Project: 1051

Project title: Contribution to AerChemMIP with ECHAM-HAMMOZ simulations

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Report period: 2020-07-01 to 2022-06-30

Text: maximum of two pages incuding figures.

The aim of the project 1051 has been the of the contribution of the ECHAM-HAMMOZ community to the Recent report of Working Group 1 of the Intergovernmental Panel on Climate Change (IPCC/AR6) with a focus on atmospheric aerosol processes. The "Aerosol Chemistry Model Intercomparison Project" (AerChemMIP) was designed to quantify the climate and air quality impacts of aerosols and chemically-reactive gases in the climate models that are used to simulate past and future climate.

The CMIP6 Diagnostic, Evaluation and Characterization of Klima (DECK) experiments and the CMIP6 historical and scenario simulations were carried out with interactive aerosol and aerosol-cloud interactions for liquid, mixed-phase and ice clouds as a basis for the AerChemMIP project. Specific diagnostics had been requested as part of the CMIP6 data request to highlight the chemical composition of the atmosphere, to evaluate the performance of the models, and to understand differences in behavior between them. These diagnostics had to be implemented in the contributing models as part of the project.

Also the AerChemMIP simulations were done to quantify the climate and air quality impacts of aerosols. Models with detailed representation of microphysics of liquid, mixed-phase and pure ice clouds and their interactions with aerosols like ECHAM-HAMMOZ help to understand how anthropogenic emissions contributed to global radiative forcing during the historical period, uncertainties in forcing estimates, model performance and differences between models.

During the previous project phase from 07/2020 to 04/2022 the the CMIP6 and AerChemMIP experiments have been run and post-processed. The output has been uploaded to the CMIP6 data archive at the Earth System Grid Federation (ESGF) (see https://pcmdi.llnl.gov/CMIP6/ArchiveStatistics/esgf_data_holdings/AerChemMIP/index.html). Overall, data from 18 simulations were uploaded, with extensive numbers of variables for each

experiment.

The generated model dataset is published as a referenced dataset

:CMIP6.AerChemMIP.HAMMOZ-Consortium.MPI-ESM-1-2-HAM under

<u>https://doi.org/10.22033/ESGF/CMIP6.1621</u> (Neubauer et al., 2019). The simulation data provides a basis for climate research designed to answer fundamental science questions, and the results were cited by the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC-AR6), e.g. in the estimate of the Multi-model mean Effective radiative forcings (ERFs) due to 3 aerosol changes between 1850 and the recent-past (1995-2014) in Chapter 6 of the report (see e.g. Figure 6.10 therein). Further publications have already used the data of these experiments (e.g. Allen et al., 2020, Mortier et al, 2020, Turnock et al., 2020, Zhang et al., 2021, and others).

During the reporting period the runs

AerChemMIP Tier 2/3 fixed SST AerChemMIP Tier 1 , fully coupled DECK-piControl (continued)

were completed with the model version MPI-ESM1.2-HAM T63L47GR15. In addition postprocessing was performed on the results as well as on previous results.

Post-processing was partly delayed to late availability of diagnostics scripts and had needed to be partially repeated, but were overall successful. Currently a considerable part of the model results remains on the DKRZ server to allow for further post prossessing and archiving, in addition to the data that were uploaded on the ESGF archive. The data have also recently been further processed on Mistral within the framework of the EU project FORCeS (https://forces-project.eu/) that, among other things, analyzes and improves the contributing ESMs (including MPI-ESM1.2-HAM) with respect to aerosol forcing and climate sensitivity.

Peer reviewed publications using the results (selected)

Allen, R. J., et al.: Climate and air quality impacts due to mitigation of non-methane near-term climate forcers, Atmos. Chem. Phys., 20, 9641–9663, https://doi.org/10.5194/acp-20-9641-2020, 2020.

Mortier, A. et al.:: Evaluation of climate model aerosol trends with ground-based observations over the last 2 decades – an AeroCom and CMIP6 analysis, Atmos. Chem. Phys., 20, 13355–13378, https://doi.org/10.5194/acp-20-13355-2020, 2020.

Turnock, S. T., et al: Historical and future changes in air pollutants from CMIP6 models, Atmos. Chem. Phys., 20, 14547–14579, https://doi.org/10.5194/acp-20-14547-2020, 2020.

Zhang, J., et al: The role of anthropogenic aerosols in the anomalous cooling from 1960 to 1990 in the CMIP6 Earth system models, Atmos. Chem. Phys., 21, 18609–18627, https://doi.org/10.5194/acp-21-18609-2021, 2021.

Dataset citation:

Neubauer, David; Ferrachat, Sylvaine; Siegenthaler-Le Drian, Colombe; Stoll, Jens; Folini, Doris Sylvia; Tegen, Ina; Wieners, Karl-Hermann; Mauritsen, Thorsten; Stemmler, Irene; Barthel, Stefan; Bey, Isabelle; Daskalakis, Nikos; Heinold, Bernd; Kokkola, Harri; Partridge, Daniel; Rast, Sebastian; Schmidt, Hauke; Schutgens, Nick; Stanelle, Tanja; Stier, Philip; Watson-Parris, Duncan; Lohmann, Ulrike **(2019)**. HAMMOZ-Consortium MPI-ESM1.2-HAM model output prepared for CMIP6 AerChemMIP. Version YYYYMMDD.Earth System Grid Federation. https://doi.org/10.22033/ESGF/CMIP6.1621