Responses to editor's comments

We thank the editor for the detailed, helpful, and overall supportive comments. We have revised the manuscript to account for each comment. Responses to the individual comments are provided below. Reviewer comments are in **bold**. Author responses are in plain text. Modifications to the manuscript are in *italics*. Line numbers in the response correspond to those in the revised manuscript text file.

1. There is no clear evidence to show that the reduction of NO_x was purely from the lockdown or the shift of meteorological conditions. The external information should be given to aid the reduction of human activity during the lockdown period.

Thank you for your comment. We believe that the reduction in NO_x during the lockdown was primarily due to decreased human activity rather than meteorological changes. According to the 2021 statistics from the Yangzhou Municipal Government, industrial energy consumption and transportation activity decreased by 25% and 46%, respectively, during the lockdown period compared to the same timeframe in 2020 (www.yangzhou.gov.cn). This significant reduction in key NO_x emission sources strongly suggests that fewer industrial and transportation activities were the main contributors to the observed drop in NO_x levels. Additionally, we have verified with the government website (www.yangzhou.gov.cn) that the lockdown in Yangzhou commenced on July 29th, 2021.

Moreover, despite meteorological conditions that typically lead to higher pollutant concentrations, such as wind speeds during the lockdown being 24% and 30% lower than in the before-lockdown (BLD) and after-lockdown (ALD) periods, and total precipitation before the lockdown being 2.6 times greater with 1.7 times more precipitation hours than lockdown, NO_x levels still dropped by 39% during the lockdown. This substantial reduction in NO_x, despite meteorological conditions that would normally favor its accumulation, underscores that the strict lockdown measures, which sharply curtailed human activities, were the primary factors driving the decrease in NO_x concentrations.

We have updated the text, and the revised version is as follows:

Line 121~128: "*In response, stringent public health measures were imposed from July 29th to September 10th, including the closure of public transport, and suspension of non-essential industrial plants, restaurants, shopping malls, and entertainment clubs. People were also mandated to quarantine at home. Consequently, Yangzhou experienced a significant decline in transportation and industrial energy consumption, dropping by nearly 46% and 25%, respectively, compared to the same period in 2020 (www.yangzhou.gov.cn), implying a substantial reduction in human activity and primary emissions.*"

Line 147~150: "*In this study, the measurement period was divided into three phases: the before-lockdown period (BLD: 30 June to 28 July 2021), the lockdown period (LD: 29 July to 9 September 2021), and the after-lockdown period (ALD: 10 September to 7 October 2021) (**Figure 2**)*"

2. For the question about whether the precipitation may have influenced the data, you should use the measured precipitation around your measurement site, rather than using the reanalysis results.

Thank you for your comment. Following your suggestion, we replaced the reanalysis precipitation data with data obtained from a local weather station near the sampling site. This update ensures that the precipitation data used for analysis accurately reflects the actual conditions experienced at the site.

Additionally, to mitigate the potential impact of heavy precipitation on the data, we excluded measurements taken during a significant rainfall event prior to the lockdown period from the analysis. This adjustment helps prevent distortion of the results due to extreme weather conditions and ensures that our analysis is based on relative consistent meteorological data. We hope these changes provide clarity regarding the influence of precipitation on the data and meet your expectations.

We have updated the text, and the revised version is as follows:

Line 173~174: "*Precipitation (PCP) data was obtained from the Yangzhou Meteorological Bureau.*"

Line 232~235: "*Notably, significantly reductions in* $PM_{2.5}$*,* NO_x*, and* SO_2 *were observed at the end of BLD due to a high precipitation event, with a peak hourly precipitation reaching 37 mm, and the data collected during this event were excluded from the analysis*."

3. Following the question above, the analysis should clearly mark the above period with significant precipitations. This may affect the conclusion, as the reduction of primary pollutants may also result from the precipitation wet removal rather than the lockdown. The results may need to be reanalyzed and the discussion should be revisited.

