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ECRA Collaborative Programme

Arctic Climate Stability and Change

The vulnerable Arctic

The Arctic is by most measures a vulnerable region, especially because it is warming two to three times faster than the global average. This phenomenon is coined Arctic Amplification. Congruent with this warming, the Arctic has experienced a massive loss of sea ice over the last three decades, which is now significant throughout all seasons. The Arctic may be on the brink of a total transformation, with summer ice-free conditions within a few decades. This will have major impacts on the climate of the Arctic and beyond. However, the large decadal variability of the Arctic-Atlantic sector makes predictions challenging.

The Arctic Ocean and sea ice is a habitat for a large number of species inhabiting the seabed of the shelves, the slopes and the abyss, the water column, and the sea ice itself. Arctic biodiversity is particularly vulnerable to changes, and global warming has already had a major effect on the sea ice habitat and volume of Arctic water suitable for these species to survive. Additionally, the Arctic Ocean plays an important role in the global carbon cycle, particularly with the uptake of carbon dioxide and the interaction with primary production. It is anticipated that Arctic warming and the concurrent sea ice retreat will trigger widespread changes in Arctic ecology, some of which will further reinforce the changes.

Key topics for ECRA – Arctic Climate Stability and Change

- *How rapidly will Arctic sea ice decline in the future?*
- *What long-term observations are essential for future predictions?*
- *What are the impacts of Arctic climate change – both locally and globally?*
- *How can we best advance environmental prediction capabilities?*

Recommendations for research priorities in H2020 and beyond

- *Future rates of Arctic sea ice decline*
  Arctic sea ice has declined at a rapid rate since the 1990s. **Summer sea ice extent has declined by about 50% and sea ice thickness by about 40%.** Arctic sea ice has thus moved into a new, more vulnerable regime with predominance of first-year ice, longer periods of open water, and enhanced surface melt rates. But – the Arctic is also subject to large natural variability, especially in the Atlantic sector; and a number of non-linear feedbacks play an important role in both enhancing and dampening the ice loss. Further research into decadal scale variability is needed to make reliable future predictions of Arctic sea ice.

- *Long-term observations using novel technologies*
  A coordinated effort for creating an optimised Arctic observation system is ongoing. Future activity should focus on **extracting the key observations for improving polar prediction** and the **connections to mid-latitude weather systems** as well as implementing **long-term monitoring** of these key observations.

- *Impacts of Arctic climate change on Arctic biodiversity*
  Many organisms in the Arctic Ocean are highly adapted to an older and thicker sea ice regime or temperatures close to freezing, leaving them and the **Arctic ecosystem vulnerable to the ongoing warming**. They are presently being pushed northward on the shelves and down the slopes where only deep-water species are able to survive. At the same time, species from the South are spreading into previously ice-covered areas and might compete with Arctic species for food and space.

- *Global impacts of Arctic climate change*
  The Arctic impacts the rest of the globe in a number of ways: The two most important ones are probably the **permafrost thawing**, which releases potentially large methane fluxes and thereby increases global warming, and **Greenland ice sheet melting**, which is now five times higher than in the 1990s and contributes significantly to sea level rise. Ongoing change may additionally open up new economic opportunities for exploitation of fisheries, transportation, rare minerals, oil and gas as well as tourism, all with an expected impact on biodiversity.

- *Advancing environmental prediction for sustainable Arctic Governance*
  In order to provide a sound basis to stakeholders and politicians for decision-making on time scales from days to centuries, it is important to enhance our predictive capacity. This requires **improved high-resolution models resolving key Arctic processes** such as boundary layer turbulence, double diffusion in the ocean, frazil ice and brine formation as well as improved sea ice mechanics. Such coupled Arctic climate system models will need to come with coupled assimilation systems to effectively combine observations and models to initialise forecasts, identify model problems and optimise the Arctic observing system.

Coordinators

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