Response to Reviewer 2

General Comments:

The unprecedented heatwave of August 2022 brought about national wide O_3 pollution in China. This study targeted the heatwave month of August, 2022 in the air pollution basin SCB in Southwest China presenting the detailed investigation on the spatial disparity of O_3 pollution between two major urban areas Chongqing and Chengdu with pollution levels of O_3 in the western SCB (Chengdu) but relatively lower concentrations in the eastern basin (Chongqing). Meteorological and precursor factors were assessed with observation, modeling study and machine learning methods, spotlighting high temperatures, intensive solar radiation, and overnight accumulative pollutants as key contributors to O_3 concentration, revealing the important role of meteorology-induced natural emissions and meteorological changes. It is suggested to be accepted this paper for ACP publication in the ACP after the major revisions:

General response to the reviewer 1: We are grateful to the reviewer for reviewing and helping to improve our manuscript. The suggestions provided contribute to making our article more logically rigorous and enhancing its overall quality. We have followed the instructions and improved our manuscript accordingly. Hopefully, this enhanced manuscript could meet with approval. Below is our point-to-point response.

Major comments:

As mentioned in the discussions, if the cross-regional transport predominantly influenced Chongqing (contributing ~80%), the local photochemical O_3 production contributed merely about 20 % to O3 variations during August 2022 in Chongqing, where the prevailing southerly drived the transport of poor-O3 air masses from the Yungui Plateau, because Chongqing is immediately adjacent to the Yungui Plateau in the south. Please give the detailed discussions and highlighted the results on the regional transport importance in the spatial disparity of O3 pollution between Chongqing and Chengdu in the following respects of changing emission and meteorology:

a) the lower O_3 in Chongqing was dominated by the transport of poor-O_3 air masses from the Yungui Plateau with the less contribution of photochemical O3 production from local and regional transported precursors.

b) the cross-regional transport of O_3-precursors from the Yungui Plateau with low anthropogenic emissions and high natural emissions. It is possible to identify the local and non-local O3-precursors with their relative contribution

in Chongqing.

c) the spatial disparity of O_3 pollution between Chongqing and Chengdu was decided by the changes in regional transport of O_3 and its precursors respectively with high and low contribution of non-local O_3-precursors to the two urban areas.

d) Please compare the 33-yr (1990-2022) averages of air temperature, relative humidity, wind speed and direction over August between Chengdu and Chengdu with the anomalies in August,2022. Please clarify that the anomalies of high air temperature and low relative humidity are connected with the strong-southerly-driven cross-regional transport of cool and dry air masses from the Yungui Plateau, which could suppress the photochemical O_3 production in Chongqing.

Reply: We feel grateful to the reviewer for providing these valuable suggestions. We have improved the manuscript based on these suggestions.

Firstly, to illustrate the different impact of regional transport on both cities. We have provided evidence from the following four aspects.

(1) By analyzing the surface diurnal meteorological parameters including winds, BLH and VC. Generally, we found lighter winds, lower BLH and smaller VC in Chengdu compared to Chongqing.

(2) By analyzing ratio of m, p-xylene and ethylbenzene. Given that m, p-xylene is more reactive than ethylbenzene, their ratios typically decrease due to photochemical reactions that take place during the transport of air masses. As shown in Fig S6, the ratio was much lower in Chongqing (1.04 ppbv ppbv-1), indicating the presence of "aged" air masses being monitored. Conversely, a higher ratio (3.11 ppbv ppbv-1) in Chengdu indicated the prevalence of "fresh" air masses likely originating from local emissions. The discovery reaffirmed that Chongqing exhibited superior ventilation conditions compared to Chengdu.

(3) By conducting LPDM simulation. We found significant differences in the dominant air masses influencing Chengdu and Chongqing. Chengdu's air masses were predominantly influenced locally, while Chongqing's were predominantly influenced by cross-regional transport (from the Yungui Plateau).

