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# A Study on the Characteristics of Heavy Rainfalls in Chungcheong Province using Radar Reflectivity

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## Abstract

This paper describes the detailed characteristics of heavy rainfall events occurred in Chungcheong province on 15 and 16 April and from 6 to 8 August 2002 based on the analysis of raingauge rainfall rate and radar reflectivity from the METRI 's X-band Weather Radar located in Cheongju. A synoptic analysis of the case is carried out, first, and then the analysis is devoted to seeing how the radar observes the case and how much information we obtain. The highly-resolved radar reflectivity of horizontal and vertical resolutions of 1 km and 500 m, respectively shows a three-dimensional structure of the precipitating system, in a similar sequence with the ground rainfall rate. The radar echo classification algorithm for convective/stratiform cloud is applied. In the convectively-classified area, the radar reflectivity pattern shows a fair agreement with that of the surface rainfall rate. This kind of classification using radar reflectivity is considered to be useful for the precipitation forecasting. Another noteworthy aspect of the case includes the effect of topography on the precipitating system, following the analysis of the surface rainfall rate, topography, and precipitating system. The results from this case study offer a unique opportunity of the usefulness of weather radar for better understanding of structural and variable characteristics of flash flood-producing heavy rainfall events, in particular for their improved forecasting.

**Key words :** precipitation system, radar



가

가

2.

2002 4 15

~ 16 8 6 ~ 8

(, 1999; ; 2000,

, 2002).

, GMS

2002 4 8

(Meteorological Information System; MIS)

가

. AWS

44

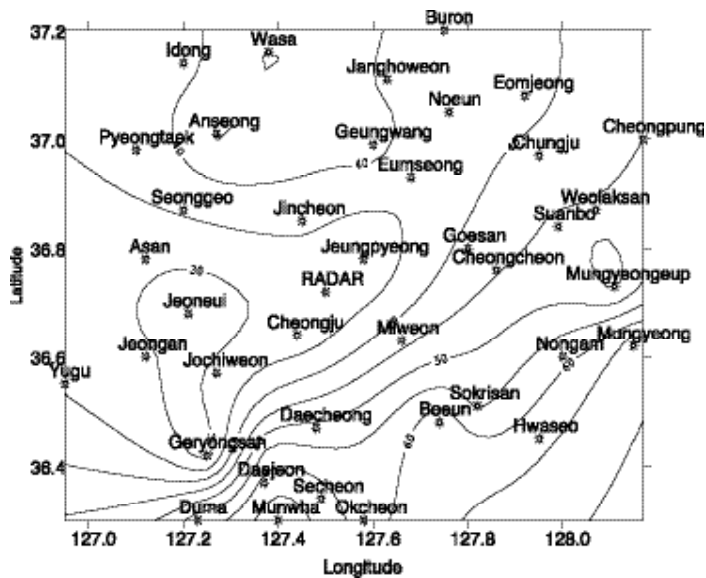
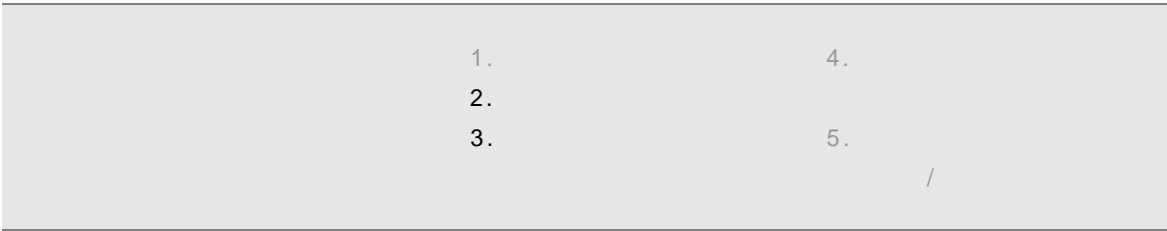


Fig. 1. Distribution of precipitation amounts during 2300 KST 15 to 1200 KST 16 April 2002 around Cheongju radar site.



- 1.
- 2.
- 3.
- 4.
- 5.

