

Sources apportionment of airborne particles in the Greater Paris Area



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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 for Industrial Environment and Risks, Paris – Dr Olivier Favez

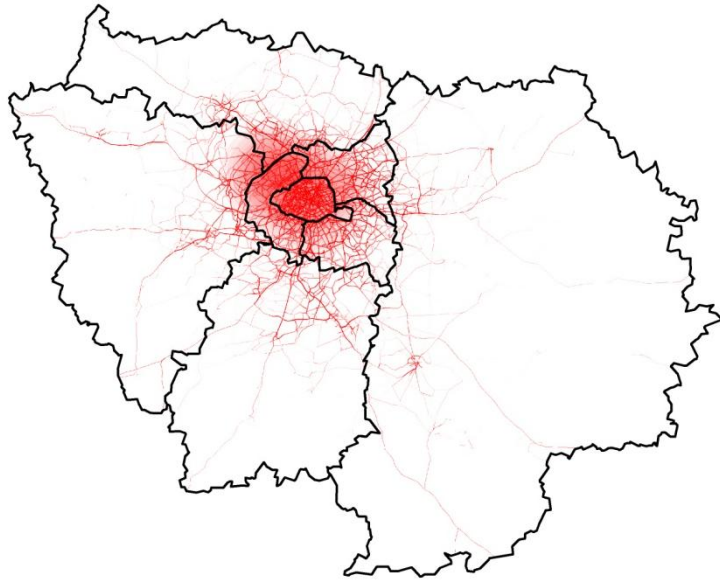
With the financial support of the government, the regional council and the City Hall of Paris



PM10 pollution in the Greater Paris Area



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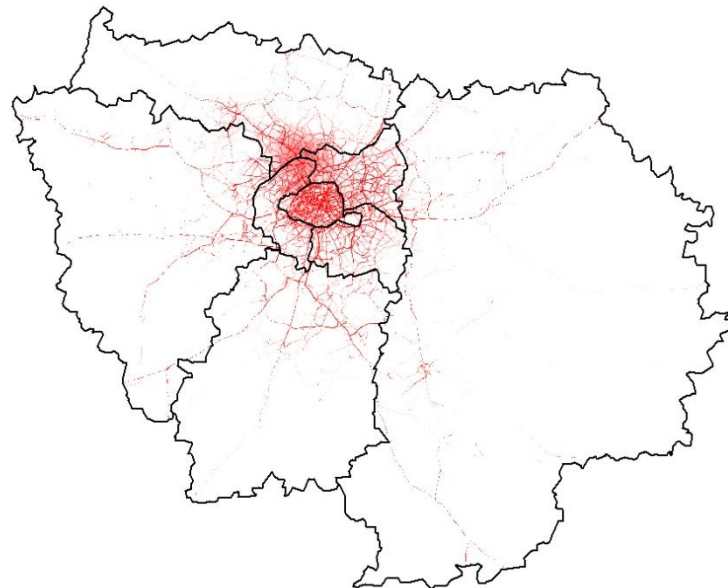
Public exposure in Ile-de-France :
4.2 million (448 km²) in 2007
exposed to an air > limit value
(daily mean > 50 µg/m³ more than 35 days a year) in 2007
2.7 million in 2011

**Chronical exceedance of the limit values
> Need for actions**

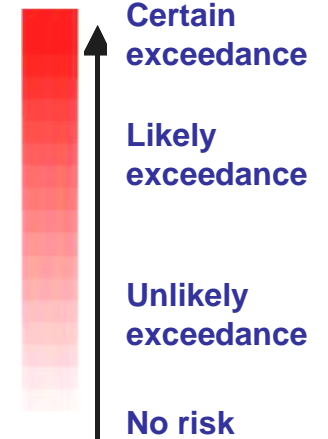
Public exposure in 2007 :
4.2 million

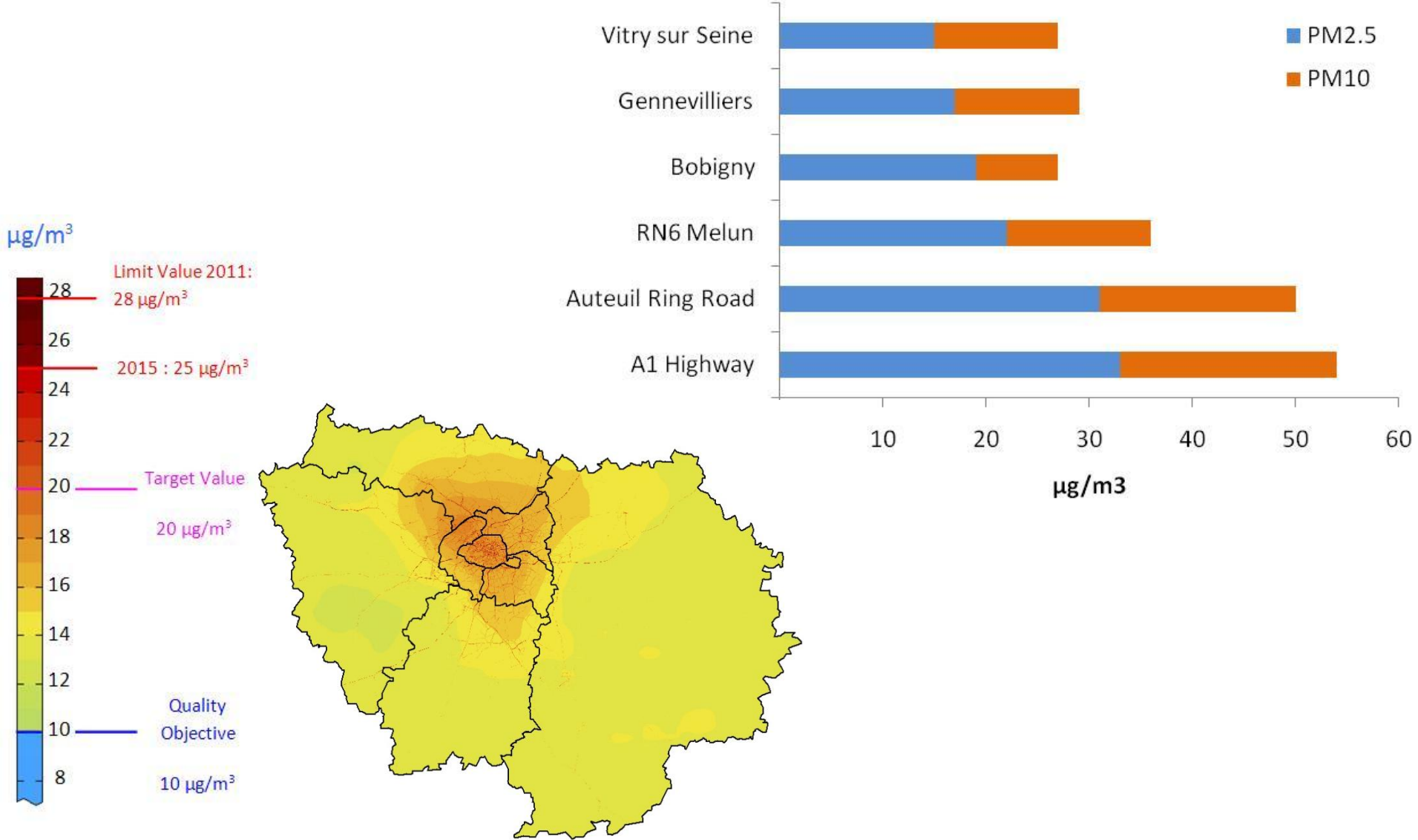
*Exceedance mainly
in highly populated areas*

