Impact of targeted dropsonde observations on the track forecast for SINLAKU (200813) using Ensemble Kalman Filter

Byoung-Joo Jung[1], Hyun Mee Kim[1*], Fuqing Zhang[2], and Chun-Chieh Wu[3]
[1]Department of Atmospheric Sciences, Yonsei University, Seoul, Korea
[2]Department of Meteorology, The Pennsylvania State University, Pennsylvania, USA
[3]Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan

1. Introduction

Typhoons are the most severe phenomena due to the intense vortex and precipitations as well as socio-economic damages. However, there are difficulties on the understanding and prediction of typhoons because typhoons are mostly located on the oceanic area of relatively data-sparse regions. During August to September 2008, THORPEX Pacific Asian Regional Campaign (T-PARC) has been performed in the Western North Pacific to investigate the formation, structures, targeting, and extratropical transition of tropical cyclones. In this study, the impact of targeted dropsonde observations on the track forecast of typhoon SINLAKU (200813) is investigated using ensemble Kalman filter (EnKF).

2. Experimental design and model setup

A serial ensemble square-root filter (EnSRF; Whitaker and Hamill 2002, Snyder and Zhang 2003), one of the deterministic algorithms of EnKF, is used for this study. A series of experiments are configured according to the observation data types that are assimilated with EnSRF. The control experiment assimilates the conventional observations and referred to as EXP1. The conventional observations contain the surface (SYNOP, SHIP, BUOY), radiosonde (TEMP), atmospheric motion vectors (AMVs), and aircraft observations. Figure 1 shows an example of observations used for EnKF data assimilation. Additional experiments are configured by assimilating typhoon location or intensity reports (Chen and Snyder 2007) or targeted dropsonde observations from T-PARC. The position and intensity observations are based on the best track data from the Regional Specialized Meteorological Center (RSMC) Tokyo. The targeted dropsonde observations are from 4 T-PARC aircrafts: DOTSTAR ASTRA, DLR Falcon, NRL P-3, and USAF WC-130. Table 1 shows a summary of observing system experiments.

Related to the EnKF data assimilation, following experimental configurations are used: i) 36 ensemble members, ii) covariance localization (Gaspari and Cohn, 1999) with 1800 km due to the sampling error, iii) covariance relaxation (Zhang et al. 2004) of 0.8 prior weighting, and iv) multiple physical parameterizations for ensemble members. The covariance relaxation and the use of multiple physics schemes are considered for maintaining the ensemble spread to avoid the filter divergence. As a forecast model, the Advanced Research WRF (ARW) modeling system version 2.2 (Skamarock, 2005) is used. Two

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*Corresponding author: khm@yonsei.ac.kr, Department of Atmospheric Sciences, Yonsei University, Shinchon-dong 134, Seodaemun-gu, Seoul, 120-749, Republic of Korea

nesting domains of 45- and 15-km resolution are centered at 25°N, 125°E on the Western North Pacific region.

3. Results

A series of ensemble forecasts are conducted, by initiated with EnKF posterior analyses. Figure 2 shows the mean tracks of ensemble forecasts, initiated at 00 UTC 10 September 2008. Up to 36 hour forecast time, all experiments show similar performance on the track forecast, however, EXP1 shows larger track error than other experiments afterward. Figure 3 shows time-averaged track error, corresponding to Fig. 2. The position assimilation (EXP2) slightly reduced the track error, compared to EXP1. The dropsonde assimilation (EXP3, 4) greatly reduced the track error. The SLP assimilation (EXP5, 6) also has a positive impact on the track forecast. Due to the smaller observation error that assumed in the analysis procedure, the impact of the SLP assimilation in EXP5 is larger than in EXP6.

The ensemble mean fields are also evaluated with radiosonde and dropsonde observations at the mandatory levels (Fig. 4). The root-mean-square errors (RMSEs) for each analysis variable are integrated in a dry total energy (DTE) form. The positive impact of dropsonde assimilation is also found (EXP3, 4). The experiments assimilating all available information (EXP7, 8) show the smallest DTE.

4. Summary

The impact of targeted dropsonde on the track forecast for typhoon SINLAKU (200813) is investigated using EnKF. A series of observing system experiments are configured. The typhoon position and intensity assimilation shows a positive impact on the track forecast. The dropsonde assimilation (EXP3, 4) reduces the track error about 50 % compared to EXP2. More detailed analyses will be given in the presentation.

Acknowledgement

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Table 1. Summary of experiments.

