

Analysis of PM_{2.5} Pollution Characteristics and Control Strategies in Jing-Jin-Ji Region

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Tsinghua University**

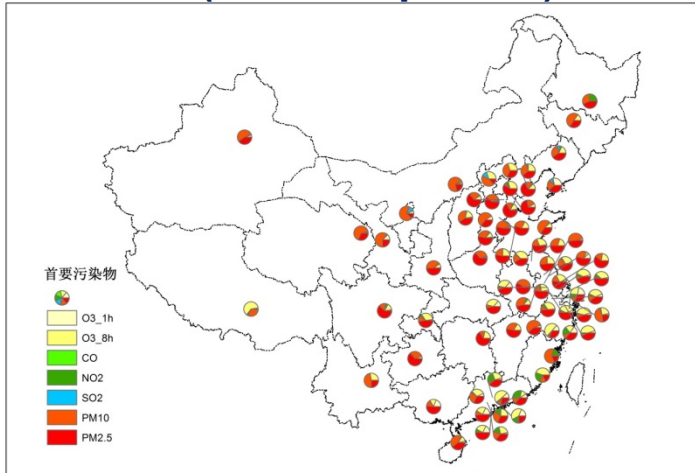
2013.11.16

Outline

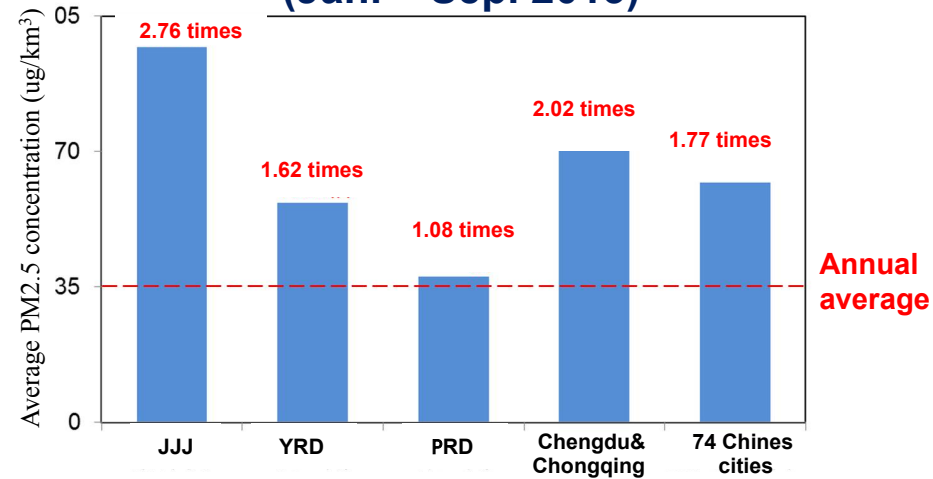
- **Background**
- **Pollution characteristics**
- **Pollution causes**
- **Control strategies**

PM_{2.5} is the main primary pollutant in the Jing-Jin-Ji region

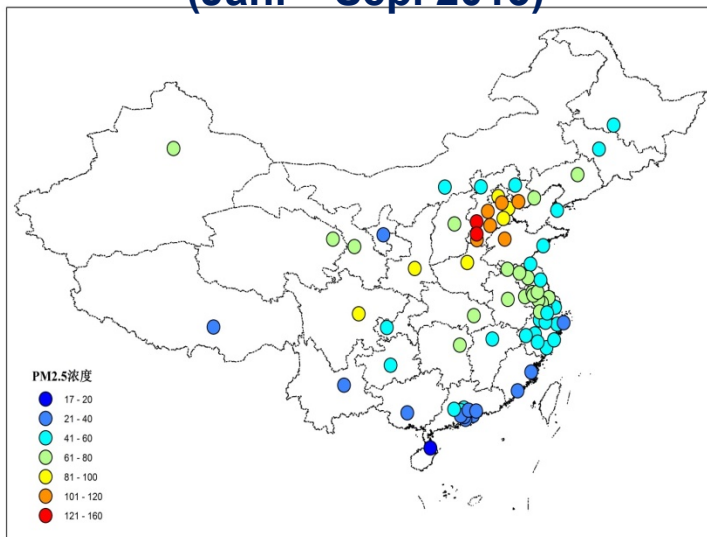
The share of primary pollutants
(Jan. – Sep. 2013)



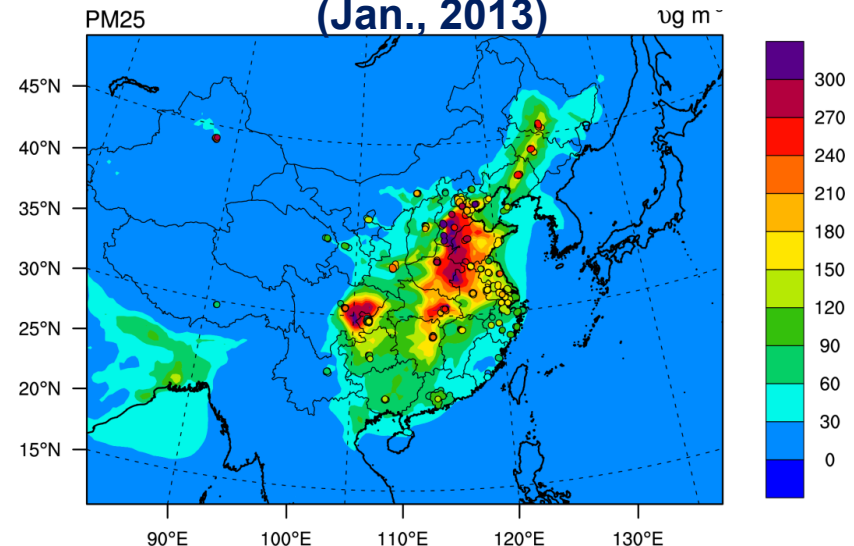
PM_{2.5} mass concentration
(Jan. – Sep. 2013)



PM_{2.5} mass concentration
(Jan. – Sep. 2013)



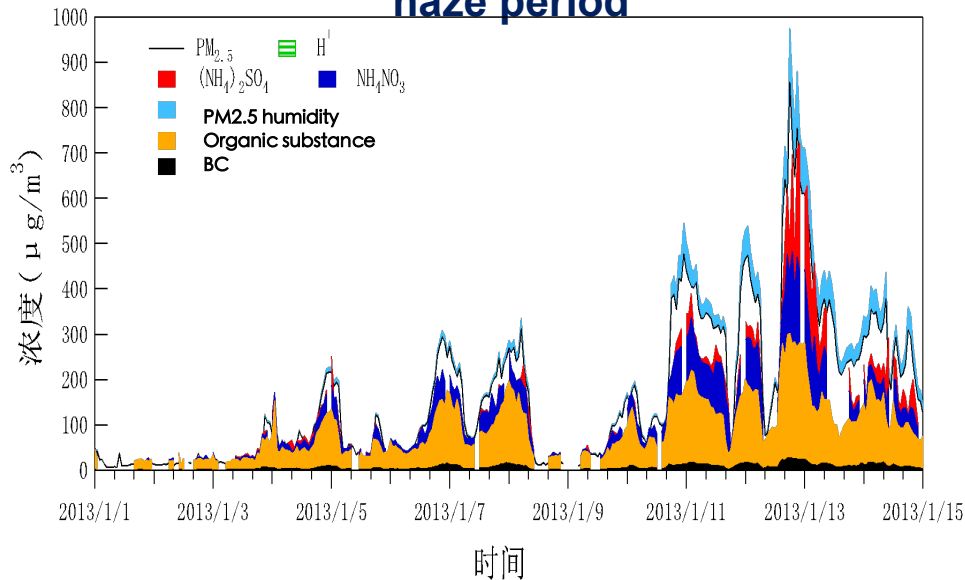
PM_{2.5} mass concentration
(Jan., 2013)



PM_{2.5} concentration is extremely high during the haze

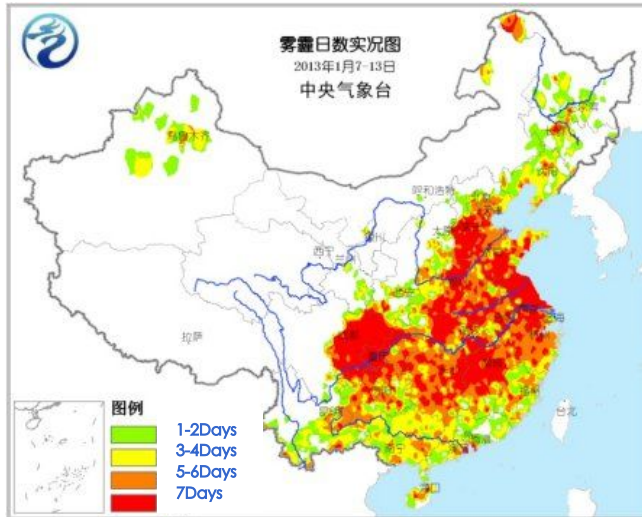


Hourly concentration of PM_{2.5} during haze period

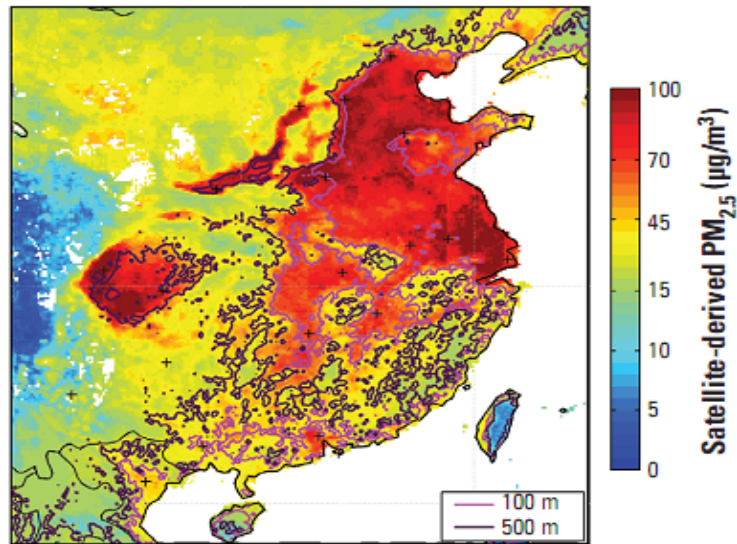


Strong relationship between haze pollution and PM_{2.5}

Haze distribution in Jan., 2013



PM_{2.5} concentration derived from satellite data



Haze continues impacting the middle and east area



Government plans to improve air quality

- PM_{2.5} concentration in Jing-Jin-Ji (JJJ, Beijing-Tianjin-Hebei) region should be reduced by 25% in 2017 and annual concentration in Beijing can't exceed 60 µg/m³

China State Council issued the Air Pollution Prevention and Control Action Plan

The regulation for the implementation on Air Pollution Prevention and Control Action Plan for JJJ region and surrounding areas



附件

京津冀及周边地区落实大气污染防治行动计划实施细则

京津冀及周边地区（包括北京市、天津市、河北省、山西省、内蒙古自治区、山东省）是我国大气污染最严重的区域。为加快京津冀及周边地区大气污染综合治理，依据《大气污染防治行动计划》，制定本实施细则。

一、主要目标

经过五年努力，京津冀及周边地区空气质量明显好转，重污染天气较大幅度减少。力争再用五年或更长时间，逐步消除重污染天气，空气质量全面改善。

具体指标：到2017年，北京市、天津市、河北省细颗粒物（PM_{2.5}）浓度在2012年基础上下降25%左右，山西省、山东省下降20%，内蒙古自治区下降10%。其中，北京市细颗粒物年均浓度控制在60微克/立方米左右。

