KTH, Stockholm, November 20-21, 2013,

Air Quality Monitoring and Forecasting to Impact Peoples' Traveling Behavior

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Contents

- Background
- The goal of the research
- Experiments and Preliminary results
- Further work

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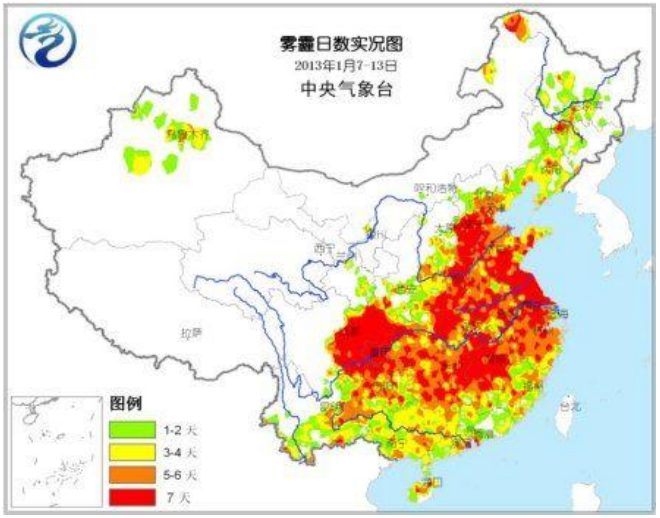
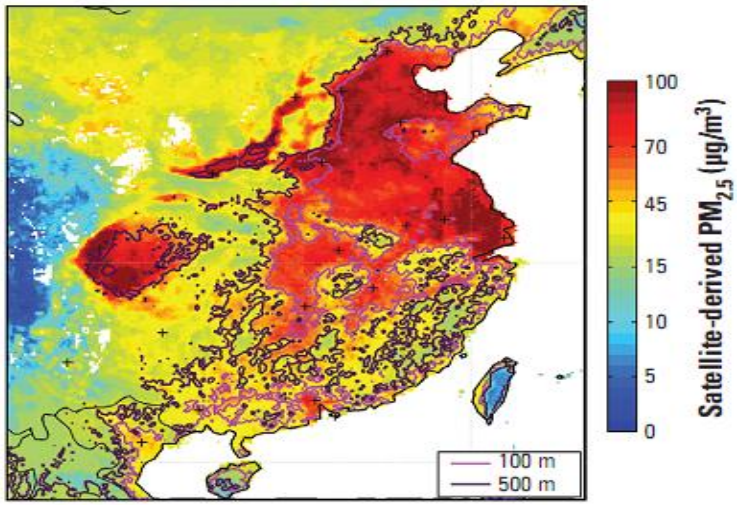
Background

Beijing

Background





Satellite observations of PM2.5 concentration distribution

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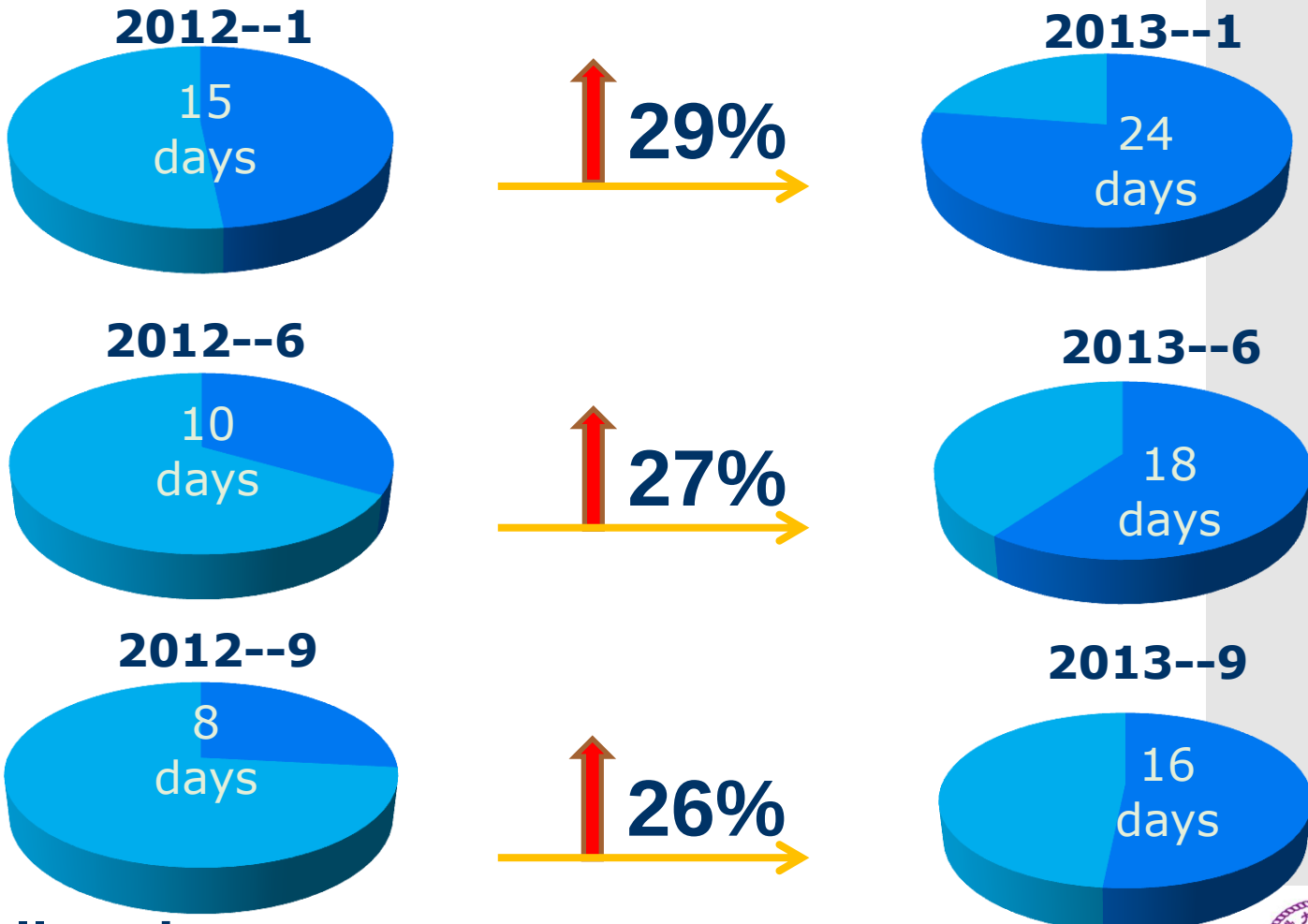
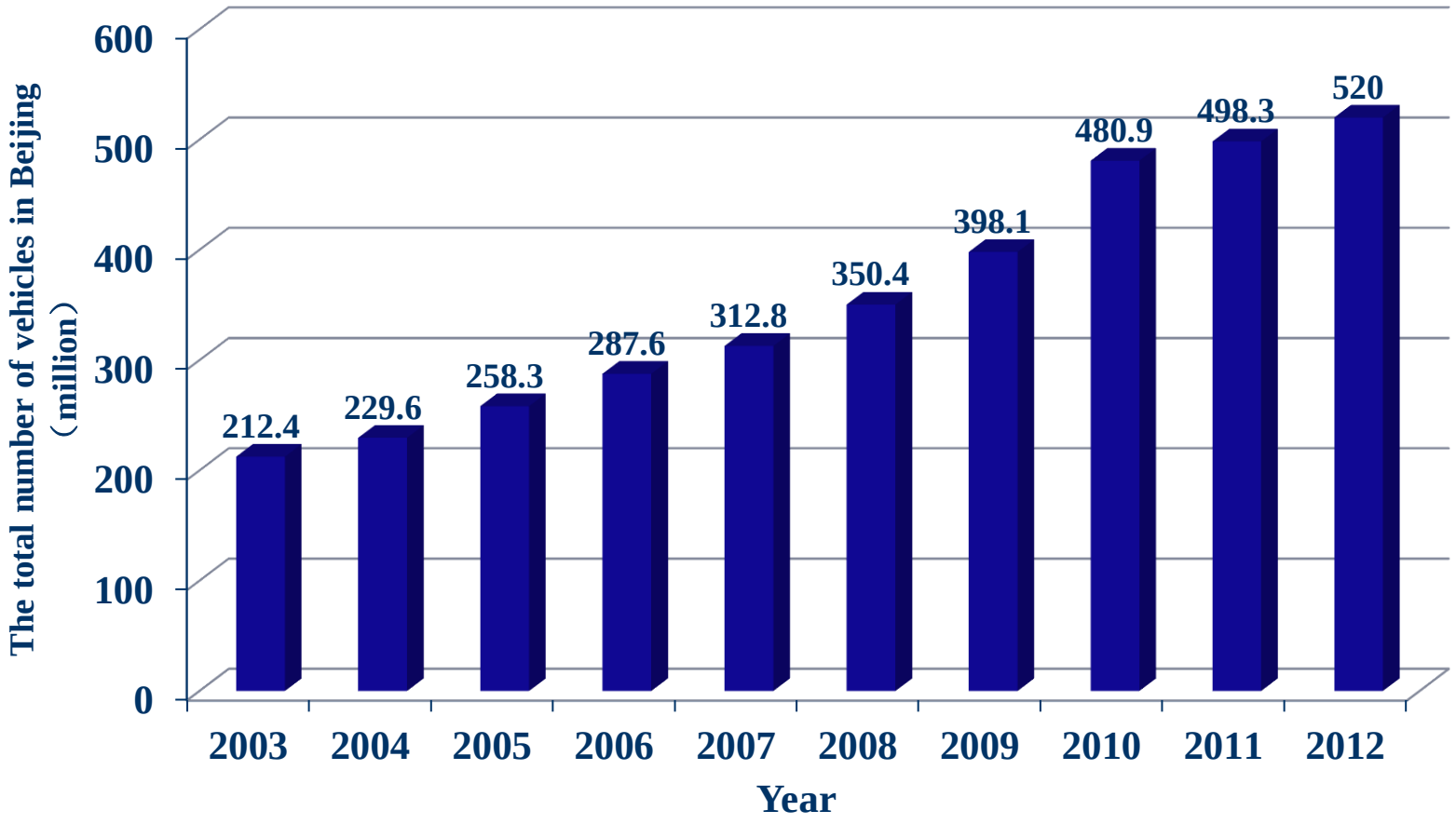
Background


