Response Letter

Dear Prof. Christo Buizert,

We sincerely thank you and the reviewers for your constructive comments. In response, we have substantially revised the manuscript and strengthened its mechanistic evidence. Below, we summarize the major revisions and respond to your comments. Detailed responses and corresponding changes are provided in the separate responses to Reviewers #1 and #2. Figures are denoted as Fig. x, Fig. Sx, and Fig. Rx for the main text, Supplementary Information, and response letters, respectively.

With best regards,

Yufei Liu, on behalf of all coauthors

Replies to the Associate Editor

Your manuscript has now been seen by two reviewers. Both reviewers believe your work has merit. However, as you can see, particularly reviewer #2 has some substantial concerns about your work, and they do not think the central claims are supported by the analyses presented in the current version of the manuscript. Their concern rises above the level of a typical manuscript revision, and I anticipate you will need to make substantial changes in response.

As the next step in the review process, please provide detailed responses to all the points raised by both reviewers. Where appropriate, please indicate how you would address the comments in a revised manuscript. Again, providing detail is critical here: rather than a general statement like "we will address this issue in a revised manuscript", please indicate the exact changes and proposed revised text.

REPLY: We sincerely appreciate the reviewers' insightful comments, which have helped us identify important limitations in the original manuscript and substantially improve the clarity, rigor, and mechanistic interpretation of our study. In response to the reviewers' concerns, we have undertaken a substantial revision and reorganized the manuscript around a two-step physical framework: precessional forcing first reorganizes the tropical Indo-Pacific mean state, and this mean-state reorganization subsequently modifies the efficiency of coupled ocean–atmosphere feedback, thereby regulating ENSO variability.

Specifically, we have expanded our analyses to address the reviewers' concerns regarding the characterization and mechanisms of ENSO variability. We quantified both ENSO frequency and amplitude across all 24 precession experiments (**Fig. S3 and Figs. R19–R20 in the responses to Reviewer #2**). We further added diagnostics of the Walker circulation, equatorial zonal wind stress, Indo-Pacific warm-pool position, mixed-layer depth, and upper-ocean stratification (**Fig. S7, Fig. 4, and R1 in the response to Reviewer #1**), together with analyses of westerly wind bursts, warm-water volume, the individual components of the Bjerknes feedback (**Fig. 4 and Figs. R1–R11 in the response to Reviewer #2**). In addition, we performed lead–lag analyses (**Fig. R12 in the response to Reviewer #2**) and composite analyses of representative 90° and 270° experiments **(Figs. R13–R18 in the response to Reviewer #2)** to further evaluate the temporal evolution of ENSO events.

Based on these additional analyses, we have revised the Methods, Results, Discussion, and Conclusions sections. Importantly, we removed the interpretation of MSE as an ENSO trigger to avoid overinterpretation and refined the mechanistic framework accordingly. The revised manuscript now emphasizes that precessional forcing induces asymmetric continental heating between Afro–Eurasia and Australia, reorganizes the tropical Indo-Pacific mean state, modifies the efficiency of coupled ocean–atmosphere feedback, and thereby regulates ENSO variability across the precession cycle. We believe that these revisions have substantially strengthened the manuscript and provide a more comprehensive and physically grounded explanation of the proposed mechanism.

Detailed responses to each reviewer comment, together with the corresponding figures, manuscript locations, and revised text, are provided in the accompanying responses to Reviewers #1 and #2.