(4) By identifying the contribution of local and non-local precursors to O_3 concentrations in both cities (CMAQ-ISAM simulation).

Secondly, in order to highlight the importance of the cross-region transport of air

masses from the Yungui Plateau, we improved the discussions and modified Fig 8.

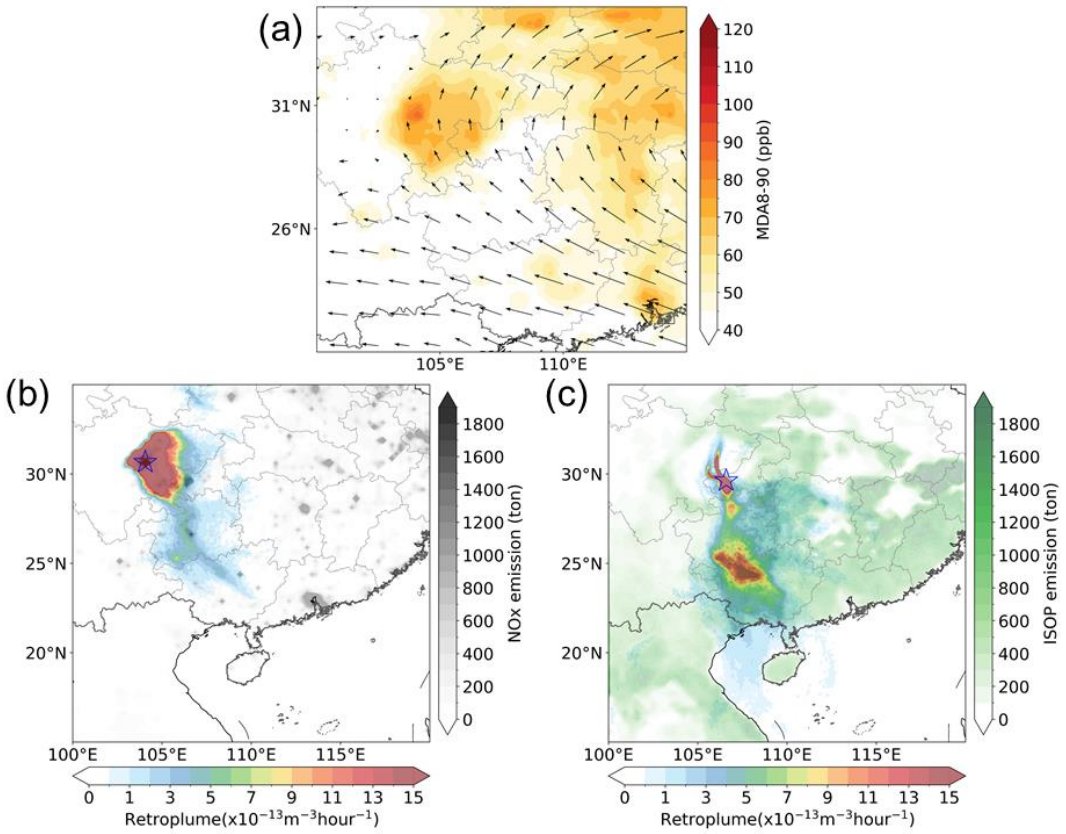

Fig 8 (a) Distribution of monthly averaged 90th percentile of MDA8 O_3 (MDA8-90) concentrations and monthly averaged winds at 500hPa; (b) 72h retroplume (footprint residence time) showing transport pathways of air masses arriving at Chengdu, and distribution of anthropogenic NO_x emissions; (c) 72h retroplume (footprint residence time) showing transport pathways of air masses arriving at Chongqing, and distribution of biogenic isoprene (ISOP) emissions in August 2022