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가

가  
X-band

가      가      가

2002 4 15 23      16 14      15      가

8 6 10      8 17      4 16 09      가

60 km      38°

SPRINT      가      300 hPa

(NCAR, 1999)

1 km,      0.5 km      (grid)

가      (echo band)      4 16

21      가

3.      4 15 19

3.1 2002 4 15 ~ 16      가      16

30.0 mm      Fig. 2

a)      Fig. 3

2002 4 15 09

가      72.5 mm      69.5

850 hPa      mm,      36.0 mm      가

(moist flux)

24      96.0 mm

300 hPa      1      16

(Polar Jet)가      09 ~ 10      16.0 mm

15.5 mm

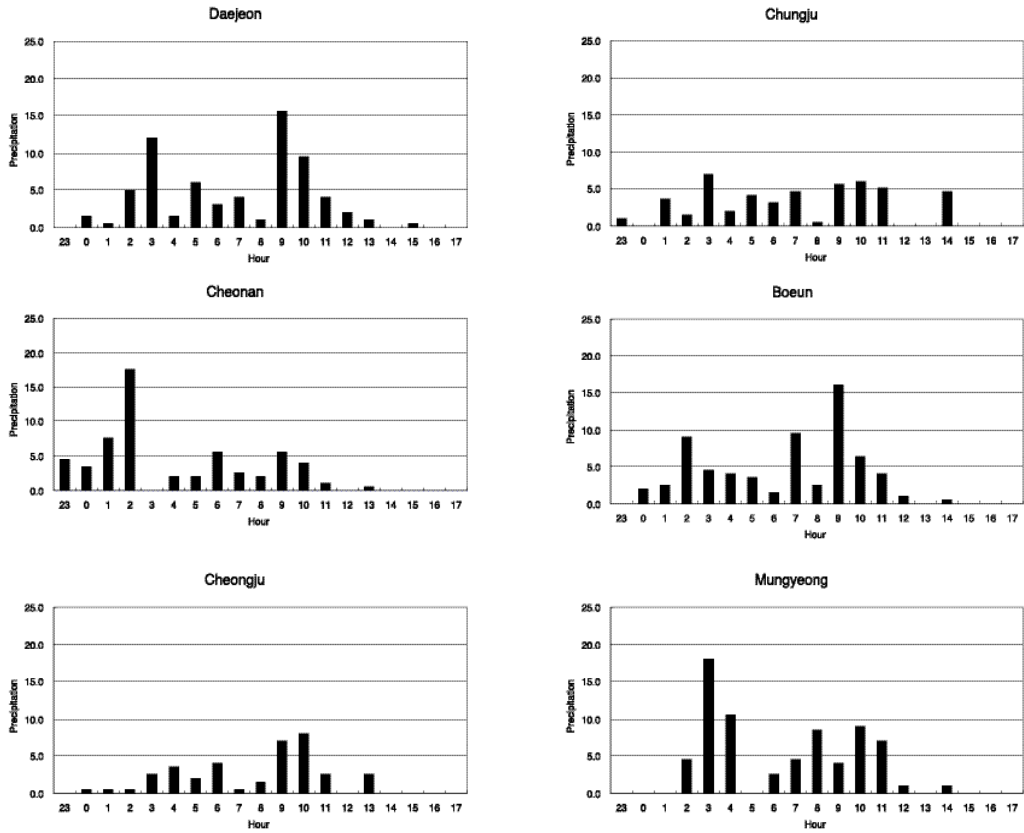


Fig. 2. Hourly precipitation amounts of several synoptic stations near Cheongju from 2300 KST 15 to 1700 KST 16 April 2002.

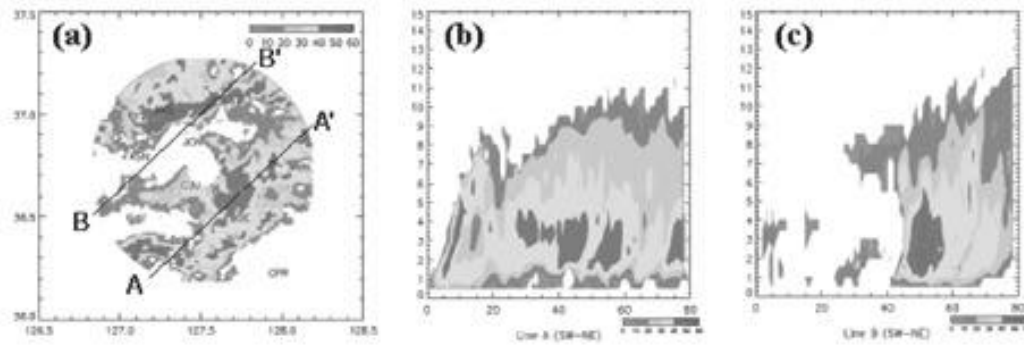


Fig. 3. The radar reflectivities of 3 km (a), cross section A-A'(b), and cross section B-B'(c) on 0200 KST 16 April, 2002.

