

**Presentation in 16<sup>th</sup> IPNC 2009**

# **Nutrient input from nitrogen deposition in the North China Plain**

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# Outline

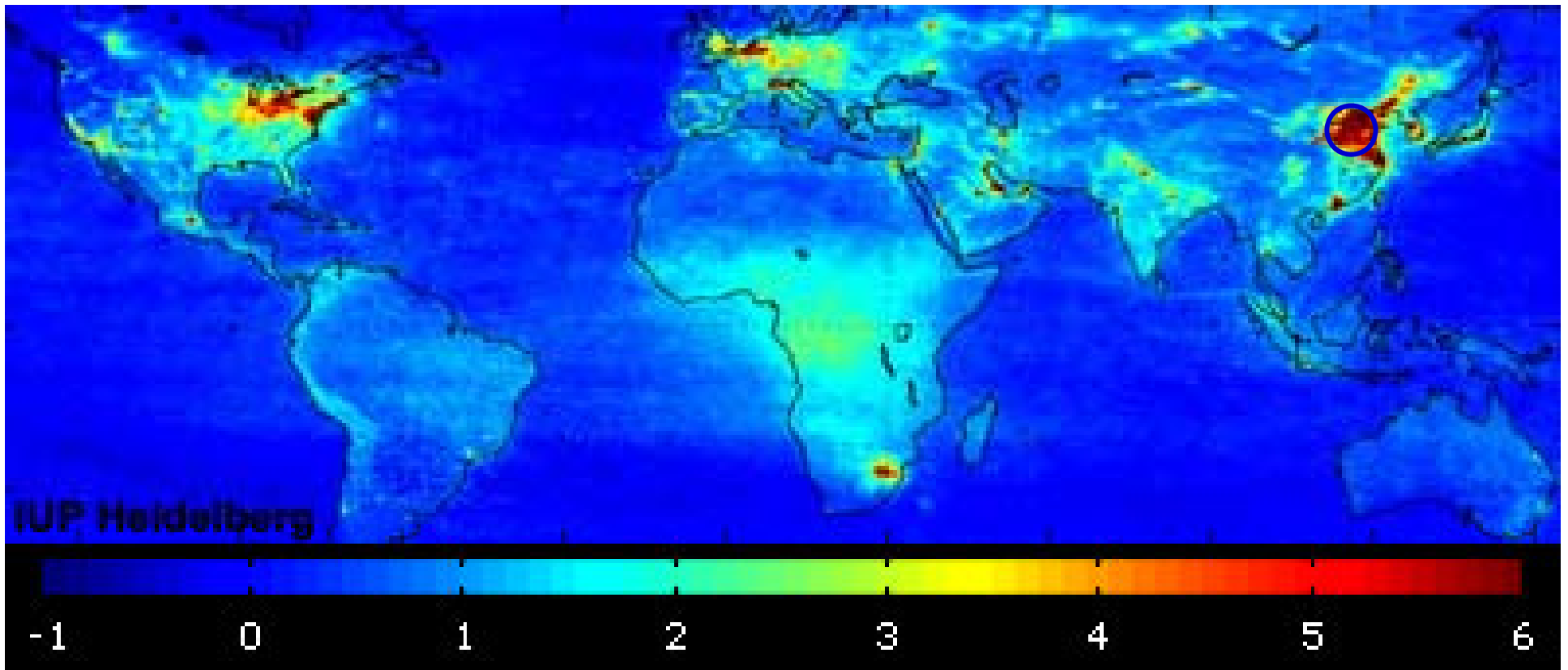
- **Background**
- **N deposition and its nutrient contribution to agroecosystems in the North China Plain**
- **Conclusion and outlook**

# **Background information on China's economic growth and its pollution cost**

- **China's annual GDP growth rate (1981-2007): ~ 10%;**
- **China's annual economy loss by environmental pollution (1981-2007): 8-13% of total GDP or the total GDP growth in the past 30 years;**
- **China's annual economic loss by air pollution (1981-2007): 2-3% of total GDP;**
- **Premature deaths from air pollution: 750, 000 people per year in China.**

(Sources from: China Statistical Year Book, 1982-2008; Wang Qingyu, 2006; FAO, 2007; Wen Jiabao, 2008,)

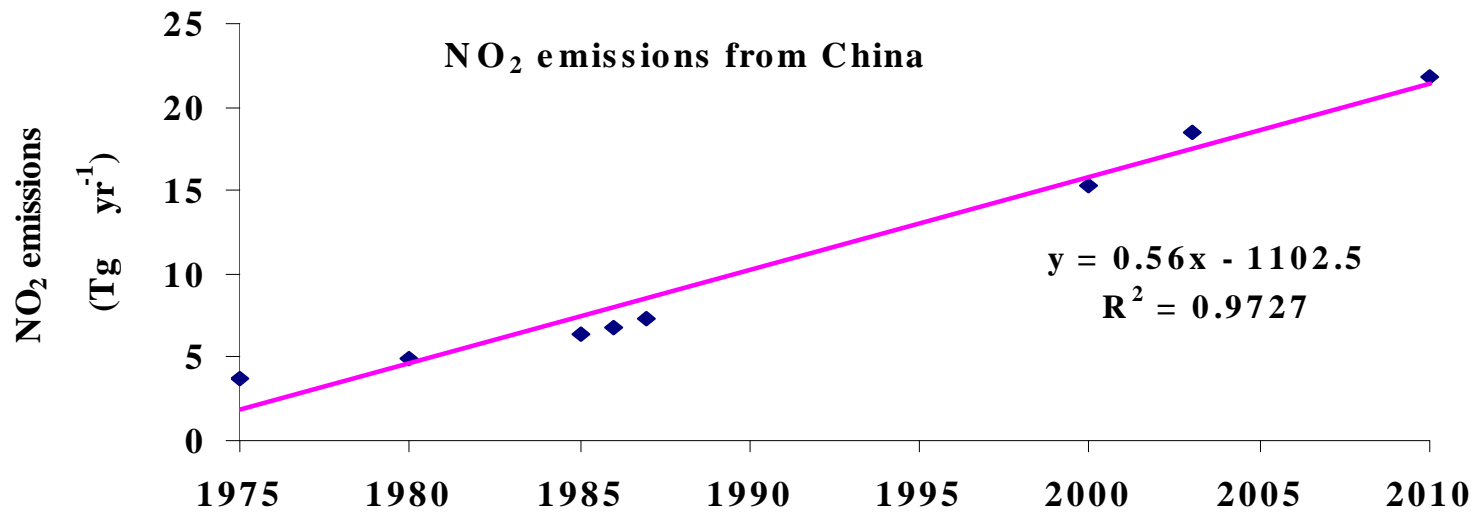
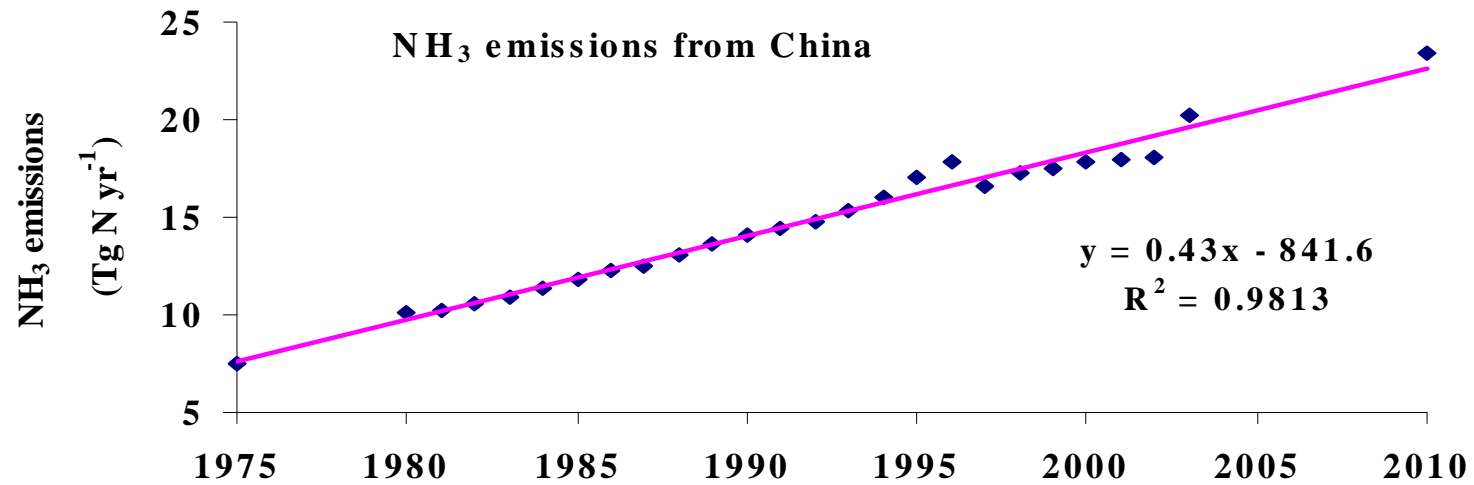
# Regional distribution of air pollution hotspots in the world



Note : the pollution index values reflect the extent of air pollution.

