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Year: 2012-2013 (***Starting Action***)

# Air quality monitoring system in Moscow: measurement methods and techniques



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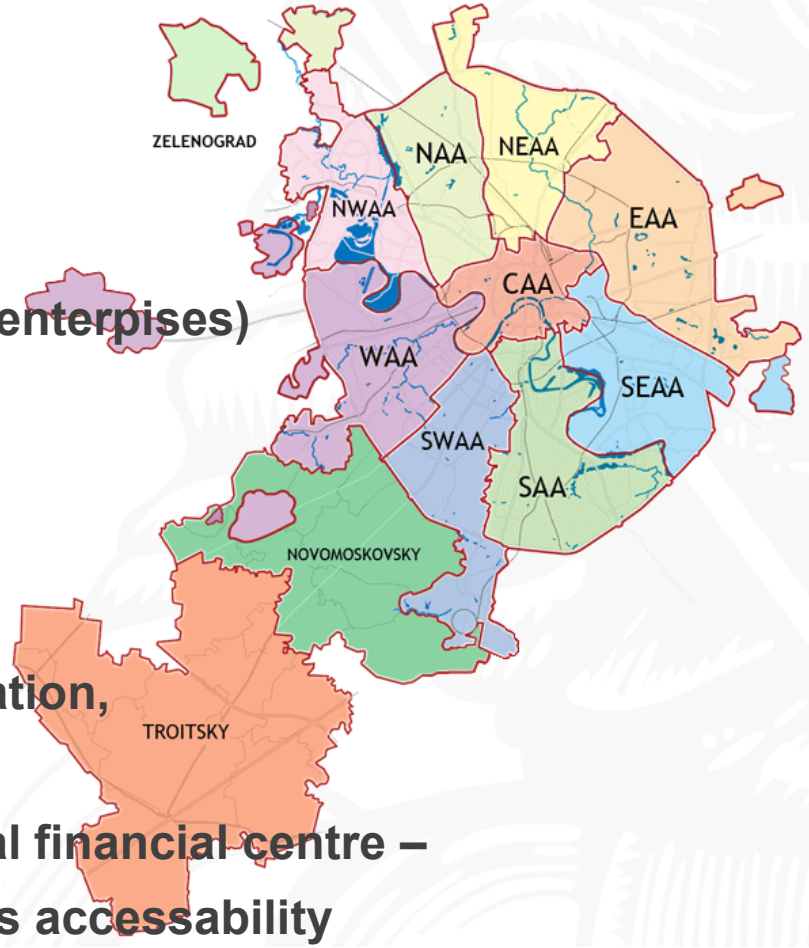
# Background

- Moscow: more than 11 million population (7% of population of the Russian Federation),
- around 27,000 stationary emission sources (506 enterpises) (emissions – around 63,000 tonn/year),
- 4.2 million vehicle fleet,
- main area – 1081km$^2$,
- high building density.
- New territories to the south-west- 200,000 population, 1500 km$^2$ with no monitoring systems
- Capital status and aim to become an international financial centre –
- high importance of environmental information, its accessability
- No state standards for automatic air quality measurement
- (federal monitoring network is based on manual sampling and manual
- analytical methods),
- Limited choice of certified and serviced monitoring devices



# Objectives

- According to Moscow Law “On environmental monitoring in Moscow” the goals of environmental monitoring are:
- 1) to gather new information on environment for better city planning, road transport systems planning, land use and social-hygienic monitoring;
- 3) to disseminate environmental information;
- 4) to expose pollution sources and their input into pollution;
- 5) to estimate the effect of environmental protection measures and city development measures (including transport sector).

## Principles

- Publicity, completeness, accuracy and credibility of acquired data,
- Compatibility with data of other information systems;
- Unity and compatibility of measurement methods, methods of data analysis and estimation;
- Scientifically based, systematic and integrated approach;
- Continuity and efficiency.

# Requirements

- **1. Constant and reliable data**

In order to estimate trends, mean long-time concentrations and carry out health risk assessment

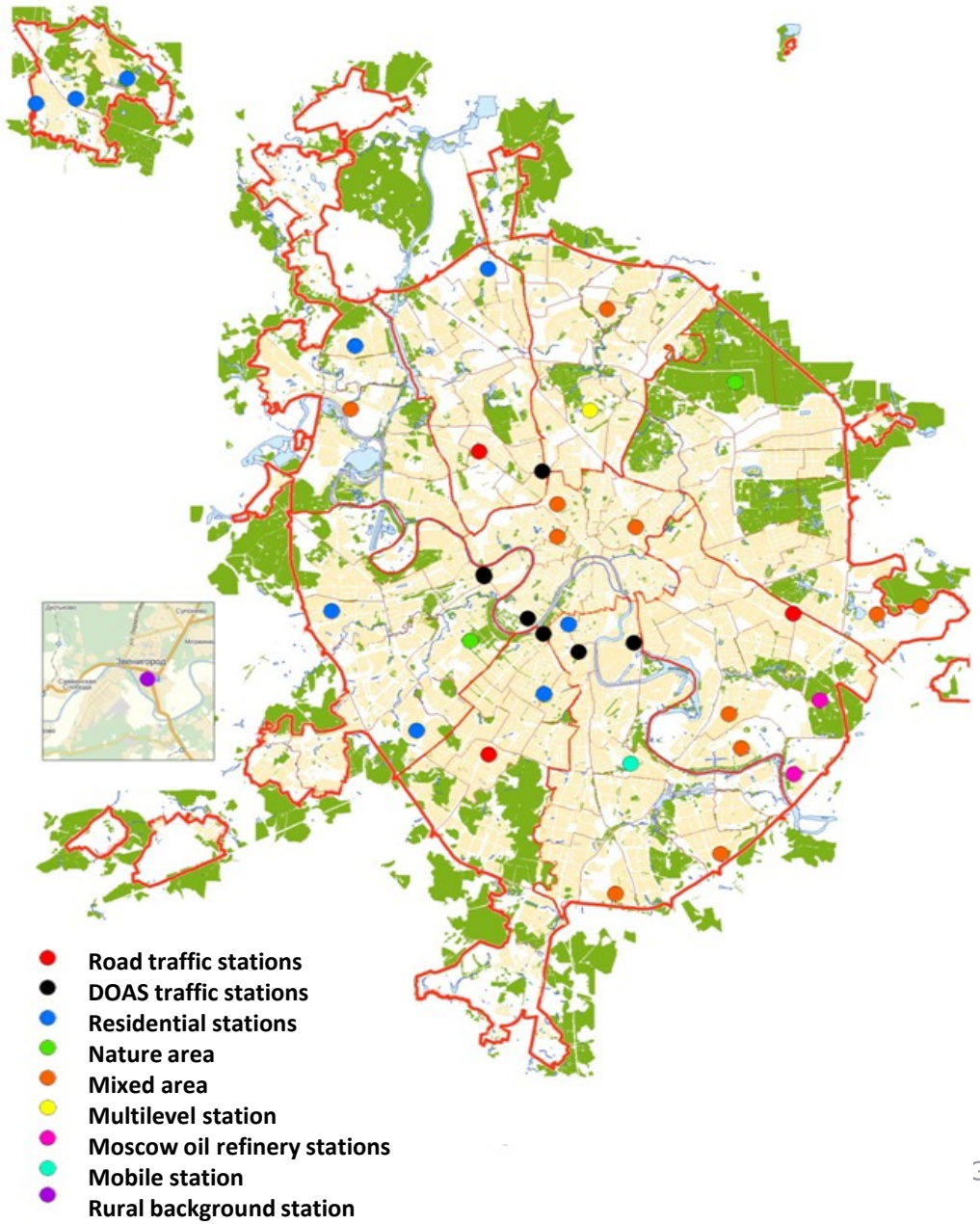
Equipment requirements:

