#AirQuality2019

September 2020

Air quality in the Paris region

SUMMARY 2019

AIRPARIF

AIR QUALITY IN THE PARIS REGION

Summary 2019

September 2020

This report is an English summary of the annual report on ambient air quality in the Paris region.
It gives an overview of the concentrations for the European Union regulated pollutants during the year 2019.

The complete report in French can be downloaded on the AIRPARIF website:
http://www.airparif.asso.fr/_pdf/publications/bilan-2019.pdf

Air quality complete data in the Paris region can be downloaded at:
http://www.airparif.asso.fr/telechargement/telechargement-statistique

Annual air pollution maps are available at *http://www.airparif.asso.fr/etat-air/bilan-annuel-cartes*

All data, reports and studies performed by AIRPARIF are publicly available.
Full and free access is granted on the AIRPARIF website.

Any use of part of this report should mention "AIRPARIF, the Observatory of Air Quality in the Paris Region".

Cover illustration: map of the annual NO_2 concentration in 2019 (Airparif – Google Earth & Landsat data)

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1. KEY FACTS FOR 2019

Except for ozone, the downward trend in chronic pollution levels continues for nitrogen dioxide (NO_2) and particles (PM_{10}, $PM_{2.5}$) and the intensity of exceeding standards is reduced every year. A significant decrease in the population exposed to exceedances of the limit value for NO_2 is observed, with major roads now below this threshold. However, PM_{10} and nitrogen dioxide concentrations in the Paris region are still problematic, with recurrent exceedances of regulatory limit values.

The decrease of the nitrogen dioxide (NO_2) concentrations in the Paris agglomeration continues in 2019. This is consistent with the decline of nitrogen oxides emissions (road traffic, industries, heating) in the Paris region. Near road traffic and on the busiest axes (Boulevard Périphérique, A1 Highway, etc.) the average NO_2 levels are always almost twice as high as the annual limit value (set at 40 µg/m³), but for the first time, some roads have passed below this threshold. In 2019, around 500 000 inhabitants of the Paris Region are potentially exposed to the exceeding of the annual NO_2 limit value, including 10% of Parisians.

→ Despite an improvement, daily and annual limit values for **PM_{10} particles** are still exceeded at some roadside sites. In 2019, **less than 1% of the inhabitants living in the Paris area and close to main roads were potentially affected by the PM_{10} exceedance of the daily limit value** (50 µg/m³ not to be exceeded more than 35 days a year). However, more than 75% of the inhabitants of the Paris Region are exposed to an exceedance of the WHO recommendations (50 µg/m³ not to be exceeded more than 3 days a year).

For **fine particles ($PM_{2.5}$)**, the annual mean concentrations are still above the French quality objective (also corresponding to the World Health Organization recommended value of 10 µg/m³). **In 2019, almost every inhabitant of the Paris region were affected in 2019 by an exceedance of these air quality objectives**.

→ Regarding **ozone (O_3) levels**, **the quality objective is exceeded every year in the whole Paris region, and especially in sub-urban and rural areas.**

→ After a long period of sharp decrease which began at the end of the 1990's, **benzene (C_6H_6)** levels continue to slightly decline and tend to stabilize (both near traffic and in background situation). The annuel limite value (5 µg/m³) is widely complied on the whole region. However, there is a low risk to locally exceed the annual quality objective (2 µg/m³). **Less than 1 % of the inhabitants living in the agglomeration and in roadside conditions are still potentially exposed to an exceedance of this threshold**.

→ **Regarding pollution episodes, the information and warning procedure was triggered 17 days in 2019.** This is 3 days more than in 2018. **These episodes are due to both PM_{10} and O_3**.

SITUATION OF THE PARIS REGION IN RELATION TO AIR QUALITY STANDARDS FOR DIFFERENT REGULATED POLLUTANTS

Figure 1 shows whether, in 2019, air quality standards (limit value, target value and quality objective) are met or exceeded in the Paris region for the regulated pollutants.

Figure 1: situation in 2019 of the Paris region in relation to air quality standards for different regulated pollutants (Glossary at the end of this document)

2. POLLUTANTS EXCEEDING AIR QUALITY STANDARDS

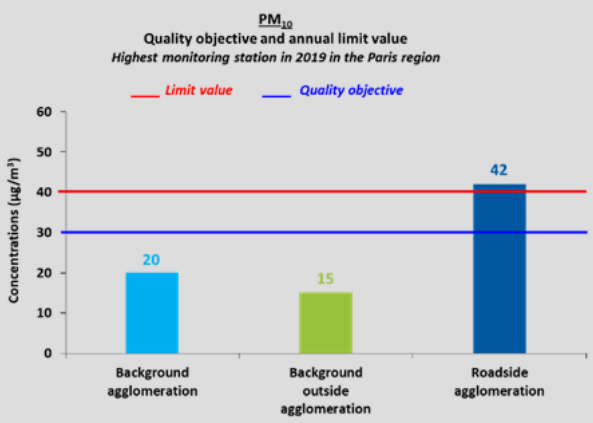
2.1 PM_{10} particles

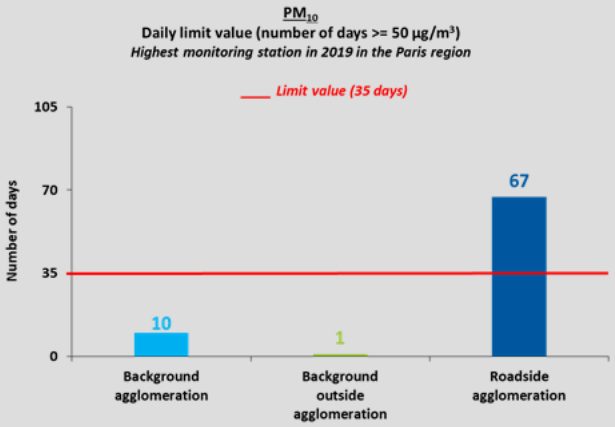
Particulate Matter (PM) in brief

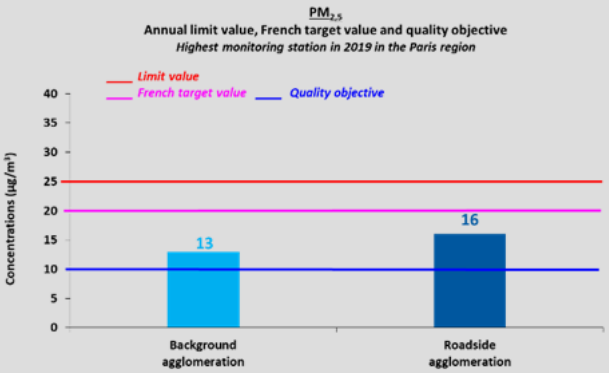
Recurrent exceedances of PM_{10} EU limit values are still observed near traffic
Less than 1% of the population is potentially exposed to an exceedance of the PM_{10} EU daily limit value
Less than 1 % of the population is potentially exposed to an exceedance of the PM_{10} quality objective
More than 75% of the population is potentially exposed to an exceedance of the WHO recommendations

$PM_{2.5}$ levels complies with the annual limit value (25 µg/m³) and with the target value (20 µg/m³). However, they are still much higher than the French quality objective (10 µg/m³) . More than 50 % of the inhabitants living in the Paris region are still exposed to an exceedance of this threshold. Moreover, almost every inhabitant of the Paris Region is exposed to an exceedance of the WHO recommendations.

Nonetheless, a decreasing trend of the PM is observed, in both background and near traffic situations.







Summary of air quality standards exceedances for Particulate Matter (PM_{10} and $PM_{2.5}$) within the Paris region

SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS

EU daily limit value (50 µg/m³ not to be exceeded more than 35 days a year)

The maps in Figure 2 show the PM_{10} annual number of days exceeding the EU daily limit value within the Paris region, with a focus on Paris and surrounding subsurbs in 2019.

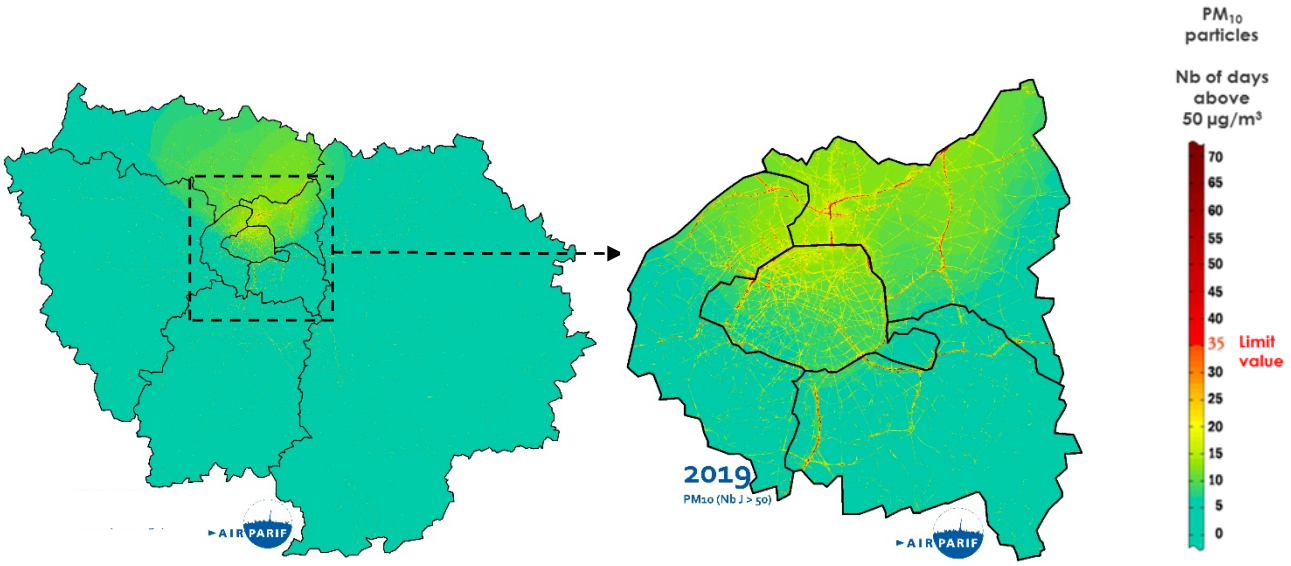


Figure 2: PM_{10} annual number of days exceeding the 50 µg/m³ EU threshold within the Paris region with a focus on Paris and surrounding suburbs in 2019

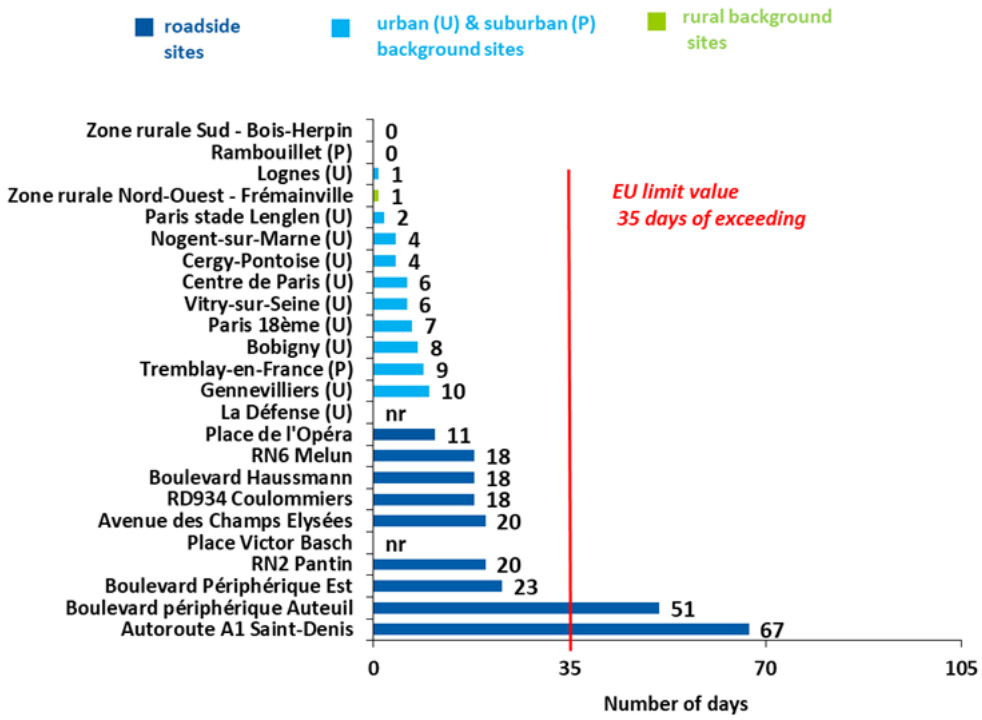


Figure 3: PM_{10} annual number of days exceeding the 50 µg/m³ EU threshold for all continuous monitoring sites within the Paris region in 2019

In 2019, the EU daily limit value is met in background situation (Figure 3). In 2019, the PM_{10} annual number of days exceeding the 50 µg/m³ is way higher (1 to 10 days) than in 2018 (1 to 2 days). During winter and spring 2019, weather conditions were generally favorable for pollution dispersion and thus for air quality, except during February where the daily exceedance of the 50 µg/m³ was measured 6 times.

The EU daily limit value for PM_{10} particles is still exceeded at roadside sites (Figure 3). In 2019, for the highest traffic site (A1 Saint-Denis), this threshold is exceeded 67 days, which is comparable with 2018.

In 2019, less than 1 % of the population is potentially exposed to an exceedance of the PM10 EU daily limit value (Figure 4).

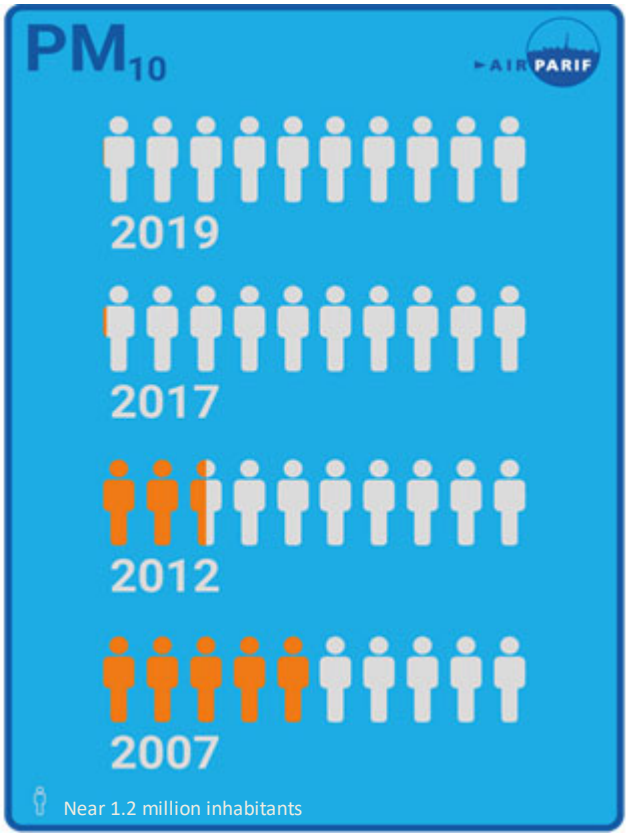


Figure 4: million of inhabitants potentially exposed to a PM_{10} level exceeding the EU daily limit value within the Paris region from 2007 to 2019

EU annual limit value (40 µg/m³ on average)

The maps in Figure 5 show the annual mean PM_{10} concentration within the Paris region, with a focus on Paris and surrounding subsurbs in 2019.

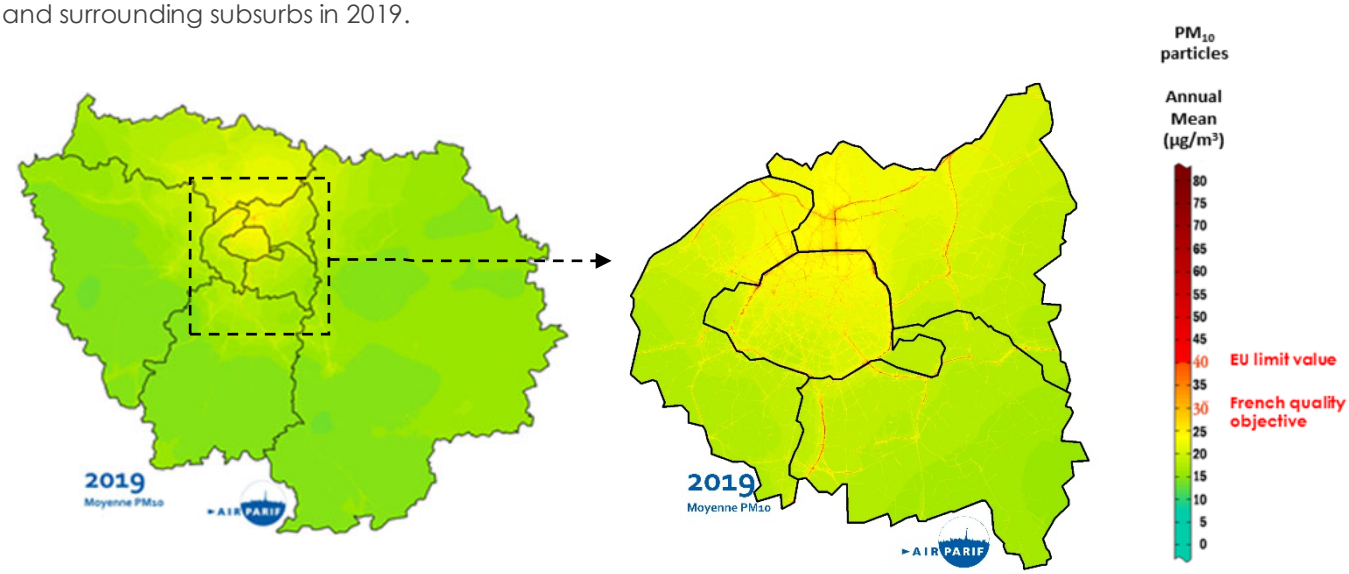


Figure 5: PM_{10} annual mean concentration within the Paris region with a focus on Paris and surrounding suburbs in 2019

As in the last four years, PM_{10} background levels measured in the Paris agglomeration are fairly homogeneous in 2019 (between 16 and 20 µg/m³). A slight decline in PM_{10} concentrations from the Paris agglomeration to the periphery of the region is observed (Figure 6). In general, **background annual mean levels are slightly lower in 2019 than in 2018.**

PM_{10} standard annual values (EU annual limit value and French annual quality objective) are widely met in background and rural situations.

