

Air Quality Problems in Eastern Asia and Issues in Shanghai City

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Overview

1. Air quality status in China
2. Regional and urban air quality in YRD
3. Future pressures in YRD
4. Conclusion

1. 中国大气污染状况

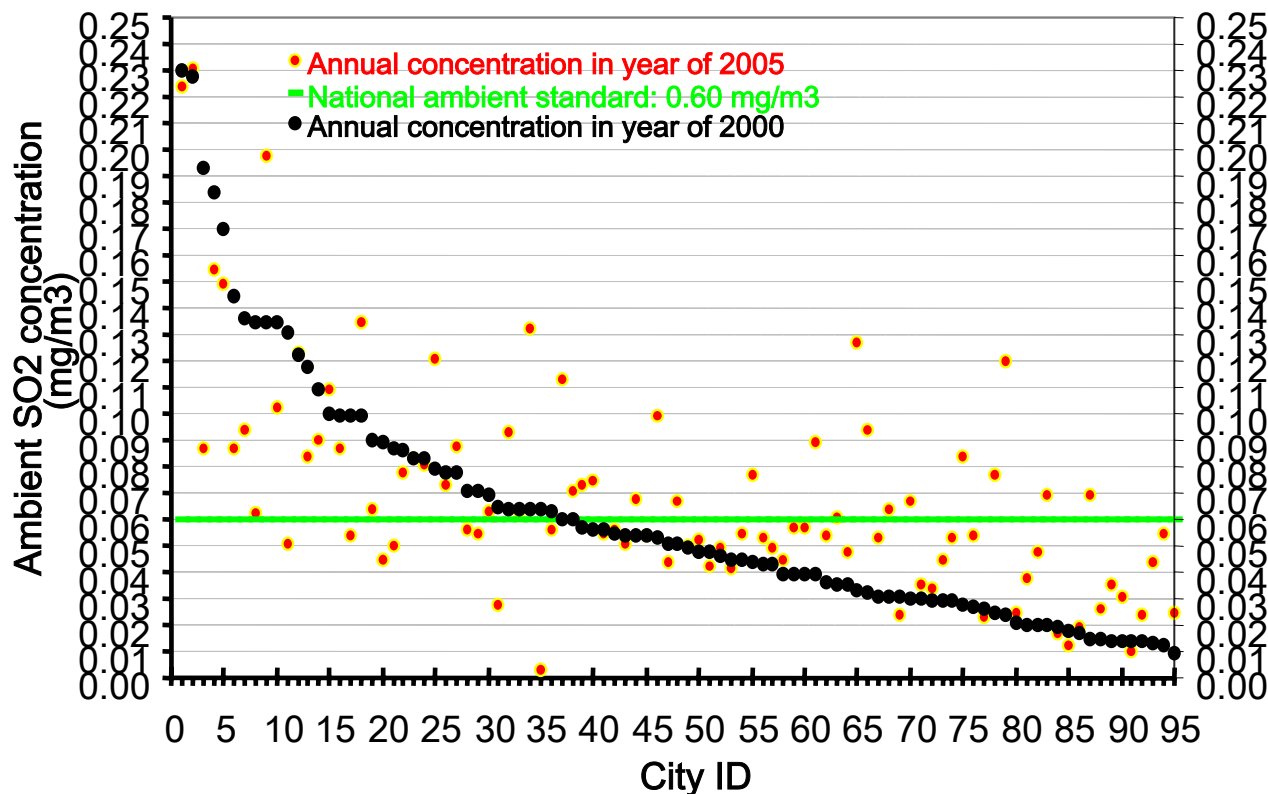
1. Air quality status in China



1.1城市空气质量总体上在改善,SO₂高浓度污染显著降低,但低浓度在恶化



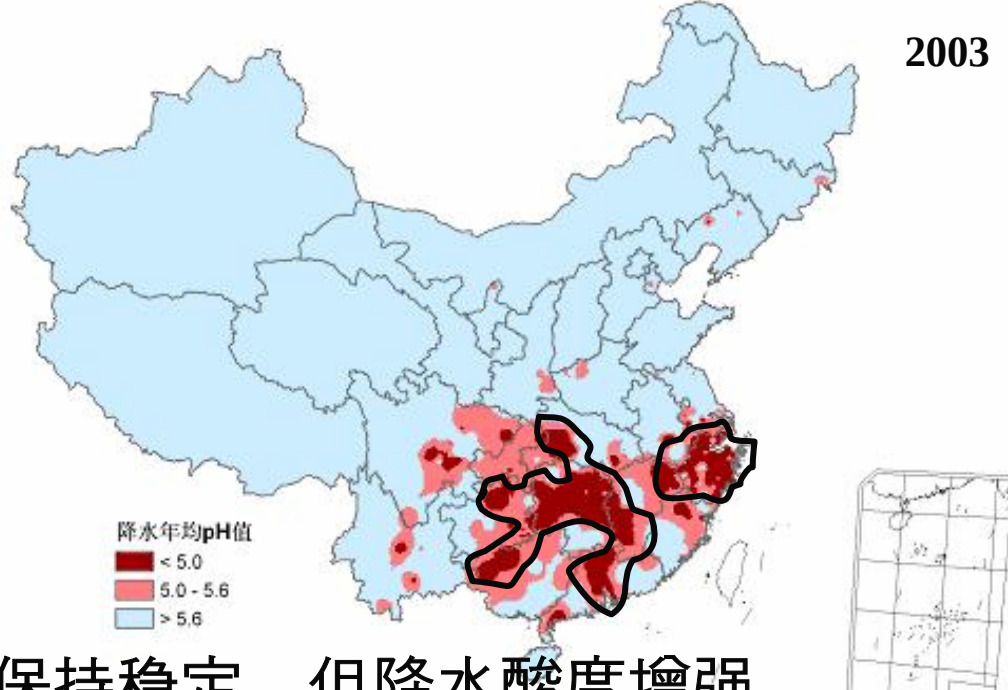
Urban air quality has been improved in the 10th five-year from 2000 to 2005, the improvement is obvious in decreasing the high concentration of SO₂ in some cities, but the low concentration of SO₂ in some cities are getting worse.



2002



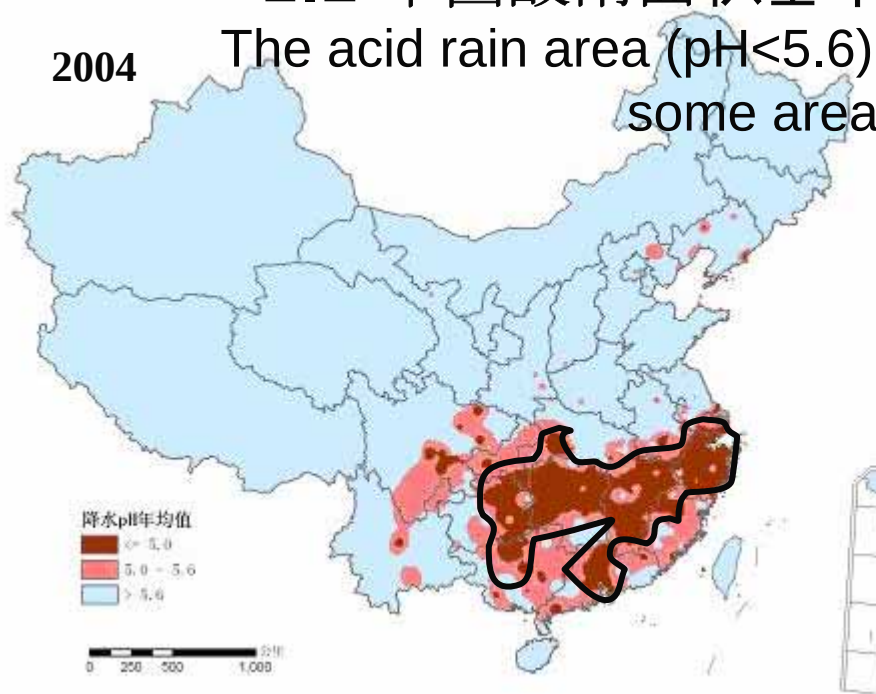
2003



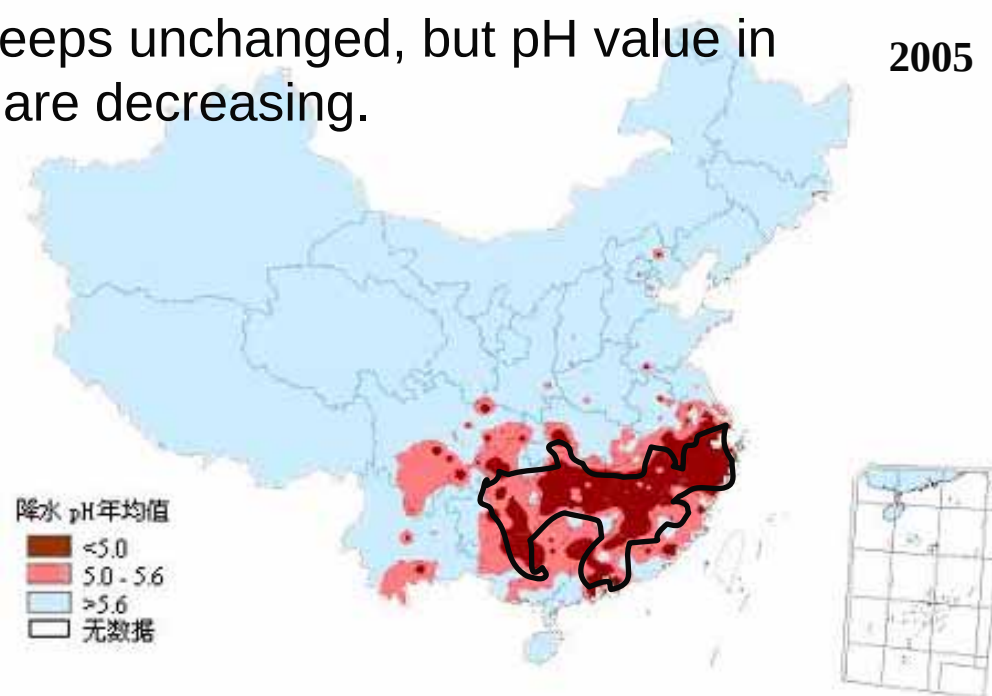
1.2 中国酸雨面积基本保持稳定, 但降水酸度增强

The acid rain area (pH<5.6) keeps unchanged, but pH value in some areas are decreasing.

2004



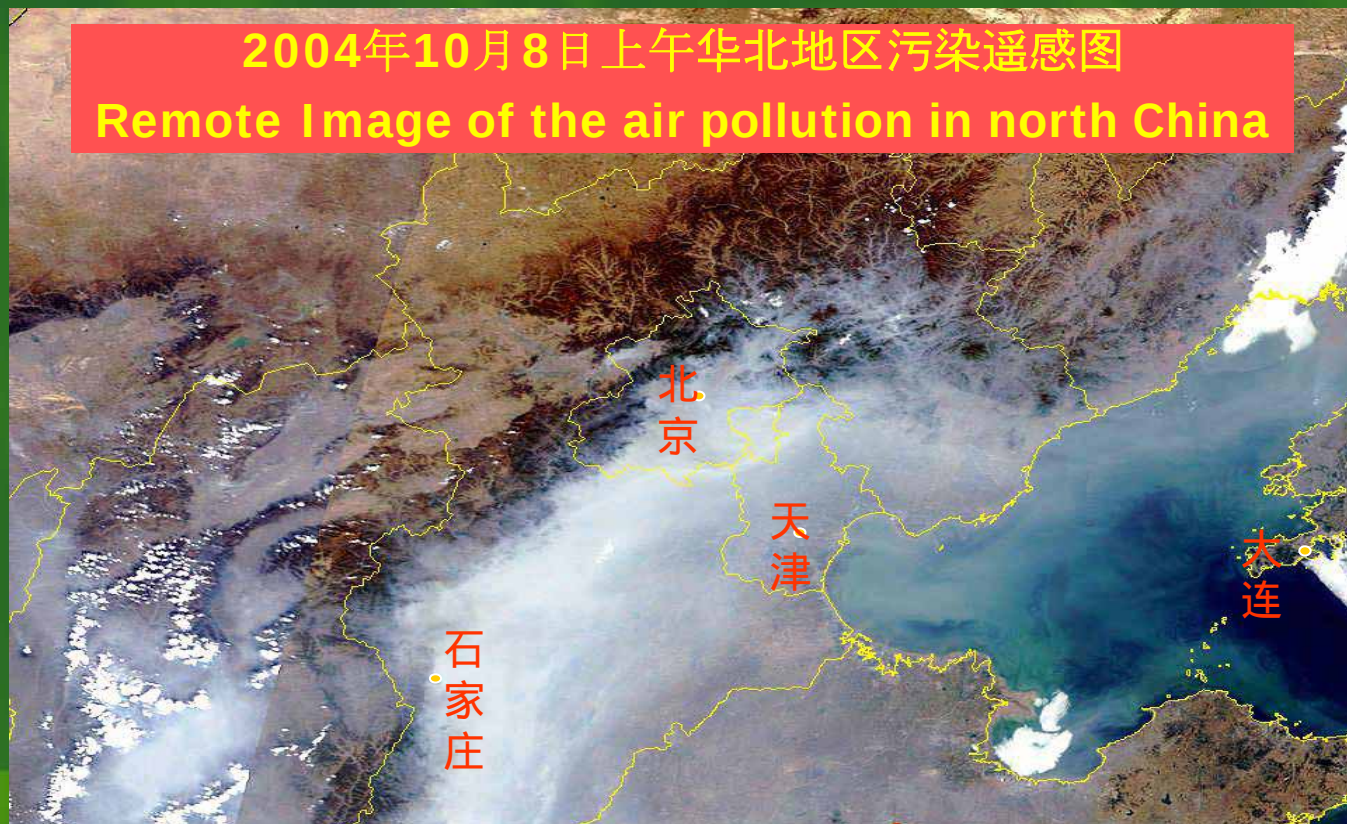
2005



1.3 区域污染源与本地污染源的共同作用导致某些地区出现复合型空气污染,细颗粒和臭氧升高,能见度降低



Regional and local air pollutant emission sources cause heavy and complex air pollution in some regions, e.g. Big Beijing area, Yangtze River Delta (YRD), and Pearl River Delta (PRD) with high level fine particle matter and ozone and poor visibilities.





1.4 在某些不利气象条件下，区域性灰霾频繁出现

Badly visibility frequently emerges in some extreme meteorological conditions.