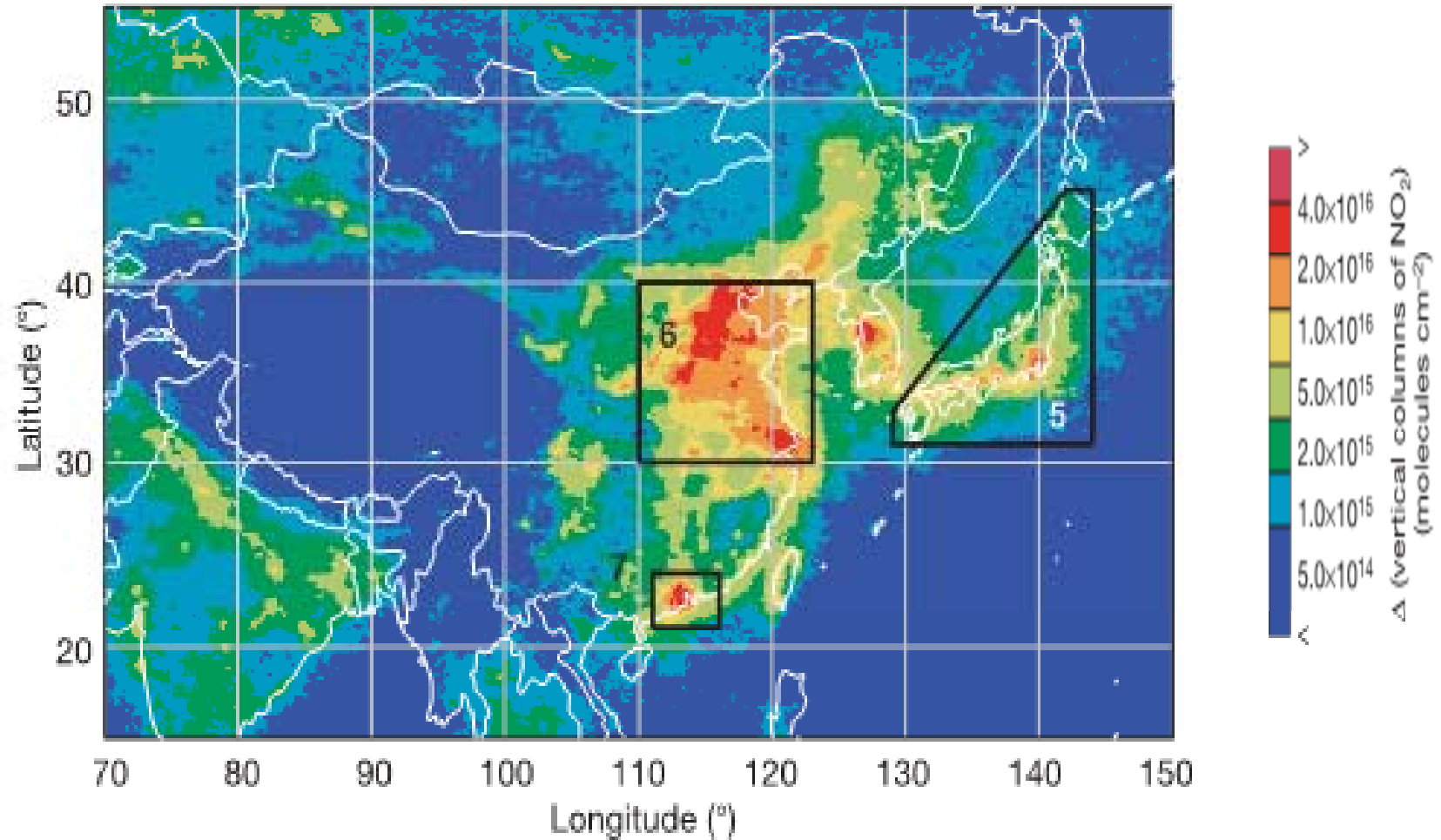
## **Why do we focus on N deposition?**

- ★ Nitrogen acts as both nutrient and pollutant in ecosystems;**
- ★ Anthropogenic induced reactive N emissions increase continuously in China;**
- ★ The amount and distribution of nitrogen deposition are not very clear so far in China.**



**Trends in NH<sub>3</sub> and NO<sub>2</sub> emissions from China**  
(Liu et al., unpublished; Ayers and Yeung, 1996. Atmos. Environ. 30:1581-1587)

**SCIAMACHY tropospheric NO<sub>2</sub> vertical columns averaged between December 2003 and November 2004 for East Asia.**



(Richater et al., Nature, 437(2005): 129-132)

# Questions concerned

- **What are the scale and magnitude of atmospheric N deposition in the North China Plain?**
- **Should we consider the nutrient contribution of airborne N input to agricultural systems in the North China Plain?**

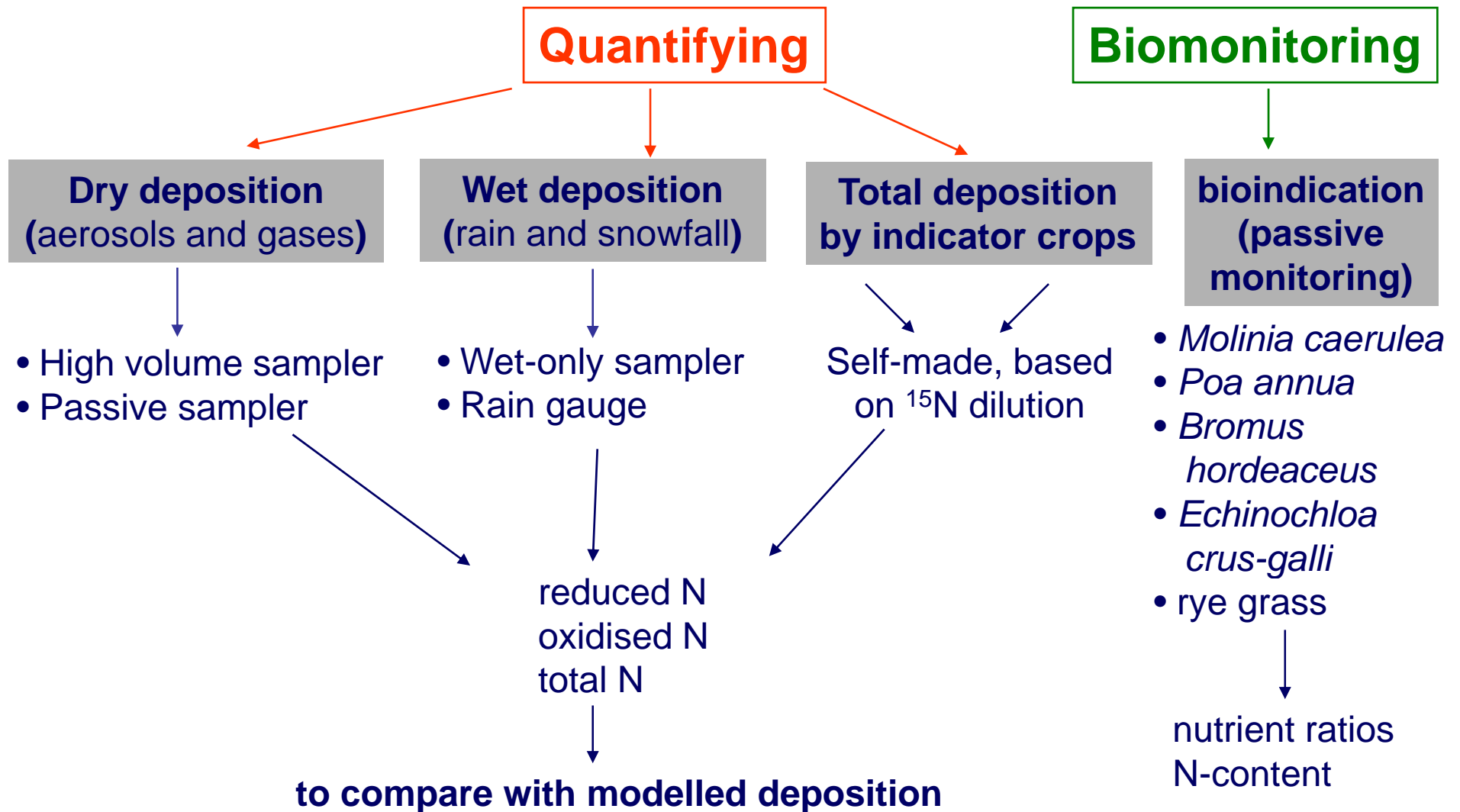
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# Map of China Monitoring Network for N deposition in China

