The $O_2(a^1\Delta_g)$ Venus nightglow intensity: internal versus solar activity control

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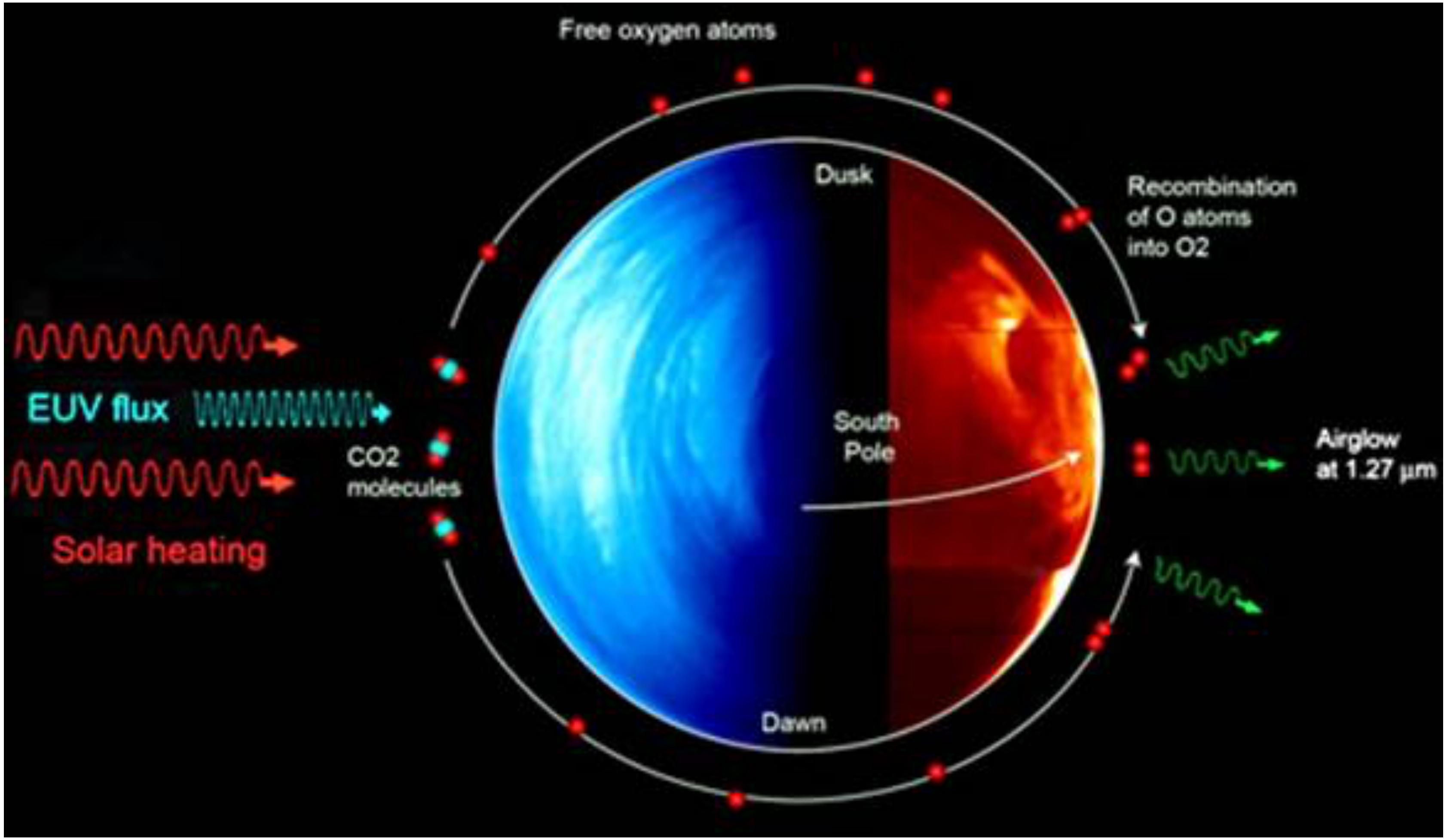
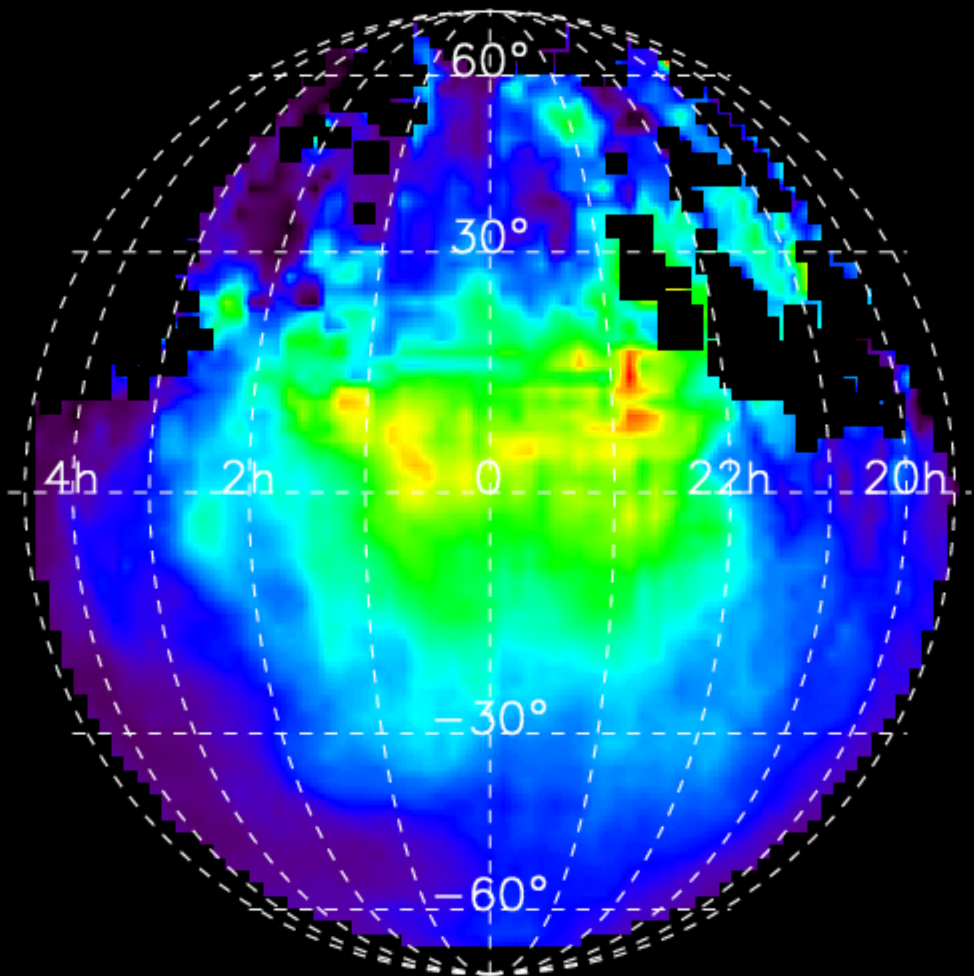
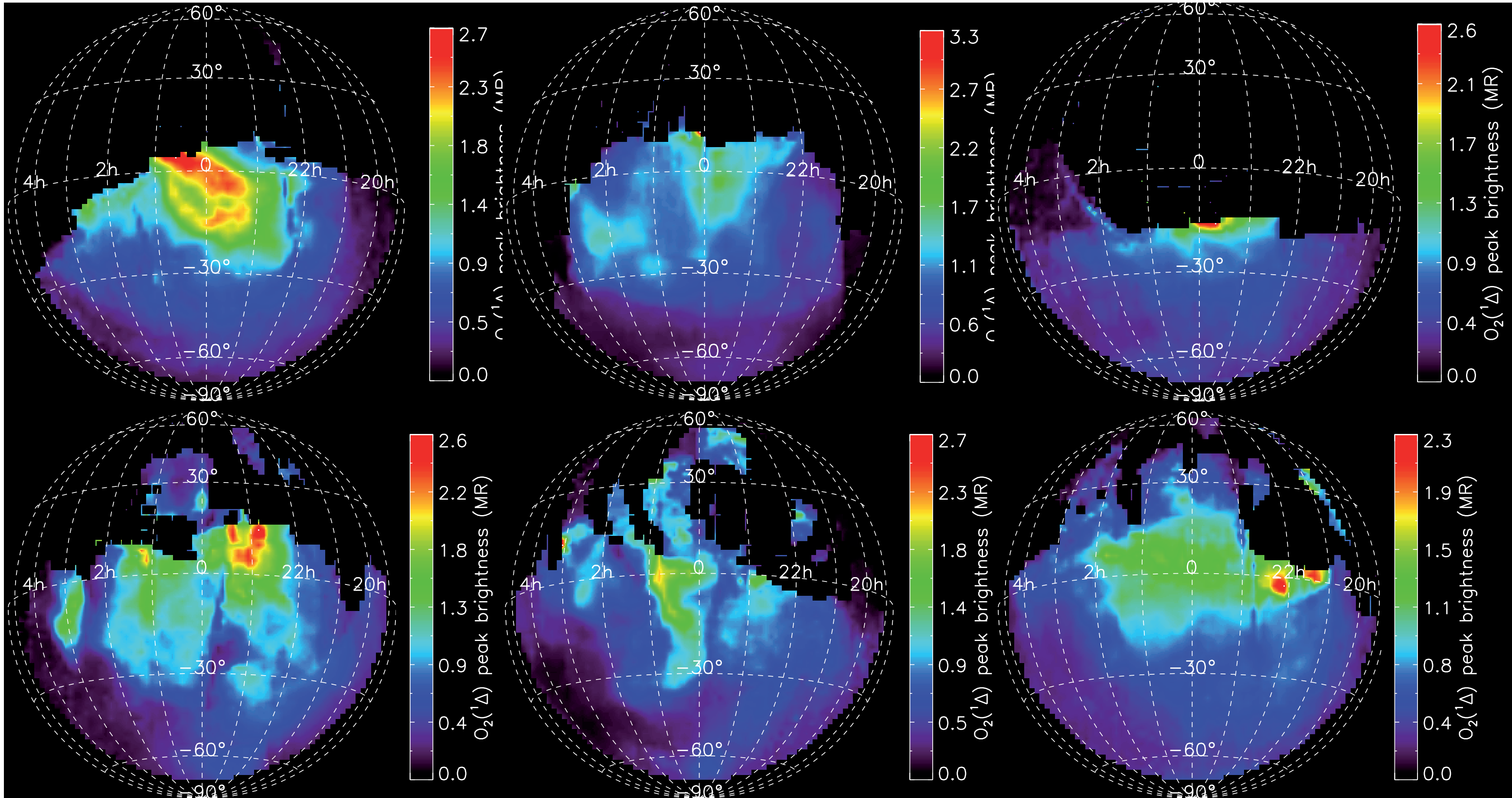


