The Arctic in Rapid Transition (ART) Initiative: Integrating Priorities for Arctic Marine Science Over the Next Decade

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1) Background of the ART Initiative:
The Arctic is undergoing rapid and significant environmental and economic transformations. Recent climate warming, which is simplifying access to oil and gas reserves, enabling trans-Arctic shipping, and shifting the distribution of renewable resources, has brought the Arctic to the top of national and international political agendas. Scientific knowledge of the present status of the Arctic Ocean and a process-based understanding of the mechanisms of change are required to make useful predictions of future conditions throughout the Arctic region. In turn, these predictions are urgently needed to plan for the consequences of climate change.

A step towards improving our capacity to predict future Arctic change was undertaken with the Second International Conference on Arctic Research Planning (ICARP II) meetings in 2005 and 2006 (www.icarp.net), which brought together scientists, policymakers, research managers, Arctic residents, and other stakeholders interested in the future of the Arctic to discuss key research priorities. More recently, the Arctic in Rapid Transition (ART) Initiative developed in an effort to synthesize the several resulting ICARP II science plans specific to the Arctic marine environment (NRC: Arctic sea ice, WGI: Deep central basin of the Arctic Ocean, WGI: Arctic margins and gateways, and WGI: Arctic shelf seas).

2) Science Goals of the ART Initiative:

The Arctic Ocean is now in a state of rapid transition with tremendous economic, social, and environmental consequences. It is the best exemplified by the marked reduction in sea-ice cover witnessed in instrumental records over the last 30 years. In further our understanding of the Arctic Ocean system, the ART Initiative is an interdisciplinary, transdisciplinary science program for the Arctic Ocean integrating past, present, and future.

- **Internationalis:** An important aspect of ART is to help bridge processes and ecosystem responses over a broad geographic range, including across international polar boundary layers, shelf seas, and the central Arctic Ocean. All of these regions are experiencing profound physical and biological change in response to recent climate warming.

- **Interdisciplinary Translatability:** An important issue in the Arctic area from uncertainties in complex feedback processes, forcing mechanisms, and initial boundary conditions of the ice-ocean-atmosphere system. The interdisciplinary approach of ART focuses on developing links between processes specific to the Arctic Ocean and its physical, biological, and geoclimatic feedback processes and forcing mechanisms, which provides a means to improve forecasts of future sea ice conditions.

3) ART Initiation Workshop in Fairbanks, Alaska (7-9 November 2009):

The first ART workshop was held at the International Arctic Research Center (IARC) in Fairbanks, Alaska in November 2009 with 58 participants from 9 countries. Over half of the participants were early career scientists or students. The workshop began with six keynote speakers from various disciplines:

- Large Scale Processes and Changes in the Biosphere (Paul Markson, University of Toronto)
- Sea Ice: A Key Topic (Michael P.A. Haynes, University of Alberta, Canada)
- North Slope of Alaska: A Case Study (Johannes Riede, Germany)
- Arctic Ocean Interfaces (Paul Costumed, Univerity of Maine)
- Large Scale Processes and Changes in the Biosphere (T. Prowse, Stockholm University)
- Land/Ocean Interface (Paul Costumed, University of Maine)

The workshop presentations set the stage for the working group meetings that took place for most of the first and second days. Discussions were centered around three major foci: (i) sea variability; (ii) land-ocean interactions; and (iii) ecosystem responses. The final day of the workshop was spent in plenary, where each working group reported to the full workshop on the results of their discussions. In addition, a marine unidate panel of experts was convened on the final day of the workshop to talk about the specific processes of developing an ART science and implementation plan.

The ART workshop was sponsored by the US National Science Foundation, AOSB/ARC, the International Arctic Research Center, the Research Council of Norway, the Department of Fisheries and Oceans, and the Association of Polar Early Career Scientists, and IFM-GEOMAR. Special thanks to Sara Dewson (AOSB) for her support with the ART process.

4) Key ART Scientific Questions:

- **How have past transitions in sea ice connected to energy flows, carbon cycling, biogeographical diversity and processes? What are the ecosystem responses to these transitions?**
- **What were the principal forcing mechanisms responsible for regional variations in sea ice cover and biogeographical diversity during past environmental transitions?**
- **How do patterns of sea ice reduction from elevated greenhouse gas concentrations differ from those driven by changes in solar forcing?**
- **Is what we are experiencing today an Arctic Ocean response to historical changes?**

**How will biogeochemical cycling in the Arctic Ocean respond to transitions in terrestrial, glacial, and shelf—basin interactions?**

- **What are the mechanisms that control Arctic Ocean biogeochemistry and how will these mechanisms be affected by changes in the Arctic environment?**
- **How do Arctic Ocean ecosystems respond to changes in temperature, vertical stratification, seasonal ice cover, and sea ice extent with current environmental transitions?**

- **What are the resilience differences in how primary production is responding to changes in physical drivers over the Arctic?**
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- **How will changes in the functioning of food webs impact non trophic (phytoplankton) and trophic processes and will they shift the system’s potential for atmospheric CO2?**

5) ART Science and Implementation Plan:

The goal of the forthcoming ART Science and Implementation Plan is to integrate, update, and develop priorities for Arctic Marine Science over the next decade. More specifically, our focus within the ART Initiative is to bridge gaps in knowledge not only across disciplinary boundaries (e.g., physiology, genomics, ecology, oceanography, physical oceanography, but also across geographic (e.g., international polar boundary layers), shelf seas, margins, and the central Arctic Ocean) and temporal (e.g., palaeo-genetics records, current process observations, and future modeling studies) boundaries as well. The approach of the ART initiative will provide a means to better understand and predict change in the Arctic Ocean system, with a particular focus on the ultimate consequences for biogeochemical cycling.

The ART Science Plan is currently in its drafting stage and the ART Steering Group Writing Team is planning to complete a draft by April 2010. On April 13, 2010, the ART Science Plan will be presented to the Arctic Ocean Sciences Board (AOSB) of the Arctic Science Summit Week in Nukuvuk, Greenland. A workshop for the drafting of the Implementation Plan is scheduled for Fall 2010.

For more information and updates on the ART Initiative, please visit www.aosb.org/art.html.