

## General Comments:

I appreciate the care the authors took in responding to my comments as well as those of the other reviewer. I'm satisfied with the changes the authors have made and my remaining comments are minor in nature. I look forward to this paper being published and added to the growing body of Houston air quality and TRACER literature.

Response: Thank you for your thoughtful review and constructive feedback throughout the process. We appreciate your time and engagement with our work. We're glad the revisions addressed your concerns, and we sincerely value your support and encouragement.

Below, we provide a point-by-point response to the reviewers' comments and concerns. Reviewer comments are shown in blue, our responses are provided in black, and the corresponding revised statements in the manuscript are highlighted in *black italics*.

## Specific Comments:

1. (Figure 3 caption) Is the spatial distribution of PM<sub>2.5</sub> averaged over the whole simulation time or is this at one particular time? Please specify in the figure caption.

Response: Thank you for pointing this out, we have modified the figure caption as shown below:

***“Figure 3. (a) Comparison of daily averaged PM<sub>2.5</sub> observed (green) at the TCEQ site, and WRF-Chem simulated (red) at the M1 site. (b) Spatial distribution of WRF-Chem simulated August 2022 mean PM<sub>2.5</sub> (filled contours).”***

2. (Page 11, lines 337-338) Based on Figure 4b, *w* is larger at M1 than S3 during both the coolest and warmest parts of the day, so I don't think this statement is true if by “lower” and “higher” they are referring to the relative difference between M1 and S3.

Response: Thanks for catching this. We agree that the original sentence was ambiguous and could be read as a cross-site comparison. We have revised it as shown below:

Line 337-338: “*w* is generally higher at M1 than at S3 for most hours of the day (Fig. 4b).”

3. (Page 11, Lines 340) Change “at similar hours” to “at this time” to make it clearer that the authors are referring to the 13-15UTC moistening pulse and increased wind speed discussed in the previous sentence.

Response: We revised the wording, replacing ‘at similar hours’ with ‘at this time (13-15 UTC)’ (Line 340) to explicitly reference the moistening pulse and wind-speed increase discussed in the previous sentence.

4. (Page 12, Lines 391-395) This language is fairly qualitative and vague without any reference to supporting figures/data. Can you specify what “different characteristics” in the NPF events “hints at possible influence of mesoscale and larger-scale controls”? A bit more specificity and information here is needed, or I suggest removing this point.

Response: Thank you for the comment. Our intent with that sentence was to provide general context on why simultaneous NPF events can exhibit different characteristics (e.g., growth rate and duration).

However, as you rightly note, we do not present figures or analyses that directly establish causality for these behaviors in this paragraph. We have discussed the possible role of SAI on the NPF events in the section 3.3 (Lines 501-510). In addition, a recent study by Kasparoglu et al. (2025) observed NPF events attributed to nucleation aloft, with daytime turbulent mixing facilitating their transport. Their analysis also examined the influence of wind direction on precursor chemistry, which in turn affects the NPF formation and growth processes. Having said this we do acknowledge that a deeper analysis of the NPF events at Houston is necessary and will be part of the studies closely in the upcoming study. We have now revised the section accordingly.

Line 391-399: *“Recent study by Kasparoglu et al. (2025) also observed NPF events attributed to nucleation aloft with daytime turbulent mixing transporting the growing mode downward, consistent with unsteady ultrafine aerosol number concentrations, gradual increases, and absence of <20 nm growth near the surface. The growing-mode hygroscopicity spanned  $\kappa = 0.05-0.34$ , varied by wind sector, implicating changes in precursor chemistry across air masses. Thus, the differing characteristics of simultaneous NPF events are plausibly driven by mesoscale to large-scale meteorological controls on these processes (such as SBCs), the prevailing condensation sink from background aerosol, and/or the availability of precursors in each air mass.”*

5. (Page 16, line 481) While it’s possible that there is more time for mixing with the antecedent airmass as the SBF approaches the S3 site, it seems possible/more likely that the greater distance the marine airmass travels over land would provide more opportunities for it to acquire more continental aerosol characteristics – meaning aerosols are added by sources over land to the marine airmass as it moves towards the S3 site. I suggest rewording this to allow for both, distinct, possibilities.

Response: Thank you for the suggestion. We agree the original wording implied only mixing. We have revised the sentence to acknowledge both processes: (i) mixing of the incoming marine SBF air with the antecedent continental boundary layer, and (ii) accretion of continental aerosols and precursors as the marine air mass advects over land.

Line 483-487: *“Even if the SBF air mass initially contains lower aerosol concentrations, a longer inland transit to S3 can (a) increase mixing with the preexisting continental boundary layer and (b) increase acquisition of continental emissions along the over-land fetch, either of which can raise concentrations by the time the SBF reaches S3.”*

6. (Figure 8, Page 19 lines 565-566) First, it’s not clear which colors in the chemical composition correspond to what species. I assume this is the same color coding as in Figure 5, but this should be stated in the Figure caption and/or the legend should be reproduced in Figure 8. Second, if this is the same color bar, I don’t see any ammonium (purple) so it is not clear how the authors can state that “the drop is more apparent in sulfate and ammonium” Please clarify. Finally, the figure caption for Figure 8 states that the 4th row has both modeled and TCEQ PM<sub>2.5</sub> time series, but each time series only has one line. Which is it?

Response: We thank the reviewer for pointing this out. The legend has now been added to Figure 8 to clarify the color scheme used for the chemical composition. The word “ammonium” has been replaced by “organics” in the revised figure for accuracy. Chloride (purple) concentrations are very low compared to organics (green), nitrate (blue), sulfate (red), and ammonium (mustard yellow) which makes their variations less apparent in the plot. Additionally, the Figure 8 caption has been updated to clearly indicate modeled PM<sub>2.5</sub> time series.

7. (Page 24, lines 733-735) I think you should also include the dependence on the antecedent airmass aerosol concentrations to this list of dependencies.

Response: We have now modified the sentence as shown below:

Line 742-744: “*The sign and magnitude of changes depend on proximity to the coast, the upwind air mass history prior to SBF arrival, and the antecedent air mass aerosol concentrations at each site.*”

8. (Page 25, lines 763-765) I’m not sure I understand/agree with the point made here. The air mass contrasts produced by SBCs owe to differential heating of land and water, but this sentence seems to suggest that differences in storms on either side of the SBF drive the air mass contrasts. Are the authors referring to convective outflows affecting the larger SBC? Otherwise, I think this is somewhat backwards. Thermodynamic and aerosol differences across the SBF should primarily affect the storms, not the other way around as is currently implied.

Response: Thank you for pointing this out. We’ve revised the text to clarify this causality.

Line 772-774: “*Thermodynamics and air mass across the maritime and continental sides of these fronts influence storm characteristics and evolution (Sharma et al., 2024).*”

### **Technical Comments:**

1. (Page 1, line 26) Should this say “but exposed only to the Gulf of Mexico”?

Response: Modified as suggested. (Line 26)

2. (Page 2, line 55) “SBC” is not needed inside the parentheses here since it was defined earlier in the sentence.

Response: “SBC” removed. (Line 55)

3. (Page 23, Line 690) “compliments” should be “complements”

Response: Modified. (Line 699)

4. (Page 24, Line 734) remove “coastal” before “proximity”

Response: Removed. (Line 743)

5. (Page 25, Line 753) Change to “(northwest to north)”

Response: Changed. (Line 762)

6. (Page 25, Line 767) Change “CCNproxy” to “CCN proxy”

Response: Changed. (Line 776)