Chemical composition of PM in a residential area of Beijing, China

K. Schäfer[1], R.R. Shen[1], N. Schleicher[2,3], U. Kramar[3], S. Norra[2,3], J. Schnelle-Kreis[4], L.Y. Shao[5], J. Wang[5], J.Y. Wang[5], K. Cen[6], Y.S. Wang[7], S. Schrader[1,2], P. Suppan[1]

[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] Institute of Mineralogy and Geochemistry (IMG) at the Karlsruhe Institute of Technology (KIT), 76128 Karlsruhe, Germany
[4] Joint Mass Spectrometry Centre, Cooperation group „Comprehensive Molecular Analytics“ at the Helmholtz Zentrum München, 85764 Neuherberg, Germany
[5] Department of Resources and Earth Sciences at the China University of Mining and Technology (CUMTB), 100083 Beijing, P. R. China
[6] State Key Laboratory of Geological Processes and Mineral Resources at the China University of Geosciences (CUGB), 100083, Beijing, P.R. China
[7] Institute of Atmospheric Physics (IAP) at the Chinese Academy of Sciences (CAS), 100029 Beijing, P.R. China

OBJECTIVES

Emission reduction measures were performed to improve air quality during the Olympic Summer Games in 2008: cut down mainly coarse particles.

Question: PM still a problem?

Objectives: Chemical composition of PM, characteristics of chemical elements, and special case studies during haze and dust events.