- RF compliance certificates;
- Type approval (welcomed);
- Reliable measurement methods;
- Equipment and maintenance costs;
- Assembly quality;
- Reliability;
- Maintenance and repair simplicity;
- Availability and qualification of service centre(s);

# Requirements

- **2. Representativeness -** monitoring network requirements:
- Covers typical functional areas;
- Covers territories near main industrial enterprises and major roads.
- **3. Mobility & Efficiency -** monitoring network requirements:
- Includes stations which can be quickly shifted to a “hot spot”;
- New substances can be added to the monitoring list if needed (ex. Natural fires in summer 2010);
- Data is constantly validated and verified (analytical department);
- Online Internet translation;
- Regular maintenance services.

# Current activities: air quality monitoring network

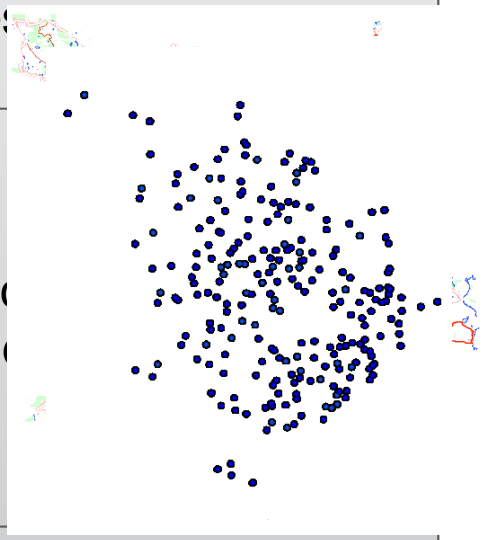



38 automatic monitoring stations


| № | Pollutants controlled | Number of stations |
|---|---|---|
| 1 | CO | 30 |
| 2 | NO2 | 35 |
| 3 | NO | 29 |
| 4 | O3 | 18 |
| 5 | PM10 | 8 |
| 6 | PM2.5 | 2 |
| 7 | SO2 | 11 |
| 8 | NH3 | 2 |
| 9 | H2S | 5 |
| 10 | Benzene | 6 |
| 11 | Toluene | 6 |
| 12 | Formaldehyde | 6 |
| 13 | Phenol | 6 |
| 14 | Styrene | 6 |
| 15 | Naphthalene | 6 |
| 16 | M-xylene, | 6 |
| 17 | P-xylene, | 6 |
| 18 | Ethyl benzene | 6 |
| 19 | Methane | 16 |
| 20 | VOC | 16 |
| 21 | VOC without methane | 16 |
| 22 | CO2 | 5 |

# Additional sources of information on air quality

| Source of additional information | | Activities |
|---|---|---|
| Mobile air quality laboratory |  | Inspection of “troublesome” territories based on queries by local authorities |
| Chemical analysis laboratory |  | Air sampling to ta complaints of resi |
| Research | | Collection of information on specific pollutants’ concentrations to improve ecological monitoring programs |



# Facilities: mobile air quality laboratory


# Automatic monitoring stations

# Facilities: Automatic equipment

| Pollutant | Model | Manufacturer | Measurement method | Number * |
|---|---|---|---|---|
| **CO** | CO12M | Environnement / France | **Non-dispersive infrared spectrometry** | 4 |
| | K-100 | OPTEK / Russia | **Electro-chemistry** | 42 |
| **NO/NO2/ NOx** | 9841B | Monitor Europe / Scotland<br>Ecotech / Australia | **Chemiluminescence** | 20 |
| | 200E | Teledyne-API / USA | | 2 |
| | ET-909 | ETEK / Russia | | 6 |
| | AC32M | Environnement / France | | 11 |
| | APNA-370 | Horiba / Japan-Germany | | 6 |
| **H2S** | 101E | Teledyne-API / USA | **Fluorescence (with preliminary thermocatalitic transformation).** | 2 |
| | AF22M/$CH_2S$ (H2S & SO2) | Environnement / France | | 9 |
| | APSA-H370 | Horiba / Japan-Germany | | 6 |
| **SO2** | 9850B | Monitor Europe / Scotland | **Ultraviolet fluorescence method** | 3 |
| | APSA-370 | Horiba / Japan-Germany | | 6 |
| | AF22M | Environnement / France | | 2 |
| | C105A | OPTEK / Russia | | 2 |
| **O3** | 9810B | Monitor Europe / Scotland | **Ultraviolet fluorescence method** | 9 |
| | 400E | Teledyne-API / USA | | 2 |
| | O342M | Environnement / France | | 2 |

