



Department  
for Environment  
Food & Rural Affairs



Department for Environment, Food and Rural Affairs

STATISTICAL RELEASE: 26 April 2018

- Urban background and roadside **particulate pollution (PM<sub>10</sub>)** has shown long-term improvement, and small decreases in concentration are observed from 2016 to 2017 for both roadside and urban background sites. A substantial network for **fine particulate matter (PM<sub>2.5</sub>)** has been operational since 2009 which shows a similar trend.
- The number of **hours of moderate or higher levels of particulate matter (PM<sub>10</sub>/PM<sub>2.5</sub>) pollution** has reduced in the long term, but a slightly greater number of hours were recorded in 2017 compared with 2016 for PM<sub>2.5</sub> at both roadside and urban background sites. This is the first increase since the peak of the time series in 2011.
- PM<sub>2.5</sub> pollution tends to **peak in the winter months and in the evening**. The month with the greatest average concentration in 2017 was January; and the time of day with the greatest average concentration was 9pm. Burning of wood and coal by households in stoves and open fires is a large contributor to emissions of particulate matter both in the UK and across Europe, and is most common in winter months and during the evenings.
- Urban background and roadside **nitrogen dioxide (NO<sub>2</sub>) pollution** has shown long-term improvement and small decreases in concentration are observed from 2016 to 2017 for both roadside and urban background sites.
- There were on average fewer **hours of moderate or higher levels of nitrogen dioxide pollution** in 2017 compared with 2016 at roadside sites. This continues a trend for reduction in short-term moderate or high NO<sub>2</sub> pollution since 2007, mainly due to reductions in this measure at monitoring sites in London.
- In 2017, NO<sub>2</sub> pollution tended to **peak in the rush hours and during weekdays; particularly for roadside sites**. Concentrations at roadside sites were 26 percent greater on a weekday compared to the weekend. This pattern of concentrations follows the daily and hourly trends in road traffic.

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- Urban background **ozone (O<sub>3</sub>) pollution** has remained fairly stable between 2003 and 2017, although concentrations have shown a long-term increase since monitoring began. Rural background ozone pollution has shown no clear long-term trend. Both these indicators increased slightly from 2016 to 2017; continuing the fluctuation in recent years.
- There were on average fewer **hours of moderate or higher levels of ozone pollution** in 2017 compared with 2016 at both rural and urban background sites. This measure can vary greatly from year-to-year, although there has been a decreasing trend over the last decade particularly for rural sites.
- In 2017, O<sub>3</sub> pollution tended to **peak in the spring months**. Concentrations at rural background sites built up over the first few months of 2017, peaking in April before reducing to a stable level from July to the end of the year.
- There were on average fewer **days of moderate or higher pollution at urban** pollution monitoring sites in 2017 compared with 2016. There is an ongoing decline in days of moderate or higher pollution at urban sites.
- There were on average fewer **days of moderate or higher pollution at rural** pollution monitoring sites in 2017 compared with 2016. However, there is a great deal of year-on-year variability and there is no clear long-term trend.
- The main drivers of the average number of days when air pollution is Moderate or higher are particulate matter and ozone, for urban and rural pollution monitoring sites in the UK respectively. In 2017, there were a greater number of days on average when air pollution was moderate or higher at rural sites compared to urban sites.

## Air quality statistics in the UK 1987 to 2017

### **Changes to this publication**

Air Quality Statistics in the UK is an annual publication that provides an overview of the concentrations of air pollutants (measured using the national monitoring network: the Automatic Urban and Rural Network) considered most damaging to human health and the environment.

Historically this publication has covered:

- Trends in the annual mean particulate matter (PM<sub>10</sub>) concentrations at urban roadside and background monitoring sites.
- Trends in the annual average of the maximum daily eight-hour running mean for ozone (O<sub>3</sub>) at rural and urban background monitoring site.
- Trends in the number of days per year where air pollution is considered to be moderate or higher, and the pollutants attributable to these instances. 'Moderate' is the threshold at which groups vulnerable to health issues caused by air pollution should consider reducing outdoor physical activity; and the classification of this is based on the concentrations of five air pollutants.

This information is still included in the publication; however new content has been added to cover:

- Trends in the annual mean fine particulate matter (PM<sub>2.5</sub>) concentrations at urban roadside and background monitoring sites. The inclusion of PM<sub>2.5</sub> reflects the increased discussion of this air pollutant relative to PM<sub>10</sub>.
- Trends in the annual mean nitrogen dioxide (NO<sub>2</sub>) concentrations at urban roadside, urban background and rural background monitoring sites. The inclusion of NO<sub>2</sub> informs the public and scientific discussion regarding concentrations of NO<sub>2</sub> particularly at the roadside.
- Trends in the average hours per year spent in the moderate or higher pollution categories of the Daily Air Quality Index (DAQI; see Table 5) for PM<sub>10</sub>, PM<sub>2.5</sub>, ozone and nitrogen dioxide. This is intended to show a trend in the amount of short-term exposure per year to harmful levels of air pollution.
- Where there is a notable trend, variation in concentrations of each pollutant in 2017 by hour of the day, day of the week or month of the year are displayed and discussed to aid understanding of the nature of variation in concentrations.
- Annual mean concentrations for each monitoring site are now included in the accompanying set of tables to enable users to construct time series for long-running sites.
- The graphs which show mean concentrations have been amended to show a 95% confidence interval for the mean. This highlights the uncertainty in the mean caused by the use of the representative monitoring stations rather than measuring the annual mean across a larger set of representative monitoring stations. It should be noted that there are other sources of uncertainty in measurement that are not accounted for by these confidence intervals.

Separately the method used to calculate the annual mean statistics for PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub> and the annual average of the daily maximum 8-hour mean for Ozone, has been reviewed and updated to ensure more coherence in the time series. The section on Methodological Changes has more detail on this change.

Defra keep all National Statistics under review and seek to make changes periodically to meet the needs of users. We welcome feedback to both the listed changes and any thoughts to improve the publication further. Please can you send your feedback to [Enviro.Statistics@defra.gsi.gov.uk](mailto:Enviro.Statistics@defra.gsi.gov.uk). Some example questions are given below to help you structure your feedback but all feedback is welcome:

- How relevant is the current content of the publication to your needs as a user? What purpose do you require the data for?
- What data related to air quality would you find most useful for the Government to provide in a statistical publication?
- Is there any content that you did not find useful?
- Do you have any further suggestions for further development of this release; including what it should cover and opportunities for further innovation in analysis and presentation?

## **Background**

### **Why do we measure air quality?**

Air pollution is a local, regional and international problem caused by the emission of pollutants, which either directly or through chemical reactions in the atmosphere lead to negative impacts on human health and ecosystems. There are many sources of air pollution, including power stations, traffic, household heating, agriculture and industrial processes.

There have been significant reductions in recent decades of [emissions](#) of air pollutants from the above mentioned sources. However, the relationship between emissions and ambient air quality is not straightforward. It is strongly affected by weather; for example, the gas ozone (O<sub>3</sub>) is not emitted directly in significant quantities, but is created in the air through chemical reactions between other pollutants in sunlight, with more being created on hot, still, sunny days.

Day-to-day changes in weather also have a great influence on air quality. Levels of pollutants that are relatively high on a still day when dispersion is limited can be much lower the next day or even the next hour if wind direction changes or wind speeds increase. In addition UK air quality can be affected by pollutants blown across from mainland Europe. For example, UK emissions of the pollutants that lead to ozone formation have reduced substantially, but this is not reflected in the long-term trend in ozone concentrations. This is partly explained by a proportion of the ozone experienced in the UK originating from air pollutant emissions from mainland Europe and beyond.<sup>1</sup> It follows that air pollutant

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<sup>1</sup> UNECE, 2010, Hemispheric Transport of Air Pollution 2010m Part D: Answers to Policy-Relevant Science Questions, Air Pollution Studies No. 20. ECE/EB.AIR/103, United Nations Economic Commission for Europe, Geneva.

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emissions reductions do not always produce a corresponding drop in atmospheric concentrations in the UK. Therefore it is important to measure ambient air quality as well as emissions. The statistics presented in this release provide an important overview of air quality in the UK.

In order to monitor air quality and help assess the risks to people's health and to the environment, the concentrations of key pollutants are measured via a national network of monitoring sites, the Automatic Urban and Rural Network (AURN), which continuously captures ambient concentrations of selected pollutants throughout the UK. Monitoring data is combined with modelled data for annual reporting of pollutant concentrations. [The UK-AIR website](#) provides further information and provides the most up-to-date data for all air pollutants measured by the Environment Agency on behalf of Defra.

In the UK, EU standards for air quality are set into English law through the Air Quality Standards Regulations (England) 2010<sup>2</sup> and equivalent regulations in Scotland, Wales and Northern Ireland. UK actions are informed by the statistics derived from air quality monitoring and modelling.

### **What does this National Statistics release report?**

This statistical release covers concentrations in the UK of four pollutants thought to have the greatest health and environmental impacts resulting from exposure:

- Chronic exposure to particulate matter (PM<sub>10</sub>/PM<sub>2.5</sub>) contributes to the risk of developing cardiovascular and respiratory diseases, and there is increasing evidence suggesting that long-term and short-term exposure to particulate matter may have a significant effect on health. The annual average concentrations for particulate matter are considered a useful measure of overall long-term exposure to particulate matter. The number of hours per site per year that the 24-hour running mean concentration is greater than 35 µg/m<sup>3</sup> is a useful summary measure of the length of short-term events when particulate pollution had potential health impacts.
- The gas ozone (O<sub>3</sub>) can affect people's health and can damage, for example, wild plants, crops and forests. Higher levels of ground level ozone can cause breathing problems, trigger symptoms of asthma, reduce lung function and cause lung diseases. Several European studies have reported that current ozone concentrations in Europe have health effects, especially in the summer, and that daily mortality rises with increases in ozone exposure<sup>3</sup>. The long-term ozone concentration reported in this release is the annual average of the maximum daily eight-hour running mean. The number of hours per site per year that the 8-hour running mean concentration is greater than 100 µg/m<sup>3</sup> is a useful summary measure

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<sup>2</sup> <http://www.legislation.gov.uk/ukxi/2010/1001/contents/made>

<sup>3</sup> WHO, 2008, Air quality and health, Fact sheet no 313 (<http://www.who.int/mediacentre/factsheets/fs313/en/>).

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of the length of short-term events when ozone pollution had potential health impacts.