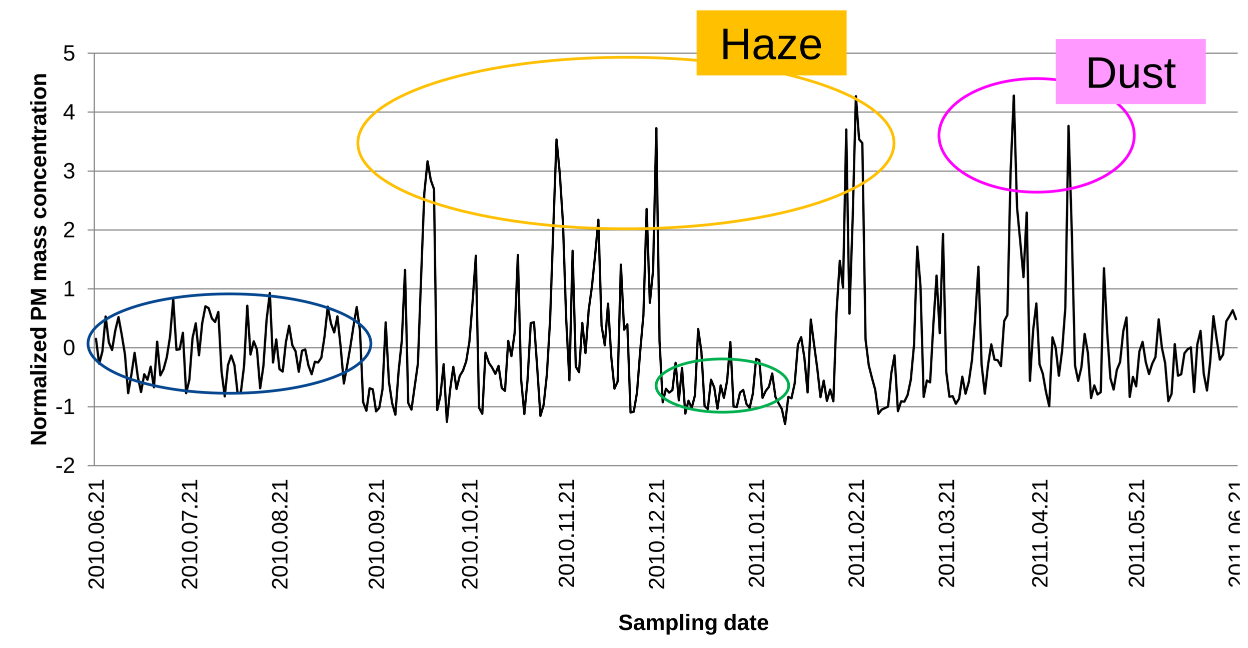
METHODOLOGY

Particulate sampling: Daily PM filter sampling on quartz fibre filters with 2 High-Volume Samplers DHA80 (Digitel) by KIT/IMK-IFU from 2010.06.21 on for one year with CUMTB at the entrance of CUGB in 20 m distance to Mini-Volume Sampler (weekly $PM_{2.5}$ samples) of KIT/IMG.

Meteorological data: ZBAA (http://weather.uwyo.edu/upperair/sounding.html) and IAP

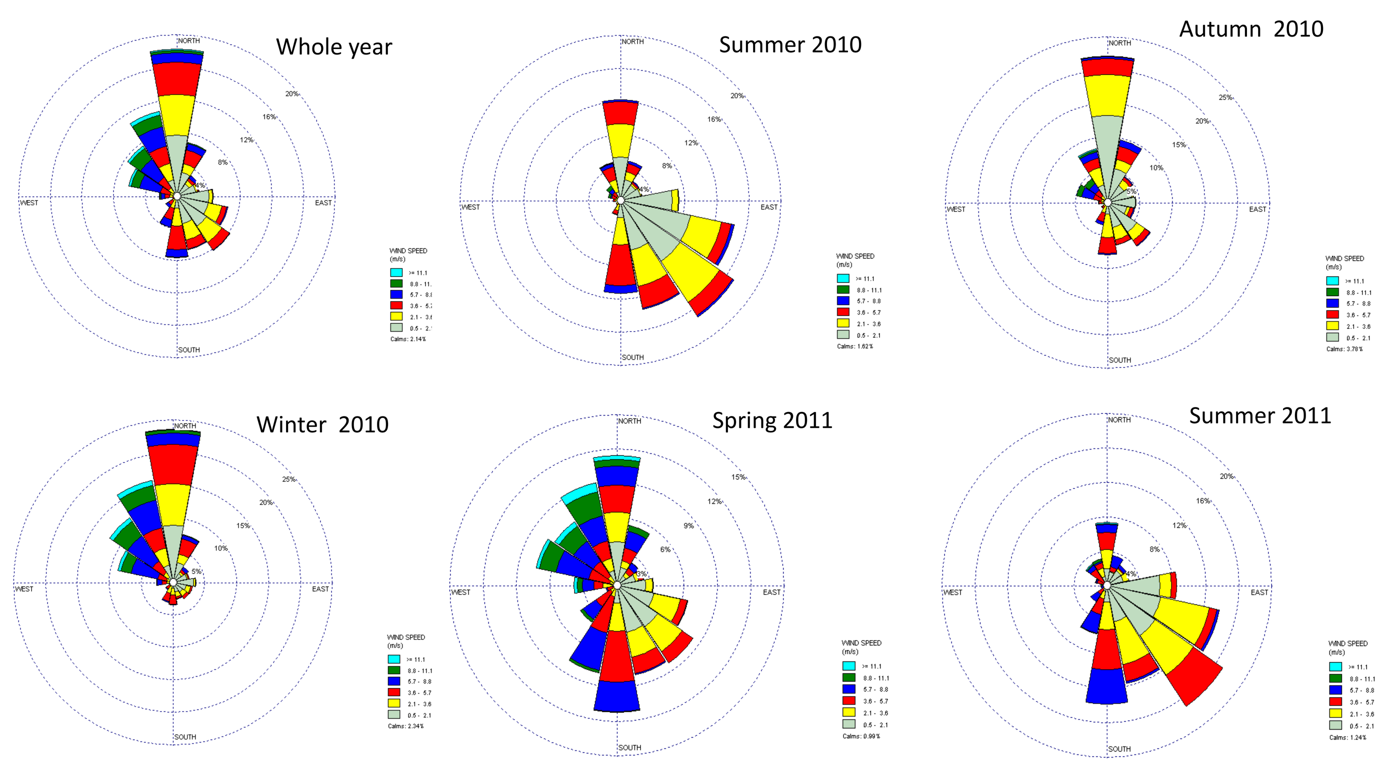
Particle composition: Main and trace elements analysed by PEDXRF (Polarized energy dispersive X-ray fluorescence) from KIT/IMG.

