



2014 Annual Report

A core project of:

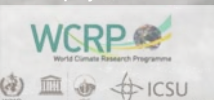


Photo Courtesy of Allen Pope



About CliC

Who we are...

The Climate and Cryosphere Project (CliC) is one of the four core projects of the WMO/ISCU/IOC World Climate Research Programme (WCRP) (<http://www.wcrp-climate.org>) together with CLIVAR, GEWEX, and SPARC, and was established as such in 2003. The four core projects work closely with the WCRP Joint Planning Staff (JPS) and other working groups of WCRP. The projects organize its work through various initiatives, experiments, and their respective scientific advisory committees and workshops.

What we do...

The Climate and Cryosphere project encourages and promotes research into the cryosphere and its interactions as part of the global climate system. It seeks to focus attention on the most important issues, encourage communication between researchers with common interests in cryospheric and climate science, promote international cooperation, and highlight the importance of this field of science to policy makers, funding agencies, and the general public. CliC also publishes significant findings regarding the role of the cryosphere in climate, and recommends directions for future study.

How we work...

The CliC Scientific Steering Group (SSG) is composed of world-renowned researchers and has the overall responsibility for planning and guiding the CliC project. SSG members are appointed by the WCRP Joint Scientific Committee (JSC), based on recommendations from the CliC SSG. Initial membership is for three years and, as a rule, two extensions of two years each may be recommended. The SSG usually meets once a year.

The CliC International Project Office (IPO) is hosted at the Norwegian Polar Institute in Tromsø, Norway. The IPO supports the SSG and the CliC community in coordinating and implementing the CliC projects and tasks. Its functions of international communication and liaison make it the primary point of contact for those wishing to participate in, contribute to, or learn more about the CliC activities.

CliC is very fortunate to have a large number of leading cryosphere researchers working through regional and national programs, working groups, expert panels, and more.



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Cover photos courtesy of Allen Pope, NSIDC

2014 Overview from the Co-Chairs

The past year saw impressive progress on a number of fronts, particularly in promoting more active engagement between CliC and the climate modelling community. The Co-Chairs felt this was an important direction given the strong role WCRP plays in coordinating global and regional climate modelling, and the application of these models to improve understanding of the climate system and to make quantitative predictions and projections of future climate change. The Working Group on Coupled Modelling (WGCM) has begun planning for the next coupled model intercomparison project, CMIP6, and several CliC activities have played a key role in ensuring a strong cryospheric element in CMIP6. Of particular note, we are leading intercomparison efforts related to large ice sheets (ISMIP6) and snow (ESMSnowMIP, a component of the broader LS3MIP effort), and the sea-ice and climate modelling forum is coordinating the sea-ice data request that will form part of CMIP6 (SIMIP).

We have also initiated work that will contribute to the Cryosphere Grand Challenge, notably a proposed intercomparison of global glacier mass balance models, which adds to ongoing efforts like WAGOM. CliC has also been involved in developing one of the work packages for the Regional Sea Level Grand Challenge, specifically related to contributions from glacier and ice sheet melt.

This year was also marked by the very sad passing of Heidi Isaksen, the Administrative Officer in the CliC Project Office. While this was a severe blow to the project, it was a tragedy for Heidi's family and friends. Thankfully, Erik Warming was able to step in and provide much-needed technical and administrative support, and Jenny, our steadfast Director, kept the office running. Late in the year, we were fortunate that our host, the Norwegian Polar Institute, hired Gwenaelle Hamon to serve as Executive Officer, and we are very grateful to have her as part of the team.

So, it was a year of ups and downs, but despite this, the Project Office supported many valuable meetings and workshops, and contributed effectively to numerous international activities related to Cryospheric Science. This impressive record is summarized later in this document. Our report to the WCRP Joint Scientific Committee in early summer 2014 was well received, and we will now prepare for the next meeting in early April 2015.

Both of the Co-Chairs wish to thank the CliC leadership for its ongoing engagement over the course of the year, particularly those of you who have devoted the time and energy to move various activities forward, organize meetings and workshops, and represent CliC in various occasions. We of course also thank Jenny for her diligent efforts and hard work on all of our behalf. We look forward to another productive year.

We would also like to thank 3 outgoing members of the CliC Scientific Steering Committee for their tireless efforts and hope they will stay engaged in CliC activities: Alexander Klepikov, Helmut Rott, and Cunde Xiao. We would also like to extend a warm welcome to our new SSG members: Margareta Johansson, Shichang Kang, and Tatiana Pavlova.

SSG Members

Chairs

Greg Flato, Environment Canada, Canada (Co-Chair, 1/2013-12/2015)
Gerhard Krinner, LGGE, France (Co-Chair, 7/2014-12/2015, member 1/2013-7/2014)

Members

Dorthe Dahl-Jensen, Niels Bohr Institute, University of Copenhagen, Denmark (1/2013-12/2015)
Larry Hinzman, International Arctic Research Center, University of Alaska Fairbanks, USA (1/2013-12/2015)
Alexandra Jahn, University of Colorado Boulder, USA (1/2014-12/2016)
Margareta Johansson, Lund University, Sweden (1/2015-12/2018)
Shichang Kang, State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, China (1/2015-12/2018)
Nalân Koç, Norwegian Polar Institute, Norway (1/2013-12/2015)
Peter Lemke, Alfred Wegener Institute for Polar and Marine Research, Germany (1/2013-12/2015)
Rob Massom, Australian Antarctic Division, Antarctic Climate and Ecosystems Cooperative Research Centre, Australia (1/2013-12/2015)
Sebastian Mernild, Center for Scientific Studies, Chile (1/2014-12/2016)
Tetsuo Ohata, National Institute of Polar Research, Japan (1/2013-12/2015)
Tatiana V. Pavlova, Voeikov Main Geophysical Observatory, Russia (1/2015-12/2018)

WCRP Joint Science Committee Liaisons

James Renwick, Victoria University of Wellington, New Zealand (2013 -)
Mauricio M. Mata, Federal University of Rio Grande-FURG, Brazil (2014 -)

Flurries in the Project Office

In 2014, the CliC Office helped to organize and fund 25 workshops; 93 people, 67% of whom were early career researchers. This support includes everything from arranging travel, website support, participating on organizing committees, and more. We have also helped to initiate a number of new targeted activities, connect researchers to potential collaborators, participate in partner organization activities, speaking about CliC at various high level meetings to help to increase funding for our research efforts, and much more. We also provide coordination support for various co-sponsored initiatives, provide several cryosphere community resources (see Outreach section of this report), and act as a contact point for cryosphere research within the WCRP. We have had a turnover in staff, and unfortunately not the healthiest of years, but it's the energy and interest of the cryosphere community in our work that keeps us motivated and moving things forward.

We were fortunate this year to have received a grant from the Norwegian Ministry of Foreign Affairs to support the Arctic Freshwater Synthesis activity. Gwen Hamon joined the office in September to help facilitate this activity and moved things forward. Gwen holds a Master's degree in Ecology and Environmental Studies from the University Paris-Sud XI in France where she is from. Gwen worked for more than four years for the Global Ocean Forum, an NGO dealing with international marine policy issues based at the Center for Marine Policy of the University of Delaware in the USA. She had a central role in the NGO in terms of project management and science coordination. Before that Gwen worked at UNESCO Headquarters in Paris as an intern working on scientific research and commercial uses of marine genetic resources. We are very glad that she has joined the office as the new Executive Officer and are sure she will handle the new responsibility well.

Lorna Little has joined the CliC team as the new volunteer FrostBytes editor. Lorna is a polar botanist from New Zealand. After studying the potential for weeds to invade alpine regions at the University of Otago, New Zealand, she went on to study all things Antarctic in the Post Graduate Certificate of Antarctic Studies at the University of Canterbury. Her background in botany and passion for polar places sent her to the northern hemisphere however, when she began her PhD investigating the role of flower color in the New Zealand Subantarctic and Arctic Svalbard with the University of Otago and the University Center in Svalbard. She has been involved in various APECS Oceania initiatives in New Zealand, and since completing her PhD in December of 2013, has been developing outreach and education activities about polar regions and botany. She has a passion for education and outreach and we are sure that she will do a great job continuing our video-related outreach efforts.

The CliC Office would like to thank the entire cryosphere community and our many partners and friends for their engagement and support through a tough, but productive, year. We will miss our dear colleague Heidi, who passed away in July from cancer and hope her daughters, family, and friends know that her contribution to our community was meaningful and that she is missed. Our past volunteer FrostBytes Editor, Erik Warming, did a great job helping with office administration in the interim, particularly with workshop reimbursements and fixing various things on our website. We wish him well in his next endeavors.

We would also like to take this opportunity to encourage the CliC Community to consider helping to support our efforts by supporting additional staff or seconding support for the many activities we currently have. We have done a lot with a few staff... imagine what we could do with more!

We would also like to thank Greg and Gerhard, our wonderful Co-Chairs, the WCRP Joint Planning Staff, and the Norwegian Polar Institute for their continued support.

2014 Workshops and Meetings

DUE Permafrost 2014

February 11-13, 2014, Frascati, Italy

<http://www.climate-cryosphere.org/meetings/past/2014/du-permafrost-2014>

<http://www.climate-cryosphere.org/media-gallery/1352-2014-bartsch-permafrosteomonitoring>

Annett Bartsch, Austrian Polar Research Institute; Birgit Heim, AWI

User workshops are an important tool for the interaction between the scientific user's community and the remote sensing experts. The DUE Permafrost team and ESA held three such workshops from 2010 to 2012. ESA, CliC and IPA funded the 4th DUE Permafrost User Workshop. This ESA-CliC-GTN-P/IPA-DUE Permafrost workshop brought together a multidisciplinary community working on permafrost-related remote sensing, field monitoring and permafrost-related modelling and climate modelling. Participants collected and discussed the up-to-date user requirements related to monitoring and modelling. The 2014 DUE Permafrost Workshop contributed to the update of the IGOS Cryosphere Theme Report (2007) for permafrost lead by Annett Bartsch. Results of the workshop feed into current efforts of GTN-P to build a permafrost observing component into the Sustaining Arctic Observing Network (SAON).



Figure 1. DUE Permafrost Meeting Participants, ESA, Frascati, Italy, February 2014

10th session of the CliC Scientific Steering Group (SSG)

February 17-20, 2014, Geneva, Switzerland

<http://www.climate-cryosphere.org/meetings/past/2014/ssg-10>

Jenny Baeseman, CliC IPO

The Tenth Session of the CliC Scientific Steering Group (SSG) took place at the WMO Secretariat in Geneva, Switzerland, on February 17-20, 2014. During the meeting, the SSG reviewed the progress of CliC initiatives and themes; made sure that CliC contributes tangibly to the WCRP objectives and key deliverables specified in the WCRP Implementation Plan 2010-2015; discussed the way forward for CliC and its sponsors in the longer-term perspective; and facilitated CliC participation in addressing the newly established WCRP Grand Challenges.

A significant number of CliC related workshop were organized in 2013 and reports from all of them are available online. In 2013, CliC created an image of a resourceful program with a wide scope of interests. All of the received proposals for a workshop were funded to some degree or another. It was agreed that in the future, CliC needs to be more selective and make sure that project activities pursue products as their outcomes. CliC needs to complete an action plan and include in it the most important targeted activities. The plan will be built on their own activities and some results will be obtained by working together with partners such as IASC and SCAR.



Figure 2. CliC SSG 10 Participants at WMO in Geneva

THAW 2014 - THERMOKARST AQUATIC ECOSYSTEMS WORKSHOP

March 12-15, 2014, Quebec City, Quebec, Canada

<http://www.cen.ulaval.ca/thaw2014/>

http://www.climate-cryosphere.org/media/com_hwdmediashare/files/c5/e5/5e/3e744a02623c6286e593d8371bea026b.pdf

Isabelle Laurion and Warwick F. Vincent, University of Laval

The THERMOKARST AQUATIC WORKSHOP was held from 12 to 15 March 2013 at Centre d'Études Nordiques (CEN), Laval University, in Québec City, Canada. The meeting was attended by around 100 researchers (including a large percentage of polar and alpine early career scientists) to present, discuss and synthesize observations concerning freshwater systems in permafrost landscapes, and to identify gaps in knowledge that are priorities for ongoing and future research. The meeting noted the increasing interest in thermokarst lakes, ponds and wetlands given the accelerated warming of the Arctic and the associated effects on permafrost degradation, and peat erosion. In some regions of the Arctic, permafrost lakes are eroding and draining, while in other areas they are expanding in size and numerical abundance. The net effects are important to assess, because these aquatic systems provide a

major class of ecological habitats in the North. They also have the potential to contribute to greenhouse gas emissions, thereby acting as a positive feedback on climate change, and may be large sources of particulate and dissolved organic materials to the coastal ocean that some of them ultimately drain into. The meeting brought together specialists from a variety of physical, chemical and biological disciplines to exchange ideas, results and information on three connected themes: a) Physical aspects and dynamics through time and space; b) Biogeochemical and photochemical properties; and c) Biodiversity and food webs. A special issue of the EGU journal Biogeosciences was produced from the meeting, and follow-up meetings were planned, including at the European Conference on Permafrost (Portugal) and the Arctic Change conference (Canada).

Understanding Linkages Between Different Elements of the High-Latitude Cryosphere – How Important Are They?

March 10-16, 2014, Hobart, Australia – in conjunction with the IGS Sea Ice Symposium <http://www.climate-cryosphere.org/meetings/past/2014/cryosphere-element-linkages>
Rob Massom, Australian Antarctic Division

The Workshop on “Understanding linkages between different elements of the high-latitude cryosphere – How important are they?” was well attended and enthusiastically received, provided strong endorsement of the new targeted activity, and generated much interest and discussion among the 40 scientists present. Those in attendance included leading and early-career scientists in the fields of sea-ice physics, observations and operations; sea ice and climate modeling; ice shelf-ocean interaction and modeling; ice-sheet glaciology; atmospheric science/meteorology; ecology and biogeochemistry; remote sensing; and oceanography – and representing both the Arctic and Antarctic. Cross-programme linkages via those present included to the SCAR/CliC Antarctic Sea Ice Processes and Climate (ASPeCt) group (Professor Steve Ackley and Dr Marilyn Raphael), WMO EC-PORS (Dr Jim Renwick), WAIS (Dr Ted Scambos) and the WCRP SPARC (Stratosphere-Troposphere Processes and their Role in Climate) project (<http://www.sparc-climate.org/>, Drs Andrew Klekociuk and Olaf Morgenstern). Importantly, the response to the targeted activity was positive and highly encouraging, and confirmed community interest in carrying this research forward. The workshop in fact generated substantial intra- and cross-disciplinary discussion and important new collaborative partnerships – not the least for the large proportion of early-career scientists/students attending. The project steering committee/working group is currently being established, comprising volunteers from the workshop, invited leaders from the wider community with a strong interest in cross-cryosphere studies, and a mix of leading and young scientists.



Figure 3. Understanding Cryosphere Linkages workshop participants in Hobart, Australia, 15 March 2014

Leading up to the workshop, a CliC-sponsored session on the emerging theme of “Sea Ice Interaction with Ice Sheets, Ice Shelves and Icebergs” (comprising both poster and oral sessions on March 13 and 14 respectively) was held at the 2014 International Glaciological Society’s International Sea Ice Symposium on “Sea Ice in a Changing Environment.” The inclusion of a special sea ice-ice sheet margin interaction session is unique in sea ice conferences to date, as far as we’re aware, and brought together not only sea ice scientists but also ice-sheet glaciologists and polar oceanographers, modelers and observationalists – including the CliC-sponsored young researchers. The special CliC-sponsored cross-cryosphere session at IGS 2014 resulted in 4 accepted refereed papers (including 3 from the CliC-sponsored young scientists plus 1 in review) on the theme of the Targeted Activity.

The accepted papers are:

- * Bintanja, R., G.J. Van Oldenborgh, and C.A. Katsman (in press). The effect of increased fresh water from Antarctic ice shelves on future trends in Antarctic sea ice. *Annals of Glaciology*, 56(69).
- * Hoppmann, M., M. Nicolaus, S. Paul, P.A. Hunkeler, G. Heinemann, S. Willmes, R. Timmermann, and O. Boebel (in press). The role of ice platelets in Weddell Sea land-fast sea ice. *Annals of Glaciology*, 56(69).
- * White, A., L. Copeland, D. Mueller and W. Van Wychen (In press). Assessment of historical changes (1959-2012) and the causes of recent break-ups of the Petersen Ice Shelf, Nunavut, Canada. *Annals of Glaciology*, 56(69).
- * Wongpan, P., P.J. Langhorne, D. E. Dempsey, L. Hahn-Woernle, & Z. Sun (in press). Simulation of the crystal growth of platelet sea ice with diffusive heat and mass transfer. *Annals of Glaciology*, 56(69).

2014 ASPeCt and Arctic Sea Ice Working Group Meetings

March 15, 2014, Hobart, Australia

<http://www.climate-cryosphere.org/meetings/past/2014/2014aspect-casiwg>
http://www.climate-cryosphere.org/media/com_hwdmediashare/files/c5/29/64/954c98c3d31a41dc3649758d35dd722d.pdf

Stephen Ackley Research Assoc. Professor University of Texas at San Antonio; Marilyn Raphael Professor, University of California, Los Angeles; Don Perovich, CRREL, NH, USA; Hajo Eicken, University of Alaska-Fairbanks

ASPeCt held a Workshop at the International Glaciological Society (IGS) meeting, Hobart, Tasmania, March 2014 – joint with the Arctic Sea Ice Working group in the morning (41 members attending) and ASPeCt alone (29 members attending) in the afternoon. The goals of the workshop were two-fold one, to bring together the two groups focused on sea ice processes to coordinate ideas and activities, and two, to discuss ASPeCt only plans. The morning session was devoted to discussion of issues of concern to both groups. The major issue discussed was the standardization of observations, such as ice cores, with the aim of forming unified approaches for sea ice observing, archiving and dissemination. This session ended with an extended discussion on ways in which Arctic and Antarctic linkages could be strengthened and a formal review of Arctic-Antarctic linkages was discussed. The afternoon session focused on a discussion of ASPeCt input to SOOS initiatives via sustained observations. Regional initiatives associated with SOOS in Prydz Bay and Amundsen and Weddell Seas were discussed. Software improvements to ASPeCt observations and the use of digital photos and other automated observations from vessels to supplement visual observations were proposed. This was followed by an exhaustive discussion of the sea ice questions that the SCAR Horizon Scan was expected to review. Rob Massom coordinated the introduction of the outcomes of this discussion into the SCAR Horizon Scan. The success of this exercise was made clear in Kennicutt et al. (2014a, b) which defined six priorities for Antarctic Science and stated “What factors control Antarctic sea-ice seasonality, distribution and volume? We need to know.”

Research Carbon Network Working Group Lead Meeting

May 12-15, 2014, Stockholm, Sweden

Christina Schädel and Ted Schuur, Permafrost Carbon Network

This one-day workshop was held in conjunction with the third and final CAPP (Carbon Pools in Permafrost) workshop organized by Dr. Peter Kuhry. The specific intent of this co-hosted workshop was to connect US activities represented by the Permafrost Carbon Network to ongoing international research efforts. Participants from the Permafrost Carbon Network presented their synthesis results in oral presentations or posters which have been made available on the PCN website. The last day of the workshop was fully dedicated to discussion of cross-group synthesis activities and development of useful benchmarks for the modelling community.

2014 Ice Sheet System Model (ISSM) Workshop

June 2-4, 2014, Bergen, Norway

<http://issm.jpl.nasa.gov/issmworkshops/>

Eric Larour, Jet Propulsion Laboratory, NASA

The Ice Sheet System Model (ISSM) team had a workshop in Bergen, Norway, in June 2014. This third workshop focused on modeling the evolution of a polar ice sheet, in a changing climate. The ISSM model is an open-source community-based ice sheet modeling software capable of using higher-order physics, a broad scalability and simulating the evolution of large-scale polar ice sheets. Over the 3-day workshop, the ISSM team taught tutorials in ice sheet modeling, including glacier flows, calculating the bedrock friction with satellite data, future ice streams and the uncertainties of these. Apart from the tutorials, some new ideas to better integrate

existing data were established. The workshop was funded by Bjerknes Centre for Climate Research and WCRP/CliC, which also provided funding for early-career scientists from four different countries to attend the workshop.

- * Larour, E., N. Schlegel, and M. Morlighem. 2014. Modeling the Evolution of Polar Ice Sheets - Ice Sheet System Model Workshop; Bergen, Norway, 2–4 June 2014. *EOS* Vol. 95, Issue 45, p 411. DOI: 10.1002/2014EO450005

Polar CORDEX

June 17, 2014, Lund, Sweden

<http://www.climate-cryosphere.org/activities/targeted/polar-cordex/meetings/868-arctic-cordex-2014>

Annette Rinke, AWI; John Cassano, University of Colorado

The second Polar CORDEX meeting was held as a side event during the Regional-Scale Climate Modelling Workshop on 21st Century Challenges in Regional Climate Modelling in Lund, Sweden in June 2014. The status of and future plans for simulations and analysis have been discussed. Further, a link to the Arctic Council “Adaptation Actions in a Changing Arctic” (AACCA) project has been established. The AACCA project looks at future climate impacts, their interactions with other non-climate and socio-economic drivers of change, and the relevance of this for designing adaptation policies. Participants discussed that available and relevant Arctic CORDEX results should feed into the AACCA report.

Southern Ocean Observing System (SOOS) - 3rd Scientific Steering Committee

June 18-20, 2014, Tromsø, Norway

<http://www.climate-cryosphere.org/meetings/past/2014/2014-soos-ssc>

Louise Newman, SOOS

The annual SOOS Scientific Steering Committee meeting was hosted by the Norwegian Polar Institute in Tromsø. The CliC Project office coordinated the meeting and helped with the logistics.

EUCOP/PYRN

18-21 June, Évora, Portugal

<http://www.eucop4.org/permafrost-young-researchers-workshop.html>

http://www.climate-cryosphere.org/media/com_hwdmediashare/files/35/01/09/2d8f7fd4211f0b28308e7775d4cd0d54.pdf

Michael Fritz, AWI

The “Permafrost Young Researchers Workshop” was hosted in context of the Fourth European Conference on Permafrost (EUCOP IV). This workshop was organized as a joint effort of PYRN (Permafrost Young Researchers Network), APECS (Association of Polar Early Career Scientists) and the young researcher representatives of the two projects PAGE21 (Changing Permafrost in the Arctic and its Global Effects in the 21st Century) and ADAPT (Arctic Development and Adaptation to Permafrost in Transition).

