OXYGEN NIGHTSIDE AIRGLOW ON VENUS IN RELATION TO ATMOSPHERIC DYNAMICS BASED ON VIRTIS-M OBSERVATIONS

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Introduction

Atmospheric oxygen $O_2(a^1\Delta_g)$ on Venus forms on the dayside in high altitudes and emits on the 1.27 um wavelength on the nightside, thus being an important indicator of the day-night circulation of the atmosphere.
This work studies the distribution of the O_2 nightside airglow using both nadir (southern hemisphere) and limb (northern hemisphere) measurements made by the M-channel of VIRTIS instrument on-board of Venus Express spacecraft.

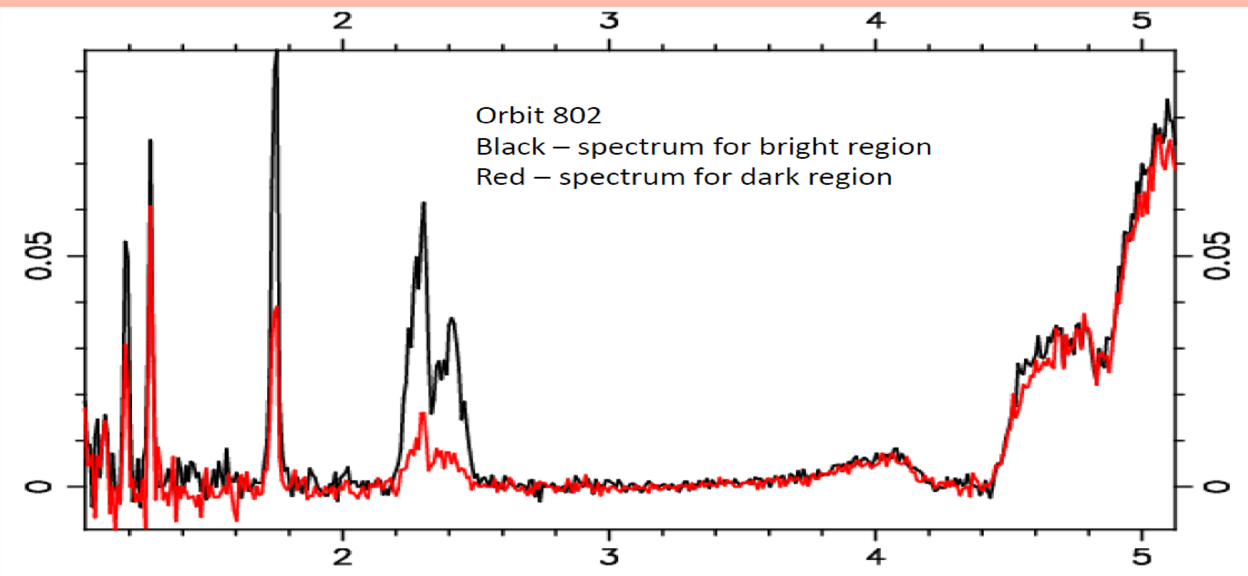

Fig. 1. Nightside infrared spectra of Venus

Data analysis approach

The O_2 1.27 µm peak and thermal emission are not resolved with the VIRTIS spectral resolution. Thus, to obtain the absolute intensity of the O_2 emission, it is necessary to exclude the thermal radiation of the low atmosphere and surface. To correct the measured intensity in 1.27 µm window for thermal emission we should find the ratio of the thermal emission intensities $k = (I_{1.27})/(I_{1.18})$, and multiply the intensity in the 1.18 µm window in observed spectrum by this ratio.

After obtaining the results regarding the modes of global circulation [4] which differ from one described in earlier papers [3], it was decided to make more accurate processing of the data in the sense of data correction for the thermal radiation. We used the fact that the surface temperature of Venus depends on the surface elevation and the temperature gradient in the lower atmosphere is close to adiabatic.

