The Arctic Freshwater System in a Changing Climate (AFS)

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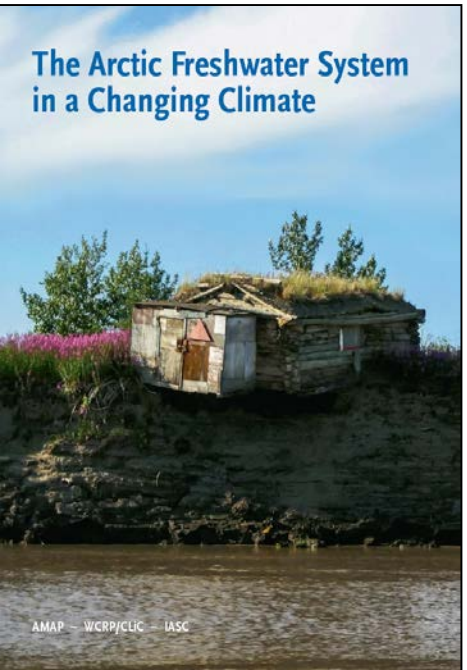
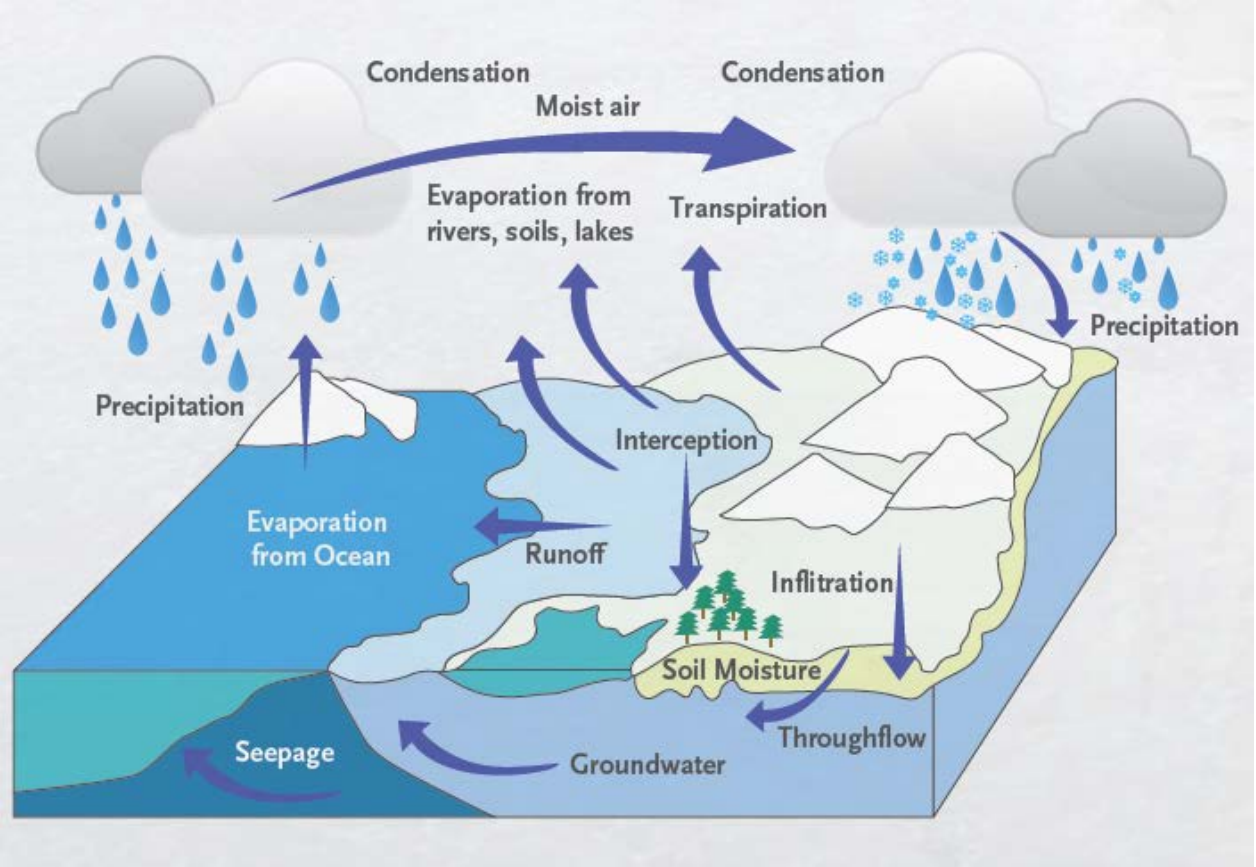


AMAP
Arctic Monitoring and Assessment Programme



The Arctic Freshwater Synthesis (AFS) project was led and coordinated by the World Climate Research Programme's (WCRP) Climate and Cryosphere (**CliC**) Project, in partnership with the International Arctic Science Committee (**IASC**) and the Arctic Council's Arctic Monitoring and Assessment Programme (**AMAP**).