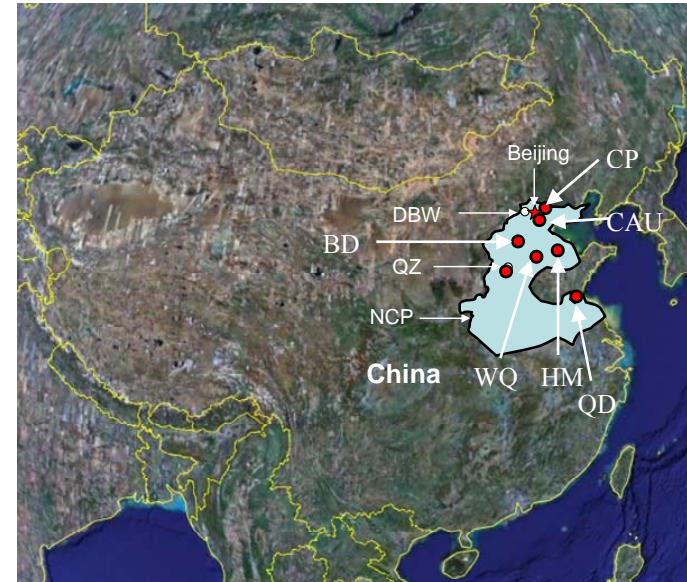
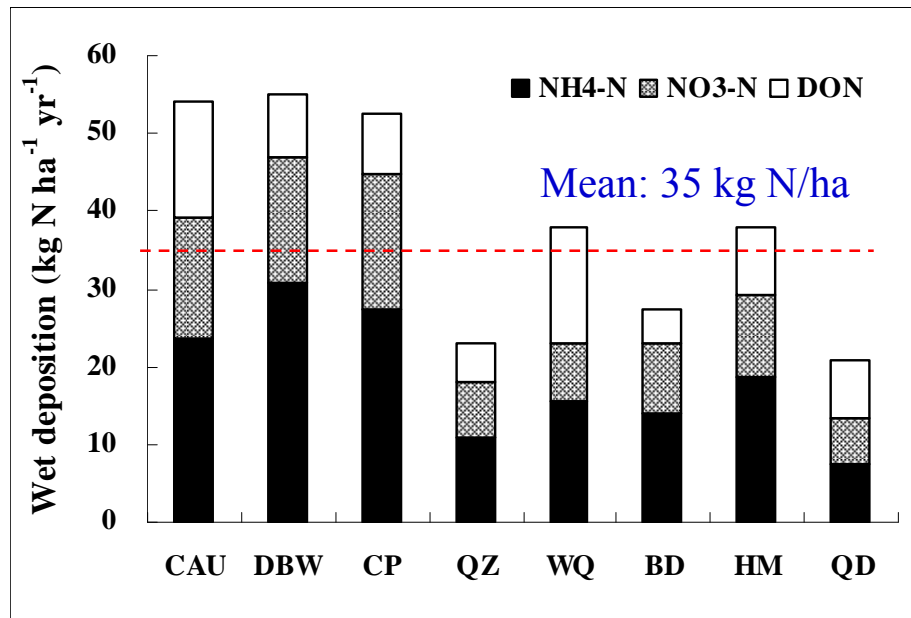
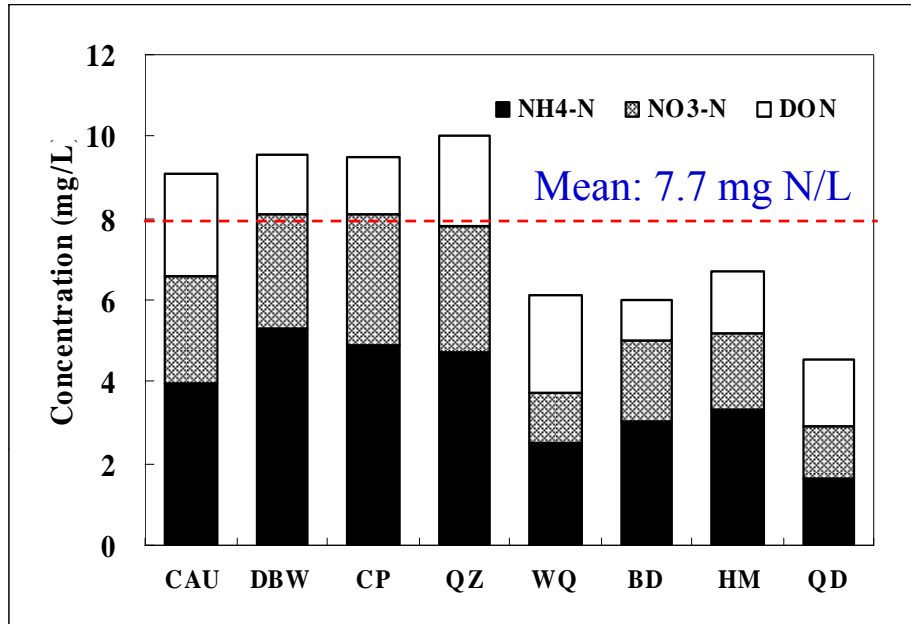


# A case study on N deposition in North China Plain



(Kopsch et al., 2005)