Public exposure in 2011:
2.7 million



Risk of exceedance of
35 days > 50 µg/m³





➔ French “Particle Plan”

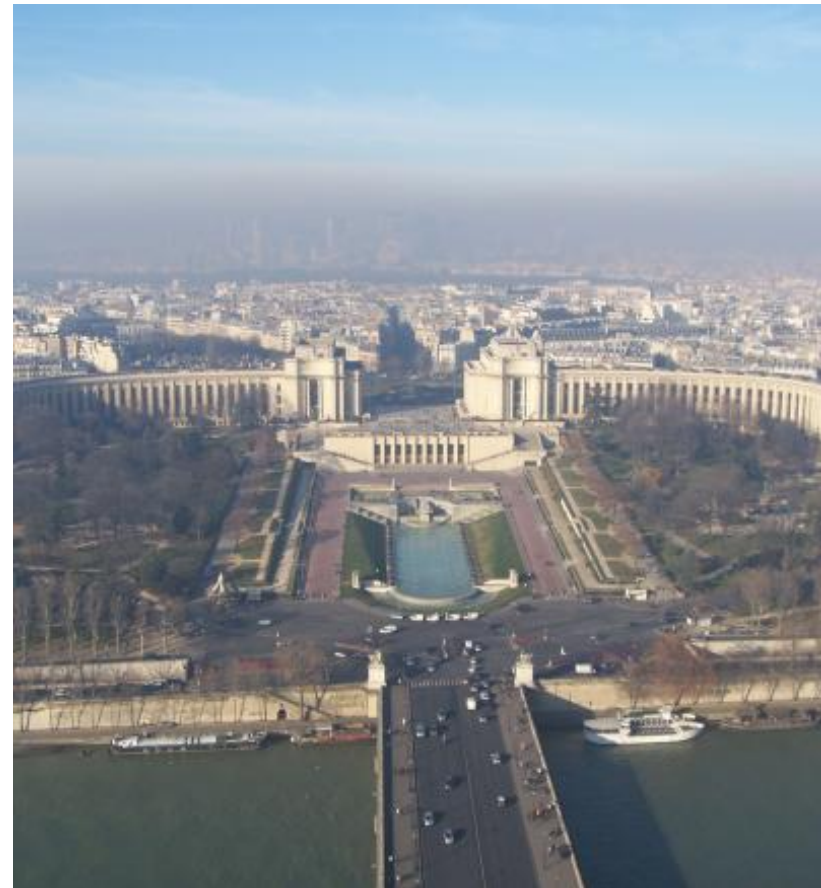
Objective of $15 \mu\text{g}/\text{m}^3$ of $\text{PM}_{2.5}$ by 2015

➔ reduction by 30 % of the $\text{PM}_{2.5}$ 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

