Response to reviewer comments: Effect of volcanic emissions on clouds during the 2008 and 2018 Kilauea degassing events

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Review Reports

Short comments and authors' responses

Allen Lerner:

We thank Dr. Lerner for taking the time to comment on the manuscript.

– **Comment:** *Most of the details about the SO2 emissions during Kilauea's 2018 eruption should be attributed to Kern et al 2020, rather than Neal et al 2019. Kern et al 2020, which is currently not referenced at all in the paper draft, provides a much more comprehensive analysis of the SO2 emissions during this eruption, as well as estimating some aerosol properties of the gas plume. Neal et al 2019 provides an extremely general overview of the 2018 eruption, with very limited (and outdated) estimates of the scope of SO2 degassing. Here is the Kern et al 2020 citation: Kern, C., Lerner, A. H., Elias, T., Nadeau, P. A., Holland, L., Kelly, P. J., et al. (2020). Quantifying gas emissions associated with the 2018 rift eruption of KÄ´nlauea Volcano using ground-based DOAS measurements. Bulletin of Volcanology, 82(7), 55. https://doi.org/10.1007/s00445-020-01390-8*

Response: Thank you. We have added the suggested reference and have included it in our citations, specifically those referring to SO_2 emissions.

– **Comment:** *In addition to the role of far greater SO2 and aerosols in the 2018 Kilauea eruption compared to the 2008 eruption, the 2018 eruption involved a very substantial ocean entry (Neal et al 2019) - this is when lava pours into seawater on the coast. During the 2018 eruption, this ocean entry process created large H2O clouds (and also included vaporized HCl and other "laze" plume components) (Kern et al 2020). These water-rich clouds often grew into cumulus rain-bearing cloud systems, that traveled to the WSW. Perhaps the effect of the additional water vaporization and cloud formation during this ocean entry should be better taken into account in the study.*

Response: This is an excellent point. Unfortunately our current setup is not equipped to simulate this kind of interaction (and as a matter of fact, we know of no model that can explicit simulate such an effect). That being said, our model is forced using observed sea surface temperatures, and we expect that they would reflect the entry process to some extent, although the horizontal resolution (about 50 km) may be too coarse to elucidate a direct effect on convection, let alone the cloud-chemistry interactions. At present this is a limitation of this work but it would be a very interesting study to conduct in the future. We have included some discussion on this topic in Section 2:

> ...the ocean entry of 2018 ERZ eruptions caused large clouds of vaporized HCl and water vapor to ascend with the plume (Kern et al., 2020). This was a compositional component absent in the 2008 plume that would increase CCN for liquid clouds in 2018 relative to 2008. We did not include an increase in sea salt aerosols in our parameterization for the 2018 simulations, but recommend this approach for future work.

References

Kern, C., Lerner, A. H., Elias, T., Nadeau, P. A., Holland, L., Kelly, P. J., Werner, C. A., Clor, L. E., and Cappos, M.: Quantifying gas emissions associated with the 2018 rift eruption of Kīlauea Volcano using ground-based DOAS measurements, Bulletin of Volcanology, 82, 1–24, 2020.