GLOBAL MAPPING OF TITAN IN THE INFRARED USING AN EMPIRICAL DECORELATION BETWEEN ATMOSPHERE AND SURFACE. S. Le Mouélic[1], J.W. Barnes[2], C. Sotin[1,3], L. Le Corre[1], R.H. Brown[4], K. Baines[3], B. Buratti[3], R. Clark[5], P. Nicholson[6]. [1] Laboratoire de Planétologie et Géodynamique, CNRS, UMR 6112, université de Nantes, France, [2] NASA Ames Research center, USA, [3] JPL, Pasadena, USA, [4] Lunar and Planetary Lab and Stewart Observatory, University of Arizona, Tucson, USA, [5] USGS, Denver, USA. [6] Cornell University, USA. [stephane.lemouelic@univ-nantes.fr]

Introduction: The VIMS imaging spectrometer onboard CASSINI provides hyperspectral images of Titan in 352 spectral channels from 0.3 to 5.1 µm. Infrared channels are particularly useful to map the surface of Titan through narrow atmospheric transmission windows (figure 1). VIMS can be used for geomorphological studies thanks to the imaging capabilities. When combined, the several spectral channels can be used to investigate the composition of the surface materials. However, the surface studies are complicated by the presence of the strong scattering and absorbing atmosphere.

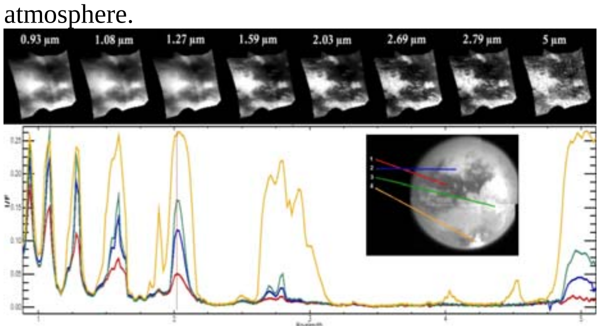

Figure 1 : The seven infrared windows where the surface can be seen with VIMS through the atmosphere.

Merging data acquired at different flybys, sometimes with very different viewing geometries (incidence, emergence and phase angles), is challenging due to the strong effects of the atmosphere (additive and multiplicative components) and also to photometric effects. This makes uncorrected mosaics appearing with seams, which can have about the same level than the surface spectral heterogeneities. Our goal is to retrieve homogeneous global maps of the different surface units, using a heuristic approach to correct the atmospheric and photometric effects.

Empirical evaluation of the additive scattering component: In order to evaluate the aerosol additive component in the VIMS images, we use an empirical approach based on band ratios. This approach was also used in [2] to calibrate Clementine NIR lunar data. When no additive component is present, the variations due to the illuminating conditions on local slopes (and to a lesser extent to pure albedo) should disappear in band ratios, provided that we are observing an homogeneous area. This is illustrated in figure 2 on the dune fields observed at T20. These dunes fields have been studied in details by [3]. They present local spectral variations due to a possible alternance of dune and interdune materials, but they also contain more homogeneous areas where the observed variations are dominated by topographic shading.

The same empirical approach was tested at a much lower spatial resolution on the Huygens landing site, where the outputs of the band ratio technique provided results which were at first order consistent with a radiative transfer model of the aerosols contribution [4].

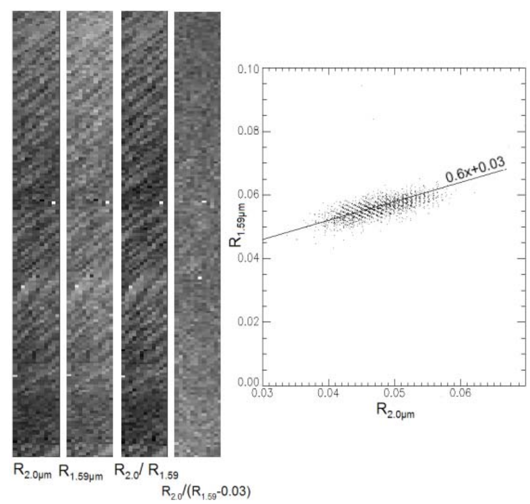

Figure 2 : Example of empirical evaluation of the additive scattering component on the dune fields observed by VIMS at T20. $R_{1.59}$ and $R_{2.03}$ correspond to the reflectance values at 1.59 and 2.03 µm. The 1.59 µm image contains a global additive offset of 0.03 compared to the 2.03 µm image.

Correction of the multiplicative factors: Once the additive term has been removed, the spectral windows might still differ due to multiplicative factors mainly linked to the atmospheric absorption and viewing geometry. Observations should therefore be normalized to a standard viewing geometry. The division by the cosine of the incidence angle provides a first first order improvement. Several other wavelength dependent factors using a combination of the incidence, emergence and phase angles are currently being investigated, taking as reference areas which have been observed sereval times with various geometries.

