Source apportionment and air quality impact assessment studies in Beijing/China

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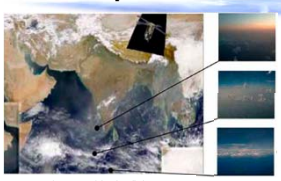
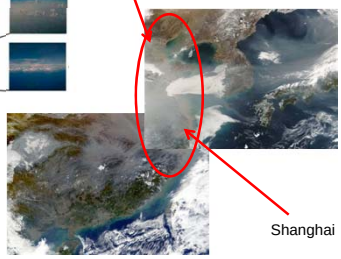
- Background
- Measurements
- Modeling case study
- Conclusions
- Outlook

Impact on Climate Change



Source: Peringe Grennfelt. Air pollution & Climate Change. Two sides of the same coin. Chapter 9. ISBN 978-91-620-1278-6



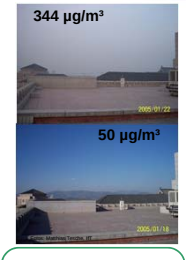
Beijing

Shanghai

ABC – Atmospheric Brown Clouds

NASA/GODDARD / NYT

Impact on Air Quality & Human Health



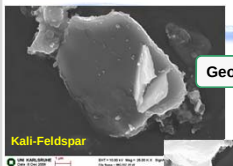
Air pollution in Greater Beijing is dominated by airborne particles from natural and anthropogenic sources…

Geogenic

Urban particle pollution

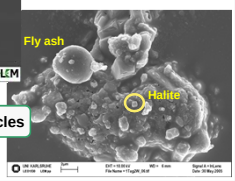
Anthropogenic

SEM Images



Geogenic particles

Anthropogenic particles



Connected particles

Assessment Tools

DOAS
Path-averaged concentrations of air pollutants NO_2, SO_2, O_3, BTX, NO, NH_3, HCHO

IAP tower
Air quality measurements up to 325 m

Dust & air pollution modelling
COSMO-ART
WRF/chem

Ceilometer
Vaisala LD40 or CL31, wave length: 855 or 910 nm, range: 4000 m, Resolution:10 or 7.5 m

High-volume samplers
150 mm ø quartz fibre filters for $PM_{2.5}$
Ultra-sonic anemometer

Particle Analysis

Sample A

Organic composition
GC-MS, EC/OC/ WSOC, stable isotopes, toxic-testing

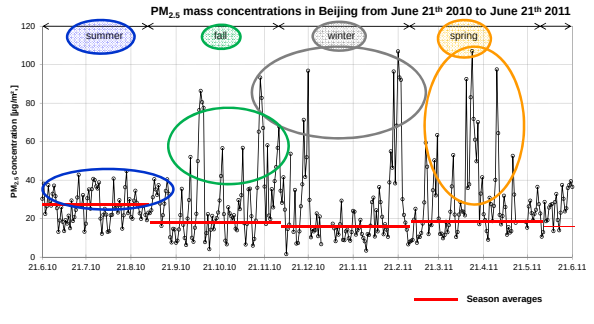
5 x 40 mm
1 x 30mm
4 x 25 mm
1 x 20 mm
5 x 10 mm

1 - Toxic assessment 2 x 40 mm **(CUMTB)**
2 - Organic 40 mm **(HMGU)**
3 - IRMS 40 mm **(IMK-IFU)**
4 - Spare 40 mm + 2 x 25 mm
5 - Toxic assessment 30 mm **(U. Cardiff)**
6 - EC/OC WSOC 2 x 25 mm **(U. Rostock)**
7 - Isotope extraction 20 mm **(IMK-IFU)**
8 - EC/OC 5 x 10 mm **(U. Rostock)**

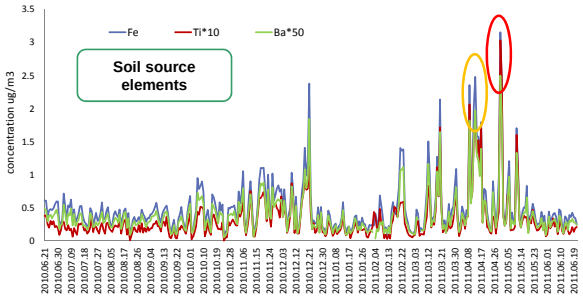
Sample B

PM mass
ICP-MS *(Inductively Coupled Plasma Mass Spectrometry),*
PEDXRF *(Polarized Energy Dispersive X-ray Fluorescence)*

