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Evidence of in Situ Cirrus Formation in the Tropical Tropopause Layer over the Southwestern Indian Ocean

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A nascent in situ cirrus was observed on 11 January 2019 in the tropical tropopause layer (TTL) over the southwestern Indian Ocean, with the use of balloon-borne instruments. Data from CFH (Cryogenic Frost Point Hygrometer) and COBALD (Compact Optical Backscatter and Aerosol Detector) instruments were used to characterize the cirrus and its environment. Optical modeling was employed to estimate the cirrus microphysical properties from the COBALD backscatter measurements. Newly-formed ice crystals with radius $<1 \mu\text{m}$ and concentration $\approx 500 \text{ L}^{-1}$ were reported at the tropopause. The relatively low concentration and CFH ice supersaturation (1.5) suggests a homogeneous freezing event stalled by a high-frequency gravity wave. The observed vertical wind speed and temperature anomalies that triggered the cirrus formation were due to a 1.5-km vertical-scale wave, as shown by a spectral analysis. This cirrus observation shortly after nucleation is beyond remote sensing capabilities and presents a type of cirrus never reported before.