Quantify laminar cirrus ice and its contribution to the total water budget in the tropical tropopause layer

Tao WANG[1,2], Dong L. WU[2], Jie GONG[2,3], and Victoria TSAI[4]

[1] *University of Maryland, College Park, USA*
[2] *NASA Goddard Space Flight Center, Greenbelt, USA*
[3] *Universities Space Research Association, Columbia, USA*
[4] *Stanford University, Stanford, California*

Laminar cirrus is a unique and critical type of cloud that dominates the total cloud fraction in the tropical tropopause layer (TTL, 15-17 km) because of its extensiveness and longevity. It effectively interchanges mass with water vapor (H_2O) and travel together with H_2O over multiple lifecycles. In this study, we construct a 10-year (2008-2017) records of laminar cirrus and the associated ice water content (IWC) by utilizing Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) L2 merged layer product and L1 backscatter image at 532 nm. The base of laminar cirrus is frequently found between 15-16 km, with geometric thickness between 0.5-1 km. About 80% of laminar cirrus's top is below the local tropopause. There is a clear annual cycle on the laminar cirrus frequency and ice abundances, with the most frequent occurring during boreal winter carrying a few hundred tons of ice. On average, the laminar cirrus has IWC of ~0.05 mg/m^3 (~0.5 ppmv) around the tropopause. By investigating the IWC and coincident H_2O measurements by the Microwave Lime Sounder (MLS) on a profile-by-profile basis, we found a robust anti-correlation of H_2O vs. IWC at the TTL, which depicts the competing effect of vapor and ice towards a balance in the total water budget. It is speculated that the ice in laminar cirrus acts as a reservoir of vapor that undergoes multiple life cycles between solid and vapor phase, which could contribute ~10-15% to the total vapor abundance in higher levels.

Key words: TTL, laminar cirrus, IWC, water vapor