

AMT REVIEW: Impact of stray light on greenhouse gas concentration retrievals and emission estimates as observed with the passive airborne remote sensing imager MAMAP2D-Light

General Summary

Huhs et al. present measurements from a new airborne hyperspectral pushbroom spectrometer targeting CO₂ and CH₄ in the 1.6 micron band. During their maiden campaign they discover that their data suffers from substantial stray light contamination, caused by reflections from the entrance slit. They implement a correction using the TROPOMI stray light correction algorithm to salvage their observations.

The subject matter is within the scope of AMT. I believe it is of use to publish as a reference for future campaigns where the instrument is deployed. I think the organisation could be improved and the paper could be made more concise. Since the stray light correction method is not new, I would prefer the authors to shift the focus more towards the stray-light impacts on the retrieval, as weirdly the novel aspect could be the unintended experiment created by the adjustable slit. I am surprised by the reaction from the other reviewers - the paper is similar in quality to an average paper I have seen in AMT.

Comments

Pg 5 L 96: I believe the first reviewer stated that the slit configuration was different during the campaign than during the stray light measurements. But it does say later that the measurements later were taken using the CoMet campaign conditions (Pg 7, L162), which I assume means the slit was in its fully open position. If this is the case perhaps it should be stated explicitly to avoid confusion.

Pg 6 L132: The notation of Eq. 1,2 is a bit weird. First, since the error term appears on the RHS, I believe the LHS of Eq 1 actually corresponds to the authors R^{mea}_{λ} . Secondly the function R^{mod}_{λ} appears on the LHS and RHS. The one on the right should be denoted something like R^{RTM}_{λ} or something like that because it corresponds to the simulated spectrum from the radiative transfer simulation. Then R^{mod} would be equation 1 without the error term, making the objective function in Equation 2 make sense. A normal way to write equation 2 would be

$$\arg \min_{\mathbf{x}, \mathbf{c}} ||\ln R_{\lambda}^{\text{mea}} - \ln R_{\lambda}^{\text{mod}}(\mathbf{c}, \mathbf{a})||^2$$

Pg. 6 ln 136: Is there any particular reason why the measured radiances are log-transformed? In terms of radiance, the noise errors are approximately normally distributed, so the errors in this

case will be log-normally distributed. This means that the least squares estimate is no longer the maximum likelihood one.

Pg 9, L206 - It might be helpful to add some arrows to Figure 5 labeling the features due to the sources of stray light discussed in Section 4.1

Pg 12, L278 - There seems to be quite a bit more variability in the intensity of the ghost spot than what is modeled using the first order polynomial fit. It also looks real, in the sense that there is correlation between the calibration measurements. Is there a reason to believe this is an error that needs to be smoothed, or could some non-parametric method like radial basis function interpolation be used instead? It might be worth testing if something like this would improve the test case in Fig. 9.

Pg 14, L325: PSF is already being used for point spread function. The acronym for profile scaling factor should be changed to something else.

Pg 16, L372: As a general rule it is best to organize figures sequentially in the order that they are first referenced in the paper.

Pg 17, L380: The proxy uncertainty seems too close to the CH₄ uncertainty in the stray light corrected case. If the error is completely uncorrelated with the CO₂ column it should be ~0.44. 0.34 implies that the errors in CH₄ and CO₂ columns retrieved are almost perfectly correlated. That is really weird to me - is the instrument random noise really that low? It could be a typo as the value for the ratio looks to be about 0.44 in Fig. 13.

Pg 23: Perhaps Fig. 14/15 and Fig 16/17 can be combined into two panel figures.

Minor Corrections

L53: building -> building

L80: "and thereby, allowing to operate the instrument at ambient temperature." -> and thereby allowing the instrument to operate at ambient temperature.

L107: adpated -> adapted

L 115 and L399:: Quadratic sounds weird in this context. I think saying "square" is fine.

L 402 Sect. D -> Appendix D.