



Pacific Basin consortium Conference 2009

Perth, Australia

Nov. 20-22, 2009

*POLYCYCLIC AROMATIC
HYDROCARBONS IN CHINA
- from emission to lung-cancer risk*

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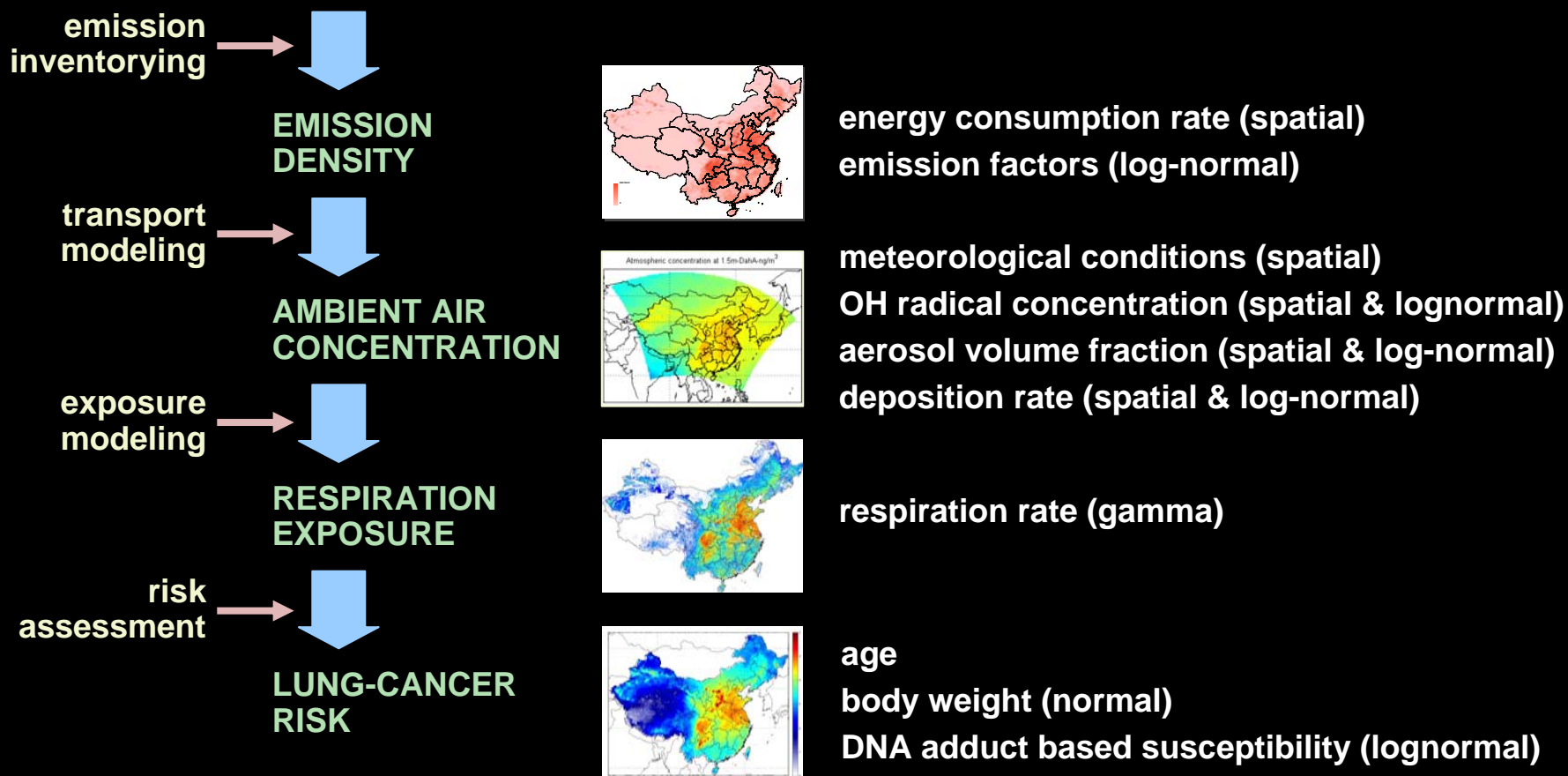


1. METHODOLOGY
2. EMISSION INVENTORY
3. AMBIENT AIR POLLUTION
4. INHALATION EXPOSURE RISK

1

1. METHODOLOGY
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- from emission inventory to lung cancer risk
- With spatial and individual variability



