CliC: Climate and Cryosphere

G. Flato & G. Krinner (co-Chairs)
J. Baeseman (Director)

JSC-35 – Heidelberg, Germany 30/June-4/July
Highlights

- New co-Chair: Gerhard Krinner (France)
- Several new targeted activities launched
- Draft ‘CliC Action Plan’ developed following discussion at SSG meeting
- Activity planning integrates Cryosphere Grand Challenge
  - Hosted grand challenge planning workshop in October
- Several productive meetings/workshops organized
- Ongoing effective collaboration with IASC and SCAR
**Limited Lifetime Targeted Activities**
(Core and Grand Challenge)

- Arctic Freshwater Synthesis
- Antarctic Ice Sheet / Ocean Interactions
- ESM Snow Model Intercomparison
- ESM Ice Sheet Model Intercomparison
- Polar CORDEX Analysis / Arctic Regional Climate Scenarios
- Polar Jet Stream Variability and Extremes
- Improved Greenland Mass Balance Estimation
- Carbon cycle feedbacks in a changing Arctic climate

- Glacier volume change monitoring
- Interactions between cryospheric elements

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**ISMASS**
Joint with SCAR and IASC

**Permafrost Carbon Network**
Joint with IASC

**Sea Ice and Climate Modelling Forum**

**Polar Climate Predictability Initiative (PCPI)**
Joint with SPARC

- Permafrost Research Priorities (with IPA)
- Southern Ocean Satellite Requirements

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*ISMASS = Ice Sheet Mass Balance and Sea Level
Notes:

- the “Climate and Cryosphere” (CliC) core project, and the “Cryosphere in a Changing Climate” grand challenge, are obviously overlapping.
  - Many of the topics raised at the CliC SSG meeting in 2013 (which led to the development of some of the ‘targeted activities’), were reiterated at the Grand Challenge workshop (despite limited overlap in attendees).
  - Some of the targeted activities identified at the GC workshop have subsequently been integrated into CliC activity planning.

- In our view, such integration is vital to avoid duplication, and to minimize organizational overhead.

- There are also evident overlaps/connections/intersections between the cryosphere and the sea-level grand challenges, but also fairly clear lines of natural division that we will exploit to clarify responsibilities.

- PCPI should also be viewed as an integral component of the cryosphere grand challenge.
Notes, cont’d:

• Connection to ‘modelling’ has been a central theme of past two CliC SSG meetings and resulting Action Plan.

• Targeted activity on polar CORDEX.

• New targeted activities on snow modelling, ice sheet modelling, and modelling Antarctic ice shelf / ocean interactions.

• Sea-ice and climate modelling forum established to promote communication and coordination amongst those involved in sea-ice component of Earth System models -- development and evaluation.
  – Producing a community-based CMIP6 output request
  – Developing recommendations for sea-ice model evaluation and observational data
  – Coordinating further analysis of CMIP5 output, aiming for a review paper
2013 meetings:

**Amundsen Sea Low Workshop for PCPI Initiative**
5-6th December, University of California, Los Angeles (UCLA)

**Polar Jet Stream 2013**
13-15 November, Reykjavik, Island

**PALSEA 2013 Workshop: Estimating rates and sources of sea-level change during past warm periods**
21-24 October, Rome, Italy

**WCRP Cryosphere in a Changing Climate Grand Challenge**
16-18 October, Tromsø, Norway

**ISMASS Steering Committee Meeting**
7 October, Sheffield, UK

**Antarctic Ice Rises**
26 - 29 August....in....Tromsø, Norway

**Sea Ice Modeling and Observing Workshop**
5 - 7 June....in....Tromsø, Norway
2014 meetings (so far):

**Workshop on Understanding Linkages Between Different Elements of the High-Latitude Cryosphere – How Important Are They?**
14 March 2014 (afternoon only)
IGS Sea Ice Symposium Venue, C3, Hobart

**2014 ASPeCt and Arctic Sea Ice Working Group Meetings**
10-16 March 2014 - Hobart, Australia

**THAW 2014 - THermokarst Aquatic ecosystems Workshop**
12-15th March 2014 - Quebec City, Quebec, Canada

**10th session of the CliC Scientific Steering Group (SSG)**
17-20th of February - Geneva, Switzerland

**DUE Permafrost**
11-13th of February Frascati, Italy

Several more meetings to be held this summer and fall ...
Polar CORDEX

Polar-CORDEX (Coordinated Regional Downscaling Experiment - Arctic and Antarctic Domains) is part of the international CORDEX initiative.