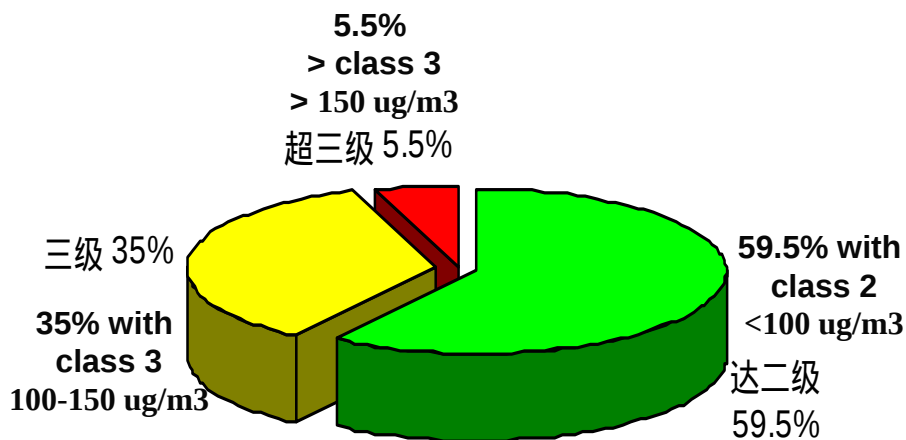


1.5 城市空气颗粒物、SO₂污染状况

Many people expose to high level of air pollutions



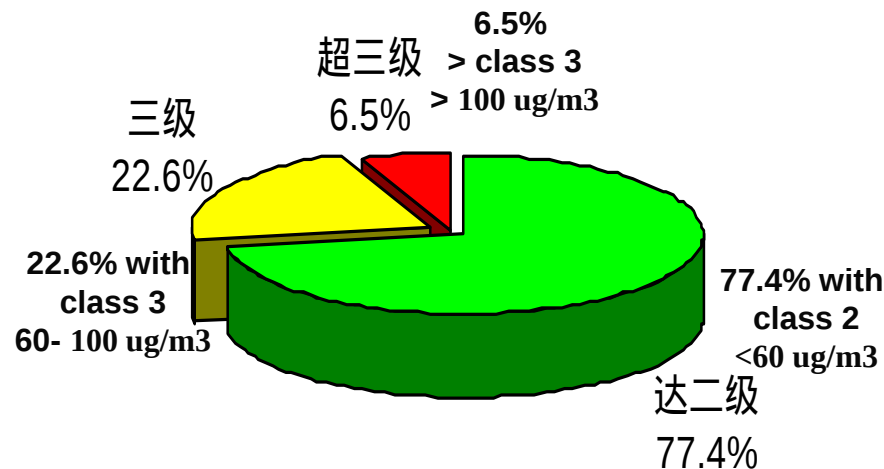
PM



522cities monitored
In 2005

2005年监测522个城市

SO₂



522cities monitored
In 2005

2005年监测522个城市

造成中国空气污染的主要原因

The driving forces of air pollution in China





造成空气污染的主要原因

The driving forces of air pollution in China

1. 经济高速增长,主要耗能产品大幅增加
Rapid growth of economics in the past years, and fast increase of products with high energy consumptions.



造成空气污染的主要原因

The driving forces of air pollution in China

2. 火电厂SO₂排放量大幅度增高

Big increase of SO₂ emission from power plants, due to:

- 电力发展十分迅速

Rapid development of power generation

- 发电机组SO₂超标排放普遍存在

Exceedance of SO₂ emission from power plants are ubiquitous



造成空气污染的主要原因

The driving forces of air pollution in China

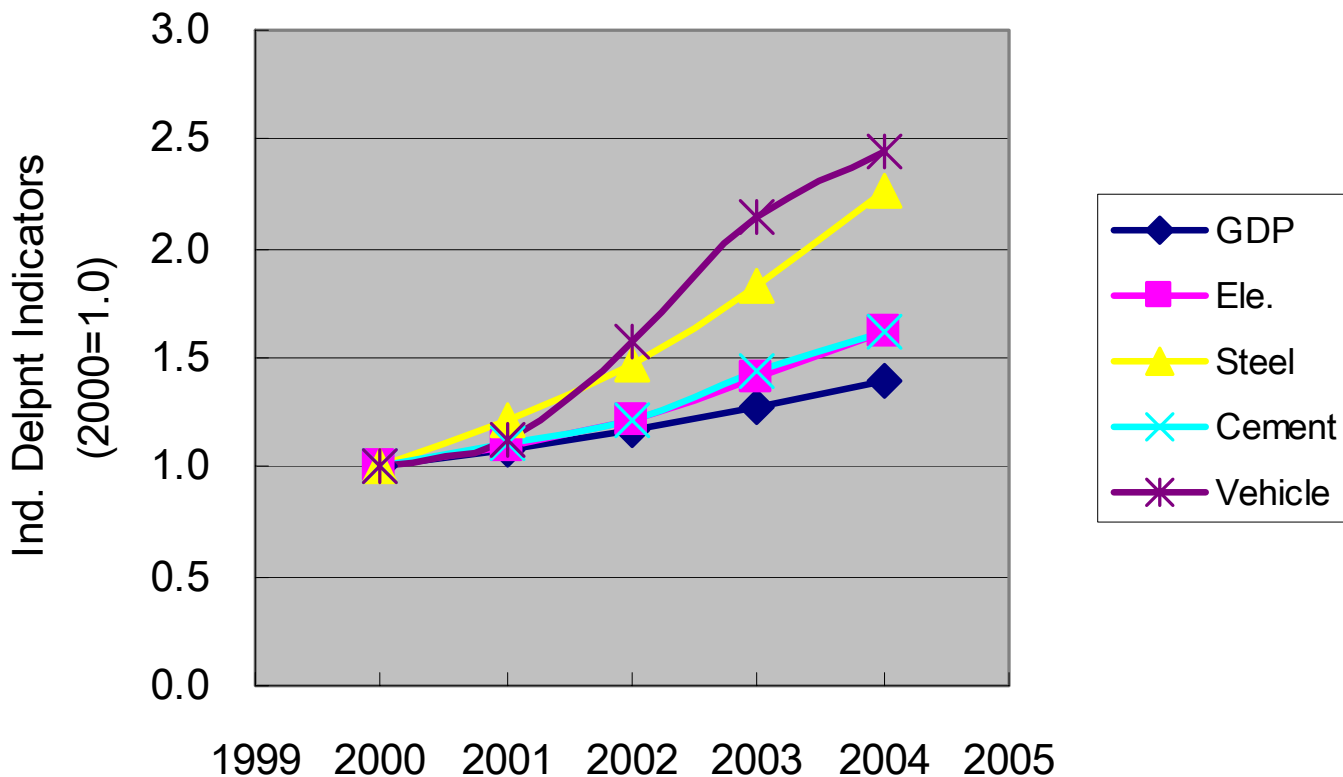
3. 污染控制力度滞缓于排放量增长速度

Pollution control policy steps slowly to follow up the emission increase or air pollution trends

1. 经济高速增长, 主要耗能产品大幅增加

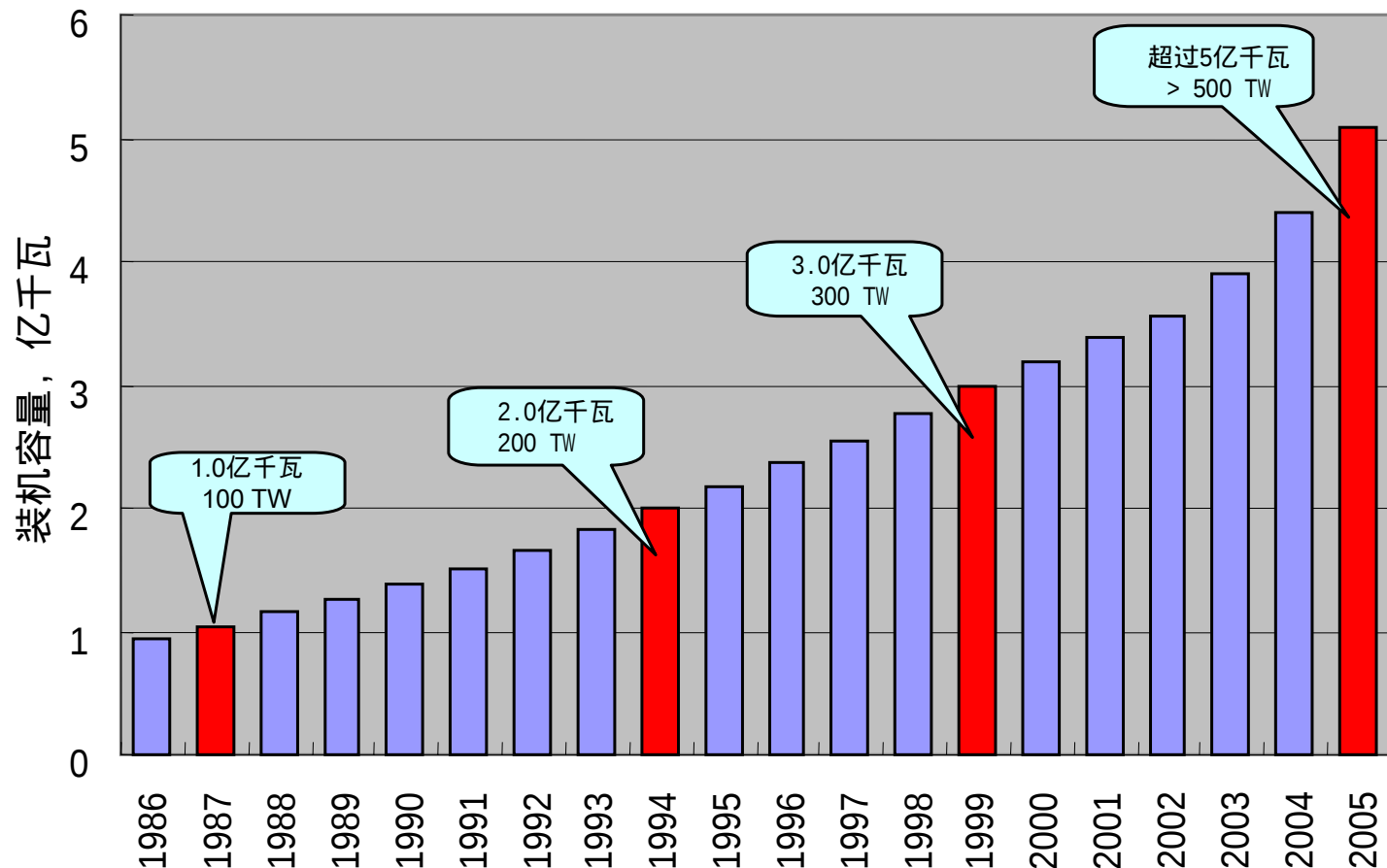


Rapid growth of economics in the past years, and fast increase of products with high energy consumptions



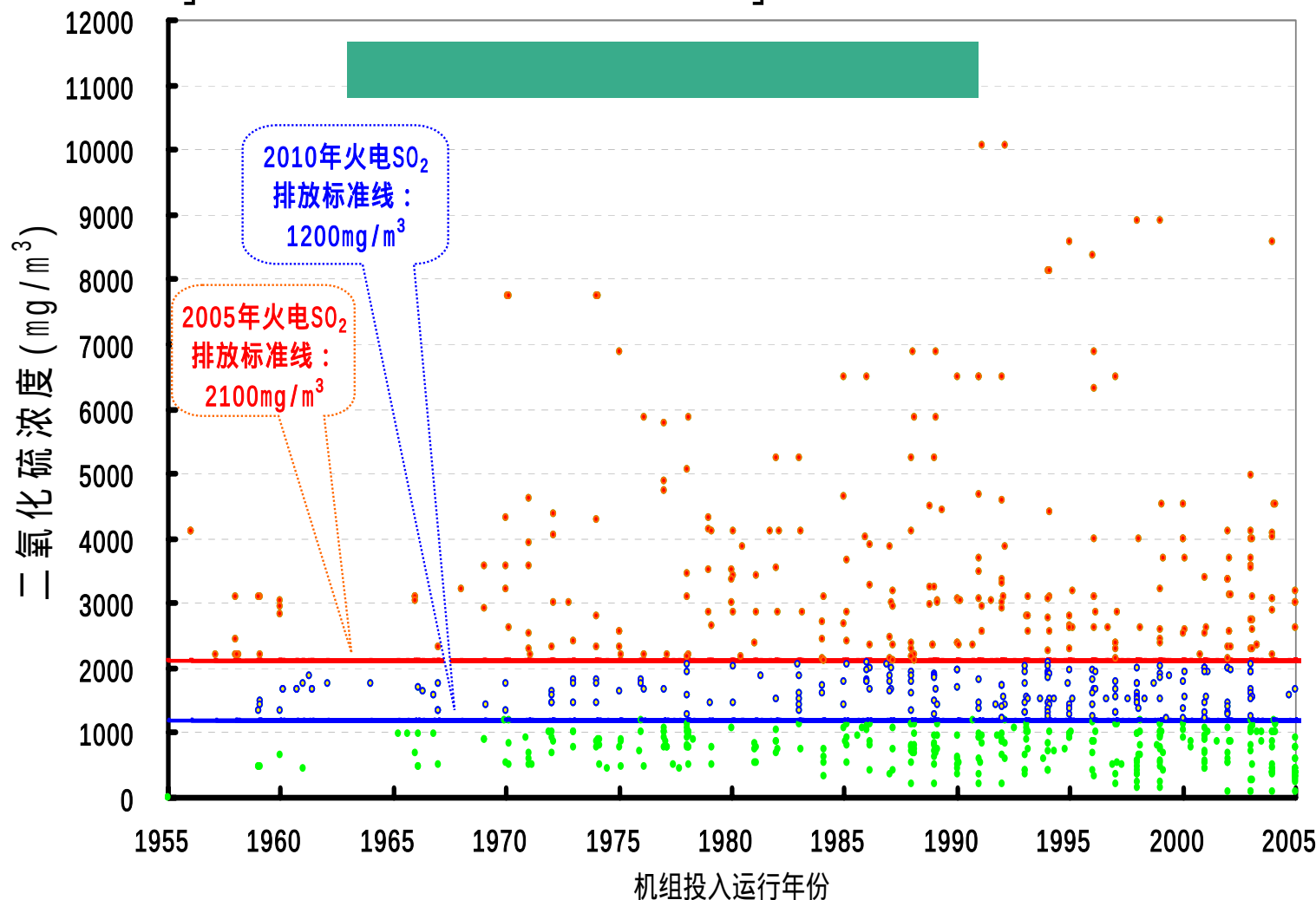
2. 电力发展十分迅速

Capacity of power plants were growing in an amazing speed.



3. 发电机组SO₂超标排放普遍存在

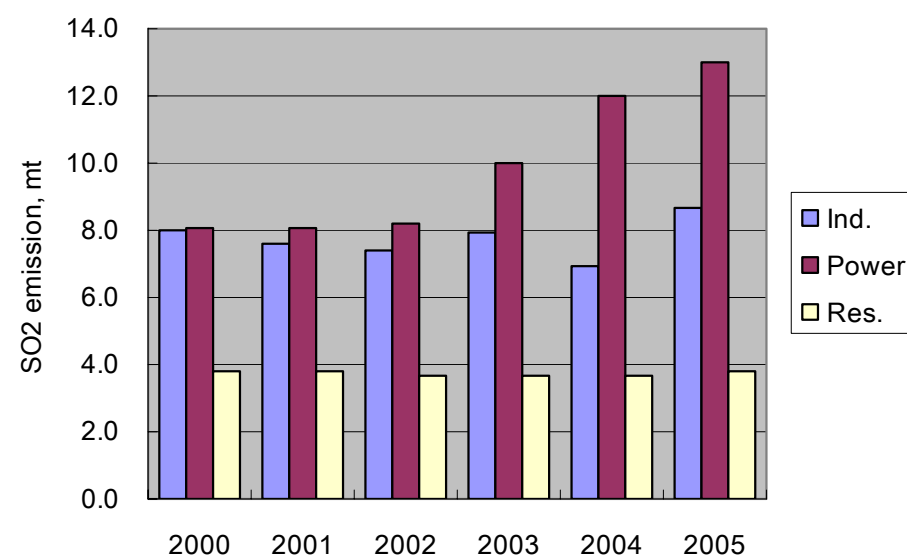
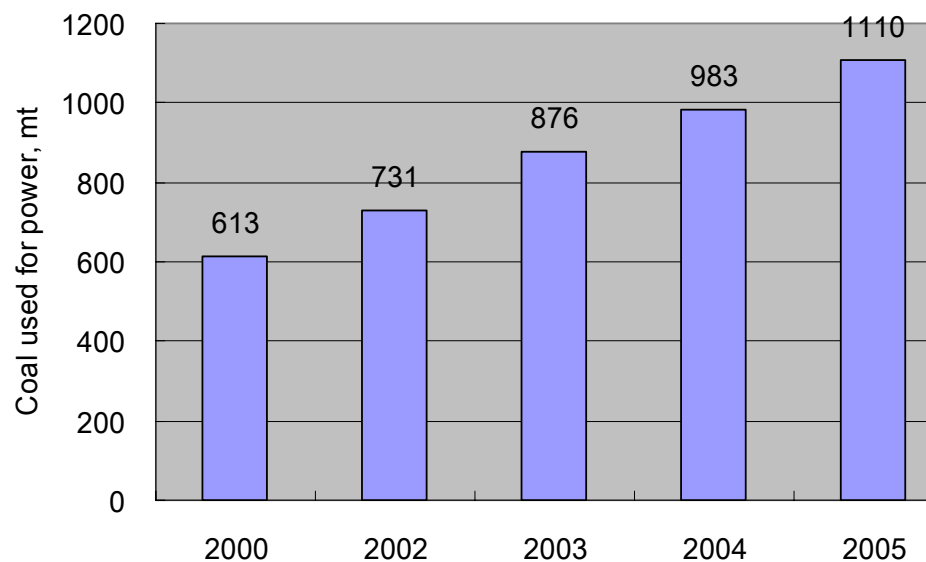
Exceedance of SO₂ emission from power plants are ubiquitous.



