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Interactive comment

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

Anonymous Referee #1

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General comments:

This study investigated aerosol impacts on cloud and precipitation over northern Taiwan using aerosol and cloud datasets from Aqua/MODIS and surface measurements. The authors showed statistical analysis including the susceptibility of cloud droplet effective radius (CER) to aerosols (ACI), correlations between CER and cloud-top temperature, and size distributions of rain drop to find some signatures of aerosol-induced changes to cloud and precipitation properties. Although the analysis results shown tend to be consistent with one another and thus appear to suggest the aerosol impacts on cloud and precipitation over the target region, most of the analysis approach and

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Discussion paper

the results shown, including the ACI analysis, relationships between rainfall and cloud water path, and CER-CTT joint statistics, are pretty much similar to what has already been done in a number of previous studies. I found no substantial novelty in materials included in the manuscript of its current form that deserves publication. Based on these evaluations, I cannot recommend the manuscript be considered for publication in Atmospheric Chemistry and Physics at least in its current form. One possible way for improving the overall study is to obtain a process-level insight into aerosol impacts on drizzle and precipitation exploiting the surface measurement of size distributions of rainfall, which might add some novelty to this study. Listed below are some specific points that (hopefully) might help the authors to re-construct their work in this direction for future potential submission of the revised manuscript.

Specific comments:

- A novel piece of material included in the manuscript is rain drop size distribution measured by the JWD disdrometer, which should provide useful observation-based information for process-level assessment of the aerosol indirect effect on precipitation, i.e. how precipitation processes are modulated by aerosols. I would suggest the authors to conduct more detailed analysis of the rain drop size distributions and their relationships to differing conditions of aerosols, rather than just showing the simple plot of Fig. 10. Such an analysis should offer size-dependent view of aerosol impact on drizzle and precipitation and thus more in-depth insight into microphysics of the aerosol indirect effect.

- The size-resolved precipitation analysis might also add new insight into the analysis shown in Fig. 11. The statistics shown in Fig. 11a is quite similar to those already shown by satellite statistics of Lebsock et al. (2008) and L'Ecuyer et al. (2009), except that the authors' plot shows the rainfall rate (in ordinate) based on surface measurement, contrary to probability of precipitation in the two previous studies. I would suggest the statistics shown in Fig. 11a be broken down into different bins of drop size to see how the cloud-to-precipitation process varies with aerosols and how it depends on particle size of drizzle and rain. Such an analysis might offer a new process-level insight into the aerosol-induced suppression of precipitation. The same approach could also be applied to the analysis of Fig. 11b to obtain a “size-resolved view” of the temporal trend of precipitation and its relationship to aerosols.

- The joint statistics between CER and CTT shown in Fig. 8 are hard to interpret in its current form. I guess that the authors like to claim different CTT-CER correlations between clean and polluted conditions in Fig. 8a, but the tendency looks quite ambiguous in the plot shown. I would suggest apply analysis methodology of Rosenfeld and colleagues (e.g. Rosenfeld and Lensky, 1998; Rosenfeld 2000) that plot the mean and variance of CER at each CTT bin separately for clean and polluted conditions. It might show more clearly what the authors want to illustrate.

- These analyses proposed above could then be combined to enable interpreting the traditional analysis such as the ACI and CER-CTT statistics in terms of size-resolved characteristics of precipitation processes. Such an analysis would connect some of the existing metrics of the aerosol indirect effect in the context of precipitation processes, which would bring a valuable progress in understanding aerosol impacts on cloud and precipitation.

Minor points:

- Page 5, Line 27: COT should have no unit. - Page 6, Line 30: radiuses -> radii - Page 7, Line 15: Does “cloud vertical profiles” mean CTT? It is not really the vertical profile but just a cloud-top temperature. - Figures 2, 5, 6, 9 and 11a: The horizontal axis for CWP should be logarithmic for at least some of the figures.

Reference:

Lebsock, M., G. L. Stephens, and C. Kummerow, 2008: Multisensor satellite observations of aerosol effects on warm clouds. J. Geophys. Res., 113, D15205, doi:10.1029/2008JD009876.

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L'Ecuyer, T. S., W. Berg, J. Haynes, M. Lebsock, and T. Takemura, 2009: Global observations of aerosol impact on precipitation occurrence in warm maritime clouds. J. Geophys. Res., 114, D09211, doi:10.1029/2008JD011273.

Rosenfeld, D., and I. M. Lensky, 1998: Satellite-based insights into precipitation formation processes in continental and maritime convective clouds. Bull. Ame. Meteorol. Soc., 79, 2457-2476.

Rosenfeld, D., 2000: Suppression of rain and snow by urban and industrial air pollution. Science, 287, 1793-1796.

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