

Cell Tracking Algorithm based on Monte Carlo Method Minimizing a Cost Function

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The research described below was carried out during the Lolight project with the aim to develop a small-scale tracking method to determine the characteristic trajectories and velocities of convective cells and cell complexes with higher accuracy than current locating systems distributed on a coarse scale.

The developed algorithm utilizes the Monte Carlo method minimizing a cost function and brings a probabilistic forecast for the movement of the thunderstorm cells. As input data two temporally separated lightning density fields are used. In the first step the correlation coefficients between the first and the second field are computed whereas the first field is shifted by all physically allowed shifting vectors. The maximum length is determined by the maximum possible speed of the thunderstorm cells and the difference in time for both density fields. To eliminate ambiguities in determination of directions and velocities, the so called Random Walker of the Monte Carlo process is used. It selects a grid point at random and suggests one vector out of all predefined shifting vectors also at random but with a probability that is related to the correlation coefficient. If this exchange of shifting vectors reduces the cost function, the new direction and velocity are accepted. Otherwise it is discarded. This process is repeated until the change of the cost functions falls below a defined threshold. After these Monte Carlo runs, one will have information about the percentage of accepted shifting vectors for all grid points. By taking intensity changes between the investigated areas of both density fields into account it is possible to consider amplifications when computing forecasts.

Knowledge of the direction and speed the storm will move at is important for nowcasting. All the more so, the method is based on the IC lightning which accounts for most lightning discharges and occur minutes before the first CG lightning. The cell tracking algorithm will be used as part of the lightning detection LoLight system.

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