The AFS is a contribution to the 3rd International Conference on Arctic Research Planning (**ICARP III**), the WCRP's Grand Challenges, and AMAP's 2016 update assessment of Snow, Water, Ice and Permafrost in the Arctic (**SWIPA**).

Arctic Temperature

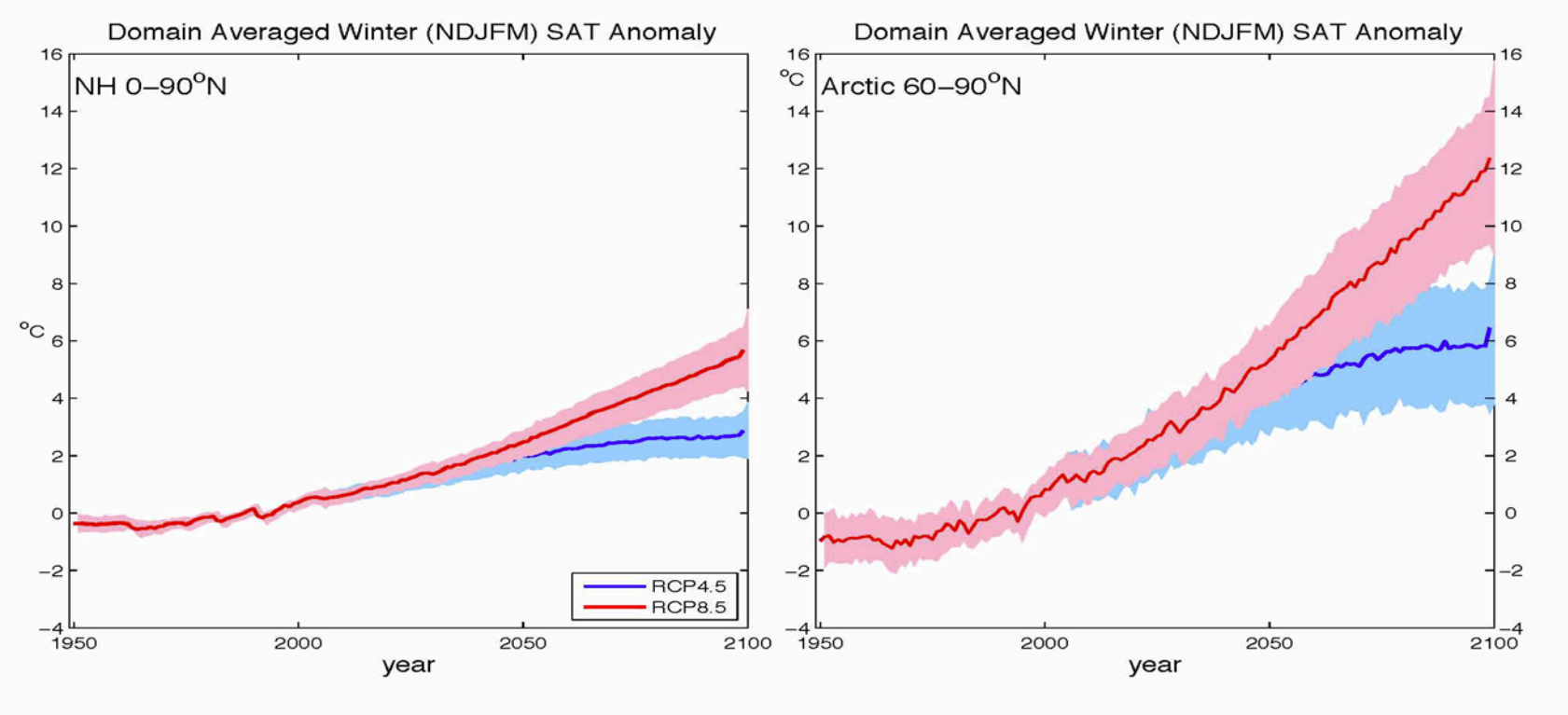
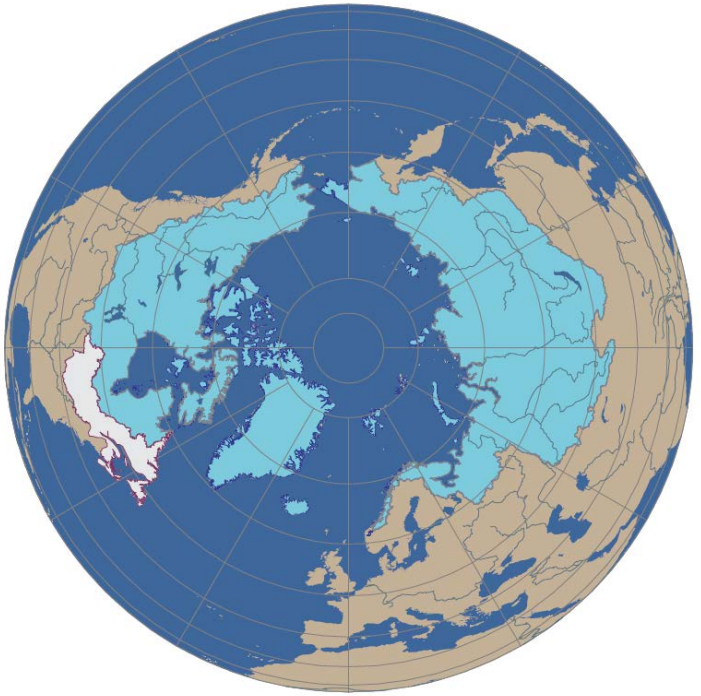