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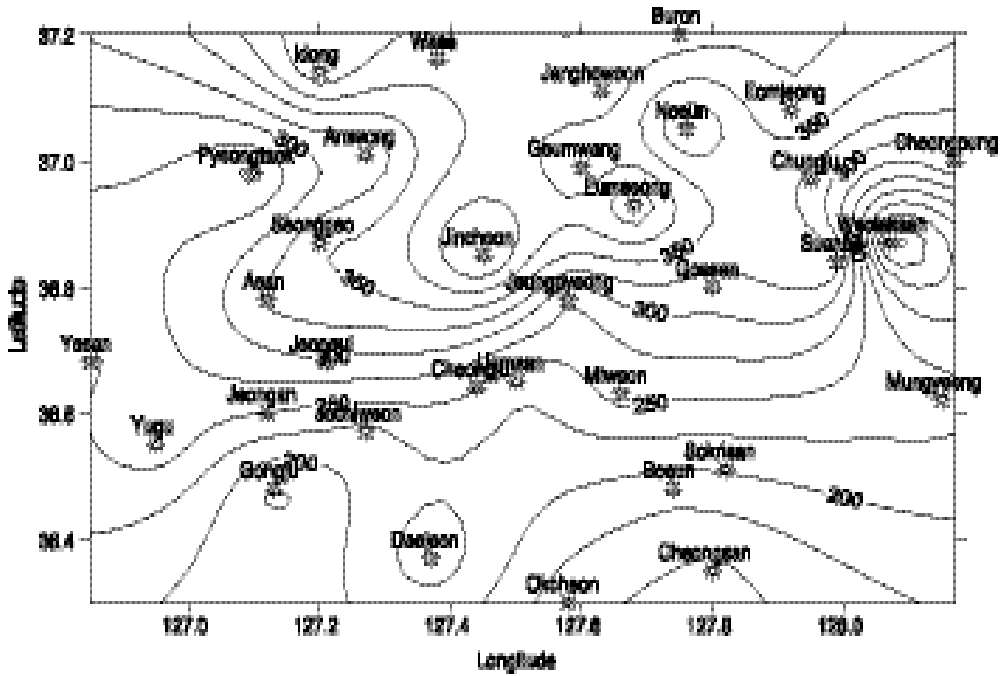


Fig. 4. Same as Fig. 2. except for 0000 6 KST to 0000 8 KST.

30.5 mm  
 10 ~ 11  
 20.5 mm 가 가  
 16 12  
 16  
 700 hPa ( 3 km )  
 15 ~ 20 m/sec  
 b) 가  
 60 km 가 bright band가

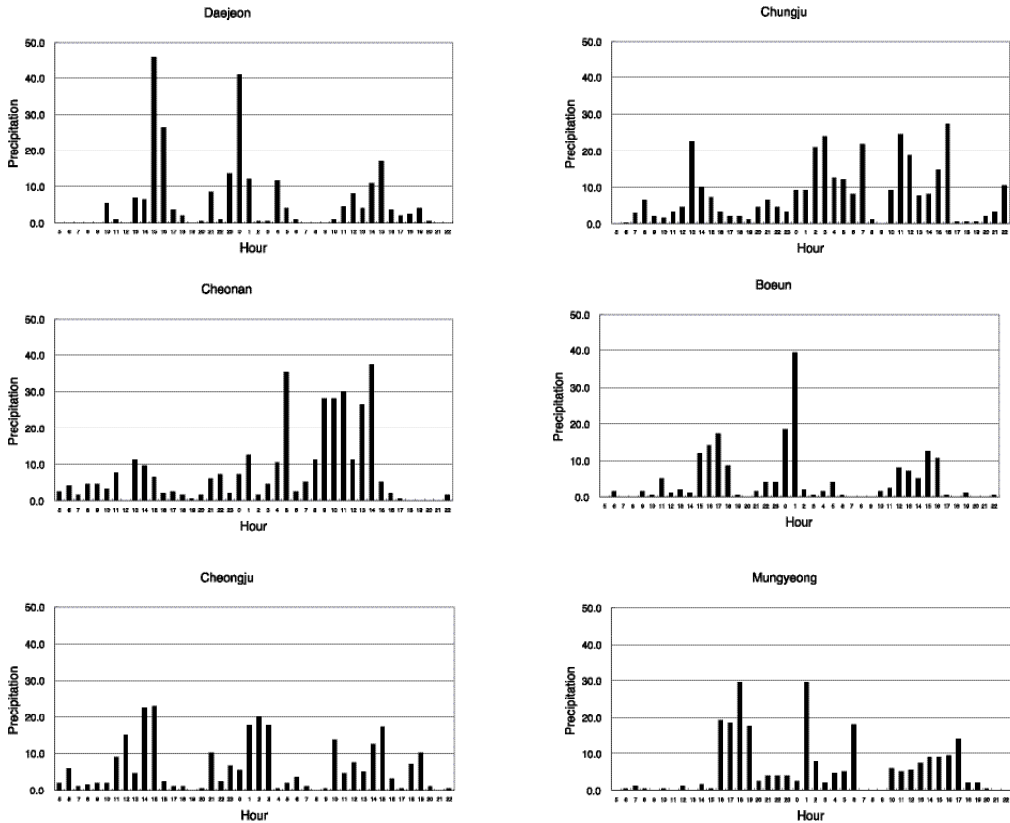
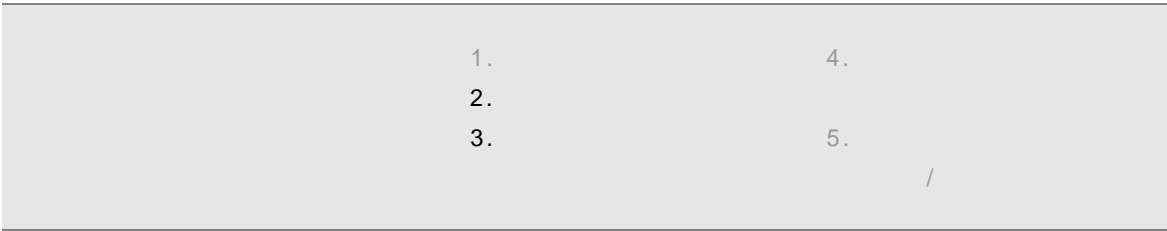


