Graupel effect on precipitation amount in KMA Regional models

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1. Introduction

The Korean Peninsula is surrounded by sea on three sides and has most of precipitation in summer season. During the last decade observed data have shown increasing trend in its frequency and amount. So, precise forecast of rainfall event becomes more important in order to prepare for an impending event.

The location and time as well as the amount of precipitation depend on the used numerical model and its grid spacing. Recently in order to improve the performance of rainfall forecast, more effort has been put on constructing initial conditions which better represent meso-scale features, together with improved moist physics. So, we investigated graupel effect of Reisner microphysics scheme on precipitation in KMA regional models.

2. Model Descriptions

Three kinds of non-hydrostatic regional models based on the PSU/NCAR MM5 have been operating on KMA supercomputer(NEC SX-5) since June 1999. These regional models are multiply nested with horizontal grid resolution of 30km, 10km and 5km, and have been running operationally twice a day in RDAPS(Regional Data Assimilation and Prediction System).

As it is shown in Fig. 1, model domain of 30km resolution covers the East Asia on the lambert conformal mapping, while 5km resolution model domain covers the Korean Peninsula.

Table 1 shows the configuration of RDAPS with three horizontal resolutions of 30km, 10km and 5km. The Reisner microphysics scheme is used for the physical parameterization, together with cloud-radiation scheme and MRF planetary boundary layer scheme. The Kain-Fritsch cumulus scheme is also adopted in 30km and 10km grids.

New pre-processing module developed by KMA produces the initial fields for regional model of 30km grid spacing using direct interpolation from global sigma levels to regional sigma levels. These fields are then analyzed by 3-D optimal interpolation method.

3. Model Simulations

To investigate the graupel effects on precipitation forecast, two runs were compared in this paper, CNTL and RSN2 runs. The only difference between these two runs was microphysics scheme, the RSN2 run used Reisner2 scheme which includes grapuel microphysics.

The rainfall event on 14 July 2001 was studied. Over 200 mm rainfall was recorded during 6 hours in Seoul.

Fig. 2 shows 24-hour accumulated precipitation fields for the 30km resolution runs. Two runs have very similar result. The precipitation amount and precipitation band as well as precipitation initiation time for RSN2 are closer to the observation (not shown). But as it is shown in Fig. 3, vertical cross- sections are somewhat different.

The top left panel of Fig. 3 shows vertical velocity(solid), temperature(dot), and temperature advection (long dash) for the CNTL run. The top middle is same except for ice(solid) and cloud water(long dash). The top right is for snow(solid) and rain water (long dash). The middle panels are same as the top ones except for RSN2 run. Note that graupel(short dash) amount is also shown on the right panel. The bottom two panels show vertical moisture structures over Seoul. On the upper levels with temperature under 0 ℃, CNTL run has more snow and ice than RSN2. On the other hand, RSN2 has larger cloud and rain waters on the lower levels.

Fig. 4 shows the difference in 24-hour accumulated precipitation for 5km resolution. We can see that difference between CNTL and RSN2 is larger in general than that for 30km grid spacing run(Fig.2).

Even though the coarse resolution runs of CNTL and RSN2 produced small difference in precipitation, the higher resolution runs made locally large difference in precipitation amount probably due to the difference in vertical moisture structures between CNTL and RSN2 runs.

4. Summary

According to the results, the graupel microphysics made closer forecasts to observations in such fields as precipitation and initiation time. It was also shown that graupel acts to increase the precipitation amount although precipitation patterns show minor difference.

As the grid resolution increases, the graupel microphysics is found more effective.

