

Arctic Research Icebreaker Cooperation towards ARICE and beyond: A strategy for meeting the needs for marine research in the Arctic

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EXECUTIVE SUMMARY

Evidence from long-running interdisciplinary polar research and observation has drawn world-wide attention to the rapid environmental change taking place in the Arctic. The international scientific community agree that these changes will affect the Earth's climate system and the natural environment at both global and regional scales. The likely political, economic and societal impact of this rapid change is the focus of current and future research plans.

The warming trend in the Arctic Ocean over the last decades opens up economic opportunities, including exploitation of marine living and non-living resources and increase in marine traffic. International security and territorial issues in the Arctic region are high on the political agenda. To provide evidence, fill gaps in knowledge, and to develop policy recommendations for a sustainable usage of the Arctic and its resources, the international polar science community must continue to enhance the coordination of ship-borne research programs. There are today only a handful of research vessels in the world capable of operating in the High Arctic. Coordinated planning and usage of heavy research icebreakers would offer a substantial contribution to global polar research.

This strategy document calls for scientific, political and financial commitment to a new initiative that aims to create an international network for joint research icebreaker operations using existing ships. The concept has been developed within a European framework under the name "**ARICE - Arctic Research Icebreaker Consortium for Europe**". The ARICE initiative is to date supported by 15 European, 2 North American and 3 international organisations, and is open for an expansion to a pan-Arctic scale. A proposal has been submitted to the European Commission "Consultation on possible topics for future activities for integrating and opening existing national research infrastructure". We further anticipate to propose the icebreaker initiative as a SAON Task during 2013.

The primary objectives are to:

- Increase the coordination of available heavy icebreakers
- Create a mechanism for a more cost-effective usage of existing polar research vessels through transnational harmonisation of scientific and ship operational planning, especially in the High Arctic

The next decade is critical for most national marine polar programs. Each is likely to review or change their infrastructure assets due to an ageing research fleet and budget constraints arising from the global economic situation.

The reasons for establishing a strategic initiative at this point in time are:

- The requirement to capture new data and fill gaps in scientific understanding and knowledge about rapid change in the Arctic Ocean is urgent
- Science operations in the High Arctic, especially in the colder season are technologically and logistically demanding as well as being cost-intensive
- Plans are emerging to build a new German polar research vessel R/V POLARSTERN 2 whilst continuing to operate the existing R/V POLARSTERN in the Arctic for an additional 5 years
- The Swedish polar research vessel R/V ODEN is operated under a new 10-year agreement making the ship available to researchers from May to December each year.

1. Introduction

Evidence from long-running interdisciplinary polar research and observation has drawn world-wide attention to the rapid environmental change taking place in the Arctic. The international scientific community agree that these changes will affect the Earth's climate system and the natural environment at both global and regional scales. There is therefore an increasing demand from the public, politicians, and other stakeholders for information on the status of the Arctic Ocean and predictions of future scenarios. **This interest in the Arctic Ocean compels for collaborative monitoring and interdisciplinary research, and thus availability of world-class marine polar research infrastructures.**

A number of environmental and societal issues triggered by the warming trend observed in the Arctic over the last decades would benefit from independent scientific investigation. Retreating sea ice in the Arctic Ocean opens up economic opportunities, including exploitation of marine living and non-living resources as well as enabling an increase in marine traffic. International security and territorial issues in the Arctic region attract considerable attention. An important aim of this initiative is to gain a better understanding of these opportunities and risks of the changing Arctic Ocean, to provide new knowledge to inform strategies for a sustainable usage of the Arctic and its resources.

Over the next decade, many national marine polar programs will review their infrastructure assets and their capability to meet the needs of the science community for suitable research vessels. They do this at a time of tight budget conditions, increasing costs, and in many cases an ageing research fleet. Science operations in the High Arctic, especially in the colder seasons, are technologically and logistically demanding, cost-intensive, and can be best achieved by international strategic planning and long term commitments.

It is envisaged that a 5-year strategic **scientific, political and financial commitment** is required to create a framework that would facilitate increased coordination of available

European heavy icebreakers as well as transnational harmonization. This would lead to a more cost-efficient usage of existing polar research vessels. To achieve this ambition, formal agreements between partners to **provide operational ship time** on these vessels are required.

The availability of suitable research vessels for investigations of the ice-covered Arctic Ocean is critical. Only a handful of research vessels have sufficient ice class to penetrate into the High Arctic, i.e. the central parts of the Arctic Ocean. Other ice-strengthened research vessels are confined in their operational envelope to the ice margin zones.

2. The ARICE initiative

This initiative calls for scientific, political and financial commitment to create an international network for joint research icebreaker operations using existing ships. The concept has been developed within a European framework under the name “**ARICE - Arctic Research Icebreaker Consortium for Europe**”. It was based on the fact that Germany plans to build a new POLARSTERN 2 whilst keeping the old POLARSTERN in operation for an additional 5 years for Arctic research, while a new 10-year agreement makes the Swedish R/V ODEN available for Arctic research from May to December each year. These ships open up the possibility for winter season tasking, and the capability to carry out two-ship campaigns for synergetic investigations.

