Interannual and intraseasonal variations of clouds in the upper Tropical Tropopause Layer observed by CALIOP

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Cloud variations in the tropical tropopause layer (TTL) during northern winter are investigated using the 10-year CALIPSO observations, in particular focusing on the cloud top level above the cold point tropopause (above approximately 18 km). The 10-year climatology of the TTL cloud shows higher occurrence frequency over South America, Africa, and the western-central Pacific. Interannual variation of the TTL clouds is strongly related with the TTL temperature variations associated with Quasi Biennial Oscillation (QBO) and El Nino and Southern Oscillation (ENSO). The TTL clouds associated with QBO appear/disappear simultaneously over South America, the equatorial Africa, and western-central Pacific. On the other hand, the TTL clouds associated with ENSO vary with the see-saw pattern between the western and central Pacific. We also investigated intraseasonal variations during December 2009 - February 2010. It is suggested that the temperature perturbation associated with the equatorial Kelvin wave and the sudden stratospheric warming (SSW) are important for the cloud formation. Interestingly, the TTL clouds occurred only over South America, Africa, and western-central Pacific along the Kelvin wave going east.

Keywords: tropical tropopause layer (TTL), CALIPSO, cloud

