Time evolution of wave amplification events of the upper-tropospheric zonal wavenumber two and its influence on the stratospheric circulation during the boreal winter

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Time evolution and characteristic features of “wave amplification events” of upper-tropospheric zonal wavenumber two (WN2) during the boreal winter are investigated using of the Japanese 55-year Reanalysis (JRA-55) data. First, we extract strong WN2 amplification events (more than one standard deviation) from 55 winters since 1958/1959, on the basis of zonal variance of meridional wind component at 250 hPa. Furthermore, we extract two groups from these events: The first one is a case that strong upward WN2 propagation is observed in the lower stratosphere two days after a WN2 amplification peak in the upper troposphere (SU_30EPFZ), and another one is a case that strong downward WN2 propagation is observed in the lower stratosphere two days after a WN2 amplification peak (DW_30EPFZ). We conduct a composite analysis and investigate tropospheric conditions for the strong WN2 amplification occurrence, including sea surface temperature (SST), and stratospheric conditions before and after the peak of WN2 amplification in the upper troposphere. Resultantly, the composite analysis shows the following differences between the two groups: In SU_30EPFZ, negative potential vorticity anomalies on the 320 K surface in relation to the development of blocking highs around Alaska and negative surface temperature anomalies in North America are statistically significant. These results suggest that the WN2 amplification in the upper troposphere is significantly related to La Niña-like conditions, or negative Pacific Decadal Oscillation (PDO), and the importance of quasi-stationary Rossby wave propagation along the sub-tropical jet. On the other hand, in DW_30EPFZ, meridional dipole potential vorticity anomalies are observed over Europe on the 320 K surface, which suggest the development of a blocking system in this region; the wide-ranged negative surface temperature anomalies from Europe to Central Asia are statistically significant, but no significant relation to the global SST is found. As for the stratospheric circulation after the peak of the WN2 amplification in the upper troposphere, the polar night vortex splitting occurs in SU_30EPFZ, while the development of the Aleutian high in DW_30EPFZ is indicated.

Keywords: stratosphere, planetary wave, zonal wavenumber two, blocking system

