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Meaning of the D/H ratio of vapor in the tropical UTLS

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Convection's role in transporting water to the UTLS (upper troposphere, lower stratosphere) is a major uncertainty that affects projections of future changes in stratospheric water vapor. Recent series of in-situ and satellite observations of isotopic composition near the tropical tropopause give the hope of quantitatively assessing this process at a global scale. We present an idealized model that investigates such a possibility and we explore the potential of our approach to advance understanding of the transition from the upper troposphere to the lower stratosphere within the tropics. The model optimally combines the tropical balance of dry static energy, vapor and deuterated vapor to yield predictions of the averaged deuterium content of water vapor within the tropics. We propose a natural interpretation of the structure of isotopic composition in the UTLS (with a distinctive turnover around 15-16 km and increasing values to the stratosphere) as a transition between two regimes. We show how satellite-observed profiles are naturally reproduced by optimizing our representation of the convective transport of condensed water, which further opens a way to retrieving useful quantities from satellite observations. We discuss some aspects of the recently observed variability of the isotopic composition of vapor within the UTLS.