Response to Reviewer #1's comments

First of all, we would like to thank the Reviewer #1's comments and suggestions, which improved significantly the presentations and interpretations of our revised manuscript. In the revised article, we have addressed all comments from the Reviewer. Our point-by-point responses to the Reviewer's comments are outlined below. The original comments are shown in italics and our responses are given in normal fonts.

This study utilized model simulations and data analysis to investigate the spatiotemporal variations of summer ozone concentrations in China and their influencing factors. The results revealed higher ozone concentrations in the Sichuan Basin and the central region of North China compared to other areas, and a strengthening correlation between summer ozone concentrations and the Western Pacific Subtropical High (WPSH) over the past two decades. Precursor emissions were identified as the dominant factor driving the long-term trends and magnitudes of summer ozone concentrations, while meteorological conditions associated with the WPSH played a key role in the interannual variability of ozone. The response of ozone evolution to precursor emissions and meteorological conditions varied across different urban areas, with inland city clusters exhibiting stronger responses to precursor emissions and coastal city clusters showing stronger responses to meteorological conditions. Therefore, the development of appropriate ozone reduction strategies should consider the specific characteristics and environmental conditions of each local urban area. Overall, I recommend the acceptance of the manuscript after making minor revisions.

Response: We thank the Reviewer's positive and encouraging comments which help us improve this article considerably. We have made every effort to address the Reviewer's comments and questions.

Point-by-point responses:

1. *This study mainly analyzes the simulation results, but it seems there is a lack of model evaluation. To enhance the credibility of the paper, it is recommended to provide a comparison between the simulated results and measurements to validate the simulated ozone concentrations.*

Response: Following the Reviewer#1's recommendation, we have extended model result evaluation using 2016 sampling data to 2016 to 2017. Considering large uncertainties in measure O_3 concentrations due to artificial intervention, we did not implement sampled O_3 concentration measurements before 2016 in our model verification (Lines 130-133 in main text and SI Text 1 and Fig. S1). The results show better agreement between modeled and sampled O_3 concentrations of 2016 through 2017. Details were referred in the end of section 2.1 and revised SI Text 1 and Fig. S1.

2. *The first paragraph of the introduction describes various hazards of ozone, which, although accurate, are not closely related to the main topic of this paper. To quickly focus on the topic, it is advised to trim down these descriptions in the introduction and emphasize the background and objectives of the research.*

Response: Following the Reviewer's suggestion, we have revised Introduction section in which we cut down discussions on health risks of O_3 pollution, thereby enhancing the direct focus on objectives of this study.

3. *Two indices of the Western Pacific Subtropical High (WPSH) were employed in this study, but the description of the impact of the second index on ozone seems more like an inference and requires a more rigorous analysis.*

Response: Since summer rainfall in China was reported to be more sensitive to the western ridge point of the WPSH (Jiang et al., 2021; Yang et al., 2022; Zhao and Wang, 2017), which might affect the O_3 wet deposition, we also considered the westernmost point of the WPSH (hereafter referred to as WPSH-I2) in the present study. We found the strongest negative correlations between O_3 concentrations and the WPSH-I2, which is likely associated with O_3 washout by precipitation.

This point has been added to revised manuscript.

4. *The paper argues that the influence of WPSH on regional ozone depends on the spatial proximity to WPSH. Firstly, please clarify the geographic scope of WPSH. Secondly, this conclusion seems to be invalid in some regions, such as Xinjiang, where the correlation between ozone and WPSH is stronger than in Mongolia. To enhance the accuracy and applicability of the paper, please provide more detailed analysis and data support regarding the relationship between ozone and WPSH in different regions, and discuss possible reasons for these differences.*

Response: To address the Reviewer#1's comment, in the beginning of revised section 2.2, we added following statements "The WPSH is an anticyclonic system hovering over the middle and lower troposphere of the northwestern Pacific Ocean. The WPSH forms during the summer months and dissipates in winter. As a high-pressure system, the WPSH is associated with stable weather conditions featured by high temperature and low rainfall. These weather conditions, in turn, perturb significantly O_3 variation. While varying year from year, the WPSH in summer generally covers much of East Asia, including parts of China, Japan, and the Korean Peninsula. It can also extend westward, affecting Southeast Asia, including Vietnam, Thailand, and the Philippines (Jiang et al., 2021; Yang et al., 2022). Although the summer WPSH determines primarily the weather and climate conditions in Eastern and Southern China, it may also influence the weather systems in Western and Northern China. For example, the westward and northward movement of the WPSH might lead to a weak high-pressure system in Northern Xinjiang extending to Central-North China, resulting in higher temperatures and lower rainfall in this region, whereas a low-pressure system could prevail in Northern and Northeastern China, enhancing precipitation in this part of

China. However, given lower O_3 levels in Westernmost China (Tibet and Xinjiang), the present study did not attempt to elucidate the associations between O_3 evolution and the WPSH in this part of China but focused on Central and Eastern China where significantly higher O_3 levels were observed."