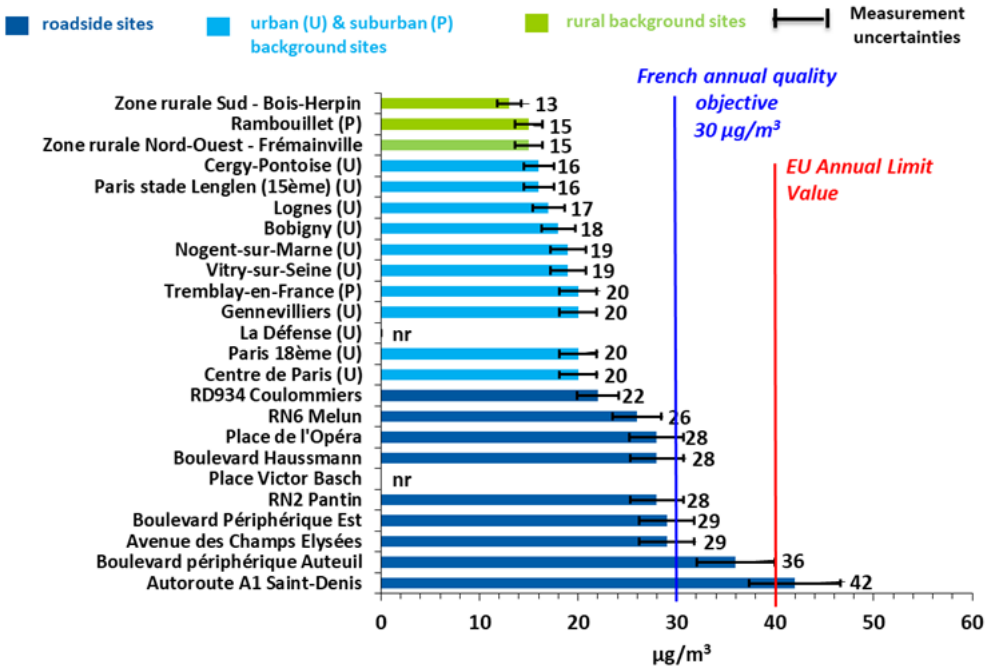


Figure 6: PM_{10} annual mean concentrations for all continuous monitoring sites in the Paris region in 2019
nr : not representative

Highest PM_{10} mean concentrations were measured near main roads in 2019. PM_{10} levels near traffic (22-42 µg/m³) can be up to twice higher than those measured in background situation. However, PM_{10} concentrations slightly decline between 2018 and 2019 at roadside sites.

Since 2015, the EU annual limit value (40 µg/m³) is exceeded only at the traffic monitoring station Highway A1 Saint-Denis. This threshold is met at other monitoring stations.

In 2019, less than 1 % of the regional population are potentially exposed to an exceedance of the PM_{10} quality objective (Figure 7). This value is comparable to last year. In 2007, almost 30 % of the regional population were concerned by this exceedance.

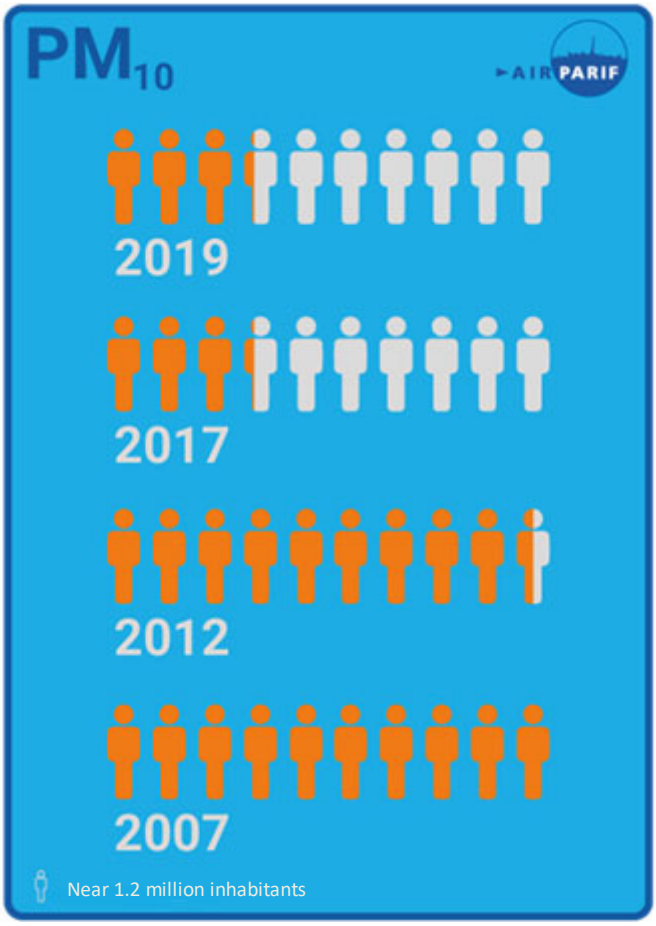


Figure 7: million of inhabitants potentially exposed to a PM_{10} level exceeding the WHO recommendations in the Paris region from 2007 to 2019

LONG-TERM TRENDS

Besides the amount of pollutants released to the atmosphere, PM_{10} levels are strongly impacted by meteorological conditions from one year to the next. For example, 2008 was characterised by weather conditions that were conductive to good air quality, resulting in few high-intensity particle episodes. Conversely, in 2007 and 2012, unfavourable weather conditions associated with higher PM_{10} emissions (especially due to wood burning combustion during wintertime episodes) led to high PM_{10} levels in winter and spring. As in the last 5 years, **2019 is a year with favorable meteorological conditions in winter and spring for pollution dispersion (Figure 8), except February.**

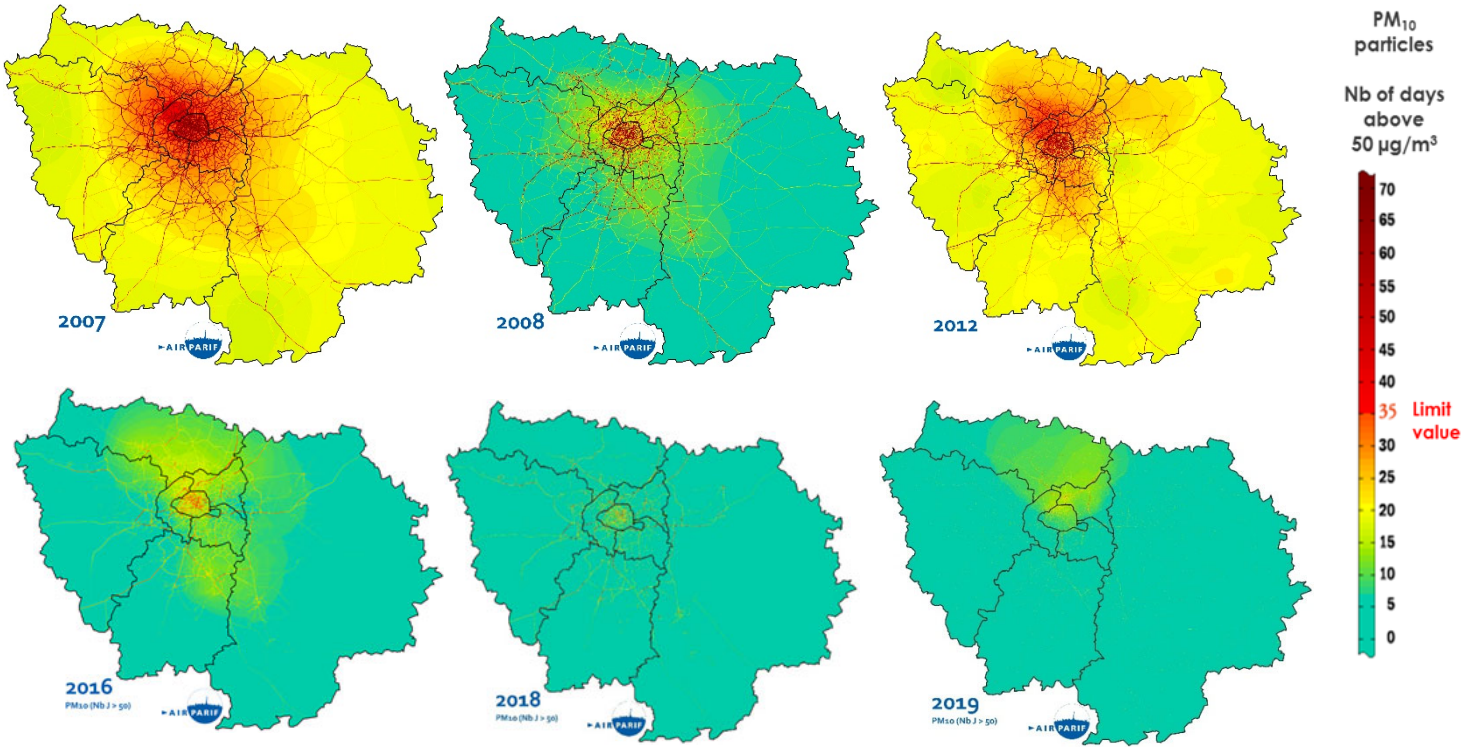


Figure 8: number of days exceeding the EU daily limit value in PM_{10} in the Paris region from 2007 to 2019

Besides these seasonal changes, **the number of days exceeding the 50 µg/m³ EU limit value is decreasing since 2007, in both background and near main roads situations.**

AVERAGE ANNUAL TRENDS

The Figure 9 shows **a downward trend of PM_{10} mean concentrations in background agglomeration**. **These PM_{10} levels decreased by about 35 % from 1999 to 2019**. This is related to the PM_{10} regional emissions reduction for almost -30 % between 2005 and 2015. **This decline is particularly strong over the last years in background situation. This decrease is also observed in rural agglomeration.**

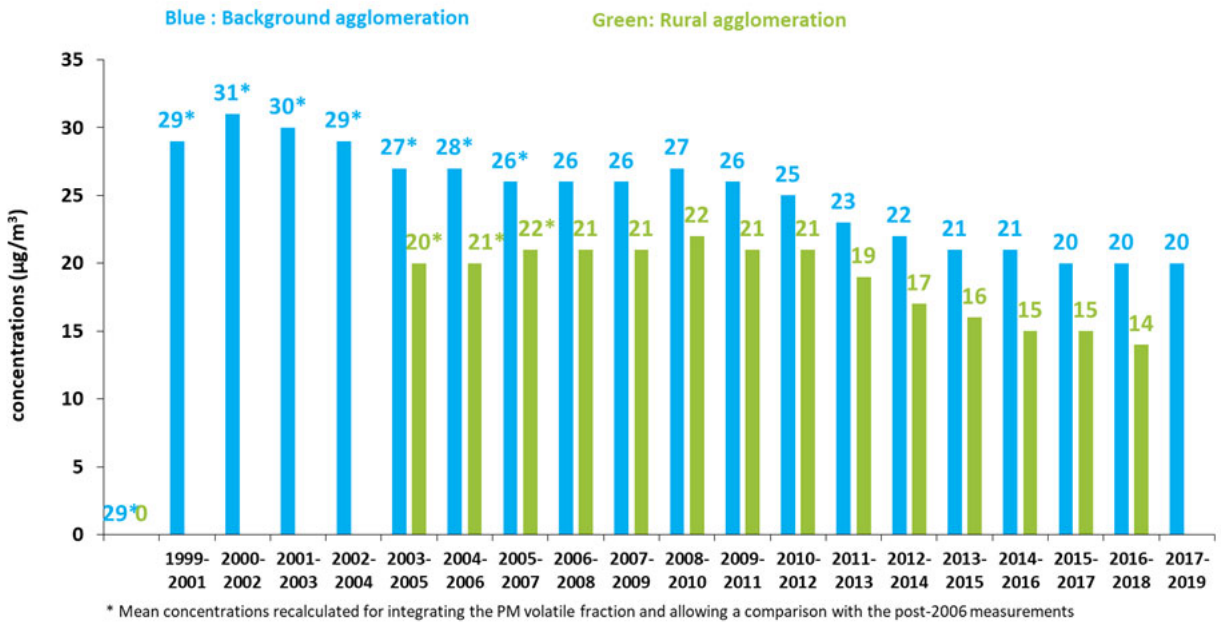


Figure 9: trend in the PM_{10} tri-annual mean concentration (based on a scalable sample of background sites located within and out of the Paris agglomeration) from 1999-2001 to 2017-2019

The Ring road "Boulevard Périphérique (BP) Porte d'Auteuil" traffic monitoring station is providing PM_{10} measurements since 1998 and Place Victor Basch since 2003. The Figure 10 shows **a downward trend of PM_{10} mean concentrations** of around -40 % for BP Porte d'Auteuil between 1998 and 2019. This trend can be explained by a greater decline in particle emissions from road traffic (around -30 % between 2000 and 2015), especially due to **the progressive introduction of diesel particulate filters**.

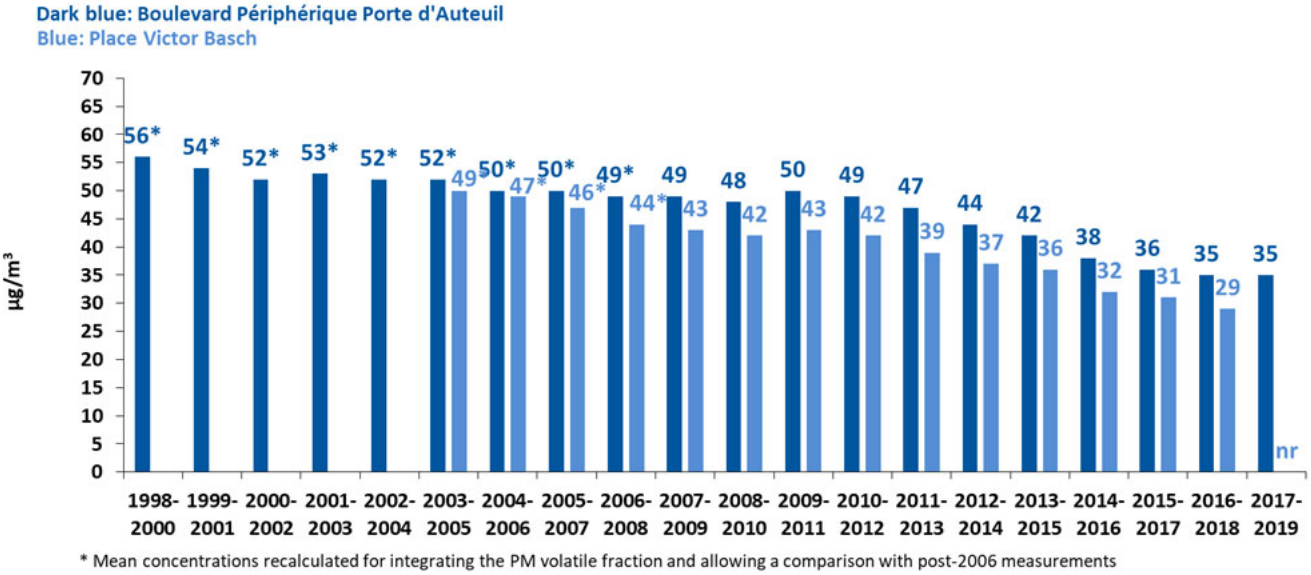


Figure 10: trend in the PM_{10} tri-annual mean concentration at the Place Victor Basch and BP Porte d'Auteuil stations from 1998-2000 to 2017-2019
nr : not representative

2.2 $PM_{2.5}$ particles

SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS

The maps in Figure 11 show the annual mean $PM_{2.5}$ concentration within the Paris region, with a focus on Paris and surrounding subsurbs in 2019.

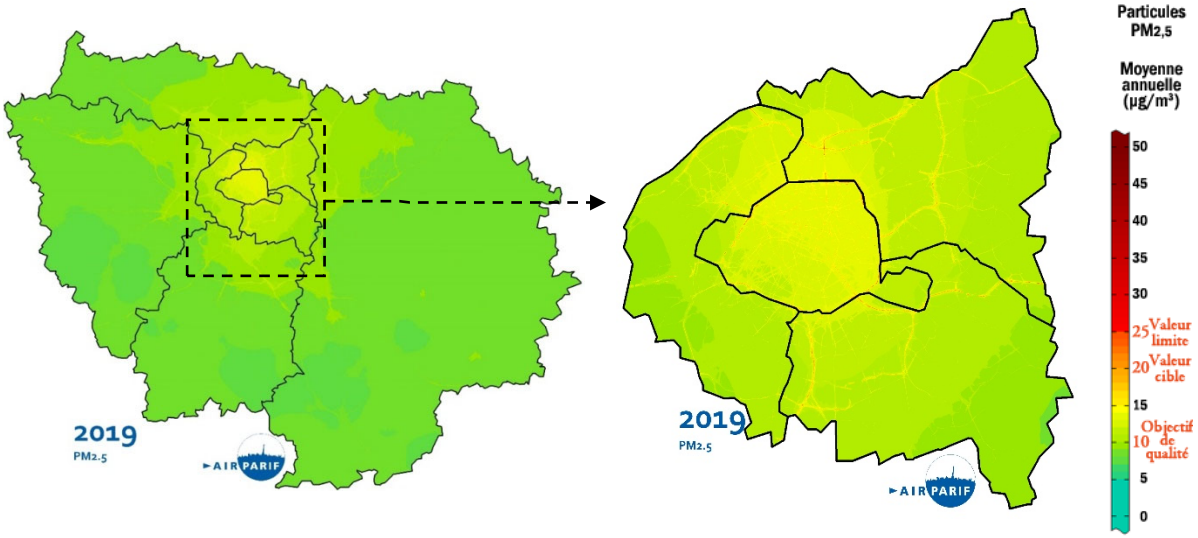


Figure 11: annual mean concentration of fine particles $PM_{2.5}$ in the Paris region, with a focus on Paris and surrounding suburbs in 2019

There is a small difference in $PM_{2.5}$ concentrations between urban and rural areas in 2019. $PM_{2.5}$ annual mean concentrations range from 7 to 9 µg/m³ in rural situation and from 10 to 13 µg/m³ for urban and suburban background sites (Figure 12).

