Geophysical Research Abstracts
Vol. 17, EGU2015-2114, 2015
EGU General Assembly 2015

Impact of seasonal synoptic weather types on local PM10 concentrations in Bavaria/Germany: recent conditions and future projections

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It is a matter of common knowledge that local concentrations of PM10 (fine particles in the air with a medium diameter less than 10 μm) vary with the seasons in Europe. These concentrations are influenced on the one hand by the amount of natural and anthropogenic emissions and on the other hand by large-scale and local meteorological conditions. In Bavaria (part of southern Germany) as the target region of the present study, the PM10 concentrations are particularly high in winter time. One reason for this are increased particle emissions due to domestic heating and traffic load in December, January and February. As several studies in other European regions indicated, a distinct effect of the large-scale synoptic weather situation in winter on local PM10 concentrations should be considered as another reason.

The main task of this study is to use seasonal synoptic weather types, which are optimized with respect to daily mean PM10 data at 16 Bavarian cities, and therefore are classified by using daily gridded NCEP/NCAR reanalysis data (2.5° x 2.5° horizontal resolution) for the recent period 1980 – 2011 over a Central European spatial domain, to describe the impact of the large-scale meteorological conditions on the local particle concentrations. The weather types are related to monthly PM10 indices by using different transfer techniques like direct synoptic downscaling, multiple regression and generalized linear models as well as random forests. The PM10 indices are determined by averaging daily to monthly data (PMmean) or by counting the daily exceedances of a particular threshold (> 50 μg/m3, PMe50).

The generated transfer models are evaluated in calibration and validation periods using several forecast skills, for example the mean squared skill score (MSSS) or the Heidke Skill Score (HSS). The sufficiently performing models are then applied to weather types derived from future climate change scenarios of the global climate model ECHAM 6 for the IPCC scenarios RCP 4.5 and 8.5 in order to estimate future climate-change induced modifications of local PM10 concentrations in Bavaria.