Interactive comment on:

"A long-term study of aerosol-cloud interactions and their radiative effect at a mid latitude continental site using ground-based measurements"

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We thank the editor and both reviewers for their careful review of the manuscript. The referee's comments were very constructive and they helped us improving the revised version of the manuscript. The reviewer's questions are addressed in bold, followed by the responses in normal font.

Response to anonymous reviewer 1

1. Page 2, Line 4: Absorbing aerosol could also modify the atmospheric temperature profile and stability, and reduce cloud amount via the semi-direct effect (e.g., Koren et al., 2008). Koren et al. (2008) just provide the cloud amount change with aerosol optical depth but didn't show absorbing aerosol could modify the atmospheric stability. Huang et al. (2009) use the Fu-Liou radiation model and CERES radiation flux to derived the heating rate of aerosol layer and directly show the changes in temperature profile.
Huang J., Q. Fu, J. Su, Q. Tang, P. Minnis, Y. Hu, Y. Yi, and Q. Zhao, 2009: Taklimakan dust aerosol radiative heating derived from CALIPSO observations using the Fu-Liou radiation model with CERES constraints,Atmos. Chem. Phys., 9, 4011-4021.
Answer: Thanks. This reference was included in the revised version of the manuscript.
We did look into aerosol extinction and single scattering albedo for a possible semi-direct effect but for the data considered aerosol amounts were simply to small to have an impact. This is now stated in the text.

2. Authors used the aerosol index instead of CCN concentration in this study. As the SGP site do equipped with the Cloud Condensation Nuclei Particle Counter, why do not use this data directly?
Answer: In this work 14-years of coincident measurements of aerosol, clouds and meteorological data were used. CCN concentration measurements were available at the SGP only from 2007 on. Furthermore, a complete scanning of CCN measurements over different supersaturation values takes about 1 hour. The use of CCN concentration would require the selection of a given supersaturation, which would considerably reduce the number of data points analysed. On the other hand, nephelometer light scattering measurements were available since 1998 at 1-minute resolution. To maximize the number of years included in the analysis, aerosol index (a quantity readily calculated from scattering measurements) was used as a proxy for CCN concentration. Shinozuka et al., 2015 propose a new methodology to estimate CCN (at a given supersaturation) using light scattering measurements. We have now used his approach in addition to Ai and the results are similar to the results previously obtained, as shown in Figures R1a-c, for a supersaturation of 0.6%. This new analysis does not result in changes to the main conclusions of this paper. The distribution of daily correlation between rCRE and CCN is centered at 0.02. Also, the scatter plot of the correlation between rCRE and CCN by the correlation of LWP and

CCN concentration shows a positive correlation of 0.42. These figures are included in the Supplementary section.

