Emission Control and Air Quality Improvement at the 2008 Beijing Summer Olympic Games

Jiming Hao
Tsinghua University

2010-05-26

Outline

- Background Information
- Source Attribution of Air Pollutants in Beijing
- Air Pollution Control Measures during the Olympics
- Emission Reductions of Pollution Control Measures
- Monitoring of Air Quality Improvements
- Summary

Long-term efforts to improve Beijing's air quality

Since 1998, air pollution control measures in Beijing has been carried out in 14 stages, with more than 200 concrete steps

- **In 2007, domestic natural gas usage reached 4.7 billion m^3**
- **Coal-fired power plants install FGD and SCR**
- **Implementation of emission standard level IV on new vehicles**
- **More than 90 percent of buses meet level III emission standards**
- **Relocation of heavily polluting industries: Beijing Coking plant……**

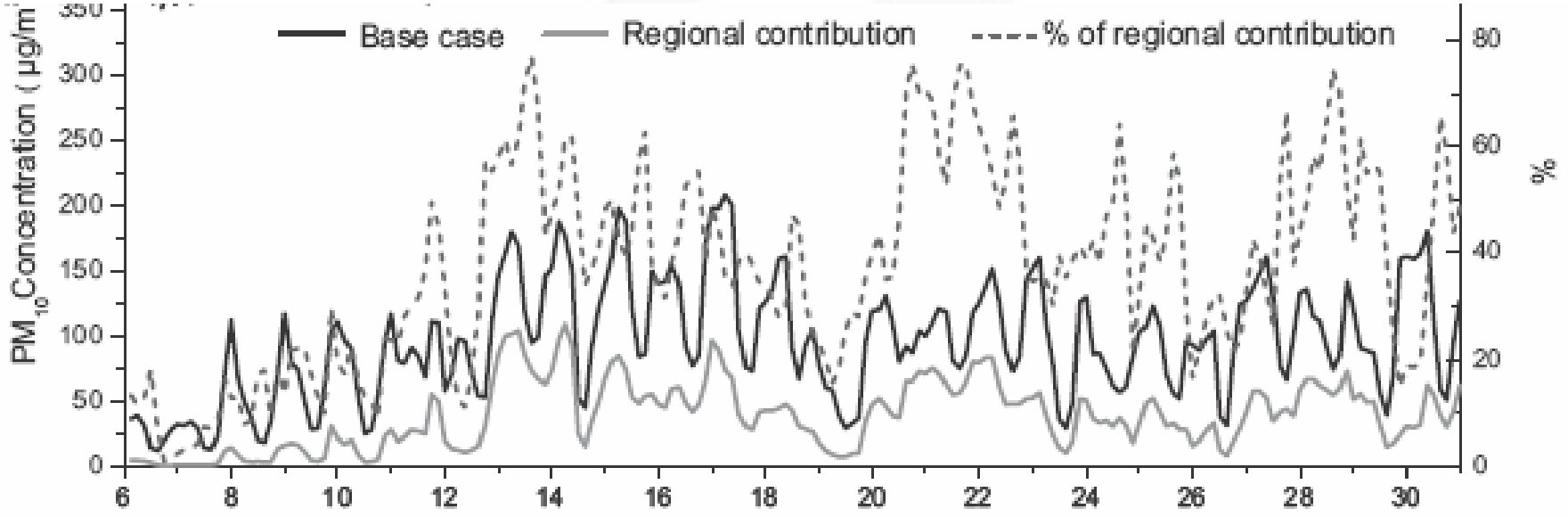
Urban air quality in Beijing improving before the Olympics

[mg/m^3]	SO_2	NO_2	CO	PM_{10}	NAAQS II days
2001	0.064	0.071	2.6	0.165	185
2002	0.067	0.076	2.5	0.166	203
2003	0.061	0.072	2.4	0.141	224
2004	0.055	0.			
2005	0.05	0.			
2006	0.053	0.066	2.	0.161	241
2007	0.047	0.066	2.0	0.148	246
Changes	-26.56%	-7.04%	-23.08%	-10.30%	32.97%

Not meeting WHO's guidelines, more intensive pollution control needed

PM_{10} Source Attribution: Regional vs Local

Model predicted PM_{10} and its regional contributions in Beijing

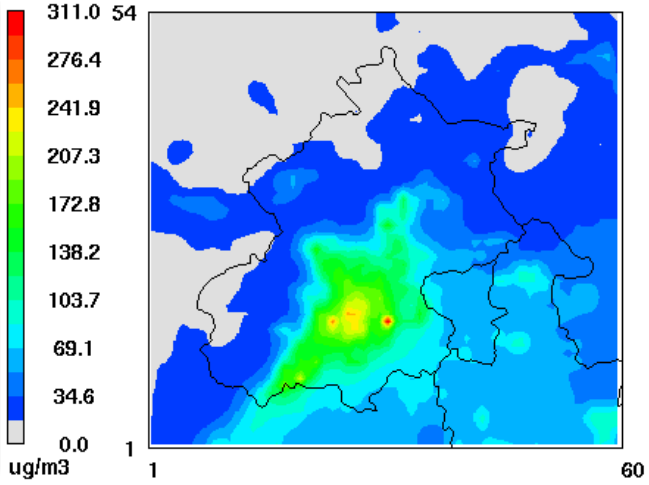


- In August, about 20%~40% of PM_{10} concentrations came from regional sources
- In the heaviest pollution episodes, the local emission sources play a more important role
- To reduce baseline PM_{10}, regional sources need to be controlled; to reduce peak PM_{10}, local sources need to be controlled.

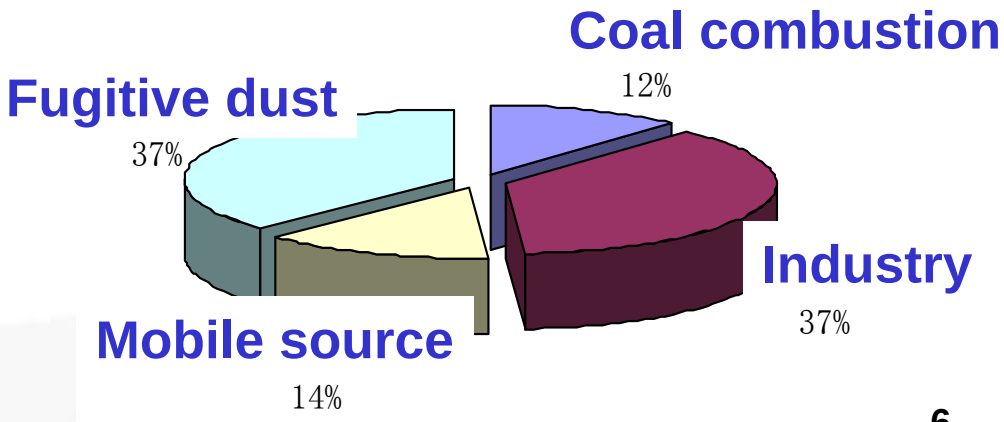
PM_{10} Source Attribution: Contributions from Local Sources

