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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Particle Aging and Aerosol–Radiation Interaction Affect Volcanic Plume Dispersion: Evidence from Raikoke Eruption 2019" *by* Lukas Ole Muser et al.

Anonymous Referee #1

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In this study, the authors investigate the importance of aerosol dynamics and aerosol-radiation interactions in the early dispersion of the volcanic plume injected by the Raikoke eruption in June 2019. They argue that physical processes influencing the transport of volcanic plumes in the UTLS region have been poorly addressed compared to work related to source parameters/initial conditions. Using a set of satellite observations including HIMAWARI-8, CALIOP and OMPS-LP, they attempt to validate their simulations of the ICON-CART global modelling system. This is a very interesting and unique study that attempt to shed light on how a complex aerosol-dynamic-radiation coupling system can be used to understand early evolution of volcanic plumes and thus is suitable for publication in the Atmospheric Chemistry and Physics Journal. However,

I believe that additional work would need to be done to validate the model results. With only one CALIPSO browse image and one OMPS-LP volcanic plume top point, the vertically resolved information that offer a unique opportunity to validate model results are not fully explored. Before this manuscript can be published, I would recommend the authors to provide additional observational evidences to support their conclusions. Herein below are additional comments that the authors may want to consider:

P1L3: I agree with this statement but essential information about mass injection rates and plume injection heights are still critical parameters to simulate volcanic plume dispersion.

P1L10: I would replace "show" by "suggest" since I'm not certain that the results presented in this paper really fully support the conclusions.

P2L36: I would argue that the rise of the plume is better documented by the two initial papers from Khaykin et al., 2017 and Peterson et al., 2017.

P3L83: Could you explain what's the implications of selecting qa_value larger than 0.5 ?

P4L109: One sentence about the adjustment technique could be explained here.

P5L126: What could be the impact of ice on those estimates?

P6L167: This is very unlikely that the Ambae eruption had a significant impact on stratospheric aerosols beyond the tropics and sub-tropics and thus it seems unrealistic to consider that Ambae could impact the retrieval of a fresh volcanic plume within the OMPS data set within the latitude band where the Raikoke was transported during the first few days.

P9L240: The treatment of externally mixed ash and sulfuric acid would be more accurate through T-Matrix calculation than Mie Theory. I think this could be further discuss in the manuscript since it seems to be an important element.

P15L349: The other optical properties (depolarization/color ratio/vertical feature mask) from the plumes from CALIPSO are not shown. This would certainly help with the interpretation as well.

Figure 6: Does the model really do a better job representing the volcanic plume with the full dynamical-chemistry-radiation coupling? I'm not really certain that the figure demonstrate that since pieces of plume seen by the AERODYN-rad scenario do not appear clearly on the observations. See link to CALIPSO browse image crossing the volcanic cloud on Jun 22nd for additionnal obs. that could be used to validate model results. https://www-calipso.larc.nasa.gov/products/lidar/browse_images/show_v4_detail.php?s=production&v=V10&browse_date=2019-06-22&orbit_time=01-59-01&page=3&granule_name=CAL_LID_L1-Standard-V4-10.2019-06-22T01-59-01ZD.hdf.

Figure 7: Even if the model indeed do a better job by including the dynamics and radiation to remove ash, it does not capture well small-scale variations. Could you further explain why it's not the case? Maybe incorporating more accurate source terms based on HIMAWARI-8 would help with that.

P17L375: It would be interesting to know which processes contribute to the removal of ash in the model. I believe the growth term that lead to the removal by sedimentation, what about ash-ice interaction and wet deposition ?

Figure 9: More data are needed to verify the model outputs. e.g. CALIPSO and OMPS.

P20L431: I believe that measurement uncertainty from OMPS could be better addressed. The vertical resolution of the instrument is probably near 1-2 km. Could you add the corresponding error bar in figure 8. In addition, I'm pretty confident that additional information on volcanic cloud top height could be found by analyzing additional OMPS data.

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