Dear Editor Dr Peer Nowack,

Many thanks for your hard editorial work. We also thank the two Reviewers for their constructive and valuable comments/suggestions. These comments/suggestions greatly improved our manuscript. According to the comments from the Editor decision, we have modified the manuscript based on Reviewer 1's comments/suggestions. In the online re-submission, we have included our point-by-point replies to these comments. Track changes are given in the revised manuscript. The following are our point-by-point replies to Reviewer 1's comments/suggestions.

We are looking forward to a further decision on the revised version.

Best regards,

Jing Wang, Yanju Liu*, Fei Cheng, Chengyu Song, Qiaoping Li, Yihui Ding, and Xiangde Xu

The revised manuscript has improved and the authors have addressed the comments. I thank the authors to include the schematic Figure 12 in the revised manuscript. However, yet at this revision as well I believe that the authors have not clearly stated what is new in this study and different from past studies. Ambiguity exists. I recommend for major revision, I have listed my comments below and request the authors to address them.

Reply: Many thanks for your constructive and valuable comments, which can greatly improve our manuscript. We have revised the manuscript based on your comments. The revisions are highlighted in track changes with red color in the second revised version. In the following, we summarize our point-by-point replies to your comments.

Major comments:

P3L100-103: The authors seek to address two questions 1) if there is interdecadal variations in the JJA EAMBZ precipitation? 2) if this is there then how IOBM and EAMBZ precipitation are interlinked? There are past studies such as Si et al. 2021(in their Figure 2) which showed the interdecadal fluctuations based on CRU-TS3.26 from 1900-2012 and also some station data from near Yangtze River which typically answers the first question this study is asking. This study uses the same CRU dataset but from 1901- 2014. Similarly, for the second question, past studies such as Zhang et al. 2018 did discuss and study the connection between IOBM and EAMBZ precipitation.

Although this study cite both Si et al. 2021 and Zhang et al. 2018, but the authors did not clarify what is new in this study compared to the past ones.

Zhang, Z., Sun, X. and Yang, X.-Q., 2018: Understanding the interdecadal variability of East Asian summer monsoon Understanding the Interdecadal Variability of East Asian Summer Monsoon Precipitation: Joint Influence of Three Oceanic Signals DOI: 10.1175/JCLI-D-17-0657.1

Si, D., Jiang, D., Hu, A. and Lang, X., 2021:Variations in northeast Asian summer precipitation driven by the Atlantic multidecadal oscillation DOI: 10.1002/joc.6912.

Reply: Thanks for your highly valuable comments. We have highlighted what is new in this study compared to the past ones.

For the publication Si et al. 2021 you emphasized (corresponds to the first question: 1) if there is interdecadal variations in the JJA EAMBZ precipitation?), please see **Line 50-55**, **Line 180-183,** and **Line 263-267** in the second revised version for the research innovation of this manuscript.

Line 50-55

"It is essential to point out that although the EAMBZ domain largely overlaps the Northeast Asian area suggested by Si et al. (2021), the EAMBZ is defined from the perspective of the interaction between the mid-latitude westerly and the EASM [see Fig. 1 in Chen et al. (2021); also see the red box in Fig. 1 and associated description in Sect. 2.5.1], not from a geographical notion. Accordingly, the EAMBZ is a transitional climate zone between the EASM-controlled moist region and the westerly-dominated arid region over central Asia (Chen et al., 2010; Chen et al., 2018, 2021), stretching from the eastern flank of the TP to Mongolia and Northeast China."

Line 180-183

"Note that our focused EAMBZ domain differs from the Northeast Asian domain (29°–50°N, 108°–140°E) suggested by Si et al. (2021). Although they are extensively overlapped, the EAMBZ is located more westward and northward, and defined from the climatic system perspective, not from a pure geographical perspective."

Line 263-267

"Note that to some extent, the observed major interdecadal fluctuation periods of summertime EAMBZ precipitation are dissimilar from those tied to summertime Northeast Asian precipitation revealed by observations (1900–2012) from 11 local meteorological stations (Si et al., 2021), e.g. the above-normal precipitation over EAMBZ (Fig. 1e) vs. the below-normal precipitation over Northeast Asia around 1990 (Si et al., 2021; their Fig. 2a)."

Furthermore, for the publication Zhang et al. 2018 you emphasized (corresponds to the second question: 2) if this is there then how IOBM and EAMBZ precipitation are interlinked?), please see **Line 317-324** in the second revised version for the research innovation of this manuscript, as you suggested again in the last comment of the Minor Comments.

