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Response of the Fram Strait transport to surface density forcing

B. I. Moat, S. A. Josey, B. Sinha, and J. P. Grist
National Oceanography Centre, Southampton, United Kingdom

Variations in the surface density flux field over the Arctic Ocean have the potential to change the exports of heat and fresh water through the Fram Strait. This may influence the thermohaline circulation at a globalscale. A better understanding of the relationship between surface fluxes, ocean circulation and water mass properties is of particular importance in the Arctic due to the recent large-scale shift to warmer climatic conditions.

The atmospheric and oceanic output from 1000 years of HadCM3 with fixed pre-industrial greenhouse gases was used to examine the response of the Fram Strait transport to variations in the surface density fluxes in the Arctic. HadCM3 is a coupled ocean-atmosphere model with sea ice and land surface schemes. It has 92 levels in the atmosphere with a horizontal resolution of 2.5° by 3.75° and 20 levels in the ocean with a resolution of 1.25° by 1.25°. Despite the modest resolution the predicted model Fram Strait volume transport agrees well with the measurements of Schauer and Fahrbach (2004).

Two regions are identified as having an influence on the Fram Strait volume transport. Firstly, increases in the winter surface density flux in the Barents Sea are associated with increased winter southward deep water transport through the Fram Strait. This density flux is primarily driven by ice formation (i.e. the water becomes denser due to brine rejection) and by heat loss to the atmosphere over the western Barents Sea region. An ocean circulation feature was found linking the Barents Sea with the Fram Strait.

Secondly, increases in the southwards winter transport of the East Greenland current through the Fram Strait are linked with increasing density flux due to ice formation in the East Siberian Sea. In this region very little heat is lost to the atmosphere due to the 90% sea ice cover.