Conclusion and perspectives: The global mapping of the surface of Titan free of atmospheric and photometric effects is a challenging task, but significant stepforwards are currently being made. Figures 3 and 4 give some examples of these global mapping products. The surface heterogeneities can be revealed by using band ratios, which are more sensitive to spectral variations than RGB combinations of single bands [5], but at the same time also more sensitive to residual calibration errors.

VIMS will be able to observe the Huygens landing site for the first time with a sub-kilometric resolution during the T47 flyby in November 2008. This site is the only one for which we have the ground truth provided by the Huygens DISR instrument (spectra of the surface from 0.3 to 1.5 µm). The forthcoming T47 VIMS observation could therefore be the key to tune up the radiative transfer models and empirical approaches aimed at decorrelating surface and atmospheric contributions.

References: [1] Brown R.H. et al. (2004), *Space Science Reviews*, *115*, 111 –168. [2] Le Mouélic et al. (1998), *JGR*, 104, 3833. [3] Barnes et al. (2008), *JGR*, in press. [4] Rodriguez et al. (2006), *Planet. Space Sci.*, 54, 1510-1523. [5] Le Mouélic et al. (2008), *JGR*, in press

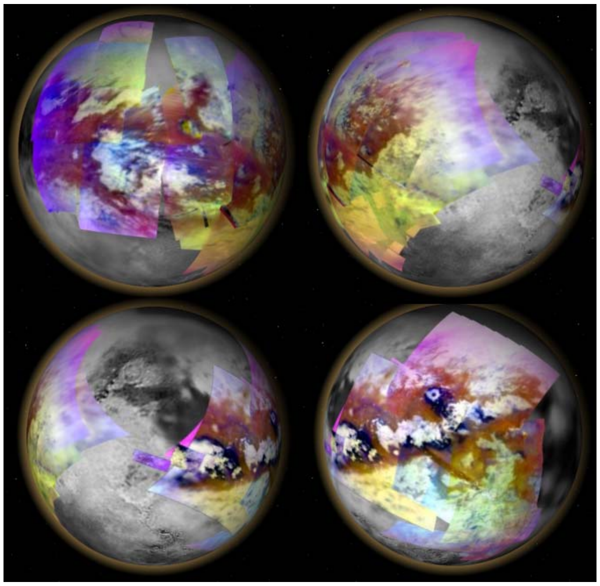

Figure 3 : False color infrared mosaics of band ratios computed from selected VIMS data from Ta to T33 flybys.

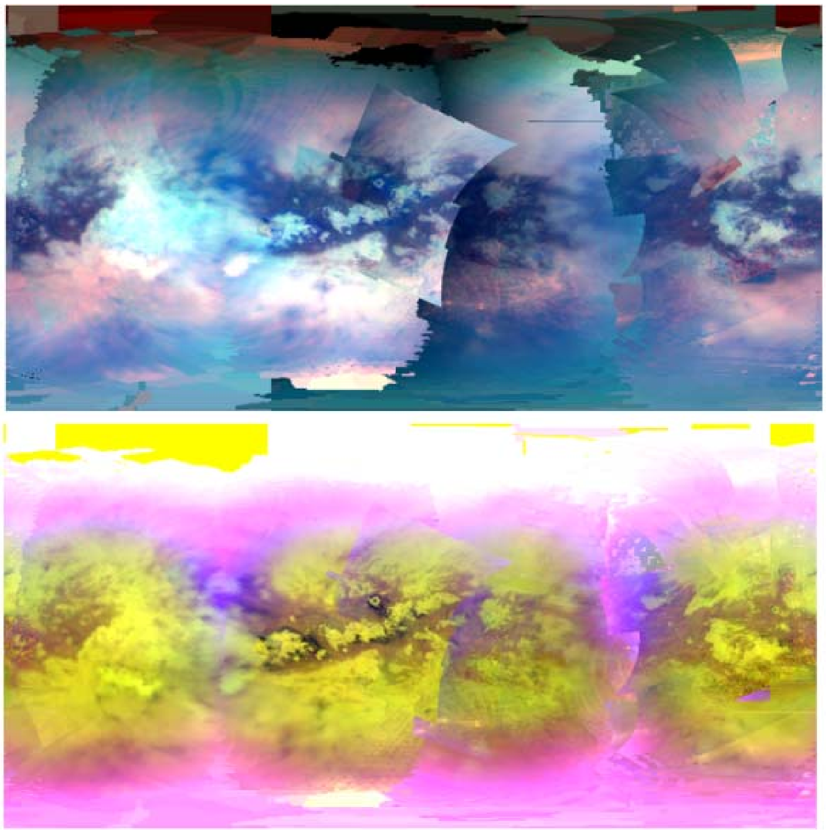

Figure 4: top : RGB color mosaic of T8, T9, T13, T32 and T34 flybys, using 5.0 µm for the red, 1.59 µm for the green and 1.27 µm for the blue.

Bottom : same mosaic empirically corrected from the additive scattering and viewing angle, using 1.59/1.27 µm for the red, 2.03/1.27 µm for the green and 1.27/1.08 µm for the blue. The pink color corresponds to areas where the atmospheric scattering in the short wavelengths is too strong to be corrected.