Thunderstorm nowcasting by means of lightning and radar data: algorithms and applications in Northern Italy

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Thunderstorms and their effects, as flash flood, hail, lightning, strong wind and tornado, are responsible of most of the weather damages in Northern Italy, especially in the warm season from May to September.

The area interested by a single thunderstorm may be large only a few kilometers and its related phenomena at ground may last for half an hour, but often the associated convective system moves horizontally for several tens of kilometers and being dangerous for some hours. These space-time dimensions result in a strong impact of T-storms on a densely populated region as the Po Valley, or even more as the boundary between the plain and the Alpine Chain, where the frequency and the intensity of these events are very high. For this reason a nowcasting and warning system focused on severe thunderstorm events would be useful to reduce risks for people involved in outside activities and for electric, telecommunication and sensitive industrial business.

C-band radar and Lighting Location System (LLS) provides useful fast and high resolution data to the purpose of detecting and following the dynamics of convective systems. Some areas in Italy, and in particular the whole of Northern Italy, are covered by radars with a resolution of 1 km and the whole of Italy is covered by the CESI-SIRF LLS with a mean accuracy of 0.5 km on the single point of impact.

In order to follow the horizontal cell movement, it is necessary to develop and run real time automatic algorithms that assimilate remote-sensing data, identify cells in space and time, track their paths and finally extrapolate their future position untill an hour in advance.

One important matter about tracking algorithms is the verification of the computed path for a thunderstorm cell. In fact, due to the continuous individual evolution of the cell and the possible split and merge between different cells during their life cycle, it is extremely difficult to decide which is the real path of a single cell and the right algorithm. Sometimes a subjective definition of a path may rise from the hand observation of animated images, but this method cannot be used on a regular basis.

Authors present some case studies in which trajectories are computed both with radar and lightning data separately, using different algorithm and parameters. The data used come from the Monte Lema Swiss Met-Service Radar and CESI SIRF LLS. Radar data consist in 15 minutes rainfall intensity maps with a grid mesh of 1 km. Cloud to ground lightning data have a continuous detection rate, calculating each flash instantly (time accuracy less than 10^{-7} sec.); the lightning peak current and polarity is also available. Case studies come both from strong perturbed situations and light instability ones. Authors emphasize the importance of the tracking algorithm as a tool for studying convective storm from a lagrangian point of view. In other words the identification of a convective cell during its whole life cycle is the first step to study the relation among different measurements related to the cell, for example the relation between lightning and rainfall. This topic is shown with some case studies.

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