Impacts of traffic and transport on air quality

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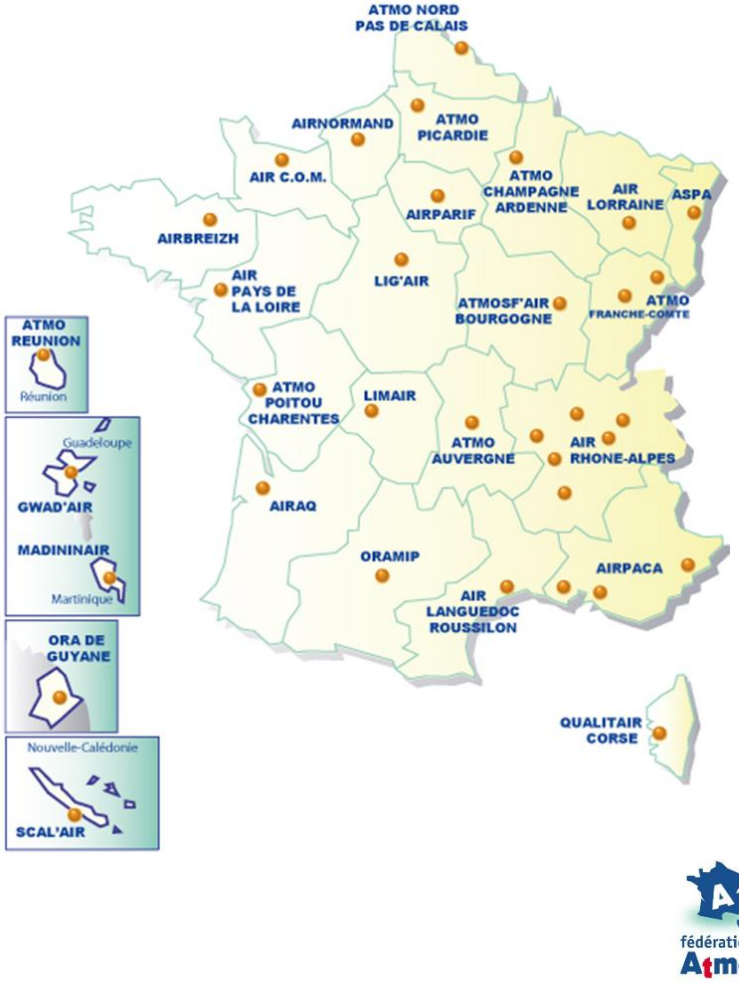
16/04/2014

AIRPARIF

Air quality monitoring network in the Paris region

AIRPARIF: non profit organisation approved by the French Ministry of the environment.



MONITORING

Air quality in the Ile-de-France region
(12 million inhabitants including Paris)

UNDERSTANDING AND ANALYSING

Air pollution phenomena

INFORMING

Citizens, medias and authorities:
- Every day ,
- In case of pollution episode,
- About the forthcoming issues

FORECASTING and DISPLAYING

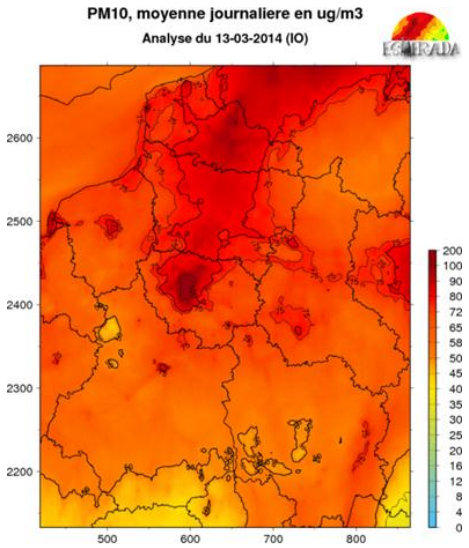
the daily air quality

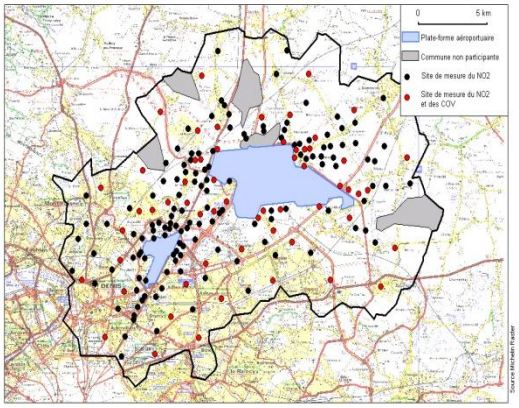
ASSESSING

Mitigation measures planned or already implemented

Air quality monitoring tools

A combined use of 3 complementary tools





Fixed monitoring stations

Modeling tools Emission inventories

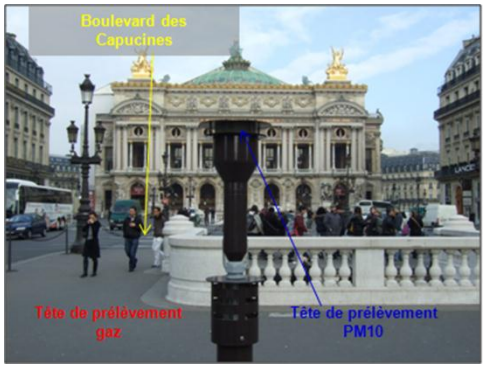
Monitoring campaign

Monitoring network

A close background station ☺

Urban station in La Défense (92)

Traffic/Road side stations



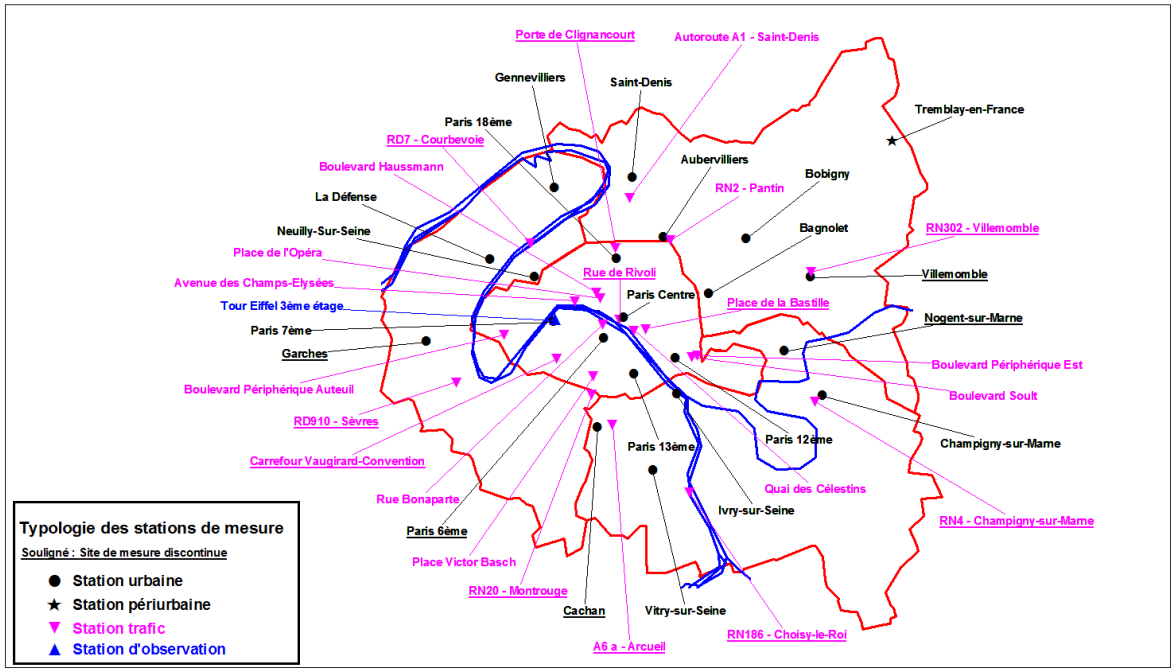
- **Objective**:

  Measure the maximum pollution levels pedestrian are exposed to (high levels but during a shorter period of time)

- **Pollutants measured**: pollutants from road traffic
  ✓ NOx, CO, particles PM10/PM2.5

- **Characterized pollutants levels in different local areas**

Location of the monitoring stations



Traffic stations

Monitoring campaigns

Purposes of monitoring campaigns

Assessment of the pollution distribution in hot spot areas

- Paris ring road
- New motorway (Duplex A86)
- Airports

Assessment of public exposure

- Inside a car,
- On a bike,
- In the subway
- During the day

Example of measurement campaigns and perspectives :
Assessing drivers exposure

Air quality monitoring is permanently developing :

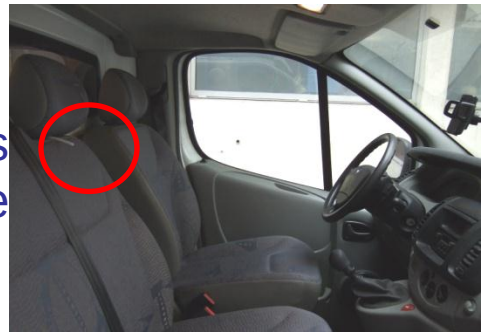
➲ **Toward a better assessment of public exposure**
especially inside the transports (high level + long time)

- individual exposure assessment
- developments of measurements techniques inside a car and for a bicycle

New issues:

Towards a better understanding of exposure in the transports

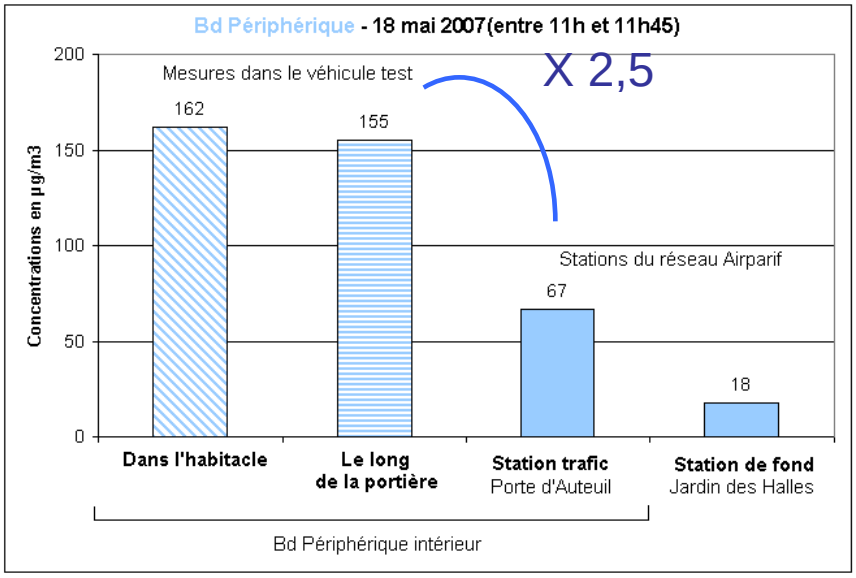
NO2 levels in real time

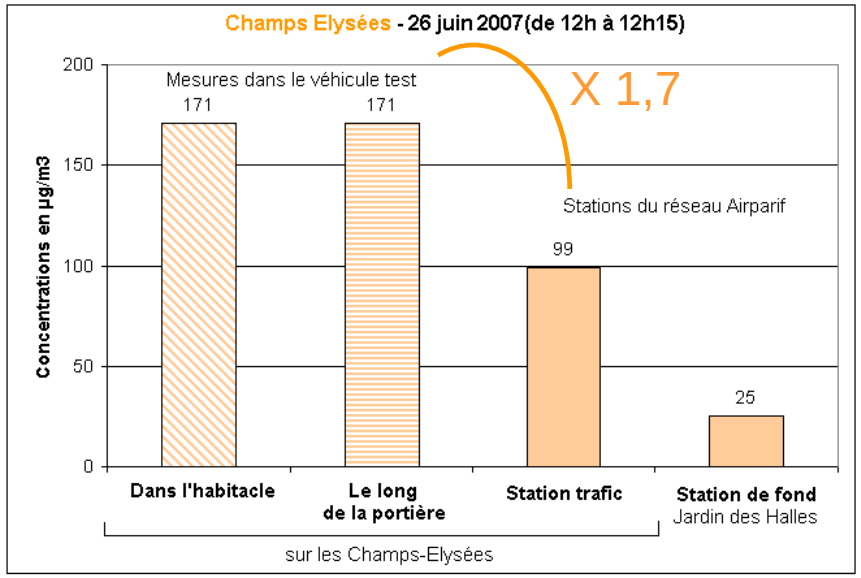


→ **The driver is more exposed than the pedestrian on the pavement**

Differences are more or less important, depending on:
road type, traffic and meteorological conditions

