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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Aerosol impacts on warm-cloud microphysics and drizzle in a moderately polluted environment" *by* Ying-Chieh Chen et al.

**Anonymous Referee #2**

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The authors present a nice, if perhaps a little over-extensive, study looking at in situ and some satellite measurements in an urban and complex setting. While the analysis presented here in some cases is not new, the data analysis of in situ data is hard and different and the analysis warrants publishing to add to our growing knowledge of aci. I find some of the discussion of adjustments overly assertive of causality, which the authors cannot show empirically. These regions need to be trimmed to report on findings without asserting a causal connection, or the authors should perform modelling of the region where they can make some advances to understanding the direction of causality in what their observations are doing. While I acknowledge that many studies utilize CER to calculate aci, I would suggest using Nd, which the authors have already



calculated to provide a complimentary calculation that may be more relevant to more recent studies. The authors may also wish to say a few words about why PM2.5 may be a good CCN and need to address near-cloud aerosol swelling in the text, which makes the direction of causality even more difficult to infer. The use of the rain size distribution is a good way to approach this problem.

Another way the authors might want to consider looking at this is performing the same analysis in their paper, but instead of sorting clean/polluted sorting by atmospheric advection from the east or west. This might reveal the underlying meteorological signal that will covary with aerosol. This result can be used to say 'on days when the dominant weather pattern is such, but there is unusually little aerosol then the clouds do this'.

P1 L15: I am not sure what this sentence is getting at- is the human activity causing low cloud?

P2 L17: You should discuss spurious correlation between AOD and cloud properties as shown in (Christensen et al. 2017; Twohy et al. 2009).

P2 L31: I might say weakly constrained (Bellouin et al. 2020).

P3 L3: What does largely dominant mean? Relative to what?

P3L6: It seems like it might be good to discuss this in the context of the current synthesis report on aci (Bellouin et al. 2020).

P4L13: So AOD was only retrieved when AOD was visible? It seems like all periods with cloud should be zeroed out since there might be AOD below cloud that is not being counted.

P4L19: What is this based on? Afternoon aerosol should be able to affect afternoon clouds.

P5 L1: This would be more reliably at a constant CWP if cloud droplet number concentration (Nd) was used instead of CER and binning by CWP (Grosvenor et al. 2018).

Any inferred aci will be a function of binning decisions.

P7L7: This is a nice comparison to previous studies. Please consider summarizing in a figure.

P7L13: This is not a robust piece of analysis. Differing PM2.5 is likely a function of atmospheric state (air masses moving from the west for instance) and this is likely to do more to CF and COT than aci.

P8L6 please comment on the unintuitive diagnosed stronger aci in more polluted clouds. A lot of studies point to stronger aci in more pristine clouds(Carslaw et al. 2013). Again, this may be a function of binning, which is also going to select for clouds in an atmospheric regime.

P9L4: Or the cleaner days could be occurring because of rain scavenging aerosol. Unfortunately in an empricial study such as this you can't make causal statements. However, the high temporal resolution of ground data used here might allow for some sort of time evolution analysis that could show causality.

P9L22: Please note that precipitation reduction is often a function of model parameterization.

Bellouin, N., and Coauthors, 2020: Bounding Global Aerosol Radiative Forcing of Climate Change. Rev. Geophys., 58. Carslaw, K. S., and Coauthors, 2013: Large contribution of natural aerosols to uncertainty in indirect forcing. Nature, 503, 67-71. Christensen, M. W., and Coauthors, 2017: Unveiling aerosol–cloud interactions – Part 1: Cloud contamination in satellite products enhances the aerosol indirect forcing estimate. Atmos. Chem. Phys., 17, 13151-13164. Grosvenor, D. P., and Coauthors, 2018: Remote Sensing of Droplet Number Concentration in Warm Clouds: A Review of the Current State of Knowledge and Perspectives. Rev. Geophys., 56, 409-453. Twohy, C. H., J. A. Coakley, and W. R. Tahnk, 2009: Effect of changes in relative humidity on aerosol scattering near clouds. J Geophys Res-Atmos, 114, n/a-n/a.



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