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Validation of PM concentrations computed with the GAINS-Asia/TM5 model

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EU 6th Framework Programme for Research

Outline

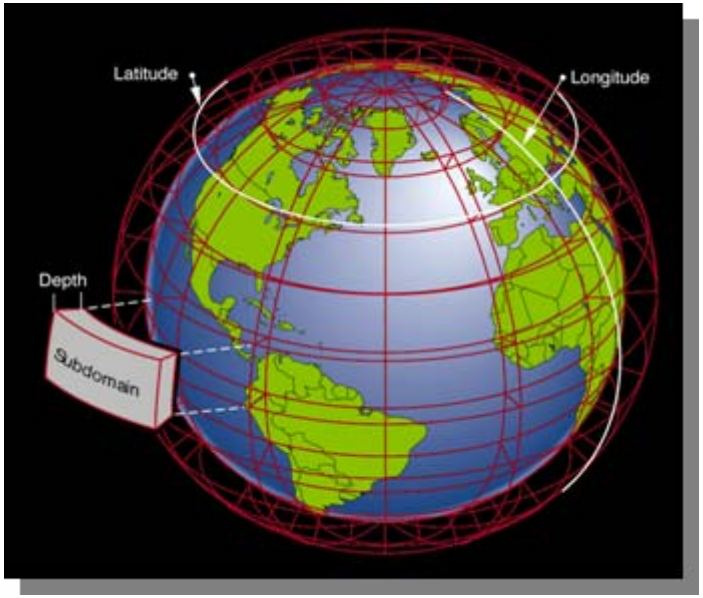
- Source-receptor relationships for $PM_{2.5}$ from TM5 model runs
  - sub-grid urban scaling

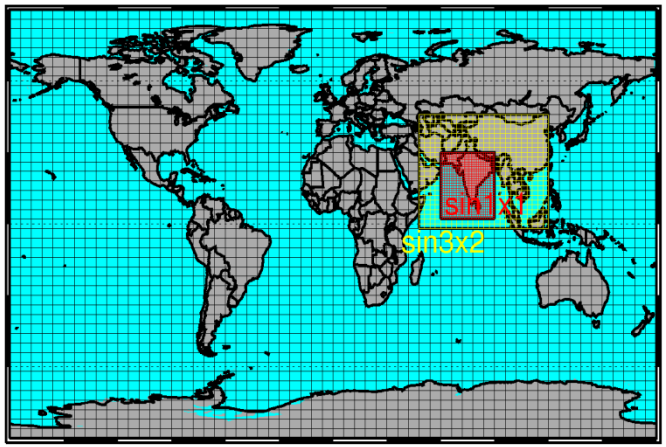
- Comparison with measurements
  - PM_{10} / RSPM
  - $PM_{2.5}$
  - composition

Acknowledgement

Frank Dentener, JRC-IES, Ispra

TM 5 model set-up





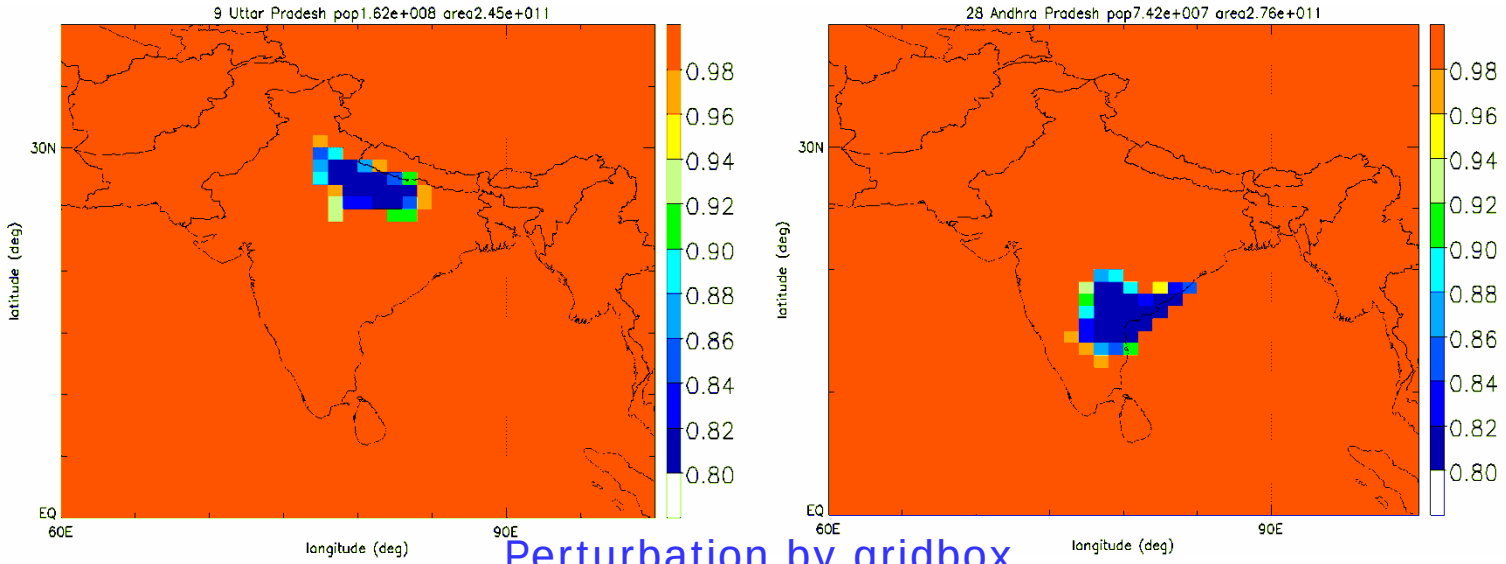
TM5 is a global 3D CTM with regional two-way nesting, developed by Utrecht University and JRC

