Life cycle study of convective structures using an object oriented methodology for total lightning and radar data

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The main objective of the present study is to obtain a life cycle model for convective structures, with the purpose to improve the operational nowcasting and weather surveillance at the Meteorological Service of Catalonia (SMC).

Lightning data was collected by the SMC SAFIR system, composed of three stations that combine a VHF interferometer with an LF antenna, allowing the detection of both intra-cloud (IC) and cloud-to-ground (CG) lightning. In the other hand, the SMC radar network (XRAD) is formed by three C-band Doppler radars, which generate complete volumes (14 elevations) every 6 minutes. The product used in this study is the composition of the maximum reflectivity in each pixel of a grid, which has a resolution of 2x2 km2, and 10 CAPPIs in the vertical separated by 1 km. The 2D radar structures (XRAD2D) are areas that verify the following conditions: $Z > 12$ dBZ, and area > 24 km2. The XRAD2D structures are characterized by the position and area, reflectivity (max and mean), top (max and mean), and the percentage of convective precipitation. The 3D radar structures (XRAD3D) are volumes which exceed one of the defined reflectivity thresholds (30, 35, 40, 45, 50, 55, 60, or 65 dBZ) in different levels, and are characterized by their position, volume, reflectivity, and echo top height. Besides radar structures, lightning structures are also considered. First of all, all IC and CG flashes identified in the same time period of the radar volume (six minutes) are selected. Next, for each IC flash detected, a circle with a radius of 5 km is defined. All the circles connected are considered in the same structure (XDDEIC). CG flash structures (XDDECG) are calculated using the same methodology. Afterwards, some parameters are defined for each IC and CG structure: number of flashes, density (maximum and mean), position, and area. Once the XRAD and XDDE structures are identified, the methodology for combining both is applied: identification of areas where at least one type of structure (XRAD2D, XRAD3D, XDDEIC, or XDDECG) has been identified for every pixel; determination of the complete area of lightning/radar activity; at last, a small growing of the structures is done in order to join closed structures and avoid merging or splitting. Once the structure is identified, the characterization is made considering: the area, number of structures of each type, position, etc. Finally, the tracking in time of the structure has been done in order to obtain the evolution of all the parameters in summer thunderstorms, from 1st July 2006 to 30th September 2006.