

## ***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 #2**

Received and published: 11 February 2019

**General comments** The manuscript "Satellite and Ground-based Measurements of  $X_{CO_2}$  in a Remote Semi-Arid Region of Australia" by Velazco et. al. describes the campaign-based deployment of an EM27/SUN near infrared spectrometer to gather targeted validation data for the Greenhouse Gases Observation Satellite (GOSAT). The paper also describes calibration of the portable spectrometer against a Total Carbon Column Observing Network (TCCON) instrument to demonstrate traceability to WMO trace gas scales and goes on to provide guidance on the ideal length of such a field campaign needed to achieve a required uncertainty in the satellite bias estimate.

The manuscript is laid out in a logical fashion and is well written.

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Overall the manuscript documents a very useful piece of work that has been designed to answer a pertinent science question, and the resulting dataset, and I would recommend its publication subject to some minor modifications and clarifications.

### Specific comments

It appears that the Authors have not smoothed the XCO<sub>2</sub> retrievals from the various instruments to account for differences in the averaging kernels and priors (if these differ between the retrieval schemes) per the method of Rogers and Connor (2003) as implemented by Wunch et. al. (2010). It may be that the effect of this process would be negligible, however this should still be discussed and quantified.

Introduction and Fig. 1. Is there a reason why there appear to be more v2.72 M-gain retrievals?

There should be some commentary on how the GOSAT specific point observations differ from normal GOSAT observations in Section 3.3.

In section 4.1.1 comparing the retrievals of X<sub>air</sub> between the EM27 and TCCON instruments, it is noted that there are both airmass and seasonal variations in X<sub>air</sub>. It seems likely that at least some of the seasonal dependence might be caused by the differing ranges of solar zenith angles that are observed throughout the year. It would be interesting to plot Fig 5 for a limited range of solar zenith angles to identify if the air-mass dependence is the only reason for the seasonal variation. In any case, it would be useful to have a few more details about the year of inter-comparison measurements in the introductory paragraph of Sect. 4.1 e.g. number of days of measurements, total number of measurements from each instrument and whether they were operated for the same periods on each day.

Section 4.1.2 and Fig. 6, what time averaging is applied to the data in Fig. 6? The colour scale and the size of the  $1\sigma$  uncertainties suggest daily averages, but this is not made explicit. There also appears to be quite a large variety in the magnitude of the

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$1\sigma$  values in Fig. 6. which would bear explanation.

Several times during the manuscript calibration factors are presented in the form  $INST1 = F * INST2$  it would be useful to have some indication of the uncertainty of the F value, or the goodness of the regression fit used to derive it. Similarly, for the drift mentioned at P9L17.

Section 4.4. describing the length of campaign required to reduce the error in the bias estimates is interesting but would benefit from some discussion of what the target for accuracy and precision in the bias estimate should be.

Conclusions: this section should have some comment relating to the presented dataset specifically. Also, as an interested reader it would be good to know if there are any plans to repeat the field campaign and build the dataset.

P15L3, the sentence starting “With the exception of Lauder...” should be qualified.

Data availability: what about the GOSAT data?

### Technical corrections

P2L24 “atmospheric conditions that can serve as a calibration point...”

P4 Fig. 1 caption: Start with "Location of.." to indicate that these do not represent the retrieved values, for consistency, use XCO2 and XCH4.

P4L7 “below 5000  $\text{cm}^{-1}$  **which** allows for...”

P5L20 The last sentence on this page is disjointed and difficult to read, consider revising.

P6L4 “However, to construct **the** time-series...”

P6L4 should refer to Fig. 8, not Fig. 7.

P8 Fig. 4 caption: it should be sufficient to say month number and delete “in a year”.

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P9L12 Sentence can be finished after “campaign” to avoid repetition.

P10L7 “...retrievals results **in** lower...”

P11 Fig. 7 caption: use XCO<sub>2</sub> for consistency.

P11 Fig. 7 caption: “days on the x-axis **are** not”

P11 Fig. 7 caption: pluralise interruption

P12L2 Start the sentence with "The number of..." to clarify that the retrieved values are not reducing.

P16L14 Explain what RA means.

P18L4 correct the rendering of the subscript

P18L33 The DOI is repeated

P19L6 insert a space between inverse and models

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