Response to Anonymous Referee #3

We thank you for your careful reading of the manuscript and helpful comments and suggestions. We have made revisions according to your comments and suggestions, as described below.

General Comment

The manuscript "Different aerosol optical properties between southern and northern slopes of the Himalayas" authored by C. Xu et al. reported aerosol optical properties by AERONET sunphotometer observations at 3 stations in southern and northern slopes of the Himalayas. This work should be appreciated for local aerosol climatology over the very special topography was described, and these information are very useful for the understanding of the atmospheric chemistry and atmospheric radiative transfer process over the Tibetan Plateau (TP). The results over this region are not easy to find in the literature. For these reasons I consider the subject of this paper interesting. I am looking forward to seeing the manuscript be published in ACP after minor revision is done. Please find below some general and more specific suggestions on how to improve the manuscript.

Response

Thank you very much for your positive evaluation. The comments and suggestions are valuable and very helpful for revising and improving our manuscript, as well as the important guiding significance to our researches.

1, The AODs over the TP are very low, especially for the northern part of Himalayas. An estimation of the uncertainty of Angstrom Exponent (AE) data should be added. This question I have proposed my concern in the "Initial Manuscript Evaluation". However, the authors did not provide enough information to convince readers. In the section "2.2 AERONET data", an emphases about the sensitivity and uncertainty of AE should be given in order to support the analysis and conclusion about the following monthly and diurnal changes. "However, the quantitative uncertainty in AE for AERONET data is lacking"(Line 25, P20966), but the authors should be able to give an estimation of the uncertainty of the AE according to the Angstrom fomula with the specific values of AOD and their uncertainty. This question must be clearly explained so not to confuse authors about the use of AE data.

Response

Thank you very much for your comments and suggestions. We followed your suggestions and added an estimation of the uncertainty in Angstrom Exponent (AE). We used the equation in Hamonou et al. (1999) to estimate the uncertainty. The equation is $\Delta\alpha = \left(\varepsilon_{\lambda_1}^2 + \varepsilon_{\lambda_2}^2\right)^{\frac{1}{2}} / \ln\left(\frac{\lambda_1}{\lambda_2}\right)$. ε_{λ_1} and ε_{λ_1} mean the uncertainty in AOD at different wavelengths. Uncertainty in the optical thickness will evidently result in uncertainty in AE. We have known the general uncertainty in AOD is about 0.01 to 0.02. If the uncertainties in AOD at two different wavelengths are set to same value, we can use the general uncertainty at two wavelengths to do a simple calculation. When the uncertainty value of AOD is 0.01, the uncertainty in AE at 440-840nm is about 0.02. When the uncertainty value of AOD is 0.02, the uncertainty in AE at 440-840nm is about 0.04. Even if uncertainty in AOD is about 0.05, uncertainty in AE is about 0.10.

To be more precise, we changed the description and added an estimation of uncertainty in AE in Section 2.2 in the revised manuscript. The sentences are 'The equation $\Delta AE = \left(\varepsilon_{\lambda_1}^2 + \varepsilon_{\lambda_2}^2\right)^{\frac{1}{2}} / \ln\left(\frac{\lambda_1}{\lambda_2}\right)$ can be used to estimate the uncertainty in AE where ε_{λ_1} and ε_{λ_1} are the uncertainties in AOD at two different wavelengths (Hamonou et al., 1999). If the uncertainties in AOD at different wavelength are set to the same value, the uncertainty in AE can be estimated by a simple calculation. When the uncertainty value of AOD is 0.01, the uncertainty in AE at 440-840nm is about 0.02. When the uncertainty value of AOD is 0.02, the uncertainty in AE at 440-840nm is about 0.04. Even if uncertainty in AOD is about 0.05, uncertainty in AE is about 0.10. Compared to the value of AE, uncertainty is low enough and has no significant effect on the results in this study.' .

From the above simple calculation, we can know that the uncertainty in AE has no significant effect on the results. And the results are reliable in this study.

Hamonou, E., Chazette, P., Balis, D., Dulac, F., Schneider, X., Galani, E., Ancellet, G., and Papayannis, A.: Characterization of the vertical structure of Saharan dust export to the Mediterranean basin, J. Geophys. Res.-Atmos., 104, 22257-22270, doi:10.1029/1999JD900257, 1999.

2, In the part of the HYSPIT analysis (Line 23, P20972), the data used should be described. The use of the model should be acknowledged.

