Responses to Reviewers

Reviewer #1

I acknowledge that the authors have taken my comments into account and the manuscript has significantly improved, however there are still several issues that should be taken into account before publication in ACP.

Response: Thank you for your comments concerning our manuscript. Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our research. We have studied the comments carefully and made corrections which we hope meet with approval.

Major comments:

1. Still it is not clearly stated in the manuscript which data set and time period is used. You mention it in the data and method section, but it should be still also added to each figure caption for clarity.

Response: Thank you for your suggestions. We added the data set and time period to each figure caption for clarity.

2. I can understand your reasoning for using ERA5 for your analysis. However, there are obvious differences between SWOOSH and ERA5 which should be discussed.

Response: Thank you for your suggestion. In Section 3.2, we made a detailed comparison of the differences in water vapor QBO between ERA5 and SWOOSH, and added the correlation between SWOOSH and ERA5 at each pressure level in Fig. 2c.

- "The water vapor QBO from ERA5 is consistent with SWOOSH but the amplitude is too weak above the 30 hPa (Fig. 2b). From the correlation between SWOOSH and ERA5 at each pressure level, the largest inconsistency between the two datasets is around 20-30 hPa (Fig. 2c)…" (L178-)

3. The data and method section should be rearranged. The comparison between SWOOSH and ERA5 should be discussed in an own subsection and this new subsection also rather belongs to the result than method section. In the data and method section, I would suggest that you first describe the ERA5 data set and its uncertainties, then the SWOOSH data set with also providing a motivation why this data set is used and finally the CMIP6 data set.

Response: Thank you for your suggestion. We made

- We have placed the comparison of stratospheric water vapor between the ERA5 and SWOOSH datasets in Section "a. Comparison of stratospheric water vapor in ERA5 and SWOOSH". (L153-)
- "To investigate the stratospheric water vapor QBO in the tropical stratosphere, the European Centre for Medium-Range Weather Forecasts' fifth generation reanalysis (ERA5) from 1960 to 2020 (Hersbach et al., 2020) was used." (L93-)
- "The Stratospheric Water and Ozone Satellite Homogenized (SWOOSH) dataset version 2.7 is also used in this paper. We use SWOOSH satellite monitoring data

to validate the applicability and uncertainty of ERA5 reanalysis data in stratospheric water vapor.…" (L102-)

- "To understand the possible climatic effects of stratospheric water vapor and its representation in models, this study also evaluates the historical simulations of water vapor QBO from 18 models with internally generating QBO from Phase 6 of the Coupled Model Intercomparison Project (CMIP6) (Eyring et al., 2016; Simpkins, 2017)" (L112-)

Specific comments:

P1, L25 and throughout the manuscript: The abbreviation "WV" for water vapour should be omitted. This only disturbs the flow reading of the text.
Response: We have changed all the abbreviations of water vapor to their full names.

P3, L78: Sentence not clear. More samples of what?
Response: Revised.

- "This study uses more samples of the QBO signal in stratospheric water vapor based on the long time series and discusses the differences in stratospheric water vapor distribution between different QBO phases and between different seasons." (L82-83)

P3, L81: Here it should be added what data is used in this study and why and which time period is considered for the analysis of the seasonality of the QBO signal.
Response: Revised.

- "Possible causes of those differences are diagnosed using ERA5 and SWOOSH data, and the performance of climate models in capturing the QBO signal in water vapor is also evaluated using CMIP6 models (Ye et al., 2018; Ziskin et al., 2022)." (L84-85)

P3, L94: Does this mean that you have downsampled the data to a coarser resolution? This should be clearly stated here. Thus, I would suggest to start the sentence with "However, here the data has been downsampled to .....".
Response: Changed.

- "This reanalysis bas been remapped to a horizontal resolution of 1° (latitude) × 1° (longitude) at 37 pressure levels from 1000 to 1 hPa in the vertical direction." (L96-97)

P3, L95: For what is SWOOSH used? You mention it later, but this should be clearly stated already here.
Response: Added.

