

Review comments on the manuscript "Investigating impacts of local circulation on coastal ozone pollution in the New York Metropolitan area: Evidence from multi-year observations" by Luo and Lu.

General comments:

This manuscript presents an extensive observational analysis that investigates the influence of local wind circulations on ambient ozone levels in the New York Metropolitan area. The study spans three years and incorporates meteorological and chemical observations, including conventional and field campaign data. It focuses on elucidating the association between ozone exceedance events and sea breezes occurring on hot days with weak background winds. The authors identify the change in the v-component of winds as the most critical meteorological factor determining sea breeze onset type and modulating ozone exceedances during extreme hot sea breeze days. The study also incorporates satellite retrieval data to illustrate the spatial variations in O₃ formation regime in this complex landscape. The study contributes to our understanding of ozone exceedance events and the driving factors in the region. However, to meet the criteria for acceptance by JGR-Atmosphere, the authors need to further demonstrate the novelty of their study and establish the sufficiency of their findings. Additionally, a deeper analysis is required to enhance our understanding of the mechanisms through which local circulations and high temperatures contribute to ozone exceedance events. Therefore, I recommend a major revision of the manuscript to address the following comments before considering it for publication in JGR.

Major comments:

1. **Novelty and significance:** The authors should clearly highlight the novelty and significance of their study and the scientific questions they want to address. They should discuss how their findings contribute to the existing literature and what new insights they bring to the field. Additionally, the authors should clearly state why their study is important for the understanding of ozone exceedance events in the New York Metropolitan area specifically.
2. **Methodology:** The application of the K-means method is critical for this study. However, the manuscript lacks specific details on how this method was used to classify the data into different groups. It is crucial for the authors to provide a comprehensive explanation of the criteria used when classifying the winds into four clusters: Sea Breeze (SB), Oscillation (O), Southerly (S), and Westerly (W) at QUESS (refer to Figures 4 and the corresponding text at Lines 253-266). The authors should outline the specific parameters and conditions employed to define each category. Merely providing the number of data points within each category is insufficient; a detailed description of the classification methodology is necessary.
3. **The structure and organization of the manuscript** require some improvements to better represent the new findings and key points. Currently, both key sections (i.e., Sections 2 and 3) of the manuscript focus on the impact of local circulation on ambient levels of O₃ on hot days. However, the latter section appears to be more concerned with the differences in O₃ and corresponding meteorological conditions between O₃ exceedance and non-exceedance events.

To enhance clarity and coherence, I recommend the following revisions:

- a) Reorganize the two sections: Consider rearranging the sections to provide a more logical flow and emphasize the main findings. It may be helpful to create a distinct section for the case studies, perhaps titled "Case Studies" or a similar descriptive subtitle.
 - b) Refine subtitles: Ensure that the subtitles clearly differentiate the two sections and accurately reflect their content. The existing difference between the subtitles is not significant, so revising them would help improve the structure.
 - c) Contextualize the sections: Provide a clear introduction and contextualization for each section to help readers understand the purpose, scope, and significance of the analysis conducted in each part.
-
- 4. Lines 191-194: The authors state that they replaced certain features from Li et al. (2020) with two new features in order to distinguish between two specific conditions. These new features are the average early morning (4:00-6:00) wind speed (fifth feature) and the ratio of morning and afternoon mean wind speed (sixth feature), obtained by dividing the average early morning wind speed by the average afternoon (14:00-16:00) wind speed. However, it is important for the authors to provide evidence or conduct a sensitivity study to demonstrate how these changes improve the analysis.
 - 5. Figure 2, Line 220-224: How do you determine the depth of sea breeze? I did not see a large change in wind vectors above and below the depth of sea breeze as indicated by a thick black line in Figure 2.a.
 - 6. Lines 239-246: The authors define three categories of days: hot, moderate, and cold, based on air temperature measurements taken at QUEE. However, it is necessary for the authors to provide further clarification on how these values were calculated and whether a statistical significance test was performed to validate the categorization. Here hot days are clustered with the maximum temperature around 30.7 °C. I assume 30.7°C is a threshold value used to define a hot day when the maximum air temperature exceeds 30.7°C. A similar question for other two threshold values for moderate and cold days. Please clarify them.
 - 7. Figure 7 and pages 311-322: It is important to expand the weather maps in Figure 7 to include the location of the Bermuda High for each case to support the discussion presented on Lines 311-322. In addition, the quality of these weather maps require further improvement.
 - 8. Figure 10: The inland penetration distance is an important parameter indicating the strength of the sea breeze. Generally, a longer penetration distance signifies a stronger sea breeze.

However, in Fig. 10d, h, and l, the penetration distance for case (l) is much longer than that of cases (d) and (h). The O₃ level for case (l) is lower than the other two cases (d and h) over LI and South Coastal CT. This is not consistent with the authors' analyses in other places, where stronger sea breezes are associated with higher O₃ levels near coastal areas.

9. Lines 411-412: The statement "we limited our analysis to 16 Hot SB days with regional daytime temperature (T) higher than 29.0°C, defined as extreme heat/hot days" seems to be slightly contradictory to the statement provided on Line 241, where 30.7°C is used to define hot days. Could you please clarify this discrepancy?
10. Figure 11 and Lines 430-435: There are minimal differences observed in several key features, such as breeze depth, onset time (*SB_OnT*), arrival time (*SB_ArrT*), regional mean temperature (*T*), etc., between days with ozone (O₃) exceedances and non-exceedance days. However, it remains unclear why some days experience O₃ exceedances while others do not. Understanding the underlying factors contributing to this phenomenon should be a priority for the authors, as it requires further investigation on the mechanism rather than solely focusing on establishing statistical relationships.
11. To facilitate comparison and understanding, it is recommended to include one or two tables that summarize the relationship between wind clusters, temperature, ambient O₃ levels, and exceedance events (number or frequency). These tables will effectively highlight the key features depicted in Figures 4, 5, 8, 9, and 10.
12. Section 2.3: It will be helpful if the authors create a new table to summarize the criteria that are used to define sea breezes?
13. It is useful by creating another table to compare the sea breeze features, ozone levels, and exceedance probability among different wind clusters or local circulations.
14. The conclusion section requires further refinement to accurately represent the key points derived from the discussion and analysis presented in Section 3.

Minor comments:

1. Figure 3: Y-axis label, T[C] should be T[°C].
2. Lines 228-236: It would improve clarity if the authors assigned numbers to each equation or formula. Additionally, it is helpful by providing the specific threshold values that are utilized to define the sea breeze front locations.
3. What are the units presented in Panels a-b, and d-e of Figs. 13 and 15?

4. L105: Please spell out “PCA” and make sure all abbreviations are defined throughout the manuscript.
5. L493: The sentence "Sound breeze ... are ..." contains a grammatical error that needs to be corrected. Please double-check the entire manuscript to ensure that all grammar errors are avoided.