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Tropospheric response to stratospheric vortex weakening events and its inter-annual variability in the Northern Hemisphere cold season

Patrick Martineau (1) and Seok-Woo Son (2)

(1) Department of Atmospheric and Oceanic Sciences, McGill University, Montreal, Canada , (2) School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea, Republic Of (seokwooson@snu.ac.kr)

The tropospheric wind response to Stratospheric Vortex Weakening (SVW) events and its variability amongst individual events are examined with momentum equations within the transformed Eulerian mean framework. Composite analyses reveal that tropospheric response to SVW events is characterized by a broad region of wind deceleration (65-85N) nearly simultaneous with the maximum deceleration of stratospheric wind. This response is associated with intensive momentum flux divergence in the upper troposphere particularly by wave number 2 component. This tropospheric response is further investigated by dividing the events into two categories: those with positive projection to the composite (typical response) and those with negative projection (atypical response). The difference between the two categories exhibits dipole pattern in zonal-wind tendency about $\sim$55N. It is found that, in high latitudes (north of 65N), different response is largely due to the meridional propagation of wavenumber 1 and 2 waves that results in opposite eddy momentum flux divergence in the upper troposphere. This is consistent with enhanced refractive index in typical events (more specifically potential vorticity gradient) located north of 75N and confined to the troposphere, and suggests that zonal-mean flow in the upper troposphere plays a key role in stratosphere-troposphere coupling in the northern high latitudes. In midlatitudes, different response between typical and atypical events is highly associated with synoptic scale waves with only weak contribution of planetary scale waves.