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Two time steps in the tropospheric northern annular variability

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The annular nature of the leading patterns of the Northern Hemisphere winter extratropical circulation variability is revisited. The analysis relays on Principal Component Analysis (PCA) of tropospheric geopotential height fields and lagged correlations with the stratospheric polar vortex strength and with a proxy of midlatitude tropospheric zonal mean zonal momentum anomalies.

In a first part of the study the analysis was applied on the daily means of the geopotential height and the zonal wind data obtained from the ECMWF Data Server, ERA-40.

Obtained results suggest that two processes, occurring at different times, contribute for the Northern Annular Mode (NAM) spatial structure. Polar vortex anomalies appear to be associated with midlatitude tropospheric zonal momentum anomalies occurring leading. After the polar vortex anomalies, zonal mean zonal wind anomalies of the same sign are observed in the troposphere at high latitudes. The time scale separation between the two signals is of about two weeks. It is suggested that the average smoothing of geopotential time series, i.e. the use of 15-days running means, monthly or seasonal averages encompasses the two processes, contributing both for the statistical connection between the leading tropospheric variability pattern and the stratospheric vortex. However, due to the different times of occurrence of each process, the tropospheric pattern may appear to lead the stratospheric vortex, contradicting the idea of downward influence.

The tropospheric variability patterns which seem to respond to the polar vortex vari-

ability have a hemispheric scale but only show a dipolar structure over the Atlantic basin resembling the North Atlantic Oscillation pattern (NAO), but with node line shifted northward.

In a second part of the study the association between zonal symmetric components of the tropospheric circulation and the stratospheric vortex is analysed performing a 3-Dimensional normal mode decomposition of the atmospheric general circulation. The decomposition is done in NCEP/NCAR reanalysis. Results confirm those obtained with the ERA-40 reanalysis. There are two zonal symmetric components of the tropospheric circulation showing statistical significant correlation with the vortex. One component seems to lead the vortex and the other seems to lag the vortex. The lagged correlation between the two tropospheric components also shows that one component tends to lead the other.