



Report of the Ninth Session
of the Climate and Cryosphere Project
Scientific Steering Group

Alfred Wegener Institute for Polar and Marine Research
Potsdam, Germany, 4-7 February 2013

April 2013
WCRP Informal Report No. 9/2013

Table of Contents

Current State of CliC	4
Introduction and Context	4
Antarctic Sea Ice Processes and Climate (ASPeCt) Report	4
CliC Arctic Sea Ice Working Group	5
CLIVAR/CliC/SCAR Southern Ocean Panel	5
Carbon and Permafrost (CAPER)	6
CliC Japan	6
CliC Chinese National Committee	6
CIPO Update	7
Discussion about CliC future priorities	7
Large International Initiatives and CliC	8
Cryosphere Grand Challenge	8
International Polar Initiative	8
Global Cryosphere Watch	9
Global Integrated Polar Prediction System	10
WCRP Polar Climate Predictability Initiative	11
WWRP Polar Prediction Project	11
Summary of CliC status, connections and initial thoughts on future targeted activities	12
Sponsor/Partner Feedback, and Identification of Gaps/Needs	13
World Climate Research Programme (WCRP)	13
Stratospheric Processes and their Role in Climate (SPARC)	13
Global Energy and Water Exchanges (GEWEX)	14
Climate Variability and Predictability (CLIVAR) Status 2013	14
International Arctic Science Committee (IASC)	15
Scientific Committee on Antarctic Research (SCAR)	15
Connections to Climate and Cryosphere modelling	16
Polar Regional Earth System Models	16
When will the Summer Arctic be Nearly Sea Ice Free? A Proposal to CliC	17
Permafrost Modeling and Observations	17
Sea Ice Model evaluation	18
Sea ice model evaluation: Data needs, opportunities, and challenges	18
WGCM and WCRP Modeling Council	18
ESA-CliC cooperation and cryospheric observations from space	19
Science Day with Potsdam Researchers	20
Identification of New CliC Priorities and Goals	21
Freshwater Balance	21
Satellite techniques for observing global glacier mass balance	21
Ice sheet mass balance work (ISMASS)	22
Regional sea-level rise and Glacier-Ocean Models	23
Connections between elements in the cryosphere	23
Towards an Intercomparison framework for Ice Sheet Models	24
Outreach Activities	24
Community Engagement	24
Ice Sheet Model Early Career Scientist Workshop	25
Karthaus Summer School on Ice Sheets and Glaciers in the Climate System	25
Action Items for CliC Outreach activities:	25

Table of Contents, continued

Practical Steps Forward	26
New CliC Targeted Activities	27
Antarctic ice-shelf and ocean coupled modeling	27
Understanding linkages between cryospheric elements	27
Coordination of cryosphere observations for model evaluation and prediction initialization	27
Arctic freshwater synthesis	27
Mode of CliC operation between sessions	28
Sponsorship of the CliC Project	29
Potential CliC Participation, Meetings, and Workshops:	29
Dates and Venue for CliC SSG-10	30
Executive SSG Session	31
Session closure	31
Appendix 1: Participants List	32
Appendix 2: Agenda	34

All presentations archived at

<http://www.climate-cryosphere.org/index.php/meetings/past-meetings/ssg-9>.

9th Session of the CliC Scientific Steering Group



Back row (left to right): Jeff Key, Peter Lemke, Jim Overland, Larry Hinzman, Mark Drinkwater, Mike Sparrow, Vladimir Kattsov, Rob Massom, Eric Larour, Alexander Klepikov, Gerhard Krinner, Thomas Jung, Alexandra Jahn, Penny Wagner, Vladimir Romanovsky, Helmut Rott, Peter Van Oevelen, Heidi Isaksen, Volker Rachold Middle row (left to right): Ed Hanna, Roger Barry, Ted Shepard, David Holland, Marilyn Raphael, Dorthe Dahl-Jensen, Nalan Koc, Ghassem Asrar Front row (left to right): Greg Flato (chair), Jenny Baeseman, Annette Rinke, Cunde Xiao. Tetsuo Ohata and Sebastian Gerland joined via skype. Vladimir Ryabinin, Hugues Lantuit and Heike Midleja were also present, but not pictured.

Current State of CliC

Introduction and Context

– Presented by Greg Flato, CliC Chair

An overview of the revised WCRP Structure was provided, along with a review of the current CliC structure. Additionally, the new WCRP “Grand challenges” were introduced and the role of CliC was outlined. Although several of the WCRP grand challenges have a cryosphere component, the “Cryosphere in a Changing Climate” is the one that CliC will have primary responsibility for. In general, CliC has rather low visibility in most countries, although a notable exception is Asia. Therefore a top priority is to raise the visibility of CliC and educate the community as to how this organization can help them. This requires targeted initiatives that will attract researchers and interest funding agencies. These initiatives need to produce a tangible output that would not have been possible without CliC support. The key to making this work is to identify leaders from the scientific community and get things started by supporting meetings/workshops. One of the main goals of this SSG meeting was to identify some targeted activities for CliC and identify people to lead them. However, it was stressed that CliC should avoid too much co-sponsorship, as well as the tendency to try and be involved in too many parallel activities. Rather the focus should be on a few key initiatives that will produce results relatively soon. This will also help CliC to establish a niche in the cryosphere community without getting confused with several other polar organizations.

Antarctic Sea Ice Processes and Climate (ASPeCt) Report

- Presented by Marilyn Raphael, ASPeCt co-chair

In 2012 ASPeCt has continued and has almost completed its reorganization. This was facilitated by meetings of opportunity at several conferences and by a dedicated Workshop held in July 2012 at the SCAR OSC in Portland (USA). At that Workshop, ASPeCt members also highlighted the scientific activities that they have been doing under the ASPeCt umbrella as well as their plans for continued research. Some of these details are posted on the ASPeCt website (aspect.antarctica.gov.au) which is now hosted by the Australian Antarctic Division (AAD) and managed by ASPeCt member Dr. Petra Heil. In future, ASPeCt's data pages will be migrated a new server (data.aad.gov.au), also hosted by the AAD. Multiple research papers have been published using the ASPeCt data, including the recent *Chlorophyll a in Antarctic sea ice from historical ice core data* by Meiners, K.M., et al. (2012), *Geophys. Res.Let.*, 39, L21602, doi:10.1029/2012GL053478. This paper was also highlighted in the *Research Spotlight* section in *EOS*, Vol.94, No 3, 15 Jan 2013.

ASPeCt convened special sessions at the 2nd International Polar Year Conference, Montreal (April 2012), at the SCAR OSC in Portland (July 2012) and at the Fall AGU meeting in San Francisco, in December 2012. Steve Ackley, co-Chair of ASPeCt, was appointed to the Science Steering Committee of the Southern Ocean Observing System (SOOS) as the sea ice representative and in this role led a forum on identifying Essential Observing Variables (EOVs) and their state of readiness for Antarctic Sea (at the AGU Fall Meeting, 2012).

In 2013, ASPeCt expects to be quite busy. Important organizational tasks to be completed are the finalization of the Science Implementation Plan and the review paper, which is currently in draft form. This will be the subject of a Workshop scheduled for March 2013 at the Gordon Research Conference in Ventura, California. ASPeCt will also participate in the planning and execution of two important events, the Sea ice Workshop in June, 2013 and the WCRP Grand Challenge Cryosphere Workshop scheduled for October, 2013. Both Workshops will be held in Tromso, Norway. To make sure that its work advances, ASPeCt will also continue its tradition of holding meetings at conferences scheduled by other organizations where ASPeCt research may be presented.

ASPeCt's future plans also include finalizing the sea ice core database and coordinating user interfaces for data access through the AAD Data Centre. Additions to the ship observations data base (ASPeCt observations) are being made on a continuing basis, and sea ice thickness and sea ice core properties databases are being developed.

Action: Budget request to support its activities in 2013, ASPeCt requests \$10,000 USD. We expect that this money will fund activities such as Workshop and Conference participation of early career

scientists. It will also be used to facilitate participation of ASPeCt members for instances where, for example, an extra day of stay at a Meeting is required in order to take part in a planned ASPeCt activity.

CliC Arctic Sea Ice Working Group

- Presented by Sebastian Gerland (by Skype), Working Group Member

The CliC Arctic Sea Ice Working Group was started in 2007/08, and has the following goals: development and implementation of standard measurement protocols for Arctic sea ice; integration of surface-based observations with remote sensing and modeling efforts; and the fostering of international partnerships in Arctic sea ice research. The challenge is to define the important questions and to put the different pieces together to answer these questions, as well as to standardize measurement practices and archive data. Examples of progress from the working group activities are the Arctic expedition website (www.iceplan.org), which lists the different Arctic sea ice experiments, with points of contacts and measurement plans, as well as Ice Watch, which was a project to develop a software package that shows observational data. The CliC Arctic Sea Ice Working Group has held several workshops to bring together experts from the different sea ice communities, and has written workshop reports and workshop summaries that have been published in EOS. The next workshop will be in June 2013 in Tromsø. The goal will be to develop connections between international groups involved in sea ice modeling, observations, and remote sensing, to determine observational needs for sea ice models, to explore future areas to best fill knowledge gaps and to improve sea ice modeling capabilities in order to predict future ice states more accurately. This workshop will also include more representatives of the Antarctic sea ice community than in previous workshops, to better connect the two communities.

CLIVAR/CliC/SCAR Southern Ocean Panel

- Presented by Alexander Klepikov, Russian representative to the Panel

The main outcomes of the 7th Meeting of the CLIVAR/CliC/SCAR Southern Ocean Region Panel (Boulder, USA, 19 – 21 October 2011) were presented. The meeting focused on three different themes: Southern Ocean carbon; atmospheric processes over the Southern Ocean; and Southern Ocean physics. The overarching aim was to provide a forum to generate an overview of current understanding in these three main areas. There was a discussion to develop a white paper on the state of carbon cycle science in the Southern ocean. The suggestion was made to organize the workshop to build international consensus. A workshop should also aim to engage the CliC community to bring together glaciologists, hydrologists, oceanographers, etc. and to look at ice interactions.

The agenda of the upcoming 8th Session of SOP (Hobart, Australia, 21 – 22 February 2013) was discussed. This meeting will be held immediately after the Working Group on Ocean Model Development (WGOMD)/SOP Workshop on Sea Level Rise, Ocean/Ice Shelf Interactions and Ice Sheets. The WGOMD is responsible for stimulating ocean model development, along with promoting interaction amongst the ocean modeling community and between this and other climate related research communities. The workshop objectives are: (i) evaluation of state-of-science of ocean and land-ice interactions, (ii) identify priorities for reducing uncertainties in the projections of global and regional sea-level rise, and (iii) investigate pathways for the development of the next generation of climate models incorporating interactive land-ice components.

The results of the Southern Ocean Observing System (SOOS) Seeing Below the Ice Workshop (Hobart, Australia, 22-25 October 2012) were presented. The workshop gave scientists the opportunity to present the current status of polar observing systems in both hemispheres, discuss key questions, define problems and recommend the solutions required to develop a sustained strategy for observations in the Southern Ocean sea ice zone. A plan had been developed by the end of the workshop to outline the measurements needed, how to collect them and from where, in the sea ice zone to study ocean - ice interactions. A strategy for observing ocean structure and circulation and ice-ocean interactions in the Antarctic sea ice zone will be developed in upcoming months.

ACTION: Sasha to communicate in detail with Jenny on what needs to be done and how to proceed.

Carbon and Permafrost (CAPER)

- Presented by Vladimir Romanovsky, CAPER Lead

The CliC CAPER initiative is a “success story” of CliC involvement in international scientific planning and implementation of important research initiatives. This initiative was conceived about 10 years ago during a CliC meeting in Hobart, Australia and commenced in the second half of the 2000s in collaboration with the Global Carbon Program. By now, at least four national/international large scientific projects are active and implementing the ideas that were developed by CliC through its CAPER initiative. The four projects where CliC plays various roles are:

- 1) Vulnerability of Permafrost Carbon Research Coordination Network (RCN)
- 2) Changing Permafrost in the Arctic and its Global Effects in the 21st Century (PAGE21)
- 3) Centre for Permafrost dynamics in Greenland (CENPERM)
- 4) Next-Generation Ecosystem Experiments (NGEE Arctic)

A short description of these projects, their activities and products was provided in the presentation. A major role for CliC is to help to coordinate interaction between these projects. Finally, a short description of the latest publication of the UNEP “Policy Implications of Warming Permafrost” was provided. This report is a natural result of the activities initiated and implemented by the CliC CAPER initiative. Three of the four authors of this report (Hugues Lantuit, Vladimir Romanovsky, and Ted Schuur) have strong relationships with the CliC CAPER initiative.

Action: Vladimir Romanovsky to write short ‘history’ of CAPER and provided details of results, publications, etc to Jenny.