2

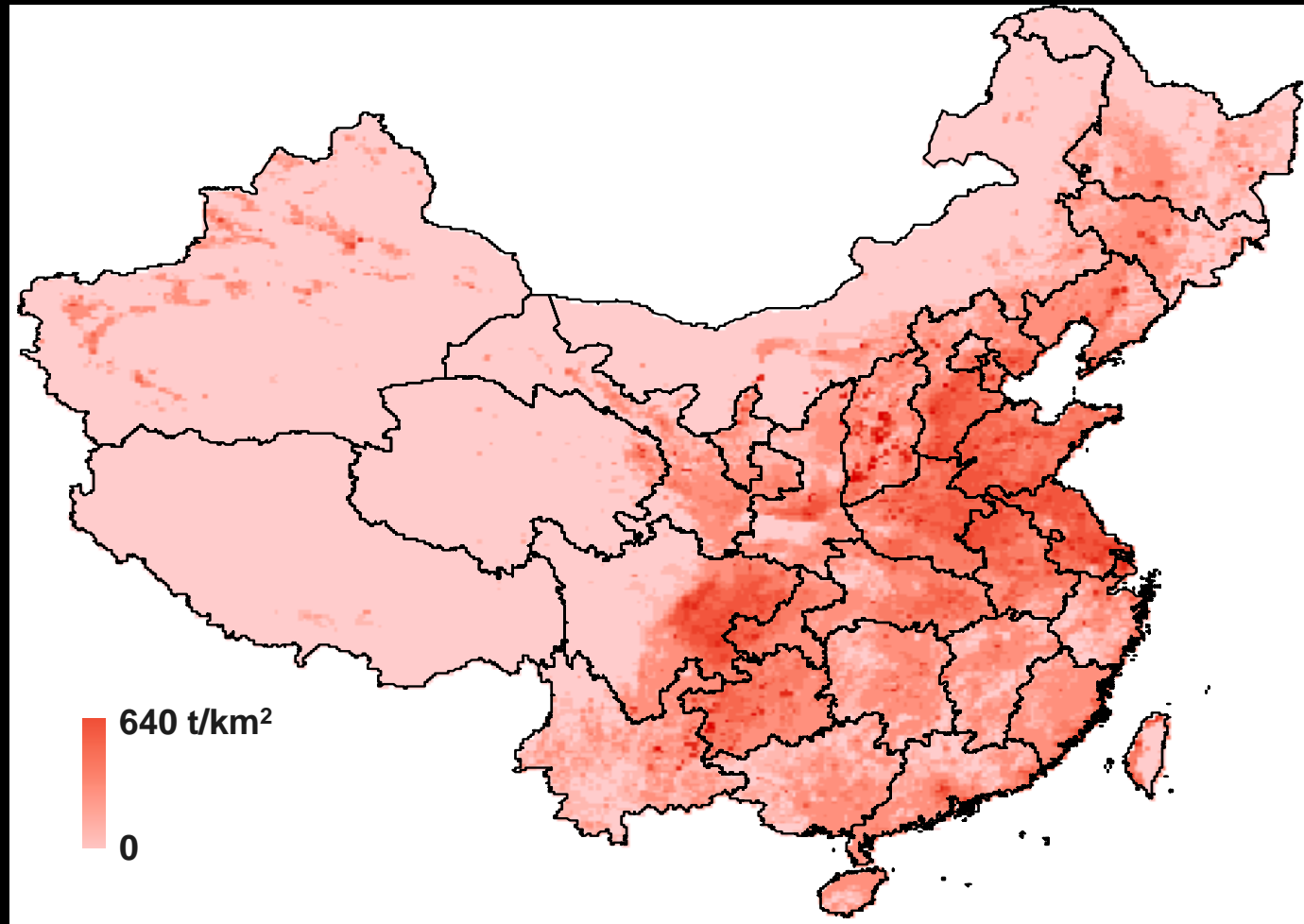
1. METHODOLOGY
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EMISSION SOURCES OF PAHs IN CHINA



EMISSION DENSITY MAPPING

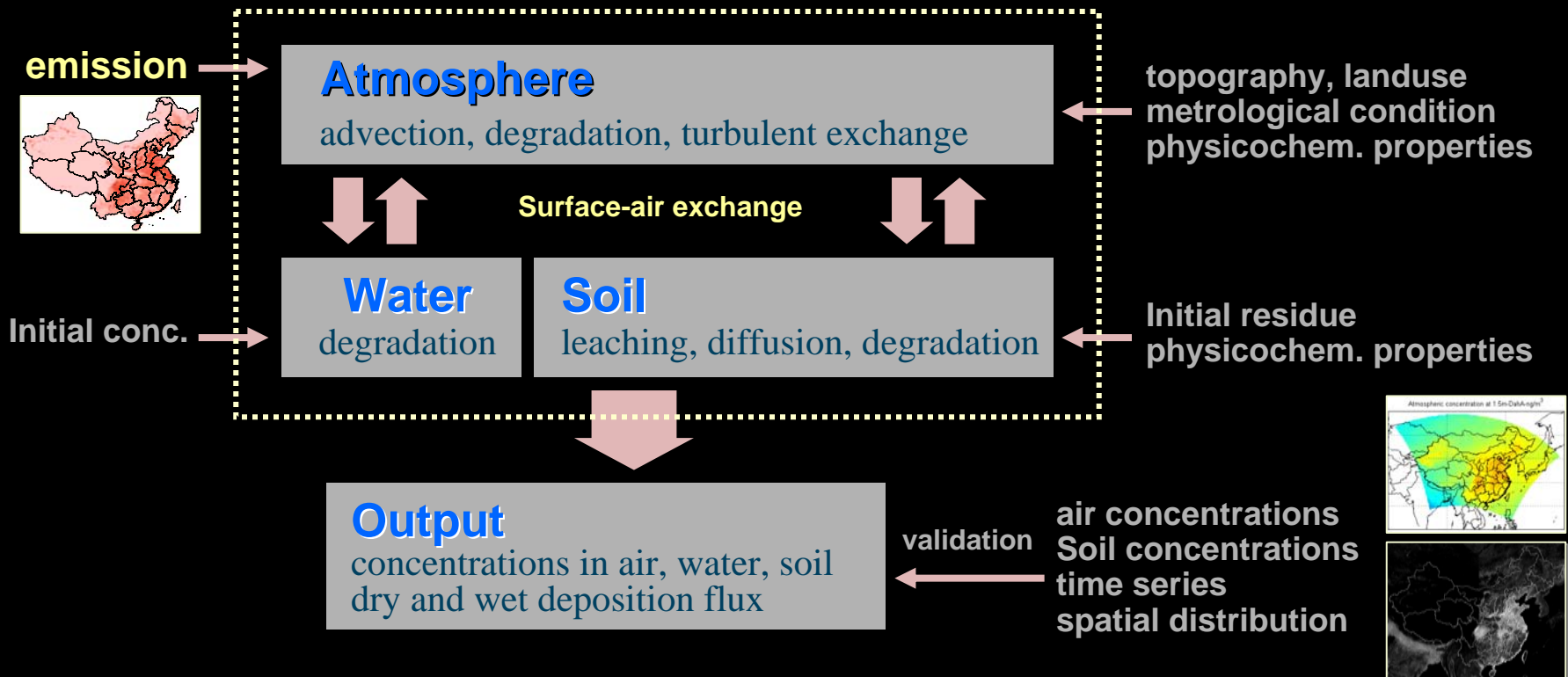
- **total emission of 16 PAHs in China in 2004 - 116,000 tons**