- Short-term exposure to concentrations of NO<sub>2</sub> higher than 200µg/m<sup>3</sup> can cause inflammation of the airways. NO<sub>2</sub> can also increase susceptibility to respiratory infections and to allergens. The long-term NO<sub>2</sub> concentration reported in this release is the annual mean. The number of hours per site per year that the hourly mean concentration is greater than 200 µg/m<sup>3</sup> is a useful summary measure of the length of short-term events when NO<sub>2</sub> pollution had potential health impacts.

The statistical release also covers variation in concentrations of these pollutants by hour of the day, day of the week and month of the year where a notable trend exists.

The statistical release also covers **the number of days when air pollution was moderate or higher**. The indicator is intended to provide a summary measure of the main air pollutants that affect health due to short term exposure. The five pollutants included in the indicator are as follows:

- Particulate matter (PM<sub>2.5</sub>)
- nitrogen dioxide (NO<sub>2</sub>)
- ozone (O<sub>3</sub>)
- Particulate matter (PM<sub>10</sub>)
- sulphur dioxide (SO<sub>2</sub>)

Defra's air pollution information service uses an index and banding system recommended by the Committee on Medical Effects of Air Pollutants (COMEAP)<sup>4</sup>. The system uses an index numbered 1-10, divided into four bands ("Low", "Moderate", "High" and "Very high") to provide more detail about air pollution levels in a simple way, similar to the sun index or pollen index. At the Moderate level, the effects of pollution may start to be noticeable to people with respiratory and other health problems, with greater risks to health at higher levels.

## Methodological changes

### ***Annual levels of PM<sub>10</sub>, PM<sub>2.5</sub>, Ozone and Nitrogen Dioxide***

Changes have been made this year to the methodology used to calculate the annual levels of PM<sub>10</sub>, PM<sub>2.5</sub>, ozone and nitrogen dioxide. The data are now extracted from UK-AIR, which automatically applies a minimum annual data capture requirement of 75% for these annual statistics<sup>5</sup>.

From a scientific point of view this is a better approach: it has therefore been adopted for the annual indicator statistics for the whole time series. In previous editions of these statistics, data from monitoring sites prior to 2013 did not have to meet the 75% minimum data capture requirement. Comparing the statistics produced with and without the 75%

<sup>4</sup> <https://uk-air.defra.gov.uk/air-pollution/daqj?view=more-info>

<sup>5</sup> That is, if a specific monitoring station does not have data for 75% (or greater) of the year then it is excluded from the statistic calculations for the relevant pollutant.

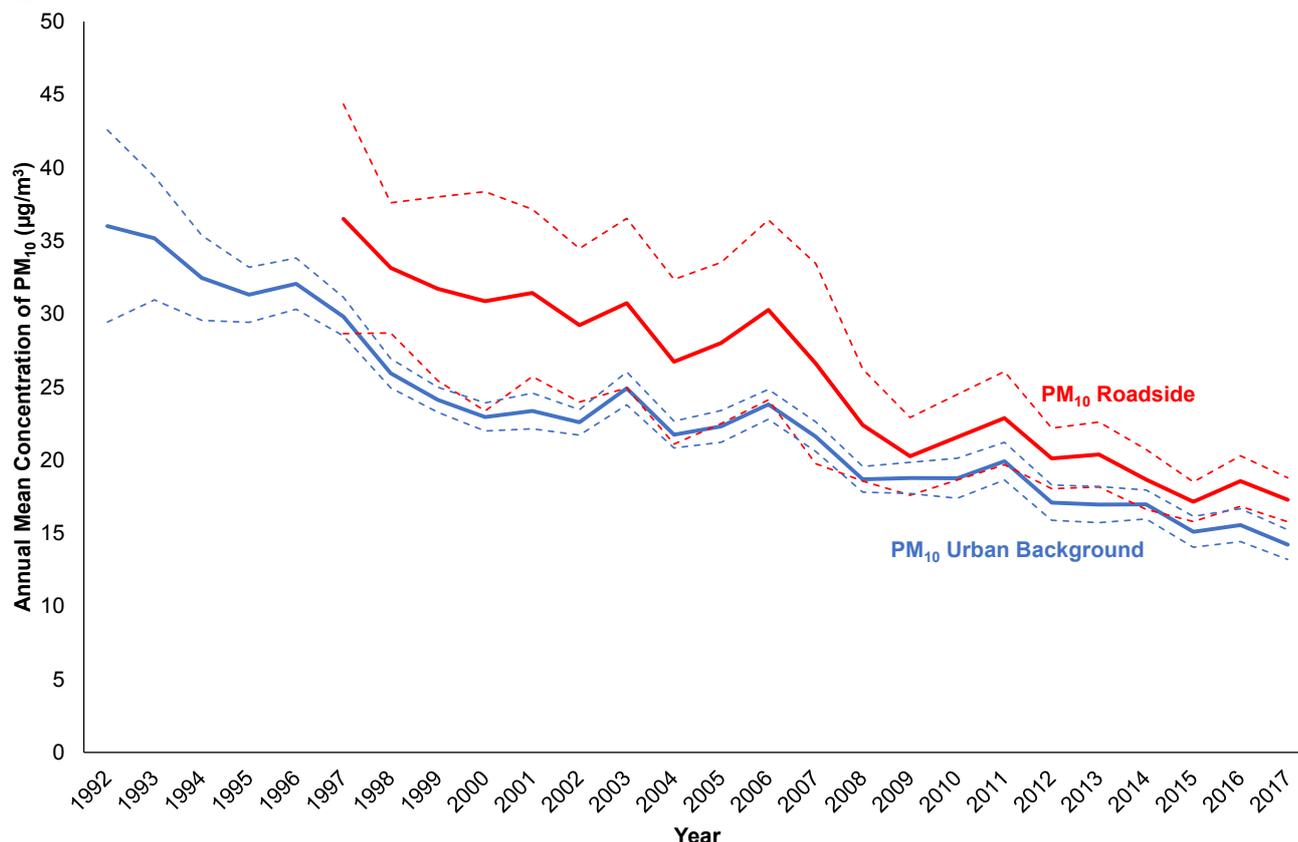
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minimum data capture requirement showed that its use had minimal effect on the indicator statistics; so the change ensures better coherence between years in the time series without fundamentally changing the trend. Typically the difference was within 1  $\mu\text{g}/\text{m}^3$  except in some cases for earlier years when there were fewer monitoring sites.

## **Particulate Matter (PM<sub>10</sub>/PM<sub>2.5</sub>) concentrations**

### Annual Mean Concentrations of PM<sub>10</sub>/PM<sub>2.5</sub>

**Figure 1: Annual concentrations of PM<sub>10</sub> in the UK, 1992 to 2017**



#### Notes:

The PM<sub>10</sub> index shows the annual mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the annual mean concentration for roadside sites (red) and urban background sites (blue). These intervals narrow over time because of an increase in the number of monitoring sites for both roadside and urban background sites; and a reduction in the variation between annual means for PM<sub>10</sub> measured at roadside sites. Annual means for individual sites can be found in the PM<sub>10</sub> tables that accompany this report.

- **Urban background PM<sub>10</sub> pollution has reduced both in the long-term and in recent years**

Average concentrations have decreased over the time series to 14.2  $\mu\text{g}/\text{m}^3$  in 2017, a low since monitoring began in 1992.

Between 1992 and 2000 inclusive, the annual mean PM<sub>10</sub> concentration at urban background sites reduced rapidly: by an average of 1.6 µg/m<sup>3</sup> each year. This reduction was observed at most monitoring sites across the UK; which could be a consequence of the large reduction in emissions of PM<sub>10</sub> over the same period in the UK.

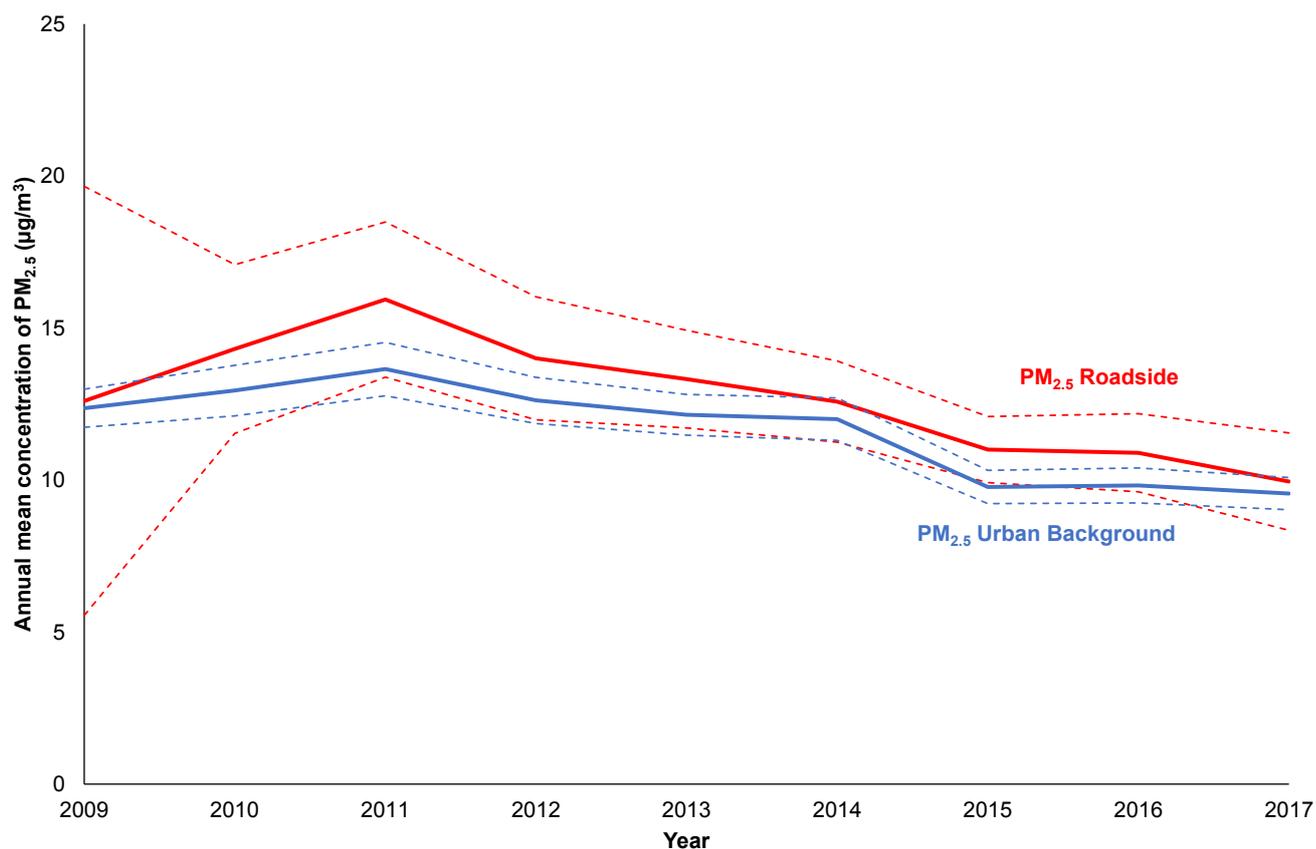
Between 2000 and 2006 the annual mean concentration fluctuated with no clear trend and this was observed at most monitoring sites across the UK. Emissions of PM<sub>10</sub> in the UK and Europe were still decreasing over this period but the reductions were largely driven by changes to fuels used for energy generation; which may have a minimal impact on urban air quality.

