11th Session of the WCRP Climate and Cryosphere Scientific Steering Committee

Meeting Report

9 – 12 February 2015 in Boulder, Colorado, USA

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Compiled by:
Alice Bradley
Christina Schaedel
Jenny Baeseman
Gwénaëlle Hamon

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Welcome

CliC Co-chair Greg Flato from Environment Canada opened the 11th Session of the Climate and Cryosphere Project (CliC) on Monday, February 9, 2015, at the US National Center for Atmospheric Research (NCAR) in Boulder, Colorado, USA, by welcoming the participants present at the meeting and thanking NCAR for hosting it.

CliC SSG member Alex Jahn from the University of Colorado and former NCAR scientist welcomed the participants as well and presented the programme for the week. Dr Jahn hosted the meeting and her help was key to its success.

Dr Bette Otto-Bliesner of the NCAR Climate and Global Dynamics Division (CGD) gave her welcome on behalf of the Division Director Bill Large. She expressed how delighted NCAR and the CGD were to host the CliC SSG 11. She then presented the background vision and the mission statement of the CGD, which hosts 100 scientists and experts. The work of the Division is focused on atmosphere, sea ice, ocean, climate analysis and terrestrial sciences. Dr Otto-Bliesner stressed that the CGD has a strong interest in polar science, notably through its Paleoclimate Working Group, which focuses on climate and the cryosphere among other topics. She noted that many of the topics discussed during the CliC SSG were relevant to the work being done by the Division.

Dr Marika Holland from the NCAR CGD, who hosted the CliC SSG 11 meeting together with Alex Jahn, expressed how wonderful it was that the meeting was held at NCAR. She stressed that a lot of the CGD activities under the Community Earth System Model (CESM), that comprises twelve working groups (WGs), touches on cryospheric science. In this regard, she particularly mentioned the Polar Climate WG, the Ocean WG, Land Ice WG, the Land Model WG, the Paleoclimate WG, and the Climate Variability and Change WG. Marika Holland invited the SSG participants to get involved in the work of the various WGs.

CliC 2014 Overview

CliC co-chair Greg Flato gave an overview of CliC activities in 2014. After a brief introduction of the three other WCRP core projects (GEWEX, CLIVAR and SPARC), Dr Flato thanked the Norwegian Polar Institute for hosting the CliC International Project Office (IPO) in Tromsø, Norway.

Dr Flato outlined the CliC structure and emphasized the role of the Scientific Steering Group and the IPO. He then listed and briefly introduced the ongoing CliC activities such as the Antarctic Sea Ice Processes and Climate group (ASPeCt), the Arctic Sea Ice Working Group, the Polar Climate Predictability Initiative (PCPI), the Permafrost and Climate Modelling Forum, the Ice Sheet Mass Balance and Sea Level Expert Group (ISMASS), and the Sea Ice and Climate Modelling Forum. The limited-lifetime targeted activities under CliC's umbrella were also introduced such as the Arctic Freshwater Synthesis, the Antarctic Ice Sheet/Ocean Interactions, the ESM Snow Model Intercomparison, the ESM Ice Sheet Model Intercomparison, the Polar CORDEX Analysis/Arctic Regional Climate Scenarios, the Polar Jet Stream Variability and Extremes, the Improved Mass Balance Estimation, and the Carbon Cycle Feedbacks in a Changing Arctic Climate. Dr Flato also mentioned that the Glacier Mass Balance Model Intercomparison Project (GlacierMIP) is being launched and will make use of the CMIP output to drive global glacier mass balance models. The Cryosphere in a Changing Climate WCRP Grand Challenge (GC), as well as other GCs that CliC is contributing to, were also briefly presented.

The CliC website (www.climate-cryosphere.org) was also featured in this overview presentation, and participants were encouraged to watch the Frostbytes, 30-60 second videos of research activities geared toward a general audience, that CliC has been producing. CliC has been very active in supporting a total of 25 workshops, as well as conducting many outreach and community-building efforts.

Dr Flato also took the opportunity in his opening presentation to present the 2014 Annual Report, that the CliC IPO produced for the first time with the contribution of the CliC Leadership Group. The co-chair emphasized that CliC wants to continue this practice of producing a comprehensive report of activities each year, following the example of its sister project in WCRP, SPARC. As budget pressures inevitably arise, it is important that CliC conveys clearly and convincingly what has been accomplished and why it is important. Dr Flato also reiterated that a CliC Action Plan also covers the period 2015-2020 and will be useful in conveying what CliC is about, and in guiding/prioritizing the key activities.

Greg Flato concluded that it has been a year of challenges for CliC, marked by the sad loss of Heidi Isaksen, CliC's administrative officer. Nevertheless, the CliC project has made very visible progress and is building momentum on a number of fronts. He pointed that WCRP-wide budget cuts will necessarily have an impact, but that hopefully CliC can continue to augment these resources through strategic partnerships and other funding opportunities.

During the discussion, the question of the link between the Permafrost Carbon Network (PCN) and the Permafrost and Climate Modelling Forum was raised. It was stressed that PCN is a standalone entity but that there are connections between the two initiatives. Participants also discussed the future of CliC and the other core WCRP projects in terms of reviews and extensions. Co-chair Greg Flato responded that the WCRP Joint Scientific Committee has been assessing the programme for the last three years with a view to what should be changed, and that this process has led to some changes (not only in names). However, he stressed that the projects cover what is in the WCRP mandate and that it did not make sense to change this structure since it has so far worked well. He also stressed that the Grand Challenges are a great addition to the programme. WCRP Director Dave Carlson emphasized that the programme is not necessarily robust ("a fragile house of cards" in Dave's word), and depends for its health and vigor on the enthusiasm of the community. WCRP oversees the four core projects (covering land, ocean, atmosphere and cryosphere), several cross-cutting working groups and works to facilitate linkages and synergies between them. The community should start to think about what will happen to CliC after 2018, which is when the commitment from the Norwegian Polar Institute to host the office will end. Participants also stressed that refocusing on the Cryosphere GC has been an appropriate activity and that the CliC IPO has been adapting to budget cuts really well by collaborating with the International Arctic Science Committee (IASC) and the Arctic Monitoring and Assessment Programme (AMAP) in 2014.

CliC Director Jenny Baeseman started by extending her appreciation for the thanks coming from the meeting participants but that the success of CliC comes from the work of the community. When she began at the CliC office in the spring of 2012, the IPO was only working on two activities. Today, more than 20 activities are under CliC's umbrella. The Arctic Freshwater Synthesis was one of the first activities that Dr Baeseman started thanks to the instigation from Terry Prowse and, after writing and submitting a proposal, the IPO received a grant from the Norwegian Ministry of Foreign Affairs to carry it forward.

Today, the CliC IPO is trying to work closely with partners to leverage resources and avoid duplication. CliC should be continuing to build its strong unique focus, as well as use developing technology to streamline day-to-day procedures. This is being done effectively on

the CliC website with the Cryosphere Community Calendar and other tools that are extensively used not only by CliC but also by other cryosphere/climate organizations. In 2014, CliC helped to organize 25 workshops. In addition, CliC provided travel funds for 93 participants to attend these meetings, 67% of which were early-career scientists – most participants fund their own travel. The CliC IPO works a bit differently than the other three WCRP core projects in the sense that it has Letters of Agreement with WCRP to manage the funding of activities through the IPO instead of the WCRP Joint Planning Staff. This leads to more freedom in workshop organization and the IPO, because it does not have to operate under all of the sometimes cumbersome and strict United Nations rules. However, this does means more work for the Office. The CliC Director expressed that she hopes that workshop funds can continue to be handled through the IPO, but that additional staff support is needed to continue coordinating the number of activities the project is running.

Currently, in addition to all the activities already mentioned, the Project Office is working with the European Space Agency (ESA) to organize another meeting in 2016 on Cryosphere Research Priorities. The IPO still continues the community calendar, Cryonews, various mailing lists, a reports archive, and the website and newsletters as well as maintaining the Projects catalog. Today, CliC counts more than 1000 Twitter followers and almost 1000 Likes on Facebook. To date, CliC has produced around 200 Frostbytes and has supported more than 250 online meetings through GoToMeeting that the CliC Office is paying for. These efforts have been very well received by the wider community.

The CliC Director also talked about the human resources invested in the IPO in addition to the two full-time positions at the office. She thanked WCRP Director Dave Carlson, WCRP Senior Scientist Vladimir Ryabinin, CliC Co-chairs Greg Flato and Gerhard Krinner, former administrative officer Erik Warming, Frostbytes Editor Lorna Little (volunteer), and Gwen Hamon (new executive officer) for their help and support to the CliC IPO. Dr Baeseman also reiterated that this year was marked by the very sad passing of Heidi Isaksen, the Administrative Officer in the CliC Project Office.

The CliC Director informed the meeting participants that her own position will be advertised in the Fall of 2015 because her contract is up, and that Executive Officer Gwenaelle Hamon's position is currently only for one year. In addition, Vladimir Ryabinin is leaving WCRP in Spring 2015. She also mentioned that the CliC Co-chairs' terms are up soon (end of 2015) as well as a number of SSG members and that ensuring the continuity of knowledge is something that the CliC Leadership has to start thinking about.

After these overview talks, there was a series of presentations on the CliC activities, intermixed with presentations on related activities sponsored by other organizations. More detailed updates from the CliC groups can be found in the 2014 Annual Report.

Sea Ice Activities

Hajo Eicken presented an update on the CliC Arctic Sea Ice Working Group (CASIWG) on behalf of Don Perovich, the group chair. CASIWG is in the process of implementing formalized terms of reference and is recruiting new members to its steering group in order to increase diversity of representation. The group is continuing its efforts in integrating observations, establishing observing protocols, and fostering modeling efforts. One major effort, led by Jenny Hutchings, is to "standardize, publicize, and utilize" ship-based sea ice observations through the Ice Watch system.

Plans for 2015 include:

- continued involvement in the Sea Ice Prediction Network (SIPN);
- work on development of international standards for satellite measurements of the cryosphere;
- support of planning efforts for the MOSAiC campaign and YOPP;
- support of model development for sea ice processes including snow on sea ice;
- designation of flagship observatory sites, including work with Russian colleagues and coordination with the Global Cryosphere Watch (GCW);
- workshop on Arctic sea ice processes; and
- support for the Arctic Expeditions website.

Discussion following the presentation focused on the flagship observatory sites, with several additional field sites suggested as candidates. The GCW programme already has CryoNet established, and is working on measurement best practices at these sites. A connection between these various observation networks would be beneficial.

Marilyn Raphael gave an update on the SCAR/CliC Antarctic Sea Ice Processes and Climate (ASPeCt) which aims to improve the understanding of Antarctic sea ice through field programs, remote sensing, and modeling, and coordination of collection, analysis and archiving of in situ sea ice observations. In 2014, ASPeCt finalized development of data acquisition software for ship-based observations, and it is slated for public release later in 2015. A joint subgroup was formed with CASIWG in order to keep observation methods consistent between the Poles and reduce duplication of efforts. The group met at the meeting in Hobart, Tasmania and drafted a new science implementation plan, as well as a contribution to the SCAR Horizon Scan initiative. Dr Raphael also outlined an NSF-funded focusing on the Terra Nova Bay and Ross Ice Shelf polynyas with the *NB Palmer* in 2017.

In the future, ASPeCT plans to work more closely with the Sea Ice and Climate Modeling Forum in order to maximize the use of observations for informing sea ice components to climate models. The ship software prototype will be further tested, as well as improved for use with autonomous vehicles. ASPeCt is also involved in planning and participation in the Antarctic Sea Ice Workshop, tentatively scheduled for 2015 and coordinated by the US National Academy of Science.

Discussion after the presentation included how ASPeCt is linking observations of sea ice into the modeling community, which was described as an ongoing challenge that more effort will be put towards in the coming years. Additionally, the Southern Ocean (Regional) Panel was identified as having similar interests, and the two groups interact primarily through SOOS.

Alexandra Jahn shared information on the new CliC Sea Ice and Climate Modeling Forum that started from the CliC SSG 10 meeting in 2014. The Sea Ice and Climate Modeling Forum aims to facilitate model development, improve communication between model developers, and to facilitate the information exchange between the observational and modeling sea ice communities, with the goal to improve sea ice models and the availability of observational for model validation and development. They organized a successful one-day workshop on large-scale sea ice simulations in 2014, and have initiated the Sea Ice Model Intercomparison Project (SIMIP), which is a proposed diagnostic Model Intercomparison project for CMIP6 that aims to compile the sea ice variable data request. The inital variable list and guidelines were submitted to the CMIP6 process shortly before the SSG meeting, and will be finalized by mid-June. The 2014 Sea Ice and Climate Modeling Forum workshop also included a discussion of observational needs, which is one area that needs additional work. A second workshop will focus on bringing together sea ice observational scientists and modelers to discuss this topic.

Discussion identified an opportunity for collaboration with the Obs4MIPS project and the need for clear documentation on how models work with regard to cryosphere processes. A suggestion that observational scientists “take a modeler to the field” was met with much enthusiasm and many jokes.

Walt Meier gave the group an update on the Sea Ice Prediction Network (SIPN), which is a U.S. interagency-supported project to improve coordination of sea ice prediction, particularly on seasonal time scales, by facilitating dialog and cooperation on prediction studies. It builds and expands on the Sea Ice Outlook project, which began in 2008 as an ad hoc group predicting the Arctic September minimum sea ice extent. SIPN provides a formal structure through SIPN (coordinated by ARCUS) to: coordinate predictions; guide observations for model initialization and evaluation; synthesize and evaluate predictions and observations; and disseminate predictions and engage key stakeholders.

