北京市空气质量监测：传统和创新技术的应用

Air Quality Monitoring in Beijing: Application of Traditional and Innovative Technologies

北京市环境保护监测中心

Beijing Municipal Environmental Monitoring Center

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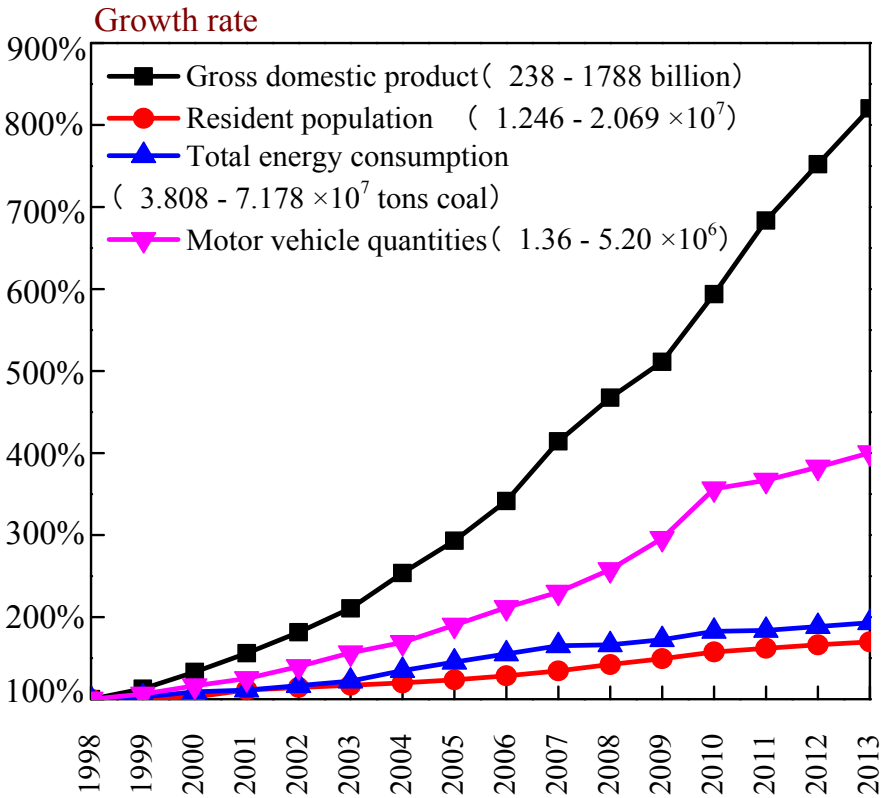
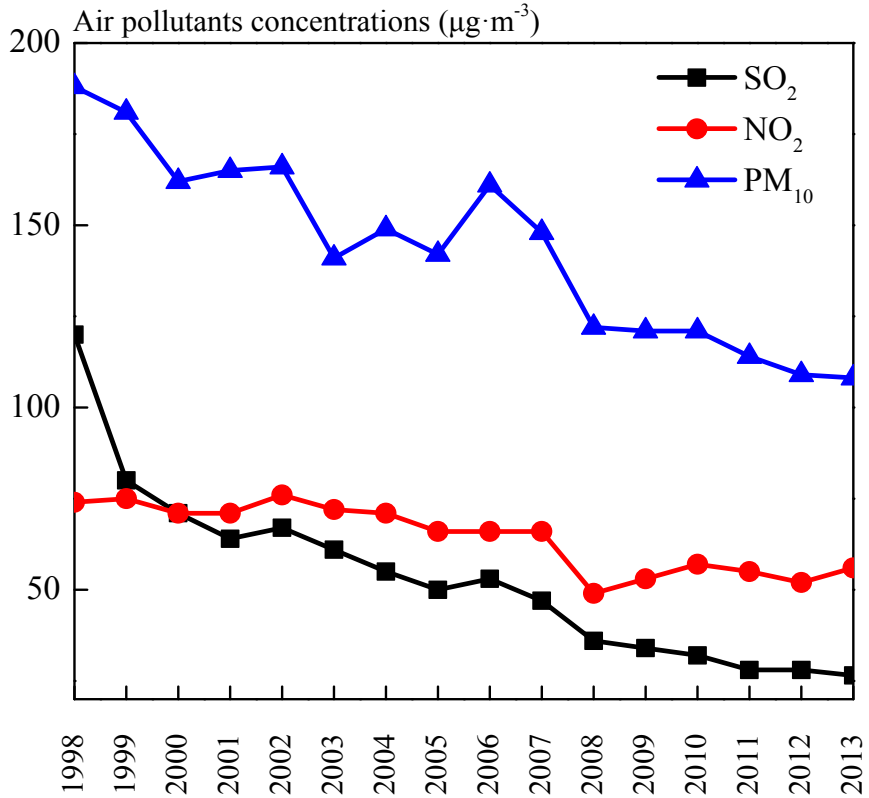
Governance History: Our Efforts（1998-2013）

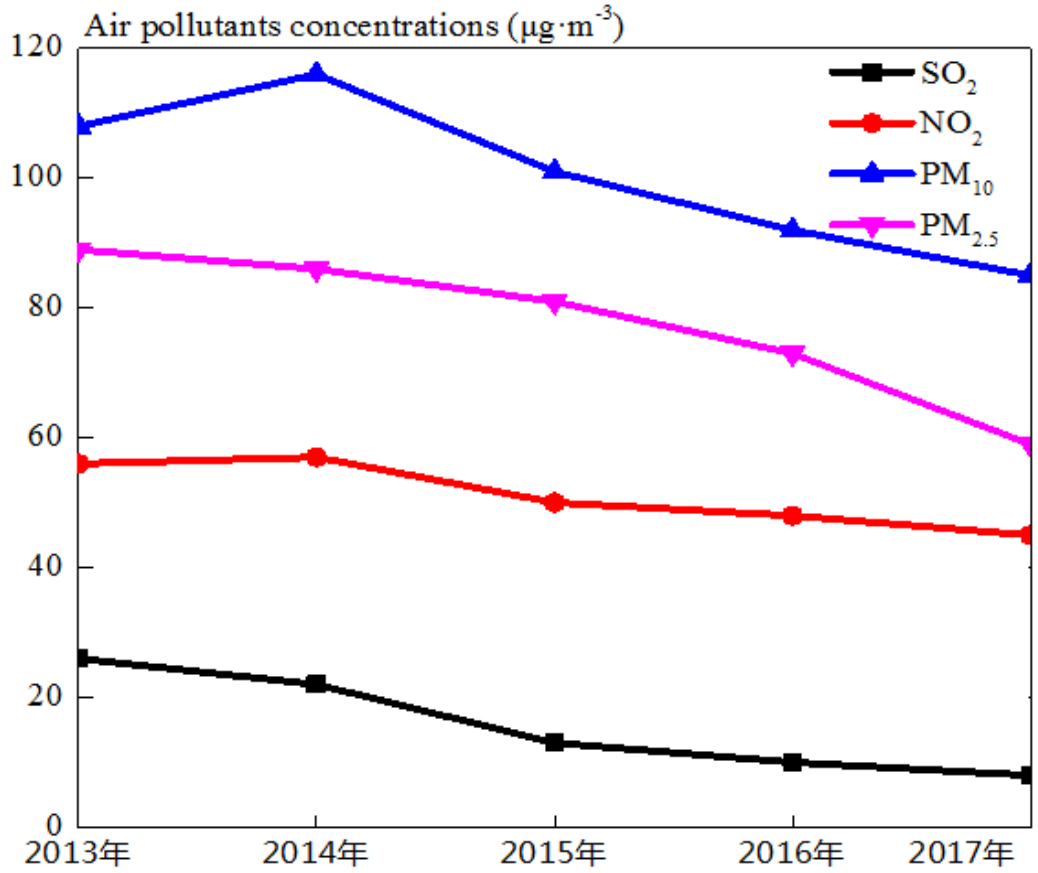
In May 2016, the United Nations Environment Program released **Beijing's Air Pollution Control Processes during 1998-2013**, which concluded that the air quality has been effectively improved along with the rapid development of Beijing.

