ICON-MUSCAT development and benchmark simulations

Abstract

MUSCAT is a modern mesoscale chemistry transport model (CTM) for process studies and air quality applications. It was recently coupled to the numerical weather forecast model ICON of German Weather Service (DWD). ICON is the predecessor model to COSMO, which until 2020 was the operational forecast model of the German Weather Service. Apart from a generally improved performance in comparison to COSMO, ICON comprises changes in the boundary layer physics, which might affect amongst others vertical mixing, deposition and online emissions (e.g., BVOC emission depending on surface temperature) of trace gases and aerosol particles.

Driven by the meteorological model ICON, MUSCAT deals with atmospheric transport and chemical transformations for various gas-phase species and aerosol particle populations. Its core is based on mass balances, which are described by a system of time-dependent, three-dimensional advection-diffusion-reaction equations.

MUSCAT is particularly detailed in the treatment of online aerosol and precursor sources (e.g., wind-driven sea salt and mineral dust or vegetation-based BVOC emissions) and chemical mechanisms (including aqueous phase and secondary organic aerosol chemistry).

The model will be applied in a nested approach for a domain over Europe (horizontal resolution ~7 km) and an inner nest over Germany (horizontal resolution ~2 km). Chemical driving data will be provided by Copernicus Atmosphere Monitoring Service (CAMS) for the European domain and by the European domain simulation for the German domain.

In the proposed project, the coupling of MUSCAT to ICON will be finalized. This requires short (few days) to medium (few weeks) intermediate evaluation simulations for Europe and Germany. Further, benchmark simulations will be conducted that are used to evaluate and document the performance in comparison to the predecessor model COSMO-MUSCAT as well as for each major further development steps. These simulations typically will cover a full year. It is planned to continue this development and computation time project in the coming years. The model performance is evaluated using regularly available observations from European Air Quality Monitoring (provided by European Environmental Agency) as well as remote sensing (e.g. AERONET).