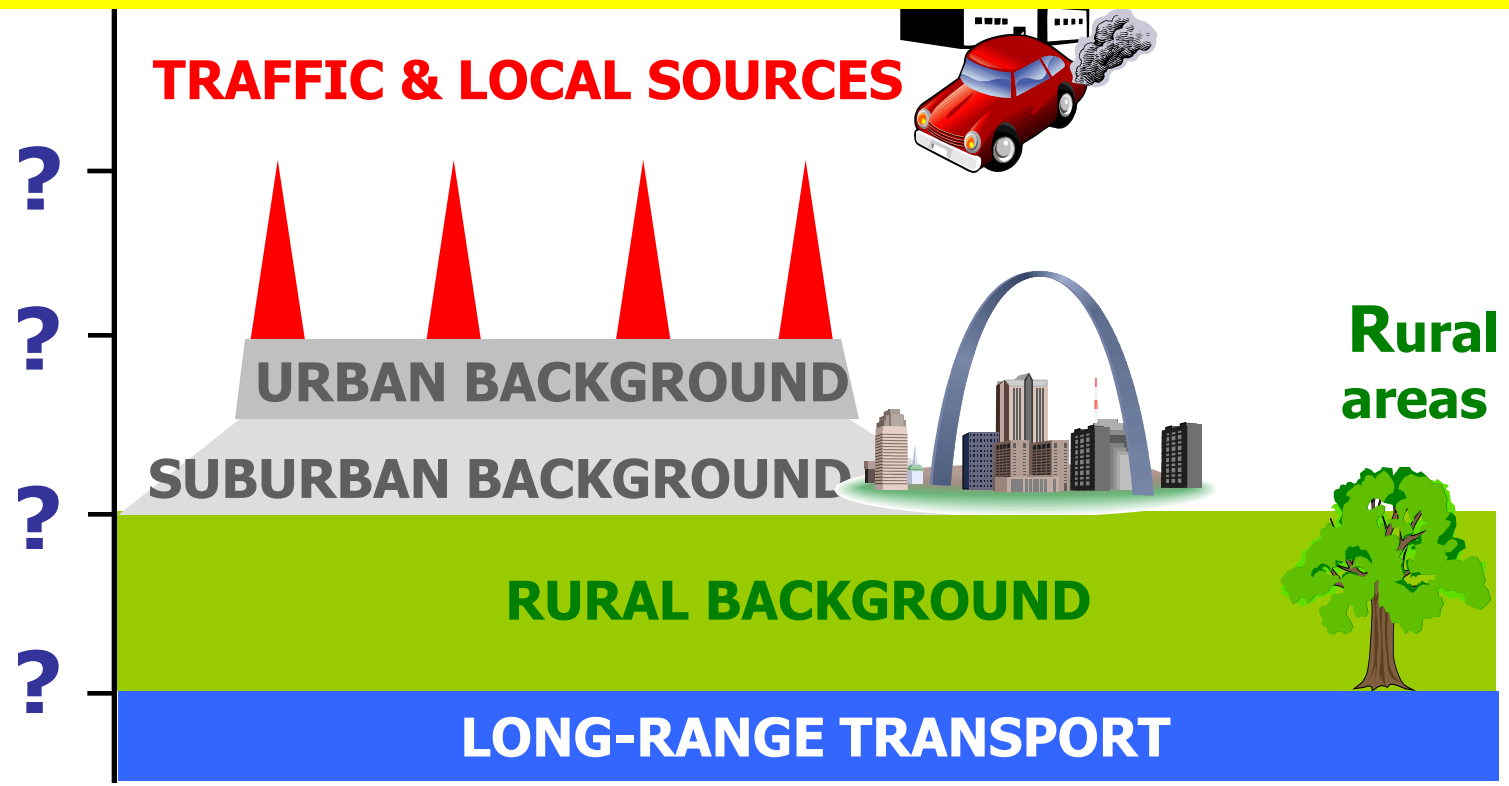


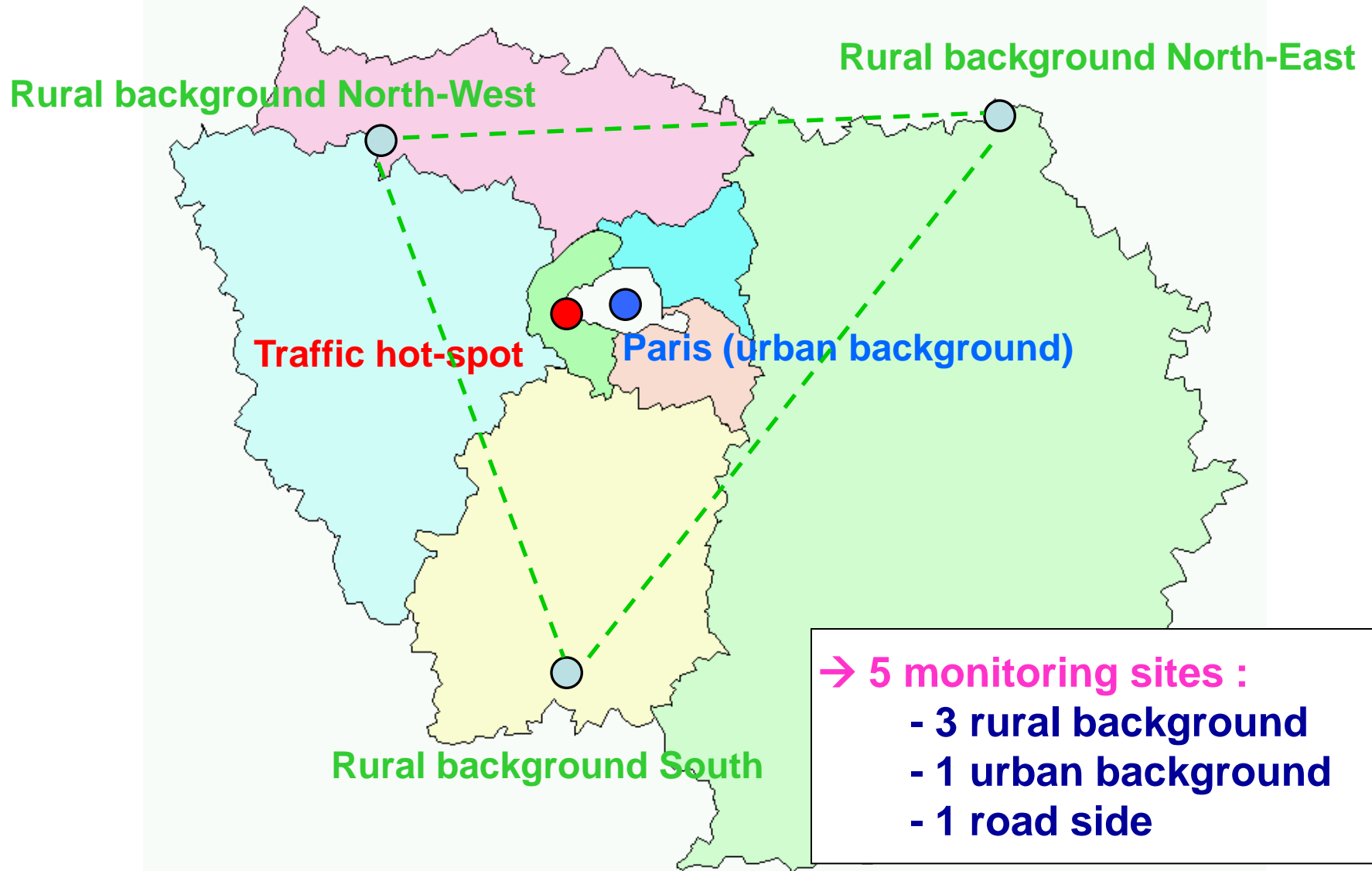
Sources apportionment study in the Greater Paris Area

- **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

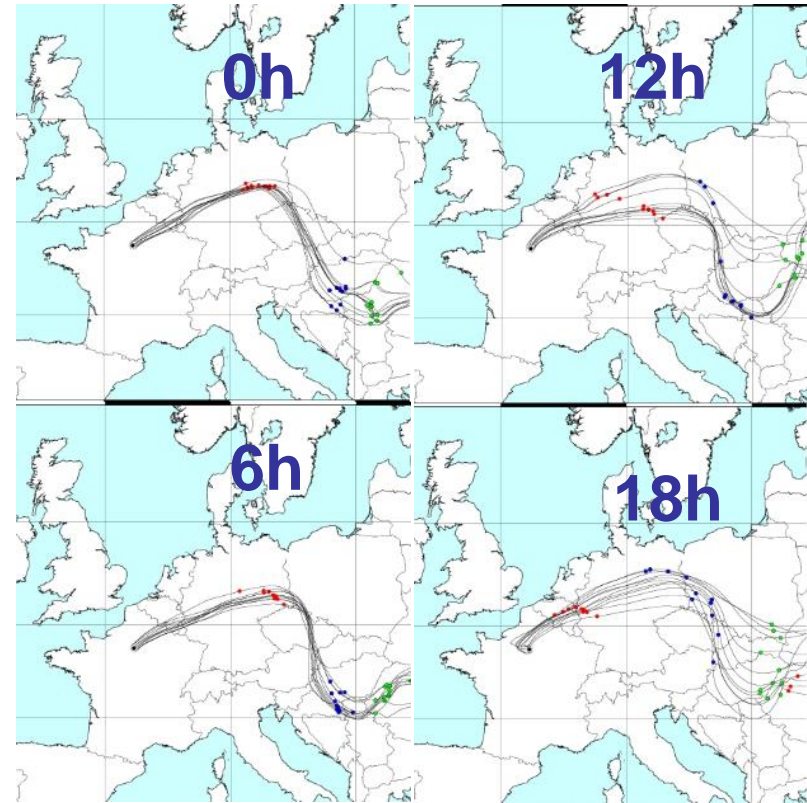




- PM imported to the region arise from the transport of the urban plume

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

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



| | | | | |
|----------------|-----------|---------|-----|---|
| 27/11/10 0:00 | Europe_NE | Benelux | NE | <p>Situation : Aspect anticyclonique froid et sec.</p> <ul style="list-style-type: none"> - Temps : ciel clair à peu nuageux devenant très nuageux à couvert avec quelques petites pluies le soir. - Insolation : 4,6 heures - Pression 12UTC : 1032,2 hPa - Vent 00/12UTC : nord-est 1,5 à 5,1 m/s (mini 11h - maxi 01h) - Vent 12/24UTC : ouest 0 à 4,6 m/s (mini 12h - maxi 22h) - Température mini : -4,6 °C - Température maxi : 5,4 °C - Indicateur météo : 0,3 |
| 27/11/10 6:00 | Europe_NE | Benelux | NE | |
| 27/11/10 12:00 | Europe_NE | Benelux | NE | |
| 27/11/10 18:00 | Europe_NE | Benelux | N/O | |