4. 火电厂SO₂排放量大幅度增高 Big increase of SO₂ emission from power plants.



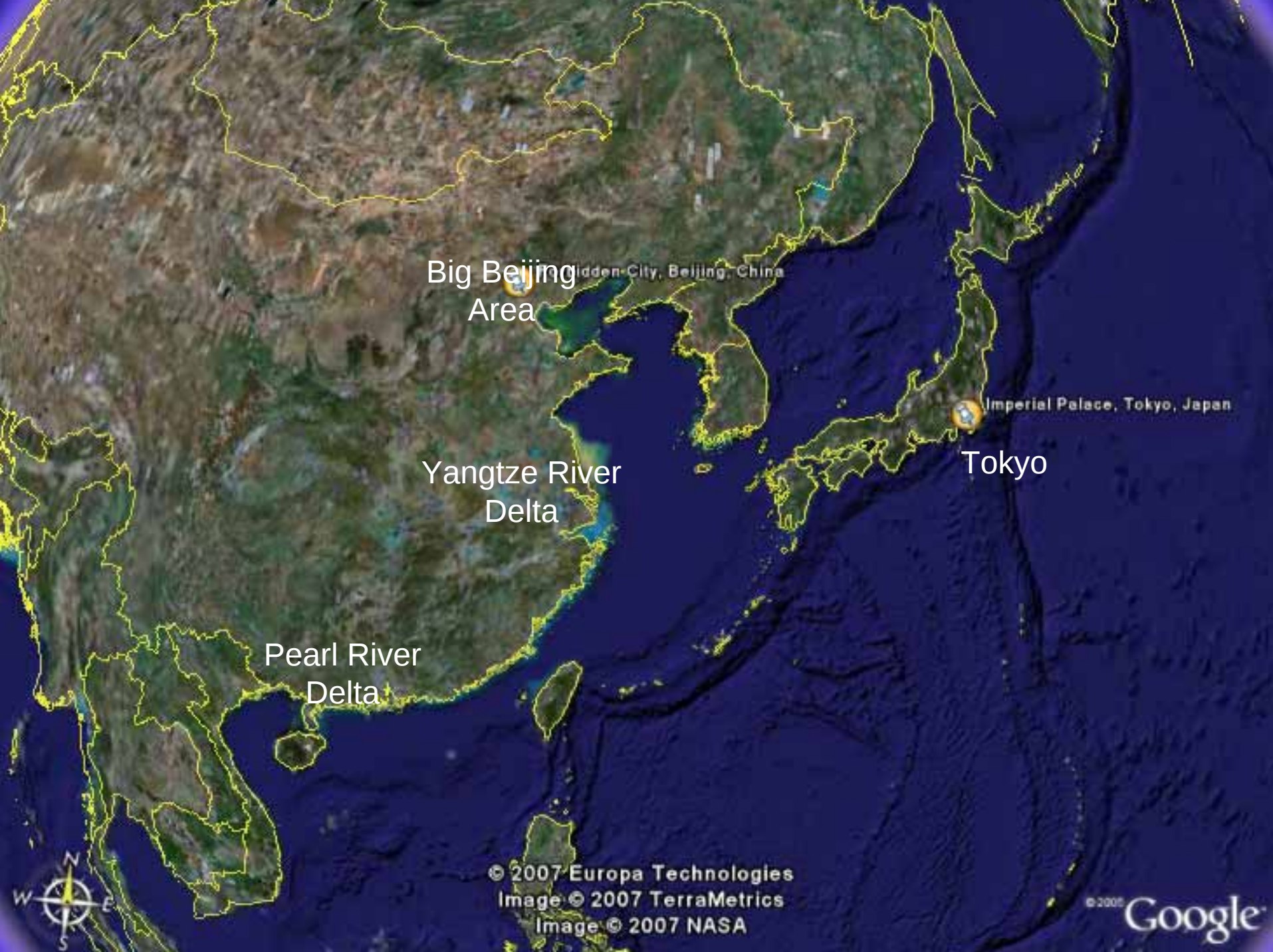
- ❖ 2005年全国发电用煤11.1亿吨，比2000年增加了5亿吨，SO₂增加了60%。
- ❖ The coal used for power generation was 600 million tons in 2000, and increased to 1.1 billion tons in 2005. Total amount of SO₂ emissions in 2005 was 60 % higher than



2. 长三角区域大气污染状况

Regional and urban air quality status in Yangtze River Delta





Big Beijing
Area

Hidden City, Beijing, China

Yangtze River
Delta

Pearl River
Delta

Imperial Palace, Tokyo, Japan

Tokyo

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Image © 2007 TerraMetrics
Image © 2007 NASA

© 2005 Google



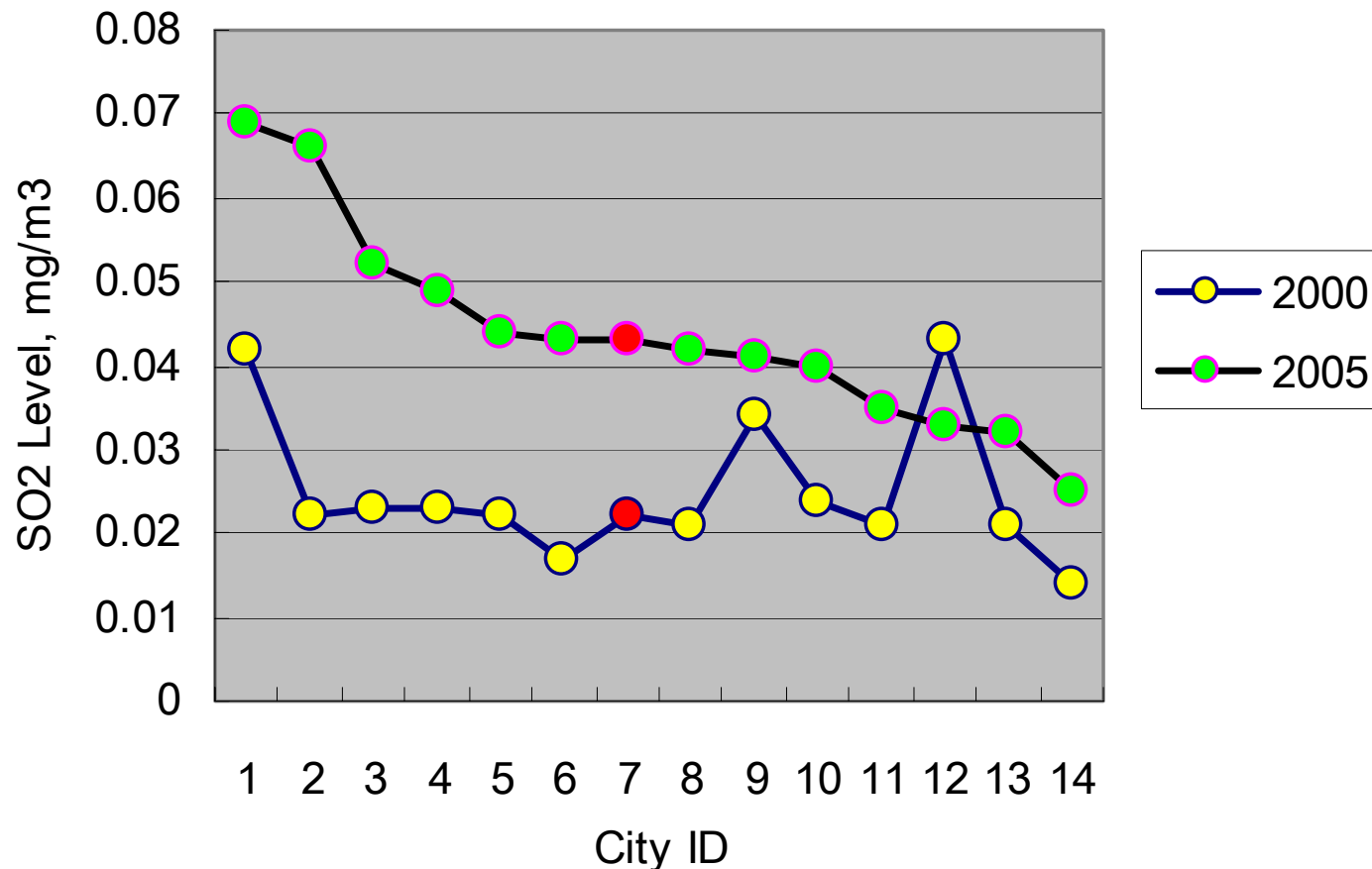
- ❖ YDR: 16 Cities
- ❖ Population : 6 %
- ❖ Land: 1 % of national territory
- ❖ GDP: > 20 %
- ❖ GDP per capita: 4-5 times of national avg.



1. 2005年城市大气质量普遍高于2000年



SO₂ pollution level in the cities within YRD in 2005 was generally higher than 2000.

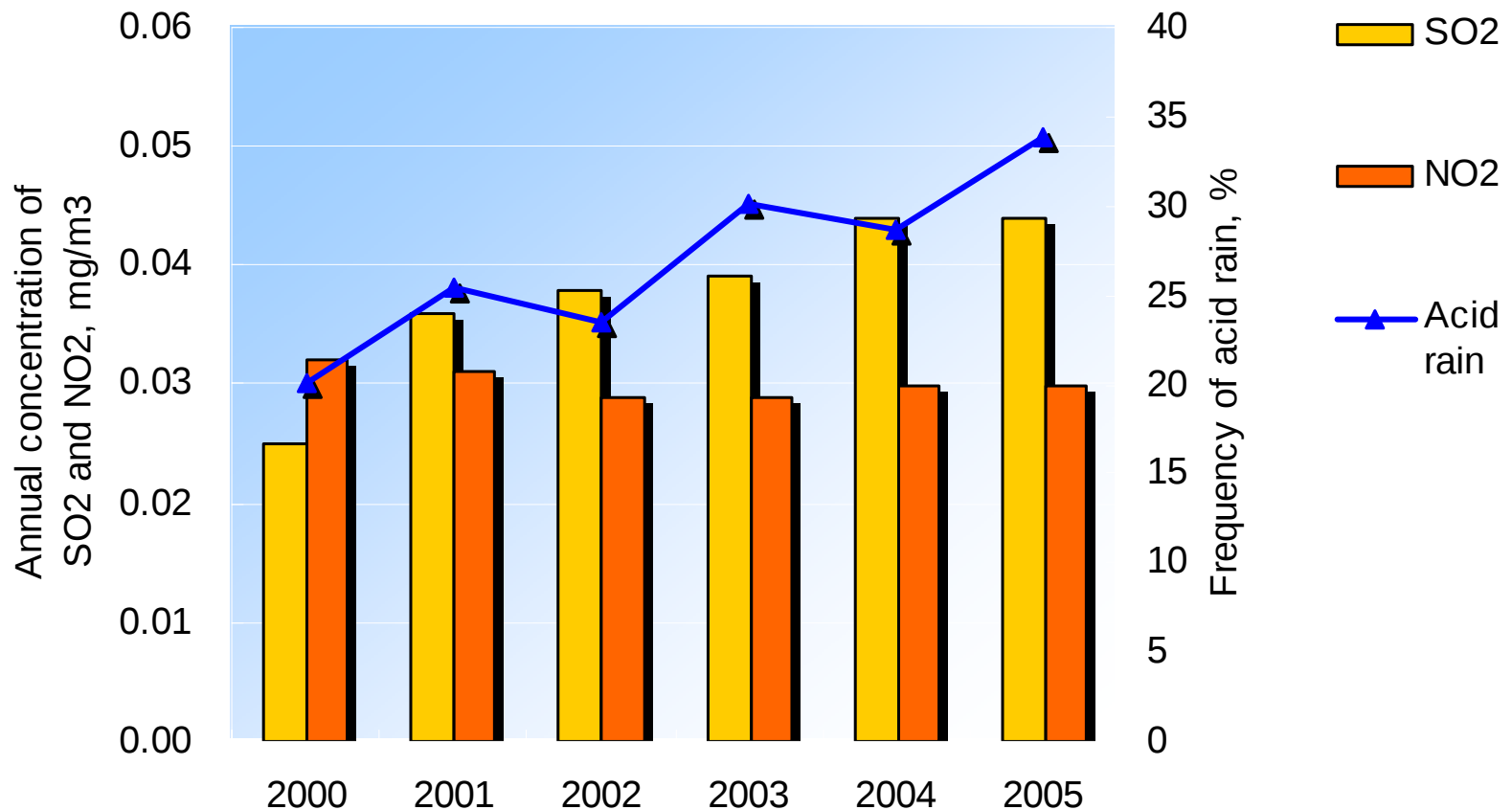


2. 2000~2005年SO₂和酸雨频率 普遍升高—江苏案例

JSEPB



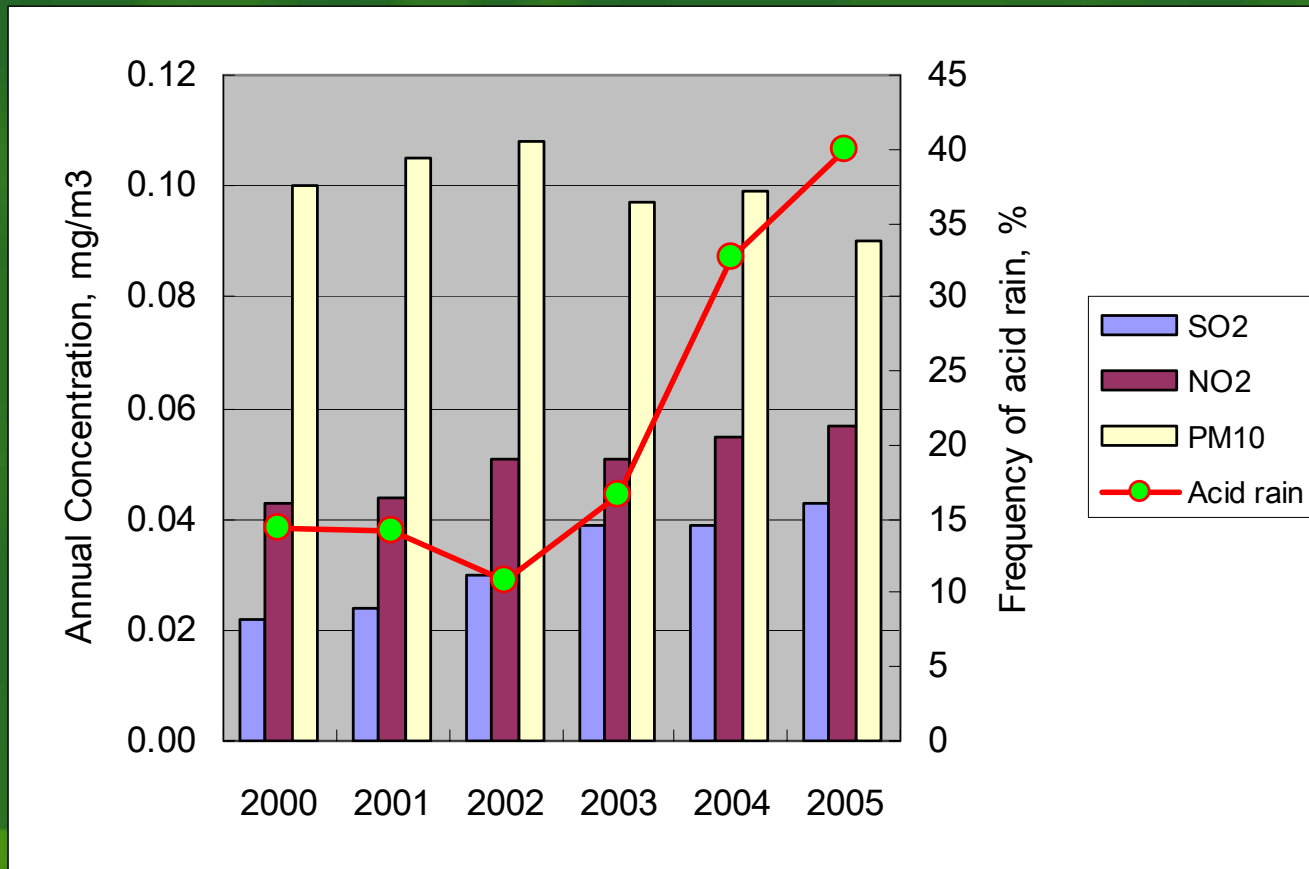
SO₂ concentration and the frequency of acid rain remains increasing in the past years from 2000 to 2005-Jiangsu case.



