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Flow separations of the intermediate water in the lees of two sills offshore Taiwan from seismic observations

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Flow separation can be generated when a stratified flow passing over an obstacle. Most examples about flow separation are observed in the shallow water regions, e.g., fjord, driven by strong tidal flows. In this study, flow separations of the intermediate water over the Hengchun Ridge and Ryukyu Arc offshore Taiwan are firstly reported using the seismic reflection method by processing two sections of seismic data from two different seismic cruise (97306 and EW9509) in 2001 and 1995, respectively. Both images show the conspicuous appearances that water masses are separated by internal interfaces detached from sill crests. Over the Hengchun Ridge with 900 m water depth, it was considered that the well-mixed intermediate water flowed out of the South China Sea into the Hengchun Trough, and flow separation occurred at the lee-side of the ridge forming a continuous interface more than 15 km between the intermediate and deep water. This interface suggests that (1) mean flow of the intermediate water always flowed eastward and (2) no lee wave generated or radiated even during the ebb tide. Near the Yonaguni Depression, the only major passage of the Kuroshio into the Okinawa Trough, flow separation also occurred when the Kuroshio intermediate water flowed over the steep sill at 500 m depth. The separation interface is nearly horizontal and more than 25 km extending from the sill break into the trough. Parameter estimations and monographic comparisons show that both separation cases are neither the boundary-layer separation nor the post-wave separation. Model data from OFES (Ocean General Circulation Model For the Earth Simulator) reveal dense pools existing downstream of the sill crests. Simulated results suggest that the dense pool forms an isopycnal boundary with the intruded water above, suppresses the lee wave growth, and helps to the generation of the observed flow separation, or the density-forced flow separation.