

Interactive comment on “In-Situ Measurements of Cloud Microphysical and Aerosol Properties during the Breakup of Stratocumulus Cloud Layers in Cold Air Outbreaks over the North Atlantic” by Gary Lloyd et al.

Anonymous Referee #2

Received and published: 28 July 2018

Review of “In-situ measurements of cloud microphysical and aerosol properties during the breakup of stratocumulus cloud layers in cold air outbreaks over the North Atlantic” by Lloyd et al.

Recommendation: Major revision

paper presents observations from 4 cold air outbreaks, describing the evolution of the cloudy boundary layer prior to the breakup of the stratocumulus in cold air outbreaks. The authors show that the processes are similar to those observed in warm clouds

C1

and pockets of open cells in the subtropics, and conclude that precipitation is strongly associated with the breakup as is the weakening of the capping inversion and the decoupling of the boundary layer. As the paper presents some unique observations of a phenomenon that has not been well observed, the paper makes a contribution to the literature and should be published. However, there are a few points that the authors should consider in a revised manuscript before the paper is published, particularly as relates to the presentation of the results.

Major Comments

It would have been nice if more attention could have been devoted to a description of what causes some of the differences between the 4 cases that are discussed. For example, was there any variation in the strength of the cold air outbreak between cases and could this be responsible for any of the differences between the cases that were observed. In addition, it would be nice if there was a better way of presenting integrated analysis from all of the different cases rather than just describing the cases 1 by 1 and then having a subsequent discussion. Figure 14 does a good job at this, but it would have been nice to have had more such figures throughout the paper describing other quantities.

Second, I think the nature of the wording of the discussion should be changed. In-situ observations provide measurements of cloud properties, but they do not by themselves measure cloud processes which instead are inferred from the observations. Thus, the statements that the authors make about things being definitively caused by should be replaced by statements like the observations are consistent with . . .

Third, I think it would be good to provide particle images from more cases than just case 1. This would allow the reader to better assess the statements that are made on the importance of secondary ice crystal production processes throughout the manuscript.

Specific Comments:

C2

Page 2, line 8: Can you replace small numbers with a more specific number?

Page 2, line 22: Can you quantify what you mean by low concentrations?

Page 3, line 26: double period present.

Page 3, lines 29-34: Although this paper focuses on microphysical processes, I think it should be acknowledged that there are many other processes that affect cloud properties. In addition to aerosols, the importance of the lower boundary condition is important as the microphysics will depend on the fetch from the ocean surface.

Page 5, line 4: There could be a problem in comparing measurements from different instrument suites as prior studies have shown that not only the instruments themselves, but also the way the data are processed could affect the results.

Page 5, line 4: Was there any shattering problem with the 3-V CPI due to the use of the tube? Heymsfield and collaborators have reported that they believe the signal of the 3-V CPI was dominated by shattering on the tube on the 3V CPI. Thus, something should be done to justify the use of the 3V CPI and show whether or not shattering affected the recorded data.

Page 5, line 8: Comparing results from the 2DS on the 3V CPI with a stand-alone 2DS may be problematic because the first may be affected by a shattering problem.

Page 5, line 16: Can you be more quantitative rather than saying good agreement?

Page 5, line 26: Should the thresholds be size dependent, since the number of pixels present also affects some of these shape factors.

Page 5, line 31: Suggested equipped with or outfitted with rather than fitted.

Page 6, line 12: How does the strength of the CAOs for the cases selected vary with the strength of cold air outbreaks that are usually observed in this region?

Page 6, lines 24-25: How were the locations of the profiles selected? This is important

C3

to determine whether there is a bias because of the limited number of profiles that are available.

Page 7, line 3: One of my major comments stated that the comparison of different cases was not as well done in this manuscript as it could have been. Would it be worthwhile to compare the different cases as a function of normalized altitude, because this would allow you to see the vertical profiles from the different cases on a similar scale? That might also help with the organization of the paper as rather than merely documenting the different cases in this section, you could focus your discussion on the different processes and how they vary between the different cases.

Page 7, line 11: Rather than saying typical can you give the mean or median and some indication of the spread.

Page 7, line 22: Can you be more quantitative when you state low numbers?

Page 8, line 1: can you give the index/strength of the CAO for all the different cases, so the reader can see if there is a varying intensity and determine if this might be causing some of the variation between the cases.

Page 9, line 16: How were the "selected" profiles chosen? It would be good to comment on this so that their representativeness is known.

Page 11, line 18: Rather than saying "led to" can you say is "consistent with". See major comment above.

Page 11, line 27: It would have been nice to see more particle images for the different cases rather than just for one case. This would help better illustrate the types of ice crystals present and help determine whether the types of crystals needed for secondary ice crystal production were present.

Page 11, line 32: Do we really know for sure for these cases that the dust are becoming active at -15C? It might have been shown for some past studies but it does not necessarily apply here.

C4

Page 13, lines 6-7: I think with more particle images (rather than for just one case) you could better illustrate what the concentrations of columnar crystals are and better justify this conclusion in the manuscript.

Page 13, lines 14-16: It would be nice if more could be added to the paper to show more integrated analysis of the cases and determine the extent to which varying aerosols, meteorology or strength of cold air outbreaks causes some of the differences between cases.

Page 13, line 18: Can you do a better job of quantifying the concentrations of drizzle in the manuscript if you are making comments about the role of drizzle in the evolution of the system?

Page 19, it would be nice to have date and time labels in the legend or caption.

Page 23: Suggest that you show effective radius and drizzle concentrations in this figure also given some of the conclusions that you are making in the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-553>, 2018.