

DEFINITIONS

LIGHTNING JUMP: It is a sudden increase of lightning flash rate (Williams et al 1999). It is used for forecasting severe weather.

SEVERE WEATHER: Hail > 2 cm; Downburst; Strong gust wind.

INTRA-CLOUD FLASHES (IC): Discharges produced inside of the cloud.

CLOUD-TO-GROUND FLASHES (CG): Discharges produced from cloud to ground.

MULTIPLICITY: It is a capability of the LLS network to detect several nodes of the IC flashes. It is understand for «WITHOUT MULTIPLICITY» when only the first node of IC flashes is considered.

LEAD TIME: Difference of time between LJ – Observation.

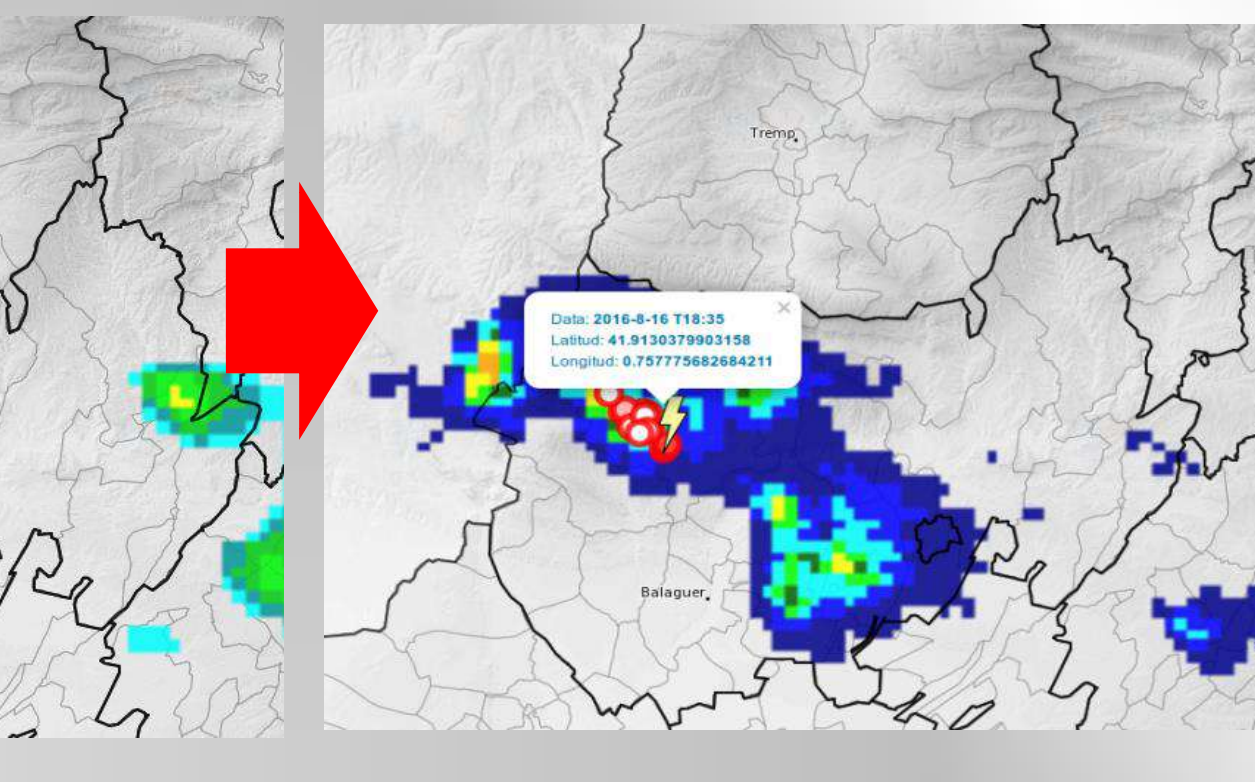
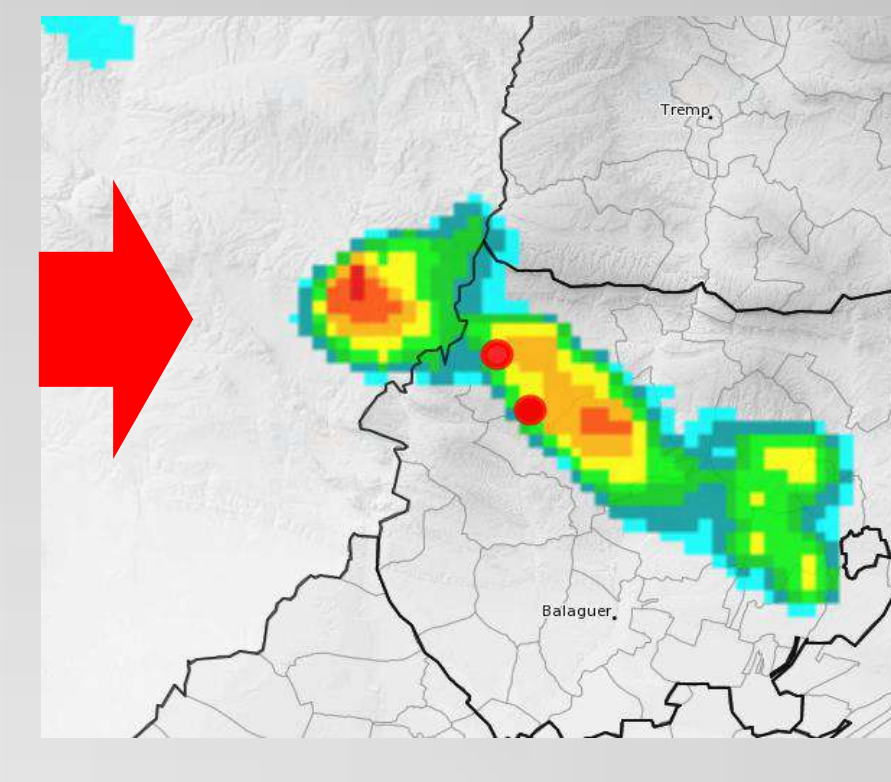
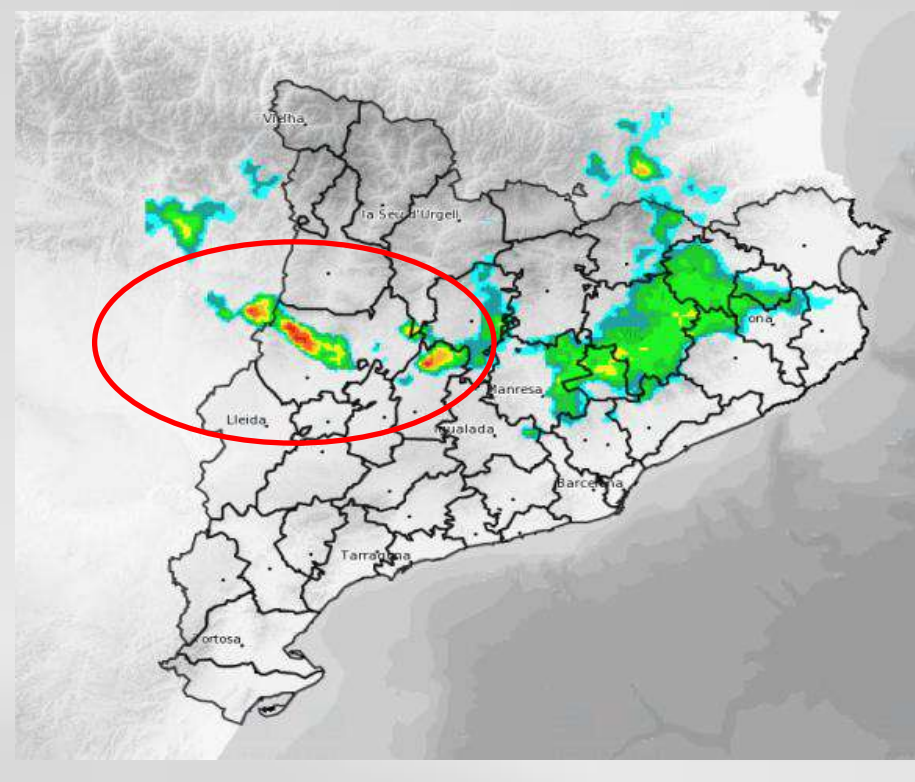
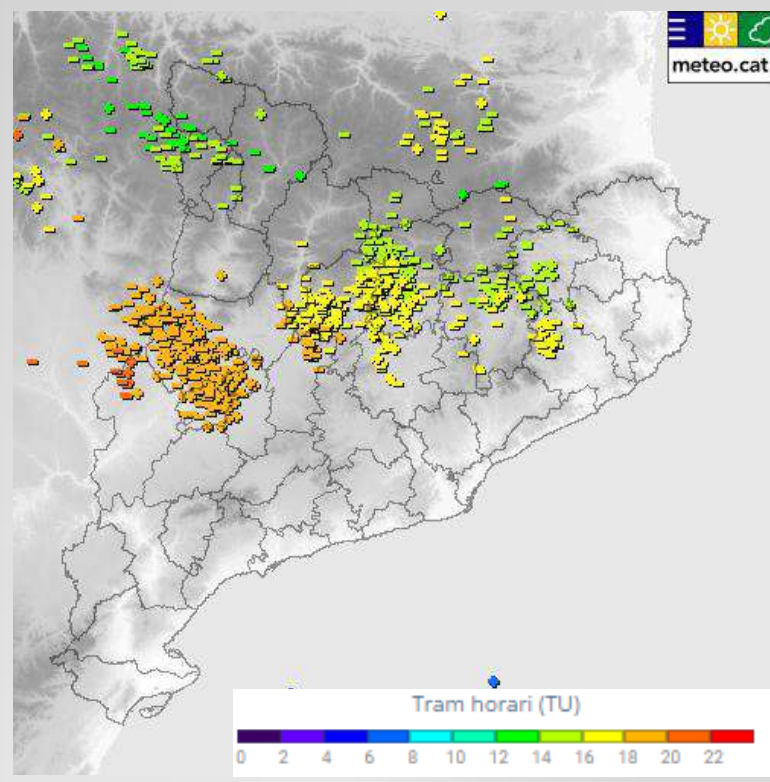