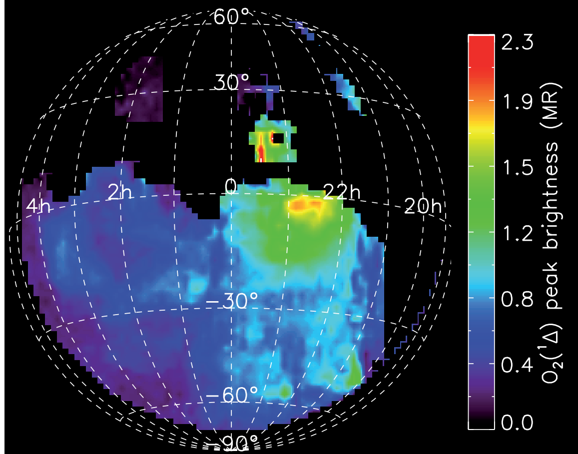
The transition region between 90 and 120 km is governed
by the subsolar to antisolar circulation.

Global map of O_2 airglow intensity at 1.27 μm (VIRTIS)



Soret et al., 2012

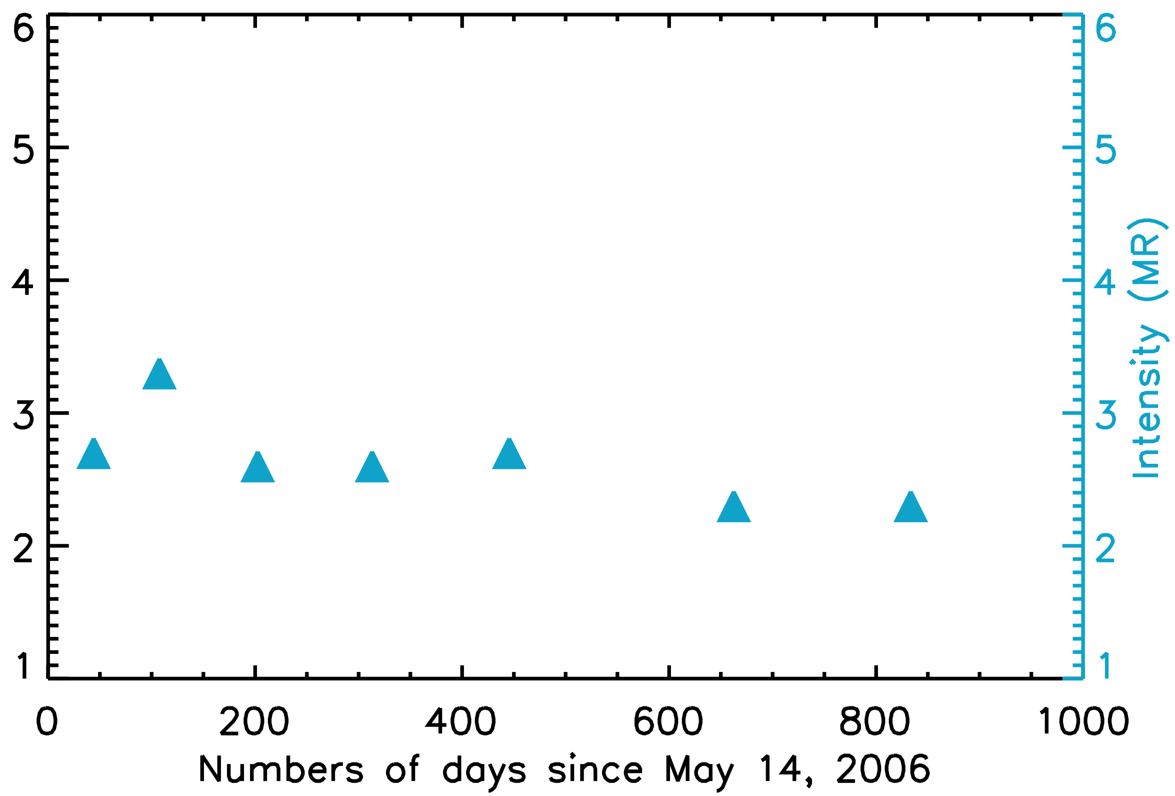




Soret et al., 2014

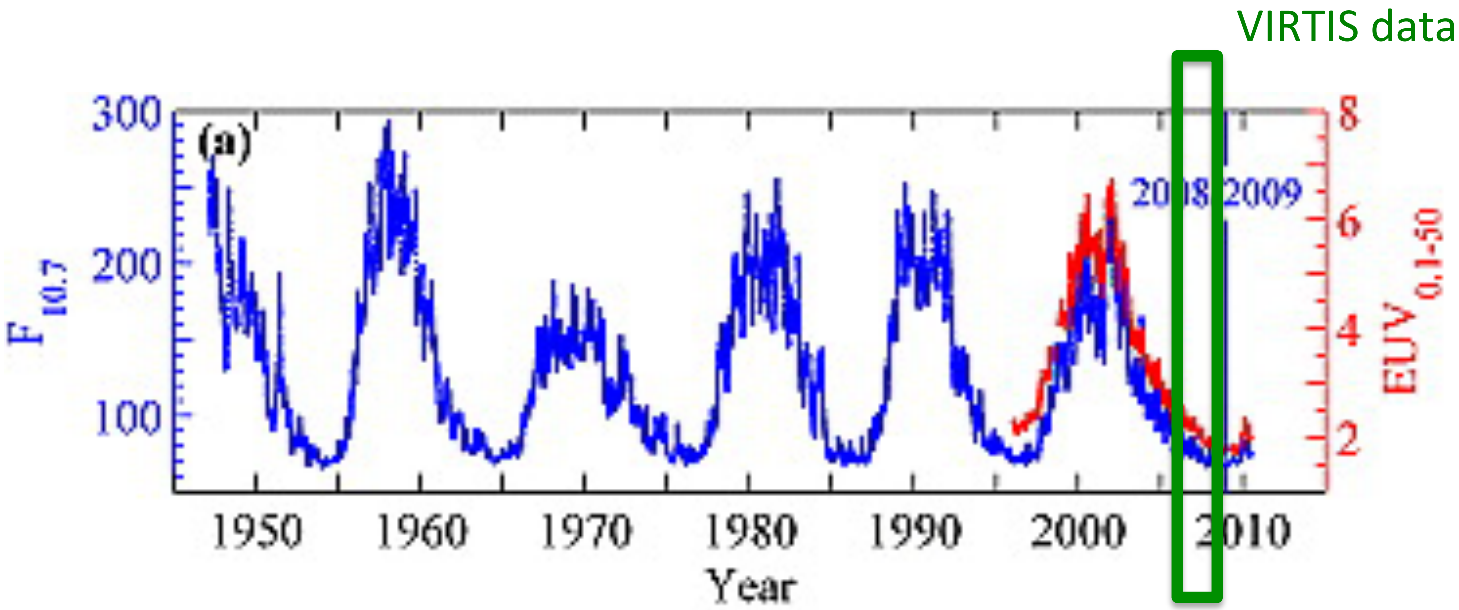
Each map includes VIRTIS nightside data from 500 orbits.

Maximum intensity



Is this apparent variability of the nightglow related to solar activity?

