CHANNELS AND FAN-LIKE FEATURES ON TITAN SURFACE IMAGED BY THE CASSINI RADAR.

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Introduction: During two close flybys of Titan on October 26, 2004, and February 15, 2005, the Cassini's radar instrument acquired synthetic-aperture radar (SAR) data revealing Titan's complex surface and intriguing geological features. Fan-like and apparently flow-related features are connected to sinuous and linear features which resemble channels. The fan-like features and channels appear to be relatively SAR-bright and suggest surface roughness properties at the scale and bigger than the K_u-band, and possible volume scattering. A strong correlation between the SAR-bright and radiometric cold regions has been observed. The correlation is consistent with radiometric cold areas being caused by volume scattering at K_u as due to broken low-loss ice and resulting low emissivity as with the surfaces of Europa and Ganymede.

Cassini SAR: The Cassini Titan Radar Mapper [1,2] is a K_u-band (13.78 Ghz, λ= 2.17 cm) radar instrument operating over a wide range of geometries and conditions in four modes: SAR, radiometer, scatterometer, and altimeter. The SAR mode operate at altitudes less than 4000 km with resolution varying from 400 m to 1 km. Images are acquired either left or right of nadir, with 2 to 7 looks, by a five beams antenna with swath width of 120-450 km and length of 4000-6000 km. The effective resolution of the images is defined by a combination of surface range and surface azimuth resolution which varies throughout the encounter with time, as shown in the SAR surface resolution plots for T_a and T_3 in Figure 1 and Figure 2 respectively. In both cases the pixel size in the image was selected to be always smaller than the real resolution and nominally of 0.17555 km/pixel.

Titan's feature detection: The capability of detecting surface geology in the SAR data of Titan is challenging as the varying resolution during the flybys makes the capability of observation resolution-dependent. The observed variations in radar backscatter is a combined effect of surface roughness and topographic variation, dielectric properties of unusual materials (water ice, water-ammonia ice and other ice, hydrocarbons, tholins) [2,3]. Also, volume scattering might play an important role and contribute to the high backscatter return, especially in the presence of

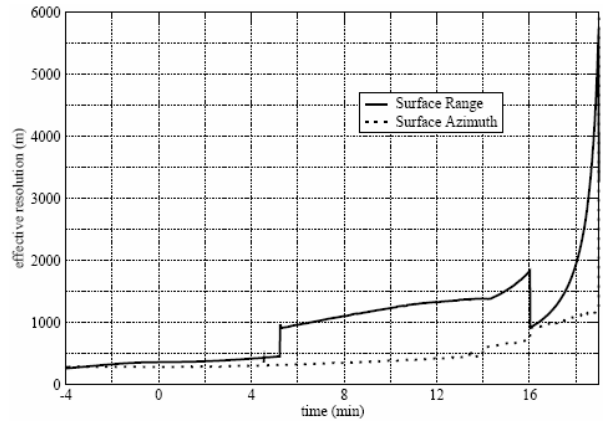

Figure 1. T_a SAR projected range and azimuth resolution. High resolution at closest approach (time=0) ~ 400m.

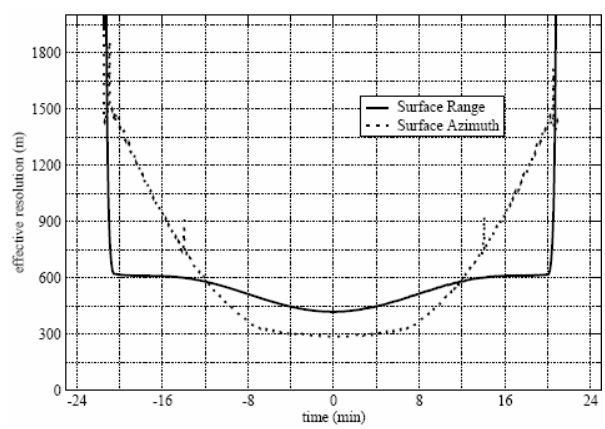

Figure 2. T_3 SAR projected range and azimuth resolution. High resolution at closest approach (time=0) ~ 600 m range and ~300 m azimuth.

absorbing-porous materials on the surface. The correlation of SAR-bright and radiometric cold regions suggest volume scattering as due to broken low-loss ices, rougher terrain, or higher dielectric constant materials [2,4] as shown in Figure 3.