二、重点任务

（一）实施综合治理，强化污染物协同减排

1. 全面淘汰燃煤小锅炉。加快热力和燃气管网建设，通过集中

国务院关于印发大气污染防治行动计划的通知

国发〔2013〕37号

各省、自治区、直辖市人民政府，国务院各部委、各直属机构：
现将《大气污染防治行动计划》印发给你们，请认真贯彻执行。

国务院
2013年9月10日

（此件公开发布）

大气污染防治行动计划

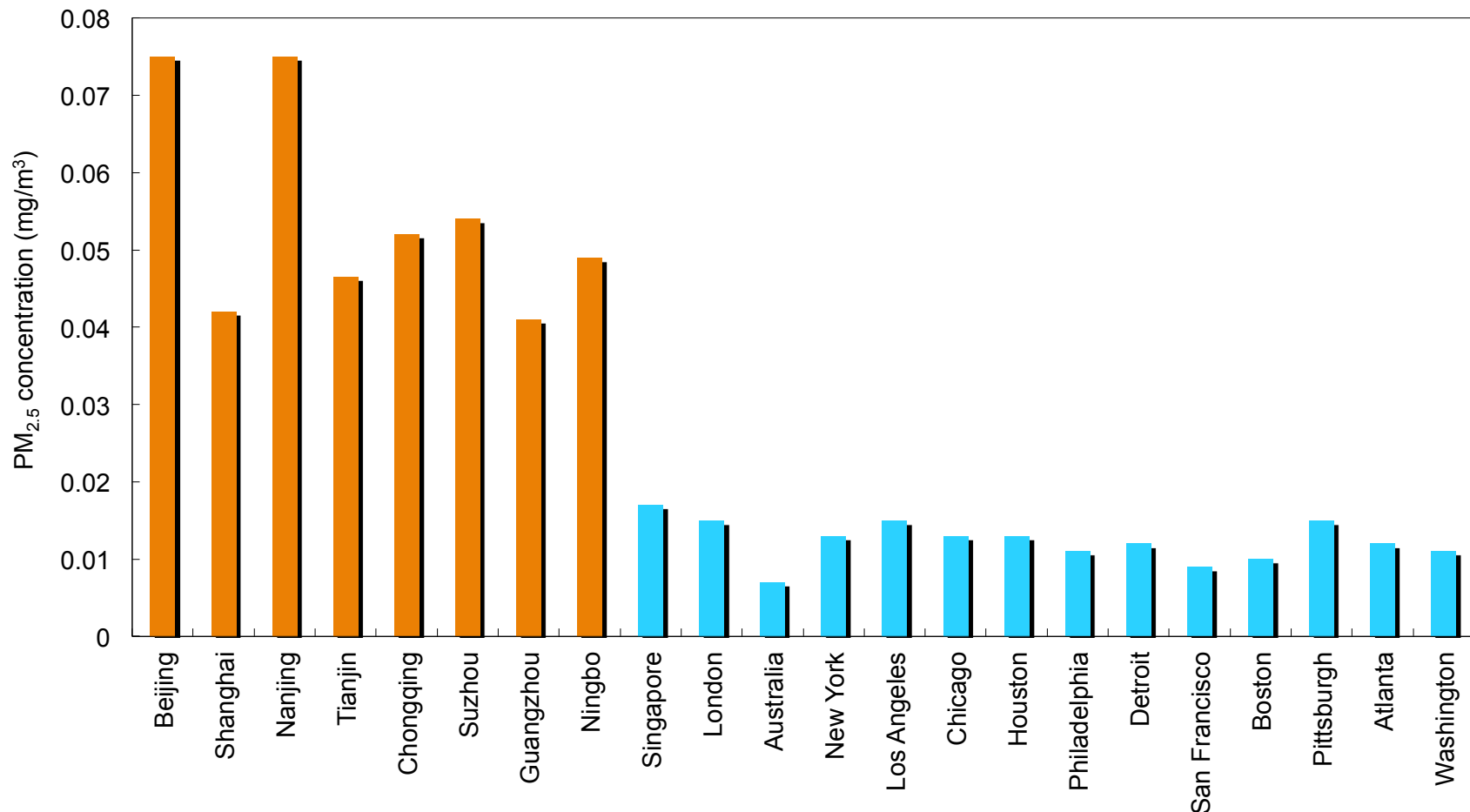
大气环境保护事关人民群众根本利益，事关经济持续健康发展，事关全面建成小康社会，事关实现中华民族伟大复兴中国梦。当前，我国大气污染形势严峻，以可吸入颗粒物（PM₁₀）、细颗粒物（PM_{2.5}）为特征污染物的区域性大气环境问题日益突出，损害人民群众身体健康，影响社会和谐稳定。随着我国工业化、城镇化的深入推进，能源资源消耗持续增加，大气污染防治压力继续加大。为切实改善空气质量，制定本行动计划。

Outline

- **Background**
- **Pollution characteristics**
- **Pollution causes**
- **Control strategies**

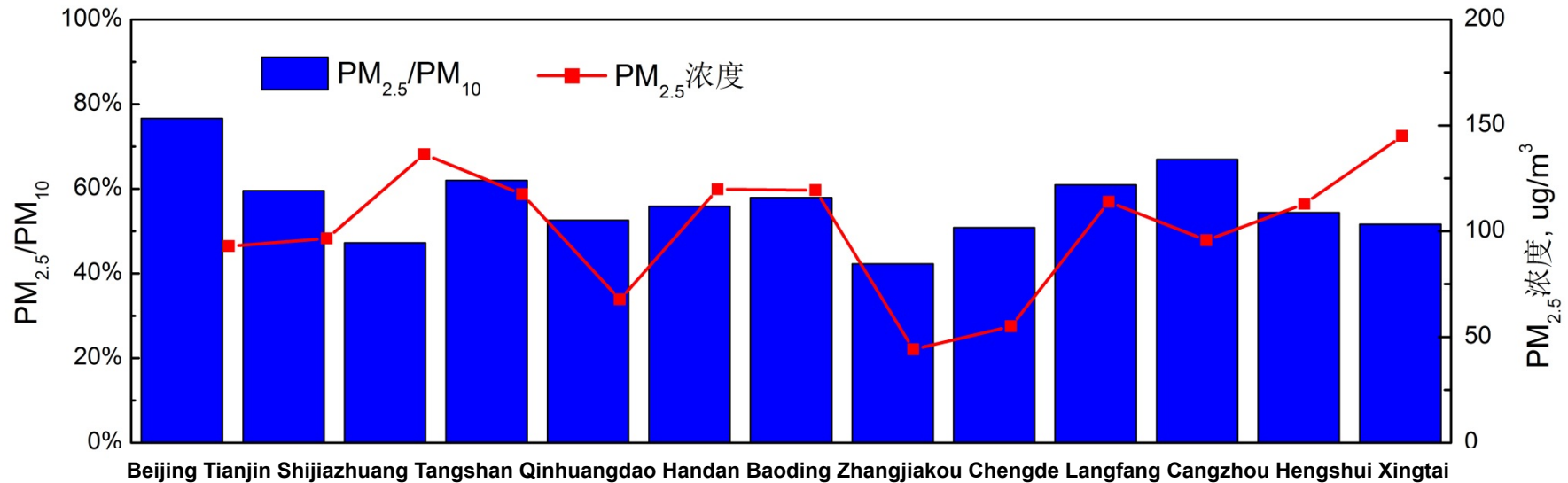
1. High annual PM_{2.5} concentration

PM_{2.5} concentration in different cities around the world

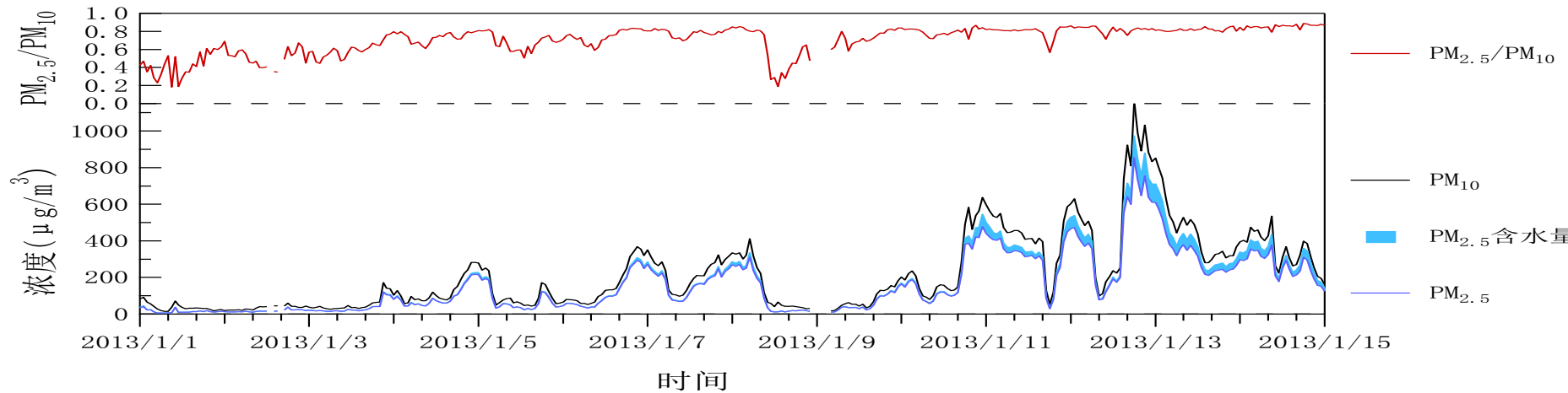


2. High ratio of PM_{2.5} to PM₁₀

PM_{2.5}/PM₁₀ of main cities in Jing-Jin-Ji region, Jan. – Sep., 2013



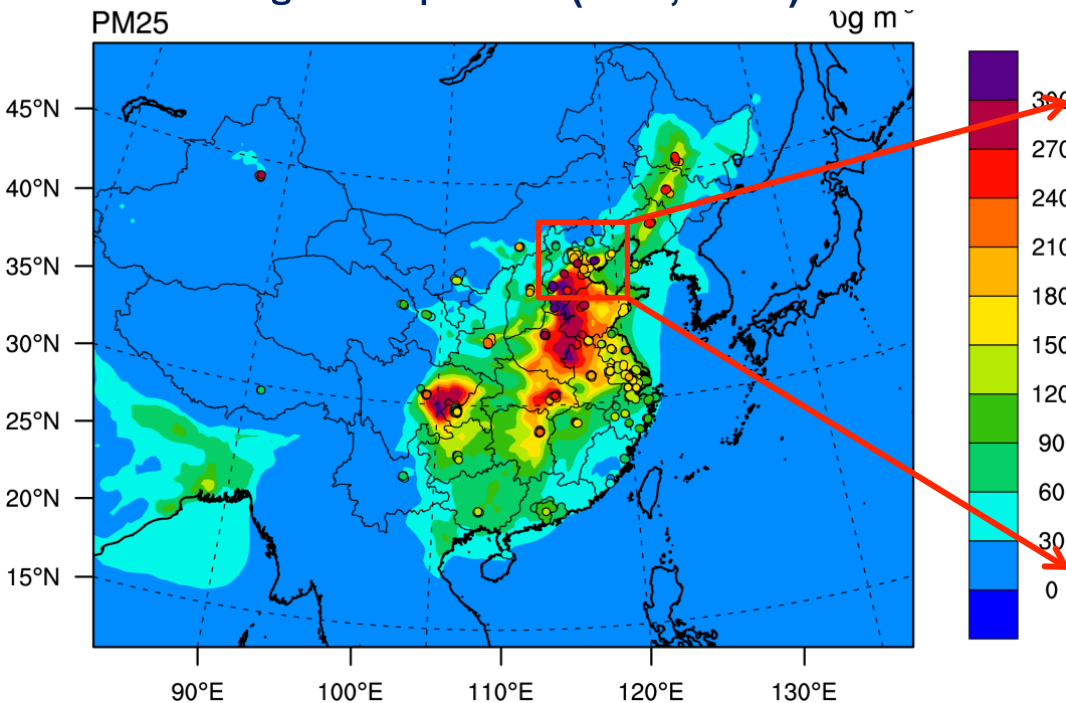
The observation of PM_{2.5}/PM₁₀ during haze period in Jan. 2013



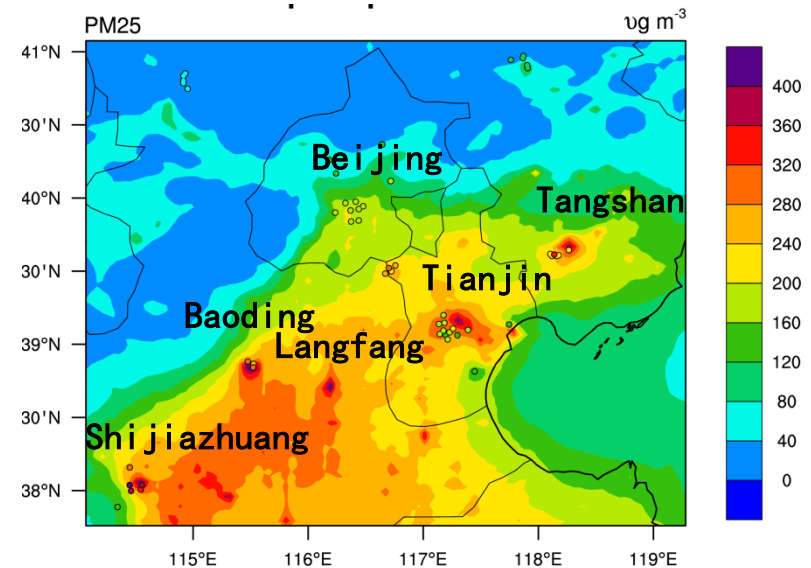
3. Strong regional distribution patterns

