

# Hail suppression system in the continental part of Croatia

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**1956** – First activity (area Križevci -- short range rockets)

**1967** – Hydrometeorological institut included in operations

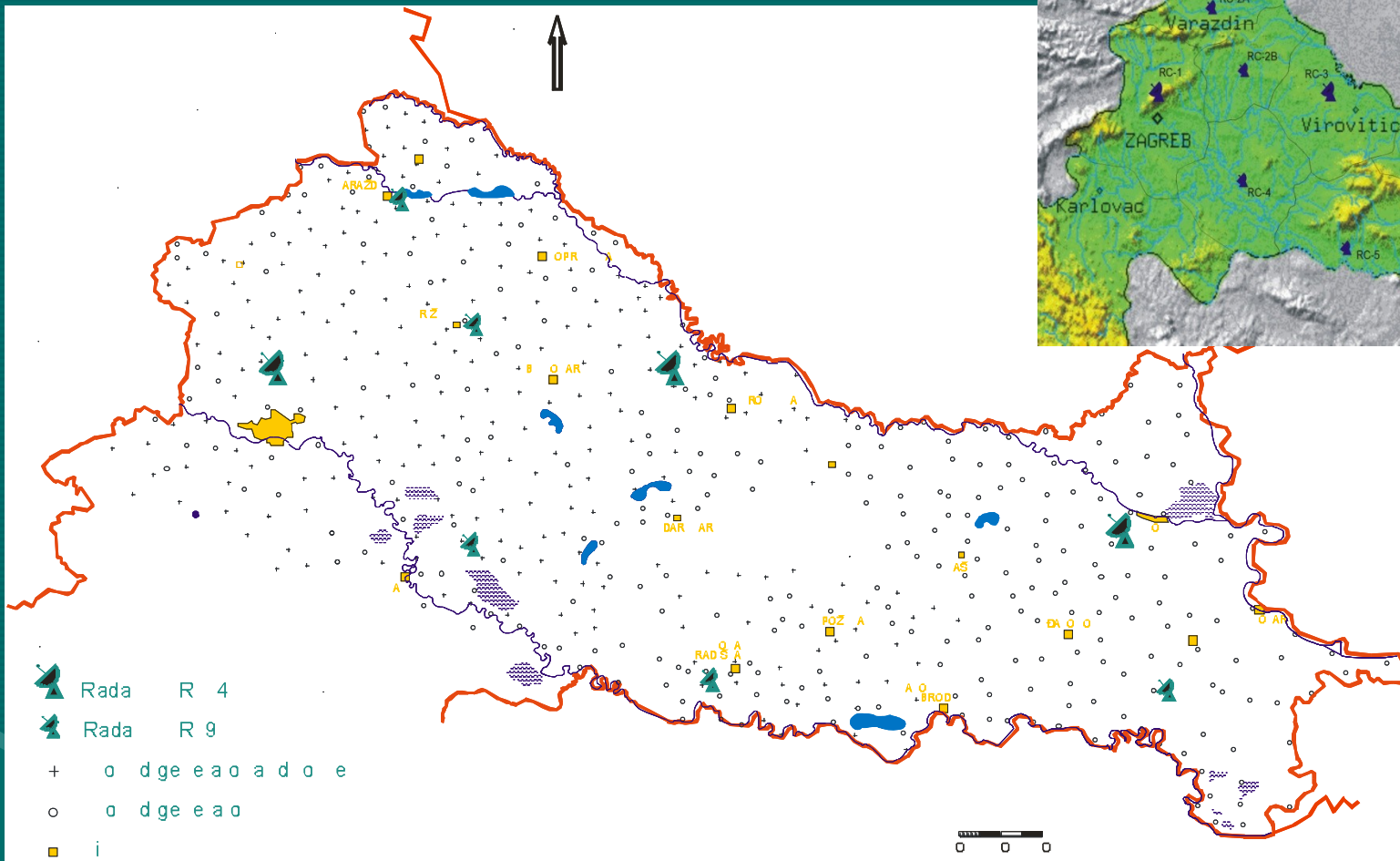
**1970** – 1. Radar center –Psunj

**1988** – Hail suppression law in Croatia

**1994** -- Introducion of ground generators

**1995** -- Combined operational system: rockets and ground generators



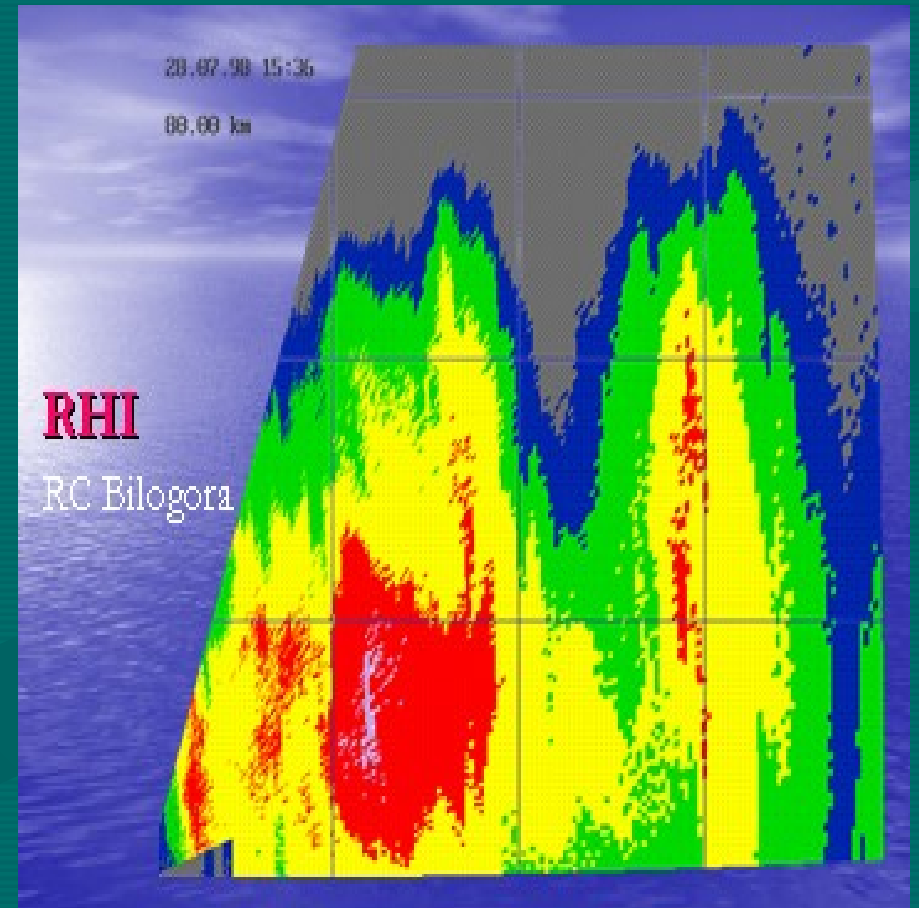


- Continental part of Croatia - 26,800 km<sup>2</sup>
- Active season: 01.05. – 30.09.
- 590 hail suppression stations
- 8 radar centers

Optimal years amount:  
 rockets: 10.000 – 12.000  
 reagent: 100 000 l.  
 budget: 2 – 3.3 mil. EUR



