Abstract View

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The Role of Mesoscale Eddies in the General Circulation of the Ocean—Numerical Experiments Using a Wind-Driven Quasi-Geostrophic Model

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ABSTRACT

Results from a two-layer, quasi-geostrophic, general circulation model of the ocean with fine horizontal resolution are presented. As in Holland and Lin (1975a.b), mesoscale eddies spontaneously arise due to instabilities in the oceanic currents, giving rise to transient oceanic circulations that reach a statistical equilibrium. In these final equilibrium states, the interaction of the eddy field with the mean state is examined, and it is shown that the eddies determine the character of the large-scale mean flow. In particular, the eddies act to limit the amplitude of the mean flow in the upper ocean, are responsible for a downward energy propagation that fills the deep sea with eddy energy, and create a downward momentum flux which is responsible for the creation of deep, time-mean, abyssal gyres that are an important component of the vertically averaged mass transport in the ocean.

Three new aspects of the mesoscale eddy problem are discussed. First, the Holland and Lin (1975a,b) results are extended to highly nonlinear free jets, a simple but more realistic treatment of the Gulf Stream as the source for mesoscale eddy energy. Second, bottom friction is examined as the likely mechanism for energy dissipation in a quasi-geostrophic turbulent flow; lateral dissipation enters as an important enstrophy sink but not as an important energy sink. Finally, the usefulness of the quasi-geostrophic nature of the model is demonstrated; only one-tenth of the computer time needed for two-layer primitive equation experiments is required for quasi-geostrophic ones with comparable resolution.

top

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