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TERRAIN EFFETCS ON THE SIMULATION OF HEAVY RAINFALL OCCURRED AT THE JIRI MOUNTAIN AREA OF THE KOREAN PENINSULA

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1. INTRODUCTION

Topographic features can exert a significant influence on the development and distribution of precipitation. These influences include forced lifting of air parcels over the terrain, convective currents induced by elevated heating of the air surrounding mountain peaks(Kuligowski et al., 1999). And Katzfey said that topography has a strong influence on the amount of precipitation: the peak precipitation is related to topographic slope while the area-averaged precipitation is related to the maximum topographic elevation.

The Jiri Mountain area is located on the southern part of the Korean Peninsula which blocks moist air flows being transported by low level jet and frequently experiences heavy rainfalls. A heavy rainfall occurred on 31 July 1998 had favorable synoptic conditions, which are adequate to examine the terrain effects on the precipitation of the mountainous region.

In this study, we investigated the sensitivity of the MM5 to the different horizontal resolutions of the terrain data by simulating the heavy rainfall case.

2. DATA, MODEL AND SENSITIVITY EXPERIMENT

The NCEP/NCAR reanalyses and synoptic observations are used as initial and boundary conditions for the MM5 model in an attempt to simulate this event and determine the sensitivity of the simulated precipitation to topography. Simulations were performed using a one-way interactive nesting between the coarse grid(81 km) and four fine grids(27 km, 9km, 3km and 1 km).

Two different topographic datasets were used to create the model terrain: the 5 minutes global USGS(the United State Geological Survey) DEM(Digital Elevation Model) and the 3 seconds DEM for the Korean Peninsula. The 3 seconds ultra-high resolution data was used for realistic terrain features. The simulation using the 5 minutes dataset will be called L-Topo, and that using topography derived from the 90 m dataset will be denoted H-Topo. More specified experiment design is shown in Table 1.

3. RESULTS

The L-Topo topography does not adequately capture the Jiri Mountain, with maximum height of only 992 m. The H-Topo model topography better resolves the Jiri Mountain, with a maximum height of 1550 m(see Fig. 1).

The 12-h accumulated precipitation for simulation L-Topo and H-Topo is shown in Fig. 2. The largest rainfall amounts were 50.5 mm and 96.8 mm for L-Topo and

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H-Topo. And the horizontal pattern of the fine minus the coarse terrain elevation was similar to the horizontal distribution of the corresponding precipitation difference(Fig. 3). The condensation heating matched very well cloud mixing ratios near the surface in the vertical section crossing the heavy rainfall area(Fig. 4). This implies that the precipitation in the H-Topo is strengthened due to the orographic lifting.

4. CONCLUSIONS

Our simulation showed more rainfall amount in the H-Topo due to the enhanced lifting by the realistic terrain. The rugged terrain seemed to play a crucial role in the development and distribution of the precipitation on the mountainous region.

Although this study is quite preliminary to investigate the complex mechanism which topographic effects on precipitation, it is evident that, the topographic features can influence the amount and distribution of precipitation. Additional verification of the simulated precipitation using observed station is currently underway. A future study will investigate the more detailed analyses on thermodynamical structures of this heavy rainfall system for each nesting domain.

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REFERENCE

Alpert, P. and S. O. Krichak, 1996: The Relative Roles of Lateral Boundaries, Initial conditions, and Topography in Mesoscale Simulations of Lee Cyclogenesis. *J. Appl. Meteor.,* **35**, 1091-1099.

Barros A. P. and R. J. Kuligowski, 1997: Orographic Effects during a severe Wintertime Rainstorm in the Applachian Mountains. *Mon. Wea. Rev*: **126**, 2648–2672.

Chen C-S., W-S Chen and Z. Deng, 1991: A Study of a Mountain-generated Precipitation System in Northern Taiwan during TAMEX IOP 8, *Mon. Wea. Rev.*, **119**, 2574-2606.

Dudhia, J., D. Gill, k. Manning, and W. Wang and C. Bruyere, *PSU/NCAR Mesoscale Modeling System Tutorial Class Notes: MM5 Modeling System Version 3*, 320 pp., Natl. Cent. for Atmos. Res., Boulder, Colo., 2003.

Guo, Y-R., S. Chen, Terrain and Land Use for the Fifth-Generation Penn State/NCAR Mesoscale Modeling System(MM5): Program TERRAIN, 114 pp, Natl. Cent. for Atmos. Res., Boulder, Colo.,1994.

Katzfey, J. J., 1995: Simulation of extreme New Zealand Precipitation Events. Part Ⅰ: Sensitivity to topography and Resolution. *Mon. Wea. Rev.*, **123**, 737-754.

Katzfey, J. J., 1995: Simulation of extreme New Zealand Precipitation Events. Part Ⅱ: Mechanism of precipitation Development. *Mon. Wea. Rev.*, **123**, 774-775.

Kuligowski, R. J. and A. P. Barros, 1999: High-resolution short-term quantitative precipitation forecasting in mountainous regions using a nested model., *J. Geophys. Res.,* **194**, 31,553-31,564

Mass, C. F., D. Ovens, K. Westrick, and B. A. Colle, 2002: Does increasing horizontal resolution produce more skillful forecasts? Bull. Amer. Meteor. Soc., **83**, 407-430.