3. 2000~2005年SO₂、NO₂和酸雨频率 普遍升高—上海案例



SO₂, NO₂ concentrations and the frequency of acid rain keeps increasing in the past years from 2000 to 2005 - Shanghai case



造成长三角空气污染的主要原因

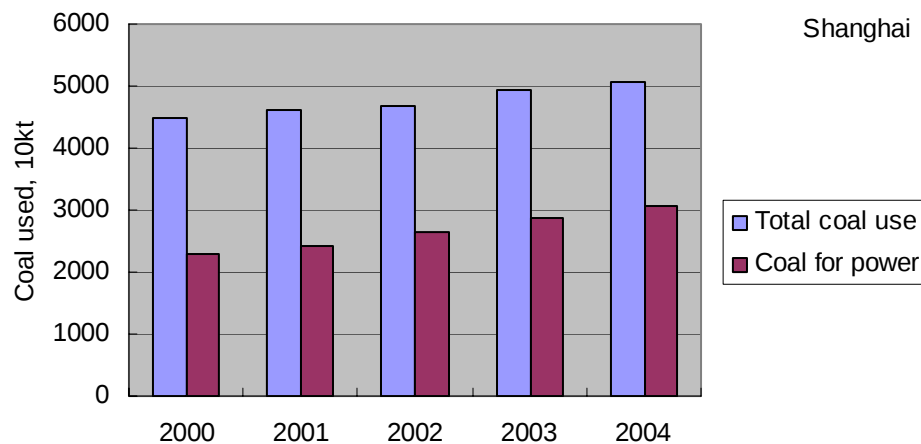
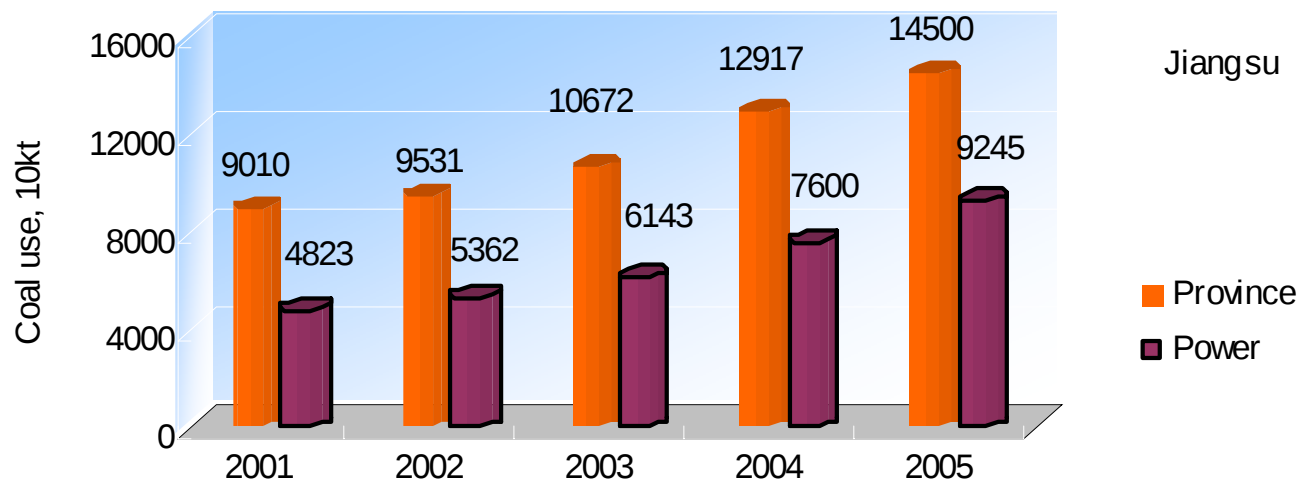
The driving forces of air pollution in YRD





1. 用煤量大幅增加

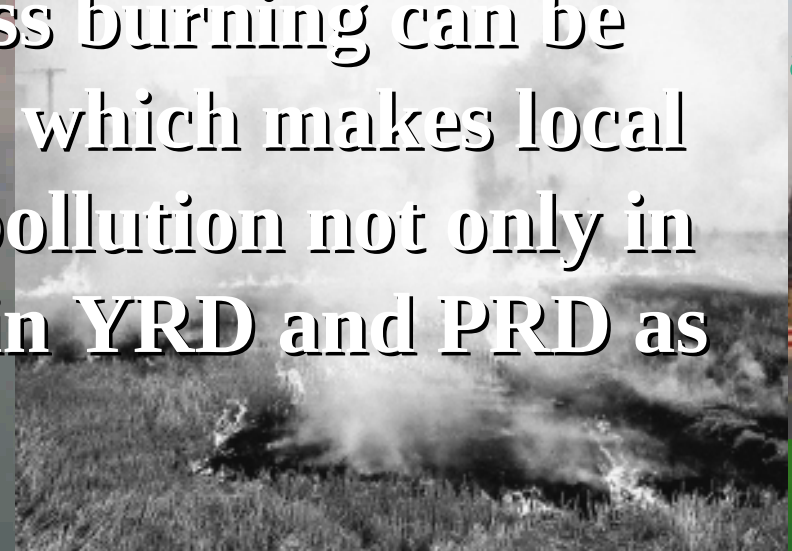
Rapid increase of coal use in YRD including Jiangsu and Shanghai





2. 工业、交通、农业和生物质燃烧随处可见，不仅造成本地而且造成大范围跨区大气污染

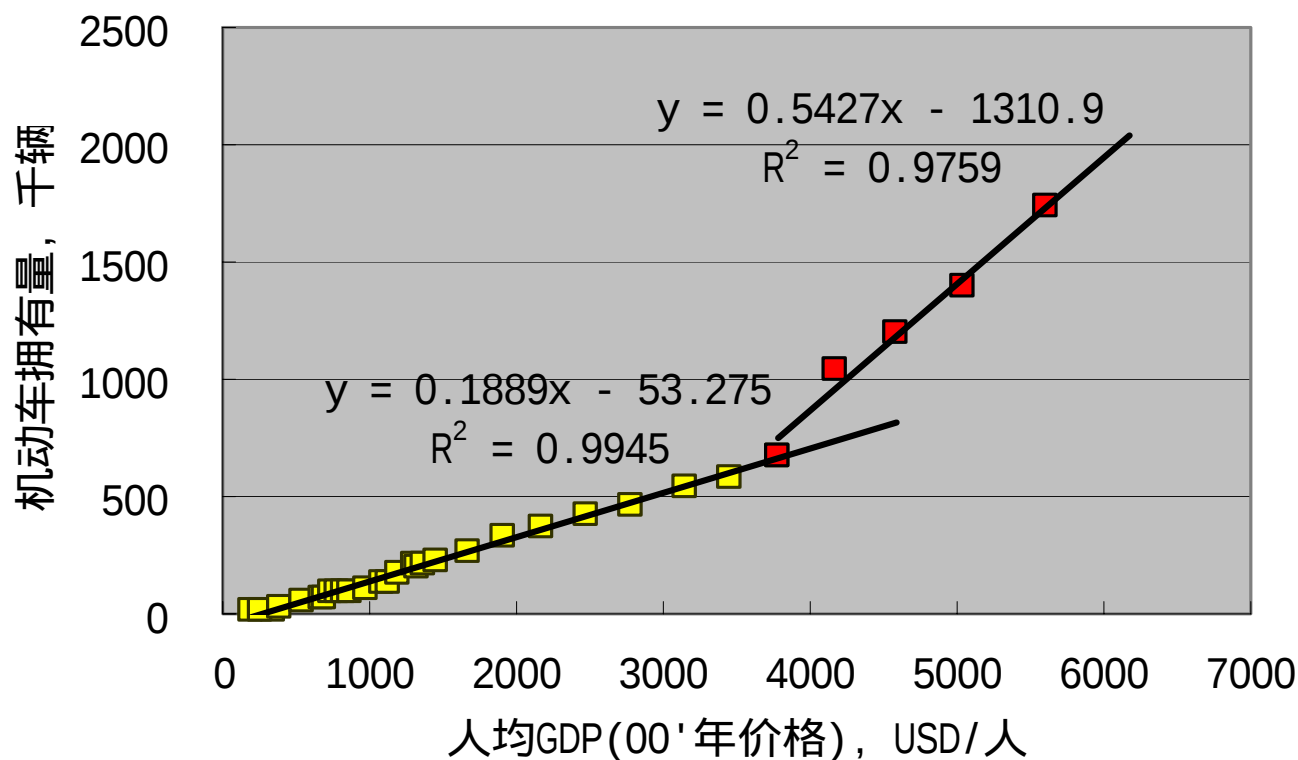
Industrial, transport, agricultural emissions and bio-mass burning can be easily found in China, which makes local and trans-boundary pollution not only in Big Beijing area, but in YRD and PRD as well.



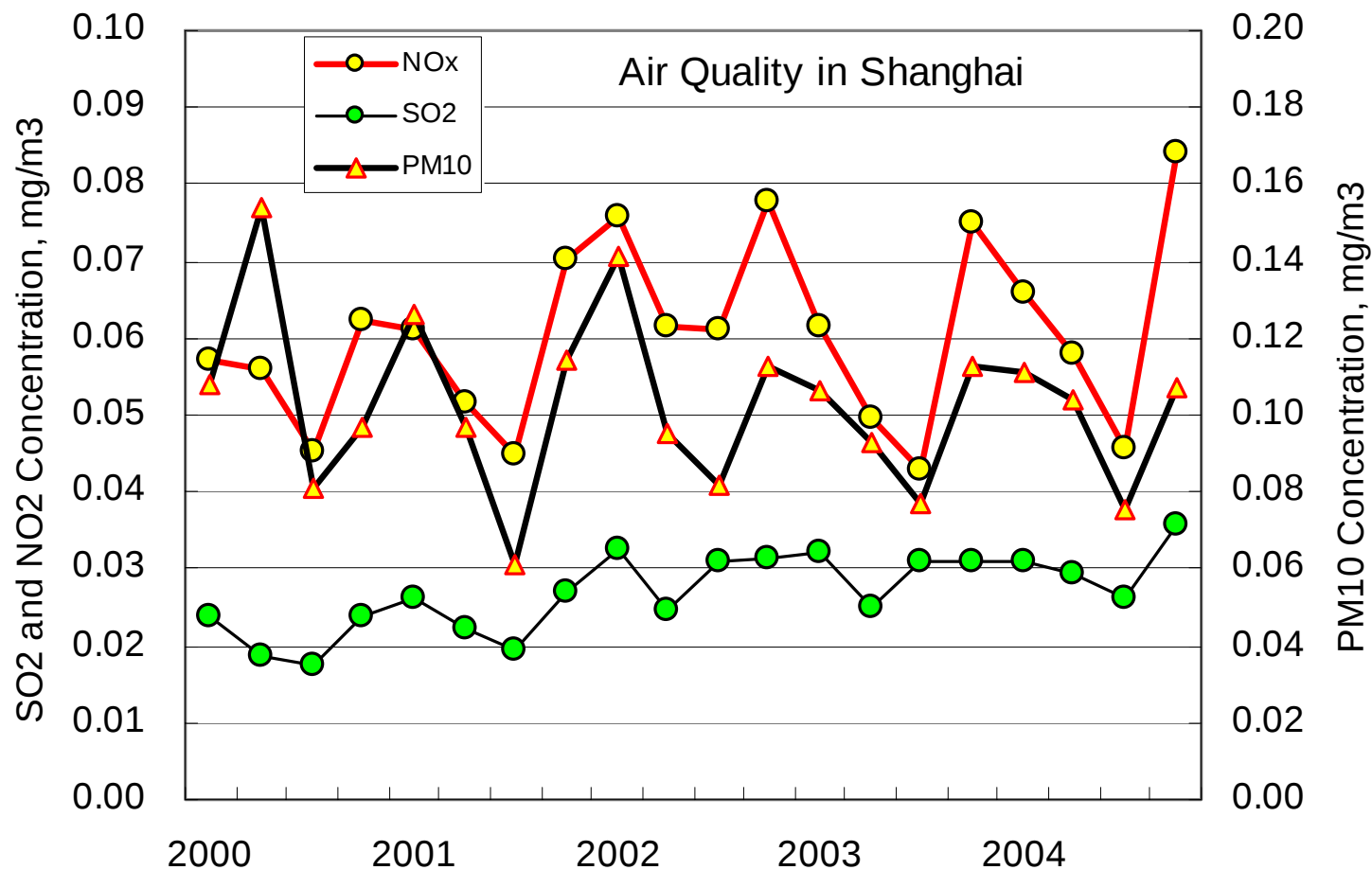
3. 人均GDP超过4000USD后，机动车保有量的增长速度明显加快

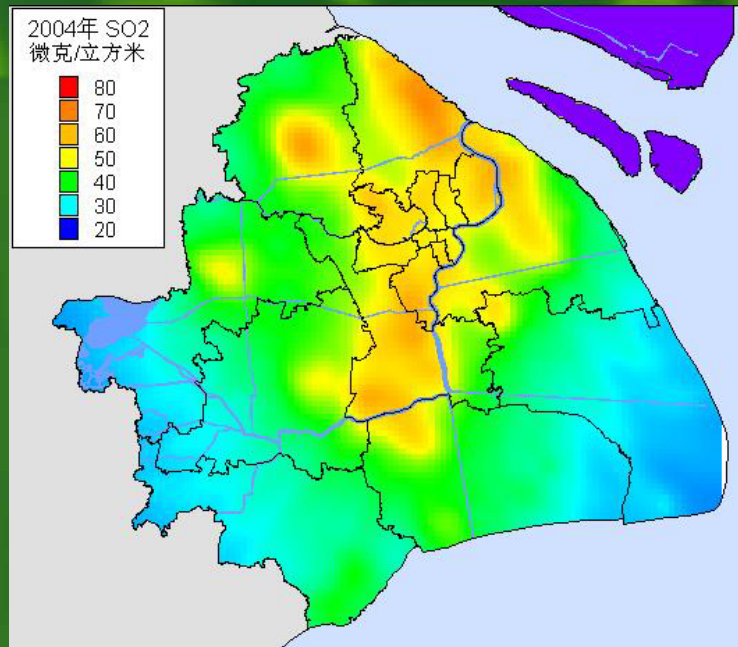


The growth speed of vehicle population is obviously fast when the GDP per capita is greater than 4000 USD.