# RC Bilogora

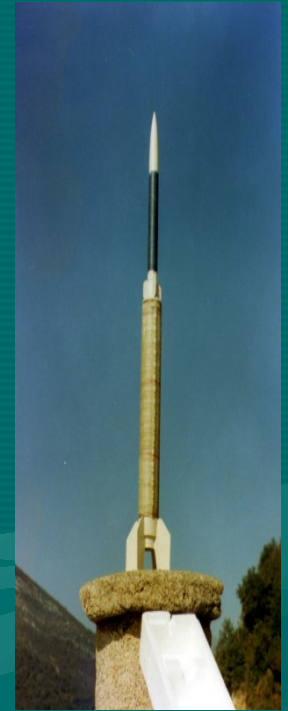






**RC Gorice**





Two types of rockets

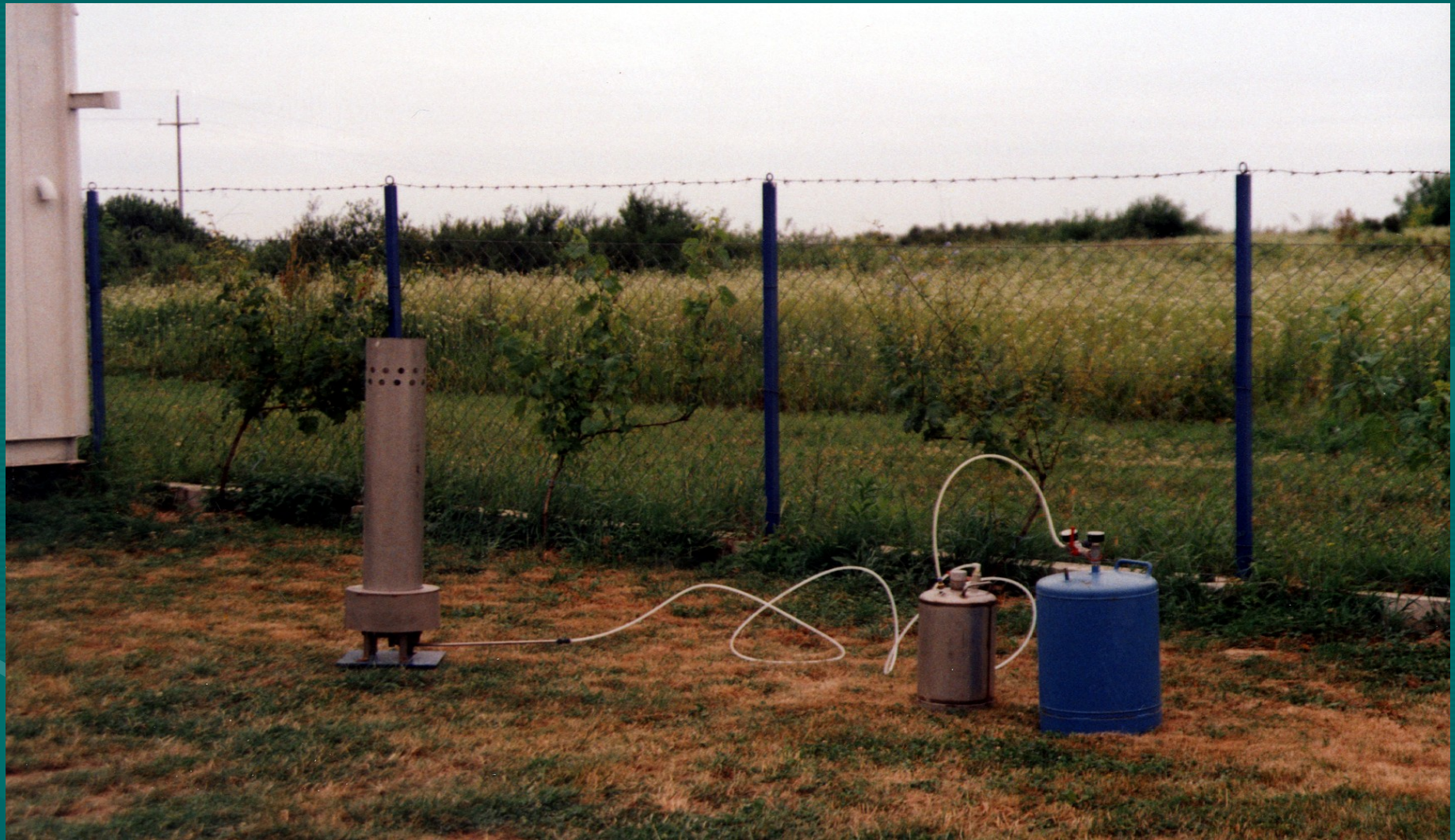
**Long range - 9 km**

**Middle range - 7 km**

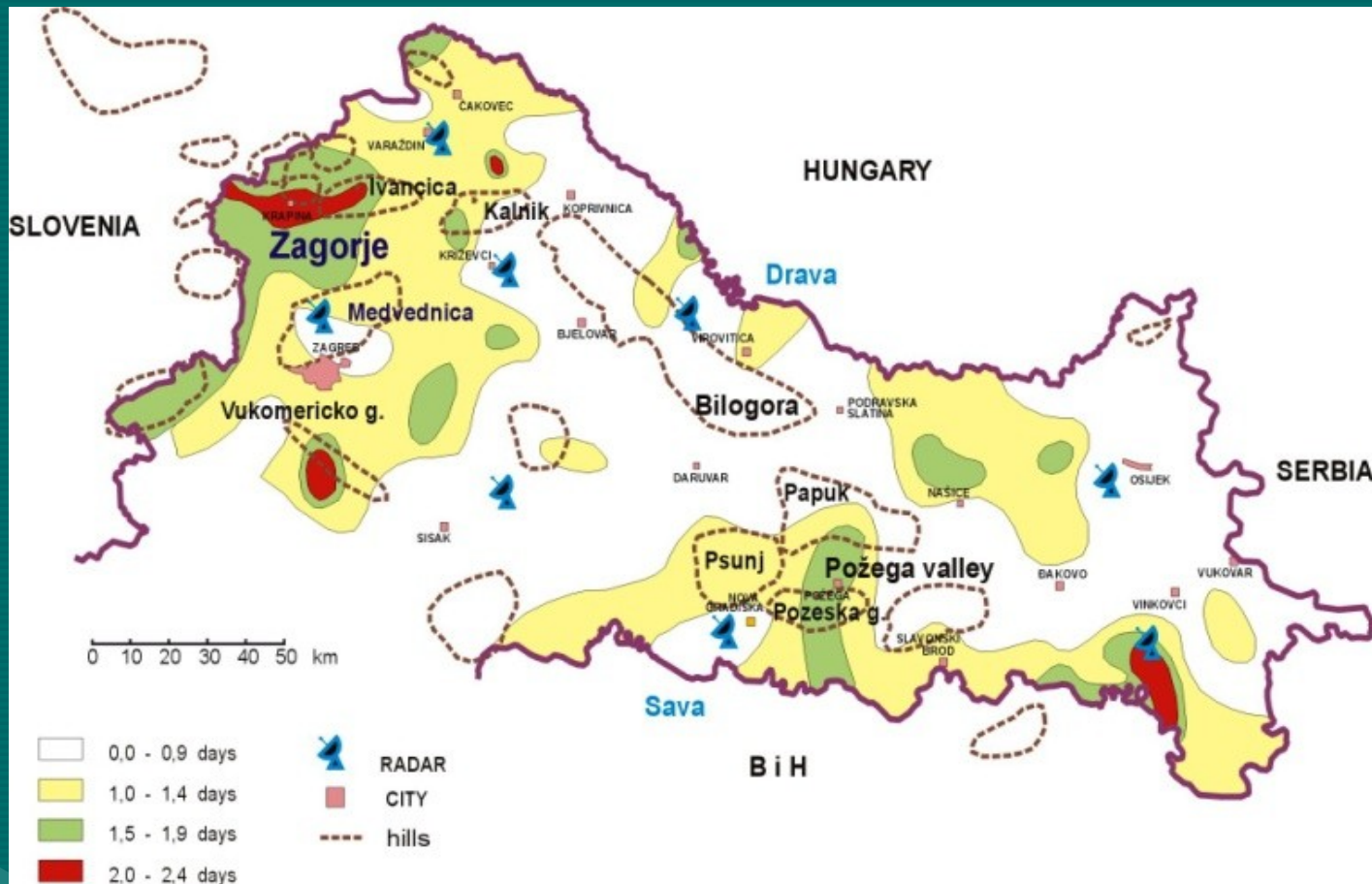
Minimal radiation of reagent  $5 \times 10^{11}$  IN per meter of the trajectory

