9.13 STOCHASTIC ENSEMBLE PRECIPITATION NOWCASTING IN WINTER CONDITIONS

S. PULKKINEN[1], E. SALTIKOFF[1], P. KARSISTO[1], A. VON LERBER[1]
[1] Finnish Meteorological Institute, Finland
seppo.pulkkinen@fmi.fi

Applying the conventional radar-based precipitation nowcasting methods in winter conditions poses unique challenges. In particular, snowfall at land-sea boundaries exhibits complex growth and decay, quasi- stationary and band-like patterns that are beyond the capabilities of the present methods.

The basic principle of radar-based probabilistic nowcasting is advection-based extrapolation, from which ensembles are generated by adding stochastic perturbations. Such techniques are based on several assumptions on the spatiotemporal structure of precipitation. These involve the distribution of precipitation intensities, power spectrum, scale-dependence of precipitation lifetime and spatial homogeneity of the precipitation process. The validity of the assumptions in winter conditions and the differences compared to summertime precipitation are discussed with examples.

This study is the first attempt to evaluate the feasibility of the Stochastic Ensemble Precipitation System (STEPS) in winter conditions. An enhanced version of STEPS has been implemented for this purpose in the Finnish Meteorological Institute (FMI). In summary, STEPS uses an optical flow technique and advection-based extrapolation, and nowcast ensembles are generated by adding stochastic perturbations to the precipitation intensity and advection fields. Precipitation features on small scales that have low predictability, are gradually filtered by an autoregressive model and replaced with stochastic noise to simulate the forecast uncertainties.

A thorough evaluation of STEPS in winter conditions is carried out using a wide range of deterministic and probabilistic verification metrics. These include Critical Success Index (CSI), Mean Absolute Error (MAE), reliability diagram, Relative Operating Characteristic (ROC), rank histogram and spread-RMSE ratio. The added value of scale filtering and probabilistic nowcasts compared to deterministic advection-based nowcasts is demonstrated.

The verification study is carried out by analyzing a representative selection of snowfall events during 2014-2018 under different synoptic conditions, including difficult cases with lake-effect snowfall. The data consists of pseudo-CAPPI reflectivity mosaics gathered from the countrywide C-band radar network operated by FMI.

Providing airport decision makers accurate point nowcasts of snowfall rates is an important practical application of the study. For verification of the point nowcasts, we use data from the Vantaa and Luosto radars that are located near the Helsinki-Vantaa and Rovaniemi airports, respectively. We demonstrate by examples that STEPS is able to produce accurate point nowcasts with reliable uncertainty estimates, which is not possible by using a simple advection-based methods.

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