NO_X and NO_2

in Paris region

London Air Quality Network Seminar

King's College – 1st July 2011

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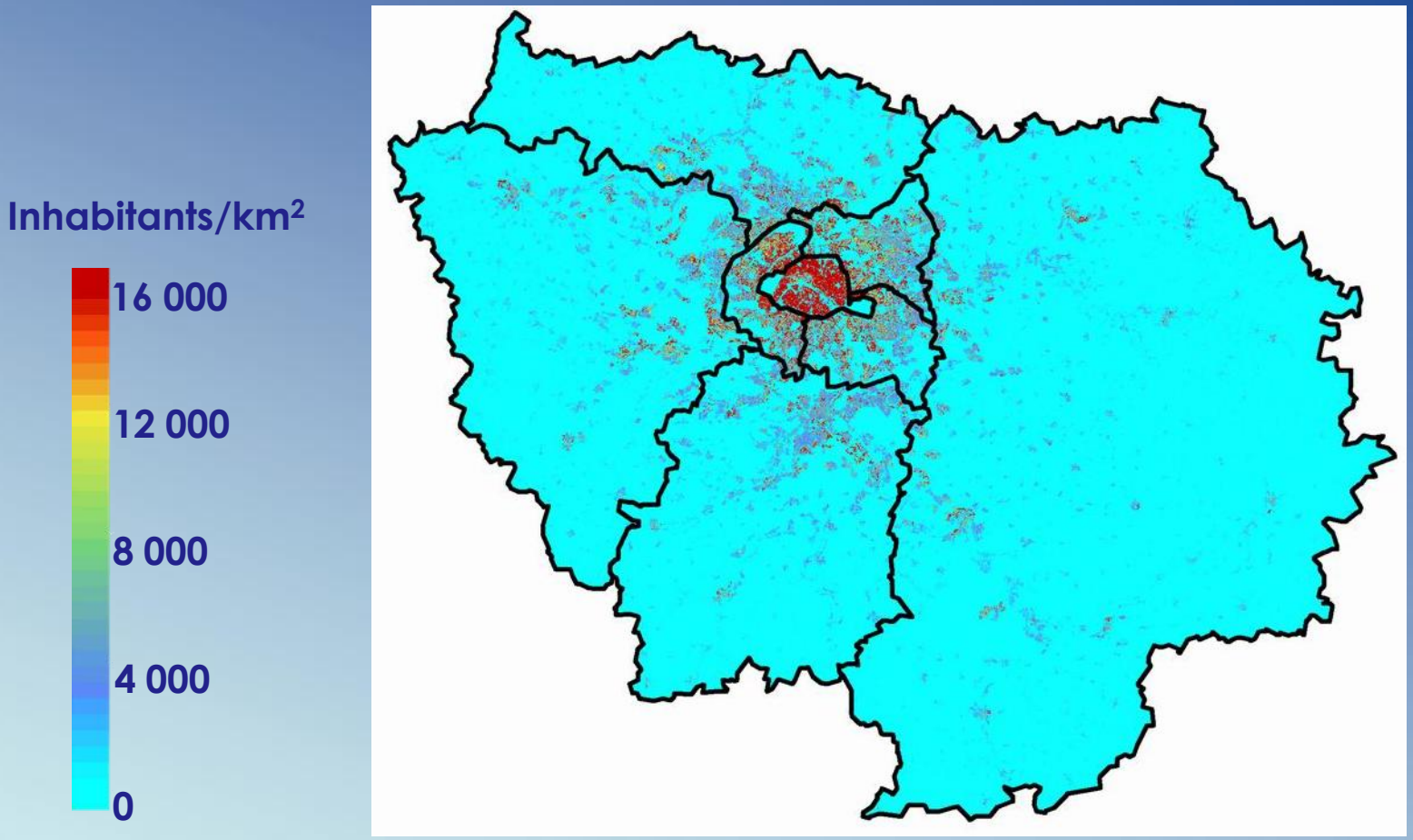
NO_2 : one of the main air quality concern in Paris region

Like most countries and main agglomerations in Europe, Paris region has 3 main air quality problems : PM10-PM2.5, O_3 and NO_2.

Paris agglomeration is one of the 20 zones exceeding a limit value for PM10 in France and one of the few zones exceeding the annual limit value for NO_2

Paris agglomeration distinctiveness

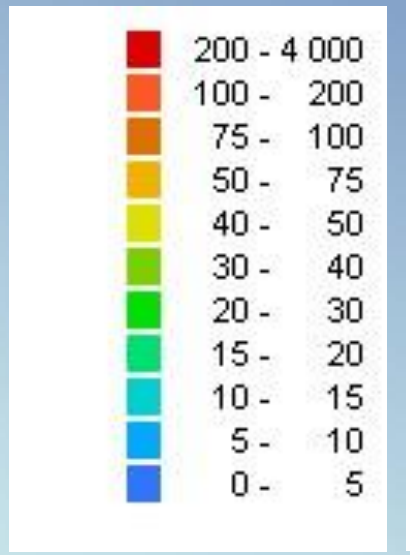
High population density in the centre of the agglomeration, particularly in Paris town : up to 20000 inhabitants/km²

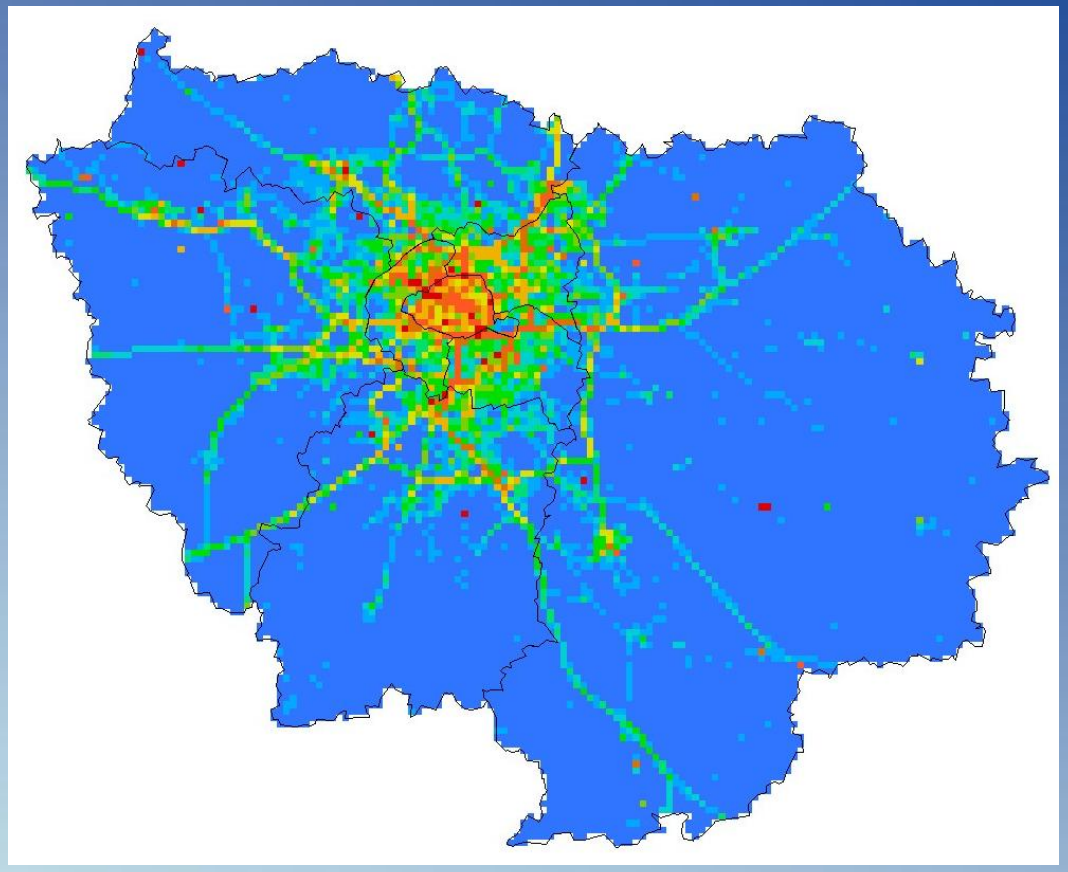


Paris agglomeration distinctiveness

Due to population density, NO_x emissions are important in the centre of agglomeration and along main roads