Highest $PM_{2.5}$ mean concentrations are measured within the Paris agglomeration and also near main roads and highway connections. In roadside situation, annual mean $PM_{2.5}$ concentrations range from 14 to 16 µg/m³. They are a little lower than the concentrations measured in 2018.

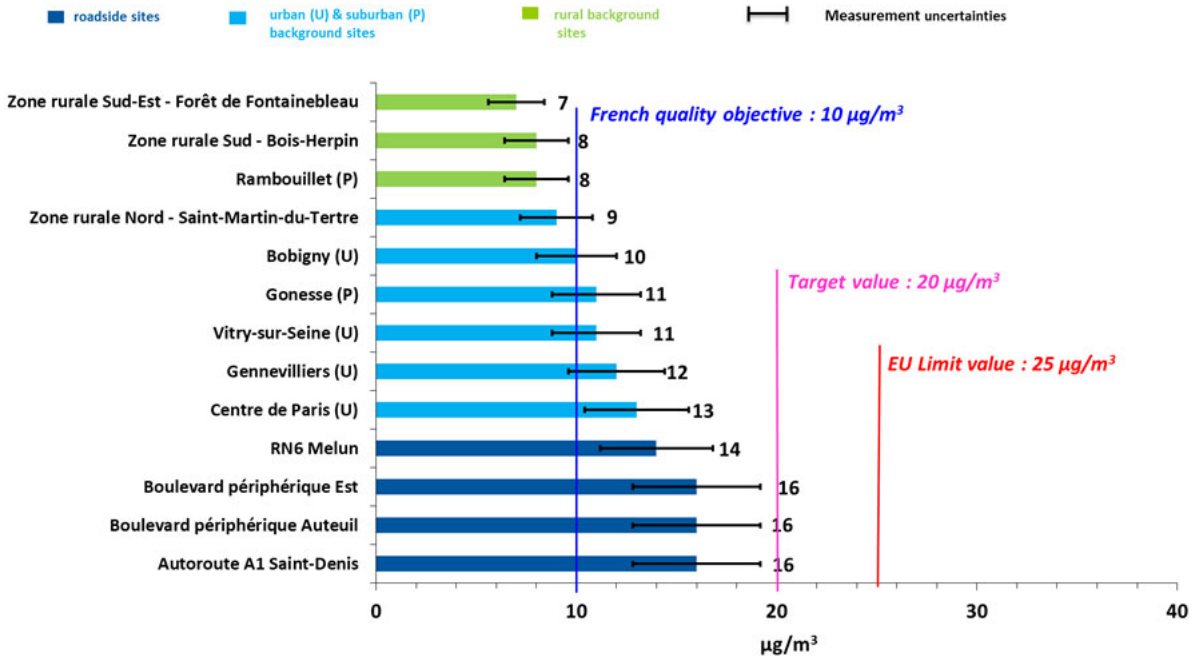


Figure 12: $PM_{2.5}$ annual mean concentration for all continuous monitoring sites in the Paris region in 2019

The EU limit value for fine particles $PM_{2.5}$ (25 µg/m³) ant the $PM_{2.5}$ target value (20 µg/m³) are met at all the monitoring stations.

$PM_{2.5}$ mean levels are above the WHO recommendations and **the French quality objective for fine particles $PM_{2.5}$ (10 µg/m³). More than 50 % of the inhabitants living in the Paris region (or around 6.5 million people) would be exposed to an exceedance of this French $PM_{2.5}$ quality objective (Figure 13).**

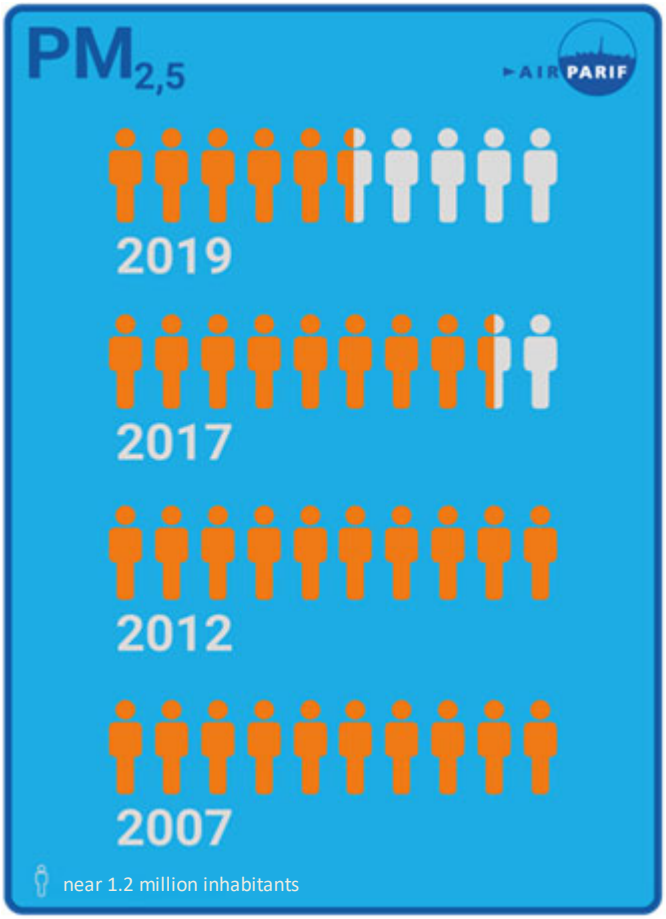


Figure 13: thousands of inhabitants potentially exposed to an exceedance of the French quality objective value for fine particles $PM_{2.5}$ (10 µg/m³) in the Paris region from 2007 to 2019

LONG-TERM TRENDS

As for PM_{10} particles, significant changes related to the occurrence of air pollution episodes are observed for fine particules $PM_{2.5}$, as illustrated in Figure 14.

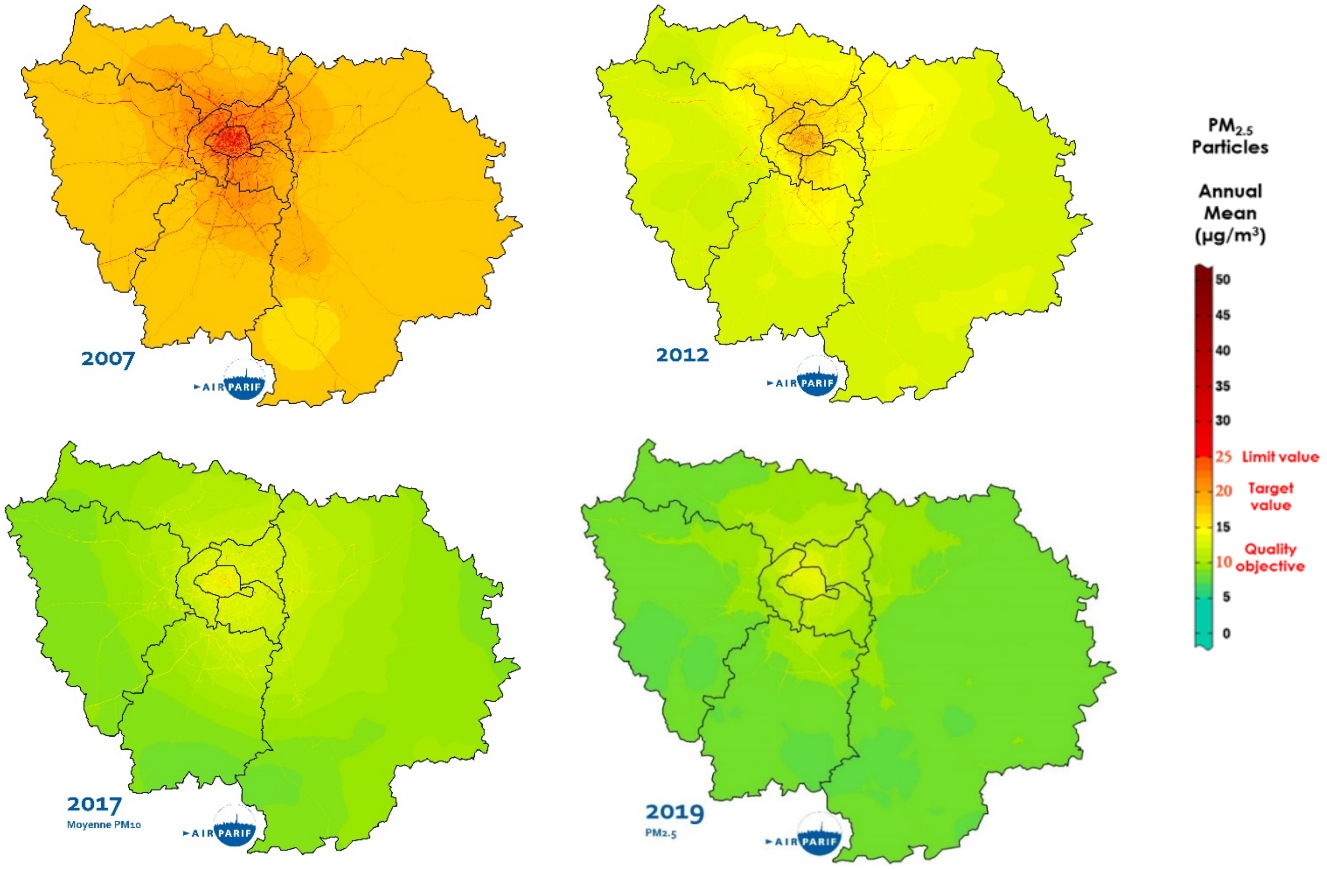


Figure 14: annual mean concentrations of fine particles $PM_{2.5}$ from 2007 to 2019 in the Paris region

$PM_{2.5}$ tri-annual mean levels reflect a significant decline of 45 % from 2000-2002 to 2017-2019 in background situation (Figure 15).

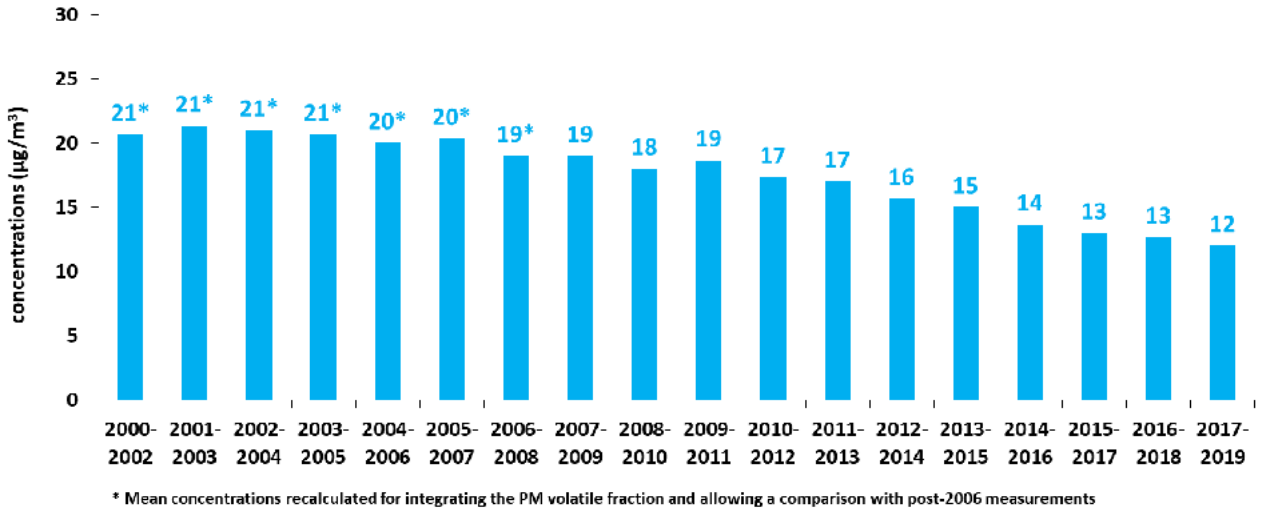


Figure 15: trend in the $PM_{2.5}$ tri-annual mean concentrations (based on a scalable sample of urban background sites) within the Paris agglomeration from 2000-2002 to 2017-2019

The decline of $PM_{2.5}$ concentrations is particularly acute for the Ring road BP Porte d'Auteuil traffic monitoring station (Figure 16). A significant reduction in $PM_{2.5}$ levels of 60 % is observed from 1999 to 2019. As for PM_{10}, this decrease is related to the reduction of primary particles emissions from diesel exhaust (approximately -35 % between 2005 and 2015). **The decrease is greater for $PM_{2.5}$ than for PM_{10} particles as most of $PM_{2.5}$ particles are emitted in vehicles exhaust.** A large part of PM_{10} particles are emitted by tyre-wear, brake-wear, road abrasion and dust suspension.

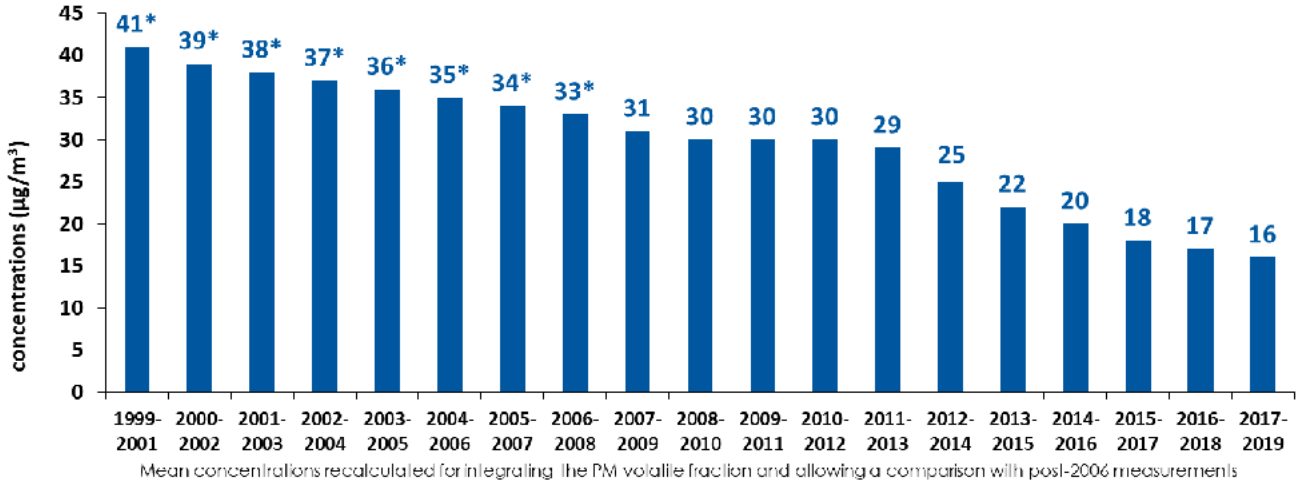


Figure 16: trend in the $PM_{2.5}$ tri-annual mean concentration for the traffic monitoring station Ring road BP Porte d'Auteuil from 1999-2001 to 2017-2019

2.3 Nitrogen dioxide (NO_2)

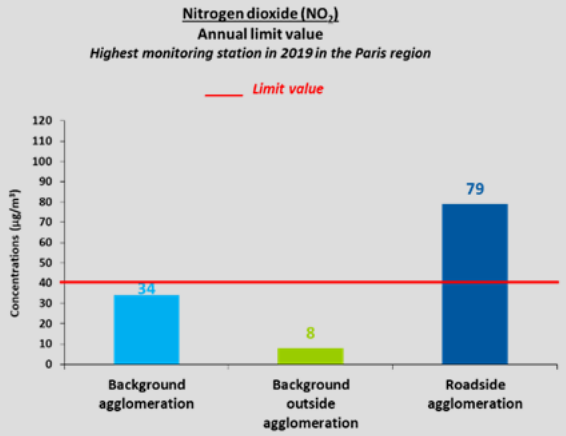
Nitrogen dioxide (NO_2) in brief

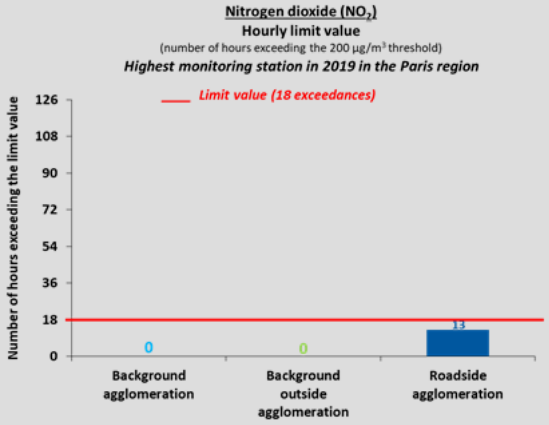
Nitrogen dioxide remains an important issue in the Paris region.

The main source of NO_2 is road traffic.
Levels along major roads are in some cases two times higher than the EU annual limit value.

For the first time, some road traffic sites register average annual concentrations lower than the annual limit value, resulting in a significant decrease of the inhabitants potentially exposed to an exceedance of this limit.

Around 500 000 inhabitants (4 % of the regional population) living in the centre of the agglomeration are potentially exposed to an exceedance of the EU annual limit value.





Summary of air quality standards exceedances for nitrogen dioxide (NO_2) in the Paris region

SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS

The maps in Figure 17 show the annual mean NO_2 concentrations within the Paris region, with a focus on Paris and surrounding subsurbs in 2019.