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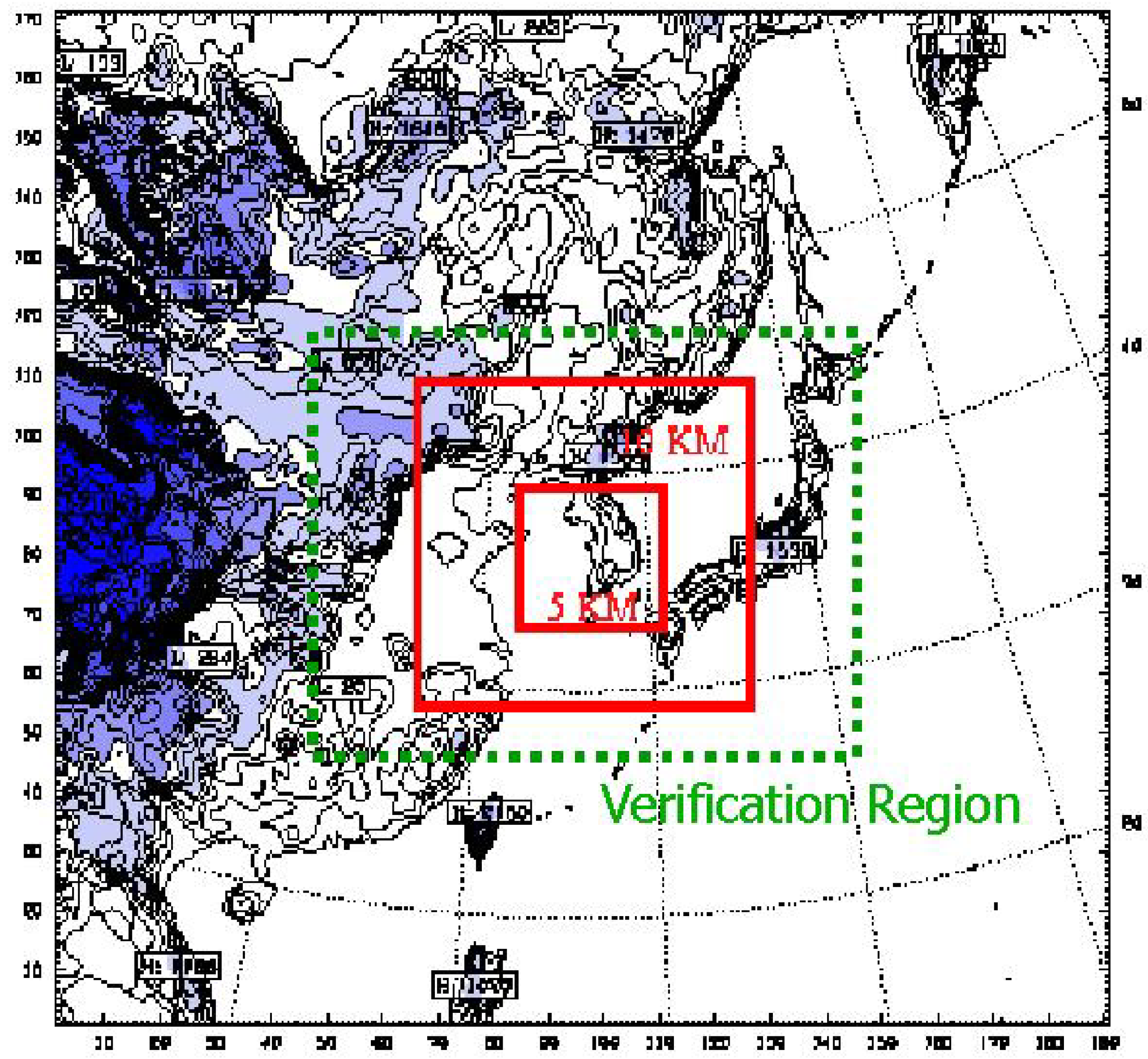

