MIX: a mosaic Asian anthropogenic emission inventory for the MICS-Asia and the HTAP projects

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Motivation of MIX Asian emission inventory

Develop a comprehensive Asian emission inventory with best available regional inventories;

Understand the differences between inventories, and seek the ways to improve them;

Provide model-ready emissions dataset to support MICS-Asia, HTAP, and other activities in the community

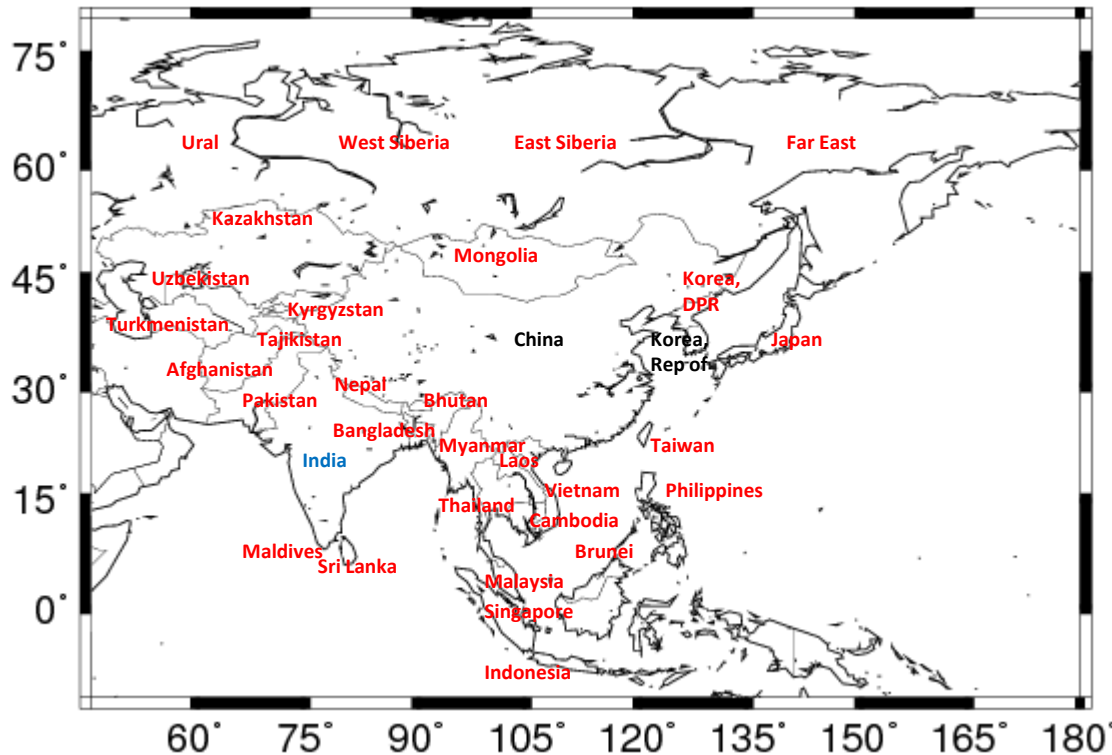# *"mosaic" of regional inventories to large domain*

Emission Inventories
- REAS 2
- MEIC v.1.0 + PKU
- JEI-DB + OPRF
- CAPSS
- HKSAR
- REAS 2 + ANL
- REAS 2 + PKU
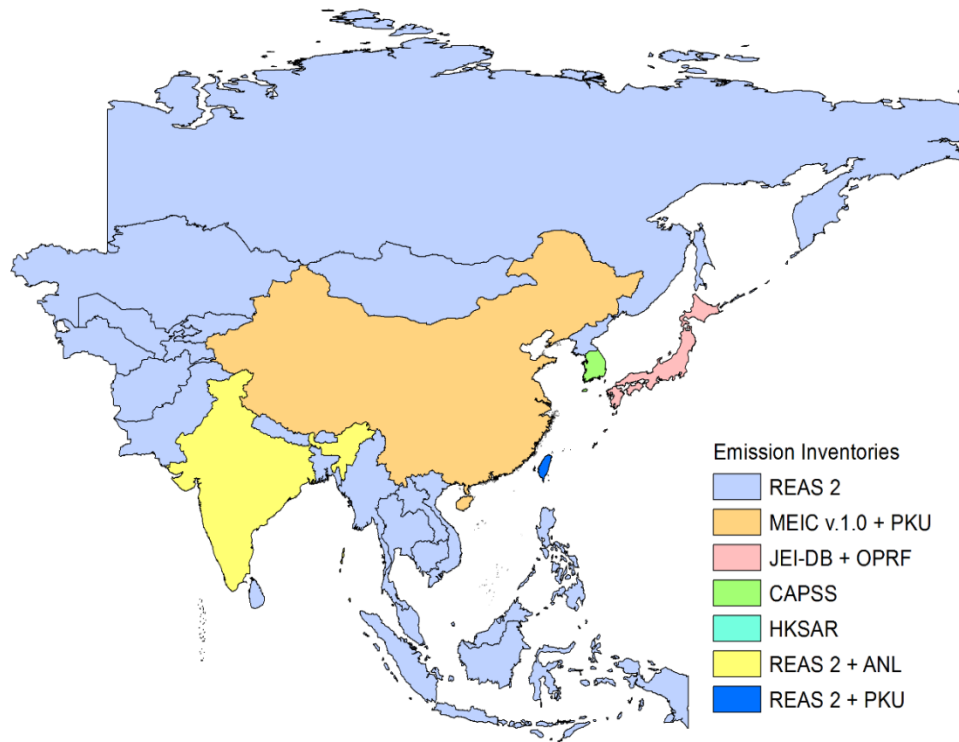
✓ **Choose** the best-available regional inventory through **comprehensive comparison**

✓ **Integration** to a unified spatial and temporal resolution

Framework of MIX compilation
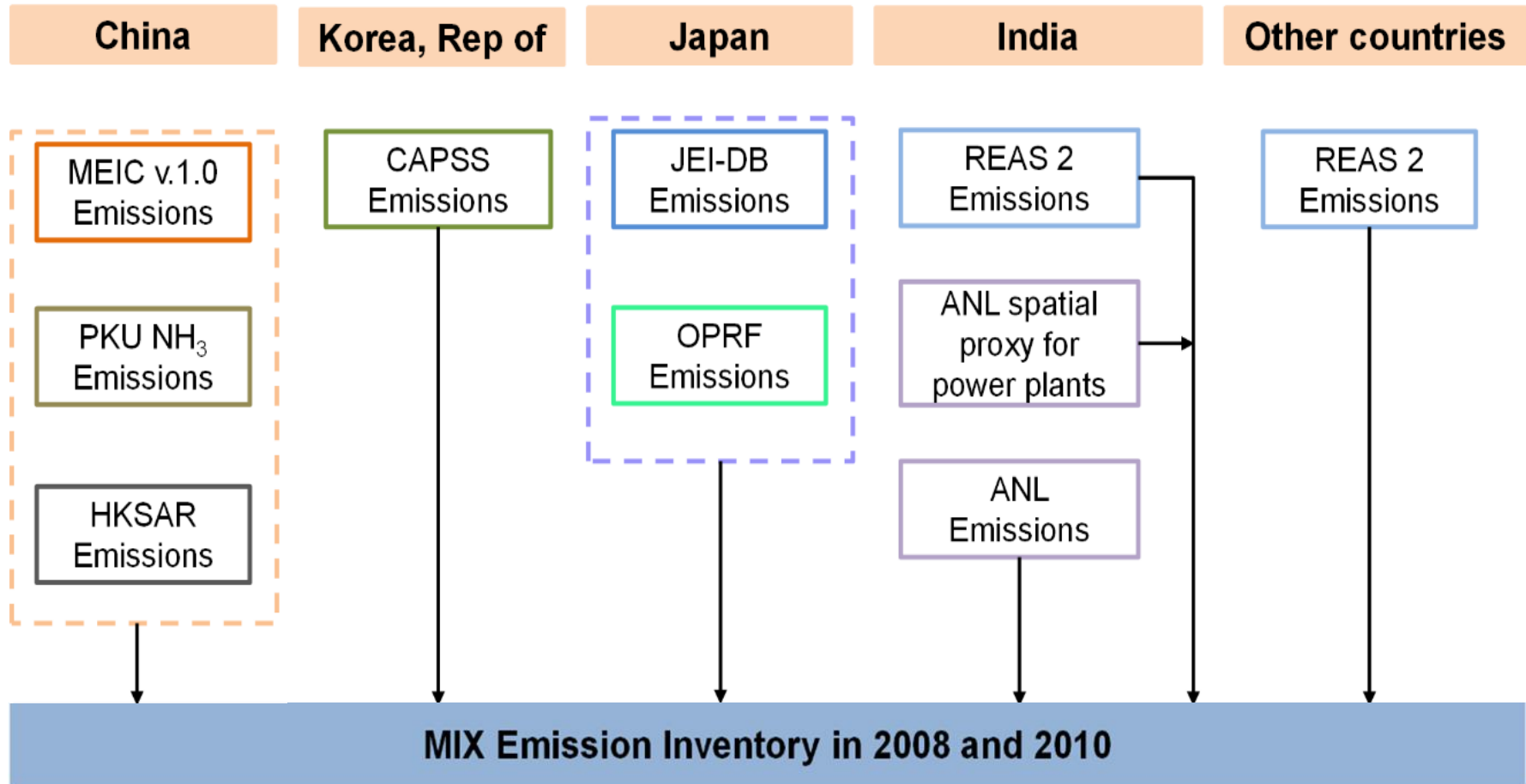
Regional Emission inventory in ASia (REAS) v2

J.Kurokawa[1,2], T. Ohara[2], T. Morikawa[3,4], S. Hanayama[5], J.-M. Greet[6], T. Fukui[7], K. Kawasima[8], and H. Akimoto[1]

1. Asia Center for Air Pollution Research
2. National Institute for Environmental Studies
3. Japan Automobile Research Institute
4. Japan Petroleum Energy Center
5. Ocean Policy Research Foundation
6. Joint Research center or the European Commission
7. The Institute of Behavioral Sciences
8. Mitsubishi URJ Research and Consulting Co., Ltd.

- REASv2 provided emissions from countries and regions except for China and Republic of Korea. Emissions in India other than SO_2, BC, and OC were also used in MIX inventory.

- For Taiwan, emissions for SO_2, NO_x,, CO, NMVOC, PM_{10} and $PM_{2.5}$ developed by the Environmental Protection Administration of Taiwan were used in REASv2.

- CH_4 and N_2O emissions are provided by REASv2 for whole region including China and Republic of Korea, but their base years are 2008.

