

Air Quality Forecasting at the Beijing Olympics

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CERC

Presentation to EPUK
October 2008

Partners

Beijing CNU

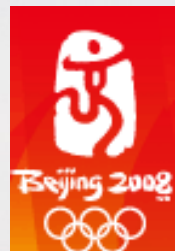
Beijing EPB

KNMI

Univ. of Athens

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DRAGON 2 龙计划



Contents

- Air quality in Beijing and the Olympics (DRAGON 2 project)
- **yourair** systems
- **BeijingAir: yourair** in Beijing
- Performance evaluation



Beijing's air quality

Same place, different days...

Good



Worse



Bad



BBC 2008



Beijing's air quality: from 1979 to 2008



Beijing's air quality caused great concern...

Four American cyclists arrived in Beijing airport wearing face masks to protect against air pollution



guardian.co.uk 6 Aug 2008

... even for beer and wine drinkers

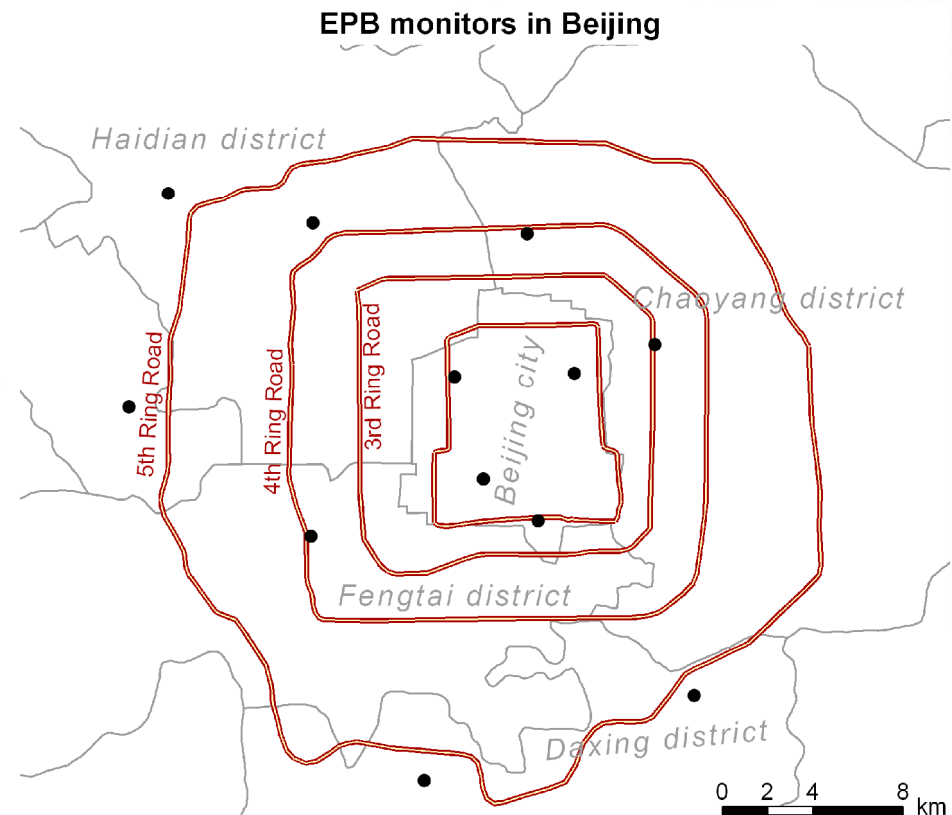
When pre-EURO I HGVs were banned on 1 July, the price of wine and beer soared



CERC July 2008

Beijing's air quality: monitoring

- Monitoring by the Beijing Environment Protection Bureau (EPB)
- Network of 27 monitors in the municipality of Beijing
 - 11 monitors located in “central” Beijing
- Pollution expressed as Air Pollution Index
 - daily value per monitor
 - daily average for Beijing



Beijing's air quality: monitoring

- Daily values published on-line daily at <http://www.bjepb.gov.cn>

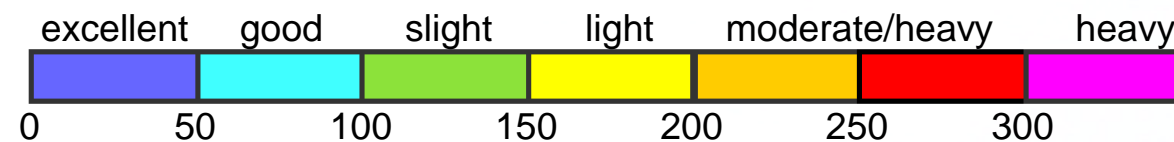


The screenshot shows a Mozilla Firefox browser window displaying the website of the Beijing Municipal Environmental Protection Bureau. The page features a banner with the bureau's name in Chinese and English, and a logo. Below the banner, there is a section titled '空气质量日报' (Air Quality Daily Report) for the period from October 13, 2008, to October 14, 2008. This section contains a table with five columns: '监测子站' (Monitoring Substation), '空气污染指数' (Air Pollution Index), '首要污染物' (Primary Pollutant), '级别' (Level), and '空气质量状况' (Air Quality Status). The table lists data for various monitoring stations across Beijing, all showing an Air Pollution Index of 115 or below, with the primary pollutant being '可吸入颗粒物' (Inhalable Particulate Matter) and the air quality status being '轻微' (Slight).

监测子站	空气污染指数	首要污染物	级别	空气质量状况
国控站平均	115	可吸入颗粒物	III级	轻微
东城区东四	132	可吸入颗粒物	III级	轻微
西城区官园	110	可吸入颗粒物	III级	轻微
崇文区天坛	106	可吸入颗粒物	III级	轻微
宣武区万寿西宫	107	可吸入颗粒物	III级	轻微
朝阳区奥体中心	110	可吸入颗粒物	III级	轻微
朝阳区农展馆	134	可吸入颗粒物	III级	轻微
海淀区植物园	104	可吸入颗粒物	III级	轻微
海淀北部新区	114	可吸入颗粒物	III级	轻微
海淀区万柳	114	可吸入颗粒物	III级	轻微
丰台区卢沟桥	123	可吸入颗粒物	III级	轻微

Beijing's air quality: monitoring

- Air Pollution Index (API)
 - defined by the China National Environmental Monitoring Centre

