Atmospheric Chemistry and Physics Discussions

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Comment on acp-2022-382

Anonymous Referee #3

Referee comment on "Stratospheric water vapour and ozone response to the quasi-biennial oscillation disruptions in 2016 and 2020" by Mohamadou A. Diallo et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-382-RC3, 2022

Diallo et al. present results from a multiple regression analysis of water vapor and ozone data from MLS and wind and temperature fields from ERA50 spanning 2013–2020 to delineate the impacts of QBO from other natural variations (e.g. El Niño) and from time-varying forcings (i.e. aerosol optical depth). They find distinct planetary wave forcing patterns corresponding to each of the two QBO disruptions, and ascribe the anomalously moist lower stratosphere during the 2020 disruption to Australian wildfires.

I have concerns about the robustness of the multiple linear regression and the statistical methods used on such a short time series. I think the paper itself could use editing for flow, clarity, and language. The figures show much more information than is actually discussed, making it a chore for the reader to discern the meaningful results.

Significance: Good (3) understanding the impact of QBO disruptions is helpful, particularly inasmuch as their frequency may increase in the immediate future.
Scientific Quality: Fair (2) The authors are abreast of recent literature, but I'm not convinced the methods are adequate to produce meaningfully significant results.
Presentation Quality: Poor (1) There is a lot of information shown in the figures, which all use the same color scales and are not prominently labeled. It takes a considerable amount of effort for the reader to distill the important information from the figures, and the language and writing in the paper make it more difficult.

- **Does the paper address relevant scientific questions within the scope of ACP?**
  Yes. The objective of this paper is important and germane to ACP.
- **Does the paper present novel concepts, ideas, tools, or data?**
  Yes. The multiple regression analysis including both the recent QBO disruptions is timely and useful.
- **Are substantial conclusions reached?**
  I think so; the location of the eddy forcing is helpful to know, and the attribution of

moist UTLS during the 2020 disruption to the Australian wildfires – an impact that has been discussed in the community – is important to show.

- **Are the scientific methods and assumptions valid and clearly outlined?**
  I don't believe they are clearly outlined. I think the multiple regression analysis on 8 years of data – dealing with oscillations that are subseasonal-to-nearly-interdecadal in scope – may be over-determined. Furthermore, while the authors state that a t-test is used to test for statistical significance, they do not specify the parameters used (e.g., the effective degrees of freedom, which I believe to be important in a time series that is temporally over-sampled with respect to the QBO, ENSO, etc.).
- **Are the results sufficient to support the interpretations and conclusions?**
  I don't believe so. Again, I think – considering the shortness of the MLS record – that the multiple regression analysis used here is likely to appear more significant than it is. Also, there is an implicit assumption in the test that the QBO disruptions are well described by a one-dimensional QBO index time series. In other words, that the impacts of the QBO are the same as the impacts of any other transition between QBO phases with a similar index. If this is indeed the case, the QBO disruptions may not be so interesting. If this is not the case, then the interesting impacts of QBO disruptions seem more likely to appear in the residual term (epsilon), but this is not examined in detail.
- **Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?**
  I don't believe so, for reasons stated above. Also, Figure 3E is said to capture the aerosol optical depth (AOD) impacts of the Australian wildfires, but since there are only two disruptions, of differing character, it seems possible that some of the impact of the QBO disruption itself may be wrapped up in the AOD term, in addition to the residual term.
- **Do the authors give proper credit to related work and clearly indicate their own new/original contribution?**
  I believe so. The authors cite a good variety of work, including very recent work, and the authors' own related contributions. It seems strange to me that Taguchi (2010) is being cited to back up the statement that there is not yet a clear understanding of how QBO disruptions are linked to anomalous sea surface temperatures, since QBO disruptions had never occurred when that paper was written.
- **Does the title clearly reflect the contents of the paper?**
  Yes.
- **Does the abstract provide a concise and complete summary?**
  Yes
- **Is the overall presentation well structured and clear?**
  The paper could use some work in this regard. Paragraphs are rambling, having at times several different subjects. There are no subsections to aid quick navigation of the paper.
- **Is the language fluent and precise?**
  The paper needs editing to be publication ready. Like the paragraphs, the sentences are long and often have weak structure. Definite/indefinite articles are often missing, singular/plural disagreement is prominent. Many other phrases (e.g. "the quasi-periodic QBO cycle of about 28–month period" on line 37) are just a bit awkward and could use careful reading by a native English speaker.
- **Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?**
  Yes.
- **Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?**
  I think many of the figures show 2D anomalies, but only certain levels or time periods are described. Perhaps reducing the dimensionality of the figures would make the authors' message clearer.

Figure production is rough, with uniformly small labeling for ticks labels, and figure panel titles. The figure lettering is added after the fact, is large, and is removed from the figure panel title. Some figure labels are missing. All color scales are the same.

- **Is the amount and quality of supplementary material appropriate?**
  I think the supplementary figures are of similarly rough quality to the figures in the main text. The figures I would be most interested in (some of the other regression terms) are not shown.

A few small edits/suggestions follow:

- Line 7: "circulation anomalous responses" needs re-wording
- Lines 9–11: this sentence needs to be split or otherwise clarified.
- Line 31: "Considered as a…" could just be "Considered a…"
- Line 37: "The quasi-periodic QBO cycle of about 28–month period" needs rewording
- Line 44: "study" should be "studies"
- Line 50: comma needed after amplitude.
- Line 74: "planetary (PWD) and gravity (GWD) wave drag" would be better as "planetary wave drag (PWD) and gravity wave drag (GWD)." It's just two words more, but much easier to read.
- Line 99: "In in"
- Lines 104–106: Sentence beginning with "Both" is then used to contrast the two QBO events. Re-word.
- Lines 161–163: This sentence is confusing. I keep reading "fits" as a verb, and it breaks everything. Make it clear.
- Lines 148–164: This paragraph doesn't have a clear direction/subject to me.
- Lines 282–285: The last sentence of the previous paragraph and the first sentence of the subsequent paragraph are a bit redundant—they both serve to introduce the topic of gravity wave drag
- Line 327: The word "finally" is repeated. Check how many times it's used. Use it once.