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Intensified tropospheric-stratospheric interaction during events of strong boreal Polar-night Jet Oscillations

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The middle atmosphere in winter shows a high variability in polar latitudes from year to year, which is primarily caused by counter acting forces of radiative cooling and of upward directed transport of zonal mean easterly angular momentum by planetary wave. The aim of this study is to examine both the annual variation of Northern Annular Modes (NAMs) of geopotential height anomalies north of 60° N and the variability of Polar night Jet Oscillations (PJOs) determined as the two leading Empirical Orthogonal Functions (EOFs) of polar cap temperature profiles from 1979 until 2013, in order to investigate the coupling between troposphere and stratosphere and vice versa.
Based on ERA-Interim reanalysis data we determine 20 major sudden stratospheric warmings (MSSWs) by the use of a NAM threshold of -2.3 at the 10 hPa layer in agreement with former studies. With an extended definition of PJO events of Hitchcook et al. (2013) we identified 9 strong PJOs (larger than (3σ for 100 degree)) and 7 no PJO events (smaller than (2σ for 100 degree)) whereas 4 intermediate PJO events remain.
In the composites analysis of strong PJOs the lag-evolution of NAM and the one of zonal mean zonal wind anomalies show a strong downward propagating signal into the middle troposphere after the central day (CD). The mean difference between strong PJOs and no PJOs is significant (95 % student-t test): (i) in the upper troposphere about 20 days before CD, (ii) in the stratosphere and troposphere after CD. Furthermore, a main finding is that in the middle troposphere the zonal mean zonal wind anomalies are significantly reduced for strong PJOs about 20 days and about 50 days after CD. The zonal mean wind reductions are in coherence with pulses of enhanced eddy heat transport by planetary waves and their induced convergence of EP fluxes. For strong PJOs, the reestablishment of a strong polar vortex with strong zonal mean zonal wind anomalies in the upper stratosphere about 10 days after CD is caused mainly by radiative cooling and reduced upward transport of angular momentum by planetary waves.
We show that strong PJOs are odds-on favorite for enhanced coupling between troposphere and stratosphere and vice versa with potential for seasonal forecasts.