Response to Reviewer 2:

Comments:

The study analyzed the long-term and short-term characteristics of surface ozone spatialtemporal variation and exposure in 2000-2020, which provides important support for environmental management and health research. This study used a machine learning method based on satellite retrieved surface temperature, combined with multi-scale and multi-temporal dimensions analysis, to reveal the spatial and temporal distribution of ozone and its potential health risks. This detailed and comprehensive study have high scientific value, and provide a reference basis for policy making in related fields. However, there are still some aspects that need to be further improved.

Response: Thank you for reviewing our manuscript and providing us constructive suggestions/comments. We have thoroughly considered your suggestions/comments and revised our manuscript accordingly. The item-by-item responses are below.

Major:

(1). The background of the article is not well researched, and the introduction only briefly mentions some O3 data at high spatial resolution for O3. However, there are already studies (Shang et al., 2024. https://doi.org/10.1021/acs.estlett.4c00106) where hourly O3 data are available, and the advantages of your research over these studies should be fully explained.

Response: Thank you for sharing the publication focusing on ground-level ozone modeling with high temporal resolution. We have reviewed this paper and incorporated a discussion in the second paragraph of Section 1 in the revised manuscript, as shown below. Overall, while previous studies, including the one you referenced, have made significant advancements in improving spatial and/or temporal resolutions, they have yet to achieve high resolution in both dimensions simultaneously, such as daily 1-km estimates—an area where this study offers a distinct advantage.

"… While previous studies have estimated ground-level ozone concentrations across China with improved estimation performance (Ma et al., 2022a; Liu et al., 2020; Wei et al., 2022a; Zhan et al., 2018; Chen et al., 2021; Shang et al., 2024), at least two key limitations persist: (1) despite advancements in resolution, these studies have not achieved high resolution in both spatial and temporal dimensions, such as daily 1-km estimates. …"

(2). There is too much restatement in the discussion section and the conclusion section, I suggest that the language be refined and that the two sections, or some of them, be considered to be merged together.

Response: Thank you for your suggestion. We have revised the discussion and conclusion sections to reduce redundancy between them. Specifically, in the revised discussion section, the content on NCP from the initial version has been integrated into the third paragraph, while the second paragraph now focuses solely on the national, long-term, three-phase trend in ground-level ozone. In the updated conclusion section, we summarize the key findings of this study in three aspects: (1) improved ozone hindcasting using satellite-derived LST, (2) non-monotonous long-term trends and seasonal shifts, and (3) emerging exposure hotspots.

(3). Why aerosol optical depth used as an index for O3 retrieval? As far as I know, solar radiation is also an important factor in the photochemical reaction of O3. Will it be improved if it is included as a feature in the model for training?

Response: The reasons for including AOD as a predictor in our ground-level ozone estimation model are outlined below. This information has been incorporated into Section S1.1 of the revised supporting document.

- Atmospheric chemical and physical perspective: Aerosols influence the scattering and absorption of solar radiation, thereby affecting the efficiency of photochemical reactions (Wang et al., 2019), which play a critical role in the formation and destruction of ozone. Additionally, certain aerosols, such as black carbon, can adsorb volatile organic compounds (VOCs) in the atmosphere (Gao et al., 2018), which are important precursors for ozone formation. By altering VOC concentrations, aerosols can indirectly impact ozone production. AOD, as a primary proxy for aerosol physical properties and concentrations, was therefore incorporated as a relevant predictor in our model.
- **Statistical perspective**: Previous studies have demonstrated a correlation between aerosol particles and ozone levels (Zhu et al., 2022). Based on this relationship, AOD was included as a predictor in our ozone estimation model. Our variable importance analysis (Fig. S9) ranked AOD 7th among the 15 predictors in the machine-learning model, further highlighting its contribution to ground-level ozone modeling.

Regarding solar radiation, we agree that it is a critical factor in ozone formation, particularly due to the direct influence of ultraviolet light on ozone generation. To account for the effects of solar radiation, we included two relevant variables in our estimation model: sunshine duration (SSD) and surface solar radiation downwards (SSRD). As shown in Fig. S9, SSRD ranked second only to land surface temperature (LST) in terms of variable

importance for predicting long-term MDA8 ozone concentrations using the proposed method.

Minor:

(1). Figure 3 lacks the label of (b).

Response: We would like to thank the reviewer for pointing out this issue. We have made the necessary modifications to Figure 3 by adding the label (b) as suggested.

(2). Line 231 has an extra set of parentheses after the NCP.

Response: Thank you for your careful review and comments on our paper. We have noted the writing error in line 231 where "NCP）" should be corrected to "NCP." We have made this correction in the revised version to ensure the accuracy of the paper.