The distribution of O_3 concentration in China's southwestern region, as shown in Fig 8a, revealed that high O_3 concentrations were mainly concentrated in the SCB region. In contrast, the O_3 concentration in the adjacent Yunnan-Guizhou Plateau (southeast) was very low, indicating a poor-O_3 region. According to the synoptic flows, it could be seen the prevailing wind was southeastward, and the wind speed gradually decreased from east to west, implying that Chengdu was more stationary than Chongqing. Our LPDM-simulated 72h backward retroplumes (Fig 8b) showed

that, Chengdu was primarily influenced by local air masses encompassing areas such as Chengdu city and the eastern parts of the SCB. Relatively fewer air masses originated from cross-province transport in the southeast direction. The distribution of NOx emissions showed that Chengdu was significantly influenced by the locally anthropogenic emissions. Differently, Chongqing showed a situation to be more susceptible to cross-regional transport influences (Fig 8c). The dominant air masses in Chongqing not only originated locally but also experienced cross-province transport from the southeast, influenced by the regions such as Yungui Plateau, a poor-O_3 region with relatively low anthropogenic emissions but high BVOC emissions. Considering the strong reactivity and limited lifetime of BVOCs, their role on downwind air quality was limited. To support this, we adopted CMAQ-ISAM to identify the local and non-local O_3-precursors with their relative contribution to O_3 concentrations in both cities. As shown in Fig 9b and Fig 9d, Chengdu was mainly affected by local regions, contributed to 46.8%. This implied that local emissions within the SCB were a significant contributor to the excessive O_3 levels in Chengdu. In contrast, the influence of the local region on O_3 levels in Chongqing was ~20%. Instead, the contribution outside the basin almost reached 50%, indicating that Chongqing was more susceptible to the influence of cross-regional transport.

Furthermore, we also added Fig S6 in the supplementary file. By examining the difference between 2022 Aug and the climate average (1990-2021), it was found that the anomalies of high air temperature and low relative humidity were connected with the strong-southerly-driven cross-regional transport of cool and relatively clean air masses from the Yungui Plateau, which could suppress the photochemical O_3 production in Chongqing. In contrast, Chengdu was in a typical stationary condition with light wind, high temperature and low relative humidity, which were conducive to a local photochemical pollution. In general, the spatial disparity of O_3 pollution between Chongqing and Chengdu was decided by the changes in regional transport of O_3 and its precursors respectively with high and low contribution of non-local O_3-precursors to the two urban areas.

