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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

Anonymous Referee #2

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General Comments

The manuscript deals with the optimization of geographic coverage, which is a problem of interest for geostationary satellite remote sensing. The approach presented in the manuscript is new and deserves publication in AMT. However, the approach and its underlying assumptions need to be better explained and the discussion of the results needs to be made clearer. The manuscript needs to be revised addressing the issues identified below.

Specific Comments

1. The proposed scheme aims at enhancing the yield and quality of a geostationary

CO2 observation system by optimizing the scanning strategy with a focus on the Signal to Noise Ratio (SNR). Many other parameters that are expected to drive the yield and quality of such observations are not taken into account. Degraded CO2 product quality is expected not only in cases with low SNR, but also in many other conditions e.g. when viewing geometries are slant, when target air masses contain clouds or aerosol, and when clouds cover parts of the field of view thus increasing the risk of spatial stray light. The choice of focusing on SNR needs to be justified, and the approach regarding other potential drivers need to be explained and motivated.

2. The link between radiometric noise and the total CO2 uncertainty need to be discussed in more detail (beyond reference to O'Brian, 2016 and Eq. 3). The main contributors to the CO2 product uncertainty budget need to be discussed, and it needs to be explained why the optimization is driven by the random radiometric error.

3. The objective function given (Eq. 5) minimized in the optimization scheme seems incomplete. The SNR depends on the radiance signal level (Eq. 2) hence also on the solar zenith angle (SZA) (Eq. 1). However, the SZA does not appear explicitly in the objective function. The penalty on slant illumination conditions seems to be missing.

4. The top-level concept of the optimization scheme needs to be explained upfront (i.e. briefly in the abstract and in more detail in the introduction). Please clarify key elements such as a) that the scheme is to be applied off-line to determine a static scanning strategy, b) that near-real time information eg on cloud conditions is not taken into account, c) that the scheme is implemented by incrementally adding observation blocks, d) that the selection of the added blocks is performed by optimizing parameters X, Y, Z.

5. It is concluded that the IO based solution outperforms the "obvious human" solution. This statement needs to be either better supported addressing a the apparent weaknesses listed below, or revised. Weaknesses include: a) the "obvious human" solution is to some degree arbitrary, there might be better guesses; b) comparisons

are shown only for two cases with similar time of day, the situation can be different for other times; c) improvements in Amazonia and degradations at other places are reported (Fig 8), but it is not clear how global performances are determined and compared; d) differences in the total number of usable observations are reported (Section 4.1) but the basis of these numbers is unclear; How is the number of 'usable soundings' determined? Are there thresholds on SZA, AMF, SNR, albedo, .. ?

6. Section 4.2 reports a sensitivity analysis based on the assessment of regression coefficients. The conclusion of this analysis is unclear. Please clarify the conclusion in Section 4.2 and discuss the result in the overall context, in Section 5.

7. Figures 5 and 10 are not understood. Specify, also in the caption, which parameter is plotted on the ordinate, what the colour coding means, which distributions are represented by the 'violins'. Why are distributions plotted as double-sided graphs?

Technical Corrections

Section 3.6 The iterative determination of scanning blocks might be dependent on the starting point (the location of the first scanning block). Have various different starting positions been investigated?

Section 3.5.2 Is full and contiguous coverage of the continental Americas within +/- 50 deg lat within a day a hard boundary conditions for the optimization?

Page 4 line 18: the aerosol optical thickness of 0.3 is considered very large. Please justify. Aerosol optical depth depends on wavelength. What is the reference wavelength for the optical depth values provided?

Page 4 Eq 2: please provider units of parameters N0 and N1 (which should be same as the units of I)

Page 4 Eq 3: please clarify the meaning of sigma (introduced as the observational uncertainty). Clarify whether it is taken as the dominant contribution to the XCO2 vertical column uncertainty. Discuss the validity of this assumption.

Page 4 Eq 3: Specify units of sigma.

Page 5 Eq 4: eq 2 established a simple noise model. Eq 5 established an alternative more simplistic noise model. Why is the latter needed?

Page 5 line 7: unclear what is meant with "multiplicative inverse"

Page 5 Eq 5: 's' is used in an inconsistent way. It is introduced as an index to label the candidate block. It appears as a parameter in the argument AF, where it probably should not appear since x and y already capture the horizontal spatial dimensions. At the same time it represents an area in the spatial overlap operation; instead a dedicated variable (eg A_s) should be used to represent the area of the candidate block s.

Page 5 Eq 5: specify across which domain the median is evaluated. I guess it is the area of the candidate block 's'.

Page 5 Eq 5: The variables E and I should be introduced as 'areas of' the target land mass and of the selected scan blocks.

Page 5 Eq 5: the distance delta is not well defined. Please clarify from which point to which point is it to be evaluated.

Page 6 Section 3.5 discusses a finite number of possible locations of a scan block, which suggests that blocks can be located only at discrete positions. Please clarify whether this is correct. If so, introduce this constraint explicitly and specify the grid of candidate locations.

Section 3.5 Page 6 Section 3.5 line 9-10: The formulation ". . . a Greedy heuristic algorithm was employed to find a minimal covering set as a lower-bound estimate for set cardinality " is not understood. Please clarify what is meant with the term 'cardinality' in the present context?

Page 7 line 7-10 very long sentence, meaning is unclear. Please split and reformulate.

Page 7 line 7-10 Please clarify and elaborate how to the optimum at weights=1 is found.

Page 7 line 7-10 The variance of predicted errors is mentioned. On which parameter and over which domain is this variance evaluated?

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