CORDEX is a WCRP-sponsored program to organize an international coordinated framework to produce an improved generation of regional climate change projections for input into impact and adaptation studies. The Polar CORDEX activities are coordinated through CliC.

Currently, the core of Polar-CORDEX consists of regional climate model simulations over the Arctic, with hindcast (ERA-Interim and GCM-driven historical simulations) and scenario (GCM-driven rcp4.5, rcp8.5 simulations) simulations are conducted. For an overview of Arctic CORDEX activities go to: activities/Targeted/polar-cordex/artic.

This effort is now expanding to include the Antarctic region as well. For an overview of Antarctic CORDEX activities go to: http://www.climatic-cryosphere.org/activities/Targeted/polar-cordex/antarctic.

Points of contact:
John Cassano, University of Colorado, USA
Annette Rinkel, Alfred Wegener Institute, Germany

Mailing List

To help facilitate communication between people interested in regional downscaling of climate models in the Arctic and Antarctic, we have created an email list that anyone can join. It is meant to be a discussion platform to share ideas, progress updates, ask questions, and more.

If you are interested in joining the Polar CORDEX email list, or would like to change your settings, please contact the CliC PO and refer to the Polar CORDEX list in the subject line.

To send an email to the group, use the email address: polar-cordex@climate-cryosphere.org

Next Polar CORDEX Meeting 17 June in Lund, Sweden

© Published on Thursday, 08 May 2014 12:17

The Polar CORDEX meeting will be held on June 17, 2014, from 14:00 to 16:00 during the 3rd Lund Regional-scale Climate Modelling Workshop, 21st Century Challenges in Regional Climate Modelling, Lund, Sweden, 16-19 June 2014 (http://www.batex-research.eu/RCM2014/).

For more information on the meeting, please contact Annette Rinkel

For more information on Polar CORDEX visit: http://www.climatic-cryosphere.org/activities/Targeted/polar-cordex

For more information on the Century Challenges in Regional Climate Modelling: http://www.batex-research.eu/RCM2014/index.html
Workshop Announcement: CliC Sea ice and Climate Modeling Forum Workshop on large-scale sea-ice simulations

© Published on Thursday, 12 June 2014 07:05

Sea ice and Climate Modeling Forum Workshop on large-scale sea-ice simulations September 26th, University of Reading, UK.

This one-day workshop brings together users and developers of sea-ice models to start a joint effort for improving sea-ice models. We will discuss the analysis of sea-ice biases in CMIP5 models, determine the most pressing needs for model development, identify the most helpful observational data, and compile a list of the most useful sea ice variables to be saved for CMIP6.

The workshop is the first in a series of planned activities from the Sea ice and Climate Modeling Forum, which is a WCRP-CliC initiative that aims at improving and better understanding large-scale sea-ice simulations by coordinating a joint effort of the International Sea Ice modeling community. Following a few short plenary talks, the workshop will consist of breakout group and discussion sessions. For further information about the workshop and to register for it (by June 30th 2014), please go to:

http://www.climate-cryosphere.org/activities/groups/sealcecmo/

The workshop is the final one in a series of related sea ice workshops around that time in central Europe, including:

16-17 Sep: 8th ICWAME-ARC workshop on sea ice modeling and data assimilation Toulouse
http://www.ice-arc.eu/2014/04/16/icearc-sea-modeling-workshop/

18-19 Sep: International Sea Ice concentration and thickness inter-comparison and evaluation workshop, Hamburg
http://www.climate-cryosphere.org/meetings/seaice-cenc-2014

22-23 Sep: Arctic sea ice reduction: the evidence, models, and global impacts, Royal Society, London
https://royalsociety.org/events/2014/arctic-sea-ice/

24-25 Sep: Arctic sea ice reduction: the evidence, models, and global impacts - further discussion, The Royal Society at Chicheley Hall
http://royalsociety.org/events/2014/sea-ice-reduction-satellite/

Please email Alexandra John, NCAR or Dirk Notz, MIP for Meteorology, if you have any questions.
Meeting deferred for now ... good progress being made electronically
Ice Sheet Modeling for CMIP6 Meeting

Ice Sheet MIP for CMIP6 Meeting
Venue: NASA GSFC, Greenbelt, MD, USA
Dates: 16-18th July, 2014

Meeting Organizers: Sophie Nowicki (GSFC), Tony Payne (University of Bristol), and Eric Larour (JPL).

