Uncertainty estimation for convective cell nowcasting

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The nowcasting of rainfall using radar data is an important component of many precipitation forecasting systems. Convective cells are however particularly difficult to forecast, not least because of the complex underlying mechanisms and evolution of their structure and intensity, as well as the possibility that they should merge or split. This paper highlights progress made in (i) cell identification; (ii) cell tracking; (iii) nowcast uncertainty estimation.

A state-of-the-art storm cell identification and tracking algorithm, originally proposed in Muñoz et al. (2018) was employed. This algorithm was developed based upon the widely-used TITAN (Thunderstorm Identification, Tracking, Analysis and Nowcasting; see Dixon and Wiener (1993)) algorithm and was further tailored with specific treatments so that it is more suitable to work with high-resolution rainfall observations. These include:

- *A multi-threshold segmentation scheme* that applies a range of threshold values to a given storm cell group to create a hierarchical tree structure. The nodes at a given level of the tree represent the isolated regions identified by a given threshold. A heuristic pruning process, which considers cell size and shape, is then employed to obtain individual storm cells at each time step.
- *A 'hybrid' storm tracker* that incorporates an optical-flow field-based motion tracker into an object-based cell tracking process. This enables largely reducing the solution space for object-based tracking, and consequently it improves the accuracy and the efficiency of convective cell tracking.

By using a *Kalman filter*, the uncertainty in the location of predicted cell centroids is investigated as a function of lead time. The implementation used here closely follows that of Rossi et al. (2015). The Kalman filter *state* is a 4-d vector comprising the true coordinates of the cell centroid location and velocity vector; the *observation* is the radar-based estimate of the centroid location. By running the Kalman filter for each cell over a warm-up period, an optimal Kalman gain is obtained from which the predicted uncertainty in the centroid location and velocity can be estimated.

This is only possible when the cell already has a history; in any case, the Kalman filter iterations requires some initial estimates of the (posterior) uncertainty. Additionally parameters characterising the process noise covariance have to be determined. While these parameters could be inferred on a trial-and-error basis, we here propose useful estimates.

References

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