Geophysical Research Abstracts
Vol. 16, EGU2014-7254, 2014
EGU General Assembly 2014

Direct estimation of QBO-related gravity wave drag from satellite observations

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The quasi-biennial oscillation (QBO) of the zonal wind in the tropical stratosphere is an important process in atmospheric dynamics. Effects of the QBO are found also in the mesosphere and in the extra-tropics. The QBO even has influence on the surface weather and climate, for example during winter in the northern hemisphere at midlatitudes. Still, climate models have large difficulties in reproducing a realistic QBO.
The QBO is driven by atmospheric waves. Both global scale waves and mesoscale gravity waves (GWs) contribute. It has been proposed that the driving of the QBO by GWs is more important than that of the global scale waves. The relative importance of GWs is however still highly uncertain, and a direct estimation of the QBO driving by GWs from global observations is still missing.
We derive GW temperature variances, GW momentum fluxes and 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 drag of resolved global-scale waves. The meteorological fields of ERAI are quite realistic because ERAI is strongly constrained by data assimilation. Therefore this missing drag can be attributed to GWs not resolved by the model.
We find good qualitative agreement between observed GW drag and the missing drag 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 lower 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.