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Open Access Earth System Science Data Discussions

Interactive comment on "Satellite and Ground-based Measurements of X_{CO_2} in a Remote Semi-Arid Region of Australia" *by* Voltaire A. Velazco et al.

Anonymous Referee #1

Received and published: 4 February 2019

This study presents ground-based remote sensing measurements obtained in remote central Australia. The primary goal of these ground measurements is to compare with satellite measurements (esp. GOSAT) since there is a paucity of ground-based observations not only in central Australia, but also in other locations worldwide with high albedo surfaces. For ground observations to be useful for satellite comparisons, they need to have a higher accuracy and the authors walk through different steps taken to ensure data quality. Overall this study is highly useful to the community and will be a guide to others collecting observations and comparing with satellite retrievals in remote locations. I recommend some minor revisions primarily to increase details and improve clarity.

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Discussion paper

General comments

G1 – The word “calibrate” has been used throughout to describe reducing the mismatch between TCCON and EM27/SUN retrievals, when in most cases “scale” would be a better choice. Calibration is generally reserved for something directly observed of known accuracy, and XCO2 is neither. In some situations “calibration” is okay so the wording is not too awkward (e.g., calibration curve), but should be changed in most instances.

G2 – It seems that differences in averaging kernels (AKs) and a priori profiles have not been considered in this study. E.g., on P2L35 it is stated measurements can be compared directly. It should be explicitly stated why AKs were not considered. Perhaps the a priori profiles are close enough to the true profiles *in this location* that accounting for these different sensitivities would make little difference? Also, it seems observations were first averaged rather than directly compared from both the EM27/SUN and GOSAT? It would also be interesting to know how much of the H to M gain bias is from AKs, if any.

Specific comments

S1, P1L7: State length of campaign here

S2, P1L∼1: How exactly are the different gains chosen and used for GOSAT? Is gain chosen in real time by an onboard sensor, or are all gains recorded and the retrieval just picks the best one later? How/why did the gains change in Fig. 1 going from v 2.60 to v 2.72?

S3, P2L16: What does this mean? There are still some large cities in deserts.

S4, P2L20: This goes back to the question of how gain is chosen, but are M-gain regions always exclusively semi-arid? If so where does the classification of climate come from in the algorithm?

S5, P2L20: Carbon cycle studies could be (and have been) carried out with biased

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satellite retrievals, even if the bias is “small.” I think the focus here though is if the goal is to continuously improve the accuracy of these studies, then accuracy of satellite retrievals needs to be improved as well. What would happen if all observations over high albedo were not available? Likely results would be biased, and would lead to misinterpretation.

S6, P2L25: Why is high reflectivity a challenge for satellite observations? How does the extra reflectance influence the retrievals negatively? (Same question on P15L12)

S7, P2L25: How does having challenging observations naturally lead to their improvement? (Maybe the meaning here is it rather an opportunity?)

S8, P2L27: Why are such studies needed?

S9, P3L1-2: Suggest you pick a notation for EM27 or EM27/SUN early on and stay consistent throughout the entire paper.

S10, P3L2: Are v 2.60 data bias corrected? How?

S11, P3L1-2: Suggest you move this sentence to later on in the paragraph where again it states EM27/SUN retrievals were compared with GOSAT.

S12, P3L9: How was the EM27/SUN retrofitted?

S13, P3L10: suggest you include 2 decimals on latitude. Also, include dates here.

S14, P4L4: Specify these are column measurements.

S15, P4L7: Was the 2nd detector present for this study? Give full spectral range for this detector.

S16, P4L7-8: Suggest you move this sentence before the previous one. Currently it sounds like O2 is measured on the secondary detector.

S17, P4L9: What is the spectral resolution of TCCON measurements?

S18, P5L2: “greenhouse gas (CO2 and CH4) total columns” could simply be replaced

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with “XCO2 and XCH4.”

S19, P5L∼23: Suggest you describe how Xair can provide info on stability (e.g., as a measure of retrieved O2, which is not particularly variable in dry air).

S20, P6L2: Clarify “specific” here. Is it only soundings within 100 km of the EM27? Are they compared individually or averaged together?

S21, P7L4: Frey et al., 2018 (https://doi.org/10.5194/amt-2018-146) would also be an appropriate reference here.

S22, P8: Was there any other alignment of the EM27 or TCCON instrument during this period?

S23, P10Fig6: Specify what points represent in caption. Daily averages? Daily averages within certain sza?

S24, P11L2: How were GOSAT data interpolated? (spatially? temporally? method?)

S25, P11L3: This is an unweighted mean?

