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Stationary planetary wave propagation in Northern Hemisphere winter – climatological analysis of the refractive index

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Abstract. The probability density on a height-meridional plane of negative refractive index squared $f(n_k^2<0)$ is introduced as a new analysis tool to investigate the climatology of the propagation conditions of stationary planetary waves based on NCEP/NCAR reanalysis data for 44 Northern Hemisphere boreal winters (1958–2002). This analysis addresses the control of the atmospheric state on planetary wave propagation. It is found that not only the variability of atmospheric stability with altitudes, but also the variability with latitudes has significant influence on planetary wave propagation. Eliassen-Palm flux and divergence are also analyzed to investigate the eddy activities and forcing on zonal mean flow. Only the ultra-long planetary waves with zonal wave number 1, 2 and 3 are investigated. In Northern Hemisphere winter the atmosphere shows a large possibility for stationary planetary waves to propagate from the troposphere to the stratosphere. On the other hand, waves induce eddy momentum flux in the subtropical troposphere and eddy heat flux in the subpolar stratosphere. Waves also exert eddy momentum forcing on the mean flow in the troposphere and stratosphere at middle and high latitudes. A similar analysis is also performed for stratospheric strong and weak polar vortex regimes, respectively. Anomalies of stratospheric circulation affect planetary wave propagation and waves also play an important role in constructing and maintaining of interannual variations of stratospheric circulation.

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