Z-transformation: Concentration data normalized according to equation $Conc_{z-trans} = (Conc_{value} - Conc_{avg}) / Stdev$



Annual variation of normalized (z-transformation) PM mass concentration

Peaks of PM mass concentration caused by **haze** and **dust**.



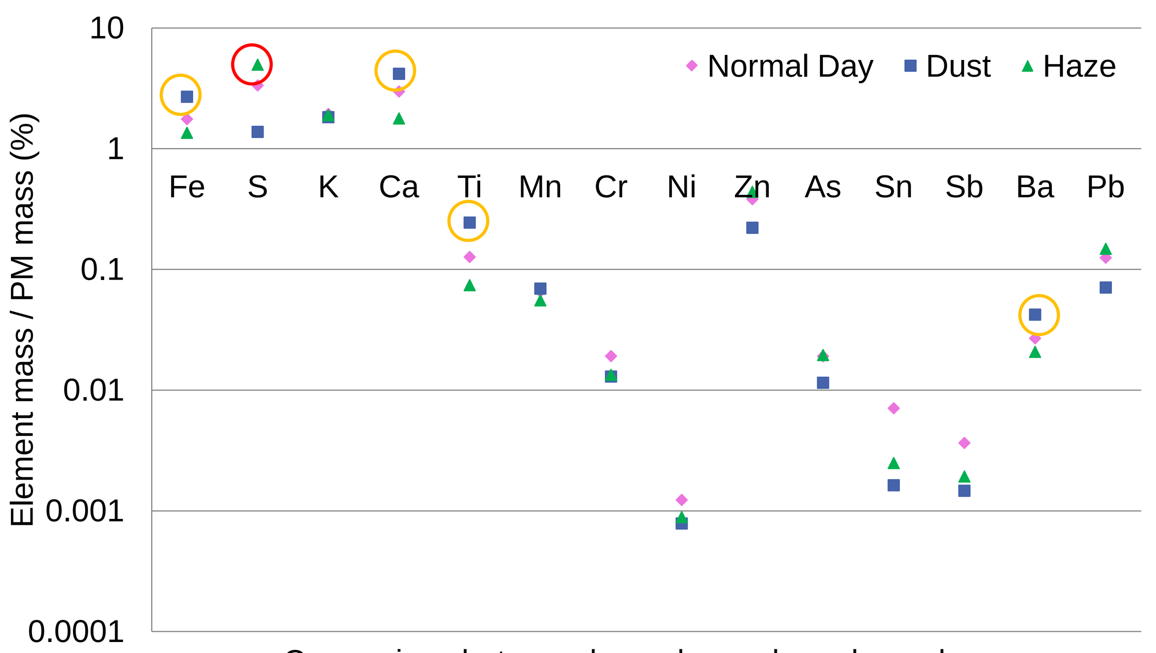
Wind and mixing-layer height (MLH) influence on PM mass concentration:

Spring – pollutant transport from South East where are industrial areas

Summer – similar, combined with precipitation and large MLH

Autumn – prevailing wind direction North and low wind speeds

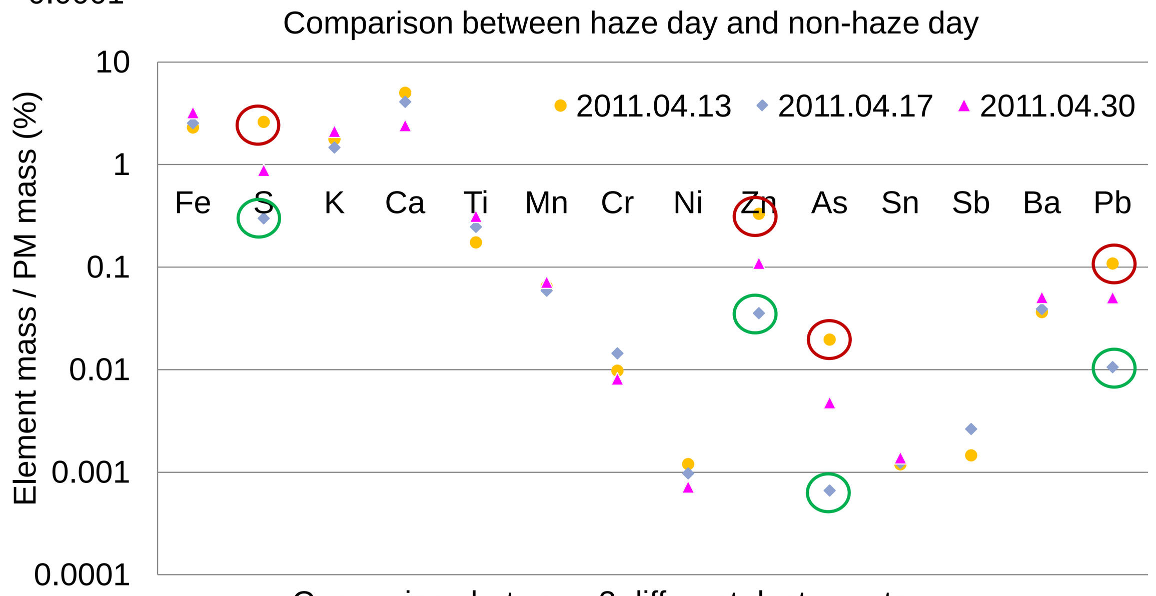
Winter - fresh air from North West with higher wind speeds reducing pollutant concentration caused by residential heating



Comparison between haze day and non-haze day

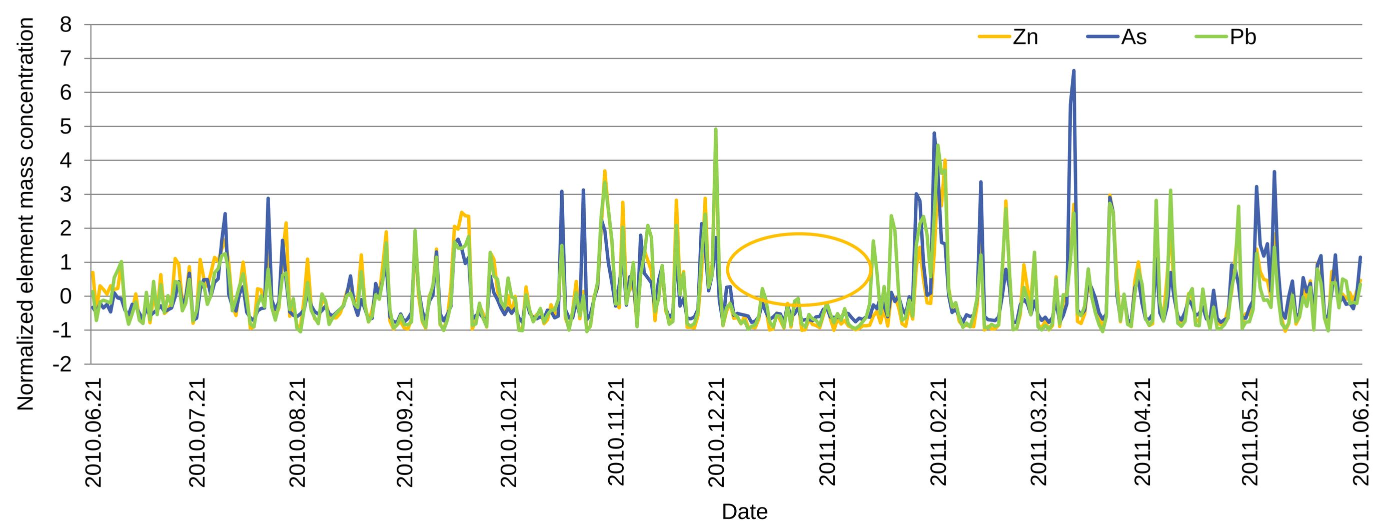
Sulfur, Zinc and **Lead** which refer to anthropogenic influences - highest amount during haze days.

