

Where do the particles we breathe in Ile-de-France come from?

For the first time, a study directed by Airparif, in association with LSCE (Environmental & Climate Sciences laboratory, CNRS-CEA) assesses particles produced in Ile-de-France out from the surrounding regions. This study also determines their main origins. With the financial contributions from the central government, the region Ile-de-France and the city of Paris, this large scale study has been executed from 2009 until 2011 and required 90 000 chemical analyses.

This study outlines that, next to the traffic, like the Paris ring road, 60% of the particles matters (PM) are locally produced. A main stable 44% of this local production is from the traffic itself. As opposed to the Paris agglomeration far from the traffic where 70% of the particles are from other French regions (even European regions). The remaining 30% are locally and mainly produced by the traffic and wood burning.

Particles have effects on human health. For these reasons they are regulated. However, in Ile-de-France the air quality standards are exceeded every years. Several millions persons are concerned and like some other European member countries, France has contentious issues with the EU with regards to the European policies on Particle matter.

In that context, the definition and the implementation of action plans require the identification of appropriated measures to reduce the level of particles and a good knowledge of their origins. The complex parts are:

- There is no direct connections between emissions (the quantity of PM ejected in the air) and the concentrations (quantity of PM in the air we breathe) as they are depending on various factors like chemical reactions and weather.
- The various origins of the particles. Particles are a complex pollutant which can be directly emitted in the air (primary particles) or coming from the chemical reactions of pollutant gases (secondary particles). Particles can travel long distances and even be resuspended once on the ground. Moreover, particles are made up by several substances which don't represent unique and homogeneous chemical substances.

In order to determinate the measures to reduce the level of particles in the air, the study has a double aim:

- **To assess the ratio between the particles produced locally by the traffic and locally by the region Ile-de-France and the ones imported by surrounding French or European regions.**
- **To assess the relationships between various pollutants origins (heating, traffic, industry and agriculture) along a dense traffic road, in the Paris agglomeration or at the Ile-de-France level.**

This study has been directed by Airparif who wished to be supported by an **European scientific committee** of experts from France, Berlin, London and Barcelona as well as some Governmental French representatives.

This study is essentially targeting the fine particle matter under 2.5 µm (PM2.5) due to their impact on human health but also because they represent an average of 70% of the particles matter.

The study is based on a **scientific method developed in Berlin**. This method was a reference for the implementation of a low emission zone to reduce the level of particles. The method is archived by coupling the particle concentration measurements with the analysis of its chemical composition, weather data and French and European emission data. Seven monitoring sites have been

The study in few facts :

- ✓ 7 monitoring sites
- ✓ 9 automated analyzers
- ✓ 14 manual samplers
- ✓ 5096 samples
- ✓ 5682 filters analysed
- ✓ More than 10 000 weighings
- ✓ More than 30 chemical substances assessed every day on each site. So **87 600 chemical analyses:**
 - ♦ 65 700 for PM2.5
 - ♦ 21 900 for PM10



implemented all over the Ile-de-France, of which 6 have been held from September 2009 until September 2010. The below results show 2 aspects: the geographical origins and the particles sources, next to the traffic and in the Paris agglomeration far from the traffic.



Along the traffic, the majority of particles are local, with a major and stable contribution from the traffic itself

Almost 60% of the annual concentration of fine particles PM2.5 measured on Paris ring road site has been produced locally: 44% by the local traffic and 17% by the Paris agglomeration. The other almost 40% has been imported by other French and European regions.

Sources and origins of particles matter PM2.5 measured near the Paris ring road traffic (Sept.2009 to Sept.2010)

Paris ring road traffic Station	Particles produced in Ile-de-France		Imported particles
	by local traffic	by the agglomeration	
Percentage of fine particles	44%	17%	39%
Primary sources	<ul style="list-style-type: none"> • Traffic including exhaust smoke (40%) 	<ul style="list-style-type: none"> • Agglomeration traffic (4%) • Wood fired heating (4%) <ul style="list-style-type: none"> - Chemical reactions in the air (5%) - Industry (2%) 	<ul style="list-style-type: none"> • Chemical reactions in the air (19%) • Residential and industrial heating (9%) • Road traffic (3%) • Other transports including naval (3%) • Industry (2%) • Natural sources (1%)
	<ul style="list-style-type: none"> • Local actions on traffic 	<ul style="list-style-type: none"> • Local actions at a regional scale 	<ul style="list-style-type: none"> • National and European actions

To compare with the coarse particle matters PM10, the Paris ring road also represents nearly half of the concentration of particles. This concentration is stable through the year. The other half is from the Paris agglomeration and imported by other French and European regions.

Particle matter sources are local

In these 60% of fine particles produced in Ile-de-France, on which a local action is possible, the traffic is the most important source: 44% on the Paris ring road where 40% is from the traffic itself. However, wood burned heating is also a non-negligible source.

Diesel vehicles provide 90% of the level of fine particles produced by the traffic. However, two-wheeled motor vehicles should not be underestimated in city as they represent most of the particle contribution of the gasoline vehicles (7%).