Fine surface features have been identified and outlined, mainly in the portion of the images characterized by higher resolution, which include a number of fan-

like and flow related features connected to sinuous and linear features which resemble channels. These features

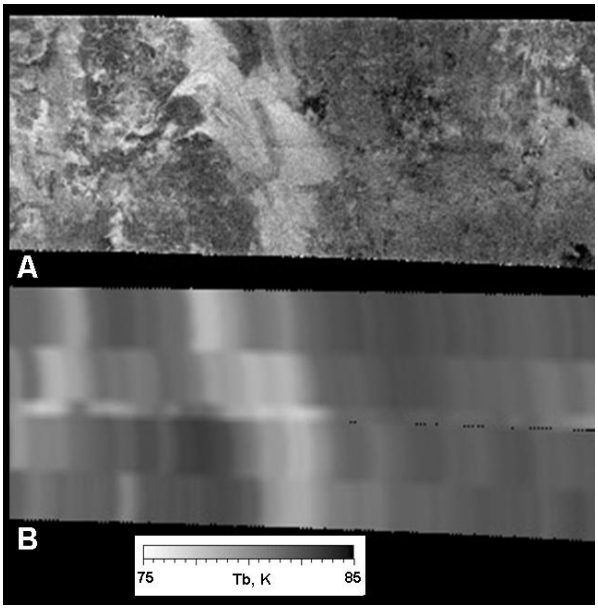

Figure 3. A) T_a SAR Titan swath central portion with SAR-bright surface features. B) Radiometry inverted image showing correlation between SAR-bright and radiometric cold regions. Images are 500 km across, North at top.

have been detected in the high resolution (400 m) portion of the T_a swath. The sinuous and linear features, fan-like and flow features show SAR-bright return and high contrast with respect to the surrounding SAR-dark material. The sinuous and linear channels are on average 500 m to 1 km across and extend for several tens of kilometers. Their association with fan-like features is not ubiquitous, but it is clearly shown in this area of the T_a flyby in Figure 4. Two main fan-like features seem to open at a possible change in topography on a sloping surface facing ENE [5]. The accumulations east of the fan features suggest the presence of possible flowing material. Flow-lines can be drawn within a SAR-greyish bounding unit with arched shape. Outside the bounding SAR-greyish unit, the SAR-bright materials define flows spreading to the East.

Considerations: The surface geology shown in the SAR swath T_a and T_3 presents a complex first view of the surface of Titan. While surface roughness drives much of the reflected signal from terrestrial surfaces, Titan's observed volume backscattering implies that near-surface structure or compositional change could, to some extent, define surface features [2].

The SAR-bright sinuous and linear channels, associated fan-like features and flows suggest the presence of transported material with different radar properties than the surrounding surfaces. We suggest two possible explanations for the SAR-bright response that are also consistent with the radiometry data. The first implies that the SAR-bright return is associated with a high component of volume backscattering possibly due to presence of low absorbing-porous material with a mixture of low and high dielectric constant (i.e. snow and fractured ice). The second implies that the SAR-bright return results from a high component of volume backscattering derived from fluvially-transported and deposited heterogeneous materials (ice-rocks) of a size greater than the operational radar wavelength of 2.17 cm. Here, the SAR-bright sinuous and linear features might be associated with "fluvial" (most likely, hydrocarbon) channels and the fan-like features then be alluvial in nature.

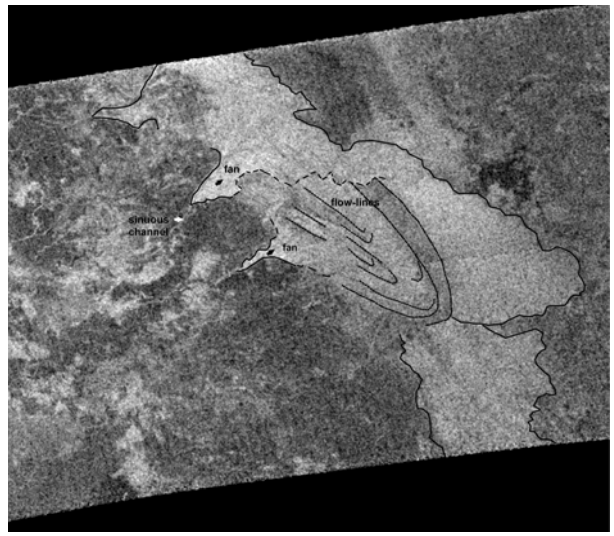

Figure 4. T_a SAR Titan swath central portion: SAR-bright sinuous channels and outlined fan-like features and flows. Image is 235 km across, North at top.

References:

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