Referee #1:

This paper describes aspects of the climatology (spatial patterns, seasonality and diurnal cycles) of open and closed mesoscale cellular convection (MCC) over the Australasian swath of the Southern Ocean extending from 60E-160W. MCC is classified by applying machine learning to labeled open and closed cellular patches of thermal infrared satellite data from the Himawari satellite. The results document interesting differences in the seasonal cycle of open and closed MCC, with a much stronger seasonal variability in open MCC, peaking in late winter/early spring, and little seasonal cycle in closed MCC. Open MCC displays very little diurnal cycle, whereas closed MCC shows a diurnal cycle typical of that for marine stratocumulus. There is interesting latitudinal structure that appears to relate to the location of the polar SST front. Little MCC is found to the south of this front. MCC frequency is also related to the location of cold fronts, open cells typically occurring closer to the cold front, and closed cells more in the warm sector. The results are very interesting and will be of interest to others in the field. The paper is well written, the methods sound, and I recommend publication in ACP. I have a few technical questions and comments that the authors may wish to consider.

Potential major issue needing address: The only major potential issue I see is the use of the thermal IR channel only in diagnosing MCC types. I believe that this is fine for diagnosing open MCC, where there is clear contrast across the scene due to breaks in the clouds. For closed cells, there is very weak thermal IR contrast, and so my question is how well one can separate closed MCC from stratus that does not display MCC. The ML approach of Yuan et al. (2020) finds clear contrasts in the locations of stratus vs stratocumulus, and both prevail in midlatitudes. I think the authors need to at least comment on their choice of not including a stratus-type class in their approach. The authors' method seems to agree with previous results (Rampal and Davies 2020), which infrequent MCC poleward of 60S, but these results use visible imagery that has much more discriminating power to separate closed MCC from stratus. I don't know how stratus are removed from the authors' dataset given the use of thermal IR only. Some explanation is required.

R: We thank you for this comment – we agree. We readily acknowledge the limitations of using an infrared channel in the identification of closed MCC. We have added a further discussion on these limitations at lines 147-149 in the revised manuscript.

We note that we do use the visible channel for the initial identification of ideal open and closed MCC clouds, much like the imagery in Yuan et al. (2020). Having identified ideal cloud type on visible images, we then use the matching infrared observation within the CNN. We accept that, potentially, a classification in the visible channel may be ambiguous in an infrared channel. For this very reason, our sample selection criteria is very conservative, only using samples where it was clearly possible to observe closed MCC clouds, as can be seen in the example on new Fig. 2 of the revised manuscript.

The physical consistency of our results, however, suggest the potential of this methodology. Certainly, future refinements may be possible to distinguish beyond clear open and closed MCCs.

We readily accept that different neural network constructions, using different observations, will have their own strengths and weaknesses. One advantage of using the infrared channels is that we can now study the full daily cycle of these clouds, taking benefit of the high-temporal resolution of Himawari-8 (lines 77-79). And using a geostationary platform allows us to consider fixed geographic features such as the relationship with the polar ocean front or the influence of Tasmania or New Zealand.

We also accept that a separation between stratus and stratocumulus would have allowed a more in-depth analysis of the different morphologies of low-level clouds. However, we chose to prioritize closed and open MCC clouds, since on the one hand, this allowed us to simplify the processing and training of the CNN (as indicated at lines 114-115) and, on the other hand, open and closed MCCs have been the primary clouds associated with the dominant synoptic conditions over the Southern Ocean (cold fronts, extra-tropical cyclones and cold-air outbreaks) as shown by McCoy et al. (2017), and as we expressed at lines 44-47.

In our conclusions, we acknowledge the limitations of our neural network in the identification of disorganised MCC and that in future research we hope to improve the sampling process and the inclusion of more categories such as disorganized MCC and no MCC (stratus), to improve our CNN model (lines 417-421). Despite the limitations mentioned above, we believe that our CNN model performs well and is able to separate open and closed MCC clouds..

Specific comments

1. Line 33: Rozendaal et al. (1995) is for me a classic paper on low cloud diurnal cycles and is well worth citing.

R: This is a great suggestion. We have added Rozendaal et al. (1995) as reference in the examples of a diurnal cycle in stratocumulus clouds in the Atlantic and Pacific Oceans.

2. Line 77. Provide references that the "largest model bias has been linked to this sector"

R: Thank you for this suggestion. We have added a couple of references for this sentence in the revised manuscript.

3. Line 99: Advanced rather than advance.

R: Suggested revision made.

4. Section 2.2.1: Some additional information is needed regarding how high clouds and multilevel clouds are screened out using the data. In addition, some basic statistics on the frequency of open and closed cells, high clouds, stratus clouds, multilevel cases, etc would be very helpful.

R: We have expanded the methodology at lines 113-114, commenting specifically on how high and mid-level clouds are classified as "other" in the training data by default, along with stratus, disorganized MCC and all other clouds.

5. Section 2.2.2: Provide some examples of visible imagery for the open and closed MCC.

R: Thank you for this suggestion. We have added a new figure to show examples of the sample selection for the neural network training (Fig. 2 in the revised manuscript). We have included Channel 11 in this figure because is the main input for the CNN.

6. Fig 3. Why not show visible imagery rather than thermal IR? I can't tell if the overcast clouds are closed MCC or just stratus.

R: Visible imagery is now added in a new Figure 2. Our intention in Figure 3 (Fig 4. in the revised manuscript) was to show examples of two different seasons, and day and night

conditions. As the analysis of the daily cycle of these clouds is a major part of this study, we consider that showing a thermal IR channel for nighttime is particularly important.

Line 195. A number of degrees is missing in my pdf.

R: Thanks for noticing this error. We have corrected this in the revised manuscript.

7. Line 198. What exactly constitutes a "system"? Is this an 80x80 km patch? Are these systems really independent if you measure them every 15 minutes?

R: A MCC system is defined as a continuous group of grid points classified as either closed or open MCCs, we use the term system to refer to an event at a specific time, rather than a complete life cycle (lines 217-219). We have specified in the revised manuscript that a system refers to an event at a specific time, rather than a complete life cycle. An 80×80 km patch corresponds to the size of the window used as a sample in the CNN training (a window of 16 × 16 grid points). Regarding to the independency of the systems, samples 15 minutes apart were not measured, all the training data have been randomly sampled across time, with at least 12 hours separation between samples.

8. The lack of diurnal cycle in open MCC frequency is very interesting and novel. However, what would be even more interesting is whether the diurnal cycle of cloud cover (rather than frequency) in open MCC exhibits a diurnal cycle. Do the authors have cloud mask data that can be used to determine this?

R: We agree that it would be interesting to analyse the daily cycle of the fractional cloud cover within the open MCC. Does the fractional cloud cover of open MCC change over the course of the day?. We are intrigued by this idea, but it is not immediately possible within our current methodology. We would need to estimate how the Himawari-8 view angle affects the fractional cloud cover. Possibly, we could correct for viewing angle using MODIS, but this is outside the scope of this paper. We thank the reviewer for this idea.

References

Rozendaal, M. A., Leovy, C. B., & Klein, S. A. (1995). An Observational Study of Diurnal Variations of Marine Stratiform Cloud. Journal of Climate, 8(7), 1795–1809. https://doi.org/10.1175/1520-0442(1995)008<1795:AOSODV>2.0.CO;2