Atmosphere-Ocean Coupling Effect on Typhoon Megi (2010)

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Typhoon Megi (2010) was one of the most intense tropical cyclones and the only typhoon that attained the minimum central pressure below 890 hPa in the decades after 1984. To investigate the ocean response to Typhoon Megi and the impact of sea surface temperature (SST) on Typhoon Megi, we used a high-resolution coupled atmosphere–ocean regional model, in which the atmospheric model is CReSS (Cloud Resolving Storm Simulator; Tsuboki and Sakakibara 2002) and the ocean model is NHOES (Non-Hydrostatic Ocean model for the Earth Simulator; Aiki et al. 2006, 2011), and the coupled model is referred to as CReSS–NHOES (Aiki et al. 2015). Three sensitivity experiments were conducted: two experiments using CReSS (hereafter FO and 1dO) and one experiment using CReSS-NHOES (hereafter 3dO). A time-fixed SST was used in the FO experiment. A simple vertical diffusion model for the ocean upper layer temperature (the so-called 1D-slab ocean model) was used in the 1dO experiment. The full three-dimensional structure of ocean was simulated in the 3dO experiment. The computational domain is 5°N –25.5°N and 109°E –150°E (Figure 1). The domain consists of 2048x1024 grid points, and the horizontal grid size of all models is 0.02° longitude by 0.02° latitude. All experiments started at 0000 UTC 14 October 2010. The integration time was 9 days.
Typhoon Megi was formed in 14 October and traveled westward in relatively large translation speed faster than 5 m s^{-1} as intensifying gradually (Figure 1a). Around 0000 UTC 17 October 2010, the storm started to intensify rapidly (hereafter, RI) and attained the minimum central pressure of 885 hPa at 1800 UTC 17 October 2010. Although all experiments represent the relatively accurate tracks over the Philippine Sea, the intensity of simulated storm differs significantly among the experiments; the minimum central pressure of the storms are 839, 901, and 892 hPa in the FO, 1dO and 3dO experiments, respectively (Figure 1b). Only the 3dO experiment represents reasonably the evolution and maximum intensity of Typhoon Megi. The simulated results reveal clear differences in the SST-cooling patterns in the vicinity of Typhoon Megi between the 1dO and 3dO experiments. In addition, the impacts of ocean responses to the storm are the most evident during the RI phase. Detailed analysis of the storm inner-core, defined by the region within a radius of 100 km, indicates that the convective activity around the storm center and onset of the RI phase could be modulated by the radial profiles of SST beneath the storm center.
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Figure caption.
Figure 1. Six-hourly tracks (a) and central pressure (b) of Typhoon Megi from RSMC best-track dataset (black) and in the FO (green), 1dO (blue) and 3dO (red) simulations between 0000 UTC 14 October 2010 to 0000 UTC 23 October 2010. Large circles in (a) indicate the locations at 0000 UTC.

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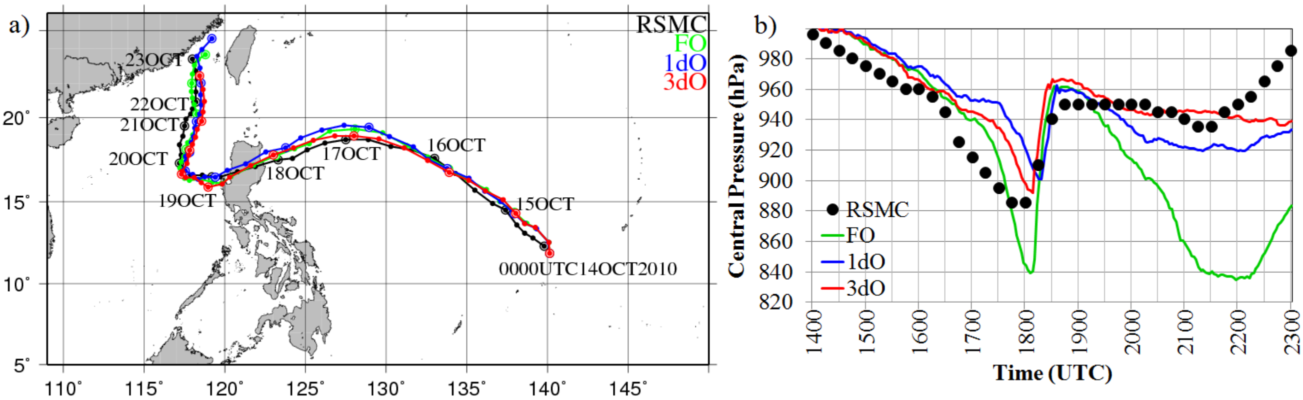
a)
RSMC
FO
1dO
3dO
23OCT
22OCT
21OCT
20OCT
19OCT
18OCT
17OCT
16OCT
15OCT
0000UTC14OCT2010
20˚
15˚
10˚
5˚
110˚
115˚
120˚
125˚
130˚
135˚
140˚
145˚
b)
Central Pressure (hPa)
980
960
940
920
900
880
860
840
820
RSMC
FO
1dO
3dO
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
Time (UTC)