A cloud-resolving model study of stable water isotopes in the tropical tropopause layer

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The processes that fix the fractionation of the stable isotopes of water (HDO and $H_2^{18}O$) in the tropical tropopause layer (TTL) are studied using cloud-resolving model simulations of an idealized equatorial Walker circulation with an imposed Brewer-Dobson circulation. This allows the explicit representation of the convective and microphysical processes at work in the TTL. In this model, the microphysical transfer of the isotopes between water vapor and other hydrometeors is explicitly represented along with those of the standard isotope ($H_2^{16}O$) during all microphysical interactions. The simulated fractionation of HDO in water vapor is consistent with observations in both its magnitude and vertical structure in the TTL. The results suggest that the sublimation of relatively enriched ice associated with deep convection affects the isotopic composition of water vapor entering the stratosphere. When a seasonal cycle is included in the Brewer-Dobson circulation, both the water vapor mixing ratio and the fractionation of water vapor display a seasonal cycle as well.