. Makar, A. Manders-Groot, E. van Meijgaard, L. Neal, J.L. Perez, G. Pirovano, R.S. Jose, W. Schröder, R.S. Sokhi, D. Syrakov, A. Torian, P. Tuccella, J. Werhahn, R. Wolke, K. Yahya, R. Zabkar, Y. Zhang, C. Hogrefe, S. Galmarini, (2015): Comparative analysis of meteorological performance of coupled chemistry-meteorology models in the context of AQMEII phase 2, *Atmospheric Environment ,* **115**, 470 - 498.

Bucchignani, E., Cattaneo, L., Panitz, H.-J., Mercogliani, P. (2015): Sensitivity analysis with the regional climate model COSMO-CLM over the CORDEX-MENA domain. *Meteorol. Atmos. Phys.*, doi: 10.1007/s00703-015-0403-3

Bucchignani, E., M. Montesarchio, A.L. Zollo, P. Mercogliano (2015): High resolution climate simulations with COSMO-CLM over Italy performance evaluation and climate projections for the 21st century, *International Journal of Climatology*, doi: 10.1002/joc.4379

Curci, G., C. Hogrefe, R. Bianconi, U. Im, A. Balzarini, R. Baró, D. Brunner, et al. (2015): Uncertainties of simulated aerosol optical properties induced by assumptions on aerosol physical and chemical properties: An AQMEII-2 perspective. *Atmos. Environ.*, doi: 10.1016/j.atmosenv.2014.09.009

Dosio, A., H.-J.Panitz, H.-J. (2015): Dynamically downscaling of CMPI5 CGMs over CORDEX-Africa with COSMO-CLM: analysis of the climate change signal and differences with the driving GCMs. *Clim. Dyn*., DOI: 10.1007/s00382-015-2664-4

Dosio, A., H.J. Panitz, M. Schubert-Frisius, D. Lüthi (2015): Dynamical downscaling of CMIP5 global circulation models over CORDEX-Africa with COSMO-CLM: evaluation over the present climate and analysis of the added value. *Clim. Dyn*., **44** (9-10), 2637-2661, doi: 10.1007/s00382-014-2262-x

Endris, H.S., B. Lennard, B. Hewiston, A. Dosio, G. Nikulin, H.-J. Panitz (2015): Teleconnection response in multi-GCM driven CORDEX RCMs over Eastern Africa. *Climate Dyn*., doi: 10.1007/s00382-015-2734-7

Fallah, B., S. Sodoudi, U. Cubasch (2015): Westerly jet stream and past millennium climate change in Arid Central Asia simulated by COSMO-CLM model. *Theoretical and Applied Climatology,* doi: 10.1007/s00704-015-1479-x

Fosser, G., S. Khodayar, P. Berg (2015): Benefit of convection permitting climate model simulations in the representation of convective precipitation. *Climate Dyn*., **44**, 45-60, doi: 10.1007/s00382-014-2242-1

Galmarini, S., C. Hogrefe, D. Brunner, P. Makar, A. Baklanov (2015): Preface. *Atmos. Environ*., **15**, 340-344, doi: 10.1016/j.atmosenv.2015.06.009.

Geyer, B., R. Weisse, P. Bisling, J. Winterfeldt (2015): Climatology of North Sea wind energy derived from a model hindcast for 1958-2012. accepted for publication in *J. of Wind Engineering & Industrial Aerodynamics*, doi: 10.1016/j.jweia.2015.09.005

Giordano, L., D. Brunner, J. Flemming, C. Hogrefe, U. Im, et al. (2015): Assessment of the MACC reanalysis and its influence as chemical boundary conditions for regional air quality modeling in AQMEII-2. *Atmos. Environ*., doi: 10.1016/j.atmosenv.2015.02.034

Im, U., R. Bianconi, E. Solazzo, I. Kioutsioukis, A. Badia, A. Balzarini, R. Baró, R. Bellasio, D. Brunner, et al. (2015): Evaluation of operational on-line-coupled regional air quality models over Europe and North America in the context of AQMEII phase 2. Part I: Ozone. *Atmos. Environ.*, doi: 10.1016/j.atmosenv.2014.09.042

Im, U., R. Bianconi, E. Solazzo, I. Kioutsioukis, A. Badia, A. Balzarini, R. Baró, R. Bellasio, D. Brunner, et al. (2015): Evaluation of operational online-coupled regional air quality models over Europe and North America in the context of AQMEII phase 2. Part II: Particulate matter. *Atmos. Environ*., doi: 10.1016/j.atmosenv.2014.08.072

Li, D., H.v. Storch, B. Geyer (2015): Testing Reanalyses in Constraining Dynamical Downscaling. accepted for publication in *J. of the Met. Society of Japan*, doi: 10.2151/jmsj2015-044

Khodayar, S., A. Sehlinger, H. Feldmann, H. (2015): Sensitivity of soil moisture initialization for decadal predictions under different regional climatic conditions in Europe. *Int. J. Climatol*., **35**, 1899-1915, DOI: 10.1002/joc.4096

Knote, C., P. Tuccella, G. Curci, L. Emmons, J.J. Orlando, S. Madronich, R. Baró, P. Jiménez-Guerrero, D. Luecken, C. Hogrefe, R. Forkel, J. Werhahn, M. Hirtl, J.L. Pérez, R. San José, L. Giordano, D. Brunner, K. Yahya, Y. Zhang (2015): Influence of the choice of gas-phase mechanism on predictions of key gaseous pollutants during the AQMEII phase-2 intercomparison. *Atmos. Environ*., doi:10.1016/j.atmosenv.2014.11.066.

Kong, X., R. Forkel, R.S. Sokhi, P. Suppan, A. Baklanov, M. Gauss, D. Brunner, et al. (2015): Analysis of meteorology–chemistry interactions during air pollution episodes using online coupled models within AQMEII phase-2. *Atmos. Environ*., doi:10.1016/ j.atmosenv.2014.09.020, 2015

Prein A.F. ,W. Langhans, G. Fosser, A. Ferrone, N. Ban, K. Goergen, M. Keller, M. Tölle, O. Gutjahr, F. Feser, E. Brisson, S. Kollet, J. Schmidli, N.P.M. van Lipzig, R. Leung (2015): A review on regional convection-permitting climate modeling: Demonstrations, prospects, and challenges. *Rev. Geophys.*, **53**, 323–361. doi:10.1002/2014RG000475.

Trusilova, K., S. Schubert, H. Wouters, B. Früh, S. Grossman-Clarke, M**.** Demuzere, P. Becker (2015): The urban land use in the COSMO-CLM model: a comparison of three parameterizations for Berlin. *Meteorologische Zeitschrift*, doi: 10.1127/metz/2015/0587.

Zollo, A. L., V. Rillo, E. Bucchignani, M. Montesarchio, P. Mercogliano (2015): Extreme temperature and precipitation events over Italy: assessment of high resolution simulations with COSMO-CLM and future scenarios, *International Journal of Climatology*, doi: 10.1002/joc.4401

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