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Evolution of radar and lightning parameters in summer thunderstorms

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The life cycle of a thunderstorm from the point of view of the weather radar and lightning activity can be divided in three stages: development, maturity and dissipation. In the development updraft is the predominant motion, allowing the growth of the water particles and the separation of electric charges. First echoes are observed by the radar as well as the first intra-cloud flashes (IC). In maturity equilibrium exists between downdraft (produced by the weight of the drops) and updraft. The descendent draft is the responsible of the generation of a cold pool and a gust front, that will be more intense as more strong is the draft. During this stage the most intense radar echoes are observed at low levels. At the beginning of this stage, first cloud-to-ground flashes (CG) are observed. Moreover, during the maturity is observed the maximum lightning activity. Finally, in the dissipation phase, downdraft is the unique motion inside the cloud. Rain rates are fewer than in the previous stage in consequence reflectivity values are less important than in the maturity. Lightning activity decreases gradually until its complete conclusion.
One of the aspects that can relate lightning activity with radar echoes in single cell thunderstorms is that the electrical charge centers altitude are well defined by the isotherm levels. In this way, the knowledge of the vertical profile of temperature allows to determine the moment that lightning activity starts, based on the exceeding of a determinate height level by radar echoes.
The relation between lightning and rainfall is characterized by certain variability, depending on the geographical features, the season of the year, the type of thunderstorm, and even the stage of the life cycle where the thunderstorm is observed at a concrete moment. Moreover, there exist some situations in which this relationship is not observed, as the dry thunderstorms or clouds with a high precipitation efficiency and null electrical activity. Anyway, this variability does not affect the advantages of combine radar and lightning data in order to improve the knowledge respecting the thunderstorm behavior.
The main objective of the present work is to characterize thunderstorm features using integrated radar and lightning data at real-time, in order to detect the stage of the thunderstorm life cycle. This study is centered on 66 thunderstorms that affected Catalonia in summer 2006, in order to obtain a model of behavior of different lightning and radar parameters. In this work, only isolated cells and multicells with no simultaneous cells are considered, in order to study the evolution of the different parameters (both derived from radar and lightning observations) along the complete life-cycle of the thunderstorm.
Among other findings, the study indicates that the normalized duration of the three stages of thunderstorm life cycle is similar in most thunderstorms, with the longest duration corresponding to the maturity stage (80% of the total time).