Abstract View

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On the Generation of Mesoscale Eddies and their Contribution to the Oceanic General Circulation. I. A Preliminary Numerical Experiment

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ABSTRACT

Numerical experiments on the wind-driven ocean circulation in a closed basin show that mesoscale eddies can appear spontaneously during the integration of the equations of motion for a baroclinic ocean. For some values of the basic parameters governing the flow, the solutions reach a steady state while for other values finite-amplitude eddies remain a part of the final statistically steady state. In the eddying cases the solutions can be regarded as a mean flow upon which is superimposed a set of eddies which propagate westward at a few kilometers per day. The eddies typically have horizontal wavelengths of a few hundred kilometers.

Analyses of die energetics show the eddies to be generated by the process of baroclinic instability. The potential energy of the mean flow is released to supply energy to the eddies. The computed Reynolds stresses, while small compared to the terms in the geostrophic balance of the mean momentum equations, do have a strong influence on the mean circulation and, in fact, the deep mean circulation is driven entirely by the eddies. If the flow were steady, there would be no flow in the deep layer in this model. Finally, the computed curl of the Reynolds stresses shows that the vorticity balance of the mean flow is strongly affected by the presence of mesoscale eddies.

In the first part of this report we describe the two-layer model and discuss its numerical formulation. Then the results of a preliminary eddy experiment are discussed in detail, showing the spontaneous growth of baroclinic eddies and describing the final statistical steady state that occurs. Energetic analyses and vorticity balances show the important role played by the eddies in determining the character of the oceanic general circulation.

Part II of this paper will discuss a variety of experiments which explore the dependence of results on the basic

parameters and boundary conditions governing the model. In particular the dependence of results on wind stress magnitude and distribution, lateral viscosity coefficient, basin size, and boundary conditions (free slip and no slip) will be examined.

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