During 2014 (1-2 April), SIPN hosted a workshop at NCAR that brought together the Arctic sea ice prediction community to discuss plans for the coming year and ideas to improve coordination. SIPN also managed the 2014 Sea Ice Outlook. This past year, there were a total of 88 contributions, with 24 to 28 per month for June through August. SIPN expanded Outlook activities this year by providing ‘perfect model’ sensitivity tests, and encouraging the submission of spatial maps of concentration forecasts and a more thorough analysis of model predictions. During the year, an analysis of prediction skill from the Outlook was published in Geophysical Research Letters. The year ended with an informal wrap-up workshop during the AGU Fall Meeting.

Discussion followed the SIPN talk. The group has looked at extending the forecasts, but is limited by available resources for the time being to seasonal. The 2-3 year outlook is a goal as the project continues. Antarctic sea ice prediction is also an area of much interest, but contingent on modeling groups having the resources and interest to dedicate to the task. Stakeholder needs were also brought up – for the time being, SIPN is a research project, but the operational applications are noted and will be reconsidered as model skill improves.

Following the specific talks, a group discussion on sea ice activities within CliC ensued. Within the sea ice community, there is a big chasm between the observational scientists and modelers. One aspect that CliC should strengthen, especially through its working groups on sea ice, is coordination and cooperation between the two communities. The need for this cooperation is increasingly being recognized in both fields, and some progress has been made, albeit slow.

Some within the modeling community are especially concerned about understanding uncertainty in observational quantities, something that can definitely be better communicated in language approachable to those outside observational science. Not discussed as much, but still important in this conversation, are the differences between in situ and remote sensing observations. Future workshops addressing the disconnect between the observational and modeling communities will do well to include representation from the in situ and remote sensing communities in order to cover both process measurements and the types of global or long-time series measurements needed for initialization and validation of models. A example of good coordination between observational and modeling communities is provided by the permafrost community, where in situ observational data sets are synthesized internationally to become more useful in the broader study of a changing cryosphere.

The group emphasized the role of CliC (and its working groups) as a platform for facilitating communication between individual (laboratory) and national and international efforts. A specific need to keep communication clear and open between the observational and modeling communities was again emphasized. Merely having some observational component to a MIP is not sufficient to engage the observational community; the titles of workshops or activities need to clearly convey that the effort is not limited to modelers.

The discussion continued to the general state of sea ice modeling. Communication between SIPN and CliC was deemed adequate because of the high number of common members. Increased skill at intermediate timescales (between seasonal and decadal) is a particular area of interest, and issues of model weighting in ensemble studies were brought up.

Hajo Eicken gave the group an update on the Study of Environmental Arctic Change (SEARCH) programme, which is a U.S. effort that seeks to provide a foundation of Arctic change science through collaboration with the research community, funding agencies and stakeholder community. While SEARCH has been active for well over a decade, it is now in the early stages of a 5-year implementation strategy (www.arcus.org/search-program) that focuses on the following four science goals:

- Improve understanding, advance prediction, and explore consequences of changing Arctic sea ice;
- Document and understand how degradation of near-surface permafrost will affect Arctic and global systems;
- Improve predictions of future land-ice loss and impacts on sea level; and
- Analyze societal and policy implications of Arctic environmental change.

Three Action Teams are targeting the first three goals, with the fourth goal addressed by the SEARCH programme as a whole. Given the key role of the cryosphere in the complex of rapid Arctic change currently underway, there are a number of potential linkages between CliC and SEARCH that can be further developed. These include international collaboration on specific Action Team activities such as the Sea Ice Prediction Network (www.arcus.org/sipn). Developing plans and best practices for coordinated long-term observations of the cryosphere to inform modeling and responses to Arctic change is important to both CliC and SEARCH. Here, participation by CliC in the Arctic Observing Summit (15-18 March 2016, Fairbanks, AK, USA) and collaboration on the development of (flagship) cryospheric observatory activities that tie into SEARCH may be of interest.

Permafrost and Freshwater Activities

The next section of the meeting was dedicated to permafrost activities within CliC. Ted Schuur gave an update on the Permafrost Carbon Network, which started out as an NSF-funded Research Coordination Network in 2011 and has successfully grown from 45 members to more than 230 members in 2015. The core group of the network includes 20 people and meets every year around May for a workshop where current synthesis work gets presented, new ideas discussed and a road map is outlined for future activities and goals. CliC has supported participation of early-career scientists in those meetings. In addition to those smaller workshops, the Permafrost Carbon Network hosts a one-day annual meeting the day before AGU in San Francisco that is open to all members of the network; this attracted more than 90 participants in 2014. At the 4th annual meeting (14th December 2014), the working group leads gave updates on past and ongoing synthesis work which was followed by breakout sessions in the afternoon that focused on: a) modeling, benchmarking and possible CMIP6 activities; b) Arctic coastal processes and Yedoma region carbon pools;

c) thermokarst upscaling; and d) aerobic and anaerobic upscaling using a pan-Arctic thermal scaling approach.

Every year, multiple new publications come out under the umbrella of the Permafrost Carbon Network and one highlight of 2014 was a review paper led by Ted Schuur with the title 'Climate Change and the Permafrost Carbon Feedback' which was in press at Nature at the time of the SSG meeting.

At the end of 2014, the Permafrost Carbon Network became part of SEARCH and the Permafrost action team. This action team has the following science goal: to 'document and understand how degradation of near-surface permafrost will affect Arctic and global systems'. The action team is just starting out and looking for people to engage in the steering committee; it's open for nomination and interested people can contact Ted Schuur.

The main activities of the Permafrost Carbon Network for 2015 were presented as following:

- 2-day workshop for leads/co-leads held in May 11-12, 2015 in Flagstaff, AZ. This workshop aims at planning and initiating new synthesis activities, inviting new core participants and working on proposals to get additional funding as some of the research ideas need the full time commitment of a postdoc.
- 5th Annual Meeting the day before AGU (December 13th).
- Session chair at 'Our Common Future under Climate Change' (July 7-10, 2015 in Paris) about biogeochemical feedbacks to climate change. This is an important outreach activity for disseminating the importance of permafrost carbon issues to climate change to the wider science community as well as to stakeholders and policy makers.

Discussion revolved around the importance of increasing our understanding of permafrost carbon and incorporating observations into global climate models. It was noted that this is an important part of the Cryosphere Grand Challenge and that it should be strengthened in the draft work plan. The importance of permafrost carbon needs to be addressed in a way that it becomes important to not just scientists. Stakeholder interests so far are on degrading permafrost and the engineering aspects of it, but we also need to strengthen visibility of the carbon feedback from permafrost.

Dr Schuur continued with information on the new Permafrost Modeling Forum that is a joint effort of the Permafrost Carbon Network, CliC and SEARCH. People involved are Drs D. McGuire, G. Krinner, K. Saito, D. Lawrence and C. Koven. The overall goal is to improve the modeling of permafrost and carbon dynamics in the northern permafrost region. This involves three elements:

- making the Earth system modeling community more aware of deficiencies in the application of Earth system models to the northern permafrost region (analysis of CMIP6 datasets 2016, 2017; LS3MIP, C4MIP);
- developing benchmarking data sets that can effectively be used to segregate poorly-performing models from models that better represent conceptual and parameterization uncertainties (C4MIP); and
- conducting coordinated model experiments that can be used to identify model deficiencies and improve parameterizations.

These steps are designed to improve interactions of the permafrost modeling community with both the larger Earth system modeling community and the empirical community in the permafrost region.

The final permafrost activity presented by Dr Schuur was the Permafrost Research Priorities (PRP) process, which aims to define research priorities for the next ten years in permafrost

science and engineering. This is a transparent process based on the engagement of the permafrost science and engineering communities. It's embedded in various international efforts and supported by several international organizations (CliC, IASC etc.). Lead people involved in this activity are H. Lantuit, M. Allard, M. Guglielmin, M. Johansson, G. Kraev, M. Krautblatter, G. Krinner, T. Schuur, Y. Sjöberg, J. Baeseman and K. Schollän.

The aim of PRP is to target policy-makers and funding agencies, and it is connected with ICARPIII. The PRP process involves input from the community to identify the most important research priorities. The current state of the PRP is to consolidate the questions submitted by the community and then send them out again for ranking by the permafrost research community. Following that, a white paper will be written and released, hopefully in April.

Details of the PRP were reported, and are summarized as: about 300 participants responded to the call, from 37 countries and 79% of whom had a PhD as their highest academic degree. The respondents have a wide range of areas of primary expertise with the most common being geomorphology, ecology, engineering and infrastructure and climate change and the least common being industrial development and impacts, land use and community planning and mapping.

An update on the Arctic Freshwater Synthesis was presented by Larry Hinzman, which highlighted the involvement of early-career scientists. The end product is a special issue of the Journal of Geophysical Research (due for publication in March). There will be a session (C7) on 'Arctic freshwater system, changes and effects with emphasis on Arctic freshwater ecosystems' at the ICARP III / Arctic Science Summit Week in Toyama, Japan, April 28, 2015. A layman's report will be prepared, summarizing key findings. The production of that report will commence in May and a professional science writer will meet with component leads in May-June of 2015 to discuss details of the report.

The following further emerging science recommendations were discussed:
- long-term monitoring of upper-ocean state at key Arctic Ocean gateways;
- satellite-based monitoring of freshwater and heat distributions and fluxes;
- expanded knowledge of cross-component interactions;
- improved parameterization of freshwater and heat flux mechanisms;
- sustained and change-adapted monitoring of water flow and water constituents in Arctic rivers;
- bridging gaps between local hydrological process studies with regional and continental observations and modeling; and
- improved understanding of water and energy fluxes in changing Arctic landscapes.

The outlook for 2015-2017 was presented with the following foci:
- results from AFS will be synthesized and provided as a contribution to ICARPIII;
- AFS special issue papers are about to be published;
- policy and science recommendations carried forward by IASC, CliC and AMAP; and
- US Arctic Council chairmanship will prioritize freshwater and may also carry AFS legacy forward.

Additionally, a short update was given on the US efforts to prioritize Freshwater Security during their term as chair of the Arctic Council. AFS could serve as the basis for a first-ever comprehensive Arctic freshwater assessment, perhaps during the Finnish chairmanship.

Cryosphere Linkages and Connections

The next section of the meeting dealt with linkages, and Ed Hanna first provided an overview of the research highlights within the field of linkages between Arctic climate change and mid-latitude weather extremes. Attribution of increasing weather extremes to Arctic climate change was discussed, and a potential chain of events to explain this phenomenon was presented. The warm-Arctic cold-continents hypothesis suggests that this may be the case, but there are insufficient data at the moment to make a clear attribution with conventional statistical methods. The community can make progress with the hypothesis that linkages are regional, episodic, and based on amplification of existing weather patterns such as Greenland blocking and the Siberian High. The field is in what can be described as a pre-consensus period on the topic, though consensus may be improving, facilitated by recent conference sessions on the subject.

A request was made to hold a small writing workshop for experts on the topic (i.e., changing cryosphere as the driver of extreme weather), but group discussion determined that the group might be more successful by working closely with SPARC's working group on storm tracks. Atmospheric dynamics are crucial to understanding the mechanisms of this correlation, and the cryosphere community cannot fully address the question without strong collaboration with the atmospheric dynamics community.

Andrew Slater gave an update on the new Earth System Model Snow Model Intercomparison Project (ESMSnowMIP). There is a large spread in modeling results of snow, and the ESMSnowMIP is attempting to identify the areas where models can be improved. This takes advantage of larger land surface MIPs (i.e. LS3MIP) to do coupled simulations including prescribed albedo and SWE experiments and fixed meteorological forcing. The challenges inherent to in situ measurement of snow were acknowledged, in that a point measurement is very difficult to compare to a model grid cell.

The discussion noted that there is very little general certainty in which parts of snow modeling are the main deficiencies – the MIP is needed to establish priorities for improvement of snow representation in climate models.

Rob Massom presented an update on the targeted activity on *Interactions Between Cryosphere Elements*. This initiative aims to encourage a holistic, cross-disciplinary and integrated approach to cryospheric science and inclusion of cross-cryosphere processes, interactions and feedbacks in models. Recent work has highlighted a number of key cross-cryosphere interactions, ranging from sea ice loss and permafrost thaw resulting in increased Arctic coastal erosion to potential linkage between Antarctic fast ice linked to ice sheet margin stability. Dr Massom reported on a number of papers produced within this topic, and on a successful first workshop held in conjunction with the International Glaciological Society Symposium on Sea Ice in a Changing Environment in Hobart (Tasmania, Australia, involving about 50 participants). These included key representatives of other communities e.g., ASPeCt, SPARC, and the West Antarctic Ice Sheet (WAIS) program. The Symposium also included a successful cross-cryosphere session on "Sea ice interaction with ice sheets, ice shelves and icebergs". Both the workshop and special session were sponsored by CliC. Upcoming activities include a special session of the 26th IUGG General Assembly (22 June-2 July 2015) co-sponsored by CliC and IACS (the International Association of Cryospheric Sciences (IACS), synthesis and review papers, and increased engagement with relevant programs and communities.

Discussions following this talk emphasized the importance of this type of system-level questions in the future of cryospheric science. The project will approach these efforts

opportunistically for the time being (whatever people have resources to study), but a strategic plan for selecting candidate areas to highlight was recommended, perhaps using the community approach taken by the PCN. These types of broad science questions were recognized as being increasingly important for the future of the field.