2 examples for a given day and hour



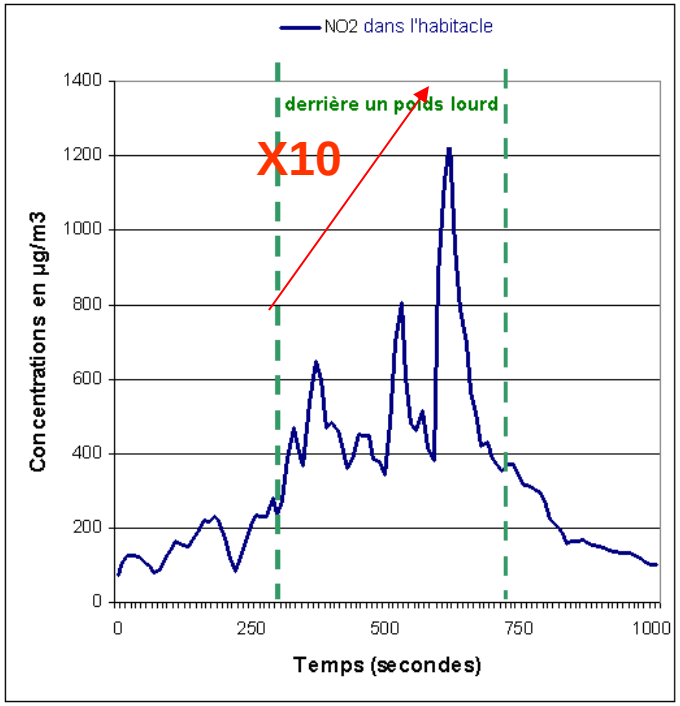


Comparison between average NO_2 concentrations in Airparifs vehicle vs monitoring stations

→ **Importance of the vehicle followed and the traffic conditions**

The surrounding vehicles and the traffic congestion have the greatest influence on the air quality in the passenger compartment

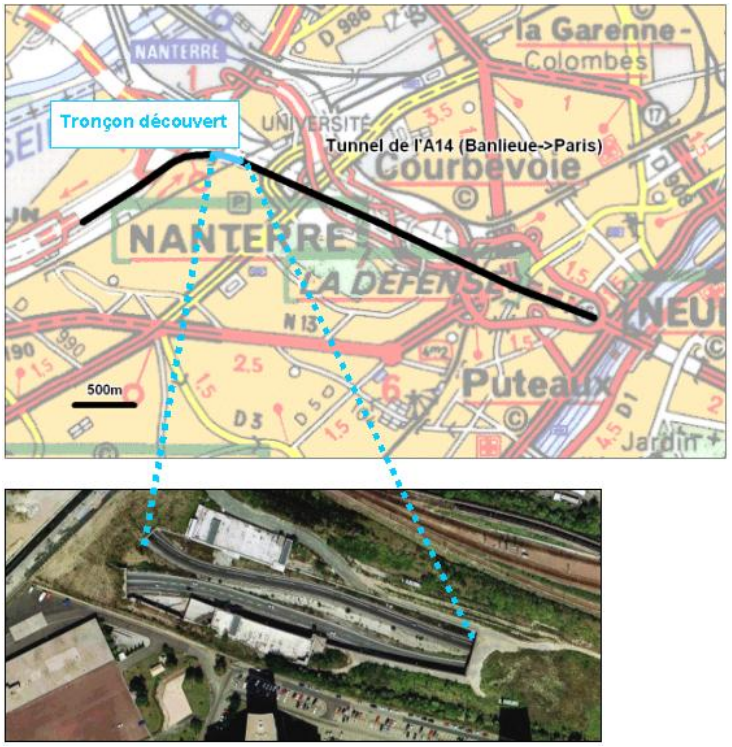
Ex: Parisian journey: the testing vehicle was briefly behind a lorry
(congested roads, average speed 3 km/h)
→ during a few secondes: NO_2 concentrations X10,
→ Decrease as soon as the lorry is overtaken.

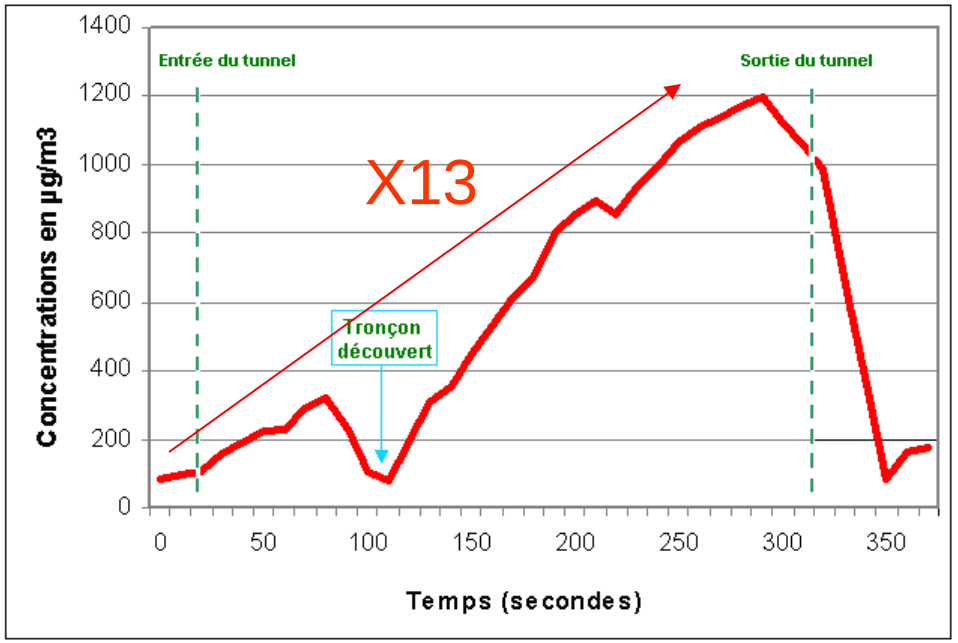


Ex: measurements on the Périphérique ring road
- A day with steadily flowing traffic :
  30 minutes (average speed 70 km/h)
  → [NO_2] average :151 µg/m³
- A day with more congested traffic :
  >1h30 (average speed 23 km/h).
  → [NO_2] average : 264 µg/m³

X1.8

→ The tunnel effect



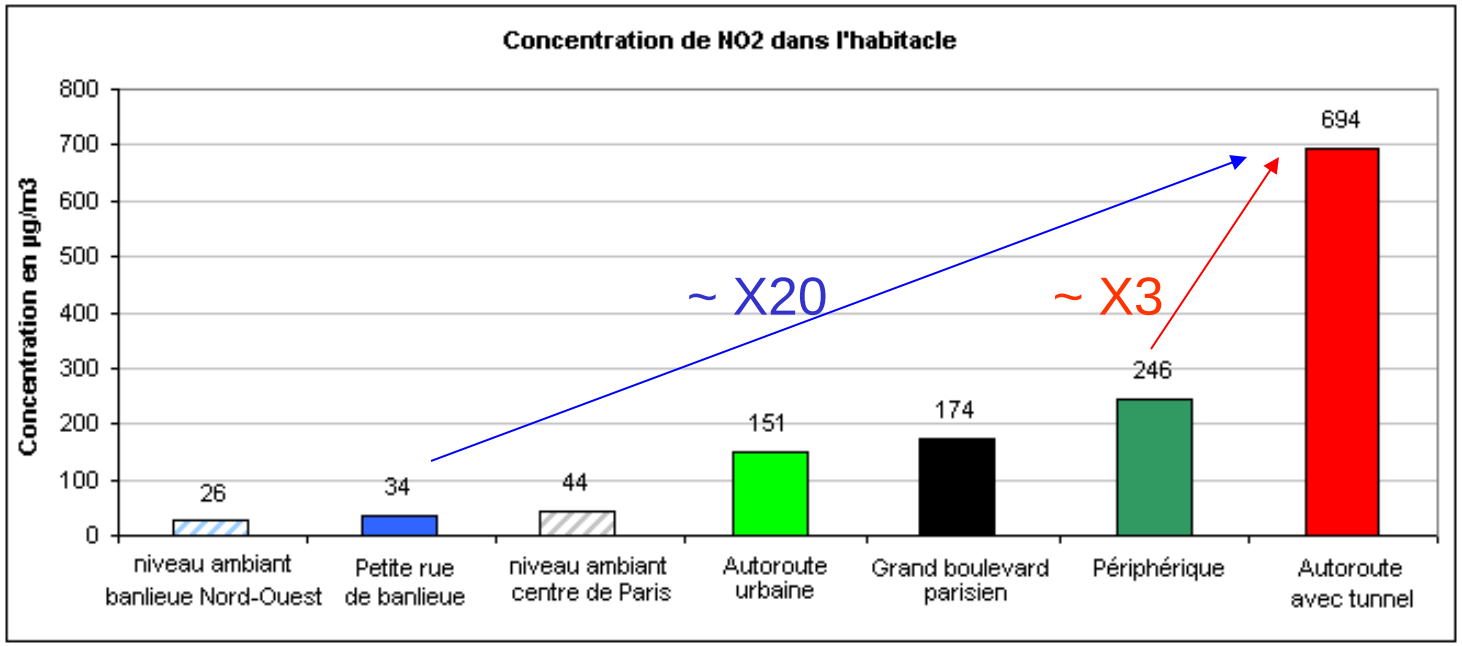


NO_2 concentrations in the A14 tunnel and without cover part 5 April 2007.

Each covered part:

- The concentrations increase progressively until a maximum
- maximum reached just before the exit or the portion without cover.
- for all studied cases: two-way or one-way roads

→ **Classification of different road types**
based on the drivers exposition



Results in the passenger compartment : journey between Ermont (Val d'Oise) and rue Crillon (Paris) – 3/07/07

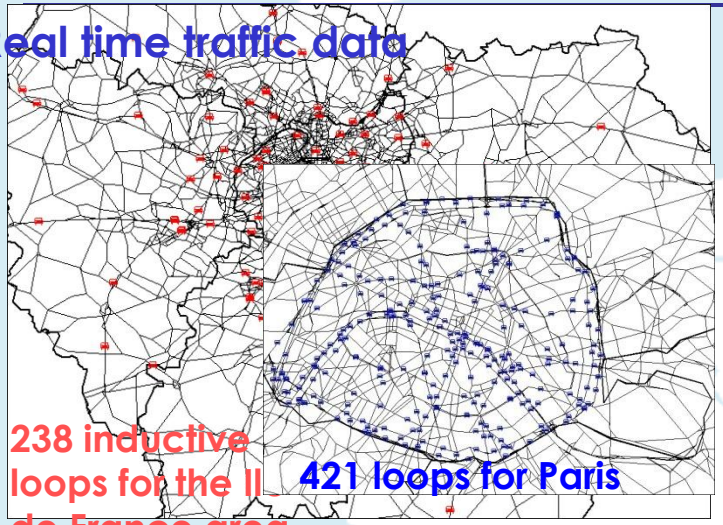
nb: results and especially their range depend a lots on meteorological and traffic conditions of a given day:

➲ Measurements was further developed:
- for other pollutants (benzene, particles)
- repetition of the journeys in order to be able to generalized the results

Modelling tools

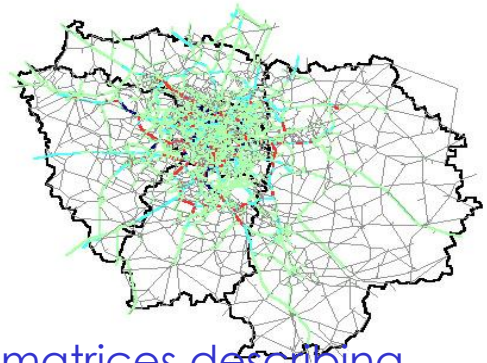
The traffic emissions in real time for the whole road network

