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Atmospheric Measurement Techniques Discussions

Interactive comment on "Remote sensing of volcanic CO_2, HF, HCl, SO_2, and BrO in the downwind plume of Mt. Etna" *by* André Butz et al.

Anonymous Referee #1

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This is a well written paper about the measurement of the volcanic gas composition of Mt Etna's with mobile remote sensing instrumentation. Although the concepts are not new since similar investigations have already been performed around the world, the authors do an excellent job describing the experimental and analytical techniques employed. Furthermore, the advances made recently in the improvement of commercially available instrumentation (i.e. robust spectrometers, refined solar tracking systems) was taken advantage of in order to get unprecedented precision in the detection of gases like CO2 from the volcanic plume via the solar absorption technique. Much is still to be improved, as the authors comment, but this manuscript provides a very good insight of what is possible in terms of quality of the results with the now available technology. The article should be published in AMT after the following recommendations are taken into consideration.

- Give more detail on the optical set-up of the UV spectrometer/telescope in p4 l4 and provide a reference if available.

- Nothing is mentioned about the plume heights during the days of the experiments. It would be useful to know for future studies considering that the sensitivity of the technique is strongly dependent on the true distance to the plume and thus the dilution effect.

- p5 l7. Why not use the background VCD-scaled profiles from the stationary FTS measurements instead of the a priori profiles?

- p5 l9. By "lower tropospheric" part you mean one or several layers in your RT model? Please specify how the constraint is set.

- p6 l10. What about atmospheric pressure. Does small variations in the detected VCD's also vary with surface pressure?

- Figs4&5. There are some intra-plume dXCO2 values which fall in negative values with as much as 1 ppm, while the precision is reported to be considerably smaller (3.7x10ˆ18 molec/cm2). This value should also be converted to delta XCO2 (ppm) to have an idea. The authors argument later that the transition from CO2-rich to CO2-poor plume might be the reason for negative values, while the other gases remain elevated. But if HF is being used as proxy for intra-plume measurements, then this doesn't explain it. Maybe a dCO2/SO2 and dCO2/HF time series for these critical phases could support the idea that strong plume composition variations are happening within the same morning.

- p7 l14. The authors state that "An improved setup might benefit from operating the stationary FTS closer to the trajectory of the mobile observatory". The way it is explained, the grey points on the plots from the mobile instruments are used to produce the time-dependent background function (P). So, it is not clear to me what is meant by this. Is it the difference between the red line and the blue crosses that they want to

minimize? What for if it is not used in the calculations?

- p10 l8. I don't see how wind direction could affect the observed variations. Should't the plume contain a mixture of all craters 5-10 km downwind?

- Figs6-8. There are clear intra-plume measurements of SO2 and BrO which are not red-colored. Please include an explanation in the text why this is so, I couldn't find it.

- Fig9. the offset in the ordinate for the different days should be made clearer in the plot and not only in the caption. Maybe they can start labelling the y-axis at 0 each time where the dotted lines are drawn.

- It would be useful for certain readers, maybe geochemists or other researchers who want to compare their previos investigations, to include average ratios for the entire campaign in the bottom of table 3.

- At the end it was unclear to me the benefit of having a fast-scan solar tracker if only stationary data during the stop-and-go periods were utilised for calculating the ratios.

Minor

- The paragraph in section 2 is too long, break into at least two paragraphs.

- p3 l32 . . .in order to increase measurement frequency.

- p4 l10. Compared to applications which require stationary deployment, volcanic . . .

- p4 l26. . . .due to unstable tracking of the sun (or clouds passing by ?!)

- p4 l32 along the vertical, -> along the optical path, and derived the corresponding vertical-columnn-densities (VCDs).

- p5 l19. Climatological profiles from a specific model? Please specify.

- p5 l29. were dark spectra measured and subtracted?

- p5 l30. remove "such"

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