Review comments (egusphere-2024-1488)
Title: Measurement Report: Long-term Assessment of Primary and Secondary Organic Aerosols in Shanghai Megacity throughout China's Clean Air Actions since 2010

General comments:

The study investigates the impact of China's Air Pollution Prevention and Control Action Plan on carbonaceous aerosols in PM2.5, particularly focusing on secondary organic carbon (SOC) in Shanghai from 2010 to 2017. The research found that organic carbon (OC) and elemental carbon (EC) concentrations peaked in 2013 but decreased consistently afterward, aligning with reductions in PM2.5 levels, indicating the effectiveness of emission control measures. However, secondary OC (SOC) concentrations remained stable during this period, with a noticeable decline only after 2018, likely due to VOC emission controls. Seasonal variations showed higher OC and EC concentrations in winter, while SOC concentrations were consistent year-round. The study also observed that SOC levels were influenced by wind direction and speed, with higher concentrations linked to winds from the southwest and northwest, suggesting distant regional sources near the middle and lower Yangtze River. The findings highlight the need for targeted measures to reduce SOC and address regional pollution sources.
Finally, although the study provides a long-term assessment of Primary and Secondary Organic Aerosols in the Shanghai Megacity, the manuscript does not clearly emphasize the research's originality. I encourage the authors to highlight the unique aspects of this work to better showcase its significance.

Overall, the manuscript is well-written and contributes to the understanding of aerosol environment in a Megacity and the role of pollution control initiatives. However, there are areas that could benefit from further refinement. Here are some comments/suggestions that may help the authors improve the manuscript and strengthen the interpretation of the study's findings.

Major comments:

Comment 1, Page 3, Line 85-89: "*The sampling site for this study is located atop an office building, 18 m above ground level, … the accuracy of airborne particulate matter measurements.*"
Is the measurement taken at the terrace (open-top) of the building? Additionally, does the last statement imply that there is no interference from nearby tall buildings within a certain radius around the measurement inlet? If so, approximately what is that radius?

Comment 2, Page 4: How far is the Pudong Environmental Monitoring Center from the office building mentioned in comment 1? Please clearly specify the co-located instruments, and if they are not co-located, indicate the distance between each of them. Also, mention the direction in which the meteorological instruments are located 1 km away, as this information is helpful for interpreting some of the results. At this point, a site map of these instrument locations would be helpful.

Comment 3, Page 6, Line: 162-164: "*Primary carbonaceous aerosol concentrations (POC and EC) were highest in 2013 (6.8 ± 5.3 μg/m^{-3} and 2.7 ± 2.1 μg m^{-3}, respectively) and lowest in 2020 (3.6 ± 2.3 μg m^{-3} and 1.0 ±0.6 μg m^{-3}, respectively)*."
Please check the units. What was the reason behind the highest concentration observed in 2013, followed by a decline in 2018, and the lowest levels recorded in 2020? How did the COVID-19 pandemic impact this trend? Please refer to the other studies regarding similar analysis performed during 2020.

Comment 4, Page 6, Line: 168-169: "*Figure 1a shows a significant reduction in PM2.5 levels in Shanghai, with a 50.7% decrease from 2013 to 2020.*"
This period includes the impact of pandemic lockdowns on overall emissions. Several studies suggest significant changes in emissions due to lockdown protocols, making it difficult to identify consistent trends in PM2.5 levels when considering data up to 2020. It would be more appropriate to focus on trends before the pandemic began. As mentioned, there was a 15-25% reduction in concentrations between 2013 and 2017 (Gao et al., 2018; Dai et al., 2021; Yan et al., 2020). Please clarify these points.

Comment 5, Page 7, Line 191-195: "*As air quality declines, the proportion of primary carbonaceous aerosols … concentrations (Ji et al., 2014; Qiao et al., 2019)*."
Please elaborate on the uniqueness of this study compared to the previously reported results.

