Project: **963**

Project title: **Volcanic Forcing Model Intercomparison Project (VolMIP)**

Project lead: **Claudia Timmreck**

Report period: **2018-01-01 to 2018-12-31**

In 2018, no MPI-ESM1.2-LR simulations for the CMIP6 (Coupled Model Intercomparison Project, Phase 6, Eyring et al., 2016) endorsed project VolMIP (Model Intercomparison Project on the climate response to Volcanic forcing, Zanchettin et al., 2016) could be carried out because the MPI-ESM1.2-LR piControl run and the corresponding working environment for CMIP6 were not available so far. This is now expected for end 2018. In addition, no VolMIP results from other model groups around the world have been submitted to the ESGF archive until now. It is assumed that a multi-model analysis of the first VolMIP experiments can be carried out in summer 2019.

In 2018, the VolMIP preparatory work which has started in 2017 has been continued in project 960. Using the eVolv2k data set (Toohey and Sigl, 2017) and the Easy Volcanic Aerosol v1.0 (EVA, Toohey et al., 2016), we have compiled three forcing time series for the early 19th century : a central estimate, consistent with that used in VolMIP; a high-end estimate, corresponding to the best estimate plus two times the (1σ) sulfur emission uncertainty; a low-end estimate, corresponding to the best estimate minus two times the (1σ) sulfur emission uncertainty. Using these different volcanic forcing data sets we have performed 90 experiments of different length (5 years up to 30 years) in the period from 1800 to 1830. At present, different scientific aspects of these runs are analyzed, e.g. the atmospheric response in Northern Hemisphere winter, carbon cycle feedback processes and ocean atmosphere sea ice coupling mechanisms. As this requires the simultaneous provisioning of 6 hourly data from all 90 ensemble members, we use some of the disk space from the VolMIP data project 963 for post-processing.

With this early 19th century ensemble we have for example recently tested whether different realistic volcanic forcing magnitudes for the 1815 Tambora eruption yield distinguishable ensemble temperature responses (Zanchettin et al, submitted). To do so, we have performed a cluster analysis on a super-ensemble of climate model simulations including all 90-member ensembles with different initial conditions and different volcanic forcings based on uncertainty estimates. The results depict how forcing uncertainties can overwhelm initial-condition spread in boreal summer due to strong direct radiative impact while the effect of initial conditions predominate in winter, when dynamics contribute to large ensemble spread. In our setup, current uncertainties prevent final conclusions about magnitude of the Tambora eruption and its relation to the “year without summer. Further analysis is ongoing.

References

Eyring, V., Bony, S., Meehl, G. A., Senior, C. A., Stevens, B., Stouffer, R. J., and Taylor, K. E.: Overview of the Coupled Model Intercomparison Project Phase 6 (CMIP6) experimental design and organization, Geosci. Model Dev., 9, 1937-1958, doi:10.5194/gmd-9-1937-2016, 2016.

Toohey, M., Stevens, B., Schmidt, H., and Timmreck, C.: Easy Volcanic Aerosol (EVA v1.0): An idealized forcing generator for climate simulations, Geosci. Model Dev., 9(11), 4049–4070, doi:10.5194/GMD-9-4049-2016, 2016

Toohey, M. and Sigl, M.: Volcanic stratospheric sulfur injections and aerosol optical depth from 500 BCE to 1900 CE, Earth Syst. Sci. Data, 9, 809-831, https://doi.org/10.5194/essd-9-809-2017, 2017.

Zanchettin, D., Khodri, M., Timmreck, C., Toohey, M., Schmidt, A., Gerber, E. P., Hegerl, G., Robock, A., Pausata, F. S. R., Ball, W. T., Bauer, S. E., Bekki, S., Dhomse, S. S., LeGrande, A. N., Mann, G. W., Marshall, L., Mills, M., Marchand, M., Niemeier, U., Poulain, V., Rozanov, E., Rubino, A., Stenke, A., Tsigaridis, K., and Tummon, F.: The Model Intercomparison Project on the climatic response to Volcanic forcing (VolMIP): experimental design and forcing input data for CMIP6, Geosci. Model Dev., 9, 2701-2719, doi:10.5194/gmd-9-2701-2016, 2016.

Zanchettin, D., Timmreck, C., Toohey, M. et al.: Clarifying the relative role of forcing uncertainties and initial-condition unknowns in spreading the climate response to volcanic eruptions, submitted to Geophys.. Res. Lett, 2018.