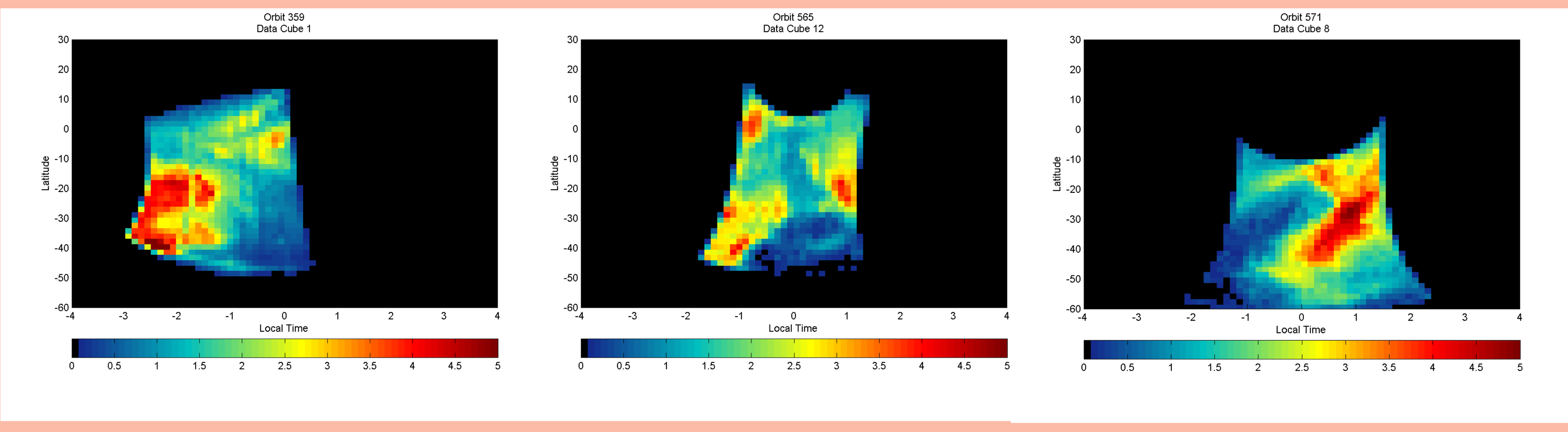

Fig.. 2. Examples of oxygen airglow as seen by VIRTIS in individual orbits.

718 nadir VIRTIS data cubes were averaged over local time (LT) and latitude (ϕ) grid with ΔLT =0.024h and $\Delta\phi$ = 0.36°. We have integrated from 1.13 to 1.22 µm and from 1.23 to 1.3 µm to obtain intensity in 1.18 and 1.27µm windows respectively. 149 limb data cubes were then added to create the average map.

Results: bright patches behaviour

Using the statistics we obtained, it was found that the maximum intensity spots, or "bright patches" occur slightly more frequently on the evening side than on the morning side. The "bright patches" (defined by intensity isolines) usually have a diagonally-stretched shape. This behaviour is consistent with the wind velocities measured at this altitudes, which as well have a diagonal front.

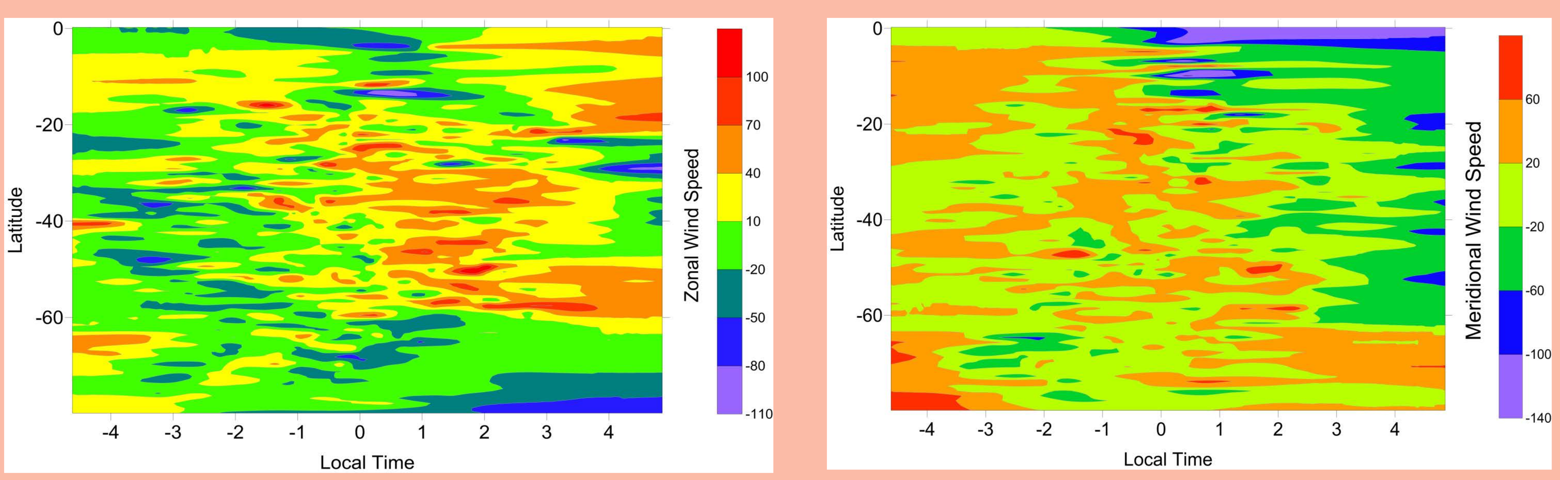

Fig. 3. Zonal (left) and meridional (right) components of the wind speed measured in 1.27 um using VIRTIS observations.