- Industrial process and fugitive dust contribute 74% of PM_{10} concentrations in Beijing
- Emission control measures should target the two sectors

CMAQ Simulated PM_{10} Concentrations. in August



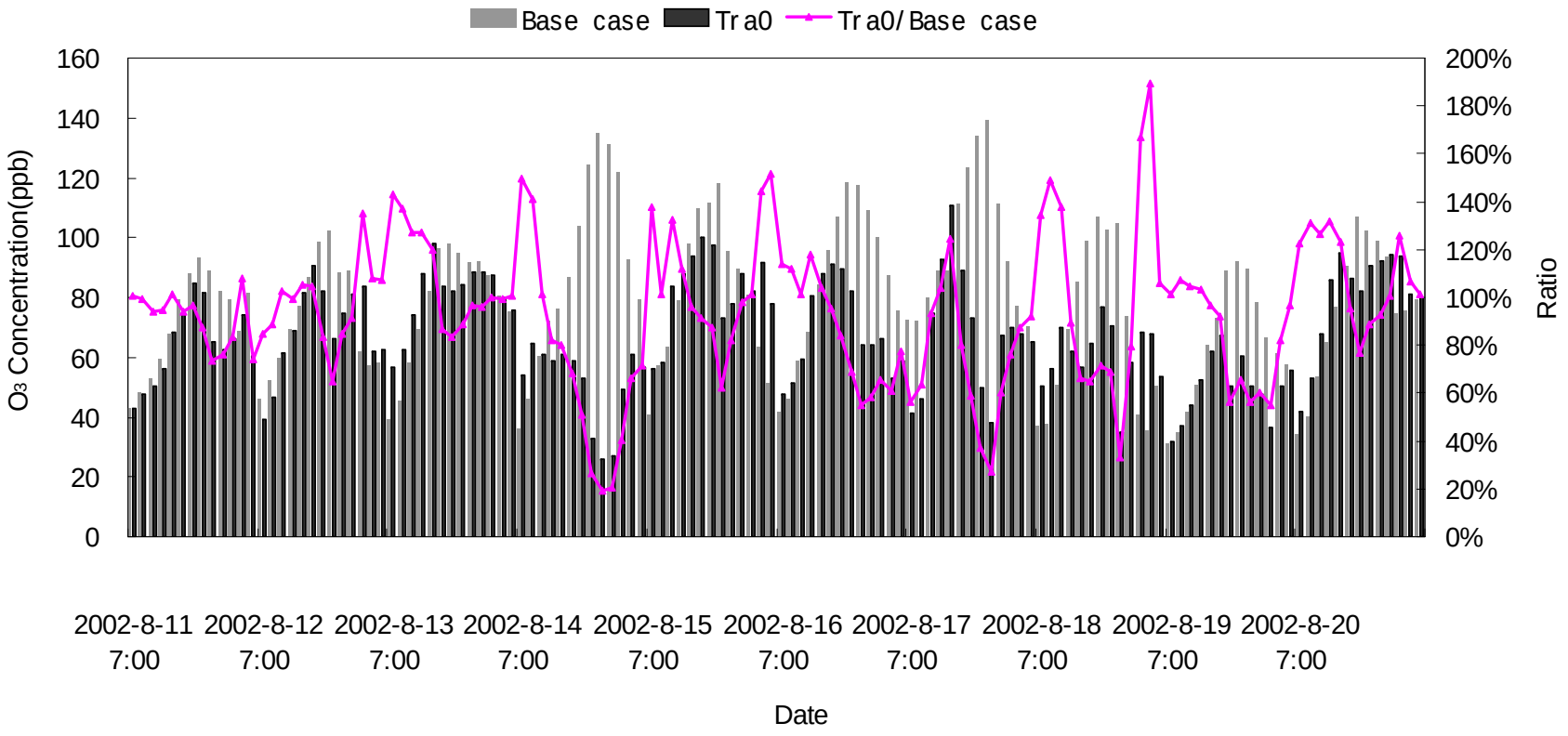
Relative contributions from different sources



O_3 source attribution: contribution of different local sources

Based on model sensitivity studies, in O_3 nonattainment hours

- **Vehicle emissions contributed 17.8%~37.8%**
- **VOC evaporation contributed 8%~23.8%**



Air Pollution Control Measures before the Olympics

Fugitive dust	Enhance emission control of construction sites
	95% of main roads in urban area and 60% of those in suburban areas will be cleaned as required
Steel	Reduce production to 4 million tons in 2008
	Install high efficiency dust collectors
Cement	Close heavily polluted plants; reduce production to 8 million tons
Chemical	Close Beijing Coking plant
	Relocation of some chemical plants
Power Plant	Install FGD, SCR and high efficiency dust collectors
	Close Jingfeng power plant
Industrial Boilers	Boilers <20t/h in urban areas change to clean energy; Boilers <20t/h in suburban areas use low-sulfur coal and meet new emission standard
	Boilers >20t/h install SO2 and TSP removal equipments and CEMS

Air Pollution Control Measures before the Olympics

Vehicles	Scrappage or retrofit of 4900 yellow-labelled vehicles in the government fleet before this June.
	Fleet renewal of 1500 buses and 2000 taxis by the end of last December
	Euro IV for all light duty gasoline vehicles since March 1
	Euro IV for heavy duty diesel engines of bus, sanitation and postal fleets
	Supply of vehicle fuel with sulfur lower than 50ppm as Euro IV adopted
	Retrofit of fueling stations, fuel transport vehicles and fuel storage depot with VOC recovery system

Air Pollution Control Measures during the Olympics

Fugitive dust	Stop high polluting construction process
	100% of urban roads and 60% of those in suburban areas will be cleaned
Steel	Stop heavy polluting smelting process
Cement	Stop most of cement plants
Chemical	Reduce pollutants emission by 30% in Beijng Yanshan Petro-Chemical Industry Corporation
	Close some chemical plants
Power Plant	Reduce pollutants emission by 30%
Industrial boilers	Execute strict emission standard and close non-attainment boilers
Vehicles	Ban yellow-labeled vehicles in Beijing
	Stop 70% government-owned vehicles
	Implement an “even and odd number system” except 0~3 am
	Ban most trucks from Beijing except those for transportation of daily living goods
	Special lanes for Olympic vehicle on some main roads

