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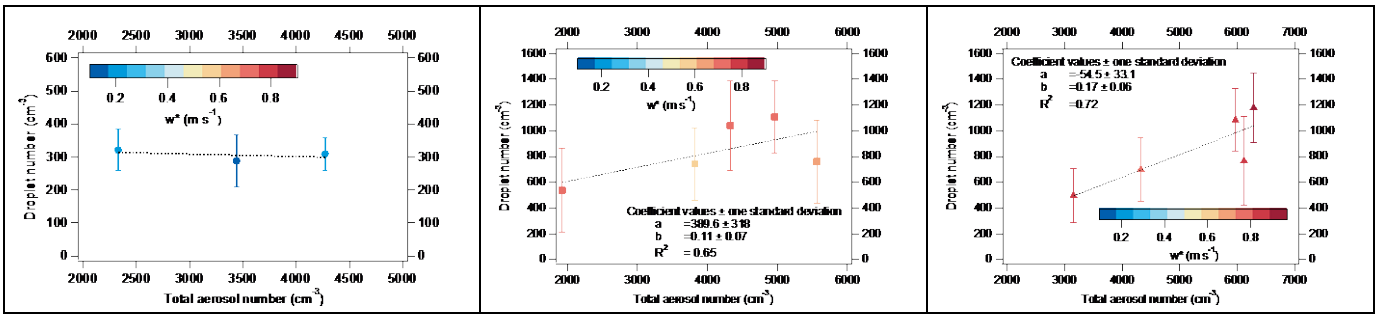
Response to Anonymous Referee #1 comments

This manuscript focuses observations of aerosol and vertical velocities over the southeast US and how it impacts predicted cloud droplet number concentration. The work uses data from the 2013 field campaign SENEX with 13 flights over the Southeast US. They find that aerosol amount and vertical velocity are responsible for up to 90% of cloud droplet number variability. They stress, early in the manuscript, that most studies do not include the impact of vertical velocity. There are some edits required, though other than that it is a fell written manuscript that will be of interest for the aerosol community.
My recommendation to accept this work with revisions and modifications to figures.
Response: *We thank the anonymous referee for the thoughtful review. Suggestions and comments for the modification of the tables and figures addressed in the revised manuscript.*

Main comments: 1) Do you have access to actual cloud data? How do the calculated N_d values compare to the calculated N_d values presented in this paper? I find it hard to believe that there were no cloud data available. Even a simple discussion about how realistic the calculated N_d values are in comparison to what was seen in in situ observations is necessary.
Response: *Unfortunately, cloud data is not available as cloud sampling was avoided (the aircraft navigating in visual flight mode most of the time). It has been shown elsewhere (e.g. Kacarab et al., 2020 and others) that our droplet number calculation methodology gives good closure with observed droplet number.*

2) For figures 5 and 6 there could be additional discussion in the manuscript. When looking at Figure 5: the first thought I had was it would be nice to see a comparison of cases when the sw* was the same and you could see how droplet number and Na were related. That seems more important than looking at a range of Na and simultaneously looking at a range of w*. Maybe a three panel figure with "Low w*," "medium w*" and "high w*" like mentioned in the text but then plot Nd and Na? Secondly, for Figure 6, Could the difference in Na with w* be due to the vertical transport? Since the w* values are higher more aerosol can be brought up from the surface.
Response: *These are great points. We have followed up on the reviewer's suggestion and splitting Figure 5 in three different graphs for low, medium and high w* values, the covariance of the total aerosol number with the vertical velocity becomes even more apparent; for low w* (during nighttime) changes in total aerosol number do not have a direct impact on calculated droplet number. On the other hand, for higher w* there is a direct correlation between total aerosol number and droplet number, which for the highest observed w* is even more accentuated, denoting*

the fact that the covariance of Na with w results in a higher variance in droplet number. Indeed, differences in Na with w* can be partially due to the entrainment of more aerosol from the surface due to higher w*, and this has been added in the revised manuscript. The respective discussion has been updated in the revised version.*



In addition, we have included a discussion on the "limiting" droplet number that develops under high aerosol number, and its dependence on σ_w (shown in Figure 6). The implications of these findings are also discussed and quite interesting.

Table Comments: 1) All the tables are ok, though it might be helpful to note daytime vs. nighttime in some way, either by shading or some type of annotation (sun and moon perhaps?)

Response: *Good suggestion! A sun and moon symbol is now added next to the number of each flight to denote whether it was a daytime or nighttime one.*

2) For Table 4: Perhaps add a mean row at the bottom for the contributions for K, Nd and sigmaw? A quick average gives k = 4.2, Nd = 75.2 and sigmaw = 13. Nd + sigmaw = 88.2. Is this where the 90% comes from that is mentioned in lines 313-314?