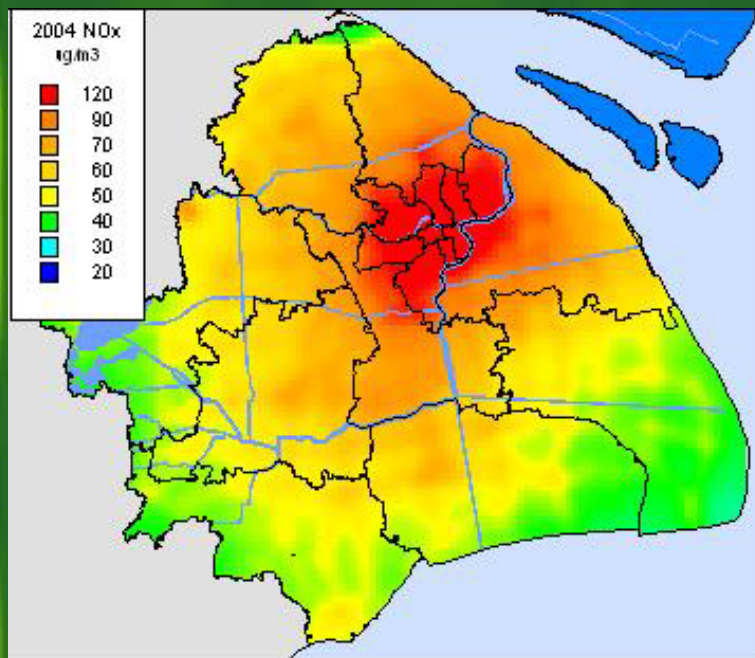


某些城市SO₂、NO₂和PM₁₀保持较高的水平. In some big cities, SO₂, NO₂ and PM₁₀ remains a high concentration.

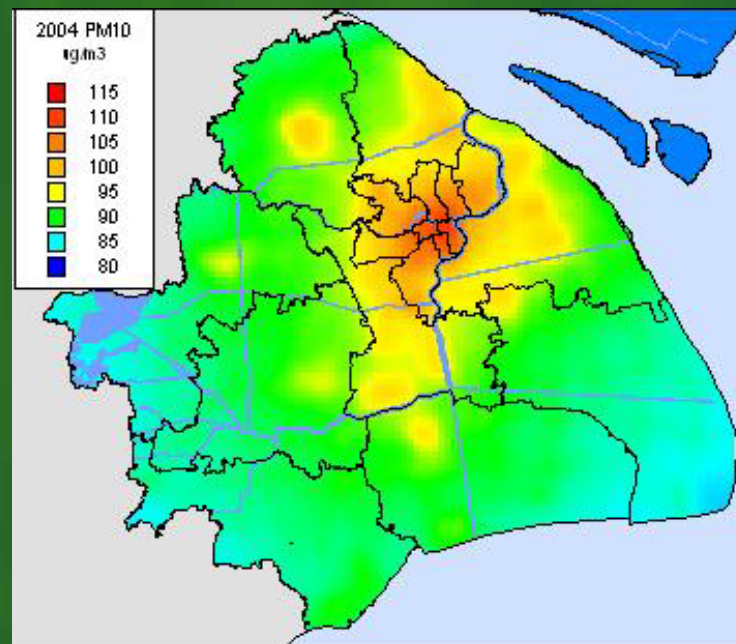




SO₂ pollution in
Shanghai, 2004



NO_x pollution in Shanghai, 2004



PM₁₀ pollution in Shanghai, 2004

3. 长三角未来面临的压力

Future pressures in Yangtze River Delta

-urban, and
-regional air qualities

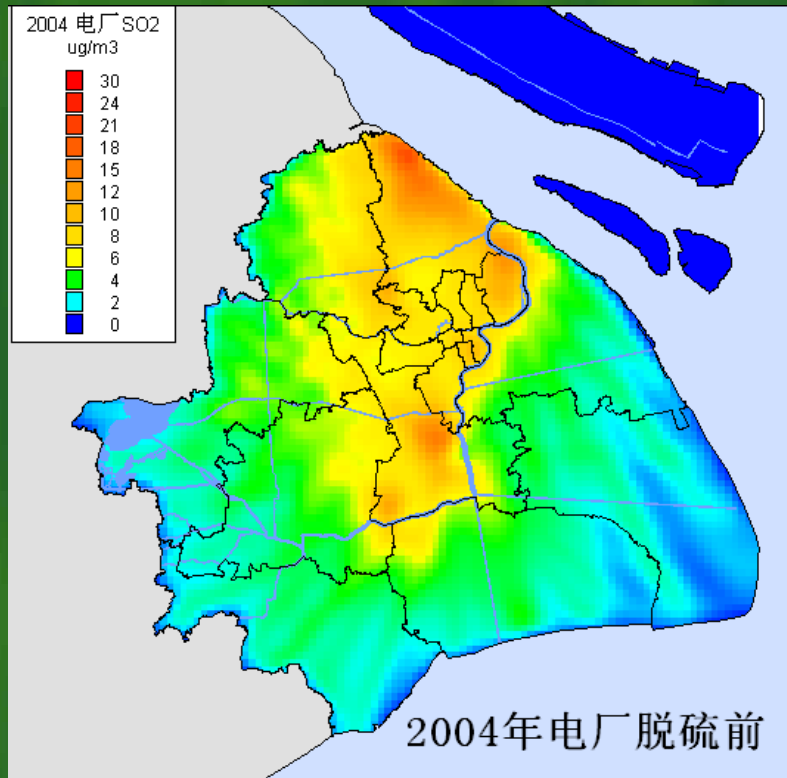


**1. First, let's look at urban, and
take Shanghai as an example**

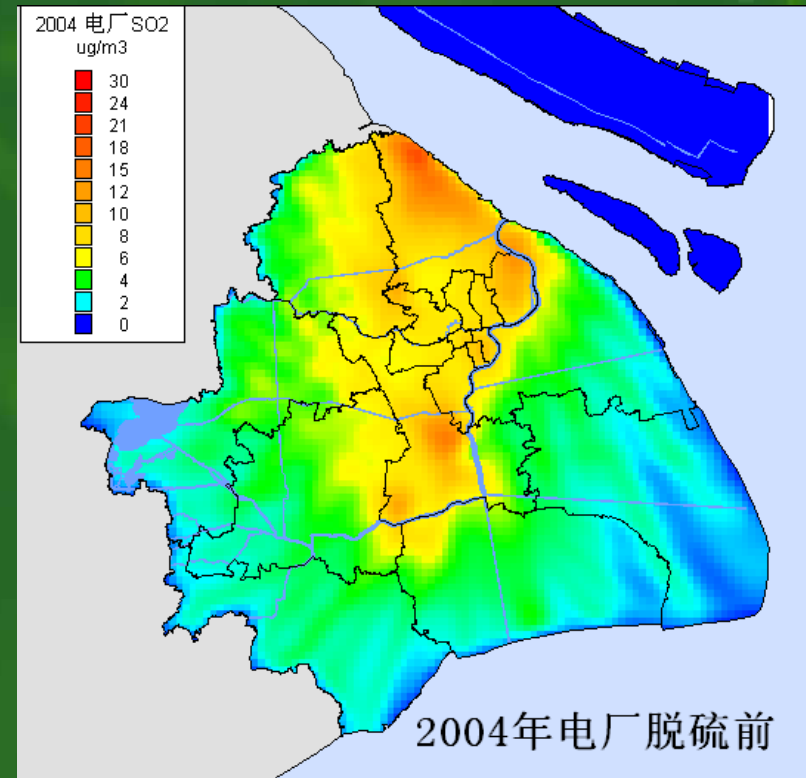


电厂脱硫前后环境效益的比较

Effect analysis of SO₂ Reduction



The concentration of SO₂ in downtown area would exceed Class II of NAAQS, if there were no effective measures in the coming years.

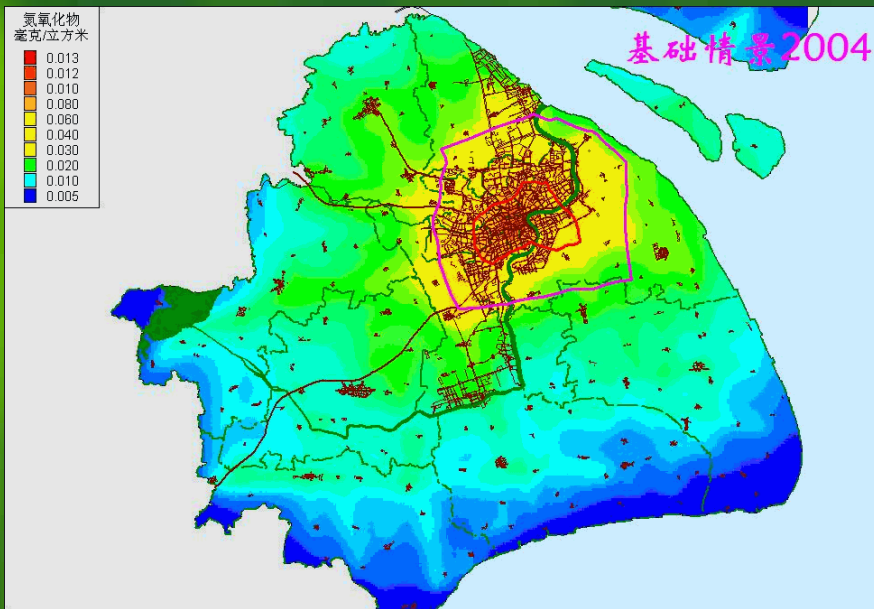


9.57 GW units must install DeSOx end pipe technologies, about 170kt SO₂ emission will be reduced by 2010.

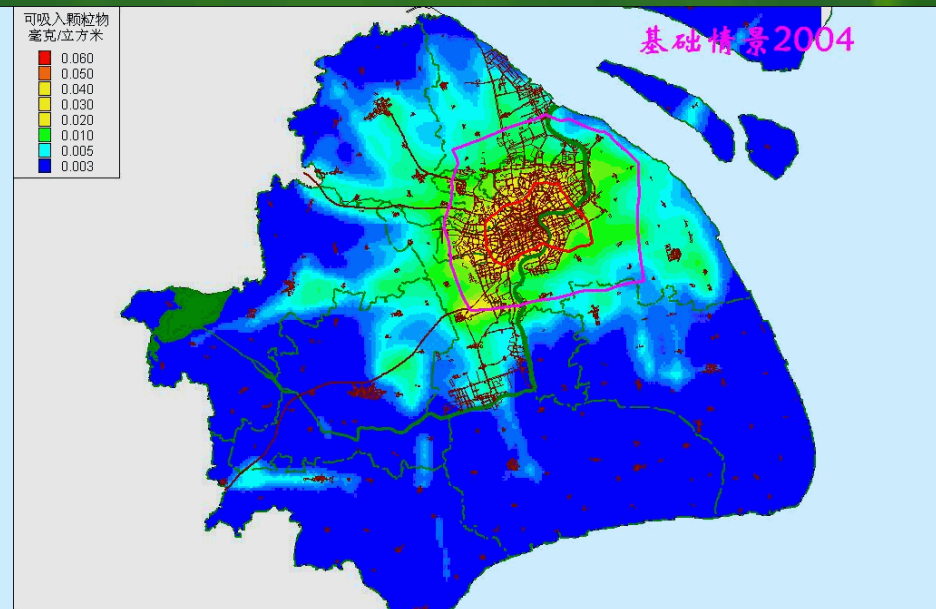


然而,因为NO_x和PM₁₀的控制政策和行动慢于排放增长速度,大气中NO_x含量还将继续升高

However, the NO_x and PM₁₀ concentration will remain increasing, since the pollution control policy and actions act slowly comparing to emission increase speed.



Trend of NO_x pollution
in BAU case, 2004-2020



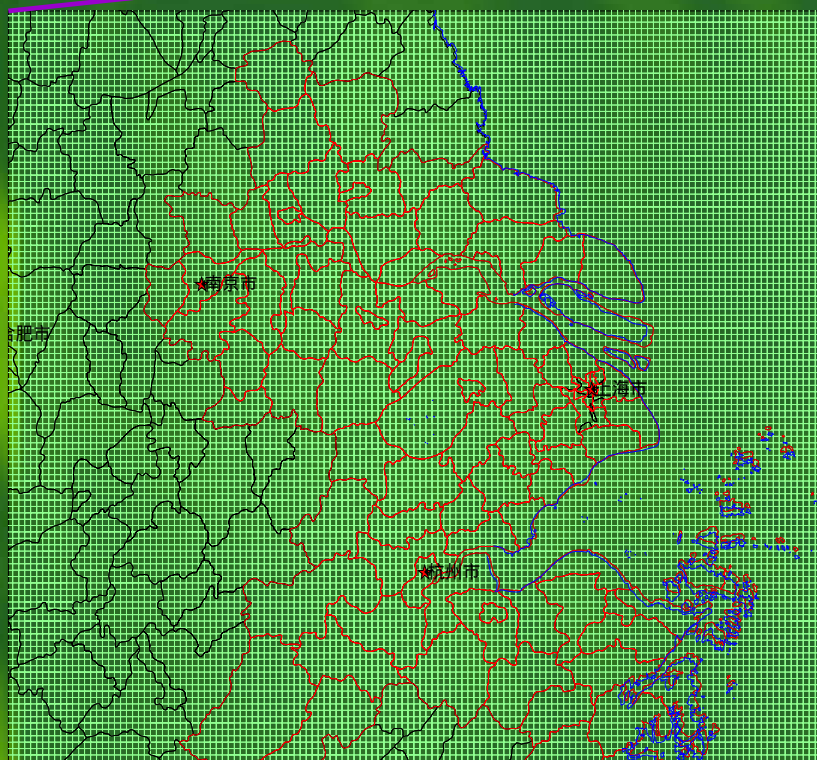
Trend of PM₁₀ pollution
in BAU case, 2004-2020

**2. Then, look at the regional air
quality problems in YRD**



长三角大气污染输送研究 范围 Domain of YRD air quality study

三层嵌套网格



网格中心 Grid center : 110°E , 34°N

网格精度 Resolution : $4\text{km} \times 4\text{km}$

网格数目 Grid number : 118行, 136列

研究范围 Domain scale :

东西向 : $136 \times 4\text{km} = 544\text{km}$

南北向 : $118 \times 4\text{km} = 472\text{km}$

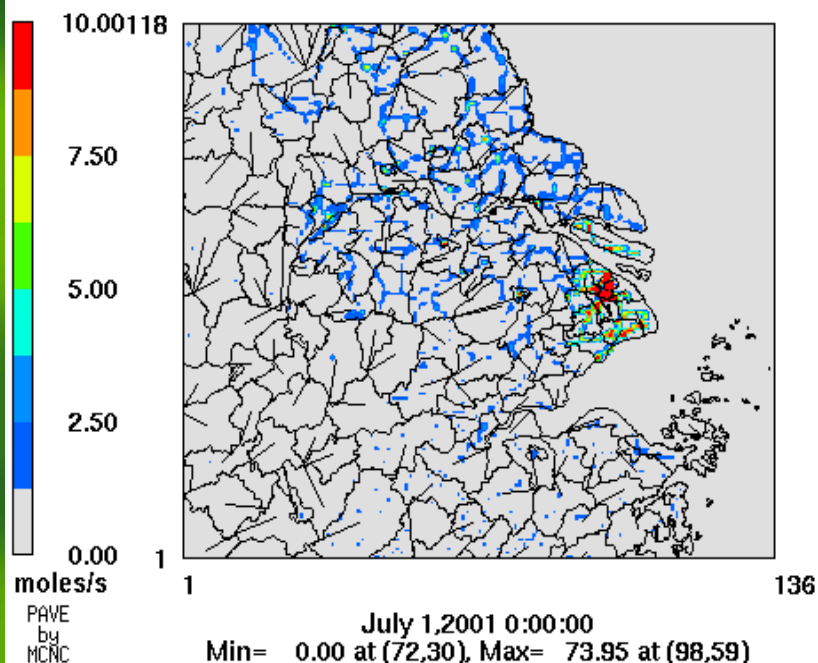


长三角区域排放清单的空间分布 Emission map of Yangtze River Delta

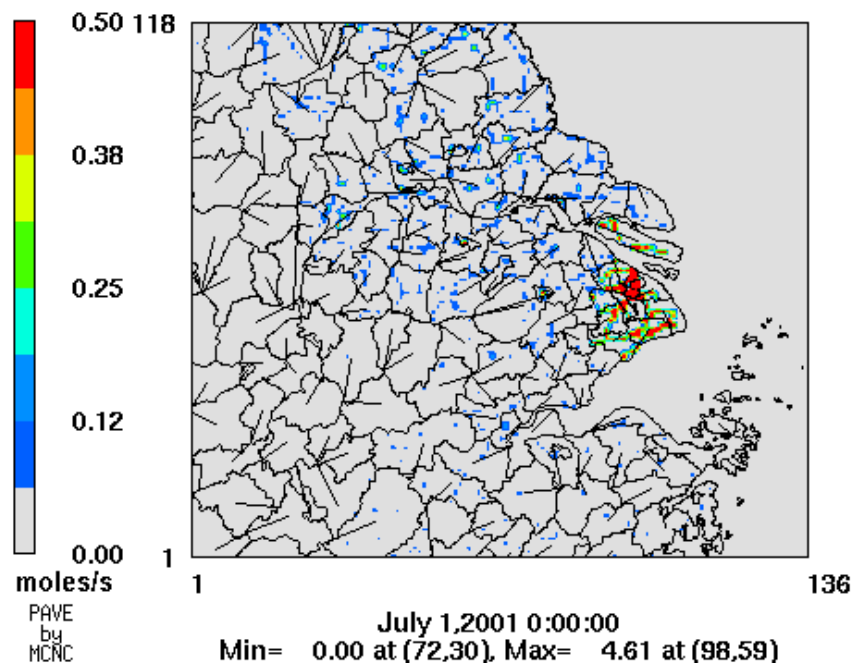
NetCDF格式

(上海替代)