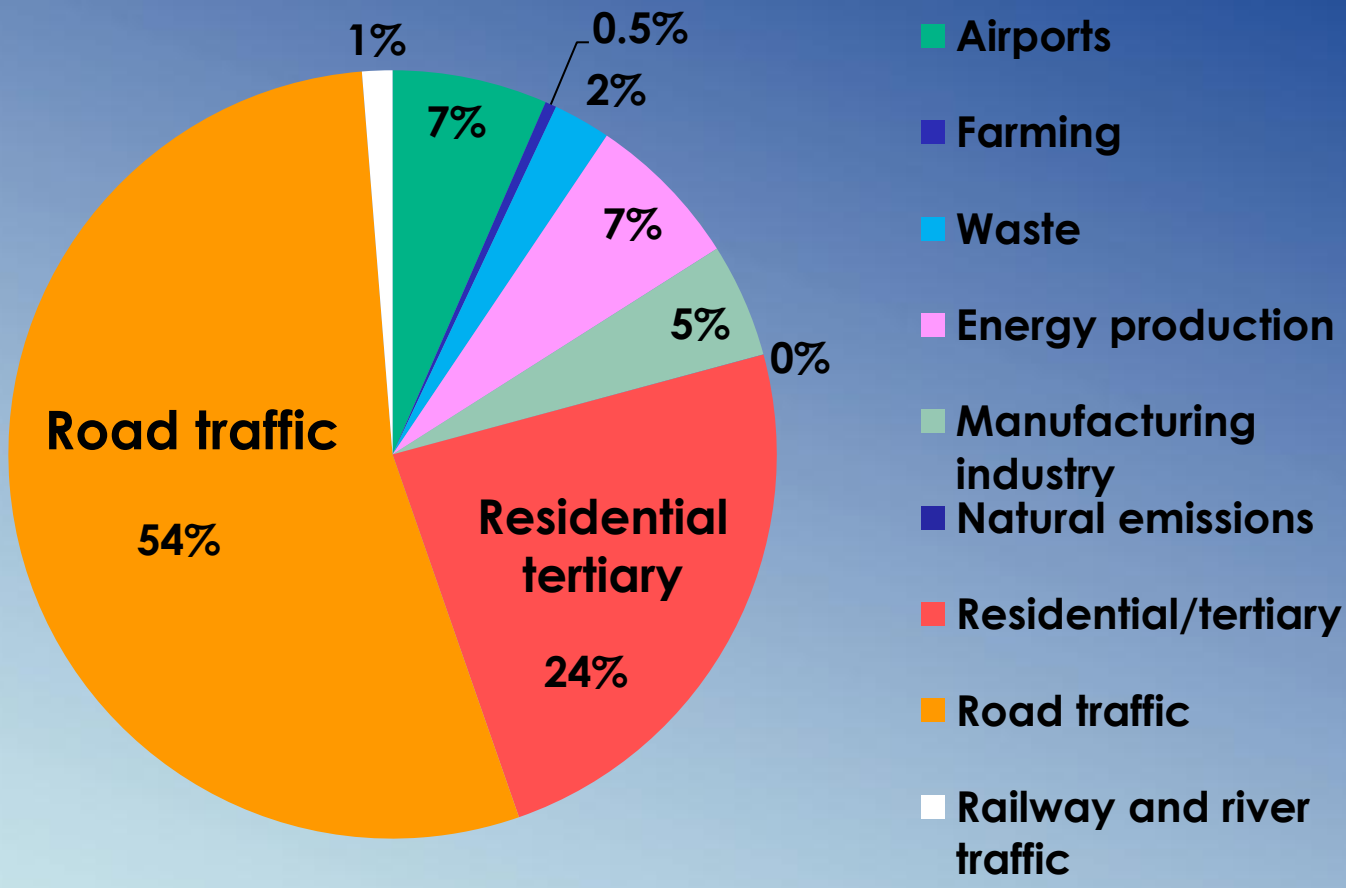
NOx tons/km^2
Year 2007





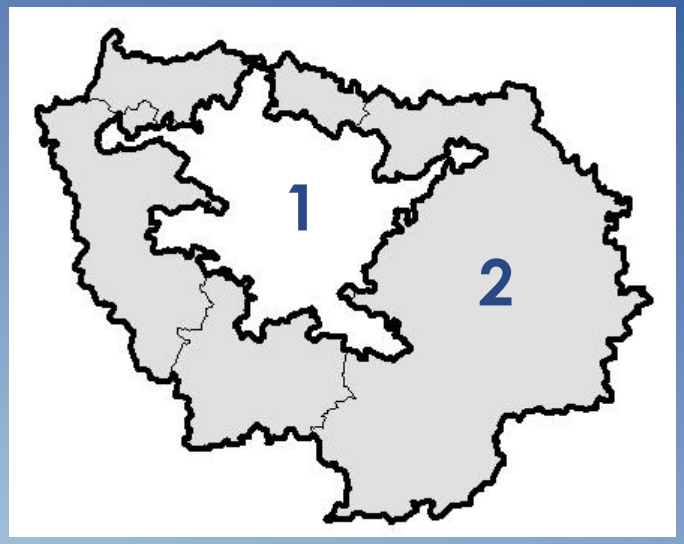
Paris agglomeration distinctiveness

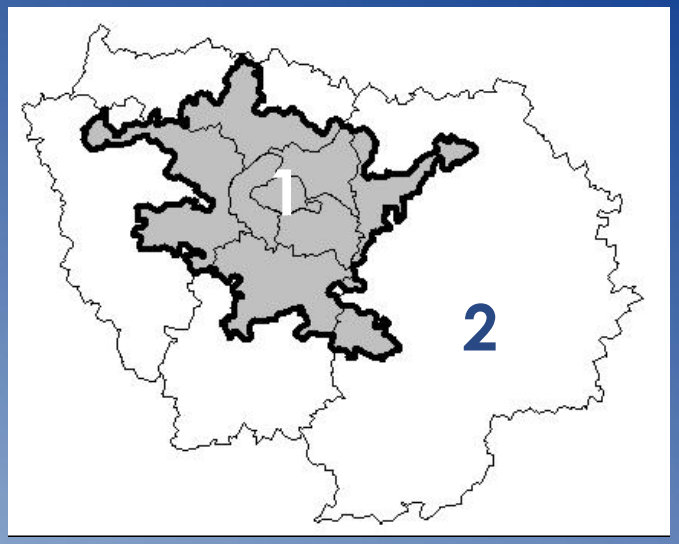
NO_x emissions are mainly from road traffic (54 %) and residential/tertiary (24 %)



2 UE zones in Paris region

1- Paris agglomeration : 2853 km^2, 10.3 millions inhabitants





2- Outside the agglomeration : rural & low density urban areas
9160 km^2, 1.3 million inhabitants

NO_2 problems are observed in the central portion of Paris agglomeration, both at background and near traffic situations

NO_x-NO_2 network

42 automatic monitoring sites : fixed measurements

- 32 background sites (30 urban, 2 rural),
- 10 road traffic sites

14 passive samplers sites : indicative measurements

- 14 weeks / year randomly determined
- 7 weeks during winter period, 7 weeks during summer period
- hot spots near road traffic
- annual means are estimated

Intensive campaigns with passive samplers : 2000, 2010

centre of agglomeration, background and influenced sites

NO_x-NO_2 network

Background sites

Criteria from French classification : distance required from road traffic depending on Annual Daily Traffic Average (ADTA)

