

Dear Prof. Griffith,

Many thanks for your helpful comments and corrections.

In the following we list our changes in the manuscript.

- I do not see any keywords in the manuscript. These should capture the potential optics and instrumentation readership as well as the atmospheric audience.

There is no option to include keywords for this journal.

- P 3546, L13: The mention of ghost to parent ratio needs short clarification in the abstract, as the abstract should be able to stand alone to a non-specialist reader. E.g.:“...inferred from measurements of the ratio of the intensities of the ghost to parent bands in spectra of a lamp taken at Lauder.

The sentence has been changed to:

“Estimated LSEs are in good agreement with sampling errors inferred from the ratio of primary and ghost spectral signatures in optically bandpass limited Tungsten lamp spectra acquired at Lauder.”

- P 3546, L13: ..The LSEs (plural)...

This mistake has been corrected.

- P3546 L18: ...may also have contributed to the residual difference.

This mistake has been corrected.

- P3547 L 7-8. A reference to flux inversions would be useful here.

We have added references to Miller et al (2007), Chevallier et al (2011) and Keppel-Aleks et al (2012).

- L16: explain here that O₂ is used as an internal standard.

A sentence to this effect has been added:

”Spectra are analysed using a standard algorithm to retrieve total column abundances of target GHG and O₂ and derive the GHG column-averaged DMFs. The O₂ column retrieval is used both in the derivation of the DMFs and (when combined with an accurate measurement of surface pressure) as an internal network standard (Wunch et al, 2011).”

- L21: It is not yet clear to the reader what this “sampling error” is, in particular if it is an X-axis or a Y-axis error. State explicitly that it is a timing error which affects the X-axis accuracy of the interferogram in a periodic way.

The sentence has been changed to:

”In the following we are concerned with an error source which is of special relevance for NIR FTS measurements, namely periodic errors in the x-axis locations where the interferogram is discretely sampled.”

- L29: (0.3-2ppm) applies strictly to X_{CO_2} , not O_2 . Remove the words after the ref to Messerschmidt et al to the end of the sentence. They are out of place here.

The sentence has been changed to:

”Typical magnitudes of the errors in X_{CO_2} and O_2 column retrievals encountered in practice are 0.1–0.5%, corresponding to 0.3–2 ppm for X_{CO_2} (Messerschmidt et al., 2010, 2011).”

- P3548 L2: Give manufacturer details as for normal equipment specs: Bruker Optics, Ettlingen Germany.

The sentence has been changed to:

”The FTS manufacturer Bruker Optics (Ettlingen, Germany) subsequently developed an improved laser sampling unit which offers the accuracy required by TCCON, and which has now been installed in all TCCON spectrometers.”

- L9: I suggest replace “reposes” with “is based on”. Add “ghost to parent intensity ratio” to clarify – see earlier comment, this will have little meaning to the reader not already familiar with the problem.

The sentence has been changed to:

”Messerschmidt et al. (2010) proposed an empirical ghost correction scheme which is based on (1) the determination of the ghost-to-parent intensity ratio (GPR) using narrowband lamp spectra and (2) an empirical determination of the variation of the column-average DMF X_Y of the target gas Y as a function of the GPR.”

- P3552 L 6: I suggest capitalising IPP to be clearer and to be on the same footing as GGG.

IPP has been capitalised.

- L19: “The (0,0) band of O_2 ” is not an accurate description of the electronic transition corresponding to the fitted band. Please specify the band.

The sentence has been changed to: “The O_2 column is analysed from the band centred at 7882 cm^{-1} ($a^1\Delta_g - X^3 \sum_g^-(0,0)$).”

- L22 and many other places – English “double f”, ff, is being substituted by an italic ff symbol in the font used.

We do not see this effect in the pdf readers we are using (evince, adobe reader) but would like to bring this feature to the editors attention.

- P3553 L 10. Suggest replace “Punctual” with “Stepwise”

The sentence has been changed to:

”Stepwise changes in the LSE on instrument intervention introduce discontinuities in the X_{air} timeseries.”

