Flow and turbulence at and downstream of a tall seamount within the Kuroshio

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Recent field surveys have revealed that the Kuroshio interacts extensively with shallow vertical topography in the east of Taiwan and in the East China Sea, resulting in strong turbulence generation. The energy pathway from the Kuroshio to turbulence is not well understood. Here, we explore the Kuroshio-topography interaction in the East China Sea by field surveys and numerical simulations. At the Tokara Strait in the East China Sea, there are shallow (i.e., the vertical size is comparable to mean water depth) seamounts within the path of the Kuroshio: the characteristic topographic height, width, current speed, and buoyancy frequency are h ~ 500 m, d ~ 10 km, U ~ 1 m s^{-1}, and N ~ 10^{-2} s^{-1}, respectively. The inverse Froude number, $Fr_t^{-1} = NhU^{-1}$ ~ 1–10, suggests that the upstream Kuroshio is partially blocked by the seamount and stratified hydraulic jump is created in the lee of seamount. A series of extensive microstructure measurements in the strait revealed the Kuroshio is actually partially-blocked and is hydraulically controlled upstream and downstream of a seamount, respectively. Kelvin-Helmholtz billows and the associated enhancement of turbulent dissipation was observed in the vicinity of the seamount. Vertically-propagating, high-wavenumber near-inertial shear was observed by a moored ADCP in the Kuroshio 50 km downstream of a seamount. Elevated turbulent dissipation and vertical eddy diffusivity at the mooring site are related to the shear instability. Hydrostatic numerical simulations of geostrophic flow interaction with an isolated topography suggest that the near-inertial shear is created by Kuroshio-seamount interaction and it can affect vertical shear field O(10 km) downstream of the seamount.

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