Abstract View

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A General Circulation Model for Upper Ocean Simulation

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ABSTRACT

A general circulation model (GCM) of the ocean that emphasizes the simulation of the upper ocean has been developed. This emphasis is in keeping with its future intent, that of an air-sea coupled model. The basic model is the primitive equation model of Bryan and Cox with the additions, of optional usage, of the Mellor-Yamada level 2.5 turbulence closure scheme and horizontal nonlinear viscosity. These modifications are intended to improve the upper ocean simulations, particularly sea surface temperature and heat content. The horizontal grid spacing is 1° latitude × 1° longitude and is global in domain. The equatorial region between 10°N and 10°S is further refined in the north–south direction to $\frac{1}{3}$° resolution. There are 12 vertical levels, with six levels in the top 70 m. The model incorporates varying bottom topography.

Prior to coupling the ocean model to an atmospheric GCM, experiments have been carried out to determine the ocean GCM's performance using atmospheric forcing from observed data. The data source was the National Meteorological Center twice daily 1000 mb analysis for winds, temperature, and relative humidity for 1982 and 1983. From these data, wind stress and total heat flux were calculated from bulk formulas and used as surface boundary conditions for the ocean model.

The response of the ocean GCM to mixing parameterization schemes and frequency of atmospheric forcing have been examined. In particular, the use of constant eddy coefficients for both horizontal and vertical mixing (A-model) versus nonlinear horizontal viscosity and turbulence closure schemes (E-model) have been examined, along with comparisons of monthly mean versus 12-hourly forcing. It was found that, in general, the E-physics produces a more realistic mixed-layer structure as compared to A-physics. Using the monthly mean values produces sea surface temperatures that are too warm, presumably because the evaporative flux, which is proportional to the wind speed, is underestimated. The 12-h forcing improves appreciably both the A and E model since the heat flux is better represented; the E-case shows an even greater improvement due to its sensitivity to wind stirring. The near surface heat budget, along with more traditional variables, is examined for a short period during the 1982–83 El Niño event. These results are encouraging considering the many possible sources of error, including those in forcing data, initial conditions, radiative fluxes, and bulk exchange coefficients.

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