Kurokawa et al., ACP, 2013

REAS inventory available at 0.25 degree resolution

(a) SO₂ in 2000

(b) SO₂ in 2008

(c) NOₓ in 2000

(d) NOₓ in 2008

Kurokawa et al., ACP, 2013
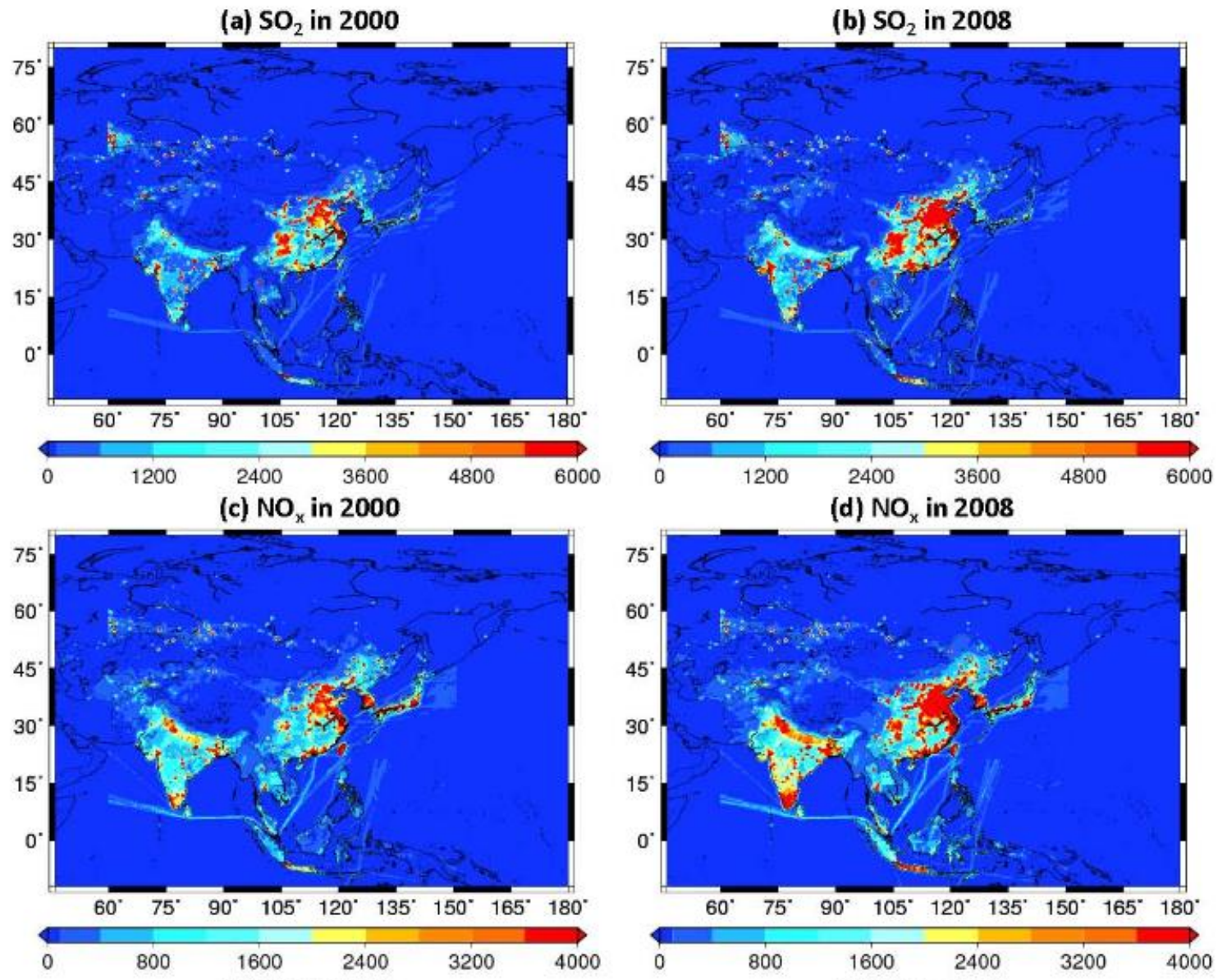
Multi-resolution **E**mission **I**nventory for **C**hina (**MEIC**)

PI: Qiang Zhang and Kebin He

Tsinghua University, Beijing, China

With contribution from X. Yu, F. Liu, B. Zheng, M. Li, S. C. Kang, Y. Lei, H. Huo, Z. L. Yao, C. P. Hong, Q. Zhang, C. H. Chen, S. W. Wang, and G. N. Geng

Emissions data in MEIC database

- **Years:** 1990-

- **Spatial domain:** Mainland China

- **Categories/Sectors:** ~800 anthropogenic sources, aggregated to four sectors (Power, Industry, Residential, Transportation)

- **Species:** SO_2, NO_x, CO, NMVOC, NH_3, BC, OC, PM2.5, PM10, and CO_2

- **VOC speciation:** ~600 individual species, lumped to six mechanisms (SAPRC99, SAPRC07, CB05, CBIV, RADM2, and RACM2)

- **Spatial resolution:** user defined

Work in progress!

Emissions data processed and delivered through an online system

MEIC   Home   Introduction ⌄   Dataset ⌄   Users   Publications   Team   中 EN

http://www.meicmodel.org

中国多尺度排放清单模型 MEIC
Multi-resolution emission inventory for China

MIX Asian emission inventory was developed by the MEIC team

MEIC team recently released an Asian emission inventory, MIX, in years of 2008 and 2010. MIX was developed to provide up-to-date model-ready emissions for multiple chemical transport models and climate models. Integrating latest MEIC, REAS2, PKU-NH$_3$, and CAPSS emission inventories, MIX covers ten air pollutants and greenhouse gaseous (SO_2, NO_x, CO, NMVOC, NH$_3$, PM$_{10}$, PM$_{2.5}$, BC, OC and CO$_2$) with a resolution of 0.25 degree at Asia scale. MIX recently has

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A *spatially* **resolved,** *unit-based emission inventory for power plants*
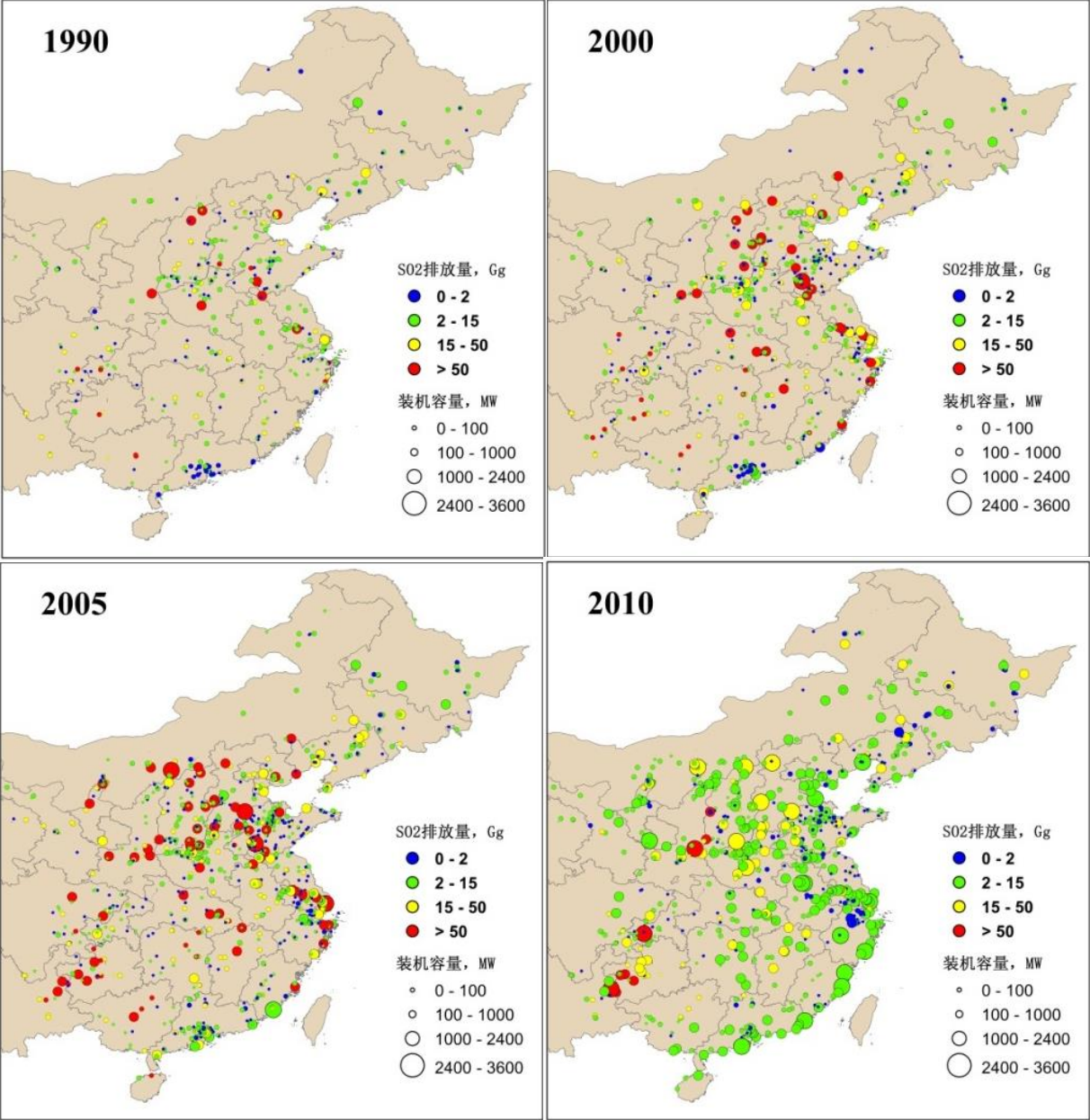
SO₂

Power plant emissions: comparison among different datasets
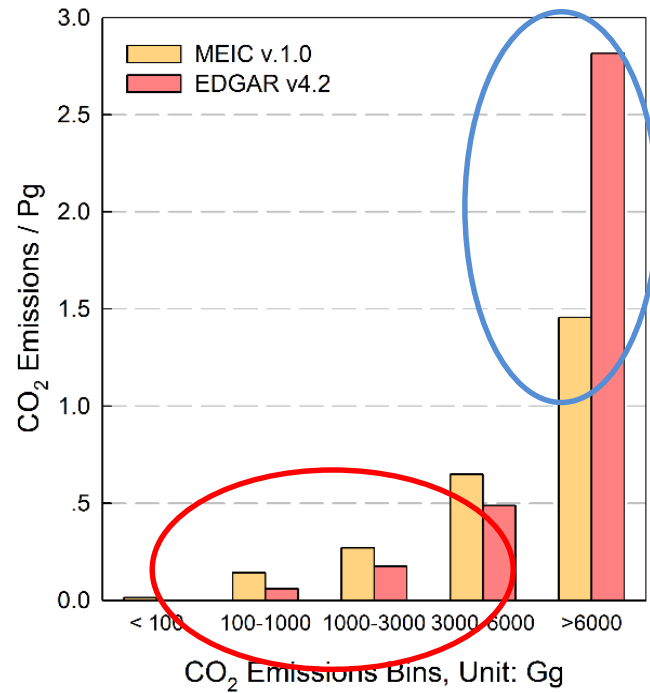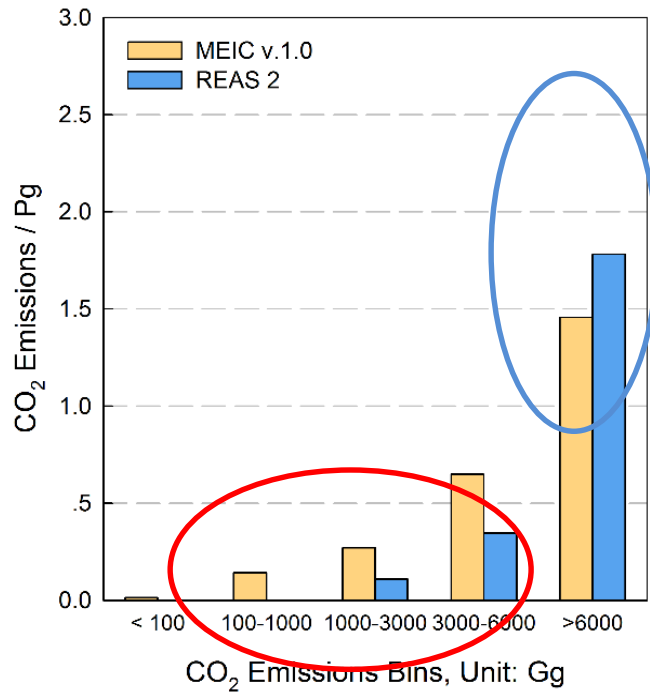
REAS 2 and EDGAR v4.2 underestimate small units and overestimate large ones

