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Arctic Ocean fresh water budget variability

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Low-frequency changes of the Arctic Ocean fresh water (FW) content for the 20th and 21st century are studied using coupled experiments with the Max-Planck-Institute climate model. Results point to the relative importance of Fram Strait and Canadian Arctic Archipelago (CAA) FW exports to drive interannual to decadal changes variability in the Arctic Ocean FW content. Pacific water inflow via Bering Strait and the inflow of Atlantic water via the Barents Shelf remain rather constant. Largest individual FW sink is Fram Strait followed by CAA export. Time integrated CAA and Fram Strait FW transports are found to be anti-correlated on interannual to decadal timescales. Furthermore, their linear superposition can almost completely explain the variability of the Arctic Ocean FW content on these time scales. The coupled model does not show a significant trend in Arctic Ocean FW content during the period 1860-1999. This, however, changes during the 21st century. Atmospheric conditions over the Arctic Ocean are predicted to change considerably due to the increase of greenhouse gas concentrations. The model shows the typical polar amplification of global warming, in particular the simulated annual mean high latitude air temperature increases almost twice as much as the global annual mean temperature at 2.5 times preindustrial C02 in 2100. Associated is an increase of the total FW input in the Arctic by 25%. Multi year sea ice disappears after 2070 and the Arctic Ocean becomes ice-free in summer. Beside eustatic effects, Arctic sea level rises by almost 0.5m due to reduced upper ocean density caused by the increased FW load. The increased sea level difference between Arctic Ocean and North Atlantic is associated with an intensified flow onto Barents Shelf and out of Fram Strait. Interestingly, the total FW transports via Barents Shelf and Fram Strait remains fairly constant, though the solid part virtually vanishes. Largest changes occur in the CAA. Here the FW transport increases by almost 50%, probably caused by the fresher halocline water and absence of sea ice blocking the narrow passages. CAA FW exports reach Fram Strait values at the end of the experi-

ment. Finally, the absence of sea ice reduces the higher frequency variability of CAA and Fram Strait transports, as well as Arctic Ocean FW content.