2012--1
15 days
29%
2013--1
24 days
2012--6
10 days
27%
2013--6
18 days
2012--9
8 days
26%
2013--9
16 days
Heavily polluted
Normal

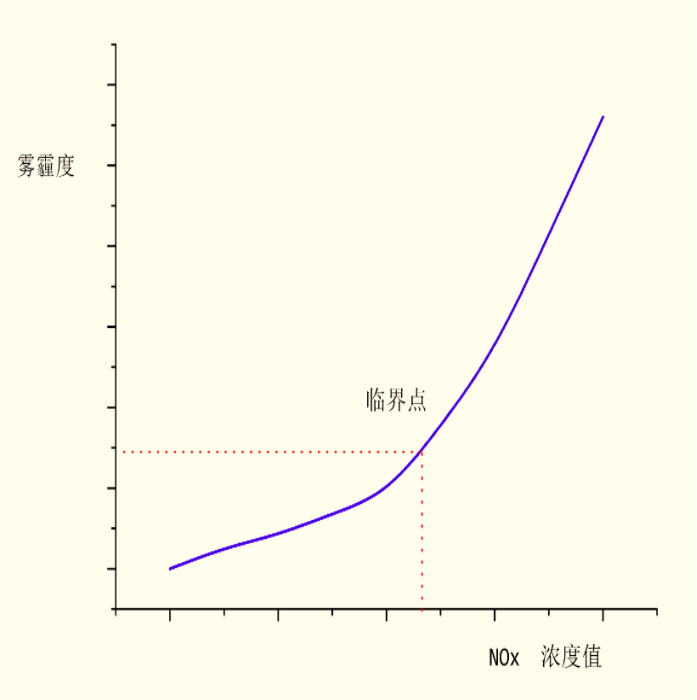
Background

Background


The total number of vehicles in Beijing (million)
600
500
400
300
200
100
0
212.4
229.6
258.3
287.6
312.8
350.4
398.1
480.9
498.3
520
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year

Background

- **The preliminary study results:**
  - 75% pollutants from surrounding areas.
  - 15-20% contributed by traffic emissions, especially NOx.
  - NOx plays a key role as catalyst in the air to form haze and mist



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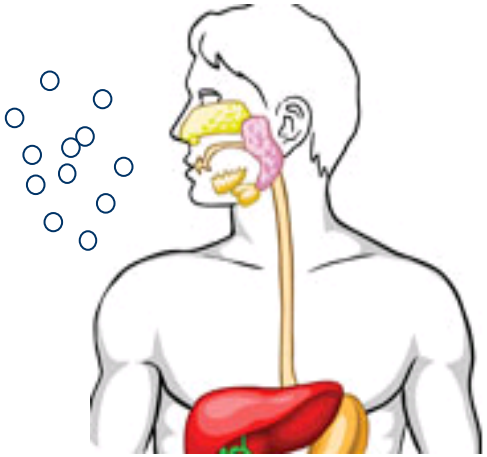
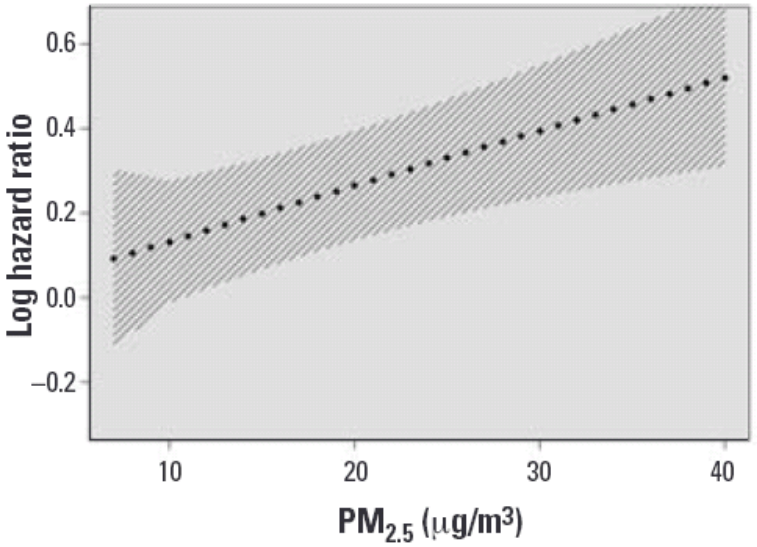
Background

