NO emission from soil and its effect on O_3 formation over China

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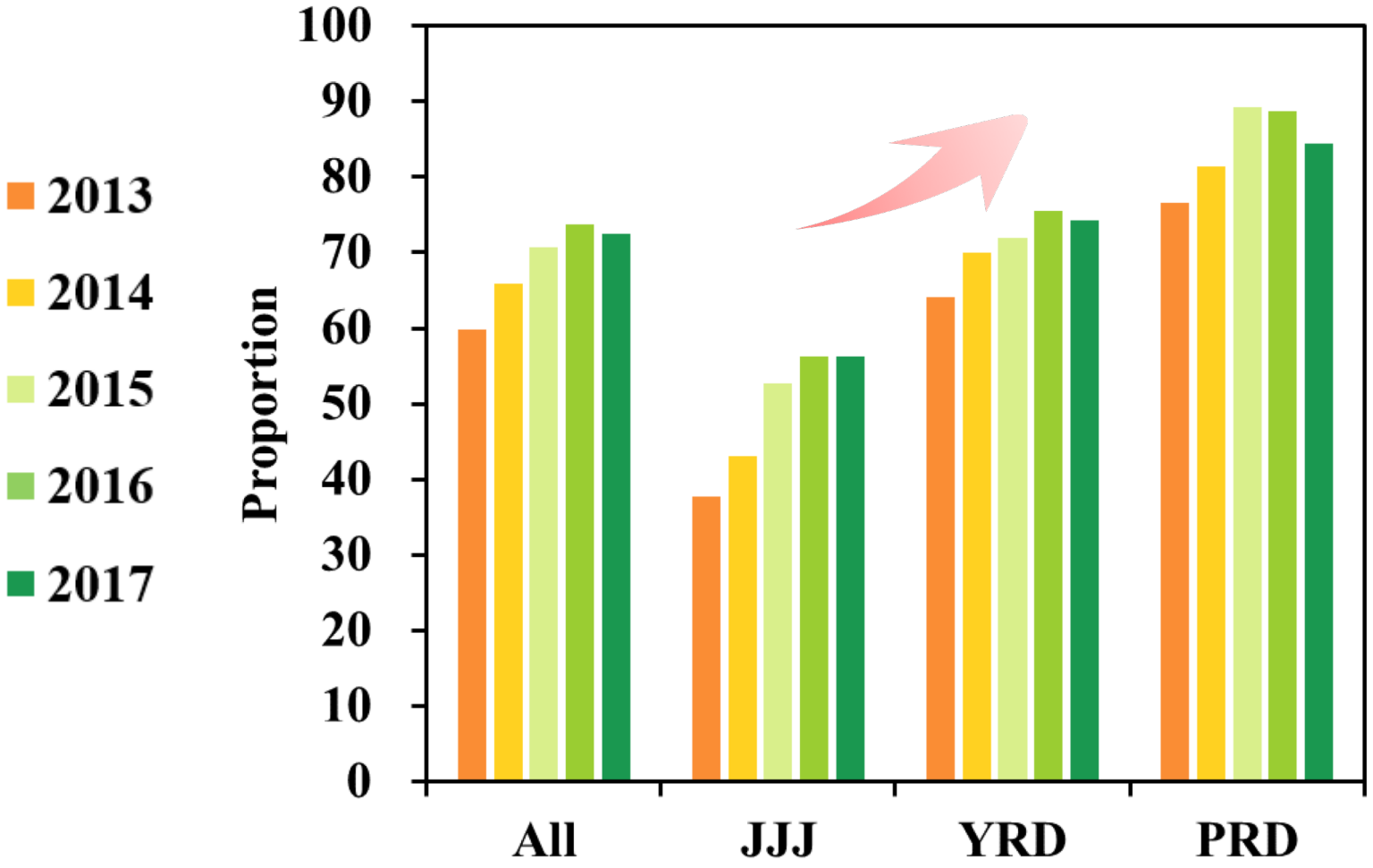
Air Quality Improvement in China

Days meet air quality standards



JJJ(Beijing-Tianjin-Hebei); YRD:(Yangtze River Delta); PRD:(Pearl River Delta);

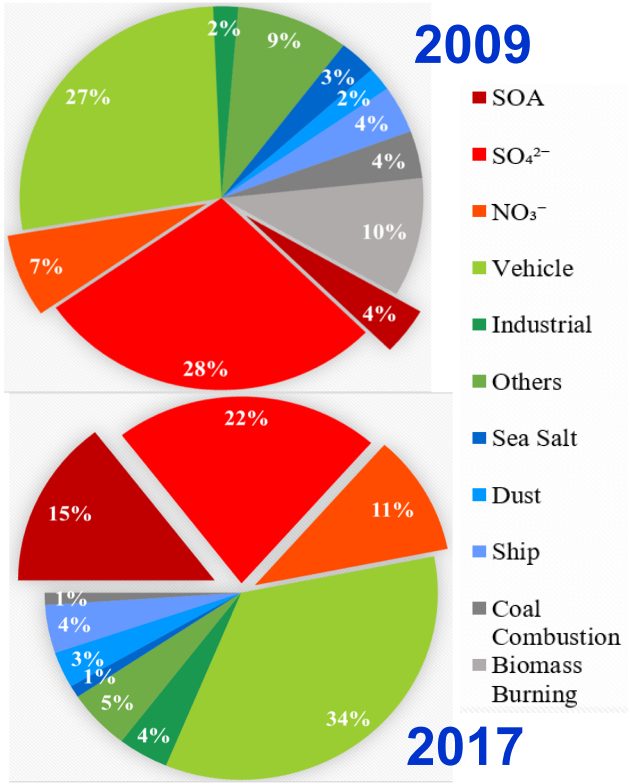
Data source: Report on the State of Environment in China