CliC Japan

- Presented by Tetsuo Ohata (via skype)

Japan hosted the Third International Arctic Symposium in January 2013, with 270 participants from 15 countries (3 early career scientists were supported by CliC). CliC is generally very active in Japan, with 5 main programs related to CliC:

- GRENE Arctic Project (2011-2016), from observations to modeling (Project of MEXT, NIPR hosting institute)
- Arctic Ocean, Siberian cryosphere, ice sheet modeling studies (JAMSTEC)
- Greenland Icesheet northern drainage studies (MRI and Universities)
- Antarctic Ice Sheet Research (NIPR)
- Glacier changes in Himalaya and Patagonia. (Nagoya and Tsukuba University)

The Arctic cryosphere study in relation with the environmental studies, will be strengthened with cooperation with Arctic countries, not only on the research itself, but also on the human resource development and networking of in-situ observations.

In the coming several few years, Japanese Antarctic research might be slowed down due to difficulties accessing the Antarctic Japanese station, caused by an increase in sea ice around the Japanese station in recent years. This will mean a decrease in the scientific overwintering team, but monitoring will be maintained. Other issues for Asia-CliC are related to limited regular communication between Asian countries, due to language and cultural differences and time difference (7 h between Japan and India). Possible solutions might be an increase of personal exchange and for the Global Cryosphere Watch (GCW) to be implemented and funded in Asian countries.

CliC Chinese National Committee

- Presented by Cunde Xiao

CliC is very active in China, and there have been annual reports from the Chinese National Committee on CliC and IASC. Specifically, China is very involved in the international “Third Pole” project, with several research projects and reports related to the subject. Future cryospheric research for 2013-2017 (and possibly the next two decades) is planned in three major areas: i) Simulation of cryosphere and climate, ii) mechanisms of cryospheric changes, and iii) impacts of cryospheric

changes. The framework for Cryospheric Sciences in China is to look at cryospheric connections within all parts of the Earth system (adaptation, disasters, sea level/hydrology, ecosystems, etc.).

Several meetings and symposia were co-sponsored by WCRP-CliC in China. In 2011, China hosted two WCRP/CliC sponsored symposia on cryosphere topics, the "Symposium on Science and Monitoring of Glaciers" and the "International Symposium on Changing Cryosphere, Water Availability and Sustainable Development in Central Asia". China also hosted the "International Conference on Cryosphere: Changes, Impacts and Adaptation". In 2012, there was a CNC-CliC annual workshop, and an International Glaciological Society international symposium on changes in glaciers and ice sheets is planned for 28 July-2 August 2013 in Beijing.

CiPO Update

- Presented by Jenny Baeseman, CliC Director

CliC is in the process of rebuilding after the Directorate Office was vacant for 2 years. Jenny started in April 2012 and Heidi in June. There is very limited documentation on procedures of how CliC runs, functions, etc. Jenny and Heidi have been working on building these processes over the past year, but much more needs to be done. A number of things have been accomplished: an email list with approximately 700 people, signed a collective Memorandum of Understanding with 8 cryosphere organizations and a separate agreement to strengthen ties with the International Permafrost Association; Ice and Climate newsletter redesigned; and established an electronic, large social media presence and redesigned the CliC website with many more resources, tools and features including a Cryosphere Community Calendar. Plans to establish a cryosphere thesis database and cryosphere project catalogue are underway. Some new CliC services for the community include: help in planning meetings, online meeting and webinar tools, and help with outreach. In addition, some of the tasks for the coming year are to develop clear functional structure of CliC, including procedures for applying for funding, new working groups and activities etc., and continue to seek funding for additional activities and hopefully staff, as CliC is by far the smallest of the WCRP core project secretariats. With the new science priorities of CliC coming together, many new tasks will be arising.

The CliC IPO did receive a grant from the Research Council of Norway for 3 workshops, and the IPO will be taking the lead on these events:

- Norwegian sea ice meeting in Tromso in late February, for Norwegian sea ice scientists;
- Sea ice workshop in Tromso in June, bringing together the Arctic and Antarctic sea ice communities; and
- WCRP Climate Grand Challenge workshop in October, also in Tromso.

WCRP has officially signed a MoU with the Norwegian Polar Institute for 5 more years of hosting the CliC Secretariat. This agreement includes salary and benefits for the Director and office assistant as well as at least 200,000 NOK for support of CliC IPO activities to be used at the CliC Director's discretion. It also includes a terms of reference for the office and outlines the responsibilities of the staff and the expectations of NPI and WCRP.

Discussion about CliC future priorities

The current under-representation of ice sheets and glaciers in CliC and the status on the Ice Sheet Working Group has been identified as major factors that need to be addressed. A number of reasons have been put forward for this under-representation. For one thing, the ice sheet and glacier community tends to be rather diffuse compared to other groups represented in CliC. Moreover, ice sheets are not currently coupled interactively in most climate models; if they are dealt with, they are typically only mentioned relative to sea level rise. In spite of this, ice sheets have many other climate-related impacts. Thus, CliC could play a lead role in fostering efforts to couple ice sheet models to Earth system models and so help connect the ice sheet and climate modeling communities. Although there are several ongoing ice-sheet activities around the globe, such as the ISSM workshop for ice sheet models, IMBER, Ice2Sea etc., there is a critical need to identify the gaps more clearly, particularly in terms of connections to climate modeling, and to determine how CliC can help. It was noted that SCAR has new Scientific Research Programmes (see <http://www.scar.org/researchgroups/progplanning/>), groups that CliC might connect with. Additionally, the possibility of CliC co-sponsoring or supporting the SCAR/IASC Ice Sheet Mass Balance and Sea Level (ISMAL) could help foster more collaboration and help that group was discussed and agreed

upon if acceptable with ISMASS leadership. It was also suggested that a Gordon Conference on ice sheet mass balance could be proposed. CliC might also be able to help move things forward by organizing more focused workshops on topics related to ice sheets and climate.

Large International Initiatives and CliC

Cryosphere Grand Challenge

– Presented by Vladimir Kattsov, Voeikov Main Geophysical Observatory

A Grand Challenge (GC) for WCRP has been defined as something that is highly specific and focused, and that identifies specific barriers preventing progress in a critical area of climate science that can be addressed on a 5 – 10 year timescale. Following these criteria, a number of focused science topics were put forward as immediate priorities for the “Cryosphere in a Changing Climate” GC:

- 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 at 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 in determining the rate of the SLR.

If the grand challenge is achieved, this should lead to improved confidence in climate models and their predictive capabilities; further information about future changes in the cryosphere, which will be relevant to stakeholders; more comprehensive and quality-controlled observational variables; and better understanding of key processes involved in cryosphere-climate interactions.

CliC has been assigned leadership of this grand challenge and is expected to contribute to the evaluation and consolidation of cryospheric data, with a view to enhancing their usefulness to the cryospheric community. There should be some overlap between this grand challenge and the one on sea level rise. CliC needs to facilitate better integration of cryosphere component models into existing Earth System models so as to allow improved representation of cryospheric processes and feedbacks. For example, tying ice sheets and ice sheet dynamics to climate models is critical to sea level rise prediction.

International Polar Initiative

– Presented by Vladimir Ryabinin, WCRP JPS

As a follow-up of the WMO/Roshydromet Workshop on the proposal for International Polar Decade (Saint Petersburg, April 2011, report attached), an interagency Steering Group was formed to develop a concept for a long-term cooperative international polar initiative. As a result of intensive exchange of views, by April 2012 the Group came up with the Concept of an International Polar Initiative (IPI). Its updates can be downloaded from the new website: www.internationalpolarinitiative.org maintained by the Canadian Polar Commission. The main idea behind IPI is that it should be a cooperative, thoroughly planned, multi-agency program of activities aimed at addressing issues of polar regions that are most important in terms of their local impact and global significance. The need to address not only high latitude but also high altitude regions (all mountains or only Himalayas – Hindu Kush) is being actively considered.

The Concept Note was initially presented at the Arctic Science Summit Week (ASSW) meeting in Montreal and the Montreal IPY 2012 Conference “From Knowledge to Action” (April 2012). In December 2012, an IPI Town Hall event was held at the AGU Fall 2012 Meeting in San Francisco. In April 2013, the updated IPI will be considered at the ASSW 2013 (Krakow, Poland). Support expressed from the science community is the initial prerequisite for proposing IPI for consideration by international agencies that are represented through members on the Steering Group.

It is proposed to start IPI in 2017-2018 if there is sufficient support for it. This allows sufficient time to generate resources. IPI should “start small” and pick up momentum and resources through convincing

demonstration of its value and success. This will hopefully bring funding agencies onboard (and, of course, they should be approached at a very early stage of IPI development). The IPI should be not only research- but also very much observation- and service- oriented.

Crucial lessons learned from the International Polar Year (IPY) relate to the importance of public engagement in, and support of, such campaigns, and the crucial role of the capacity building, education and outreach, as well as the involvement of young generations and local communities. These requirements are well reflected in the IPI Concept, which helps to continuously accumulate support for the potential initiative.

IPI is a large-scale initiative. There is no guarantee that it will be eventually endorsed by the main international organizations. If this happens, however, IPI has the potential to help coordinate many important polar activities, focus them on achieving useful goals, and generate resources to help attain the goals. In particular, it may help to achieve the key objectives of WCRP and CliC e.g., WCRP Grand Challenges on Cryosphere and Regional Climate Information. WMO considers the Global Cryosphere Watch and the Global Integrated Polar Prediction System, to which the WCRP Polar Climate Predictability Initiative contributes, to be building blocks for an IPI.

Several questions and comments about the IPI were raised as discussion: for example, why is the IPI only focusing on the 2 Poles and perhaps the 3rd Pole environment should also be considered? Connecting the IPI to the International Year of Ice seems like a good way to help launch this effort. A question about funding was also raised, and it seems likely that there will be any additional funding, although the IPI is a way to better coordinate existing funding. Another suggestion was to perhaps concentrate on one key science question, given that doing it well would be a better approach than trying to do everything at the same time (but with less successful outcomes).

Global Cryosphere Watch

- Presented by Jeff Key, NASA / University of Wisconsin-Madison

The International Polar Year (IPY) helped demonstrate the urgent need for a sustained, robust, end-to-end cryosphere observing and monitoring system, not only for polar regions but also globally. In 2007, the World Meteorological Congress supported a proposal to create a Global Cryosphere Watch (GCW). The World Meteorological Organization (WMO) initiated widespread consultations with WMO programs, other organizations, agencies, and the cryosphere scientific community, resulting in Congress approving the GCW Implementation Strategy in 2011. GCW is now being implemented as an IPY legacy for sustained cryosphere observing, monitoring and provision of data and information. WMO's Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS), through its GCW Task Team, is guiding the implementation of GCW.

GCW will soon provide service-oriented information for informed decision-making and policy development related to climate, water and weather, for use in real time, for climate change adaptation and mitigation, and for risk management. GCW builds on the recommendations of the Integrated Global Observing Strategy (IGOS) Cryosphere Theme (CryoOS, see report at: http://igos-cryosphere.org/docs/cryos_theme_report.pdf) to ensure a comprehensive, coordinated and sustainable system of observations and information that will allow for a full understanding of the cryosphere and its changes. This includes initiating a cryosphere observing network called "CryoNet", a network of reference sites and "supersites" in cold climate regions. Reference sites will lead in the effort to establish best practices, guidelines and standards for cryospheric measurement. A complementary task involves developing an inventory of candidate satellite products for GCW that are mature and generally accepted by the scientific community. This task includes an inter-comparison of products to assess quality and to ensure an authoritative basis. GCW is working to improve exchange of, access to, and utilization of observations and products from WMO and other observing systems through a GCW portal. Establishing inter-operability between data management systems supporting cryospheric data directly addresses GCW objectives.

There are a number of areas in which GCW and CliC can work together. CliC can participate in the development/selection of measurement standards and practices; help develop an inventory of satellite products and foster their inter-comparison; review and provide input to observing system requirements; lead the prediction component of GCW; develop cryosphere climate indices; contribute to the development of regional GCW activities; and foster transfer of observational research to

operations. By the same token, GCW can improve access to CliC research data through the GCW data portal and provide high-quality data for models.

There was some discussion during the SSG meeting as to whether the GCW is simply another overarching international coordination effort. Jeff assured the group that the 'hand-waving days are over' and that there are now many things happening, mainly in the form of workshops. Data were also discussed, Øystein Godoy from Met.no was mentioned as the lead on the GCW data portal, and it was suggested that CliC work closely with GCW to minimize duplication in data reporting. SnowWatch was also discussed as an ongoing activity that GCW is supporting and that may be of interest to CliC. It was also suggested that CliC could help to be, or strengthen, the modeling/prediction component of GCW.

Mark Drinkwater (ESA) made a strong case for the Space Agencies' need for a consolidated effort to review community requirements for satellite data. The group agreed that this was indeed important and, ideally, the whole IGOS-Cryosphere Theme Report could be reviewed and updated. GCW and CliC can do this together.

Action: Jeff Key will lead a revision of the IGOS Cryosphere Theme Report with help and endorsement from CliC

Action: Request Walt Meier to serve as a 2-way liaison between CliC and GCW.

Global Integrated Polar Prediction System

– Presented by Peter Lemke, AWI

The Executive Council (EC) of WMO at EC-LX in 2008 established the EC Panel of Experts on Polar Observations, Research and Services (EC-PORS), which has responsibility for WMO Polar activities. This is the entry point to all WMO Programmes and to external partners seeking to collaborate with WMO on polar activities. The aim is to bring observations, research and services together in order to allow WMO to maximize the value of its and its partners' investments in Polar Regions.