Power plant emissions: comparison among different datasets

SO₂/CO₂:

Indicator of FGD

penetration for

power plants

Shanxi province
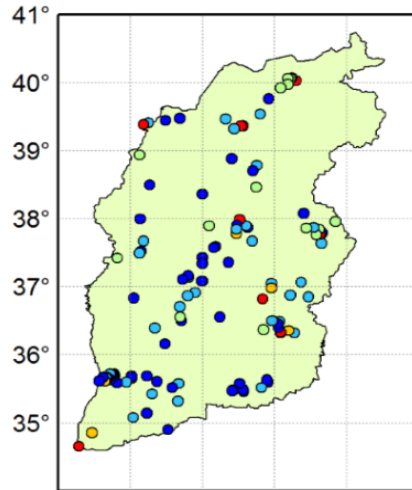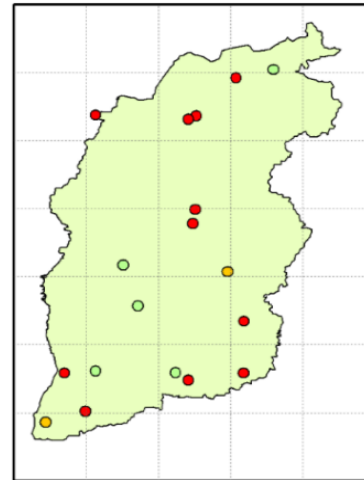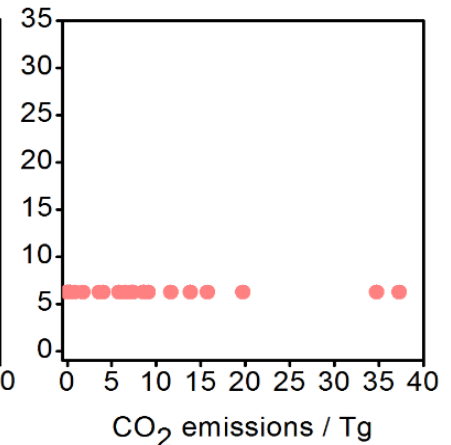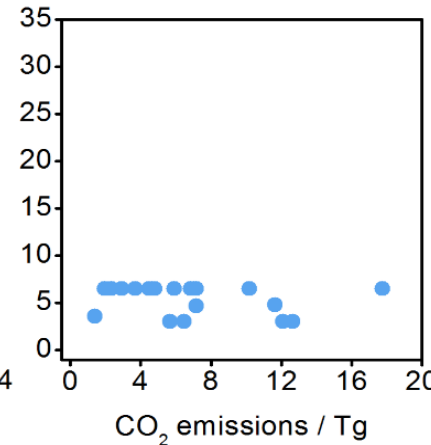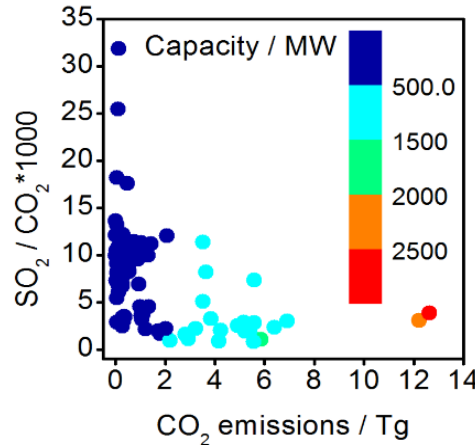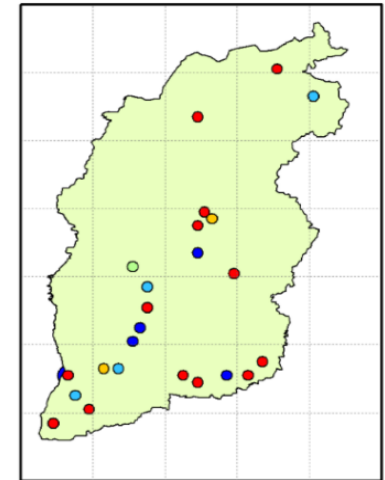
Approach for a high spatial resolution vehicle emission inventory

Zheng et al., ACP, 2014
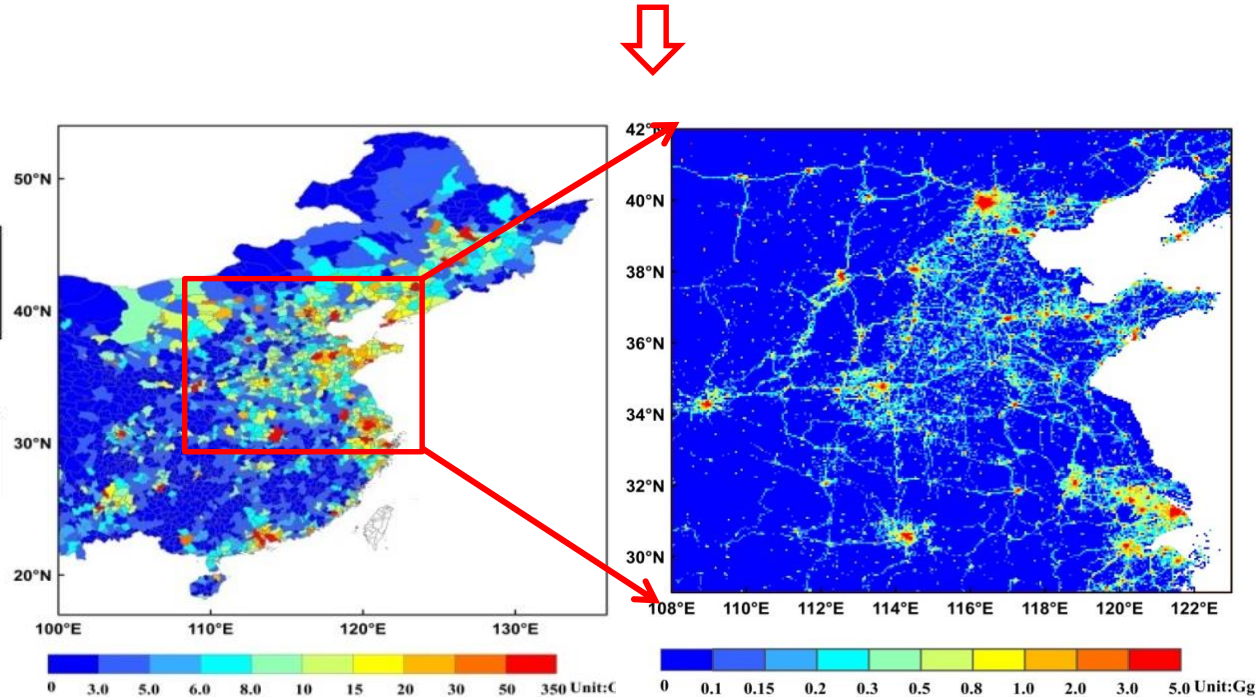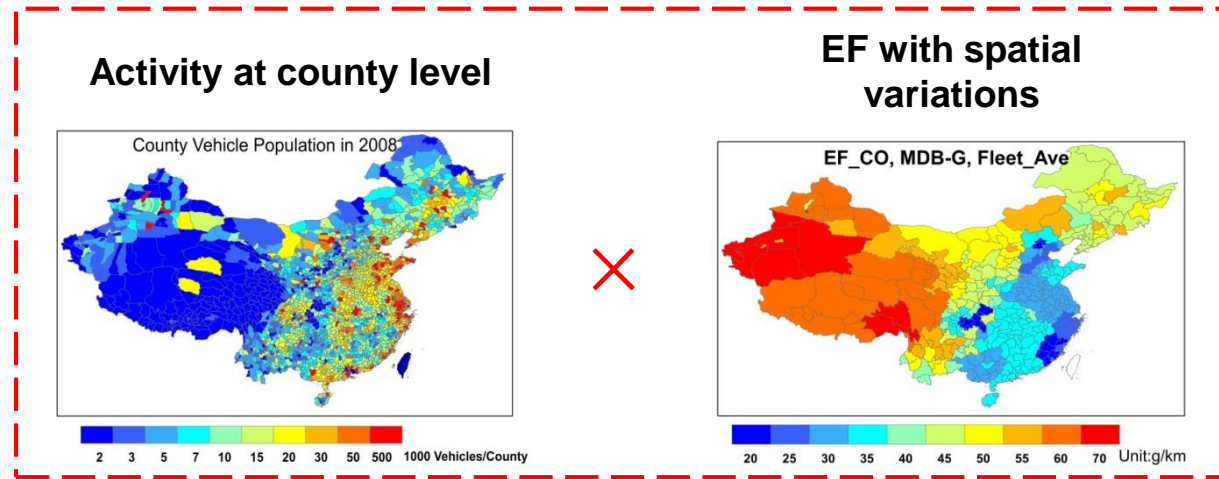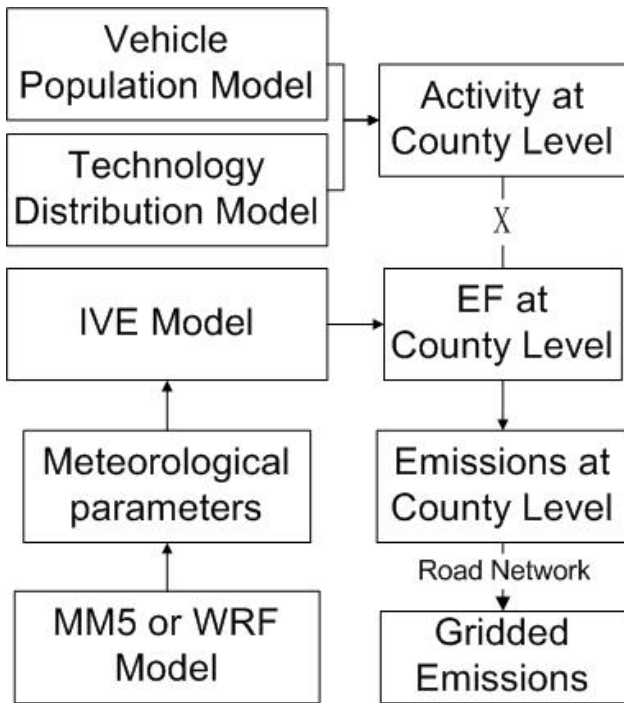
Emissions at high resolution are very sensitive to spatial proxies

