

Interactive comment on “Impact of major volcanic eruptions on stratospheric water vapour” by M. Löffler et al.

M. Löffler et al.

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We thank referee #2 for the comments. Here are our replies:

- *The paper investigates the impact of past volcanic eruptions on stratospheric water vapour. The subject of the paper is suitable for ACP and understanding long-term variability in climatic gases, in particular water vapour, is of importance for our understanding of the Earth system. However, I do have some concerns regarding the paper, which I hope can be rectified.*

Reply: Thank you for the summary. We hope that our replies will dispel your concerns.

- 1) *Experimental setup: I understand that all nudging methods have to compromise. However, it is not clear to me why the authors have chosen to exclude the optical but not the chemical impact of volcanic aerosols on the system. Presumably the heating change will be the leading order effect, but changes in composition might counteract or support the heating rate changes (e.g. ozone anomalies will impact heating rates as well). Please explain in more detail what you can or cannot conclude from the experimental setup.*

Reply: The reason was to exclude the secondary effects of the volcanic aerosol (via heterogeneous chemistry and corresponding radiative forcing, e.g. via ozone), but rather to isolate the primary effect of the direct aerosol induced heating. We add this information to the revised manuscript (Section 2.2).

Moreover, the experimental setup is explained in more detail in the revised Section 2.3 (Methodology) and the discussion on conclusions and limitations is extended.

- 2) *Observational backing: The paper lives in the “model world” only. I really miss some direct links to observations (apart from sometimes confusing citations of observational evidence in the text, see example below). It would be good to know if the model with the aerosol effect fully included captures the observed variability well. At the moment the paper is a nice technical sensitivity study without a solid link to the real world. This in itself is not a problem, but the authors sketch out a mechanism, which might not have a link to the “real world”.*

Reply: Here you agree with a similar comment by Theodore Shepherd. And as we point out in our reply to him, we also agree. The revised manuscript contains a comparison with observations.

- *In summary: I feel the paper requires a significant re-work with a better link (illustrated with one or two figures) to observational evidence and a contextual link to the data used to “drive” the model: How freely can the temperature structure*

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evolve compared to the reanalysis? What is the water vapour signal in the reanalysis?

Reply: As stated above, we show an inter-comparison to observational data in the revised manuscript. A comparison to ERA-Interim data is also included.

- *Unfortunately I found the paper hard to read. Here are some examples of what could be improved:*

P34408, I18: Everything is know? Please rephrase . . .

Reply: We reformulated the sentence.

- *P34408, I20: Please avoid negations (“not only”) . . .*

Reply: Removed.

- *P34412, I25: What does “in some parts” mean?*

Reply: This and the subsequent section have been reformulated in accordance with other comments referring to the nudging procedure.

- *P34417, I119: What has this to do with the stratospheric fountain?*

Reply: Nothing. We removed this sentence as it is misleading.

- *P34420, I23: Not sure what the message of this paragraph is. Different peaks in different plots? Please simplify (short sentences, direct comparison, is it your model or the reanalysis you are using that is causing the differences?)*

Reply: This paragraph is part of a comparison with other model simulations and observations and subsequent discussion. The message in line 23 is that we found two maxima in our water vapour signal, similar as Considine et al. (2001)¹.

¹Considine, D. B., Rosenfield, J. E., and Fleming, E. L.: An interactive model study of the influence of the Mount Pinatubo aerosol on stratospheric methane and water trends, *J. Geophys. Res.-Atmos.*, 106, 27711-27727, doi:10.1029/2001JD000331, 2001. 34410, 34419, 34420, 34421

Nevertheless, we agree that this text passage should be simplified and we did so in the revised manuscript.

- *P34422, I6: Why not use Figure 10 to summarise in a concise way what you think is going on?*

Reply: Indeed, the purpose of Figure 10 was exactly this. In the revised manuscript we refer to it, where appropriate and expand the summary accordingly.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 34407, 2015.

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