Comment on acp-2022-102
Anonymous Referee #1

Referee comment on "The semi-annual oscillation (SAO) in the upper troposphere and lower stratosphere (UTLS)" by Ming Shangguan and Wuke Wang, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-102-RC1, 2022

The paper by Shangguan and Wang is an interesting piece of work that addresses the semiannual oscillation (SAO) in the UTLS. This topic is of relevance because of its potential to provide predictive capabilities on seasonal and subseasonal time scales. Another merit of this work is that the SAO in the UTLS region has not been topic of many studies so far. The authors investigate the UTLS SAO in temperatures of two reanalyses, temperatures observed by GNSS RO, and simulations with WACCM. In a sensitivity simulation, the influence of the SST SAO on the UTLS SAO is examined.

The topic of this paper falls into the scope of ACP and is of interest to its broad readership. Generally, the paper is well written. The paper is therefore recommended for publication in ACP after addressing my mainly minor comments that are given below.

Main Concern:

The authors claim that regions where the UTLS SAO is strongest would coincide with the global monsoon regions, and it would therefore indicate that the UTLS SAO is related to the monsoon processes. However, this is not supported by the figures shown in the paper. The UTLS SAO has even minima in the monsoon regions. It maximizes roughly at 35N and 35S, and in some regions near the equator.

Specific comments:
The MA-SA0 is a complex interplay of momentum advection, planetary waves from the extratropics, and vertically propagating waves (both global-scale waves and small-scale gravity waves) (Hamilton and Mahlmann, 1988; Richter et al. (2006); Ern et al. (2015, 2021)).


In a recent paper, Yang and Wu (2022) relate the semiannual surface air response to changes in the oceanic mixed layers.


Bracegirdle (2011) showed that at latitudes between 50S and 65S the SAO in sea level pressure is coupled with the stratospheric circulation, and correlations are found over a large altitude range in the troposphere and stratosphere. In particular, a downward influence from the stratosphere is significant in late summer/early autumn.

Bracegirdle, T. J.: The seasonal cycle of stratosphere-troposphere coupling at southern high latitudes

(3) l.55: Also harmonics of the annual cycle could result in a significant contribution to the semiannual signal. For example, if the annual variation is not a sinus-like variation, but instead consists of only a narrow peak, a whole series of harmonics would be needed to describe its temporal variation. Therefore you should emphasize that the SAO variations that you are investigating are more sinus-like, as you show in Fig.3.

(4) l.67: GNSS-RO temperatures of the wetPrf product may not be fully reliable anymore in the troposphere. For the wetPrf retrieval usually ECMWF analysis temperatures in lower resolution are used as input, and then a 1DVar retrieval is performed to disentangle the effect of humidity and temperature on RO bending angles in the troposphere (Kursinski et al., 2000). Therefore it is not completely clear to which degree the wetPrf product and ECMWF analyses are independent (perhaps this is the reason why GNSS RO and ERA5 agree so well). I guess, you are using GNSS-RO temperatures at altitudes above ~5-8km where they should still be reliable. But still you should add a cautionary note for altitudes below ~5-8km, where biases could exist (see Xu et al., 2017).

References:


Please note that $w^*$ is not the pressure vertical velocity! Please mention the conversion between $w^*$ and $\omega^*$ that you are using!

Here, you should also mention the cooling by upwelling in the tropics.

Please clarify! Did you use both resolved and parameterized terms?

It is not clear to me what the unit "dBmonth" means that is used in Figs.1, 2, and 8. For a temperature response the unit Kelvin should appear somewhere!

The good agreement between ERA5 and GNSS RO could also be an effect of using ECMWF temperatures as input for the wetPrf retrieval.

Here you state that the largest SAO signal would be over the global monsoon regions. I disagree with this statement! Having a look at Fig.2, the strongest signal is seen at 35deg in both hemispheres, as well at places near the equator, and not in the monsoon regions! The monsoon regions are located around 15N and 15S, see:


or:


At latitudes of 15deg the opposite is found in Fig.2: over the monsoon regions, there are minima of SAO PSD, and the signal is mostly insignificant! Particularly, for North America the maximum SAO PSD is found over the Great Lakes, and not over Central America. Also in Eurasia, the maximum is between 35N and 45N, away from the monsoon region. Perhaps it makes sense to compare the locations of the SAO PSD maxima with the
seasonal changes of the jet streams, but this is just a speculation.

(11) Fig.4, Fig.6, and Fig.9:
Please plot from Jan to Jan, and not from Jan to Dec, otherwise the seasonal variations do not look cyclic.
Further, the peak in Dec is not given much space so that it is easily overlooked.

(12) l.225-237:
Can you briefly mention the mechanisms that lead to the SST-SAO, and whether there are global phase variations?

(13) l.292/293: I do not agree with the statement that the SAO is strongest in the monsoon regions.

(14) l.299-301: This is not necessarily an effect of the monsoons. The summer thunderstorm season at midlatitudes would have the same effect.

Technical corrections:

Affiliations:
1: Information -> Information
   Wuhan, China -> Wuhan, China
2: Science, China -> Science, China
   Wuhan, China -> Wuhan, China

l.24: maximum -> maxima
l.54: significant test -> significance test
l.54: diagnose the SAO -> diagnose whether the SAO

l.62: 2008 and -> 2008, and

l.72: whereas -> for this,

l.79 significant test -> significance test

l.82 Details information -> Detailed information

l.85 Both reanalysis -> Both reanalyses

l.110: with R is -> with R =

l.122 MEERA2 -> MERRA2

l.156:
signal overlies on the -> found in the
indicate that -> indicates that

l.158, l.160: than other regions -> than in other regions

Fig.3: labeling of the panels does not match with the figure caption, labeling is a-c-b-d, and not a-b-c-d

l.180: two hemispheres -> the two hemispheres

l.185: the are -> there are
to show in -> and shown in

Overall, ->

January-February -> January-February

but with -> but for the

caption of Fig.7:
at 200 hPa -> at 200 hPa
eddy, heating -> eddy, heating

Eastern Pacific ->

with the Control simulation. -> with respect to the Control simulation.

Figures 8c -> Figure 8c

Figures 8d -> Figure 8d

Compares the magnitude -> if we compare the magnitude

in the three model simulations -> in the three model simulations

to three -> to the three

caption of Fig.9:
The averaged of the extracted SAO singals -> The average extracted SAO signals
(SH) mid-latitudes -> (SH) mid-latitudes (b)
The blue, red -> The red, blue
In the theory of filter amplifiers -> On the theory of filter amplifiers

1.349: doi and page range missing for reference Gelaro et al. (2017)

1.353: doi and page range missing

Units are missing in Figs. S2 and S5

In Fig. S5 Panel (c) is not addressed in the figure caption