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Abstract

Title: A method for obtaining high frequency, global, IR-based Convective Cloud Tops for studies of the TTL

Models of varying complexity that simulate water vapor and clouds in the Tropical Tropopause Layer (TTL) show that including convection directly is essential to properly simulating the water vapor and cloud distribution. In boreal winter, for example, simulations without convection yield a water vapor distribution that is too uniform with longitude, as well as minimal cloud distributions. Two things are important for convective simulations. First, it is important to get the convective cloud top potential temperature correctly, since unrealistically high values (reaching above the cold point tropopause too frequently) will cause excessive hydration of the stratosphere. Second, one must capture the time variation as well, since hydration by convection depends on the local relative humidity (temperature), which has substantial variation on synoptic time scales in the TTL.

This paper describes a method for obtaining high frequency (3-hourly) global convective cloud top distributions which can be used in trajectory models. The method uses rainfall thresholds, standard IR brightness temperatures, meteorological temperature analyses, and physically realistic and documented corrections IR brightness temperature corrections to derive cloud top altitudes and potential temperatures. The cloud top altitudes compare well with combined CLOUDSAT and CALIPSO data, both in time-averaged overall vertical and horizontal distributions and in individual cases (correlations of .65-.7). An important finding is that there is significant uncertainty (nearly .5 km) in evaluating the statistical distribution of convective cloud tops even using lidar. Deep convection whose tops are in regions of high relative humidity (such as much of the TTL), will cause clouds to form above the actual convection. It is often difficult to distinguish these clouds from the actual convective cloud due to the uncertainties of evaluating ice water content from lidar measurements. Comparison with models show that calculated cloud top altitudes are generally higher than those calculated by global analyses (e.g., MERRA). Interannual variability in the distribution of convective cloud top altitudes is also investigated.