ADTA vehicles/day	Minimal distance meters
< 1000	--
1000-3000	10
3000-6000	20
6000-15000	30
15000-40000	40
40000-70000	100
> 70000	200

NO_x-NO_2 network

Road traffic sites

Immediate vicinity of traffic
Sampling distance from road lane : from 1 to 2 meters

Sampling height : from 1.6 to 3 meters

Daily traffic : from 14.000 to 230.000 vehicles/day

Various types :
square, open avenue, canyon, canyon street, motorway…

NO_x-NO_2 network

Examples of monitoring sites near road traffic

NO_x-NO_2 trends and concentrations in Paris

First automatic measures : 80's
But low quality data and only a few sites

Trends start during 90's, both for background and traffic

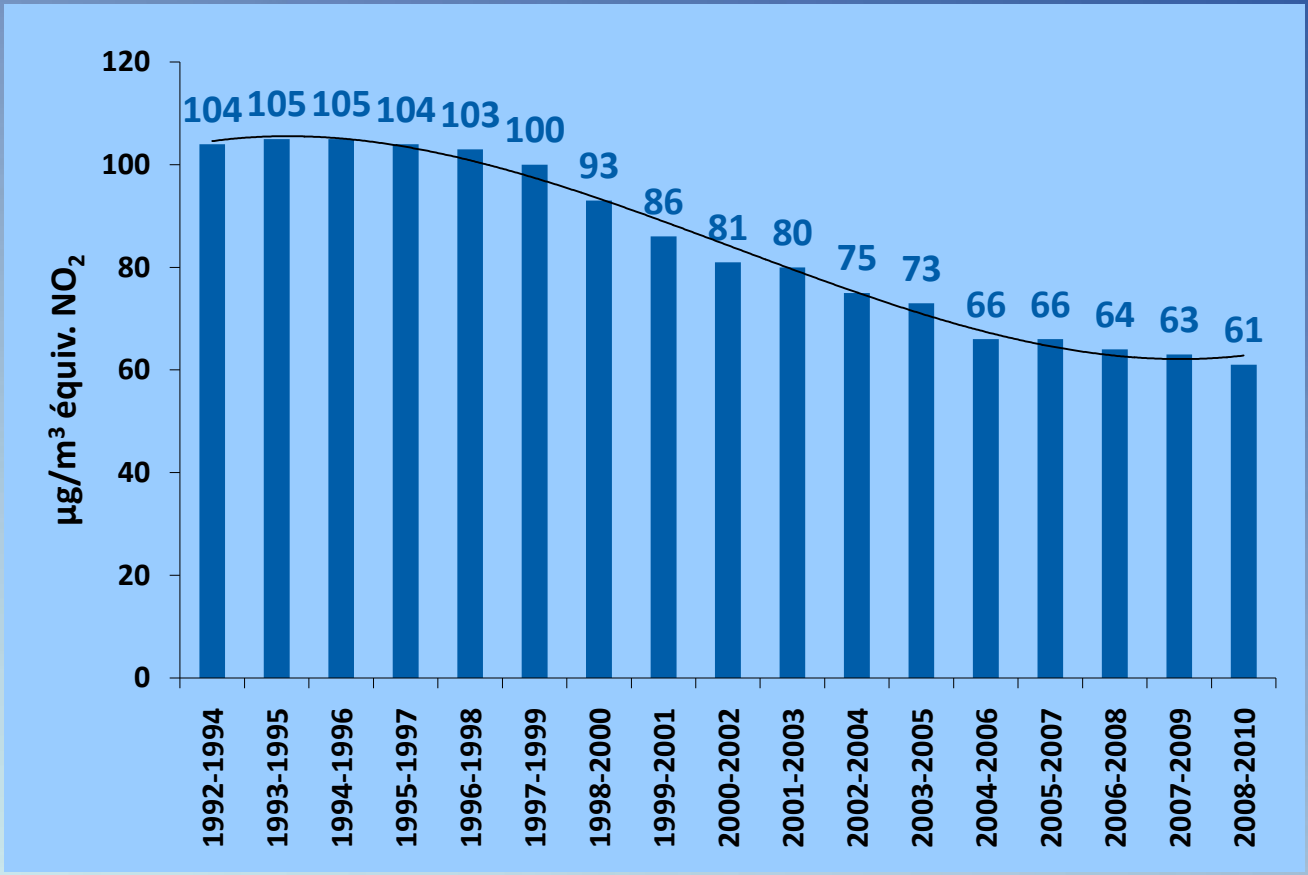
Trends

3 years rolling mean to diminish the impact of meteorological variation from year to year

Same sample of sites for all the period pictured
Background : 6 sites
Traffic : 5 sites

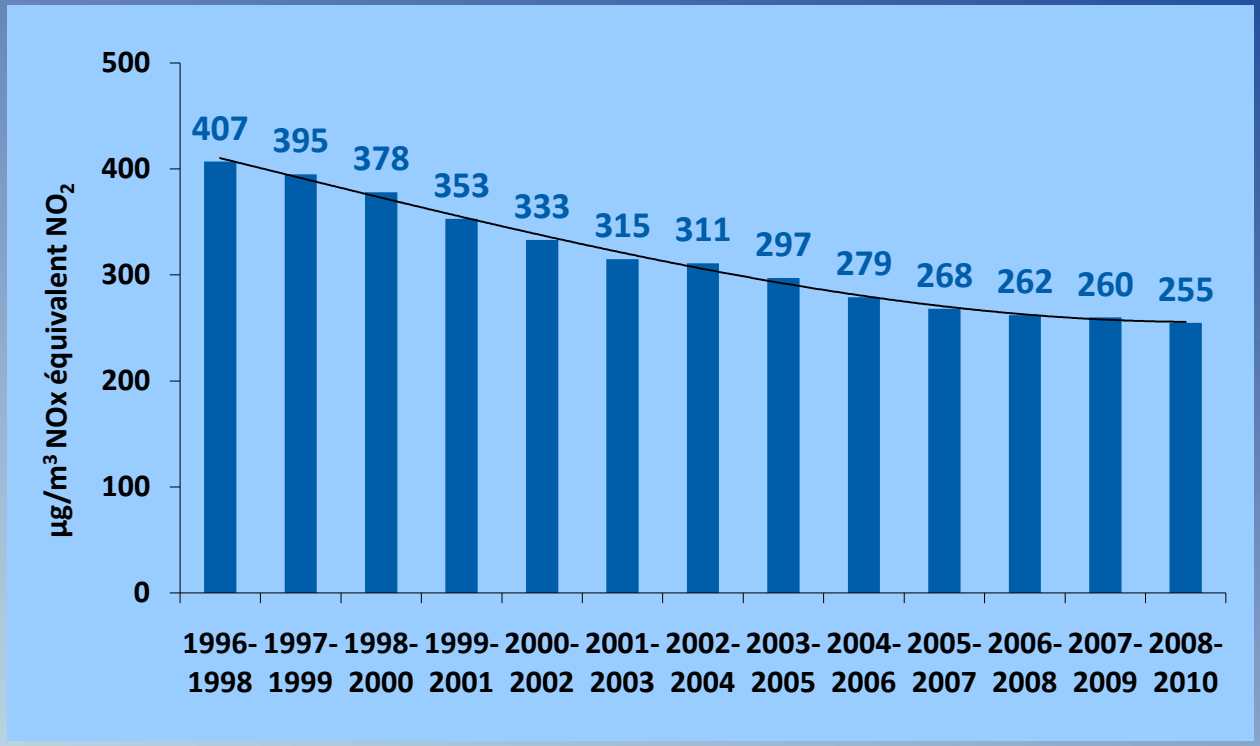
NO_x trends – background annual mean

After an important decline from the mid 90's to the mid 00's, levels are now constant



