Karlsruher Institut für Technologie

Campus-Alpin
IMK-IFU: Atmosphärische Umweltforschung

Source apportionment studies on particulate matter in Beijing/China

P. Suppan[1], R. R. Shen[1] , S. Schrader[1,2], L.Y. Shao[3], K. Schäfer[1], S. Norra[2], B. Vogel[4], K. Cen[5], Y. Wang[6]

[1] Institute of Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU) at the Karlsruhe Institute of Technology (KIT), 82467 Garmisch-Partenkirchen, Germany
[2] Institute of Geography and Geoecology (IfGG) at the Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany
[3] Department of Resources and Earth Sciences, China University of Mining and Technology (CUMTB), 100083 Beijing, P. R. China
[4] Institute of Meteorology and Climate Research, Tropospheric Research (IMK-TRO) at the Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany
[5] School of Earth Sciences and Resources, China University of Geosciences (CUGB), 100083, Beijing, P.R. China
[6] Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences (CAS), 100029 Beijing, P.R. China

Contact: Dr. Peter Suppan – peter.suppan@kit.edu

Problem & Motivation

More than 15 million people in the greater area of Beijing are still suffering from severe air pollution levels caused by sources within the city itself but also from external impacts like severe dust storms and long range advection from the southern and central part of China.

Within this context particulate matter (PM) is the major air pollutant in the greater area of Beijing (Garland et al., 2009). PM did not serve only as lead substance for air quality levels and therefore for adverse health impact effects but also for a strong influence on the climate system by changing e.g. the radiative balance..

In order to discriminate the composition of the particulate matter levels, the different behavior of coarser and smaller particles investigations on source attribution, particle characteristics and external impacts on the PM levels of the city of Beijing by measurements and modeling are performed.

Methodology

Measurements

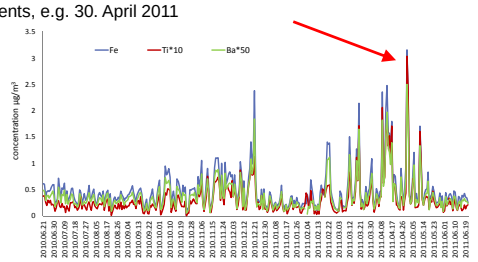
- **Particulate concentrations:** Daily PM filter sampling on quartz fiber filters with 2 High-Volume Samplers DHA80 (Digitel)
- **Particle composition:** Main and trace elements analyzed by PEDXRF (Polarized energy dispersive X-ray fluorescence)
- **Period:** One years episode from **June 2010 to June 2011**

Modeling

- **Meteorology:** COSMO weather forecast model of the German Weather Service
- **Gases & Aerosols:** simulation in ART (developed at KIT) of 80 gaseous species, 5 anthropogenic aerosol modes, mineral dust, sea salt and pollen
- **Feedbacks:** meteorology, aerosols, gas phase, dynamics, clouds
- **Period:** 9-days episode from **April 23rd to May 2nd 2011**

Measurements

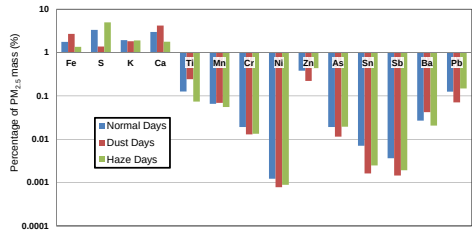
Annual course of concentrations of natural sources (**Fe, Ti** and **Ba**) in particulate matter. Highest concentrations during dust storm events, e.g. 30. April 2011



Element	Factor 1	Factor 2	Factor 3
PM	**0.684**	**0.647**	0.129
Fe	**0.944**	0.261	0.107
S	0.009	**0.874**	-0.009
K	**0.620**	**0.653**	0.097
Ca	**0.885**	0.218	0.124
Ti	**0.954**	0.040	0.117
Mn	**0.843**	0.417	0.137
Cr	**0.520**	**0.514**	-0.078
Ni	**0.467**	**0.564**	0.060
Zn	0.367	**0.814**	0.273
As	0.132	**0.677**	0.419
Sn	0.008	0.174	**0.792**
Sb	0.172	0.068	**0.680**
Ba	**0.947**	0.240	0.110
Pb	0.348	**0.850**	0.236

