TROPICAL WESTERN PACIFIC CURRENTS AND THE ORIGIN OF INTRASEASONAL VARIABILITY BELOW THE THERMOCLINE

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ABSTRACT

The complex tropical western Pacific current system remains inadequately documented, especially below the thermocline, where the few available observations show a dominant intraseasonal, mesoscale variability along the western boundary.

A new collection of shipboard acoustic Doppler current profiler (ADCP) sections with a depth range of 600 m provides a description of the circulation and its annual variability, from 5°S-25°N, 126°E-156°E. Velocities derived from altimetry and from drifters complement the ADCP observations near the surface. A realistic high resolution numerical simulation is used to evaluate the SADCP sampling and to partially compensate for its limitations. Pathways and transports of the western boundary currents – the New Ireland Coastal Undercurrent, the New Guinea Coastal Current and Undercurrent, the Mindanao Current – and their variability are revisited, and their connections with basin-scale flows are drawn.

Beneath the thermocline, three regional current features are described, each with a different timescale. First, from 10°N to 17°N, weak zonal flows reversing meridionaly every 2-3° are ubiquitous in meridional synoptic sections. The same pattern emerges marginally in zonal and time averages, suggesting that it represents slowly varying, zonally elongated currents. Their observed characteristics are captured by the simulation where they can be identified as vertically coherent zonal jets. Second, an annual signal with a meridional structure resembling a meridional mode 1 Rossby wave is prominent from the equator to 7°N. It modulates the flow, such that the Equatorial Intermediate Current (EIC) reverses annually west of 145°E. In boreal winter the westward EIC is maximum and feeds a newly discovered southeastward intermediate coastal current with maximum magnitude of 0.2 m s^{-1} along New Ireland. Finally, beneath the Mindanao Current, the intermediate flow appears dominated by intraseasonal, mesoscale variability.

The source of this intraseasonal variability is sought in the broad northern low-latitude western Pacific, using three global 1/10° state of the art numerical simulations forced by different wind products. All models reproduce observed surface to subthermocline variability patterns off Mindanao. The 50-100 days spectral band is prominent at the coast in all simulations. Since one simulation lacks non-seasonal transient forcing,

we conclude that the variability is intrinsic to the ocean. Analysis of the eddy kinetic energy (EKE) and transient wave activity (M) budgets in the most realistic simulation reveals three sources of variability at the Philippine coast. Most of the eddy energy is generated locally via mixed horizontal and vertical shear instability of the background flow. Additional energy propagates in from the east, where it is generated in bursts of baroclinic instability in the North Equatorial Current. The third source is horizontal shear of the surface, thermocline and intermediate flows at the entrance to the Sulawesi Sea, which generates intraseasonal eddies that sporadically propagate northward toward the Philippines.