Project: **893**

Project title: **Convection and Clouds in Earth System Modelling**

Principal investigator: **Holger Tost**

Report period: **2023-11-01 to 2024-10-31**

In the current allocation period more than the granted resources in CPU hours have been utilised, given the fact that Levante apparently still had available resources left.

Besides the WP I, in which further developments for the EMAC model have been developed tested and applied, the majority of the resources have been used in WP II. In that WP, simulations with interactive chemistry and aerosol particles and additionally interactive vegetation (combining the EMAC and the LPJ/GUESS model) have been conducted under present day and re-forestation scenarios to analyse the impact of afforestation on the atmospheric composition, atmopsheric aerosols and their radiative impacts. The scenarios are constructed by comparing a potential natural vegetation with a present day land-use data set, as well as afforestation of grazing land to allow for sufficient food production, but carbon capturing by additional forest growth. The land use has a direct effect on the emissions of isoprene and monoterpenes, which are oxidised in the atmosphere forming secondary organic aerosol particles. A corresponding picture can be found below, taken from Vella et al.(2024). This study points out, that the influence for the organic aerosol budget is substantial, whereas the climate impact is mainly driven by the direct aerosol-radiation interactions. Due to the relatively high particle numbers in most of the respective regions, the impact on clouds and precipitation is mostly not statistically significant. This study is currently in the final minor revision phase of Atmospheric Chemistry and Physics (Vella et al., EGUSPHERE, 2024) and will (most likely) be accepted within the next weeks. The manuscript also allows for an estimate of effects from the surface to the tropopause, with implications also for the UTLS region. Consequently, this study links this individual PhD project with the CRC 301 “TPChange – The Tropopause in a changing atmosphere”.

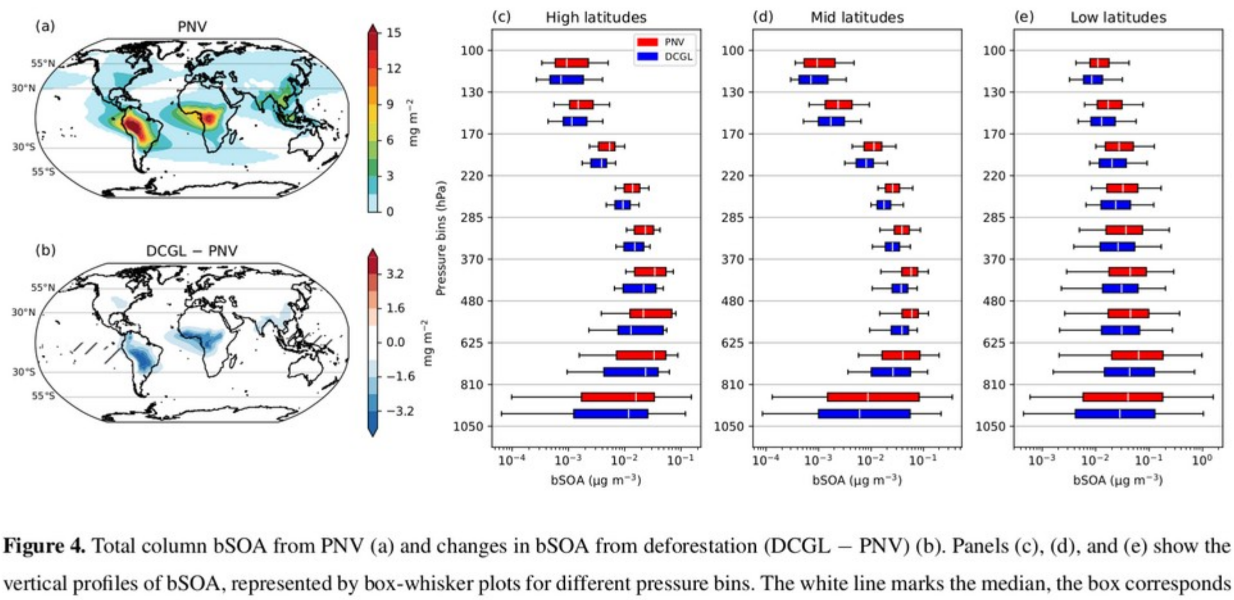


**Figure 4.** Total column bSOA from PNV (a) and changes in bSOA from deforestation (DCGL − PNV) (b). Panels (c), (d), and (e) show the vertical profiles of bSOA, represented by box-whisker plots for different pressure bins. The white line marks the median, the box corresponds to the lower and upper quarterlies, and the whiskers represent the 5th–95th percentile of the spatial mean over the 10 years simulated. The latitude ranges are defined as follows: High latitudes (90–55°S and 55–90°N), mid-latitudes (55–30°S and 30–55°N), and low latitudes (30°S–30°N). A log scale is used for the x-axis of (c), (d), (e). Panel (b) includes diagonal crosshatching to indicate areas that are not statistically significant, based on a two-tailed Student’s t-test with a 90% confidence level.

For WP III only small test simulations with different neural networks embedded in the 3D EMAC have been conducted with final production simulations still pending, potentially being conducted (if resources remain available until the end of the year) in the upcoming months. The technical development for this project is finalised.

Given the cuts in the request WP IV has not been conducted at the DKRZ computers.

Preparations and some test simulations for WP V have been conducted, analysing the fire impact on the upper troposphere in South America. Given reduced personal as a consequence of long-term illness and the cuts in the computing resources, the final simulations have not been conducted, yet.

The work anticipated for WP VI has been finalised. This work is part of the CRC 301 “TPChange” – Project C07. All tests of a new submodel for Aerosol Optical Properties (AOP) have been successful and the code developments have been included in the main branch of the EMAC modeling system, being available for the scientific community. This submodel includes several parameterisations for the mie calculations to be performed online during the simulation as well as the option of using pre-generated lookup-tables for aerosol optical properties depending on particle size, wavelength of the radiation and the respective chemical compounds, represented by different wavelength dependent complex refractive indices. Beyond the model development and links of aerosol optical properties to the radiation schemes and aerosol submodels of EMAC, production simulations covering a decade of simulation period with multiple calls of the AOP calculations and respective multiple calls to the radiation scheme to determine the radiative impacts have been performed and analysed. The results have been presented at the EGU general assembly this year and a corresponding publication will be submitted before the end of the year. A figure showing the contribution of individual aerosol components to the upper tropospheric aerosol extinction is provided below. It shows that the inorganic ions (sulphate, nitrate, ammonium) and aerosol water are the key components for UTLS AOD, whereas organics and black carbon play minor roles for the total extinction. Nevertheless, their impact on heating and the absorption potential shows substantial influences on the radiative flux budget.