3

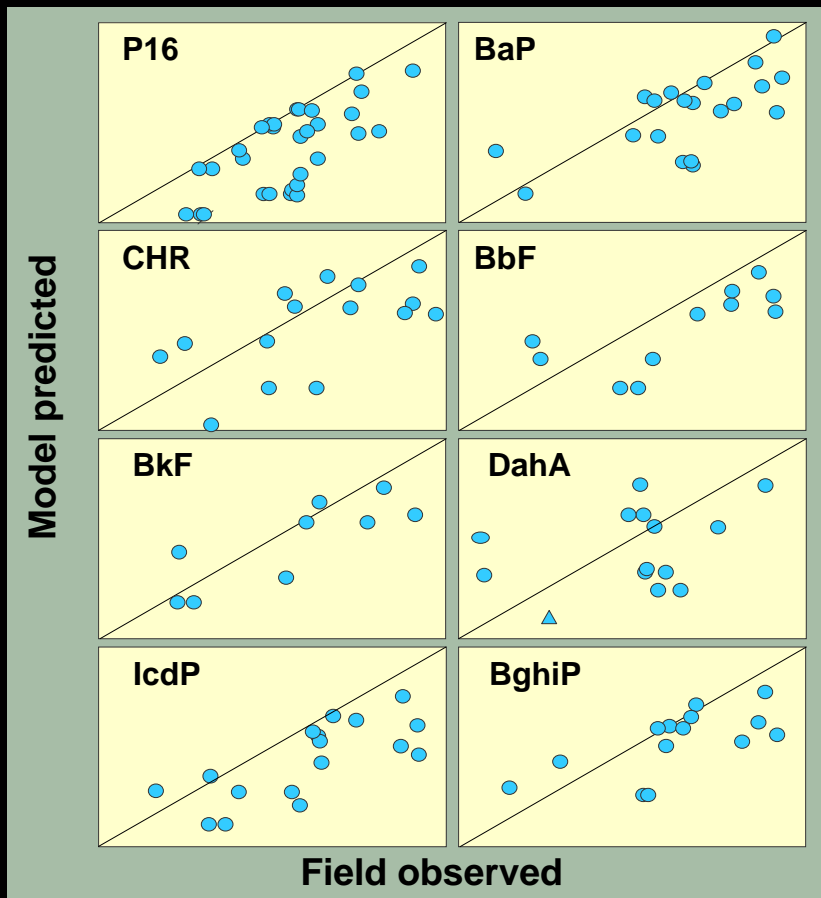
1. METHDOLOGY
2. EMISSION INVENTORY
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4. INHALATION EXPOSURE RISK

- atmospheric transport model (Ma, 2003), modified**
 atmospheric transport Module (24km x 24km x 12 layer), processes added
 soil-air exchange and soil module (fugacity)
 water-air exchange module (stagnant film)
 modeled for 2003

