Observations of Water Vapor and Total Water in the Extremely Dry Tropical Tropopause Layer (TTL) from the NASA Global Hawk

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The Airborne Tropical Tropopause Experiment (ATTREX) is a multi-deployment mission utilizing the NASA Global Hawk (GH) Unmanned Aicraft System (UAS) to examine transport and phase transformation of water in the TTL, leading to a more complete understanding of the hydration and dehydration mechanisms taking place in the tropical upper troposphere and lower stratosphere. We recently developed a new Tunable Diode Laser (TDL) based absorption hygrometer for quantification of Water Vapor (WV) and enhanced Total Water (water vapor + condensed phase, TW) and deployed this instrument during the January-March 2013 installment of ATTREX (ATTREX-2).

The instrument exploits newly available TDLs near 2.7 μm where the H_2O absorption cross section is more than one order of magnitude higher than that of the commonly used 1.4 μm band. The high absorption cross-section allows for a simple and compact optical design, operated in a closed path configuration. The instrument contained two detection cells for continuous measurements of WV and TW, and an on-board calibration system used to routinely deliver calibration flows to the instrument during science flights on the GH.

During ATTREX-2 science flights, the GH extensively profiled the TTL between 45 and 60 kft throughout the central and eastern tropical Pacific. Numerous high altitude cirrus clouds were encountered with highly elevated water content relative to the extremely dry air (<2 ppmv) in the region. Here we present the new instrument and these measurements from its highly successful first deployment during ATTREX-2.

Figure 1. A NASA Global Hawk UAS in flight (photo credit: NASA).

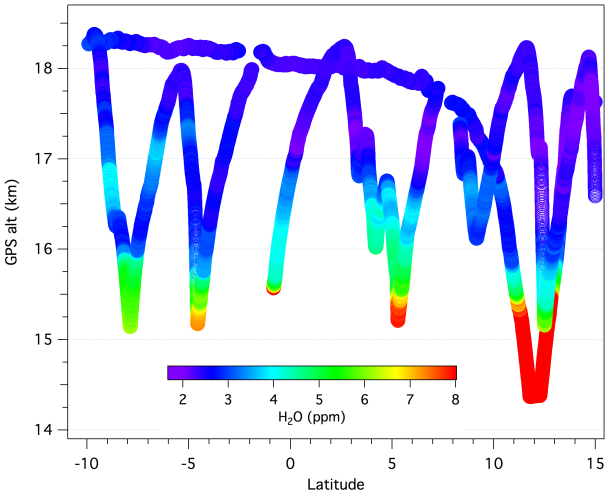

Figure 2. Plot of GH altitude versus latitude for the southern leg of ATTREX-2 science Flight #2 on 9-10 February 2013. The trace is colored by the water vapor mixing ratio measured using the new NOAA TDL H_2O instrument and shows the vertical structure of H_2O observed during multiple dives through the TTL. Mixing ratios of < 2 ppm can be seen in a layer just above 17 km in the northern hemisphere.