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Comment on acp-2022-479

Anonymous Referee #1

Referee comment on "Summertime ozone pollution in China affected by stratospheric quasi-biennial oscillation" by Mengyun Li et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-479-RC1, 2022

Stratospheric quasi-biennial oscillation (QBO) is an important climate mode that not only modulates the variability in tropical climate system, but also has potential influence globally and may further lead to possible impacts on air quality. Li et al. examined the effects of QBO on interannual variabilities of tropospheric ozone over China mainly by correlation analysis with the help of GEOS-Chem simulations. It is quite an interesting and novel topic. The manuscript is well-organized and easy to follow. I suggest it to be published after addressing my comments below.

- Lines 62-64: The 'downward transport of stratospheric ozone into troposphere' is usually named by 'stratospheric ozone intrusion'. I suggest authors using the proper terminology here.
- Lines 69: O_3 pollution is getting worse in recent years, not decades. At least the two references did not show trends over 10 years.
- Line 153: If the anthropogenic emissions are fixed in 2017, then why use this simulation to evaluate simulated O_3 interannual variability? I think changes in anthropogenic emissions could significantly influence O_3 year-by-year. Also, I am very confused by the last sentence in this paragraph. Did anthropogenic emissions significantly change between 2018 and 2019?
- Lines 150-151: O_3 concentrations are accounted during summertime, but QBO and Niño 3.4 indices are calculated with annual climate data (If my understanding is right). Will such mismatch significantly influence the results?
- Lines 174-175: The correlation coefficient numbers should be exhibited in one of the Tables or Figures. The same issue also shows in GEOS-Chem process analysis (lines 277, 294-299 and 305). I strongly suggest authors to add one or several figures to show the differences in O_3 budget between QBOW and QBOE.
- Lines 195-197: Although authors did many analyses in this study to show that O_3 differences over China can be significant only when ENSO and QBO were considered together, I still wonder if such insignificant correlations between O_3 and QBO were led by some time-lag effects since the tropical QBO signal may need some time to influence China (although I'm not sure about the exact period…). Could authors try some lag-correlation analysis to examine this hypothesis?
- Lines 287-289: I don't think changes in boundary layer height could influence vertical

O_3 transports between lower and upper troposphere. In addition, I suggest authors to clarify the exact levels of the vertical transport. I guess it is mainly in the free troposphere, since 850 hPa -500hPa is higher than boundary layer, but much lower than stratosphere. If so, I believe such downward transport also cannot be considered as a stratospheric ozone intrusion.

- Lines 317-321: It is interesting that QBO may have higher influences on O_3 in China without anthropogenic emission. Could authors add more explanations here? And I am confused by the statement that this finding is consistent with the significant roles of vertical transport. Does the vertical transport become higher in NO_CHN compared to BASE?
- Lines 329-332: Could authors provide data or numbers to support this statement?
- Lines 366-373: I suggest to increase some discussion in the dynamic mechanism, although it may slightly beyond the scope of this study. At least one significant question needs to be answered: If the related upward-downward motion transition between QBOE and QBOW are important for O_3 in China, why the correlation coefficient between O_3 and QBO index is insignificant? What are possible roles of ENSO in influencing meteorological factors in China between QBOW and QBOE years? I believe further discussion depending on data analysis or literature is necessary.