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Modeling the Arctic hydrologic cycle and its variability

Laura Niederdrenk, Dmitry Sein, and Uwe Mikolajewicz
Max-Planck-Institut für Meteorologie, Hamburg, Germany (laura.niederdrenk@zmaw.de)

Antrophogenic climate change causes strong warming increasing the moisture transport northward to high latitudes and thus the freshwater input into the Arctic Ocean.

This change in the Arctic Ocean freshwater budget leads to the following questions: Does the Arctic Ocean store the additional freshwater or does the freshwater export to the North Atlantic increase? How is the meridional overturning circulation influenced by these changes in the Arctic hydrologic cycle?

Several global general circulation models show remarkable differences in their response to such an increase in freshwater input. Some models simulate an increasing export, while others show an almost constant total freshwater export, but an increase in the storage of freshwater within the Arctic Ocean.

One main uncertainty of such a global general circulation model is due to the resolution, which is too coarse to resolve small scale processes and complex topography such as the Canadian archipelago adequately.

To obtain high resolution in the region of interest, we set up the primitive equation global general circulation model MPI-OM with rotated poles (leading to a resolution of about 15 km in the Arctic) coupled with the regional atmospheric general circulation model REMO covering the full catchment area of the Arctic rivers. To close the hydrologic cycle of the Arctic, a discharge model providing lateral terrestrial waterflows is included in REMO. The model is forced with atmospheric data from NCEP reanalysis and has been run from 1958-2007. As a first step we validate the relevant processes for the hydrologic cycle of the Arctic with reanalysis and measured data. We analyze the results of the hydrological discharge model with respect to climatologies and changes within the seasonal cycle. Comparison with output from a global general circulation model (MPI-OM/ECHAM) and from the above mentioned setup in lower resolution shows an improvement in the components of the freshwater budget, most obvious in the transport through the Canadian archipelago as well as in the seasonal cycle of sea ice.