

## Warm ocean conditions and increased typhoon intensity in 2019

\*Akiyoshi Wada<sup>1</sup>

1. Department of Typhoon and Severe Weather Research, Meteorological Research Institute

It is sometimes pointed out that the increase in the upper-ocean temperature, particularly sea surface temperature, is one of the factors that cause stronger landfalling typhoons such as FAXAI and HAGIBIS in 2019. Since these landfalling typhoons cause serious disasters, it is necessary to explore the effects of increases in the upper-ocean temperature on the typhoons. First, an empirical orthogonal function (EOF) analysis method was applied for tropical cyclone thermal potential (TCHP) data from 1982 to 2019 to investigate upper ocean temperature variations. From the EOF analysis, we can find the correlation map that TCHP increased in almost all areas in the North Pacific as the second mode, while the first mode shows the variation corresponding to the El Nino-Southern Oscillation. In 2019, we find that the second mode is dominant. In order to investigate the impact of the increase in the upper-ocean temperature on typhoons in 2019, numerical simulations were conducted for Typhoons FAXAI and HAGIBIS with a nonhydrostatic atmosphere model and the atmosphere-wave-ocean coupled model, and with two different oceanic initial conditions. One oceanic initial condition is the average from 1982 to 2019, while the other is the daily operational oceanic analysis data in the Japan Meteorological Agency. The simulation results show that the difference in track predictions between the four simulations was very small although all simulated tracks showed the westward errors. However, the simulated central pressures and the simulated maximum wind speeds show that the simulated typhoon intensity became weak when both the coupled model and the average from 1982 to 2019 were used. In some experiments, there was no systematic difference between the four experiments as to the accumulated precipitation distribution over the Japanese archipelago. Therefore, the effect of the increase in the upper-ocean temperature on landfalling typhoons can be found only in the intensity.

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