Fig. 5. Same as Fig. 3. except for 0500 KST 6 to 2300 KST 7 August 2002.

3 km 가  
 700 hPa 0 ( , 2000)  
 GPM 3,000 ~ 3,200 m , 9 ~ 10 km  
 20 dBZ 가 40 dBZ  
 9 km . 40 dBZ 20 km 가  
 2 ~ 5 km 3 km (Fig. 4).  
 bright band



1.  
2.  
3.

4.  
5.

/

3.2 2002 8 6 ~8

46.0 mm

3

a)

200 mm

가

가

8 6 ~7

Fig. 6

Fig. 7

4

가  
6 ~7

8

가

8 6

가

가

b)

가

8 6 ~7

12

KAMMUR가

가

band  
4

가

3~4 km

bright

가

12~13 km

30 dBZ

2~6 km

4

2002 8 6

가

가

8

3

353.5 mm ,

337.5 mm

273.0 mm,

254.3 mm

8 6

7

가

7 12

(1)

가

~13

, (2)

가

, (3)

38.0 mm

, 13 ~14



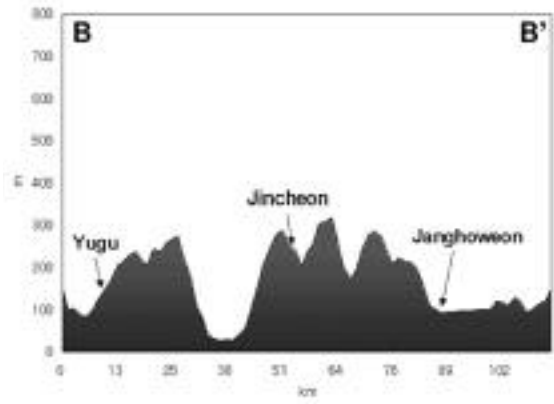
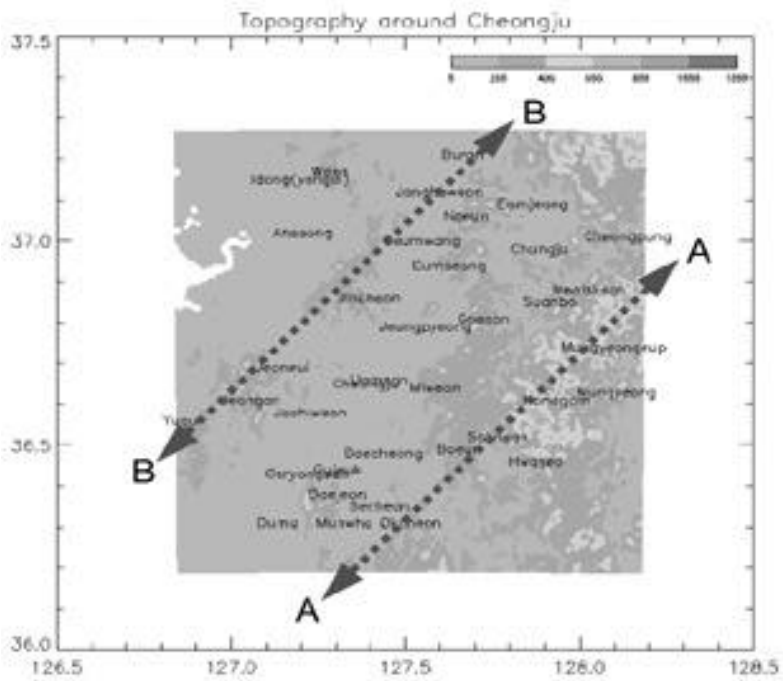


