Multispectral analysis of the Martian dayglow from UVIS-NOMAD on board TGO

J.-C. Gérard[1], S. Aoki[1,2], L. Soret[1], L. Gkouvelis[1,3] , Y. Willame[2], I. Thomas[2], C. Depiesse[2], B. Ristic[2], A.C. Vandaele[2], F. Daerden[2], M. Patel[4], J. Lopez-Moreno[5], G. Bellucci[6], J. Mason[4]

[1]LPAP, Université de Liège, Liège, Belgium
[2]Royal Institute for Space Aeronomy, Brussels, Belgium
[3]NASA-AMES, Mountain View, USA
[4]Open University, Milton Keynes, UK
[5]Instituto di Astrofisica de Andalucia,/CSIC, Granada, Spain
[6]Istituto di Astrofisica e Planetologia Spaziali, INAF, Rome, Italy

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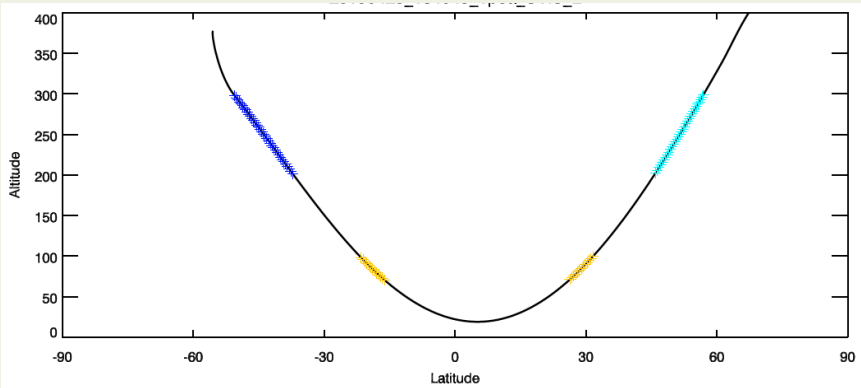
TGO-UVIS limb observations

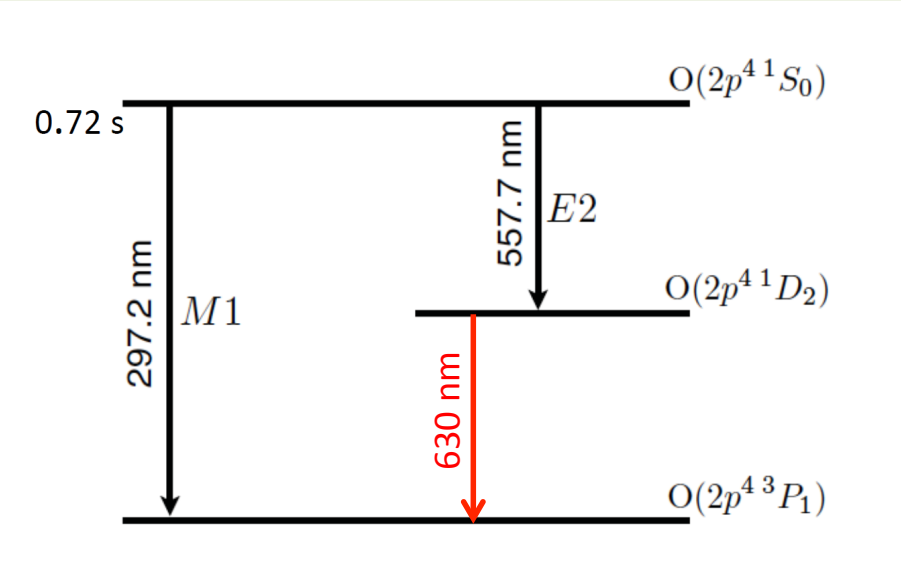
Since April 2019, the UVIS spectrometer on board EXOMARS-TGO has been observing the Martian dayglow between 200 and 650 nm with a spectral resolution of about 1.5 nm. The 'nadir' channel has been used to increase the sensitivity.

Two special pointing modes have been used:

- **Inertial limb** pointing: the line of sight keeps a fixed direction in the inertial space. The spacecraft motion along its orbit generates an ingress and an outgress limb profiles



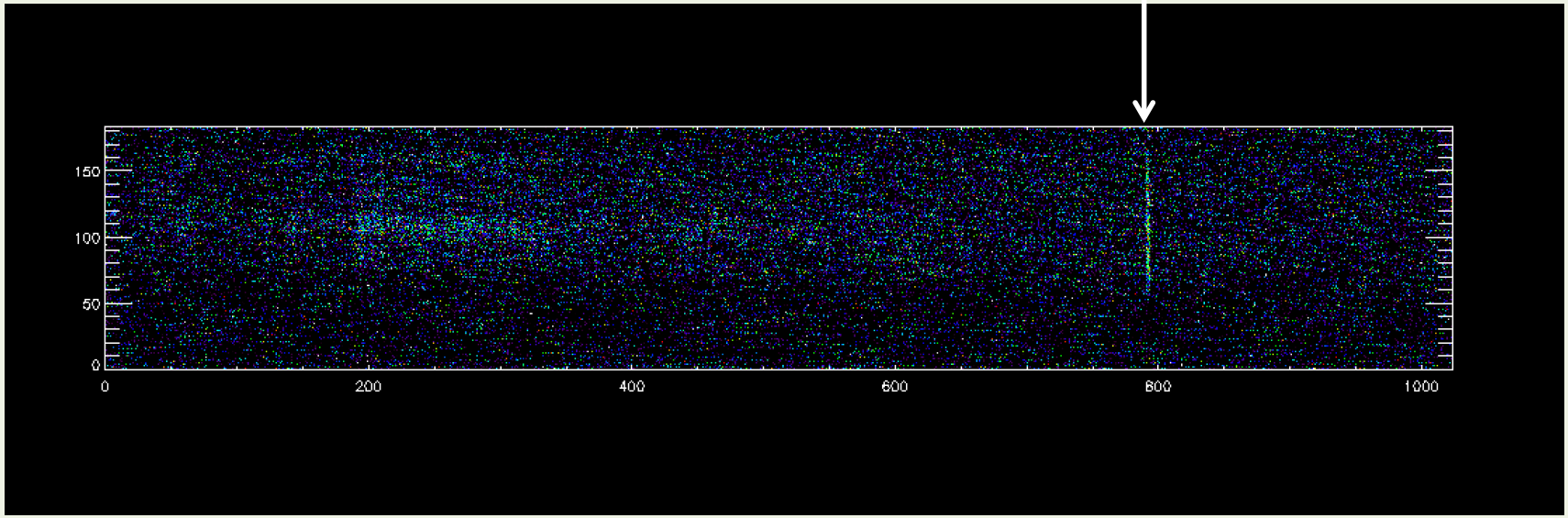
- **Limb tracking** pointing: the line of sight remains at a quasi-fixed altitude above the surface

