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Simulation of air quality over Central-Eastern Europe – Performance evaluation of WRF-CAMx modelling system

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Abstract

The main goal of presented work is to evaluate the accuracy of modelling the atmospheric transport and transformation on regional scale, performed with 25 km grid spacing. The coupled Mesoscale Weather Model – Chemical Transport Model (CTM) has been applied for Europe under European-American AQMEII project (Air Quality Modelling Evaluation International Initiative - http://aqmeii.jrc.ec.europa.eu/). The modelling domain was centered over Denmark (57.00°N, 10.00°E) with 172 x 172 grid points in x and y direction. The map projection choice was Lambert conformal. In the applied modelling system the Comprehensive Air Quality Model with extensions (CAMx) from ENVIRON International Corporation (Novato, California) was coupled off-line to the Weather Research and Forecasting (WRF), developed by National Center for Atmospheric Research (NCAR).

WRF-CAMx simulations have been carried out for 2006. The anthropogenic emisions database has been provided by TNO (Netherlands Organisation for Applied Scientific Research) under AQMEII initiative. Area and line emissions were proceeded by emission model EMIL (Juda-Rezler et al., 2012) [1], while for the point sources the EPS3 model (Emission Processor v.3 from ENVIRON) was implemented in order to obtain vertical distribution of emission. Boundary conditions were acquired from coupling the GEMS (Global and regional Earth-system Monitoring using Satellite and in-situ data) modelling system results with satellite observations.

The modelling system has been evaluated for the area of Central-Eastern Europe, regarding ozone and particulate matter (PM) concentrations. For each pollutant measured data from rural background AirBase and EMEP stations, with more than 75% of daily data, has been used. Original 'operational' evaluation methodology, proposed by Juda-Rezler et al. (2012) was applied. Selected set of metrics consists of 5 groups: bias measures, error measures, correlation measures, measures of model variance and spread, which together with various graphical analysis enable comprehensive assessment of the model skill.

The results show, that in general, WRF-CAMx modelling system underpredicts measured concentrations, however, the fractional bias (FB) and fractional error (FE) skill criteria, as well as the benchmark of index agreement (IA), for both ozone and PM in various averaging time ranges have been fulfilled at a satisfactory level.

[1] Juda-Rezler K., Reizer M., Huszar P., Krüger B.C., Zanis P., Syrakov D., Katragkou E., Trapp W., Melas D., Chervenkov H., Tegoulias I., Halenka T., (2012). Modelling the effects of climate change on air quality over Central and Eastern Europe: concept, evaluation and projections. Climate Research, 53(3), 179-203.