Figure reproduced from Redone figures from the Pithan feedback paper and the Arctic temperature plot from our Earth's Future paper (Overland et. al. 2014)

Arctic Freshwater domain

The AFS adopts an expanded hydrological regime that includes shelf and coastal regions, freshwater recirculated back into the Arctic Ocean, and terrestrial drainage systems that extend further south than those considered before.



This allows for a more complete understanding of how the Arctic hydrological system operates, how it is linked to systems in the mid-latitudes, and the forces and processes that influence it.

AFS inter-linkages

A warmer climate will result in changes in type, intensity and distribution of precipitation

Changes in the terrestrial environment (e.g. permafrost thawing) will alter runoff patterns

Changing hydrological conditions have implications for ecosystems and humans within and beyond the Arctic

Scientific Publications

Special edition of the Journal of Geophysical Research: Biogeosciences

(http://agupubs.onlinelibrary.wiley.com/agu/jgr/journal/10.1002/(ISSN)2169 8961/)

- **The atmospheric role in the Arctic water cycle: processes, past and future changes, and their impacts** (T. Vihma, J. Screen, M. Tjernström, B. Newton, X. Zhang, V. Popova, C. Deser, M. Holland, and T. Prowse)
- **Fresh water and its role in the Arctic Marine System: sources, disposition, storage, export, and physical and biogeochemical consequences in the Arctic and global oceans** (E. Carmack, M. Yamamoto-Kawai, T. Haine, S. Bacon, B. Bluhm, C. Lique, H. Melling, I. Polyakov, F. Straneo, M. Timmermans, W. Williams)
- **Arctic terrestrial hydrology: A synthesis of processes, regional effects and research challenges** (A. Bring, I. Fedorova, Y. Dibike, L. Hinzman, J. Karlsson, S. Mernild, T. Prowse, O. Semenova, S. Stuefer, M. Woo)
- **Transitions in Arctic Ecosystems: Ecological Implications of a Changing Freshwater System** (F. Wrona, M. Johansson, J. Culp, A. Jenkins, J. Mård Karlsson, I. Myers-Smith, T. Prowse, W. Vincent, P. Wookey)
- **Modeling the Arctic Freshwater System and its integration in the global system: Lessons learned and future challenges** (C. Lique, M. Holland, Y. Dibike, D. Lawrence, J. Screen)
- **Changes to freshwater systems affecting Arctic infrastructure and natural resources** (A. Instanes, V. Kokorev, R. Janowicz, O. Bruland, K. Sand, T. Prowse)

