EPSC Abstracts
Vol. 6, EPSC-DPS2011-1596, 2011
EPSC-DPS Joint Meeting 2011

Titan's Ammonia Feature

W. Smythe (1), R. Nelson (1), M. Boryta (2) and M. Choukroun (1)
(1) Jet Propulsion Laboratory, USA, (2) Mount San Antonio College (William.d.smythe@jpl.nasa.gov / Fax: +01-393-4555)

Abstract

NH_3 has long been considered an important component in the formation and evolution of the outer planet satellites. NH_3 is particularly important for Titan, since it may serve as the reservoir for atmospheric nitrogen. A brightening seen on Titan starting in 2004 may arise from a transient low-lying fog or surface coating of ammonia. The spectral shape suggests the ammonia is anhydrous, a molecule that hydrates quickly in the presence of water.

1. Introduction

NH_3 has long been considered an important component in the formation and evolution of the outer planet satellites. NH_3 is seen in clouds in the atmospheres of giant planets, but has yet to be detected on any of the satellites. This may be because all forms of NH_3 are unstable in the ambient conditions of the satellite's surfaces or that its spectral features are altered by other components of the surface, and have not been identified. NH_3 has been suggested as a possible source for sustaining Titan's thick nitrogen-dominated atmosphere.

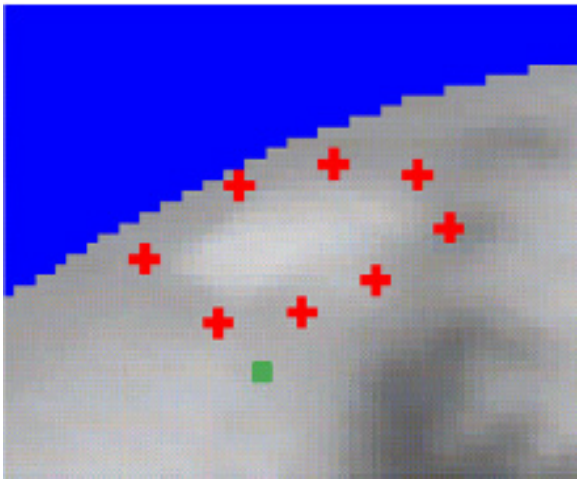

Figure 1 *The brightening observed on Titan recurs in same locale, has a short lifetime and low altitude and is consistent with a surface coating that rapidly either evaporates, is covered, or is converted to a composition that is not bright in the wavelength range of VIMS.*

2. Surface brightening on Titan

It has been demonstrated [1] that brightening occurs on Titan that is transient on the timescale of months. Figure 1 shows the size and shape of the brightening event on Titan and figure 2 demonstrates that the event is both transitory and recurrent. Figure 3 shows the spectral behaviour of the brightening (for various pass bands of the Titan atmosphere) contrasted with laboratory spectra of several frosts. The spectral shape of the brightening is consistent with that of the transient apparition of a pure ammonia frost, but not of ammonia monohydrate or ammonia dihydrate frost.

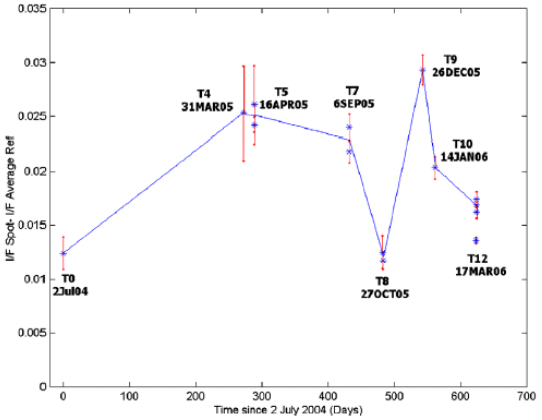

Figure 2 *The apparent brightness of the feature varies over time , suggesting both and active source and a rapid sink or covering of the brightened area.*

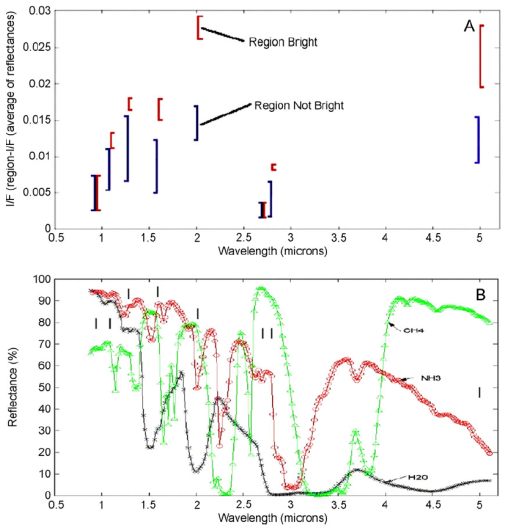

Figure 3 *The spectral shape of the feature is consistent with anhydrous ammonia frost.*

3. Anhydrous Ammonia

The hydrated forms of ammonia would be expected to be present if the frost, or the reservoir from which the frost was derived, had any water present. This is because these hydrates show peritectic behavior in the phase diagram of ammonia.

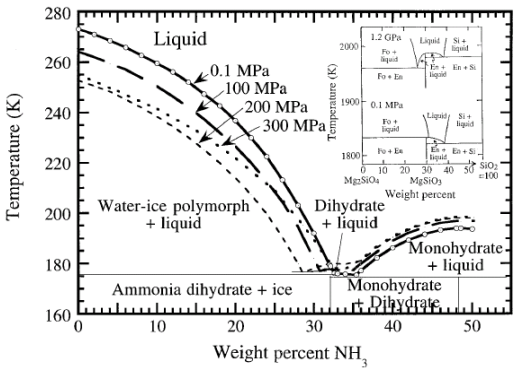

Figure 4 *The hydrated forms of ammonia are more stable than anhydrous ammonia in the presence of water [3].*

The condition for the presence of an anhydrous ammonia frost thus appear to be that no water is present in the ammonia reservoir or that some mechanism exists for removing the water from the ammonia. The former condition is inconsistent with the model that methane clathrate serves as the reservoir for methane, which is also ubiquitous at Titian. Miller [2] noted that clathrates are more stable than ammonia hydrate which could satisfy the requirement for removing water of hydration from ammonia. Thus a transient anhydrous ammonia surface frost or fog could have a mixed ammonia plus methane clathrates reservoir as its source.

Acknowledgements

The authors would like to thank the NASA Outer Planets Research program, and the Jet Propulsion Laboratory for their support of this researc

References

[1] Hogenboom et al, The Ammonia-Water System and the Chemical Differentiation of Icy Satellites, *Icarus* **128**, pp171-180, 1997

[2] Miller, S. L, The occurance of gas hydrates in the solar system, Proceedings of the National Academy of Science, 1961

[3] Nelson, R.M., et al. Saturn's Titan: Surface Change, Ammonia, and Implications for Atmospheric and Tectonic Activity, *Icarus*, **199**, pp. 429-441, 2009