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Microphysical Modeling of Nitrile Ice Clouds in Titan's Atmosphere

Sachchida Tripathi (1) and Sachchida Tripathi (1,2)

(1) Indian Institute of Technology Kanpur, Department of Civil Engineering, Kanpur, India (snt@iitk.ac.in), (2) NASA Goddard Space Flight Center

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S. N. Tripathi1,2, Paul. N. Romani1, and Carrie M. Anderson1
1NASA Goddard Space Flight Center
2Oak Ridge Associated Universities
Greenbelt, MD 20771
Nitrile ice clouds in Titan's lower stratosphere at high northern latitudes were inferred from the analysis of Voyager IRIS thermal infrared spectra. Recently these ice clouds have been confirmed utilizing far-infrared spectra from Cassini CIRS. Mean particle radii are small (<5 micron) with an assumed narrow distribution (variance = 1.01). In order to understand the various processes involved in the formation, subsequent growth, and existence of these ice clouds, we employ an independent microphysical cloud model. This model includes heterogeneous ice nucleation, condensational growth of nucleating crystals, their collision and coalescence amongst themselves, and evaporation. The most recent temperature, pressure and aerosol distributions, and best available thermodynamic data are employed. The model confirms small ice particles with mean radii ranging between 0.5 and 3 microns, which depend on the supersaturation of the condensing gas and altitude location of the cloud. Interestingly, smaller supersaturations lead to larger particles due to a smaller concentration of nucleating ice particles that can grow to larger sizes. At latitude 70N, two distinct cloud layers of condensed HCN located at altitudes 140 and 80 km are predicted, with larger ice particles in the upper cloud layer. Sublimation of falling ice particles at a local temperature maximum may be responsible for the absence of cloud particles between the 140 and 80 km layers ($\sim$100 km).