# Monthly mean $PM_{10}$ concentrations in Augsburg (Germany) and their relation to large-scale atmospheric circulation types

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## Overview

In this contribution the connection between large-scale atmospheric circulation types and local monthly mean $PM_{10}$ concentrations in Augsburg (Germany) is investigated.

Thereby the focus is put on quantifying the relationships between interannual variations in monthly mean $PM_{10}$ concentrations during the period 1979 to 2007 and corresponding changes in monthly frequencies of daily circulation types determined on the basis of varying circulation type classifications by means of multiple linear regression and synoptic downscaling models.

The skill of the models is estimated and results for different circulation type classifications and varying downscaling approaches are compared.

## Data

- Daily $PM_{10}$-data for the traffic related measuring station Augsburg Königsplatz (Fig. 1) are available for the period 1979 to 2007 from the Bavarian Air Monitoring Network (LÜB) that is maintained by the Bavarian Environment Agency (LfU).

- For circulation type classifications daily (12 UTC) gridded (2.5° x 2.5°) MSLP data from the NCEP7NCAR reanalysis for the period 1979 to 2007 have been used.

## Approach

Monthly mean $PM_{10}$-values have been calculated on the basis of daily values.

Five different circulation type classifications have been determined on the basis of daily gridded SLP data (Beck & Philipp 2010, Philipp et al. 2010):

- GWT: Threshold based Grosswetter-types or prototype classification
- PTT: T-mode principal component analysis
- LND: Correlation based Lund classification
- CKM: K-means based cluster classification
- SAN: Simulated annealing and diversified randomization clustering.

Each of the classifications have been performed:

- for different numbers of types (9, 18 and 27 types) and
- for domains of varying size (Fig. 2).
- Two classifications (PTT, CKM) have been additionally applied not only to single days but as well to sequences of 3 days.

Monthly occurrence frequencies of circulation types have been utilised in:

- Stepwise multiple regression models and
- Synoptic downscaling models

as predictors to estimate monthly mean $PM_{10}$-concentrations from Augsburg Königsplatz.

The models have been calibrated in the period 1979 – 1995 and have been verified in the period 1996 -2007.

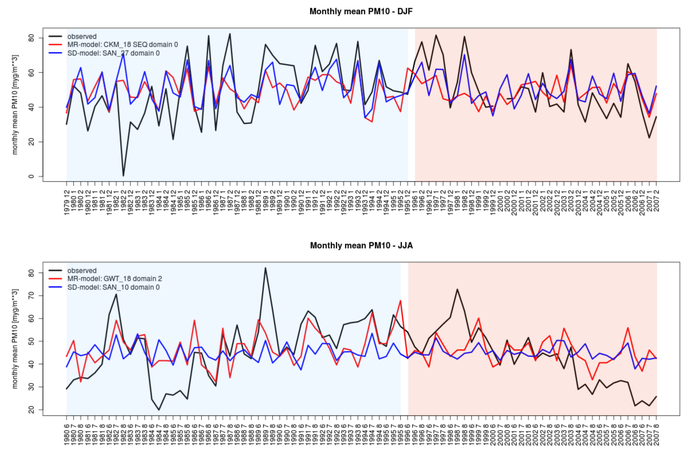


**Figure 3:** Monthly mean $PM_{10}$ at Augsburg Königsplatz for Winter-DJF (top) and Summer-JJA (bottom).

Shown are:

- observed values (black),
- Values estimated by the best performing multiple regression model (red) and
- Values estimated by the best performing synoptic downscaling model (blue).

Blue shade denotes calibration period, red shade denotes verification period.

Best models have been selected according to maximum values of RV (Reduction of Variance) estimated for the verification period.

## Results

Selected results displayed in Fig. 3 and Fig. 4 can be summarized as follows:

- model skill is generally better in winter-DJF than in summer-JJA; models for spring-MAM and autumn-SON show intermediate skill (not shown)
- in most cases better skill is achieved with synoptic downscaling models rather than with multiple linear regression models
- modelled time series reflect well the observed interannual fluctuations
- distinct discrepancies appear with respect to longer term multiyear variability and trends
- in most cases better skill of the models is achieved on the basis of circulation types determined for smaller (regional scale) spatial domains
- results give no clear indication on a specific circulation classification method that should be preferably used in such downscaling approaches