Effects of measures on coal-fired power plants

Power plant 1

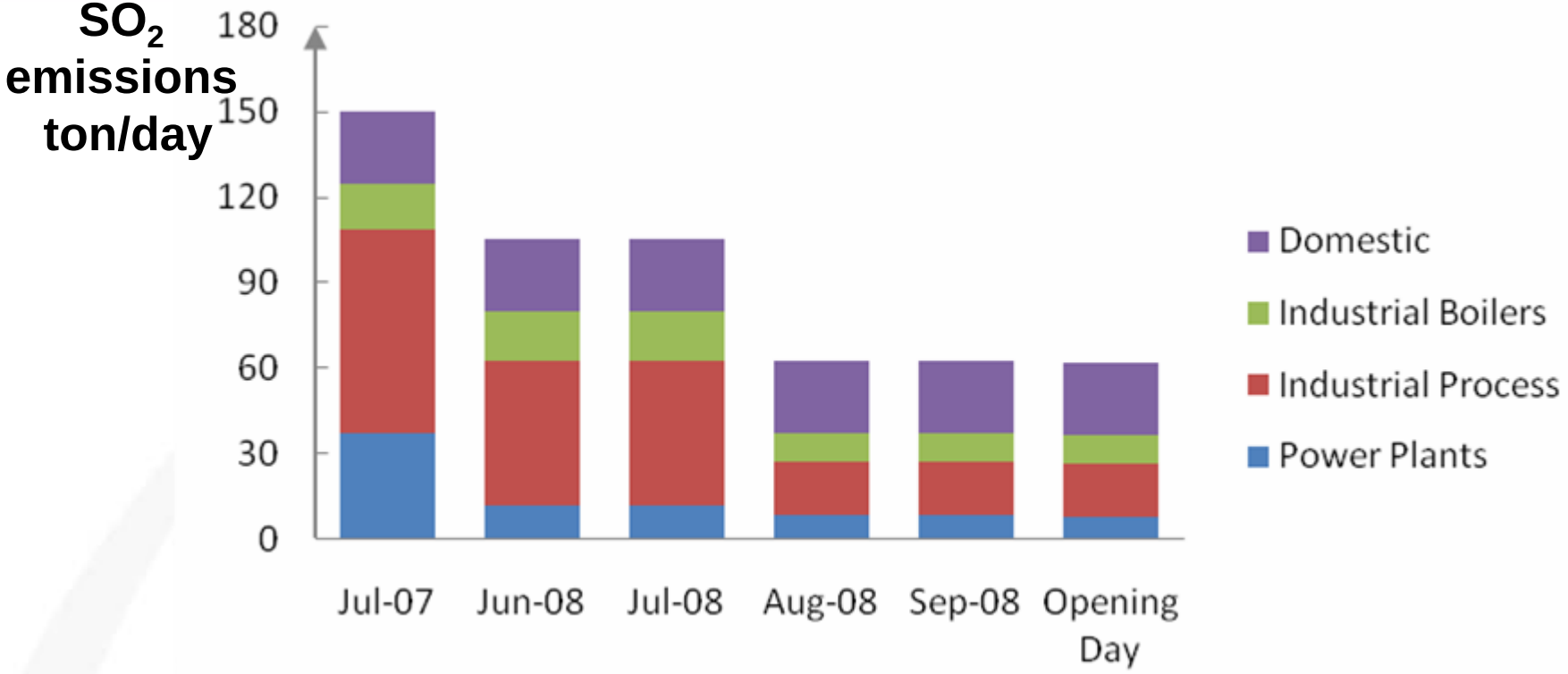
Date	Coal use, ton	TSP mg/Nm^3	SO_2 mg/Nm^3	NO_X mg/Nm^3
2007				
Jun 20~Jul 19	193156	14	37	284
Jul 20~Aug 20	209618	14	36	255
2008				
Jun 20~Jul 19	193618	10	27	144
Jul 20~Aug 20	206936	10	23	61
Standard		20	50	100

Power plant 2

Date	Coal use, ton	TSP mg/Nm^3	SO_2 mg/Nm^3	NO_X mg/Nm^3
2007				
Jul 20~Aug 20	172537	14.8	71.8	505.4
2008				
Jul 20~Aug 20	225096	12.1	28.3	65.8
Standard		20	50	100

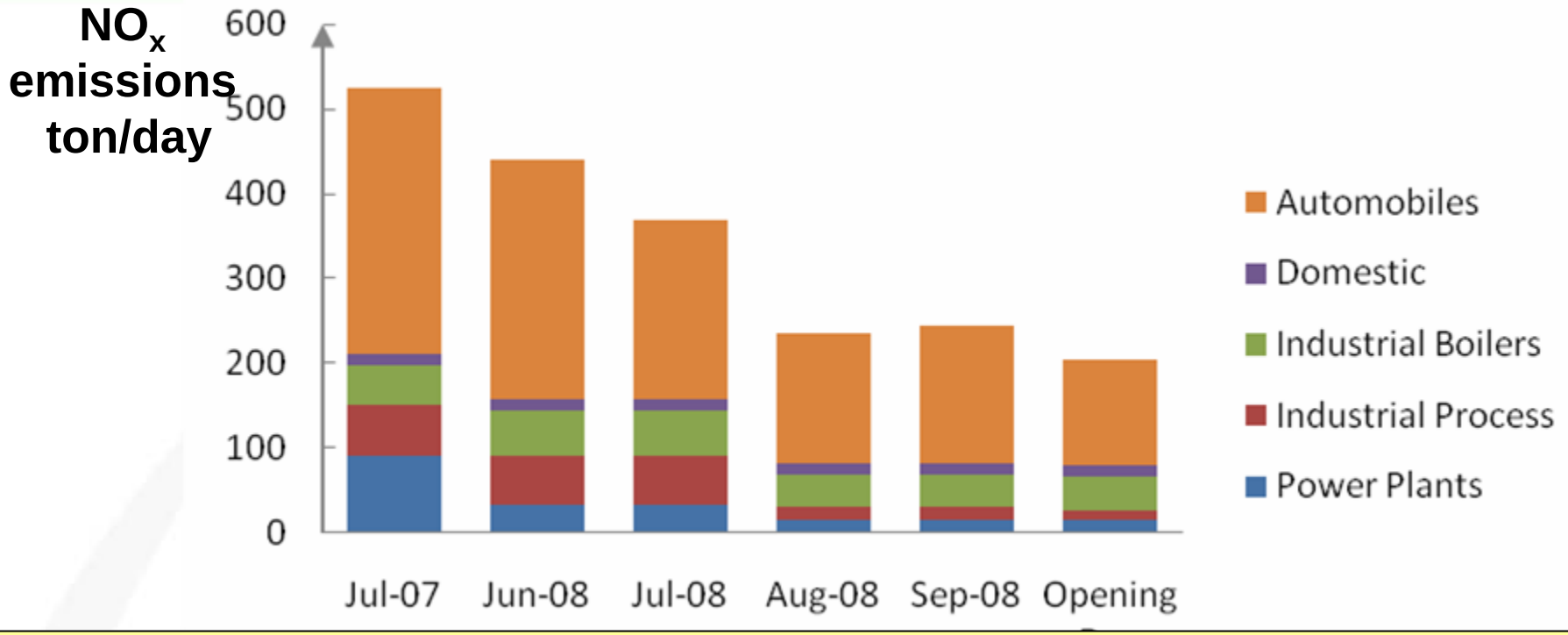
During Olympic Games, emissions from power plants reduced over 30%, much lower than that in 2007

