

Bottom-water intrusion and subsequent water exchange induced by Yamase around Mutsu Bay

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Bottom-water intrusion in the Bungo channel, which is the cold-water intrusion onto the continental shelf from the Kuroshio intermediate layer, was studied by Takeoka et al. (2000). The bottom-water intrusion in the Bungo channel occurs when the Kuroshio Current passes along the Kyushu of the Bungo channel (Kaneda et al., 2002). In the case of Mutsu Bay, bottom-water temperature fluctuated by more than 3 degree Celsius during summer (June –September). However, Tsugaru Warm Current is not so strong compared with Kuroshio and, thus, we had to find other mechanisms for the bottom-water intrusion to occur. We here focused on Yamase which is a cold, moist and westward wind blowing from the Okhotsk Sea during summer and analyzed water temperature, current velocity and wind velocity.

Ocean buoy automatic monitoring system (hereinafter, buoy system) at three points of Mutsu Bay (Tairadate, Aomori, Higashiwani) have observed water temperature, current velocity, salinity, and so forth at a depth of 1m, 15m, 30m every single hour. An observation ship “Natsudomari” records water temperature, salinity, and so forth at eleven points of Mutsu Bay once a month. Water temperature and current velocity from 2008 to 2017 (buoy system), water temperature from 1981 to 2016 (Natsudomari), water temperature from 1981 to 2010 (Japan Oceanographic Data Center (J-DOSS)) and water temperature deviation in August from 2008 to 2017 in Tsugaru Strait (Hokkaido Research Organization) were obtained. Wind data at Oma observatory free of terrain-derived disturbances was obtained from the Japan Meteorological Agency.

A correlation analysis of time series between water temperature (5 –15 days) at Tairadate, Aomori, Higashiwani and zonal wind at Oma was performed. The days when daily average easterly (westerly) wind velocity was greater than 2 m/s was referred to as “eastern (western) wind day”. Composite maps of cross sections of water temperature in Tsugaru Strait and Mutsu Bay was created on the eastern and western wind day, respectively. The relationship between annually average bottom-water temperature at Aomori and Higashiwani and eastern winds at Oma was investigated during summer (June –September) from 2008 to 2017. Water temperature in 2011 was excluded because water temperature in Tsugaru Strait was extraordinarily low.

Long-period bottom-water temperature (about 10 days) at Tairadate and Aomori, both of which are located in western Mutsu Bay, remarkably fluctuated, that is, bottom-water intrusion occurred in the western part of Mutsu Bay. The correlation coefficients between the bottom temperature and Oma winds were 0.68 at Tairadate (a significance level of 0.05) and 0.75 at Aomori (a significance level of 0.05). Consequently, it was suggested that zonal wind induced bottom-water intrusion in western Mutsu Bay. Moreover, the composite maps stated that cold-water < 10 degree Celsius intruded onto the bottom of Mutsu Bay from Tsugaru Strait during eastern wind days. These findings suggest that westward Yamase triggers bottom-water intrusion in Mutsu Bay. However, as bottom-water temperature become lower, bottom-water intrusion was prevented even when Yamase blows continuously.

Keywords: Bottom-water intrusion, Mutsu Bay, Yamase