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Saturn's Titan: Reports Suggesting Surface Activity from Cassini VIMS and Radar Observations

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Instruments on the Cassini Saturn Orbiter have been observing the surface of the satellite Titan since mid 2004. The Visual and Infrared Mapping Spectrometer (VIMS) has returned images of the same surface units on Titan at selected wavelengths on repeated flybys. We have previously reported that a region near 26^oS, 78^oW exhibits changes consistent with surface activity (1). We now report another region that exhibits apparent surface change. In this case, the region was observed on four occasions (Tb-Dec13/2004, T8-Oct27/2005, T10-Jan15/2006, T12-Mar18/2006). For each apparition, we measured the I/F of 26 points on Titan's surface at different angles of incidence (i), emission (e) and phase (θ). In order to address the brightness change of the surface units with respect to viewing geometry (the photometric function) of any given point we measured the I/F of each of the 26 points the four epochs. Thus, four I/F measurements were obtained for each points at a distinct i, e, θ.

For 12 of the 26 points under investigation the change in I/F with respect to i, e, θ did not exhibit normal (expected) photometric behavior. In these instances, I/F was higher in instances where i, e, θ was also high. This behavior is not predicted by

photometric theory and is not observed in laboratory investigations of the angular scattering properties of solid materials regardless of grain size(2).

The 12 points that exhibit this unexpected photometric behavior are located near each other on Titan's surface; centered at $\sim 10^o$S, 140^oW. The 14 points that exhibit expected photometric behavior surround the 12 points that exhibit unexpected photometric behavior. The most reasonable interpretation of these results is that the surface changed between the differing epochs at the locations defined by the points that exhibit unexpected photometric behavior; the region was more reflective in 2004.

Changes in the appearance of any particular point on Titan's surface might be due to transitory atmospheric processes such as tropospheric clouds. Such clouds exhibit photometric behavior that is detectable with VIMS mulitwavelength image ratioing techniques (3). We have undertaken this photometric analysis and we are find that the region that shows the reflectance change on Titan's surface does not exhibit photometric properties consistent with tropospheric clouds. This region must be at or very near the surface. We note an additional result of interest in the Cassini SAR data(4). We note that the Case 2 region is just to the north and east of the circular feature identified in the SAR data as the crater Guabonito.

We conclude that the VIMS instrument has found two instances in which selected regions on Titan's surface become unusually reflective and remain reflective on time scales of days to months. In one instance (Case 2) the anomalously reflective region has a nearby large crater at its border as seen in SAR images. In both cases the size of reflectance variability is large, larger than Loki or Big Island of Hawaii. This is the strongest case yet for currently active surface processes on Titan. Pre Cassini, Titan was thought of as a pre-biotic earth that was frozen in time. Cassini VIMS observations now suggest that Titan is a snapshot of a episodically changing or evolving object.

References: [1] Nelson R. M. et al, LPSC 2007 , EGU 2007, Europlanets 2007. [2] Hapke, B. W. Theory of emittence and reflectance spectroscopy, p 199 and onward. [3] Griffith et al. Science, 310, 474-477(2005).[4] Stofan et al. Icarus 185, 443-456. Lopes et al. Icarus 186, 395-412.Paganelli et al, Icarus 191, 211-222, Kirk et al., DPS 2007.

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