



Operational use of the Lightning Mapping Array for tracking, nowcasting and warning about severe weather

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In order to overcome the legacy of perceiving lightning information as tertiary in importance for weather surveillance tasks, this study documents severe weather signatures observed by the largest Lightning Mapping Array (LMA) network operating in Europe. Weather offices like *Servei Meteorològic de Catalunya* (SMC) are taking advantage of total lightning data in real-time in the short-term forecast process, as well as for the automatic generation of severe weather warnings.

The joint venture of the Polytechnical University of Catalonia (UPC) and the SMC has allowed the deployment of a network of more than 20 LMA stations to cover Catalonia and its surroundings (NE of the Iberian Peninsula).

The LMA system locates the impulsive very high frequency (VHF) breakdown processes produced by the lightning channels. Each LMA station records the time and magnitude of the electromagnetic radiation received in successive 80 μ s intervals and relays, in real-time, this information to the base station. With data from 5 or more stations, processed with the time-of-arrival technique, the system calculates the horizontal, vertical, and temporal location of each source. Typically, hundreds of sources per flash can be reconstructed, which in turn produces accurate three-dimensional lightning image maps. Indeed, these VHF sources then can be used for various operational products in either their raw form (i.e., source densities) or recombined into flashes.

Since lightning discharges tends to connect opposite charged parts of storm, plots of the density of LMA resolved sources reveal features of severe-storm structure, complementary to those revealed by the weather radar. Animations of lightning density can reveal strong updrafts (overshooting tops, V-shaped patterns), storm intensification (lightning jump) and early stages of a mesocyclone (transient minimum in lightning density, also named lightning “holes”).

In this work, LMA severe weather signatures are presented, corresponding to tornadic supercells and large hail events occurred during the 2023 thunderstorm season.