

Interactive comment on “Averaging Bias Correction for the Future Space-borne Methane IPDA Lidar Mission MERLIN” by Yoann Tellier et al.

Anonymous Referee #3

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The authors describe 4 different averaging schemes for implementing an Integrated Path Differential Absorption (IPDA) retrieval of methane, and provide mathematical analyses for 3 of them in regards to bias inherent in each approach. The context provided is the ESA MERLIN lidar mission, but the treatment provided is quite general and not specific to particular mission parameters.

I think the results provided are important considerations for developing the CH₄ retrieval algorithms. Horizontal averaging is a necessity in the retrieval, especially for weak signals, and the authors address the ramifications of various algorithmic design choices in regard to the bias inherent in the different averaging approaches. Congratulations to the authors on sharing an interesting result. It would be interesting to revisit this treatment with real mission data after MERLIN launches or with other suborbital

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data from mission formulation concepts like NASA's ASCENDS.

Isn't it true that in practice, a combination of the approaches presented might be necessary? For instance, the offline and online signals might need to be averaged separately first in order to accurately identify weak signals. Then further averaging of the DAOD or column mixing ratio can be applied to hammer down the noise.

I understand that the negative values indicated in Fig 3 are due to deriving the signal by subtracting a background value. For low SNR signals, the noise can dominate and push the background-corrected signal negative. In practice these cases would likely be filtered out by quality control executors, resulting in a skewed distribution as indicated. I would ask that the authors clarify what is meant by the negative signal values in the revised manuscript.

It is not obvious to me how or if the skewed distribution implies a bias. As I mentioned, in practice, I think such negative signal values would probably be filtered out so as not to enter the analysis. Please clarify.

Is laser speckle the dominant source of the statistical fluctuations? If so, speckle should be specifically treated in the manuscript.

Clouds in the field of view are a significant factor that are not treated. Partial/Spotty clouds might necessitate short averaging times to take measurements in the gaps. Thin cirrus clouds might be difficult to detect, yet cause significant biases. The authors should provide any input they might have on quantifying these factors.

Throughout the paper, the term "through" of the spectral line is used. Should this be "trough" or "center"? Furthermore, on page 2, line 8 is it really several absorption lines or just 1 selected methane line?

Page 2, line 14: "analyzes" should be "analysis"