

International Council for Science

ISSN 1755-9030

SCAR report

No 36
November 2009

Contents

Report on Summer School on Ice Sheet Models for the 21st Century

A contribution from the SCAR Expert Group on
Ice Sheet Mass Balance and Sea Level (ISMASS)



SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

at the

Scott Polar Research Institute, Cambridge, United Kingdom

SCAR Report

SCAR Report is an irregular series of publications, started in 1986 to complement SCAR Bulletin. Its purpose is to provide SCAR National Committees and other directly involved in the work of SCAR with the full texts of reports of SCAR Standing Scientific Groups and Group of Experts meetings, that had become too extensive to be published in the Bulletin, and with more comprehensive material from Antarctic Treaty meetings.

SCAR Bulletin

SCAR Bulletin, a quarterly publication of the Scientific Committee on Antarctic Research, carries reports of SCAR meetings, short summaries of SCAR Standing Scientific Groups, Action Groups and Groups of Experts meetings, notes, reviews, and articles, and material from Antarctic Treaty Consultative Meetings, considered to be of interest to a wide readership.

Report on Summer School on Ice Sheet Models for the 21st Century

A contribution from the SCAR Expert Group on Ice Sheet Mass Balance and Sea Level (ISMASS)

Date and Venue:

The workshop took place at Portland State University, in Portland, Oregon, USA, on 3-14 August 2009. It involved 19 participants from Canada, USA, France, UK, China, and NZ (see Appendix 1), a lecturing staff of 20, from the US, UK, NZ, Scotland, and Sweden, including the organising team of 3, from the US (Christine Hulbe, Jesse Johnson and Cornelius van der Veen).

Outcomes:

The major tangible outcome of the Summer School is a set of lecture notes available at http://websrv.cs.umt.edu/isis/index.php/Summer_Modeling_School.

Lectures were held on:

- Theoretical basis of ice sheet modelling (4-5 Aug)
- Basal conditions (6 Aug)
- Data sets for ice sheet modelling (6 Aug)
- Ice shelves and distributed stress-field solutions (7 Aug)
- Quantifying model uncertainty (11 Aug)
- Glimmer, the community ice sheet model, and higher-order models (12-13 Aug)
- Coupling the Cryosphere to other Earth systems (14 Aug).

Objectives:

An intensive Summer School aimed to bring together current and future ice-sheet scientists to develop better models for the projection of future sea-level rise (slr). The IPCC Fourth Assessment Report acknowledged that current models do not adequately treat the dynamic response of ice sheets to climate change, and that this is the largest uncertainty in assessing potential rapid slr. Recognizing this, an ice-sheet modelling Workshop took place during the July 2008 SCAR/IASC meeting, in St. Petersburg, Russia. That meeting developed a community strategy on how best to

- (i) improve the physical understanding of ice-sheet processes responsible for rapid change;
- (ii) incorporate improved physical understanding into numerical models;
- (iii) assimilate appropriate data into the models for calibration and validation; and
- (iv) develop prognostic whole ice-sheet models that better incorporate non-linear ice-sheet response to environmental forcing (such as change in surface mass balance, loss of buttressing from floating ice shelves and ice tongues, and rising sea level).

The Workshop resulted in a Science Plan for a joint SCAR/IASC/WCRP-CLiC programme outlining research and observational strategies over the next five years, building on existing research groups as appropriate.

The two-week Summer School was a first step towards implementing this Science Plan. It was designed to bring scientists from differing backgrounds together to allow more extensive and in-depth interactions between the relevant polar research communities. A series of general background lectures as well as discussions of more specialized and advanced topics during this Summer School was planned to provide the foundation for cross-disciplinary research, particularly for early career scientists. We anticipate publication of lecture notes both in hard copy and on a dedicated home page, to provide the glaciological community with an up-to-date overview of the science and observational techniques that will serve to guide further research efforts. Direct beneficiaries will be young researchers; indirect beneficiaries will be coastal zone communities who will gain improved sea level change forecasts to underpin their plans for sustainable development.

