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Mapping the north polar regions on Titan with the Visual and Infrared Mapping Spectrometer onboard Cassini.

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1. Introduction

Titan is the only satellite in the solar system to be veiled by an atmosphere, with a pressure close to the terrestrial one. This atmosphere is primarily nitrogen, with few percents of methane. During the winter season, Titan polar latitudes, where the temperatures are the coldest, provide a cold trap for several species produced by a complex relationship of both chemistry and atmospheric transport processes. Since its insertion in Saturn orbit in 2004, the Cassini spacecraft provides the opportunity to investigate the north polar area (in northern winter until 2009) in details.

2. Cartography of the north polar regions

The VIMS imaging spectrometer onboard CASSINI acquires 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 [2]. We report here on the processing and analysis of VIMS observations of the north pole, by focusing our study on the morphology and temporal evolution of polar features. On December 28, 2006 (T22 flyby), VIMS acquired a succession of 395 lines scanning the limb of Titan while the CIRS instrument was driving the pointing of the spacecraft. The images were acquired with a time exposure of 80 ms, a phase angle of 113°, with an average incidence of 80° and emergence of 50°, and from a distance of 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. Once reconstructed, the data cube provided an image of the half-lit north pole, which appeared covered by a huge cloud system. Figure 1a shows an average of 14 spectels in the 5 µm window. Figure 1b and 1c displays a RGB color composite of the same image with red = 5 µm, Green=2.78 µm and blue=2.03 µm. Figure 1d displays a RGB color composite (R=3.26 G=3.21 B=4.86 µm), which shows the fluorescence of methane. It clearly shows the structure of the atmospheric haze layer, up to the detached haze layer, well above the cloud itself. Figure 1e displays an orthographic projection of the cloud centered on the north pole. 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, which seem to follow a parallel, correspond to the transition between dried and filled lakes as imaged by the RADAR [3].

3. Evolution of the north polar cloud with time

The north polar cloud can be observed in several flybys (see for example figure 2). This observation confirms models of Titan global circulation models [4] that predict exactly at the same latitudes the formation of the polar clouds due to the downwelling of atmospheric streams. This conclusion is also supported by the study of [5], which systematically detects spectral cloud signatures at these latitudes between July 2004 and December 2007.

A season on Titan lasts 7 years. It should therefore be possible to monitor the northern cloud evolution with time during the Cassini extended mission, and witness the vanishing of this cloud system and the formation of a similar complex over the south pole in the coming years.

4. References

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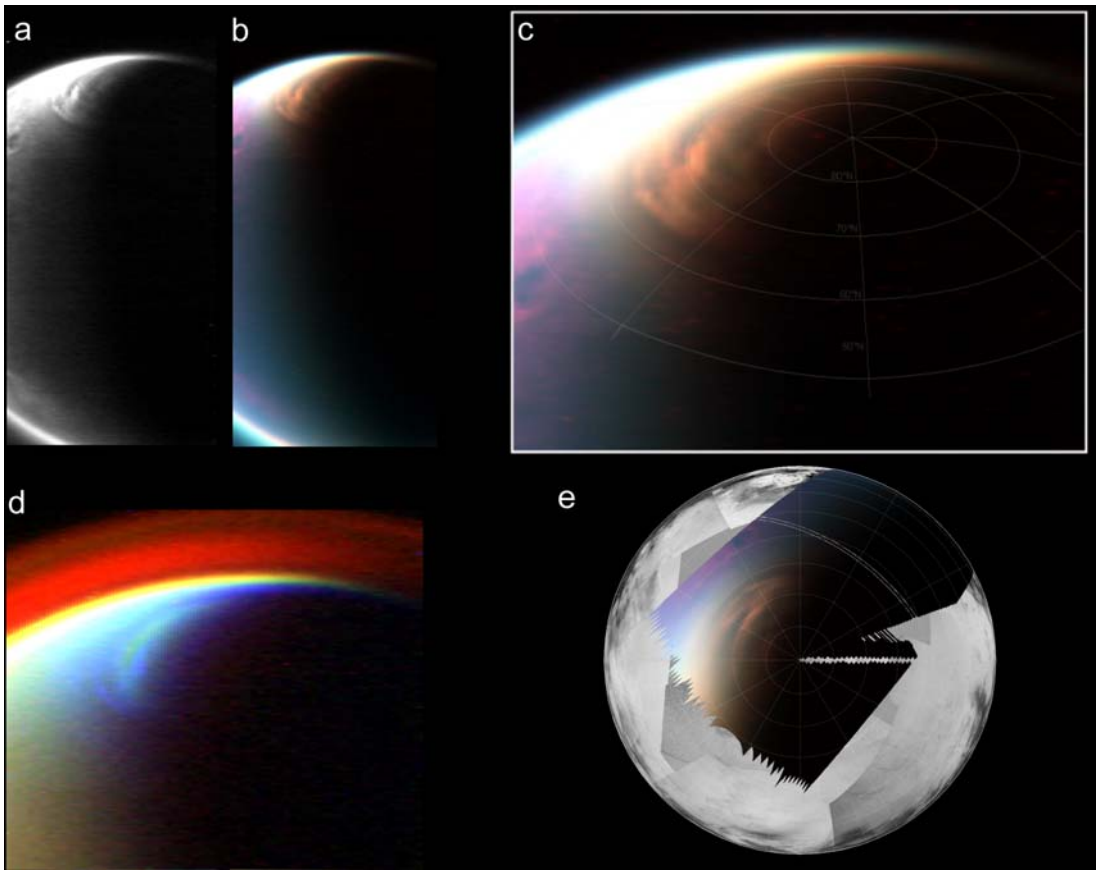

Figure 1: imaging of the North polar cloud with VIMS data acquired the 22th December 2006. (a) average of 14 channels in the 5 µm window. (b) and (c) color composite with red = 5 µm, green = 2.78 µm, blue = 2.03 µm. (d) Color composite (R=3.26 G=3.21 B=4.86 µm) showing the methane fluorescence in the upper atmosphere. (e) orthographic projection of the cloud .

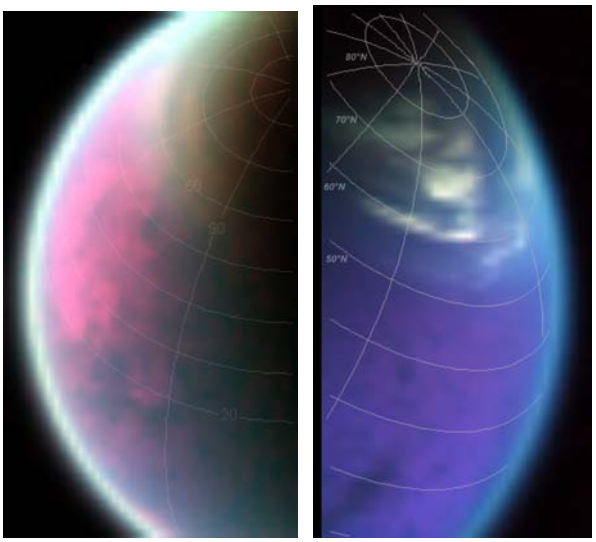

Figure 2 : observations of the north cloud in January 2007 (left) and in May 2008 (right)