

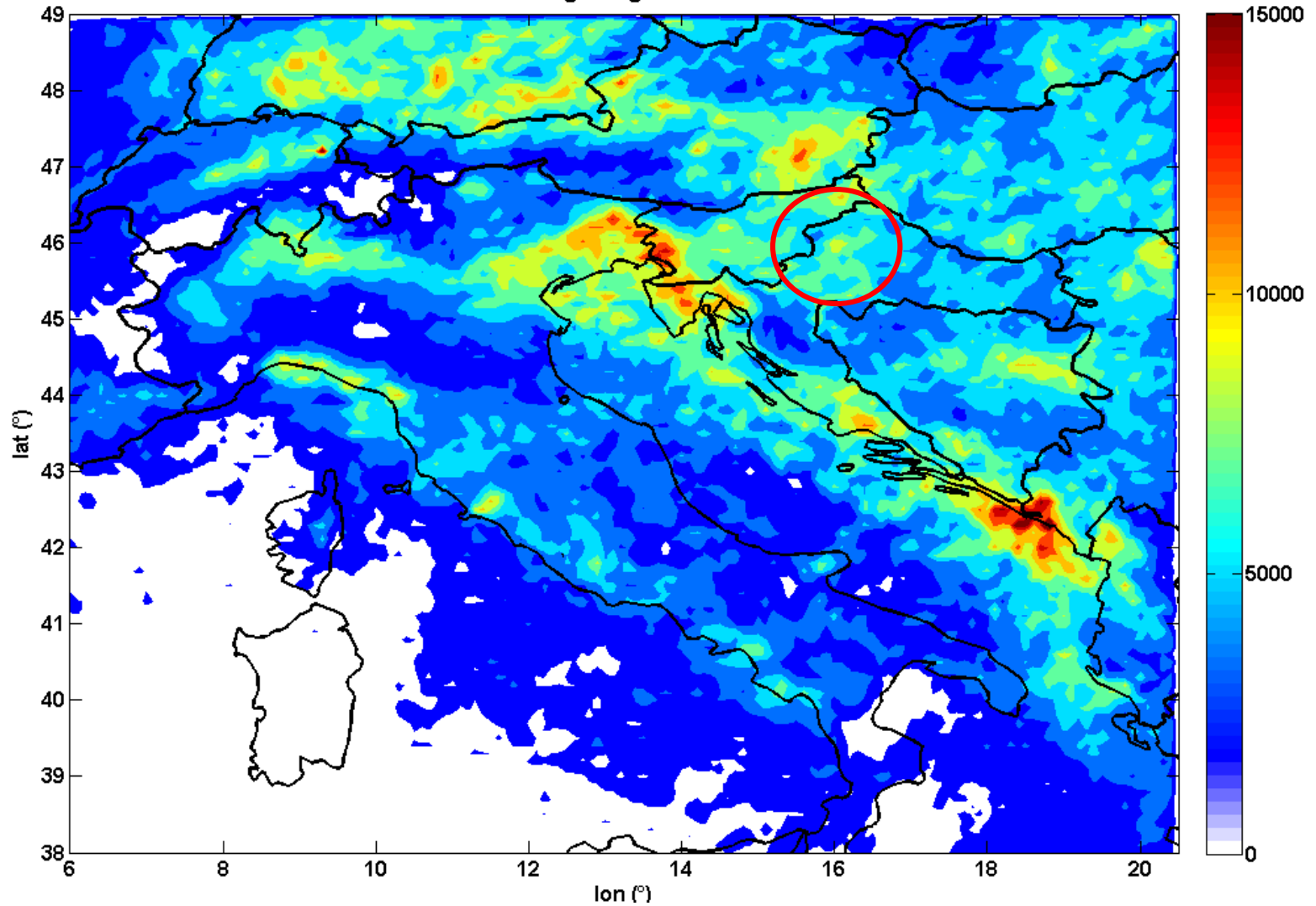
Characteristics of lightning activity during hailstorms

**Petra Mikuš Jurković, Nataša Strelec Mahović
DHMZ, Croatia**

Results of the previous studies:

- ▶ intensification of the storms' updraft
 - >> accompanied by an increase in total lightning rate
- ▶ rapidly growing flash rate
 - >> increased potential for severe weather
- ▶ during severe thunderstorms
 - >> cloud-to-ground (CG) lightning production usually decreasing
 - >> significant increase in the number of intra-cloud (IC) flashes
- ▶ in hailstorms >> regions with a reduced number of lightning strokes detected

