CASSINI/VIMS OBSERVATIONS OF TITAN DURING THE T20 FLYBY.

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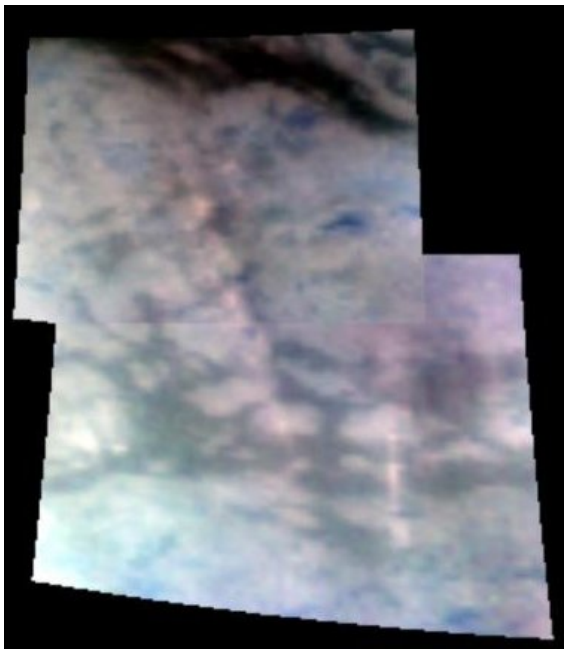
Since its insertion in Saturn's environment in July 2004, the Cassini spacecraft has realized 26 flybys of Titan. Titan, with a diameter of 5150 km, is Saturn's largest satellite. It is twice the size of the Moon and even bigger than the planet Mercury. Titan is one of the most interesting planetary bodies of the solar system since it is veiled by a thick atmosphere composed mainly of Nitrogen. This atmosphere is hosting a complex organic chemistry, and a cycle of methane (with rain, evaporation, clouds) is active. The surface (at a temperature of –180°C) cannot be seen at visible wavelengths, making Titan appearing as a uniformly orange sphere to the naked eyes.
Three instruments onboard CASSINI can see through the atmospheric haze: the ISS camera thanks to an infrared channel, the SAR (Synthetic Aperture Radar) and the Visual and Infrared Mapping Spectrometer (VIMS). During the first flyby in 2004, the VIMS showed its great potential to map and to characterize Titan's surface using several infrared "windows" through the atmosphere. The images taken at different wavelength can be combined to reveal the compositional heterogeneities of the surface.
Because the VIMS capabilities were unexpected before the first observations, the VIMS camera had never been the prime instrument observing during the closest approach before the twentieth (named T20) flyby that happened on 24 October 2006. This paper reports on the findings of this flyby, during which the camera took its highest-resolution infrared views of Titan, resolving surface features as small as 400 meters (or about 440 yards, a resolution similar to that of the radar swaths). Infrared images provide information which are very complementary to the radar data when available. During this single flyby, several geological features have been observed, such as a deposit that resembles a volcanic flow emanating from a circular feature also seen in radar images, a huge field of dunes, and a series of bright curvilinear features which have been interpreted as mountains. Shading across these bright lineaments is observed at the different wavelengths and suggest topographic heights on the order of 1 to 1.5 km. Different models can be invoked to explain their formation. In one model, the surface crust pulls apart, and material beneath the crust wells up through the crack, creating a ridge. Another interpretation is that Titan's contraction, as it cools down, generates compressive stresses that can break the ice upper crust and lead to the upwelling of hot water ice. During this upwelling, methane clathrates are destabilized, creating overpressures and release of methane in Titan's atmosphere. Cloud belts have been observed at these latitude, in the trailing of these mountain features. The presence and shape of these clouds may well be linked to the underlying topography.
The T20 flyby provided a wealth of infrared data, from which we also learned how to operate efficiently during the forthcoming flybys of the nominal mission (ending in 2008) and of the

extended tour (up to 2010). This should provide new step forwards in the understanding of this frozen Earth-like planet.