Mr. Achim Steiner, also pointed out that **in front of huge challenges, Beijing has successfully improved its air quality while maintaining the high-speed development.**





Air quality variation from 2013-2017

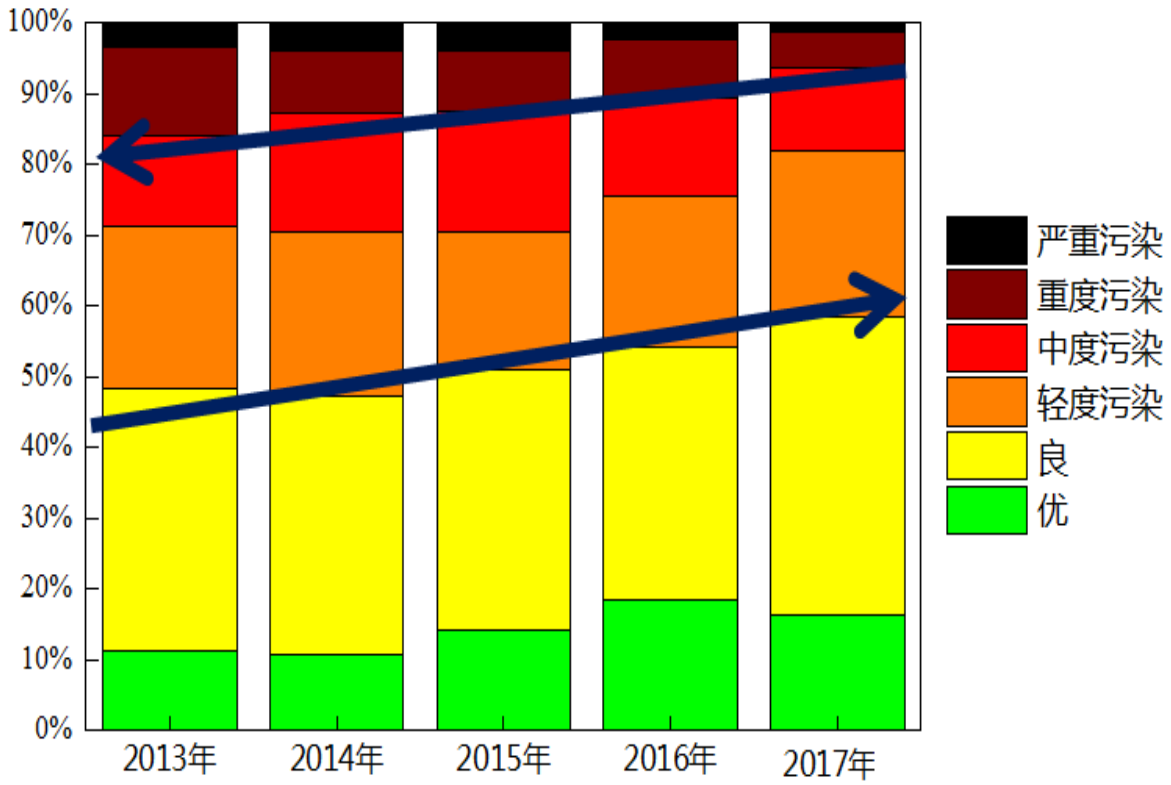


From 2013 to 2017

- PM_{10} decreased by 22.2%
- **$PM_{2.5}$ decreased by 35.6%**
- NO_2 decreased by 17.9%
- SO_2 decreased by 70.4%

In recent five years, Beijing's air quality has been greatly improved**. From 2013 to 2017, $PM_{2.5}$ has dropped from 90 to 58, with a decrease of 35.6%,** and decline of other pollutants is also very obvious.

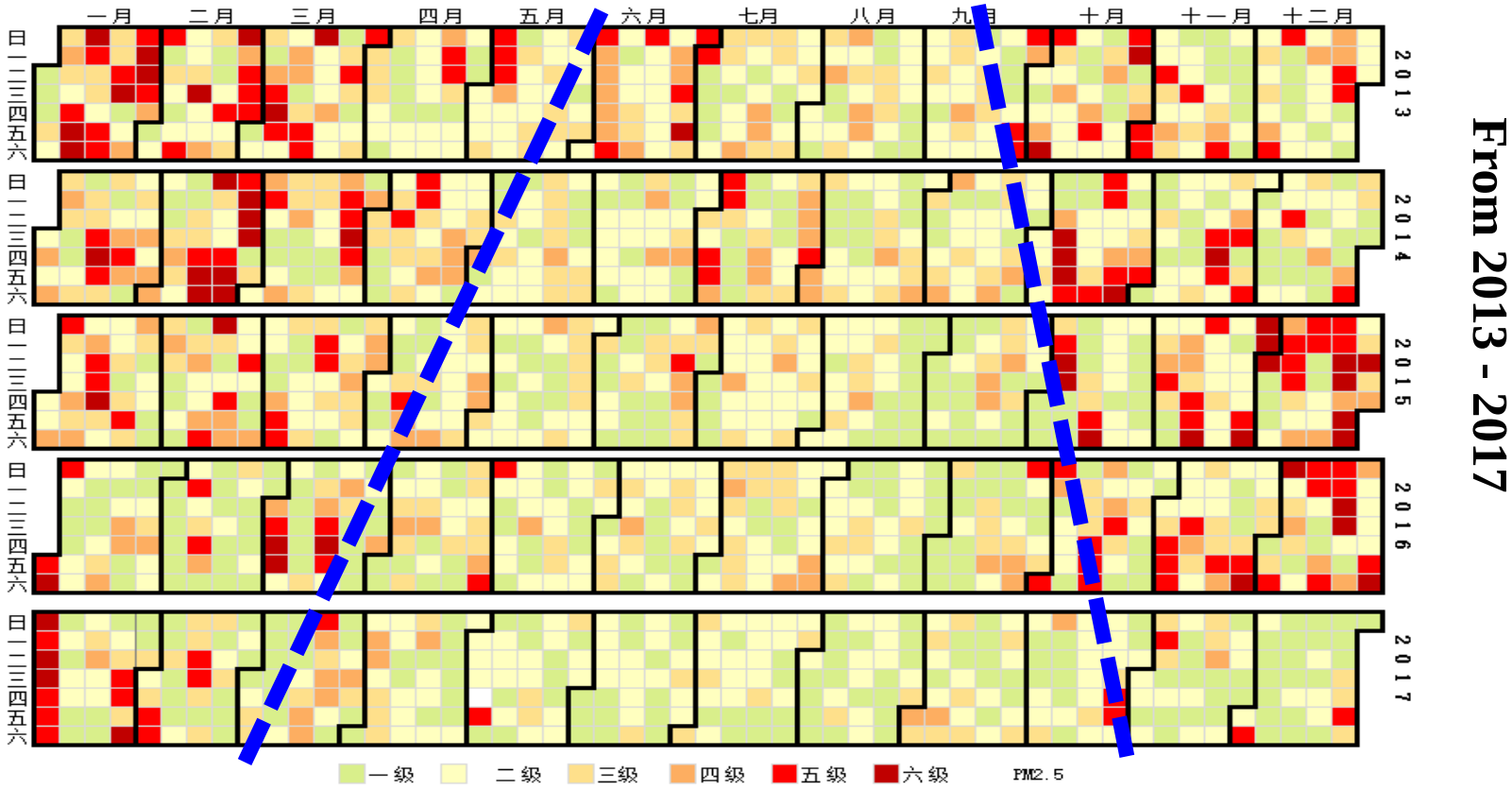
Air Quality Status in Recent 5 Years



This is the map of Beijing's air quality levels in recent five years. The darker the color, the heavier the pollution level. It can also be seen from the map that in recent years the number of days with air up to standard has increased year by year, and the number of days with heavy pollution has decreased year by year.