New Road Network
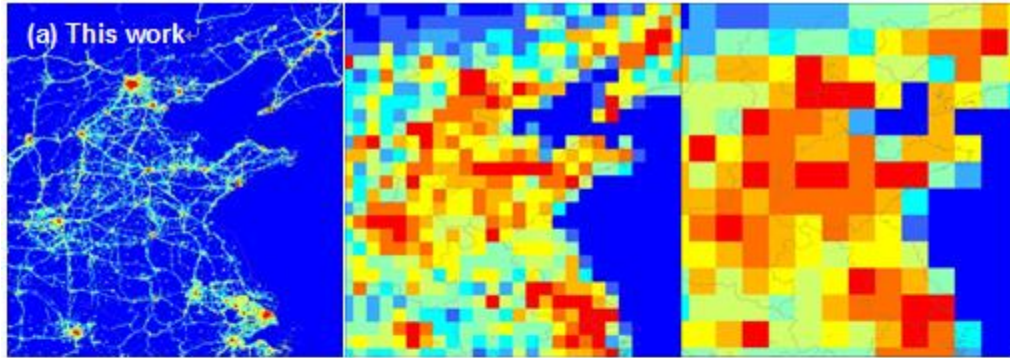
Population Density

Old Road Network

Zheng et al., ACP, 2014
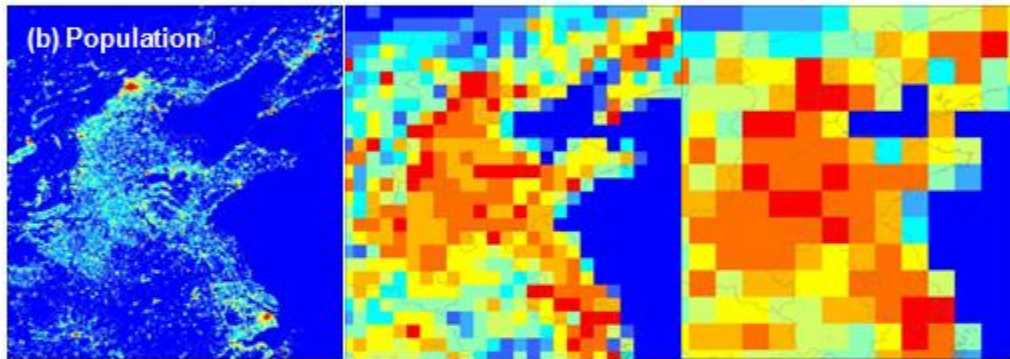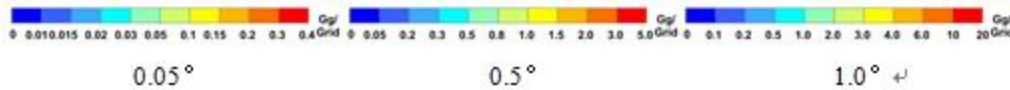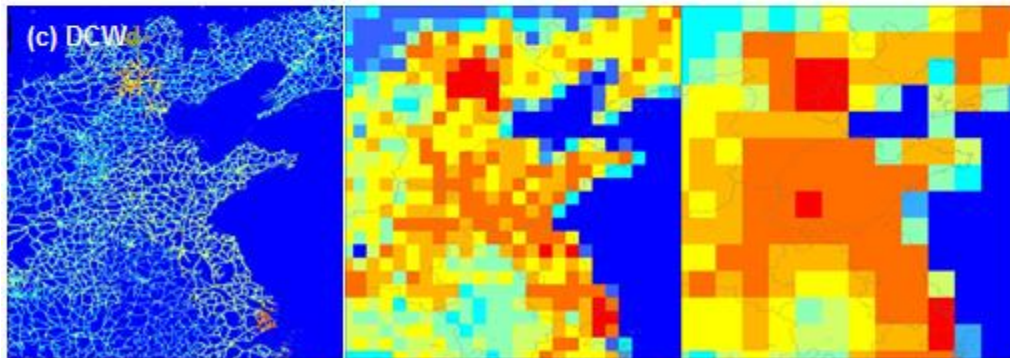
Emission maps by sector: 2010 NO_x
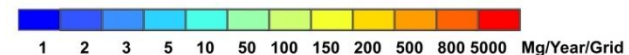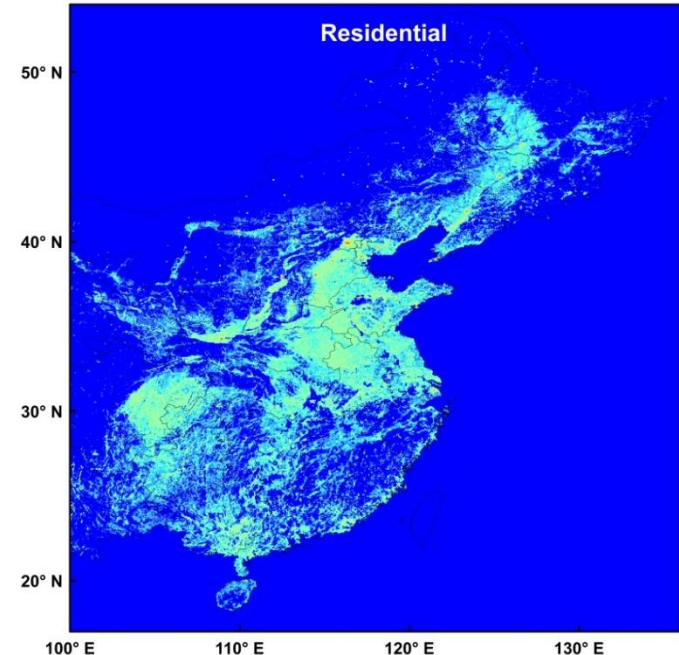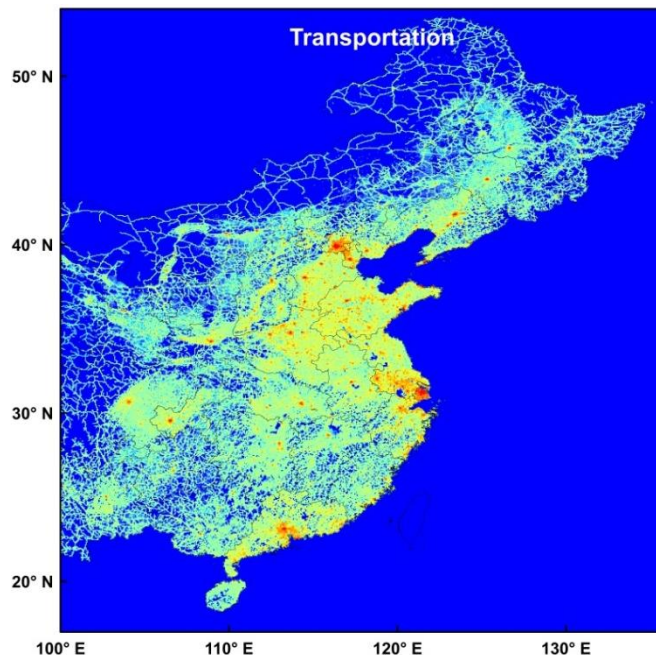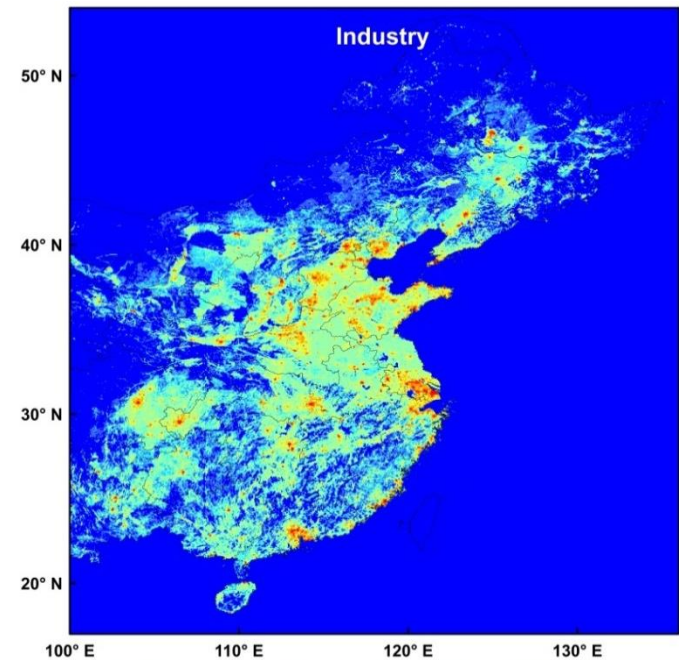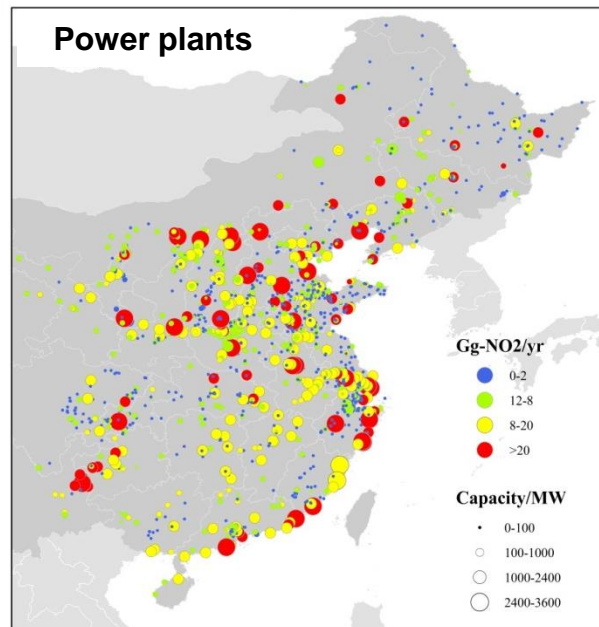
Point sources:

- **Power plants**
- **Cement works**
- **Iron & steel**
- **Oil refineries**
- **Gas stations**

Spatial proxies:

- **Industrial GDP**
- **Populations**
- **Urban/rural**
- **Road network**

PKU-NH₃ Emission Inventory for China
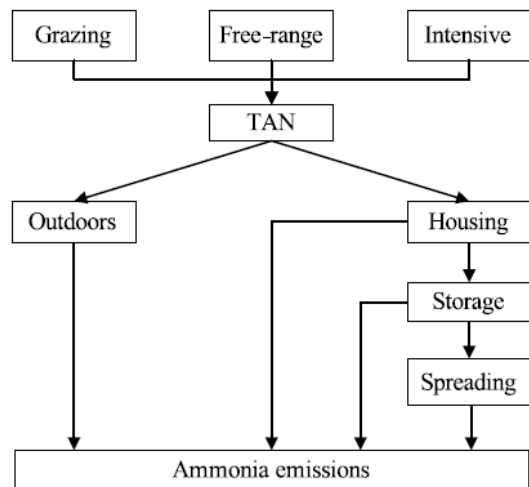
Figure 1. N flows in the manure management system and ammonia volatilization (TAN: ammoniacal nitrogen).
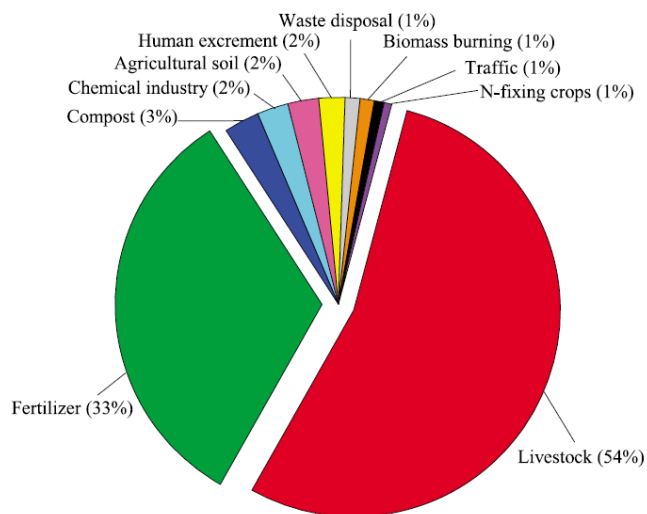
Figure 2. Source contributions (%) to ammonia emissions in China.