Total lightning 2008-2014



Hail observations

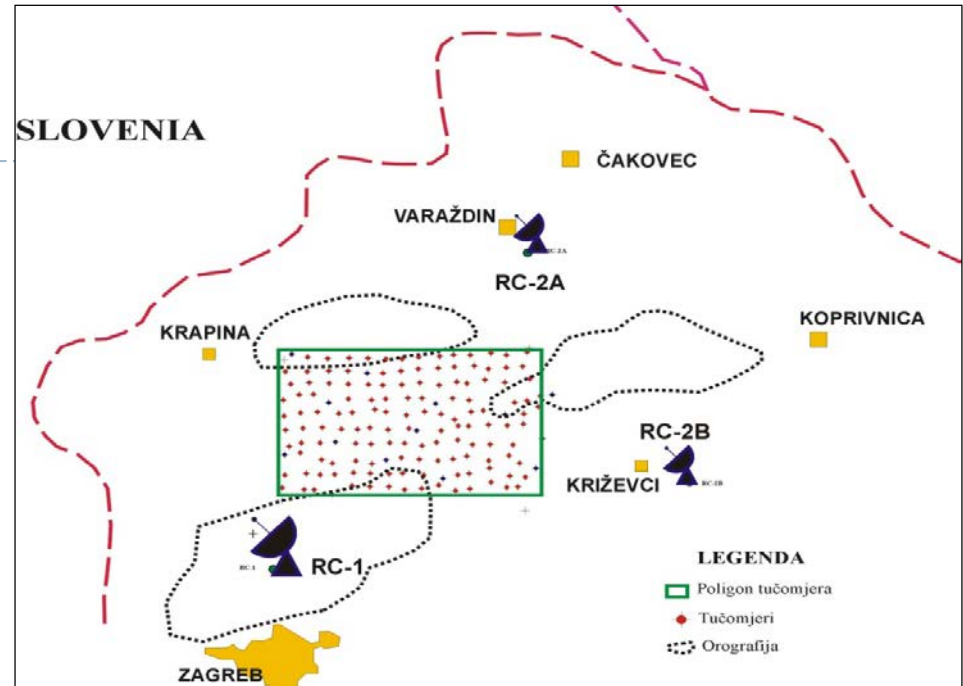
hailpad network,
150 hailpads in NW Croatia

location:

46.00N 15.95E - 46.16N 16.42E

hail characteristics:

diameter
kinetic energy
spatial distribution

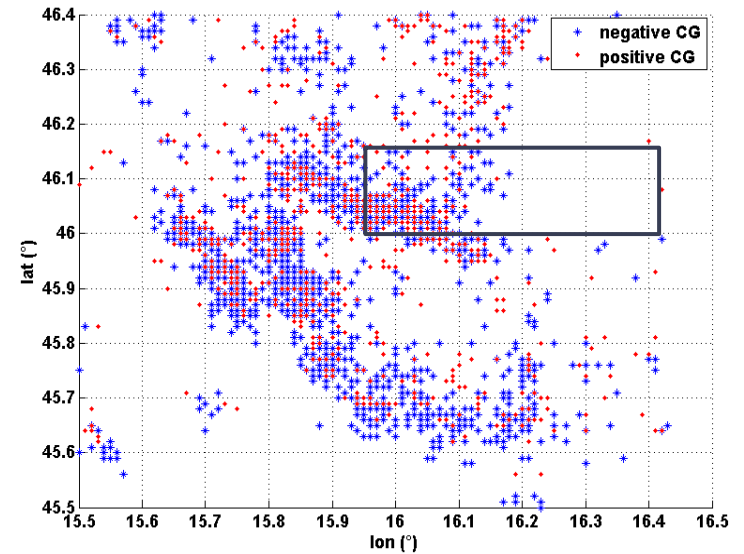
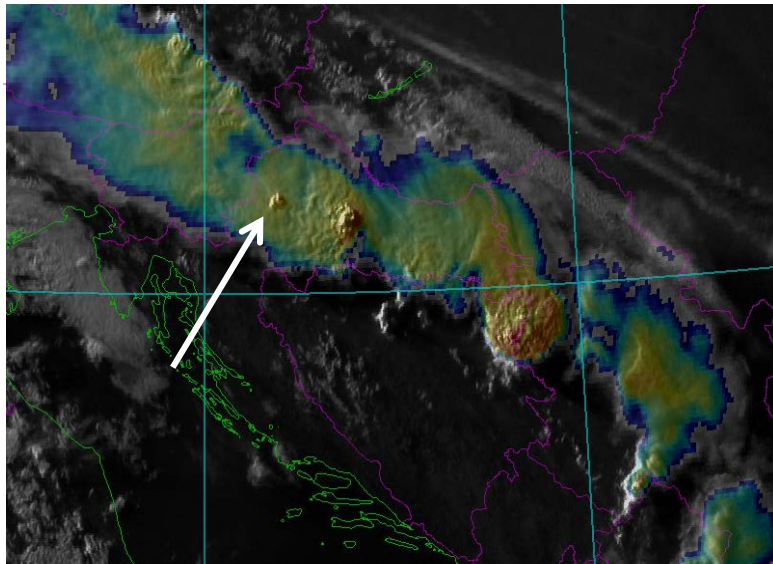