Fig. 1 Model domain and Terrain for RDAPS

	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		

Table 1 Configurations for RDAPS

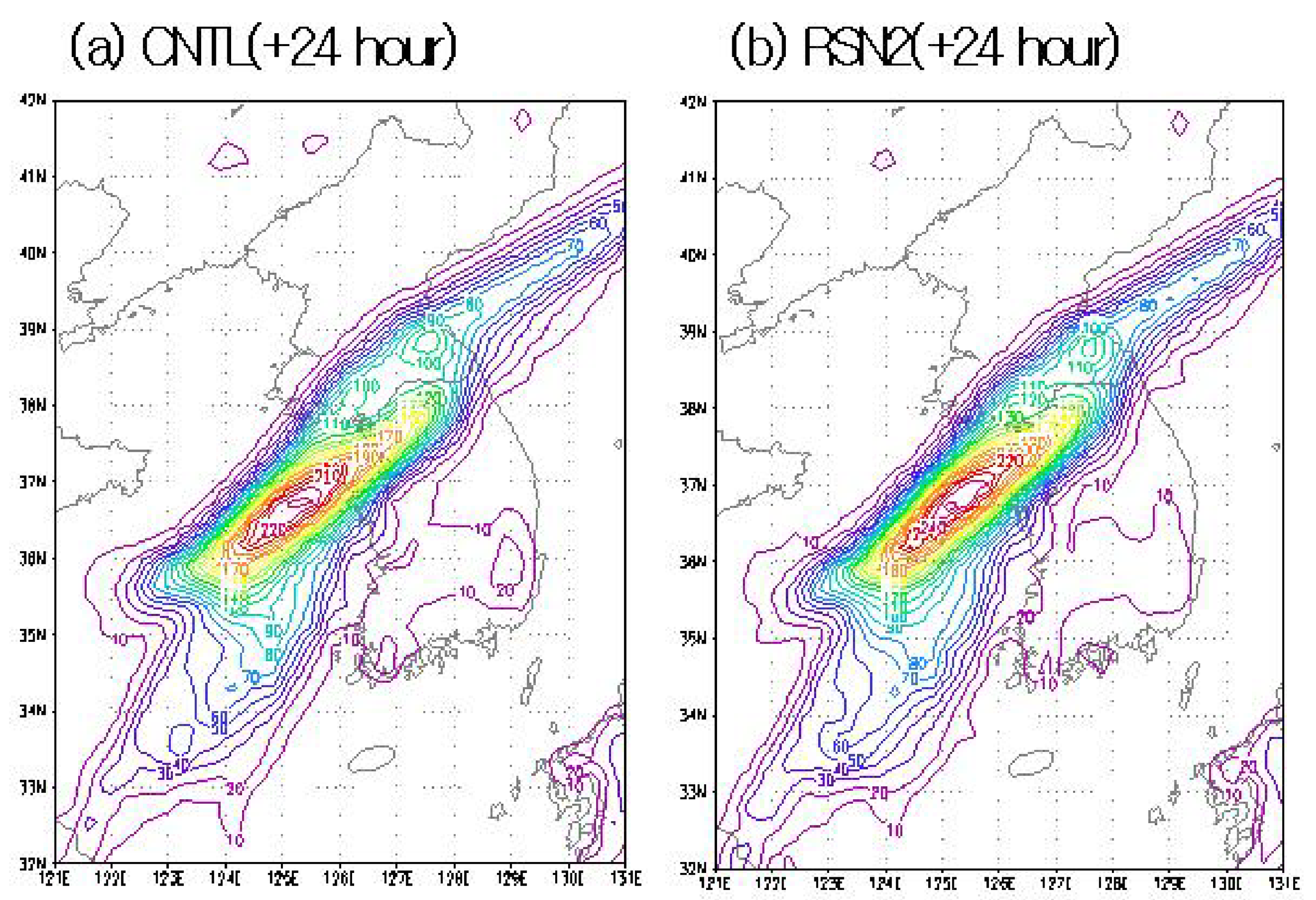

Fig. 2 Accumulated precipitation from 00UTC 14 to 00UTC 15 July 2001 for 30km resolution runs. (unit:mm)

