Project: **1242**

Project title: **Simulating the atmospheric dust cycle**

Principal investigator: **Kerstin Schepanski**

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

The simulations performed were carried out to study the atmospheric dust cycle with particular focus on the representation of atmospheric dust concentrations. Overall, the objectives of the simulations were to improve the dust emission module in HAM2.3 and thus to improve the representation of the atmospheric dust concentrations and its variability. Finally, we used the atmospheric general circulation model ICON coupled to the aerosol model HAM2.3 (Salzmann et al., 2022; Tegen et al., 2019).

During the reporting period, we continued and finalized our work on implementing a scheme accounting for the mobilization of mineral dust during vegetation fire such as agricultural fires or wildfires. The 'fire-dust emission' parameterization scheme has been developed based on the conceptual approach discussed in Wagner et al. (2021) and tested thoroughly in the ICON-HAM model framework in 2023 and 2024. Finally, 10-year simulations with and without the fire-dust emission scheme have been performed (Wagner & Schepanski, submitted). The work carried out included in particular the following tasks:

(1) Thorough testing of the newly developed fire-dust emission scheme, which required multiple multi-year simulations

(2) 10-year simulations with and with-out the fire-dust emission scheme in order to assess the geographical and fractional contribution of fire-driven dust emission versus wind-driven dust emission. A 10-year simulation furthermore reveals seasonal and interannual variability due to e.g. fire activity and atmospheric conditions.

Finally, the development of this new parameterization enables us to estimate the amount of mineral dust particles emitted during wild fire events. The fractional contribution of mineral particles to the combustion aerosol plume supposedly alters the optical properties, which in turn impact on the aerosol radiative impact.

In addition to the simulations carried out in the framework of the 'fire-dust' project, we requested computational resources for the starting PhD project on 'dust mineralogy'. In the framework of this project, the PhD student successfully familiarized theirselves with ECHAM-HAM and was able to perform some first test simulations by using the standard setup. As one of the project objectives is the development and implementation of the explicit representation of the dust aerosol particles' mineralogical composition as function of the geographical position and size distribution, time was spent on adding code to the HAM dust routines.

Salzmann, M., S. Ferrachat, C. Tully, S. Münch, D. Watson-Parris, D. Neubauer, et al. (2022), The global atmosphere-aerosol model ICON-A-HAM-2.3 - Initial model evaluation and effects of radiation balance tuning on aerosol optical thickness, JAMES, 14, e2021MS002699, https://doi.org/10.1029/2021MS002699.

Tegen, I., Neubauer, D., Ferrachat, S., Siegenthaler-Le Drian, C., Bey, I., and co-authors: The global aerosol–climate model ECHAM6.3–HAM2.3 – Part 1: Aerosol evaluation, Geosci. Model Dev., 12, 1643–1677, https://doi.org/10.5194/gmd-12-1643-2019, 2019.

Wagner, R., K. Schepanski, M. Klose (2021), The Dust Emission Potential of Agricultural-Like Fires – Theoretical Estimates From Two Conceptually Different Dust Emission Parameterizations, J. Geophys. Res., doi:10.1029/2020JD034355.

Wagner, R., K. Schepanski, Quantifying fire-driven dust emissions using a global aerosol model, submitted to JAMES.