

Response to Reviewer 2

Manuscript: Physical Climate Drivers of East Africa's March–April–May (MAM) Seasonal Rainfall Identified through Machine Learning Analysis

Dear Reviewer,

We sincerely thank you for your careful and constructive evaluation of our manuscript and for recognising its potential contribution to seasonal forecasting in East Africa. We acknowledge the concerns regarding physical interpretation, independence of selected predictor regions, methodological transparency, and robustness. We will strengthen the methodology and distinguish statistical predictors from demonstrated causal drivers. Our point-by-point responses follow. The responses are written as proposed revisions; statements should be updated after the additional experiments have been completed.

Major and specific comments

Comment 1. Large number of regions; physical interpretation and independence

Reviewer concern: The reviewer finds too many predictor regions, insufficient evidence that individual regions physically drive MAM rainfall, and no assessment of their independence.

Response: We agree that predictive associations cannot, on their own, establish causal physical drivers. We will revise identification using gridded maximum covariance analysis (MCA) against standardized MAM rainfall anomalies, followed by partial-regression screening at $p \leq 0.05$ and assessment of basin stability across independent training subsets. We will assess geographic overlap, correlation and incremental predictive value between candidate indices, combining or excluding redundant indices where justified. The manuscript will distinguish physically interpretable associations from causal attribution; we will reconsider the title and conclusion accordingly.

Comment 2. Incomplete description of methods

Reviewer concern: Several methods are insufficiently documented, limiting interpretation and reproducibility.

Response: We will expand the Methods section to specify data coverage and resolution. We will also all the metrics methods used in this study such BSS, HSS and AUC.

Comment 3. MCA methodology and Walker Circulation interpretation

Reviewer concern: The MCA data and method are unclear; figures and the Walker Circulation interpretation require explanation, including the role of individual regions.

Response: MCA method will also be expanded for easy interpretation of the results. We will also explain and distinguish clearly what each drive's role to the walker circulation and its net effect.

Comment 4. Years used; sensitivity to training and validation periods

Reviewer concern: The hindcast/reforecast years are omitted, and robustness to different training/validation periods is not demonstrated.

Response: We refer to our response we gave the other reviewer (1) over the same issue

Comment 5. Dataset description and independent rainfall product

Reviewer concern: More information is needed on dataset resolution and period; relying on GPCC alone requires justification and an independent observational test.

Response: We selected the GPCC monthly 0.25° rainfall product for its long historical coverage, but acknowledge station-network and product uncertainties. We will document source, versions, periods, resolutions and climatologies for every dataset. We will also perform regression analysis of each identified driver against a different data source such as monthly CHIRPS to check if the drivers are significant enough to MAM rainfall

Comment 6. Rainfall-region definition and SSRZ

Reviewer concern: The definition of Figure 1 regions belongs in Methods; the relevance of low-MAM-rainfall areas in SSRZ and geographic context are questioned.

Response: We will clearly explain the combination of PCA and clustering method we used in identifying the zones within East Africa region.

Comment 7. Weakly correlated basins; gradients and dipoles

Reviewer concern: Some selected predictor regions have weak correlations or appear physically invalid (such as SST over land); gradients/dipoles lack justification.

Response: We will redo the basin identification analysis. Only basins with significant correlation with MAM rainfall will be kept. This part will be addressed as per reviewer's suggestion

Comment 8. EOF explanation and missing Table 1 correlations

Reviewer concern: How EOFs were calculated, their explained variance, and the promised basin correlations are unclear or absent.

Response: We will strengthen the EOF explanation but including the explained variance as well as correlations

Comment 9. SST maps, straight lines, December–January changes

Reviewer concern: SST correlations over land and odd straight lines may be artefacts; it is unclear how December-to-January changes enter the model.

Response: we will address this problem by considering irregular shapes for each driver basin rather than considering square boxes. Also an error of showing significance over land for SST will be addressed accordingly

Comment 10. SHAP beeswarm interpretation

Reviewer concern: The interpretation of SPT2 seems inconsistent with the direction of the SHAP values in Figure 6a.

Response: We agree with the reviewer. This will be corrected accordingly with respect to SPT2. SPT2 contribution is as what the reviewer pointed.

The discussion in the revised manuscript reads as....”.....”

Comment 11. Figure legibility and white patches

Reviewer concern: Fonts and labels are difficult to read, and white areas in Figure 11 are unexplained.

Response: We will enlarge text, simplify crowded labels and improve captions, panel organisation and legends. White patched on Figure 11 represents cells with insignificant skill i.e BSS < 0 was masked out. We have added this last masking information in the figure caption.

Comment 12. Excessive abbreviations

Reviewer concern: Numerous region abbreviations make the manuscript difficult to follow.

Response: We will spell out names at first mention and provide a consolidated table of abbreviations, geographical definitions, variables and index interpretations. Unnecessary abbreviations will be removed from the narrative.

Try to make quantitative and say you removed XX abbreviations (YY%)

Comment 13. Definition of OND_ANOM_PY

Reviewer concern: OND_ANOM_PY is introduced without a clear definition or specification of its use.

Response: We will define the index at first use, including its underlying variable, October–December aggregation, anomaly climatology, previous-year OND rainfall anomaly used as a predictor for the upcoming MAM season.

Comment 14. Additional references

Reviewer concern: The reviewer suggests Hirons and Turner (2018) and Kisembe et al. (2026).

Response: We thank the reviewer for these suggestions and will review both sources for relevance, citing them where they strengthen the scientific framing.

Comment 15. Country versus region

Reviewer concern: At line 160, “cross-validation for each country” may mean region.

Response: We confirm that “region” is intended and will correct the sentence.

Comment 16. Masking procedure

Reviewer concern: The masking procedure at line 176 is not defined.

Response: The map in Figure 1 for East Africa Region isn't complete. Sudan wasn't included fully because part of the country will be off season by MAM. So the northern part of Sudan rainfall values we masked off so that they aren't considered during our analysis. This masking information has been added to the caption of Figure 1

Comment 17. “Thermal regions” terminology

Reviewer concern: The phrase “thermal regions” is ambiguous.

Response: We will replace it with more precise terms such as “2-m air temperature predictor regions” or “temperature anomaly regions”, consistently throughout the manuscript. Agree

Comment 19. Skill metrics and years

Reviewer concern: Skill statistics and verification years should be included in the Methods section.

Response: We will define AUC, Heidke Skill Score and the relevant Brier/multicategory Brier Skill Score formulations; specify probability and climatological references, classification and aggregation; just as the above response. Reforecasts seasons will be defined and be used for computation of these metrics

Comment 20. Meaning of OV

Reviewer concern: The abbreviation OV in Figure 12 is unexplained.

Response: We will clarify the meaning of OV (overall skill) in the revised manuscript