

RETRIEVALS OF OZONE AT THE TERMINATOR OF MARS FROM SPICAM/MEX SOLAR OCCULTATIONS

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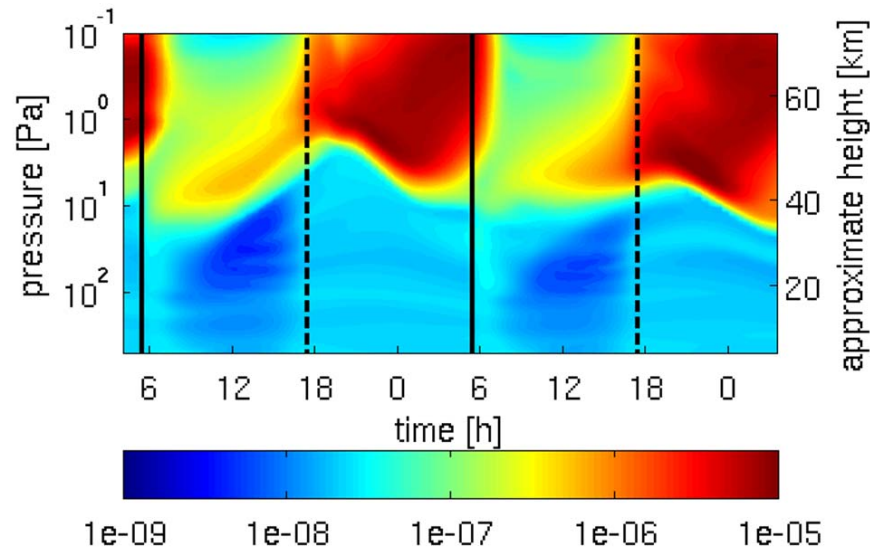


ESAC, Madrid 2018

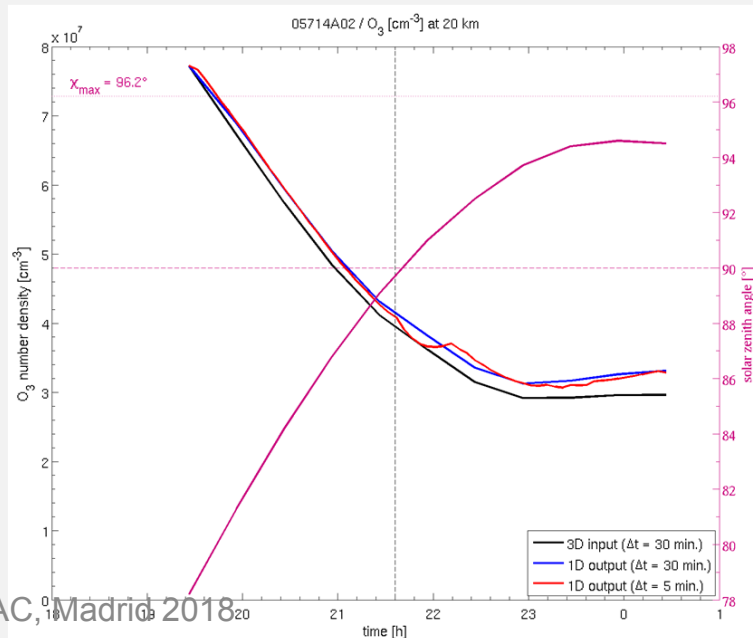


Martian atmosphere @the terminator

Diurnal cycle of ozone (3D GCM)



Ozone at sunrise terminator (1D model)



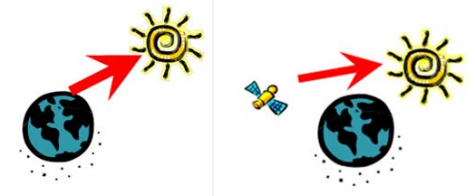
- Atmosphere simulated by the **GEM-Mars GCM** (Neary, L. et al., 2017).

- complex photochemistry driven by the solar illumination
- **rapid timescales of photochemistry at sunrise and sunset**
- Ozone (O₃) is more abundant during the nighttime, especially above 40-50 km.
- As the Sun rises, the destruction of O₃, although stronger in the high atmosphere, is observed at all altitudes.

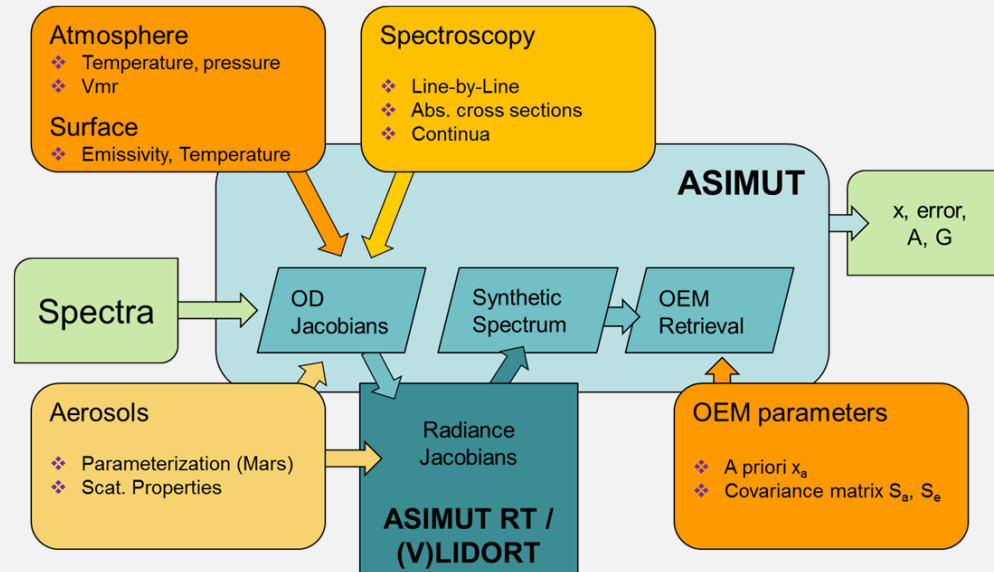
- **Comparison of the model results of a 3D-GCM & a 1D model using a short time step**

- At 20 km, the agreement between the three model ozone fields is fairly good.
- A disagreement can be found at other altitudes, which is due to the **inability of the 1D model to describe the horizontal transport of ozone.**
- Recent improvements of the **3D GCM** (e.g. implementation of the Kinetic PreProcessor (KPP) and of a correct calculation of the slant path) make it more appropriate for interpreting the observations of ozone around the terminator.