Between 2006 and 2017 inclusive, the annual mean PM<sub>10</sub> concentration at urban background sites reduced by an average of 0.9 µg/m<sup>3</sup> each year. Reductions in concentrations were observed at most monitoring sites across the UK. Emissions of PM<sub>10</sub> in the UK and Europe have been relatively stable since 2006, but emissions from sources such as road transport and construction which tend to produce significant emissions in urban areas have decreased substantially since then.

- **Roadside PM<sub>10</sub> pollution has reduced in the long-term and has been stable since 2015**

Average concentrations steadily declined to 17.1 µg/m<sup>3</sup> in 2015, a new low since monitoring began in 1997. The average concentration in 2017 was 17.3 µg/m<sup>3</sup>; similar to 2015 and lower than 2016. The annual mean PM<sub>10</sub> concentration in 2017 is significantly greater at roadside sites compared to urban background sites; and there were 11 roadside monitoring sites with greater annual mean concentrations than the greatest mean concentration from an urban background site. This is most likely due to substantial PM<sub>10</sub> emissions from road transport sources.

Between 1997 and 2015 inclusive, the annual mean PM<sub>10</sub> concentration at roadside sites reduced by an average of 1.1 µg/m<sup>3</sup> each year. This reduction was observed at most long-running monitoring sites across the UK; which could be a consequence of the large reduction in emissions of PM<sub>10</sub> over the same period in the UK, particularly from road transport sources. Since 2015 there has been no clear trend in the annual mean PM<sub>10</sub> concentration at roadside sites.

**Figure 2: Annual concentrations of PM<sub>2.5</sub> in the UK, 2009 to 2017****Notes:**

The PM<sub>2.5</sub> index shows the annual mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the annual mean concentration for roadside sites (red) and urban background sites (blue). The interval for roadside sites narrows over time because of an increase in the number of monitoring sites and a reduction in the variation between annual means for PM<sub>2.5</sub> measured at roadside sites. Annual means for individual sites can be found in the PM<sub>2.5</sub> tables that accompany this report.

- **Urban background PM<sub>2.5</sub> pollution has decreased gradually, but has remained at a similar level since 2015**

Average concentrations have decreased over the time series to 9.6 µg/m<sup>3</sup> in 2017, a low since the beginning of the time series in 2009. The decline in concentrations of PM<sub>2.5</sub> at urban background sites approximately follows the trends seen for PM<sub>10</sub> (PM<sub>2.5</sub> is a subset of PM<sub>10</sub>), although since 2015 there has been little change in PM<sub>2.5</sub> concentrations while PM<sub>10</sub> concentrations have continued to decline. This could be due to a substantial proportion of PM<sub>10</sub> emissions coming from construction and demolition (emissions from this source are decreasing over time) while this source only forms a small percentage of PM<sub>2.5</sub> emissions.

- **Roadside PM<sub>2.5</sub> pollution has decreased gradually since the roadside monitoring network has come into operation**

Average concentrations have decreased over the time series to 9.9 µg/m<sup>3</sup> in 2017, a low since the beginning of the time series in 2009. The decline in concentrations of PM<sub>2.5</sub> at roadside sites approximately follows the trends seen for PM<sub>10</sub> (PM<sub>2.5</sub> is a subset of PM<sub>10</sub>).

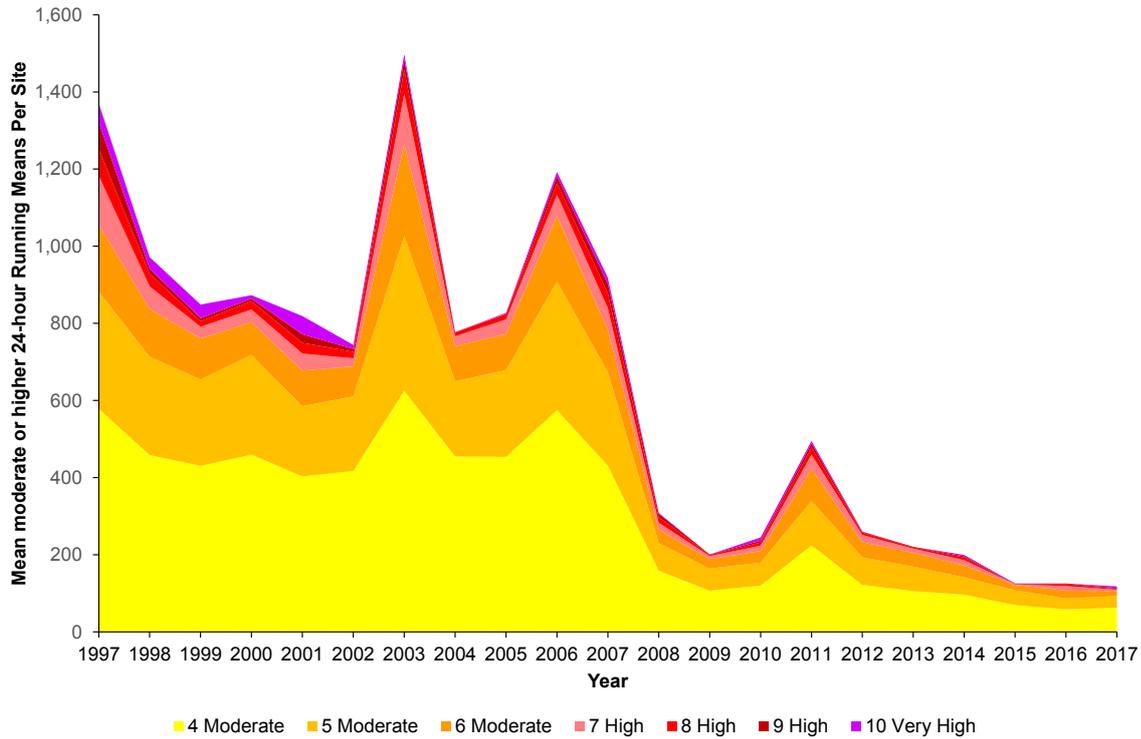
Unlike for PM<sub>10</sub>, the annual mean PM<sub>2.5</sub> concentrations for roadside and urban background sites in 2017 are not significantly different. This may be due to a smaller impact of particulate emissions from brake and tyre wear and road abrasion for PM<sub>2.5</sub> roadside concentrations relative to PM<sub>10</sub> concentrations.

Concentrations of PM<sub>2.5</sub> tend to be greatest in urban environments in the southern and eastern areas of the UK due to greater exposure to pollution sources from mainland Europe; in 2017 8 of the top 9 sites in urban environments with the greatest annual mean concentration of PM<sub>2.5</sub> are located in the London, South East, East or East Midlands region.

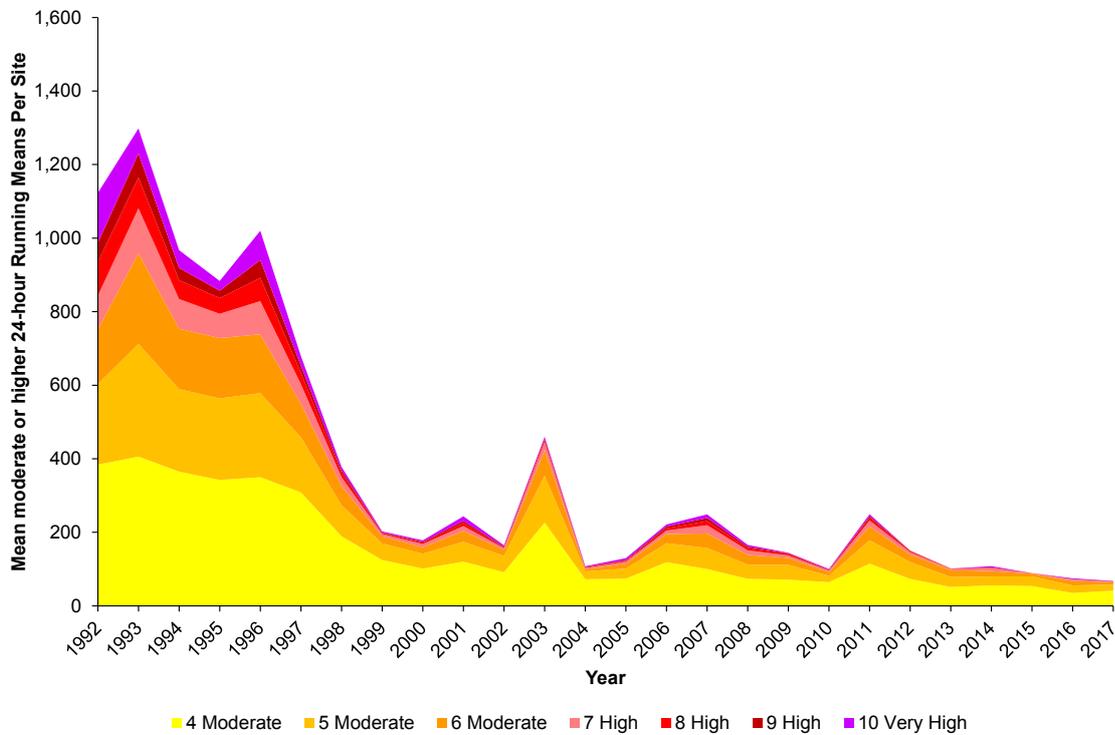
#### Average hours spent in 'Moderate' or higher PM<sub>10</sub>/PM<sub>2.5</sub> pollution

This metric measures the annual trend in the number of hours on average that concentrations are recorded at levels that may have impacts on human health. For PM<sub>10</sub>, 'moderate' air pollution (which requires action by citizens who are vulnerable to the health impacts of air pollution) is triggered when the latest 24-hour running mean concentration is greater than 50 µg/m<sup>3</sup>. The coloured categories relate to the categories of the Daily Air Quality Index (see Table 5).