Emission Reduction of Control Measures: SO_2



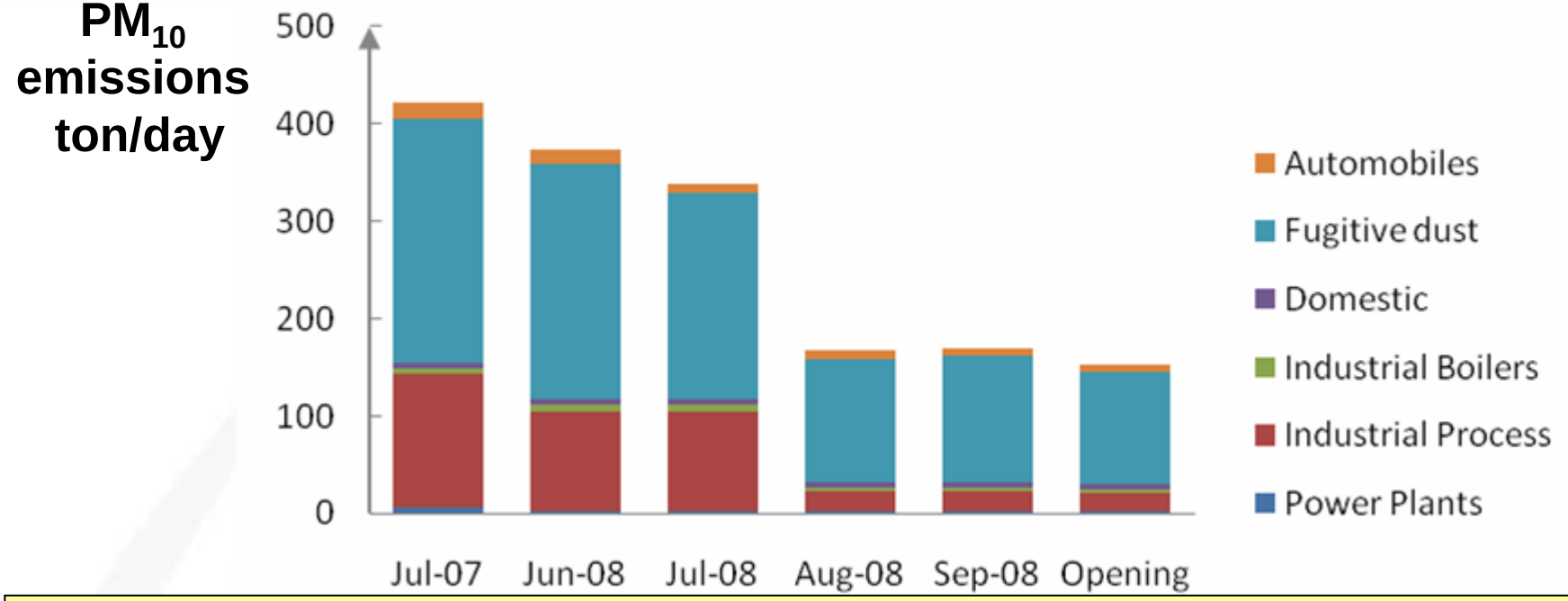
- During the Olympics, SO_2 emission reduced by 58% from July, 2007. Power plants and industrial process reduced by 78% and 74%, respectively.
- Power plants and industrial process contribute 35% and 28% of the total SO_2 reductions, respectively.
- During the Olympics, SO_2 emission reduced by 41% from June, 2008. Stopping cement-production plants contribute 49% of emission reductions

Emission Reduction of Control Measures: NO_x



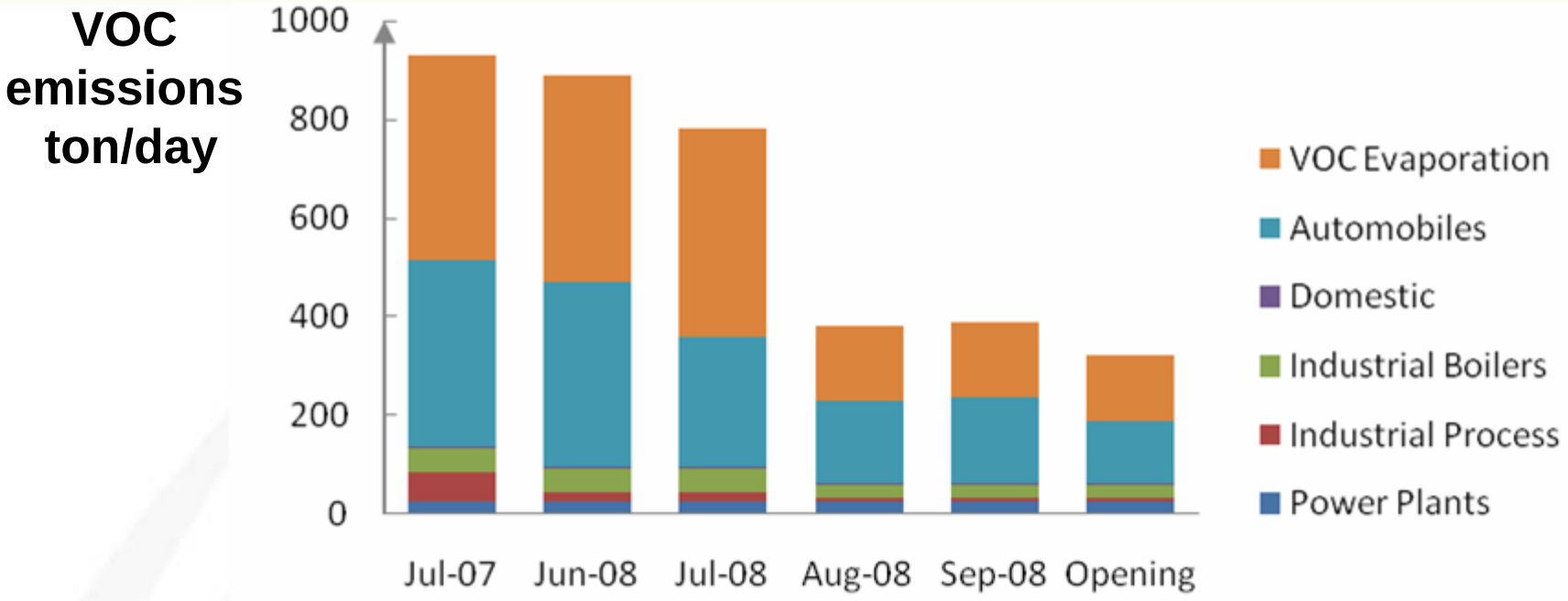
- During the Olympics, NOx emission reduce by 55% from July, 2007. The mobile sources and the power plants reduce by 51% and 82%, respectively.
- The mobile sources and the power plants contribute 56% and 26% of the total NOx reductions, respectively.
- During the Olympics, NOx emission reduced by 46% from June, 2008. The measures of limiting cars and closing cement-production plants contribute 63% and 20% of the total NOx reductions, respectively

