

Referee 3

Many thanks for your detailed review. All our responses or comments are written in green through the text.

This paper reports the development of an optical gas analyzer for high temporal resolution and high precision measurement of $\delta^{18}\text{O}$ and atmospheric O_2 concentration based on the optical-feedback cavity-enhanced absorption spectroscopy (OF-CEAS). The results were compared with the isotope-ratio mass spectrometry (IRMS) and showed good agreement.

General comments:

1, Although this work was based on a commercial device (AP2E) and similar experiments have been performed elsewhere, the experimental details still require detailed explanation.

We do give detailed explanations about the special modification of the instrument relative to previous realizations for which we give references where the working principle of the technique and all details about the realization of different prototypes are fully explained. It would be completely redundant to provide an experimental scheme and description of the technique and of the working principle of the instrument which would not be different from what presented in the cited references. In addition, since the presented instrument was realized by a private company we cannot give details concerning the software and the control electronics or the model of pressure and temperature gauges which were selected by the company, which represent proprietary information and some are not available as individual parts (notably, the control electronics). In addition, we note that several works were published in this journal mentioning the exploitation, possibly with modifications, of industrial instruments (chromatographers, mass spectrometers, but also optical devices by Picarro or Aerodyne Research, eg. Berhanu et al., 2019; Kooijmans et al., 2016; Lebegue et al., 2016) without providing detailed descriptions of those instruments.

2, The conclusions of this paper need to be supported by solid experimental data, rather than just stating the conclusions.

The conclusion of the manuscript was improved.

3, A detailed review and comparison with other methods, especially spectroscopic methods, should be made.

We only find one reference of a spectroscopic method for measuring both $\delta^{18}\text{O}$ and mixing ratio of O_2 (see also our answer to the specific comment 2). The other commonly used method is isotope ratio mass spectrometry, also discussed in the manuscript.

Specific comments:

1, Page 2, line 32, the argument should contain high accuracy.

We slightly modified the manuscript to explicitly show that our instrument accuracy was compared with calibrated results from dual inlet IRMS.

2, Page 3, for O₂ concentration measurement, some other spectroscopy can also achieve ppmv level detection limit, such as Opt. Express 20, 2927, 2012. More discussion and comparison of other high sensitivity laser spectroscopy method is needed.

We refer in this manuscript mainly to the study of Berhanu et al. (2019) using spectroscopy method for measuring O₂ concentration in atmospheric air and possibly d18O (O₂) but not at the same time than the O₂ concentration. We will emphasize more on the performances of this instrument which can be used for similar applications to ours (despite d18O(O₂) cannot be measured at the same time as O₂ concentration which is a limitation). We have here a lower performance for the O₂ concentration since our primary goal was to obtain good performance for the d18O(O₂) while still be able to measure O₂ concentration at the same time.

We can also cite the work by Brumfield and Wysocki (2012) who developed a faraday rotation spectroscopy instrument for detection of small dioxygen concentration at the level of 1.3 ppmv at integration times of 1 minute. The objective of such a development is different from our development since it aims to detect small amounts of O₂ and not variation of O₂ concentration (+ d18O(O₂)) in atmospheric air.

3, line 80, the difference between two models and parallel measurements is unclear.

Clarified in the text. It refers to the fact that the Picarro instrument operates with 2 modes: O₂ high precision (without isotopes) and high precision isotopes (with low precision for O₂ mixing ratio). Both modes cannot be operated simultaneously, and an instrument restart is required for switching.

4, line 99, first OF-CEAS in the visible range, incorrect. Salter et al. (Analyst, 137, 4669, 2012) performed optical feedback measurement with 635 nm diode laser.

The reference provided describes a cavity enhanced system using optical feedback locking, however the detection is obtained by Raman spectroscopy, thus it is very far from being an OF-CEAS setup where, like here, the detection is made by measuring directly the absorption occurring inside the optical cavity.

5, Page 4, a detailed description of the experimental setup is required.

See answer above.

6, line 136, more discussion about the tuning coefficient and the intensity noise is needed.

We finally decided to remove that paragraph since the development involved in the choice of a diode laser appropriate to the instrument represents excessive details and we believe is of no interest to most readers of AMT. On the other hand, we added the detailed model of the Toptica DFB diode laser that was selected for this instrument, so that the detailed specs of this laser (such as the tuning slope) can be found on the manufacturer's site. We should add that the slope of the laser is not the only critical parameter, thus providing that detail may give the false impression that one needs to satisfy that condition to ensure proper operation of a DFB laser with the OF-CEAS technique.

