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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of atmospheric CO_2 vertical profiles from ground-based near-infrared spectra" *by* Sébastien Roche et al.

Anonymous Referee #1

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Summary

The TCCON network is an immensely valuable WMO-calibrated record of CO2 essential for validation of satellite CO2 columns (as well as other trace gases) and has additional use in the study of the carbon cycle.

Currently TCCON is used for validation of satellite full-column products in the near-infrared, e.g. XCO2 products from OCO-2/3, GOSAT/2, Tansat, and future planned missions will also rely on the TCCON network. It would be immensely valuable if TCCON had a vertically resolved product that could be used to validate vertically-resolved satellite products, e.g. thermal infrared CO2 from AIRS or GOSAT/2, the GOSAT NIR/TIR profile, the lower tropospheric research products from GOSAT/2 or OCO-2/3, and to study the carbon cycle.

Overall comments

The paper was well laid out and provides useful and important information about the sources of errors in different TCCON and satellite NIR bands. It would be useful to see results of joint-band retrievals, however accept this limitation of GFIT. The two things that are missing are:

1) predicted errors propagated from the interferent errors, These errors are calculated empirically and should also be compared to their predicted impact, at least for temperature and water. These errors can be calculated using Jacobians, following Connor et al. (2016) Eq. 6, or Worden et al. (2004) (second term of Eq. 18).

2) The performance of the profile retrieval with real spectra is only reported as a column result (e.g. Fig 13). The standard deviation and bias versus AirCore should be calculated at all pressures and summarized in the paper.

Specific comments

Line 17. To help the reader understand the scope of the paper, I would change the second sentence of the abstract to, "With these improvements, CO2 profiles were obtained from sequential retrievals in five spectral windows with different vertical sensitivities using synthetic and real spectra."

Add to the paper: It was unclear to me (or maybe I missed it) what is retrieved. Is surface pressure? Water profile? Water scaling? Temperature profile? Temperature scaling? This could be listed at the start of methods.

Line 82. I would add, "... and would also allow TCCON to be used for validation of TIR satellite products, e.g. from AIRS and GOSAT/2, and vertically resolved NIR GOSAT and OCO-2 experimental products."

Line 117. I would add a sentence saying, "OCO-2/3 and GOSAT/2 use the Weak1 and Strong bands as well as a band centered at 0.765 um not used by TCCON."

Line 147. The sentence, "We see no advantage to fitting noncontiguous windows in parallel, rather than in series, and then averaging the results." is incorrect. Mathematically these are very different. The way to fit sequentially is called a sequential update and discussed in Rodgers, 2000 or Dudhia et al., 2002 and involves setting the constraint for the next step to the error covariance from the previous step.

Line 189. It would help the reader to have the value for sigma listed for 100, 500, 200, and 1 hPa.

Line 194. A 2 km length scale seems very narrow, particularly above 4 km. Just a comment.

Line 228. Add a sentence, "The DOFS are shown in figures 3-6, and 8-9."

Figures 3-5. These errors should be compared to the predicted errors.

Figures 3-5. Question that might be out of the scope of this paper: do these errors affect TCCON XCO2? In other words can the same tests from Figures 3-5 be done for the standard TCCON retrieval?

Figure 8. I do not understand how the result can be up to 50 ppm off when the a priori is set to 6 ppm.

Table 5. My note: I have not found information content to be useful because it is not aware of many of the systematic errors in the system.

Figure 13. My note: The variability of the results for xco2 for the different bands was surprising.

References

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