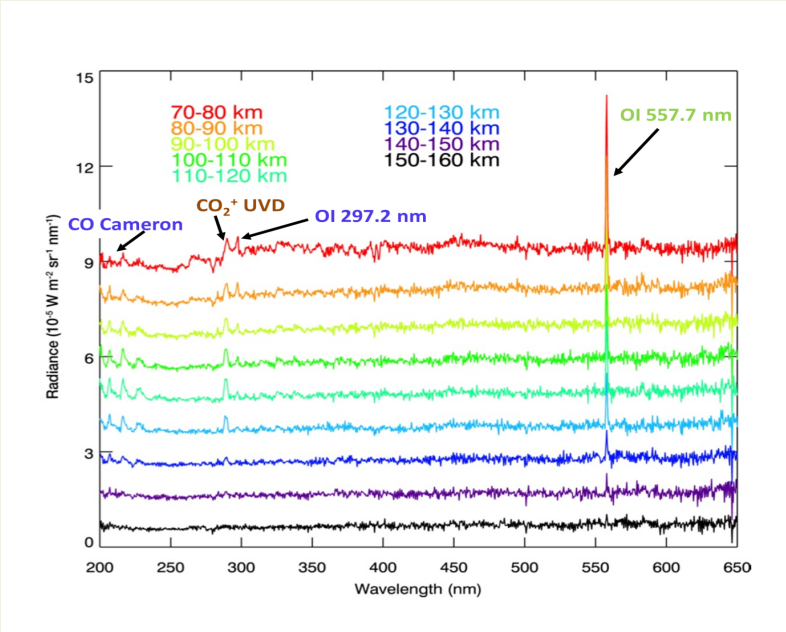


The O (^{1}S—^{1}D) transition generates the green line at 557.7 nm which is conspicuous in the dayglow visible spectrum (see detector image below)

The (^{1}D—^{3}P) transition at 630 nm is expected to be also present, but much weaker, as the ^{1}D state has a much longer radiative lifetime and is efficiently deactivated by CO_2 (slide 5)

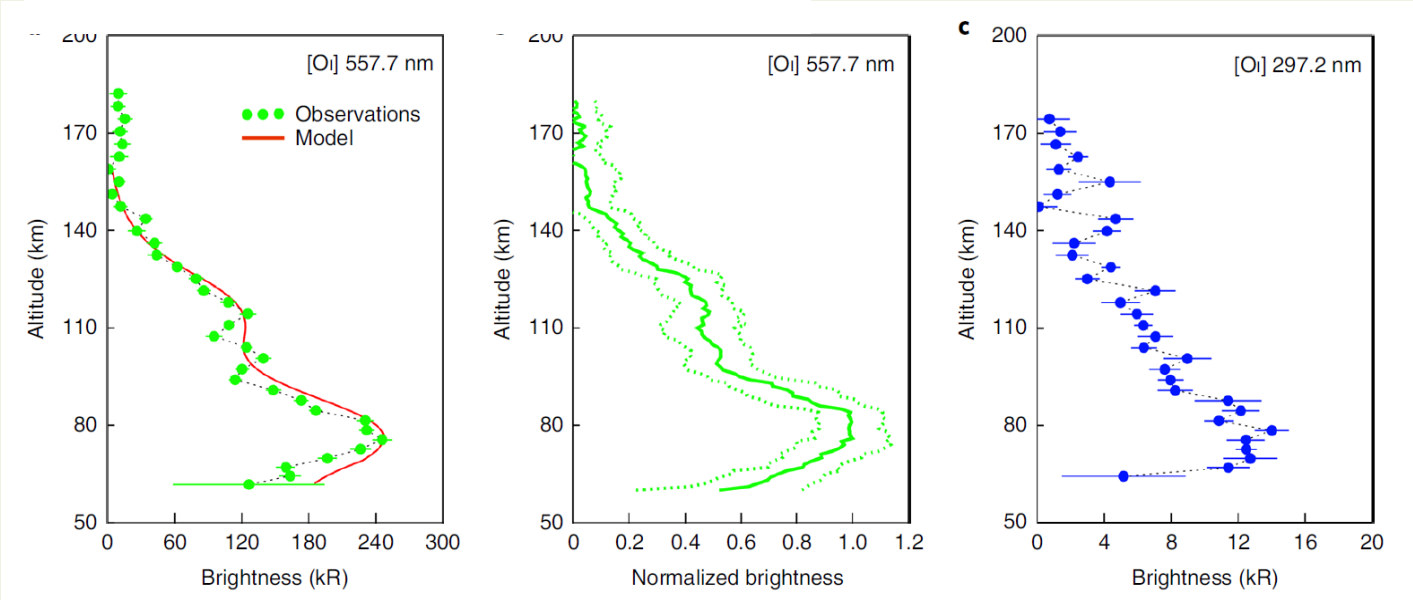
OI 557.7 nm





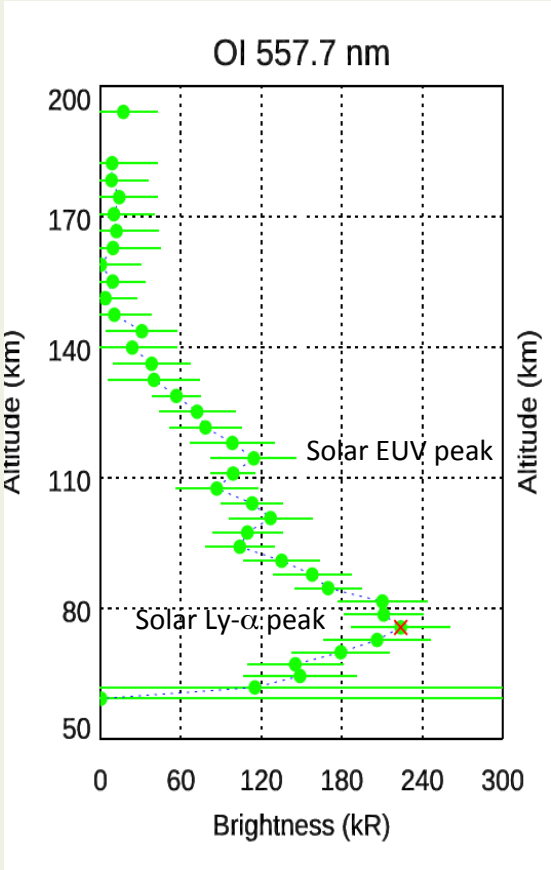
The green line dayglow is observed between 70 and 150 km together with UV emission for OI, CO and CO_2^+