- 226 compliance days in 2017, 28 days more than 2016 , **50 days more than 2013**, with a compliance rate up by 14%;
- 23 heavy pollution days in 2017 (20 days for $PM_{2.5}$, 1 days for PM_{10} and 2 day for O_3), 16 days less than 2015, **35 days less than 2013**.

$PM_{2.5}$ Pollution Calendar during 2013-2017



- As for $PM_{2.5}$, it can be seen from the calendar figure that the improvement in recent five years is also particularly obvious. **The top is 2013 and the bottom one is 2017. In 2017, the heavy pollution was basically eliminated from March to September.**

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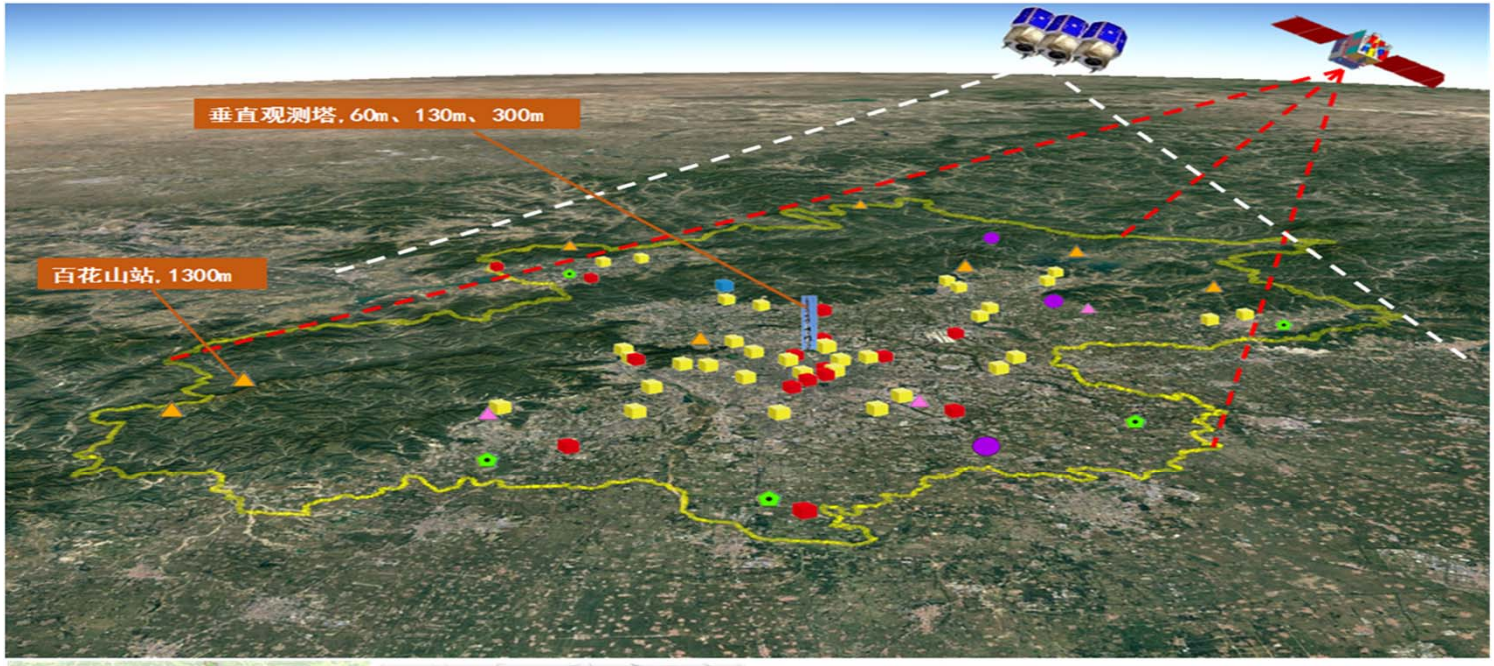
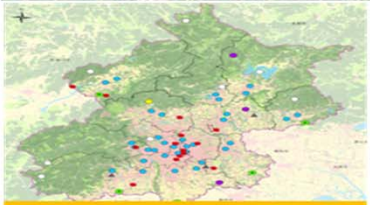
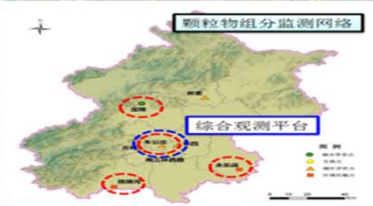
Three-dimensional Monitoring Network for the Current Air Quality (2015-2017)

