

# Titan's stratospheric condensibles at high northern latitudes during northern winter

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The Infrared Interferometer Spectrometer (IRIS) instrument on board Voyager 1 caught the first glimpse of an unidentified particulate feature in Titan's stratosphere that spectrally peaks at  $221\text{ cm}^{-1}$ . Until recently, this feature that we have termed 'the haystack,' has been seen persistently at high northern latitudes with the Composite Infrared Spectrometer (CIRS) instrument onboard Cassini. The strength of the haystack emission feature diminishes rapidly with season, becoming drastically reduced at high northern latitudes, as Titan transitions from northern winter into spring.

In contrast to IRIS whose shortest wavenumber was  $200\text{ cm}^{-1}$ , CIRS extends down to  $10\text{ cm}^{-1}$ , thus revealing an entirely unexplored spectral region in which nitrile ices have numerous broad lattice vibration features. Unlike the haystack, which is only found at high northern latitudes during northern winter/early northern spring, this geometrically thin nitrile cloud pervades Titan's lower stratosphere, spectrally peaking at  $160\text{ cm}^{-1}$ , and is almost global in extent spanning latitudes  $85^{\circ}\text{N}$  to  $60^{\circ}\text{S}$ . The inference of nitrile ices are consistent with the highly restricted altitude ranges over which these features are observed, and appear to be dominated by a mixture of HCN and  $\text{HC}_3\text{N}$ . The narrow range in altitude over which the nitrile ices extend is unlike the haystack, whose vertical distribution is significantly broader, spanning roughly 70 km in altitude in Titan's lower stratosphere.

The nitrile clouds that CIRS observes are located in a dynamically stable region of Titan's atmosphere, whereas  $\text{CH}_4$  clouds, which ordinarily form in the troposphere, form in a more dynamically unstable region, where convective cloud systems tend to occur. In the unusual situation where Titan's tropopause cools significantly from the HASI 70.5K temperature minimum,  $\text{CH}_4$  should condense in Titan's lower stratosphere, just like the aforementioned nitrile clouds, although in significantly larger abundances.

We will present the spectral and vertical distribution of Titan's stratospheric particulates during northern winter on Titan. The drastically changing abundance of the haystack over a small latitude range will be highlighted, specifically comparing the IRIS and CIRS epochs. Finally, we will discuss the situation in which  $\text{CH}_4$  condenses in Titan's lower

stratosphere, forming an unexpected quasi steady-state stratospheric ice cloud.