Solar activity

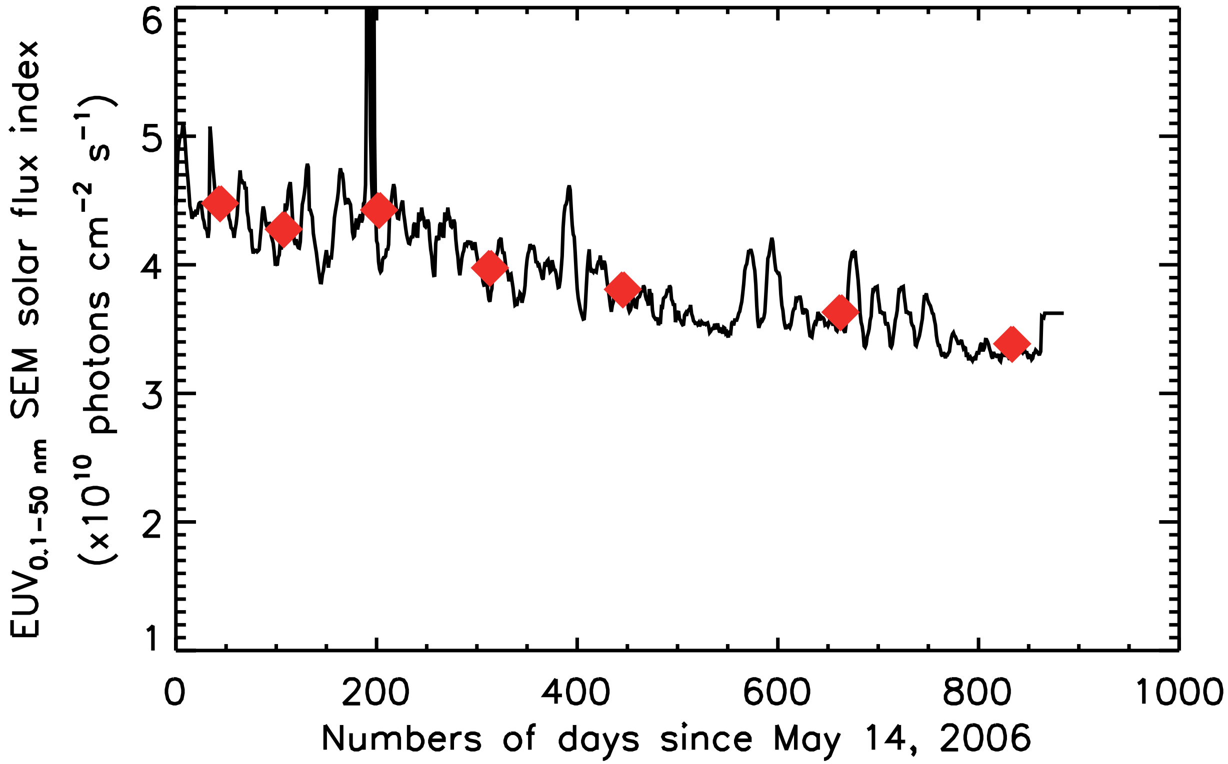


VIRTIS data have been acquired during
a deep solar minimum (2006-2008).

