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Circulation in upper mesosphere of Venus in the Southern and Northern hemispheres from the O_2 1.27 µm night glow (VIRTIS-M/VEX data)

L. Zasova (1), A. Shakun (1), I. Khatuntsev, D. Gorinov(1), A. Migliorini (2), F. Altieri (2), G. Picconi (2) , P. Drossart (3)
(1) space research Institute RAS, Moscow Russia, (2) IAPS – INAF, Rome, Italy, (3) LESIA, Paris-Meudon, France
(zasova@iki.rssi.ru / Fax: +7-495-3331248

Abstract

Mapping spectrometer VIRTIS-M on board Venus Express [1] made observations of the O_2 1.27 µm airglow intensity distribution on the night side of Venus in nadir and limb modes in Southern and Northern hemispheres respectively. The work is devoted to comparison of the results, obtained for both hemispheres.

1. Introduction

Horizontal distribution of the oxygen nightglow in the Venus atmosphere is an effective tracer of circulation in upper mesosphere and lower thermosphere (in the vicinity of the mesopause level (90-100 km). This is a transition region between two major circulation modes. In thermosphere the subsolar-to-antisolar (SS-AS) circulation prevails, while in mesosphere a zonal retrograde superrotation (ZRS) dominates [2]. Besides, the thermal tides are observed in mesosphere with diurnal and semi-diurnal amplitudes of exceeding 5 K at 90-100 km height [3]. Gravity waves are also present there, revealing itself in the vertical distribution of the O2 emission [4], [5]. The layer of the O_2 emission is centered at 97 ± 3 km, with half width of the emitting layer 8 ± 3 km (VIRTIS-M, limb measurements [6]).

2. Southern hemisphere observations

Nadir measurements are related to Southern hemisphere. Night glow and its intensity is strongly variable, distribution inhomogeneous, maximal observed emission rate exceeds 6 MR. In the paper [4] the map of the emission rate in coordinates local time – latitude is given. .Bright spot around antisolar point gives evidence for importance of SS-AS circulation with transport of the air masses through poles and terminators with ascending/descending flows at SS/AS areas. We made new processing of the data [6]. To avoid high noisy data we use for analysis only those, obtained with exposure > 3 s. Maps of airglow were obtained in the coordinates "local time – latitude" for individual data cubes as well as the global map averaged over 718 orbits. Individual maps of the airglow show highly variable character of the O_2 nightglow distribution. Maximum emission in low latitude region are observed in the local time interval LT= 20 h ÷ 4 h. More detailed global map was obtained, compare to [4]. It was also found evidence of the SS-AS circulation, Global map for southern hemisphere (from nadir data) has good statistics at φ > 10-20°S and pretty poor at lower latitudes. Averaged over 718 orbits global map shows maximum emission shifted from midnight by 1 – 2 hours to the evening (22 - 23h) and deep minimum of emission is found at LT=2 - 4 h at φ > 20°S. This asymmetry is extended up to equatorial region, however statistic is poor there. No evident indication for existence of the Retrograde Zonal Superrotation (RZS) is found: maximum emission in this case, which is resulting from downwards flow, should be shifted to the morning terminator. Horizontal wind, measured independently from the same set of data show that at 22 - 23 h the horizontal wind changes its direction, indicating to downwelling there, maximal wind speed coincides with minimum emission rate, observed near morning terminator.

3. Northern hemisphere

VIRTIS limb observations cover the low northern latitudes and they are more sparse at higher latitudes. Intensity of airglow at φ = 0 - 20° N shows wide maximum, which is shifted by 1 - 2 h from midnight to morning terminator. This obviously indicates that observed O_2 night glow distribution in low North latitudes is explained by a superposition of SS-AS flow and RZS circulation at 90-100 km. This

behavior is similar to the NO intensity distribution, obtained by SPICAV. In the map from paper [4] one may also find that intensity of emission in the bright spot around midnight in the Northern low latitudes after midnight exceeds value of the O_2 emission observed before midnight.

4. Summary

Distribution of the O_2 night glow in both hemispheres indicates to more complex circulation in the transition region than SS-AS flow. In equatorial region and low latitudes of the Northern hemisphere the superposition of SS-AS and RZS reveals itself in the shift of the maximum of the O_2 emission to the morning (2 h), similar to that of the NO night glow, observed by SPICAV. No evidence of influence of the ZRS in Southern hemisphere from nadir data was found. The bright area of emission is observed at 1 - 2 h before midnight indicating to downward flow before midnight.

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