RESPONSE TO REFEREES

Referee #1:

Review V3 for "Classification of Large-Scale Environments that drive the formation of Mesoscale Convective Systems over Southern West Africa" by Nkrumah et al.

Overview: Overall, the latest iteration of the present manuscript has included an extended set of nodes, which, in my view, has improved the coherence of the paper. From my side, there are only minor revisions.

We are grateful for the in-depth constructive review the referee provided for our manuscript. This has helped significantly to improve our results' robustness and sharpen our discussion.

General comments/questions on the responses

The aspect of different within-season states is an interesting one as they can transition across each other within days. Therefore, can the authors further, but briefly, elaborate on the potential dynamical sources of these transitions? From Fig. 4, it appears that low to midlevel westerlies are more pronounced in the top row compared to the rest, which might show the impact of extratropical signals. Overall, these transitions seem to have an impact on the probability of MCS occurrence (Fig. 8), which warrants at least a short evaluation.

Thank you for this comment, it is correct that this may be linked to extratropical wave passage, similarly however (as is particularly visible for node 3) this change in the mid-level westerlies may also or in addition be linked to fluctuations of the West African Heat Low, as was described by Lavaysse et al. 2009, which was shown to take place on the order of days, in some cases modified by dust concentration (Lavaysse et al. 2011). This is now included in the main text in page 9 as follows:

"As was shown in Fig. 3, the discussed node states have an average duration on the order of days, indicating frequent transitions. Notably, mid-level westerlies are strengthened or shifted southwards for all top-row nodes in Fig. 4, which is associated with increased probability for MCS occurrence compared to other nodes, as we will outline later (c.f. Fig. 8). Potential synoptic factors that may drive the frequent node transitions and hence affect MCS frequency include extratropical waves, as well as the WAHL that is most pronounced for top-row nodes. WAHL variations were shown to take place on the order of days, in some cases modified by dust concentration (Lavaysse et al. 2011), while its southward expansion on sub-seasonal timescale has been associated with higher shear and more intense MCSs in SWA (e.g. Talib et al. 2022)."

Other specific comments/questions

L135: "TCWV represents the precipitable water the atmosphere holds better than the humidity." I do not get this sentence.

This statement has been removed since the preceding sentence already covers the point made.

L140: "km2". Set the "2" in superscript.

The change has been effected

L182: "Based on 6 different large-scale node patterns …" Should be nine!?

Thank you for catching this. Changed!

Fig. 3: Colours + patterns for the within-season nodes are visually not necessarily well distinguishable. It helps though that the bars are ordered the same way as in the legend.

Thank you for this comment. We changed the pattern colour for this plot for better visibility with the image below:

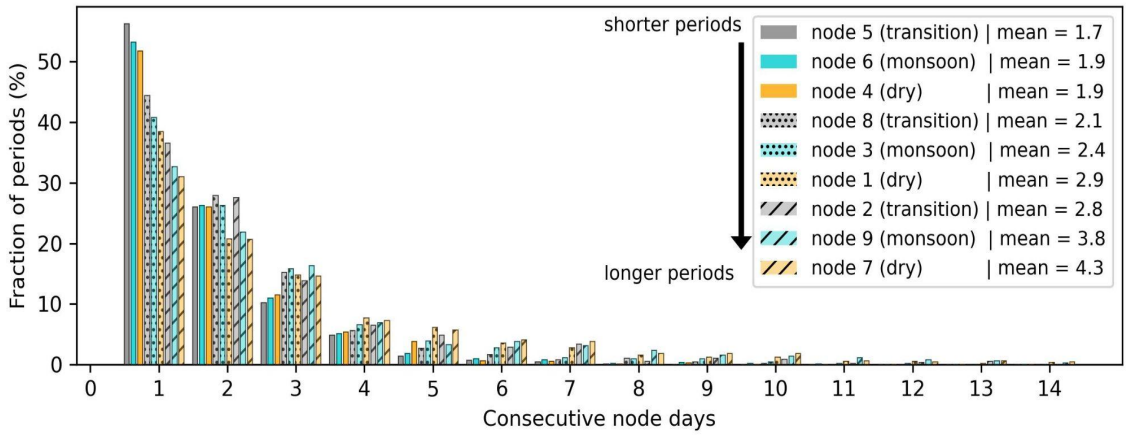

Fig. 8: It appears to me that signals in node 1 are dominated by land-sea breeze convection along the coast which are gradually suppressed in nodes 4 and 7. Therefore, the large-scale settings seemingly facilitate such rather local-scale developments. Maybe the authors can briefly pick up on this in the text.

