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Atmospheric Measurement Techniques Discussions

Interactive comment on "On the absolute calibration of SO_2 cameras" *by* P. Lübcke et al.

Anonymous Referee #2

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This paper concerning the calibration of SO2 cameras is a timely contribution to the literature. Such cameras are growing more and more popular as a means of measuring volcanic SO2 emissions and the examination of calibrations that this paper addresses will be of value to the scientific community. It is critical that errors associated with such cameras are better known prior to more widespread use. The authors carefully address a number of possible errors with the 'calibration cell-only' method, effectively highlighting the need for integrated DOAS measurements for accurate quantification of SO2 emissions.

The main item I see as lacking in this paper is more of a mention of the fact that, while important, merely ensuring a good camera calibration does not mean that the end emission rate will be accurate. If accurate emission rates (and not just calibration) are the goal of such camera measurements, issues like grounded/partially visible plumes,

as the authors encountered in their own field work, will need to be addressed as well. That is not to say that the authors need to tackle those problems for this paper, but they are relevant and should be mentioned as a caveat to readers new to SO2 camera usage.

In general, this is a good paper with sound and valuable science and should be published, given some small changes. One minor thing to be careful of is mixed usage of British and American English. Clarify which one is the journal's preference and check for consistency. In particular, page 6195 has successive paragraphs with different spellings of characterize/characterise. Favorable/favourable and center/centre were also noted throughout text. In addition, certain parts are wordy or ill-worded (e.g., pages 6188 and 6204), which may lead to confusion on the part of readers. Below are constructive suggestions for minor changes that would improve the reader's experience.

I thank the editors and authors for the privilege of reviewing this paper.

Page 6185

Lines 7/8: Multiple uses of "two-dimensional." Could substitute "synoptic" or similar word.

Page 6186

Lines 10 & 13 and elsewhere: Mixed usage of "flux" and "emission rate." While flux has often been used in literature pertaining to volcanic emissions, it actually pertains to a property with an areal component, i.e., flow (per unit time) per unit area. As volcanic emissions are not reported per square inch or square kilometer, but as unit mass per unit time, the term "emission rate" is preferable.

Line 2: Spell out "field of view" before first abbreviation of FOV in main text.

Lines 4-5: Sentence about NOVAC approach is irrelevant; remove.

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Lines 11-13: Is there evidence/testing showing error related to summation of the wide-angle FOV intensities? Otherwise, it's just speculation on the part of the author with no supporting reason.

Line 18: McGonigle is the correct spelling of the first author citation.

Line 24: Not clear whether 22.4 degrees is the FOV of the IDOAS or camera.

Line 27: Change "like" to "e.g.,"

Page 6187

Lines 3-13: Combine these paragraphs.

Page 6188

Lines 1-19: This section is very choppy and disjointed, which could cause confusion or misunderstanding. Most points are important, but could be written much better in order to have a stronger end to the introduction section.

The entire first paragraph should be rearranged to flow more logically and smoothly. For example, the first two sentences could be combined. The third sentence is awkward, as it describes the "differential optical density" being the "difference between the optical densities." The final two sentences of the first paragraph are also awkwardly worded and don't flow well together. The third paragraph is out of place and could perhaps be integrated with text on the previous page. A better transition to the fourth paragraph is necessary; make it more clear in the previous paragraphs that the DOAS calibration of the camera is preferable but has yet to be adequately studied/constrained and that that is what your fieldwork/paper sets out to do.

Lines 3-4: Either "see Mori. . ." or "e.g., Mori. . ." but not both together.

Line 21: Influenced in what ways? Mention specific examples.

Lines 22-23: Can you really call it differential optical density if you're referring to a

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situation with only one band-pass filter?

Line 25: Delete the word “still.” What is considered to be a “reasonable” exposure time? Why? There are issues related to the speed of the plume features through the field of view relative to the exposure time, and also to the exposure time relative to the opening/closing of the shutter. More explanation of which factors lend themselves to “reasonable” exposure times should be mentioned.