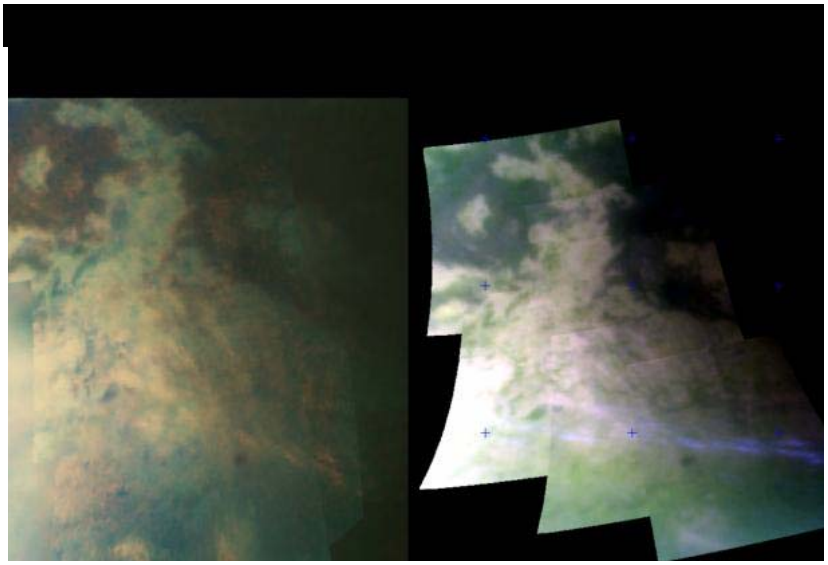
Selection of relevant images : (credits **NASA/JPL/University of Arizona)**

The composite VIMS image on the right shows the large continuous mountain range, which runs just south of Titan's equator. The range is about 150 km long and 30 km wide. The peaks are topped with bright white material, which is possibly methane snow.



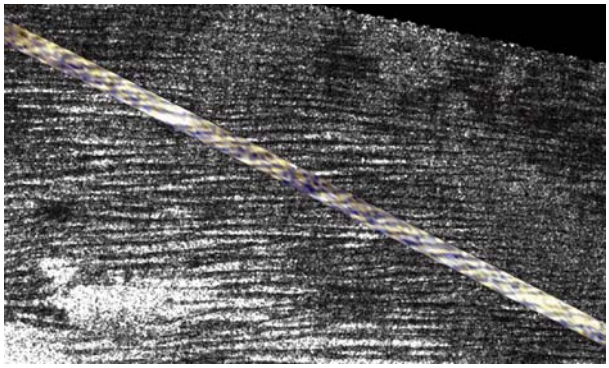
Clouds

The origin of clouds on Titan's southern mid latitudes is not yet fully understood. At the bottom of the rightmost image, a bright band of clouds is seen running over terrain that is riddled with mountain ranges. This image was also obtained by the VIMS instrument during the recent high-resolution pass and encompasses a slightly bigger area around the mountain range than in the above close-up. The clouds in this image are probably produced when gaseous methane in the atmosphere is driven over the mountains by winds, causing it to cool and condense into methane fog



Dunes

The recent T20 flyby represented one of the mission's best opportunities to obtain very high resolution infrared observations of Titan. Thanks to this resolution, dunes fields have been observed for the first time in the optical wavelengths. This is shown on this composite image showing a strip made by VIMS during



Cryovolcanism

By combining the infrared data from VIMS with radio observations from the Cassini radar instrument, more details on Titans geological features can be discerned. The first VIMS infrared images acquired in 2004 revealed a feature which was interpreted as a cryovolcano. Radio images, obtained during a flyby in February 2005, already showed the presence of a circular feature with a fan-shaped feature extending from it. High-resolution observations by VIMS from the 25 October 2006 flyby, made in a strip crossing this fan-shaped feature, strengthen the evidence that material is deposited after erupting from the small circular crater. The VIMS image shows that the flow has very sharp boundaries with the background.