Review of the manuscript

The Model Intercomparison Project on the climatic response to Volcanic forcing (VolMIP): Experimental design and forcing input data

by D. Zanchettin et al.

submitted for publication in Geoscientific Model Development

General:

The manuscript presents a protocol for investigations of the impact of volcanic eruptions on different time scales on climate in the framework of the Coupled Model Intercomparison project CMIP6 – The manuscript is well written, the background introduced in an adequate manner and the arguments carrying out the specific sensitivity studies are addressed properly. Also connections to other CMIP6 initiatives such as PMIP are outlined and interrelations are presented. However, some issues might be improved and/or extended, to improve the readability of the manuscript, especially for readers or modelling groups that are not in the core of the topic related to the volcanic impacts on climate.

I recommend the final publication of the manuscript when the minor points below are addressed in the revised version of the manuscript.

Specific:

Introduction

The authors state in their paragraph on synergies with other CMIP6 activities the connection to "Clouds and atmospheric circulation" – I suggest including a paragraph on the potential impacts of volcanic eruptions on cloud formation (cf. suggested additional references) and the importance of the aerosol microphysical schemes implemented within the respective models (refs. 1–5).

A second issue relates to the (empirical) data side currently available for comparison with simulated response on past/historical volcanic eruptions – A paragraph addressing the data issues in terms of observations of volcanic eruptions can add the awareness that to date only the Pinatubo eruption is well documented based on satellite and meteorological observed data. For larger eruptions like Tambora or Samalas mostly proxy reconstructions are available afflicted with non-climatic influences and limited spatial coverage (refs 6–10).

2. Experiments: rationale and general aspects:

ll. 175 ff: The authors state that the VolcLong experiments should allow investigations on the response of the deep ocean – I wonder if a decade long simulation ("up to a decade time scale") could allow for such investigations. Therefore I suggest to increase the simulation time to at least 50 or better 100 years or to restrict the analysis to the mid- and upper oceanic response.

2.1 VolcShort

2.1.2 VolcShort-Eq-surf and Volc-Short-Eq-strat

ll 226. The authors state the DynVar diagnostics must be calculated. Some words on how this should be realized (with a link to the appendix) would be helpful as this experiment is labeled as Tier1 (mandatory) simulation and therefore it should be warranted that the information could be obtained via the VolMIP protocol outlined in this manuscript.

2.2 VolcLong

2.2.2. VolcLongSingle-HL

An idea to complement the Northern Hemisphere eruption is to propose an additional (non-mandatory) experiment for a high latitude Southern Hemisphere eruption. Processes over the SH are more complex in terms of direct thermal response because of the vast oceanic areas – This kind of experiment would however allow comparison with eruptions of similar magnitude over the NH.

3. Forcing

3.3 VolcLong

An extension to the proposed experiment is to carry out experiments with different amounts of sulfur ejected during the 1809 and 1815 eruptions (within certain empirically constrained ranges) – This would allow not only to test the sensitivity to the background conditions but also to get an idea how strong uncertainties of the simulated climatic response are due to the magnitude of the volcanic forcing.

Both, the VolcLongSingle-HL for the high latitude southern hemisphere and the VolcLong-Cluster-Mill for different sulfate ejections of Tambora should be relatively easy to implement given the respective forcing data sets (one for an high latitude southern hemisphere eruption and possibly two additional Tambora [one larger 60 Tg, a second lower 60 Tg] are provided by the protocol.

4. Follow-up research and synergies with other modeling activities

In this chapter a paragraph addressing experiments that were not proposed in the present VolMIP protocol could also stimulate further initiatives and experiments. This relates for instance to sensitivity studies in the context of the exact timing of the eruption within the seasonal cycle, direct (interactive) simulation with a more realistic point-source of the eruption, sensitivity studies related to aerosol microphysical schemes, and the potential impacts of future eruptions under anthropogenically changed background conditions (cf. also Short comment and proposal by I. Bethke) with volcanic eruptions trajectories constrained by historical eruptions.

Minor comments:

l 130: I suggest rephrasing the term "increase the SNR" to "assess the SNR". Especially in the context of comparisons between simulated and empirical data, noise is an integral part of the system.

ll 390ff: The authors mention a couple of related MIPs – one might include for theindividual MIPs links to their respective web pages to get an immediate overview.

Additional references for introduction chapter:

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3. T.A. Mathera,, C. Oppenheimerb, A.G. Allenc, A.J.S. McGonigle (2004), Aerosol chemistry of emissions from three contrasting volcanoes in Italy, Atm. Envorin., 38, 5637–5649, doi:10.1016/j.atmosenv.2004.06.017.
4. Zhao, Z., M. S. Pritchard, and L. M. Russell (2012), Effects on precipitation, clouds, and temperature from long-range transport of idealized aerosol plumes in WRF-Chem simulations, J. Geophys. Res., 117, D05206, doi:10.1029/2011JD016744.

5. Seifert, P., et al. (2011), Ice formation in ash-influenced clouds after the eruption of the Eyjafjallajökull volcano in April 2010, J. Geophys. Res. , 116, D00U04, doi:10.1029/2011JD015702.
6. Corona, C., Guiot, J., Edouard, J. L., Chalié, F., Büntgen, U., Nola, P., and Urbinati, C.: Millennium-long summer temperature variations in the European Alps as reconstructed from tree rings, Clim. Past, 6, 379-400, doi:10.5194/cp-6-379-2010, 2010.
7. Oppenheimer, C. Climatic, environmental and human consequences of the largest known historic eruption: Tambora volcano (Indonesia) 1815, Progress in Physical Geography 27,2 (2003) pp. 230–259.
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10. Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258 (2000), Climatic Change 45: 361–374, 2000.