Lightning data

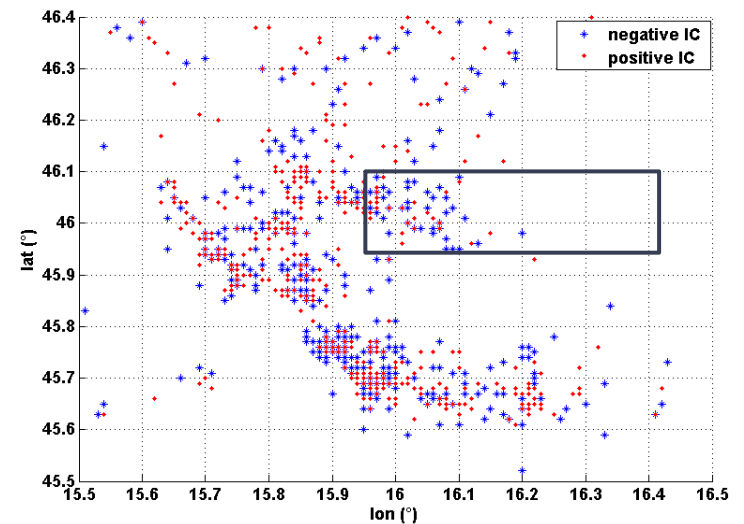
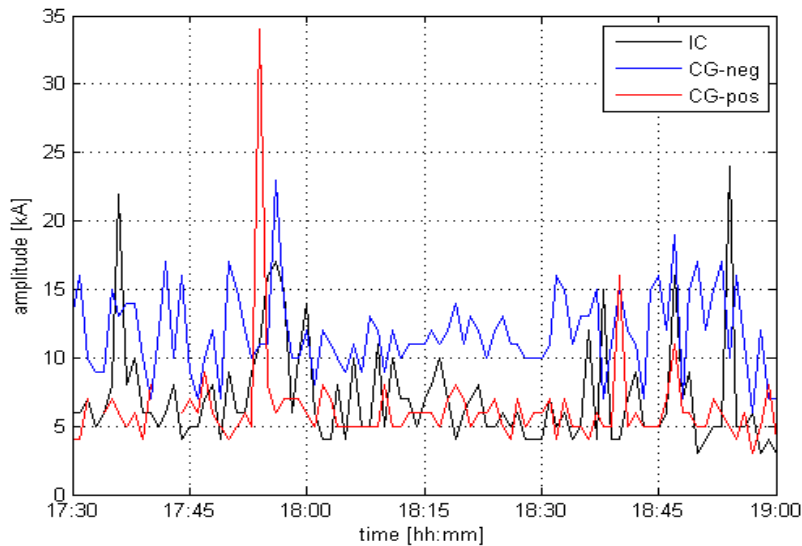
LINET (nowcast GMBH, Munich)
Lightning Detection Network
Total, CG, IC lightning

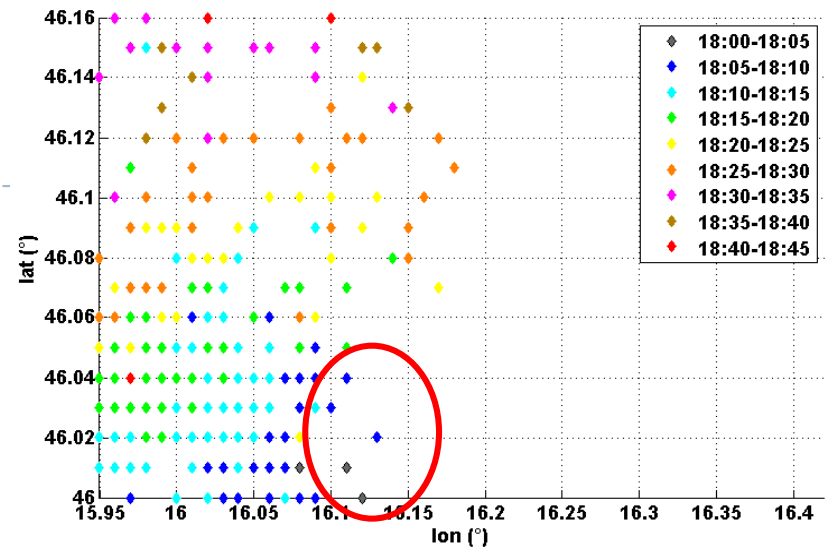
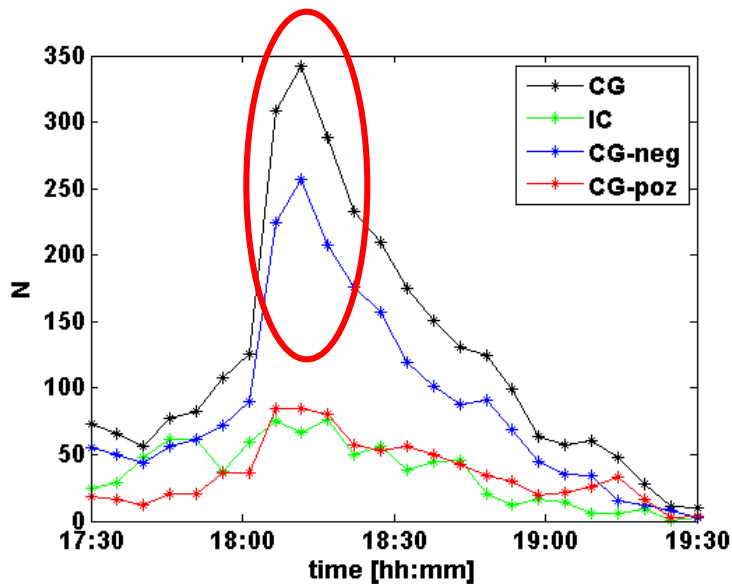
temporal and spatial distribution of
lightning strokes
>> compared to hail occurrence
and hail distribution