Emission Reduction of Control Measures: PM_{10}



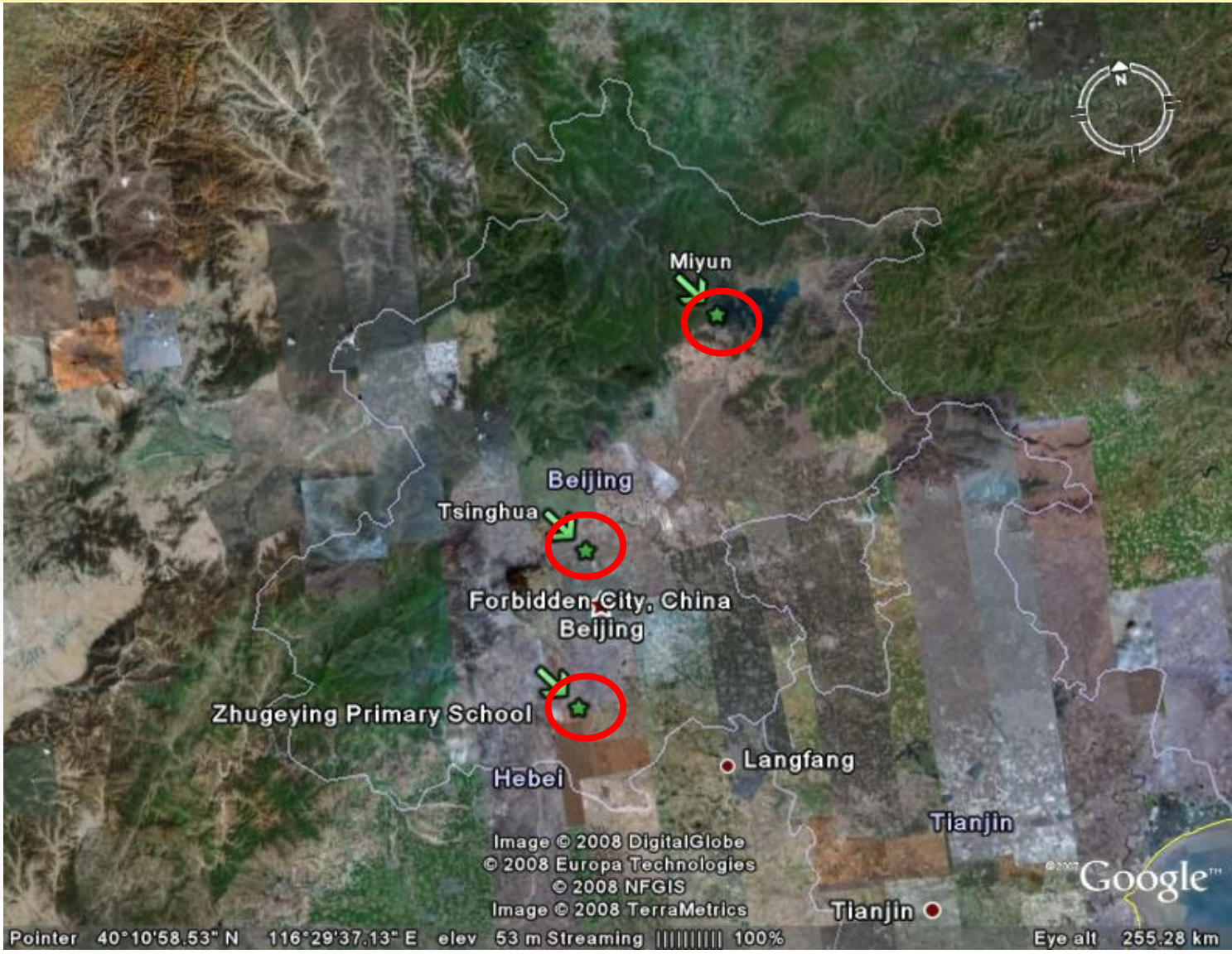
- During the Olympics, PM10 emission reduce by 61% from July, 2007. The industrial process and the fugitive dust reduce by 86% and 49%, respectively.
- The industrial process and the fugitive dust contribute 46% and 48% of the total PM10 reductions, respectively.
- During the Olympics, PM10 emission reduced by 56% from June, 2008. The fugitive dust and the industrial process contribute 55% and 40% of the total PM10 reductions, respectively

Emission Reduction of Control Measures: VOCs

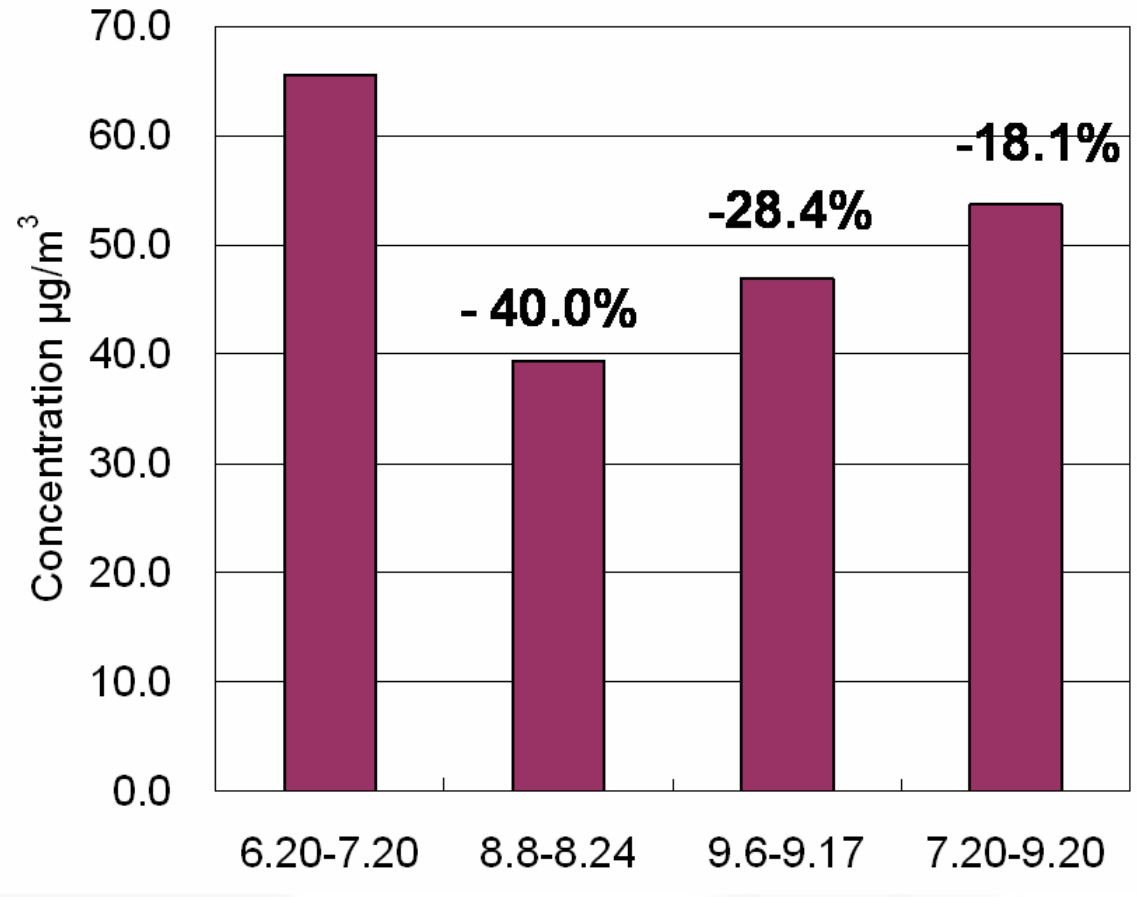


- During the Olympics, VOC emission reduce by 59% from July, 2007. The VOC evaporation and the cars' emission reduce by 63% and 56%, respectively.
- The VOC evaporation and the cars' reduction contribute 48% and 38% of the total VOC reductions, respectively.
- During the Olympics, VOC emission reduced by 57% from June, 2008. The VOC evaporation and the cars' reduction contribute 53% and 41% of the total VOC reductions, respectively

