

REVIEWER 1

Review of North Atlantic Ocean–Atmosphere Driven Variations in Aerosol Evolution along Lagrangian Cold-Air Outbreak Trajectories by K. Sanchez et al.

This manuscript presents an interesting case study which provides new insights on aerosol-cloud interactions in cold-air outbreaks. The data presented in this manuscript and the derived conclusions may be useful both for the modelling and experimental aerosol-cloud interactions research communities. The manuscript is well organized and clearly written. I recommend publications after the following (minor) comments are addressed.

We thank the reviewer for their feedback which has improved the readability of the figures and more clearly indicated the significance of our results. Please see direct responses to comments in blue text below.

Further considerations on the data robustness and uncertainty would be necessary in the manuscript, to allow a more sound interpretation of the results. If we take Table 3, which is a keystone of the manuscript, as an example, and consider the data displayed in Figure 4, we can conclude that not all the numbers reported in the Table are characterized by the same level of robustness. Clearly AMS concentrations are derived from few and quite scattered data, which make them more uncertain than other data presented contextually. I understand the scientific value of these data and the technical efforts necessary to obtain them and believe they are worth of publication. Nevertheless, at least, in the Table it should be reported the number of observations (n_1 , n_2) used to derive the delta values so that the reader can judge about the robustness of the provided information. In alternative, the authors might evidence (e.g., with a *) which of the delta values are based on poorer statistics than the others, based on appropriate criteria.

We have added a supplemental table (Table S1) that includes the number of observations used in each comparison in Table 3.

The results reported in Table 3 are likely depending on the selection of the representative 10-minute periods of measurements used to calculate the deltas. Figure 2 suggests that a different choice, even by few minutes, may result in significantly different results. The authors should explain better how they selected the reference periods and show that their choice does not affect the results in a significant way (i.e., they should present the sensitivity of the results to the selection of the reference periods).

We agree that there were significant shifts in the measurements at times, shown in Figure 2. Upon implementing a statistical test on the Table 3 results (to indicate result significance, as the reviewer suggested in a later comment), we realized that the ship measurements represented in Figure 2 were mistakenly indicated as 10-minute averages. They were in fact 1-hour averages.

This information has been updated in the figure caption. Due to the significantly longer average and inclusion of the standard deviation in the result and the significance test (Z-score test), we believe that the choice of time does not significantly affect the results.

Specific comments

L270. I would invite the authors to indicate in brackets at what time the transition occurred, to help the reader in interpreting Figure 2.

Done.

L313-314. Please refer to my comments on Fig. 1 and Fig. 3.

Responses to comments on figures are below.

L388-390. A more robust statistic approach would make this assumption stronger. I invite the authors to apply a statistic test on the datasets to evidence which difference are statistically significant for a given confidence interval.

We thank the reviewer for this excellent suggestion. Assuming a confidence interval of >99%, 23 of the 28 comparisons in Table 3 were deemed significantly different. These comparisons that are statistically significant are now presented as bold print in the table.

L402. The authors may want to double check this sentence: "... resulted in the decreased the overall rate in aerosol particle".

The sentences has been corrected to read: "Either way, the different meteorological processes in the initially cloud-free and closed-cell region of the cold air outbreak likely resulted in the overall rate of particle removal between the two measurements relative to upwind trajectories that were clearly in the cold-air outbreak (Table 3)."

Table 1. Please correct the units of measurement in the caption (superscripts are missing). I have not clear the concept of "updraft-weighted updraft velocity", maybe some explanations are needed here..

Fixed and the following equations were added to the table footnote to explain the calculations:

$${}^1\text{Updraft weighted CDNC} = \frac{\sum_i \text{CDNC}_i W_i [w_i > 0 \text{ m s}^{-1}, \text{CDNC}_i > 2 \text{ cm}^{-3}]}{\sum_i W_i [w_i > 0 \text{ m s}^{-1}, \text{CDNC}_i > 2 \text{ cm}^{-3}]}$$

$${}^2\text{Updraft weighed } W = \frac{\sum_i W_i [w_i > 0 \text{ m s}^{-1}, \text{CDNC}_i > 2 \text{ cm}^{-3}]}{\sum_i [w_i > 0 \text{ m s}^{-1}, \text{CDNC}_i > 2 \text{ cm}^{-3}]}$$

Table 2. Please correct the units of measurement in the caption (superscripts are missing).

Fixed.

Figure 1. I believe that the manuscript would be more immediately comprehensible by a wider audience if more information were provided in Figure 1. I would invite the authors to mark the borders of the open cell, closed cell and clear sky regions object of their investigation on the satellite images of Figure 1. In alternative, they could provide the required information adding an extra Figure in the supporting information.