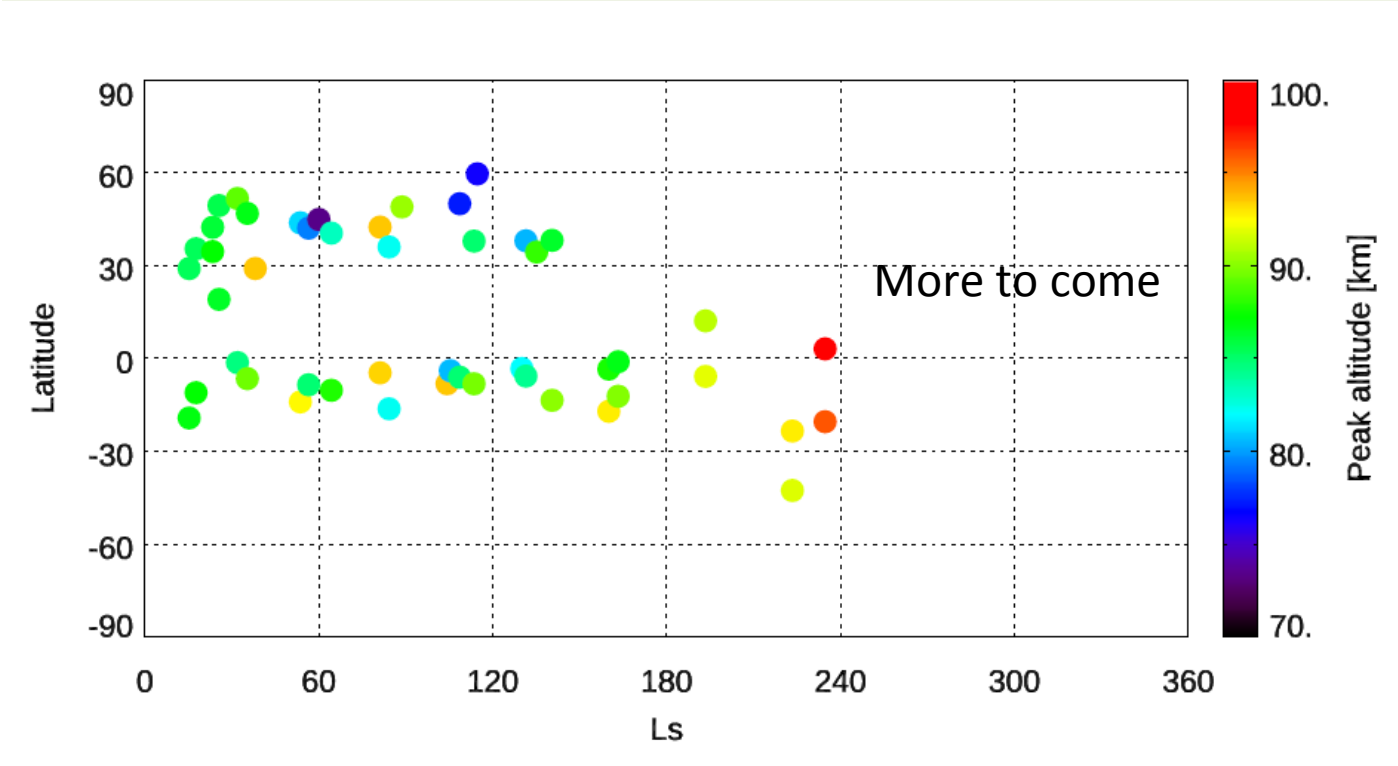
Green line limb profiles have been collected since April 2019 2-4 times/month



Gérard et al., Nature Astronomy, 2020

[OI] green line seasonal evolution (inertial limb mode)



