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The Structure of Predictability in a Quasigeostrophic Atmospheric Model

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The local predictability of planetary atmospheric flow is investigated in the framework of a three-level quasigeostrophic (QG) model with realistic climatological mean state and variance pattern as well as Pacific/North America and North Atlantic Oscillation teleconnection patterns. Local predictability is quantified by instantaneous and finite-time Lyapunov exponents and vectors. The variation of local predictability across state space is examined. The study also aims to infer predictability information in geographical rather than spectral space. To this end, local growth exponents are calculated from the Lyapunov vectors and their time evolution. Moreover, a local Lyapunov vector dimension is introduced to measure the dimension of the space spanned by the leading Lyapunov vectors locally in geographical space.

The methodology of cluster-weighted modeling is used to derive a probabilistic model of the first Lyapunov exponent conditioned on the leading empirical orthogonal functions (EOFs) of the QG model. This approach allows the identification of regimes in the large-scale circulation that tend to be associated with large or small finite-time Lyapunov exponents as quantified by a regime-weighted mean Lyapunov exponent.