The sea-level projections made by the glaciological community as part of the IPCC process have often been out of phase with the projections considered by the wider CMIP community. For instance in AR5, the ice2sea and SeaRISE ice sheet projects predominantly worked with AR4 scenarios, while the CMIP5 community used new RCP scenarios. A primary focus of this meeting is therefore to develop a plan that will allow ice sheet and glacier models to be better integrated in the CMIP6 initiative, in order to improve both sea level projections due to changes in the cryosphere and our understanding of the cryosphere in a changing climate. These goals map into the Cryosphere Grand Challenge and the Sea-Level Rise Grand Challenge relevant to CIC and the WCRP. Participation is by invitation only, and will primarily include ice sheet and Earth system model development and analysis leaders, representatives of MIPs that are relevant to the cryosphere and observation data set providers. If you would like to be invited to the meeting, please email Sophie Nowicki.

The meeting goal is to develop an Ice Sheet MIP proposal for participation in the CMIP6 initiative.
Norwegian Ministry of Environment recently committed 660,000NOK (~US $110,000) to support this.
Ice-sheet mass balance and climate change


Since the 2007 Intergovernmental Panel on Climate Change Fourth Assessment Report, new observations of ice-sheet mass balance and improved computer simulations of ice-sheet response to continuing climate change have been published. Whereas Greenland is losing ice at an increasing pace, current Antarctic ice loss is likely to be less than some recently published estimates. It remains unclear whether East Antarctica has been gaining or losing ice mass over the past 20 years, and uncertainties in ice-sheet change for West Antarctica and the Antarctic Peninsula remain large. We discuss the past six years of progress and examine the key problems that remain.

Box 1 Recent deve models

Glacial isostatic adjustment (GIA) models, tested and evaluated against GPS data, have recently led to significant downward revisions in GIA, and hence downward revisions of glaciological and altimetric satellite estimates of Antarctic mass loss. This paper summarizes the most important contributions of the ice-sheet models, and their impact on future climate change projections.

Recent changes in ice-sheet mass balance

Comparison of mass-balance estimates

One of the most sought after but elusive goals in contemporary Earth science is to determine the mass-balance state of the global ice sheets. The ice sheet is a significant contributor to sea level rise and is sensitive to changes in climate. The mass balance of an ice sheet is determined by the balance between snow accumulation and ice melt. Positive mass balance (snow accumulation exceeds ice melt) leads to ice sheet growth, while negative mass balance (snow accumulation is less than ice melt) leads to ice sheet thinning and eventual disintegration.

Pre-2012 studies

2012 studies

GIIS (Gt yr⁻¹)

GRACE
Mass budget
Radar altimetry
Laser altimetry
IMBIE combined

Antarctica

Greenland

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High risk of permafrost thaw

Northern soils will release huge amounts of carbon in a warmer world, say Edward A. G. Schuur, Benjamin Abbott and the Permafrost Carbon Network.

Arctic temperatures are rising fast, and permafrost is thawing. Carbon released into the atmosphere from permafrost soils will accelerate climate change, but the magnitude of this effect remains highly uncertain. Our collective estimate is that carbon will be released more quickly than models suggest, and at levels that are cause for serious concerns.

We calculate that permafrost thaw will release the same order of magnitude of carbon as deforestation if current rates of deforestation continue. But because these emissions include significant quantities of methane, the overall effect on climate could be 2.5 times larger.

Recent years have brought reports from the far north of tundra fires, the release of ancient carbon1, CH₄ bubbling out of lakes and gigantic stores of frozen soil carbon². The latest estimate is that some 18.6 million square kilometres of northern soils hold about 1.7 billion tonnes of organic carbon—enough to store as much as in the atmosphere now.

As soils defrost, microbes decompose the ancient carbon and release CH₄ and carbon dioxide. Not all carbon is equally vulnerable to release: some soil carbon is easily metabolized and transformed to gas, but more complex molecules are harder to break down. The bulk of permafrost carbon will be released slowly over decades after thaw, but a smaller fraction could remain within the soil for centuries or longer. The type of gas released also affects the heat-trapping potential of the emissions. Waterlogged, low-oxygen environments are likely to contain microbes that produce CH₄—a potent greenhouse gas with about 25 times more warming potential than CO₂ over a 100-year period. However, waterlogged environments also tend to retain more carbon within the soil. It is not yet understood how these factors will act together to affect future climate.

