COMBINED ANALYSIS OF RADAR T3 AND VIMS T20 OBSERVATIONS: PRELIMINARY RESULTS ON POSSIBLE CRYOVOLCANIC FLOWS ON TITAN. L. Le Corre[1], S. Le Mouélic[1], C. Sotin[1], S. Rodriguez[1], G. Tobie[1], R.H. Brown[2], J. Barnes[2], B. Buratti[3], L.A. Soderblom[4], R. Jaumann[5], R. Lopez[3], K.H. Baines[3], R. Clark[6], P.D. Nicholson[7], [1]Laboratoire de Planétologie et Géodynamique, 2 rue de la Houssinière, 44322 Nantes, France, [2]Lunar and Planetary Lab and Stewart Observatory, University of Arizona, Tucson, USA, [3]JPL, Pasadena, USA, [4]USGS, Flagstaff, USA, [5]DLR, Institute of Planetary Research, Berlin, Germany, [6]USGS, Denver, USA, [7]Cornell University, Astronomy Departement, Ithaca, USA.

Introduction: The Visual and Infrared Mapping Spectrometer (VIMS) aboard Cassini spacecraft allows us to characterize spectral properties of Titan's surface through the atmosphere in seven narrow windows in the near infrared [1,2]. VIMS acquires images in 64*64 pixels cubes, with a 352 channels spectrum acquired for each pixel. The best resolution obtained so far was 1.4 km/pixel during T4 flyby (31 March 2005). A new observing strategy has been tested during T20 (25 October 2006) in order to observe at closest approach. It consists in acquiring a succession of single lines (using the first scanning mirror), the second dimension of the image being given by the evolution of the groundtrack of the satellite (instead of using the second scanning mirror). This new line mode provides a wider surface coverage than the nominal snapshot mode, and a spatial resolution of ~500 m/pixel at closest approach (which could go down to 250 m/pixel if the double resolution mode is used). We focus here on these new T20 VIMS data which crosses previous observations from the RADAR instrument recorded during the T3 flyby. The radar (in SAR mode) is mainly sensitive to surface roughness, dielectric constant variation and topography, and it can also probe the subsurface materials. Both data sets are therefore very complementary.

Data reduction of VIMS T20 images: In order to obtain a continuous surface coverage, the time exposure of VIMS was set at its minimum value (13 ms), with lines ranging from 10 to 20 pixels of width. The time exposure of 13 ms for each pixel increases the noise in the data. The calibration of T20 data was therefore first optimized using a modified dark frame correction [3]. In a next step, we used the minimum noise fraction (MNF) transform [4] to reduce the contribution of the noise in the data. This was done by performing first a direct MNF transform and then by doing the inverse transform by keeping only the bands showing a coherent spatial pattern in the images (the first 6 bands without the fourth in our case). Maps of spectral criteria have then been created by georeferencing the data on a cylindrical projection, and by using the T3 radar swath as background (fig. 1).

T3 radar swath: The T3 radar swath has been acquired on February 2005 with a spatial resolution of 300 m/pixel. It revealed complex features such as impact craters, dunes, channels, cryovolcanic or tectonic features [5,6,7]. It also contains a circular smooth feature with rough rims [7], from which bright materials (in radar) seem to flow out, drawing a fan-shaped structure with diffuse edges (right side of figure 1). The VIMS infrared image acquired at T20 shows a bright flow with very sharp boundaries exactly at the same location than the rough material (fig. 2). However, such a correlation is not systematic (see for example the bright feature located within the channel network system seen by the radar, or the bright units south-east of the T4 VIMS image in figure 2). Different kinds of cryovolcanic features have been located in T3 SAR images [6]. This bright lobate feature is interpreted by [7] as a possible cryovolcanic flow originating from a crater. It seems to have flown over a long distance (about 200 km), which implies that the corresponding cryolava must have a low viscosity.