Fig. 8. Topography around Cheongju radar site.

1.	4.
2.	
3.	5.
	/

(moist tongue) 가 , (4) 1,058 m , 1,097 m  
 가 , (5) 1,000 m 가

4 15 ~ 16

가 . 8 6 ~ 8

4.

4.1

127 30 36 43 , ( A)  
 51 m B) ( )  
 60 km 가 A  
 200 m B  
 400 m 200  
 m (Fig.  
 8).  
 699 m , 613 m  
 4.2  
 가 400 m ~



가  
Z-R Steiner

You(2003)가

(Wilson and Brandes,  
1979).

1 1

Steiner and Listimaa Biggerstaff

Fig. 9 Steiner 1.5 km

(Zawadski, 1975; Rosenfeld et al, 1994).

(2002) Window

Rosenfeld et al. (1995),  
Steiner et al. (1995) Biggerstaff and  
Listemaa (2000)

가 가 가

가 X-band  
8 km

Steiner et al. (1995) 1.5 km, 3

50 km

and Listemaa(2000) Steiner  
가 Biggerstaff

가 (Fig. 10).

3

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AWS  
1

가

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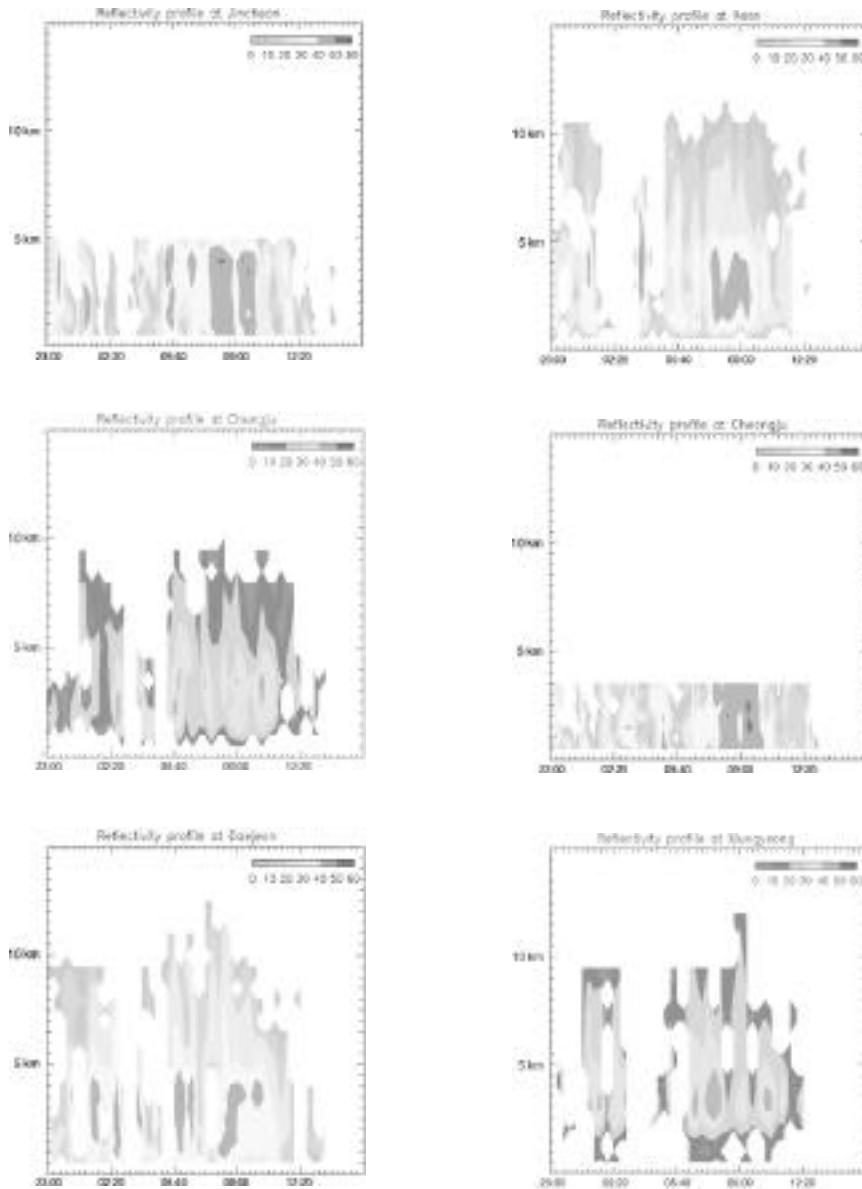


