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Comment on acp-2022-253

Michael Fromm (Referee)

Referee comment on "Measurement report: Plume heights of the April 2021 La Soufrière eruptions from GOES-17 side views and GOES-16–MODIS stereo views" by Ákos Horváth et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-253-RC2, 2022

Review of Horvath et al. "Measurement report: Plume heights of the April 2021 La Soufrière eruptions from GOES-17 side views and GOES-16–MODIS stereo views"

Reviewer: Mike Fromm

Horvath et al. apply a suite of techniques they introduced in a pair of 2021 publications to the stratospheric volcanic eruption at Soufriere St. Vincent in April 2021. This volcano and eruption event were advantageous for its location (quite close to perfect lib view) and the dozens of eruption pulses spanning a variety of column heights. In this manuscript the authors expand on their previously introduced topic of side-view IR limb profiling of the eruption column, demonstrating promise for eruption-monitoring applications at night.

Like their pair of publications in 2021, this manuscript achieves a high quality in terms of rigor, clarity, and organization. Figures are clear and easy to interpret. For the most part, referenced literature is appropriate. Sources of uncertainty are fairly described and dealt with. I have only minor questions and suggestions for improvement. Given an adequate response to these, I expect to highly recommend publication.

The overriding weakness of this manuscript, minor though it is, is that the reader may want to know if the innovative analyses herein have a relevance beyond the arcane or

academic. Presumably the answer is yes, but the authors do not "sell" their advances in terms of practical applications. For instance, it would be great to learn where on Earth these side views intersect with volcanoes. Each operational Geo bird has an entire limb perimeter to offer. Hence, some accounting for each Geo bird's limb swath and the volcanoes worth watching within each swath would immeasurably add to the impact of this paper.

Secondarily, it is serendipitous that La Soufriere was so close to a Geo/ABI limb. The paper makes a wonderful demonstration of that near ideal condition. However, from a volcano reference frame, it would be important for the reader to get some idea as to how these side-view visible and IR potentials degrade away from the limb toward a satellite's nadir. The authors are encouraged to present an assessment, within a volcano-location-with-respect-to-Geo-limb reference frame, how far from limb these tools can apply. I realize this is a multi-variate challenge, but it is nonetheless important for the reader to know how much value is delivered by this proposed Measurement Report.

I was curious to know if there were any strategic encounters by the lidar aboard CALIPSO? If so, might the authors consider showing such an encounter and discussing agreement/disagreement with their independent plume height calculations? If there were no such encounters, there is no reason to modify the paper.

L24, regarding the 1979 eruption: Please provide a citation if one exists.

L60, "dark pixel": I am not aware of this term. Please provide a definition and/or citation.

L80, Regarding pixel resolution. Is a citation needed?

L86, "Such uncertainty can still be competitive for…": It is unclear what is meant by "competitive" here. What is competing with what?

L99, "As a result,": As a result of what? The actual cold point temperature? How does that translate to "~220K"? In general, any BT will have more than one solution as long as there is a layer warmer than that in the atmospheric column. So, is 220K simply chosen here as a practical value considering eruption column range? Please clarify.

L102, "…opposite sign, but comparable magnitude…": What is the significance of the comparable magnitudes? Presumably that has no bearing on how meaningful the midpoint plume height is. Perhaps the authors should at this point explain how the midpoint is to be interpreted. If the cloud is opaque, an assigned plume height in between the two points on the T profile is seemingly arbitrary. So, some justification is needed.

L89, “2.2 GOES-16 brightness temperatures”: This is just a thought, not a suggestion for the current manuscript…Have the authors considered invoking a radiometric cloud-top topography metric? By that I mean defining a simple cloud with a single, local BT minimum (e.g. Figure 3g) with all surrounding pixels having warmer BT. To first order, this is what one would find when the column is rising up toward the cold-point. When the column enters the tropopause zone, the topography may be expected to get wavier, with multiple local BT minima and maxima. This wavy/complex topography can be distinguished from the “simple” topography and be used as an indicator of greater uncertainty in the BT/z lookup result.

L173, 174, “Because the OT can be assumed to exhibit only small downwind advection and thus to lie nearly above the vent,…”: Why resort to assumption, when we can look at wind profile (radiosonde or reanalysis data) to assess forcing on the column top tilt? Please expand on this or justify the assumption.

L181, “This cold bias is likely the consequence of observing a warm subpixel stratospheric target above a colder umbrella spreading at the tropopause, combined with potential thermal disequilibrium due to…”: This sentence is long and unclear. We're talking about the coldest pixel. All the other BTs are warmer. What is meant by the cold umbrella? Please reword for clarity.

L221, “The GOES-16 plume-top BT11 shows a cold…”: Citation needed for this sentence.

L223, 224, “The minimum BT11 of 197.6K is located considerably downwind of the volcano, over an optically thick and opaque part of the umbrella.”: How do we know about the optical opacity there? It is not self-evident from the figure. Please explain.

Speaking of opacity, have the authors considered citing and applying works such as Inoue (1987), who employed split-window BTD to independently characterize cloud opacity? Since the issue of semi-transparency is a theme here, it may be essential for the authors to demonstrate usage of tested means for evaluating the opacity of selected IR BT pixels.