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Quasi two-day wave excitation in the mesosphere by gravity wave induced jet instabilities

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Quasi two-day waves (QTDWs) are strong planetary wave modes that always occur in the mesosphere when the summertime mesospheric easterly wind jet starts to decay. They can reach considerable temperature amplitudes of over 10K and wind amplitudes of several ten m/s. Strongest amplitudes are observed for zonal wavenumbers 3 and 4.

Details of the excitation mechanism of QTDWs are investigated using Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) satellite data. For this purpose the following parameters are derived from SABER data: geostrophic background winds and potential vorticity gradients, daily QTDW temperature and wind amplitudes, as well as Eliassen-Palm fluxes (EP fluxes). QTDW drag on the zonal background wind is calculated from the EP flux divergence. Further, gravity wave (GW) momentum fluxes and GW drag are derived from pairs of observed temperature altitude profiles using the method by Ern et al. (2004, 2011).

We find that QTDWs are excited in regions of strong curvature of the zonal wind jets when these start to decay. This curvature is induced by dissipation of GWs: strongly enhanced GW drag is observed directly above the jet instabilities. Above the jet instabilities the EP flux of the QTDWs is directed upward, and downward below. QTDWs are weakening the easterly jet in its core in the middle mesosphere, and they are counteracting the wind reversal from westward wind in the mesosphere to eastward wind in the upper mesosphere/lower thermosphere. Comparison with a QTDW modeling study by Pendlebury (2012) shows good qualitative agreement between model and SABER observations. Our observations support the theory that QTDWs are atmospheric normal modes excited by jet instabilities. Non-uniformities of the observed global distribution of GWs in the summer hemisphere subtropics might play a certain role in details of the QTDW excitation.