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Spatial downscaling of modeled air pollutant concentrations in urban environments using open access road map database

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High concentrations of air pollutants in urban environment develop near roads due to the proximity of traffic originated emission sources. This fact can be utilized in air quality modeling by applying distance dependent interpolation to modeled concentration data in order to downscale them. This way a finer spatial resolution can be achieved for the output data of model runs which focus on concentrations of photochemical smog components.
In our study, we used the WRF-Chem (v3.6), which is a non-hydrostatic Eulerian weather forecasting numeric model coupled to a chemistry module to estimate concentration fields of air pollutants. Its meteorological component, the WRF-ARW is a frequently applied tool for both research and operative purposes. We set one parent domain for the Central European region and two nested domains: one for Hungary and another one for the city of Budapest and its surrounding area with 15 km, 5 km and 1 km horizontal resolutions, respectively. Nesting is essential for creating boundary conditions for the second nested domain while initial conditions are given by the GFS model output fields with a $0.25° \times 0.25°$ horizontal and a 3-hour temporal resolution. In an online integrated model system such as the WRF-Chem the emission input data and the meteorological data share the same grid. In order to create the 1 km spatial resolution emission input data we used the annual values of the National Emission Ceiling Directive - Informative Inventory Report (NECD-IIR) for 2015. This emission inventory has a $0.1° \times 0.1°$ horizontal resolution grid for several air pollutants, e.g., NOX, CO, SO_2, particulate matter (PM), and for different emission source types, e.g., industrial, waste, road transport. For the temporal distribution with 1-hour resolution, we applied a simplistic diurnal emission pattern with one maximum at approximately 7 UTC and a second one at roughly 16 UTC. As for the spatial downscaling of the NECD-IIR grid to the WRF-Chem grid, a distance dependent interpolation was made with the OpenStreetMap roadmap database weighted with the road types. The interpolation process can be also used on the output air pollutant concentration fields. Evaluating the interpolated and the unaltered simulated NOX and O_3 concentrations with measurement data provides information about the validity of this spatial downscaling method. This comparison can be done by using the measurement data recorded by the automated monitoring sites of the Hungarian Air Quality Network.