At its First Session in Ottawa (Canada), 13 – 15 October 2009, the EC-PORS discussed the timeliness of a Polar Prediction System and started the development of a concept paper. At the Second Session in Hobart, Australia, 18 – 20 October 2010, the EC-PORS agreed on a decadal initiative to develop a polar prediction system, entitled the Global Integrated Polar Prediction System (GIPPS). The word "Global" reflects that it would be an international effort and that the poles affect systems (weather, climate, hydrological, biological, chemical, etc) globally. "Integrated" reflects the interconnections between all of these systems, and also the fact that the System itself will be based on the principles of research, observations and services that are integrated and aligned.

The Panel recognizes that GIPPS needs to meet 'user requirements' through accurate prediction of the future state of the atmosphere, (upper) ocean and hydrosphere/cryosphere for high northern and southern latitudes, and with the support of appropriate observational systems and enabling scientific research and development. Three distinct timescales are envisioned for the system: short (hours to months), medium (years to decades) and long (centuries). Important linkages with major research programs and activities that are focusing on the three timescales are essential, e.g. the WWRP-THORPEX/WCRP Polar Prediction (short-term), WCRP's "Seasonal to Multi-decadal Predictability of Polar Climate" (medium term), and the long-term projection (in the IPCC sense) of ice sheet mass balance and sea level for the next few centuries. Important stakeholders in this engagement include the WMO technical commissions, regional associations, the IOC, Antarctic Treaty Consultative Meeting (ATCM), the Arctic Council, key science groups such as the ICSU, SCAR, IASC and WCRP, ECMWF and NMHSs with polar activities.

The GIPPS concept, developed by the EC-PORS Research and Services Task Teams and endorsed by World Meteorological Congress in 2011, is presented below. This concept is the umbrella of two subsequent endeavors: The WWRP-THORPEX Polar Prediction Project and The WCRP Polar Climate Predictability Initiative. These two projects concentrate their activities on the short-term (1.) and the long-term (2.) aspects of polar prediction.

Some key gaps in our understanding of the polar regions were outlined: boundary layers, polar cloud, permafrost, ice sheet dynamics, sea ice ocean dynamics, and hydrology. Getting sea ice cover/

concentration and thickness correct, so that the heat fluxes and predicted temperatures are correct, is also a major priority. The eventual goal of all these programs is to have a seamless prediction scheme, across all temporal and spatial scales, but to do that the gaps should be closed as soon as possible. A starting point would be to operationalize some output, even if it is not perfect, but that would be a good start to work out the problems before everything else is ready.

Action: Peter Lemke to serve as liaison between EC-PORS and CliC

WCRP Polar Climate Predictability Initiative

– Presented by Ted Shepherd, University of Reading

Ted Shepherd presented the current status of the WCRP Polar Climate Predictability Initiative (PCPI). The PCPI has developed over the last couple of years, and will be a component of the “The Cryosphere in a Changing Climate” Grand Challenge (although the scope of the PCPI extends well beyond the cryosphere). The main motivation behind the formation of the PCPI is that whilst polar climate predictability is an area of increasing importance in climate science, with a current need for a focused effort, its scope cuts across all components of the WCRP and thus it represents an inherently cross-cutting activity. The PCPI will work in close collaboration with the WCRP core projects and working groups to identify gaps in knowledge or scientific research and develop strategies to fill those gaps through well-defined, goal-oriented activities. A preliminary implementation strategy has been recently developed through a community consultation process including two workshops, and the PCPI will now move towards implementing a number of specific activities.

WCRP brings the global perspective and strength in global modeling. Some key scientific questions that will be addressed under this initiative are:

- How predictable is Arctic climate?
- Why are the two polar climate regions changing unevenly in the Southern Hemisphere and the Northern Hemisphere?
- Is the stability of ice sheets changing?

Overall, the pieces are in place to address most of these questions, and by bringing together the different communities to work on common problems, lots of progress can be achieved.

The discussion revolved mainly around improving modeling capabilities and reducing biases and uncertainties. Additional topics that were brought up included how predictable Antarctic Sea Ice is or isn't, looking at extreme events in the polar regions. CliC is looking forward to working with SPARC and other groups to move this effort forward under the WCRP Grand Challenge on the cryosphere.

WWRP Polar Prediction Project

– Presented by Thomas Jung, AWI

The WWRP Polar Prediction Project (PPP) is an IPY legacy activity that aims to promote cooperative international research enabling development of improved weather and environmental prediction services for the polar regions, on time scales from hourly to seasonal. It represents the short-term component of the Global Integrated Polar Prediction System. A detailed Implementation Plan has been finalized and published in January 2013 and is available from WWRP.

PPP deals with classical forecast related issues such as observations, models, data assimilation and ensemble prediction. The focus will be on issues specific to the polar regions such as the prediction of sea ice. Furthermore, research will explore fundamental limits of polar predictability, diagnose the origin of forecast errors and determine linkages between polar and non-polar regions. Finally, science stakeholder interactions will be studied and the field of polar forecast verification will be advanced.

The Year of Polar Prediction (YOPP), which is tentatively scheduled to take place in 2017-2018, is one of the key elements of PPP. YOPP represents an intensive observational and modelling period to advance polar prediction capabilities. It is augmented by research into forecast-stakeholder interaction, verification and an educational component which will be jointly implemented with APECS. The involvement of other initiatives will be crucial and, to this end, a YOPP planning workshop will be held on 27-28 June 2013 at ECMWF.

Close collaboration of PPP with other WCRP activities will be crucial, especially with PCPI, WGSIP and WGNE, in order to jointly implement all elements of GIPPS. To this end, the establishment of an International Coordination Office (ICO) has been proposed, and an offer has been received from the AWI to host such an office. Furthermore, possible topics of future collaboration have been identified, namely coupled reanalyses, model development and seasonal prediction. We envisage that joint WWRP-WCRP workshops will be organized on these issues.

Summary of CliC status, connections and initial thoughts on future targeted activities

There are many areas in which CliC could become more active, and more visible, and make valuable and unique contributions to the climate science community. Some specific near-term opportunities present themselves in the form of specific diagnostic projects in which cryosphere observations and modeling communities could better collaborate (for example in the analysis of CMIP5 and CORDEX output). In addition, CliC could help foster more targeted process parameterization evaluation and improvement. This would be aided by an assembly of homogenized, documented error-characterized cryospheric data sets for use in analysis, model evaluation and forecast initialization (following the very pragmatic approach taken in “obs 4 mips”). Additionally, observational intercomparisons would be good to assess the differences between sea ice data sets, and Ice shelf/ocean interactions. Some specific diagnostic activities might involve evaluation of the surface mass balance over large ice sheets as simulated by Earth System models, implications of climate change for regional glacier mass balance, and better understanding of the differences between (and regional similarities in) recent trends in Arctic and Antarctic sea-ice extent and seasonality.

The discussion opened with the topic of determining how global and regional models simulate surface mass balance of glaciers. This would be a beneficial focus for CliC to initiate. Some targeted activities on ice sheet dynamics are dealt with Ice2Sea, but that ends in mid 2013. Therefore, there is a lack of a coordinated initiative that targets 95% of the cryosphere. We need a coordinated initiative to lead this focus on Ice Sheet Dynamics in which the following can be addressed:

- Quantification of extreme events on ice sheets (and maybe other parts of the cryosphere).
- Helping eliminate impediments to progress on international collaboration in this area.
- Exploring CliC sponsorship of an International Ice Sheet Modeling Meeting

Permafrost is another surface process that is part of the Grand Challenge. There are many carbon/permafrost projects going on currently, but there is a need for an international coordination of these efforts that could be tied to EUCOP. As not much work is being done on sub-sea permafrost, CliC could take the lead on including this with the surface processes focus.

Additional coupling of different cryosphere components could help us to understand the linkages across the cryosphere (i.e. If there is less pack ice, how does that impact fast ice? Etc.), which is something that could come out of a CliC-sponsored workshop.

Mountain glacier mass balance is a topic with considerable uncertainty, with large differences between various observational estimates. An intercomparison of mountain glacier models and glacier volume databases would be very valuable and could facilitate assessment of commonalities and differences.

Other suggestions were that CliC should try and coordinate the different SHEBA-like (for first-year sea ice) projects so they can coordinate before rather than after the fact. However, we do not want to push CliC into these projects, as they are already quite well established and aware of one another.

CliC can coordinate with existing CliC-CLIVAR activities (ocean model development, Southern ocean) Several approaches for CliC include:

- Organize meetings/workshops for communities that do not meet otherwise (like ice sheet modelers and permafrost carbon).
- Identify targeted focused activities that can be done quickly and need only some initial assistance.
- Sponsor focused sessions at conferences – perhaps with a special journal issue afterwards.
- Find some projects from this list that will lead to tangible results within 1-2 years, and a couple of medium (~5 year) projects.

Sponsor/Partner Feedback, and Identification of Gaps/Needs

World Climate Research Programme (WCRP)

– Presented by Ghassem Asrar, WCRP Director

The Director of WCRP, Dr G. Asrar, spoke on progress achieved by the WCRP and future plans of the Programme. They are shaped by the urgent need for actionable climate information based on sound science. In turn, this calls for a “symbiotic” relationship between providers and users of climate information to ensure that climate information is timely, accessible, and understandable, and translates into a need for training and development of next generation of scientists and decision makers who pursue and promote the use of actionable climate/environmental information.

WCRP is expected to maintain scientific objectivity and excellence as a foundation for generating science-based climate information. A dialogue is required with users of climate information to understand their needs and to obtain their feedback on the use of available knowledge and new information. Generating such information will require a holistic approach to Earth climate system research that also includes socioeconomic aspects of the problems and decision-making processes, with stronger focus on research capacity development and regional aspects of climate variability and change and their impact on climate-related risk management, adaptation planning, and global sustainability and development.

The WCRP Grand Science Challenges include:

- Provision of skillful future climate information on regional scales.
- Sea-Level Change and its regional implications.
- Cryosphere in a Changing Climate.
- The role of clouds, aerosols, precipitation, and radiation in climate sensitivity.
- Water availability and distribution in a changing climate.
- Science foundation for prediction and attribution of extreme events.

The WCRP renewed structure is built on natural composition of the Earth system and the dominating interactions in it, which are at the intersections of the ocean and atmosphere, land and atmosphere, stratosphere and troposphere, and cryosphere and the rest of the climate system. It is along these boundaries that the WCRP will continue to develop scientific methods and apply observation and analysis, process understanding, modeling, and generate projections and prediction to generate climate Information and develop practical applications stemming from such information.

Dr. Asrar also introduced the main goals and objectives of the WCRP, its current structure, and the new composition of the WCRP Joint Scientific Committee (JSC). He concluded his presentation, which was also given on behalf of the JSC Chair, Dr A. Busalacchi, with a brief review of JSC decisions and recommendations pertaining to CliC and the Grand Challenge on Cryosphere, for which CliC is responsible. There is a need for authors of the Grand Challenge write-up to identify focused initiatives that could progress significantly in a five-year timeframe. One of these will be the polar climate predictability, to be initially led by SPARC. Overall responsibility for this Grand Challenge, now entitled “Cryosphere in a Changing Climate”, will be with CliC, but the project is expected to work in close coordination with other projects and partner programmes, such as IASC and SCAR.

Stratospheric Processes and their Role in Climate (SPARC)

– Presented by Ted Shepherd, Past SPARC SSG Co-Chair

Ted Shepherd, outgoing co-Chair of the SPARC SSG, gave an overview of the SPARC (Stratospheric Processes And their Role in Climate) core project. He described the ‘modus operandi’ of SPARC, which involves identifying ‘bite-sized’ activities with clear deliverables, and managing all SPARC activities collectively at the SSG level. This sort of management model, which enables flexibility and helps the integration and communication between activities, may be appropriate for CliC. He also outlined several scientific points of contact between SPARC and CliC: the impact of stratospheric ozone depletion and recovery on Antarctic surface climate, Southern Ocean circulation, and sea-ice

extent; the impact of stratospheric sudden warmings on NH high-latitude wintertime climate; and the role of the stratosphere in modulating the Arctic surface pressure response to climate change.

Global Energy and Water Exchanges (GEWEX)

– *Presented by Peter van Oevelen, Director, GEWEX IPO*

With the reorganization of WCRP, the core-project GEWEX has derived a new set of imperatives that describe the projects activities in general strategic terms. It furthermore developed a new mission and vision statement as well as a set of 4 GEWEX Science Questions that match or contribute directly to the WCRP newly developed Grand Challenges. These 4 questions are meant to be a focus area for the next 5 years and are related to the following areas:

- Observations and Predictions of Precipitation
- Global Water Resource Systems
- Changes in Extremes
- Water and Energy Cycles and Processes

The collaboration between CliC and GEWEX can be strengthened in many areas but primarily depends on individual efforts and interests as well as funding opportunities. That said, some alignment of activities that both projects undertake within the WCRP Grand Challenges is desirable and should be fairly easy to attain.

