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Spectral Analysis of the Spread-Skill Relationship in a Limited-Area Ensemble Prediction System

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We will present a scale-separation verification method developed at Environment and Climate Change Canada for studying the spread-error relationship in limited-area ensemble simulations. The method basically allows for expressing the error-to-spread ratio as a function of the range of spatial scales that are resolved in a limited-area domain. The scale decomposition is conducted by calculating and combining power spectra and cross spectra of ensemble fields and objective analyses.

The results of the verification method applied on the high-resolution operational Canadian Regional Ensemble Prediction System (REPS) reveal a range of scales characterized with a significant lack of balance between spread and error. In some cases, such as, for example, 200-hPa temperature, REPS is only apparently under-dispersive – and this is due to the fact that the simulated fields are too smooth. Improving the transient-eddy variability would thus be quite sufficient for balancing the error and spread. On the other hand, the results also imply more fundamental error-spread discrepancies. For example, REPS tends to be initially under-dispersive at sub-synoptic scales below 1200 km, which is compensated by being over-dispersive at larger scales. After 12-24 hours of integration the error-to-spread ratio becomes more uniform across the scales. This finding implies that power spectra of initial condition perturbations do not reflect the initial condition uncertainty but are rather tuned to achieve an overall balance of spread and error at later stages of integration. In addition, the predictive skill of ensemble spread in representing the time-varying model error is almost inexistent in the early stages of integration. These findings imply the need for readjustment of (1) the amplitudes of initial perturbations and (2) stochastic physics perturbations that control the REPS error growth.