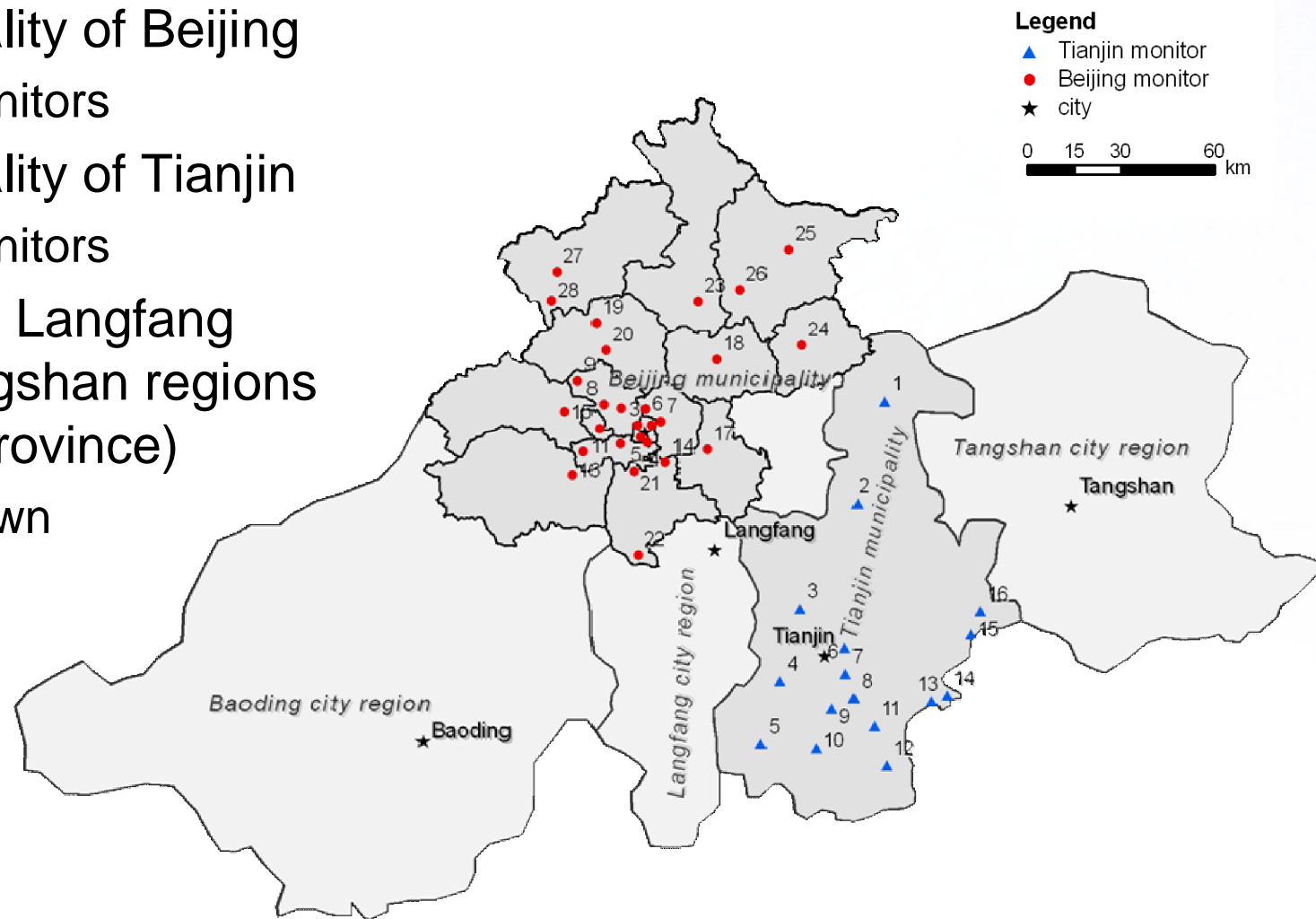


- API and species concentrations (mg/m³)

API	SO ₂ (daily mean)	NO ₂ (daily mean)	PM ₁₀ (daily mean)	CO (hourly mean)	O ₃ (hourly mean)
50	0.05	0.080	0.05	5	0.12
100	0.15	0.120	0.15	10	0.20
200	0.80	0.280	0.35	60	0.40
300	1.60	0.565	0.42	90	0.80
400	2.10	0.750	0.50	120	1.00
500	2.62	0.940	0.60	150	1.20

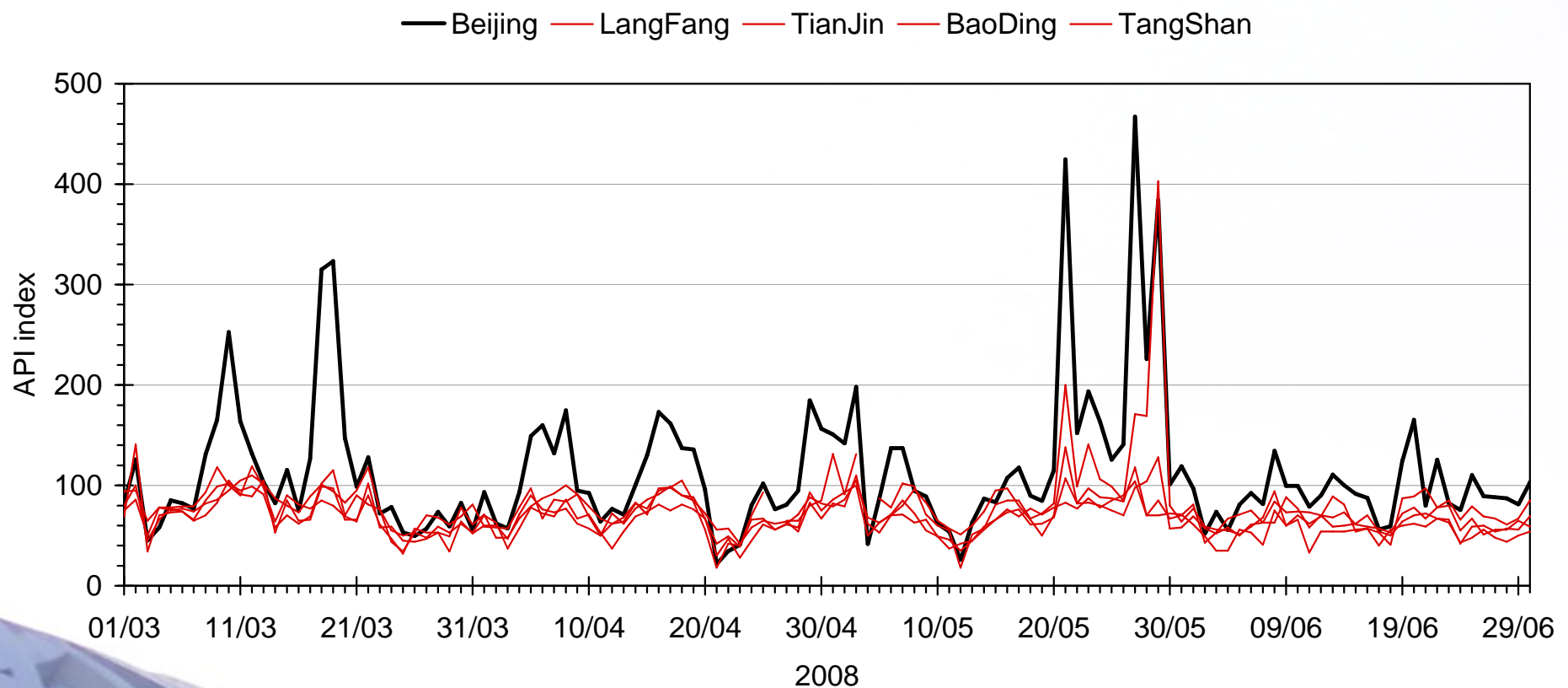
Beijing's air quality: monitoring

- Municipality of Beijing
 - 27 monitors
- Municipality of Tianjin
 - 16 monitors
- Baoding, Langfang and Tangshan regions (Hebei province)
 - unknown