The workshop aimed at building interdisciplinary knowledge on how the Arctic and Antarctic permafrost regions play a key role in the Earth System and to give each participant a more overarching view on the regions beyond disciplinary research questions. To achieve this, the participants shared knowledge with each other in thematic break-out sessions and elaborated on future avenues of permafrost research, together with mentors, playing a key role in permafrost research either in large-scale international projects or science policy.

35th Session of the WCRP Joint Scientific Committee

June 30 – July 4, 2015, Heidelberg, Germany

<http://www.wcrp-climate.org/JSC35/index.html>

<http://www.climate-cryosphere.org/news/clic-news/950-clic-35th-session-of-the-wcrp-jsc-2014>

Dave Carlson, WCRP

WCRP had their 35th annual Joint Science Committee meeting from June 30 to July 4 in Heidelberg, Germany. The CliC community was well represented. The meeting created a relaxed atmosphere where the new WCRP Director David Carlson was introduced to the group and was able to hear about the great things that are happening within CliC and WCRP. The meeting also provided a unique opportunity for several of the CliC leaders to meet with other WCRP activity leads to discuss ways to better collaborate and increase our understanding of the cryosphere's interactions with climate.



Figure 4. CliC Leadership at WCRP Joint Science Committee in Heidelberg, Germany, June 2014

Ice Sheet Modelling for CMIP6 Meeting

July 16-18, 2014, NASA GSFC, Greenbelt, MD, USA

<http://www.climate-cryosphere.org/meetings/past/2014/ice-sheet-modelling-for-cmip6-meeting>

http://www.climate-cryosphere.org/media/com_hwdmediashare/files/4a/d5/ac/f787948d184d63dec3b2a4b65e253b36.pdf

Sophie Nowicki, NASA GSFC; Tony Payne, University of Bristol; Eric Larour, NASA JPL

CliC sponsored and helped organize a workshop in July 2014, whose goal was to bring together ice sheet and Earth System modelers and developers, along with representatives of other activities that are relevant to the cryosphere (such as Polar CORDEX, CLIVAR, WAGOM). The meeting was attended by about 60 participants (including remote participants) and was held at NASA Goddard Space Flight Center(GSFC).

The meeting was organized around key topics driving current ice sheets and glaciers model development and analysis, along with the incorporation of dynamic ice sheets into fully coupled Earth System Models (ESM):

- Mechanics of coupled simulations: How close are we to having models that could run as part of a CMIP-style ESM? And how suitable are CMIP models over the cryosphere?
- Missing physics and numerics, which can impact on cryospheric and sea-level projections: What are the major obstacles to credible projections of the cryospheric components of sea level?
- MIP experiment design: What type of experiment can we tackle and how?
- Data sets: What data sets are needed for model development and validation? What fields need to be saved from CMIP models and from the ice sheet models?

The main outcome of the workshop was the agreement to work towards a proposal for participation in the CMIP6 initiative, and request for endorsement by CMIP6 was submitted in September 2014. This new activity, called Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6), also now has a Scientific Steering Committee, whose current members are: Helene Seroussi (USA), Heiko Goelzer (BE), Andrew Shepherd (UK), William Lipscomb (USA), Jonathan Gregory (UK) and Ayako Abe Ouchi (JP).

Pan-GEWEX and Pan-CLIVAR Meetings

July 17-15, 2014, The Hague, The Netherlands

<http://www.gewex.org/gewexnews/Aug2014.pdf>

Gerhard Krinner, CliC Co-Chair, LGGE

Gerhard Krinner participated in the Pan-GEWEX and Pan-CLIVAR meetings to foster CliC collaborations. These meetings outlined joint activities that will make important contributions to the WCRP Grand Challenges, particularly those on regional climate information and climate extremes. Important joint efforts evolved out of these discussions. The Southern Ocean Panel meeting was used as an opportunity to clarify CliC involvement in this joint CliC/CLIVAR panel. Discussions at a meeting of the GEWEX-GLASS (Global Land/Atmosphere System Study) panel led to the decision to join the CliC-led ESM-SnowMIP activity with the GEWEX-led GLACE

(Global land-atmosphere coupling experiment) and GSWP3 (Global soil wetness project, phase 3) actions to form a coherent, unified project with respect to CMIP6. This project, jointly led by CliC and GEWEX, is named LS3MIP (Land surface, snow and soil moisture MIP) and was subsequently submitted as a CMIP6 sub-project.

International Sea-Ice Concentration and Thickness Evaluation and Inter-comparison Workshop

September 18-19, Hamburg Germany

<http://www.climate-cryosphere.org/meetings/past/2014/seaice-conc-2014>

http://www.climate-cryosphere.org/media/com_hwdmediashare/files/b1/e3/3d/29c62d02a3212ec638ecd1d4a37b7609.pdf

Stefan Kern, Integrated Climate Data Center, University of Hamburg

The International Sea Ice Concentration and Thickness Evaluation and Inter-Comparison Workshop was initiated as part of work package WP4000 of the ESA-CCI Sea Ice ECV project (SICCI project, <http://esa-cci.nersc.no>). Main objectives of WP4000 are the evaluation of the sea ice concentration, computed from satellite microwave radiometry, and sea ice thickness, computed from satellite radar altimetry, prototype products generated by the SICCI project, the inter-comparison of these prototype products with independent data, and the user assessment and usage of the prototype products in, e.g., numerical models.

1st International Satellite Snow Products Intercomparison Workshop

July 21-23, 2014, College Park, MD, USA

http://calvalportal.ceos.org/documents/10136/379794/ISSPI_WORKSHOP_REPORT/15d4be34-95d1-41b2-b39a-1f004d7eddd0

Helmut Rott and Thomas Nagler, ENVEO, Austria

The ISSPI-1 Workshop took place at NOAA, College Park, MD, US, from July 21-23, 2014. Overall 42 scientists from institutions working in seasonal snow pack monitoring met to discuss plans to assess the quality of current satellite-based snow products and work out guidelines for improvements. The Workshop was organized in 3 parts. Part 1 and Part 2 were sessions on Monday and Tuesday morning. Part 1 provided the motivation for performing this exercise, an overview of the SnowPEXproject and proposed protocols and methods for validation and intercomparison of global/ hemispheric snow extent (SE) and snow water equivalent (SWE) products. Part 2 included presentations on available EO based snow products from optical and microwave satellite data, and the product characteristics including period of availability, sensors used, current status of validation, etc. These presentations were given by the scientists responsible for each product. Additionally, validation sites and datasets where product evaluation has been performed, or are candidate site for validation, were presented.

Linkage between Arctic Climate Change and Mid-latitude Weather Extremes

September 2-6, 2014, Seattle, WA, USA

Edward Hanna, University of Sheffield; James Overland, NOAA

Following the IASC/CliC/IMO/NOAA Northern Hemisphere Polar Jet Stream and Links with Arctic Climate Change Workshop held from November 13-15, 2013, at the Icelandic Met Office in Reykjavik, a group of eight international experts including one early career scientist met in Seattle from September 3-5, 2014 to address the topic of the current state of science in regards to the connection between the recent Arctic changes to influence broader Northern hemispheric weather. The workshop resulted in a submission to the Journal of Climate on *The Melting Arctic, the Polar Vortex, and Mid-latitude Weird Weather: Are They Connected?* As part of this project, a session will be held at the Third International Conference on Arctic Research Planning (ICARP III), where 28 abstracts have been submitted. The session is part of the ASSW/ICARP III/ISAR Symposium to be held on April 27-30, 2015, in Toyama, Japan. The Seattle workshop suggested a 'way forward through case studies of regional episodic mechanisms. Two candidates for linkages are increased Siberian high pressure and wave trains of high/low pressures bring cold air into eastern Asia, and an amplification of the North American ridge/trough structure related to Greenland blocking (a slowing of the wind pattern) affecting cold weather in eastern North America.'

Large-Scale Sea-Ice Simulations Workshop

September 26, 2014, University of Reading, UK

<http://www.climate-cryosphere.org/activities/groups/seaicemodeling/meetings>

Alexandra Jahn, NCAR, USA; Dirk Notz, Max Planck Institute for Meteorology, Germany; Daniel Feltham, University of Reading, UK

This workshop brought together a representative large fraction of active sea-ice modellers. This allowed for a very constructive discussion that will in particular inform the CMIP6 modeling activities related to sea ice. This workshop was key for defining sea-ice variables for CMIP6, which will allow for a more in-depth analysis of sea ice from any CMIP6 experiment. The workshop participants also signaled that they would be very interested in continuing these discussions and in particular in allowing for a broader exchange of sea-ice model development ideas and issues. These will be, among others, the topic of a follow-up workshop in 2015.

Arctic Snow Cover Changes and their Consequences

October 16-14, 2014, Denmark, Copenhagen

Terry Callaghan, University of Sheffield, UK; Margareta Johansson, Lund University, Sweden

An IASC cross-cutting activity (co-sponsored by CliC) to plan input on snow to the ICARP III meeting was motivated at a meeting of the IASC Terrestrial Working Group meeting in Krakow in 2013. The motivation was largely based on the fact that snow is a critically important and rapidly changing characteristic of the Arctic but has too often been overlooked in major environmental assessments. The main aims of the workshop were: 1) to bring together researchers from each IASC Working Group

and others who represent a range of disciplines related to snow per se and the multiple consequences of changes in Arctic snow cover; 2) to assess current knowledge and identify gaps and challenges in existing data and models including those relevant to facilitating adaptation; 3) to develop a research agenda that represents each discipline but also crosses disciplines using an Arctic system approach while addressing adaptation needs at local scales; 4) to identify mechanisms to implement the research agenda; 5) to identify mechanisms to implement an improved, standardised monitoring of snow conditions and their effects; 6) to construct a road map that combines the agendas and implementation plans for research and monitoring; 7) to present the road map for snow studies at ICARP III; and 8) to integrate activities on arctic snow monitoring and research with global cold region initiatives. The main product is a short, multi-authored report on recommendations for ICARP III.

Rising Coastal Seas on a Warming Earth

October 27-29, 2014, New York University-Abu Dhabi campus
<http://www.climate-cryosphere.org/activities/targeted/wagom/2014-kick-off>
David M. Holland, New York University, USA

In 2014, CliC approved a new targeted activity looking at the interaction between glaciers and oceans, using the West Antarctic Ice Sheet as a test case. From October 27 to 29, 2014, the project held their kick-off meeting at the New York University-Abu Dhabi campus. This three-day workshop brought together a group of 30 international experts on the topic of sea-level rise. The workshop was organized by David and Denise Holland and sponsored by NYU Abu Dhabi, the US National Science Foundation, NASA's Cryosphere Program and CliC. The meeting had three goals. The first was to review current knowledge about the modelling of sea-level rise focused on the contribution made by glaciers being melted by warm ocean waters. The second was to make a plan for future research that combined ocean modelling with glacier modelling. The third goal was to have the group draft a brief research paper on this topic so that others in the community could be updated on the status of modelling capabilities for sea-level rise. Outcomes from the meeting have been submitted to AGU's Eos. If you are interested in learning more about the project or the workshop outcomes, visit the WAGOM website or contact David Holland.

4th Annual Meeting of the Permafrost Carbon Network

December 14, 2014, San Francisco
Christina Schädel, Permafrost Carbon Network, USA
<http://www.permafrostcarbon.org/>

The annual Permafrost Carbon Network meeting took place on the December 14, 2014 before AGU in San Francisco. After an introduction to the network for newcomers, update on finished products, and future direction of the network, updates were given on Carbon quantity and quality, Thermokarst, aerobic/anaerobic upscaling and model integration before the breakout sessions in the afternoon where these issues were tackled more in depth.

Arctic Freshwater Synthesis

Terry Prowse, Environment Canada; Arvid Bring, University of New Hampshire, USA;
Johanna Mård Karlsson, Stockholm University, Sweden
<http://www.climate-cryosphere.org/activities/targeted/afs>

- Scientific Co-Leads Meeting

May 4-6, 2014, Stockholm, Sweden

<http://www.climate-cryosphere.org/activities/targeted/afs/meetings/sc-may14>

http://www.climate-cryosphere.org/media/com_hwdmediashare/files/49/2a/05/b8d6e116377df7af79e3ef824269c452.pdf

The meeting gathered AFS co-leads for cross-component dialogues to continue forward with identifying recent advances and knowledge gaps in the Arctic freshwater system, identifying synergies between components that can generate new knowledge from the AFS, and plan for the continued process.

-Terrestrial Hydrology and Resources Components Writing Team Meeting

September 14-16, 2014, Tromsø, Norway

<http://www.climate-cryosphere.org/activities/targeted/afs/meetings/afs-resources-hydro>

On September 14-15, 2014, the Hydrology and Resources Component Teams met at the Norwegian Polar Institute in Tromsø, Norway. The meeting was sponsored by CliC, the Norwegian Ministry of Foreign Affairs, the Norwegian Ministry of Climate and Environment, and AMAP. The purpose was to make progress on the drafts of their separate chapters of the AFS, as well as to strengthen the integration of the two components and avoid duplication. Seven members of the Hydrology team attended the meeting (two remotely) and four from the Resources team. The two groups discussed the best approach to take in the next steps of the drafting process as well as ways to tackle the cross-component issues. Both groups agreed to have regular conference calls among themselves as well as more frequent phone calls among component co-leads. The co-leads agreed to send the outline of their chapters to their teams within a week after the meeting as well as a list of action items and milestones.

-Terrestrial Ecology Component Writing Team Meeting

October 6-9, 2014, Wallingford, UK

<http://www.climate-cryosphere.org/activities/targeted/afs/meetings/afs-ecology>

http://www.climate-cryosphere.org/media-gallery/1290-meeting-report-terrestrial-ecology?album_id=41

Margareta Johansson, Lund University, Sweden and Fred Wrona, Environment Canada/ University of Victoria, Canada

On October 6-9, 2014, the Terrestrial Ecology Component writing team met at the Centre for Hydrology and Ecology in Wallingford, UK. This meeting was sponsored by CliC, the Norwegian Ministry of Foreign Affairs, the Norwegian Ministry of Climate and Environment and the Swedish Environmental Protection Agency. Eight members of the writing team participated in this meeting and made progress on the draft of their chapter of the AFS.

-Atmosphere Component Writing Team Meeting

November 6-7, 2014, Helsinki

On November 5-7, 2014, the Atmosphere Component met at the Finnish Meteorological Institute (FMI) in Helsinki, Finland, both in-person and online. This meeting was sponsored by CliC, the Norwegian Ministry of Foreign Affairs, the Norwegian Ministry of Climate and Environment, and FMI.

-Leads and Steering Committee Meeting

November 24-25, 2014, Tromsø

<http://www.climate-cryosphere.org/activities/targeted/afs/meetings/sc-all-leads-meeting>

An Arctic Freshwater Synthesis Component Leads and Steering Committee (SC) Meeting was organized on November 24-25, 2014, at the Norwegian Polar Institute in Tromsø, Norway. Eight participants attended in-person and two remotely. The leads and/or co-leads of each component participated as well as three members of the SC. This meeting was organized by the CliC International Project Office and sponsored by CliC, the Norwegian Ministry of Foreign Affairs, the Norwegian Ministry of Climate, Environment Canada and the University of Victoria, Canada. The leads/co-leads reported on the state of their chapters. The participants then discussed ways to harmonize the AFS manuscripts, to ensure that they come across as a synthesis product. One important change was that the authors decided on a common outline for the chapters. It was also suggested that all the components should produce a cross-system effects diagram to tie the different components together. The project is still on target to have manuscripts submitted for the special issue of JGR-Biogeosciences in Spring 2015.



Figure 5. From left to right: James Screen (University of Exeter, UK), Eddy Carmack (Department of Fisheries and Oceans, Canada), Gwen Hamon (CliC IPO), Camille Lique (University of Oxford, UK), Terry Prowse (Environment Canada), Irina Fedorova (Otto-Schmidt Laboratory, Russia), Vasily Kokorev (State Hydrological Institute, Russia), Fred Wrona (University of Canada, Victoria), Arne Instanes (Instanes Polar AS), and Jenny Baeseman (CliC IPO) at the AFS Leads and SC meeting in November 2014

CLiC Activity Report Summaries

Arctic Freshwater Synthesis

Terry Prowse, University of Victoria/Environment Canada; Johanna Mård Karlsson, Stockholm University, Sweden; Arvid Bring, University of New Hampshire, USA

Introduction

The Arctic Freshwater Synthesis (AFS) is an interdisciplinary science integration activity that aims to produce a circum-Arctic review and synthesis of the Arctic freshwater system, focusing on the storage, fluxes and effects of freshwater. There is increasing scientific recognition that changes to the Arctic freshwater systems have produced, and could produce even greater, changes to the Arctic environment, society and economy. Changes in these systems affect not only the Arctic and its cryosphere, but also other areas, and these impacts will have consequences at the global level. AFS activities prior to 2014 include a planning phase during 2013, with an open community meeting at the Arctic Science Summit Week in Krakow, Poland in April and a first AFS co-leads workshop in Stockholm, Sweden in November. The AFS is supported by CLiC, the International Arctic Science Committee (IASC), the Arctic Monitoring and Assessment Programme (AMAP), the Norwegian Ministry of Environment and the Norwegian Ministry of Foreign Affairs.

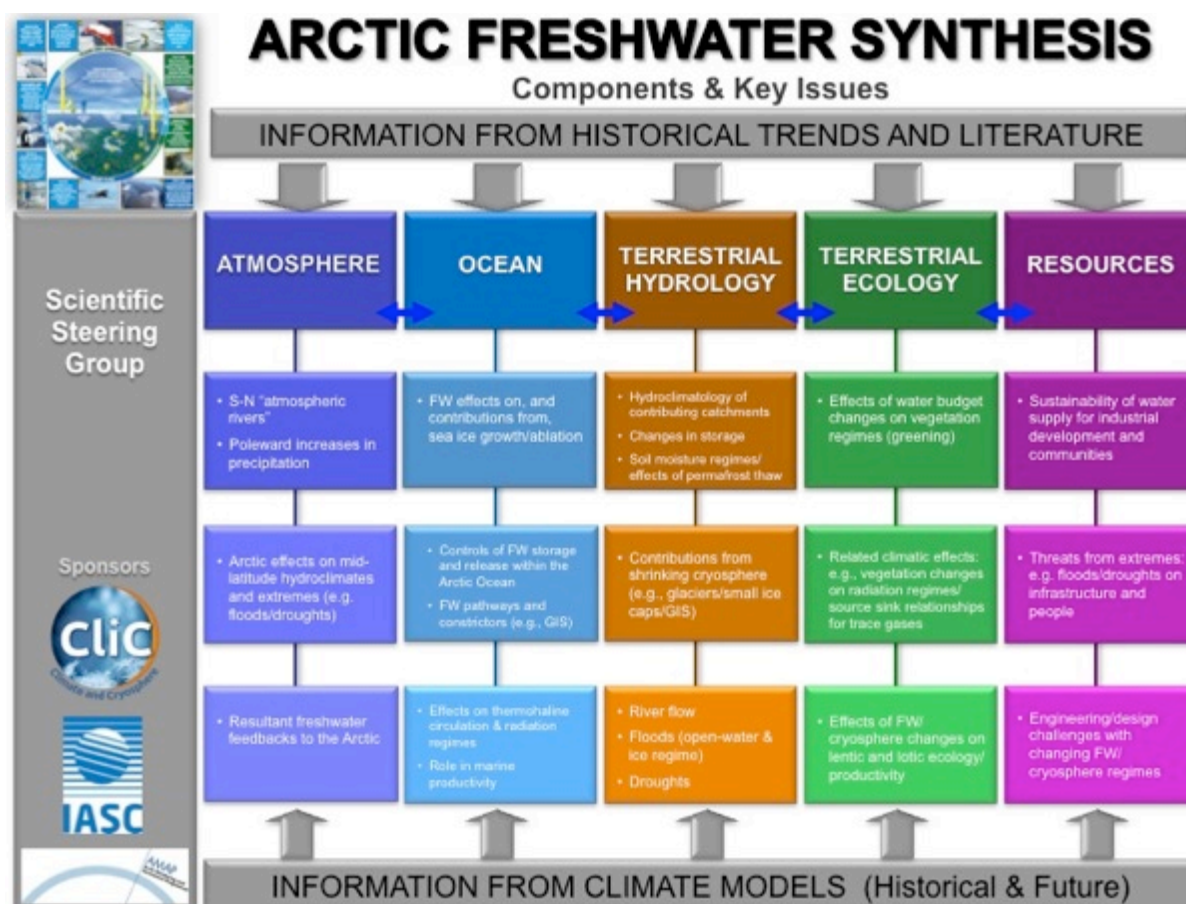


Figure 6. Arctic Freshwater Synthesis project outline

Achievements for 2014

The intensity of AFS activities has increased through 2014 and the project is now in a key phase, with project participants currently producing the project's core science output, in the form of six synthesis papers. In May and November, two meetings of lead authors have greatly facilitated the cross-component interaction and identification of process links that are central motivations for the project. In between meetings, component leads have worked with their corresponding author teams to produce first- and second-order draft versions of the component manuscripts. Work is now progressing towards final drafts of the papers, which are to be submitted in the first months of 2015.

The scientific outcome is currently being developed, but some emerging results include the role of the near-coastal domain as an important unknown at the interface between terrestrial hydrology and the ocean. Along the coast, information shortages combine to yield great uncertainty both in surface flows, which are poorly monitored for many smaller rivers, and the interaction between groundwater, surface water, permafrost and seawater. Another change in this domain is warming of Arctic islands, which has reduced semi-perennial snowbanks that sustain local summer runoff. This in turn influences local ecosystems, as possibilities for plant growth and wetlands in the otherwise arid polar desert are altered. The change in terrestrial freshwater availability across the Arctic, and the hydrological impacts of altered climate extremes, are some other emerging key unknowns.

Plans for 2015 and beyond

During January-March 2015, the AFS writing teams will be finishing their corresponding component papers, and the scientific steering group will produce two additional synthesis papers that provide an overview of the project rationale and put the results in context. These papers will also extract and summarize a number of main scientific findings and research gaps. Subsequently, the AFS supporting organizations will work with the steering group to produce a report in shorter and more accessible format. This document will also highlight recommendations for future research planning and prioritization. A session centering on science related to the AFS and its domain, "Arctic freshwater system, changes and effects with emphasis on Arctic freshwater ecosystems", is being organized at the Arctic Science Summit Week in Toyama, Japan, on April 23-30, 2015.