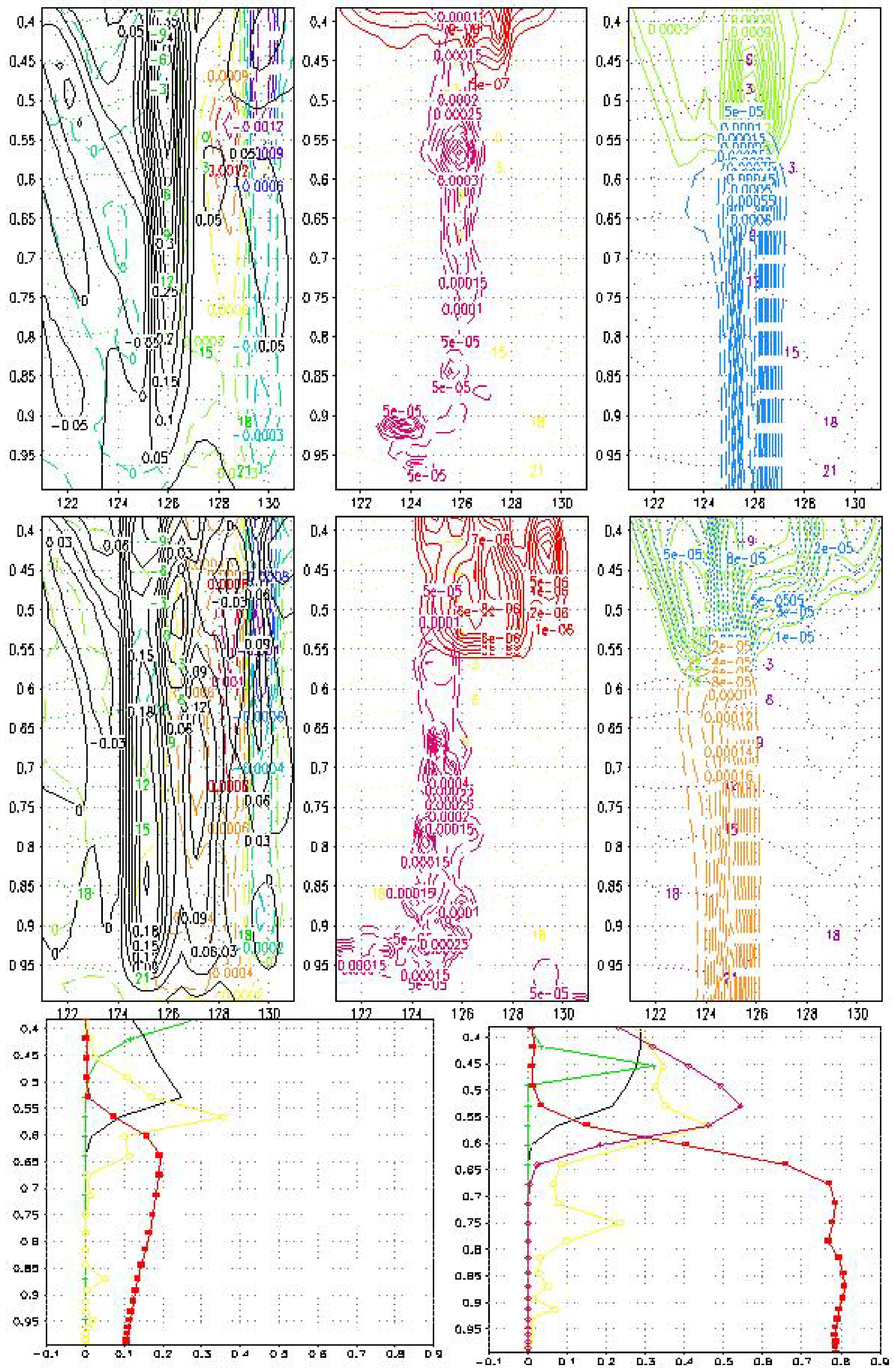

Fig. 3 Vertical cross-section of moisture and other variables. The top and middle panels are vertical-longitude for CNTL and RSN2 runs at 37.5N. Left panel is shown vertical velocity(solid), horizontal temperature advection (long dash) and temperature(dot). In Middle panel, ice is shown by solid and cloud water by long dash. Right is snow(solid), rain water(long dash) and graupel(short dash). The lower panels are vertical moisture structures over Seoul(37.5N, 126.58E). Left and Right panels are for CNTL and RSN2 runs(marks are ice:cross, cloud water:open circle, rain water :closed square, graupel:triangle and none:snow)