HAIL CASE 1: 30 May 2008

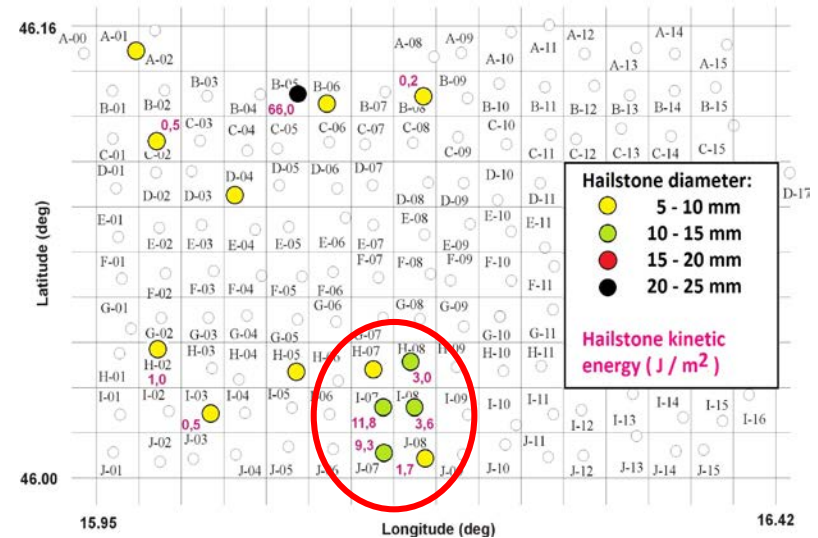


17:30 - 19:30 UTC lightning frequency

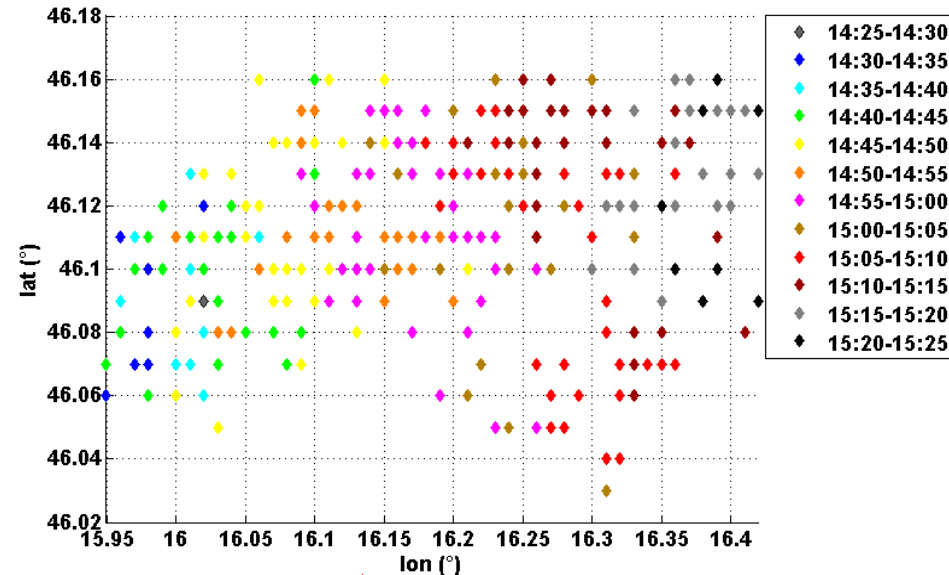
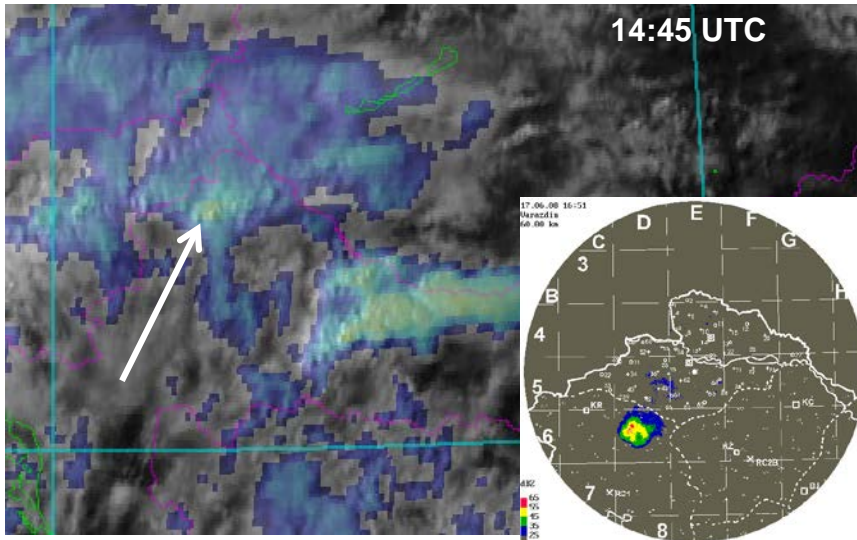




