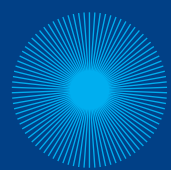
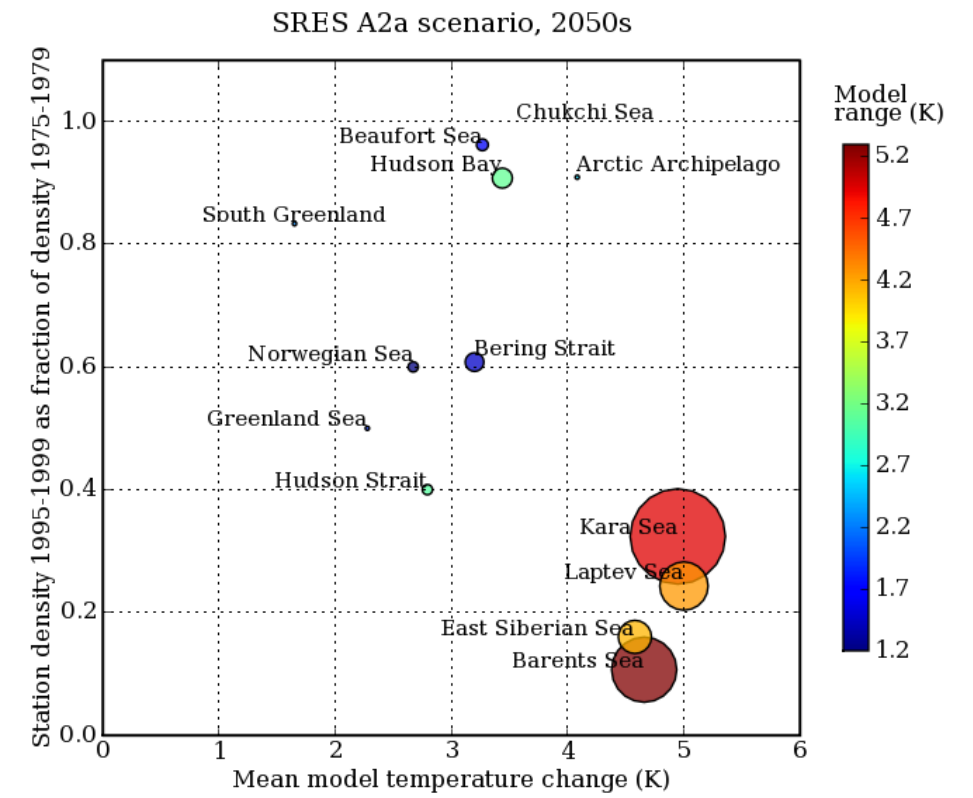


Pan-Arctic hydrological and biogeochemical responses to climate change



Arctic-HYDRA

The Arctic-HYDRA project is
a network for the observation
and studies of the Arctic
Hydrological Cycle.



Evolution of discharge monitoring station density from the period 1975-1979 to the period 1995-1999 in relation to the GCM-projected temperature change fields for the A2a emission scenario and the period 2040-2069. Circle sizes correspond to the absolute reduction in number of discharge monitoring stations with accessible data between the periods 1975-79 and 1995-99. Circle colours represent the range in mean projected temperature by three different GCMs.

About the project

There is mounting evidence that the Arctic water cycle may today be experiencing an unprecedented degree of environmental change, including increasing discharges of major rivers into the Arctic Ocean, which also feed large quantities of waterborne substances from land to sea. With the Arctic experiencing relatively large climate change effects, the effects on river discharges also modulate erosion and nutrient release, and associated downstream sediment and solute transport, which affects the biogeochemistry of inland waters as well as of the recipient Arctic Ocean. Increases in freshwater transport to the Arctic Ocean may further play an important role for the planetary redistribution of moisture and capacity to form North Atlantic Deep Water, which may result in major shift in the global ocean circulation and temporary slowdown in poleward atmospheric heat transport.

This project aims at:

1. quantifying the spatial-temporal distributions of coupled hydrological and biogeochemical change responses to climate change in the Pan-Arctic Drainage Basin; and
2. identifying main data gaps, uncertainties and future priorities in monitoring of the pan-Arctic hydrological system.

The project is linked to Core Theme 5, Biogeochemical and Hydrological Cycles (www.bbcc.su.se/biogeochemical-and-hydrological-cycles/introduction.html), of the Bert Bolin Centre for Climate Research (BBCC) at Stockholm University (www.bbcc.su.se); BBCC is supported by a long-term Linnaeus grant from the Swedish Research Council (VR) and The Swedish Research Council Formas.

Early results

Early work within the project has investigated whether the reported decline in discharge monitoring station density implies important bias with regard to climate change. An analysis of the station density changes in the Arctic Runoff Database (ARDB; GRDC, 2006) program was compared to observed present and modeled future temperatures for a range of Arctic drainage basins with discharge monitoring.

In order to analyze the decline in accessible hydrological monitoring data, we introduce a measure to represent this decline in a coherent way across drainage basins with varying sizes and station densities. For this purpose, we calculate first the development of ARDB stations with accessible discharge data over time, from 1950 to present. This development analysis shows that the period 1975-79 represents the period of peak accessible monitoring data density. As a general measure of relative network density decline, we therefore use the ratio between the number of ARDB stations with accessible discharge data for the relatively recent period of 1995-99 with the corresponding number of stations for the peak-monitoring period of 1975-79. Since we cannot distinguish between stations that have actually been closed and stations that have ceased to provide access to data, the term network density in this context represents the density of stations with accessible data. We also determined the absolute difference in the number of stations with data accessible for the two periods.

Recent observed temperature trends for 1995-2002 were obtained by combining gridded data sets CRU CL 1.0 (New et al, 1999) and CRU TS 2.1 (Mitchell and Jones, 2005). Future climate trends were acquired from the IPCC Data Center (IPCC, 2007), in the form of Special Report on Emissions Scenarios (SRES) Global Circulation Model (GCM) temperature change fields, which represent change compared with 1961-1990 averages. The change fields of three GCMs (CCC, ECHAM and NIES) were averaged for the A2a emission scenario and the time period 2010-2039. Furthermore, the range in temperature obtained by the different models was calculated, as an indication of the degree of uncertainty in model predictions.

Four Eurasian drainage basins – draining into the Barents, East Siberian, Laptev, and Kara Seas – have been subject to the greatest absolute and relative decrease in discharge monitoring density in the ARDB database (figure on the left). The difference between the number of stations with data accessible for the two periods are -243, -63, -134, and -520 stations for these four drainage basins, respectively. With respect to observed climate trends during the period 1995-2002, the smallest temperature change so far has occurred in the four drainage basins with the most significantly decreasing monitoring density (top panel).

However, the pattern is reversed in modeled future temperature trends. The four drainage basins with the most pronounced decline in discharge monitoring density are also the ones that are expected to have the greatest future temperature change (bottom panel). The absolute range, i.e., the uncertainty of modeled future temperatures, is also particularly large for these four areas. The diverging spatial patterns in future modeled and recently observed temperatures make it difficult to determine whether the basins with the greatest decline in discharge monitoring density are in fact the ones that will experience the greatest future temperature change.

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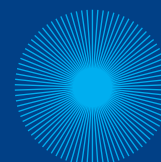
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