PM_{2.5} concentration distribution in Jing-Jin-Ji cities

PM_{2.5} mass concentration
during haze period (Jan., 2013)

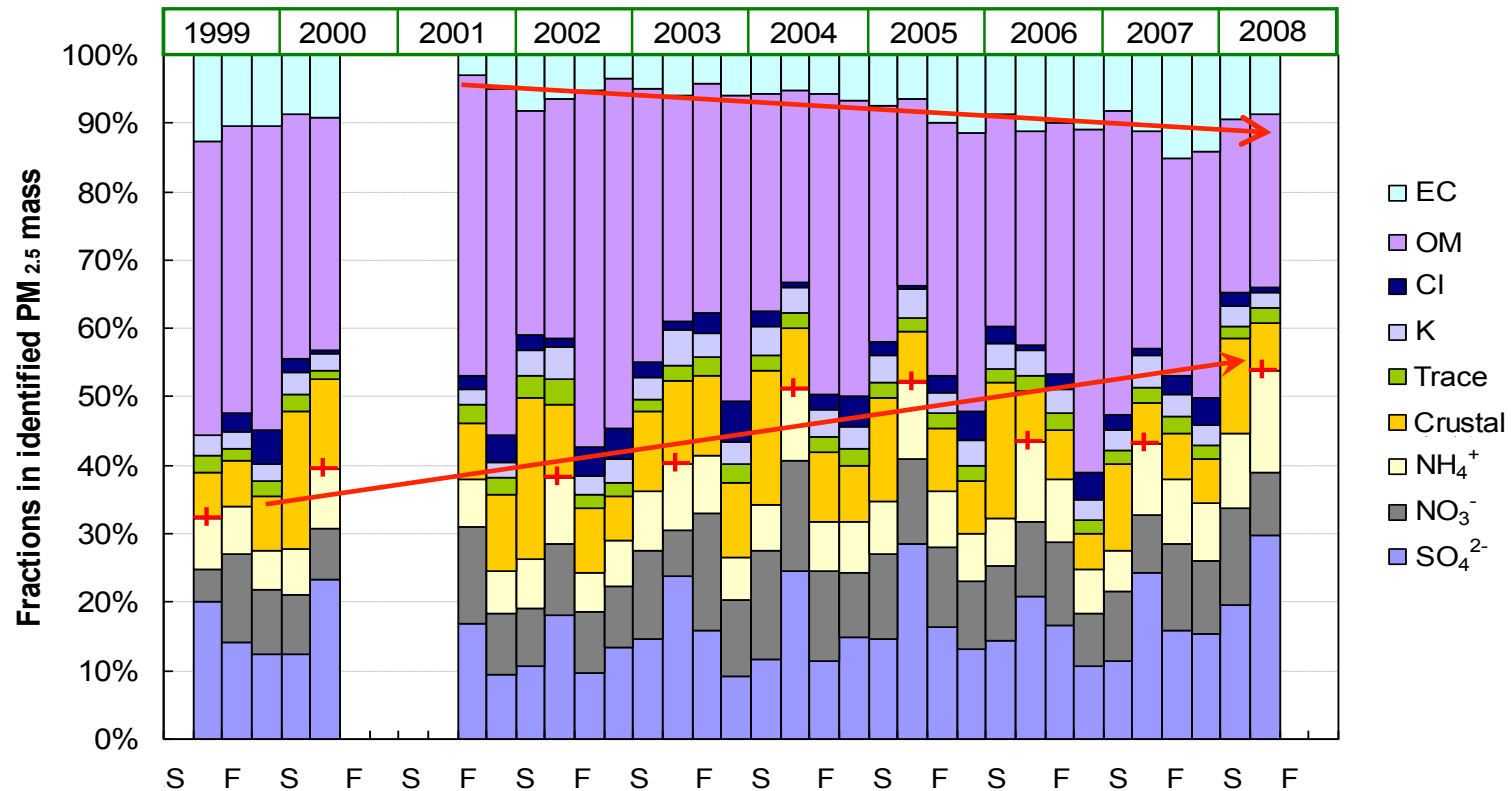


PM_{2.5} concentration in Jing-Jin-Ji
urban areas



4. The ratio of secondary PM_{2.5} is increasing

Seasonal and annual variation of PM_{2.5} composition in Beijing

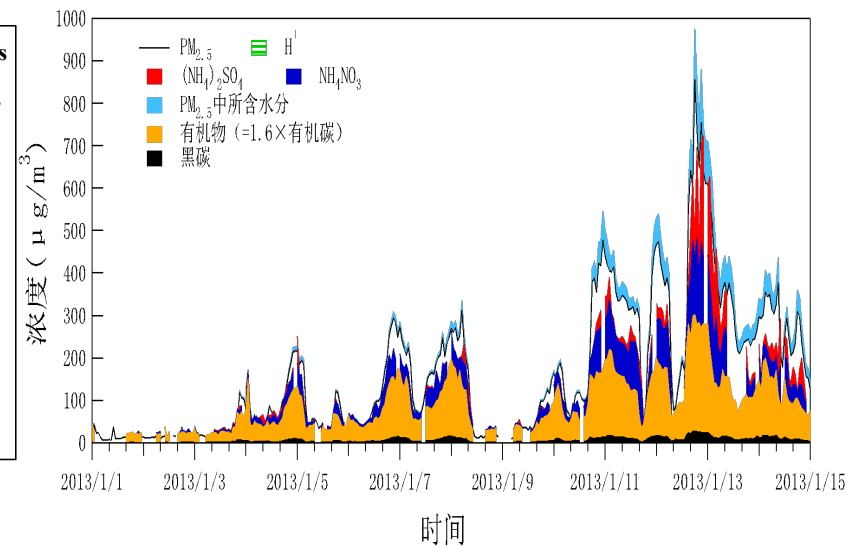
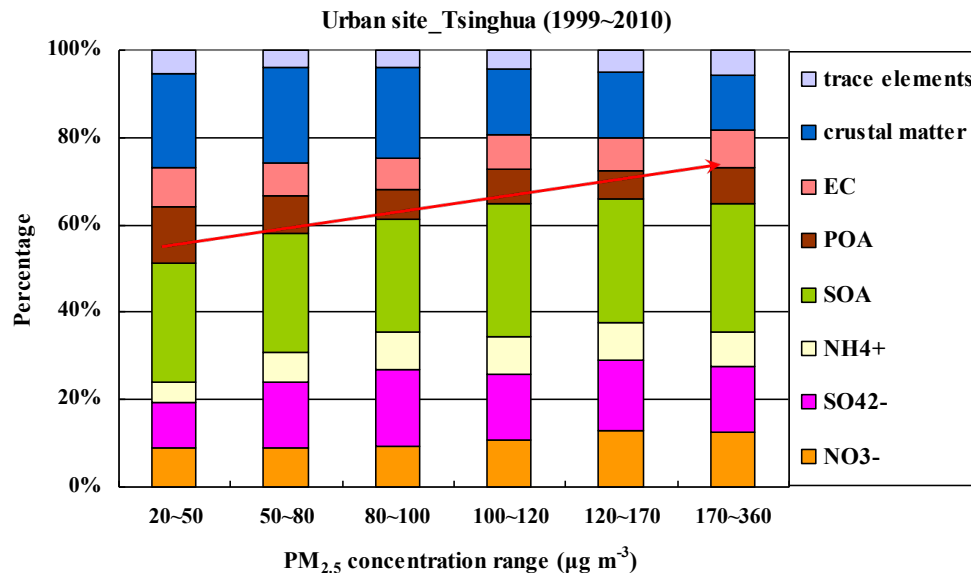


Conclusion of time series analysis:

- The share of SNA and EC is increasing for more than decade;
- High extinction efficiency, high contribution to reduced visibility ;

5. High secondary component ratios in severe pollution period (1)

PM_{2.5} chemical compositions at different concentration levels



➤ Conclusion of time series analysis:

The SNA and SOA ratios increase with high PM_{2.5} concentration

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Environmental Pressure

京津冀重工业的发展以及能源消耗

	2000	2010	2010/2000	占全国比例 2010
煤炭消费量（百万吨）	173	349	2.02	9%
发电量（10亿千瓦时）	120	285	2.38	7%
粗钢产量（百万吨）	239	170	0.71	27%
水泥产量（百万吨）	58	147	2.53	8%

Emission Analysis by MEIC Model

中国多尺度排放清单模型

Multi-resolution Emission Inventory for China (MEIC)

- 年份: 1990-2010
- 空间范围: 中国大陆地区
- 污染源分类: 约800种人为排放源, 最终合并为四个部门 (电力、工业、民用、交通)
- 物种: SO_2 , NO_x , CO , NMVOC, NH_3 , BC, OC, $\text{PM}_{2.5}$, PM_{10} , CO_2
- 空间精度: 可根据模式空间分辨率定制
- 数据库访问地址: <http://www.meicmodel.org>

MEIC Model

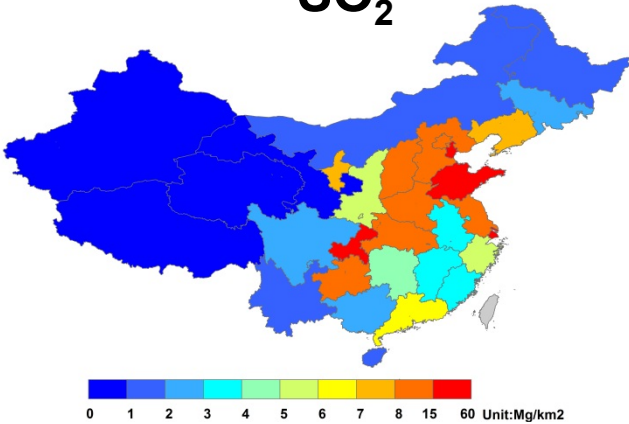
BETA



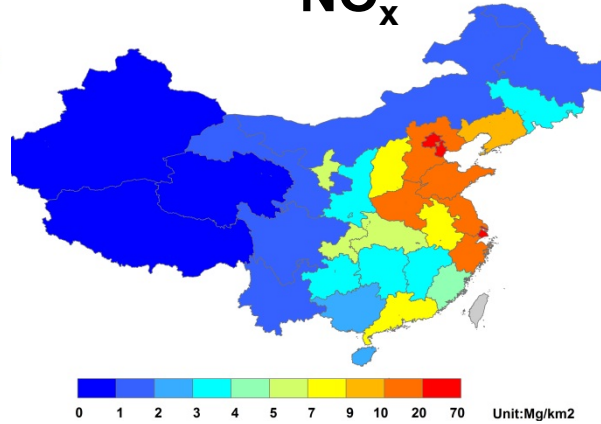
The China Sustainable Energy Program
中国可持续能源项目

