Regional atmospheric data assimilation coupled with an ocean mixed layer model: a case of typhoon Soudelor (2015)

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Abstract

This study investigates the effect of atmosphere-ocean coupling in a regional atmospheric data assimilation system for a case of Typhoon Soudelor (2015). A simple ocean mixed layer model, known as the Price-Weller-Pinkel (PWP) model (Price et al. 1986), has been implemented into a regional atmospheric data assimilation system SCALE-LETKF (Lien et al. 2017), composed of the regional atmospheric model SCALE-RM and the local ensemble transform Kalman filter (LETKF). It is expected that the ocean mixed layer model brings more realistic physics to the simulation and modifies the ensemble spread, particularly near the ocean surface.

The numerical experiments were conducted at 15 km resolution with 50 ensemble members. The ocean states were prescribed in an experiment named CTL and calculated by the ocean mixed layer model in an experiment named PWP. We performed data assimilation cycles with conventional observations from the NCEP PREPBUFR dataset for 2 weeks starting at 0000UTC 25 July 2015 after a 1-day spin-up.

Although the sea surface temperatures (SSTs) in PWP change depending on the atmospheric-flow, the mixed layer model does not improve the track and intensity of the typhoon (Fig. 1). This can be explained by a decrease of the SSTs and by a decrease of the ensemble spread of the near surface atmospheric temperature (SAT) compared with those in CTL (Fig. 2). In the atmosphere-ocean coupling system, the stronger a typhoon, the cooler the SSTs via heat releases from the ocean surface and via vertical mixing of the upper ocean. These processes induce negative feedback for the typhoon development, so that the typhoon growth rates are suppressed (enhanced) in ensemble members with strong (weak) typhoon. This results in more similar typhoon intensities among ensemble members. Therefore, the coupled system reduces the ensemble spreads in the atmospheric fields associated with typhoon.

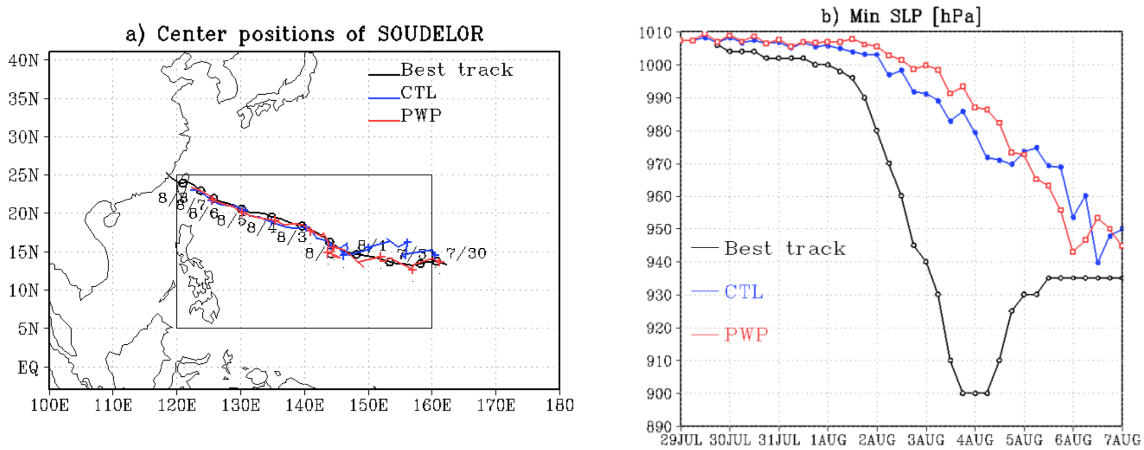

Fig. 1. a) Tracks and b) minimum sea level pressures (SLP, the unit is hPa) of the Typhoon Soudelor (2015). Black lines denote the data obtained from the best track, blue lines CTL, and red lines PWP. The rectangle region in panel a) is used for statistics.

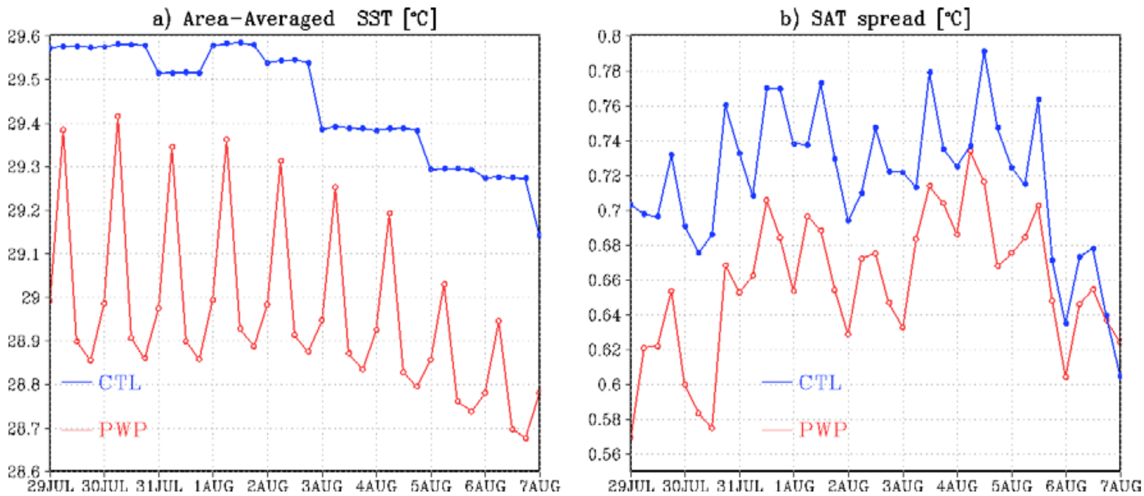

Fig. 2 a) Area averaged SSTs and b) SAT spreads over the rectangle region in Fig. 1a (the units are °C). Line colors are same as those in Fig. 1.

References

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