Review on Manuscript No. AMT-2023-267

Using OMPS-LP color ratio to extract stratospheric aerosol particle median radius and concentration with application to two volcanic eruptions by Wang et al.

Wang et al. derive stratospheric aerosol microphysical parameters from OMPS using the color ratio. They discuss various sources of uncertainty and apply their algorithm to measurements from SAGEIII on ISS and validate their method with balloon data and then apply the algorithm to measurements made during two volcanic eruptions.

I personally do not have any problems with this study being published. Although the method itself of using two wavelengths for deriving microphysical parameters seems not to be new, I still think this study is of value for the community since it is applied to a different instrument and under different conditions than the ones used in previous studies. Especially when only measurements at two wavelengths are available such a method is clearly of value. However, I agree that the referencing should be done correctly, that the study should be better motivated and that the implications for the community should be more clearly stated. In addition, before resubmission the manuscript should be carefully checked for language and technical correctness. The present version is full of mistakes and could have definitely be prepared with more care.

General comments:

For me it did not become clear why you do everything with two wavelengths if there are more wavelengths available and one could do everything more accurately without making so many assumptions? Or are the observations at several wavelengths only available from SAGE III and not from OMPS? If you have only measurements at two wavelengths from OMPS I can totally understand why you develop the method you are presenting here. If there however are measurements of three or more wavelengths available from OMPS I would wonder why you make analyzing the data more complicated than necessary.

I think adding subsections describing the OMPS-LP and SAGE III measurements would be quite helpful for the reader. This is definitely missing in the current version of the manuscript. You cannot expect the reader to be an expert on both instruments. Further, I would suggest that you first describe the comparison to the balloon measurements since this is the main comparison (validation) of your method and then present the SAGE III comparison.

Why do you apply your method then to SAGE III? Why is it necessary to have a comparison to another satellite? Could you more clearly state what you try to achieve with this comparison? Couldn't you also use more than two wavelengths from SAGE III to also show what the difference to the more accurate way of deriving aerosol microphysical parameters is?

Specific comments:

P1, L15: "….assuming…… width of 1.6". You are not only assuming this with value. You also derive the best result/agreement with this value, thus I think you could/should clearly state this.

P1, L22: Instead of citing the text book from Seinfeld and Pandis (2016) I would suggest to cite Brock et al. (1995) and/or Kremser et al. (2016). Note, stratospheric (sulfuric acid) aerosols form mainly in the tropical upper troposphere (see Brock et al., 1995). Please rephrase/correct the sentence.

P1, L28: What is meant with "black" and "brown" aerosols? Please explain this to the reader. To my knowledge these terms are only used for tropospheric aerosol (e.g soot containing aerosols).

P1, L28: What is meant with “self loft”? Without explanations this sentence is useless. I would suggest to omit this sentence.

P2, L34: What about SAGE and SAGE II? I think a sentence about this two instruments should be added.

P2, L37-38: Is the stellar occultation technique also used to measure aerosols? Without any further explanations this sentence is useless and could be omitted.

P2, L51: Are there currently or in the future other missions measuring aerosols in the stratosphere? Or will OMPS be the only one irrespective of the measurement technique? When was OMPS launched and how long are the measurements expected to continue? Please add here some more information.

P2, L63-P3, L64: Without any further explanation this sentence is useless. What is the difference between your algorithm and the one from Thomason and Vernier (2013)? What are the differences between the algorithms? What has been changed?

P3, L69: Add here a section or sections describing the instruments/data used in this study (SAGE, OMPS, balloon)

P3, L77: What are N, r_0 and s are. This has not been explained.

P3, L81: Why in this study? How is the color ration defined in other studies? Isn’t the color ratio always defined the same way?

P3, L83: There is no Ångström exponent in Equation 1b.

P3, L8: Which wavelengths combinations are available and which ones have been used?

P4, L116: How “large”? Please give some numbers.

P4, L121: Why? Why this value? Do you derive this value from Fig. 1? Provide figure or reference for this value.

