

## ***Interactive comment on “Investigation of Aerosol-Cloud Interactions under Different Absorptive Aerosol Regimes using ARM SGP Ground-Based Measurements” by Xiaojian Zheng et al.***

**Anonymous Referee #1**

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This manuscript presents a study about the effect of aerosols on cloud properties using ARM facility over the SGP. The study based their analysis on 16 low-level stratus under coupled boundary layer conditions. A comprehensive comparison is performed between weak and strong light-absorbing aerosols cases. An ACI index has been retrieved for different cases: different LWP bins and different absorptivity. The article based their results on multiple parameters to assess the impacts of aerosols on cloud microphysical, optical, and radiative properties. The manuscript is well-structured and well-written, the illustrations included are useful. I expect the paper to be of consider-

C1

able interest to readers of ACP. Nevertheless, in my view, the following issues require particular attention before a potential submission.

General Comments:

1. The uncertainties and hypotheses are mentioned in the article but a discussion about them is needed. For the hypotheses, it is referred that  $\sigma_x$  is assumed constant at 0.38 (page 5 line 23): Is there a way to estimate the impact from a variation of this value according to a sensible range? The same comment goes for the supersaturation fixed at 0.2% (page 6 line 21), what are the impacts on the results if  $SS = 1.15\%$ .

The parameters are associated with uncertainties, as mentioned several times in the text: LWP (page 5 line 9), re and Nd (page 5 line 25), SW fluxes (page 7 line 17), the contamination by insect (page 4 line 27). Unfortunately, these uncertainties are not considered in the study when comparing the ACI parameters for the different regimes. What are the impacts of the uncertainties on the results? Can you estimate the impacts on ACI to ensure that the observed difference is real?

2. Two "meteorological" parameters have been considered (section 2.3): the liquid water potential temperature and the total water mixing ratio. These parameters have been used to consider if the boundary layer is well-mixed or not. I think a deeper study on the impact of meteorological parameters on ACI would increase the impact of the paper. As shown in Table 1, the cases correspond to different seasons and air-mass sources. The different ACI observed for absorptive or non-absorptive aerosols might be due to different meteorological parameters (as stated in page 11 line 16) and potentially not to the difference of aerosol optical properties. I think different regimes based on meteorology parameters (e.g., stability) should be considered to strengthen the results.

3. In the study, I do not understand if each day is taken separately to perform the analysis or if the study considers each measurements: For example, in Figure 4, we observe that some days have a large range of AE (2011/05/13), did the distribution of

C2

AE shown in Figure 2-b consider each point from Figure 4 or the average for each day (total of 16 points)? I assume that it is each point but the text needs to make it clear. Therefore, I do not understand why the cloud lifetime needs to be more than 3 hours (page 7 line 26) if each measurement is considered independently

Specific Comment:

There is no indication of how many data points are considered in the analysis.

Abstract: A sentence about the context, and why it is important to study the aerosol cloud interaction is missing.

page 3 line 10: I suggest to remove the "co-albedo" has it can confuse a reader which is not familiar with this term, or to specify that it is 1-SSA.

Page 4 line 20: The study uses two different instruments with different spatial and temporal resolutions, how does it affect your results? Is the uncertainty from the KAZR lower?

page 5 line 4: Why has the "cloud-top height lower than 3 km" limit been chosen?

page 6 line 14: What is the initial temporal resolution?

Is there a study comparing the measurements from SGP with in-situ data to evaluate the performance of the instruments? The results are provided for cloud microphysical properties (page 5 line 25), but is there something similar for the aerosol properties, cloud boundaries, and boundary layer conditions?

page 7 line 6: 0.5 K and 0.5 g/kg: are these thresholds the same as in Dong et al. (2015)?

page 8 line 24: Can you describe the difference between FMF and AE? I am not sure to understand why the study needs the two parameters.

page 10 line 5: How is the uncertainty on ACI retrieved? Is it the 95% confidence

C3

interval of the fit?

page 10 line 6-: The authors are comparing ACI values with previous studies. I am a bit sceptical about it: There is plenty of studies retrieving ACI values with different methods, datasets, geographical locations. ACI parameter depends on that. The authors only report ACI values which range with their study without a discussion on the differences. I think there is two different possibilities: Either you consider all the studies retrieving ACI and discuss about the potential differences or the comparison is limited to studies looking at the same region and/or same data.

page 11 lines 23-26: I do not understand the sentence, can you rephrase it?

page 11 line 26-27: Can it be quantified?

page 12 line16: The "majority", can it be quantified?

Figure 2: Can the standard deviation be displayed with the mean? Also, considering that the distributions are not Gaussian, why did you consider the mean rather the median?

Figure 7: Is there a reason why the standard deviation is not included for the ratios NCCN to Na and Nd to NCCN?

Technical corrections:

page 5 line 18 "100" should not be here.

page 8 line 17: find → fine

page 15 line 25: Fig. 10 → Fig. 8

Figure2 caption: the order to describe the figures is: a-d-b-c-. . . instead of a-b-c-d-. . .

Figure 4: The definitions of the dotted lines are missing in the caption?

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C4

2019.

C5