

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-106

Anonymous Referee #2

Referee comment on "Evaluation of the High Altitude Lidar Observatory (HALO) methane retrievals during the summer 2019 ACT-America campaign" by Rory A. Barton-Grimley et al., Atmos. Meas. Tech. Discuss., <https://doi.org/10.5194/amt-2022-106-RC2>, 2022

This paper describes the first results from a lidar system deployed onboard a research aircraft measuring atmospheric methane. The paper is well-written, and fits well within the scope of AMT. However, a few issues listed below should be addressed before the paper can be recommended for publication.

General comments:

Note that the term "mole fraction" is recommended rather than "mixing ratio", see e.g. https://www.empa.ch/web/s503/gaw_glossary#recommendations. I suggest simply replacing throughout the text. Also I would recommend to consistently use ppb for dry air mole fractions of CH₄. Using both ppb and ppm (e.g. Fig. 10 (b)) is confusing to the reader.

Comparison to in-situ measurements: The deployment of the different aircraft sampling different altitude regimes really has potential, as indicated e.g. by Figs. 12 and 13 and the associated discussion. I suggest a simple combination of the in-situ measurements within the free troposphere from the C-130 aircraft, the boundary layer in-situ measurements from the B200 aircraft, and the estimate of the boundary layer height derived from the HSRL measurements onboard the C-130, to calculate a partial column XCH₄ based on in-situ observations that can directly be compared to HALO XCH₄. The assumption is that CH₄ is well mixed within the PBL and also within the free troposphere. Any advection of air masses with enhanced CH₄ above the PBL would clearly stick out as differences between HALO XCH₄ and the aircraft derived XCH₄.

Dry air mole fraction - impact from H₂O: In the in-situ measurement community there is much discussion on drying/conditioning samples before measurement vs. correcting based on simultaneous H₂O measurement within the exact same sample. As the authors describe, MERRA humidity is used in the retrieval of XCH₄ (the column average dry air

mole fraction). The uncertainty in XCH₄ introduced by this choice should be assessed, e.g. by comparing MERRA water vapor to that of the in-situ observations.

Specific comments:

L271 "over samples" -> "oversamples"

L280 "Altitude is used in lieu of MSL for all figures" this is not clear. May be "Altitude above MSL is used in lieu of Altitude above ground level"?

L280: "post- flight reanalysis" may be drop "post-flight"? I guess reanalysis products are available only for past periods, i.e. after the flights, anyway.

L331: "The superscript will be dropped for simplicity." Which superscript?

L362: the matrix T should contain the elements that the beta-vector elements are multiplier with, i.e. 0th, 1st 2nd and 3rd order terms as formulated in the Eq. on line 361. May be simply write down the first and last row of the matrix, and the few elements

Fig. 6: please adjust color selection for the different gains so that color blind people can read the figure. To me HOLE and LOLE are identical, LOLE is very slightly different.

Fig. 6 caption: please explain DEM (I know what it is, but it should be mentioned once)

Fig. 11: the Y-intercept is not clear. It should be negative, given the slope is larger than one, and the regression line crosses the 1:1 line at around 1900 ppb.

L522: "PA region" – to make this clear to non-US readers (AMT it is a European journal) may be add a label to Figs 11 (a) and (c)

L571: I don't see any cross-hatched area in Fig. 14, may be I am misunderstanding something

L612 "spatial" -> "spatially" or drop

L659: the dial DAOD estimated at SSE shown in the inset of Fig. 17 (b) (magenta symbol) is around 0.2875, not at 0.9243 as given in the text. Please clarify.

L661: "un-bias-corrected" may be use non-bias-corrected

L736 "PBL fluxes" use PBL mole fractions or concentrations