1. Heilongjiang
2. Jilin
3. Liaoning
4. Xinjiang
5. Inner Mongolia
6. Tibet
7. Beijing
8. *Jiangxi*
9. Hebei
10. Shandong
11. Shaanxi
12. Henan
13. Jiangsu
14. Shanghai
15. Sichuan
16. Guizhou
17. Hunan
18. Jiangxi
19. Guangdong
20. Fujian
21. Hainan
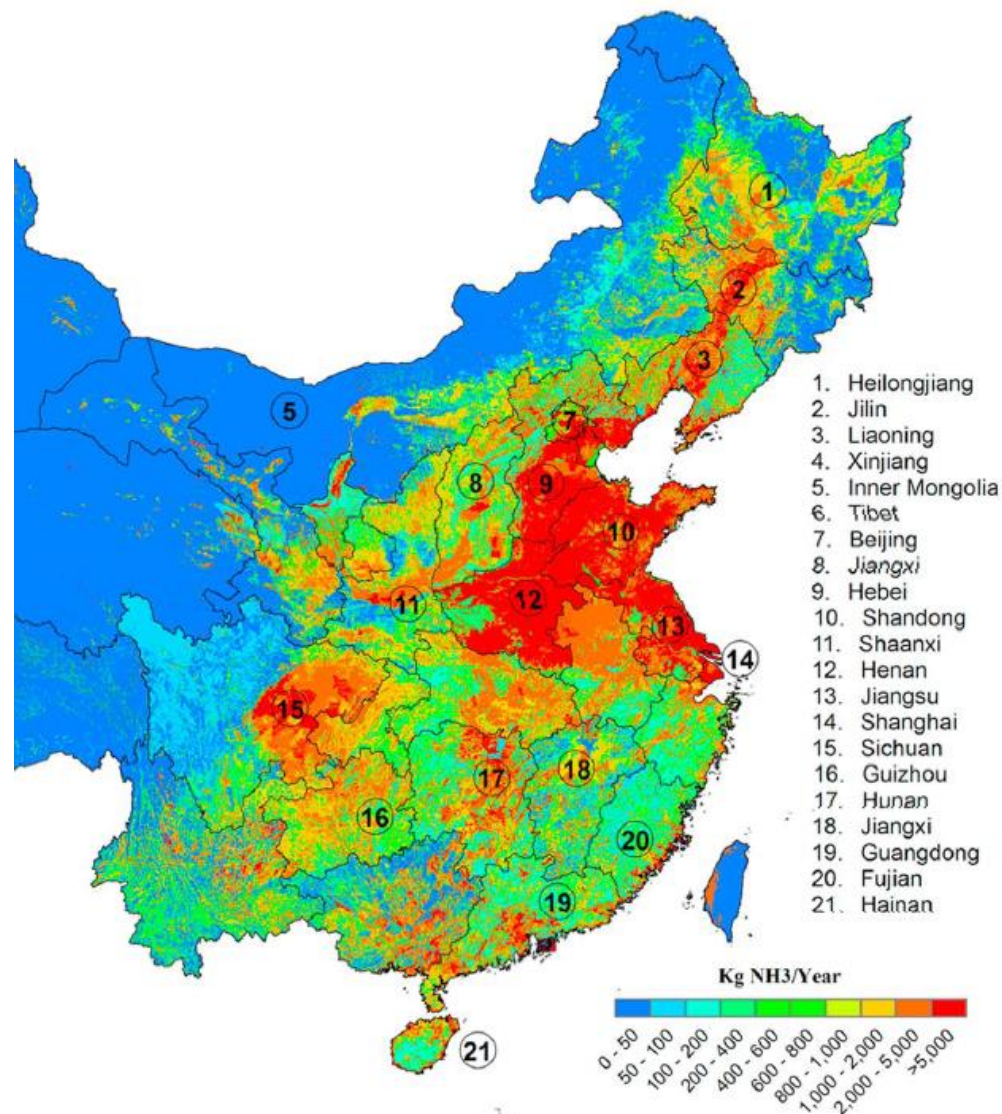
Huang, X., Y. Song, M. Li, J. Li, Q. Huo, X. Cai, Z. Tong, and H. Zhang (2012), A high-resolution ammonia emission inventory in China, Global Biogeochem. Cycles, 26, GB1030, doi:10.1029/2011GB004161

Comparison between MEIC and PKU-NH₃ for China
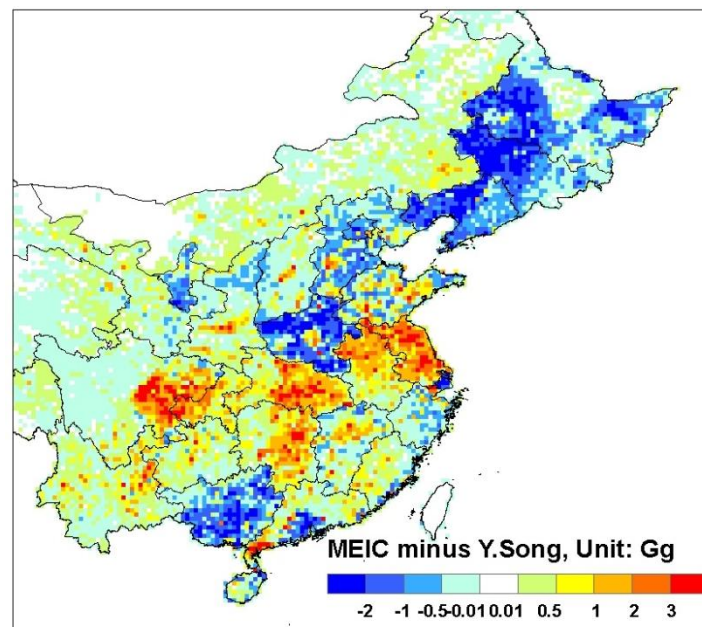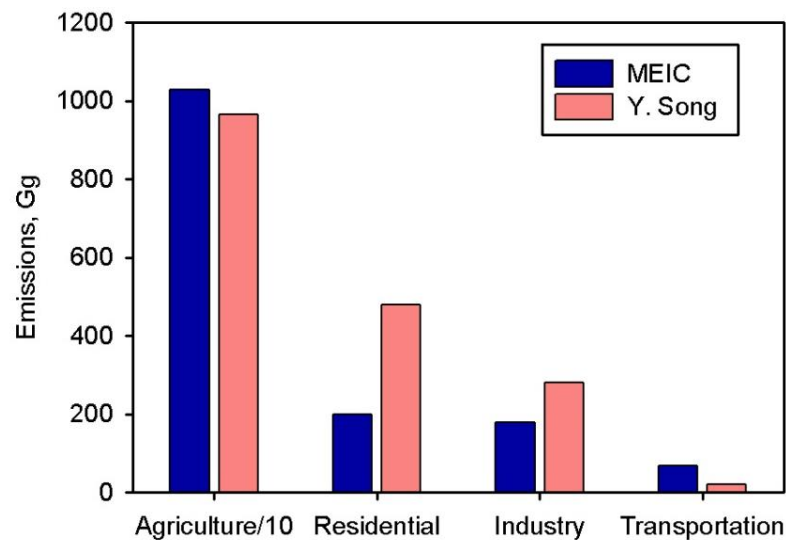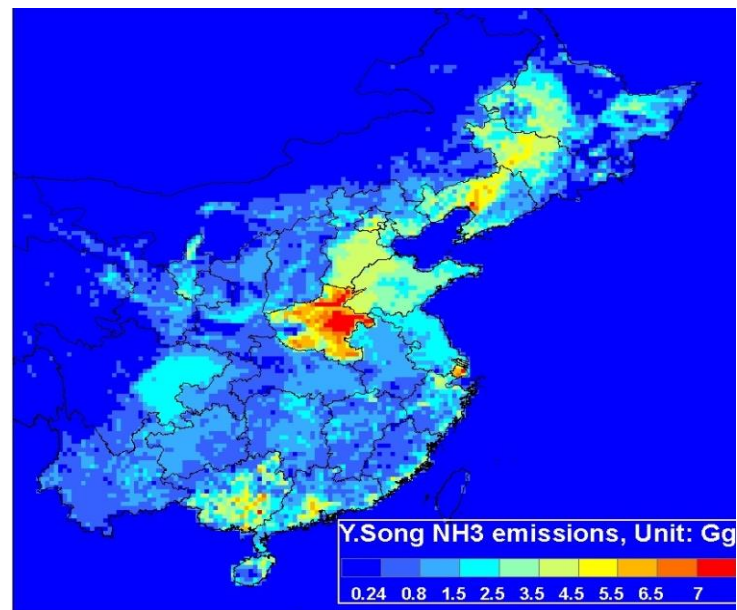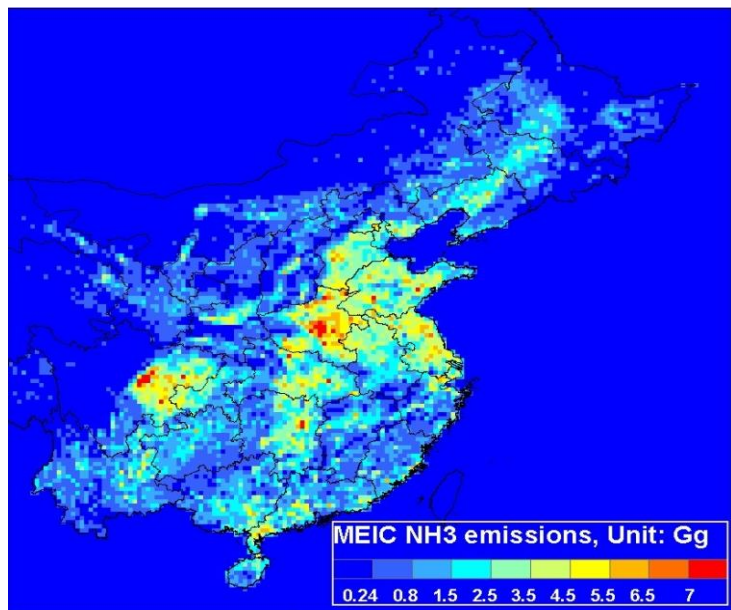
CAPSS : Korea Official Emission Inventory