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



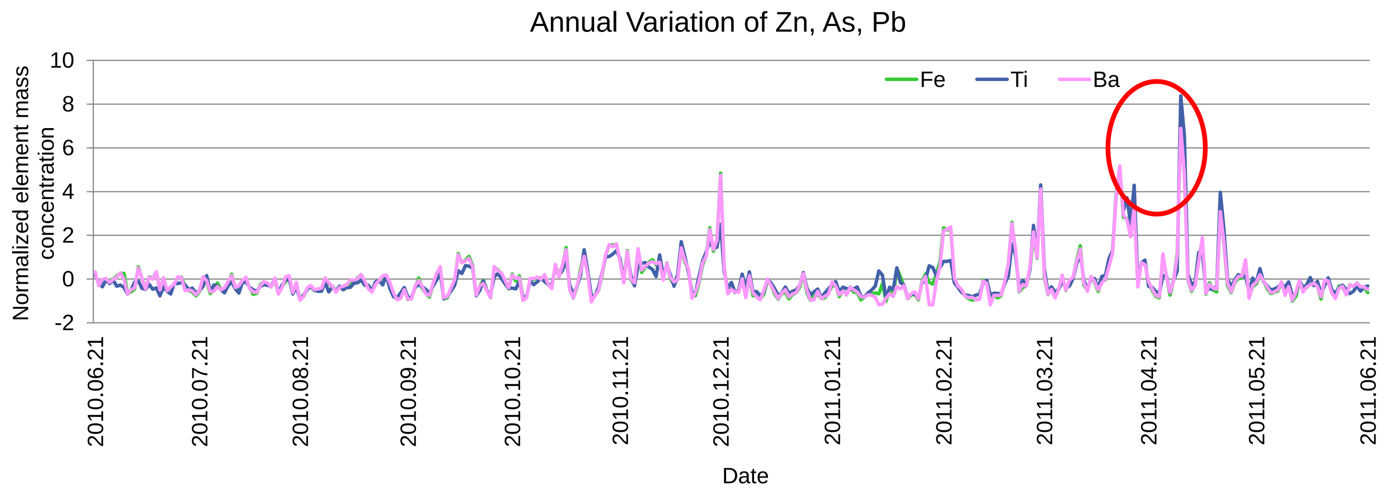
Comparison between 3 different dust events

Sulfur and Zinc highest amount during dust event on 2011.04.13 - influenced by re-suspended dust.



