DETERMINATION OF THE HAZE LAYER PARAMETERS IN THE SATURN ATMOSPHERE FROM CASSINI-VIMS IMAGES. A. Adriani[1], M. Moriconi[2], F. Colosimo[1], A. Coradini[1], G. Filacchione[3], R. Orosei[3], E. D'Aversa[1], F. Capaccioni[3], P. Cerroni[3], G. Bellucci[1], R. H. Brown[4], K. H. Baines[5], J. P. Bibring[6], B. J. Buratti[5], R. N. Clark[7], M. Combes[8], D. P. Cruikshank[9], P. Drossart[8], V. Formisano[1], R. Jaumann[10], Y. Langevin[6], D. L. Matson[5], T. B.McCord[11], V. Mennella[12], R. M. Nelson[5], P. D. Nicholson[13], B. Sicardy[8], C. Sotin[14], [1]INAF-IFSI, via del Fosso del Cavaliere, 100, Rome, Italy, [2]CNR-ISAC, via del Fosso del Cavaliere, 100, Rome, Italy, [3]INAF-IASF, via del Fosso del Cavaliere, 100, 00133, Rome, Italy, alberto.adriani@ifsi.rm.cnr.it, [4]Lunar and Planetary Lab, University of Arizona, Tucson, AZ, USA, [5]Jet Propulsion Laboratory, Pasadena, CA, USA, [6]Institut d'Astrophisique Spatiale, Orsay, France, [7]US Geological Survey, Denver, CO, USA, [8]Observatoire de Paris, Meudon, France, [9]NASA Ames Research Center, Moffett Field, CA, USA, [10]Institute for Planetary Exploration, DLR, Berlin, Germany, [11]HIGP/SOEST, University of Hawaii, 22 Fiddler's Rd. Winthrop, WA, USA, [12]INAF-OAC, Napoli, Italy, [13]Cornell University, Astronomy Department, Ithaca, NY, USA, [14]Laboratorie de Planetologie et Geodynamique, Universitè de Nantes, Nantes, France.

Introduction: The mission Cassini reached the Saturn system in July 2004. The VIMS imager spectrometer is part of the payload of the Cassini spacecraft. Since the insertion in orbit, VIMS has produces a great amount of images of the planet and its moons and rings by means of the two different channels of it, one in the visual spectral range between approximately 0.3 and 1.0 µm and one in the infrared between approximately 1 and 5 µm. The main goal of this study is the determination of the altitude of the upper clouds and some of optical parameters of them. In order to do this we have chosen two images taken in April 15, 2005.

The images: The images that we analyzed are named V1492271850_1 and V1492289586_1. They have been taken from a distance of approximately 6x10^5 km from the optical surface of the planet. In our analysis, we used the IR channel images where the contamination by the aerosol scattered light is less. The images are formed by 64x64 pixel and cover surfaces of about 19,200 x 9,600 km. Figure 1 depicts the scenes seen in the two images at 1.458 and 1.59 µm on which we have made the calculations. The VIMS spectral resolution in the infrared is about 16 nm. The shade of the rings is visible at the top of the images that span between the equator and about 35S latitude. Figure 2 shows a spectrum taken on the image V1492271850_1 with the indication of the wavelengths used in the calculation. Besides the ones of the images, the third wavelength used in the calculations is 1.492 µm. The shortest two wavelengths are in the CH_4 1.4-µm absorption band.

The analysis: The atmospheric parameters, pressure and temperature profiles versus altitude have been taken from Lindal et al. [1] who retrieved the data from an analysis of the Voyager radio occultation measurements. On the basis of this atmospheric profile, the optical depth of the atmosphere for the CH_4 absorption in the 1.4-µm band have been computed by using the k-correlated method from the Irwin et al. database [2]. Transmittances have been calculated down to about 1000 hPa and are reported in figure 3 along with the temperature and the pressure profiles with a vertical resolution of 5 Km. The signal measured in the 1-2 µm spectral range is the sum of two contributions: (1) the amount of Sun radiation that is reflected back by the clouds and that is reduced by absorption in its way in and its way out due to the presence of CH_4 the Saturn atmosphere; (2) the amount of light which comes from the atmospheric particle scattering. As the transmittance at 1.59 µm is 1 down to 1000 hPa (the reference pressure for alti-

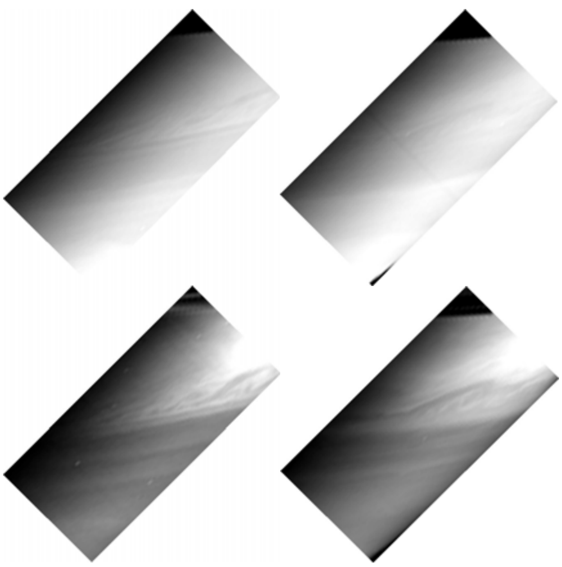

Figure 1: Images that we analyzed are V1492271850_1 (left) and V1492289586_1 (right) at wavelengths 1.59 µm (top) and 1.458 µm (bottom). The reflectance intensities of the images are relative to each single one, therefore they are not comparable among images.