Real time traffic data



238 inductive loops for the Ile de France area

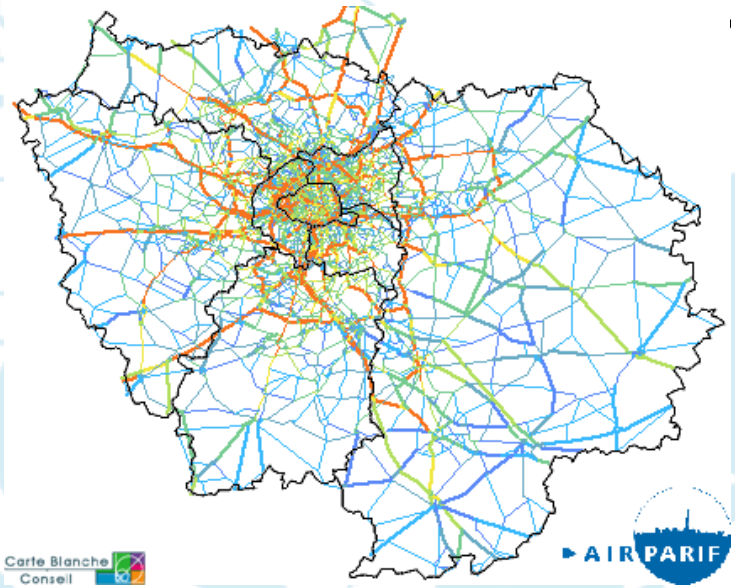
« Ad hoc » reference matrix



258 matrices describing typical hours and days

Trafic Model

Real time traffic for 20 000 km of network

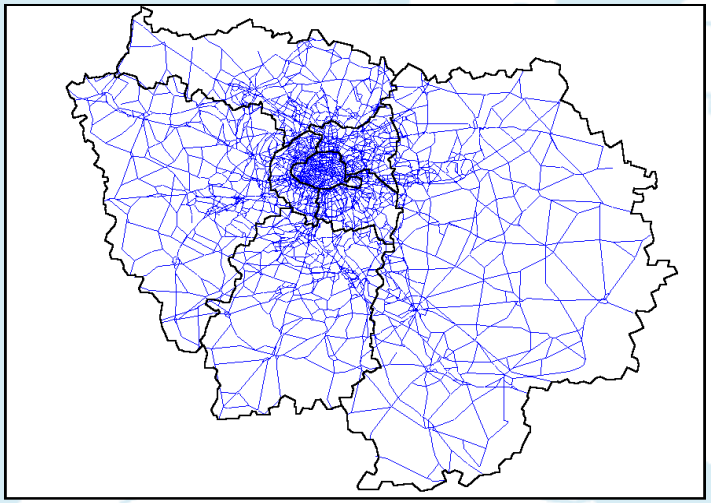


The traffic emissions in real time for the whole road network

HEAVEN

Emissions factors
Copert IV

Real time traffic

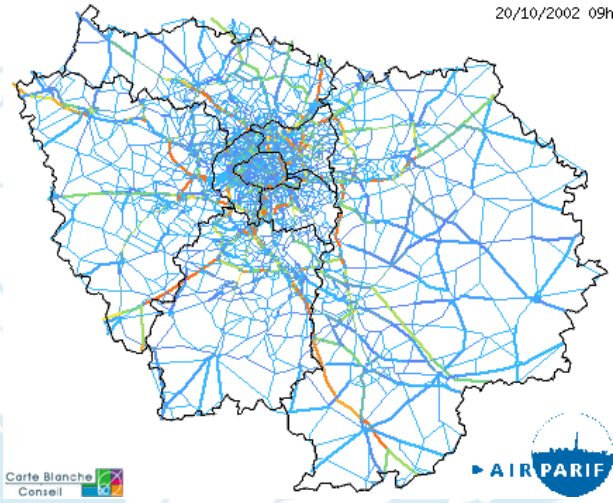


- number of vehicles
- average speed
- cold start %

Hourly description
for 39 000 links

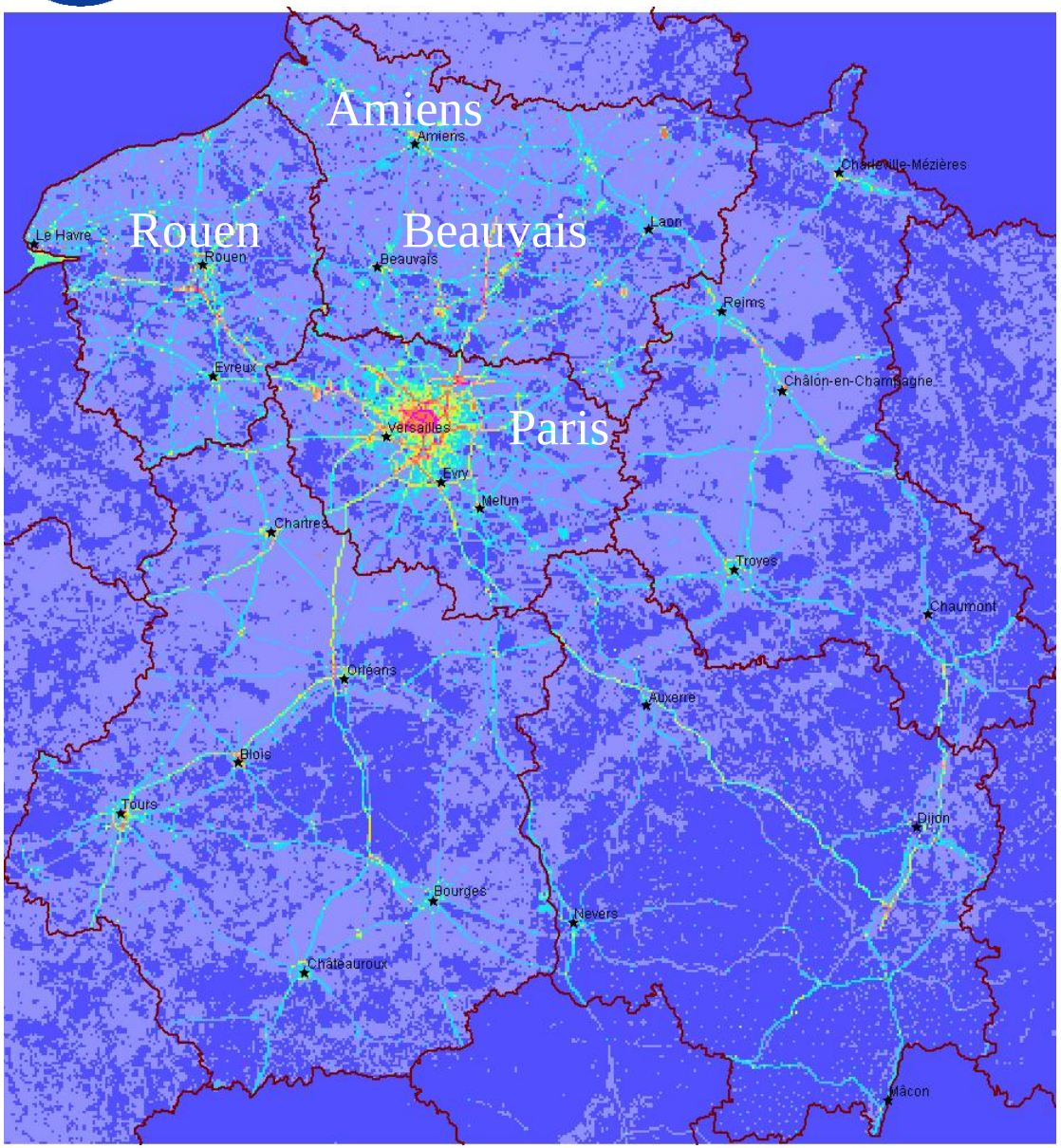
Running fleet based on local and national data (ADEME/IFSTTAR/Ville de Paris)

Traffic Emissions in real time



AIR PARIF

Urbanized areas and pollutant emissions (NOx) : inventory



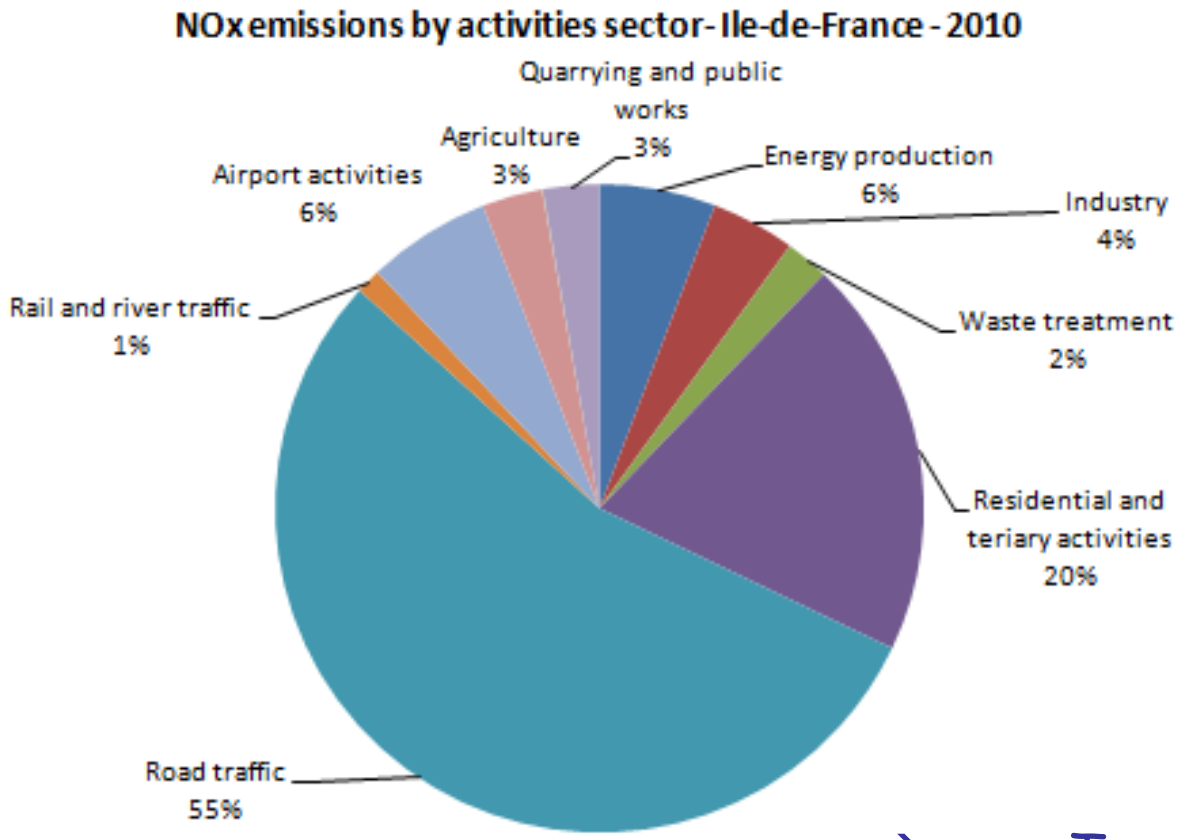
Listing pollutants and the responsible activities at every point of the region

High density of :

- urbanization
- roads

→ very high density in Paris and its agglomeration for all the pollutants

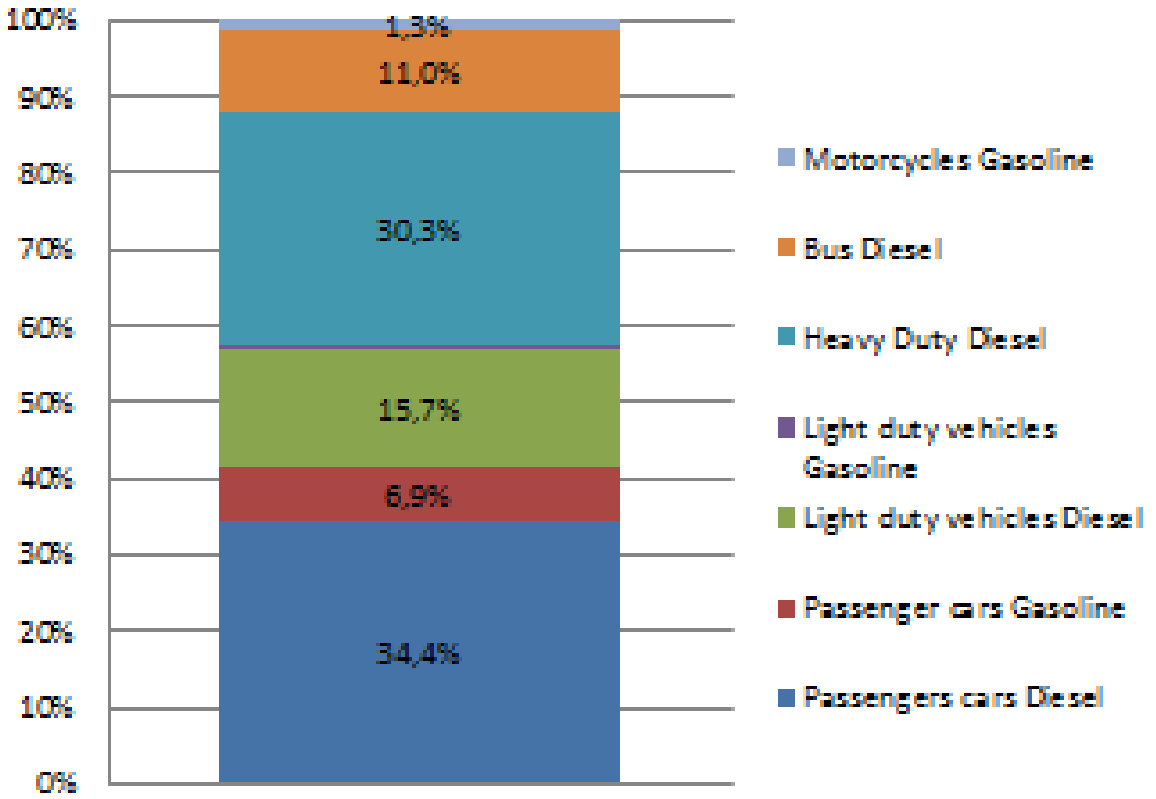
Budgets of regional emissions : annual NOx regional



→ **Transport**
a major source of pollutants

Source : 2010 AIRPARIF inventory

NOx Contributions of the different types of vehicles



Source : 2010 AIRPARIF inventory

Air Quality
Focus on key pollutants :

Particles (PM10 and PM2.5),
Nitrogen dioxyde)

2012 Air quality report

For 3 pollutants : Particles (PM10 and PM2.5), Nitrogen dioxyde (NO_2)

