General comments

This study investigates stratospheric QBO teleconnections with global monsoon systems based on 42 years (1979–2020) of reanalysis data. By focusing on boreal summer (JJA) and austral summer (DJF), and by excluding extreme ENSO events, the authors examine how QBO anomalies in the lower stratosphere modulate global and regional atmospheric circulations and precipitation. The results highlight significant impacts over the Northwest Pacific, North Atlantic, and Northeast Pacific, where the QBO appears to influence circulation systems such as the Walker Circulation, the Azores High, and the PNA pattern, leading to distinct precipitation anomalies.

The topic is timely and of interest, and the scientific questions are well-posed. However, in its current form the manuscript does not yet meet the standards of completeness, clarity, and rigor required for publication. In particular, the underlying mechanisms of the proposed associations are not sufficiently demonstrated, and the manuscript requires substantial technical revisions. I therefore recommend major revisions before the manuscript can be considered for publication.

Specific comments

Point1: Novelty of this study

It remains unclear how this study fundamentally differs from Yoden et al. (2023), and what new findings are provided. Figures 1–9 appear very similar to those in Yoden et al. (2023), with the only difference being the inclusion of an additional two years in the analysis period. Specifically, Figs. 1–6 show the vertical profile of the QBO, followed by the climatological mean precipitation pattern and the impacts of phases 4–8 over the Northwest Pacific during JJA (Fig. 7), the impacts of phases 4–8 over the North Atlantic during DJF (Fig. 8), and the impacts of phases 5–1 over the Northeast Pacific during DJF (Fig. 9). These figures are nearly identical to those in Yoden et al. (2023). Figs. 10–11 show additional results, but these appear insufficient to elucidate the underlying mechanisms.

Thus, the novelty of this work requires clarification. The authors should explicitly specify 'what is new or improved.' For instance, this could involve identifying the impacts of the QBO in regions not considered by Yoden et al. (2023), or providing robust evidence of mechanisms through new model experiments or analyses not previously demonstrated, as you mentioned in lines 90–93.

L90-93: "Recently Yoden et al. (2023) reported on new observational aspects of QBO modulation of the GM system, highlighting modulation of low-pressure cyclonic perturbations over the NH western Pacific during JJA and eastern Pacific during DJF. However, this study does not provide an in-depth view of the QBO association with the GM system from both a phenomenological and mechanical perspective."

Point 2: Causality and mechanisms

The way in which zonal-mean QBO anomalies influence the regional GM system remains unclear. Why do the strongest impacts occur specifically over the Northwest Pacific, North Atlantic, and Northeast Pacific? Which atmospheric processes realize these linkages? A more concrete depiction and explanation would strengthen the manuscript. For example, time-lagged composites could demonstrate the temporal evolution of QBO-related signals and the development of circulation anomalies, or model experiments could help identify the key mechanisms in each region, even though establishing the exact causality of wave–mean flow interactions is inherently challenging.

Furthermore, the factors causing zonal-mean stratospheric signals to become zonally asymmetric in the troposphere, as well as their sensitivity to the QBO phase (50, 70 hPa), should be clarified. If these issues have already been addressed in previous studies, they should be discussed in greater detail in the Introduction. Currently, the Introduction provides only a broad overview of the tropical, subtropical, and stratospheric QBO teleconnection routes (L51–98). As in the ENSO literature, the documented regional impacts of the QBO, particularly in the Northwest Pacific, North Atlantic, and Northeast Pacific, and the limitations of current understanding should be presented more explicitly to the reader.

Point3: ENSO definition and its impact

A more detailed description of ENSO's impacts on the three target regions (Northwest Pacific, North Atlantic, Northeast Pacific) should be provided in the Introduction (L44–50). Does ENSO affect these regions independently of the QBO, or do they exert joint impacts? The rationale for excluding ENSO from the analysis should be explained more clearly to the reader.

L44-50: 'On interannual time scales, the GM system is also influenced by the El Niño Southern Oscillation (ENSO), a major driver of global teleconnections (Mooley and Parthasarathy, 1984; Shen and Lau, 1995; Krishnamurthy and Goswamy, 2000; Yu et al., 2021). The impact of ENSO can be confined to a specific monsoon system and may vary with the time scale. Recently, Yu et al. (2021) demonstrated that, at interannual time scales, the Indian summer monsoon exhibits a stronger relationship with ENSO, whereas on the decadal time scale, this relationship is weaker. Despite extensive studies on the teleconnection between GM dynamics and surface atmospheric circulations, interannual variability of GM is still unclear, and further research is needed to improve understanding.'