Webpage

<http://www.climate-cryosphere.org/activities/targeted/afs>

Arctic Sea Ice Working Group

Don Perovich, Engineer Research and Development Center Cold Regions Research and Engineering Laboratory, USA

Introduction

The goals of the Climate and Cryosphere Arctic Sea Ice Working Group (ASIWG) are: i) Develop, standardize, and implement observation and measurement protocols for Arctic sea ice in coastal, seasonal, and perennial ice zones; ii) Integrate surface-based observations with remote sensing and modelling efforts; and iii) Establish and

foster connections between international groups involved in sea ice observations, modelling, remote sensing, and data assimilation.

We have organized several workshops, a major part of our activities, which have fostered the needed international collaboration in achieving our goals. Results from these workshops have been disseminated through journal articles and reports, and have been published on the web.

- Workshop on Arctic surface-based sea ice observations: Integrated protocols and coordinated data acquisition, Tromsø, January 2009
- 2nd Meeting of the CliC Arctic Sea Ice Working Group, Tromsø, June 2010
- CliC Arctic Sea Ice Working Group Meeting, Boulder, October/November 2011
- Workshops on Passive Microwave Remote Sensing of Sea Ice at NASA Goddard Space Flight Center, Greenbelt, MD in 2011, and the Danish Meteorological Institute, Copenhagen, Denmark in 2013
- Workshop on Boundary-Layer Processes (co-sponsored with IASC), Boulder, June 2012
- MOSAIC Science Workshop (co-sponsored with IASC), Boulder, June 2012
- CliC Sea Ice Modelling and Observing Workshop, Tromsø, June 2013

Achievements for 2014

The ASIW working group conducted several activities in 2014. We had a joint meeting with the ASPeCt in Hobart, Australia, following the March International Glaciological Society Symposium on Sea Ice in a Changing Environment addressing standardization of observational methodologies, data access and archiving, and integrating observations and models.

The ASIWG contributed to the development of the Sea Ice Prediction Network and wrote a letter of endorsement for a proposal that was funded in 2013. ASIWG members Hajo Eicken and Walt Meier are active participants in the SIPN project, which started in April 2014 with a well-attended workshop in Boulder, Colorado. SIPN is already contributing to improvements in the SEARCH Sea Ice Outlook, which is currently collecting projections for the September 2014 Arctic sea ice extent. The linkages to CliC have helped make the Outlook a much more international effort, both with respect to contributors and circulation. Several ASIWG members have regularly contributed to the NOAA Arctic Report Card and to the Bulletin of the American Meteorological Society State of the Climate issue. Lead by Walt Meier ASIWG members contributed to the Snow, Water, Ice, Permafrost in the Arctic (SWIPA) assessment report that was co-sponsored by CliC, as well as a follow-up journal article in Reviews of Geophysics. The ASIWG also contributed a section in the UNESCO Encyclopedia of Life Support Systems; Cold Regions Science and Marine Technology



The Ice Watch program, developed by Professor Jenny Hutchings and Alice Orlich to standardize visual sea ice observation protocols from ships was beta-tested during 2014 cruises. A software package, ASSIST, was developed to facilitate data collection and archiving. The ASIWG is helping to distribute this to the Arctic sea ice

community. The software is similar to the ASPECT software used in the Antarctic, but is customized for Arctic sea ice conditions. A joint technical working group has been created between ASIWG and ASPECT to facilitate i) Arctic/Antarctic collaboration, ii) improved observation methods, and iii) transfer of technology between groups. The International Arctic Research Center (IARC) has volunteered to be the data archive for these observations. They are also working with the Geographical Information Network of Alaska (GINA) to develop a database architecture with capability for near-real time dissemination.

Walt Meier served as the CliC representative to the WCRP Data Advisory Council (WDAC). He presented on CliC activities at the WDAC annual meeting in May. He also provided information on cryospheric data sets, including sea ice, to the Observations for Model Intercomparison Projects (Obs4MIPs) workshop in May. Obs4MIPs is a WCRP-supported effort to develop a framework to provide validated, well-documented, and consistently formatted satellite data products to climate modelers. He also provided a sea ice concentration climate data record summary document to the project and is helping to coordinate the incorporation of the product within the Obs4MIPs framework.

Alexander Makshtas and Matt Shupe took part in the Second YOPP planning meeting focusing on observations (Helsinki, April 2014) with a report about preparation of MOSAIC. They also discussed an international program of atmospheric observations, executed by Roshydromet (Russia), NOAA (USA) and FMI (Finland) at the Tiksi Hydrometeorological observatory and possible extended programs at “Ice Base Cape Baranov” in concert with Polar Observatories at Summit, Ny-Ålesund, Eureka, Alert and Barrow (www.iasoa.org) offer YOPP a comprehensive data set on the polar atmosphere and underlying surface (including fast ice and grounding icebergs) in a “picket fence” configuration surrounding the Arctic Ocean.

Plans for 2015 and beyond

A primary focus for our 2015 efforts is coordination. We plan to work with other groups to integrate several Arctic sea ice related activities including MOSAIC, Year of Polar Prediction, Sea Ice Prediction Network, and the ASPeCt and Sea Ice and Climate Modelling Forum. The Year of Polar Prediction is 2017-2019 and MOSAIC is planning a field campaign from 2018-2019. Now is the time to plan, coordinate, and integrate.

We plan to work on Arctic sea ice data standardization and accessibility. There are several sea ice parameters that are needed for model initialization and evaluation including ice thickness, ice type, ice motion, and albedo. Considerable data is available on these parameters, but it is scattered in different formats and different places. One approach to help with standardization will be the development and evaluation of data templates and formats to help guide more standardized observations.

We will continue deploying the IceWatch software on Arctic cruises and work on a web site where IceWatch data can be accessed in near real-time. There will be continued development of IcePlan.org web site, designed to provide a central location for information on Arctic sea ice field activities. ASIWG members will be

conducting coordinated studies of fast ice in Barrow and Cape Baranov, which are formed under different synoptic conditions in the atmosphere and ocean.

In 2015 the ASIWG would like to finalize its terms of reference and, with the approval of CliC SSG, select its Science Steering Committee. During the coming year there will be a teleconference of the members of the ASIWG-SSC to review progress and discuss future plans. In addition, the ASIWG-SSC will also hold a Town Hall meeting at an international conference.

A new activity, that builds on discussions at the last ASIWG workshop and input from the broader CliC community is to facilitate the development of sea-ice/cryospheric flagship observatories in the Arctic. This effort builds on activities by different countries to establish coastal observatory sites (e.g., CHARS in Canada, Ny-Ålesund in Svalbard, Barrow in US, Tiksi and Cape Baranov in Russia and others) with different, as of now uncoordinated sea ice and cryospheric components. The ASIWG proposes to compile an inventory of existing efforts and to develop a science plan for coordinated cryospheric flagship sites in the Arctic Ocean region. This effort would be closely coordinated with the Global Cryosphere Watch program and other relevant efforts. A first workshop will be held in the fall of 2015, in conjunction with an international meeting that already draws participants from key disciplines and countries. The details are still to be determined.

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Webpage

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Antarctic Sea Ice Processes and Climate (ASPeCt)

Stephen Ackley, University of Texas at San Antonio, USA; Marilyn Raphael, University of California, Los Angeles, USA

Introduction

ASPeCt has the key objective of improving our understanding of the Antarctic sea ice zone through focussed and ongoing field programs, remote sensing and numerical modelling. Designed to complement, and contribute to, other international science programs in Antarctica as well as existing and proposed research programs within national Antarctic programs, ASPeCt coordinates the collection, analysis and archiving of in situ sea-ice observations for use in validation/verification of remote-

sensing, numerical modelling and other climate studies. ASPeCt also includes a component of data rescue of valuable historical sea ice zone information.

Achievements for 2014

ASPeCt data base progress

A data acquisition and analysis software for bridge-based observations of the nearby (within approx. 1 km radius) has been developed at the Australian Antarctic Division (AAD), Hobart, Australia. The data acquisition is aligned with the former manual log and follows WMO [1970] nomenclature. Tabulated data entry is limited to the three dominant ice types, and captures ice type and thickness, its areal coverage, floe size, topography and type and thickness of any snow cover.

Post-processing includes secondary error checks as well as generating derived parameters, including area- or time-averaged ice or snow parameters. Bulk albedo, chlorophyll estimates and meltpond coverage are derived for each ice type, but may also be integrated in time or space. Graphical presentations are included in the output options. Observations from a new voyage can be uploaded in the data center by a simple synchronization of the voyage laptop (or other device used) with the ASPeCt holdings at the data center.

Currently first in field trials of the software are underway, with the public release intended for 2015. Furthermore, in response to an ASPeCt submitted resolution passed at the 2014 SCAR Delegates meeting in Auckland, New Zealand, the SCAR president is charged to draft a letter to national representatives of COMNAP to request that "national programmes which operate shipping in the sea-ice zone participate, where possible, in the underway sea ice data collection according to the ASPeCt protocols". This resolution at this time effectively coincides with the release of the full ASPeCt ship-based observation software. Member nations will be encouraged to contribute observations on sea-ice parameters for each of their voyages into the Southern Ocean sea-ice zone using the new data acquisition software. Parties with special interest are invited to register for access to the beta-version, and to provide feedback to the developers, both from Arctic and Antarctic voyages. Contributors to the ASPeCt data base, will in turn, have direct access to the digital ASPeCt archive of ship-based observations on polar sea ice.

The ASPeCt-Bio ice core database is being further developed (through activities of SCOR-BEPSII, Biogeochemical Exchange Processes at the Sea-Ice Interfaces) and is currently being extended to include carbonate system parameters and trace-metal parameters. Sea ice core nutrient data, both in pack ice and landfast sea ice are also being included. Some 1250 measurements from various areas off Antarctica have been collated. Preliminary analysis show that nutrient concentrations have a peak in winter with median salinity-normalized concentrations close to the concentration encountered in the upwelled circumpolar deep water. Related to this, the ASPeCt-Bio, paper (Meiners et al., 2012) has been well received in the community and has been used to evaluate emerging biogeochemical sea ice models (e.g., Saenz and Arrigo 2014, JGR). Ice observations collected and collated through the physical ASPeCt ice thickness database and the ASPeCt-Bio dataset are now the "go-to" observational products for quantitative sea ice research/model evaluation. As an example, ASPeCt sea ice thickness data have been used/cited in the Williams et al. 2014 paper (Nature Geoscience). Additionally, the ASPeCt visual sea ice

observations and snow depth data played a key role in an intercomparison exercise for satellite passive microwave algorithms done by the Integrated Climate Data Center (ICDC) (Beitsch et al., 2015, Kern et al., 2014).

WCRP/SCAR International Programme for Antarctic Buoy maintain a network of drifting buoys in the Southern Ocean. IPAB works in close collaboration with ASPeCt in particular over sea ice. More than 50 buoys were deployed during AWI Polarstern cruises in Weddell Sea, June - Aug 2013 and Jan-Mar 2014. Buoys of various types (Surface Velocity Program (SVP), Ice Mass Balance (IMB), snow, Automatic Weather Stations (AWS)) contributed by the following institutions: AWI, AAD/ACE CRC, FMI, WHOI. Ten SVPs were deployed by the US Interagency Program for Antarctic Buoys (USIPAB) during the Networked Profiling Buoy (NPB) cruise in Feb 2014, in Ross Sea sector between 140° and 150° W, 55° and 65° S.



Figure 7. CASIWG and ASPeCt Workshop Participants, Hobart, Australia, 15 March 2014

ASPeCt Workshop

ASPeCt held a Workshop at the International Glaciological Society (IGS) meeting, Hobart, Tasmania, March 2014 – joint with the Arctic Sea Ice Working group in the morning (41 members attending) and ASPeCt alone (29 members attending) in the afternoon. The goals of the workshop were two-fold; one, to bring together the two groups focused on sea ice processes to coordinate ideas and activities, and two, to discuss ASPeCt only plans. The morning session was devoted to discussion of issues of concern to both groups. The major issue discussed was the standardization of observations, such as ice cores, with the aim of forming unified approaches for sea ice observing, archiving and dissemination. This session ended with an extended discussion on ways in which Arctic and Antarctic linkages could be strengthened and a formal review of Arctic-Antarctic linkages was discussed. The afternoon session focused on a discussion of ASPeCt input to SOOS initiatives via sustained observations. Regional initiatives associated with SOOS in Prydz Bay and Amundsen and Weddell seas were discussed. Software improvements to ASPeCt observations and the use of digital photos and other automated observations from vessels to supplement visual observations were proposed. This was followed by an exhaustive discussion of the sea ice questions that the SCAR Horizon Scan was

expected to review. Rob Massom coordinated the introduction of the outcomes of this discussion into the SCAR Horizon Scan. The success of this exercise was made clear in Kennicutt et al. (2014a,b) which defined six priorities for Antarctic Science and stated “*What factors control Antarctic sea-ice seasonality, distribution and volume? We need to know.*”

Plans for 2015 and beyond

ASPeCt’s Near Future Plans include

- ASPeCt data collection & testing of software prototype by the AAD, AWI and CHINARE.
- Additions to the ship observations database (ASPeCt observations) on a continuing basis.
- Development of the ASPeCt ship-based observation system and database for sea ice measurements taken by remote vessels (airborne and under ice), ship-based instruments and surface-based instruments and sampling.
- Planning and participation in the Antarctic Sea Ice Workshop, organized under the auspices of the Polar Research Board and tentatively scheduled for 2015 – This workshop will would address our current understanding of processes driving Antarctic sea ice changes, whether or not these changes remain within the expected range of natural climate variability, and why climate models continue to fail at simulating observed Antarctic sea ice changes.

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Webpage

<http://aspect.antarctica.gov.au>

Technical Committee on Sea Ice Observations

Stephen Ackley, University of Texas at San Antonio, USA; Jennifer Hutching, Oregon State University

Introduction

Based on discussions at the CliC Sea Ice Observations and Modelling Workshop, a joint subgroup of SCAR/CliC Antarctic Sea Ice Processes and Climate (ASPeCt) and the CliC Arctic Sea Ice Working Group was formed to work on updating sea ice observation technology from vessels and apply these technologies to vessels working in both the Arctic and Antarctic. The group and its planned activities are summarized below. Any questions or input for this group's consideration are welcome, and can be addressed to any of the members. The following is the description of the committee:

Shipboard and on-ice sea ice observations are routinely collected during expeditions to ice covered seas. This data, if well managed, is of value to operational sea ice services, industry, researchers, and environmental planners. We recognize a need to share resources between groups working in all sea ice regions to support collection and archival of standardized, quality controlled data.

Our goals are to facilitate: 1) standardization of observational methods; 2) archival of data collected; 3) near-real time transference of data to users; and 4) rescue and integration of historical data collections. These goals may be accomplished through the following objectives:

- development of a comprehensive Arctic/Antarctic observation system that can be adjusted to the local conditions;
- design of robust equipment and software to facilitate standardized and autonomous observations;
- development of novel observation methods, providing data follow WMO or accepted standards.
- exchange technical information on hardware and software between institutes and nations to best leverage limited funding availability; and
- provide expert development of technical and training material to broaden participation in sea ice watches with sufficient standardization and quality control.

Initial Membership: Jenny Hutchings (OSU), Petra Heil (AAD), Blake Weissling (UTSA), Alice Orlich (UAF), Marcel Nicolaus (AWI) and Stephen Ackley (UTSA). Other members are welcome to join, or may be asked to join, based on their interest and expertise in contributing to the objectives of the Technical Committee.

Achievements for 2014

The CliC ASIWG, under the leadership of Jenny Hutchings, has created IceWatch and ASSIST. Ice Watch addresses the need to standardize and archive shipborne sea ice observations in the Arctic. Many thanks are due to the many tireless sea ice researchers who, in ad-hoc meetings over the recent years, found consensus for shipborne visual observations methodology and coding for the Arctic Shipborne Sea Ice Standardization Tool (ASSIST) software, which allows observers to record in situ sea ice, weather and sea state conditions, specific to the Arctic environment. ASSIST is a multi-media data collection tool to support standardization of observation methods throughout the Arctic Ocean. Observers on vessels from multiple nations are using ASSIST to report near real-time visual sea ice observations. This observation method follows the WMO (1970) convention to be compatible with previous protocols (including Egg Code, ASPeCt, Canadian MANICE) with special attention to characterizing Arctic specific conditions, including surface melt conditions, sediment and ice algae. This software has been tested and only a bit more work needs to be done to have it ready for wide spread use. More information as well as the software download can be found here: <http://www.iarc.uaf.edu/icewatch/assist>

The APeCt group has long been collecting sea ice observations from ships in the Antarctic using a standardized protocol. During this past year, Petra Heil from AAD/ACE CRC, has been working on an updated version of the software and data processing tool. More info on this is in the ASPeCt update above.

Jenny Hutchings, programmers at IARC, and Jenny Baeseman have also been working on an update to IcePlan. IcePlan was initiated in 2009 to help coordinate Arctic Sea Ice Field Expeditions and is based on recommendations and input provided by the more than 30 participants from 13 nations on how to help improve coordinated planning for field-based sea-ice research. Recent activity has included developing an online form for researchers to fill in information themselves, plan for many years in the future, and potentially expand IcePlan to include other cryosphere domains.

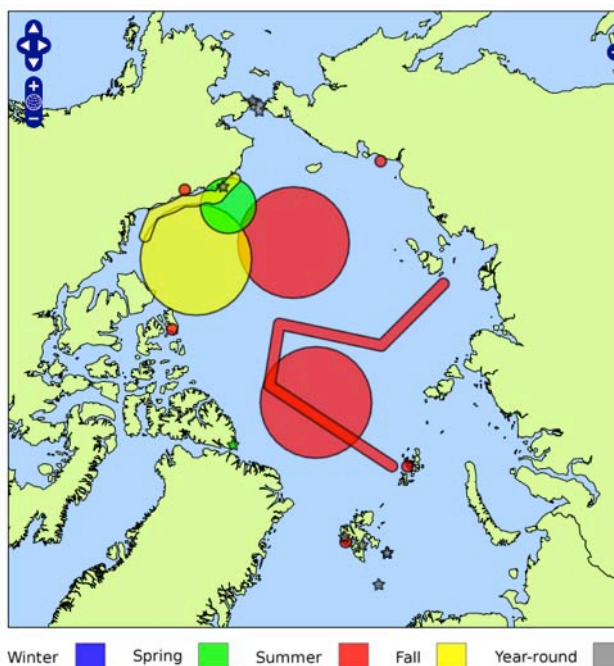


Figure 8. IcePlan map of 2011 Arctic Sea Ice Expeditions. <http://www.iceplan.org/>.

Plans for 2015 and beyond

It is hoped that both data collection systems will be completed and in use this year. The next steps will be to make sure that data from both the Arctic and Antarctic systems are fed into databases where they can be used for various purposes.

Meetings of opportunity as well as online meetings will be held during 2015 to continue progress. For IcePlan, work continues as ad hoc when extra time for the programmer at IARC can be secured.

Interactions Between High-latitude Cryosphere Elements

Rob Massom, Australian Antarctic Division and Antarctic Climate & Ecosystems CRC

Introduction

Major change is occurring across the high-latitude cryospheres of both polar regions, yet little is known about the inter-relationships between the different component “elements” of the cryosphere - sea ice, ice sheet/glaciers, icebergs, snow and permafrost (connected by oceanic and atmospheric processes). How does change in one element affect others, and what processes are involved? Recent studies suggest that these linkages may be complex and involve subtle and previously unconsidered feedbacks. Examples of apparent linkages between Antarctic ice-shelf basal melt and sea-ice extent (Bintanja et al., 2013); regional sea-ice loss and ice-shelf basal melting (Padman et al., 2012); Arctic sea ice loss and permafrost warming and erosion (Lawrence et al., 2008); and landfast sea ice distribution and ice-sheet margin stability around Antarctica (Massom et al., 2010). These examples suggest that better understanding of cross-cryosphere linkages, and their realistic inclusion in Earth-system models, is required to determine the state of the Earth’s cryosphere and its likely future trajectory. This need for better information on, and understanding of, cross-cryosphere linkages was underlined by the recent SCAR Antarctic Horizon Scan initiative (Kennicutt et al., 2014a, b), and represents an exciting challenge.

The aim of this CliC Targeted Activity is to draw together experts and emerging/young scientists from across cryospheric disciplines (and underpinning fields) to promote and foster a more holistic approach to cryosphere-climate change/variability research i.e., one that crosses cryospheric boundaries, bridges and links the disciplines and polar regions, coordinates current and future research activities, and bridges the observational and modeling communities. The ultimate aim is to provide new information towards more realistic parameterization of cross-cryosphere components, linkages and processes in models (Earth System, coupled regional high-resolution, ice sheet and ice shelf-ocean). This emerging field of research is of direct relevance to the goals of CliC, in that it bridges and links (integrates) sea ice, ice sheet, ocean, permafrost and atmosphere, and involves observational analyses, remote sensing and model studies. This activity not only initiates an international activity that addresses and integrates key questions across the four main CliC Science Themes and integrates the major CliC Integrating Initiatives, it also links the six key scientific questions of CliC’s Implementation Strategy. We have coined a new term to encapsulate this: “Cryosphere Without Borders.”

Achievements for 2014

In March 2014, CliC provided sponsorship towards a Workshop on “*Understanding linkages between different elements of the high-latitude cryosphere – How important are they?*”, and an associated special cross-cryosphere session on “*Sea ice interaction with ice sheets, ice shelves and icebergs*”. Both were convened as part of

the International Glaciological Society (IGS) International Sea Ice Symposium on *Sea Ice in a Changing Environment*, held in Hobart on 9-15 March 2014 and co-chaired by Rob Massom and Petra Heil. They provided an important means of launching the new CliC Targeted Activity “*Interactions Between Cryospheric Elements*” to the international community and gauging community interest in carrying it forward.

The IGS symposium attracted over 210 delegates from 17 different countries and a broad range of disciplines, including a high proportion of young researchers. The latter included 5 outstanding young scientists who were chosen to receive CliC sponsorship totaling 8,000 Euros towards travel and accommodation costs, based on the subject suitability (and quality) of their abstracts relative to the target activity theme. These were: Mario Hoppmann and Christine Wesche (Germany), Miriam Richer McCallum and Adrienne White (Canada), and Pat Wongpan (New Zealand). These fine young researchers made a significant contribution to both the Workshop and special session. They have also contributed three refereed papers to *Annals of Glaciology* (see below). The conference and workshop were also graced by the presence of Dr. Jenny Baeseman, Director of CliC and a wonderful supporter of young scientists.

