Reply to anonymous Referee #1

The authors' lack of interest in the spatial variations of the BDC and QBO regressors should not hinder publication (referring to their response to my second recommendation in the initial review). However, the spatial variations in the delta T regression coefficients (Figure 4) are a key part of the paper's argument that convection is moistening the TTL.

The authors need to give a quantitative explanation of why the spatial variations in the BDC and QBO coefficients are less important for water vapor variability than the spatial variations in the delta T coefficient.

Response: As discussed on page 6 lines 3-7, the trajectory model accurately reproduces the features of the BDC and QBO coefficients (see the consistency shown in the scatter plots in Figs. 2 and 3). That is not the case for the T coefficient, which is why we focus on that one. We already make this point, but we?ve added one sentence to make this explicit (page 6 lines 7-8).

We have also added tropical average BDC and QBO coefficients from observations and trajectory model simulations in section 3.1 to emphasize the good quantitative agreement (page 5 lines 24-26, 27-28 and page 5 line 33- page 6 line 1):

> Page 5 Lines 24-26: "The average BDC coefficient in the MLS/ERAi regression (Fig. 2a) is -2.6 $\mathrm{ppmv}\ (\mathrm{K\ day^{-1}})^{-1}$, in good agreement with the average value from the accompanying trajectory regression (Fig. 2b), -2.4 $\mathrm{ppmv}\ (\mathrm{K\ day^{-1}})^{-1}$"
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> Page 5 Lines 27-28: "The average BDC coefficient in the MLS/MERRA-2 regression (Fig. 2d) is -2.3 $\mathrm{ppmv}\ (\mathrm{K\ day^{-1}})^{-1}$. The average coefficient from accompanying trajectory regression (Fig. 2e) is -1.4 $\mathrm{ppmv}\ (\mathrm{K\ day^{-1}})^{-1}$."
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> Page 5 Line 33- Page 6 Line 1: "For the MLS/ERAi comparision (Fig. 3c), the average QBO coefficients are 0.084 $\mathrm{ppmv}\ (\mathrm{m\ s^{-1}})^{-1}$ and 0.075 $\mathrm{ppmv}\ (\mathrm{m\ s^{-1}})^{-1}$; for the MLS/MERRA2 comparison (Fig. 3f), the average coefficients are 0.14 $\mathrm{ppmv}\ (\mathrm{m\ s^{-1}})^{-1}$ and 0.15 $\mathrm{ppmv}\ (\mathrm{m\ s^{-1}})^{-1}$."

Reply to anonymous Referee #2

The authors have done a reasonable job of addressing my previous comments and revising the paper. I appreciate the new results in Fig. 6a showing how observed convective cloud occurrence frequency changes with mean tropospheric temperature, but I would like to see a little more detail on these results in the final version of the paper.

In particular, the variations in convective cloud frequency at 370 K in Fig. 6a are $\sim 0.01\%$, and I wonder how large this signal is compared to background values (i.e. how large are the fractional variations?).

Also, since the cold point is above 370 K (e.g. Seidel et al, 2001, JGR), how do these observed variations at 370 K mesh with the statement on p. 2, line 6 that "only convection reaching above the cold point is likely to significantly impact the humidity of the stratosphere"?

Response: To address these two linked comments, we first now plot data at 390 K instead of 370 K. We also changed the GEOSCCM convective IWC from 118 hPa to 100 hPa. The conclusions are not altered by this change.

To better show the magnitude of the changes, we now plot the percent change in cloud frequency in Fig. 6a (the convective cloud frequency anomaly divided by the mean convective cloud frequency).

We have also added the magnitude of the tropical average convective cloud occurrence frequency at 390 K to the text (Page 20).