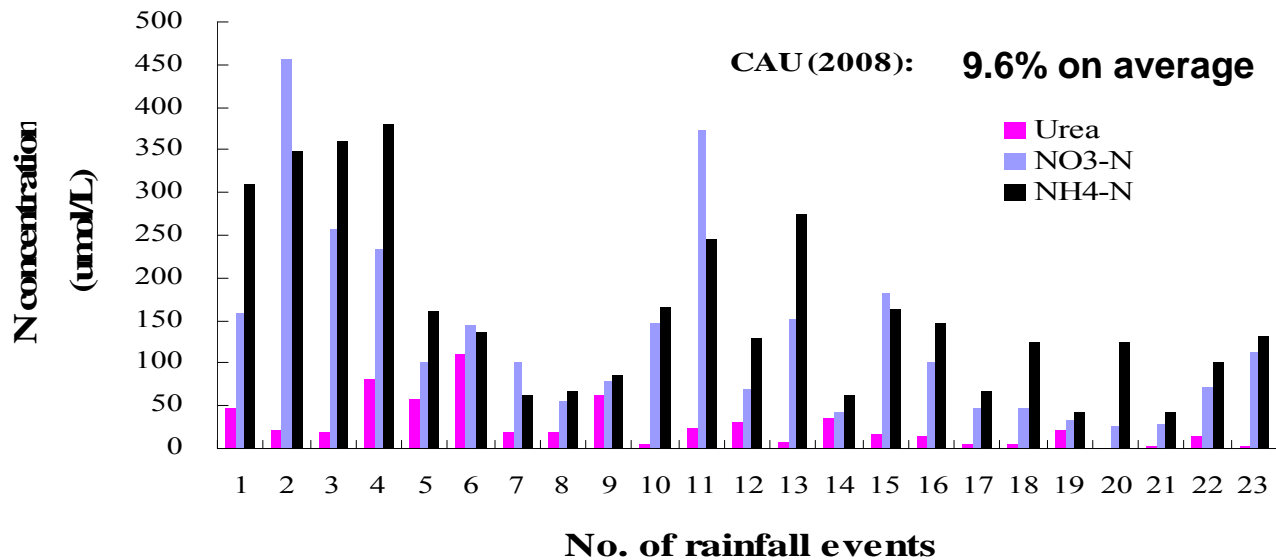
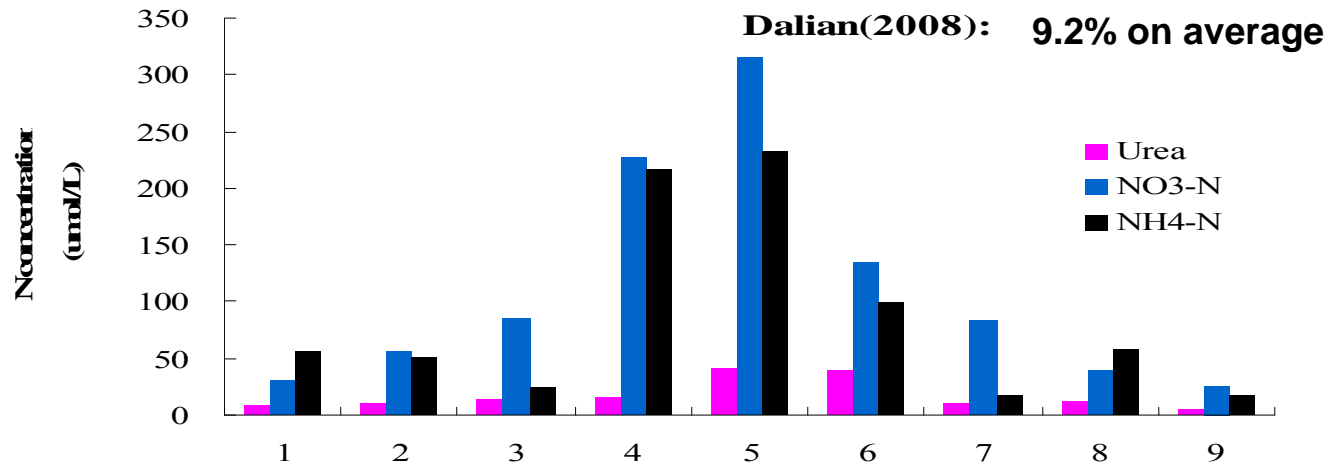
# N wet deposition



- 1) Spatial and temporal variations of N wet deposition were found in the NCP;
- 2) Mean concentration and input of inorganic+organic N in rain were 7.7 mg N L<sup>-1</sup> and 35 kg N ha<sup>-1</sup> yr<sup>-1</sup> at 8 sites of NCP, respectively;
- 3) Organic N contributed 23% of total N wet deposition, compared with that of NH<sub>4</sub>-N (48%) and NO<sub>3</sub>-N (29%).

(Adapted from Zhang et al., 2008 a,b)

# Further study indicated that **urea** is an important component of organic N in rainwater.



(Bai ZC, unpublished data)

