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Probable signs of the vertical inhomogeneity of Jovian cloud layer

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Abstract

The latitudinal variations of the central depths of the methane absorption bands at wavelengths 619, 725, 798 and 887 nm were studied in 1999 at all longitudes of Jupiter. It was shown that these variations are generally similar at all longitudes, but not the same for different bands extremes (max and min) absorption position. A comparison of the latitudinal variation of the absorption bands in the 619 and 725 nm show a loop-form of the relation of these bands depths in the low-latitude region of Jupiter. Rough estimates of the effective optical depth of the absorption formation and their differences in a simple two-layer model indicate the existence of varying with latitude vertical inhomogeneity of cloud cover.

1. Introduction

In November and December 1999 special observations of Jupiter were carried out for detailed study on latitudinal and longitudinal variations of the absorption bands of CH_4, centered on 619, 725, 798 and 887 nm. 388 CCD-spectrograms of the central meridian of Jupiter were recorded and processed. During four nights all longitudes were observed twice with the step 1.8 degrees on longitude [1]. In this work some latitudinal differences of the behavior of the absorption in the CH_4 619 and 725 nm bands are compared

2. General latitudinal distribution of the methane absorption

Figure 1 shows the curves of the latitudinal variation of the central depths of the absorption bands (*Rv*), averaged over a range of longitudes 144 degrees (23 to 167 degrees in the II system) The relatively weak band at 619 nm CH_4 over all observations has a maximum value *Rv* just south of the equator, at a latitude of about -5 degrees. The depth of 725 nm band shows a clearly expressed absorption maxima at latitudes of about -18 and +23 degrees and with a minimum at about 4 degrees latitude. For other observation dates the view of graphics is identical. The comparison of the 619 and 725 nm bands depths shows for all data a loop at low latitudes -25 to +25 degrees and significant difference in their latitudinal variations (Figure 2).

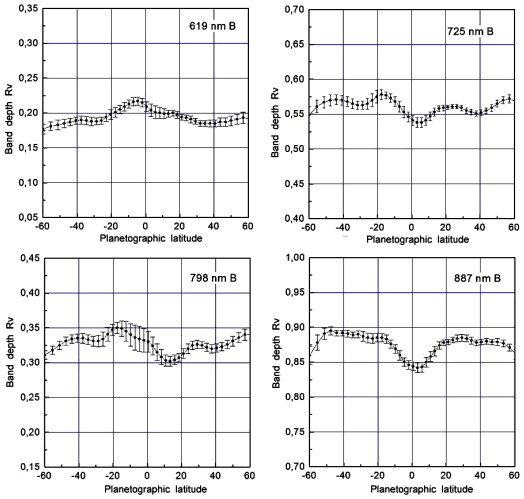

Fig.1 Latitudinal variations of the CH_4 absorption bands central depths

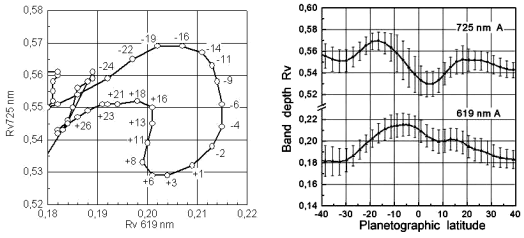

Fig.2 A comparison of the CH_4 619 and 725 nm absorption bands depths at low latitudes

3. The effective optical depths latitudinal differences

The discrepancy between the positions of maximum and minimum absorption for the weak band 619 nm and of stronger band at 725 nm may be considered as a result of different effective levels where the absorption formed inside the cloud layer. If the vertical inhomogeneity of the cloud particles distribution varied with latitude it must be seen in the

latitudinal differences of the absorption bands intensity. If the observed variations were due to absorption inhomogeneities in the atmosphere above the clouds, for example, in the stratospheric layer of haze, the effect should be expressed more or less equally in both bands. As a simple model for the interpretation of the observed latitudinal differences, we used a two-layer model with semi-infinite cloud layer and pure gas atmosphere above the clouds. For the cloud layer Henyey-Greenstein scattering function with the asymmetry parameter g = 0.75 has been adopted The reflectivity in the continuous spectrum of the cloud layer is assumed to be 0.75 . Calculations were based on the numerical data tables [2] for the reflection in the absorption bands, and [3] to calculate the effective optical depth of the absorption formation.

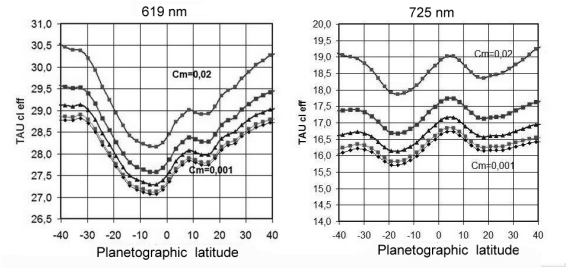

Fig.3 The estimates of the effective optical depths of the CH_4 absorption formation for centers of the 619 and 725 nm bands at different *Cm* values.

Discrete tabular data were approximated with good accuracy by polynomials that allowed to make the calculations for all values of the arguments. The absorption coefficients for the centers of the bands 619 and 725 nm were taken from [4], the methane abundance in the atmosphere above the clouds *Cm* ranged from 0.001 to 0.02 km-amagat. The results are presented in Figure 3 at a number of the methane abundance *Cm* values.

The difference of effective optical depths

$$\Delta\tau_{ef} = \tau_{ef}(619) - \tau_{ef}(725)$$

may characterize the degree of vertical inhomogeneity of the cloud layer at different latitudes. These latitudinal variations of $\Delta\tau_{ef}$ are shown on Figure 4 for two observational nights and for two values of *Cm*.

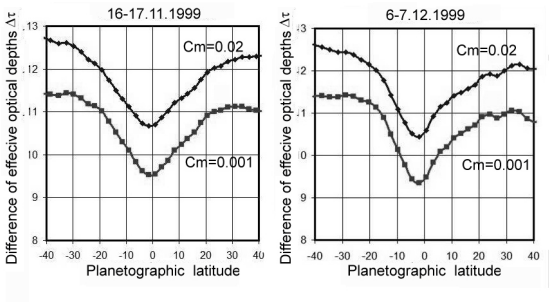

Fig.4 Latitudinal changes of $\Delta\tau_{ef}$ at two valies of *Cm* 0.001 and 0.02 km-amagat for two observations dates.

It is Interesting that the minimum degree of inhomogeneity falls on the equatorial zone. Of course, these results should be considered preliminary and subject to verification by the data of further observations.

Acknowledgements

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