NO_x trends – road traffic annual mean

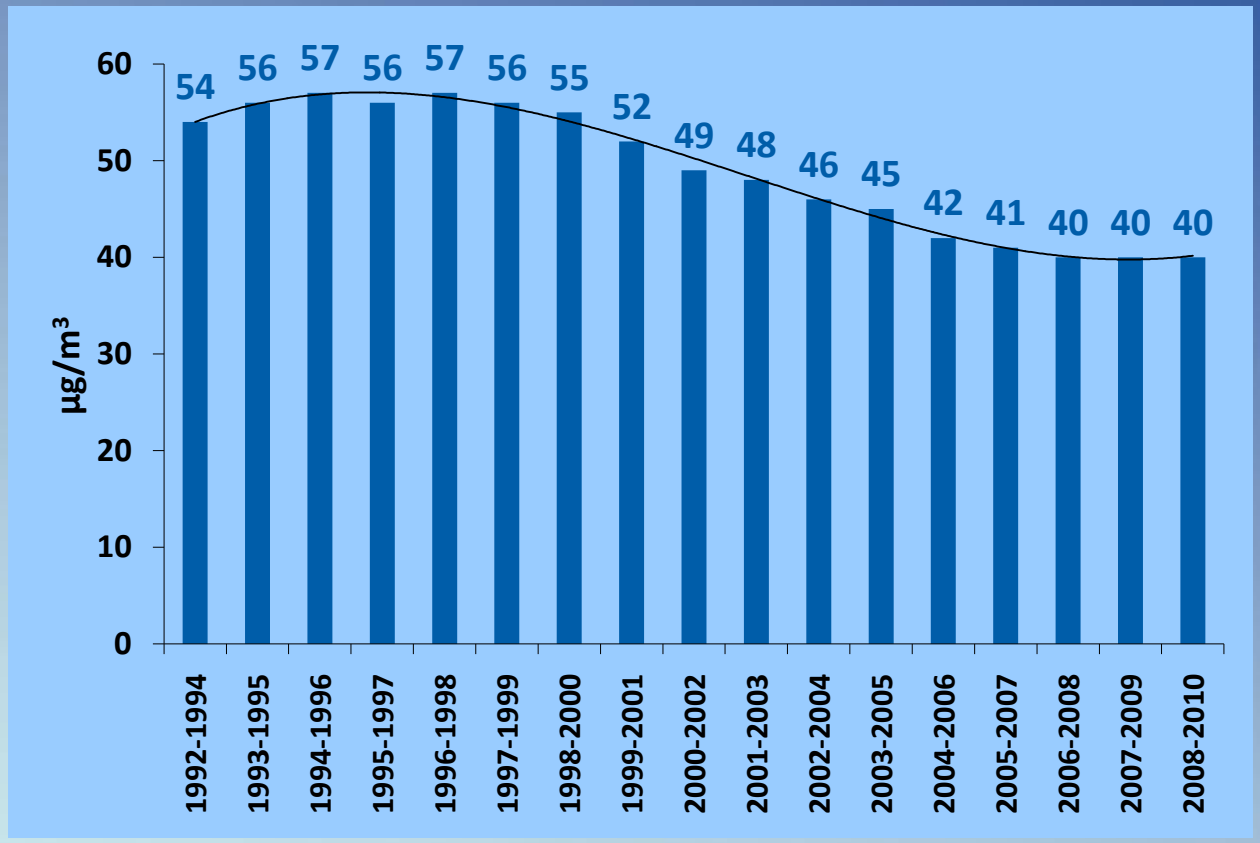
After an important decline from the mid 90's to the mid 00's, annual decrease is now less important



Benefit from catalyst converters is now less visible, most vehicles are now equipped

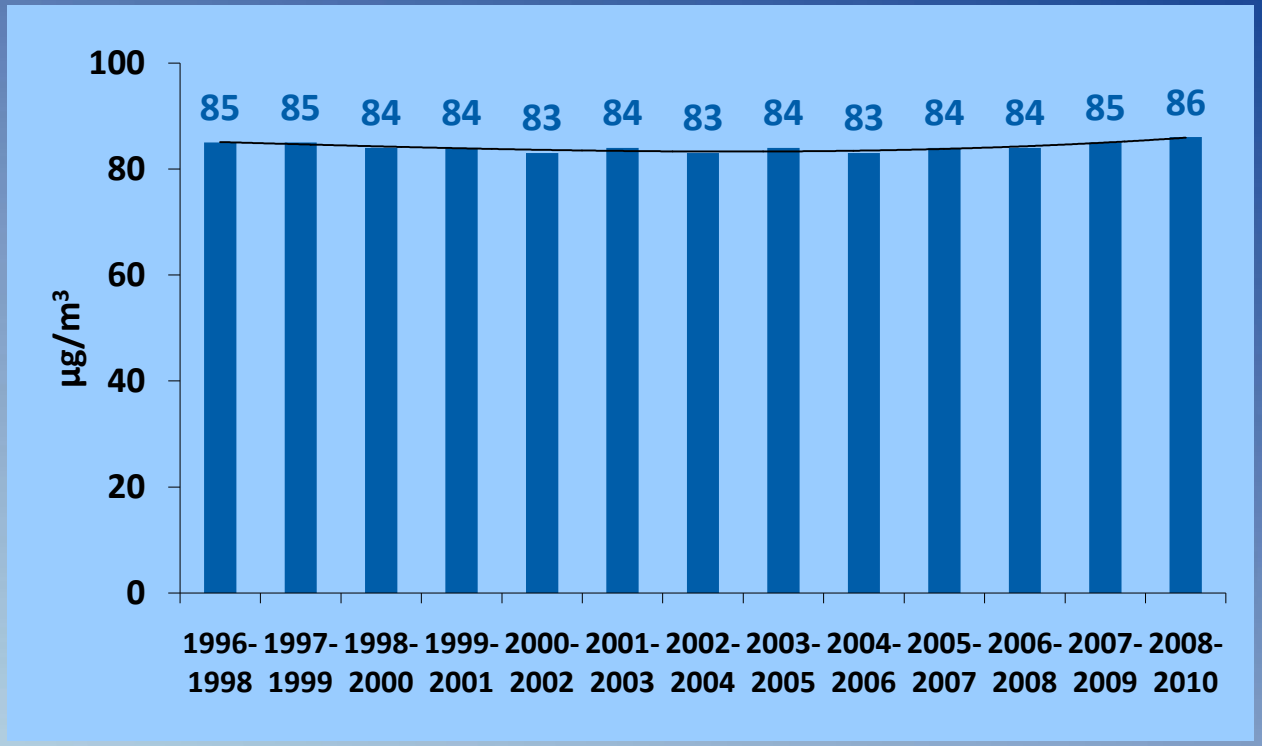
NO_2 trends – background annual mean

After a significant decline from the mid 90's to the mid 00's, levels are now constant



NO_2 trends – traffic annual mean

Mean level of NO_2 is steady on road traffic sites



- Sites with low traffic volume : slight decrease
- Sites with high traffic volume and/or high diesel vehicles proportion : increase since a few years

NO_2 trends – why the end of the decrease in background and increase on some traffic sites ?