Results: average map

Although the coverage in local time for the individual measurements was not perfect, we obtained a statistically meaningful result in dependence on local time and latitude after averaging over 867 data cubes (Fig. 4).

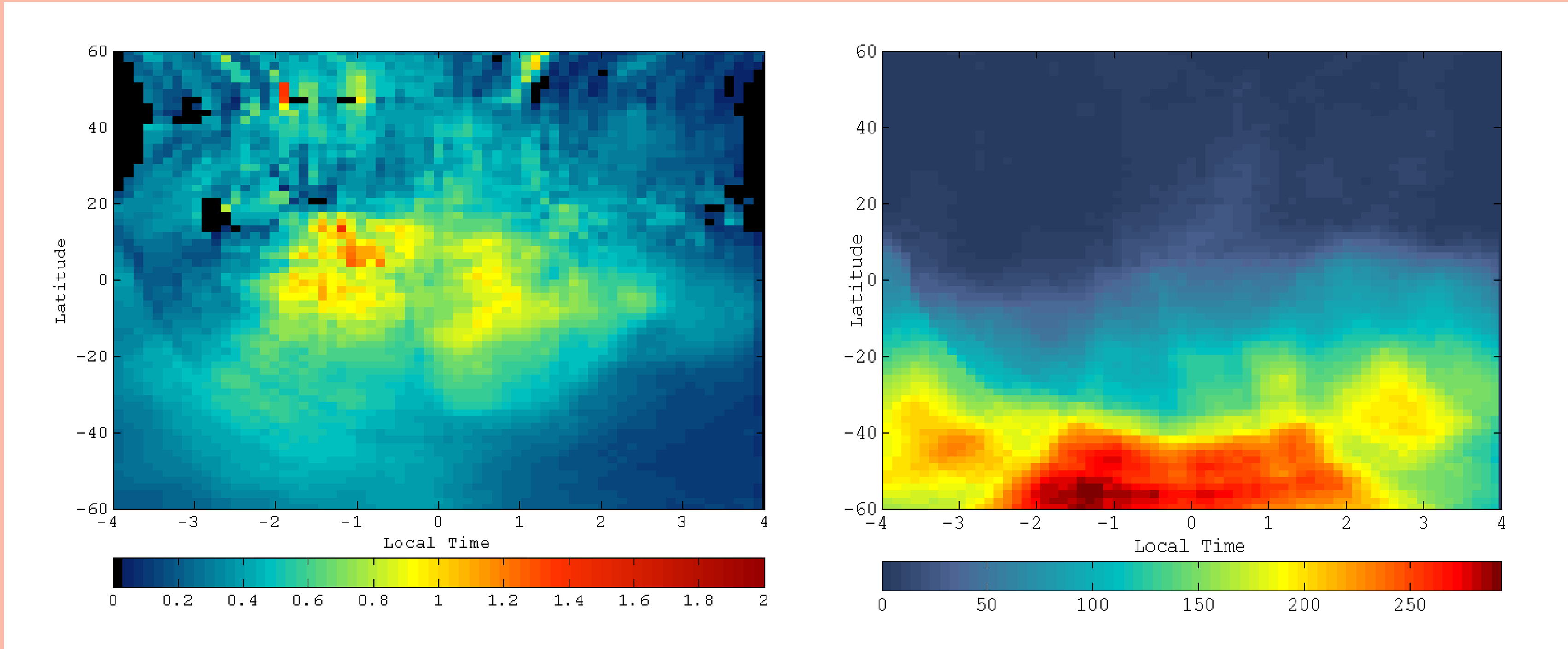

Fig. 4. Averaged over 718 data cubes map of the O2 night airglow intensity (left) and the data coverage (right)

We then analysed the day-to-day variation of the data as well as its correspondence to the wind velocities, which were tracked at the same wavelength channels.