ASIMUT



- Possibility to retrieve columns and/or profiles of atmospheric constituents simultaneously from different spectra , different geometries



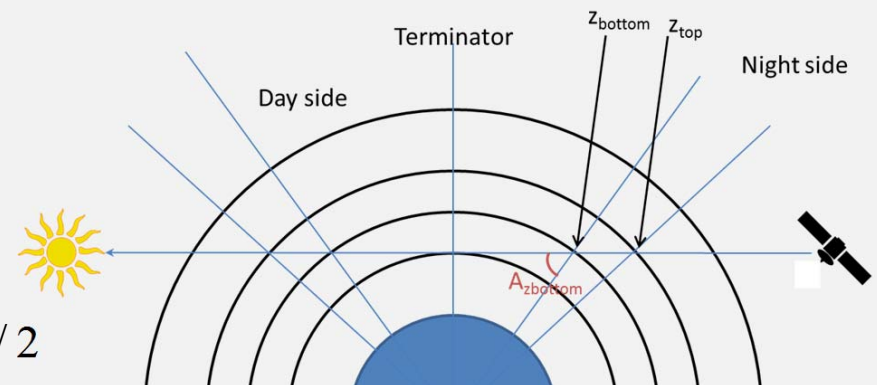
- New improvement: consider the gradients across the terminator:

- Temperature and total density gradients
- Density gradient for specific species (here: O₃)

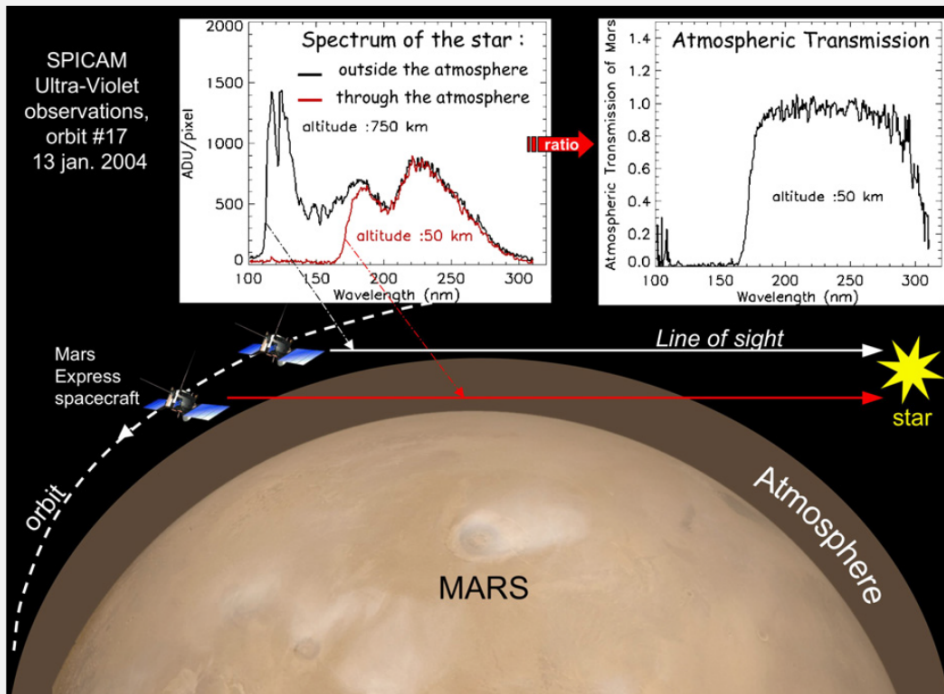
$$LST_z = LST_{\text{Terminator}} + \text{Correction}(A(z), \text{D/N side})$$

Interpolation of T and N at LST_z

$$OD_{\text{Layer } i}^{\text{species } k} = \left[OD_i^k(T_i^{\text{Day}}) \times N_{k,i}^{\text{Day}} + OD_i^k(T_i^{\text{Night}}) \times N_{k,i}^{\text{Night}} \right] / 2$$