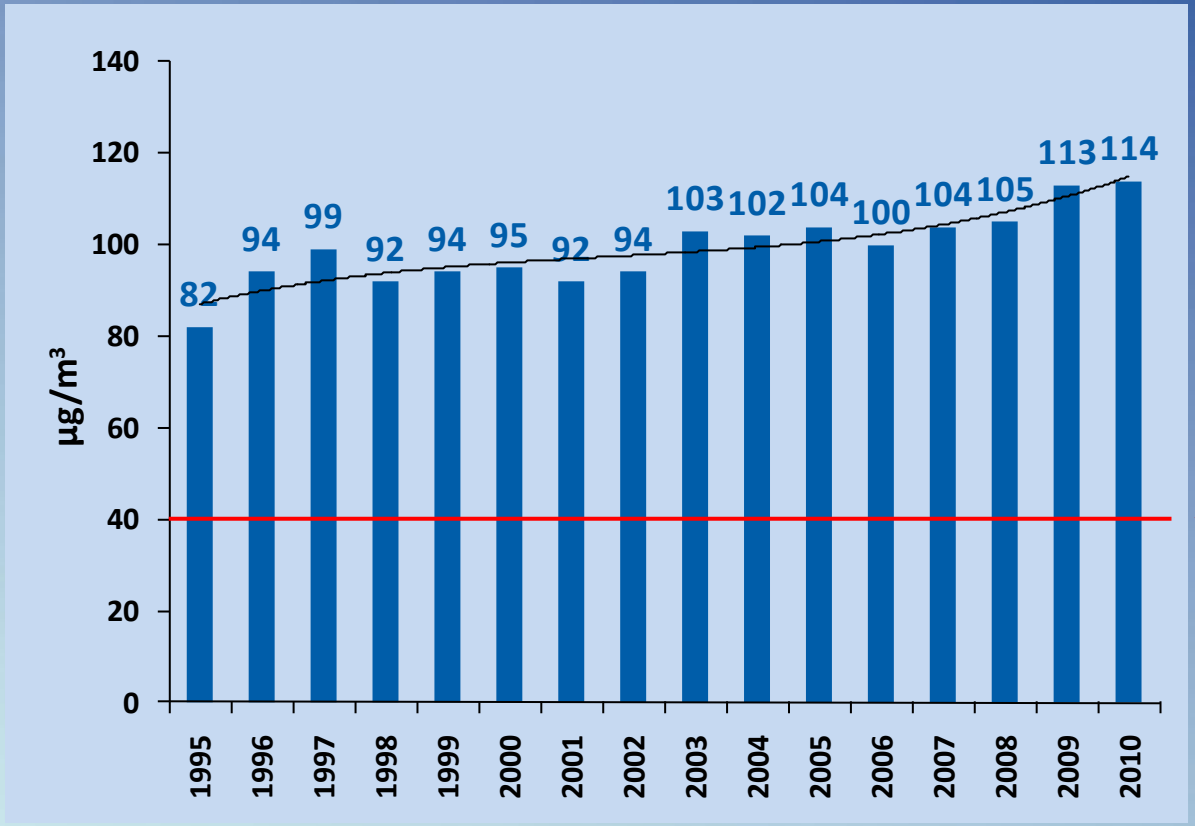
Less benefit from catalyst converters, most of vehicles are now equipped.

Progressive arrival of diesel vehicles with particulate filter : less emissions of particulate matter but catalysed models have a negative impact on direct NO_2 emissions :
Due to oxidation at high temperature to eliminate particulate matter, there is an increase in NO_2 contribution among global NO_x emissions

Some traffic sites with high volume diesel traffic (bus, trucks) observed increases in NO_2 levels

NO_2 trends – why the end of the decrease in background and increase on some traffic sites ?

Example of the Paris ring road, around 200.000 vehicles/day, no significant change in traffic volume/sort and road configuration

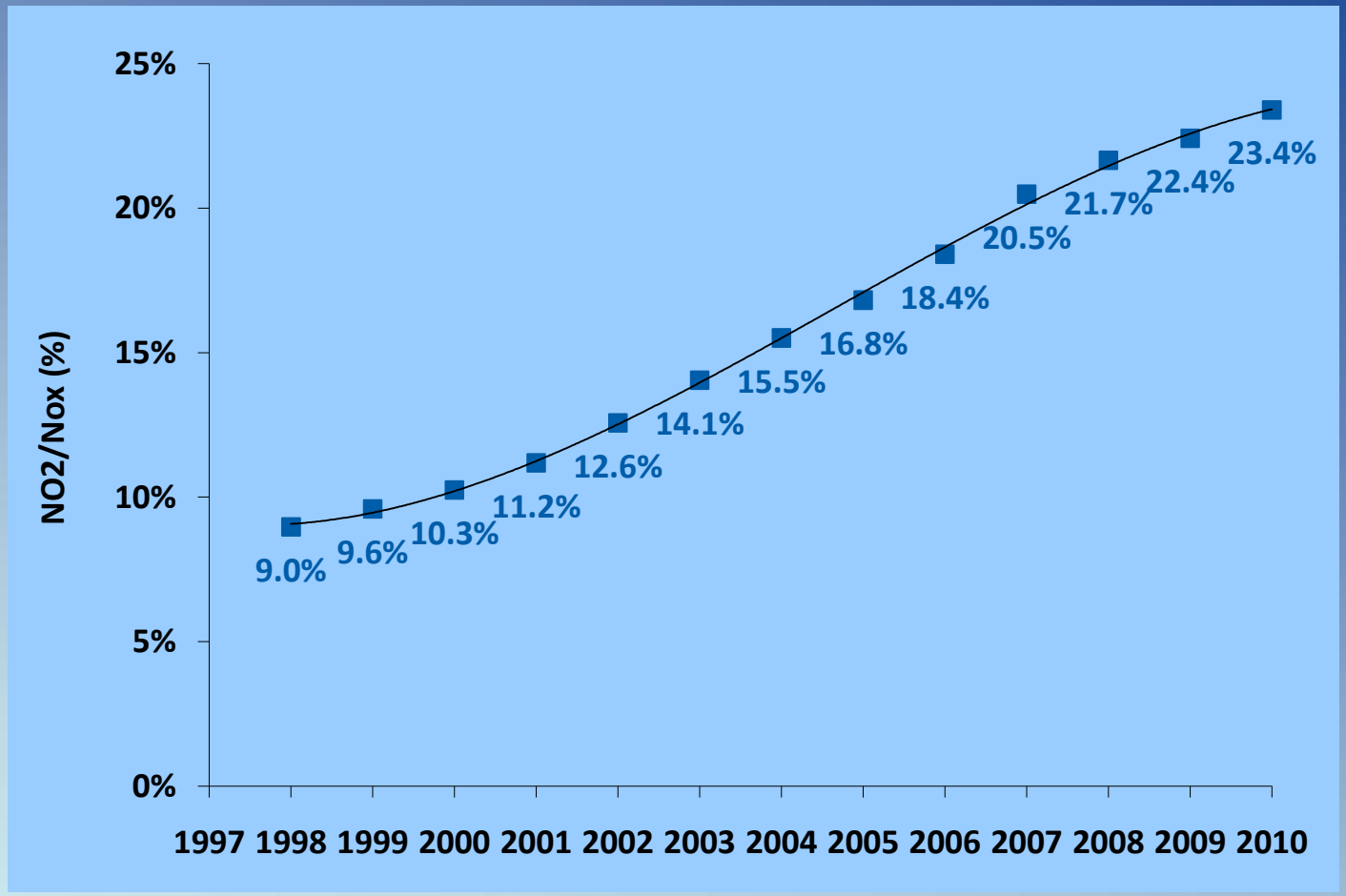


NO_2 trends – why the end of the decrease in background and increase at some traffic sites ?