Fig. 10. Time cross section of radar reflectivity at several weather station from 2300 KST 15 to 1500 KST 16 April, 2002.



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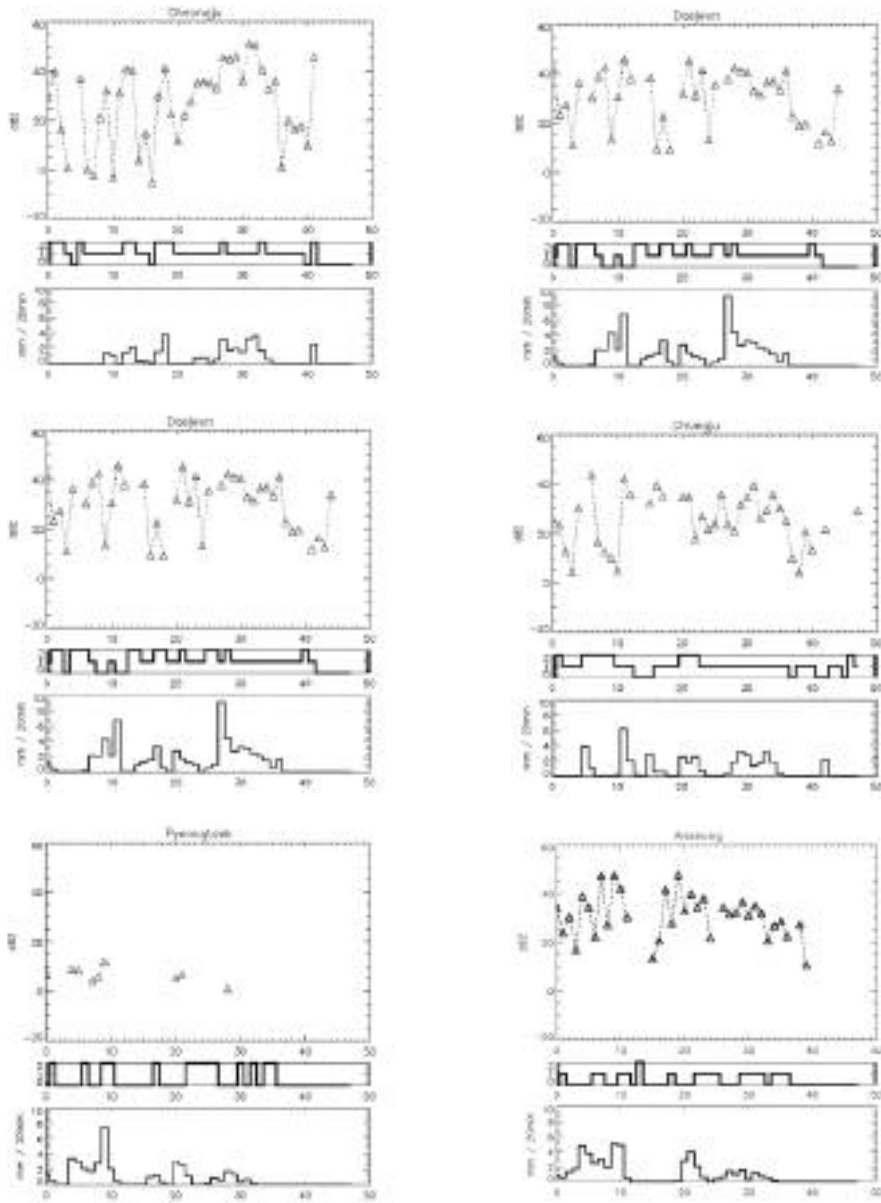


Fig. 12. Time series of radar reflectivity at 1.5 km, echo classification by Biggerstaff and Listimaa(2000) and 20-min rainfall in several stations.

Listimaa(2000) and 20-min rainfall in several stations.