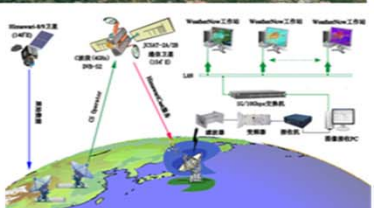



Routine monitoring network


High density sensor monitoring network



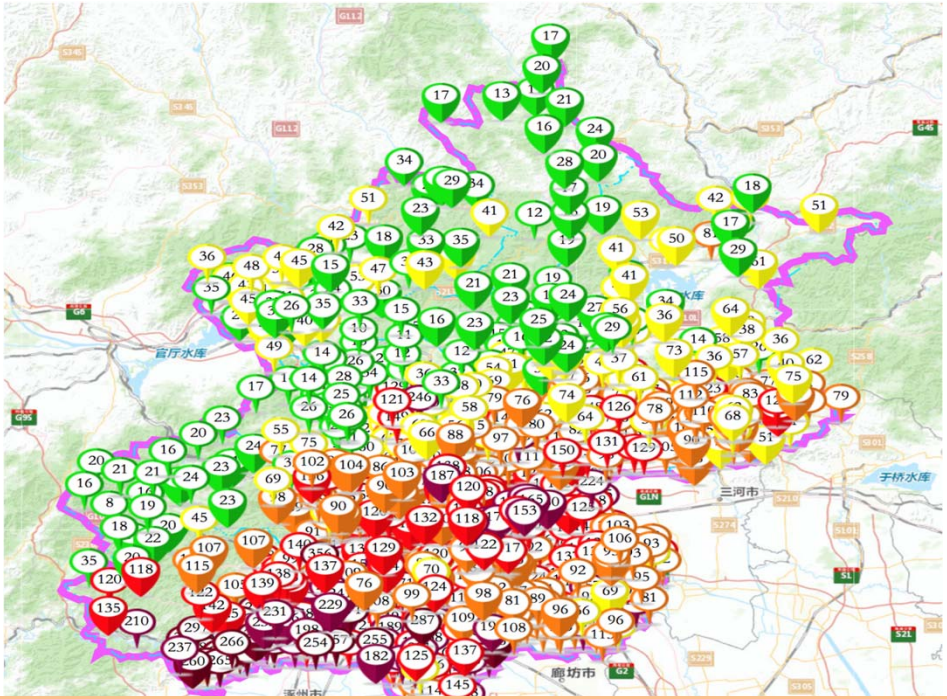
Composition observation network


Vertical monitoring network

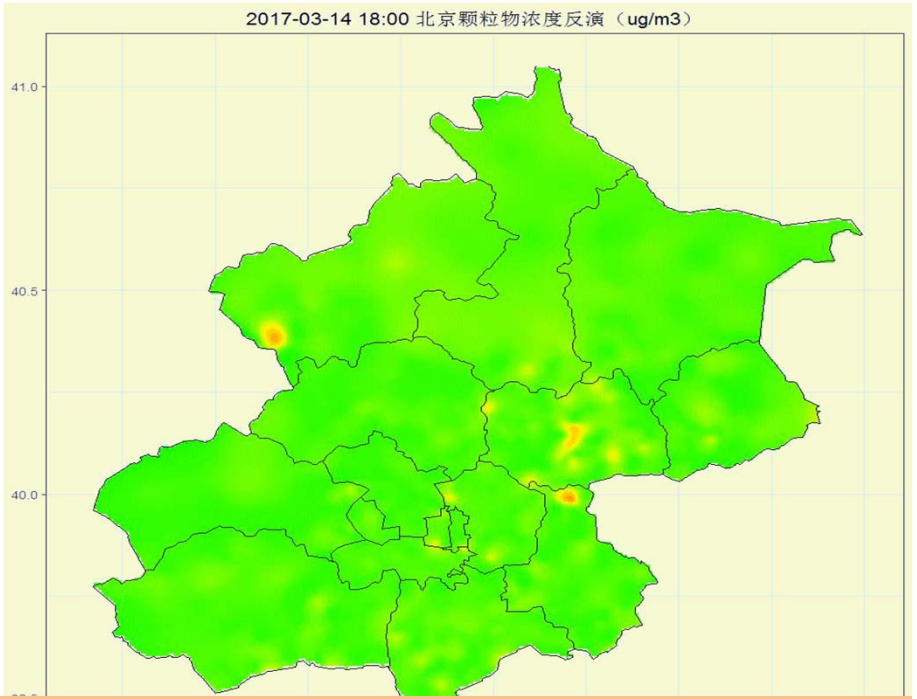
The above monitoring results are all from the air monitoring network. In 2015, Beijing once again upgraded the air quality monitoring network and built **the three-dimensional monitoring network as shown in the following figure**, and added **the composition monitoring network, vertical observation network and high-density sensor monitoring network**.

High density grid monitoring based on Internet of Things

- **Individual Station Coverage: 460 km^2 - 15 km^2**
- **Target object: $PM_{2.5}$; point quantity: 1500; monitoring frequency: 5min;**



Sensor Network Distribution in Beijing

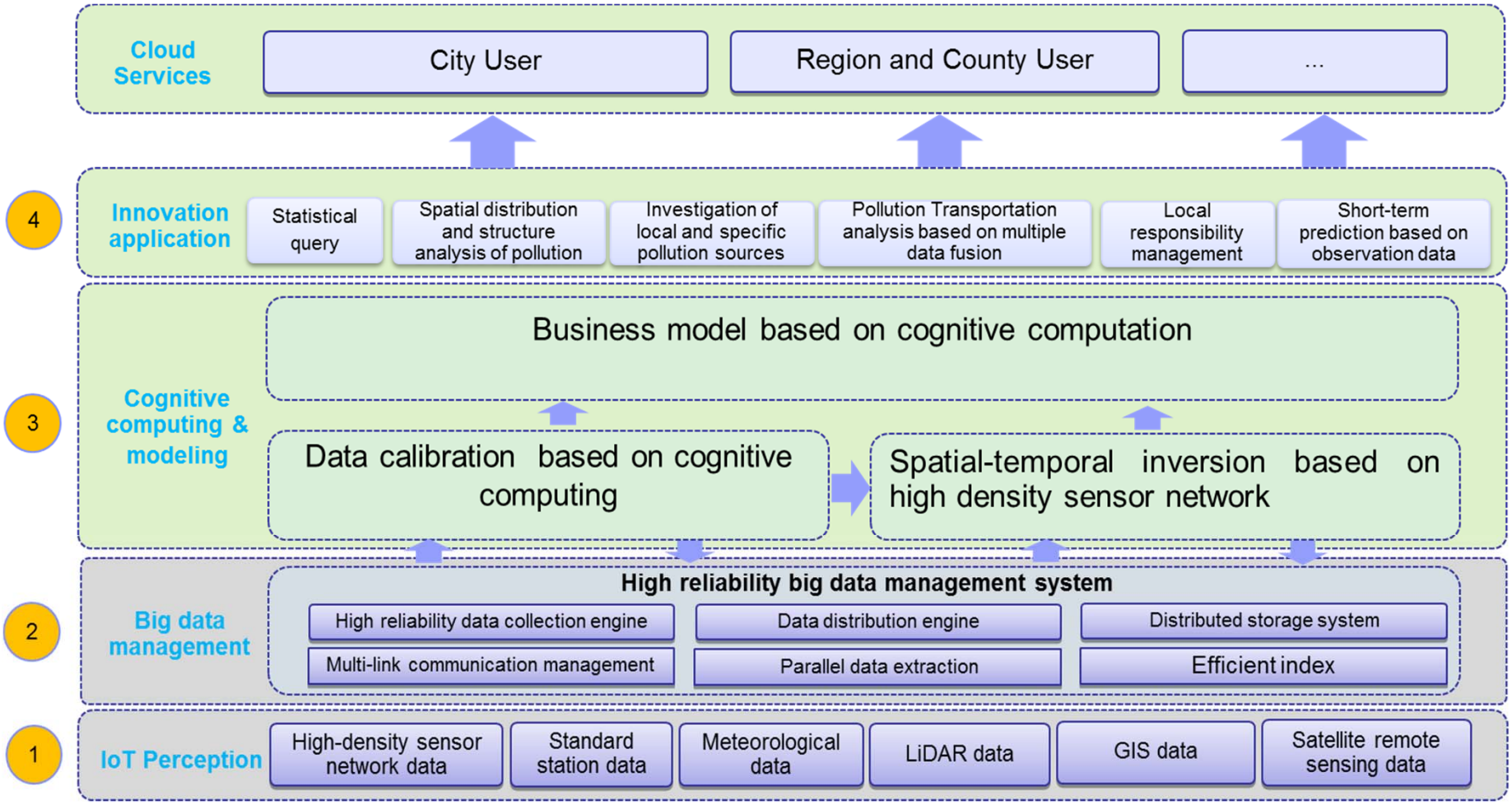


High Resolution Air Quality Variation

Especially the high density sensor monitoring network, we apply this technology to large-scale monitoring of air quality in Beijing for the first time, and **we totally lay 1,500 point locations**, and the data will be sent out **every five minutes**.

Sensor Network Platform Framework

The monitoring network mainly uses $PM_{2.5}$ small sensors, and adopts advanced technologies such as **Internet of things, cognitive computation, big data analysis and cloud service**. In the following, I will focus on the content of this section.