Health effects

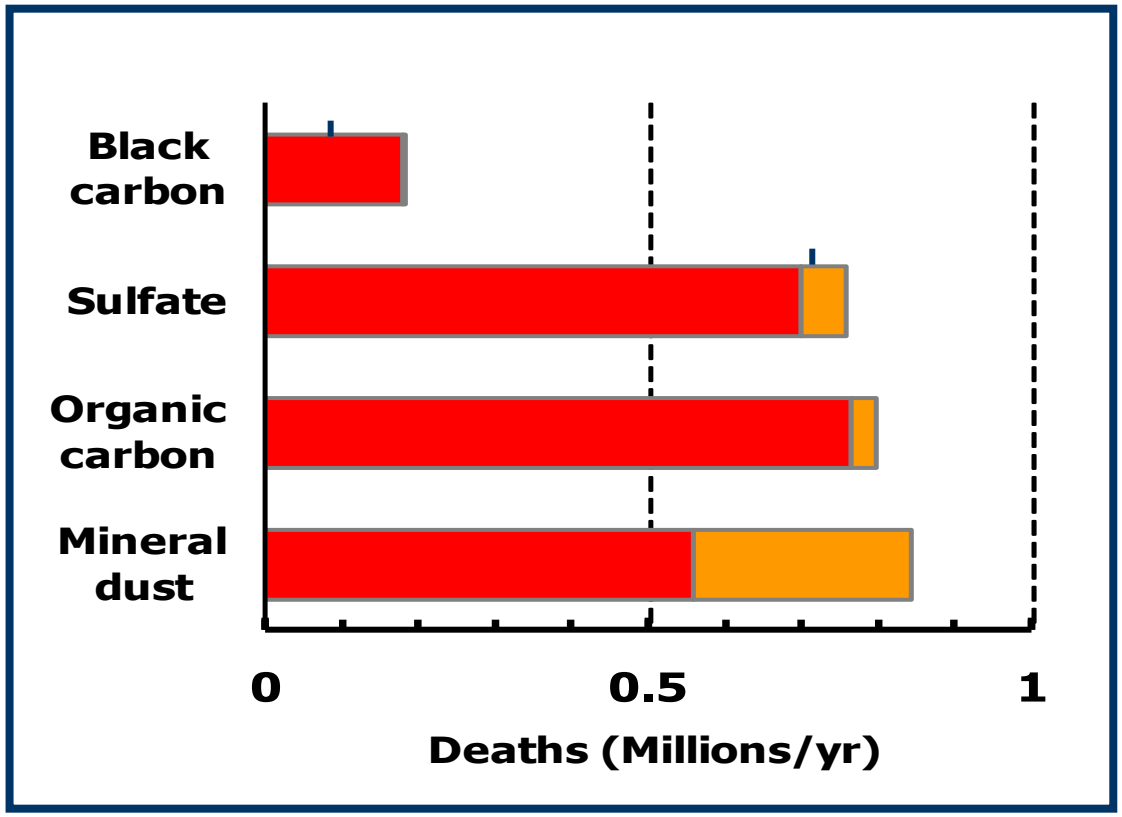




- Inhalable particles
  - Respiratory system, and
  - Cardiovascular system

Background

Each year due to inhalable particle long exposure leads to early death toll at about 0.80-2.5 million



Liu et al. [2009] AE

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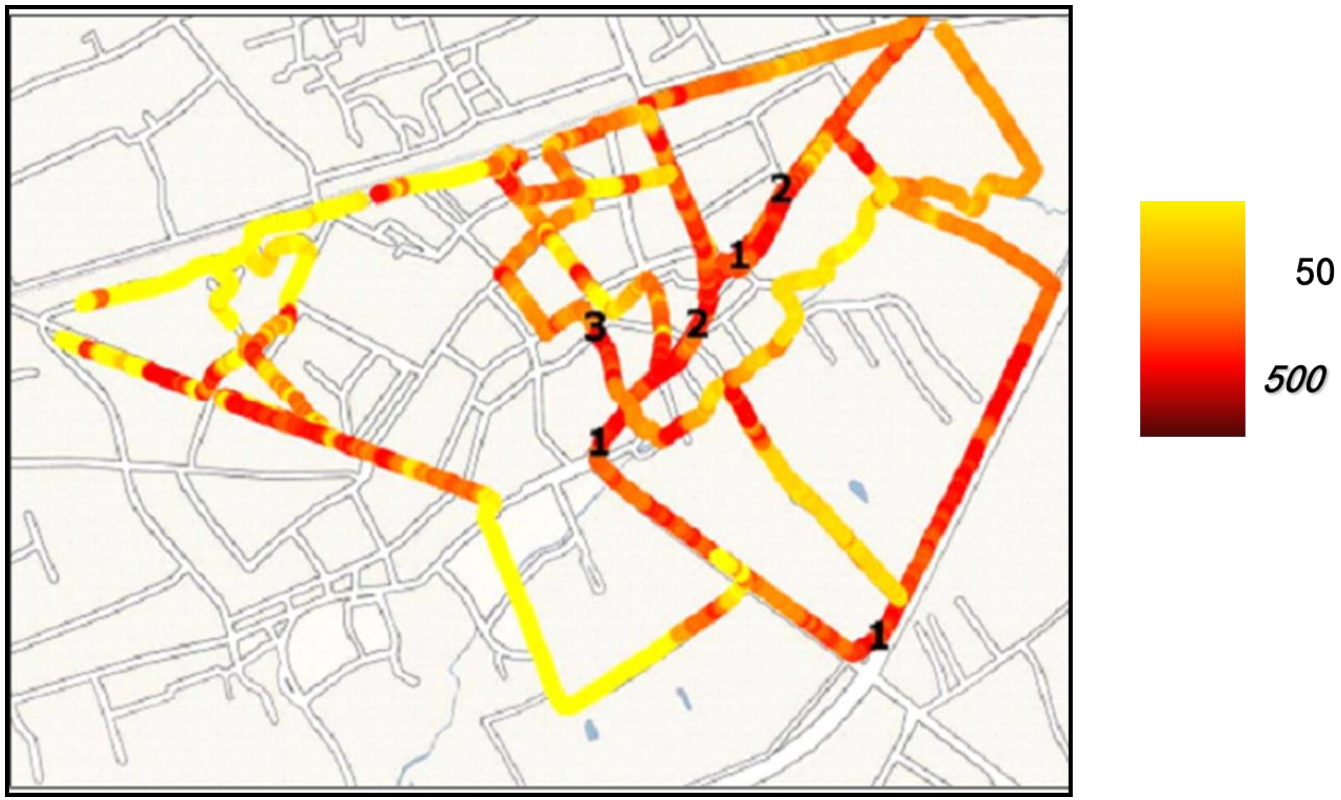
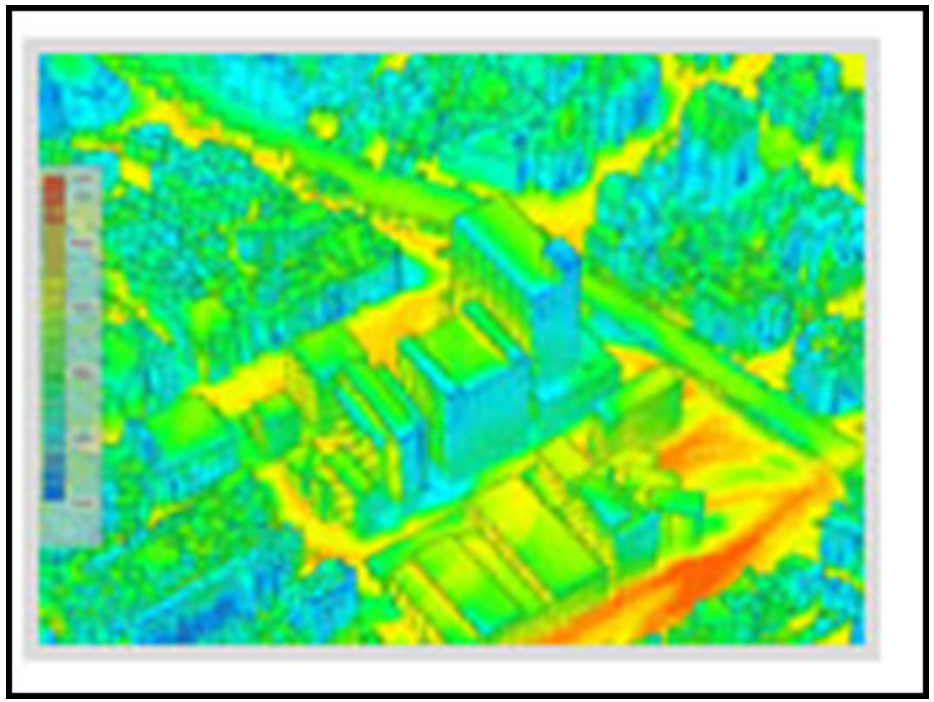
The Goal

