

Response to Reviewer-3

The paper presents the results of the aircraft in situ measurements carried out at three selected locations in the Indo Gangetic plains (IGP) in the summer of 2016 before the advent of the South West Asian Monsoon to obtain the vertical distribution of composite aerosols and Black Carbon (BC). The aim of the experiment was to distinguish the characteristics of aerosols in the vertical column from surface to peak aircraft altitude. The location and timing of the experiment was so conceived that it covers the west east cross section of the IGP from the semi-arid desert in the west, the central IGP characterized by significant anthropogenic activity and the east coast location influenced by the marine environment and industrial activity. Some other aspects investigated during the SWAAMI are already in the public domain. The well-planned experiment reveals that in spite of the known east west heterogeneity in aerosol characteristics in the IGP as unveiled from ground-based observations, the coarse mode concentration and coarse mode mass fraction of aerosols representing mainly soil dust increases with increase in altitude across the IGP especially above the well mixed layer. Hence, the mode radii and geometric mean radii of aerosol particles increase with height. The east west heterogeneity is mainly restricted to within the boundary layer e.g. the highest coarse mode mass fraction (of the total aerosol load) is seen in the western IGP and highest accumulation mode mass fraction in the central IGP. The high concentration of coarse mode fraction is attributed to mineral dust loading. Simultaneous International Space Station overpass measurement reveals that dust aerosols reach altitude as high as 5 km in this season. On the contrary, BC mass concentration shows very little altitude variation upto the aircraft top height. The results so obtained are new, and significant from the point of view of aerosol-radiation interaction and aerosol-cloud interaction. It also establishes unequivocally for the first time the heterogeneity between aerosols within the ABL and free troposphere in the IGP. In view of the above, I strongly believe that the paper qualifies for publication in the prestigious journal ACP. I recommend publication of the article with minor revisions.

We appreciate the summary observations of the reviewer and the subsequent recommendation on the manuscript. We have addressed to all the queries/suggestions raised by the reviewer in the revised manuscript. Our point wise response to each of the comments is given below.

Minor comments/suggestions

1. Though the paper is well written I would suggest a thorough editing of the text by the authors for more clarity at some points and inadvertent grammatical mistakes or overwrite. Also, chronology in references inside the text should be maintained throughout the text.

Complied with. We have made a thorough revision of the text and grammatical issues in the manuscript. We have also taken care of the references, arranging in chronological order.

2. How the hygroscopic growth under extremely humid conditions as in case of BBS are taken care of in the APS measurement, please specify in the relevant text.

"The TSI-APS (3321) is suitable for operating at 10 to 90% RH (non-condensing) and 10-40°C ambient temperature. For BBR it is likely that aerosols grew under high RH conditions but might have also shrunk due to higher instrument temperature as compared to ambient. However, more controlled laboratory experiments are required to ascertain the response of the APS to hygroscopic growth of particles."

The above information is included in the revised manuscript, Line nos. 177-181.

3. The main concern regarding a few figures and their captions as given below.
- a. Figure 1: Caption please re-write. It is the AOD 500 nm which is shown in the surface plot upon which the stations are marked. In the figure, the triangles may be identified with the abbreviated station names for better visibility. Authors may rethink about Figure 1, as not much discussion on it is found in the text. Figure 2 is sufficient to represent the site description with the base stations. Otherwise, a few lines on AOD distribution may be added in the text based on Figure 1.

Response: Complied with

- b. Rewrite the figure caption 4.

Response: Complied with.

- c. Figure 5: Replace . . . 'eastern part of India by 'eastern part of IGP'.

Response: Complied with.

- d. Figure 8, Caption please delete 'distinct': also replace 200 by 2000

Response: Complied with.

- e. Figure 11b replace MBC by FBC, perhaps there is some confusion with Fig. S2.

Response: Complied with. The figure caption is corrected.

- f. Figure 12. Please zoom in the areas between the ellipse for clarity of the aircraft tracks. Also interchange b & c in the caption.

Response: A zoom in view of the flight tracks is shown (Figure-13R1) in the revised manuscript. Figure caption is corrected.

- g. Figure 15 What is indicated by the vertical dashed line? Please mention in the caption.

Response: Complied with. Thanks for pointing out the error on the vertical lines, which are properly set in the revised figure (Figure-16R1) and details are included in the caption.

4. *In continuation to comment 1, following are a few suggestions in the text.*

- a. Line 90: correct ". . .various aerosol properties" as ". . .various aerosol parameters".

Response: Complied with.

- b. Line 93: modify as . . . (Bhubaneswar (BBR), the industrialized coastal location in the eastern end of the IGP.

Response: This sentence is removed as was repeating with the sentence in line no 111-125.

- c. Line 90-95 can be merged with Line no 111-120 and figure 1 can be shifted to this section.

Response: Lines 90-95 is modified considering the repeating information with lines 111-120. Figure-1 is shifted to this section.

- d. Line: 96-99: Please rewrite the sentence

Response: Complied with, the sentence is modified.

- e. Line 103-110: can be placed at the end of this section or can be shifted to section 2.2

Response: Complied with, the lines are shifted to section 2.2

- f. Line 138-146: Should be rewritten and placed at Line 131.

Response: Complied with. These lines are rewritten and shifted as suggested.

Line nos. 127-134: " Figure-2a shows the actual dates of onset of the monsoon at different parts of India in 2016. As can be seen from the figure, despite a delayed onset at the southern tip of India, monsoon advanced fast in to the central/northern parts of India. Yet, all the flight sorties from the respective base stations were completed ahead of the advent of monsoon to that station. At the eastern IGP, the aircraft sorties were made from 'BBR' before the onset of monsoon over India; at 'VNS', the flights were conducted while monsoon advanced only to the central peninsula. The final sets of sorties were conducted at 'JDR' when the monsoon covered most of the central and eastern part of India, but yet to progress towards northwestern parts."

- g. Section 2.4 should be merged with section 2.2 or put before section 2.3.

Response: Complied with.

- h. Line 287-292: See if these sentences are more appropriate to place in previous paragraph (after Line 271)

Response: Complied with.

- i. Line 349: ' organic carbon being strong absorbers of UV radiation', please check.

Response: Complied with. We have modified the sentence as

Line nos. 357-359: " Higher values of AAOD at 388 nm are indicative of the presence of dust or biomass burning aerosols. This is because absorption by dust and organic carbon from biomass burning sources have strong wavelength dependency with higher absorption at near-UV wavelengths."

- j. Line 503: Rewrite the sub-section heading

Response: Complied with. We have modified the section heading as "Inter-seasonal variability: a case study at JDR".