GEWEX is organizing two very small, invitation-only strategic workshops on the WCRP Grand Challenge on Water Resources, namely: 1) a workshop on a Water Strategy for WCRP organized in Saskatoon, and 2) a workshop on Observation and Prediction of Precipitation organized in Ft. Collins. Cryospheric scientists are invited to both workshops. A large consultation with the wider community will take place after these workshops, and follow-up meetings are planned for 2014 as part of the 7th GEWEX Scientific Conference and the 3rd Pan-GEWEX Meeting. Similarly, we hope to organize comparable activities for the WCRP Grand Challenge on Extremes, but plans for this are not as far developed yet (but should be within the next month).

Next to the aforementioned programmatic workshops, there are direct GEWEX Panel activities to which CliC can and is contributing. For example, the High Elevations activity that is being developed in the GEWEX Hydrometeorology panel would certainly benefit from CliC expertise and input.

It was noted that GEWEX (Peter) has been involved in the initial discussions to 'revive' the Arctic freshwater initiative. More work with GEWEX needs to be done, particularly with high latitude glacier freshwater supply and precipitation.

Climate Variability and Predictability (CLIVAR) Status 2013

– *Presented by Roger Barry, Director IPO*

Following the statement of CLIVAR's mission, CLIVAR's organizational structure was reviewed, noting changes from 2012 to 2013. Its responsibilities for three of WCRP's Grand Challenges were listed, followed by a summary of the five Tiger Teams who are addressing CLIVAR research foci. These are:

- Intraseasonal, seasonal and interannual variability and predictability of monsoon systems.
- Decadal variability and predictability of ocean and climate variability.
- Trends, nonlinearities and extreme events.
- Marine biophysical interactions and dynamics of upwelling systems.
- Dynamics of regional sea level variability.

The role of ICPO in communicating to CLIVAR was summarized. The topics of recent Exchanges Newsletters were listed.

Finally, areas of mutual interest to CLIVAR and CliC were identified, such as the Southern Ocean and potentially an Arctic Ocean Panel. Discussion on the Arctic Ocean Panel was mainly around making sure that it was actually needed, as there are so many other groups doing work in the Arctic; a CliC/CLIVAR Arctic Ocean Panel would need to have specific goals and objectives that are not addressed by any of the other groups.

International Arctic Science Committee (IASC)

– Presented by Volker Rachold, Executive Secretary

The International Arctic Science Committee (IASC) promotes and supports leading-edge multi-disciplinary research in order to foster a greater scientific understanding of the Arctic region and its role in the Earth system. IASC encourages and facilitates cooperation in all aspects of Arctic research, but the rapidly changing Arctic cryosphere is a central theme of many of IASC's research activities. Seeking to better understand and predict changes in the Arctic cryosphere in relation to the global climate system is a common interest of IASC and CliC.

This presentation provided an overview of IASC's ongoing and planned activities related to climate and the cryosphere, some of which already involve CliC. A number of IASC activities that would benefit from CliC's participation were presented for consideration by the CliC Scientific Steering Group. A complete list can be found in the presentation.

Scientific Committee on Antarctic Research (SCAR)

– Presented by Mike Sparrow, Executive Director

SCAR has a dual mission of (i) Scientific Leadership and (ii) Scientific Advice. Its remit is broad, covering everything from Astronomy to Genomics in the Antarctic and Southern Ocean region.

Five new SCAR Scientific Research Programmes have been approved from 2013. Three of these are of particular relevance to CliC:

- Antarctic Climate 2100 (AntClim²¹): *"Predictions of the future role and response of Antarctica to global change."*
- Past Antarctic Ice Sheet Dynamics (PAIS): *"Improving our understanding of ice sheet dynamics during past warm world conditions."*
- Solid Earth Response and influences on Cryosphere Evolution (SERCE): *"Advancing our understanding of the interactions between the solid Earth and the cryosphere, to better constrain ice mass balance and sea level change in a warming world."*

Other relevant groups include:

- The SCAR/IASC Ice Sheet Mass Balance and Sea Level (ISMASS) group. A 2012 ISMASS workshop was co-sponsored by CliC and other partners.
- The SCAR/SCOR Southern Ocean Observing System (also endorsed by CliC, CLIVAR and POGO). The next Steering Meeting will be in May 2013 and will also include a meeting of the SOOS data committee (note that a draft SOOS data portal is now active).
- The SCAR Antarctic Climate Change and the Environment (ACCE) advisory group, which will shortly have a major update to the ACCE report published in a peer-reviewed journal, Polar Record (tentative publication date 20th April)..
- The SCAR/CliC ASPeCt group.
- The International Partnership in Ice Core Sciences (IPICS) co-sponsored by PAGES, SCAR and IACS.
- The SCAR Antarctic and Sub-Antarctic Permafrost, Soils and Periglacial Environments Group.
- The CLIVAR/CliC/SCAR Southern Ocean Panel.

SCAR also has several products of relevance to CliC, including:

- BEDMAP2 - Antarctic Bedrock Mapping.
- READER - REference Antarctic Data for Environmental Research (including ICE READER).

SCAR now administers the Martha T Muse Prize, SCAR/COMNAP Fellowships and a new Visiting Professor Scheme.

SCAR will be carrying out a major Horizon Scanning activity in which it hopes that CliC and CliC scientists will participate. This will involve:

- Identification of the most compelling questions that will improve understanding of Antarctica and the Southern Ocean and connections to the Earth System over the next 20 years.
- Online input, including (a) identification of key scientists to act as 'theme leaders', and (b) submission of intermediate scope questions in which substantial progress can be made.

- A Horizon Scanning Meeting in NZ (April 2014) supported by Foundation(s), AntNZ and others, at which 50-60 scientists/policy experts are to identify top '100' science questions and draft short white papers.
- Outputs will include high-profile journal publications and summaries for a wide range of audiences and will guide the next SCAR Strategic Plan 2017+.

Connections to Climate and Cryosphere modelling

Polar Regional Earth System Models

– Presented by Annette Rinke, AWI

The applications and performance of Arctic RCMs are very promising, and their development is ongoing. The most recent results were presented at an AGU session “U51B. The Arctic System: From Critical Process Studies to Global Perspectives”.

Currently, the models include coupling between atmosphere, ocean, sea ice and land. The following ongoing developments are underway: improvement of parameterization of key atmospheric processes (clouds, ABL, cyclone development), improvement of ice-ocean models (AOMIP/FAMOS), coupling with the Greenland Ice Sheet model, improvement of land surface schemes with respect to frozen ground and dynamic vegetation, and implementation of a river routing scheme.

Why is Arctic regional climate system modeling relevant for CliC and what could/should be its role?

(i) Forcing of cryospheric models with high-resolution atmospheric data or direct use of high-resolution RCM simulations. Resolution is important for Greenland SMB. High-resolution RCMs are therefore an important tool contributing to reliable projections of sea-level rise. Now, there are a lot of papers about GrIS SMB using available RCMs. These studies have made it possible to assess uncertainties in model estimates of SMB and to point out important processes (detailed snow physics scheme, e.g. albedo and meltwater refreezing). This also applies to Antarctic SMB. Sea-ice simulations from coupled RCMs help to identify key mechanisms for sea ice-atmosphere feedbacks (e. g. cyclones, albedo). Additionally, atmosphere data from high-resolution RCMs would be of interest for coastal erosion and frozen ground.

CliC: Data advertisement and knowledge dissemination. This could be achieved by improving the newsletter and web page. A CliC-sponsored user workshop or summer school on “Arctic high resolution climate modeling: Bridge between natural and applied science” could be organized (e.g. at Arctic Center, Rovaniemi, Finland, B. Forbes).

(ii) Improvement and evaluation of (coupled) models; Arctic process studies with RCMs. Research is needed towards improved representation of cryospheric processes and better understanding of physical processes/feedbacks through which the cryosphere interacts within the climate system. It is also important to remember that many model shortcomings in cryospheric aspects are derived from errors, not in cryosphere components themselves but rather from the coupled atmosphere (or ocean).

CliC: Promote Arctic model evaluation. CliC should promote and support the MOSAiC project (2017/2018) initiated by IASC, which will combine field experiment and model simulations/parameterizations, with a focus on atmosphere and interface to sea ice and snow over ice. CliC should promote data assimilation studies, like the Japanese-German-Russian pilot study. A workshop to prepare this could be sponsored. ESA-CliC should continue supporting satellite-based analysis and methods to be used for model evaluation. The ESA-CliC conference in November 2012 and a forthcoming special issue in “The Cryosphere” are good results. CliC should sponsor a workshop to foster these interdisciplinary studies.

(iii) Polar climate changes and projections at high resolution.

CliC: Promote Arctic CORDEX and specific analysis. A first meeting (Adsimnor-Cordex workshop) was organized in Norrköping (March 2012). Now the start of concrete analysis should be organized. This could be fostered by a CliC-IASC sponsored meeting for Arctic-specific analysis. Representation at the International Cordex conference (November 2013) should be organized.

Action: Jenny to follow up with Annette on how to move forward.

When will the Summer Arctic be Nearly Sea Ice Free? A Proposal to CliC

– Presented by Jim Overland, NOAA

Multiple Groups (AMAP, WCRP, National Programs), as well as the climate research community and the general public, are interested in this question for adaptation planning and as an indicator of climate change. The observed rapid loss of thick, multi-year sea ice over the last seven years, and the September 2012 Arctic sea ice extent reduction of nearly 50 % relative to 1979-2000 climatology, appear inconsistent with projections of a nearly sea ice-free Arctic summer of 2070 and beyond made just a few years ago. A survey of recent scientific literature suggests three scientific approaches to estimating the timing of future sea ice loss: extrapolation of sea ice volume data, assuming several more rapid loss events such as 2007 and 2012, and climate model projections. Time horizons for a nearly sea ice-free September (<1.0 million km²) for these three approaches are roughly 2020, 2030, and 2040 respectively. Loss estimates from models are based on a subset of the most rapid ensemble members. It is not possible to choose one approach over another depending on relative weights given to data versus models. Observations and citations support the conclusion that current rapid Arctic change is likely out-of-sample for many Global Climate Models' results in the CMIP5 archive due to multiple causes. Recent data and expert opinion should be considered in addition to model results in suggesting the timing of future sea ice loss.

Jim proposed that CliC and its Arctic Sea Ice Working Group address the question: What is a reasonable composite summer sea ice loss estimate and range, based on model projections, data, and expert judgment? One approach would be a short report (<10 pages) and be completed relatively soon (< 1 year) to be relevant to multiple audiences. Another would be a review of the manuscript by Overland and Wang (which is the basis of the above abstract) and/or joint CliC/IASC Workshop.

Action: Jim to follow up with Greg and Jenny

Permafrost Modeling and Observations

- Presented by Vladimir Romanovsky, University of Alaska-Fairbanks

Modeling permafrost and frozen ground in climate models is required not only for correct representation in models of the state of the land surface and its upper layer, but also for adequate account of important terrestrial feedbacks related to changes in the permafrost including energy and mass exchange with atmosphere and the carbon cycle. Contemporary difficulties were highlighted in permafrost modeling stemming from permafrost dependence on a proper representation of hydrology, vegetation dynamics, surface processes, etc., and emphasized that the results of permafrost modeling are very sensitive to biases in the related forcing. Biases in near surface air temperatures on the order of 1 or 2°C are common in climate models. Additionally, biases in snowfall lead to significant biases in modelled permafrost. High vertical and horizontal resolution is needed to resolve freezing/thawing cycles and spatial inhomogeneity of permafrost. The opinion of the leading experts in the field is that low confidence in permafrost models makes it difficult to draw conclusions on the strength of the carbon and permafrost feedback and its implications for future climates. The existing problems are confirmed by analysis of permafrost thermal dynamics and response to climate change in the CMIP5 runs, which demonstrate a very high degree of difference.

Possible steps forward would be to address the following:

- Examine recent solutions of permafrost representation in several leading GCMs and RCMs;
- Test the performance of permafrost-related components of GCMs/RCMs in comparison with more sophisticated off-line permafrost models and observations;
- Formulate the necessary critical improvements in GCM/RCM's permafrost modules;
- Conduct sensitivity analysis using sophisticated off-line permafrost models to choose the most important input parameters, and
- Start working towards development of corresponding standard databases.

The development of a permafrost observation network under the coordination of the GCOS/GTOS Global Terrestrial Network for Permafrost and the International Permafrost Association, which received a significant development in the course of the International Polar Year 2007-2008, needs to be continued. CliC's unique role in permafrost science would be more related to encouraging the development of improved permafrost models and products that tune the models, as well advances in

modeling research on the role of permafrost in Earth system models, which include explicit representation of processes determining the carbon cycle.

Sea Ice Model evaluation

– Presented by Vladimir Kattsov, Voeikov Main Geophysical Observatory

In the context of evaluation of sea-ice models, among its immediate priorities CliC should consider: (1) assessing and documenting uncertainties of observationally-based and reanalyzed data used in evaluation of sea-ice models and particularly sea-ice (and other cryosphere) components of Earth System models; and (2) contributing to planning and designing the CMIP6.