Secondary components increases

Components in $PM_{2.5}$

Secondary 39%

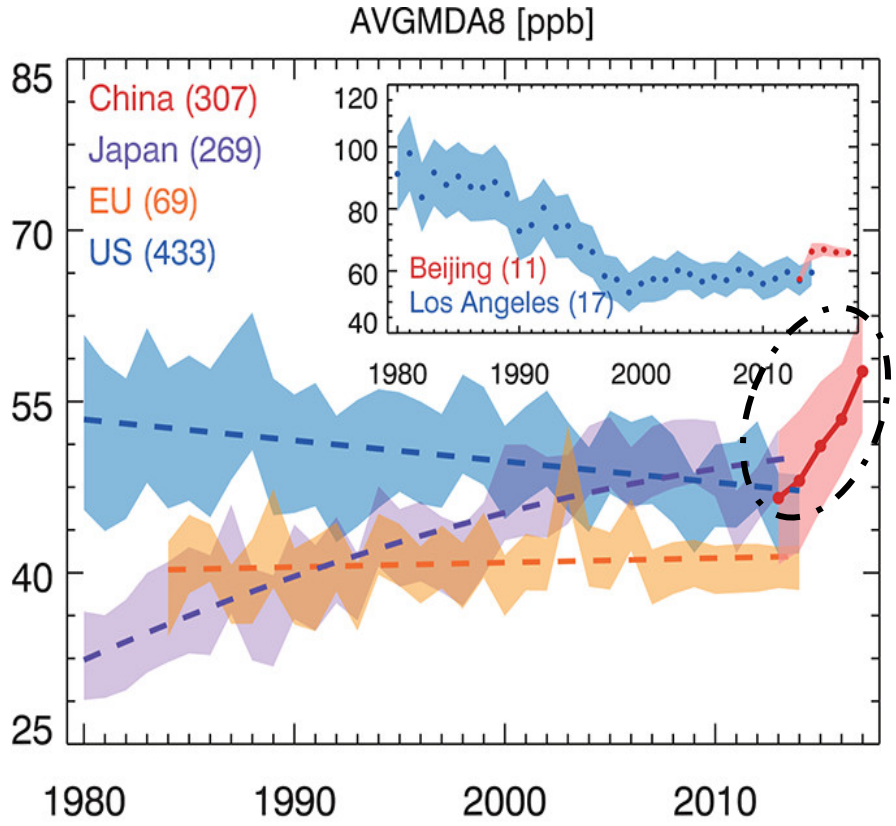
45%



Source: Huang et al., 2018;

