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A Quasigeostrophic Model for Data Assimilation Studies

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The primary objective of data assimilation is the construction of an optimal estimate of the atmospheric state by blending a priori and observational information. A variety of techniques have been proposed to address this objective, among them variational, sequential, and ensemble–based methods. In the process of assessing the properties of these data assimilation methods, it is critical to study them in the framework of models that faithfully resemble atmospheric properties, such as time scales, dynamics and error growth behavior. At the same time, due to the high computational expense of most data assimilation methods, models used for exploring properties of data assimilation methods need to be restricted in terms of their resolution and internal complexity.

A model possessing both of the above properties (realistic behavior and reduced complexity) that is based on the nonlinear quasigeostrophic potential vorticity equation is presented here. The dynamical core of the model is spectral, and it contains a number of physical processes, such as climatological forcing, diffusion, and damping to match observed atmospheric properties. The model properties are compared against atmospheric properties in terms of energy spectra, time–mean and transient behavior, as well as in terms of singular–vector perturbation growth. The model behaves realistically at a variety of resolutions (horizontal and vertical), and is also well suited for data assimilation studies as it contains a complete tangent–linear and adjoint package.