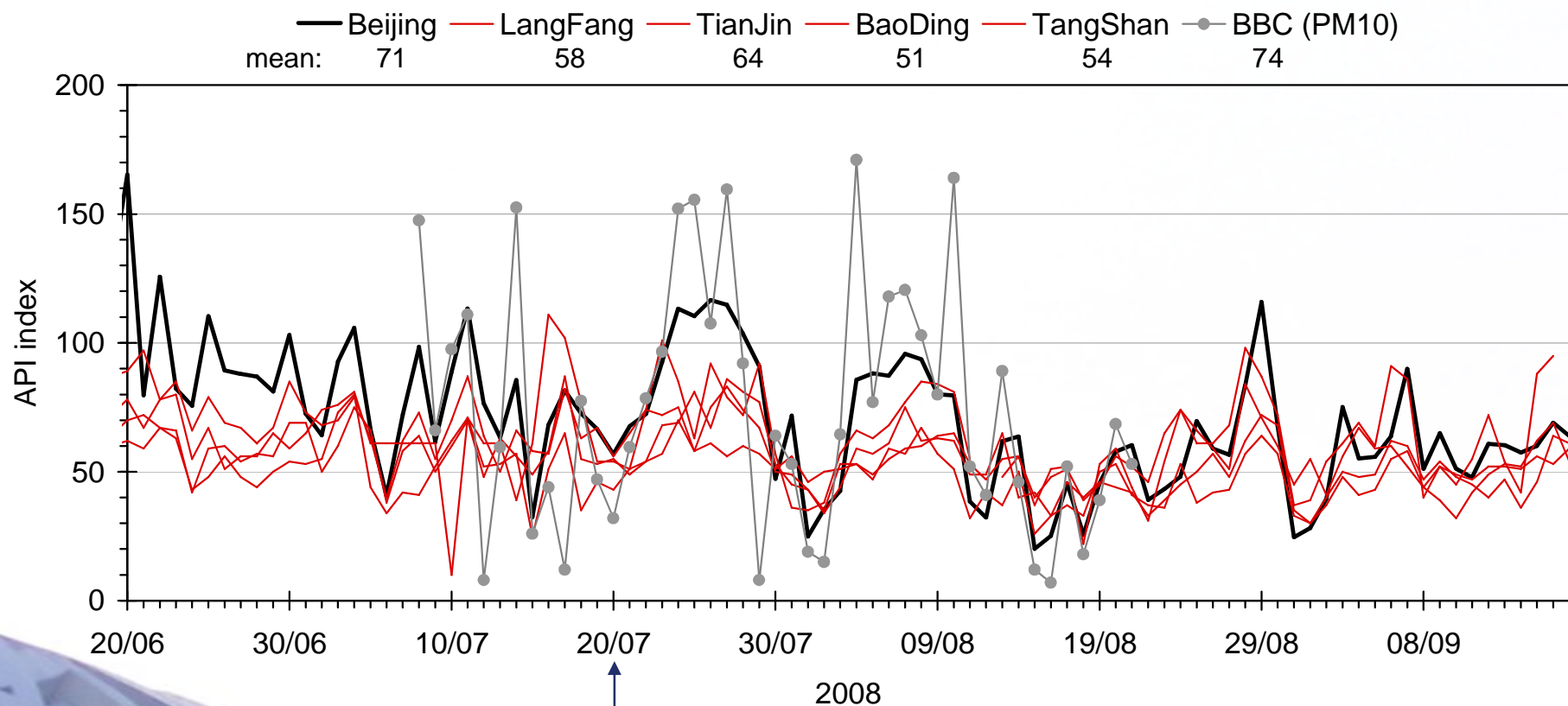
Beijing's air quality: API (March to June 2008)

API monitored by the EPBs of Beijing, Hebei and Tianjin



Beijing's air quality: API (June to September 2008)

API monitored by the EPBs of Beijing, Hebei and Tianjin
PM₁₀ measurements by a BBC reporter James Reynolds



Last emission controls coming into force

Beijing's air quality: emission controls

- 10 years of planning and implementation of emission controls by the Beijing EPB to control air pollution
 - 13 programmes since 1998, 60 billion RMB
 - Four main categories of controls
 - reconstruction of energy supply
 - control of traffic
 - control of construction
 - control of industrial pollution
- Levels of all major pollutants roughly constant or decreasing despite a growth in traffic of 10 % each year



Beijing's air quality: emission controls

- Final stage on 20 July 2008
 - reduction in the use of private cars
 - further reduction in the use of government cars
 - a temporary halt to construction during the Olympic period
 - more cleaning of the roads to reduce dust
 - the suspension of heavily polluting industry
 - a reduction in production for coal-based enterprises



Vehicles restricted to operating on alternate days according to whether the final number on their licence plate is odd or even

Green sticker for Euro I (III) or above for petrol (diesel) vehicles



Signs alert drivers to areas of congestion and inform if the roads are free flowing



Higher polluting vehicles banned on urban roads from 1 July to 20 September - no yellow stickers



Special dedicated lanes should ease congestion for vehicles associated with the Olympics entitled to use them



The DRAGON 2 project

- DRAGON is a cooperation project between
 - the European Space Agency and
 - China's Ministry of Science and Technology
- DRAGON 1: 4-year long, has just concluded
- DRAGON 2: starting
- The prediction of air quality is part of a project looking at the effect of hosting the Olympic Games by considering various factors including quality of life
- The Greek partners studied environmental impacts including air quality for the Athens Olympics



The DRAGON 2 project: the team



DRAGON 2 龙计划

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yourair system



Input

- Regional background concentration
- Ground based monitoring
- Emissions
- Meteorology
- Land use
- Surface topography