- "The Stratospheric Water and Ozone Satellite Homogenized (SWOOSH) dataset version 2.7 is also used in this paper." (L102)

P4, L99: This is not clear and I think this is also not correct. The original satellite data

is on different grids, but isn't the SWOOSH dataset an averaged data set on one specific grid? If it would be provided on different grids, then how can you choose which dataset on which grid to be used?
Response: Changed.

- "The gridded SWOOSH data provide monthly averages, standard deviation, number of observations and average uncertainty from each satellite instrument." (L107-)

P4, L109: How large were the biases? Please add some numbers.
Response: This sentence was removed to avoid ambiguity.

P4, L112: What is meant with "was superior"? Was it higher or better than ERA-interim?
Response: Changed to "better". (L99)

P4, L115: Is here for both data sets the time period 1992-2019 considered? If yes, this should be more clearly formulated.
Response: Changed.

- "Figure 1 shows the climatological means of the annual mean, summer mean, and winter mean of the water vapor mixing ratio in the stratosphere in SWOOSH satellite data and ERA5 reanalysis, and the calculation period for both datasets is from 1992 to 2019." (L156-)

P4, L116: I do not agree here, there are obvious differences between SWOOSH and ERA5 which should be discussed and taken into account in the results based on ERA5 presented in this study.
Response: Changed.

- "SWOOSH and ERA5 display consistent distribution of stratospheric water vapor: water vapor concentration in the stratosphere is much less than in the troposphere and thermosphere. The largest difference between two datasets is the wet bias around 0.3 ppm at the tropopause (Krüger et al., 2022)." (L157-)
- "Compared with SWOOSH, the water vapor QBO amplitude in ERA5 decays rapidly with height until 30 hPa" (L431-)

P5, L125: Evaluate not clear. Are you evaluating these models with ERA5?
Response: Added.

- "The water vapor QBO simulated by CMIP6 models is evaluated using the ERA5 reanalysis." (L114-)

P5, L132: What about the spatial resolution of the CMIP6 simulations? Are these comparable to the resolution of ERA5 used in your study?
Response: Added.

- "CMIP6 models are remapped to 2.5° (latitude) × 2.5° (longitude) grids." (L121-)

P5, L140: The sentence starting with "Considering ....." is not clear. Please rephrase.

Response: Changed. (L130)

P6, L164: What do you mean with "In terms of data and methods"? Do you mean "As described in the data and methods section"? If yes, it should also be written like this.
Response: This sentence was deleted in the latest manuscript for clarity.

P6 and Fig. 2 on P7: There are clear differences between SWOOSH and ERA5 and these should be discussed.
Response: Thank you for your suggestion. We added a vertical profile showing the correlation between the two datasets at each pressure level at Fig.2. More discussions were inserted.

- "The water vapor QBO from ERA5 is consistent with SWOOSH but the amplitude is too weak above the 30 hPa (Fig. 2b). From the correlation between SWOOSH and ERA5 at each pressure level, the largest inconsistency between the two datasets is around 20-30 hPa (Fig. 2c). By comparison, it is found that although there are some differences in the stratospheric water vapor QBO between the SWOOSH satellite data and the ERA5 reanalysis data: the ERA5 reanalysis data reproduce the distribution pattern of water vapor propagation from the lower stratosphere to the upper stratosphere below 30 hPa, but the stratospheric water vapor QBO signal in ERA5 can not be trusted above 30 hPa. Therefore, the long-term data from ERA5 reanalysis can still be used to diagnose the influence and dynamics of water vapor in the middle and lower stratosphere below 30 hPa. Our subsequent analysis mainly uses ERA5 reanalysis data. (L178-185)

P7, Figure 2: Add label with time period also to the middle panel of the figure.
Response: Added.

Figure 4-9: Add which data set and time period has been considered.
Response: Added "…from 1959–2019 for ERA5 reanalysis…" in Figure 4-9.