Response

Thank you very much for your comments and suggestions. We followed your suggestions and added the description 'NCEP/NCAR monthly reanalysis data (2.5°×2.5°, 6 h temporal resolution) were input to HYSPLIT model.' in Page 13 line 17-18 in the revised manuscript. We appreciate that you remind us to acknowledge the use of the model. In the acknowledgement, we added this sentence 'We would like to thank the NOAA Air Resources Laboratory team for providing the HYSPLIT_4 trajectory model' (please see Page 27 line 3-4 in the revised manuscript).

3, The authors emphasized that "The aerosol load in upper atmosphere is comparable to that in the lower Atmosphere" about the daytime variations over the site QOMS_CAS (P20980-P20981), could you give some observation result, for instance, lidar observed vertical distribution of aerosols over the TP region, to support your analysis?

Response

Thank you very much for your comments and suggestions. This speculation is deduced by the diurnal variations of AOD and AE together. At QOMS_CAS, AOD don't have a consistent diurnal variation pattern, but AE shows a consistent pattern. The aerosol parameters are affected by both higher altitude and lower altitude aerosols. The diurnal variations of AOD reflect the randomness of higher altitude aerosols. The

diurnal variations of AE reflect the impact of ABL evolution, which mainly happened at lower altitude. Sinha et al. (2013) revealed that at a urban station the aerosols within atmospheric boundary layer (ABL) dominated the column aerosol loading. But the aerosols above ABL also affect the column aerosol loading. Urban site is heavily influenced by ground level urban air pollution, while QOMS_CAS is not. Observations at QOMS_CAS can generally be representative of a remote background atmosphere. The aerosol vertical distribution at QOMS_CAS would be different from a urban site. Then we make this speculation. We changed the previous expression into 'The aerosol load at QOMS_CAS in the upper atmosphere is possibly comparable to that in the lower atmosphere.' (please see Page 23 line 11-12 in the revised manuscript). And this speculation is inappropriate for the conclusions section. We have deleted these sentences in the conclusion section 'It is deduced that the aerosol load in lower atmosphere is comparable to that in the upper atmosphere at QOMS_CAS on a daily time scale. And the aerosol load in lower atmosphere is a bit more than that in the upper atmosphere at EVK2-CNR. But the aerosol load at Pokhara is nearly completely influenced by the local emissions.' in the revised manuscript.
This comment guides our researches in the future. Lidar observations can really provide vertical distribution of aerosols over the TP region. This suggestion guide our future studies. We do want to make a specialized study about the vertical distribution on the TP. And we made some discussions in the last paragraph 'The mechanisms that we deduced are in qualitative agreement with the results presented in the figures. The interpretations are inferred by us, however, they need more direct evidences to prove these, such as chemical sampling at different atmosphere layers, micro-pulse lidar observations from surface or lidar remote sensing measurements.' (please see Page 26 line 11-15 in the revised manuscript).

Special Comment

1, The English should be improved. For example: Line 13, P20965: "In monsoon season, the leading surface wind direction is southwest, while in other seasons the dominant surface wind direction is northeast. Southwesterly winds prevail during the monsoon season, and in other period the westerly winds prevail", the two sentences are duplicated.

Response

Thank you for your comment and suggestion. The previous description is not appropriate. We have changed the sentences into 'Southwesterly winds near the surface prevail during the monsoon season, while in other seasons northeasterly winds prevail' (please see Page 5 line 15-16 in the revised manuscript). And English writing has already been further polished in the new revised manuscript by one co-author (Prof. A. Panday, Department of Environmental Sciences, University of Virginia, Charlottesville, Virginia, USA) now.

2, In the Figure 1 (P20994). The area of the lower left is not consistant with the rectangle in the upper left image. Please re-plot it.

Response

Thank you for your comment and suggestion. We have ignored this problem before. And we followed your suggestion and re-plotted this figure in the revised manuscript. Please see Figure 1 in the revised manuscript.

3, In the title of Figure 2 (P20995), “and the black dots indicate the locations of the three station”, it is difficult to find the black dots. Please re-plot it.

Response

Thank you for your suggestion. The previous figure doesn’t show clearly. Therefore we re-plotted this figure in the revised manuscript. We have changed the color of the precipitation and station to show the figure more clearly now. Please see Figure 2 in the revised manuscript.