**Different types of rockets**





**Ground generator vortex type** -- Minimal radiation of reagent  $5 \times 10^{13}$  IN per hour of work of generator



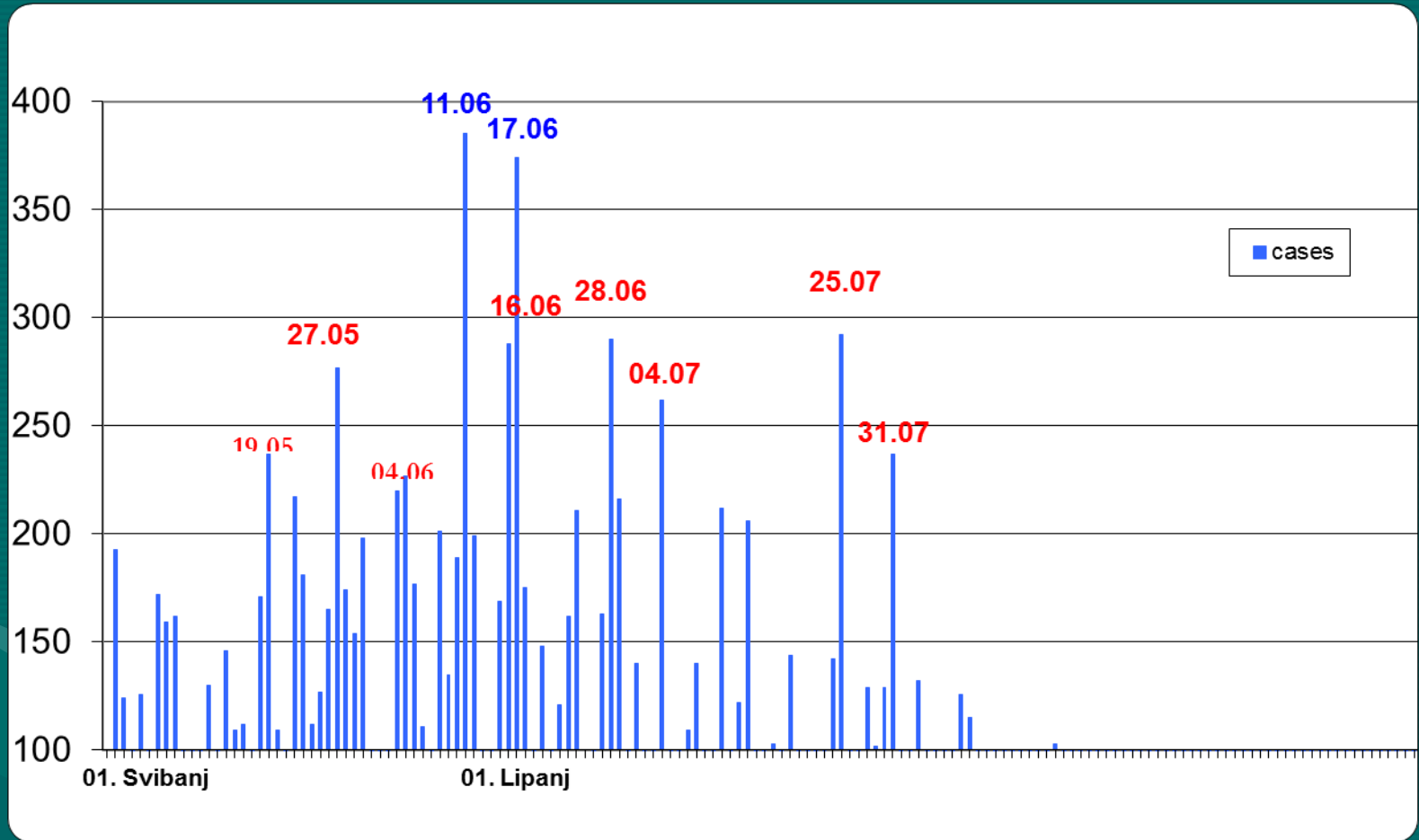
Spatial distribution of mean number of days with hail/season in continental part of Croatia (1981. – 2012.)