Monitoring of Air Quality during the Olympics



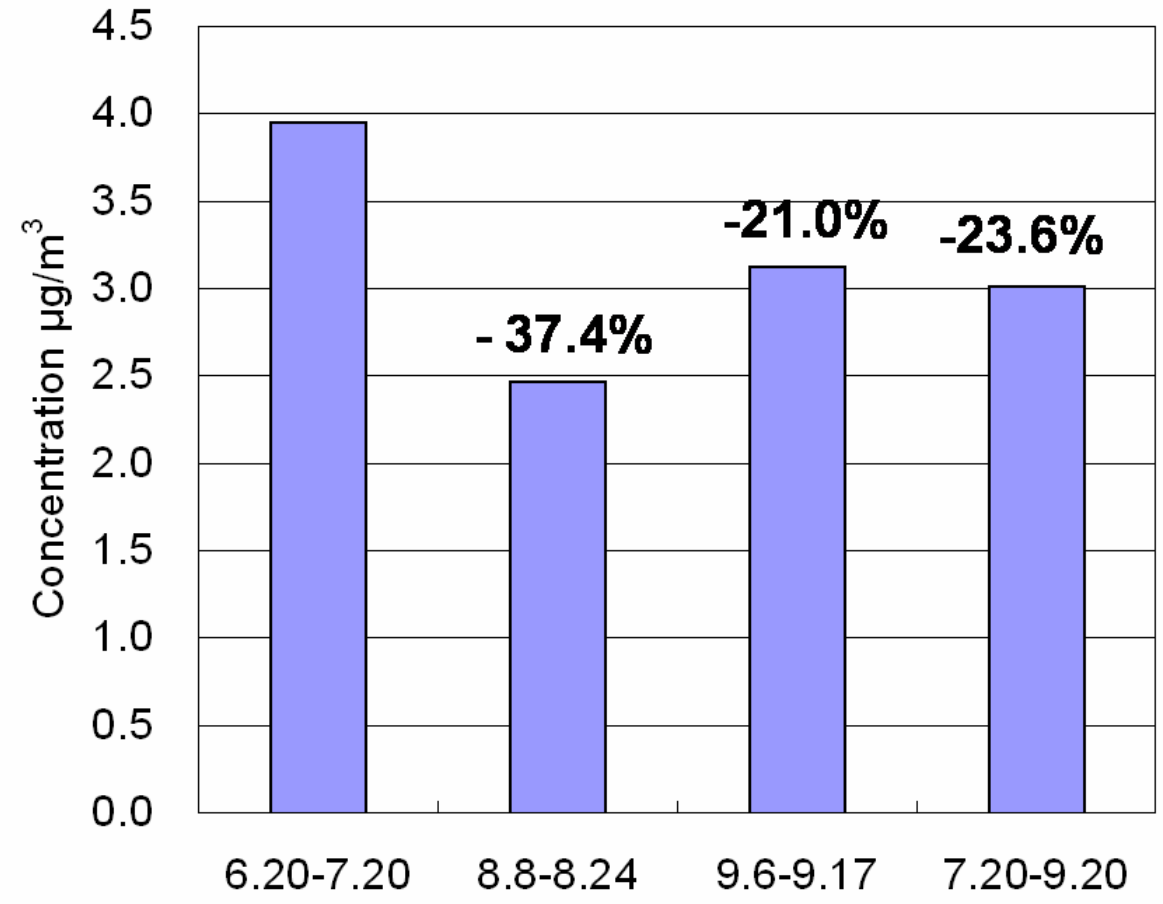
Air Quality Improvement: $PM_{2.5}$ Monitoring