* owned

# Facilities: Automatic equipment

| Pollutant | Model | Manufacturer | Measurement method | Number * |
|---|---|---|---|---|
| **Hydrocarbons CHsum, CH4, HCH** | Гамма-ЕТ | ETEK / Russia | **Flame ionization (gas chromatography)** | 36 |
| **CO2** | ОПТОГАЗ-500.4С | OPTEK / Russia | **Infrared absorption** | 6 |
| **Ammonia (NH3)** | 9842B | Ecotech / Australia | **Chemiluminescence (with preliminary thermocatalitic transformation)** | 1 |
| | 201E | Teledyne-API / USA | | 2 |
| | AC32M – CNH3 | Environnement / France | | 2 |
| | APNA-N370 | Horiba / Japan-Germany | | 6 |
| **Oxygen(O2)** | T802 | Teledyne-API / USA | **Paramagnetic** | 3 |
| **PM10, PM2,5** | TEOM 1400A | Thermo Environmental Instruments Inc./ USA | **Tampered element oscillating microbalance** | 11 |
| | TEOM 1405D | | | 3 |
| | SM-200 | OPSIS / Sweden | **Beta-gauge** | 20 |
| | MP101M | Environnement / France | | 2 |
| | F-701-20 | Verewa / Germany | | 1 |
| | Даст | Monitoring/ Russia | | 10 |
| | EDM-180 | GRIMM / Germany | **Nefelometry** | 3 |
| | EDM-107 | | | 1 |
| **$NO_2$; $SO_2$; O3; Benzene, toluene, formaldehyde, phenol, naphthalene, styrene, xylene** | AR-500 | OPSIS / Sweden | **Differentiated optical absorbtion spectroscopy** | 15 |



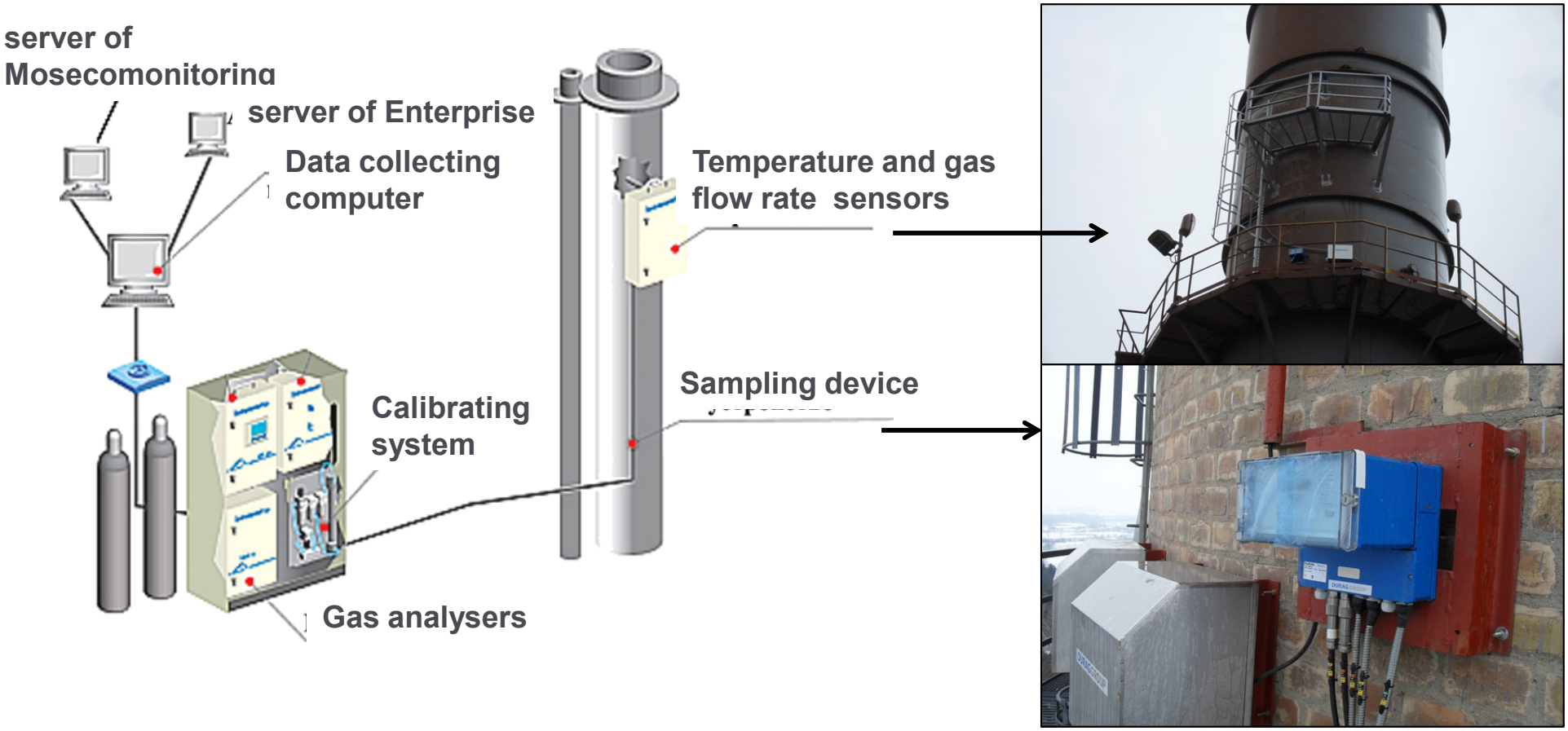
+ analytical laboratory
(more than 100 substances)