1. To produce micro-scale (street level) urban pollutants concentration map



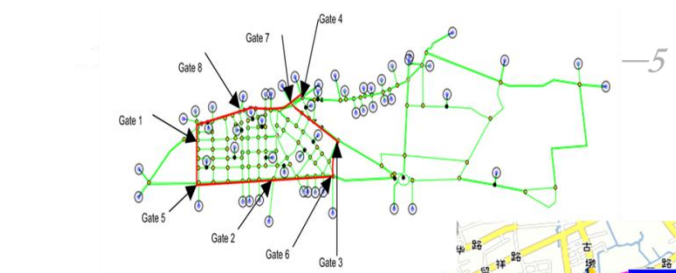
The Goal

2. **To produce forecasting and guidance to advise travelers :**
   1. to select different routes and destinations, and
   2. to use public transports



The Goal

3. **To use traffic management and traffic guidance technologies to:**
   1. limit traffic entrance to areas with heavy pollution, and
   2. guild traffic to use less congested roads
   3. to reduce traffic congestions and air pollution



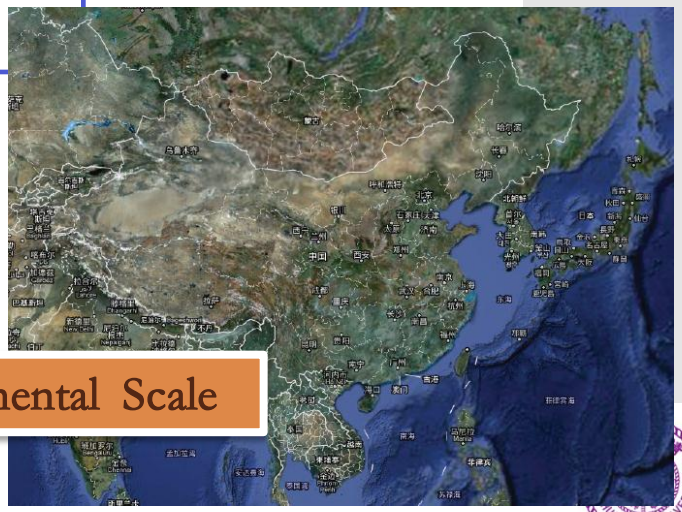
The Multi-scale Models

Street Scale

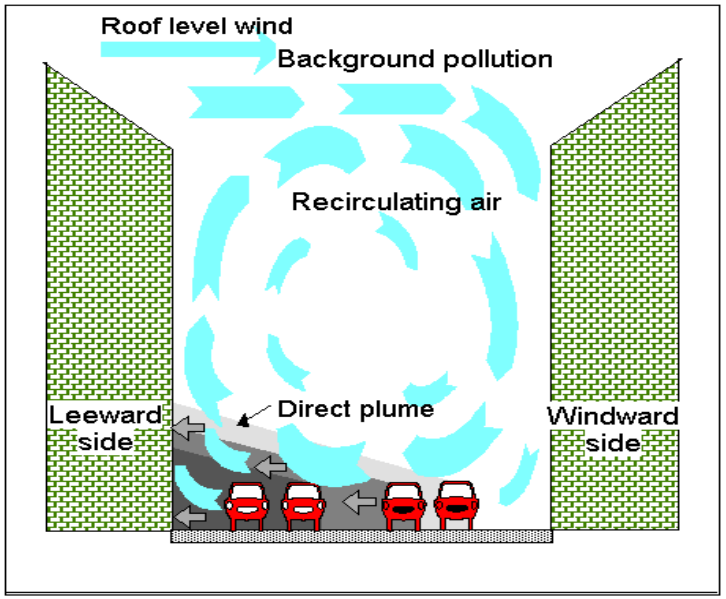
City Scale

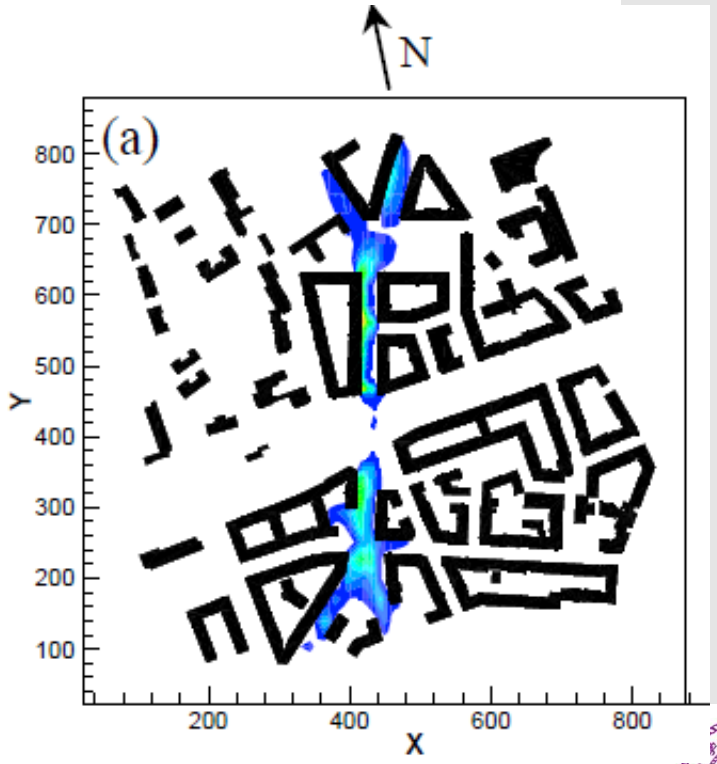
Area Scale

Continental Scale



The Street Level Pollution Concentration

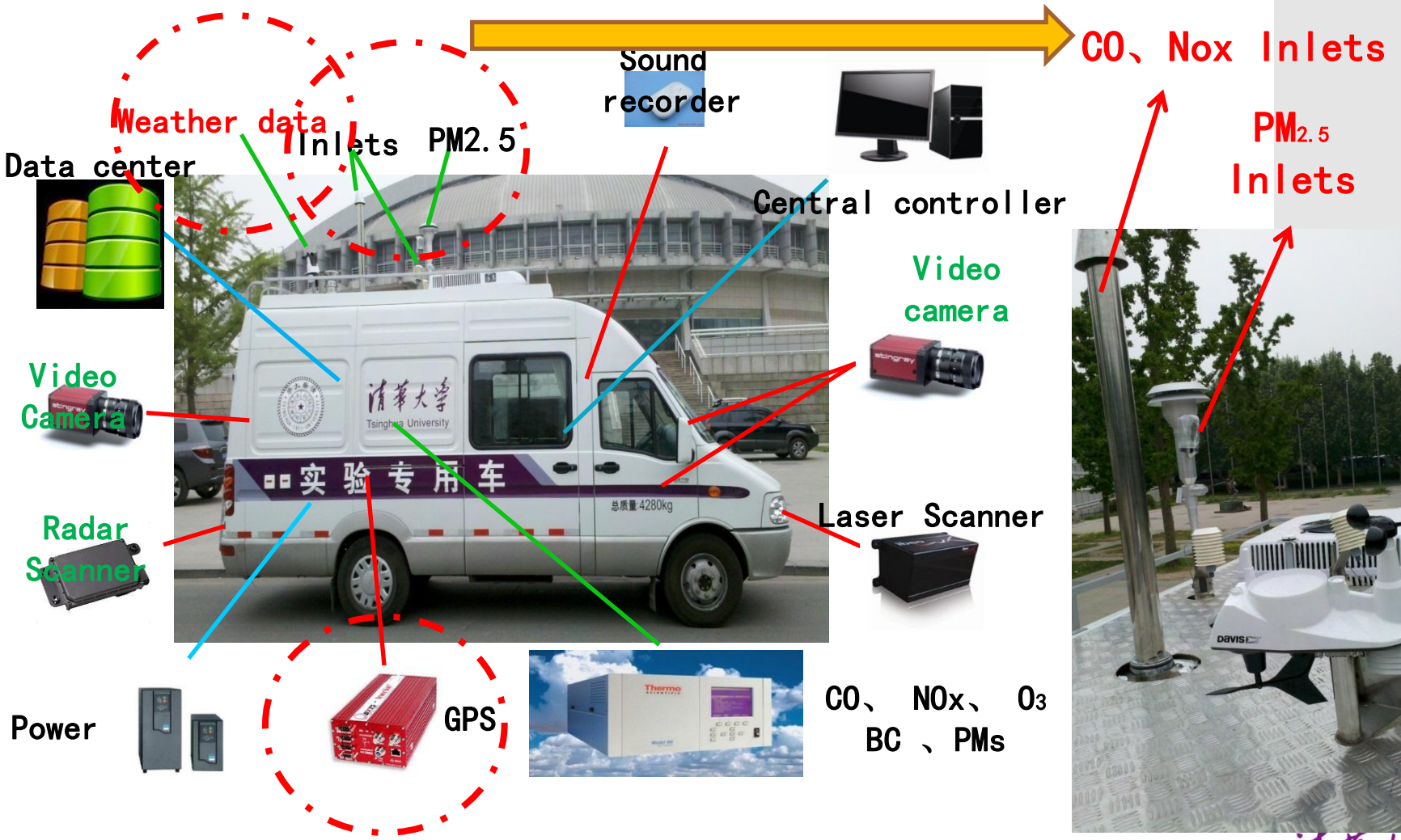




the number of air quality monitoring stations

- **Urban area（within ring road 5） needs 80 air quality monitoring stations**
- **Current total 12 air quality monitoring stations**

the Mobile Monitoring Station



the Mobile Monitoring Station

	Data	Unit	Frequency
Traffic Data	GPS	longitude and latitude	10s
	Headway	(m)	5s
	Speed	(m/s)	5s
	Acceleration	(m/s^2)	5s
	Radar Scanner	(m)	5s
	Video Camera		
	Sound Recorder		
Environmental Data	NOx	(ppb)	60s
	CO	(ppm)	60s
	BC	(ppb)	60s
	O_3	(ppb)	60s
	$PM_{2.5}$	($\mu g/m^3$)	60s
Weather Data	Wind direction		60s
	Wind speed	(m/s)	60s
	Rain	(cm/d)	1 day
	Humidity		5min
	Air pressure	(Kpa)	5min

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- The relationship between moving speed and pollutants concentration

The equipment validation

- Difference on sampling tube length of the mobile monitoring station
- The monitoring values comparison between mobile and the stationary monitoring station

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Main Variables considered

1、Road types: Urban expressway、main roads, minor roads

2、Traffic volume: Peak hours, off peak

3、Moving speeds:
5、10、15、20、25、30、35、40 (km/h)

4、Background concentration (nearby air quality monitor)

