

## ***Interactive comment on “Long-term record of aerosol optical properties and chemical composition from a high-altitude site (Manora Peak) in Central Himalaya” by K. Ram et al.***

**Anonymous Referee #1**

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The manuscript presents the results of long-term measurements of the aerosol chemical and optical properties at a high-altitude (ca. 2000 m asl) site in north India, in a strategic location for studying the transport of pollutants and desert dust towards the Himalayas. The data presented here are of great value in the context of the research about the impact of natural and anthropogenic aerosols on the atmospheric transparency in south Asia. However, the quality of the paper can certainly be improved, because the discussion is often confused, there are many sentences with an unclear syntax, and the comparison with the results from literature studies is done indifferently with past observations at the same station, with other sites in the Indian subcontinent and with mountain sites of any altitude around the world distracting the

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reader from the actual purposes of the paper. Overall, the section dealing with the optical properties is better conceived compared to the discussion of the chemical data. I list below my specific comments:

- The main result of this study, i.e., natural dust sources account for the greatest fraction of TSP and of AOD but at the same time anthropogenic combustion sources are responsible for almost all aerosol light absorption, should be better emphasized in the abstract and in the conclusions.
- The Authors attribute the source areas of dust particles to Thar desert and as far as in the Middle East, but they do not provide any data to support this statement.
- Seasonal cycles are reported according to the time periods: summertime (April – June), monsoon (July – August), post-monsoon (Sept – Nov), winter (Dec – Mar). However, the summertime and monsoon seasons overlap with the Northern Hemisphere spring and summer, respectively. It would be less ambiguous to refer simply to the phases of monsoon circulation, so that the period April-June would be better defined as the premonsoon period.
- The comparison of OC and EC concentrations at Manora Peak with those at mountain stations in very different geographical locations (page 7444) leads to contradicting statements: “more or less similar” concentrations (page 7444, line 17) or “significantly higher compared to other high-altitude sites in the world” (page 7452, line 2)? Please, clarify.
- The conclusion of section 3.3, i.e., the variations of OC/EC ratio can be explained by the transport of biomass burning aerosols with a varying but significant amount of SOC, does not follow clearly from the discussion. The summertime formation of SOC is supported by the OC/EC data alone but not by the WSOC/OC ratios, which instead do not show any clear seasonal cycle. For this reason, the Authors’ statement in the conclusion about a significant contribution by SOC is not convincing.

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- The presentation of the results is often confused and difficult to follow. Some examples: Total carbonaceous aerosols are defined and treated in a specific section (3.2), however some results are anticipated in section 3.1 dedicated to mineral aerosols. WSOC/OC ratios have a dedicated section (3.4) but some data are anticipated in section 3.3 dealing with the OC/EC ratios. Data collected at Manora Peak are treated together with results of previous studies at unknown locations (e.g., page 7450, line 3, when quoting the study of Cozic et al.).
- There are numerous grammatical errors. The quality of English is inadequate to an international journal and must be improved.

Minor comments:

- Abstract, line 10: What is the meaning of "temporal variability in the abundance pattern"? Do the Authors refer to the geographical pattern of the concentrations or what else?
- Page 7438, line 8: "sea" not "see".
- Page 7438, lines 10 – 14: "Our strategy" etc.. This statement is gratuitous. It is not clear why sampling at a mountain site is a better option than sampling elsewhere in respect to characterize all processes listed here (aerosol ageing, change in mixing state, heterogeneous reactions).
- "rainfall" is more commonly used than "rain fall".
- Page 7740, line 1: Please, specify that such determinations of the PBL thickness were done at Manora Peak, to clarify to the reader that a PBL height of 1300 m corresponds to an altitude of 3300 m a.s.l. for the top of the PBL.
- Page 7442, first line: a proper reference should be added here to support the presented composition of mineral dust. The study of Cong et al. was focused on TSP not specifically on mineral dust.

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- Page 7442, line 10. The displacement of carbonate by sulphuric and nitric acids is an acid/base reaction which leaves unaltered the concentrations of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  in the aerosol. It is the solubility product of the salts which changes. Moreover, why such reactions should alter the mixing state of aerosol compounds?
- Page 7442, line 14: "The chemical composition during dust storm events is dominated by mineral aerosols" sounds pleonastic.
- Page 7442, last line: "normal days" should be better called "out-of-dust conditions".
- Page 7443, line 2: same as above.
- Page 7444, line 17: "...more or less similar". Please use a less colloquial expression.
- Page 7445, line 13: "Manora Peak is located at an altitude of 2000 m and represents a typical remote site". The absence of in situ emissions makes the sampling station a background site, but not necessarily remote, given the proximity of sources in the plains beneath the peak.
- Page 7445, line 6 contradicts line 16.
- Page 7447, line 5:  $R^2 = 0.57$  means a positive correlation but not a good correlation.
- Page 7448, line 3: "The dust storm" or "Dust storms"?
- Page 7450, line 3: What is the sense of reporting at this point of the discussion that in the study of Cozic et al. the absorption coefficient was highly correlated with the EC concentrations?
- Page 7450, line 17: "greater coating of BC due to photochemical activity". Please, explain better.
- Figure 3. Indicating the boundaries between the seasons would help the reader in following the yearly cycles of the chemical species.