

## **Response to Referee Comments of Referee 2**

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**Title:** Signals of El Niño Modoki in the Tropical Tropopause Layer and Stratosphere

**We are very grateful for the reviewer's helpful comments. We have modified our paper according to the comments. Our replies are summarized as below:**

### **General Comments:**

*El Nino Modoki is a mode of tropical SST interannual variability identified in recent years. How the atmosphere responds to such an interannual SST mode has been a hot topic in recent years. In the paper, the authors performed comprehensive studies on responses of the tropopause and the stratosphere to El Nino Modoki and compare it with that responding to the conventional mode of El Nino, using reanalysis and satellite data as well as GCM simulations. They show significant different responses of the tropopause and stratosphere to the two types of El Nino. Especially, their simulations greatly help us understand this issue. The paper is acceptable in general sense. The following specific comments are for the authors to make minor changes.*

### **Specific comments:**

*1. In many places of the paper, the authors say their results are consistent with previous studies. It sounds like that the paper does not make new progress, although it is not the case. It would be better to make it clear: what is new in the present paper, and what has been done by others.*

### **Response to Specific comment 1:**

**Thanks very much for the helpful comment. The results, which we say are**

consistent with previous studies, are mainly composite anomalies during typical El Niño events. The typical El Niño anomalies have been broadly analyzed in previous studies. In the paper, the typical El Niño anomalies are used to compare the anomalies caused by El Niño Modoki. Now, in the revised paper, we modified the texts in many place to make it more clear: what is new in the present paper, and what has been done by others.

2. *In general, the paper is written well and readable. However, it appears that there is space of writing improvement. I will list some errors below. I hope the authors check the paper carefully.*

#### **Response to Specific comment 2:**

**Thanks very much for the corrections for our paper writing. The errors, which pointed out in our paper, have been carefully corrected in the revised version.**

3. *Figures 4, 5, 7: The spatial patterns in these figures look very like tropical Rossby wave modes responding to stationary equatorial heating or stationary tropical SST anomalies. If authors agree with this, it would be great to address this in interpreting their results. It may also be a topic for future studies.*

#### **Response to Specific comment 3:**

**It is a very good suggestion. In the paper, we mainly focus on the different effects of typical El Niño and El Niño Modoki on atmosphere, but preliminary explain some reasons what cause the different effects. Actually, this is a part of our other work which focuses on investigating the influence of tropical SST changes on tropical tropopause temperature interannual variations in the past six decades. The new work will answer the question.**

4. *Section of stratospheric water vapor: Is it possible to interpret why water vapor has such vertical distributions in Figure 8.*

#### **Response to Specific comment 4:**

Stratospheric water vapor is mainly controlled by the tropopause temperature, it is also affected by the cross tropopause transport of the water vapor. Among others, the large scale Brewer-Dobison (BD) circulation has an important modulation of stratospheric constituents including water vapor. El Nino events have an impact on both the tropopause temperature and BD circulation which have different effects on water vapor concentration in the lowermost, lower and middle stratosphere. A detailed analysis of the vertical distributions of stratospheric water vapor anomalies during El Niño events can be found in Xie et al., (2011). Nevertheless, the analysis of stratospheric water vapor anomalies during El Niño events based on MLS data has been deleted since the MLS data is too short for composite analysis.

#### **References:**

Xie, F., Tian W.S., Austin J., Li J.P., Tian H.Y., Shu J.C., Chen C.: The Effect of ENSO Activity on Lower Stratospheric Water Vapor, Atmos. Chem. Phys. Discuss., 11, 4141-4166, doi:10.5194/acpd-11-4141-2011., 2011.

5. *Interaction with QBO: the results of QBO experiments are interesting. However, it would be better not to attribute the simulation results to linear or nonlinear interaction or overlap. This is because the forced QBO would modify tropical stratospheric flows. Changes in tropical stratospheric flows consequently influence tropical wave modes excited by tropical SST anomalies. Thus, it is complicated sequences, rather than linear interactions.*

#### **Response to Specific comment 5:**

**We have modified the text to explain this problem in the revised paper. Thanks for the good comment.**

#### **Technical issues:**

1. *Page 3620, L27: However → By contrast*

**Thanks. We have modified this.**

2. *P3623, L7: delete “the ” after between,*

**Thanks. We have revised this.**

3. *P3623, L18: analyses → analyzes,*

**Thanks. We have corrected this.**

4. *P3624, L24: recorders → records*

**Thanks. We have corrected this.**

5. *P3625, L4: than can be → than that can be*

**Thanks. We have revised this.**

6. *P3627, L4: with the results of → with that of*

**Thanks. We have modified this.**

7. *P3627, L27: than do → than typical El Nino activities do*

**Thanks. We have modified this.**

8. *P3633, L5-L10: Figure 9a shows decreased EP fluxes. It indicates that wave-driven dynamic heat is reduced in the polar region. This could be the major reason in causing polar cooling. Of course, the decrease in EP fluxes should cause less ozone transported to the polar region.*

**We completely agree with this comment. We have modified the explanation for the question following this comment.**

9. *P3633, L20: Nevertheless → In contrast*

**Thanks. We have modified this.**

10. *P 3634, L1: contributes to → is associated with*

**Thanks. We have revised this.**

*11. P 3637, L9: time series data → data*

**Thanks. We have modified this.**

*12. P3637, L14: canonic Modoki events → canonic El Nino events?*

**Thanks. We have corrected this.**