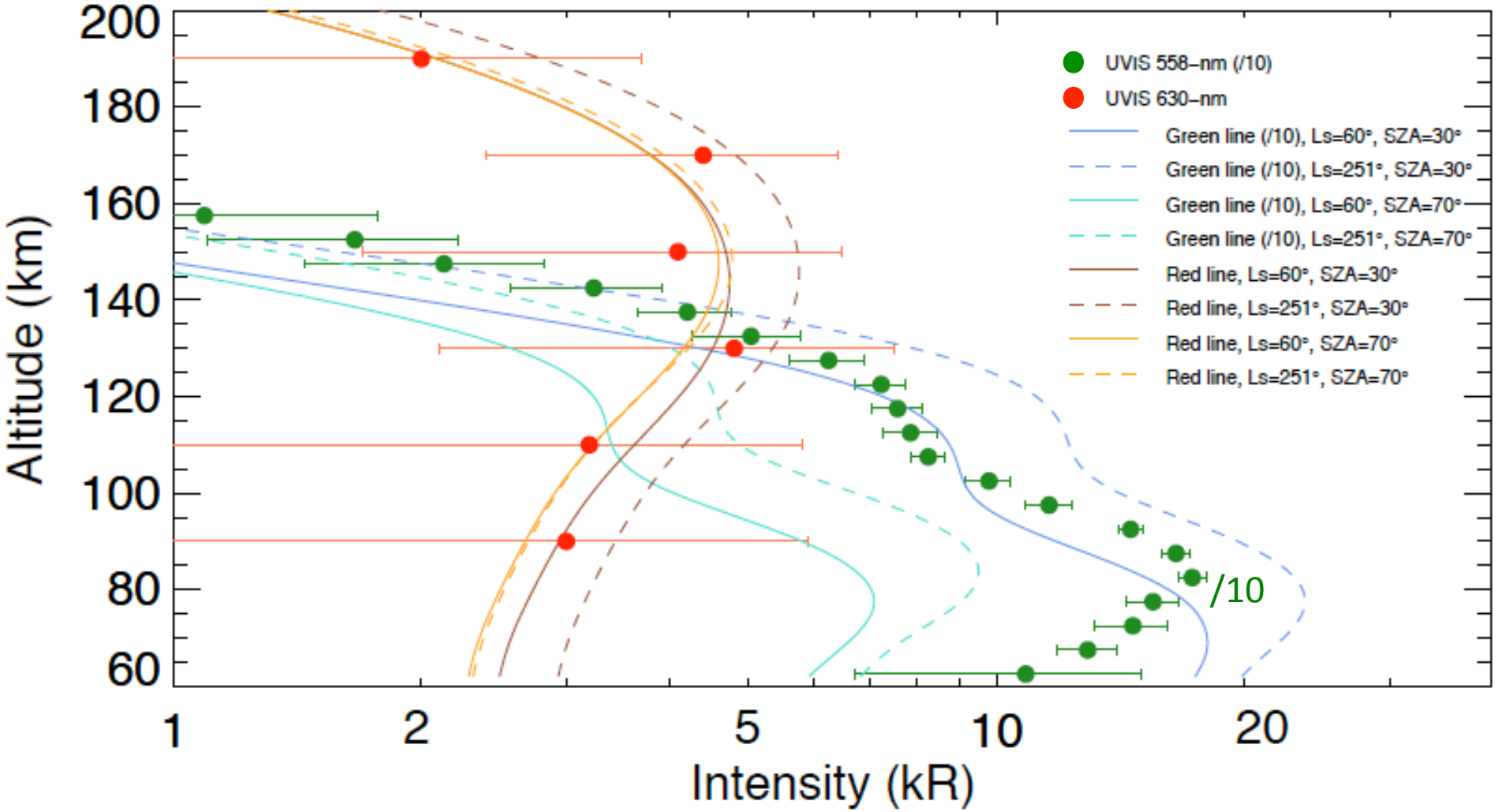


Aoki et al., in preparation

What can we learn?

- Expansion of the atmosphere (increased solar heating near perihelion, dust storms)
- Latitudinal trends
- Scale height and temperature

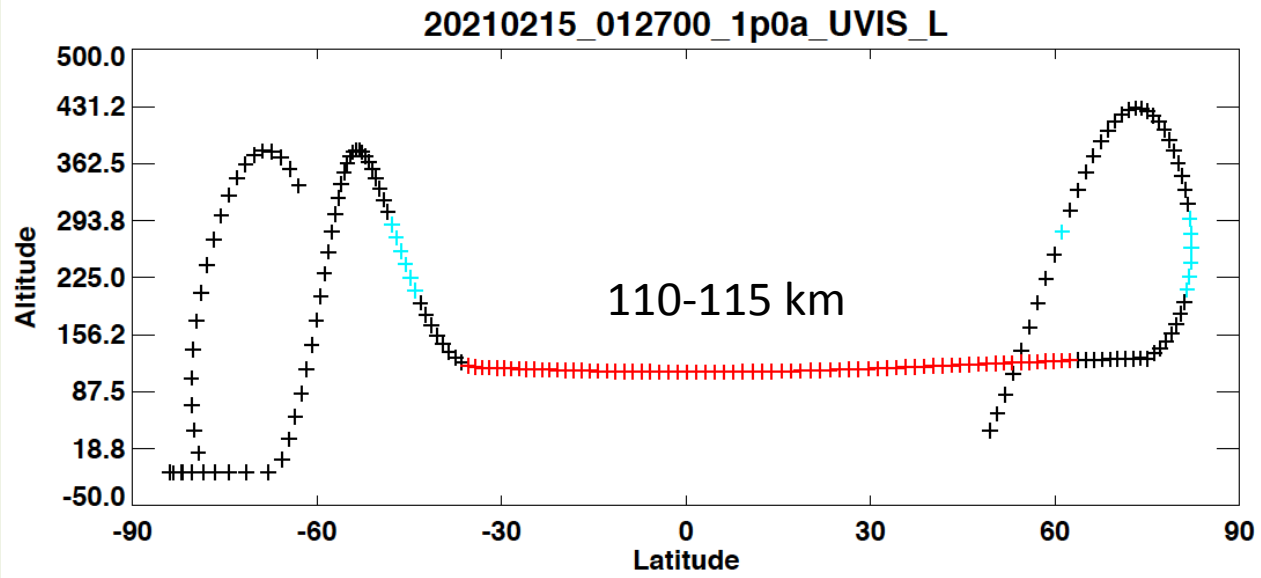
[OI] Red line: observations and model

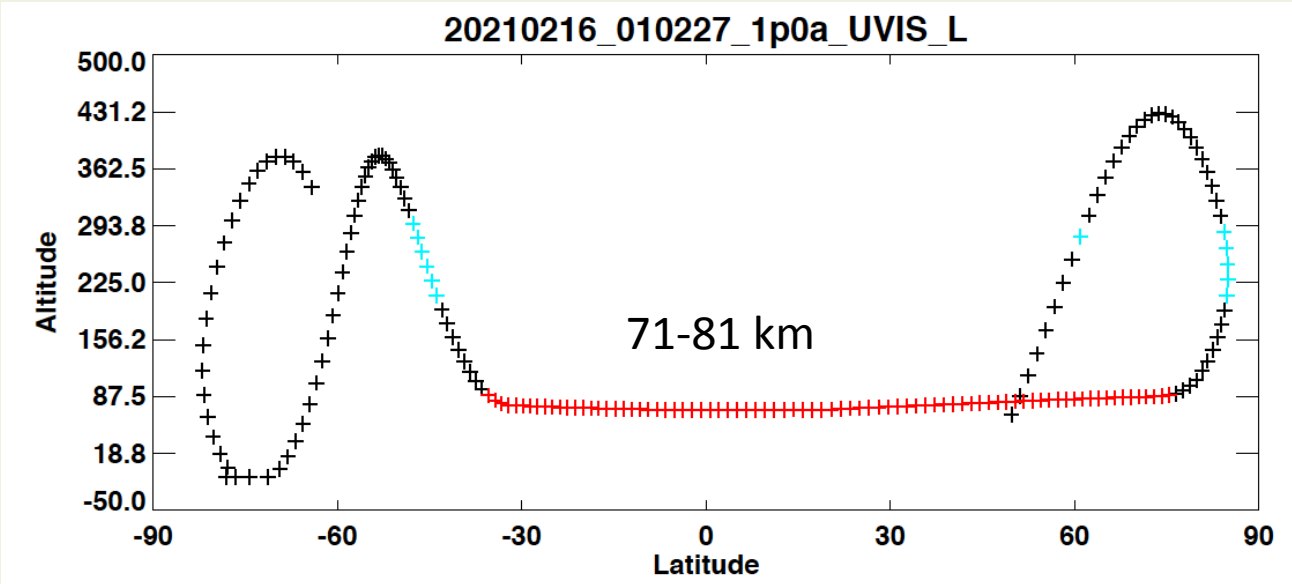


777 spectra have been co-added to get a OI 630-nm limb profile (red dots).
The mean profile is compared with model simulations for 2 SZAs near perihelion and aphelion

