

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-63

Anonymous Referee #3

Referee comment on "Contrasting characteristics of open- and closed-cellular stratocumulus cloud in the eastern North Atlantic" by Michael P. Jensen et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-63-RC2>, 2021

This study investigates the difference between closed- and open-cellular low clouds using long-term ground observations from the ARM ENA site on an island of the Azores. The biggest merit of the study is its usage of long-term data (~ more than 5 years) whereas previous studies of the topic are mostly based on short-duration field campaigns. The manuscript is very well written. The technique is overall sound. For these reasons, this paper has great potential to be published in ACP.

However, there is a lack of new insights. Most findings are consistent with prior knowledge. The presentation of the results is too descriptive and lacks discussions about the underlying physics. Also, some conclusions are questionable due to insufficient reasoning. These issues must be addressed. See below for detailed comments.

Major comments:

1. It is not straightforward from Figure 4 to conclude that "cold air advection is stronger for open-cellular cases". It seems the majority of trajectories in open-cell cases align with the SST contours, indicating a weak temperature gradient along the trajectory. Quantification is needed, which is absent in the analysis.
2. The analyses of the composite sounding have a couple of problems. First, the height should be scaled (e.g. by the main inversion height) to avoid artificial cancellation. Second, similarly, scaling may be needed for the temperature and humidity because samples are from different seasons (e.g. scaled by the seasonal mean). Given the limited

number of cases, the composite absolute values of both variables may be biased toward a specific season with the largest samples.

3. The discussion about the time evolution of the thermodynamic structure (Fig. 6) lacks physical insights. How do the diurnal cycle and advection influence evolution?

4. Line 198. Could you discuss why closed-cell cases are more coupled? Is it due to large-scale factors such as temperature advection or the boundary-layer scale factor such as cloud-top radiative cooling or precipitation?

5. Lines 222-223. Again, why open-cellular cases are associated with stronger subsidence) needs more discussion. From the perspective of PBL mass conservation: $dz_i/dt = \text{ent} - w_{\text{sub}}$, in which z_i is the inversion height, ent is entrainment rate, and w_{sub} is subsidence rate. Larger subsidence leads to PBL swallowing whereas open-cellular cases have deeper PBL. Therefore, it must be the stronger entrainment that is responsible for the deeper PBL.

6. Line 230. Sill, why open-cellular cases have slightly higher PWV should be discussed. The key idea of Zhou and Bretherton's series of studies on cellular convection is that PWV **perturbation** is highly correlated with LWP perturbation. For case-averaged PWV, the story is completely different. The latter is a synoptic-scale problem whereas the former is a mesoscale problem.

Minor comments:

Figure 1: the resolution is a little bit too low.

Figure 9: use local time or mark the period of day/night times.