

## ***Interactive comment on “The use of O<sub>2</sub> 1.27 μm absorption band revisited for GHG monitoring from space and application to MicroCarb” by Jean-Loup Bertaux et al.***

**Anonymous Referee #2**

Received and published: 23 July 2019

### General comments:

This paper deals with an interesting and relevant aspect, i.e. the contamination of nadir O<sub>2</sub> measurements in the 1.27 micron IR atmospheric band caused by the corresponding airglow emission. The paper will be relevant for the community and the approaches employed in the study appear to be robust. However, there are two major issues with the paper. It is unnecessarily long (which distracts from the main content) and it is full of typos, minor inconsistencies and little errors. Many sections make the impression of hastily written drafts that were not proof read. It took me two full days to go through this manuscript, which is not acceptable. We expect from young scientists and postdocs

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that manuscripts are in tip-top shape and it should also be expected from senior scientists. It is certainly not the reviewer's task to correct all the mistakes. Please correct the manuscript carefully.

### Specific comments:

P. 1, line 18: “i.e. OCO-2 .. “ -> “e.g. OCO-2 ..”; otherwise all instruments carrying out these measurements should be listed.

P. 1, line 38: “model underestimate” -> “model underestimates”

Same line: “This is fully confirmed ..”

It is not entirely clear, what this refers to. Is it confirmed that the model underestimates by 15%? Or that the airglow intensity is mainly determined by the SZA. Please clarify.

P. 2, line 13: “Dioxyde” ->“dioxide”

P. 2, line 14: “The atmospheric fraction ..”

I suggest being more precise here. Mention CO<sub>2</sub> explicitly and that the fraction is a mass ratio – that's what it is, right?

P. 2, line 30: “The first satellites to be launched with the aim ..“

Why don't you list SCIAMACHY/Envisat? SCIAMACHY is certainly not as specialized to CO<sub>2</sub> retrievals as the other instruments, but it was also built to measure CO<sub>2</sub> and it should be listed here. The CO<sub>2</sub> retrievals were also quite successful.

P. 3, line 13: “mission“ -> “missions“

Same line: “Airglow has a spectrum that is very similar ..“

This statement is not generally true for all airglow emissions occurring in the atmosphere and should be phrased more precisely. There are many other airglow emissions apart from O<sub>2</sub>, for which the statement is not valid.

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P. 3, Figure 1: the figure shows O3 photolysis as the only source of the 1.27 micron emission. Ozone photolysis is only one of several excitation mechanisms. I suggest stating in the caption that it is the main mechanism on the dayside.

Caption Fig. 1, line 3: "are crossing" -> "is crossing"

Same line: "which emission" -> "whose emission"

P. 4, line 6: "confirms" -> "confirmed"

P. 4, line 9: "mission" -> "missions"

P. 4, line 12: "to determine from nadir viewing observations the CO2 vertical columns"

Word order wrong. Please replace by: "to determine CO2 vertical columns and mixing ratios from nadir viewing observations"

P. 4: "secular variation" -> "secular variations"

P. 4, line 21: "plugged to a" -> "combined with a"

P. 4, line 22: "We also note that the TCCON ground-based spectrometer array, observing the sun, uses this  $1.27 \mu\text{m}$  band to derive the CO2/dry air mixing ratio"

This is the third time this is mentioned and can be removed.

P. 4, line 32: "intimately intricated."

Grammar wrong, please correct.

P. 4, line 38: "Second, the transmittance  $\text{Tr}=\exp(-\tau)$  saturates at high optical thicknesses  $\tau>1$ , while the emission does not."

I don't understand this statement and think it's wrong. Emission is certainly also limited if the optical depth becomes quite large. What you probably mean is that extinction is not important for the emission, because the emission mainly occurs above 30 km. But this is not what the sentence states.

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P. 5, line 1: "on Fig." -> "in Fig."

P. 5, line 3: "which positions" -> "whose positions"

P. 5, line 5: "rending" ??

Do you mean "rendering"? Word order is also wrong: "rendering this proposal unpractical"

P. 5, line 7: "contributes" -> "contribute"

Caption Fig. 2, line 1: "The transmittance within an individual O2 line (red) is much larger than"

"transmittance .. much larger" is not well phrased. The transmittance is zero in the center of the line. Please be more precise.