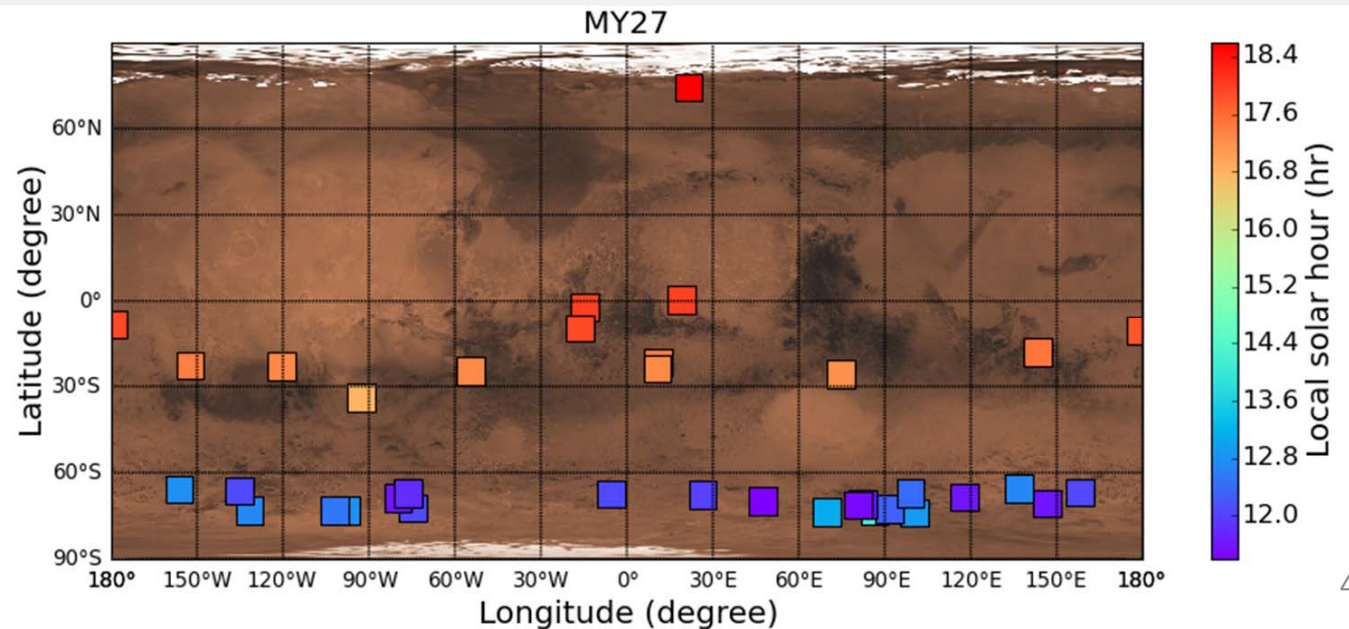
SPICAM solar occultations



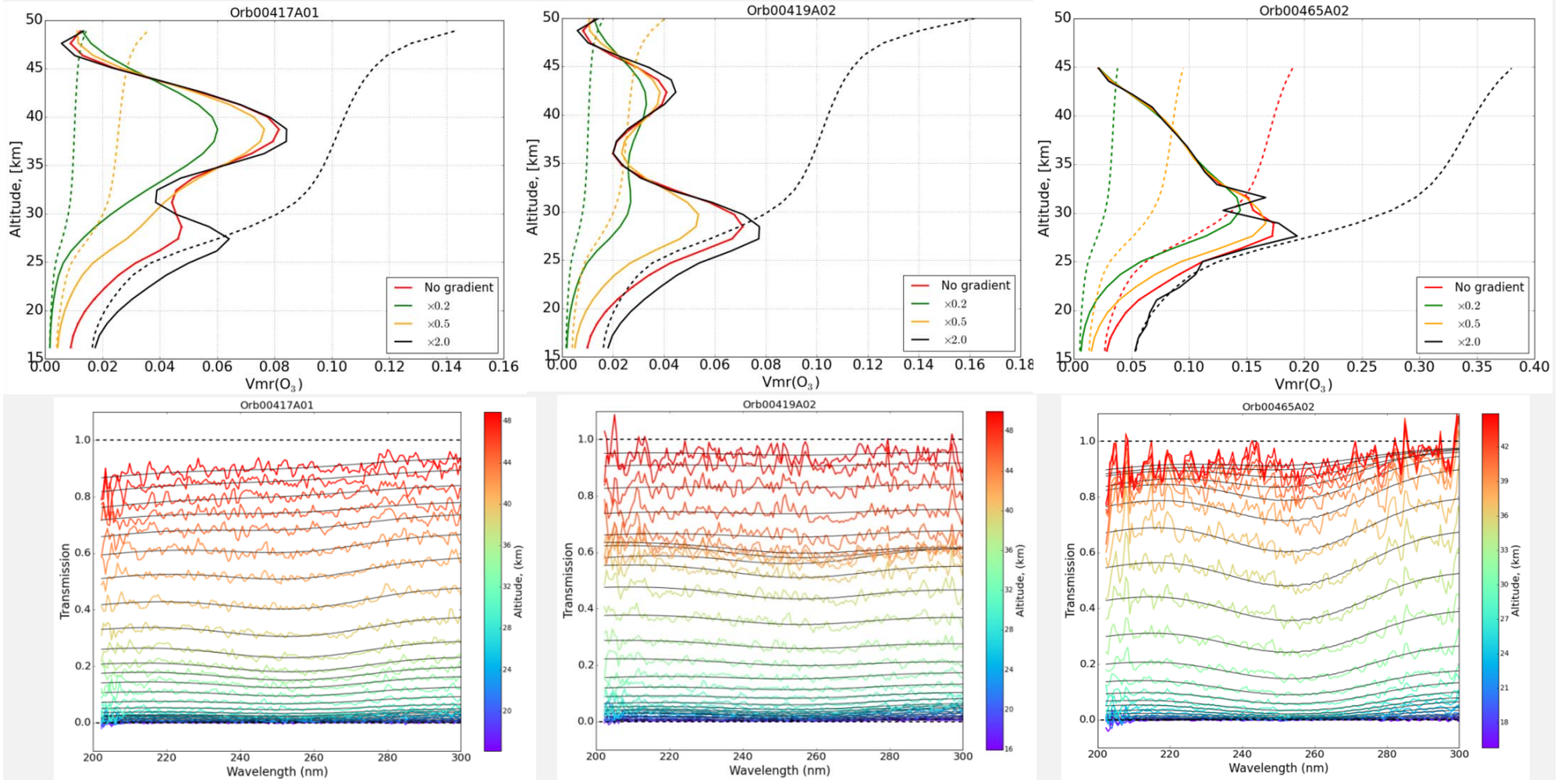
New transmittances calculation

- Improved way of defining the 'Solar Reference' spectrum
- To avoid transmittances > 1
- Same method as in Trompet et al., 2016

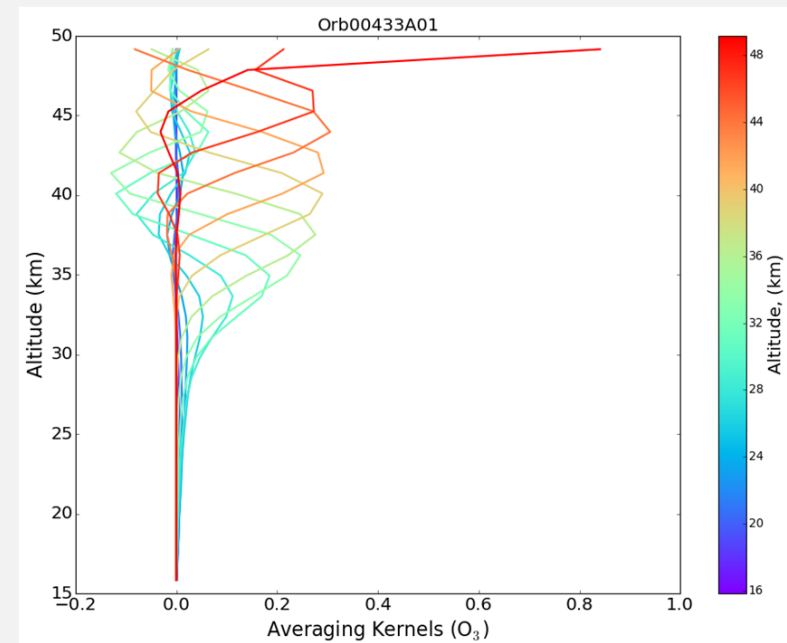
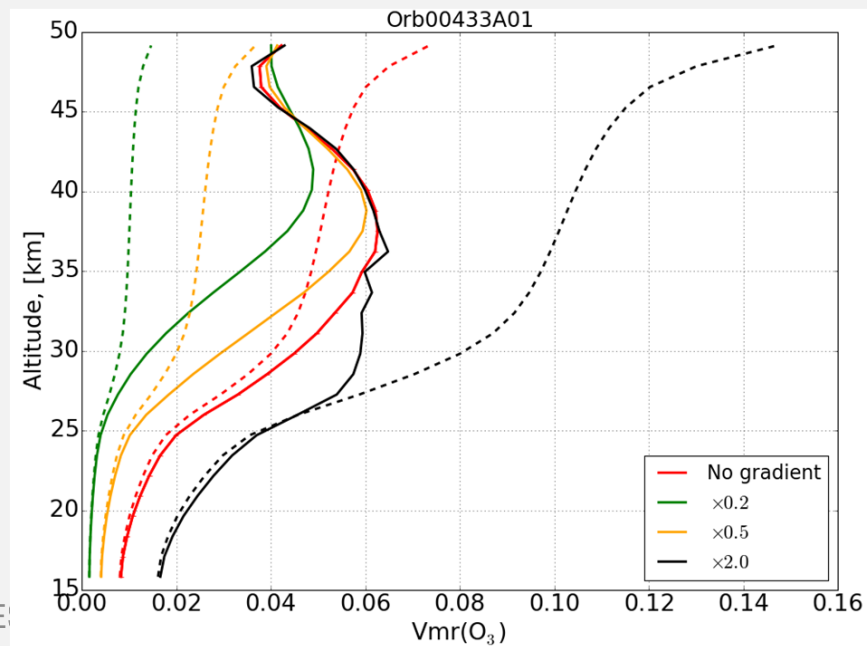
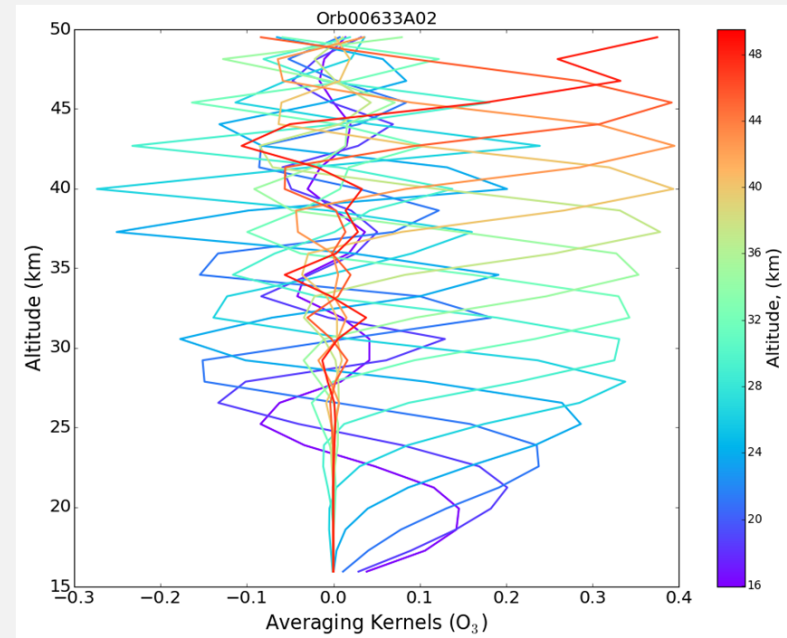
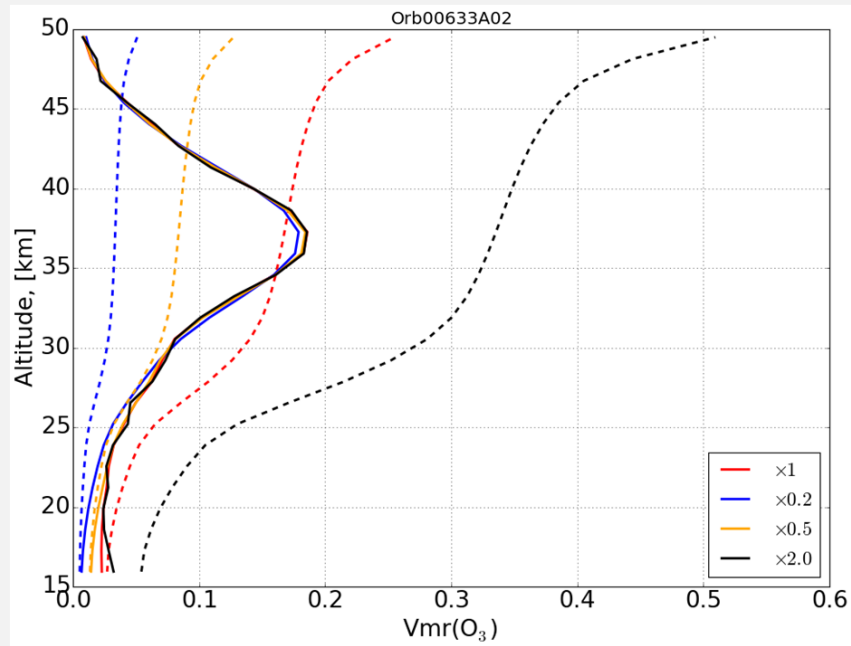
- **36** Solar occultations for MY 27