P9, L217-218: Check sentence, positive appears here twice.
Response: In Fig. S2a, the water vapor anomalies in the tropical region are distributed in a "+ - +" pattern from bottom to top stratosphere, so "positive" appeared twice during the description. (L227)

P10, L238: What exactly is meant with "in tropics-subtropics"? In the tropics and subtropics or between tropics and subtropics?
Response: Changed to "…in the tropics and subtropics…" (L248)

P12, L276: Sentence not clear. I would suggest to start the sentence with "In northern winter, ..." to avoid double use of in northern winter in the sentence.
Response: This sentence changed to start with "In the northern winter…". (L276)

P13, L317: Is here something missing after cold? Do you mean cold anomalies?

Response: Changed to "…warm anomalies…" and "…cold anomalies…". (L317)

P15, L343: Improve phrasing of the sentence.
Response: Revised.

- "Through the above analysis, it can be found that the QBO influences tropical stratospheric water vapor variations primarily through two mechanisms. One is the mean advection term of the residual circulation, and the other is the tropopause cold point temperature that exerts influence on stratospheric water vapor entry." (L343-346)

P18, Figure 11: In this comparison ERA5 is an obvious outlier. These differences to the CMIP6 models should also more clearly be discussed.
Response: In Figure 11, we added the description of the differences between the ERA5 and CMIP6 models.

- "Compared with the CMIP6 models, the 70 hPa water vapor lagging by six months in ERA5 reanalysis is significantly larger." (L399-)
- "Eight models simulate QBO index differences between easterly and westerly phases exceeding 30 m/s, which are comparable to the ERA5 QBO indices, but the 70 hPa water vapor of all models are only half that ERA5." (L402-)
- "Eight models show higher 30 hPa QBO index than that in ERA5, but only six of them exhibited water vapor anomalies around 0.1 ppm, with too-small water vapor amplitudes." (L405-)

Technical corrections:
P2, L45: Add "the" -> the westerly phase
Response: Added. (L46)

P2, L51: Add "e.g." before the references of Ricciardulli and Garcia (2000) and Lott et al. (2014).
Response: Added. (L53-54)

P2, L56: Add "are", so that it reads "are now able". However, I would rather suggest to skip now and write "were able".
Response: Changed to "were able". (L58)

P3, L73: Abbreviation "BD" has not been introduced.
Response: Added "Brewer-Dobson (BD)". (L72)

P3, L74: Add "the" and "in the" so that it reads "amplitude of the QBO was 2 K in February in the northern winter
Response: Changed. (L73-74)

P3, L74: of summer -> in summer or in the summer
Response: Changed. (L74)

P3, L82: section 2 -> Sect. 2
Response: Changed. (L86-90)

P3, L90: add “original”? It should be made clear that this is the resolution at which ERA5 data is provided by ECMWF.
Response: Added. (L94)

P4, L97: Write “satellite instruments” instead of just satellites.
Response: Changed. (L106)

P4, L97: Write instead “of different data sources, including” by “observations from the following satellite instruments, such as .....”.
Response: Considered. “This dataset is a combination observation from the following satellite instruments: SAGE-II/III/ISS, UARS HALOE, UARS MLS, Aura MLS, ACE-FTS, and OMPS-LP (Davis et al., 2016).” (L105-107)

P4, L108: GCCM -> GCM
Response: This sentence was removed.

P4, L109: Change “showed cold deviation” to “showed a cold bias”.
Response: This sentence was removed.

P4, L115: Rephrase “during SWOOSH satellite data”
Response: Changed. (L180)

P5, Figure 1 caption: Comparative analysis -> comparison
Response: Changed. (L161)

P5, Figure 1 caption: Add “data” so that it reads “reanalysis data”.
Response: The reanalysis refers to a dataset. The reanalysis provides different data such as surface, surface flux, vertical integration, and isobaric variables. This sentence is correct.

P5, L127: They are -> These are
Response: Changed. (L115)

P5, L140: anomalies -> anomaly
Response: Changed. (L129)

P6, L164: monitoring -> observations
Response: Changed. (L168)

P6, L169: tropics -> tropical

Response: Changed. (L173)

P10, L241: cool -> cools
Response: This sentence was removed.