Category	Sub-category	Target Pollutant
Energy industry combustion(P)	32	7(SOX, NOX, TSP, PM10, CO, VOC, NH3)
Non-industry combustion(P,A)	32	7(SOX, NOX, TSP, PM10, CO, VOC, NH3)
Manufacturing industry combustion(P,A)	32	7(SOX, NOX, TSP, PM10, CO, VOC, NH3)
Manufacturing process(P,A)	32	7(SOX, NOX, TSP, PM10, CO, VOC, NH3)
Energy transportation and store(A)	32	1(VOC)
Using organic solvents(A)	37	1(VOC)
Road mobile pollutant sources(T)	33	7(SOX, NOX, TSP, PM10, CO, VOC, NH3)
Off-Road mobile pollutant sources(T)	33	7(SOX, NOX, TSP, PM10, CO, VOC, NH3)
Waste disposal(P,A)	33	7(SOX, NOX, TSP, PM10, CO, VOC, NH3)
Natural pollutant sources(A)	7	2(VOC, NH3)
Agriculture(A)	2	1(NH3)
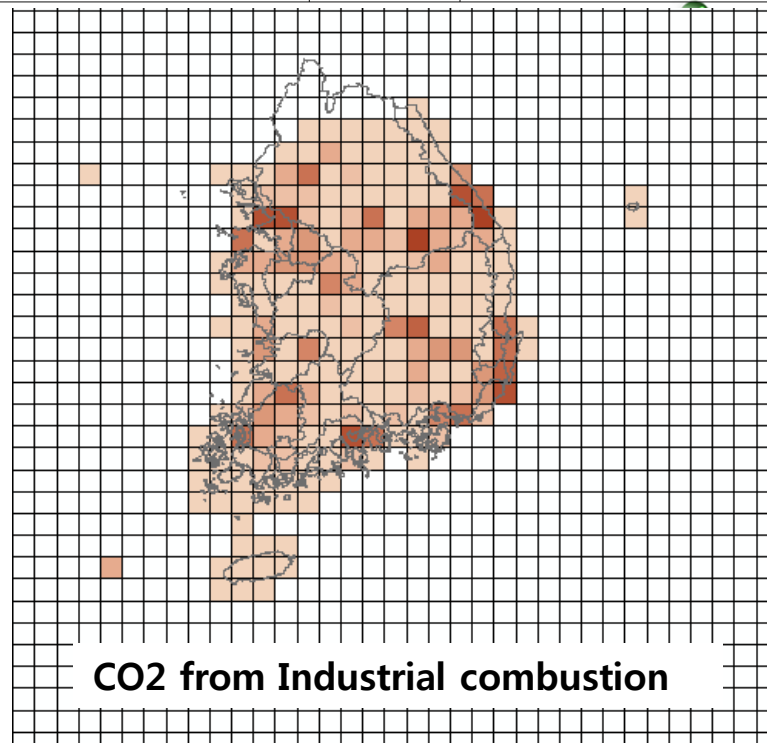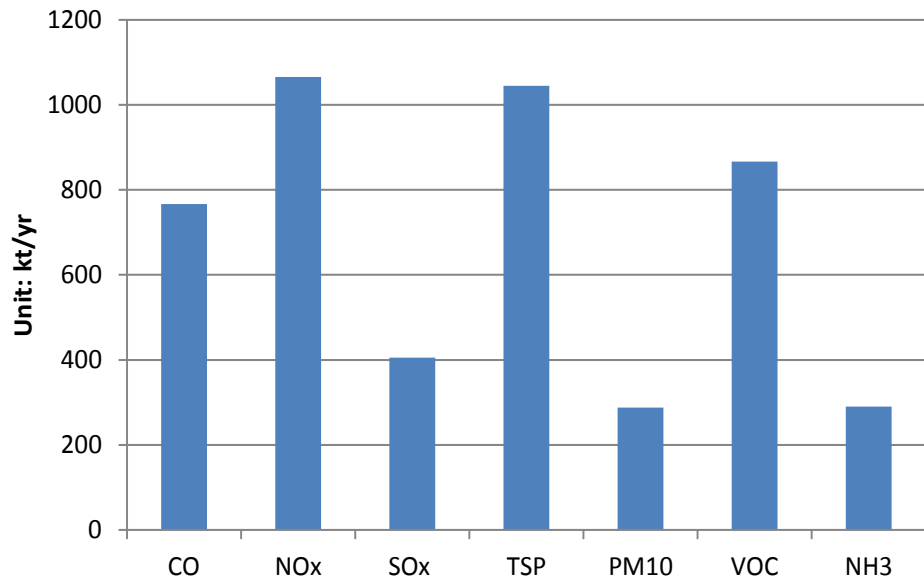
**CO2 from Industrial combustion**

Streets Indian Emission Inventory
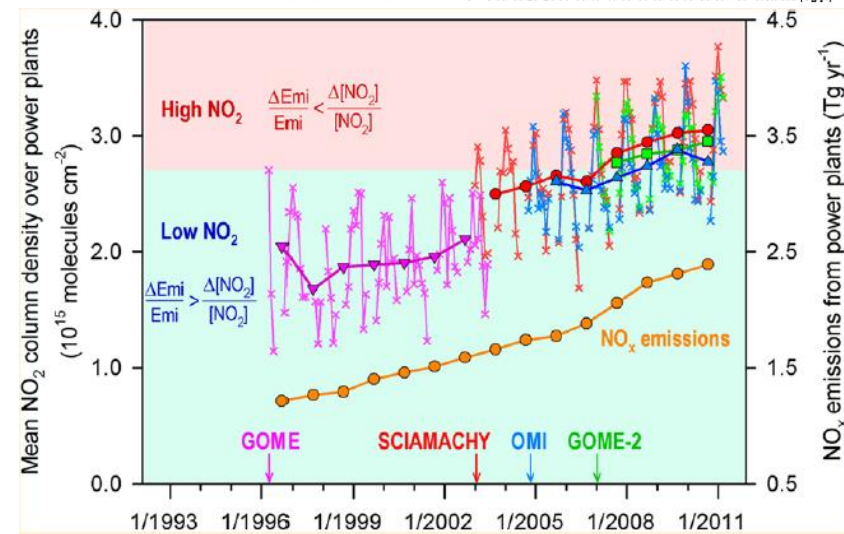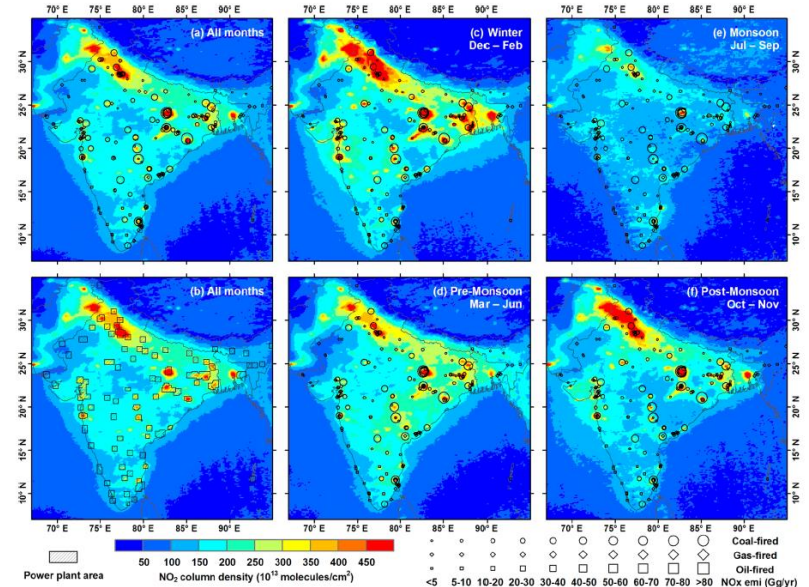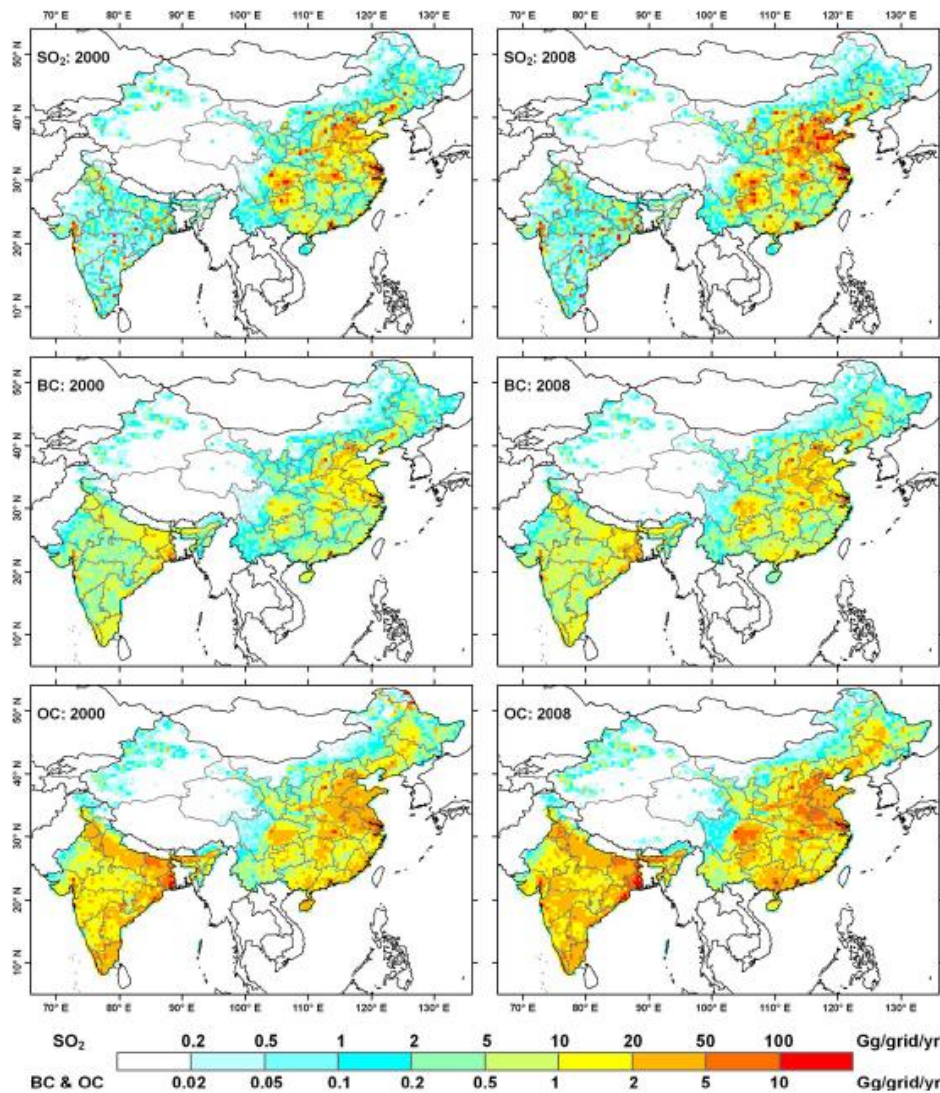
Lu, Z., Zhang, Q., and Streets, D. G.: Sulfur dioxide and primary carbonaceous aerosol emissions in China and India, 1996–2010, *Atmos. Chem. Phys., 11*, 9839-9864, doi:10.5194/acp-11-9839-2011, 2011.

Lu, Z., and D.G. Streets, Increase in NOx emissions from Indian thermal power plants during 1996-2010: unit-based inventories and multi-satellite observations, Environ. Sci. Technol., 46, 7463−7470, 2012
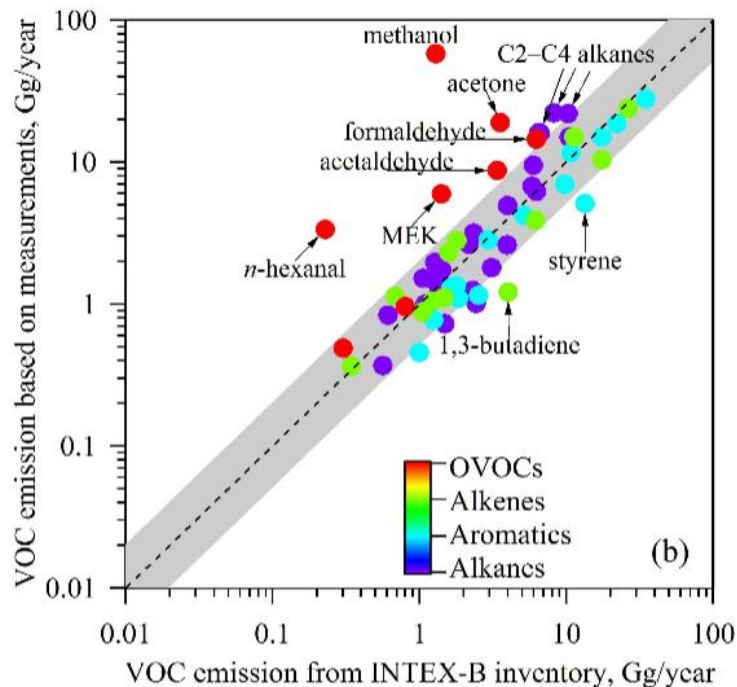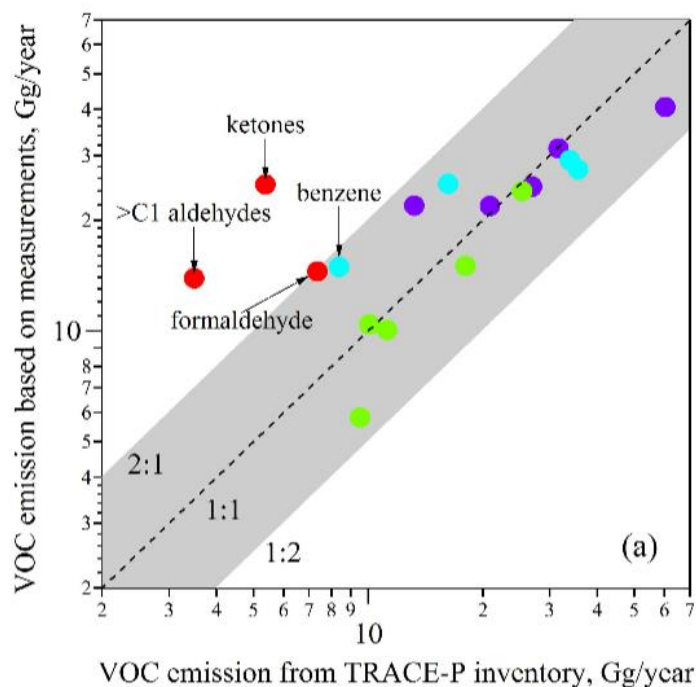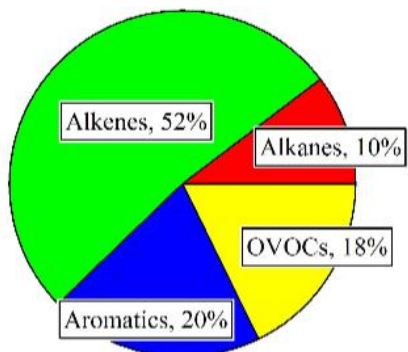
Power plant emissions: comparison between ANL and REAS