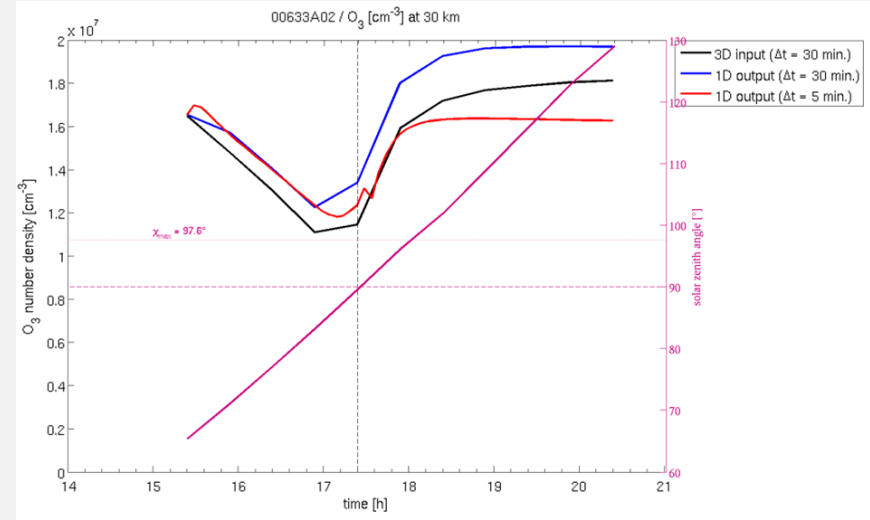
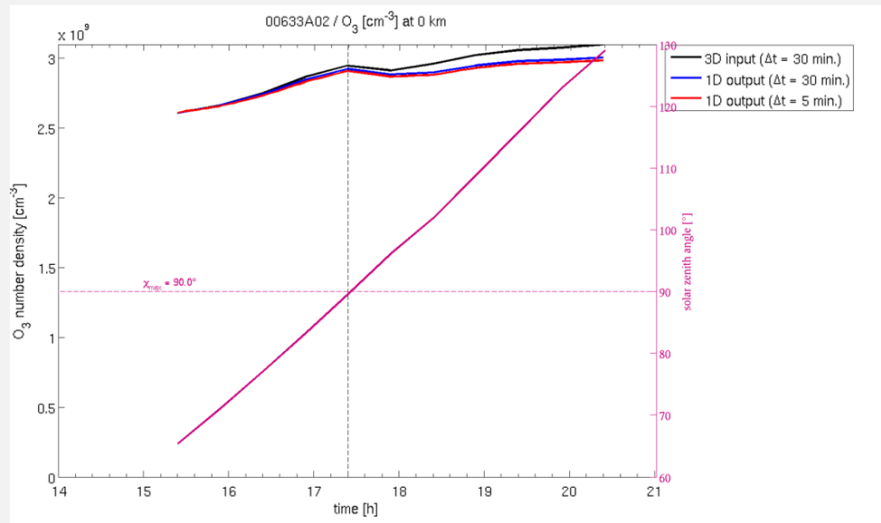
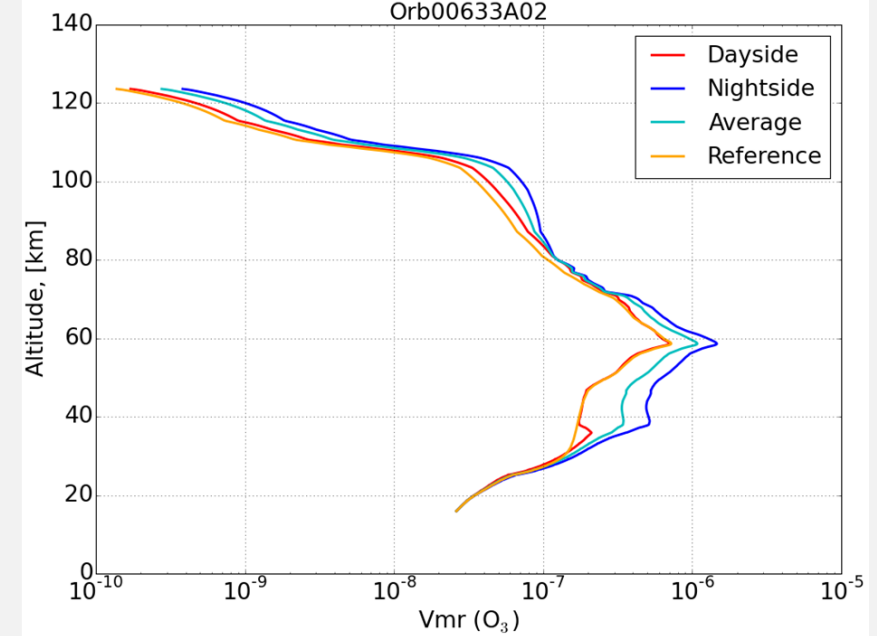
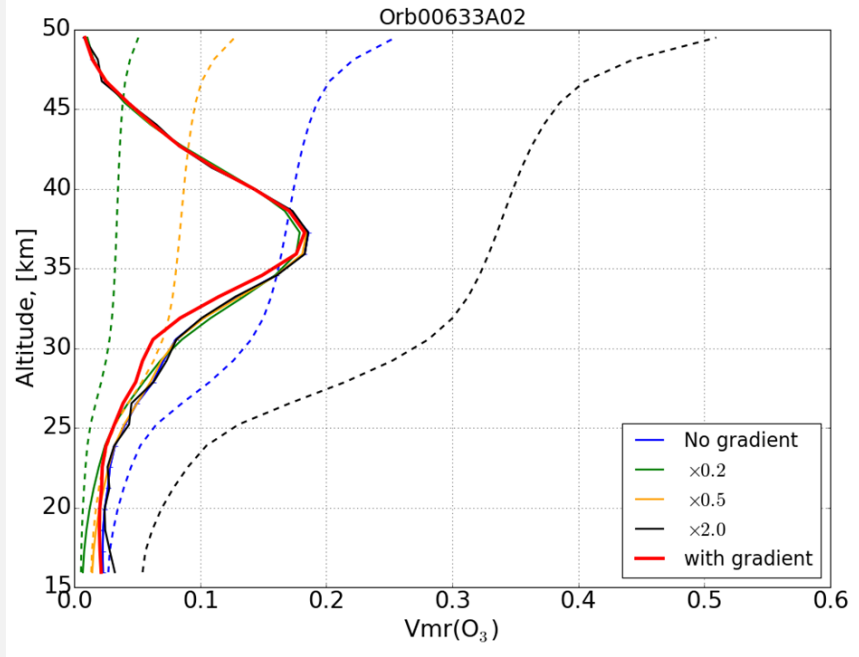
O₃ retrieval (without gradients)