P5, L134: Using a log-normal distribution is quite common for stratospheric aerosols and thus here you should instead of a specific paper rather cite a textbook as e.g. Seinfeld and Pandis (2016).

P6, L176: If the error is large for small radii wouldn’t this then cause difficulties when plume events are considered where many small particles are produced?

P6, L185-186: In both sentences you cite Chen et al. (2018). One of these citations could be skipped and the grammar of the second sentence should be corrected.

P7, L21-202: Not necessarily. You will have both small and large particles. If you make such a statement you should give a reason and/or provide a reference.

P7, 208ff: I would suggest to change the order and to first describe the validation with the balloon data and then the verification with SAGE. If you want to keep the current order you should provide a motivation or reasoning why this order is more logical.

P8, L227: Which wavelength pair has been chosen and why? How would the result differ if a different wavelength pair would be used?

P8, L231: Be more precise. Cleary state above which altitudes.

P8, L235: “matched at all altitudes”. This is not correct. You do not have a match at all altitudes. Give the altitude range. Further, I see here a better agreement for particle size than for number density.

P9, L279: If this method does not give you information on bimodal distributions, isn’t than that a significant drawback for investigating volcanic plumes? Especially shortly after the eruption the distribution will be bimodal for a certain time. Could you give an estimate in percent how large the deviation for the derived microphysical parameters are?

P9, L281: “……. Because the extinction is mostly due to fewer large particles…..”. Sentence not clear. Please rephrase.

P10, L296: What is meant with “concentration”? A high number of measurements with extinction coefficients 4x10-4 km-1?

P10, L298: Which sizes? Give some numbers.

P10, L300: Also here. Give a number. How small?

P10, L309-310: This is not clear. What has the self-lofting of the plume to do with the composition?

P10, L313: Give a number.

P11, L316: Is the eruption equal to day 0? If yes, I would write or state this more clearly, e.g. eruption = day 0.

P11, L319: at a later time -> add when exactly

P11, L323: at higher altitudes -> at which altitudes. Add a number.

P11, L323-324: the settling or sedimentation process is several times mentioned, but never explained.

P11, L326-327: Why referring here to other studies? Why don’t you include a figure showing the same from SAGE?

P11, L328-329: This result is for this study not important and thus, the sentence does not make any sense here.

P11, L333-334: Why is the impact of the distribution width limited? The evolution of the width could be simulated with a box model. I assume that the small particles will quickly disappear (within a few days). You could check the literature for modelling studies of volcanic eruptions. I guess you could find there some numbers how quickly the distribution is back to the background distribution.

P12, L352: Sentence not clear. Check and rephrase. Further, I could not find your statement in Wrana et al. (2023). How did you derive this width? From the figures?

P12, L365: Don’t just write larger. Give numbers.

P12, L366: Which settling rate? You mean the sedimentation rate of the particles. Do you mean that particles < 0.5 µm sediment out?

P12, L374-375: Sentence not correct. Please check and correct.

P13, L378-382: This paragraph is giving a motivation for the study and thus this paragraph should rather appear in the introduction than in the summary and conclusion section.

P13, L387: Clearly state here that you refer here to log-normal distributions with one mode.

P13, L390-391: The two sentences should be rephrased and maybe combined. Add also why a CR of 1 is problematic.

P13, L403-405: I think before you stated the opposite. Further, the second sentence starting with "We examined……." is incomplete.

P13, L406-408: Add more details. Under which conditions does this happen?

P14, L420: What are the future implications? For what can the method be applied? The future OMPS measurements? Nevertheless, during volcanic eruptions you have large uncertainties and you need to rely on other studies to derive your input values?

Reference list: Check the style. Some journal names are written out. others not. Same with the author names. In some cases the entire first name is written, in most other cases the first initial. Check the ACP guidelines and prepare your reference list accordingly. Further, there are some references misplaced as e.g. Kremser and Yue and Deepak. The Box and Deepak paper is listed in the reference list, but not cited throughout the manuscript.

Figure 9 and 10: Add a legend to the figure. Is there no uncertainty range for the CPC data given or are these so low that these are not visible? What are the black zigzag lines on the right and left corners of the figure?

