

The Innovative European Research Icebreaker AURORA BOREALIS
A unique facility for integrated earth system research in extreme environments



An Executive Summary



The Polar Regions and their Impact on a Sustainable Future for Modern Societies

Understanding and responding to the dynamics of ongoing global change is of highest urgency and societal relevance and consequently immense attention is paid to the Polar Regions by the highest political authorities. It is recognized that securing the future of humankind requires immediate action and a considerable intensification of polar research. The properties of northern and southern high latitude marine and terrestrial areas are at present subjects of intense scientific debate. They react more rapidly and intensely to global changes than any other region on Earth. At the same time they are also a major driver of climate change and hence their impact is not only of regional, but also of global importance.

While the polar land surfaces are characterized by extreme habitats, they are at least accessible to scientists during all seasons. This is not so for the polar oceans. Signs of dramatic changes are currently observed: News about the shrinking Arctic sea-ice cover, potentially leading to an opening of sea passages for commercial traffic to the north of North America and Eurasia, of the calving of giant table icebergs from the Antarctic ice shelves, of changes in the Meridional Overturning Circulation of the deep polar oceans, of the increase in global sea level rise witness such changes in real time. In the Arctic these processes will open up new and un-investigated provinces of non-living resources, while habitats of living resources may be changed. Dedicated research vessels capable to operate during all seasons of the year and under unfavourable weather conditions in the central Arctic Ocean and in the Southern Ocean are required to fulfil the new needs of polar ocean research for all marine disciplines. Today, no available ship has the required capabilities and capacities; in addition these vessels are few and outdated, thus having to split research efforts between the Arctic and the Southern oceans.

The European Initiative

The European Polar Board has taken the initiative to develop a plan for a novel and dedicated research icebreaker with technical capabilities hitherto unrealised, which will enable it to autonomously operate in the central Arctic Ocean even during the severest ice conditions in the deep winter serving all marine disciplines of polar research including deep-sea drilling: The AURORA BOREALIS. Such a ship will necessarily offer possibilities whose effective use reaches far beyond the capacities and capabilities of an individual nation. Therefore complex interdisciplinary experiments can only be conducted under close international and inter-/multidisciplinary co-operation. The AURORA BOREALIS will act as a basis to support such research efforts and fulfil the operational needs of the science community as well as political obligations of governments, which have a high interest in the polar oceans, their seafloors, the environmental properties, and the impact of these regions on the adjacent subpolar and polar habitats of indigenous and non-indigenous populations.

What are the main interests in the project ?

The AURORA BOREALIS project, through close connection with the European Science Foundation's European Polar Board will support multidisciplinary research in areas like Climate Change, biodiversity assessments, geohazard analysis, resource engineering or long-term monitoring. It will foster the integration of diverse scientific disciplines such as Glaciology, Biology, Meteorology, Geosciences into common scientific frameworks. The generation of joint research programmes at the European level will be an important facet of the cooperation. Research missions comprising several years will examine in a holistic way the properties and dynamics of processes controlling the central Arctic environments. The project will be beneficial for the understanding and analysis of natural resources, northern sea routes, helping the delineation of EEZs through scientific research, mapping gas hydrate and submarine permafrost distributions. New technologies in extreme environments will be tested and the project serves as a proliferator of key marine technologies for participating countries.

AURORA BOREALIS will be a 'European scientific flagship facility' (also open to non-European partners), a multidisciplinary platform for studies ranging from the sub-seafloor into the atmosphere. The ability of AURORA BOREALIS to penetrate into the harshest conditions on Earth and to carry out research even in the polar winter will set new standards in the fields of polar research and naval architecture, including environmental safety of the highest standards. Currently, no polar research vessel has the capability to autonomously operate in pack ice except during the optimal ice conditions of the late summer season. AURORA BOREALIS, in contrast, is planned as a multi-purpose icebreaking research vessel for Arctic and Antarctic operations with the capability to autonomously navigate in sea-ice with a thickness of more than 2.5 metres. This will for the first time facilitate year-round research, e.g. on the nature of global environmental change. The ship shall have the unique capability to perform scientific deep-sea drilling operations in water depths between 100 and 5000 metres with a penetration of more than 1000 metres into the seafloor, even while being located amid drifting pack-ice fields. An innovative, high-performance dynamic positioning system shall enable the ship to keep position in such a demanding environment.

The Planning of the world's largest Multinational Marine Research Facility for the Polar Oceans

After a careful scientific assessment of Arctic Ocean research needs (published in 2004 by ESF) the European Polar Board and its partners have taken steps to further the planning process towards generating this new facility. At present, it consists of 2 major efforts:

Governance: The 4.56 Million EURO European Project ERICON-AB (European Research Icebreaker Consortium – AURORA BOREALIS, cf. www.eri-aurora-borealis.eu) is financed by the European Commission under 7th Framework Program (FP 7) and coordinated by the ESF in Strasbourg www.esf.org. It runs from 2008-2012 and is designed to prepare the strategic, legal, financial and governance frameworks for the vessel. AURORA BOREALIS is included in the priority list of the European Commission's 'European Strategy Forum on Research Infrastructures' (ESFRI) within the FP 7, is the largest Environmental Sciences project on the roadmap and is specifically mentioned in the European Commission's recently published Arctic Communication. Currently, 10 countries participating in this preparatory project: Belgium, Bulgaria, Finland, France, Germany, Italy, The Netherlands, Norway, Russia, Romania. Denmark will become an official ERICON partner in the coming months. Interests to cooperate ERICON-AB have been expressed by the science communities in Spain, and Ireland.