Major Pollutant Emission Intensity

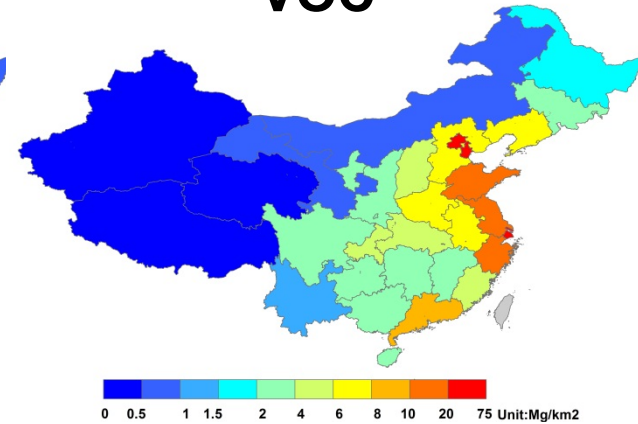
SO₂



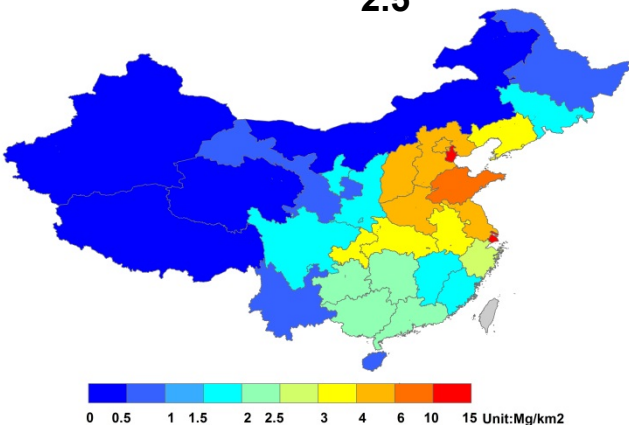
NO_x



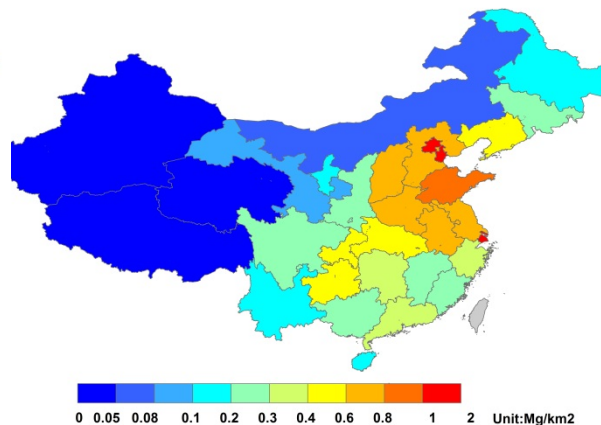
VOC



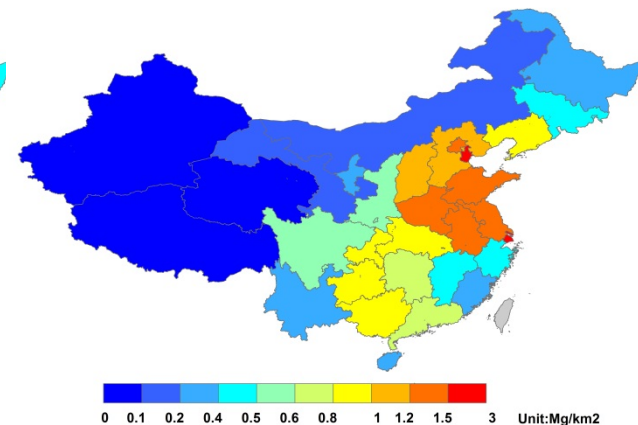
PM_{2.5}



BC

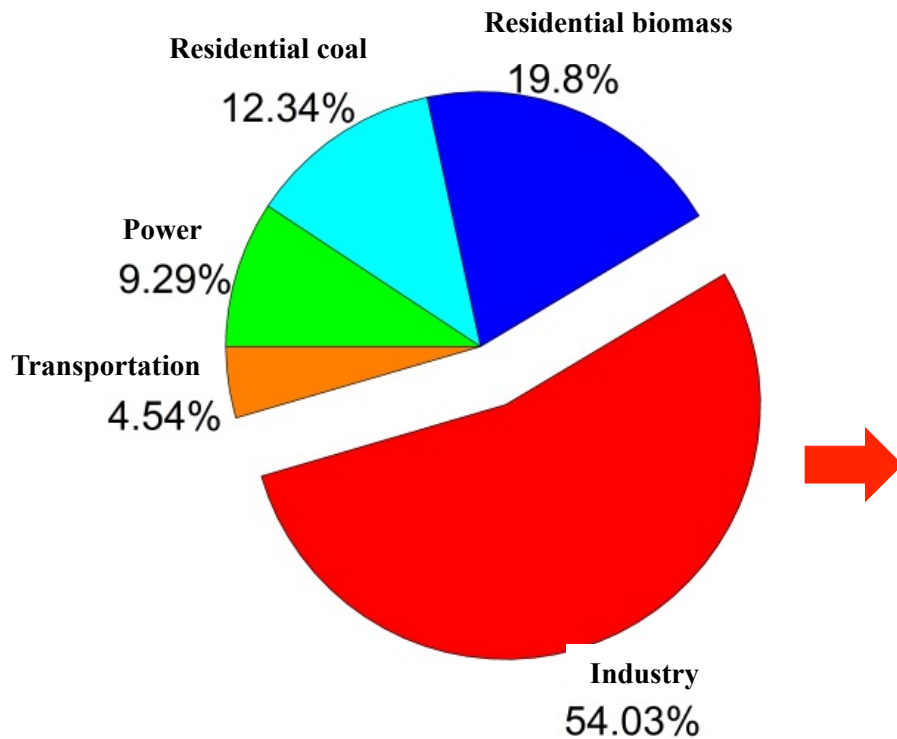


OC

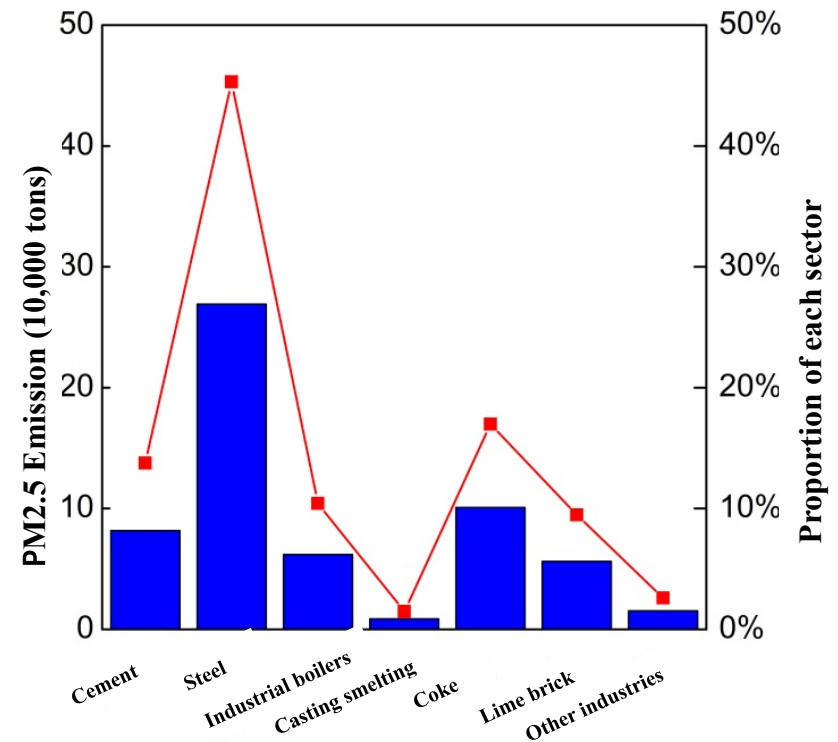


Emissions are mainly contributed by industry sources (1)

Source apportionment of primary PM_{2.5} in Jing-Jin-Ji region



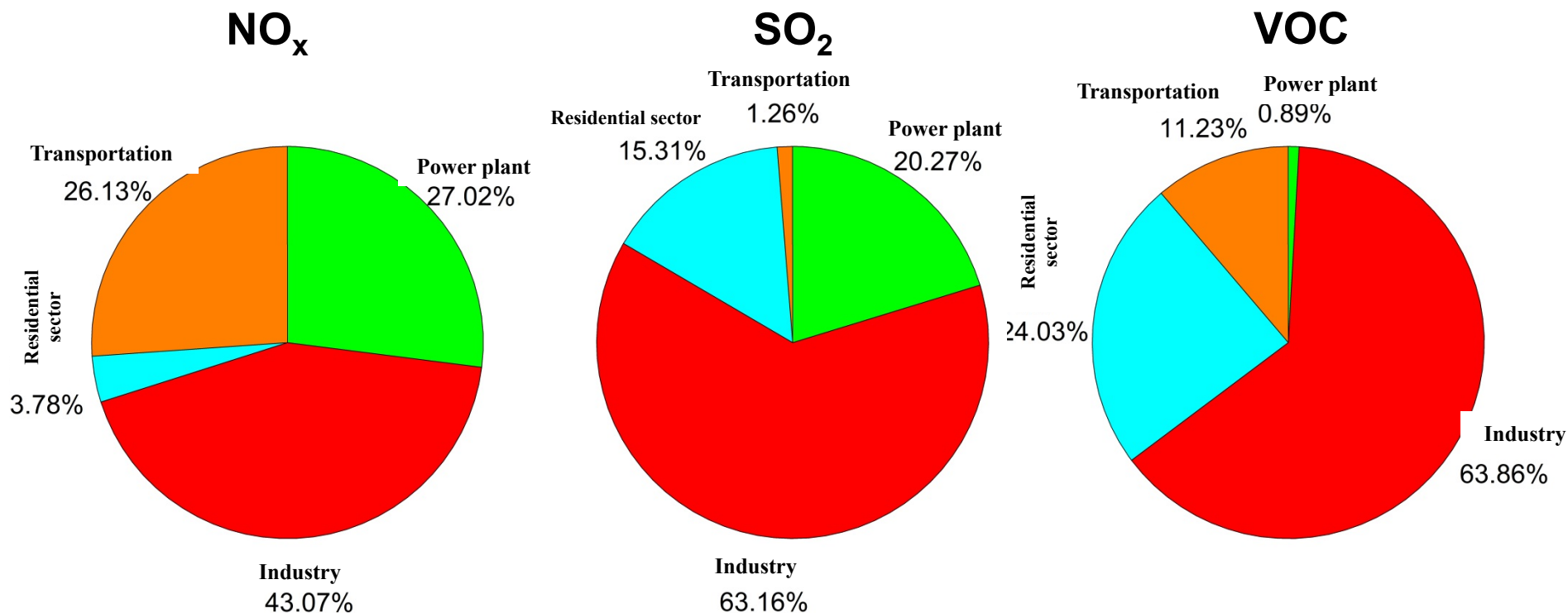
Source apportionment of primary PM_{2.5}



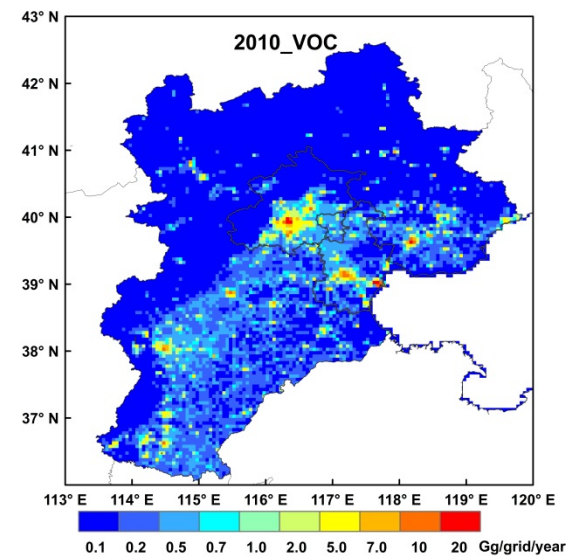
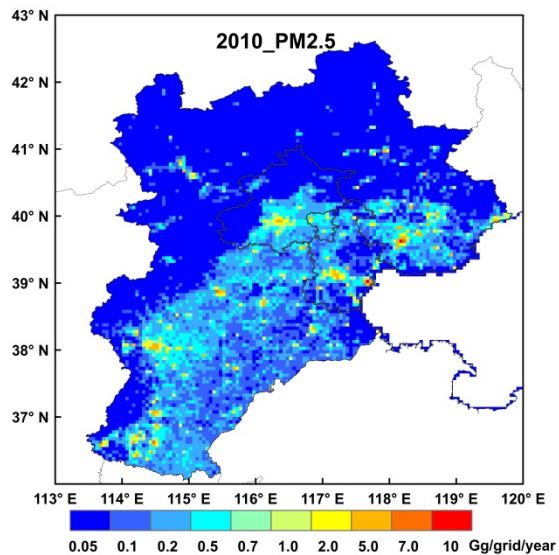
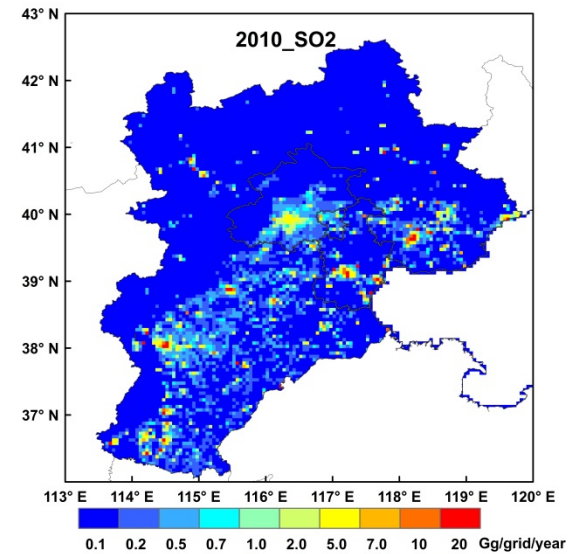
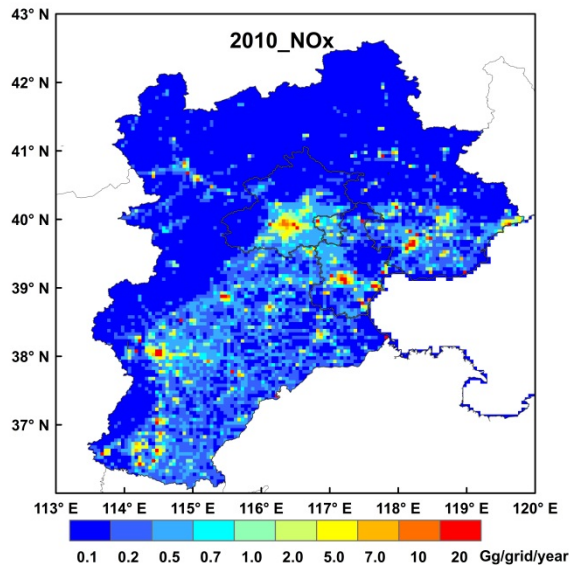
Source apportionment of primary PM_{2.5} in industry sector

