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Atmospheric Measurement Techniques Discussions

Interactive comment on "Anthropogenic CO_2 monitoring satellite mission: the need for multi-angle polarimetric observations" *by* Stephanie P. Rusli et al.

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general comments

This is a very interesting paper that addresses a very important, relevant question. The authors use a simulation system to investigate the benefits of including multiple angles and polarization sensitivity for instrumentation aimed at characterizing XCO2. It is a well structure paper - clearly explains the experiment that was conducted and the outcome. There are a few areas where I'd like to see some additional information, as this work suggests a real transformation in our ability to retrieve XCO2 from space, so any critical assumptions should be articulated.

specific comments 1) The performance shown in Figure 7 is astonishingly good. It would be a significant advancement if we can see this performance with remote sensing data. Therefore, it is critical that there is an understanding of how the simulation relates to actual data. Without experimental data that has the features described, this is hard to do, but I believe that a number of groups have performed simulation and then applied their algorithms to real data - for example RemoteC and ACOS applied to GOSAT and OCO-2? If earlier work informs us how do the simulations compare with the reality we can gain confidence that there are not significant error sources missing from the simulation system. The Wu et al paper on MSR makes a brief comparison between simulations and actual OCO-2 retrievals. I would recommend that the authors review the literature and see if there are more detailed discussions in Butz et al or O'Dell et al. to clarify the expected relationship between simulations of XCO2 retrievals and real life performance.

2) The separation of the spectrometer error out from the other errors is a good strategy. How did you decide on that allocation?

3) You don't have any discussion of the errors that will come from weaknesses in the forward model - the gas spectroscopy has remained a source of error for the OCO-2 mission, and I fully expect this will remain. How can you also consider that error in your analysis or estimate the impact?

4) The Frankenberg et al paper (2012) addresses multiple angle measurements and how they might help both aerosol and xco2 characterization. that paper should be cited in the introduction where a review of literature on the interference of aerosols and the value of multi-angle measurements is presented.

5) Is the the linear error analysis section with all the OE equations really needed? Citation of earlier papers (such as Hasekamp et al or Kulawik et al) should be sufficient. Alternatively, include the central equation in the paper and the rest in the appendix. Don't need to lay out that math in every paper that uses OE and applied linear error

analysis.

6) Is there enough difference in the aerosol variables of the simulation and those in the retrieval?? Some of the terms remain the same, and it isn't clear if that contributes to . I think it would be useful to have one table that has the simulation and retrieval info all in once place. I found myself repeatedly flipping back and forth so I could see how the retrieval set up differed from the simulation set up.

7) I am very interested in the performance of the aerosols themselves. The authors just say this won't be addressed. If this is to be written up in a separate paper, say that. If not, some information about the performance should be included. This could even be an appendix - There is a lot of insight to be gained about the overall retrieval system if we see all of the parameters.

8) What is the variability of water vapor and temperature profile information? Where we they drawn from? Was there any analysis of correlation of errors with these variables?

9) Again, the results presented here are impressive - a significant advance for remote sensing of XCO2. The simulations are all conducted for land surfaces, as the driver for this work is the study of human emission of CO2. But, for the larger carbon cycle science community, such an advance would be important. Can the authors add a few comments about how this work could be extended for glint measurements or if they explored the performance over water bodies (perhaps at a range of distances from the glint spot)? Or perhaps this is planned work for a future manuscript?

technical corrections

1) line 33: spelling of Commission

2) line 73: verb and subject don't match. Also, sentence structure us awkward. Suggest rewording to this "Linear error analysis is part of our study, to derive the optimal instrument specification for each of the two MAP concepts with regard to wavelength range, number of viewing angles and the measurement uncertainties."

3) line 77 and following - I don't think commas are needed. These sentence are correct if written this way: For the retrieval input we generate synthetic measurements that correspond to an ensemble of atmospheric and geophysical scenes over land. The MAP instrument for which the synthetic measurements are generated is tailored to the CO2M mission precision and accuracy requirements.

4) line 382 - refer to Equations A1, 2-4. What is A1? There is no appendix that I am aware of.

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