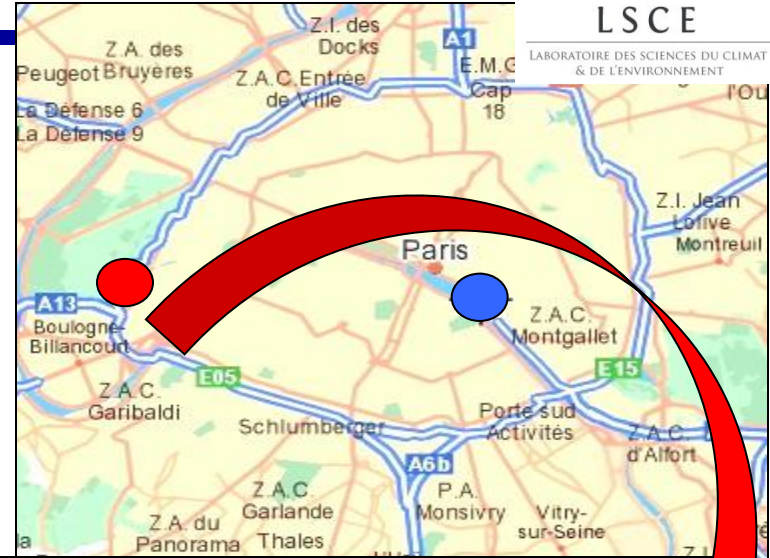
Hot-spot = road side station



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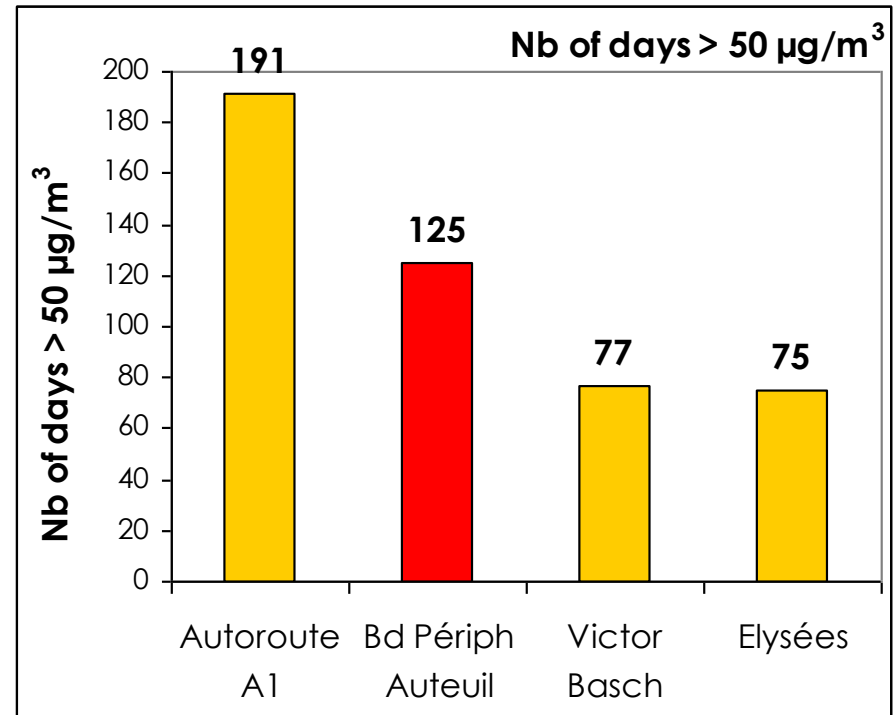
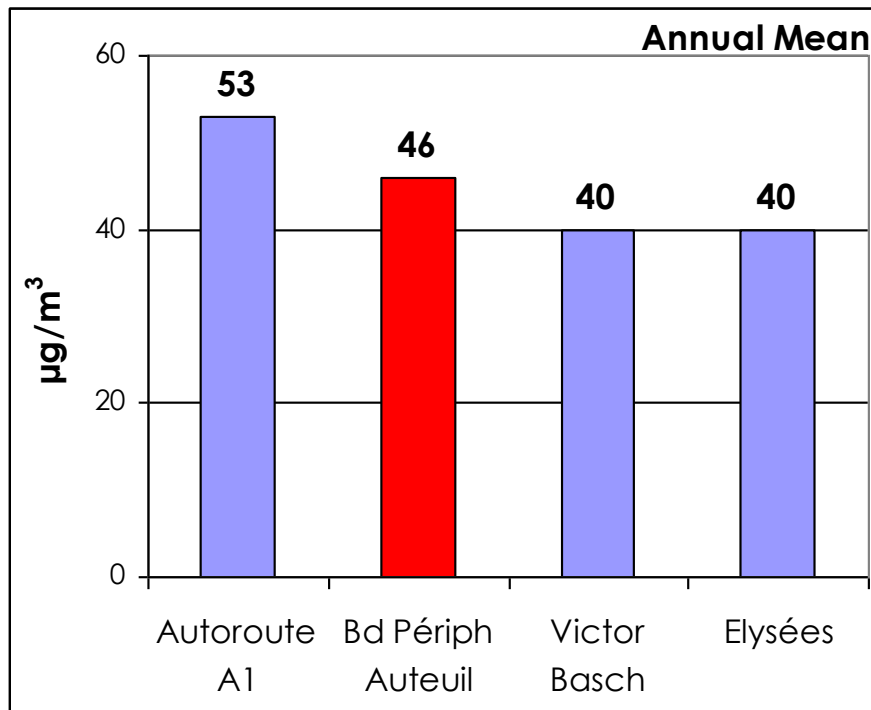
Boulevard périphérique **Porte d'Auteuil** located on the **Paris ring-road:**



Traffic Hot-spot: Ring road Porte d'Auteuil

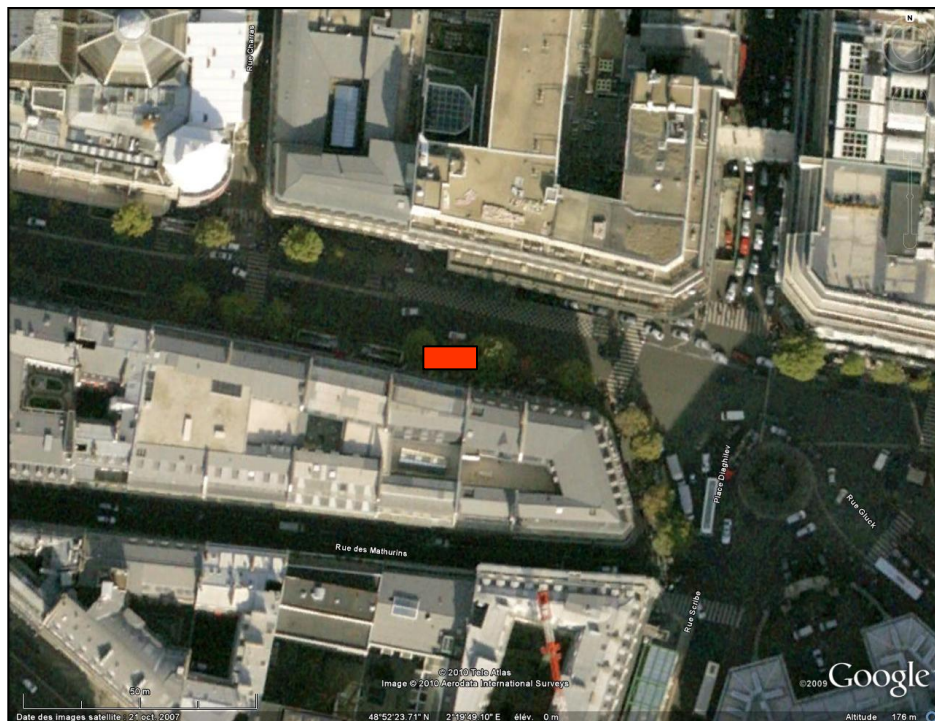


- ✓ Major road in the Ile-de-France region (240.000 vehicles/day)
- ✓ Measurements available for the past years (NO_x, CO, SO₂, PM₁₀, PM_{2.5})
- ✓ Lot of tests already performed on this station
- ✓ Levels half-way between our different road-side monitoring sites



