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Finite or infinite predictability horizon?

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It is well-accepted that the chaotic nature of atmospheric dynamics imposes an inherent finite limit of predictability. The idea originated from a paper by Edward Lorenz in 1969, in which he presented a theoretical argument suggesting that the predictability horizon cannot be indefinitely extended by reducing the initial error to anything above zero. In his derivation the 2D barotropic vorticity model was used, and the error growth behaviours with kinetic energy spectral slopes of -5/3 and -7/3 were compared. Extrapolating from his results, Lorenz hypothesised that the predictability would become infinite if the spectral slope steepened to -3 — without providing any direct numerical or theoretical evidence.

We have performed direct numerical simulation of a forced-dissipative version of the spectral 2D barotropic vorticity model with a -3 spectral slope. Contrary to Lorenz's hypothesis, our results suggest finite predictability. Repeating Lorenz's derivation for the case of a -3 spectral slope, we discuss the possible reasons leading to the disagreement of our results with his hypothesis.