

Dear Editors and Reviewers,

Thank you for your valuable comments on our manuscript entitled “Modeling of PAHs From Global to Regional Scales: Model Development and Investigation of Health Risks from 2013 to 2018 in China” (MS No.: EGUSPHERE-2024-1437). Those comments are greatly helpful for improving our manuscript. We provided point-by-point replies to your comments and revised the manuscript accordingly (in **blue and highlighted**).

The comments (in black) are copied here and responses to the comments (in blue) are as follows:

### **Response to Referee #1:**

This study employed an improved global-regional nested Atmospheric Aerosol and Chemistry Model (IAP-AACM) to investigate the global distribution of PAHs and the health risk in 2013 and 2018, respectively. The new developed model includes more parameterized processes and shows satisfied simulation results. The results reveal a decline of PAH concentration in most area of China except Sichuan Basin, attributed to meteorology conditions. However, the total incremental lifetime cancer risk posed by BaP only show a slight decrease and the health risks still exist especially in East China. All the findings indicate more tough control measures for PAH when considering both pollution and public health. Besides, meteorology factors play an important role when assessing the control measures for concentration measuring.

The paper is well structured and contributes importance for air pollution and health risks. However, there are several limitations outlined below that need to be addressed before considering it for publication.

**Response:** We appreciate your comments and suggestions, and we have revised the manuscript accordingly.

**Comment 1:** The title as well as main text of this paper shows the analysis results “from 2013 to 2018”, while the simulation tests were performed for 2013 and 2018,

respectively. Therefore, the expression is ambiguous.

**Response:** We agree with this point. We have changed the expression “from 2013 to 2018” to “in 2013 and 2018”. (Line3)

**Comment 2:** In abstract, Line 28-29, the study concluded the decrease for BaP is smaller than PM2.5 during the same period. However, it seems no analysis was performed in section4 to support this conclusion.

**Response:** Thanks for the comment. The relevant description has been added in Section 4. (Line 457-458)

**Comment 3:** Is the computation for TILCR consider the population data for each simulation resolution? From formulation 14-18, there are no population data related but in Line 214-216, the population data were used.

**Response:** We apologize for this confusion. We considered the population data with different resolutions when calculating the TILCR values, as described in the manuscript (Line 219) “re-gridded to  $1^\circ \times 1^\circ$  and  $0.33^\circ \times 0.33^\circ$  to match the model resolution”. According to this comment, we also added the description of population database resolution in the revised manuscript. (Line 217)

**Comment 4:** 9 shows the distribution of TILCR. As shown in formula (18), the TILCR is calculated for children, women and men, respectively. Is the TILSR in Fig.9 calculated with the number of children, women and men as weight? If so, please clarify how to obtain the TILCR in this figure.

**Response:** Yes, the meaning of TILCR is not clear in Fig. 9 in the original manuscript. The TILCR in Fig. 9 is the total lifetime risk of cancer through dermal contact and inhalation exposure, where we have averaged the inhalation rate (IR), exposure duration (ED), body weight (BW), and surface area of skin exposure (SA) for children, women and men to calculate the TILCR. It has to be admitted that this method would slightly overestimate the TILCR for children and underestimate the TILCR for men and women due to insufficient consideration of age and gender differences. However, these

uncertainties are acceptable according to the studied using this method (Nam et al., 2021; Su et al., 2023). To clarify the meaning of TILCR, we added the following sentence in the revised manuscript “TILCR (the sum of ILCR values of the two exposure routes after averaging the parameters of the different groups)”. (Line 385-386)

**Comment 5:** Line 436-437, “It can be seen that the spatial distribution of TILCR (Fig. 9a) is consistent with the spatial distribution of the BaP annual concentrations”. According to the formula (14)-(18), the TILCR seems to be proportional with the concentration of PAHs, as the other parameters have fixed values, so the TILCR should be consistent with Fig.7. The same problem also exists regard to Fig.10. The differences between children, women and men depends on the coefficients in formula (14)-(17). In my understanding, the conclusion can be obtained directly from these formulas. Please elaborate more about the meaning of these two figures.

**Response:** We completely agree with this point. However, the health risks are classified as negligible, potential, and high potential depending on the concentrations, and we believe that the health risks posed by the different routes to different regions and groups can be demonstrated concretely through Fig. 9-12. Combined with the comment 6, we added two figures showing the health risks grade distribution for a more intuitive understanding (Fig. R1).

**Comment 6:** In part 4.3, the author wants to show the health risks of PAHs. I think it's better to add a figure of the distribution of health risk grade in China for a more intuitive understanding.

**Response:** Thank you for your constructive comments. As shown in Fig. R1a and b, the health risks in western China is negligible, while there is a potential cancer risk in eastern China. The figures have been added in the revised manuscript (Figure 10).

