

Interactive comment on “Intercomparison of TCCON data from two Fourier transform spectrometers at Lauder, New Zealand” by David F. Pollard et al.

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Anonymous Referee #1

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We thank the reviewer for taking the time to review our manuscript and for their constructive and thought provoking comments.

Below we have included the full text of their review as indented text, interspersed with our responses addressing their specific comments as non-indented text and changes

C1

to the manuscript in *italicised* font.

The paper “Intercomparison of TCCON data from two Fourier transform spectrometers at Lauder, New Zealand” by Pollard et al. presents an intercomparison of two high-resolution Fourier transform spectrometer measurements to assure the continuity of the Lauder TCCON data. Pollard et al. demonstrate that the difference between the column-averaged dry-air mole fraction of carbon dioxide (X_{CO_2}) data obtained from the two instruments is well below the uncertainty of the TCCON product.

The Lauder TCCON data have been widely used for carbon cycle studies and validation of satellite-based greenhouse gas and carbon monoxide measurements. The topic of this paper is significant for those research fields and well suited to Atmospheric Measurement Techniques. This paper is concisely written and contains a full description of the instrumental intercomparison. I therefore recommend publication of this paper after correcting and addressing several minor concerns below.

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Specific comments

L80-81: X_{air} is scaled by the O_2 column because Equation (2) can be rewritten as follows:

$$X_{air} = \left(VC_{air} - VC_{H_2O} \frac{m_{H_2O}}{m_{air}} \right) \frac{0.2095}{VC_{O_2}} \quad (1)$$

The reason X_{air} is used as a diagnostic of the measurement system is that the ratio between the retrieved columns is not taken for X_{air} .

C2

Thank you for pointing out this error. We have replaced the sentence at L80-81 with: *"The value and stability of X_{air} is used as a diagnostic of the measurement system as VC_{air} is independent of the instrument system and instrumental biases are not removed by scaling. Therefore deviations from the nominal value can be indicative of instrumental and systematic problems such as timing or pointing errors."*

L146: The median shift relative to the central wavenumber $\Delta\nu/\nu$ is -0.469×10^6 ($-0.469 \Delta\nu/\nu \times 10^6$ is not the median shift). In addition, please define the variables $\Delta\nu$ and ν or $\Delta\nu/\nu$.

This sentence has been modified to read *"For a one-month period of the intercomparison we find that the median shift relative to the central wavenumber ($\Delta\nu/\nu$) for the II instrument is -0.469×10^{-6} (standard deviation 0.028×10^{-6}) and for Ir is -0.507×10^{-6} (0.026×10^{-6})."* and the axis label of Fig. 4 amended accordingly.

L154: Please clarify what the solar gas shift (SGS) means, in relation to just above sentence [GFIT accounts for ...].

We have moved the definition of SGS to the preceding paragraph to make it clear what it refers to.

L184: It is unclear why "a small difference in the computed airmass for forward and reverse scans" induces the difference between the X_{gas} data from the two instruments. Do the authors mean "a small error in the computed airmass (i.e., an error in zero path difference time)"?

C3

This sentence has been modified to read as follows: *"This is likely caused by small differences in the time it takes both instruments to conduct a measurement, due to slightly different firmware versions or hardware, leading to small errors in the computed airmass which differ in magnitude for the forward and reverse scans."* to clarify the source of the spread in X_{air} values at high solar zenith angles.

L186-187: Please cite references for the values of the expected uncertainty of the retrieval scheme (0.25%) and the target site-to-site bias (0.2%). Provided that there are expected uncertainties of the retrieval scheme and target site-to-site bias for X_{CH_4} and X_{CO} , I recommend specifying a similar evaluation here.

The paragraph has been re-written and the expected retrieval uncertainty altered to 0.2% to be consistent with the wider literature, a discussion of the X_{CH_4} results included and citations added to Wunch (2010) and Wunch (2015). The footnote to Tab. 3 has also been amended so as not to describe the site-to-site bias estimate as a target.

L197: October 2018 - October and November 2018 (to be consistent with Abstract and Introduction)

This change has been incorporated into the revised manuscript.

Caption of Table 1: Transform - transform

This has been changed in the manuscript.

C4

References

- Wunch, D., Toon, G. C., Wennberg, P. O., Wofsy, S. C., Stephens, B. B., Fischer, M. L., Uchino, O., Abshire, J. B., Bernath, P., Biraud, S. C., Blavier, J. F. L., Boone, C., Bowman, K. P., Browell, E. V., Campos, T., Connor, B. J., Daube, B. C., Deutscher, N. M., Diao, M., Elkins, J. W., Gerbig, C., Gottlieb, E., Griffith, D. W. T., Hurst, D. F., Jiménez, R., Keppel-Aleks, G., Kort, E. A., Macatangay, R., Machida, T., Matsueda, H., Moore, F., Morino, I., Park, S., Robinson, J., Roehl, C. M., Sawa, Y., Sherlock, V., Sweeney, C., Tanaka, T., and Zondlo, M. A.: Calibration of the Total Carbon Column Observing Network using aircraft profile data, *Atmos. Meas. Tech.*, 3, 1351-1362, 2010.
- Wunch, D., Toon, G., Sherlock, V., Deutscher, N. M., Liu, C., Feist, D. G., and Wennberg, P. O.: The Total Carbon Column Observing Network's GGG2014 Data Version, doi:10.14291/tccon.ggg2014.documentation.R0/1221662, 2015. 2015.

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