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Comment on acp-2022-623

Anonymous Referee #3

Referee comment on "Evaluation of aerosol–cloud interactions in E3SM using a Lagrangian framework" by Matthew W. Christensen et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-623-RC2, 2022

General comments

This paper investigates aerosol-cloud interactions of warm clouds. A huge number of Lagrangian trajectories (> 1,500) are extracted from various datasets (ARM site observation, satellite retrievals, and earth system model simulations) to understand aerosol-cloud interactions, especially precipitation-aerosol and aerosol-cloud radiative effect relations. I think this work is interesting and scientifically valuable. Some comments are below.

Scientific comments

- As authors already know, aerosol-cloud interactions depend on cloud characteristics. This paper provides some features about the clouds over the studied region, but those are scattered. It would be helpful if the authors could add one paragraph for some information about the clouds over this region.
- It is difficult to find a clear reason to reduce N_d dependency and increase Q_c dependency for autoconversion constants. It will be helpful to describe that in Section 2.4. Same as for autoconversion parameters, the reason for the accretion factor change could not be found. Also, it is good to explain how the specific parameter values in Table 2 were selected.
- Explains about N_d derivation from the CERES and MODIS data are missing.
- For CERES data, I am concerned about using the dataset during the less trustworthy time (Figure 7 and Table 4, 5, 6, and 7). Figure 7 R_e and N_d figures show significantly different values between trustworthy and less trustworthy time. I hope that the authors discuss this.

- I understood that this paper considers low-level clouds. If this is correct, I guess that 500 hPa could be too high to check the large-scale vertical motion affecting low-level clouds. I think this confusion could be automatically resolved if comment 1 is considered.

Technical comments

- I would like to recommend using the words "CCN" and "CCN number concentration" more precisely (one example, "increase in CCN concentration" seems better in line 24). Because, as authors already know, concentration is not the only CCN property that could influence cloud (e.g., radius, hygroscopicity, …).
- Both "MERRA2" and "MERRA-2" are used. It seems better to choose just one of them.
- line 25: constant changes -> no change
- line 42: geophysical -> physical
- line 89-90: complete a complete cycle -> complete one cycle
- line 153: aerosol optical depth (AOD): AOD is already mentioned in line 64
- line 188: oceanic -> marine
- line 220: start -> center
- line 306: 3b -> 3d
- line 358: 500-hPa vertical velocity, free tropospheric vertical velocity -> Does it mean "500-hPa free tropospheric vertical velocity"?
- line 393: The change -> The difference
- line 398: from (Chen et al., 2014) -> from Chen et al. (2014)
- line 446: global-based observational -> global observational-based
- line 450: lagrangian -> Lagrangian
- line 497 and 506: equation 5 -> equation (5)
- Figure 5a caption: rain rate -> rain rate (blue) or CCN concentration (red) -> CCN concentration
- Figure 5c caption: Is Figure 5c for A1R0 simulation? If so, why A1R0 simulation result is displayed here instead of the control simulation (A0R0)?
- Figure 7: description for c and d should be checked.
- Table 1: geophysical -> physical
- Figure S4: Is this figure for relative frequency or precipitation rate?
- Figure S9a and b: W/m^{-2} -> W/m^2 or $W\ m^{-2}$
- Figure S10: Description for pink shading is missing.
- Figure S14: LWP unit should be checked.