Chen et al., 2011

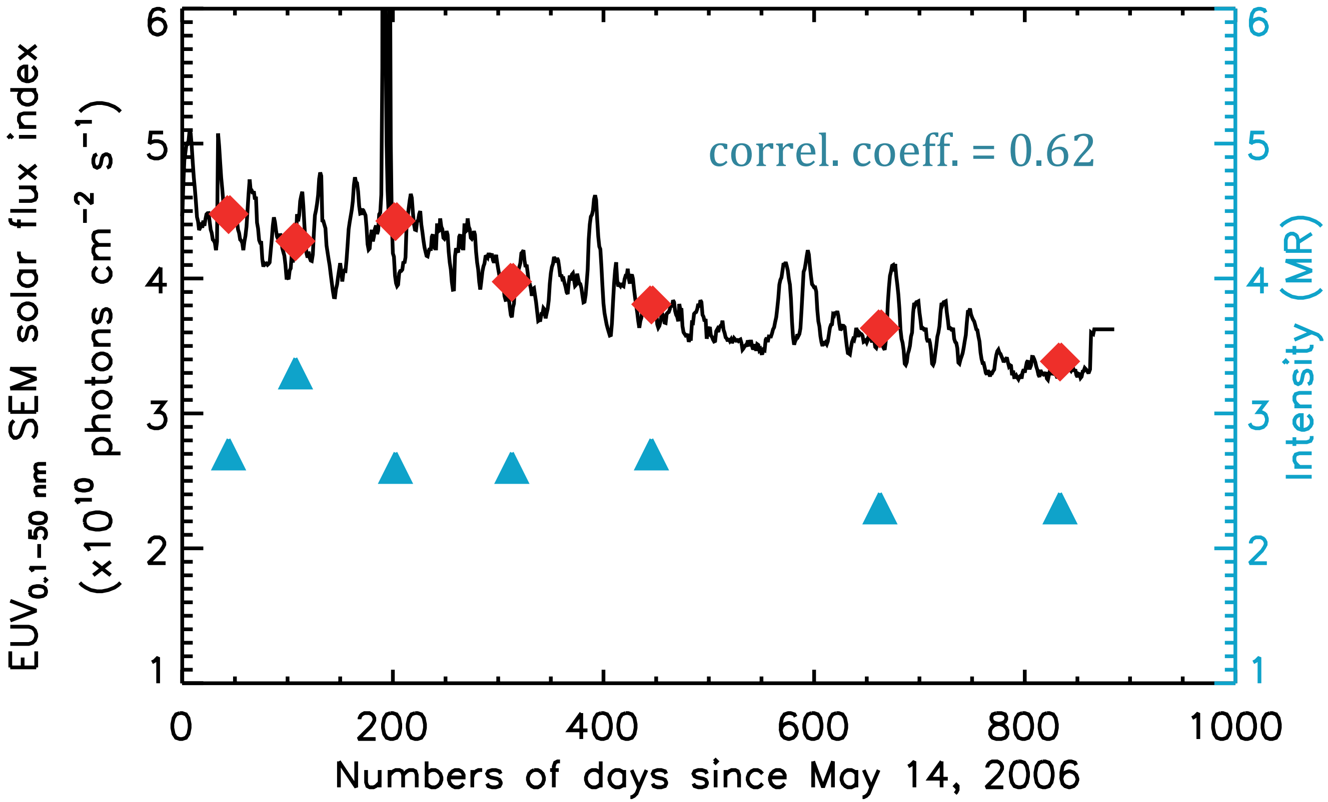
Solar activity

We use the SEM daily solar activity index (0.1-50 nm)
Variation of 10.4% compared to a complete solar cycle
And average the SEM values over