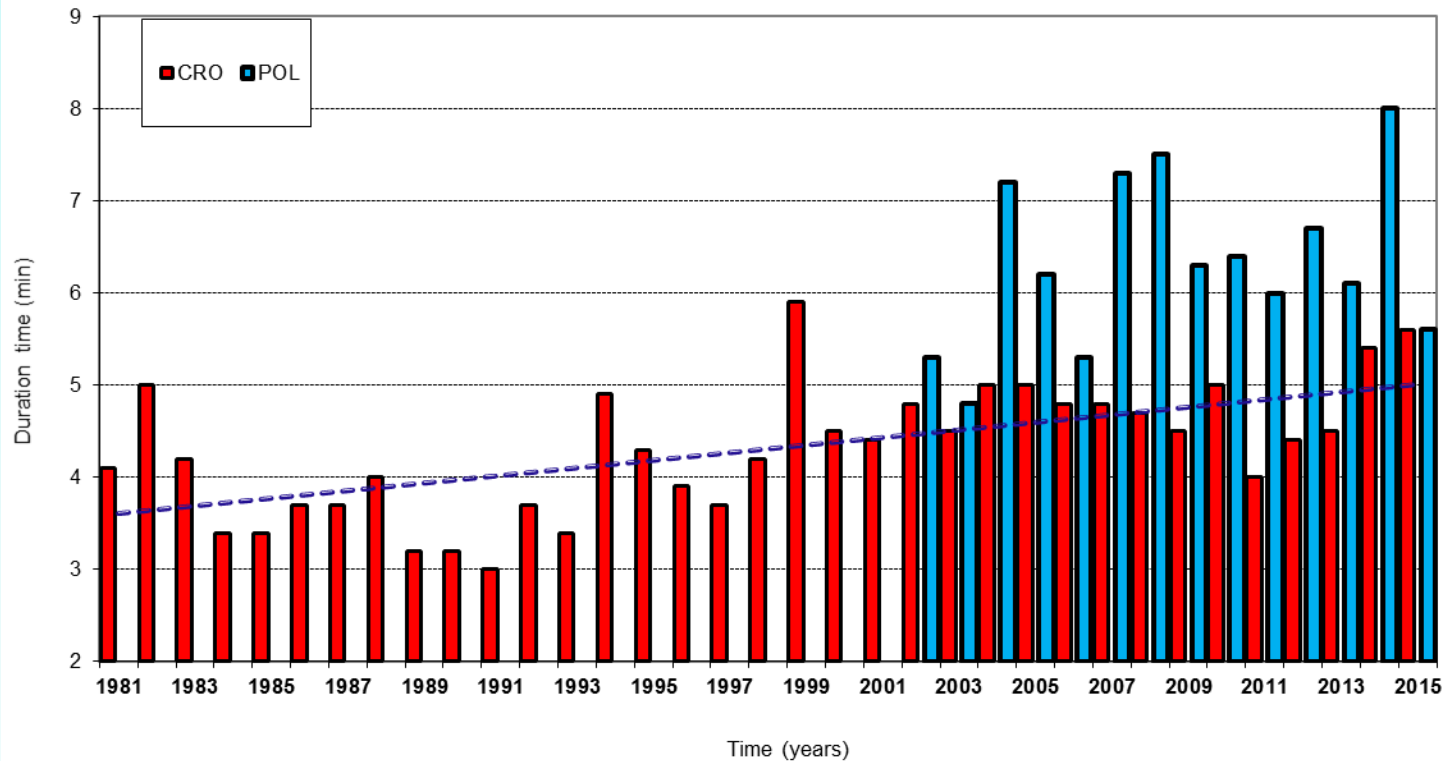
•Hail suppression stations data:

(a) observed hail and damage data (1981.-2015.)

(b) hailpad data (2002.-2015.)