- Chronic pollution levels are preoccupying,
  in the agglomeration and along the traffic.
- Stable for few years
  with few variation from one year to another.
- Do not respect the standards, including the limit value
  contentious with European commission for the particles PM10 ,
  and probably coming for the NO2

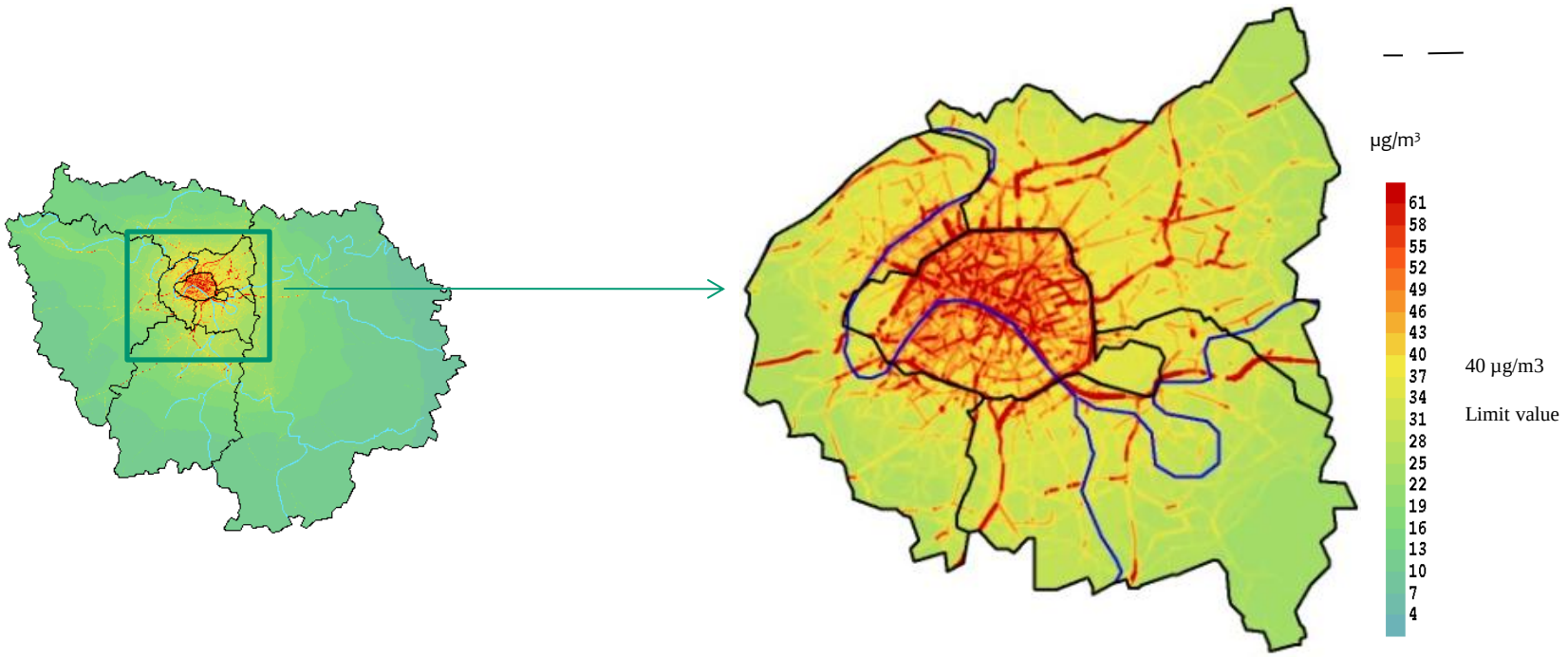
➢ Need for long term actions to impact the daily pollution

	Standards		Normes non contraignantes			
	Limit Value		Objectif de qualité		Valeur cible	
						
Particules PM10	Respectée	Exceeded	Respecté	Exceeded		
Particules PM2.5	Respectée	Exceeded	Exceeded	Exceeded	Respectée	Exceeded
Dioxyde d'azote NO_2	Exceeded	Exceeded	Exceeded	Exceeded		
Ozone O_3			Exceeded		Respectée	
Benzène	Respectée	Respectée	Respecté	Exceeded		

Key pollutants : Nitrogen dioxyde

3 million of citizens in 2012 (9 Parisians out of 10)

exposed to an air > quality standards 40µg/m3 annual mean(LV)



Exceedences mainly in highly populated areas

= **about 1/3 of the population** and 9/10 Parisians concerned

= **20% of the regional road network 200 km** and 90% of the roads of Paris

Focus on key pollutants: NO2

NO2 : a major issue and a difficult challenge to be faced

Background and traffic levels already exceed the regulation

Background : *improvements seem to have reached a stabilization*

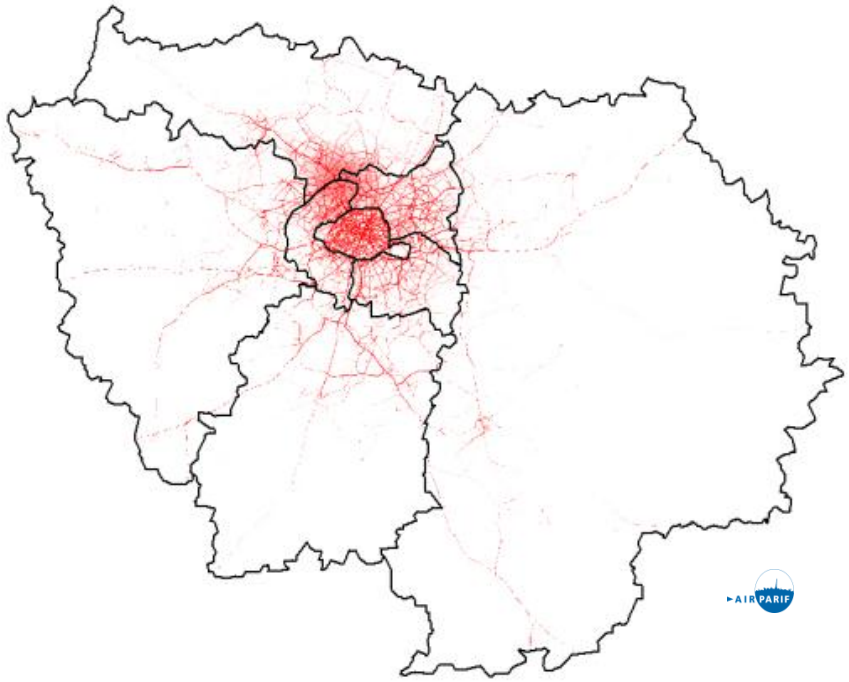
Traffic: *levels stable, or which even tend to increase, up to twice the Limit Value*

- Almost all the vehicles now equipped with cat converters
- NOx level reduced but still not enough to become a limiting factor in the NO2 chemical production given the increase in O3 levels increase
- Impact of the development of catalyzed particles filters for diesel engines: produce more primary NO2 emission

Key pollutants : Particles PM10

In 2012, 2.4 million of citizens exposed to air quality exciting the Limit Value (LV)

Exceedences mainly in highly populated areas



Ile-de-France région

1.4 à 4.2 millions of Franciliens concerned depending of the year.

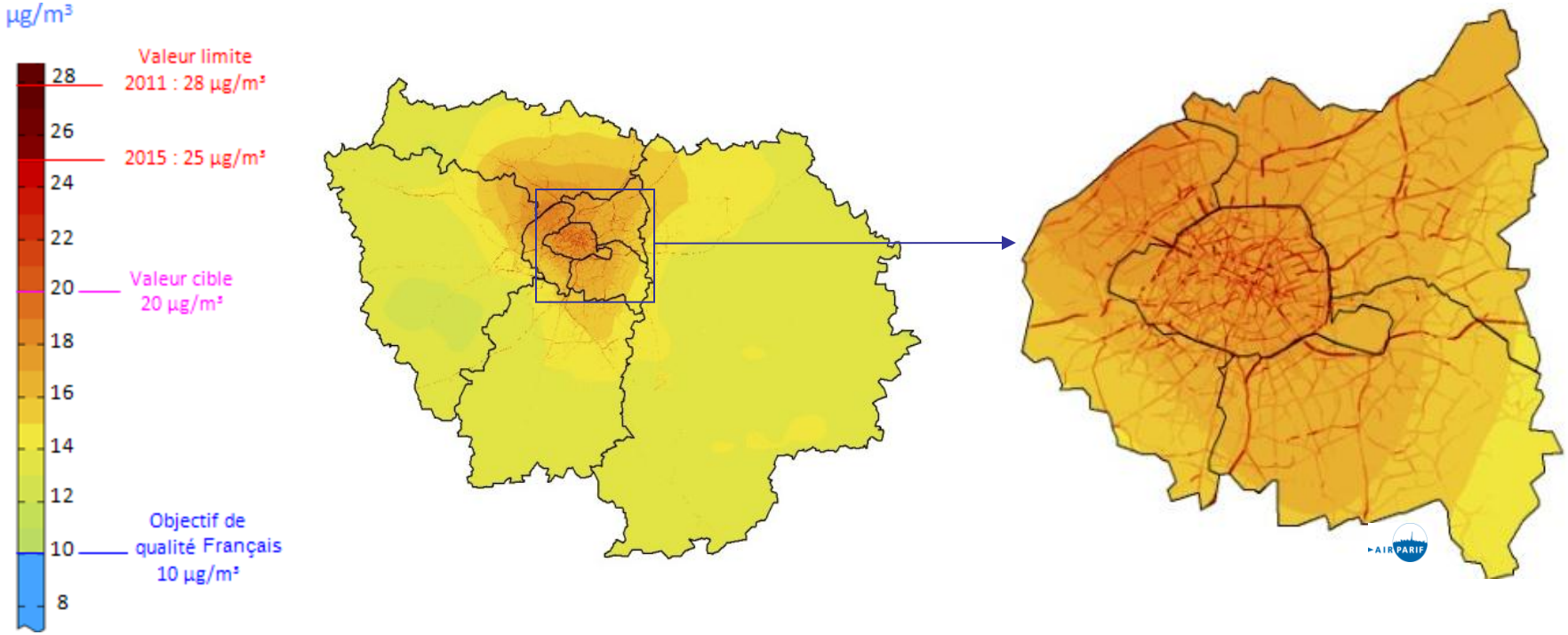
Essentially along the traffic and densely populated area

Exceedance area: 260 km² and 3520 km of road network (1/3 of Regional traffic network And half of the Paris network)

* more than 35 days of exeedance of 50µgm3

Particles PM2,5 : Stable levels

- European yearly Limit Value for 2012 (27 µg/m^3): respected far from traffic sources but exceeded along major traffic road (ex: Paris ring road and motorway A1)
- Exceedance of the French Quality objectives (Grenelle II + OMS, 10µg/m^3) : all the 11,7 millions Ile-de-France inhabitants are concerned

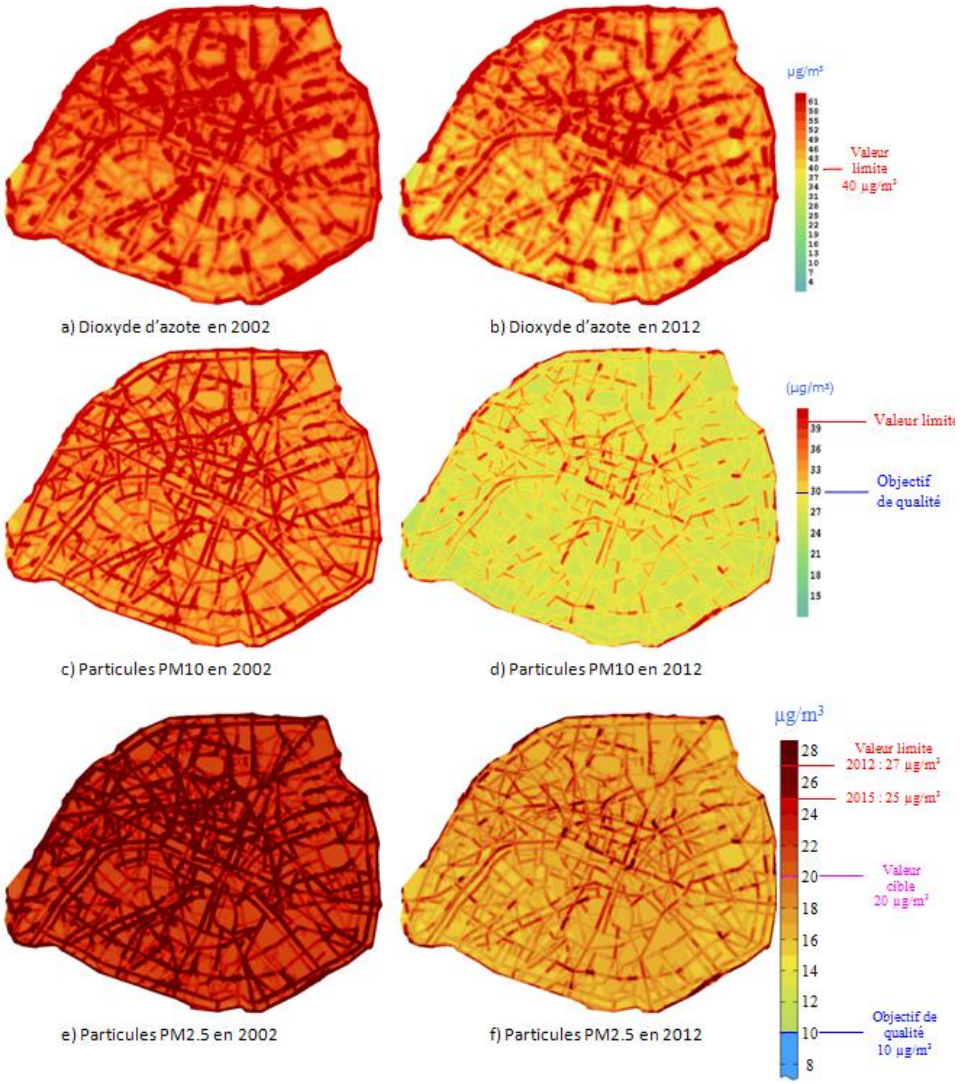


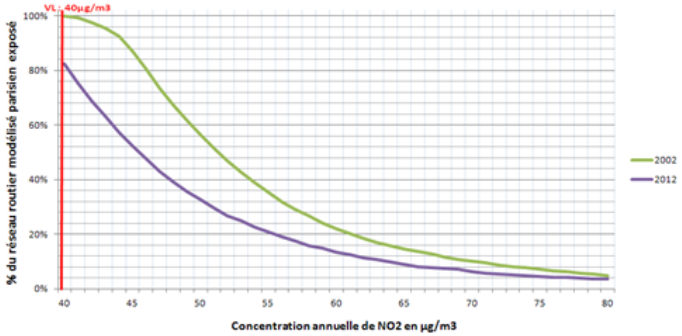
Air Quality trends :