time integration interval of the 7 nightglow maps previously shown



Soret and Gérard, 2015

Solar activity vs maximum intensity



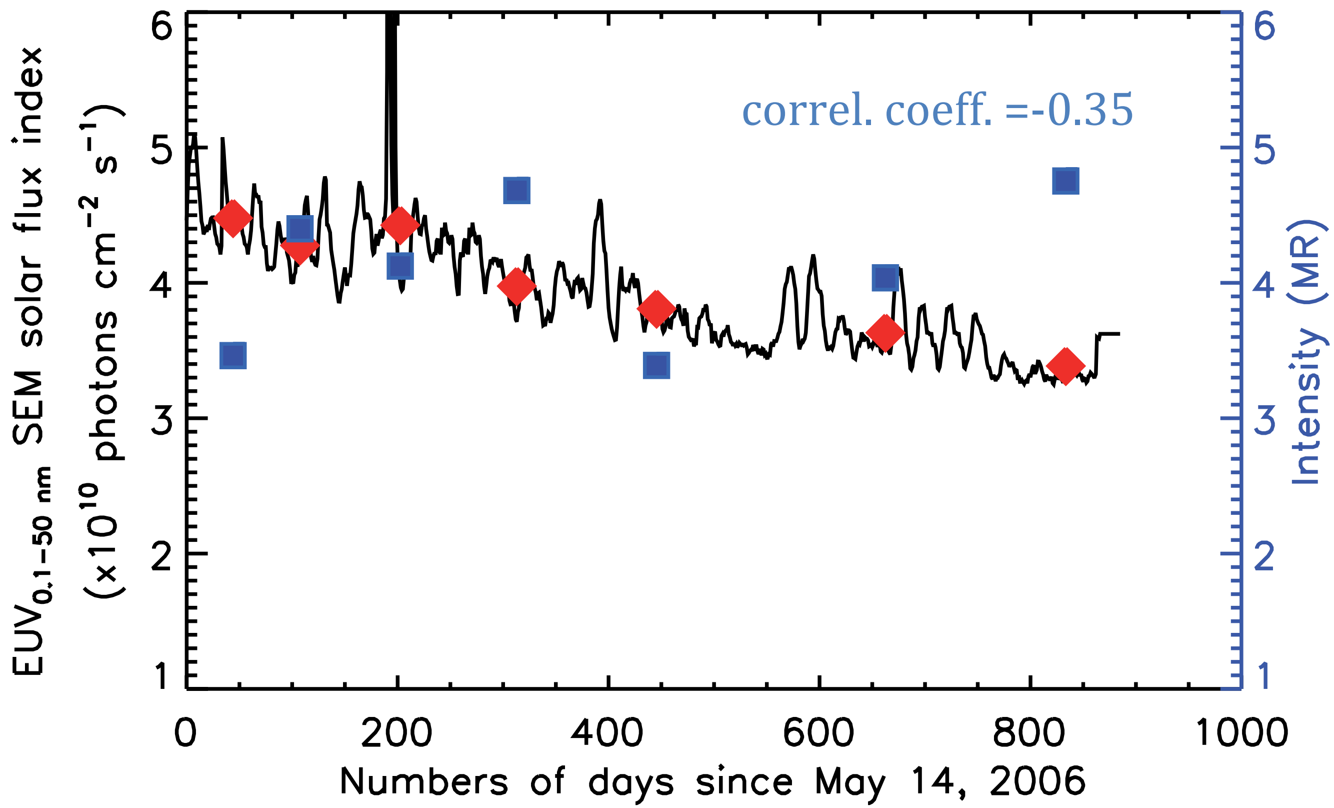
SEM daily solar activity index (0.1-50 nm)

