Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., author comment AC1
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Reply on RC1

Sean Crowell et al.

Author comment on "Performance and polarization response of slit homogenizers for the GeoCarb mission" by Sean Crowell et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-146-AC1, 2022

<General Comments>

Imaging spectrometer with high spectral resolution is a key technology for greenhouse gases and their related species monitoring by remote sensing. Acquired image provides large emission sources and plume information. Very narrow spectral width needs moderate optical throughput to achieve high signal to noise ratio. Inhomogeneity within the footprint distorts the instrument spectral response function (ISRF). Gratings are conventionally used, but they have high polarization. Measurement techniques acquiring solar lights reflected by the Earth's surface and scattered by thin cloud and aerosols should care input light polarization, too. The topics discussed here is challenging and important. My question is which is more critical for GeoCarb: polarization sensitivity or spatial inhomogeneity? Both OCO-2 and GeoCarb are using high resolution imaging spectrometer technology, but they have different swath, spectral coverage, and throughput, The OCO-2 and OCO-3 on orbit already achieved low bias and reduce random errors in CO_2 retrieval without using state-of-art slit homogenizer. Are there a critical angle and/or spectral band, and footprint size, where the distortion in ISRF becomes critical for CO2 retrieval? What is the main difference between OCO-2 and GeoCarb?

Thanks for your question. Indeed, the ISRF shape is very important for GeoCarb as it is for the OCO missions. We have done some experiments that are in a paper in preparation that show we can mitigate much of the retrieval error by introducing an ILS stretch parameter into the state vector of the retrieval algorithm. We will add some text to the manuscript to this effect. Note that the OCO missions mitigated the effects of scene inhomogeneity through reduction in image quality. This, combined with the much smaller footprint, have effectively gotten rid of this as a challenge. This was checked with our ILS fitting tests applied to the OCO-2 data where we found almost no change.

Slit design, method, and results of characterization test in the laboratory are well described. I recommend minor revision before publication.

Thank you!

<Specific Comments>

(1) Page 4. MODIS data

If it is a real data, the location and date of the observation should be described.

Agreed. We will add this in the revised manuscript.

(2) Page 10, Fig. 6 The right figure

Is “analyzer” a “polarizer” in the middle figure? Description of analyzer is needed.

Yes, that's the case. We will correct this label in the revised manuscript.

(3) Page 10, Line 187 “noise”

Is it random electrical noise?

The variations in values in the image are driven primarily by shot noise and read noise.

(4) Page 13, Figure 8, “different level of illumination”

More detailed explanation such as definition of “level”, will help readers’ understanding.

We will clarify in the revised manuscript.