(15)

Ljubljana
1984

WORLD METEOROLOGICAL ORGANIZATION

LECTURES
PRESENTED AT
THE

SEMINAR ON RADAR METEOROLOGY

ERICE, 4-14 October 1982

WMO - No. 626

Secretariat of the World Meteorological Organization - Geneva - Switzerland

SOME RADAR MEASUREMENTS IN THE NORTH ADRIATIC SEA

Bojan Lopovscak

Hydrometeorological Institute
Zagreb, Yugoslavia

Summary

Cumulus clouds observations over the area of Istra (the north Adriatic sea) were made with 3MK7 radar from May 10 to June 21, 1979. The measurements showed that the accumulation zone of cumulus clouds over Istra was of larger vertical spread than over NW Croatia.

On the basis of photo-documentation of radar measurements the frequency distribution map of cumulus clouds occurences was made.

1. INTRODUCTION

Radar measurements were made during the GARP intensive observation period, in Istra, near Pazin from May 10 to June 21, 1979.

Istra is a peninsula situated in the north part of the Adriatic sea surrounded by the gulf of Trieste in the north and Kvarner in the south. On the NE side of the peninsula are the mountain ridges called Cicarija and Ucka.

From the climatological records it is known that in May and June there is a great frequency of thunderstorm appearance over Istra.

Equipment in the radar centre was one S band radar 3MK7, radio sounding and wind finding radar, optical theodolyte for pilot balloon tracking and meteorological station.

Radar 3MK7 is equipped with standard A and PP indicators and with IF attenuator (with f dBZ steps).

The maximum range of radar was 61 km and the maximum measuring range 33 km.

The attenuator is used to attenuate the reflected signal and high reflectivity zone is determined. The accumulation zone is defined as the zone of isoecho 10 dB below maximum reflectivity.

Standard parameters of Cb clouds which are in operational hail suppression programmes in Croatia (Gelo 1976) are determinated every 5 minutes.

For careful determination of cloud characteristics the photographs of PPI scope were made at constant intervals.

The photo-documentation of radar echos was done for the first time in Croatia and the quality of filmed material is good enough for the analysis of movements and locations of Cb clouds.

2. RADAR MEASUREMENTS ANALYSIS

Measurements are carried out in order to define space and time coordinates of cloud parameters, as well as their horizontal distributions and vertical profiles.

Measurements were made in the following order:

- time of measuring,
- azimuth of maximum echo intensity,
- elevation of maximum echo intensity,
- distance of maximum echo intensity,
- value of maximum echo intensity in dB,

- horizontal spread,
- elevation of high reflectivity zone,
- distance of high reflectivity zone,
- elevation of cloud top,
- distance of cloud top.

By constant measuring of parameters the data of cloud evolution and direction and speed of its movements were determined. From the measured parameters of elevation and distance were computed the height of maximum intensity H_{zmax}, the top of high reflectivity zone H_{vz} and the top of the cloud H_v above sea level.

$$H_i = H_R + d_i \sin e_i \qquad (1)$$

The meaning of the symbols is:

H - height, H_R - radar antenna height above sea level, e - elevation, d - distance, i - index (meaning: zmax, vz or v).

Physical indication: H_{zmax} - zone of maximum water content, H_{vz} defined by n_{max} - 10 dB is accumulation zone, i.e. the zone of hailstone growth, H_v echo top determines vertically the clouds spread but it does not correspond to the visual cloud top. During the measuring period of 43 days, 20 days showed radar echos. The total number of measured clouds cells was 359, from which 149 were selected for analysis. The measurement made in Istra were compared to those made in NW Croatia - Puntijarka (Lipovscak 1980). The radar on Puntijarka showed radar echos only 9 days, during which period parameters of 134 cloud cells were recorded.

Table 1 shows mean values of H_{zmax}, H_{vz}, RH_v for Istra and Puntijarka.

It is obvious that mean values of H_{zmax}, H_{vz} and H_v over Istra are lower compared with those of Puntijarka.

Assembling of data in classes and relative frequencies are shown in table 2.

