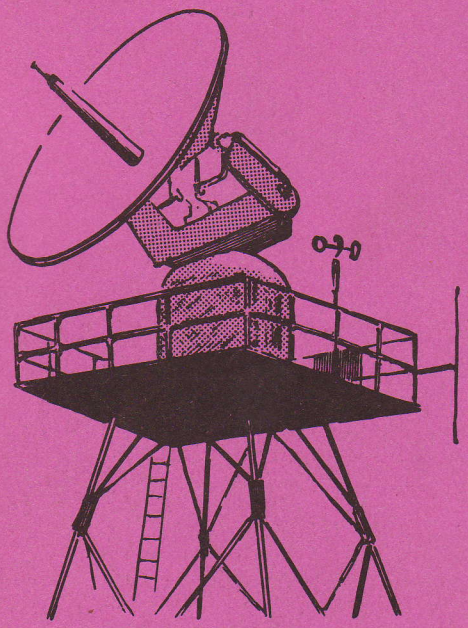
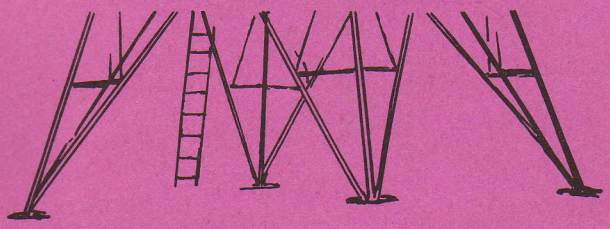
# COST 72

# WORKSHOP/SEMINAR ON



# WEATHER RADAR



EUROPEAN CENTRE FOR MEDIUM RANGE WEATHER FORECASTS
SHINFIELD PARK, READING
&
THE METEOROLOGICAL OFFICE
RADAR RESEARCH LABORATORY, MALVERN
UNITED KINGDOM

PAPERS OF THE WORKSHOP/SEMINAR OF THE

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# RADAR NETWORK IN SR CROATIA - YUGOSLAVIA

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## 1. Introduction

During 1959 the first attempts of weather modification were performed in Croatia in order to reduce hail damage. The weather modification is carried out by seeding the hailstorms with AgI reagent which is introduced into the cloud by rockets. The first hail suppression actions were carried out on the initiative of peasants who were launching the rockets in cloud direction, without radar observations, only according empirical criterion.

In 1970 started the building of radar network based on experiences of the Soviet scientists ( Sulakvelidze et al., 1967 ). The main purpose was to detect and measure the hailstorms in order to perform hail suppression. The radar serves to detect the stadia of convective clouds growth and the determination of relative cloud position in relation to the launching stations.

The absolence of the used radars brings about the making of first projects of radar network modernization ( Gelo et al., 1978 ). During 1979 the projects of a single radar centre were made and the S-band radar network was defined ( Lipovšćak et al., 1979 ). At the same time the buying of radar and computer equipment was organised.

The development of hydrometeorological activities causes the need for rain measurements with radar. Therfore the first idea of S-Band radar network was supplemented by C-Band radars.

## 2. The present radar network in Croatia

The present radar network in Croatia is based on S-Band military radar 3MK7 modified by a built in attenuator, Fig. 1. Technical characteristics of radars are:

- wavelenght 9.8 cm;
- frequency 3000 - 3120 MHz;
- pulse width 0.55 microseconds;
- peak power output 200 KW;
- receiver intermediate frequency 60 MHz;
- maximum visibility range 61 km;
- maximum measuring range 33 km.

The first radar centre was established on 04 th of August 1970 on the Psunj mountain. The following experimental measurements of cloud parameters were performed:

- azimuth,
- distance from radar,
- the height of the top of the echo,
- the height of the region of maximum radar reflectivity,
- the depth of the radar echo.