Spectral properties of the cryovolcanic flow-like feature: Spectral properties can be evaluated thanks to band ratios. In figure 1 and 2, we use a RGB false color composite of the 1.59/1.27, 2.03/1.27, and 1.27/1.08 µm ratios. The first two ratios are sensitive to the presence of water ice, which absorbs at 1.59 and 2.03 µm, but not at 1.27 µm, in the sense that bluish tones in the RGB composite may witness for higher water ice content than the surroundings [8]. No significant color variations is observed in the RGB color composite, except the overall brighness level. This suggests that the materials constituting the bright flow and the dark background do not differ markedly in their water ice content.

Figure 3 shows a set of spectra representative of the main units (see figure 5 for location). Spectra have been averaged on several pixels in order to increase their S/N ratio. Figure 4 shows the same spectral units after the filtering by the MNF transform. The spectra do not cross each other in the seven spectral windows. This suggests that no major difference in composition of the surficial material is present. However, we can note that dark materials have a steeper negative slope between the 1.59 and 2 µm windows than the bright materials.

Conclusion: The new VIMS data acquired at T20 with a spatial resolution of 500 m/pixel show a bright region with very sharp boundaries, this seems to be spatially correlated with the cryovolcanic flow which was observed in the T3 radar image. The bright materials (both at infrared and radar wavelengths) could be a flow which is younger than the surrounding dark areas, and originating from the small circular feature seen nearby in the radar data. Ammonia-water-methanol slurries have been proposed as possible candidates for the observed flow features based on rheological considerations [7]. The chemical composition of the corresponding materials is still under investigation. It will probably require improved atmospheric corrections (haze scattering, methane absorption) using a radiative transfert code to identify the type of materials which matches the corresponding VIMS spectra. It would be very useful to observe with VIMS during closest approach with the same operating mode as the one used at T20 in order to widen the complementarity between VIMS and radar data in such areas of interest.

References: [1] Brown R.H. et al., (2003), *Icarus*, 164, pp. 461-470. [2] Sotin C. et al. (2004) *Nature, 435,* 768–789. [3] Le Mouélic, LPSC abstract, this issue. [4] Green A. A. et al. (1988), *IEEE Trans. Geosci. Remote Sens.,* 26, 64/74. [5] Elachi C. et al. (2006) Nature, 441, 709-713. [6] Stophan E. R. et al. (2006) Icarus, 185, 443-456 [7] Lopes R. M. C. et al. (2006) *Icarus, in press*, [8] Rodriguez S. et al. (2006), *P&SS, 54, Issue 15, 1510.*

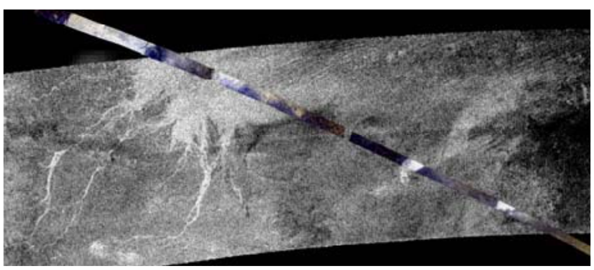

Figure 1: subset of VIMS T20 data crossing theT3 radar swath near Menrva crater at 20°N-90°W.

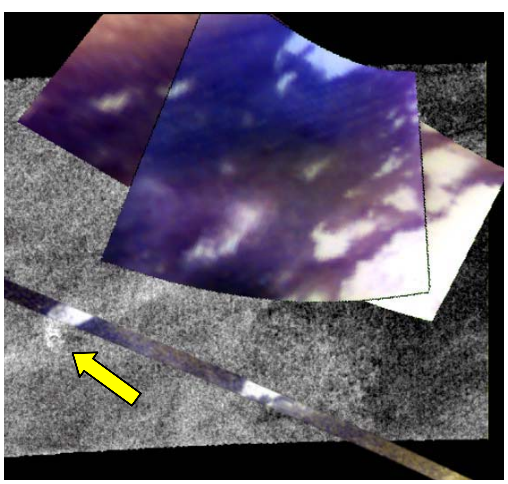

Figure 2: bright lobate flows from T3 SAR radar mode overlaid with VIMS T20 and T4 data (RGB composite of 1.59/1.27, 2.03/1.27, and 1.27/1.08 band ratios, upper right). A circular feature seems to be the source of the flow near 20°N 70°W.

