EMS Annual Meeting Abstracts
Vol. 14, EMS2017-575, 2017

Use of an Ensemble Kalman Filter technique for two-meter temperature analysis

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State-of-the-art high-resolution Numerical Weather Prediction models represent realistic features of surface temperature down to the Meso-γ scale (i.e. between 2 and 20 Km). Because of the model error and mismatch between the actual and the model topography, the predicted fields may show systematic errors and misplacement of temperature features. Furthermore, the limited small-scale processes predictability would require rapid update model cycles, which is not always the case. As a consequence, the forecast error increases the uncertainty of the predicted temperature fields.

Our study aims at providing accurate and precise temperature fields as meteorological forcing to Norwegian hydrological models, which require the correct representation of atmospheric phenomena at the spatial scales of the smallest catchments (in Norway, those scales may become of the order of a few square kilometres). Numerical model outputs fit our purpose and the uncertainties mentioned above may be reduced by combining them with temperature observations from the network of weather stations. The availability of reliable temperature fields at such resolution has several other applications, such as: automatic weather forecasts; automatic data quality control.

A statistical post-processing scheme of the hourly 2-meter temperature fields for the operational Arome MetCoOp 2.5 km model has been developed. A Local Ensemble Transform Kalman Filter (LETKF) has been employed to combine the two sources of information on temperature: model field as the background and in-situ observations. The temperature bias of the model fields is taken into account explicitly, thus implementing a bias-aware LETKF. At each analysis time, the most recent forecast has been chosen as the best temperature estimate and an ensemble of lagged forecast differences (i.e. from the best estimate) has been used to obtain the actual background error covariance matrix. The specification of observation errors has been made individually for each station. By means of the transformation and localization strategies, it has been possible to implement an efficient post-processing scheme. A spatial consistency test is performed simultaneously with the analysis, such that the scheme is also resistant and robust from a statistical point of view.

The bias-aware LETKF has been evaluated on the Norwegian mainland over a period of six months and for a case study: one cold week in winter. The verification shows that the analysis ensemble mean is a better estimate of the temperature field than the most recent model forecast, especially for low temperatures. Furthermore, the analysis ensemble displays better verification scores than the background ensemble.