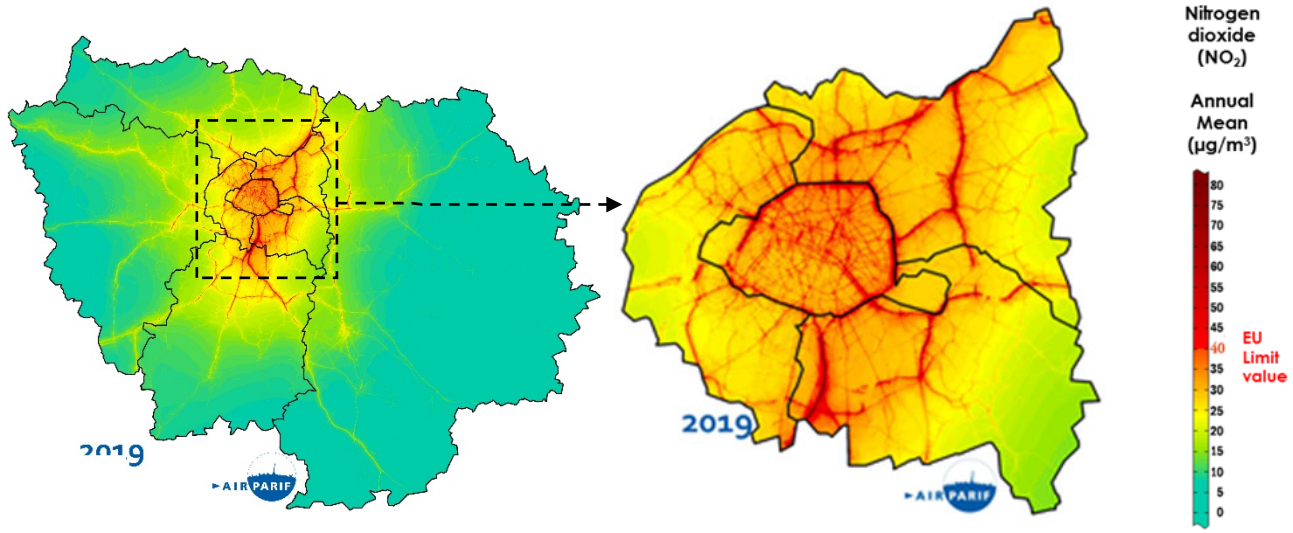


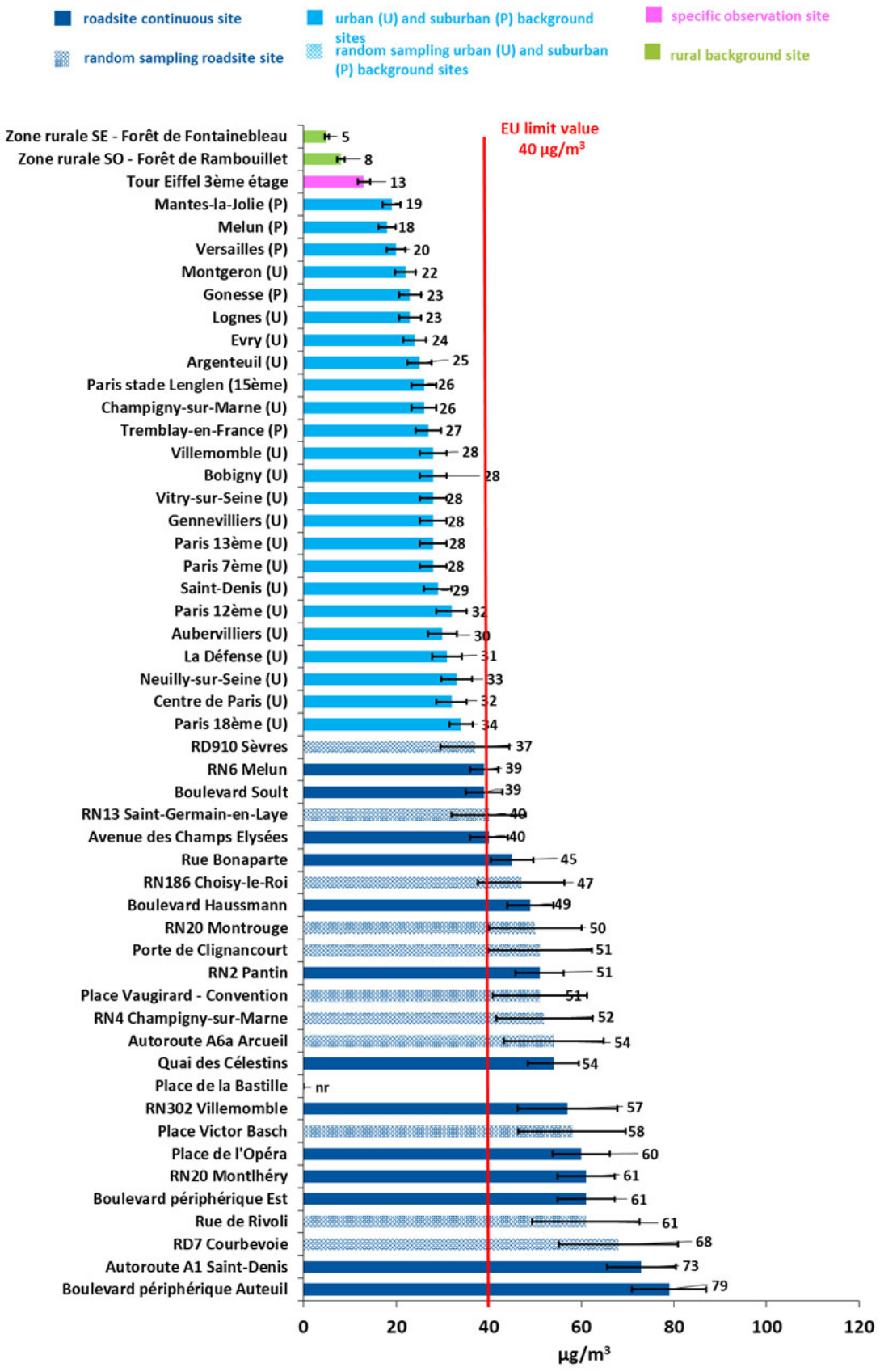
Figure 17: nitrogen dioxide (NO_2) annual mean concentration within the Paris region, with a focus on Paris and surrounding suburbs in 2019

There is a **strong NO_2 background concentrations gradient** between rural areas and the centre of the Parisian conurbation. Thus, annual mean levels measured within the agglomeration reach 34 µg/m³ (Figure 18) and the mean regional background level of NO_2 is between 5 and 10 µg/m³ in 2019.

Highest NO_2 mean concentrations are measured within the Paris agglomeration, near major traffic roads (motorways and national highway). In Paris, the right bank of the Seine River is broadly more polluted than the left bank because of higher roads density.

Since 2015, the EU limit value for nitrogen dioxide (40 µg/m³) has been met at all the monitoring stations in background situation. In 2019, background mean concentrations are lower than those measured in the previous years.

NO_2 levels along major roads are more than twice those in background situation. In some cases, they are two times higher than the EU annual limit value. The threshold exceedance has been confirmed in 2019 for approximately 1330 kilometres of roads and highway connections. This corresponds to approximately 12 % of the main road network modeled by Airparif. These road axes are mainly located in the urban area of Paris.



In addition to continuous measurements of NO_2, discontinuous measurements are performed by AIRPARIF since 2007. These measurements are carried out using passive diffusion tubes during 12 uncontinuous weeks evenly distributed over the year. For these sampling sites, the results reported in this figure represent the average of twelve weeks measurements.

Figure 18: nitrogen dioxide (NO_2) annual mean concentration for all monitoring sites in the Paris region in 2019

NO_2 mean concentrations are highly variable from one traffic site to another. It reflects a wide range of concentrations measured near major traffic roads and are due to **differences in traffic conditions** (traffic flow, speed, vehicle fleet) **and topography** that are more or less favorable to the pollutants dispersion.

In 2019, **around 500 000 inhabitants are potentially exposed to an exceedance of the NO_2 EU annual limit value (Figure 19)**. They are mainly living within the Parisian agglomeration. **Around 10 % of the Paris inhabitants** are concerned by the exceedance of the NO_2 annual limit value.

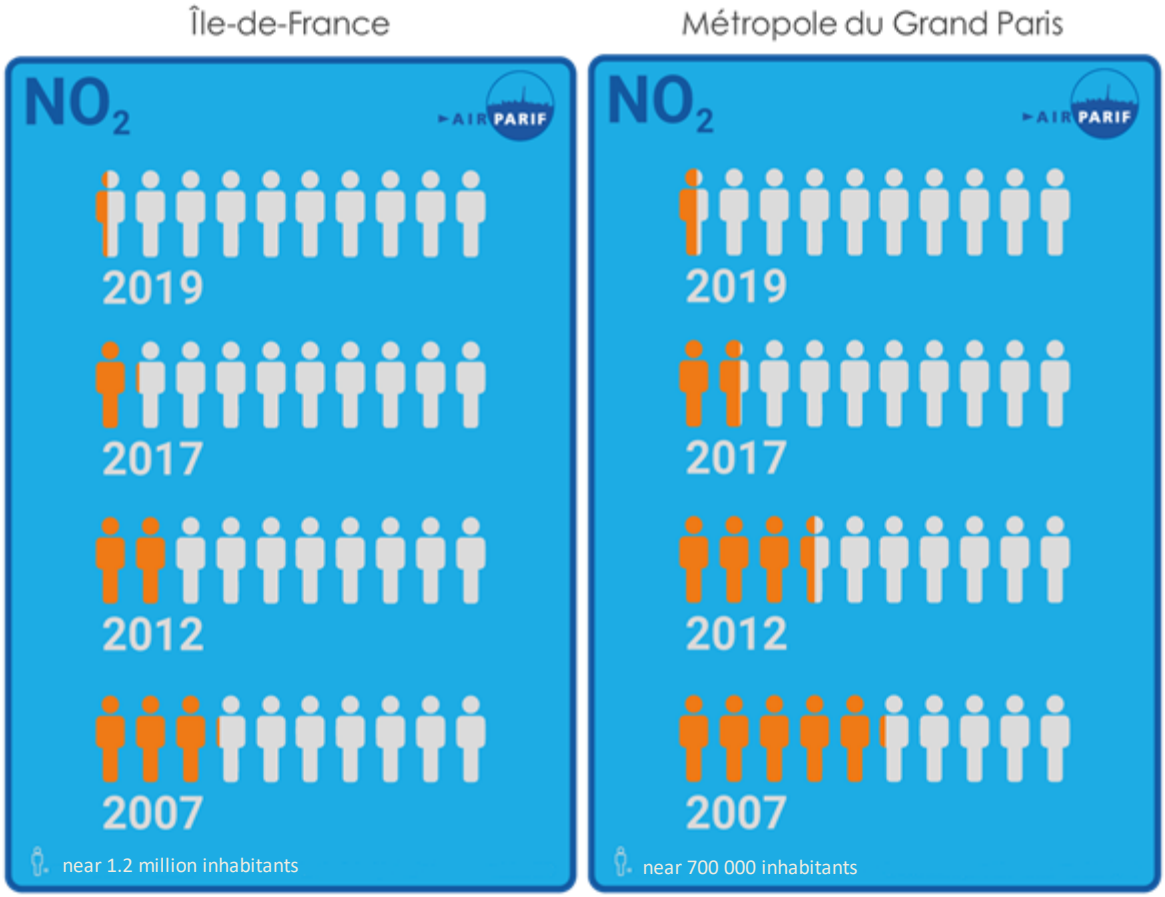


Figure 19: million of inhabitants potentially exposed to a nitrogen dioxide (NO_2) level exceeding the EU annual limit value in the Paris region from 2007 to 2019

Due to the high road density within the Paris region, modelling tools do not currently allow any estimation of the number of hours exceeding the NO_2 hourly threshold (200 µg/m³) throughout the regional road network. Developments are ongoing to estimate kilometres of roads, surface areas and the number of inhabitants exposed to an exceedance of this NO_2 hourly limit value (200 µg/m³ not to be exceeded more than 18 times per year).

In 2019, **the NO_2 hourly limit value is met** on every monitoring station. The site having recorded the maximum hours of exceedance of 200 µg/m³ is the traffic station Ringroad BP Auteuil (13 hours). This site does not allow, regarding European criteria, to assess the exceeding of the limit value, because the public does not have access to it. Nevertheless, it allows us to characterize the maximum impact observed in the immediate vicinity of a major axis, which is particularly representative of the exposure of the users of this axis.

LONG-TERM TRENDS

The maps in Figure 20 show a similar pollution pattern illustrating **a downward trend of NO_2 annual mean concentrations between 2007 and 2019 within the Paris region.**

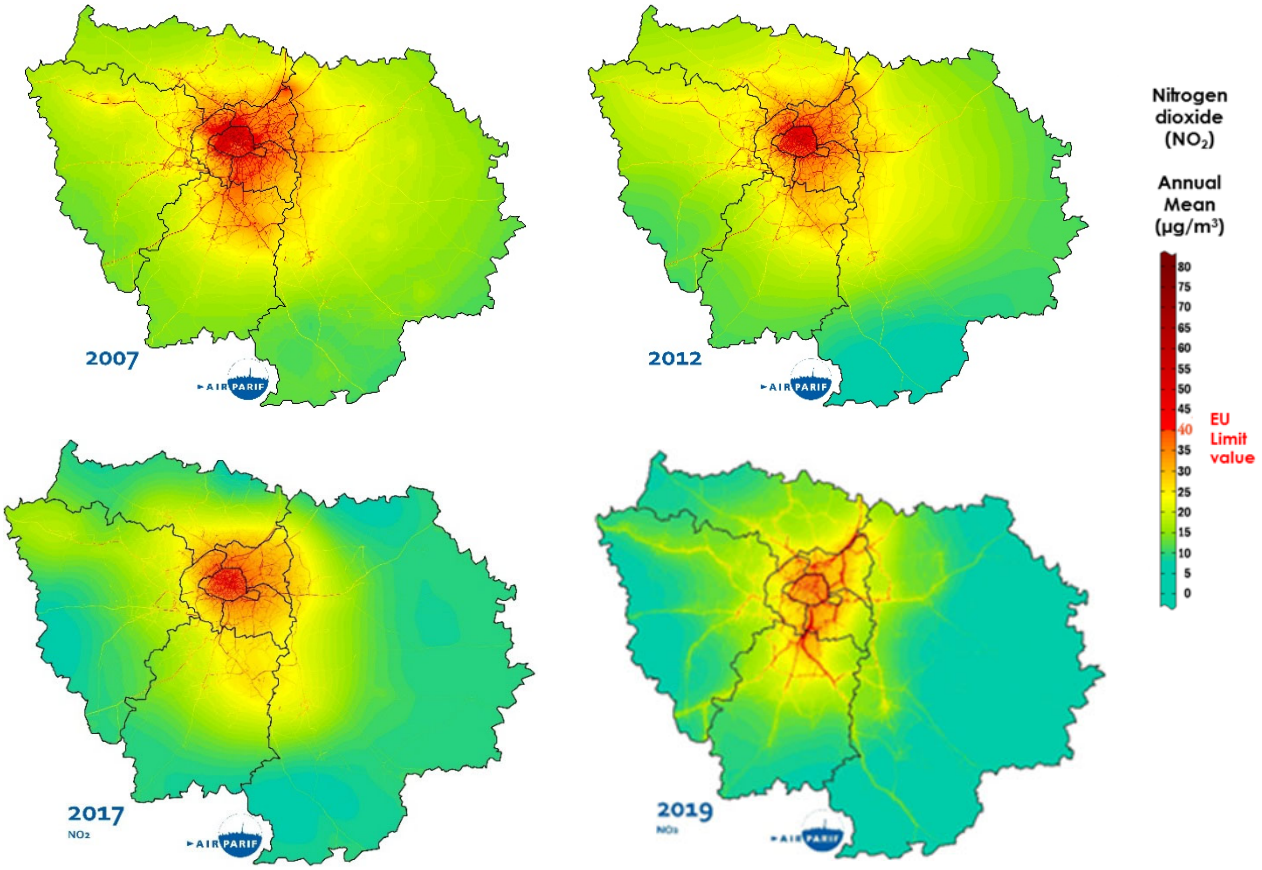


Figure 20: annual mean concentrations of nitrogen dioxide (NO_2) from 2007 to 2019 in the Paris region

A downward trend of NO_2 tri-annual mean levels is observed since the end of the 1990's on background sites (Figure 21). Technological improvements of emission sources (road traffic, heating, industry) can explain reduced NO_2 levels, especially due to **the progressive expansion of catalytic converters on gasoline and diesel vehicles.** NO_2 tri-annual mean concentrations are broadly stable from 1992-1994 to 1999-2001. The average annual decrease of about -3 % from 2000 to 2006. It is slower since then (with an annual average of around -2 %). Between 1992 and 2019, the annual background concentrations decreased by around 40 %.

The trend in NO_2 tri-annual mean concentrations is quite different in roadside situation. **NO_2 levels based on a permanent sample of traffic stations are broadly constant between 1998 and 2012. A downward trend of NO_2 concentrations is observed since the 2011-2013 period**. From 2011 to 2019, annual concentrations in proximity to road traffic decreased by around 30%. Over this period, the average annual decrease is 3%.

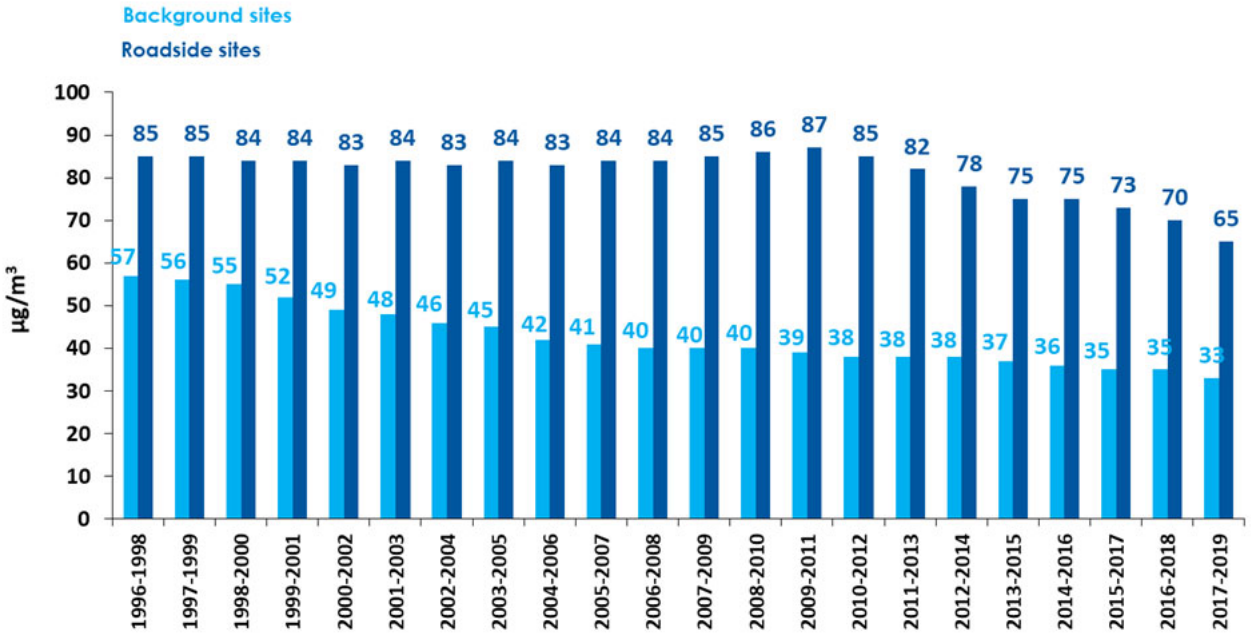


Figure 21: trend in the NO_2 tri-annual mean concentration (based on a sample of the same 6 urban background sites and 5 roadside sites) within the Paris agglomeration from 1996-1998 to 2017-2019

Nitrogen dioxide (NO_2) is a complex pollutant related to direct emissions (from transport, heating and industry sectors) and chemical reactions with other atmospheric pollutants, especially ozone (O_3).

