Project: **885**

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

Principal investigator: **Claudia Timmreck**

Report period: **2020-11-01 to 2021-08-31**

Stratospheric Sulfur and its Role in Climate" (SSiRC) http://www.sparc-ssirc.org/ (Rex et al., 2012) is an international WCRP/SPARC[1] activity to better understand changes in stratospheric aerosol and its precursor gaseous sulfur species that are a direct input of major volcanic eruptions. One part of SSiRC is an international model data intercomparison project named ISA-MIP with four co-ordinated intercomparison studies. An overview of ISA-MIP describing the rationale, observations and experimental specifications and the experimental design was given in Timmreck et al. (2018).

Several models have submitted data during the last 12 months, and multi model analyses have started. Ilaria Quaglia (PhD student, Univ. L'Aquila, Italy) and guest at MPI-M, Hamburg from Nov 2020 to Oct 2021 has started with the analysis. Currently, she concentrates on the analysis of the largest volcanic eruption over the last 100 year (Mt Pinatubo 1991), comparing co-ordinated simulations within the so-called HErSEA experiments (Historical Eruptions SO2 Emission Assessment). The HErSEA experiment consists of several simulations of the evolution of the stratospheric volcanic aerosol cloud, where the injection height and amount of SO_2 are varied considering different available estimates. This experimental design allows to investigate models' differences or agreement in the dynamical, microphysical, and chemical processes that govern the evolution of the stratospheric aerosol layer by looking at how the emitted SO_2 translates into perturbations to stratospheric aerosol properties.

We are currently analysing the Pinatubo HErSEA data of seven global aerosol models (ECHAM6-SALSA, EMAC, MA-ECHAM5-HAM, SOCOL-AER, ULAQ-CCM, UM-UKCA, WACCM6-MAM4) by analysing in depth microphysical and chemical aspects of the simulations (Quaglia et al., EGU 2021, paper in prep).

Figure 1 shows the Stratospheric Aerosol Optical Depth (SAOD) agreement with respect to the GloSSAC[2] dataset (Thomason et al., 2018)) at 525 nm over the period June 1991- June 1993. Taylors diagrams calculated per each model from monthly and latitudinal values, shown in this figure, provide a concise statistical summary of how well the simulated and measured patterns of SAOD match each other in terms of their correlation (COR, how closely related the spatial and temporal distributions are), their root-mean-square difference (RMSD, how different they are in magnitude), and the ratio of their variances (STD, how they differ in term of variations in the respective distributions). All models agree that the experiment with low injection at medium altitude (El_lsm – orange circle) has higher correlation and lower RMSD with respect to the GloSSAC SAOD, meaning that it has similar amplitude of variation in terms of latitudinal distribution and time evolution.

Figure 2 shows the timeseries of mean zonal values of SAOD in the El_lsm experiment for all models, GloSSAC and AVHRR (Long and Stowe, 1994) dataset (in this case AOD is calculated at 600 nm). Comparing the GloSSAC and AVHRR[3] dataset, we realised that the saturation of the SAGE II instrument (on which the GloSSAC dataset is based in the period under review) produces an underestimation of the AOD in the peak period. This points to the importance of using more sets of observations to test and validate the models results and to look into different phases of the time evolution. While for now we have focused on the differences in the microphysical schemes of the models, at a later stage we plan to extend the analysis to the study of the differences in the dynamical and thermodynamical model responses.

We will continue the analysis of HErSEA and ISA-MIP experimentsin 2022.

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[1] WCRP: World Climate Research Programme, SPARC: Stratosphere-troposphere Processes And their Role in Climate

