

## Frontal waves in the east of the Tsugaru Strait revealed by the high-frequency radar observation

\*Hitoshi Kaneko<sup>1</sup>, Takahiro Tanaka<sup>2</sup>, Hiroto Abe<sup>1,3</sup>, Masahide Wakita<sup>1</sup>, Ken'ichi Sasaki<sup>1</sup>, Daisuke Hasegawa<sup>2</sup>, Takeshi Okunishi<sup>2</sup>, Shuichi Watanabe<sup>1</sup>, Shoko Tatamisashi<sup>1</sup>, Yoshiaki Sato<sup>1</sup>

1. Japan Agency for Marine-Earth Science and Technology, 2. Japan Fisheries Research and Education Agency, 3. Graduate School/Faculty of Fisheries Sciences, Hokkaido University

Surface velocity observations of the eastern part of the Tsugaru Strait made by the high-frequency radar revealed frequent occurrence of frontal waves along the axis of the Tsugaru Warm Current in 2017–2019. The current axis (zonal flow maximum in the meridional direction) disturbed in the north-south direction with period of about 14 days that is dominant timescale of tide modulation in the strait. In addition, another peak of the timescale of the modulation was also recognized around ~27 days. The amplitude of the axis fluctuation increased in the downstream direction, from the eastern neck of the channel (~141°E) to the wider mouth adjacent to the Pacific Ocean (~141°30' E). The disturbance propagated downstream with far later speed than that of surface advection especially in the seasons when the stratification was developed. It took from a week to 10 days for propagation of about 100 km. The density and vertical velocity distribution obtained from repeated shipboard observations across the channel in each season were used for investigation for phase speed of the baroclinic instability waves. The propagation speed of the disturbance agreed well with that estimated from the theory based on the two-layer baroclinic instability model except for winter when the stratification was weak. The north-south modulation of the axis at the outlet of the strait (~141°30'E) could cause short-term (from 20 days to one month) clockwise rotation of the Tsugaru gyre that is developed in the east of the outlet during summer, as suggested by the previous studies. In addition, such frontal disturbance may contribute to the water mass exchange and modification between the water of the Tsugaru Warm Current and the Oyashio water across the front, and subsequent faster acidification in the strait than in the open ocean.

Keywords: Tsugaru Strait, Tsugaru Warm Current, High Frequency Radar, Frontal Wave