

Interactive comment on “Stratospheric water vapour and high climate sensitivity in a version of the HadSM3 climate model” by M. M. Joshi et al.

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Replies to reviewer 2: *reviewer’s comments in italics*

Please see attached pdf for revised manuscript as supplemental material

Several general comments can be made:

1. The paper needs some substantiation in points. The base climatology of stratospheric water vapor in the STD case should be shown, and this should include the UTLS region for STD and LEP cases

We have now added plots of q for STD1, and have extended the plots down to the UTLS region

C3744

2. I am perplexed why no explanation for the increase in water vapor in the runs is given. In STD and LEP simulations, what is the mechanism for water entering the stratosphere? This is necessary to make a reliable determination of whether the model is reasonable or not. Is enhancement in H₂O in the UTLS due to changes in the cold point tropopause temperature? What is the cold point temperature difference between the runs (STD 1 2, LEP 1 2)? Is there convection above the cold point or not? Is the annual cycle of water vapor in each of the 4 simulations reasonable? Why or why not?

We have now put in extra wording and figures to flesh this out. We now include a figure for tropical temperature in the STD and LEP cases, and show plots of water and vertical velocities in JJA that show how extra water is uplifted into the stratosphere preferentially in JJA. The stratospheric water cycle is reasonable in CON1 and CON2, but as we now say in the text, does not appear to be reasonable in LEP1 and LEP2 (it not being controlled by tropical cold-point temperatures)

3. There is now a literature of model diagnostics in the UTLS through the Chemistry-Climate Model Validation (CCMVal) project, and a recent report on coupled chemistry climate model performance in the UTLS region is now available. This should be used as a guide to understand better the mechanism for regulating stratospheric water vapor in the runs.

We have placed extra diagnostics and plots in the paper. The stratosphere of HadCM3 is poorly resolved (also see answer to reviewer 1); as a result many stratospheric diagnostics would appear poor in HadCM3: part of the *raison d’être* of the paper is to show that stratospheric processes must be handled better if results such as the LEP1 and LEP2 cases are to be believed.

Specific Comments:

p6244, L20: Show STD1 STD2 water vapor distributions. I would recommend also showing a zonal mean equatorial time-height plot (A tape recorder plot) from both STD and LEP runs.

C3745

We thank the reviewer (as well as reviewer 1) for pointing this out. We now have plots for STD1- (STD2 is less than 0.5 ppmv different from STD1- we state this in the text). The tape recorder is valid if stratospheric water vapour is controlled by the tropical cold point temperature, which appears not to be the case in LEP1, which is why we show where the elevated water is coming from.

P6244, L22: what is the change in q between STD1 STD2?

The change in stratospheric q is less than 0.5 ppmv- we now state this in the text

P6245, L7: "Fig 1, grey dashed line" what does this refer to?

Apologies- this is a typo and has been removed.

P6245,L7-12: Show the entire UTLS in the plot: i.e.: down to the extratropical tropopause at say 300hPa at least. Also, temperature and cold point temperature should be shown as noted above.

We have extended the plots down to 300 hPa, and separately show tropical temperature profiles

P6245, L13-17: show the radiative forcing (at least zonal mean in latitude). Is this tropopause or TOA?

This is a very good point- we have included a longitude-latitude plot of the difference in tropopause forcing which does nicely bring out where SWV amounts are raised in LEP1 compared to STD1. This is a tropopause forcing, which we state in the text.

P6246, L17: Please add a few more sentences of description of the Webb 2006 method. The current text is not interpretable without the Webb paper now. I am not familiar with the method and have no idea what you are doing in the rest of the paragraph.

We thank the reviewer for noting this. A description of this method is now in the text.

C3746

P6248, L22: as noted, further work needs to be done here to examine mechanisms for the water vapor increase. Temperature and cold point temperature, and convective heights need to be examined.

We now discuss in detail the temperature and cold point temperature (with plots of the relevant quantities). We show that the JJA subtropical summer appears to be responsible for the bias in LEP1 and LEP2

Fig 1: Caption should state that values are in PPMV. Include a color bar for both panels.

We now state the contour interval in the caption: we have replaced the shaded plot with a contour plot, with contour intervals labelled in situ.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/10/C3744/2010/acpd-10-C3744-2010-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 6241, 2010.

C3747