P13, L294: Southern and northern hemisphere should be written starting with small letters.
Response: Changed in this paragraph. (L302-)

P14, Figure 8 caption: Pa/s should be written as Pa s^{-1}
Response: Changed. (L325-)

P16, L368 and L369: Space between "Fig." and figure number ("S8" and "S5", respectively) missing.
Response: Added. (L372)

P16, L377: Rephrase "is not little". It should rather read "are not small", but better would be to clearly state that "obvious biases are visible".
Response: Changed. (L379-)

P19, L425: low -> lower
Response: Changed. (L434)

P19, L445: omit "spontaneously"
Response: Deleted. (L457)

P20, L447: low -> lower
Response: Changed. (L460)

P20, L449: very few models -> only a few models
Response: Changed. (L462)

Reviewer #2

In my first review I asked the authors in particular to sharpen their motivation and to more clearly specify, what is known about the seasonality (of the QBO signal in water vapour) and what not. Unfortunately, I don't think that the changes have improved the manuscript with respect to these two points, such that I still can't recommend publication. After a somewhat more extensive literature search from my side, I'd now rather suggest to reject the manuscript. As explained below, it is now even more unclear to me what the new findings of this manuscript are. I'm sorry that I didn't do a better literature search earlier, but apparently the authors didn't either.

Response: Thank you for your suggestion. We conducted a more extensive literature review this time, introduced the current research progress of water vapor QBO in the stratosphere, and elaborated in more detail on the innovations of our research based on existing studies. Therefore, I expect the reviewer could patiently read our revised paper with appreciative eyes.

To well address your concern, we carefully selected more recent studies and cited in our paper. We also insert more discussion this time in the introduction section.

- "The relationship between the QBO and tropical stratospheric water vapor has been widely investigated (Chen et al., 2005; Tao et al., 2015; Xia et al., 2021). Some studies based on short-term data have shown the seasonal differences in the impact of QBO on stratospheric water vapor, but have not quantified specific values (Tian et al., 2019; Wang et al., 2020). It still remains unclear the specific differences in the impact of QBO on stratospheric water vapor in northern winters and summers based on long-term reanalysis data." (L75-80)

The authors write that "it still remains unclear whether the effects of the QBO on stratospheric water vapor differ between northern winter and summer". In the conclusions they report that "the difference of WV distribution in the lower stratosphere between westerly and easterly QBO phases in summer is smaller than in winter, which has not been reported in the relevant literature." That is not entirely true. Fig. 5 of Tian et al. (ACP, 2019, https://doi.org/10.5194/acp-19-9913-2019) shows such a signal. Admittedly, in an analysis of combined QBO and ENSO effects, but comparing the signals of only warm or cold ENSO phases reveals such a signal. The authors need to refer to earlier literature properly and clearly and correctly identify which gap they think they can close with their analysis.

Response: Thank you for your suggestion. We have carefully read the earlier literature and introduced the current research progress of water vapor QBO in the introduction, and clearly and correctly elaborated in more detail on the improvements of this research based on the existing studies.

- "Some studies based on short-term data have shown the seasonal differences in the impact of QBO on stratospheric water vapor, but have not quantified specific values (Tian et al., 2019; Wang et al., 2020). It still remains unclear the specific differences in the impact of QBO on stratospheric water vapor in northern winters and summers based on long-term reanalysis data." (L77-80)

- "The difference of water vapor distribution in the lower stratosphere between westerly and easterly QBO phases in summer is smaller than in winter. Although this conclusion has been shown in relevant literature (Tian et al., 2019; Wang et al., 2020), no specific differences have been given based on long-term data." (L437-440)