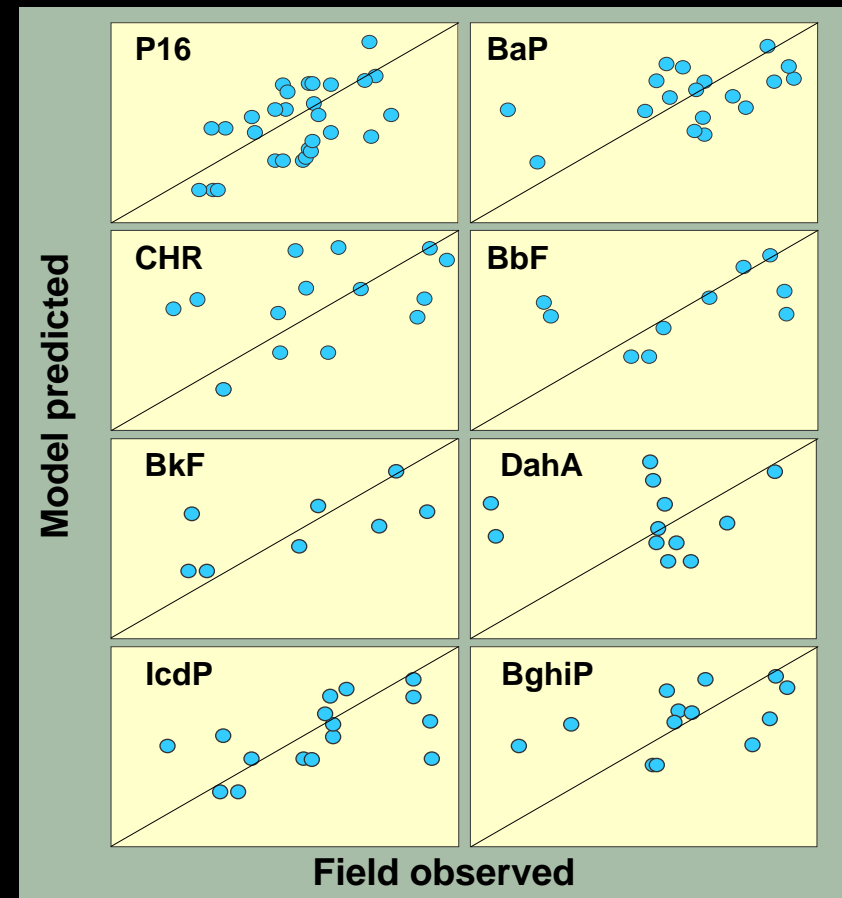


MODEL VALIDATION – AMBIENT AIR, ANNUAL MEANS

- field observed ambient air concentrations at 35 sites
- scaling effect – emission-based 1x1 km² interpolation