The IGS special session comprised 10 oral presentations (including a keynote) and 9 poster presentations. The Workshop on “*Understanding linkages between different elements of the high-latitude cryosphere – How important are they?*” was well attended and enthusiastically received, provided strong endorsement of the new targeted activity, and generated much interest and discussion among the 40 scientists present. Those in attendance included leading and early-career scientists in the fields of sea-ice physics, observations and operations; sea ice and climate modelling; ice shelf-ocean interaction and modelling; ice-sheet glaciology; atmospheric science/meteorology; ecology and biogeochemistry; remote sensing; and oceanography – and representing both the Arctic and Antarctic. Cross-programme linkages via those present included to the CliC/SCAR Antarctic Sea Ice Processes and Climate (ASPeCt) group (Professor Steve Ackley and Dr Marilyn Raphael), WMO EC-PORS (Dr Jim Renwick), WAIS (Dr Ted Scambos) and the WCRP SPARC (Stratosphere-Troposphere Processes and their Role in Climate) project (<http://www.sparc-climate.org/>, Drs Andrew Klekociuk and Olaf Morgenstern). Importantly, the response to the targeted activity was positive and highly encouraging, and confirmed community interest in carrying this targeted activity forward. The workshop in fact generated substantial intra- and cross-disciplinary discussion and important new collaborative partnerships – not the least for the large proportion of early-career scientists/students attending. The project steering committee/working group is currently being established, comprising volunteers from the workshop, invited leaders from the wider community with a strong interest in cross-cryosphere studies, and a mix of leading and young scientists.

The special CliC-sponsored cross-cryosphere session at IGS 2014 resulted in 4 accepted refereed papers (including 3 from the CliC-sponsored young scientists plus 1 in review) on the theme of the Targeted Activity. The accepted papers are:

- * Bintanja, R., G.J. Van Oldenborgh, and C.A. Katsman (in press). The effect of increased fresh water from Antarctic ice shelves on future trends in Antarctic sea ice. *Annals of Glaciology*, 56(69).

- * Hoppmann, M., M. Nicolaus, S. Paul, P.A. Hunkeler, G. Heinemann, S. Willmes, R. Timmermann, and O. Boebel (in press). The role of ice platelets in Weddell Sea land-fast sea ice. *Annals of Glaciology*, 56(69).
- * White, A., L. Copeland, D. Mueller and W. Van Wychen (In press). Assessment of historical changes (1959-2012) and the causes of recent break-ups of the Petersen Ice Shelf, Nunavut, Canada. *Annals of Glaciology*, 56(69).
- * Wongpan, P., P.J. Langhorne, D. E. Dempsey, L. Hahn-Woernle, & Z. Sun (in press). Simulation of the crystal growth of platelet sea ice with diffusive heat and mass transfer. *Annals of Glaciology*, 56(69).



Figure 9. Understanding linkages between different elements of the high-latitude cryosphere workshop participants, Hobart, Australia, March 2014

We are particularly proud of the fact that 23 CliC FrostBytes were generated by those attending the Hobart Workshop and Symposium, covering a wide range of topics and including outstanding contributions from the 5 CliC-sponsored young scientists. These FrostBytes were played (looped) on screens throughout the meeting and at a highly successful public Open Science Day on the day before, and are a lasting legacy to a memorable occasion. We are very grateful to WCRP and CliC for sponsoring the Targeted Activity Workshop and special conference session. In particular, we thank Dr. Jenny Baeseman for her tireless and much-appreciated guidance, encouragement and help. The CliC funding provided a wonderful opportunity to support attendance by, and participation of, an outstanding group of early-career scientists who will play a key role in carrying this new cross-cutting initiative forward into the future.

In other activities and outcomes, a poster on the new Targeted Activity was produced by Rob Massom and presented by Ben Galton-Fenzi at a meeting of West Antarctic Ice Sheet initiative (WAIS) in September 2014 (California, <http://www.waisworkshop.org/workshop-2014>). The aim of this poster (“*Cryosphere without frontiers – A new WCRP CliC Targeted Activity for understanding interactions between cryosphere elements*”) was to inform the WAIS community about this new target activity, to engage them in it, and to establish closer linkage between the two programmes.

Finally, a new paper is in review that directly contributes to this Targeted Activity (Massom et al., in press, see References below). Amongst other things, this shows that small grounded icebergs can affect the small-scale calving of advancing glacier tongues that come into contact with them (in East Antarctica in this case study)

Plans for 2015 and beyond

As endorsed in the Workshop, the new targeted activity will be linked in the coming year to appropriate and related programmes e.g., the CLIVAR WGOMD and CLIVAR/CliC/SCAR SORP groups and their closely-associated initiative on “Sea Level Rise, Ocean/Ice Interactions and Ice Sheets” (see <http://www.clivar.org/sites/default/files/Exchanges/Exchanges62.pdf>). Engagement with the various modelling communities (global and regional climate, coupled sea ice-ocean-atmosphere, ice sheet etc.) is also essential and planned, as an ultimate aim is to provide information that enables more effective representation of cross-cryospheric linkages in models. Strong linkage and overlap is noted with Dr. David Holland’s CliC Targeted Activity “West Antarctica Glacier-Ocean Modelling” (see <http://www.climate-cryosphere.org/activities/targeted/wagom>); the *Interactions Between Cryospheric Elements* Targeted Activity could inform and contribute to this.

To engage interest and input from the wider cryospheric community in this targeted activity, a special session on “*Understanding Linkages Between Different Elements of the High-Latitude Cryosphere*” has been convened at the upcoming 26th IUGG (International Union of Geodesy and Geophysics) General Assembly in Prague, June 22–July 2, 2015 (<http://www.iugg2015prague.com/>). This session, which is organised by IACS and co-sponsored by CliC, has been convened by Rob Massom, Professor Ian Allison (IACS and University of Tasmania, Australia) and Cristina Surdu (an early-career scientist from University of Waterloo, Canada) to introduce the Targeted Activity to a wider audience. Contributions are invited from any area of Arctic and Antarctic cryospheric science, which is investigating (or has an interest in) linkages between sea ice, ice sheet/glaciers, icebergs, snow and permafrost (connected by oceanic and atmospheric processes).

The next planned step is to plug a major gap in current literature by producing a (first-ever) series of review papers highlighting the current state of knowledge (including key gaps) on cross-linkages and feedbacks between different elements of the cryosphere (underpinned by the ocean and atmosphere), their likely and actual response to (and role in modulating) climate change/variability, and how change in one element can affect other elements. A first paper that presents an overview is in its early stages. Subsequent review papers will focus on specific cross-cryosphere linkages e.g., sea ice-ice shelf interactions.

In other (parallel work), a paper is taking shape (led by Rob Massom) that investigates potentially-important linkage between changing regional patterns in Antarctic sea-ice seasonal coverage and the timing and nature of ice shelf disintegration events along the Antarctic Peninsula. This work involves strong cross-disciplinary collaboration across the cryosphere, atmosphere and ocean science.

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- * Massom, R.A., A.B. Giles, H.A. Fricker, R.C. Warner, B. Legrésy, G. Hyland, N. Young and A.D. Fraser (2010). Examining the interaction between multi-year landfast sea ice and the Mertz Glacier Tongue, East Antarctica: Another factor in ice sheet stability? *Journal of Geophysical Research*. 115, C12027, doi:10.1029/2009JC006083.
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Webpage

Under development. <http://www.climate-cryosphere.org/activities/targeted>

ESM-Snow Model Intercomparison Project (ESM-SnowMIP)

Gerhard Krinner, Laboratoire de Glaciologie et Géophysique de l'Environnement/Université Joseph Fourier, France; Chris Derksen, Climate Research Division, Environment Canada
 Steering Committee: Richard Essery, Stefan Hagemann, Alex Hall, Helmut Rott, Andrew Slater, Matthew Sturm

Introduction

Terrestrial snow cover plays a significant role in the radiative forcing component of the Earth's energy budget by reflecting a high proportion of incident solar radiation back to space. This contributes to the cooling influence of the cryosphere on the global climate system, with the proportion of cooling attributable to terrestrial snow approximately the same as Arctic sea ice. Snow is also a very effective insulator, so variability in the timing of snow cover onset in the autumn and snow melt in spring, as well as the magnitude of seasonal snow accumulation, influences the thermal state of the soil beneath the snowpack (deeper snow = warmer soil). Snow is a significant freshwater resource for a large proportion of the northern hemisphere, and is connected to other hydrological variables such as runoff and soil moisture. Because climate models show divergent responses and representations of snow-related feedbacks, and systematic biases due to simplifications or missing parameterizations of key processes, an inter-comparison of snow models within Earth System Models was identified by CliC as a priority contribution to the WCRP "Cryosphere in a Changing Climate" Grand Challenge. The overall goal of the Earth

System Model-Snow Model Intercomparison Project (ESM-SnowMIP) is to improve our knowledge and understanding of the temporal dynamics and physical properties of snow as an active component of the coupled climate system through the investigation of:

- the performance of current snow models within land surface modules of ESMs
- snow cover and land surface feedbacks within offline and coupled simulations

ESM-SnowMIP was identified as a CliC Grand Challenge at a workshop in October 2013, and formally initiated in early 2014 with the formation of a steering committee. Current activities are focused in two areas:

- Development of a CMIP6 proposal to perform a comprehensive assessment of land surface feedbacks, and diagnosis of systematic biases in the land modules of current ESMs using constrained land-module only experiments (“Land Surface, Snow and Soil moisture MIP-LS3MIP”) in collaboration with the soil moisture and land surface communities.
- Development of specific actions of ESM-SnowMIP to complement LS3MIP activities, including additional global and point offline model experiments focusing on snow-related processes, in collaboration with select climate modelling groups.

Achievements for 2014

The ESM-SnowMIP steering committee, in collaboration with the soil moisture and land surface communities, developed the Land Surface, Snow and Soil moisture MIP (LS3MIP) proposal, submitted in November 2014 as a potential CMIP6 endorsed MIP (<http://www.wcrp-climate.org/index.php/wgcm-cmip/wgcm-cmip6>). The goal of the LS3MIP experiment is to provide a comprehensive assessment of land surface-, snow-, and soil moisture-climate feedbacks, and diagnose systematic biases in the land modules of current ESMs using constrained land-module only experiments. LS3MIP will provide the means to quantify the associated uncertainties and to better constrain climate change projections, of particular interest for highly vulnerable regions (densely populated regions, polar regions, agricultural areas, land ecosystems).

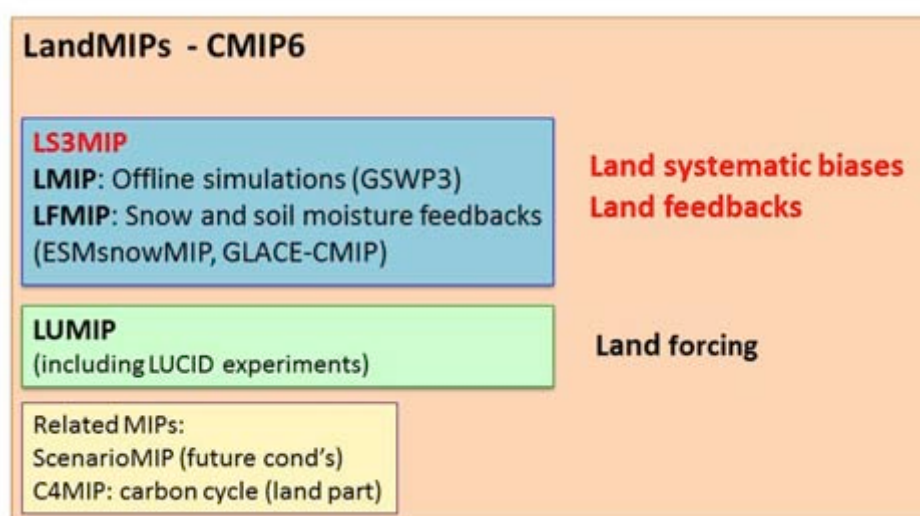


Figure 10. Overview of the embedding of LS3MIP in land-related CMIP6 MIPs. LS3MIP will allow the quantification of land systematic biases and feedbacks induced by snow and soil moisture processes, while Land Use Model Intercomparison Project (LUMIP) addresses land forcing on climate

As highlighted in the figure above, the LS3MIP experiments are subdivided in two overarching components. The first addresses model land systematic biases in offline mode (Land Model Intercomparison Project (LMIP) which will build on the already initiated 3rd phase of the Global Soil Wetness Project (GSWP3). The second addresses Land Feedbacks in an integrated framework MIP (LFMIP) and will include ESM-SnowMIP and Global Land Atmosphere Coupling Experiment (GLACE-CMIP) experiments for assessing snow- and soil moisture-climate feedbacks. LS3MIP is part of a larger “LandMIP” series of experiments fully addressing biases, uncertainties, feedbacks, and forcings from the land surface (Figure 8), which are complementary to similar experiments for ocean or atmospheric processes. LS3MIP will also foster the exchange of data and knowledge across communities, as snow and soil moisture dynamics are often interrelated and contribute together to climate and hydrological variability.

In parallel to the LS3MIP proposal development, the ESM-SnowMIP steering committee developed plans for additional coupled, global offline, and point offline experiments, and initiated engagement with select modelling centers for participation. These experiments include offline simulations (including the use of GSWP3 forcings), prescribed climatological and observed albedo and snow water equivalent experiments, and point simulations at reference sites.

Observational datasets (both gridded and comprehensive point scale) play an important role in forcing offline experiments (global and pointwise), as input to prescribed runs, and as a baseline for model evaluation. Through the ESM-SnowMIP steering committee, there are formal links with the European Space Agency (ESA) funded and CliC endorsed Satellite Snow Product Inter-comparison & Evaluation Exercise (SnowPEX), which will provide quantitative uncertainties for northern hemisphere snow extent and snow water equivalent products which will provide the basis for the evaluation of global model simulations. SnowPEX activities started in the summer of 2014, with the first round of results anticipated by spring 2015.

Site	Snow Class	Forcing & Evaluation	Reference/Contact
Reynolds Creek	Alpine	X	Reba et al., 2011
Col de Porte	Alpine	X	Morin et al., 2012
Senator Beck	Alpine	X	Landry et al., 2014
Weissfluhjoch	Alpine	X	Feirz
Sodankyla	Taiga	X	Menard/Essery
BERMS	Taiga	X	Barr
Imnavait Creek	Tundra	X	Slater/Sturm
Bayelva, Svalbard	Tundra	X	Boike
Canadian Rockies	Alpine	X	Pomeroy/Essery
Fraser*	Alpine		Elder
Trail Valley Creek*	Tundra		Marsh
Abisko*	Taiga		Essery
China	Alpine		Rott

Table 1. Summary of potential ESM-SnowMIP reference sites. * denotes Diagnostic Only

Experiments using offline point simulations driven with in situ data from a set of well-instrumented reference sites could aid the interpretation of model performance in the ESM-SnowMIP global offline and global coupled simulations (including experiments in which in situ driving data and site characteristics are replaced by data from the corresponding grid points in global simulations). An inventory of potential sites with adequate forcing data for point offline simulations (as were conducted in SnowMIP-1 and -2) is currently being prepared, as summarized in Table 1. Secondary sites with insufficient forcing data, but measurements suitable for model evaluation are also being considered.

Plans for 2015 and beyond 2015

- Integrate results from SnowPEX in order to have quantified uncertainty for the gridded snow extent and snow water equivalent products available for model evaluation (and potentially as input to prescribed runs).
- Continue the planning of LS3MIP in collaboration with the GSWP3 and GLACE-CMIP communities.
- Complete the detailed experiment planning for ESM-SnowMIP simulations to be conducted in addition to LS3MIP, and confirm participation of select modelling centres.
- Finalize the network of reference sites with suitable observations to drive point offline model runs and/or comprehensive measurements for model evaluation.
- In collaboration with select modelling centres, conduct the first ESM-SnowMIP pilot simulations (including GSWP3 baseline experiments).
- Hold a workshop with LS3MIP collaborators in late 2015 in order to finalize coordinated experiment plans, and hold breakout discussions within the snow and soil moisture communities.
- Hold potential meeting of opportunity with other LS3MIP leads at appropriate meetings/conferences.

2016 and beyond

- Completion of SnowPEX and integration of results with ESM-SnowMIP activities (2016)
- Continuation of ESM-SnowMIP simulations (2016-2018)
- Initiation of LS3MIP (2016-2018)

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Webpage

<http://www.climate-cryosphere.org/activities/targeted/esm-snowmip>

Ice Sheet Mass Balance and Sea-Level (ISMASS)

Catherine Ritz, LGGE, France (chair); Frank Pattyn, Université libre de Bruxelles, Belgium (representing SCAR); Francisco Navarro, Technical University of Madrid, Spain (representing IASC); Edward Hanna, University of Sheffield, UK (representing CliC)

Introduction

The goals of ISMASS are to promote research on the estimation of ice-sheet mass balance and its contribution to sea-level change, to facilitate co-ordination among the different international efforts focused on this field of research, to propose directions for future research in this area, to integrate observations and modelling efforts as well as the distribution and archiving of the corresponding data, to attract a new generation of scientists into this field of research, and to contribute to the dissemination to society and policymakers of the current knowledge and the main achievements in this field of science. The ISMASS group was formed originally as a SCAR group and became bipolar when cosponsored by IASC. The Expert Group on Ice Sheet Mass Balance and Sea Level (ISMASS) is currently co-sponsored by the Scientific Committee on Antarctic Research, the International Arctic Science Committee (IASC), and the WCRP Climate and Cryosphere Project (CliC). The new Steering Committee of ISMASS met at University of Sheffield, UK, on 7 October 2013. New terms of reference were defined. Catherine Ritz (LGGE-Grenoble, France) was appointed as new chair of ISMASS. Representatives from member organizations are Frank Pattyn (SCAR), Francisco Navarro (IASC) and Edward Hanna (CliC).

Achievements for 2014

An ice-sheet model inter-comparison splinter group meeting was held at EGU in April 2014 and at the IGS conference on Ice sheets and Sea Level rise at Chamonix, May 2014, both organized by Frank Pattyn. It was agreed to proceed with a new MISMIP (Marine Ice Sheet Model Intercomparison Project) to test ice sheet models on how to cope with grounding line retreat due to basal melting under the shelf and loss of buttressing. A preliminary website was set up: [http://homepages.ulb.ac.be/~fpattyn/mismip+/,](http://homepages.ulb.ac.be/~fpattyn/mismip+/) where details on the procedure can be found.

A workshop on ice-sheet future projections was held on Tuesday 26 August 2014, Auckland, New Zealand, linked with the SCAR Open Science Conference. The objective was to stimulate the ice-sheet community to improve methods and agree on a common framework when producing ice-sheet mass balance model projections for the next 100 years. This meeting included a report by Ryan Walker on the outputs of the "Ice sheet MIP for CMIP6" workshop that was held in July 2014 at Washington DC, supported by CliC.

A major model intercomparison initiative on West Antarctic Glacier-Ocean Models had its Kick-Off Meeting on October 27-29, 2014 at the New York University Campus in Abu Dhabi, United Arab Emirates (organized by David Holland). This is a CliC and ISMASS endorsed initiative.

Plans for 2015 and beyond

Greenland Ice Sheet SMB workshop

A CliC-sponsored workshop is being organised by Edward Hanna, to be held at the University of Sheffield, UK, on 19-20 May 2015. The title is: “Constraining uncertainty in Greenland Ice Sheet (GrIS) surface mass balance (SMB) model output and in situ validation”. The purpose of the proposed workshop is to direct future research for reconciling the considerable differences in Greenland Ice sheet SMB between several different models that are currently widely used.

The workshop will

- Prompt more comprehensive spatial comparisons between SMB model output from the several different SMB modelling approaches (Regional Atmospheric Climate Model 2 (RACMO2)², Modèle Atmosphérique Régional (MAR), Distributed Snow-Evolution Modeling System (SnowModel), Hanna et al. PDD approach). The first measurable deliverable/output will be a new international peer-reviewed publication on SMB model intercomparison that will highlight remaining disparities and uncertainties and the best next steps forward; this will be led by EH and co-authored by members of the workshop (i.e. authors of the various SMB models), and will be produced for a leading geophysics or cryospheric science journal.
- Discuss how major discrepancies between GrIS SMB model estimates (e.g. relating to precipitation/snow accumulation amounts in inland south-east Greenland) can be better reconciled through the improved use and implementation of in situ validation observations, including (but not limited to) weather stations, ice radar and shallow ice cores. It is anticipated that the results of our improved/updated SMB model intercomparison can be directly used to recommend specific spatial areas and parameters for improved in situ data collection for better validating GrIS SMB models to major international (e.g. UK/European and US) funding agencies. This will be the second measurable deliverable/output of our workshop.

Marine Ice Sheet Model Intercomparison Project

We plan to organize a one-day joint SCAR/IASC/CliC ISMASS workshop before or after the IGS International Symposium on Contemporary Ice-Sheet Dynamics: ocean interaction, meltwater and non-linear effects. The symposium in itself touches upon many subjects that are particularly linked to ISMASS. This workshop will be seen as a preparation of IPCC AR6. We plan to use SCAR funding for this meeting, to invite scientists related to ISMASS initiatives and in particular to aid young scientists and part of the steering committee of ISMASS to attend. The ISMASS steering committee will be held in Cambridge also.

References

- * A review paper was published in 2013 in *Nature*. This was an outcome of the ISMASS Workshop held within SCAR-Portland 2012: E. Hanna, F.J. Navarro, F. Pattyn, C.M. Domingues, X. Fettweis, E.R. Ivins, R.J. Nicholls, C. Ritz, B. Smith, S. Tulaczyk, P.L. Whitehouse, H.J. Zwally (2013). Ice-sheet mass balance and climate change. *Nature*, 498, 51-59, doi:10.1038/nature12238.

Edward Hanna proposes revisiting this with an updated re-evaluation of ice-sheet mass balance (a more observationally-based study this time), possibly during

2015/16, which would fall conveniently between the ~6-yearly IPCC report evaluations. If ISMASS SC are in agreement, this is something we could maybe ask CliC to look at potentially part-sponsoring in due course in the form of a targeted workshop.

Webpage

<http://www.climate-cryosphere.org/activities/groups/ismass>

ISMIP6: Ice Sheet Model Intercomparison Project for CMIP6

Sophie Nowicki, NASA GSFC, USA; Tony Payne, University of Bristol, UK; Eric Larour, NASA JPL, USA

Introduction

The sea level projections made by the glaciological community as part of the Intergovernmental Panel on Climate Change (IPCC) process have often been out of phase with the projections considered by the wider Coupled Model Intercomparison Project (CMIP) community. For instance in Assessment Report 5, the ice2sea and SeaRISE (Sea-level Response to Ice Sheet Evolution) ice sheet projects predominantly worked with AR4 scenarios, while the CMIP5 community used new Representative Concentration Pathways (RCP) scenarios. A primary focus of this emerging activity is therefore to develop and implement a 5-year plan that will allow ice sheet models to be better integrated in the CMIP6 initiative, in order to improve both sea level projections due to changes in the cryosphere and our understanding of the cryosphere in a changing climate. These goals map into both Cryosphere and Sea-Level Rise Grand Challenges relevant to CliC and WCRP.

