

## ***Interactive comment on “Quantifying light absorption and its source attribution of insoluble light-absorbing particles in Tibet an Plateau glaciers from 2013–2015” by Xin Wang et al.***

### **Anonymous Referee #1**

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This paper reports BC, ISOC, MD concentrations in TP glaciers using an integrating sphere/integrating sandwich spectrophotometer (ISSW). The data are valuable and I am happy to see these can be published. I have two major concerns: 1. The manuscript seems to be prepared in 2016. There are very few updated literatures were cited. Since 2017, lots of LAIs (BC, OC, MD) data measured by TOR methods (DRI) in TP glaciers have been published, and assessment of LAIs impacts on surface albedo and glacier melt has been also reported. I encourage the authors to check these references and add necessary discussion on BC and MD loadings, sources and impacts on accelerating glacier melt. Here I list some of new literatures in the region.

1. Li X., S Kang, G. Zhang, B. Que, L. Tripatheea, R. Paudyal, Z. Jing, Y. Zhang, F.

- Yan, G. Li, X. Cui, R. Xu, Z. Hu, C. Li. 2017. Light-absorbing impurities in a southern Tibetan Plateau glacier: Variations and potential impact on snow albedo and radiative forcing. *Atmospheric Research*, 200: 77-87. Doi: 10.1016/j.atmosres.2017.10.002.
2. Li X. F., S. Kang, X. He, B. Qu, L. Tripathee, Z. Jing, R. Paudyal, Y. Li, Y. Zhang, F. Yan, G. Li, C. Li. 2017. Light-absorbing impurities accelerate glacier melt in the Central Tibetan Plateau. *Science of the Total Environment*, 587-588: 482-490. Doi: 10.1016/j.scitotenv.2017.02.169.
3. Zhang Y., S Kang, M. Sprenger, Z. Cong, T. Gao, C. Li, S. Tao, X. Li, X. Zhong, M. Xu, W. Meng, B. Neupane, X. Qin, M. Sillanpää. 2018. Black carbon and mineral dust in snow cover on the Tibetan Plateau. *The Cryosphere*, 12: 413-431. Doi: 10.5194/tc-12-413-2018.
4. Zhang Y. L., S. Kang, C. Li, T. Gao, Z. Cong, M. Sprenger, Y. Liu, X. Li, J. Guo, M. Sillanpää, K. Wang, J. Chen, Y. Li, S. Sun. 2017. Characteristics of black carbon in snow from Laohugou No. 12 glacier on the northern Tibetan Plateau. *Science of the Total Environment*: 607-608: 1237-1249. Doi: 10.1016/j.scitotenv.2017.07.100.
5. Zhang Y.L., S. Kang, Z. Cong, J. Schmale, M. Sprenger, C. Li, W. Yang, T. Gao, M. Sillanpää, X. Li, Y. Liu, P. Chen, X. Zhang. 2017. Light-absorbing impurities enhance glacier albedo reduction in the southeastern Tibetan Plateau. *Journal of Geophysical Research - Atmosphere*, 122. Doi: 10.1002/2016JD026397.
6. Zhang Y.L., S. Kang, M. Xu., M. Sprenger, T. Gao, Z. Cong, C. Li, J. Guo, Z. Xu, Y. Li, G. Li, X. Li, Y. Liu, H. Han. 2017. Light-absorbing impurities on Keqikaer Glacier in western Tien Shan: concentrations and potential impact on albedo reduction. *Sciences in Cold and Arid Regions*, 9(2): 97-111. Doi: 10.3724/SP.J.1226.2017.00097.
7. Schmale J., M. Flanner, S. Kang, M. Sprenger, Q. Zhang, J. Guo, Y. Li, M. Schwikowski, D. Farinotti. 2017. Modulation of snow reflectance and snowmelt from Central Asian glaciers by anthropogenic black carbon. *Scientific Reports*, 7: 40501. Doi: 10.1038/srep40501.
8. Niu H., S. Kang, Y. Zhang, X. Y. Shi, X. F. Shi, S. Wang, G. Li, X. Yan, T. Pu, Y. He. 2017. Distribution of light-absorbing impurities in snow of glacier on Mt. Yulong, southeastern Tibetan Plateau. *Atmospheric Research*, 197: 474-484. Doi: 10.1016/j.atmosres.2017.07.004.
9. Niu H., S. Kang, X. Shi, R. Paudyal, Y. He, G. Li, S. Wang, T. Pu, X. Shi, 2017.

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In-situ measurements of light-absorbing impurities in snow of glacier on Mt. Yulong and implications for radiative forcing estimates. *Science of the Total Environment*. 581-582: 848-856. Doi: 10.1016/j.scitotenv.2017.01.032. 10. Ji Z., S. Kang, Q. Zhang, Z. Cong, P. Chen, M. Sillanpää. 2016. Investigation of mineral aerosols radiative effects over High Mountain Asia in 1990–2009 using a regional climate model. *Atmospheric Research*, 178-179: 484-496. Doi : 10.1016/j.atmosres.2016.05.003. 11. Jenkins, M., S. Kaspari, S., S. Kang., B. Grigholm, B., P.A. Mayewski. 2016. Tibetan Plateau Geladaindong black carbon ice core record (1843–1982): Recent increases due to higher emissions and lower snow accumulation. *Advances in Climate Change Research*, 7(3): 132-138. Doi: 10.1016/j.accre.2016.07.002. 12. Yang J., S. Kang, Z. Ji, D. Chen. 2018. Modeling the origin of anthropogenic black carbon and its climatic effect over the Tibetan Plateau and surrounding regions. *Journal of Geophysical Research: Atmospheres*, 123. Doi: 10.1002/2017JD027282.

