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Evaluation of high-resolution air pollution modelling for the continental Nordic countries

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This study presents the evaluation of the high-resolution air pollution model UBMv10, which has been set-up for a 2,900,000 km^2 domain covering Norway, Sweden, Finland and Denmark with a 1 km x 1 km resolution and run for the time period 1979-2018. The UBMv10 is coupled to a long-range transport-chemistry model, DEHM, for boundary conditions. High-resolution emission data input and measurements of urban and rural air pollution concentrations have been obtained within the NordicWelfAir project from the four countries, in order to provide input and basis for evaluation of the UBM model.

In the NordicWelfAir project, the modelled hourly mean concentrations of air pollutants for the 40 year time period on this high resolution are applied in various epidemiological studies of the link between air pollution and health effects. The model results represent concentrations at the rural and urban background local scale level which in this study are evaluated for the components NO_2, O_3 and $PM_{2.5}$, which are the most important components to address when studying health effects of air pollution.

The simplicity of the model makes it possible to perform model runs for a combination of large domains with high resolution and long time periods that is currently very difficult to obtain with more comprehensive Eulerian high-resolution models, which take much longer time to run, since they are limited by the Courant–Friedrichs–Lewy (CFL) stability criteria. When studying the long-term effects of air pollution components, e.g. with the home address of individuals in a cohort as proxy, these high-resolution model runs are required.

The evaluation is part of a study with the aim to investigate, how well the UBM model with its relatively simple description of atmospheric dispersion and chemistry captures the temporal and spatial variations in the four Nordic countries. In general, the model performs relatively well for describing the temporal variations with correlation coefficients around 0.5-0.8. The model has a

tendency to overestimate NO_2 levels with a few µg for all four countries, and overestimate $PM_{2.5}$ with for Norway and Sweden with 3-5 µg across all stations.

The coupled model setup will be presented together with examples of 40 years of high-resolution model results for the four Nordic countries as well as the results of the model evaluation against measurements in the domain.