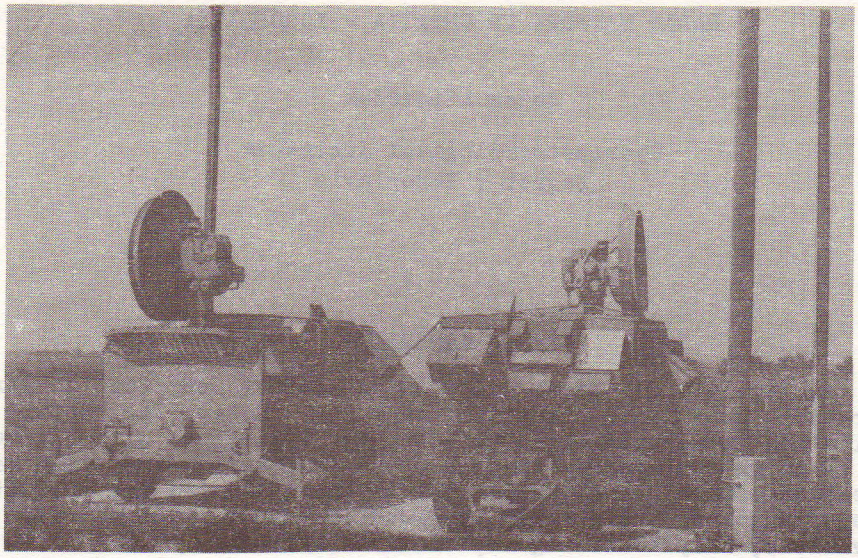

Figure 1. 3MK7 radars on radar centre Gradište.

The measurements were performed in a 3 minute intervals. In 1972 the measuring of the hight of the region of high echo intensity ( 10 dB below the maximum value of echo reflectivity ) and determination of log Z were introduced. Nowadays all the quoted parameters are measured operationally on 10 radar centres, Fig. 2. Depending on temperature structure of the atmosphere the parameters must satisfy defined probability criteria of hail appearence. The table 1. shows the development of the radar network in past 10 years.

Table 1. Development of 3MK7 radar network in Croatia.

| | |
|---|---|
| 1970 | RC 5 Psunj ; |
| 1971 | RC 6 Gradište ; |
| 1972 | RC 1 Puntijarka ; |
| 1973 | RC 3 Bilogora ; |
| 1974 | RC 2a Varaždin, RC 4 Stružec ; |
| 1975 | RC 2b Trema ; |
| 1976 | RC 7 Igrač ; |
| 1980 | RC 8 Osijek, RC 8a Kapelna. |

Each radar centre has two 3MK7 radars, a generator, radio connection equipment, meteorological instruments and a building for the staff. The radar centres are radio linked, radar data are transmitted in code. The distance between two neighbouring radar centres is not bigger than 60 km and it assures radar covering of the whole hail suppressed area.


Figure 2. 3MK7 radar network in Croatia.

