Response to reviewer comments

Dear Editor,

Thank you very much for handling our manuscript. We sincerely thank the second anonymous referees for the time, valuable comments, and suggestions, which have helped us to improve our manuscript. We have carefully revised the manuscript to include the inputs from the referee and are attaching the updated version. Please find below a point-by-point response to the reviewer comments. We hope that these revisions make our work acceptable for publication in HESS.

Response to Reviewer comments

We thank the Referee for the thorough review, which has helped to improve our paper.

The authors have made commendable efforts to address the concerns raised during the first review. The expanded Introduction and Methodology sections, revised figures, and clarified details regarding the coupling framework reflect an attempt to improve the manuscript.

However, significant concerns remain regarding the interpretation of results. Below, I outline specific issues that need further attention:

Thank you for your comments regarding the interpretation of the results. We have carefully re-examined our results and identified a few aspects that required attention.

First, we noticed that the WOFOST standalone model was not harmonized with the soil properties when compared to the coupled models. Previously, the standalone model used spatially constant soil properties, which may have affected comparability. Second, we observed that WOFOST does not account for the residual moisture content, whereas PCR-GLOBWB 2 does. To ensure consistency, we have adjusted the models accordingly and rerun the simulations with harmonized soil properties across all models. Additionally, we have updated the methodology section to reflect these harmonized efforts (lines 521-526 in the manuscript with track changes).

Furthermore, we have rewritten our rationale and hypothesis in the Introduction section (please refer to lines 96-103; lines 132-146 in the manuscript with track

changes). We have also updated the results and the corresponding text accordingly. Please refer to the manuscript with track changes for details.

1. **Lines 591–605: The authors claim that two-way coupling improves hydrological simulations for rainfed crops by incorporating soil moisture dynamics and detailed processes. However, the normalized RMSE for rainfed maize in the stand-alone model (0.22) is notably smaller than in the two-way coupled model (0.50) (Table 1). This discrepancy contradicts the claim of improved performance and raises questions about the validity of the conclusions. The authors need to explicitly discuss whether this result is due to calibration issues, model assumptions, or inherent limitations of the coupling approach, particularly if the goal is to emphasize scientific contributions.**

Thank you for this observation. The model performance metrics table (Table 1) was previously filled with an erroneous value for the two-way coupling, resulting in identical values being reported for both the one-way and two-way models. We have updated the validation section and corrected the values in Table 1 based on the new model runs with harmonized soil properties (see updated section 3.2 in the manuscript with track changes).

2. **Lines 722–733: The added text claims that two-way coupling captures crop stress feedback mechanisms that are missing in one-way coupling, explaining regional yield differences. However, these claims lack supporting evidence, such as observational validation or references to previous studies. To address this, the authors should provide supporting references or additional quantitative analyses, and clearly distinguish between conclusions based on results and those based on assumptions or hypotheses. Furthermore, the differences in feedback mechanisms between the coupled and stand-alone models are not adequately explained and require clarification.**

Thanks for the comment. We have added a new section to the supplementary material, referenced in the main text, to further illustrate the feedback mechanism between one-way and two-way coupling. This section highlights how soil moisture dynamics respond to crop growth and capture crop water stress. Please refer to lines 803-807 in the manuscript with track changes. Additionally, we have included a detailed explanation of the differences in feedback mechanisms between the coupled model and the standalone model. Please see

lines 634-689 in the manuscript with track changes and lines 58-346 in the supplementary information with the updated version.

3. **Lines 699–709: The claim that the stand-alone model overpredicts yields under rainfed conditions is not supported by direct observational comparisons, and is therefore speculative. Moreover, this conclusion seems inconsistent with the time-series data in Figure 4.**

We have revised the text and referred to the figures where necessary. Please see the updated text in lines 790-801 in the manuscript with track changes.

4. **While Figures 6–9 have been revised, the interpretation of results, such as "notably" (e.g., lines 701, 710), is not convincingly supported. If differences are quantitatively significant, they should be more clearly highlighted, e.g., by bar plots.**

Thanks for the comment. We have added Supplementary Figures S13 and S14. (see Supplementary Information V) to supplementary document showing the relative difference in 1979-2019 mean and coefficient of variation between two-way coupling and stand-alone runs for rainfed maize, soybean, and wheat crops. We refer to these newly developed figures in line 796 in the manuscript with track changes.

We have referred to the figures where necessary to support the statement (line 783; line 803 in the manuscript with track changes)