5、Weather condition

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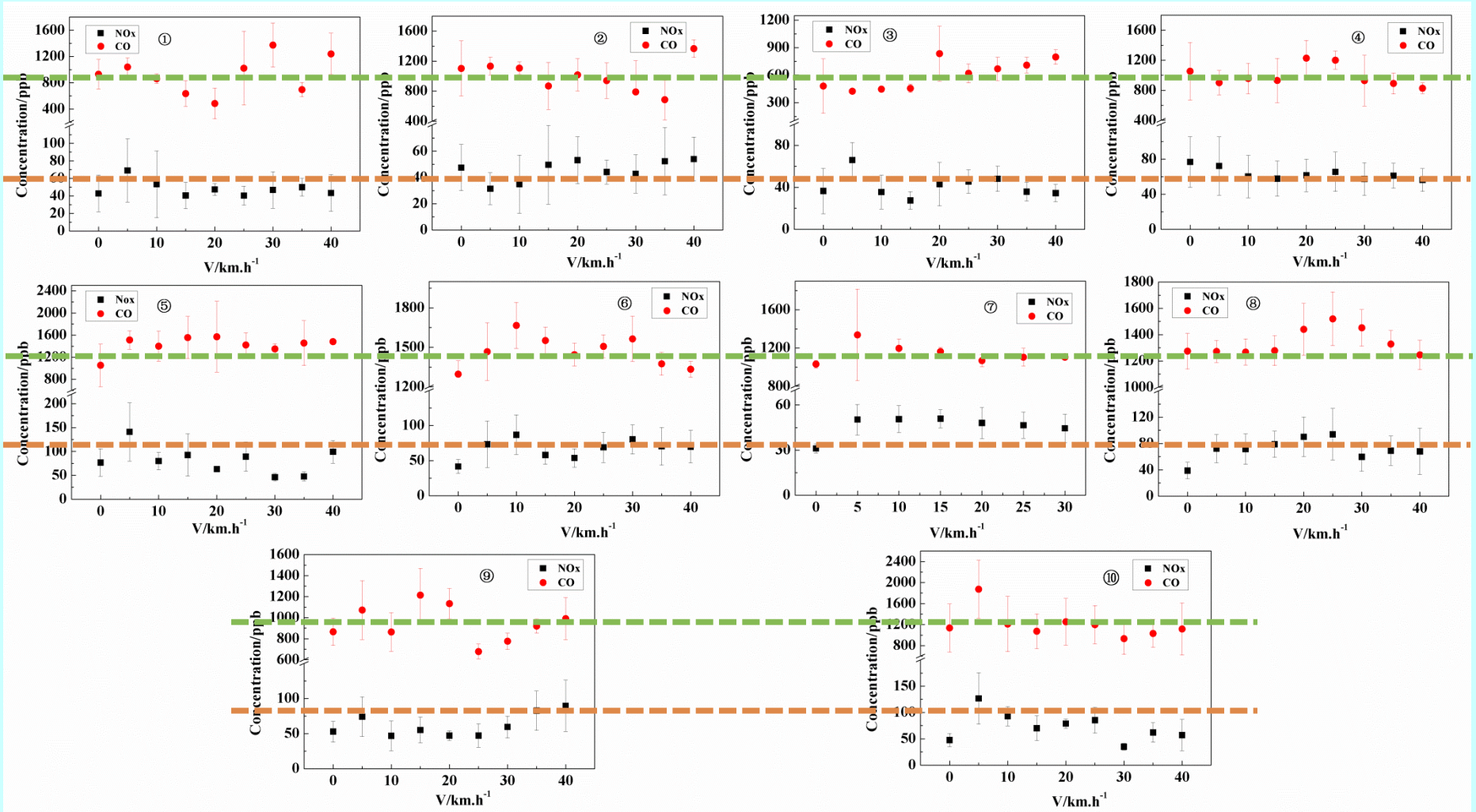
