



The isotopic composition of water vapor as a tracer of water balance in the TTL

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The relatively small amount of water vapor in the tropical tropopause layer (TTL) region is of disproportionate radiative importance, and projections of changes in TTL water are hampered by poor understanding of its sources and controls. We show here that the profile of the isotopic composition of water vapor can be used to quantify the contribution of various processes to the water budget of the region: convective sources of water, dehydration via in situ cirrus formation and sedimentation, and moistening from mixing with extratropical air. We combine these processes into a simple model for the isotopic ratio of TTL water vapor. By fitting the model parameters to reproduce an averaged tropical profile of water vapor isotopic ratio in the TTL, we can retrieve the convective contribution to TTL water vapor. Using isotopic measurements from the ACE-FTS solar-occultation instrument, we show that convective injection of water vapor must provide a significant contribution to TTL water vapor. That contribution in turn has large radiative effects, because it increases the production of in-situ cirrus over what would be inferred from large-scale uplift alone, by a factor 2-10 over the TTL (15-17.5 km).