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Ocean response to typhoons moving toward north in the East China Sea

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1.Introduction

From summer to fall, a lot of typhoons approach Japanese Islands and a part of them moves toward north on the East China Sea (ECS). Ocean responses with the passage of typhoons appear mainly as vertical mixing and upwelling. These phenomena cause to drastically change environment of the upper ocean such as SST (Sea Surface Temperature) decrease, supplement of nutrient-rich from the bottom, and so on. Thus it is important to clarify the ocean response to the typhoon passage. However, there are a few studies for the ocean response as an atmosphere-ocean interaction to the typhoon passage in ECS where the bottom topography is abrupt and the Kuroshio flows along the steep slope.

In this study, we elucidate mechanisms of ocean response to Typhoon SONGDA (2004) that moves toward north on ECS. Moreover, we indicate a unified tendency of the ocean response to typhoon passage in ECS. The ocean assimilation data in Kyushu University (RIAMOM) and GPV(MSM) weather forecasting data are mainly used to analyze upper-ocean and surface winds.

2.Results and Discussion

Typhoon SONGDA (2004) was one of the biggest typhoons in the past passing toward north on ECS. The typhoon entered in ECS on September 5, 2004 18:00 (JST) and departed there on September 7, 2004 9:00 (JST). Focusing on the variation of SST between September 3 and September 9, we find that SSTs in the sea area decrease. The sea state also changes largely after the typhoon enters in ECS. In order to confirm the variations of SSTs due to the passage of typhoon in more detail, we obtained the difference of SSTs between September 7 and September 4. In particular, decreases of SSTs appeared in the continental slope of ECS and the line of sea areas from the east coast of Nansei Islands to the east coast of southern Kyushu(Fig.1).

On the remarkable ocean response in the continental slope of ECS, the initial condition of ocean before passage of the typhoon is important. This condition was determined by the geostrophic adjustment of the Kuroshio Current flowing along the continental slope before the typhoon entered in ECS. In the continental slope, cold water upwelled from the lower layer and hence the thickness of surface layer with warm-water became thinner than the surrounding sea. The cooling condition of surface water has been arranged before the passage of typhoon. When the typhoon reached the sea area, the water further upwelled and mixed due to the strong winds and the water temperature reduced prominently. We conclude that above factor causes the significant decrease of the sea temperature.

On the other hand, on the sea area from the east coast of Nansei Islands to the east coast of southern Kyushu, the location and the pass of the typhoon were associated with cooling of the sea water. Since the typhoon moved toward north passing ECS, these sea areas were given stress by the southerly winds. The Ekman transport toward east was generated by the southerly winds at the boundary of the line of islands. Then the coastal upwelling was occurred at the eastern side of the islands and the surface water was cooled there.

Moreover, we examined the SST difference due to typhoon passage of all 16 cases in ECS during year 2002 to year 2010 based on the result of Typhoon SONGDA (2004). We also paid attention to the ocean response of the continental slope of ECS and the line of sea areas from the east coast of Nansei Islands to the east coast of southern Kyushu. It is found that with high probability, SSTs in these sea areas reduced with passage of typhoons. As a result, we suggest that when typhoons pass toward north on ECS, the SSTs decrease in the continental slope of ECS and the line of sea areas from the east coast of Nansei Islands to the east coast of southern Kyushu.

Lastly, we appreciate Research Institute for Applied Mechanics in the Kyushu University and Meteorological Agency in Japan for using the ocean assimilation data and the wind data to carry out the present study.

Keywords: Ocean response, Typhoon, East China Sea, the Kuroshio

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