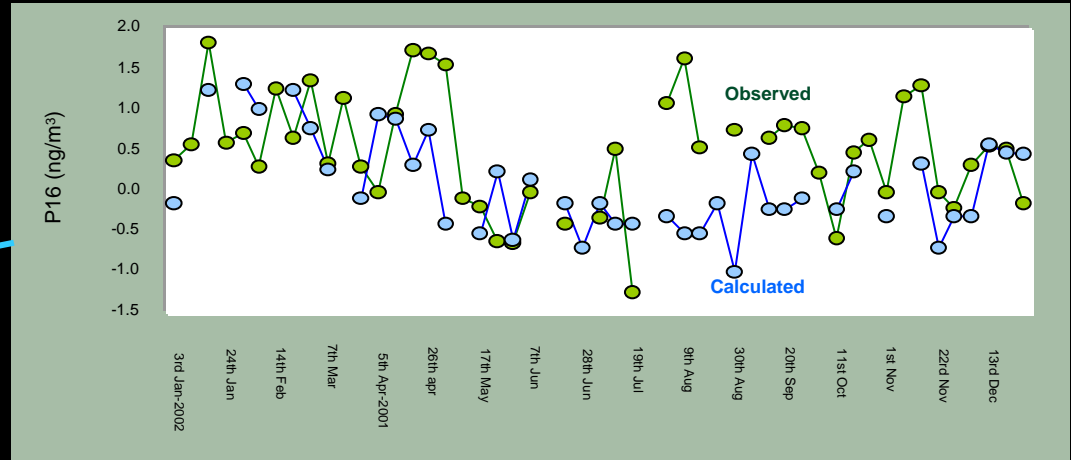
original



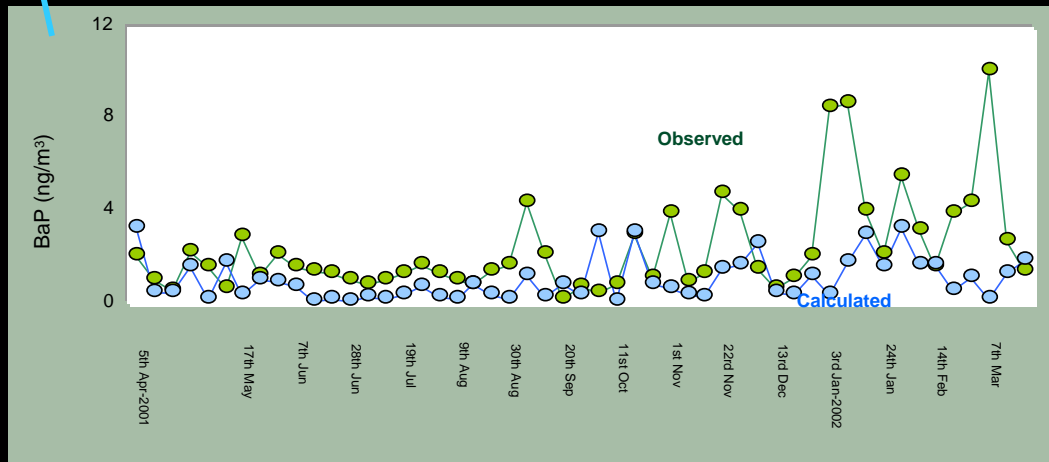
down-scaled

MODEL VALIDATION – TIME TREND

- two sites of Guangzhou and Gosan



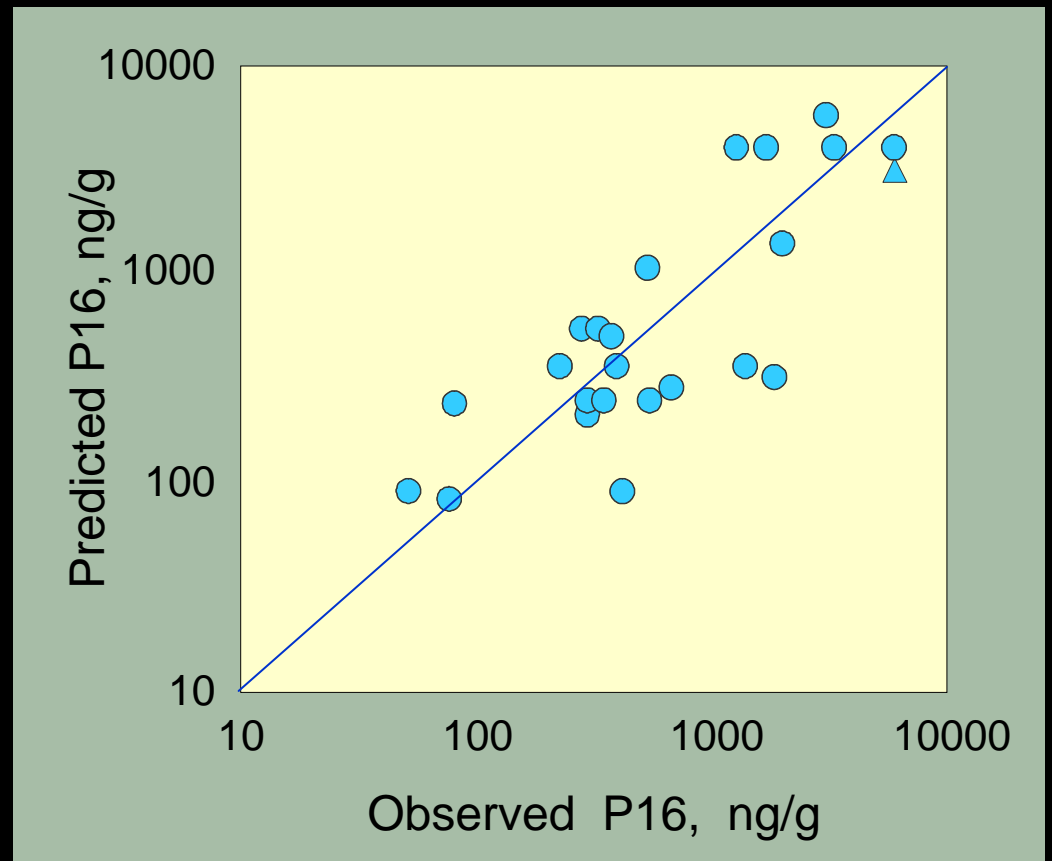
Gosan, Korea, *Lee et al., JGR, 2006*



Guangzhou, China., *Li et al., 2003*

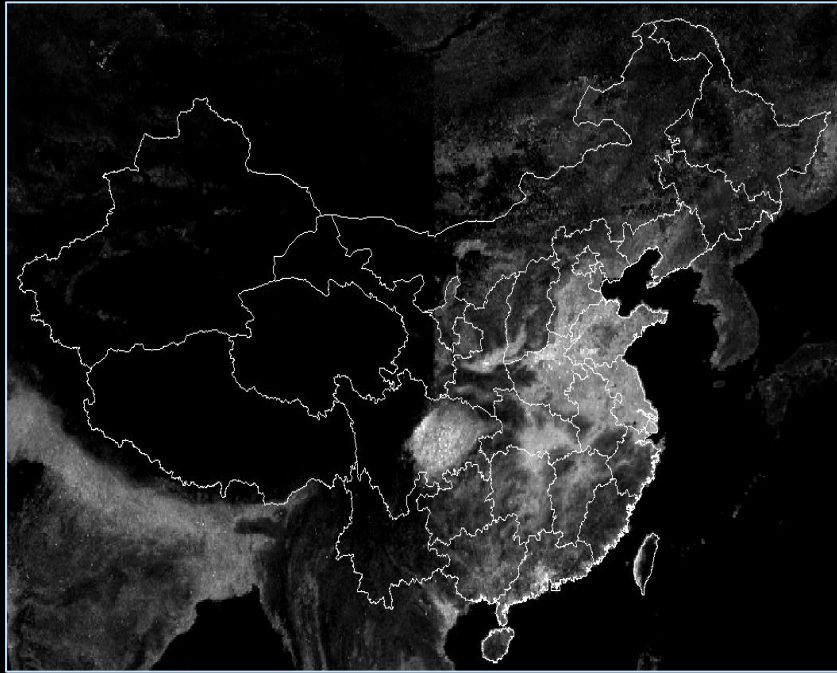
VALIDATION – SURFACE SOIL

- field observed top soil concentrations at 24 sites

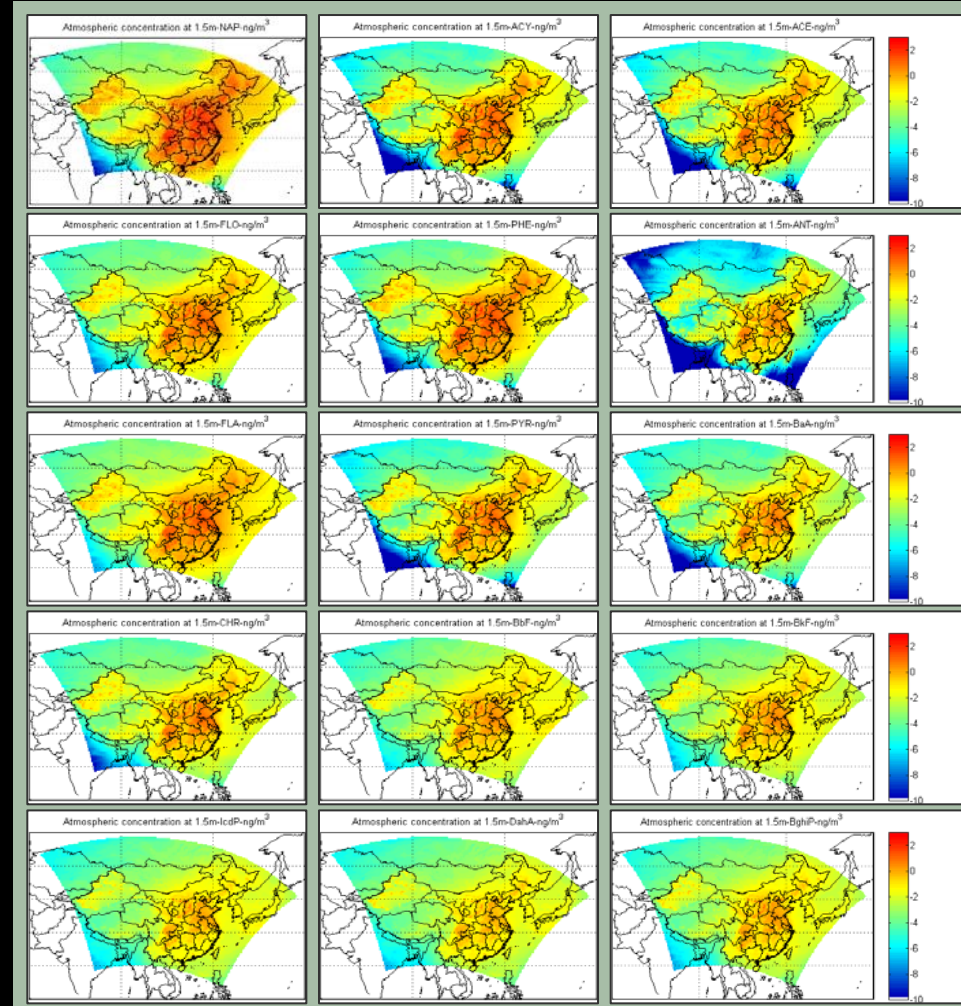


GEOGRAPHICAL DISTRIBUTION - AIR

- annual mean PAHs, 1.5 m above the ground, 2003

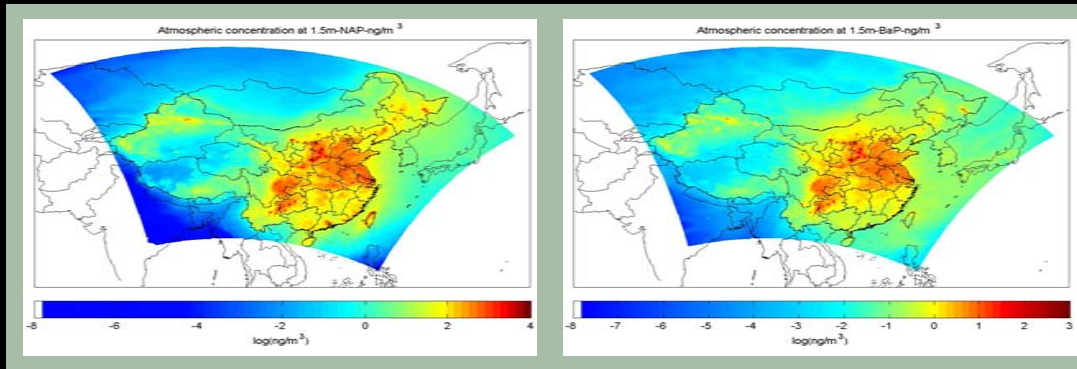


