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Which boundary species are required? An evolutionary evaluation

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Analyses and forecasts of air pollutants at regional and local scales require air quality modelling at high resolution therefore introducing the necessity of nesting into larger scale models.

Currently within the FP7 GMES downstream service project PASODOBLE air pollution forecasting services for regional and local applications are developed. These activities are complementary to the large scale service currently developed by the Atmospheric Core Service MACC (Monitoring Atmospheric Composition Climate).

We report on our results regarding the question which boundary information from MACC is needed for smaller-scale air pollution modelling and forecasting. The major problems are expected to result from chemical incompleteness as well as chemical inconsistency with the small-scale model. Currently, the MACC European air quality ensemble product contains four single species (CO, NO_2, O_3 and SO_2) and one aggregate species (PM_{10}). This is clearly much less than models require if full nesting into the MACC-ensemble is desired. Here we study the problem of chemical incompleteness and the question, which species should additionally be provided.

We employ the POLYPHEMUS/DLR air quality model for a region covering Southern Germany. In order to isolate the effect of chemical incompleteness, boundary conditions are generated using the same model but covering a larger domain. In this way we obtain boundary conditions for all chemical species.

We perform a large number of simulations with different subsets of the available boundary species. An evolutionary feature selection approach allows us to estimate, which species have the most important influence on the model results. Each simulation is compared to a reference simulation using full boundary conditions.

In every generation of the evolutionary algorithm one boundary species selected from a pool of available species is added. The five best setups, evaluated with a cost function, are advanced to the next generation.

The largest improvement is obtained by adding PAN to the set of boundary conditions. Other important species are HNO_3, isoprene and methane.