

Kuroshio variations in the northeast of Taiwan associated with typhoon revealed by ocean radar and numerical model

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The Kuroshio flows northward east of Taiwan, and then turns to northeastward along shelf edge in the northeast of Taiwan. The Kuroshio in the northeast of Taiwan fluctuates with various time-scales. Seasonally, the Kuroshio flows along the shelf edge in summer and moves shoreward in winter. Shoreward movement of the Kuroshio in winter is considered to be related with northeast monsoon or winter cooling. Previous studies reported that the Kuroshio northeast of Taiwan varies with a time-scale of several tens of days. The Kuroshio axis movement around Taiwan associated with typhoon passage also reported by some studies. The mechanism of the Kuroshio axis movement due to typhoon passage has been continued to be a matter of discussion. In the present study, we investigated the Kuroshio axis variation associated with typhoon passages using the Long Range Ocean Radar data from 2001 to 2008. In addition, we conducted numerical experiment for the case of two typhoons by mean of an ocean-atmosphere coupled model.

We made daily Kuroshio axis data from sea surface current vectors observed by the Long Range Ocean Radar data. We examined relationship between typhoon passage and the Kuroshio axis variation for 23 typhoons during observed period. At 7 typhoons, the Kuroshio axis moved shoreward after typhoon passages. Comparing wind variation with the Kuroshio axis variation for the cases of the Kuroshio axis moved or not, we could not see characteristics in common. However, it was found that typhoon moved from east to west around Taiwan when the Kuroshio axis moved shoreward.

We coupled both CReSS (Cloud Resolving Storm Simulator) and NHOES (Nonhydrostatical Ocean Model for Earth Simulator) to reproduce the Kuroshio axis movement associated with typhoons Hai-Tang in 2005 and Morakot in 2009. The paths of the typhoons calculated were consistent well with those observed. Model wind at Yonaguni Island was a little stronger than observation, but tendency of variation was almost the same each other. The Kuroshio flowed north-eastward along shelf edge in the model before typhoon approach, and then the Kuroshio axis changed the direction to the north. Our model well reproduced phenomena around northeast of Taiwan during typhoon Hai-Tang. It was suggested from the numerical model result that the Kuroshio axis movement to the north associated with typhoon passage is caused by a negative vorticity supplied to the shelf due to Ekman transport and water mass with low water temperature transport from subsurface in the Kuroshio region to the shelf by coastal upwelling.

Keywords: Kuroshio, Typhoon, Ocean Radar, Numerical Model