Concerning the diesel vehicles, and depending on the traffic, 50% of these particles are from private vehicles, 20 to 35% from delivery services vehicles, and 10 to 20% from heavy good vehicles.

If exhaust smokes represent most of the traffic contribution, the particles resuspension, road and vehicle abrasion (tires, brake pads...) could be important too.

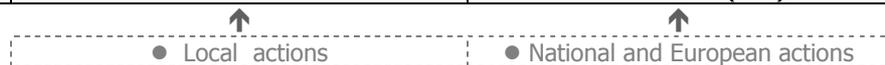


**In Paris agglomeration and far from the traffic,
particles are mainly from import**

Far from the traffic, two third of the annual concentration of Paris fine particles PM2.5 are from outside the region. One third is locally produced in the Paris agglomeration: equally by wood burning and traffic for which local actions are possible and the other third by chemical reactions, for which only indirect actions on the gaseous precursors could be possible.

Sources and origins of fine particles matters PM2.5 measured in the Paris agglomeration in Paris (Sept.2009 to 2010)

Urban site far from traffic (Paris)	Particles produced in Ile-de-France By the agglomeration	Imported particles
Particle matters PM2.5	32%	68%
Primary sources	<ul style="list-style-type: none"> • Chemical reaction in the air (7%) • Wood fired heating (7%) • Road traffic (8%) • Industry (3%) 	<ul style="list-style-type: none"> • Chemical reaction in the air (34%). • Residential and industrial heating (16%) • Road traffic (6%) • Other transports including naval (5%) • Industry (3%) • Natural sources (2%)



Even if wood burned heating is barely used in Ile-de-France, this residential heating is a significant source of fine particles in the Paris agglomeration (25%).

➤ Quantity of fine particles emitted: Wood burning represents only 5% of the [combustible energy consumption used for residential heating](#) however, according to the Ceren¹, it represents 84% of fine particles emitted by the residential heating.

➤ In terms of concentration, and in other words air quality, this study establishes that winter wood burning is a non-negligible part of the local fine particles emitted. It represents 7% of the annual PM2.5 in rural area (9% in winter) which is a quarter of the Paris agglomeration contribution.

Imported fine particles sources

Pollution from other regions represents more than 70% of the fine particles level in Ile-de-France. These particles are mostly secondary particles (34%) generated by chemical reactions in the atmosphere from 3 major gas sources: traffic, agriculture and industry.

Residential and industrial heating across France and Europe is the second major source of fine particles imported into Ile-de-France (16%). Other sources are: Road traffic (6%), other types of transport including naval (5%) and Industry (3%)

¹ Ceren : Centre d'études et de recherches économiques sur l'énergie

Conclusion and Prospect

Due to the Russian doll structure of the geographical scales and the various particles sources, complementary actions have to be taken **to improve the Paris agglomeration air quality and to be in accordance with legal regulations:**

- **In terms of geographical scales:** with some local actions to reduce the road traffic pollution. This is particularly destined to numerous inhabitants along busy roads. At the Ile-de-France level, some complementary actions (like the Atmosphere protection plan) tend to reduce the level of particles locally emitted. And some National and European measures (like Emission standards, European directives and standards...) are targeting the imported particles.

- **To compare with targeted activities:** Diesel traffic has a relatively important contribution, whatever the type of vehicle and not only private vehicles. However, this study highlights other non-negligible sources like wood burning. Its consideration is even more important as this type of heating is minor, as opposed to its impact. Moreover, its contribution could increase due to some Climate change measures which don't integrate the air pollution.

- **In terms of targeted pollutants:** this study highlights the fine particles PM2.5 contribution in the particles PM10. Both particles are currently regulated. But by targeting the PM2.5, this will also reduce the level of PM10.

The chemical analysis of the particles composition along the traffic indicates that some measures on the traffic could generate some health benefits by reducing some substances. Like the Black carbon, emitted at 80% by the traffic and could be responsible of the PM2.5 toxicity.

Nevertheless, it is not possible to act on secondary particles. They are resulting of the chemical reactions in the atmosphere from precursors. These precursors are mainly produce by the traffic, the agriculture and the industry.

With regards to the number of campaigns to reduce the traffic, its stable contribution recommends a wider long term campaign rather than occasional during an air pollution episode. On average through the year, one day out of two are above the recommended level of pollution. Some long term measures would reduce the number and the intensity of the air pollution episodes. When the pollution is rising, like during a day with no wind, some occasional actions could reduce the scale of the episodes by acting on the agglomeration and traffic contribution. These occasional measures few days a year show some health benefits but won't affect the daily air quality.

During this study, an immense database has been built. This database will improve the modelling tools and the air quality forecast. It could also be used by Healthcare and Research&Development teams. This will allow a better understanding of the particle behaviour in the atmosphere and their effect on Human health. Also, some campaigns could be done on the resuspension, the abrasion and the secondary aerosols. However, they are difficult to assess, more studies should be carried.