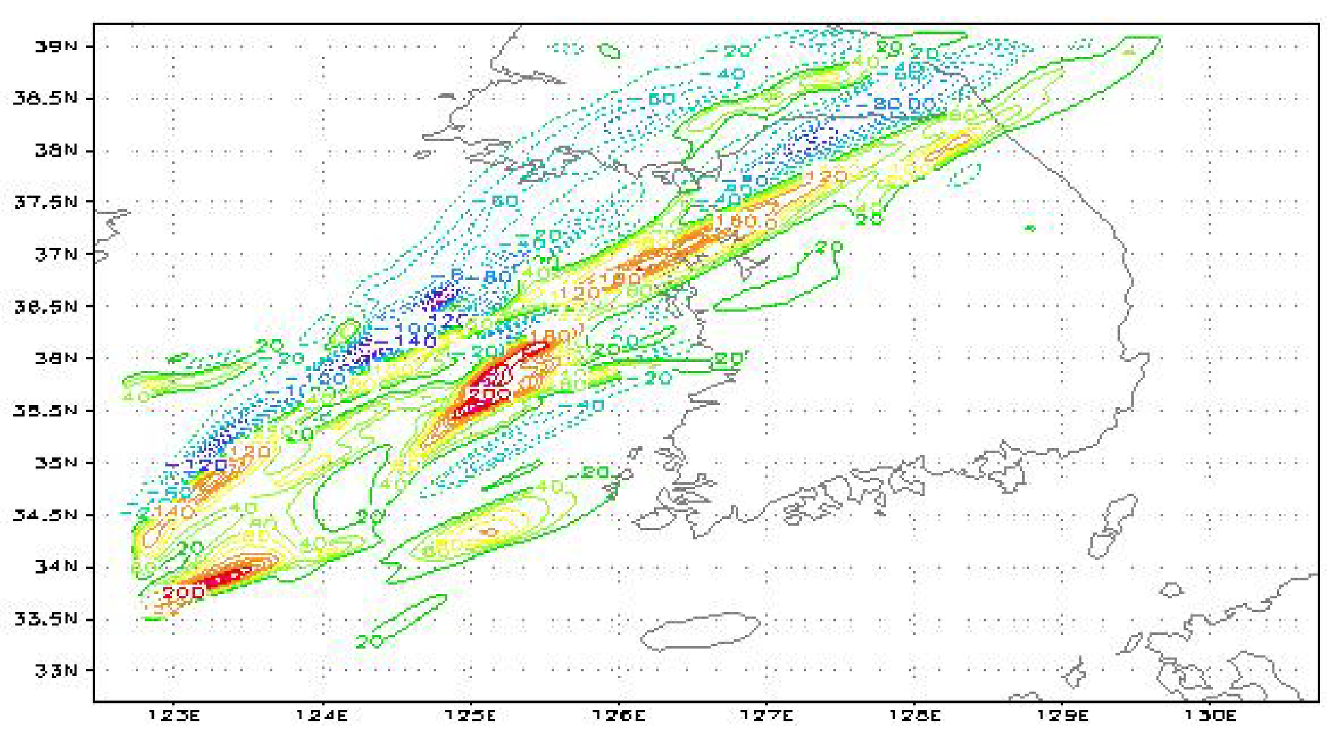

Fig. 4 Difference of accumulated precipitation during 24 hours between CNTL and RSN2 runs for 5km resolution (unit:mm).