A study on the specific impact of traffic measures to improve air quality in Paris and London has been conducted by the King's College and Airparif (Font et al., 2019). This study focuses specifically on the share of pollution related to road traffic. It enables to highlight the influence of the evolution of the road fleet, in connection with the implementation of the euro standards and the local measures aiming at reducing traffic emissions.

Over the 2005-2009 period, the overall stability of NO_2 levels close to traffic is mainly due to the dieselisation of the road fleet. Indeed, numerous studies show that the treatment carried out to reduce particulate emissions has led to an increase in primary NO_2 emissions since the introduction of Euro 3 diesels (Grice et al., 2009, Weiss et al., 2012; et al., 2016).

The decrease of NO_2 levels near traffic is related to the introduction of the Euro 5 standard, especially for heavy vehicles. However, the Euro 5 standard on light diesel vehicles did not lead to a significant decrease in actual emissions. Indeed, the emissions of this pollutant in real traffic conditions are way higher than the standards corresponding to this standard.

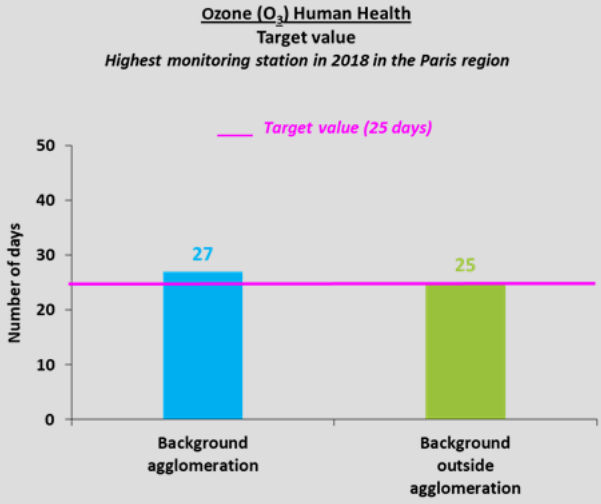
One of the major reasons to the changes of nitrogen dioxide levels, both in terms of background and proximity to road traffic situations, is linked to the renewal of the road fleet and the evolution of NO_2 primary emissions by diesel vehicles.

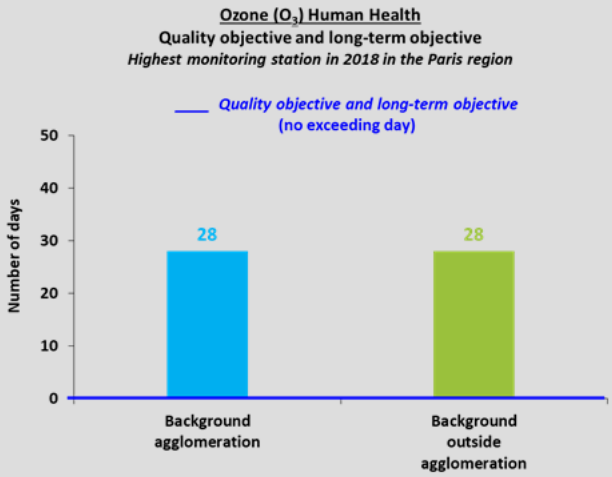
2.4 Ozone (O_3)

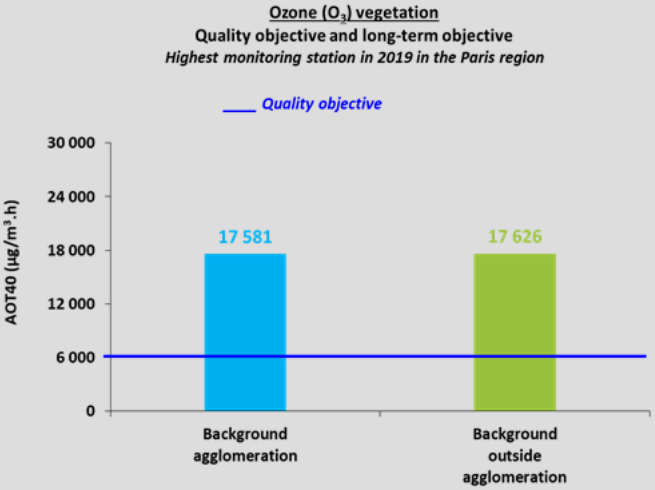
Ozone (O_3) in brief

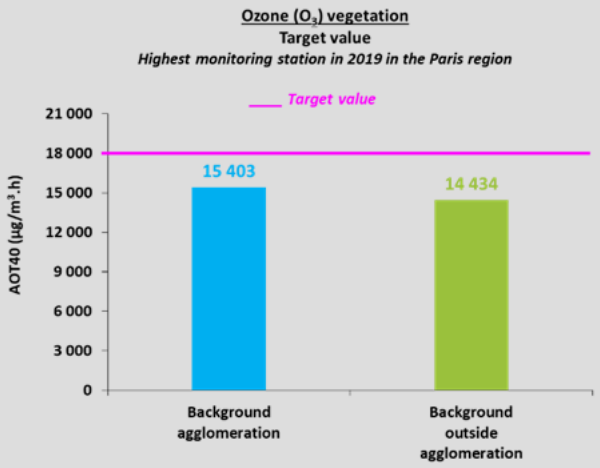
Quality objectives for the protection of health and vegetation are exceeded at any point of the region in 2019.
Target value for the protection of Human Health is afresh exceeded, especially in some peri-urban and rural areas.
100 % of the population is affected by the exceedance of the WHO recommendation value (100 µg/m³ over 8 hours).

Ozone remains an important issue in the Paris region. It is the only pollutant with increasing annual concentrations.









Summary of air quality standards exceedances for ozone (O_3) in the Paris region

SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS

Ozone (O_3) is a secondary pollutant (and also a greenhouse gas) not directly emitted to the atmosphere but formed in air from complex reactions between the precursor gases (nitrogen oxides (NO_x) and volatile organic compounds (VOC)) in the presence of sunlight and high temperatures. Meteorological conditions (especially in spring and summer) influence O_3 concentrations.
2019 was a hot and sunny year. The anticyclonic conditions observed from June to August 2019, coupled with several heat waves and a high level of sunshine, led to a rise in summer ozone concentrations. As a result, ozone levels are much higher than those recorded in 2017 (in particular the parameters for exceedances of the threshold of 120 µg/m³ on a maximum daily 8-hours mean), but lower than those of 2018, were the summer weather conditions were even more intense.

Protection of Human Health

As in previous years, **the O_3 quality objective for the protection of human health** (120 µg/m³ on a maximum daily 8-hours mean per civil year) **is exceeded over the whole Paris region in 2019 (Figure 22). Suburban and rural areas are more commonly affected than the Paris agglomeration.** Annual prevailing meteorological conditions (mainly summer conditions) have an impact on the number of threshold exceedances.

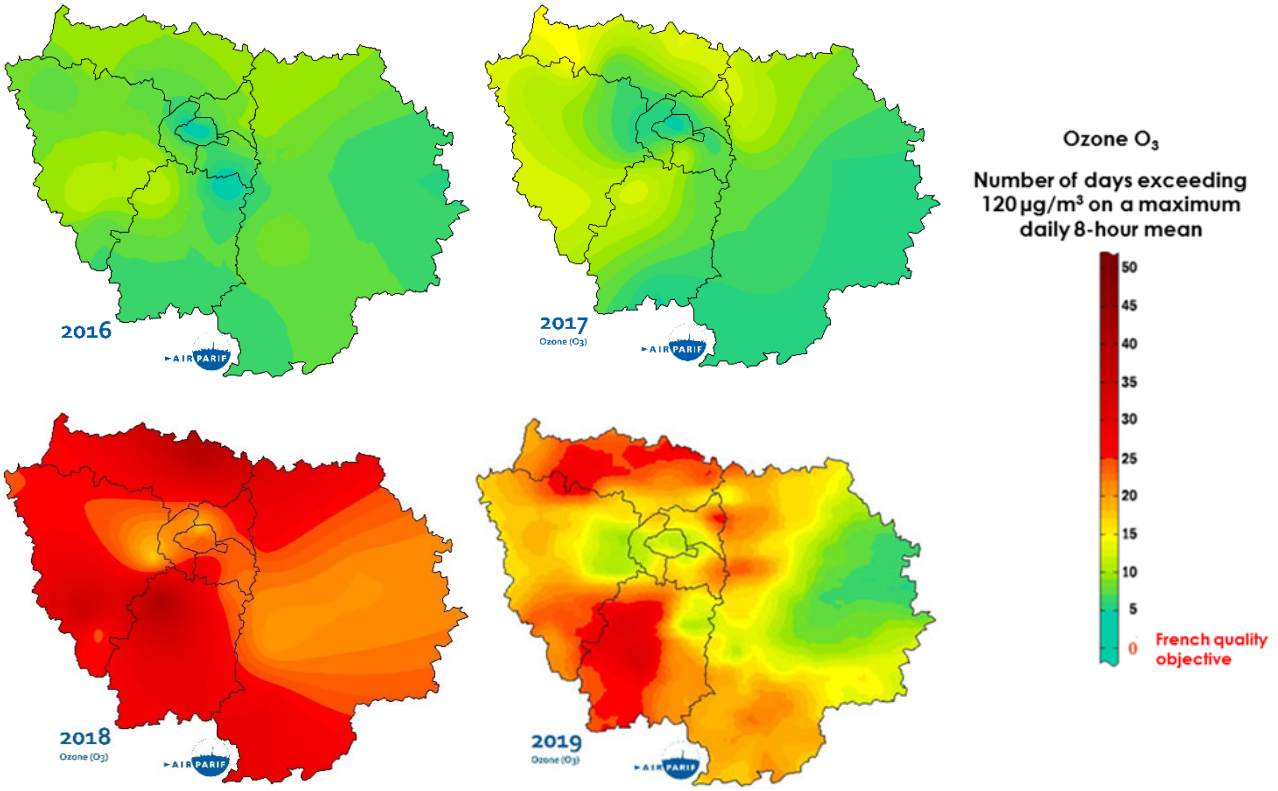


Figure 22: number of days exceeding the French quality objective (=EU long-term objective) threshold of 120 µg/m³ on a maximum daily 8-hours mean (objective = no exceedance) for ozone (O_3) in the Paris region from 2016 to 2019

Due to higher sunlight and temperatures from June to September, **the year 2019 recorded a number of days of exceeding the quality objective way higher than in 2017, but lower than in 2018.**

The **target value for the protection of human health** (calculated on a 3-years average) was exceeded until 2007 within southwest rural areas and in the north of the Paris region, and then complied until the 2006-2008 period. **This regulating threshold is afresh exceeded in the Paris region,** on the 2017-2019 period, **more specifically in some rural and suburban areas of the Essonne and Val d'Oise departments**(Figure 23).

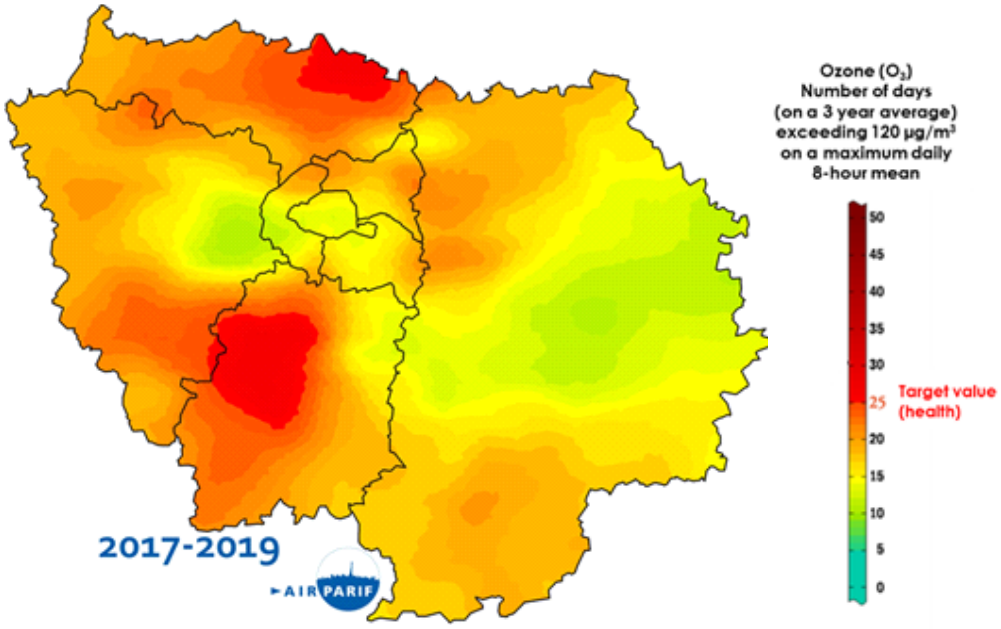


Figure 23: number of days exceeding the O_3 target value for the protection of human health (120 µg/m³ for the daily maximum on an 8-hours average not to be exceeded more than 25 days per calendar year calculated on a 3-years average) within the Paris region for the 2017-2019 period

The average number of days exceeding the O_3 target value is usually higher in rural and suburban areas than in the Paris agglomeration (Figure 24). This is due to the « ozone sinks » effect. It is specific to large metropolitan areas which concentrate NO_x sources from road traffic and residential heating. As a consequence, ozone is consumed by NO_x emissions through photochemical reactions.

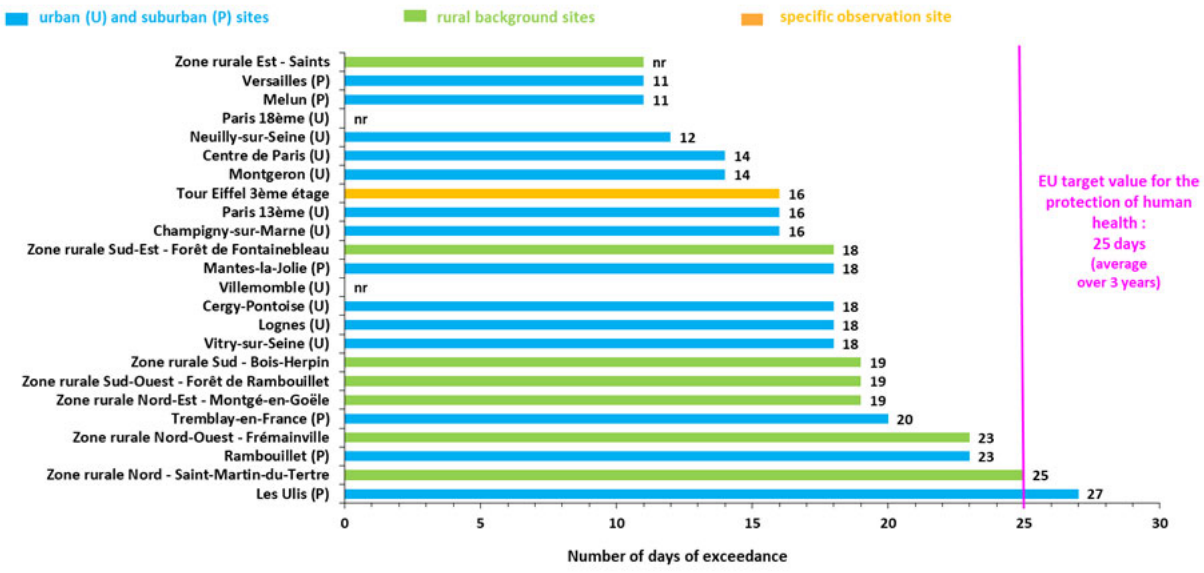


Figure 24: number of days exceeding the O_3 EU target value for the protection of human health (120 µg/m³ 8-hours) in the Paris region (average 2017-2019)

Protection of vegetation

Many scientific studies have revealed the ozone negative effects on the vegetation (forests, ecologically or biologically significant areas and cereal/wheat crops) due to its strong oxidizing action. Consequently, European regulations focus the quality objectives and target values for the protection of vegetation on growing vegetation and crops periods, in the spring and early summer. AOT 40 (corresponding to '*Accumulated Ozone exposure over a Threshold of 40 parts per billion (ppb)*') means the sum of the difference between hourly concentrations greater than 80 µg/m³ and 80 µg/m³ over a given period using only the one-hour value measured between 8.00 am and 8.00 pm Central European Time (CET) each day. It is expressed in µg/m³.h⁻¹.

The EU target value for the protection of vegetation (18 000 µg/m³.h⁻¹) is calculated on a 5-year average. The averaged value is less prone to fluctuations from one year to the next. In 2019, **the EU target value is met in the whole Paris region.** The highest average recorded per station over the 2015-2019 period is 15 403 µg/m³.h⁻¹ (+3 % compared to 2018).