Comment 6, Page 7, Line 201-202: "*increased fuel consumption for domestic heating and unfavourable meteorological… mixing layer height, temperature inversions, and calm winds*"
Does this mean that the primary source of OC and EC at the measurement location and surrounding areas is fuel consumption for domestic heating? Could you please elaborate? Additionally, as mentioned, the lowering of the boundary layer height may significantly contribute to trapping pollutants closer to the earth's surface. How do biomass burning impacts factor into this, considering the central-east corridor is a major source region, and biomass burning contributes about significantly to PM2.5 concentrations in the Yangtze River Delta during the harvest season?

Comment 7, Page 8, Line 212-2013: "*The elevated winter concentrations of carbonaceous aerosols in other years are likely due to atmospheric stagnation and increased regional transport during this period.*"
This statement appears to be contradicting. What does it mean by increased regional transport? This is contradicting to Line 215: "*This trend suggests that POC emissions in Shanghai are predominantly from local sources.*"
Please rewrite this section.

Comment 8, Page 8, Line 219-220: "*Unlike POC, SOC concentrations are influenced by both primary emissions aging and secondary formation from precursor gases*"
What are the precursors for the SOA and what are the sources influencing the SOC formation in the region of interest?

Comment 9, Page 8, Line 227-228: "*Conversely, POC reaches its zenith concentration during the morning commute hours, indicating a significant contribution from local primary vehicular emissions.*"
This statement shows that the contributors are vehicular emissions which is contradicting to the household heating reasoning as mentioned in the Comment above? Please clarify.

Comment 10, Page 9, Line 253-254: "*Throughout the study period, Figure 5a shows that SO2 levels consistently declined, indicating effective control measures.*"
What are the specific sources of SO_2 that fall under effective control measures and could have led to the decline? Is this more related to long-range transported emissions or local emissions?

Comment 11, Page 10, Line 272-274: "*Furthermore, high SOC … Shanghai during this season*."
It is interesting that only Fall appears to have different SOC formation processes. Is this related to long-range transport? What could be the other potential sources of precursors during this season? According to the PSCF analysis, the regions contributing to air masses in Shanghai during Fall are northern and southern Zhejiang and Anhui. How much would this influence the air mass reaching the measurement site?
Please use one: Autumn or Fall.

Comment 12, Page 10, Line 276-285:
Regarding the correlation between wind and aerosol concentrations, was the meteorological center located 1 km away used for this analysis? How would the 1 km distance of the meteorological center impact this result? In this context, urban boundary layer dynamics could play an important role in influencing air mass trajectories. Please discuss this further in this section.

Comment 13, Page 11: Line 307:311: "*Notably, stricter regulations on VOCs post-2017 led to a discernible decrease in SOC levels, indicating the effectiveness of emission control measures.*"
This statement does not appear to be a primary conclusion of this study, as the post-2017 period is not the focus. Most of the figures and results pertain to the 2010-2016 period. If not, please clarify.

Comment 14: The novelty of the current work is lacking and needs some improvement. I recommend revisiting the study's approach to ensure it offers a more unique contribution to the field.

Minor comments:

Comment 1, Page 6, Line 158-159: "*The average concentration of PM2.5 peaked in 2013 at 59.5 ± 37.8 µg m^{-3} and reached its lowest in 2020 at 30.2 ± 14.0 µg m^{-3}.* "
Are this yearly average values?

Comment 2, Page 6, Line 159-160: "*Carbonaceous aerosols (calculated as the sum of OC multiplied by a factor of 1.4 and EC) contributed*"
How was this factor derived?

Comment 3, Page 7, Line 185-189: "*Air pollution levels are classified as Excellent (0 < PM2.5 ≤ 35 µg m-3), Good (35 < PM2.5 ≤ 75 µg m-3), … Class I and Class II.*"
Where do these levels compare in terms of global PM2.5 level classifications.

Comment 4, Page 9, Line 245-247: "*This discrepancy suggests a lack of significant … possibly attributable to the absence of license plate-based driving restrictions during weekends.*"
Please add reference.

Comment 5: Please provide available references to all the equations.