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INTERNAL TIDE CHIMNEY

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1. Tsugaru-Oyashio front

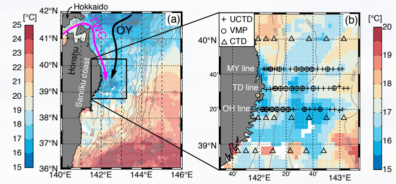


Fig. 1. Hydrography off Sanriku coast

Sharp front is formed between the Tsugaru Warm Current (**TWC**) and the Oyashio (**OY**)

Q. Front-wave interaction? Vertical mixing?

2. Internal waves under strong shear

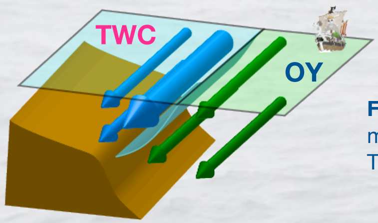


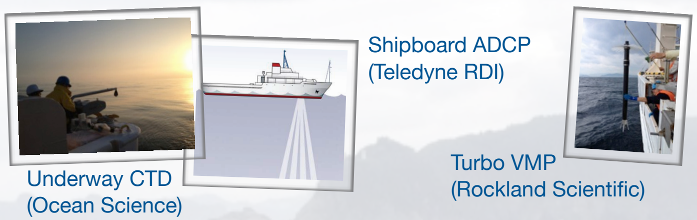
Fig. 2. Idealized model of the TWC-OY front

Dispersion relationship assuming a linear solution (after *Whitt & Thomas* 2013)

$$\omega = \sqrt{N^2\left(\frac{k}{m} - \frac{f v_z}{N^2}\right)^2 + F^2 - \frac{f^2 v_z^2}{N^2}} \quad \text{where} \quad F = \sqrt{f(f + \partial v_g/\partial x)}$$

The modification from the linear theory is expressed via **Ro** = v_x/f and **Ri**= N^2/v_z^2

3. Shear-resolving observations



Ro and **Ri** are calculated from profiles of temperature, salinity and horizontal velocity for three lines across the front (**Fig. 1**)

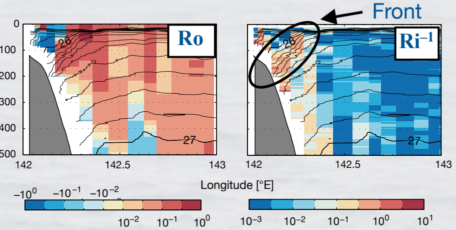


Fig. 3. Ro⁻¹ and Ri (color) along OH line, overlaid with potential density (contour)

Ro: negative inshore & positive offshore across the front

Ri: Elevation along the frontal band

- T_{max} decreased around the front mainly due to large Ri^{-1}
- Even lower than 24 h in some areas

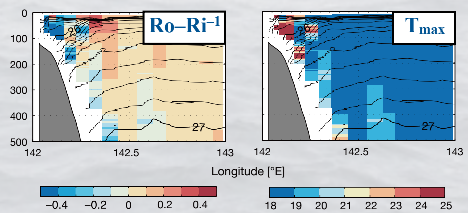


Fig. 4. Same as Fig. 3 but for **Ro–Ri⁻¹** and T_{max} [h], maximum period for internal waves to exist

4. Enhanced turbulence along the front

Below the surface pycnocline, patches of elevated occurred in the coastal side, typically along the TWC-OY front

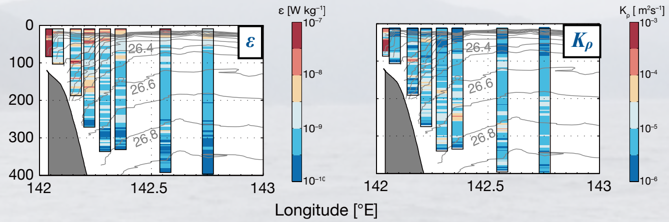


Fig. 5. Turbulent energy dissipation rate ε and vertical diffusivity K_ρ

5. Internal tide chimney

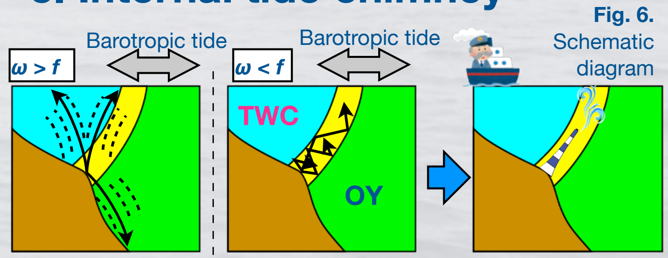


Fig. 6. Schematic diagram

Internal waves can

almost freely propagate

only propagate upward within the frontal band

- Upward energy transfer
- Pathway of nutrient supply?

Full title: Fine-scale structure and mixing across the front between the Tsugaru Warm and Oyashio Currents in summer along the Sanriku Coast, east of Japan

Authors: Itoh, S., H. Kaneko, M. Ishizu, D. Yanagimoto, T. Okunishi, H. Nishigaki and K. Tanaka

Reference: Journal of Oceanography, 2016, 72, 23–37, doi:10.1007/s10872-015-0320-6