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Water vapor isotopic variations of the upper troposphere/ lower stratosphere in the N. American and Asian Summer Monsoons

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The 2022 ACCLIP (Asian summer monsoon Chemical and CLimate Impact Project) high-altitude aircraft campaign has provided a sampling of the diversity of processes that affect moisture transport in the upper troposphere / lower stratosphere (UT/LS). We report here on ACCLIP observations of water vapor isotopologues, which trace the origin and microphysical history of water vapor. Measurements with the Chicago Water Isotope Instrument (ChiWIS) show isotopic variations in the UT/LS that correlate with airmass history, and 100-150 ‰ variation even at the same water content. ACCLIP flights out of Osan, South Korea sampled monsoon anticyclone outflow with CO values over 200 ppb, recent local convection, extensive in-situ cirrus, and an overflight of tropical cyclone Hinnanmor showing strong isotopic depletion. Flights out of Houston, TX sampled week-old remnants of sublimated ice from deep convection, producing enriched vapor, and possible mixing of convective overshoots with stratospheric air before sinking. We show through case studies from both Asia and North America that isotopologues provide a sensitive diagnostic of ice sublimation, and demonstrate how different meteorological contexts produce distinct isotopic signatures.