Achievements for 2014

CliC sponsored and helped organize a workshop in July 2014, whose goal was to bring together ice sheet and Earth System modelers and developers, along with representatives of other activities that are relevant to the cryosphere (such as Polar CORDEX, CLIVAR, WAGOM). The meeting was attended by about 60 participants (including our remote participants) and was held at NASA GSFC. A group photo of the participants is shown below.



Figure 11. Participants of the 2014 ISMIP6 workshop

The meeting was organized around key topics driving current ice sheets and glaciers models development and analysis, along with the incorporation of dynamic ice sheets into fully coupled Earth System Models (ESM):

- Mechanics of coupled simulations: How close are we to having models that could run as part of a CMIP-style ESM? And how suitable are CMIP models over the cryosphere?
- Missing physics and numerics, which can impact on cryospheric and sea-level projections: What are the major obstacles to credible projections of the cryospheric components of sea level?
- MIP experiment design: What type of experiment can we tackle and how?
- Data sets: What data sets are needed for model development and validation? What fields need to be saved from CMIP models and from the ice sheet models?

The main outcome of the workshop was the agreement to work towards a proposal for participation in the CMIP6 initiative, and request for endorsement by CMIP6 was submitted in September 2014. This new activity, called Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6), also now has a Scientific Steering Committee, whose current members are: Helene Seroussi (USA), Heiko Goelzer (BE), Andrew Shepherd (UK), William Lipscomb (USA), Jonathan Gregory (UK) and Ayako Abe Ouchi (JP) as the project leaders, Sophie Nowicki (US), Tony Payne (UK) and Eric Larour (NASA).

As stated in the CMIP6 application, the primary goal of ISMIP6 is to improve projections of sea level rise via improved projections of the evolution of the Greenland and Antarctic ice sheets under a changing climate, along with a quantification of associated uncertainties (associated with both uncertainty in climate forcing and in the response of the ice sheets). As depicted in Figure 3, this goal requires an evaluation of Atmosphere-Ocean Global Circulation Model (AOGCM) climate over and surrounding the ice sheets; analysis of simulated ice-sheet response from standalone models forced “offline” with CMIP AOGCM outputs and, where possible, with coupled ice sheet-AOGCM models; and experiments with standalone ice sheet models targeted at exploring the uncertainty associated with ice sheets physics, dynamics and numerical implementation. A secondary goal is to investigate the role of feedbacks between ice sheets and climate in order to gain insight into the impact of increased mass loss from the ice sheets on regional and global sea level, and of the implied ocean freshening on the coupled ocean-atmosphere circulation.

ISMIP6 is directly related to the WCRP Grand Challenges on ‘Changes in the Cryosphere’ and ‘Regional Sea-Level Change and Coastal Impacts’. A white paper on the former identifies the need for “a focused effort on developing ice sheet models, with specific emphasis on the role of ice sheet dynamics on the rate of the sea-level rise”, which ISMIP6 is ideally placed to deliver by linking the improved process-based understanding delivered within CliC (and elsewhere) to projections of future ice-sheet mass budget. While a white paper on the latter identifies several open issues that strongly relate to our proposed activity, including the need to understand the ocean’s response to high latitude freshwater forcing and the impact of ice sheet dynamics. ISMIP6 is primarily focused on the CMIP6 scientific question “How does the Earth System respond to forcing?” and offers the exciting opportunity of widening the current CMIP definition of Earth System to include (for the first time)

the ice sheets. The emphasis on standalone, ensemble modelling will also shed light on the question “How can we assess future climate changes given climate variability, predictability and uncertainties in scenario” for the mass budget of the ice sheets and its impact of global sea level.

Plans for 2015 and beyond

ISMIP6 will work to refine the experiments that are being proposed for CMIP6 and align itself with the timelines set by CMIP6. For example, ISMIP6 will hear back from the CMIP Panel mid February 2015 and will revise its proposed effort by the next deadline (31st March). If endorsed by CMIP6, ISMIP6 will participate in writing a publication describing the ISMIP6 experimental setup in the planned Special Issue on the CMIP6 experimental design. The nominal period of CMIP6 is 2015-2020. The July 2014 meeting highlighted the need for a workshop that is specifically targeted at identifying the datasets that will be used for model initialization and validation. The plan is to hold this workshop early/mid 2015, so that data preparation can be completed in time for the journal publication.

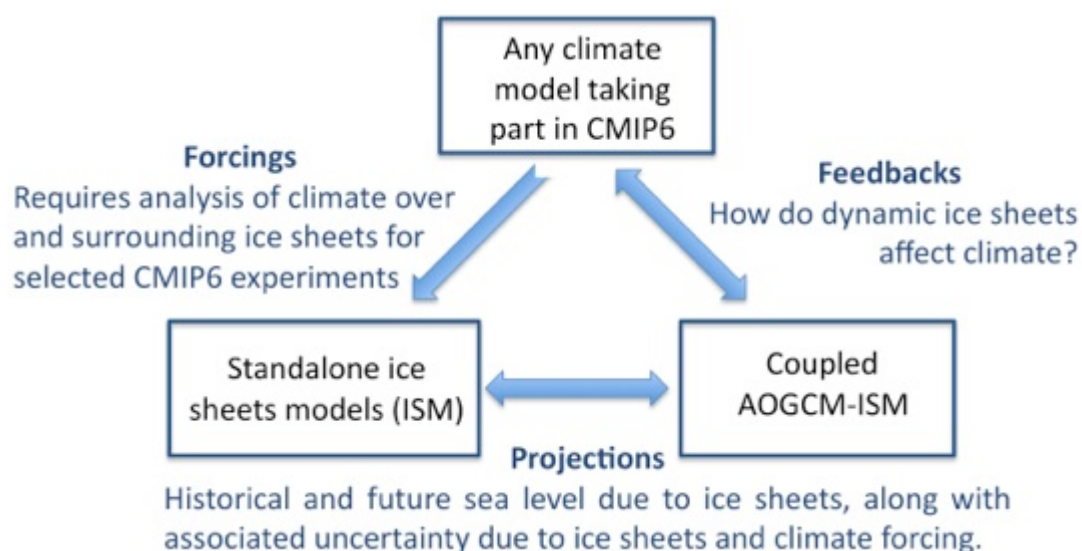


Figure 12. Overview of the ISMIP6 framework that is being proposed to CMIP6

Webpage

<http://www.climate-cryosphere.org/activities/targeted/ismip6>

Linkage Between Arctic Climate Change and Mid-Latitude Weather Extremes

Ed Hanna, University of Sheffield, UK; James Overland, NOAA, USA

Introduction

The assessment of the potential for recent Arctic changes to influence broader hemispheric weather is a difficult and controversial topic, with considerable skepticism. There is little agreement on problem formulation, methods, or robust mechanisms in the research community.

The topic, however, is a major science challenge, as continued Arctic changes are an inevitable aspect of anthropogenic global change and is an opportunity for improved extended range forecasts at mid-latitudes. An intriguing and increasingly important question from scientists and the broader community is whether recent extreme weather in North America, eastern Asia and northern Europe were merely random events or were related to recent global or Arctic climate change. CliC, the Atmospheric Working Group of IASC, other IASC Working Groups and multiple programs have prioritized the challenge: CliC, WMO/Polar Prediction, NOAA, UK Met Office, and the Icelandic Met Office.

Achievements for 2014

Following an IASC/CliC workshop in Iceland in November 2013, a smaller group met in Seattle during September 2014 to address the difficult topic of the current state of the science. A manuscript has been submitted to *Journal of Climate* and 28 abstracts on linkages and related topics have been submitted to the ASSW/ICARP III/ISAR session in Japan April 2015. Seattle suggested a way forward through case studies of regional episodic mechanisms.

Two candidates for linkages are increased Siberian high pressure and wave trains of high/low pressures that bring cold air into eastern Asia, and an amplification of the North American ridge/trough structure related to Greenland blocking (a slowing of the wind pattern) affecting cold weather in eastern North America. The abstract and a key figure from the paper submitted to *J. Clim.* are reproduced below.

Chain of Events Linking Arctic Amplification (AA) with Increased Extreme Weather in Mid-Latitudes

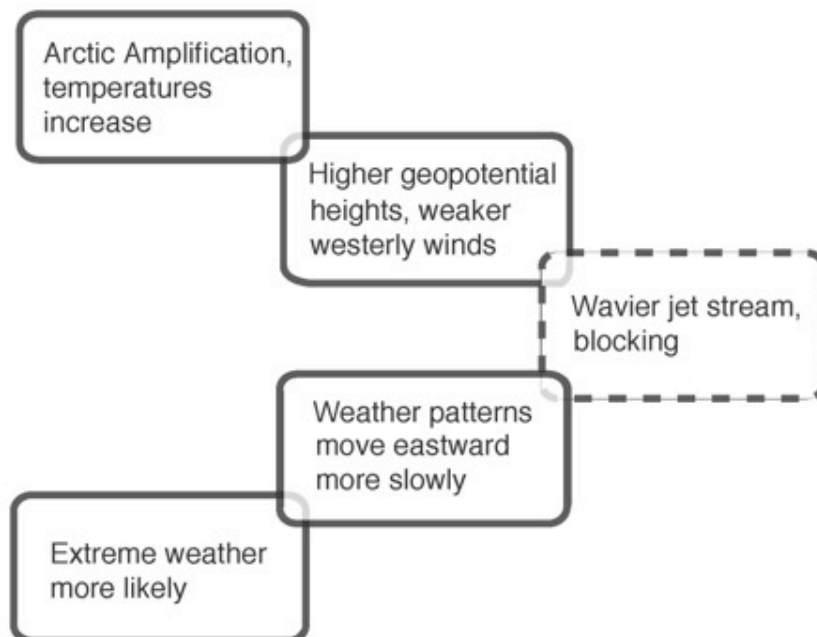


Figure 13. Hypothesized steps linking Arctic amplification with extreme weather events in Northern Hemisphere mid-latitudes

Plans for 2015 and beyond

Our topic will be represented by an ASSW/ICARP III/ISAR session in Japan April 2015, to be convened by Jim Overland (Edward Hanna, representing CliC, is a co-convenor).

Linkages will continue to be an important topic moving forward in the next few years to decades, so we anticipate that occasional meetings and author workshops will prove fruitful.

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Webpage

<http://www.climate-cryosphere.org/activities/targeted/linkages>

Polar Coordinated Regional Downscaling Experiment (Polar CORDEX)

Annette Rinke, AWI, Germany; John Cassano, Cooperative Institute for Research in Environmental Sciences (CIRES)/ Department of Atmospheric and Oceanic Sciences (ATOC), University of Colorado, Boulder, USA

Introduction

Polar CORDEX is part of the international CORDEX (Coordinated Regional Downscaling Experiment - Arctic and Antarctic Domains) initiative. Its primary goal is to organize an international coordinated framework to produce an improved generation of regional climate change projections for input into impact and adaptation studies. Currently, the core of Polar CORDEX consists of regional climate model (RCM) simulations over the Arctic, with both hindcast and scenario simulations being conducted. This effort is now expanding to include the Antarctic region as well. The Polar CORDEX community organized itself in 2013. The first meeting was held as a side event during the International Conference on Regional Climate (CORDEX 2013) in Brussels in November 2013. CliC helped building up and maintains the Polar CORDEX web page and mailing list.

Achievements for 2014

Focus was on atmosphere-only simulations over the Arctic CORDEX domain at ca. 50 km resolution forced by the ERA-Interim (global atmospheric reanalysis from 1979, continuously updated in real time) data. Simulations from 7 Regional Climate >Models (RCMs) from different groups (Rossby Centre regional Atmospheric model (RCA4) from the Swedish Meteorological and Hydrological Institute (SMHI), Norrköping; Canadian Regional Climate Model (CanRCM4) from the Canadian Centre for Climate Modelling and Analysis (CCCma), Victoria, Canada; modelCCLM from Univ. of Trier, Germany, model HIRHAM5 (regional climate model) from AWI, Potsdam, Germany; model WRF from Iowa State Univ., USA; model HIRHAM5 from DMI, Copenhagen, Denmark; model RRCM from MGO, St. Petersburg, Russia) have been finished. Other RCM simulations are running (model

MAR from Univ. of Liège, Belgium; model Weather Research and Forecast (WRF) from Uni Research Climate Bergen, Norway; new WRF simulations from Iowa State Univ. and Univ. of Colorado, USA). First results of individual models are published. They discussed the effects of spectral nudging on the simulations (Berg et al., 2013; Glisan et al., 2014) and established the credibility of daily precipitation extremes over four North American regions (Glisan and Gutowski, 2013) in individual models. First results of a multi-model intercomparison with respect to temperature extremes quantified the considerable regional-scale across-model scatter (Matthes et al., 2014). First scenario simulations (CMIP5 GCM-driven RCP4.5, RCP8.5 simulations) have been conducted by 3 atmospheric RCMs and the other models will start their simulations in 2015. Also, the first Arctic CORDEX simulations with a coupled atmosphere-ice-ocean RCM (RCAO from SMHI) have been conducted, both driven by ERA-Interim and GCMs. A few Antarctic CORDEX (hindcast, historical, scenario) simulations have been finished by 2 groups (model RACMO from KNMI, Netherlands; model WRF from New Mexico Inst., Socorro, USA).

The second Polar CORDEX meeting was held as a side event during the Regional-Scale Climate Modelling Workshop on 21st Century Challenges in Regional Climate Modelling in Lund, Sweden in June 2014. The status of and future plans for simulations and analysis have been discussed. Further, a link to the Arctic Council “Adaptation Actions in a Changing Arctic” (AACCA) project has been established. The AACCA project looks at future climate impacts, their interactions with other non-climate and socio-economic drivers of change, and the relevance of this for designing adaptation policies. It was discussed that available and relevant Arctic CORDEX results should feed into the AACCA report.

Plans for 2015 and beyond

Arctic CORDEX

The Era-Interim driven runs will be finished in 2015. All groups will put their data on the Earth System Grid Federation (ESGF) archive such that the results are readily available for scientific analysis. Multi-model analysis will then be started. One focus of this analysis will be on extreme events and cyclones. Additional analysis may focus on other mesoscale processes (e.g. atmospheric boundary layer and marginal ice zone processes, clouds, etc.), which are one aspect of the simulations expected to demonstrate added value by the RCM simulations. It would also be interesting to investigate the atmospheric response to sea ice anomalies in the RCMs. Analysis relevant for the AACCA report will be conducted. Some higher resolution (ca. 25 km) circum-Arctic atmospheric simulations and very high-resolution (few km) runs for subdomains (e.g., Svalbard, Greenland) have already been done by individual groups; these will be included in these analyses.

The Polar CORDEX group also plans to downscale additional CMIP5 GCMs future projections for the Arctic CORDEX domain. In doing this we aim to arrive at a good RCM-GCM matrix, i.e. the groups will try to run their RCM with at least two different GCM forcings. Focus will be on RCM simulations for the RCP8.5 scenario. We expect to have simulations from ca. 6 RCMs.

Another goal is to set up coordinated coupled atmosphere-ice-ocean simulations. Different groups run or develop coupled Arctic RCMs (model RCAO from SMHI; model RASM from Univ. of Colorado, Boulder and Iowa State University; model

COAWST from Uni Research Climate Norway; model HIRHAM-NAOSIM from AWI; model HIRHAM-HYCOM from DMI). Era-Interim- and GCM-driven runs are planned for the coupled model simulations.

Additional groups (model CRCM5 from the Université du Québec à Montréal, Canada; model RACMO from Univ. Utrecht, KNMI, Netherlands) plan to participate with atmospheric RCM simulations.

Antarctic CORDEX

More Antarctic simulations are planned (model HIRHAM from DMI; model RACMO from Univ. Utrecht, KNMI; model COSMO-CLM from Univ. Leuven, Belgium).

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Webpage

<http://www.climate-cryosphere.org/activities/targeted/polar-cordex/>

Permafrost Carbon Network

Ted Schuur, Northern Arizona University, USA; A. David McGuire, University of Alaska Fairbanks, USA; Christina Schaedel, Northern Arizona University, USA

Introduction

Approximately 1330-1580 Pg of soil carbon (C) are stored in soils of the northern circumpolar permafrost zone, almost twice as much C as currently contained in the atmosphere. Permafrost thaw, and C released via the microbial decomposition of previously frozen soil organic matter (SOM), is considered one of the most likely positive feedbacks from terrestrial ecosystems to the atmosphere in a warmer world. Yet, the rate and form of permafrost C release is highly uncertain but crucial for predicting the strength and timing of this carbon cycle feedback during this century and beyond. The Permafrost Carbon Network is a synthesis project whose objectives are to link biological C cycle research with well-developed networks in the physical sciences focused on the thermal state of permafrost. Over the last four years, the network expanded from a core group of 40 scientists to more than 200

scientists from 88 research institutions located in 17 countries. It is structured into five working groups that focus on improving our understanding of 1) the size of permafrost C pools, 2) the decomposability of thawed permafrost SOM, 3) the fate of permafrost C from thermokarst and thermal erosion (abrupt thaw processes), 4) anaerobic and aerobic processes affecting CO₂ and CH₄ release, and 5) the capability to upscale and model the fate of permafrost C to develop more reliable projections of the role of permafrost C dynamics in the climate system. The working groups produce new knowledge by synthesizing data that can be assimilated by biospheric and climate models and that will contribute to future global environmental assessments, including the Intergovernmental Panel on Climate Change (IPCC).



Figure 14. Permafrost Carbon Group photo of workshop participants, Stockholm 2014

Achievements for 2014

In May of 2014, we had our seventh network workshop in Stockholm, Sweden. This one day workshop was supported by CliC and held in conjunction with the third and final CAPP (Carbon Pools in Permafrost) workshop organized by Dr. Peter Kuhry. The specific intent of this co-hosted workshop was to connect US-activities represented by the Permafrost Carbon Network to ongoing international research efforts. Besides general oral and poster presentations we jointly worked with the working group leads (Figure 13) on a review paper on the topic of climate change and the permafrost carbon feedback. The past four years of synthesis activities had produced multiple new peer-reviewed papers (e.g. Grosse et al., 2013, Harden et al., 2012, Hugelius et al., 2013a, Hugelius et al., 2014, Hugelius et al., 2013b, Hugelius et al., 2013c, Olefeldt et al., 2013, Schädel et al., 2014, Schuur et al., 2013, Strauss et al., 2013, Treat et al., in revision) and archived datasets that produced new knowledge and were used for model-data intercomparisons intended to enhance our knowledge of the vulnerability of permafrost carbon to climate change. Bringing together the working group leads in Stockholm facilitated valuable group discussions and substantial progress on a review manuscript that was successfully submitted to Nature in summer of 2014. The manuscript will be published after some minor editorial changes are made. The review brings together new knowledge produced in network synthesis products and gives more insight into the amount and timing of the permafrost carbon feedback (Figure 14) in a way not possible from a single published study.

We expect this article to be published in early 2015, shining a spotlight onto the science activity of the Permafrost Carbon Network.

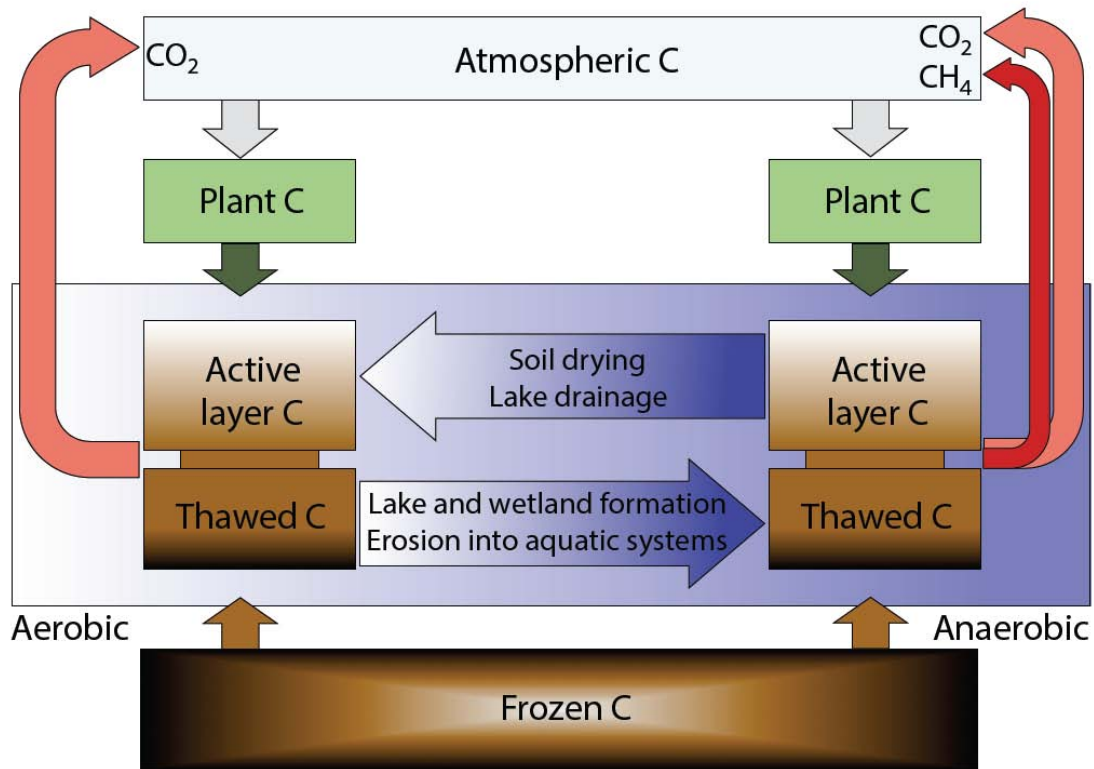


Figure 15. Permafrost carbon feedback to climate change. Carbon (C) stored frozen in permafrost, once thawed, can enter ecosystems that have either predominantly aerobic (oxygen present) or predominantly anaerobic (oxygen limited) soil conditions. Across the permafrost region, there is a gradient of water saturation that ranges from mostly aerobic upland ecosystems to mostly anaerobic lowland lakes and wetlands. In aerobic soils, CO₂ is released by microbial decomposition of soil organic C, whereas both CO₂ and CH₄ are released from anaerobic soils and sediments. Microbial breakdown of soil organic C can happen in the surface active layer, which thaws each summer and refreezes in the winter, and in the subsurface as newly-thawed C becomes available for decomposition after it has emerged from the perennially frozen pool. The decomposability of soil organic C varies across the landscape depending in part on the plant inputs as well as the soil environment, and also with depth in the soil profile. The landscape mosaic of water saturation is also affected by permafrost thaw. Gradual and abrupt thaw processes such as top-down thawing of permafrost (increasing the active layer thickness) and lake draining can expose more C to aerobic conditions. Alternately, abrupt thaw processes can create wetter anaerobic conditions as the ground surface subsides attracting local water. Carbon can also be mobilized by erosion or by leaching from upland soils into aquatic systems or sediments. Plant C uptake can be stored in increased plant biomass or deposited to the surface soils, which in part can offset losses from soils.