A brief overview of Polar CORDEX was presented by John Cassano. For details, see the targeted activities report. Polar CORDEX has a mailing list that is open to scientists interested in analysis and modeling – participation in the modeling efforts is not required.

Discussion was active, but mostly focused on what model runs would be done as part of the project. Without outside funding, these efforts are limited to what groups can do with their own funded projects. There is interest in fully coupled regional models (rather than downscaling atmospheric forcing from GCMs), but this is not likely to be accomplished in the immediate future. High-resolution models (~km scale) are in high demand. Requests for CMIP6 variables have not been submitted yet.

Ice Sheet Activities

The update on the West Antarctic Glacier-Ocean Modeling report presented by David Holland showed that, after IPCC 2013, uncertainties still exist but also that relevant time scales are slow. In October 2014, a kick-off meeting was held in Abu Dhabi that brought together 30 participants including 3 early-career scientists. This workshop resulted in an article to EOS about projecting Sea-level Rise from West Antarctica. The website was initiated with the help of CliC, but needs to be updated with current content and to reflect the new name (http://www.climate-cryosphere.org/activities/targeted/wagom).

An effort to connect MISMIP and ISOMIP to MISOMIP was presented which will be discussed in a side meeting at EGU 2015. This meeting will be used to design MISMIP+ISOMIP, and MISOMIP + ice-sheet, ocean, and coupled ice sheet-ocean intercomparison projects. Communications for MISOMIP are happening through a googlegroup which already has 47 members. Another workshop is to be held in Abu Dhabi in October of 2015 and possibly at AGU in December 2015.

Ed Hanna presented details on the purpose and goals of ISMASS. It was mentioned that new terms of reference were defined at a Steering Committee Meeting of ISMASS at the University of Sheffield, UK in 2013. ISMASS was involved in a workshop in Auckland, NZ in August 2014, then at the WAGOM/MISOMIP kick-off meeting in Abu Dhabi, October 2014 (with CliC involvement).

A workshop is planned for May 2015 in Sheffield, UK, which centers on constraining uncertainty in Greenland Ice Sheet surface mass balance model output and in situ validation (GrIS SMB workshop). The goal is to reconcile the differences. Expected outputs from the workshop are:

- Prompt, more comprehensive spatial comparisons between SMB model output from the several different SMB modelling approaches (RACMO2, MAR, 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.
- 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 the 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.

It is likely that an additional ISMASS activity on the Marine Ice Sheet Model Inter-comparison Project will be held in Cambridge, UK, in August 2015. Dr Hanna also suggested revisiting and updating ice sheet mass balance evaluation (a continuation of the 2013 Nature paper)

Discussion revolved around clarifying the role of ISMASS and its added value. It might be good to have ISMASS develop an action plan on the activities for the coming years. This should ensure that it ties in with all the other CliC related ice-sheet activities as well as those of the other sponsoring organizations.

Sophie Nowicki provided background information on the creation of ISMIP6. 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 CMIP community. For instance in AR5, 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 future scenarios. As the next phase of CMIP is being designed (CMIP6), an effort for ice sheet models to be better integrated into the CMIP6 initiative has been proposed to the CMIP panel.

Dr Nowicki presented the framework for the new effort, ISMIP6, the Ice Sheet Model Intercomparison Project for CMIP6. 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 (including uncertainty in both climate forcing and ice-sheet response). This goal requires an evaluation of 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. These goals map into both Cryosphere and Sea-Level Rise Grand Challenges relevant to CliC and the WCRP.

An update was given on a workshop held in 2014 that had the goal of bringing Greenland and Antarctic ice sheet working groups together. The presentation included an overview of the questions asked at the July 2014 workshop and the experimental framework for ISMIP6.

The plans for 2015 include:
- identifying the variables that need to be saved in CMIP6;
- sending information to CliC for the website;
- working on the standalone ISM experiment;
- identifying key observations;
- revising the MIP proposal once feedback is received; and
- if endorsed, writing an experiment paper, setting the model and carrying out analysis.

The main point of discussion revolved around making funding agencies aware of this project and determining how CliC might encourage funders to support the efforts. Connecting the ISMIP6 to the WCRP Sea Level and Cryosphere Grand Challenges could help spur funding.

Fiamma Straneo followed on with information about other projects dealing with the Greenland Ice Sheet. Recent mass loss from the Greenland Ice Sheet, and other Arctic ice caps, is contributing to global sea level rise and increasing the discharge of fresh water into the North Atlantic and Arctic oceans, where it can affect the large-scale ocean circulation. Regionally, these changes are impacting local populations and infrastructure and the marine ecosystems. The complex nature of the processes occurring at Greenland's margins, including the interaction of multiple components of the climate system, combined with the challenges of obtaining data from this region, imply that scientific progress can only be achieved through a concerted effort across disciplines, approaches, and national borders.

The Greenland Ice Sheet-Ocean Interactions Network (GRISO) and the Land-Ice Team of SEARCH are complementary efforts aimed at advancing collective understanding of problems related to Greenland and Arctic land-ice change, and its interaction with the ocean, the atmosphere, the marine ecosystems and local communities. GRISO is an international, multi-disciplinary science network that builds on activities (several review papers and a workshop report synthesizing priorities) led by the GRISO U.S Working Group. SEARCH is aimed at understanding Arctic environmental change through exchanges within the scientific community, stakeholders and decision makers. Efforts led by GRISO and the SEARCH Land-Ice Team are presently focused on two objectives:

- making relevant physical ocean/ice/atmosphere data available to the broad, interdisciplinary community of scientists studying aspects of Greenland ice/ocean/atmosphere interaction; and
- facilitating the establishment of a Greenland Ice-Ocean Observing System (GrIOOS),within which long-term time series of critical glaciological, oceanographic, and atmospheric variables will be collected at a number of key locations.

These are two of the four major scientific priorities identified in the GRISO report (Heimbach et al. 2014, US CLIVAR Report) derived from the GRISO Workshop held in June 2014. The other two priorities are:

- targeted process studies to fill specific gaps; and
- a megasite experiment – in depth study at one or two sites to study the interaction of the different components.

The new GRISO is just getting going (http://web.whoi.edu/griso/). One of its main goals is to make data available, to establish protocols for data standards and to encourage and facilitate data submission and data sharing. CliC could help in facilitating connections with the international community, advertising, organizing and coordinating with other overlapping activities. CliC's role here is important to avoid duplication.

WCRP Grand Challenges

The meeting topic then switched to the WCRP Grand Challenges (GCs) with CliC co-chair, Greg Flato, presenting the Cryosphere in a Changing Climate GC, which is led by CliC and intimately linked to ongoing and planned activities within the CliC Core Project, as well as initiatives like PCPI. There is, however, a need to identify clearly those activities that are specifically tied to the GC. To this end, a work plan specific to the Cryosphere GC was drafted, and it explicitly identifies activities that are being undertaken in the following areas (identified as priority topics in the GC White Paper):

- A coordinated focus on seasonal, interannual and longer-term predictions and projections of polar climate and the role of the cryosphere in climate predictability.

- A more focused analysis of model intercomparison results aimed specifically at understanding and attributing model biases and shortcomings related to the cryosphere.
- 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.
- 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.

During the presentation, it was stressed that the observational target is important. This will be addressed by making use of existing observational data, but no observational programme is involved as part of this GC. CliC needs to be engaged in the CMIP6 activity, which is strength of the WCRP and feeds into the IPCC. The Cryosphere GC fosters interaction with other prediction efforts including SIPN. CliC has a role to play in maintaining communication even if it is informal.

CliC is currently in discussion with the WCRP Director and the JSC Chair on refining the work plan. The Cryosphere GC is very broad in scope, and there are overlaps with the core project that need to be clarified. A revised work plan will be prepared prior to the JSC meeting in April 2015. CliC is also contributing one of the work packages (cryospheric contributions) to the GC on Regional Sea Level Rise led by CLIVAR.

Joining remotely, Cecilia Bitz presented the Polar Climate Predictability Initiative (PCPI), which aims to advance understanding of the sources of polar climate predictability on timescales ranging from seasonal to multi-decadal. Dr Bitz emphasized that polar climate predictability cuts across all elements of WCRP, but tends to fall between the cracks. WMO EC Panel of Experts on Polar Observations, Research and Services (EC-PORS) is promoting a Global Integrated Polar Prediction System (GIPPS) through the WWRP Polar Prediction Project (hours to seasonal) and the WCRP Cryosphere GC (seasonal to multi-decadal) which will liaise closely through their common coordination office. The CliC office is providing the logistical support for PCPI, including its website (http://www.climate-cryosphere.org/wcrp/pcpi). Environment Canada is providing substantial funding for PCPI and Polar Prediction Project (PPP) meetings through the Global Framework for Climate Services (GFCS). Sessions and workshops were organized in 2014 as part of the PCPI activities. More meetings are planned for 2015. They will be organized during major conferences such as EGU and IUGG.

The question of PCPI being a GC or not was raised. Dr Bitz emphasized that PCPI is part of the Cryosphere GC but its activities are not driven or constrained by it. She also talked about the Year of Polar Prediction (YOPP), the core of which will take place from mid-2017 to mid-2019 (with associated activities covering the period 2015-2019). YOPP is a flagship activity of the Polar Prediction Project (PPP) and covers both the Arctic and Antarctic. PCPI will be involved in YOPP through joint activities. An extended period of coordinated intensive observational and modelling activities in order to improve polar prediction capabilities on a wide range of time scales is planned. A coupled assimilation in the Arctic on an experimental basis, to guide future reanalyses will be encouraged. Several planning meetings have already taken place, and a Draft Implementation Plan exists.

PCPI is also participating in a Polar Prediction School (Sweden, April 2016) in which CliC is involved, with CliC director Jenny Baeseman being on the organizing committee and several scientists serving as lecturers. There is also a strong link with APECS, through APECS Liaison Johnny Day who is part of PPP. Organization representatives present at the CliC SSG were invited to encourage both PhD and postdoctoral students to participate in the Summer School. It was suggested that the Swedish Polar Research Secretariat might be

able to help with funding the summer school since it is hosted in Abisko, and CliC offered to follow up on that.

CLIVAR co-chair Detlef Stammer reported on the Sea Level (SL) GC, now called the Regional Sea Level Change and Coastal Impacts GC, which is led by CLIVAR and other partners since dealing with sea level issues requires interaction with many communities. The programme was designed with interaction from several cryosphere/CliC scientists. This GC is an integrated interdisciplinary programme on sea level research reaching from the global to the regional and local scales. Its aims are to: establish a quantitative understanding of the natural and anthropogenic mechanisms of regional to local sea level variability; promote advances in observing systems required for integrated SL monitoring; and foster the development of SL predictions and projections that are of increasing benefit for coastal zone management. This GC includes five parallel, but interconnected, working groups:

- An integrated approach to paleo time-scale sea level estimates.
- Quantifying the contribution of land ice to near-future sea level rise.
- Causes for contemporary regional sea level variability and change.
- Predictability of regional sea level.
- Sea level science for coastal zone management.

Detailed studies on adaptation plans will not be done as part of this GC but will provide information to the community and increase the interactions with the community.

CliC designed the second of the four work packages of the GC focusing on Quantifying the Contribution of Land Ice to Near-Future Sea Level Rise in which up to 30 people will be involved. How this works will be decided at the First Steering Group meeting on March 19-20, 2015. The GC committee aims to enhance the discussion with SPARC and GEWEX. At this stage, there is still a need for a strong outreach component on the results of the GC. Dr Stammer also emphasized that a lot of national funding will be raised as well as through the funding agencies. He stressed that this could be of interest to ISMIP6.

During the discussion, the involvement of the large group at the University of Kansas Center for Remote Sensing of Ice Sheets (CRESIS) in this GC was suggested. The question of combining extreme events with sea level regional change was also raised and this will be part of WG5 on Sea Level Science for Coastal Zone Management.

Follow up with the leads of the Clouds, Circulation and Climate Sensitivity and Climate Extremes GCs is required to get more information on their progress, as they were not represented at the CliC SSG. The Cryosphere GC Implementation Plan will be revised once there is more clarity on what the format should be and what should be addressed. Once this is done, CliC will lead by example and start developing a Cryosphere GC webinar. This idea came up a while back but has not been developed yet.

Emerging Activities

Allen Pope presented an update on the Southern Ocean Satellite Requirements Project which is joint with SOOS and recently SCAR. The WMO Polar Science Task Group asked for science community input on the need for Southern Ocean observations from satellites. The survey to data users went out in 2014, the draft of the summary report has been compiled, and the report will be distributed for expert and community review shortly. A full description of the conclusions is included in the targeted activity report, but interest generally focused on sea ice observations with an emphasis on data suitable for process studies (i.e. polynyas).

Discussion noted that other organizations have compiled essential variables for climate science and that these lists should be consulted. The International Ice Chart Working Group was noted as an organization that can provide information on operational community needs, and they have already been consulted. The co-chair of the SORP also expressed interest in providing comments on the draft.

Regine Hock outlined the need for increased attention on global glacier mass balance modeling in a presentation, with help from Ben Marzeion. The objectives of the GlacierMIP are to coordinate model inter-comparison, identify deficiencies and data needs, and take advantage of new opportunities in global glacier mass balance studies through the Randolph Glacier Inventory. Full details are available in the 2014 Annual CliC Activity report.