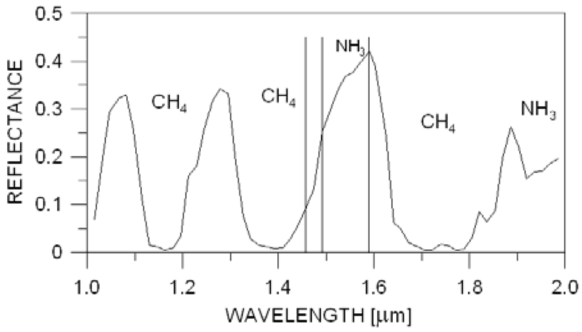

Figure 2: Spectrum of the image V1492271850_1. The vertical lines sign the position of the wavelengths used in the calculations: 1.458, 1.492 and 1.59 μm.

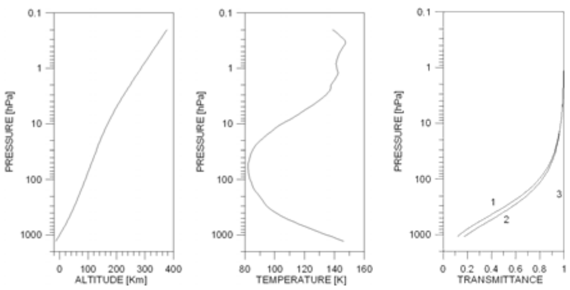

Figure 3: Atmospheric profiles: altitude, temperature and transmittances calculated at the three wavelengths calculated from Irwin et al. [2]: (1) 1.458 μm, (2) 1.492 μm and (3) 1.59 μm.

tude 0 Km), we can assume that the reflectance measured in the spectral window can be written as: $R_w = \rho + S$, (*a*), where R_w is the measured reflectance, ρ is the equivalent albedo of the Saturn top cloud and S is the contribution of the atmospheric scattering. The scattering contribution is strong in the spectral window but it is low or negligible in the spectral bands where the gas absorption is significant. Then, we can assume that the reflectance measured inside the absorption band can be written, at the first order of approximation, as $R_B = \rho\ exp[-\tau\ f(\theta_S,\theta_E)]$, (*b*), where ρ is the equivalent albedo (we assume that the albedo do not vary significantly between the window and the absorption band being spectrally close), τ is the optical depth and $f(\theta_S,\theta_E)$ is the geometrical correction factor which is function of the solar zenith angle (θ_S) and the emission angle (θ_E) towards the spacecraft. Combining the reflectances in the bands and the window, the quantity $-(ln\ [R_B/R_w])/f(\theta_S,\theta_E)$, (*c*), gives an estimation of the optical depth that, by comparison with the function optical depth vs altitude, permits an estimation of the correspondent pressure level or altitude where the cloud is located (see figure 3). The preliminary results calculated for the 1.458-μm and the 1.492-μm bands and assuming S=0 do not give the same estimation of the altitudes of the same clouds confirming that the contribution of S in the spectral window is not negligible. Then, the value of S can be progressively increased to calculate the new values of ρ and to recalculate R_W by equation (*a*) removing the scattering contribution to be used in the equation (*c*). The iterative calculation stops when the results of equation (*c*) for both the spectral bands give the same altitude.

Results: Finally, three different parameters can be calculated by this simple model: the altitude (or corresponding pressure level) at which the cloud is located (see figure 4); the estimation of the equivalent albedo (ρ) and the environmental contribution (S) of the atmospheric particles (see figure 5). The results reported in the figures 4 and 5 have been computed for the sample 14 of the two images. The higher clouds, closer to the equator, result to be at a reference altitude of about 100 km, corresponding to a pressure level of about 70 hPa. Clouds between 20S and 30S are lower of about 15 km corresponding to a pressure level of about 130 hPa. Moreover, the average equivalent albedo of the clouds is about 0.29 at 1.59 μm and the environmental contribution to the measured reflectance in the spectral window is about 30% of the total amount.

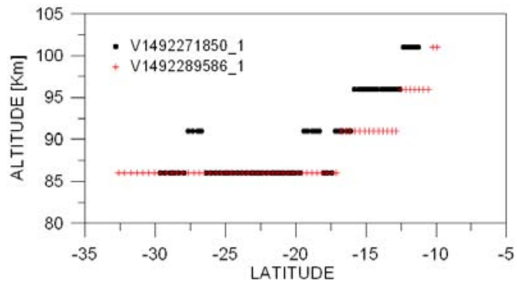

Figure 4: Altitude of the cloud layer at sample 14 for the two images.

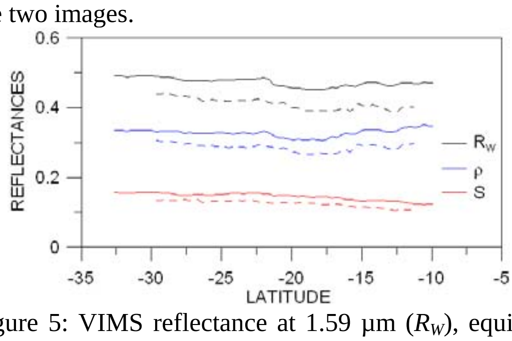

Figure 5: VIMS reflectance at 1.59 μm (R_W), equivalent albedo of the haze layer (ρ) and environmental contribution (S) for sample 14 of the images V1492271850_1 (dashed curves) and V1492289586_1 (solid curves).

References: [1] Lindal, G.F., Sweetnam, D.N., Eshleman, V.R. (1985), *Astron. J.*, *90*, 1136–1146. [2] Irwin P.G.J., Sihrab K., Bowles N., Taylor F.W., Calcutt S.B. (2005), *Icarus*, *176*, 255–271.