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Atmospheric Measurement Techniques Discussions

Interactive comment on "An SNR-Optimized Scanning Strategy for Geostationary Carbon Cycle Observatory (GeoCarb) Instrument" *by* Jeffrey Nivitanont and Sean Crowell

Jeffrey Nivitanont and Sean Crowell

jeffniv@ou.edu

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"This paper develops a scanning strategy for the upcoming GeoCarb mission from geostationary orbit, using an optimization algorithm to establish the greatest return in terms of soundings that exceed an unspecified minimum threshold in signal-to-noise ratio (SNR). The development of the approach appears logical and seems to give reasonable results. To me, though, it feels like a starting point for a more detailed treatment. It treats the land masses of the Americas as a "uniform space," treating all points as equally important. While it is crucial to obtain global coverage (over the viewing area of the satellite), it seems to me that not all locations are equivalent in terms of monitoring

greenhouse gas emissions. There are presumably hot spots of industrial activity that could benefit from closer scrutiny. The measurements do no extend to high enough latitude to capture emissions from the Alberta oil sands, but you will measure over the U.S. oil shale deposits in Colorado, Utah, and Wyoming, for example. I say this because one of the purported benefits of having the mission on a geostationary platform was that, according to the manuscript, "areas with high and uncertain anthropogenic emissions of CO2, CH4 and CO may be targeted with contiguous sampling," but this benefit is not exploited with the proposed scanning strategy. One would need to attribute increased weight to the hot spots to properly shade the coverage. The authors do mention the notion of adjusting the coverage to study events such as volcanoes and large wildfires, but that is a separate notion, a temporary campaign mode rather than a regular coverage strategy."

Our original goal for this study was to quantitatively obtain a scanning strategy that would cover the satellite viewing area once and result in the highest quality measurements of the Americas. The decision was made to scan the area between 50 degrees north and 50 degrees south in our study because it includes the areas of interest in the six science hypotheses stated in Moore et al (2018). To make this clearer to the reader, we've included the six hypotheses in the introduction.

We also agreed that demonstrating a scanning strategy with equal weighting for all land masses in the satellite viewing area does not illustrate to the reader the advantage of a geostationary platform. Therefore, we ran an additional experiment for a "city campaign" mode and added it to Section 5 of our manuscript. We would like to reiterate that this study is just a demonstration of one of many possible techniques and is not the proposed scanning strategy for the GeoCarb mission.

"Another benefit mentioned for the geostationary platform was that you could improve the signal by increasing the dwell time for a measurement. I do not know if there is some constraint that would require every scan to be identical. If one could select the measurement dwell time employed in each individual scan, for example, one could im-

prove the results in regions where a large percentage of the soundings would otherwise fall below the SNR threshold and therefore be tagged as unusable. In this scenario, scan time would become an additional parameter to include in the optimization."

GeoCarb does not have the measurement dwell time as a parameter to be optimized since the long observation slit will, in general, cover areas of both low and high SNR in every scan. Additionally, maximizing observations from low SNR areas is not a primary goal of the mission, as seen in Moore et al (2018).

"The authors indicate that no results above the oceans are possible due to low signal. Is there no possibility of making use of ocean glint, as the OCO-2 mission does? This would obviously only work at certain times, when the conditions were such that sunlight reflected off the ocean at the same angle that the instrument was viewing the surface, but it would expand the coverage."

It is true that GeoCarb can theoretically make observations of ocean glint, but that is also not a primary objective of the mission.

"Judging from Figure 4, the gain in "usable soundings" relative to the baseline approach appears to be strongly related to a reduced number of measurements over the oceans. The expected improvement in errors over the Amazon is presumably related to the increased number of overlapping scans in that region."

In general, the increased number of overlapping scans is indeed a reason for increased number of soundings. However, we have added histogram plots of airmass and solar zenith angle, which are the stationary parameters on which our algorithm optimizes on, to show that the algorithm is selecting scanning blocks at peak airmass and solar zenith angle more than the baseline strategy.

"Note that no mention was made of what constituted a usable sounding. The last sentence relates the gain in soundings with SNR > 100, but it is not clear if that was the threshold employed for the determination of whether a particular measurement was us-

able. Based on the discussion on page 4, the calculated SNR was associated with the O2 A-band measurements. That means you assumed the SNR for the measurements of the CO2 bands was higher, or at the very least comparable?"

That was a typo and it has been corrected to say the SNR associated with the Weak CO2 band.

"In the text (page 8, lines 9-10), the statement is made that Figure 6 showed the minimum error distribution medians and variances occur where both weights are equal to 1. For me, that does not seem like an obvious conclusion to draw from the figure. It certainly seems true for the upper left panel, and maybe for the median in the upper right panel, but unless I misinterpret what is being said, I do not see it for the other plots."

We changed our language to say that the weighting of the terms does not have a large impact on the predicted error. We point that the spread of error medians and variances is approximately 0.01 ppm and ultimately decided to leave the weighting at 1.

"Minor comments Page 2, line 2: the acronym "FoV" was defined but not used again, so there is no need to define the acronym"

Fixed in manuscript.

"Page 8, line 9: "Figure 6" should be "Fig. 6""

Since the figure is referenced at the beginning of the sentence, AMT guidelines tell us to spell out the entire word.

"Page 8, line 17: "Fig. 7 and 8" should probably be "Figs. 7 and 8""

Fixed in manuscript.

"Page 9, line 9: . . . mean Error. . . >Why is "Error" capitalized?"

Fixed in manuscript.

“Page 9, line 13: “Fig. 5 and 10” should probably be “Figs. 5 and 10””

Fixed in manuscript.

“Page 10, lines 4-5: “We also found that by optimizing for the global distribution of error, we obtained an improvement in regional errors as well, seen in Fig. 8” >This is not true for all regions, maybe an “overall improvement””

We agreed and fixed our language to state an “overall” improvement rather than the former.

“Page 10, line 13: the acronym "AOD" is not defined”

Now defined in manuscript.

“Figure 2: The caption claims that the plots relate to June (on the left) and December (on the right). The titles on the plots suggest they relate to September (on the left) and June (on the right).”

Fixed in manuscript.

“Figure 6: The variables w_dist and w_overlap are used to label the plots rather than w_d and w_o, the variables employed in the text.”

Noted in caption.

“In Figures 8 and 9, it looks like there are no results over Cuba (greyed out?), even though that region appears to be within the scan range.”

Cuba is not included in our scanning region as it is not a region of interest for the six hypotheses listed in Moore et al (2018).

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