As research operators of POLARSTERN and ODEN, the Alfred Wegener Institute (AWI) and the Swedish Polar Research Secretariat (SPRS) have agreed to lead this initiative. It is to date supported by 15 European, 2 North American and 3 international organisations, and is open for an expansion to a pan-Arctic scale. We have submitted a proposal to the European Commission “Consultation on possible topics for future activities for integrating and opening existing national research infrastructure”. We further anticipate to propose the icebreaker initiative as a SAON Task during 2013.



Europe's two heavy icebreakers, the Swedish Oden (left) and the German Polarstern (right).

The ARICE initiative aims to **share and jointly fund operational ship time on both heavy icebreakers**. This would for the first time establish dedicated research platforms for the Arctic Ocean that support year-round research. It will also lead to a more cost-effective usage of existing vessels. In addition, ARICE concentrates today's heterogeneous national polar research strategies into a **coherent science planning** based on an open, transparent and international process.

ARICE is planned in an international context, with contributions from European and non-European nations with Arctic research interests. It requires the formation of a consortium of countries and their polar research organizations to assure the quality of science and efficient employment of the research icebreakers. Arctic research programs exist in many European nations, but each has a different organizational structure, size and funding. Joint operation of heavy icebreakers would require a considerable commitment by participating nations to co-ordinate their polar marine research programs, in order to operate and coordinate the ships efficiently. The ARICE initiative will in this sense also be an important contribution to establishing a common European Research Area.

Current Key Partners in the ARICE initiative:

1. Alfred Wegener Institut für Polar- und Meeresforschung (AWI), Germany, Nicole Biebow
2. Swedish Polar Research Secretariat (SPRS), Sweden, Magnus Tannerfeldt
3. Swedish Maritime Administration (SMA), Sweden, Tomas Årnell
4. Swedish Meteorological and Hydrological Institute (SMHI), Sweden, Amund Lindberg
5. Institut de Ciències del Mar (CSIC), Spain, Roger Urgeles
6. Italian National Research Council (CNR), Italy, Enrico Brugnoli
7. Programma Nazionale di Ricerche in Antartide (PNRA) Italy, Carlo-Alberto Ricci
8. Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Italy, Angelo Camerlenghi
9. British Antarctic Survey (BAS), United Kingdom, Alan S. Rodger
10. European Polar Board (EPB) of the European Science Foundation, France, Roberto Azzolini
11. Geological Survey of Denmark and Greenland (GEUS), Denmark, Christian Marcussen
12. Finnish Environment Institute, Marine Research Center (SYKE), Finland, Juha Flinkman
13. Finnish Meteorological Institute (FMI), Finland, Johanna Ikävalko
14. Institute of Oceanology, Polish Academy of Sciences (IOPAS), Poland, Waldemar Walczowski
15. Arctic Portal.org, Iceland, Halldór Jóhannsson
16. National Resources Canada (NRCAN), Canada, Marian Campbell Jarvis
17. National Science Foundation (NSF) Office of Polar Programs, USA, Simon Stephenson
18. International Arctic Science Committee (IASC), International, Volker Rachold
19. Sustaining Arctic Observing Networks (SAON), International, Tom Armstrong
20. International Study of Arctic Change (ISAC), International, Maribeth Murray

3. Scientific relevance and demand

The largest gaps in our knowledge and understanding of the Arctic system concern processes during the cold seasons, which remain largely unknown. There are today only a handful of research vessels in the world capable of operating in the High Arctic, and in the colder seasons of the year. Coordinated planning and usage of the most capable research icebreakers would thus offer a substantial contribution to global polar science as a whole.

A warming trend in the Arctic over the last decades has triggered a demand for accurate weather predictions, information on the status of the Arctic Ocean and marine life, and complex predictions of future scenarios. Most questions of particular environmental and societal concern require collaborative interdisciplinary research and availability of world-class research infrastructures.

A collaborative effort will support year-round observations and experiments from the ships, and sustain long-term ocean and atmospheric monitoring time-series. Automated vehicles (AUVs and ROVs) able to navigate under ice shelves, and sophisticated buoy systems, will be deployed to collect measurements on temperature, in situ chemistry, ice formation, freshwater flux, heat flux and bottom melt, and to sample marine biota in an otherwise inaccessible environment.

Research topics and key questions to be addressed are for example:

The Changing Polar Oceans, Ice and Atmosphere

Key questions on the interaction of sea ice, ocean and atmosphere in times of climate change:

- How does global climate change affect long term trends and seasonal variability of sea ice and polar oceanographic and atmospheric circulation patterns? And vice-versa: How do reduced extension of sea-ice (albedo) and changing patterns of air and water masses influence the global climate?
- Which are the polar oceans sources and sinks of CO₂ and other gases? And which are the rates and impacts of their changes?
- What are the effects of diminishing sea ice cover on weather patterns and ozone concentrations in the Northern Hemisphere?