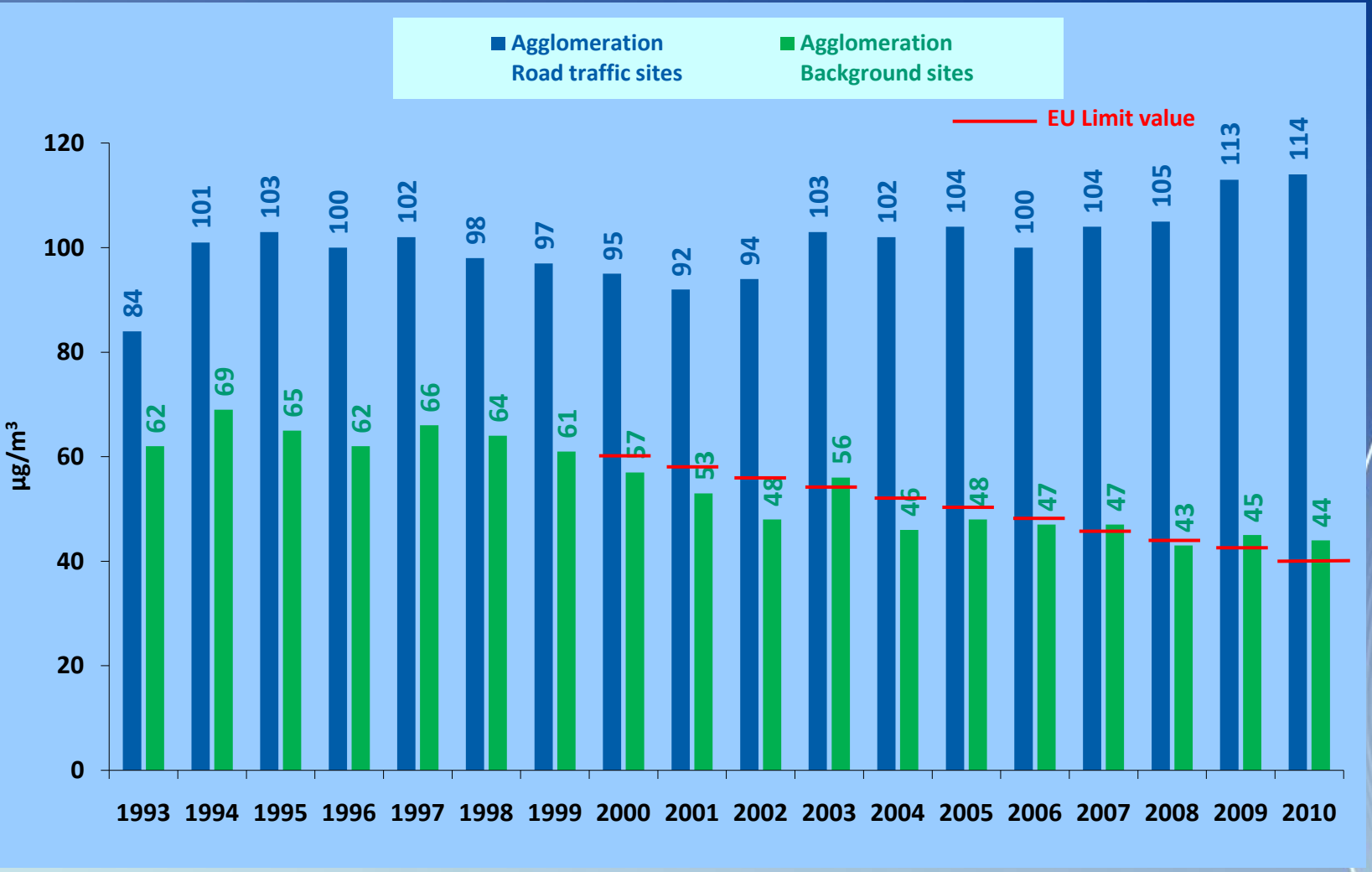
NO_2 /NOx emissions/concentrations

For each traffic site, calculation of ratio NO_2/NO_X

[NO_2 traffic] – [NO_2 background] / [NO_x traffic] - [NO_x background]

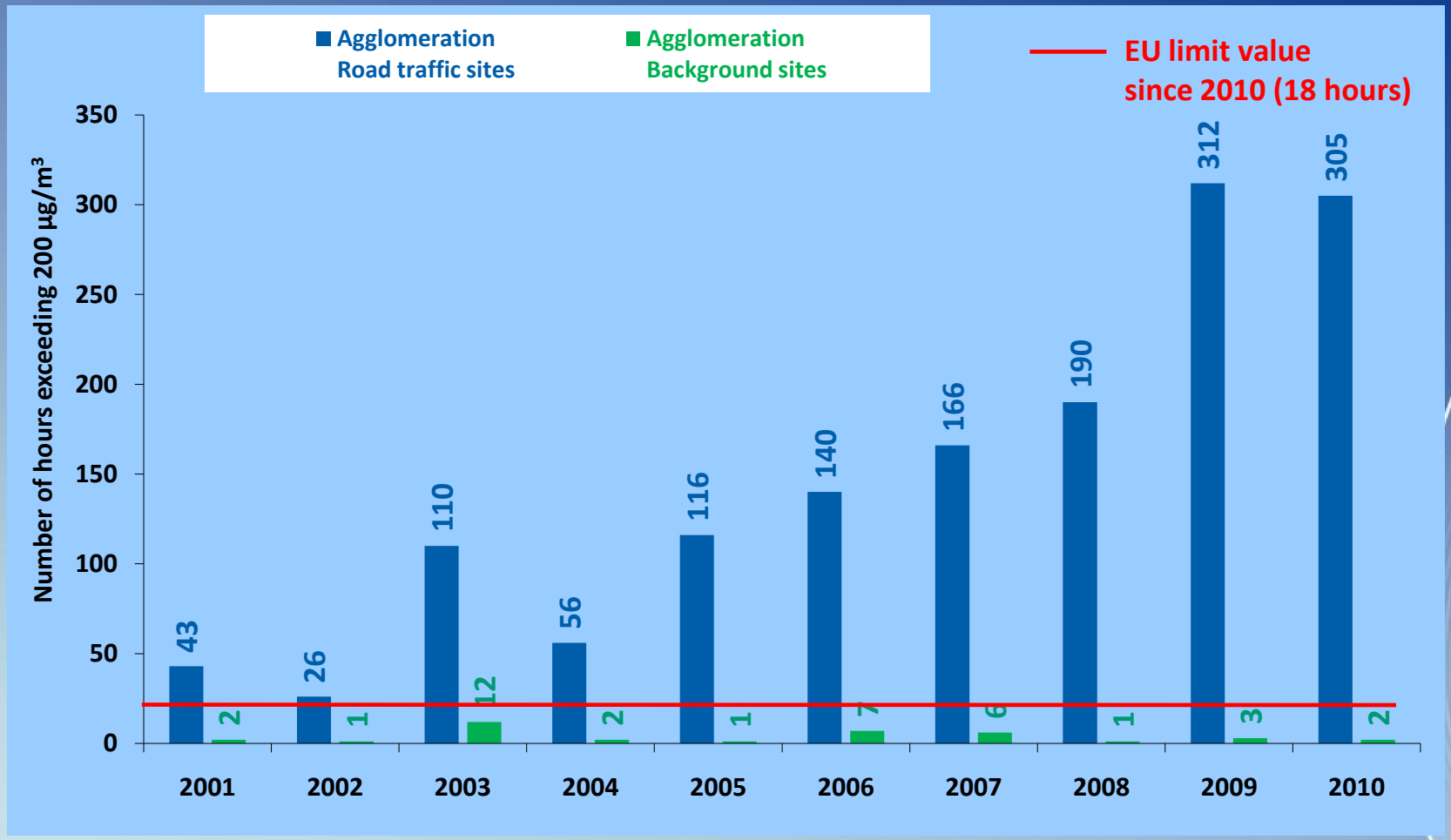


NO_2 trends – maximum annual mean



NO_2 trends – exceedances of 200 µg/m³ threshold

One traffic site : increasing the number of hours exceeding the hourly European threshold