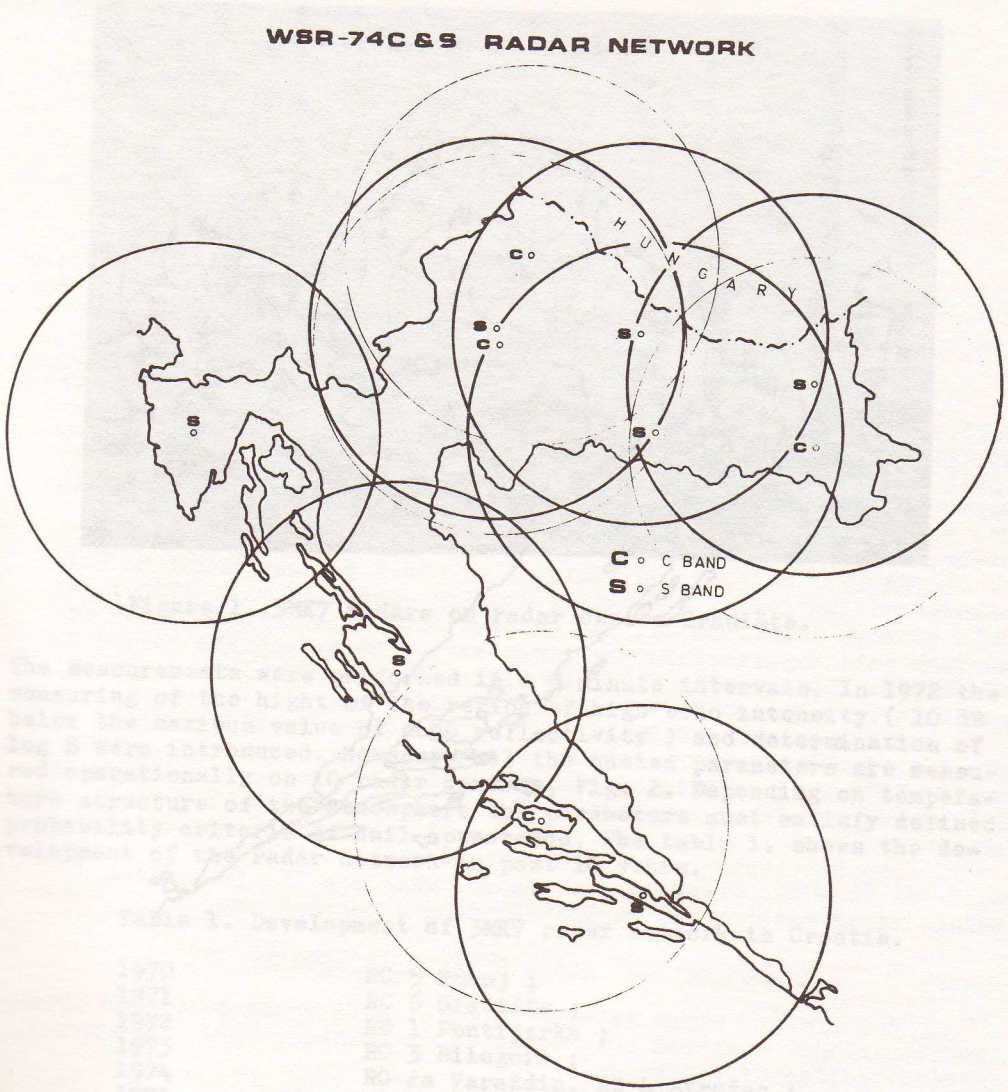


Figure 3. WSR 74 C and S radar network in Croatia.

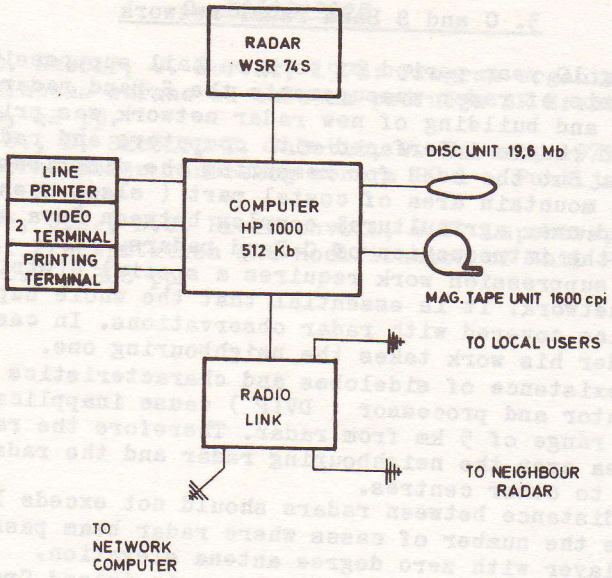


Figure 4. Scheme of equipment of one radar centre.