Average of SEM values over map time integration interval

Maximum intensity over map time integration interval

Soret and Gérard, 2015

Solar activity vs average intensity



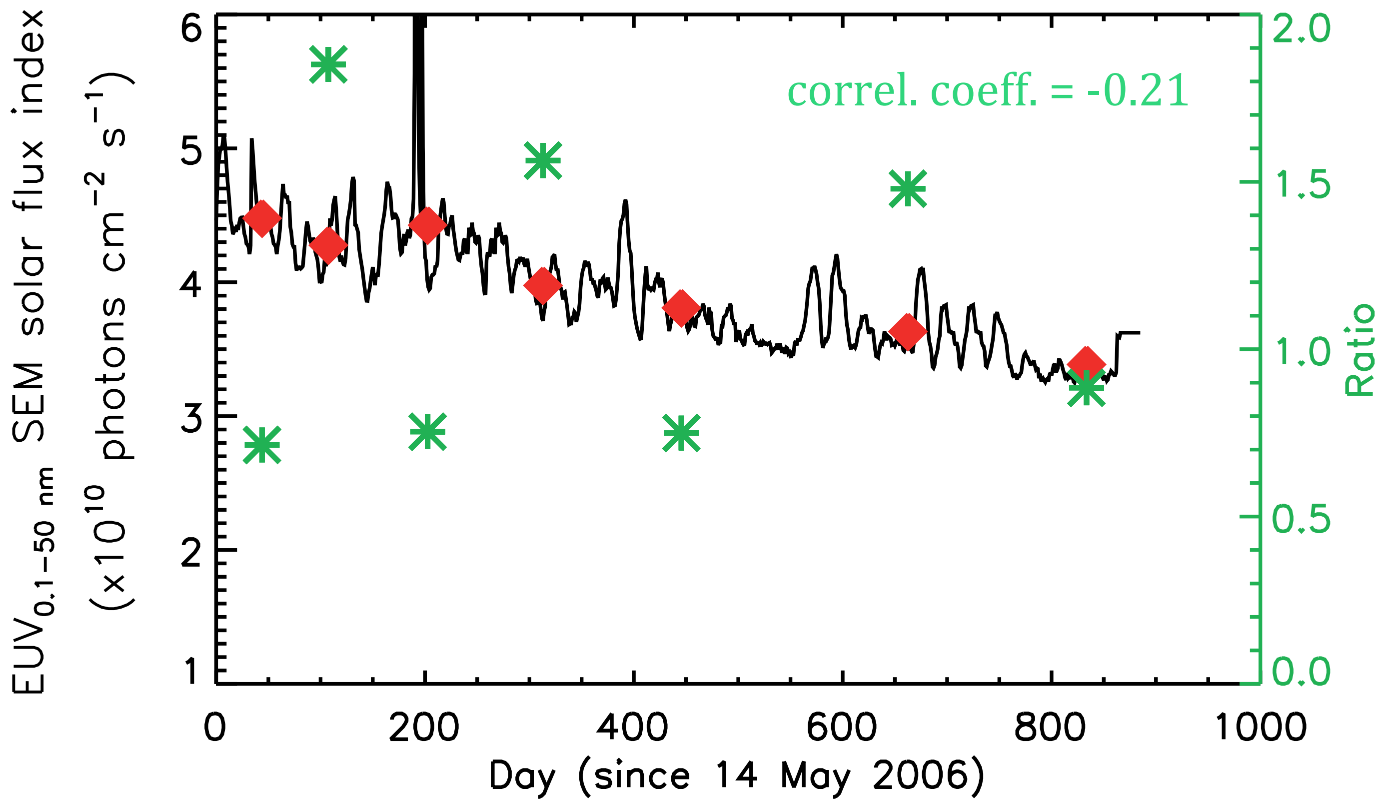
Soret and Gérard, 2015

SEM daily solar activity index (0.1-50 nm)

SEM index averaged over each map time integration interval

Mean intensity of a common zone where each 1°x1° pixel has been observed at least 10 times in each map and averaged over each map integration interval

Solar activity vs nightglow evolution



SEM daily solar activity index (0.1-50 nm)

