# The impacts of a cold eddy induced by Typhoon Trami (2018) on the intensity forecast of Typhoon Kong-Rey (2018)

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## 1. Introduction

A tropical depression was upgraded to a tropical cyclone around 12.6˚N, 142.6˚E at 06 UTC on 29 September in 2018 and was named Kong-Rey (2018). According to the Regional Specialized Meteorological Center (RSMC) Tokyo best track analysis, the central pressure reached 900 hPa at 12 UTC on 1 October around 16.8˚N, 134.4˚E. Kong-Rey had kept the intensity for 18 hours and then its central pressure rapidly increased by 940 hPa for the subsequent 12 hours, like Typhoon Trami (2018) (Wada, 2019). Kong-Rey moved to follow Trami after a week, but no redevelopment like Trami was analyzed in the RSMC best track data. In fact, unlike Trami, Kong-Rey passed over an oceanic cold eddy induced by the passage of Trami. Figure 1 shows the horizontal distributions of sea surface temperature (SST) at 12 UTC on 29 September in 2018. One is obtained from the Merged Satellite and In-situ Data Global Daily Sea Surface Temperatures (MGDSST) data set with the horizontal resolution of 0.25° (Kurihara et al., 2006) (Fig. 1a) and the other is obtained from Microwave Optimally Interpolated Sea Surface Temperatures (OISST) data set with the horizontal resolution of 0.25°(http://www.remss.com/measurements/sea-surface-temperature/oisst-description/) (Fig. 1b). The representation of sea surface cooling (SSC) induced by Trami is much different between the two data sets.

The purpose of this study is to clarify the impacts of the cold eddy induced by Trami on the intensify forecast of Kong-Rey. Numerical simulations were performed with two different oceanic initial conditions obtained from MDGSST and OISST and a 2 km-mesh nonhydrostatic atmosphere model coupled with ocean surface wave and multilayer ocean models (Wada et al., 2010, 2018) with the Japan Meteorological Agency (JMA) global objective analysis with horizontal resolution of 20 km and the JMA North Pacific Ocean analysis with horizontal resolution of 0.5°. In addition, sensitivity numerical experiments were conducted with the oceanic initial condition at 12 UTC on 29 September merged with an artificial cold vortex centered at 21˚N, 129 ˚E, which is the same procedure as Wada (2019). The initial time, corresponding to the time of atmospheric initial condition, and integration period are 12 UTC on 29 September and 144 hours with the time interval of 3 seconds.

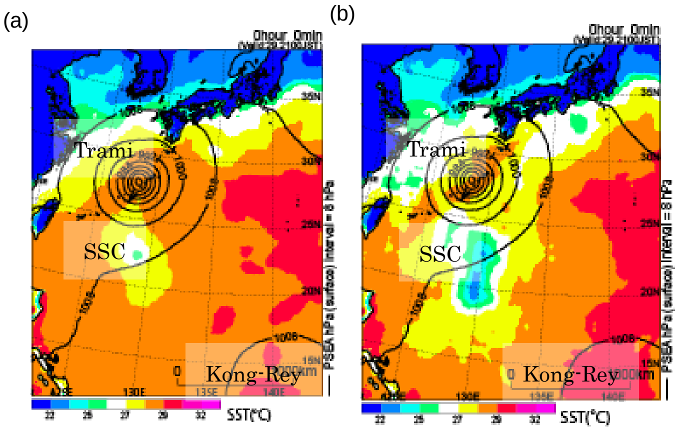


Figure 1. Horizontal distributions of sea-level pressures at the interval of 8 hPa and SST obtained from (a) MGDSST and (b)OISST datasets at 12 UTC on 29 September in 2018.

## 2. Experimental design

The list of numerical simulations is shown in Table 1. Four numerical simulations were performed in this study. The model physics in the coupled model is the same as Wada (2019): That includes an explicit three-ice bulk microphysics scheme, turbulent closure model in the atmospheric boundary layer, a radiation scheme, roughness lengths based on the third-generation ocean surface wave model and a sea spray parameterization. These are the same as Wada et al. (2018). No cumulus parameterization was used in this study.

Table1 List of numerical simulations

| *Name* | *Model* | *Oneanic initial data* | *Additional information* |
|---|---|---|---|
| MGDSST | Coupled NHM-wave-ocean | MGDSST+JMA analysis | |
| OISST | Coupled NHM-wave-ocean | OISST+JMA analysis | |
| MGDSST_COLD | Coupled NHM-wave-ocean | MGDSST+JMA analysis | +Artificial cold eddy |
| OISST_COLD | Coupled NHM-wave-ocean | OISST+JMA analysis | +Artificial cold eddy |

## 3. Results

Figure 2 shows the results of track simulations and the RSMC best-track together with the horizontal distribution of SST obtained from OISST on 3 October in 2018. The model used in this study reasonably simulated the track of Kong-Rey although the track excessively moved westward north of 20˚N. The effect of ocean coupling on the track simulation was negligibly small although SSC was clearly seen along the track. All the results regarding the track simulations are consistent with those in Wada (2019).