- P3554 L3: either laser interferogram or laser’s interferogram.

The sentence has been changed to:

”The zero crossings of the laser interferogram serve as reference for the sampling of the infrared signal.”

- L3. Suggest shorten this sentence to “The original measurement signal of the reference laser is actually a cosine oscillation”

The sentence has been shortened.

- P3555 L 19. Please clarify if the additional window was used as well as or instead of the 7290-7360 cm⁻¹ window at Izana.

The sentence has been changed to:

“Therefore a second microwindow (10900—11300 cm⁻¹) was used in addition to the 7290—7360 cm⁻¹ microwindow to determine the LSE timeseries at Izaña (the results for these two microwindows are shown with different symbols in Figure 6).

The Figure 6 caption has also been updated to explicitly reference the symbols used to identify which window was used to determine the LSE.

- P3557 L 17: “... the LSE must be determined ...” (delete “to”)

The mistake has been corrected.

- P3558 L23: Should Lamp LSE estimates be section 3.4?

“Lamp LSE estimates” is now section 3.4.

- P3559 L 4: please specify which frequency – the wavenumber sigma, not laser frequency, sampling frequency or any other.

The sentence has been changed to:

”The GPR is wavenumber dependent and is related to the LSE by a factor $\gamma=(\pi\sigma\Delta)^{-1}$, where σ is the optical filter bandpass centre frequency, and Δ is the sampling interval (Learner et al., 1996).”

- Table 1 is rather difficult to follow and could use a better description so it stands alone, or refers to text for explanation (for example, of gamma).

The lamp results given Table 1 have been simplified significantly to make the presentation clearer (but without any loss of information regarding the essential features of the solar/lamp intercomparison). We now simply tabulate the resampling LSE estimates and the sampling error inferred from the GPR using the NDACC filter. The caption has also been rewritten to explain all parameters given in the table and reference section 3.4 for full explanation of gamma. A few minor changes have been made to the text of 4.1.1 accordingly.

Figures 4 and 5 have been regenerated with thicker vertical dotted and dashed lines.

- P3560 L 26: tendency (spelling).

The mistake has been corrected.

- P3563 L10. Why not do the 20 kHz correction and show that the agreement is further improved. As presented this looks like a lazy omission.

The 20 kHz data were not previously resampled because of the discrepancy (a factor of 2-3) between solar and lamp estimates, and because it was felt this might give an unduly optimistic view of the resampling algorithm performance.

Results for resampled 20 kHz data are now included. Figures 7 and 8 have been updated and the text of 4.2.1 has been revised accordingly. The sampling errors assumed in the 20 kHz resampling are described in section 4.1.1, and where it is explicitly noted that the use of the solar LSE estimates might give an unduly optimistic view of the resampling algorithm performance if the lamp LSE estimates are in fact the truth.

Note the retrieval error associated with the uncertainty in the LSE estimates is (and has always been) quantified in Section 4.3.3.

- L12: acquired (spelling)

The mistake has been corrected.

- L22: why not show the CH4 bias, so the reader can assess the problem?

Misunderstanding solved by email-communication with referee.

- P3564 L1-5: Please clarify of the forward and backward interferograms are transformed separately and then coadded, or vice versa.

The sentence has been changed to:

”Note in the KIT interferogram pre-processing the forward and reverse scans are corrected for their respective sampling errors, then coadded and transformed to generate one spectrum per forward/reverse pair, so the reduction in the discrepancy between forward and reverse scans on resampling has not been characterised explicitly.”

- P3565 L15: to enable the Conclusions to be read standalone without jargon, spell out LSE as laser sampling error.

LSE was spelled out.

- P3566 L12 TCCON (N missing)

The mistake has been corrected.

- Figures 4,5,6, please use consistent X axis labelling convention.

The x-axis labelling convention is now consistent.

- Fig 7 caption: replace IFGs with interferograms

IFGs has been replaced.