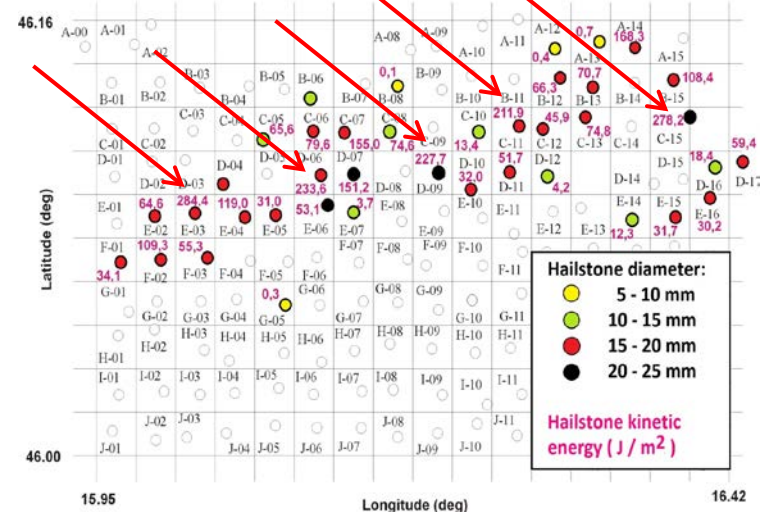
- ▶ **highest number of lightning strikes**
18:00 - 18:45 UTC - peak at 18:10 UTC
- ▶ **largest hailstones** (\emptyset 10 to 15 mm) with the highest value of kinetic energy
>> **at the beginning of the hailstorm** (18:00 - 18:10 UTC)
- ▶ coincides with the **time of the largest increase in lightning frequency**, especially negative cloud-to-ground lightning



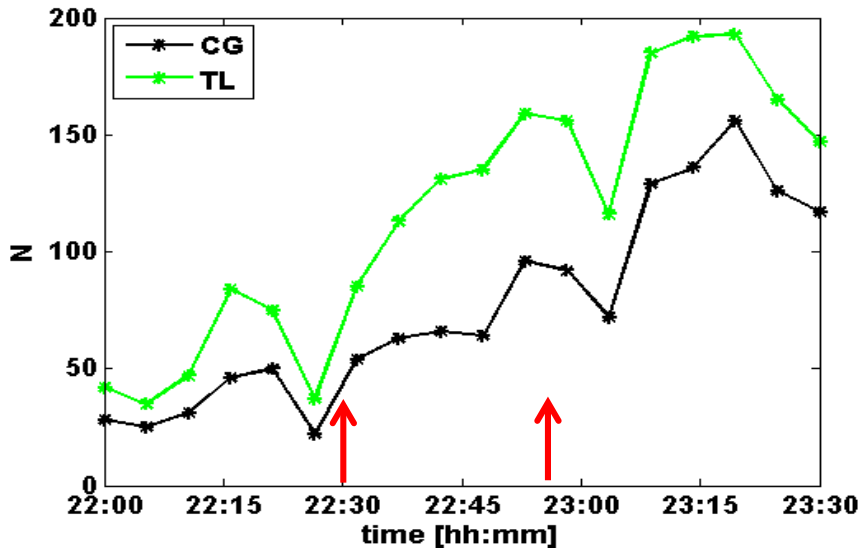
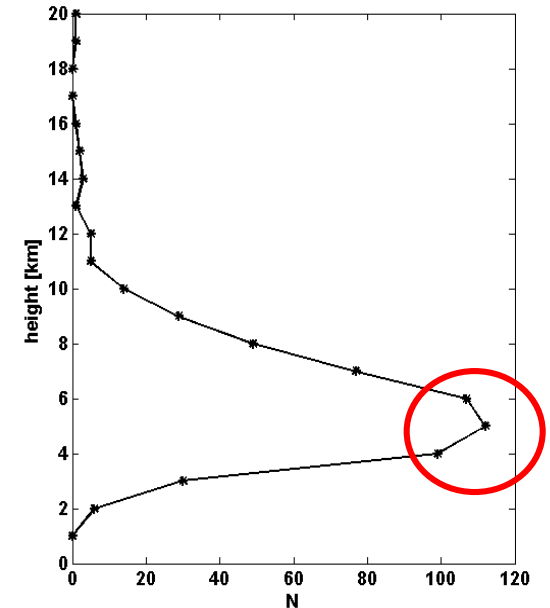
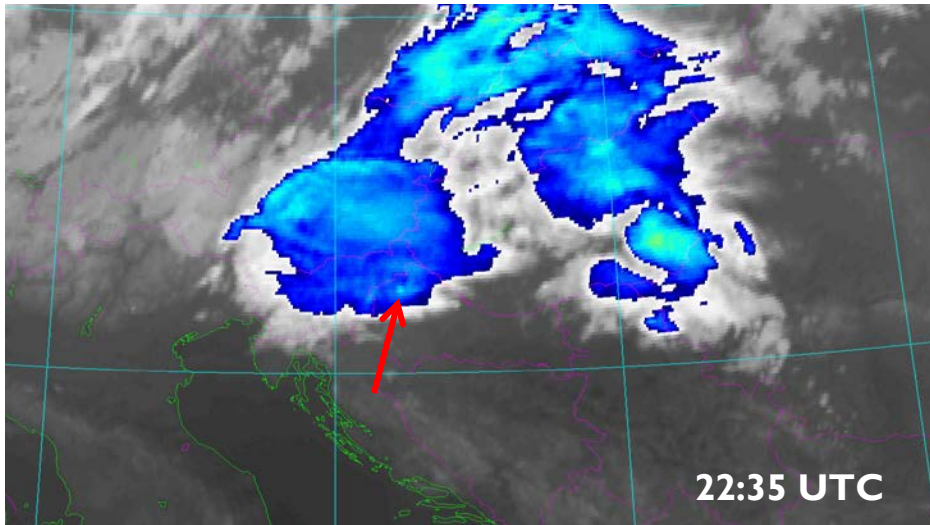
HAIL CASE 2: 17 June 2008



