交通源排放的雾霾污染贡献及其应对策略

Haze pollution contribution from transportation emissions and its control strategies

黄成 Huang Cheng，陈长虹 Chen Changhong

上海市环境科学研究院
Shanghai Academy of Environmental Sciences

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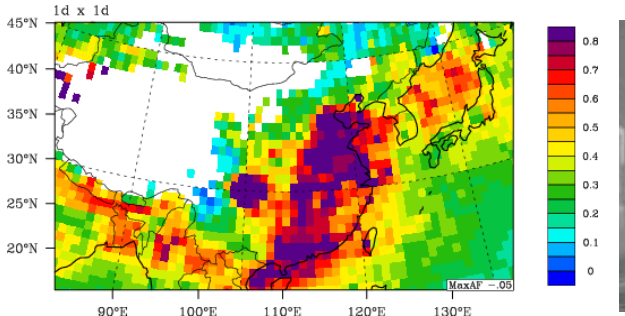
Tongji, Shanghai, China



报告内容 Contents

一、交通源排放与雾霾污染

Transportation emissions and haze pollution

二、交通源减排面临的问题与挑战

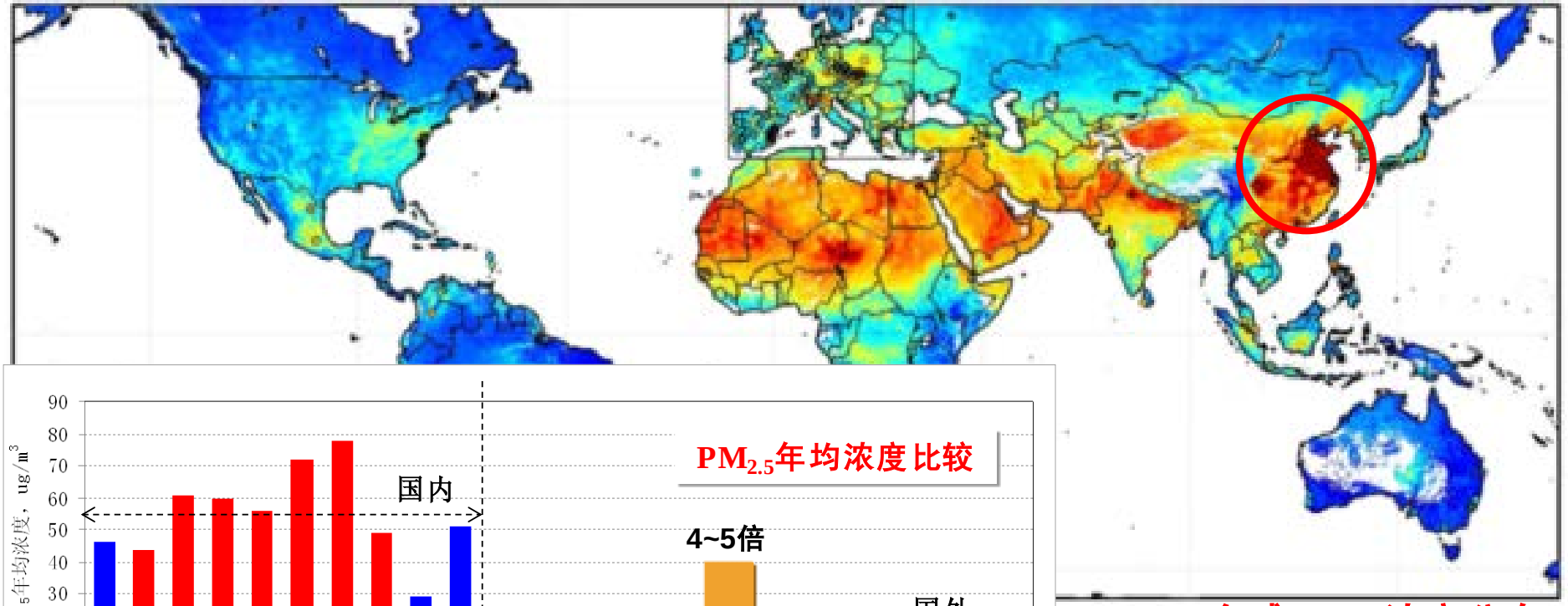
The challenges of transportation emission reduction

三、上海市交通源排放的控制对策

Control strategies of transportation emissions in Shanghai

中国是全球$PM_{2.5}$浓度最高的区域

China is suffering from the world's highest $PM_{2.5}$ concentration



Annual $PM_{2.5}$ concentration of the foreign and domestic cities

全球$PM_{2.5}$浓度分布

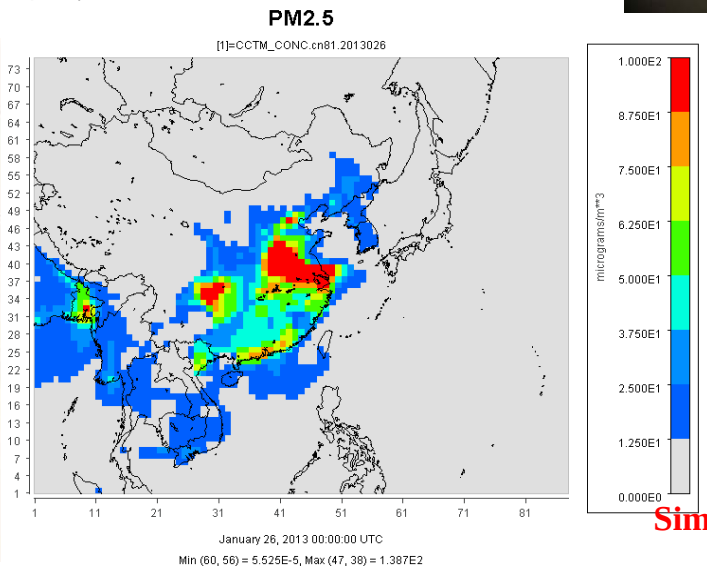
Global $PM_{2.5}$ concentration distribution

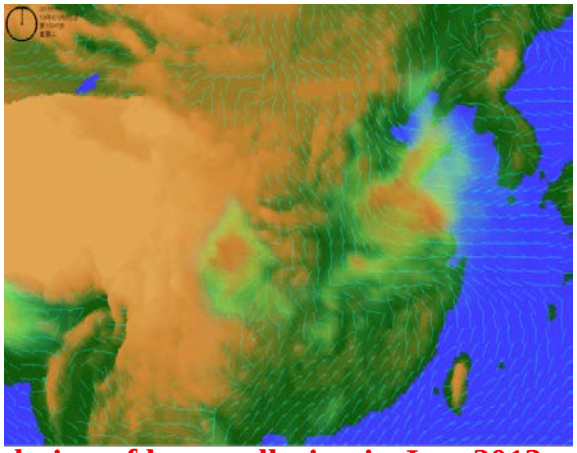
高强度、长时间的雾霾污染频发

High intensity and long persistent haze was frequently occurred

- 2013年，我国中东部地区频繁爆发长时间大范围高强度的雾霾天气，10省市近8亿人口暴露于高浓度$PM_{2.5}$污染。

  High intensity and long persistent haze pollution was frequently occurred in 2013. Almost 10 provinces and 800 million people were suffering high $PM_{2.5}$ concentration.

