EPSC Abstracts
Vol. 5, EPSC2010-857, 2010
European Planetary Science Congress 2010

Simulations of Titan observations in the 1.58 µm methane window with high-resolution, low temperature CRDS CH_4 spectra

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Abstract

The 1.58 micron region is an atmospheric window in the near-infrared spectrum of Titan. However, it has been known for a long time that numerous very weak absorption lines of methane are present in that range that cannot be ignored in the models (e.g. de Bergh et al., 1988). Their knowledge is very important for both atmospheric and surface studies of the satellite. Current band models and databases for methane do not allow for a complete exploitation of the available observations for example from the ground (Negrão et al., 2006 and references therein) or from Huygens/DISR (Tomasko et al., 2008; Karkoschka and Tomasko 2010). We have undertaken a combined effort among 4 French laboratories doing experimental, theoretical and data analysis work in order to produce more adapted (for Titan's low temperatures and high pathlength) methane absorption parameters for planetary applications in general and for analysing the Cassini-Huygens data in particular.
For the moment, the CH_4 absorption has been studied at the Laboratoire de Spectrométrie Physique in Grenoble at very high sensitivity and at room (Figure 1) and low temperatures (80 K) by CW-Cavity Ring Down spectroscopy (Kassi et al., 2009, Wang et al., 2010a, Campargue et al., in press). More than 15000 lines have had their intensities measured, and low energy values have been derived allowing to predict the temperature dependence of the absorptions in the region. Bands of CH_3D are present in that range. They have been identified by comparison with FTS spectra of the CH_3D isotopologue recorded separately at USTC (Hefei-China) at room and low temperature by FTS spectroscopy. Its contribution to the absorptions observed in the laboratory spectra of methane obtained in Grenoble is being carefully evaluated.
We will briefly describe the especially designed experimental set-up and the method used to analyze the spectra and obtain the line list at 80 K. We will then show comparisons with data of Titan taken from the ground at high resolving power and from the Huygens/DISR instrument (Figure 2). We will further discuss the planetary applications that are foreseen. The obtained data will be very useful to properly analyze the available observations and to get more accurate measurements of the D/H in the atmosphere of Titan (also for Uranus and Neptune), as well as for other minor constituents (CO, etc), from high-resolution planetary spectra. They will also be used to measure spatial variations of methane in the low atmosphere of Titan from high spectral and spatial resolution observations. When the atmospheric component is correctly modelled, we shall be able to explore the surface spectrum of Titan in that region. In addition, the DISR Titan spectra will be re-interpreted by combining this new set of data with other data that have just been obtained on both sides of the window (Wang et al., 2010b; Campargue et al., 2010), to obtain additional information on Titan's atmosphere and surface. Furthermore, these new laboratory data will help to analyze recent ground-based and also Cassini/VIMS spectra of Titan, with the goal to derive the

atmospheric component and the surface albedo at these wavelengths, and therefore get information on the atmospheric and surface composition.

This work is part of a large French program concerning methane spectroscopy for Titan with the support of Agence Nationale de la Recherche (CH4@Titan Consortium).

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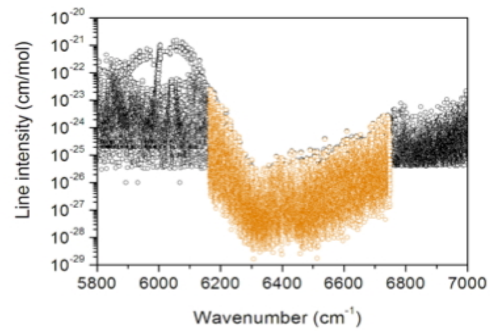

Figure 1: CRDS spectra at room temperature (Wang et al., 2010a, Campargue et al., 2010)

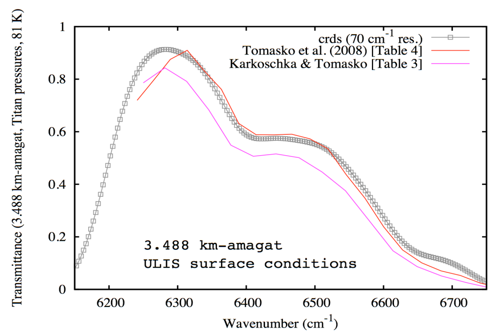

Figure 2 : simulation of Titan's Huygens/DISR transmittance spectra with the CRDS data.