System engine

**LOCAL
FORECASTS
ADMS-Urban**

Output

- Colour contour image of forecast overlaid on image
- Text and number summaries
- Alerts to TV, the public, health professionals
- **Send alert via SMS, e-mail or voice mail**



yourair system: data

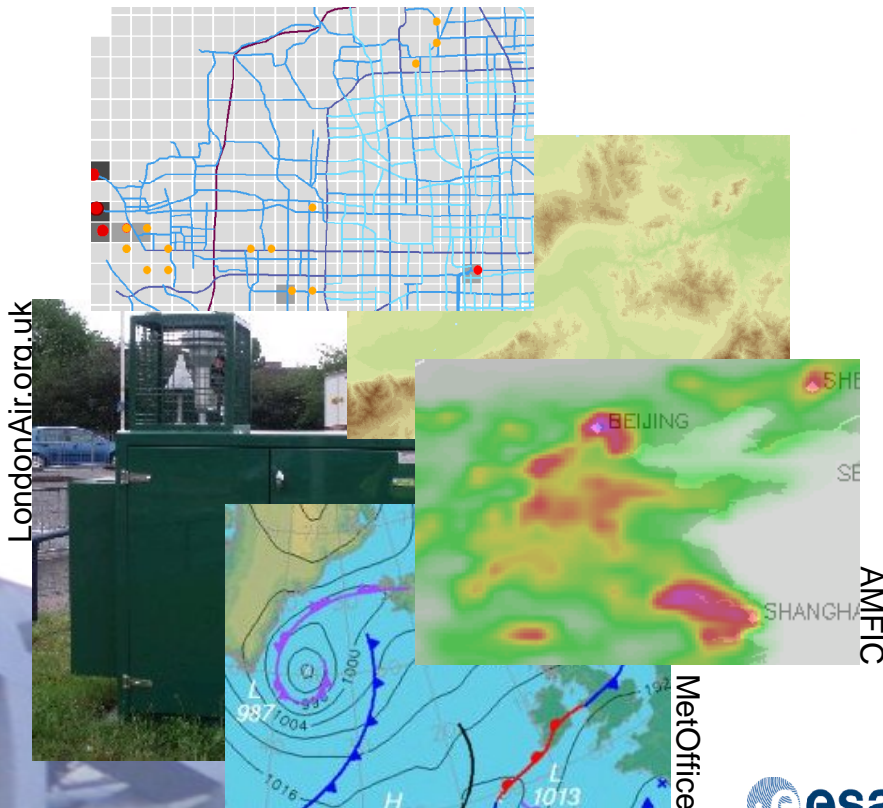


Data providers

- Forecast meteorological data 
- Forecast background air quality data 
- Automatic feed of locally monitored ambient air quality data

Data requirements

- Emissions inventory
- Topographical data
- Background image
- Historical meteorological data
- Locally monitored ambient air quality data



BeijingAir: yourair in Beijing

BeijingAir 北京

- **yourair** system set up for Beijing: **BeijingAir**
- Project phases

Phase	Phase 1 Feasibility study	Phase 2 System set up in the UK	Phase 3 Installation & launch in Beijing	Phase 4 Ongoing support
Start date	mid-March 2008	mid-April 2008	July 2008	September 2008
End date	mid-April 2008	end of June 2008	August 2008	August 2012
Duration	1 month	2.5 months	2 months	4 years

BeijingAir: phases 3 and 4

BeijingAir 北京

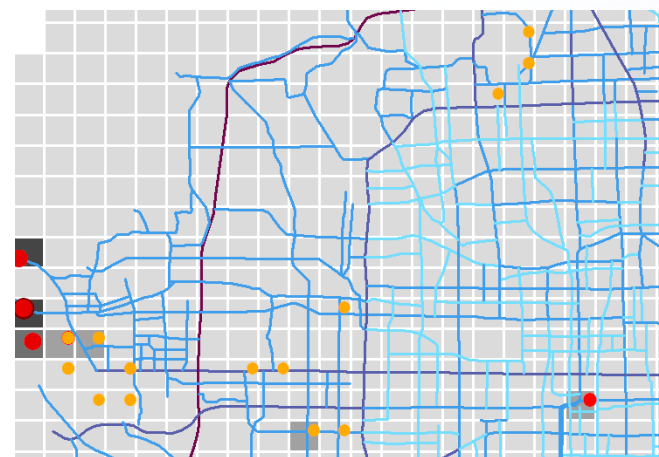
- The **yourair** system was installed
 - at the Beijing EPB
 - at the Capital Normal University
- Training was given in Beijing early July
- The system was launched in Beijing on 8 July and operational forecasts have been produced since
- Ongoing support for 4 years, involving
 - further training
 - upgrades to the system and models
 - advice on optimising the system with satellite data, ground based measurements and regional modelling as they become available



BeijingAir: input data

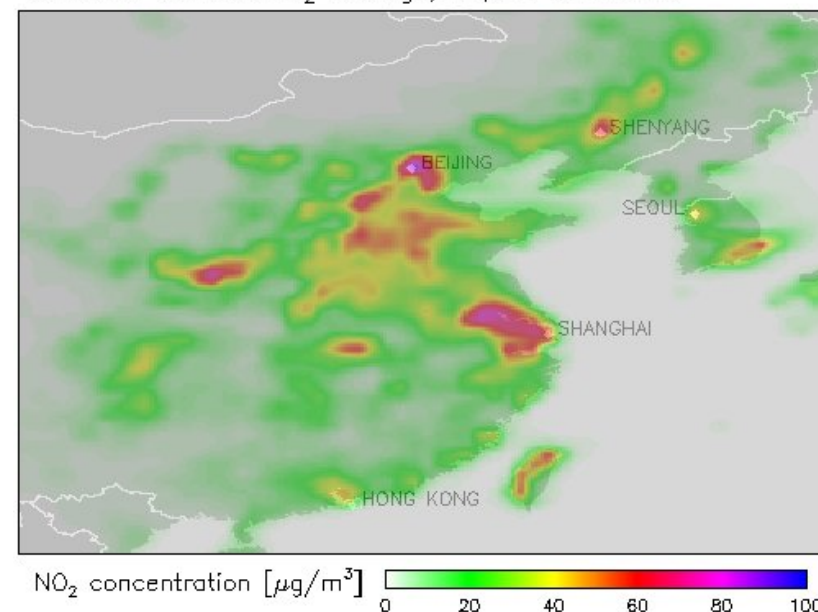
BeijingAir 北京

- Inventory: difficult to obtain
 - roads, industries, domestic heating
- Meteorology: forecasts by ECMWF
 - Forecasts for 9 days ahead
- Background air quality: output of CHIMERE model (KNMI)
 - use of NO_2 , PM_{10} , SO_2 , CO , O_3
 - spatial resolution of 0.25 degree



East China – NO₂ daily average

CHIMERE surface NO₂ average, F0, 06 Jun 2008



BeijingAir: result, dissemination *BeijingAir* 北京

Results

- Colour contours of total API, TSP, NO₂, SO₂ and O₃
- Detailed contours around Olympic stadium, Olympic village and tourist sites in the centre of Beijing
- Less detailed contours elsewhere in the city

Dissemination

- Results posted with a text summary to a website
- Website in Chinese and English
- Forecast sent 1x or 2x/day
- Forecast e-mail bulletins 2x/day



BeijingAir: website

BeijingAir 北京

BeijingAir 北京 • DRAGON 龙计划

Air quality forecasts for Beijing

Partner log in
English | 中文
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Language

Main tabs

forecasts

health effects

news

data resources

how it works

partner login

Login

Forecast for Tuesday 9 September, 2008 - Beijing



Interactive map

BeijingAir provides street-scale air quality forecasts for Beijing:

Forecast of Air Pollution Index for:
Tuesday 9 September, 2008

Beijing: Good air quality to slightly polluted.