There was some discussion on how this type of model evaluation should not be limited to just sea ice, but should cover other and all parts of the cryosphere. Another suggestion was to go after understanding the biases in models using process-based analyses and metrics. This would involve much closer collaboration between the observational and modeling communities.

Sea ice model evaluation: Data needs, opportunities, and challenges

– Presented by Alexandra Jahn, NCAR

New Arctic observations have improved the possibility for model evaluation against data. However, different models (regional, column, global, climate models or forced models) need different kinds of data. Furthermore, variables are sometimes called the same in observations and models, but are computed very differently, making quantitative comparisons difficult. To highlight these and other topics, F. Massonnet and A. Jahn wrote up a short note on “Data needs for Arctic sea ice models”. This note was expanded upon by the Polar Working group, which extended it to polar climate models in general (including atmospheric and oceanic data). This second document is a living document open to feedback, and is updated every six months after the working group meetings. Both documents are available at: http://www.cesm.ucar.edu/working_groups/Polar/. The need for good documentation of observational data is emphasized in both documents, and one way to contribute to this is by documenting cryospheric datasets for climate model evaluation on portals like the NCAR Climate Data Guide website (<https://climatedataguide.ucar.edu/>), where key strengths and weaknesses can be listed and the way to access the data can be explained. This is very useful for modelers, who are not experts on the observational data and often do not know the weaknesses of different data sets or methods, or even which different products exist. The Cryospheric section of the NCAR Climate Data Guide still needs to be filled in.

CliC could enable better model evaluations by:

- Encouraging the documentation of data sets on the NCAR Climate Data website (for climate data, i.e. large scale gridded multi-year products) or similar efforts (for non-climate data).
- Sponsoring a workshop on model-data intercomparison, with the goal of establishing a database of metrics against which to evaluate climate (and other) models.
- Helping to work towards a consistently defined “vocabulary” of sea ice properties to be used in model evaluations. This could include a list of definitions of variables, and how they should be computed, on the CliC webpage, and the development of suggestions for new output for the next CMIP so that new observations can be used to evaluate models (ensuring output of certain high frequency output or specific non-standard variables)

WGCM and WCRP Modeling Council

– Presented by Greg Flato, CliC Chair

An overview of the WGCM and the new modeling council was presented, along with opportunities for CliC to become more engaged. A particular role is to represent the cryosphere and its representation in climate models and to serve as the focal point for communication between the climate modeling and cryosphere process and observational communities. In the future, it would be very helpful if CliC could provide input into the planning of activities like the Coupled Model Intercomparison Projects and the Coordinated Regional Downscaling Experiment so as to ensure that both the experimental design and the list of requested model output is suitable for a range of cryosphere-related analyses. In

addition, CliC could help coordinate and promote analysis of the outputs of such projects via the organization of diagnostic sub-projects.

Specific opportunities include:

- Contribution to planning of the next phase of CMIP – CMIP6.
- Targeted analysis of output from the CORDEX Arctic and Antarctic domain experiments.
- Input into the analysis of predictive skill in seasonal to decadal climate prediction, particularly as it relates to sea-ice and the high-latitudes (this in conjunction with WGSIP and the PCPI).
- Taking a more proactive, leadership role in activities aimed at improving the representation of cryosphere processes in Earth System models. Examples include the role of Black Carbon deposition on snow as a high-latitude warming agent, the role of high-latitude wetlands and peatlands in the global carbon cycle, and the role of snow processes (including interaction with vegetation) on high-latitude hydrology.

ESA-CliC cooperation and cryospheric observations from space

- Presented by Mark Drinkwater, ESA

Mark Drinkwater of ESA started his presentation to CliC SSG by paying a tribute to Professor Seymour Laxon who tragically passed away in January 2013. Professor Laxon was a key scientist in development of techniques for deriving crucial sea-ice thickness information from ERS-1, ERS-2, Envisat, and CryoSat 2 satellite data. He was also an active member of the ACSYS/CliC Observations and Products Panel.

Impressive achievements in cryospheric observations were related to recent completion of the first CryoSat-2 calibration reprocessing campaign. The importance of measurements obtained using CryoSat-2 is particularly high now due to the completion of the Envisat mission. Currently, the CryoSat SAR interferometric radar altimeter is instrumental in bridging past and future ocean altimetry missions. However we will be able to augment these data with the future launch of the operational Sentinel – 1A C-band SAR imaging mission.

There are three proposals that will be considered for the forthcoming selection of the 7th Earth Explorer 7 (EE7) mission. One of the proposed missions is called Cold Regions Hydrology High Resolution Observatory (CoReH2O). It is a single satellite with a dual-frequency (X- and Ku-band) and dual-polarization SAR capable of delivering the first global high resolution measurements of fresh water stored in snow, providing important new capabilities for observing glaciers worldwide, and enriching the ongoing research on permafrost processes.

The EE7 feasibility studies, including supporting scientific and technology studies, were completed in 2012, and their results were documented in the Reports for Mission Selection. Their outcomes will be discussed at the User Consultation Meeting in Graz, Austria, on 5-6 March, 2013, and the final decision on EE7 will be made in May 2013.

In view of the extreme importance of the CoReH2O mission to the objectives of the CliC, SSG decided to send a letter to the ESA Earth Observation Directorate expressing the project's support of the CoReH2O mission. Being involved in the design of the CoReH2O, Dr Helmut Rott abstained from any comments on this matter.

Action: Jenny Baeseman and Vladimir Ryabinin to draft a letter to ESA Earth Observations Directorate expressing support on behalf of CliC to the CoReH2O mission as the new EE7.

M. Drinkwater further recalled to the SSG that a framework cooperation agreement between ESA and WCRP was signed on 16 March 2009. Its objectives were: i) to ensure effective and full exploitation of ESA Earth Observation satellites and ESA data assets in climate research; and ii) to use the WCRP Projects and community as a source of consolidated requirements for ESA activities. The agreement helps to focus ESA's exploitation activities such as the Data User Element (DUE), Support To Science Element (STSE), and the Climate Change initiative (CCI). The key initiatives and projects already initiated in this domain include the DUE GlobSnow, GlobIce, GlobGlacier, and Permafrost projects and the STSE studies on Northern Hydrology and Essential Climate Variables (glaciers, ice sheets, sea level, and sea ice).

ESA is updating its strategy of the Living Planet Programme, and WCRP and CliC in particular should take advantage of this update to align the cryosphere element of the ESA EO Programme with the CliC Grand Challenges. This requires a cross reference between cryospheric challenges with EO challenges and identification of observation gaps and critical observational needs.

The recent CliC-ESA-EGU Workshop (Frascati, 13-16 November 2012) made it possible to specify priority studies that fit the ESA EO programme guidelines. Participants in the workshop represented a vibrant community that was capable of conducting a very comprehensive assessment of the needs for cryospheric observations from space.

Two newest initiatives of ESA that were intended to serve as CliC goals include:

- The ESA-CliC Mass Balance Study to develop potential methodologies of exploiting the synergies of the ESA multi-mission data (altimeter, new 3-day interferometry campaign, CryoSat 2, GRACE...) in order to reduce uncertainty in mass balance studies.
- CryoSat 2 and Cryosphere Study to explore, develop, and validate innovative scientific applications of CryoSat 2 data beyond its primary mission objectives.

The ESA-WCRP Framework Agreement provides a solid foundation for aligning the WCRP Grand Challenges and preparation of new ESA Earth Observation Strategy. It was suggested that CliC contribute to the organization of User Consultation Workshops that help to collect priorities and recommendations including required ESA satellite observations or archived data products and to foresee new studies that can be incorporated in the ESA DUE and STSE activities planning. One way of updating such requirements and presenting them in a consolidated way would be a revision of the IGOS-P Cryosphere Theme Report, which may be undertaken together with the Global Cryosphere Watch. Some parts of such an update are already in place, e.g. for ice sheets they can be found in the Schuechl ice sheet community requirements document. The need for such an update is critical, particularly because of the loss of Envisat and the resulting need to collect additional data from other missions.

Science Day with Potsdam Researchers

See CliC website for more details

<http://www.climate-cryosphere.org/index.php/meetings/past-meetings/awi-clic-symp>

Identification of New CliC Priorities and Goals

Freshwater Balance

– Presented by Larry Hinzman (on behalf of Terry Prowse)

Freshwater integrates and propagates many of the rapid changes that are currently transforming the Arctic system. Therefore, understanding and adapting to changes in the Arctic freshwater budgets will be integral for sustainable development in the region. Several international research programs that have focused on the Arctic freshwater system (e.g., the NSF Arctic-CHAMP and FWI programs, and the Arctic-HYDRA program carried out under IPY 2007-2009) have now formally ended, and currently no major network or program exists on the cross-cutting water cycle in the Arctic. While the above-mentioned initiatives have contributed to major advances in knowledge, a multitude of remaining challenges and knowledge gaps have also been identified under these programs and in other research.

A range of other issues coupled to the freshwater cycle are in urgent need of comprehensive synthesis, including (identified in the ICARP II overview) sub-regional impacts, coupled socio-economic and environmental impacts from rapidly expanding natural resource extraction, and assessing vulnerabilities.

It was proposed that CliC could lead an international activity and sponsor an associated series of workshops, with a focus on the Arctic freshwater system. Leading up to the Third International Conference on Arctic Research Planning (ICARP III) in Tokyo, 2015, activities will include a review paper(s) to be published in a high-impact journal, and the development of a concise but comprehensive integrated assessment and synthesis document of current knowledge on the Arctic freshwater system. The synthesis document should consist of several chapters covering various aspects of the Arctic freshwater system, with about 3-6 authors responsible for each chapter. The document should also include a summary of the state of the art of current research as well as identify major imperatives for continued research in the coming decade.

Satellite techniques for observing global glacier mass balance

– Presented by Helmut Rott, University of Innsbruck

There is still considerable uncertainty about the global mean mass balance of glaciers and the regional pattern. This impairs the assessment of recent contributions to sea level rise from mountain glaciers and ice caps, and affects the estimates for future decrease in glacier volume for which large regional differences are expected. High resolution satellite sensors (radar interferometry – InSAR and optical stereo) are able to deliver spatially detailed observations of surface topography with near global access. These sensors offer excellent opportunities for reducing the uncertainty in mass balance estimates for glaciers and ice caps world-wide. The geodetic mass balance technique is applied, converting volume changes into net mass balance numbers. The retrieval and intercomparison of surface topography on glaciers from different sensor types requires compensation of various effects on the observed signal. Proper assessment of measurement uncertainty is also an issue, which has not always been taken into account properly for the published data.

Main uncertainties in determining the net mass balance over a certain time interval with the geodetic method are due to (1) uncertainties and/or systematic errors in the topographic data; and (2) uncertainties in converting volume changes into mass changes. For point (1) in case of radar interferometry (InSAR), a potential error source arises from radar penetration, which varies with radar wavelength and with the propagation and scattering conditions of the snow and ice volume. On the other hand, InSAR offers advantages over optical stereo sensors in regions of low optical contrast (bright snow surfaces), and the SAR acquisitions are not affected by clouds so that observations in regular time intervals are possible. Uncertainties related to point (2) are relevant if the vertical density profiles of snow and firn change.

The main issues with techniques in retrieving glacier volume changes were reviewed. Particular attention was paid to the German TanDEM-X (TerraSAR-X add-on for Digital Elevation Measurements) satellite of DLR, which was launched in June 2010. Results of the analysis of glacier

volume changes from InSAR and optical sensors were compared and the accuracy was compared with airborne and in situ data sources. The results confirmed the high potential of TanDEM-X for regular and precise surveys of glacier surface topography. This was thought to have potential which has so far been exploited only marginally due to focus on the acquisition of a global DEM.

Discussion revolved around the importance of better understanding snow, and validation of snow properties and measurements using satellites.

Action: Vladimir and Jenny to draft and send a letter of endorsement for the CoReH2O project from ESA.

Ice sheet mass balance work (ISMASS)

– Presented by Ed Hanna, University of Sheffield

There has recently been some improved convergence of satellite (altimetry, interferometry and gravimetry) estimates of ice-sheet mass balance (MB), as evidenced through the IMBIE programme (Shepherd et al. 2012, Science) - but poor agreement remains between some estimates, which needs to be reconciled. There is a need to better define error estimates and uncertainties of ice-sheet mass-balance change. We need to accurately discriminate 1-2% changes in Antarctic (and Greenland) mass balance (sea-level equivalent). Continued satellite monitoring of Antarctic and Greenland Ice Sheet mass balance using a variety of platforms and sensors is critical. The recently acknowledged role of postglacial rebound model corrections in mass balance estimates has resulted in a significantly reduced Antarctic sea-level contribution compared with previous estimates. However, to improve matters, we should obtain more GPS measurements in data-poor regions. Adequately representing firn compaction is also important for more accurate MB estimates, as is improved representation (modelling and observational verification) of the surface mass balance component of total mass change.

