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Large-scale atmospheric circulation and local particulate matter concentrations in Bavaria – from current observations to future projections

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Particulate matter with an aerodynamic diameter of 10 μm or less (PM10) may have distinct adverse effects on human health. Spatial and temporal variations in PM10 concentrations reflect local emission rates, but are as well influenced by the local and synoptic-scale atmospheric conditions. Against this background, it can be furthermore argued that potential future climate change and associated variations in large–scale atmospheric circulation and local meteorological parameters will probably provoke corresponding changes in future PM10 concentration levels. The DFG-funded research project „Particulate matter and climate change in Bavaria“ aimed at establishing quantitative relationships between daily and monthly PM10 indices at different Bavarian urban stations and the corresponding large-scale atmospheric circulation as well as local meteorological conditions. To this end, several statistical downscaling approaches have been developed for the period 1980 to 2011. PM10 data from 19 stations from the air quality monitoring network (LÜB) of the Bavarian Environmental Agency (LfU) have been utilized as predictands. Large-scale atmospheric gridded data from the NCEP/NCAR reanalysis data base and local meteorological observational data provided by the German Meteorological Service (DWD) served as predictors.
The downscaling approaches encompass the synoptic downscaling of daily PM10 concentrations and several multivariate statistical models for the estimation of daily and monthly PM10, i.e.mean and number of days exceeding a certain PM10 concentration threshold. Both techniques utilize objective circulation type classifications, which have been optimized with respect to their synoptic skill for the target variable PM10.
All downscaling approaches have been evaluated via cross validation using varying subintervals of the 1980-2011 period as calibration and validation periods respectively. The most suitable – in terms of model skill determined from cross validation – downscaling procedures are finally applied to CMIP5 climate models (ECHAM6, EC-Earth) to derive estimates of possible future climate change related variations in PM10 concentrations considering two time periods (2021-2050, 2071-2100) and two different climate change scenarios (RCP 4.5, RCP 8.5).