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An online emissions processing tool for air quality models

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Gridded and temporally varying emissions fields are a critical input for any air pollution model. Traditionally, such emissions are obtained from an inventory and pre-processed for the model as external files, which are read in during simulation at regular intervals. The pre-processing typically includes a mapping of the inventory onto the model grid and the application of temporal and vertical profiles depending on emission category. In case of a large number of tracers and hourly input, the pre-processing and reading of the emission fields imposes a large computational burden both in terms of computation time and storage. An alternative is to apply the temporal and vertical profiles online in the model, which greatly reduces I/O during simulation and simplifies the overall processing chain. A further advantage is that meteorology-dependent emissions, such as emissions from residential heating depending on outdoor temperatures, can be incorporated more easily.
Here we present the implementation and application of such a tool in the air pollution model COSMO-ART. The tool is composed of two parts, (i) a python script library preparing the input data for COSMO-ART, (ii) a Fortran-90 module integrated in COSMO-ART applying source-specific temporal and vertical profiles at each hour of the simulation. The tools are written in a generic way and are extensively documented to facilitate integration into other models. Four netCDF4 files are produced by the python scripts: gridded emission fields containing annual mean emissions per emission category (separately for area and point sources), temporal profiles describing hourly, day-of-week and seasonal variability per category (and country), vertical profiles per category, and speciation for VOCs, NO_x and PM per category. These files are read in only once at initialization of COSMO-ART, and the temporal, vertical and speciation profiles are updated each hour during the simulation. We will demonstrate the equivalence of the online tool with offline data processing and its application in a European-scale air quality simulation.