Source apportionment - Factor Analysis:
Factor 1: Geogenic sources
Factor 2: Fossil fuel combustion (oil and coal combustion) and waste incineration
Factor 3: Brake wear

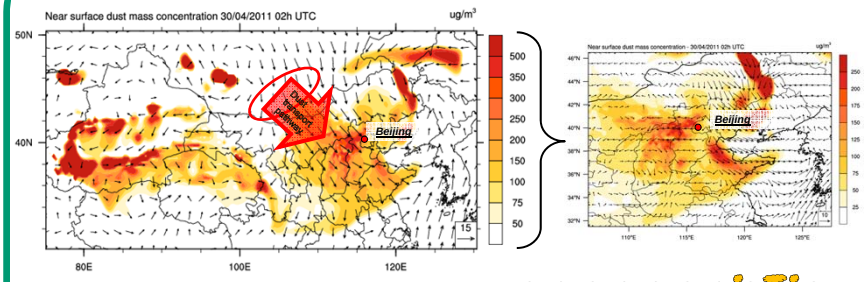
See also poster on *"Chemical composition of PM in a residential area of Beijing, China"* → P-2-082



Particle composition:
S, Zn and **Pb** refer to anthropogenic influences - highest amount during haze days.

Fe, Ti, Ca, Mn, Ba refer to geogenic sources - highest amount during dust days.

Model results

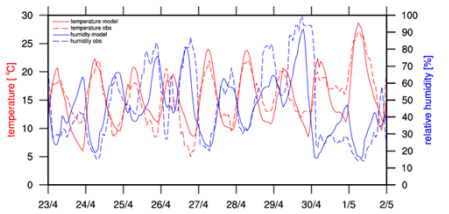


Model & Measurement:

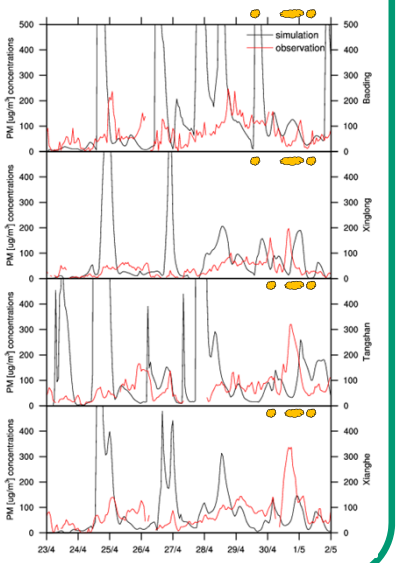
- Comparison of modeled mineral dust mass concentrations with mean diameter d= 1.5 µm and $PM_{2.5}$ for several Greater Beijing urban measurement stations
- The mineral dust event at April 30th and May 1st can be reproduced by the model
- Strong overestimation of simulated mineral dust concentrations originated from soil emission data

Meteorology:

- The general behavior of the meteorological parameters during the dust event can be reproduced by the model



Comparison of modeled and measured 2 m temperature and relative humidity for the location at CAS-IAP station Beijing without feedback processes



Outlook

- Source apportionment on the basis of inorganic compounds, organic compounds, EC, OC, carbon isotope
- Integration of anthropogenic emissions in addition to the natural ones to quantify the contributions of each source category to $PM_{2.5}$ and PM_{10} in Greater Beijing
- Consideration of interactions between dust, radiation and cloud processes

Acknowledgement
This work was partly funded by the Chinese Scholarship Council (CSC) and the Helmholtz Graduate School for Climate and Environment (GRACE) at KIT