

## ***Interactive comment on “Vertical and horizontal distribution of sub-micron aerosol chemical composition and physical characteristics across Northern India, during the pre-monsoon and monsoon seasons” by James Brooks et al.***

### **Anonymous Referee #2**

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Review on ‘Vertical and horizontal distribution of sub-micron aerosol chemical composition and physical characteristics across Northern India, during the pre-monsoon and monsoon seasons’ by James Brooks et al., (ACP-2018-1109)

This manuscript presents the results on physical and chemical properties of elevated aerosol layer and their vertical and horizontal distribution within and outside of IGP region over India using UK Facility for Airborne Atmospheric Measurements Bae-16 research aircraft measurements. In general, results presented in this manuscript are unique which are first of its kind and authors made nice compilation of physical and

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chemical characteristics of elevated aerosol layers (EAL) over north part of India. First of all, I should congratulate the authors for bringing out this study. Authors also brought out the differences in aerosol characteristics during pre-monsoon and monsoon both within and outside the IGP regions which will be very useful for further understanding the role of these EAL on the background atmosphere. As rightly pointed out in the summary, the information provided in this paper is very much useful in producing more accurate climate models by estimating the energy balance and for getting insights on the climate forcing accurately.

In general, paper is well written and will be interest to the researchers working in this field and very apt to publish in journals like ACP. However, there are few mistakes and sometimes interpretation is missing at some instances including literature survey which demands careful editing or re-writing. Below are the some of the issues which authors may take care in revising the manuscript. Authors are strongly encouraged to revise and re-submit this manuscript.

Below are my specific comments/suggestions for the potential solutions which authors may consider for future analysis.

Specific comments/suggestions:

1. Number of aircraft flights mentioned in the text (section 2) are 22, but only 4 dates are selected (in abstract) representing pre-monsoon (2 days) and monsoon season (2 days). However, from Table 1, it is clear that flights are operated on 10 days. It is not clear that why all the aircraft measurements are not considered in the present analysis.
2. In Figure 3, Aerosol Extinction (AE) is shown for the two days in pre-monsoon season. Do you have similar profiles in monsoon season? It will be interesting to see the presence of elevated aerosol layer in monsoon season as also shown by Sinha et al. (2013) and very recently by Venkat Ratnam et al. (2018). Latter study showed the presence of elevated aerosol during monsoon season and wet scavenging is clearly brought out.

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3. Elevated aerosol layers over Asian region are formed either due to convective or long-range transport. If it is through convective transport, chemical composition near surface should match with that observed aloft. In this study, surface concentrations of the chemical composition of the aerosol are missing. Information from either earlier published literature or their own surface measurements will be useful in interpreting the role of convective and long-range transport. I am wondering whether surface concentrations are measured with same set of instruments onboard aircraft before starting of the aircraft measurements each time?

4. One of the conclusions that the dust and sulphate dominated aerosol layer aloft was removed upon monsoon arrival matches with the findings of Vernier et al. (2018) where they found Nitrate as dominant source in the UTLS region using zero pressure balloons from Hyderabad whereas sulphate near the surface. Some of these finds are useful in further interpreting the results.

5. Are the profiles in figure 4 is the average of two flights in each season? If yes, it is better to show them separately to feel how different these profiles are within the same season (one can add as supplementary figure, if you feel that already figures are more).

6. Page 11, line 7: It is mentioned that elevated aerosol layer diminish as monsoon arrives leaving aerosol only within boundary layer. If monsoon washout (wet scavenging) is expected to remove the elevated aerosol layer, then throughout the profile including boundary layer aerosol should have also washed out? Why only elevated aerosol layer is diminished? Further there was no mention of rainout process which is also important during monsoon.

7. There was no mention of true boundary layer altitude though many times it is used. 950 hPa do not represent throughout the Boundary layer though it is expected that within boundary layer all the species are well mixed. In figure 3 description, boundary layer is considered as 2-4 km?

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8. As also pointed out by other reviewer, use of CALIPSO profiles (aerosol, extinction and aerosol types) will be very useful for two reasons. One is to know how good satellite retrievals over this region and also whether aerosol types obtained from CALIPSO match with aircraft observations or not.

Minor comments/suggestions:

There is repetition in the abstract (lines 17 and 24) ...that total mass reduced to 50%

Page 8 line 6: How average total mass concentrations are obtained is not clear.

Page 13, line 16: Quoted reference over China is almost a decade back where level of pollution over India may also be less at that time. Re-wording of this statement is required.

Additional References:

Sinha, P. R., Manchanda, R.K., Kaskaoutis, D.G., Kumar, Y.B., and Sreenivasan, S. (2013). Seasonal variation of surface and vertical profile of aerosol properties over a tropical urban station Hyderabad, India. *J. Geophys. Res.* 118, doi:10.1029/2012JD018039.

Vernier, J., et al. (2018). BATAL: The Balloon measurement campaigns of the Asian Tropopause Aerosol Layer. *Bull. Amer. Meteor. Soc.*, <https://doi.org/10.1175/BAMS-D-17-0014.1>.

Venkat Ratnam, M., P. Prasad, M. Roja Raman, V. Ravikiran, S.V.B. Rao, B.V. Krishna Murthy and A. Jayaraman. (2018). Role of dynamics on the formation and maintenance of the elevated aerosol layer during monsoon season over south-east peninsular India. *Atmospheric Environment*. 188. 10.1016/j.atmosenv.2018.06.023.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2018-1109>, 2018.

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