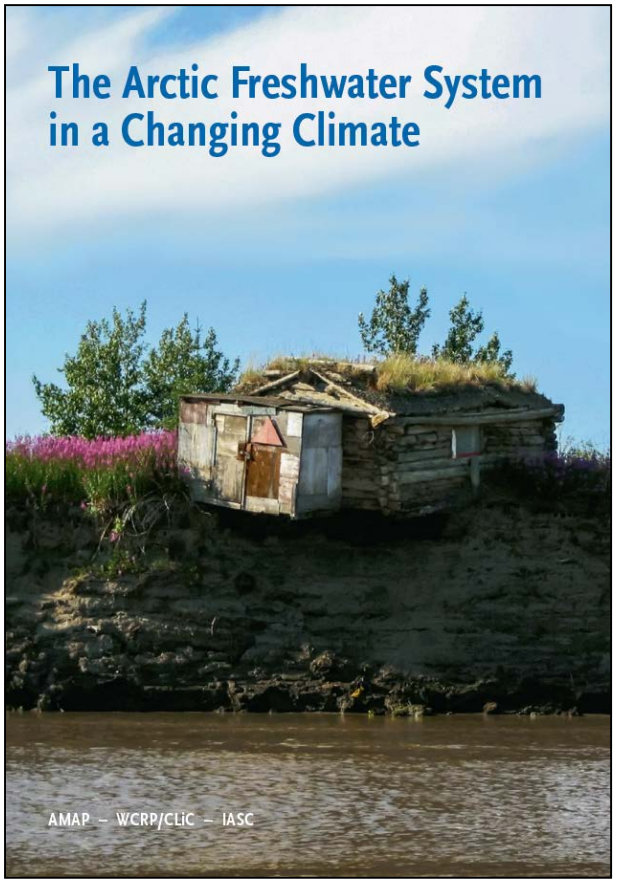
AMAP: SWIPA-II Chapter 4: Freshwater

(T. Prowse, A. Bring, J. Mård, E. Carmack, M. Holland, A. Instanes, T. Vihma, and F. J. Wrona)

SWIPA-II will be delivered to the Arctic Council in 2017

AFS Summary Report

- Why the Arctic Freshwater System is important
- Climate change is affecting the Arctic Freshwater System
- The changing Arctic atmosphere will have effects within and beyond the region
- Changes to the water cycle are changing Arctic landscapes and ecosystems
- … and are having profound effects on the coast and nearshore environments
- Changing freshwater flows into the oceans are affecting ocean currents and ocean biology
- The ability of the Arctic to provide the 'ecosystem services' on which humans rely will be impacted
- Changes to the Arctic Freshwater System will have important positive and negative implications for the economy in the Arctic
- **The changing hydrological cycle will have impacts far beyond the Arctic region (changing ocean circulation, jet streams, Arctic as a store of carbon…….)**



Water-policy concerns

Examples of projected water-policy concerns resulting from climatic re-distribution of water resources identified in the AFS:

- Growth in disparity between water rich and water poor regions.
- Range of socio-economic hardships for water poor.
- Likely result: calls for enhanced redistribution of water to reduce disparity (e.g. inter-basin flow transfers among various jurisdictional levels).
- Increasing need to store water with infrastructure as natural snow-regime storage diminishes → major economic costs.
- Other economic implications for multiple water resource users.
- Conflicts for multiple users and rise in value where scarcity increases.
- More focus on inter-jurisdictional hydro-electric power sharing.

