Response to comment from Referee #2

This work observed size and mixing states of black carbon aerosols over a site on Yulong Mountain in southwestern China. With the monitoring data, authors calculated absorption of black carbon. However, the observation duration is very short, about two weeks. Authors separated the duration to three time intervals. The background duration only covered 4 days. I don't understand why 4 days can represent a background, thus general conditions on the site.

Response: Thank the referee for the comment. First of all, we want to clarify that, the time separation for Period II (background) is not aimed to represent the general condition on the site and we did not make such a similar statement in our manuscript. Our purpose of defining this period is to compare with Period I, thus to compare the condition unaffected by the transported BB plumes (Period II) and the condition affected by the transported BB plumes (Period I).
Secondly, we want to demonstrate that, the study of this manuscript is one of the pieces of an integrated and systematic atmospheric observation research. The time period (4/1/2015-4/4/2015) which we marked as Period II has been previously defined as the same background period in a few published papers. According to the papers of Zheng et al. (2017), Shang et al. (2018), Wang et al. (2019), they also marked the same time period (4/1/2015-4/4/2015) as the background period to illustrate the impact of transported BB plumes on the atmospheric environment of the site.

References:

Zheng, J., Hu, M., Du, Z. F., Shang, D. J., Gong, Z. H., Qin, Y. H., Fang, J. Y., Gu, F. T., Li, M. R., Peng, J. F., Li, J., Zhang, Y. Q., Huang, X. F., He, L. Y., Wu, Y. S., and Guo, S.: Influence of biomass burning from South Asia at a high-altitude mountain receptor site in China, Atmos Chem Phys, 17, 6853-6864, https://doi.org/10.5194/acp-17-6853-2017, 2017.

Shang, D. J., Hu, M., Zheng, J., Qin, Y. H., Du, Z. F., Li, M. R., Fang, J. Y., Peng, J. F., Wu, Y. S., Lu, S. H., and Guo, S.: Particle number size distribution and new particle formation under the influence of biomass burning at a high altitude background site at Mt. Yulong (3410 m), China, Atmos Chem Phys, 18, 15687-15703, https://doi.org/10.5194/acp-18-15687-2018, 2018.

Wang, Y. J., Hu, M., Lin, P., Tan, T. Y., Li, M. R., Xu, N., Zheng, J., Du, Z. F., Qin, Y. H., Wu, Y. S., Lu, S. H., Song, Y., Wu, Z. J., Guo, S., Zeng, L. W., Huang, X. F., and He, L. Y.: Enhancement in Particulate Organic Nitrogen and Light Absorption of Humic-Like Substances over Tibetan Plateau Due to Long-Range Transported Biomass Burning Emissions, Environ Sci Technol, 53, 14222-14232, https://doi.org/10.1021/acs.est.9b06152, 2019.

Period I, which was defined as biomass burning event, covered 6 days. Comparing the6-days data to the 4-days background, authors make results and conclusions. such as; Resulted from both increase of BC loading and aging degree, the transported BB plumes eventually enhanced the total light absorption by 15 times, in which 21% was contributed by the BC aging and 79 % was contributed from the increase of BC mass. With those very limited data output, authors claim this study revealed the impact of transported aged BB plumes on the atmospheric environment over the TP, which can serve as constraints for climate models to help with improving our understanding how human activities affect the global climate change.

I can not believe such short observation can have us a verified result.

Response: We thank the referee for the comment. As mentioned above, the results presented in this manuscript were part of an integrated and systematical observation campaign. The biomass burning event in Period I and the definition of the background period have been verified by three published papers (Zheng et al., 2017; Shang et al., 2018; Wang et al., 2019). Therefore, we believe that such research methods have been academically recognized and have certain scientific significance. In our study, we conducted accurate measurement of the BC mixing state by using the well-recognized instruments. And the data was precisely calculated which was explicitly described in our manuscript. More importantly than the absolute length of the time period, the complete pollution event disturbed by the transported biomass burning plumes has been captured and targeted analysis has been carried out. And we also provided the evidence of biomass burning tracers in the following response, which was also added to our revised manuscript.

Therefore, we are confident that the results presented in our manuscript are scientifically verified. But we still thank the referee for the scientific advice. For further field observations in the future, we will try to conduct a more in-depth and targeted discussion on the time scale to make a better optimization. If the reviewer meant that the implication of our study should be rephrased more specifically, please see the revised text below:

Line 64-66: "By probing into the microphysical properties of BC aerosols, this study revealed that the recurring pre-monsoonal BC concentration peaks in the southeastern TP could be resulted from regional transport of aged BC aerosols, which led to a strong light absorption over the region."

Moreover, the biomass burning source identification is not well supported with tracer or receptor model methods, which should be typically applied for source identification.

Response: Thank the referee for the comment. The source identification of biomass burning has been verified by the tracers in the papers of Zheng et al. (2017) and Wang et al. (2019), which was also explained in Line 170-173 of our manuscript. In our revised manuscript, we also added a supplementary figure (Figure S5) to give further explanation. As shown in the Figure S5 below, the concentrations of levoglucosan, potassium and acetonitrile, the three widely used BB tracers, are much higher during Period I (biomass burning-influenced period, 3/23-3/29) than those during Period II (background period, 4/1-4/4).