Thanks for the comment. we have clearly marked the periods of significant precipitation in our data (from July 25^{th} to July 28^{th}) to distinguish the event from the overall temporal trends. Furthermore, we have reanalyzed the results excluding the marked period of heavy precipitation and update the relative figures. The discussion section of our paper was also be revisited to incorporate these changing, ensuring that our conclusions are robust.

We have updated the text, and the revised version is as follows:

Line 349~351: "*During the transition from BLD to LD, heavy and continuous precipitation occurred from July* 25^{th} *to July* 28^{th} *(the eve of lockdown), resulting in the removal of a majority of the pollutants (*$PM_{2.5}$*: 4 μg* m^{-3}*,* O_3*: 35 μg* m^{-3}*,* NO_x*: 8 μg* m^{-3}*).*"

Line 365~367: "*Despite the abrupt reductions of NOx (-39%) due to the city lockdown, it is important to note that the concentration of PM2.5 only slightly decreased during LD (-1%), highlighting the non-linear relationship between primary emissions and PM2.5 levels*."

Line 369~371: "*During ALD (PM2.5: 26.7 μg m-3, NOx: 27.9 μg m-3, TVOC: 76.0 μg* *m-3), the number fraction of BC-fresh particles rose from 28% (LD) to 31% (ALD), while the fraction of VE particles also increased from 3% (LD) to 12% (ALD) (Figure 7a).*"

Line 247~265: "*During LD, strict measures resulted in notably lower surface concentrations of $PM_{2.5}$ (20.3 μg m^{-3}), NO_x (16.8 μg m^{-3}) and TVOC (55.9 μg m^{-3}) compared to BLD and ALD. Conversely, the surface O_3 concentration showed an increase of 18.4 μg m^{-3} (28%) during LD relative to BLD. The reduction of fresh NO emission alleviates O_3 titration (Steinfeld, 1998) could be an explanation. Analysis from **Figure S3** indicates that the O_3 level is higher than those of neighboring cities in the YRD, suggesting higher local atmospheric oxidation capacity during LD. However, the average concentrations of $PM_{2.5}$ (20.6 vs. 20.3 μg m^{-3}), SO_2 (9.1 vs. 9.2 μg m^{-3}) and CO (0.61 vs. 0.62 mg m^{-3}) were comparable during both BLD and LD (**Figure 3**). After LD, social activities gradually resumed in Yangzhou City, leading to an apparent increase in all observed pollutants during the ALD period. For instance, there were relative increases of 66% for NO_x, 19% for SO_2, 36% for TVOC, 14% for O_3, 32% for $PM_{2.5,}$ and 16% for CO from LD to ALD, respectively (**Figure 3**). Given that both BC and CO are byproducts of incomplete combustion of carbon-containing fuels (Wang et al., 2015), and the high correlation between BC and CO (Zhou et al., 2009), it is plausible to infer that the primary emission source of BC during LD differed from those during ALD. This change likely reflects the shift in combustion practices and fuel usage patterns as economic activities restarted during ALD.*"

Line 349~351: "*During the transition from BLD to LD, heavy and continuous precipitation occurred from July 25^{th} to July 28^{th} (the eve of lockdown), resulting in the removal of a majority of the pollutants ($PM_{2.5}$: 4 μg m^{-3}, O_3: 35 μg m^{-3}, NO_x: 8 μg m^{-3}).*"

Line 518~521: "*However, the decline in NOx (-39%) and TVOC (-14%) levels might on the other hand result in increased O3 (28%), leading to a rise in BC-aged particles and a slight elevation in PM2.5 levels during the lockdown.*"