Forecast selector:

Beijing
Air Pollution Index
☐ Monday 13 October, 2008
☐ Tuesday 14 October, 2008
☐ Wednesday 15 October, 2008

[Calendar: archived forecasts](#)

Archives

Air Pollution Index:

The definitions of air pollution levels and health effects used are those defined by the China National Environmental Monitoring Center.



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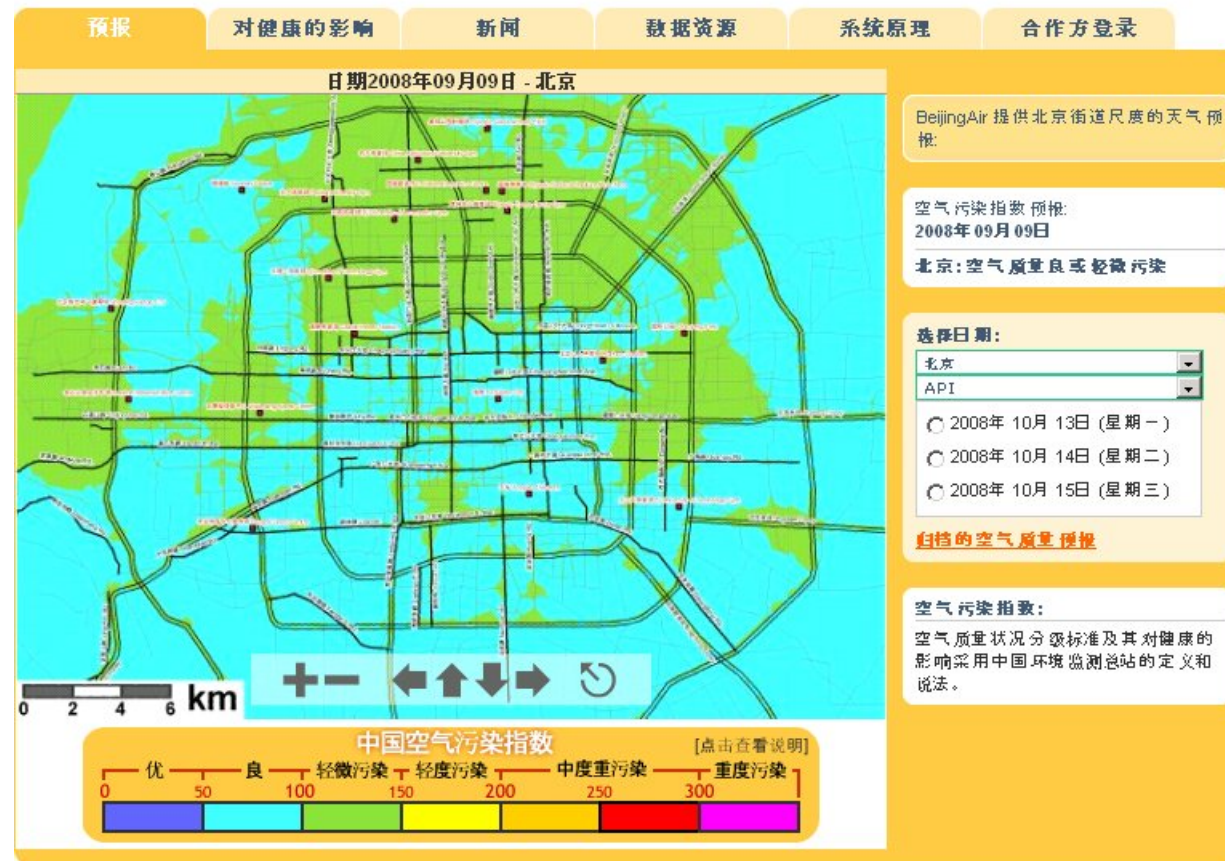
BeijingAir: website (in Chinese)

BeijingAir 北京

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北京空气质量预报

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English | 中文
字体: 正常 | 较大 | 特大 | 文本格式



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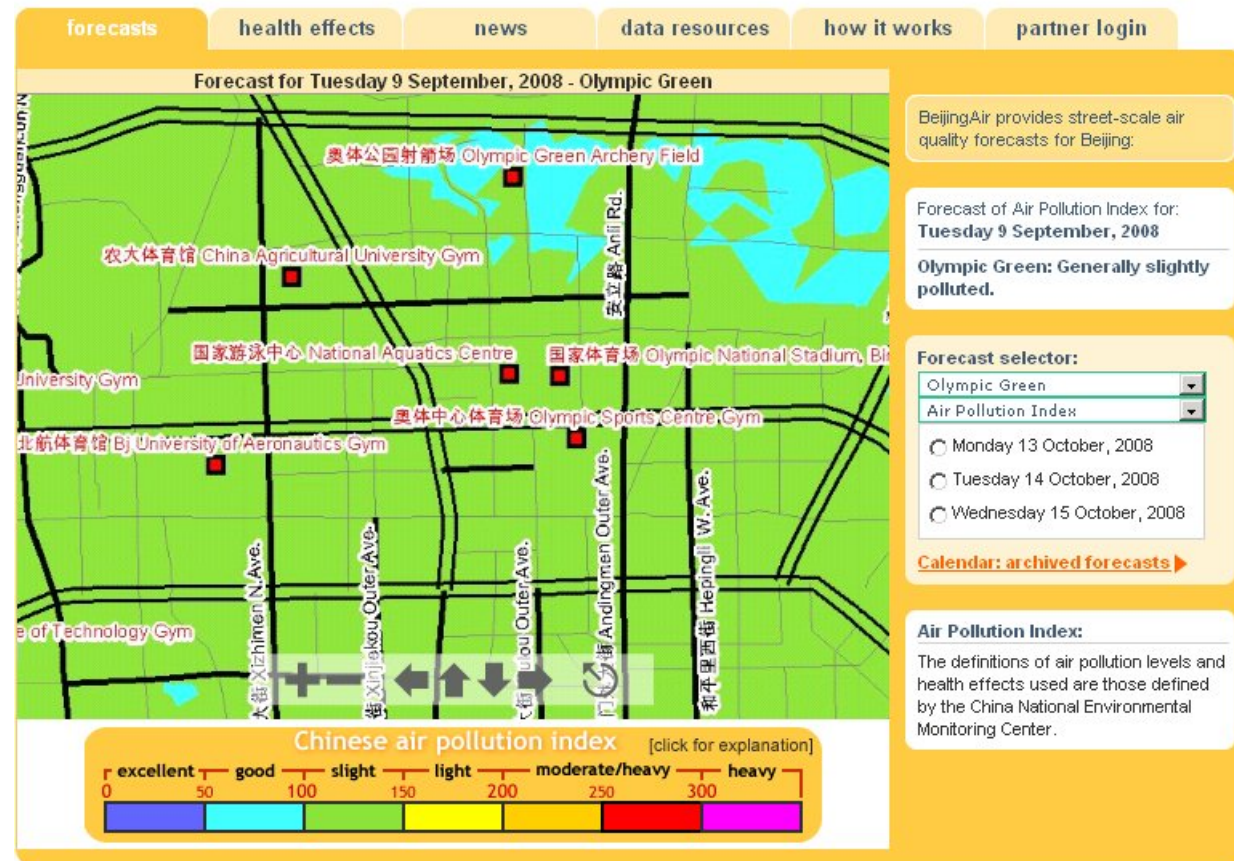
BeijingAir: website (zoom)