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

PM_{2.5} sampling on a large avenue in the inner Paris (Boulevard Haussmann: 35 000 vehicles / day). From March 15th to April 4th



➔ **Step 1: Sampling and chemical analysis - from 2009/09/11 to 2010/09/10**

➤ **Sampling**

- Daily PM_{2.5} Sampling on the five sites - 2 filters collected / site (a teflon and a quartz).
- Daily PM_{2.5} 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.

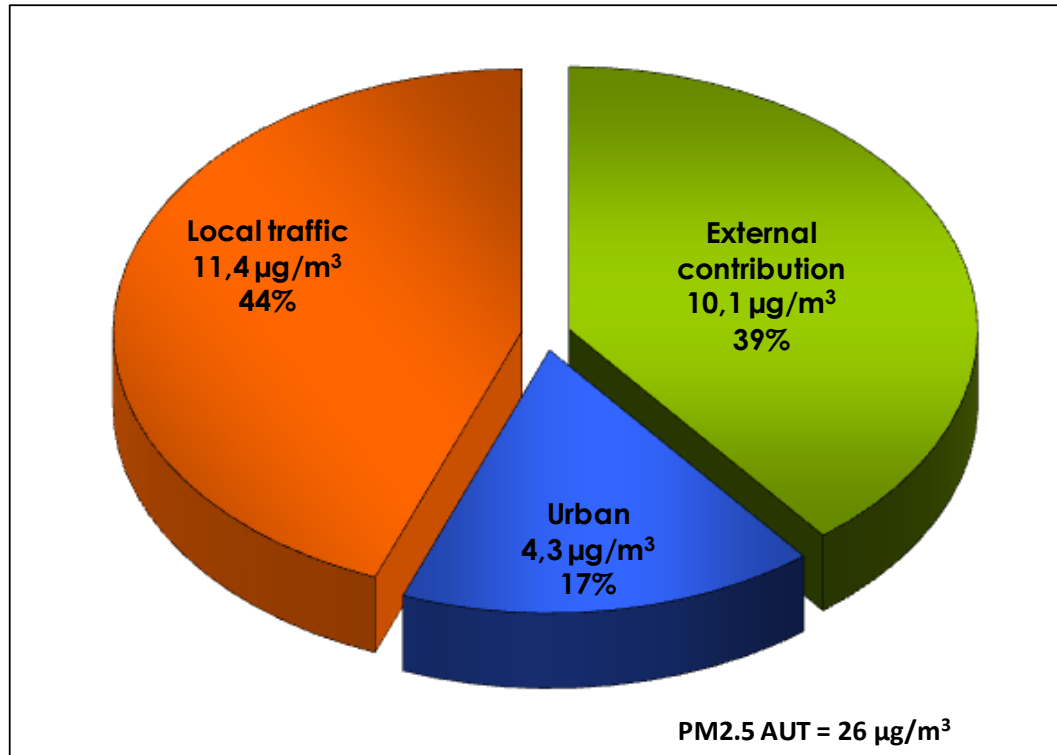
➤ **Total mass is measured by gravimetry.**

➤ **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**



PM2.5 mean concentration measured on the ring road traffic site comes from :

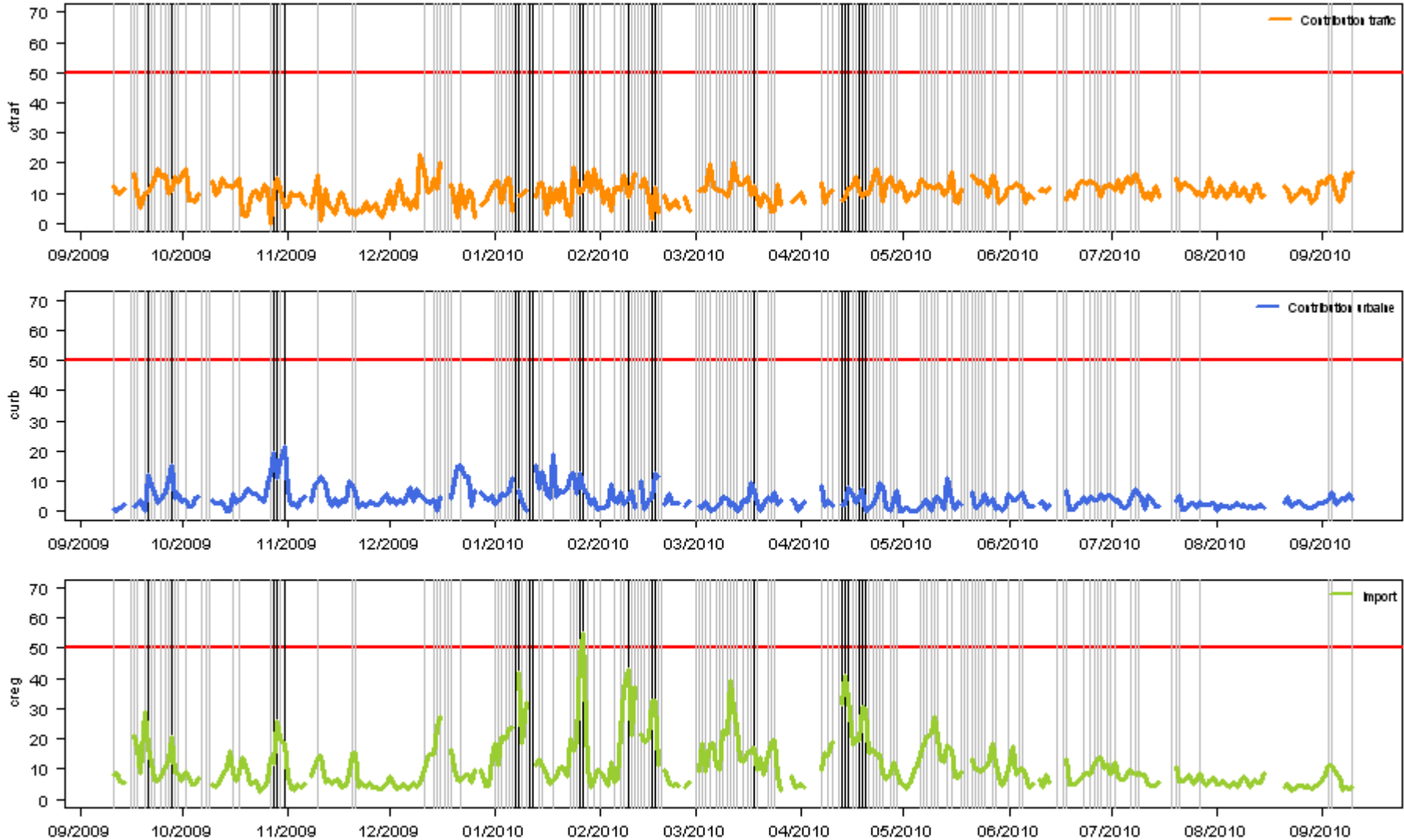
- About 40% from external sources
- About 60% from local sources :
 - ~45% from local traffic
 - ~15% from urban background