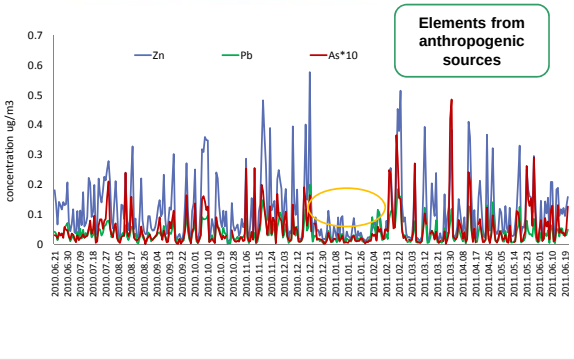
$PM_{2.5}$ mass concentration



Fe, Ti, Ba mass concentration



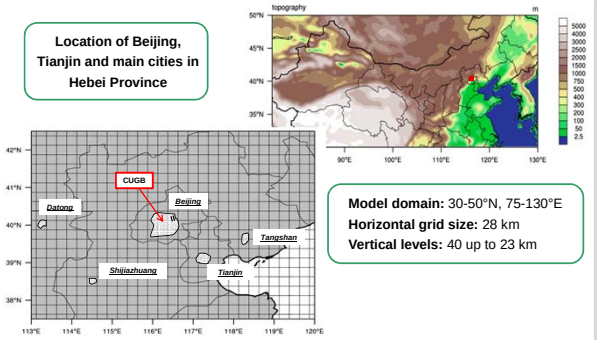
Zn, As, Pb mass concentration



Elements from anthropogenic sources

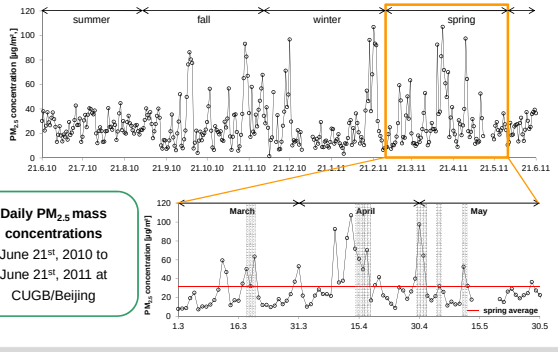
COSMO-ART setup

Location of Beijing, Tianjin and main cities in Hebei Province



Model domain: 30-50°N, 75-130°E
Horizontal grid size: 28 km
Vertical levels: 40 up to 23 km

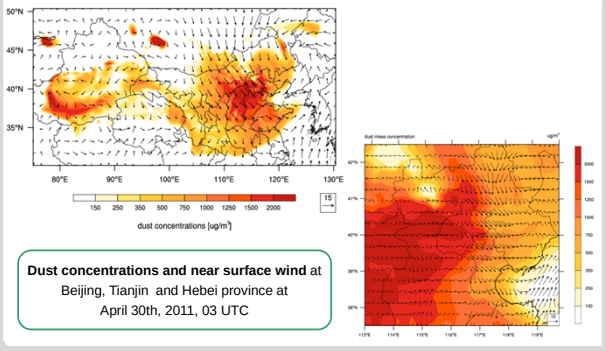
Case study – Spring 2011



Daily $PM_{2.5}$ mass concentrations
June 21st, 2010 to June 21st, 2011 at CUGB/Beijing

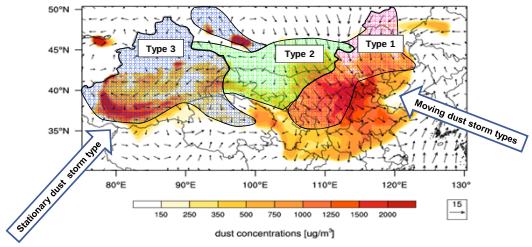
Mineral dust particles distribution

- April 30th, 2011 -



Dust concentrations and near surface wind at Beijing, Tianjin and Hebei province at April 30th, 2011, 03 UTC

Source regions of mineral dust aerosol



Dust source type 1: deserts in dry agricultural areas in the south part of the East Mongolia Plain

Dust source type 2: deserts and Gobi-deserts on flat plateaus in the south Gobi area

Dust source type 3: deserts and Gobi-deserts in topographical lows, i.e. Great Lake Basin

Conclusions

- $PM_{2.5}$ mass concentration show high variability depending on the season
- $PM_{2.5}$ mass concentration is correlated with wind speed, direction, humidity, precipitation (→ feedback to visibility)
- Source attribution by filter analysis of $PM_{2.5}$ (natural → Fe, Ti and Ba and anthropogenic sources → Zn, As and Pb)
- In general mineral dust is always present in the urban atmosphere in Beijing
- Main source region for the dust storm event seems to be Inner Mongolia but also from south-western China (loess plateau)

Outlook

- Further analysis (measurements) on $PM_{2.5}$ source attribution with the focus on seasons (→ meteorological influence)
- Analysis of path averaged air pollution measurements with inverse modeling (→ traffic emission validation)
- Online coupled modeling for source apportionment analysis
- Integrated analysis of air pollution situation in the greater region of Beijing (meteorological influence, source apportionment)
- …..

Thanks and Acknowledgment

Stefanie Schrader
PhD Thesis "Spatial and temporal distribution of particles in the greater region of Beijing/China by means of modeling and satellite data"

Rongrong Shen
PhD Thesis "Study of regional meteorological [illegible] (transport and exchange conditions) and [illegible] processes for the development of high particulate [illegible] exposures in Beijing"

Nina Schleicher, Hon[illegible]rgen Schnelle-Kreis, Guiqan Tang

...and all [illegible]hich are involved in this work and which I fo[illegible]o mention – sorry for that...

Thank you for your attention