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Atmospheric Measurement Techniques Discussions

Interactive comment on "Quantification and mitigation of the impact of scene inhomogeneity on Sentinel-4 UVN UV-VIS retrievals" *by* S. Noël et al.

Anonymous Referee #2

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1 General comments

The article addresses an important question in the development of retrieval algorithms for hyperspectral UVN instruments for atmospheric chemistry. With changes, the article should certainly be published.

There are some areas in the text that require clarification before publication. Some of the figures will need to be updated with bigger lettering and some perhaps with a more convenient color scale.

I miss a discussion of the applicability of this study to other spectral regions, in partic-

ular the NIR channel. The oxygen A-band itself may cause an inhomogeneous illumination of the spectral slit, i.e. the reflectance ratio may itself (strongly) depend on the wavelength. For the trace gases considered in the present form of the article this is not an issue, but for the oxygen A-band this most likely isn't the case. Without showing actual results the authors mention that the method is applicable. Further evidence of this is appreciated.

2 Specific comments

2.1 Scene description

The scene description given on page 2047, lines 16 – 19 is not consistent with the latitude where the spacial resolution requirement mentioned in footnote 1 is given. The latter can be found on page 2048. The time given in this scene description is not consistent with the time of overpass of the reference scene as observed by MODIS, as shown in figure 1 either. This is probably inconsequential, but using a consistent set of parameters is highly recommended.

2.2 Reflectance ratio

On page 2048, in equation 1 the reflectance ratio is defined. This definition is not symmetric, and I wonder if this is indeed the most practical definition. Have the authors considered something similar to

$$RS = 2\frac{L_{left} - L_{right}}{L_{left} + L_{right}} \tag{1}$$

as a "reflectance symmetry". It has the property that it is symmetric with a sign change when L_{left} and L_{right} are interchanged, and ranges from -1 to 1.

2.3 Cloud fractions

The MODIS cloud fractions are determined from thermal infrared observations. However, the threshold values for the visible channel are determined such that the averrages are the same. This requires a more thorough explanation. Thin cirrus may be given too much weight in this method, leading to a higher level of cloudiness than is actually visible.

2.4 Reflectance

The authors use a definition of reflectance on page 2050 in equation 2 that is a direct ratio of radiance and irradiance. They then explain in a footnote that there are other definitions. This is confusing. Please call the direct ratio “Sun normalised radiance”, or use a definition of the reflectance which scales to the range $[0, \ldots, 1]$, i.e. $L = \pi I/(\mu_0 R)$. It is agreed that this is not relevant to the study, but this type of confusion should be avoided.

2.5 Retrieval and error mapping

The description of the retrieval method in section 2.5 is very minimalistic, and should be expanded. While optimal extimation as written down by Rodgers is a well known technique, there are many implementation details that affect the output. A discussion of the retriaval bias and retrieval precision is needed. Also the description of the role of the a-priori information should be expanded.

Op page 2052, lines 3 – 8, the authors mention that the error analysis is incomplete, and separates out the error on a single parameter. They imply that this error is the error due to inhomogeneous slit illumination. In my view further clarification of this paragraph is needed, as it plays a central role in describing what is shown in the article.

2.6 Results

The effect of the wavelength calibration is discussed in section 3. However, the size of the wavelength shift itself is not given.

2.7 Conclusions

More quantitative conclusions may be drawn. The three separate conclusions on page 2054, lines 7 – 12 are rather qualitative, while numbers are avaliable elsewhere in the article.

The last part of the conclusions were not discussed earlier in the article. While plausible, they should appear earlier on. The conclusion as given here seems in contradiction with the good results obtained in the error analysis and error reduction. Further details are needed why additional attention to the effect of inhomogeneous illumination of the spectral slit in the on-ground calibration phase is needed.

2.8 Inhomogeneous ISRFs

I found appendix A hard to read, but after careful reading I believe this is correct. However, I miss a discussion on the limitations of the modeling of the inhomogeneous illumination. Does an inhomogeneous illumination of the spectral slit lead to an inhomogeneous illumination of the dispersive element? If so, what is the impact of that on the width of the slit function?

2.9 Spectral calibration

The authors introduce equation B5 on page 2060 for the spectral calibration of radiance spectra. They state that this can be used for oxygen in the NIR channel, using equation B6. They state that this is a DOAS-type method. Applying a DOAS like technique to the oxygen A-band is likely to end in tears. The authors should either explain in detail how this can work for the oxygen A-band, or remove references to the NIR channel.

3 Technical corrections

- Page 2044, line 12. Be specific. "It could be concluded. . . " is vague. Suggest to use "We conclude".
- Page 2044, line 16: "by factors up to > 10". Suggestion to write "by factors up to 12", as this is the actual maximum in table 3, or use "by factors up to about 10".

3.1 Comments on the figures

Fig 2 A cloud frction is given without further details in the caption. Describe its source here.

The colorscales are not adequate. Many pixels fall into the same color-bin, this could be addressed by selecting an appropriate range.

Panel *d* has a clear central value (either 1 or 0 if my suggestion for RS is followed). The colorscale should reflect this.

Fig 3 The lettering is too small.

Fig 5 The lettering is too small. The color combination is especially hard on (most) colorblind readers.

Fig 6 The lettering is too small. Mention the abbreviation in the caption (CF = cloud fraction).

Fig 7 Mention the abbreviation in the caption (SC = spectral calibration).

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 2043, 2012.