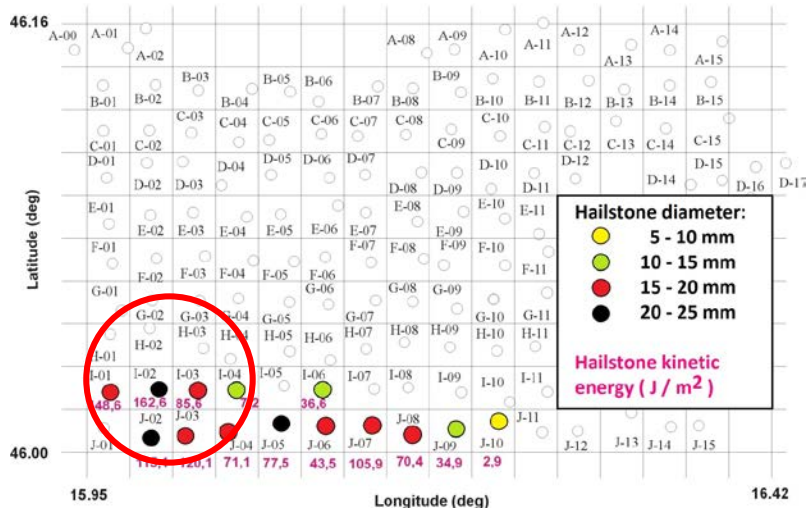
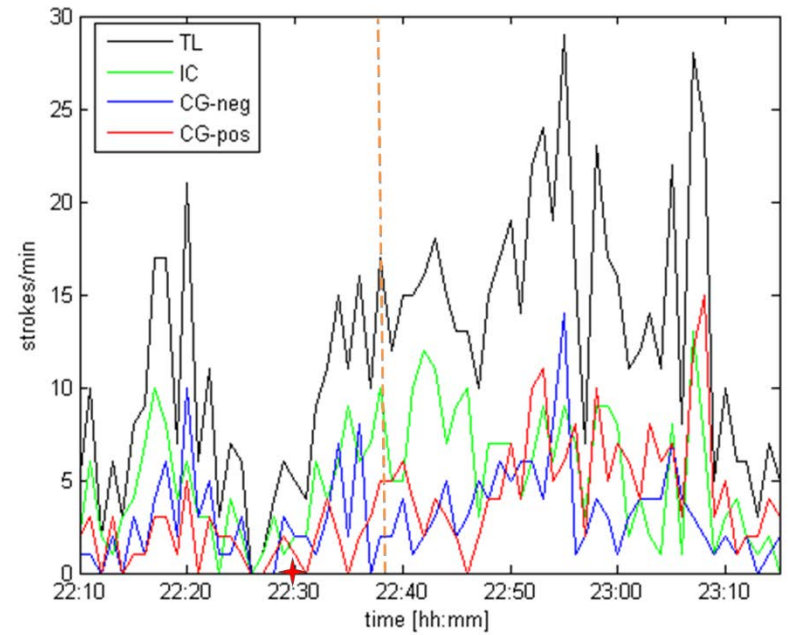
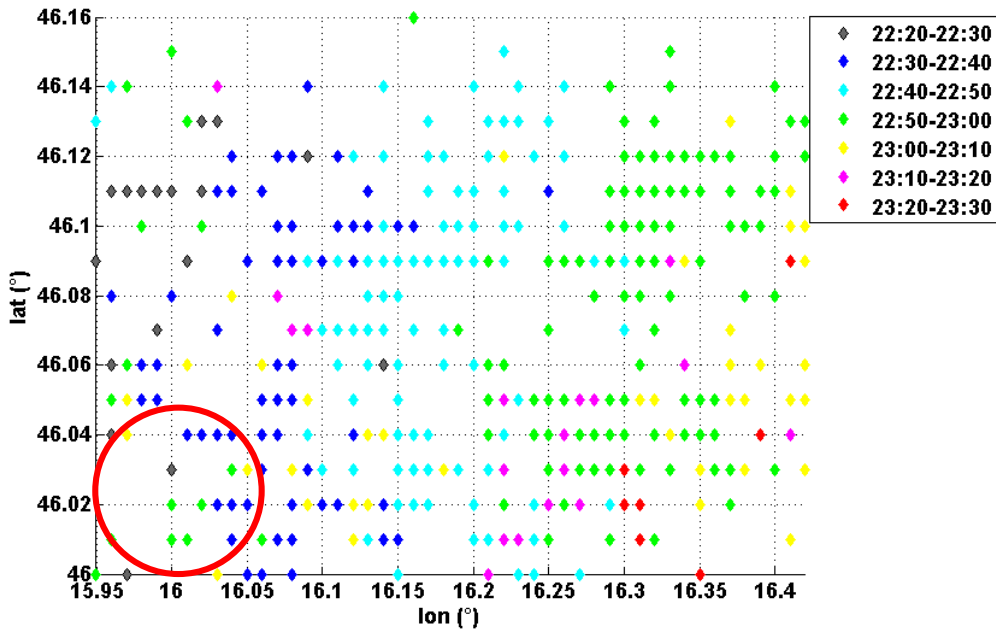
- ▶ During hailfall (14:40 - 15:30 UTC) distribution of maximum hailstone sizes and kinetic energy quite uniform along the storms' path.
- ▶ Hailstone kinetic energy of **100 to 200 J/m²** causes **heavy damages** and energy **>200 J/m²** **severe damages** to all plants.
- ▶ a case with **the largest maximum hailstone energies**