Layer 1 CO

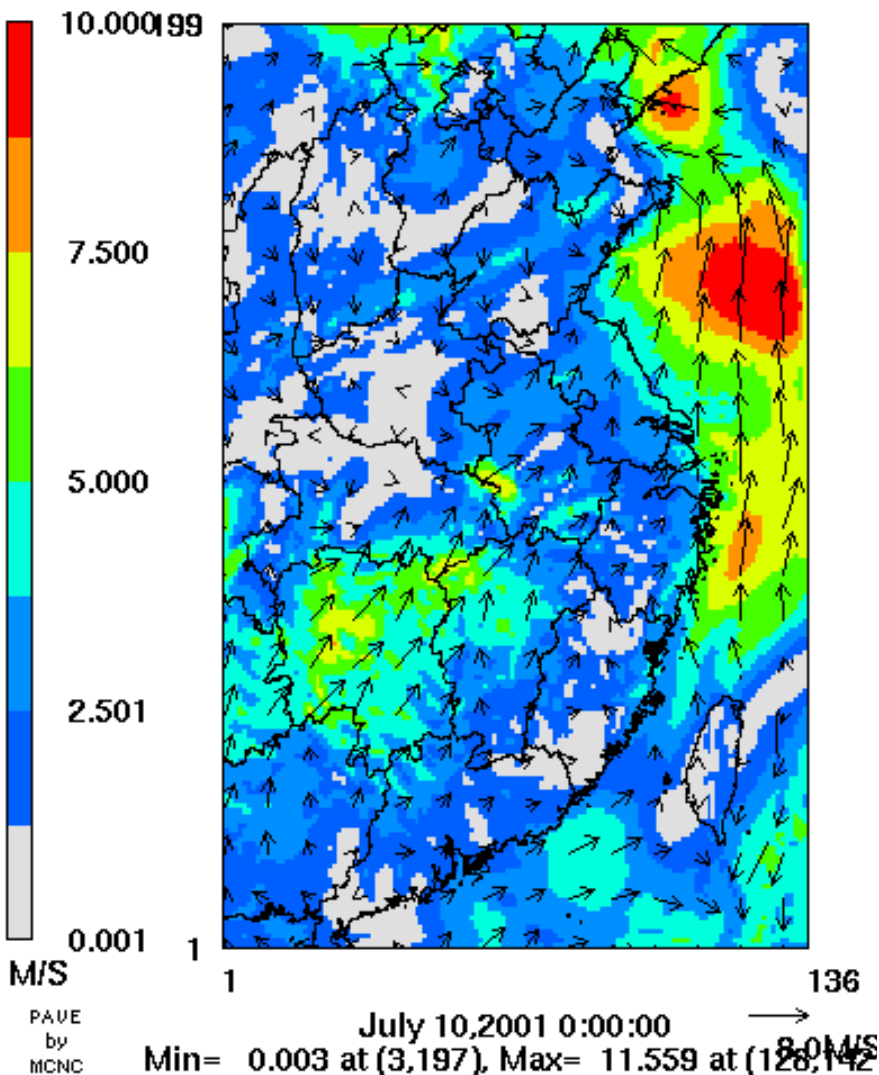


Layer 1 NOx



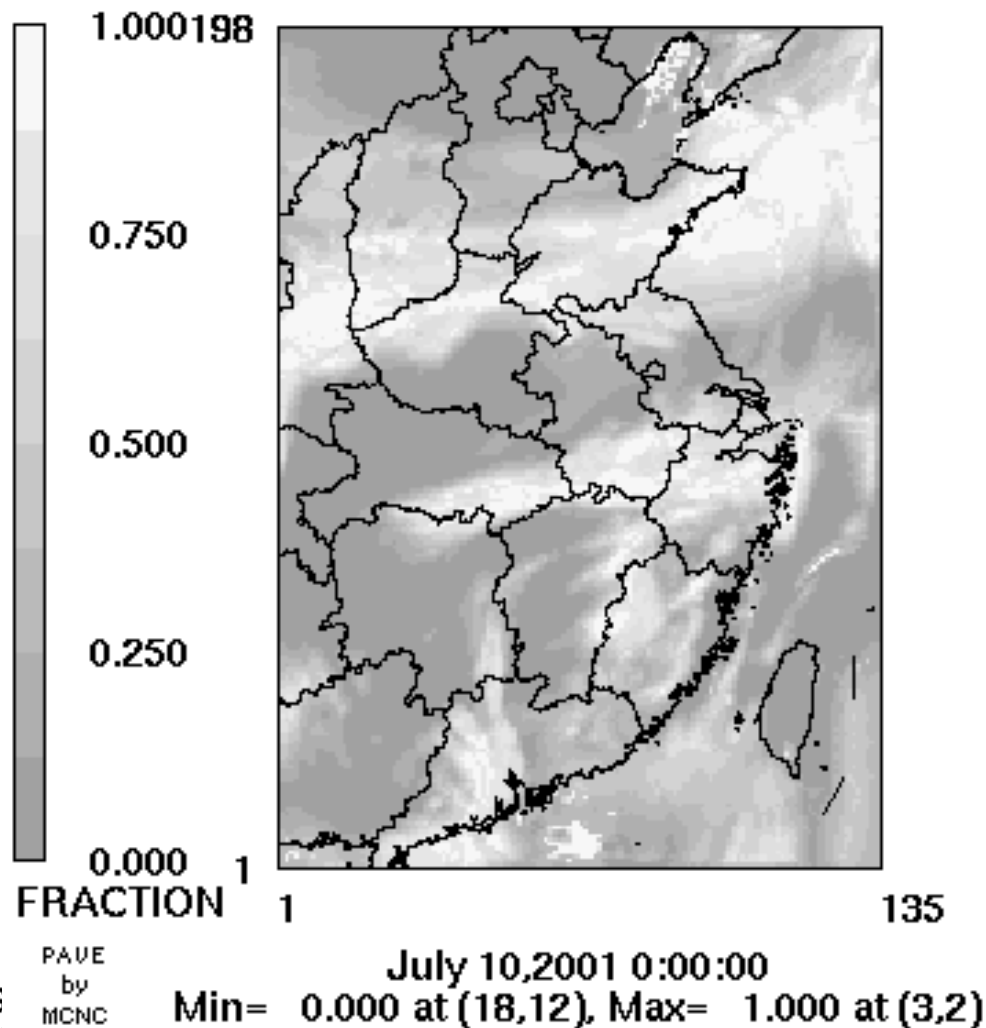
Wind Field

July 10 2001 12km MM5 Simulation



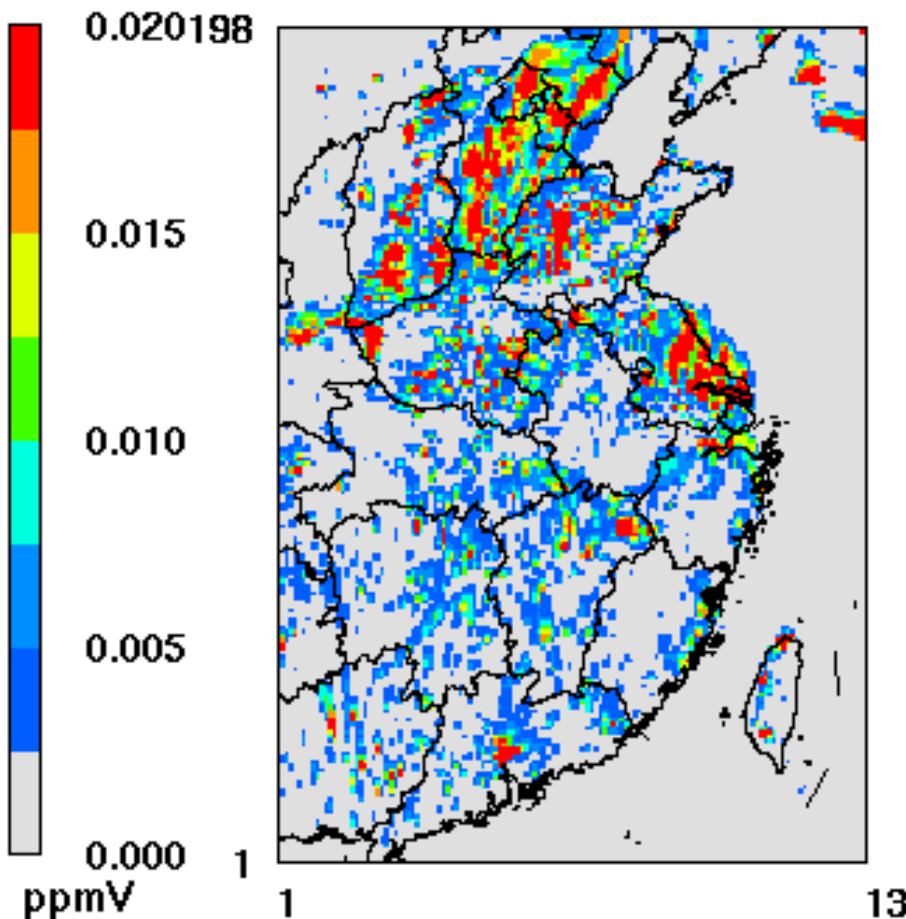
Cloud Fraction

July 10 2001 12km MM5 Simulation



SO2

12km CMAQ Simulation

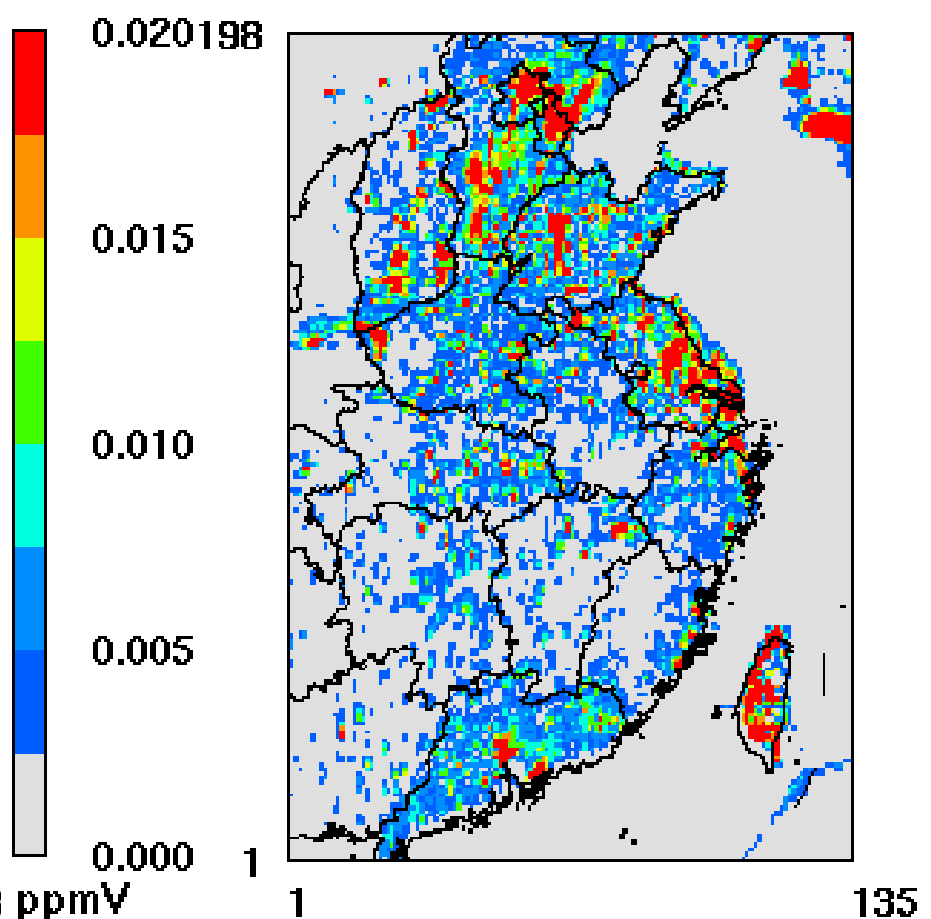


July 10, 2001 12:00:00

PAVE by MCNC Min= 0.000 at (13,49), Max= 0.870 at (6,153)

NOX

12km CMAQ Simulation



July 10, 2001 12:00:00

PAVE by MCNC Min= 0.000 at (3,9), Max= 0.533 at (66,153)

