

# Traveling Planetary Waves in the Northern Hemisphere Winter Middle Atmosphere

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It is a well-established overview that quasi-stationary planetary waves propagating upward from the troposphere dissipate in the stratosphere to drive the meridional circulation in the winter hemisphere, while the meridional circulation in the mesosphere is driven mainly by gravity waves. On the other hand, the importance of traveling planetary waves in the stratosphere and mesosphere has been underscored in recent studies to bring about significant impacts on mean flows through their generation and dissipation. However, observational studies are insufficient for this region, so that detailed features are still unclear. Hence, this study investigates contributions of planetary waves (PWs) to the mean flow in the stratosphere and mesosphere during the Northern Hemisphere winter when PW activities are strong, by analyzing satellite data from Sounding of the Atmosphere using Broadband Emission Radiometry (SABER). Our analyses suggest that there would be a cancellation mechanism between easterly acceleration by monthly mean stationary planetary waves (STPWs) and westerly acceleration by remaining travelling planetary waves (TRPWs) in the polar lower mesosphere. When easterly winds appear in the mesosphere, STPWs propagating from the troposphere would dissipate in the lower mesosphere to accelerate easterly winds because STPWs could not propagate in easterly regions, but TRPWs would be generated there due to barotropic and/or baroclinic instability caused by the easterly winds in the mesosphere and accelerate westerly winds. This cancellation would contribute to maintain the easterly wind in the mesosphere for more than 10 days in some cases. Further analyses reveal that the wave generated in the polar lower mesosphere would be a downward propagating TRPW with a zonal wave number 1 traveling eastward with a period ~20 days. Moreover, the easterly wind in the mesosphere is frequently triggered by the dissipation of TRPWs developed in the stratosphere in the recovery phase of sudden stratospheric warmings, in addition to the dissipation of STPW propagating from lower layers.

Keywords: Planetary wave, Stratospheric sudden warming, Stratosphere, Mesosphere