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Discussions

Interactive comment on "The millennium water vapour drop in chemistry-climate model simulations" *by* S. Brinkop et al.

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General comments:

(1) The authors are not native English speakers and thus the paper needs some through grammatical editing and improved organization. For example, the first sentence is almost incomprehensible. Long sentences are common in German, but are considered bad grammar in English. A better first sentence would be: Since the early 1980's climate models have predicted a increase in stratospheric water vapor [refs]. Satellite and balloon borne measurements have not yet observed such an increase.[refs].

(2) A key missing reference in this work is "Dessler, A.E., M.R. Schoeberl, T. Wang,

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S.M. Davis, K.H. Rosenlof, and J.-P. Vernier, Variations of stratospheric water vapor over the past three decades, J. Geophys. Res., 119, doi:10.1002/2014JD021712, 2014." Reprint This work describes how the QBO, diabatic heating, and the tropospheric temperatures can be use to successfully model stratospheric water vapor including the year 2000 water vapor drop. The implication of this work is that unless models get the three components that contribute to the drop correct, they will not be able to simulate the drop. This paper is extremely relevant to this work, and it is somewhat surprising that the authors were unaware of it.

(3) I think that the model discussion (Section 2.1) is totally confusing – at least to someone outside the CCMI world . I feel like a diagram of what models are being used for what components of the simulation. There are references to hindcast simulations, nudging to ERAI, etc. The model sounds like a pile of components – which does not give me confidence in its veracity – nor does its rather poor simulation of the tape recorder (see below)

(4) The main point of this paper is to show that ENSO, combined with the west phase of the QBO can product sufficient upwelling (cold temperatures in the UTLS) to produce the water vapor drop. The "event analysis" appears to support their conclusions – at least with the nudged model. The main problem I have is that there are other water vapor anomalies not associated with ENSO (for example the most recent). By not analyzing these events, their conclusion is foregone. This problem can be repaired if the authors analyze some drop events not linked to ENSO and compare them with ENSO linked events.

Specific comments: (pg:line)

2:1 Water vapor is an important greenhouse gas in the troposphere. It isn't so clear it is as important in the stratosphere. I would delete this sentence and instead reference the Solomon et al. [2010] paper showing the impact of stratospheric water vapor on the surface radiative balance.

2:12 The analysis by Dessler et al. shows that the to reproduce the water vapor field, you need the QBO, among other things. This means that models that fail generate a QBO (which is most of them) will naturally fail in generating the water vapor time series. I note that this model does include a QBO (4:27) which is good.

4:22 What hindcast simulations? – what are you talking about here?

4: I think it would be helpful to have a table describing the models and their differences (RC1SD, RC1SDNT, RC1, RC2) that show up in Figure 4 as a quick reference.

5:2 I object to the words 'model data' better is 'model output'

5:22 Fair point!

6:5 What is 'It' – the chart, the measurements, the curve?

6:8 'specified dynamics' – below you call this 'EMAC .. nudged mode' I think you should be consistent, or I am not understanding something.

6:28 The model average (in Gettelman et al., 2009) is cold biased but only by about a degree. More models are above the model mean than below – and the spread is large – almost 10K. I think that the text could be more precise.

7: I think that it is obvious that the cold tropopause temperature anomaly reduces water vapor and that signal propagates into the stratosphere (a bit asymmetrically). Something like this statement would be a nice way to summarize the discussion of Figure 3.

Figure 3. Please put titles on the individual figures.

8:11 How does it point to a shift in 'temperature relevant processes'? What are you talking about here? Why does this point to ENSO? I think something is missing here.

8:25 Please provide a reference to this statement 'propagates… lower stratosphere' Maybe reference Calvo et al. 2010?

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9:25 I think it is obvious from Figure 6 that the causal relationship is weak to non existent. Why all the discussion about it?

9 Okay, I get that RC1SD has problems for Mt. Pinatubo and I also get that you should see a surface temperature anomaly for (Fig. 7) – I think that the authors can just state this rather than waste time discussing it. Fig. 7 only shows that RC2 is not useful – which the other figures already indicate.

9:26 I am confused by this sentence. Are you now saying that there is no relationship between ENSO and water vapor drops?

10:7 You should also reference the Dessler et al. paper noted in the general comments here.

10:14 There are also positive anomalies in non ENSO years such as 1976, 2000, 2006.

Figure 8 Please title the figures.

Figure 8 – the tape recorder signal looks funky to me. The amplitude is way too weak. The authors need to comment on this or provide more explanation. It would be useful to produce the observations in Figure 9 along with the model runs. I am attaching a tape recorder figure. The amplitudes is a lot larger.

10:21 Ozone anomaly? Where is this shown?

10:25-30 Just use correlation coefficient (not Pearson's correlation coefficient). These correlations aren't very strong.

10:29 decreases at lower altitudes.

11:4 also see Schoeberl et al. , J. Geophys. Res, 113 Doi: D24109, 2008 for vertical velocity calculations using the observed tape recorder.

11:14 Basically what the authors are saying here is that they assume that all these other processes (like convection) and that the water vapor drop is primarily tempera-

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ture driven. However, during ENSO there is a significant collapse in western Pacific convection which provides about 30% of the water vapor to the UTLS. Thus I don't think that it is a good idea to assume that convection is unimportant. In any event, I presume these models include convective processes and water vapor transport so that they are probably included in the correlation.

11:21 But there are strong upwelling periods not near ENSO .. so the data doesn't quite fit the hypothesis. In fact the biggest (model) upwelling is in 2005 in Fig. 9 - nowhere close to an ENSO event.

11:30 The episode analysis described in the next few pages and in the Figures 10 – 14 but I have to wonder if the results are also true for drop episodes not associated with ENSO. For example, just pick a period of temperature decline not associated with ENSO. The authors are selecting events and making an assumption that the water vapor drops are all produced by the ENSO events – the correlation is weak it seems from the previous figures. While ENSO events appear to contribute, they are just one component of the whole system producing the drop such as the phase of the QBO.

13:31 So you conclude that it is the coincidence of ENSO upwelling and west phase of the QBO that produces lower temperature anomalies and the water vapor drop. Yes?

14:1 what level is Figure 15 plotted for, 80hPa? What are the units, vertical velocity?

Figure 16. The 72/73 case sort of blows your hypothesis since the lag is 36 months – longer than a QBO cycle.

15:1-14 RE SSTs-> more convection -> more waves. How is that relevant to this study?

15:17 First use of UTLS – please define.

15:24 Please provide a reference to " cold point is slightly too high" – how do we know this. How would too high a cold point lead to reduced variability (next sentence) I can see that it might lead to an overall bias but not reduced variability.
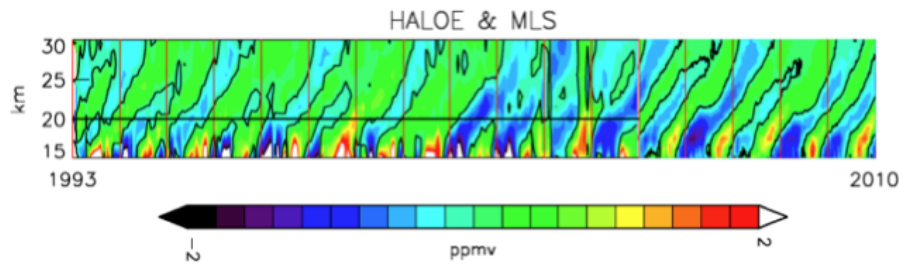
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16:12-15 What are you trying to say here?

Fig. 1. tape recorder

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