

WCRP Polar Climate Predictability Initiative

Over the last few decades, the Polar Regions have exhibited some of the most striking manifestations of climate change. Due to the polar amplification of the greenhouse-gas effect, the Arctic has been warming at a rate several times higher than the rest of the globe. At the same time, the average Antarctic sea-ice extent is observed to be slightly increasing, contrary to the model predictions (but with very high regional and temporal variability). The strong coupling between polar oceans, sea ice, troposphere, and stratosphere calls for an interdisciplinary approach to research on this regional climate system. Modern climate prediction systems, especially on the seasonal time scale, mostly rely on teleconnections originating from the tropical regions such as those associated with ENSO. However, recent studies have shown the existence of predictability associated with interactions in the climate system that involve aspects of mid- and polar latitudes such as soil moisture, snow cover, sea-ice, solar variability, etc. Theoretical studies also suggest the possibility of having a predictable climate signal on the decadal time scale with maximal signal-to-noise ratio in subpolar areas.

Reviewing the knowns and unknowns in this area of research, with the goal of identifying chains of processes that may lead to predictable skill for seasonal to multi-decadal time scales was the main motivation for the WCRP workshop in Bergen in October 2010. It brought together a wide range of experts on polar climate variability and predictability. They had diverse backgrounds covering all the above-mentioned physical disciplines and worked using all types of scientific methodologies with results stemming from making and analyzing observations, conducting field and model experiments, and even using heuristic approaches. The workshop identified prospective avenues for polar climate research in the Arctic and Antarctic, and summarized the current state of knowledge of polar climate predictability. An important outcome of the workshop was making participants aware of the existence of considerable expertise relevant for their research in other, previously less known to them, parts of the WCRP community.

Based on the recommendations from the workshop, a group of people chaired by Ted Shepherd is working on the implementation considerations for a WCRP polar climate predictability initiative. Several people in the group are also affiliated with other research entities such as the International Arctic Science Committee (IASC), and particularly the IASC Working Group on Atmosphere. For that reason this activity enjoys the interest and support of IASC. A WCRP workshop was held in Toronto on 2-4 April 2012, which was co-sponsored by IASC to discuss an implementation strategy for the initiative. A draft strategy will be presented to the JSC-33 in Beijing July 2012.

A sister Polar Prediction Project (PPP) is being developed by the WMO World Weather Research Programme as a legacy of the International Polar Year 2007-2008 (IPY) polar weather prediction research. It is focusing on time scales from weather nowcasting to a season. The project is chaired by Dr Thomas Jung of AWI, Germany; has an established steering group; and their implementation plan is almost complete. There is close working contact between the scientists and coordinators developing the WCRP Polar Climate Predictability Initiative and the PPP project. There is also very significant common interest between the groups, including sharing knowledge on aspects of polar ocean, atmosphere, snow and sea-ice modeling and data assimilation. Early cooperation between groups focusing on interaction of time scales is useful for exploiting possible "seamlessness" of future polar prediction.

The WMO Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS) is promoting a Global Integrated Polar Prediction System (GIPPS). It is expected to address three time scales: from weather time scales to a season, from seasons to decades, and centuries. For the two shorter time scales, EC-PORS sees the WWRP PPP project and the WCRP Polar Climate Predictability Initiative as GIPPS building blocks. At its third meeting in Finland in February 2012, EC-PORS recommended to WWRP and WCRP to have a single polar project and a single project office for PPP and the WCRP initiative

WCRP intends to develop its polar initiative as a part of the identified Grand Challenge on provision of regional climate information. In the WCRP tradition, the initiative will address critical issues in our understanding of polar climate predictability. It will have activities focussing on the

Arctic and Southern Ocean and Antarctic. Existence of scientific interest, and the ability to achieve progress in key aspects of the scientific issue, will be taken into account in developing the programme.

The WCRP workshop in Toronto identified the following frontier questions for the WCRP initiative:

- Why are the climates at the two poles changing so differently to each other (with the Arctic changing rapidly, and the Antarctic unevenly), and to global climate?
- Why is the rate of Arctic change at the edge (or beyond) the distribution of model estimates, with observations on average exceeding the model rate of change? And why is the situation essentially the opposite in the Antarctic?
- Do the ongoing amplified changes in the Arctic have an influence on extremes in the Arctic?
- How predictable is Arctic climate?

The Imperatives being considered include:

- Reconstruct past climate variations (100+ years)
- Improve reanalysis products for the high latitudes including ocean reanalyses as well as atmospheric analyses; and eventually coupled reanalyses
- Design optimised sustained observing systems and sharing of data with the public
- Improve the climate models that are used for simulating past and future polar climate
- Assess model performance and inform new model development
- Assess how much confidence we can place in models
- Improve process parameterizations and possibly resolution for prediction
- Make the case for an experiment at high resolution of the 21st century (time slice) to target polar-mid-latitude connections and extreme events
- Define activities that address questions
- Connect with global model priorities
- Coordinated experiments (CMIP5 and other predictability activities)
- Better understand predictability on various timescales
- Define methods for proper initialization of the coupled system

The science topics under consideration include:

- Impacts of atmospheric jet strength and position on the oceans, sea-ice, ice sheets, and carbon flux
- Relative roles of modes of climate variability in the fully coupled ocean-atmosphere-ice system
- Impact of small-scale processes on the larger scales
- Stability of West Antarctic and Greenland Ice Sheets
- Biases in Antarctic Sea Ice model representation
- The role of ocean eddies and means of representing ocean eddy processes in models
- Mechanisms of bringing ocean heat to the sea-ice margin

The implementation mechanisms include workshops, temporary working groups, cooperation with developers of reanalyses, numerical experiments, etc. A Year of Polar Prediction (YOPP), tentatively planned for 2016-2018, will be taken into account in the planning. The PPP and WCRP Polar Climate Predictability initiative will be a WCRP contribution to the emerging International Polar Initiative (IPI), which is being developed to preserve the legacy of IPY and seek coordinated commitments to more sustained polar observations in support of environmental services in the Polar Regions.

The JSC is asked to endorse the above considerations and agree that a Scientific Steering Group is established to move forward the preparation of the WCRP Polar Climate Predictability Initiative implementation plan and start corresponding activities.