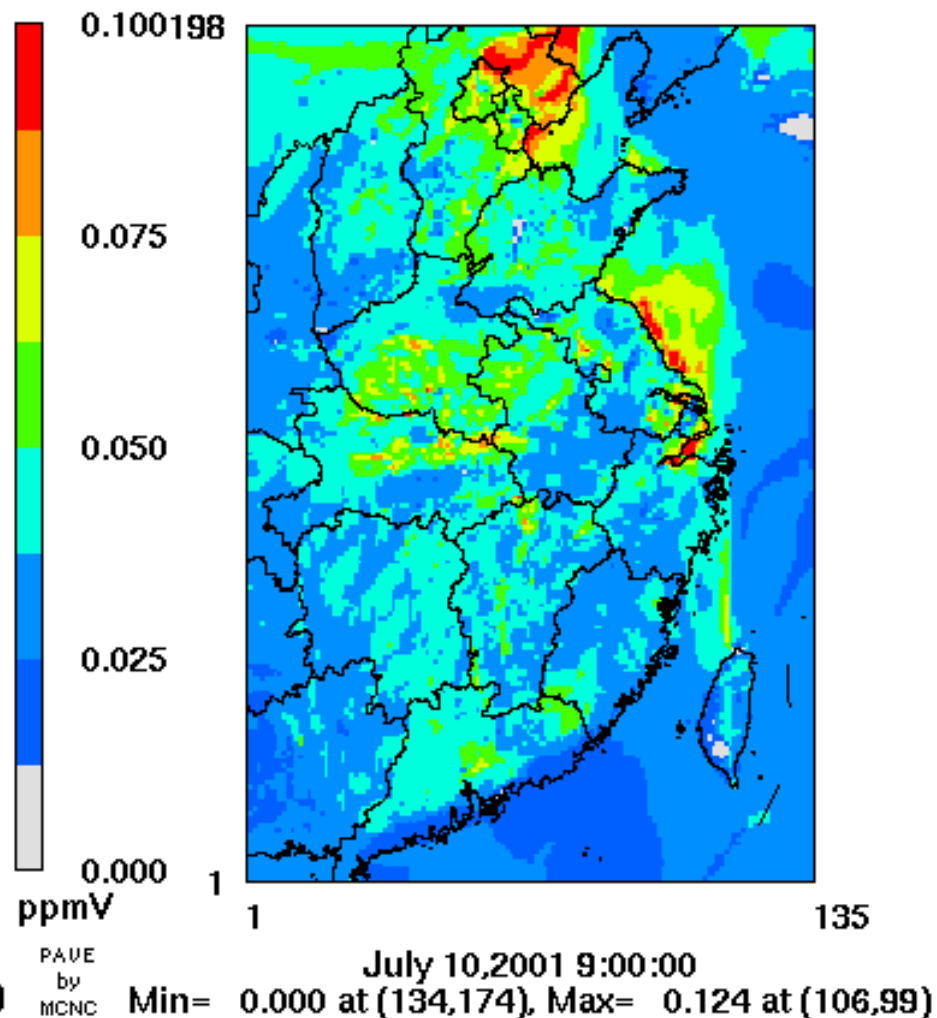
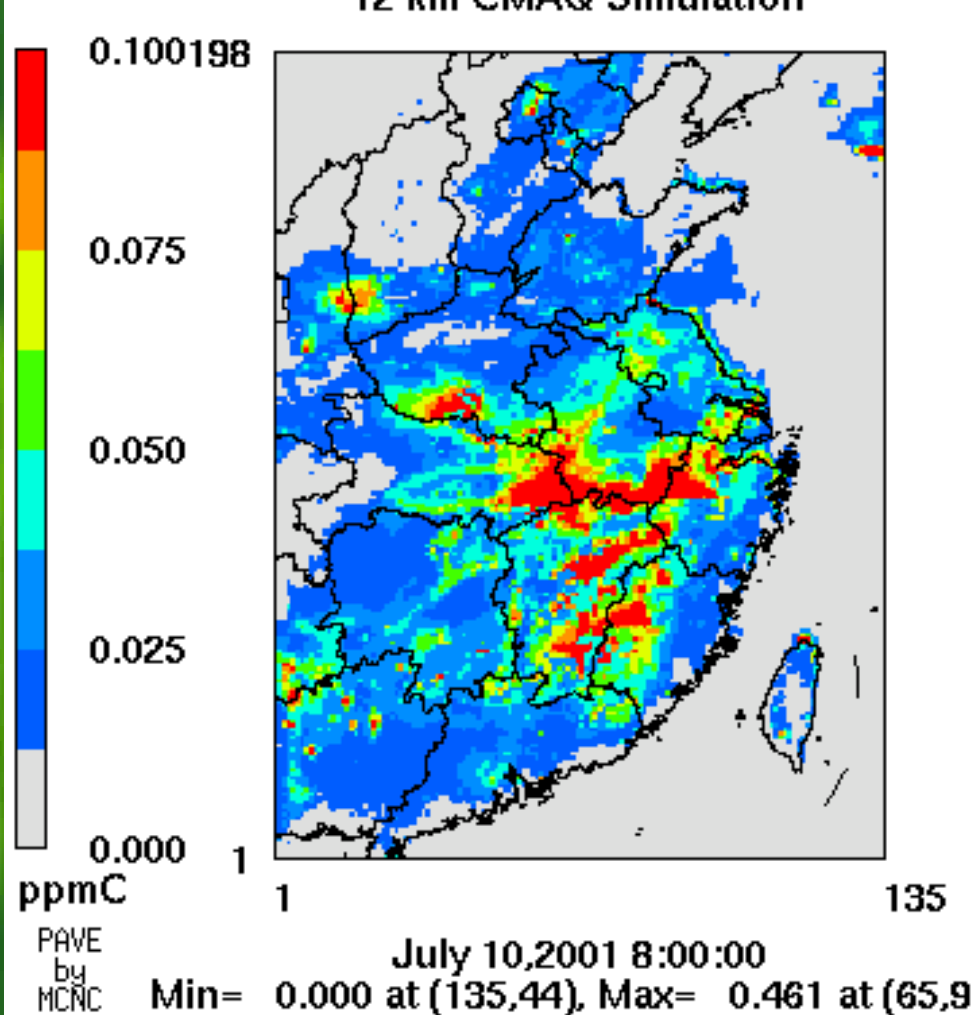


VOC

Ozone Concentrations

12 km CMAQ Simulation

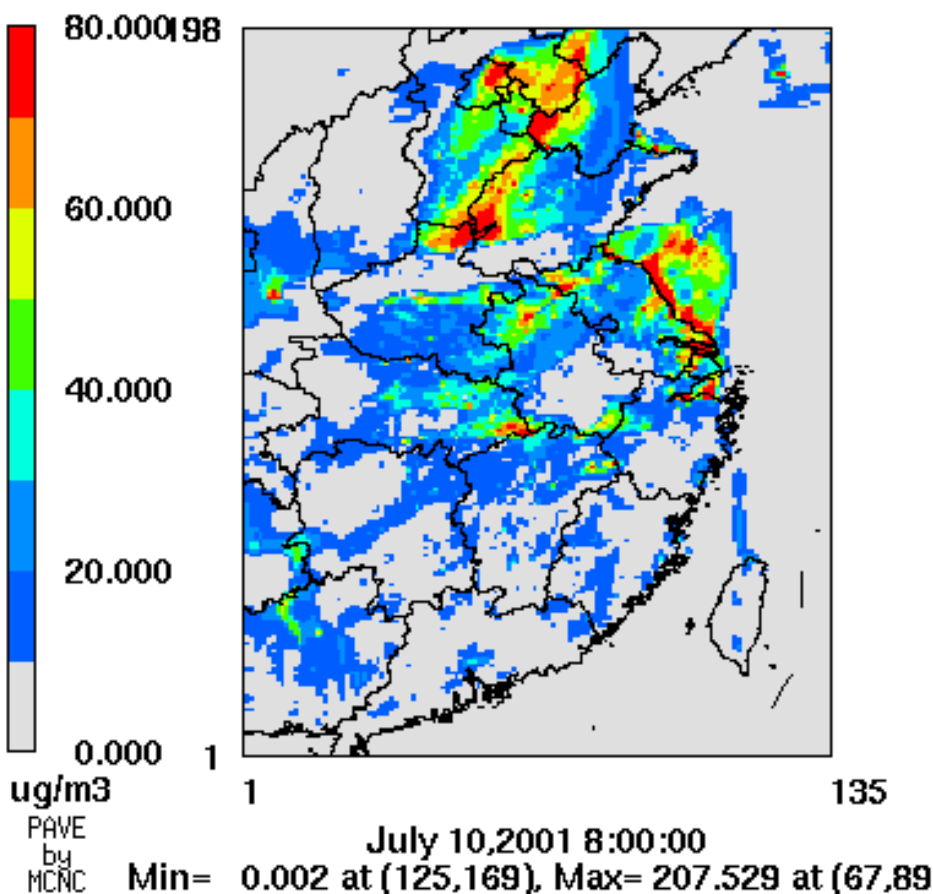
July 10 2001 CMAQ Simulation





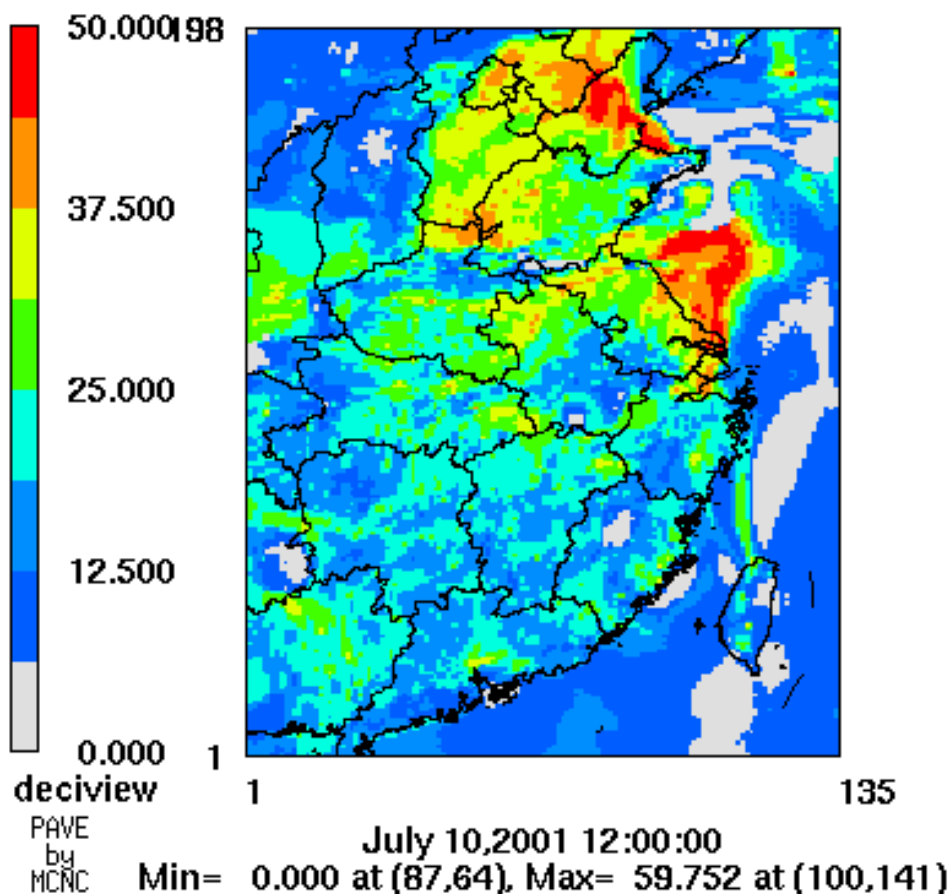
PM25

12km CMAQ Simulation



Visibility

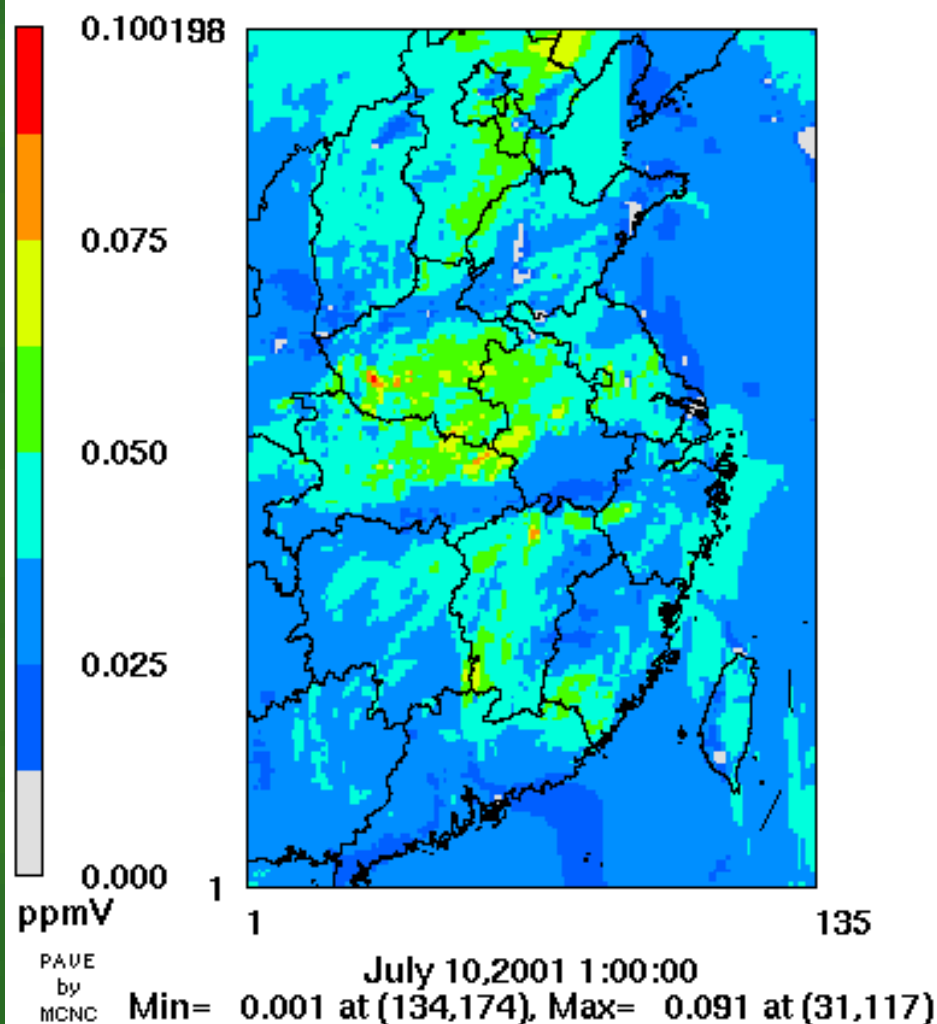
(Deciview)
12km CMAQ Simulation





Ozone Concentrations

July 10 2001 CMAQ Simulation



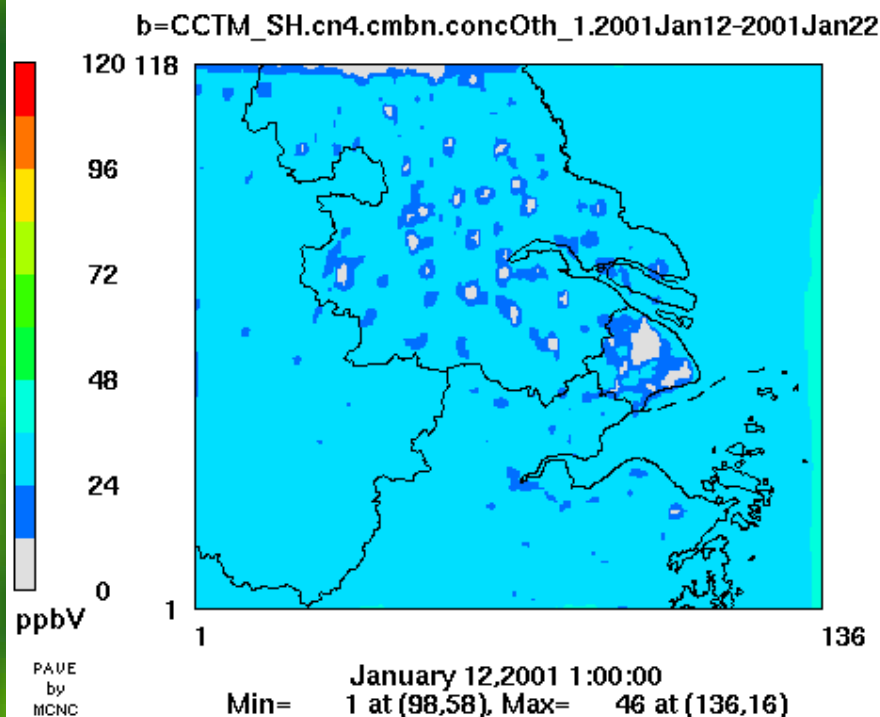


长三角 O_3 的空间分布 Regional O_3 simulation for Yangtze River Delta

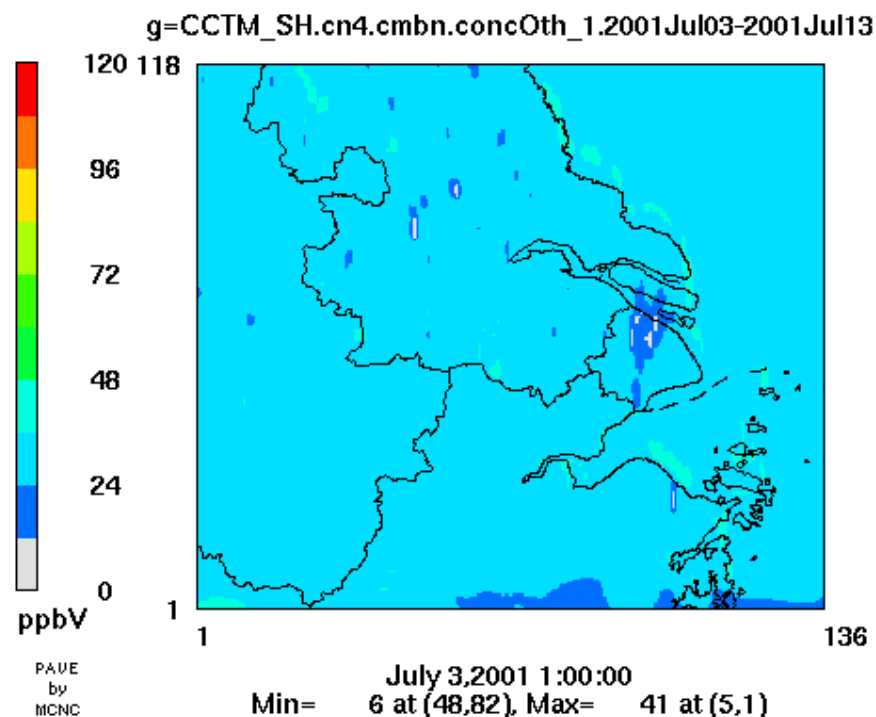
冬季

夏季

Layer 1 O_3b



Layer 1 O_3g



国家二级标准：小时浓度
 $0.20\text{mg}/\text{m}^3$ (93ppb)

