Preliminary results from numerical simulations of high PM10 level episodes in January-April 2003

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Goal of the study: to perform numerical experiments aiming at:

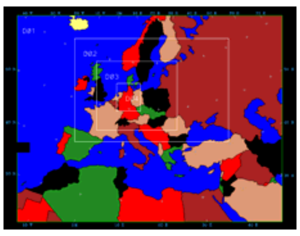
- to examine the ability and the limitations of US EPA Models 3 system to adequately reproduce air pollution episodes;
- outline the influence of meso-scale meteorology on air pollution transport;
- to evaluate the effect of horizontal grid resolution on Models 3 system performance;

The case study focuses on the meteorological situation in Germany in February and March of 2003 during which three major PM10 episodes could be identified: Between Feb 10 and Feb 14 with observed peak PM10 concentrations from Feb 11 to Feb 13, the core episode between Feb 21 and March 5 with peak PM10 concentrations from Feb 28 to March 4, and the episode between March 24 and March 31 with PM10 maxima at March 27 and March 28.

Modeling tools: As stated above the US EPA Models 3 system (the meteorological pre-processor MM5 and the chemical transport model CMAQ), is applied.

Input data: US NCEP Global Analyses data for 2003 is used as a large scale meteorological input for the MM5 model. The emission input for the CMAQ is prepared on the basis of the TNO emission inventory. Speciation and temporal variation are introduced according to the methodology developed in USA EPA.

Simulations: MM5 has been run on both outer grids (90 and 30-km) simultaneously with “two-way” nesting mode on. Then, after extracting the 10-km initial and boundary conditions from the resulting fields MM5 is run on the finest grid as a separate simulation with “one-way” nesting mode on. All simulations are made with 23 σ-levels going up to 100 hPa height. CMAQ has been run day by day on both inner domains. The pre-defined (default) concentration profiles are used for initial conditions in both domains at the beginning of the simulation. The concentration fields obtained at the end of a day’s run are used as initial condition for the next day. Default profiles are also used as boundary conditions of the 30-km domain during all period.



Model domains and nesting: The MM5 downscaling abilities are applied to define three nested domains with 90, 30 and 10 km horizontal resolution, the innermost domain covering the territory of Germany.

Model validation data: The simulated aerosol concentrations are compared with measurements from the EMEP stations in Germany.

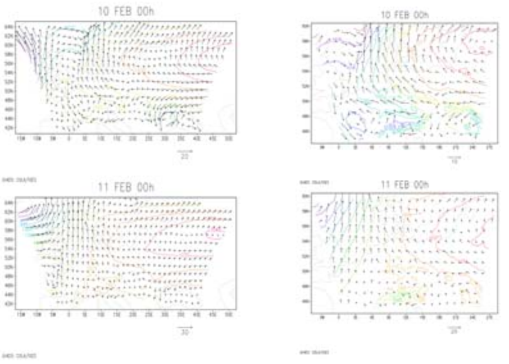


Fig.1 D2 (left) and D3(right) sea level pressure and wind fields for 10 and 11 February

Results from MM5:
The meteorological simulation is very close to the observed state ot the atmosphere: on 10-11 February the main pressure system that influences the domain of interest is a high pressure system over Central and Eastern Europe with winds from S and SE blowing over Germany (Fig.1.); from 25 February until 2 March there are two large pressure systems – low pressure over the Atlantic and high pressure over Eastern Europe, an almost stationary warm front is evident dividing Germany in two parts with different meteorological (especially wind) conditions (Fig.2.).

Results from CMAQ CTM:
Spatial plots of surface concentrations for days with observed PM episodes are shown on Fig.3, 4.The sum is over these aerosol species that have significant contribution to the total concentrations (>1 μg/m^3) and the hours are chosen so that daytime concentrations are shown as well as the peak at 20h. On 11 February two main polluted areas are seen (one over Netherlands and one over Belgium) as well as a number of smaller “spots” over Germany, having maximum concentrations as high as 75-100 μg/m^3. From 28 February to 4 March a large PM plume is evident over western Germany. This plume moves forwards and backwards in E-W direction, changing shape as well as location and intensity of maximum concentration.