P. 5, line 22: "compared" -> "compare"

Same tense as in previous sentences

P. 6, line 1: "while in Section 6 are detailed the accuracy and bias results of"

Word order incorrect

P. 6, line 4: "In section 7 are examined briefly"

Word order wrong: "In section 7 some other cases ... are examined"

P. 6, line 20: suggest to define Rayleigh the first time it is used.

P. 7, line 3: "strong solar light scattered component" -> "strong contribution of scattered solar radiation"

P. 7, line 5: "From high altitude the O2 absorption will be a little bit reduced."

This is incomprehensible? Do you mean that the absorption is weaker at higher altitudes?

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P. 7, line 26: please cite Bovensmann and/or Burrows here. For all the other instruments you provide a citation, but not for SCIAMACHY.

P. 7, line 37: "On Fig. 3 (from Khomich et al., 2008) are represented the various electronic"

"On Fig." -> "In Fig" and the word order is incorrect: "Fig. 3 presents the various .."

P. 7, last line: "on Fig." -> "in Fig."

P. 8, line 2: "on Fig." -> "in Fig."

P. 8, equation (4): "C" -> "c"

Same equation: the units are incorrect, i.e. the equation is not valid as is. Please correct.

P. 8, line 18: "Fraunhofer" -> "Fraunhofer's"

P. 9, line 24: "solar effect"

One can tell what you mean, but it is not well phrased, too unspecific.

P. 9, line 31: "emitted photon" -> "emitted photons"

P. 9, equation (5): the middle part of the equation is incorrect. During the day, there will essentially be a steady state, i.e.  $O_2^*$  is produced by  $O_3$  photolysis (mainly) and removed by emission, i.e.  $d[O_2^*]/dt = 0$ .

P. 10, title section 2.3.3: remote period from section title

P. 10, line 15: "A -coefficients" -> "A-coefficients"

P. 10, line 16: "second members"

Unclear, what you mean.

P. 10, line 34: please provide  $k_B$  in SI units

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P. 11, line 4: "on all" -> "over all" (2 occurrences)

P. 11, line 11: "on Fig." -> "in Fig."

P. 11, line 12: "term by" -> "term and"

P. 11, caption Fig. 4, line 3: "There are 5, 7, or 8 values (and transitions) for each black circle on the figure"

Not clear to me, why there are 5, 7 or 8 values for each black circle. Please explain.

Same line: "on the figure" -> "in the figure"

P. 11, line 21: "On Fig. 5 are represented the various energy"

"On" and word order incorrect: "Fig. 5 presents .."

P. 12, Title section 2.3.4: add space at beginning

P. 12, line 6: "sate" -> "state"

Next line: "sum on" -> "sum over"

P. 12, line 21: "We found that the total decay rate is  $A_{21\text{tot}}=2.29 \cdot 10^{-4} \text{ s}^{-1}$ ."

Above you determined the total decay rate to be  $2.22 \times 10^{-4} \text{ s}^{-1}$ . What does "We found" refer to? This is not clear.

Next line: "in average" -> "on average"

P. 13, line 9: "on Fig." -> "in Fig."

Figure 6: spell out "eps" in Figure caption

P. 14, line 16: "on Fig." -> "in Fig." and word order needs to be adjusted

P. 15, line 30: "to the study" -> "for the study" or "for studying"

P. 15, line 32: "Osiris" -> "OSIRIS"

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P. 15, line 34: "Gao et al."

Please cite the main SABER paper by Russell.

Same line: Please also cite a SCIAMACHY paper (Bovensmann and/or Burrows). It almost seems as if the authors avoid citing SCIAMACHY papers.

P. 16, line 12: "At each tangent point, the vertical resolution is 2.6 km"

That's the FWHM of the FOV, the vertical resolution is worse.

P. 16, lines 20 – 28: please show sample spectra and illustrate the correction procedure.

P. 17, line 5: Onion peeling is prone to noise, particularly lower down and is usually not the method of choice, but OK ..

P. 17, line 15: "radiuses" -> "radii"

P. 18, equation (21): this usually does not work well, but leads to unrealistic oscillations.

Section 3.2.2: is the model atmosphere divided into several angular segments in order to describe the attenuation within a given atmospheric layer properly? This doesn't seem to be the case and this should be stated explicitly, i.e. the technique applied is only an approximative treatment of the self-absorption.

P. 19, line 2: "each .. spectra" -> "each .. spectrum"

P. 19, line 17: "the more the lower latitude."

Why should it depend on latitude? Do you mean altitude? This part of the sentence is also incomplete.