There has been a major improvement of ice sheet models since IPCC AR4 i.e., full-Stokes, higher-order, grounding line migration, dynamic evolution, and initialization (inversion). AR5 will incorporate a number of process studies, but a certain degree of cross-scaling will still be necessary. It is important to accurately reconstruct and understand past ice sheet and climate change since the Last Glacial Maximum, making special reference to the Melt Water Pulse 1A event. GIA models need to be coupled with ice sheet models linked to grounding line motion/ocean interaction. Better model representation is needed of thermal and hydrological processes, including widening of ice streams and their margins. More comprehensive observations will help link iceberg calving to atmosphere/ocean processes, and help develop new calving laws. The role of basal sliding (plastic vs viscous vs nonlinear) needs to be better understood.

Further pressing research priorities concern ice-ocean interactions (coupling models at different scales), observations (melting-refreezing under ice shelves), ocean measurements and cavity shapes (data). Improved velocity and bedrock data would also be useful.

We should reduce uncertainties introduced by instrumental bias corrections and mapping approaches in estimates of the global evolution of thermosteric sea level and its spatio-temporal variability. An improved quality and consistency of ocean sub-surface temperature and salinity measurements is required to meet the more demanding climate-related requirements. We should expand the current ocean monitoring system to coastal boundaries/marginal seas, below 2000 m and under sea ice coverage/nearby ice sheets (with unique water properties, mixing and circulation changes).

We need to better define the impacts of different global sea-level rise scenarios. How will these change with socio-economic developments, with subsidence, with and without adaptation, and in relation to other climate change e.g. storminess variations? We need to understand the major impacts, and adaptation in subsiding areas, of relative sea-level rise.

We should decide what observational system is required to detect unexpected acceleration of sea-level rise due to ice loss in Greenland and Antarctica. What temperature threshold do we need to 'avoid deglaciation' in Greenland and Antarctica?

The discussion focused mainly on the ISMASS initiative from SCAR and IASC. There was a workshop last summer in Portland that CliC helped support to try to reinvigorate this activity. The group is hoping to have a new strategy and leaders by Easter this year. CliC is represented in this group by Edward Hanna. Co-sponsorship of ISMASS by SCAR, IASC and CliC was suggested.

Ice Sheet Modeling did not appear to be a large focus this far for the group and it was recommended that this area is strengthened. CliC should be more active in Ice Sheet modeling and perhaps a CliC working group on this could feed into the ISMASS efforts.

Action: Jenny to follow up with Ed and the ISMASS group on co-sponsorship, website hosting, and future workshops

Regional sea-level rise and Glacier-Ocean Models

– Presented by David Holland, New York University

Satellite observations over West Antarctica over the last few decades have revealed a strong signal of glacier thinning, particularly in the Amundsen-Belingshausen Seas area of the Southern Ocean. This thinning has been linked with the presence of warm water beneath the floating ice shelves in this sector of Antarctica. Because the ice shelves in this region link to inland ice, which is grounded below present day sea level, and because that ice is on a reverse bedrock slope, it is speculated that this inland ice could be unstable and melt and crack into the ocean. This could have a major impact on global sea level change over the present century and beyond.

There is a pressing need to develop regional coupled glacier-ocean models that can simulate the present day state of the system as well as to project possible future changes. It is therefore proposed that CliC initiate an activity that will bring together the international community of researchers working in this area in order to accelerate progress. The activity would first establish a common framework that would define a suite of common experiments to be conducted, including common forcing and experimental protocols.

Connections between elements in the cryosphere

– Presented by Rob Massom, AAD and ACE CRC

The talk by Rob Massom (AAD and ACE CRC, Australia) addressed a developing line of research, namely identifying and understanding linkages between different elements of the high-latitude cryosphere and how change in one may affect others, with wider ramifications. This emerging field is of direct relevance to the goals of CliC, in that it bridges and links (integrates) sea ice, ice sheet, ocean, permafrost and atmosphere, and involves remote sensing, in situ observations and modelling. A number of examples were given to illustrate the potential importance of developing improved knowledge of cross-cryospheric linkages. One area under investigation is the potentially crucial yet poorly understood role of landfast sea ice in mechanically binding and stabilizing vulnerable floating ice-sheet margins (e.g., Massom et al., 2010). The distribution of the fast ice is in itself affected by the distributions of grounded icebergs and the surrounding sea ice. This work, for example, suggests that understanding the coupling between fast (sea) ice may be an important (yet largely overlooked) factor when trying to better understand (and model) processes controlling ice tongue and ice shelf evolution and calving mechanisms, and how they may respond to climate change. Further work in progress (Massom et al.) is investigating the potential role of recent regional change in sea ice seasonality in the breakup of ice shelves along the Antarctic Peninsula, with implications for global sea level rise. Another example of a key yet subtle cross-cryosphere linkage is the relationship between loss of sea ice (both pack and fast ice) in the Arctic and permafrost warming and erosion (e.g., Lawrence et al., 2008).

The IGS Symposium on Sea Ice in a Changing Environment will be held from 9-14 March 2014 in Hobart. CliC was asked to co-sponsor this event, as they co-sponsored the last one that was held in Tromsø in 2010. A special session on cross-cryosphere connections is planned for this symposium, and CliC support will be sought to sponsor future workshops that draw together expertise from across the disciplines to carry the Targeted Activity forward (this is a challenge that needs to be met). An expected outcome will be a (first ever) review paper in a high-profile journal on cross-linkages and feedbacks between different elements of the cryosphere, and their response to climate change. The aim is to bridge a current gap in the literature (with a view to future representation in IPCC

Assessment Reports), but also to identify gaps in our current knowledge and understanding. Engagement with the various modeling communities (global and regional climate, coupled sea ice-ocean-atmosphere, ice sheet etc.) is essential, and is planned, as an ultimate aim is to provide information that enables more effective representation of cross-cryospheric linkages in models.

Towards an Intercomparison framework for Ice Sheet Models

– Presented by Eric Larour, JPL, NASA

With the emergence of new ice sheet models in the last 5-10 years, a concerted effort has been carried out to try and understand what fundamental differences between different ice sheet models are responsible for the wide divergence in projections of mass balance. This led to the "Sea-level Response to Ice Sheet Evolution" (SeaRISE) community effort on the US side, and the "Estimating the future contribution of continental ice to sea-level rise (Ice2Sea)" effort on the European side. Both efforts were independently conducted, with some synchronization carried out only in the later stages of the projects. This led to different requirements for both sets of benchmarks, and resulted in difficulties for ice sheet modelers in answering such requirements twice. In addition, no financial support was provided on the SeaRISE side, which grew-up as a grass-root effort. This created strains on ice sheet modelers, as the amount of effort needed to run the required models was significant.

It was proposed that advantage be taken of the fact that both efforts are currently at an end that there is a need to secure funding for a second phase of benchmarking activities i.e., to try and coordinate both efforts under the CliC umbrella. The goals could be to: 1) minimize the effort between both communities to run both sets of benchmarks; 2) potentially synergize both efforts to target different aspect of benchmarking activities; 3) facilitate diffusion of benchmarking results within the Climate Community, especially through integration within the Earth Grid System; and 4) better understand how both efforts could be synergized with the CMIP5-6 generation of climate benchmarks, and potentially assimilated/folded into the latter in the longer run.

Outreach Activities

Community Engagement

- Presented by Penny Wagner, University of Delaware

This session constituted two topics of discussion. The first introduced the International Ice Chart Working Group (IICWG) to see how we can forge closer collaborative links between both groups. The IICWG includes every active sea ice charting organization (see: <http://nsidc.org/noaa/iicwg/>). This is relevant to CliC's agenda because research and development aims in the IICWG are working towards using their current and archived data in improved data assimilation. The sea ice charting operations organizations have comprehensive data archives for areas in the Arctic and the Antarctic. Their data products are generated using various satellite products and spatial and temporal resolutions. Though each operational organization's sea ice products vary depending on their operational needs, their products can be used for research purposes following further qualitative and quantitative evaluations with regards to sea ice uncertainties and errors when producing forecasts. Ultimately, the IICWG would like to make the best use of their products, with data assimilation to produce automated and real-time data for operations and navigation, as well as further applications such as the tuning of climate models. We should expand our awareness of how we can optimize resources with the science and operation communities, especially during this critical time when the need for improved data availability in the polar regions is so important. A suggestion is for CliC allow participation of IICWG members in some of its agendas; this would be a great step in the future towards obtaining our goals with the sea ice focus of our discussions.

The second topic of discussion focused on how we can make CliC more relevant in the international cryospheric research community and build better connections to other WCRP activities. This began with a recap about the Association of Polar Early Career Scientists (APECS) and how we can bring in young and early career scientists to participate in CliC activities. The first suggestion (geared towards the whole CliC community) was that we need to re-engage previous partners/members and get new scientists involved with activities that captivate them and keep them engaged. We have a need to promote and include young scientists to participate with CliC activities, but this also applies to senior colleagues, organizations, and groups who could benefit from collaborations forged by CliC. Current

members need to advertise CliC to their community by including CliC information in with upcoming activities and presentations, as well as seeking out opportunities for further involvement. This could include initiating working groups (through CliC) and combining CliC activities with current groups and organizations. Some suggestions from Larry Hinzman and Marilyn Raphael were for those working in faculty positions to set aside some time for selected students to assist with CliC action items. Additionally, CliC needs to establish a transparent framework that allows previous and new members to get involved and stay involved.

Ice Sheet Model Early Career Scientist Workshop

– Presented by Eric Larour, JPL, NASA

Ice sheet modeling is a field of cryosphere science where much progress has been achieved in the last 5-10 years, starting with the realization that climate models do not include higher-order ice flow models that could capture the full range of ice flow dynamics necessary to correctly assess the contribution of polar ice sheets to sea level rise. Due to the rapid emergence of large-scale, higher-order ice sheet models, the need for synergizing various efforts across the globe has arisen. In particular, there is presently no forum wherein ice sheet modelers can share results, methods specific to ice sheet models, or discuss issues that are specific to this field. There are of course local efforts such as the CISM-LLWG workshop, the ISSM workshop and the Karthaus Ice-Sheet Summer School, but nothing synchronized at the international level.

It was proposed that the existing ISSM workshop, organized every year at JPL and UCI (California, USA), be expanded to create a new CliC-sponsored forum/workshop, where cryosphere scientists interested in ice sheet modeling could participate. We could invite scientists to give invited talks on specific issues relevant to ice sheet modeling, invite young researchers to discover this new field, and organize sessions for ice sheet modelers to present their science results, technological advances, modeling challenges, etc ... In addition, we would continue the ISSM model of tutorials/classes, with a hands-on approach to ice-sheet modeling, using laptops with pre-installed ice modeling software such as ISSM. This format is very interactive in nature, and is much appreciated by young researchers, as it provides a blend of science talks and hands-on tutorials that improve the learning experience. The format could be extended to other frameworks/modeling software initiatives that are willing to participate (such as PISM, ELMER/ICE, etc). The location for the workshop could rotate, with the Niels Bohr Institute potentially hosting the 2013 workshop. More details will be provided in a proposal currently being written.

Karthaus Summer School on Ice Sheets and Glaciers in the Climate System

- Presented by Dorte Dahl-Jensen, University of Copenhagen

The following website describes a course that teaches the basic introduction to the dynamics of glaciers and ice sheets with a focus on ice-climate interactions. This course is meant for Ph.D. students that work on (or will soon start working on) a glaciology-related climate project. A few places are available for junior scientists. This course takes 20,000 Euros / year to run, but funding has run out. For more information the website is: <http://www.projects.science.uu.nl/iceclimate/karthaus/>.

Action Items for CliC Outreach activities:

A discussion on membership was raised regarding what an affiliation with CliC should entail. Not only members of various CliC bodies can be associated with the project. CliC SSG agreed to continue the discussion on creating a "CliC community". CliC should create a 'member' database to include postdocs and PhD students who are involved in, or want to participate in, CliC research priorities. This could help to initiate new networking opportunities as well as the development of educational resources.

A means to ensure 'brand visibility' of CliC needs to be proposed as well. CliC could consider developing an outreach committee, developing a mentoring program for early career scientists, holding webinars on cryosphere topics, and helping early career scientists to develop leadership skills by assisting with report writing, organizing workshops, etc. A special effort should be put into increasing participation of scientists from developing countries. An example proposed would be a workshop for South American students on glaciology. The suggestion of having CliC help with

education through answering questions from students and the general public through an online forum was also proposed. A great example to use as a model is from the JPL site outreach activities: <http://www.jpl.nasa.gov/education/>

Ultimately, we should make it a high priority to remind researchers what CliC can do for the community. Additionally we should clearly state our immediate tasks to include information on the timeframe of the project and assemble questions to answer the Grand Challenges initiated by the CliC community. If we can get specific questions that state what the main gaps in knowledge are, CliC could then put a call out for researchers in the applicable fields to get involved.

Action: Jenny to develop 'branding policy' and related materials, establish outreach committee, and follow up on other items discussed.

Practical Steps Forward

The SSG has reviewed the project structure. It was decided to retain the previously existing working groups "Antarctic Sea-Ice Processes and Climate" (ASPeCt, cosponsored with SCAR), the CliC Arctic Sea-Ice Working Group (CASIWG), and the CLIVAR/CliC /SCAR Southern Ocean Panel. Their terms of reference and composition should be revised before the next SSG.