Daily distribution of all hail cases recorded on hail suppression stations in continental part of Croatia (1981-2015)

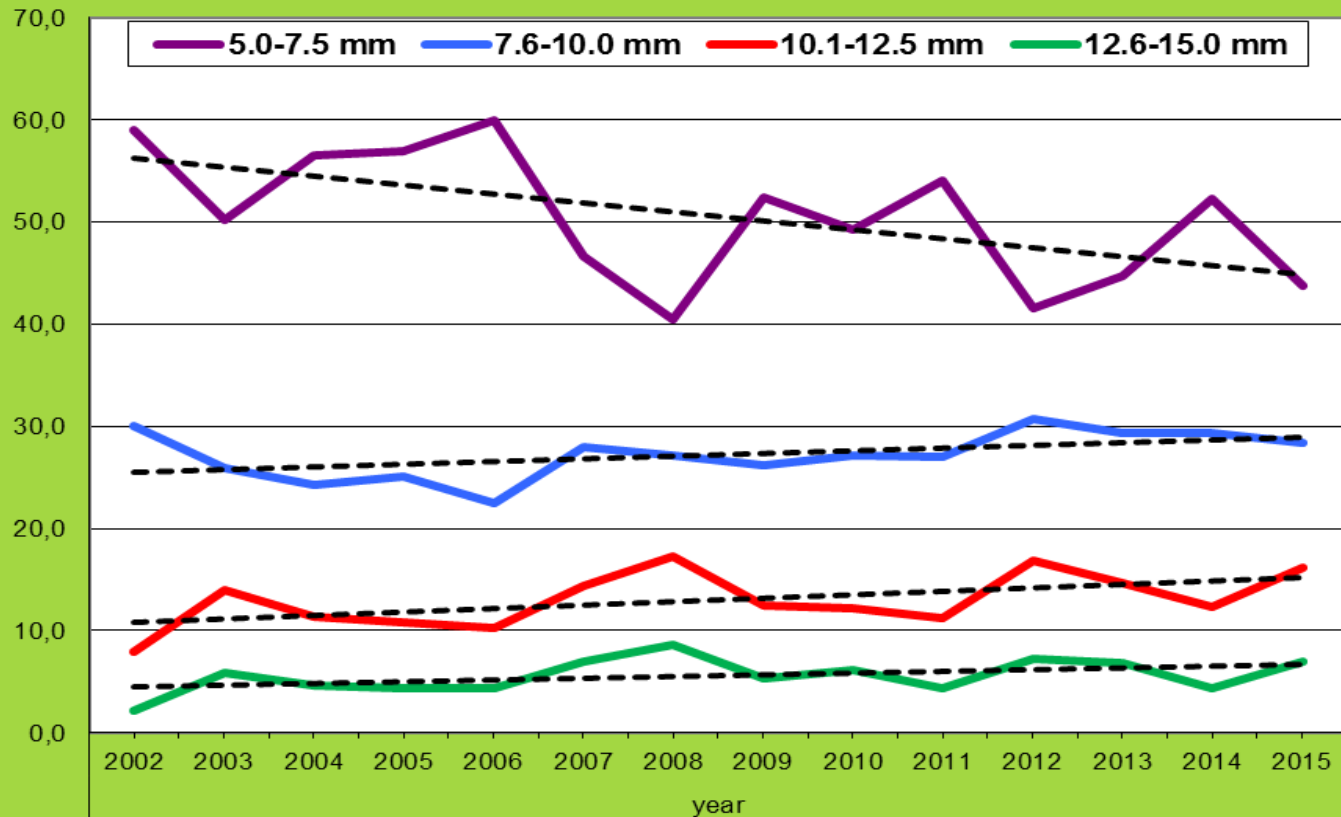


**Mean hailfall duration and trend on all hail suppression stations for Croatia (1981.-2015.) and polygon (2002.-2015.).**