Gérard et al., GRL, 2021

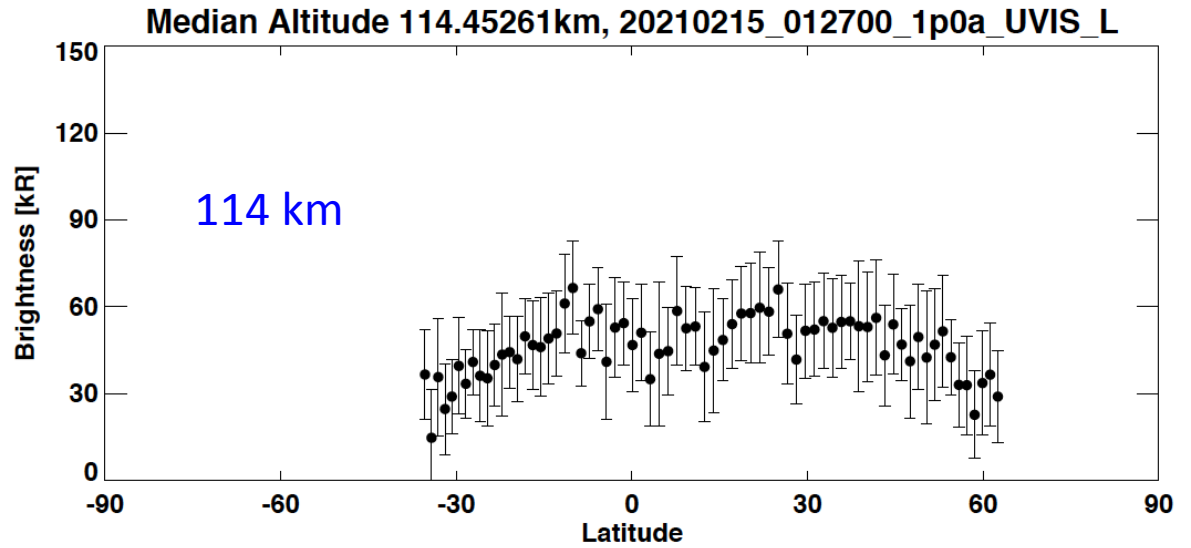
Limb tracking mode: altitude of the tangent point remains quasi-constant

