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The southern polar cloud on Titan as viewed by VIMS-V

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Abstract

During 2012 a new long-lived cloud appeared very close to the southern pole of Titan. Several Cassini observations were planned to its study and several instruments are still acquiring data on it. The emergence of this cloud, together with the vanishing of the northern pole's cloud system after 2008, could be one of the most direct evidence of seasonal changes in the titanian meteorology. We report about an ongoing data analysis of the Visible channel of the Cassini-VIMS spectrometer. We used data from the VIMS-V spectrometer to characterize the location, shape, spectral reflectance, and time-evolution of this rare atmospheric feature. Contributions and crosschecks from other instrumental datasets (ISS, CIRS, VIMS-IR) could greatly improve the constraints on the cloud macro- and micro-physical properties of this cloud and locate it in the context of the Titan's polar dynamics. Results will be valuable to better understand the seasonal changes of titanian atmosphere, significant topic in atmospheric science and comparative planetology.

1. Introduction

After almost three years from equinox (August 2009), the southern pole of Titan began to host a bright cloudy feature which was repeatedly observed during many Cassini Titan flybys by several instruments on board the spacecraft [2].

The phenomenon could be interpreted as the southern counterpart of the extensive north polar cloud/haze system detected by Cassini since its arrival to Saturn, which gradually vanished after 2008. Since the last equinox happened in August 2009, these two polar structures are probably the most significant evidences of the meteorological switchover between the two hemispheres expected on the basis of general circulation models [1].

2. Data analysis

In this report we mainly focus on data collected by the Visible channel of the VIMS spectrometer, covering the 0.35-1.05 micron range with a spectral resolution of about 7 nm. Up to date we selected data acquired between May 2012 and February 2013, characterized by a spatial resolution up to about 80 km/pixel in limb viewing geometry and about 125 km/pixel in nadir-like geometry.

The cloud always appears fully illuminated just behind the terminator line, from which its minimum altitude can be derived by means of geometrical considerations. These calculations, together with some cloud observation in limb viewing geometry, place the cloud base at altitudes greater than 200-250 km, therefore fully located in the polar stratosphere of Titan.

The VIMS-V data can be usefully complemented by datasets from other instruments (ISS, CIRS) and of course from the IR VIMS channel. Comparison with ISS images acquired in very similar geometries gives a useful crosscheck for correctly interpreting the low resolution VIMS-V images. The size of the cloud can be estimated to be about 500-600 km in diameter. Its shape is however slowly variable in time at the VIMS resolution, probably due to the changing of its directly illuminated part with decreasing of the solar elevation during the southern autumn.

Spectrally, the cloud reflectance could in principle be measured comparing its I/F with that of the surrounding atmosphere, but this measurement is made difficult by the peculiar geometric configuration, since the cloud is illuminated from below and its nearest neighbourhood is mostly in shadow. In fact the I/F contrast changes if measured in limb viewing geometry or in nadir-like geometry. In limb viewing the VIS contrast is increasing with wavelength from 0.5 to 1.1 micron almost linearly. In the near-UV range (about 0.35-0.43 micron) the

cloud appears very faint. Radiative transfer modelling in spherical geometry is then needed in order to remove the atmospheric gaseous contribution from the measured spectra and correctly retrieve the spectral properties of the cloud particles.

The merging of data from different instrument could provide significant constraints to the composition and microphysics of the cloud, together with its formation and evolution in the context of the polar atmospheric dynamics.

6. Summary and Conclusions

Seasonal changes in Titan's atmosphere are a high-valued topic in atmospheric science and comparative planetology. We report about an ongoing data analysis of a southern polar cloud which could witness the beginning of a seasonal meteorological switchover between the two hemispheres. We used data from the VIMS-V spectrometer to characterize the location, shape, spectral reflectance, and time-evolution of this rare atmospheric feature.

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