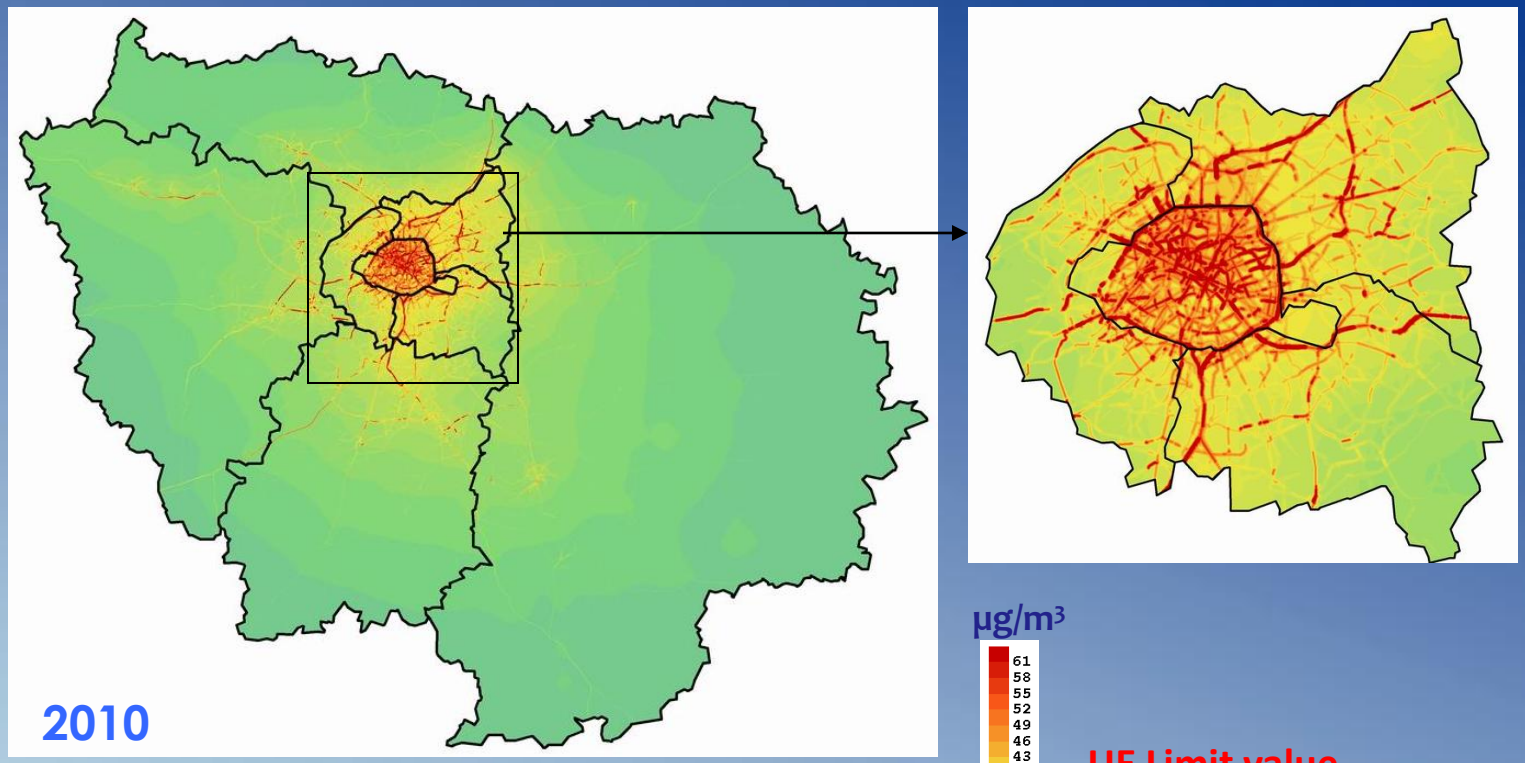
NO_2 in Paris agglomeration – 2010 situation

Maximum annual mean
background : 44 µg/m³ traffic : 114 µg/m³

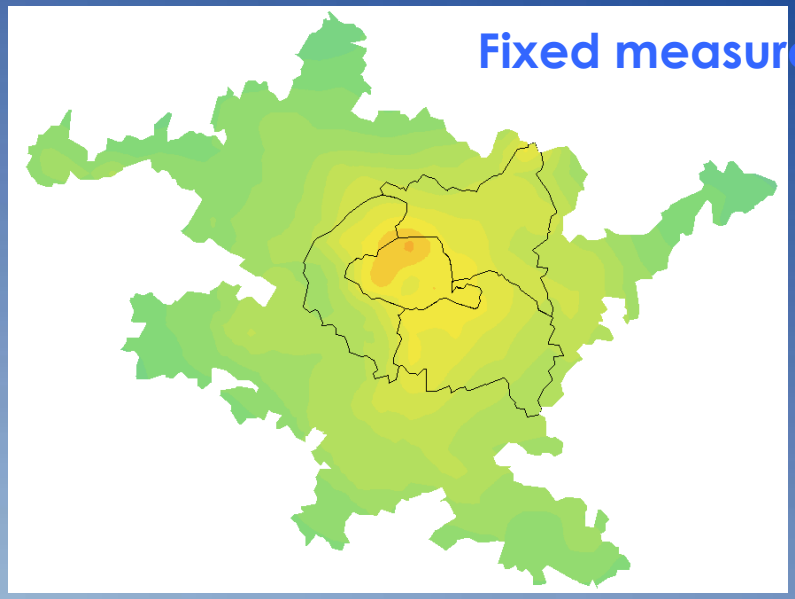
Maps for annual mean : background + traffic

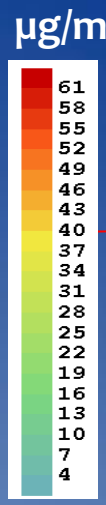
- Background : geostatistical method, 30 sites co-kriging (NOx emissions)
- Traffic concentrations : modelled with STREET
- Between background and road immediate vicinity : linear decrease depending on urban configuration

NO_2 in Paris agglomeration – 2010 situation

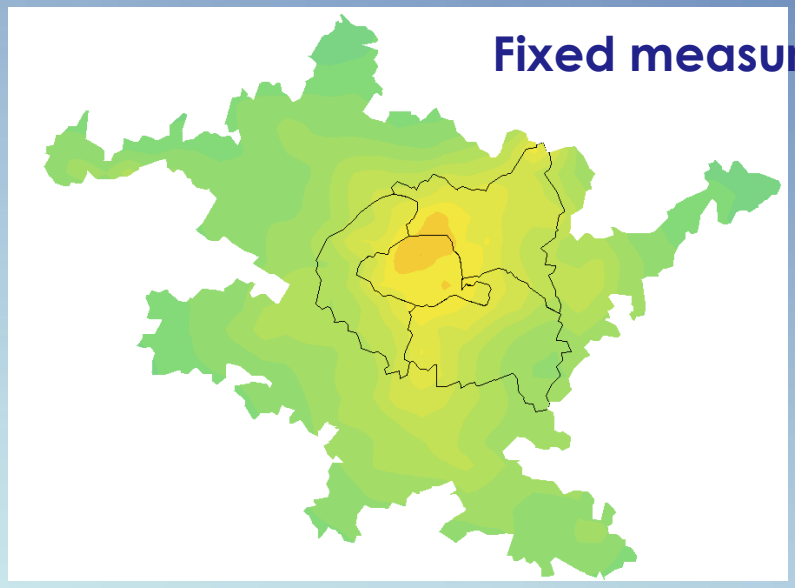


2010 situation – background NO_2 annual level





UE Limit value 40 µg/m³



Area above the limit value (in orange colour) is slightly different

NO_2 in Paris agglomeration – 2010 situation

Estimation of the inhabitants potentially exposed over the annual limit value (40 µg/m³) : from 3.5 to 4 millions each year

NO_2 in Paris agglomeration – the future ?

In order to respect NO_2 limit value, plans are under construction

-LEZ in Paris : more polluting cars and trucks would be excluded from the centre of the agglomeration, 3 years experimental period

Which type of vehicles ? still in discussion, AIRPARIF is working on emissions estimations in accordance with several hypothesis

- Paris agglomeration = sensitive zone where air pollution will be considered as a priority against climate change and greenhouse gas : avoid measures on greenhouse gas than could have a negative impact on air pollution

NO_2 in Paris agglomeration – the future ?

