Flow-topography interaction within the Kuroshio and energy dissipation: observation and numerical simulation in the Tokara Strait south-west of Japan and the I-Lan Ridge east of Taiwan

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The Kuroshio is the western boundary current constituting a part of North Pacific sub-tropical gyre, which carries heat and materials from low- to mid- latitude ocean. There are many small-scale topographic features such as small islands, seamounts, and shallow ocean ridges in the route of the Kuroshio. In recent years, interaction of western boundary currents with small-scale topography draws increasing attention because it can dissipate significant fraction of the wind-driven large-scale energy and the associated turbulent mixing could promote ocean biological productivity. In the Kuroshio, recent microstructure surveys have revealed that the Kuroshio interaction with small-scale topography induces strong turbulent mixing through hydraulic control, boundary-layer shear instabilities, internal waves and submesoscale vortices. However, the energy pathways to dissipation have not been identified yet. In this study, we investigate energy dissipation processes of the Kuroshio in the Tokara Strait south-west of Japan and in the I-Lan Ridge east of Taiwan, where the Kuroshio strongly interacts with small-scale shallow topographies. Shipboard surveys with microstructure profiler revealed that in both area, turbulent kinetic energy dissipation rate was elevated to O(10^{-5}) W kg^{-1} at a shallow sill (water depth < 100 m) associating with hydraulic control and shear instability. High-resolution numerical model simulation forced by the Kuroshio and barotropic tides successfully reproduced the observed nature of flow and turbulent dissipation at the sill and it suggests that O(1) GW of the Kuroshio energy is directly dissipated or converted to super-inertial energy.

