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Vertical and Latitudinal Distributions of the 3.3-micron Feature of Saturn

Jaekyun Park (1), Sang Joon Kim (1), Henrik Melin (2) Tom S. Stallard (2) and Régis Courtin (3)
(1) School of Space Research, Kyung Hee University, Republic of Korea, (2) Department of Physics and Astronomy, University of Leicester, United Kingdom, (3) LESIA, CNRS, Observatoire de Paris, PSL University, 5 place Jules Janssen, 92195 Meudon, France (jkpark@khu.ac.kr)

Abstract

Kim et al. [2,3] analyzed the spectro-images of Saturn observed by Visual and Infrared Mapping Spectrometer (VIMS)/Cassini, which revealed altitudinal distributions of the spectral structure of haze in Saturn's south-polar regions and at 55°N latitude. However, other regions of Saturn still have not been investigated. We derived series of high-spatial resolution VIMS images of Saturn's limb at various latitudes. Using our updated code, the altitudinal intensity profiles of 3.3-μm emission and H_3^+ through different latitudes were plotted. Then we obtained the averaged vertical spectra of the 3.3-μm emission which is all blended with fluorescent methane and hydrocarbon haze. The vertically resolved spectra were measured from the limb of Saturn in 50 km intervals to see altitudinal variance. We will present a comparison of spectral structures of the 3.3-μm emission at different latitudes.

1. Introduction

Recently, Kim et al. analysed the 3 μm emission spectra of Saturn's southern auroral region [3] and non-auroral region at 55°N [2] using VIMS/Cassini spectra and Procyon occultation data. In their study, vertically resolved spectral structures of Saturnian polar haze between 375 and 925 km altitude were derived after extracting adjacent 3 μm H_3^+, CH_4 and C_2H_6 emissions. Resultant spectra show the polar haze at high altitude is dominated by aromatic hydrocarbons, whereas the low latitudinal haze (55°N) is dominated by aliphatic hydrocarbons. In addition, they found that haze composition also changes with altitudes, and suggest that the aging process may occurs during both horizontal and vertical ways.

2. Data Selections and Results

We analyzed VIMS/Cassini data, which were recorded in the 2004-2013 period. To prevent the reflection from Saturn as much as possible, we selected limb data excluding pixels greater than 300 km. Ring and ring shadow were removed using a ready-made code in order to obtain uncontaminated dayside 3.3-μm emission. As a result, 69 spectro-images on Saturn's limb were selected from 2005 to 2013. Based on the latitudinal coverage of the data, the images were finally classified into 18 latitudinal groups.

2.1 Altitudinal Profiles

In order to make altitudinal profiles of the H_3^+ emission intensities, we used 5 wavelength bins at 3.5319, 3.6159, 3.6672, 4.2004 and 4.3529 μm. Because of the nonnegligible contribution from reflected sunlight as high as 500 km above the limb, we subtracted the backgrounds at 3.5645, 3.6329, 3.7015, 4.1850 and 4.3167 μm, respectively. To give an account of wavelength variations of reflected sunlight, the backgrounds were also multiplied by a factor of 0.7, 0.7, 0.7, 0.75 and 0.8 [4]. Then we averaged the intensity for each according to the number of bins used (Fig. 1). For the 3.3-μm emission, three wavelengths at 3.3334, 3.3498 and 3.3656 μm were used and averaged (Fig. 1).

2.2 Vertically-Resolved Spectra

To obtain vertically-resolved spectra, we projected each pixel to altitudinal grids and calculated intensities at every 50 km intervals. Each altitudinal bin was then averaged by the number of latitudes it covers. Because the wavelength value of VIMS shifts as time goes by, we added calibration with reference to values presented in [1]. Resulted vertically-resolved 3.3-μm spectra from 375 to 1025 km are as shown in Fig. 2.

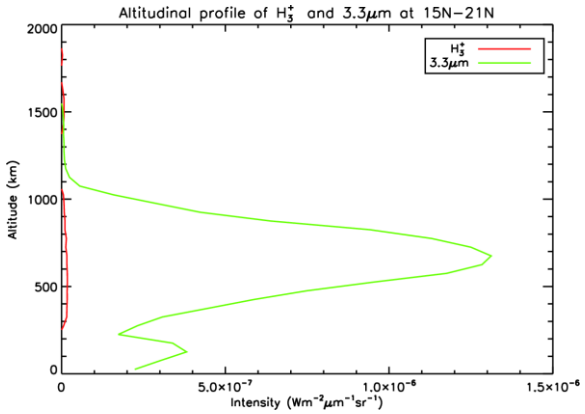

Figure 1: Examples of altitudinal profiles of H_3^+ and the 3.3-μm emissions at 15-21°N. We obtained 18 altitudinal profiles from 18 different latitudinal groups.

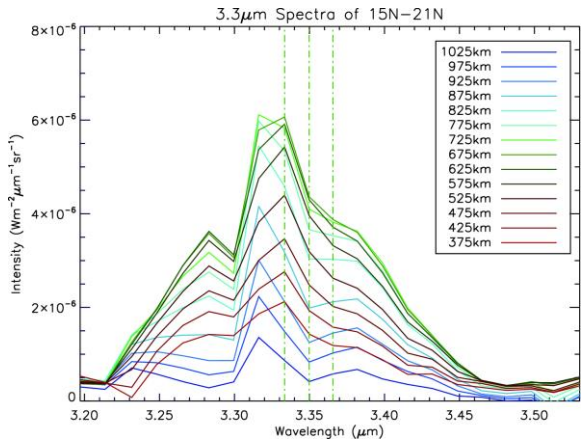

Figure 2: Examples of vertically-resolved spectra at 15-21°N. Note that each spectrum is comprised of various emissions from CH_4, C_2H_6, and H_3^+, and haze.

3. Summary

Kim et al. [3] showed that the 3.3-μm feature is dominated by the haze emission. As shown in Fig. 2, the peak positions of the spectral features vary with altitude. Kim et al. [3] suggested that the aging process may occur either vertically and/or horizontally. However, the research so far has been confined to limited regions (77°S and 55°N). Using our new data with wide latitudinal coverage, we look forward to a better understanding of global distribution of Saturnian haze. However, because the spectra contain emission from other molecules, we must remove them out using our radiative transfer code to derive the vertically-resolved spectra of pure haze for different latitudes.

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