

Review of the paper:

“The semi-annual oscillation (SAO) in the upper troposphere and lower stratosphere (UTLS)”

written by Shangguan and Wang,

General comments:

This paper examines the semi-annual oscillation (SAO) of temperature in the upper troposphere and lower stratosphere (UTLS) using the data from satellite observations, two reanalyses, and model simulations. Furthermore, this paper investigates the thermodynamic components which affect the SAO and find the connection between SAO in the surface and SAO in the UTLS. Overall, this is an interesting and well written paper. The manuscript contains material that is of interest to ACP readers. However, there are a few issues that I would like to see addressed before it is suitable for publication.

Specific comments:

- Figure 1, Figure 2, and Figure 8
It is really difficult to understand Figure 1, Figure 2, and Figure 8. I was confused the first time that I read the paragraphs regarding these three figures. The color shading in the figures seems to indicate some variable related to the time period from the unit 'dBmonth' in the figures. However, the texts related to these figures describe the color shading as the strength or magnitude of temperature SAO. The PSD method is briefly mentioned in the end of Section 1. Since several figures and a lot of the results in the manuscript are based on the PSD method, it might be worth introducing the PSD method in more detail and explaining the meaning of 'dBmonth' to guide the readers. If possible, it might be better to connect 'dBmonth' with 'Kelvin' unit.
- L138-L139
I'm not sure how the result is consistent with the results from Fueglistaler et al. (2009)?
- L154-L160
The UTLS SAO is significant almost in the whole zonal band in the middle latitude. Monsoon might amplify the amplitude of the SAO inside of some monsoon regions, but it does not suggest the direct connection between monsoon and the UTLS SAO outside of monsoon regions from Figure 2. Especially, the authors use Asian summer monsoon as an example to prove the influence of the transportation of water vapor and its condensation on the SAO. Does this also apply in the connection between Australian region and SAO? Maybe the authors should clarify the statement.
- The authors mentioned "We then mainly focus on the SAO in the UTLS region (250-175 hPa) in mid-latitudes (22.5 °-42.5°) hereafter in this study." in L142-143. However, almost all the results are about the region in 32.5 °-42.5° since Section 3.2. An explanation is required for taking different regions.

- L207-L209 and Figure 6
There is no new information related to Figure 6 described in the manuscript. I would suggest to remove Figure 6 here and put it in the supplement.
- L219
"by the -vTy term", should it be "by the eddy term"? Please check
- L236-L238
The nearly concurrent UTLS-SAO in the two hemisphere can explain the similar correlation patterns between SH and NH mid-latitude with SSTs, but not between SH/NH mid-latitude and tropical UTLS-SAO with SSTs.
- L248-L251
"However, while the...in extra-tropics is important.", I would suggest to change this sentence as "While the SST-SAO is removed globally, the SAO in the tropical upper-middle troposphere (500-175 hPa) is not significant. However, if the SST-SAO is removed only in the tropics, the upper troposphere SAO in the tropics is still significant, which indicates that the upper-middle troposphere SAO in the tropics is significantly influenced by the SST-SAO in the extra-tropics".
- L257-L258
"Such reduction of..." Maybe the reduction of the absolute magnitude is more evident in the SH/NH compared to that in the tropics. The relative reduction seems comparable given the weak SAO in tropics in the control simulation.
- L258-L260
This sentence just repeats the conclusion in L255-L256. Additionally, it should be "Figure 1d, 8a-b"
- L281-L282 and L308
The modification in the summer moist heating is really small compared to that in the dynamical heating and radiative cooling for SH. I am not sure it is appropriate to make this conclusion for SH.

Technical comments:

- L8
"the winter time ... the summer time maximum" -> "the austral winter time ... the austral summer time maximum"
To avoid the confusion, please check and add "austral" in front of winter and summer for SH in the whole manuscript
- L82
Details information -> Detailed information
- L185
Therefore, the are -> Therefore, there are

- L187
in Figure 5 → Figure 5a
- L190
Figure S4 → Figure S4a
- L216
Abalos et al. (2013) → (Abalos et al., 2013)
- L231
”between the tropical(5°S-5°N), SH/NH mid-latitude UTLS-SAO and the SST-SAO” might be better to change as ”between the SST-SAO and the UTLS-SAO over the tropical(5°S-5°N) and the SH/NH mid-latitude”
- L236
Pacific, whereas the SST-SAO are most pronounced (Figure S6) → Pacific (Figure S6a), whereas the SST-SAO are most pronounced (Figure S5a)
- L256
31% for NH and 55% for SH → 31% for NHM and 55% for SHM
Please check and replace NH/SH with NHM/SHM through the whole manuscript when it is necessary, and add abbreviation about NHM/SHM in proper place ahead
- L263
in Figure 9 → in Figure 9a
- L267
SH (Figure 9b) → SH (Figure 9b) compared to that in the NHM
- L286-L287
except for a relatively large difference with other data sets in the tropical region → except in the tropical region