Lines 26-27: Delete “Therefore.”

Page 6189

Line 9-10: More of a transition is needed than just a colon before introducing equation 2.

Page 6190

Lines 17-21: The paragraph between lines 18 and 21 should be split into two, with the first sentence added to the preceding paragraph, which speaks about aperture. The second sentence should be in the paragraph below, which concentrates on the filters.

Page 6192

Line 13: Change to “. . .azimuth angle and, most importantly, changes. . .”

Page 6193

Lines 9-11: Not necessary to include this reference to future discussion. Remove this paragraph.

Line 13: No comma after CD.

Lines 13-17: Move to between other two paragraphs.

Lines 15-16: Change to “Thus a calibration curve can be obtained for each pixel from AA/CD. . .”

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Lines 19-22: Delete “When calibration cells are place... can be obtained.” The sentence is unnecessary if the above change is made. Also delete “However” from the next sentence.

Page 6194

Line 11: Replace “which” with “though this issue”

Line 12: Comma after “As mentioned above”

Line 26: No comma after “taken”; commas before and after “over time”

Page 6195

Line 16: Change “perpendicular” to “perpendicularly” Multiple British/American English issues on this page.

Page 6200

Lines 5-6: No need to re-define AA; delete “the difference between tA and tB.” Also, expand on why the aerosol-induced effect is neglected, and why it is acceptable to neglect the effect.

Lines 7-8: Put AOD in parenthesis in line 7 after aerosol optical density, as the acronym is not yet defined prior to the usage in line 8.

Line 14: Change “radiation on volcanic” to “radiation by volcanic”

Page 6203

In reference to the convolution of absorption cross sections to instrument resolution, the past tense of this verb is “convolved,” not “convoluted”. Two instances on this page.

Page 6204

Lines 6-7: Combine first two sentences of paragraph, change wording to make less confusing, e.g, Because the data from the NFOV-DOAS, together with the correspond-

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ing AA data from the SO2 camera, are used to create a calibration curve, it is important to know the exact area in the camera image at which the DOAS telescope is directed.

Lines 11-12: No paragraph break here.

Lines 12-21: Your use of FOV here could be quite confusing. There is the true FOV the DOAS telescope, but what you often refer to as FOV is actually the location of the footprint of the DOAS FOV in the camera image. The FOV of the DOAS did not change during transport; the location of the footprint did. Clarify this wording.

Page 6205

Line 9: Change “extension” to “extent” For the transformation matrix, presumably you only had fixed feature points in half (or less) of the image (i.e., the lower part, where the edifice was). What sort of errors might you be introducing by extending a transformation applicable to only a limited spatial extent of the image to the entire image?

Page 6206

Lines 9-10: Delete “The results will be discussed and interpreted in this chapter.” Unnecessary.

Page 6207

Did you investigate residuals between the polynomial images and the raw data? Are you left with just the ring structure, or are other effects that may cause issues with an accurate calibration?

Page 6214

Line 8: Delete “with them”; switch “errors” and “associated” More British spellings on this page that are inconsistent with American spellings elsewhere.

Page 6216

Line 18: Remove “first time.” While the SO2 camera is offering more opportunities for

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capturing high temporal resolution emission rate fluctuations, it's certainly not the first time it has been done, as such variations have been captured at other volcanoes with everything from cameras to COSPEC. If you are referring to the first time at Popo, make that more clear. I suspect it wasn't even the first time at Popo; DOAS systems, FLYSPECs, and SO2 cameras from multiple institutions measured at Popo at the CCVG workshop in 2008.

Figures 7, 10, 12, 13

Y-axis labels indicate "DOAS SO2 CD". If red "X"s on plots are SO2 camera data only, then this axis label is not accurate and the DOAS portion of the label should be removed.

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