

Author's Response to Reviewer #2

The authors presented aerosol-cloud-rainfall associations over Indian derived using multiple datasets from satellite and meteorological stations. The subject of the paper is appropriate for ACP. However, the paper contains some issues indicated in the following comments. I recommend the acceptance of the paper for publication only after these issues being addressed by the authors.

Response: We are thankful to the reviewer for the thorough reading of our manuscript. We have addressed all the comments and suggestions provided by the reviewer. Our point-to-point responses for the specific comments are mentioned below in blue color. The subsequent changes and additions made in the revised manuscript against each comment are shown in red color.

1. Though the number of total samples is given in Figure 3, the number of samples in each AOD bin is not found in the figure and the text. The vast majority of cases may be with middle AOD, but the very clean cases (e.g. 0.01~0.1) and very heavy polluted cases may be relatively rare over the study region in Indian. Therefore, the representation of samples in both very clean and very polluted cases is unclear. Conclusions based on a few extreme data points or from largely scattered data need further scrutiny. Such concerns are also in Figure 11.

Response: We have used equal number of samples in each AOD bin for the correlation analysis in Figure 3 and 11. Therefore, the representation of samples in both very clean and very polluted cases is equal. For better clarity and ease of understanding, we have mentioned the methodology used to create these plots explicitly in the caption of Figure 3, 4 and 11 in the revised manuscript.

Caption of Figure 3. Associations of (A) daily rainfall, (B) precipitation rate, (C) cloud fraction, (D) cloud top pressure, and (E) cloud top temperature with AOD. The collocated data points for these five variables (A-E) were sorted as a function of AOD over ISMR during JJAS 2002-2013. The total number of collocated data points are then used to create 50 bins with 'n' numbers of data points (2 percentile) each and averaged. These 50 scatter points are shown in the respective panels.

2. The analysis based on the simulation work is irrelevant to the title of this paper "A long-term observational analysis of aerosol-cloud-rainfall associations over Indian Summer Monsoon region". Some modifications are necessary.

Response: As suggested we have slightly revised the title of the paper to better convey the relevance. The revised title reads as -"Investigation of aerosol-cloud-rainfall association over Indian Summer Monsoon region "

In this study, we used 12 years of in-situ and satellite observations to examine association of aerosol loading with cloud fraction, cloud top pressure, cloud top temperature, and daily surface rainfall over Indian summer monsoon region (ISMR). We found high aerosol loading might induce cloud invigoration thereby increasing surface rainfall over the ISMR. The physical mechanisms of these relationships were better illustrated by performing numerical experiments on WRF-SBM platform using thermodynamic conditions typical of ISMR. Further, we have also examined the associations from different possible explanations.