A new severe weather warnings system to very short term, based on the lightning jump technique

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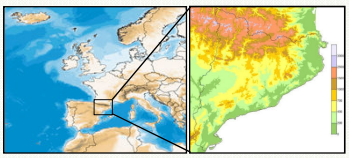
AREA OF STUDY

Catalonia is located northeast the Iberian Peninsula, on the Mediterranean side. This area covers more than 30.000 km².



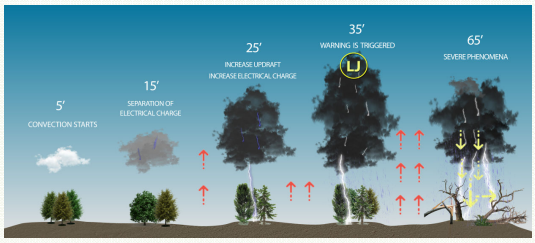
MOTIVATION

Severe Weather events (hail, tornadoes or waterspouts, downburst and strong wind gusts) ocurred about 12 times a year in Catalonia. Lightning Jump is a technique to forecast these events between 30 min and two hours in advance. It is a very useful tool for nowcasting.

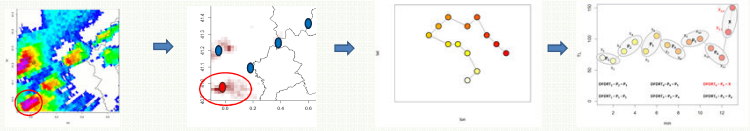
LIGHTNING JUMP TECHNIQUE

Lightning Jump (LJ) is a sudden increase of the total number of lightning rate (Williams et al. 1999). It is a consequence of strong updraft which favours the crash between ice particles and a higher separation of the charge (Williams, 2001).

Conceptual Outline



Algorithm



Each minute, all the thunderstorms are analyzed

Flashes are grouped in thunderstorms. Their centroid characterizes the position of the convective cell.

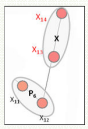
Coordinates, hour, flashes number, size and track are analyzed every minute.

The average of total lightning (TL) is calculated in a two minutes period (P$_i$).

$\sigma = \{DFDRT_1, DFDRT_2, DFDRT_3, DFDRT_4, DFDRT_5\}$

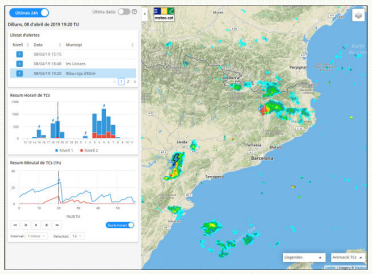
σ variance

$\sigma * 2 < DFDRT_6$ ⇨ LJ

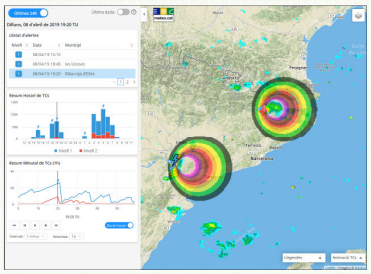


THE SEVERE WEATHER WARNINGS SYSTEM

An specific software has been developed to visualize LJ. The software shows the level (with or without multiplicity), time and position of every LJ. Also a summary of hourly flashes (TC) evolution is plotted.



When a LJ warning is triggered, the software estimates a forecast tracking for the center point with radar data (Rigo and Llassat, 2016) and overlaid it on the map.
Forecaster analyzes the different probability levels of occurrence in the next two hours.