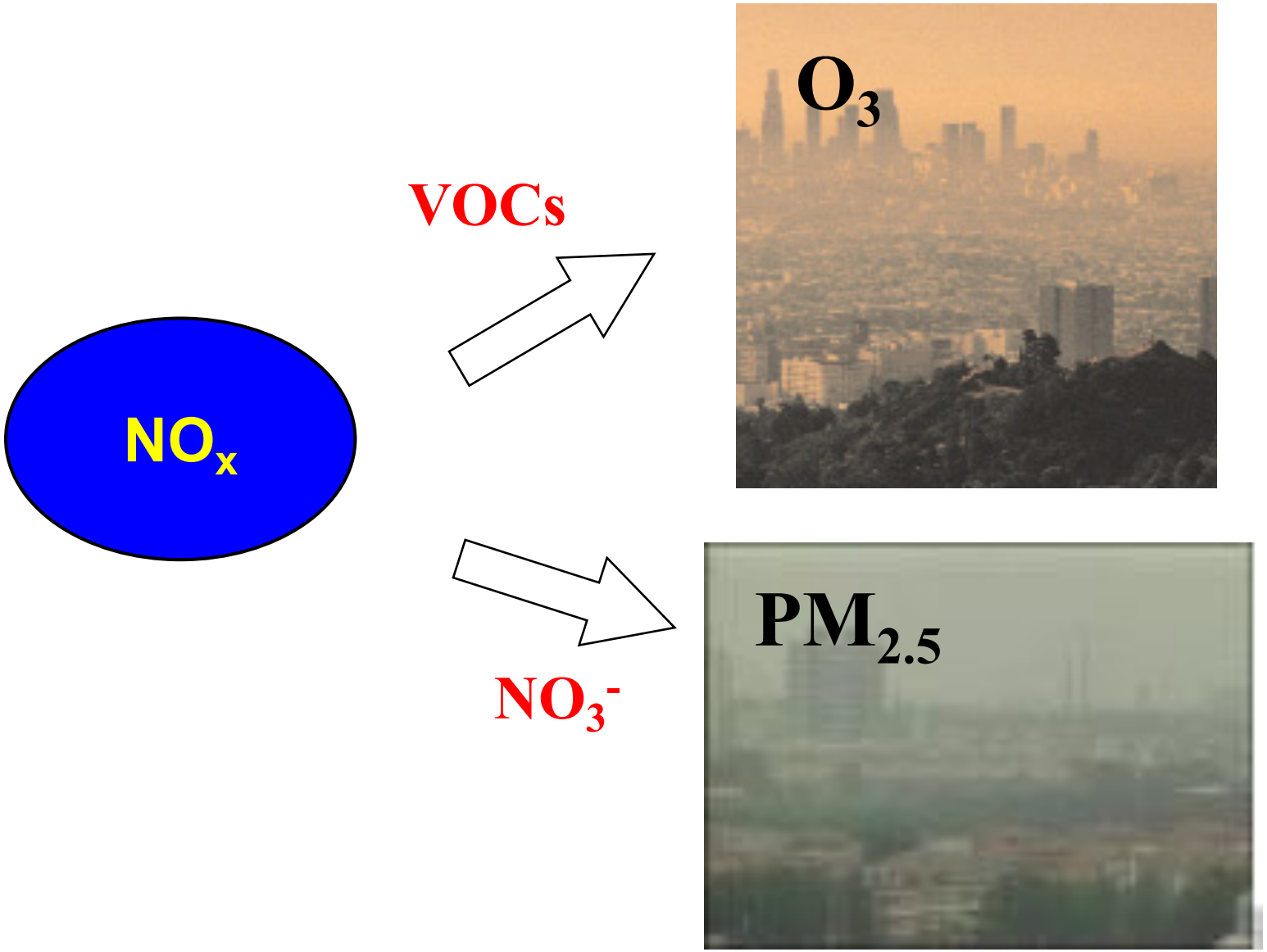
Zheng et al., 2018

Surface O_3

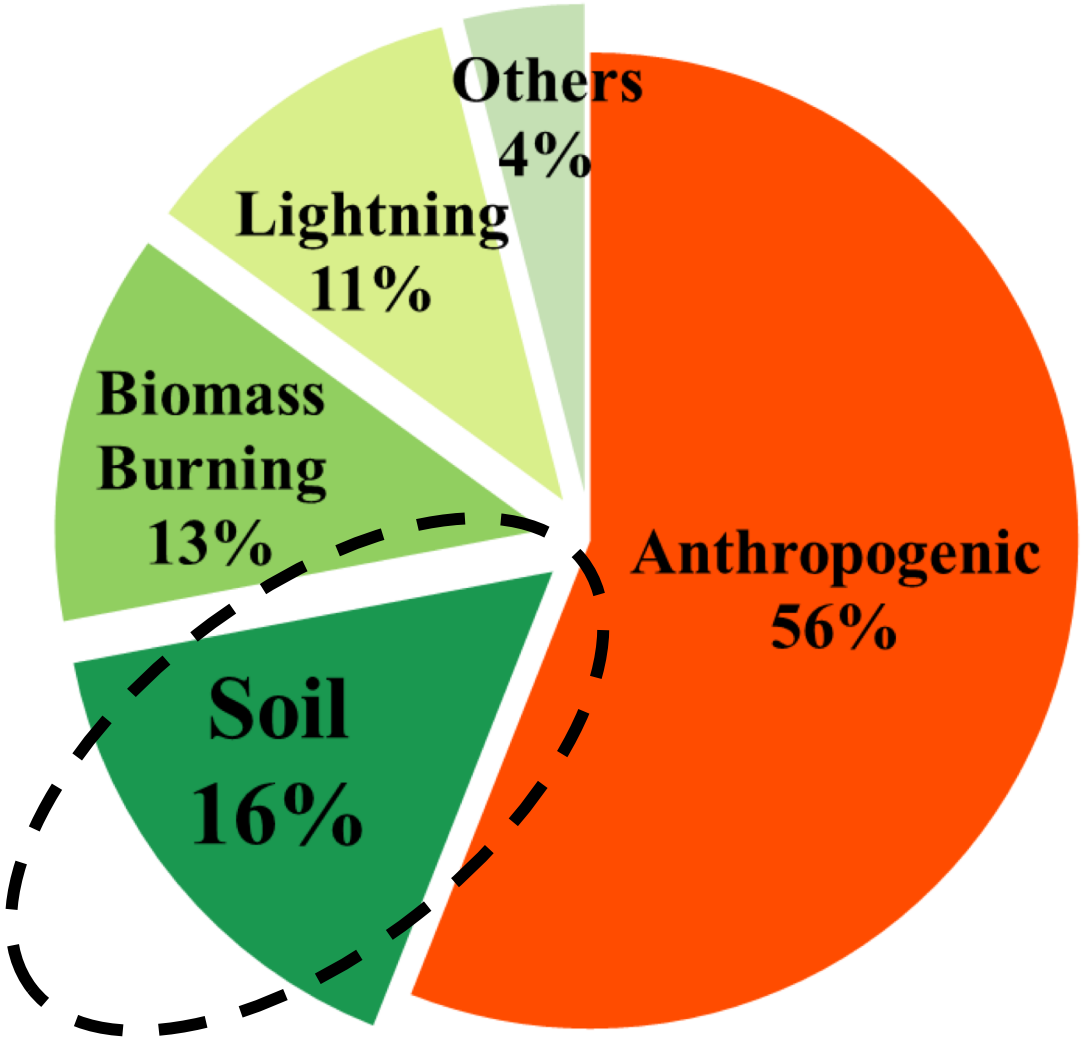


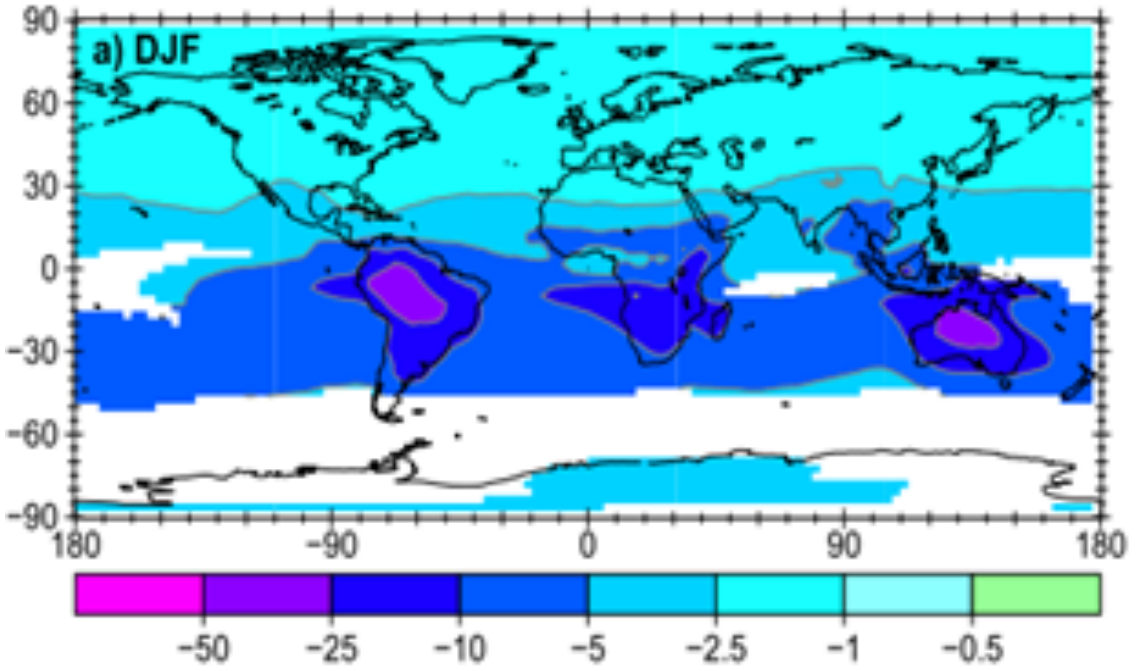
Lu et al., 2018

NOx is key precursor for air quality



Soil NO emission account for 16%

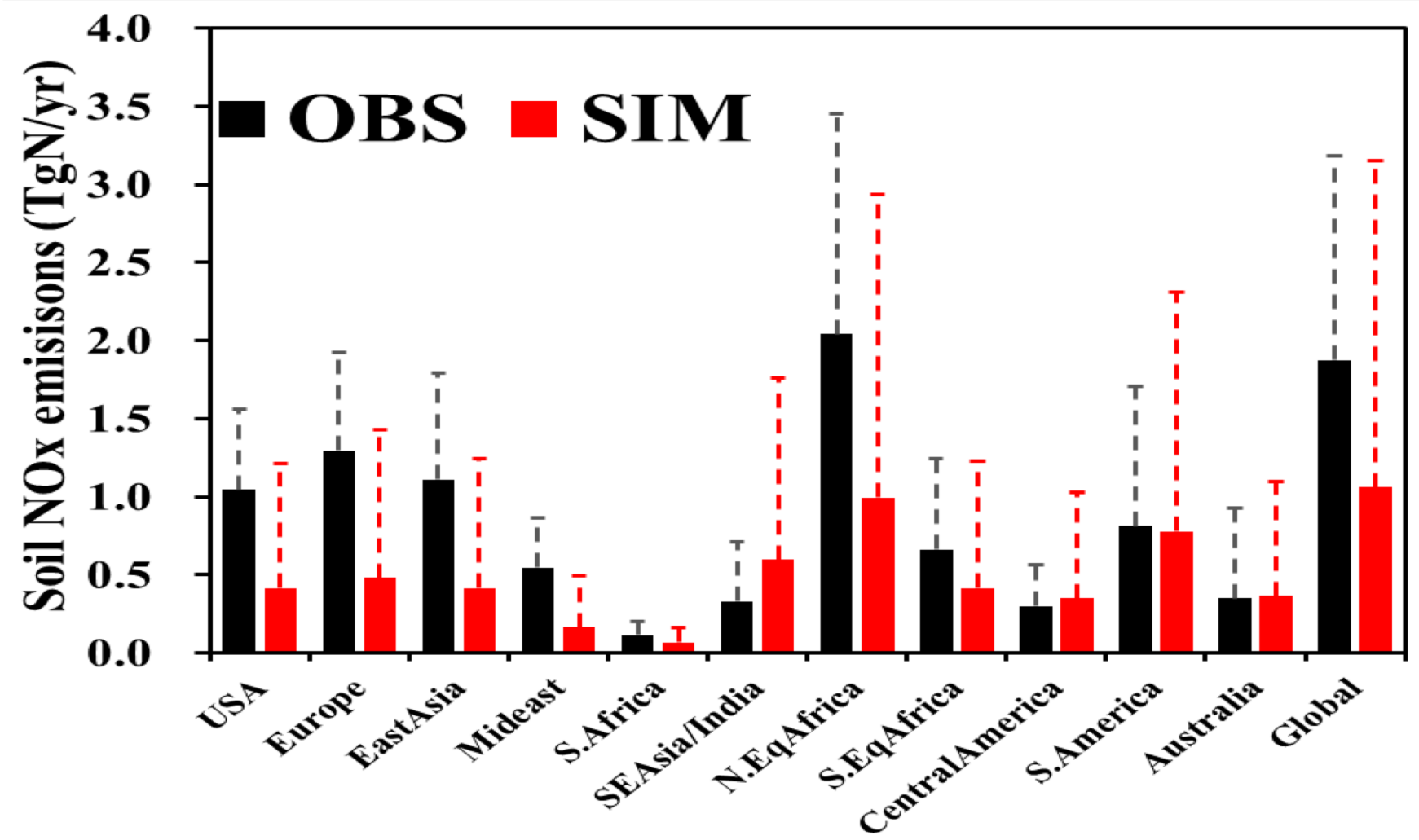




Soil NO emission results in the variation of global O_3 concentration by ~20 ppb

IPCC AR4; Houweling et al., 1998; Hodzic et al., 2016; Kanakidou et al., 2005; Folberth et al., 2006; Snider et al., 2016; Zare et al., 2014

