One month cycle experiments of the JMA mesoscale 4-dimensonal variational data assimilation (4D-Var) system

Yoshihiro Ishikawa and Ko Koizumi*
Numerical Prediction Division, Japan Meteorological Agency

The JMA is developing a 4-dimensional variational data assimilation (4D-Var) system for a hydrostatic mesoscale model (MSM) with a horizontal resolution of 10km and 40 vertical levels. The system becomes operational from March 2002 with three-hour assimilation windows. Since it is aimed to provide MSM products within one and half hours from observation times, an incremental approach is taken to save computational time, using a 20km version of MSM for inner loop calculation of 4D-Var. The adjoint model includes simplified physics. Assimilated data are radiosonde, synop, ship, buoy, airep, wind-profiler and radar-AMeDAS precipitation data.

In order to evaluate the total performance of 4D-Var in the operational environment, 3-hour forecast-analysis cycle experiments were performed for one month period of June and September 2001. 18-hour forecasts were made four times a day (00, 06, 12 and 18 UTC initials). The root mean square errors (RMSE) of 120 forecasts were calculated for each month against radiosonde observations in Japan and threat scores were also calculated for precipitation forecasts evaluation. These scores were compared with those of the routine forecasts which employ the one-hour cycle optimal interpolation and physical initialization as an analysis method during the last three-hour period preceding to the initial time.

Fig. 1 shows threat scores of 10mm/3hour calculated against 40km-averaged radar-AMeDAS precipitation analysis data. The scores of 4D-Var surpass those of routine forecasts for every forecast time of both June and September.

Fig. 2 shows RMSEs of 500hPa heights and 850hPa temperature of June 2001. The RMSEs of 4D-Var forecasts are smaller except for the 500hPa height error at FT=0, the reason of which is supposed to be that temperature data of radiosondes are used for assimilation, not geopotential height data. Although the error at FT=0 is slightly larger, the errors are smaller at the other forecast times, which indicates that the 4D-Var analysis has a better quality than the routine analysis. The RMSEs of September also have similar improvements over the routine analysis (not shown).

Fig. 3 shows an example of precipitation forecast. In this case, a typhoon (T0115) was approaching and heavy rain areas appeared in the southern coastal region of Japan. The forecast from 4D-Var shows a good agreement with the observation.

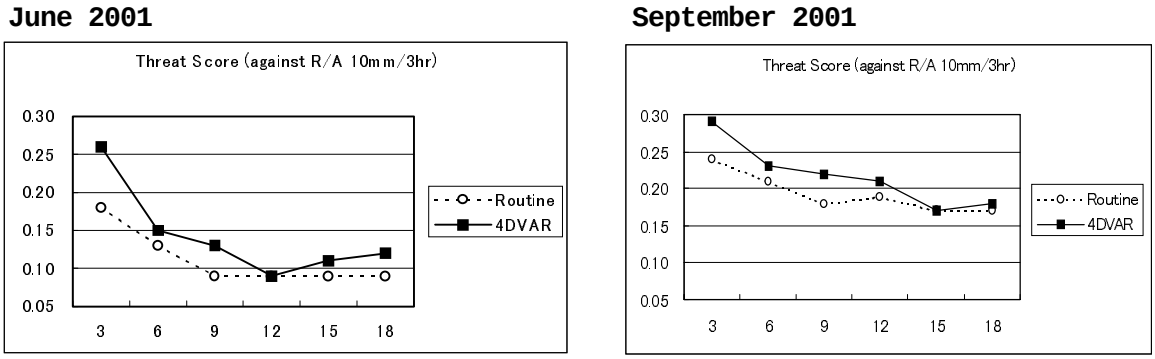

Fig. 1 Threat scores of 10mm/3hour (left: June 2001, right September 2001). Solid lines are scores of 4D-Var and dashed lines are those of routine forecasts.

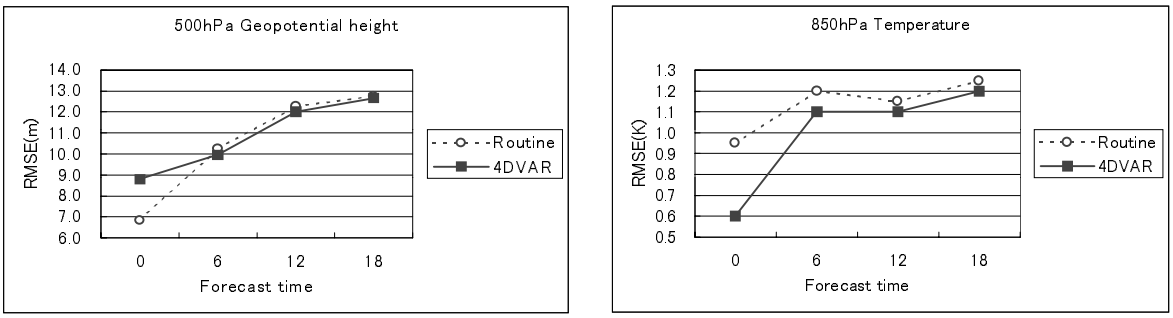

Fig.2 Root mean square errors of 500hPa geopotential height (left) and 850hPa temperature against radiosonde data. Solid lines are scores of 4D-Var and dashed lines are those of routine forecasts.

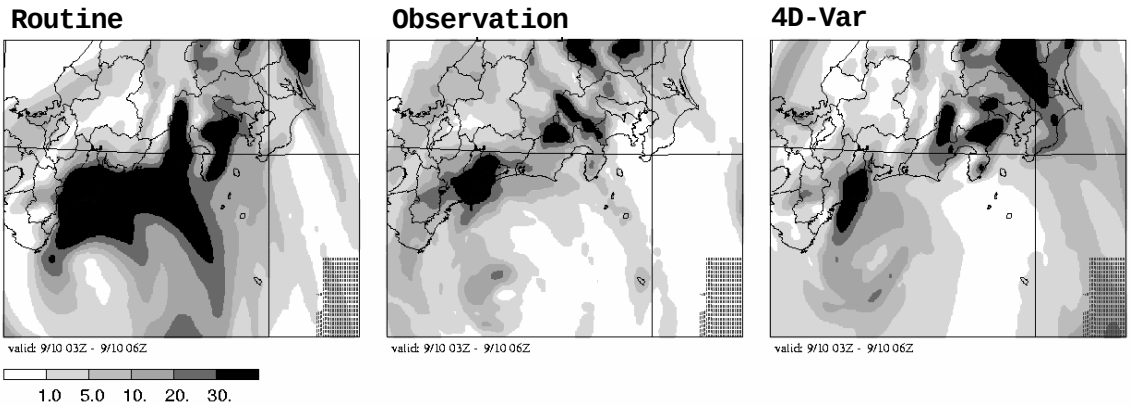

Fig.3 Three-hour precipitation amount in 03-06 UTC 10 September 2001. Initial time of forecasts is 12 UTC 09 September 2001 (FT=15-18).