

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2021-999

Anonymous Referee #1

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Referee comment on "Addressing the difficulties in quantifying droplet number response to aerosol from satellite observations" by Hailing Jia et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-999-RC1>, 2022

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Jia et al. "Addressing the difficulties in quantifying the Twomey effect for marine warm clouds from multi-sensor satellite observations and reanalysis"

This study investigates the changes of Twomey effect for marine warm clouds with various influential factors including the updraft, precipitation, retrieval errors, and vertical co-location between aerosol and clouds. Valuable results have been obtained, which can improve our understanding of the radiative impacts from aerosol-cloud interaction from perspective of satellite observations. Also, the paper is well written. I personally think this manuscript is suitable for publication after a minor revision.

### Detail comments

Line 19-21, In addition to the radiative impacts of aerosols by serving as CCN, aerosols can also affect the development of clouds and then precipitation and radiation by modifying the thermal structure of atmosphere via direct radiative effect.

Line 24-25, regarding the rapid adjustments, one reference is suggested here which showed the increase of cloud liquid water path and decrease of cloud re with increased  $N_d$  via Twomey effect, Zhao and Garrett (2015, doi: 10.1002/2014GL062015).

Line 28-29, Actually even with the same climate model simulation (such as CAM5), the aerosol first indirect effect also varies with the aerosol variables that are used to present the aerosol amount.

Line 33-41, There are various influential factors, which are not limited to these five points. For example, the existence of precipitation particles within clouds as indicated by Yang et al. (2021, doi: 10.1029/2021JD035609) based on satellite observations, the aerosol amount or availability of water vapor amount as indicated by Qiu et al. (2017, doi: 10.1016/j.atmosenv.2017.06.002), cloud types or vertical locations as indicated by Zhao et al. (2019, doi: 10.3390/atmos10010019), and potential large uncertainties in cloud retrievals as indicated by Zhao et al. (2012, doi: 10.1029/2011JD016792), and so on.

Line 54-56, Good idea. However, with this assumption or method, we may limit the cloud types as cumuliform clouds.

Line 65-66, The reference mentioned above (Yang et al. 2021) also took use of the simple threshold value method with 14  $\mu\text{m}$ .

Line 69, Do the authors mean "Solving this problem is helpful to ..."?

Line 77-81, Actually, the existence of aerosols could also cause biases to satellite-based cloud retrievals. As indicated by Li et al. (2014, doi: 10.1002/2013JD021053), the existence of absorbing aerosols could cause the satellite based retrieval of optical depth lower, effective radius higher, and so on.

Line 107-110, previous studies have already indicated that the aerosol-cloud interaction is sensitive to the spatial resolution. How do the authors consider this point?

Line 110-111, It is well known that the retrieval uncertainties are large over polar regions, how about that over land regions? A reference might be helpful.

Line 112-125, why are the Level 3 aerosol data but Level 2 cloud data used in this study?

Line 123, it might be better used as Feingold et al. (2021)

Line 130-136, what are the potential limitations or uncertainties in the cloud base height retrievals by the introduced method? It is worthy to briefly describe.

Line 136-141, even within non-precipitating clouds, drizzle could exist and affect the aerosol-cloud interaction, as indicated by the reference mentioned earlier Yang et al.

(2021), how could the authors consider this impact?

Line 180-181, One possibility is the large volume of datasets. Could the data selection also play a role to the higher correlation?

Line 200-201, it is easy to understand that the low AI zone is more likely aerosol-limited. However, I cannot understand why the high AI zone is close to updraft-limited regime if we do not know how large the updraft is? Could the authors explain more?

Line 226, I would suggest using the same format, either with or without parenthesis for  $\ln AI$ .

Line 233-237, if possible, I personally would like to suggest separating this long sentence to a few short sentences.

Line 270, "appears to" -> "appear to"

Line 317, why do the authors choose to use daily time series values instead of hourly?