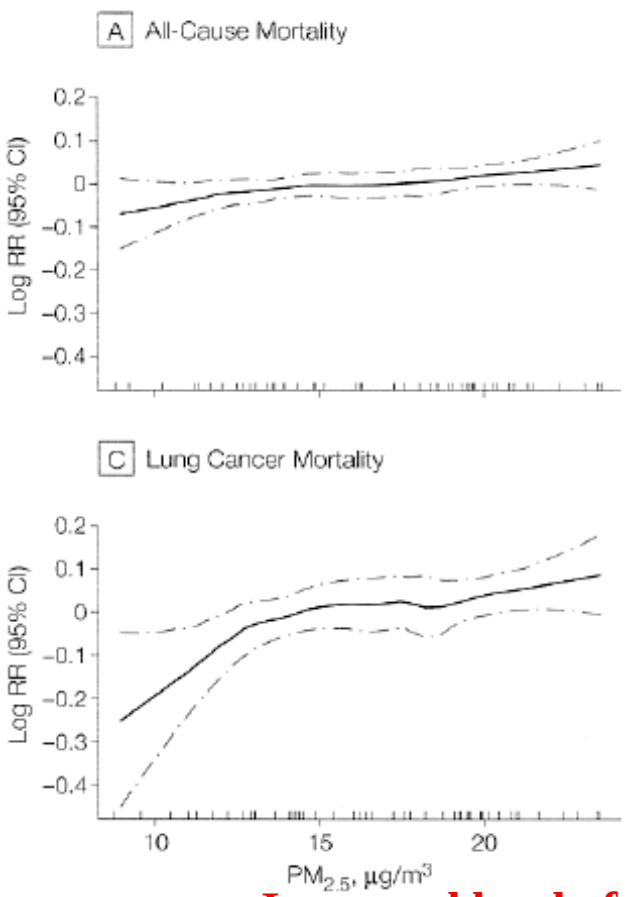


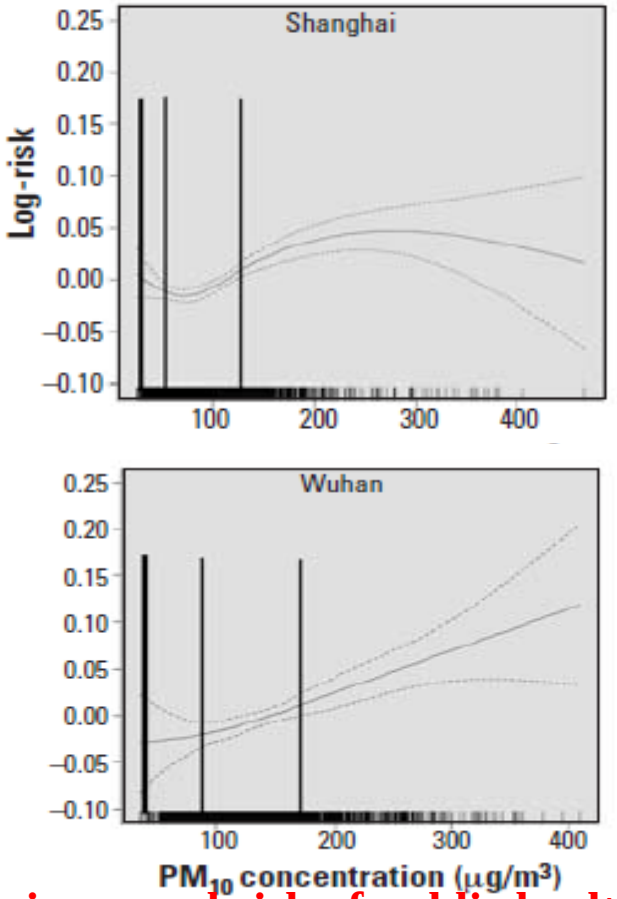


Simulation of haze pollution in Jan. 2013, Fu Zongbin, 2013

高浓度颗粒物暴露的健康风险

High concentration particle exposure will induce high risk of public health



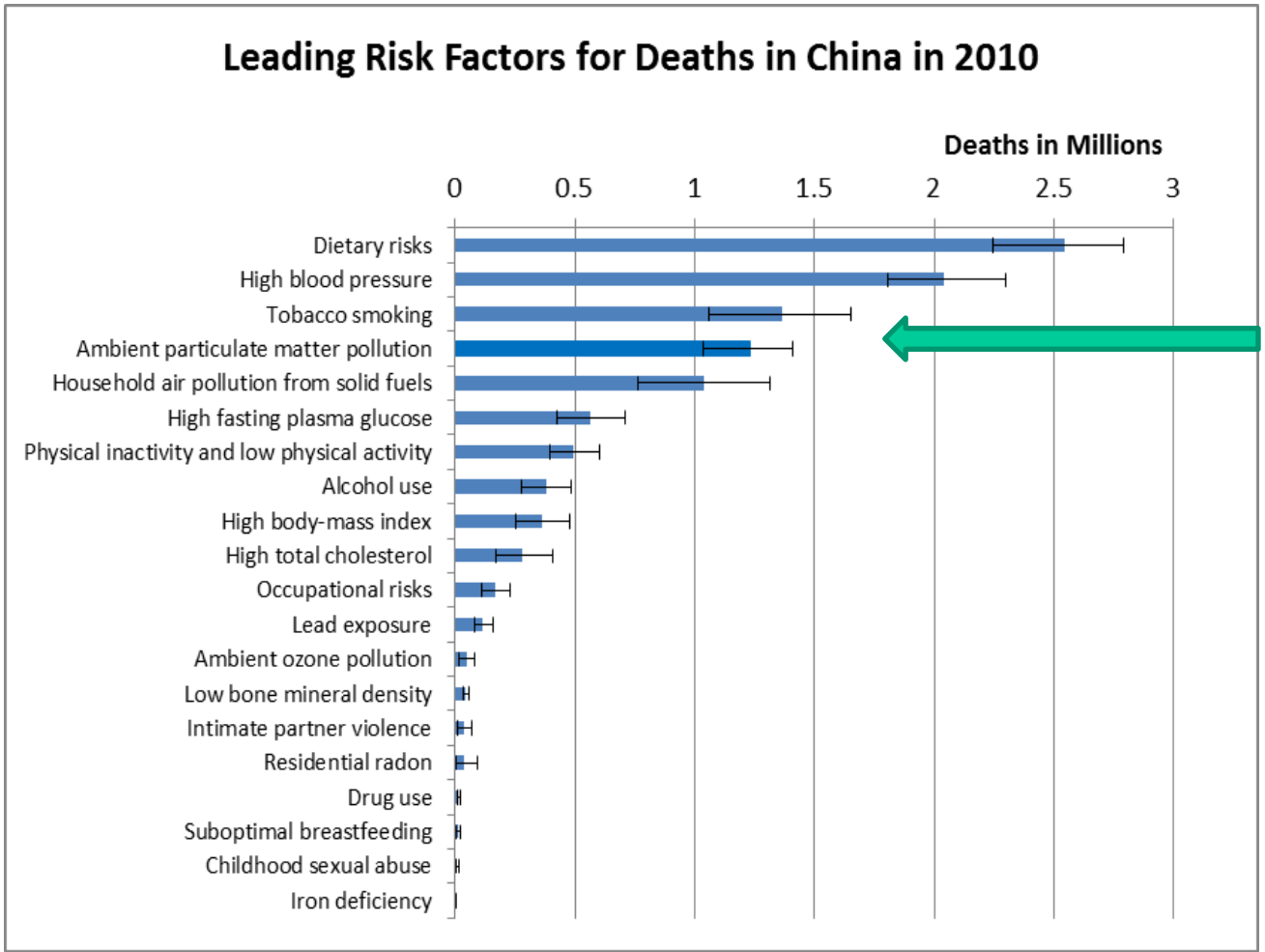


Increased level of $PM_{2.5}$ vs. increased risk of public health

JAMA, 2002 and Wong CM, EHP, 2008

大气$PM_{2.5}$已成为我国第四大健康风险因子

Ambient $PM_{2.5}$ has been 4th leading mortality risk factor in China for 2010

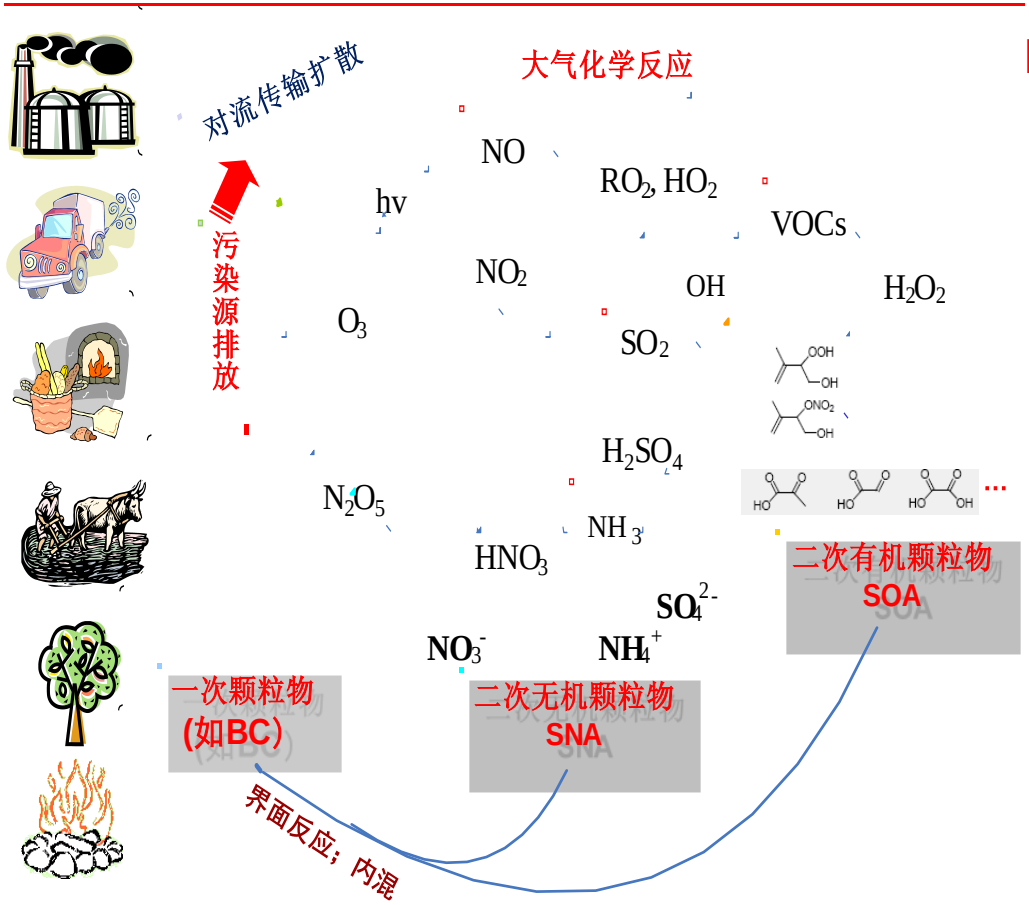


Ambient $PM_{2.5}$ caused an estimated 1,234,000 deaths; 14.9 % of all deaths in 2010

Source from Aaron Cohen

大气$PM_{2.5}$的主要来源？

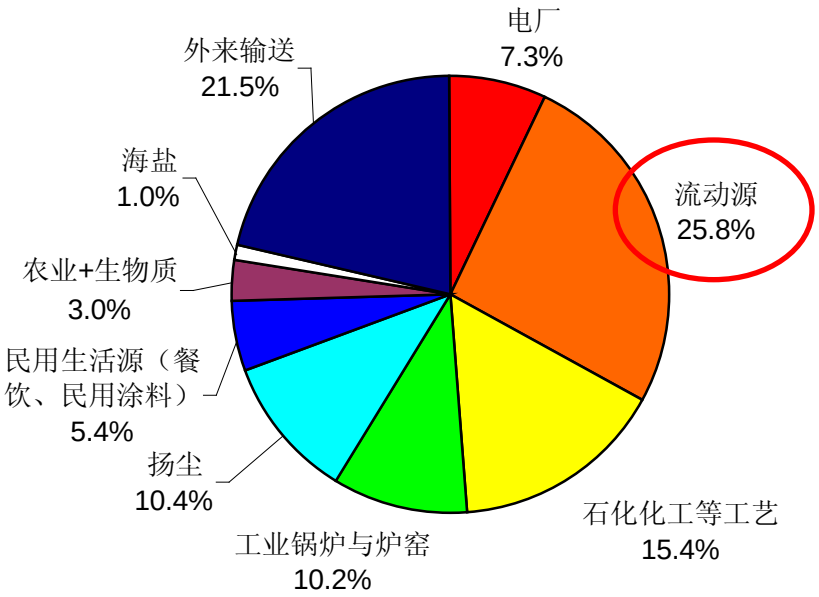
The major pollution source of ambient $PM_{2.5}$ concentration?