The ability to project how much carbon will be released is hampered both by the fact that models do not account for some important processes, and by a lack of data to inform the models. For example, most large-scale models predict that permafrost warming depends on how much the air is warming above them. This warming then boosts microbial activity and carbon release. But this is a simplification. Abrupt thaw processes can cause ice wedges to melt and the ground surface to collapse, accelerating the thaw of frozen ground. Evidence of rapid thaw is widespread. You can see it in the Uralian trees that tip dangerously as a result of ground subsidence, and in collapsed hill slopes marked by scars from landslides. These are just some of the complex processes that models don’t include.

At the same time, few data are available to support these models because of the difficulties of gathering data in extreme environments. Only a handful of remote field stations around the world are collecting data to support this research, even though the permafrost zone covers about almost one-quarter
Cross-Project issues:

- Need to work more on coordination of PCPI and Cryosphere GC with SPARC.
  - Both activities are progressing well, just need to make sure information is flowing.

- Have had active GEWEX participation at GC workshop and SSG
  - Topics of mutual interest identified; Arctic Freshwater Synthesis is one (participants are from both GEWEX and CliC ‘communities’).

- CliVar/CliC/SCAR Southern Ocean Panel
  - Not really a ‘joint’ activity (CliC asked to identify a member); discussion initiated with CliVar to address this. Open question about Arctic Ocean panel.

- Discussion with CliVar regarding CliC role in sea-level GC.
  - Clear and agreed-upon strategy in place.

- Cross-attendance at SSG meetings is desirable but challenging.
CliC Resources

- Cryosphere in the Media/News
- Recent Cryosphere Literature Publications
- Community Calendar and Planning Resource
- Cryosphere Community News
- Polar and Cryosphere Job Opportunities (APECs)
- Videos, Photos, Reports and Other Useful Stuff
- Cryosphere Specialist Directory
- **WCRP** Community Calendar & RSS

New
- Frostbytes
- Cryosphere Projects Catalogue
http://www.climate-cryosphere.org/categories/138-frostbytes

Available as iTunes podcasts!
# Cryosphere Projects Catalog

The Cryosphere Projects Catalog is meant to give an overview of the current research happening within the various fields of cryospheric science. This is a living resource and we encourage people to add their own projects and let us know if any of the information provided here needs updating. Entries are from individual PIs, national funding agencies, international organizations and other sources. We hope this will help people find new collaborators, share resources, and more. Suggestions on improving the catalog are always welcome.

To search the directory, click on the binoculars below.

To add a new project, click on the green plus below.

<table>
<thead>
<tr>
<th>Title of Project</th>
<th>Lead Institution</th>
<th>Country</th>
<th>Category</th>
<th>Map Location</th>
<th>Project Location</th>
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</thead>
<tbody>
<tr>
<td>Development of EM ice thickness systems</td>
<td>Norwegian Geotechnical Institute</td>
<td>Norway</td>
<td>Observations</td>
<td>Sea ice</td>
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<td>DYNAWARM: Dynamics of Warm Climates</td>
<td>University of Bergen</td>
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<td>Gaffney Sea Ice Review Page</td>
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<td>Norway</td>
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<td>The role of Sea Ice processes on CO2 exchange and Carbonate saturation levels: BIOCA (PS 4 Flagship)</td>
<td>Norwegian Polar Institute</td>
<td>Norway</td>
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<td>ICE-Flows</td>
<td>Norwegian Polar Institute</td>
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<td>BIOS</td>
<td>NPIR - Research Council of Norway</td>
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<tr>
<td>CILSAR - CryoSat land and sea ice studies in the Arctic</td>
<td>Norwegian Environmental &amp; Remote Sensing Center</td>
<td>Norway</td>
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<tr>
<td>Arctic sea ice variability: a comprehensive study using satellite and in-situ observations - ArcticSV</td>
<td>Norwegian Environmental &amp; Remote Sensing Center</td>
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<td>Remote Sensing</td>
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Recent Cryosphere Literature

Combined RSS feeds of recent journal articles from major cryosphere journals: The Cryosphere, Polar Research, Polar Science, Polar Record, Antarctic Science. Brought to you by the Climate and Cryosphere Project (Clic).

