Rei Ueyama
rei.ueyama@nasa.gov
NASA Ames Research Center
Moffett Field, CA 94031

Eric Jensen
eric.j.jensen@nasa.gov
NASA Ames Research Center
Moffett Field, CA 94031

Leonhard Pfister
leonhard.fister@nasa.gov
NASA Ames Research Center
Moffett Field, CA 94031

Journal of Geophysical Research - Atmospheres
Journal URL https://publications.agu.org/journals/
Publisher: American Geophysical Union (AGU)

Title: Convective influence on the humidity and clouds in the tropical tropopause layer during boreal summer

Abstract:
The impact of convection on the humidity and clouds in the tropical tropopause layer (TTL) during boreal summer 2007 is investigated in simulations of detailed cloud microphysical processes and their effects on the water vapor (H_2O) profile along backward trajectories from the 379 K potential temperature (100 hPa pressure) surface. Convective influence is determined by tracing the trajectories through time-dependent fields of satellite-based convective cloud-top height. The simulated H_2O mixing ratios at the 100 hPa level and cloud occurrence fractions in the mid to upper (16-18 km) TTL exhibit a pronounced maximum over the Asian monsoon region as in observations; these local enhancements are virtually absent in the simulation without convection, indicating that convection is the dominant driver of the localized H_2O and cloud maxima in the Asian summer monsoon region. Convection moistens the 100 hPa level by 0.6 ppmv (~15%) averaged over the 10°S-50°N domain and increases tropical (10°S-30°N) mean cloud occurrence in the mid to upper TTL by ~170%. Nearly all of the convective enhancements in H_2O and clouds are due to the effect of convective saturation; convectively detrained ice crystals have negligible impact. Parcels are most frequently hydrated by deep convection in the southern sector of the Asian monsoon anticyclone and subsequently dehydrated downstream of convection to the west, shifting the locations of final dehydration northwest of the cold temperature region in the northern Tropics. Infrequent, extreme deep convective systems (cloud tops exceeding 380K) have a disproportionately large effect on TTL humidity and clouds.