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Effect of the large-scale atmospheric circulation on the Arctic Ocean freshwater and heat exchange

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Freshwater (FW) is leaving the Arctic Ocean through sea-ice export and the outflow of low-salinity upper ocean water. Whereas the variability of the sea-ice export is mainly driven by local winds, the mechanisms which regulate the variability of the liquid FW export are still unclear. In this paper we present an analysis of the variability of the liquid FW export from the Arctic Ocean, using simulations from a coupled global ocean-atmosphere model forced with specified daily winds. We focus in particular on a large positive signal in the Fram Strait liquid FW export during the 1990s. Our results show that the simulated variability of the Fram Strait liquid FW export lags changes in the low-frequency variability of the large-scale atmospheric circulation over the Arctic by about five years. This is due to changes in the cyclonicity of the large-scale atmospheric forcing that cause a redistribution of FW in the Arctic Ocean through changes in the Ekman pumping in the Beaufort Gyre. This in turn causes changes in the sea surface height and salinity upstream of Fram Strait that affect the velocity and salinity of the outflow and explain a large part (70%) of the variance of the liquid FW export. The local wind forcing explains a much smaller fraction of the variance of the liquid FW export (21%). We further show that the variability of the liquid FW export is strongly coupled with the ocean heat transport into the Arctic Ocean. This coupling between oceanic FW and heat fluxes is important because it potentially provides a strong positive feedback for the Arctic sea-ice decline associated with global warming.