Focus on Paris

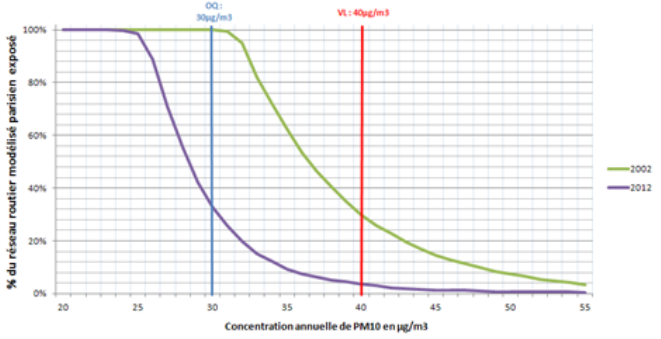
An evaluation of air quality from 2002 to 2012

Km of roads > thresholds

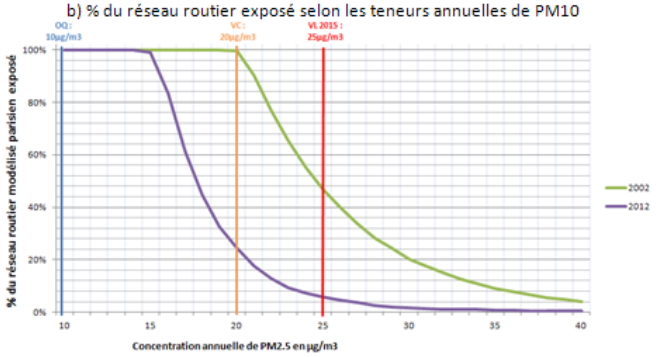




a) % du réseau routier exposé selon les teneurs annuelles de dioxyde d'azote



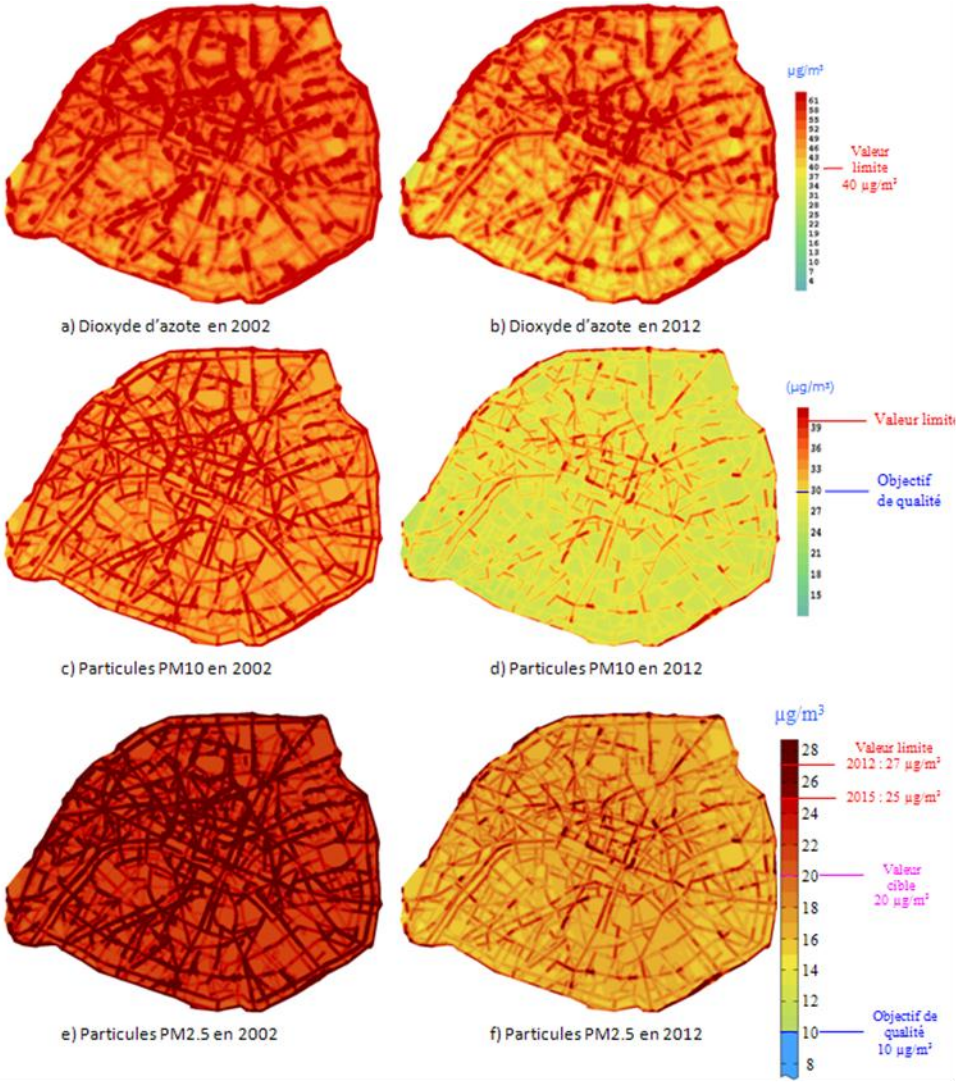
b) % du réseau routier exposé selon les teneurs annuelles de PM10



c) % du réseau routier exposé selon les teneurs annuelles de PM2.5

An evaluation of air quality from 2002 to 2012

Population > thresholds



a) Dioxyde d'azote en 2002

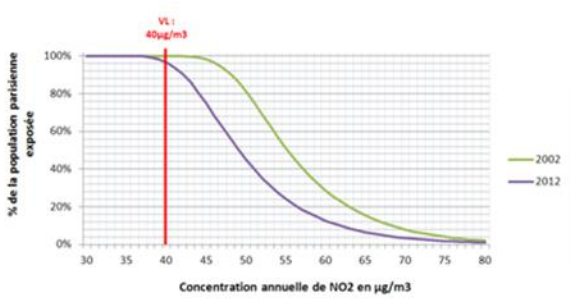
b) Dioxyde d'azote en 2012

c) Particules PM10 en 2002

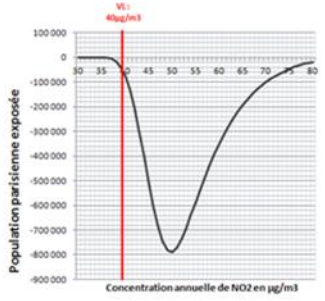
d) Particules PM10 en 2012

e) Particules PM2.5 en 2002

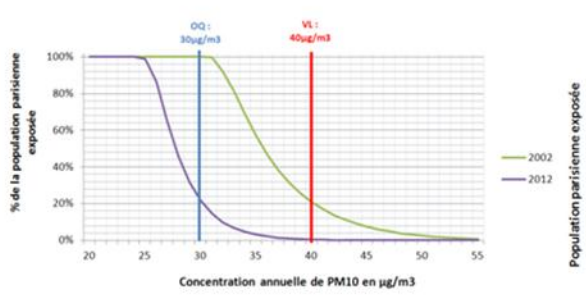
f) Particules PM2.5 en 2012



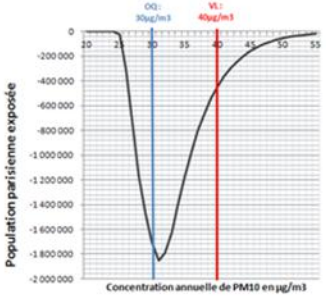
a) % de la pop. exposée selon les teneurs annuelles de NO_2



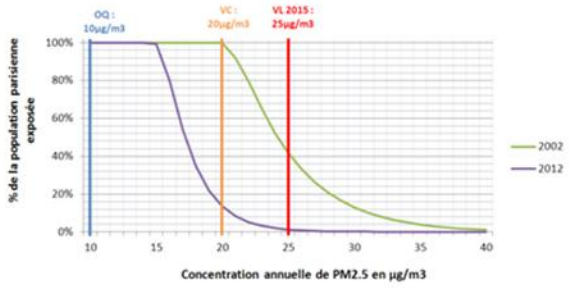
b) Différence du nombre d'habitants selon les teneurs annuelles de NO_2.



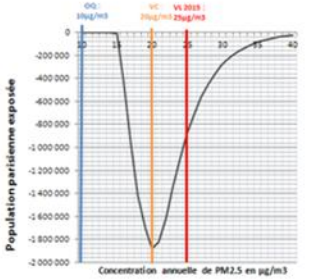
c) % de la pop. exposée selon les teneurs annuelles de PM10



d) Différence du nombre d'habitants selon les teneurs annuelles de PM10.



e) % de la pop. exposée selon les teneurs annuelles de PM2.5



f) Différence du nombre d'habitants selon les teneurs annuelles de PM2.5.

An evaluation of air quality from 2002 to 2012

→ A decrease of background level of pollution (decrease of global emission of pollutant at the regional scale)

→ A lower impact of road traffic (decrease of emissions)

BUT not for NO_2 on major roads:

At the roadside level :

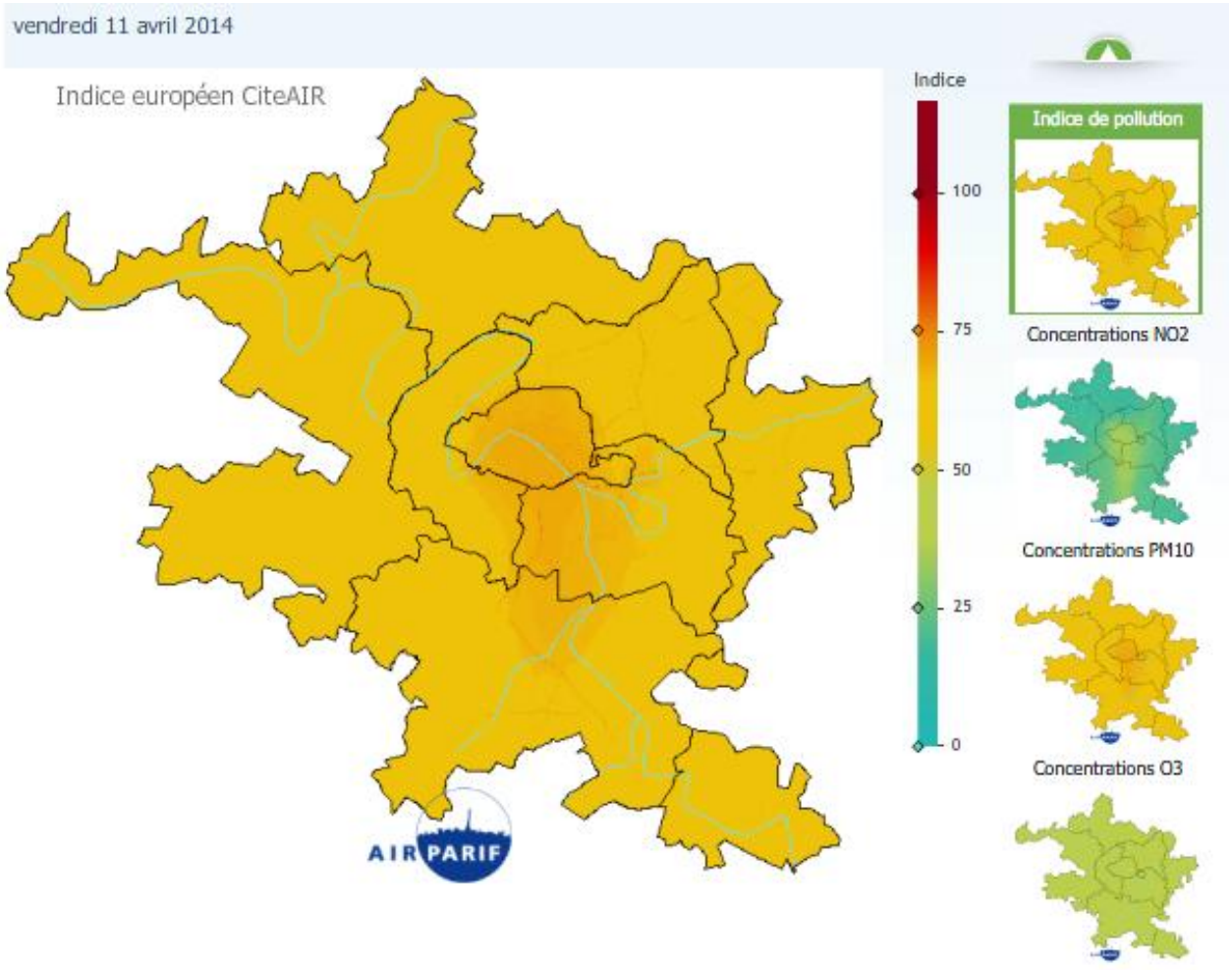
decrease of exhausted NOx mitigated by increase of NO_2/NOx