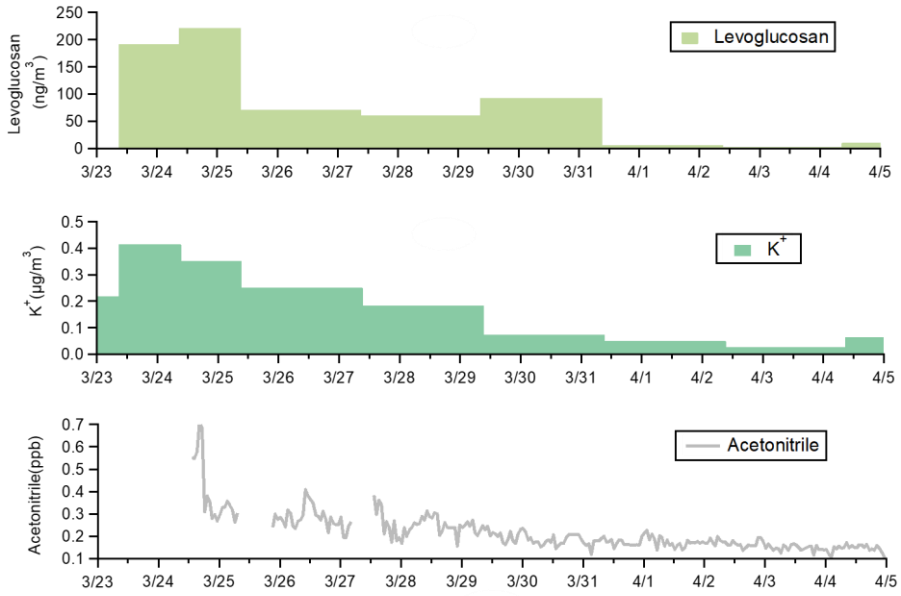

Figure S5. Temporal variation of the biomass burning tracers during the observation.

My evaluation is that current observation is not enough verification to be published on ACP. Authors should extend observation for several repeats of events and longer background condition. Chemical analyzing should be useful for identification of sources before the definition of biomass events.

Response: Thank the referee for the comment. As mentioned in the response above, the results presented in this manuscript were part of an integrated and systematical observation campaign. The biomass burning event in Period I and the definition of the background period have been verified by three published papers (Zheng et al., 2017; Shang et al., 2018; Wang et al., 2019). Therefore, we believe that such research methods have been academically recognized and have certain scientific significance. More importantly than the absolute length of the time period, the complete pollution event disturbed by the transported biomass burning plumes has been captured and targeted analysis has been carried out.

By probing into the microphysical properties of BC aerosols, our study provides direct evidence that the recurring pre-monsoonal BC peaks in the Himalayas and Tibetan Plateau (HTP) region can result from the regional transport. Because these BC particles have a higher aging degree than the background BC particles. Before our study, there are many papers reporting that the BC concentration has a maximum value in pre-monsoon season around the year in HTP region (Decesari et al., 2010; Zhao et al., 2013; Marinoni et al., 2013; Cong et al., 2015; Marinoni et al., 2010). However, due to lack of information on the BC mixing state, they could only deduce from the back trajectories that these BC particles are possibly transported from the South Asia. By investigating the microphysical properties of BC particles, our study revealed that those transported BC particles are mostly thickly coated and have thicker coatings than the background BC. Based on this, our research elucidates that the aging process during the long-range transport would strengthen the radiative heating of those transported BC aerosols. Furthermore, based on the analysis of the diurnal variation, our research indicated that the regional transport of BB plumes might increase the BC concentration in the free troposphere, which would exert a more profound effect on the regional

climate system. Overall, we believe our study can expand our knowledge on atmospheric aerosols over the HTP region and may help us understand the climate change occurring in this region. Additionally, our research is one of the few studies that conducted field observations in the free troposphere to focus on the BC mixing state. Therefore, we believe our studies is qualified to be published on ACP.

References:

Cong, Z., Kang, S., Kawamura, K., Liu, B., Wan, X., Wang, Z., Gao, S., and Fu, P.: Carbonaceous aerosols on the south edge of the Tibetan Plateau: concentrations, seasonality and sources, Atmos Chem Phys, 15, 1573-1584, https://doi.org/10.5194/acp-15-1573-2015, 2015.

Decesari, S., Facchini, M. C., Carbone, C., Giulianelli, L., Rinaldi, M., Finessi, E., Fuzzi, S., Marinoni, A., Cristofanelli, P., Duchi, R., Bonasoni, P., Vuillermoz, E., Cozic, J., Jaffrezo, J. L., and Laj, P.: Chemical composition of PM10 and PM1 at the high-altitude Himalayan station Nepal Climate Observatory-Pyramid (NCO-P) (5079 m a.s.l.), Atmos Chem Phys, 10, 4583-4596, https://doi.org/10.5194/acp-10-4583-2010, 2010.

Marinoni, A., Cristofanelli, P., Laj, P., Duchi, R., Calzolari, F., Decesari, S., Sellegri, K., Vuillermoz, E., Verza, G. P., Villani, P., and Bonasoni, P.: Aerosol mass and black carbon concentrations, a two year record at NCO-P (5079 m, Southern Himalayas), Atmos Chem Phys, 10, 8551-8562, https://doi.org/10.5194/acp-10-8551-2010, 2010.

Marinoni, A., Cristofanelli, P., Laj, P., Duchi, R., Putero, D., Calzolari, F., Landi, T. C., Vuillermoz, E., Maione, M., and Bonasoni, P.: High black carbon and ozone concentrations during pollution transport in the Himalayas: Five years of continuous observations at NCO-P global GAW station, J Environ Sci, 25, 1618-1625, https://doi.org/10.1016/S1001-0742(12)60242-3, 2013.

Zhao, Z. Z., Cao, J. J., Shen, Z. X., Xu, B. Q., Zhu, C. S., Chen, L. W. A., Su, X. L., Liu, S. X., Han, Y. M., Wang, G. H., and Ho, K. F.: Aerosol particles at a high-altitude site on the Southeast Tibetan Plateau, China: Implications for pollution transport from South Asia, J Geophys Res-Atmos, 118, 11360-11375, https://doi.org/10.1002/jgrd.50599, 2013.