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A Numerical Study of Sea Ice and Ocean Circulation in the Arctic

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ABSTRACT

A sea-ice model based bulk-viscous plastic dynamics and 3-layer thermodynamics is coupled to a multilevel primitive equation model of the Arctic Ocean and Greenland Sea. The combined model is forced by inflow through the Faeroe-Shetland Channel and Bering Strait and by observed monthly atmospheric forcing and river runoff. A long-term integration produces a realistic cycle of ice cover, whose extent is strongly influenced by ocean heat transport. The wintertime maximum is controlled by northward heat transport of 0.4 petawatts in the Greenland Sea and by southward transport of ice and water through the Fram Strait. The summertime minimum extent of sea ice is influenced by subsurface flow through the Fram Strait of warm Atlantic water, which rises in winter and thins the ice lying over the Eurasian continental shelf and along the Alaskan and Siberian coasts. The oceanic circulation in the Canadian Basin is anticyclonic at all depths, but changes to cyclonic in the Eurasian Basin below 200 meters. Offshore ice transport in the Barents Sea promotes oceanic convection on the continental shelf through enhanced brine rejection, whereas surface heat loss in the ice-free Greenland Sea produces intermediate water sources similar in *T-S* characteristics to observed water masses of the region. Two short additional integrations of the coupled model show that the Arctic ice is vulnerable to the environmental effects of atmospheric $C0^2$ increase, but relatively insensitive to the maximum proposed amount of Soviet river diversions.

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