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Air pollution modeling over Europe using WRFchem

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The aim of this study is to model air pollution for entire Switzerland with a very high spatial resolution. For the first time a several year period of air pollution is modeled for entire Switzerland. The high resolution domain of Switzerland is nested into a coarser European domain with a horizontal resolution of 50 km, extending from south of Spain to south of Finland. So far only the framework for the European domain exists and therefore we focus on the method and first results of this particular domain. The state-of-the-art "Weather Research and Forecasting" (WRF) model with a chemistry extension (WRFchem) is used to simulate air pollutants. It is one of the first times that these two "online" coupled models are applied for entire Europe. Gas phase chemistry is modeled with the "Carbon bond mechanism version Z" (CBMZ) with 67 prognostic chemical species and 164 chemical reactions. Aerosols are treated by the "Model for Simulating Aerosol Interactions and Chemistry" (MOSAIC) using 4 sectional aerosol bins. The meteorological initial and boundary conditions are derived from the NCEP Reanalysis 2 and GFS data. The anthropogenic emissions are taken from the European Monitoring and Evaluation Programme (EMEP), which have a horizontal resolution of 50 km and are divided into 11 SNAP-sectors (Selected Nomenclature for reporting of Air Pollutants). According to these different sectors and the countries the data could be disaggregated into hourly emissions according to the GENEMIS project. To use this dataset also a spatial conversion with the inverse next neighbor method and a vertical disaggregation as well as a re-apportioning of different chemical species were applied. Biogenic emissions are computed during runtime using the Guenther Scheme. We noticed that chemical initial conditions are not needed as they are mainly driven by emissions. Hence a spin-up of at least five days is used. For verification purposes correlations with European ground-based measurements (O3, NO2, SO2, PM10) are analyzed. As expected, better results are achieved using the GFS instead of the Reanalysis 2 dataset as meteorological input. As boundary conditions the performance of monthly mean values (1997-2001) from the LMDZ-INCA model and idealized profiles from the NALROM chemistry model were evaluated, but no significant differences could be found. The outcome of the model is comparable or better than other models used over entire Europe. Overall the European simulations show encouraging results for observed air pollutants, with ozone being the most and PM10 being the least satisfying, respectively.