For daily average concentrations at different stations (Fig.5) the agreement is very good – for all the stations the concentrations time evolution is fairly well simulated, except for some underestimation of the peaks observed.

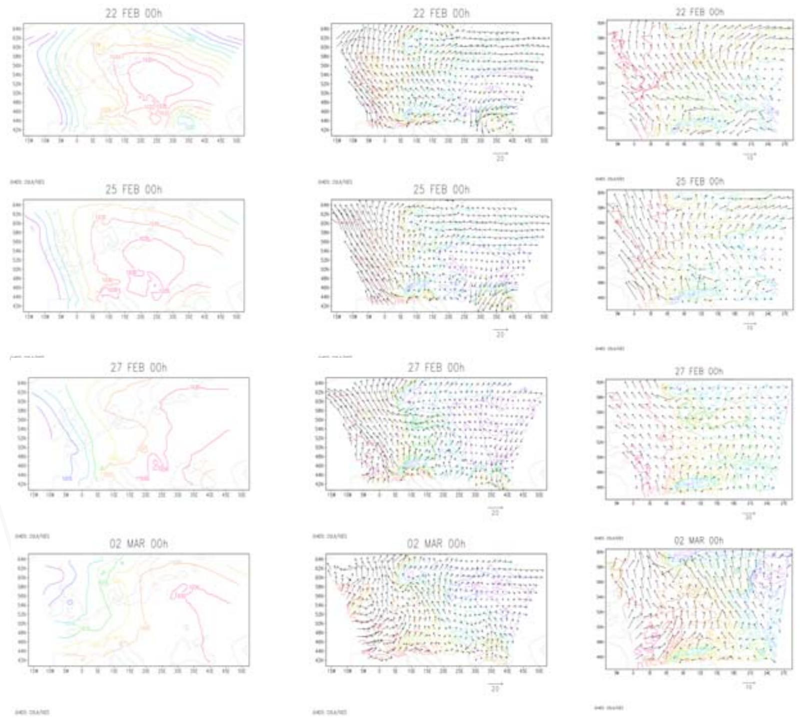


Fig.2 D2 (left) and D3(right) sea level pressure, temperaure and wind fields for 22, 25, 27 February and 2 March

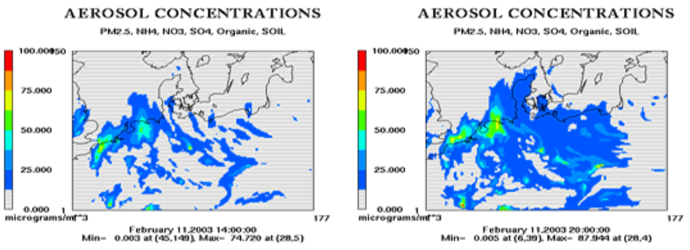


Fig 3. D3 surface concentrations of aerosol for 11 February at 14 and 20h.

