

Responses to the Second reviewer's comments

We sincerely appreciate your time in reviewing our manuscript as well as your suggestion. Please note that the reviewer's comments are written in bold font, and our responses are written using a regular font.

✓ **The paper studies the sensitivity of the Holton-Tan mechanism to global warming and stratospheric geoengineering. This mechanism plays an essential role in different phenomena, from the climate impact of volcanic eruptions to stratospheric aerosol interventions (SAI). To study these complex dynamic processes associated with the interaction of QBO and polar vortex, the authors used may be the best available modeling tools that can simulate QBO dynamics and frequency realistically. I have little to criticize the paper. It is well-written and logically organized, and the scientific approach and the analysis are sound. The only suggestion that could add to the value of this study could be an explicit link to the tropospheric climate responses, like winter warming in high northern latitudes over the Euroasian Continent.**

✓ our response:

We thank the reviewer for the suggestion. Investigating surface influence of the Holton-Tan ought to be done in a model with high vertical resolution. The CMIP6 (standard, 70L) version of WACCM is not useful for such study. In fact, the authors looked at this in the early version of the manuscript but such connection was not found (even in the control run). There is a 110L WACCM6 run through 2100 that is done for the QBOi at NCAR, which is, however, not a geo-engineering run. Hopefully, the future simulations of geoengineering at NCAR will take this into account.

We added the following text to the first paragraph of section 5 (Discussion and Conclusion): "It is worthwhile to mention that the HT relationship in this study only refers to the teleconnection between the QBO and the Arctic stratospheric polar vortex and other aspects of QBO influence such as surface impacts are not studied in this paper. One reason is that investigating the surface influence of the QBO via the stratospheric polar vortex path requires a model with high vertical resolution. The WACCM6 with a relatively coarse vertical resolution of 70 layers between surface and model top at 140 km is not useful for such investigation."