Titan's Aerosol and Condensation Cloud Properties in the Far-IR between 2005 and 2010

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Abstract

Analyses of far-IR spectra between 20 and 560 cm^{-1} (500 to 18 μm) recorded by the Cassini Composite Infrared Spectrometer (CIRS) yield the spectral dependence and the vertical distribution of Titan's photochemical aerosol and ice clouds. Titan's aerosol appears to be well mixed between the surface and an altitude of 300 km, with a spectral shape that does not change with latitude or time. The aerosol exhibits an extremely broad emission feature with a spectral peak at 140 cm^{-1} (71 μm), which is not evident in laboratory simulated Titan aerosols (tholin). This low-energy aerosol emission feature may arise from low-energy molecules such as polycyclic aromatic hydrocarbons and/or nitrogenated aromatics.

Unlike the vertically well-mixed aerosol, Titan's condensate clouds are located in highly restricted altitudes in the lower stratosphere, ranging between 60 and 100 km at low and moderate latitudes, to between 150 and 165 km at high northern latitudes during northern winter. Such clouds are located at altitudes where nitrile vapors are expected to condense and appear to be dominated by HCN and HC_3N, which are the two most abundant nitriles in Titan's atmosphere. Associated with this ice cloud is a broad emission feature that spectrally peaks near 160 cm^{-1} (62.5 μm). This ice composite appears to chemically change with altitude and latitude, probably as a result of differences in vapor abundance and condensation temperature, and the ice cloud appears to be global in extent. Both CIRS and the *Huygens* Descent Imager and Spectral Radiometer (DISR) show evidence of cloud layering in Titan's lower stratosphere. The 15 km difference in cloud altitude indicated by the two instruments suggests a difference in ice composition. CIRS also indicates a second ice cloud that exists at isolated latitudes and is consistent with hydrocarbon condensation above the tropopause. This cloud exhibits an emission feature that spectrally peaks near 80 cm^{-1} (125 μm), possibly due to C_2H_6 ice or dominated by an ethane-acetylene composite ice, given that C_2H_6 then C_2H_2 are the two most abundant hydrocarbons next to methane in Titan's atmosphere.