The SSG agreed to propose to IASC and SCAR that the ISMASS (Ice Sheet Mass Balance) Working Group would become co-sponsored by SCAR, IASC, and CliC and that new terms of reference are developed for the group. Ed Hanna has agreed to continue representing CliC on the ISMASS interim steering group and will work with Eric Larour and Dorthe Dahl-Jensen on these matters. They will work together toward potentially extending the scope of ISMASS to include an ice-sheet modeling forum, which is the main interest of CliC and which will represent CliC's main contribution to ISMASS future activities. The 'structure' of the 'forum' will need to be determined.

Action: Ed Hanna, in cooperation with Eric Larour and Dorthe Dahl-Jensen to propose an extension of the ISMASS terms of reference and draft a short statement on its expected outcomes (by end of April 2013). A town hall meeting at EGU, to get as many modelers involved as possible, may be organized.

The SSG agreed to establish a Sea-ice and Climate Modelling Forum. Its goal will be to provide coordination of sea-ice modelling, coupled ice-ocean modelling, global and regional climate modelling on topics related to sea-ice physics, numerics, and coupling/feedbacks with ocean and atmosphere. ASPeCt, CASIWG, and the AOMIP should be represented in the forum. This Forum will act as the CliC point of contact for all research activities associated with ice and climate, such, e.g., as the proposed Mosaic project.

Action: Alexandra Jahn will serve as the lead for this forum. She will work together with Marilyn Raphael, Annette Rinke, and Greg Flato to draft the Forum terms of reference and ~2 page document outlining scope and initial plans, support needs, etc. All CliC sea ice groups will be working with and through the Forum. Issues related to the Forum should be included in the programme of the June 2013 sea-ice workshop in Tromsø.

The SSG agreed to establish a Permafrost Modelling Forum, which will continue to provide support to the activities addressing the research on permafrost and carbon, and will coordinate the development of all aspects of cold climate land surface modeling that shape the future of permafrost.

Action: Vladimir Romanovsky, Gerhard Krinner, Annette Rinke and Larry Hinzman will prepare the terms of reference of the Forum and will draft a ~2-pager on its scope, initial plans, support needs, etc. This work will constitute a CliC contribution to GCW and will involve developing, in a 1-2 - year time frame, a permafrost retrospective simulation tool that will be using available soil moisture remote sensing data and reanalysis data as forcing.

CliC agreed to continue supporting the Research Coordination Networks focusing on research on permafrost including such important aspects for coupled modeling as hydrology and related energy exchanges at the surface. CliC's role may be to facilitate connections between RCN and other activities, e.g., the PAGE21 program, and reach out to involve Russian, Japanese, Chinese, and

probably Mongolian researchers. The main objective of this supporting work will be to continue the research on carbon and permafrost.

A stronger connection between CliC and EC-PORS and GCW needs to be established. Peter Lemke will act as the CliC liaison to EC-PORES and Cunde Xiao to GCW. As a first step in a joint activity between GCW and CliC, Jeff Key agreed to lead a follow-up to the IGOS-Cryosphere Theme.

New CliC Targeted Activities

Four CliC Targeted Activities (CTAs) have been agreed as described below. A short (~5 pages) prospectus should be developed for each of them to provide a description, team members, specific deliverables, timeline, available support, and support needed from CliC.

Antarctic ice-shelf and ocean coupled modeling

- to be led by Dave Holland and Eric Larour

This activity can have a direct link to several regional projects. Joint interests and perspectives of cooperation with SOOS can be discussed at the forthcoming SOOS meeting in Shanghai, China in May 2013. Cooperation with research groups involved in the FRISP and WAIS activities was suggested for this CTA.

Understanding linkages between cryospheric elements

- to be led by Rob Massom

The focus will be to draw together cross-disciplinary expertise and work with a view to identifying and better understanding cross-cryosphere linkages in both polar regions, involving sea ice, ice sheets, permafrost, snowcover and the ocean and atmosphere. CliC will consider supporting (co-sponsoring) a special session on this topic at the IGS International Sea Ice Symposium in Hobart in March 2014. Change and variability in regional sea ice and interactions between ice shelves, icebergs, pack and fast ice, and other elements of the marine cryosphere are the prime focus of this initial session.

Coordination of cryosphere observations for model evaluation and prediction initialization

- to be led by Dorthe Dahl-Jensen, Vladimir Romanovsky, Marilyn Raphael, and Alexandra Jahn, and others

The Obs4MIPs approach and the activities at NCAR that summarize available datasets for model evaluation (see, e.g. <https://climatedataguide.ucar.edu>) can serve as a basis for developing approaches for cryospheric model evaluation and calibration. Process-oriented model validation as developed by the SPARC CCMVal, emphasis on a single cryospheric element as the starting point, analysis of 1-D datasets, review of reanalysis data could be considered as initial activities. Past ACSYS and CliC experience and people that used to be involved in associated data management may be instrumental in guiding data access in this activity.

Arctic freshwater synthesis

- to be led by Terry Prowse, Larry Hinzman, Nalan Koç (TBC)

CliC SSG confirmed the previously announced decision to develop a science-oriented assessment of freshwater balance of the Arctic Ocean, with a focus on the cryosphere. Terry Prowse will lead this assessment and, together with Larry Hinzman and Nalan Koç, will determine its actual scope. It was noted that GEWEX communities may be interested in participating in this should be invited to contribute.

In addition to CTAs, it was agreed to start working on several topics of strategic interest for CliC. They are described below.

CliC should contribute to activities of WGCM and WGSIP, planning of some climate model intercomparison activities, and generating representative list of desired output parameters from climate modeling experiments, for example from the proposed CMIP6. Greg Flato will represent CliC

at the next WGCM meeting, which he is hosting in Victoria, BC, Canada, in October 2013. One possible avenue of the joint work with WGCM and WGSIP is the implementation of the Polar Climate Predictability Initiative (PCPI), for which JSC assigned CliC as the responsible WCRP core project. It is important to determine how and where CliC can engage in PCPI and take the lead in the initiative implementation activities. To do so, CliC has to continue to work with Ted Shepherd and James Overland focusing on relevant process studies and representation of cryosphere in the predictability experiments. Marilyn Raphael and David Holland are involved in PCPI planning and Vladimir Ryabinin will continue to provide coordination and support from the JPS in Geneva.

In the activities of the Arctic Monitoring and Assessment Programme, there is a need for updated information on Arctic climate change scenarios. User-friendly access to climate change predictions and projections based on regional and global climate models could inform several types of impact assessments and information on cryosphere in such datasets is of high importance. CliC will engage with the AMAP climate expert group for an ACIA follow up and will contribute to the expected related workshop in St. Petersburg. Greg Flato will take the lead on this activity and will attend the workshop as well as Annette Rinke and Sasha Klepikov.

Projections of mountain glacier water availability, response to climate change, vulnerability regarding future water supply, etc. are indispensable for future assessments of water reserves. Intercomparison of glacier volume estimation based on the potentially available SAR data represents a highly desirable dataset for such assessments. However, releasing such information is technologically very challenging and requires a lot of resources. This topic is not well addressed currently within CliC and should be future developed, perhaps as a contribution to the WCRP Grand Challenge on Water Availability and Distribution in a Changing Climate. A forum on mid-latitude cryosphere may be considered as another CliC action aimed at glaciers. Cunde Xiao, Helmut Rott, and Tetsuo Ohata will review the way forward. There may be a need to develop a new regional framework for CliC-oriented research on the Asian cryosphere.

Action: Helmut Rott will put together a summary on the status of mountain glacier water availability issues with help from Cunde Xiao and Tetsuo Ohata, with the intent that this summary will lead to actionable items CliC can undertake.

Mode of CliC operation between sessions

Active involvement of SSG members between sessions and their continuing guidance of and support to CliC activities are needed for successful implementation of agreed project activities. While there is no obligation for CliC SSG members to directly lead the activities, it is important that they look for opportunities to generate resources for CliC activities and attempt to create incentives and facilitate funding opportunities for activities addressing priorities identified by CliC. The SSG resolved not to form a CliC Executive Committee. In order to preserve the positive momentum achieved by the SSG session, SSG members are asked to complete all expected writeups specifying proposed activities within one month after the SSG-9 Session. Regular teleconferences of SSG will be organized approximately every two months at an agreed time, most often at 3 PM UTC. CliC SSG members may be expected to represent CliC at various WCRP and partner meetings. For that purpose, the office will prepare a generic CliC Powerpoint set of slides that describe CliC and its goals.

The following scientists will act as CliC liaisons to various WCRP groups:

WGCM, WMAC: Greg Flato

WGSIP: Yvan Orsolini

WGRC: Annette Rinke

WDAC: Walt Meier

WGOMD: David Holland

The CliC IPO has developed a long-term calendar of future events of professional interest to CliC. Sponsorship of some of them and/or sponsorship of participation of early career people in such meetings should be pursued, depending on the theme of the meeting and availability of resources. It is important to define conditions and guidelines for offering CliC endorsement or supporting (sponsoring) and events and activities and to start applying them.

Action: Jenny Baeseman will draft a guidance material on CliC sponsorship and support of an activity or an event, including dealing with endorsement / support requests that may come intersessionally and draft generic CliC powerpoint for others to use.

The Third International Conference on Arctic Research Planning (ICARP -3, Japan, early 2015) will represent a milestone for CliC and some its partners. CliC has to actively help in developing the agenda of ICARP-3 and use it for facilitating research on the goals of the project.

Action: Jenny Baeseman to join ICARP-3 planning committee

The SSG agreed that there is a need to review and update the CliC Implementation Plan, which was reviewed for the last time in 2007. The plan has to reflect recent changes in WCRP, the existence of GFCS, Grand Challenges, and new foci, etc.

Action: A writing team composed of Greg Flato, Peter Lemke, Gerhard Krinner, and Larry Hinzman will begin work on the CliC Implementation Plan in the third quarter of 2013 with support from Jenny Baeseman and Vladimir Ryabinin. The next draft will be discussed at the 10th Session of the CliC SSG.

Funding requirements for CliC events in 2013 need to be compiled and submitted to the WCRP Joint Planning Staff. There is also some budget for activities associated with Grand Challenges, outreach and capacity building. The framework cooperation agreement with ESA makes it possible to receive some support for CliC activities. SPARC is developing a space-based data requirements review, and space agencies may be interested in a similar work with respect to the cryosphere (e.g. an update of the IGOS Theme on Cryosphere).

Action: Jenny Baeseman and Vladimir Ryabinin will work with Greg Flato to develop a CliC work package that can be submitted to ESA for consideration.

Sponsorship of the CliC Project

The Memorandum of Understanding between WCRP, IASC, and SCAR on sponsorship of CliC and some other activities expires in July 2013. Representatives of WCRP, CliC, IASC and SCAR met during the CliC SSG session for discussion on ways of strengthening collaboration and cooperation of the programmes. The consensus was that the formal co-sponsorship was suboptimal and that the most fruitful approach to developing joint activities would be to prepare and sign a 'memorandum of agreement' outlining continued close collaboration and cooperation and focusing on several specific areas of joint activities. It was also noted that it is highly desirable for maintaining momentum and creating favorable conditions for a number of joint activities that the aspects of partnership between CliC, IASC and SCAR are highly visible be on CliC web site.

Action: Jenny Baeseman, Volker Rachold, Vladimir Ryabinin, and Mike Sparrow will prepare a Memorandum of Agreement to be signed at the Arctic Science Summit Week in April 2013.

Potential CliC Participation, Meetings, and Workshops:

The following meetings in 2013 were endorsed by the CliC SSG:

Cryosphere Grand Challenge Workshop

This will be the concluding workshop in the series of three workshops supported by the Research Council of Norway. The scope, objectives, and the organizing committee for the workshop will be prepared by Jenny Baeseman, Greg Flato, and Vladimir Ryabinin.

Ice sheet model intercomparison/benchmarking

Eric Larour will lead the development of this workshop in parallel with the activities aimed at setting up an ISMASS ice-sheet modeling forum

Ice sheet 'outreach' and training

Eric Larour has the lead on scoping and preparing the workshop based on past experience and available support from the Jet Propulsion Laboratory.

Arctic CORDEX (and CMIP5?) analysis

Annette Rinke will work with John Cassano to prepare this meeting not later than one or two months before the WCRP CORDEX Conference in Brussels (4-7 November 2013). A connection to AntClim²¹ to share ideas and compare approaches is desirable. It was mentioned in the discussions on regional Arctic modeling that easier access to and improved visibility of existing runs could benefit from their association with CORDEX. The OBs4MIP standard could be followed and a dedicated website could be set up to facilitate necessary collaboration. One potentially very important outcome of this work may be a local archive of CORDEX Arctic domain simulation datasets that will also have links to relevant observations. One possible outcome of this workshop will be closer communication between regional modelers of cold climate.

Narrowing uncertainties in future Arctic sea-ice decline

James Overland and Greg Flato will work on this meeting, which will involve an analysis of the AR5 outcomes. The scope of the analysis should not only include sea-ice but other components of the polar climate system that tend to reflect links between relevant large-scale processes. Ideas on how to use historical observations to put constraints on future projections could be explored, potentially with help of Alex Hall. Methods of communicating uncertainty should be reviewed as well. A follow-up activity for the Antarctic should follow suit.