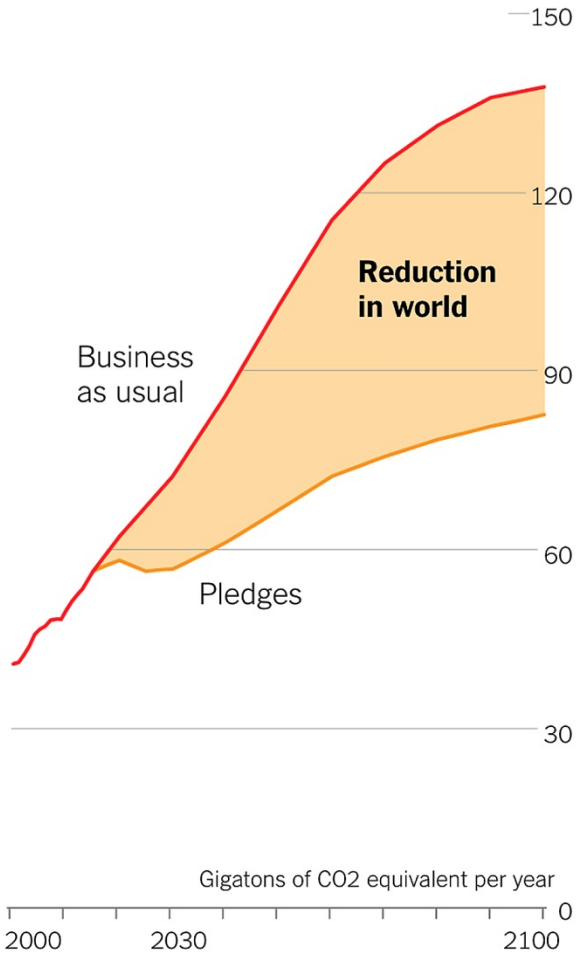
Summary Findings/Messages

- The Arctic freshwater system is undergoing profound change, with significant impacts already observed within and beyond the Arctic.
- The impacts will become more pronounced over the coming decades.
- The Arctic freshwater system is of critical importance to people living in the region.

Identified needs:

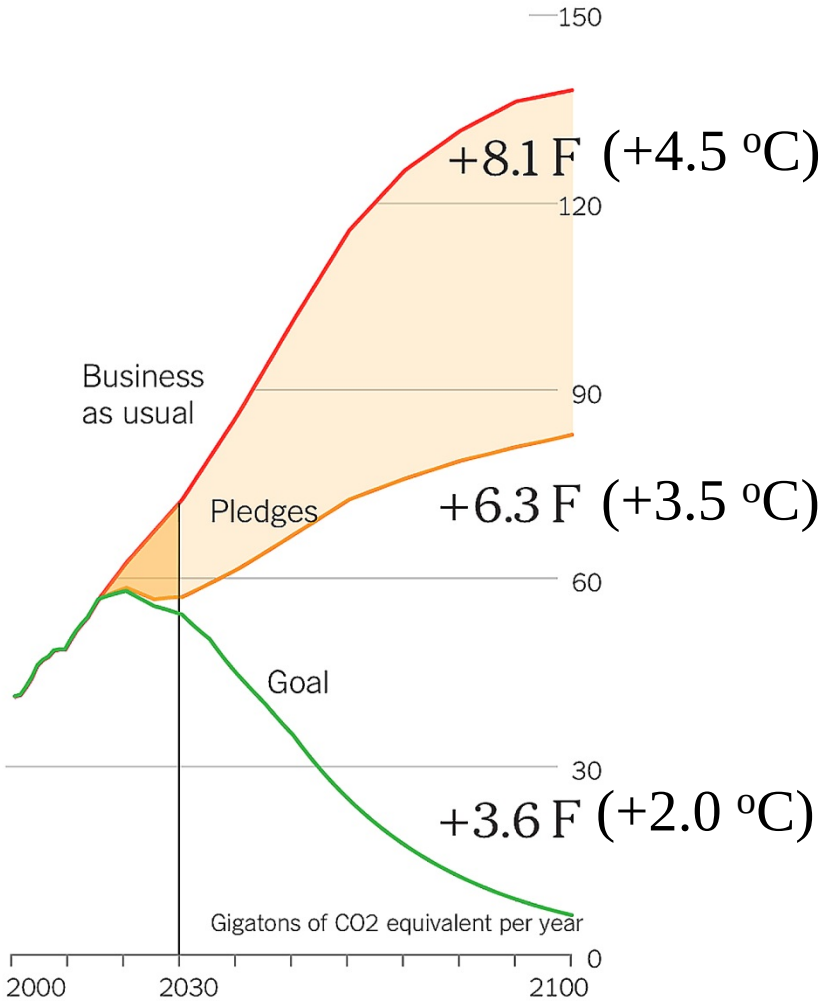
- Supporting efforts of the research community in improving the observation of key processes that affect the hydrological cycle in the Arctic and sub-Arctic regions.
- Deeper understanding of physical, biological, ecological and climatic consequences of a more intense freshwater cycle (short, medium and long terms).
- Better understanding of likely socioeconomic consequences of Arctic freshwater system changes.
- Assessing the potential for some parts of the Arctic to become a future source of freshwater for water-poor regions to the south.
- Improving access to safe drinking water and waste treatment facilities for smaller communities in the Arctic.
- Continuing outreach and education.

Impact of Paris COP21 pledges



Taken together, the pledges are the **biggest cut ever achieved**, but are still not enough.

(Source: ClimateInteractive)



Right now, most of the pledges do not extend past 2030.

(Source: ClimateInteractive)