# Facilities: equipment selection

| Device | Manufacturer | Controlled pollutant | Error-free running time, days | Average time spent in repair, % | Decisions |
|---|---|---|---|---|---|
| ET-909 | ETEK, RF | NOx | 30 | 40% | **Replaced by other equipment in 2003** |
| ME-9841B | Monitor Europe | NOx | 180 | 5% | **Actively used since 2003** |
| Палладий-3 | Analitpribor RF | CO | 7 | 20% | **Replaced by other equipment in 2003** |
| К-100 | OPTEK, RF | CO | - | - | No failures. **Actively used since 2003** |
| ДАСТ | Monitoring RF | PM10 | 30 | 50 | **Replaced by TEOM by 2008** |
| Теом1400а | Thermo Electron, USA | PM10 | - | 6 | **Actively used since 2004** |

# Facilities: chemical analysis laboratory

# Facilities: tailpipe emission monitoring




Controlled parameters:

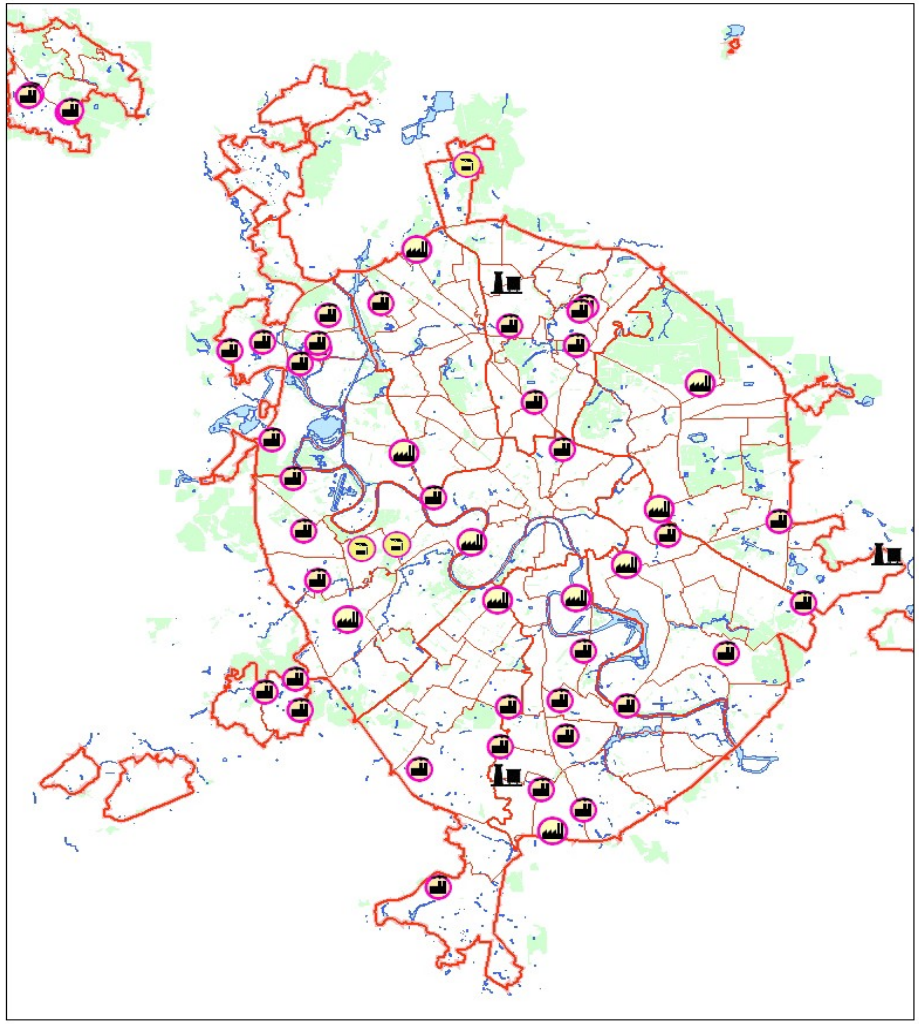
NO, $NO_2$, CO, HCl, particulate matter, $O_2$, temperature, gas flow rate

# Tailpipe emission monitoring system

**58 industrial enterpises**

**175 emission sources**

**213 monitoring systems**




cost
EUROPEAN CO

# Facilities: Meteorological complex

Data from Hydrometeorological center

Temperature profile complex

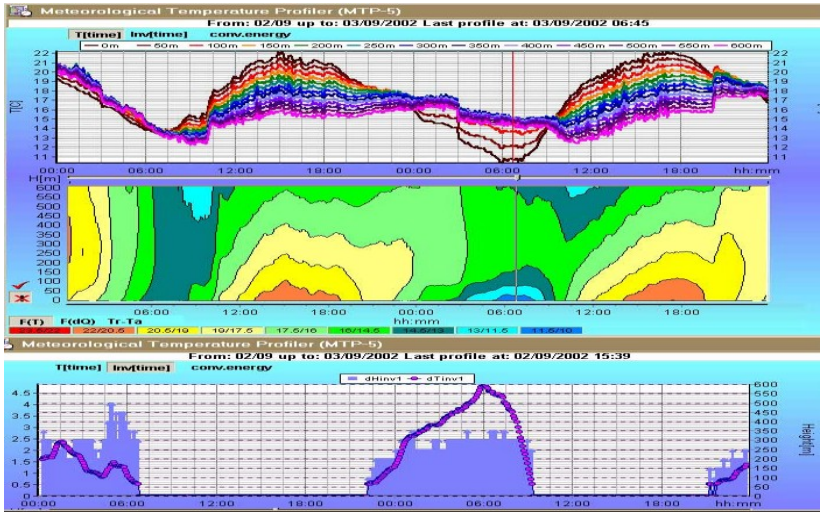
Integrated system of ecological monitoring

