Abstract View

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Meridional Circulation Cells and the Source Waters of the Pacific Equatorial Undercurrent

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ABSTRACT

A 3½-layer model is used to study the meridional circulation cells that provide the source waters of the Pacific Equatorial Undercurrent (EUC). Its three active layers represent tropical, thermocline, and upper-intermediate waters, respectively, and across-interface flow between the layers parameterizes the processes of upwelling, subduction, and diapycnal mixing. Solutions are driven by climatological winds in a domain resembling the Pacific basin from 35°S to 55°N. An additional forcing mechanism is a specified inflow into layer 3 across the open southern boundary and a compensating outflow from layers 1 and 2 along the western boundary just north of the equator; the resulting circulation simulates the Pacific interocean circulation (IOC), in which intermediate water enters the South Pacific and the same amount of thermocline and tropical waters exit via the Indonesian Throughflow.

Five meridional cells contribute to the EUC in the main-run solution: north and south Subtropical Cells (STCs), north and south Tropical Cells (TCs), and an equatorial branch of the IOC. The STCs require subtropical subduction for their existence; however, their strength is determined largely by the Ekman divergence across ±18°, which are externally specified, equatorward boundaries of the subduction regions. The STCs are the primary source of water for the model EUC, supplying 21.9 Sv (Sv $\equiv 10^6$ m^3 s^{-1}) in the main run. The TCs are generated by diapycnal mixing in the tropical ocean that causes layer-1 water to detrain into layer 2, and they contribute 6.8 Sv to the EUC. The equatorial branch of the IOC provides 8.8 Sv, and this contribution ensures that nearly two-thirds of the extratropical water in the EUC is of Southern Hemisphere origin. Finally, equatorial recirculations confined to layer 2 supply an additional 3.8 Sv; these gyres exist because potential vorticity conservation causes water on the flanks of the EUC to diverge from the equator as it flows into a region where layer 2 is thicker.

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