Plans for 2015 and beyond

The Permafrost Carbon Network will continue beyond 2015 as part of the SEARCH (Study of Environmental Arctic Change) project, headed by the University of Alaska Fairbanks as the lead institution and funded by the National Science Foundation. The Permafrost Action Team, led by Ted Schuur will, in part, support activities developed by the Permafrost Carbon Network, although the scope of the Action Team also extends beyond the more narrow issue of carbon and climate. One important aspect of the SEARCH link is that it provides funding for a synthesis

researcher (in our case Christina Schädel) but operates under a similar funding framework that it is up to Action Team leads and participants to raise additional

funding for workshop activities. As one of the activities in 2015, a session on permafrost carbon issues under climate change has been proposed for the conference entitled 'Our Common Future under Climate Change', which will be held ahead of the COP21 of UNFCCC in 2015 in Paris, France. This is crucial to disseminate the importance of permafrost carbon issues under climate change to the wider science community as well as reach out to stakeholders and policy makers. This meeting is an important venue for scientists in our network to interface with decision makers in the climate arena. In addition to this important outreach activity, the next workshop for the network leads will be in late spring of 2015, or possibly as an add-on to the Paris conference. This workshop has several key goals: 1) to advance models development by exploring possible benchmarking tools that can be provided by field and lab based scientists; 2) finalize model output from the Permafrost Carbon Model Intercomparison Project (lead by D. McGuire) that estimates the permafrost carbon climate feedback for this century and beyond; 3) finalize upscaling estimates based on empirical datasets synthesized by the network; 4) Initiating several new permafrost carbon synthesis activities as a natural evolution of network activities. Both the Paris connection to stakeholders, and the science workshop will rely on additional funding from outside groups to make these workshops possible.

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Webpage

<http://www.permafrostcarbon.org>

Permafrost Research Priorities– A roadmap for the future of permafrost research

Permafrost Research Priorities Core Group:

Hugues Lantuit, AWI, Germany (Chair); Michel Allard, Université Laval, Canada, Mauro Guglielmin, Insubria University, Italy; Margareta Johansson, Lund University, Sweden; Gleb Kraev; Centre for Forest Ecology and Productivity, Russian Federation; Michael Krautblatter, Technical University of Munich, Germany; Gerhard Krinner, LGGE Grenoble, France; Edward A. G. Schuur, Northern Arizona University, USA; Ylva Sjöberg, Stockholm University, Sweden, CliC Fellow; Jenny Baeseman, CliC, Ex-Officio, Norway; Karina Schollän, IPA, Ex-Officio, Germany

Introduction

The International Permafrost Association (IPA) and CliC were invited to participate in the Third International Conference on Arctic Research Planning (ICARP III) process, led by the International Arctic Science Committee (IASC). The ICARP III process aims at integrating priorities for forward-looking, collaborative, interdisciplinary Arctic research and observing. The IPA and CliC, acknowledging that no consensus document exists at the international level to identify forward-looking priorities in permafrost research, decided to initiate a process by which such a document, focusing on permafrost research at large (i.e. including Arctic, Mountain, Antarctic and Sub-sea permafrost) would be published based on the engagement of the permafrost research community as a contribution to ICARP III. The product stemming from the effort should consist of a high level, but short benchmark publication listing and putting into context research priorities for the next 10 years.

Achievements for 2014

A core group was appointed in January 2014 and consists of the above mentioned individuals. The core group set up an online questionnaire on the IPA and CliC websites for the input of scientific questions. The questionnaire was open from July 15th until September 20, 2014. The announcement was circulated widely to encourage input into the process. A townhall meeting as well as a dedicated “world café” session in the young researchers workshop were held during the Fourth European Conference on Permafrost and has been used as the venue to launch the process and to foster community engagement.

The Permafrost Research Priorities survey received almost 650 questions from more than 300 participants. A list of all the submitted questions and preliminary figures depicting demographic data can be found at the project website.

Preliminary statistics from part two (demographics) of the survey show that:

- The respondents come from 37 countries
- A majority of the respondents (69 %) are men working within academia (68%)
- 79 % of the respondents have a PhD as their highest academic degree
- The respondents have a wide range of areas of primary expertise, the most common being geomorphology (13 % of respondents), ecology, engineering and infrastructure, and climate change (each 8 % of respondents) and the least common being industrial development and impacts (no respondent), land use and community planning (1 respondent), and mapping (1 respondent).
- Age distribution and years of experience working with permafrost related issues for respondents are across the full spectrum.

The PRP core group is now reviewing the submitted questions to assure they meet the criteria by Sutherland et al. (2011) outlined at the beginning of the project, discard questions that do not meet the criteria, merge similar questions, and if necessary, reword questions with grammatical errors or other language issues. This will set the stage for the community ranking set to start in March 2015.

Plans for 2015 and beyond

At the end of the categorizing process, envisioned to start in March 2015, a consolidated list of questions will be put online for community review and consultation. The voting phase is one of the most important parts of the PRP process as it will lead to the ranking of the top ~10-15 permafrost research priorities. The online voting will take place in Spring 2015. Participants will be asked to select the themes they have expertise in. They will then be asked to rank the questions within that theme(s) based on the overall importance of answering that question to fundamentally improving our understanding of permafrost over the next 10 years. The results of the ranking and demographic information of the participants will be included in the master database.

Using the rankings from the voting process, the core group will analyze the results and select the top questions from each theme. The number of themes selected and the quality of the questions will ultimately determine the final research priorities. A core group meeting will be organized in April 2015 to finalize the process and distribute the tasks for the writing of the manuscript stemming from the effort. The core group will work on a manuscript to be published as draft in April 2015 for the ASSW/ICARP III/ISAR conference in Toyama (Japan). The output will consist of a short publication highlighting the top 10 research priorities and a longer academic paper describing the entire process.

References (if any)

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Permafrost Research Priorities

Preliminary Demographic Statistics and Submitted Questions

6 October 2014

Below are a few figures describing early results of demographic data from the participants of the PRP Research Questions Survey. A more detailed analysis will be provided with the final research priorities document.

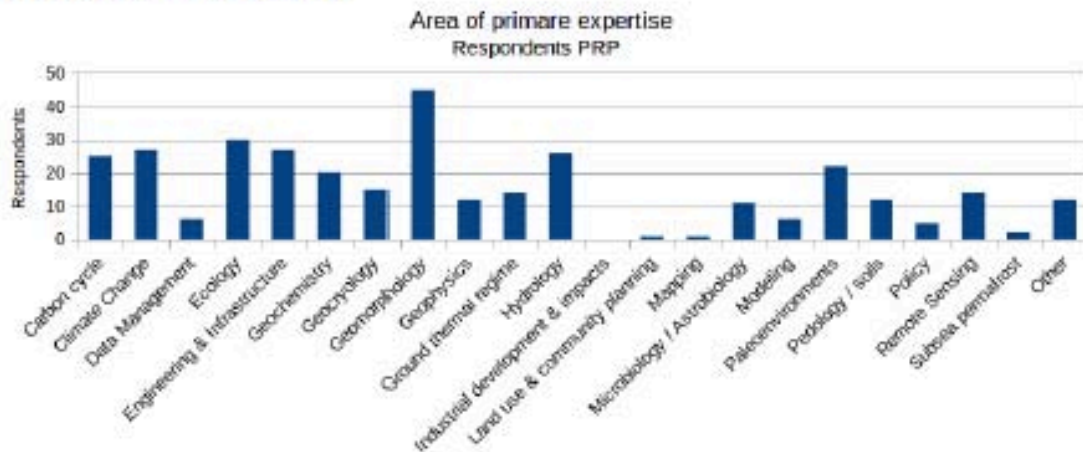


Figure 1. Responses to the question: "Please select your area of primary expertise". Note that these statistics are preliminary crude results from the survey and have not yet been checked in detail by the core group for any potential errors.

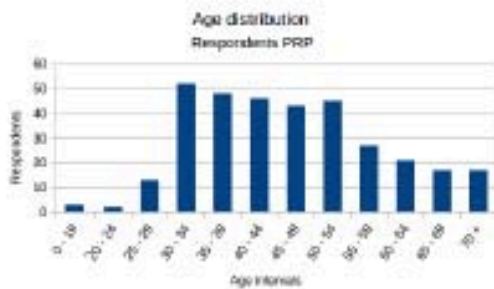


Figure 2. Responses to the question: "What is your age category?" Note that these statistics are preliminary crude results from the survey and have not yet been checked in detail by the core group for any potential errors.

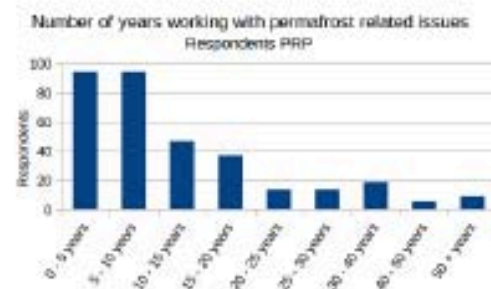


Figure 3. Responses to the question: "How long have you worked on permafrost-related issues over the course of your career?" Note that these statistics are preliminary crude results from the survey and have not yet been checked in detail by the core group for any potential errors.

Figure 16. Permafrost Research Priorities survey – preliminary demographic statistics and submitted questions

Webpage

<http://www.permafrostpriorities.org>

<http://www.climate-cryosphere.org/activities/targeted/permafrost-research-priorities>

Sea Ice and Climate Modelling Forum

Alexandra Jahn, NCAR, USA; Dirk Notz, Max Planck Institute for Meteorology, Germany

Introduction

The CliC sea ice and climate modelling forum has the goal to improve the simulations of sea ice in large-scale models by addressing the following priorities:

- **Model evaluation:** Compile a list of useful variables to be included in coordinated model experiments like CMIP6 to facilitate model-model comparisons as well as model-data comparisons. Develop a standardized sea-ice simulation protocol and identify data needs,
- **Causes of model biases:** Facilitate the analysis of biases and their underlying reasons in sea ice model simulations through the analysis of existing simulations (CMIP5, CORE-II) and targeted additional experiments when needed. One goal is to determine the role of sea-ice model deficiencies versus biases originating from the forcing of the sea-ice model in the coupled system,
- **Model development:** Facilitate ongoing sea-ice-model developments through improved communication between related groups. Coordinate analysis of the impact of model development both on the sea-ice simulations and on the other components of the coupled model. Summarize observational data needs for the development of new parameterizations. This relates for example to new schemes for prognostic salinity, melt pond coverage and rheology.

Achievements for 2014

The first workshop of the CliC sea ice and climate modelling forum was held at the University of Reading, Reading, UK, on September 26, 2014. Prof. Daniel Feltham was the local host at the University of Reading, and arranged the meeting logistics. This meeting brought together 35 researchers working on various aspects of sea ice, with a strong focus on sea ice modelling. It followed four days of sea ice talks and discussions at the Royal Society meeting on Arctic sea ice decline in London and at Chicheley Hall. At the CliC sea ice and climate modelling workshop in Reading sea-ice biases in CMIP5 models, sea-ice model development needs, CMIP6 planning for sea ice, and the need for new sea-ice observations were discussed.

As a concrete result from the workshop, the chairs of the CliC Sea Ice and Climate Modelling Forum submitted a Sea Ice Model Intercomparison Project (SIMIP) application to CMIP6 that clearly defines how sea-ice variables should be saved in CMIP6 simulations. The first draft of this list of variables was based on discussions at the workshop, which concluded that there should be a focus on budget diagnostics for the next CMIP phase. This allows scientists to better diagnose and understand sea-ice related model biases and cross-model differences in CMIP6 compared to CMIP5. This list has been circulated to the workshop participants and the SIMIP Steering Committee members, and will be revised and further circulated before being submitted to CMIP6 by January 15, 2015, and in its final form in March 2015.



Figure 17. 2014 Sea Ice and Climate Modelling Forum workshop in Reading

Plans for 2015 and beyond

We plan to organize the second workshop of the CliC sea ice and climate modelling forum in 2015, aimed at bringing together sea ice observers and modelers to (a) develop a concrete list of observational data that would be most useful for the evaluation and improvement of sea ice simulations by climate models and to (b) discuss the various methods and the impact of the tuning of sea-ice models for climate simulations.

CLIVAR/CliC/SCAR Southern Ocean Region Panel

Lynne Talley (Co-chair), Scripps Institution of Oceanography, USA

Introduction

The CLIVAR/CliC/SCAR Southern Ocean Region Panel (SORP) is finalising its Achievements Report, similarly to all CLIVAR panels. After the pan-CLIVAR meeting in July 2014, new plans have been discussed, including closer collaboration with CliC and joint membership, selected equally by the CLIVAR and CliC SSGs.

Achievements for 2014

SORP has developed a strong relationship with the CLIVAR Ocean Model Development Panel (OMDP), particularly in the use of the Coordinated Ocean-Ice Reference Experiments Phase II (CORE-II) datasets.

Planning for a Southern Ocean MIP (SOMIP) was initiated with the OMDP:

- Goal is improvement in carbon modeling and understanding of response to wind, in coupled climate models
- Development of proposal of Southern Ocean wind perturbation and freshwater forcing protocols in OGCMs in preparation for a SOMIP.
- Development of SO metrics under the auspices of the US CLIVAR Southern Ocean Working Group in preparation for a SOMIP.

SORP provided input on Essential Ocean Variables to GOOS/SOOS through the OOPC.

Several SORP members, in particular the co-chair Lynne Talley and member Joellen Russell, have been instrumental in developing and then securing funding for the Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program, a six-year initiative funded by the USA's National Science Foundation. Lead investigator of the multi-institutional US program is Jorge Sarmiento (Princeton U.). Strong international collaborations are central to the program.

Plans for 2015 and beyond

Strengthen CliC/CLIVAR co-sponsorship of SORP through joint CliC/CLIVAR appointment of co-chairs and members.

Continue development of SORP modelling and observations priorities, together with CliC, SOOS and SCAR.

Continue development of a SOMIP.

Review the CliC Southern Ocean satellite survey, and the YOPP implementation plan.

Begin review of regional Antarctic science and existing observing systems/regional experiments to provide framework and advice to SOOS and SCAR, particularly in ice-covered regions. Include air-ice-sea flux review, as lead-up for SOOS flux workshop.

Host a joint workshop with SOOS air-sea flux observational efforts in the Southern Ocean, planned for Frascati, Italy, in September 2015.

SOP-10 meeting in Qingdao in conjunction with CLIVAR Open Science conference in 2016

Webpage

<http://www.clivar.org/panels-and-working-groups/southern>

Southern Ocean Satellite Requirements

Allen Pope, NSIDC, Colorado, USA; Penelope Wagner, Norwegian Ice Service, Norway; Rob Johnson, Bureau of Meteorology, Australia; Louise Newman, SOOS, Australia; Jenny Baeseman, CliC, Norway.

Introduction

Earlier in 2014, CliC together with Southern Ocean Observing System (SOOS) and World Meteorological Organization Polar Space Task Group (WMO PSTG) put together a survey to collect information on satellite data requirements for monitoring changes in the biological, geophysical, and biogeochemical regimes in the Southern Ocean (across all temporal/spatial scales). The survey received ~65 replies. The key motivation of the survey and report/publication is to provide the Satellite data providers with a strong, consolidated "user voice" on Southern Ocean satellite data requirements for use when planning future satellite missions. These results will be compiled and contextualized with further information from the research and

operational communities, and summarize the findings in a report, as well as a peer-reviewed publication.

Achievements for 2014

This project is still in the beginning stages. A team was successfully assembled to carry out the summary and report. We organized one conference call to discuss our approach and ideal outcomes. We decided on a timeline, have created an outline for our product, and have assigned tasks as appropriate. Deadlines have been set for early in 2015 and we look forward to carrying out the work.

Plans for 2015 and beyond

All work should be completed in 2015.

- Jan 12, 2015: Authors contribute to 1st draft of report
- Jan 21, 2015: Second conference call of authors
- Short presentation on preliminary results at CliC SSG in February 2015
- Write full report & summary report for submission to “Antarctic Science”
 - In-person meeting in April or May to achieve this
- Ready for full presentation at SOOS SSG in May/June 2015

References

Survey:

<https://docs.google.com/spreadsheets/d/1DRIYsFal5dRWkosJzSX5WGNPhD3HCWrMPMtpEYNZnR8/edit?usp=sharing>

Webpage

<http://www.climate-cryosphere.org/activities/targeted/so-sat-req>
<http://www.soos.aq/science/satellite-data>

Submarine Permafrost Mapping Action Group

Paul Overduin, AWI, Germany

Introduction

In Fall 2011, the International Permafrost Association (IPA) voted to support the new IPA Subsea Permafrost Mapping Action Group (SuPerMAG), proposed by the Coastal and Offshore Permafrost Dynamics Interest Group of the IPA. The action group recognized the need to support the development and production of a map or maps of subsea permafrost, based on resolutions met by the Coastal and Offshore Permafrost Dynamics (COPD) Working Group at the 9th International Conference on Permafrost (NICOP) in 2008. In March 2013, the Climate and Cryosphere (CliC) Project endorsed this effort and agreed to support it as one of its Targeted Activities.

Achievements for 2014

To kick off the process, the Submarine Permafrost Mapping Action Group (SuPerMAG) of the IPA and CliC Targeted Activity organized a workshop on June 18, 2014 at the 4th European Conference on Permafrost (EUCOP4) in Evora, Portugal. This workshop brought together modelers and regional experts, to review current observational data and our understanding of processes determining

submarine permafrost distribution, discuss numerical modelling of relevant processes and techniques for model validation, and to recommend options for the cartographic representation of submarine permafrost.

As part of the meeting's resolutions, it was recognized that, based on the sparse publically available observational data on permafrost distribution and thermal state, a self-consistent submarine permafrost map at the circum-arctic spatial scale will need to be based at least in part on the results of modelled permafrost thermal state. Numerical models of permafrost evolution exist for both terrestrial and marine environments. These are generally 1-dimensional models that generate temperature fields for the subsurface based on time-dependent boundary conditions at upper and lower bounds given a set of sediment properties. Validation data against which model results can be tested are derived from borehole logs, sediment temperatures and geophysical measurements, sediment cores, sea bed probing, geophysical surveys or indirect evidence of permafrost presence or absence, such as seabed morphology, or gas seeps. Any mapping effort should accommodate differences between modelling approaches, and will need to deal with the challenge represented by the lack of publically available validation data and by potentially incomplete representation of processes relevant to the development of submarine permafrost.

The workshop synthesis and discussion focused on multiple options for moving forward. The necessity of bringing many of the discussion elements into the citable literature lead to the suggestion that a publication be prepared that synthesizes existing knowledge and outlines the needs associated with a mapping effort for submarine permafrost. A document outline was created and targeted contributions are being solicited from the action group members. In parallel, further meetings are required, to co-ordinate the interdisciplinary group required to provide input parameterization for a modelling effort. Further planning meetings of the modelling core group took place in fall 2014, with the aim of planning a meeting focused on the modelling effort in 2015. A database of existing geo-data has been initiated and populated with the results of a data-mining effort that took place between March and November 2014.

Plans for 2015 and beyond

The immediate next steps for the Action Group are:

- continued harvesting and assembly of observational data, esp. geophysical and borehole data; a geodatabase for model validation is in progress.
- to assemble input parameter data sets for modelling – ongoing.
- text contributions to the review paper effort – end of submission phase in first half of 2015.
- implementation of modelling efforts – this will require a small meeting of modelling representatives, planned for Norway, hosted by CAGE and/or the University of Oslo.

Marine Ice Sheet Ocean Model Intercomparison Project (MISOMIP)

David M. and Denise Holland, New York University, USA

Introduction

Global sea-level rise is one of the most discussed potential consequences of global warming. The most uncertain aspect of such future sea-level change has to do with the marine based ice sheets, and particularly that of the West Antarctica Ice Sheet (WAIS). Despite its potential importance, current generation global climate models are unable to simulate sea-level change arising from glacier-ocean interaction.

As a step towards remediating this situation, we intend to bring together, through annual workshops, the international modelling community with expertise in this area so to advance the state-of-the-art in regional-scale simulations. The outcome of these workshops will be physically-based estimates of sea-level change coming from WAIS over the present century and beyond. Such regional-modelling research will lay the ground work for an appropriate manner to include glacier-ocean interaction in global scale, IPCC class models.



Figure 18. Rising Coastal Seas on a Warming Earth - MISOMIP Kick-Off Meeting. Abu Dhabi, UAE, 27-29 October 2014

Achievements for 2014

From October 27 to 29, 2014, the CliC programme in conjunction with NYU Abu Dhabi, held a three-day workshop bringing together a group of 30 international experts on the topic of sea-level rise. Three international graduate students were also invited. The two major outcomes of this workshop were 1) a technical plan for future coupled modelling activities, and 2) an overview report for *Eos* magazine.

Plans for 2015 and beyond

A second workshop is planned for Fall 2015 focused on implementing the main findings of the workshop: a) bring together existing glacier and ocean modelling intercomparison projects and b) have these disciplinary projects joined together to advance coupled modelling. The novel modelling activity will be the creation of the

Marine Ice Sheet Ocean Model Intercomparison Project (MISOMIP). An email listserver has been set up at NYU under the address of misomip@nyu.edu, which serves to connect the meeting participants going forward, as well as to connect other participants who will likely join the project later on. The tentative timeline for activities is:

First Year:

- Designing/testing the MISOMIP experiments (many groups have already run many of the experiments as part of designing them)
- Deliverable: Experiments to be defined in a peer-reviewed paper for the journal, *Geoscientific Model Development*

Mid-Project:

- Comparison of MISOMIP results between those models that have already completed the experiments
- Coordinated idealized and regional realistic experiments (perhaps agree on a region to focus on further experiments)
- Deliverable: Paper intercomparing the results from MISOMIP

Project-End:

- Modelling goal: Provide reference simulations and solutions for model development
- Science goal: Focus regionally and on processes relating to coupling. Perhaps doing perturbations to explore uncertainties or processes.

References

Eos article was submitted in early January.