This is unfortunately not the only part of the conclusions where it is unclear what is a finding of the authors and what is existing knowledge. Under point II earlier studies are referenced for the relevance of the cold point temperature for stratospheric water vapour and the QBO effect on the cold point temperature. Then the authors write "However, the intensity and coverage of tropical temperature anomalies in winter are significantly greater and broader than that in summer" without giving a reference. Hence the reader may have the impression that this is a new finding, but it isn't (see Martin et al., ACP, 2020; https://doi.org/10.1175/JCLI-D-20-0287.1).
The authors need to identify their new findings (if there are any) much more rigorously to allow a judgement if sufficient new knowledge is created to justify publication of this manuscript.
Response: Thank you for your suggestions and serious criticism. All those papers that mentioned the seasonality of the water vapor QBO are cited in our paper this time. We further emphasized existing knowledge in conclusions 2 and 3 and highlighted our new findings.

- "However, the intensity and coverage of tropical temperature anomalies in winter are significantly greater and broader than that in summer (Martin et al., 2021), which is consistent with the BD circulation anomalies being significantly stronger in winter than in summer (Abalos et al., 2021; Butchart, 2014)." (L444-)
- "The intensity of the QBO-related residual secondary circulation is stronger in the boreal winter than in summer (Abalos et al., 2021; Butchart, 2014), which not only influences the cold point tropopause temperature in tropical regions but also drives the transport of stratospheric water vapor." (L451-)

I won't comment further on the manuscript except that in addition to this fundamental flaw, unfortunately, I think that the writing hasn't been improved through the modifications. Maybe the most blatant examples for a change that has gone awry are the first sentences of abstract and introduction. The paper now starts with mentioning "the feedback of water vapor". It is unclear from these sentences what water vapor feedback is meant, and how this is relevant for the paper. The word "feedback" is not used anywhere else in the manuscript. Also the remaining part of the abstract contains several unclear or misleading statements. E.g.: "The 30 hPa QBO index exerts the greatest influence on 100 hPa water vapor …" An index can't exert an influence. Similar formulations are used in several places of the manuscript and make it hard to understand how the authors think about causes and effects.
Response: Thank you for your suggestion. We have tried to explain the main findings of our paper. We also expect that our reviewer could see our endeavors put into revising our paper. The paper in the last round revision is really improved. We also thank our

editor and reviewer for give us another chance of revising the paper again.

To well address your concern, we have made many revisions:

- "Stratospheric water vapor is a powerful greenhouse gas…" (L10)
- "The stratospheric water vapor has an important effect on global temperature changes (Held and Soden, 2000; Dessler et al., 2013; Solomon et al., 2010)…" (L25-26)
- "The QBO (represented by the 30 hPa QBO index) exerts the greatest influence on 100 hPa water vapor at a lag of six months." (L14-15)
- "Figure 4 shows that the modulation effect of QBO (30 hPa zonal wind) on…" (L229-)
- "The QBO (represented by the 30 hPa QBO index) exerts the greatest influence on 100 hPa water vapor at a lag of six months…" (L432-433)
- "…the QBO (represented by the 30 hPa QBO index) has a significant impact on the 100 hPa temperature after six months…" (L447-448)
- "The CMIP6 models can simulate the lagged effect of the QBO (represented by the 30 hPa QBO index) on water vapor in the lower stratosphere." (L459-)

Reviewer #3

Overall, I find that the authors satisfactorily addressed my comments and from my point of view the paper can be published now. When reading, I found a few instances where the wording seemed unclear to me and still needs improvement (listed below). Please check the entire manuscript again thoroughly for unclear writing and potentially misleading formulations.

Response: Thank you for your positive feedback on our work. We have meticulously checked the language throughout the paper to eliminate any instances of unclear expression.

L128: I'd suggest to rewrite "...ERA5.1 was better than that of ERA5..." with e.g. "more realistic", and also stating with respect to which reference.

Response: We removed this sentence for clarity this time.

L129: As far as I know, the Krueger et al. (2022) focusses on extratropical water vapor, and does not state that there is "a wet bias in the tropical tropopause in the ERA5", as written here. Please clarify and eventually correct.

Response: Thank you for your suggestion. This sentence was also removed for clarity.

L626: Think it should read "The CMIP6 modelS can ..."