Before sand storm



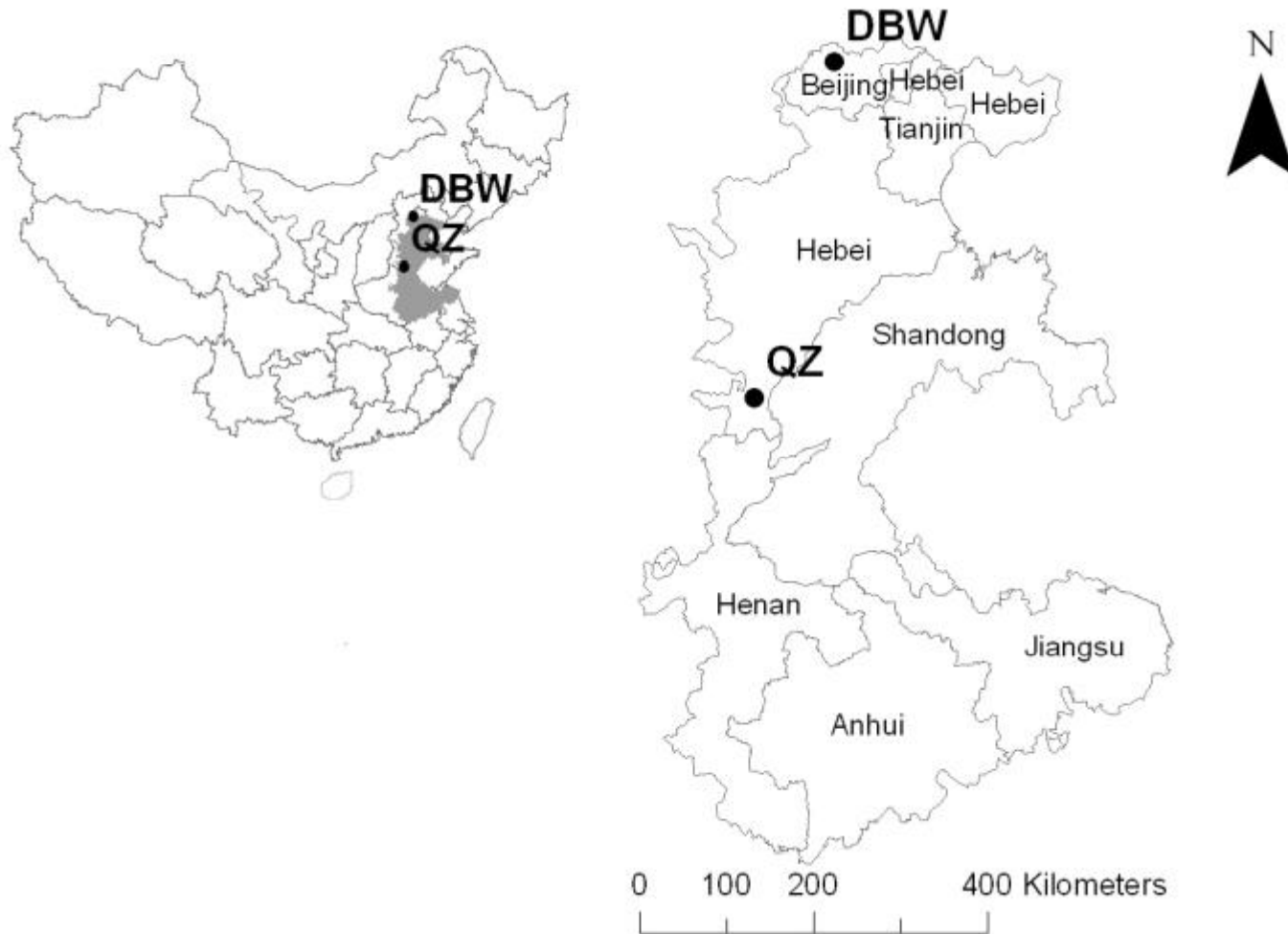
**N dry deposition**

**Sand storm in Beijing (17 April 2006)**

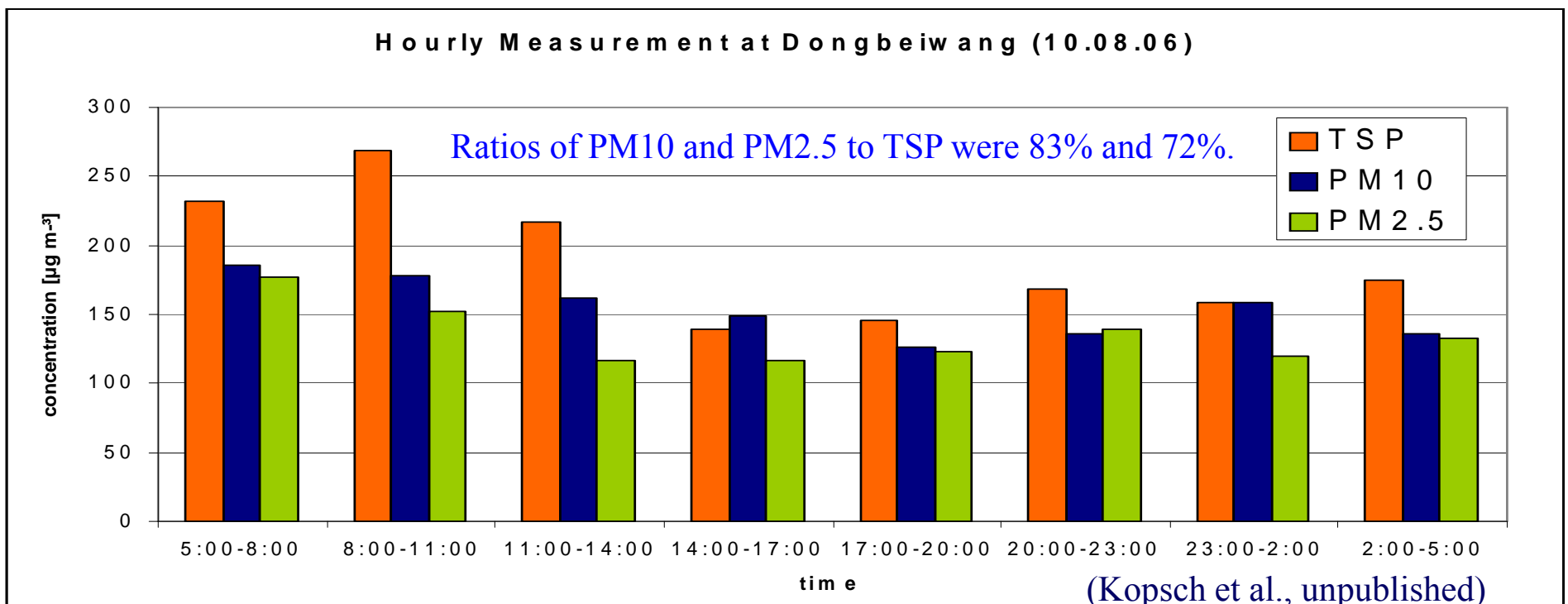
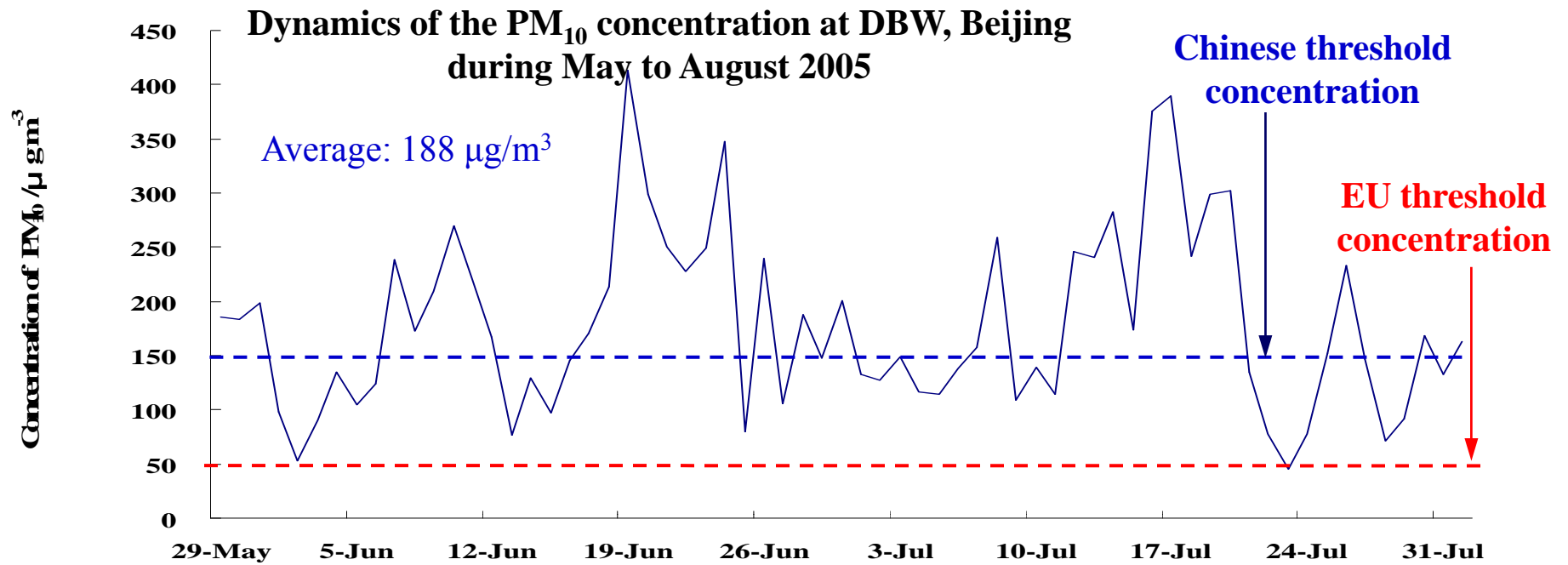
**~ 6000 t N input onto the Beijing area**

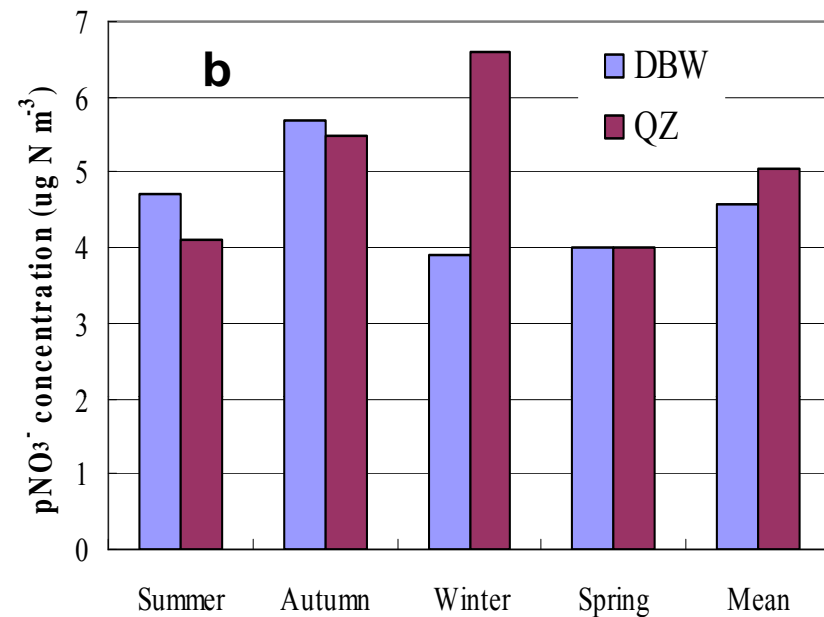
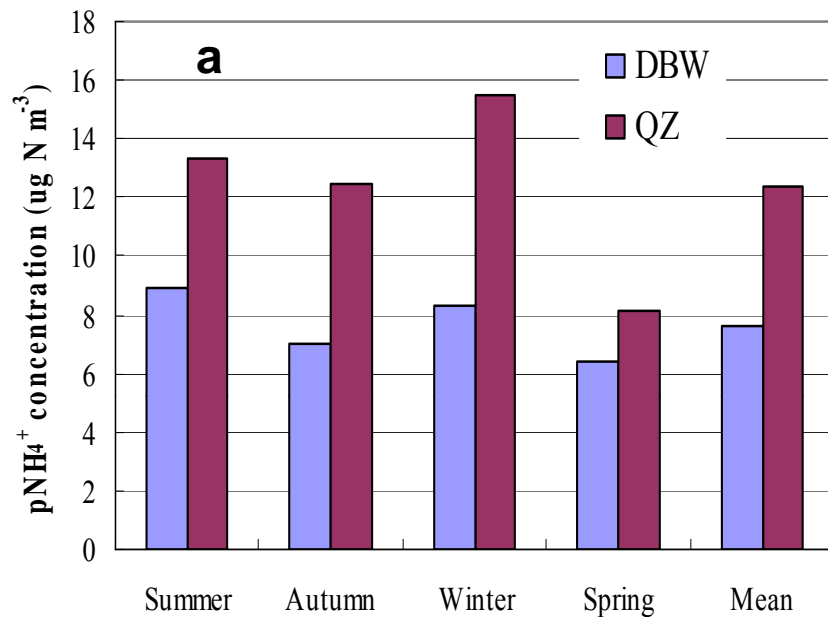
After sand storm





