THE $O_2(a^1\Delta)$ VENUS NIGHTGLOW INTENSITY: INTERNAL VERSUS SOLAR ACTIVITY CONTROL

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Introduction:

The $O_2(a^1\Delta_g)$ Venus nightglow emission at 1.27 µm occurs in the atmospheric region governed by the subsolar to antisolar circulation. Several studies showed that the intensity of this emission is highly variable on a timescale of hours. Here, we study the possible correlation between the solar flux and the O_2 infrared emission using VIRTIS-VEx spectral images at 1.27 µm that has been predicted to exist by the VTGCM model calculations by Bougher and Borucki (1994).

VIRTIS data:

Using the entire VIRTIS-M-IR nadir database, Soret et al. (2014) generated seven statistical maps of the $O_2(a^1\Delta_g)$ emission, each containing 500 observations. The purpose was to analyze the location of the brightest spot of the emission and its variations over time. Here, we analyze the intensity of the emission over time. Several methods have been used by Soret et al., (2015) to do so (evolution of the emission maximum, evolution of the average intensity, …) Here we present the results of a new analysis using a masking technique to calculate the time evolution of the nightglow brightness. However, none of them follow the same trend over time.

Solar flux data:

We now focus on solar flux variations in the time of VIRTIS observations (between May 2006 and October 2008), which were collected during a deep solar minimum. We use the SOHO-CELIAS/SEM (Judge et al., 1998) EUV daily average full solar disk fluxes at 1 AU between 0.1 and 50 nm available from the Space Sciences Center of the University of Southern California. $EUV_{0.1–50}$ daily average fluxes decrease from 2.6 in May 2006 to 1.9 in October 2008 at the Earth. These values have been adapted to Venus by taking into account the distance from the Sun to the planet, but also the shift in date, considering the difference in solar longitude of the two planets. Values at Venus vary from 4.4 to 3.4, which corresponds to a decrease of 10.4% of the solar flux at Venus compared to a complete solar cycle (ranging from 13.5 to 3.9)

Comparison of VIRTIS and SEM datasets:

The linear correlation coefficient between the solar flux and the intensity peak is found to be 0.62, which expresses the global decreasing trend for both quantities. This coefficient is not higher because internal variations of the two studied variables do not occur simultaneously. More significantly, the correlation coefficient between the solar flux and the averaged intensities is found to be 0.35, meaning that no relation-ship exists between the $O_2(a^1\Delta_g)$ brightness and the solar activity.

Conclusions:

Contrary to the VTGCM calculations, we do not observe here a correlation between the $O_2(a^1\Delta_g)$ brightness and the solar flux. However, VIRTIS data were acquired during a deep solar minimum and, more importantly, during a relatively stable phase of the solar activity. A high level of variability of the $O_2(a^1\Delta_g)$ emission has been detected in the same dataset from day to day though (Hueso et al., 2008; Soret et al., 2014). It thus appears that the variability is more controlled by internal than external conditions: transport appears to play a major role in the nightglow emissions than the solar activity eventually does. This conclusion is at least valid for solar minimum conditions. A space mission with global imaging capabilities over an entire solar cycle would definitely allow determining the relative role played by solar activity and internal factors.

References:

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