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Ultrathin Tropical Tropopause Clouds (UTTCs): II. Stabilization mechanisms

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Abstract. Mechanisms by which subvisible cirrus clouds (SVCs) might contribute to dehydration close to the tropical tropopause are not well understood. Recently Ultrathin Tropical Tropopause Clouds (UTTCs) with optical depths around 10^{-4} have been detected in the western Indian ocean. These clouds cover thousands of square kilometers as 200-300 m thick distinct and homogeneous layer just below the tropical tropopause. In their condensed phase UTTCs contain only 1-5% of the total water, and essentially no nitric acid. A new cloud stabilization mechanism is required to explain this small fraction of the condensed water content in the clouds and their small vertical thickness. This work suggests a mechanism, which forces the particles into a thin layer, based on upwelling of the air of some mm/s to balance the ice particles, supersaturation with respect to ice above and subsaturation below the UTTC. In situ measurements suggest that these requirements are fulfilled. The basic physical properties of this mechanism are explored by means of a single particle model. Comprehensive 1-D cloud simulations demonstrate this stabilization mechanism to be robust against rapid temperature fluctuations of +/- 0.5 K. However, rapid warming (\Delta T > 2 K) leads to evaporation of the UTTC, while rapid cooling (\Delta T < -2 K) leads to destabilization of the particles with the potential for significant dehydration below the cloud

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