5 acoustic meteorological stations

2 SODARs

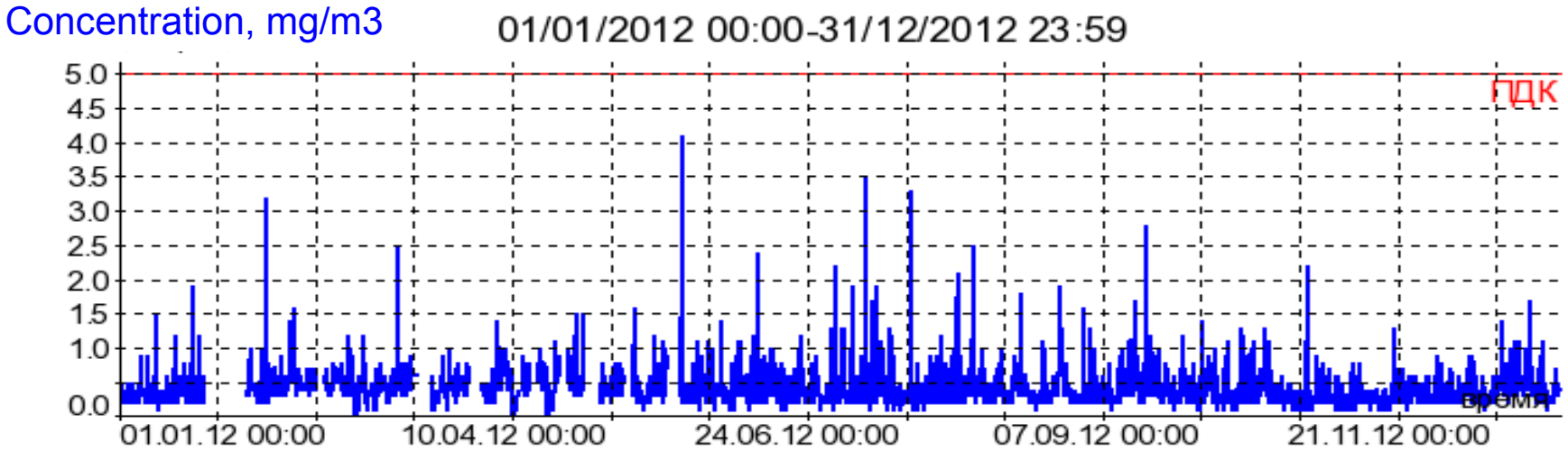
Meteorological stations on monitoring stations (33 stations)

Temperature profile from Moscow TV tower



# Results: proportion of valid data

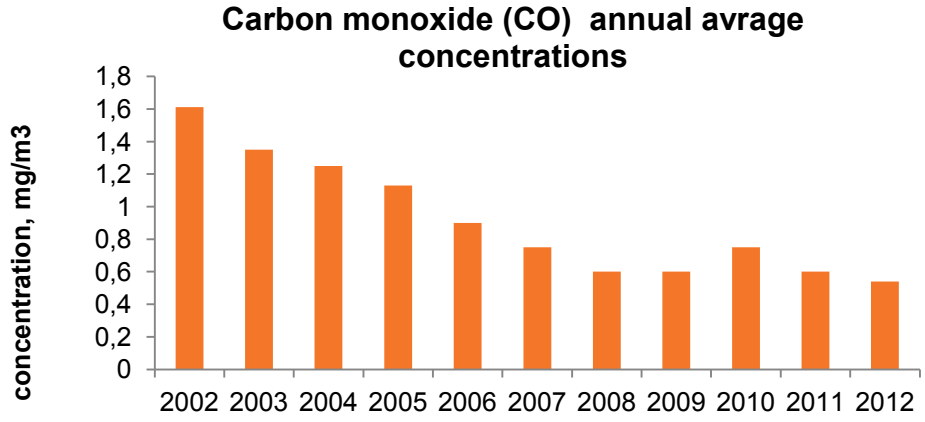
Example: CO data on one of the stations (2012)