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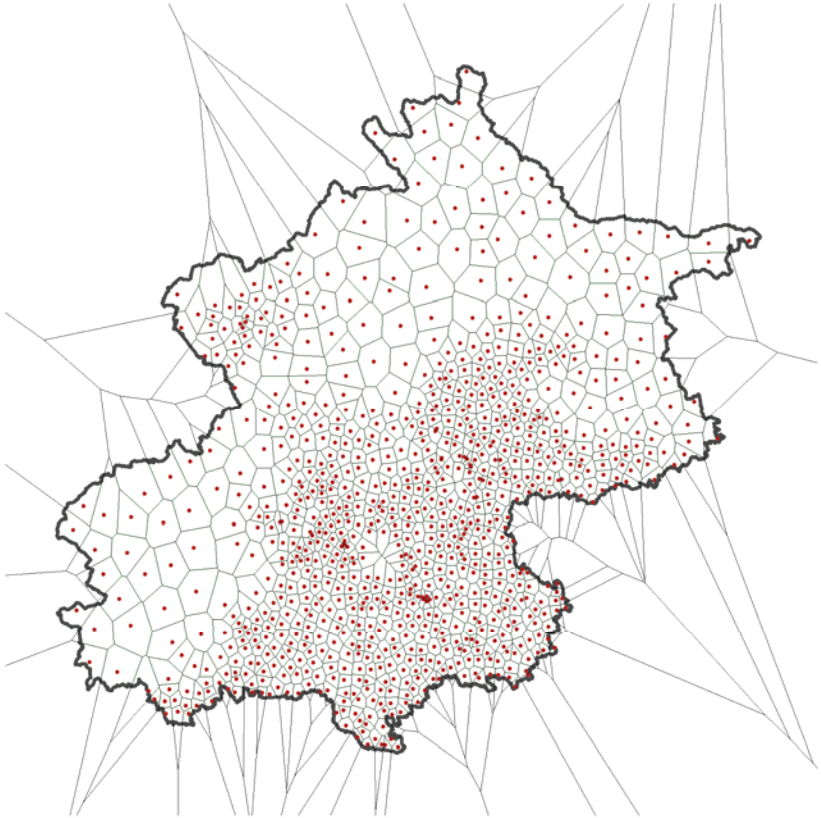
Grid planning and Scientific Layout Design in Beijing



First Stage Scale：

- 1500 sensors

Layout Principle：

- Even coverage
- High density in key areas
- Dynamic calibration
- Elastic layout

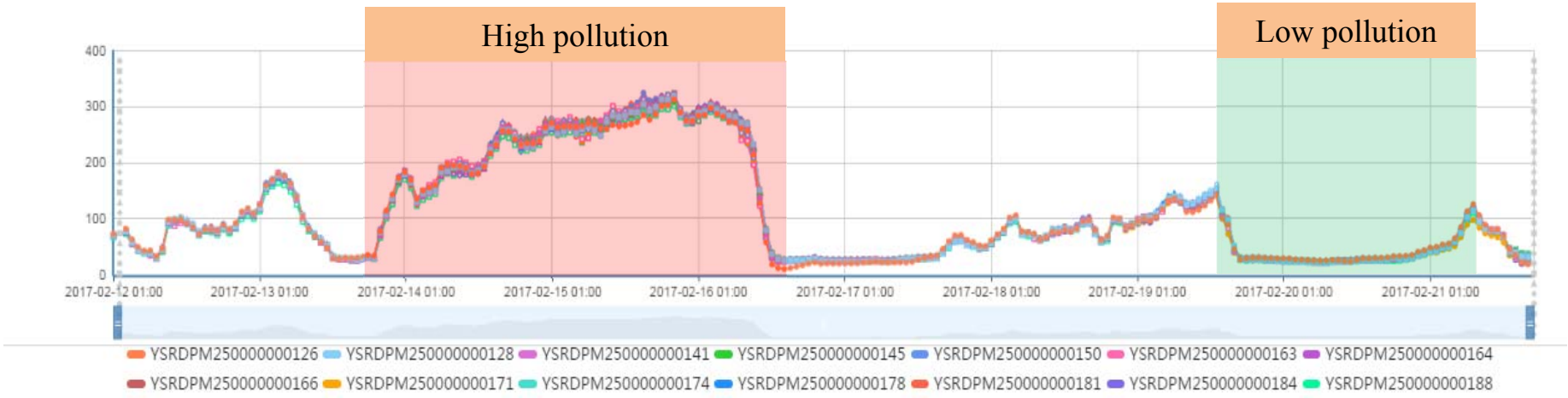
Basic Grid Planning:

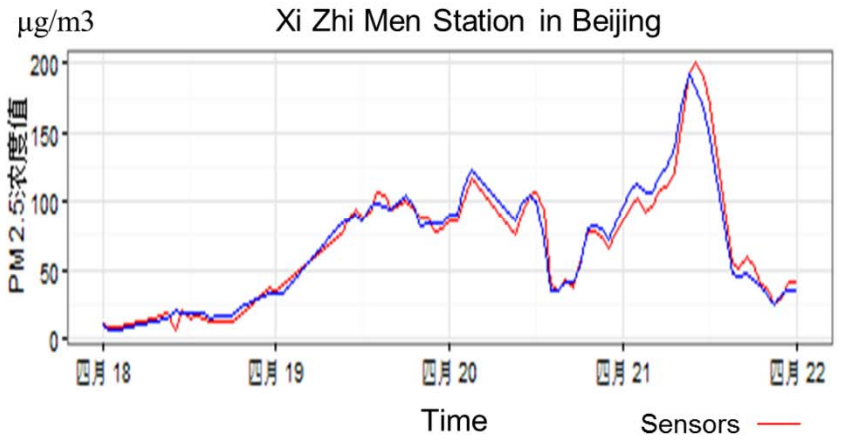
- Plain area 3x3km
- Mountain area 8x8km

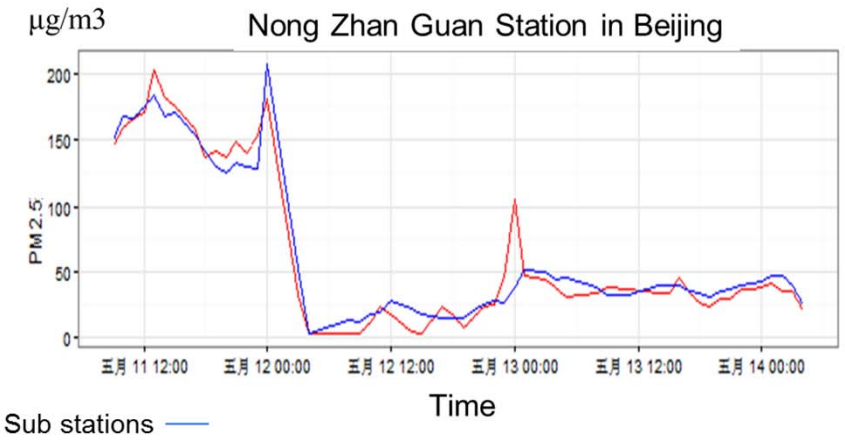
In terms of layout of point locations, we divide the urban area of Beijing into grids of 3 km times 3 km and the mountain area of 8 km times 8 km, and a small sensor of $PM_{2.5}$ is laid in each grid.

Intelligent Sensor Device

Before the layout, multiple parallelism comparison and comparison with the standard site's accuracy of each sensor will be made, and the comparison will cover the main pollution concentration range.