Soil NO is underestimated by 50-400%



Neglect of Nitrogen fertilizer and deposition

Updates the Soil NO emission

$$\mathrm{SNO} = A'_{biome}\,(N_{avail}) \times f(\mathrm{ST}) \times g(\mathrm{SM}) \times P(\mathrm{l}_{dry}) \times CR(LAI, MET, Biome)$$

Soil Characters/ Met./ Veg. are considered

Nitrogen fertilizer

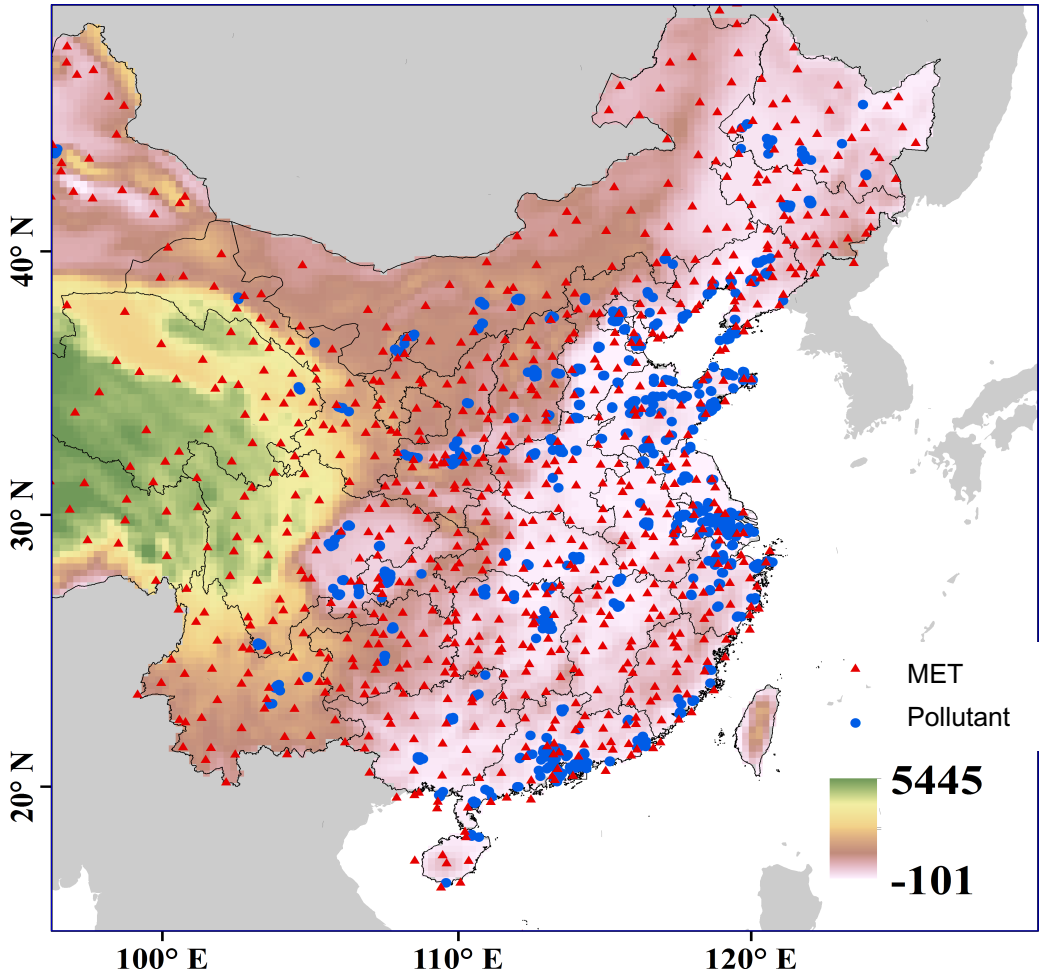
Nitrogen deposition

Global nitrogen fertilizer dataset

- **Gas phase : NO 、 NO_2 、NO_3 、 N_2O_4 、 N_2O_5 、 HNO_2 、 HNO_3 and PAN**
- **Particle phase : NO_2^- 、 NO_3^- 、NH_4^+ and ON**