Developing the next generation of ice-sheet models is not a trivial task that can be undertaken by isolated smaller research teams. Instead, a community-wide approach is needed that involves scientists from various disciplines including glaciology, high-latitude oceanography and meteorology, geophysics and engineering and computer sciences, representing both the modelling and observational communities. The school provided the new generation of polar scientists with the necessary interdisciplinary tools to develop the next generation of ice-sheet models. It provided a platform for in-depth exploration of issues related to ice-sheet modelling, in situ data collection, and satellite remote sensing. In addition to lectures covering necessary theoretical background, given by leading scientists in their respective fields, shorter lectures on more specific topics (such as Introduction to Programming in Fortran) were included. Most lectures were built around hands-on exercises, providing all participants the opportunity to apply what was being taught. This interactive format proved to be very successful as evidenced by the course evaluations. Ample time was set aside for discussions, and outlining concrete research strategies for improving ice-sheet models. In addition to a discussion session organized by the students (8 Aug), social activities provided opportunities for students to present their work, and for increased interactions and small group discussions. A collection of lecture notes will be published as a reference book for ice sheet modelers, and on the web. This will help to strengthen the legacy from the International Polar Year 2007-2009.

Value of collaborative partnerships and benefits to the scientific community and other stakeholders:

The Summer School fostered a number of international collaborations for future research. It helped to develop a research community that will work to improve ice-sheet models to improve estimates of future sea-level change. The School was designed to maximize interactions between participants with instructors and students working in groups on the hand-on activities and exercises. This approach resulted in blurring the distinction between student and instructor. Because of the wide range of expertise and topics covered, many of the instructors also learned about topics outside of their research area, and became familiar with certain software and modelling procedures and protocols. Such joint learning is a valuable first step to developing interdisciplinary project that can benefit the broader glaciological community.

As a direct result of the Summer School, a number of the participants have started to formulate a collaborative proposal to form an interdisciplinary team focusing on the connection between (changes in) floating ice geometry and grounding line position at marine margins of ice sheets. This objective requires us to consider three boundaries, 1) the grounded/floating transition, 2) ocean/ice shelf base and 3) calving front. The objective is to develop parameterizations for better treatment of grounding-line dynamics into continental-scale ice-sheet models. This will directly feed into ongoing modeling efforts at Los Alamos National Laboratories and other institutions around the world.

Follow up activities and future implications:

The newly built community will continue to work on these issues, providing input to SCAR's programme on Ice Sheet Mass Balance and Sea Level, and through that to the Intergovernmental Panel on Climate Change. These results will also feed in to WCRP's Climate and Cryosphere (CliC) programme, which is co-sponsored by SCAR and IASC. A number of the participants are in the process of developing a collaborative proposal to be submitted next month to the National Science Foundation. Building on the success of the Summer School (as evidenced by the Course Evaluations), possibilities for repeating the Summer School in 2011 are being explored.

Funding:

The workshop was funded by:

- SCAR
- The International Council for Science (ICSU)
- The International Arctic Science Committee (IASC)
- The International Association of Cryospheric Sciences (IACS)
- The World Climate Research Programme (WCRP)
- The National Science Foundation (NSF, USA)
- The Centre for Remote Sensing of Ice Sheets (CreSIS)
- The Cooperative Institute for Research in Environmental Sciences (CIRES)

Appendix 1: Attendees

Anderson, Brian
Antarctic Research Centre
Victoria University, Wellington
New Zealand

Hagdorn, Magnus
School of Geosciences
University of Edinburgh
Scotland

Heimbach, Patrick
Earth, Atmospheric and Planetary Sciences
Massachusetts Institute of Technology
Boston, MA, USA

Jezek, Ken
Byrd Polar Research Center
Ohio State University
Ohio, USA

Kirchner, Nina
Bert Bolin Centre of Climate Research
Stockholm University
Sweden

Lipscomb, Bill
Los Alamos National Laboratory
New Mexico, USA

Price, Steve
Los Alamos National Laboratory
New Mexico, USA

Rutt, Ian
Department of Geography
Swansea University
Wales

Sergienko, Olga
Geophysical Fluid Dynamics Lab
Princeton, New Jersey, USA

Tulaczyk, Slawek
Earth and Planetary Sciences
UC Santa Cruz
California, USA

Williams, Gethin
School of Geographical Sciences
University of Bristol
England

Colleoni, Florence
LGGE, CNRS
France

Fyke, Jeremy
Antarctic Research Centre
Victoria University of Wellington
New Zealand

McGovern, Jonathan
School of Geographical Sciences
Swansea University
Wales

Normani, Stefano
Civil and Environmental Engineering
University of Waterloo
Ontario, Canada

Wang, YuanXiang
Chinese Academy of Meteorological Sciences
Beijing, China

Werder, Mauro
Simon Fraser University
British Columbia, Canada