Emissions are mainly contributed by industry sources(2)

Source apportionment of secondary PM_{2.5} precursors in Jing-Jin-Ji region

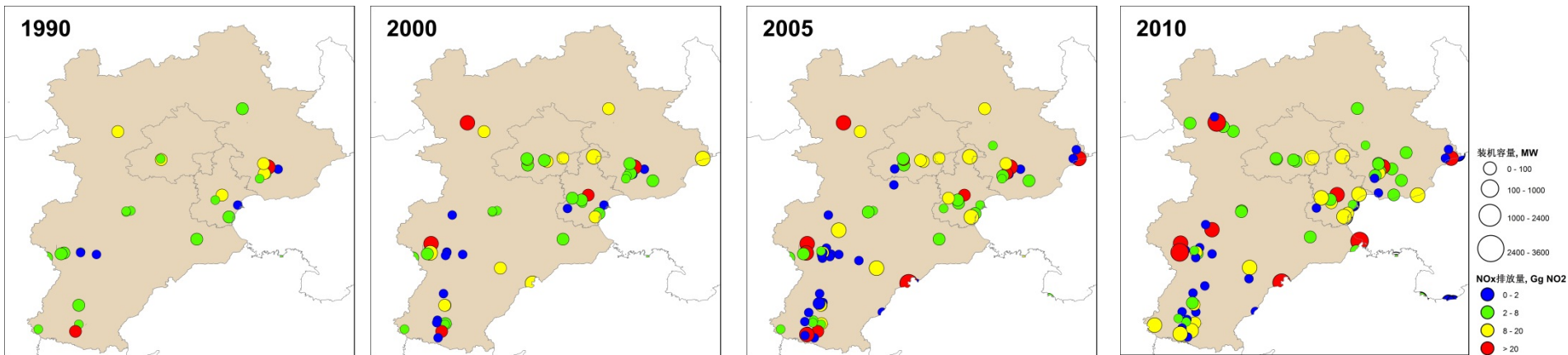


Artificial Emission Sources in JJJ Region

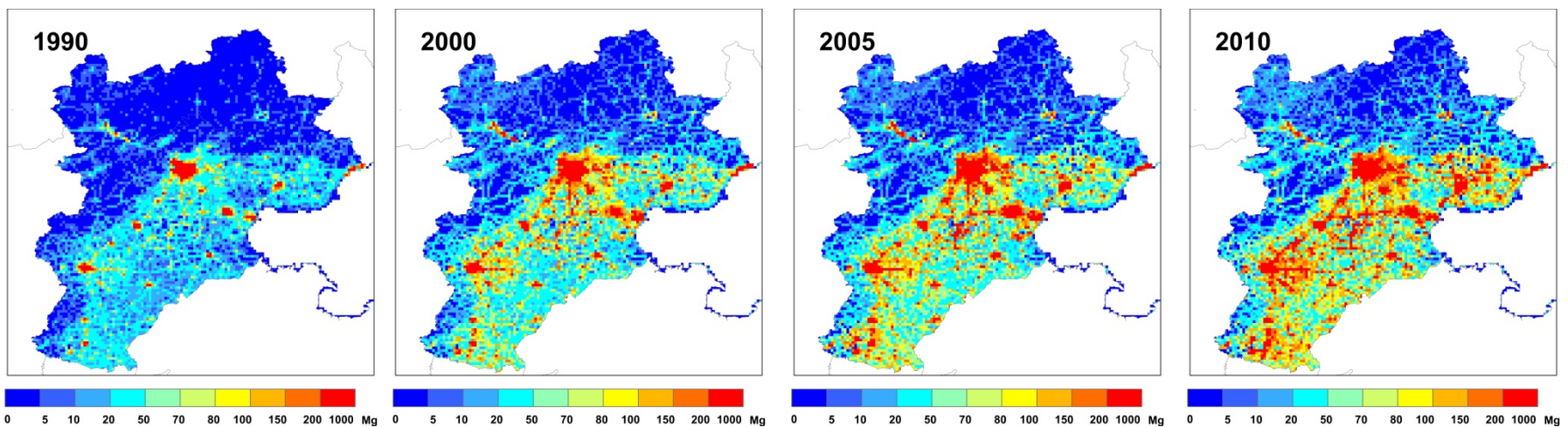


Pollutant Emission Trend

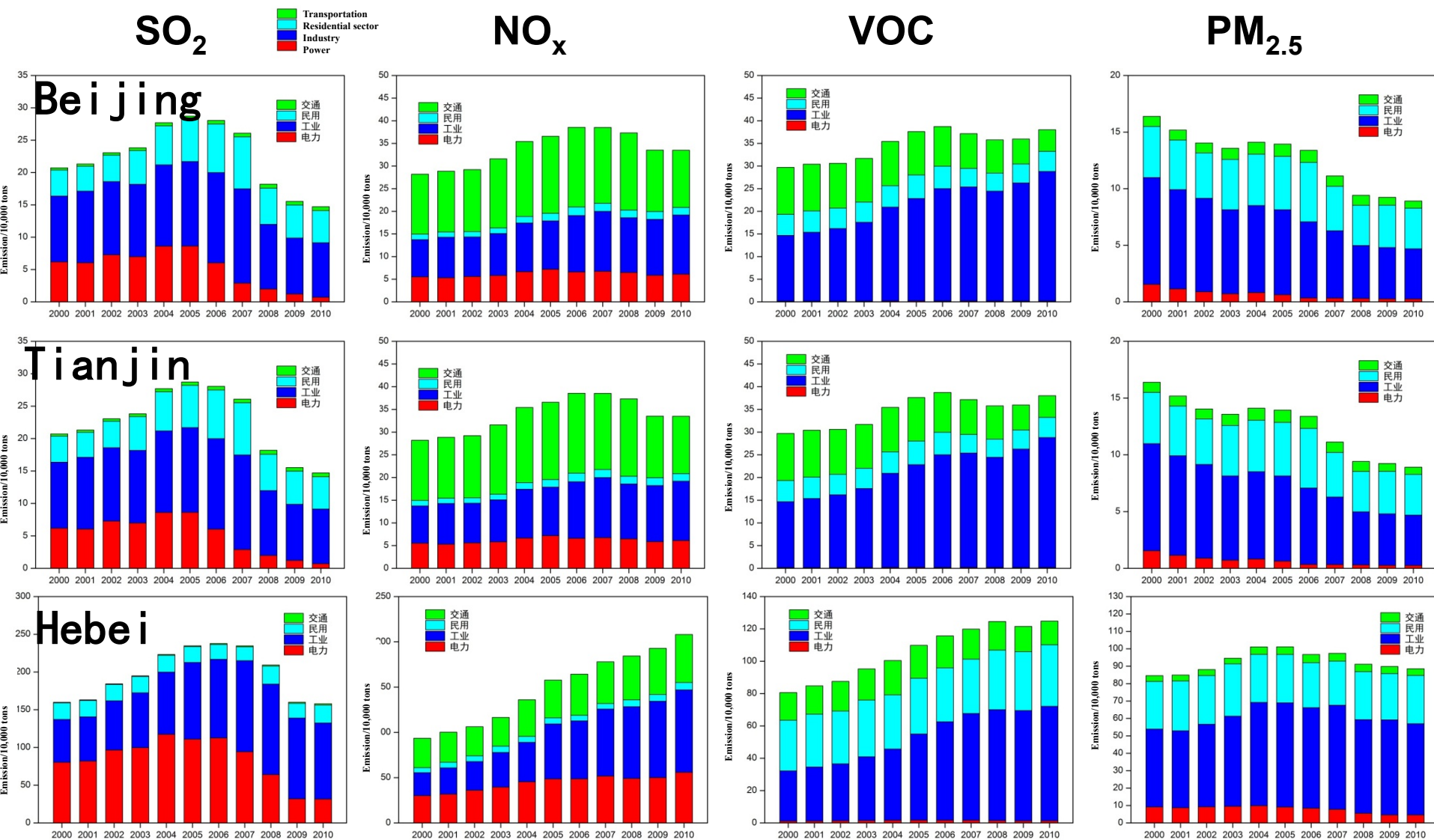
电厂NO_x排放



交通NO_x排放



The emission trend of primary PM_{2.5} and precursors of secondary PM_{2.5}



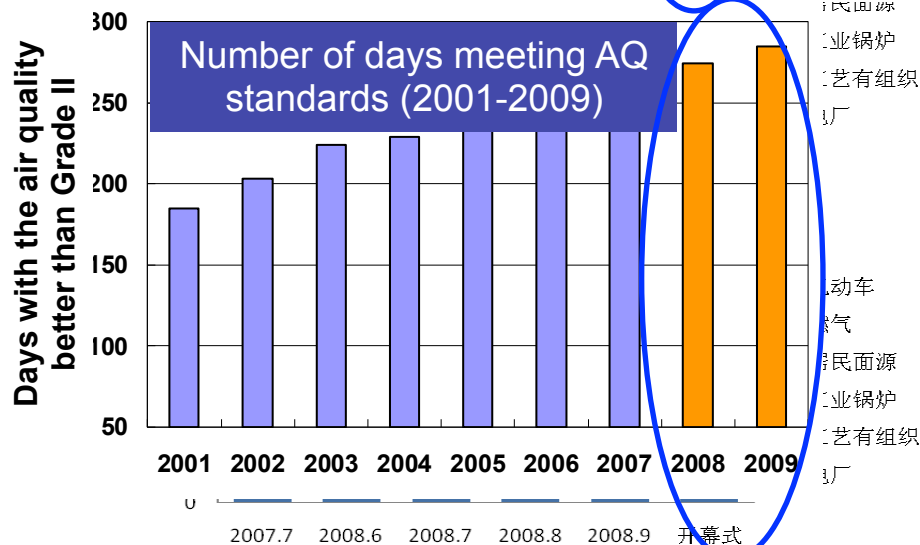
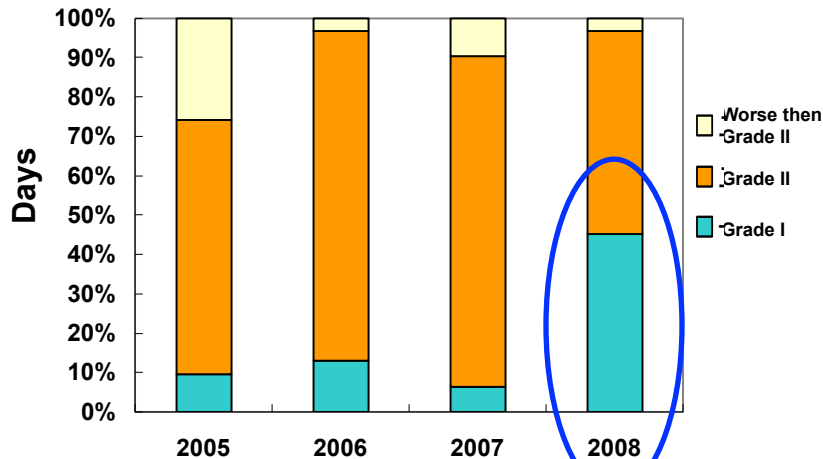
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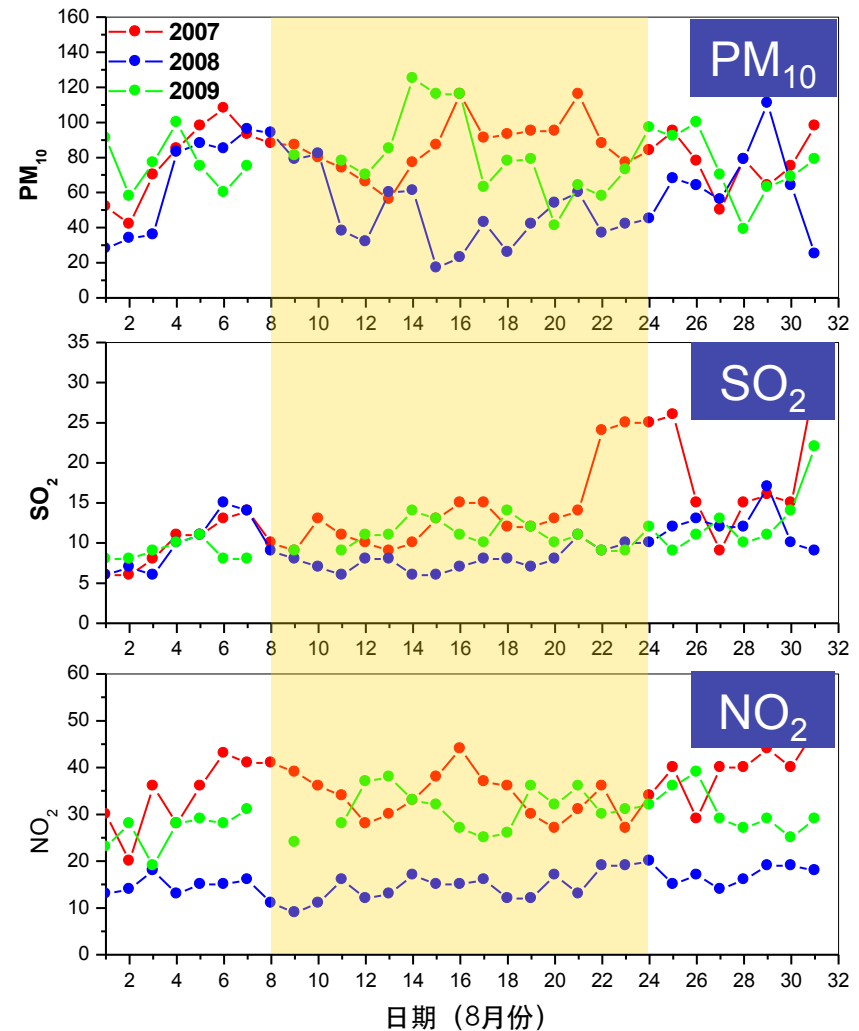
Short-term practices of region air pollution control (1)