Line 317-324

"Many previous studies have substantiated that the IOBM can remotely modulate summer rainfall fluctuations over the mid-latitude Asia at interdecadal timescales (e.g., Zhang et al., 2018; S. Wang et al., 2022; Wu et al., 2022). Note that the existing studies primarily highlighted the impacts of IOBM on the summer rainfall variations over northwest portion of the mid-latitude Asia a (e.g., S. Wang et al., 2022; Wu et al., 2022). As for the work of Zhang et al. (2018), although this study focused the northeast portion of the mid-latitude Asia including the EAMBZ, it highlighted the combined roles of IOBM, AMO and PDO. In the present study, however, we identify that it is the IOBM that may exert profoundly simultaneous impacts on the interdecadal variations of the EAMBZ precipitation in boreal summer, which will be revealed subsequently."

Abstract-L18-20: from observations, the interdecadal variations in the summer precipitation over EAMBZ has been shown by past studies and not a new finding. The authors could cite past studies or may include "as previously shown"…

Reply: Thanks for your helpful comments. Please see **Line 18-20** in the second revised version for our response.

Line 18-20

"Observational evidence reveals that, similarly to previous studies, the EAMBZ precipitation featured prominent interdecadal fluctuations, e.g., with dry summers during the periods preceding 1927, 1939–1945, 1968–1982, and 1998–2010, and wet summers during the periods of 1928–1938, 1946–1967, and 2011 onwards."

Abstract-L20-22: The IOBM connection to EAMBZ has been discussed by past studies such as Zhang et al. 2018, also cited by the authors. Here, it is important to clearly separate out the past findings and mention clearly the findings of this new study.

Reply: Thanks for your helpful comments. Please see **Line 20-22** in the second revised version for our response, highlighting the independent modulation role of the IOBM on the summertime EAMBZ precipitation at interdecadal timescales.

Line 20-22

"Further analyses identify that the Indian Ocean basin mode (IOBM) is a significant oceanic forcing responsible for the interdecadal variations of the EAMBZ precipitation, playing an independent and critical modulation role."

Abstract-L26-28: The physical-empirical model has its own limitations, so again clarifying that as included by the authors in this revised manuscript.

Reply: Thanks for your insightful comments. Please see **Line 27-29** in the second revised version for our response.

Line 27-29

"For this reason, a physical-empirical model for the EAMBZ precipitation is developed in terms of the IOBM cooling. Despite the fact that the extreme summer EAMBZ precipitation cannot be captured by this model, it can still well capture its interdecadal fluctuations and reflect their steady relationship."

Minor Comments:

P2L61-182: Is this discussion on the interannual variability in the summer EAMBZ precipitation really needed? The authors may want remove this paragraph.

Reply: Thanks for your question. However, we suggest that a review of the scientific advances regarding the physical mechanisms responsible for the interannual variability of summer EAMBZ precipitation is imperative. Such review is an organic part in this study. On one hand, such discussion you mentioned could tell the readers current knowledge gap about the summertime rainfall variability over the EAMBZ. That is, most existing pertinent studies focused on the interannual variability, paying

less attention to the interdecadal variability. On the other hand, the methodologies within the physical mechanisms responsible for the interannual variability of summer EAMBZ precipitation are helpful to unravelling the mechanisms tied to the interdecadal variability of summer EAMBZ precipitation in this manuscript. Therefore, it is reasonable for us to keep this paragraph.

P3L90: Please replace "as well as" to "while"

Reply: Revised as suggested. Thank you. Please see **Line 93** in the second revised version.

Line 93

"…, ~~as well as~~while wet…"

The authors write "oceanic interdecadal signals" in P3L92-93 and in the next sentence P3L95, they say referring to same as "interdecadal oceanic forcing". Generally, "signal" refers to response to some forcing. Please clarify.

Reply: Thanks for your insightful comments. We totally agree that "signal" refers to response to some forcing. To clarify this and highlight the forcing role of SST anomalies, the "oceanic interdecadal signals" has been changed into "interdecadal oceanic forcings" for consistency. Please see **Line 96** in the second revised version.

Line 96

"The ~~oceanic interdecadal signals~~ interdecadal oceanic forcings…"

Similarly, in P6L214: Please rephrase "external radiative forcing signals". I believe the authors mean "the radiative forcing due to external perturbations such as GHGs"

Reply: Thanks for your constructive comments. Rephrased as suggested. Please see Line 219-220 in the second revised version.