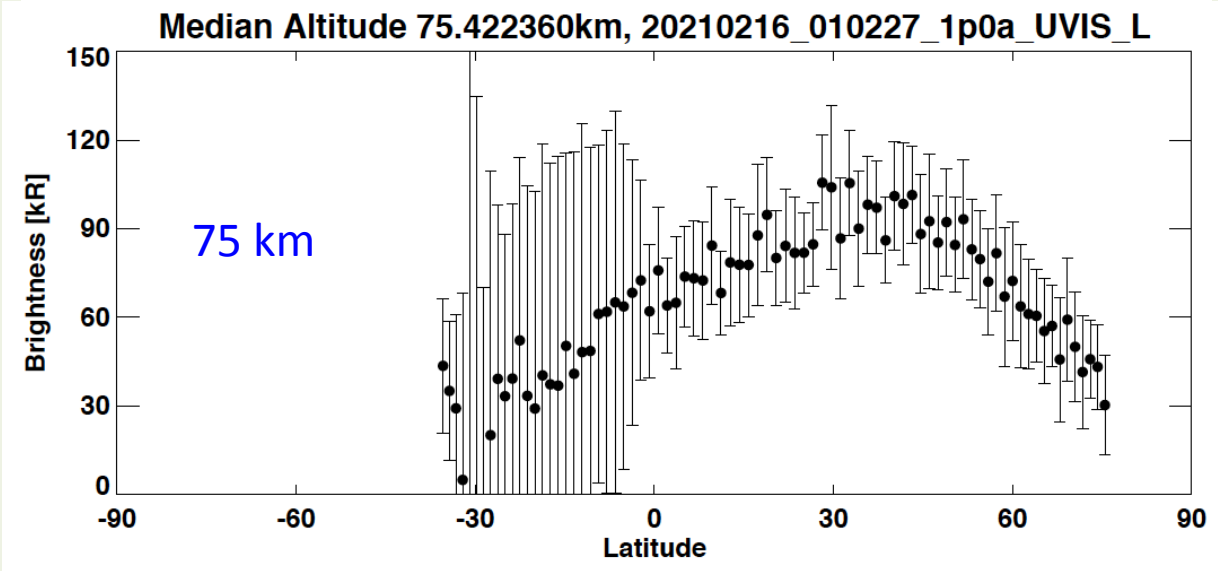


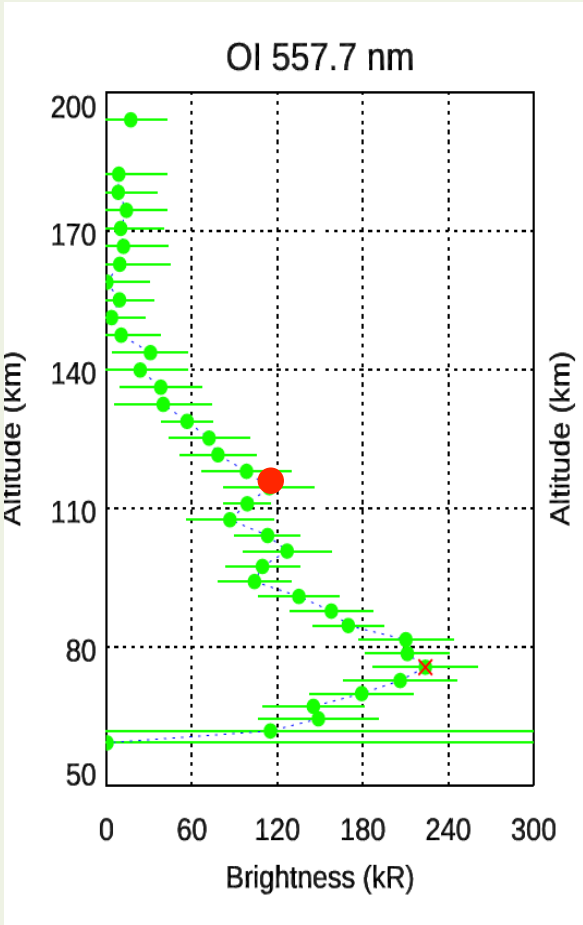


dayside

OI green dayglow latitudinal distribution

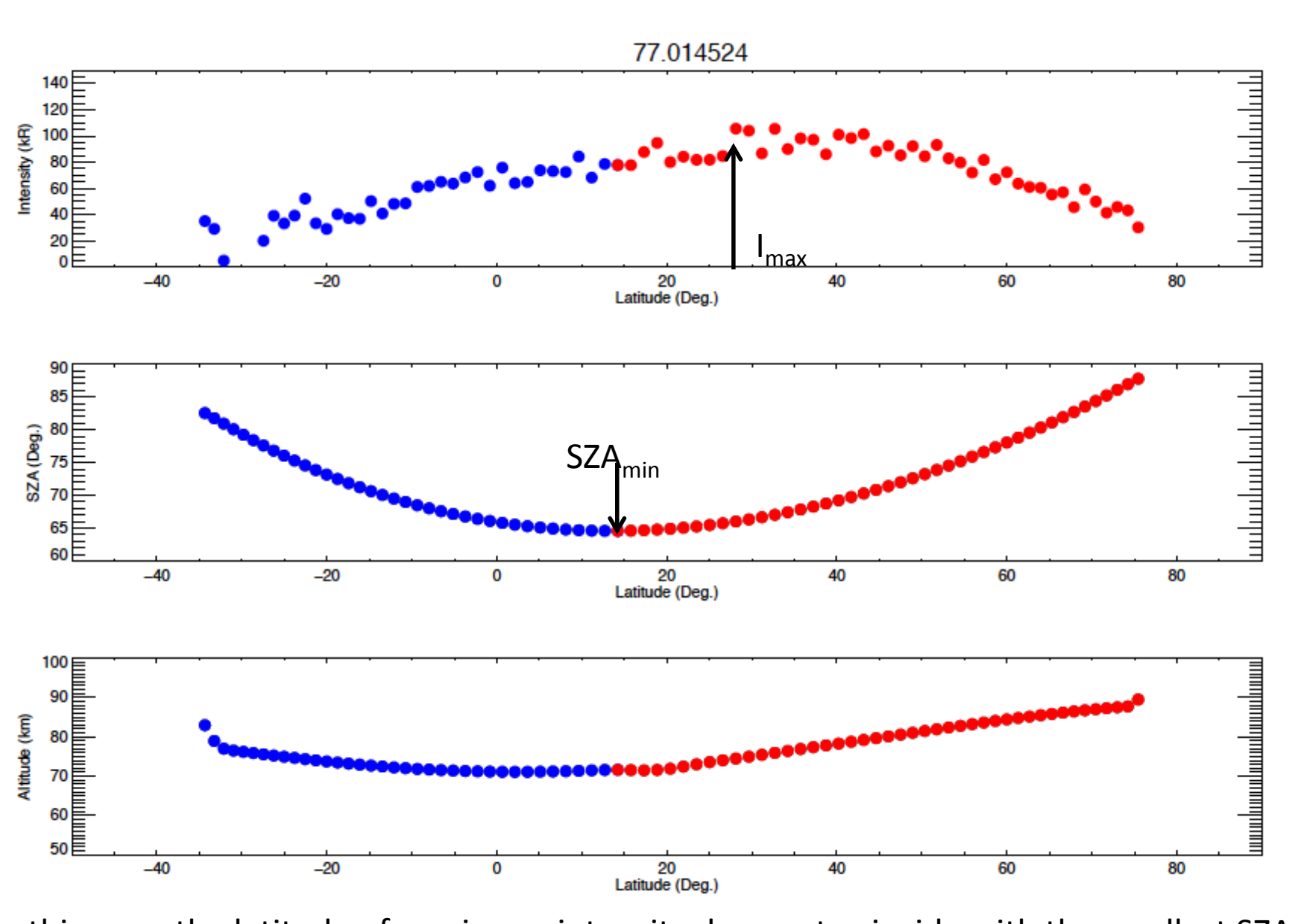






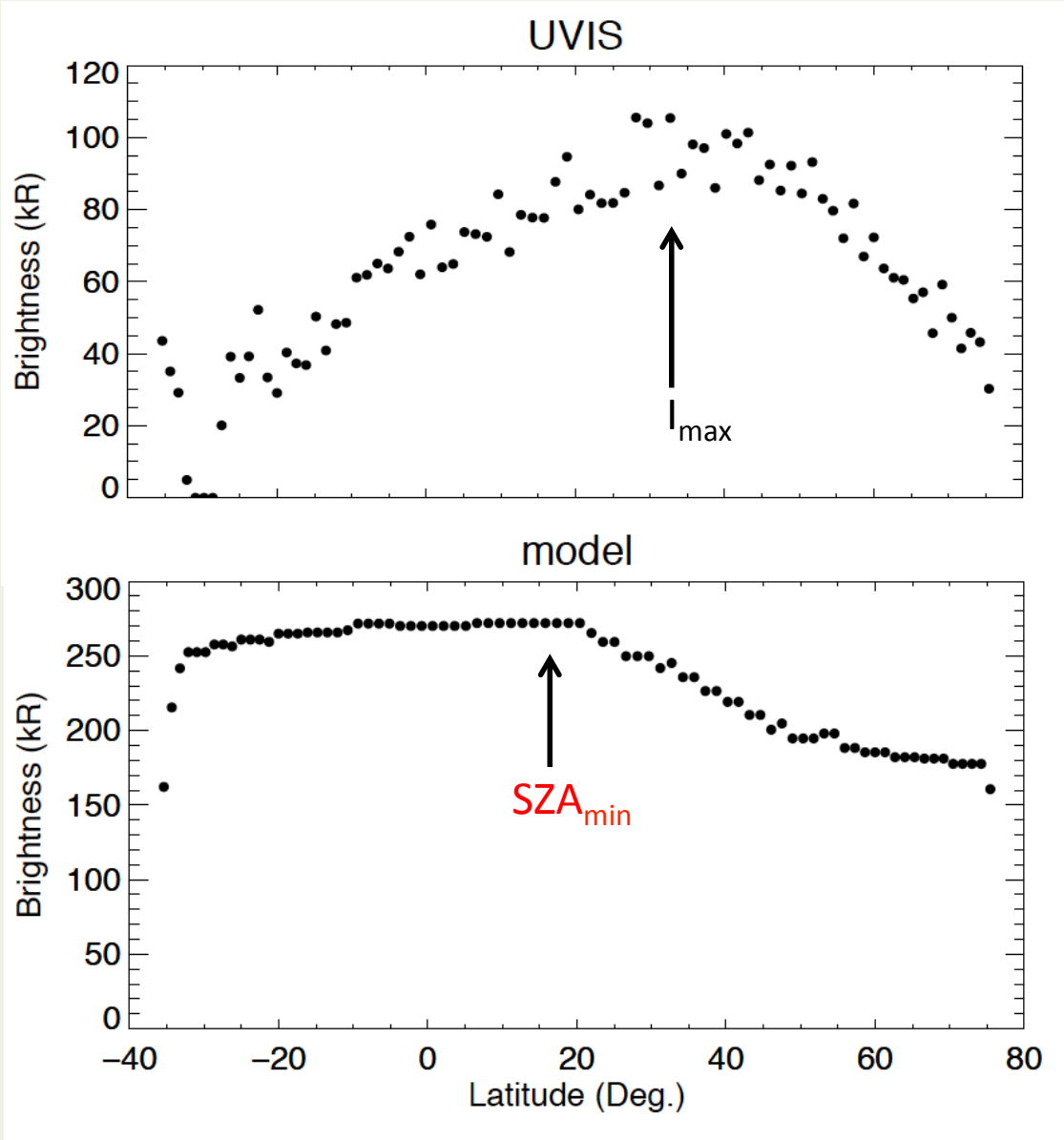
Limb tracking observations provide latitudinal cuts of the 557.7 nm brightness at different altitudies (in this case the main ★ and secondary ● peaks)