As every year, the French quality objective for the protection of vegetation (6 000 µg/m³.h⁻¹ from May to July 8 am to 8 pm, equivalent to EU long-term objective) **is exceeded in the Paris region.** In 2019, all the stations of the Airparif network recorded levels above the quality objective for the protection of vegetation, as in 2018. Exceedance is generally pronounced in rural and peri-urban areas aimed by this protection threshold, where the levels are up to about 3 times higher than the norm (Figure 25).

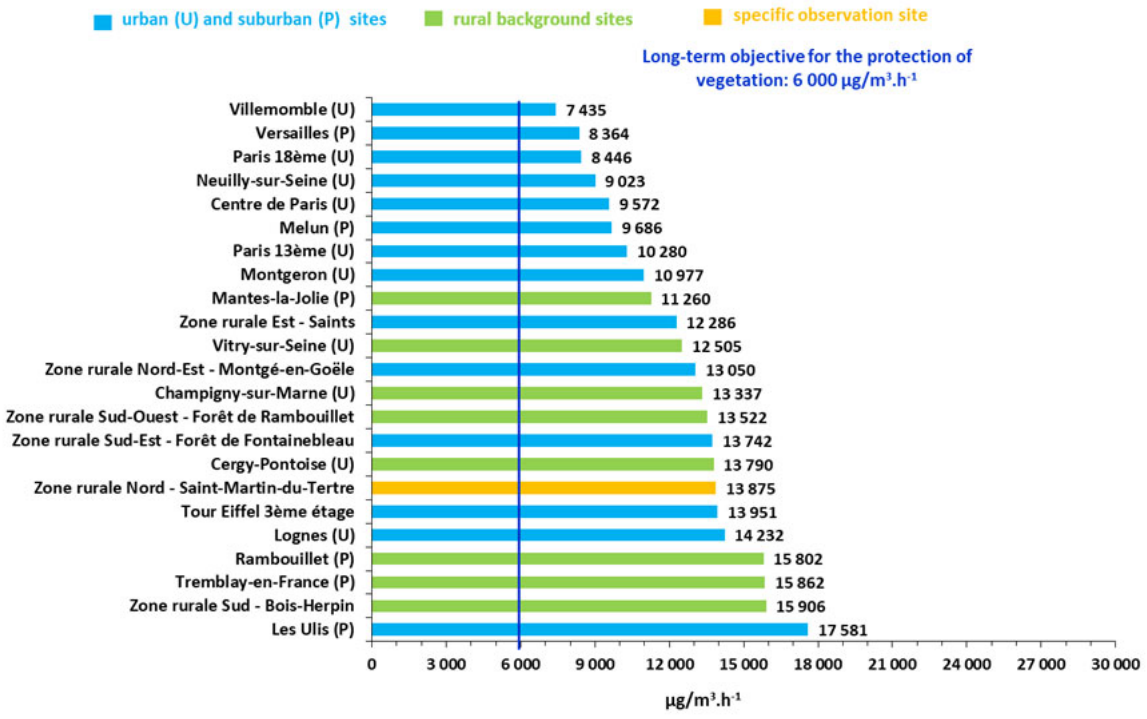


Figure 25: long-term objective in ozone (O_3) for the protection of vegetation (AOT40, threshold of 6 000 µg/m³.h⁻¹) in the Paris region in 2019

AVERAGE ANNUAL TRENDS FOR THE PROTECTION OF HUMAN HEALTH

Due to strong interannual fluctuations related to meteorological conditions, **the average number of exceedance days of the quality objective for the protection of human health (120 µg/m³ 8-hours average) can vary considerably over time.** It depends on summer weather conditions, and in particular the presence of durably warm periods.

The year 2019 is characterized by an average insulation and a number of days of high heat above average (22 in 2018, 20 in 2019). The number of days exceeding the quality objective in the agglomeration and in rural areas in 2019 are higher than those of the last ten years (Figure 26) except for 2018.
This number of days exceeding the quality objective is lower than to those of 2018 and way below the year 2003 which had experienced a very intense heat wave.

Over the period 1998-2019, **the number of exceedance days does not show a clear downward trend. It still exceeds the quality objective** (no exceedance allowed).

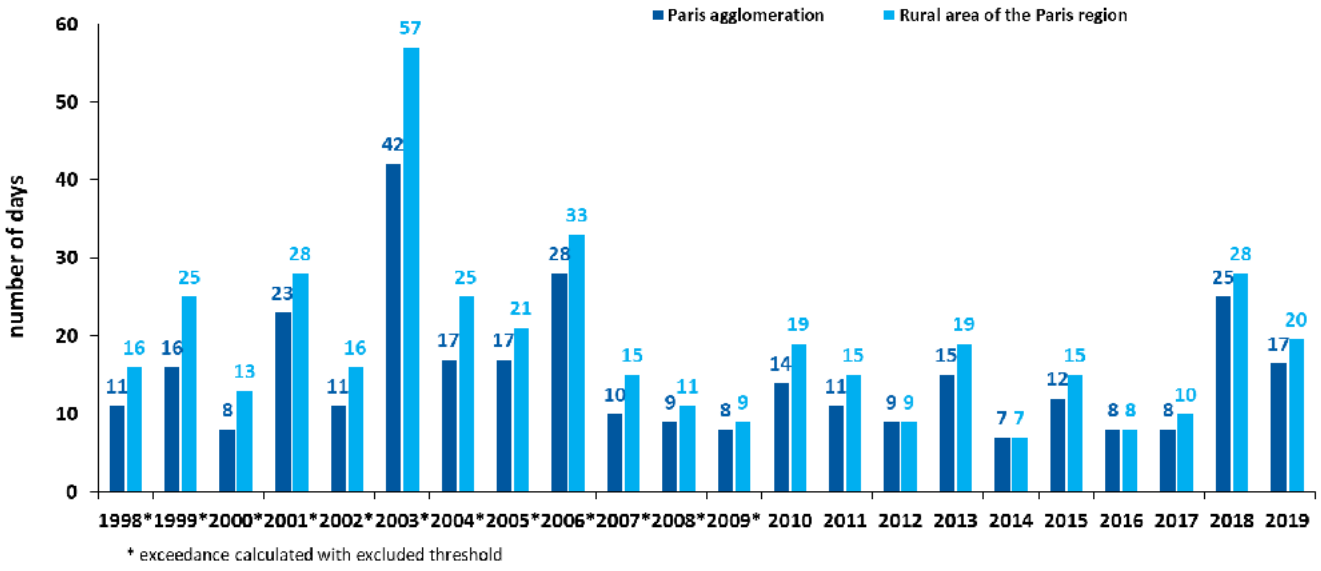


Figure 26: average number of days exceeding the O_3 french quality objective for the protection of human health (120 µg/m³ 8-hours average) in the Paris region from 1998 to 2019

Due to the strong dependence to weather conditions, the evolution of the number of days exceeding the threshold of 120 µg/m³ over 8 hours can only be meaningful in the medium term. The number of days exceeding the EU target value for the protection of human health on a 3-year period is shown in Figure 27.

From 2006-2008 to 2016-2018, this regulated threshold has been met in the agglomeration and rural areas of the Paris region. The period from 2007-2009 to 2015-2017 has the lowest number of exceeding days of the entire history.
The number of days exceeding the target value is increasing since the 2016-2018 period (Figure 27). This increase is due to the 2018 and 2019 exceptional summer weather conditions, with high temperature and sunshine, leading to high ozone concentrations. **The return of an exceedance of the target value over the 2017-2019 period prevents establishing a clear trend and estimating the risk of exceedances for the coming years.**

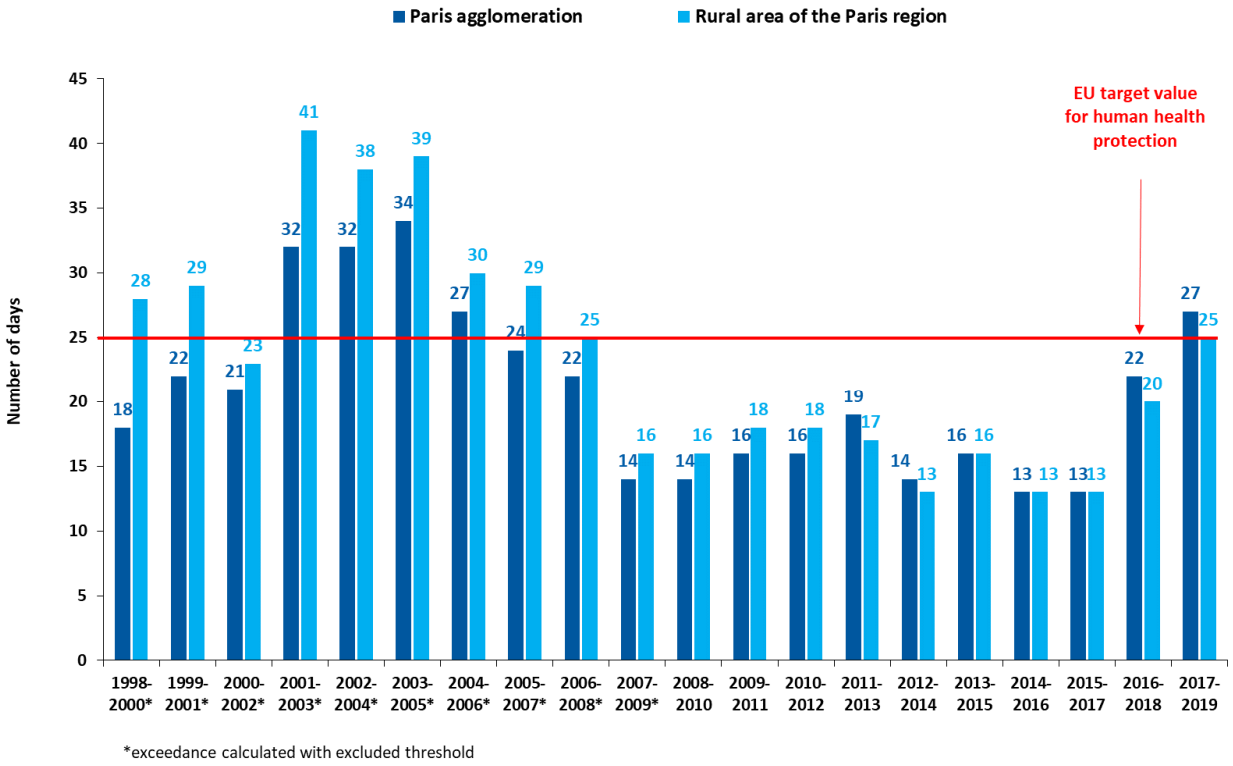


Figure 27: number of days exceeding the EU target value for the protection of human health (120 µg/m³ 8-hour average, not over 25 days of exceedance on a 3-year period) for the highest monitoring station in the Paris region from 1998-2000 to 2017-2019

The trend of the O_3 tri-annual mean concentrations measured within the Paris agglomeration is shown in Figure 28. These O_3 levels have risen by 94 % between 1994 and 2019. **The annual average rate reached 7 % per year between 1994 and 2003. Between the 2001-2003 and 2015-2017 periods, urban background ozone concentrations were statistically stable.** The 2017-2019 period has the highest average ozone concentrations of the entire history.

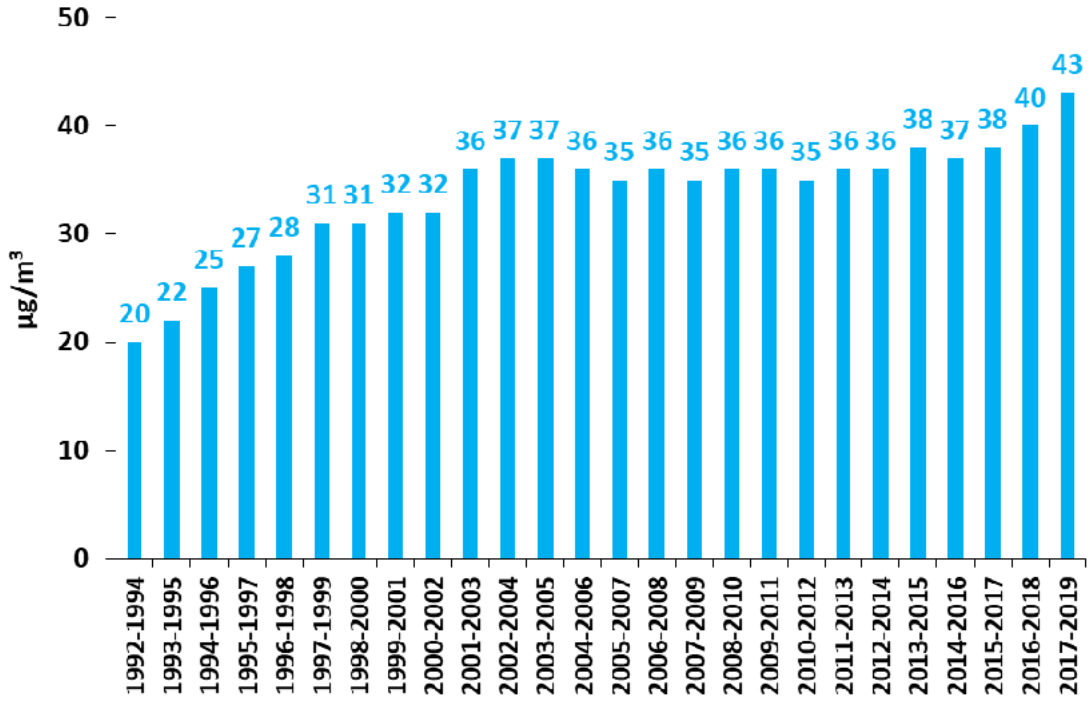


Figure 28: trend in the O_3 tri-annual mean concentrations (based on a sample of the same three urban background sites) within the Paris agglomeration from 1992-1994 to 2017-2019

2.5 Benzene (C_6H_6)

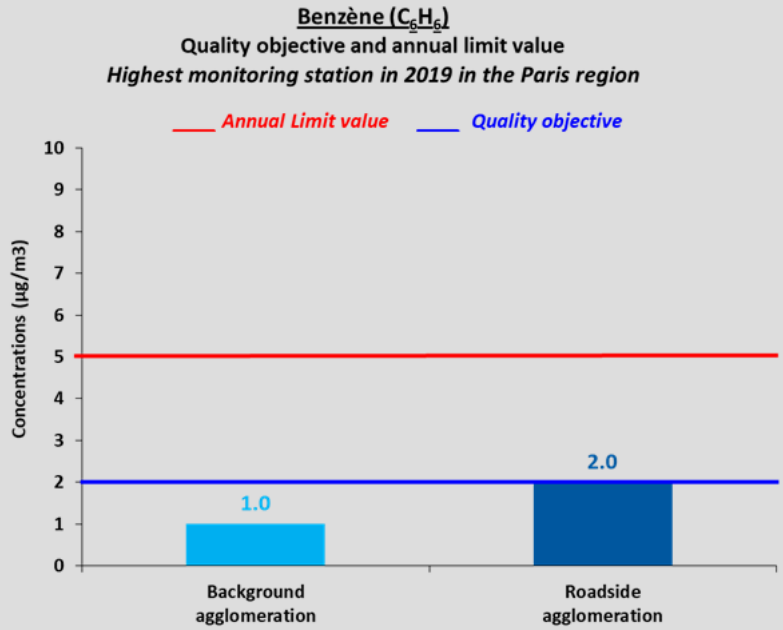
Benzene (C_6H_6) in brief

Annual limit value for benzene (5 µg/m³) has been met everywhere in the Paris region since 2006. Complied in background situation, the quality objective (2 µg/m³) can be very locally exceeded near some parisian roads.

Less than 1 % of the regional population are potentially exposed to an exceedance of the annual quality objective (2 µg/m³).

The decreasing trend of benzene levels observed within the Paris region from 1994 to the beginning of the 2000's goes on but at a significantly lower pace over the 2007-2019 period.

Benzene levels slightly decreased between 2018 and 2019.



Summary of air quality standards exceedances for benzene (C_6H_6) in the Paris region

The maps in Figure 29 show the annual mean benzene concentrations within the Paris region, with a focus on Paris and surrounding subsurbs in 2019.

