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# Energetics of planetary waves associated with the variability of the northern polar vortex

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Stratospheric planetary waves are generally considered to be vertically propagating Rossby waves and one of the basic questions is how their propagation depends on the structure the basic state wind. Linear wave propagation theory and wave activity conservation have both been used to address this question. However, more information on the processes involving polar vortex-planetary wave interaction may be obtained analysing the total (i.e. Kinetic + Available Potential) energy associated with planetary waves.

An analysis of the energetics of planetary waves for winter in the extratropical Northern Hemisphere is presented here. The analysis is based on a 3-Dimensional normal mode decomposition scheme of the atmospheric global circulation, as discussed by Castanheira (2000). This method seems to be very appropriate for the proposed analysis, as it allows the separation of the atmospheric circulation between planetary (Rossby) and inertio-gravity waves, on one hand, and on the other hand each zonal wave is decomposed onto a number of meridional scales. Furthermore, the 3-D normal mode scheme gives the contribution of each wave for the global total energy. Finally, the use of the energy will not exclude crossed terms of anomaly with climatology, a problem that Eliassen-Palm flux may present.

The methodology is applied to the global NCEP/NCAR (National Centers for Envi-

ronmental Prediction / National Center for Atmospheric Research) reanalysis data set, using November to March daily means of the horizontal wind components $(u, v)$ and of the geopotential height, at the 17 standard pressure levels, with the spatial horizontal resolution available (2.5º regular grid) and spanning the period 1979-2003.

The results show that the anomalies of the energy associated with planetary wavenumber one oscillate out of phase with the jet strength: negative energy anomalies precede positive vortex anomalies, and positive energy anomalies precede negative vortex anomalies.

Looking for different levels in the stratosphere, a downward propagated effect is observed. Positive anomalies in the energy associated with tropospheric wavenumber one appear after strong positive vortex anomalies, suggesting that the vortex anomalies reaching the troposphere alter the wave generation.

The wavenumber two did not show to be important for the jet strength oscillation. However the vortex disruption in the spring onset is preceded by an anomalous positive amount of energy associated with wavenumber two.

Castanheira, J. M. (2000): “Climatic Variability of the Atmospheric Circulation at the Global Scale". Ph. D. Thesis, University of Aveiro, Portugal, 186 pp.