Permafrost Carbon Research Network – mid-May is also to be supported.

The SOOS Asian Workshop in connection with SOOS Scientific Steering Committee meeting will be held in Shanghai in late May 2013. The workshop will provide an opportunity to highlight research and observations being undertaken by Asian countries in the Southern Ocean and to stimulate discussion, and foster further involvement, from Asian countries in SOOS activities. Sasha Klepikov will participate in the both meeting and workshop to give an update on CliC and report back on the progress of SOOS.

2014 IGS International Sea Ice Symposium on "Sea Ice in a Changing Environment) – chaired by Rob Massom, March 2014:

<http://www.igsoc.org/symposia/2014/hobart/>

Arctic Climate scenarios information archive and delivery - To be lead by Greg Flato, Annette Rinke and Scott Rupp. This will aim to provide user information in a friendly way.

A suggestion for future large CliC Symposiums was brought forward. Thus far, the only large CliC Conference was held in 2005 in Beijing. Some raised concerns about adding yet another meeting to an already packed cryosphere related meeting schedule. It was suggested that for the time being, we should proceed to try to organize CliC sponsored sessions at other conferences or one-day collective events tried to already existing meetings. However, larger meetings, joint with other WCRP Core Projects and partners should be explored as this would foster interdisciplinary interactions.

Other meetings will likely be planned dealing with the new targeted activities and after discussion new priorities with the cryosphere community. A full budget for WCRP needs to be developed and submitted.

Dates and Venue for CliC SSG-10

Several CliC SSG members graciously and enthusiastically invited next sessions of the Group to Japan, Alaska, Denmark or Greenland, China, and Svalbard. For the next session, it was decided to accept the kind offer from the Norwegian Polar Institute, the host of the CliC IPO, and hold the jubilee 10th Session of CliC SSG on Svalbard during the last week of February 2014. The Session will include a celebration of the project's 10th anniversary. SSG was very grateful for the other offers and accepted them as venues for future CliC SSG sessions. It was suggested that a longer term schedule for future SSG meetings be laid out.

Executive SSG Session

The SSG, in the course of a closed session, reviewed its membership. Terms of service for Annette Rinke and Vladimir Romanovsky will be completed in 2012. CliC SSG exchanged views and proposals on potential new members and it was decided to nominate at least two new members for consideration by the WCRP JSC-34 (27-31 May 2013, Brasilia, Brazil). The gender, age and regional balance should be taken into account along with professional qualities of the candidates. A possibility for open call for CliC SSG members can be explored in the future.

Action: SSG to discuss candidates in more detail. CliC IPO to prepare documents for WCPD submission process.

The CliC budget was also discussed in terms of what should be the priorities for the next year and how the process by which we request WCRP support occurs. Projects generally receive ~100,000 CHF of travel support each year. There are also additional funds for cross-project activities, such as the Grand Challenges. WCRP tries to support as many requests for support as possible.

Action: Jenny and Greg to draft budget with workshops and general topic areas to prioritize for the year. The SSG will discuss these during an online meeting and the approved request will be sent to WCRP for final confirmation.

Session closure

Greg Flato closed the SSG session at 1PM on 7 February 2013. On behalf of SSG, he thanked very much Annette Rinke and Vladimir Romanovsky for their multi-year and very active and productive service to CliC. He expressed a hope that both of them will continue their support to the project in a different capacity - as was agreed during the session. Greg Flato also thanked the CliC IPO for successful organization of the session and Nalan Koç for the continuing NPI support for the CliC IPO. SSG thanked Greg Flato for taking on the role of the CliC SSG Chair and for the very ably chairing the session.

Participant List



Scientific Steering Committee Members

Name	Institution	E-Mail address
Flato, Greg Chair	Environment Canada, Canada	Greg.Flato@ec.gc.ca
Dahl-Jensen, Dorthe	University of Copenhagen, Denmark	ddj@gfy.ku.dk
Hinzman, Larry	University of Alaska Fairbanks, USA	lhinzman@iarc.uaf.edu
Klepikov, Alexander	Arctic and Antarctic Research Institute, Russia	klep@aari.ru
Koç, Nalan	Norwegian Polar Institute, Norway	nalan.koc@npolar.no
Krinner, Gerhard	Glaciology and External Geophysics Laboratory, France	gkrinner@ lgge.obs.ujf-grenoble.fr
Lemke, Peter	Alfred Wegener Institute for Polar & Marine Research, Germany	peter.lemke@awi.de
Massom, Rob	Australian Antarctic Division, Antarctic Climate and Ecosystems Cooperative Research Centre, Australia	rob.massom@aad.gov.au
Ohata, Tetsuo <i>via Skype</i>	Japan Agency for Marine-Earth Science and Technology, Japan	ohatat@jamstec.go.jp
Rinke, Annette	Alfred Wegener Institute for Polar & Marine Research, Germany	annette.rinke@awi.de
Romanovsky, Vladimir	University of Alaska Fairbanks, USA	veromanovsky@alaska.edu
Rott, Helmut	University of Innsbruck, Austria	helmut.rott@uibk.ac.at
Xiao, Cunde	Chinese Academy of Meteorological Sciences, China	cdxiao@cams.cma.gov.cn

Sponsors and Staff

Name	Affiliation	E-Mail address
Asrar, Ghassem	World Climate Research Programme, Switzerland	gasrar@wmo.int
Ryabinin, Vladimir	World Climate Research Programme, Switzerland	VRyabinin@wmo.int
Sparrow, Mike	Scientific Committee on Antarctic Research, UK	mds68@cam.ac.uk
Rachold, Volker	International Arctic Science Committee, Germany	volker.rachold@iasc.info
Midleja, Heike	International Arctic Science Committee, Germany	Heike.Midleja@iasc.info
Baeseman, Jenny	Climate and Cryosphere Project Office Norway	jenny@ climate-cryosphere.org
Isaksen, Heidi	Climate and Cryosphere Project Office Norway	heidi@ climate-cryosphere.org

Participant List, continued



Invited Guests

Name	Affiliation	E-mail address
Barry, Roger	Climate Variability and Predictability - CLIVAR Project Office, UK	rogbar@noc.ac.uk
Drinkwater, Mark	European Space Agency, Netherlands	mark.drinkwater@esa.int
Gerland, Sebastian <i>via Skype</i>	Norwegian Polar Institute, Norway	Sebastian.Gerland@npolar.no
Hanna, Edward	University of Sheffield, UK	E.Hanna@sheffield.ac.uk
Holland, David	New York University, USA	holland@cims.nyu.edu
Jahn, Alexandra	National Center for Atmospheric Research, USA	ajahn@ucar.edu
Jung, Thomas	Alfred Wegener Institute for Polar & Marine Research, Germany	Thomas.Jung@awi.de
Kattsov, Vladimir	Voeikov Main Geophysical Observatory, Russia	kattsov@mail.ru
Key, Jeff	National Oceanic and Atmosphere Administration, USA	jkey@ssec.wisc.edu
Lantuit, Hugues	Alfred Wegener Institute for Polar & Marine Research, Germany	hugues.lantuit@awi.de
Larour, Eric	National Aeronautics and Space Administration, USA	eric.larour@jpl.nasa.gov
Overland, Jim	National Oceanic and Atmosphere Administration, USA	james.e.overland@noaa.gov
Raphael, Marilyn	University of California, USA	Raphael@geog.ucla.edu
Shepherd, Ted	University of Reading, UK	theodore.shepherd@reading.ac.uk
van Oevelen, Peter	Global Energy and Water Cycle Experiment - GEWEX Project Office, USA	peter.vanoevelen@gewex.org
Wagner, Penelope	University of Delaware / Association of Polar Early Career Scientists, USA	penelopewagner@live.com

Agenda – Day 1



Monday, 4 February 2013

Current State of CliC

Albert Einstein Campus, Haus H

Time	Agenda Item
09:00 – 09:30	Opening Session <ul style="list-style-type: none">- Call to order – Greg Flato, CliC Chair- Welcome from the host– Volker Rachold, IASC Executive Secretary- Round of self-introductions- Approval of agenda
09:30 – 10:45	Current Status of CliC <ul style="list-style-type: none">- Introduction and Context – Greg Flato, CliC Chair- ASPeCt – Marilyn Raphael- Arctic Sea Ice Working Group – Sebastian Gerland (by Skype)- Southern Ocean Panel – Alexander Klepikov- Carbon and Permafrost – Vladimir Romanovsky
10:45 – 11:15	Coffee Break
11:15 – 12:45	Current Status, Continued <ul style="list-style-type: none">- China–CliC – Cunde Xiao- Japan–CliC – Tetsuo Ohata (by Skype)- International Project Office Report – Jenny Baeseman- Discussion
12:45 – 14:00	Group Photo followed by Lunch
14:00 – 15:30	Large International Initiatives and CliC <ul style="list-style-type: none">- Cryosphere Grand Challenge – Vladimir Kattsov- International Polar Initiative – Vladimir Ryabinin- Global Cryosphere Watch – Jeff Key- Global Integrated Polar Prediction System – Peter Lemke- WCRP Polar Climate Predictability Initiative – Ted Shepherd
15:30 – 16:00	Coffee Break
16:00 – 16:15	Large International Initiatives and CliC, Continued <ul style="list-style-type: none">- WWRP Polar Prediction Project – Thomas Jung
16:15 – 17:15	Summary of CliC Status, Connections and initial thoughts on future targeted activities <ul style="list-style-type: none">- Brief summary – Greg Flato- Initial discussion (Note: we will return to this topic on Wednesday)
19:00	Group Dinner in Mercure hotel

Agenda – Day 2



Tuesday, 5 February 2013

*Connections to the Cryosphere Research
Community and their Needs*

Albert Einstein Campus, Haus H

Time	Agenda Item
09:00 – 10:45	Sponsor/Partner Feedback, and Identification of Gaps/Needs <ul style="list-style-type: none">- WCRP – Ghassem Asrar, Director<ul style="list-style-type: none">- SPARC – Ted Shepherd, Past SPARC SSG Co-Chair- GEWEX – Peter van Oevelen, Director- CLIVAR Status 2013 – Roger Barry, Director- IASC – Volker Rachold, Executive Secretary- SCAR – Mike Sparrow, Executive Director- Discussion
10:45 – 11:15	Coffee Break
11:15 – 13:00	Connections to climate and Cryosphere modeling <ul style="list-style-type: none">- Polar regional Earth System models – Annette Rinke- Data and Model Intercomparison Proposal – Jim Overland- Permafrost Modeling – Vladimir Romanovsky- Sea Ice Model evaluation – Vladimir Kattsov- WGCM and WCRP Modelling Council – Greg Flato- Others?- Discussion
13:00 – 14:00	Lunch
14:00 – 20:00	CliC/AWI Science Symposium and Reception Albert Einstein Campus, Haus H, Auditorium See separate agenda

Agenda – Day 3



Wednesday, 6 February 2013

Identification of New CliC Priorities and Goals

Albert Einstein Campus, Haus H

Time	Agenda Item
09:00 – 10:45	Discipline-specific ideas/needs <ul style="list-style-type: none">- Freshwater Balance – Larry Hinzman- Satellite techniques for observing global glacier mass balance – Helmut Rott- Ice sheet mass balance work (ISMAS) – Edward Hanna- Regional sea-level rise – David Holland- Others?- Discussion
10:45 – 11:15	Coffee Break
11:15 – 13:00	Future Priorities for CliC and broader linkages <ul style="list-style-type: none">- Suggested topics and approach to targeted activities – Greg Flato- Initial Discussion
13:00 – 14:00	Lunch
14:00 – 15:30	Community Engagement <ul style="list-style-type: none">– Discussion led by Penny Wagner, APECS President- Making CliC more relevant in the Cryosphere community- Making better connections to other WCRP activities- Getting New Scientists involved- Reconnecting with former participants- Meaningful Support of Early Career Scientists
15:30 – 16:00	Coffee Break
16:00 – 17:30	Discussion on Strategy, Priorities, and Targeted Activities <ul style="list-style-type: none">– Discussion led by Greg Flato

Agenda – Day 4



Thursday, 7 February 2013

Practical Steps Forward

Hotel Mercure, Parkett 1+2

Time	Agenda Item
09:00 – 10:00	CliC Infrastructure <ul style="list-style-type: none">– Discussion lead by Jenny Baeseman- CliC Procedures and Structure- CIPO Development- Funding needs / Upcoming Meetings- Dates and Venue for CliC SSG-10
10:00 – 11:00	Summary of Action Items and Decisions <ul style="list-style-type: none">- Input to CliC Work Plan
11:00 – 11:15	Coffee Break
11:15 – 13:00	Executive SSG Session <ul style="list-style-type: none">– <i>Open to SSG Members, WCRP, SCAR, IASC, CIPO</i>- SSG and Committee Membership,- Executive Committee and Vice-Chairs- Funding / Sponsorship- Other
13:00 – 14:00	No-host Lunch
14:00 – 16:00	Executive Committee Meeting