Given the key roles of the non-conventional products of latent heat and updraft, it is key to demonstrate that the uncertainties of these products won't outweigh the signals of the aerosol invigoration. Referring to the paper introducing these products (WALRUS) (Nelson et al., 2016), their uncertainties seem so large whose impact on the findings of this study may be overwhelming.

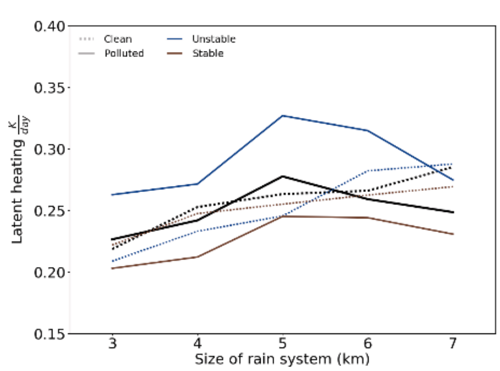
We agree that the uncertainty in certain derived products can be large. We have added an appendix with shaded ranges of error. To quote Nelson & L'Ecuyer 2018,

> Assumed errors are consistent with observation uncertainties and algorithm resolution: reflectivities are 1 dBZ, attenuations are 2 dB, and heights are 300 m. Since the reflectivity structure provides strong constraints on both the vertical structure of hydrometeors and column-integrated water content, errors in model physics are not likely to exert a prohibitive influence on the retrieval. The algorithm simply requires that the RAMS database adequately span a range of atmospheric scenes that may be encountered in nature and lets the observations define the relative frequency. Nevertheless, it is important to note that the process rates analyzed below derive from a model database. At worst, WALRUS can be considered as providing a framework for mapping state-of-the-art RAMS microphysics globally.

Further, the uncertainties from WALRUS in some cases may be large when the signal is attenuated or the cloud structure is not well resolved. We do not include cases with high rain rates or drizzle in order to reduce the uncertainty in the WALRUS derived quantities. We have added to section 2.2

"We limit our observations to only rain certain scenes, discarding drizzling and higher rain rate observations that may attenuate the CloudSat signal. This reduces some of the uncertainty due to a model derived, observationally based product. As Nelson & L'Ecuyer have also commented, the results herein could instead be reframed as how the RAMS microphysics scheme would map onto real observations of global precipitation."

In all the figures, only the mean curves are drawn without any measures of variations. I'd suggest to present some scatter plots showing the real distributions of the data points, and add standard deviations for all the rest, together with significance tests to see if the differences among the curves are significant at certain level of confidence. The colors of the different curves are too close to differentiate.




In order to clearly represent the differences, we chose to use mean curves. To show the variation in the plots, we have added versions of the figures to an appendix with shading to represent the standard error. We chose the colors to have the same intensity, which helps those who are differently abled to differentiate the lines. An example of how someone with a weak red/green colorblindness would see the figures is shown here.

If green or purple were introduced to color by aerosol loading as well, the differences between the two lines would become less obvious for some with some amount of colorblindness. Therefore, we chose to delineate using dashes and a small subset of colors.

Now that turbulence is estimated from updraft speed, it is somewhat misleading to state evidences are found for both updraft and turbulence. Of course, such inference itself is debatable that induce more uncertainties.

We did not intend to imply both turbulence and updraft were increasing, rather that because updraft speed is increasing, it is more likely turbulence is increasing. We have corrected all usage of the term turbulence within the paper, specifically in section 3.3 where vertical motion is discussed, to instead say vertical motion which may imply turbulence.

The inference of latent heat was based on the RAMS modeling data which are highly limited to a handful of cases at very few locations. How much error may be incurred for this global application study ?

There is some uncertainty due to the limited environmental states represented by the range of RAMS simulations, however we do not think these would significantly alter the results. Saleeby et al. 2015 showed that a range of RAMS simulations can capture a range of shallow convection processes and environmental states. Further, they verified that the RAMS runs agree well with others who have simulated various cases of shallow convection. We have added to our section on WALRUS (2.2)

“The latent heating profiles from WALRUS are based on a limited range of simulations from RAMS, meaning it is possible that some environmental states were not represented by the RAMS runs/WALRUS inference and could lead to some amount of error in our analysis.”

All the findings are shown with respect to size of rain system which does have some merit to this study in disclosing the dependence of the invigoration on cloud size. It would also be valuable and revealing if some findings are given w.r.t. aerosol loadings as in many previous studies.

In order to reduce the uncertainty from the non-linear relationships between warm rain suppression processes and aerosol, we chose to only contrast high and low aerosol while taking into account some of the cloud organization by using the rain size as a constraint. Future work may explore these relationships in more detail while adding more information on organization, similar to how Janssens et al. 2021 showed four dimensions (including a statistic similar to ours based on cross track cloud size) can be used to explain multiple cloud features. This work is preliminary work to show that there are differences in the latent heat and vertical motion that may be explained by the differences in aerosol state, after constraining the environment and rain size. We have added to section 4, conclusions:

“Additionally, we aimed to reduce uncertainty by only contrasting high and low aerosol loading scenes. An aim of future work should include defining the patterns of changes in relation to incremental increases in aerosol to better define and understand these relationships.”