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A NUMERICAL INVESTIGATION OF THE MARGINAL ICE ZONE USING A SIMPLE ICE-OCEAN COUPLED MODEL (ABSTRACT)

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In the marginal ice zone, various characteristic mesoscale phenomena, such as upwelling, downwelling, fronts, and eddies have been observed. These phenomena are investigated using a simple ice-ocean coupled model, which consists of a dynamic-thermodynamic ice model and a thermodynamic, reduced-gravity ocean model. The thickness of ice is assumed to be constant. The density in the upper layer can be changed by atmospheric heating, ice melting, and entrainment from the deep ocean into the upper layer. Initial atmospheric, ice, and ocean conditions are specified based on observed values in the Antarctic Ocean during the melting season. A spatially-uniform wind field is applied in the direction roughly parallel to the ice edge, so that Ekman divergence is caused due to spatial variations of ice concentration in the marginal ice zone.

Atmospheric heating generates strong salinity gradients between ice-covered and ice-free areas due to intense ice melting near the ice edge. There are ice-edge currents associated with the salinity gradients. When a weak wind field random in time and space is applied in addition to the spatially-uniform field, the currents start to meander with a wavelength of about 20 km. The meander evolves into mesoscale eddies around the ice edge. The currents associated with these eddies advect saline and fresh waters, so that the salinity gradients weaken. This solution suggests that instability of ice-edge currents associated with salinity gradients is a possible generation mechanism of mesoscale eddies observed in the actual marginal ice zone.

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