EXP	Description
EXP1	Conventional obs.
EXP2	Conventional obs. + Tc position
EXP3	Conventional obs. + Tc position + DROP (100km IN)
EXP4	Conventional obs. + Tc position + DROP (100km OUT)
EXP5	Conventional obs. + Tc position + Tc SLP (Obs Err = 5 hPa)
EXP6	Conventional obs. + Tc position + Tc SLP (Obs Err = 10 hPa)
EXP7	Conventional obs. + Tc position + Tc SLP (Obs Err = 5 hPa) + DROP (100km IN)
EXP8	Conventional obs. + Tc position + Tc SLP (Obs Err = 5 hPa) + DROP (100km OUT)

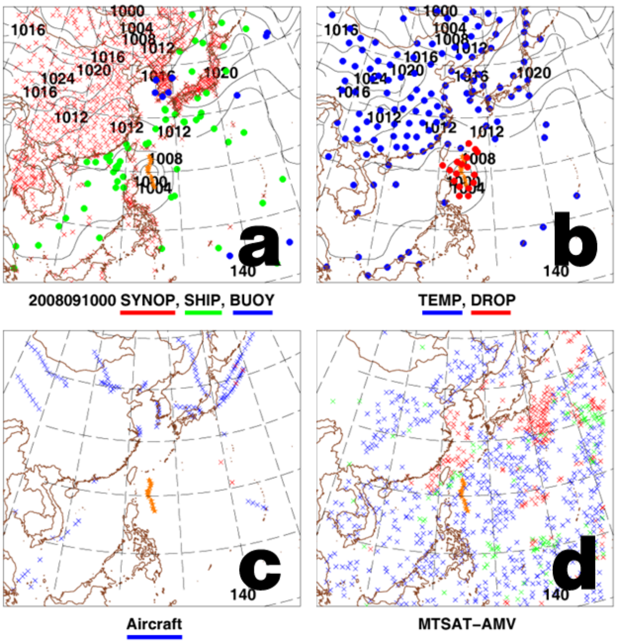

Figure 1. Observational distribution for (a) SYNOP, SHIP, and BUOY, (b) TEMP and DROP, (c) Aircraft, and (d) MTSAT-AMV at 00 UTC 10 September 2008.

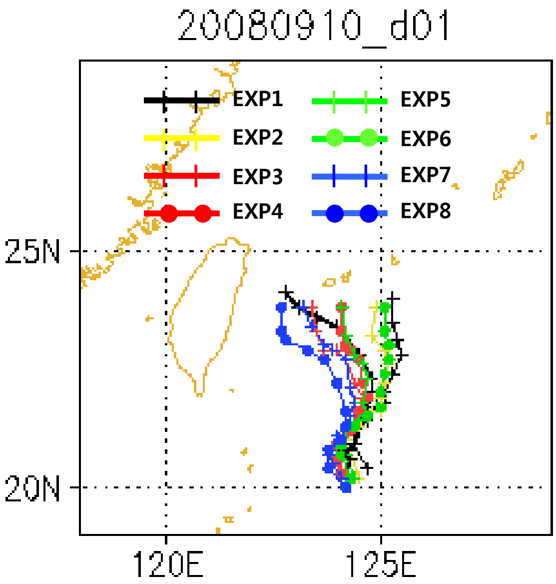

Figure 2. Mean tracks of 72 hour ensemble forecast, initiated at 00 UTC 10 September 2008. The best track is denoted by thick black line.

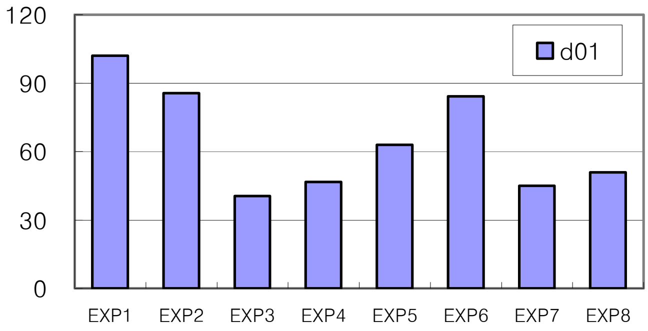

Figure 3. 72 hour-averaged error (km) of ensemble forecast mean track, initiated at 00 UTC 10 September 2008.

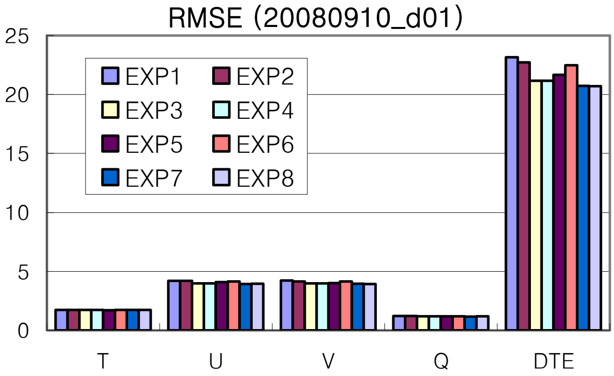

Figure 4. 72 hour-averaged RMSEs of ensemble forecast mean fields, verified with TEMP+DROP mandatory levels.