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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Personal exposure to $PM_{2.5}$ emitted from typical anthropogenic sources in Southern West Africa (SWA): Chemical characteristics and associated health risks" *by* Hongmei Xu et al.

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Anonymous Referee 1 Received and published: 11 November 2018

We would like to thank the reviewer for all the comments firstly. Below we address to the best of our ability each comment.

Comments and suggestions for improvement:

- I understand that the authors are not native speakers but in some parts of the manuscript, the clumsy phrasing hinders comprehension. This point should be taken care of.

Response: I will look for a native speaker cooperator to polish the language of this manuscript.

- In the chemical analysis, I am surprised by the choice of Fe as a tracer of the crustal component of the aerosol. It is well known that at least a part of its concentration is contributed by anthropogenic activities. Wouldn't Al or Ca be a better choice? By the way, why were these elements not quantified by the XRF analysis?

Response: This is a good point. In order to analyze the carbonaceous aerosol, the authors selected quartz fiber filters to collect personal exposure PM2.5 samples in this study. Due to the limitations of personal exposure sampling, it is difficult to collect quartz fiber filter and Teflon membrane filter simultaneously.

Moreover, the analytical uncertainties by using ED-XRF for smaller molecular weight crustal elements in quartz fiber filter (with high Na, Al, Ca and Mg background), such as Al, Si and Ca, are high. So, Al, Si and Ca are not suitable to be used as a tracer of the crustal component of the aerosol in this study. Meanwhile, the high accuracy of Fe analysis with ED-XRF has been demonstrated in our previous publication (Xu at al., 2016), and Fe has been used often as a tracer for crustal component in PM2.5 (e.g., Cao et al., 2004; Hao et al., 2007; Sun et al., 2014; Wu et al., 2012; Xu at al., 2016).

Furthermore, based on the previous references (Gelado-Caballero et al., 2012; Zhuang et al., 2001), the enrichment factors of Fe in dust storm period and non-dust storm were both 1-2, always < 10, proving that Fe in aerosol was still mainly derived from the crustal source. Therefore, taking into account the above points, the author finally picked Fe as a tracer of the crustal component in this study.

Reference:

Cao, J. J., Rong, B., Lee, S. C., Chow, J. C., Ho, K. F., Liu, S. X., and Zhu, C. S.: Composition of indoor aerosols at emperor Qin's terra-cotta museum, Xi'an, China, during summer, China Particuology, 3(3), 170-175, 2004.

Gelado-Caballero, M. D., López-García, P., Prieto, S., Patey, M. D., Collado, C., and Hérnández-Brito, J. J.: Long-term aerosol measurements in Gran Canaria, Canary Islands: Particle concentration, sources and elemental composition, J. Geophy. Res.-Atmos., 117, D03304, doi:10.1029/2011JD016646, 2012.

Hao, Y. C., Guo, Z. G., Yang, Z. S., Fang, M., and Feng, J. L.: Seasonal variations and sources of various elements in the atmospheric aerosols in Qingdao, China, Atmos. Res., 85, 27-37, 2007.

Sun, Y. Y., Hu, X., Wu, J. C., Lian, H. Z., and Chen, Y. J.: Fractionation and health risks of atmospheric particle-bound As and heavy metals in summer and winter, Sci. Total Environ., 493, 487-494, 2014.

Wu, F., Zhang, D. Z., Cao, J. J., Xu, H. M., and An, Z.S: Soil-derived sulfate in atmospheric dust particles at Taklimakan desert, Geophy. Res. Lett., 39, L24803, doi:10.1029/2012GL054406, 2012.

Xu, H.M., Cao, J. J., Chow, J. C., Huang, R.-J., Shen, Z. X., Chen, L. W. A., Ho, K. F., and Watson, J. G..: Inter-annual variability of wintertime PM2.5 chemical composition in Xi'an, China: Evidences of changing source emissions, Sci. Total Environ. 545-546, 546-555, 2016.

Zhuang, G. S., Guo, J. H., Yuan, H., and Zhao, C. Y.: The compositions, sources, and size distribution of the dust storm from China in spring of 2000 and its impact on the global environment, Chinese Sci. Bull., 46(11), 895-900, 2001.

- In the health risk assessment, it would be useful to detail the type of risk quantified. The categories 'cancer risk' and 'non-cancer risk' are very broad. Also, is the risk

a long-term or a short-term one? Why did you assess only the risks resulting from exposure to Mn, Ni, Zn, Pb, the PAHs and the PAEs? There is also a risk due to exposure to PM2.5 and given the large concentrations reported in your work, I expect this one might be very important.