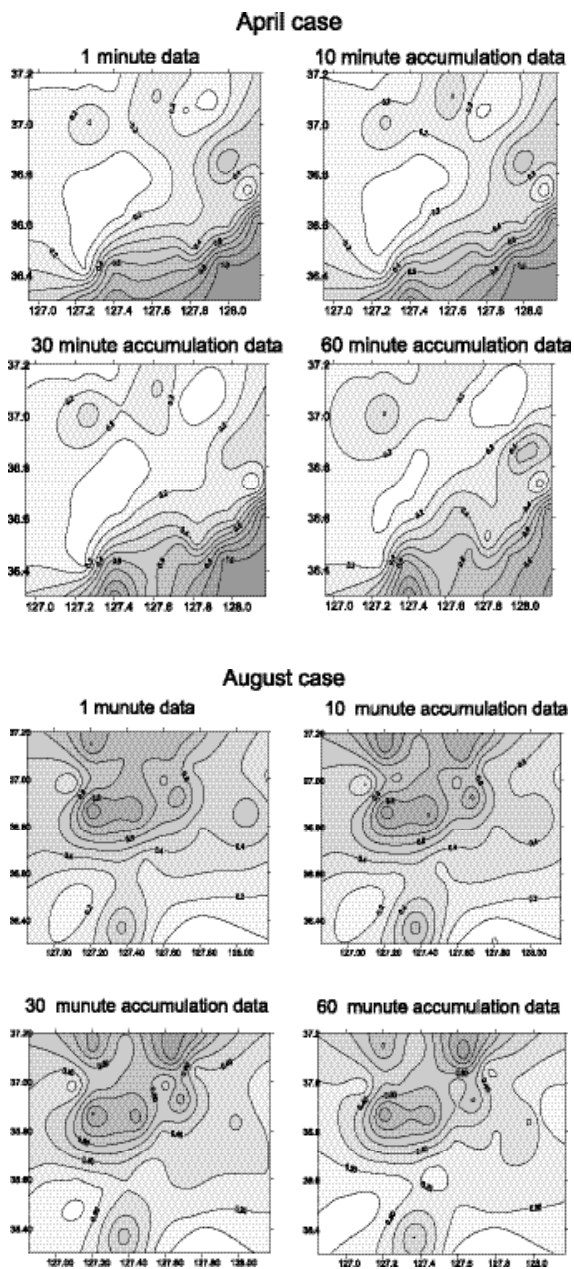
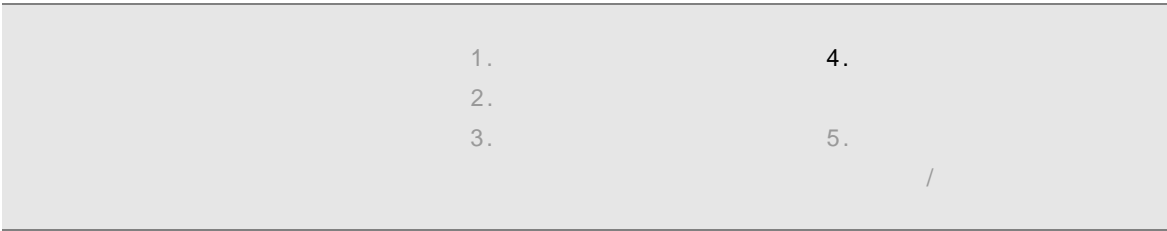


Fig. 13. Spatial distribution of variance of precipitation time series of two heavy rainfall case.



20

, 20 . 2002 8 31 9 1

RUSA가  
870.5 mm

가 가

20 dBZ

( ,  
2002). 가

1

(time lag)  
44

4.3

. 4 4 15 23  
~ 16 11 12 1  
10 , 20 , 30 , 1

가

Sawyer(1959)

3가

. 8 8 6 0 ~ 7  
24

(normalize)

(Fig. 13). 4 8

(1978)

(1994)

가

(2000)

