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Influences of seasonal synoptic weather types on local PM10 concentrations from 1980-2011 in Bavaria (Germany)

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Ambient air quality parameters like nitrogen dioxide, sulphur oxides and particulate matter are influenced by the prevailing meteorological conditions on different temporal and spatial scales. Several studies confirm the dependence of local PM10 (particulate matter with a medium aerodynamic diameter < 10 μg/m^3) concentrations on local meteorological and large-scale atmospheric conditions.

For describing the linkage between large-scale atmospheric conditions and local PM10 concentrations, circulation- and weather-type classifications are used in a number of studies. The applied methods represent a wide range of different statistical approaches, e.g. methods based on cluster analysis, principal component analysis or neural networks. Up to now, only few systematic attempts have been made to modify existing or to develop new weather- and circulation-type classifications with regard to their discriminative power for local PM10 concentrations, especially for such a longer-term period from 1980 to 2011 as presented in this contribution.
A k-means cluster analysis classification of circulation and weather types, performed on daily 2.5 x 2.5 gridded parameters of the NCEP/NCAR reanalysis data set, is optimized with regard to its discriminative power for local daily PM10 concentrations at 16 Bavarian measurement sites for the period 1980 to 2011. Seasonal patterns emerging from this optimization are varying combinations of three large-scale atmospheric variables in several levels with different weights. Their performance is evaluated by using a range of skill scores for varying calibration and validation periods.

Depending on the season and the target PM10 station, the combinations of large-scale atmospheric variables vary, but as most relevant parameters air temperature (1000 hPa level), relative (850 hPa level) and specific humidity (1000 hPa level), mean sea level pressure, geopotential heights at the 500 hPa level as well as zonal wind (500 hPa level) were detected.

Based on these analyses, it is further intended to develop robust downscaling models for estimating possible future – climate change induced – variations of local PM10 concentrations in Bavaria from scenario runs of global CMIP5 climate models. With climate changing rapidly, these connections need to be better understood in order to provide estimates of climate change related consequences for air quality management purposes.