IMAGING OF THE NORTH POLAR CLOUD ON TITAN BY THE VIMS IMAGING SPECTROMETER ONBOARD CASSINI.

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Introduction: The VIMS imaging spectrometer onboard CASSINI provides hyperspectral images of Titan in 352 spectral channels from 0.3 to 5.1 µm [1]. A giant cloud system covering the north pole of Titan was observed in December 2006 using infrared wavelengths. We report here on the processing and analysis of the corresponding VIMS data.

Observations of the North pole with VIMS : On December 28, 2006 (T22 flyby), VIMS acquired a succession of lines scanning the limb of Titan while the CIRS instrument was driving the pointing of the spacecraft. Once reconstructed, the data cube provided an image of the half-lit north pole, which appeared covered by a huge cloud system (figure 1).

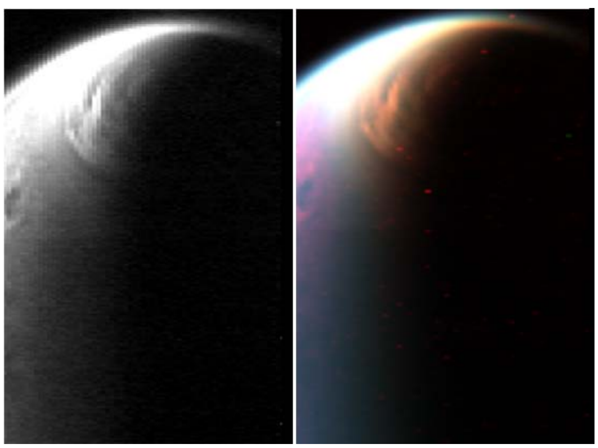

Figure 1 : imaging of the North polar cloud with VIMS. Left : average of 14 channels in the 5 µm window. Right : color composite with red = 5 µm, green = 2.78 µm, blue = 2.03 µm.

The clouds extend up to 64°N in latitude, and are surrounded by a diffuse hood down to a latitude of 55°N. These limits corresponds to the transition between dried and filled lakes as imaged by the RADAR [2,3]. This huge cloud system covers an area of 5,6 10^6 km^2, about 6,7 % of Titan's surface. The data were acquired from a distance of about 90000 km, thus with a spatial resolution of 45 km/pixel. A dark frame correction was implemented in order to get rid of a spurious striping effect on the images.

By using wavelengths which are sensitive to the fluorescence of methane, one is able to see the structure of the haze layer, up to the detached haze layer, well above the cloud itself (figure 2). The combination of band ratios can also be used in order to emphasize the cloud features, as shown in figure 3.

Figure 2 : Color composite showing the methane fluorescence in the atmosphere. R=3.26 G=3.21 B=4.86 µm.

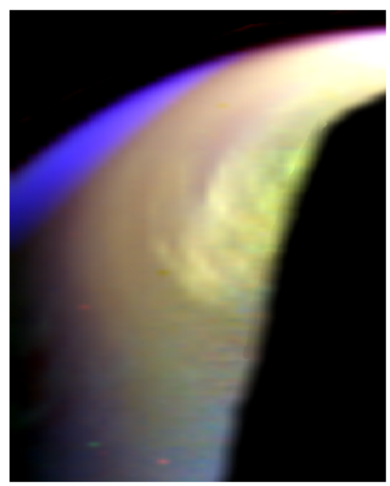

Figure 3: False color composite of band ratios (R=1.59/1.27 µm, G=2.03/1.27 µm, B=1.27/1.08 µm) emphasizing the cloud structure

This cloud system has also been observed two weeks later in January 13, 2007, despite a lower spatial resolution (figure 4). No other well resolved observation has been made so far with VIMS, due to the geometry of the Titan flybys and the allocated observing time.

