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Transparency of the 2 µm window on Titan studied with observations made by VIMS

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Abstract

The study of Titan properties with remote sensing relies on a good knowledge of the atmosphere properties. The in-situ observations made by Huygens combined with recent advances in the definition of methane properties enable to model and interpret observations with a very good accuracy. However, intensity at some wavelengths are poorly modeled because additional opacities must be studied. We focus here on the case of the 2 µm window, which is essential to determined cloud and surface properties.

1. Introduction

The Huygens probe has allowed to describe the atmosphere of Titan in detail. Such a description would not have been possible from remote sensing, and it gives a unique set of information to further describe the atmosphere at other latitudes and at wavelengths not probed by DISR, beyond 1.6 µm. In addition, thorough analysis of Titan spectra has also become possible thanks to a unique set of data that gives methane properties in extreme details (De Bergh et al., 2012). However, despite these unique set of information, several recent studies have clearly indicated that the 2 µm window is not correctly modeled and this leads to uncorrect cloud altitude (Rannou et al., 2012, Griffith et al. 2012). For instance, the cloud properties found in windows at shorter wavelength than 2 µm and at 2 µm are not the same. Similarly, it is also expected that the retrieved surface albedo to be severely biased at 2 µm .

2. The 2 µm window

A key parameter, when using spectroscopic data for atmospheric application, are the cut-off of the far wings of the line profiles. They are necessary to match data, they must be set in an empirical way, and the details of the cut-off clearly modify the shape and the opacities in the window. Therefore many properties retrieved from modeling directly depends on the quality of the cut-off, and obviously a un-correct cut-off may give misleading results.

Here we studied the role of the cut-off at two locations on Titan : above the polar cloud and at the limb (**Figure 1**). The reason is that for these locations, the intensity only depends on the methane and the aerosols. To do so, we admit that the polar cloud layer is colorless within the 2 µm window.

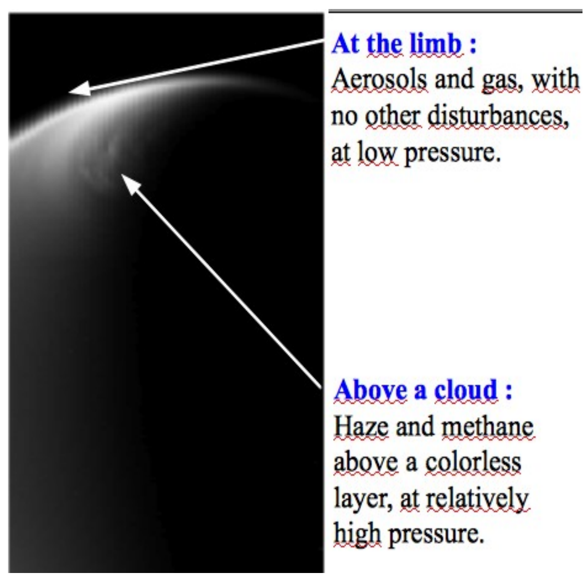

Figure 1: Photo of Titan taken at 113° degrees phase angle. Two locations are of particular interest : the north polar cloud and the limb, where the intensity only depends on the haze and on the methane absorption.

3. The role of the cut-off

The cut-off of the far wings gives the background opacity in the window and it modulates the shape of the windows. The **Figure 2** shows an example of synthetic spectra modeled with two different cut-off above the polar cloud. Using an observation above a white and relatively thick cloud allows obtain data that only depends on the gas absorption and the haze. The latter essentially has a continuous behaviour at the scale of the window. Therefore the difference between the model and the data can be attributed to the gas absorption and, since the spectroscopic data are assumed to be well known at these wavelengths, essentially to the way the far wings are cut.

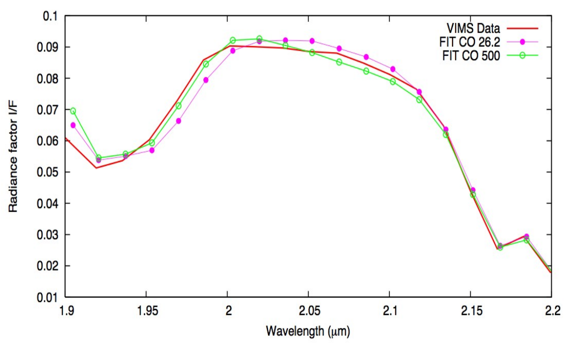

Figure 2: Spectrum at 2 µm above the polar cloud layer. Two synthetic spectra are shown, with two different cut-off, at 26 cm^{-1} and at 500 cm^{-1} from the line core. The shape of the window depend on the choice of the cut-off used in the calculation.

4. Brief of the work

In this presentation we will describe how we used these specific observations to constrain the far wings cut-off at 2 µm. We also will discuss the impact of the cut-off on the retrieval of the cloud altitude and on the surface albedo. Comparison between observations made at other windows will be crucial to validate our results.

References

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