Response: Changed. (L459)

Reviewer #4

General Comment

The authors clarified that the added value of the ERA5 SWV does not lie in direct observational constraints (as there are none) but simply in the indirect constraints brought by realistic dynamics. Hence their comparison of the seasonalities of QBO signal, between ERA5 SWV and CMIP6 SWV, is similar to a comparison between GCCM with specified dynamics and unspecified dynamics. In this sense, the QBO signal in ERA5 SWV is indeed expected to be more realistic than in the CMIP6 SWV.

Response: Thank you for your comments concerning our manuscript. Those comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our research. We have studied the comments carefully and made corrections which we hope meet with approval.

We agree that the dynamics are important for the water vapor distribution. The simulation of the dynamics determines the simulation of water vapor.

Major Comments

A very simple comparison between climatological SWV in SWOOSH and ERA5 (new Fig. 1) leads the study to focus on pressure levels below 10 hPa. But Fig. 2 shows that the signal in ERA5 is not realistic above 30 hPa as it quickly becomes much weaker than in SWOOSH. This is noted by the authors in their response: "We noticed that the WV anomalies above 30 hPa are weaker in ERA5 than in SWOOSH. We mainly focus on the WV below 30 hPa (especially in Figure 5)." Yet this is not mentioned explicitly in the revised manuscript, which keeps a very high top (1 hPa) for Figures 6, 8, 9 and still computes ERA5-CMIP6 correlations over the whole 100-1 hPa pressure range (Table 1). Figure 2 clearly shows that the QBO signal in SWV can not be studied with ERA5 in the middle stratosphere (30-10 hPa). Figure S2 does show some signal with ERA5 in the upper stratosphere (10-1 hPa) but still much weaker than SWOOSH. Hence the paper should

Response: Thank you for your suggestions. We have carefully revised these issues; please see the following section for details. For your easy check, we listed all places of revision below.

- "The amplitude of the water vapor QBO also gradually weakens during the upward propagation, and the maximum amplitude of the water vapor anomalies at 10–30 hPa is only ±0.15 ppm (Fig. 2a). The water vapor QBO from ERA5 is consistent with SWOOSH but the amplitude is too weak above the 30 hPa (Fig. 2b)." (L176-178)
- "From the correlation between SWOOSH and ERA5 at each pressure level, the largest inconsistency between the two datasets is around 20-30 hPa (Fig. 2c). By comparison, it is found that although there are some differences in the stratospheric water vapor QBO between the SWOOSH satellite data and the ERA5 reanalysis data: the ERA5 reanalysis data reproduce the distribution pattern of water vapor

propagation from the lower stratosphere to the middle stratosphere below 30 hPa, but the stratospheric water vapor QBO signal in ERA5 can not be trusted above 30 hPa. Therefore, the long-term data from ERA5 reanalysis can still be used to diagnose the influence and dynamics of water vapor in the middle and lower stratosphere below 30 hPa. Our subsequent analysis mainly uses ERA5 reanalysis data." (L179-)

• improve Fig. 2 and S2 by the addition of a vertical profile showing, as a function of pressure, the overall agreement between the QBO signals in SWOOSH SWV et ERA5 SWV. This could be simply, at each pressure level, the normalized standard deviation of the differences between both time series.
Response: Thank you for your suggestion. We added a vertical profile showing the correlation between SWOOSH and ERA5 at each pressure level in Fig. 2 and Fig. S2. The quality of the ERA5 can be compared with SWOOSH.

• clearly state that the QBO signal in ERA5 SWV can not be trusted above 30 hPa.
Response: Thank you for your suggestion. We clearly stated that the SWV QBO signal in ERA5 can not be trusted above 30 hPa. (L179-)

• limit the vertical range of Figures 6, 8, 9 to the 100-10 hPa pressure range. This would also allow Fig. 6 and 9 to show more details (finer color bars) and Fig. 8 would become clearer.
Response: The vertical range of Figures 6, 8, 9 changed to the 150-10 hPa pressure. The details of those figures are more clearly shown.