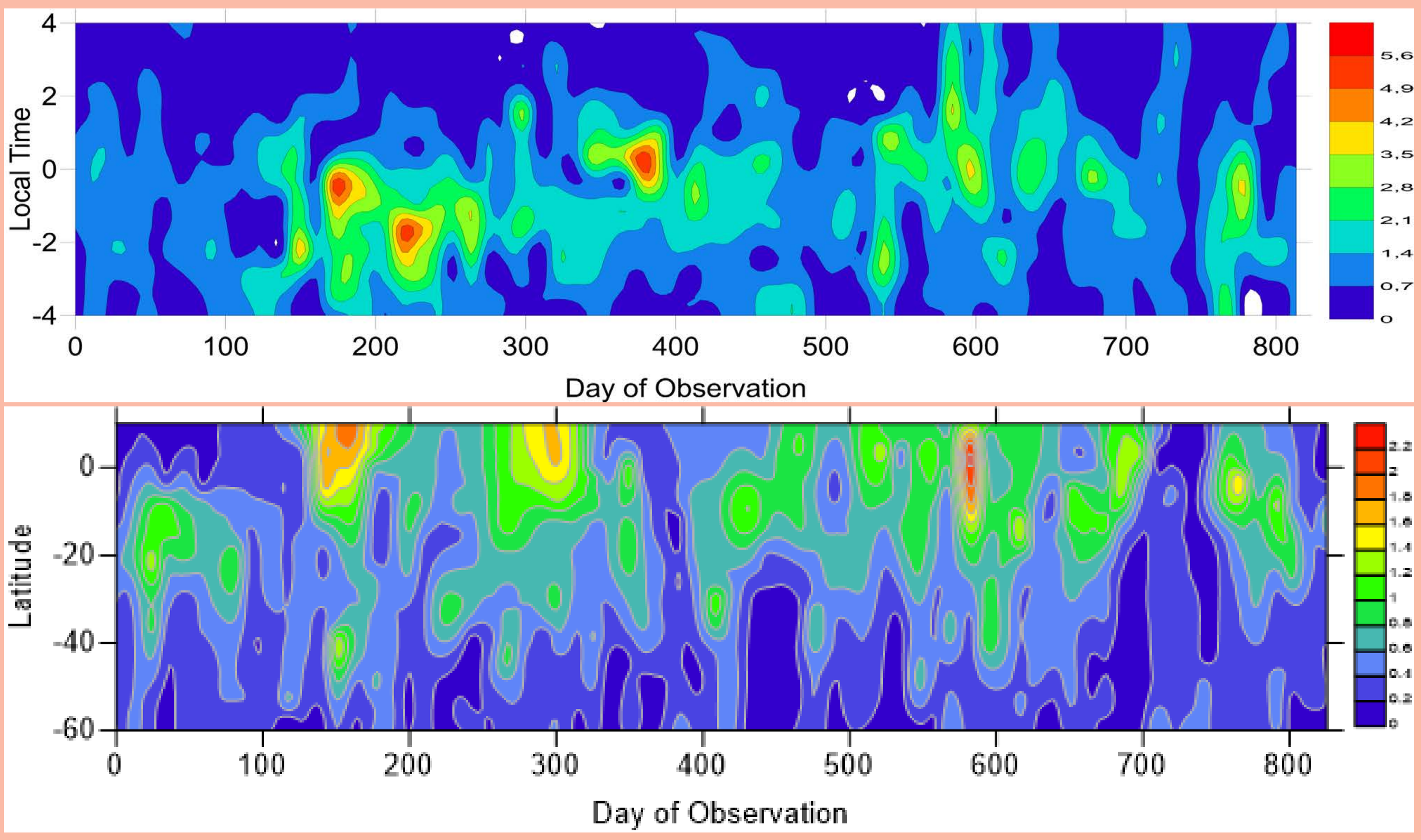

Fig. 5 Day-to-day variation of the airglow as a function of latitude (top) and local time (bottom).

Summary and Conclusions

Reprocessing of the VIRTIS-M data on the O2 1.27 µm airglow allowed obtaining more detailed map of the intensity distribution on the night side of Venus, compared to previous papers [1,3]. Analysis of the individual orbits shows a strong temporal variability of the O2 emission; maxima of emission were observed both before midnight and after. The global map of the O2 nightglow distribution, based on data from 867 data cubes, indicates a complex character of the circulation in this transition region. Appearance of the intensity maximum before midnight (from equator up to high latitudes) cannot be explained in terms of SS-AS circulation, or superposition of SS-AS and ZRS, which may explain the existence of maxima after midnight. This effect is not caused by data sampling as the data are distributed approximately uniformly according to the local time data distribution as shown in Fig. 4.

References

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