We have marked the borders of the relevant open-cell, closed-cell and clear sky regions in the bottom 2 panels of the figure. See below:

September 17

September 19

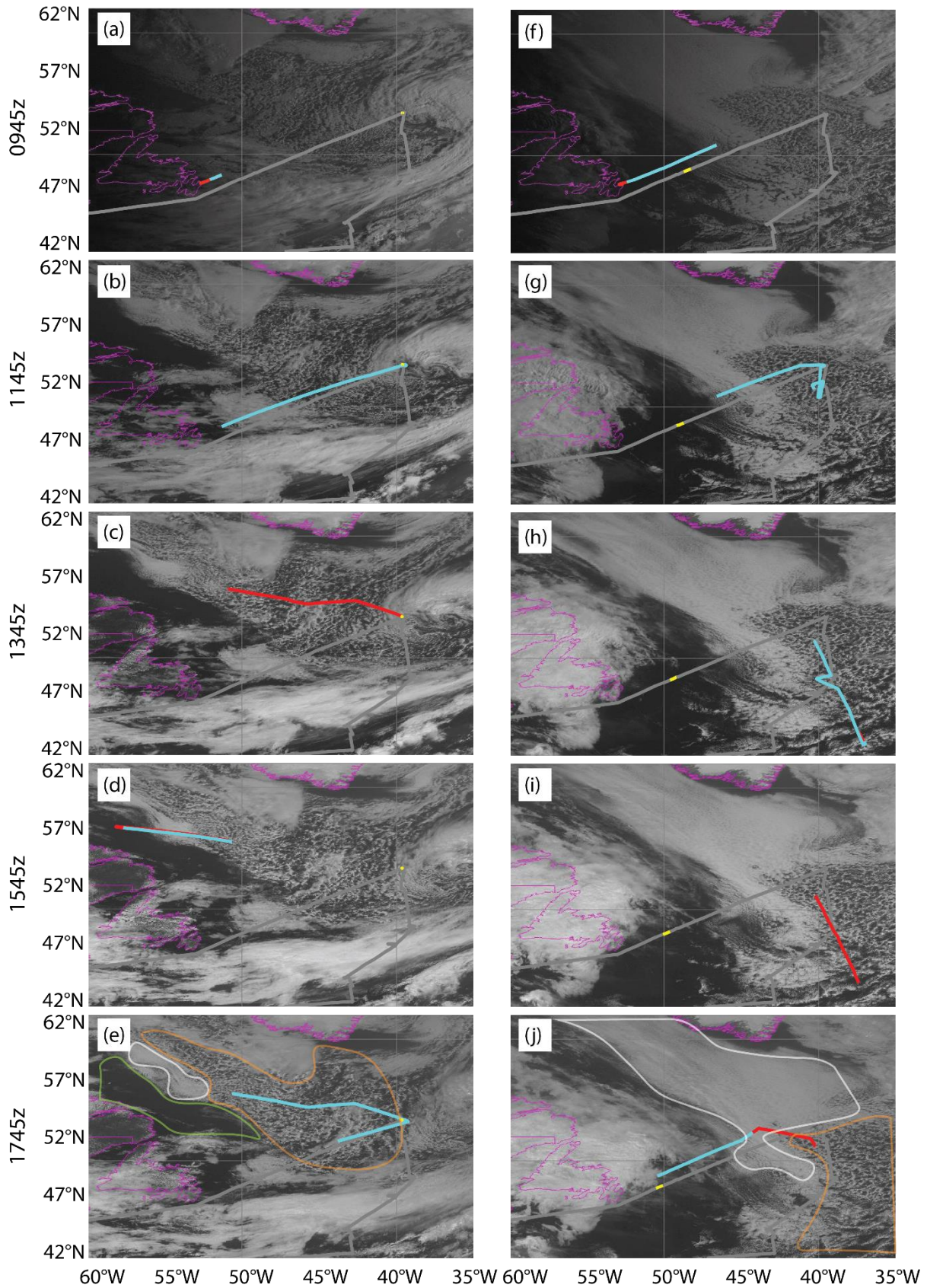


Figure 1. GOES-East visible satellite imagery at two-hour intervals for 17 September 2017 (left column) and 19 September 2017 (right column). Purple lines outline the coast of eastern Canada and the southern tip of Greenland. Cyan and red lines represent the flight track at altitudes > 3km and < 3km, respectively, ± 1 hour from the satellite image time (shown on the y-axis). The yellow line represents the ship position ± 1 hour from the satellite image time. The gray line is the entire ship track for the NAAMES3 campaign. In panels e and f, the cloud-free, closed-cell, and open-cell region are highlighted with approximate outlines in green, white, and orange, respectively.

Figure 3. The Figure could be improve by showing which data points refer to which of the considered regimes: closed cell, open cell, clear sky... This could be done by adding a horizontal bar at the bottom of the plot, marking the respective regimes.

We have added color coded horizontal bars to the bottom of the figure to differentiate closed-cell, open-cell, and cloud-free regions.

Figure 8. In panel d), it would be interesting to discriminate between statistically significant and not significant correlations (according to a chosen confidence interval). It can be done easily by using two different colours for significant and not significant R values data points.

Only correlations with $P < 0.05$ are included in this figure. We do not think it is necessary to included insignificant correlations so, to clarify, we have added the following text to the figure-caption: “Correlations with $P > 0.05$ have been excluded.”

According to the Journal guidelines, the Data availability statement should be separated from the Acknowledgement Section.

The acknowledgements section, financial support, and data availability sections are now separated.