The impact of the new Kain-Fritsch scheme in the KMA RDAPS(Regional Data Assimilation and Prediction System)

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1. Introduction

Precipitation is recognized as one of the most difficult parameters to forecast in numerical weather prediction(Wang and Seaman, 1997). It is divided into one by microphysical processes of grid scale and by convective process of sub-grid scale.

Convective parameterization schemes(CPS) are used in numerical prediction models to account for effect of sub-grid scale convection since the model cannot resolve convective motions explicitly. CPS directly or indirectly has an effect on severe weather events such as heavy rain, heavy snow and typhoon.

Consequently, the Kain-Fritcsh scheme(1990) has been used as the operational convective parameterization scheme in the RDAPS(Regional Data Assimilation and Prediction System)of KMA(Korea Meteorology Administration). The KF scheme(1990) is one of CPSs which have developed for mesoscale model. It has been used successfully for many years in the PSU/NCAR mesoscale model and more recently has been incorporated into various other models(Wang and Seaman 1997; Kuo et al. 1996; Black 1994; Bechtold 2001).

However, RDAPS shows some problems for forecasting precipitation which overestimate light precipitation of under 1 mm but underestimates heavy rainfall of above 10mm. This problems are similar to a common criticism from users of the KF scheme(1990).

A systematic bias revealed in the RDAPS means that it produces widespread light precipitation because of easily activating deep convection in marginally unstable environments, so that weak instability in the atmosphere reduced by light precipitation(Kain 2002). Perhaps as a consequence, it tends to under-predict maximum precipitation amount within the precipitation area.

To improve the KF scheme(1990)'s forecasting skill, several different components of the KF scheme have been changed in recent years by feedback from numerical modelers who use the scheme(Kain 2001). In the modified KF scheme, the systematic bias are corrected and also the shallow convective cloud effect is included.

The purpose of this paper is to revise the systematic bias for forecasting precipitation and the predictability for convective precipitation occurring in short time when the modified KF scheme is adopted as operati -onal convective parameterization scheme in the RDAPS.

2. The description of RDAPS

The RDAPS based on the PSU/NCAR MM5 has run as the operational model twice a day, 00UTC and 12UTC since June 1999 and has analyzed by 3-D optimal interpolation method since November 2002.

Table 1 shows the configuration of the RDAPS. The RDAPS is triply nested-grid model with horizontal grid resolution of 30km, 10km and 5km, and has vertically 33 layers. The RDAPS of 30km is analyzed by 3-D optimal interpolation method, and uses FDDA during 12 hours for reducing initial problem of model. The Reisner microphysics scheme is used for the microphysical parameterization, together with cloud-radiation scheme and MRF planetary boundary layer scheme. The KF scheme(1990) is also adopted in the RDAPS of 30km and 10km.

Table 1 Configurations for RDAPS (30-10-5km)

	Regional model	High resolution model	
Dynamics	non-hydrostatic		
Horizontal resolution	30km	10km	5km
Vetical Layers	33/50hPa	33/50hPa	33/50hPa
Time steps	75 sec	30 sec	15 sec
forecast times	48 hr	24 hr	24 hr
Initialization	FDDA(12hr)	1-way interaction	
explicit scheme	mixed-phase (Reisner)		
cumulus scheme	Kain-Fritach		No
PBL scheme	MRF		
Radiation scheme	Cloud Radiation		
Soil scheme	5-layer Soil		

3. Experiment and result

To investigate an effect of the new KF CPS on the RDAPS of KMA, we run two experiments, CNTL and NEW. Here, the NEW is to use the new KF CPS for convective parameterization and CNTL is to use the old KF CPS.

For case study, we selected a number of heavy rainfall events. In the case of 5-7 August 2002, the Korea Peninsular was effected by the cP(continental polar) and mT(maritime tropical) system.

Fig. 1 shows the observed precipitation distribution from AWS(Automatic Weather Station) during 0500UTC-0700UTC August 2002. for the period of 0500UTC-0600UTC August 2002, the rain band is located in the Seoul and Kyung-ki province(Fig. 1(a)).

