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Atmospheric Measurement Techniques Discussions

Interactive comment on "Simultaneous measurement of δ^{13}C, δ^{18}O and δ^{17}O of atmospheric CO_2 – Performance assessment of a dual-laser absorption spectrometer" *by* Pharahilda M. Steur et al.

Anonymous Referee #1

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This is a good paper that deserves publication in AMT after revision. The authors did a great job in describing the mid-IR laser-based spectroscopic instrument for direct 17O-CO2 detection in air and reporting all relevant aspects of long-term operation and calibration of this instrument. The paper contains a lot of technical details and high-quality data. However, underlying spectroscopic principles are only partially covered. This might be outside the main scope of the paper, but some brief explanations are desirable.

The authors might consider addressing the following points:

1. The abstract of the paper ends with the sentence, which is only partially supported by the main text. Authors might want to elaborate improvements in measurement procedure, spec. fit and 17O calibration.

2. In recent years, significant progress has been made towards high-precision optical measurements of rare 17O-CO2 isotopologue: doi.org/10.1021/acs.analchem.7b03582, doi.org/10.1021/acs.analchem.7b02853, doi.org/10.1021/acs.analchem.9b03316. An overview of these works could be mentioned in the introduction.

3. Spectrometer's description still lacks some important details: a) what was the output power of ICLs? b) were measurements realised in static or flow-through mode? c) CO2 is known to be absorbed by aluminium, did authors encounter losses of gas in the optical cell? d) typical level of residuals, absorption line profiles, and spectroscopic line parameters are not mentioned in the text. Figure 2 might be improved by adding subplots with fit residuals and reporting noise level.

4. The authors tested the novel calibration scheme based on the isotopologue mole fraction and compare it with a conventional isotope ratio calibration. Several groups demonstrated successful application of the isotopologue mole fraction calibration recently (doi.org/10.1088/1681-7575/ab948c and doi.org/10.1002/rcm.8836). Not too much effort has been made towards the explanation of the advantages and disadvantages of both methods. Discussion on spectroscopic principles and limiting factors of the methods fit the scope of the paper. The discussion given in the end of 4.1 is very brief. Authors might want to expand this section.

5. This paper might attract more readers if it ends with a crisp recommendation summary on how to operate the laser-based isotope ratio spectrometer in practice. The findings reported in the paper are sufficient for this.

6. The paper would benefit from reduced use of abbreviations. I also suggest using roman typesetting for chemical formula and conventional (not AFGL) notation for

isotopologues, e.g., \ce{^{12}C^{16}O_2} instead of 626. Captions of the figures and tables might be extended for Figs. 1 – 3, and Tabs. 1 – 4.

7. Parts of the main text with technical details that are not directly related to the main subject of the paper, e.g., p.9 starting line 199, might be moved to the Appendix.

Some technical corrections: page 2, line 40: isobaric interferences of m/z = 46 with m/z = 45 ? Please elaborate. page 3, line 80: citation to out-dated HITRAN version. page 4, figure 1: label in the figure contradicts main text (QCL vs ICL). page 4, figure 2: typical level of fit residuals might be added here. page 5, figure 3: not all elements of the diagram are explained. page 9, line 201: here and throughout the text, mbar, not mBar or mBars page 9, line 291: cite doi.org/10.5194/amt-13-2797-2020 for matrix effect in mid-IR analysers page 14, line 295: purity <=99.99% ? page 16, table 5: briefly explain the errors page 17, line 364: cite doi.org/10.5194/amt-11-6189-2018 page 27, figure A1: no caption

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