- For GAINS-Asia operated by JRC
- 6°x4; 3°x2°,1°x1°; 25 vertical layers
- Aerosol and photo-chemistry
- ECMWF meteorology; output every hour
- Participated in AEROCOM, PHOTOCOMP, HTAP intercomparisons

TM5 experimental set-up for GAINS-Asia

Source-receptor relationships derived for:

- 26 regions in China
- 32 regions for India; Bangladesh, Pakistan and Sri Lanka
- Perturbation by -20 % of anthropogenic emissions per region
- Emissions: GAINS/EDGAR3.2; BC/POM: Bond (2004).
- 2 separate cases: NO_x-BC-POM; and SO_2-CO-VOC
- Altogether ca. 120 simulations of 1 year + spin-up 2 months



Perturbation by gridbox

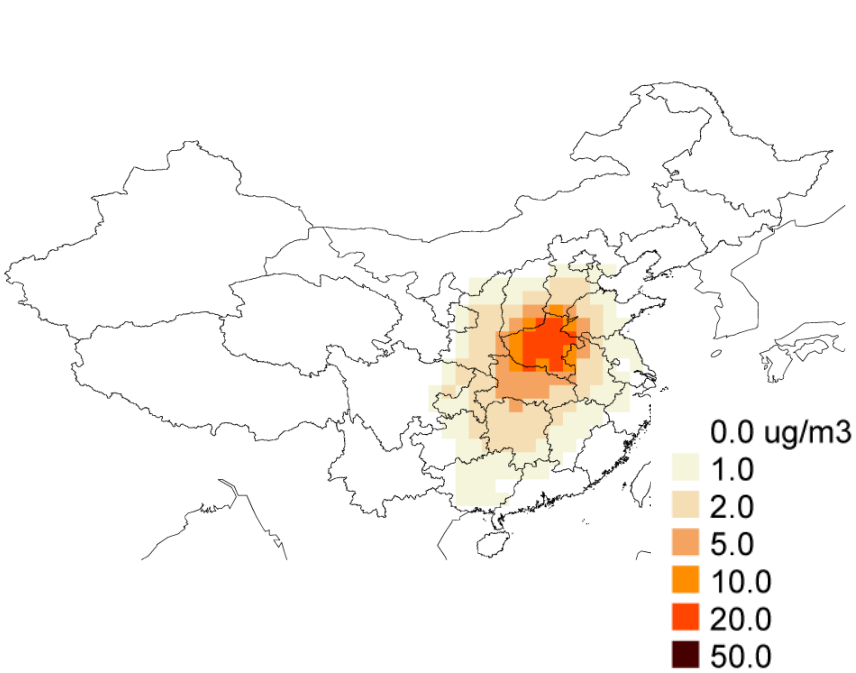
Subgrid (urban) scaling of PM concentrations in TM5

- Identify subgrid urban areas based on population density using a 0.1° x 0.1° population database
- Observations in Italy show that the diurnal patterns of Rn222 and PM concentrations are correlated
- TM5 calculates for each grid the dispersion characteristic of an inert tracer (Rn222) based on vertical mixing
- This is then used by GAINS to compute the “urban increment” of $PM_{2.5}$, linked to urban primary $PM_{2.5}$ emissions from low level sources (domestic, transport, local industries)