Yienger and Levy, 1995; Hudman et al., 2012; Rasool et al., 2016

Model configuration



Model：WRF/Chem-megan

Period：Jan. Apr. Jul. Oct. 2014

Domain：27km× 27km

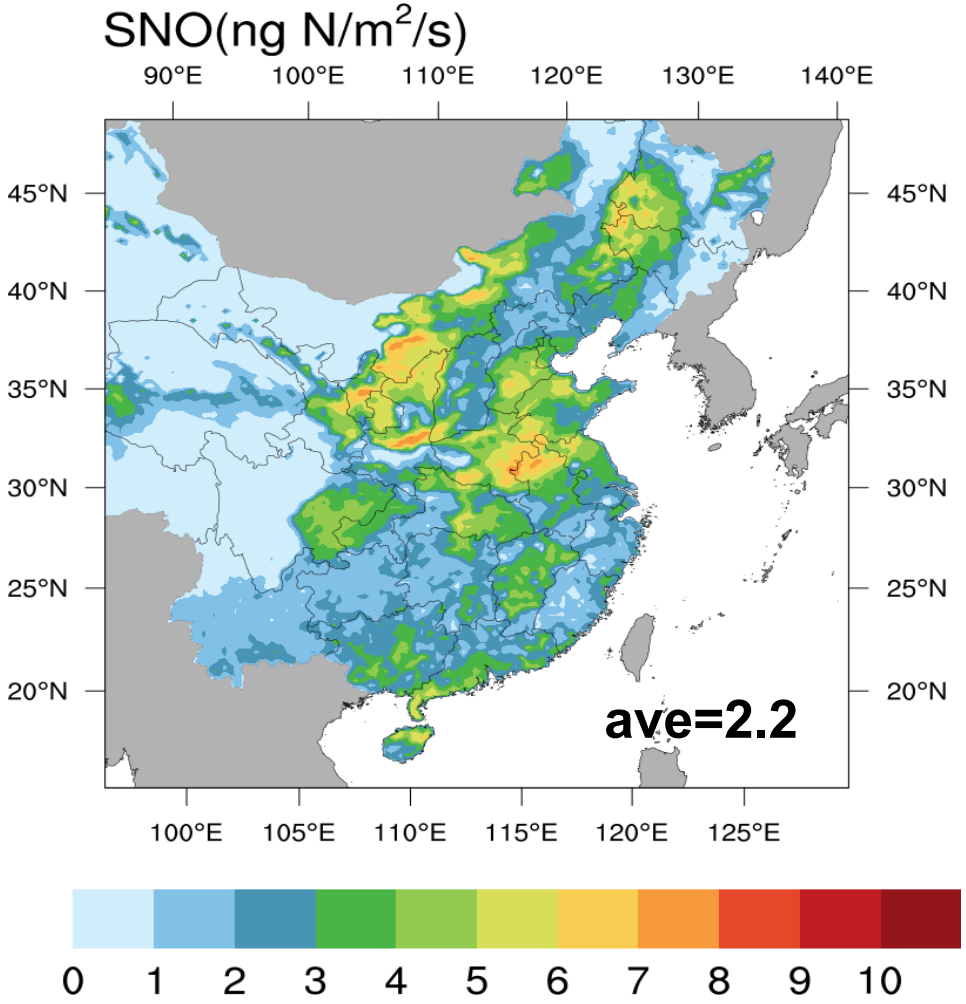
Time step: 18s

Original scheme: YL95

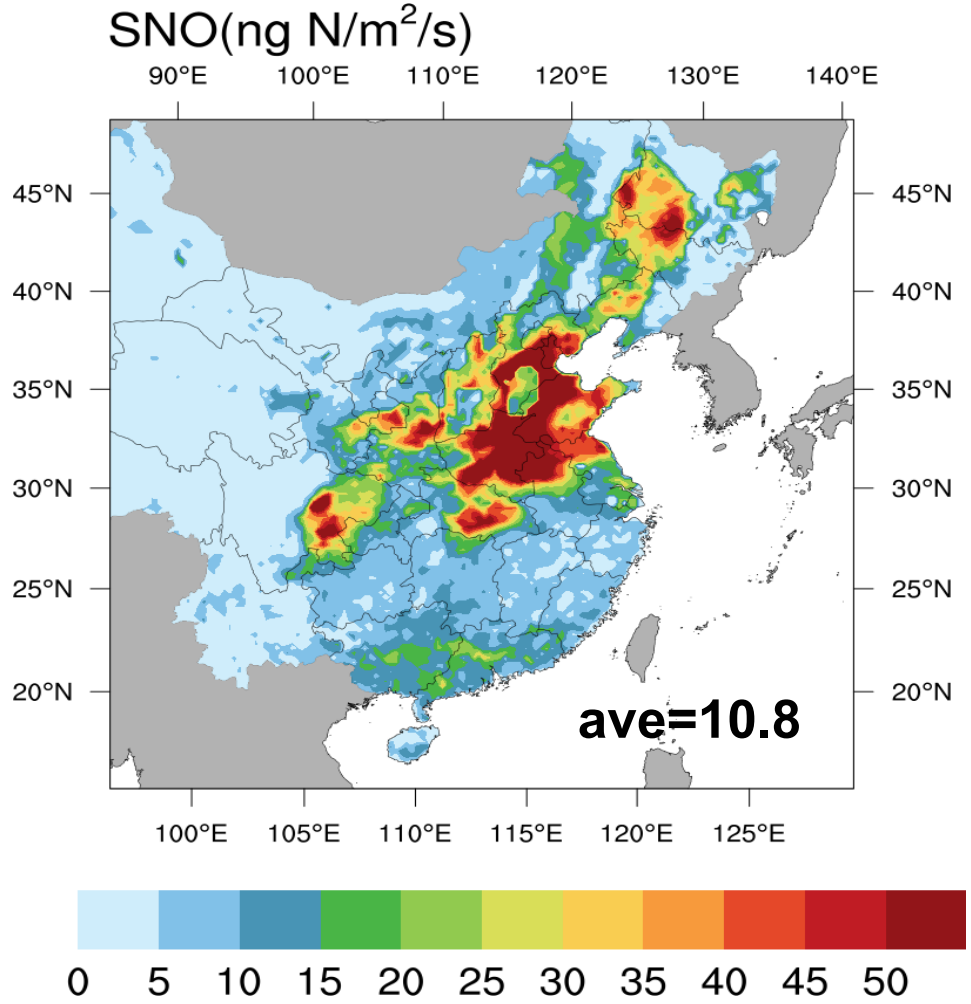
Updated scheme: YL95 + fertilizer and deposition

