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Comparing VIMS observations of the Huygens Landing Site with DISR and radar observations: implications for Titan geology and its spin rate.

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Introduction

The Cassini spacecraft has been orbiting in the Saturn's system since July 2004. Remote sensing instruments have discovered that Titan's surface is rich in geological features including dunes, river beds, hydrocarbon lakes, seas, impact craters, mountains and cryovolcanic features [1, 2 , 3, 4, 5 ,6, 7].

The Visual and Infrared Mapping Spectrometer (VIMS) onboard the Cassini spacecraft can provide images of Titan's surface at a resolution as good as one kilometre per pixel [8]. But only few observations at this resolution were obtained during the nominal mission because the VIMS capabilities were unexpected before the first observations. The VIMS simultaneously acquires 352 images at wavelengths from the visible to 5.11 µm. Because Titan's atmosphere absorbs most of the photons, the surface can only be observed in seven narrow atmospheric windows in the 0.88 to 5.11 µm wavelength range [8].

One goal of the extended mission is to better constrain the surface composition. One way is to compare the VIMS images with the information acquired by the Huygens probe. The Huygens landing site is a ground truth for the VIMS. This study reports on the comparison between the images acquired by the Descent Imager/Spectral Radiometer (DISR) during the descent of the Huygens probe in January 2005 and the high resolution image of this site acquired by the VIMS in November 2008 (T47). One difficulty in implementing this observation was related to the uncertainty on Titan's spin rate. Radar observations of several geological landmarks suggest that Titan spin's rate may be faster than synchronous by about 10^{-3} º/day [9]. During the almost 4 years between the Huygens landing and the T47 flyby, the offset can be as large as 1.5 º, which is larger that the VIMS field of view. Because there is a strong correlation between precession and spin rate, it was decided to keep the hypothesis of synchronous rotation.

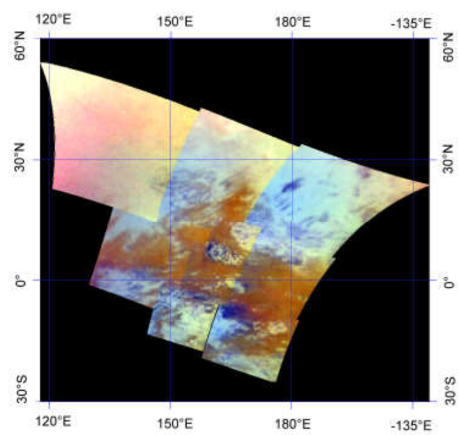

Figure 1: VIMS mosaic of the area where the Huygens probe landed in January 2005. Each color is a ratio of two images in infrared windows which are transparent for methane. The ratio images allow us to remove a large part of the atmospheric effects. Red = 1.59 µm /1.27 µm ; Green = 2.03 µm /1.27 µm and Blue = 1.27 µm /1.08 µm.

Data acquisition, processing and analysis

The Huygens landing site is located at about (10S, 168E) in plains. Figure 1 shows a VIMS mosaic for the context. The colour-coding is explained in the caption. Dune fields appear in brown. They

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cover plains which are around the bright, likely elevated, terrains. Note also the presence of a well-preserved impact crater named Selk.

The Huygens landing site is located in a blue area which is believed to be enriched in water ice [7]. It is located between the bright terrains and the dune fields.

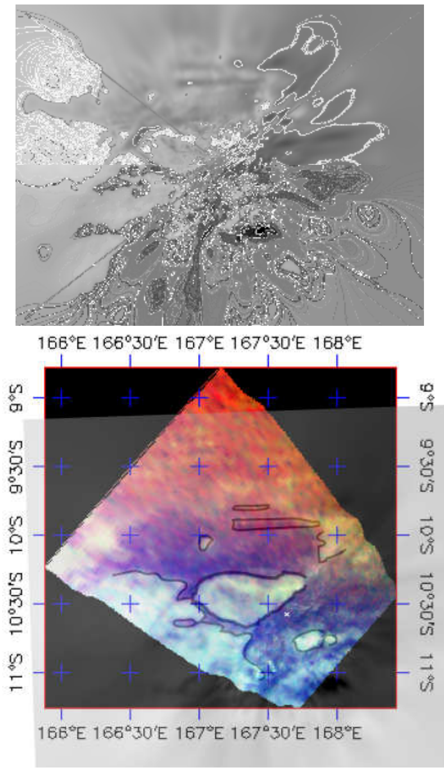

Figure 2: DISR image of the Huygens landing site (top) is overlaid on top of the VIMS image. Color-coding of the VIMS image is the same as in Fig. 1.

The T47 flyby is one of the 3 flybys which were allocated to VIMS at C/A during the extended mission and the first of the entire mission devoted to the mapping of the Huygens landing site at high resolution. The image cube (CM1605804042) was acquired on November 19, 2008 with an integration time of 60 ms. The altitude of the observation varied from 1523 km to 2761 km during the acquisition of the image, which translates into a resolution from 760 m to 1.4 km. The phase (incidence) angle varied from 56º (36 º) to 77 º (39 º). The mean values of the phase, incidence and emergence angles are 68.6 º, 37.6 º, and 32.2 º, respectively. The spice kernel that is used to project the observation onto the Titan surface was released in February 2009 (cpck02Feb2009.tpc). It allowed us to project a color-coded image and to compare it with the DISR mosaic (Fig. 2).

The first conclusion is that the VIMS and the DISR images correlate very well to each other. The bright elevated terrains observed by DISR match exactly the bright terrains observed by the VIMS. Other landmarks allowed us to adjust the VIMS image and the DISR mosaic if a rotation of 2 º is applied. The second observation is that the spin rate is close to synchronous. It may reflect a perfect compensation between the non-synchronous rotation inferred from radar observations and the precession rate of the spin axis [9]. Other implications on spectral properties and geological evolution will be described during the presentation.

Conclusion

The comparison between the VIMS images at 1 km resolution and the DISR images underlines the importance of spatial resolution in order i) to map geological features, ii) to determine the surface composition, and iii) to constrain Titan's spin rate. It shows what a spacecraft equipped with both a 50 m resolution optical camera and an infrared spectrometer could achieve.

References

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