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An unidentified emission in Titan's upper atmosphere

B. M. Dinelli (1), M. López-Puertas (2), A. Adriani (3), M. L. Moriconi (1), M. García-Comas (2), B. Funke (2), E. D'Aversa (3) and A. Coradini (3)
(1) ISAC-CNR, Bologna and Roma, Italy (bm.dinelli@isac.cnr.it/Fax:+39-051-6398055, (2) IAA, CSIC, Granada, Spain, (3) IFSI-INAF, Roma, Italy

Abstract

Observations of Titan atmosphere made with the instrument VIMS on board the Cassini satellite in October 26th, 2004 show in the spectral region around 3.0 μm a strong limb emission at high atmospheric altitudes (above 500 km). This emission shows the spectral signatures of CH_4 and HCN. A detailed analysis of the methane emission showed a residual emission that peaks at about 900 km centered at 3.28 μm that could not be assigned to any known CH_4 bands. We report on the analysis carried out for unrevealing this emission and propose a possible candidate.

1. Introduction

Saturn's moon Titan possesses a substantial atmosphere, made mainly of nitrogen and methane, that extends higher than 1000 km above its surface. The part of atmosphere between 400 km and 950 km has been called 'Agnostosphere' since it cannot be sampled directly by Cassini (the lowest flyby is 950 km) and it is difficult to be studied with remote sensing instrument due to its low density. Observations of Titan atmosphere made with the instrument VIMS on board the Cassini satellite in October 26th, 2004 show in the spectral region around 3.0 μm a strong limb emission at high atmospheric altitudes (above 500 km). This emission shows the spectral signatures of CH_4 and HCN. Other observations also exhibit the same features.

2. Analysis

The Visual Infrared Mapping Spectrometer (VIMS) on board the Cassini satellite measures the near infrared radiation in the spectral region 0.85 - 5.1 microns with a spectral resolution of about 16 nm (FWHM). The spatial resolution of VIMS at Titan surface is about 45 -- 70 km. We have examined the images acquired by VIMS during the flyby of Titan, on October 2004 in the spectral region of the methane ν_3 band (3.0 μm). We concentrated on the radiation measured by VIMS outside the Titan's disk, in order to study the emission due Titan's atmosphere. Outside Titan's disk VIMS measurements behave like limb observations of Titan's atmosphere. Each pixel corresponds to the signal originated from the atmosphere encountered along the line of sight of VIMS, with the majority of the signal coming from the atmospheric region around the minimum distance

of the Line of Sight from Titan's surface (tangent altitude). On each of the examined images we have selected pixels distributed along verticals to the Titan-s surface, and examined each set of spectra separately. This is like to consider a limb sequence. A thorough analysis of the methane emission, simulated using a detailed Non-LTE model[1], show a residual emission that peaks at about 900 km centered at 3.28 μm. To understand the origin of this discrepancy we have compared the observed integrated intensity for the three branches of methane with the non-LTE simulations. While the relative behaviour of the observed and simulated integrated intensity of the P and Q branches are in agreement, the R branch shows a different behavior. This suggests that part of the R branch emission is due to a different spectral band, possibly generated by a molecule different from CH_4. From now on, we will refer to this as 'anomalous' emission. The spectral shape of the anomalous emission has been evaluated by subtracting the simulated non-LTE CH4 emission spectrum from the measured one. The residual spectrum peaks at 3280 nm. The intensity distribution, that can be considered directly proportional to the distribution of the producing species, peaks at about 950 km, with a secondary maximum at 1200 km. The 'anomalous' emission could not be assigned to any known CH_4 bands. The nature of such emission is under investigation. The fact that its radiance is comparable to that of CH_4, points to some very abundant species, in similar

relative amounts to CH_4. This feature largely constrains the potential emitter(s) and surprises that, being so abundant, it has not been identified before. We will report on the analysis carried out for unrevealing this emission and propose a possible candidate.

References

[1] M. Garcia-Comas, M. Lopez-Puertas, B. Funke, B. M. Dinelli, M. L. Moriconi, A. Adriani, A. Molina, A. Coradini, Analysis of Titan CH4 3.3 μm upper atmospheric emission as measured by Cassini/VIMS, *Icarus*, In Press, Accepted Manuscript, Available online 30 March 2011, ISSN 0019-1035, DOI: 10.1016/j.icarus.2011.03.020.