Figure 11: Wouldn't it make much more sense to compare the background at 30°-60°N with the distribution during Raikoke at 30°-60°N and the background at 30°S-15°N to the 30°S-15°N distribution during Hunga-Tonga? I really think the same regions should be compared.

Figure 14: I think it would be better to use black instead of red lines. Also omitting some lines would be helpful, e.g is the 26 km line really necessary? I think this one could be omitted. Why is here the eruption on day 15 and not on day 0 as before?

Technical corrections:

P1, L20: Introduce the abbreviation "Cb".

P1, L20: Reference of Kremser et al. (2016) is missing in the reference list.

P2, L42: Full stop before reference of Taha et al. (2021) obsolete.

P2, L57: PyroCB -> pyroCb. Use a consistent writing.

P3, L65: In the next section, we detail -> In the next section we describe in detail

P3, L79: scattering measurements -> scattering measurement

P3, L80: is the same as Wrana et al. (2021) Eq. 2 -> is the same as Eq. 2 in Wrana et al. (2021)

P4, L97: Add "the" -> we simulate the scattering….

P4, L103: show the how CR -> show how the CR

P4, L118: Add "a" -> We found that selecting a CR

P4, L119-120: Check sentence and correct sentence.

P5, L137-138: Either use singular or plural.

P6, L171: PyroCB -> pyroCb

P6, L186: Comma obsolete (reference of Chen et al.)

P6, L188: Comma obsolete.

P7, L197: “CR (510/869)” here you write it without adding nm. In other occasions nm is added. This should be done more consistently throughout the manuscript.

P7, L210: using the same algorithm -> the above described algorithm

P8, L246: comparation -> comparison

P8, L246: Add “as shown” -> during Raikoke volcano eruption as shown in Fig. 8

P8, L248: Add “the” -> the bias

P8, L249: Add “the” -> “the comparisons” and move references at the end of the sentence.

P9, L275: settle out -> sediment

P10, L283: Use comma instead of writing twice “and” -> Background Aerosol Radius, Concentration and Volcanic Perturbations.

P10, L285: Add “conditions” so that it reads “background conditions”

P10, L288: Thompson -> Thomason

P10, L287: Move “Figure 11” before “(a, c, e)” so that it reads “The extinction coefficient vs CR is shown In Fig. 11 (a, c, e) and radius vs concentration distributions for these three situations in Fig. 11 (b, d, f).

P10, L291: Put a, c, e in parenthesis -> (a, c, e)

P10, L296: One “shows” obsolete. Write “background aerosols” instead of just “background”.

P10, L301: aerosols -> aerosol and density -> densities

P10, L302: Section 3 -> Sect. 3

P10, L 306: Comma before reference of Gorkavyi obsolete.

P11, L318: screen -> screening

P11, L320: add “altitude” after 10-15 km

P11, L327: add “is” and particles should read particle -> Our result is also consistent with the larger particle radius……

P11, L332: After the comma “The” should be “the”.

P12, L350: Feb.-March -> February to March

P12, L353: Add “is” -> which is consistent

P12, L355: Delete “is” before represents.

P12, L372: Add “the” -> the radius

P12, L373: Add “the” -> the aerosol radius

P12, L372: Add “altitude” -> the altitude range

P12, L374: Add “of” -> conversion of SO2

P13, L390: radius -> radii

P14, L416: Delete “the” before “median radius”.

Figure 2 caption: Add “nm” after 501/869. Use a consistent writing style throughout the manuscript.

Figure 5 caption: plot -> Plot and add space before and after “=”

Figure 6 caption: Add space before and after “=”

References:

Brock, C. A., P. Hamill, J. C. Wilson, H. H. Jonsson, and K. R. Chan (1995), Particle formation in the upper tropical troposphere: A source of nuclei for the stratospheric aerosol, *Science*, 270(5242), 1650–1653, doi:10.2307/2887916.

Kremser, S., et al. (2016), Stratospheric aerosol—Observations, processes, and impact on climate, *Rev. Geophys.*, 54, 278–335, doi:10.1002/2015RG000511.