Table 1. Mean values of H_{zmax}, H_{vz} and H_v for Istra and Puntijarka from May 10 to June 21, 1979

	H_{zmax}(km)	H_{vz}(km)	H_v(km)
ISTRA	2.65	6.01	7.87
PUNTIJARKA	5.69	7.15	7.87

Based on relative frequencies analysis, conclusion can be made that the most frequent occurrence of H_{zmax} over Istra is in the class 1.6 to 2.5 km, of H_{vz} in the class 5.6 to 6.5 km and of H_v in the class 6.6 to 8.5 km. In the continental

Klasa	Istra						Puntijarka					
	H_{zmax}		H_{vz}		H_v		H_{zmax}		H_{vz}		H_v	
	f_i	f_{ri}	f_i	f_{ri}	f_i	f_{ri}	f_i	f_{ri}	f_i	f_{ri}	f_i	f_{ri}
1,6 - 2,5	12	0,60	0	0	0	0	0	0	0	0	0	0
2,6 - 3,5	4	0,20	0	0	0	0	0	0	0	0	0	0
3,6 - 4,5	2	0,10	1	0,05	0	0	2	0,22	2	0,22	0	0
4,6 - 5,5	2	0,10	5	0,25	0	0	2	0,22	0	0	2	0,22
5,6 - 6,5	0	0	8	0,40	2	0,10	3	0,33	3	0,33	0	0
6,6 - 7,5	0	0	5	0,25	7	0,35	1	0,11	2	0,22	0	0
7,6 - 8,5	0	0	0	0	7	0,35	1	0,11	2	0,22	4	0,44
8,6 - 9,5	0	0	1	0,05	3	0,15	0	0	0	0	1	0,11
9,6 -10,5	0	0	0	0	0	0	0	0	0	0	2	0,22
10,6 -11,5	0	0	0	0	1	0,05	0	0	0	0	0	0

Table 2. Frequency (fi) and relative frequency (f_{ri}) of H_{zmax}, H_{vz} and H_v for Istra and Puntijarka from 10th of May to 21st of June 1979.

part of Croatia (Gelo 1976) H_{zmax} is most frequent in the class 3.0 to 3.9 km, Hv 5.0 to 5.9 km.

The measuring of Cb clouds over Istra showed that the accumulation zone is more vertically spread than in NW Croatia.

3. PHOTO-DOCUMENTATION ANALYSIS OF RADAR MEASUREMENTS

The frequency of cloud cell occurrence over Istra is determined by means of a grid superimposed over the PPI. Relative frequency of cloud cell appearances on one grid os computed from the following formula:

$$f_{ri} = \frac{fi}{\sum_i f_i} \qquad (2)$$

where f_i is frequency, f_{ri} relative frequency.

Maximum relative frequency 80.3×10^{-3} of Cb cloud cells over Istra is north of Pazin, near Motovun, and SE of Pazin, over the south slopes of Ucka mountain (Fig. 2).

Frequency of Cb cloud appearances according to photo-documentation is compared to the frequency of thunder registrated on ground stations network. The data of thunder frequency are collected on 3 synoptic, 8 climatological and 51 raingauge stations. Manual analysis was performed and values were interpolated on grid points. The data obtained on the grid points correspond to the data obtained by radar measurements. The number of days with thunder is equal to the number of days with radar Cb echos. Maximum relative frequency of Cb cloud cells correspond to the maximum relative frequency of thunder appearances, and it is placed over the same area of Istra. The relative frequency of thunder appearances is shown on fig. 3. The correlation coefficient between these two data sets is computed on the grid points = its value is 0.77.

4. CONCLUSION

The radar measurement in Istra during GARP intensive observation period enhance the difference between cloud characteristics in maritime and continental parts of Croatia. Analyses show the need for modifying hail suppression criteria. It is necessary to analyze the radio sounding data over Istra and NW Croatia, to compare them and define new criteria for hail suppression. It is very difficult to make general conclusions on the basis of the above mentioned data because the observing period was too short, so it is strongly recommended that measurements will continue for the future.