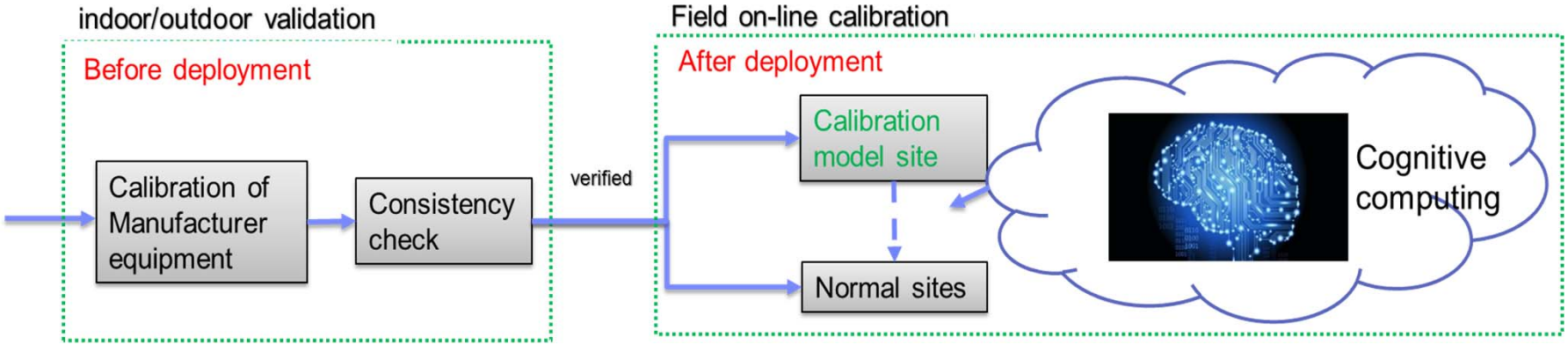


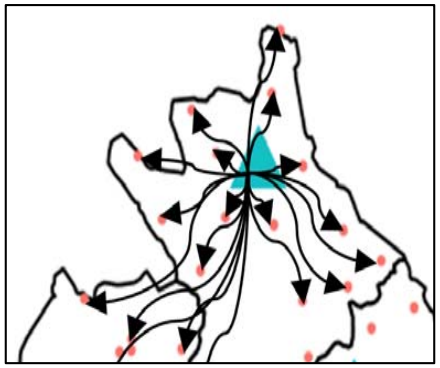




Cognitive Calibration System (CCS)

QA and QC are the focus of our research work. **Before the installation**, we need to carry out strict calibration work, and **after installation**, we used the **"cloud quality control"** model to transfer the quality of the standard station to 1,500 small sensors so as to ensure the accuracy of the data of sensors.

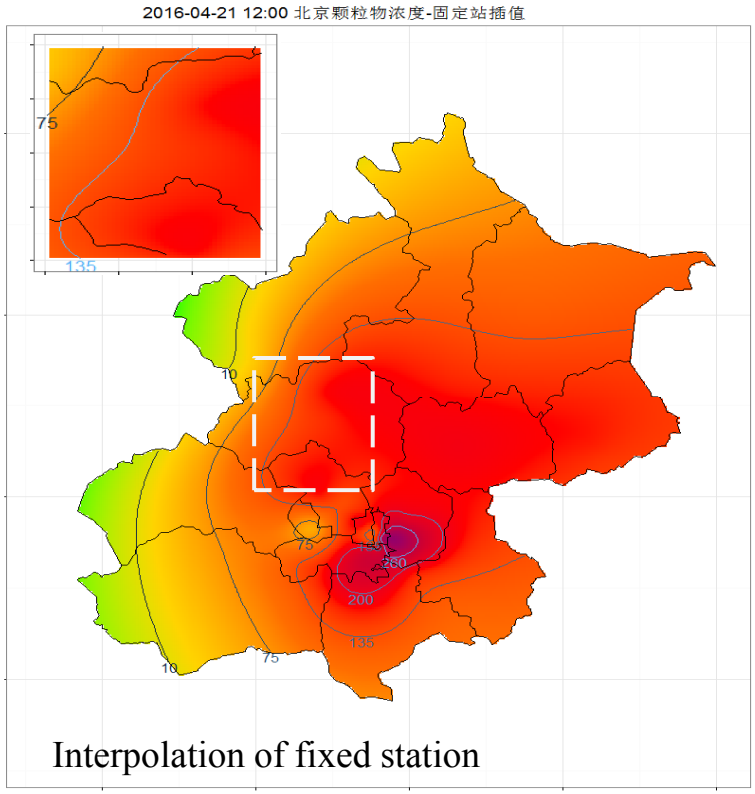




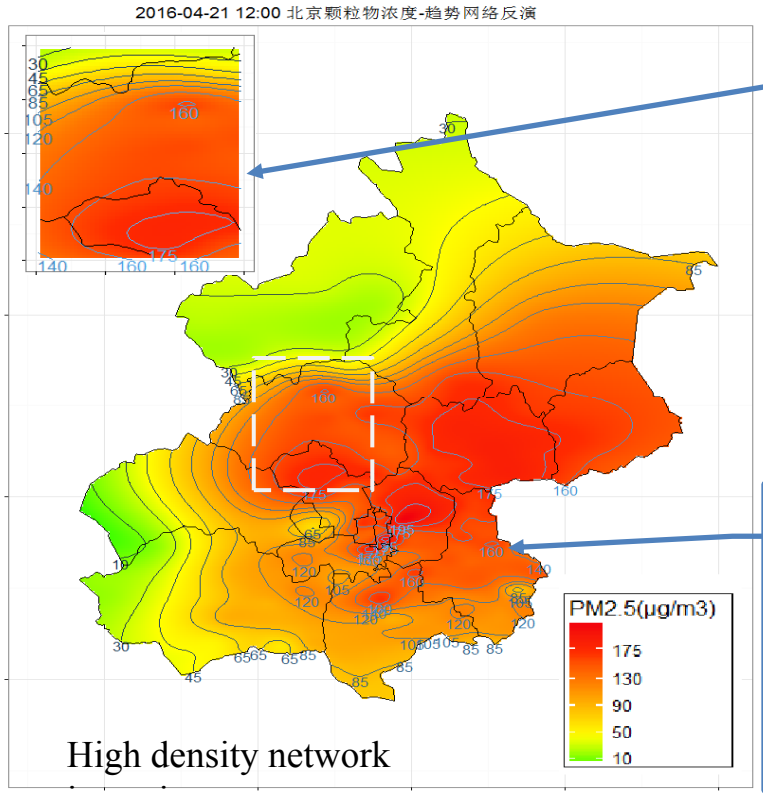
Application 1-- Ground-based Spatial and Temporal Distribution with High Precision

At present, our high density sensor network is mainly used in following several aspects:

（1）The first is to achieve $PM_{2.5}$ concentration knowability at any point.