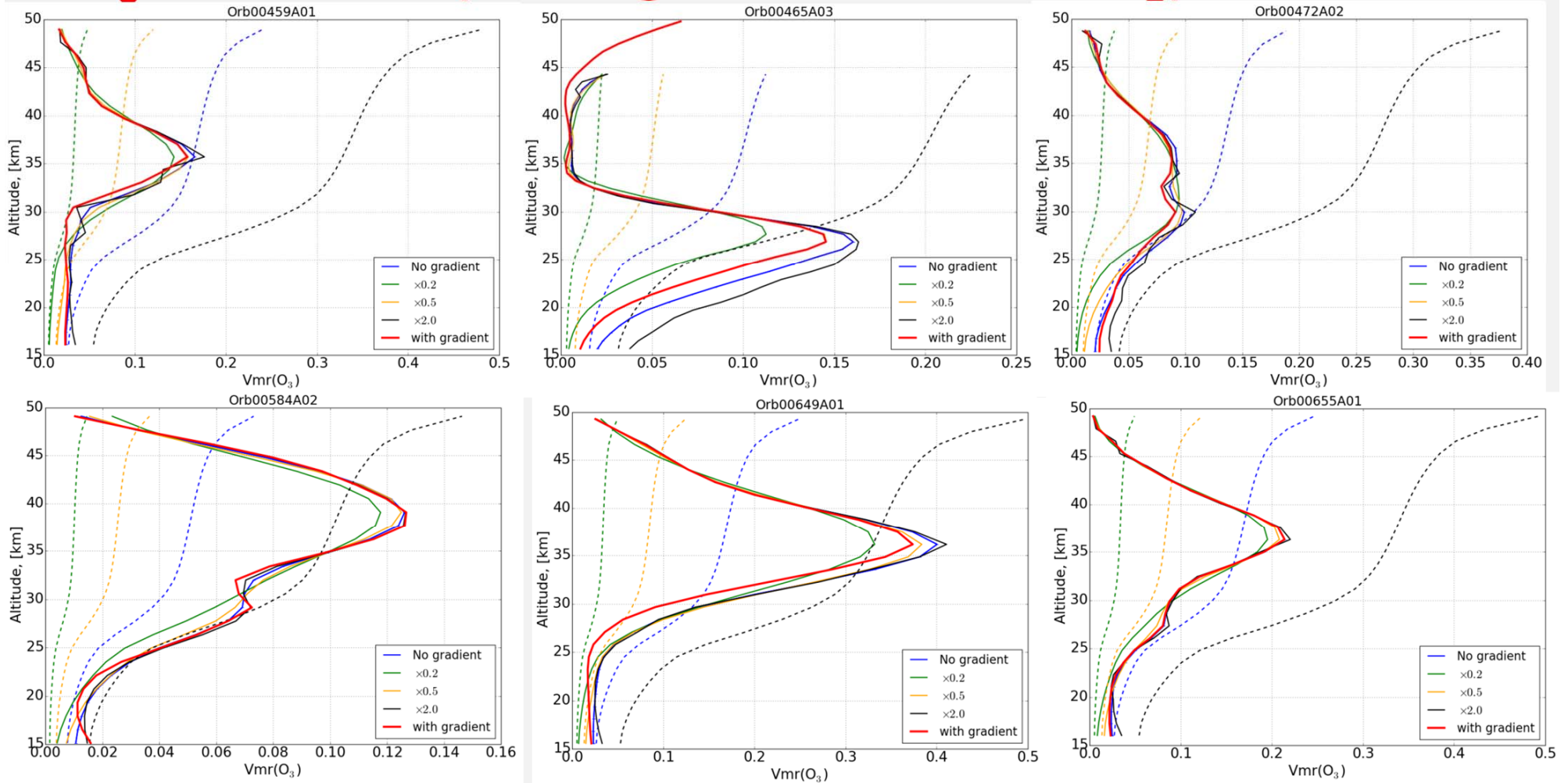
O₃ retrieval (without gradients)