Algorithm (Farnell et al. 2017)

Operative

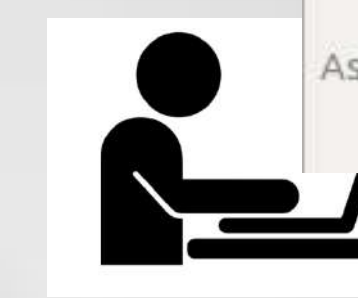
Example: 16th August 2016

1. Active cell is detected by flashes
2. 13 minutes are analysed according by the algorithm
3. The tool produces warnings when detects sudden increases of electrical activity



Thunderstorm related to hail around 3 cm, a local downburst and strong wind. It can be see the path of the electrical activity during the 13 minutes before of the LJ. Moreover, the characteristics of LJ, like latitude, longitude and time, are shown.

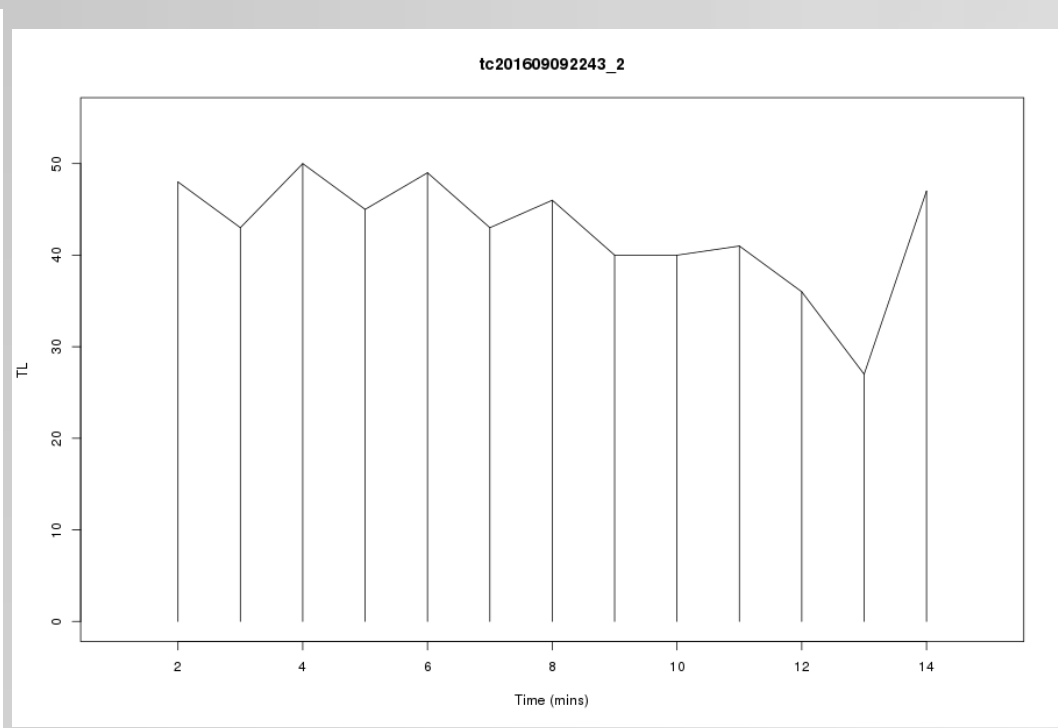
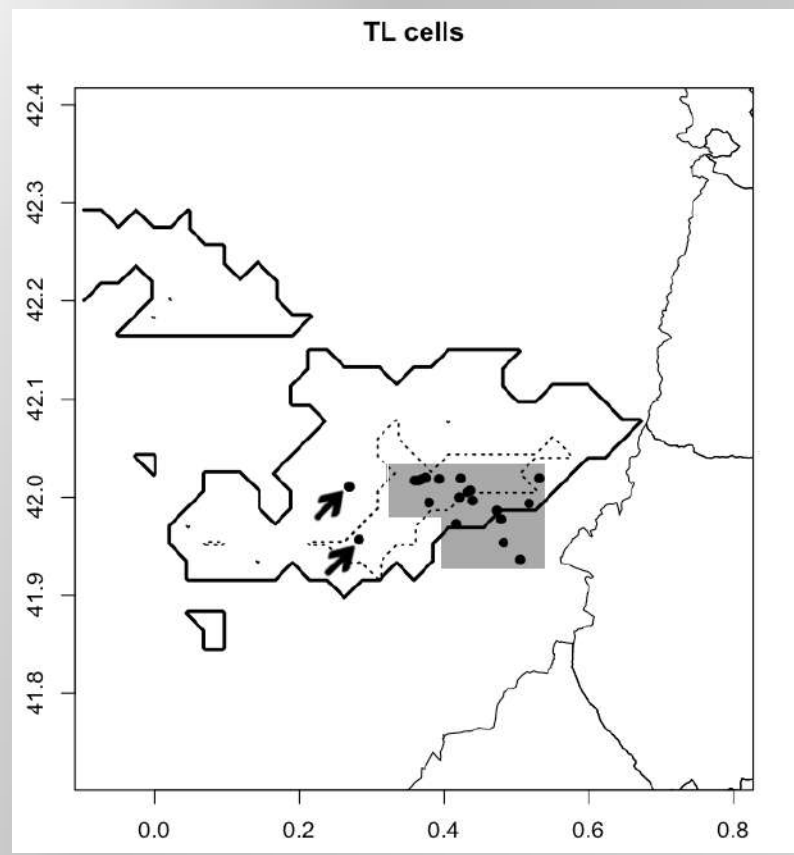
When the LJ is activated, the forecasters receive an email where can see the hour and the location. This information is accompanied by a map.



De nobody@meteo.cat
 Asunto: LJ 2016-09-09/22:44:16 Alguaire;Segrià,0.61894791112766,41.7540155491064
 A Rigo Ribas, Tomeu



Using this warning forecasters could provide alerts To users with 40 min in advance (for this particular case).