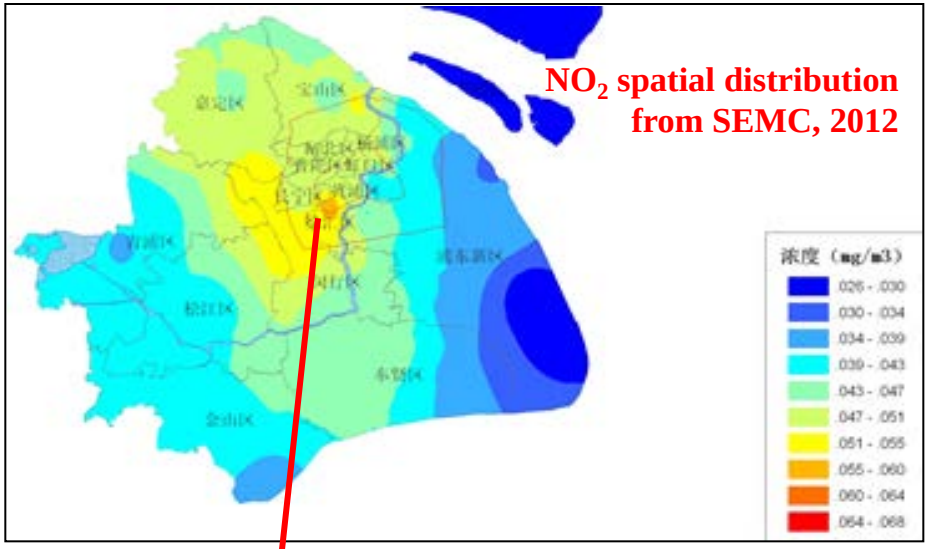
Hao Jiming, 2013

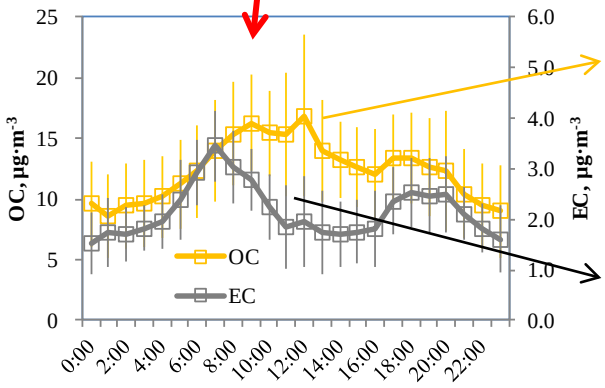
- 源解析结果显示，交通源是上海市大气$PM_{2.5}$的最主要来源。
  Transportation has been the most major source of ambient $PM_{2.5}$ concentration in Shanghai.

SEPB, 2012



为何是交通源?
Why is transportation?





Secondary particle formation

Primary particle emission

车辆排放水平的实际道路测量

Real-world emission measurements of various vehicle types

交通源排放特征实测

非道路机械

工程机械 | 农用机械 | 发电机

机动车

公交 | 集卡 | 货车 | 轻汽 | 轻柴 | 摩托

内河船舶 | 内燃机车 | 航空器

燃料类型/质量 | 排放控制技术 | 运行工况 | 使用年限

整车试验 | 车载实测 | 台架试验

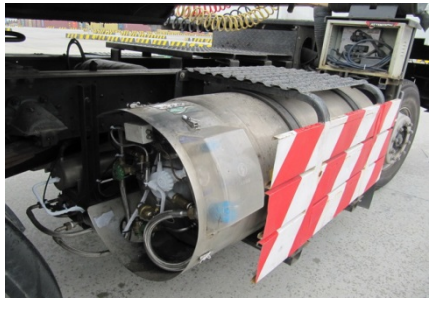
交通源排放因子与成分谱数据库

颗粒物粒径分布 | 颗粒物化学组分 | 常规污染物 | VOCs化学组分

实测结果在新能源车辆发展规划中的应用

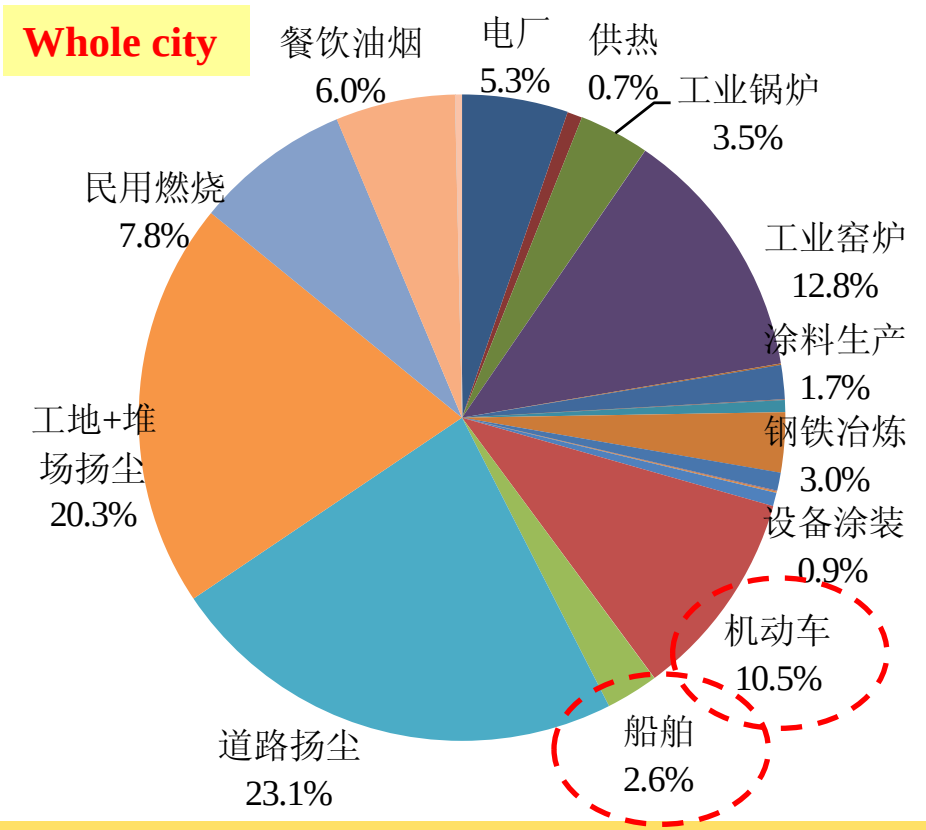
Its application in new energy vehicle development plan

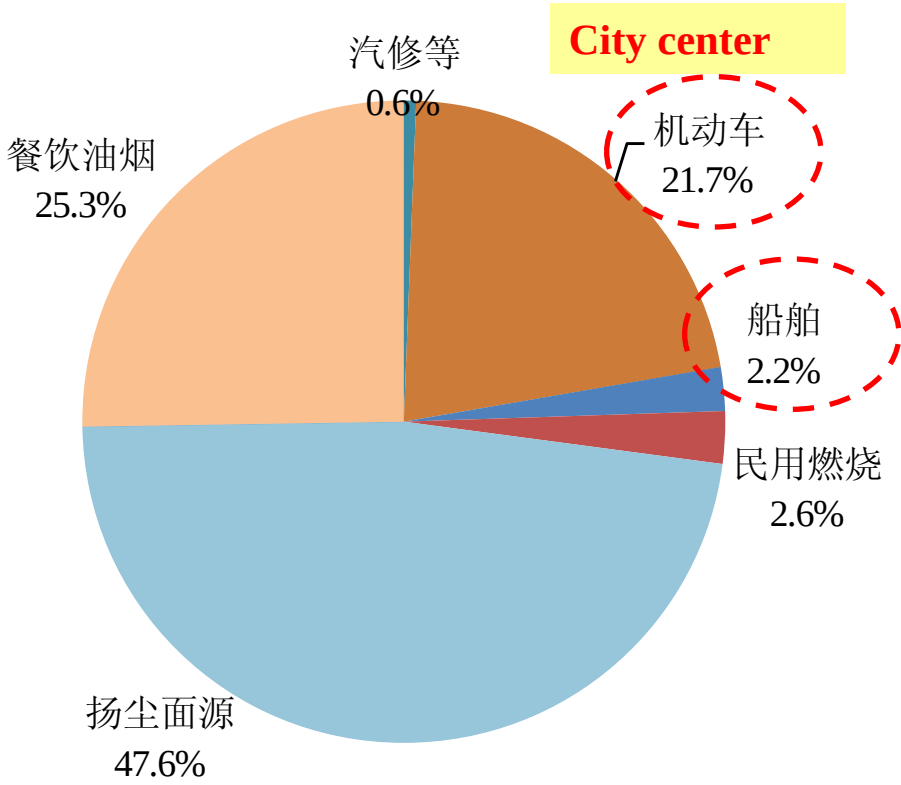
	Euro IV diesel bus	LNG bus	Electric bus
单车排放水平/g·km^{-1}			
NOx排放	12.93	4.28	-
PM排放	0.48	-	-
单车成本/万元			
购车成本	60～80	70	200
年养护成本	3	3	8
替代20%柴油车的减排量/（吨）			
NOx排放	-	~2000	~3000
PM排放	-	~100	~100
替代20%柴油车的减排成本/（万元/kg）			
NOx排放	-	0.05	0.30
PM排放	-	1.01	8.15