P. 19, line 38: "at (lat" -> "(at lat"

P. 20, line 12: "Absorption by O2 may be computed in the nadir viewing geometry, though attenuation in this geometry is small (2% for the Q branch, less outside of the

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Q branch)."

This is only valid for  $z > 30$  km, right? I suggest mentioning this explicitly.

P. 20, line 20: "On Fig." -> "in Fig." and word order needs to be adjusted

P. 21, Caption Fig. 10, line 1: "form" -> "from"

Same Caption, line 4: "ADAPTEE" -> "ADAPTED"

P. 21, line 19: "On Fig." -> "in Fig." and word order needs to be adjusted

Same on line 29.

P. 22, Figure 11: Figure is truncated at bottom

Caption Fig. 11: "for ENVISAT orbit 20070101\_1256."

This is not the orbit number. Please provide orbit # and date.

P. 23, line 6: "The ratio of spectra measured /model, Sobs/ Smod"

This phrase is sloppily, please be more precise.

P. 23, line 10: "validates completely"

Well, there is roughly a systematic 10% difference in the right panel of Figure 13, i.e. I would not speak of "complete" validation.

Caption Fig. 12: "Ratios of measurements/model of limb spectra"

Sloppy phrase, please be more precise.

P. 24, line 11: "(some limb scans do not reach low enough altitudes)."

What does this mean? Does it refer to the MLT measurements? Please clarify.

P. 24, line 14: "aerosols" -> "aerosols"

P. 24, line 14: "and pollutes the SCIAMACHY measurements"

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This sounds like this is an instrumental problem, which is certainly not the case. Most of the SCIAMACHY limb data products are based on scattered radiation. Scattering does not generally "pollute" the limb measurements. I also suggest using a different word.

P. 24, line 23: "On Fig." -> "in Fig." and word order needs to be adjusted

P. 25, line 7: "On Fig." -> "in Fig." and word order needs to be adjusted

P. 26, Fig. 15: "Brightness = f(SZA..)" and "Color scale -> latitude"

This should be mentioned in Figure caption, not overplotted onto the Figure. This seems like an unfinished figure from a presentation, unsuitable for a paper.

P. 28, line 21: "radiation, atmosphere + aerosols+ surface)."

Please form a sentence.

P. 28, line 28: equality sign in equation is subscript.

P. 29, line 10: "Fig." -> "Figs."

P. 31, line 27: "which is almost polar and descending"

As it is "which" appears to refer to "month", which doesn't make sense. Please adjust.

P. 31, line 29: "on the intensity" -> "for the intensity"

P. 32, line 1: "which is incorrect"

It is specified like that in the SCIAMACHY documentation, I think, i.e. it's not correct to state, that this is incorrect. It's not the natural choice, but it is as documented, I believe. Maybe I'm wrong.

P. 32, Figure 19: Order of panels not specified. Which is which?

Same Figure: the legends in the individual panels overlap. Overall, the quality of the figure not suitable for publication. Please improve. Also: It's essentially impossible to

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separate the SCIA and the model symbols. Needs to be replotted.

P. 32, line 15: which local time was used for the model data?

P. 33, Figure20: increase spacing between legend lines.

P. 34, Figure 21: increase spacing between legend lines.

Caption Fig. 21: "Fig.20" -> "Fig. 20"

P. 37, line 2: "At night, GOMOS ozone profiles show a strong ozone depletion around 80 km"

I suggest using "minimum" rather than "depletion", because the phrase suggests that there is less ozone during night than during the day, which is not the case.

P. 38, line 1: "on Fig." -> "in Fig."

Same line: "observed on" -> "observed in"

P. 38, Caption Fig. 25: you need two GOMOS measurements for occultations with two different stars, right? Were both on the same day?

P. 39, line 1: "GOMOS ozone concentration vertical profiles show quite similar values below 60 km between day and night, and quite lower values of O3 at night above 60 km, a feature well understood from mesospheric chemistry."

?? Statement unclear. Do you mean the comparison of GOMOS with the model or the comparison of GOMOS night vs. day measurements? Nighttime O3 in the mesosphere is significantly larger than daytime O3 (photolysis during the day). The statement is not correct as is.

P. 39, line 18: "11h30 ascending node or 13h30 descending"

This is impossible. One of the two times is incorrect (at least).