Webpage

<http://www.climate-cryosphere.org/activities/targeted/wagom>

<http://nyuad.nyu.edu/en/research/nyuad-institute/institute-research/cslc.html>

Where Are They Now?

A Case Study of International Travel Support for Early Career Researchers

Sanna Majaneva, University of Helsinki, Finland; Jenny Baeseman, CliC, Norway; Gerlis Fugmann, APECS, Norway; Maja Lisowska, Jagiellonian University, Poland, and Christie Logvinova, Clark University, USA

Introduction

When establishing priorities for Arctic science for the coming decade it is essential to prepare and retain early career researchers (ERS) to ensure that research will be continued well into the future. To maintain the continuum of knowledge in polar sciences that was established during the 2nd International Conference on Arctic Research Planning and the International Polar Year, it is of great importance to continue to support the next generation of researchers. Many organizations are working on that allow early career researchers to discuss their ideas, work together,

and exchange information with an international and renowned group of Arctic scientists. Yet, the evaluation of how effective these initiatives are is still missing.

To aid in assessing how past support has influenced early career researchers and potentially enhanced future opportunities, the APECS and CliC have launched the *Where are they now?* project. It is a case study to assess the value of international travel support for early career researchers.

Achievements for 2014

For the first time, the project is investigating the subsequent career paths of early career Arctic researchers that received travel funding from International Arctic Science Committee since the start of the most recent International Polar Year (2007-2008) until 2013. International Arctic Science Committee has provided travel support for 287 early career researchers during this time.

A survey, with 50 questions concerning demographics, meeting, benefits, Arctic research, IASC, and other questions, was sent to each of these researchers and 132 people responded, a 45.9 % response rate. In addition, 1-2 page summaries of their experience of the event where the early career scientists received the funding were analyzed. In these reports they are expected to describe; What they expected to get out of the workshop? What they got out of the workshop? and a description of how the workshop enhanced their research goals?

Preliminary results indicate that 90% of these researchers are still active in Arctic work and qualitative results indicate that travel support was beneficial to both the research and careers of the early career scientists responding. Of the 10% that are no longer working with Arctic issues, 29% stated personal reasons influencing their decision to quit working with Arctic issues. Other reasons were change of topic; related to funding or institutional issues, or that they took whatever job they were able to get. As the biggest challenges in their work with the Arctic issues, they name funding and limited positions. As the most important benefit from the funding they name networking. Quite a few early career researchers mentioned that the networking in the event had resulted in new opportunities and new collaborations.

Plans for 2015 and beyond

Responses from survey participants provided details on the specific impacts of travel support to various meetings and included suggestions on how funds could be better used in the future. Results will help form new standards for supporting the next generation of Arctic researchers. Results will be written into peer-reviewed paper, which is to be ready and submitted by early 2015 and presented in the ASSW/ICARP III/ISAR symposium in April 2015 in Toyama, Japan.

Webpage

<http://www.climate-cryosphere.org/activities/targeted/wherenow>

WCRP Grand Challenge Contributions

Cryosphere in a Changing Climate Grand Challenge

The Grand Challenge on the Cryosphere in a Changing Climate is intimately linked to ongoing and planned activities within the CliC Core Project, as well as initiatives like the PCPI (described in the next section). There is however a need to identify clearly those activities that are specifically tied to the Grand Challenge. To this end, we have begun drafting a work plan specific to the Cryosphere Grand Challenge, and it explicitly identifies activities that are being undertaken in the following areas (identified as priority topics in the Grand Challenge White Paper):

1. A coordinated focus on seasonal, interannual and longer-term predictions and projections of polar climate and the role of the cryosphere in climate predictability.
2. A more focused analysis of model intercomparison results aimed specifically at understanding and attributing model biases and shortcomings related to the cryosphere.
3. A focused effort on improving the representation of permafrost and high-latitude land surface, including wetlands, in climate models, with specific emphasis on their role in the global carbon cycle.
4. A focused effort on developing ice sheet models, with specific emphasis on the role of ice sheet dynamics on the rate of sea-level rise.

Under topic 1, the PCPI is the most visible effort. Under topic 2 we have the various contributions to CMIP6 such as ISMIP6, ESMSnowMIP and SIMIP, along with the new initiative on global glacier mass balance modelling. Under topic 3, there is the permafrost carbon project, co-sponsored by CliC, and plans for a CliC Permafrost Modelling Forum similar to that established for sea ice. Finally, under topic 4 there is the ice sheet model intercomparison effort mentioned above (ISMIP6) which is building a bridge between ice sheet and climate modellers as well as underpinning efforts to improve sea-level projections.

A workplan for the Grand Challenge should be available by mid-2015.

Polar Climate Predictability Initiative

Ted Shepherd, University of Reading, UK; Cecilia Bitz, University of Washington, USA

Introduction

PCPI aims to advance understanding of the sources of polar climate predictability on timescales ranging from seasonal to multi-decadal. Polar predictability stems from the unique persistence of signals in ice and snow and through exchange with the ocean at all depths and the stratosphere. PCPI is concerned with the success of modelling and observing the rapid changes seen in the Arctic and the mixed, slow and fast changes occurring in the Antarctic. PCPI is investigating the role of the poles in global climate and prediction. An implementation plan for PCPI arose from a pair of workshops in 2010 and 2012, defining six themes. The WCRP JSC agreed to designate PCPI as a sub-initiative of the “Cryosphere in a Changing Climate” Grand

Challenge: A cross-cutting Initiative, with especially close ties to CliC and SPARC. Two champions were chosen for each of our six themes to comprise a PCPI leadership committee, which began organizing activities in 2013. Half of the PCPI themes are joint with our sister program, the Polar Prediction Project (PPP) of the WWRP, which focuses on similar problems but at subseasonal timescales.

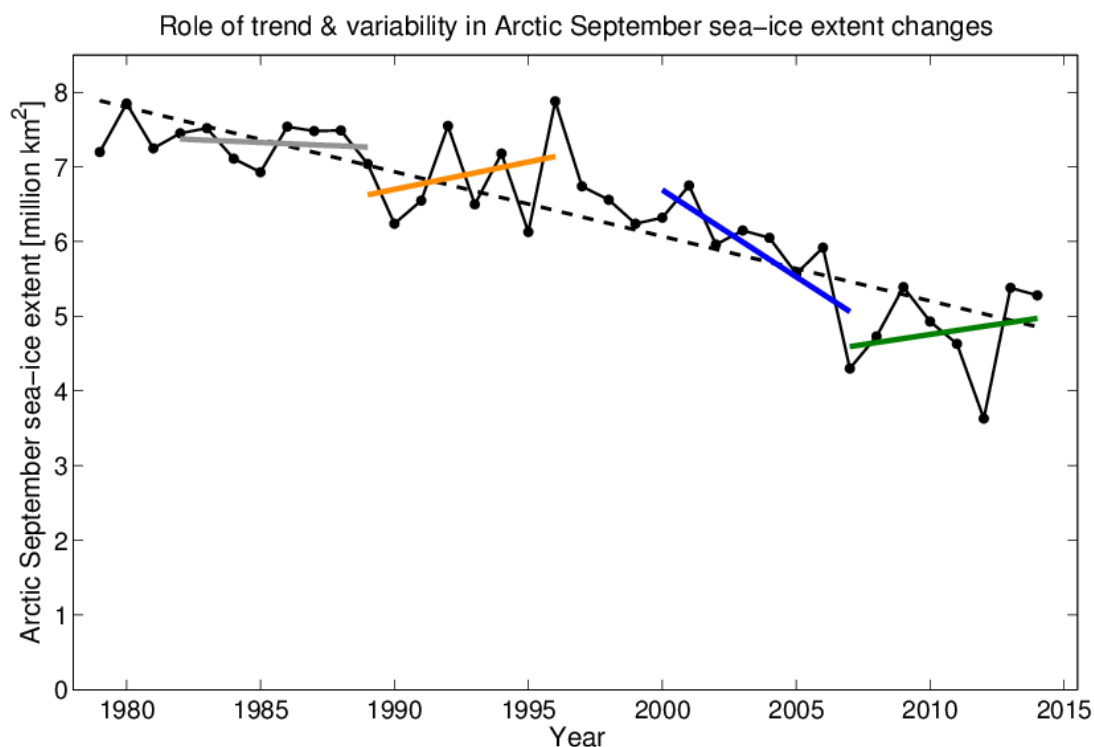


Figure 19. Seven-year trends in Arctic September sea ice extent can be highly variable. The Sea Ice Prediction Workshop, held in Boulder, USA, with 60 attendees, in April 2014, made recommendations to improve the Sea Ice Outlook, many of which were subsequently implemented in the summer of 2014. For example, Outlook participants were asked to provide additional diagnostics and more information about their methods. The Outlook reports contained this additional information and it was also included in an article that has been submitted to Eos. A follow-up meeting with 34 attendees was held at AGU to plan coordinated experiments for summer of 2015. Although the Sea Ice Outlook was originally developed as a US initiative, the PCPI is internationalizing the activity.

Achievements for 2014

The first PCPI leadership meeting was held in Boulder, USA, in April 2014. Plans and goals were established for each of the six themes. A subset of the participants wrote a journal article titled “Influence of internal variability on Arctic sea-ice trends” (Swart et al, 2015), which is in-press for Nature Climate Change (see Figure 17).

An international workshop on “Polar-lower latitude linkages and their role in weather and climate predictions” was held in Barcelona, Spain, in December 2014. The meeting was joint with PPP. A report and set of recommendations are being prepared as an outcome of the meeting.

PCPI sponsored a session on the “Southern Ocean: Circulation and Carbon Cycle” in a US CLIVAR and OCB workshop titled “Ocean’s carbon and heat uptake: Uncertainties and metrics” in San Francisco, December 2014.

PCPI sponsored a session on “Polar Climate Mechanisms and Predictability” at the Fall AGU in San Francisco, December 2014.

A journal article for the Bulletin of American Meteorology reviewing the Amundsen Sea Low was written as an outcome of a late 2013 workshop organized by PCPI theme leaders. The article is in revision.

Plans for 2015 and beyond

- A workshop titled “Large-scale climate variability in Antarctica and the Southern Ocean over decades-to-centuries, and links to extra-polar climate”, is to be held at Scripps Institution of Oceanography, San Diego, USA, March 2015. The workshop is joint with PAGES.
- Sea Ice Prediction Workshop in Reading, UK, in April 2015.
- Polar Climate Predictability and Prediction session at EGU in Vienna, Austria, in April 2015.
- “Polar Amplification” session at IUGG in Prague, Czech Republic, July 2015.
- Year of Polar Prediction Summit, in Geneva, Switzerland, in July 2015. Organized by PPP with help from PCPI (through Jenny Baeseman, CliC Director).
- Polar Feedbacks Workshop, summer 2015.
- Session on the role of jets and non-zonal circulation in the Antarctic at the 2015 International Conference on Southern Hemisphere Meteorology and Oceanography in Chile, in October 2015.
- Polar Prediction School in Abisko, Sweden, in April 2016. Joint with PPP and the Bolin Center.

References

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- * Swart, N. C., J. C. Fyfe, E. Hawkins, J.E. Kay and A. Jahn, 2015: Influence of internal variability on Arctic sea-ice trends, *Nature Climate Change*. In press.

Webpage

<http://www.climate-cryosphere.org/wcrp/pcpi>

Regional Sea-Level Change and Coastal Impacts Grand Challenge

The Grand Challenge on Regional Sea level rise is being led by the CLIVAR core project, but CliC is leading one of the work packages within this overall effort. Specifically, Tony Payne, David Holland, Roderik van de Wal, and Ayako Abe-Ouchi are leading Work Package 2, entitled, “Quantifying the contribution of land ice to near-future sea level rise”. This will build upon previous community efforts like SeaRISE and ice2sea, and will integrate results from ISMIP6 and the global glacier mass balance modelling work undertaken as part of the Cryosphere Grand Challenge. This work package will also exploit linkages to established activities like GRISO (particularly the focus on calving and fjord processes), ice-ocean interactions (notably via MISOMIP), the ISMASS expert group on ice sheet mass balance, the Ice sheet Mass Balance Inter-comparison Exercise (IMBIE, which focused on satellite observations), the CLIVAR Atlantic and Southern Ocean Regional Panels, and the CORDEX Arctic and Antarctic regional foci.

A workplan for the full grand challenge, including the cryosphere pieces should be available sometime in 2015.

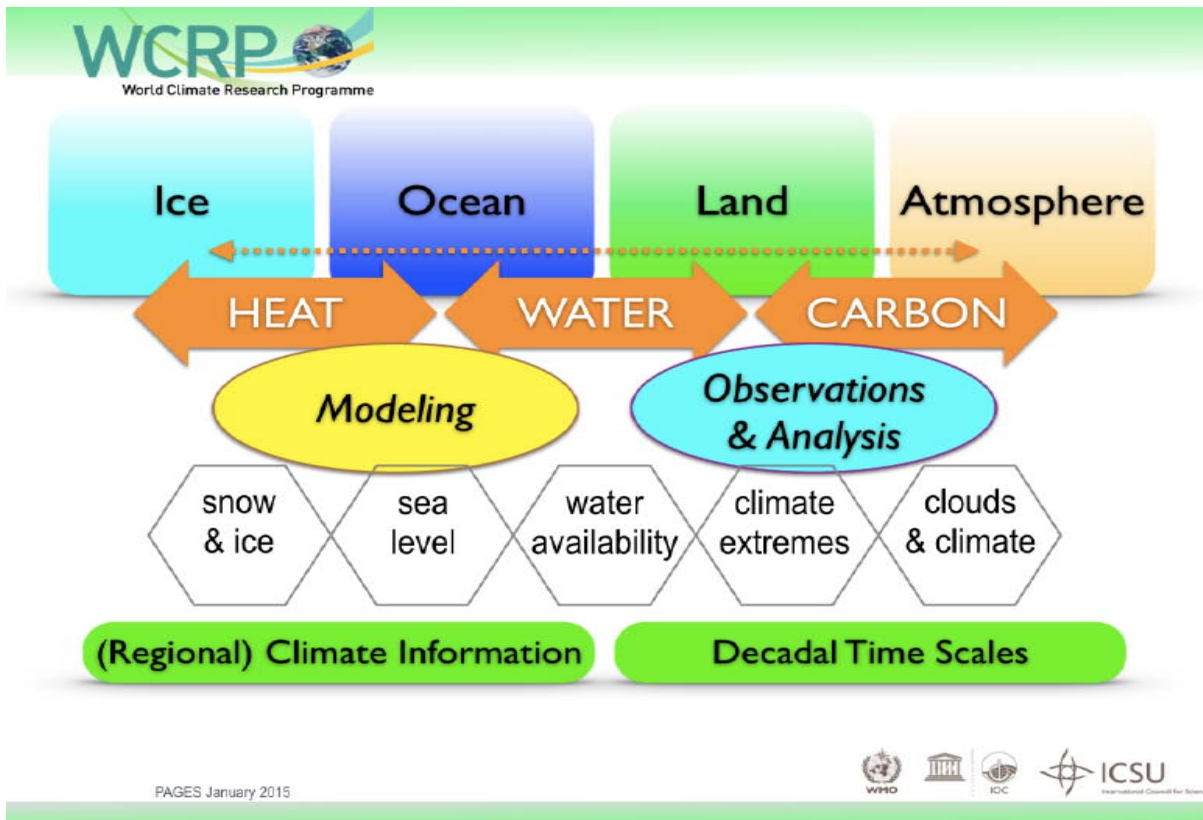


Figure 20. WCRP Grand Challenges Overview. Tentative Diagram. D. Carlson

Emerging Activities and Ideas

In addition to the many new activities that CliC has started in the past few years, several more are developing. Here we summarize just a few.

Shrinking mountain glaciers have become icons of anthropogenic climate change. Although much smaller than the Greenlandic and Antarctic ice sheets, glaciers contribute significantly to current sea level rise, and will continue to be important contributors during the 21st century. They are important regulators of seasonal water availability in many regions, and both growing and shrinking glaciers may cause geohazards. For all these reasons, it is essential to develop accurate predictive tools of the glaciers' response to climate variability and change suitable for regional to global scales. A new targeted activity proposed by Regine Hock and Ben Marzeion is aimed at coordinated, for the first time, efforts to model glaciers (other than the ice sheets) on regional to global scales and make decadal to century scale projections. Activities will include an intercomparison of large scale glacier mass change models including comprehensive uncertainty measures of these estimates. More information on this potential new activity will be made available to the CliC Community in the coming months.

The potential for enhanced release of carbon from thawing permafrost (in the form of either methane or carbon dioxide, both greenhouse gases), is a worrisome source of uncertainty in future climate projections owing to the possibility of a strong, positive warming feedback. The Permafrost Carbon Network, co-sponsored by CliC, pulled together a large modelling community aware of this challenge. It recently carried out an informal model intercomparison project to diagnose key model weaknesses, and to identify some of the major causes of weakness. CliC projects to set up a Permafrost Modelling Forum to provide a basis for this community to continue making progress after this initial determination of the currently insufficient state of the art. It is anticipated that fluid knowledge exchange through such a forum will enable the broader international community to make coherent progress within the next five years. The aim is to implement essential physical and biogeochemical processes related to permafrost in a large range of global climate models, and to eliminate sources of major biases in the existing models, such as incorrect representation of snow (here clear synergies with ESM-SnowMIP exist). It is to be noted that permafrost (carbon) diagnostics will be carried out within the Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP) subproject of CMIP, spearheaded by scientists involved in the definition of the CliC Permafrost Modelling Forum, which will in particular be coordinated with activities at national levels, such as within US SEARCH. This Forum bears resemblance to the CliC Sea Ice and Climate Modelling Forum, but it is limited in time to the Grand Challenge 5-year time frame, within which it is anticipated to provide tangible progress in permafrost modelling.

A number of other potential ideas have been suggested as new targeted activities or areas where a collaboration with the CliC project could add value to other international efforts. We hope that these will continue to develop and encourage the community to contact the CliC leadership with suggestions and ideas.

Links to Other Projects and Groups

2014 has been a productive year for CliC in working with many of our international partners. Below we list just a few of some of the more developed collaborations and relationships, as well as ideas that are just beginning to develop – in no particular order. We welcome more ideas from the community and other organizations to continue to develop our global efforts on enhancing our understanding of the connections between the cryosphere and climate. For a list of acronyms, see Appendix 2.

- * The CliC-lead and initiated Arctic Freshwater Synthesis is co-sponsored by IASC and AMAP. This will be presented to the Arctic Council and is part of ICARP III.
- * IASC and CliC are also co-sponsoring the Linkage Between Arctic Climate Change and Mid-Latitude Weather Extremes project and are in close cooperation on many other activities and events.
- * CliC has recently become a co-sponsor, together with SCAR and IASC for the ISMASS group.
- * SCAR invited CliC to participate in their Horizon Scan activity, which has demonstrated a great deal of interest in new Antarctic research.
- * Together with SOOS we are working on a Southern Ocean Satellite Data Requirements report and paper and CliC helped with the logistics for their annual steering committee meeting in Tromsø in June.
- * In January 2015, ESA and CliC are sponsoring the Earth Observations and Arctic Science Priorities Workshop and planning another conference on Earth Observations and Cryosphere Science in Frascati, Italy from 13-16 May 2016.
- * The IPA and CliC have worked together a lot over this past year on several things including, but not limited to: the Permafrost Research Priorities project, sponsoring the PYRN workshop in Portugal, initiating the creation of a new sub-sea permafrost map, and permafrost carbon activities.
- * ICARP III is an international effort to help set priorities for Arctic Research for the next 10 years and CliC is a proud partner for this effort and sits on the steering committee.
- * CliC's Director was appointed to the Steering Committee for GCW and we hope this will start to bridge some of the gaps between observations and modelling of the cryosphere.
- * CliC is co-sponsoring 2 sessions with IACS at the IUGG 26th Assembly this coming year, and discussions on creating an internationally agreed upon cryosphere glossary are beginning.
- * CliC works with IASC, IACS, ARCUS, SOOS, SCAR, and other groups to maintain the Cryosphere Community Calendar, which brings together all the events happening related to the cryosphere in an automatically updated online calendar.
- * Support for early career researchers is an important component of CliC's activities and part of this is working on various activities with APECS such as the Where Are They Now project, creating FrostBytes, and developing leadership opportunities for enthusiastic early career cryospheric scientists.
- * This year has seen a stronger connection between the CliC project and the WWRP Polar Prediction Project where we have worked together to create a polar prediction mailing list with over 300 subscribers, a joint calendar for polar

prediction events, planning of a Polar Prediction 2 week school in 2016 (together with APECS and others), helping to plan the YOPP Summit for 2016, and more. This has also helped to strengthen the connection between PCPI as it is an important part of the Cryosphere Grand Challenge, and is co-sponsored by SPARC.

- * CliC and GEWEX enhanced collaborations this year through the development of the LS3MIP activity and we hope more joint efforts will continue to come to fruition.
- * A renewed effort spurred by CLIVAR to engage CliC in the Southern Ocean Region Panel activities (joint with CLIVAR and SCAR) is beginning, as well as discussions about CliC's contributions to the cryosphere portion of the Sea Level Grand Challenge. Discussions with CLIVAR, particularly lead by US CLIVAR on fostering stronger collaborations on Greenland Ice Sheet – Ocean Interactions are also underway.
- * CliC also supports Polar Educators International (PEI), an international organization for polar educators, by providing online tools and website hosting, sharing of new science results and other important outreach activities.
- * CliC has active representatives on WCRP's Modelling and Data advisory councils which help to tie together various cross-cutting WCRP efforts.
- * We have been working with the WCRP Working Group on Seasonal to Interannual Prediction (WGSIP) concerning potential links between ESM-SnowMIP and SnowGLACE, a WGSIP activity studying the effect of snow on predictability on seasonal time scales.
- * The CliC SSC co-chairs are ex-officio members of the WCRP Working Group on Coupled Modelling (WGCM). WGCM is organizing CMIP6, and several CliC-led activities (LS3MIP, ISMIP, SIMIP) are being proposed as sub-projects of CMIP6.



Figure 21. ICARP III Steering Group Meeting, Potsdam (Germany), 2014

Capacity Building, Outreach, and Community Services

CliC has a long history of supporting the career development and providing opportunities for early career researchers through their support of the Association of Polar Early Career Scientists (APECS). This tradition continued this year by CliC providing travel support to almost 70 early career researchers, including participation in the CliC Scientific Steering Group meeting. In addition, we have offered opportunities for several young researchers to help lead activities, including the Arctic Freshwater Synthesis, the Permafrost Research Priorities project, and the Southern Ocean Satellite Requirements. CliC is also working with APECS to develop a CliC Fellows program where early career researchers would be actively involved in supporting the development of our targeted activities and be mentored by some of the most successful cryosphere researchers in the world.