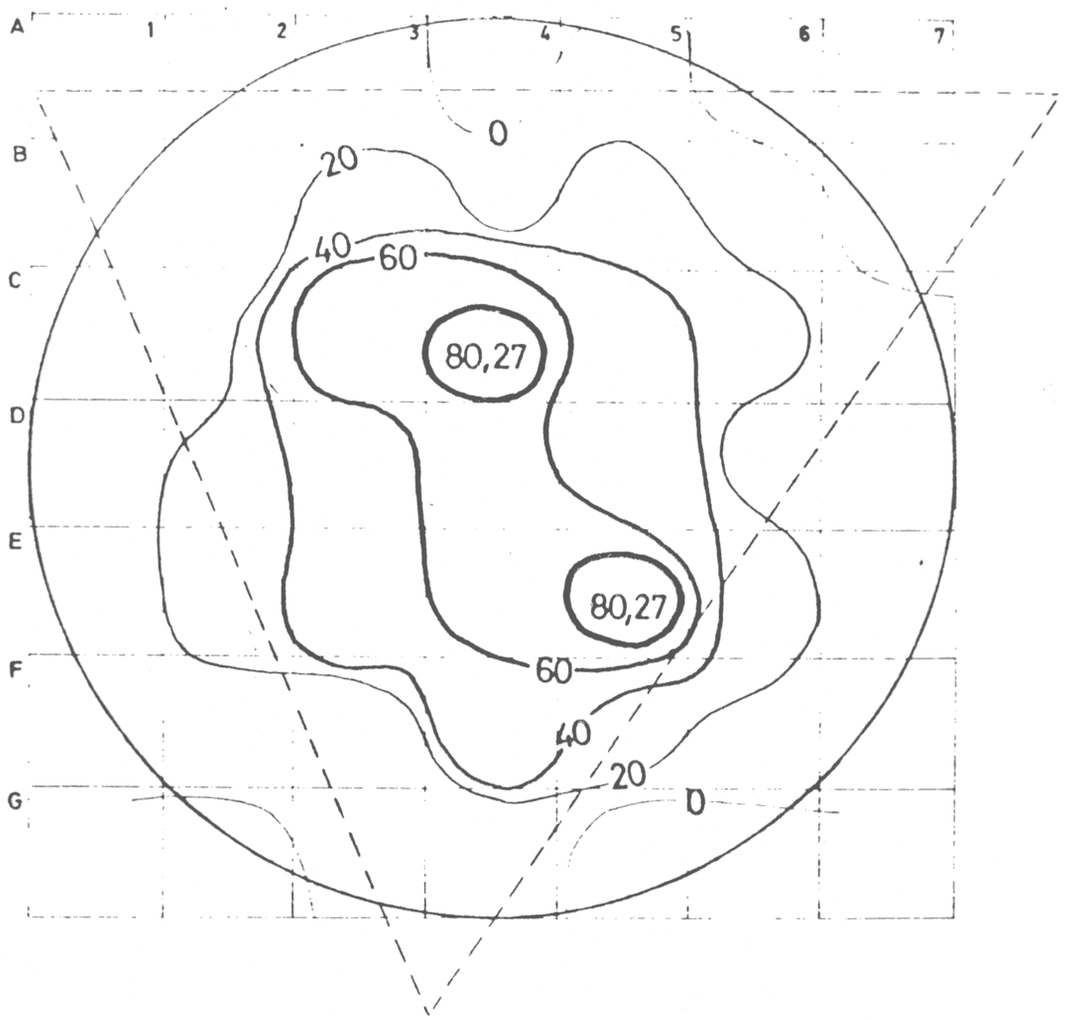

Figure 2. Relative frequency of Cb cloud cell appearance according to photodocumentations ($x10^{-3}$).