HAIL CASE 3: 11 July 2012

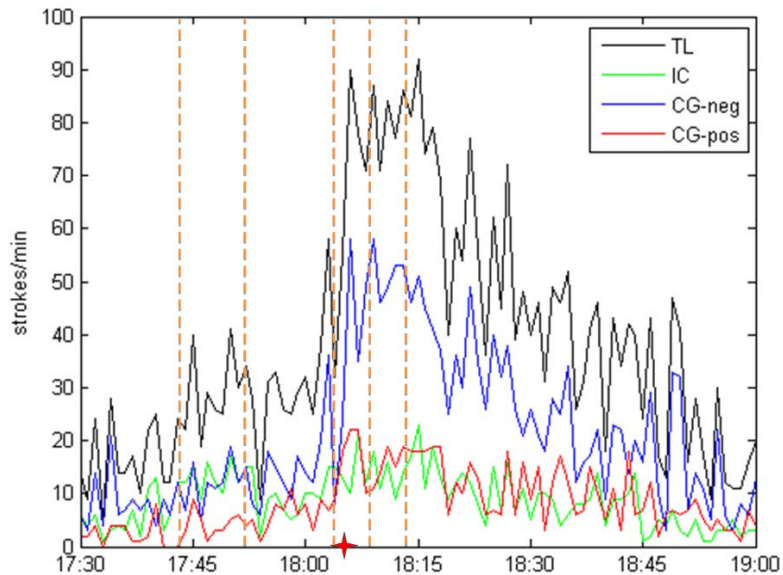


- ▶ cloud top temperatures above $-40\text{ }^{\circ}\text{C}$
>> **storm with warm tops**
- ▶ height of the tropopause above the storm $\sim 9.5\text{ km}$
- ▶ distribution of the lightning with height
>> **strongest lightning activity** was registered **between 4 and 7 km height**