Soil NO emission flux has increased by a factor of 4

Original emission

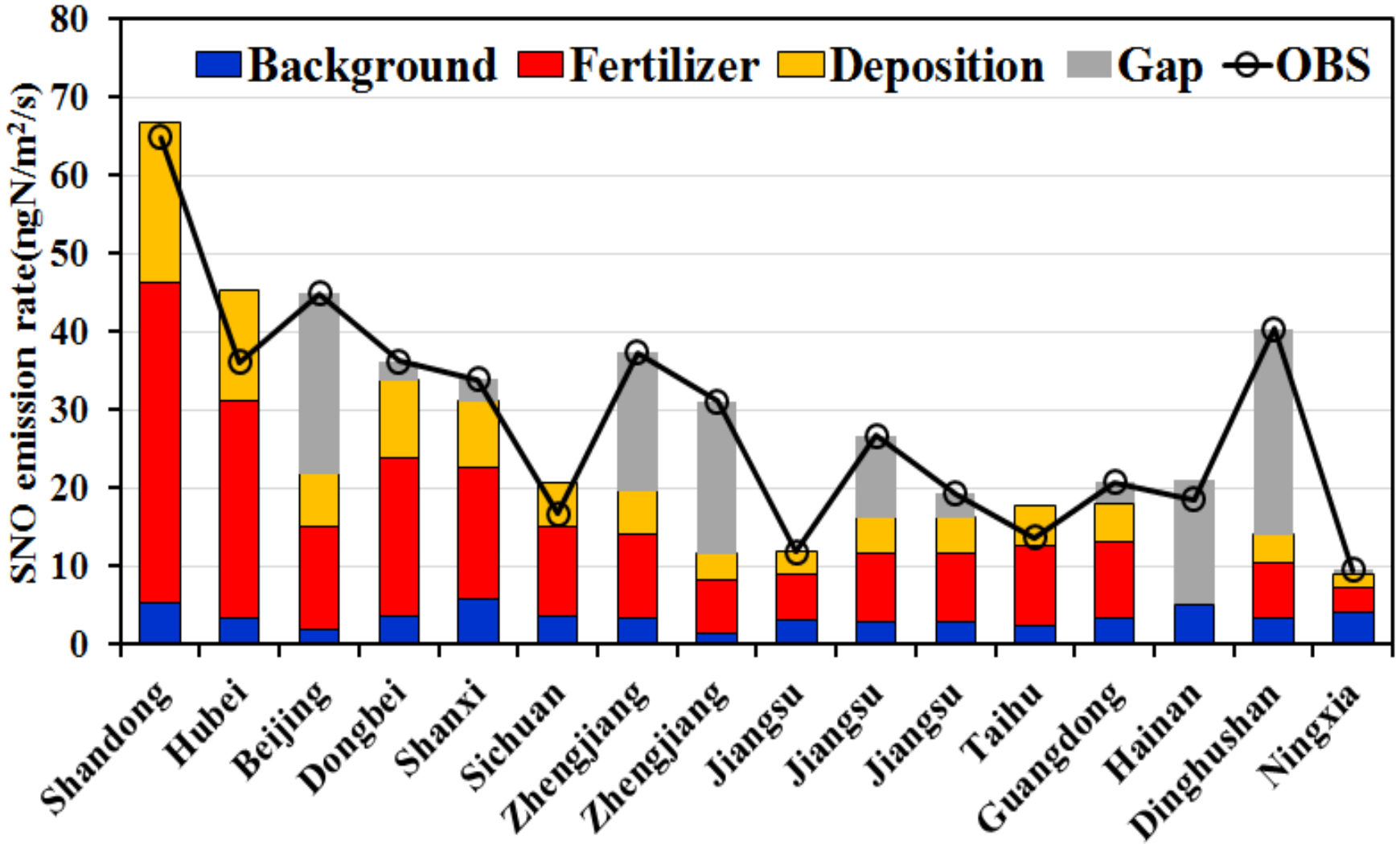


Updated emission



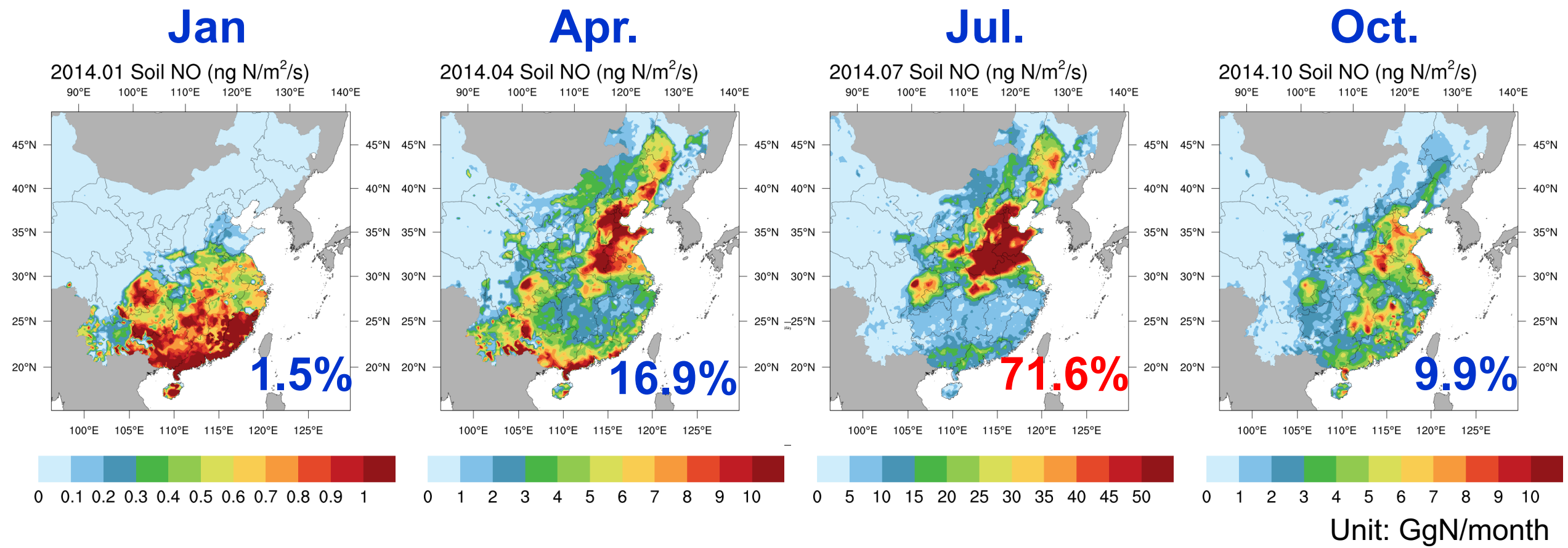
Huo et al., 2012; Liu et al., 2006 ; Li et al., 2007; Liu et al., 2011;Zheng et al., 2004; Zhou et al., 2010; Fang et al., 2007