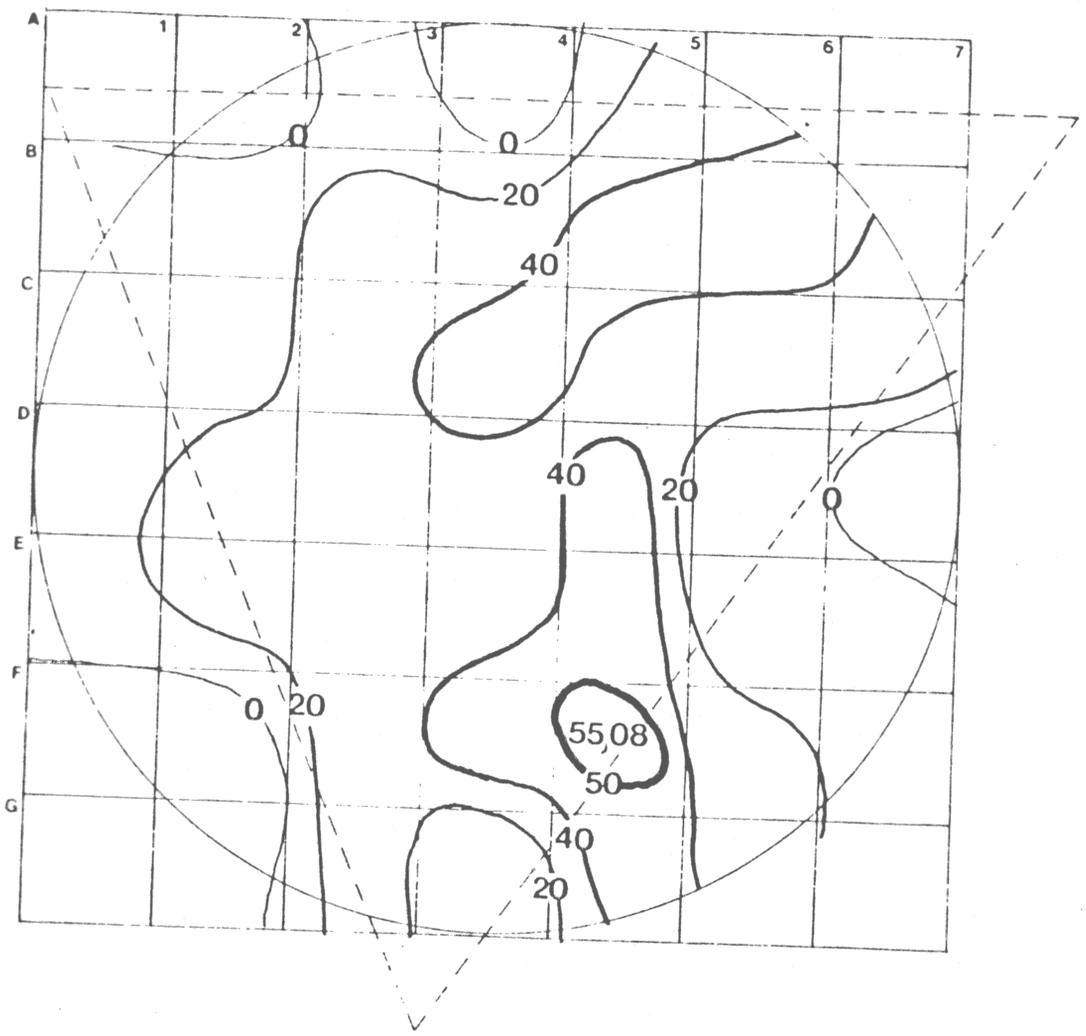

Figure 3. Relative frequency of thunder over Istra according to ground stations network observations ($x10^{-3}$).

5. REFERENCES

Gelo, B., 1976: Razvoh i gibanje konvektivnih oblaka u sjevernoj Hrvatskoj u razdoblju radarskih mjerenja, Magistarski rad, Sveuciliste u Zagrebu, 77 p.

Lipovscak, B., I. Cacic, I. Huzjak, D. Glasnovic, 1980: Obrana od tuce na podrucju SR Hrvatske u 1979. godini, RHMZ SR Hrvatske, Zagreb, 145 p.