**Figure 3: Mean hours when PM<sub>10</sub> pollution was moderate or higher, for roadside sites, 1997 to 2017**



**Figure 4: Mean hours per site when PM<sub>10</sub> pollution was moderate or higher, for urban background sites, 1992 to 2017**



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- **Roadside and urban background monitoring sites have recorded fewer hours of 'moderate' or higher PM<sub>10</sub> air pollution year-on-year in the long term**

At roadside and urban background sites the long-term trend has been a decline in the number of hours for which the mean PM<sub>10</sub> concentration over the previous 24 hours exceeded 50 µg/m<sup>3</sup>.

At the roadside the mean number of hours where PM<sub>10</sub> concentrations exceeded this threshold for a monitoring site decreased by 91 percent between 1997 and 2017 to the fewest hours in the time series (118 per site); an average decrease of 63 hours per year per site over the period.

At urban background sites the mean number of hours where PM<sub>10</sub> concentrations exceeded the threshold for a monitoring site decreased by 94 percent between 1992 and 2017 to the fewest hours in the time series (68 per site); an average decrease of 42 hours per year per site over the period. These statistics reflect the reduction in activity that cause short-term high concentrations of PM<sub>10</sub> in the UK and Europe over time.

The downward trend in the time series has been interrupted in several years: most notably in 2003. In March and April 2003, meteorological analysis showed that concentrations at many monitoring sites were elevated due to primary emissions from Northern or Central Europe along with secondary particles caused by chemical reactions in the atmosphere. When cleaner Atlantic airflows became dominant in April 2003, pollution levels dropped drastically<sup>6</sup>.

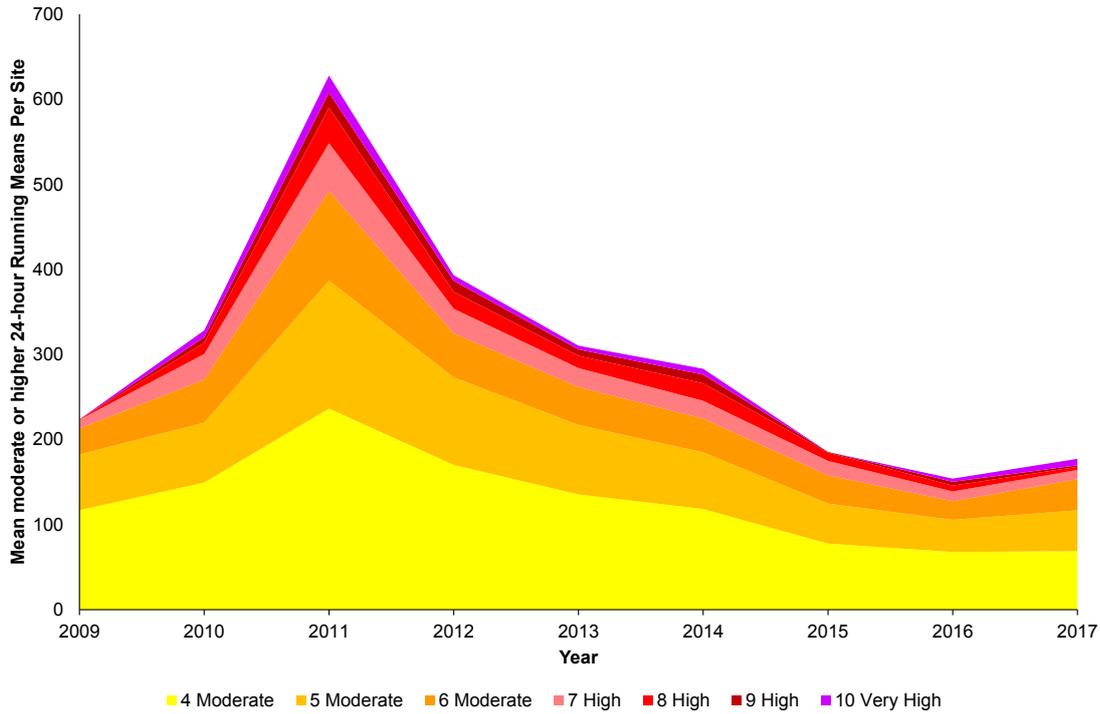
For PM<sub>2.5</sub>, 'moderate' air pollution (which requires action by citizens who are vulnerable to the health impacts of air pollution) is triggered when the latest 24-hour running mean concentration is greater than 35 µg/m<sup>3</sup>. The coloured categories relate to the categories of the Daily Air Quality Index (see Table 5).

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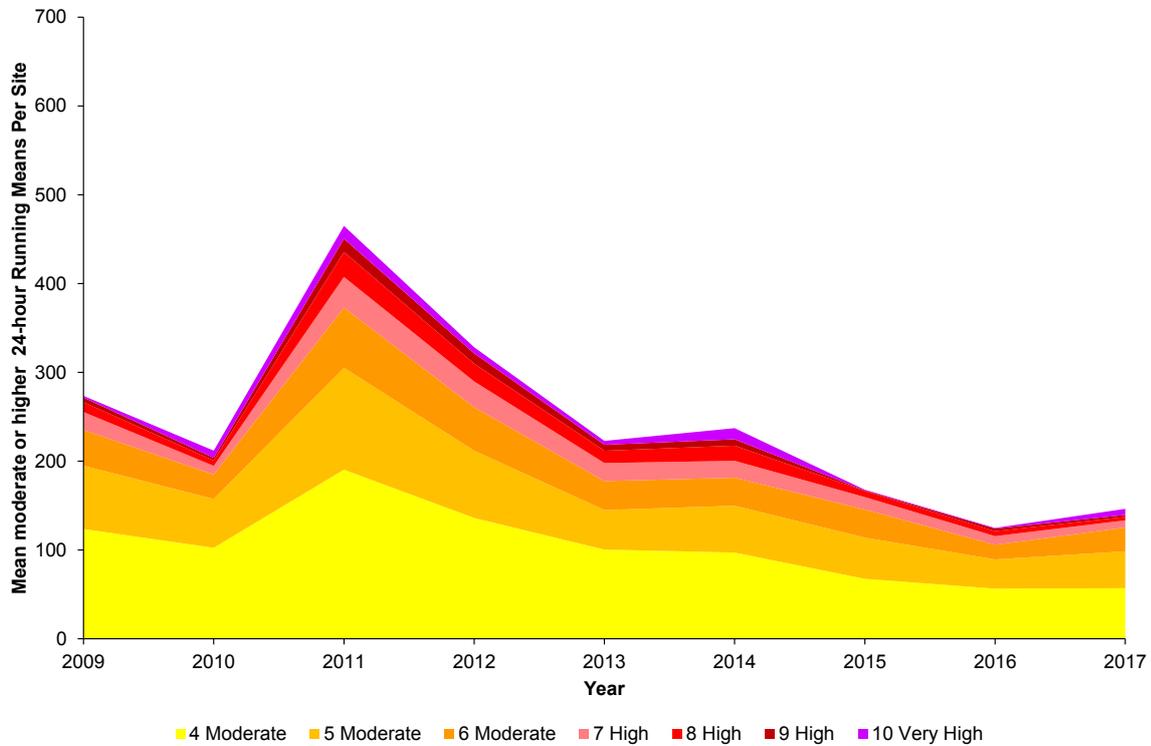
<sup>6</sup> 'Air Pollution in the UK, 2003' [https://uk-air.defra.gov.uk/assets/documents/reports/cat05/0502251134\\_Report\\_Air\\_Pollution\\_in\\_the\\_UK\\_Part\\_1\\_text.pdf](https://uk-air.defra.gov.uk/assets/documents/reports/cat05/0502251134_Report_Air_Pollution_in_the_UK_Part_1_text.pdf)

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**Figure 5: Mean hours when PM<sub>2.5</sub> pollution was moderate or higher for roadside sites, 1992 to 2017**



**Figure 6: Mean hours when PM<sub>2.5</sub> pollution was moderate or higher for urban background sites, 1992 to 2017**



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- **Roadside and urban background monitoring sites have recorded fewer hours of 'moderate' or higher PM<sub>2.5</sub> air pollution since 2011; with a small increase between 2016 and 2017**

At roadside and urban background sites between 2016 and 2017 there was a small increase in the number of hours for which the mean PM<sub>2.5</sub> concentration over the previous 24 hours exceeded 35 µg/m<sup>3</sup>.

At the roadside the mean number of hours where PM<sub>2.5</sub> concentrations exceeded this threshold for a monitoring site in 2017 was 177 compared with 154 in 2016. The mean hours with moderate or higher PM<sub>2.5</sub> pollution was 72 percent less in 2017 compared to the peak in 2011 (628 hours per site).

At urban background sites the mean number of hours where PM<sub>2.5</sub> concentrations exceeded this threshold for a monitoring site in 2017 was 146 compared with 125 in 2016. The mean hours with moderate or higher PM<sub>2.5</sub> pollution was 69 percent less in 2017 compared to the peak in 2011 (465 hours per site).

Particulate pollution was particularly high in March and April 2011; due to a combination of secondary pollution being formed over mainland Europe and wind conditions carrying this pollution to the UK. A period of low wind conditions followed which allowed emissions from UK sources to build up in the atmosphere, leading to unusually high concentrations of particulate matter<sup>7</sup>.

