# Introduction of "Long-term plan for Arctic Environmental Research"

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1. Background

One of the main tasks of the Japan Consortium for Arctic Environmental Research (JCAR) is to develop a long-term Arctic research plan. This plan is organized around core subjects, and encourages forward progress towards common goals using a collaborative network of multidisciplinary researchers in JCAR. Although many researchers in JCAR have been conducting environmental research in the Arctic, some of the researches have not directly addressed the topics of global warming and biodiversity, and, we believe, those researches may also provide important new information on global warming and biodiversity and enhance the activities of JCAR as an academic community. Furthermore, this report includes guidelines to develop research infrastructure, construction of a research platform, and capacity building.

2. Brief summary

More than 140 JCAR members and scientists were involved in the development of this long-term Arctic research plan. The planning, writing, reviewing and publishing of this document took more than 1.5 years, and was completed in September 2014. The document describes the research important for next 10-20 years with four research focus areas identified by JCAR: 1) Elucidation of abrupt environmental change in the Arctic associated with on-going global warming; 2) Elucidation of environmental change in relation to biodiversity; 3) Broad and important subjects on the Arctic environment; 4) Development of methods enabling breakthroughs in environmental research. This report also describes the networks and infrastructures required to achieve the research goals and objectives. For each focus area a review of the current status of research is presented, along with several scientific questions and their justification.

3. Research topics.

The long-term plan for Arctic environmental research describes how the following research topics will be evaluated over the next 10-20 years:

- Atmospheric: Arctic warming by increase in longwave radiation and sensible-latent heat with sea ice reduction; Improvement in cloud modeling; Aerosols on cloud formation; Black carbon on snow and ice sheet; Arctic sea ice reduction on mid-latitude weather; Interaction between the Arctic and the equatorial region.
- Terrestrial snow and ice: Glacier calving-marine interaction; Northing of forest belt; Observation network and satellite observation; Biological effect on snow/ice albedo; Monitoring of early winter snow on permafrost in southern peripheral area; Increase in discharge of main Arctic rivers.
- Sea ice / Ocean: Prominent sea ice reduction at Siberian coast; Sea ice stability in Arctic Ocean due to warm water from the Pacific Ocean through Bering Strait; Monitoring of vertical mixing and reduction of sea ice in Barents Sea; Sea ice prediction in multiple time scales for Arctic Sea routes.
- Paleoclimate and solid geophysics: Proxy data from glacier and ocean bottom cores in the Artic; Watching hydrothermal mine and ocean bottom crustal change; Grounding line retrieval of calving glaciers with sea level rise; Melt water effect to glaciers and ice sheets.
- Upper Atmosphere: Monitoring of cooling in upper atmosphere; Continual monitoring in ozone depletion and global warming; Monitoring of solar activity; Monitoring of the geospace plasma for the safety in operating satellites.
- Terrestrial plant ecosystem: Fertilization in the feedback argument; Albedo reduction, evapotranspiration increase and reduction in soil moisture by northing of Forest belt; Biodiversity research in the Arctic.
- Terrestrial material cycle: Clarifying unknown part of carbon cycle in the Arctic; Amount of organic carbon in soil and permafrost for $CO_2$ and$CH_4$ release due to warming and forest fire; Nutrient and rare metal transferred by rivers and coastal erosion.
- Marine material cycle and ecosystem: Effect of sea ice reduction on productivity due to lower nutrient upwelling; Monitoring of change in biodiversity; Material transfer between continental shelf and ocean basin for the response of the

ecosystem; Changes in food chain and material cycle in other than summer.

- Social influence: Influence of opening of Arctic shipping routes; Earthquake and tsunami information transfer to residents; Influence to life style by changes in terrestrial ecosystem, increase in forest fire, changes in agricultural and fishing products; Information exchange, collaboration, mutual understandings on scientific research results.

4. Research infrastructure

   The research efforts outlined in the long-term Arctic research plan will require the following infrastructure:

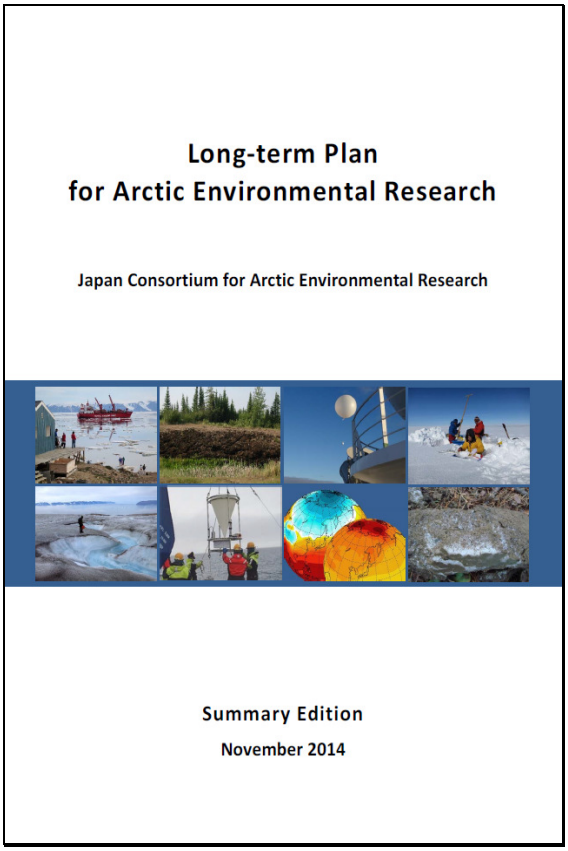
   - Satellite remote sensing: Improve microwave sensors in order to better monitor sea ice distribution; Development of combined SAR, Lidar, radar altimeter for monitoring ice sheet, glacier, sea ice and snowpack; Development of gravitation sensor: Visual band sensors for terrestrial and marine ecosystem.
   - National Researches: Matching of governmental and individual research; Taking use of non-Arctic states' perspective for international Arctic research.
   - Research Vessels: Necessity of national research ice breaker for conducting independent and international research; Higher grade and better specification of the icebreaker than the ones existed.
   - Data Archive: Establish a domestic data center; Retrieval and digitization of historical data; Putting DOI code to all Arctic data set; Collaboration with international data center.
   - Observation network: Establishment of coordinated super site network for long-term monitoring and collecting the various parameters; By-lateral framework for cooperation in maintaining the observation site.

5. Practical use of this report

This report suggested the needs for Arctic environmental research without putting priorities, which could be done by whom needs them. It is a department store of research topics and purchased by stakeholders who need them.

Arctic research of non-Arctic states involves with Arctic states, therefore the research projects always have its international or by-lateral nature. Precondition of scientific activities in the Arctic is geopolitical stability in spite of rapid environmental and social change. It is important to educate young scientists in international circumstances.

Arctic environmental assessment must be done fairly. It is sometimes easily done by institutions in non-Arctic states rather than by domestic institutions due to no conflictions with local political organizations.

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