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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A long-term observational analysis of aerosol-cloud-rainfall associations over Indian Summer Monsoon region" *by* Chandan Sarangi et al.

Anonymous Referee #1

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The authors used 12 years of in-situ and satellite observations combined with model simulations 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). They found high aerosol loading might induce cloud invigoration and thereby increasing surface rainfall over the ISMR. This study contributes to address aerosol-cloud-rainfall associations over ISMR. Before this manuscript can be considered for publication, I have a few comments that need to be addressed by the authors.

My major concern of this paper is that the author found that impact of aerosols on cloud and rainfall dominated the aerosol-cloud-rainfall relationship over ISMR. However, many previous studies found that wet scavenging of aerosols by rainfall control

this relationship, while aerosol indirect effect could only perturb it (Grandey et al., 2013, 2014; Yang et al., 2016a,b). Why they are different from the results shown here?

Specific comments:

Page 1 Line 24: What is the seminal role? It needs to be expressed more specifically.

Page 3 Line 16: Aerosols interact with clouds and rainfall two ways. Aerosols impact clouds and precipitation, and clouds and precipitation can influence aerosols through wet scavenging processes (Quaas et al., 2010; Grandey et al., 2013, 2014; Gryspeerdt et al., 2015; Yang et al., 2016a,b,c). In introduction section, the authors only discussed aerosol impacts on cloud. They might add the cloud and rainfall influence on aerosols here.

Page 4 Line 11: Also, please also add description about impact of monsoon on aerosols (e.g. Corrigan et al., 2006; Lou et al., 2016).

Page 6 Line 8: This sentence is hard to follow. Please make it clear.

Page 6 Line 15: Could you also calculate the ratio of AODs>1.0 as same as 7% shown below?

Page 8 Line 20 and Page 9 Line 5: Why high and low AOD categories are different here?

Page 12 Line 10: aerosol humidification effect is not the only effect that causing co-variation of AOD- and rainfall. Engström and Ekman (2010) and Yang et al. (2016a) found wind speed also lead to co-variation of AOD-cloud and rainfall, it impact could be larger than aerosol humidification effect.

Page 12 Line 10: Also, I suggest adding impact of cloud-rainfall on AOD here as (3) and analysising it in result section.

Page 14 Line 17: Figure 3A. Is this figure the JJAS daily data for 2002–2013 (total 1464 samples)? How did you treat intra-seasonal variability of these variables? Please

make it clear here or in figure caption.

Figure 4: Again, please make clear how data used. What are these radiative fluxes, net, upward or downward?

Figure 7: Why not show Ex2?

Page 26 Line 21: The authors did not consider the impact of combination of meteorological fields. They may dampen each other. And the correlation in Figure 10 between different meteorological fields did not take into account the correlation among the meteorological variables.

Page 31 Line 2: Could you describe the method used in Bar-Or et al. (2012)?

Page 31 Line 16: This conclusion needs more cautiousness. The analysis using all-sky and clear-sky of CERES radiative fluxes may not represent aerosol direct and indirect effects. At lest, add region here.

Technical corrections:

Table 1: change 2002–13 to 2002–2013

Page 7 Line 8: I suggest changing abbreviation of rainfall. DRF is often used to represent direct radiative forcing.

Figure 2: What are these colored lines? Please add more information in in figure caption.

There are too many abbreviations in this study.

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