Discussion focused on how glacier models deal with the scaling issues inherent to representing small-scale processes in global climate models. The issues surrounding downscaling are acknowledged by the glacier mass balance community. GlacierMIP was encouraged to coordinate with ISMIP in order to make sure that variables needed for GlacierMIP are being saved in CMIP6.

WCRP Updates and Connections

Day 3 of the meeting was dedicated to strengthening CliC's relationships with other WCRP efforts as well as partner organizations.

Dave Carlson gave a brief update on WCRP. In summary, WCRP has developed by accretion, with new projects, working groups and various other initiatives or activities added based on immediate merits and strong internal or external advocacy. WCRP itself has deliberately and of necessity added a set of Grand Challenges while changes in the larger science landscape - for example the demise of IGBP and the emergence of Future Earth at a time of generally decreasing science funding - present additional challenges. Guy Brasseur, chair of the WCRP Joint Scientific Committee and Dr Carlson have attempted to make a science-based rather than organizational-based re-assessment of WCRP with an eye toward internal efficiency and external impact. Although present WCRP structures map quite well to the overall goal of analysis and prediction of this planet's climate, a few areas have been identified for focus and improvement.

Dr Carlson presented a new 'facelift' for WCRP where there was more emphasis on the science being produced and its relevance, without acronyms and in plain terms, and particularly emphasizing the Grand Challenges as the 'teeth' of WCRP. It was pointed out that momentum and circulation seemed to be missing from the presentation package and it was agreed that, in future, explicit ties to ocean heating and circulation should be addressed. Another point that was brought up was that even though it's important to address areas of the globe where there are limited data for climate projections, we should not lose sight of the data-rich regions and use those to increase our understanding of climate change.

Joan Alexander, co-chair of SPARC, presented a brief update on SPARC's activities and specific projects that are of potential interest to the CliC community. PCPI is co-sponsored by CliC and SPARC and has been making steady progress over the past year. The Year of Polar Prediction effort is of interest to SPARC, but mainly through PCPI. SPARC has started a reanalysis inter-comparison project that may have some ties to CliC, and is active in the Clouds, Circulation, and Climate Sensitivity Grand Challenge. CliC should become more engaged in this activity, particularly with efforts on Polar clouds. There was also a lot of discussion about the need to connect the CliC Targeted Activity "Linkages between Arctic

climate change and mid-latitude weather extremes" and the SPARC Storm Tracks team. A workshop on Storm Tracks Jets and their Modes of Variability will be held in August and members from the CliC Linkages activity should be part of that workshop. There was also discussion on having more joint efforts on atmospheric predictability and ocean, sea-ice and land surface conditions.

Graeme Stephens, co-chair of GEWEX, presented an update on their activities, including the Water Availability and Extremes Grand Challenges. GEWEX has been and continues to be pro-active in the development of data resources, and assessment of these resources always with a vision to develop new data records of pressing need. The question regarding whether there is a pressing need for integrated data concentrating on the cryosphere was raised. The NASA Jet Propulsion Laboratory is working on bringing together Arctic-related data products which may be of interest to CliC. In the past, there has not been much connection between GEWEX and CliC, but there is now a strong desire from both groups to change this and work on projects together. Solid precipitation and the Arctic Energy Balance might be two places to start.

Detlef Stammer, co-chair of CLIVAR, gave a lengthy explanation of the evolution of CLIVAR, its structure and research foci. The new climate dynamics panel focuses on large-scale dynamics of climate variability and change over seasonal, interannual, multi-decadal to centennial timescales and is particularly interested in addressing phenomena that span two or more ocean basins. It may be of interest to CliC to work with this panel on ocean-atmosphere-sea ice interactions. The joint CLIVAR/CliC/SCAR Southern Ocean Regional Panel was also briefly discussed and involvement from CliC was encouraged. The idea of a joint CliC/CLIVAR Arctic Ocean panel was again brought up and a decision on this was requested. Plans for a CLIVAR Open Science Conference in 2016 were presented. James Renwick (WCRP JSC Liaison to CliC) and Anna Wahlin (co-chair of SOOS) have been suggested by CliC to serve on the organizing committee to help ensure that cryosphere connections are made in meeting planning.

Lynn Talley, co-chair of the CLIVAR/CliC/SCAR Southern Ocean Region Panel (SORP), stated that their Terms of Reference have recently been updated. The mission of the panel is "to serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean and to advise CLIVAR, CliC, and SCAR on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research". They may have a meeting of opportunity connected to the SOOS air-sea flux workshop in Frascati, Italy at the end of September, 2015; otherwise, communication will mostly be done via email and online meetings. The group is hoping to develop a Southern Ocean Model Inter-comparison Project. There is a strong desire to increase the cryosphere-related activities of SORP, and CliC has been asked to put forward suitable people. There was much discussion on membership of the panel and connections to SOOS, and the need for stronger ties with SCAR. It was suggested that there may be some opportunity for interactions with SPARC if there was an interest in ocean-atmosphere activity.

Mike Patterson remotely presented an update on the US CLIVAR Project and its activities relevant to CliC. In late 2013, US CLIVAR released a new Science Plan outlining updated goals, strategies, and research challenges to guide programme implementation for the next 15 years. Polar climate change is one of four research challenges identified in the plan, recognizing the fundamental role that polar regions play in variability and change in Earth's climate system – particularly through their role in heat, freshwater, and gas exchange, water mass formation and transformation, and influence on the global ocean and atmospheric circulation. To address this challenge, US CLIVAR is engaging the polar and cryosphere

science communities in the US and internationally to foster collaborations to better observe, understand, and improve model performance in simulating climate in polar regions and its global impacts. International collaboration is primarily fostered through CLIVAR-CliC interaction.

Several US CLIVAR activities have been mounted in recent years and are being planned to address knowledge gaps in polar climate variability and change. These include:

- GRISO - building upon the work of the US CLIVAR Greenland Ice Sheet-Ocean Interactions (GRISO) Working Group (presented at last year's SSG meeting), the GRISO Science Network, an international, multi-disciplinary group of scientists has formed to foster continued interaction on the science of Greenland Ice Sheet change and its interactions with ocean, atmosphere, and marine ecosystems.
- SOWG – The Southern Ocean Heat and Carbon Uptake Working Group (SOWG), sponsored jointly with the Ocean Carbon Biogeochemistry Program, has developed a set of observationally-based metrics (including those for the cryosphere) for the consistent evaluation of model simulations and projections of Southern Ocean and Antarctic changes, is identifying important biases in CMIP5 simulations of present and future climate, and is providing guidance for estimating and reducing uncertainty in climate projections.
- AMOC – The US Atlantic Meridional Overturning Circulation (AMOC) Science Team comprising over 100 US scientists on ~60 funded projects is coordinating collaborative research to implement a sustained AMOC observing system spanning the Atlantic; to document AMOC state, variability and change; to gain a mechanistic understanding of variability and predictability of AMOC; and to determine the response of the climate to AMOC variability and change, including Arctic sea ice, the Greenland Ice Sheet, and sea level changes.
- CPTs – US CLIVAR is exploring the possible expansion of Climate Process Teams – multi-agency supported projects to advance US climate model development – to include other Earth system components (e.g., sea and land ice) beyond the original focus of CPTs on ocean and atmosphere model improvement.

There was some discussion on how the US CLIVAR project gets their funding and operates. The project office is funded through a cooperative agreement with the four US sponsoring agencies: NASA, NOAA, NSF, and Department of Energy and operates similar to CLIC. Most of the work of US CLIVAR is sponsored and coordinated through the individual US agency-funded research grants to US scientists.

Walt Meier, the CliC representative on the WCRP Data Advisory Council (WDAC) presented an update on that council that was established in 2011 to act as a single point for all WCRP data, information, and observation activities and to coordinate such activities between the various WCRP groups as well as other partners and programs. The WDAC provides input on data issues to the Joint Steering Group, helps coordinate sustained observation programs, and promotes data assessments and standards. They held their annual meeting 6-7 May in Galway, Ireland. A primary focus of the meeting was on flux observations because it is a cross-cutting issue that affects all of the various WCRP groups. Another focus of discussion at the meeting was on data dissemination, inventories, and standards. One particular project is Obs4MIPs, Observations for Model Intercomparison Projects, which aims to provide key observational data sets (primarily satellite) in a common framework (including uncertainty estimates and documentation) useful for evaluation and intercomparison of models within CMIP. An Obs4MIPs workshop was held 29 April to 1 May in Washington, DC and was attended by several WDAC and other WCRP representatives. Of particular relevance is a passive microwave sea ice product that is being transitioned to Obs4MIPs, and an ice sheet MIP was discussed. The sea ice product is being transitioned as part of a larger NOAA effort,

through it's Climate Data Record (CDR) program, to provide CDR products to Obs4MIPS. The WDAC has also been involved with the planning and coordination of the WCRP Polar Challenge to reward the first autonomous underwater vehicle (AUV) to successfully complete a long transect beneath the sea ice. Walt also lightened the mood with a potential new CliC activity, the WaltMIP. There will be a few upcoming meetings this year and CliC should be sending representatives to those events.

Greg Flato gave an update on the WCRP Modelling Advisory Council (WMAC), which was designed to strengthen the coordination and synergies between the various modeling efforts across the program. WMAC meetings are generally held in conjunction with the WCRP Joint Science Committee meetings, and the last one was in Heidelberg in June 2014. The group is currently working on a synthesis paper on model biases and helping address some of the governance questions that have arisen lately with the Earth System Grid Federation (ESGF). They are also helping to facilitate summer schools on model development and the model development prize. There is also much interest in Obs4MIPs especially for the upcoming CMIP6.

Dr Flato also provided an update on the WCPR Working Group on Coupled Modeling (WGCM) activities. The WGCM aims to foster the development and review of coupled climate models, including organisation of model intercomparisons projects aimed at understanding natural climate variability on decadal to centennial time scales and its predictability, and at predicting the response of the climate system to changes in natural and anthropogenic forcing, in close cooperation with WCRP core projects and other international groups. Both Drs Flato and Krinner sit on the committee as CliC liaisons. The main activity of this group this year is the coordination of the CMIP6 activities.

An update on the WCRP Working Group on Seasonal to Interannual Predictions (WGSIP) was also provided by Dr Flato. WGSIP aims to develop a programme of numerical experimentation for seasonal-to-interannual variability and predictability, paying special attention to assessing and improving predictions. Further research aims are to develop appropriate data assimilation, model initialization and forecasting procedures for seasonal-to-interannual predictions, and to consider such factors as observing system evaluation, use of ensemble and probabilistic methods and statistical and empirical enhancements, and measures of forecast skill. The group is mostly focused on the tropics, but does have one project looking at sea ice historical forecasts, which may be of interest to the CliC community.

Observing Activities and Potential Connections

Tom Wagner, program manager at NASA, called in to the CliC SSG meeting in order to talk about NASA priorities for polar science. He presented an overview of the satellites available for cryospheric science, both currently in orbit and planned for future launch, and highlighted the role of NASA in supporting airborne remote sensing and in situ campaigns. The NAS decadal survey on polar science is starting, and will be considering the big themes in polar science that will be critical over the coming decade.

With limited geoscience funding available in the US, it is important to make full use of what is available, including the vast stores of data available at data centers like NSIDC. Several questions and challenges were presented to the community i.e., what major initiatives and themes should we be looking at, and how can the cryosphere be a stronger presence in the larger geoscience community?

The potential utility of the SMAP sensor for measuring soil moisture and freeze/thaw state was identified, but there are currently no plans to turn it on over the Southern Ocean due to data link limitations (http://smap/jpl.nasa/gov). It may be possible to do so at a later date if the community can make a compelling case for the science need. The GRISO report was held up as an example of a community report that was highly circulated in Washington in order to justify the science. A pressing need for graduate level courses in polar change was particularly emphasized.

James Renwick shared an update on the WMO Executive Committee on Polar Observations, Research and Services (EC-PORS). EC-PORS activities promote and coordinate relevant programmes that are carried out in the Antarctic and Arctic regions (and in the "third pole" region of the Tibetan Plateau and Himalayan region) by nations and by groups of nations. It interfaces with all WMO programmes, including the World Weather Watch (WWW), and other related programmes throughout the world, meeting global needs and requirements for meteorological observations, research and services in the polar regions. Information on the activities of the Antarctic Coordination (AntON) project, the Polar Space Task Group (PSTG) and Arctic-HYCOS was provided. An update on the Global Integrated Polar Prediction System (GIPPS) was given, and the ties to PPP and PCPI were discussed. The group is also working on a Services Requirements Paper that related to GIPPS and user requirements and builds on the WMO Strategy for Service Delivery. A brief discussion on the International Polar Partnership Initiative was also had, particularly regarding the current status, future plans and what role CliC should play, if any. The basic agreement was for CliC to wait and see how things progress and act as needed and/or requested from the efforts leaders.

Jeff Key shared the progress that the WMO Global Cryosphere Watch has made, future plans, and detailed ways that CliC and GCW should work together. In summary, WMO recognizes that there is an urgent need for a sustained, robust, end-to-end cryosphere observing and monitoring system, not only for Polar Regions, but globally. With its partners, WMO is implementing a Global Cryosphere Watch (GCW). GCW will ensure a comprehensive, coordinated and sustainable system of observations and information that will allow for a more complete understanding of the cryosphere and its changes, which are now recognized for their major socio-economic impacts.

