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Preface

Tellus A Special Issue on probabilistic short-range weather forecasting

The fourth SRNWP workshop on short-range ensemble prediction was held at UK MetOffice during 23–25 June 2009. SRNWP is the programme on Short-Range Numerical Weather Prediction Programme organized under the network of European meteorological services (EUMETNET). SRNWP has formalized expert teams on selected NWP topics. One such topic is EPS (ensemble prediction systems) for the short range. This expert team, at the time lead by the author of this preface, was formally responsible for the scientific programme for the workshop, whilst Ken Mylne, a member of the expert team, was also the main responsible for the success of the local arrangement. During the workshop, the expert team decided to generate a special issue of a renowned scientific journal based on the presentations on the workshop. The present issue of Tellus A contains the resulting articles.

Over the more than 1.5 years that has passed since the workshop, there has been considerable development both scientifically and in the operational production of probabilistic forecasts with lead-time of 60 hours and shorter. The experience with such systems is still more fragmented than for the medium-range, partly because NWP designed for the short range employs limited area models (LAMs). Efforts to compare or combine systems from several operational centres are fewer, simply because of different geographical scopes, even though efforts are made within TIGGE-LAM (Thorpex Interactive Grand Global Ensemble). Examples are also seen in connection with happenings that attract world-wide attention, such as the Beijing Olympics in 2008. Two articles in the present issue are associated with probabilistic forecasting for that occasion. It is expected that similar activities will increase during the coming few years, along with the enhanced attention for probabilistic forecasting of potentially high-impact weather on small spatial scales.

Any attempt at predicting future events involves uncertainty. It follows logically that predictions of events are estimated with probabilities. To the extent that the uncertainty varies with the actual case at hand, also the expected uncertainty should be forecasted. Ideally, the forecasted probabilities should be as close to either 1 or 0 as the actual predictability permits. Thus, forecasts should, as sharply as possible, separate occurrence from non-occurrence with high hit-rate and without false alarms. The forecasts will then have maximum possible resolution and be fully reliable at any forecast lead time.

The papers in this special issue address probabilistic NWP for lead-times up to 2–3 days with grid-resolution 10–20 km (the short range) and for lead-times 6–24 hours with grid resolution 1–4 km (the very short range). For very short range forecasts, provided spin-up problems are avoided, one would expect almost dichotomous forecasts to be reliable if the sharpness requirements are the same as for medium-range forecasts. This expectation is questionable, however, since the requirements for details and sharpness should increase with decreasing forecast lead-time. With the exception of weather systems closely associated with fixed geographical contrasts in ground surface properties, small scale systems will have little direct predictive value in the medium-range predictions. With the ambition of predicting in the short and very short ranges, however, such smaller scale systems will occasionally have theoretical predictability that should be realized with skill by the forecast system.

One may ask if probabilistic forecasting is useful in the short and very short ranges. Scientific and technical findings presented in this issue helps to answer this, as well as to define the necessary elements of weather forecasts that exploit any weather predictability with available practical means. One prerequisite is that analyzed initial states are considerably more accurate than the saturation level of forecast errors for all model-resolved spatial scales. The data-assimilation procedure both needs to be computationally very fast and to produce sufficiently accurate analyses for the short forecast lead-times aimed at. The system needs to estimate realistic uncertainties in the analyses as well as in the model physics as a basis for generating ensembles. Furthermore, the shorter the forecasts, the more frequent updates are needed. So-called rapid update cycling (RUC) further emphasizes the need for efficient and accurate systems.

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High-resolution forecasts are needed to realistically describe the dynamics and physics behind most high-impact weather events, since they are frequently influenced by small scales. Furthermore, such events are frequently embedded in meso- and synoptic scale weather patterns, and modelling high-impact weather generally requires representation of a broad spectrum of scales. Since errors associated with free small scale flows grow fast and saturate quickly the prediction of such events requires a probabilistic approach.

In the medium range, one will in general detect potentially high-impact events with relatively moderate probabilities (e.g. $\sim$10% or smaller), even though they can be considerably larger than inferred from climate statistics (e.g. $\sim$0.1%). Such occurrences should increase any forecaster's attention. If the event is realistic, the probability patterns should gradually become geographically confined as the event approaches in time, and in well designed short and very short range NWP systems, the description of the associated flow should gradually contain more details. Such a validated system for extreme weather prediction from the medium- to the very short range, should enable reliable alerts in due time for societal instruments to take action. Without EPS in the short and very short ranges the alerts are prone to be considerably less reliable, and actions taken (or not taken) on the basis of such forecasts may increase damage or costs.

This special issue contains 16 papers addressing different aspects of complete systems for probabilistic forecasting. One paper addresses the medium-range predictions in a region strongly influenced by geographically fixed ground-surface forcing, while the others analyze and describe systems for $\sim$10–20 km short-range EPS and even finer-resolution convection-permitting systems for the very-short range. Several short-range systems have already been used operationally over several years, while those for the very-short range still mainly are in the early phase of development.

The first 5–7 papers deal in particular with methods for generating suitable perturbations of initial and boundary conditions and for model physics. To develop efficient and realistic perturbations for the very short range is an important scientific challenge, and will be subject for intense research over the first few coming years.

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