



Formation of Pileus Clouds near the Tropopause

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During CRYSTAL-FACE thin tropopause cirrus layers (TTC) were often seen above cirrus anvils. Compared to the anvil cirrus, TTC were typically a hundred times more tenuous and about 20 K colder, however they had similar horizontal dimensions, suggesting the two layers were related. Here we show how TTC might begin as pileus, forced as deep convection pushes stratified air upwards. If the air is cooled to the point of homogeneous ice nucleation, a cloud forms. Pileus formed at the apex of the convection are sustained only in the upward phase of the ensuing gravity wave. Lower, however, pileus may be punctured by the faster moving deep convection, enabling ice crystals to be mixed into the pileus. These act as a reservoir of moisture and inhibit evaporation in the gravity wave's downward phase - the pileus spreads as a continuous sheet of TTC. It appears that pileus may act a "safety catch", permitting deep convection to squeeze excess moisture from the tropical tropopause air before its ascent into the stratosphere. We show evidence of for this process using airborne photographs, modeling studies, and meteorological and isotope data.