Instruments for $PM_{2.5}$: R&P and TEOM1400

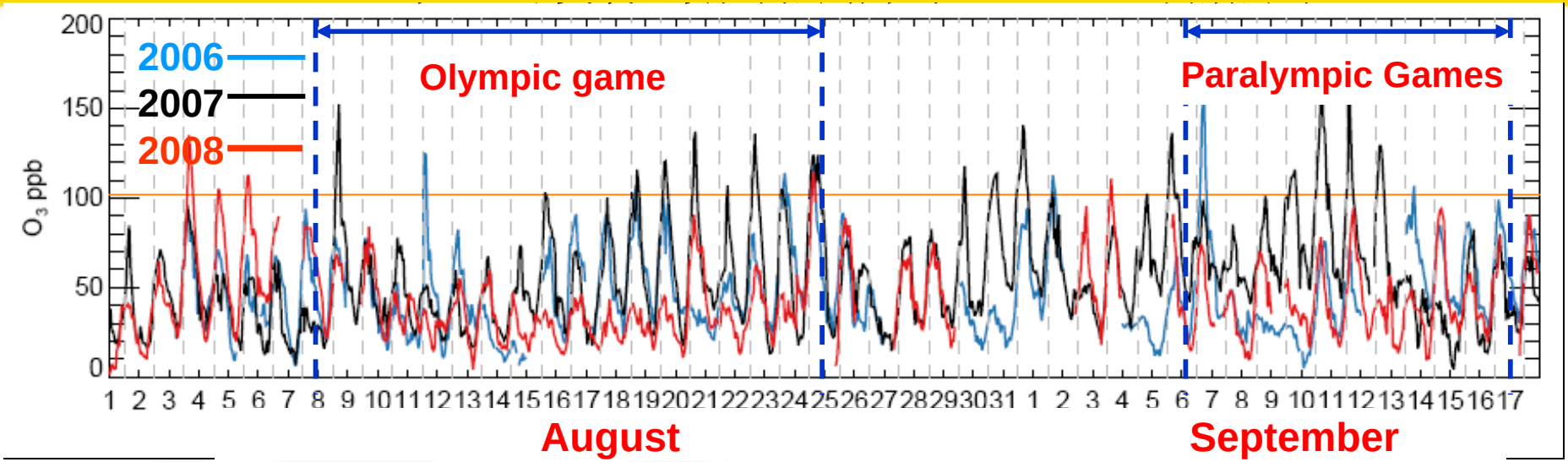
Air Quality Improvement: BC Monitoring

Change of BC concentrations



BC monitor：R&P Aethalometer Series 8100

Air Quality Improvement: O_3 Monitoring



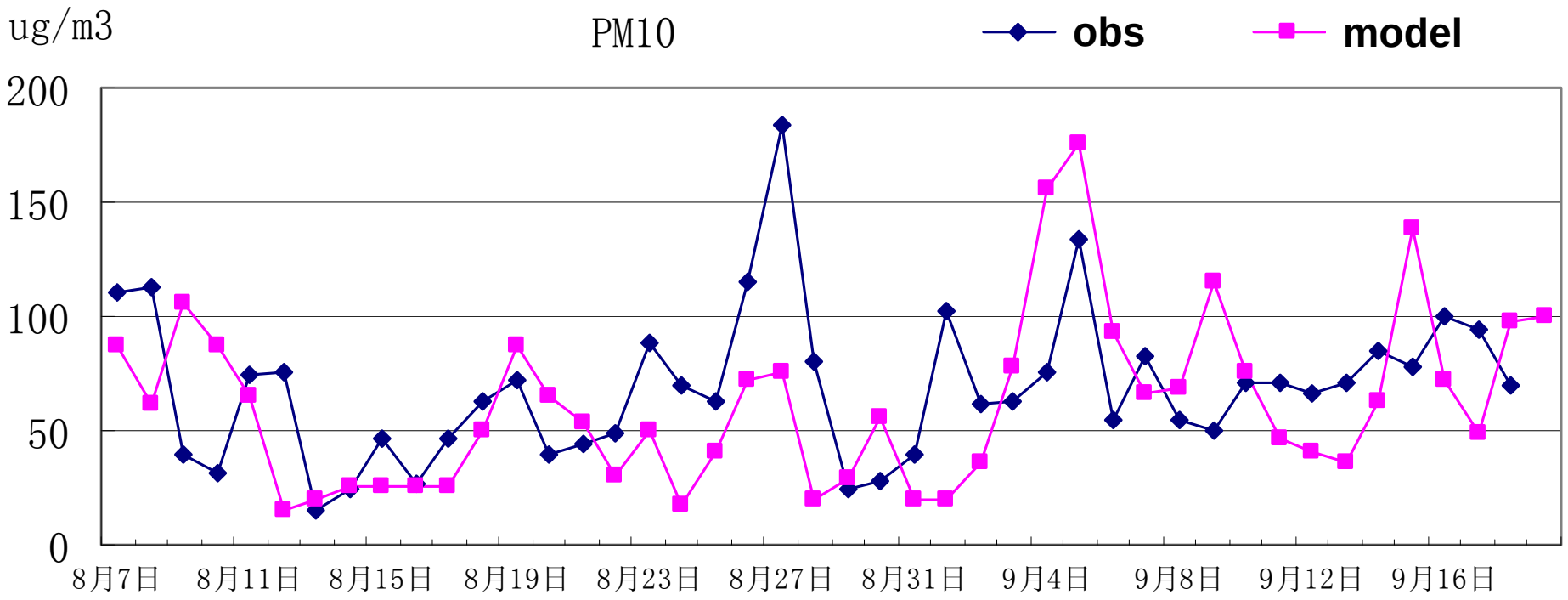
daytime O_3	8 Aug – 24 August			6 Sep – 17 Sep		
	mean (ppb)	maximum (ppb)	#hrs > 102 ppb	mean (ppb)	maximum (ppb)	#hrs > 102 ppb
2006	58.8	131.8	20	59.1	156.8	9
2007	66.8	152.2	30	72.2	167.6	22
2008	41.7	114.6	3	50.4	94.1	1
% diff. in 2008	-33.7%	-19.3%	-88.0%	-23.3%	-42.0%	-93.5%
ppb diff. in 2008	-21.2	-27.4	-22	-15.3	-68.1	-14.5

Air Quality Improvement: other gases

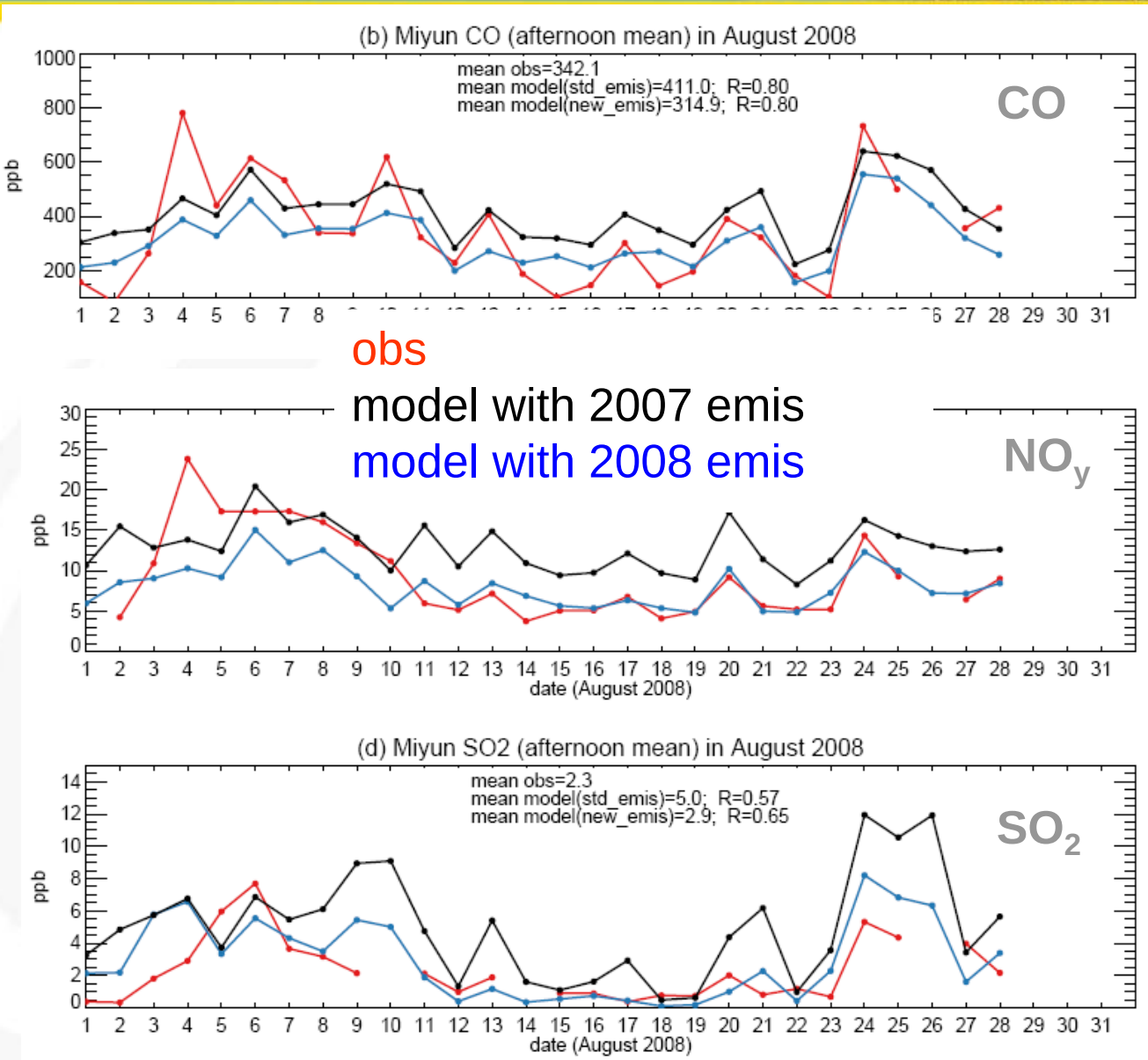
Miyun Observations for air masses coming from Beijing Urban Area

