

On the appearance of abnormal water temperature over inner shelf of the Kuroshio south of Japan

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We examined appearance of abnormally high and low water temperature in the inner shelf (Bungo and Kii Channels) of the Kuroshio south of Japan using monthly observed data from 1964 to 2013 and demonstrated how the Kuroshio, Kuroshio recirculation, and Kuroshio path meandering affect the appearance of abnormal water temperature in the inner shelf using a reanalysis data (FORA-WNP30) from 1982 to 2012. The observed data show that the abnormal low water temperatures frequently occurred in 1980s, while the abnormal high water temperatures frequently occurred in 1990s in both the Bungo Channel and the Kii Channel. In addition to this feature, the reanalysis data show that the occurrence of abnormal water temperatures is not limited in two channels. The same abnormal low and high events can also be found over the inner shelf of the Kuroshio offshore of the two channels.

In order to reveal the causes for occurrence of abnormal water temperatures, we separated the temporal variations of water temperature in the reanalysis into a component of linear trend, a component with a variation time longer than 1 year (long-term variations), and a component with a variation time shorter than 1 year but longer than 1 month (middle-term variations). The separation shows a positive linear trend in the reanalysis data from 1982 to 2012. We can confirm the same positive linear trend from the observed data in the Bungo and Kii Channels for the same period (1982-2012) but cannot find it from the observed data over entire observation period (1964-2013). Apparently, the linear trend from 1982 to 2012 is a part of interannual variations. For this reason, we kept the linear trend from 1982 to 2012 in the long-term variations in the following analysis.

The long-term variations in the water temperature are likely the cause for the low abnormal water temperatures in 1980s and the high abnormal water temperatures in 1990s. The long-term variations in water temperature are associated with the strength of the Kuroshio velocity. The strength of the Kuroshio velocity is further related to the strength of recirculation offshore the Shikoku that is affected by the North Pacific Subtropical Mode Water, and the propagation and accumulation of mesoscale eddies as known from the sea surface height anomaly.

The middle-term variations in water temperature are associated with the variation in the Kuroshio path and velocity due to perturbation from Kuroshio upstream.

Dynamically, the variations in the Kuroshio path and velocity resulted in variations in offshore velocity that further caused upward or downward shift of thermocline over inner shelf through the geostrophic adjustment and induced the water temperature variations over inner shelf of the Kuroshio south of Japan.

Keywords: the inner shelf of the Kuroshio, abnormally high and low water temperature, Kuroshio recirculation