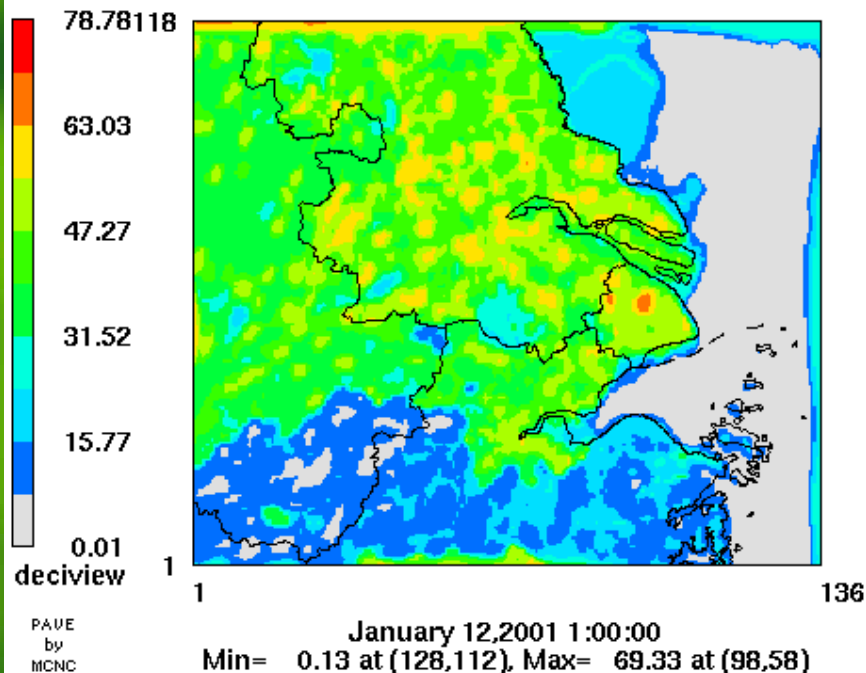
能见度



Regional visibility simulation for Yangtze River Delta

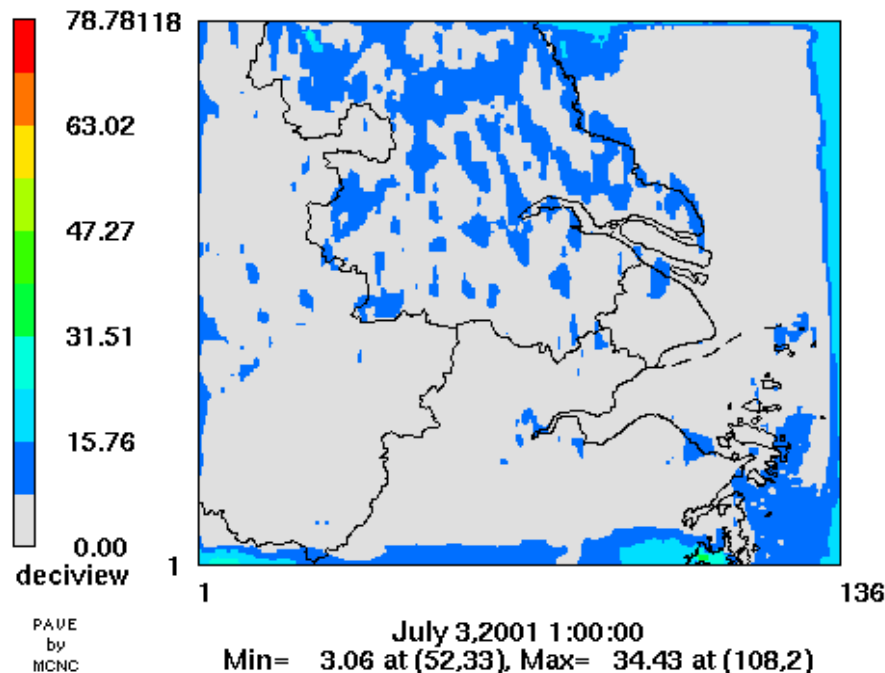
Layer 1 DCV_Recona

a=CCTM_SH.cn4.cmbn.DCV_Recon.2001Jan12-2001Jan22



Layer 1 DCV_Reconf

f=CCTM_SH.cn4.cmbn.DCV_Recon.2001Jul03-2001Jul13



$$dV = 10 \ln (\beta/0.01)$$

优	良	中	差	很差
≤ 14	15~20	21~24	25~28	≥ 29

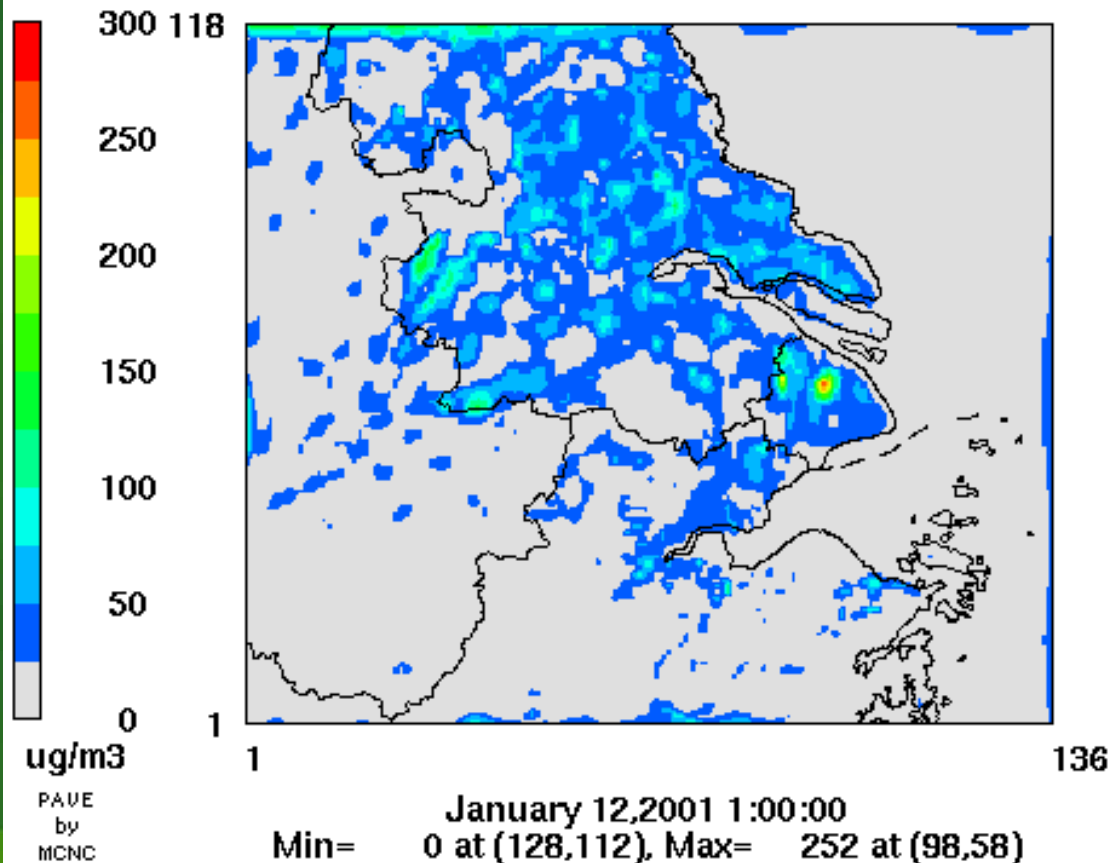
长三角 PM_{10} 浓度的空间分布

PM_{10} simulation for YRD



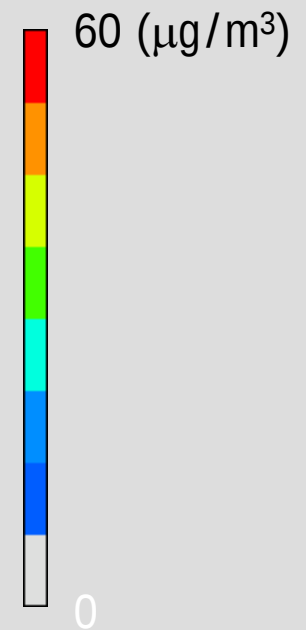
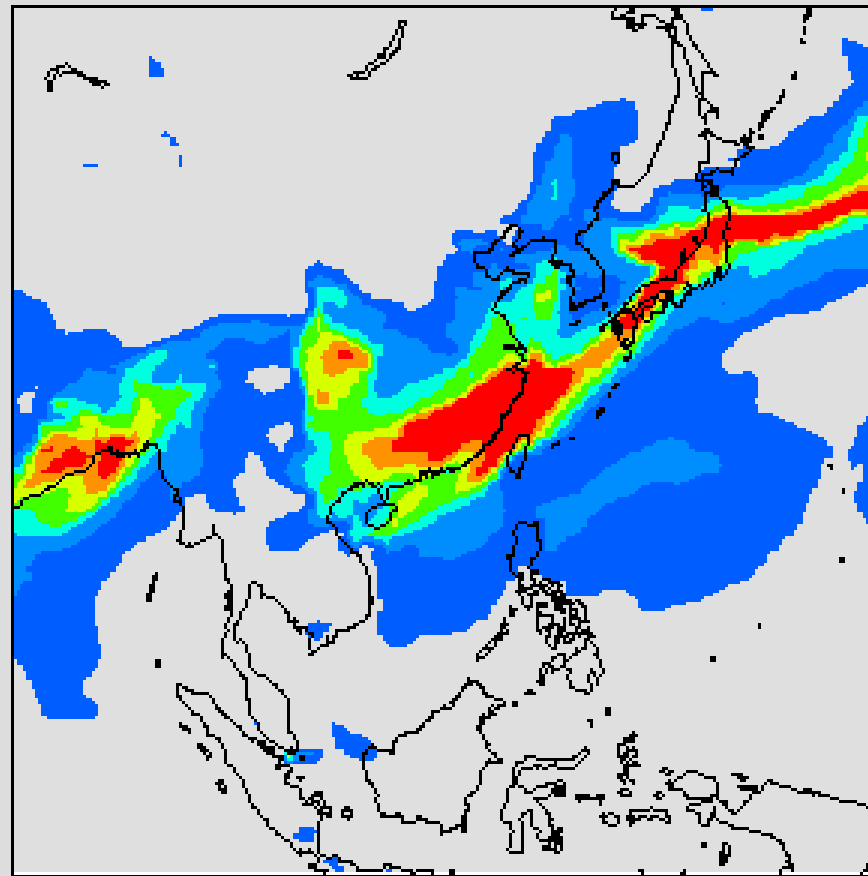
Layer 1 PM10e

e=CCTM_SH.cn4.cmbn.concPM_2.2001Jan12-2001Jan22



東アジアの計算結果例一PM10

1999 年 12 月 6 日 00 時



4.结束语

Conclusions





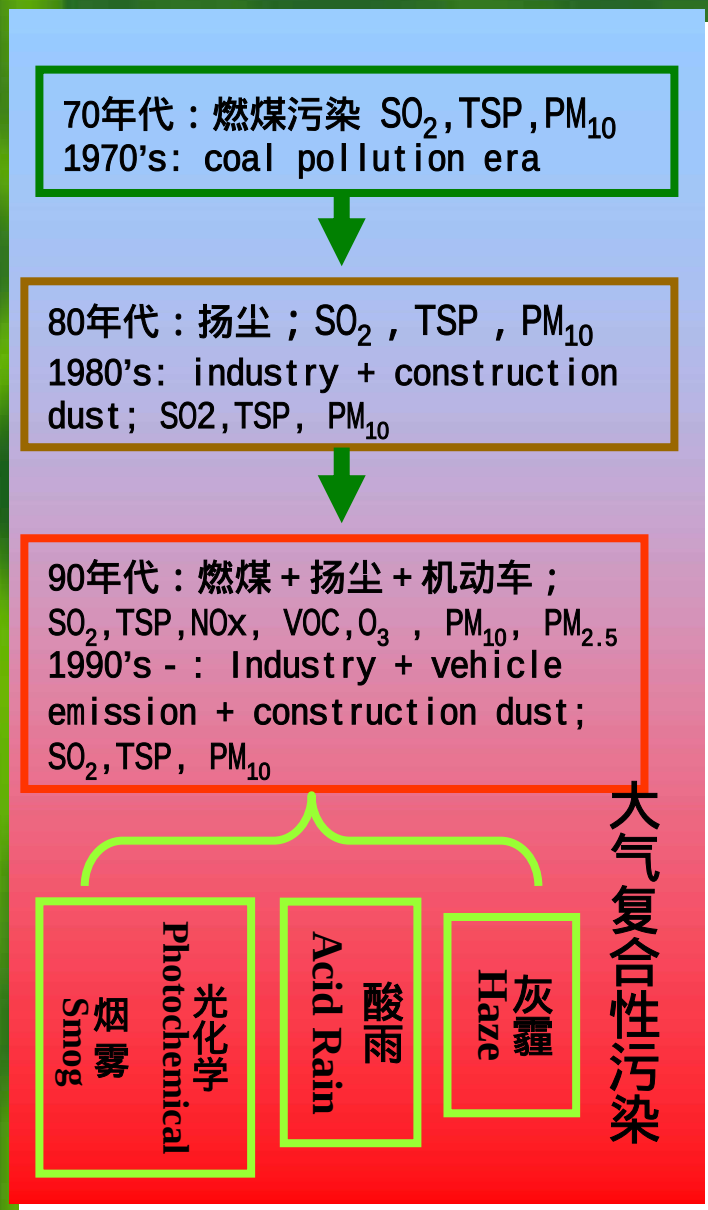
中国大气污染的历史与现状

—全球大气污染浓缩版在中国的再现

原始型、区域型和复合型

The current air pollution in China is a duplicate of the air pollution happened in the developed countries in the past, but in compress pattern

- original, regional, multiple types



- 老的污染还未解决，机动车尾气污染、臭氧污染、细微颗粒物污染、光化学烟雾污染等新的问题已经开始凸现

The original air pollution haven't been solved, new pollutants, are coming out.

- 发达国家一百多年经济发展分阶段出现的环境问题，在近20年的发展历程中，集中性出现

Air pollution happened in the developed countries by type/ time, however it comes to China in a very short time period.

问题1: 十一五脱硫后,中国酸雨、 SO_2 、 PM_{10} 会有什么样的变化?

Q1: How it will change when De SO_x action implemented in terms of acid rain, SO_2 , and PM_{10} ?

问题2: PM_{10} 和 O_3 的暴露情况？

Q2: How about air pollution exposure to PM_{10} and O_3 in future?

问题3: 提高能见度, 降低 PM_{10} 和 O_3 的政策？

Q3: What type policies or actions need to be taken for reducing PM_{10} and O_3 level for blue sky?

关键技术:

要解决上述问题, 制定有效的政策, 除了污染控制技术外, 模型是一个好的选择

Key technologies:

To get better understand of air pollutants disperse, transport, and transform in air from one place to another, and for policy recommendations, MODELING WORK IS A GOOD SELECTION.