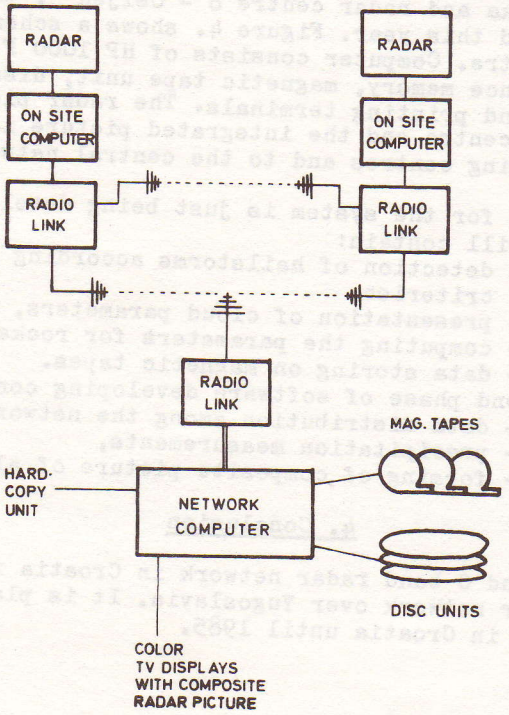


Figure 5. Scheme of equipment of radar centres and network computer.

## 3. C and S Band radar network

During 10 year period of work on hail suppression and clouds seeding on basis of radar measurements the S-Band radars were used. Modernization and building of new radar network was primarily based only on S-Band radars interfaced with computers and radio linked in a unique ring. But the need for measuring the distribution of precipitation in mountain area of costal part ( electro energetical sources ), and ower agricultural complex between Sava and Drava rivers require the introduction of C-Band radars.

Hail suppression work requires a special distribution of radars in a network. It is essential that the whole suppressed area should be twice covered with radar observations. In case one radar is out of order his work takes the neighbouring one.

The existence of sidelobes and characteristics of digital video integrator and processor ( DVIP ) cause inapplicability of measuring in range of 5 km from radar. Therefore the radar must observe the area over the neighbouring radar and the radar picture must be sent to other centres.

The distance between radars should not excede 150 km in order to minimalize the number of cases where radar beam passes through the melting layer with zero degree antena elevation.

The existing network of 10 radars in inland Croatia will be reduced to 4 S-Band and 3 C-Band radars. On costal area the building of 3 S-Band and 1 C-Band radars is planned, Fig. 3. The main task of S-Band radars is hail suppression and of C-Band radars the acquisition of cloud data and precipitation measurements.

During 1980 EEC - WSR 74S radars were bought for radar centre 1 - Puntijarka and radar centre 8 - Osijek , their experimental start is expected this year. Figure 4. shows a scheme of equipment of one radar centre. Computer consists of HP 1000 F model with 512 Kb high performance memory, magnetic tape unit, disc unit, line printer, video and printing terminals. The radar picture integration is performed in centre and the integrated picture is radio linked to the neighbouring centres and to the central network computer in Zagreb, Fig. 5.

Software for the system is just being developed and in its first phase it will contain:

- detection of hailstorms according to required criterion,
- presentation of cloud parameters,
- computing the parameters for rockets launching,
- data storing on magnetic tapes.

The second phase of software developing consist of:

- data distribution among the network,
- precipitation measurements,
- forming of composite picture of all radars.

## 4. Conclusion

New S and C band radar network in Croatia is a part of meteorological radar network over Yugoslavia. It is planned to finish 80 % of network in Croatia until 1985.



1. Gelo, B
izgradn
SRH, Za
2. Lipovšć
projekt
SRH, Za
3. Sulakve
Formati
Washing

## 5. References


1. Gelo, B., D. Skočir, V. Horvat, 1978: Program organizacije i izgradnje sistema obrane od tuče na području SR Hrvatske, RHMZ SRH, Zagreb, 42 pp.
2. Lipovšćak, B., D. Skočir, T. Vučetić, V. Horvat, 1979: Idejni projekt modernizacije radarskog centra RC 1 - Puntijarka, RHMZ SRH, Zagreb, 22 pp.
3. Sulakvelidze, G.K., N.S. Bibilashvili, V.F. Lapcheva, 1967: Formation of Precipitation and Modification of Hail Processes, Washington D.C., 208 pp.