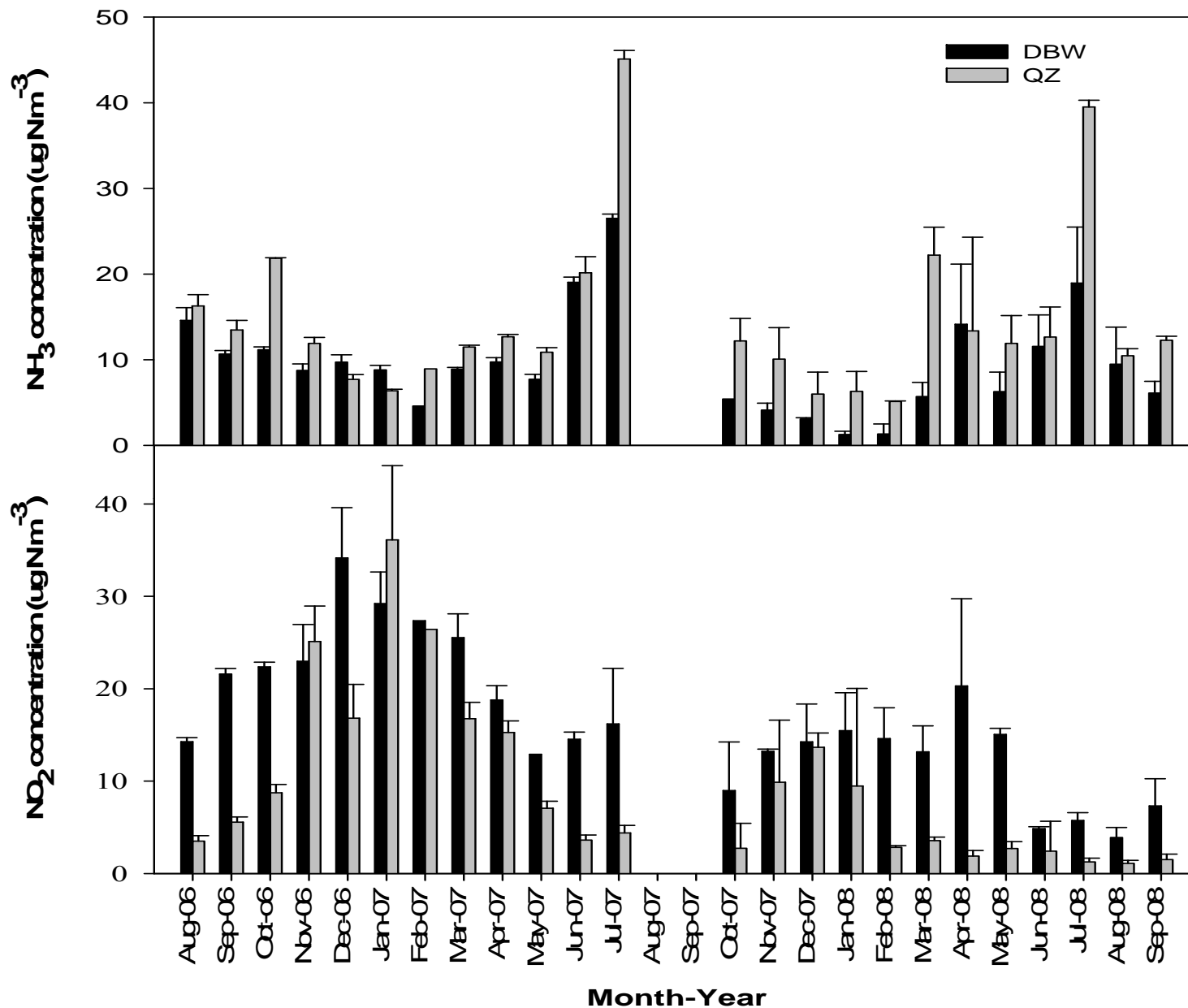
**Monitoring sites for N dry deposition in the North China Plain**





**Ammonium (a) and nitrate (b) in PM<sub>10</sub> at DBW and QZ in the North China Plain (average of 2006-2008)**

(Shen et al, 2009. Env Pollut. 157: 3106-3033)



**Dynamics of  $\text{NH}_3$  (A) and  $\text{NO}_2$  (B) concentrations at DBW and QZ in the North China Plain (2006-08)**

(Shen et al, 2009.

Env Pollut.157:  
3106-3033)

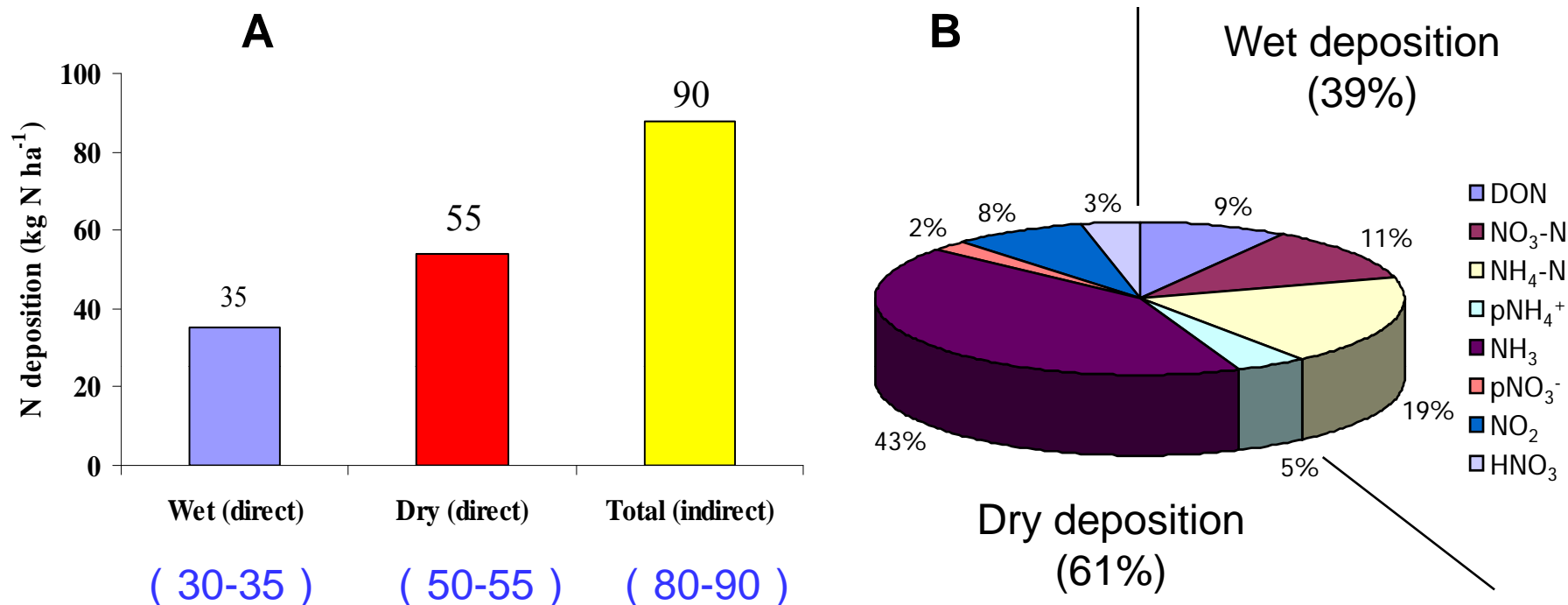
## N dry deposition in the North China Plain (averaged from 2006 to 2008)

Reactive N species	N concentration # ( $\mu\text{g N m}^{-3}$ )	$V_d$ & ( $\text{cm s}^{-1}$ )	Annual N input ( $\text{kg N ha}^{-1}$ )
Particles			
pNH <sub>4</sub> <sup>+</sup>	10.0 ±1.7	0.13	4.1 ±0.7
pNO <sub>3</sub> <sup>-</sup>	4.6 ±0.7	0.13	1.9 ±0.3
Gases			
NH <sub>3</sub>	14.7 ±4.2	0.81	37.5 ±10.6
NO <sub>2</sub>	11.8 ±4.6	0.20	7.4 ±2.9
HNO <sub>3</sub>	0.66 ±0.28	2.00	4.2 ±1.3
<b>Sum</b>	<b>41.8</b>		<b>55.1</b>

