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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Impact of Volcanic Eruptions of Different Magnitude on Stratospheric Water Vapour in the Tropics" *by* Clarissa Alicia Kroll et al.

Anonymous Referee #2

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Review of "The Impact of Volcanic Eruptions of Different Magnitude on Stratospheric Water Vapour in the Tropics" by Kroll et al.

Overall, this is an interesting paper on how volcanic eruptions perturb stratospheric water vapor.Âă I particularly like the novel data set âĂŤÂăa large ensemble of model simulations containing volcanic eruptions.Âă Overall, I judge this paper to be publishable after correction of a few points âĂŤÂăI don't think these are hard, but they are important to address.

* The calculation of the forcing needs to be better explained.Âă In Solomon et al. (2010) and Dessler et al. (2013) papers, forcing was estimated using a fixed dynamical heat-

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ing assumption (Fels et al. 1980), where it is assumed that the stratospheric circulation remains fixed), so the temperature adjusts to maintain the heating rates.Âă This is not what they're doing here.Âă They're letting temperatures adjust completely to changes in SWV.Âă I think this is close to what was done in this paper (which should probably be cited): Huang, Y., Zhang, M., Xia, Y., Hu, Y., & Son, S.-W. (2016). Is there a stratospheric radiative feedback in global warming simulations? Climate Dynamics, 46(1), 177-186, doi:10.1007/s00382-015-2577-2 I should add that Huang, Y., Wang, Y., & Huang, H. (2020). Stratospheric Water Vapor Feedback Disclosed by a Locking Experiment. Geophysical Research Letters, 47(12), e2020GL087987, doi:https://doi.org/10.1029/2020GL087987 found a very small net feedback when temperature and water vapor are both allowed to adjust.Âă

In any event, they need to more completely discuss the fundamental assumptions that go into the calculation of TOA forcing and how it is the same or different from what previous investigators have done.

A related issue arises in Section 3.6. Here, they talk about forcing, but they're really looking at flux differences at various altitudes. I don't think this is commonly referred to as "forcing", which is normally a TOA quantity. This needs to be clarified.

* What is the cold point? A lot of analysis in the paper are of the temperature and location of the cold point. They need to explain how they calculate that. Is this the coldest temperature on one of the model's pressure levels, or are they doing some kind of interpolation to find the lowest temperature, even if it is between the model levels?

They also need to mention that the model has relatively poor vertical resolution around the tropical tropopause. I'm not sure this will interfere with their conclusions, but it might and they should probably mention this as an uncertainty in the paper.

* "However, the water vapour enters the tropics mainly in the inner tropical region and then spreads throughout the globe, leading to values lower than expected according

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to the Clausius Clapeyron equation." This statement and the analysis around it are built on a conceptual error. The process of entering the stratosphere and the process of dehydration are different and they can occur in different locations and on different time scales. Entry of air into the stratosphere occurs everywhere in the tropics were tropopause heating rates are positive. This is almost all of the tropics. Dehydration, on the other hand, tends to occur mainly over the deep tropics (Fig. 8 of Schoeberl, M. R., & Dessler, A. E. (2011). Dehydration of the stratosphere. Atmospheric Chemistry and Physics, 11(16), 8433-8446, doi:10.5194/acp-11-8433-2011). That's why you get such a good agreement vs. deep tropical temperatures.

One other note: I'm surprised that there's such good agreement between zonal average temperatures and water vapor. One paper that might be of interest is Oman, L., Waugh, D. W., Pawson, S., Stolarski, R. S., & Nielsen, J. E. (2008). Understanding the changes of stratospheric water vapor in coupled Chemistry-Climate Model simulations. Journal of the Atmospheric Sciences, 65(10), 3278-3291, doi:10.1175/2008jas2696.1, which shows that it is the temperatures in the limited dehydration region that really matter.

* code availability: The code and data availability statement does not actually tell the reader where the code and data can be downloaded from. I know that the MPI GE can be obtained from the ESGF, but where are the other data sets available? If they're not making these available, they should come right out and say it. Also, are they archiving their analysis code?

More minor comments: Water vapor is expressed in the paper as mass mixing ratio (ppmm). This is highly non-standard and makes comparison to the rest of the literature, which almost exclusively uses volume mixing ratio, harder than it needs to be. I would go through the paper and convert ppmm to ppmv.

In various places in the paper, such as on figure 3, it says "10ˆ6 per meter extinction".Âă Maybe I'm missing something, but that doesn't sound right âĂŤÂăshould it be 10ˆ-6?

The paper is already quite long.Âă I would suggest removing the paragraph beginning on line 94 ("In the following ...").Âă While I understand the desire to put this material here, let me assure you that no one actually reads these paragraphs.

The paper is not terribly written, but there are a lot of grammar errors. One frequent error was a missing comma after an introductory phrase (https://www.grammarly.com/blog/commas-after-introductory-phrases/). For example, on line 175, it says: As a consequence of the negative TOA imbalance the surface temperatures ... but there should be a comma after imbalance. That error is made repeatedly and should be fixed. In general, the paper would benefit from a close-read from a native english speaker.

Fig. 4 shows SWV at 100 hPa, but 100 hPa may not be in the stratosphere in the tropics.

The use of so many footnotes is unusual and seems odd. I guess I would encourage the authors to ask themselves whether this material really needs to be in a footnote. If it's sufficiently important, it should be in the main text. If not, perhaps it can be left out.

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