

Interactive comment on “Remote sensing of CO₂ and CH₄ using solar absorption spectrometry with a commercial low resolution spectrometer” by C. Petri et al.

Anonymous Referee #1

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The study by Petri et al. reports on the performance of a sun-viewing Fourier Transform Spectrometer (FTS) with low spectral resolution. Performance is compared to a similar instrument operating at high spectral resolution. The study focuses on comparing retrievals of total column CO₂ and CH₄ retrieved from absorption bands in the shortwave infrared spectral range such as conducted by the Total Carbon Column Observing Network (TCCON). It is shown that the low-resolution instrument can measure CO₂ and CH₄ total columns which generally agree to better than 0.5% with the high-resolution measurements. Reasons for the residual differences are discussed by artificially degrading spectra of the high resolution spectrometer.

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The study is of interest to AMT since a low-resolution FTS measuring CO₂ and CH₄ total columns with high accuracy would be an appealing supplement to the TCCON. The latter currently relies on rather large, delicate, and expensive high-resolution FTS. It is indeed a scientific challenge to achieve the required accuracy with low-resolution instrumentation. The paper, however, requires some major work concerning thoroughness of the employed methods and the way it is written up. Some major aspects remain speculative, so far.

Comments

1. Throughout the manuscript, the reader lacks information that is required to follow the rationale and to potentially reproduce the presented results. In particular, section 3 must be extended: What are the spectroscopic databases used? What are the spectral ranges used? Is retrieved [O₂] actually used to calculate XCO₂, XCH₄? What is the “retrieval error” plotted in Fig. 2 ff? Is it detector noise fed into error propagation? I recommend revising the manuscript with an eye on reporting duties, keeping in mind that the general reader might not be an FTS expert.
2. Before evaluating performance for XCO₂ and XCH₄ (Fig.2 through Fig.5), the individual total columns [O₂], [CO₂], and [CH₄] are to be evaluated in order to disentangle effects coming from [O₂] and the actual target gases.
3. Retrieval errors related to uncertain knowledge of the instrument line shape (ILS) or errors related to spectroscopic line broadening parameters typically result in an air-mass dependence of the retrieval parameters. The longer the atmospheric path, the larger the errors. Unfortunately, the study does not cover measurements for a large range of solar zenith angles (as far as I can judge, information on observation conditions is rudimentary) although ILS and spectroscopy related error sources are highlighted several times. The revised manuscript should cover a discussion on airmass dependencies.
4. A crucial step toward making a low-resolution instrument appealing for monitoring

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networks such as TCCON is stability and robustness. This is acknowledged by section 4.1 and 4.5 and the finding that the optical alignment plays a key role for retrieval accuracy of the low-resolution spectrometer. Unfortunately, there is mostly speculations but no effort to actually assess stability of the instrument in a systematic manner. The rather large residual patterns in figure 1 (lower panel) might suggest that alignment issues contaminate the retrievals. (Is the ILS asymmetric?) The revised manuscript should elaborate in more depth on this aspect.

5. The title emphasizes that the low-resolution spectrometer is a “commercial” instrument. In my opinion, this is not a major scientific achievement. It should not be highlighted in the title of a research paper submitted to a scientific journal.

Minor comments

p. 2, l.4: actually -?-> currently

p.3,l.4: It should be noted that the downside of total column measurements is their smaller sensitivity to surface fluxes compared to in-situ sampling.

p.3,l.13: obtain -> to achieve

p.3,l.14: missing “CH₄, named XCH₄”

p.3,l.20: “VMRs are achieved”: Do you mean “the retrieved columns might share systematic errors” ?

p.4,l.7: remove “now”

p.4,l.13: used to create -> used to measure

p.4,l.20: TANSO -?-> TANSO-FTS onboard GOSAT

p.4,l.20: Define acronyms.

p.4,l.24: Except for SCIAMACHY, the other instruments resolve individual absorption lines.

p.6,l.19: fits -> fit

p.7, sec.4.1: Explain what “modulation efficiency “ is and how it affects the ILS.

p.8, sec 4.3: With the information given, I cannot trace the numbers and I doubt that the calculation is complete. Elaborate on it or remove this section. Shouldn't the error bars in Fig. 2 and 3 essentially represent SNR?

p.9, last line: GOSAT/TANSO has significantly better resolution than SCIAMACHY.

p.10,l.6: “depending on the spectral band analyzed”: Spectral bands have never been defined.

p.11, sec.4.5: I do not understand the last sentence. Please rephrase.

Tab. 1: What is “xCO₂(O₂)”? Is it XCO₂? Avoid use of multiple flavors of notation.

Fig.1: upper figure -> upper panel. I guess “intensity” on the y-axis should be “transmittance”.

Fig.2 and all other figures that follow: What is CO₂(O₂) (or similar)? Avoid use of multiple flavors of notation. The label of the y-axis are only units. The label should make clear what quantity is plotted.

Fig.8, 9: Panels are not labeled c) and d) while the text refers to “c)” and “d)”. The caption should make clear what the panels show.

Fig.9: The three lower panels seem redundant. Is there more information in it than just dividing the three lower panels of Fig.8 by the upper panel of Fig.8 ?

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 245, 2012.

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