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Atmospheric Measurement Techniques Discussions

Interactive comment on "High precision laser spectrometer for multiple greenhouse gas analysis in 1 mL air from ice core samples" *by* Bernhard Bereiter et al.

Anonymous Referee #1

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The broad research question behind this paper – how can the tiny volumes of gas contained within the heavily thinned 'Oldest Ice' be analyzed effectively without sacrificing data quality – is of interest to many in the paleoclimate community. Unfortunately, despite the promising title, abstract and introduction, this study provides more questions than answers. The reader is not told until L53, after an Introduction loaded with information related to the Oldest Ice challenges, that this study only reports on the development of a new laser spectrometer for multiple gas analytes. This study does not include any information about the sublimation technique, i.e., how the gas sample will be extracted from the ice. This makes it impossible to assess the potential efficacy of the system for ice core measurements, which makes the last sentence (L377) seem a

little premature, and the title, abstract and introduction seem misleading. I don't mean to criticize the significant achievement of the authors in developing this instrument, just to highlight that the instrument is a long-way from being well-suited to ice core analysis.

In particular, the section beginning at L337 focuses on one of the challenges of using laser spectrometers for small gas volumes – that the volume of gas must be kept constant. Figure 10 nicely shows the problems this causes for the measurements. As the sublimation system is not described and no results reported, it is difficult to judge how effectively this problem will be dealt with via the calibration method suggested.

I am not an expert in optical physics but, from what I understand, the instrument design is well-described and includes enough novel features or improvements on previous work to warrant a publication. At two points I felt that more technical information could have been provided: L83 on the selection of absorption lines, and ∼L102 on the beam characterization.

The figures are all clear and helpful and the paper itself is well-written.

Other comments: Abstract L10: Where are these precision values from? I can't find their origin in the manuscript. Values at L288 are different. Please state that these are 1 sigma values, if that is the case.

L11: How do "Repeated measurement cycles of air samples" demonstrate "an excellent accuracy level"?

Introduction: Nice summary of modern measurements and the Oldest Ice campaign but it doesn't provide much context for this technical study on spectrometer design. L68-71: Both studies cited here use Picarro instruments that do not utilize cavity-enhanced technology. L77-78: How were these values chosen? Are they 1 sigma values? L151: Last sentence is repetition.

Section 3.1, L255, sentence beginning "Our setup. . ." I didn't catch the meaning here. L258: Can the authors further explain why d13C-CO2 and CO2 behave differently to

the other analytes during the Allan-Werle test? Why do the d13-CO2 measurements drift significantly when the others do not?

L270-271: The Allan-Werle shows the optimum time to integrate the data over to obtain high precision. How does this ensure high accuracy?

Figure 9 and associated text: Much of this underestimation of all the analytes is attributed to optical saturation. . .this seems to be a significant problem because the offset changes with pressure. What is preventing you from reducing the intensity further? The 'neutral density filter' mentioned at L118 doesn't seem enough here.

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