

An assessment of upper-troposphere and lower-stratosphere water vapor in GEOS5, MERRA, and ECMWF analysis and reanalyses using Aura MLS observations

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Abstract

Global water vapor (H₂O) measurements from the Microwave Limb Sounder (MLS) are used to evaluate upper troposphere (UT) and lower stratosphere (LS) H₂O produced by Goddard Earth Observation System assimilation system, version 5 (GEOS5), Modern-Era Retrospective Analysis for Research and Applications (MERRA) and European Centre for Medium-Range Weather Forecasts (ECMWF) ERA-Interim reanalyses. Focusing on quantifying the H₂O amount and the transport from UT to LS, we show that all analyses/reanalyses overestimate UT H₂O by ~200% compared to MLS observations. Both observation and analyses show that boreal summer monsoon convection has a dominant influence on UTLS H₂O, resulting in moister air in the northern hemisphere (NH) than in the southern hemisphere (SH). However, substantial differences in H₂O transports are found in different datasets. Vertically, H₂O transport across the tropical tropopause simulated by GEOS5, MERRA and ECMWF are faster by ~200%, 130% and 300% respectively, compared to the MLS observations; in the LS (20-30 km), ECMWF simulated vertical transport is twice as fast as implied by MLS observations, while GEOS5 and MERRA have vertical transport velocities similar to the MLS values. Horizontally, both observation and analyses show faster poleward transport in the NH than in the SH; In the NH, the simulated 100 hPa H₂O “effective horizontal transport velocities” are 180%, 210%, and 130% of the MLS observed value for GEOS5, MERRA, and ECMWF respectively; In SH, these simulated “effective horizontal transport velocities” are slower (50%) for GEOS5 and MERRA, but faster for ECMWF (120%), compared to the MLS observations.