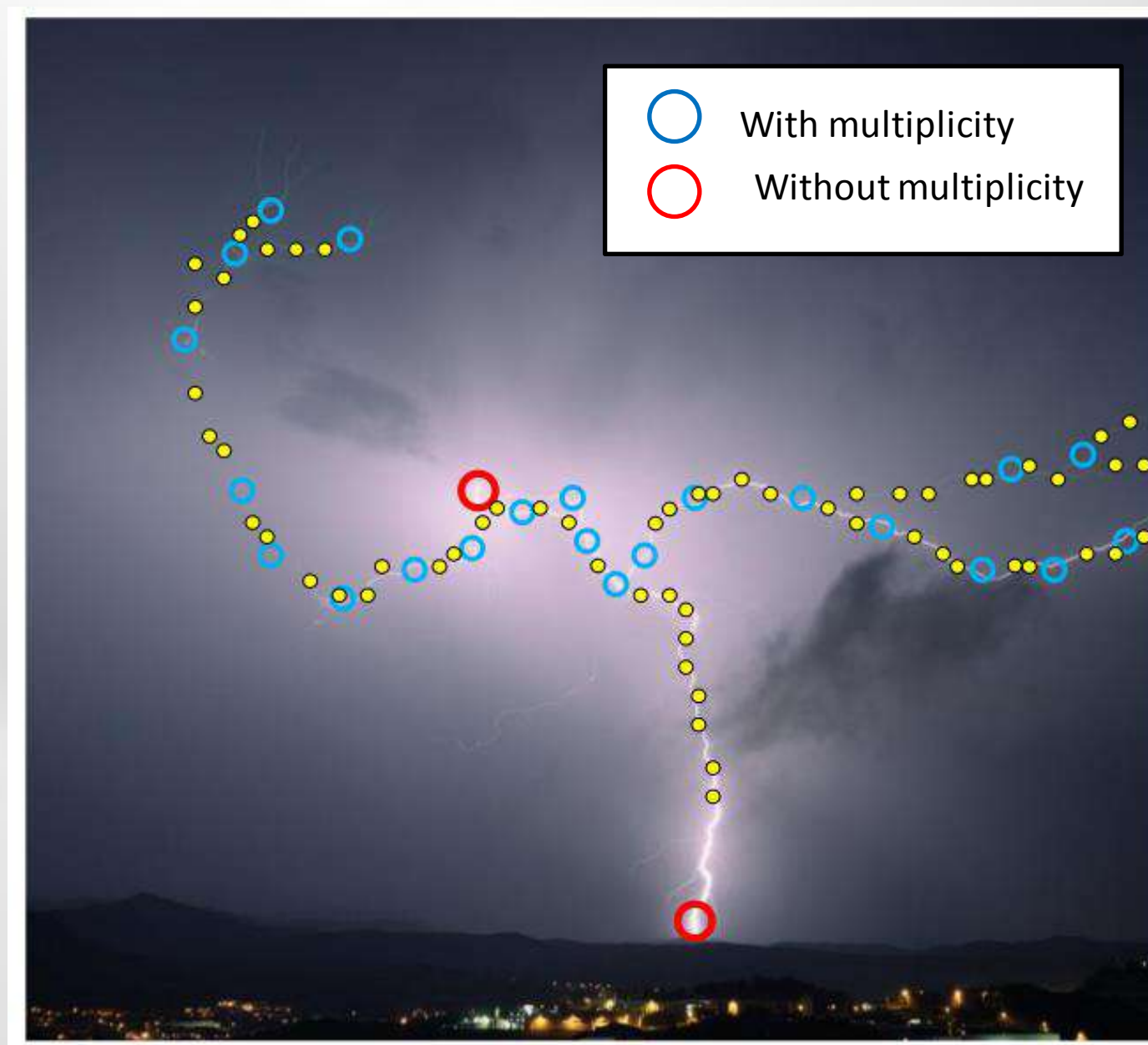
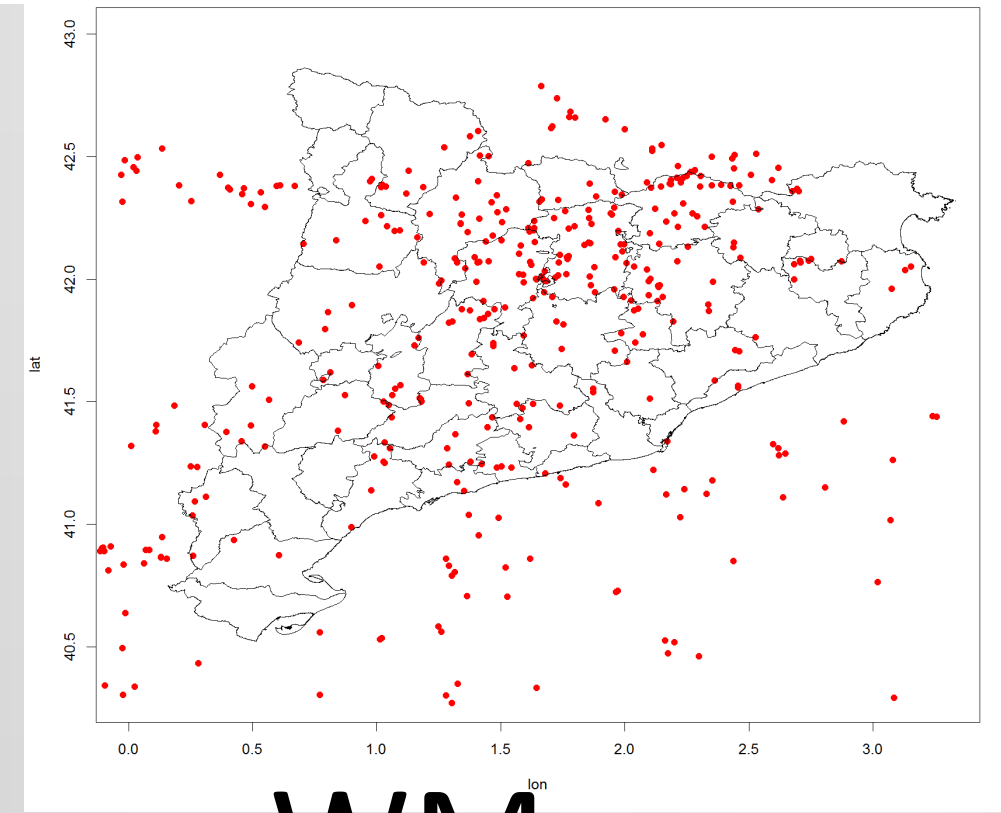
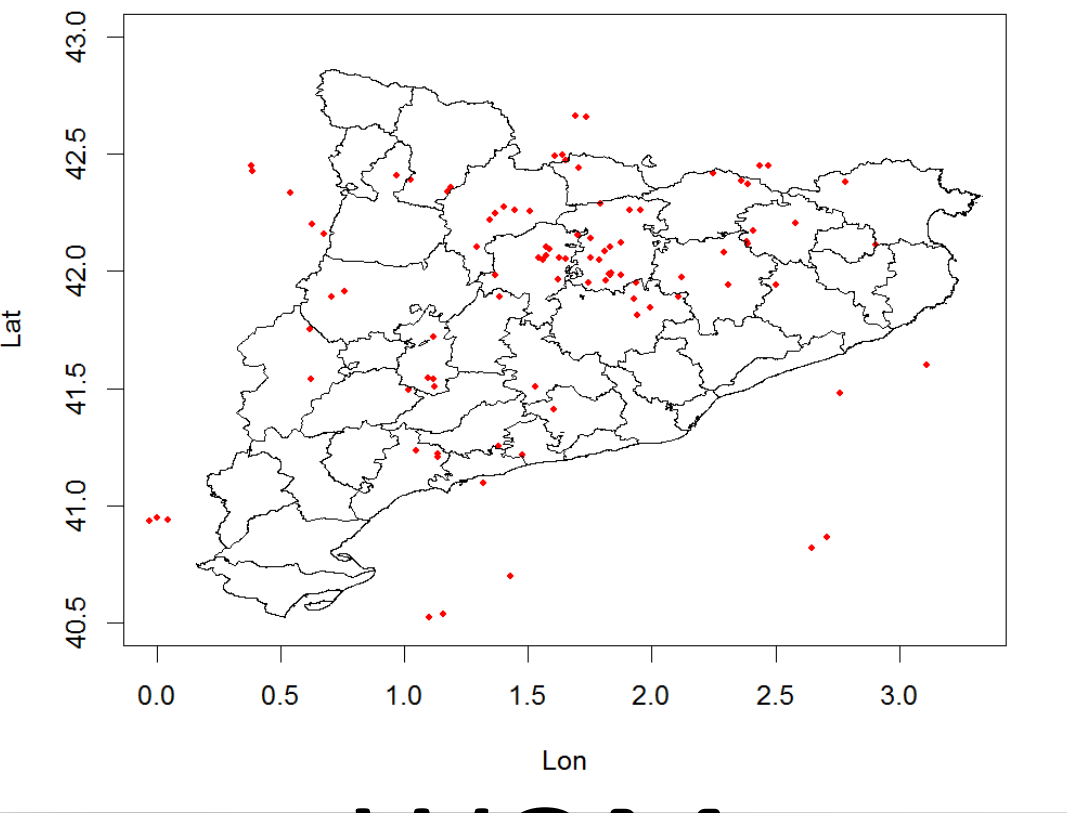
It works using **TOTAL LIGHTNING (TL):** Intra-Cloud flashes + Cloud-to-Ground flashes.

| Type of Lightnings | CG | TL (CG+IC) |
|-------------------------|----|------------|
| Alerts LJ (2006 – 2013) | 6 | 630 |