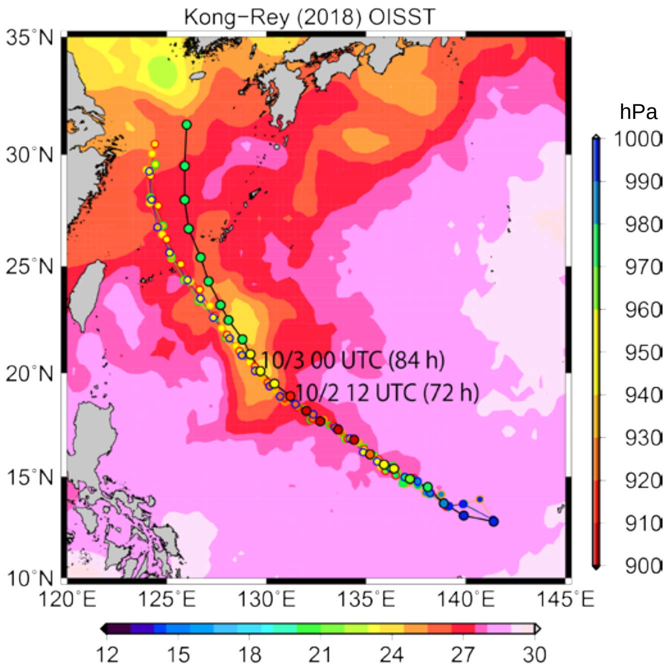


Figure 2. Results of track simulations together with the best-track analysis. Colors within the circles indicate the value of the central pressure. Color lines indicate the result of OISST (orange), MGDSST (green), OISST_COLD (red) and MGDSST_COLD (blue), respectively. Color shades indicate SST obtained from the OISST data set.

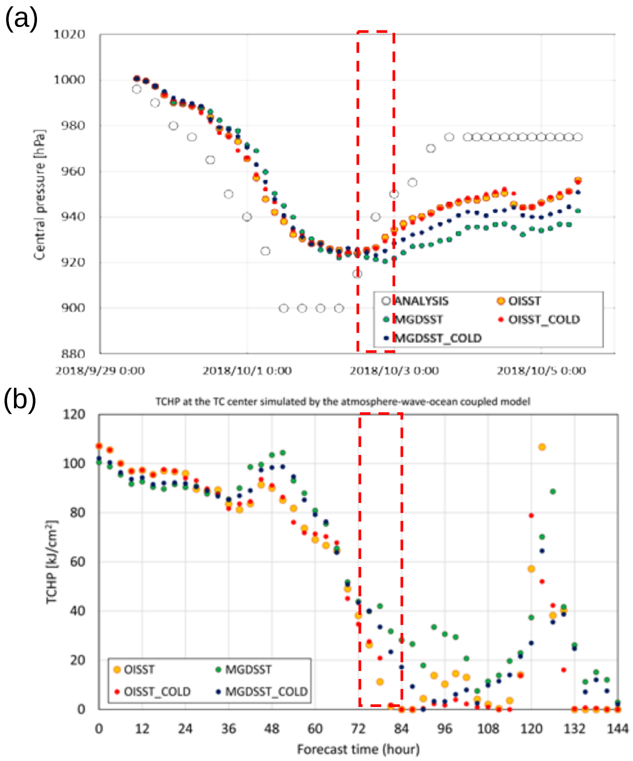


Figure 3. Time series of (a) the best-track analyzed central pressure and simulated central pressures and (b) tropical cyclone heat potential at the location of the simulated storm center. Dashed boxes indicate the period from 2 (72-hour integration time) to 3 (84-hour integration time) October.

Figure 3a shows the time series of simulated central pressures together with the best-track central pressure. The coupled model hardly simulated the minimum central pressure of Kong-Rey in all four simulation experiments. In addition, the coupled model hardly simulated rapid increase in the central pressure from 2 to 3 October. The effect of the artificial cold eddy on the central pressure simulation was significant when MGDSST was used, while that was not clear when OISST was used. This was because the SST at the initial time obtained from OISST data set was so low compared with the SST obtained from MGDSST that tropical cyclone heat potential (TCHP, Wada et al., 2018) at the center of the simulated storm rapidly decreased from 2 (72-hour integration time) to 3 (84-hour integration time) October (Fig. 3b). The difference of TCHPs between MGDSST and MGDSST_COLD experiments was much larger than that between OISST and OISST_COLD experiments, which is consistent with the result of central pressure simulations (Fig, 3a). The differences also affected the net heat flux (summation of solar radiation, long-wave radiation sensible heat and latent heat flux) transported from the ocean to the atmosphere within a radius of 50 km from the storm center (not shown). In fact, the value of TCHP in the OISST_COLD experiment was almost the same as that in the OISST experiment. The artificial cold eddy could not contribute to further increasing the simulated central pressures and improve the intensity prediction of Kong-Rey, which is different from Trami (Wada, 2019).

## 4. Concluding remarks

Unlike the concluding remarks in Wada (2019), this study has shown that there is a limit to the improvement of typhoon prediction by improving the ocean initial condition. It is necessary to improve not only ocean coupling prediction system but also the atmospheric initial conditions and the physical processes in the atmosphere model to improve the prediction of rapid decaying of typhoons.

## References

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