A 4-dimensional variational assimilation system

for the JMA Global Spectrum Model

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The JMA has been developing a 4-dimensional variational data assimilation (4D-Var) system for the Global Spectrum Model(GSM). An incremental approach is taken to save computational time. The method calculates an analysis increment at a low resolution (T63L40) and then adds the increment to the high-resolution first guess(TL319L40). The model for forecast uses the semi-Lagrangian scheme(Yoshimura et al., 2003). The tangent-linear and adjoint model uses the Eulerian scheme with simplified physics. Assimilated observational data are the same as in the operational 3D-Var system. Two typhoon bogus methods are applied. In the analysis for the assimilation cycle, typhoon bogus profiles are embedded in first guess fields of surface pressure, temperature, and wind in the same way as in the 3D-Var. In the analysis for the model forecasts, pseudo observational data of sea-surface pressure and wind around a typhoon center are assimilated together with other observational data.

In order to evaluate the system performance, forecast-analysis cycle experiments were performed for each of one-month periods of January and August 2004. Nine-day forecasts were made once a day from 12 UTC initial conditions throughout the experiment periods. Figure.1 shows the RMSE of 500hPa geopotential height against the initialized analysis for January and August cases. The forecasts starting from 4D-Var are better than those from 3D-Var in the January case. In the August case, the forecasts starting from 4D-Var are better than those from 3D-Var in Southern Hemisphere and almost neutral in Northern Hemisphere. Figure.2 shows the RMSE and BIAS of 850hPa temperature against radio-sonde observations in the tropical region for the August case. The RMSE for 4D-Var is generally better than that for 3D-Var. The BIAS for 4D-Var is worse than that for 3D-Var in short-range forecasts, and it may result from model-originated cooling bias in the lower troposphere. Figure.3 shows the track-forecast error for typhoons T0411- T0419. The typhoon track-forecast error is reduced compared to 3D-Var except for very short-range forecasts.

This 4D-Var system will be operational in early 2005.

References:

Yoshimura, H., T. Matsumura, 2003: A Semi-Lagrangian Scheme Conservative in the Vertical Direction. Research Activities in Atmospheric and Ocean Modeling, CAS/JSC Working Group on Numerical Experimentation, 33, 0319-0320.

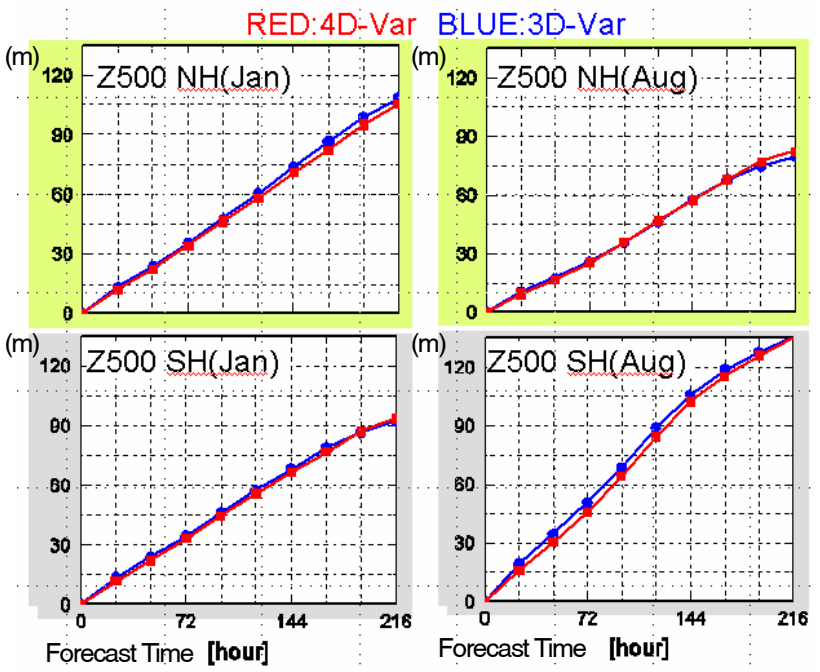

Fig.1 RMSE of 500hPa geopotential height against the initialized analysis.

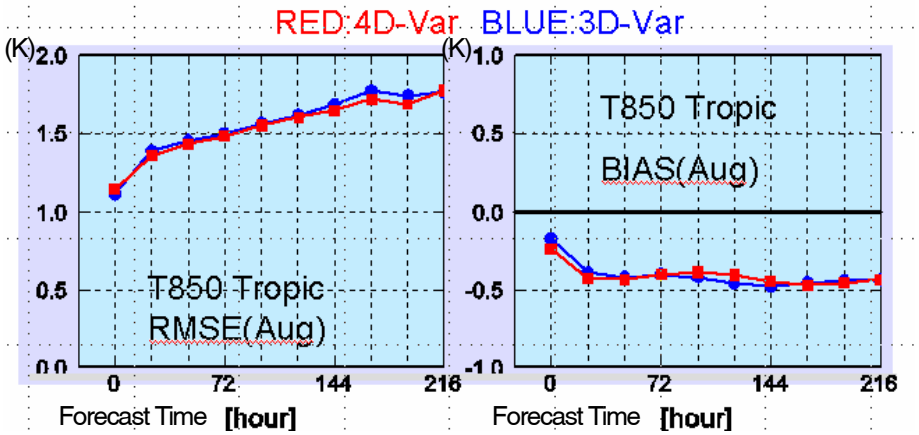

Fig.2 RMSE and BIAS of 850hPa temperature against radio-sonde observations.

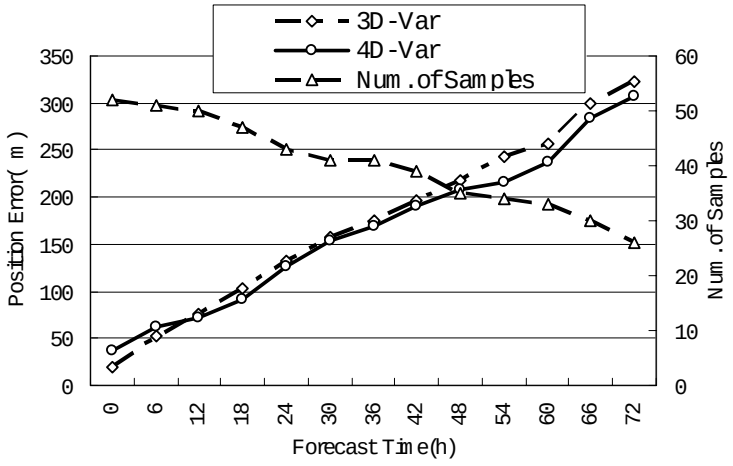

Fig.3 Position error of typhoon forecasts(T0411-T0419).