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Imaging Titan's surface with the Visual and Infrared Mapping Spectrometer : from global to local.

S. Le Mouélic (1), A. Lefèvre (1), T. Cornet (1), S. Rodriguez (2), C. Sotin(1,3), J. W. Barnes(4), R. H. Brown(5), B. J. Buratti(3), K. H. Baines(3), R. N. Clark(6), R. Jaumann(7) and P. D. Nicholson(8).

(1) Laboratoire de Planétologie et Géodynamique, CNRS-UMR 6112, Université de Nantes, 2 rue de la Houssinière, 44322 Nantes, France (stephane.lemouelic(at)univ-nantes.fr); (2) Laboratoire AIM, Université Paris Diderot – Paris 7/CNRS/CEA-Saclay, DSM/IRFU/SAp, France ; (3) Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, USA.; (4) Department of Physics, University of Idaho, Engineering-Physics Building, Moscow, ID 83844, USA; (5) Department of Planetary Sciences, University of Arizona, Lunar and Planetary Laboratory, 1629 E. University Blvd., Tucson, AZ 85721, USA; (6) United States Geological Survey, 2255 N. Gemini Drive, Flagstaff, AZ 86001, USA; (7) DLR, Inst. of Planetary Research Rutherfordstrasse 2, 12489 Berlin, Germany; (8) Department of Astronomy, Cornell University, 418 Space Sciences Building, Ithaca, NY 14853, USA.

1. Introduction

Titan, the biggest satellite of Saturn, is the only Moon in the solar system to have a thick atmosphere. It has been observed by the Cassini spacecraft thanks to 70 targeted flybys during the nominal and extended mission between 2004 and 2010. We focus our study on data acquired by the Visual and Infrared Mapping Spectrometer (VIMS) onboard Cassini [1]. Despite the strong scattering and absorbing effects of the aerosols and atmospheric gases in the atmosphere, the surface can be seen in seven spectral windows between 0.93 and 5.1 µm [2, 3].

2. VIMS data reduction

We have computed a global mosaic of all the VIMS data of Titan acquired between July 2004 (T0) and June 2010 (T70) in 256 spectral channels from 0.88 to 5.10 µm, at a resolution of 32 pixels per degree (corresponding to 1.3 km/pixel at the equator). Data have been sorted to use low resolution cubes as background and high resolution cubes ontop of the mosaic. To mitigate the blurring effect of the atmosphere, a series of filters has been created so as to include in the mosaic only the pixels acquired with emission and incidence angles lower than 80°, a phase angle lower than 100°, an airmass (defined by 1/cos i + 1/cos e) lower than 7, and with an exposure time in the range 40-240 ms to avoid both too noisy cubes and saturation effects at short wavelengths. The data were first calibrated to I/F. The illumination geometry has then been normalized by dividing the calibrated data by the cosine of the incidence angle.

3. Global maps

Figure 1 presents an RGB color composite of the global mosaic in cylindrical projection, with red=5.0 microns, green=2.0 µm and blue=1.27 µm. In this image, the green and blue images have been corrected for atmospheric aerosols additive contribution using an empirical approach based on differential spectroscopy, by subtracting a pure atmospheric image taken in the wings of the methane windows at 1.95 µm or 1.22 µm [3]. The corresponding orthographic views are given in Figure 2.

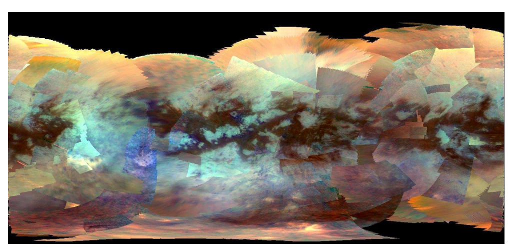

Figure 1: false color mosaic of Titan with Red=5.0 µm, Green = 2.0 µm and Blue=1.27 µm.

4. Integration of high resolution data

In the nominal and equinox mission, only a few flybys where allocated to VIMS at closest approach. During these opportunities, two observing modes

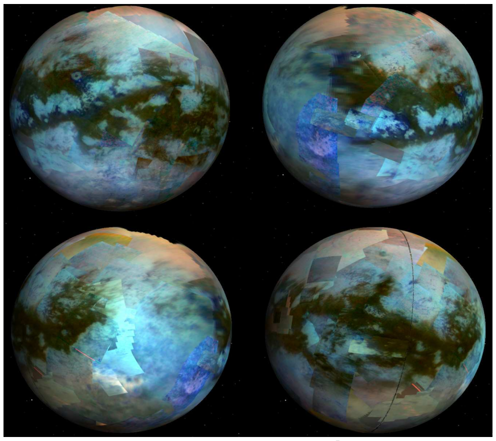

Figure 2: Same mosaic as Figure 1 shown in orthographic projection

were used. The first corresponds to the acquisition of a 64x64 image in targeted pointing mode (i. e. Cassini is tilted during the acquisition to compensate for the fast motion of the groundtrack). The second mode, called “noodle” mode, uses a series of 1x5 or 1x10 pixels lines with a very short exposure time (13 to 20 ms), the second dimension of the image being progressively built by the spacecraft orbital motion. An example is given for the T47 flyby in figure 3. The targeted pointing mode proved to be very useful to image the Huygens landing site with a resolution between 0.75 and 1.4 km/pixel [5], and the noodle allows the observation of new terrains in the infrared with a spatial resolution as low as 500m/pixel at closest approach.

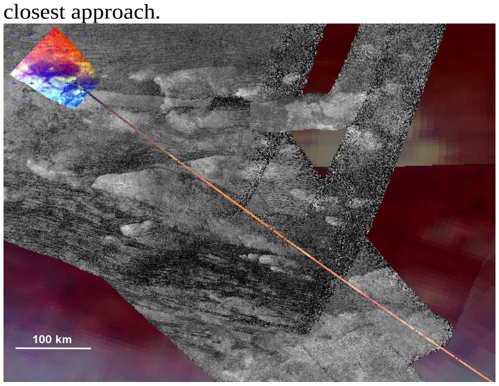

Figure 3: Example of integration of high resolution VIMS data with a radar background, in the vicinity of the Huygens landing site (upper left).

5. Summary and Conclusions

Additional efforts are needed to better constrain the spatial registration of the data sets, when looking at the local scale (an effect linked to both to the spacecraft trajectory relative to Titan and to Titan rotational parameters), and to remove both residual atmospheric artefacts and transient phenomena such as clouds. Once integrated together with ISS and Radar data, these VIMS global mosaics can provide first steps toward a “Google Titan” environment based on the Google Earth engine, to provide a user easy access to synthetic CASSINI imagery products, from the global to the local scale.

References

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