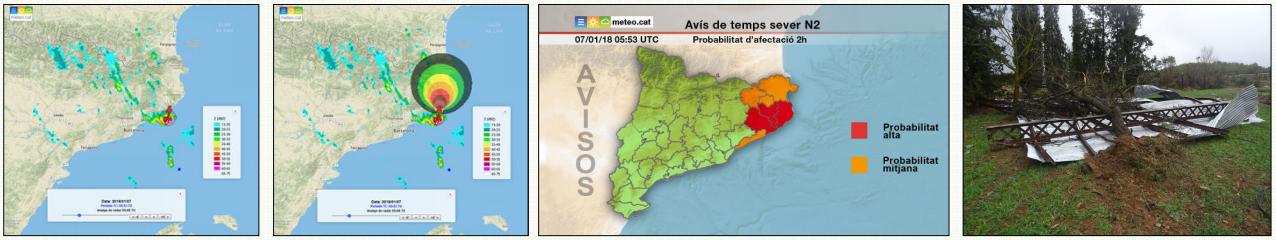


EXAMPLES

A pilot severe weather warning system was tested during 2018 with the aim to be operational in the future. If a LJ level 2 (LJ without multiplicity) is detected, a very short term warning is issued using the tracking tool. Warning are divided into two different levels, moderate and high probability.

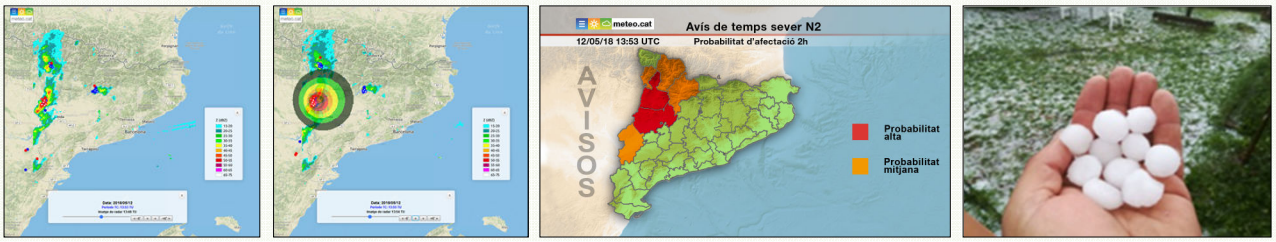
07/01/18

Tornado
Large Hail



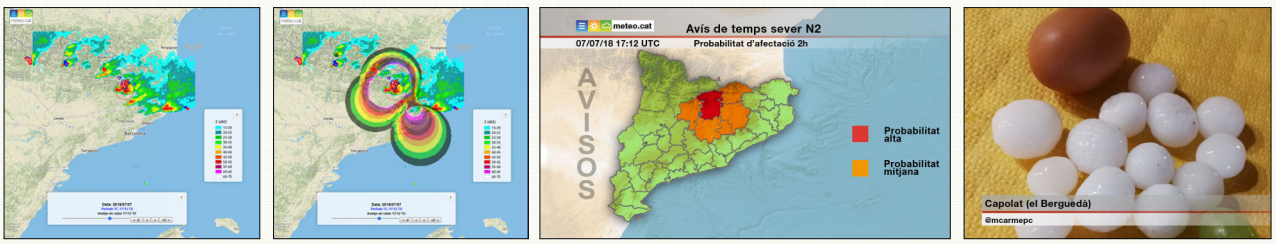
12/05/18

Heavy Rain
Large Hail



07/07/18

Heavy Rain
Large Hail



RESULTS AND VERIFICATION

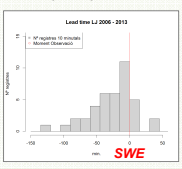
LJ verification

Period	#events	POD	FAR	BIAS
2006-2013	49	0,73	0,11	0,70
2016	69	0,94	0,25	1,00
2017	109	0,82	0,22	1,01
2018	146	0,88	0,19	0,89

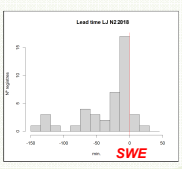
Severe Weather warnings verification

Period	#events	POD	FAR	BIAS
2018	59	0,86	0,01	1

Lead Time (LT) is defined as the time between LJ2 and a severe weather event (SWE).



On 2018, LT was lower than observed in the previous years (Farnell et al. 2017), likely due to the static characteristics of storms during 2018.



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