PM2.5 concentrations during pollution events at the ring road traffic site

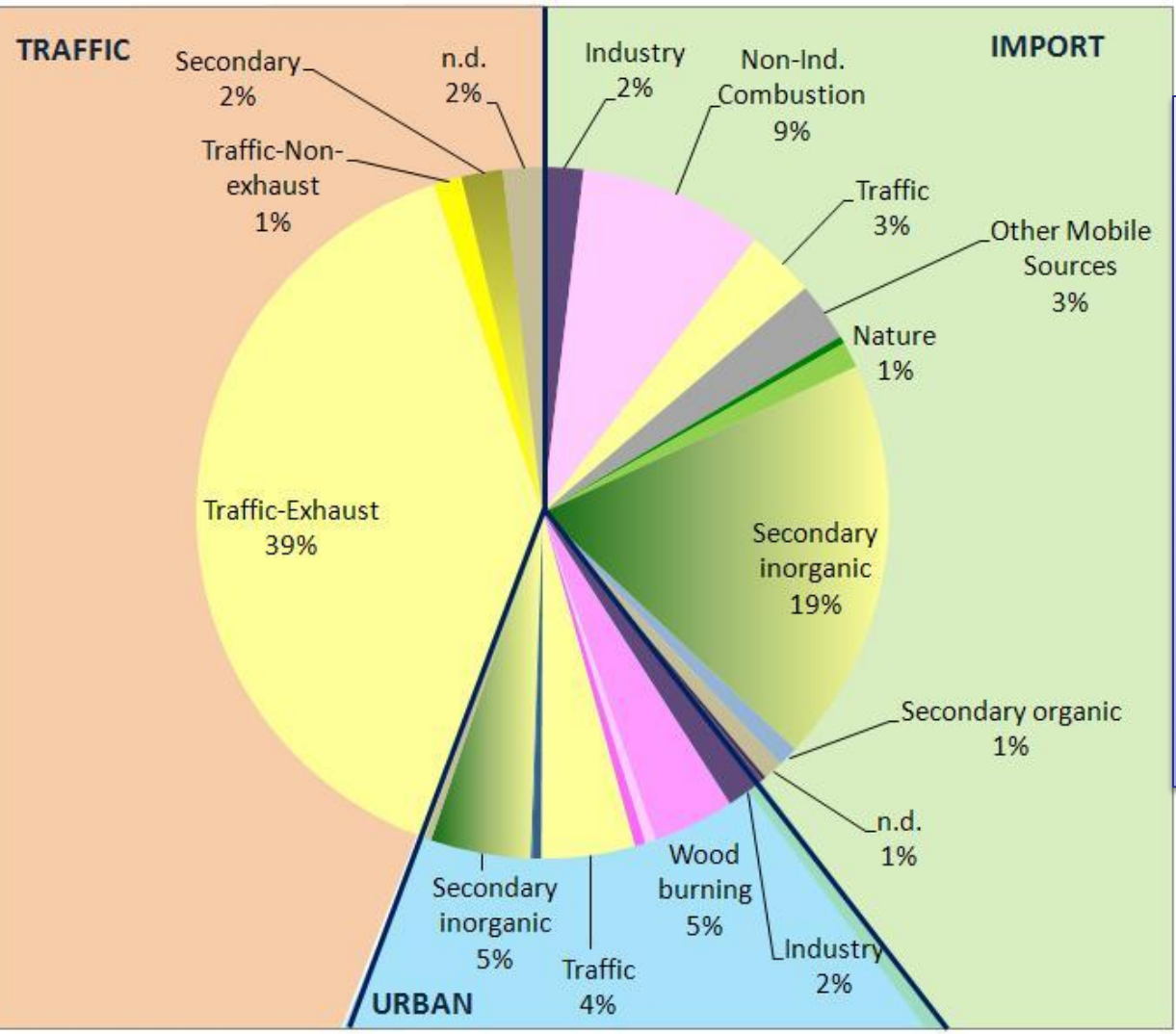


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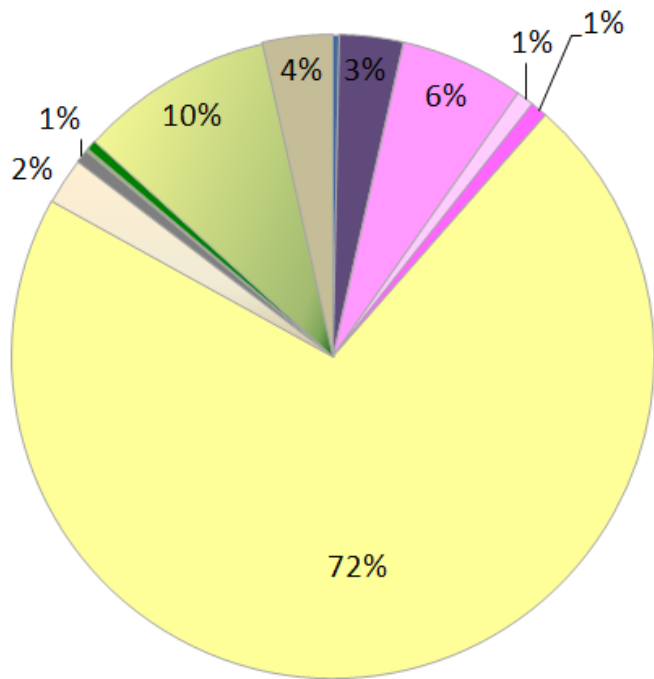