Impacts of transport on Air Quality :

Some specific areas (and methods)

Roadside + background Air Quality : daily mean

http://www.airparif.asso.fr/indices/proxfond



Roadside + background Air Quality : daily mean

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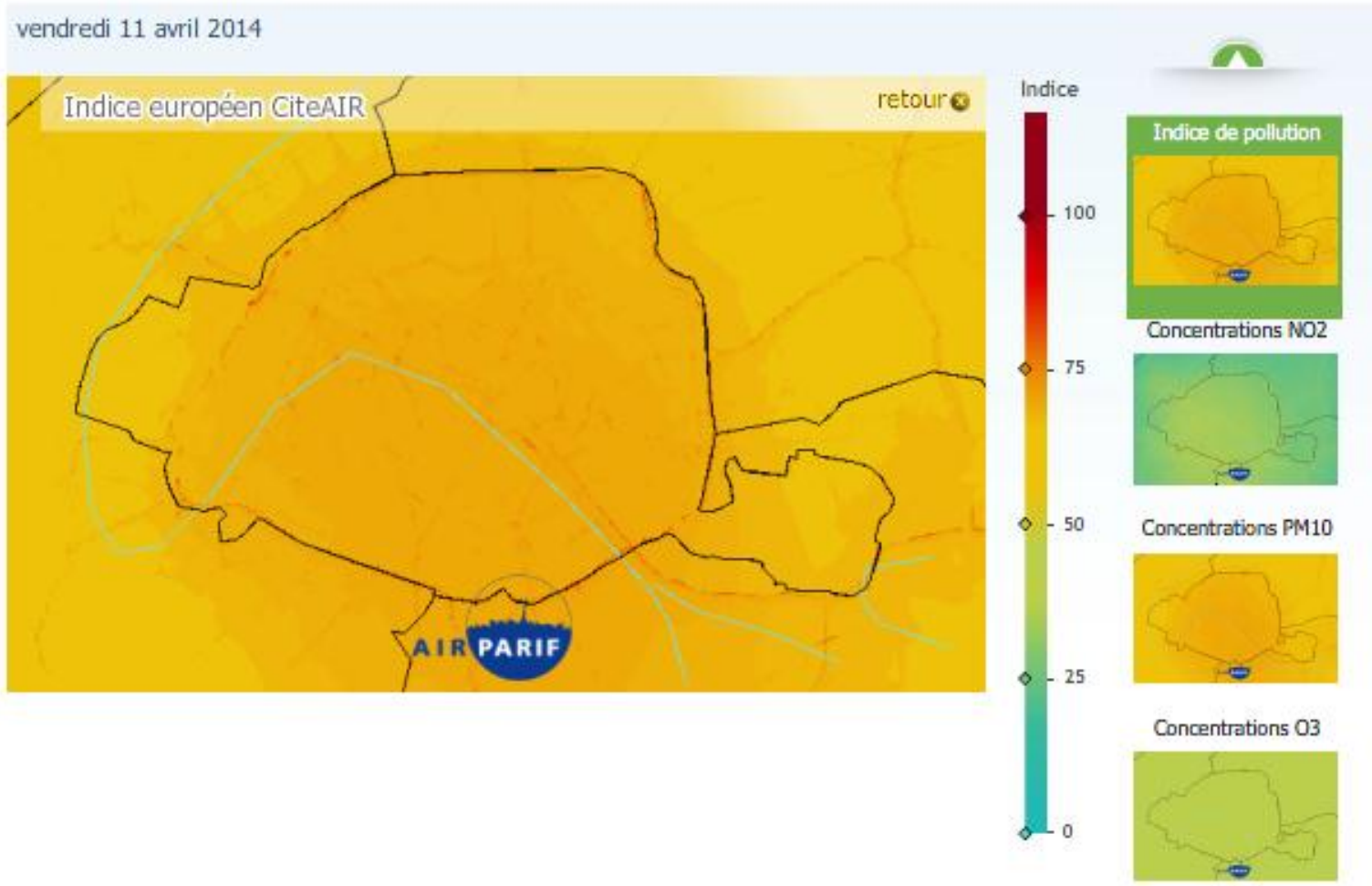


AIRPORT LOCAL AIR QUALITY

- **Airport facilities**:
  Data from ADP and DGAC
  APU, GPU, park stations, power plant

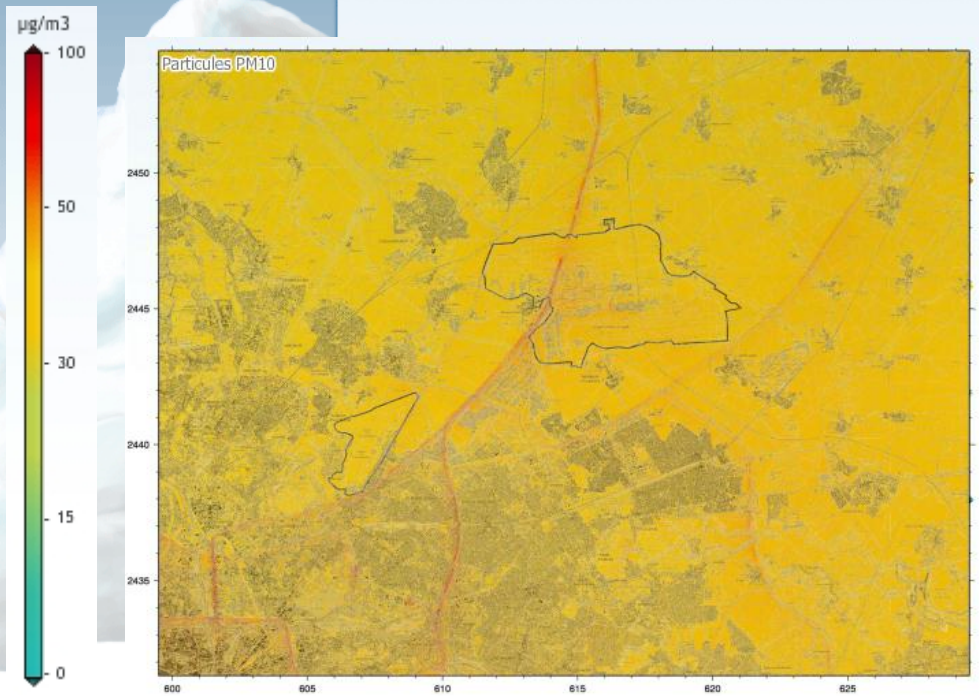
- **Air trafic**:
  Data from DGAC for the day before
  (hourly volume, type of aircraft, runway used)

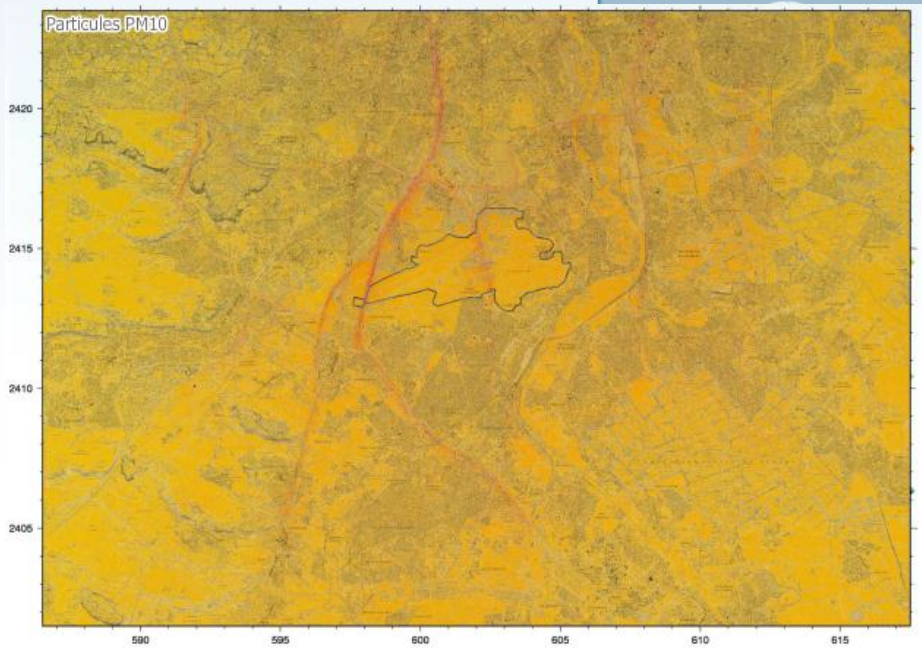
- **Road trafic** :
  Data from Heaven (DIRIF)