Line 219-220

"~~external radiative forcing signals (e.g., greenhouse gas)~~ radiative forcing due to external perturbations such as greenhouse gases"

P6L215-219: This is not clear. Taking an ensemble mean removes the internal variability and gives an estimate of forced response. So taking the ensemble mean from both CESM1_LENS and CESM1_IOPES would remove the variability. Please clarify.

Reply: Thanks for your constructive comments. We have clarified your concerns. Please see **Line 220-229** in the second revised version.

Line 220-229

"Furthermore, the 10-member ensemble mean results in CESM1_IOPES contain the responses to both the time-evolving radiative forcing due to external perturbations and the restored observed time-varying SSTAs over the above broader TIO domain (Yang et al., 2020). Note that though the ozone forcing data used in CESM1_IOPES differ from those in CESM1_LENS, the differences in the corresponding simulated tropical and extratropical climates were indistinguishable (e.g., Schneider et al., 2015; Schneider and Deser, 2018; Zhang et al., 2019; Yang et al., 2020). Therefore, by subtracting the CESM1_LENS ensemble mean from the CESM1_IOPES ensemble mean (i.e., removing the shared radiative forcing described above), we can obtain the response of the climate system to the internal variability stemming from the time-varying SSTAs over the specific TIO, isolating the intrinsic climate variability driven by TIO SSTAs through excluding the impacts of the time-evolving external radiative forcing. More details about CESM1_LENS and CESM1_IOPES can be found in Kay et al. (2015) and Yang et al. (2020), respectively."

Reference:

Kay, J.E., Deser, C., Phillips, A., Mai, A., Hannay, C., Strand, G., Arblaster, J.M., Bates, S.C., Danabasoglu, G., Edwards, J., Holland, M., Kushner, P., Lamarque, J.F., Lawrence, D., Lindsay, K., Middleton, A., Munoz, E., Neale, R., Oleson, K., Polvani, L. and Vertenstein, M., 2015. The community earth system model (CESM) large ensemble project: a community resource for studying climate change in the presence of internal climate variability. Bulletin of the American Meteorological Society, 96(8): 1333-1349.

Schneider, D.P. and Deser, C., 2018. Tropically driven and externally forced patterns of Antarctic sea ice change: reconciling observed and modeled trends. Climate Dynamics, 50(11): 4599-4618.

Schneider, D.P., Deser, C. and Fan, T., 2015. Comparing the impacts of tropical SST variability and polar stratospheric ozone loss on the southern ocean westerly winds. Journal of Climate, 28(23): 9350-9372.

Yang, D., Arblaster, J.M., Meehl, G.A., England, M.H., Lim, E.-P., Bates, S. and Rosenbloom, N., 2020. Role of tropical variability in driving decadal shifts in the Southern Hemisphere summertime eddy-driven jet. Journal of Climate, 33(13): 5445-5463.

Zhang, L., Han, W., Karnauskas, K.B., Meehl, G.A., Hu, A., Rosenbloom, N. and Shinoda, T., 2019. Indian Ocean warming trend reduces Pacific warming response to anthropogenic greenhouse gases: An interbasin thermostat mechanism. Geophysical Research Letters, 46(19): 10882-10890.

P8L307-308: At this point please explain here how this study is different from the past studies looking at the connection between IOBM and EAMBZ precipitation.

Reply: Thanks for your helpful comments. Explained as suggested. Please see **Line 317-324** in the second revised version.

Line 317-324

"Many previous studies have substantiated that the IOBM can remotely modulate summer rainfall fluctuations over the mid-latitude Asia at interdecadal timescales (e.g., Zhang et al., 2018; S. Wang et al., 2022; Wu et al., 2022). Note that the existing studies primarily highlighted the impacts of IOBM on the summer rainfall variations over northwest portion of the mid-latitude Asia a (e.g., S. Wang et al., 2022; Wu et al., 2022). As for the work of Zhang et al. (2018), although this study focused the northeast portion of the mid-latitude Asia including the EAMBZ, it highlighted the combined roles of IOBM, AMO and PDO. In the present study, however, we

identify that it is the IOBM that may exert profoundly simultaneous impacts on the interdecadal variations of the EAMBZ precipitation in boreal summer, which will be revealed subsequently."