Sources apportionment of PM on the ring road traffic site

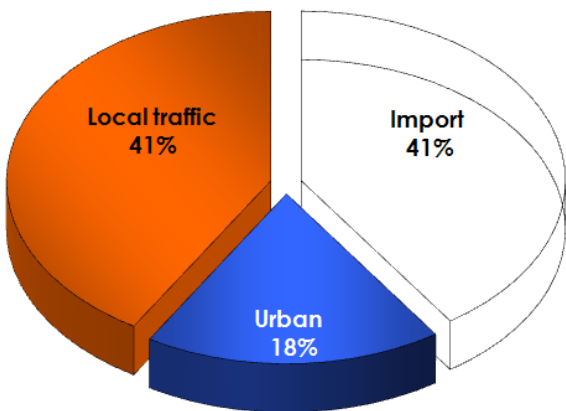
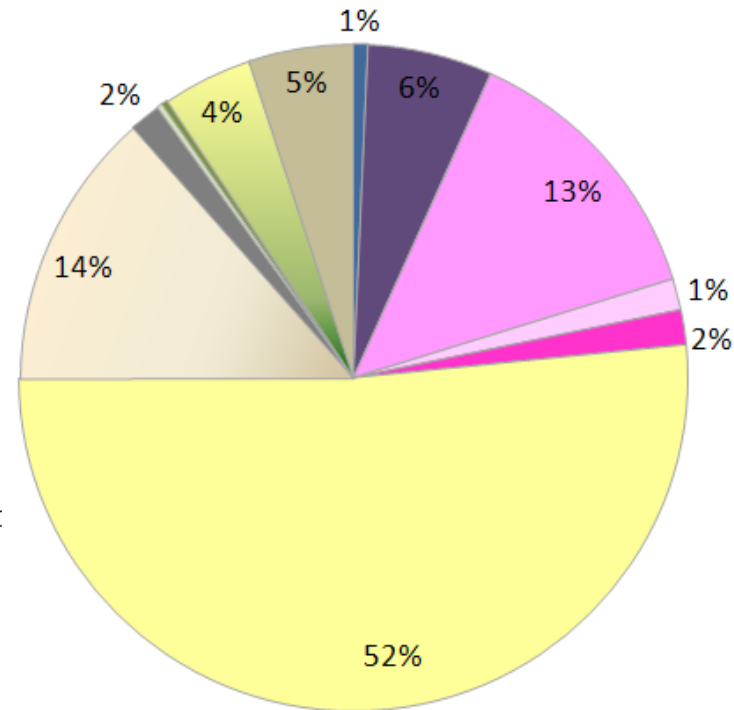


Main sources of PM for the whole year

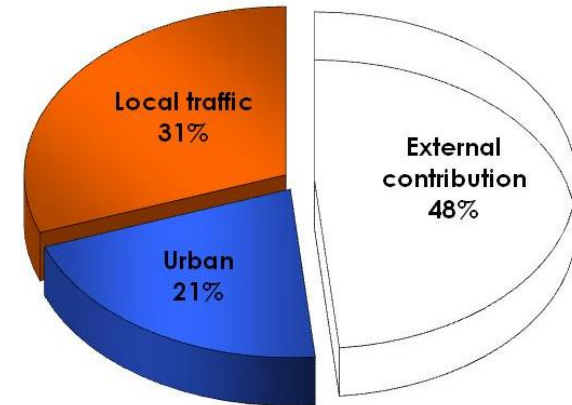
- Traffic: **47%**
(44% from local sources)
- Secondary inorganic PM: **26%**
(7% from local sources)
- Residential heating: **16%**
(7% from local sources)



- Energy
- Industry
- Wood burning
- RES-Other fioul
- Tertiary
- Traffic-Exhaust
- Traffic-Non-exhaust
- Other Mobile Sources
- Agriculture



Ring road – 23 µg/m³



Inner Paris – 18 µg/m³

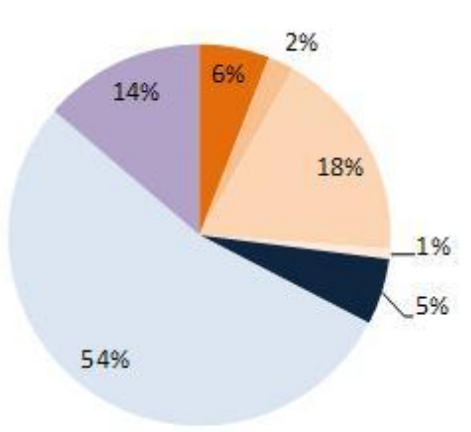
Emissions sources of PM2.5 by traffic



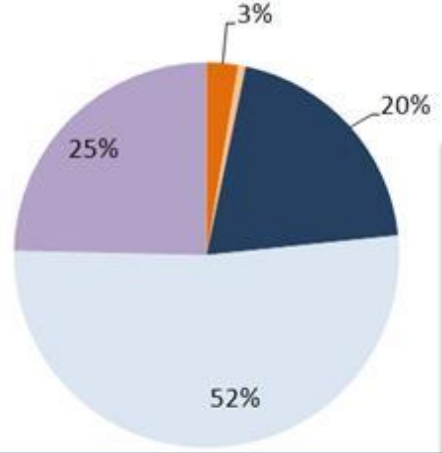
- Moped & Motorcycles < 50 cm3
- Motorcycles > 50 cm3
- Passenger Cars Gasoline Pre-Euro
- Passenger Cars Gasoline Euro
- Light Duty Vehicles Gasoline
- Heavy Duty Vehicles Diesel
- Public Transport Diesel
- Passenger Cars Diesel
- Light Duty Vehicles Diesel

Auteuil

Percentage of each vehicles type



PM2.5 Emissions

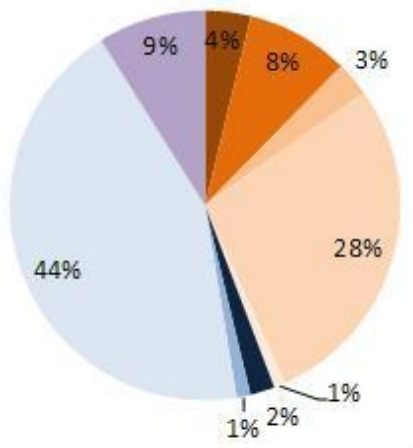


Ring road
73% of the vehicles = Diesel
→ 96% of the PM2.5 emissions

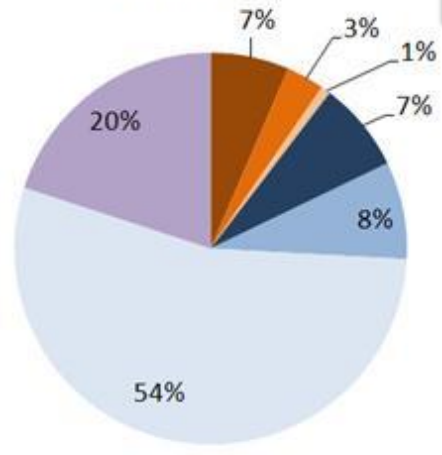
Inner Paris
56% of the vehicles = Diesel
→ 90% of the PM2.5 emissions

