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# Performance and evaluation of local scale wind flow fields for urban air pollution modeling with the coupled prognostic model TAPM driven by ERA5 climate reanalysis data

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Urban air quality management is supported by chemical transport model (CTM) simulations on the local scale. Besides the chemical transformation, CTM models are calculating the atmospheric transport processes of emissions, driven by prognostic meteorological fields for a region and period of interest. When it comes to the local scale, it is important that the computed wind flow fields realistically reflect the specific characteristics of urban areas and complex terrain in order to serve as input data for pollutant dispersion in CTM simulations. For this purpose, mainly climate reanalysis data is applied and scaled down to local scales, e.g. using local scale meteorology models which are able to predict local scale wind system phenomena, such as sea breeze and mountain-valley winds, that are not captured in synoptic scale reanalysis. However, with different synoptic reanalysis data, different local wind fields are computed in local scale meteorological models and finally used for local CTM. Therefore, to ensure the applicability in local CTM, it is necessary to evaluate the prediction of prognostic meteorology models for the urban area of interest using different reanalysis datasets.

In this study, the recently published ERA5 climate reanalysis by ECMWF is applied with different spatial and temporal resolutions in the coupled prognostic meteorological and air pollution concentration model TAPM (The Air Pollution Model). Different ERA5 scenarios with varying degree of vertical, horizontal and temporal resolution were tested to investigate the impact of different synoptic scale reanalysis data on the prediction of local scale wind flow fields. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate system for three-dimensional simulations. TAPM solves approximations to the fundamental fluid dynamics and scalar transport equations to predict meteorology and the flows important to local-scale air pollution, such as sea breezes and terrain-induced flows, against a background of larger-scale meteorology provided by synoptic analyses. By default, TAPM uses NCEP/NCAR reanalysis data with 2.5° grid spacing, 17 pressure levels and 6-hour time steps to predict local scale meteorology. For a period of three years (2011-2013) over the urban area of Hamburg, Germany, meteorological simulations have been performed with the default synoptic reanalysis dataset and with a set of different ERA5 reanalysis datasets.

The evaluation of TAPM predictions with measurements at two sites in different heights above ground shows high correlation and low BIAS for wind frequency distributions with the NCEP/NCAR reanalysis datasets. Nevertheless, the application of ERA5 datasets with different spatial and temporal resolutions shows significant improvements for all statistical parameters in all ERA5 scenarios under research. Based on this comparison, the ideal configuration of ERA5 reanalysis data to predict reliable local wind fields with TAPM is identified. The next step is the evaluation of other meteorological variables important for air pollution modeling as well as the evaluation of the predicted meteorology in historical simulations and forecasts of urban air pollution concentrations with TAPM in Hamburg on a local scale.