1. Enthalpy benchmark experiments for numerical ice sheet models.
2. Independent evaluation of the SNODAS snow depth product using regional scale LiDAR-derived measurements.
3. A novel method to describe dust and the supraglacial debris and their effects on ice albedo: the case study of Pinn Ice Glacier, Italian Alps.
4. The sub-te plateau layer and its influence on freezeout to the conversion of Antarctic sea ice.
5. Surface kinematics of penibidal sorted cirques using structure-from-motion technology.
   The Polar Journal, Ahead of Print.
10. Antarctica: a biography.
    The Polar Journal, Ahead of Print.
11. Antarctica in fiction: imaginative narratives of the far south.
    The Polar Journal, Ahead of Print.
12. Glacier area and length changes in Norway: from repeated inventories.
15. Simultaneous solution for mass trends on the West Antarctic Ice Sheet.
16. Seasonal cycle of solar energy flux through Arctic sea ice.
17. Provenance governing the mass balance of Chhota Shigri Glacier (Western Himalaya, India) assessed by point-scale surface energy-balance measurements.
18. Glacial-ice forms on Mars.
19. Thermal characteristics of paraglacial in the scarp-alpine rock walls of the Aiguille du Midi, Mont Blanc Massif, 3842 m a.s.l.
20. The GLOCHAM Glacier Inventory: a quality controlled inventory of Asian glaciers.
22. Conference reports: notes and announcements.
   The Polar Journal, Ahead of Print.
24. SMOS-derived thin sea ice thickness: algorithm baseline, product specifications and initial verification.
26. Brief communication: Light-absorbing impurities can reduce the density of melting snow.
27. On the interest of positive degree day models for mass balance modeling in the inner tropics.
28. Glacial changes in the Karakoram region mapped by multilateral satellite imagery.
29. Deastrabilisation of an Arctic ice cap triggered by a hydro-thermodynamic feedback to summer melt.
30. Oscillatory subglacial drainage in the absence of surface melt.
31. Climate change implications for the glaciers of the Hindu Kush, Karakoram and Himalayas region.
32. Winter speed-up of quiescent surge-type glaciers in Yukon, Canada.
33. Elevation changes of Inylchek Glacier during 1974–2007, Central Tian Shan, Kyrgyzstan derived from remote sensing data.
34. Representativeness and seasonality of major ion records derived from NEEM fir cones.
35. Spatial-temporal dynamics of chemical composition of surface snow in East Antarctica along the Progress station–Vostok station transect.
### Supporting Documents SSOS-SSC2014

**3rd Scientific Steering Committee Meeting 18-20 June 2014, Tromsø, Norway**

- **Permafrost Research Priorities Business Cards**
  - Business cards used to promote the Permafrost Research Priorities process.

- **Minutes and Action Items: Participants**
  - Hiroshi Kusaka (Konosuke-Halvekorp), Japan
  - Kaschevsky (GFDL), Germany
  - Osheroid (NOAA), USA
  - Andrea Bindi (IGBP), Italy
  - Erika Fein (IPCC), Switzerland
  - Michel Allard (Université Laval, Canada)
  - Yvonne Stoffel (Stockholm University, Sweden)

- **International Council for Science**
  - bulb for different talks in here from 2010 to 2005

- **Cryospheric Organizations Meeting 9 December 2012, San Francisco**
  - Participants: Anne Nolin (CSU—Cryospheric), Regine Hock (CSU—Cryospheric), Kascha Krecek (ARCUS), Horst Heinrichs (University of Virginia—Cryospheric, SSC2013 Chair), Gary Wilson (NASA—IASC), and others.
  - Apologies from: Jenny Broadhead (CICIMI) Main Issues: The only agenda item...

- **Set-derived Sea Ice Products Community Workshop Report**
  - Sponsored by WCRP Climate and Cryosphere (CICIMI) Program Office NASA Goddard Space Flight Center.
  - Focus on: Opening Sea Ice Products Community Workshop at NASA Goddard Space Flight Center, Greenbelt, Maryland, USA.

- **2010 Kutuzov_unpublished.pdf**
  - Description of figure: A plot of time series data showing changes in sea ice extent. The data is from the period of moderate service.
Capacity Development:
- Strong link to APECS

- Support meeting attendance and engage young scientists in CliC activities. Require them to contribute a ‘FrostByte’.

- Implementing ‘CliC Fellows’ program where a young scientist is funded to help coordinate some activity (currently have one assigned to Permafrost Research Priorities activity).
Action Items from JSC-34:

- **Action 8 – liason with WGRC**
  - Annette Rinke is CliC contact; coordinating CORDEX polar activities and contribute future climate scenario information to AMAP assessments that are just starting.