**Croatia (1981.-2015.):  $t = 4.4$  min; polygon (2002.-2015.):  $t = 6.3$  min.**

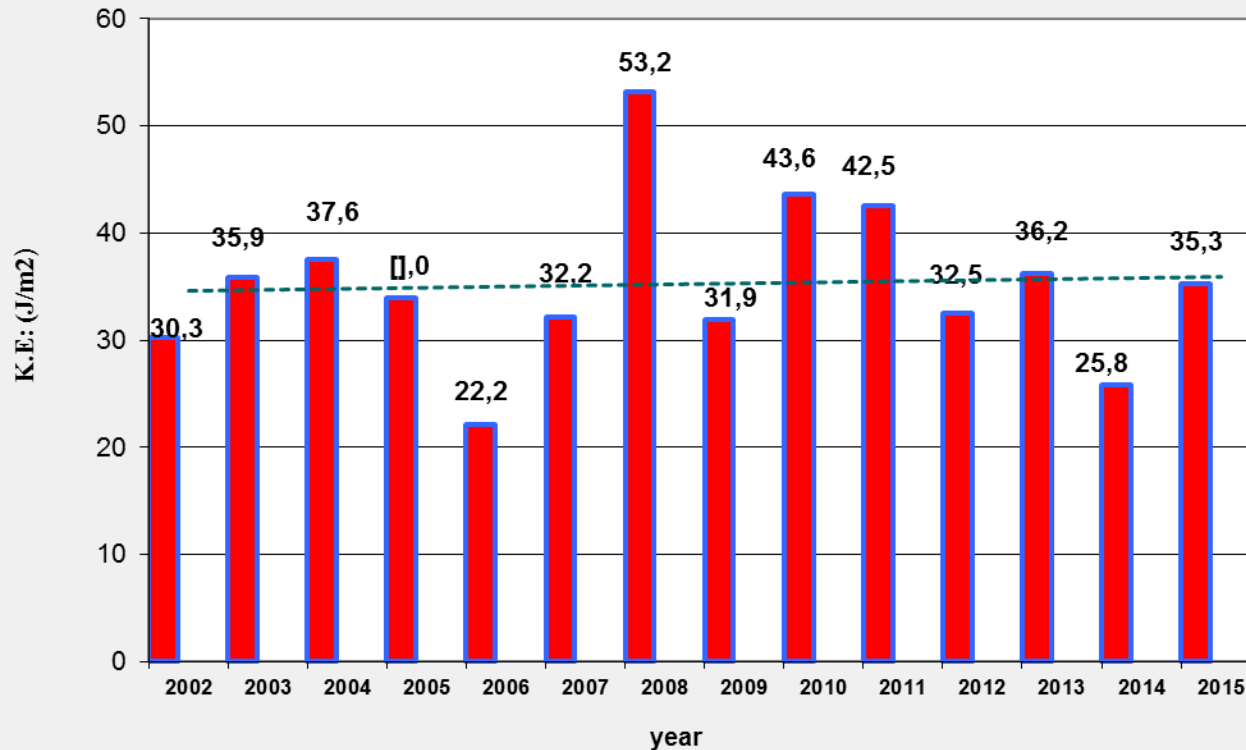


### Distribution and trend of relative frequency for a hailstone diameter on continental part of Croatia (2002.-2015.)



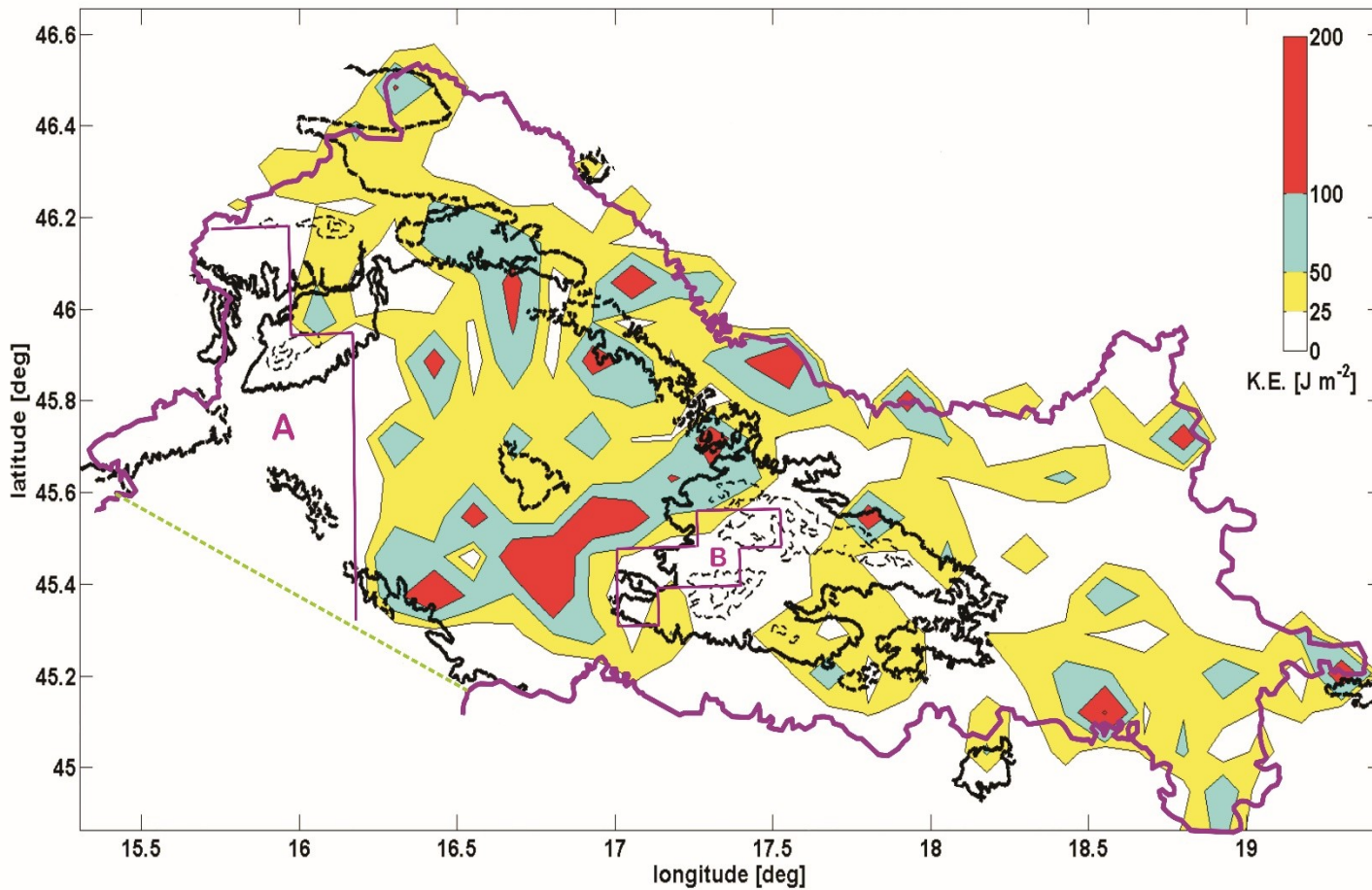
**Distribution and trend of relative frequency for hailstone diameter on continental part of Croatia (2002 – 2015)**

Average values of kinetic energy for continental part of Croatia  
(2002. - 2015.)



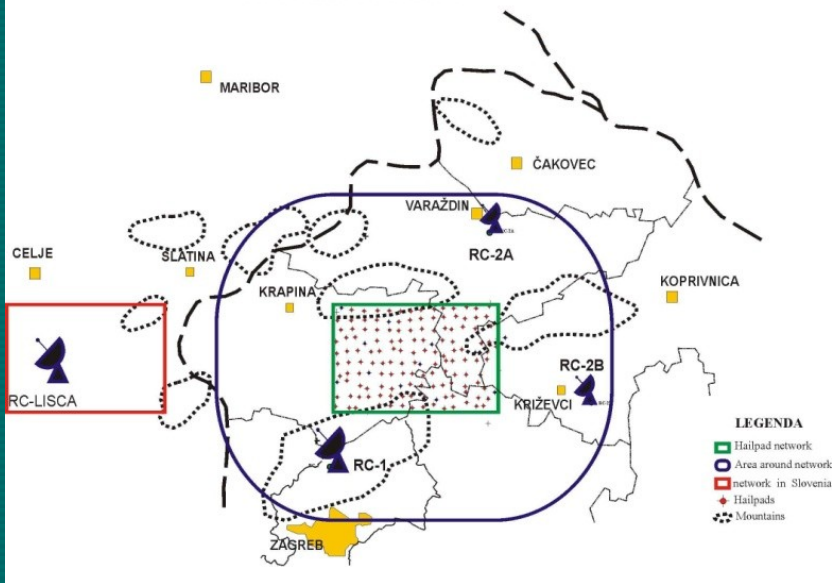
**Annual average kinetic energy for continental part of Croatia (2002.-2015.)**





