C2SM-NEWSLETTER

Center for Climate Systems Modeling
No. 4, December 2010

Linking air pollution and climate change

Brigitte Buchmann

– C2SM steering committee member

C2SM not only bridges gaps between different spatial and temporal scales but also opens remarkable possibilities to link two major environmental problems, namely air pollution and climate change. Both are intimately related through closely coupled physical and chemical processes and by the fact that air pollutants and greenhouse gases are often emitted from common sources. Let us take the opportunity in C2SM to address them together in an integrated way using comprehensive online-coupled models of atmospheric transport and chemistry!

The atmosphere is a closely coupled system of physical and chemical phenomena requiring an integrated modelling approach to properly account for the many links and feedbacks. But surprisingly, air pollution and climate research have largely evolved separately in the past and policy makers have regarded the two issues as unrelated problems. One reason might be the different communities involved; the lack of sufficient computing capacity to run coupled models might be another cause. Only recently, a few modelling groups started to use online-coupled models for air pollution on a regional scale and the rapidly evolving infrastructure of high-performance computing has opened the possibility to apply these models also for Switzerland at very high resolution (few kilometers) accounting for the complex topography of our country.

Numerical models are indispensable tools for the investigation of complex systems like the atmosphere.

>> *page 2*

C2SM Center for Climate Systems Modeling

ETH Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

>>

The computational treatment of atmospheric processes on global, regional and local scales with various degrees of complexity enables us to simulate past, current and future scenarios. Different communities working on different aspects of the atmosphere/climate system developed specific models that are now about to converge: The numerical weather prediction (NWP) community developed regional scale models with grid sizes in the order of a few kilometres. The climate community models simulate future scenarios on a coarser resolution but for longer timescales. The models developed in the air quality community can represent the atmospheric photochemical system and are able to simulate transport and reactions of trace gases and aerosols. However, feedbacks between phenomena in the research focus of different communities have traditionally been neglected, mostly due to the complexity of the problem and the lack of sufficient computation power. An atmospheric model such as COSMO can be a central building block for a comprehensive regional earth-atmosphere-chemistry system, as its meteorological core forms the basis for further developments in different research communities.

Aerosols play a major role in such interactions, as they strongly interact with both meteorology and chemistry. In order to study these interactions, online coupled chemistry-transport models such as the regional models COSMO-ART and COSMO-M7 or the global model ECHAM-HAMMOZ offer a promising model environment. The online coupling of chemistry, aerosols and meteorology, as it is implemented in COSMO-ART or in ECHAM-HAMMOZ significantly widens the scope of possible applications enabling the simulation of the dispersion and transformation of atmospheric constituents as well as their feedbacks on meteorology and climate.

With the advent of online coupled model systems those interactions can progressively be taken into account and several studies on the global as well as the regional scale have shown the added value of this integrated approach. COSMO-ART is used at Empa to investigate aerosol formation processes on the regional scale within Europe and - in a more detailed manner - over Switzerland. This model is robustly embedded in the COSMO model family used by different scientists in C2SM and thus complements the multi scale approach of C2SM. Capturing synergies and avoiding trade-offs by addressing the two issues of air quality and climate change simultaneously offers new approaches and justifies reorientation of scientific research in the two areas. Ultimately, an integrated approach not only opens new dimensions for scientific investigation but also for policy development.

Thus C2SM offers a tremendous potential along the whole range from basic to applied research and plays an important role in providing a scientific basis for political decisions. I look forward to increasing cooperations over ranges of scales and between complementary disciplines in a growing community of scientists in C2SM.

» www.c2sm.ethz.ch

Global climate modeling (GCM) activities at C2SM

C2SM is now the host institution for the fully coupled aerosol-chemistry-climate ECHAM6-HAMMOZ model that builds upon the well-established global climate model ECHAM.

GCM activities at C2SM are centered around the global climate model ECHAM although other global models such as the National Center for Atmospheric Research (NCAR) Community Atmosphere Model (CAM) are also used in some groups. ECHAM is a comprehensive general circulation model that has been originally developed and is currently maintained and distributed by the Max Planck Institute for Meteorology (MPI-M) in Hamburg.

Over the years, several groups in the European research community (e.g, Dr. Philip Stier at Oxford University, Dr. Martin Schultz at Forschungszentrum Jülich) have contributed to couple ECHAM to complementary modules to represent specific components and processes of the Earth climate system. In particular, an aerosol module (HAM) and a trace gas chemistry module (MOZ) have been coupled to ECHAM, leading to the formation of the fully coupled aerosol-chemistry-climate model ECHAM-HAMMOZ.

Since fall 2008, these different research groups (the so-called HAMMOZ community) have organized themselves by forming a Steering Committee that is chaired by C2SM member Prof. Ulrike Lohmann. Among other things, the Steering Committee is in charge of overseeing the model development by deciding upon the new processes or features to be included in the coupled model. Monthly conference calls also provide a very good pathway for facilitating the communication within the HAMMOZ community.

The establishment of the HAMMOZ Steering Committee has resulted in C2SM/ETH becoming the host institution for the ECHAM-HAMMOZ model. >> *page 3*

>>
As such, C2SM is in charge of archiving, maintaining, and releasing the different versions of ECHAM-HAMMOZ within its community and to any other potential user.

Over the last months, the ECHAM-HAMMOZ model has undergone a substantial re-structuring in order to achieve full modularity and thus to facilitate its management. It also incorporates new technical and scientific features. In addition, the core component ECHAM is kept in synchronization with the latest ECHAM6 version that is being prepared by MPI-M for contributing to the up-coming Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5).

Within C2SM, a large number of scientists and students are involved in the continuous development of the ECHAM model and of the related modules. The model is also applied in many different configurations. For example, strong emphasis is put on further developing the coupling between aerosol and clouds or on investigating to what extent the model can be used to quantify the different processes underlying the observed brightening/dimming in solar radiation at the Earth's surface.

