

Atmos. Meas. Tech. Discuss., referee comment RC1
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Comment on amt-2021-224

Anonymous Referee #2

Referee comment on "The Space Carbon Observatory (SCARBO) concept: assessment of X_{CO_2} and X_{CH_4} retrieval performance" by Matthieu Dogniaux et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2021-224-RC1>, 2021

The authors introduce a new concept called the Space CARBOn Observatory (SCARBO), which aims to measure CO₂ and CH₄ from a constellation of ~20 satellites in sun-synchronous low Earth orbit, with a multi-angle polarimetric aerosol instrument to account for scattering effects. SCARBO will have higher spatial coverage and revisit frequency compared to existing greenhouse gas missions. The authors assess the performance of SCARBO for a variety of scenarios, both with and without the aerosol instrument. They find that systematic errors in column-averaged CO₂ and CH₄ (X_{CO_2} and X_{CH_4}) retrievals can be greatly reduced by using aerosol information from the polarimeter. The authors also parameterize results as a function of relevant parameters in order to facilitate efficient computation of error maps for CO₂ and CH₄ flux estimation.

The manuscript is well written and the topic extremely relevant to the greenhouse gas remote sensing community. However, a few issues need to be addressed before it is ready for publication.

Lines 148-149: "Entanglements between CO₂, CH₄, O₂, H₂O and aerosols signals have been considered, with the assumption that albedo models are constant over all four spectral bands." What is the impact of varying albedo on the results? Also, only soil, vegetation and desert types are considered. What about water? Many emission sources (e.g., power plants) are near the ocean, so coastal areas would need to be considered.

Lines 235-236: "The interfering impact of temperature has not been taken into account for the latest optimized OPD selection used in this work, and is not considered in the state vector." What is the impact of this assumption on the retrievals?

What is the impact of retrieving profile scaling factors for CO₂ and CH₄ as opposed to retrieving the vertical profile (that is traditionally done by OCO-2, for example)? Have the authors assessed the impacts on accuracy and on downstream flux estimation?

Lines 300-301: "For this synthetic performance study, constant trace gas concentration profiles have been used: 394.85 ppm for CO₂ and 1855.3 ppb for CH₄." This seems (unnecessarily) restrictive (see also previous comment). There needs to be an assessment of how results change for realistic CO₂ and CH₄ profiles.

Aerosols: the authors might want to say that the fine mode particles are assumed to be spherical. It would also be useful to have a sentence describing how the aerosol single scattering properties were calculated (e.g., Mie for spherical, T-Matrix for spheroidal?).

Is SCARBO only going to make measurements in the nadir mode? If not, the viewing zenith angle needs to be a parameter that is considered in the evaluation of the scattering error.

Grammatical Errors / Typos:

Line 118: Acronym OPD already defined

Line 151: FOV (2) an analytical approximation -> FOV, and (2) an analytical approximation

Lines 152, 258: "line-by-line" would be more appropriate than "pseudo-infinite"

Lines 171-172: "The constellation sizing aims at ensuring intra-daily revisit of the largest possible amount of anthropogenic CO₂ emission hotspots which emission rate is compatible with the 1 ppm SCARBO δ □□□!!! precision objective." Awkwardly phrased

Line 173: "performed" -> "compiled"?

Line 178: remove "a" before "global coverage" and "daily revisit"

Line 179: compromise well -> provides an optimal compromise

Line 191: measures -> measurements

Lines 197-198: what is meant by "without artificial noise"? The text indicates that instrument noise is considered in the retrievals. I would recommend removing this phrase to avoid confusion.

Line 260: measure -> measurement

Line 268: Acronym FOV already defined

Line 276: fasten -> speed up

Line 368: "more disadvantageous" is too vague. Please use a more descriptive term.

Lines 369-360: "more favourable" please use a more quantitative term (more forward scattering?)

Line 448: of all atmospheric layers -> in all atmospheric layers

Line 498: on the optical path -> in the optical path