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Strong correlation between cirrus amount and water vapor in the TTL as observed by Calipso and Aura/MLS

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Water vapor in the tropical tropopause layer (TTL) has a significant radiative cooling effect on the Earth's climate system. As a source for cirrus clouds, however, it can also indirectly produce infrared heating. The amount of water vapor in the TTL is strongly controlled by temperature (correlation R=0.9) with a seasonal cycle of ~1 ppm vmr in amplitude (25% of mean value) at 100 hPa and minimum values in northern hemisphere winter (December-January-February, DJF). Studying the A-Train CALIPSO cirrus and MLS water vapor measurements, we find that the cirrus seasonal cycle is highly (R=-0.9) anticorrelated with the water vapor variation in the TTL, showing higher occurrence during DJF. We further investigate the anticorrelation on a regional scale and find that the high correlation occurs generally in the ITCZ (Intertropical Convergence Zone). Our results support the hypothesis that the total water (H2O) is roughly constant in the TTL, providing a reservoir for cirrus clouds and water vapor, while temperature acts as a regulator for balancing the partition between water vapor and cirrus clouds. Thus, to a large extent, the depleting water vapor in the TTL during DJF is a manifestation of cirrus formation.