GCW is initiating a surface-based cryosphere observing network called "CryoNet" which will, by building on existing efforts, establish best practices and guidelines for cryospheric measurement. A complementary task is to conduct satellite product intercomparisons, which are essential in the provision of authoritative information. GCW is establishing interoperability between major data centers and data management systems. The GCW Data Portal (gcw.met.no) will provide the ability to exchange data and information among a distributed network of providers. The "Watch" is provided through the GCW website (http://www.globalcryospherewatch.org).

GCW and CliC are fundamentally different in that GCW is oriented toward operational monitoring of the cryosphere while CliC focuses on cryospheric research in a climate context. Nevertheless, they have a common goal i.e., improving our understanding of the cryosphere and its impact on climate change and society. Therefore, it is not surprising that there are a number of topics on which they could collaborate. These include, but are not limited to:

- Ice products - A robust, international, ice thickness intercomparison project along the lines of GCW's Snow Watch or the GEWEX CREW series of workshops would be beneficial to both groups.

- Modeling – CliC's modeling activities would benefit GCW, and GCW's data would benefit the modeling efforts. Collaboration in planning the Year of Polar Prediction (YOPP) is also important.
- User needs - CliC and GCW have many of the same stakeholders. A survey of user needs is of interest to both groups. Observational requirements are also a common interest.
- Research to operations - GCW may be able to help "operationalize" observations in some CliC research projects.
- Some CliC activities are concerned with data formats, metadata, and data center interoperability, e.g., GRISO, WDAC. This is also an active area for GCW.
- CliC members are encouraged to participate on GCW teams. Young scientists are especially encouraged to get involved.
- Shared outreach – CliC has already shared some website technology with GCW. Further collaboration in both directions is desirable.

INTERACT was brought up as another potential group for GCW, particularly CyroNet, to connect too. Discussion resulted in a firm need for CliC to connect with GCW, on the above items, and a number of other items (see Key presentation).

Mark C. Serreze, Director the National Snow and Ice Data Center (NSIDC), presented an update on activities from NSIDC, which is dedicated to advancing our knowledge of the Earth's frozen realms. NSIDC is part of the Cooperative Institute for Research in Environmental Sciences (CIRES) at the University of Colorado Boulder. Their data management professionals and scientists work with data providers and users to create or publish data products, tools, and resources. They work to ensure that past, present, and future data remain accessible for studying the Earth and its climate. Scientists at NSIDC specialize in remote sensing of snow and ice, Arctic climate, frozen ground, ice sheets, glaciers, local and traditional knowledge and education and outreach. Informatics research at NSIDC focuses on an appropriately integrated system of systems with multiple points of external connection, grounded in well-curated data prioritizing scientifically-useful descriptions and content that support community analyses as well as science education and outreach. NSIDC began in 1976 as an analog archive and information center, the World Data Center for Glaciology. Since then, NSIDC has evolved to manage cryosphere-related data ranging from the smallest text file to terabytes of remote sensing data from NASA's Earth Observing System satellites. NSIDC is a node of the ICSU World Data System.

A suggestion was made that more emphasis could be made on ways to easily visualize the amazing amount of data stored at NSIDC. A question about the possibility to host additional data sets was raised, with the response that technically this is possible but that everything costs money. The suggestion for data sets to be linked to the NCAR Climate Data Guide was also made, which would allow more effective and efficient use of data.

Marika Holland gave an update on the progress of the WWRP's Polar Prediction Project that promotes cooperative international research enabling the development of improved weather and environmental prediction services for the polar regions, on time scales from hourly to seasonal. The flagship activity for PPP is the Year of Polar Prediction (YOPP) which will enable significant improvement in environmental prediction capabilities for the polar regions and beyond, by coordinating a period of intensive observing, modelling, prediction, verification, user engagement and education activities. A summary of the YOPP implementation plan was provided including specific suggestions on how CliC could contribute. YOPP has numerous cryosphere-related themes; sea ice prediction from days to seasons, the importance of snow cover for predictive capability, sea ice and snow model simulation quality and future improvements, observational protocols for cryospheric variables

and improving satellite retrievals of snow and sea ice. There could also be strong ties with PCPI, ESM-SnowMIP, the Arctic Sea Ice Working Group, ASPeCt, CMIP6 data efforts, the Cryosphere Grand Challenge and the Sea Ice and Climate Modeling Forum and other activities. There will be a YOPP Summit in July in Geneva, Switzerland; Dr Baeseman is on the planning committee and Gerhard will give a keynote presentation. Discussions revolved around the coordination between MOSAiC and YOPP and the potential benefits of a strong overlap in activities and outcomes. It was concluded that CliC should develop a short white paper on specific contributions to YOPP.

Clara Deser gave a briefing on the NCAR Climate Data Guide, which is a community tool to provide concise and reliable expert guidance on the strengths, limitations and applications of climate data. It now contains more than 150 data sets with documentation, evaluation, pros and cons for usage for various purposes provided by nearly four dozen experts. Documentation includes a concise summary, metadata, references, key figures, expert user guidance, and comments. Information on data sources, spatial domain and resolution, period of record, data formats and download links are also provided. CliC is encouraged to use this for the various cryosphere modeling activities, as well as provide content for additional data sets. Information on the new Climate Variability Diagnostics package was also provided. The package computes leading 'modes' of variability (AMO, PDO, ENSO, PNA, NAO, NAM, SAM, AMOC) for any number of user-specified models and time periods and compares them to observations on the fly. It is also a data repository for all CMIP3 and CMIP5 model runs. Visit http://www2.cesm.ucar.edu/working-groups/cvcwg/cvdp for more information.

Partner Organizations

Larry Hinzman, IASC Vice-President, gave an overview of IASC structure and recent activities. The International Conference on Arctic Research Planning III (ICARPIII) is the major push from IASC this year. This is to provide a framework to help identify Arctic research priorities for the next decade; coordinate various Arctic research agendas; inform policy makers, people who live in or near the Arctic and the global community; and build constructive relationships between producers and users of knowledge. Many groups, including CliC who is contributing with the Arctic Freshwater Synthesis, Permafrost Research Priorities, Where Are They Now, FrostBytes, and a few others, are sponsoring the effort. A summary statement of outcomes is to be presented in Toyoma, Japan in April. It was recommended that this summary statement be sent to the sponsoring organizations soon for review. CliC has helped to sponsor several of the Atmosphere and Terrestrial working groups activities. There seems to be little connection with the Cryosphere Working group and a recommendation was made for closer collaboration with their activities. IASC also has a marine working group that focuses on the Arctic Ocean and there was a discussion about CLIVAR's suggestion for an Arctic Ocean Panel and if there is a need considering this working group exists and has for quite some time, previously as the Arctic Ocean Science Board. It was suggested that perhaps IASC could add an *ex-officio* member from CliC/WCRP that could help to connect activities instead of forming another new group for this region.

An overview of current activities of the Scientific Committee on Antarctic Research (SCAR) most relevant to CliC was presented by David Bromwich, Chief Officer, SCAR Standing Scientific Group-Physical Sciences (SSG-PS), presented. It reflected the deliberations of the most recent meeting of SCAR in Auckland, NZ during late August 2014. The Scientific Research Programs (tackle major research topics for a period of 6 years) of interest to CliC are Antarctic Climate Change in the 21st Century (AntClim21), Solid Earth Response and influence on Cryosphere Evolution (SERCE), and Past Antarctic Ice Sheet Dynamics (PAIS).

Other SCAR-wide activities linked to CliC interests are the Southern Ocean Observing System (SOOS) and the Antarctic Climate Change and Environment (ACCE) Advisory Group. Particularly close links between SCAR and CliC are Expert Groups (typical lifetime of 8 years) that report to the SSG-PS and are co-sponsored: Ice Sheet Mass Balance and Sea Level (ISMASS), International Partnership in Ice Core Sciences (IPICS), and Antarctic Sea-ice Processes and Climate (ASPeCt). A new action group (typical lifetime of 2 years to address one task) under SSG-PS formed in Auckland was the Snow in Antarctica (SnowAnt) that aims to study, protect, collect data about, and educate concerning Antarctic snow. The chair is Martin Schneebeli of Switzerland. SCAR and CliC can further enhance their collaborative efforts by co-sponsoring and promoting SnowAnt. Discussions revolved around the potential connection between AntClim21 and CliC's ISMIP6 activity as well as the lack of an action plan for ISMASS. The relationship between SCAR and the SORP was also discussed again and the need for more connection was emphasized.

Regine Hock presented an update on the International Association of Cryospheric Sciences. Charles Fierz, IACS President, met the Executive Director of the Climate and Cryosphere Project (CliC) Jenny Baeseman 18 January 2014 in Tromsø, Norway. He first acknowledged that IACS activities are now included in the Cryosphere Community Calendar. A discussion on various possibilities for our two organizations to collaborate based on the CryoOrganizations' Memorandum of Understanding (MoU) followed. For example, it was envisaged to organize a face-to-face retreat meeting of all partners involved in that MoU, possibly inviting new partners to join.

At its meeting in Japan in July 2014, the IACS Bureau decided on several actions related to CliC. The list below shortly describes them and gives the current status from an IACS point of view:

- Make certain that IACS is still represented in CliC's SSG; CliC and IACS agreed that IACS Vice President Cunde Xiao would continue to represent IACS at CliC's SSG meetings when possible. Unfortunately, Cunde cannot be in Boulder and Dr Regine Hock kindly accepted to step in.
- Acknowledge the very much appreciated contribution of CliC to the IACS scientific programme at the XXVI IUGG General Assembly 2015 in Prague, Czech Republic; IACS is looking forward to successful, co-sponsored sessions and welcomes a CliC representative at its open Bureau meeting on Wed 24 June 2015 18:00-20:00
- Contact the CliC Office regarding a potential joint IGS/IACS/CliC conference to be held 2017 in New Zealand; This task is ongoing. IACS Secretary General Andrew Mackintosh will soon contact the CliC Office with a title hopefully satisfying all parties involved in the organisation of that conference.
- Get back to CliC and the CryoOrganisations regarding a "glossary of the cryosphere"; Currently the WMO cross-cutting initiative Global Cryosphere Watch (GCW) is pushing on that topic and it should be brought up soon to the attention of the CryoOrganisations.
- To go through the numerous activities of CliC to spot the best possible point of collaborations, particularly with regards to the limited human and financial resources IACS can provide; The IACS Bureau thinks that the approved targeted activity "ESM-SnowMIP & LS3MIP" as well as the proposed targeted activity "Glacier volume change monitoring" are both well suited for a collaborative effort. We would have to establish liaisons between the CliC activity and the corresponding IACS Divisions, making sure that both the liaisons and the Division Heads are interested in such a 'joint venture'. In the case of the above two targeted activities, we would propose to ask Richard Essery and Regine Hock, respectively, whether they would agree to act as such.

In addition, IACS has a strong interest in the activities around ISMASS, the ICARP III initiative on Arctic Snow, as well as on sea ice. IACS either sponsored them in the past or is

currently actively participating in them. IACS is looking forward to a continuing fruitful collaboration with CliC and wishes all attendees an enjoyable SSG meeting in Boulder.

Alice Bradley updated the SSG participants on the efforts of the Association of Polar Early Career Scientists (APECS), which is an international and interdisciplinary organization for undergraduate and graduate students, postdoctoral researchers, early faculty members, educators and others with interests in Polar Regions and the wider cryosphere. Their aims are to stimulate interdisciplinary and international research collaborations, and develop effective future leaders in polar research, education and outreach. They seek to achieve these aims by: facilitating international and interdisciplinary networking to share ideas and experiences and to develop new research directions and collaborations, providing opportunities for professional career development, and promoting education and outreach as an integral component of polar research and to stimulate future generations of polar researchers.

APECS supports CliC goals by training upcoming polar researchers in interdisciplinary cooperation through research features, webinars, schools and training programs, and facilitating networking amongst early career researchers. One popular and highly successful programme has been helping organizations (most recently IASC) find highly qualified early career researchers to serve on working groups and other committees. CliC (and other organizations) can help by including early career researchers in projects whenever possible. The ongoing "Where are they now?" collaboration between APECS and CliC is assessing impacts of early-career support on retention in polar science. Further collaboration on FrostBytes and other outreach programs will always be welcomed.

A brief discussion followed on how CliC can implement a Fellows programme. This has been talked about for several years and a draft description of tasks for such fellows has been completed. The CliC office should work with APECS to formalize this process.

Summary and Ways Forward

The group felt that CliC has made very good progress in the last year, and the annual report compiled by the IPO is strong evidence of the many accomplishments of the different working groups. Thanks were given to Jenny Baeseman and Gwen Hamon, whom the group felt deserved a lot of credit for coordinating so much activity over the year. The remainder of the meeting was focused on summarizing the discussions, creating action items, and making other decisions.

The broader issue of modeling versus observational focus within CliC was discussed further. At the moment, it seems like the vast majority of CliC activity is modeling-focused, but this is largely because of the heightened activity in preparation for CMIP6. Several of the working groups are specifically focused on observational science (i.e. ASIWG, ASPeCt), and their contributions should be highlighted alongside the MIPs in order to keep the observational community engaged with CliC. Once the model data requests are in, focus will shift to observations necessary to evaluate model outputs. Data synthesis efforts, along the lines of what the PCN has accomplished, will be a major component of this phase.

Regardless of the relative contributions, CliC should pay attention to the messaging accompanying the ongoing activities to make sure that both communities feel welcome and included in the discussion. Workshop titles should accurately reflect the desired balance between modeling and observations.