# Average concentrations of 7 sites in NCP during Jun 2005 and Oct 2008;

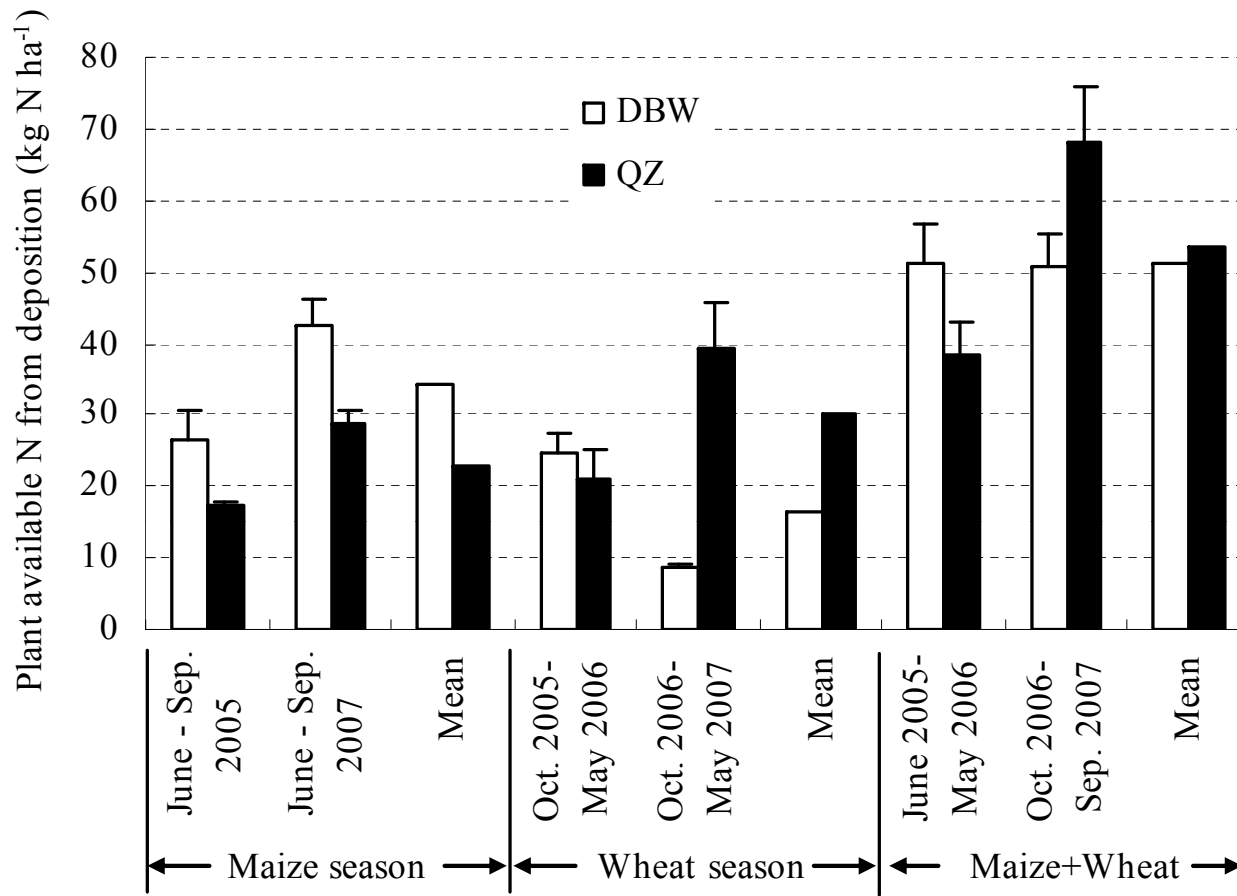
& Dry deposition velocity, according to Zapletal (1998). Environ. Pollut. 102(S1), 305-311

Total airborne N input in NCP: 2.5-3 Tg N yr<sup>-1</sup>



## Wet and dry deposition of reactive N species in the North China Plain

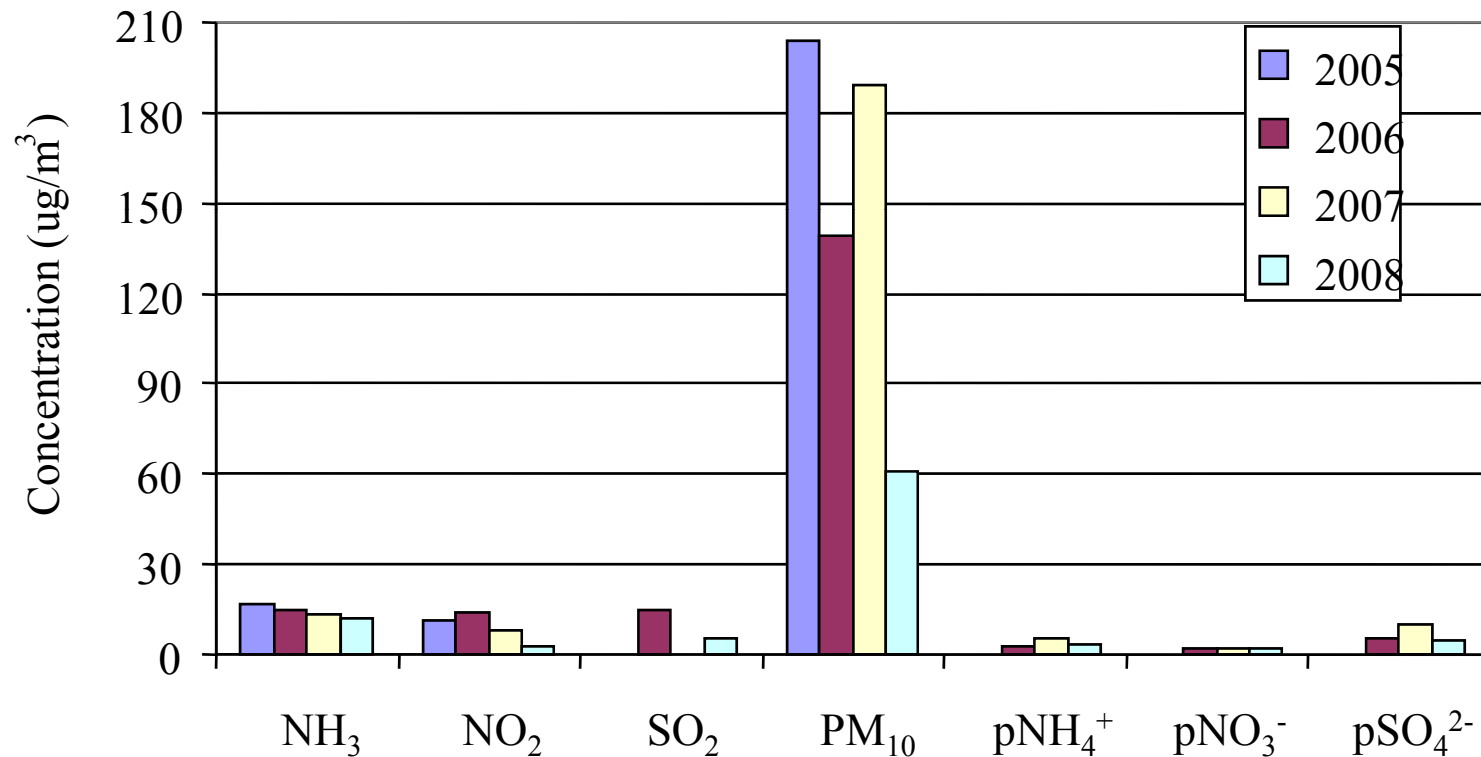
(A. Annual N deposition; B. Composition of reactive N species)