The bias of Soil NO simulation has reduced (~60%)



Huo et al., 2012; Liu et al., 2006 ; Li et al., 2007; Liu et al., 2011;Zheng et al., 2004; Zhou et al., 2010; Fang et al., 2007

Seasonal variation of soil NO emission



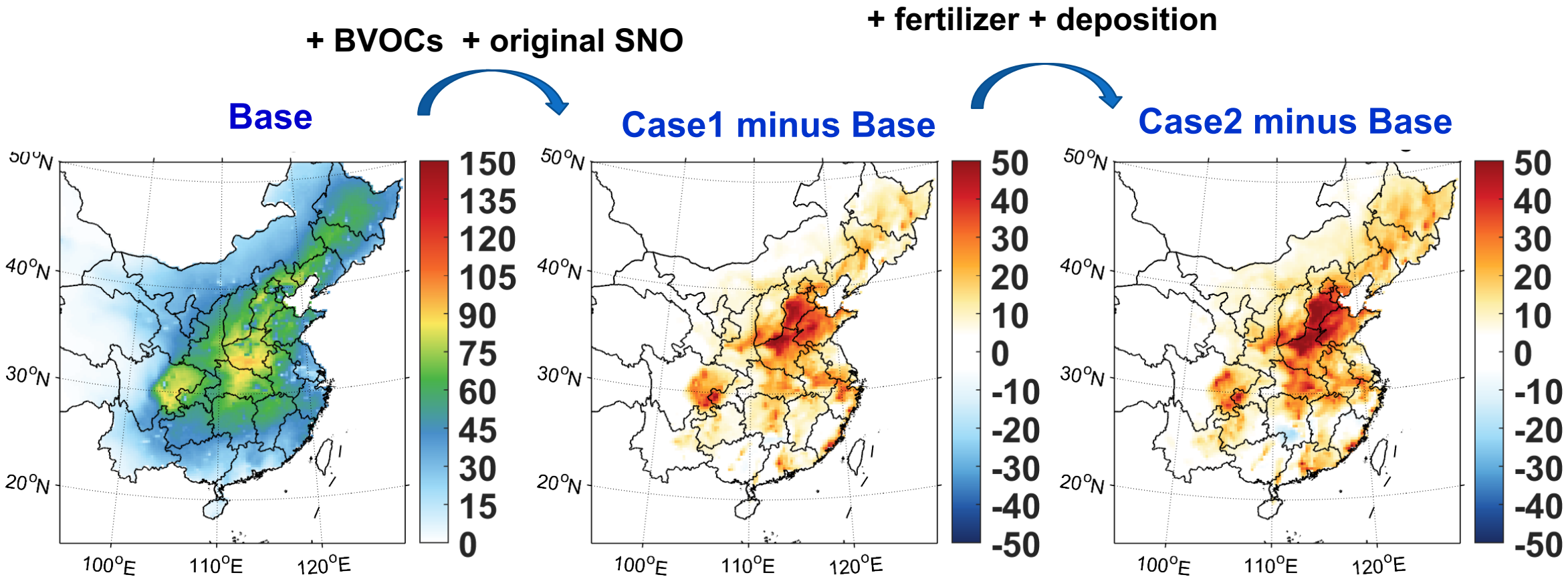
Highest soil NO emission is found in July with the contribution of 70%

Sensitivity study for O_3 formation

Scheme	Anthropogenic EI	Soil NO
Base	✓	✗
Case 1	✓	Original scheme
Case 2	✓	Updated scheme

Simulation period: Jul, 2014

The effect of soil NO emission on O_3 (ug/m^3)



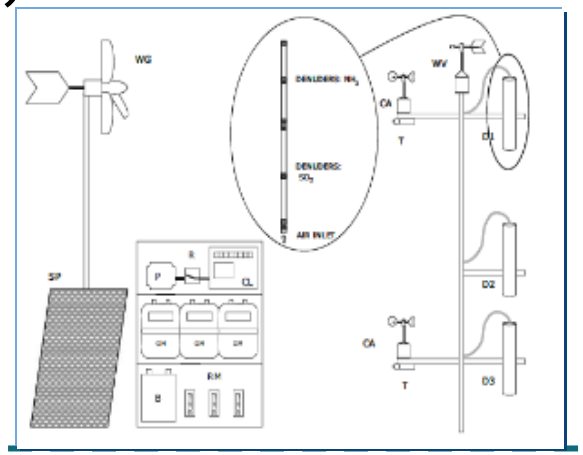
Future work

High Frequency Observation

- CO_2（10Hz）
- H_2O（10Hz）
- MET.

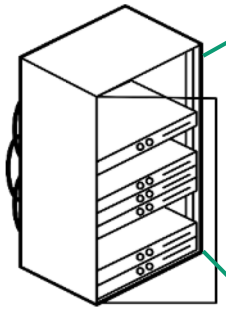
- NO_2/NO（10Hz）
- NH_3（1Hz）

- ……..

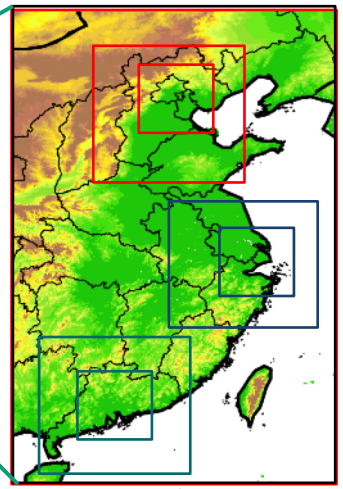


Model Development

Chemical mechanism and Boundary Layer schemes



$$F_{dry} = C \times V_d$$



High-resolution landscpes
(urban, cropland, forest etc.)