交通源的一次排放贡献：一次$PM_{2.5}$排放

Primary emission contribution of transportation: $PM_{2.5}$ emission



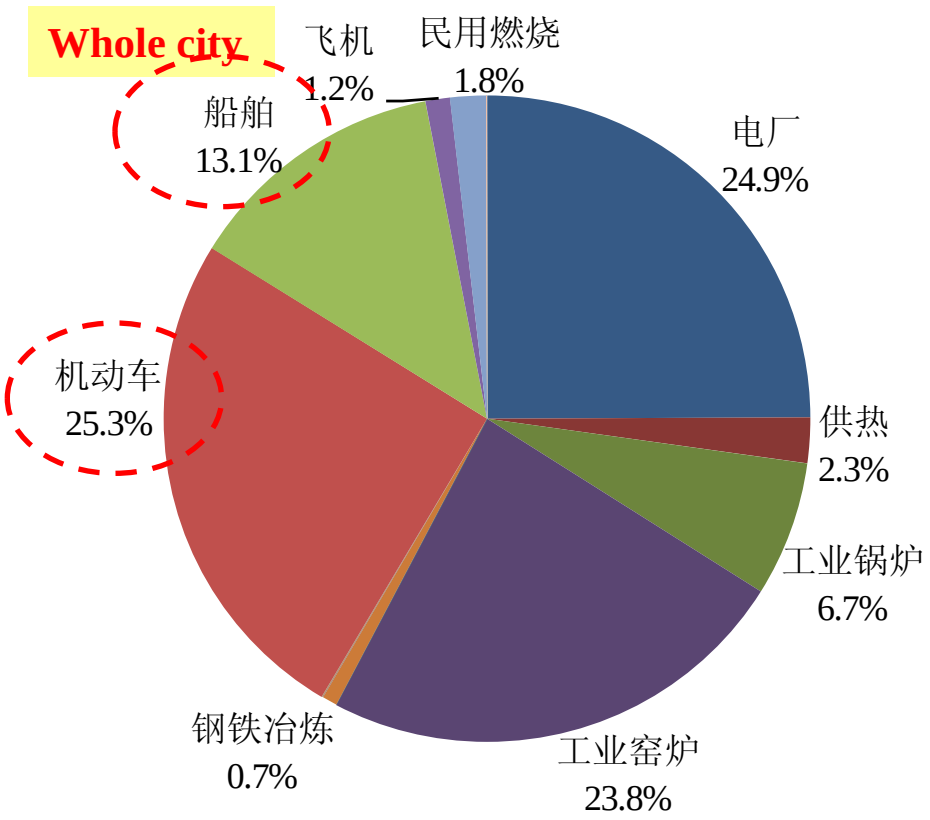


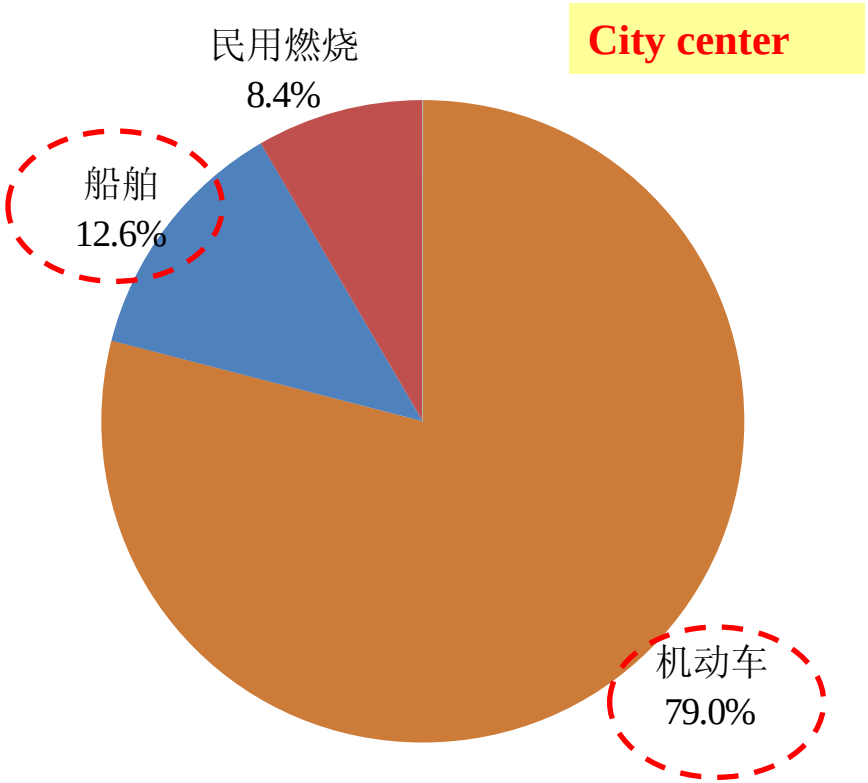
- 机动车和船舶共占全市一次$PM_{2.5}$排放的13%，占市中心$PM_{2.5}$排放的24%；

Vehicle and marine take up 13% and 24% of primary $PM_{2.5}$ emission of whole city and city center, respectively.

交通源的一次排放贡献： NOx排放

Primary emission contribution of transportation: NOx emission



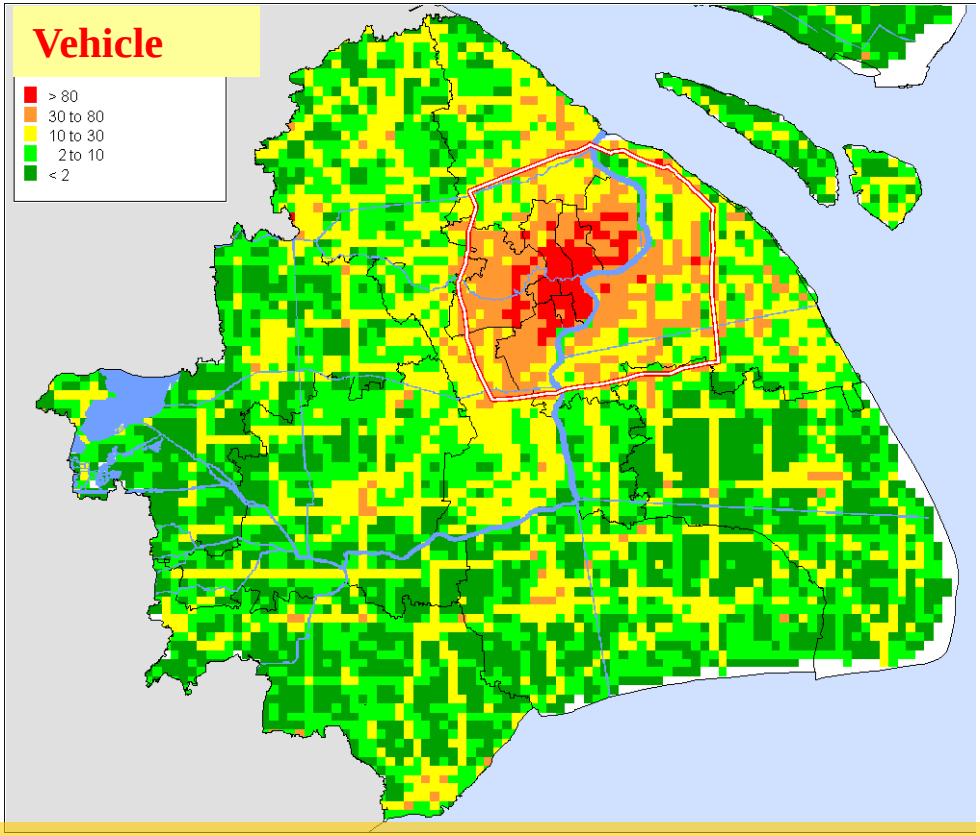


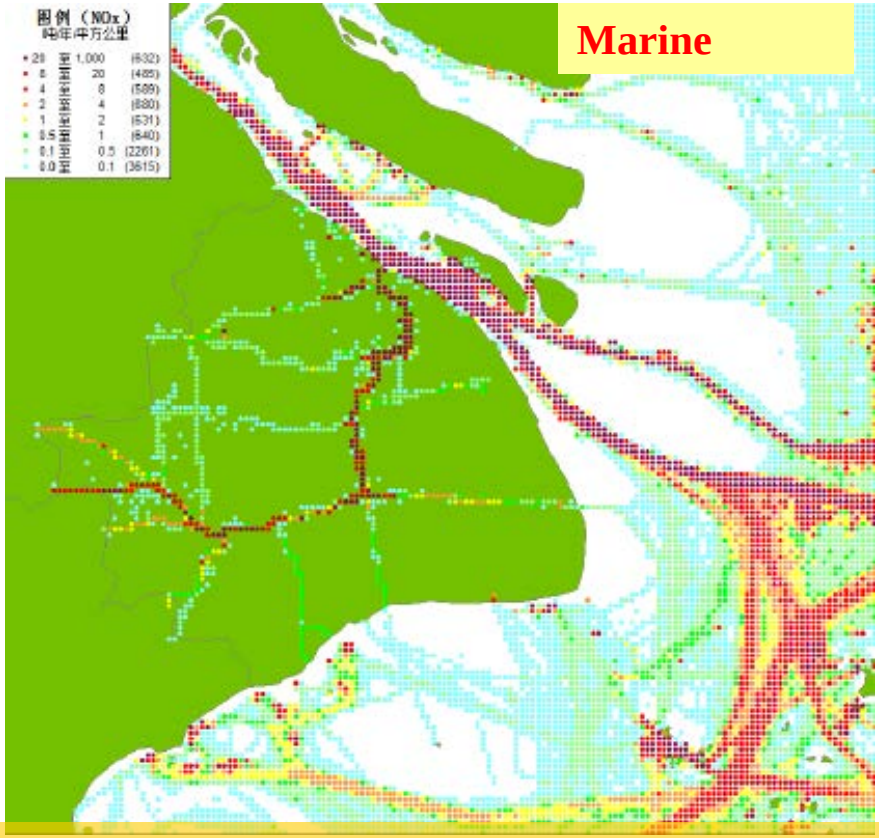
- 机动车和船舶共占全市NOx排放的38%，占市中心NOx排放的90%；

Vehicle and marine take up 38% and 90% of NOx emission of whole city and city center, respectively.