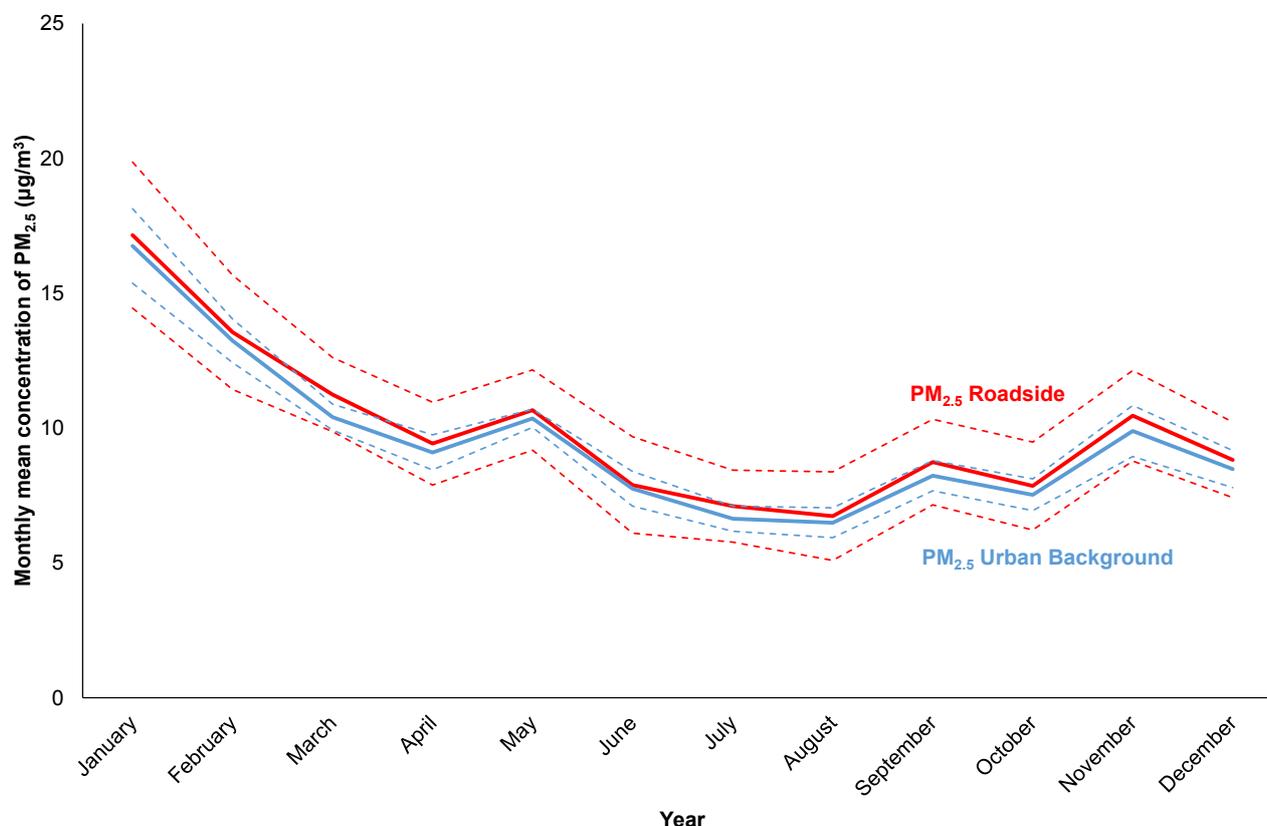
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<sup>7</sup> 'Air Pollution in the UK 2011' [https://uk-air.defra.gov.uk/library/annualreport/viewonline?year=2011\\_issue\\_2](https://uk-air.defra.gov.uk/library/annualreport/viewonline?year=2011_issue_2)

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## Monthly variations in PM<sub>2.5</sub> concentrations

**Figure 7: Monthly mean PM<sub>2.5</sub> concentration at roadside and urban background sites, 2017**



### Notes:

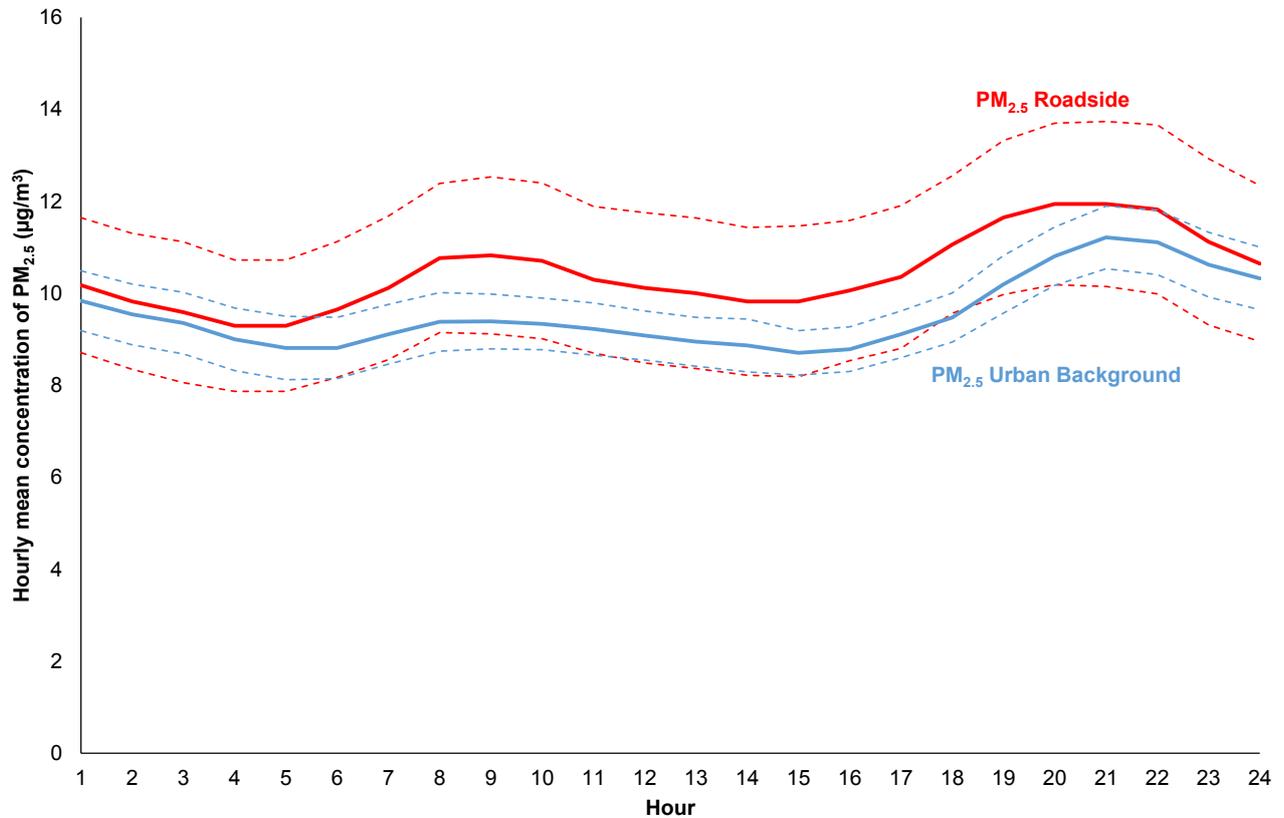
The PM<sub>2.5</sub> index shows the monthly mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the annual mean concentration for roadside sites (red) and urban background sites (blue).

For both PM<sub>10</sub> and PM<sub>2.5</sub> the highest concentrations in urban areas tended to occur during the winter months in 2017. The greatest mean concentration in 2017 was in January (17.2 µg/m<sup>3</sup> for roadside sites and 16.6 µg/m<sup>3</sup> for urban background sites) and the greatest variation between sites was also in that month. Sites with relatively low annual mean PM<sub>2.5</sub> concentration have less monthly variation in concentrations than other sites.

Burning of wood and coal by households in stoves and open fires is a large contributor to emissions of particulate matter both in the UK and across Europe, and is more common in winter months. It should be noted that there are a large number of emission sources for particulate matter, and there may be other sources which contribute to this pattern.

Hourly variations in PM<sub>2.5</sub> concentrations

**Figure 8: Hourly mean PM<sub>2.5</sub> concentration at roadside and urban background sites, 2017**



Notes:

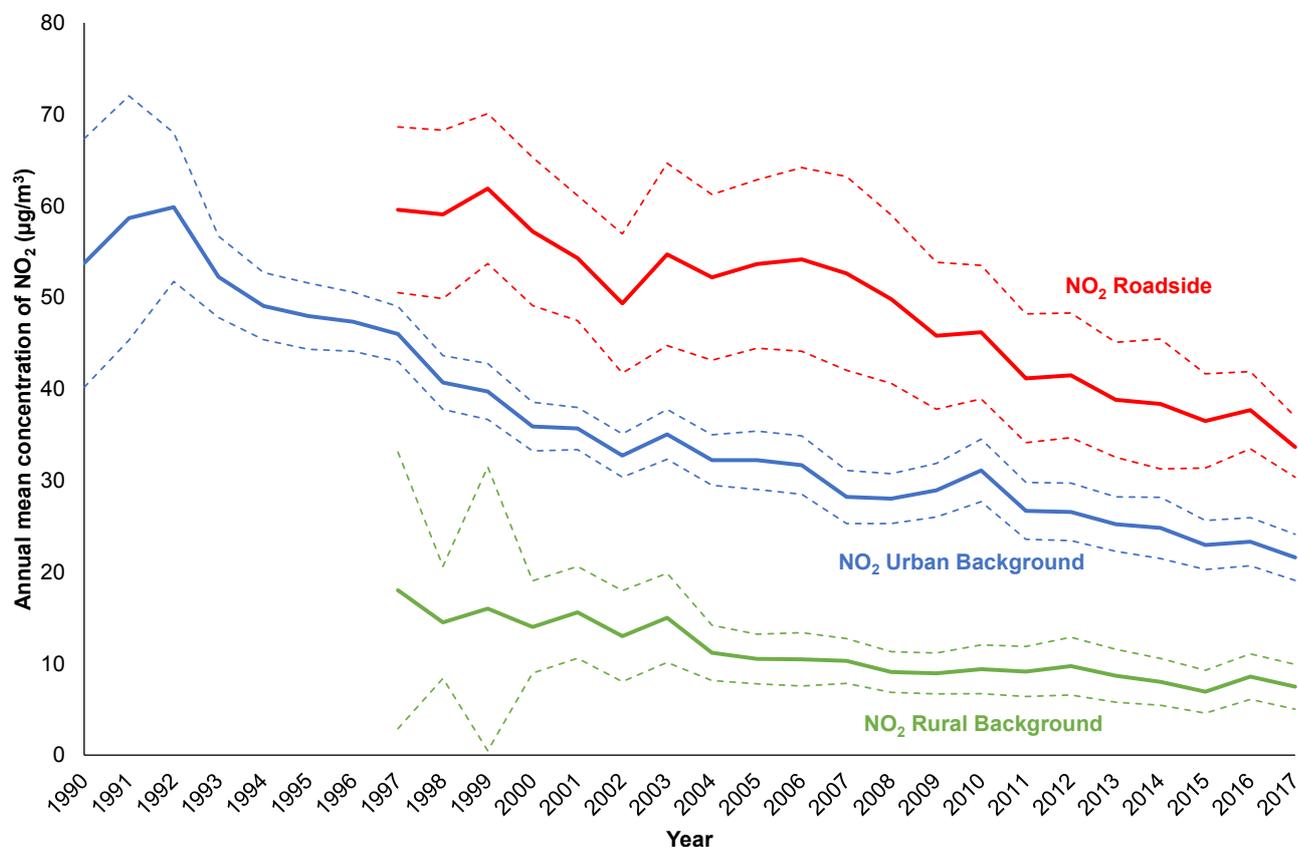
The PM<sub>2.5</sub> index shows the hourly mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the annual mean concentration for roadside sites (red) and urban background sites (blue).