+ ADP data on the platform

-> as input on trafic model

PM10 : daily concentration 11 avril 2014

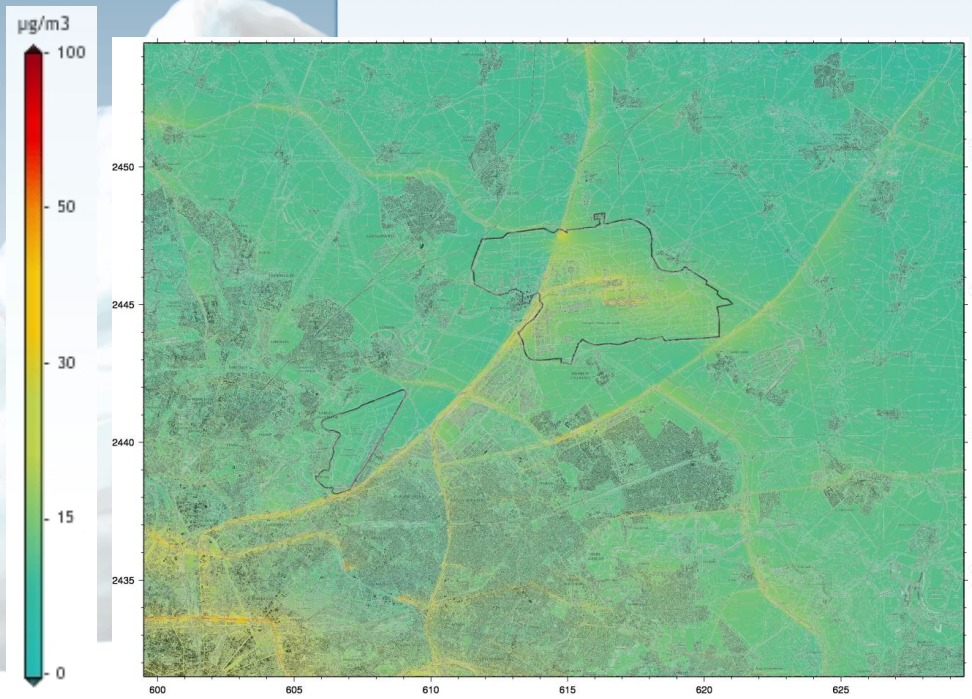


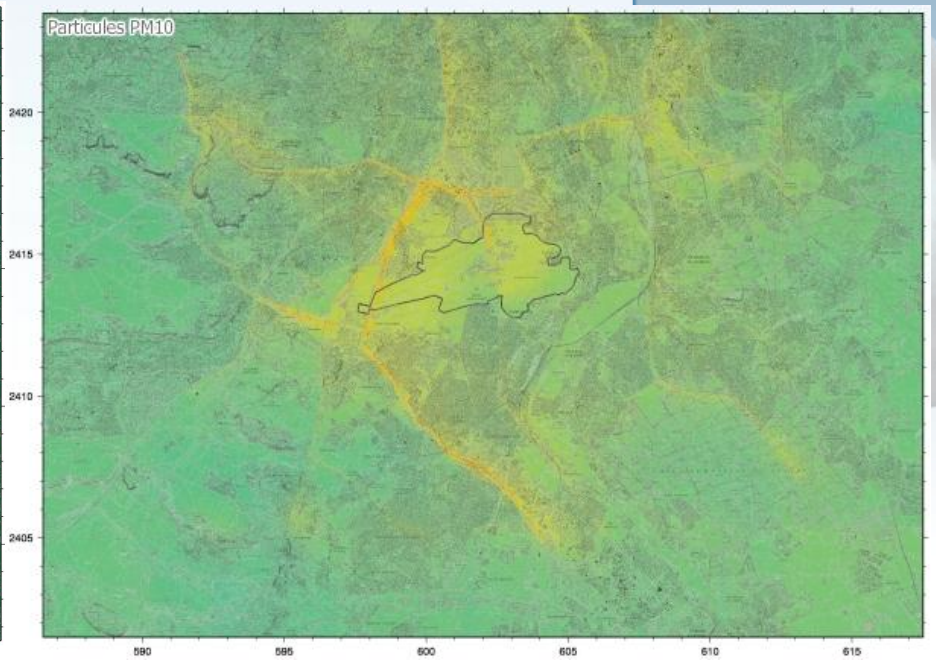


Domaine Roissy Le Bourget

Domaine Orly

PM10 : daily concentration 05 janvier 2013

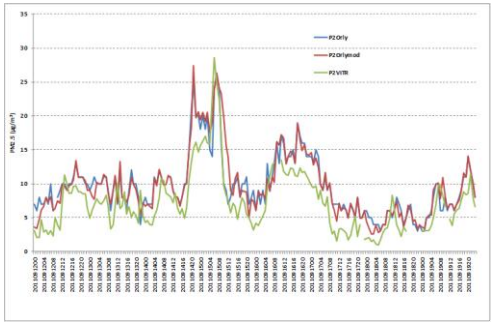


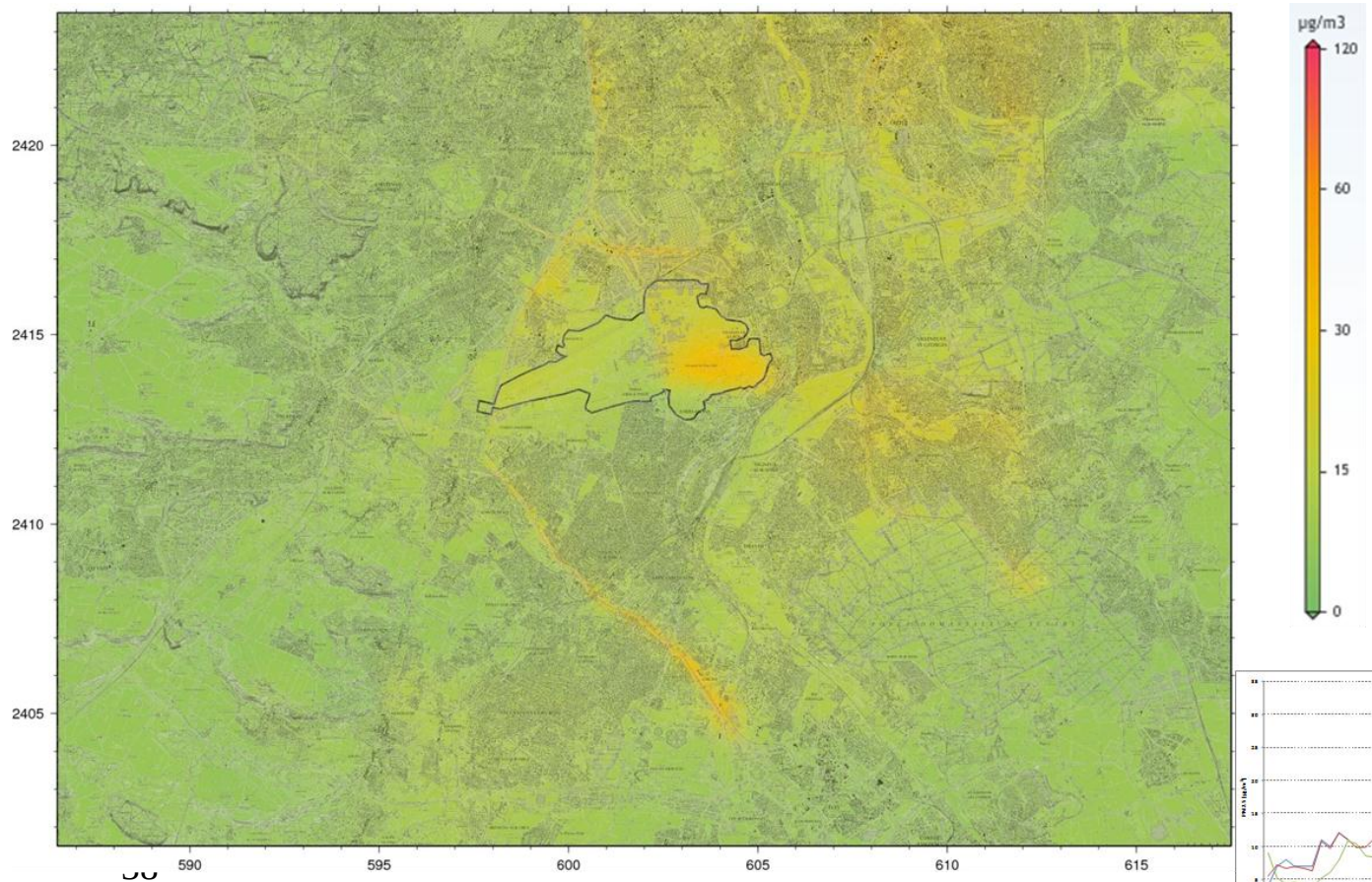


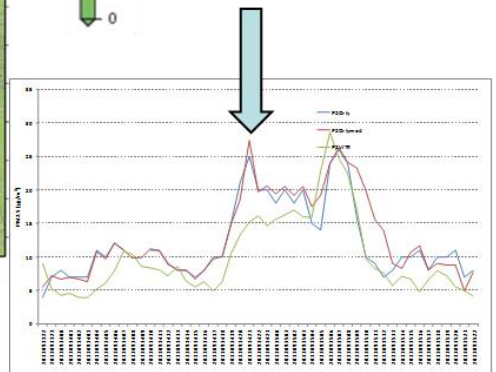
Domaine Roissy Le Bourget

Domaine Orly

Survol : validation







PM2.5 14/09/2011 24h

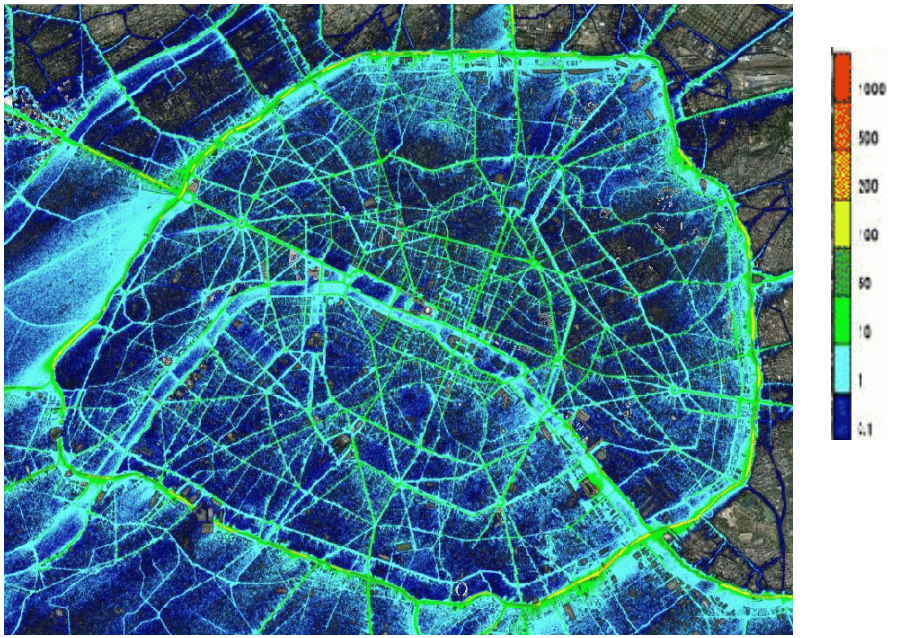
AIRCITY

The Aircity project

A very high resolution 3D atmospheric dispersion modeling system for Paris city ☺

25 mars 2013

PM10 25 mars 2013 8-9h (avec fond)



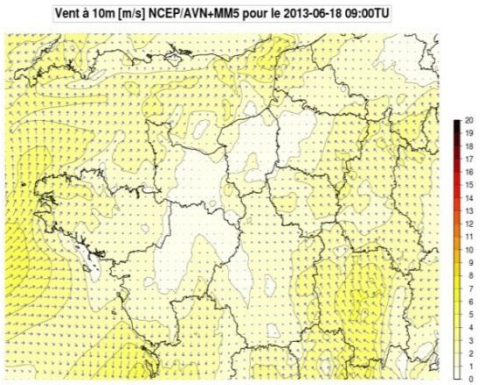
NOx 11-12 h (avec fond)

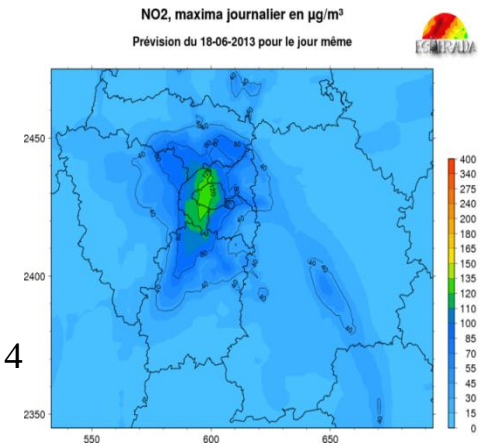
The Aircity Platform

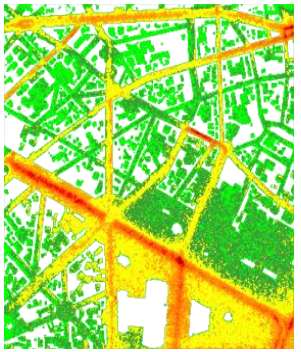
Meteorology and background

Traffic emission

Air Quality



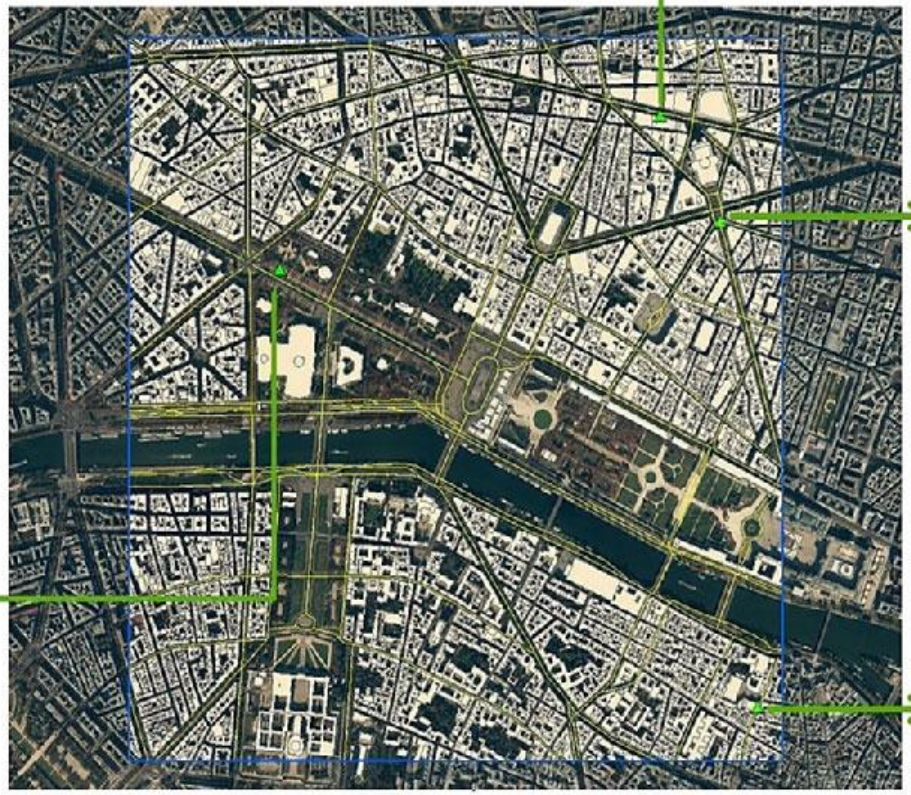




Aircity : validation

Station trafic
Boulevard Haussmann

Station trafic
Place de l'Opéra

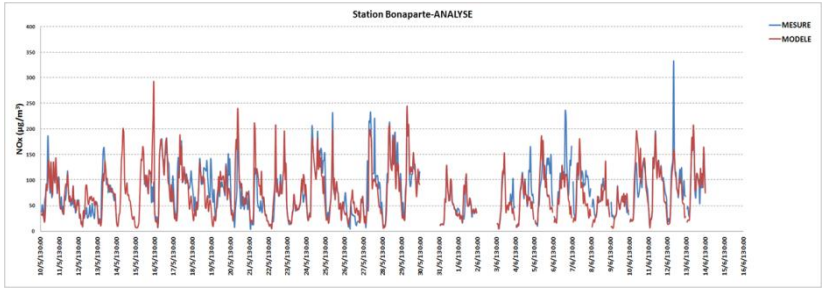


Station trafic
Avenue des Champs Elysées

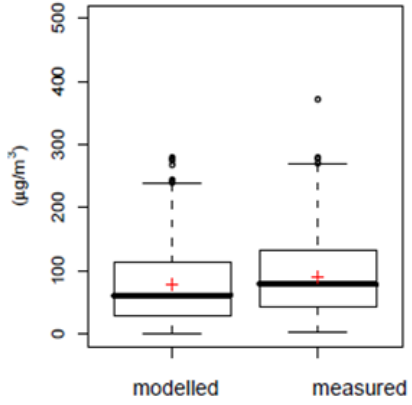
Station trafic
Rue Bonaparte

Les stations d'Airparif situées dans l'hypercentre de Paris, le long du trafic, ont permis de valider les résultats des calculs.

