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

Anonymous Referee #1

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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

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Discussion paper

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.

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 improve 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.

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.

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.

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 usable. 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?

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.

Minor comments

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

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

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

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

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

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”

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

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).

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.

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.

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