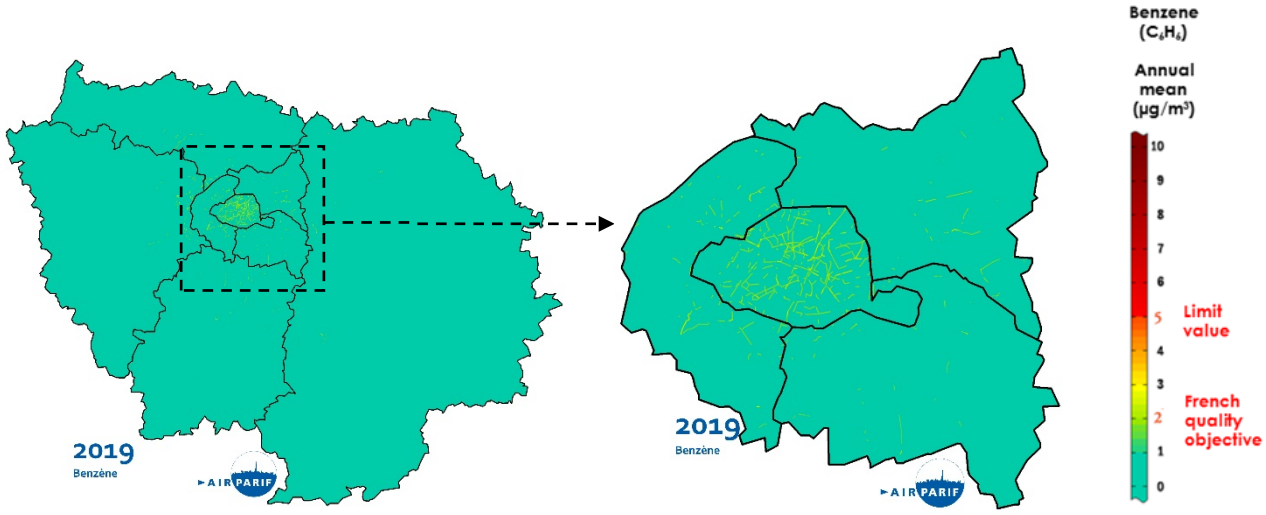


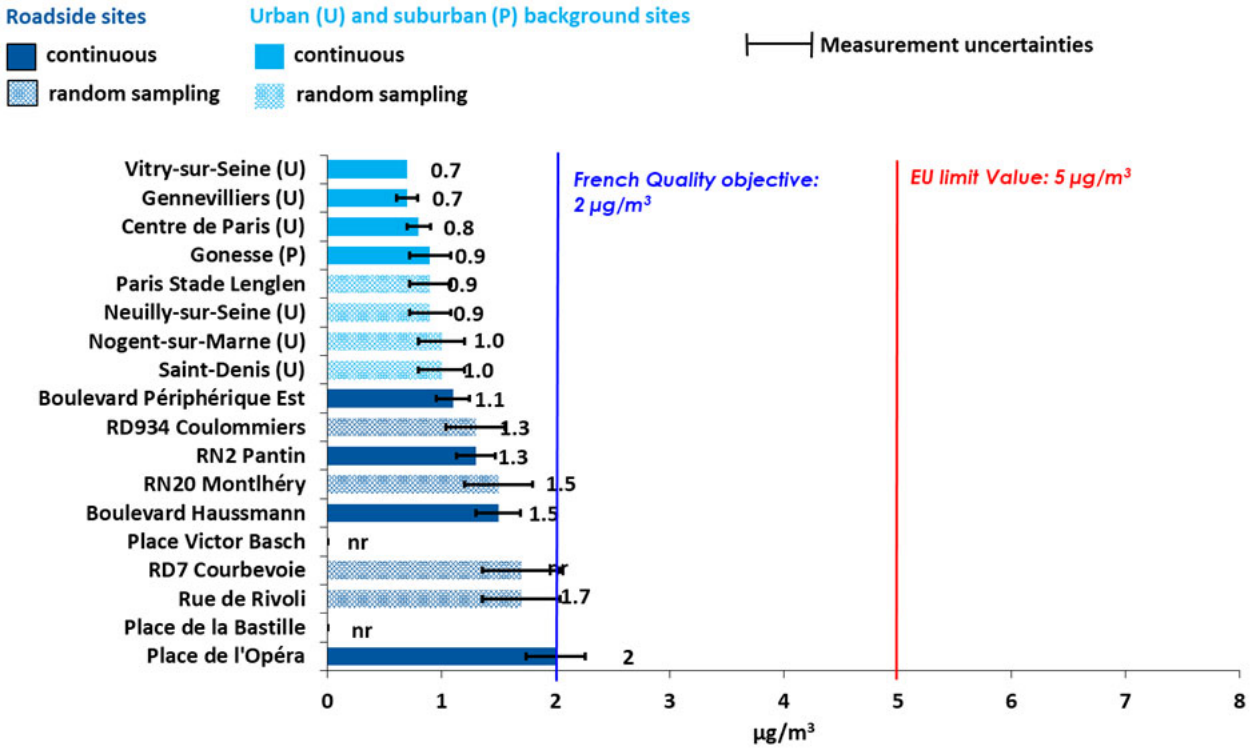
Figure 29: annual mean concentration of benzene (C_6H_6) in the Paris region, with a focus on Paris and surrounding suburbs in 2019

Every year, annual mean concentrations of benzene are slightly higher in the centre of the Paris agglomeration than in the periphery of the region. Background benzene concentrations are lower than the French quality objective and the EU annual limit value (2 and 5 µg/m³, respectively). In 2019, background benzene levels (from 0.7 to 1 µg/m³) are similar to those of the last four years (Figure 30).

Highest annual mean concentrations of benzene are measured near main roads located in the Paris agglomeration, due to traffic-clogged conditions associated with unfavourable conditions for pollution dispersion (major traffic roads contained in the urban fabric like street canyons). These concentrations are between 1.1 and 2 µg/m³ for the traffic monitoring stations. They are in the same range than those measured over the last four years.

For several years now, benzene levels are on a slightly downward trend, especially along traffic roads.

In 2019, the French quality objective (2 µg/m³) is met on every monitoring station. Benzene annual levels are way lower than the EU limit value (5 µg/m³). These finding are based on modeling results and measurement network observations, especially onto heavily-loaded traffic roads. Highest concentrations can be observed in close proximity to emission sources such as service stations or garages.



In addition to continuous measurements of benzene, discontinuous measurements are performed by AIRPARIF since 2007. These measurements are carried out using passive diffusion tubes during 12 uncontinuous weeks evenly distributed over the year. All these sites are characterised by a high pedestrian density and the presence of residences near road axes. For these sampling sites, the results reported in this figure represent the average of twelve weeks measurements.

Figure 30: annual mean concentration of benzene in the Paris region in 2019

In 2019, less than 1 % of the regional population are potentially exposed to an exceedance of the annual quality objective for benzene. People concerned by this exceedance are mainly living within the Paris agglomeration.

The number of inhabitants potentially exposed to an exceedance of the benzene quality objective has dropped significantly since the beginning of the 2000's. In 2002, 3.2 million inhabitants were potentially concerned by this threshold exceedance.

AVERAGE ANNUAL TREND

After a significant decrease of benzene concentrations since the beginning of the 2000's (-66 % between 1994-1996 and 2000-2002, due to the decline in the benzene content of petrol), levels are rather stable in the recent years (Figure 31).

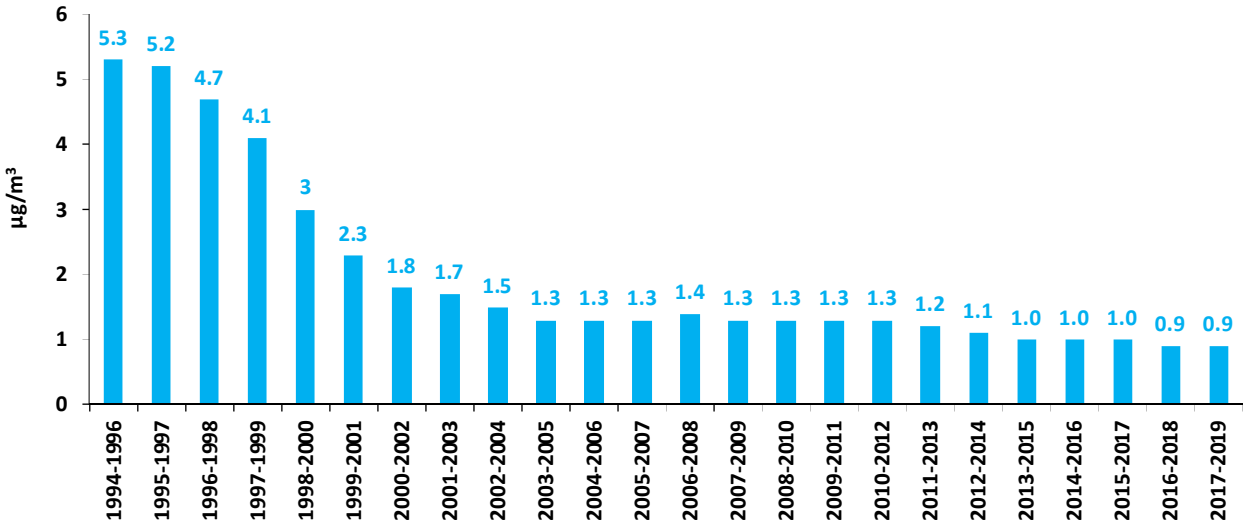


Figure 31: trend in the benzene tri-annual mean concentrations (based on a scalable sample of urban background sites) within the Paris agglomeration from 1994-1996 to 2017-2019

In roadside situation, the trend in benzene concentrations is consistent with those of other primary pollutants directly emitted by road traffic (particles, NO_2). However, a decline in benzene levels is more marked since 2000 (date on which an EU regulation limiting the benzene content in petrol is implemented) (Figure 32). Benzene average concentrations decreased by approximately threefold from 1994-1996 to 2000-2002. This decline has slowed down substantially since 2007 (-50 % between 2009 and 2019).

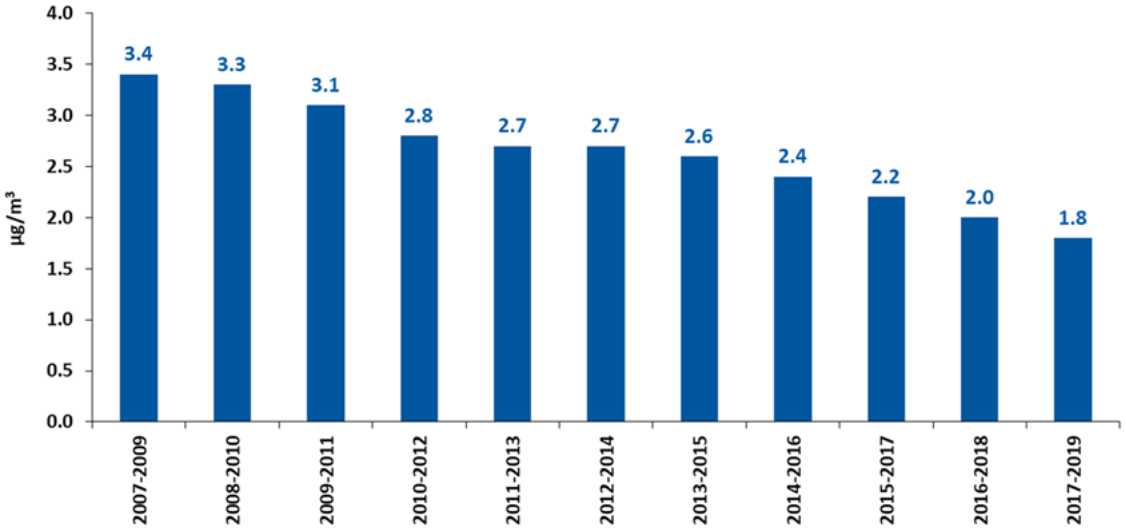


Figure 32: evolution of the mean benzene concentrations over 3 years for 5 traffic stations (Place Victor Basch, Place de l'Opéra, Boulevard Haussmann, RN2 Pantin, RD7 Courbevoie) from 2007-2009 to 2017-2019

3. Pollutants meeting air quality standards

3.1 Benzo(a)pyrene (BaP)

SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS

The BaP EU target value (1 ng/m³) is widely met on the five Airparif monitoring sites (Figure 33).

Differences in benzo(a)pyrene concentrations can be observed between background sites. **Local emissions (related to wood burning fireplaces, open uncontrolled burning of wastes) are more significant in suburban residential areas (Gennevilliers, Argenteuil), even in the greater Paris area (Pommeuse), than in Paris and its neighbouring cities.**

The Pommeuse site (77), representative of a residential area consuming firewood in the outer suburbs [Airparif, 2015], records the highest concentrations of BaP of the monitoring network (between 2 and 3.5 times greater than those of the other stations of the network).

In 2019, BaP levels are stable compared to 2018, with the exception of the Pommeuse site (+0.07 ng/m³, representing +30 % between the two years).

In 2019, the BP Est traffic site recorded levels slighty higher than those measured in Gennevilliers and Argenteuil.

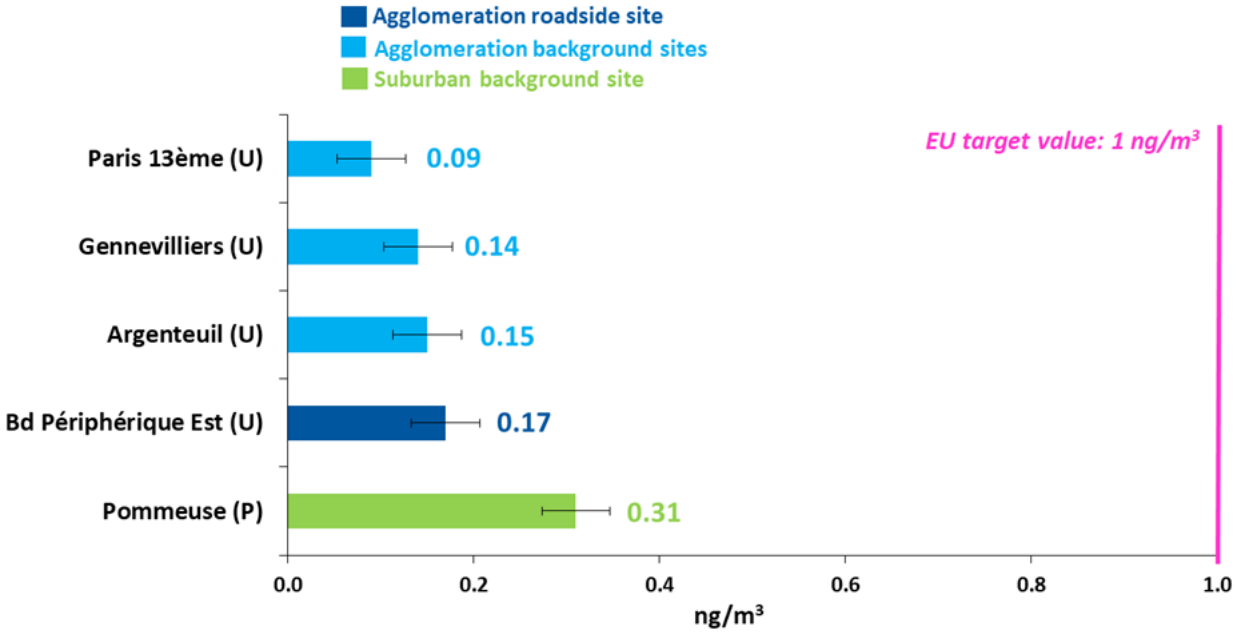


Figure 33: benzo(a)pyrene annual mean concentrations for all monitoring sites in the Paris region in 2019

AVERAGE ANNUAL TREND

A significant decrease of BaP levels is observed near traffic roads (-87 %) between 1998 and 2019 (Figure 34). However, there is no clear trend in background situation.

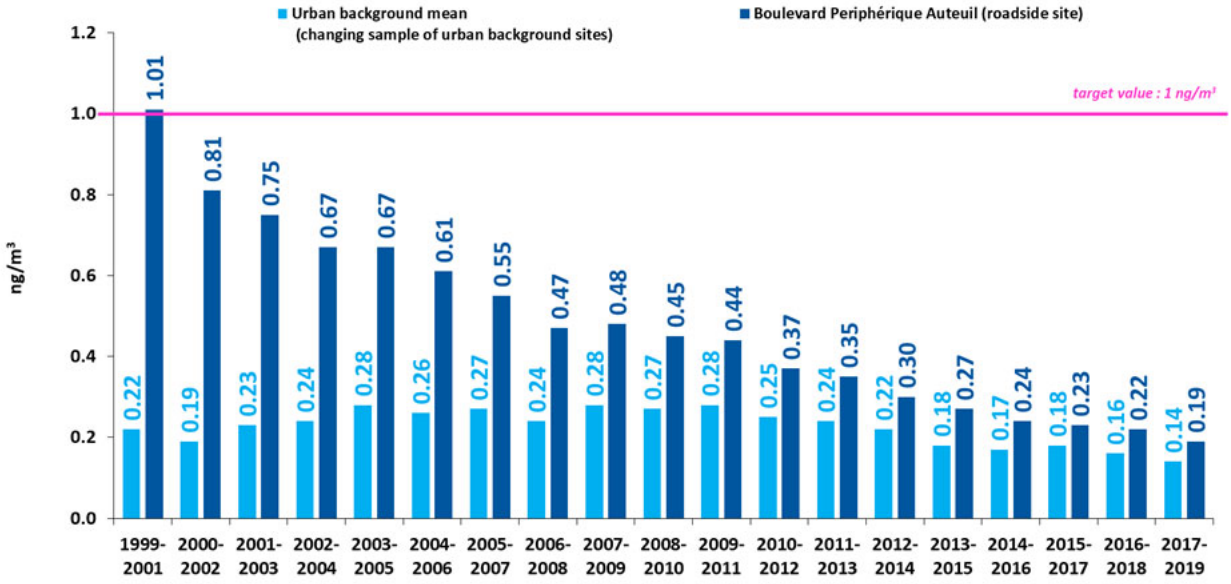


Figure 34: evolution of the benzo(a)pyrene 3-years mean concentrations (based on the means of urban background sites and the Boulevard Périphérique site) in the Paris agglomeration from 1999-2001 to 2017-2019

3.2 Metals (Lead, Arsenic, Cadmium and Nickel)

SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS AND LONG-TERM TRENDS

Lead (Pb) annual mean concentrations significantly decreased in 15 years (-97 % between 1991 and 2005), due to its gradual disappearance in fuels since 2000 (Figure 35). Lead no longer represents a relevant indicator of road traffic. As a consequence, lead measurements at the Place Victor Basch site were stopped at the end of 2005. Each year, lead concentrations are very low and close to the limits of quantification in background and industrial situations. **The EU limit value and the French quality objective for lead are widely met (the 2019 annual value being from 25 to 50 times below air quality standards).** The same observation is also observed in the vicinity of the industrial sites of Limay and Bagneaux-sur-Loing.

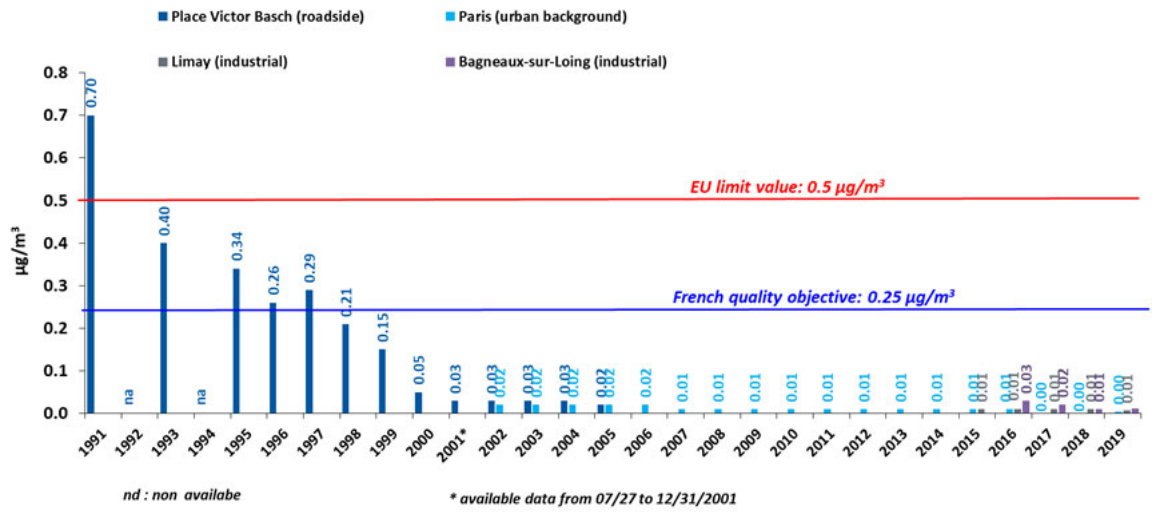


Figure 35: trends in the lead (Pb) annual mean concentration at urban background, roadside and industrial sites within the Paris region from 1991 to 2019

After a significant decrease of **arsenic (As)** concentrations between 2007 and 2008 (around -50 %), an increasing trend was observed from 2008 to 2011 in background situation. It ended in 2012. In 2019, arsenic levels measured in background situation (0.22 ng/m³) decreased compared to the previous years (Figure 36). The Limay industrial station (located near a glass factory, an arsenic emitting installation) shows lower levels (-42 %) compared to 2018.