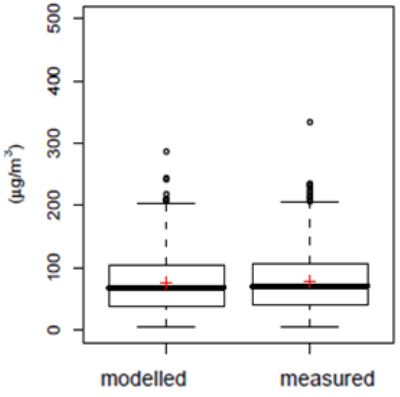
Aircity : NOx validation



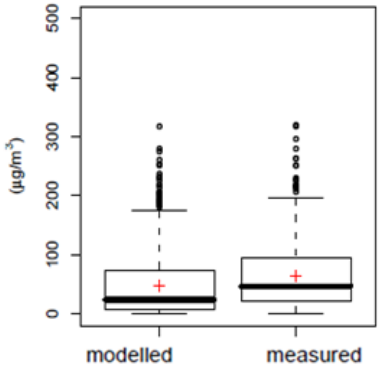
Comparison to measurements from May to June 2013



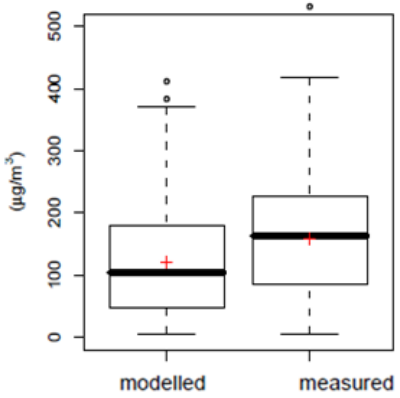
Av. Champs-Elysées



Rue Bonaparte



Bd. Haussmann



Place de l'Opéra

NOx boxplot metrics:

modelled (left) and measured (right)

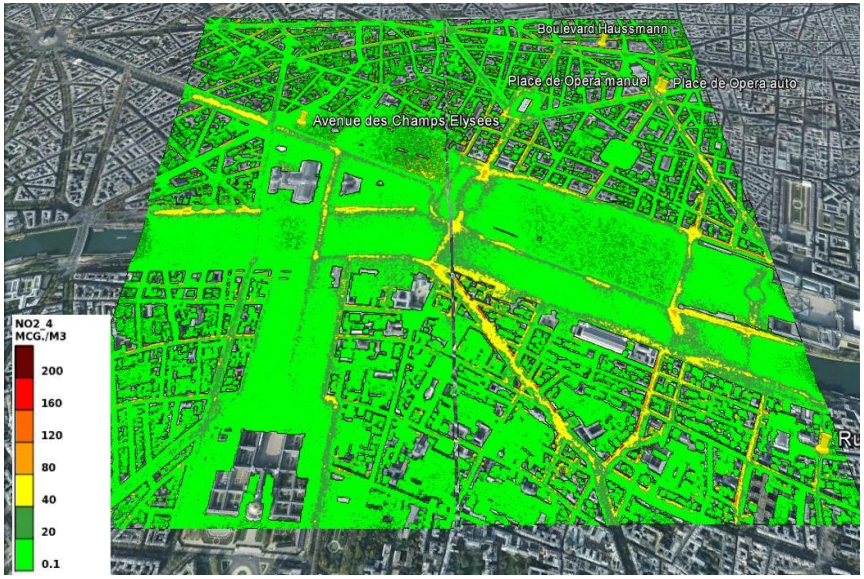
for 4 monitoring stations(mean: red cross, median:bold line)

Aircity : some outputs

07 h

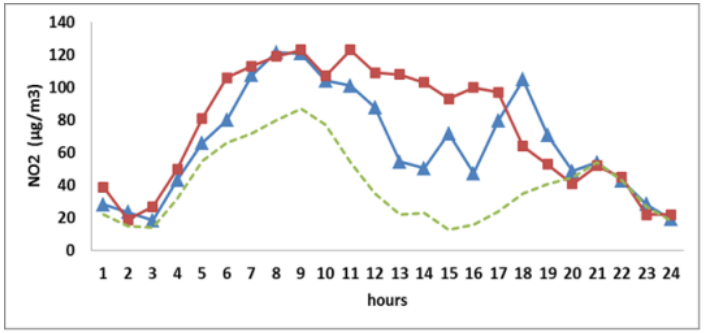
12 h

16 h

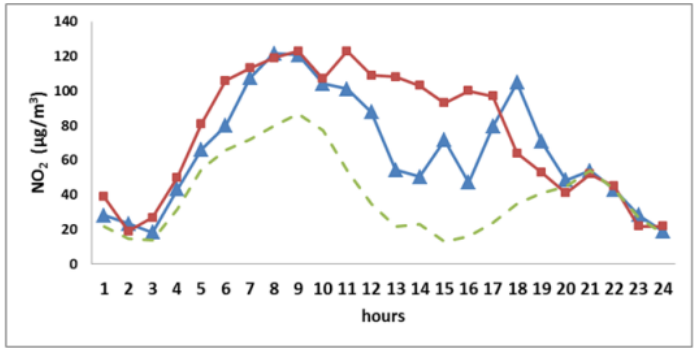


20 h

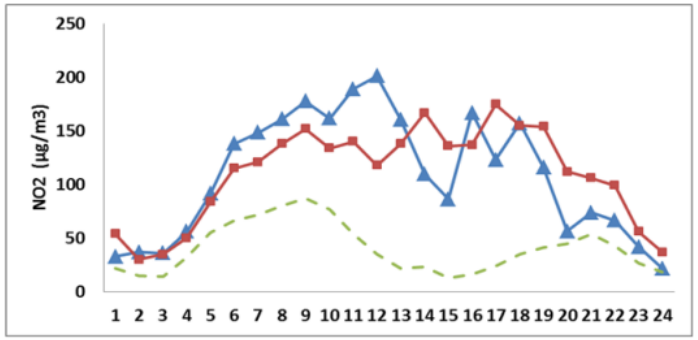
Aircity : NO_2 a first assessment



Av. Champs-Elysées



Bd. Haussmann



Place de l'opéra

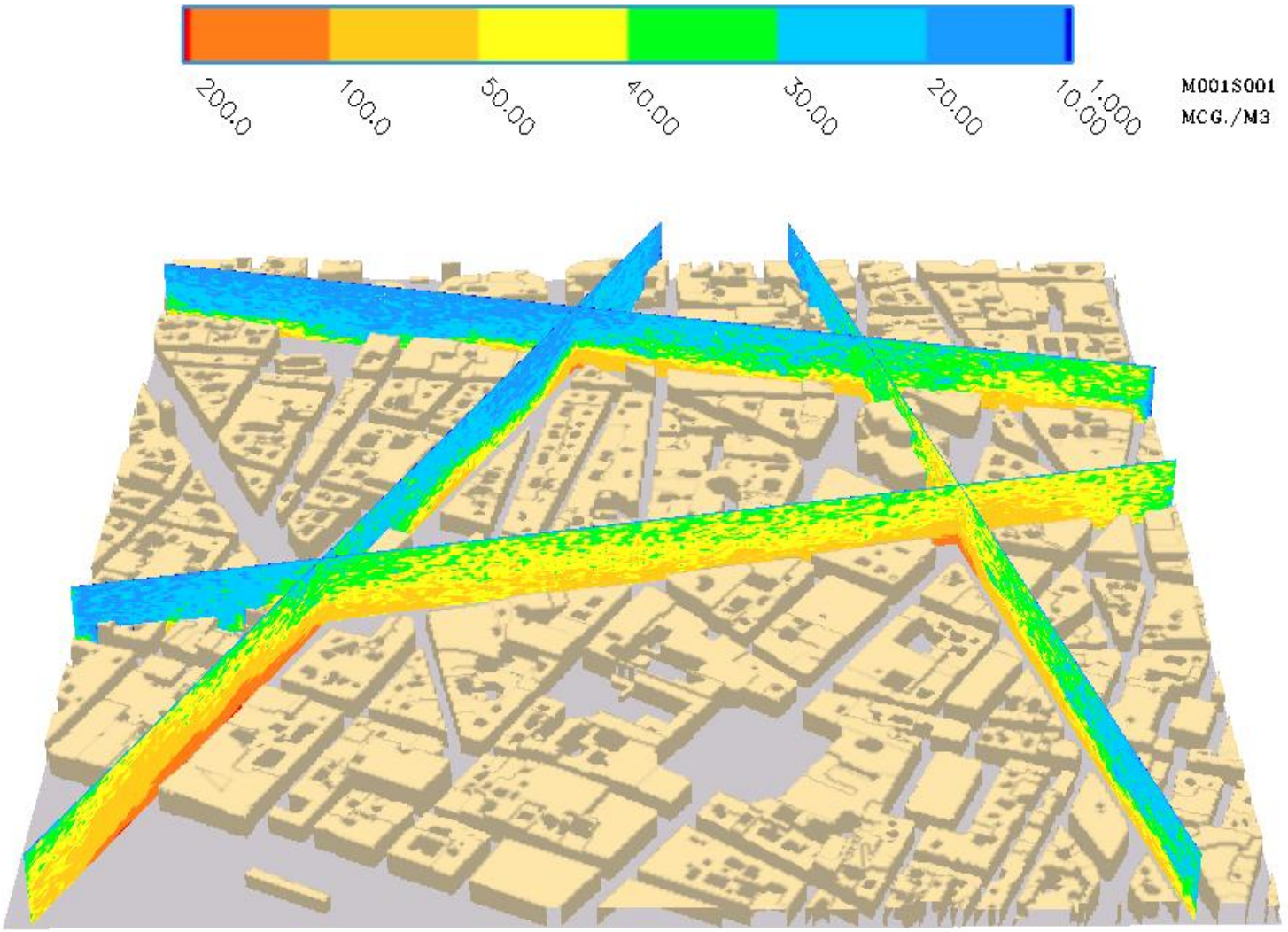
On this a typical day (18 June 2013),

the model was able to reproduce a strong local impact measured by AIRPARIF stations.

Results are very promising and need to be confirmed on a longer time period.

A 3D model : a way to assess the vertical variability of pollutants

NOx



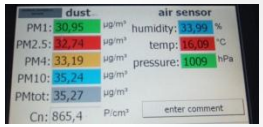
Impacts of transport on Air Quality :

a permanently subject of progress

TRAFIPOLLU

Sustainable city : impacts of trafic pollutants on air, water and ground

A research project (March 2013 to August 2016)

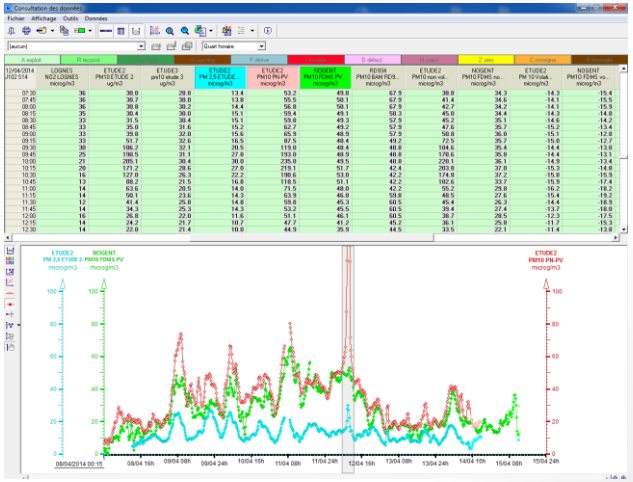


Measurements : NOx/NO2,PM2.5, PM10, Black-carbon,

Particle number/size distribution

PAH (e.g. Benzo(a)pyrène), Metals

Modelisation : from road/district to large area



TRAFIPOLLU

Thank you
for your attention

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