Interpolation of fixed station



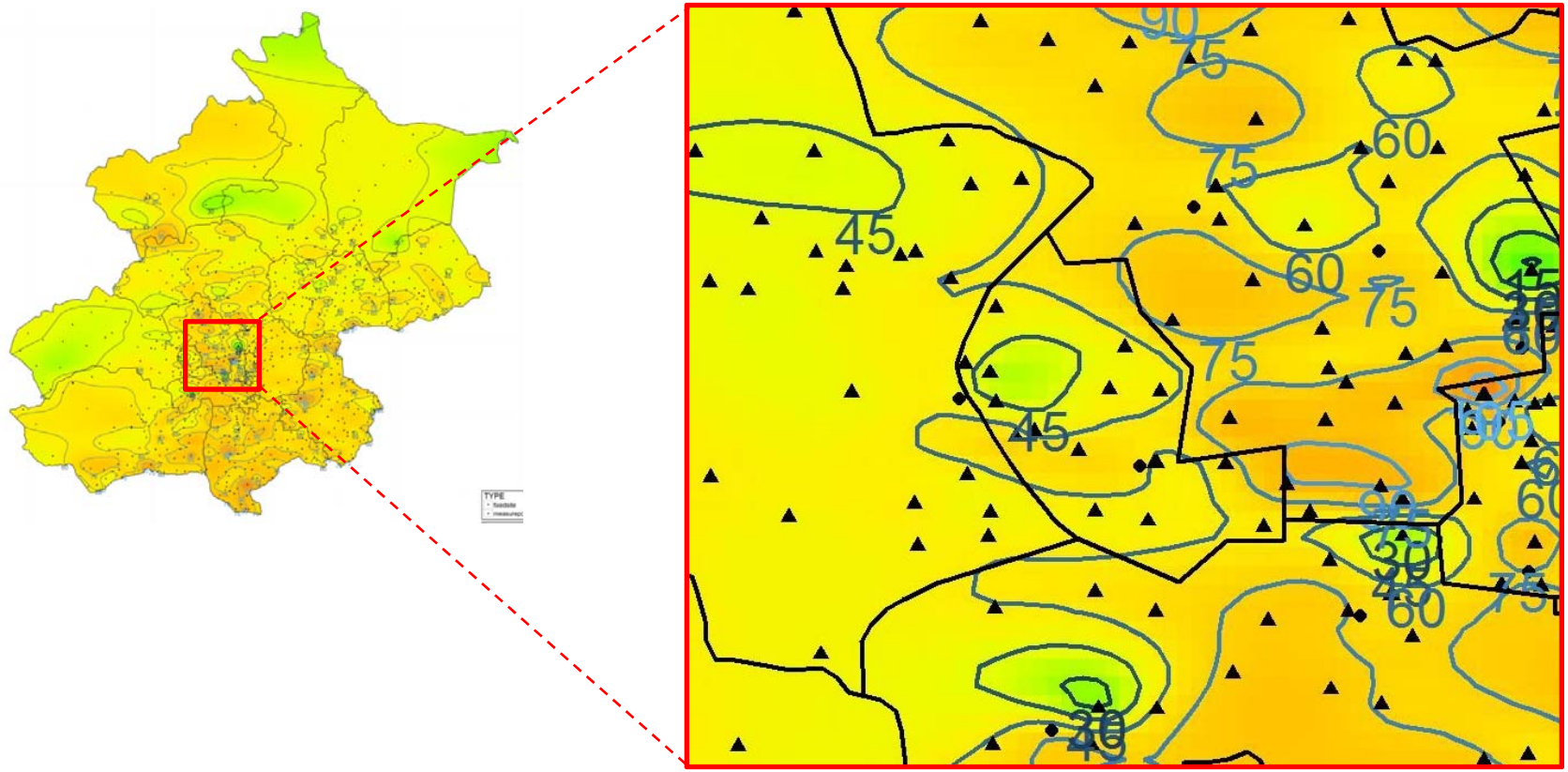
High density network inversion

Reflect local change tendency to pollution situation on a more subtle and detailed level compared with data interpolation rendering in the substation.

- 500m× 500m grid cell rendering
- Fine-grained concentration contour

Application 2-- Recognition of Polluted Areas with High Values

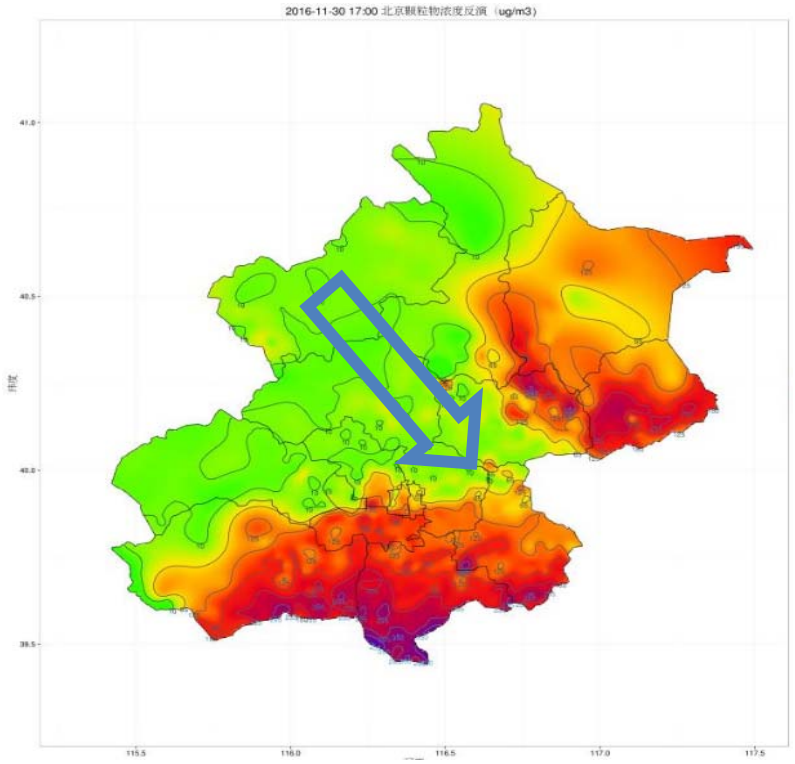
(2) The second is to carry out the identification of high value of pollution in certain areas.

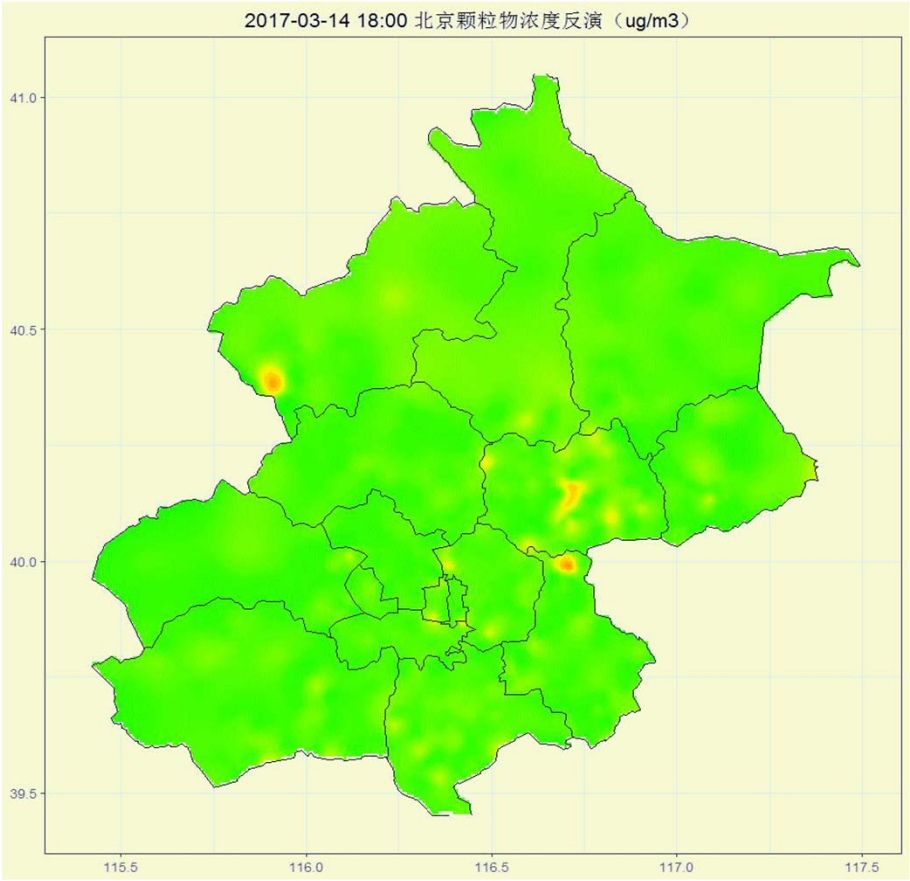


Within the distance in KM, stable distribution characteristics of internal pollution still can be found