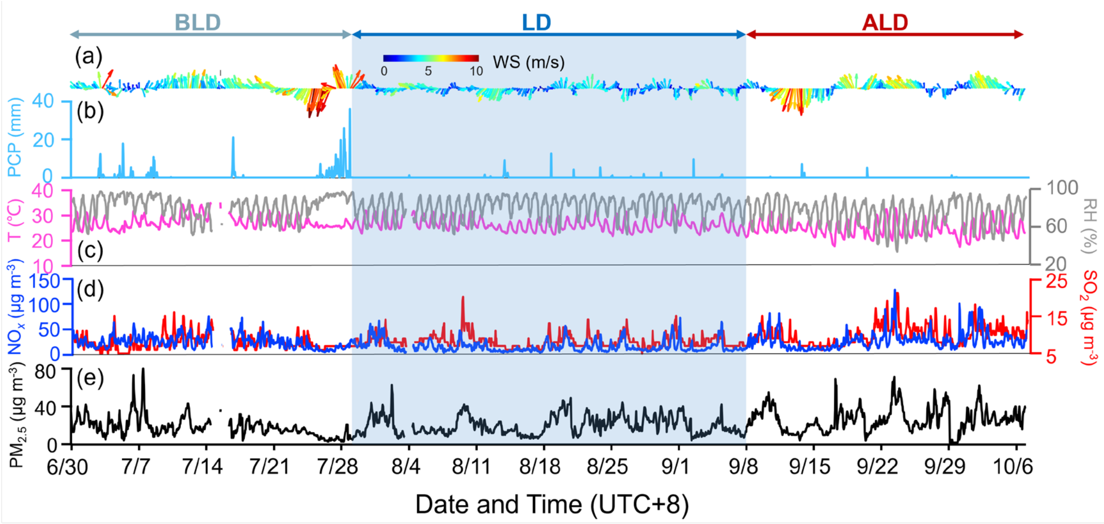

Figure 2. Temporal variations of **(a)** wind direction (WD) and wind speed (WS), **(b)** precipitation (PCP), **(c)** temperature (T) and relative humidity (RH), **(d)** concentrations of NO_x and SO_2, and **(e)** mass loading of $PM_{2.5}$. The grey, blue, and red arrow ranges denote the periods before lockdown (BLD), during lockdown (LD), and after lockdown (ALD).

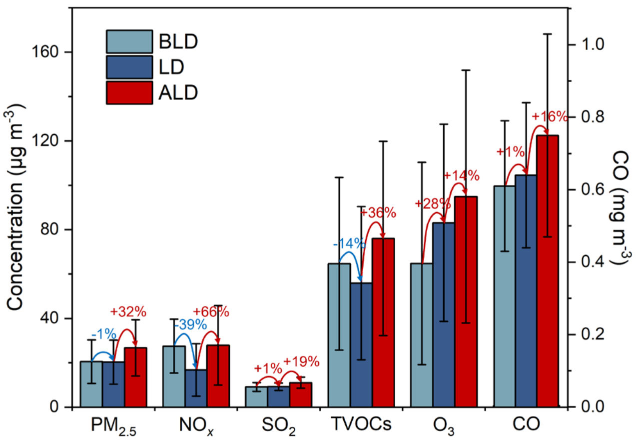

Figure 3. Ground-based observations of $PM_{2.5}$, NO_x, SO_2, O_3, CO, and TVOC concentrations in Yangzhou. The figure compares the averages during the BLD (grey), LD (blue), and ALD (red) periods. Error bars indicate SDs over different lockdown periods.

References:

Steinfeld, J.I., 1998. Atmospheric Chemistry and Physics: From Air Pollution to

Climate Change. Environment: Science and Policy for Sustainable Development 40, 26–26. https://doi.org/10.1080/00139157.1999.10544295

Wang, Q., Liu, S., Zhou, Y., Cao, J., Han, Y., Ni, H., Zhang, N., Huang, R., 2015. Characteristics of Black Carbon Aerosol during the Chinese Lunar Year and Weekdays in Xi'an, China. Atmosphere 6, 195–208. https://doi.org/10.3390/atmos6020195

Zhou, X., Gao, J., Wang, T., Wu, W., Wang, W., 2009. Measurement of black carbon aerosols near two Chinese megacities and the implications for improving emission inventories. Atmospheric Environment 43, 3918–3924. https://doi.org/10.1016/j.atmosenv.2009.04.062