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Gravity wave driving of the QBO estimated from satellite observations and ERA-Interim

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The quasi-biennial oscillation (QBO) of the zonal wind in the tropical stratosphere is an important process in atmospheric dynamics. The QBO has effect on atmospheric dynamics over a large range of altitudes and latitudes. Effects of the QBO are found, for example, in the mesosphere, and selective filtering of upward propagating waves plays an important role for the stratopause semiannual oscillation (SAO). The QBO also influences the extratropics and even surface weather and climate. Still, climate models have large difficulties in reproducing a realistic QBO.

Atmospheric waves play an important role in the driving of the QBO. Both global scale waves and mesoscale gravity waves (GWs) contribute.

We derive GW temperature variances, GW momentum fluxes and potential GW drag from three years of High Resolution Dynamics Limb Sounder (HIRDLS) and from 11 years of Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) satellite data. These observations are compared with the drag that is still missing in the tropical momentum budget of the ECMWF ERA-Interim (ERAI) reanalysis after considering zonal wind tendency, Coriolis force, advection terms, and the drag due to resolved global-scale waves. Being strongly constrained by data assimilation, the meteorological fields of ERAI are quite realistic. Therefore this missing drag can be attributed to small scale GWs not resolved by the model.

We find good qualitative agreement between observed GW drag and the missing drag due to waves not resolved in ERAI. During eastward QBO wind shear even the magnitude of observed and ERAI missing drag are in good agreement. During westward shear, however, observed drag is much weaker than the ERAI missing drag. This asymmetry might hint at uncertainties in the advection terms of ERAI. Further, observed GW spectra indicate that QBO-related GW dissipation is mainly due to critical level filtering.