

***Interactive comment on* “The Impact of Increasing Stratospheric Radiative Damping on the QBO Period” by Tiehan Zhou et al.**

Anonymous Referee #2

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This is the first review of the manuscript "The Impact of Increasing Stratospheric Radiative Damping on the QBO Period" by Tiehan Zhou, Kevin DallaSanta, Larissa Nazarenko, Gavin A. Schmidt, Paper # acp-2020-925. The approach of the paper is to conduct sensitivity experiments using 1-D mechanistic model to find an impact of radiative dumping in the stratosphere to QBO period. Experimental parameters in this paper are Newtonian cooling (α ; unit: s^{-1})/Brunt-Vaisala frequency (N ; unit: s^{-1}), and the upper boundary conditions (G). Diagnostics are monthly zonal wind, and the frequency power spectra using the fast Fourier transform. The results are interesting and relevant to Atmospheric Chemistry and Physics because this paper is trying to ascertain the trend of the QBO period in a warming climate, focusing on the radiative damping that would influence that period. But I suggest a major substantial revision

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since I have serious concerns about generalization and validation of authors' results. (mainly described in the line-by-line comments).

Major comments

1. Statistical significance L047 "the doubling of CO2 shortens the QBO period by 4.7%" What kind of meaning does a value of 4.7 hold for the science? Results of sensitivity experiments using 1D model mostly depend on an assumption of the experimental design, here in Newtonian cooling profiles of Fig. 1. Can you show realistic vertical profiles of Newtonian cooling with standard deviations? And then, you can estimate errors about the shortening of the QBO period, from an assumption of errors of Newtonian cooling.

2. Scale height Scale height would be changed in a warming climate. How does the change of scale height due to the temperature change in a warming climate affect the QBO period?

3. Ozone The ozone also affects QBO period. It is useful for readers to assess an effect of the ozone on the QBO period using 1D model in a warming climate. Shibata, K., and M. Deushi (2005), Radiative effect of ozone on the quasi-biennial oscillation in the equatorial stratosphere, *Geophys. Res. Lett.*, 32, L24802, doi:10.1029/2005GL023433.

L10-16. Why the authors do not show that QBOs simulated in this paper are derived only from planetary waves and that gravity waves are not included? Without manifestation about exploring the response to enhancing radiative damping of only planetary waves in the experiments, their conclusion would lead to misleading.

L15-16. Most climate models project a strengthening of tropical vertical residual velocity, as you mentioned in the introduction. This could contribute to projecting a lengthening of the QBO period, which is opposite direction to the authors' conclusion.

L232. "QBO was not essential for QBO theory" You can estimate QBO power

with/without SAO. To what extent does the SAO impact the QBO power spectrum?

Minor comments L301-323. Redundant descriptions. You can omit most of them.

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