In this study, only ENSO events with amplitudes greater than |1.0 K| were excluded, which implies that moderate and weak ENSO events were included. The authors state that lowering the threshold to |0.5 K| yields the same results (L471–472). However, this raises the question of why all figures were not produced using the NOAA CPC threshold of |0.5 K|. If the intention was to re-examine the new teleconnection pathway reported by Kumar et al. (2024), the ENSO-neutral threshold of 0.4 K employed in that study would seem more appropriate. Instead, the threshold of 1.0 K used in Yoden et al. (2023) was adopted. This inconsistency is likely to raise questions among readers. A sufficient explanation of the rationale behind the chosen threshold should therefore be included.

L471-472: 'Note that our analysis includes only the neutral ENSO phase, and obtained the same patterns even with a low threshold of the ENSO index (±0.5 K).'

Additionally, the number of El Niño cases differs from Yoden et al. (2023). Although the analysis period was extended from 1979–2018 to 1979–2020 (two additional years), the number of El Niño months decreased from 59 to 57, while neutral and La Niña months increased. One would expect the El Niño count to remain stable or increase, so this discrepancy requires clarification. (374 neutral, 59 El Niño, and 47 La Niña → 395 neutral, 57 El Niño, and 52 La Niña).

Point4: Completeness of the manuscript

4-1) Structure

The structure of the main text should be revised. For example, Fig. 3 currently presents JJA U Difference (Fig. 3c) → JJA and DJF U (Figs. 3a, b, d, e; note there may also be a typo in the manuscript) → JJA and DJF T (Figs. 3g, h, j, k) for the thermal wind relationship → DJF U and T (Figs. 3l, f). What about Fig. 3i? Since the description mainly focuses on the differences (right panels), presenting only those panels might be enough.

In addition, the first two paragraphs of the Introduction could be merged into a single paragraph for better flow.

4-2) References

The appropriateness of the references should be carefully checked. For example, the manuscript states that increased midlatitude surface cold air outbreaks during QBO-E are reported by Kumar et al. (2022) (L61–64). However, Kumar et al. (2022) does not demonstrate surface cold air outbreaks. A more suitable reference should therefore be cited throughout the manuscript.

L61-64: 'This pathway is known as "Holton-Tan effect", or H-T effect (Holton and Tan 1980; 1982), which operates during boreal winter when westerlies exist in the polar stratosphere, QBO E favors a disrupted polar vortex, and therefore a weak Northern Annular Mode (NAM) and increased midlatitude surface cold air outbreaks (e.g., Kumar et al., 2022).'

Minor comments

1) It seems that P5–P1 shows a peak at 20 hPa rather than at 70 hPa (Figs. 1a,e). Could the authors clarify this?

L165-167: 'this study will focus on the phases when QBO anomalies arrive in the UTLS regions, separately for JJA and DJF, with results presented for the composite difference P4 – P8 (QBO W – QBO E 50 hPa), as well as for P5 – P1 (QBO W – QBO E at 70 hPa)'.

2) The STJs are not shown in the figures. Adding the climatological mean U (STJs) as contours would make the meridional shift more apparent. A similar modification is recommended for Fig. 4.

L230-231: 'Along the UTLS, this dipole favors an equatorward shift of the zonal mean STJs during QBO W at 50 hPa'.

3) Would 'reverse' be the correct term?

L464: 'The reverse scenario during can be seen during the QBO E phase.'

4) Are the years used to define QBO 50 hPa and QBO 70 hPa the same?

L20: 'As QBO phase progress,'

Technical corrections

There are numerous typographical errors, ranging from minor issues to those that may lead to misinterpretation of the results. These reduce the readability of the manuscript. Below I list only a subset. The authors are strongly advised to thoroughly proofread the entire manuscript to correct these errors and enhance clarity.

L585: The abstract and main text state that the analysis period is from 1979 to 2020. However, the

conclusions section refers to the period from 1979 to 2022.

L148: *profile of P1-P5 is different above 0.3 hPa* → 0.3?

L465: *Consistent with previous results (section 5.2 & 5.4)* → this sentence is written in section 5.4.

L489:*190°W and 260°W'*→ 190-260E.

L14: *coincide with* → coincides with

L15: *Northen Hemisphere* → Northern Hemisphere

L15: *for same QBO W* → for the same QBO W

L20: *QBO phase progress* → QBO phase progresses

L67: *synoptic and 'and' planetary-scale* → remove 'and'

L101: *neither El Niño or La Niña* → neither El Niño nor La Niña

L102: *ESNO* → ENSO

L233: *Fig.s* → Figs.

L239: *(Figs., 3 f)*

L265: *P5 (hereinafter QBO W at 70h Pa) and P1 (hereinafter QBO W at 70 hPa)*

L497: *Brunt–väisälä frequency* → Brunt–Väisälä frequency

L505: *Zhou at el* → et al.

L581: *annualar mode* → annular mode

L613-614: *As a result, strengthens the anticyclonic circulations* → incomplete sentence..