Reply to review by Filip Vanhellemont

The authors provide an explanation for the observed green twilight observations that were reported by eye witnesses after the eruption climax of Krakatoa in 1883. They use the well-known SCIATRAN radiative transfer code to simulate radiances, based on an educated assumption on the aerosol density profile shape. The perceived color is then estimated by converting radiances to chromaticity values using the CIE color matching functions. The color is studied as function of particle size distribution parameters, total ozone column and aerosol optical depth, for a number of solar zenith angles representative of twilight. The authors arrive at the clear conclusion that green twilight can be simulated for sufficiently large aerosols from a narrow size distribution and sufficiently large optical depth.

General Comments

This article is perfectly suited for publication in ACP. I am not aware of any other publication that presents an explanation of volcanically related green twilight, so the obtained conclusions are important. Furthermore, while it is difficult to obtain precise numbers on e.g. particle size from observations that are subjective (visual color perception), clear constraints/thresholds are obtained on particle size and optical depth. These are new numerical results on an important past volcanic event, and should be published.

> ***Reply: We thank the reviewer for his positive evaluation of our manuscript!***

The applied methodology is clearly explained, and it should be possible for other researchers to reproduce the results. The article title and the abstract perfectly describe the content. The body text is very well written and needs almost no adaptation. Plenty of references are provided.

I really don't see any major problem with this paper; I have a few minor remarks that should be taken into account (see below), so I strongly recommend the publication of this paper.

> ***Reply: Thank you!***

Specific comments

Comment: It is not clear to me at which wavelength Aerosol Optical Depth (AOD) is evaluated in the entire paper. This should be specified.

> ***Reply: Thanks, the wavelength should of course be mentioned. It is now mentioned in Table 1.***

Comment: The finding that green twilight is associated with narrow size distributions suggests that these green colors are only observed in the early stages of the stratospheric aerosol evolution (say, a few months after the event of August 27). Coagulation of particles shifts the distribution to higher size values, but also tends to widen the distribution, but this process takes quite some time. It might explain why no green twilight is reported at later times after the eruption (as far as I can tell from the paper). Perhaps you can add a small comment if you agree with this.

> ***Reply: Thanks for this suggestion. We are, however, not sure how the particle size distribution (PSD) will exactly evolve after an eruption. In another one of our recent papers (Wrana et al., 2023; reference provided below) we investigated the evolution of the PSD after the eruptions of Ambae (2018), Ulawun and Raikoke (2019) and La Soufriere (2021). In three***

of theses cases, the median (and effective) radius of the stratospheric aerosols – as retrieved from SAGE III/ISS solar occultation measurements – decreased rather than increased as a consequence of the eruption. In addition, the reduction in size seen in the observations lasted for about half a year after the eruption of Ulawun. The accompanying model simulation also reproduced the initial decrease in size (effective radius), but after August 2019 the modelled sizes increased again, probably due to coagulation. Also because of the discrepancy between observation and model we are uncertain what role coagulation actually plays and how effective and fast it is to change the PSD significantly. For the Raikoke eruption (2019) an increase in particle size is seen in both observations and model simulations. In summary, we do not really know what exactly could have happened after the Krakatoa 1883 eruption and decided not to mention the hypothesis proposed by the reviewer. But it is certainly a possible interpretation or explanation.

Reference:

Wrana, F., Niemeier, U., Thomason, L. W., Wallis, S., and von Savigny, C.: Stratospheric aerosol size reduction after volcanic eruptions, Atmos. Chem. Phys., 23, 9725–9743, doi.org/10.5194/acp-23-9725-2023, 2023.

Comment: In Fig. 3, the phenomenon of purple light that is often observed after large volcanic eruptions is also simulated, but it is not mentioned in the paper. A small description (one sentence or so) of this finding would enhance the credibility of the method even more.

Reply: Another good point, thanks for pointing this out. The purple colours are now mentioned in section 3.

Technical Corrections

Comment: Line 3: volcanic activity of Krakatau started already several months before August 27. It is perhaps better to speak about the eruption climax of August 27, or something similar.

Reply: Good point. We decided to remove the exact date from the abstract, because otherwise the sentence would suggest that the green sunsets were observed immediately after the eruption. Now only the year of the eruption in mentioned.

Comment: Line 70: This sentence seems to be incorrect. Suggestion: 'Please note that …, while the displayed …'.

Reply: Changed.

Comment: Figure 3: the caption seems to be wrong. Panel (b) shows Total Ozone Column, Panel (c) Aerosol Optical Depth, while the caption indicates the reverse.

Reply: Thanks for catching this – corrected.