Advancing Arctic Climate Research in Europe for the Benefit of Society

Briefing Document

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Purpose

The Arctic climate is changing at a rate, which takes many people – including climate scientists – by surprise. The ongoing and anticipated changes provide vast economic opportunities; but at the same time they pose significant threats to the environment. Important decisions will need to be made in the coming years which take into account economic, societal and environmental issues. In this context, a reliable knowledge base, on which decisions can be based, is a prerequisite to provide sustainable solutions.

It is increasingly being recognised that what happens in the Arctic does not stay in the Arctic. A prominent example is the proposed atmospheric link between Arctic sea ice decline and the severity of cold European winters. Therefore, Arctic climate change is likely to affect the weather and climate of Europe.

In this Briefing Document, it is argued that gaps in our scientific understanding and predictive capabilities are still hampering the evidence-based decision making processes by stakeholders. There is an urgent need to accelerate progress in building a reliable knowledge base, and it is recommended that the EU fund collaborative research that aims to provide answers to the following three central questions:

- **Why is Arctic sea ice disappearing so rapidly?**
- **What are the local and global impacts of Arctic climate change?**
- **How can environmental prediction capabilities be advanced?**

The content of this Briefing Document is based on the consensus view following extensive discussions among European climate scientists during three Arctic ECRA workshops held in 2012 and 2013. This group comprises senior scientists who have played pivotal roles in many recent international, collaborative Arctic climate research activities such as the International Polar Year (IPY).

Facts about Arctic climate change

- Temperatures in the Arctic are rising more than twice as fast as in the rest of the world. This is known as "Arctic amplification".
- Arctic sea ice continues to decline at a rapid rate. In recent decades...
    - Summer sea ice extent has declined by about 50%, and
    - Sea ice thickness has reduced by about 40%.
- Sea ice has moved into a new, more vulnerable regime with predominance of first-year ice, longer periods of open water, and enhanced surface melt rates.
- Northern Hemisphere early summer snow cover is disappearing at an unprecedented rate (~ 18% / decade).
- Permafrost is thawing and releasing methane at an increasing rate.
- Many organisms in the Arctic Ocean are highly adapted to an older and thicker sea ice regime, leaving them and the Arctic ecosystem vulnerable to the ongoing changes.
- Greenland's ice sheet is melting at a rate five times higher than in the 1990s, contributing significantly to sea level rise.
- Ongoing change opens up new economic opportunities for exploitation of fisheries, rare minerals, oil and gas, and tourism.
- Opening of the Northern Sea Route would cut the distance between Europe and the Far East (~ 20-25%).

Recommendations

Why is Arctic sea ice disappearing so rapidly?

The mismatch between expected and observed rates of Arctic climate change is most clearly reflected by the fact that despite the progress, climate models are still unable to predict critical aspects of sea ice changes and their timing. This mismatch highlights the gap in our understanding of the underlying processes and feedbacks, as well as their realistic representation in climate models. To ensure progress, Arctic ECRA recommends to:

- Maintain and enhance our European multi-disciplinary monitoring capabilities, which have been effective at detecting recent changes,
- Carry out dedicated joint observational and modelling campaigns to gain a better understanding of climate relevant processes and ensure their accurate representation in climate models,
- Study natural variability of the Arctic climate system and its representation by models,
- Provide more reliable Arctic climate change predictions and projections to stakeholders based on the output of improved climate models, and
- Develop schemes that provide improved information of climate change uncertainty.

What are the local and global impacts of Arctic climate change?

For planning and managing purposes it is crucial to obtain a comprehensive quantitative understanding of the past, present and future impacts of Arctic climate change. It is therefore recommended to support research that:

- Provides a comprehensive understanding of *the local impacts of global significance* of Arctic climate change. Aspects to be considered include:
    - Sea ice, snow cover, and Greenland ice sheets,
    - Permafrost and methane release, and
    - Ecosystems.
- Provides a thorough understanding of the consequences of Arctic climate change on Europe and the world.

How can environmental prediction capabilities be advanced?

In order to provide a sound basis for decision making on time scales from days to centuries, it is important to enhance our existing prediction systems. More specifically, Arctic ECRA recommends to:

- Understand the role of sea ice and snow cover on seasonal to decadal climate prediction,
- Develop high-resolution models with an improved representation of key Arctic processes (e.g. boundary layer turbulence, double diffusion in the ocean, frazil ice and brine formation, sea ice mechanics),
- Optimise the Arctic observation system for polar prediction purposes,
- Develop data assimilation systems of the coupled Arctic climate system to effectively combine observations and models,
- Represent the forecast uncertainty associated with Arctic key processes in ensemble prediction systems,
- Liaise with the user community to provide relevant forecast products to stakeholders.

In summary, the opportunities and challenges arising from Arctic climate change are enormous. It is argued that progress in providing the required knowledge base for decision-making needs coordinated research encompassing theory, modelling and observations. More specifically, it is recommended to include a number of focussed Arctic climate change initiatives within Horizon 2020.

Arctic ECRA

Arctic ECRA is one of four Collaborative Programmes of the European Climate Research Alliance (ECRA). It aims to advance Arctic climate research for the benefit of society by carrying out collaborative research projects. Arctic ECRA is a network of 24 institutions from 9 European countries, ECRA members and non-members, and provides a breadth of expertise including theory, observations, modelling, operational forecasting and logistics. It is unique in its flexibility and responsiveness to new ideas, new results and emerging challenges. The network is backed by access to large-scale infrastructure such as icebreakers, polar stations, aircraft and supercomputing facilities. Furthermore, Arctic ECRA scientists develop and run some of the most advanced regional and global climate models. Arctic ECRA is an inclusive organisation that is open to new participants.

The CP Arctic is coordinated by the Alfred Wegener Institute for Polar and Marine Research (AWI), Germany and the Bjerknes Centre for Climate Research, Norway.

Participating institutions:

Denmark

Finland

France

Germany

Italy

Norway

Sweden

The Netherlands

United Kingdom