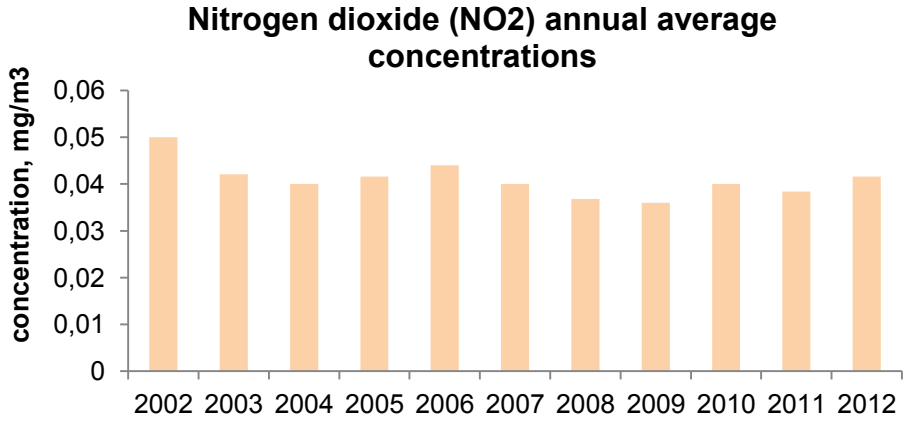


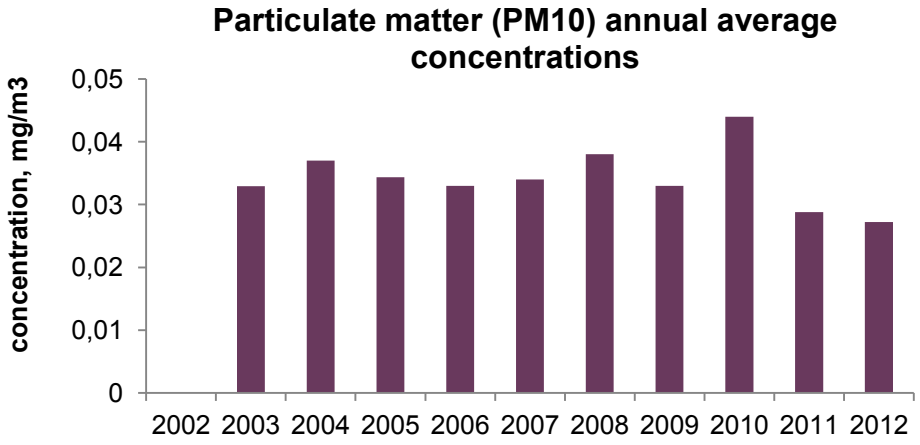

| Parameter | WHO criteria for validity of stations | Conformity (2012) | Roshydromet criteria |
|---|---|---|---|
| One hour value | At leas 75% of valid data | Conformed in 7858 out of 8784 hours (89%) | None |
| Daily mean value | At least 50% of valid one hour values | Conformed in 326 out of 366 days (89%) | None |
| Annual mean | At least 50% of valid data for the period | Conformed (89% of valid data) | At least 20 measurements a month |