Spatial distribution of the mean kinetic energy in the continental part of Croatia in the period 2002.-2012. (colored contours). Black dashed lines denote orography, starting from 270 m (thick line) at the outer edge of certain mountain. Areas A and B are excluded from the EOF analysis because of none homogenous set of data

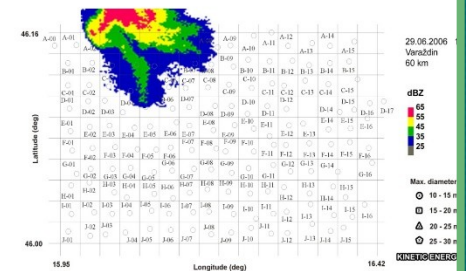
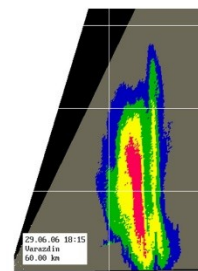
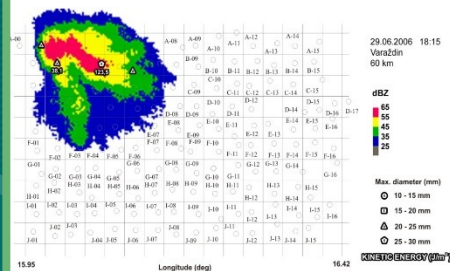
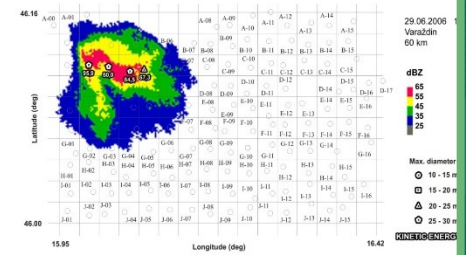
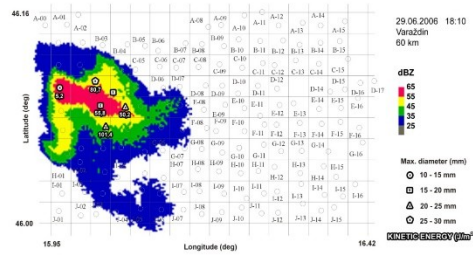
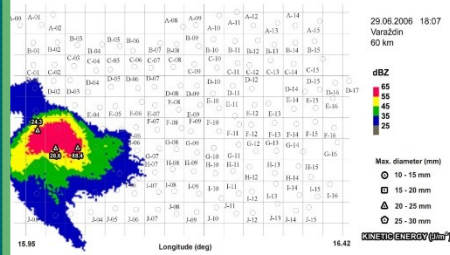
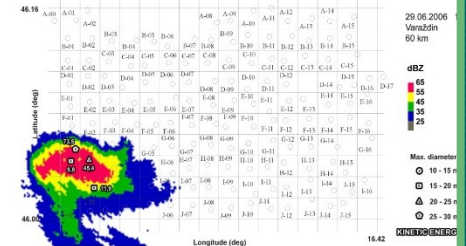
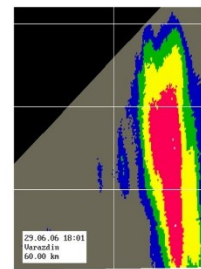
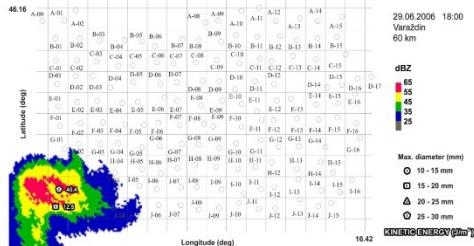
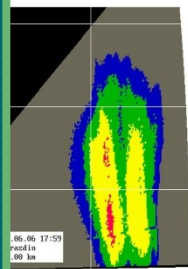
## HAILPAD NETWORK



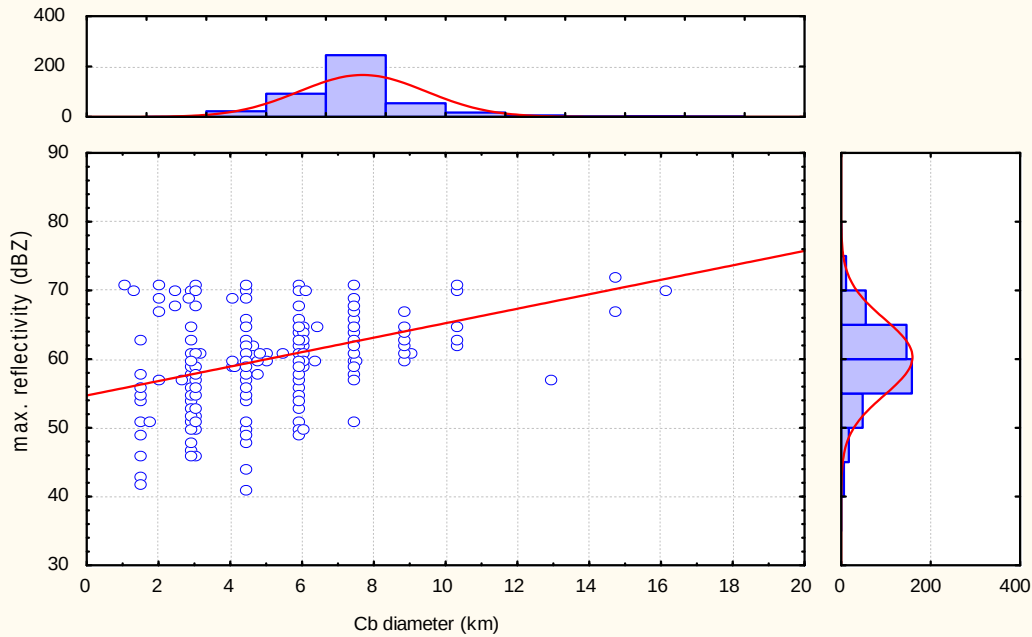
The hailpad polygon (30 x 20 km) in the western part of the hail-protected territory of Croatia; n=150.