PM<sub>2.5</sub> concentrations tend to be much greater in the evening compared to other times of the day; in 2017 the greatest mean concentrations were at 9pm (11.9 µg/m<sup>3</sup> for roadside sites and 11.2 µg/m<sup>3</sup> for urban background sites). This is thought to be the result of households burning wood, coal or other solid fuels in stoves or open fires for heating in the evenings, particularly in winter months. For PM<sub>10</sub> the variation is less clear due to the contribution of other emission sources.

## Nitrogen dioxide (NO<sub>2</sub>) concentrations

### Annual Mean Concentrations of NO<sub>2</sub>

**Figure 9: Annual mean concentrations of NO<sub>2</sub> in the UK, 1990 to 2017**



#### Notes:

The NO<sub>2</sub> index shows the annual mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the annual mean concentration for roadside sites (red), urban background sites (blue) and rural background sites (green). The intervals narrow over time because of an increase in the number of monitoring sites and a reduction in the variation between annual means for NO<sub>2</sub>. Annual means for individual sites can be found in the NO<sub>2</sub> tables which accompany this report.

- **Urban background NO<sub>2</sub> pollution has reduced both in the long-term and in recent years**

Average concentrations have decreased over the time series to 21.6 µg/m<sup>3</sup> in 2017, a low since monitoring began in 1990.

Between 1992 and 2002 inclusive, the annual mean NO<sub>2</sub> concentration at urban background sites reduced rapidly: by an average of 2.7 µg/m<sup>3</sup> each year. This reduction was observed at most monitoring sites across the UK; which could be a consequence

of the large reduction in emissions of nitrogen oxides over the same period in the UK and in Europe.

Between 2002 and 2006 the annual mean concentration fluctuated with no clear trend and this was observed at most monitoring sites across the UK. Emissions of nitrogen oxides in the UK and Europe were still decreasing over this period but these years also coincided with increased use of coal in power stations, and with the increasing popularity of new diesel cars (which produce more nitrogen oxide emissions than petrol equivalents).

Between 2006 and 2017 inclusive, the annual mean NO<sub>2</sub> concentration at urban background sites reduced by an average of 0.9 µg/m<sup>3</sup> each year. Reductions in concentrations were observed at most monitoring sites across the UK. Emissions of NO<sub>2</sub> in the UK and Europe have continued to decrease as newer road vehicles subject to stricter emission standards enter the fleet and power generation moves away from the use of coal, particularly in the UK.

- **Roadside NO<sub>2</sub> pollution has reduced in the long-term and in recent years, having been stable for most of the 2000s**

Average concentrations have decreased over the time series to 33.7 µg/m<sup>3</sup> in 2017, a low since monitoring began in 1997. The annual mean NO<sub>2</sub> concentration in 2017 is significantly greater at roadside sites compared to urban background sites. This is most likely due to substantial NO<sub>2</sub> emissions from road transport sources, as around 80 percent of concentrations at the roadside come from local transport sources.

For most of the 2000s, the annual mean NO<sub>2</sub> concentration was stable, likely as a result of the increased ownership of diesel vehicles which emit far more nitrogen oxides compared to petrol-fuelled vehicles. This may have offset the impact of reduced emissions from other sources.

Between 2007 and 2017 inclusive, the annual mean NO<sub>2</sub> concentration at roadside sites reduced by an average of 1.9 µg/m<sup>3</sup> each year. This reduction was observed at most long-running monitoring sites across the UK; which could be a consequence of the large reduction in road transport emissions of NO<sub>2</sub> over the same period in the UK, as newer vehicles subject to stricter emissions standards enter the transport fleet.

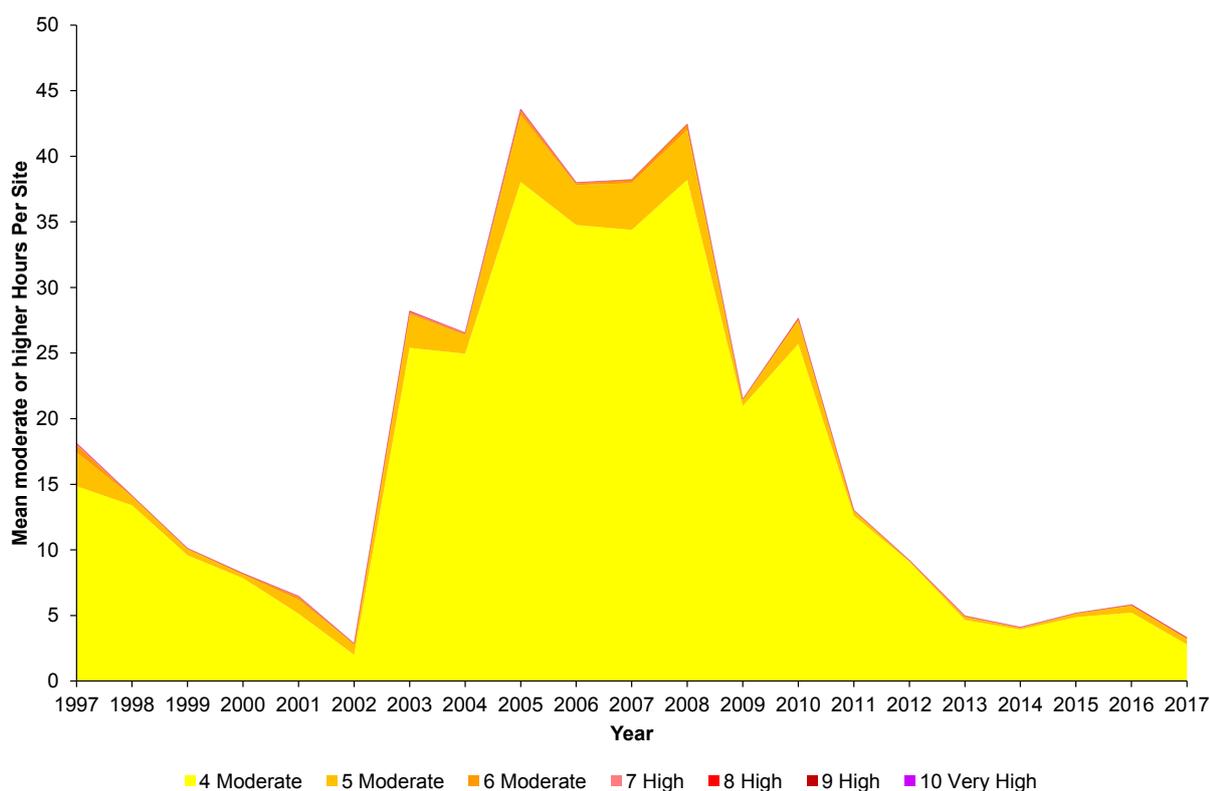
- **Rural background NO<sub>2</sub> pollution has reduced at a gradual rate over time; and is at low concentrations generally**

Average concentrations have decreased over the time series to 7.5 µg/m<sup>3</sup> in 2017, similar to the time series low of 6.9 µg/m<sup>3</sup> in 2015 and a decrease from 2016. Since the start of the time series in 1997, the annual mean NO<sub>2</sub> concentration at rural background sites reduced rapidly: by an average of 0.5 µg/m<sup>3</sup> each year. This reduction was observed at most monitoring sites across the UK; which could be a consequence of the large reduction in emissions of nitrogen oxides over the same period in the UK and in Europe.

### Average hours spent in 'Moderate' or higher NO<sub>2</sub> pollution

This metric measures the annual trend in the number of hours on average that concentrations are recorded at levels that may have impacts on human health. For NO<sub>2</sub>, 'moderate' air pollution (which requires action by citizens who are vulnerable to the health impacts of air pollution) is triggered when the latest hourly mean concentration is greater than 200 µg/m<sup>3</sup>. The coloured categories relate to the categories of the Daily Air Quality Index (see Table 5).

**Figure 10: Mean hours when NO<sub>2</sub> pollution is moderate or higher for roadside sites, 1997 to 2017**



- **Roadside monitoring sites have recorded fewer hours of 'moderate' air pollution due to NO<sub>2</sub> in general since 2008. 2017 had the fewest hours of 'moderate' air pollution due to NO<sub>2</sub> since 2002.**

At roadside sites between 2016 and 2017 there was a decrease in the number of hours for which the mean NO<sub>2</sub> concentration over the previous hour exceeded 200 µg/m<sup>3</sup>; from 5.8 hours to 3.3 hours per site. Urban background sites rarely record concentrations at these levels; only 0.1 hours per site in 2017.