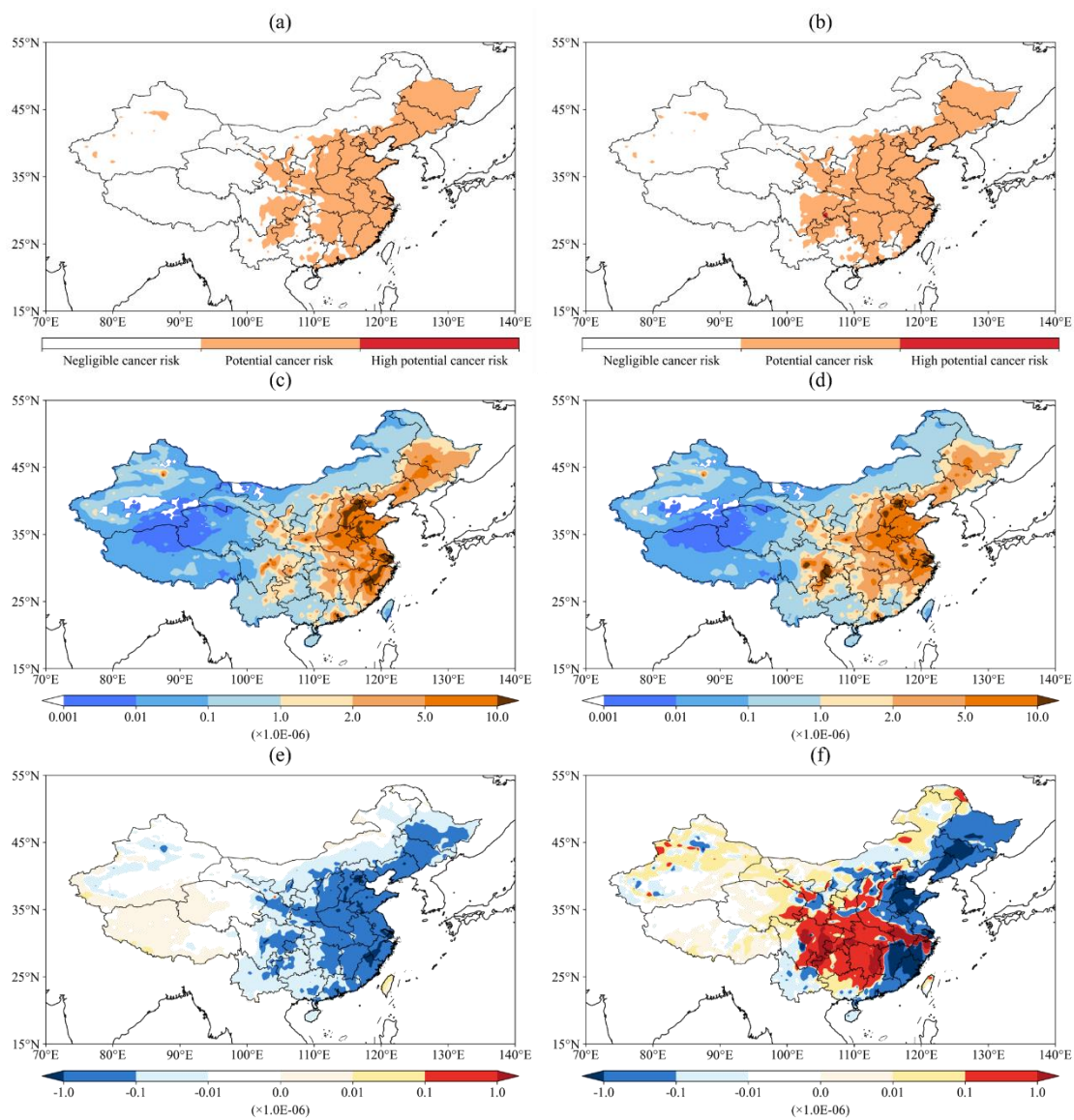


Figure R1. The distribution of health risks grade in China in (a) 2013 and (b) 2018, the distribution of TILCR in (c) 2013 and (d) 2018, and the TILCR changes from 2013 to 2018 when considering the change in (e) emissions only, (f) both emissions and meteorological conditions. This figure corresponds to Figure 10 in the revised manuscript.

**Comment 7:** Formulation (14) lacks the explanation for parameter AF and CF.

**Response:** Thank you for the careful review. The explanation and values for AF and CF have been provided in the revised manuscript and supplement (Table S2). (Line 228, 236)

**Comment 8:** Line 507, it should be YRD, not YRH.

**Response:** It has been corrected. (Line 550).

**Comment 9:** 7, the figure annotation has some errors. Simulated concentrations are in orange not red and observed values are in blue not black, please check.

**Response:** “Red” and “black” have been changed to “orange” and “blue” in Line 418.

## References

Nam, K. J., Li, Q., Heo, S. K., Tariq, S., Loy-Benitez, J., Woo, T. Y., Yoo, C. K.: Inter-regional multimedia fate analysis of PAHs and potential risk assessment by integrating deep learning and climate change scenarios, *Journal of Hazardous Materials*, 411, 12, <https://doi.org/10.1016/j.jhazmat.2021.125149>, 2021.

Su, C., Zheng, D. F., Zhang, H., Liang, R. Y.: The past 40 years' assessment of urban-rural differences in Benzo a pyrene contamination and human health risk in coastal China, *Science of the Total Environment*, 901, 9, <https://doi.org/10.1016/j.scitotenv.2023.165993>, 2023.