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Modeling the Arctic hydrologic cycle: About the influence of atmospheric modes on the variability

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Warming caused by anthropogenic climate change increases the moisture transport northward to high latitudes and thereby also the freshwater input into the Arctic Ocean. Does the Arctic Ocean store this additional freshwater or does the freshwater export to the North Atlantic increase?
Global general circulation models show remarkable differences in their response to such an increase in freshwater input. Some models simulate an increasing freshwater export, while others show almost no change in the amount of the total freshwater export, but an increase in the storage of freshwater within the Arctic Ocean. One main problem of global general circulation models is the resolution, which is too coarse to adequately resolve small scale processes and complex topography. To overcome this difficulty we use a high resolution regional coupled climate model to simulate the Arctic hydrologic cycle.

We establish the following model setup: We use the Max-Planck-Institute global ocean/sea ice model MPIOM with high resolution in the Arctic region, due to shifted grid poles over North America and Asia. The ocean model is coupled to the regional atmospheric general circulation model REMO. The domain of the atmosphere model covers the full catchment area of the Arctic rivers. Furthermore, we include a discharge model providing lateral terrestrial waterflows.
In contrast to most regional setups, we run the model without salinity restoring but with freshwater correction. Additionally, this freshwater correction is set to zero in the central Arctic. This enables the analysis of a closed freshwater budget in the Arctic region.
As lateral forcing for the regional atmosphere model as well as for the ocean model in the uncoupled domain we use data from an A1B scenario run with MPIOM/ECHAM5, which was performed for the last IPCC report.

We present model results for the 20th and 21st century. Our model results show a realistic seasonal and interannual cycle of the freshwater components. We investigate the influence of the dominant atmospheric modes of Arctic interannual climate variability on the hydrologic cycle. Doing so, we mainly focus on the North Atlantic Oscillation, the Arctic Oscillation and the Arctic dipole pattern and its influence on the freshwater exports through the Canadian Arctic Archipelago and through the Fram Strait.