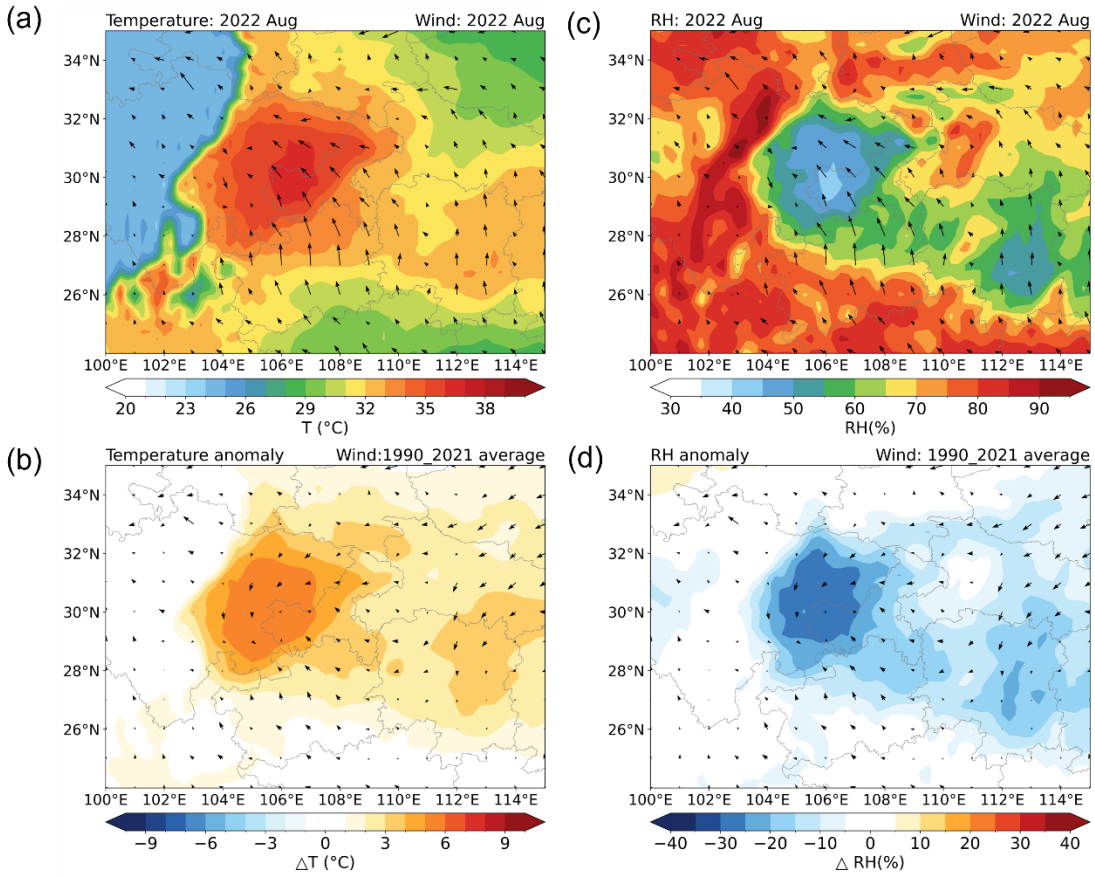

Fig S6 (a) Distribution of temperature and winds at 1000 hPa during 2022 Aug; (b) Distribution of temperature anomaly (2022 – climate average) and the averaged wind between 1990 and 2021. (c) same as (a) but for relative humidity (RH). (d) same as (b) but for RH.

Specific comments:

1) Observational data showed that Chengdu experienced a consecutive 17-day period of O3 exceedance, Did the extreme heatwave last the consecutive 17-day period in Chengdu? How long was the extreme heatwave in Chongqing? As the study targeted the month of August, 2022 (not a heatwave), please modify the title of manuscript for the study.

Reply: Thanks for the questions. By using the standard that the daily maximum temperature is above 32°C (WMO standard). There are 29 heat days in Chongqing and 24 heat days in Chengdu (Fig R1). As kindly suggested, we changed the title to "Spatial disparities of ozone pollution in the Sichuan Basin spurred by extreme hot weather".

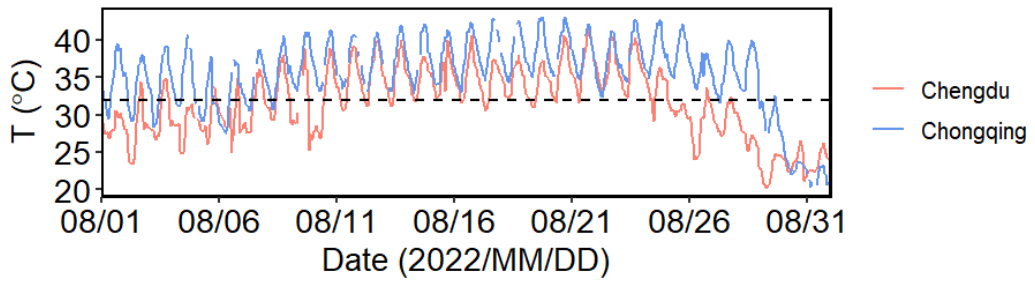

Fig R1 Time series of temperature in Chengdu and Chongqing during Aug 2022

2) The first paragraph in sect. 1 Introduction is too long with the disorder presentation. Please restructure this paragraph in 2-3 paragraph.

Reply: Thanks for the suggestion. We now divided this paragraph into 2 paragraph . We believe this revised arrangement is much better.