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Air quality forecasts for Beijing



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BeijingAir: website (health)

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Air quality forecasts for Beijing

forecasts

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news

data resources

how it works

partner login

Health effects of air quality

Definition of Air Pollution Index (API) in terms of concentrations (PDF file)

Depending on how high pollution levels are forecast to be, there are various simple steps you can take to reduce the likelihood of any impacts on you. The action you can take depends on the level of pollution expected. Pollution levels in the People's Republic of China are expressed using the Air Pollution Index (API) defined by the government. The overall Air Pollution Index includes particulates, nitrogen dioxide and sulphur dioxide.

SLIGHTLY
POLLUTED

LIGHT
POLLUTION

MODERATE
POLLUTION

MODERATE
TO HEAVY
POLLUTION

HEAVILY POLLUTED

API 100-150

API 151-200

API 201-250

API 251-300

API 301+

What health effects may I notice?

- Those who are susceptible may experience slight deterioration in symptoms.
- The general public may experience some irritation.

What can I do?

- People with heart disorders or pulmonary disorders should avoid physical exertion and outdoor activities.

What health effects may I notice?

- Those who are susceptible will experience severe deterioration in symptoms. Their tolerance for exercise decreases.
- The wider general public will experience some symptoms.

What can I do?

- The elderly and people with heart disorders or pulmonary disorders should remain indoors and reduce their physical activities.

What health effects may I notice?

- The general public will experience decreased tolerance for exercise with obvious and severe symptoms.
- Some diseases may be prematurely induced.

What can I do?

- The elderly and people with heart disorders or pulmonary disorders should remain indoors and avoid physical activities.
- The general public should avoid outdoor activities.

BeijingAir provides street-scale air quality forecasts for Beijing:

Forecast of Air Pollution Index for:
Tuesday 9 September, 2008

Olympic Green: Generally slightly polluted.

Air Pollution Index:

The definitions of air pollution levels and health effects used are those defined by the China National Environmental Monitoring Center.

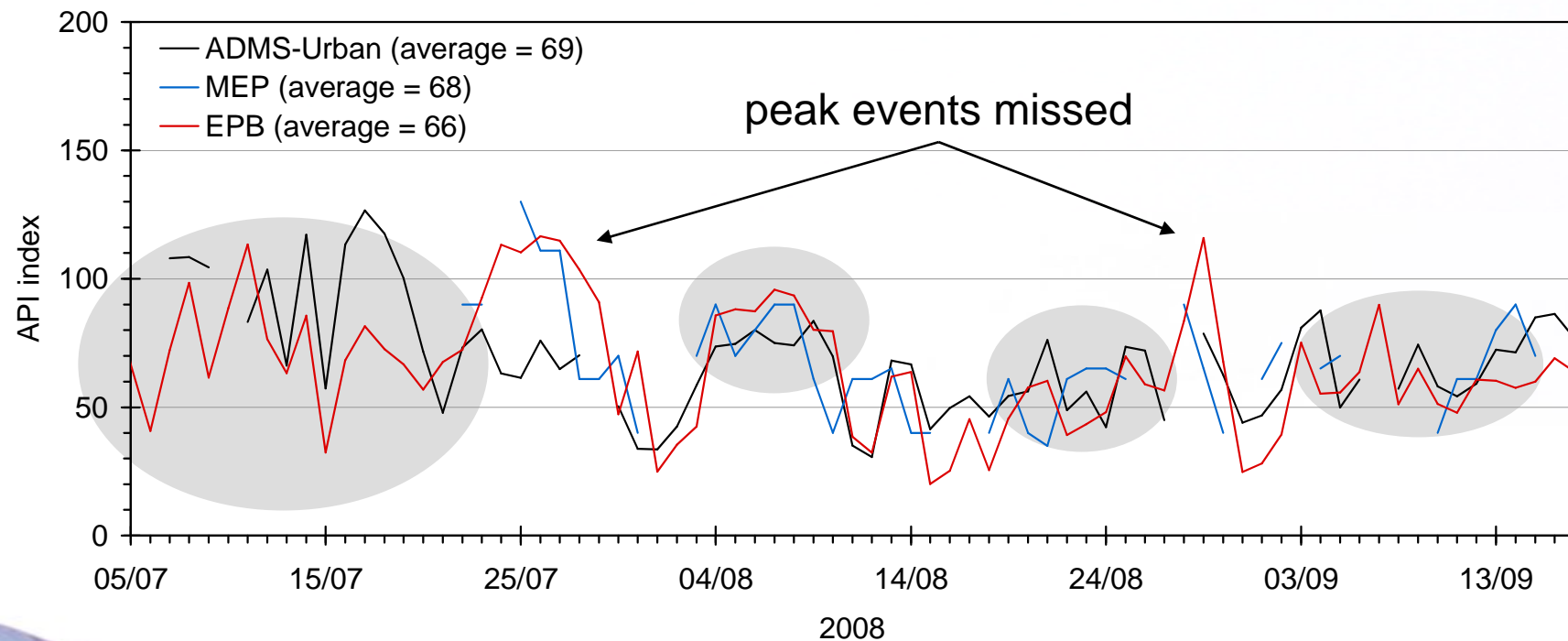
BeijingAir performance

- Data compared
 - ADMS-Urban (*BeijingAir* forecasts)
 - in **live mode** (published on-line)
 - in **hindcast mode** (model rerun afterwards)
 - MEP (forecasts by the Ministry of Environment Protection)
 - CHIMERE (forecast concentrations by the CHIMERE model)
 - EPB (monitor observations in Beijing)
- Period of comparison: 5 July to 19 September
(before and after the emission cut, Olympics, Paralympics)
- Points of comparison: Beijing (average over 11 monitors)

BeijingAir performance: live (1)

