9.9 BLENDING FIELD-BASED AND CELL TRACKING METHODS FOR IMPROVED PRECIPITATION NOWCASTING

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The present radar-based precipitation nowcasting methods can be broadly divided into two categories: 1) field-based advection extrapolation and 2) cell-based methods that identify and track the motion of high-intensity areas as separate entities. Both can be extended to produce probabilistic nowcasts by adding stochastic perturbations.

The assumptions of field-based methods include 1) logarithm of precipitation intensities follows the normal distribution 2) predictability is proportional to spatial scale and 3) the spatiotemporal structure of precipitation can be modeled as a Gaussian random field. While mostly valid, these assumptions fail to hold for intense convective precipitation having different spatiotemporal structure from the remaining precipitation field. Consequently, the stochastically generated nowcast ensembles are unable to reproduce such features.

On the other hand, cell-based methods are ideally suited for nowcasting convective precipitation. However, such methods discard information about low-intensity areas that are relevant for hydrological applications, where precipitation accumulations are of interest.

In order to address the above limitations, a statistical methodology for seamless blending of field- and cell-based nowcasts is proposed.

The field-based method used in this study is the Short-Term Ensemble Prediction System (STEPS). The basic principle is to use an advection-based nowcast, where ensembles are generated by adding stochastic perturbations to the precipitation intensity and advection fields. The intensity field is decomposed into multiple spatial scales, and the weights between the deterministic nowcast and the stochastic perturbation field are determined by predictability on each spatial scale.

The cell tracking is done by identifying and matching cells between consecutive time frames. Advection-based temporal interpolation is applied in order to improve the reliability of the matching. Additionally, a set of decision rules is applied to detect merging and splitting of cells. Estimation of the probability distributions of cell positions and velocities, from which ensembles are generated, is done by using a Kalman filter model.

Finally, the merging is done as a weighted average of the two nowcast ensembles. The weights are determined by a predictability measure that combines the critical success index (CSI) and autocorrelation for areas containing precipitation. It is shown that compared to the original STEPS, this approach leads to improved reliability of nowcasts for intense precipitation, which is relevant for risk management and providing early warning. The data used in the study is obtained from two different sources: the country-wide C-band radar network operated by the Finnish meteorological institute, and the dense high-resolution X-band radar network deployed in the Dallas Fort-Worth area on a small-scale urban environment.