

## ***Interactive comment on “A low-cost portable fibre-optic spectrometer for atmospheric absorption studies” by J. Bailey***

### **Anonymous Referee #1**

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The paper under review presents a very compact fibre-optic Fabry-Perot spectrometer customized for solar absorption spectroscopy in the shortwave infrared spectral range. Instrument setup and calibration procedures are described and illustrated for the CO<sub>2</sub> absorption band at 6350 cm<sup>-1</sup>. The paper recommends the compact spectrometer as a candidate for future remote sensing of atmospheric total column concentrations of CO<sub>2</sub>, CH<sub>4</sub>, and potentially other absorbers.

The paper is well written and the employed methodology appears solid and robust. Given high spectral resolution, low noise, and good spectral coverage, the measurements of the 6350 cm<sup>-1</sup> CO<sub>2</sub> absorption band look promising.

However, the paper lacks an estimate of the accuracy to be expected for routine retrievals of CO<sub>2</sub> (or CH<sub>4</sub>) total column concentrations. The authors themselves recom-

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mend such an assessment “by using [the Fabry-Perot spectrometer] alongside a high-resolution Fourier Transform spectrometer” (p.1080, 1st paragraph). All referenced precursor studies [Kobayashi et al., 2010; Kawasaki et al., 2012; Petri et al., 2012, Gisi et al., 2012] include at least a first estimate of the retrieval accuracy to be expected based on a reasonable ensemble of atmospheric observations. I would consider such an assessment the heart of an demonstrator study.

Therefore, I do not recommend publication in AMT. The paper requires a plausible investigation on the expected accuracy and on the usefulness of the spectrometer for the chosen science question – be it CO<sub>2</sub> total column measurements. This should be based on a reasonable set of actual atmospheric observations, preferably under various ambient conditions.

I list some related concerns below.

\*\*I would consider a  $\sim 13$  min scan time per spectrum a major shortcoming of the technique and quite a challenge for data reduction.

The first issue that comes to mind is the moving sun implying a considerable difference in the slant airmass between the start and the end of the scan. Probably, this can be taken into account by the retrieval algorithm by choosing the correct solar zenith angle for each monochromatic transmittance calculation. Nevertheless, I would recommend describing such aspects in a section about data reduction.

Brightness fluctuations of the solar source due to thin clouds, cirrus, or aerosols could cause major baseline fluctuations within 13 min. Even on much smaller timescales and thus, within sub-ranges of the spectrum, such fluctuations could be non-negligible. Thus, as the authors admit, the technique “requires completely cloud-free skies to produce quality spectra” (p.1080, last paragraph). In practice, I would expect major difficulties for gas concentration retrievals (if these baseline fluctuations are not monitored).

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\*\*For direct sun observations, it seems very useful to simultaneously monitor an O<sub>2</sub> absorption band with CO<sub>2</sub> and to ratio total column CO<sub>2</sub> by total column O<sub>2</sub>. The ratio will cancel quite some instrumental and spectroscopic error sources and yield a highly accurate total column mixing ratio XCO<sub>2</sub>. This is the standard technique currently used by the Total Carbon Column Observing Network (TCCON). In the view of a 13 min scan time and other instrument issues described in the paper, I would consider a reference O<sub>2</sub> channel highly desirable.

\*\*Is the filter response and the instrument line shape stable with respect to changes in ambient conditions?

Fig. 7 shows the filter response function determined from fitting a modeled transmittance spectrum to a measured one and then, low-pass filtering the residuals. Is the modeled spectrum actually fitted (eg. in a least-squares sense) or does it just assume an a priori CO<sub>2</sub> (and H<sub>2</sub>O) concentration? Could this filter response function be determined once in a calibration setup and then, be used for the actual target observations?

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Interactive comment on Atmos. Meas. Tech. Discuss., 6, 1067, 2013.

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