Project: **885**

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

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Report period: **2024-11-01 to 2025-10-31**

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. Therefore, an international model data intercomparison project named ISA-MIP (Timmreck et al., 2018; https://isamip.eu) has been established for which project 885 serves as a virtual working environment. Recent ISA-MIP studies already helped to better understand changes in stratospheric aerosol and its precursor gaseous sulfur species under volcanically perturbed (Quaglia et al., 2023) and unperturbed conditions (Brodowsky et al., 2024).

During the reporting period Katharina Perny (BOKU University Vienna) has investigated the impact of the Pinatubo eruption on atmospheric temperature and dynamics in the ISA-MIP HErSEA Pinatubo experiments (Perny et al., to be submitted to ACP) as a follow-up study to Quaglia et al. (2023) who have analysed the radiative forcing in the participating models. The results confirm our general understanding of stratospheric aerosol forcing, while simultaneously highlighting structural differences across the global aerosol models. While for the Pinatubo-like experiments the multi-model mean temperature anomalies agree well with reanalyses, we find that differences between models are in most cases larger than differences for individual models across experiments (Figure 1). Differences in transport, radiative transfer and microphysics as well as the characterization of aerosol size distributions play a crucial role for the emergence of the inter model spread in the temperature response. The sensitivity of the stratospheric temperature response to model selection, as also apparent in comparisons with outputs of historical CMIP6 studies, argues for caution in attribution studies and the interpretation of sulfur aerosol intervention experiments relying on individual or only few models.

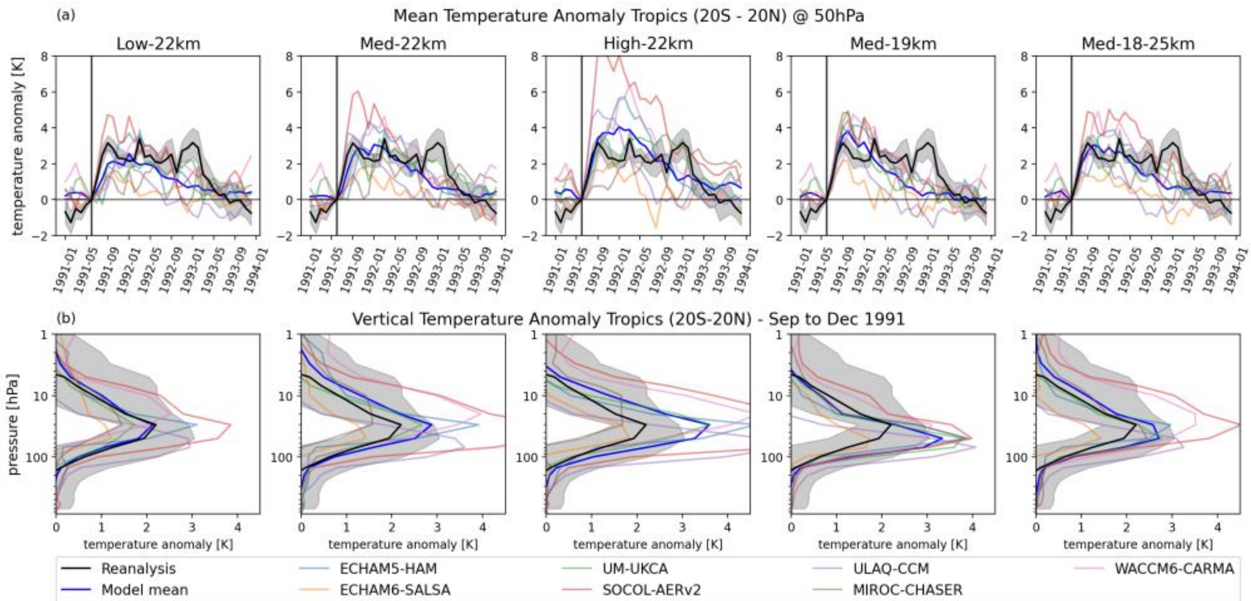

Figure 1. Time evolution of the observed (multi-reanalysis mean) and model derived tropical mean temperature anomaly normalized to June 1996 (a) and tropical vertical temperature anomaly for the period September to December 1991 (b). In all panels the multi-model mean is provided as blue bold line and the grey shading indicates the ±3σ confidence bound for the reanalysis mean (black, bold) (From Perny et al, to be submitted)

References:

Brodowsky, C.V. et al.: Analysis of the global atmospheric background sulfur budget in a multi-model framework, Atmos. Chem. Phys., 24, 5513–5548, https://doi.org/10.5194/acp-24-5513-2024, 2024.

Perny, K. et al.: Assessing the stratospheric temperature response to volcanic sulfate injections: insights from a multi-model framework, to be submitted to ACP, 2025

Quaglia, I. et al.: Interactive Stratospheric Aerosol models response to different amount and altitude of SO_2 injections during the 1991 Pinatubo eruption, Atmos. Chem. Phys., 23, 921–948, https://doi.org/10.5194/acp-23-921-2023.

Timmreck, C. et al.: The Interactive Stratospheric Aerosol Model Intercomparison Project (ISA-MIP): motivation and experimental design, Geosci. Model Dev., 11, 2581–2608, https://doi.org/10.5194/gmd-11-2581-2018, 2018