List of Publications: dpe Stand 3.01.2019

Selected Abstracts:

28-R. Peters, D. und D. Waugh, Influence of barotropic shear on the poleward advection of upper tropospheric air, J. Atmos. Sci., 53, 3013-3031, 1996.

The characteristics of the poleward advection of upper-tropospheric air are investigated using meteorological analyses and idealized numerical models. Isentropic deformations of the tropopause during Northern Hemisphere winter are examined using maps of Ertel's potential vorticity together with contour advection calculations. Large poleward excursions of upper-tropospheric air are observed during Rossby wave breaking events. These ''poleward'' breaking events occur in regions of diffluence (over the eastern Atlantic Ocean–Europe region, and over the eastern Pacific Ocean–North America region), and the evolution of the tropospheric air depends on the local, meridional shear: in anticyclonic (or weak cyclonic) shear the tropospheric air tilts downstream, broadens, and wraps up anticyclonically, whereas in cyclonic shear the tropospheric air tilts upstream, thins, and is advected cyclonically. The role of ambient barotropic flow is further examined by considering the flow in two numerical models: a planar, equivalent-barotropic, contour dynamics model and a simplified general circulation model. In both models, the variation of the poleward wave breaking with the zonal and meridional shear is consistent with that in the analyses.

102-R. Karpechko, A.Y., P. Hitchcock, D.H.W. Peters, A. Schneidereit, 2017. Predictability of downward propagation of major sudden stratospheric warmings, QJRMS 2017, DOI: 10.1002/qj.3017

Major sudden stratospheric warmings (SSWs) are striking phenomena of wintertime stratospheric circulation usually defined as a reversal of zonal mean circulation from westerlies to easterlies. SSWs often have significant impact on tropospheric circulation and cause anomalies in surface climate lasting for up to 2 months. For this reason, dynamics and predictability of SSW receive considerable attention. It is however well-known that not all SSWs cause significant, long-lasting impact on the troposphere. In order to explain differences in tropospheric impacts following SSWs, several reasons have been previously proposed, including differences in type of SSW (split or displacement), persistence of stratospheric anomalies, preconditioning of the tropospheric circulation, and whether or not SSW was accompanied by a planetary wave reflection in the stratosphere. Here we address the predictability of tropospheric impacts by SSWs by seeking early precursors of the impacts. We separate midwinter SSWs into two groups: those which are followed by significant, long-lasting impacts on the tropospheric circulation (defined in terms of anomalous Northern Annular Mode) and those not followed by significant anomalies in the annular mode. We show that SSWs characterised by a more negative Northern Annular Mode index in the lower stratosphere around 150 hPa and enhanced wave activity propagation to the stratosphere during the first few days following the central date have a larger probability of being followed by tropospheric impact, both in reanalyses and in climate model runs. These anomalies play a more important role in the subsequent downward propagation of the signal to the troposphere than the type of SSW: whether it is a split or a displacement, or absorptive or reflective SSW. We propose that using these anomalies as precursors of tropospheric impacts of SSW can enhance climate predictability.

105-R-Kalicinsky, Ch., D.H.W. Peters, G. Entzian, P. Knieling, V. Matthias, Observational evidence for a quasi-bidecadal oscillation in the summer mesopause region over Western Europe, JASTP 2018, 178, 7-16, https://doi.org/10.1016/j.jastp.2018.05.008.

We analyzed plasma scale height observations (about 80 km altitude) over the Eifel region (50°N, 6°E) observed from Kühlungsborn (54°N, 12°E) in the time interval 1959–2016 and OH*

temperatures (center altitude 87 km) observed from Wuppertal (51°N, 7°E) in the time interval 1988–2016. In summer months both time series show a dominant oscillation with a period of about two decades (20–26 years) with amplitudes of about 180 m and 3 K, respectively. These two oscillations are anticorrelated, because their observation altitudes are located above and below the temperature minimum in the mesopause region in summer, i.e. in a region of a positive and negative temperature gradient, respectively. We assume that a periodic vertical displacement of the mean temperature profile (upward and downward shifts following each other) in long-term variability leads to such an anticorrelated temperature evolution at the different observation altitudes. This mechanism is confirmed by SABER observation on board the TIMED satellite.

106-R. Peters, D.H.W., A. Schneidereit, A.Y. Karpechko, Enhanced Stratosphere/ Troposphere Coupling During Extreme Warm Stratospheric Events with Strong Polar-Night Jet Oscillation, Atmosphere 2018, 9, 467; doi:10.3390/atmos9120467

Extreme warm stratospheric events during polar winters from ERA-Interim reanalysis and CMIP5-ESM-LR runs were separated by duration and strength of the polar-night jet oscillation (PJO) using a high statistical confidence level of three standard deviations (strong-PJO events). With a composite analysis, we demonstrate that strong-PJO events show a significantly stronger downward propagating signal in both, northern annular mode (NAM) and zonal mean zonal wind anomaly in the stratosphere in comparison with non-PJO events. The lower stratospheric EP-flux-divergence difference in ERA-Interim was stronger in comparison to long-term CMIP5-ESM-LR runs (by a factor of four). This suggests that stratosphere–troposphere coupling is stronger in ERA-Interim than in CMIP5-ESM-LR. During the 60 days following the central date (CD), the Arctic oscillation signal was more intense during strong-PJO events than during non-PJO events in ERA-Interim data in comparison to CMIP5-ESM-LR runs. During the 15-day phase after CD, strong PJO events had a significant increase in stratospheric ozone, upper tropospheric zonally asymmetric impact, and a regional surface impact in ERA-Interim. Finally, we conclude that the applied high statistical threshold gives a clearer separation of extreme warm stratospheric events into strong-PJO events and non-PJO events including their different downward propagating NAM signal and tropospheric impacts.

107-R. Schneidereit, A. and D.H.W. Peters, Long-Term Wintertime Trend of Zonally Asymmetric Ozone in Boreal Extratropics During 1979–2016, Atmosphere 2018, 9, 468; doi:10.3390/atmos9120468.

Strong zonally asymmetric ozone (ZAO) changes are observed in the boreal extratropics for winter. During the TOMS (Total Ozone Mapping Spectrometer) period (1979–1992) the decrease of zonally asymmetric total ozone (ZATO) was twice as large as the observed zonal mean total ozone trend over Europe in January mainly caused by ultra-long wave transport. Recent studies have demonstrated that the ozone evolution reveals three different quasi-bidecadal trend stages: (i) Decline, (ii) leveling, and (ii) healing. This study focuses on the ZAO structure in boreal extratropics and on ozone transport changes by ultra-long waves during winter months. ERA-Interim data together with a linearized transport model are used. During the healing stage ZATO increases significantly over the North Atlantic/European region for January. The ZATO increase (healing stage) and ZATO decrease (decline stage) are caused by different monthly mean ozone transport characteristics of ultra-long planetary waves over the North Atlantic/European region. Furthermore, the vertical advection (ageostrophic transport) of ozone versus its horizontal component dominates in the lower and middle stratosphere during the healing stage. It is hypothesized that these ageostrophic wind changes are mainly caused by a wave train directed northeastwards which seems to be directly linked to the Arctic warming.

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