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Atmospheric Measurement Techniques Discussions

Interactive comment on "Comparison of XCO abundances from the Total Carbon Column Observing Network and the Network for the Detection of Atmospheric Composition Change measured in Karlsruhe" *by* M. Kiel et al.

Anonymous Referee #1

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General comments

The paper by Kiel et al reports on a comparison between FTIR spectra recorded from a collocated TCCON/NDACC site in Karlsruhe. The spectra are recorded from the same FTIR spectrometer, with the addition of internal optics that permits recording spectra in both the near IR and mid-IR simultaneously. The authors retrieve the total columns of CO, comparing the derived product xCO, the CO column divided by the dry air column. The TCCON spectra were analysed using the standard GFIT suite of software using the CO overtone bands around $4200 - 4300cm^{-1}$, whereas with the NDACC spectra,

the fundamental band at $2050 - 2150cm^{-1}$ range were analysed using the software package PROFFIT.

The purpose of the paper is to compare the xCO product produced by these two networks in terms of current and future satellite measurements and supporting model studies. This is an important issue to address, and if both network datasets can be utilized, this will add significantly to the success of comparing these data. The authors therefore look at a number of underlying issues that affect the two different analysis methods and identify their respective biases. Through testing, some of these biases are identified and means of reducing their effects are outlined.

The paper is well written, and structured in a clear and sensible fashion. Some of the figures of a little difficult to read/understand, but some minor improvements here are listed below. Subject to some minor corrections and additions listed below, this paper is suitable for publication in AMT.

Specific comments

1) Analysis procedures, section 3.1: What are the apriori covariances and assumed measurement signal to noise? These have direct impact on the retrieval stability, averaging kernels, and dofs. Is this outlined in Kramer's PhD thesis (which is not readily available online)?

2) While the xCO air mole fractions reported have precisions reported, there is not any discussion or mention of the typical errors associated with a CO column estimate from both analysis methods per spectra. Are they similar? The NDACC spectra have inherently higher spectral noise due to the larger OPD; is this an issue? The CO fundamental band line at $2157cm^{-1}$ is very strong, whereas both of the CO lines in the overtone are much weaker, and subject to more interference from other absorbers and solar CO. Are these effects important?

3) 4.2.1: suggest writing the averaging kernel symbol as ($A_{MIR-NIR}$)

4) Figure 1. The TCCON apriori has very low CO mixing ratios above 50 km or so. This is only 1% of the column that is effectively missing, but this might account for some of the sharp features in the residual of figure 3. This probably does not affect the biases, but it might account for the shape of the TCCON averaging kernel significantly over weighting in the upper atmosphere.

5) Figures 2 and 3. It would be instructive for readers not familiar with the spectroscopy to identify the absorbers in the spectra. Why are the residual axes scaled to $\pm 5\%$, much higher than the noise. Is this driven by the scaling in figure 3 which has a couple of features around 3%?

6) Fig 9 and 13: the data labelled "original" is a little confusing at first. Perhaps an explicitly reference to what this actually means in the legend.

7) Figures 17 and 18 are not referred to all in any discussion. Why are they there?

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