In the revised introduction, paragraph one mainly introduces the complexity and difficulty in controlling O_3. Paragraph two mainly introduces the non-linear relationship between O_3 and its precursors. Paragraph three mainly talks about the role of meteorology in O_3 formation. Paragraph 4 introduces the region of SCB. Paragraph 5 introduces the study target of this research.

3) Please mark the location of Tibetan Plateau and Yungui Plateau and indicate the meaning of color contours in Fig. 1a. Please change Fig. 1b with the 33-yr averages of air temperature over August between Chengdu and Chengdu with the anomalies in August over 1990-2022 based on the site observations.

Reply: OK. We have modified Fig1 based on the comment. Please see our revised Fig 1.

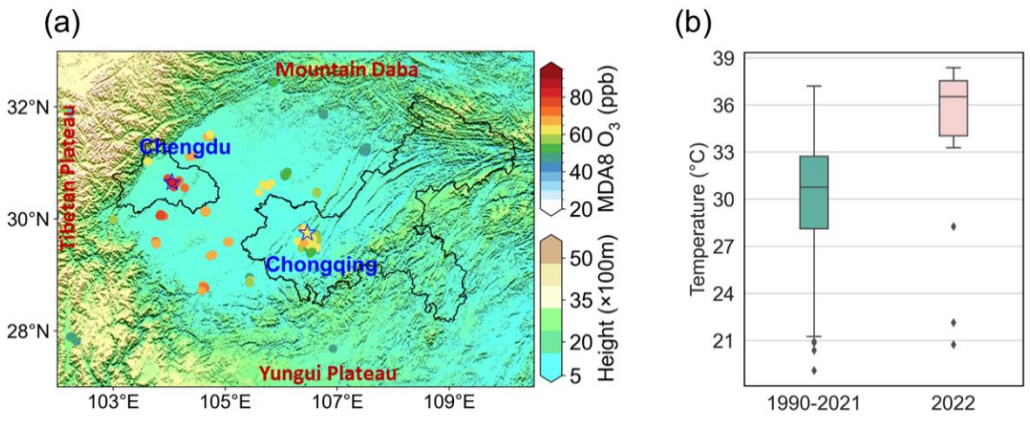

Fig 1 (a) Geographical distribution of Sichuan Basin with scattered averaged monthly MDA8

O_3 concentrations (data obtained from Ministry of Ecology and Environment of China). The contoured shows the 3D terrain height in SCB. The black lines highlight the administrative border of Chengdu and Chongqing, respectively. The blue stars indicate the supersite in Chengdu and Chongqing, respectively. (b) Historical monthly averaged daily-maximum air temperature (August) comparison between 2022 and 1990-2021 of the SCB.

4) Please carefully check the caption of Fig. 2 against the Figure, give a correct caption (vc, wind, averages over August 2022).

Reply: Thanks. We have revised the captions as suggested.

5) Fig. 1g presented the significant differences in RH. Please add the discussions on role of RH in the spatial disparity of O3 pollution between Chongqing and Chengdu.

Reply: Usually, a condition with lower RH would be more conducive to photochemical reaction. As RH reflects the amount of water vapor in the atmosphere, which is a removal source of O_3 concentrations (e.g., through HO_x reactions). We found that Chongqing had higher temperature, stronger solar radiation and lower relative humidity than Chengdu, but had lower O_3 concentrations. This is the phenomenon that has left us puzzled.

We revised the discussions based on the following, "*Additionally, significantly lower relative humidity was observed in Chongqing, suggesting a potential reduction in O_3 removal by water vapor, for instance, through HO_x reactions.*"

6) Please remove the discussions (lines 302-313) on the synoptic system. 200hPa and 500hPa are too high to discuss the stationary and unstable atmosphere for air quality change over the SCB.

Reply: Thanks. We have removed this part.

7) Please thoroughly check the English presentations in the text and all the Figs. with the clear and captions.

Reply: Okay. We have carefully revised the manuscript as suggested. Revisions are highlighted in red color.