Modelling the impact of mineral dust on air quality in Beijing during a dust event

S. Schrader[1,3], B. Vogel[2], H. Vogel[2], K. Schäfer[3], R. R. Shen[3], R. Forkel[3], P. Suppan[3], G. Tang[4], Y. Wang[4], S. Norra[1]

[1]Institute of Geography and Geoecology, Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany
[2]Institute of Meteorology and Climate Research – Department of Troposphere Research (IMK-TRO), Karlsruhe Institute of Technology (KIT), 76344 Eggenstein-Leopoldshafen, Germany
[3]Institute of Meteorology and Climate Research – Department of Atmospheric Environmental Research (IMK-IFU), Karlsruhe Institute of Technology (KIT), 82467 Garmisch-Partenkirchen, Germany
Institute of Atmospheric Physics (IAP) - State Key Laboratory of Atmospheric Boundary Layer Physics and Atmospheric Chemistry (LAPC), Chinese Academy of Sciences (CAS), Beijing, China

Keywords: Modelling (regional), Asian dust, air pollution, megacity

Presenting author email: stefanie.schrader@kit.edu

Sand- and dust storms frequently occur in spring in Northern China causing very high geogenic particle mass concentrations in the atmosphere in the source regions (Wu *et al*., 2009). These dust particles can be also transported over long distances towards the highly urbanized areas of Eastern China. In megacities like Beijing, the anthropogenic and geogenic aerosol loading can lead to severe reduction of air quality and and visibility as well as harm the human health (Schleicher *et al*., 2010; Chen *et al*., 2011). Moreover the aerosol has impact on the state of the atmosphere altering radiative fluxes and cloud formation processes (Bangert *et al*., 2012). Still, a lack of information exists about the mixing of mineral dust in the urban atmosphere.

To investigate the contribution of mineral dust to the urban air quality of the Greater Beijing area and its impact on the state of the atmosphere the comprehensive online coupled model system COSMO-ART (Vogel *et al.*, 2009) has been set up for Northern China. COSMO-ART consists of the meteorological weather forecast model COSMO of the German Weather Service (DWD) and ART for the treatment of aerosols and reactive trace gases. The mineral dust module of COSMO-ART allows the online coupled calculation of mineral dust mass and number concentrations and their interactions with the physical parameters of the atmosphere. The model domain covers whole Northern China which allows the investigation of the influence of mineral dust from all Chinese desert areas to the aerosol loading in Beijing atmosphere. COSMO-ART is set up with 40 vertical levels and a horizontal resolution of 28 km x 28 km.

The simulated mineral dust and anthropogenic PM_{10} and $PM_{2.5}$ concentrations are compared to PM_{10} and $PM_{2.5}$ measurement data from ground based stations. Measurements are conducted by LAPC in the Greater Beijing area (Xin *et al*., 2012). The meteorological data for model and measurement comparison are taken from WMO meteorological stations. Additional information about the spatial distribution and aerosol types are available from CALIPSO lidar data.

COSMO-ART is applied for the Asian dust storm event that hit Beijing on April 30th in 2011 lasting for about one day. Several meteorological stations in the Greater Beijing area reported blowing sand, widespread dust conditions and strong wind speeds from north-western directions. Visibility in this area dropped down to 1 km due to the high aerosol loading in the atmosphere. Observed PM_{10} and $PM_{2.5}$ concentrations of all stations showed a sudden steep peak of up to 1250 µg/m³ and 350 µg/m³, respectively. COSMO-ART is able to simulate the timing and level of this peak quite well. This confirms that the high particle concentrations observed in Beijing during this episode are of geogenic origin brought into the city area from dust sources north-west of Beijing (Gobi desert mainly). Additional information about the spatial distribution of the mineral dust is taken from CALIPSO lidar data. It shows that there is a mixing of the mineral dust particles with anthropogenic pollutants in the urban atmosphere of Beijing.

This work is partly funded by the Graduate School for Climate and Environment (GRACE) of KIT and the KIT Centre for Climate and Environment.

Bangert, M., Nenes, A., Vogel, B., Vogel, H., Barahona, D., Karydis, V., Kumar, P., Kottmeier, C. and Blahak, U. (2012) *Atmos. Chem. Phys*., 12, 4045-4063

Huang, K., Zhuang, G., Lin, Y., Li, J., Sun, Y., Zhang, W. and Fu, J. S. (2010) *J. Geophys. Res*., 115, D00K16.

Schleicher, N., Norra, S., Chai, F., Chen, Y., Wang, S., Stüben, D. (2010) *J. Environ. Monit.*, 12, 434-441.

Vogel, B., Vogel, H., Bäumer, D., Bangert, M., Lundgren, K., Rinke, R. and Stanelle, T. (2009) *Atmos. Chem. Phys.*, 9, 8661-8680.

Wu, Z. J., Cheng, Y. F., Hu, M., Wehner, B., Sugimoto, N. and Wiedensohler, A. (2009) *Atmos. Chem. Phys*., 9, 6915-6932.

Xin, J., Wang, Y., Wang, L., Tang, G., Sun, Y., Pan, Y. and Ji, D. (2012) *Adv. Atmos. Sci*., 29, 1330-1342.