

Interactive comment on “The use of O₂ 1.27 μm absorption band revisited for GHG monitoring from space and application to MicroCarb” by Jean-Loup Bertaux et al.

Anonymous Referee #4

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General Comments: I believe that the authors intend to show in the submitted manuscript that O₂(1Δ_g) airglow can be modeled with sufficient accuracy to use the 1.27 μm O₂ absorption band to retrieve O₂ columns for greenhouse gas studies. It seems that the authors have done a lot of very good work over the past 3 years or so, and a lot of it appears in this manuscript. The paper is very long at 75 pages, and I am not sure that all this detail needs to be in the paper, as some of it is in the published literature (O₂ spectroscopy and non-LTE calculations, for example) and references might suffice. I feel that the paper might be easier to follow and make a stronger case for the conclusion if content in the main body were limited to what is needed to support the conclusion, and use references or supplemental material otherwise. More specific

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suggestions follow below.

I thought it might also help to include some discussion regarding how the O₂ column retrievals using the 1.27 μm band will be validated, given the very high accuracy (0.01%) that is required. Will they be compared against the O₂ A-band retrievals? But if O₂ A-band retrievals are good enough to be the standard, then what is the benefit of switching to the 1.27 μm band, given the added complication of the airglow correction? How will one know if the new retrievals are better?

Specific Comments:

I found the papers by Zarbo et al. (2018), Sun et al. (2018), and Simeckova et al. (2006), all cited by the authors, to be particularly helpful, and I think that there are places where the present manuscript presents conclusions or material that is similar (although clearly independently derived), so there are opportunities to make use of references to shorten the text. Again, my intent in making this comment is to find a way to limit the material in the paper to what is required to support the conclusion.

- a) Introduction, sections 2.0, 2.1: I think this was about the right length, although I'm not sure that the discussion of observations of Venus and Mars add much to supporting the goal of the paper.
- b) 2.2,2.3: This section is around 7.5 pages, and includes a lot of standard spectroscopy and line-by-line radiative transfer calculation information, including the use of Einstein A coefficients for non-LTE situations. The discussion could be shortened considerably by the use of references and limiting the text to what is unique. I was a little uncomfortable with the way that LBLRTM is being used in section 2.3.7, as it would be cleaner to just start from scratch with fresh code and do it right, but I appreciate that this may not have been practical given the resources available and it seems to have worked.
- c) Section 3, the use of SCIAMACHY data: The authors have done a lot of work here,

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but I would suggest including only those elements of this section that are directly relevant to section 6. This section is 11.5 pages, and it is not clear to me how the onion peeling retrieval of VER from limb scans is relevant to simultaneous nadir retrievals of O₂ column and airglow from MicroCarb.

d) Section 4, comparison between REPROBUS airglow model and SCIAMACHY observations: The conclusion seems to be that the model underpredicts ozone and so underpredicts airglow, and so is not suitable for estimating airglow instead of retrieving it. Not sure if this is worth 12.5 pages; perhaps this work could be summarized?

e) Sections 5 and 6: It seems to me that this is the heart of the paper, and other sections should be adjusted so that they contain just what is needed to support the material in these two sections.

f) Section 7: This seems to be a literature review, and not directly relevant, except perhaps the comments regarding CO₂ airglow and potential impact on MicroCarb retrievals.

g) Section 8, Conclusion: might need adjusting if the revisions above are considered.

Technical Corrections: Some of these corrections may be OBE if the major changes identified above are considered:

1) page 17, eq. 19: I think that the expression under the sq root in the third line should be $r_0^2 - p_1^2$, NOT $r_1^2 - p_0^2$

2) Figure 19: It was very difficult to distinguish the stars and diamonds in the plots.

3) page 40, line 21: 4ARTIC retrieves CO₂ and H₂O on 19 vertical layers: what is the typical number of degrees of freedom for these retrievals? Is the profile information actually meaningful, or is it really just a column retrieval?

4) page 41, line 20: "...Henyey Greenstein function with g currently fixed to 0.8." A reference might be helpful here, for the function and for the choice of g.

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5) page 44, line 4: drop the extra "(" in $Ag((\lambda))$; line 13: what reference spectrum is used?; line 14: drop the "." after "spectrum.,"; line 27: change "spectru" to "spectrum"; line 28: So random error only, no calibration error, channel crosstalk, etc?

6) page 55, line 14: delete "contaminated" (redundant after "contamination"); line 35: change "ETL" to "LTE"?

7) page 59, line 11: delete "inclusion of a" (redundant with previous "inclusion in the")

8) page 66, line 15: I think that O₂(b¹S) should be O₂(b¹Σ)?

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