# Data assimilation experiments for tropical cyclones with the NHM-LETKF

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Forecasts for tropical cyclones (TCs) have been one of the most important issues from the view point of mitigating natural disasters. Although TC track forecasts have constantly improved over the past several decades owing to advances in numerical weather prediction (NWP) models as well as observational capabilities (Rappaport et al. 2009), improving TC intensity has still been a challenging task. One of the major difficulties in simulating TC intensity is the lack of observations over the ocean, especially near TCs. As compensation of real observations, a TC bogus method has been utilized to modify TC structures in initial conditions, leading to improvement of TC forecasts. However, because the typical structure is assumed in the bogus scheme, the discrepancy between actual TCs and these artificial data may become large, especially in the generation and extra-tropical transition stages of TCs.

In the current study, motivated by Chen and Snyder (2007), assimilation of TC position and intensity information is applied with a realistic NWP model. Although many studies have been published thus far investigating the impacts of best track estimates of TC minimum central pressure and position, so-called TCVital observations (Torn and Hakim 2009; Torn 2010; Hamill et al. 2011), the comparison of the TCVital data with different assimilation methods has not been performed. Here, impacts of the TCVital data are evaluated through sensitivity experiments with different assimilation strategies. For data assimilation experiments, the NHM-LETKF system (Kunii 2013) is utilized with almost similar configurations of the literature.

Throughout the following sensitivity experiments, TCVital data with large difference from the first guess field are assimilated so as to emphasize the impact of the data. Compared with the TC intensity and position represented in the first guess field, the minimum central pressure and central position of the TCVital are deeper by 16 hPa, and located 100 km west from the first guess, respectively. First, the impact of the different assimilation strategies is examined. When the data are assimilated as a surface pressure observation, unnatural pressure pattern emerges near the TC center in the analysis (Fig. 1a). This is probably due to the large discrepancy of the TC positions in the first guess field and the assimilated observation. By contrast, assimilating TC position and intensity improves the sea level pressure field with reasonable analysis increments (Fig. 1b).

Next, in order to show the individual impact of the intensity and position information, the TC minimum central pressure and position data are separately assimilated. Figure 2 shows the analysis increments of surface pressure fields in each experiment. When the TC minimum central pressure information is assimilated, the intensity becomes closer to the observation although relatively small positive increments appear near the center of TC. With TC position information, positive and negative increments emerge east and west side of the TC center in the first guess. This increment pattern implies the relocation of the TC position, indicating the assimilation works as expected.

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In the current study, the impact of the TCVital data is evaluated through sensitivity experiments. Besides further comparison of TCVital with TC bogus data, exploration of new assimilation strategies of TCVital would be a future subject.

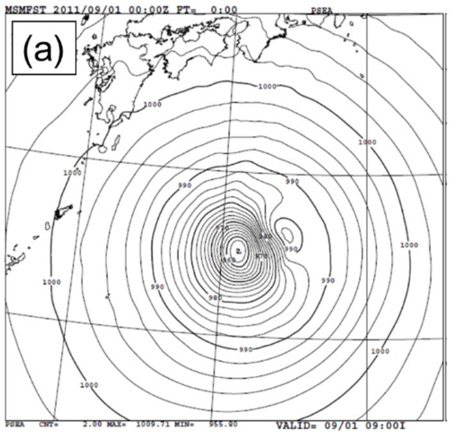


FIG. 1. Analyzed sea level pressure (hPa) when TCVital data are assimilated (a) as a surface pressure observation, (b) as position and intensity information.

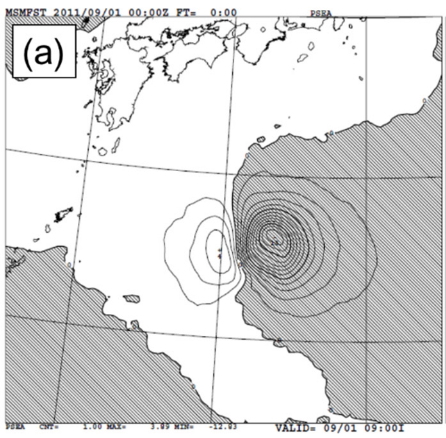


FIG. 2. Analysis increments of mean sea level pressure (hPa) when (a) TC intensity, (b) TC position information is assimilated. Shade color shows negative analysis increments.

## References

Chen, Y., and C. Snyder, 2007: Assimilating vortex position with an ensemble Kalman filter. *Mon. Wea. Rev.*, **135**, 1828–1845.

Hamill, T. M., J. S. Whitaker, M. Fiorino, and S. G. Benjamin, 2011: Globalensemble predictions of 2009's tropical cyclones initialized with an ensemble Kalman filter. *Mon. Wea. Rev.*, **139**, 668–688.

Kunii, M., 2013: Mesoscale data assimilation for a local severe rainfall event with the NHM-LETKF system. *Wea. Forecasting*, doi: http://dx.doi.org/10.1175/WAF-D-13-00032.1.

Rappaport, E. N., and Coauthors, 2009: Advances and challenges at the National Hurricane Center. *Wea. Forecasting*, **24**, 395–419.

Torn, R. D., 2010: Performance of a mesoscale ensemble Kalman filter (EnKF) during the NOAA High-Resolution Hurricane test. *Mon. Wea. Rev.*, **138**, 4375–4392.

Torn, R. D., and G. J. Hakim, 2009: Ensemble data assimilation applied to RAINEX observations of Hurricane Katrina (2005). *Mon. Wea. Rev.*, **137**, 2817–2829.