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Objective Circulation type classifications for the estimation of local PM10 concentrations in Bavarian cities (Germany)

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Concentrations of particulate matter with a particle distribution of a median aerodynamic diameter < 10 μm (PM10), are known to be relevant for public health, notably concerning cardiovascular and respiratory diseases. High pollution events of PM10 are defined by a threshold of a daily mean concentration of 50μg/m^3 by directive 1999/30/EC and following directive 2008/50/EC of the European Union, which are relevant for regional air-quality mitigation strategies.
Local concentrations of these fine particles are influenced by meteorological parameters on different scales, e.g. local meteorological conditions and large scale circulation dynamics. In order to detect critical periods of high PM10 concentrations, one focus in recent studies is the improvement of accurate short-term deterministic and statistical prediction models as well as reliable approaches for long-term air-quality prediction.
The general relationship between local PM10 and large-scale circulation dynamics – as for example reflected by weather- or circulation types - has been proven in several studies, but so far only a few systematic attempts have been made to optimize weather- and circulation type classifications concerning their relationship to local PM10 concentrations.
Against this background the aim of this study is to evaluate various approaches for the optimization of circulation type classifications with respect to their relevance for local PM10 concentrations in Bavarian cities (Germany) in order to detect those approaches that are best suited for the use in planned subsequent studies (e.g. estimation of potential PM10 variations due to future climate change).
The used data set of daily mean PM10 has been provided by the Bavarian Environment Agency. For the analysed period 1980-2011 measurements of 16 urban traffic related stations, spread over the whole of Bavaria, are available. We provide initial characteristics of this data set concerning data availability, basic quality aspects, long-term trends and correspondance between locations.
In a first step two different circulation type classification approaches, a k-means cluster-analysis and a threshold-based classification (Grosswettertypes) are applied to gridded (2.5° x 2.5° spatial resolution) daily NCEP/NCAR reanalysis data for the period 1980 – 2011.
Variants of these two approaches are performed for varying spatial and temporal domains (varying domain sizes, single- or multiple day sequences, seasonal or whole year samples) and for different numbers of classes (circulation types). All resulting classifications are evaluated concerning their discriminatory power for local PM10 concentrations in several Bavarian (Germany) cities by using different evaluation criteria, e.g. the Explained Variance (EV) and the Brier Skill Score (BSS).
Based on evaluation results the basic classifications configurations that are most suitable for discriminating local PM10 concentrations are determined. In further analytical steps these basic approaches will be further refined by including alternative or additional variables into the classification algorithm or by performing classifications conditioned by the target variable.