

Interactive comment on “Aerosol-induced high precipitation events near the Himalayan foothills” by Goutam Choudhury et al.

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1. In line 60, you mention “aerosol concentration”. Do you mean “aerosol optical depth”? If yes then please change it accordingly as they both have different meaning.

Reply: We thank the reviewer for pointing this out. We actually meant aerosol load. We have changed it to “aerosol load”.

2. In the second section, you say that the domain selection is based on the work of Bohlinger et al. 2017. However, they have classified three domains in their study. Is there any specific reason of considering only one part of Himalayan foothills? Does the AECD mechanism only works in the selected domain and not in other parts? Please explain this in the conclusion section to be clearer.

C1

Reply: We appreciate the reviewer’s point. We have tested this hypothesis for the whole region; however, it worked more closely for the study domain. The limited AOD data may be a valid reason for this over other areas, and also the flow of winds transporting MSE and AOD to the regions differently. However, this needs further analysis of long term data before reaching any conclusions, and not in the preview of the present work. We now have included the following in the Results Section from line 129 to 131: “We repeated this composite analysis for other parts of the Himalayan Foothills and also for days with no or low precipitation (with the threshold of 5 percentile) but were unable to find a feature as observed in Figure 2 for high precipitation events (not shown).”

3. Typo in line 70: change “toMODIS” to “to MODIS”.

Reply: We apologize for the typo. We have corrected it in the revised manuscript.

4. The information regarding the successful AOD retrieval described in the second section from line 71 to 78 would make more sense in the result section after you describe the AOD composite plot.

Reply: We appreciate the recommendation of the reviewer. However, we think it is better to discuss about the data quality used to make the composite images in the data section. We have also discussed about it in the conclusion section where we list the uncertainties of the study.

5. In Figure-2, why are the color-bar limits different in the plots of AOD and MSE? Please make it same for better comparison.

Reply: The AOD data is used from two sources (MODIS and MERRA-2) which use different methodologies to estimate the AOD. This leads to difference in the maximum AOD and, hence, in the set upper limit of the colorbar. The same is true for MSE which is derived from ERA-Interim and MERRA-2. We have tried to address this in the result section from line 119 to 124. We try to emphasize on the variations rather than magnitudes which can be clearly seen in the figures.

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6. Lines 123 & 124: Does "R" means Pearson's correlation coefficient? The methodology used in calculating correlation coefficient should be mentioned in the draft.

Reply: Thank you for pointing this out. We used Pearson's correlation coefficient. We have modified the text accordingly.

7. Typo in line 131: it should be BLH instead of PBLH.

Reply: We apologize for the typo. We have corrected it in the revised manuscript.

8. The third paragraph of result section describes the association of aerosols and CAPE for extreme events. The effect is described; however the causation needs to be elaborated. Following papers can be referred and included in the manuscript. Wang, Y., Khalizov, A., Levy, M. and Zhang, R., 2013. New Directions: Light absorbing aerosols and their atmospheric impacts. *Atmospheric Environment*, (81), pp.713-715. Li, Z., Rosenfeld, D. and Fan, J., 2017. Aerosols and their impact on radiation, clouds, precipitation, and severe weather events. In *Oxford Research Encyclopedia of Environmental Science*.

Reply: We apologize for the confusion. We have included the two references and an additional reference (shown below). Sarangi, C., Tripathi, S.N., Tripathi, S. and Barth, M.C., 2015. Aerosol-cloud associations over Gangetic Basin during a typical monsoon depression event using WRF-Chem simulation. *Journal of Geophysical Research: Atmospheres*, 120(20), pp.10-974.

We have explained it in more details by adding the following in the manuscript from line 147 to 156. "The presence of absorbing aerosols within the planetary boundary layer may result in an increase in temperature in the lower atmosphere. This can result in higher CAPE values above the convection condensation level (Wang et al., 2013; Sarangi et al., 2015; Li et al., 2017). Please note that many recent studies have highlighted that Aerosol Invigoration effect (Rosenfeld et al., 2008; Fan et al., 2018) is a relevant phenomenon over this region during monsoons (Sarangi et al., 2017;

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2018). Aerosol-induced microphysical changes (like smaller cloud droplets) cause the droplets to move higher up in the atmosphere instead of falling down as rain. As such, the ratio of ice to liquid water content in the clouds increase in such invigorated clouds. A higher CAPE (induced due to the aerosol radiative effect) can further add to the cloud invigoration and lead to more ice formation, and thus higher rain rate eventually. Moreover, higher CAPE anomalies on the severe event days in the presence of higher AOD values are representing the possibility of a severe event as the convection grows for a longer time with more accumulation of MSE, CAPE and AOD, going to a positive feedback cycle."

9. The abstract needs modification. Could you please add some quantitative findings (AOD increase and MSE increase percentages) of this study in your abstract?

Reply: We agree with the reviewer. We have added the following sentence in the abstract discussing about the quantitative increase in AOD and MSE. "Results show an increase in AOD by ~36 % along with an increase in moist static energy by 1500 J/kg per total air mass for high precipitation events.

10. A schematic diagram showing the AEI mechanism over the Himalayan Foothill (similar to Fan et al., 2015) would better convey the message and ease the understanding of literature.

Reply: We are thankful to the reviewer for this suggestion. Though we believe that the AEI process is working as explained by Fan et al. (2015) and the diagram given by them is apt, we have added a simple schematic diagram in the supplement of our manuscript. The following text has been added to the manuscript in the line 206. "We have schematically summarized the AEI mechanism for the Himalayan region in Figure S3 in the supplementary file."

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2020-440/acp-2020-440-AC1-supplement.pdf>

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