It slowly moves to a southward of the Korea Peninsular, therefore, there is large precipitation in the middle region of the Korea Peninsula during 0600UTC-0700UTC August 2002(Fig. 1(b)). Moreover, for the period of 0700UTC-0800UTC August 2002 the main rain belt is located on the region from south-west to north-east of the Korea Peninsula(Fig. 1(c)). Consequently, during this periods rainfall is recorded more than 200-500mm all over Korea peninsula.

(a) 0500UTC-0600UTC (b) 0600UTC-0700UTC (c) 0700UTC-0800UTC

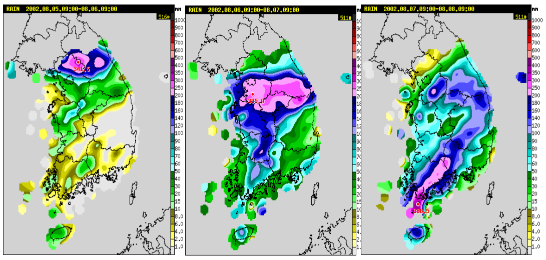

Fig. 1. The rainfall distribution observed from KMA AWS network during 0500UTC - 0700UTC August 2002

Fig. 2 shows the 24-h accumulated precipitation field simulated from two experiments, CNTL and NEW. The analysis time is from 0500UTC to 0600UTC August 2002 for the forecasted filed at 12UTC 4 August 2002. For the same period with analysis time, rainfall was recorded more than 200mm in Seoul and Kyung-ki province in a short time(Fig. 1(a)). The result indicates that the maximum precipitation amount is about 120mm(Fig. 2(b)) for NEW, and precipitation amount increases all over precipitation area. But for CNTL one is merely 50% of NEW. Although the maximum rain amount is still smaller than observed one for this event, the amount and band location as well as initiation time of precipitation are closer to the observation than CNTL.

To verify the predictability of the RDAPS that contains the new KF CPS, the NEW experiment had been run twice a day from 11 to 31 July 2001. This period includes most of heavy precipitation events occurred in 2001.

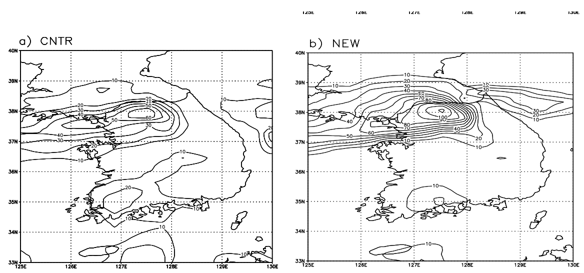

Fig. 2. The simulated 24-h accumulated rainfall rate in the (a) CNTL and (b) NEW.

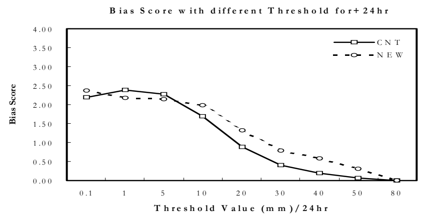

Fig. 3. The averaged bias score(BS) as a function of threshold for the 24-h forecast time. The threshold values are various from 0.1 to 80mm.

Fig. 3 shows the averaged bias score(BS) as a function of threshold for the 24-h accumulated rainfall during 11-31 July 2001. The threshold values are various from 0.1 to 80mm. The figure shows that the BS is lower than 1.0 in all of two experiments for the threshold over 30mm, but the NEW's BS is higher than the CNTL's. Although for light precipitation(under 5mm) the BS is greater than 1.0 in all of two experiments, the NEW's BS is lower than CNTL. This means that the new KF CPS is effective on decreasing the wide light-precipitation and increasing the heavy precipitation.

4. Summary

In this paper, we understand an impact of the new KF CPS in the RDAPS of KMA. For using the new KF CPS, the maximum precipitation amount increases about 80% than one from the operational run. Also we found that the systematic bias behavior revealed in the old KF CPS, the over-estimation for light-precipitation and the under-estimation for heavy precipitation, could be improved by the new KF CPS. Since December 2002, the RDAPS that contains the new KF CPS has been run twice a day in a semi-operational mode.

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