Within the cryosphere community, there is a plethora of organizations with efforts in very similar areas. In order to keep the acronym list in check and to minimize duplicate effort, there needs to be frequent communication among organizations. There is a cryosphere organizations mailing list, and this could perhaps be used to send out an annual survey to get the list of activities from groups that do not produce an annual report or summarize lengthy reports. This could be a collaboration between CliC, ARCUS, IASC, SCAR and others.

Several working groups affiliated with CliC have put significant effort into identifying stakeholders and their needs. Many national funding agencies require that proposals indicate stakeholders and address how research (even, at times, basic research) will benefit the country/citizens. The question of whether CliC should take on a larger stakeholder survey to combine efforts was brought up, but since the definition of stakeholder varies so dramatically between topics (i.e. inhabitants of polar regions versus policy makers versus shipping route planners) this seemed unproductive if not impossible.

CliC should however identify its own stakeholders. The two primary groups identified were the scientific community (through research priority reports, workshops, and facilitation collaboration) and the assessment community that prepares IPCC-type reports for policy makers (through MIPs, data synthesis, and review papers). A document explaining this would be helpful for affiliated projects to cite when explaining to funding managers the broader impacts of their research. A full list of action items is included in the appendix to this report. Here we highlight a few:

- Solid precipitation over sea ice, glaciers, and ice sheets is especially important for understanding processes related to the cryosphere. The satellite-based sensors measuring precipitation are limited to mid-latitudes, and in situ data are difficult to acquire and are highly variable. This area would benefit from collaboration with GEWEX, GCW and the SPICE project. The resulting action item is to write a white paper.
- CLIVAR has suggested an Arctic Ocean Panel. CliC SSG discussed this, but could not identify a role for this panel that is not already filled by IASC's Marine Working Group. Larry Hinzman (SSG member and VP of IASC) will follow up with the working group about potentially including a representative from CliC/CLIVAR/WCRP in an ex-officio role on the committee in order to maintain effective communication between the groups.
- The proposed Arctic/mid-latitudes linkages group led by Ed Hanna and Jim Overland needs to connect with the SPARC Storm Tracks working group in order to collaborate with atmospheric dynamists and make for a more effective study.
- ISMIP6 should contact and collaborate with AntClim21.
- ISMASS should compile and distribute an action plan for their immediate future and longer-term goals. Communication between the ISMASS steering committee and the CliC SSG and IPO needs to become more frequent.
- A white paper explaining the need for satellite instruments to be turned on and collecting data over Antarctica needs to be written for the Space Agencies. The specific measurement needs identified were ice motion and ice thickness. This should be done in conjunction with the Southern Ocean observing requirements project to minimize duplicated efforts.
- The CliC SSG did not feel a pressing need to be involved in IPPI at this time. EC-PORS will provide an update if more action is necessary at a later date.
- CliC is represented on the steering committee for the YOPP Summit. The SSG discussed ways that CliC will contribute to this effort (including preparing white papers on observational needs and working group efforts in several modeling areas), and will write this up as a short document for distribution. Several of the more observationally focused working groups will make significant contributions in data synthesis and defining standards for cryospheric measurements.

- NSIDC used to have more active ties to CliC. Though they are relatively large, extremely active, and very engaged in outreach and education as a cryosphere-focused organization, they are entirely on soft money and are therefore limited in their potential for outside activity. Collaborations of opportunity should be sought when possible.

There were some complaints about the length of the SSG meeting and the amount of information presented. Suggestions included having pre-meeting conference calls, required reading before the meeting, trying to compress talks, or cutting certain parts. Increased use of electronic meeting systems was encouraged, but no proposed plans cut either the time necessary for the total meeting or the travel budget. The most debated part of the meeting was the full day of non-CliC groups, but those discussions are critical for maintaining communication between organizations. A few things were suggested as ways to cut down on time:

- Have presentations from each of the various partner groups every two years, as little seems to change year-to-year, so every two years might make ore sense and could cut the number of these presentations in half each year (saving half a day).
- Having representatives from partner organizations present to engage in discussions, but not necessarily to present. Perhaps submitting something in writing ahead of time would suffice.
- Limit presentations to 10 minutes, and cut them off when time is up. Limiting the number of slides could also help here.

Different meeting formats were suggested – ranging from extending the time between meetings, attaching the SSG to a science conference, or shrinking the size of the SSG. WCRP requirements for budget and annual planning make changing the meeting timing difficult. No firm conclusions came out of the discussion on alternate meeting formats. Any suggestions on how to make the meeting more efficient should be sent to CliC IPO.

This concluded the open session of the meeting. Greg Flato thanked participants for their time and energy, not just at the meeting, but throughout the year.

Closed-door SSG Session

The SSG approved the GlacierMIP Targeted Activity and encourages increased involvement of Eurasian modeling groups.

The SSG established a new guideline for travel support funding requests: CliC funding will be used to support travel for workshops where there is group activity and result in tangible outcomes or formal plans for future action. Side meetings at larger conferences are encouraged in order to minimize the cost of workshops, but travel for science sessions at meetings will not typically be supported.

Plans for future meetings were discussed:

- 2016 in Copenhagen, Dorthe Dahl-Jensen to host.
- 2017 in New Zealand in conjunction with IGS/IACS/CliC meeting, James Renwick to host.
- 2018 in China, with a workshop likely on alpine cryosphere, Shichang Kang to host.

Having both the budget spreadsheet and the Word document with details was useful and should be continued in the future. Proposed allotments were agreed upon and the IPO will inform the activity leads in the coming weeks.

Southern Ocean Regional Panel members were nominated. It was recommended that SCAR nominate a co-chair for the panel with experience in physical oceanography and preferably with an emphasis in modeling. Nominations will be confirmed with CLIVAR in the coming weeks.

Names were put forward for new membership for the CliC SSG to fill slots for those whose terms are ending, as well as proposed extensions for those wishing to stay on the SSG. A package on this will be prepared for the WCRP JSC for their April meeting.

Note: The meeting will take place at the beautiful NCAR Mesa Lab location. There is no bus up to the NCAR Mesa lab where the SSG meeting will be held. We have organized a daily shuttle from the Best Western Plus Boulder Inn hotel, which will take participants to and from the hotel to the NCAR Mesa Lab in the morning and evening according to the meeting schedule. If you need to get to the NCAR Mesa lab at other times or miss the shuttle, a taxi or a 45 min uphill hike from the closest bus stop on Table Mesa Drive is the only way to the NCAR Mesa Lab.

Monday, 9 February – CliC Status - ML room

Time	Agenda Item
9:00 - 9:25	Welcome Greg Flato, Environment Canada, CliC SSG Co–Chair Alex Jahn – University of Colorado, CliC SSG Member / Meeting Host Bette Otto-Bliesner – Division Deputy Director, Climate and Dynamics, National Center for Atmospheric Research Marika Holland – Community Earth System Model, National Center for Atmospheric Research
9:25 - 9:50	2014 Big Picture CliC Achievements – Greg Flato, CliC Co-Chair
9:50 - 10:00	Update from the Project Office – Jenny Baeseman, CliC Director
	Sea Ice
10:00 - 10:15	Arctic Sea Ice Working Group – Don Perovich / Hajo Eicken
10:15 - 10:30	Antarctic Sea Ice Processes and Climate (ASPeCt) – Marilyn Raphael
10:30 - 11:00	Break – Continental Breakfast
11:00 - 11:15	Sea Ice and Climate Modeling Forum – Alex Jahn
11:15 - 11:30	Sea Ice Prediction Network – Walt Meier
11:30 - 12:30	Sea Ice Activity Discussion
12:30 - 13:30	Lunch
13:30 - 13:40	SEARCH – Hajo Eicken
	Permafrost / Hydrology
13:40 - 14:10	Permafrost Carbon Network, SEARCH Permafrost Plans, Permafrost Modeling Forum and Permafrost Research Priorities – Ted Schuur
14:10 - 14:30	Arctic Freshwater Synthesis – Larry Hinzman
14:30 - 15:30	Permafrost and Carbon / AFS discussion
15:30 - 16:00	Break
	Connections
16:00 - 16:15	Linkage Between Arctic Climate Change and Mid-Latitude Weather Extremes – Ed Hanna
16:15 - 16:30	ESM Snow Model Intercomparison – Andrew Slater
16:30 - 16:45	Interactions Between Cryosphere Elements – Rob Massom
16:45 - 18:00	Connections Discussion
18:30	Group Dinner Hosted by CliC at the Med restaurant

Tuesday, 10 February– CliC Status, Cont.- ML room

Time	Agenda Item
9:00 – 9:15	West Antarctic Glacier–Ocean Modeling Activity – David Holland
9:15 – 9:30	SCAR/IASC/CliC Ice Sheet Mass Balance and Sea Level (ISMASS) – Ed Hanna
9:30 – 9:45	ISMIP6 – Sophie Nowicki
9:45 – 10:10	GRISO / SEARCH Land Ice – Ocean Project– Fiamma Straneo
10:10 – 10:45	Ice Sheet Discussion
10:45 – 11:15	Break – Continental Breakfast
	WCRP Grand Challenges
11:15 – 11:30	Cryosphere Grand Challenge – Greg Flato
11:30 – 11:45	PCPI (include PP field school) – Cecilia Bitz (remotely)
11:45 – 12:00	Sea Level Grand Challenge – Detlef Stammer
12:00 – 12:30	Other GC Connections and Discussion
12:30 – 13:30	Lunch
13:30 – 13:40	Group Photo
	Emerging Activities
13:40 – 13:50	Southern Ocean Observing Requirements – Allen Pope
13:50 – 14:10	Emerging global glacier mass balance modelling effort – Regine Hock
14:10 – 14:25	Polar Coordinated Regional Downscaling Experiment (Polar CORDEX) / WGRC – John Cassano
14:25 – ?	Other Emerging Activities?
15:30 – 17:00	Seminar with NCAR 1) Welcome – Alex Jahn 2) Intro to CliC and current activities/priorities – Greg Flato, CliC Chair 3) Polar Climate Feedbacks, particularly dealing with clouds – Jen Kay, CU Boulder 4) Greenland ice cores tell tales on the extent of the Greenland Ice Sheet during past warm climate periods – Dorthe Dahl–Jensen, Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen 5) ISMIP6: Ice Sheet Model Intercomparison Project for CMIP6 – Sophie Nowicki, NASA 6) Permafrost in Earth System Models: Progress and Future Plans – David Lawrence, NCAR 7) Concluding Remarks – Dave Carlson, WCRP Director
	– informal reception to follow at Under the Sun

Wednesday, 11 February – WCRP and Partners - ML room

Time	Agenda Item
9:00 – 9:20	Brief update from WCRP – Dave Carlson
9:20 – 9:30	SPARC – Joan Alexander
9:30 – 9:40	GEWEX – Graeme Stephens
9:40 – 9:50	CLIVAR – Detlef Stammer
9:50 – 10:00	CLIVAR/CliC/SCAR Southern Ocean Panel – Lynne Talley
10:00 – 10:10	US CLIVAR – Mike Patterson
10:10 – 10:20	WDAC – Walt Meier
10:20 – 10:30	WMAC – Greg Flato
10:30 – 11:00	Break – Continental Breakfast
11:00 – 11:10	WGCM / WGSIP – Greg Flato/Dave Carlson
11:20 – 12:30	WCRP Collaboration Discussion
12:30 – 13:30	Lunch
	Observing
13:30 – 14:00	NASA – Tom Wager (remotely)
14:00 – 14:10	WMO EC-PORS – James Renwick
14:10 – 14:20	GCW – Jeff Key
14:20 – 14:30	NSIDC – Mark Serreze
14:30 – 14:40	Year of Polar Prediction / PPP – Marika Holland
14:50 – 15:00	Climate Data Guide – Clara Deser
15:00 – 15:30	Discussion
15:30 – 16:00	Break
	Other Collaborators
16:00 – 16:10	IASC – Larry Hinzman
16:10 – 16:20	SCAR – David Bromwich
16:20 – 16:30	IACS – Regine Hock
16:30 – 16:40	APECS – Alice Bradley
16:40 – 18:00	General Collaboration Discussion

Thursday, 12 February – Decisions, Priorities, Future of CliC – Damon Room

Time	Agenda Item
9:00 – 9:20	Summary of Discussions
9:20 – 10:30	Way Forward Discussion
10:30 – 11:00	Break – Continental Breakfast
11:00 – 12:00	Action Plan
12:00 – 12:30	Action Items
12:30 – 13:30	Lunch
	Closed Session – CliC SSG and Staff Only
13:30 – 15:00	Budget Discussion and Decisions
15:00 – 15:30	New SSG Membership
15:30 – 16:00	Break
16:00 – 17:00	Meeting Wrap-up

