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The effect of convection and in-situ dehydration on the tropical tropopause layer

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The Tropical Tropopause Layer (TTL), a region that surrounds the thermal tropical tropopause and extends from about 14 to 18 km, controls the input of water vapor into the lower tropical stratosphere. It is also the location of large sheets of subvisible cirrus clouds, which are a factor in the earth's radiation budget. Though most convection does not penetrate the TTL, the convective turnover time is comparable to the radiatively driven vertical transit time. This makes the process of dehydrating tropospheric air to stratospheric values a complex mix of convective hydration (or dehydration) and in-situ dehydration by subvisible cirrus cloud sheets. Previous work has simulated water vapor and cloud distributions with reasonable success (based on comparisons with HALOE water and SAGE cloud data) using only in-situ dehydration processes.

This work examines both convective and in-situ processes by use of a one-dimensional, trajectory based microphysical model with convective injection. Water vapor and cloud vertical profiles are calculated along 648 different tropical trajectories, representing a lat-lon grid of points in the global tropics. Convective injection is based on 3-hourly geostationary satellite imagery, and the overall convective turnover times derived from our formulation is consistent with other estimates using independent methods. Results so far show that convection clearly hydrates at all levels, bringing the calculated water vapor distribution into better agreement with satellite measurements. In situ generated clouds are also enhanced by the convective injection, bringing the overall results into better agreement with observations. One important feature is that, though convection hydrates the TTL, much of that hydration is negated by subsequent dehydration as air passes through cold regions.

Our calculations, which essentially simulate the water vapor on a particular day, show a large contrast between wet and dry regions in the TTL, a greater contrast than is seen in seasonal average data. Further work will focus on direct comparisons between calculations for the 2004-2005 winter and day to day Aura water vapor measurements from the MLS instrument.