交通源排放的空间分布特征

Spatial distribution of transportation emissions in Shanghai



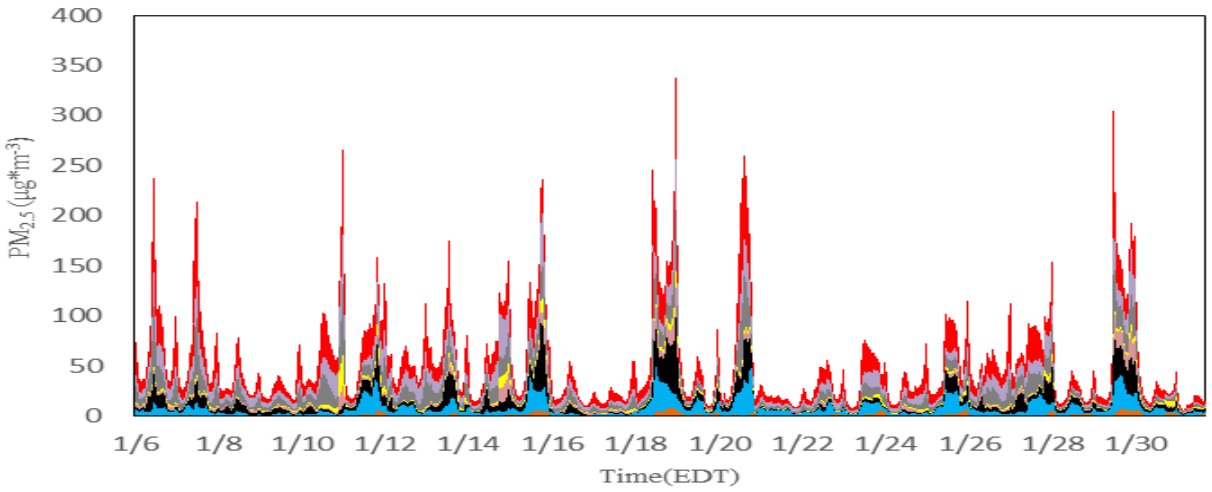


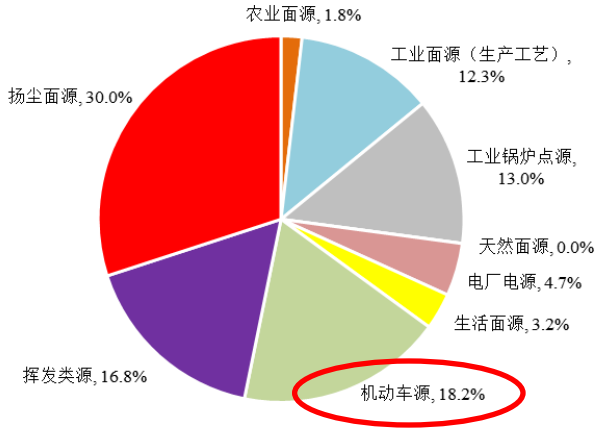
- 机动车排放主要集中在城市中心区，船舶排放集中在黄浦江和长江沿岸；

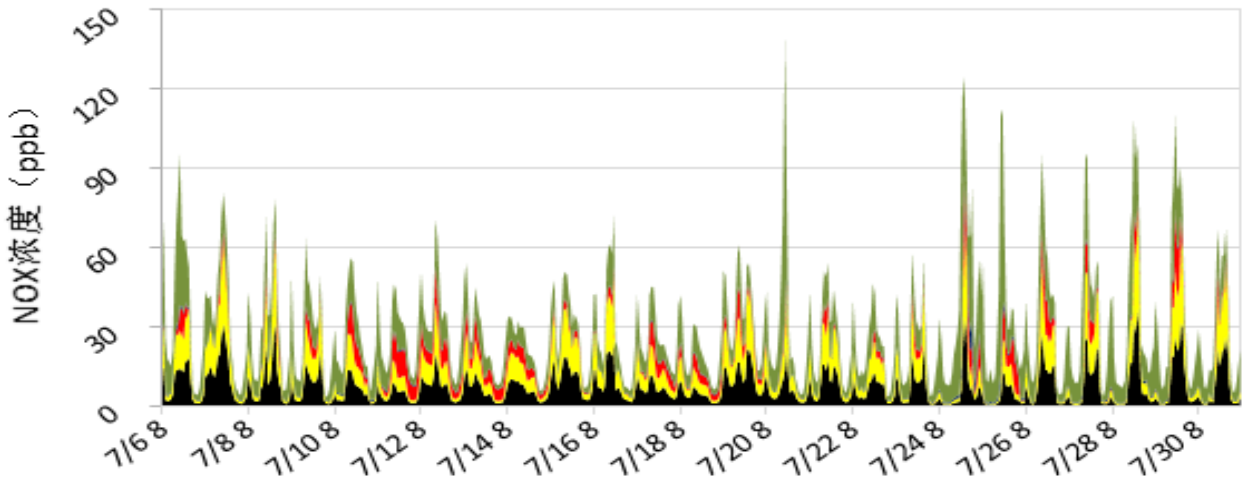
Vehicle emission concentrated in city center, and marine emission mainly distributed along Huangpu river and the Yangtze river estuary.