annual aerosol optical depth, MODIS
Li et al., in press

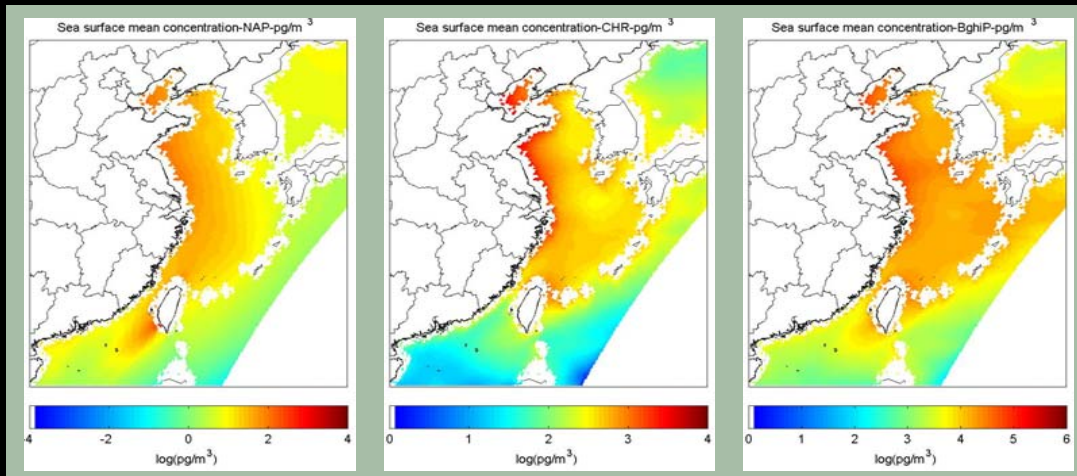


GEOGRAPHICAL DISTRIBUTION - SOIL & SEA WATER

- surface soil – naphthalene, benzo(a)pyrene
- surface sea water – naphthalene, chrysene, benzo(a)pyrene



top soil



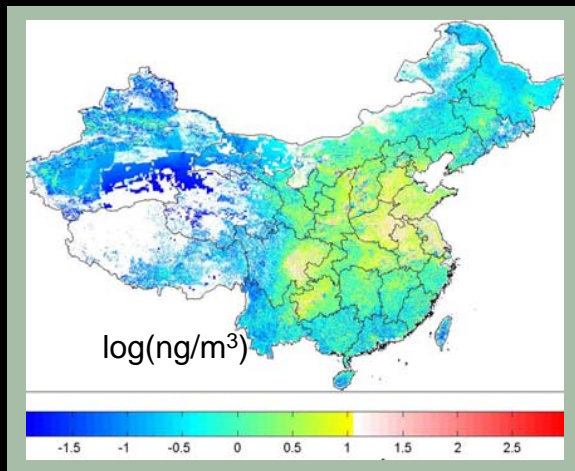
marine surface water

4

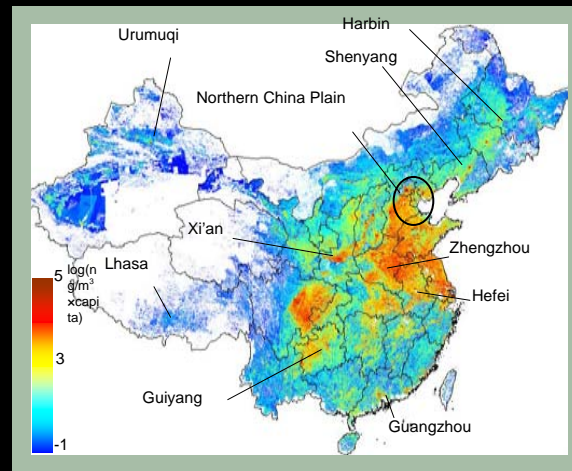
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AMBIENT AIR BaP_{eq}

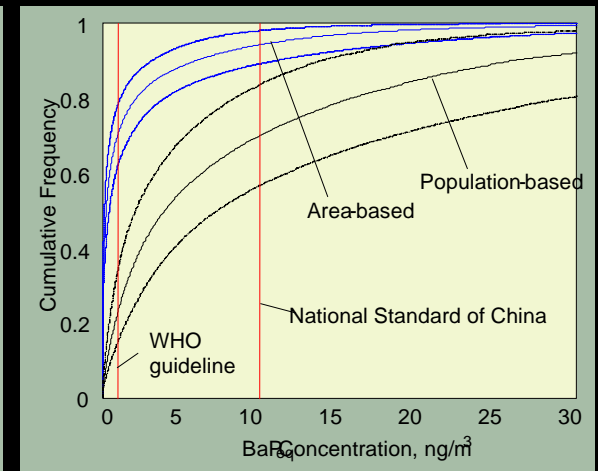
- ambient air concentration of BaP_{eq}, 1.5 m above the ground
 - area based mean: 2.4 ng/m³
 - population weighted mean: 7.6 ng/m³
 - over 10 ng/m³ (Chinese std): 5.8% of territory, 30% of population
 - over 1 ng/m³ (WHO guideline): 30% of territory, 77% of population



BaP_{eq}, area based



BaP_{eq}, population weighted



cumulative frequency distribution

LUNG CANCER RISK

- **dose-response relationship – lung cancer**
unit relative risk = 4.49 per 100 ng/m³ annual BaP exposure
derived from an epidemical study in Xuanwei, China
- **population attributable fraction – lung cancer**
0.53% based on the population weighted mean exposure concentration