가



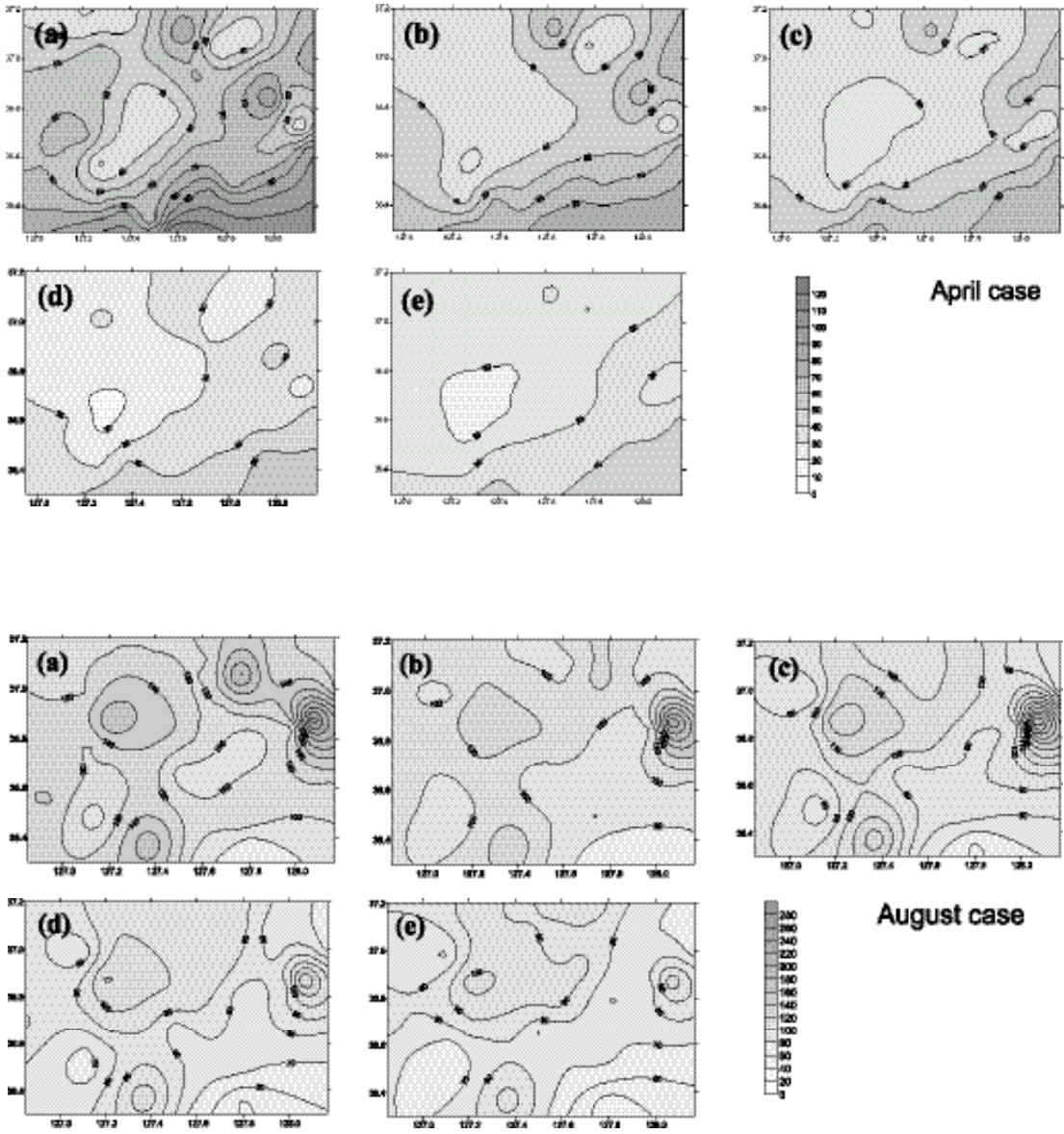


Fig. 14. Distribution of time rate of average rainfall intensity(mm/hr) (a) 1 (b) 5 (c) 10 (d) 20 and (e) 30 minutes.

1.	4.
2.	
3.	5.
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( , 1999). (2000) 가 30 가 4 10 8 가 . 가 (1999) 1998 8 12 가 50 mm 가 가 5 , 10 , 20 , 30 , 60 , 2 (Fig. 14). 100 km 100% 5 ) 1 가 1 8 4 4~5 가 X-band 가 가 가



가 가

, 1999:  
, pp.120.  
, 2002: 15 (RUSA)  
, pp.47.  
, 2000:  
36 , 4 , pp.441-454.  
, 1999:  
, pp.101.  
, 2002: WPMM  
, 1. 1998  
DWSR-88C Ze-R  
, 5  
1 , pp.25-36.  
, 1999:  
가  
, 1999  
, pp.323-325.  
, 2002:  
, pp.148.  
, 2000:  
“  
” 21  
” , 33 , 2 ,  
“  
( 1-3-1)  
, 2000:  
, J. Kor. Data  
Analysis Soc., Vol.2, No. 4, pp.465-475.

1. 4.  
2.  
3. 5.

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- , 1999: method for rainfall measurements with radar, J. Appl. Meteor., Vol. 33, pp. 682-693.
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