Application 3-- Formation and Elimination of Pollution

(3) The third is to understand the pollution formation and dissipation process dynamically

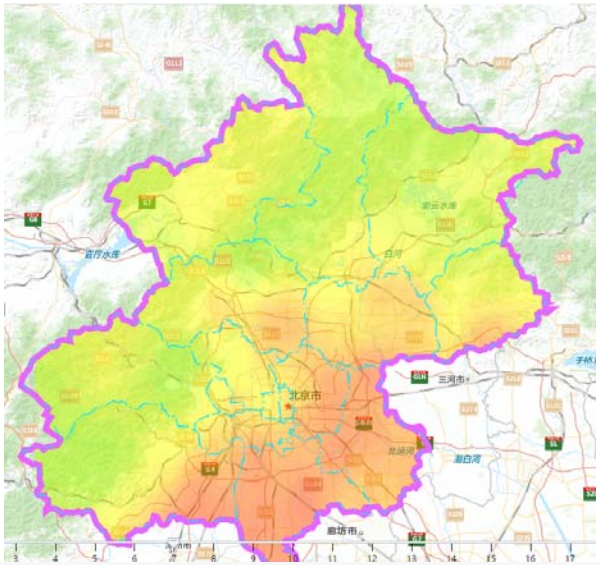


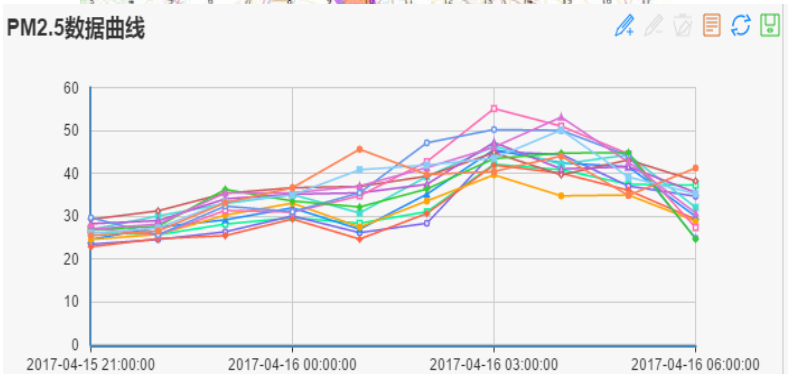


Use a high density monitoring network to conduct elaborate recognitions of the impact on different wind directions and landforms, different elimination courses of pollution, improved sequential orders and areas detained by pollutants.

Application 4-- Provide Air Quality Information Based on Positions and Paths (in the Future)

(4) In the future, we will also use the network to provide real-time air quality information based on location or path.

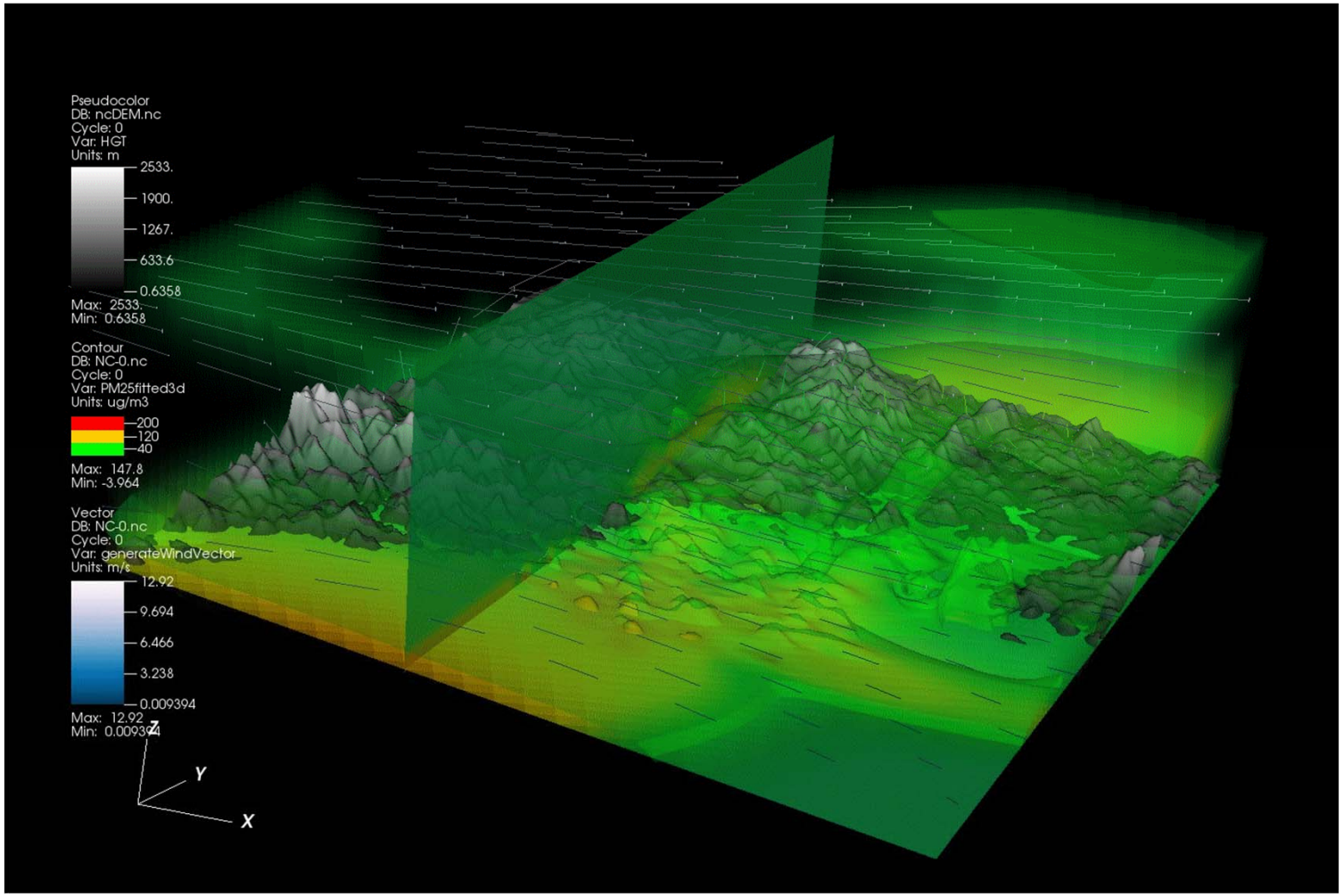




2017 Beijing International Marathon

Application 5-- Three-dimensional Air Quality CT in the City (in the Future)

(5) In the future, we will construct urban three-dimensional air quality dynamic monitoring model combined with other monitoring data.



Thanks for your attention!







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