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Scale-Dependent Estimates of the Growth of Global Forecast Uncertainties

Nedjelika Zagar
University of Ljubljana
Ljubljana, Slovenia

Many studies of the forecast error growth focused on the extra-tropical quasi-geostrophic dynamics and often considered the error-free large-scale initial state. In contrast, the operational global numerical weather prediction and ensemble prediction systems are characterized by uncertainties in the initial state at all scales, especially in the tropics. In this seminar the evidence will be discussed about the dominant role of the large-scale error growth early in the forecasts in comparison with the errors cascades from the smaller scales. A new parametric model for the representation of the error growth will be derived. In contrast to the commonly used models, the new model does not involve computation of the time derivatives of the empirical data. The asymptotic error is not a fitting parameter, but it is computed from the model constants.

Simulated forecast errors by the operational ensemble prediction system of the European Centre for Medium-Range Weather Forecasts are decomposed into scales and the new model is applied independently to every zonal wavenumber. A combination of hyperbolic tangent functions in the parametrization of the error growth proves robust to reliably model complex growth dynamics across many scales. The range of useful prediction skill, estimated as a scale where forecast errors exceeds 60% of their asymptotic values is around 7 days on large scales and 2-3 days at 1000 km scale. The new model is easily transformed to the widely used model of Dalcher and Kalnay (1987) to discuss the scale-dependent growth as a sum of two terms, the so-called α and β terms. Their comparison shows that at planetary scales their contributions to the growth in the first 2 days are similar whereas at small scales the β term describes most of a rapid exponential growth of errors towards saturation.

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