ICARP III Activity - Reporting Template

Title of activity Arctic Freshwater Synthesis		
Type of activity International Assessment	**Date** 2013 – 2015	**Place** Global

Main organizer(s) (name and/or organization) and additional partners

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Sponsors: Climate and the Cryosphere (CliC), Arctic Monitoring and Assessment Programme (AMAP), IASC
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Abstract[1]

The Arctic Freshwater Synthesis (AFS) is an interdisciplinary science integration activity that is producing a circum-Arctic review and synthesis of the Arctic freshwater system, focusing on the storage, fluxes and effects of freshwater across atmosphere, ocean, terrestrial hydrology, terrestrial ecology, and resource components. Modeling of the water system across these components is also addressed. Changes in the system affect not only the Arctic but also other areas, and some of these impacts will have consequences at the global level. A central aim of this project is to cover the links between the components to highlight the cross-system effects of freshwater in the Arctic and its change. The project is a collaborative effort lead by the WCRP Climate and Cryosphere Project, with co-sponsorship from the Arctic Monitoring and Assessment Programme (AMAP) and the International Arctic Science Committee (IASC).

Main contributions to ICARP III[2] in terms of the ICARP III priorities[3]

The project is currently in the final phase of preparing the scientific publications that address various components of the Arctic freshwater system, in particular the links across components. These publications will present in more detail the key knowledge gaps and science recommendations that have been identified for each component. Below we briefly summarize a few highlighted science priorities:

In general, concerted ground observations, remote sensing, field studies and modeling are required to improve understanding of the role of freshwater and its change in the Arctic.

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[1] Provide a short summary of the activity

[2] List a few key statements (findings, priorities, recommendations) that you would like to see reflected in the overarching ICARP III products

[3] ICARP III priorities:
- identify Arctic science priorities for the next decade
- coordinate various Arctic research agendas
- inform policy makers, people who live in or near the Arctic and the global community
- build constructive relationships between producers and users of knowledge

Long-term observational data is essential, complemented by focused studies that interpret patterns and temporal changes in these data.

For atmospheric research, cloud and humidity observations from ground or ships will help advance process understanding. Sustained observations with unmanned aerial vehicles or dropsondes may complement radiosonde sounding stations. Among other concerns, future research should address observational and parametrization challenges of evaporation from drifting snow and spray droplets. Modeling issues that require focus included the representation of storm tracks, orographic precipitation and the effects on ice loss on evaporation and precipitation.

Better estimates of evaporation and evapotranspiration are also a priority for terrestrial hydrology, as well as improved understanding and representation of these and other land surface processes in climate models. To estimate all components of the water balance, maintaining a number of research basins in different landscapes will continue to be essential. Ongoing observations of river discharge across the pan-Arctic drainage basin should at least be sustained, preferably augmented, and a number of key downstream gauges are overdue for updates to their rating curves. Observations of water constituents, temperature, and sediment, which should be expanded to allow tracking of large-scale changes across the Arctic, also all depend on reliable discharge measurements, and a coordination effort between the Arctic coastal states to support water chemistry monitoring is highly desired in this regard. To improve runoff estimates from Greenland, ice sheet models require better retention and percolation schemes and representation of non-linearities.

For Arctic marine and terrestrial ecosystems, effects of hydrological and climate changes are still quite uncertain. Better estimates are needed of the greening and browning in terrestrial and aquatic systems, including improved process-based understanding of inter-ecosystem interactions (e.g., increased flows of carbon, nutrients, and sediments from terrestrial to aquatic systems). Improved prediction of how an intensified hydrological cycle affects productivity and influences biogeochemical cycles is also needed. Hotspots of ecosystem change and tipping points need to be identified, and effects of changing seasonality on productivity should be explored. Also, the implications for acquatic ecosystems of changing ice dynamics are less known.

In terms of the Arctic Ocean, improved understanding of processes that control freshwater delivery, transport, storage and discharge back to the lower latitudes is required. For this, the role that atmospheric and terrestrial components of the system play in terms of two-way interactions and system feedbacks, and the joint effects that sea ice decline and the accelerated hydrological cycle have on northern hemisphere weather and global climate, should be explored more. Observations using moored arrays across key ocean gateways, as well as from ships, aircraft, and snow machines, are needed to provide information on upper-ocean state and flux of water and heat. Freshwater inflow estimates from major river gauges is also a key concern. Satellite-based observations of ice volume and land surface water systems, such as Cryosat and GRACE, are required for year-round information across the entire Arctic domain, both marine and terrestrial.

In general, the interfaces of the Arctic freshwater system, such as land-ocean, land-atmosphere, and ocean-atmosphere, should be brought into greater focus in order to understand how freshwater flow and storage function and change across the system. Changes at all of these interfaces are also associated with effects on people and environment in the Arctic, something that will also require increased attention.