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Solid Earth Discussions

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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This study presents an important contribution to our ability to quantify the degassing of volcanic CO2, through the use of a tunable diode laser (TDL) system. Our ability to accurately measure the flux of both actively and passively/diffusely degassed CO2 is hindered by the difficulty of distinguishing between atmospheric and volcanic CO2 as well as the often dispersed nature of the degassing sources (e.g., open vent vs diffuse degassing structures); this makes rapid comprehensive monitoring particularly difficult. Furthermore, as the authors point out, we are only just starting to understand the importance of the contribution by volcanoes in a state of unrest to the global volcanic

degassing budget. This methodology therefore has significant potential to rapidly and comprehensively monitor and quantify the degassing of volcanic CO2 through time and facilitate volcanic eruption forecasting.

Once the comments (below) are dealt with, I look forward to seeing this manuscript published in Solid Earth.

General comments

That being said, 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?

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?

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.

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 ∼4h of readings collected at Nea Kameni.

Minor comments

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.

p. 2652 Section 4.2 & p. 2655 Section 4.4 – A video of vertical 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.

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