Cirrus and Wave-induced Temperature Anomaly Relationships in ATTREX Measurements

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Wave-induced temperature changes are known to influence formation of cirrus clouds in the tropical tropopause layer (TTL). Formation and sedimentation of thin cirrus are a primary process affecting dehydration of air entering the stratosphere through the tropical tropopause. Previous studies have identified Kelvin wave influences on cirrus formation above 15-km altitude, and model studies have shown that higher frequency gravity wave temperature changes can increase cirrus cloud occurrence frequency and efficiency of dehydration in the TTL. Radiosonde observations indicate that wave induced temperature anomalies in the TTL typically have short vertical scales, with wavelengths commonly shorter than 4 km. These waves are generally poorly represented in global models due to limitations on vertical and horizontal resolution, and due to associated difficulties in representing the spatial and temporal scales of latent heating in precipitating cloud that are wave sources. We investigate relationships between fine-vertical-scale temperature structure and cirrus layers in ATTREX measurements.

Flight paths of the Global Hawk during ATTREX included frequent dive maneuvers through the TTL with insitu measurements of fine-scale structure in both temperature and ice particles. Measurements near radiosonde sites indicate layers due to very low-frequency gravity waves with periods of 2-3 days and vertical wavelengths of 1-2 km that have large horizontal extent, and are associated with thin cirrus layers. Overflight measurements with the down-looking cloud lidar give further indication of the horizontal extent of the cirrus layers. We also investigate statistical relationships between layered temperatures, winds, and ice particle occurrence in ATTREX data to support interpretation of layers as wave-induced.