

Author's reply to Referee #1:

First of all, we would like to thank the referee for helpful comments and suggestions and for pointing out that this paper provides a roadmap for other stations within TCCON which are considering a similar instrumental approach in the future. We will adopt most of the suggestions and correct language errors in the final version of the manuscript.

Point-by-point response to specific comments and suggestions:

Referee: Title: The title is not informative to someone browsing contents. I suggest something like "Improved (or Amended) retrieval of trace gas amounts from near infrared solar spectra measured at Karlsruhe TCCON station"

Author: We will change the title to "Improved retrieval of gas abundances from near infrared solar FTIR spectra measured at the Karlsruhe TCCON station".

Referee: p12205 L5: Omit the parentheses around 3800 - 11000, this is not correct usage here. Either "... the 3800-11000 cm⁻¹ spectral region is measured ..." or "... the spectral region (3800-11000 cm⁻¹) is measured ..." I prefer the former. There are many other instances throughout the paper.

Author: We will omit the parentheses and use following format 3800 -11000 cm⁻¹ throughout the paper.

Referee: p12204 L20: ... is available through the TCCON data portal at CDIAC." (The web site address would be better omitted here in the abstract and specified later.)

Author: We will remove the web address in the abstract since it is already included in the conclusions.

Referee: P12206 L4 & 6. Replace precision with comparability or consistency. We are talking about bias between stations here, not repeatability (~precision)

Author: We will replace precision with consistency.

Referee: P12206 L17: ... automated mid infrared NDACC (....

Author: We will insert "mid infrared" in front of "NDACC"

Referee: P12207 L13: replace "climatized" with "air conditioned"

Author: We will replace "climatized" with "air conditioned"

Referee: L19: A dichroic mirror (Optics...

Author: We will insert "mirror" in front of "(Optics..."

Referee: P12208 L21: It is not at all clear to the reader here how the InSb spectra are used to correct for ghosts, or how this is normally carried out with the InGaAs / Si detectors.

Author: The Karlsruhe TCCON instrument was initially shipped with the updated laser sampling electronics board, therefore Karlsruhe spectra (and historic Karlsruhe spectra) are not affected by Laser Sampling Errors (LSE) and do not need to be corrected for "ghosts". However, to be consistent with other TCCON sites, we use the I2S method described in Wunch et al. 2015 (4ff.) using the InSb detector to correct for any LSE in the system. A potential discussion about the used

LSE correction for Karlsruhe spectra might be subject to a TCCON site paper which is planned to be submitted in a planned TCCON special issue later this year. Therefore, we consider to remove P12208 L21 in our manuscript.

Referee: P12209 L20: define cw at first use, or write as O₂ spectral window centred at 7885 cm⁻¹.

Author: "cw" is defined at first use in P12209 L15

Referee: P12210 L18: It would be more correct to say the residual has a single extremum, rather than that it is parabolic.

Author: We will change the sentence to: "The residuals in the O₂ spectral window have the shape of a higher order polynomial while the N₂O residual has a single extremum."

Referee: L22: replace "cavity" with something more descriptive on first use - black-body cavity or black body source, for example. It is more important that it is a source than that it is a cavity.

Author: We will change the sentence to: "To demonstrate this, we show that these curvature exist in laboratory measurements using a black-body-cavity at 1000°C as a source."

Referee: P12211 L 3: ... curvature in the residuals IS due to... L8: ... of the spectrum that IS caused by...

Author: In both cases we mean the plural of curvature. We will replace "curvature" with "curvatures".

Referee: section 5.1: This is incorrect use of the word "calibrated". You could explain that you ratio the measured spectrum to a black body spectrum, then refer to "ratioed" spectra rather than "calibrated"

Author: We will change P2211 L24 - P12212 L3 to: "Using cavity-ratioed spectra as a reference, we show that implementing our continuum curvature fitting scheme significantly reduces the airmass-dependent biases caused by the curvature. Our cavity-ratioed reference spectra are produced by dividing atmospheric spectra by a high signal-to-noise ratio, reduced-resolution (0.05cm⁻¹) black-body-cavity spectrum (1000°C)." Thereafter, we will replace occurrences of "calibrated" with "ratioed".

Referee: P12212 L3" replace "oscillations" with "features"

Author: We will replace "oscillations" with "features"

Referee: Section 5.2: It is not clear how the DMFs are "improved". How is this defined or assessed? In principle I would actually expect the "calibration" factors relative to WMO- in situ measurements to change somewhat compared to standard TCCON retrievals. It is important to show that there is no significant difference, but not at all clear what is meant by "improved".

Author: The term "improved" is misleading here. While the spectral fits (including residuals) improved, DMFs "are adjusted accordingly". For example, using the higher order continuum fit for Karlsruhe spectra, XCO₂ is now more consistent with other European TCCON sites as seen in Figure 8 (which is discussed in section 6). Therefore, we will change P12212 L2 to: "It is also important to note that the computed DMFs are changed."

Referee: P12214 L13: remove "precision and". The scaling affects bias but not precision.

Author: We will remove "precision and".

Referee: L24: ...does not take into account CONTINUUM curvature..."

Author: we will include "continuum" in front of "curvature"

Referee: P12216 L 1: ...sufficiently flexible (not sufficient flexible)

Author: We will change "sufficient flexible" to "sufficiently flexible"

Referee: P12218 L 15: It is not appropriate to acknowledge co-authors. One or the other.

Author: The Caltech/JPL scientists remain as co-authors and will be removed from the Acknowledgements section. If convenient, we will thank the entire Caltech/JPL Team for making the Author's stay at Caltech/JPL possible.

Referee: For brevity, Figures 8 and 9 could be removed.

Author: We will remove Figure 8.