

Observations of small island wakes in the Kuroshio: flow-pattern evolution, shear instability and turbulent mixing

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Evolution and turbulent mixing of Green Island wake (~5 km in diameter) was investigated in the alongshore flowing Kuroshio (1-1.5 ms⁻¹) east of Taiwan with shipboard ADCP and echo sounder, Underway CTD and microstructure profiler. Repeated 12 cross-wake and 4 along-wake surveys in the lee of Green Island reveal transects of wake evolution and downstream eddy propagation, respectively. In the cross-wake section, the cyclonic and anti-cyclonic recirculation alternatively presents at a period of ~12.5 hours, in agreement with a 1-month moored measurement. A resonance effect with semidiurnal tide is the most likely explanation for the observed period. The repeated along-wake surveys depicted that a cyclonic eddy shed downstream at a speed of 0.34 ms⁻¹, 1/3 of the upstream current speed. A cross-wake microstructure survey reveals an average TKE dissipation rate of O(10⁻⁷) WKg⁻¹ and an enhanced value of O(10⁻⁵) WKg⁻¹ at the horizontal shear line, separating the mean flow and the recirculation in the leeward side of the island. The depths of enhanced turbulence are co-located with the strong vertical shear of horizontal velocity, where the Kelvin-Helmholtz billows with a vertical scale of ~30 m are observed in the echo sounder image. Presumably, the tilting of the lateral boundary-induced vorticity likely causes the strong vertical shear.

Keywords: Kuroshio, island wake, turbulent mixing