

Interactive comment on “Modeling of 2008 Kasatochi volcanic sulfate direct radiative forcing: assimilation of OMI SO₂ plume height data and comparison with MODIS and CALIOP observations” by J. Wang et al.

Anonymous Referee #1

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General Comments

This paper is one of the first to assimilate retrieved OMI satellite SO₂ plume altitudes into a model for examining volcanic aerosols. The authors validate the model results using CALIOP and MODIS observations and then extend the work to look at radiative forcing. The work demonstrates the usefulness of the GEOS-Chem model for examining volcanic emissions. The paper is generally clear and well-written, and suitable for publication in ACP. I have some general and specific comments for improving the text, and several suggestions for clarifying figures.

C9836

Some more discussion of the initialization parameters would be useful with reference to previous literature and observations. For instance, Kristiansen et al. (JGR, 2010) estimate SO₂ emissions at 7 and 12 km, and some up to 20 km. The AVO also noted three distinct eruptions (<http://www.avo.alaska.edu/volcanoes/activity.php?volcname=Kasatochi&eruptionid=605>), although a one-day duration is used here. How might the assumptions used in the model initialization affect the model results, if at all? A brief mention of how uncertainties in OMI retrieval might affect final results would also be useful: i.e., from retrieval uncertainties due to volcanic ash etc.

It is mentioned several times that the low SO₂ in the model is likely due to more clouds in GEOS-5 than are seen by MODIS. Is it possible to test this hypothesis in GEOS-Chem by using MODIS observations for met fields, or simply perturbing the GEOS-5 cloud amounts? How does this fit in with fact that Yang et al. (2010) mention OMI may be biased low in the first couple of days after eruption?

Specific Comments

There is significant discussion about the stratosphere, but nowhere is the tropopause height in the simulation mentioned. Can you give value of tropopause height somewhere near the beginning for context? (Particularly important for when injection heights are discussed.)

Is the OMI data you use filtered by cloud fraction at all?

P 26440, L 8: The original reference describing the OMI SO₂ simultaneous height and amount retrievals seems to have been excluded. Probably the more appropriate reference here would be Yang et al., 2009, GRL “Estimating the altitude of volcanic sulfur dioxide plumes from space borne hyper-spectral UV measurements”.

P 26440, L 10: Again, I think the wrong reference is included here. Do you mean the other GRL 2009, or Yang et al., 2010?

C9837

P 26441, L16: Why is 2 km half-width used? Is there evidence in literature for this plume shape and vertical extent? Does it make any difference to simulations?

P 26443, L 21: Stratospheric resolution also mentioned later in text. Give a brief indication of layer distribution/vertical resolution of model here.

P 26445, L 20: It is a bit confusing how the model was initialized. Is a total of 2 Tg emitted continuously spread over a 24 hour window into the spatial distribution inferred by OMI, all at 10 km, or is OMI data assimilated exactly at the overpass time?

P 26448, L 7: Not sure sentence makes sense. Do you mean “We note” instead of “In the comparison, it is noted”? Also, give a number for “low altitudes”.

P 26449, L 9: Noted by you or by Kravitz et al? If noted by you, please explain in a bit more detail how statistics are affected.

P 26450, L 4: It makes sense that the lifetime would depend on injected height, but why would it be expected to depend on injected mass? Chemistry?

P 26450, L 15: Interesting. Do you know if this is seen anywhere else in the literature?

P 26452, L 11: Please give a rough numerical value for fraction.

P 26455, L 2: Why do you only do simulations below 10 km? Why not go to 12 km? Also, important to note where tropopause is located in this discussion.

P 26457, L 23: Are there others? Mention specifically which other references are doing this in introduction.

Table 1: I don't think this table is necessary; it seems to add unnecessary detail to paper. Could be summarized with a couple of examples in introduction to show spread in estimates of altitude.

Figure 1: Looks like western-most part of cloud isn't observed by OMI. Is this the case? If so, are you making assumptions about the remainder of the cloud, or can you use

C9838

another instrument to infer information about that part of the cloud? Also, model shown on high-resolution grid here. Mention it is interpolated/smoothed data, or show on 2x2.5 grid.

Figure 2: There is a labeling error here. (a,c) instead of (a,b) for example. Also, what is meant by GCno_omi? Is this GEOS-Chem using AEROCOM emissions? Clarify in text.

Figure 3: I am confused about why OMI and GEOS-Chem don't have same mass on day one. Also, Yang et al (2010) showed mass of 1.5 Tg on first day but you use 2 Tg to initialize, and then OMI shows up higher than GEOS-Chem in this figure. How does this factor into graph, initialization and analysis? Explain in text. There is no black x on graph as discussed in caption.

Figure 5: Color of orbit is confusing as it is the same as background and hard to see. “and” is spelled wrong. “6a, d” should be “6a, c”.

Figure 6: The pink letters and lines used here are confusing as they seem to reference the same areas as in Figure 5, since both are discussed in text at the same time (but in Fig 5 “A” means something totally different from “A” in Fig 6). Consider using a different color and labeling scheme in Fig 6.

Figure 7: Capitalize “temporal”.

Figure 8: Is black line best fit or another parameterization?

Technical Corrections

Address #2 has Lincoln, NE as location.

P 26437, L 11: Change “(b) a” to “(b) an”

P 26437, L 13: Add period to sentence.

P 26440, L 28: Add period here. Maybe start new paragraph.

C9839

P 26411, L 17: No sure that second half of sentence necessarily follows first. Maybe reword and remove "hence".

P 26442, L 28: Missing hyphen.

P 26443, L13: Add "with" between "comparison" and "volcanic".

P 26448, L 6: Change "decent" to "descend".

P 26448, L 23: Change "forecast" to "forecasts" or "forecasting".

P 26449, L6: Remove "is".

P 26449, L19: Change to "e-folding".

P 26450, L 1: Change "lower" to "lowered".

P 26452, L 28: Should be "10⁻⁴" instead of "10⁴".

P 26454, L 5: Should be "-4" instead of "4".

P 26454, L15: Grammatical problems with phrase in brackets.

P 26454, L 20: Remove "of" in front of "showing".

P 26455, L 15: I think it should be $W \text{ m}^{-2}$ here instead of %.

P 26457, L4: Should be -2.

P 26457, L 6: Add "the" before "majority". Also awkward use of semicolon.

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