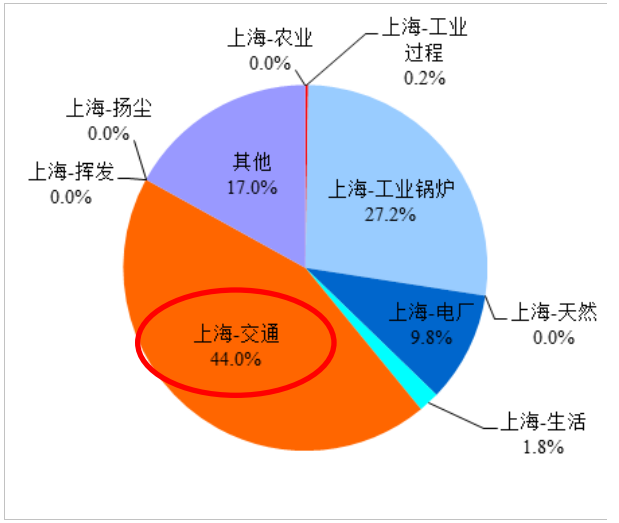
重污染天气下的$PM_{2.5}$污染来源贡献

$PM_{2.5}$ source apportionment under high pollution episode



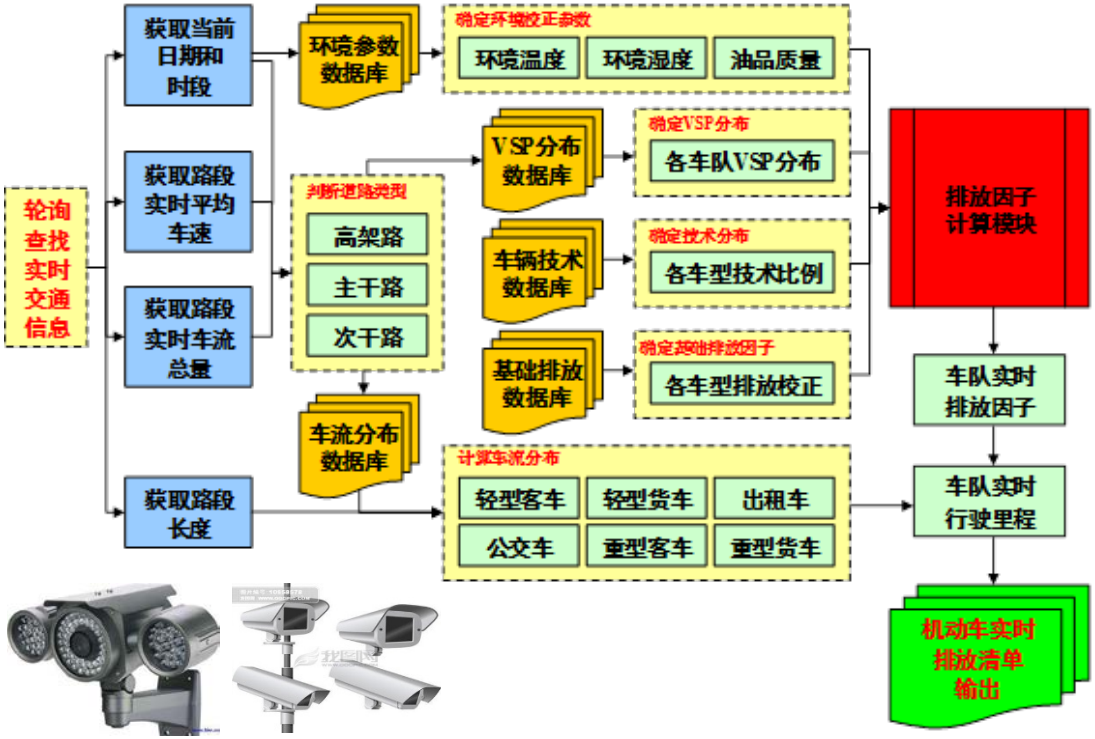


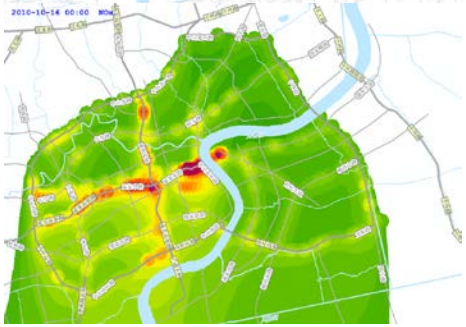


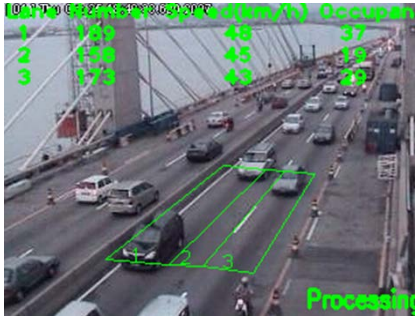


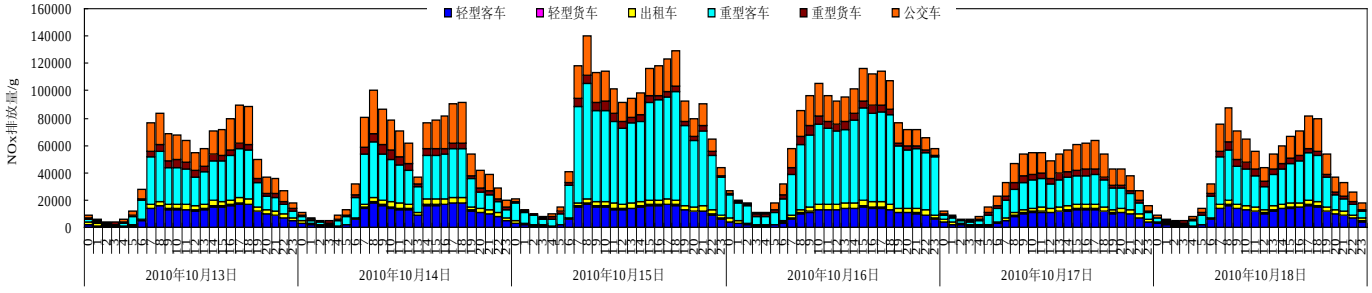
重大活动日的交通环境实时模拟

Real-time simulation of traffic environment on big days









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城市交通面临的“三高”顽症

Urban transportation is facing with “three high” ailment

- 高速度增长
  High speed growth
- 高强度使用
  High intensity use
- 高密度聚集
  High density gathered

高速度增长与高强度使用

High speed growth & high intensity use

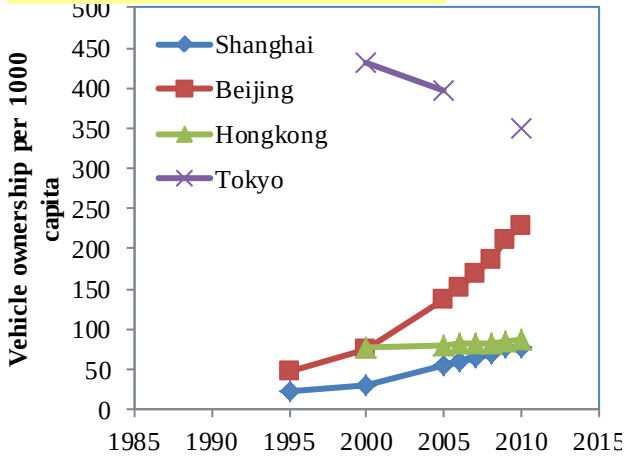
2002

2012: 3~11 times growth in average

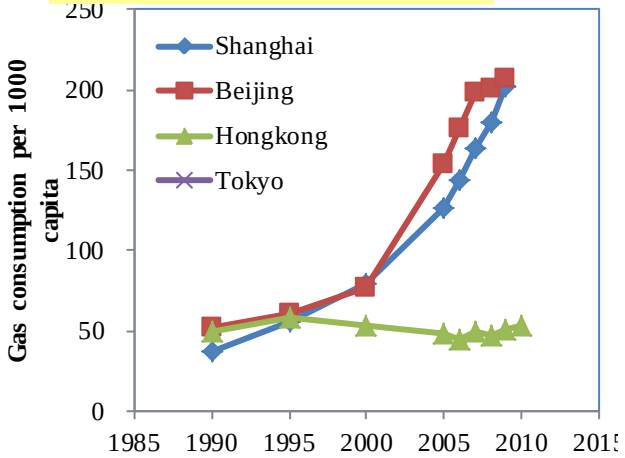
预计到2020年，我国机动车保有量将从目前的2.4亿辆增长到4～5亿辆

Vehicle population is estimated to grow from 240 million to 400~500 million in 2020 in China.