Innovative Technology: Following an earlier feasibility study, a principal technical design and General Arrangement Planning for the vessel was completed by Wartsila Ship Design in Hamburg in 2008-09. The contract issued by the AWI and funded by a 5.2 Million EURO grant from the German Federal Ministry for Education and Research (BMBF) also involved specialised subcontractors like "Aker Arctic Technology" in Helsinki and the "HSVA" (Hamburg Ship Model Basin).. These expert advisors provided extensive ice tank testing of the model. Initial decisions about construction will be prepared in late 2010-11.

For the first time, routine scientific deep-sea drilling will become possible even in drifting pack ice, without support by additional icebreakers. To perform these drilling operations AURORA BOREALIS has to be kept exactly on position in the floating ice. A dynamic positioning system capable for manoeuvring and staying on position in drifting sea-ice is mandatory for this task – an absolute novelty in the shipping industry. Extensive model tests in the ice tanks of the Hamburg Ship Model Basin (HSVA) and Aker Arctic Helsinki have proven that AURORA BOREALIS is indeed able to dynamically position in closed sea-ice cover with thickness of two meters and more. Another unique characteristic of AURORA BOREALIS are the two moon pools (7x7 meters each). These are continuous vertical funnels in the midst of the hull into the water below the vessel that enable scientists to deploy

equipment into the ocean without being subject to wind, waves and ice. The aft moon pool is mainly dedicated to drilling operations, while the forward moon pool is reserved for most other scientific works. This allows as a first the deployment of very sensitive and expensive equipment, e.g. remotely operated (ROVs) or autonomous (AUVs) underwater vehicles within closed sea ice cover. Scientific laboratories are located on several decks around the moon pool, which is designed in an atrium-like shape with circular walkways and preparation areas. In order to optimally equip the ship even for mission specific expeditions, containerized laboratories can be also loaded here and become fully integrated into the scientific workflow on board.

Committed partners?

The European Commission has recently published (in November 2008) an Arctic Communication , requesting *inter alia* specifically the completion of the AURORA BOREALIS project. The ERICON-AB project is carried out with partners from 10 European countries. During a national review by the German “Wissenschaftsrat” (German Science and Humanities Council) it was recommended that more than 30% of the construction and running costs should be provided by Germany, on the condition that the infrastructure is realised within an international consortium of committed (European?) countries. The German Federal Ministry for Education and Research (BMBF) has subsequently funded the technical design process, ice tank testing and scientific workshops with 5.2 Million EURO. Norway has strong interests in the project, as the vessel is placed on its national infrastructure roadmap. Discussions between Germany and the Russian Federation at ministerial level took place and led to a declaration from the Russian side in favour of a future participation in the project. Recent discussions in Moscow (May 2009) by the ERICON management team have confirmed the scientific and strategic and political interests in the project by the Russian Federation.

The ERICON project is continuing in negotiations with several countries on the political level to advance the decision on financing of the project. Interests from Italian shipyards and multiple national polar programmes are also pursued. ERICON will work towards the foundation of an AURORA BOREALIS Political Council and legal entity, with decisions on financial commitments sought at the end of 2011.

How will the expenses of the project be divided?

This will be the subject of a business planning process conducted as part of ERICON-AB, but it is estimated that core construction costs will range from 635-850*M Euro (subject to financial panel validation) while running costs are projected to range between 30-45M. Euro/yr* including financial support to the management structure. One structure for financial participation under discussion consists of a system of shares – where stakeholder ministries will have to commit funds for these elements. In order to support clusters of smaller countries, using risk share financing facility of the European Investment Bank will also be assessed. Exact costs and participation models will be generated and proposed during the business planning process with advice from a dedicated panel of financial experts and stakeholders of the ERICON-AB project.

Consequences of the AURORA BOREALIS and her Consortium

Realising this new major infrastructure facility will add substantial new capacities to marine polar research; it will result in additional 15,000 scientist's days/yr if operated for at least 300 days/yr and bring the participating countries into a position of international leadership. It will free up capacities of existing polar research vessels, which could be devoted to expeditions in the Southern Ocean where they are much needed. AURORA BOREALIS can be considered to be closely complementary with that of SIAOS (Svalbard Integrated Arctic Observing System), which is another element of the EU-ESFRI Roadmap. A participation in AURORA BOREALIS will expand and establish dedicated scientific working groups/communities capable to make efficient use of the abilities and capacities of this novel research ice breaker.

The Arctic and Antarctic deep-sea drilling perspectives will be incorporated in close cooperation with ECORD and IODP, and it is expected that the AURORA BOREALIS will also serve as 'Polar dedicated' research platform for the ocean basins in the high latitudes.

More information is available on the websites:
www.eri-aurora-borealis.eu and www.esf.org/polar