For PM<sub>2.5</sub> moderate air pollution has historically been experienced at many monitoring sites across the UK; but for NO<sub>2</sub> moderate air pollution has been experienced by only a few particular sites. The overall trend follows the same trend as the London Marylebone

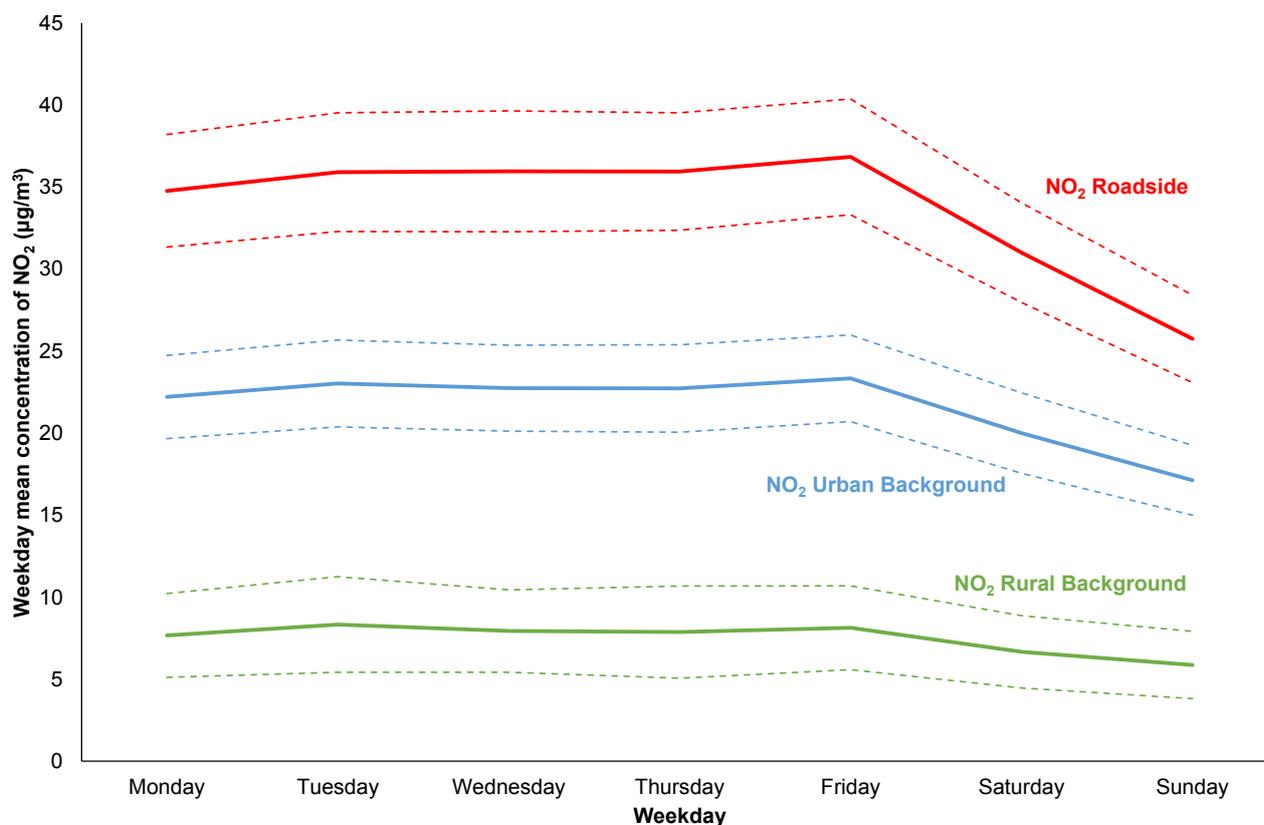
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Road site which recorded a peak of 853 hours in the ‘moderate’ category in 2005 and has reduced to 38 hours in this category in 2017. The other main site contributing to ‘moderate’ NO<sub>2</sub> pollution in 2017 was the Hafod-yr-ynys Roadside site in South Wales.

Moderate NO<sub>2</sub> pollution at the roadside is usually the consequence of a build-up of emissions of nitrogen oxides from transport sources, and the street canyon or wind conditions preventing dispersion of pollutants. For example, the London Marylebone Road site is on a six-lane congested road surrounded by high-rise buildings in central London.

Weekday variations in NO<sub>2</sub> concentrations

**Figure 11: Weekday mean NO<sub>2</sub> concentration at roadside, urban background and rural background sites, 2017**



Notes:

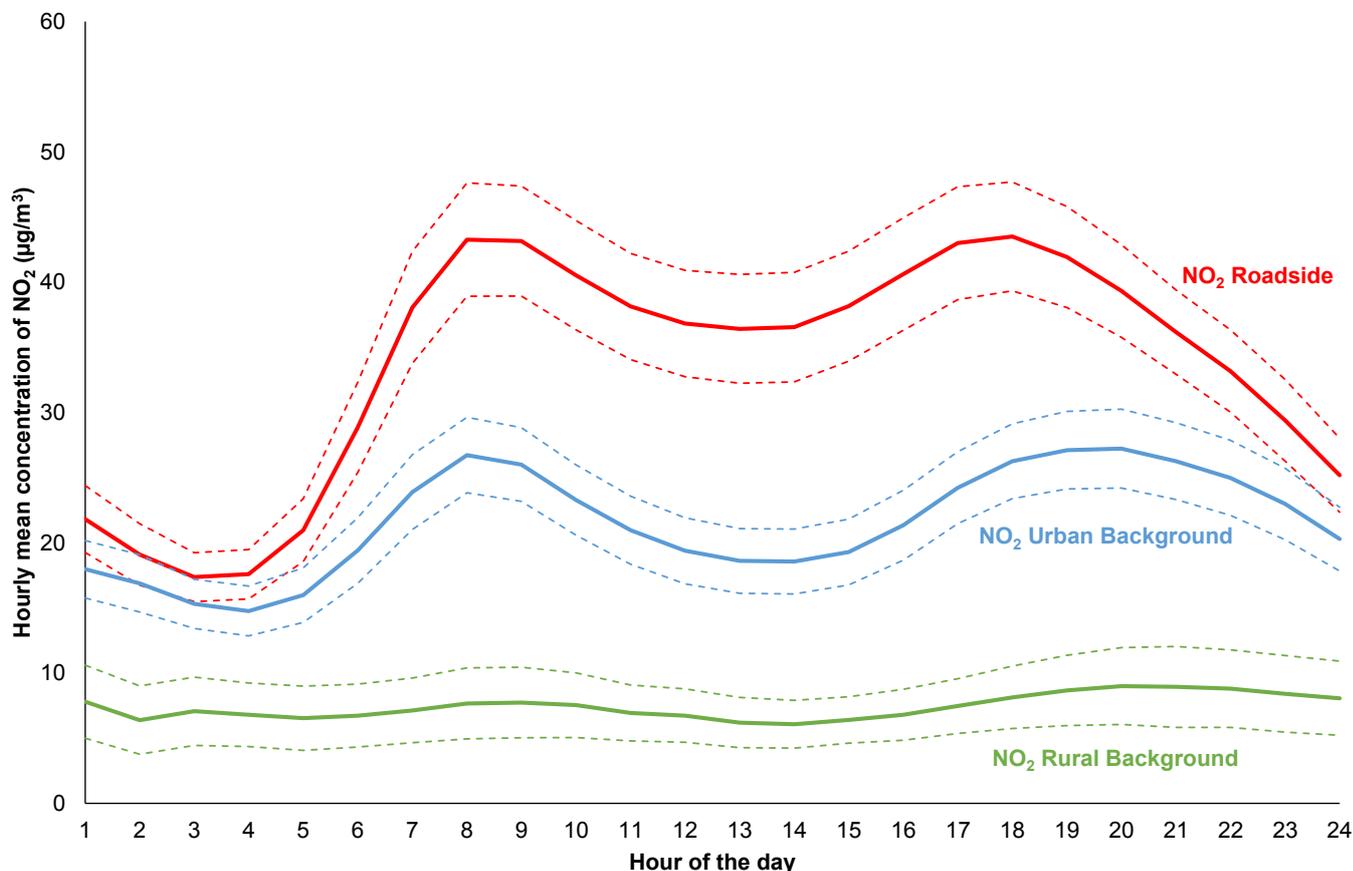
The NO<sub>2</sub> index shows the weekday mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the weekday mean concentration for roadside sites (red), urban background sites (blue) and rural background sites (green).

NO<sub>2</sub> concentrations tend to be much lower at the weekend compared to during weekdays; particularly for roadside sites. This is likely to be primarily driven by far less road traffic at the weekends. In 2017, the Monday-to-Friday mean concentration at roadside sites was 35.9 µg/m<sup>3</sup>; significantly greater than the mean concentration at the weekend (28.4 µg/m<sup>3</sup>).

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Hourly variations in NO<sub>2</sub> concentrations

**Figure 12: Hourly mean NO<sub>2</sub> concentration at roadside, urban background and rural background sites, 2017**



Notes:

The NO<sub>2</sub> index shows the hourly mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the hourly mean concentration for roadside sites (red), urban background sites (blue) and rural background sites (green).

NO<sub>2</sub> concentrations tend to be much greater during the morning and evening rush hour compared to other times of the day, for roadside and urban background sites. This is most likely due to commuter traffic during the working week; as this observation does not apply to Saturdays and Sundays. This pattern of concentrations follows the distribution of road traffic by time of day<sup>8</sup>.

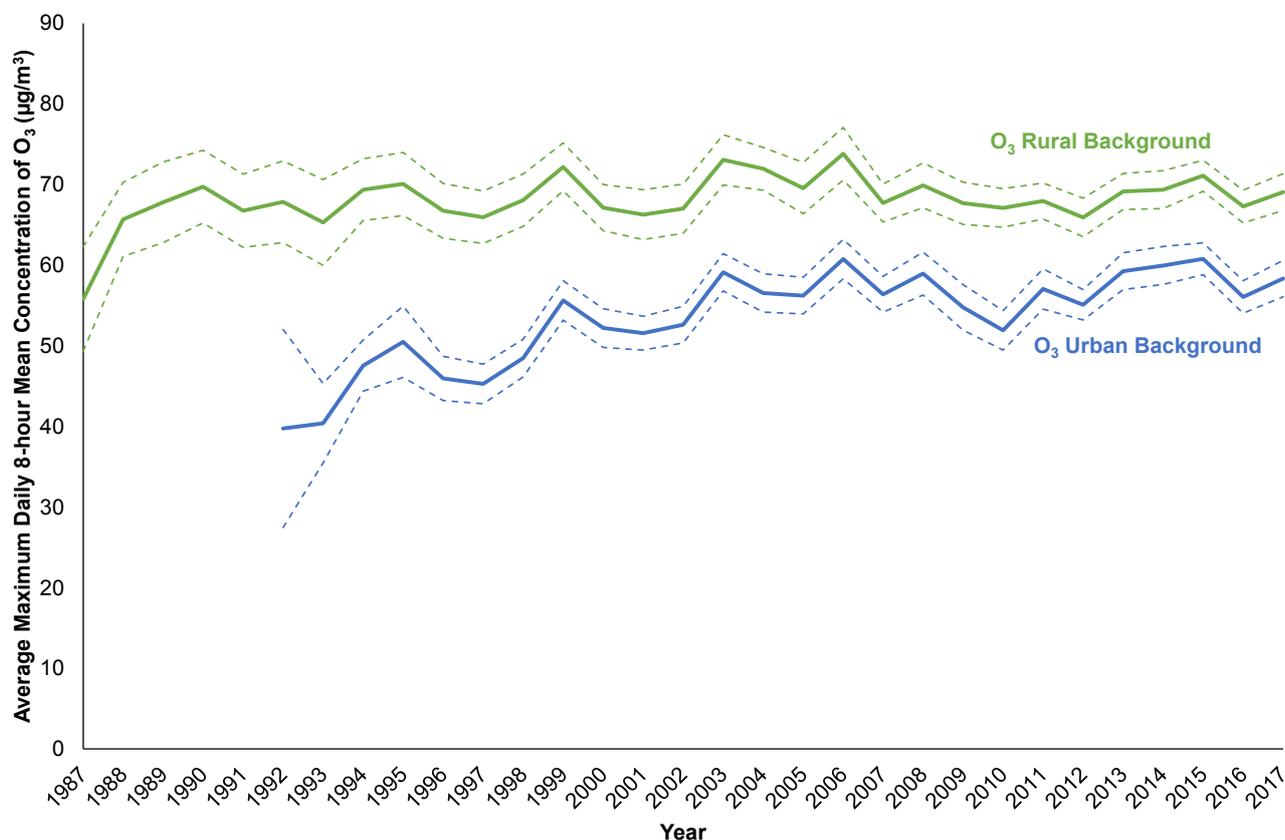
<sup>8</sup> Road traffic estimates in Great Britain, 2016 <https://www.gov.uk/government/statistics/road-traffic-estimates-in-great-britain-2016>

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## Ozone (O<sub>3</sub>) concentrations

### Annual Mean Concentrations of O<sub>3</sub>

**Figure 13: Annual concentrations of O<sub>3</sub> in the UK, 1987 to 2017**



#### Notes:

The O<sub>3</sub> index shows the annual mean, averaged over all included sites that had data capture greater than or equal to 75%. The dotted lines represent upper and lower bounds of the 95% confidence interval for the annual mean concentration for urban background sites (blue) and rural background sites (green). Annual means for individual sites can be found in the O<sub>3</sub> tables which accompany this report.