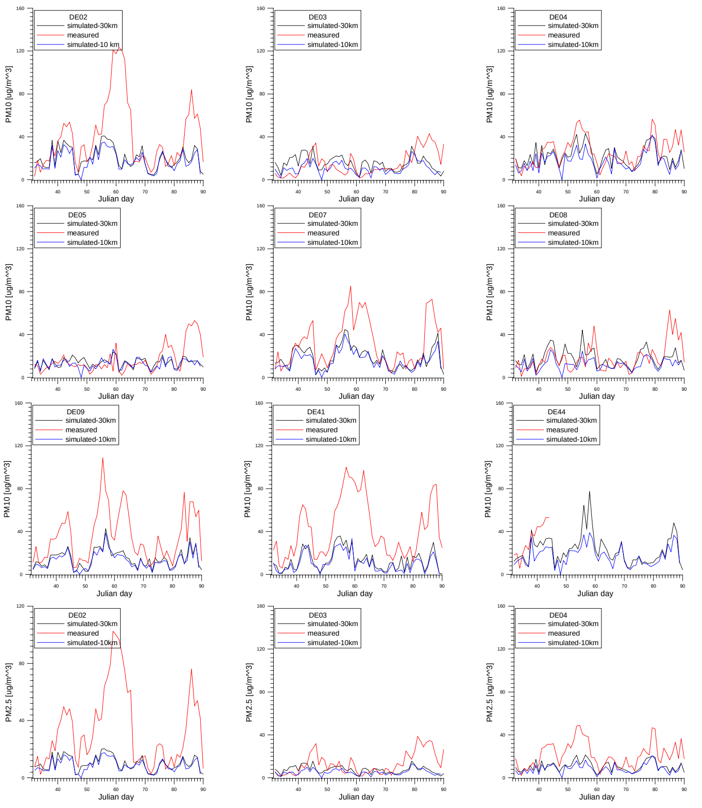


Fig. 5 Simulated vs. measured PM10 and PM2.5 surface concentrations for the following stations DE02R-Langenbrugge, DE03R-Schauinsland, DE04R-Deuselbach, DE05R-Brotjacklriegel, DE07R-Neuglobsow, DE08R-Schmucke, DE09R-Zingst, DE41R-Westerland Tinnum, DE44R-Melpitz

CONCLUSIONS

The simulated meteorological fields agree well with the patterns described in the case study definition. The simulated PM10 agreement with measurements is as good (or “as bad”) as many other model runs demonstrate for many other cases.

The simulation results obtained so far are tentative. The numerical experiments are still going on, testing the effect of varying model options and parameters. Biogenic emissions and sea salt have still to be added to the emission output

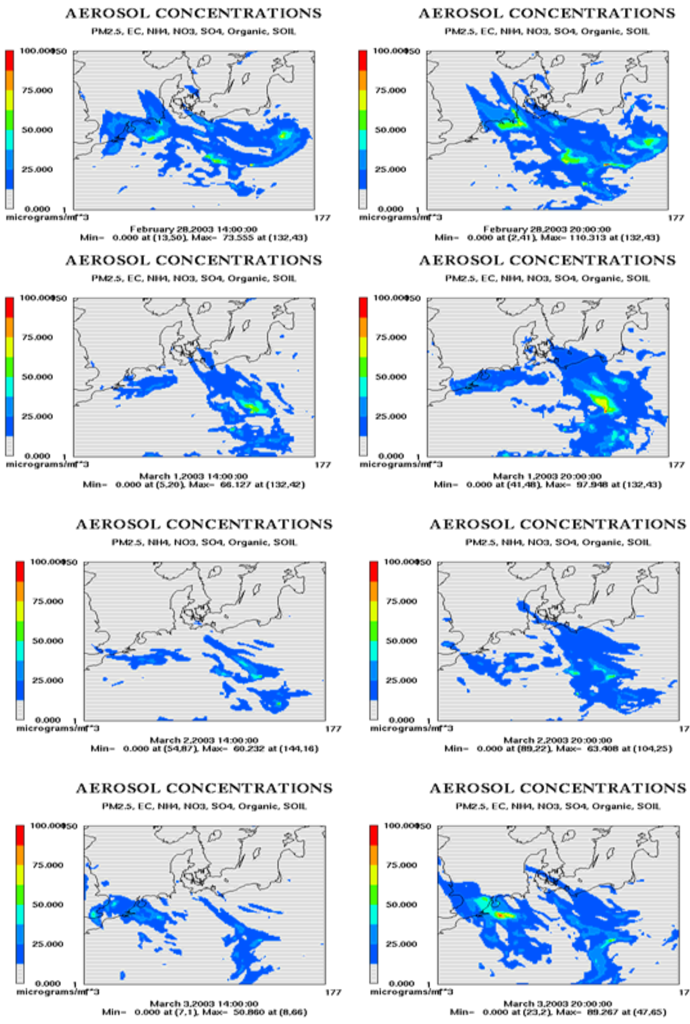


Fig 4. D3 surface concentrations of aerosol for 28 February – 4 March at 14 and 20h.

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