Quantification of SST cooling induced by Typhoons Faxai (2019) and Hagibis (2019)

*Koki Iida[1,2], Fudeyasu Hironori[1], Tanaka Yuusuke[2], Iizuka satoshi[3], Yoshiaki Miyamoto[4], Tomoya Shimura[5], Nobuhito Mori[5]

1. Yokohama National University, 2. Japan Agency for Marine-Earth Science and Technology, 3. National Research Institute for Earth Science and Disaster Resilience, 4. Keio University, 5. Disaster Prevention Research Institute, Kyoto University

Kanto District, Japan. In early October, a month later, Typhoon Hagibis (2019) approached the Japanese Islands with a track relatively similar to Faxai's track over the ocean south of the eastern part of the main island of Japan. High-resolution satellite observations of Himawari-8 showed that sea surface temperature (SST) decreased with the passage of both typhoons. The SST was more cooled by Hagibis than by Faxai. Typhoon-induced SST cooling is caused by the effects of strong winds associated with typhoons. Typhoon-induced SST cooling can directly suppress typhoon intensity via oceanic feedback. Therefore, it is important to understand typhoon-induced SST cooling to predict typhoon intensity. The amount of typhoon-induced SST cooling is related not only to the ocean conditions beneath a typhoon but also to the characteristics of the typhoon, such as maximum wind, horizontal size, and speed of movement. The impacts of ocean conditions on typhoon intensity are indicated by the ocean heat content and the tropical cyclone heat potential. These are useful indicators of ocean conditions, but they do not indicate the magnitude of the impact on SST cooling dependent on the typhoon characteristics.
This study focused on the cooling parameter (Co), a non-dimensional number that theoretically indicates the amount of SST cooling during the passage of a typhoon, proposed by Miyamoto et al. (2017). Based on the results of ocean model, we attempt to evaluate typhoon-induced SST cooling quantitatively, separating the impacts of typhoon characteristics from the impacts of ocean conditions using the Co. The average decrease in SST due to the effects of strong winds associated with the typhoons differed in Faxai (0.9℃) and Hagibis (1.5℃) shown by the ocean model. The average Co value was 1.6 for Faxai and 3.6 for Hagibis, indicating that SST was more easily cooled by Hagibis than by Faxai, consistent with the observations and the ocean model. The impact of ocean conditions on SST cooling by Hagibis was 2.6 times larger than that for Faxai, indicating that it is difficult to cool SST in the ocean under Hagibis than Faxai. However, the impact of Hagibis's characteristics was 4.8 times larger than the impact of Faxai's characteristics, indicative of more SST cooling by Hagibis. In particular, among Hagibis's characteristics, the size in the horizontal direction had the most efficient effect on SST cooling. Although Co does not estimate the effects of advection of ocean water, we suggest that Co is a useful indicator for estimating the SST decrease caused by a typhoon.

Keywords: Typhoon, SST, Cooling parameter, Ocean model, Typhoon characteristics, Ocean conditions