The work of Dr. Grazia Frontoso (the scientific programmer in charge of the GCM activities at C2SM) aims at facilitating the maintenance and application of these various model versions by e.g., developing a suite of post-processing tools and porting the code to supercomputers available at the Swiss supercomputing center (CSCS). Over the last months, in collaboration with the HAMMOZ community, her work has focused on developing and testing the ECHAM6-HAMMOZ model, which will be released later in 2011. In the future, she will contribute to the management of the HAMMOZ project by means of the open source project management web application Redmine. This HAMMOZ platform is currently being developed by Dr. Sylvaine Ferrachat (a scientific programmer in the group of Prof. Ulrike Lohmann) and will soon be released. It will be used to distribute the ECHAM6-HAMMOZ model and to offer online community support through a code repository, a ticketing system, a wiki, and a forum. At maturity this platform will include documentation, scripts (job scripts as well as pre/post-processing tools and other kinds of helper), control run library, and scientific resources and will thus become a large knowledge base for the entire HAMMOZ community. **(gf, ib, sf)**

» www.c2sm.ethz.ch/development/gcm

Towards the second phase of C2SM

Following the science planning meeting in October, the C2SM community is developing research proposals on the changing water cycle and on greenhouse gas emission.

As announced in the September newsletter, a science planning meeting was held on 4 October 2010. More than 30 people attended this meeting with the objective to define the scientific topics of the second phase of C2SM.

Three overarching themes had emerged from the call for ideas, "Water cycle in a changing climate from global to regional scales", "Assessment of sources, sinks and transport of greenhouse gases", and "Geoengineering". These themes were presented by Christoph Schär, Dominik Brunner, and Thomas Peter, respectively. The speakers highlighted the key scientific challenges in these areas and identified possible specific questions and hypotheses that could provide the seed for formulating concrete proposals. The presentations resulted in a lively debate, where ideas were confronted and first possible layouts of the proposals developed.

As a result of these discussions, it was decided to initiate the preparation of two proposals:

- Nicolas Gruber will take the lead to prepare a proposal in response to ETH's internal funding framework aiming at supporting the 2nd stage of „Collaborative, Highly Interdisciplinary Research Projects—(CHIRP2)". The focus will be on the changing water cycle theme with particular emphasis on the challenge of multi-scale interactions (Due date is March 1, 2011).

- Dominik Brunner will lead the preparation of a NSF collaborative project in the framework of the Sinergia initiative. The project will aim at exploring the links and feedbacks between greenhouse gas fluxes and climate on the scales of Europe with a focus area on Switzerland (Due date is January 15, 2011).

For additional information and in particular if you are interested in these scientific themes, please contact the proposal leaders or Isabelle Bey. **(ib)**

» www.snf.ch/E/funding/projects/sinergia
» www.vpf.ethz.ch/services/TH/index_EN

Agenda

Global Atmosphere Watch Conference 2011
Tuesday-Wednesday 18-19 January 2011
ETH Zentrum, Rämistrasse 101, Zürich

» www.meteoswiss.ch/gaw-conference

2° - Das Wetter, der Mensch und sein Klima
bis 20. Februar 2011
Kunstfreilager Dreispitz, Basel

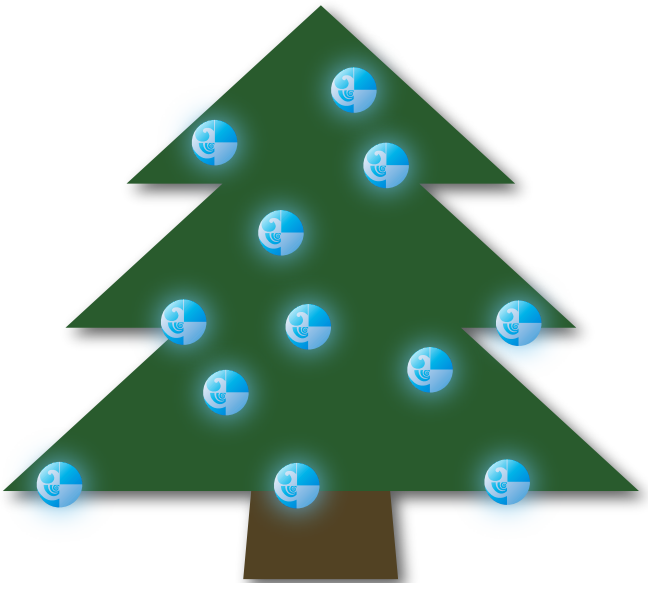
» www.2grad.ch

12th Swiss Global Change Day
Tuesday, 19 April 2010
Freies Gymnasium, Beaulieustr. 55, Bern

» events.scnat.ch/proclim/index_en.php?id=15220

Updates & Further events

» www.c2sm.ethz.ch/news



Season's Greetings!

Imprint
Center for Climate Systems Modeling (C2SM)
ETH Zurich
Universitätstrasse 16
8092 Zurich
www.c2sm.ethz.ch

Editor
Center for Climate Systems Modeling (C2SM)
Thierry Corti, ETH Zurich
Phone: +41 44 658 87 06
tcorti@env.ethz.ch

Authors
Grazia Frontoso (gf)
Isabelle Bey (ib)
Sylvaine Ferrachat (sf)

Credits
Cover: Nasa/courtesy of nasaimages.org

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement des Innern EDI
Bundesamt für Meteorologie und Klimatologie
MeteoSchweiz

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Volkswirtschafts-
departement EVD
Forschungsanstalt
Agroscope Reckenholz-Tänikon ART

EMPA
Materials Science & Technology