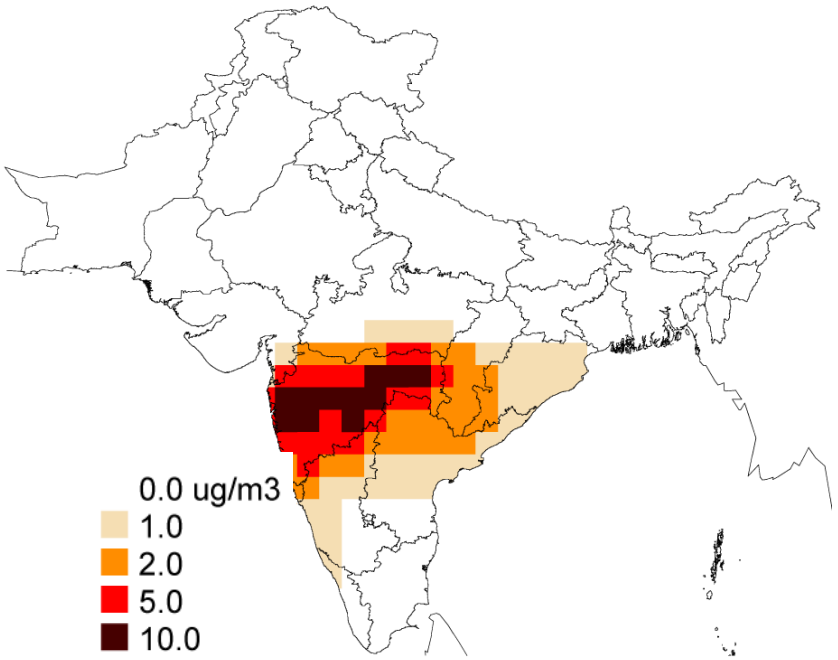
Source – receptor relationships

Contribution to [$PM_{2.5}$] – baseline scenario 2000

China - Henan



India - Maharashtra

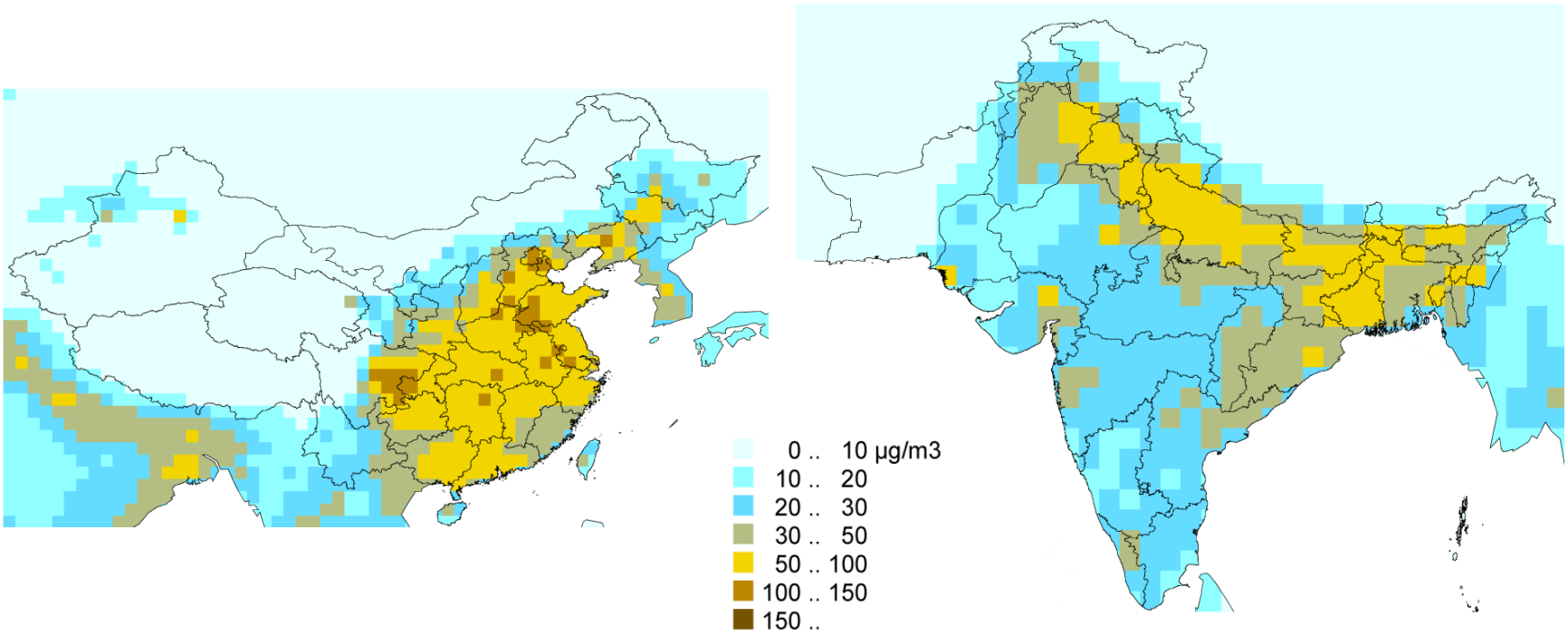


GAINS–Asia [$PM_{2.5}$] estimates

Baseline scenario - 2000

China

India



Comparison with measurements:

Data sources

China

- [PM_{10}]
  - Institute of Public and Environmental Affairs, China:
  - http://air.ipe.org.cn/en/qyInfoEn.do

- [$PM_{2.5}$]
  - Chan and Yao, 2008
  - Duan *et al.*, 2006
  - Kim Oanh *et al.*, 2006
  - Zheng *et al.*, 2005
  - Wang *et al.*, 2005, 2006
  - Louie *et al.*, 2005
  - Ye *et al.*, 2003
  - Qian *et al.*, 2001
  - He *et al.*, 2001