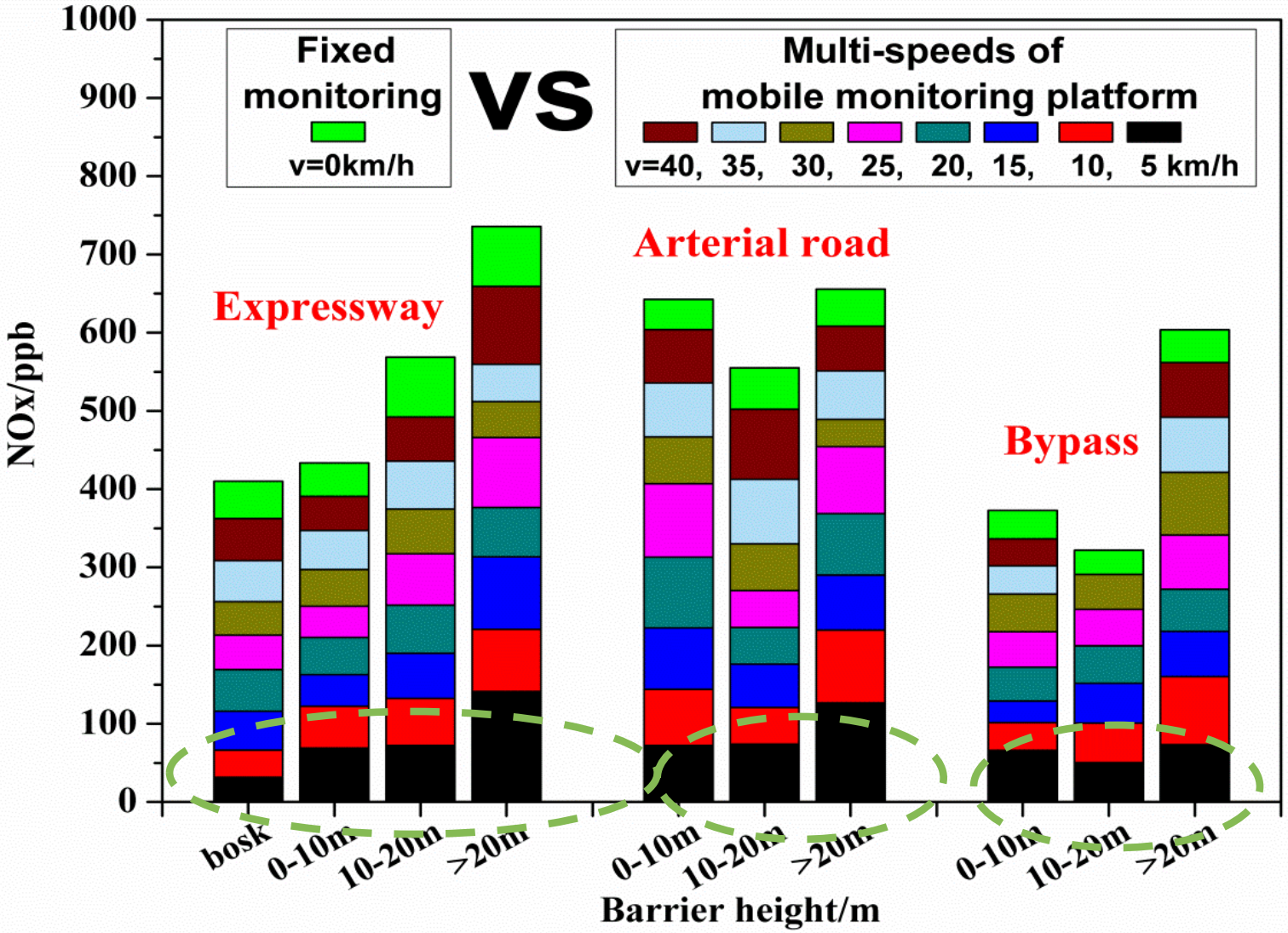
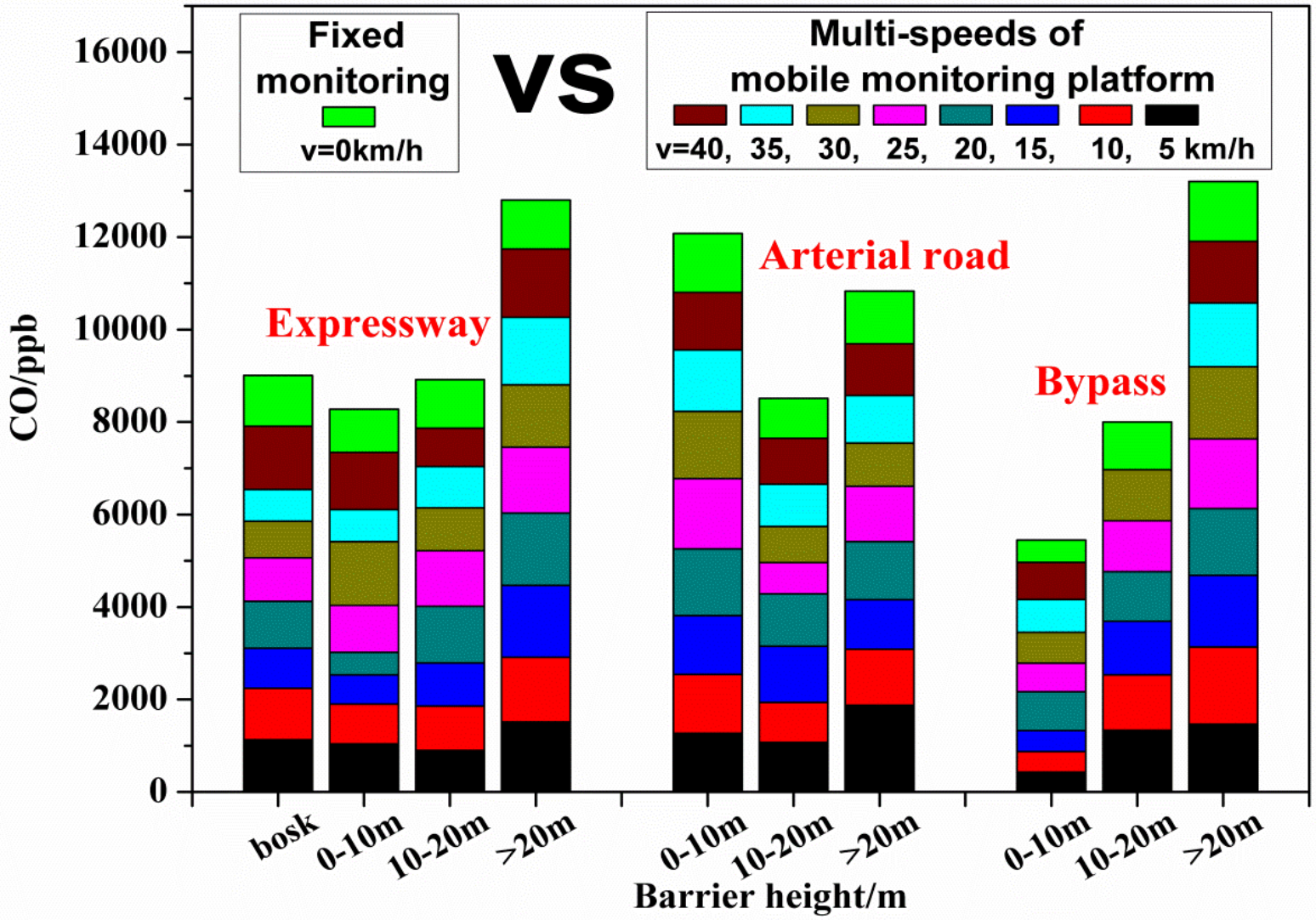
The Preliminary Results