Beijing Olympic Games

Emission reduction by more than 50%



The air quality met the requirement of Olympic Committee

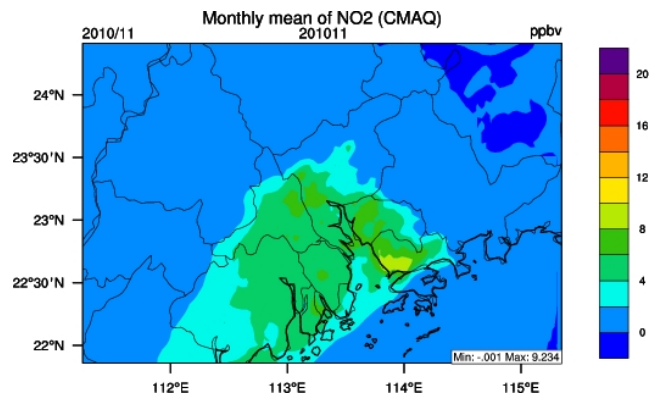
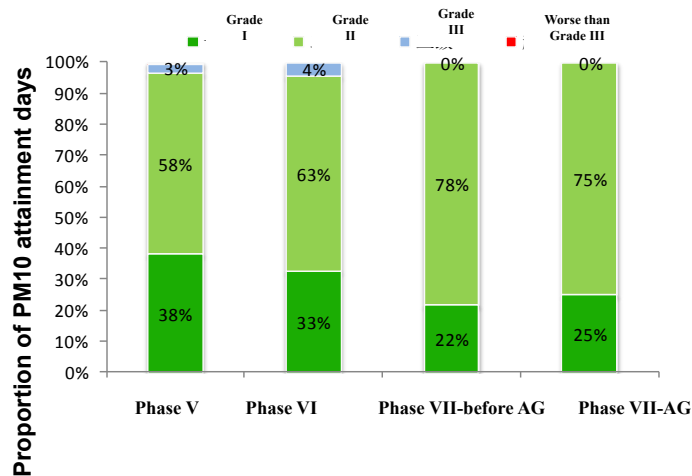


Short-term practices of region air pollution control (2)