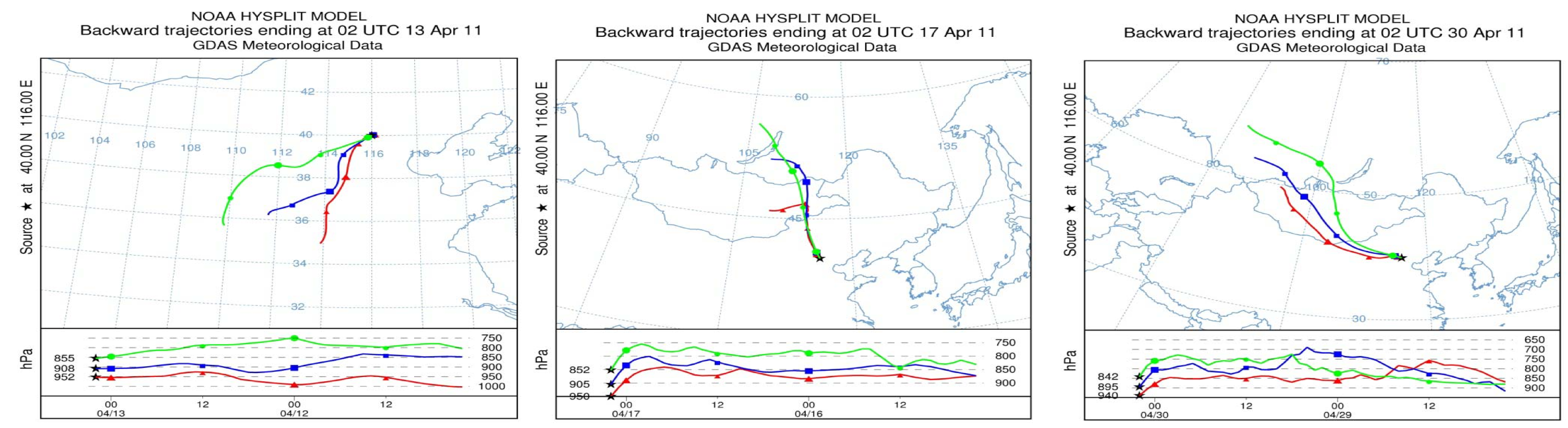
Annual Variation of Zn, As, Pb

See also poster on "Source apportionment studies on particulate matter in Beijing/China"



Annual Variation of Fe, Ti, Ba

Concentrations of Fe, Ti and Ba (**natural sources**) and Zn, As and Pb (**anthropogenic sources**) in PM: dust storm on 2011.04.30 highest Fe, Ti and Ba concentrations.



Backward trajectories of 3 different dust events

RESULTS

PM mass concentration:

Highest in April - dust storm, re-suspended road dust.

Lowest in January - low emissions during Spring Festival holiday, influenced by wind direction, speed.

Wind:

Wind plays a key role for influences on PM mass concentration.

Haze:

S, Zn and Pb - anthropogenic influences - highest contribution to PM and highest mass concentration: relative humidity and wind speed favor formation of secondary aerosols and aggravate pollution level.

Dust:

High PM mass concentration by re-suspended road dust, Mongolian desert and Gobi desert respectively.

CONCLUSIONS

Meteorological parameters: PM mass concentrations influenced by wind direction, surrounding emissions contribute to air quality.

Haze days: highest PM mass concentration from anthropogenic activities, highest sulfur amount, air pollution event during all seasons.

Dust events: sources different (re-suspended dust, dust storm), mainly desert dust, highest Fe, Ti, Ca, Mn, Ba amount, contribution to anthropogenic air pollution.

REFERENCES

Garland, R.M., Schmid, O., Nowak, A., Achtert, P., Wiedensohler, A., Gunthe, S.S., Takegawa, N., Kita, K., Kondo, Y., Hu, M., Shao, M., Zeng, L.M., Zhu, T., Andreae, M.O. and Pöschl, U. (2009) *Journal of Geophysical Research, 114(D00G04), 1–12.*

Schleicher, N., Norra, S., Dietze, V., Yu, Y., Fricker, M., Kaminski, U., Chen, Y. and Cen, K. (2011) *Science of the Total Environment, 412-413, 185-193.*

Shi, Z.B., Shao, L.Y., Jones, T.P., Whittaker, A.G., Lu, S.L., Bérubé, K.A., He, T.E. and Richards, R.J. (2003) *Atmospheric Environment, 37, 4097–4108.*

Acknowledgement
This work was partly funded by the Chinese Scholarship Council (CSC) and the Centre of Climate and Environment at KIT