The Bagneaux-sur-Loing station recorded higher levels than in 2018. Over the 2017-2019 period, arsenic levels measured at the Bagneaux-sur-Loing station increased (+67 %). **In 2019, the arsenic annual mean concentration slightly exceeds the target value the target value, set at 6 ng/m³.**
Installed on the municipal territory of Bagneaux-sur-Loing (77), the Keraglass and Corning SAS factories are specialized in the manufacture of glasses special items (glass-ceramic glass, eyeglasses and optical glasses, respectively). This industrial production emits heavy metals, and more particularly lead and arsenic. In the vicinity of Keraglass, significant arsenic emissions were occasionally measured in ambient air. This industrial site is the leading arsenic emitter in the Paris region and the fifth largest national emitter. It should be noted that these emissions can vary greatly from one year to another depending on the productions [Airparif, 2014].

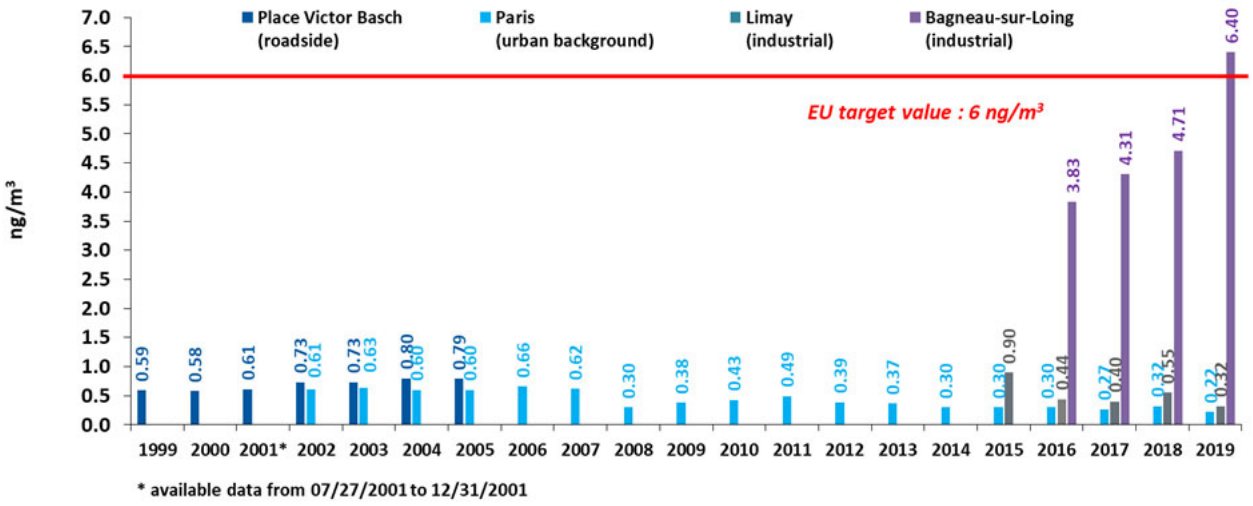


Figure 36: trends in the arsenic (As) annual mean concentrations at urban background, roadside and industrial sites within the Paris region from 1999 to 2019

For **cadmium (Cd)**, a downward trend of annual mean levels was observed both in urban background and roadside situations between 1999 and 2005 (Figure 37). Over the period 2008-2014, cadmium levels do not show a clear trend. Since 2015, background concentrations of cadmium are rather stable. The annual average recorded in background situation in 2019 is 25 times lower than the European target value (set at 5 ng/m³). The Limay site (industrial) records a slightly decrease. The site of Bagneaux-sur-Loing (industrial) records an average annual level in cadmium rather stables.

These values are way lower than the target value of 5 ng/m³.

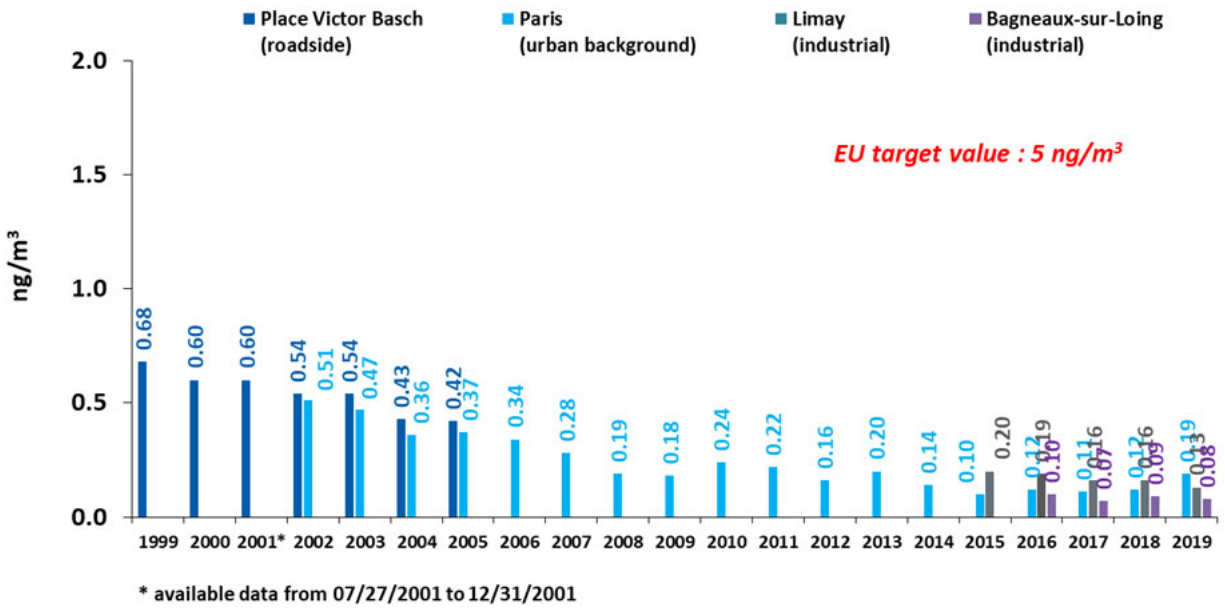


Figure 37: trends in the cadmium annual mean concentrations at urban background, roadside and industrial sites within the Paris region from 1999 to 2019

For **nickel (Ni)** levels were measured from 2007 to 2010 at the reference monitoring station Paris 1er les Halles. Due to renovation on this site, nickel is now measured at the Paris 18ème station. Between 2007 and 2019, annual background mean concentrations are going from 2.6 to 0.9 ng/m³ (Figure 38). **These nickel levels are from 8 to 20 times lower than the EU target value** (20 ng/m³). Nickel background levels are slightly higher in 2019 than in 2018 only at the Bagneaux-sur-Loing site.

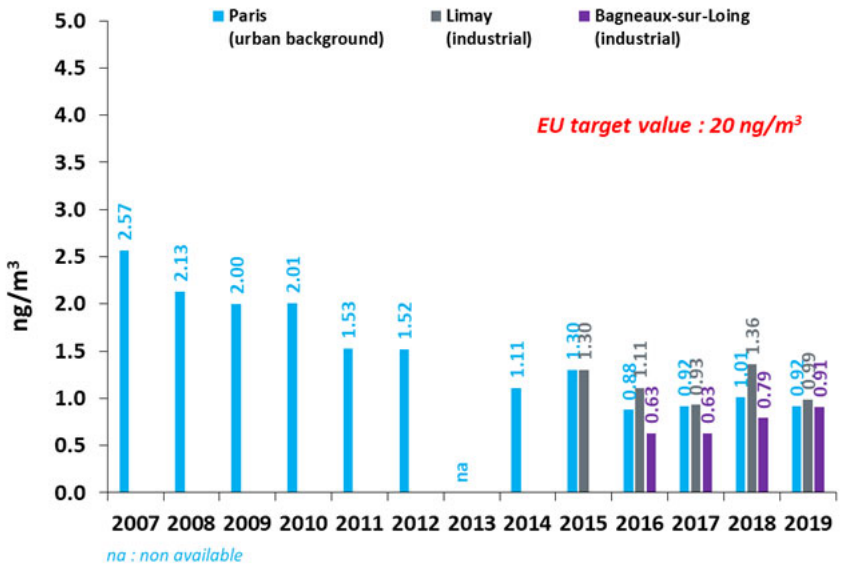


Figure 38: trend in the nickel (Ni) annual mean concentrations at urban background and industrial sites within the Paris region from 2007 to 2019

3.3 Carbon monoxide (CO)

SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS

The carbon monoxide EU limit value for the protection of human health (10 000 µg/m³ for the maximum 8-hours mean) **is widely met at urban background sites** (max. in 2019 = 2 mg/m³) **and at roadside sites** (max. = 2 mg/m³) (Figure 39). In 2019, mean CO levels are comparable to those measured in 2018.

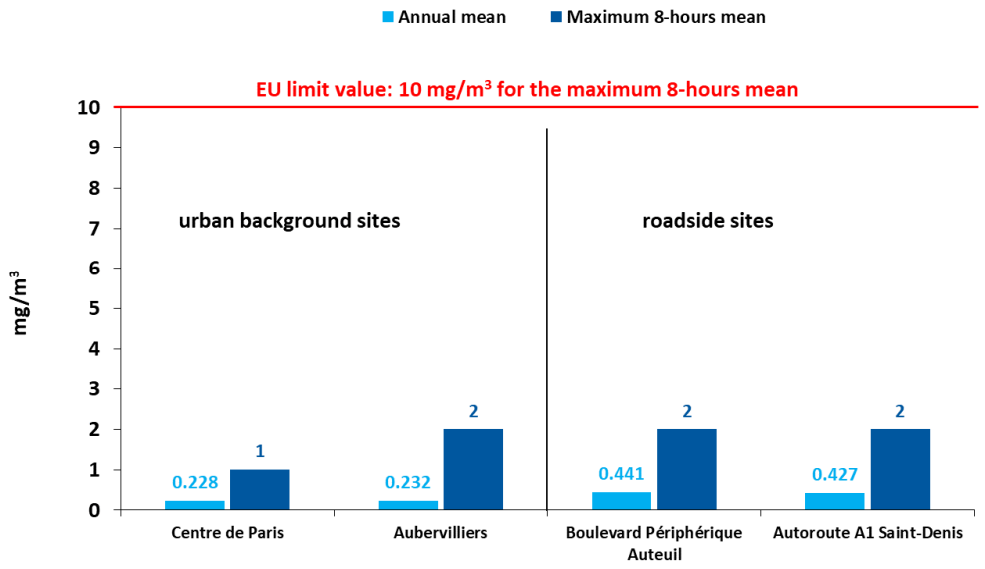


Figure 39: carbon monoxide (CO) annual mean and annual maximum 8-hours mean concentrations for all continuous monitoring sites in the Paris region in 2019

AVERAGE ANNUAL TREND

CO annual maximum 8-hours mean concentrations have significantly decreased between 1994 and 2019 (-88 %) (Figure 40). Average concentrations over 3 years tend to stabilize since 2010. CO levels are, as for other primary pollutants from road traffic, lower in background conditions than in the immediate vicinity of roads. However, the gap tends to stabilize from year to year.

Major technological improvements in emissions from on-road vehicles explain this long-term trend.

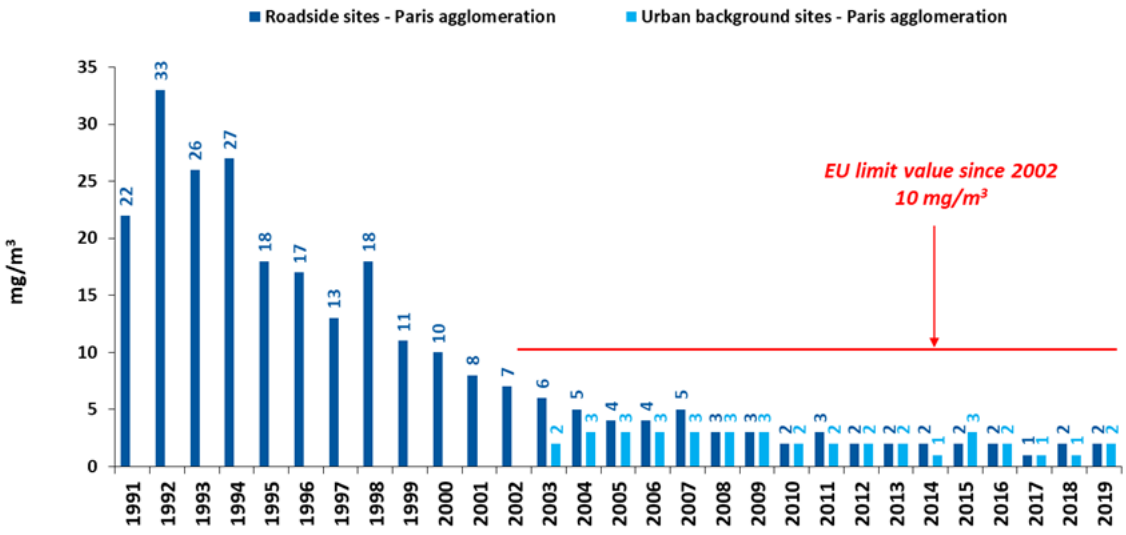


Figure 40: trend in the carbon monoxide (CO) annual maximum 8-hours mean concentrations at roadside and urban background sites within the Paris agglomeration from 1991 to 2019

3.4 Sulfur dioxide (SO_2)

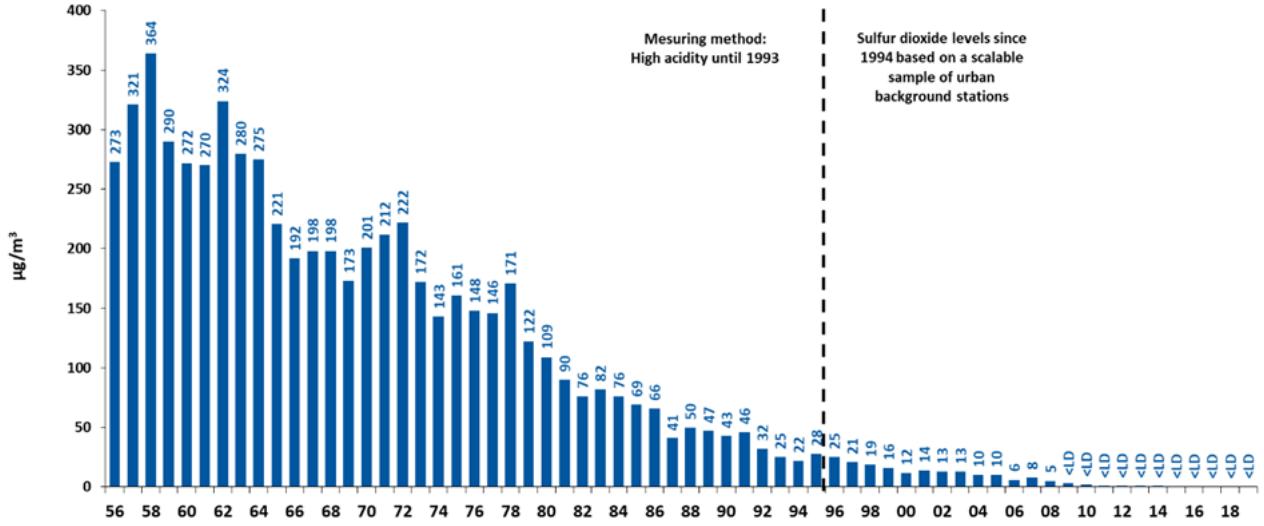
SITUATION IN 2019 RELATED TO AIR POLLUTION STANDARDS

The sulfur dioxide (SO_2) tri-annual mean concentrations are lower than the detection limit (5 µg/m³) at all the monitoring stations, even on the Ringroad BP Auteuil site. **They are way lower than the French quality objective** (50 µg/m³).

SO_2 limit values are also widely met over the whole monitoring stations in the Paris region. No exceedance of the 125 µg/m³ daily threshold and the 350 µg/m³ hourly threshold was observed in 2019.

AVERAGE ANNUAL TREND

A significant decrease of SO_2 levels was observed over the long-term (Figure 41). Considered as a relevant pollution indicator related to heating and electricity generation activities, the trend in SO_2 concentrations spectacularly dropped since the 1950's (SO_2 levels divided by 100). It is related to the decrease of the number of industrial sites in the Paris region since the 1950's. The sharp decrease in the use of some fuels (such as coal) and the decline of sulphur content in fuels also explain this trend.



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Glossary

Français	English
Particules	Particulate Matter
Dioxyde d'azote	Nitrogen dioxide
Monoxyde de carbone	Carbon monoxide
Dioxyde de soufre	Sulphur dioxide
Oxyde d'azote	Nitrogen oxide
Plomb	Lead
Autres métaux	Other metals
Normes	Standards
Normes à respecter	Standards to be respected
Normes à respecter dans la mesure du possible	Standards to be respected as much as possible
Recommandations OMS	WHO recommendations
Valeur limite	Limit value
Valeur cible	Target value
Objectif de qualité	Quality objective
Respectée	Met
Dépassée	Exceeded