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Interactive comment on "Identifying meteorological influences on marine low cloud mesoscale morphology using deep learning classifications" *by* Johannes Mohrmann et al.

Anonymous Referee #2

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Summary Satellite images of fields with low clouds are categorized with a machine learning technique to identify fields with solid stratus, closed-cellular mesoscale cellular convection (MCC), disorganized MCC, open-cellular MCC, clustered cumulus or suppressed cumulus.This enables an assessment of their frequency of occurence and their impact on radiation is quantified. It is explored whether conditions like the large-scale divergence of the horizontal wind, bulk thermal stability or humidity may be factors controlling the prevailing cloud regime. This approach demonstrates that 1) stratus clouds are more likely to be associated with frontal systems rather than synoptic high pressure systems with large-scale subsidence whereas 2) the bulk thermal stratification (as quantified by the estimated inversion strength EIS) nicely sorts mesoscale

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cellular convection from suppressed cumulus.

The findings are key to anyone with an interest boundary-layer clouds, either from an obserational or a modeling perspective. The paper is well written, to-the-point, and the figures are clear. The strength of the present work is the use of a large amount of satellite images, including satellite observations of radiative fluxes, in addition to aircraft observations to analyse the vertical boundary-layer structure as well as reanalysis data to assess the large-scale subsidence and divergence.

I believe the manuscript is almost ready for acceptance in its present form. However, I have some questions and remarks that the authors may find useful for improving the manuscript.

Remarks ———

l101: 'surface wind divergence is derived...' . Perhaps the equation for the conservation of mass can be presented to illustrate the relation between the large-scale divergence of the horizontal winds and the large-scale vertical motion (subsidence), including the sentence from l133 "The terms large-scale divergence and subsidence are used interchangeably throughout;"

l202: "Panel (f) shows the large-scale divergence as inferred from the 700 hPa vertical motion." The large-scale divergence Div =partial u/partial x + partial v/partial y, so why is Div not diagnosed from the local horizontal velocities at 700 hPa?

l218: 'suppressed MCC' This seems like an error and should be replaced by suppressed cumulus?

l218-220: 'The mean cloud fraction across all scenes (black dot at right of panel a) also shows that the Cu-vs-Sc cloud types also split tidily into the below-average and above-average cloudy scenes,' Is it meant that cumulus have low cloud fraction as opposed to the mesoscale mean values (the black dots?) for MCC and stratus?

l234: paper of L'Ecuyer et al (2019) is missing in the bibliography

3.5 Aircraft observations and decoupling parameter alpha_q 1) It may helpful to the reader not familiar with alpha_q to give a short explanation of this quantity. 2) alpha_q measures the difference between cloud-layer and subcloud layer properties. How is this computed for fields of shallow cumulus clouds where moisture and potential temperature vary with height in the cloud layer? 3) I consider Fig. 10 which shows PDFs of the PBL depth and the decoupling parameter a highlight of the present work. I was wondering whether their joint PDF might display some additional useful information? This question is motivated by two recent intercomparison papers that diagnose alpha_q and cloud layer depth for both LES and single-column model results of stratocumulus-to-cumulus transitions (Fig 6 in De Roode et al. 2016 and Fig. 14a Neggers et al. 2017, respectively). It is found that the LES results deviate somewhat from the fits as proposed in Wood and Bretherton (2004). A joint PDF may shed some light on the question whether the modeling results fall within the observations as presented in the manuscript?

Cumulus versus stratocumulus Lock (2009, factors influencing cloud area at the capping inversion for shallow cumulus clouds) finds from LES results that a parameter called kappa, and which depends on the inversion jumps of potential temperature and the total specific humidity, controls cloud cover. Would it be possible to verify the relation he found from the satellite images and the aircraft observations?

Fig. 2: - Could the horizontal sizes of the images be mentioned in the caption?

- Disorganized MCC and clustered cumulus bear some similar structures. Could the authors briefly describe which main criterion identifies these two regimes?

Fig. 5: - although not present in cloud scene, the colors of disorg MCC and Open MCC as shown in the legend appear almost the same on my screen

- the range of values shown for the divergences in figs b and c are different. wouldn't it be neater to use the same axis ranges as they both display the same quantity?

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l342 : where -> were

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