A LOOK AT TITAN SURFACE FROM THE CASSINI RADAR SAR AND RADIOMETRY DATA

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Introduction: The Cassini Titan Radar Mapper [1] has proven to be of crucial importance for the investigations of Titan's surface. Synthetic Aperture RADAR (SAR) and radiometry of two Titan flybys (T3: February 2005; T7: September 2005; T8: October 2005) are reviewed in this paper with emphasis on the correlation and comparison of surface features and physical characteristics.

Cassini SAR and radiometry: SAR and radiometry are two of the operational modes of the K_u-band (13.78 Ghz, λ= 2.17 cm) Cassini Titan Radar Mapper [1]. The radiometry data used are acquired during the SAR active mode using 5 antenna beams. The observations are then modeled [2, 3] to derive brightness temperature measurements and form surface maps covering the same areal extent of the SAR swath to allow the comparison of radiometry and SAR surface features. The correlation between SAR and radiometry is limited by the low radiometry footprint resolution at closest approach, preventing detection and correlation of surface features smaller than 6 km azimuth resolution. Further, there is a large-scale variability in calibration among the five radiometer beams caused by sidelobes that must be accounted for to obtain relative brightness variations. However, a general comparison of surface characteristics among swaths is informative.

Titan's features seen by SAR and radiometry: An inverse correlation between SAR-bright and radiometric cold regions, SAR-dark and radiometric warm regions has been observed extensively in association with diverse geological features, which suggests that the correlation is not caused by a specific geologic process but characterizes the constituent material and surface properties of the features.

The observed variations in radar backscatter is a combined effect of surface roughness, topographic variation, and dielectric properties of unusual materials (mix of hydrocarbons or tholins, water ice, water-ammonia ice) [2, 3]. Also, volume scattering might play an important role and contribute to the high backscatter return, especially in the presence of absorbing-porous materials on the surface. The correlation of SAR-bright and radiometric cold regions suggest volume scattering due to broken low-loss water ice, terrain rough on the size scale of the radiometer wavelength, or higher dielectric constant materials [3]. Choosing amongst these three is possible only if the same area is covered in dual polarization, allowing the polarization dependency of the brightness to be determined.

In the T3 SAR and radiometry swaths shown in Figure 1, a variety of terrain and geologic features exhibit the same anti-correlation that was observed in the Ta flyby.

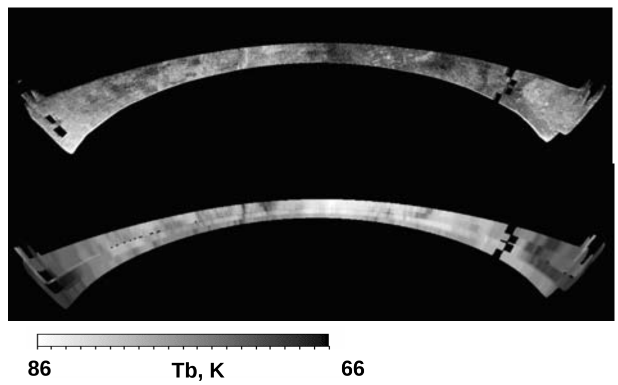

Figure 1. T_3 SAR swath (top panel) and radiometry swath (bottom panel). Images ~6000km across.

In T3, two impact features, and what are now (after the T8 flyby) recognized as dune fields [3, 4, 5] were observed for the first time, and present various degrees of anti-correlation between SAR and radiometry. Most striking are the radiometrically cold region approximately coinciding with the ejecta blanket of the 80-km Sinlap crater, in the eastern edge of the swath shown in Figure 2, and the radiometrically warm region corresponding to the dune fields in the central portion of the swath visible in Figure 3.

In T8 SAR and radiometry swaths, shown in Figure 3, there are more dune fields [6] and hilly terrains or mountain chains [7, 8], along with coverage of the Huygens landing site in the most eastern portion of the swath [9]. The radiometry data set for this swath is characterized by a very remarkable contrast between the vast areas covered by the dune fields and the eroded hill or high standing rough edifice surrounded by them (Figure 4), suggesting that dune material could be characterized by smooth surfaces with homogeneous high absorbing, compact, and fine textured material.

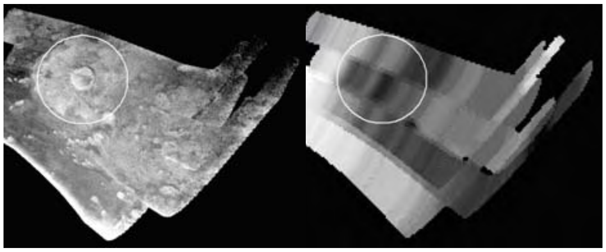

Figure 2. T_3 Sinlap crater ~80 km: SAR coverage (left panel) and radiometrically cold region approximately coinciding with the crater ejecta blanket (right panel). Images ~300km across.