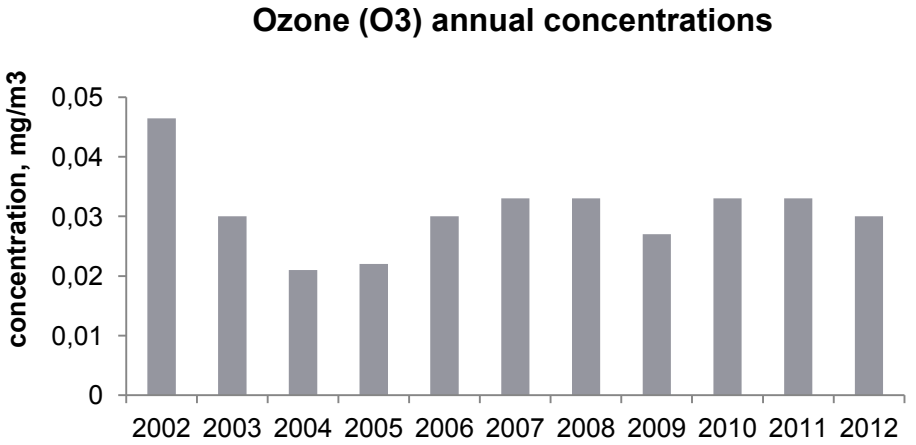
# Results

## Database on air quality since 2002 (10 years)

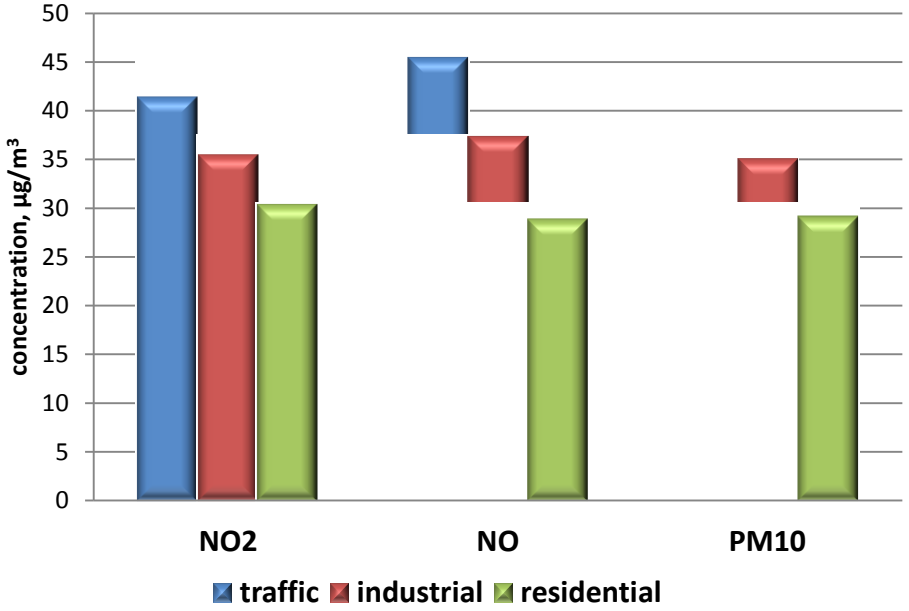


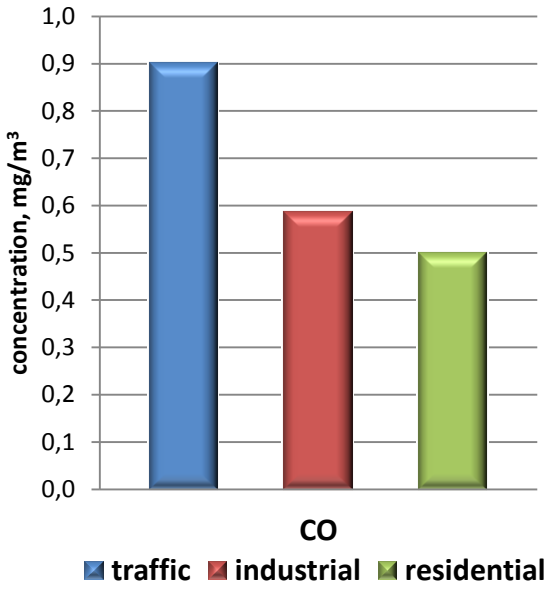



# Main results of air quality monitoring in Moscow*



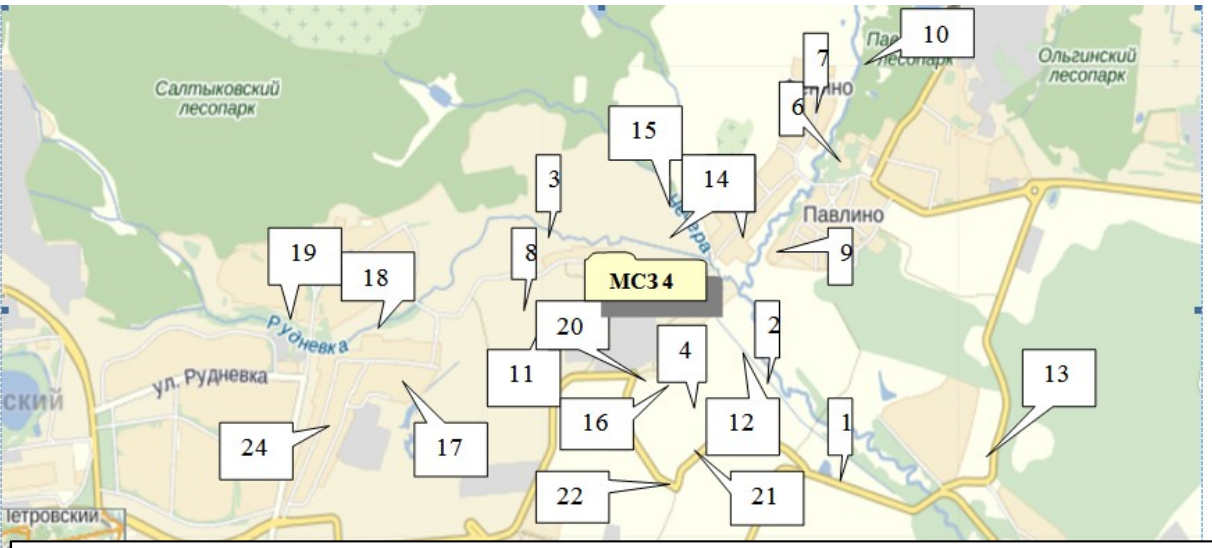

**In the sites along major motorways frequency of exceedances of one hour limit value for NO2 is more than 90 times per year.**
**In the residential sites one hour limit value is exceeded less than 10 times per year.**

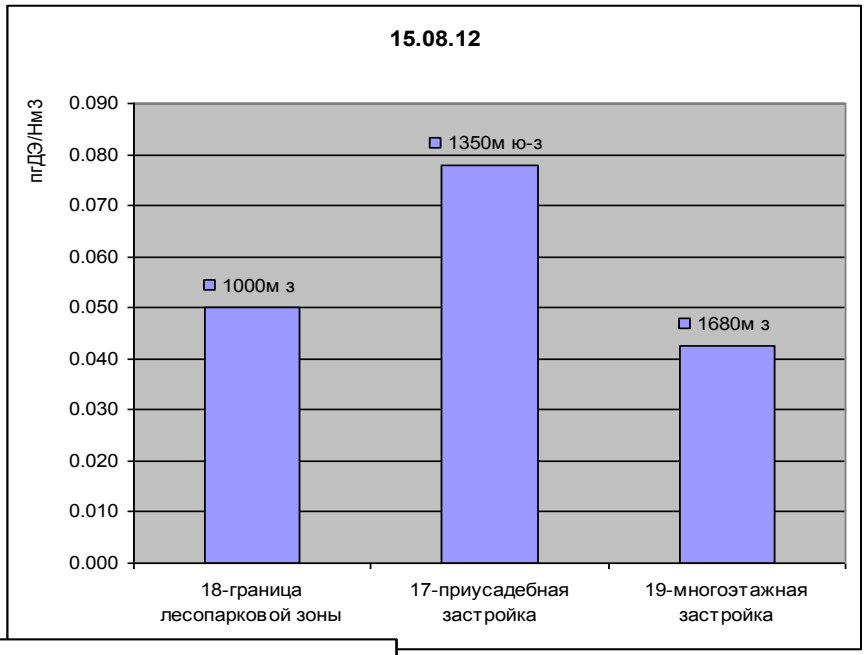
**Annual average PM10 concentrations in Moscow vary from 27 to 43 µg/m3. 24-hour average concentrations exceed EU limit value more than 40 times**

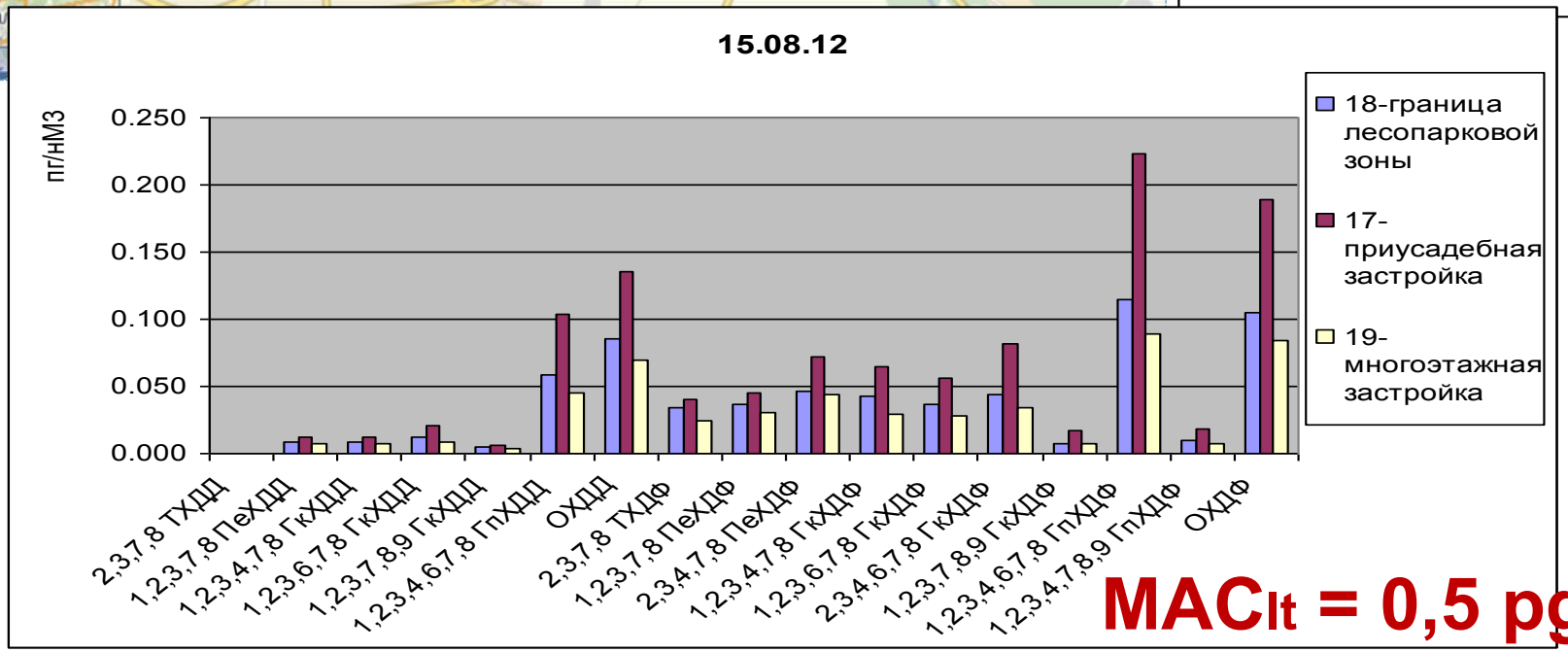
**European Union limit values and Russian maximum allowable concentrations of carbon oxide and sulfur dioxide are not usually exceeded.**

