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Operational on-line coupled chemical weather forecasts for Europe with WRF/Chem

Marcus Hirtl (1), Simone Mantovani (2), Bernd C. Krüger (3), Claudia Flandorfer (1), and Matthias Langer (1)

(1) ZAMG, Environmental Meteorology, Vienna, Austria (marcus.hirtl@zamg.ac.at), (2) SISTEMA GmbH, Vienna, Austria (mantovani@sistema.at), (3) Institute of Meteorology, BOKU, University of Natural Resources and Life Sciences, Vienna, Austria (be.ch.krueger@gmail.com)

Air quality is a key element for the well-being and quality of life of European citizens. Air pollution measurements and modeling tools are essential for the assessment of air quality according to EU legislation. The responsibilities of ZAMG as the national weather service of Austria include the support of the federal states and the public in questions connected to the protection of the environment in the frame of advisory and counseling services as well as expert opinions.

ZAMG conducts daily Air-Quality forecasts using the on-line coupled model WRF/Chem. Meteorology is simulated simultaneously with the emissions, turbulent mixing, transport, transformation, and fate of trace gases and aerosols. The emphasis of the application is on predicting pollutants over Austria. Two domains are used for the simulations: the mother domain covers Europe with a resolution of 12 km, the inner domain includes the alpine region with a horizontal resolution of 4 km; 45 model levels are used in the vertical direction. The model runs 2 times per day for a period of 72 hours and is initialized with ECMWF forecasts.

On-line coupled models allow considering two-way interactions between different atmospheric processes including chemistry (both gases and aerosols), clouds, radiation, boundary layer, emissions, meteorology and climate. In the operational set-up direct-, indirect and semi-direct effects between meteorology and air chemistry are enabled. The model is running on the HPCF (High Performance Computing Facility) of the ZAMG. In the current set-up 1248 CPUs are used. As the simulations need a big amount of computing resources, a method to safe I/O-time was implemented. Every MPI task writes all its output into the shared memory filesystem of the compute nodes. Once the WRF/Chem integration is finished, all split NetCDF-files are merged and saved on the global file system. The merge-routine is based on parallel-NetCDF. With this method the model runs about 30% faster on the SGI-ICEX.

Different additional external data sources can be used to improve the forecasts. Satellite measurements of the Aerosol Optical Thickness (AOT) and ground-based PM10-measurements are combined to highly-resolved initial fields using regression- and assimilation techniques. The available local emission inventories provided by the different Austrian regional governments were harmonized and are used for the model simulations.

A model evaluation for a selected episode in February 2010 is presented with respect to PM10 forecasts. During that month exceedances of PM10-thresholds occurred at many measurement stations of the Austrian network. Different model runs (only model/only ground stations assimilated/satellite and ground stations assimilated) are compared to the respective measurements.