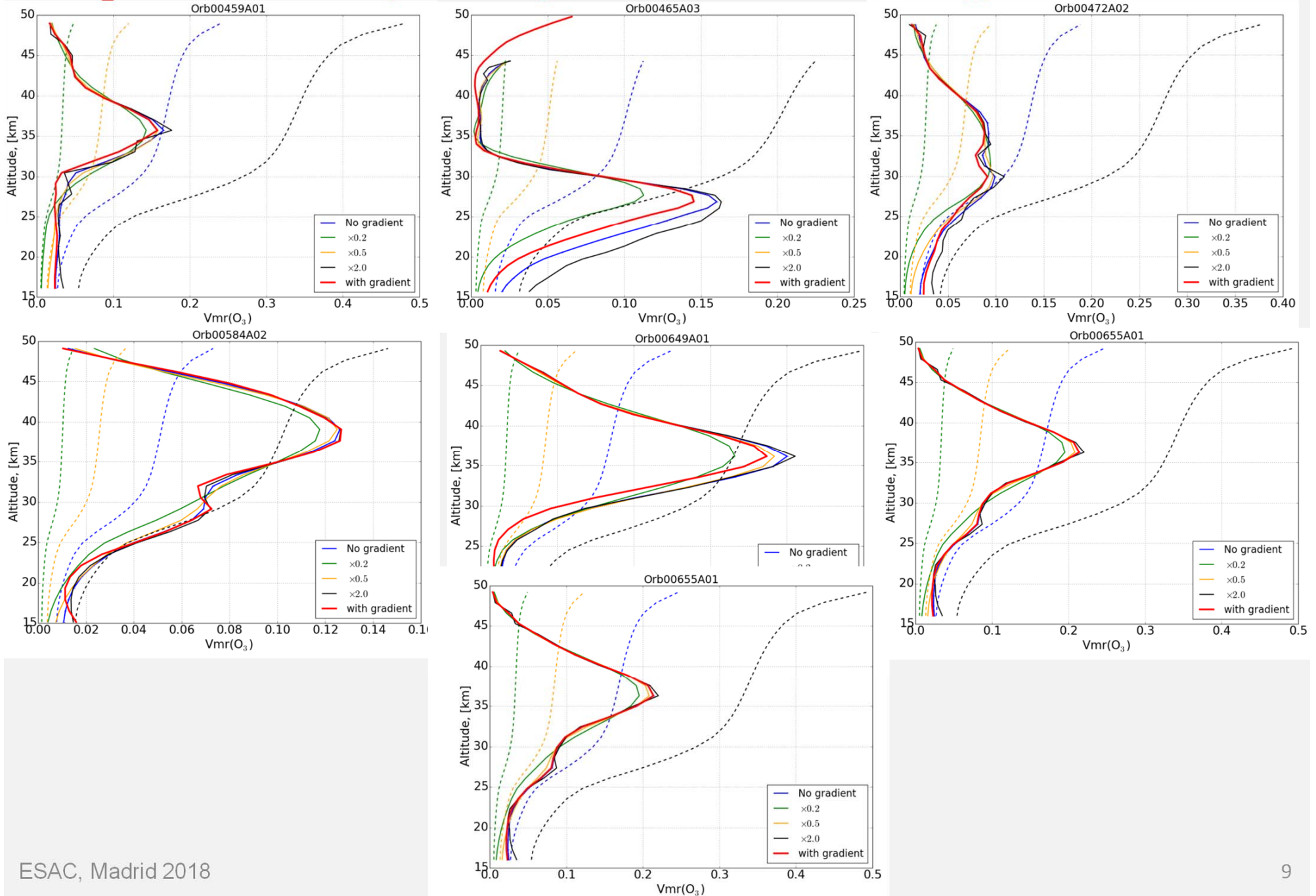
O₃ retrieval (with gradients T & O₃)



O₃ retrieval (with gradients T & O₃)



O₃ retrieval (with gradients T & O₃)



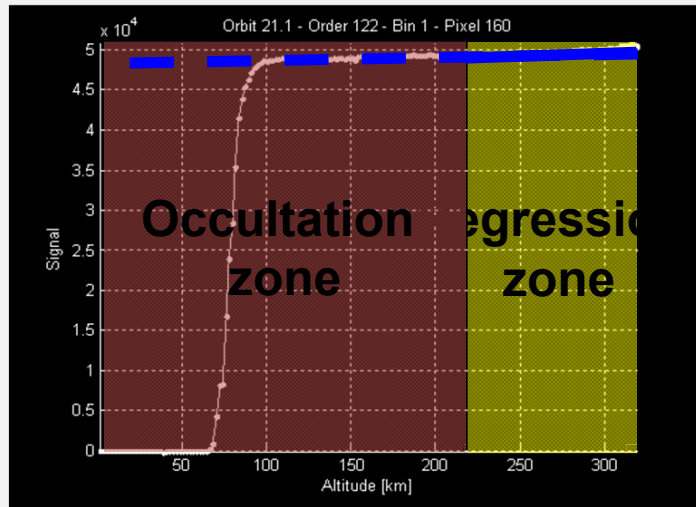
Conclusions & Future Work

- We implemented the Radiative Transfer Model used at BIRA-IASB, **ASIMUT**, to better take into account the temperature, pressure and O_3 gradients across the terminator predicted by GCM.
- **Transmittances** were calculated using a **new method previously** used for SOIR/Vex (Trompet et al. 2016).
- As first step, we retrieved **O_3 profiles without** taking in account **gradients** (results in agreement with previous studies).
 - Tested sensitivity to a priori profiles (converge between **20-45 km altitude**).
- **Retrievals of O_3 taking in account gradients:**
 - O_3 gradient has an impact on the retrieval
 - O_3 (with gradients) are systematically lower than profiles without considering gradients.
- **Future work:**
 - Sensitivity studies to investigate fully the impact of the gradients on the retrieval.
 - Analyze the whole SPICAM database
 - We will compare the slant profiles from SPICAM LATMOS with the results from the work by BIRA-IASB.

