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Titan's night-glow mechanisms

P. Lavvas (1), R. A. West (2), and G. Gronoff (3)
(1) GSMA UMR 7331, Universite de Reims, Champagne-Ardene, Reims, France, (2) Jet Propulsion Laboratory, California Inst. of Tech., Pasadena, USA, (3) SSAI/NASA LaRC, Science Directorate, Chemistry and Dynamics Branch, Hampton, Virginia, USA (panayotis.lavvas@univ-reims.fr)

Abstract

Observations of Titan's emissions during its 2009 eclipse by Saturn revealed a weak airglow around the moon, as well as a brighter emission from its disk (Fig.1). We explore here the potential mechanisms that could generate these emissions and more specifically the role of magnetospheric plasma and cosmic rays in the upper and lower atmosphere, respectively [2]. We consider excitation of N_2 by these energy sources and calculate the resulting emissions through a detailed model of N_2 airglow [3](Fig.2), followed by careful radiation transfer of the emitted photons through the atmosphere, and into the UVIS and ISS instruments (Figs 3 & 4). Our results indicate that the observed limb emissions are consistent with magnetospheric plasma energy input, while emissions instigated by cosmic ray excitation deep in the atmosphere are strongly attenuated by the haze and can not explain the observed disk emissions [4](Tables 1 & 2). We discuss possible contributions from other sources that could potentially explain the disk observations. These include airglow from other species, chemiluminescence, aerosol particle fluorescence, and scattered light from the stellar background.

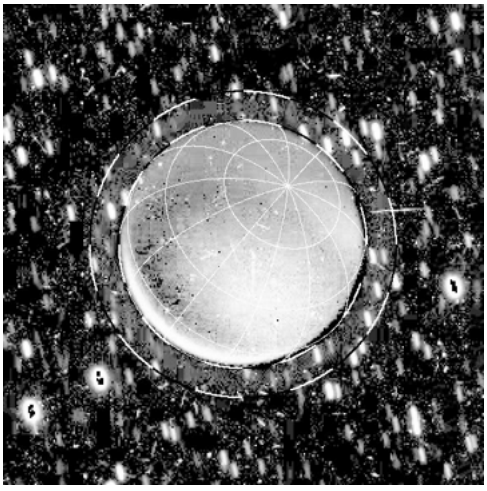

Figure 1: Portion of a calibrated ISS image on the [CL1,CL2] filter combination with a lat/lon grid. The two dashed circles mark the 300 and 1000 km altitude regions bounding the bright disk and faint limb emissions, respectively. Background contributions by star light and cosmic rays is also visible.

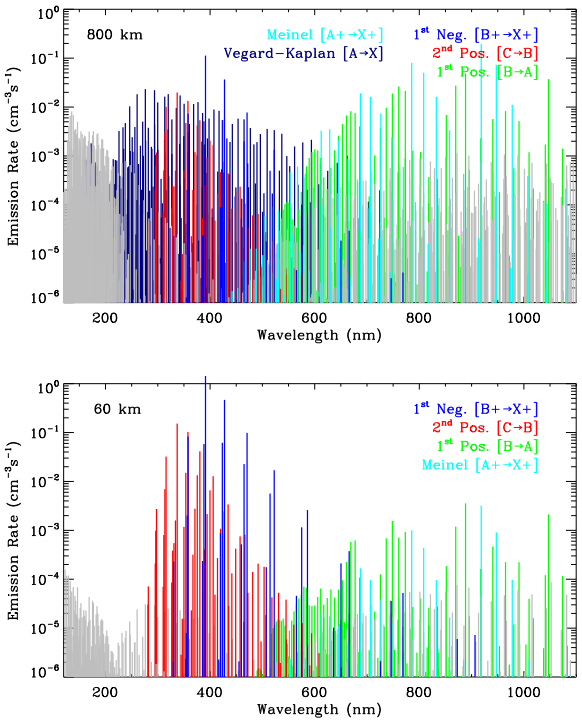

Figure 2: Spectral distribution of produced night glow photons at 800 (magnetosphere) and 60 km (cosmic rays) altitude. The color code designates the stronger bands. A clear redistribution in emitted photons is observed between the two altitude regions as a results of enhanced collisional transitions.

Table 2: Comparison between observed DN values for disk and limb observations from different ISS filters, and the corresponding DN values from our model. The uncertainty on the observed DN values are of 0.2 DN.

	Limb Average (300-1000 km)				Disk Average			
	CL1,CL2	CL1,VIO	CL1,BL1	IR2,CL2	CL1,CL2	CL1,VIO	CL1,BL1	IR2,CL2
Observed	11	0.2	1.1	0.5	71.7	0.7	4.5	6.5
Modeled	4.35	0.17	0.42	0.39	0.1	0.005	0.014	0.004
Ratio	2.53	1.18	2.62	1.28	717	140	321	1625

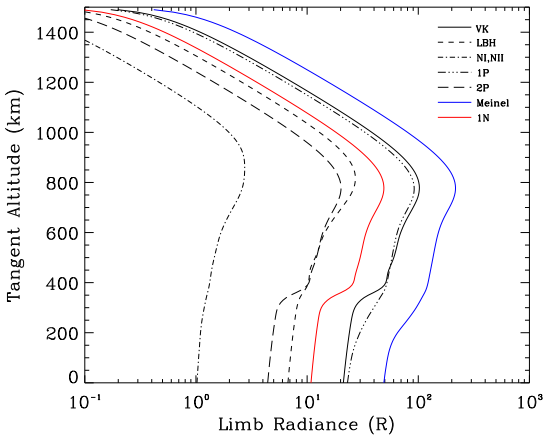

Figure 3: Vertical profiles of limb emissions to the UVIS instrument for different N_2 emitting bands.

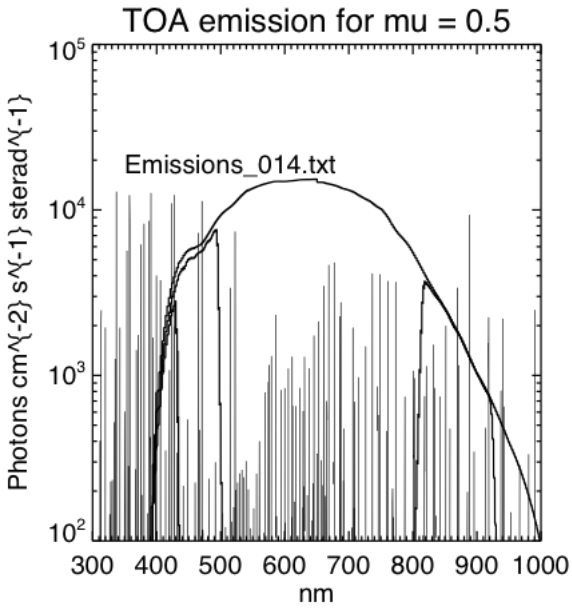

Figure 4: Simulated outgoing disk intensity at 300 km altitude. The relative sensitivities of the four ISS filters listed in the table 2 are also plotted.

Table 1: Comparison between simulated emissions and UVIS observations from [1]. In the model column, "total" corresponds to the emission from all emitted wavelengths for each band and "UVIS" to the observable fraction by UVIS. All values are in Rayleighs.

Band	Model		Observation	Ratio
	Total	UVIS		
LBH	10.3	8.9	7.2±5.1	0.8
VK	39.4	1.1	3.9±2.6	3.5
NI	1.3	0.9	4.4±1.4	4.7
NII	0.2	0.2	0.4±0.1	2

References

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[4] Lavvas P., et al., (2014) Titan's emission processes during eclipse. Icarus, *under review*