[2] GLOSSAC: Global Space-based Stratospheric Aerosol Climatology

[3] AVHRR: Advanced Very High Resolution Radiometer

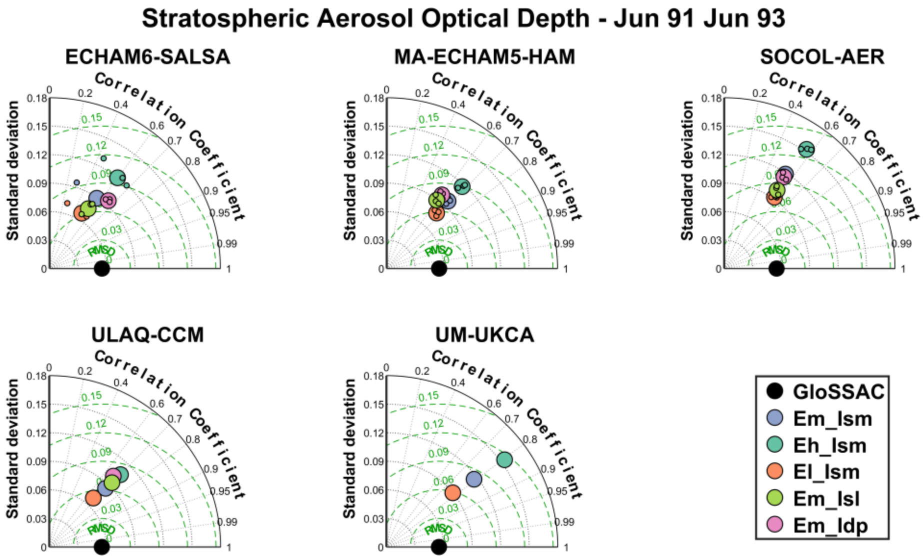

Figure 1. Taylor diagrams of SAOD for each model, calculated from latitudinal and monthly values. Standard deviation, correlation coefficient and root-mean-square (RMS) difference are calculated between model experiments (coloured circles) and the GloSSAC dataset (Thomason et al., 2018: black circle), over the period Jun 1991- Jun 1993.

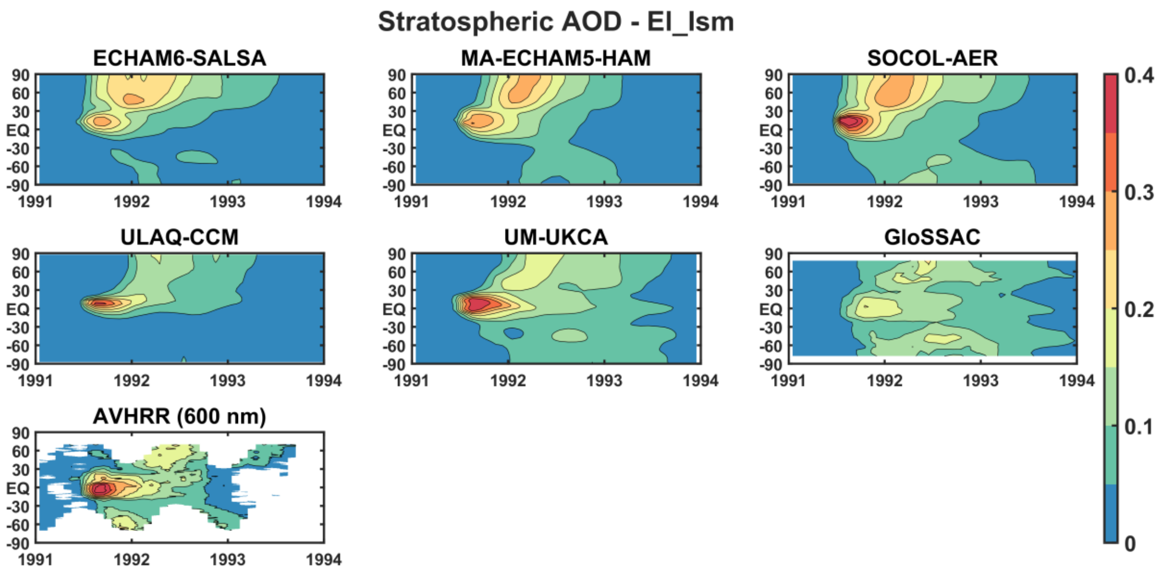

Figure 2. Timeseries of mean zonal values of SAOD in low injection at medium altitude experiment (El_lsm). Models and GloSSAC AOD is calculated at 525 nm, AVHRR at 600 nm.

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