NOx emissions from power plants in 2008, India. Unit: Gg/grid
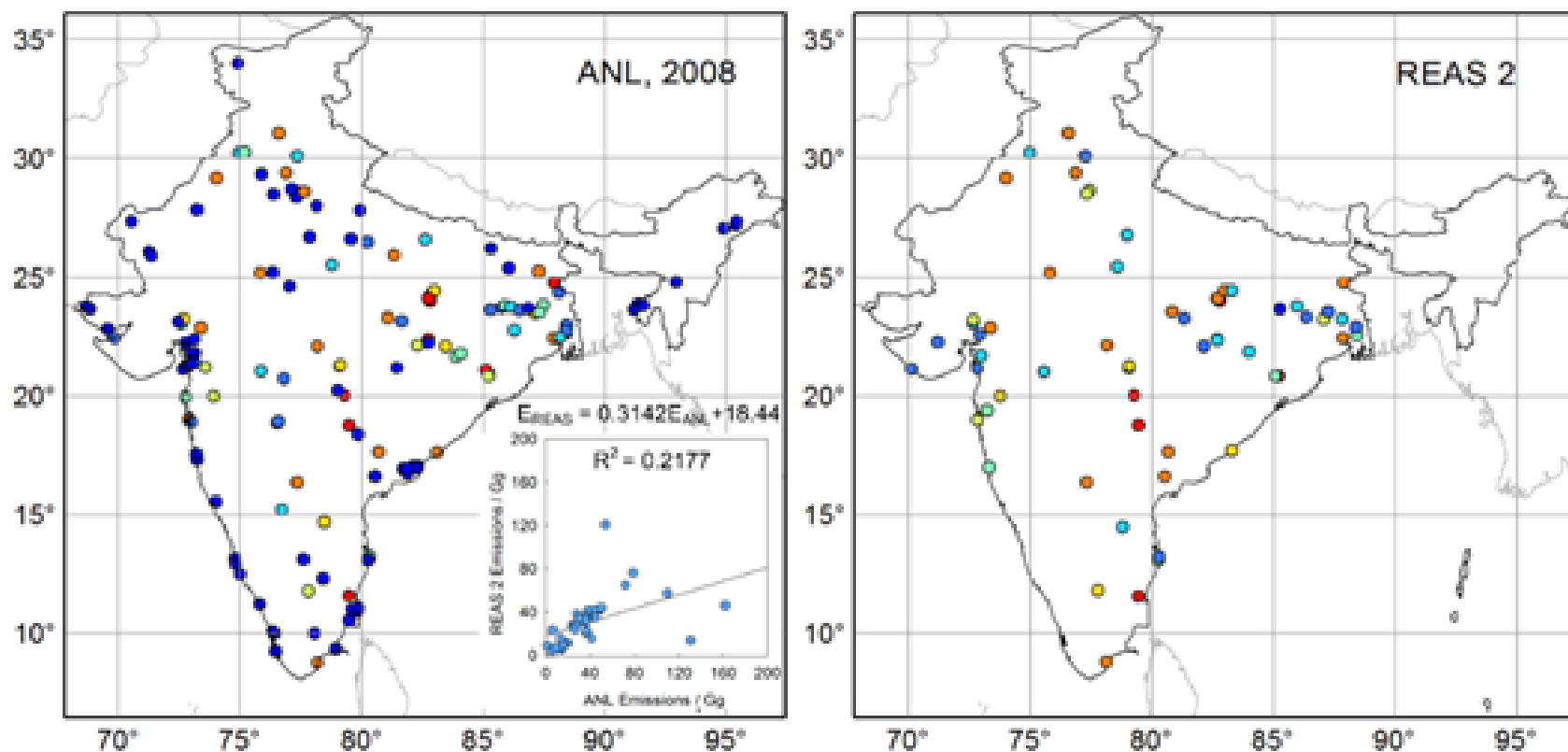
NMVOC *speciation* in MIX database

Li et al., ACP, 2014
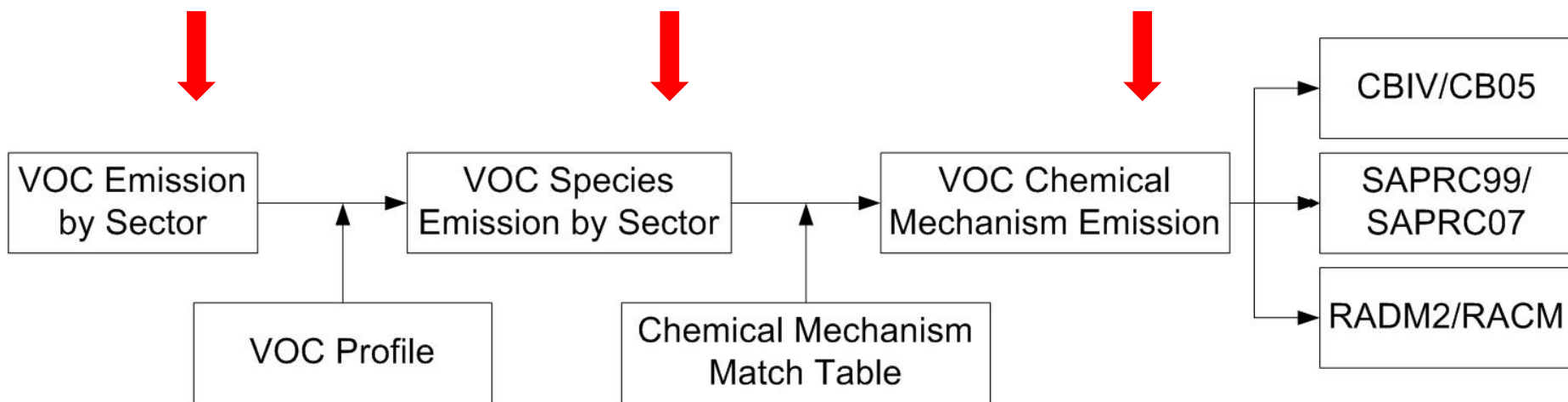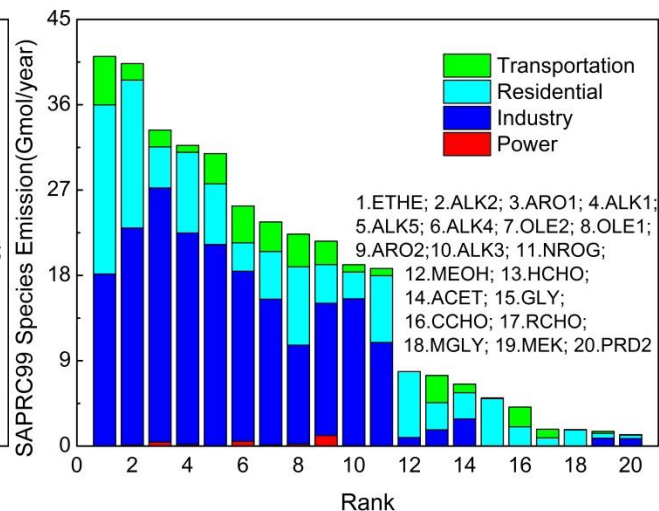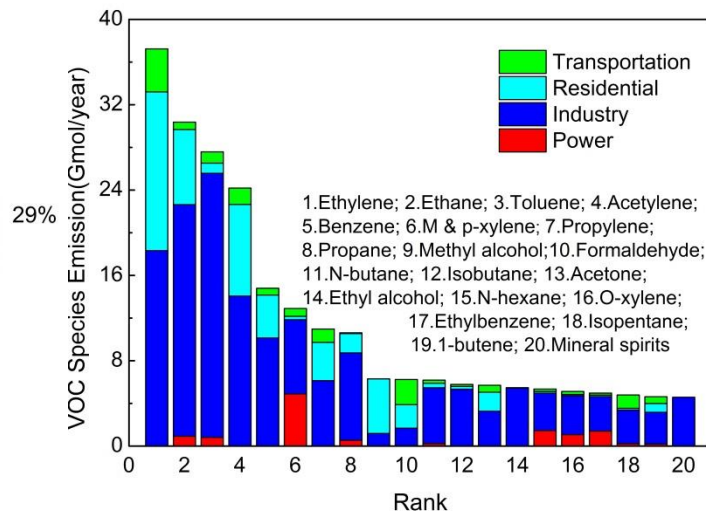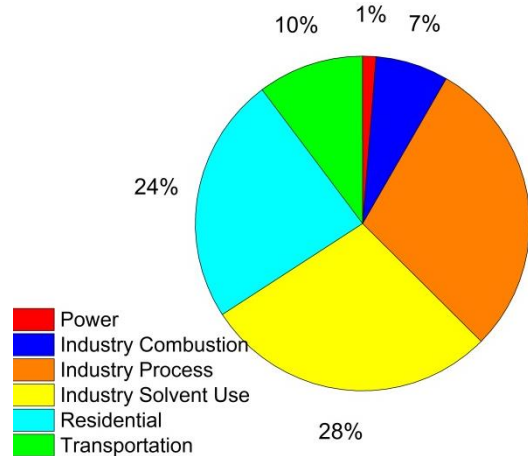
Evaluation of speciated VOC emissions using in-situ observations


Wang, Shao et al., ACP, 2014
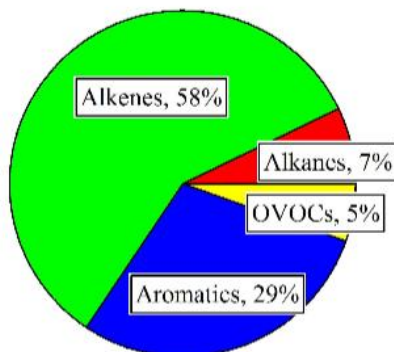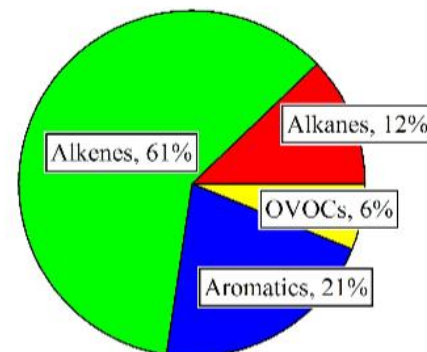
Speciated VOC emissions are very sensitive to source profiles!