2. Geographical information is poor. Some glacier name are not correct. And sampling method and site should be represented clearly. In a glacier, you can collect samples from surface snow, surface ice and snowpit. These information are absent. I emphasize this because LAIs concentration mainly depends on which kind of samples collected in the glacier. Usually old snow and ice have higher LAIs concentrations than fresh snow and snowpit (with one or two magnitudes).

Other minor comments: 1. About the phrases in this manuscript. The author use the term of “Light-absorbing particles” in the title, while in the main text, “particulates” were used. What is the differences between these two phrases? I suggest to use the same one in the whole manuscript. In the main text, the author use the term of “High glacier”, it is not a proper phrase. The author should revise these words. “Cold season and warm season” in the Tibetan Plateau which should be “monsoon season and non-monsoon season”. “soil dust” should be “mineral dust”.

2. Introduction: The authors mentioned “BC, OC and MD contribute to spring snowmelt and surface warming through snow darkening effects (Page 3 Line 19-21)”. Then the

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authors give the research progress of BC and OC, what is the role of MD in this study? The authors should give their points on MD. Page 4 Line 17-18: Check the recent literatures and the authors should point out the differences/advantages between previous studies and this study. In the Tibetan Plateau, Li et al. (2016) use the dual-carbon isotopes to distinguish the different sources of BC, which is helpful for interpretation of BC sources.

3. For the sampling: In the abstract, the author used “~67 snow/ice samples” (Page 2 Line 3), do the authors mean about 67 snow/ice samples or more/less than 67 snow/ice samples? The author can give the exact number of samples. But then in the section 2.5 the author mentioned “189 samples”. Do you mean 67 snowpits? Do these snow samples collect from the accumulation zone of the glaciers? What is the “sites” mean in the main text? (for example in Page 10 Line11 “site65”). For the same glacier, for example Qiyi glacier, as shown in Table S1, I can't find any information for the site 1 or site 2? What is the differences between them (which part of the glacier)? And in the main text, did the authors also show the results from surface snow samples? The author need to clarify type of samples in the section 2.

Section 2.1: What is the glacier name at Tanggula Mountains? “Tanggula glacier” is not the exact name of the glacier. The same question for “Yangbajing glacier” (I think it is Gurenhekou glacier).

Section 2.1 and 2.2: When the snow/ice sample were prepared for analysis, what is the procedure on how to get the samples for ISSW analysis and WSOC analysis? What kind of filters and vials you used? Do you have blank samples? And duplicate samples?

Page 5 Line 16: “0.5-m pure, clean tubes”, what is the material of this tube? What is the diameter of this tube? Do you have any photos provided in the SI?

Page 5 Line 18-20: “was cut vertically into small pieces from”, please indicate a resolution.

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Section 2.3: equation 2 and equation 6, there are many saline lakes on the Tibetan Plateau, Na and K may be affected by the moisture evaporated from these saline lakes. How the authors to eliminate this effects when to discuss the NaSs?

4. Section3: The author used “site 65” (Page 10 Line 11) confused me. Do the authors mean for the same glacier, the ILPS were affected by different sources? (Page10 Line 9-13)

Page 11 Line19-20, this is not a complete sentence.

Page 12 Line 25-26: this sentence is contradict with the next sentence.

Page14 Line7-8, biomass burning? Do you mean the agricultural/straw burning?

5. Section 3.6: lack of several important references to discuss the potential sources of BC. Yang et al., 2018 JGR; Li et al., 2016, Nature Communications; Zhang et al., 2018 TC.

Page17 Line12-14: “originated from the local soil source instead of the biomass burning and industrial pollution than previous studies”. This sentence is contradict with the authors stated above.

Page17 Line20-22: “Qiyi glacier” is located in the northeast TP. In this region (Lao-hugou glacier), Li et al. (2016) indicated that 67% of BC was from fossil fuel combustion. You result is different. Why? Potential reasons? I am inclined to the dual carbon isotopes results.

Page17 Line16 to Page 18 Line 11: the authors only give the specific result of each glacier, what is the general characteristics of sources for glacier in south or north TP? The author should supplement the related references to discuss the sources.

6. Conclusions: in Page18 Line22, Page18 Line29-30, Page19 Line8, the authors mentioned the sources of ILAPs repeat.

7. Unit used in this manuscript: Page7 Line1-3, the unit should be “ng ml<sup>-1</sup>”

8. Figure 4: Please clear indicate the mean of red line, the blue box, and the upper and bottom black line. Figure 5: the author should define the meaning of QY QYM MK YZF TGL HRQ YBJ in the figure. In this figure, the authors can show the average ratios of ISOC to BC. The caption should change Figure 6: the relationships between ISOC and BC rather than ratios?

9. Other comments: Page7 Line 6: Gao et al. (2003) is not the proper references here. Cong et al., 2010 or Li et al., 2009 may be better. These data were measured used the same equipment in the same institute.

Page 3 Line 4-6, “most negative mass balance “with the deposition of black carbon”, I don’t believe. Estimates from related studies and simulations, the contribution from BC, OC, MD can reach to about 30%.

Page 6 Line 19-20, “Previous from BC, OC and Fe” needs references.

Page 8 Line 23, “elements”? Parameters?

Page 7 line 5, delete the sentence.

Page 7 Line 10-11, the sentence should be insert into the section 2.

Page7 Line 15-16, the samples were collected in “warm season”, then the results were attributed to the warm season? For snowpit, it can contain the cold season and warm season snow (non-monsoon and monsoon snow).

Page 8 Line 2-4, “with previous studies”. The references here is not related to the study area (See Li et al. 2016 NC).

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