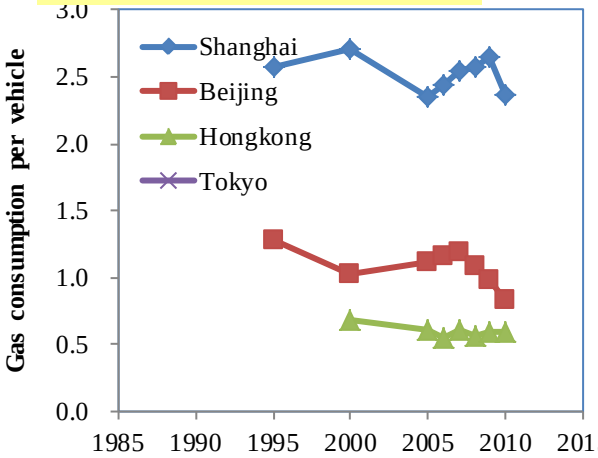
Vehicle per 1000 capita



Gasoline per 1000 capita

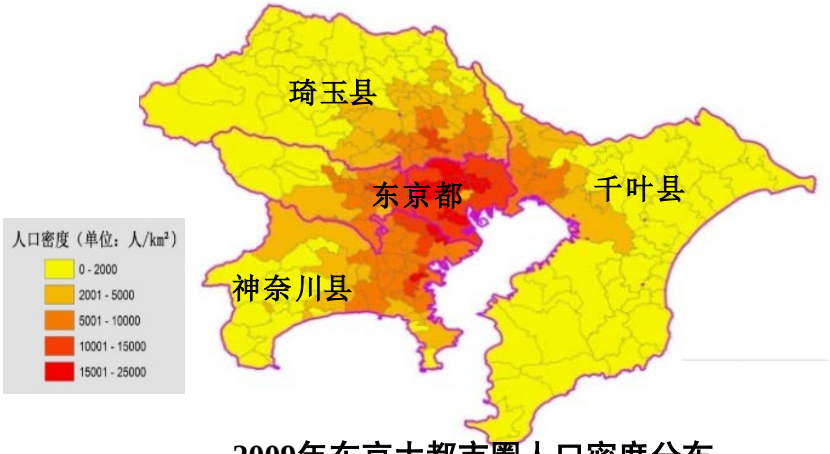


Gasoline per Vehicle

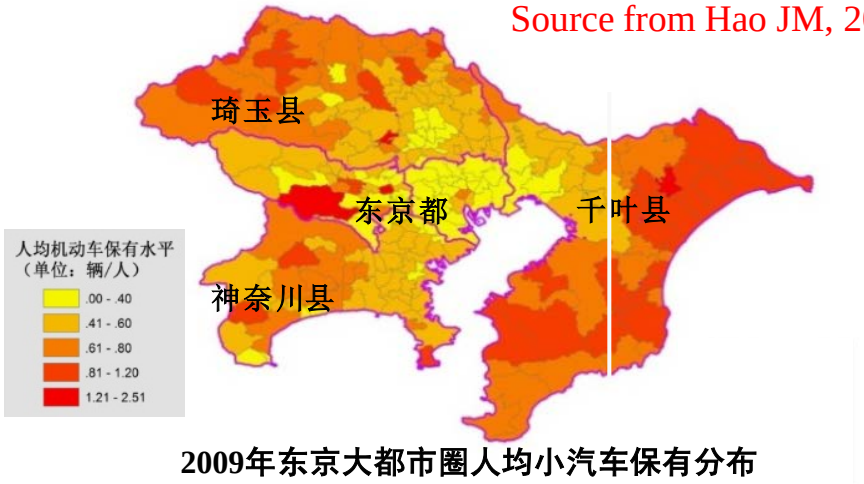


高密度聚集
High density gathered

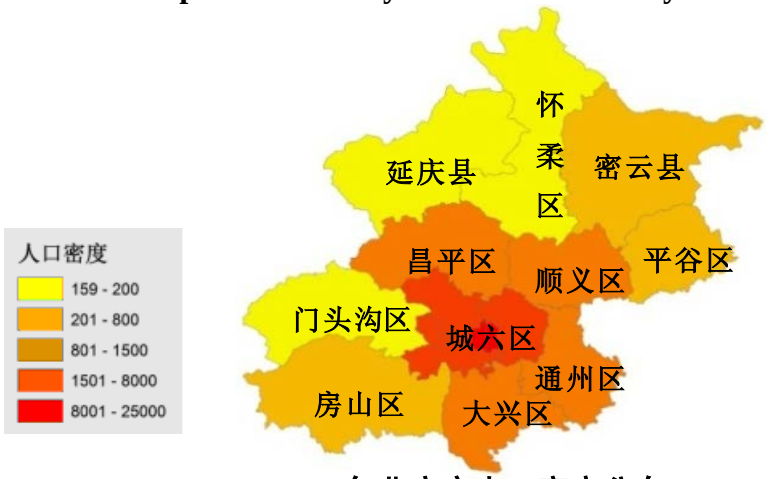
Source from Hao JM, 2013



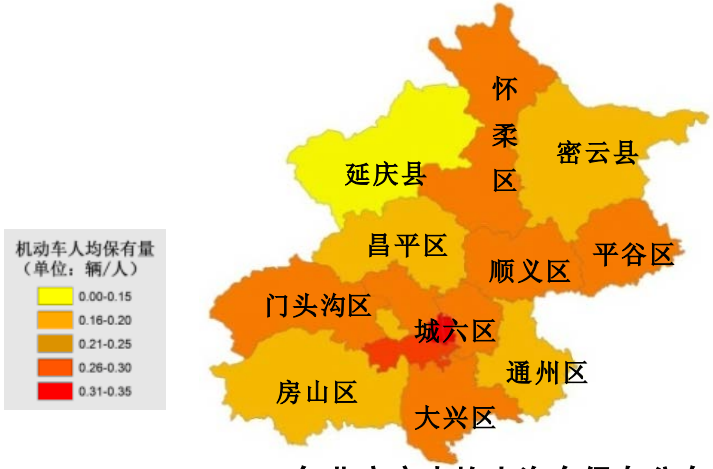
2009年东京大都市圈人口密度分布
Population density distribution of Tokyo in 2009



2009年东京大都市圈人均小汽车保有分布
Vehicle per capita distribution of Tokyo in 2009



2010年北京市人口密度分布
Population density distribution of Beijing in 2010



2010年北京市人均小汽车保有分布
Vehicle per capita distribution of Beijing in 2010

交通源排放控制水平明显滞后

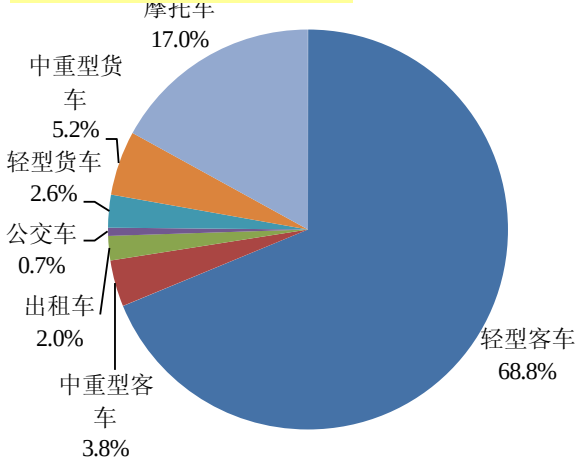
Vehicle emission control level is obviously lagged behind

国家/地区	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
轻型汽油车																							
美国	Tier1				Tier1					Tier2						Tier2							Tier3
欧盟	Euro1		Euro2				Euro3				Euro4					Euro5					Euro6		
日本	JP-1994*			JP-1997*					JP-2002*			JP-2005^					JP-2009^						
中国	无控						国I					国II				国III			国IV				
北京	无控					国I			国II				国III				国IV				京V		
上海	无控					国I				国II				国III				国IV					
广州	无控						国I				国II				国III				国IV				
重型柴油车																							
美国	US1987~2003										US-2004			US-2007				US-2010					
欧盟	Euro1			Euro2					Euro3				Euro4				Euro5				Euro6		
日本	JP-1994¤				JP-1997¤					JP-2003¤			JP-2005ˇ					JP-2009ˇ					
中国	无控						国I					国II					国III				国IV		
北京	无控						国I				国II					国III					国IV		
上海	无控						国I				国II					国III					国IV		
广州	无控						国I					国II					国III				国IV		
非道路移动机械用柴油机																							
美国	无控		Tier1					Tier2					Tier3					Tier4					
欧洲	无控				Stage1				Stage2						Stage3A					Stage3B		Stage4	
中国	无控															国I				国II			

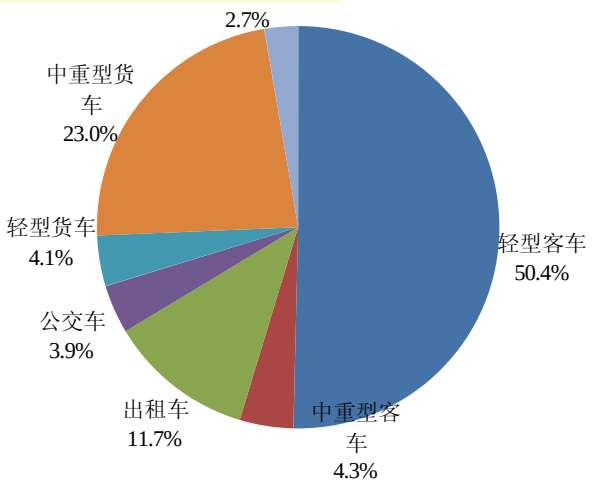
重型车辆的减排挑战

Emission reduction challenge of heavy duty vehicle

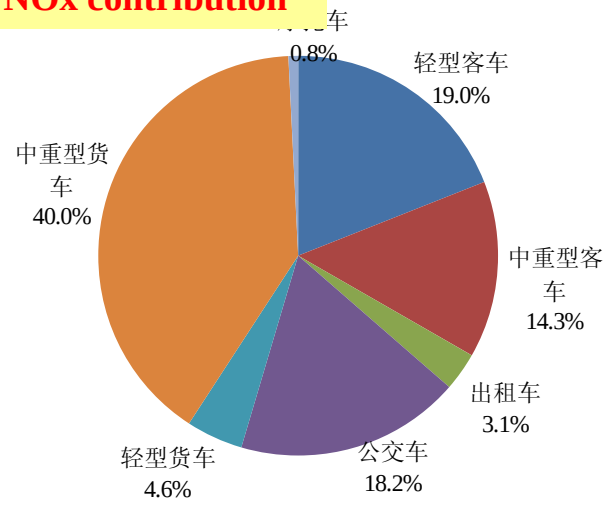
Vehicle category

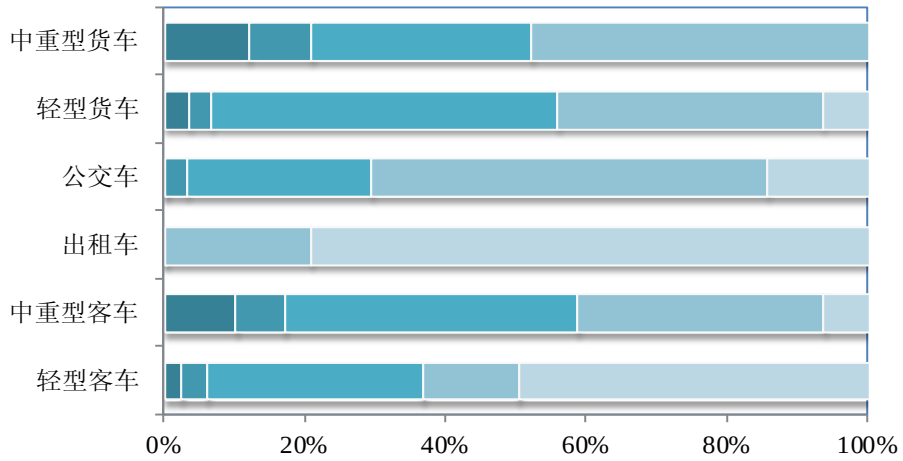


Mileage composition



NOx contribution





- Main reason for high emission contribution of HDV
  - High emission factor
  - More old vehicles
  - Long distance traveled
  - Poor fuel quality

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最新颁布的国家及本市大气污染防治政策

Latest state and Shanghai air pollution control strategies

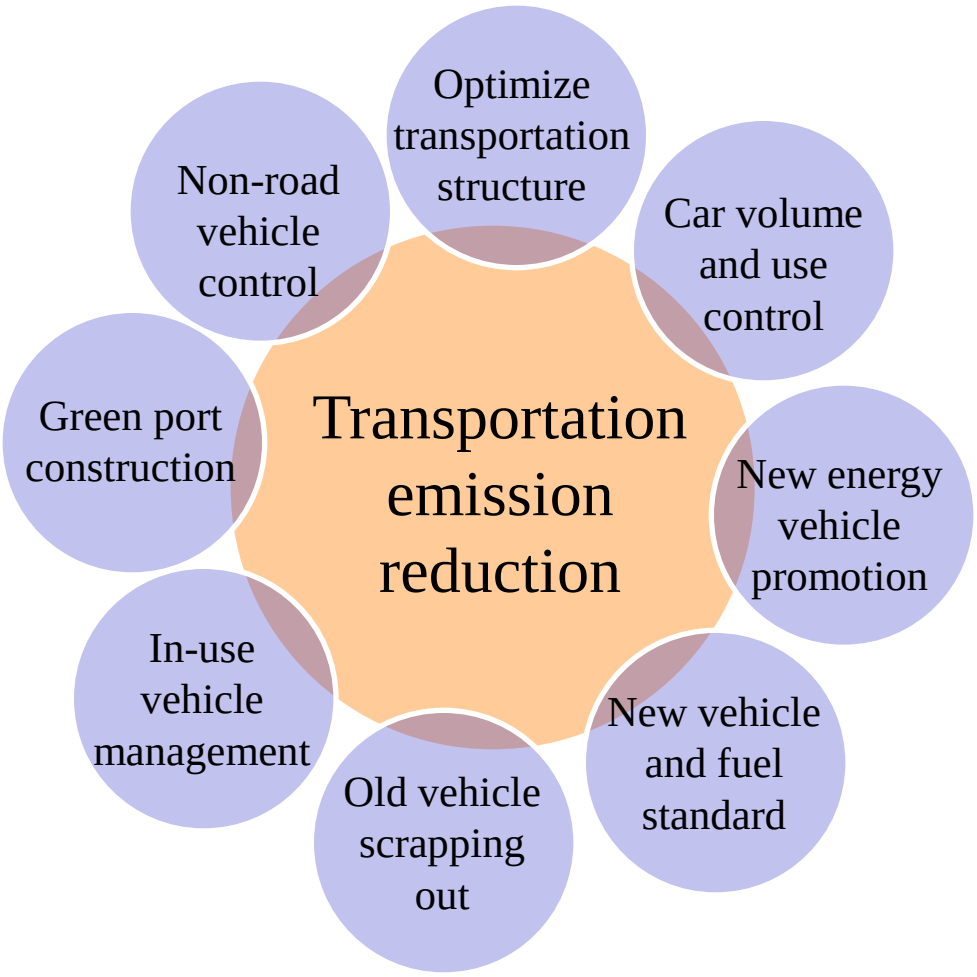
国家“气十条”
10 measures of state air pollution control

