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Interactive comment

Interactive comment on "Diode laser based gas analyzer for the simultaneous measurement of CO_2 and HF in volcanic plumes" *by* Antonio Chiarugi et al.

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The paper is an interesting application of standard absorption spectroscopy techniques. There are a number of specific criteria that the authors address, particular to application for studying volcanic plumes. They have developed an instrument that successfully achieves their requirements for volcanic science, including precision, power consumption, size and weight.

I felt that the manuscript could be of greater value to the community and have greater impact with some relatively minor changes.

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Discussion paper

First and foremost, the 3D Figure 1 is useful, but would be much more useful if accompanied by a schematic diagram showing the optical configuration. That is, a box and line drawing showing the key elements (lasers, mirrors, detectors, fibres) and the light paths, particularly the multipass arrangement in the cell. Figure 2 would also be much more useful if they could provide line drawings showing waht the cells are - to my untrained eye, I see a skinny black tube and a fat white tube, which provide little guidance if I wanted to build a similar instrument. Scale bars would be helpful for both figures.

Second, there is frequent mention of key metrics such as precision, power consumption, size, weight, but the requirements are not quantified. The manuscript would be much more readable, and also easier to write, if the requirements were specified in the introduction. What precision is needed for their volcanic research? What power consumption is acceptable? How long must it operate on battery power, or what could be achieved if that was possible for 1 hour, 4 hours, 8 hours etc? Why is size important and what size thresholds are there? Once those parameters are defined, it becomes very clear to list alternatives that do not meet those requirements, and show how their instrument compares. The conclusion paragraph could also then be more concise and have greater impact.

In a related sense, the paper is quite long for the content. It would have greater value if more concise; for example removing frequent repetition (references to precision, power consumption, etc). In considering alternatives, they could be tabulated, with a row for each, and columns for the metrics mentioned above. A reader could then very quickly appraise the existing options and see why this new instrument is worth learning about.

I have a number of small queries/suggestions. Line 120: I did not understand this sentence.

Line 150, 228: The manuscript uses mixed units for laser wavelength/frequency (e.g. laser wavelength in microns and spectroscopic features in wavenumbers). It would be helpful to provide both when using either, for example 1.27um (7875 cmˆ1) and 7823.82 cmˆ-1 (1.27815 um).

Line 182: The data acquisition requirements do not seem very demanding (1 MHz/16-bit measurement), and thus the use of a system crate with dual-core processor and FPGA seems extreme for an instrument which is nominally low power and compact. I am not particularly expert in what is available in such technology but I would first consider something like a BeagleBone single-board computer, raspberry Pi, and other devices which operate at just a few watts. Could they comment on why this approach was taken rather than something more specific to the task?

Line 235: Why did they not use two detectors and a dichroic splitter, so they could detect both wavelengths simultaneously, rather than switching them on and off?

How ere the scanning times determined, i.e. the ramp time of 1600us, and the dead-times of 100us and 300us? What is the time-constant of the detection system? Are these times excessive, or is the 1.6ms ramp time so fast that there is significant loss of fidelity due to scanning too fast over small features that are lost due to the analogue bandwidth?

Line 250: It would be helpful if the authors could provide a calculation of the expected measurement time required to achieve their desired sensitivity, and compare that to the time they used in their experiments. In particular, to better understand the limits; for example, could we reasonably expect to achieve measurements of comparable precision and accuracy at 10/s or 100/s rather than 4/s? If not, what would we need to improve?

Line 257: They refer to simulation of a sloping background by *multiplying* a Voigt profile by a two-order polynomial (which I take to mean a quadratic). But fitting a background would involve addition/subtraction of a polynomial; multiplication simulates a varying gain or optical power. Could the authors please clarify?

Line 330: I did not understand this sentence: what do they mean by "get rid of fringes"? What fringes?

Line 388: The instrument measures ambient CO2 concentration of (390 +/- 20) ppm. How does that compare with standard data or independent measurement?

Line 434 (conclusion): Again, it would be helpful if the authors could compare their achievements against quantitative metrics. Some suggestions on how the instrument might be improved could be helpful (improved in terms of precision, accuracy, power, weight, size etc). I wondered if perhaps an AC measurement technique might be useful; their measurements are essentially DC, and thus sensitive to low-frequency (1/f) noise. Would fast modulation (of frequency or power) and demodulation (i.e. lock-in detection) be helpful?

In summary, the authors have developed a very nice instrument and their work is likely to be useful to others interested in field-deployable spectroscopy, but could be much more useful with some schematic diagrams and a little reorganisation of the manuscript.

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