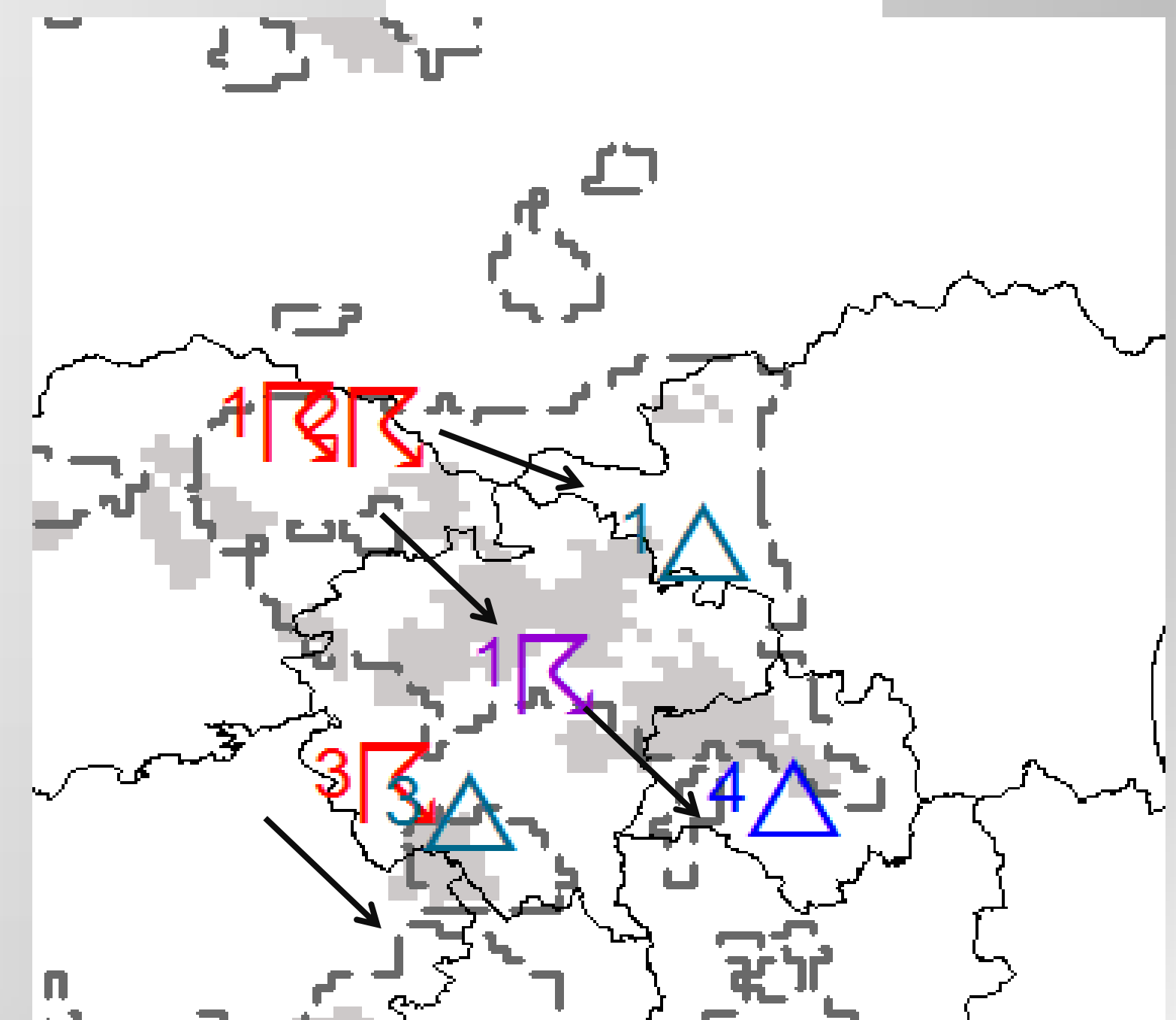
With Multiplicity (WM) vs Without Multiplicity (WOM)

2016 Warnings

The number of LJ taking into account multiplicity is higher than not considering the multiplicity.



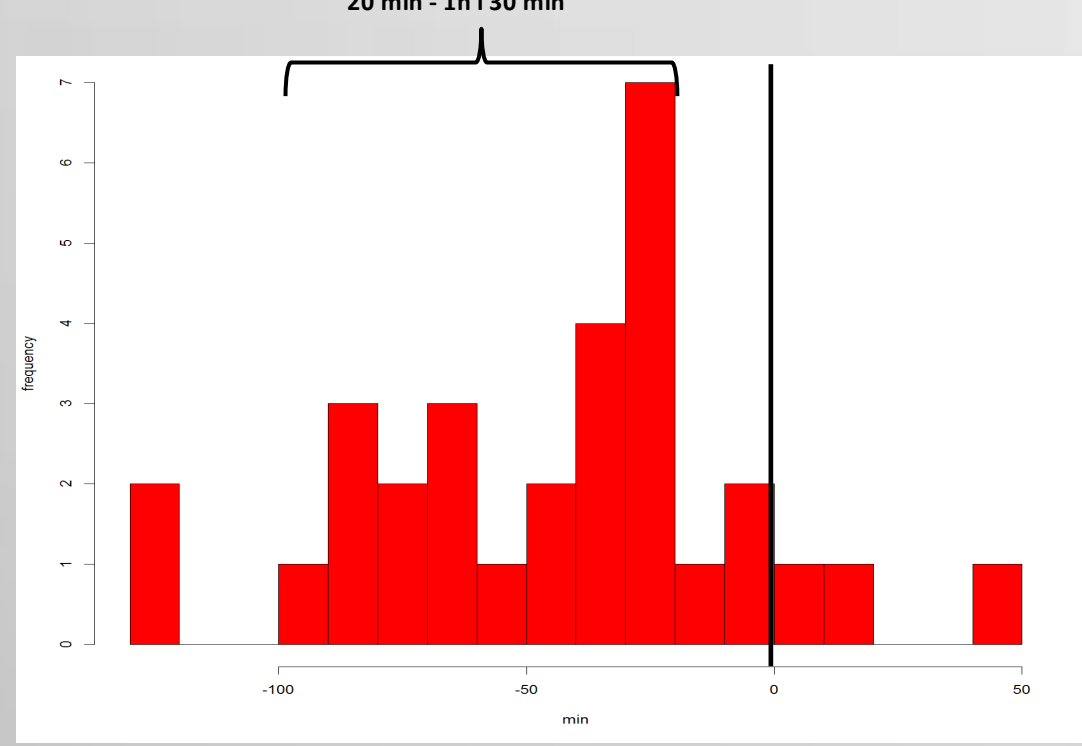
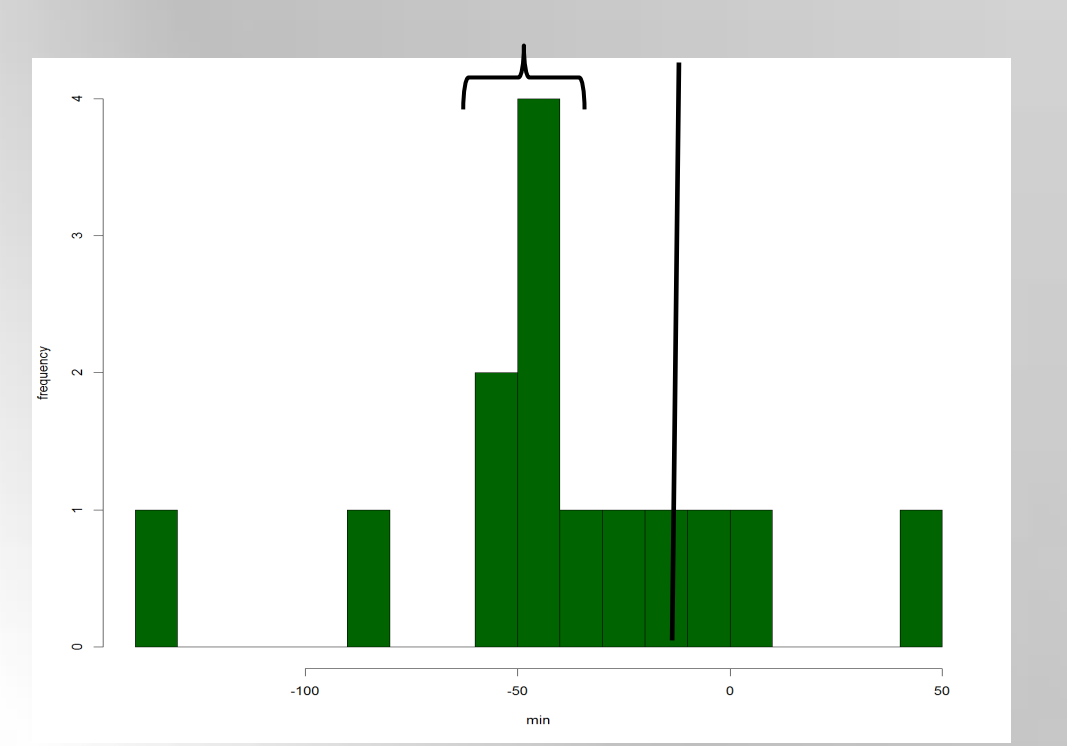
CASE OF STUDY