* Data as of 2011

# Dioxins concentrations near incineration plants (research results)




**max = 0,16 MACIt**

Research performed by the laboratory of the Federal medical-biological agency

**$MAC_{It}$ = 0,5 pg/m³**

# Results: *achievement of typical goals of environmental monitoring*

| *Goals* | *Achievement analysis* |
|---|---|
| *Limit values (MAC) compliance assessment* | + |
| *Information of public about air quality and development of a system of early information about adverse weather conditions (heat) and severe air pollution* | + |
| *Objective data for action planning, city and transport planning use* | + |
| *Environmental information for health risk assessment* | + |
| *Pinpointing pollution sources and their inputs in pollution levels* | -+ |
| *Pinpointing factors endangering ecosystems* | -+ |
| *Development and applicability assessment of air quality models based on geoinformation systems* | + |
| *Development of statistical air pollution forecasts* | + |

# *Future planned Activities*

- Comparison of PM10 equipment performance (different measurement methods);
- Development and improvement of air quality forecasts (both statistical and meteorological - chemical transformation modelling) with verification by monitoring data;
- Routine elemental analysis of PM in ambient air in Moscow;
- Expansion of monitoring network on new territories of Moscow (using mobile automatic stations);

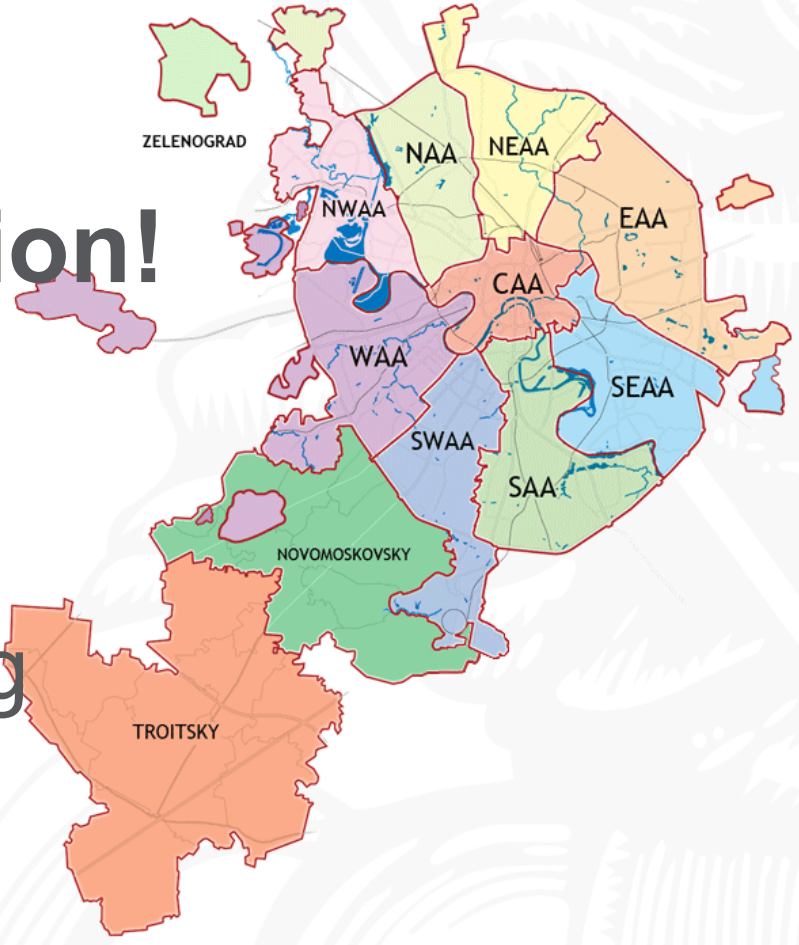
# Future planned Activities

- Expansion of PM10 and PM2.5 monitoring networks;
- Participation in intercomparison exercises;
- Examination of potential to organise manual sampling and analysis of some of the polycyclic hydrocarbons and dioxins;
- Development of a system of early information about adverse weather conditions (heat) and severe air pollution based on the system of air quality forecasts;
- Trial of new measuring equipment

# CONCLUSIONS

- ***CONCLUSIONS:***
- A reliable monitoring network is set up in Moscow allowing both efficient information on air quality to residents and feed for research
-
- Problems
- Not always good quality transfer standards
- No reliable automatic equipment measuring cyclic and polycyclic hydrocarbons
- No legislative base for emission inventory (several not cooperating government bodies, no databases on emissions and enterprises)

# Thank you for attention!

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