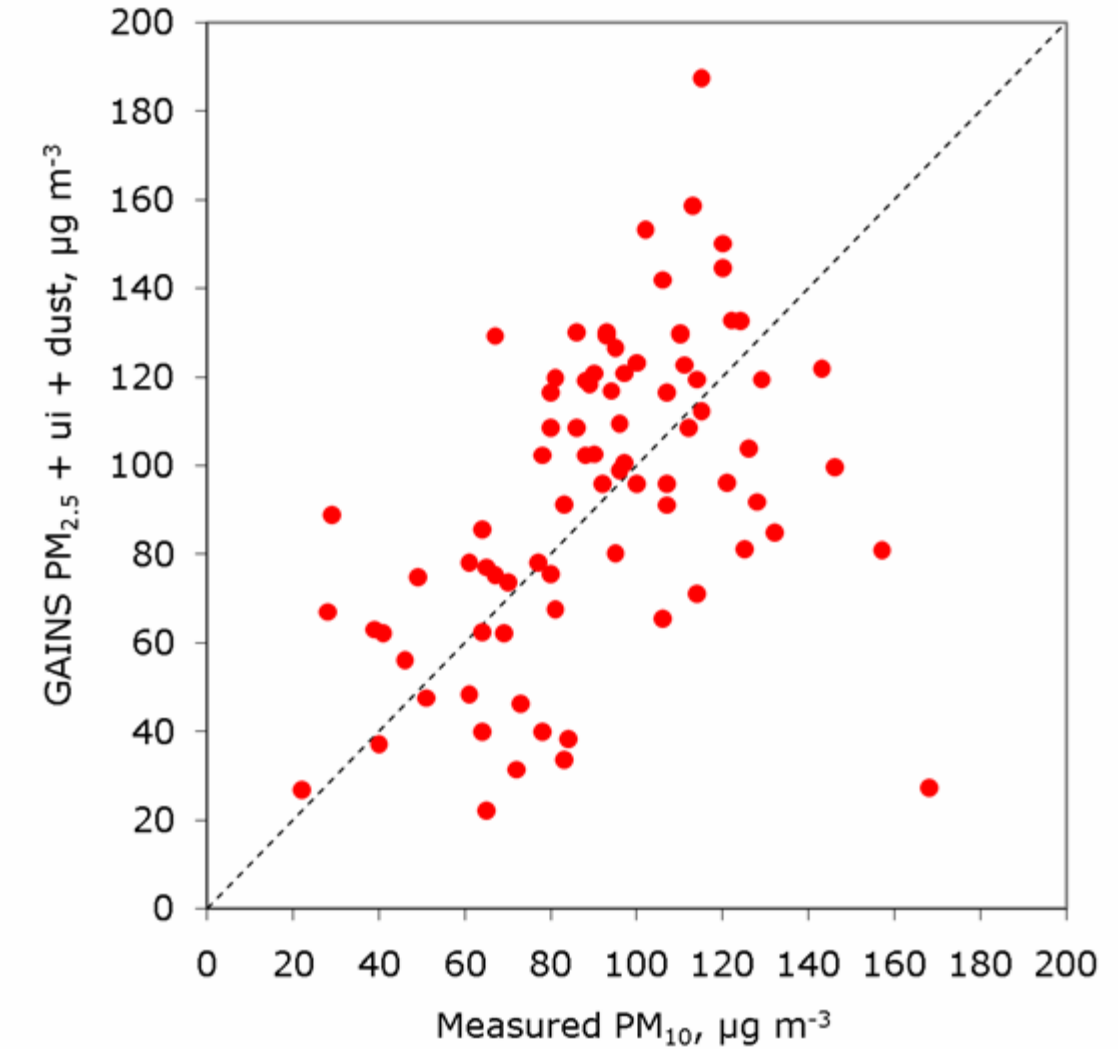
India

- RSPM
  - Central Pollution Control Board, Ministry of Environment and Forests:
  - http://www.cpcb.nic.in/Air_quality_data.php

- [$PM_{2.5}$]
  - Barman *et al.*, 2008
  - Kim Oanh *et al.*, 2006
  - Kumar and Joseph, 2006
  - Sharma and Maloo, 2005
  - ESMAP, 2004

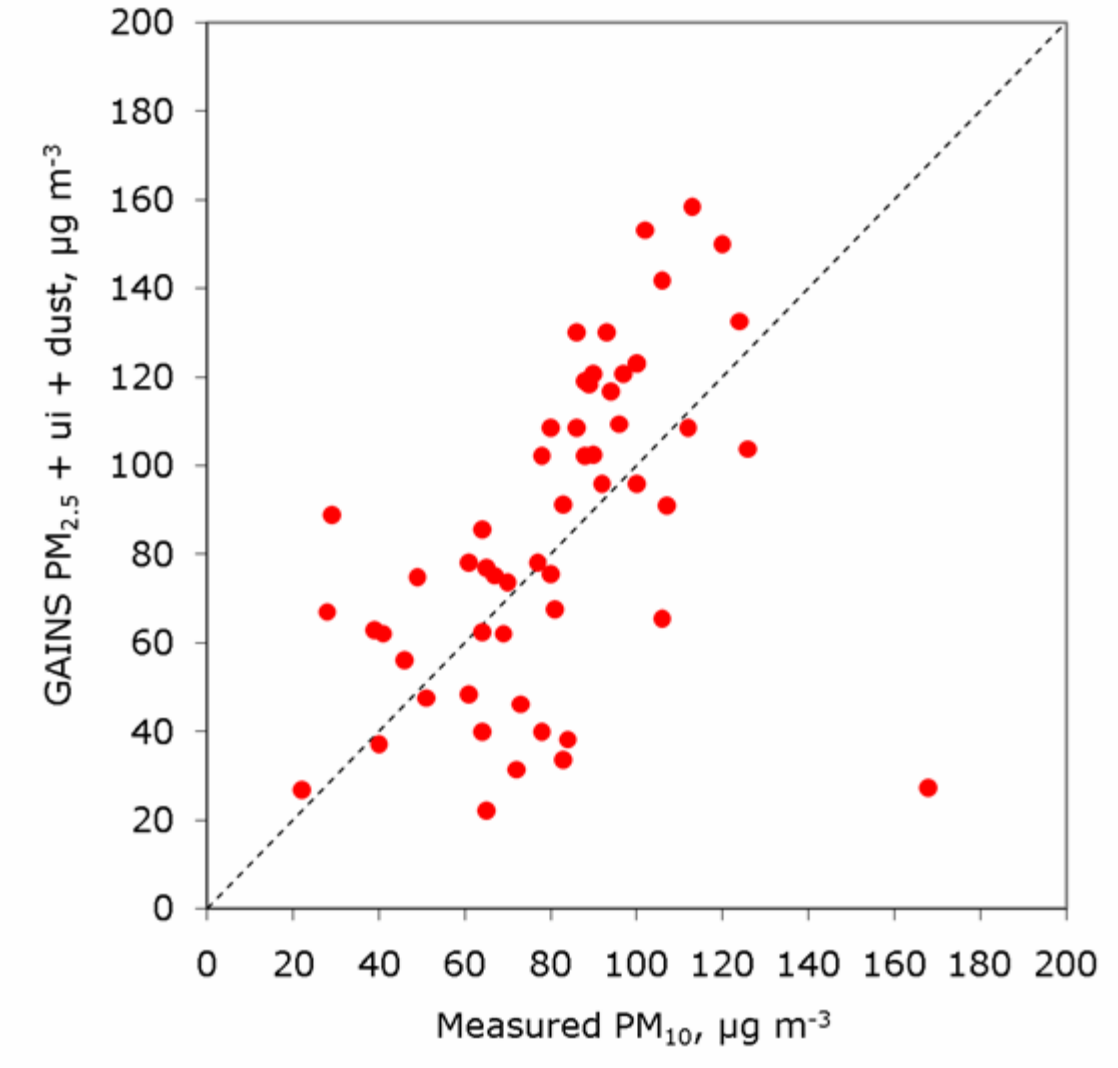
Comparison with measurements:

PM_{10} measurements in China (2005)



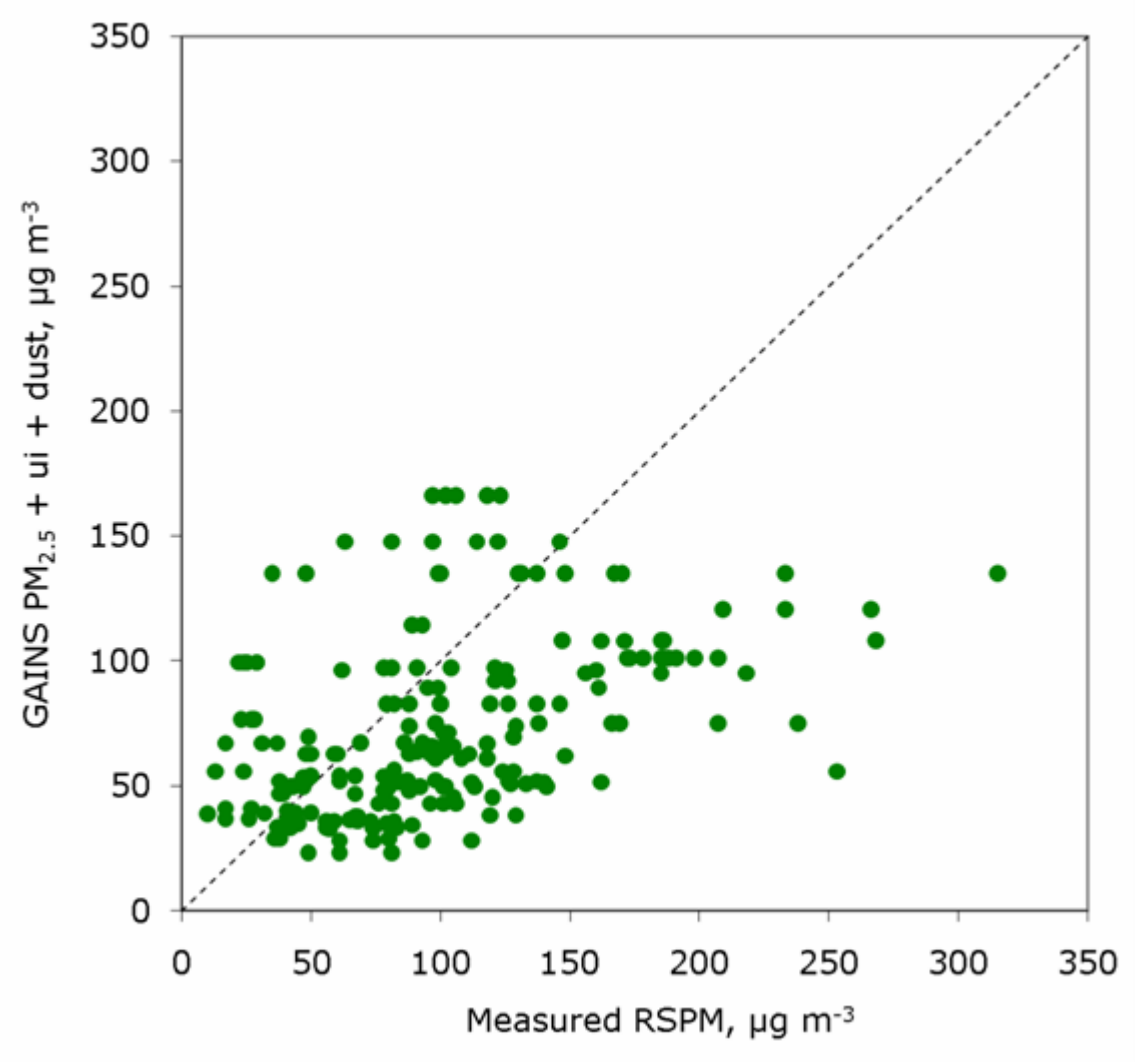
Comparison with measurements:

PM_{10} measurements in China (2005) – low dust



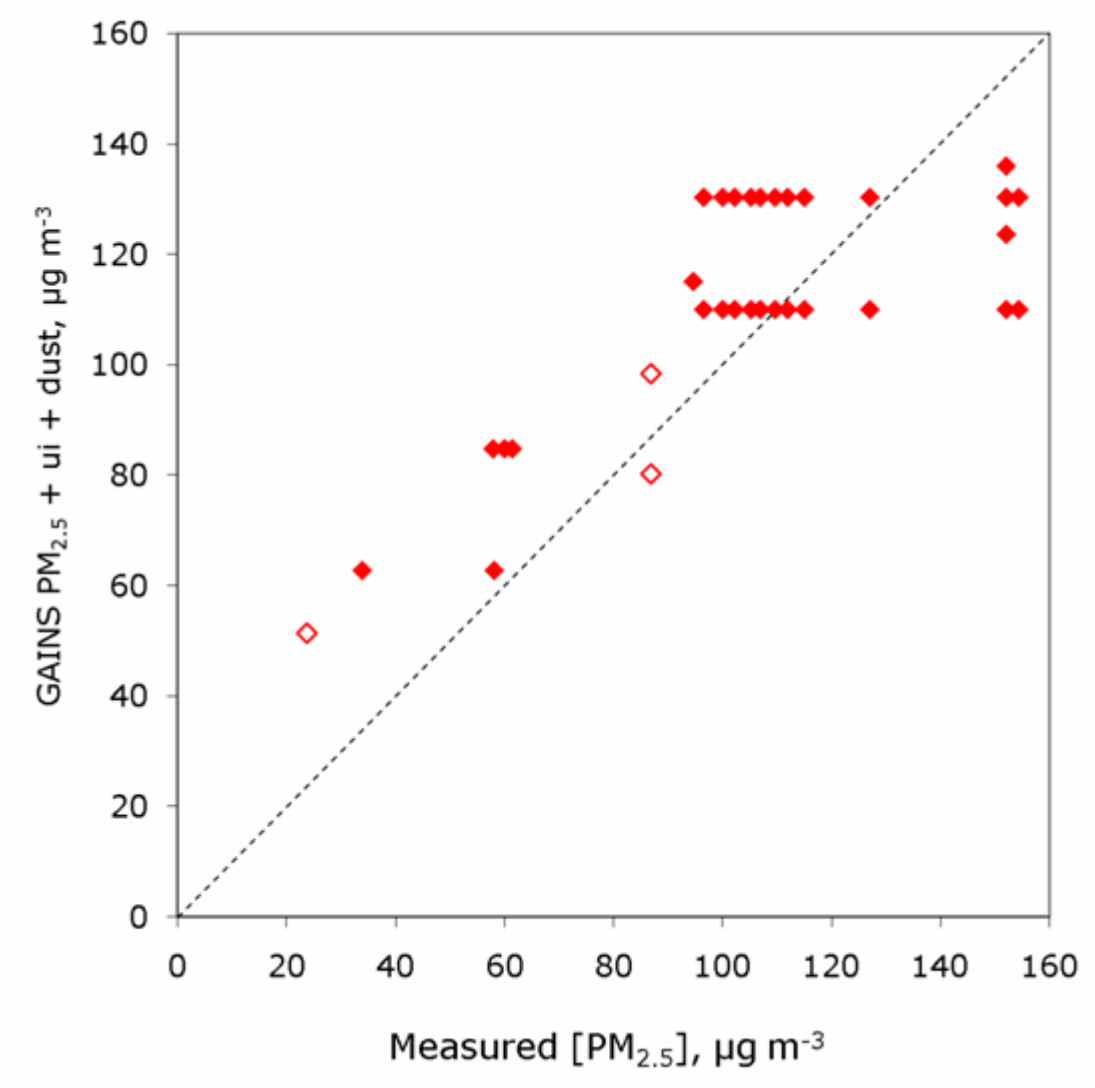
Comparison with measurements:

Respirable suspended particulate matter in India (2005)