SSW,SW,S winds	August 2007 (ppb)	August 2008 (ppb)	Reduction (%)
SO_2	6.2	2.4	61.3
CO	468	352	24.8
NO_y	11.7	9.2	21.4
O_3	78	58	25.6

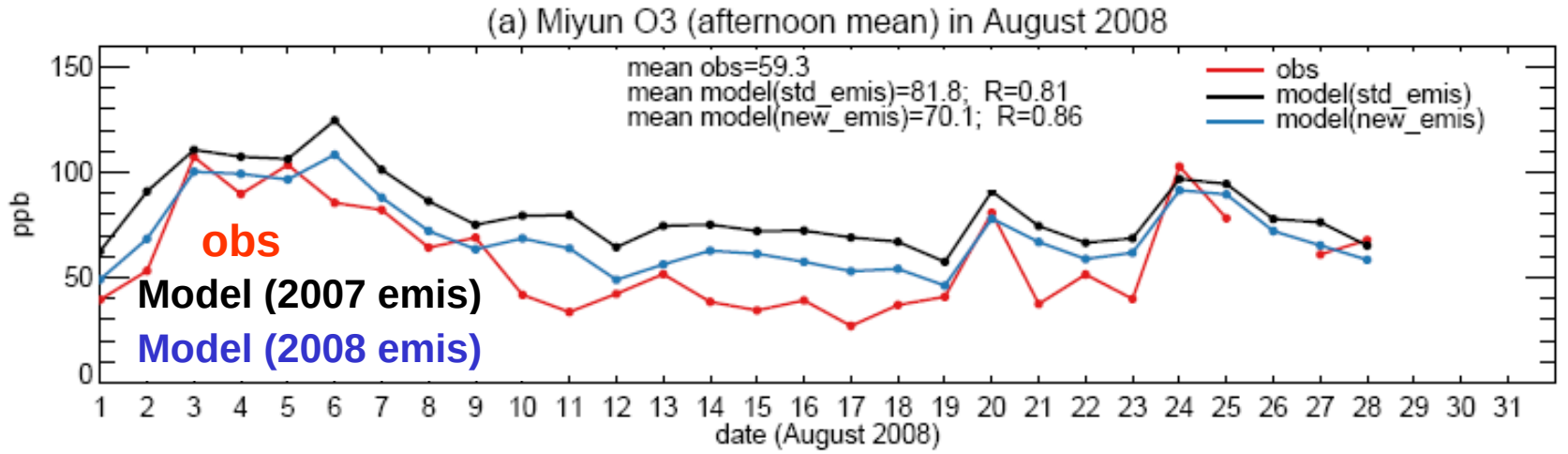
Air Quality Improvement: PM_{10} Simulations



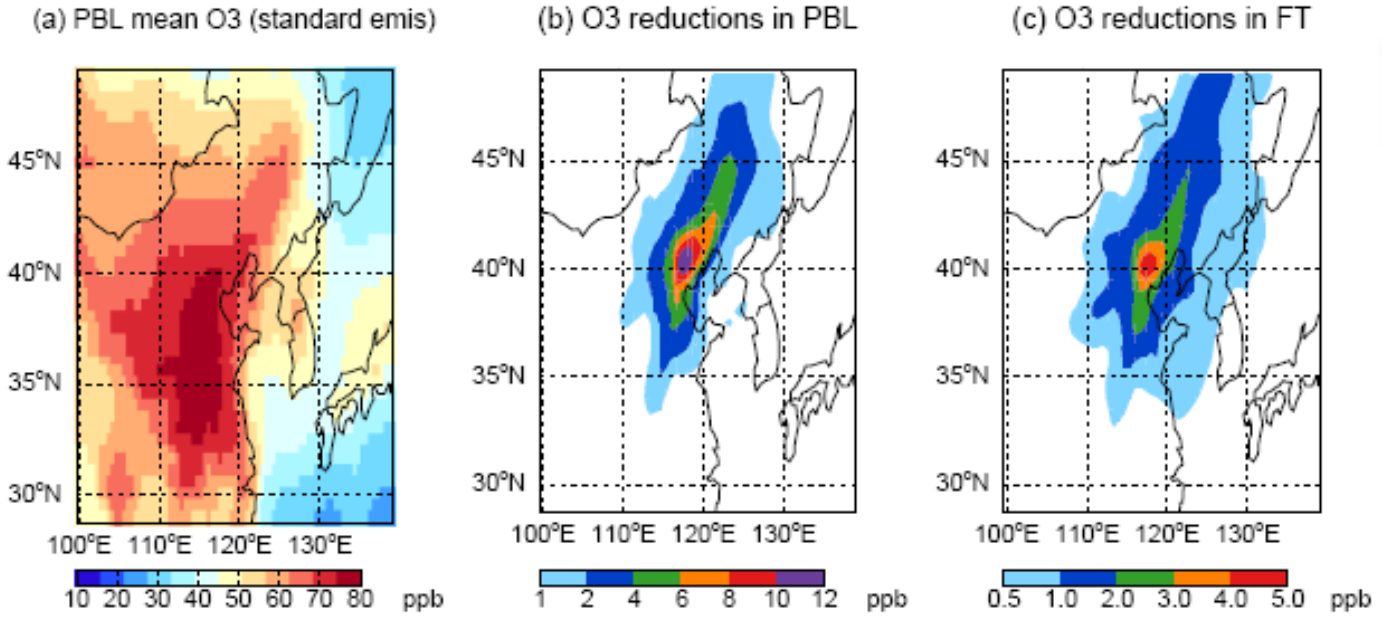
Air Quality Improvement: CO, NO_y and SO_2 Simulations



Air Quality Improvement: O_3 Simulations



Regional impact on O_3 of the emission reductions



Summary

- Beijing has been improving its air quality since 1998.
- About 20%~40% in PM_{10} concentration could attribute to the emission sources outside Beijing
- In Beijing:
  - fugitive dust, industrial sources and coal-fired boilers are the most important sources for PM_{10}
  - mobile sources and fugitive VOCs emissions are the most important source of O_3.

Summary

- Strict control measures were implemented during Olympic games, which reduced 58% of SO_2, 55% of NO_x, 61% of PM_{10}, and 59% of VOC emissions compared to that in July 2007
- Air quality were significantly improved during Olympic Games, of which PM_{10} and O_3 concentrations were reduced ~40%
- Emission estimation and model simulation can basically catch the emission reduction and air quality changes

Thanks for your attention!

For a better air quality in Beijing!

Beijing 2008

北京欢迎你

Beijing Welcomes You