Participants

Name	Affiliation, Country	Email Address
Alexander, Joan	NWRA, USA	alexand@nwra.com
Baeseman, Jenny	CliC International Project Office, Norway	jenny@climate–cryosphere.org
Bradley, Alice	University of Colorado, USA (APECS Rep)	bradley.alice@gmail.com
Bromwich, David	Ohio State University, USA	bromwich.1@osu.edu
Carlson, David	WCRP, Switzerland	dcarlson@wmo.int
Cassano, John	University of Colorado, USA	John.Cassano@Colorado.edu
Dahl–Jensen, Dorthe	University of Copenhagen, Denmark	ddj@gfy.ku.dk
Deser, Clara	NCAR, USA	cdeser@ucar.edu
Eicken, Hajo	University of Alaska Fairbanks, USA	heicken@alaska.edu
Flato, Greg	Environment Canada, Canada	Greg.Flato@ec.gc.ca
Hamon, Gwenaelle	CliC International Project Office, Norway	gwen@climate–cryosphere.org
Hanna, Edward	University of Sheffield, UK	E.Hanna@sheffield.ac.uk
Hinzman, Larry	University of Alaska Fairbanks, USA	lhinzman@iarc.uaf.edu
Hock, Regina	University of Alaska Fairbanks, USA	regine@gi.alaska.edu
Holland, David	New York University, USA	holland@cims.nyu.edu
Holland, Marika	NCAR, USA	mholland@ucar.edu
Jahn, Alexandra	University of Colorado, USA	Alexandra.Jahn@Colorado.EDU
Johannson, Margareta	Lund University, Sweden	margareta.johansson@nateko.lu.se
Kang, Shichang	Institute of Tibetan Plateau Research, CAS, China	Shichang.kang@itpcas.ac.cn
Key, Jeff	NOAA, USA	Jeff.Key@noaa.gov
Marzeion, Ben	University of Innsbruck, Austria	ben.marzeion@uibk.ac.at
Massom, Rob	Australian Antarctic Division, Australia	rob.massom@aad.gov.au
Meier, Walt	NASA, USA	walter.n.meier@nasa.gov
Nowicki, Sophie	NASA, USA	sophie.nowicki@nasa.gov
Ohata, Tetsuo	NIPR, Japan	ohata.tetsuo@nipr.ac.jp
Otto-Bliesner, Bette	NCAR, USA	ottobli@ucar.edu
Patterson, Mike	US CLIVAR, USA	mpatterson@usclivar.org
Pavlova, Tatiana	Voeikov Main Geophysical Observatory, Russia	t–v–pavlova@mail.ru
Pope, Allen	NSIDC, USA	apope00@gmail.com
Raphael, Marilyn	University of California – LA, USA	Raphael@geog.ucla.edu
Renwick, James	Victoria University, New Zealand	James.Renwick@vuw.ac.nz
Schädel, Christina	Northern Arizona University, USA	Christina.Schaedel@nau.edu
Serreze, Mark	NSIDC, USA	serreze@kryos.colorado.edu
Shuur, Ted	Northern Arizona University, USA	Ted.Schuur@nau.edu
Slater, Andrew	NCAR, USA	aslater@kryos.colorado.edu
Stammer, Detlef	University of Hamburg, Germany	detlef.stammer@zmaw.de
Stephens, Graeme	JPL, NASA, USA	Graeme.Stephens@jpl.nasa.gov
Straneo, Fiamma	WHOI, GRISO, USA	fstraneo@whoi.edu
Talley, Lynne	University of California – San Diego, USA	ltalley@ucsd.edu

Online Participants and Instructions

Name	Affiliation, Country	Email Address
Ackley, Stephen	University of Texas – San Antonio, USA	Stephen.Ackley@utsa.edu
Bitz, Cecila	University of Washington, USA	bitz@atmos.washington.edu
Krinner, Gerhard	Glaciology and External Geophysics Laboratory, France	gkrinner@lgge.obs.ujf–grenoble.fr
Wagner, Tom	NASA, USA	thomas.wagner@nasa.gov

For online participation for the CliC 11th Scientific Steering Group Meeting, we will use the GoToMeeting Platform (www.gotomeeting.com). **If you have not used this system before, we suggest logging on ~15 minutes before the start of the first day – a small plugin will need to be downloaded from the web and installed on your computer the first time you use it** (after that you should not need to reinstall the plug in). You have the ability to test your audio to make sure we can hear you, etc. There is a chat box that you can use to ask questions, chat to other online participants, etc. You will be able to hear the presenter and see the slides – and we are hoping to have video of the presenter as well (that part will depend on the bandwidth of participants, etc). If you prefer to connect using a telephone, please contact Jenny prior to the meeting.

If you would like to ask a question or provide a comment during the meeting, **please us the chat box to alert the online moderator that you would like to speak** so we can get that attention of the presenter. We will then give you the floor to ask your question to the room. Please be sure to **mute your line (by clicking the microphone icon)** when you are not speaking to reduce background noise. If you are a presenter, we will give you the ability to share your computer screen. This means that you can give the presentation from your own computer and use whatever platform you normally do (ie PC, Mac, Keynote, PowerPoint, etc*).

If you have participated in an online meeting before, you know that there can sometimes be technical glitches and challenges to overcome. We will do our best to make sure everything goes smoothly, but if at anytime during the meeting you have suggestions on how we can improve sound quality, etc, please send Jenny Baeseman a text: +47 4821 8095 or email.

*Please note that a PC or Mac is required (Android or Apple mobile devices can also be used). Unfortunately gotomeeting does not work with LINUX based machines. More information about system requirements can be found here: http://support.citrixonline.com/GoToMeeting/all_files/GTM010003

To join the meeting, simply click on the link corresponding to the day and follow the instructions.

Monday, 9 February (08:00 – 18:00 MST (Boulder time))
https://global.gotomeeting.com/join/434166669 Access Code: 434 166 669

Tuesday, 10 February (08:00 – 18:00 MST (Boulder time))
https://global.gotomeeting.com/join/465218437 Access Code: 465 218 437

Wednesday, 11 February (08:00 – 18:00 MST (Boulder time))
https://global.gotomeeting.com/join/348863045 Access Code: 348 863 045

Thursday, 12 February (08:00 – 18:00 MST (Boulder time))
https://global.gotomeeting.com/join/592188453 Access Code: 592 188 453

If for some reason you cannot use your computer / microphone, you can find the phone numbers for your country here: https://global.gotomeeting.com/434166669/numbersdisplay.html

Accommodation and Other Local Information

BEST WESTERN PLUS BOULDER INN
770 28TH STREET, BOULDER, COLORADO, 80303–2343, USA – TEL: +1–303–449–3800

We have organized a free shuttle to the NCAR meeting venue daily from this hotel, so we strongly recommend you use this hotel.

Getting to the NCAR Mesa Lab – Meeting Site
There is no bus up to the NCAR Mesa lab where the SSG meeting will be held. For those of you who are staying at the Best Western Plus Boulder Inn hotel, we have organized a daily shuttle from the Best Western, which will take participants to and from the hotel to the NCAR Mesa Lab in the morning and evening according to the meeting schedule.

Morning departure times from the Best Western: 8:15 am and 8:30 am

Evening departures times:
Monday: Pick up time from NCAR 6:15pm – Drop off at the Med at 6:30
Tuesday: Pick up times from NCAR 5:05pm – Drop off at Under the Sun and 5:15pm – Drop off at the Best Western
Wednesday: Pick up time from NCAR: 6:15PM – Drop off at the Best Western
Thursday: Pick up time from NCAR 1:30PM – Drop off at the Best Western
Pick up time from NCAR 5:15PM (for SSG members and staff only) – Drop off at the Best Western

If you need to get to the NCAR Mesa lab at other times or miss the shuttle, a taxi (~7 $) or a 45 min steep uphill hike from the closest bus stop on Table Mesa Drive is the only way to the NCAR Mesa Lab.

Getting back to the hotel after dinner
To get back to the hotel, we suggest that you share cabs for ~$10 ((303) 777–7777) or take a bus. On Monday you can take a bus up Broadway to Baseline (Skip, Dash, 225, 204) and then walk ~10 minutes. On Tuesday you can take the Dash or Skip down Broadway to Baseline and then walk ~10 minutes. Cash fare is $2.25 (exact change only). You should not take the AB or BV/BX buses, as they are regional buses with a higher fare that do not serve in–town passengers.

Getting to Boulder

The closest airport to Boulder is Denver International Airport.
From Denver International Airport

–RTD skyRide Bus

SkyRide's air conditioned buses have plush, adjustable seating and ample luggage storage; drivers take your bags at curbside and return them to you at your destination. This service of the Regional Transportation District (RTD) runs hourly between roughly 6:00 am and midnight; travel time to Boulder is approximately 55–75 minutes, depending on time of day and weather.

To get to Boulder:

- Purchase tickets at the RTD counter in the main terminal (northwest corner of fountain area), or pay exact fare (currently $13) on the bus.
- Follow signs to the RTD bus stop at the airport (map)
- Take the RTD skyRide AB bus (schedule – see West Bound section for service from terminal to Boulder)
- To go directly to the meeting at NCAR Mesa Lab, get off at the Table Mesa Park n' Ride stop in Boulder and phone one of the Boulder taxi companies in advance to have them meet you at the Table Mesa Park n' Ride stop on arrival in Boulder to take you to the NCAR Mesa Lab.
- To go to the BEST WESTERN PLUS Boulder Inn, get off at the stop at Broadway & Baseline and walk ~5–10 minutes to the hotel.

–Commercial Shuttle Vans

Boulder SuperShuttle information, schedule, and pricing
For the Super Shuttle, there is a discount code "NCAR1" which can be used only online when reserving a shuttle, it gives a $10 discount round–trip.
For alternatives, see the DIA ground transportation page.

Getting to the NCAR Mesa Lab – Meeting Site

There is no bus up to the NCAR Mesa lab where the SSG meeting will be held. For those of you who are staying at the Best Western Plus Boulder Inn hotel, we have organized a daily shuttle from the Best Western, which will take participants to and from the hotel to the NCAR Mesa Lab in the morning and evening according to the meeting schedule.

Summary of NCAR/CliC Joint Seminar

A joint seminar was held on the afternoon of 10 February 2015 with the host institution, NCAR to foster collaborations. Approximately 70 people were in attendance. The agenda and summaries of the presentations follow.

Welcome
- Alex Jahn, University of Colorado, Boulder and CliC SSG Member

Introduction to CliC: Current Activities and Priorities
- Greg Flato, Environment Canada and CliC Co-Chair

Definite, possible, and unlikely mechanisms for Arctic climate change
- Jennifer Kay, University of Colorado at Boulder

Despite a long and rich history of observational analysis and numerical model experiments, the relative importance of processes controlling Arctic climate change is still subject to debate. In this talk, I will use both observations and model experiments to identify processes and feedbacks affecting Arctic climate change. First, I will present what I have learned by analyzing observed Arctic sea ice loss. Next, I will use coupled climate model experiments to identify the influence of atmospheric and oceanic processes on the Arctic climate response to idealized greenhouse gas forcing. My findings underscore that cloud feedbacks can be more important than northward heat transport for explaining the equilibrium and transient Arctic surface climate response and response differences in coupled climate models.

Greenland ice cores tell tales on the extent of the Greenland Ice Sheet during past warm climate periods
- Dorthe Dahl-Jensen, Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen

The Greenland ice sheet is losing mass at an accelerating rate at present and will contribute significantly to sea level rise in the future.

Knowledge on the long-term response of the Greenland ice sheet to climate warming during past interglacials is essential for estimating the potential of future rise in sea level. During the last million years, the Greenland Ice Sheet (GRIS) has waxed and waned in response to glacial and interglacial periods. The deep ice cores through the Greenland ice sheet contain ice from the time ice covered the site. Ice from the last interglacial period (the Eemian, LIG) 130 to 115 kyears before present is present in most of the deep ice cores and can be used to determine both temperature and extent of the ice sheet during this warm interglacial period.

Going to the bed, basal material enclosed in the ice cores contain DNA remnants that can be used to determine the ecosystems present before ice covered Greenland.

The reaction of the Greenland ice sheet to climate changes in the future and the sea level change from mass loss from the Greenland ice sheet is discussed.

ISMIP6: Ice Sheet Model Intercomparison Project for CMIP6

- *Sophie Nowicki, NASA Goddard Space Flight Center, USA and ISMIP6 Project Co-Chair*
  Co-authors: Tony Payne, University of Bristol, UK; Eric Larour, NASA Jet Propulsion Laboratory, USA; Ayako Abe Ouchi, The University of Tokyo, JP; Heiko Goelzer, Vrije Universiteit Brussel, BE; Jonathan Gregory, University of Reading and Met Office Hadley Center, UK; William Lipscomb, Los Alamos National Laboratory, USA; Helene Seroussi, NASA Jet Propulsion Laboratory, USA; Andrew Shepherd, University of Leeds, UK

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 AR5, 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 future scenarios. As the next phase of CMIP is being designed (CMIP6), an effort for ice sheet models to be better integrated in the CMIP6 initiative has been proposed to the CMIP panel.

We present the framework for the new effort, ISMIP6, the Ice Sheet Model Intercomparison Project for CMIP6. 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 (including uncertainty in both climate forcing and ice-sheet response). This goal requires an evaluation of 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. These goals map into both Cryosphere and Sea-Level Rise Grand Challenges relevant to Climate and Cryosphere (CliC) and the World Climate Research Programme (WCRP).

Permafrost in Earth System Models: Progress and Future Plans

- *David Lawrence, NCAR*

Historically, permafrost has not been explicitly represented in land models in Earth System Models. But, over the last several years, several modeling centers have begun to focus on improving the representation of permafrost thermal, hydrologic, and carbon cycle dynamics to enable the models to be used in investigations of the permafrost carbon feedback. The CMIP5 models show an extremely broad range of skill in representing permafrost due to deficiencies in the simulated Arctic climate as well as the treatment of snow, cold region hydrology, and freeze/thaw processes. Improvements that have been incorporated into the Community Land Model, which is the land model of the Community Earth System model will be presented as well as plans for future model development and assessment.