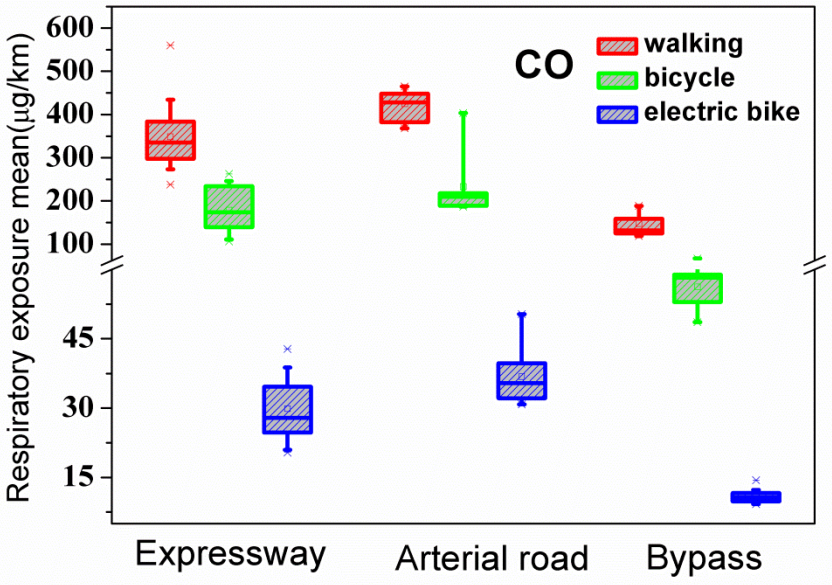
The Preliminary Results

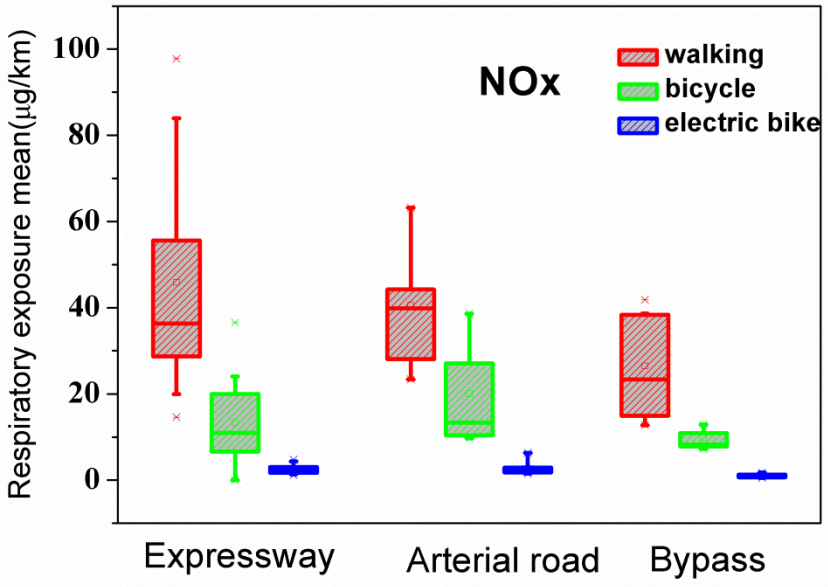


The Preliminary Results



Preliminary Results





The average respiratory exposure of CO and NOx per kilometer for different travel mode between 9:00am—16:00pm (Beijing)

