# Enhanced vertical mixing along a shelf-slope front east of Japan

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Off the Sanriku Coast, east of Japan, three characteristic water masses from the Tsugaru Warm Current (TWC), the Oyashio (OY) and the Kuroshio warm-core rings (WCR) often form complex fronts along a narrow shelf. The sharp gradient of the environment and occasional mixing processes associated with these fronts are known to play important roles in fresh water/material exchanges and biological productivity. While the internal tides are constantly excited around the shelf-edge, vertical mixing processes have yet to be understood, mainly because of the occurrences of the sharp oceanic fronts around the shelf. In order to clarify the structure of the front, interaction with internal tides and the vertical mixing processes, we conducted high-resolution observations using an underway CTD (UCTD) and vertical microstructure profilers across the shelf off the Sanriku Coast, in four different seasons in 2018 and 2019. The UCTD sections with intervals of 0.4–1.5 km resolving submesoscale, revealed the frontal structure and its seasonal variability, caused by the interactions of three water masses. The front was most clearly formed at a shelf-slope boundary in summer and fall between the warn/saline TWC on the shelf and cold/fresh OY or warm and more saline WCR in the slope area. This shelf-slope contrast became unclear by early spring due to the cooling of the TWC water on the shelf, while an extremely sharp thermohaline front, warm/saline inshore and cold/fresh offshore, emerged again in late spring when the TWC and OY became intensified. One-day repeated observations suggested occurrences and propagations of short-wavelength internal waves all around the shelf. While turbulent energy dissipation rate $\varepsilon$ were elevated at various areas/layers, marked band-like structure of high $\varepsilon$ was observed along the front during the stratified season. Analyses considering the balanced Richardson number and Rossby number suggests that strong vertical shear of horizontal velocity enable subinertial internal waves with respect to the local inertial frequency to exist within the frontal band. These waves might be trapped within the frontal band and broken to yield enhanced vertical mixing.

 