

Quantifying Vertical Transport Above the Tropical Tropopause Using Water Vapor and Carbon Monoxide Measurements from the Aura Microwave Limb Sounder

Ken Minschwaner
Department of Physics
New Mexico Institute of Mining and Technology
Visiting Faculty Fellow, NCAR ASP and ACOM

The vertical distributions of water vapor and carbon monoxide in the tropical lower stratosphere are controlled largely by their mixing ratios near the tropopause and by ascending motions of the Brewer-Dobson circulation. The upward propagation of seasonal variations imprinted on H₂O and CO vertical profiles (the so-called “tropical tape recorder”) can be used to place upper bounds on the residual mean vertical velocity in the lower stratosphere. Ascent rates are very slow (10's of meters/day) and are difficult to measure directly, but this motion has an important role in shaping the distribution of stratospheric trace gases and in governing the atmospheric lifetimes of many compounds. We analyzed Aura Microwave Limb Sounder observations of the H₂O and CO tape recorders from 2004 to 2014 to establish a time series of effective mean vertical velocity from 90 to 16 hPa pressure (about 18 to 28 km altitude). The implied ascent is largely consistent with calculated velocities derived from net radiative heating rates based on observed temperature, humidity, cloud distributions, and trace gas amounts. Temporal variations in derived velocities are dominated by a quasi biennial oscillation and a seasonal component. Smaller amplitude, interannual variations are associated with the El Niño Southern Oscillation, although the details of this association are less clear.