7, Page 7, page 8, a detailed description of data processing methods is required. The corresponding experimental data need to be presented.

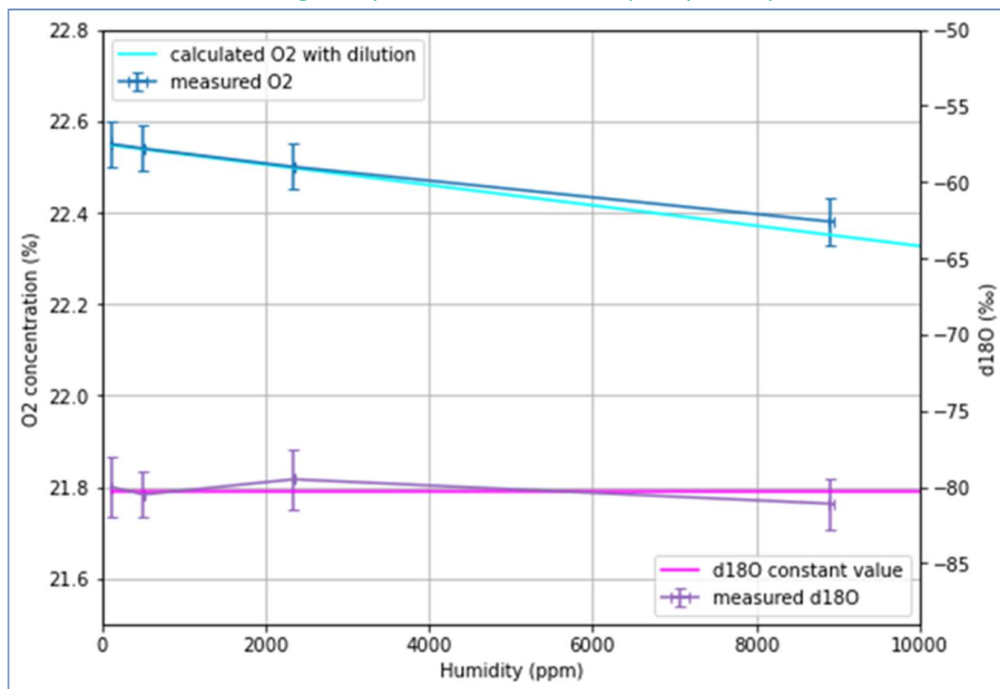
We guess the referee is asking to show examples of raw data obtained in transmission through the V-shaped cavity of the OF-CEAS spectrometer, then display and explain the intermediate steps needed to obtain an absorption spectrum and analyze it. As explained above, all that is already fully explained in cited references about the technique, there would be no new information in adding all those details in the present manuscript. That said, we added in figure 1 a panel with an example of OFCEAS spectrum from the instrument (which was already plotted in the figure together with the HITRAN simulations), together with the spectral fit and the residuals of the fit.

8, line 258, is a data acquisition time of 10 to 20 minutes fast enough for concentration and isotopic measurements?

Our first application for this instrument is the measurements of the evolution of the elemental and isotopic composition of dioxygen in controlled biological chambers. In this kind of experiments, the concentration of O₂ and d18O(O₂) varies continuously on timescales of several days so that obtaining one accurate data point every 10 or 20 minutes is largely enough. Similarly, this kind of instrument could be used to measure the evolution of O₂ concentration and d18O(O₂) by continuous flow analysis of gas trapped in ice core (as done for methane by Chappellaz et al., 2013). For this application, it can also be shown that one accurate measurement every 20 minutes is enough to capture the slow temporal variations of O₂ concentration and d18O(O₂).

9, the influence of water vapor requires experimental data.

Because we remove the water, we only characterize with a few data points the dependency of d18O and O₂ on humidity. The graph is provided below and can be included in the revised version of the manuscript if needed. The dependence of the O₂ concentration is only due to the dilution of the O₂ signal by the added water vapor quantity.



References

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Kooijmans, L. M. J., Uitslag, N. A. M., Zahniser, M. S., Nelson, D. D., Montzka, S. A., and Chen, H.: Continuous and high-precision atmospheric concentration measurements of CO₂, CO and H₂O using a quantum cascade laser spectrometer (QCLS), *Atmospheric Meas. Tech.*, 9, 5293–5314, <https://doi.org/10.5194/amt-9-5293-2016>, 2016.

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