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Finite-time instability of atmospheric flow

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Both observations and initial-value experiments (for instance designed to model rapid atmospheric cyclogenesis) indicate the importance of non-modal growth over finite-time. The non-normality of the underlying linearized dynamical operator formally explains the transient growth. During its evolution, the initial condition significantly changes its disturbance structure. What is the role of these *structural* changes? Which *physical* mechanisms support the rapid growth? These are topics that typically have been left largely unexplored.

The dynamics of large-scale atmospheric motion is determined to large extent by material conservation of potential vorticity, which upon inversion determines the complete balanced flow. We present new tools that make an unambiguous investigation of the mechanisms behind the finite-time growth possible. The techniques are Green's function-based and can be used to examine flows with arbitrary profiles of zonal wind and vertical stratification. We apply the techniques to well-known existing theories for cyclogenesis.