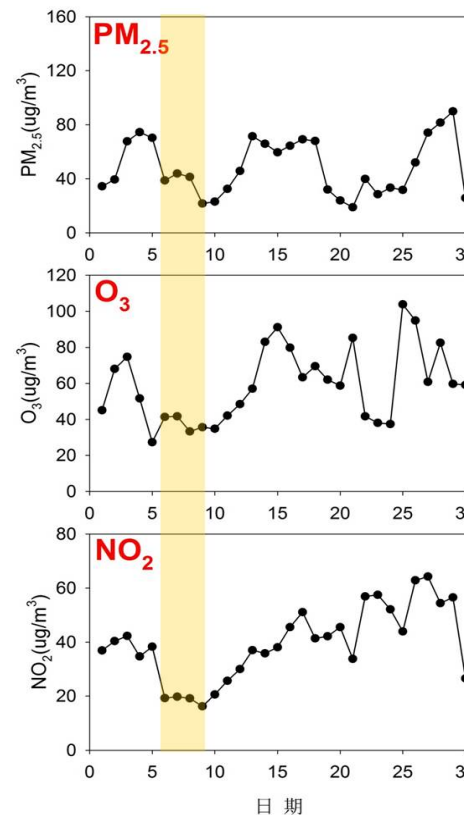
Guangzhou Asian Games

Chengdu Fortune Global Forum and Chinese Merchant Forum

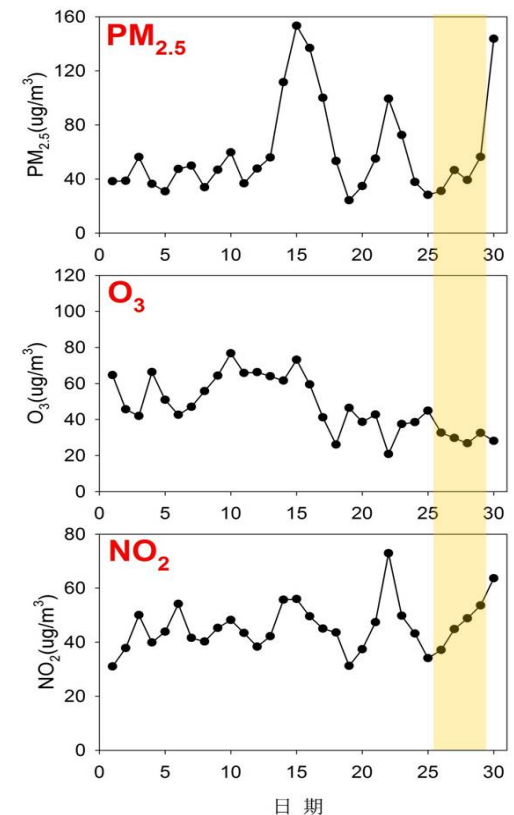
Air quality met AQ standards



Air quality during Fortune Global Forum

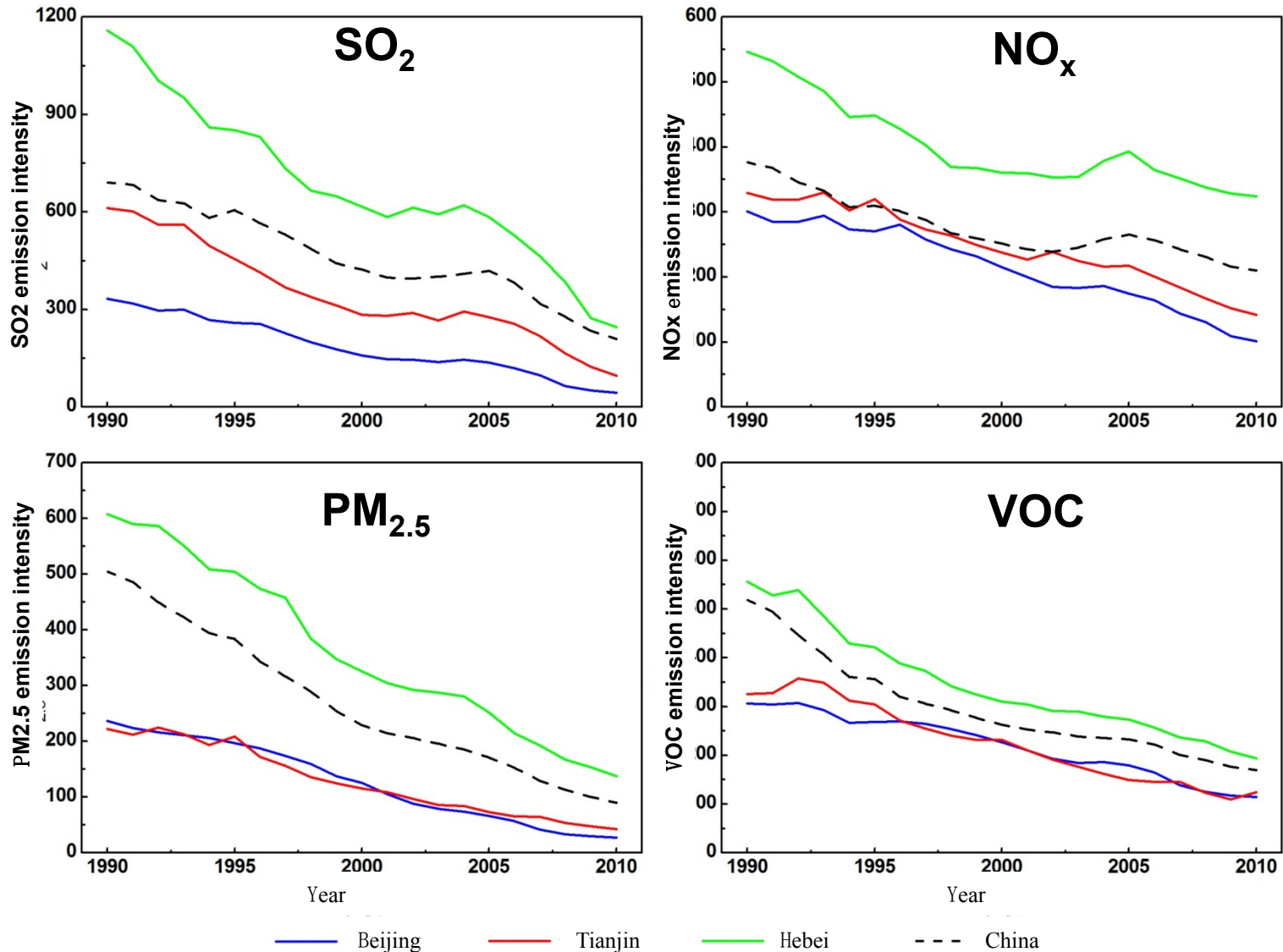


Air quality during Chinese Merchant Forum



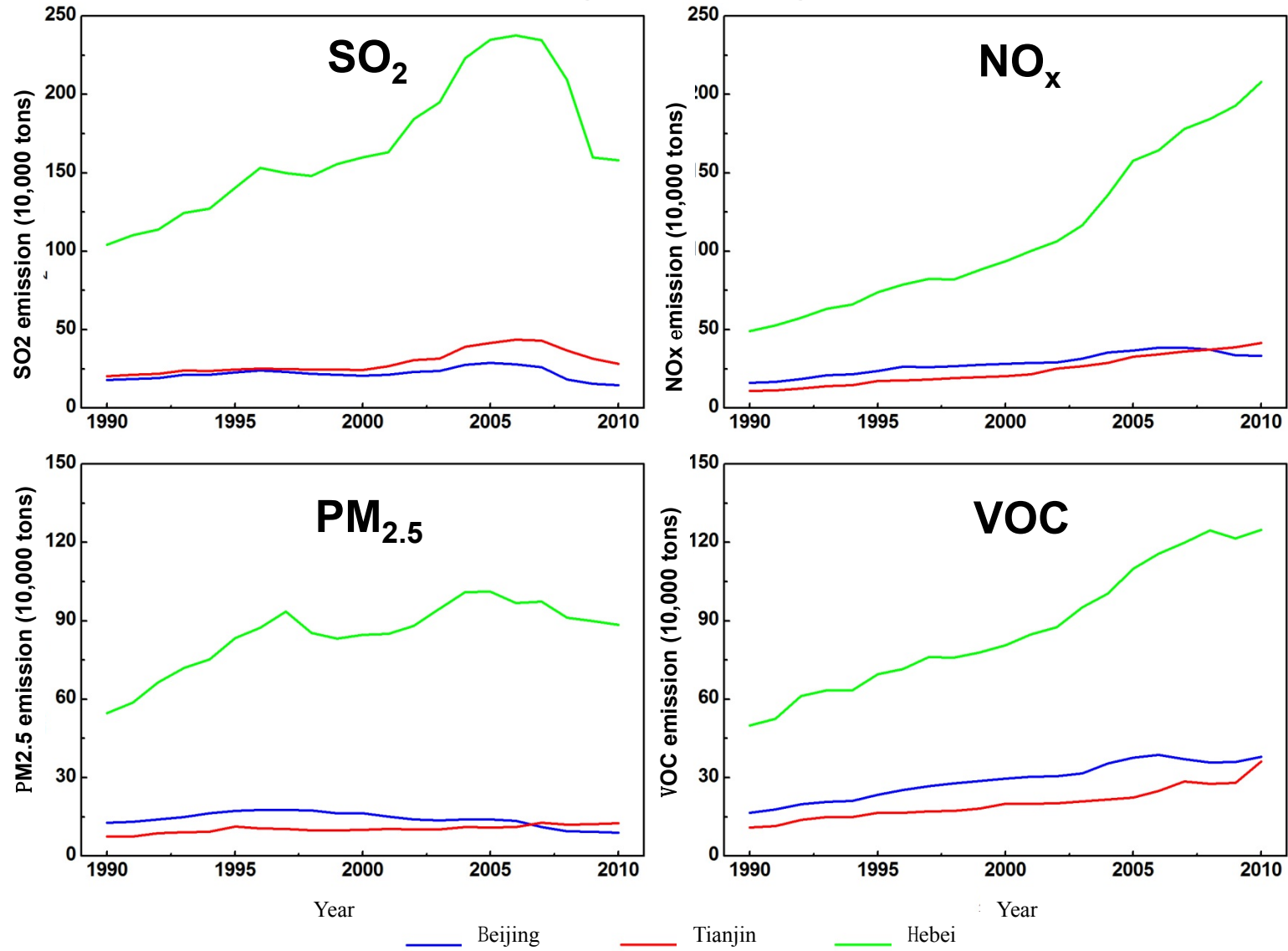
Strategy 1. Accelerate the transformation of development pattern (2)

Emission intensities per unit GDP from 1990 to 2010



Strategy 1. Accelerate the transformation of development pattern (1)

The emission trend in Jing-Jin-Ji region from 1990 to 2010



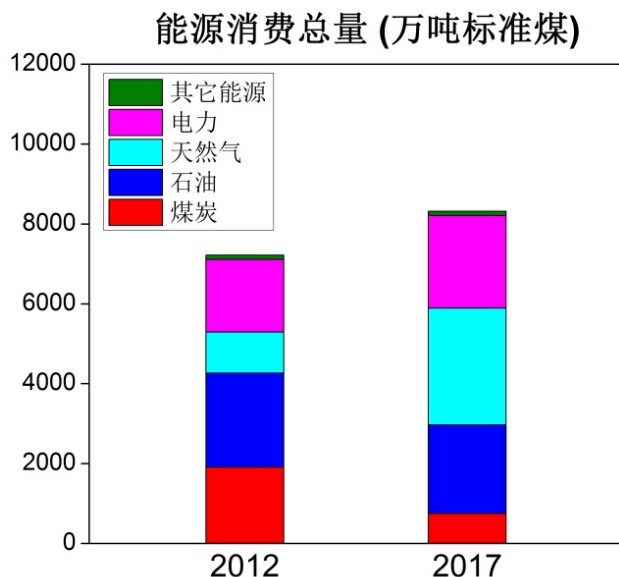
Rules for JJJ Region (10 Measures by SC)

- 能源结构调整，实施煤炭总量控制，提高外输电比例、增加天然气供应、加大非化石能源利用强度，力争实现煤炭消费总量负增长
- 严控“两高”行业新增产能，淘汰落后产能，压缩过剩产能。重要行业如电厂、工业锅炉、工业窑炉等加快重点行业脱硫、脱硝、除尘改造工程建设
- 限制机动车保有量，加快推进燃油与排放标准，加快淘汰黄标车与老旧车辆
- 削减民用炊事、采暖和设施用煤，加强建筑节能

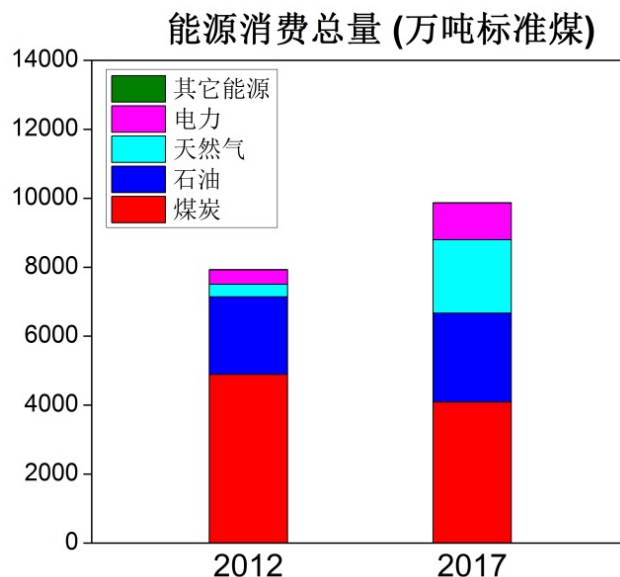
Impact Analysis by 10 Measures (1)

京津冀地区主要能源品种消费量预测

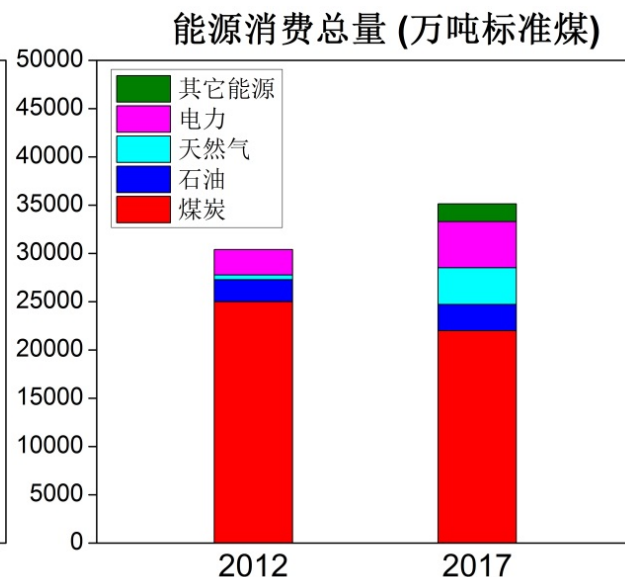
北京



天津



河北



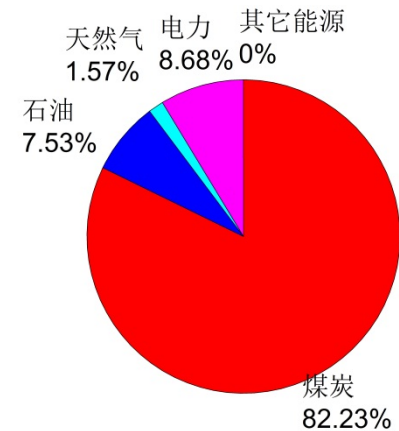
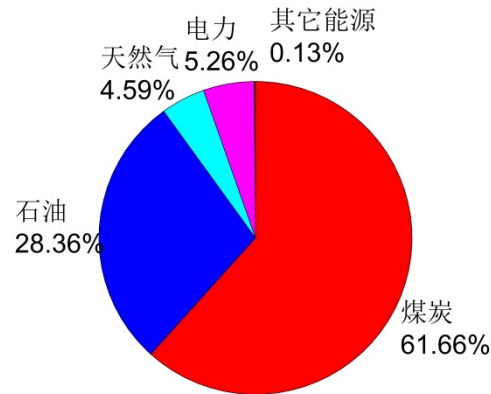
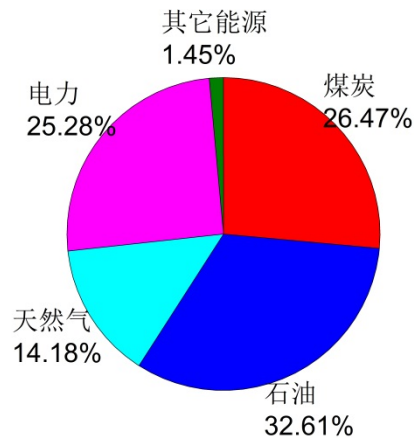
“国十条” 要求：

➤ 2017年京津冀煤炭总量削减6300万吨，新增天然气用量500亿立方米

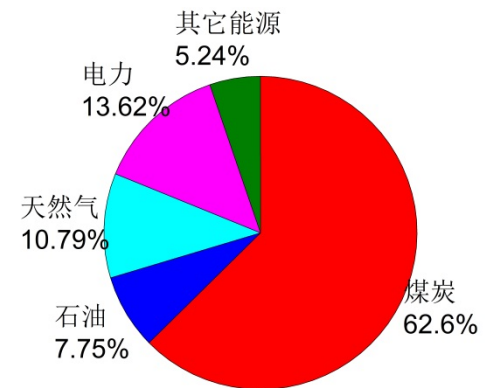
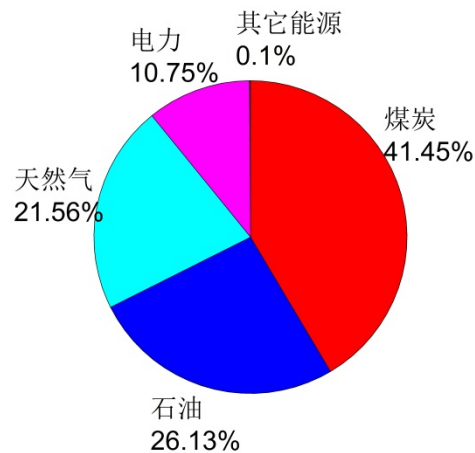
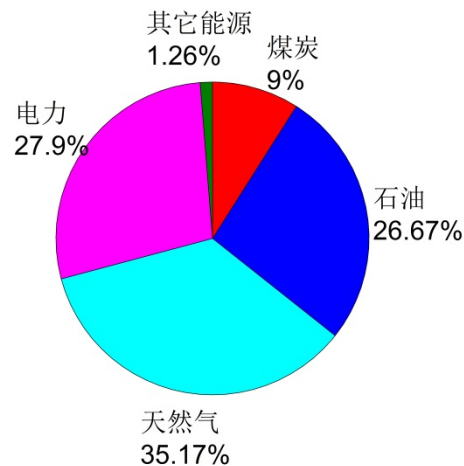
Impact Analysis by 10 Measures (2)

主要能源品种消费比重

2012



2017

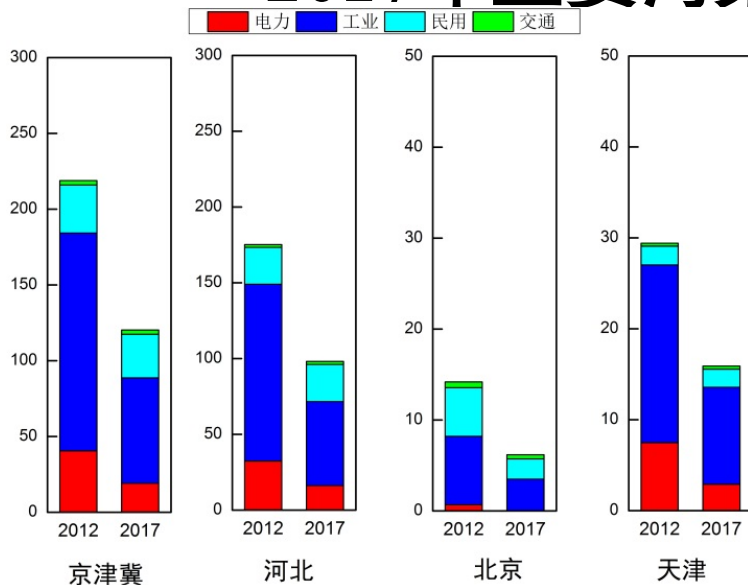


Impact Analysis by 10 Measures (3)

