# Improving flow-dependent reliability - a route to more useful ensemble forecasts

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**Abstract**

In ensemble weather prediction, a measure of forecast uncertainty is the ensemble "spread" (e.g. standard deviation or variance). It is important for users that this spread is, on average, a good reflection of the eventual forecast error. For example, the average difference between an ensemble member and the ensemble-mean should match the average difference between the eventual outcome and the ensemble-mean (when averaged over a sufficiently large number of cases, and using a multiplier to account of finite ensemble size). Such "spread-error" agreement is a consequence of a more generally property; that the forecast system is statistically "reliable".

It is shown that, for medium-range forecasts of the extra-tropical circulation, this relationship is largely satisfied in current forecast systems when averaged over a year's worth of forecasts. The key question now is how to take the important next step towards improving medium-range ensemble forecast skill? In addition to the improved assimilation of observational information, it is argued that we need to focus on regime-dependent reliability. However, the flow-dependent growth in ensemble spread (and bias) is not easy to evaluate at the medium range due to complications associated with error propagation and non-linear interactions. The key conclusion of this study is that it is possible and sufficient to make this evaluation at much shorter lead-times ( 12h). To do this, the spread-error relationship needs to be extended to include the uncertainty in our knowledge of the true state of the system (by including our estimate of observation error, for example).

The approach is demonstrated for a previously identified "regime" - that of a trough over the Rocky Mountains, with high convective available potential energy to its east, and increased likelihood for the development of meso-scale convective systems; MCSs - which is associated with particularly uncertain weather forecasts for Europe 6 days later. Results identify a local lack of short-range ensemble Jetstream spread associated with the MCS activity which, if addressed, should improve error growth-rates at all lead-times.