Thank you for this suggestion, it has been considered in the text in ll. X as follows:
"Frequency signals in node 1 are dominated by land-sea breeze convection along the coast which are gradually suppressed in nodes 4 and 7. Large-scale settings, therefore, seemingly facilitate such rather local-scale developments. "

L359: "… reveal a widespread increase in zonal wind shear anomaly…". But in this case, it means (mostly) a weaker westerly shear? The authors may work with directional indications for clarity.

Thank you for catching this. Directional indications have been made to the section on zonal wind shear for clarity

Referee #2

We thank the referee for their valuable input, which has helped to improve the clarity of our manuscript and figures. The line references below refer to the newly changed manuscript. Additionally, we provide a document with tracked changes.

General comments:

I find the revised manuscript as a significant improvement. The full SOM appears to better grasp the variability in the system, as is evident by the sharp clustering in Fig. 13. The persistency-transition analysis and the spatial variability of MCSs greatly enhance the scope of the paper, and lead to valuable findings while enabling a deeper understanding of the SOM analysis.

I think the manuscript should be accepted for publication following several minor comments:

Thank you very much for such encouraging comments.

Minor comments:
L1: Be consistent with capital letters.

Changes have been implemented to this effect

L21: I suggest adding a motivational sentence stating the importance of the topic.

Thank you for this comment. The sentence “These MCS events are the dominating rain-bearing systems, contributing over 50% of annual rainfall over SWA.” has been added to the abstract stating the importance of the topic.

L35: … the SOM identified…

This has been corrected

L145: The sentence is incomplete.

The sentence has been completed to read: “Here, only land-based MCSs are considered because MCSs over land are fundamentally more intense and deep than its counterpart over the ocean (Mohr and Zipser 1996).”

L174: analysis

This change has been effected

L175: remove “to choose”

This has been removed

L316: MCSs rarely develop…

Thank you for pointing this out. Changed!

L317: address the similar frequencies of clusters 1 and 9.

We now added the following sentence: "Nodes 1 and 9 feature the same overall MCS frequency, where node 1 however shows coastal MCS frequency peaks as is representative for dry season characteristics, while MCS frequency peaks are shifted towards the Sahel during node 9 monsoon conditions."

L383: I would replace “swath” with a more common word.

The word “swath” has been replaced with “broad strip”. The statement now reads: “During monsoon nodes, node 3 shows a broad strip of high CAPE values in particular to the coast and in some instances extends to the entire SWA (node 6) and north of SWA (node 9).”

L439: arrange the spacing.

This has been corrected

L469: southward

This has been corrected

L471: why "presumably"? Is this not shown in Fig. 9?

Thank you for pointing this out. This is well shown in Fig. 9. We have, therefore, removed the word ‘presumably’ from the statement.

L491-492: Why then don't these nodes show maximum MCS frequencies?

Thank you for raising this point. Note that the climatologies as presented in Fig. 13 represent conditions at the locations where MCSs were sampled rather than a full-domain mean. This means that, while monsoon nodes may have higher TCWV and similar shear as compared to transition nodes, the domain area affected by these favourable MCS conditions may still be smaller during monsoon months, which thus feature a lower MCS frequency. For transition nodes, a larger domain area is indeed affected by favourable MCS conditions (c.f. Fig 5, Fig 6, with moisture and shear maxima covering most of SWA for the transition nodes, while only limited areas are affected for monsoon months with maxima shifted to the north, outside of the domain). Hence, most of the MCSs and rainfall over southern West Africa occur during the transition season. This is now clarified in the concluding statements under Section 4.3 to read: "Note that while monsoon months feature higher TCWV and similar shear conditions compared to transition nodes for MCS-location climatologies in Fig. 13, a larger domain area is affected by MCS-favourable conditions for transition nodes (c.f. Figs. 5,6). As a consequence, transition nodes exhibit higher overall MCS frequencies."