OI green line limb tracking observations



In this case, the latitude of maximum intensity does not coincide with the smallest SZA

OI green line limb tracking observations



UVIS – model intensity comparison

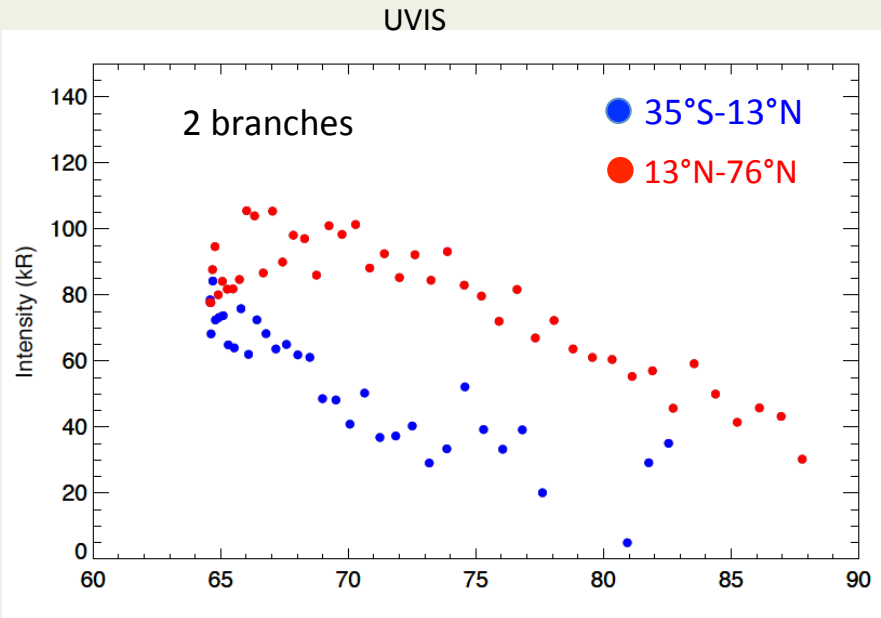
The comparison with the photochemical model indicates:

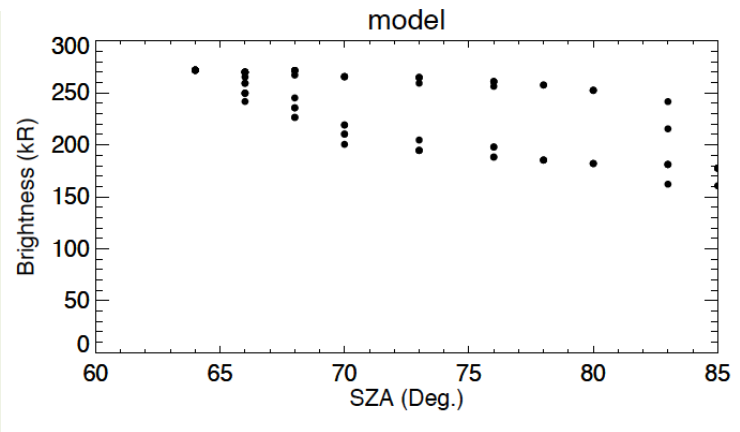
- The model simulated intensities are higher than observed

- The observed brightness maximum is shifted northward relative to the model simulation

In progress

OI green line limb tracking observations





The main source of the 557.7-nm dayglow:

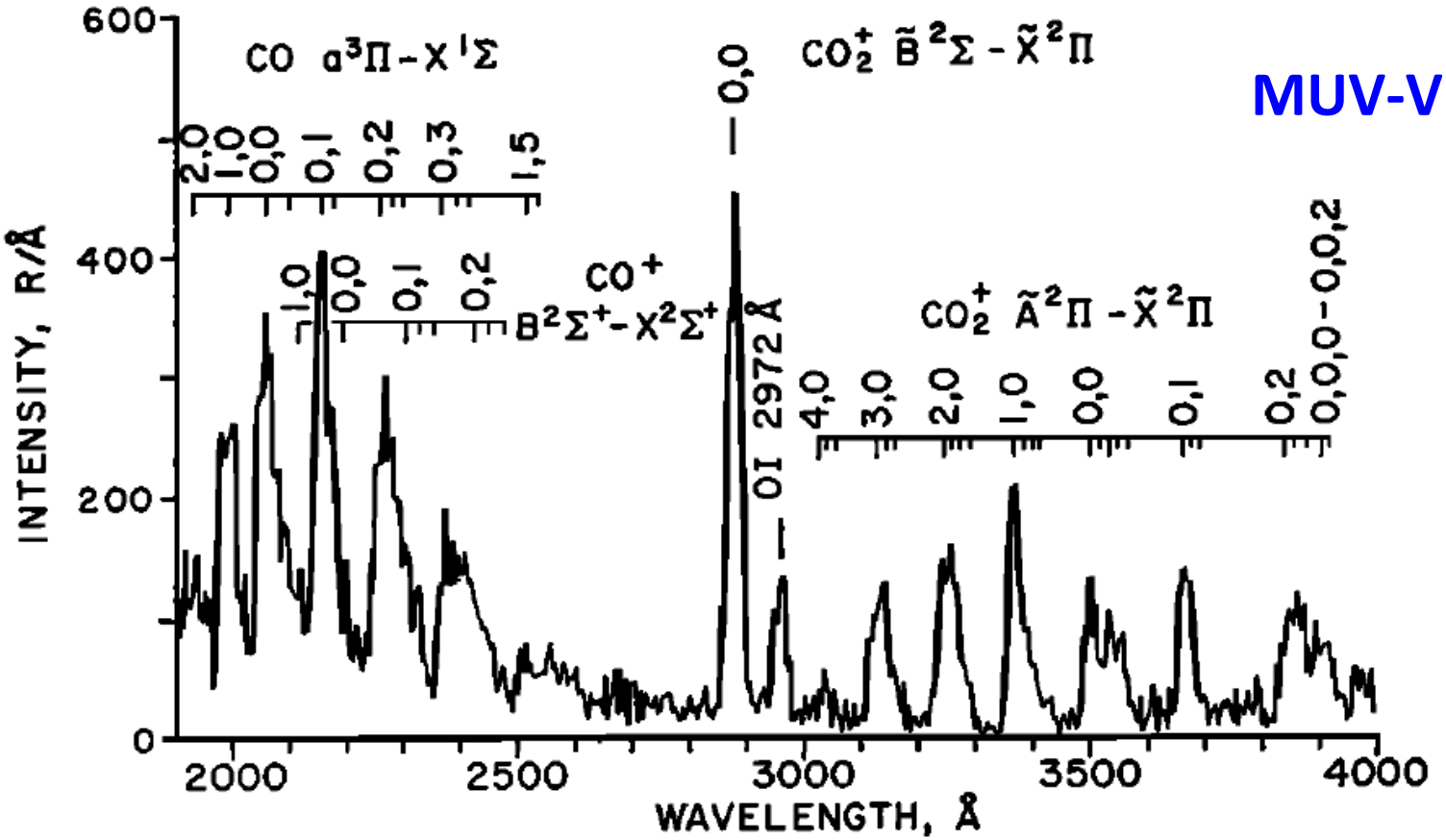
CO_2 + UV photons → CO + O(^{1}S)

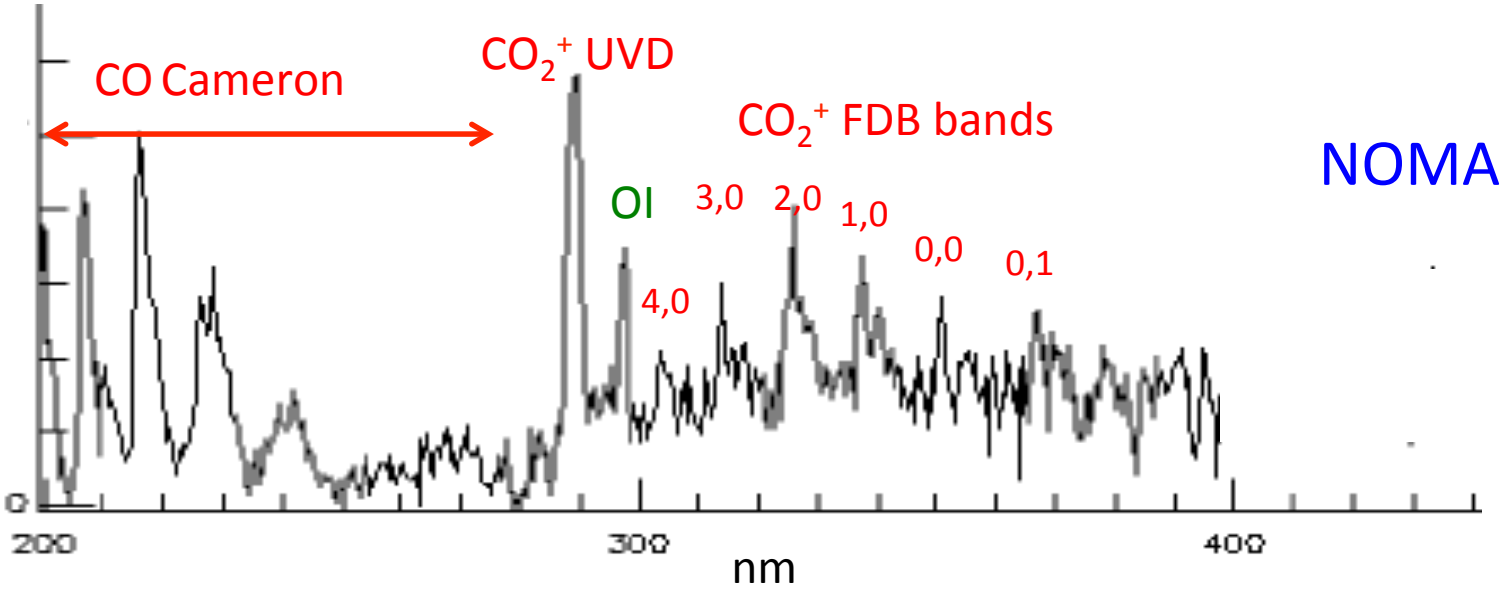
O(^{1}S) → O(^{3}P) + 557.7 nm

The model predicts a smaller intensity difference between the two branches

The same may be done for other dayglow emissions

In progress


MUV-Violet
CO a³Π - X¹Σ
CO₂⁺ B̃²Σ - X̃²Π
CO⁺ B²Σ⁺ - X²Σ⁺
CO₂⁺ Ã²Π - X̃²Π
OI 2972 Å
INTENSITY, R/Å
WAVELENGTH, Å
MARINER


CO Cameron
CO₂⁺ UVD
CO₂⁺ FDB bands
OI
4,0
3,0
2,0
1,0
0,0
0,1
nm
NOMAD-UVIS

Conclusions

- NOMAD-UVIS limb observations have been performed successfully in a special spacecraft pointing mode since April 2019
- They have lead to the discovery of the OI 557.7 and 630 nm dayglow emissions
- The vertical distribution of their intensity is correctly predicted by photochemical model simulations
- The CO Cameron and CO_2^+ UV doublet and FDB bands are also observed in the near ultraviolet
- Limb tracking observations, now in progress, provide latitudinal cuts at a fixed altitude for comparison with model

Contact: jc.gerard@uliege.be