Abstract View

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A Global Ocean-Atmosphere Climate Model. Part II. The Oceanic Circulation

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ABSTRACT

A numerical experiment has been carried out with a joint model of the ocean and atmosphere. The 12-level model of the world ocean predicts the fields of horizontal velocity, temperature and salinity. It includes the effects of bottom topography, and a simplified model of polar pack ice. The numerical experiment allows the joint ocean-atmosphere model to seek an equilibrium over the equivalent of 270 years in the ocean time scale. The initial state of the ocean is uniform stratification and complete rest. Although the final temperature distribution is more zonal than it should be, the major western boundary currents and the equatorial undercurrent are successfully predicted. The calculated salinity field has the correct observed range, and correctly indicates that the Atlantic is saltier than the Pacific. It also predicts that the surface waters of the North Pacific are less saline than the surface waters of the South Pacific in accordance with observations. The pack ice model predicts heavy ice in the Arctic Ocean, and only very light pack ice along the periphery of the Antarctic Continent.

The poleward heat transport of the model is very sensitive to the strength of the circulation in the vertical meridional plane. The heat transport is strongest in the trade wind belt where Ekman drift and thermohaline forces act together to cause a net flow of surface water toward the poles. At higher latitudes in the westerly belt the wind and thermohaline forces on the meridional circulation tend to oppose each other. As a result, the beat transport is weaker. Heat balance computations made from observed data consistently show that the maximum heat transport by ocean currents is shifted 10°-20° equatorward relative to the maximum poleward heat transport by the atmosphere in middle latitudes. The effect of the zonal wind in enhancing poleward heat transport at low latitudes and suppressing it in middle latitudes is offered as an explanation.

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