PM2.5 pollution: The situation in the Greater Paris Area

Sources apportionment of airborne particles in the Greater Paris Area

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Airparif study in partnership with the LSCE (Laboratory for Climate and Environmental Sciences, CNRS-CEA)

With the participation of:
- The King's College of London – Dr Gary Fuller
- The Berlin Senate Department for Health, Environment and Consumer Protection – Dr Martin Lutz
- The Institute of Environmental Assessment and Water Research, CSIC, Barcelona – Dr Xavier Querol
- The Center for Research and Teaching in Atmospheric Environment, Ecole des Ponts, Paris – Dr Christian Seigneur
- The Inter-university Laboratories for atmospheric System, Paris – Dr Matthias Beekmann
- The National Institute for Industrial Environment and Risks, Paris – Dr Olivier Favez

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PM10 pollution in the Greater Paris Area

Public exposure in Ile-de-France:
4.2 million (448 km²) in 2007
exposed to an air > limit value
(daily mean > 50 µg/m³ more than 35 days a year) in 2007
2.7 million in 2011

Chronical exceedance of the limit values
> Need for actions

Exceedance mainly in highly populated areas

Public exposure in 2007: 4.2 million

Public exposure in 2011: 2.7 million

Risk of exceedance of
35 days > 50 µg/m³
Certain exceedance
Likely exceedance
Unlikely exceedance
No risk
PM 2.5 pollution in the Greater Paris Area

Limit Value 2011: 28 µg/m³
2015: 25 µg/m³
Target Value: 20 µg/m³
Quality Objective: 10 µg/m³

<table>
<thead>
<tr>
<th>Location</th>
<th>PM2.5</th>
<th>PM10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitry sur Seine</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Gennevilliers</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Bobigny</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>RN6 Melun</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Auteuil Ring Road</td>
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<td>10</td>
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<tr>
<td>A1 Highway</td>
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µg/m³

Air Pollution Seminar – King’s College – 280612
Context of the source apportionment study

- French “Particle Plan”

Objective of 15 µg/m³ of PM2.5 by 2015

- reduction by 30% of the PM2.5 levels

- Implementation of an efficient abatement strategy requires a clear understanding of the origins and the various sources of PM

- Final goal:

Actions to reduce the chronic pollution
Sources apportionment study in the Greater Paris Area

- METHODOLOGY
- RESULTS
Based on the assumption that:

atmospheric PM concentrations = addition of geographical contributions

- [Rural] representative for the import
- [Urban] – [Rural] representative for the urban background contribution
- [Traffic] - [Urban] representative for the traffic contribution
Sites implementation

- Traffic hot-spot
- Paris (urban background)

5 monitoring sites:
- 3 rural background
- 1 urban background
- 1 road side
The rural background

- PM imported to the region arise from the transport of the urban plume

- Each day: analysis of meteorological data provided by Meteo France and by our own modelling platform ESMERALDA

- for each day, selection of the rural background located upwind of the urban site

<table>
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<th>Day</th>
<th>Time</th>
<th>Region</th>
<th>Plume</th>
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</table>
Hot-spot = road side station

Boulevard périphérique Porte d’Auteuil located on the Paris ring-road:
Traffic Hot-spot: Ring road Porte d’Auteuil

✓ Major road in the Ile-de-France region (240,000 vehicles/day)

✓ Measurements available for the past years (NOx, CO, SO\textsubscript{2}, PM10, PM2.5)

✓ Lot of tests already performed on this station

✓ Levels half-way between our different road-side monitoring sites
Representativeness of the traffic monitoring site

Complementary campaign: comparison of chemical composition and quantity of PM on a different traffic site

PM2.5 sampling on a large avenue in the inner Paris (Boulevard Haussmann: 35 000 vehicles / day). From March 15\textsuperscript{th} to April 4\textsuperscript{th}
Step 1: Sampling and chemical analysis - from 2009/09/11 to 2010/09/10

Sampling
- Daily PM2.5 Sampling on the five sites - 2 filters collected / site (a teflon and a quartz).
- Daily PM2.5 Sampling on the inner Paris traffic site for 15 days - 2 filters collected.
- Daily PM10 Sampling on the traffic and the urban sites - 1 filter collected/site.