Li et al., ACP, 2014
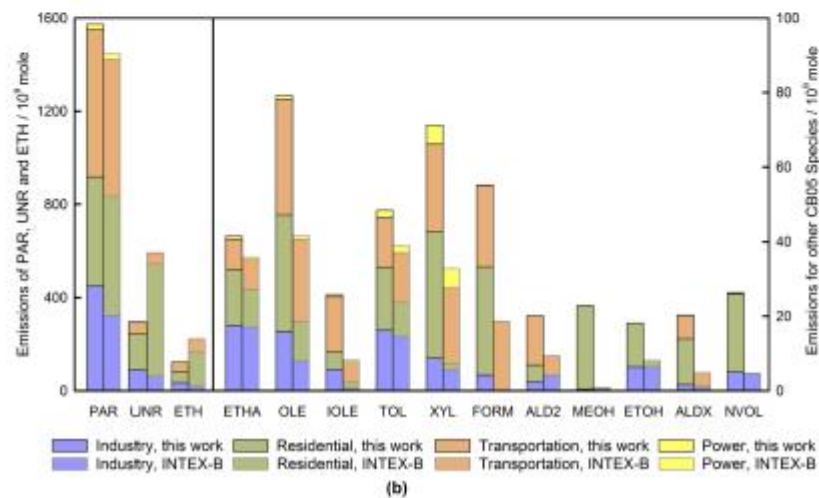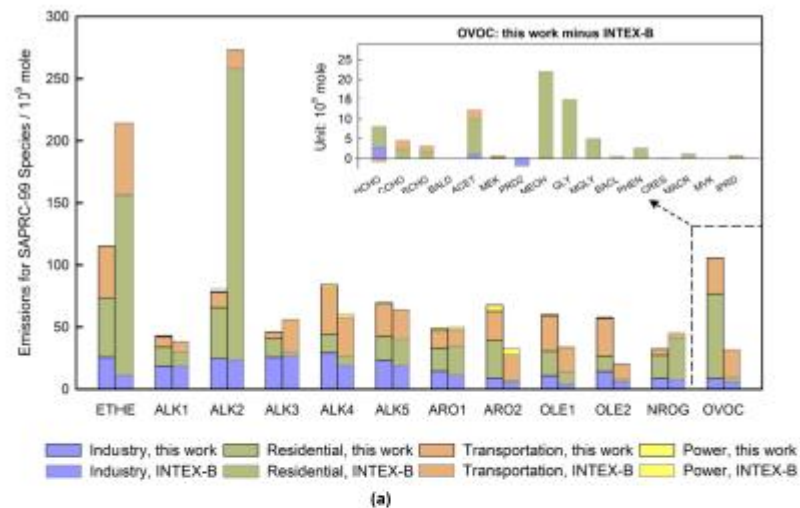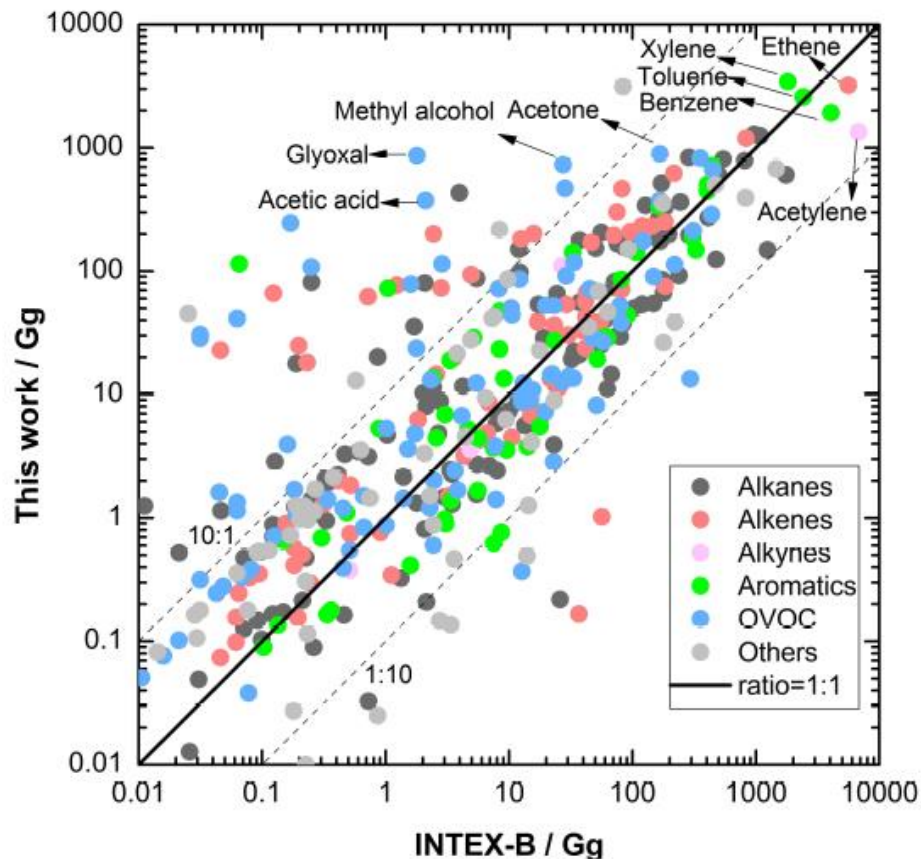
Key features of MIX inventory

- **Years:** 2008, 2010

- **Spatial domain:** Asian + Far East Russia

- **Sectors:** Power, Industry, Residential, Transportation, and Agriculture

- **Species:** SO_2, NO_x, CO, NMVOC, NH_3, BC, OC, $PM_{2.5}$, PM_{10}, and CO_2

- **VOC speciation:** SAPRC99 and CB05

- **Spatial resolution:** 0.25x0.25 degree

- **Temporal resolution:** monthly

MIX inventory available at 0.25 degree resolution
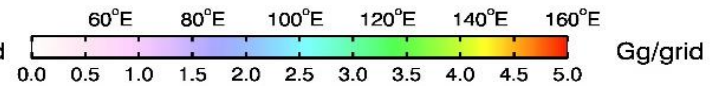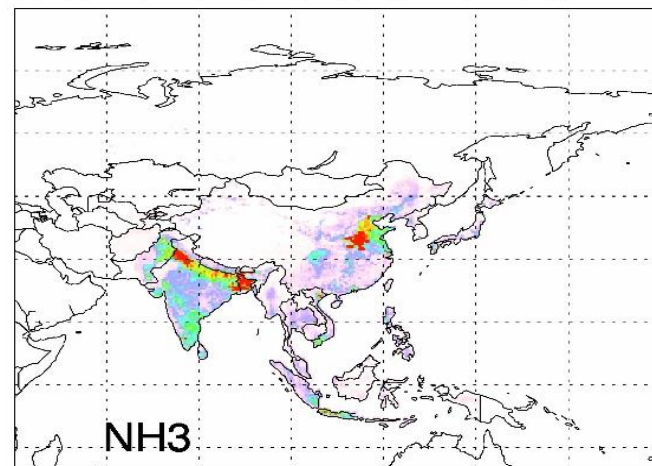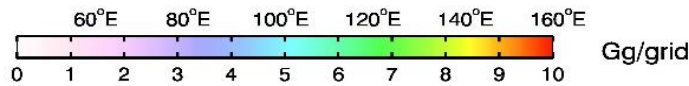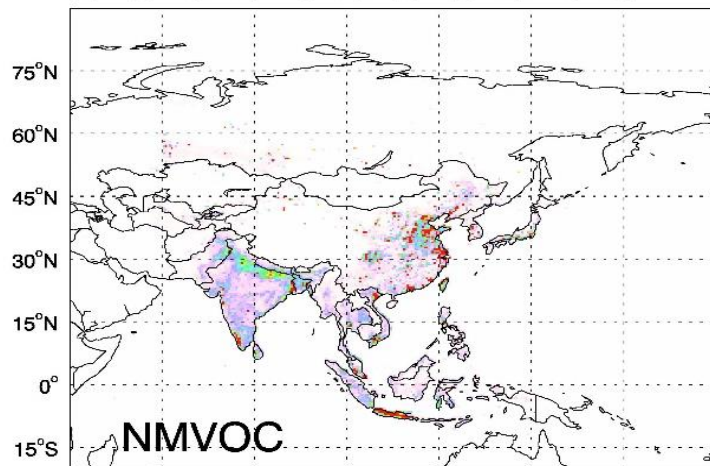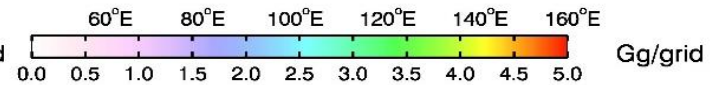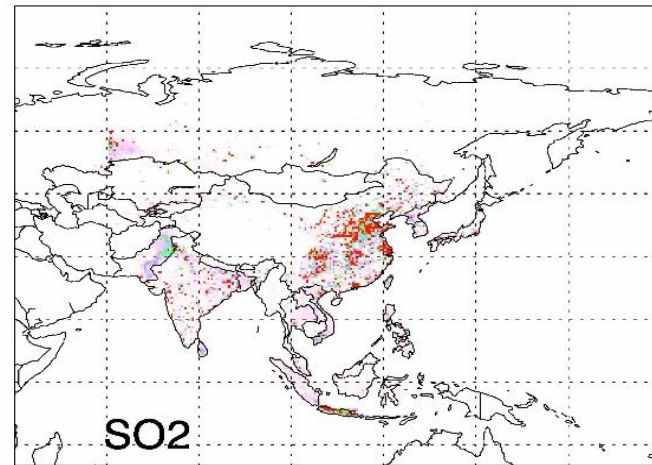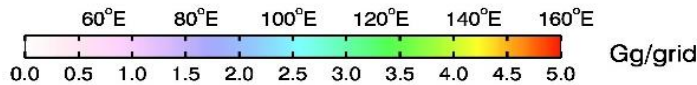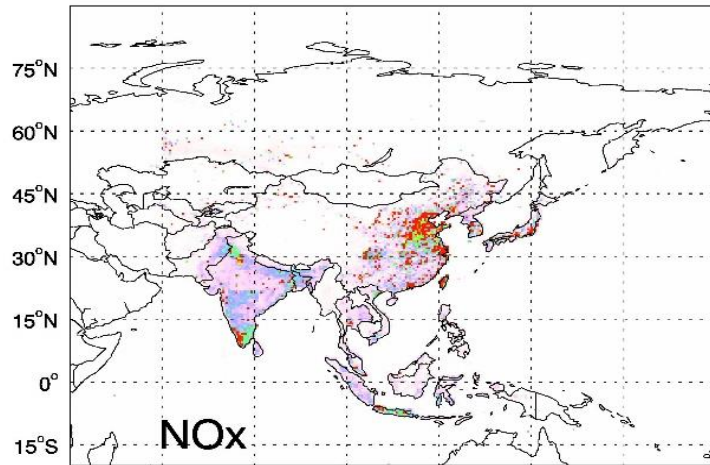
Gridded product of MIX, 2010, available @IAP

Thanks for your attention!