Haussmann

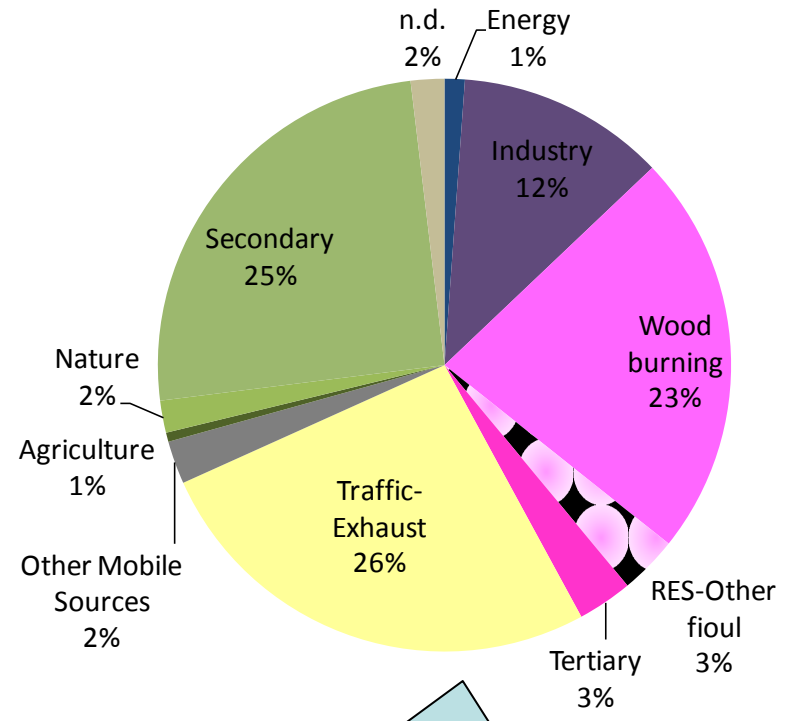
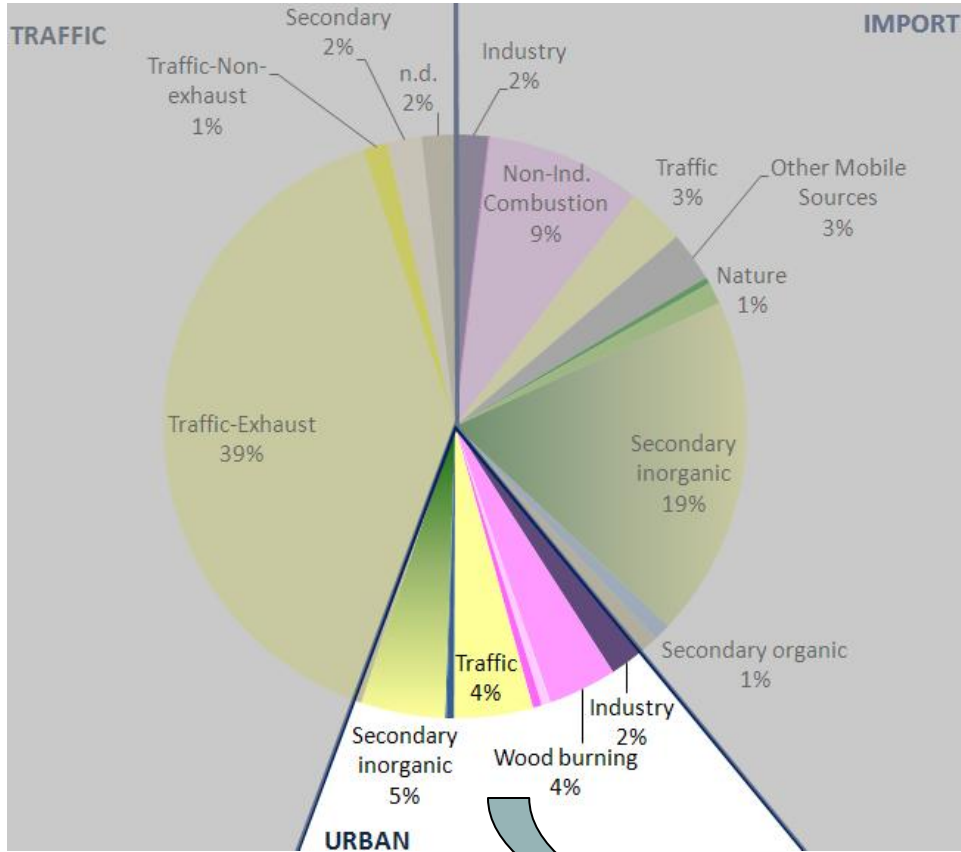
Percentage of each vehicles type



PM2.5 Emissions



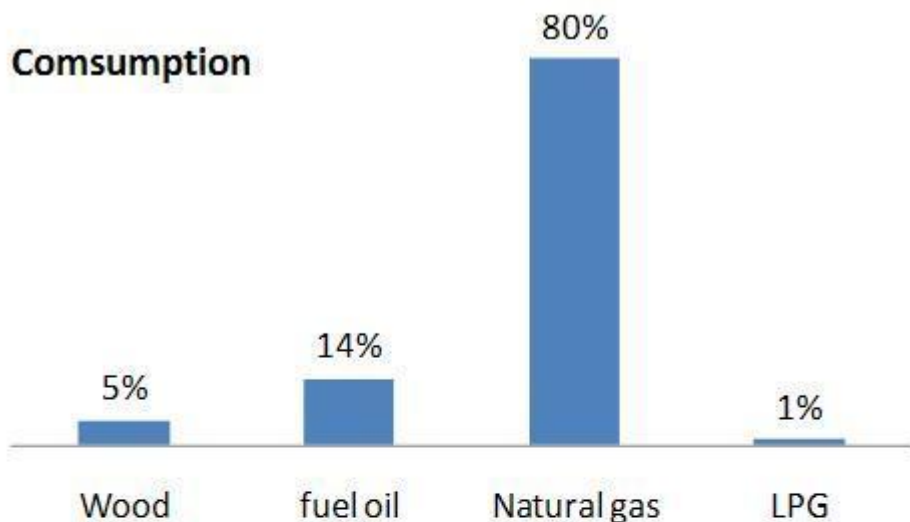
Sources of PM2.5 produced by the urban area



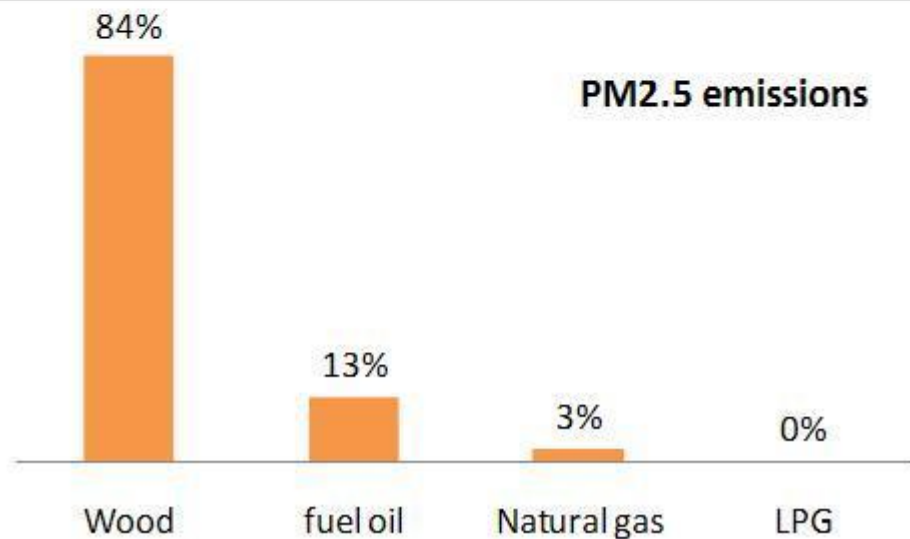
Main sources of the urban contribution:
Traffic exhaust, Sources of secondary inorganic and wood burning.

Comparison between wood consumption and wood burning emission

Consumption



PM2.5 emissions



**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, NO_x 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!**