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A modelling study of the influence of anomalous wind forcing over the Barents Sea on the Atlantic water flow to the Arctic Ocean in the period 1979-2004

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Arctic climate system is influenced by oceanic heat transport with the Atlantic water (AW) streaming towards the Arctic Ocean in two branches, through the deep Fram Strait and the shallow Barents Sea. In Fram Strait, the AW submerges below the Polar surface water and then flows cyclonically along the margin of the Arctic Ocean as a subsurface water mass in the Arctic Slope Current. In contrast to the Fram Strait branch, which is the major source of heat for the Arctic Ocean, most of the heat influx to the Barents Sea through the Barents Sea opening (BSO) is passed to the atmosphere. Only cold remnants of AW outflow to the Arctic Ocean through the northeastern gate of the Barents Sea. Some AW entering the Barents Sea recirculates westward, contributing to an outflow from the Barents Sea through the BSO along the shelf slope south of Bear Island, in the Bear Island Slope Current. Even though the two-branched AW flow toward the Arctic Ocean has been known for more than a century, little is known about co-variability of heat fluxes in the two branches, its mechanisms and climatic implications. Recent studies indicate that the Bear Island Slope Current may play a role in this co-variability. Here, co-variability of the flow through the BSO and Fram Strait is investigated using a pan-Arctic coupled ice-ocean hindcast model run for the period 1979-2004 and forced with daily atmospheric data from the ECMWF. Significant wintertime co-variability between the volume transport in the Bear Island and Arctic slope currents and its link to wind forcing over the Barents Sea is confirmed. It is found that the volume transports in these currents are, however, not correlated in the annual mean and that the wintertime co-variability of these currents has no immediate effect on either the net heat flux through the BSO or the net heat flux divergence in the Barents Sea. It is shown that the main climatic effect of wind forcing over the northern Barents Sea shelf is to induce temperature anomalies in the Murman/West Novaya Zemlya current system on the eastern side of the Barents Sea. These anomalies affect sea ice in the eastern Barents Sea 1-3 months later, but are not completely lost on the interactions with the sea ice and local atmosphere. Statistically significant subsurface temperature anomalies driven by anomalous winds over the Barents Sea join, on their exit to the Arctic Ocean through St. Anna Trough, the Arctic Slope Current, in which they persist for several years.