EPSC Abstracts
Vol. 8, EPSC2013-459, 2013
European Planetary Science Congress 2013

Surface of Titan studied with observations made by VIMS

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Abstract

In-situ observations made by Huygens combined with recent advances in the definition of methane properties enable to model the radiative transfer and to interpret observations with a very good accuracy. Although the atmosphere properties is still known perfectly known at some wavelengths, it enable to study the surface signature. In this presentation we will describe describe how we retrieve the surface albedo of Titan, showing where are the main uncertainties, and we will show how we model the surface signal to give an interpretation of the observations.

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, Hirtzig et al., 2013).

The surface signal, as observed by Huygens, or retrieved from the orbit, are highly complementary. In the first case, the signal is accurate and does not suffer from the filtering by the atmosphere. On the other hand, it is limited to the range 0.4 to 1.6 µm. From the orbit, we have to retrieve the surface albedo in methane windows from a signal that include information from the atmosphere, and the retrieval is quite delicate. But, in this case, we potentially have access to the surface albedo at 2 µm, 2.8 µm and 5.0 µm that can give clues about the surface properties.

2. Retrieved surface albedo

Using a photometry model, we are able to retrieve the surface albedo in the methane windows, which are quite transparent. However, since the transparency of the windows increase with the wavelength, with a good knowledge of gas opacities, we should obtain that the uncertainties of retrievals decrease (**Figure 1**). But, unfortunately, the 2 µm window is not yet well understood and the 5 µm is very noisy with VIMS so the retrieval from orbit is not yet accurate, and we will discuss this point.

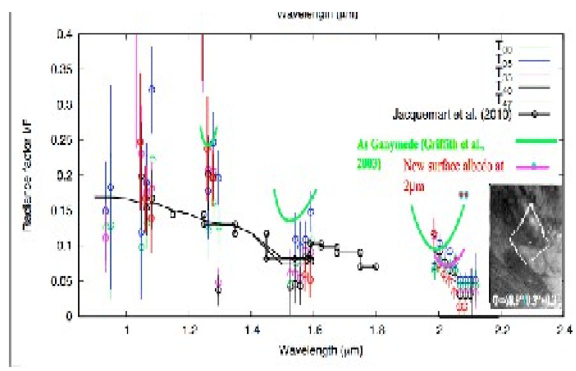

Figure 1: *Surface reflectivities as observed by DISR (Jaquemart et al., 2010), and retrieved from 5 different observations made by VIMS (**T** $_{XX}$). We also plotted Ganymede surface albedo(green line) and the purple line ('New surface albedo') shows the effect of the far wing cut-off on the retrieval of the surface albedo.*

3. Model of surface reflectivity

To understand the surface albedo, we have model the signal by a simple model based on aggregate properties and using reflectance of ice grains (http://ghosst.osug.fr/). Our objective is to model the surface albedo as retrieved bu DISR, but also to anticipate the type of surface reflectivity we should find from windows beyond 1.6 μm.

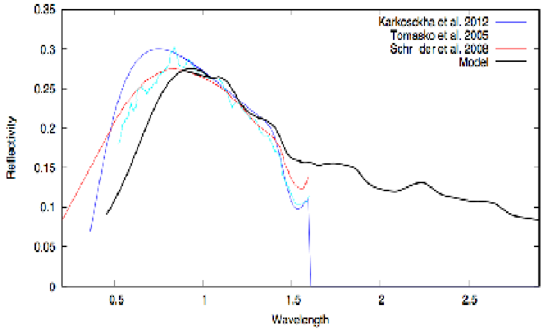

Figure 2: *Surface reflectivity of Titan estimated from DISR (Tomasko et al., 2005, Schröder et al., 2008, Karkoschka et al., 2012) and approximately rescaled to the cruve of Schröder et al. (2008). We also plot the surface albedo modeled to fit*

References

[1] de Bergh et al. "Applications of a new set of methane line parameters to the modeling of Titan's spectrum in the 1.58 μm window" Planetary and Space Science, Volume 61, Issue 1, p. 85-98 (2012)

[2] Hirtzig et al., "Titan's surface and atmosphere from Cassini/VIMS data with updated methane opacity" Icarus, revised (2013)