C2SM-NEWSLETTER

Center for Climate Systems Modeling
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The IPCC SREX report – What did we learn about extreme events since the AR4?

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This month saw the release of the full IPCC Special Report on "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (SREX). Chapter 3 of that report addresses "Changes in climate extremes and their impacts on the natural physical environment". It includes about 1100 references, of which more than 70% were published after the last IPCC Assessment Report (AR4).

The new IPCC SREX report was coordinated jointly by the IPCC Working Groups I and II, with involvement of the UN International Strategy for Disaster Reduction (ISDR). This special report reviews the scientific literature on past and projected changes in weather and climate extremes, and the relevance of such changes to disaster risk reduction and climate change adaptation. Chapter 3 of that report ("Changes in climate extremes and their impacts on the natural physical environment") provides the physical science basis for the overall report.

As one of two coordinating lead authors of this chapter, a task that I was thankful to share with Neville Nicholls from Monash University (who had been an author in almost every single IPCC reports since the 2nd Assessment Report in 1996), it is interesting to reflect on these past 2.5 years and on the progress accomplished (and some challenges met) over the course of this endeavour.

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First, the compilation of this report represented the first time that research on climate extremes was synthesized by a single team in a single chapter, i.e., including observed changes, causes of the changes, and projected changes (which are treated separately in the IPCC 4th and 5th assessment report, AR4 and AR5). This obviously meant significant challenges given the breadth of the chapter and the wide expertise the lead author team (14 scientists altogether), but also chances for exchanges across disciplines, which are normally difficult given the rather static structure of the assessment reports. Specifically, this for instance allowed a better consideration of observational uncertainties when assessing the reliability of projections (e.g. for the drought assessments).

Overall, for many topics/extremes, the extra material did not lead to a revision of the assessments compared to the AR4, but it has confirmed that for many extremes the AR4 assessments have stood the test of time and were robust. Nonetheless, some AR4 assessments were revised, either because new literature points towards clearer evidence in some areas, or because the new material has highlighted more uncertainties and issues than were identified at the time of AR4. This is particularly the case for tropical cyclones or droughts, two types of extremes for which new literature has highlighted significant issues in terms of process understanding, proper metric definition, and the representation of the relevant processes in current models.

A major contribution of the chapter is the regional information. A new definition of regions was chosen for the assessments and analyses, which takes better account of the regional specificities of climate on several continents, in particular in South America and Europe. Separate regional assessments on extremes are provided in tables both for observed and projected changes. Furthermore, specific regional quantitative assessments for temperature and precipitation extremes (rather than solely information on the sign of change) are provided in the chapter figures.

The chapter also addresses some topics/extremes that were only partly addressed previously (e.g. winds; droughts; glacier, geomorphological and geological impacts) or not addressed at all (e.g. high-latitude change including permafrost; sand and dust storms).

As another change compared to the AR4, we applied more formal and structured assessments of uncertainties, using a two-stage process distinguishing the confidence we have in the "tools" to assess changes in that extreme, and – only for cases with high confidence – also providing a quantitative assessment of the uncertainty. This procedure was used for more than 50 usages of the prescribed uncertainty terms in the Executive Summary (and many hundreds through the chapter).

Obviously, there were also some challenges along the way, most importantly:

- the scale discrepancy between the information typically available in physical climate literature and that required by end users
- the fact that for many extremes there is still insufficient literature, data or model projections or physical understanding to allow us to make useful projections of changes
- dealing with an enormous range of extremes and trying to do this in about 75 pages
- ensuring some geographical balance, given the discrepancy in the amount of material for e.g Europe vs Africa or small islands states
- dealing with a change in the IPCC uncertainty guidance document after the chapter had gone through two rounds of review (following the InterAcademy Council review of the IPCC)
- and last but not the least, responding in writing to about 5000 review comments (including summary for policymakers review comments that had to be dealt with by the Chapter 3 lead authors)

These few points notwithstanding, taking on this task was a unique and gratifying experience, both in term of the breadth of our chapter and the expertise and dedication of our lead author team. Also the direct collaboration with a user community offered enlightening perspectives on how to balance the needs of the disaster risk reduction community for detailed, regional information with the scientific concern that credibility of projections reduces on smaller spatial scales. This on-going challenge is also an eye-opener on new avenues that climate research ought to follow.

