Abstract View

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Numerical Simulation of the Arctic Ocean Circulation

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ABSTRACT

The circulation of the Arctic Ocean and Greenland Sea is simulated using the 1969 numerical model of Bryan and Cox. The coastline and bottom topography of the region are resolved by a 110 km horizontal grid spacing and by 14 vertical levels. The transfers of mass, heat and momentum at the ocean surface and at open lateral boundaries are specified from observations. In particular, the pattern of wind stress is obtained using a map of mean annual atmospheric pressure; and a scalar multiplier is applied to account for the nonlinear dependence of stress on wind speed. Three experiments with different values of this scalar multiplier are run to simulate the effect of high, medium and low wind stress. The first experiment is carried out for the combined Arctic Ocean and Greenland Sea, while the other two experiments are run for the Arctic Ocean only.

Many of the observed features of the Arctic circulation are reproduced by the simulations. The Greenland Sea exhibits cyclonic flow at all levels and deep convection in its central region. The Beaufort Sea shows anticyclonic flow at the surface and a stable stratification maintained by a halocline. The Arctic Ocean receives bottom water and an intermediate layer of warm Atlantic water through the Greenland-Spitsbergen Passage, and it exports surface water of low salinity into an intense East Greenland Current. The sense of circulation of the Atlantic layer in the central Arctic Ocean, although opposite to that usually inferred from water mass properties, seems to be in reasonable agreement with existing direct current measurements.

For computational reasons, an excessively large eddy viscosity is required in the experiments. As a result, predicted currents are too weak unless a large wind stress is used, but. then an excessive Ekman pumping makes the halocline too deep and erodes the temperature maximum in the Atlantic layer. These results indicate that simulations with finer resolution and reduced viscosity should be more realistic.

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