Concluding Remarks

- *David Carlson, WCRP Director*

An informal no-host reception will be held after at Under the Sun

List of Acronyms

AACA: Arctic Council Adaptation Actions in a Changing Arctic Section
AFS: Arctic Freshwater Synthesis
AGU: American Geophysical Union
AMAP: Arctic Monitoring and Assessment Programme
AMO: Atlantic Multidecadal Oscillation
AMOC: Atlantic Meridional Overturning Circulation
AntClim21: Antarctic Climate Change in the 21st Century
AOGCM: Atmosphere-Ocean General Circulation Model
APECS: Association of Polar Early Career Scientists
ASIWG: Arctic Sea Ice Working Group
ASPeCT: Antarctic Sea Ice Processes and Climate
AWI: Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Germany
C4MIP: Coupled Carbon Cycle Climate Model Intercomparison Project
CASIWG: CliC Arctic Sea Ice Working Group
CESM: Community Earth System Model
CGD: NCAR Climate and Global Dynamics Division
CIRES: Cooperative Institute for Research in Environmental Sciences
CliC: Climate and Cryosphere Project
CryoNet: GCW core network surface measurement sites
EGU: European Geosciences Union
ENSO: El Niño Southern Oscillation
EOS: Premier international magazine of the Earth and space sciences (AGU magazine)
ESMSnowMIP: Earth System Model Snow Model Intercomparison Project
GC: Grand Challenge
GCM: General Circulation Model
GCW: Global Cryosphere Watch
GEWEX: Global Energy and Water Exchanges
GFCS: Global Framework for Climate Services
GIPPS: Global Integrated Polar Prediction System
GlacierMIP: Glacier Model Intercomparison Project
GrISMB: Greenland Ice Sheet Surface Mass Balance
GrIOOS: Greenland Ice-Ocean Observing System
GRISO: Greenland Ice Sheet-Ocean Interactions Network
IACS: International Association of Cryospheric Sciences
IARC: International Arctic Research Center
IASC: International Arctic Science Committee
ICARPIII: 3rd International Conference on Arctic Research Priorities
ice2sea: Project on estimating the future contribution of continental ice to sea-level rise
ICSU: International Council for Science
INTERACT: International Network for Terrestrial Research and Monitoring in the Arctic
IPCC AR: Intergovernmental Panel on Climate Change Assessment Report
IPO: International Project Office
IPPI: International Polar Partnership Initiative
ISM: Ice Sheet Model
ISMASS: Ice Sheet Mass Balance and Sea Level Expert Group
ISMIP: Ice Sheet Model Intercomparison Project
ISOMIP: Ice Shelf-Ocean Model Intercomparison Project
JPS: WCRP Joint Planning Staff
JSC: WCRP Joint Scientific Committee
KU CRESIS: University of Kansas Center for Remote Sensing of Ice Sheets
LS3MIP: Land Surface, Snow and Soil moisture MIP

MISMIP: Marine Ice Sheet Model Intercomparison
MISOMIP: Marine Ice Sheet Ocean Model Intercomparison Project
MOSAiC: Multidisciplinary drifting Observatory for the Study of Arctic Climate
MoU: Memorandum of Understanding
NAM: Northern Annular Mode
NAO: North Atlantic Oscillation
NASA: National Aeronautics and Space Administration
NB Palmer: Nathaniel B. Palmer is an ice-capable research ship
NCAR: US National Center for Atmospheric Research
NCSCD: Northern Circumpolar Soil Carbon Database
NSF: National Science Foundation
NSIDC: National Snow and Ice Data Center
Obs4MIP: Observations for Model Intercomparisons
PAGE21: Changing permafrost in the Arctic and its Global Effects in the 21st Century project
PCN: Permafrost Carbon Network
PCPI: WCRP Polar Climate Predictability Initiative
PDO: Pacific Decadal Oscillation
PNA: Pacific/ North American teleconnection pattern
Polar CORDEX: Coordinated Regional Downscaling Experiment - Arctic and Antarctic Domains
PPP: Polar Prediction Project
PRP: Permafrost Research Priorities
SAM: Southern Annular Mode
SCAR: Scientific Committee on Antarctic Research
SEARCH: Study of Environmental Arctic Change
SeaRISE: Sea-level Response to Ice Sheet Evolution
SERCE: Solid Earth Response and influence on Cryosphere Evolution
SIMIP: Sea Ice Model Intercomparison Project
SIPN: Sea Ice Prediction Network
SL: Sea Level
SMB: Surface Mass Balance
SnowAnt: Snow in Antarctica
SnowMIP: Snow Model Intercomparison Project
SOOS: Southern Ocean Observing System
SPARC: Stratospheric Processes and their Role in Climate
SPICE: Solid Precipitation Measurement Intercomparison
SSG-PS: SCAR Standing Scientific Group-Physical Sciences
WCRP: World Climate Research Programme
WDAC: World Climate Research Programme's Data Advisory Council
WG: Working Group
WGCM: WCRP Working Group on Coupled Modelling
WGRC: WCRP Working Group on Regional Climate
WGSIP: WCRP Working Group on Seasonal to Interannual Prediction
WMAC: WCRP Modelling Advisory Council
WMO: World Meteorological Organization
WMO EC-PORS: WMO Executive Council Panel of Experts on Polar Observations, Research and Services
WWRP: World Weather Research Programme
YOPP: Year of Polar Prediction

2015 CliC Action Items

Note: These are specific overarching tasks identified by the SSG but does not include all the specific activities from each project as discussed during presentations

Activity/Project	Action Items	Timeline	People specifically involved
AFS	-Organization of the C7 session on Arctic freshwater system, changes and effects with emphasis on Arctic freshwater ecosystems at ISAR-4/ICARP III Symposium in April 2015, in Japan -Submission of the Arctic Freshwater Synthesis Special Issue in the JGR Biogeosciences journal -Writing of the Layman's report emanating from the AFS papers	Spring 2015	-CliC IPO -C7 Session organizers -AFS components leads -AFS writing teams
AntClim21	-CliC needs to make connections with AntClim21 (http://www.scar.org/srp/antclim21) especially through ISMIP6	Spring 2015	-CliC IPO -ISMIP 6 Leads
APECS	-Development of the CliC fellowship - one APECS representative should be involved in each CliC activity	2015	-CliC IPO -APECS Leadership
ASIWG	- CliC IPO to send comments on draft of TOR to committee - Website for group needs to be established and mailing lists created/updated - Action plan for coming years should be sketched out	Spring and Summer 2015	-CliC IPO -ASIWG members
AsPeCt	-Testing of software system, ship data database, workshop - Group needs to develop formalized terms of reference, leadership turnover plan and action plan for future efforts		
Cryosphere Directory List	-Cryosphere organizational list which identifies the people to get in touch with for the activities they are involved in, get APECS involved in this. Make an effort to connect to other cryosphere organizations as needed.	2015	-CliC IPO -APECS Leadership
Emerging global glacier mass balance modelling effort	-create website and communications tools -announce project exists and begin work	Spring 2015	-CliC IPO -GlacierMIP Leaders
ESA/NASA/WMO-PSTG	-CliC Leadership to work with ESA (Diego) on finalizing January workshop report, strategy for release and implementation, -discuss community white paper needs and potentially develop additional white papers for specific needs (snow cover on sea ice, solid precipitation estimation at high latitudes, precipitations over ice sheet and glaciers, ice motion (lead by Rob Massom), and surface air temperature maybe). There should also be mention of the need for ice motion estimation as well -CliC Leadership to write letter to encourage turning on more satellite coverage of Antarctica to give a higher priority	2015	-CliC Leadership -CliC IPO
GCW	-GCW and CliC can work together on the cryosphere glossary -CliC will look into getting more early career scientists involved on the working group -develop plan for sea ice thickness intercomparison collaboration (connection to CCI)	2015	-CliC leadership -CliC IPO -GCW Leadership
GEWEX	-Graeme will send the links to database and archive to the CliC IPO who will transfer them to the community	Spring 2015	-CliC IPO -GEWEX Leadership

	-CliC IPO will send information on the Cryo GC to Graeme as well as AFS information -CliC will also send information of Glacier Mass Balance and Ice Sheet Mass Balance to GEWEX (2 opportunities for interactions) -CliC to engage GEWEX on white paper on means of estimating solid precip at high latitudes (remote sensing focus)		
Grand Challenges	-CliC IPO will contact other GC leads to get the information on Clouds and Extreme Events GCs. -CliC will lead by example and organize Cryo GC webinar -Revise GC implementation plan to a stand alone plan in readable language, suggest broader discussion on the plan -The permafrost carbon feedback should be more clearly defined in the Cryo GC. -CliC co-chair will follow up with WCRP leaders (Dave Carlson and Guy) to get more information on what they want to see. -A document is needed for funding agencies	Spring 2015	-CliC IPO -CliC Co-chairs / Cryo GC Leads -WCRP Leadership
GRISO	-The CliC community was invited to provide input and suggestions on the activity and funding is always welcome. -Facilitate connections with international community, advertise, organizational support, coordination other overlapping activities. -Not ready to submit a proposal at this stage -A thank you note should be sent to thank for the participating and include offer help to support where possible	Spring 2015	-CliC IPO
IACS	-Identify a CliC representative already attending IUGG to attend the session at IACS Council Mtg -Cryosphere Glossary as potential project	Spring 2015	-CliC IPO
IASC	-Suggest having an ex-officio person on the Arctic Ocean/Marine working group to represent CliC/CLIVAR/WCRP interests instead of creating another panel/project/organization -Follow up on the discussion related to the ICARP III SC needing to see the summary statement before it is presented	Spring 2015	-CliC IPO -Larry Hinzman
ice kinematics white paper	CliC can help discuss with southern ocean observation project	Spring 2015	Rob Massom
ISMASS	-CliC continues to help organize (travels, etc.) the Sheffield meeting -CliC recommends that ISMASS develop a multi-year action plan with cohesive vision of future activities and coordination -ISMASS workshops should be on the CliC website as well as the reports coming out of them -ISMASS SC meetings should also be listed -ISMASS should have a better connection with ISMIP6 as well	Summer 2015	-ISMASS Leadership -CliC IPO
ISMIP 6	-Letter of Support is written from CliC for contact to funding agencies for this project	Spring 2015	-Sophie Nowicki -CliC IPO
MISOMIP	-change the title of the project on the CliC website and update documents accordingly	Spring 2015	-CliC IPO
NASA	-CliC sponsors an Antarctic sea ice workshop (asked by ASPeCt). Send information to Tom. -CliC can play a role in education-helps bringing remote sensing data in the classroom	2015	-Marilyn and Steve from ASPeCt -CliC IPO
NSIDC	rethink connection with CliC, can there be a tighter connection or is it good they way it is now?	2015	-CliC Leadership

PCN	-Finish populating steering committee and priorities ranking project, interested in more collaboration with CliC where possible -Provide update on new changes for CliC Newsletter/Community	Summer 2015	-PCN Leadership -CliC IPO
PCPI	- Swedish Polar Research Secretariat may be able to help fund the 2016 Polar Prediction Summer School (suggested by Margareta since the school is hosted in Abisko). CliC will follow up and get in touch with them.	Spring 2015	-CliC IPO
Permafrost Modeling Forum	-joint effort of CliC, SEARCH and Permafrost Carbon Network -scoping document written -website home developed and now find members	2015	-CliC Leadership -PCN -SEARCH -CliC IPO
SCAR	-might be of interest to strengthen communication, something more frequent than once a year	2015	-CliC IPO -SCAR Leadership
SIMIP	-get all the information on the CliC website -help organize the second workshop focusing on sea ice observers and modellers (date TBD). One day or so. Back to back with another sea ice meeting	2015	-Alex and Dirk -CliC IPO
SORP	-Make sure that SORP has a clear focus that is distinct from SOOS -CliC's interest is in coordination of sea ice and ice sheet activities in southern ocean. If direction of the group is more physical oceanography, SCAR may be better poised to suggest co-chair	2015	-SORP Co-Chairs -CliC/CLIVAR leadership -CliC IPO
Southern Ocean Observing Requirements	-CliC helps facilitate the meeting in Tromsø in April -CliC helps circulate the report for feedbacks at draft stage and promoting it once it is done	2015	-CliC IPO
Southern precipitation/ solid precipitation	-Develop a community white paper on needs, in collaboration with GCW (SPICE) and GEWEX; focus on global measurements, definitely beyond 60°N/S. -CliC can help push for this white paper and provide coordination	2015	-CliC Leadership/IPO -GCW -GEWEX
SSG	-rethink the meeting format for the annual SSG meeting, how can it be more efficient and give more room for discussion, shorten to three days -Dorthe to host SSG in Copenhagen in 2016, James Renwick in Wellington, NZ in 2017, and Kang in China in 2018 -CliC Leadership to draft letter to NPI and office staffing issues	Spring/Summer 2015	-CliC Leadership
Stakeholder input/needs	-CliC should define its stakeholders and needs; and work with others to provide information for CliC activities on identifying stakeholders and needs for specific projects. -Caution is suggested as connections to already existing documents, etc should be found as this could be a multi-year, mulit-position staff project which may be outside the scope of CliC	2015	-CliC Leadership -CliC IPO -APECS?
WDAC	-Walt may need replacement for upcoming meetings -Need more action between CliC and Obs4MIPS	2015	-Walt Meier -CliC Leadership/IPO
Cryo Organizations	Update CryoOrgs mailing list and try to rejuvenate coordination.	2015	-CliC IPO
YOPP	-Develop white paper on CliC involvement in YOPP to help coordinate/recommend (long time series, big geographic, synthesis efforts) observations, on observational gaps (2-3 pages)	Spring 2015	-Rob, Marilyn, Steve, Don, Alice, others? -CliC Leadership/IPO