Abstract View

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On the Wind-Driven Circulation of the South Pacific Ocean

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ABSTRACT

A layered model of the study circulation in the South Pacific Ocean is constructed along the lines of Luyten, Pedlosky and Stommel, and driven by the mean annual wind stress distributions computed by Hellerman and Rosenatein. The results of the model agree quite well with published maps of topography of density surfaces and circulation. Best agreement is found in the deeper layers. The deepest modeled layer, of density range $26.90 < \sigma_0 < 27.30$, which contains the core layer of the Antarctic intermediate Water, transports northwards some 14 Sv (1 Sv = 10^6 m^3 s^{-1}) between New Zealand and South America. Of this, about three quarters comes from the west in an intense zonal jet that rounds the southern tip of New Zealand and quickly fans out from the boundary current along those islands into the anticyclonic gyre. Some 5 Sv returns southwards in the Australian boundary current. Much of the anticyclonic gyre in the western South Pacific is taken up by a shadow zone formed in the shelter of New Zealand, where the submerged layer loses direct contact with the wind driving, and where uniform potential vorticity is populated. The modeled circulation in the shallowest layer in tropical regions is considerably weaker than the observed circulation.

Transport in the New Zealand western boundary current is determined by the necessity to achieve the same pressure in each layer at the northern end of the islands as at the southern. Similar considerations applied to the landmass of Australia and Papua–New Guinea, regarded as isolated from Southeast Asia, suggest a considerable net northward transport between Australia and South America, which can only escape through the Indonesian passages. The contribution of this transport among layers is set in the model by the input conditions at the southern boundary (where much of it must be in the deeper layers), after which it cannot change because of mass conservation within each layer (i.e., no cross-isopycnal flux is allowed). This modeling assumption is too strict and may be the reason for the prediction of shallow circulations much weaker than observed.

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