Gravity Waves Amplify Upper Tropospheric Dehydration by Clouds

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We use a 1D cloud model run along trajectories to investigate the role of gravity waves in dehydration near the tropopause, more specifically the Tropical Tropopause Layer (TTL). We find that gravity waves play an important role in the TTL dehydration process beyond just a lowering the temperature of the air parcels. We show that the more rapid cooling associated with gravity waves significantly increases the number of ice crystals formed. This increase causes a more rapid depletion of vapor in excess of saturation and increases the cloud dehydration efficiency. The nucleation effect on dehydration has a larger impact than the suppression of temperature by the waves. Using a spectrum of gravity waves, we generate ice particle statistics that are in good agreement with observations. We also find that the presence of gravity waves increases cloudiness. Our results show that cloud physics and gravity wave temperature fluctuations cannot be neglected in simulating the TTL dehydration process.