Improvement of the Cumulus Parameterization Scheme of the Operational Global NWP Model at JMA

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The cumulus parameterization scheme implemented in the operational Global Spectral Model (GSM) at the Japan Meteorological Agency (JMA) follows the scheme proposed by Arakawa and Schubert (1974) with modifications by Moorthi and Suarez (1992), Randall and Pan (1993) and Pan and Randall (1998). The convection triggering mechanism proposed by Xie and Zhang (2000), dynamic CAPE generation rate (DCAPE), is introduced to improve the rainfall forecast (Nakagawa 2005).

JMA revised the calculation procedure of DCAPE for the operational GSM in January 2008 to consider the effect of wind crossing the isobar at the surface more precisely, which is not taken into account sufficiently in the previous version. An excessive limitation on cumulus upward mass flux from redundant vertical CFL condition was also removed.

The effect of the revision on DCAPE calculation appears mainly in forecasts of orographic precipitation. Figure 1 shows 6-hour accumulated precipitation at 12UTC 18 August 2006 by the forecasts with the previous GSM (left) and the current GSM (center) and by the radar observation (right). Typhoon T0610 (WUKONG) was moving northward over Kyusyu Island (big island in the center of the figure) and heavy precipitation occurred in the western part of Japan. Strong southerly wind was observed around the east side of the typhoon. It can be seen that the peak of rainfall near the Shikoku Island (the island east of

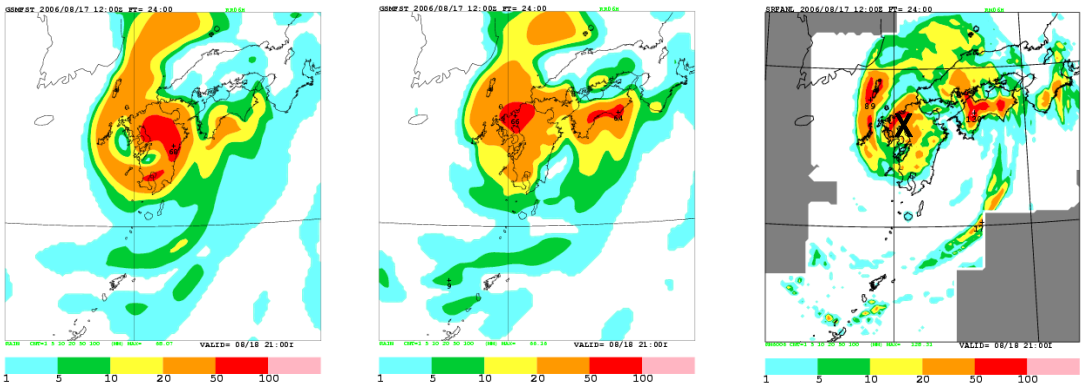

Fig. 1. Six-hour accumulated precipitation at 12UTC 18 August 2006 by the forecasts with the previous GSM (left) and the current GSM (center) and by the radar observation (right). Initial time for forecasts is 12 UTC 17 August 2006. X in the right panel indicates the position of typhoon T0610 (WUKONG).

Kyusyu Island) is predicted over the sea by the previous GSM. On the other hand, the current GSM simulates the peak over the Shikoku Island, which agrees better with the observation. The heavy precipitation over the Kyusyu Island is also predicted more appropriately by the current GSM.

Figure 2 shows the equitable threat scores for 6-hour accumulated precipitation forecasts against the raingauge observation over Japan in August 2006. The score of the current GSM is superior to that of the previous one.

The mean positional errors of the typhoons track forecast in August 2006 are shown in Figure 3. We can see that the revision of the cumulus parameterization scheme reduced the typhoon positional error substantially.

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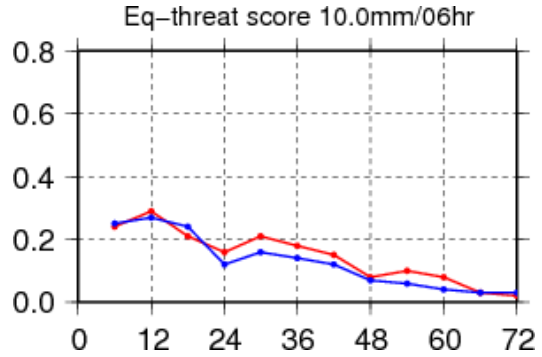

Fig. 2. Equitable threat scores for 6-hour accumulated precipitation forecasts against the raingauge observation over Japan in August 2006 by the current (red) and the previous (blue) GSM. The x-axis denotes the forecast time (hour).

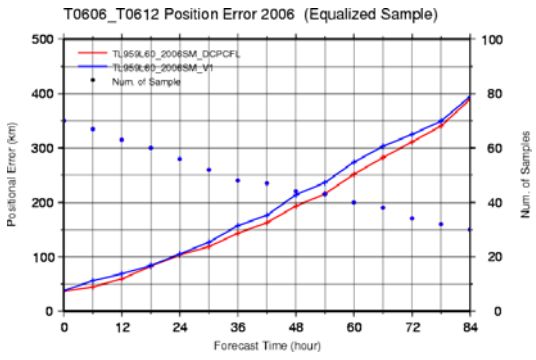

Fig. 3. Mean positional errors of the typhoons track forecast in August 2006. The red and blue line indicates the mean error of the current and the previous GSM, respectively. The dots represent the sample size.