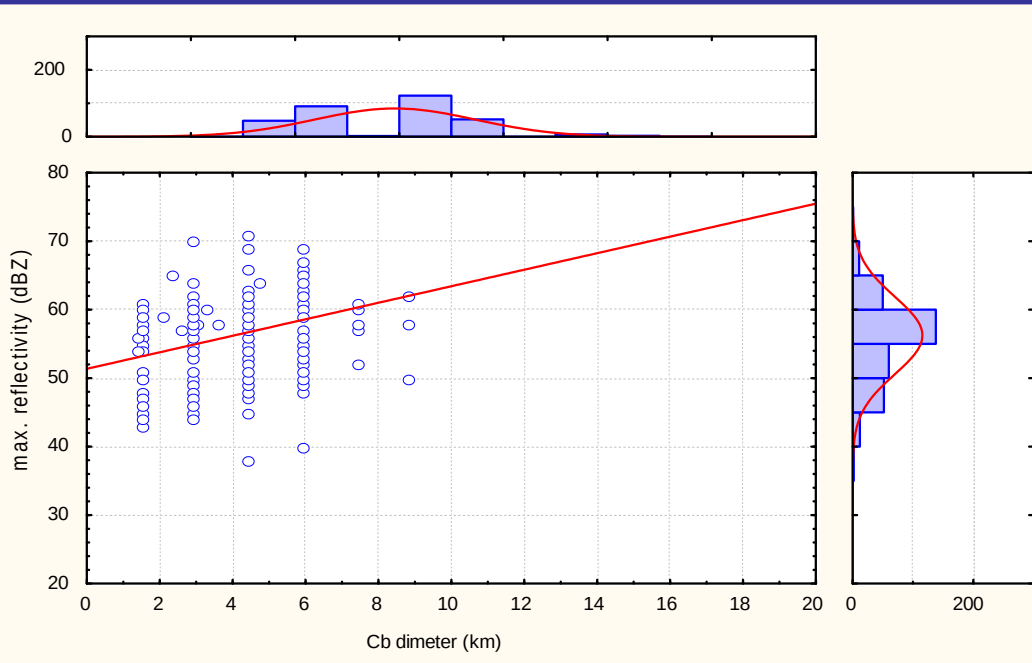
Hailpad



**Radar (RHI and PPI) images and hail stone parameters measured on 29.06.2006. between 17.59 and 18.18 hours (local time) on hailpad polygon (time interval 3 min.)**

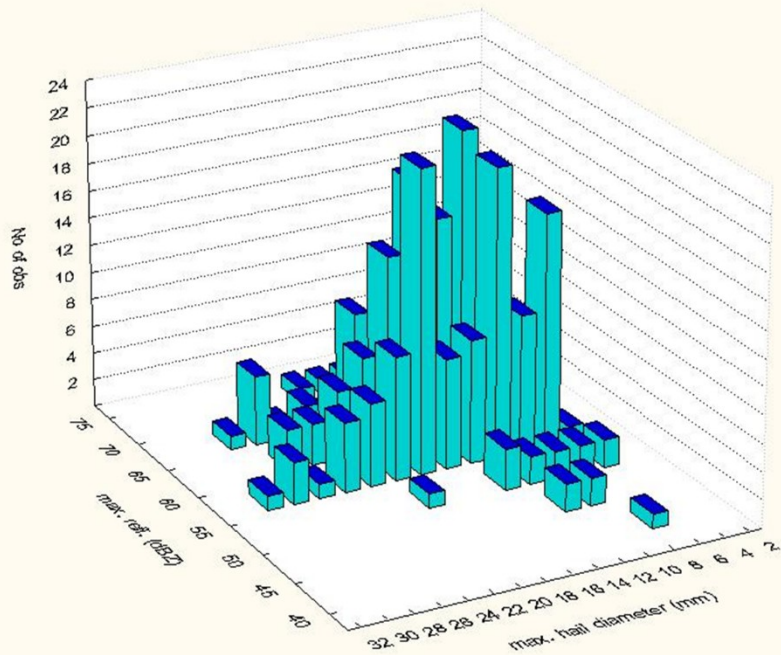


**Relation between diameter and max. reflectivity of Cb with hail**



**Relation between diameter and max. reflectivity of Cb without hail**





**Most frequent Cb cells with hail, have diameter between 6 and 10 km with average of 60 dBZ.**

**Diameters between 7 and 9 km are not measured for Cb without hail on the ground**

**Hail stones greater than 30 mm can occur when the reflectivity is greater than 55 dBZ.**

**Maximal kinetic energy is connected with reflectivity greater than 60 dBZ.**

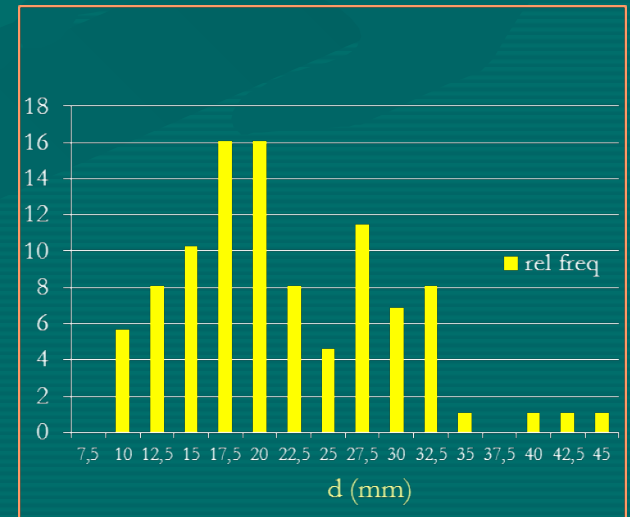
**Greater hail stone (>30 mm) occur in greater Cb diameter and/or with greater reflectivity.**

**Similar as max. hail stone, greater kinetic energy is connected with greater diameter and reflectivity.**

Croatia (RC-Sljeme; LP 24)- **11.07.2011**, (18:56 - 19:10 CET)  
K.E. = **1918,3** J m<sup>-2</sup>;  $d_m = 44.0$  mm;  $m = 8269$  g m<sup>-2</sup>;  $N_t = 1392$



Thank you !



Hailstone diameter distribution