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Interactive comment on "Tunable diode laser measurements of hydrothermal/volcanic CO_2, and implications for the global CO_2 budget" *by* M. Pedone et al.

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General comments

Reviewer's comment: I think the manuscript would benefit from a discussion as to how this technique could be installed as a semi-permanent monitoring system. Clearly, some of the most important variables (as the authors point out) to constrain are the meteorological conditions (e.g., wind speed and direction, relative humidity, light levels, etc.). It would be useful to the reader to know which are the most important variables to consider, e.g., wind speed/direction vs relative humidity vs light levels; what minimum environmental conditions are necessary for accurate measurements?

Authors: Although the present study was based on a survey approach only, we yet concur with Dr William-Jones that there is potential for this technique to be employed as semi-permanent monitoring installation. While this possibility has not been specifically been explored in this study, we argue that mutable meteorological conditions would represent a primary constrain to consider for long-term observations. Based on experiences conducted over the last 3 years, we suggest that two environmental factors would play a major control on accuracy of observations in semi-permanent installations: (1) visibility: the laser beam is strongly attenuated in foggy environments and in cases of condensed plumes. It can be expected that measurements would be limited to good visibility/non-condensed plume conditions; (2) plume transport direction and speed: the TDL approach described here is ideal for stable, slow (convective) plume transport direction/speed. Measurements would become challenging or even impossible in strong wind conditions (when the plume has strong lateral velocity component) or if/where plume transport direction varies rapidly and frequently.

Reviewer's comment: Limiting the amount of time required to comprehensively image/measure the target area, thus reducing the amount of variation in meteorological conditions is crucial. So, while the authors moved the TDL and reflectors in order to produce comprehensive tomographic images of the target areas, would it be possible to fix the TDL in one or two positions and merely rotate the TDL (e.g., as mentioned on p. 2652) to encompass the target, essentially as a scanning system. The authors recorded for 4-5 min along each retro-reflector path but could this not be reduced (e.g., to 10s of seconds) such that more retro-reflector paths could be measured over a shorter period of time? What is the minimum measurement time per path to achieve an >95% confidence?

Authors: we concur with Dr William-Jones that limiting the measurement duration is key to improved measurement quality, and specifically to mitigate against the effect of changing environmental parameters. A pan-tilt unit is already available in the market that can be interfaced to the GasFinder TDL to allow rapid scanning of a target area

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from a fixed position. We suggest that – in stable meteo conditions – recording time for each target (retro-reflector) could be reduced to 30-60s without compromising data accuracy.

Reviewer's comment: Furthermore, it would be particularly useful to present a sensitivity analysis of the minimal vs optimal number of reflector stations necessary to accurately image a given degassing area. For example, using a subset of the data shown, what would be the minimum number of TDL/reflector combinations to acceptably "replicate" (to say 95% confidence) the optimal measurements presented here. This is key information both for campaign surveys and observatory monitoring where access, time, weather and financial limitations may be important.

Authors: the number of TDL/retro-reflectors combinations needed depends on target area dimension. Based on available results, we recommend to keep TDL/retro-reflectors combinations at least as dense as those used in the present study. We believe our field configuration should be viewed as a minimum configuration for obtaining reasonable accuracy.

Reviewer's comment: The manuscript would also benefit from an example of the time series variability of atmospheric CO2, volcanic CO2 and meteorological (e.g., wind, light), for example from the $\sim$ 4h of readings collected at Nea Kameni.

Authors: We concur with the reviewer this example would be useful and are keen to add this upon revising the manuscript.

Reviewer's comment: p. 2651 Section 4.1 – I do not think that it is necessary to state the total number of hours/readings of data collected over the four field campaigns, however, it would be useful to have the survey duration and number of reading with R2>95% (for each) listed in Table 1.

Authors: table 1 has been modified as the reviewer suggests.

Reviewer's comment: p. 2652 Section 4.2 & p. 2655 Section 4.4 – A video of vertical

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plume rise is important for situations where there is a visible rising plume in order to calculate flux. However, in many cases, especially at quiescent volcanoes with only diffuse degassing structures, there is no visible plume and thus the only source of information on the flux would be horizontal plume speeds from (ideally) portable weather stations proximal to the degassing area.

Authors: Agreed. We used a video camera to measure the vertical transport speed of each visible rising plume at each investigated area. At each site, we additionally used a portable weather station to measure wind speed at the measurement site.

Interactive comment on Solid Earth Discuss., 6, 2645, 2014.