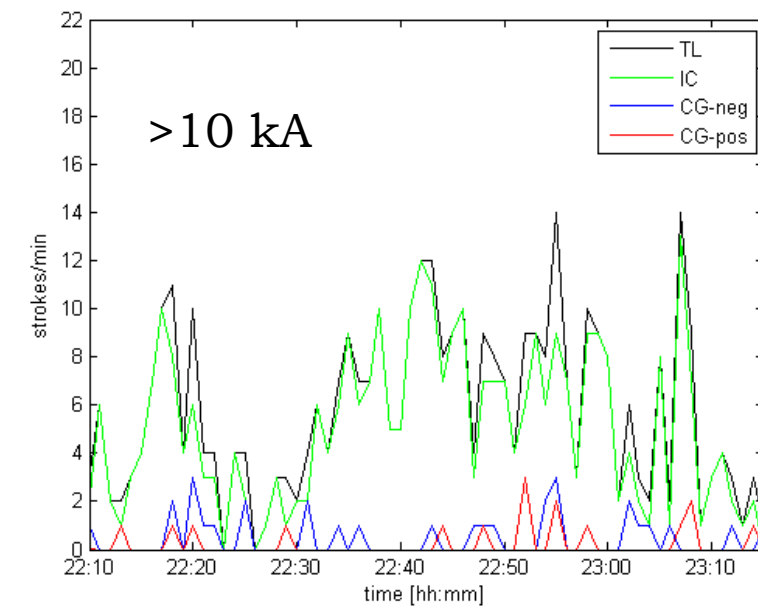
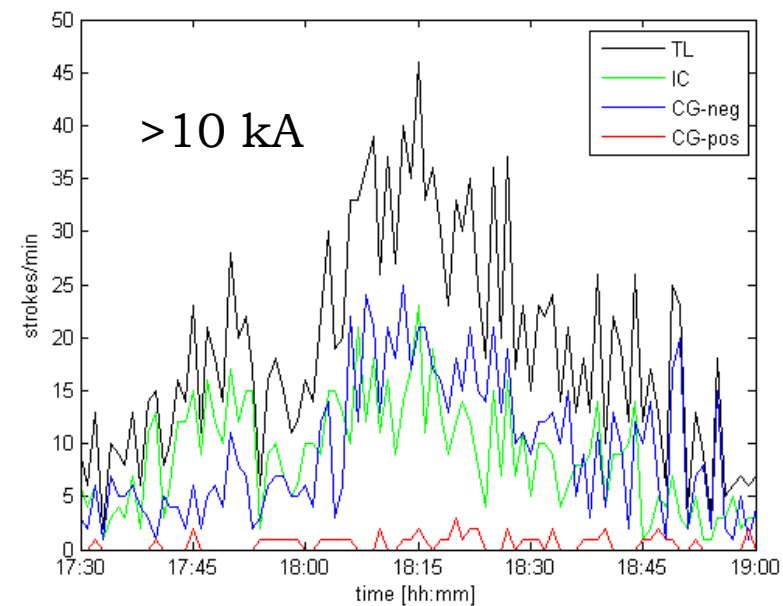
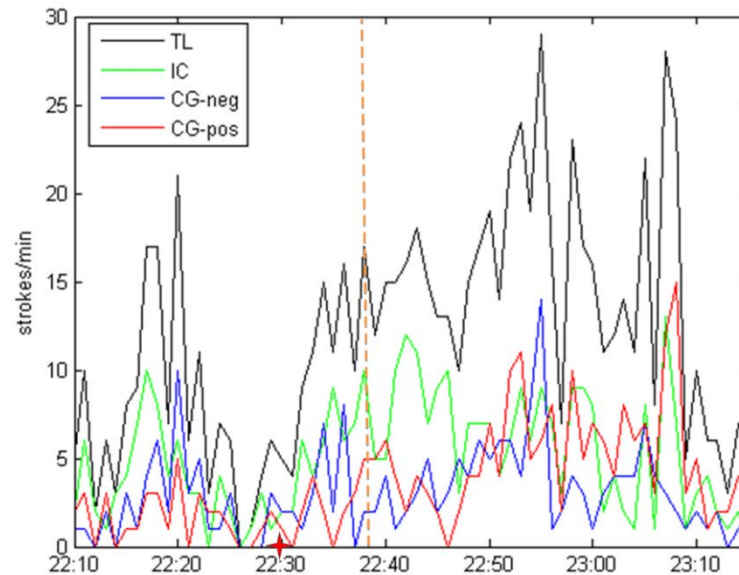


- ▶ lightning registered over broad area – hail only at the southernmost part of the polygon
- ▶ **largest hailstones** (Ø 15 to 25 mm) with the highest values of kinetic energy (110 – 160 J/m)
- ▶ >> at the **beginning of the hailshower** (22:30 to 22:50 UTC).
- ▶ coincides with the time of the **increase in total lightning frequency**

30 may 2008



11 July 2012



SUMMARY

- ▶ 35 hail cases at the hailpad polygon in NW Croatia in summer months 2008 - 2012 examined.
- ▶ **Number of total lightning strikes sharply increases at the beginning of hailfall.**
- ▶ **Larger hailstones with higher kinetic energy values appear at the beginning of the hailshower.**
- ▶ More IC lightning present when only currents > 10 kA considered
- ▶ **Total lightning information** is considered to be one of the best early indicators of a **strengthening updraft** within a thunderstorm