

## ***Interactive comment on “Response of stratospheric water vapor and ozone to the unusual timing of El Niño and QBO disruption in 2015–2016” by Mohamadou Diallo et al.***

### **Anonymous Referee #1**

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General Comments: This is an excellent manuscript that addresses the important topic of stratospheric water in present processes and in a changing future climate.

There is a debate in the literature whether the 2015-2016 El Niño event dominated changes to lower stratospheric water [Avery et al., 2017] or whether the QBO disruption played a larger role [Tweedy et al., 2017]. Here, the Diallo et al. manuscript aims to resolve this debate by quantifying the impact of the interaction between the most recent El Niño event and the QBO disruption on stratospheric H<sub>2</sub>O and O<sub>3</sub> from spaceborne measurements during 2015–2016. The paper admits that disentangling the effects of these two processes is challenging, but achieves this quite successfully with a multiple

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regression model.

The anomalous stratospheric circulation in boreal winter of 2015–2016 is described. The authors show evidence for the impact of the El Niño event and QBO disruption on stratospheric H<sub>2</sub>O and O<sub>3</sub>, and discuss the results in the context of anomalous stratospheric water vapor. In particular, their results suggest that the interplay of ENSO events and QBO phases will be crucial for the control of the lower stratospheric H<sub>2</sub>O and O<sub>3</sub> budgets under changing future climate.

Overall, this is an excellent paper that I recommend for publication after minor revisions (see comments below). The paper is a well-written substantial contribution to scientific progress, with relevant science questions, novel multiple regression analysis tools, and substantial conclusions quantifying the interplay of ENSO and QBO. The results are sufficient to support the interpretations, which have widespread impact. The authors do an excellent job of giving credit, citing the literature, and indicating their own original contribution. I have very few comments because I generally like this manuscript.

Specific comments:

1.1) Page 4, lines 14-15: How accurate are ERA-Interim temperatures in the tropical tropopause layer? Could you please address this?

1.2) Page 4, line 16: the simplified dehydration scheme in CLaMS may be an oversimplification of the microphysical processes that occur in the tropical tropopause layer, controlling water entering the stratosphere. For instance, supersaturation is common in the upper troposphere. Also, stratospheric entry-level value of water vapor is strongly dependent on temperature (see my point 1.1). How do we know that the processes that control stratospheric water are properly represented by the reanalysis meteorology (ERA-Interim) in combination with the CLaMS transport model?

Admittedly, the remarkable similarity of Figures 4 and 5 lends confidence to the CLaMS model, but one should be careful about interpretation because of the MLS vertical

resolution of  $\sim 2.5$  to 3 km for H<sub>2</sub>O. Is this vertical resolution similar to the model, or mismatched with the model?

1.3) Page 6, lines 26-28: given the MLS vertical resolution, how do you separate tropospheric water vapor anomalies from stratospheric anomalies?

1.4) In your conclusion, page 10, lines 30-32, you conclude that your “results suggest that the interplay of ENSO events and QBO phases will be crucial for the control of the lower stratospheric water vapor and ozone budget under changing future climate. . .” Do you address the separate impact of future changing tropopause height/tropopause temperature on stratospheric water?

Technical corrections (minor): 2.1) Page 3, line 11: I do not like the word “unprecedented” because you actually mean to say “previously unobserved”. ENSO, QBO and stratospheric water vapor have only been monitored during the era of satellite observations. A similar interplay between ENSO and QBO could have occurred in the historic or even geologic record.

2.2) Page 8, line 27: I recommend that you replace “unprecedented changes” with “changes larger than previously observed”.

2.3) Figure 1: Please define the horizontal black lines in the Figure 1 caption. Are these Pressures?

2.4) Figures 1,2,3,4,5: I recommend that you label the x-axis with “year”.

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