- **Action 14 – contribution to interannual/decadal predictability research and regional GC white paper.**
  - CliC connection primarily via PCPI which has several relevant activities; were not contacted regarding regional GC white paper. See above re AMAP.

- **Action 15 – identify optimal choice of leadership for work on skilful/action-oriented regional climate information …**
  - ???

- **Action 17 – Cryosphere grand challenge input**
  - Several core projects and working groups were represented at GC workshop; also participation at CliC SSG. Connection to, and role in, sea-level GC being actively discussed.
• Action 18 – seek opportunities to contribute to international research on role of declining Arctic sea-ice and snow in climate predictability … atmos. Circulation. CliC/WGSIP to discuss …
  – Being pursued within PCPI; will be a topic for sea-ice and climate modelling forum; note work underway in ISMASS on polar jet stream variability. ESMSnowMIP will contribute. Discussion initiated with ESA on funded Arctic research activity.

• Action 19 – strengthen sea-ice and ice-sheet modelling in support of WGSIP, WGCM and WGNE
  – Initiated ‘sea-ice and climate modelling forum’ to foster improved communication/collaboration. Will work with CMIP panel on sea-ice data request. New Antarctic ice-ocean modelling and ESMIceSheetMIP activities. Potential Greenland ice-ocean activity (GRISO). Some aspects of PCPI.
• Action 20 – update JSC Chair on Cryo GC workshop
  – Meeting agenda and description sent to Chair 9/Sept/2013; meeting report available on CliC web site

• Action 24 – establish communication between GC leads.
  – Invited GC leads to CliC SSG meeting in Geneva in March (devoted more than half a day to this topic); would be nice if JPS coordinated more regular communication.

• Action 25 – consider benefits of US Climate Process Team approach
  – Noted

• Action 26 – develop/articulate implementation of GC
  – Template not provided by JPS (to our knowledge). Implementation of cryosphere GC integrated with CliC Action Plan.
• Action 34 – guidelines/datasets for ESGF
  – CliC does not generate a lot of ‘data’. ASPeCt and ASIWG may have some. Sea-ice and climate modelling forum, ESMSnowMIP and ESMIceSheetMIP will certainly have interest in ‘Obs4MIPs’ type activities using ESGF. Not clear what (if anything) needs to be done here.

• Action 43 – ‘gap’ in WCRP structure in the area of atmospheric dynamics.
  – CliC was involved in e-mail discussion of this; not at all clear to us that there really is a ‘gap’, or if there is, that we need a structure for it.

• Action 45 – better define role of CliC in involving Arctic Ocean research communities in WCRP priorities … involve IASC.
  – CliC has MOU with IASC and co-sponsors several activities (though not specific to Arctic Ocean). Ocean research not central to CliC mandate. Some discussion initiated re GRISO. Some discussion with CliVar.
• Action 46 – CliC, WGSIP and WGCM to develop proposals on facilitating their interactions.
  – Is a ‘proposal’ really needed? Interactions are already developing naturally via PCPI, new MIP activities (snow and ice sheets). Sea-ice and climate modelling forum will further improve connections. CliC co-chair (Flato) hosted WGCM meeting in Victoria in Fall 2013.

• Action 47 – CliC Chair to develop plan for sea-ice and ice sheet modelling to present to JSC-35
  – Connection between CliC and WCRP modelling activities has been a central theme at two recent CliC SSG meetings. New targetted activities specifically address snow in earth system models, ice sheets in earth system models, and modelling ice-shelf ocean interactions. Sea-ice and climate modelling forum established. Co-sponsor of ISMASS which is very active.
  – These activities are now ‘mainstreamed’ into CliC.
• Action 52 – inform CMIP6 of questions/research requirements
  – ESMSnowMIP, ESMIceSheetMIP, and Sea-Ice and Climate Modelling Forum will all be interacting directly with WGCM CMIP panel, specifically on CMIP6 planning.

• Action 58 – synthesis papers in advance of IPCC assessments
  – Noted. E.g. Arctic Freshwater Synthesis is aimed specifically at this. Sea-ice and climate modelling forum planning a paper on in-depth evaluation of sea-ice in CMIP5 results.

• Action 59 – update project web sites
  – CliC IPC Director (Jenny) has been VERY active in developing/expanding the CliC website and regularly updating content. She has also been very active in fostering communication through social media, web-casting, meeting/project web hosting, tele-conf and video-conf support, etc.