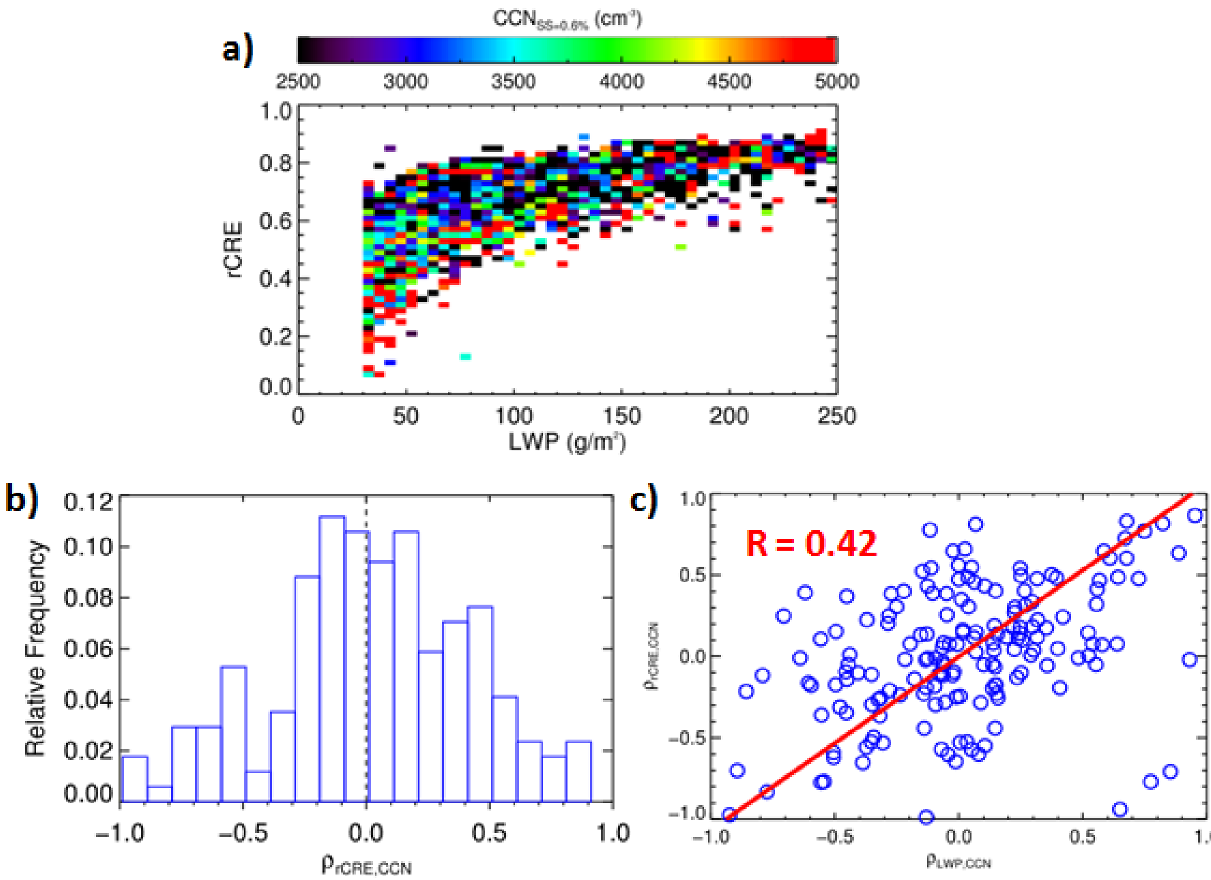

Figure R1: a) Relative cloud radiative effect (rCRE) as a function of liquid water path (LWP) colored by CCN concentration, b) daily distribution of the correlation between rCRE and CCN, and c) correlation between rCRE and CCN versus the correlation between LWP and CCN. To calculate CCN concentration, a supersaturation of 0.6% was considered.

3. Authors mentioned that all of the relevant variables were averaged to 1-minute resolution. Does this time resolution is suitable for this study?

Answer: The choice of 1-minute resolution resulted from a consideration of a number of factors such as a desire for representation of small-scale aerosol-cloud processes, large statistics, consideration of the temporal scales of variability of aerosol and cloud fields, and the recognition that averaging might be required to show clear trends. The 1-minute timescale balances these factors. A higher temporal resolution for cloud fields would have been more desirable for broken cloud fields but these are a small fraction of the current data set.

4. Koren et al. (2008, ACP) show ω (550 hPa) and RH(350 hPa) yielded the highest correlations with the satellite-derived cloud properties, these parameters will be used to represent the primary meteorological controls on the cloud system. Herein, authors examined the impact of cloud macroscopic properties (fc and τ) and meteorological variables (Di, LTS, and w'^2) on cloud radiative effect. How did authors choose those

variables?

Answer: Cloud fraction and cloud optical depth were selected because they are the two main macroscopic cloud variables related to cloud radiative properties. w'^2 was used as a proxy for turbulence. Higher turbulence leads to an increase in vapor supersaturation, favoring the formation of cloud droplets. This effect could increase cloud albedo, also affecting cloud radiative forcing. Di is a meteorological index associated with the coupling between the surface and the boundary-layer. Di is an indicator of how well-mixed the atmosphere is below the cloud, and therefore, how well surface measurements of aerosol loading and properties represent cloud-level aerosol. LTS is another meteorological index associated with the strength of the inversion capping. This parameter is related to cloud fraction, a parameter that also influences cloud radiative forcing. A minor change was included in the text reinforcing the influence of turbulence on supersaturation.