Daily API

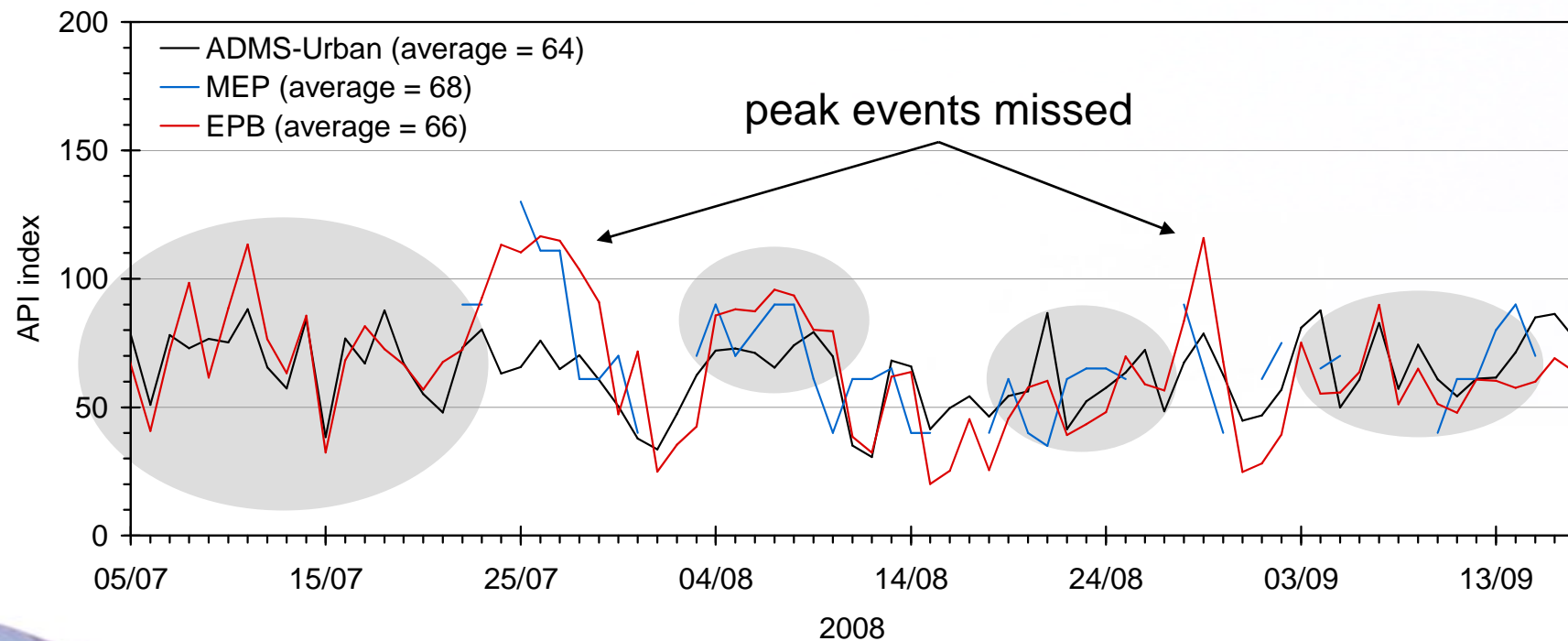
ADMS-Urban forecasts, MEP forecasts, EPB observations



BeijingAir performance: hindcast (1)

Daily API

ADMS-Urban hindcasts, MEP forecasts, EPB observations

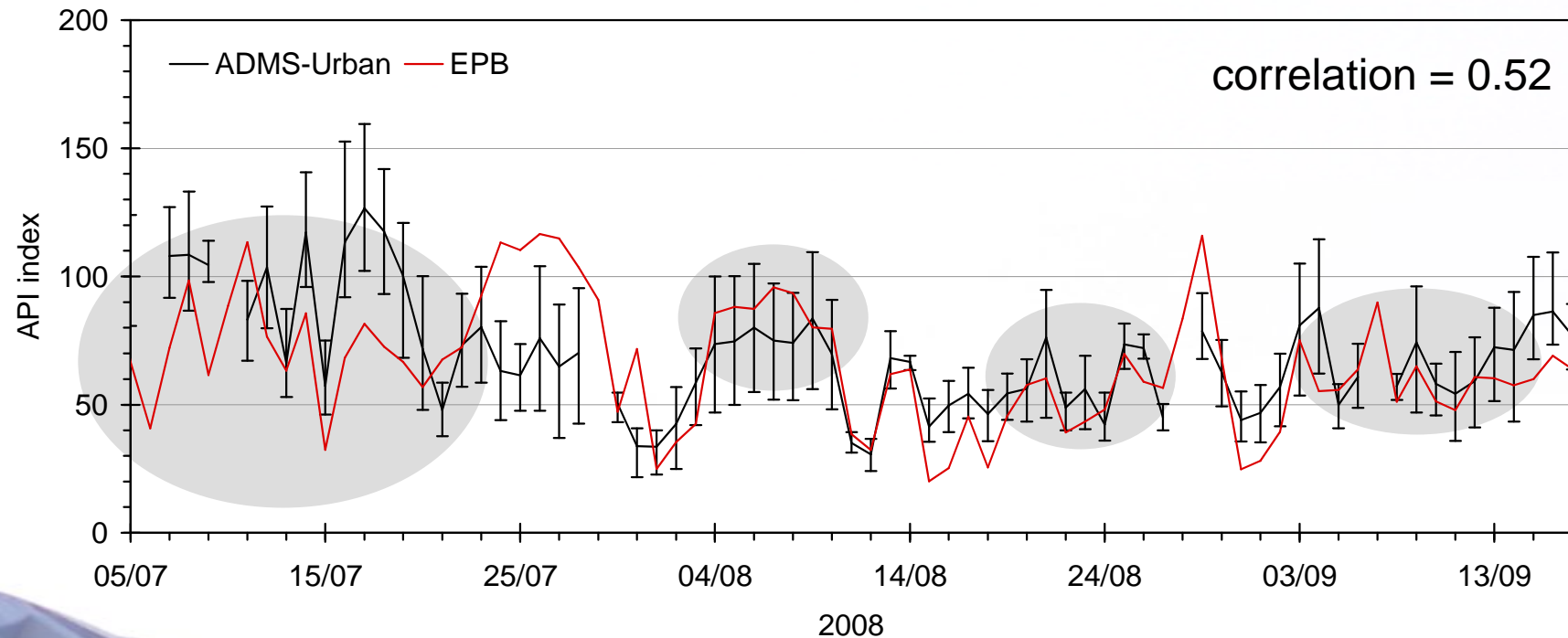


BeijingAir performance: live (2)

