

Reviewer comments to authors of “Surface-based observation of cold-air outbreak clouds during the COMBLE field campaign.”

In this paper, the authors characterized low-level cumulus clouds during the Cold-air Outbreak (CAO) in Marine Boundary Layer Experiment (COMBLE) using ground-based observations. They investigated 13 COMBLE cases of low-level convective clouds, and found a general understanding of cloud dynamical properties (e.g., vertical air motion and eddy dissipation rate) related to thermodynamical quantities (e.g., liquid water path). Last, the authors presented the presence of secondary ice production in one available case (31 December 2019). The characteristics of these low convective clouds are important to improve model parameterizations, and response to a changing climate. This scientific information will be very useful to many scientific and stakeholder communities.

I have three serious concerns about the manuscript, in addition to specific questions and comments listed as below.

1. The thresholds in this study are somewhat arbitrary and the lack of background. The review needs to understand why the authors choose those thresholds. This is important because the results should be changed in how the authors selected the thresholds. I strongly recommend that the authors should add an exact explanation (or specific background) in choosing the below thresholds.

(1) Line 119: 13 cases – why did the authors choose those cases?

(2) Line 120: Why are the prefrontal and frontal clouds neglected?

(3) Line 135–143: LWP threshold of 0.25 - I cannot find a strong relationship between KAZR observation and $LWP > 0.25 \text{ kg m}^{-2}$. Also, the frequencies are too small when you choose $LWP < 0.25 \text{ kg m}^{-2}$ as a low LWP period in Figure 7. Please add the percentage of LWP data as the author mentioned in Line 307–308.

(4) Line 268: the horizontal resolution of 250 m and 1 km. Why did the authors choose the resolution of 250 m? Also, the reviewer does not convince the data conversion from time-height to horizontal distance-height. Since the KAZR is a vertically pointing radar, this data is unable to explain (or represent) the horizontal distribution associated with the model resolution.

(5) Line 277: three categories of updraft depths (1 km and 2 km). The results should be changed when the authors choose different categories.

(6) Line 323: cloud thickness types - cloud top heights (CTH) of 3.5 km and 4.5 km. I can not find any results and references why the authors choose the CTH of 3.5 km and 4.5 km to categorize the cloud thickness.

2. Overall, the author presented the results without detailed physical interpretation. I don't want to point them out here. Please add a more detailed physical interpretation in the result section.

3. Introduction: the reviewer suggests adding more research background in the introduction.

(1) Please review the previous studies using the COMBLE field campaign

(2) There are some recent field campaigns the authors mentioned in Line 64–71. What are the differences compared to previous field campaigns?

(3) Previous field campaign (i.e., ACTIVATE) collected the observational data for the high-resolution dynamic and microphysical observation.

Minor comments:

1. Line 139–140: Please add the figure if the authors want to explain the relationship.
2. Line 150: What is the " $V_{SED, BE}$ "?
3. Line 170: I do not find how authors can calculate the uncertainty (below 0.1 m s^{-1}).
4. Line 190: What do intervals for the sonde observation? I assume the authors collected the sonde data every 6 hours, then interpolated 2 sec. Can this interpolated data (2 sec) compare with KAZR? The reviewer thinks that this interpolated data for horizontal winds cannot correlate with updrafts derived from KAZR due to large time differences. Can you estimate the uncertainty of eddy dissipation rates? If so, please add the uncertainties.
5. Line 241: Please add a local time
6. Line 245: There are peaks of LWP ($> 0.25 \text{ kg m}^{-2}$) around 8.3–8.5 hours and ~ 10.8 hours in Figure 2c. What is the reason for those peaks?
7. Line 251: Remove "."
8. Line 287: $10^{-1} \text{ m}^2 \text{ s}^{-3}$, I do not think this value is correct, because there is no frequency between $\log_{10}-1.7$ to $\log_{10}-1.5$. Please recheck this value.
9. Line 288: What is "the strong surface forcing"? Does it mean "surface sensible heat flux"?
10. Line 290: Please add reference about "above a value of $10^{-3} \text{ m}^2 \text{ s}^{-3}$ "
11. Line 291: "strong turbulence" – Please add a correct explanation.
12. Line 300–301: Does it correct? How can the authors argue the correlation (or relationship) with $R^2=0.121, 0.153$?
12. Line 299: Suggest removing "physical"
13. Line 318: Please add the meaning of the normalized height at 1 or 0. I assume normalized height at 1 would be cloud top height, right?
14. Line 378: Suggest changing "modeling"