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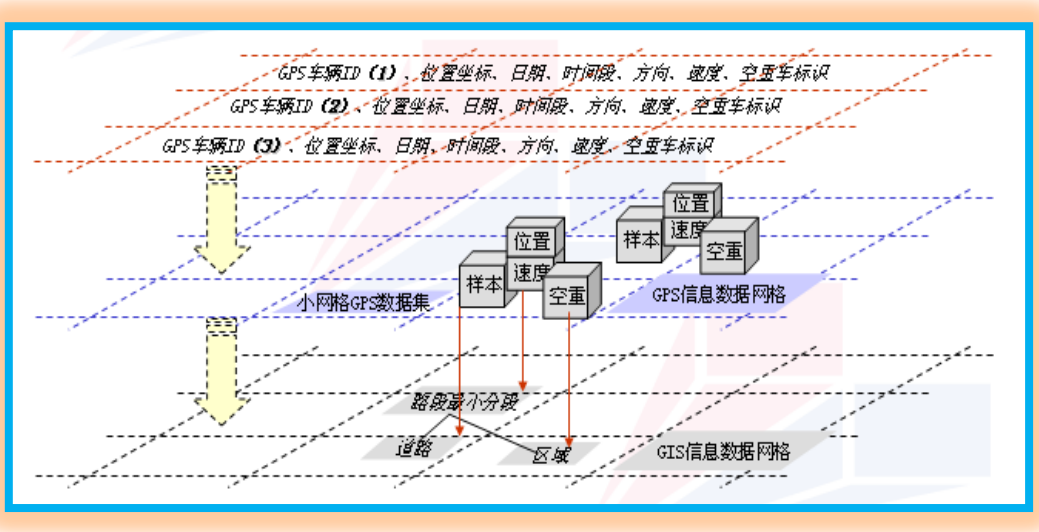
1. Real-time Air Pollution Concentration Map In Grids



2. Prediction and Guidance

- Historical Air Quality data
- Historical Weather Data
- Street characteristics

- Real Time Air Quality data
- Historical Weather Data
- Street characteristics

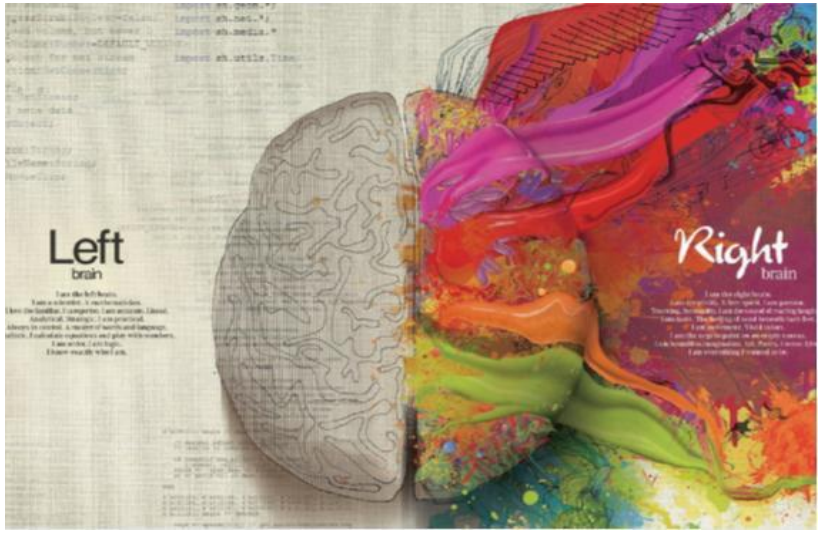
Air Quality Prediction Model

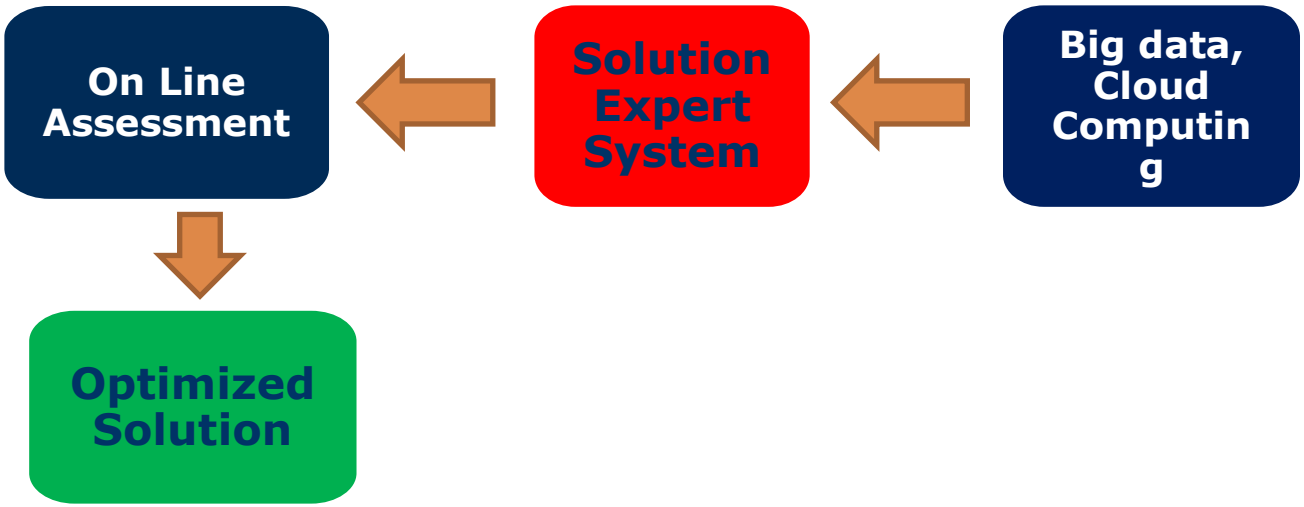
Travel Guilance
- Travel mode
- Route and Destination

How to provide Information

- Overloaded Information
- Vague information

How to provide Information





3. To reduce concentration by traffic management measure

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   1. limit traffic entrance to areas with heavy pollution, and
   2. guild traffic to use less congested roads
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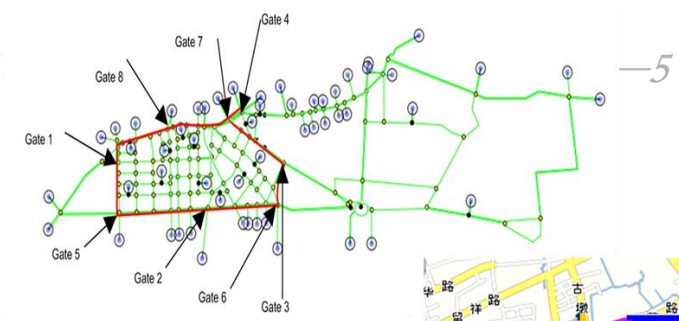

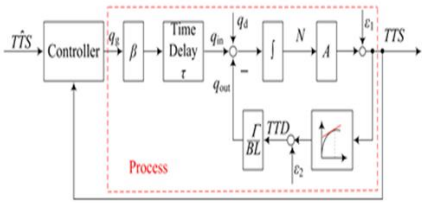

Summary

1. **We used to monitoring traffic flow and generating traffic state map to guild travelers to avoid congested roads, areas**
2. **Now, we also monitor and predict street level air quality (generating air quality map)to:**
    1. Advise travelers to avoid the streets with bad air quality by choosing:
        1. different destination, different routs or different time to travel
        2. different transport mode
    2. Employ smart transport technologies (e.g. access control and traffic guidance) to reduce air pollution concentration in key areas

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Thanks for your attention!

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