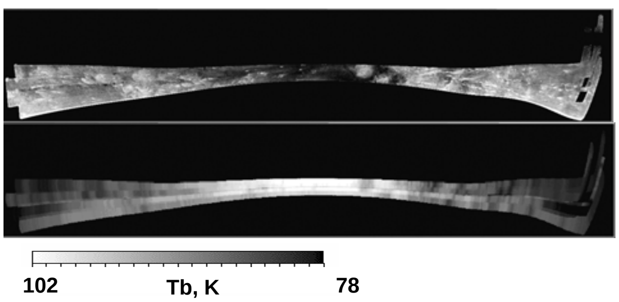

Figure 3. T_8 SAR swath (top panel) and radiometry swath (bottom panel). Images ~6000km across.

Considerations: T_3 and T_8 data contain common surface features that allow a better understanding of the radiometric return of Titan's surface. Although surface roughness and topography contribute substantially to the reflected signal for the SAR-bright response [10], Titan's observed volume backscattering [11] implies that structures below the surface, as well as compositional variations , also are important in determining the appearance of the SAR images. The presence of low absorbing-porous material with a mixture of low and high dielectric constant (i.e. snow and fractured ice), or heterogeneous materials (ice-rocks) of a size greater than the operational radar wavelength of 2.17 cm are consistent with this interpretation. The SAR-dark return observed in localized areas could derive from smooth surfaces, like ponded hydrocarbon liquids, or plains of solid non-water-ice materials (solid organics), consistent with the radiometric high emissivity and observed brightness temperature. However, in the dune areas a combination of smooth surfaces, covering the dune topographic expression, and homogeneous high absorbing (compact and fine textured) material could be responsible for the radiometric high emissivity and brightness temperature observed.

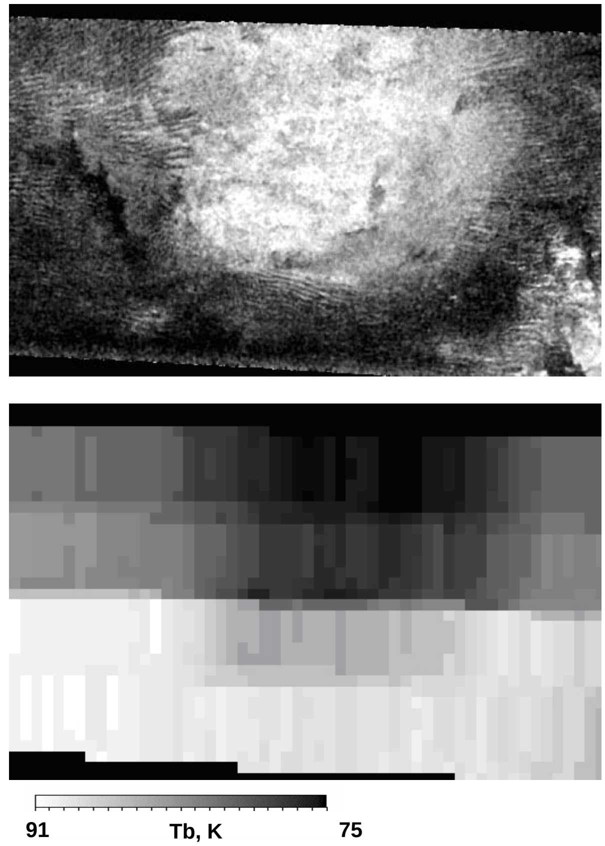

Figure 4. T8: SAR coverage eroded high standing edifice surrounded by dunes (top panel) and radiometrically cold and warm regions (bottom panel) characterizing them. Images ~300km across.

References:

[1] Elachi C. et al. (1991), *IEEE*, 79, 867-880. [2] Janssen M.A. et al. (2004), *DPS*, 36, 4, 1075. [3] Elachi C. et al. (2005), *Science*, 308, 970-974. [4] Lopes R.M. et al. (2006), *LPSC XXXVII*, this volume. [5] Lorenz R. et al. (2006), *Nature*, submitted. [6] Lorenz R. et al. (2006), *LPSC XXXVII*, this volume. [7] Wood C.A et al. (2006), *LPSC XXXVII*, this volume. [8] Radebaugh J. et al. (2006), *LPSC XXXVII*, this volume. [9] Elachi et al. (2006), *LPSC XXXVII*, this volume. [10] Paganelli F. et al. (2006), *LPSC XXXVII*, this volume. [11] Wall S.D. et al. (2006), *Nature*, submitted.