Next line: "consists in" -> "consists of"

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P. 40, line 12: "lands" -> "land"  
P. 40, line 13: "over seas" -> "over lakes" ? (sea = ocean)  
P. 40, line 18: "e.g" -> "e.g."  
P. 40, line 22: "slope of albedo"  
?? slope with respect to what? This is unclear  
Same line: "for each bands" -> "for each band"  
Same line: "aerosols properties" -> "aerosol properties"  
P. 40, line 24: define "CAMS"  
Next line: "Sentinel 2"  
Which instrument on Sentinel 2?  
Same line: please add reference for "PlanetObserver"  
P. 41, last line: "scattered solar radiation by the surface"  
There is also scattering by the atmosphere  
P. 42, line 18: "to O<sub>2</sub> absorption is a continuous function of the wavenumber"  
What exactly does that mean? The ratio will certainly be a function of wavenumber.  
P. 43, line 10: "then applied IT to"  
P. 43, line 19: "spectral resolution" -> "resolving power"  
P. 44, line 6: I suggest speaking of higher / lower temperature, not warmer / colder.  
Temperature cannot be warm or cold, strictly speaking.  
P. 44, line 14: "spectrum,"  
2 lines below: "SCHIAMACHY" -> "SCIAMACHY"

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P. 44, line 27: "spectru"  
Next line: "spectel"  
I assume this is not a typo, please explain.  
P. 44, second line bottom-up: "resolution" -> "resolving power"  
There are several more cases, where "resolution" is used rather than the correct "resolving power". Please search for them all and correct them.  
P. 48, caption Fig. 31, line 3: "g" in the term symbol should be subscript.  
P. 49, Caption Fig. 32: "SCHIAMACHY" -> "SCIAMACHY"  
P. 49, line 7: "spectral resolution" (see comment above)  
P. 49, line 16: "spectra resolution" (see comment above)  
P. 50, line 6: "resolution power" (see comment above)  
P. 50, line 25: "slope on albedo"  
Unclear, specify.  
P. 50, line 29: "Lmoy"  
Please define. If this is french, please change to english.  
P. 50, line 48: "which associated" -> "whose associated"  
P. 51, line 11: "which peak" -> "whose peak"  
P. 51, line 13: "These two spectra are then normalized at the intensity of the airglow spectrum that is put inside the simulated spectrum to invert."  
I read this sentence several times, but didn't get it. Please rephrase.  
Figure 33: "VER moy"

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Replace by english term.

Figure 34: legends overlap with figures, please correct.

P. 53, line 22: "which intensity" -> "whose intensity"

Same line: move "respectively" after the numbers.

P. 54, caption Fig. 35, line 2: "value" -> "values"

P. 55, line 1: "spectral resolution" (see comment above)

P. 55, line 35: "non-ETL" -> "non-LTE"

2 lines below: "transition at 1.58  $\mu\text{m}$  of the O2 (1Delta) around 1.58  $\mu\text{m}$ "

2 lines below: "CO2 band" -> "CO2 bands"

P. 56, line 7: "nw" ??

Next line: "nw" ??

P. 56, line 19: "spectral resolution" (see comment above)

P. 57, line 10: "of 2007 SCIAMACHY 12,833 limb-scans"

Word order wrong.

Next line: "with though" -> "although with"

P. 57, line 16: "the O2\* airglow is well organized"

What is this supposed to mean? Airglow is well organized?

P. 57, line 39: "on Fig." -> "in Fig."

P. 57, last line: "and the reflected solar flux is far to be"

This makes no sense.

P. 58, lines 10, 13, 20, 27, 30, 38: "resolution" (see comment above)

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P. 58, line 32: "which broad" -> "whose broad"

Same line: "on Fig." -> "in Fig."

P. 58, line 34: "for a better constraining" -> "allow to constrain the .. absorption better"

P. 59, lines 1, 7, 9: "resolution" (see comment above)

P. 59, line 4: "Mission space mission"

Is the repetition intended?

P. 67, line 27: "From the pressure and temperature are also calculated the total density an"

Word order incorrect.

P. 71, line 2: "the loss term .. becomes very long" ?

Do you mean "large" rather than "long"? "Long" doesn't really make sense.

P. 72, line 13: "present" -> "presents"

P. 74, line 7: "On Fig. A6 (left) are represented the"

Word order incorrect.

Same comment on line 16 on the same page.

P. 74, line 8: comma missing in "40 S 40N"

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-54, 2019.