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Observed convective transport of water vapor and CO over the Asian monsoon/Tibetan Plateau and implied challenge for modeling this process

Previous studies suggest that most of transport to the TTL in the Asian monsoon region is carried out either by tropical convection over the South Asian monsoon region or by extratropical convection over Southern China. Using measurements from newly available NASA Aura Microwave Limb Sounder along with observations from the Aqua and Tropical Rainfall Measuring Mission satellites, we suggest that the TP provides the main pathway for cross-tropopause transport in this region. Tropospheric moist convection driven by elevated surface heating over the TP is deeper and detrains more water vapor, CO, and ice at the tropopause than over the monsoon area. Warmer tropopause temperatures and slower falling smaller cirrus cloud particles in less saturated ambient air at the tropopause also allow more water vapor to travel into the lower stratosphere over the TP, effectively short-circuiting the slower ascent of water vapor across the cold tropical tropopause over the monsoon area. Air high in water vapor and CO over the Asian monsoon/TP region enters the lower stratosphere primarily over the TP, then it is transported equatorward toward the Asian monsoon area and disperses into the large scale upward motion of the global stratospheric circulation.

Preliminary evaluation of the reanalysis products (e.g., NCEP and GMAO) shows unrealistically stable atmospheric thermodynamic structure, thus lack of deep convection, over the Tibetan Plateau. Contrary to available observations, a center of maximum cross-tropopause transport appears over the South central China. These discrepancies between satellite observations and reanalysis products in terms of location of a major global center for the summer cross-tropopause transport highlight an importance and challenge area for modeling the deep convective transport to the TTL.