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Energetics associated with the variabilities of the northern and southern stratospheric polar vortices

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The time variations in the kinetic and available potential energies, and in the interactions an conversions between the two forms of energy will be discussed for periods of strong accelerations or strong decelerations of the stratospheric polar vortex. The analysis was performed separately for the northern and the southern polar vortices. The similarities and differences between the two hemispheres may help to elucidate the relative roles of the internal stratospheric dynamics and planetary wave forcing in the variability of the polar vortex.

The analysis is based on a 3-dimensional (3-D) decomposition of the energy cycle of the general atmospheric circulation by using the 3-D normal mode functions of the primitive equations linearized about an adiabatic reference state at rest (Marques and Castanheira, 2012). The 3-D normal-mode energetics scheme allows one to partition the kinetic and available potential energy amounts, as well as their interactions and conversions, onto zonal mean and eddy components, and also onto barotropic and baroclinic components.

A marked barotropic signal during strong variations of the polar vortex strengths, associated with the extratropical annular mode variability, is clearly seen in the barotropic components of the kinetic and available potential energies. The strong vortex decelerations are preceded by an increase in the flow of baroclinic available potential energy from the zonal mean to the baroclinic eddies and an increase of conversion of the baroclinic eddy available potential energy into eddy kinetic energy, with the total (kinetic + available potential) energy peaking during the transition from strong to weak vortex. During the vortex accelerations there is a decrease of conversion of the baroclinic eddy available potential energy into eddy kinetic energy, in agreement with a recovering of the vortex by radiative relaxation. The time variations of the zonal mean barotropic components of the energy follows the variation of the vortex intensity, and have relatively low frequencies. On the other the time variations of the baroclinic components have higher frequencies showing a peak around 30 days, that seems to be phase locked with the strong vortex accelerations or strong vortex decelerations.

Marques CAF, Castanheira JM (2012), A detailed normal mode energetics of the general circulation of the atmosphere. *J. Atmos Sci*, 69(9):2718–2732.