

Climate and Cryosphere (CliC) Report

1. Highlights for JSC

A. The Arctic Freshwater Synthesis (AFS): The AFS is an innovative science integration of the Arctic freshwater system that focuses on storage, fluxes and effects. The results of this work show that there is increasing changes to the Arctic freshwater systems which affect changes to the Arctic environment, society and economy, with consequences at the global level. The AFS was a collaboration between CliC, the International Arctic Science Committee (IASC), the Arctic Monitoring and Assessment Programme (AMAP), the Norwegian Ministry of Environment and the Norwegian Ministry of Foreign Affairs. Eight scientific papers were published in a special issue of JGR Biogeosciences, and the results are being integrated into the Snow, Water, Ice, and Permafrost in the Arctic II (SWIPA II) report. The Nordic Council of Ministers and The Arctic Council are currently prioritising freshwater as an issue in their upcoming chairmanships.

B. Cryosphere modelling to support the CMIP6 process: CliC is leading the cryosphere modelling work that will underpin the 2020 assessment reports being prepared by the IPCC. The work covers snow, sea ice, ice sheets, and glaciers and allows for targeted analysis of coupled model performance over these domains globally as well as more structured analysis of uncertainty in their projections. This work also links to the CliC supported Permafrost Carbon Network (PCN) which is an active international collaboration aimed at quantifying the carbon sequestered in frozen ground and the extent to which it might be liberated – and hence acting as a positive climate feedback – as the climate warms. All of these activities are expected to contribute directly and visibly to the IPCC 6th Assessment Report and the IPCC's Special Report on the Oceans and Cryosphere. They provide a unique and tangible addition to the broader WCRP contributions to climate science that the IPCC ultimately depends upon.

2. Primary science issues (ahead, 3 to 5 years)

- A. An emerging field in cryospheric research has centred on **biogeochemical dynamics at sea-ice interfaces**, and this arena will continue to evolve rapidly in the coming years. Future research will focus on larger temporal and spatial scales which are still rarely described in current research as well as increased stimulation of the interaction between experimentalists and modellers working on this topic. The intention is to improve observation methods, build larger-scale databases and upscale processes within models.
- B. An increasing amount of research is emerging in our understanding of the **linkages between different elements of the high-latitude cryosphere**. The focus in upcoming years will be to bridge and link (integrate) current and planned work in the fields of sea ice, ice sheet, ocean, permafrost and atmosphere – with a view to encouraging a more holistic view of the high-latitude cryosphere, its role in the climate system and its response to climate change/variability. How does change/variability in one cryosphere “element” affect other elements, what feedbacks are involved, and on what scales?
- C. A rapidly growing field with many current initiatives is examining **polar-lower latitude linkages** and their role in weather and climate prediction. Some of the current questions being addressed include: Does polar weather and climate affect the predictions of the occurrence of high-impact climate events in the mid-latitudes? How best to assess the

value of forecasting system development in the polar regions for predictive climate information for decision making in lower latitudes?

3. Issues and challenges

A. How we work with other Core Projects (CPs)

CliC has a number of ongoing collaborations with the other WCRP CPs. CliC and CLIVAR both support the Southern Ocean Region Panel (SORP), which serves as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean. In the terrestrial domain, CliC and GEWEX jointly provide input to the Land Surface, Snow and Soil Moisture Model Intercomparison Project (LS3MIP) which assesses the performance of current land surface modules of Earth System Models and quantifies land surface feedbacks in a changing climate. CliC also supports the ESM-SnowMIP, which is tightly linked to LS3MIP. The ESM-SnowMIP Simulation Protocol describes the numerical experiments proposed as complements to the simulations proposed in LS3MIP. ESM-SnowMIP is part of the Melting Ice & Global Consequences Grand Challenge and is closely linked to the GEWEX-GLASS Global Soil Wetness Project Phase 3 (GSWP-3). The Polar Climate Predictability Initiative (PCPI) is an activity that both CliC and SPARC lead together, which is addressing the seasonal to multi-decadal component of the GIPPS (Globally Integrated Polar Prediction System) and also supports the Melting Ice and Global Consequences Grand Challenge. Finally, CliC has been supporting the Polar-CORDEX (Coordinated Regional Downscaling Experiment - Arctic and Antarctic Domains) project, which is part of the international CORDEX initiative. The core of Polar-CORDEX consists of regional climate model simulations over the Arctic, with hindcast and scenario simulations. The Antarctic component of this work is becoming active in 2017. In addition to the jointly run activities above, CliC representatives regularly participate in the partner CP annual SSG meetings. To help coordinate our activities, the CPs have also begun holding quarterly planning meetings with the project directors.