Daily API

ADMS-Urban forecasts, EPB observations

bars: ADMS-Urban min/max API over 11 monitors

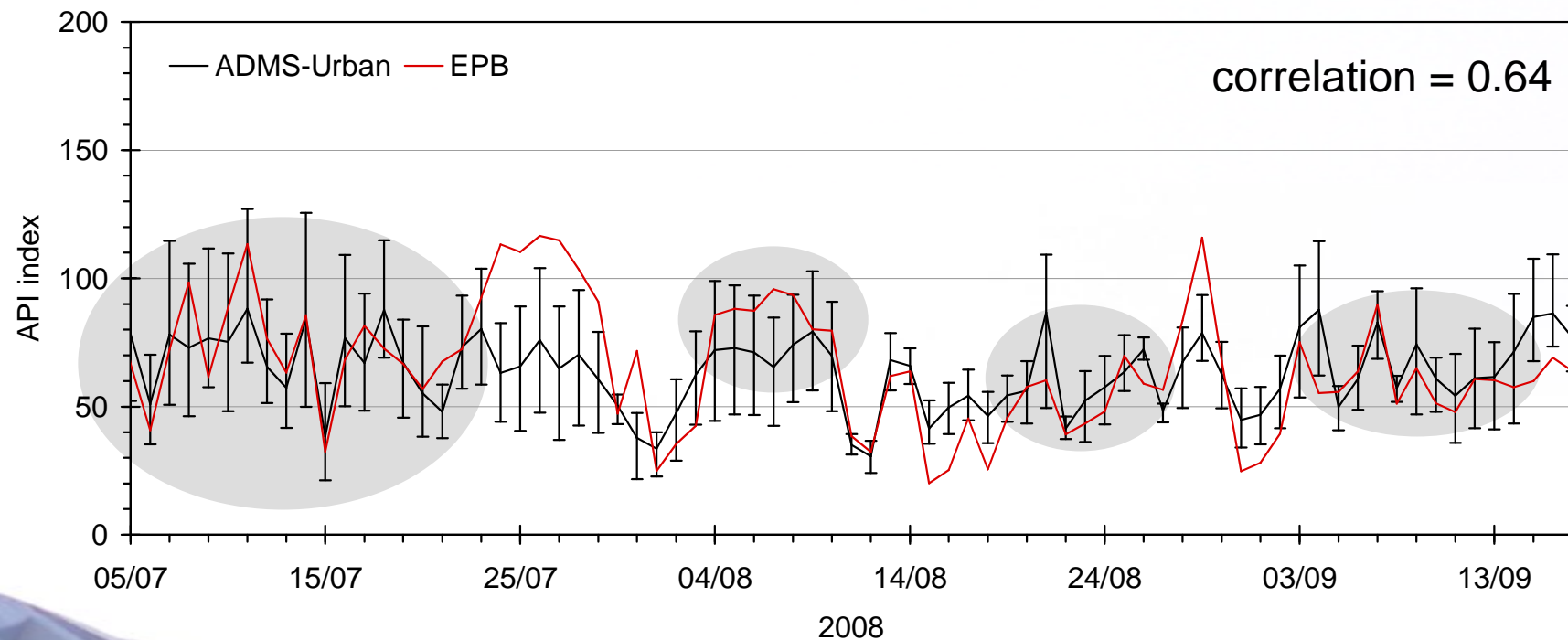


BeijingAir performance: hindcast (2)

Daily API

ADMS-Urban hindcasts, EPB observations

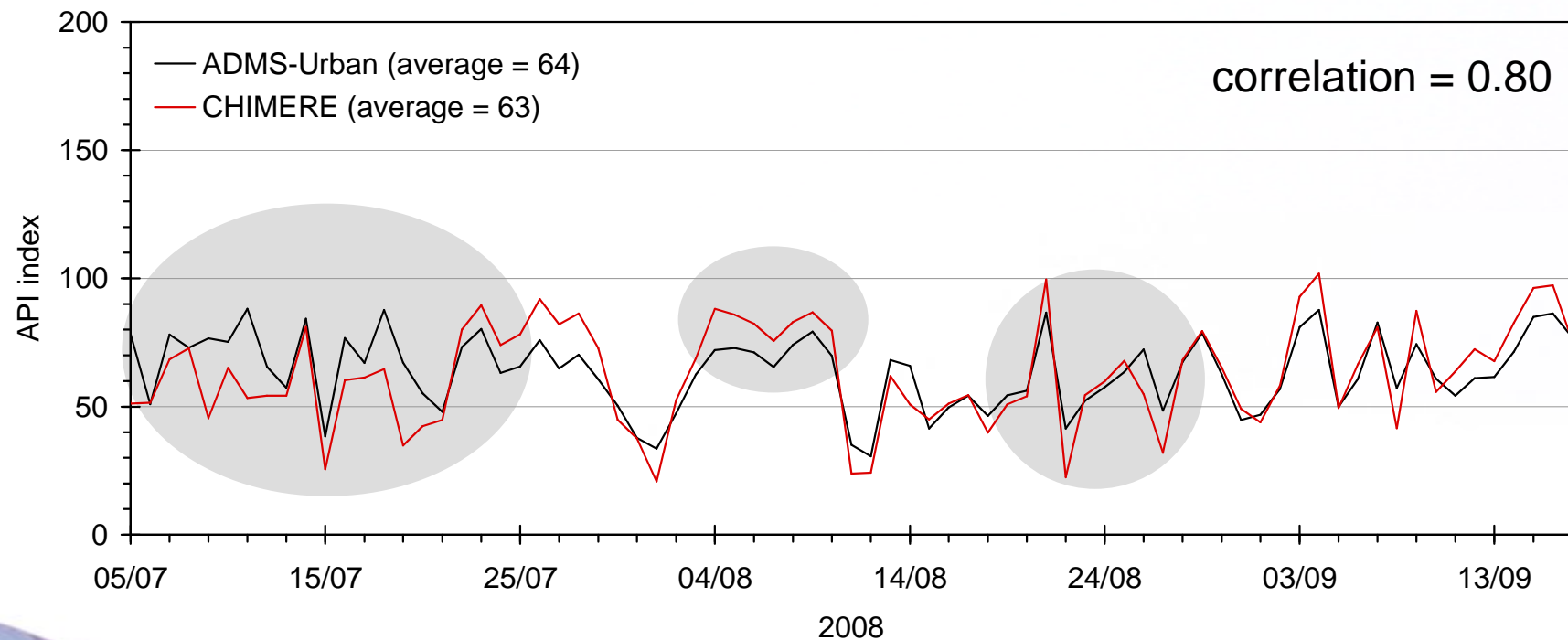
bars: ADMS-Urban min/max API over 11 monitors



BeijingAir performance: hindcast (3)

Daily API

ADMS-Urban hindcasts, CHIMERE concentrations



BeijingAir performance: summary

- Good global correlation of the **yourair** forecasts with the observations
- But peak events missed (24-28 July, 29 August)
- Possibly explanations of discrepancies
 - lack of information regarding observations
(data quality? location of monitors? monitors involved in means?)
 - live forecasts could not always use most up-to-date input data
 - strong correlation with background
(bias transferred from a model to another?)
 - rainfall not modelled
(overestimation of concentrations by rainy day)
 - inaccuracy of the emission inventory



BeijingAir performance: summary

- Good system reliability

In 75 days of operation

- a forecast was made on 74 days (99 %)
- the system could not use the most up-to-date input data on 29 days (39 %), of which on 16 days (21 %) this was due to failures in partners' systems



Coming...



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Air pollution forecasts and alerts by text, email, voicemail

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Forecast for Monday October 13th, 2008 - East London

air pollution index

good1-3moderate4-6high7-9very high10

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text - email - voice

airTEXT alerts you if elevated pollution is expected in your chosen area:

Forecast of Air Pollution Index for:
Monday October 13th, 2008

East London:
LOW air pollution expected everywhere

Forecast selector:
East London
- Choose a pollution type -

Calendar: archived forecasts

Zoom map to your post code:

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London Olympics 2012