Response: We agree and understand the reviewer's concern. The details of these categories have been clarified and revised in the manuscript: "The heavy metals non-carcinogenic risks and toxic organics carcinogenic risks of PM2.5 via inhalation were calculated according to the U.S. EPA health risk assessment model (USEPA, 2004, 2011).". U.S. EPA health risk assessment model is the process to estimate the nature and probability of adverse health effects in humans who may be exposed to chemicals in contaminated environmental media, now or in the future. The reason we chose Mn, Ni, Zn, Pb, PAHs and PAEs to assess the health risks in personal exposure PM2.5 samples is because these chemicals (among all the chemicals we analyzed in this study) are included in this model and they are assessed to be hazardous to human health in the previous studies (e.g., Hu et al., 2018; Kong et al., 2015; Sun et al., 2014; Xu et al., 2018).

Moreover, indeed, as the reviewer said "There is also a risk due to exposure to PM2.5", but PM2.5 is a complex mixture containing a lot of chemicals. There is no clear and better way to assess its whole health risks for now based on PM2.5 chemical concentrations (except for the model simulation and medical animal exposure experiments). So, at this moment, we calculated the risks of the certain toxic chemicals in PM2.5 to estimate PM2.5 health risks.

Reference:

Hu, Y. J., Bao, L. J., Huang, C. L., Li, S. M., Li, Liu, P., and Zeng, E. Y.: Assessment of airborne polycyclic aromatic hydrocarbons in a megacity of South China: Spatiotemporal variability, indoor-outdoor interplay and potential human health risk, Environ. Pollut., 238, 431-439, 2018.

Kong, S. F., Li, L., Li, X. X., Yin, Y., Chen, K., Liu, D. T., Yuan, L., Zhang, Y. J., Shan, Y. P., and Ji, Y. Q.: The impacts of firework burning at the Chinese Spring Festival on air quality: insights of tracers, source evolution and aging processes, Atmos. Chem. Phys., 15, 2167-2184, 2015.

Sun, Y. Y., Hu, X., Wu, J. C., Lian, H. Z., and Chen, Y. J.: Fractionation and health risks of atmospheric particle-bound As and heavy metals in summer and winter, Sci. Total Environ., 493, 487-494, 2014.

Xu, H. M., Guinot, B., Cao, J. J., Li, Y. Q., Niu, X. Y., Ho, K. F., Shen, Z. X., Liu, S. X., Zhang, T., Lei, Y. L., Zhang, Q., Sun, J., and Gao, J. J.: Source, health risk and composition impact of outdoor very fine particles (VFPs) to school indoor environment in Xi'an, Northwestern China, Sci. Total Environ., 612, 238-246, 2018.

- In the results section (line 328-330), you cannot extrapolate to the whole SWA region your results collected during two weeks at three very specific locations.

Response: Thank you for this point. The authors have revised this statement to "The average personal exposure to PM2.5 (PE PM2.5) mass concentrations were 331.7$\pm$190.7, 356.9$\pm$71.9 and 242.8$\pm$67.6 μg m-3 for women at Domestic Fires (DF), students at Waste Burning (WB) and drivers at Motorcycle Traffic (MT) respectively in this study." Moreover, the authors have checked related issue in this manuscript and will make changes in the revised version.

- Line 400: you say that total carbon was the most important chemical species in PE PM2.5 but it contributes only about 20

Response: We are sorry for the confusion. In section "3.1.2. PE PM2.5 chemical compositions", the authors were talking about the PE PM2.5 chemical compositions, which includes carbon fractions (OC and EC), water-soluble inorganic ions and heavy metals. Total carbon (TC=OC+EC) was the most important chemical species in PE PM2.5, which means TC was the most important chemical species among these three

kinds of major components of PM2.5.

Strictly speaking, the mineral dust in PM2.5 is not directly analyzed by the instrument. It is estimated by empirical formula based on the concentration of some chemical components (mineral elements). Therefore, mineral dust cannot be regarded as the chemical composition of PM2.5. It should be considered as the source of PM2.5. On this issue, the authors will standardize the terms used in the text to avoid ambiguity. Thank you for your suggestion!

-Paragraph 705-724: First, you say that there is no non-carcinogenic risk linked with the exposure to Mn, Pb, Ni, and Zn (line 709), then you discuss the fact that the risk is much higher in the dry season (line 718). What is the point of discussing the magnitude of this risk, especially before repeating (line 723-724) that it is negligible?

Response: Although our results show that the average non-carcinogenic risk linked to heavy metals in this study was below the international thresholds, we have noticed that it has a seasonal behavior, especially for the driver group. We now first present the risk and then highlight this latter point by giving the dry/wet season ratios.

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