B. How we work with CMIP and the modelling groups (WMAC)

CliC co-chairs Greg Flato, and Gerhard Krinner are members of the WCRP Modelling Advisory Council. Greg provides strategic links between the data needs of CliC, WMAC and the IPCC. CliC and the Grand Challenge on Melting Ice – Global Consequences and also supports the development of CMIP6 related modelling work, namely ISMIP6, SIMIP, ESMSnowMIP, and GlacierMIP. CliC has also promoted cross-cutting events such as the Workshop on Connecting Climate Model Evaluation to Assessing Fitness for Purpose.

C. How we address observations/data requirements (WDAC)

CliC's ongoing CMIP6 focussed modelling activities have broad demands for data across all cryosphere domains and the WDAC provides a forum for clarifying, quantifying and evaluating such needs. There is an increasing requirement for quality-controlled (ideally gridded) data sets, with quantified uncertainty, to be used in evaluating model output, improving model physics, and potentially integrating with CMIP models, especially ISMIP6, MISOMIP, SIMIP and ESM-SnowMIP. The CliC sea ice observation project, CASIWG, provides input to WDAC through its ongoing efforts to help standardise and integrate sea ice observations at existing monitoring sites (Barrow, Tiksi, Ny Alesund, CHARS, Cape Baranov, etc.). In the Antarctic, the CliC supported ASPeCt project has developed protocols, which are used in ASSIST/IceWatch – software to record ship observations of sea ice in a consistent format. CliC representative Walt Meier (NASA) has been contributing to the WDAC in recent years, and the process of nominating a replacement is currently being finalised.

D. How we work with Grand Challenges

CliC has a lead role in implementing the Grand Challenge on Melting Ice – Global Consequences. This GC has focused on mobilising the cryosphere research community's engagement with CMIP6. This follows directly from the work plan that was presented at the last JSC meeting, and it allows for tangible outputs within CMIP6 that will feature prominently in new climate science literature that will underpin the reports being prepared by the IPCC. There are four specific activities that were launched as a part of the Grand Challenge, namely: ISMIP6, SIMIP, ESMSnowMIP, and GlacierMIP.

E. How our community is evolving

Cryospheric research (primarily in polar regions) has gained substantial prominence during the last decade, as changes in the frozen parts of the world have evolved rapidly and increasingly touch on scientific, economic and cultural aspects of society. In recent years the rapid changes in the Polar Regions have opened opportunities for wide-ranging scientific research across all cryosphere domains. This has led to new research fields as well as an increasingly crowded network of scientific initiatives with similar goals. There is a sustained need for the CliC network to be observant in ensuring that the focus of our future work remains at the forefront of climate and cryosphere research and finding synergies with other related programs, while not duplicating efforts of others.

F. How we work with WCRP

CliC is primarily engaged with WCRP through the Joint Planning Staff (JPS). We hold regular on-line coordination meetings between the CliC IPO, co-chairs and JPS to review activities, plan events and communicate ongoing issues. The JPS are particularly helpful in advising on process and protocols, strategic issues linked to the CliC SSG, as well as guidance on allocations of resources and emerging priorities in the WCRP. CliC also engages with the current 'communication strategy' team and will continue to promote collective WCRP outreach efforts through social media and common branding practices. The WCRP administrative staff also facilitate CliC travel requests, event bookings and compensations for travels.

G. How the current funding affects our community, activities, and services

The decline in recent project funds allocated to CliC will result in less activity for the project in 2017. The CliC SSG made decisions in February about funding distributions to its activities and some projects that submitted proposals, and normally would have received financial support from CliC, will not get any this year. The project office is actively looking for other sources of funding to help supplement the decline in WCRP funds.