Development of a meso 4D-Var data assimilation system using a coupled atmosphere-ocean model for typhoon intensity prediction

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Since typhoons are often highly destructive, a better prediction of their intensity is important for disaster prevention. One of the promising approaches is to use a sophisticated high-resolution data assimilation system with a treatment of inner core dynamics and oceanic features. The Japan Meteorological Agency has developed the JMA-Nonhydrostatic model based Variational data Assimilation system (hereafter, JNoVA; [1]), which has been used operationally to construct a mesoscale objective analysis dataset and for regional forecasts since April 2009. JNoVA employs an adjoint-based 4D-Var technique using an incremental approach [2]. The analysis field is obtained by performing a high-resolution model run with the horizontal grid spacing of 5km, which is sufficient to represent the typhoon inner core structure, whereas the grid spacing is 15 km in the adjoint calculations. The purpose of this presentation is to summarize the recent progress toward improving the typhoon intensity prediction, including the coupling to the ocean mixed layer model and the use of ensemble-based background-error covariances.

To represent the impacts of sea surface temperature (SST) decrease along the typhoon passage, a simple one-dimensional ocean mixed layer model [3] is coupled to the high-resolution model. The initial condition of SST at the first assimilation cycle is set to the same as in the original system. Ocean temperature anomaly relative to the SST and salinity are taken from the World Ocean Atlas 2009. The SST is restored toward the values originally employed in JNoVA in a time-scale of one day because the ocean model is too simple to represent the long-term tendency. The assimilation experiment is conducted for Typhoon Talas (2011). With the coupled configuration, the SST decreases particularly in the right of the typhoon pathway with the maximum value of 1-2 K, which is consistent with the observation. The forecast experiment from 0000UTC Sep. 2 exhibits that the typhoon intensity is overestimated in the original system (minimum sea level pressure = 932 hPa) at FT=36 h, while the coupled configuration brings about the closer estimate (971 hPa) at FT=36 h to the JMA best track (970 hPa).

Currently, we are testing the impact of introducing the background-error covariances that are obtained from a local ensemble transform Kalman filter with 51 ensemble members. As a result, an observational data near an inner core yields the analysis increment according to nearly a gradient wind balance, contrary to a geostrophic balance which was obtained from the original system. This difference becomes more obvious when the observation is added in the beginning of an assimilation window.

References

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