Abstract:Japan Meteorological Agency (JMA) performed Observing System Experiments (OSEs) on a typhoon track forecast to investigate the usefulness of a sensitivity analysis based on a moist singular vector method. The results show the sensitivity analysis using JMA singular vector method may be useful for targeting observations like Dropsonde Observation for Typhoon Surveillance near the Taiwan Region (DOTSTAR).

Keywords – OSE, typhoon track forecasts, sensitivity analysis, moist singular vector

1. INTRODUCTION

Dropsonde Observation for Typhoon Surveillance near the Taiwan Region (DOTSTAR) has demonstrated the effectiveness of dropsonde observation on typhoon track forecasts. Japan Meteorological Agency (JMA) has performed several Observation System Experiments (OSEs) for DOTSTAR data of typhoon CONSON, in order to investigate the usefulness of a sensitivity analysis based on a moist singular vector method, which has been developed for typhoon ensemble forecasts planned to be operational in 2007.

2. JMA SINGULAR VECTOR METHOD

A singular vector method is known as a strategy for a sensitivity analysis (Majumdar et al., 2006) as well as for making initial perturbations in an ensemble prediction system (Puri et al., 2001). The linearized model and its adjoint version of JMA singular vector method are derived from the global 4D-VAR analysis system, and consist of full dynamics based on Eulerian integrations and full physical processes containing representations of vertical diffusion, gravity wave drag, large-scale condensation, long-wave radiation and deep cumulus convection. The model resolution is T63 (about 200km grid size at middle latitude) with 40 vertical layers. The norm to evaluate the growth rate of a singular vector is based on a total energy norm (Barkmeijer et al., 2001), but which is adjusted in order to obtain singular vectors explained mainly by wind and specific humidity component below about 300hPa, which are highly likely to relate with the uncertainties on typhoon track forecasts.

3. OSE SET-UP

The sensitivity analysis is performed for typhoon CONSON at 12UTC 8 June 2004 when totally 16 dropsondes were dropped under the DOTSTAR project (Figure 1). In this singular vector calculation, the optimization time interval is 24 hours and a targeting area is set to rectangle, 25N – 30N and 120E – 130E, including CONSON’s center position at the optimization time. The result is shown in Figure 2. The sensitive region, which is defined in this study as the distribution of vertically accumulated total energy of the 1st singular vector, is computed around northeast of the typhoon. Four predictions with JMA Global Spectral Model (TL319L40) were performed starting from above time. The four predictions were different only in the use of the DOTSTAR data in the global 4D-VAR analysis; (I) all dropsonde observations were used for making the initial condition, (II) no dropsonde was used, (III) only eight observations within a sensitive region were used, and (IV) only observations outside of the sensitive region were used (Table 1). In these experiments, the typhoon track forecasts are compared with each other.

4. RESULTS

OSEs results are shown in Figure 3. In the comparison of the typhoon track forecasts, CONSON’s northeastward movement in the third prediction is similar to that in the first one while in the second and forth ones CONSON stays at the almost same position as an initial position. Furthermore, it is found in an additional experiment that even one dropsonde data within the sensitive region can contribute to the improvement on CONSON’s track forecast.
5. CONCLUSION

The OSEs result suggest two conclusion; one is that dropsonde data within the sensitive region is enough to predict typhoon CONSON’s track well, and the other is that a sensitivity analysis using JMA singular vector method may be useful for targeting observations like DOTSTAR. In other typhoon cases, for example, typhoon MELOR in 2003 which is also a DOTSTAR case, and typhoon MARIA in 2006, which forecasts may have been sensitive in initial conditions, the singular vector method proves to be useful for targeting observation for tropical cyclones.

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REFERENCES

