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Development and verification of a real-time stochastic precipitation nowcasting system in Belgium

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The Short-Term Ensemble Prediction System (STEPS) is a probabilistic nowcasting system that was jointly developed by the Australian Bureau of Meteorology and the UK MetOffice. The core idea of STEPS is to empirically represent the forecast uncertainty by adding stochastic perturbations to the deterministic extrapolation of radar images. The stochastic perturbations are designed to account for the scale-dependence of the predictability of precipitation, i.e. the observation that large scale precipitation features are more predictable than small scales convective cells. The rate of temporal evolution of precipitation at different spatial scales due to unpredictable rainfall growth and decay processes is estimated in real-time and allows the stochastic simulations to adapt to the predictability of the situation.

The local implementation of STEPS at the Royal Meteorological Institute (RMI) of Belgium (STEPS-BE) provides 20 member ensemble nowcasts at 1 km^2 and 5 min resolutions up to 2 hours lead time on a 512x512 km domain. STEPS-BE uses as input the Belgian radar composite comprising the C-band radars of Wideumont (RMI), Zaventem (Belgocontrol), Jabbeke (RMI) and Avesnois (Météo-France). STEPS-BE also includes a couple of improvements compared with the original implementation: a kernel-based interpolation of optical flow vectors to obtain a smooth velocity field and the generation of stochastic noise only within the advected radar mask to respect the validity domain of the forecasts.

The visualization system of STEPS-BE at the weather office is very similar to the one of INCA-BE, the local Belgian implementation of the Integrated Nowcasting through Comprehensive Analysis (INCA) system developed at the Austrian weather service (ZAMG). The forecaster can visualize and scroll through the ensemble mean forecast, the probabilistic forecast of exceeding various precipitation thresholds and all the ensemble members, together with the past observations. Time series of observed and forecast rainfall accumulations/probabilities are also given at the location of major cities and weather stations.

STEPS-BE was specifically developed in the context of the Belspo research project PLURISK for better management of rainfall-induced risks in the urban environment. STEPS forecasts will be integrated as inputs into sewer system hydraulic models for nowcasting urban inundations using the cities of Leuven and Ghent as case studies. Accurate forecasts are particularly important for this type of application and a detailed forecast verification was performed to detect whether there are systematic biases over the considered urban areas and if the probabilistic forecasts are reliable.