» ipcc-wg2.gov/SREX/

Adapting climate models to future supercomputers: porting the physical parametrizations to GPUs

The continuous increase in available computer power can greatly benefit the weather predictions and climate community by allowing to run simulations at higher resolution, to have more complex models or to increase the number of ensemble members. In order to fully benefit from future supercomputers, which tend to have more and more computer cores and will make use of new hardware architectures such as GPUs (Graphical Processing Units), atmospheric models will need to undergo some modifications.

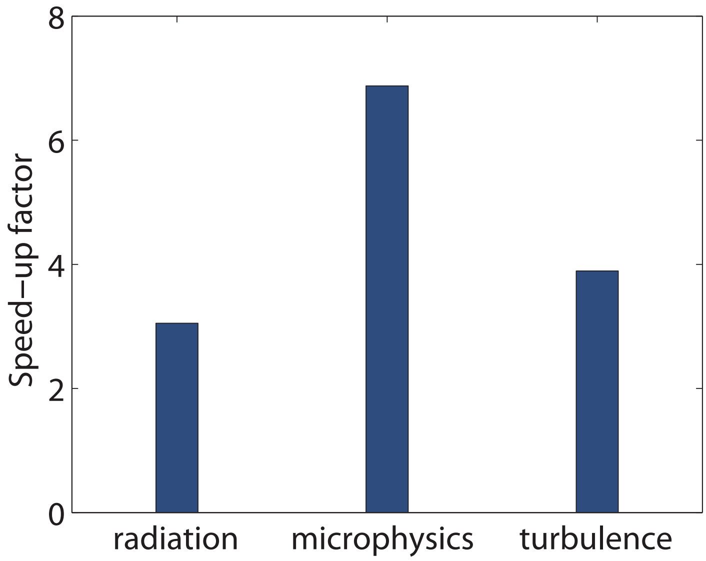
In view of these challenges and as part of the HP2C initiative (High Performance High Productivity computing), C2SM is engaged in an ambitious project to adapt the regional weather and climate model COSMO (Consortium of Small-Scale Modeling) for emerging hardware. The new prototype code should be able to run efficiently both on massively parallel scalar machines as well as on GPU systems.

The reason why GPUs can be attractive for scientific applications is that they can provide larger floating point performance and memory bandwidth than actual CPUs (Central Processing Unit) for comparable energy consumption and price. Computing with GPUs is a so called-heterogeneous approach where the host CPU and the GPU execute different parts of the code and have separate memories. The cost of data transfer between the GPU and the CPU can become very large, and one solution consists of doing all the calculation where the data reside, that is on the GPU. For this reason it was decided in this project to port the entire COSMO time evolution loop to such hardware. To this end, a new GPU enabled version of the dynamical core, i.e., part of the code accounting for the equations of flow motions, was designed and rewritten.

Concerning the physics, which account for processes not described by the dynamics, such as radiation or turbulence, a directive approach was chosen. The idea hereby is to introduce directives, i.e., specific comments, in the original source files which are then interpreted by the compiler to generate code that can be executed on the GPU. In order to validate this approach, three important parametrizations (the radiation, microphysics and turbulence scheme) have been ported to GPU using directives and tested in standalone codes. The performance of the new GPU codes is assessed by comparing it with the parallel version of the original CPU code (see Figure). A speed-up by a factor between 3 and 6 is observed when comparing the execution time obtained on GPU or multicore CPU of an equivalent generation, showing that it is possible to efficiently use the GPU device with the directives. Note that these results do not take into account any data transfer time as the data is assumed to reside on the GPU.

After these first promising results, the next step is to port the other required parametrizations, and to combine them with the new dynamical core. Together with a GPU-enabled communication library, this will then enable us to fully assess the potential of a GPU-equipped cluster computer with respect to a CPU only distributed architecture for climate modeling and weather forecast. Further opportunities and developments are also addressed in the parallel project "OPerationalCOSMO DEmonstrator" (OPCODE) led by MeteoSwiss. **(xl)**

» www.c2sm.ethz.ch/research/COSMO-CCLM



Speed up factor comparing the execution time using a M2050 Tesla GPU card with respect to 12 cores Magny-Cours CPU for three physical parametrizations.

News

SPARC International Project Office now at ETH Zurich

Project

The international project for atmospheric and climate research SPARC (Stratospheric Processes And their Role in Climate) relocated its coordination centre from Canada to Switzerland. On 7 February 2012, at the occasion of the SPARC Scientific Steering Group meeting held in Zurich, SPARC celebrated the inauguration of its new office at ETH Zurich and its 20th anniversary. The SPARC Office in Zurich is sponsored by ETH Zurich, the Federal Office for the Environment (FOEN), MeteoSwiss, and WCRP. In addition, the Swiss National Science Foundation funds the position of a young researcher working at the office.