## Plant available N deposition (2006-2008) at two sites in the North China Plain using <sup>15</sup>N dilution method

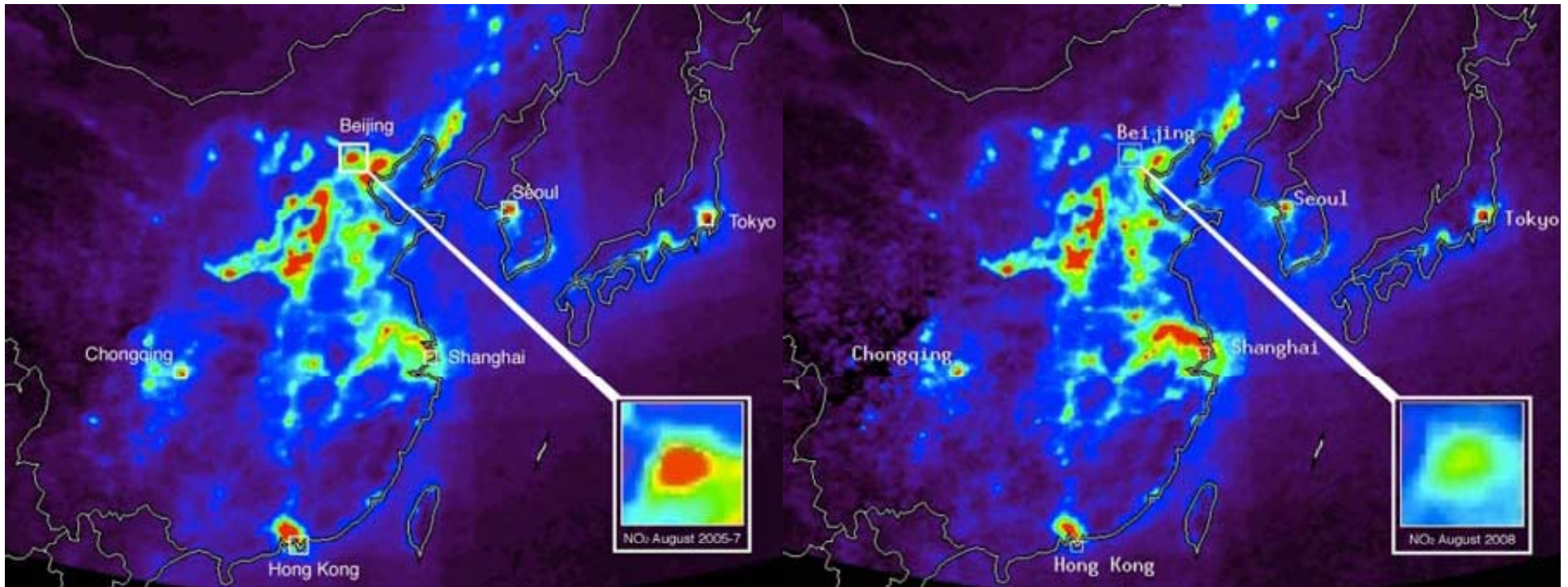
(He et al., Ecol. Appl., accepted)

# Concentrations of $\text{NH}_3$ , $\text{NO}_2$ , $\text{SO}_2$ , $\text{PM}_{10}$ , ammonium N, nitrate N and sulfate in $\text{PM}_{10}$ (p $\text{NH}_4\text{-N}$ , p $\text{NO}_3\text{-N}$ , p $\text{SO}_4\text{-S}$ ) at DBW, Beijing in August from 2005 to 2008



(Shen et al., in review, *Atm Env.*)

# Tropospheric NO<sub>x</sub> concentration over China in August 2008 compared with that in 2005-07.

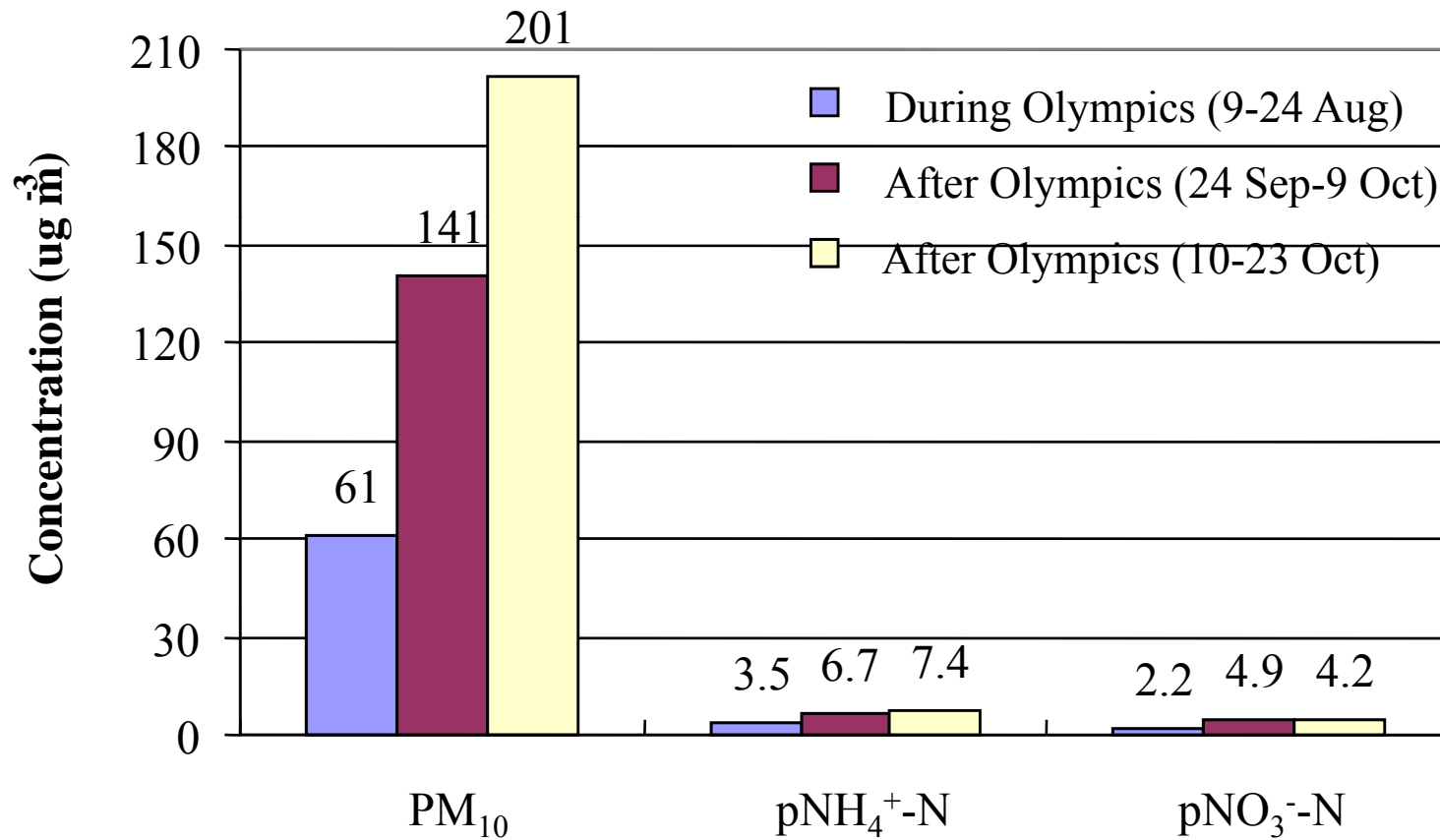


**August 2005-07 (average)**

**August 2008 (Olympic period)**

(Adapted from TEMIS (2009))

# Concentrations of PM<sub>10</sub>, ammonium N and nitrate N in PM<sub>10</sub> (pNH<sub>4</sub>-N and pNO<sub>3</sub>-N) at DBW, Beijing during August and October 2008



(Shen et al., in review)

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- Background
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# Conclusion

- 1. Serious pollution of atmospheric reactive N species was observed in the North China Plain (NCP);**
- 2. Wet and dry deposition of inorganic and organic N species were up to 90 kg N ha<sup>-1</sup> yr<sup>-1</sup>, nearly 60% of which could be utilized directly by crops according to the <sup>15</sup>N dilution method;**
- 3. Reactive N pollution and deposition could be reduced substantially if anthropogenic emission sources were controlled strictly.**

# Outlook

- 1. Further quantification and mapping of N wet and dry deposition in NCP and China using national monitoring network and deposition models;**
- 2. Systematic evaluation of N deposition impact (across N deposition gradient) on biodiversity and soil processes in ecosystems of northwest China, which are more sensitive to N and climate change.**



*Thank you and  
welcome to Beijing!*