The Polar Marine Biosphere

Key questions on the threats and capacity of polar organisms to survive and adapt in times of changes:

- How did polar marine organisms adapt to past climate changes and what does this tell us about their capacity to adapt to future change?
- How will changes in the biological systems of the polar regions influence global biogeochemical cycles?
- To which extent, in what direction and on what time-scales will polar organisms and ecosystems change?

Polar Paleo-climate and Paleo-environment

Key questions on the paleoclimatic history of the polar regions:

- How did paleo-atmospheric CO₂ concentrations and temperature increase affect ice sheet stability (on different time scales)?
- Which were the mechanisms governing the CO₂ cycle and what was the role of the polar oceanic-ecosystems including the deep biosphere, in terms of global carbon budgets and turnover rates in the past?
- What were the consequences of past polar shallow - and deep - oceanographic changes for global oceanic circulation?

Seafloor Processes and Natural Hazards

Key questions on the potentially hazardous geological and geomorphological activity of the polar regions' seafloor:

- What is the real extent of subsea permafrost on Arctic continental shelves?
- How can we quantify the role of gas hydrate systems in marine Arctic sediments?
- How likely are massive disintegrations of gas hydrates, and associated slope failures and tsunamis in the future?

4. Implementation

The initiative strives to create a strong capability that allows for a basic research program in the Arctic Ocean. This can be combined with national and international initiatives to support research beyond the reach of any individual nation.

To implement the ARICE initiative, European and non-European governmental and national agencies have to join forces under an agreement defining the models for participation and the financial commitments needed for a successful program. Governance and financial schemes developed within the FP7 funded ERICON-AB project, or as used in the Integrated Ocean Drilling Program (IODP), could serve as models.

One model for a “**Coordinated Usage Concept**” could be the formation of an Icebreaker Consortium of international partners that contribute to a virtual common pot. The total ship-time is distributed amongst the consortium partners based on scientific excellence of their proposals, in line with a national quota reflecting the respective national financial contribution to the virtual common pot. Ship time allocated to each partner should be balanced over the lifetime of the initiative rather than for each expedition, thus allowing scientific excellence and creation of unified research programs to take precedence over strict enforcement of quota regulations. The **foreseen lifetime of five years** for the first phase, allows for strategic planning, and principally corresponds to medium-range national polar program planning in most countries under consideration. Implementation of a joint proposal review system should be considered in order to give access for all scientists on the condition of scientific excellence. A lean managing agency would support the consortium by allocating

ship-time to successful proponents and scheduling of the cruises in close cooperation with national ship operators.

5. Funding and resources

The yearly number of ship-days devoted to this initiative will be determined by scientific needs and financial contributions. It will also depend on national research priorities, annual and seasonal availabilities and principal economic cost development in the shipping sector. While the majority of financial contributions for realization will originate from national resources, the nature and scope of the Coordinated Usage Concept shall also fit European and international strategic science perspectives and funding. We expect the creation of bottom-up networks that will build strong scientific proposals related to societal relevant questions. This should attract supplementary funding by national entities, both for the operation of the icebreaking vessels and the funding of basic research.

6. Risks

Without this initiative the international polar community will lose an opportunity to deliver effectively a collaborative scientific effort that brings together the intellectual capacity, knowledge, expertise and operational excellence from world-leading polar programs. The risk of not developing ARICE to its full potential is that the financial pressures on polar organisations that operate large infrastructure will limit the capability of the polar science community to provide the environmental knowledge that will ultimately benefit economies and societies within the Arctic region and beyond.

7. Further reading

The ERICON *Aurora Borealis* initiative

http://www.eri-aurora-borealis.eu/en/the_project/preparatory_phase/ericon_ab/

ERICON SCIENCE PERSPECTIVE 2015-2030

http://www.eri-aurora-borealis.eu/fileadmin/user_upload/Home/download/RELEVANT_FINAL_DOCUMENTS/ERICON_2015-2030_SP.pdf

Models for Governance and financial schemes developed within the FP7 funded ERICON-AB project, or as used in the Integrated Ocean Drilling Program (IODP) can be found here:

Report on joint European research icebreaker capacity: http://www.eri-aurora-borealis.eu/fileadmin/user_upload/Home/download/RELEVANT_FINAL_DOCUMENTS/ericon_del_2-5.pdf

Business plan and financial models for AURORA BOREALIS: http://www.eri-aurora-borealis.eu/fileadmin/user_upload/Home/download/RELEVANT_FINAL_DOCUMENTS/ericon_del_4-2.pdf

Report on organisational structure of the legal entity to manage the infrastructure:

http://www.eri-aurora-borealis.eu/fileadmin/user_upload/Home/download/RELEVANT_FINAL_DOCUMENTS/D_5_2_Part_A_and_B.pdf

Recommendations and scenarios of legal implementation structures for the multi-purpose research icebreaker AURORA BOREALIS:

http://www.eri-aurora-borealis.eu/fileadmin/user_upload/Home/download/RELEVANT_FINAL_DOCUMENTS/ericon_del_6-1.pdf

Governance structure and financial participation models of IODP:

<http://www.iodp.org/about>