Total mass is measured by gravimetry.

Analysis of the chemical composition of PM: Major ions, Metals, Elementary carbon / Organic Carbon, Levoglucosan (only in winter) as a tracer for biomass burning.

Step 2: Coupling of chemical composition per geographical area with the emission inventory
Sources apportionment study in the Greater Paris Area

- METHODOLOGY
- RESULTS
Geographical origins of PM2.5 on the ring road

PM2.5 mean concentration measured on the ring road traffic site comes from:
- About 40% from external sources
- About 60% from local sources:
  ~45% from local traffic
  ~15% from urban background
PM2.5 concentrations during pollution events at the ring road traffic site
Main sources of PM for the whole year

- Traffic: 47%  
  (44% from local sources)

- Secondary inorganic PM: 26%  
  (7% from local sources)

- Residential heating: 16%  
  (7% from local sources)
Local sources of PM2.5 on two different traffic sites

**Ring road – 23 µg/m³**
- Energy: 72%
- Industry: 10%
- Wood burning: 4%
- RES-Other fuel: 3%
- Tertiary: 6%
- Traffic-Exhaust: 1%
- Traffic-Non-exhaust: 1%

**Inner Paris – 18 µg/m³**
- Energy: 52%
- Industry: 13%
- Wood burning: 14%
- RES-Other fuel: 6%
- Tertiary: 2%
- Traffic-Exhaust: 4%
- Traffic-Non-exhaust: 6%

**Import**
- Local traffic: 41%
- Urban: 18%

**External contribution**
- Local traffic: 31%
- Urban: 21%
- External contribution: 48%
Emissions sources of PM2.5 by traffic

Ring road
73% of the vehicles = Diesel → 96% of the PM2.5 emissions

Inner Paris
56% of the vehicles = Diesel → 90% of the PM2.5 emissions
Main sources of the urban contribution:
Traffic exhaust, Sources of secondary inorganic and wood burning.
Comparison between wood consumption and wood burning emission

Wood in residential heating:
- 5% of energy consumption
- 84% of PM2.5 emission
Strong import to the region but still: 50 to 60 % of PM are produced locally on an annual average basis.

Traffic is the main local source of PM:

- Strong impact of resuspension which still need to be investigated.
- Diesel vehicles are some strong particles emitters compared with gasoline ones.

Wood burning is also a strong source of particles compared to other fuel.
Definition of the Atmosphere Protection Plan (APP).

Definition of a Low Emission Zone (ZAPA) which takes into account Paris and the close suburb.
5 Groups are taken into account:
Airports, Industry, Residential sector, Agriculture, Transports

Measures presented on 2011/10/19 to the APP Elaboration Board:

- 11 regulatory measures, among which:
  - To limit emissions related to biomass combustion, for devices less powerful than 400 kW
- 3 objectives and recommendations, among which:
  - To limit circulation of the most pollutant vehicles in the very center of the Paris metropolitan area
  - To promote an AQ friendly policy, and comply with the objectives set by the Urban Mobility Plan (project)
- 7 secondary measures
- 3 studies

Prospectives scenarios have been achieved to estimate the impact of the APP on the PM, NOx and O₃ concentrations in 2020.
Transportation Measures in the Low Emission Zone:

- To restrict or prohibit the access to the vehicles which are the greatest sources of pollution.
- To accelerate the introduction of cleaner vehicles and services.
- To regulate the offer for parking space
- To allocate the roads to favor the less polluting form of transport (bike, public transit, carpooling…)
- To develop and improve public transit…

Preliminary step for the definition of the low emission zone:

- Definition of a geographical area and of a list of vehicles for which the entry in the area is not permitted (based on a classification of vehicles by category of pollution)
- Impact assessment on air quality, socio-economic impact (deadline July 2012)…
- Determination of a method for monitoring and survey.
Thank you for your attention!