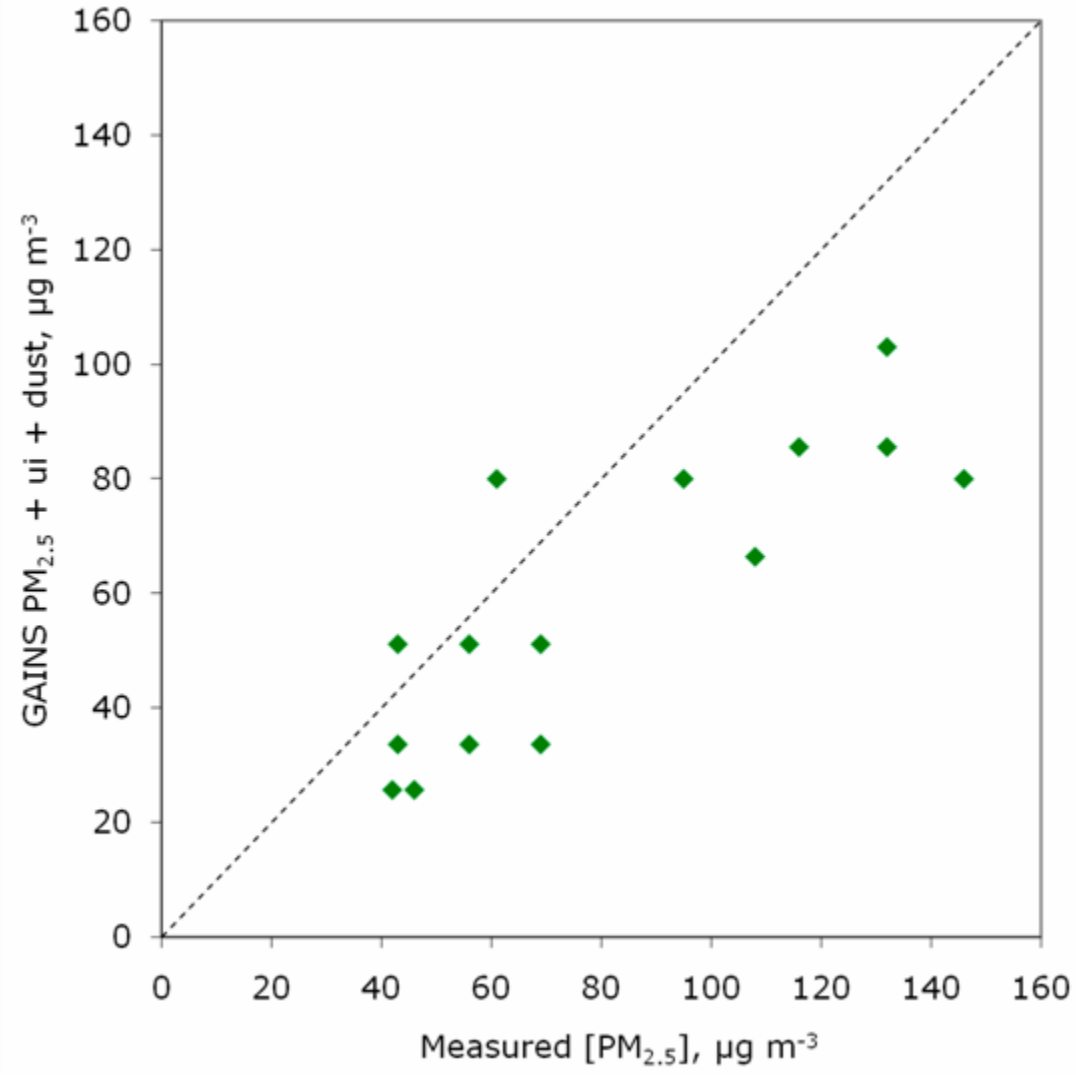
Comparison with measurements:

$PM_{2.5}$ measurements in China (2000 - 2005)



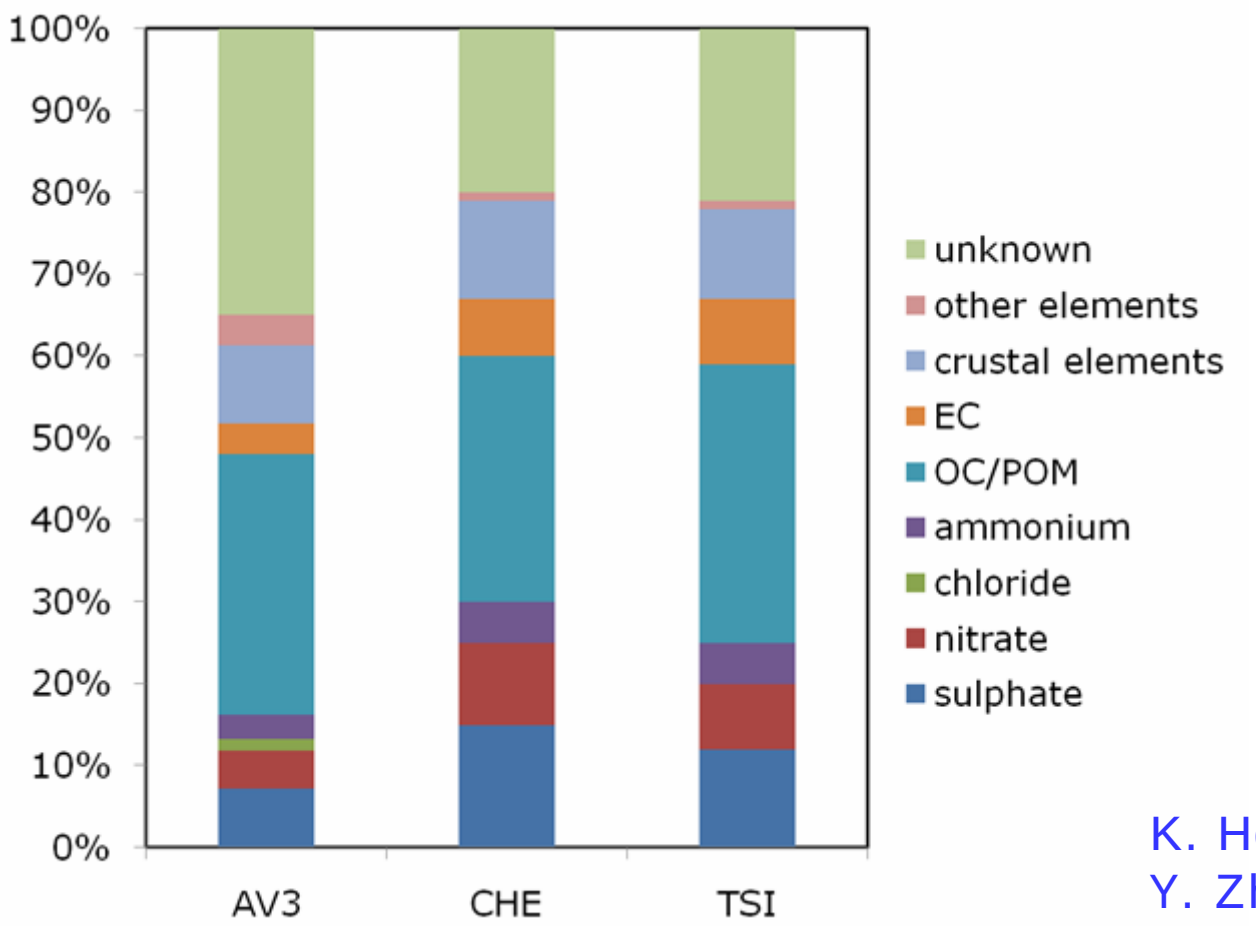
Comparison with measurements:

$PM_{2.5}$ measurements in India (2000 - 2005)



Comparison with measurements:

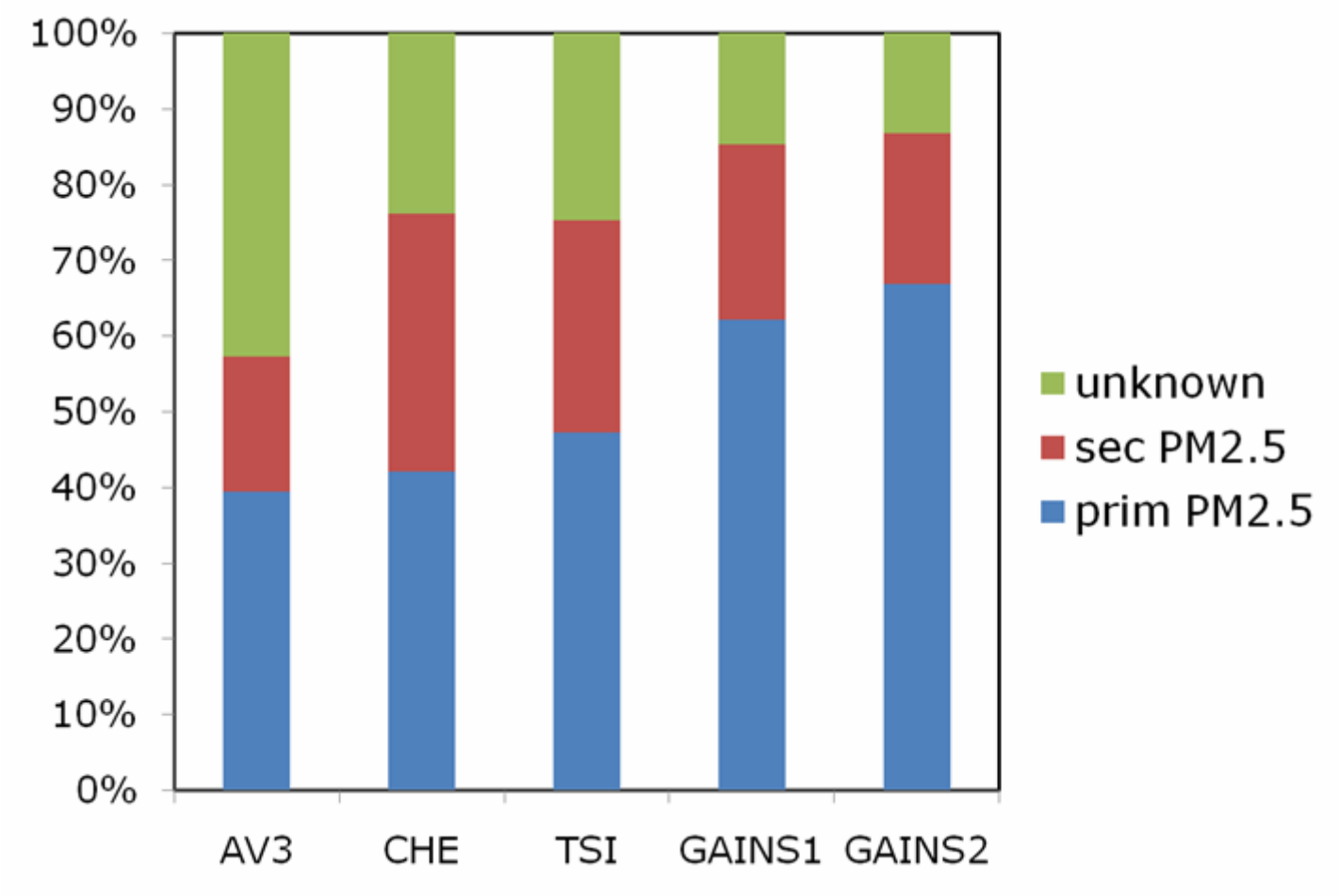
$PM_{2.5}$ species composition in Beijing



K. He *et al.*, 2001
Y. Zhang et al., 2004

Comparison with measurements:

$PM_{2.5}$ species composition in Beijing compared to GAINS



Summary

- Validation of GAINS [$PM_{2.5}$] estimates in Asia is hampered by scarcity of long-term $PM_{2.5}$ measurements
- Comparison with more widespread SPM/PM_{10} measurements is reasonable despite considerable scatter associated with uncertain estimates of dust
- Comparison with available $PM_{2.5}$ measurements is also reasonably good
- Overall GAINS [$PM_{2.5}$] estimates are generally encouraging but further validation is necessary