| LJ wom | LJ wm | Small hail | Severe Hail |
|--------|-------|------------|-------------|
| UTC | 12:36 | | |
| | 12:43 | 13:00 | |
| 13:14 | 13:19 | | 14:00 |

More warnings of WOM, but WM one adjusted better to severe weather occurrence.

Lead Time



The Lead Time WM is larger than WOM.

The most of the LJ warnings were triggered between 20' - 1h 30' before the observation.

Application of the tool for improving the location of wind mills

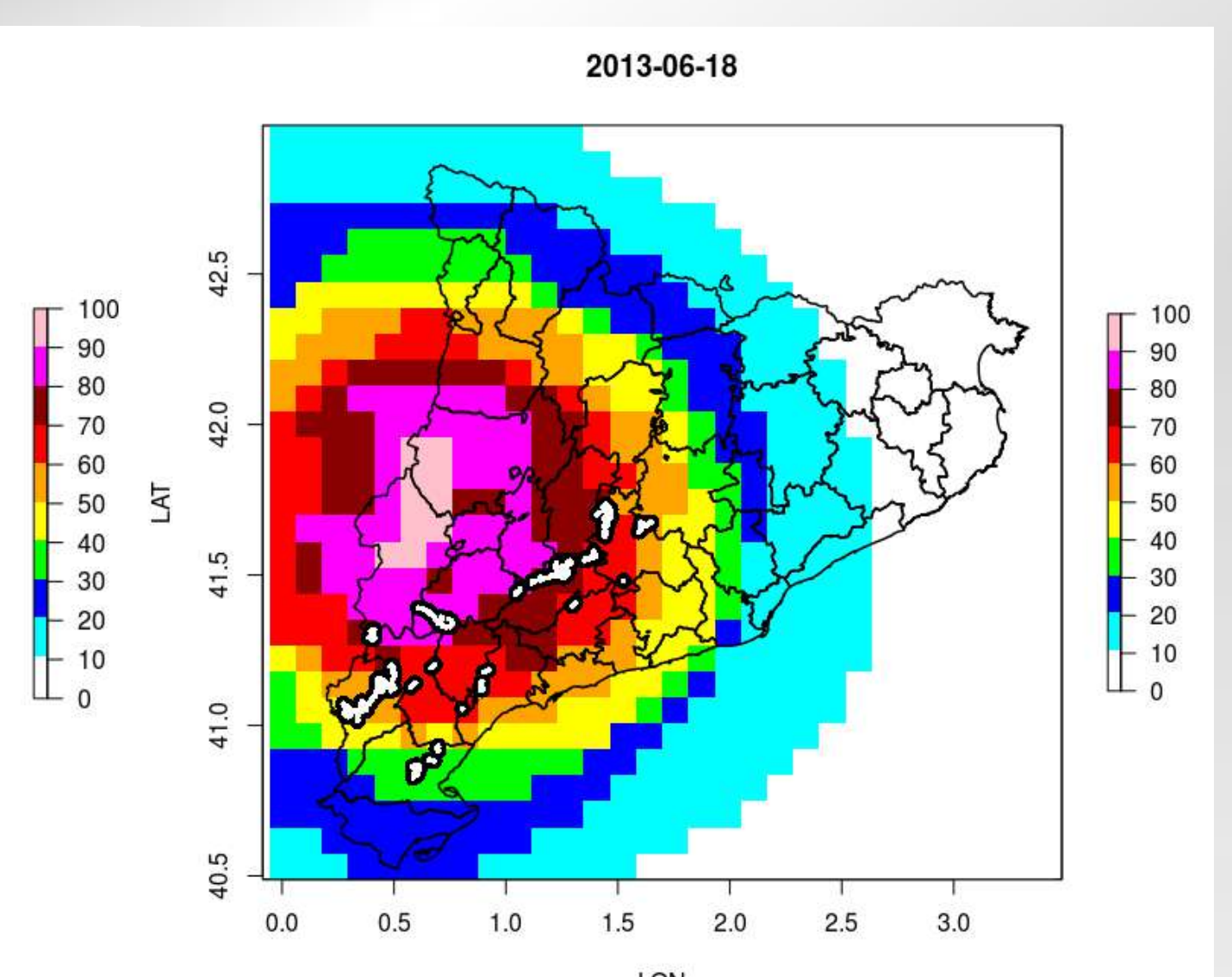
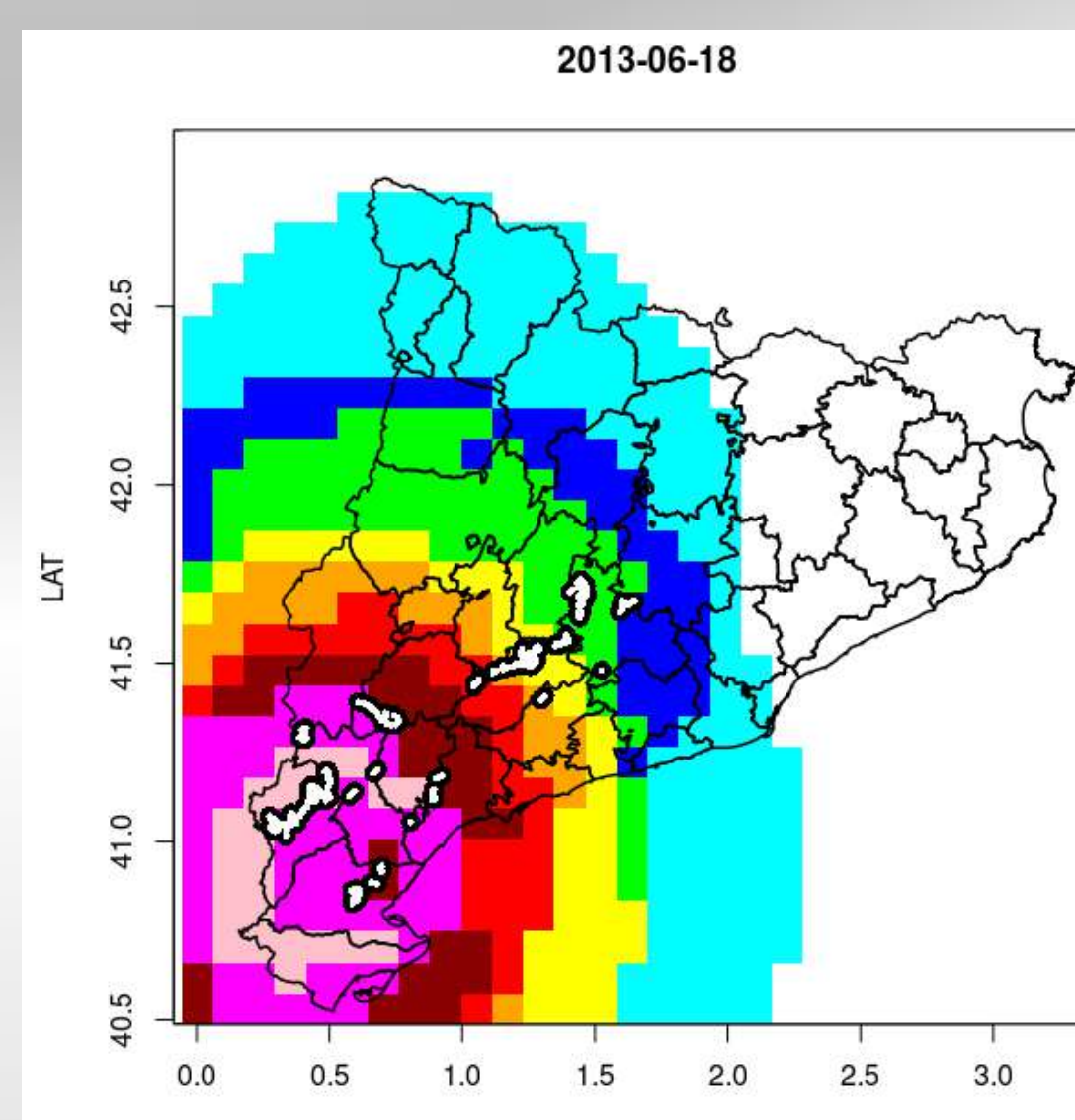
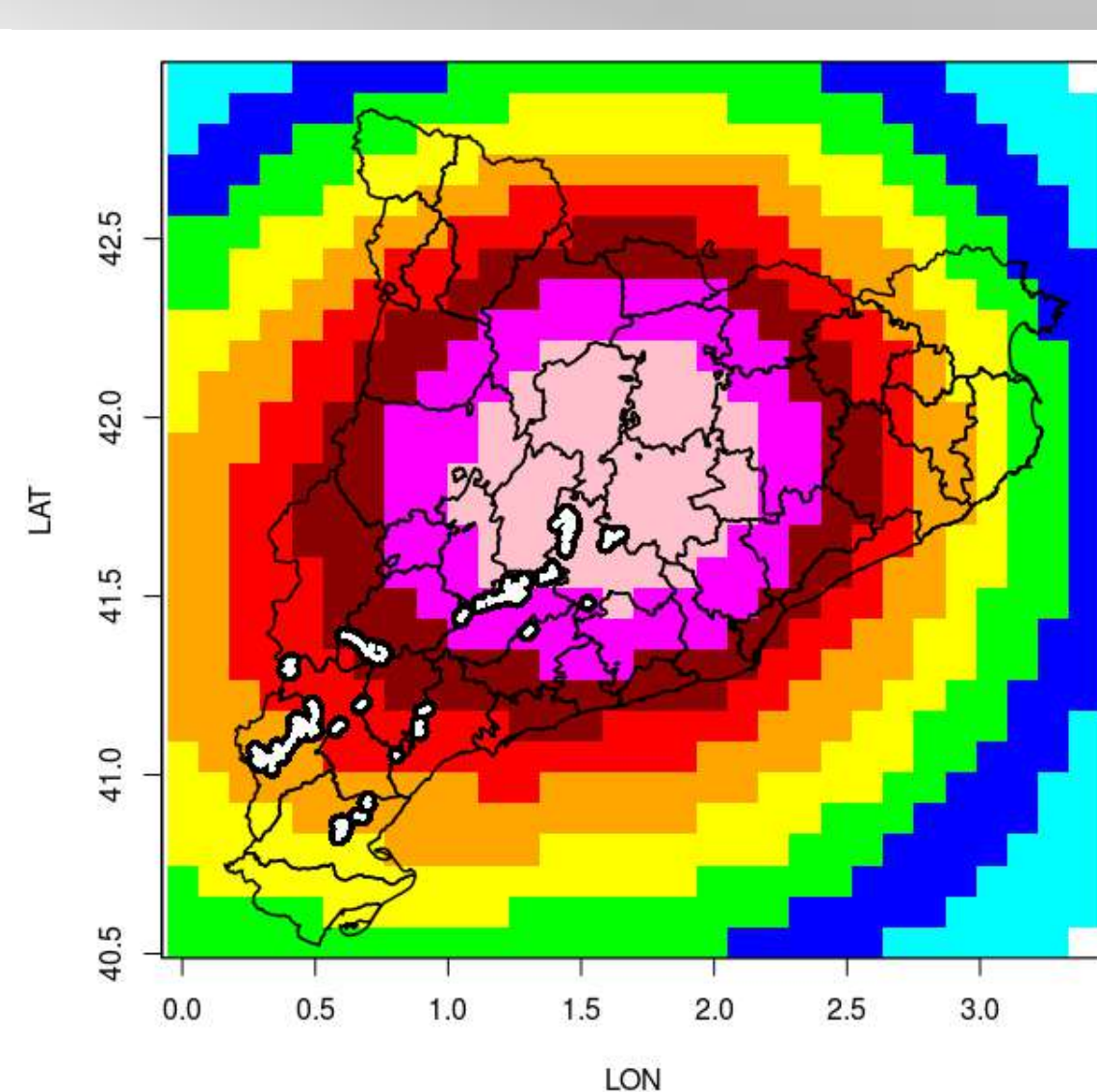
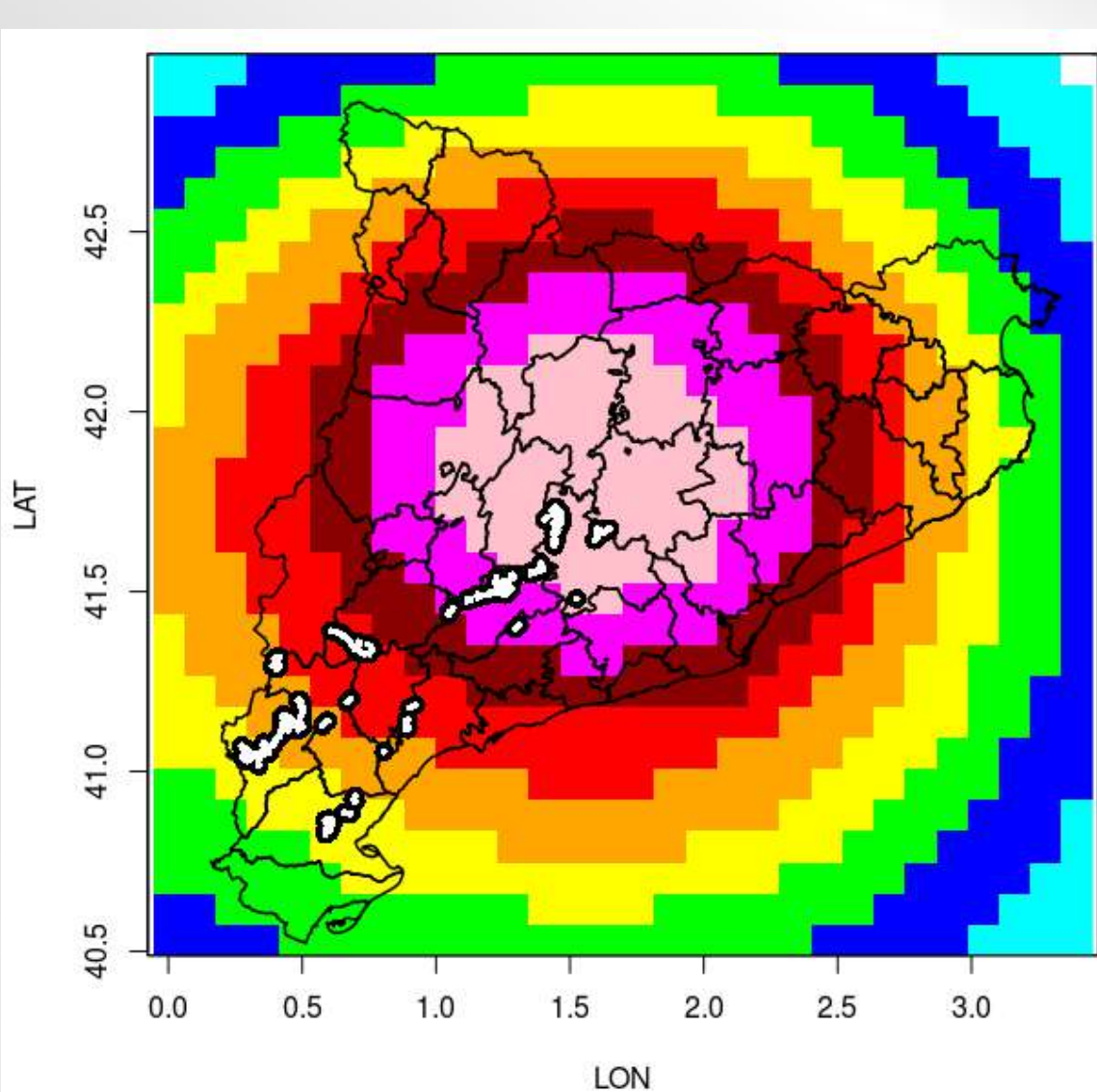
The technique is applicable to other users. This is divided in two parts:

1) Previous to the installation of mean sensors (wind mills, solar panels ...)

2) Warning in real-time.

Considering the climatology of warning, the maps of SW affection an be developed (areas more prone to be affected)

Taking into account the warnings, production can be stopped and the systems can be protected



In all figures, red to pink areas (>60) indicates areas more prone to be affected (climatological –left cases- or individually/real-time –right cases-). Black and white dots are current wind mills. (source: Institut Català d'Energia).

References

Williams, E., Boldi, B., Matlin, A., Weber, M., Hodanish, S., Sharp, D., ... & Buechler, D. (1999). The behavior of total lightning activity in severe Florida thunderstorms. *Atmospheric Research*, 51(3), 245-265.
 Pineda, N., Béch, J., Rigo, T., & Montanyà, J. (2011). A Mediterranean nocturnal heavy rainfall and tornadic event. Part II: Total lightning analysis. *Atmospheric research*, 100(4), 638-648.
 Farnell, C., Rigo, T., & Pineda, N. (2017). Lightning jump as a nowcast predictor: Application to severe weather events in Catalonia. *Atmospheric Research*, 183, 130-141.

Acknowledgements

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