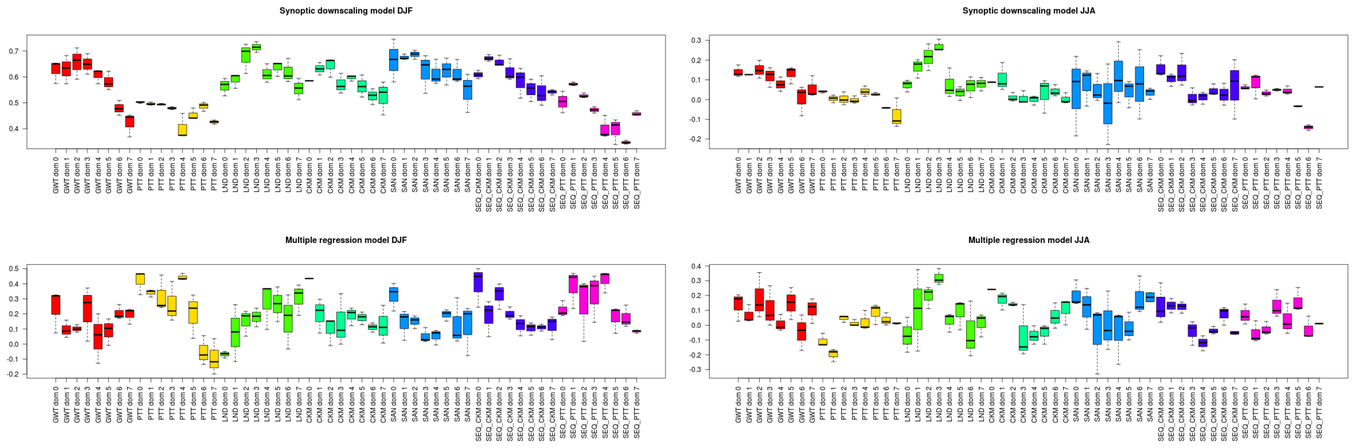


**Figure 4:** Model Skill (in terms of pearson-r between observed and modelled PM10-series in the verification period from 1996-2007) of synoptic downscaling models (top) and multiple regression models (bottom) for Winter-DJF (left) and Summer-JJA (right).
Varying circulation type classifications used in the models are indicated on the y-axis concerning method, domain size and sequence length.


**Figure 1:** Location characteristics of the traffic related $PM_{10}$ measuring station Augsburg Königsplatz (10°53´42´´ E, 48°21´52´´ N, 492 m a.s.l.).

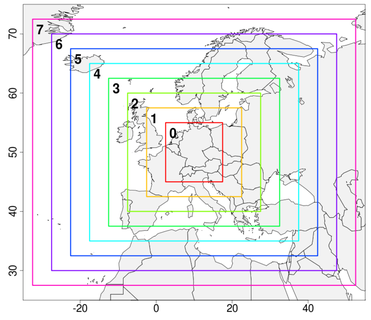


**Figure 2:** Spatial domains of varying size (0 to 7) to which circulation type classifications have been applied.

## Summary / Outlook

Multiple linear regression models and synoptic downscaling models have been applied to estimate monthly mean $PM_{10}$ values at a traffic related site using varying circulation type classifications.

Remarkable skill – especially of synoptic downscaling approaches – can be stated particularly in winter and on the basis of circulation types determined from regional scale spatial domains.

Further analyses will focus on:

- the optimisation of circulation type classifications with respect to local $PM_{10}$ concentrations via the inclusion of alternative or additional variables into the circulation classification scheme (e.g. humidity parameters) and
- the application of appropriate downscaling approaches to climate model data in order to achieve estimates of the $PM_{10}$ related relevance of potential future circulation variations.

### References

Beck C. and A. Philipp (2010): Evaluation and comparison of circulation type classifications for the European domain. Physics and Chemistry of the Earth 35: 374-387.

Philipp A., J. Bartholy, C. Beck, M. Erpicum, P. Esteban, X. Fettweis, R. Huth, P. James, S. Jourdain, F. Kreienkamp, T. Krennert, S. Lykoudis, S. Michalides, K. Pianko-Kluczynska, P. Post, D. Rassilla Álvarez, R. Schiemann, A. Spekat, F.S. Tymvios (2010): COST733CAT - a database of weather and circulation type classifications. Physics and Chemistry of the Earth 35: 360-373.