Task 6.2 : “New retrieval of SPICAM solar occultation observations” (IASB, CNRS)

New transmittances calculation

- Improved way of defining the ‘Solar Reference’ spectrum



Criteria

$$|1 - \text{Tr}(i)| < f * \delta \text{Tr}(i) \quad i \in R,$$

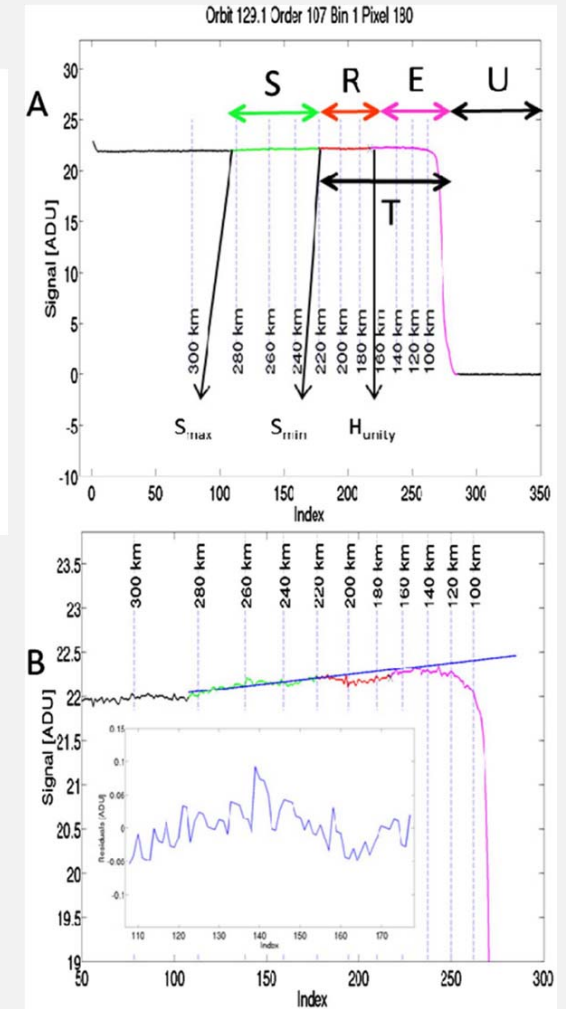
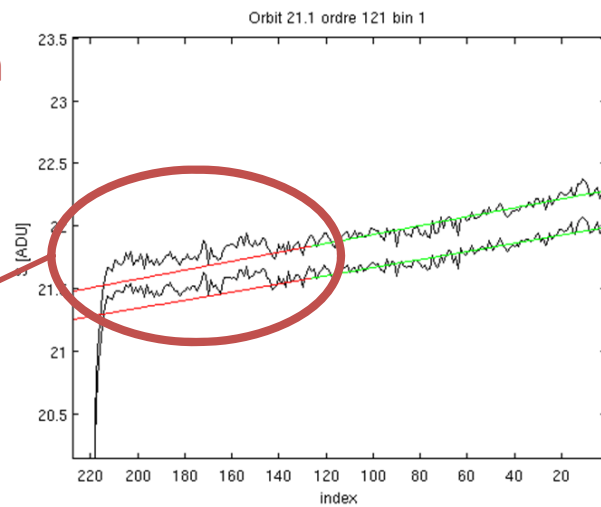
$$\delta \text{Tr}(i) < \frac{1}{\text{SNR}_{\min}} \quad i \in R,$$

$$\delta \text{Tr}(i) < f * \text{std}(\text{Tr}(R)) \quad i \in R,$$

$$\text{Tr}(i) - 1 < f * \delta \text{Tr}(i) \quad i \in E,$$

$$|1 - \text{Tr}(H_{\text{unity}})| < f * \delta \text{Tr}(H_{\text{unity}}),$$

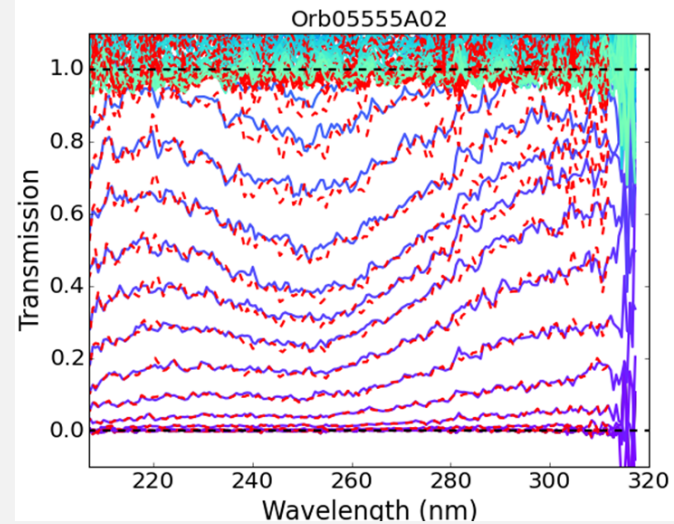
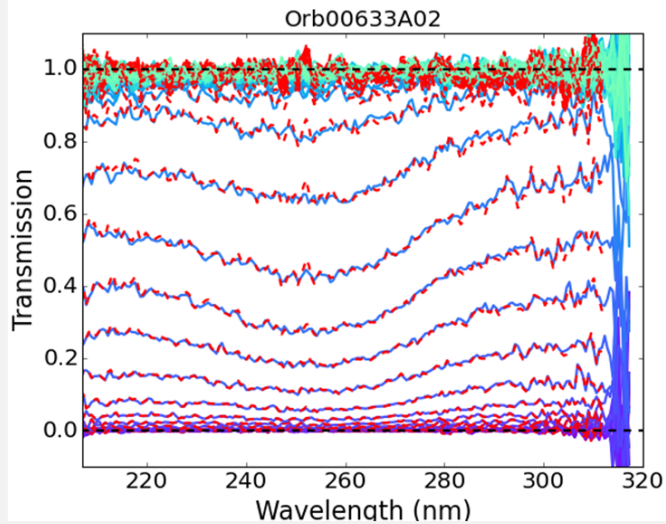
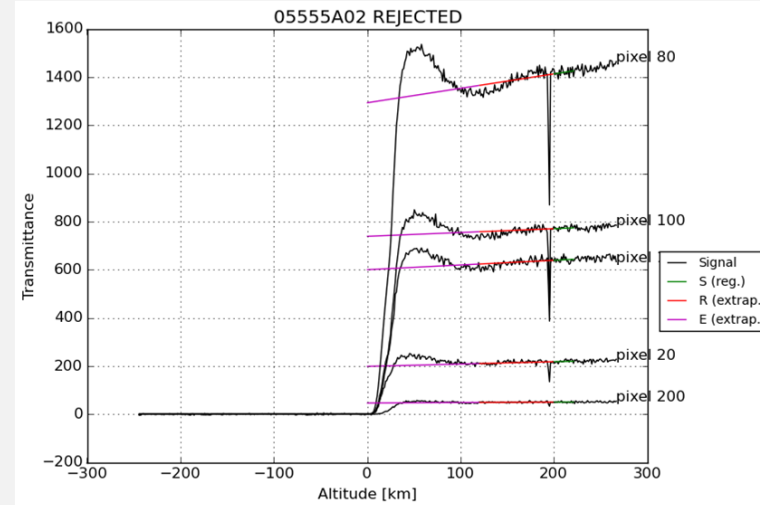
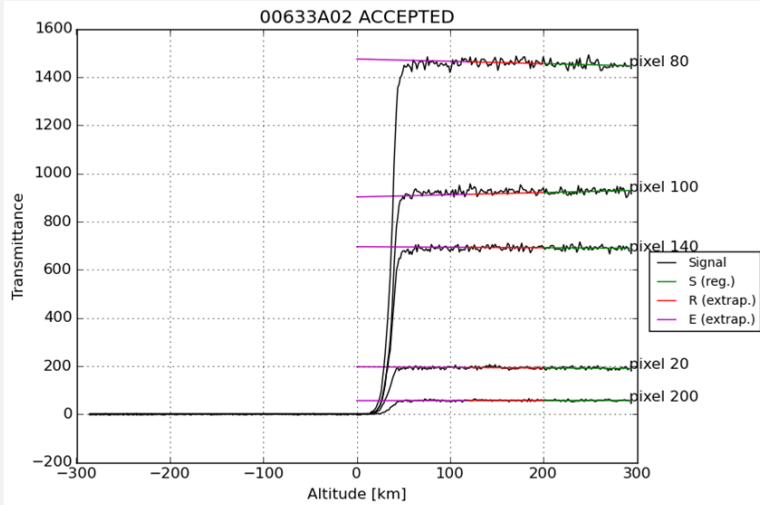
OLD situation