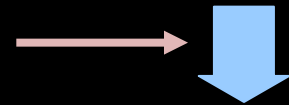
CHARACTERIZATION OF THE SUSCEPTIBILITY

- **DNA adduct: a lung-cancer susceptibility indicator** *Matullo et al. 2003*
- **relationship between polymorphism & DNA adduct level**

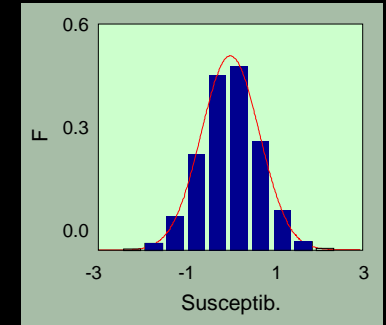
13 lung-cancer related
polymorphism of 8 genes
(literature)

frequencies of the
at-risk alleles of the
polymorphisms ,
China/East Asia
(literature)

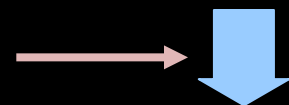
*Monte Carlo Simulation
One million runs*



distribution of the
numbers of the at-
risk alleles



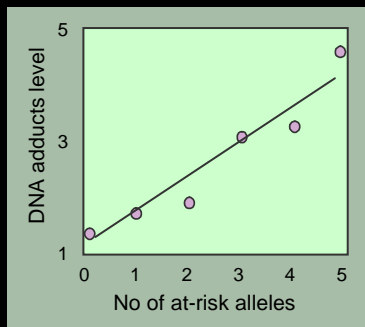
dose-response:
no. of at-risk alleles
& DNA adduct level
(Matullo et al., 2003)



distribution of DNA
adduct levels

normalization

distribution of
susceptibility



LUNG CANCER RISK

- **population attributable fraction**

from the Monte Carlo simulation

1.6 (0.91~2.6)% compared to 0.53%

- **Lung cancer risk in China**

excess annual mean

0.65 (0.37~1.06) per 100,000 person

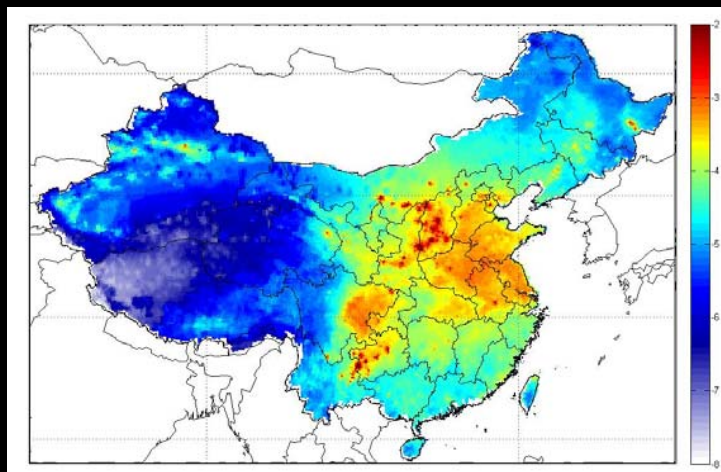
excess life-long

45.5 (25.9~74.2) per 100,000 person

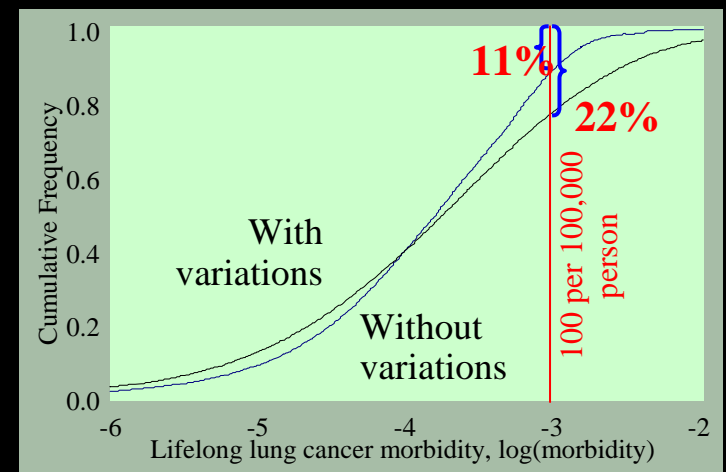
- **spatial and cumulative distributions**

high in north China and Sichuan-Guizhou

one fifth of population have the risk greater than 100 per 100,000 person



spatial distribution of lifelong risk



cumulative distribution of lifelong risk

SUMMARY

- **total annual PAH emission in China was 116,000 ton**
- **major sources: indoor biomass and small-scale coke oven**
- **population weighted annual mean BaP_{eq}: 7.6 ng/m³**
- **PAH induced annual lung cancer morbidity: 0.65/100,000**
- **the risk was not evenly distributed**

ACKNOWLEDGEMENT



FINANCIAL SUPPORT
NATIONAL SCIENTIFIC FOUNDATION OF CHINA