SEM index averaged over each map time integration interval

Ratio individual map mean intensity/global map mean intensity of a common zone

No correlation has been observed

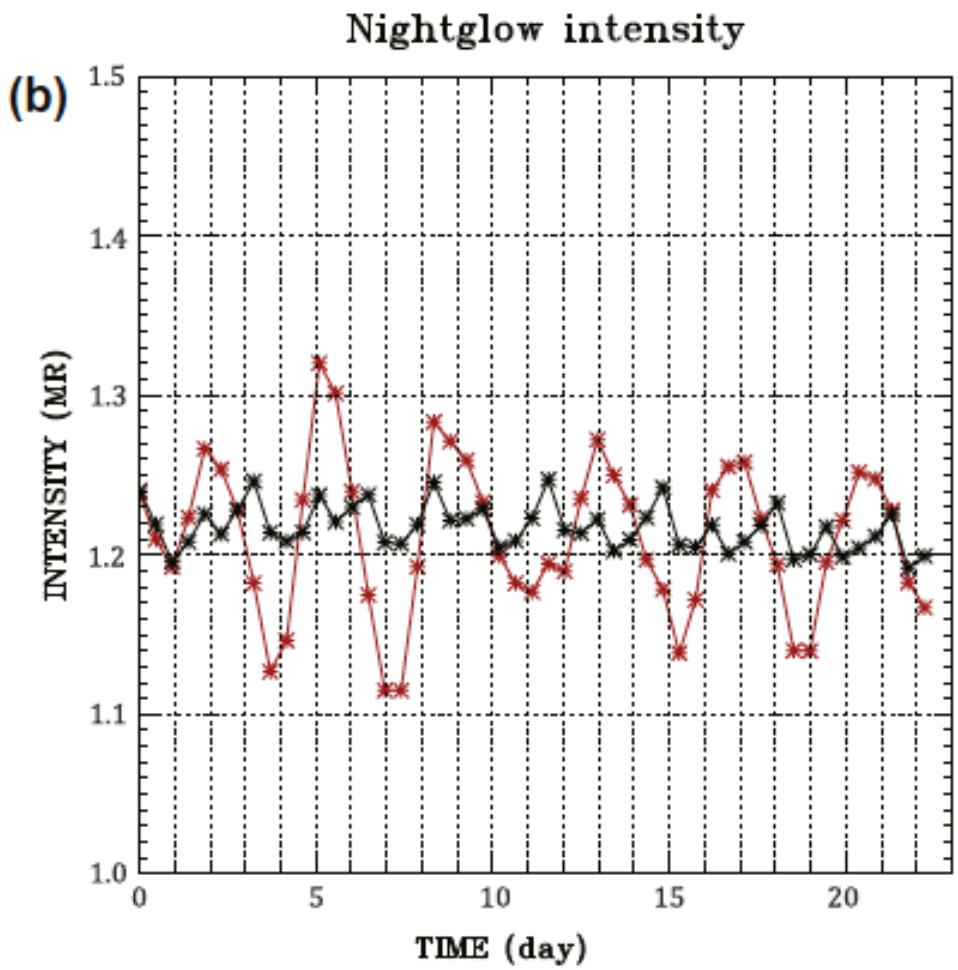
VIRTIS data were acquired during a deep solar minimum and a relatively stable phase of the solar activity.

No correlation between the $O_2(a^1\Delta_g)$ brightness and the solar flux has been observed, contrary to VTGCM calculations (Bougher and Borucki, 1994).

However, 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).

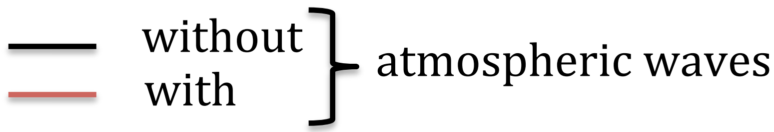
Several models intended to reproduce this day-to-day variability, without considering solar activity.

Kelvin waves (Hoshino et al., 2012)



Kelvin waves induce variations with an amplitude of ~0.2 MR, with a 4-day periodicity.

In VIRTIS data, day-to-day variations can reach several MR.



Day-to-day variability

2007/04/26-27

From 20:12
to 01:35

From 1.7
to 4.5 MR

2.8 MR
variation
in ~5 hours

Gravity wave-drag (Zalucha et al., 2013)

- They include breaking of gravity waves to the VTGCM to slow down the global circulation (instead of Rayleigh friction).

- They did not find a combination of wave parameters to produce sufficient drag in the jet cores that would bring VTGCM densities and nightglow emissions into agreement with Venus Express observations.

- Gravity waves launched below 100 km either break in the strong shear zones below 115 km or are reflected and do not propagate into the jet core regions where drag is needed.

Conclusion

According to the data, 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.

At this point, neither solar activity nor internal sources have been able to model the time variations observed in the NO and O_2 nightglows.

Variability remains misunderstood.

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.