Trompet et al., 2016

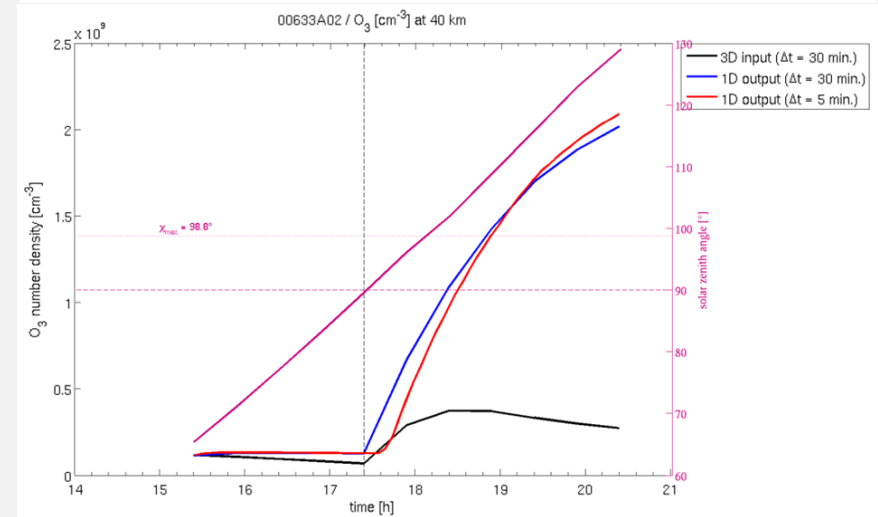
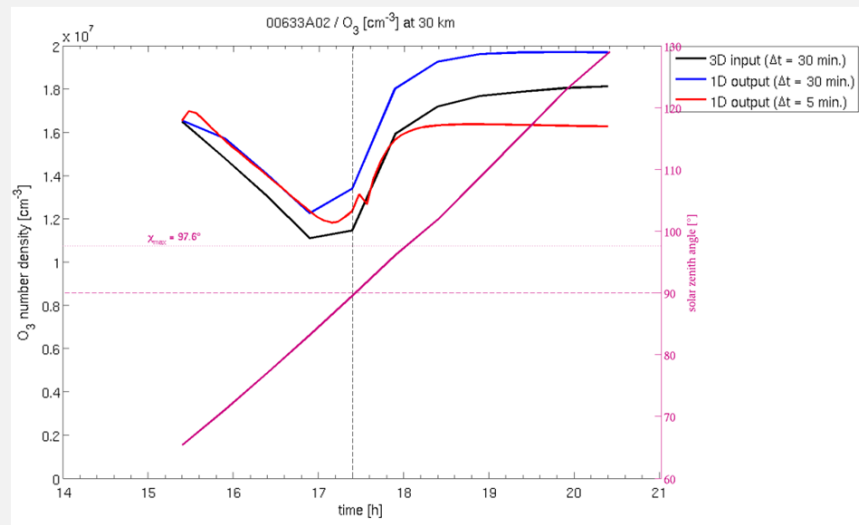
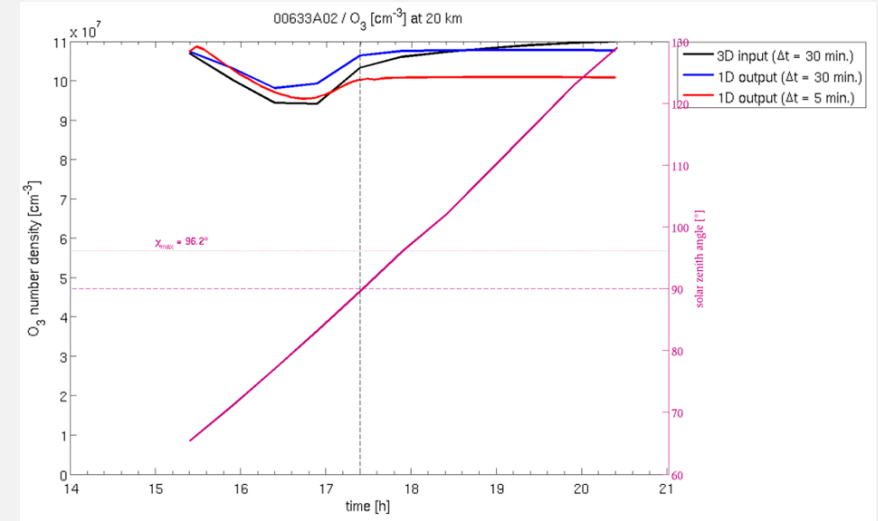
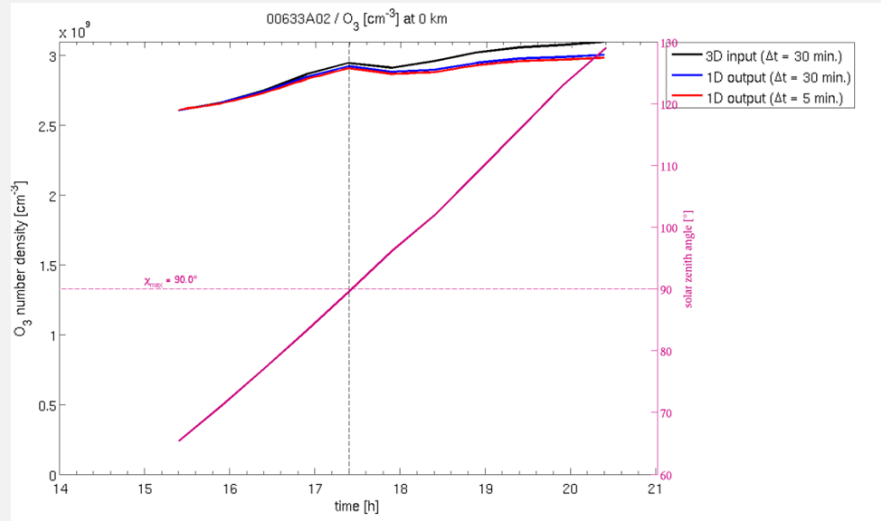
Task 6.2 : “New retrieval of SPICAM solar occultation observations” (IASB, CNRS)

New transmittances calculation



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O₃ retrieval (with gradients Temperature & O₃)



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