上海市清洁空气行动计划（2013-2017）
Clean air act plan of Shanghai (2013-2017)

- 优化能源结构
  Optimize the energy structure
- 工业污染防治
  Industrial pollution control
- 发展绿色交通
  Develop green transportation
- 建设行业管理
  Construction industry management
- 农业污染治理
  Agriculture pollution governance
- 社会生活源整治
  Residential pollution source regulation

未来五年交通源综合排放控制措施

Integrated transportation emission control measures in next 5 years

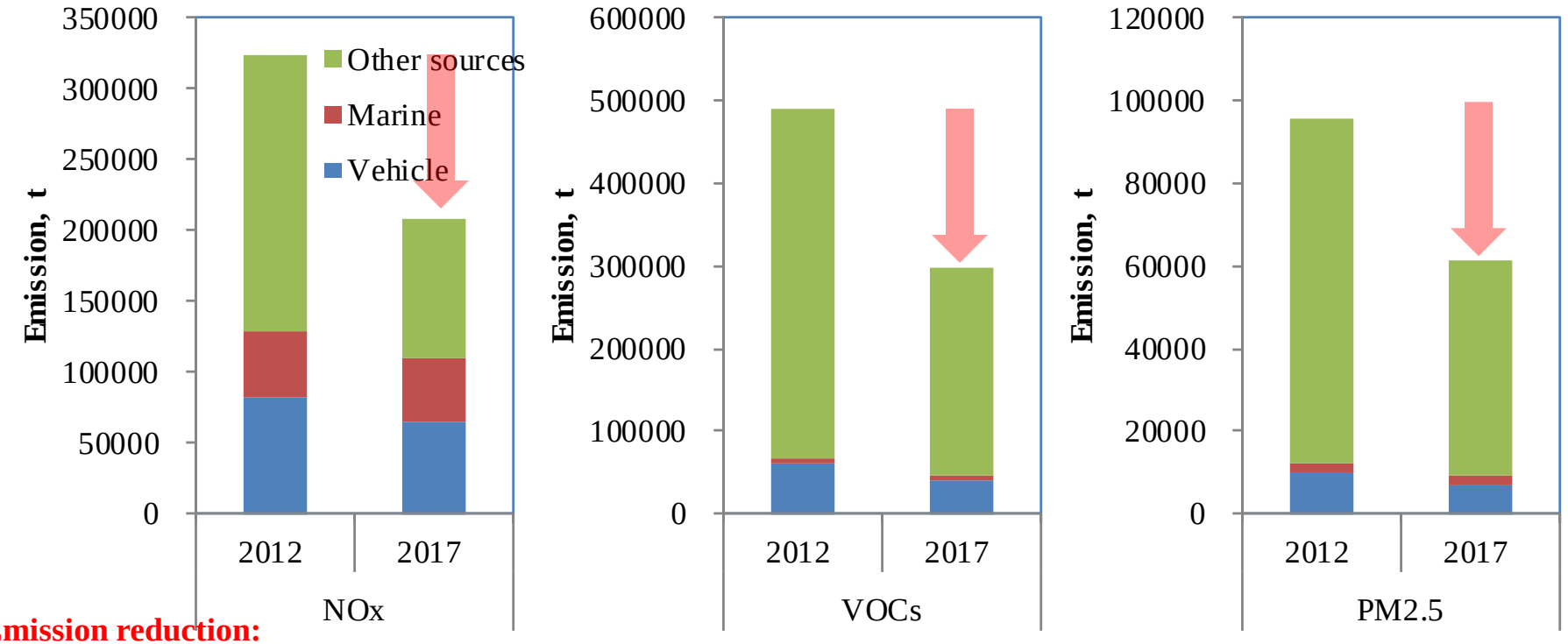


Totally 8 regions and 22 measures:

- Optimize transportation structure
- Car volume and use control
- New energy vehicle promotion
  - Update above 60% of new energy bus
  - More than 400 new energy trucks
  - 5000 Charging pile
- New vehicle and fuel standard
  - Euro V vehicle and fuel standard
- Old vehicle scrapping out
  - Yellow-label vehicle scrapping subsidies
- In-use vehicle management
- Green port construction
- Non-road vehicle emission control

清洁空气行动计划的环境效果评估
Environmental impact evaluation of Clean Air Act plan

- 减排效果
  Emission reduction perspective



Emission reduction:

Transport	**15%**	**30%**	**27%**
Total	**36%**	**39%**	**36%**

清洁空气行动计划的环境效果评估
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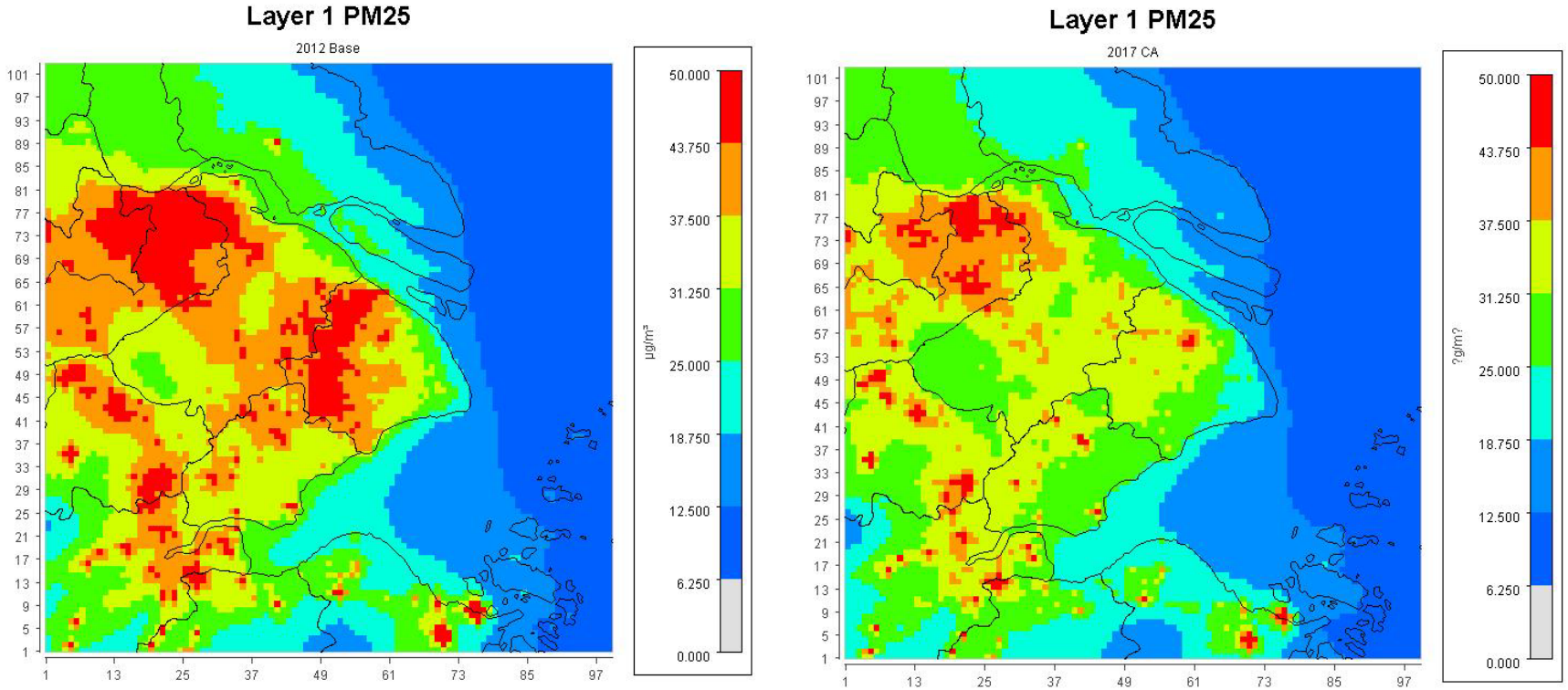
- 空气质量改善效果
  Air quality improvement perspective



Annual $PM_{2.5}$ concentration is expected to be decreased by 20.3% by 2017

谢谢！

Thanks for you attention！

报告人：黄成

Reporter: Huang Cheng

Email: chenghsaes@163.com