Project: **885**

Project title: **Stratospheric Sulfur and its Role in Climate (SSiRC) data project**

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Report period: **20223-11-01 to 2024-10-31**

Stratospheric sulfate aerosol is an important climate driver, causing solar dimming in the years after large volcanic eruptions. Hence, a growing number of general circulation models are adapting interactive sulfur and aerosol schemes to improve the representation of relevant chemical processes and associated feedbacks. However, uncertainties of these schemes are not well constrained. calling into question the reliability of global aerosol model simulations for future scenarios (e.g. Clyne et al., 2021; Quaglia et al., 2023). The international WCRP/SPARC/SSiRC[1] activity has therefore established an international model data intercomparison project named ISA-MIP (Timmreck et al., 2018; https://isamip.eu) to better understand changes in stratospheric aerosol and its precursor gaseous sulfur species that are a direct input of major volcanic eruptions.

In this project period we have completed the analysis of the background conditions of the sulfur cycle which have not been addressed in a global model intercomparison project before (Brodowsky et al., 2024). We could show that differences in the atmospheric sulfur budget among the models arise from the representation of both chemical and dynamical processes, whose interplay complicates the bias attribution. Several problematic points identified for individual models are related to the specifics of the chemistry schemes, model resolution, and representation of cross-tropopause transport in the extra tropics.

In the frame of a PhD thesis (Katharina Perny, BOKU University Vienna) the impact of the Pinatubo eruption on atmospheric temperature and dynamics is investigated in the ISA-MIP HErSEA Pinatubo experiments as a follow-up study to Quaglia et al. (2023) who analysed the radiative forcing in the participating models. The analysis performed so far has concentrated only on four models (ECHAM, ULAQ, ECHAM-SALSA and UM-UKCA) and on different sulfur emission strengths (Low-22km, Med-22km and High-22km).

Figure 1 shows a mean of the simulated tropical stratospheric temperature anomalies between September and December 1991. It reveals quite interesting results of the simulated tropical stratospheric temperature response. Although all models ran the HErSEA Pinatubo experiments according to the same emission protocol, there are significant differences. Not only do the models differ in the strength of the anomaly by a factor of 2 to 3, they also show a different range of variability over the period considered. The highest variability is found in the ULAQ experiment with a temperature range of ±5 K and the lowest in the UK-UMA with a range of ± 2-3 K. Furthermore, the dependence of the temperature anomalies on the sulphur emission strength is also different between the models. Further analysis is underway to understand the reasons for this.

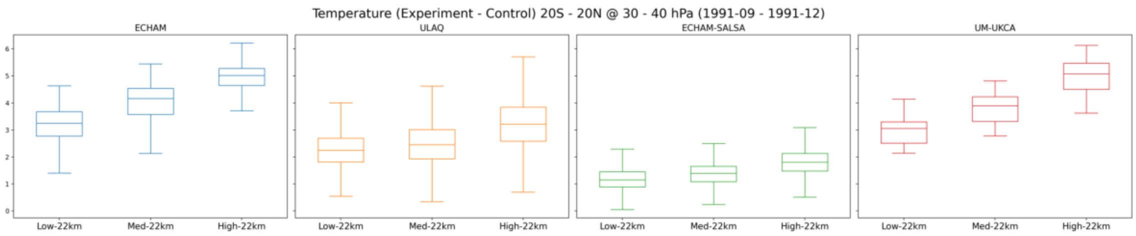

Figure 1: Box-and-whisker plots of simulated tropical stratospheric temperature anomalies between the respective HErSEA experiment and the control run, picking the region of the peak in the signal which is identified for most models from September until December 1991.The whiskers show the minimum and maximum anomalies, the lower and upper limits of the boxes show the 25th and 75th percentiles, the central line inside the box indicates mean (K. Perny pers com.).

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[1] WCRP: World Climate Research Programme, SPARC: Stratosphere-troposphere Processes And their Role in Climate, SSiRC: Stratospheric Sulfur and its Role in Climate

References

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