

## Author response to Anonymous Referee #2.

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We thank Anonymous Referee #2 for their positive review of the manuscript. Below are our responses to their comments. Referee comments are ***bold and italicised*** with our responses below.

***Line 99, about HITRAN database. Have you tried HITRAN2016 in your retrieval? Do you expect using HITRAN2016 will further improve your results?*** As detailed in the response to Anonymous Referee #1, we had not previously tried HITRAN2016 for our retrievals but have now done so. Using HITRAN2016 instead of HITRAN2008 improves the derived biases compared to the in situ measurements by about 50% for CO<sub>2</sub> and CH<sub>4</sub> and makes little difference to O<sub>2</sub> or the derived repeatabilities for any of the gases.

***Line 137 and Figure 2: the refitted black trace is also after excluding some poor measurements due to weather...as described in line 152-155, correct? So the difference between red and black is NOT purely due to the refit process, right? Since there are some low spikes in the “original”, and they are gone in the “refitted”. So please clarify this here in the text.***

Actually the data shown in Figure 2 is filtered identically for both the original and refitted data shown, that is the differences are indeed entirely due to the refitting process. The largest differences that are referred to in the referee’s comment usually occur at times when the long-path signal is low, and therefore the short-path reflections make a large contribution. As discussed in the response to Anonymous Referee #1, the effect of the short-path correction is to increase the retrieved trace gas mole fractions - the larger the relative contribution of the short-path, the larger the trace gas increase. This is what is seen here.

***Line 140 and Figure 3: please include scale in the map, so readers know how far your site is from Sydney urban area.*** The site is 52 km from Sydney CBD. We’ve added this to the text and included a scale bar on the map in Figure 3. This required changing from a Google maps image to one generated using Google Earth

***Table 2 and Table 3 could merge into a single table. As the first time reader, I had a hard time remembering the difference between different periods, when reading Table 3.***

We considered merging these into a single table when originally drafting the publication, but opted to keep them separate to avoid including too much information in a single table. For that reason we’ve kept them separate, but added a column to Table 3 to summarise the instrument setup. Hopefully this makes it clearer without cluttering up a single table too much. A copy of

the revised Table 3 is shown below (Table 1)

30 *Figure 4: It seems that there is some step change in N2O right before 2018-10. Do you know the reason? Did the retrieval of other gases changed at the same time of this step change in N2O?*

As noted in the response to Anonymous Referee #1, this step-change should actually occur over the gap during which the instrument didn't operate while the telescope was being changed from 10" to 12" diameter version. The step-change therefore corresponds to the change due to this instrument modification.

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*Line 183, "a small improvement". Can you please put the percentage change after "a small improvement"?*

Sure. The changes are 18% for CO<sub>2</sub> and 44% for CH<sub>4</sub>. For CO the repeatability is about 3.5 times worse because of the changed reflector substrate and poorer reflectivity in the CO retrieval region. We've changed the text in the manuscript to: **and a small improvement in trace gas retrieval repeatability for CO<sub>2</sub> (18%) and CH<sub>4</sub> (44%)**

40 *Figure 7: although you have written the info in the text and figure caption, please label the Picarro, CSG, and the stock in Figure 7 to help readers and help your discussion on the following polar plot.*

We have marked the location of the Picarro, coal-seam gas well, and areas in which we observed grazing stock.

*Line 220: " A polar bivariate plot of CH4..." you are talking about open-path measurement, correct? Here could be an confusion, since you just talked about Picarro measurement. So maybe include "from open-path measurement" after "CH4".*

Thanks. Yes, this is from the open-path measurements, and we have clarified this as suggested.

*Figure 9: in the text, it is interesting to see the discussion of the enhancement of CH4 could relate to the cattle to the North, but the Figure 9 is very hard to tell if there is any enhancement to the North. So is it possible to further tune your color scale and somehow more clearly show the enhancement to the North.*

Actually this is quite difficult to do; however, we've included here a version of the plot (Figure 1) that only shows the northerly data at wind speeds above 0.75 m/s, which hopefully illustrates a little better that there are some small enhancements from the north and slightly west of north. We've not included this in the manuscript.

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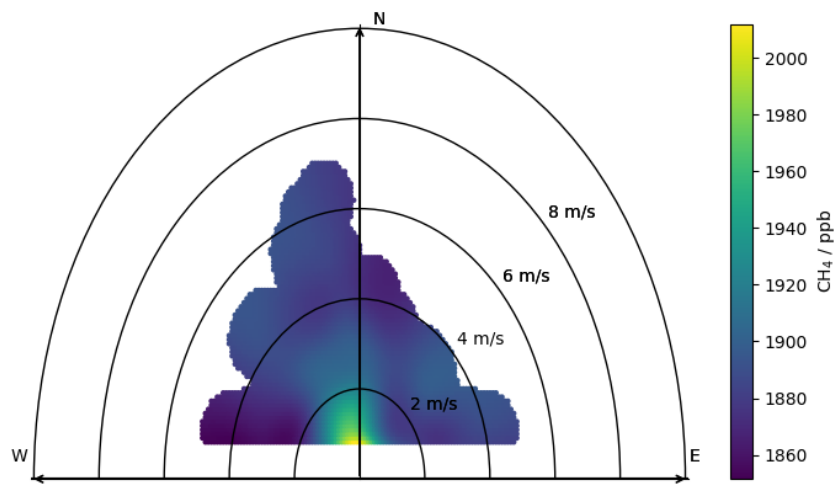
*Line 235: "There is much more scatter in the relationship," of what? I think it is also helpful to include r value of each fit in the text of this paragraph.*

Here we are referring to the in situ versus open-path comparison for CH<sub>4</sub> compared to CO<sub>2</sub>. We've clarified this by adding the text **for CH<sub>4</sub> than CO<sub>2</sub>**. We've added the r values to the text as well.

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## References

Griffith, D. W. T., Pöhler, D., Schmitt, S., Hammer, S., Vardag, S. N., and Platt, U.: Long open-path measurements of greenhouse gases in air using near-infrared Fourier transform spectroscopy, *Atmospheric Measurement Techniques*, 11, 1549–1563, <https://doi.org/10.5194/amt-11-1549-2018>, <https://www.atmos-meas-tech.net/11/1549/2018/>, 2018.



**Figure 1.** Polar bivariate plot showing the relationship between CH<sub>4</sub>, wind speed and wind direction over the full campaign for winds with a northerly component and wind speeds greater than 0.75 m/s.

**Table 1.** Summary of the measurement performance during the field deployment at each pathlength and over changes in instrument setup. The numbered measurement periods and setups correspond to those in Table 2 from the manuscript.

Measurement period	<b>Instrument setup</b> <b>(path, reflector, telescope)</b>	Signal-to-noise		Repeatability ( $1\sigma$ )		
		ratio (SNR)	CO <sub>2</sub> / ppm	CH <sub>4</sub> / ppb	CO / ppb	N <sub>2</sub> O / ppb
1	<b>600m, gold, 10"</b>	2050	0.66	8.2	6.9	-
2	<b>600m, glass, 10"</b>	6400	0.54	4.6	23.8	7.7
3	<b>1110m, glass, 10"</b>	3750	0.35	3.7	26.9	35.5
4	<b>1500m, glass, 10"</b>	2300	0.48	3.9	28.4	35.4
5	<b>1500m, glass, 12"</b>	3200	0.26	2.0	17.0	21.7
ref <sup>#</sup>	<b>1500m, quartz, 12"</b>	750	1.7	21	-	-

<sup>#</sup>Deployment at Heidelberg (Griffith et al., 2018).