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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Quantifying contributions to the recent temperature variability in the tropical tropopause layer" *by* W. Wang et al.

Anonymous Referee #3

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Review of "Quantifying contributions to the recent temperature variability in the tropical tropopause layer" by Wang et al.

This paper investigates natural and anthropogenic contributions to the decadal variability of the tropical tropopause layer (TTL) temperature. Using a series of sensitivity experiments with NCAR's CESM model, the authors quantify the impacts of solar cycle, SST, QBO, stratospheric aerosol and greenhouse gas increase on the observed TTL warming in the 2001-2011 period. They find that the recent TTL warming is mainly caused by tropical SST decrease and QBO amplitude increase. This paper also highlights the importance of using high vertical resolution in order to correctly simulate TTL decadal variability.

Results presented in this paper are important to understand decadal variability in the TTL. I have some comments, especially on the design of model experiments, to improve the manuscript. I recommend publication after my comments are addressed.

Comments:

What is the benefit of using the fully-coupled CESM-WACCM instead of WACCM? It appears to me that the method used with the stand-alone WACCM runs (section 2.2) is more straightforward. All the runs listed in table 1 can be conducted with the stand-alone WACCM.

Page 22122, How the nudged QBO is done in CESM? I know there are references, but it would be better to have a brief description in the text.

Page 22125, last paragraph, Why don't just repeat the 2001-2011 solar cycle in the nature run? Then there would be more samples to compare with the SolarMean run.

Page 22129, section 3.4, Why increased QBO leads to warming in the TTL? Maybe it is related to the weakening of upwelling in the TTL. If this is true, I suggest the authors compare differences in upwelling in the control and NOQBO runs.

Section 4, It's difficult to follow the discussions. Changes in the residual circulation shown in Figures 10c and 10d are complicated and not easy to explain. I suggest the authors using simple diagnostics, e.g., mean upwelling in the TTL and lower stratosphere, to illustrate differences in the BDC in the high and low resolutions runs.

Figure 10b shows a strong cooling trend in the Antarctic lower stratosphere in the high resolution run? What causes this cooling? Is it related to the Antarctic ozone hole? A more general question is how stratosphere ozone depletion might affect TTL temperature variability.

Summary, I think it would be helpful to add a simple figure summarizing the contribution of different factors to the TTL decadal variability.