

Cryosphere Grand Challenge:

“Melting Ice – Global Consequences”

Draft initial workplan developed by G. Flato, V. Kattsov and J. Baeseman



Cryosphere Grand Challenge

Four focused science topics were initially proposed in the GC white paper, namely:

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



Motivation for narrower focus

As the climate warms, the response of the cryosphere is inevitably enhanced melt. This has had, and will continue to have, profound, societally relevant global consequences. The most pressing of these involve:

- thawing permafrost and the potential for enhanced natural emissions of carbon dioxide and methane to the atmosphere;
- shrinking of mountain glaciers and large ice sheets with consequent sea-level rise and impacts on water resources;
- declining coverage of sea ice and snow, which will affect marine and ground transportation across the Arctic



In order to make scientifically credible, quantitative projections of these critical changes, we need to better understand the underlying processes and improve our capability to represent them in global earth system models.

*The overarching question: **How will melting ice respond to, and feedback on, the climate response to increasing greenhouse gases, and what will the impacts be?***

So, our initial focus will be in the following three areas ...



1. Quantifying the amount of carbon available in permafrost areas, evaluating the potential for release of this carbon, and improving our capability to simulate the response of permafrost, and its connection to the global carbon cycle, under a warming climate.

This is a pressing and timely issue given the potential for significant, positive feedback in the climate system, in addition to the direct ramifications of permafrost thaw on human activities throughout the high latitudes.



2. Assembling glacier and ice sheet models for use in projecting melt rates and corresponding sea-level rise – in both cases these represent scientific communities that have not been strongly engaged in climate projection activities, and we will take advantage of the WCRP' s leadership in both climate modelling and cryospheric science.

In addition to sea-level rise, shrinking glaciers will have profound and direct impacts on millions of people whose water resources depend on the summertime storage provided by mountain glaciers.



3. Assembling the most reliable observational data on sea-ice and snow and using these data to evaluate and improve climate model simulations of the remarkable changes that have already been observed and to enhance confidence in future projections.

Many activities in the Arctic, from marine transportation to seasonal roads and traditional hunting are profoundly affected by the amount and timing of sea-ice and snow cover. In addition, changes in snow and ice have direct consequences for fragile high-latitude ecosystems (terrestrial and marine), and, some have suggested, impacts on hemispheric circulation and weather patterns.



The initial workplan lays out specific activities to make rapid progress in these areas, namely:

- establishing a Permafrost Modelling Forum to foster engagement amongst the permafrost observation/process and large-scale modelling communities so as to improve confidence in carbon stock estimates and the potential release rates under warming climate;
- focusing analysis efforts on large-scale ice sheet models and global glacier mass balance models, and applying them in the CMIP6 context to provide quantitative estimates of future sea-level contributions (this may also be relevant to water availability grand challenge);
- enhancing the involvement of sea-ice and snow obs/process specialists in analysis of CMIP6 simulations.



The goal is to have community-led papers summarizing these results in time to make a visible contribution to the next IPCC and similar assessments.

These activities are aimed directly at filling gaps identified in the IPCC Lessons Learnt workshop, and providing clearly traceable WCRP-led contributions to moving science forward in areas of clear societal relevance.

Timely action is needed ...



Progress to date:

- Workshop to gather community input held in Tromso – this brought in people not traditionally engaged in WCRP activities.
- Detailed CMIP6 proposals submitted and accepted by CMIP panel (sea-ice, snow, ice sheets).
- Workplan and leaders in place for global glacier mass balance initiative.
- Leadership in place for permafrost modelling forum, and international participation is building.
- Teams are active and enthusiastic!



WCRP Polar Climate Predictability Initiative (PCPI)

(closely aligned with WWRP Polar Prediction Project (PPP))

Cecilia Bitz and Ted Shepherd – co-chairs

Planned Activities

- PCPI-PAGES workshop on “Large-scale climate variability in Antarctica and the Southern Ocean over decades-to-centuries, and links to extra-polar climate” (San Diego, March): Gille, Jones, Goose
- Sea Ice Prediction workshop (Reading, April)
- Polar prediction session at EGU (Vienna, April)
- Polar amplification session at IUGG (Prague, July)
- Year of Polar Prediction (YOPP) Summit (Reading, July)
- Second face-to-face meeting of PCPI leadership (Reading, September)
- PCPI workshop on Polar Feedbacks proposed to ISSI (summer): Kay, Goose, Svensson
- PCPI session on the role of jets and non-zonal circulation in the Antarctic at the 2015 ICSHMO (Chile, October)



Year of Polar Prediction (YOPP): mid-2017 to mid-2019

- A flagship activity of the PPP, covering Arctic and Antarctic
 - PCPI will participate through three joint initiatives
- An extended period of coordinated intensive observational and modelling activities in order to improve polar prediction capabilities on a wide range of time scales
 - Augmented by preparation and consolidation phases

