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Climatological structure and behavior of planetary waves and mean flows in the middle atmosphere during the Northern Hemisphere winter

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It is a well-established overview that planetary waves propagating upward from the troposphere dissipate in the stratosphere to drive the poleward meridional circulation in the winter hemisphere, while the meridional circulation in the mesosphere is driven mainly by gravity waves. Quite recently, however, the importance of traveling planetary waves has been underscored in the onset and/or the recovery periods of sudden stratospheric warmings (SSWs); traveling planetary waves could be generated in the middle atmosphere due to barotropic and/or baroclinic instability to bring about significant impacts on the mean flow through their generation and dissipation. However, observational studies are insufficient for the region, so that detailed climatological features are still unclear. Hence, we investigate planetary wave behavior in the middle atmosphere during the Northern Hemisphere winter by using TIMED/SABER satellite data. Resultantly, it is found that EP-flux convergence regions climatologically appear with two separate peaks in the middle atmosphere around the stratopause (50N, 50km) and in the polar mesosphere (65N, 80km). These two peaks could be generated by the following mechanisms: EP-fluxes of stationary planetary waves propagating from the troposphere converge in the widely extended region around the polar stratopause. On the other hand, those of traveling planetary waves climatologically diverge in the polar upper stratosphere and lower mesosphere, which partly offsets the convergence region due to stationary waves around the stratopause, and propagate upward and/or toward lower latitudes to converge in the above mentioned two convergence regions. It is also found that the divergence region was coincident with the region fulfilling the necessary conditions for zonal flow instability.