Geophysical Research Abstracts,
Vol. 11, EGU2009-6368-2, 2009
EGU General Assembly 2009

Troposphere-stratosphere exchange - constraints from water vapour

Y. Liu, S. Fueglistaler, and P.H. Haynes

University of Cambridge, Department of Applied Mathematics and Theoretical Physics, Cambridge, United Kingdom (yl238@cam.ac.uk)

Troposphere-to-stratosphere transport involves both cross-isentropic transport across the tropical tropopause to the stratospheric 'overworld' and quasi-horizontal transport into the lowermost stratosphere. The distribution of stratospheric water vapour is sensitively dependent on the detailed temperature history of air parcels entering the stratosphere, which can be used to constrain troposphere-stratosphere exchange pathways. We carry out trajectory calculations for the years 2001 and 2005-2008 with winds and diabatic heating rates from the ECMWF 40-year reanalysis project (ERA-40) and the new interim reanalysis project (ERA-Interim). Trajectories are either kinematic, where the vertical velocity is calculated from mass continuity, or diabatic, where diabatic heating rates are used to drive cross-isentropic motion. Water vapour is estimated using a simple dehydration model, and results are compared with measurements from HALOE and the Microwave Limb Sounder (MLS) on board the AURA satellite.

In general diabatic trajectories yield spatial and temporal variations in water vapour that are in better agreement with observations, but for the ERA-Interim dataset the differences between kinematic and diabatic trajectories are small. Diabatic trajectories, which give the best estimate in seasonal variation of water vapour, show a consistent dry bias for the stratospheric overworld of 0.5 ppmv compared to previously published ERA-40 trajectory results and observations. The results suggest that trajectories calculated using ERA-40 winds show excessive vertical dispersion which overestimates troposphere-to-stratosphere exchange, an effect also seen in the lowermost stratosphere. The new results suggest that moistening processes in addition to the instantaneous dehydration to large-scale saturation mixing ratio could contribute up to 0.5 ppmv to stratospheric H_2O.