EPSC Abstracts
Vol. 6, EPSC-DPS2011-1830, 2011
EPSC-DPS Joint Meeting 2011

Two-micron Spectro-Images and Radiative Transfer Calculations of Titan's Atmosphere

C.K. Sim (1), S.J. Kim (1), L.M. Trafton (2), and T.R.Geballe (3)
(1) Kyung Hee University, Korea (cksim@khu.ac.kr) (2) University of Texas at Austin, USA (3) Gemini Observatory, USA

Abstract

We investigated limb brightening phenomenon and east-west asymmetry shown in the 2-μm spectro-images of Titan by using radiative transfer equations. Resultant synthetic spectro-images constructed by an inversion algorithm have been used for studying possible variations of the properties of the haze.

1. Introduction

Limb brightening is a common phenomenon seen in near-infrared images of Titan within strong CH_4 absorption bands [2,5], whereas the limb darkening occurs within spectral windows. Another noticeable feature is the east-west asymmetry of the observed brightness, which could not be explained by the sole influence of the solar phase angle when it is as small as ~±1° [3]. In this work, we study the relevance between the east-west asymmetric limb brightening and the possible change of the haze.

2. Observations

2-μm spectro-images of Titan were obtained using the Near-Infrared Integral Field Spectrometer (NIFS) on the Gemini-North telescope with an adaptive optics system on 7 February 2006. Reduced images are deconvolved using maximum entropy method to remove the point spread function. At the time of the observations, the solar phase angle was ~ +1.2°.

3. Radiative Transfer Calculations

To reproduce the observed Titan spectro-images, we used the radiative transfer program of Kim et al. [4] and modified it in order to adopt the spherical geometry correction to the plane-parallel approximation. The anisotropic-scattering haze was assumed following the *Huygens*/DISR result [6]. An iterative inversion algorithm was used to tune the surface albedo and haze properties such as single scattering albedo. We also made a model which adopts the 400 cm^{-1} cut-off of the sub-Lorentzian line shapes of CH_4 as suggested by Bailey et al. [1] and compared it with the previous model with 10 cm^{-1} cut-off.

4. Results

A wavelength dependent single scattering albedo of the haze in the wavelength range between 2.14 and 2.22 μm was derived (Figure 1). As it goes toward the limbs, higher single scattering albedo is needed gradually. Adopting an extended sub-Lorentzian cut-off of CH_4 spectral features improves the fit in the central region of observed Titan's disk whereas it becomes less important near the limb. The EWA of the observed brightness could be explained by that of the haze albedo. These trends are consistent regardless of latitude, suggesting that it is not a seasonal phenomenon whereas the north-south asymmetry is. We recognize that the haze albedo derived here may not be unique owing to the lack of information on Titan's haze properties.

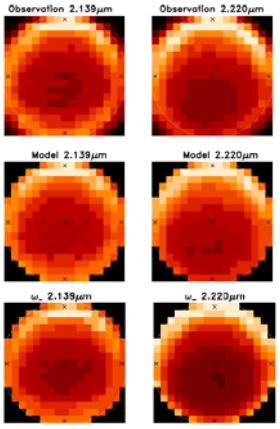

Figure 1: Observed images (top row), our model images (middle row), and maps of derived forward single scattering albedos of haze in the ~60 km altitude level (bottom row).

References

[1] Bailey, J., Linda, A., and Meadows, V.S.: The near-IR spectrum of Titan modeled with an improved methane line list, Icarus, Vol. 213, pp. 218-232, 2011.

[2] Coustenis, A., Gendron, E., Lai, O., Véran, J., Woillez, J., Combes, M., Vapillon, L., Fusco, T., Mugnier, L. and Rannou, P.: Images of Titan at 1.3 and 1.6 μm with Adaptive Optics at the CFHT, Icarus, Vol. 154, pp. 501-515, 2001.

[3] de Pater, I., Ádámkovics, M., Bouchez, A. H., Brown, M. E., Gibbard, S. G., Marchis, F., Roe, H. G., Schaller, E. L. and Young, E.: Titan imagery with Keck adaptive optics during and after probe entry, J. Geophys. Res., Vol. 111, E07S05, 2006.

[4] Kim, S. J., Geballe, T. R., Noll, K. S. and Courtin, R.: Clouds, haze, and CH4, CH_3D, HCN, and C_2H_2 in the atmosphere of Titan probed via 3μm spectroscopy, Icarus, Vol. 173, pp. 522-532, 2005.

[5] Roe, H. G., de Pater, I., Macintosh, B. A., McKay, C. P.: Titan's Clouds from GEMINI and Keck Adaptive Optics Imaging, Astroph. J., Vol. 581, pp. 1399-1406, 2002.

[6] Tomasko, M.G., Doose, L., Engel, S., Dafoe, L.E., West, R., Lemmon, M., Karkoschka, E., and See, C.: A model of Titan's aerosols based on measurements made inside the atmosphere, Planet. Space Sci., Vol. 56, pp. 669-707., 2008.