2017年主要污染物排放下降幅度

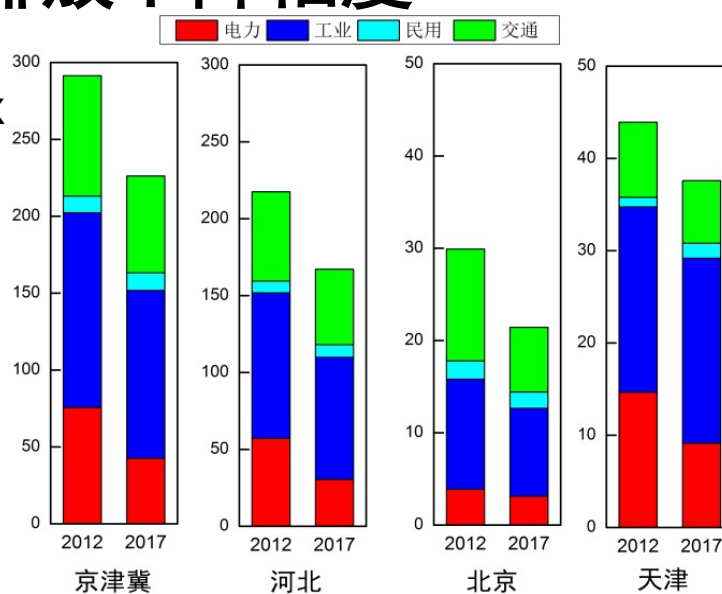
SO₂

-45%



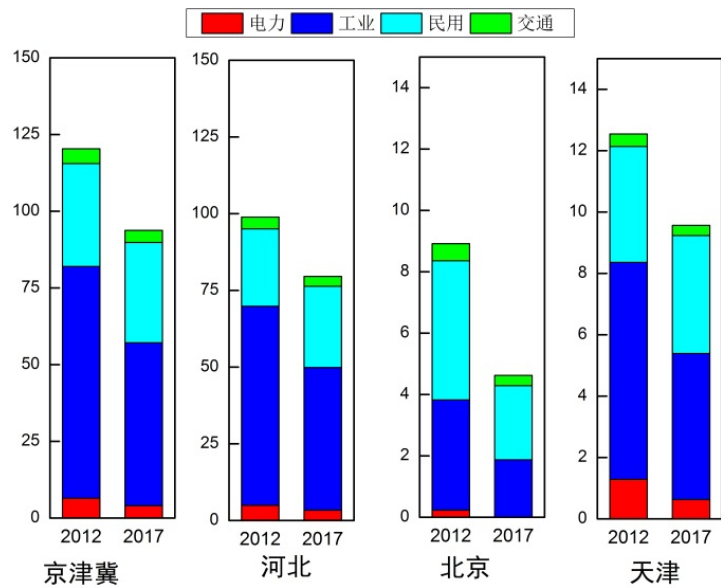
NO_x

-22%



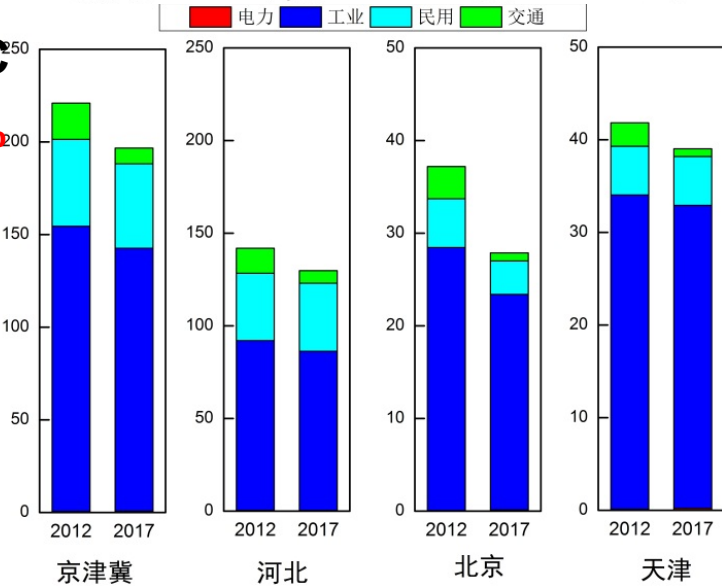
PM_{2.5}

-22%



VOC

-11%

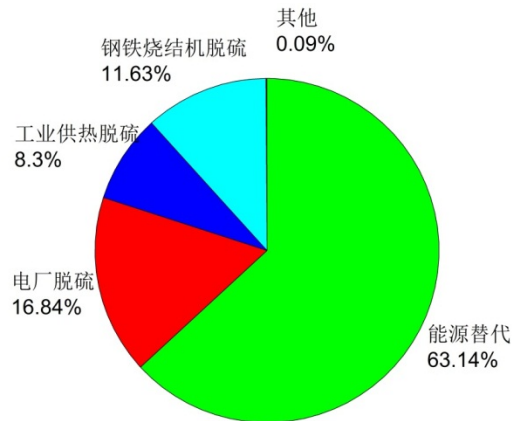


单位: 万吨

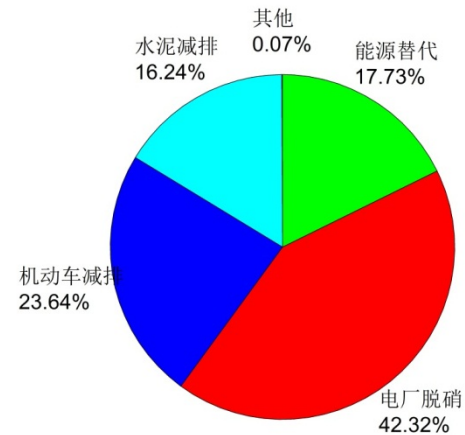
Impact Analysis by 10 Measures (4)

主要控制措施的减排贡献

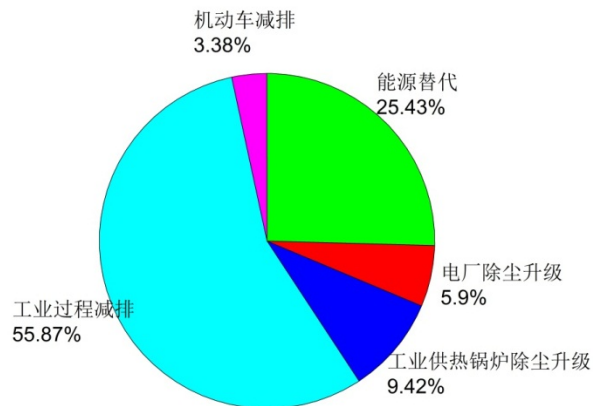
SO₂



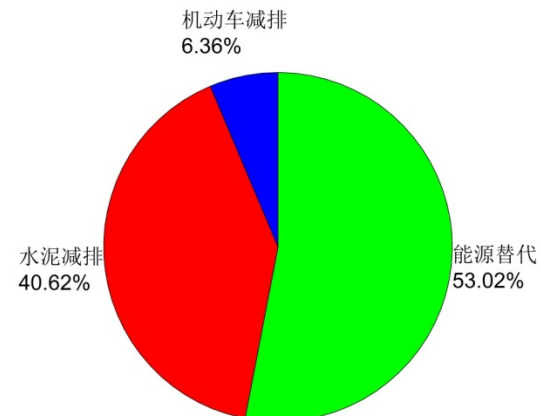
NO_x



PM_{2.5}

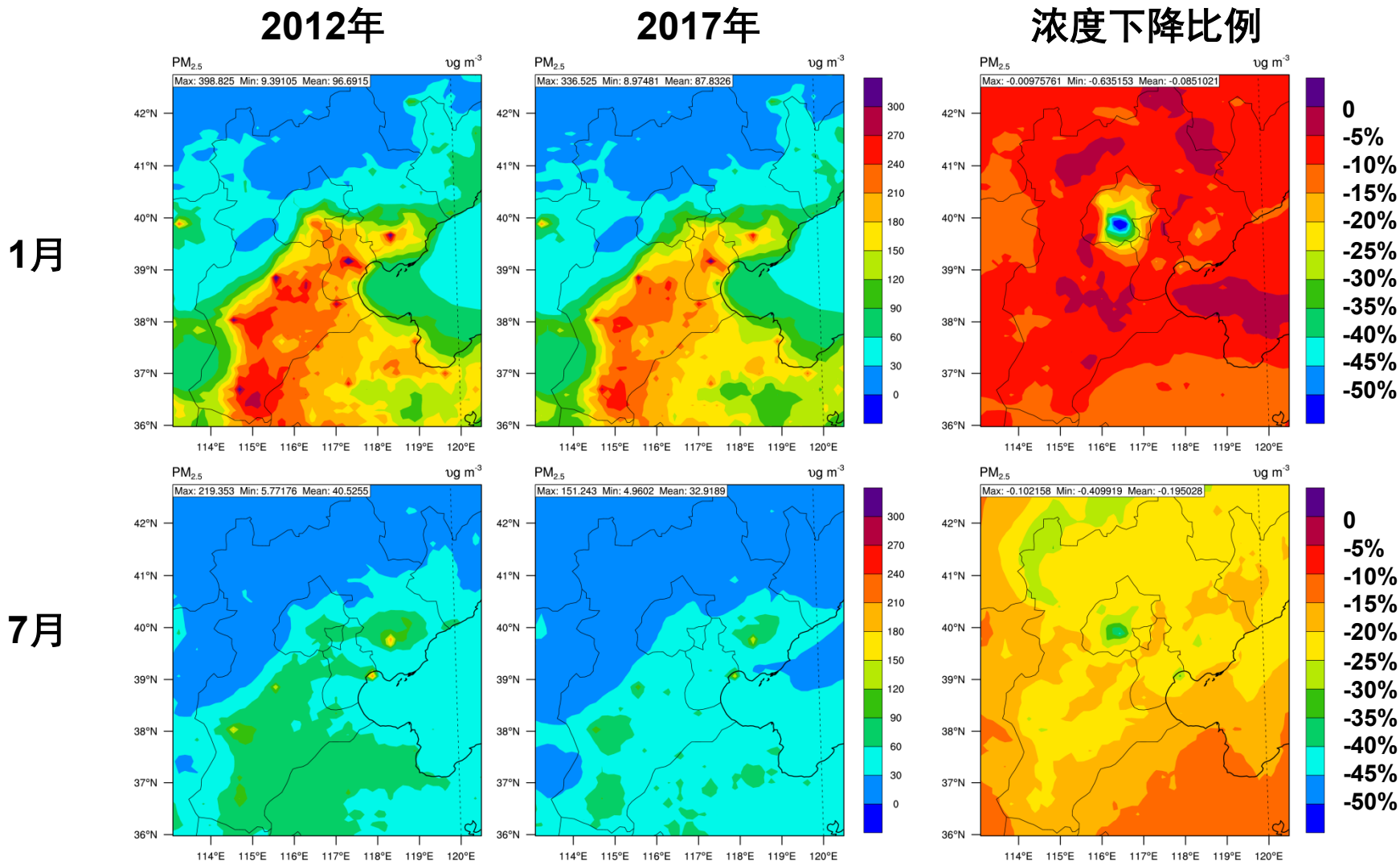


CO₂



Impact Analysis by 10 Measures (5)

实施“国十条”后2017年京津冀地区PM_{2.5}浓度下降情况



10 Measures

- 加强重点行业挥发性有机物综合治理，推广使用水性涂料、低挥发性溶剂
- 实施重点污染企业搬迁改造
- 实施建筑节能改造，推动绿色建筑发展
- 加强农村面源污染治理，开发缓释肥料新品种，减少化肥施用过程中氨的排放
- 。 。 。 。 。 。

Conclusions

- 京津冀地区是中国细颗粒物污染最重的地区之一，具有浓度绝对值高、区域性特征明显、二次组分比例高等特点。
- 大气“国十条”针对京津冀地区一次颗粒物及二次颗粒物气态前体物排放强度高的特点，针对重点排放源提出了强有力的控制对策。
- 依据现行可明确量化措施的初步分析结果表明，实施“国十条”后，京津冀地区PM_{2.5}浓度降幅显著，但仍有部分地区存在达不到2017年浓度降低25%的风险。
- 各地区需要对“国十条”进行细化，逐一明确量化各类控制措施，将“国十条”落实为实际的污染物减排量。
- 同时应当加大对NO_x、VOC、NH₃的控制力度，实现PM_{2.5}多组分协同减排。

Thanks !