S26, P11L12: Quantify approximate magnitude of annual increase here.

S27, P12L1: Did the number of H-gain observations decrease, or just the number of successful retrievals? If it’s just the retrievals could it be an increased failure of convergence?

S28, P12L2: Apr-Aug mean in absolute number of soundings would also be useful here, same on line 4.

S29, P12L1-7: Seems a better sentence order could be: less rain -> less vegetation -> bright surface/more M-gain (rather than less vegetation -> bright surface/more M-gain -> less rain).

S30, P12Table1: What do the seconds mean on the measurement times? Start time? Central time? Seems the measurements could take up to 20 seconds. Also, the pur-

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pose of the first and second to last rows is not clear if no GOSAT soundings were acquired.

S31, P13Fig9: I do not really like lines fit through single points. Granted the intercept is forced through zero, but I think this information would be better for a table.

S32, P14L2: Where did these values come from?

S33, P14L7: satellite measurements -> satellite and ground-based measurements

S34, P15L2: What about Wollongong? Darwin? Reunion? Showa? Arrival Heights? Ascension? (Fig. 1: https://doi.org/10.5194/amt-9-2381-2016)

S35, P15L4-5: This sentence seems a bit redundant with the first sentence.

S36, P16L∼1: Also add a description on how GOSAT data can be acquired

Technical

T1, P1L7: values, a -> values, another

T2, P1L11: improve -> better understand (or estimated -> estimation of)

T3, P2L4: along with -> and there has been

T4, P2L6: version 2.72 -> version 2.72 Xgas retrieval algorithm (w/o sentence seems to be missing a subject)

T5, P2L8: precise -> precise and accurate (?)

T6, P2L17: by anthropogenic -> by recent anthropogenic

T7, P2L20: are -> is

T8, P2L25: provides -> has

T9, P2L25: which challenges -> which is a challenge for

T10, P2L27: could be -> is

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T11, P2L28: portable -> portable solar-viewing

T12, P3L8: “in the urban area” seems redundant, maybe omit?

T13, P3L17: average high -> average daily high

T14, P3L18-19: omit parenthetical comment (already on page 2, and Fig 1 caption)

T15, P3L21: maybe omit “reasonably accessible” as this is somewhat vague

T16, P5L19-20: suggest “s” on Ps and “a” on Na be subscripts

T17, P5L21: can -> is (?)

T18, P6L6: retrievals -> retrievals separately.

T19, P8L6: should give -> gives

T20, P11L5: were -> are

T21, P12L1: H-gain -> the number of H-gain (or better, -> there were 23% fewer H-gain)

T22, P12L2: Could omit “derived”

T23, P14L14: Could omit “in Alice Springs”

T24, P14L15: cover -> enclosure (x2)

T25, P14L17: omit “the assumption”

T26, P15L8: suggest omission of “and on other future satellites”

T27, P15L11: provides -> has

T28, P15L12: to -> for

T29, P15L12: this data is especially needed -> observations are especially needed here

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T30, P16L7: calculated -> characterized

T31, P16L9: co-funded -> co-acquired funding for (?)

T32, P16L14: define RA

T33, P16L14: advise -> advice

Other notes/optional

O1, P2L15: The population of the greater LA area includes parts of other counties. https://www.citypopulation.de/world/Agglomerations.html lists the population as 17.7 million.

O2, P5L3: The authors may also consider publishing a description of the design and/or control software in the future (e.g., compare https://doi.org/10.5194/amt-11-2173-2018). Such a project/paper could be especially useful to the community if the control software were open source, and fully automated neither of which have been done yet. Example automation of OPUS: https://doi.org/10.1364/AO.57.000689, example of alternate solar tracking software: http://hdl.handle.net/10222/64642, Chapter 4.

O3, P6Fig2: More details on this schematic could be useful, such as the path of light, and parts that move/rotate or disassemble (it looks like a seam at the "v" part?) An actual picture at Alice Springs could be nice if available. A picture would provide the readers an idea if any precautions needed to be taken to prevent interference from unique Australian fauna, such as fencing or placement away from trees.

O4, P9L9-11: The ME at MOPD values seem particularly small, compared to typical values around 98-99% (Frey at al, 2018). It may be beneficial to realign the spectrometer. Though changes in Xair do not look large. . .

O5, P10: Future measurements in Alice Springs may be useful to help derive an airmass correction for all EM27/SUN instruments. This dataset may not be ideal though

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since the ME at MOPD seems to differ from most other EM27/SUN instruments, and is only for part of one season.

O6, P14L2: A histogram of the standard deviations for the different gains could be useful.

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