• focus all discussions in sections 4 and 5 on the lower stratosphere (i.e. the 100-30 hPa pressure range).
Response: Thank you for your advice. We have revised the content in Sections 4 and 5 by removing discussions on levels above 30 hPa, and these changes have been marked in the text using Track Changes.

• re-calculate the the correlations of Table 1 using only the 100-30 hPa pressure range.
Response: We have re-calculated the the correlations of Table 1 using only the 100-30 hPa pressure range. The corresponding text description has also been modified. (L393-394)

2. While this is not mentioned in either version of the manuscript, it appears that an asset was actually uploaded with the manuscript: https://doi.org/10.5281/zenodo.14999285. It is a collection NCL codes, probably to generate the figures. In its present form, this asset is useless. Four improvements are necessary:
• Mention the existence of this asset, and reference it properly, in a dedicated section at the end of the mansucript (as is standard in Copernicus journals).
Response: Thank you for your suggestion. We added a Code availability section and

then referenced this code. (L484-487)

• Update the NCL files: the recorded date for this asset is March 2025, i.e. before the revision of the paper.
Response: We re-uploaded the code on December 28, 2025.
(https://zenodo.org/records/18072746)

• Rename the NCL files according to the figures which they generated. Include the datasets which are plotted, e.g. "/nuist/scratch/raojian/luqian/water/u.nc" which is read by "bd.ncl".
Response: We renamed the NCL files according to the figures which they generated. Further, all the datasets were collected from the third party. It might be improper or even illegal to redistribute those datasets. We provide the data sources this time. (L)

Minor comments
1. Lines 114-115: "Figure 1 shows the evolution of the annual mean, summer mean, and winter mean of the WV mixing ratio in the troposphere during SWOOSH satellite data and ERA5 reanalysis from 1992 to 2019".
Please revise this sentence: this figure shows climatological means of SWV over 1992-2019, not its evolution over that period. It shows WV in the stratosphere, not in the troposphere.
Response: Thank you for your suggestion. Changed

- "Figure 1 shows the climatological means of the annual mean, summer mean, and winter mean of the water vapor mixing ratio in the stratosphere in SWOOSH and ERA5 during 199 -2019. SWOOSH and ERA5 display consistent distribution of stratospheric water vapor: water vapor concentration in the stratosphere is much less than in the troposphere and thermosphere. The largest difference between two datasets is the wet bias around 0.3 ppm at the tropopause (Krüger et al., 2022)." (L156-160)

2. Lines 173-174: "The WV QBO from SWOOSH is consistent with ERA5 reanalysis, but the amplitude is stronger, and the strong WV QBO in SWOOSH propagates upward at a higher level. (Fig. 2b)".
In this comparison SWOOSH is the observational (i.e. reference) dataset. So the comparison should be formulated the other way around, e.g. **"The WV QBO from ERA5 is consistent with SWOOSH but it does not propagate as high, with a much too weak amplitude above the 30 hPa pressure level."** This is also the right place to draw the consequence about the vertical extent of the study (see Major Comment 2).
Response: Changed.

- The amplitude of the water vapor QBO also gradually weakens during the upward propagation, and the maximum amplitude of the water vapor anomalies at 10–30 hPa is only ±0.15 ppm (Fig. 2a). The water vapor QBO from ERA5 is consistent with SWOOSH but the amplitude is too weak above 30 hPa (Fig. 2b)." (L176-178)

3. Figure 5: it is difficult to distinguish the different shadings due to the dots. You should either reduce the density of these dots, or decrease their size. Also, their meaning must be explained in the caption (confidence level).
Response: We reduced the density of these dots in Figure 5, and added the confidence level in the caption. (L241-244)

4. Figures 10 and Figure 2: must have exactly the same color bar and shadings, to enable visual comparisons. In Figure 10, the labels of the color bar are not complete (dot missing, e.g. “-0 25” → “-0.25”).
Response: Thank you for your suggestion. We have modified the color bar and shadings in Figure 10 to match that of Figure 2.