High-frequency and synchronous flux and concentration measurement to support model development

Summary

1. **Improve the scheme** of soil NO emission by **further considering** nitrogen fertilizer and deposition.
2. Revised model shows an increase in SNO emission and surface ozone levels, getting better **approach to the observations**.

Thanks for Your Attention!

Acknowledgement

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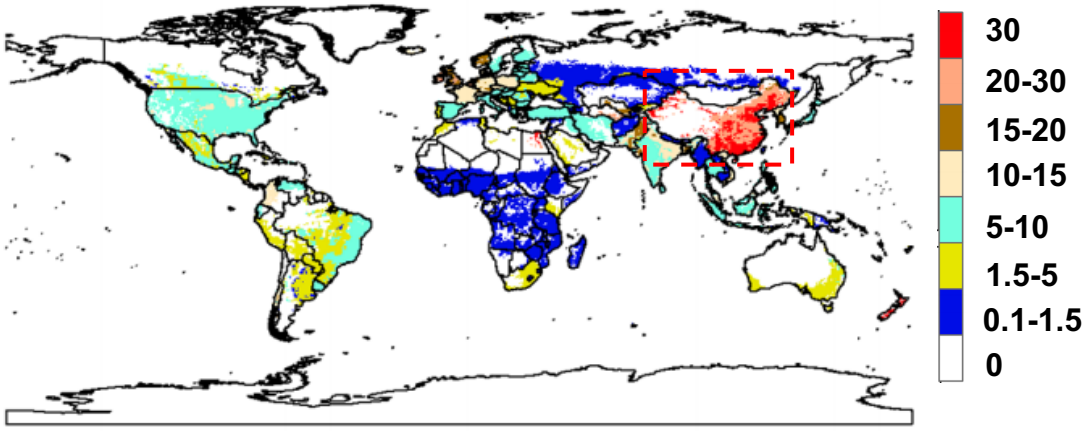
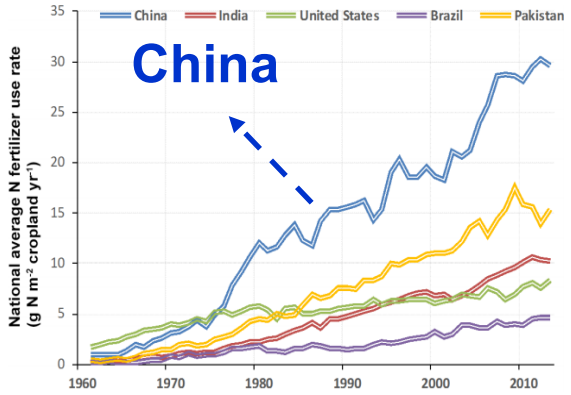
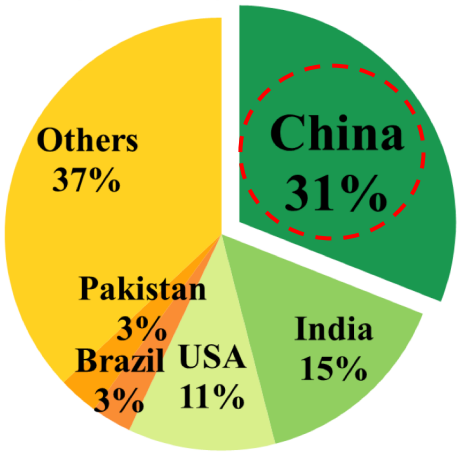
***Young Scholar*(41425020)**

Human Activities: Nitrogen fertilizer and Nitrogen Deposition

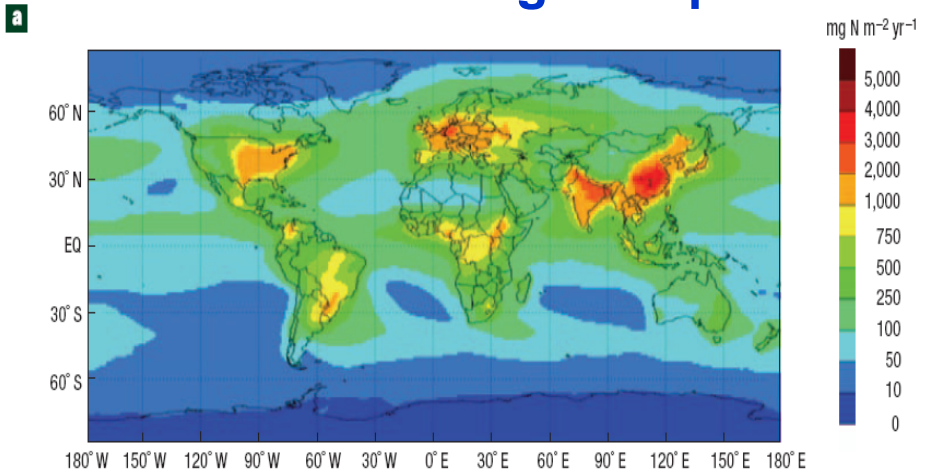
The application of nitrogen fertilizer

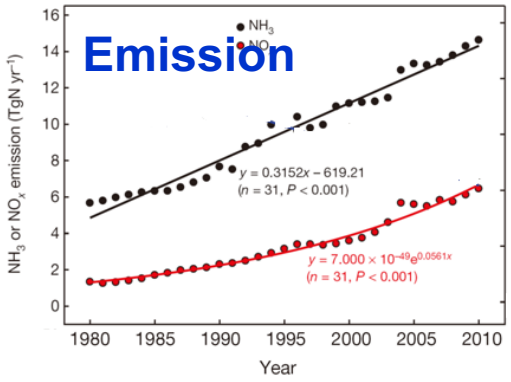


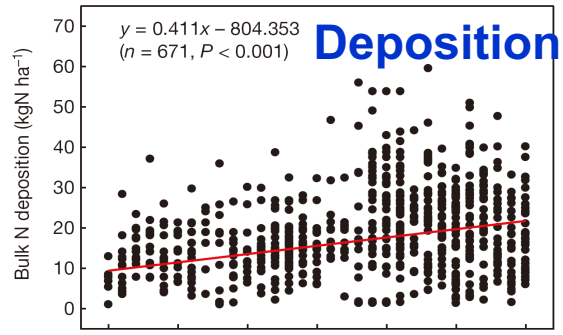




The distribution of nitrogen deposition







Liu et al., 2013; Lu and Tian, 2017; Reay et al., 2008

The effect of natural source to ozone

单位：ug/m³