Impact of convectively detrained ice crystals on the tropical upper troposphere and lower stratosphere

Rei Ueyama, Eric Jensen, Leonhard Pfister, Martina Krämer, Mark Schoeberl

1000 words (2000 characters excluding spaces)

The role of convectively detrained ice crystals on the humidity of the tropical upper troposphere and lower stratosphere (UTLS) is investigated in simulations of cirrus clouds along trajectories launched from the 378K potential temperature level in the tropics. The one-dimensional (vertical) cloud model tracks individual ice crystals through their lifecycle beginning with detrainment from convection, followed by deposition growth, sedimentation and sublimation. Convective influence of the parcels is diagnosed by tracing the trajectories through time-dependent fields of convective cloud-top height adjusted to match the CloudSAT and CALIPSO statistics. Model simulations of UTLS water vapor and cloud fields are evaluated and constrained by comparison with Aura MLS and CALIPSO measurements.

Preliminary results indicate sensitivity of the detrained ice crystal lifecycle to atmospheric conditions downstream of convection. Specifically, cooling (high relative humidity and supersaturation) downstream of convection leads to deposition growth and sedimentation of detrained ice crystals, resulting in net dehydration of the UTLS. In contrast, warming (low relative humidity and subsaturation) downstream of convection leads to sublimation of detrained ice crystals and subsequent hydration. As such, the impact of detrained ice crystals on the humidity of the UTLS exhibits distinct spatial variability. Detrained ice crystals predominantly dehydrate the UTLS in the tropical mean. Sensitivities to the convectively detrained ice crystal size and concentration are also examined using measurements from the StatoClim aircraft campaign. The importance of convectively detrained ice crystals will be discussed within the context of the overall contribution of convection to the lower stratospheric humidity.