Project: **1509**

Project title: **ICON-MUSCAT development and benchmark simulations**

Principal investigator: **Roland Schrödner**

Report period: **2025-05-01 to 2026-04-30**

The project was outlined for development simulations and sensitivity applications of the chemistry transport model ICON-MUSCAT in a nested approach for a domain over Europe (horizontal resolution ~7 km) and an inner nest over Germany (horizontal resolution ~2 km).

In the reporting period, the coupling of MUSCAT to ICON was finalized. Apart from several sanity test simulations, the year 2019 was simulated and evaluated against available observations. The evaluation was done in a Master Thesis (Sührig, 2026). The results were already presented at different conferences (ICCARUS 2026, ITM 2026, Nationales Forum Fernerkundung und Copernicus 2026, EGU 2026). It is aimed that the ongoing analysis and evaluation will be summarized in a publication in the upcoming reporting period. The current year 2019 simulation will serve as benchmark for upcoming developments. Therefore, the simulation results shall be transferred to the archive.

In addition to the production runs, short sensitivity runs on the effect of the surface temperature (deposition, BVOC emission), the dry deposition in general, the boundary layer representation (parameter tkhmin in ICON), and the emission time profiles (time-resolved emission factors of traffic and residential combustion) were conducted. Alternative setups will be tested in upcoming longer simulations.

Furthermore, production runs for the connection between increasing ozone levels and decreasing PM2.5 in the Greater Shanghai area and for investigating airborne concentrations of Microplastics were conducted. These are currently under analysis. Therefore, results cannot be reported.

During the project duration, most of the planned resources were used. In addition to the storage resources, archive resources are now applied for to transfer production runs to the archive. Computational resources are almost used up already. In the upcoming application period more production simulations will be done, hence more CPU node hours will be applied for.

Sührig, A. (2026), Globale Analyse der potentiellen Bedeutung von sekundärer Eisproduktion, Bachelor Thesis, Universität Leipzig.

Results

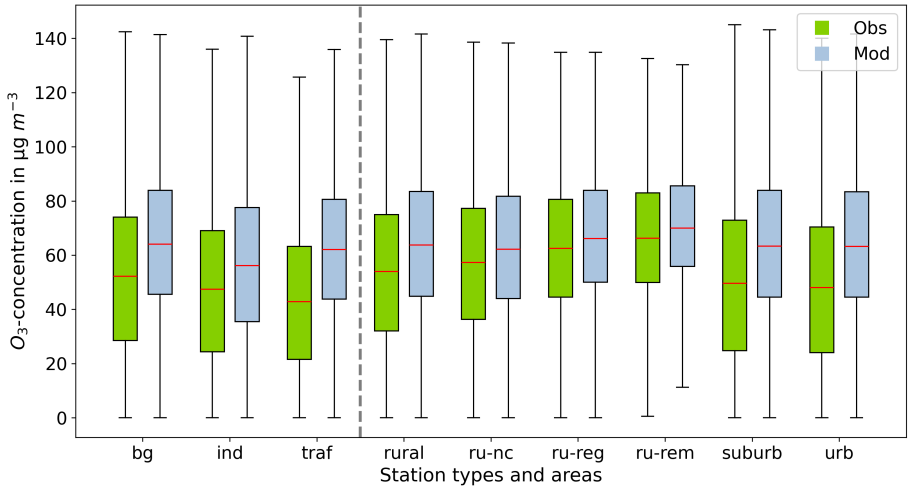

Figure 1: Comparison of modeled (7 km grid spacing, European domain) and observed (~1200 monitoring stations of the European Environmental Agency) of annual mean ozone, the

interquartile range and 10th and 90th percentile. It can be seen that the 7 km resolution simulation is able to capture the ozone concentration in the regional background (rural stations). However, the local features in urban environments and at traffic stations (which usually have a small area of representativeness of only few hundred meters around the station) are overestimated. This is due to underestimation of NO2 at the same locations and can partly be solved by applying a higher resolution.

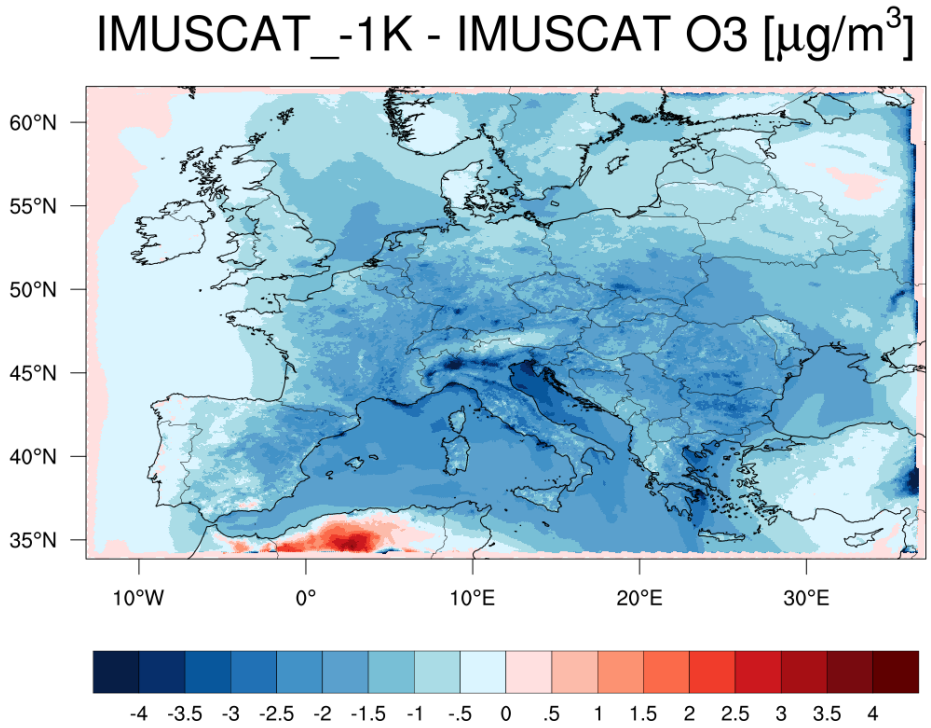

Figure 2: Effect of artificially 1K lowered surface temperature on ozone concentration. The lower surface temperature leads to lower BVOC emissions and hence ozone production throughout the simulation domain on hot summer days. Reason for this experiment is that the surface temperature in ICON is constantly higher than in COSMO, to which MUSCAT was previously coupled.