Response: *We added a mean row with the respective averages for dNd/Nd and the contribution of each one of kappa, chemical composition and vertical velocity to the droplet number.*

Figure Comments: 1) Figure 1: The 3D flight paths are hard to see in such a small format. Perhaps just 2D would be better, or make each panel larger. How many flights look like (a) and how many flights look like (b)? Could you include statistics about this? Otherwise it looks like your cherry picking examples.

Response: *We replaced the 3D flight paths with 2D ones, showing the values of the organics mass fraction at the different altitudes throughout the flight. All figures will be added as supplementary material and a discussion about the similarity (or not) between flights is now added in the revised manuscript. We also fixed one of the color scales that was accidentally in reverse.*

2) Figure 2: Make all the panels larger, the legends are hard to read. Why are the words and numbers together in the legends (e.g. Flight15 pass2): : : spread them out Flight 15 pass 2. Also, in the caption Line 523: you say “flights” did you mean passes? In panel (c) you have Flight 14 pass 6 and in (b) you also have Flight 14 put pass 1. Also, on panel c) consider different colors for the lines. If someone was colorblind they would not be able to tell the difference between the pink/red lines and the greenish ones.

Response: *All panels and legends are now larger and words spread within each legend. Indeed in Figure 2 we have different passes of the same flight shown in different panels; in panel (c) we have Flight 14 pass 6; in (b) Flight 14 pass 1; in panel (b) Flight 10 pass 7; in panel (c) Flight 10 pass 3; in panel (a) Flight 11 pass 6;in panel (c) Flight 11 pass 1. The transects were often made at different altitudes, thus exhibiting different characteristics each time, which were subsequently compared to other similar passes. Different colors are now used for the lines in order to make them stand out more.*

3) Figure 3: Suggestion: 4) Figure 4: same comment as in Figure 3: Add annotations to the figures to label the columns “Day” and “Night” and the rows “Alabama” and “Atlanta”

Response: *We would like to thank the reviewer for the suggestion, the specific annotation for the columns and the rows are now added to both figures (Figure 3 and 4).*

5) Figure 5: In the caption (line 547) “shading” is mentioned but is not visible in the figure. Also, the yellow marker for Flight 15 (I think) is difficult to see.

Response: *The tinted background denoting nighttime flights is now darker, thus the marker for Flight 15 is now more easily visible.*

6) Figure 6: In the caption (line 552) “shading” is mentioned but is not visible in the figure. What is the “constant altitude” that is referred to in this figure? Include the altitude somehow.

Response: *The tinted background denoting nighttime flights is now darker. As far as the constant altitude is concerned, is it clear from Table 2 that it is not the same even within each flight, let alone between flights. We do not see how it would be easy to include this information in the graph.*

Line by line comments: Line 37: Try not to use symbols in the abstract, just describe in words (it’s clearer).

Response: *We have left few symbols in the abstract, because we believe it helps with conveying our message more concisely.*

Line 45: remove “the” before “incoming”

Response: *Amended*

Line 182: Specify Figure 1b here. Figure 1a does NOT show the significant decrease in organic mass fraction.

Response: *We have changed how Figure 1 is presented along with the accompanying discussion in the text.*

Line 236: how do you define what an "important contributor" is? What percentage do you consider important?

Response: *Values for σ_w during daytime flights are in the range of 0.7-1.22 with standard deviations between 0.07 and 0.31, while during nighttime flights the range of σ_w is of 0.2-0.33 and standard deviations <0.04. Therefore during a whole day the variation in σ_w values is more than a factor of 3.*

Line 242: Specify that the "first pair of flights" is for the Alabama flights.

Response: *Amended as follows:*

"The first pair of flights were conducted over a rural area under moderate aerosol number conditions…"

Line 244: Specify that the "second pair of flights" is for the Atlanta flights.

Response: *Amended*

"…while the second pair exhibited somewhat higher aerosol numbers owing to its proximity to the Atlanta metropolitan area."

Lines 253-256: The sentence that starts with "Figure 3" would be better up after "(see Fig 3.)" on line 240. It doesn't make sense where it is now.

Response: *We would like to thank the reviewer for pointing out this inconsistency. The description of Fig. 3 is now moved to L259 where Fig. 3 was introduced.*

Line 264: "characteristic", should be "characteristic,"

Response: *Section 3.2 has been rewritten, and the sentence is question no longer appears in the revised text.*

Line 313-314: How do you get the 90% number?

Response: *When adding the contribution of N_a and σ_w to the variability of the total droplet number, for each flight this added contribution is more than 90%.*

Line 319: "S.Atlantic" should be "Southeast Atlantic"

Response: *Amended*

Line 523: you say "flights" did you mean passes? In panel (c) you have Flight 14 pass

6 and in (b) you also have Flight 14 put pass 1.
Response: *Indeed so, amended*

Line 527: add “calculated” between “showing” and “cloud”
Response: *Amended*