The advantages of using intra-cloud data for severe weather warnings

The Lightning Jump phenomenon

It is associated with strong updrafts, this is, a powerful charg e separation (Williams 2001). Its detection is used as a predictor of severe weather (Hail > 2 cm, downbursts, strong wind gusts, and tornadoes/waterspouts). The tool used in the SMC is an adaptation of the Schultz et al. (2013), but using exclusively flashes (instead of radar and lightning data), and takes profit of the capabilities of the LLS.

ARE CG ENOUGH?

The Experiment

The LLS tool has run off-line over 873 days with lightning activity over the region of study (Fig. 1), with severe weather records in the same day (D), or the contiguous (D-1, D+1). Period of analysis: 2006-2015. Different configurations of TL flashes:

- Only CG, without any IC (LLW0)
- CG plus IC, with multiplicity (LLW1)
- CG plus IC, without multiplicity (LLW2)

1. Number of warnings for each configuration

The number of alerts considering only CG was of 6. On the contrary, using ICs the number has been 3874 (LLW1) and 1388 (LLW2).

2. Cases where CG flashes only are enough

We have focused in characteristic brief events with LWO (Fig. 6): in all cases the warnings occurred near or after the event, with the LWO short duration (14 minutes of flashes activity (necessary for the triggering of alerts)), with LWO (2016) in average and LWO (LLW2) in average. Moreover, no LWO were triggered in most of the severe hail events (>3 cm) occurred in Catalonia for the period of analysis.

3. TL evolution in LW

The evolution of TL before the warning is very variable, depending on the type of data used (Fig. 7). The number of CG flashes is near a third of the TL in LW2 and ~5% in lower cases, even in the same categories. Taking into account that a LW2 needs continuity in time and space of LW (Ferrall et al., 2017), it is complicated the triggering of alerts in many events, when CGs are null in a large part of the time.

4. Areas more prone to be affected

Fig. 8 shows the spatial distribution of the three types of LW. Maps of LW1 and LW2 show a similar pattern, with a maximum in the Central part (black ellipse). On the opposite, the few LW2 have occurred over the Sea and the Coastal areas, being probable a sea influence in those cases.

5. Seasonal distribution of LW

Fig. 9 presents a bi-monthly distribution of LW1 and LW2, with the maximum centered between July and August. LW1 have occurred only during August to October (the period when the Sea surface temperature reaches max values).

CONCLUSIONS

We have shown that severe weather cannot be forecasted using only CG flashes, because:

- The rates are low, without a continuity of the 14 minutes of flashes activity (necessary for the triggering of alerts).
- The low rates cannot help to a rising of the flashes activity exceeding the double of the standard deviation of the previous twelve minutes (main condition of the LL, see Ferrall et al., 2017).
- The influence of sea is observed in those cases with LW0, however, most of severe flashes weather events occur in area far to the coast, except waterpools.

We strongly suggest the separate identification of IC and CG, considering both types of flashes for the application of the LLS algorithm.

References


The probabilities of lightning and severe weather: A comparison between total and cloud-to-ground lightning trends. Weather and Climate Extremes, 3(4), 242-250.