

Two Years of Continuous Water Vapor Isotope Ratio Measurements at Mauna Loa: A New Glimpse Into Humidity Controls in the Subtropics

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Long a home to baseline measurements of trace gases important for climate, the Mauna Loa Observatory (MLO) now hosts the longest record of continuous *in situ* measurements of stable isotope ratios in water vapor. Since 2010 the University of Colorado Boulder has operated a Picarro water vapor isotope analyzer in close partnership with MLO, measuring the water vapor mixing ratio and isotope ratios of hydrogen and oxygen at a 10-second frequency. Unlike humidity measurements alone, the D/H and $^{18}\text{O}/^{16}\text{O}$ ratios provide an integrated history of condensation in MLO air masses, offering key constraints on the water cycle processes that shape humidity patterns in the subtropics. While the full two-and-a-half-year record reveals diurnal variability associated with the convective rise and fall of the boundary layer on the Big Island, strong correlations between the nighttime Picarro mixing ratio measurements, Hilo radiosondes, and Modern-Era Retrospective Analysis for Research and Applications (MERRA) reanalysis suggest nighttime isotope ratios are representative of free tropospheric conditions across the region. Indeed, a ten-day peak in the power spectrum of the nighttime isotope ratio time series suggests synoptic-scale conditions control the free tropospheric moisture variability at MLO to first order. However, extended periods of high isotope ratios indicate a possible role for local convective mixing in transporting boundary layer moisture upward. The dataset thus provides a rare opportunity to analyze the climatological flux of moisture between the boundary layer and free troposphere and to test the sensitivity of subtropical vertical moisture transport to global and synoptic-scale atmospheric circulation patterns.

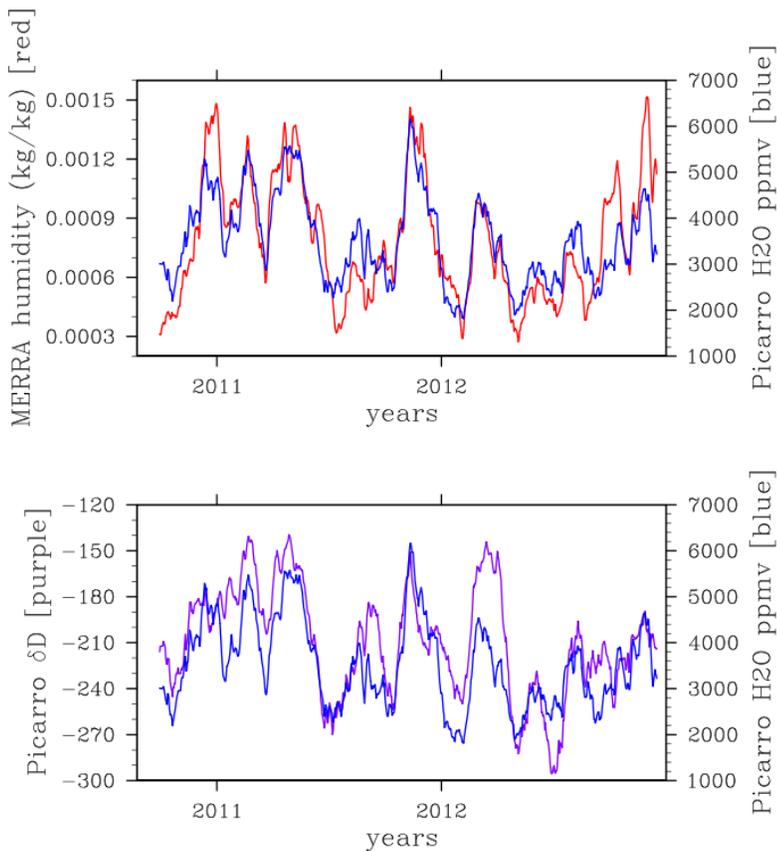


Figure 1. (Top) Nighttime humidity at the MLO measured with a Picarro water vapor isotope analyzer (blue) and estimated from the nearest MERRA reanalysis grid point (red). (Bottom) Nighttime humidity (blue) overlain with the D/H isotope ratio (purple), measured by the MLO Picarro.