The influence of convection on the water isotopic composition of the TTL and tropical stratosphere

D. S. Sayres[1], L. Pfister[2], T. F. Hanisco[1,5], E. J. Moyer[1,6], J. B. Smith[1], J. M. St. Clair[1,4], A. S. OBrien[1], M. F. Witinski[1], M. Legg[3], J. G. Anderson[1],

Abstract. We present the first in situ measurements of HDO across the tropical tropopause, obtained by the ICOS and Hoxotope water isotope instruments during the CR-AVE and TC4 aircraft campaigns out of Costa Rica in winter and summer, respectively. We use these data to explore the role convection plays in delivering water to the tropical tropopause layer (TTL) and stratosphere. We find that isotopic ratios within the TTL are inconsistent with gradual ascent and dehydration by in-situ cirrus formation and suggest that convective ice lofting and evaporation play a strong role throughout the TTL. We use a convective influence model and a simple parameterized model of dehydration along back trajectories to demonstrate that the convective injection of isotopically heavy water can account for the predominant isotopic profile in the TTL. Air parcels with significantly enhanced water vapor and isotopic composition can be linked via trajectory analysis to specific convective events in the Western Tropical Pacific, Southern Pacific Ocean, and South America. Using a simple model of dehydration and hydration along trajectories we show that convection during the summertime TC4 campaign moistened the upper part of the TTL by as much as 2.0 ppmv water vapor. The results suggest that deep convection is significant for the moisture budget of the tropical near-tropopause region and must be included to fully model the dynamics and chemistry of the TTL and lower stratosphere.

[1] School of Engineering and Applied Sciences, Harvard University, 12 Oxford Street, Cambridge, Massachusetts, USA

[2] NASA Ames Research Center, Moffett Field, CA, USA

[3] BAERI, Sonoma, CA, USA

[4] now at Geology and Planetary Sciences Division, California Institute of Technology, Pasadena, CA

[5] now at NASA Goddard Space Flight Center, Greenbelt, MD

[6] now at Department of Geophysical Sciences, University of Chicago, Chicago, IL