Spectral analysis : Figure 5 displays spectra extracted from the main cloud units : spectra 1 and 2 corresponds to the cloud, and spectra 3 and 4 correspond to the surrounding polar hood. Modeling of these spectra with a radiative transfer code (DISORT2.0) shows that the clouds spectra can be modeled by spherical particles of 3 to 10 microns at an altitude lower than 50 km. Assuming that this cloud reaches the ground, we find a total opacity of about 10. The characteristics of this polar cloud are similar to those reported in [4], suggesting that it is the same object seen in better viewing conditions.

Interpretation : The morphology and spatial inhomogeneities of the cloud are revealed in Figures 1 and 3. This cloud covers the north polar region beyond 64°N. Its edge seems quite sharp, although it presents irregular structures, possibly due to the circulation near the poles. No information concerning the composition can be extracted from this data alone. But, such a cloud was predicted by the IPSL Titan Global Climate Models, exactly at the same location and with the same range of droplet size [5]. It is caused by the downwelling, in the north polar region, of air coming from the stratosphere, enriched in aerosols and in various photochemical byproducts (ethane being the most abundant). Condensation is triggered in the cold trap above the tropopause. Thus, we conclude that the cloud should be a mixture of several hydrocarbons and nitriles, with ethane as a major component.

Conclusion and Perspectives : A season on Titan lasts 7 years. It should therefore be possible to monitor this cloud evolution with time during the Cassini extended mission, with possibly the vanishing of the cloud system and the formation of a similar complex over the south pole in the coming years. Several isolated cloud features are also observed on the southern hemisphere, but none resembling so far to the one observed above the north pole. It could be important to implement dedicated observations with VIMS during the Titan approach phases, using the same limb scanning strategy as the one which was used during T22.

Bibliography : [1] Brown R.H. et al. (2004), *Space Science Reviews*, *115*, 111 –168, doi:10.1007/s11214-004-1453-x. [2] Stofan et al. (2007), *Nature*, doi:10.1038/nature05438. [3] Hayes et al. (2007), *AGU fall meeting*. [4] Griffith et al. (2006), *Science*, 313, 1620-1622. [5] Rannou et al. (2006), *Science*, 311, 5758, 201-205.

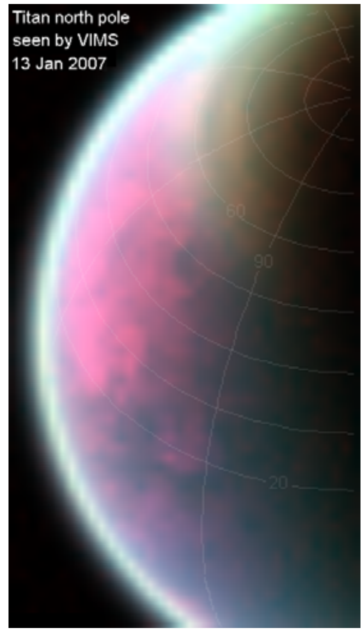

Figure 4 : observation of the cloud in January 2007, with a lower spatial resolution (distance 220000 km).

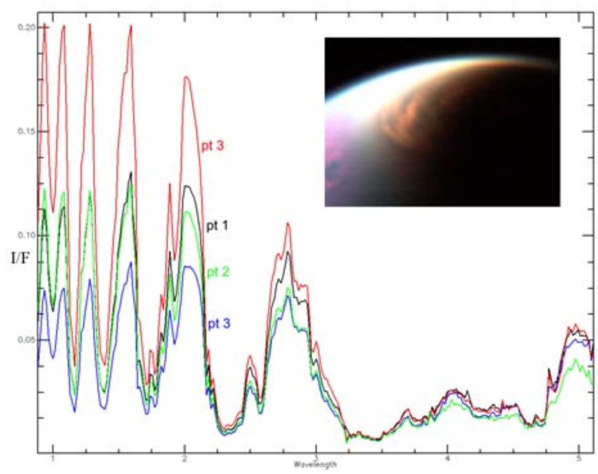

Figure 5 : typical spectra extracted from the cloud. Points 1 and 2 are taken within the cloud, and points 3 and 4 in the surrounding polar hood.