Project: **893**

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

Principal investigator: **Holger Tost**

Report period: **2019-01-01 to 2019-12-31**

In the current allocation period not all requested resources have been used. This is partly a consequence of the dropping out of one PhD student at the beginning of the year, such that his work package had not been worked on in terms of extensive simulations and analysis, namely WPIII. The PI has conducted some of the proposed model development and the project is planned to be continued with new staff in the coming allocation period as a joint project between JGU and Max-Planck Institute for Chemistry in Mainz. However, new funding for a PhD student has to be secured from external funding sources (in progress).

Within the proposed WPI, technical development has continued, such that now the MECO(n) modelling system is capable of utilising the aerosol scheme GMXE, as well as prognostic aerosol – radiation and aerosol – photolysis interactions. For this purpose the aerosol scheme GMXE has been extended and required rank identifiers have been introduced such that identical code can be used for the global EMAC and the regional MECO(n) systems. Some shorter test simulations on the DKRZ architectures have been conducted and a picture of the simulated regional aerosol optical depth can be seen in Fig. 1.

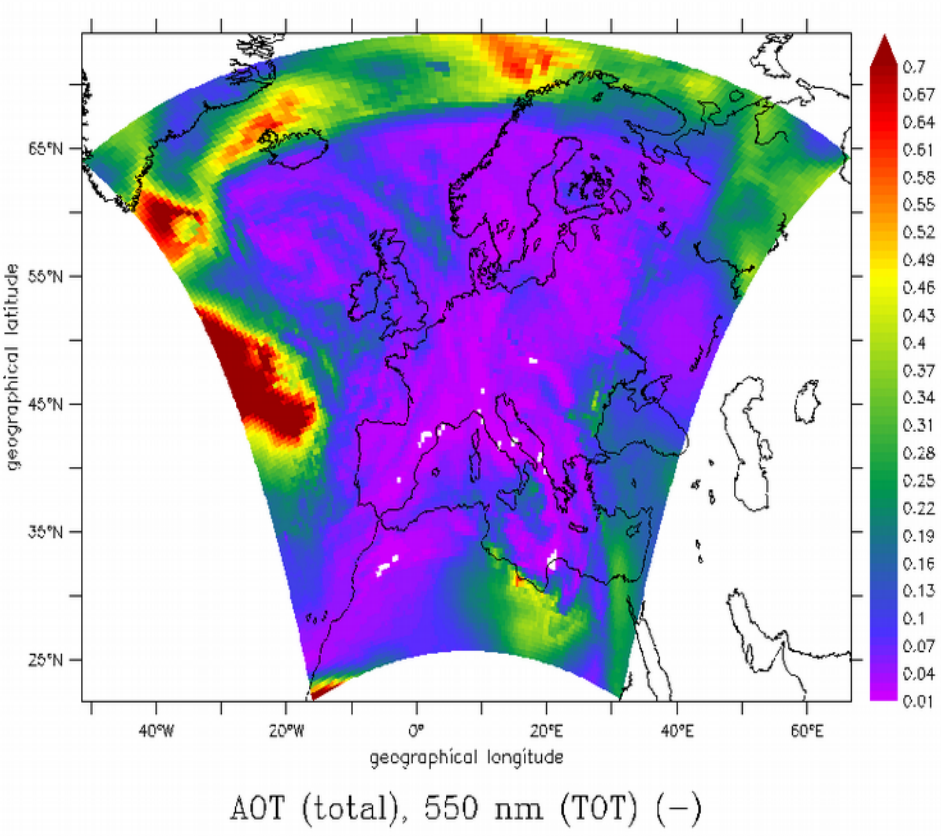

Figure 1: Aerosol optical depth (at 550 nm) determined for all aerosol types within the regional domain of MECO(n) over Europe.

Additionally, regional comparison with observation data for Rhineland-Palatinate have been conducted and presented at several conferences (e.g., EGU 2019, Vienna). Furthermore, the impact of local and regional feedbacks have been investigated and a strategy for systematic analysis via short term ensembles has been developed. Additionally, the links of the aerosol scheme GMXE to the 2-moment microphysics scheme of the COSMO model have been explored and are currently tested. These developments will be easily convertible to links between the MESSy software packages and the standard physics routines of ICON. However, a majority of the simulations of this project are conducted elsewhere.

WPII included further model development and improvement of the EMAC/MECO(n) modelling system. This is partly incorporated into the CMIP6/AERChemMIP activities of the DKRZ consortial project ID0853 of the EMAC consortium. Within this framework test simulations with respect to aerosol-cloud-coupling and hence aerosol-cloud-radiation interactions had been conducted to analyse the strength of the corresponding feedback and provide some parameter tuning for the long-term simulations within the project ID0853.

Additionally, the SCAV submodel (and also some part of the aerosol scheme GMXE), which calculate non-equilibrium chemistry in the aqueous phase, have been updated from the usage of the differential equation solver system KPP1 to the new version KPP2 which is also capable to use vector blocking and hence increase the performance. This is also beneficial for future applications using GPUs or booster CPU architectures, which is expected to increase model performance substantially (as shown for gas phase chemistry by colleagues using the Juelich supercomputer). Even though this development does not result in different results (apart from numerical noise), it is a substantial step forward in maintaining the EMAC and MECO(n) modelling systems and will be also beneficial for an upcoming ICON/MESSy modelling system.

Furthermore, continuous model developments, updates and tests have been conducted in the model maintenance within the EMAC consortium.

The anticipated transition to ICON has been a bit slower than expected. Despite the successful proposal for the second phase of the TRR Waves2Weather, a research scientist for the project could only be hired recently starting in the next months, such that apart from one small test simulation, ICON has not been utilised in the current allocation period. However, as the project is funded, it will be part of the upcoming allocation request.