First objective is to avoid exceeding the annual limit value at background sites and to reduce the number of inhabitants exposed to it

First elements about NO_2 levels in 2020 calculated according to 2 road traffic hypothesis :

1 - no new actions : road traffic will still increase

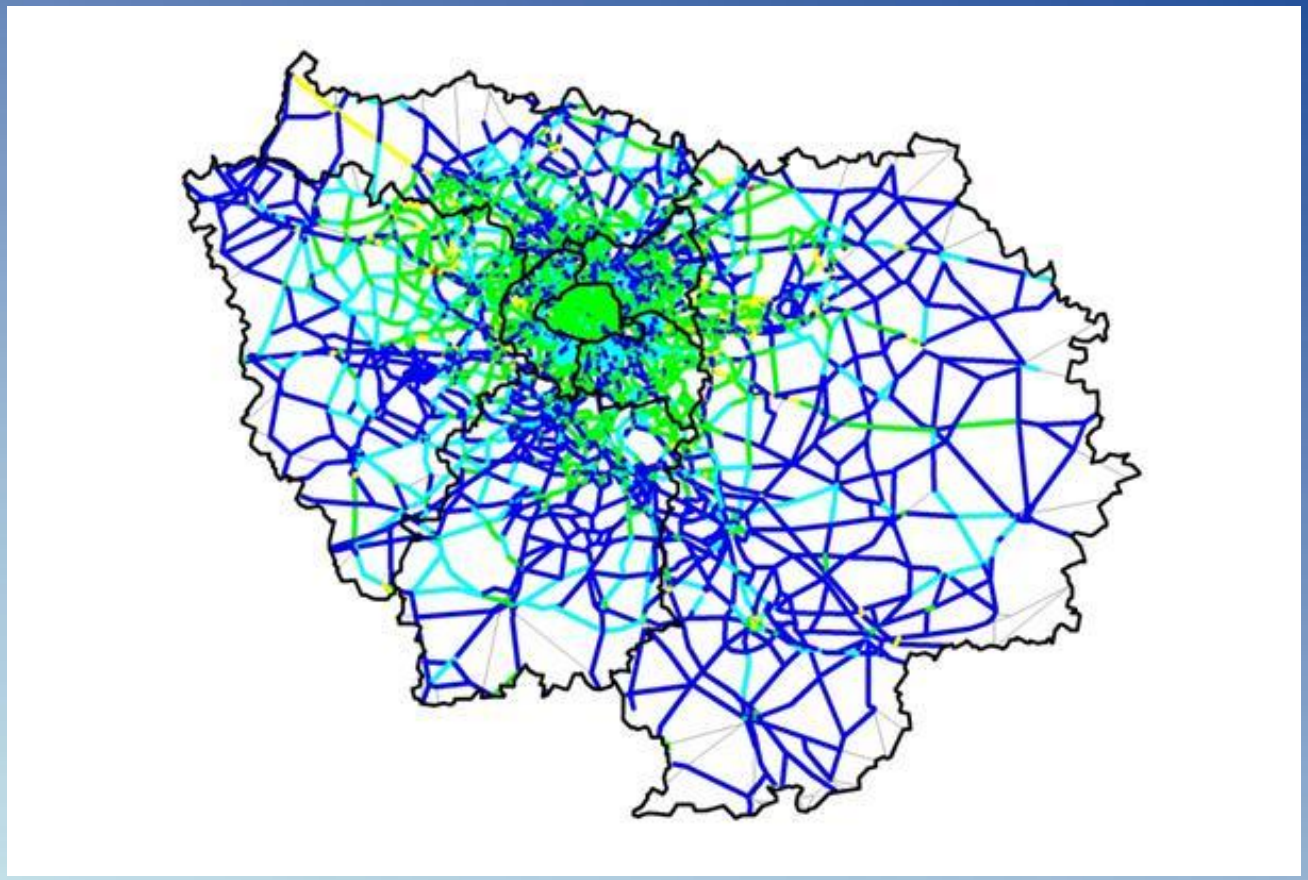
2 - new measures to reduce road traffic and increase public transport

Limits : NO_2 primary emissions from diesel vehicles are very uncertain in the future

Only little differences on NO_2 levels between hypothesis, main reduction comes from technological progress (EURO standards)

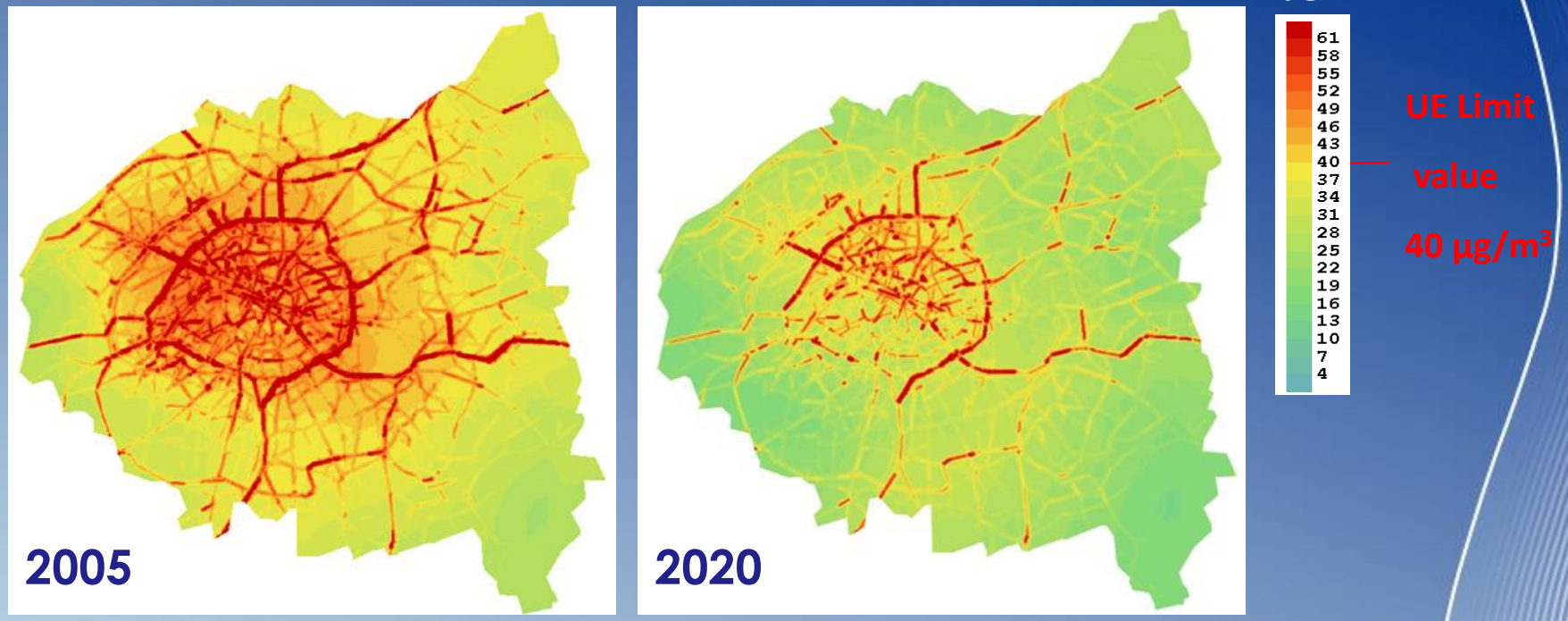
NO_2 in Paris agglomeration – the future ?

Road traffic emissions : reduction in % between 2005 and 2020
Hypothesis 2 : - 45 to -75 %



NO_2 in Paris agglomeration – the future ?

NO_2 annual level 2020 versus 2005, hypothesis 2



Important reduction but still insufficient near the traffic on main roads

Other reductions have to be found, road traffic and other sources : work in progress about residential/tertiary emissions

NO_X and NO_2 in Paris region

Thanks for your attention and …
hope my English was clear enough

AIRPARIF