CliC has lead the effort to continue to build the APECS' FrostBytes initiative. FrostBytes are 30-60 second sound bytes or videos highlighting

cryosphere research targeted for a general audience. CliC has instituted a policy where people receiving travel funding are required to produce a FrostByte with the help of our volunteer technical video editor. To date over 250 FrostBytes have been produced and are featured on the FrostBytes iTunes podcast channel. More information can be found at <http://www.climate-cryosphere.org/activities/outreach/frostbytes>.

A new resource that the CliC office has been helping groups to use is the GoToMeeting and GoToWebinar system. This online meeting tool is easy to use and works well with low bandwidth. Many groups are now using CliC's service including CliC's own activities, and partners such as PEI, PPP, and AMAP. Interested parties should contact the IPO if they are interested in using this free service.

In addition to the quarterly newsletter that goes out to over 2000 people, CliC has an active Twitter feed with over 1000 followers including scientists, journalists, policy makers, and members of the general public. The Facebook page has over 930 likes and helps to keep connected with the community. CliC also provides an RSS feed used by several partner organizations that pulls together items from the media dealing with the cryosphere. The CliC office also maintains the Cryosphere Community Calendar, which keeps track of meetings and events from several partner organizations as well as other announcements that come across our desktops. The office also set up a similar system for WCRP to bring together all events and news items to facilitate communication between projects. The CliC website also has comprehensive database of reports from various meetings dating back to the late 1990s, presentations and pdfs from workshops and meetings, and generates a list of all recently published cryosphere literature articles.

We are also in the process of expanding our cryosphere projects catalog to join with Iceplan.org (developed by Jenny Hutchings and CASIWG) to serve as a resource where people can find projects on a variety of topics in the cryosphere, as well as keep track of which groups will be in the field and when, to allow for shared data collection and enhanced collaboration. This year we have also started a database of resources of interest to the cryosphere community.

Useful Links:

FrostBytes

<http://www.climate-cryosphere.org/activities/outreach/frostbytes>.

Cryosphere Community Calendar

<http://www.climate-cryosphere.org/meetings/community-calendar>

Cryosphere Projects Catalog

<http://www.climate-cryosphere.org/resources/catalog>

IcePlan (update coming in 2015)

<http://www.iceplan.org/>

Reports, powerpoints, and more

<http://www.climate-cryosphere.org/resources/multimedia>

Recent Cryosphere Literature

<http://www.climate-cryosphere.org/resources/literature>

Cryosphere Resources

<http://www.climate-cryosphere.org/resources/resource-database>



Photo Courtesy of Allen Pope

2015 Workshops and Meetings

In 2014, CliC support provided travel assistance for almost 100 international researchers to help increase our understanding of the connections between the cryosphere and our climate. Unfortunately due to budget cuts from many national programmes and from our main sponsor, the World Climate Research Programme, it is likely that this year will see reduced financial support. However, there are many new and exciting projects that CliC is sponsoring and we are looking forward to another productive year. Below is a list of some of the meetings that are being discussed for this year. Plans for most are just beginning and we encourage anyone interested in more information to contact the CliC Project Office. If you have suggestions for a workshop that CliC should be involved in, please let us know.

11th Session of the CliC Scientific Steering Committee

9-12 February in Boulder, CO, USA

Permafrost Research Priorities Writing Meeting

March in Potsdam, Germany

Gordon Polar Marine Science Conference

March 15-20 in Lucca (Barga), Italy

Polar Prediction Workshop

8-10 April in Reading, UK

Southern Ocean Observing Requirements Writing Meeting

April in Tromsø, Norway

International Conference on Arctic Research Planning III

April in Toyoma, Japan

Constraining Uncertainty in Greenland Surface Mass Balance Models

May 19-20, in Sheffield, UK

ASPeCt Antarctic Sea Ice Workshop

Late Spring / Early Summer, US

Permafrost Carbon Network Meeting

June/July in USA

Year of Polar Prediction Summit

July 13-15 in Geneva, Switzerland

26th International Union of Geodesy and Geophysics (IUGG) General Assembly

June 22 – July 2 in Prague, Czech Republic

Several CliC-sponsored sessions and side meetings planned

Ice Sheet Model Intercomparison Project 6 (ISMIP6) Data Workshop

Summer

Subsea Permafrost Modelling Meeting

Summer in Norway

Land Surface, Snow and Soil Moisture Model Intercomparison Project (LS3MIP)

Fall

Marine Ice Sheet-Ocean Model Intercomparison Project Meeting

Fall, Abu Dhabi, UAE

Arctic Sea Ice Flagship Observatory Workshop

Fall

Polar Coordinated Regional Downscaling Experiment (Polar CORDEX) Annual Meeting

Summer/Fall

South American Glacier Workshop

Fall

Sea Ice and Climate Modelling Forum Annual Meeting

December in Boulder, CO, USA

and more... Check out the meetings page on the CliC website for more information and updates as they develop: <http://www.climate-cryosphere.org/meetings>



Appendix 1: CliC SSG Members, Activity Leaders, and Staff

Name	Affiliation	Project(s)
Ackley, Stephen	University of Texas at San Antonio, USA	ASPeCt/ Technical Comm on Sea Ice Observations
Allard, Michel	Laval Université, Canada	Permafrost Research Priorities/ IPA
Baeseman, Jenny	CliC International Project Office, Norway	Director
Bartsch, Annett	Austrian Polar Research Institute, Austria	DUE Permafrost / IGOS Permafrost Update
Bertler, Nancy	Victoria University of Wellington, New Zealand	SCAR connection
Bitz, Cecilia	University of Washington, USA	Polar Climate Predictability Initiative
Bring, Arvid	University of New Hampshire, USA	Arctic Freshwater Synthesis
Bromwich, David	Ohio State University, USA	Polar Climate Predictability Initiative
Carlson, David	WCRP, Switzerland	WCRP Director
Carmack, Eddy	Depart. of Fisheries and Oceans, Canada	Arctic Freshwater Synthesis
Cassano, John	University of Colorado, USA	Polar CORDEX
Dahl-Jensen, Dorthe	University of Copenhagen, Denmark	CliC Scientific Steering Group
Derksen, Chris	Environment Canada	ESM SnowMIP
Doblas Reyes, Paco	Catalan Institute of Climate Sciences, Spain	WGSIP
Eicken, Hajo	University of Alaska, USA	Arctic Sea Ice Working Group
England, Matthew	University of New South Wales, Australia	CLIVAR/CliC/SCAR Southern Ocean Region Panel
Essery, Richard	University of Edinburgh, Scotland	ESM SnowMIP
Fedorova, Irina	AARI, Otto-Schmidt Laboratory, Russia	Arctic Freshwater Synthesis
Flato, Greg	CCCMA, Environment Canada	CliC SSG (co-chair)/ Cryosphere Grand Challenge/ WGCM/ WMAC
Fugmann, Gerlis	APECS, Norway	Where Are They Now?
Fyfe, John	Environment Canada	Polar Climate Predictability Initiative
Gerland, Sebastian	Norwegian Polar Institute, Norway	Arctic Sea Ice Working Group
Gille, Sarah	Scripps Institution of Oceanography, USA	Polar Climate Predictability Initiative
Goosse, Hugues	University of Louvain, Belgium	Polar Climate Predictability Initiative
Guglielmin, Mauro	Insubria University, Italy	Permafrost Research Priorities/ IPA
Hall, Alex	University of California – Los Angeles, USA	ESM SnowMIP
Hamon, Gwenaëlle	CliC International Project Office, Norway	Executive Officer
Hanna, Edward	University of Sheffield, UK	Arctic Climate Linkages to MidLatitudes/ ISMASS
Hawkins, Ed	University of Reading, UK	Polar Climate Predictability Initiative
Heim, Birgit	AWI, Germany	DUE Permafrost / IGOS Permafrost Update
Hinzman, Larry	University of Alaska Fairbanks, USA	CliC SSG/ Arctic Freshwater Synthesis/ IASC
Hock, Regine	University of Alaska Fairbanks, USA	GlacierMIP
Holland, Denise	New York University, USA	Marine Ice Sheet-Ocean MIP
Holland, David M	New York University, USA	Marine Ice Sheet-Ocean MIP

Name	Affiliation	Project(s)
Holland, Marika	NCAR, USA	Arctic Freshwater Synthesis
Hughes, Nick	Norwegian Ice Service, Norway	Sea Ice Users / IICWG
Hutching, Jennifer	Oregon State University, USA	CASWIG, Technical Comm. on Sea Ice Observations
Instones, Arne	Instones Polar AS	Arctic Freshwater Synthesis
Jahn, Alexandra	University of Colorado, USA	CliC SSG/ Sea Ice and Climate Modelling Forum
Jochum, Markus	Niels Bohr Institute, Denmark	Polar Climate Predictability Initiative
Johansson, Margareta	Lund University, Sweden	CliC SSG/ Arctic Freshwater Synthesis/ Permafrost Research Priorities
Johnson, Rob	Bureau of Meteorology, Australia	Southern Ocean Satellite Requirements
Jones, Julie	University of Sheffield, UK	Polar Climate Predictability Initiative
Karlsson, Johanna Mård	Stockholm University, Sweden	Arctic Freshwater Synthesis
Kang, Shichang	Chinese Academy of Sciences, China	CliC Scientific Steering Group
Kattsov, Vladimir	Voeikov Main Geophysical Observatory, Russia	Cryosphere Grand Challenge
Kay, Jennifer	University of Colorado, USA	Polar Climate Predictability Initiative
Koç, Nalân	Norwegian Polar Institute, Norway	CliC Scientific Steering Group
Kokorev, Vasily	State Hydrological Institute, Russia	Arctic Freshwater Synthesis
Kraev, Gleb	Centre for Forest Ecology and Productivity, Russia	Permafrost Research Priorities / IPA
Krautblatter, Michael	Technical University of Munich, Germany	Permafrost Research Priorities / IPA
Krinner, Gerhard	Glaciology and External Geophysics Laboratory (LGGE), France	CliC SSG (co-chair)/ Permafrost Research Priorities/ ESM SnowMIP/ Permafrost Modelling Forum/ WGCM
Lantuit, Hugues	AWI, Germany	Permafrost Research Priorities / IPA
Larour, Eric	JPL, NASA, USA	ISMIP6
Lemke, Peter	University of Bremen and AWI, Germany	CliC Scientific Steering Group
Lique, Camille	University of Oxford, UK	Arctic Freshwater Synthesis
Lisowska, Maja	Jagiellonian University, Poland	Where Are They Now?
Little, Lorna	CliC International Project Office, New Zealand	Volunteer FrostBytes Editor
Logvinova, Christie	Clark University, USA	Where Are They Now?
MacDonell, Shelley	El Centro de Estudios Avanzados en Zonas Áridas, Chile	South American and Antarctic Glacier Activities
Majaneva, Sanna	University of Helsinki, Finland	Where Are They Now?
Marshall, Gareth	British Antarctic Survey	Polar Climate Predictability Initiative
Marzeion, Ben	University of Innsbruck, Austria	GlacierMIP
Massom, Rob	AAD and ACE, Australia	CliC SSG/ Cryosphere Linkages
Mata, Mauricio	Federal University of Rio Grande-FURG, Brazil	WCRP JSC Liaison
McGuire, David	University of Alaska Fairbanks, USA	Permafrost Modelling Forum
Meier, Walt	NASA, USA	Arctic Sea Ice Working Group/ WMAC
Mernild, Sebastian	Center for Scientific Studies, Chile	CliC SSG/ South American Glacier Activities
Navarro, Paco	Technical University of Madrid, Spain	Ice Sheet Mass Balance and Sea Level
Newman, Louise	SOOS, Australia	Southern Ocean Satellite Requirements
Notz, Dirk	MPI for Meteorology, Germany	Sea Ice and Climate Modelling Forum
Nowicki, Sophie	NASA GSFC, USA	ISMIP6

Name	Affiliation	Project(s)
Ohata, Tetsuo	National Polar Research Institute Japan	CliC Scientific Steering Group/ IASC
Orsolini, Yvan	NILU - Norwegian Institute for Air Research	WGSIP
Overduin, Paul	AWI, Germany	Subsea Permafrost Map
Overland, Jim	NOAA, USA	Arctic Climate Linkages to MidLatitudes/ IASC
Pattyn, Frank	University of Brussels, Belgium	Ice Sheet Mass Balance and Sea Level/ SCAR
Pavlova, Tatiana	Voeikov Main Geophysical Observatory, Russia	CliC Scientific Steering Group
Payne, Tony	University of Bristol, UK	ISMIP6
Perovich, Don	Cold Regions Research Engineering Laboratory, USA	Arctic Sea Ice Working Group
Pope, Allen	NSIDC, Colorado, USA	Southern Ocean Satellite Requirements
Prowse, Terry	Environment Canada	Arctic Freshwater Synthesis
Rachold, Volker	IASC	Arctic Freshwater Synthesis
Raphael, Marilyn	University of California, Los Angeles, USA	ASPeCt/ Polar Climate Predictability Initiative
Reiersen, Lars-Otto	AMAP	Arctic Freshwater Synthesis
Renwick, James	Victoria University of Wellington, New Zealand	Polar Climate Predictability Initiative/ WCRP JSC Liaison
Rinke, Annette	AWI, Germany	Polar CORDEX
Ritz, Catherine	LGGE, France	Ice Sheet Mass Balance and Sea Level
Romanovsky, Vladimir	University of Alaska Fairbanks, USA	Permafrost Modelling Forum
Rott, Helmut	Austrian Polar Research Institute, Austria	ESM SnowMIP
Ryabinin, Vladimir	WCRP, Switzerland	WCRP JPS
Saito, Kazuyuki	JAMSTEC/IARC	Permafrost Modelling Forum
Scaife, Adam	UK Meteorological Office	WGSIP
Schädel, Christina	Northern Arizona University, USA	Permafrost Carbon Network
Schollän, Karina	IPA, Germany	Permafrost Research Priorities / IPA
Schuur, Ted	Northern Arizona University, USA	Permafrost Research Priorities / Permafrost Carbon Network/ Permafrost Modelling Forum
Screen, James	University of Exeter, UK	Arctic Freshwater Synthesis
Sharp, Martin	University of Alberta, Canada	IASC connection
Shepherd, Ted	University of Reading, UK	Polar Climate Predictability Initiative
Sjöberg, Ylva	Stockholm University, Sweden,	Permafrost Research Priorities / CliC Fellow
Sturm, Matthew	University of Alaska, USA	ESM SnowMIP
Sueyoshi, Tetsuo	National Institute for Polar Research, Japan	IASC Cryosphere WG
Svensson, Gunilla	Stockholm University, Sweden	Polar Climate Predictability Initiative
Talley, Lynne	University of California - San Diego, USA	CLIVAR/CliC/SCAR Southern Ocean Region Panel
Vihma, Timo	Finnish Met Institute, Finland	Arctic Freshwater Synthesis
Wagner, Penelope	Norwegian Ice Service, Norway	IICWG/ Southern Ocean Satellite Requirements
Walsh, John	University of Alaska, USA	Arctic Freshwater Synthesis
Wrona, Fred	University of Victoria, Canada	Arctic Freshwater Synthesis
Yamamoto-Kawai, Michiyo	Tokyo University of Marine Science and Technology, Japan	Arctic Freshwater Synthesis

Appendix 2: Acronyms and Glossary

AACA: Arctic Council Adaptation Actions in a Changing Arctic Section
ADAPT: Arctic Development and Adaptation to Permafrost in Transition
AFS: Arctic Freshwater Synthesis
AGU: American Geophysical Union
AMAP: Arctic Monitoring and Assessment Programme
AOGCM: Atmosphere-Ocean General Circulation Model
APECS: Association of Polar Early Career Scientists
ARCUS: Arctic research Consortium of the United States
ASIW: Arctic Sea Ice Working Group
ASPeCt: Antarctic Sea Ice Processes and Climate
AWI: Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Germany
AWS: Automatic Weather Stations
C4MIP: Coupled Climate Carbon Cycle Model Intercomparison Project
CanRCM4: CCMA Canadian Regional Climate Model
CAPP: Carbon Pools in Permafrost
CCMA: Canadian Centre for Climate Modelling and Analysis
CEN: Centre d'Etudes Nordiques
CHARS: Canadian High Arctic Research Station
CLIVAR: Climate and Ocean – Variability, Predictability and Change
CLIVAR WGOMD: CLIVAR Working Group on Ocean Model Development.
CMIP: Coupled Model Intercomparison Project
COAWST: Coupled-Ocean-Atmosphere-Wave- Sediment Transport
COPD: Coastal and Offshore Permafrost Dynamics Working Group at EUCOP 4
COSMO-CLM: COnsortium for Small scale MOdeling- Climate Limited-area Modeling
DMI: Danish Meteorological Institute
DUE: Data User Element
ECV: Essential Climate Variable
EGU: European Geosciences Union
Eos: Premier international magazine of the Earth and space sciences (AGU magazine)
ERS: Early career researchers
ESA: European Space Agency
ESA CCI: ESA Climate Change Initiative
ESM: Earth System Models
EUCOP 4: Fourth European Conference on Permafrost
FMI: Finnish Meteorological Institute
GEWEX: Global Energy and Water Exchanges
GCM: Global Climate Model
GCW: Global Cryosphere Watch
GINA: Geographical Information Network of Alaska
GLACE: Global Land Atmosphere Coupling Experiment
GMD: Geoscientific Model Development
GrIS: Greenland Ice Sheet
GSWP3: 3rd phase of the Global Soil Wetness Project
GTN-P: Global Terrestrial Network for Permafrost
HYCOM: HYbrid Coordinate Ocean Model

IASC: International Arctic Science Committee
ICARP III: Third International Conference on Arctic Research Planning
ICSU: International Council for Science
IGOS: Integrated Global Observing Strategy
IGS: International Glaciological Society
IMO: International Maritime Organization
IOC: International Oceanographic Commission
IPA: International Permafrost Association
IPCC: Intergovernmental Panel on Climate Change
IACS: International Association of Cryospheric Sciences
IARC: International Arctic Research Center
IASC: International Arctic Science Committee
ice2sea: Project on estimating the future contribution of continental ice to sea-level rise
IMB: Ice Mass Balance
IPCC AR: Intergovernmental Panel on Climate Change Assessment Report
ISAR-4: Fourth International Symposium on the Arctic Research
ISMAS: Ice Sheet Mass Balance and Sea Level
ISMIP: Ice Sheet Model Intercomparison Project
ISSM: Ice Sheet System Model
IUGG: International Union of Geodesy and Geophysics
JGR: Journal of Geophysical Research
KNMI: Royal Netherlands Meteorological Institute
LFMIP: Land Feedbacks in an integrated framework MIP
LMIP: Land Model Intercomparison Project
LS3MIP: Land Surface, Snow and Soil moisture MIP
LUMIP: Land Use Model Intercomparison Project
MAR: Modèle Atmosphérique Régional
MCE: Norwegian Ministry of Climate and Environment
MFA: Norwegian Ministry of Foreign Affairs
MIP: Model Intercomparison Project
MISOMIP: Marine Ice Sheet Ocean Model Intercomparison Project
MOSAic: Multidisciplinary drifting Observatory for the Study of Arctic Climate
NAOSIM: North Atlantic/Arctic Ocean Sea Ice Model
NASA GSFC: NASA's Goddard Space Flight Center
NASA JPL: NASA Jet Propulsion Laboratory
NICOP: Ninth International Conference on Permafrost
NOAA: National Oceanic and Atmospheric Administration
NPB: Networked Profiling Buoy
NYU: New York University
Obs4MIPs: Observations for Model Intercomparison Projects
OCB workshop: Ocean Carbon & Biochemistry workshop
OGCMs: Ocean General Circulation Models
OMDP: Ocean Model Development Panel
PAGE21: Changing Permafrost in the Arctic and its Global Effects in the 21st Century
PCPI: WCRP Polar Climate Predictability Initiative
PEI: Polar Educators International
Polar CORDEX: Coordinated Regional Downscaling Experiment - Arctic and Antarctic Domains
PPP: Polar Prediction Project

PYRN: Permafrost Young Researchers Network
RACMO2: Regional Atmospheric Climate Model
RASM: Regional Arctic System Model
RCA4: SMHI Rossby Centre regional Atmospheric model
RCAO: Rossby Centre Atmosphere Ocean
RCM: Regional Climate Model
RCP: Representative Concentration Pathway
SAON: Sustaining Arctic Observing Network
SC: Steering Committee
SCAR: Scientific Committee on Antarctic Research
SCOR-BEPSII: Scientific Committee on Oceanic Research Working Group on
Biogeochemical Exchange Processes at the Sea-Ice Interfaces
SEARCH: Study of Environmental Arctic Change
SeaRISE: Sea-level Response to Ice Sheet Evolution
SICCI: ESA CCI Sea Ice ECV project
SMB: Surface Mass Balance
SMHI: Swedish Meteorological and Hydrological Institute
SMI: Snow Model Intercomparison
SORP: CLIVAR/CliC/SCAR Southern Ocean Region Panel
SnowModel: Distributed Snow-Evolution Modeling System
SnowPEX: Satellite Snow Product Inter-comparison & Evaluation Exercise
SOCCOM: Southern Ocean Carbon and Climate Observations and Modelling
SOOS: Southern Ocean Observing System
SOM: Soil Organic Matter
SPARC: Stratospheric Processes and their Role in Climate
SSG: Scientific Steering Group
SuPerMAG: Subsea Permafrost Mapping Action Group
SVP: Surface Velocity Program
SWIPA: Snow, Water, Ice, Permafrost in the Arctic
THAW 2014: Thermokarst Aquatic Ecosystems Workshop
UNESCO: United Nations Educational, Scientific and Cultural Organization
USIPAB: US Interagency Program for Antarctic Buoys
WAGOM: West Antarctica Glacier-Ocean Modelling
WAIS: West Antarctic Ice Sheet initiative
WCRP: World Climate Research Programme
WDAC: WCRP Data Advisory Council
WGNE: WCRP Working Group on Numerical Experimentation
WGSIP: WCRP Working Group on Seasonal to Interannual Prediction
WGCM: WCRP Working Group on Coupled Modelling
WMAC: WCRP Modelling Advisory Council
WMO: World Meteorological Organization
WMO PSTG: WMO Polar Space Task Group
WP: Work Package
WRF model: Weather Research and Forecasting Model
WWRP: World Weather Research Programme



*Og når alt er forbi
høres ingenting lenger
Ingenting
og det høres.*

*Nils-Aslak Valkeapää
Solen, min far*

In Memoriam

Heidi Isaksen

CliC Administrative Officer from 2012-2014





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