» www.sparc-climate.org

MeteoSwiss renews its participation in the EUMETSAT Satellite Application Facility on Climate Monitoring

Project

From 2007 to 2012, MeteoSwiss derived and validated 25 years of surface solar irradiance from Meteosat first and second generation satellites. In the next five years, MeteoSwiss will derive climatological information on cloud cover and radiative land surface temperature. This work and data sets will directly be used by the CHIRP II Project for model validation purposes. Other potential applications include trend detection in cloudiness, the extension of human-based cloud observations, monitoring the state of land surface or for closing the surface radiation budget. These activities are carried out as part of EUMETSAT's Satellite Application Facilities (SAFs) and in support of the EUMETSAT implementation plan on climate monitoring.

» www.meteoswiss.admin.ch/web/en/research/current_projects/climate/cmsaf.html

CarboCountCH project started

Project

This collaborative project focusing on human-related emissions and biosphere-atmosphere exchange of carbon dioxide and methane has started last December. Three PhD students and one PostDoc have been hired. Four measurements sites will be installed early summer.

» www.c2sm.ethz.ch/research/CarboCountCH

CHIRP II project launched

Project

The CHIRP II collaborative project "Modeling the water cycle in a changing climate" was launched with a kickoff meeting on 5 March, providing the opportunity for the interdisciplinary community to meet and discuss the objectives of the individual projects and potential synergies. Nearly all positions have been filled and the first projects are well underway. First results are already emerging with some first major milestones expected to be reached during the second half of this year.

» www.c2sm.ethz.ch/research/CHIRP2

Swiss Climate Change Scenarios CH2011 – From dissemination to application

Project

C2SM is in charge of disseminating the scenario data to the new Swiss Climate Change Scenarios CH2011, providing a new assessment of how the climate in Switzerland is expected to change in the 21st century. These new scenarios are used as a common base for numerous academic studies. Other activities using the scenarios include the creation of a Swiss adaptation strategy led by the Swiss Federal Office for the Environment (BAFU) and the cross-sectorial quantitative impact study for climate change (CH2014-Impacts)initiated by the Oeschger Centre and the NCCR-Climate.

» www.ch2011.ch

The isotopic composition of precipitation from a winter storm – a case study with the limited-area model COSMOiso

Publication

Atmospheric moisture does not only consist of the standard light isotope H2O, but also of different heavy isotopes, which can be regarded as naturally available tracers of the atmospheric water cycle. The isotopic composition of water vapor and precipitation is sensitive to, e.g., the conditions during evaporation and cloud formation. However, due to the involved complexities, numerical models have to be applied in order to quantify these sensitivities. In the study published in ACP by Stephan Pfahl and colleagues, isotope physics have been implemented in the COSMO model, allowing a detailed investigation of synoptic-scale isotope variability and the associated microphysical and dynamical processes.

» dx.doi.org/10.5194/acp-12-1629-2012

Agenda

Events in Switzerland

Kolloquium – IAC ETH Zurich
until May 2012 (Mondays, 16:15)
ETH Zentrum, Zürich

» www.iac.ethz.ch/events/?type=a

Colloquium in Climatology, Climate Impact and Remote Sensing
until May 2012 (Wednesdays, 14:15)
University Bern, Hallerstrasse 10, Bern

» www.geography.unibe.ch/content/forschungsgruppen/klimatologie/aktuell/events/

Monday Seminars – Climate & Environmental Physics
until May 2012 (Mondays, 16:15)
University Bern, Sidlerstrasse 5, Bern

» www.climate.unibe.ch/?L1=courses&L2=seminar

13th Swiss Global Change Day
Wednesday, 4 April 2012
Freies Gymnasium, Bern

» www.proclim.ch/4dcgi/proclim/all/event?1995

Die Relevanz historischer Dokumentendaten für die aktuelle Klima- und Naturgefahrendiskussion
Donnerstag, 3. Mai 2012
Hauptgebäude der Universität Bern

» events.scnat.ch/proclim/index.php?id=16633

Abschlusstagung CCHydro
Freitag, 8. Juni 2012
Bern

» events.scnat.ch/proclim/index.php?id=16542

Updates & Further events

» www.c2sm.ethz.ch/news

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