Richard, E., N. Chaumerliac and J. F. Mahfouf and E. C. Nickerson, 1987: Numerical Simulation of Orographic Enhancement of Rain with a Mesoscale Model, J. Clim. Appl. Meteor., 26, 661-669.

Smolarkiewicz, P. K., R. M. Rasmussen

and T. L. Clark, 1988: On the dynamics of Hawaiian Cloud Bands: Island Forcing. *J. Atmos. Sci.*, **45**, 1872-1905.

Table 1. Summary of an experiment modeling system used in this study.

	Domain1	Domain2	Domain3	Domain4	L-Topo	H-Topo
Horizontal grid spacing	81 km	27 km	9 km	3 km	1 km	
Horizontal Dimension	67*57	67*58	82*67	91*79	76*64	
Time step (sec)	200 s	72 s	20 s	8 s	3 s	
Terrain Data Resolution	30min (~56 km)	5min (~10km)	5min (~10 km)	5min (~10 km)	5min (~10km)	3sec (~0.09 km)
Vertical layers/Top	39 sigma layers / 50 hPa					
Lateral B.C.	Relaxation					
Vertical B.C.	Radiation					
Grid-resolvable precipitation	Simple Ice					
Cumulus Parameterization	Grell	Kain-Fritsch	None			
Shallow Conveticon	None					
Planetary Boundary Layer	Burk-Thompson					
Radiation	Cloud Radiation					

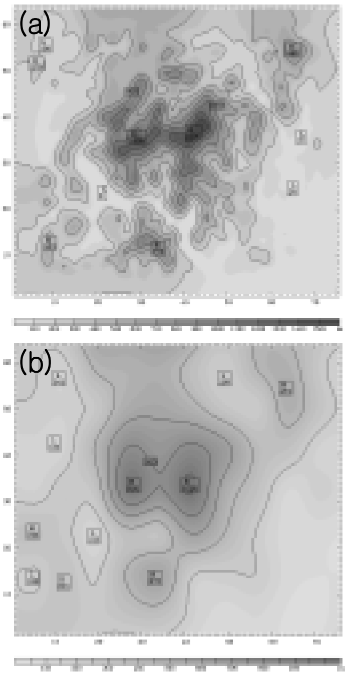

Fig. 1. Model terrain elevation for L-Topo(a) and H-Topo(b) for the 1 km domain run with 200 m interval.

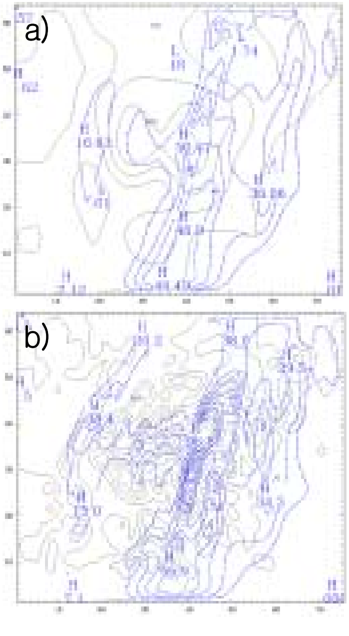

Fig. 2. 12 hour accumulated rainfall amount in 1 km domain run. a) is for L-Topo and b) is for H-Topo.

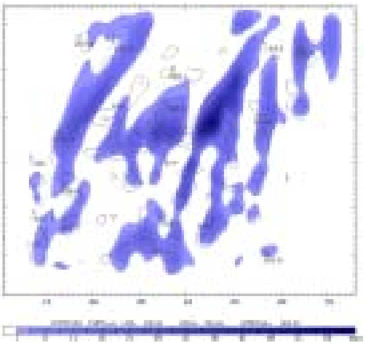

Fig. 3. Difference of terrain height and rainfall amount between L-Topo and H-Topo. Contour lines represent the difference of terrain height with 200 m interval. Shading represent difference of rainfall amounts [mm].

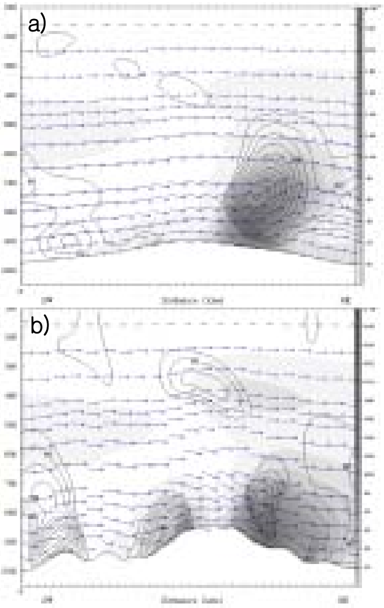

Fig. 4. Rain Water mixing ratio and vertical velocities in an southwest-northeast cross section passing the peak of Jiri mountain at 18 UTC July 1998 for L-Topo(a), H-Topo(b). Shading represent rain water mixing ratio using g/kg units and the contour line represent the vertical velocities with 30 cm/s interval. Circulation wind vector also is superimposed.