# 8.3 SIMULATION OF OBSERVED LOW-FREQUENCY ANOMALIES USING GENERALIZED BAROTROPIC MODELS

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## 1. INTRODUCTION

To study the dynamics of low-frequency variability, a single lever barotropic model presents distinct advantages. Its linear instabilities do not generate high-frequency transient eddies, yet they produce low-frequency motions reminiscent of those in the atmosphere. The dynamics are simple conceptually and numerically. Moreover, extra-tropical low-frequency atmospheric motions are nearly equivalent barotropic.

To model the behavior of low-frequency eddies using the flow on a single level the large scale low-frequency divergence must be included as a forcing term along with the vorticity flux divergence from high-frequency eddies. An alternative view arises if potential vorticity is used instead of relative vorticity. Potential vorticity is conserved following the fluid motion for frictionless, adiabatic conditions. It incorporates information about the vertical structure and the baroclinicity of the atmosphere through its stability component.

Here we explore the possibility of using an empirically derived spectral relationship between the streamfunction and the potential vorticity as the basis of a single level model.

## 2. METHODOLOGY

Using the conservation of Rossby-Ertel potential vorticity ($q$) in a frictionless, adiabatic atmosphere, a generalized model may be constructed that applies at a single atmospheric level: $\partial q/\partial t + J(\psi,q) = 0$, $q = L\,\psi$, where $\psi$ is the streamfunction, $J$ is the Jacobian operator, and $L$ is a linear operator. For the standard barotropic model $L = \nabla^2$.

To estimate the spectral relationship between potential vorticity and streamfunction, data from the NCEP reanalysis is used. An effective squared wavenumber can be calculated by performing a linear regression of each spherical harmonic component of the isentropic potential vorticity against the same component of the streamfunction.

For the present study, data from the winter months of the period from 1990 to 1999 are low-pass filtered using a Lanczos filter that retains anomalies with periods greater than 10 days. The model equation is linearized about the upper-level basic flow of the nine winters. The model includes linear drag and biharmonic diffusion.

For each day in the data record, given the low-frequency streamfunction anomaly, the 10-day model forecast is predicted and compared with the observed 10-day anomaly. To obtain a succinct overview of the model's skill, the anomaly correlations both in time and in space are calculated. Another measure of the model's performance is the resemblance of the 10-day lag covariance of the predicted streamfunction to the observed one.

## 3. PRELIMINARY RESULTS AND FUTURE WORK.

Preliminary runs of the generalized model exhibit some improvement over the pure barotropic model. Nonetheless, more experiments and analysis is necessary to understand and enhance the proposed generalization. By the presentation time of this preprint paper the understanding of the generalized model will be more extensive.

Updated results of model runs that include animations of forecasts, anomaly correlations and lag covariances may be found in the first author's web page at: http://www.atmos.uiuc.edu/~mitas.

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