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Arctic freshwater cycle and the interaction with the North Atlantic

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This study aims to evaluate to what extent atmospheric, land and ocean related datasets in the Climate Data Store are suitable for performing studies on the Arctic freshwater cycle and the interaction with the North Atlantic. The Arctic freshwater cycle is analyzed on the mean, seasonal cycle, and the trend of the atmospheric terms, runoff, ocean liquid and sea-ice freshwater storage over Arctic Ocean (AO) and transport through the Fram Strait (FS), Bering Strait (BS), Barents Sea branch (BSB) and Canadian Arctic Archipelago (CAA).

It is found that (1) the annual mean freshwater input to the AO is dominated by the river runoff (38%), inflow through BS (30%), and net precipitation (24%) and the total freshwater export from the AO is dominated by the outflow through the FS (53%) and CAA (34%). Though the net precipitation over ocean, runoff from drainage basin and seawater and sea-ice freshwater transport through the BS are close to other studies, the much lower annual mean ocean freshwater exports from the FS and CAA contribute to the imbalance of the AO freshwater cycle based on ORAS5 reanalysis data. (2) The precipitation and total water column over the ocean and land are largest in summer, while the evaporation is smallest over ocean and largest over land in summer. The total runoff in June is largest and is modulated by the snow melting though the net precipitation is the smallest. AO liquid freshwater storage increases from May to September with a peak value in September. The ocean liquid freshwater imports from the BS and exports from CAA show much larger values in summer, while the sea-ice freshwater exports in summer is strongest for the CAA but weakest for the FS. The weakest sea-ice freshwater export from the FS is consistent with other studies though the values are much smaller. (3) Both the precipitation and evaporation over the AO increased significantly, while over land only the evaporation increased and the net precipitation decreased during both 1979-2018 and 1990-2018. The moisture convergence over land increased significantly during 1979-2018 and the total water volume over the ocean and land has also increased. The annual mean runoff decreased during 1979-2018 and is much improved with a lower trend from ERA5-land outputs than ERA5. The annual mean AO freshwater storage as sea ice decreased, while the annual mean ocean liquid freshwater storage increased during both 1979-2018 and 1990-2018.

It is indicated that (1) the usage of ERA5 reanalysis data is recommended for the atmospheric

freshwater cycle, and ERA5-land data for runoff, while freshwater transport from the FS and CAA are not well represented on ORAS5 reanalysis data. (2) The trends of AO liquid and sea-ice freshwater transport are very sensitive to the chosen period and quite uncertain. Extreme care must be exercised when using ORAS5 data to study the AO freshwater transport. (3) The use of ORAS5 ocean products is not recommended before 1990, as some adjustment seems to occur during the 1979-1990 period.