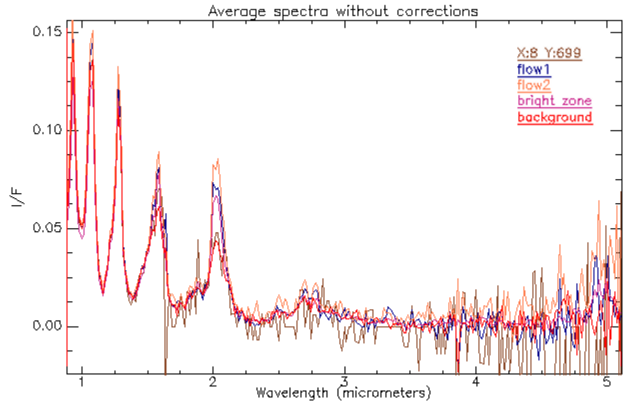

Figure 3: averaged spectra of different units (before destriping and filtering by MNF transform).

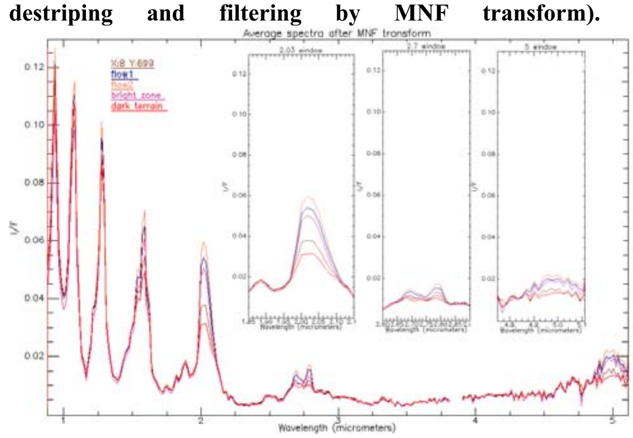

Figure 4: averaged spectra of the same units after optimization of dark frame removal and filtering by MNF transform.

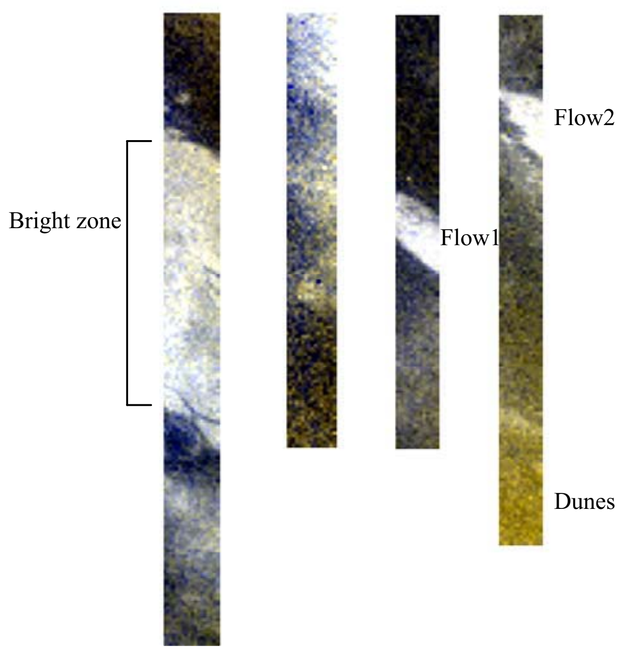

Figure 5: unprojected T20 VIMS data (resolution ~500m/pixel).