- **Urban background ozone pollution has shown a long-term increase but has been stable for the last decade**

The average maximum daily eight hour mean concentration has increased since 1992 and was 58.3 µg/m<sup>3</sup> in 2017; an increase in concentration compared to 2016 (56.0 µg/m<sup>3</sup>). This continues a fluctuation in concentrations since the mid-2000s. Some variance from year-to-year is expected due to fluctuations in the occurrence of hot summer weather conditions which are associated with high ozone concentrations.

From the start of the time series in 1992 to the mid-2000s, urban background ozone concentrations were increasing. This may have been due to the reduction in emissions

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of nitrogen oxides in the UK and Europe, which can inhibit the formation of ozone in urban areas.

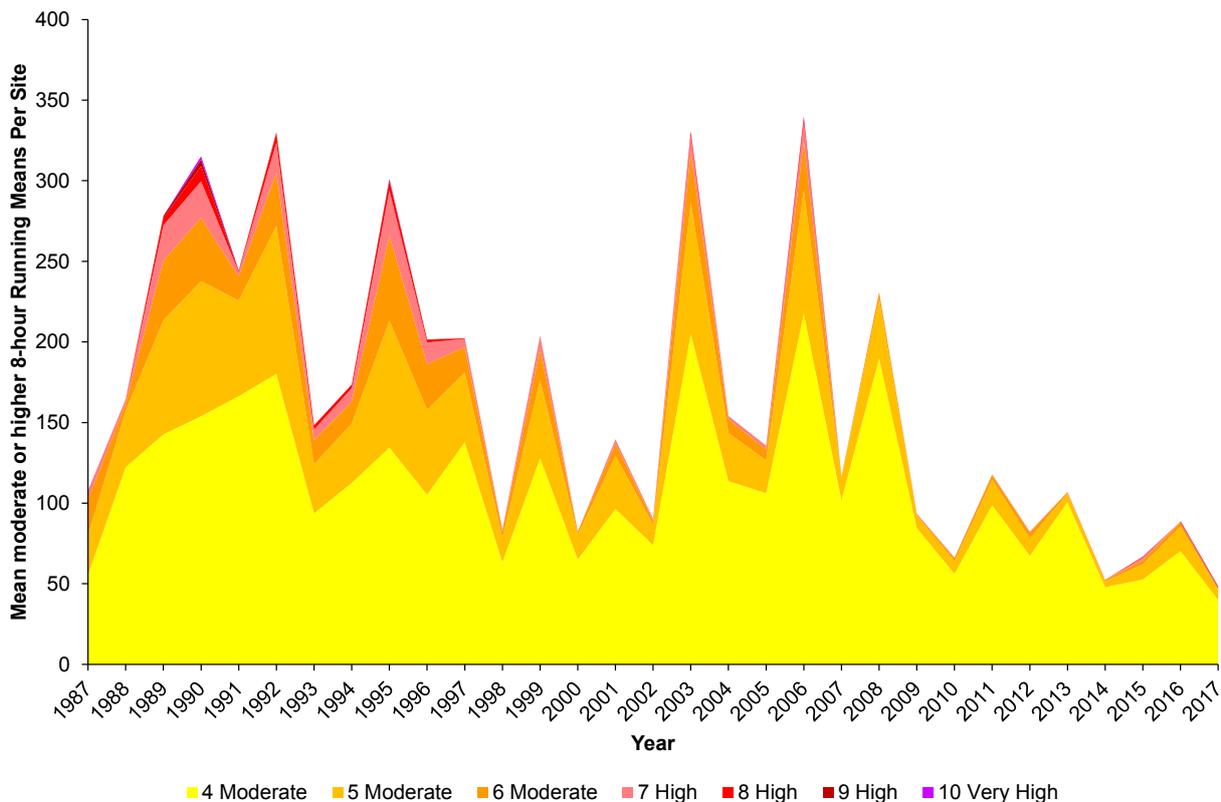
- **Rural background ozone pollution has shown no clear long-term trend**

The average maximum daily eight hour mean concentration has fluctuated since the start of the time series in 1987 and was 69.1  $\mu\text{g}/\text{m}^3$  in 2017; an increase in concentration compared to 2016 (67.3  $\mu\text{g}/\text{m}^3$ ). Some variance from year-to-year is expected due to fluctuations in the occurrence of hot summer weather conditions which are associated with high ozone concentrations. The future trend in concentrations may be dependent on global emissions of ozone precursor substances.

Average hours spent in ‘Moderate’ or higher O<sub>3</sub> pollution

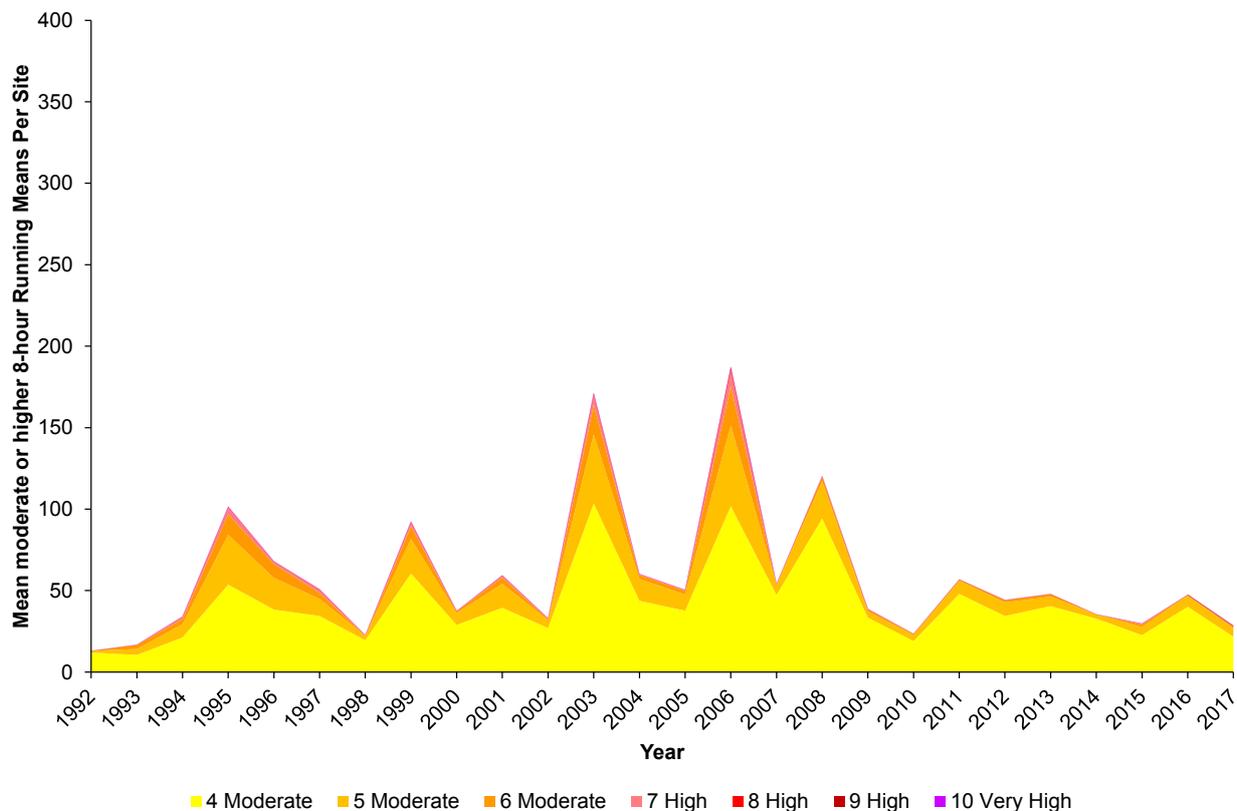
This metric measures the annual trend in the number of hours on average that concentrations are recorded at levels that may have impacts on human health. For O<sub>3</sub>, ‘moderate’ air pollution (which requires action by citizens who are vulnerable to the health impacts of air pollution) is triggered when the latest 8-hour running mean concentration is greater than 100  $\mu\text{g}/\text{m}^3$ . The coloured categories relate to the categories of the Daily Air Quality Index (see Table 5).

**Figure 14: Mean hours when O<sub>3</sub> pollution is moderate or higher for rural background sites, 1987 to 2017**



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**Figure 15: Mean hours when O<sub>3</sub> pollution is moderate or higher for urban background sites, 1992 to 2017**



- **Rural and urban background monitoring sites have recorded fewer hours of ‘moderate’ or higher O<sub>3</sub> air pollution in 2017 compared to 2016; though overall the time series is volatile.**

At rural and urban background sites between 2016 and 2017 there was a decrease in the number of hours for which the mean O<sub>3</sub> concentration over the previous 8 hours exceeded 100 µg/m<sup>3</sup>.

At rural sites the mean number of hours where O<sub>3</sub> concentrations exceeded this threshold for a monitoring site in 2017 was 48 compared with 89 in 2016. The comparable figures for urban background sites were 28 hours in 2017 compared with 47 hours in 2016.

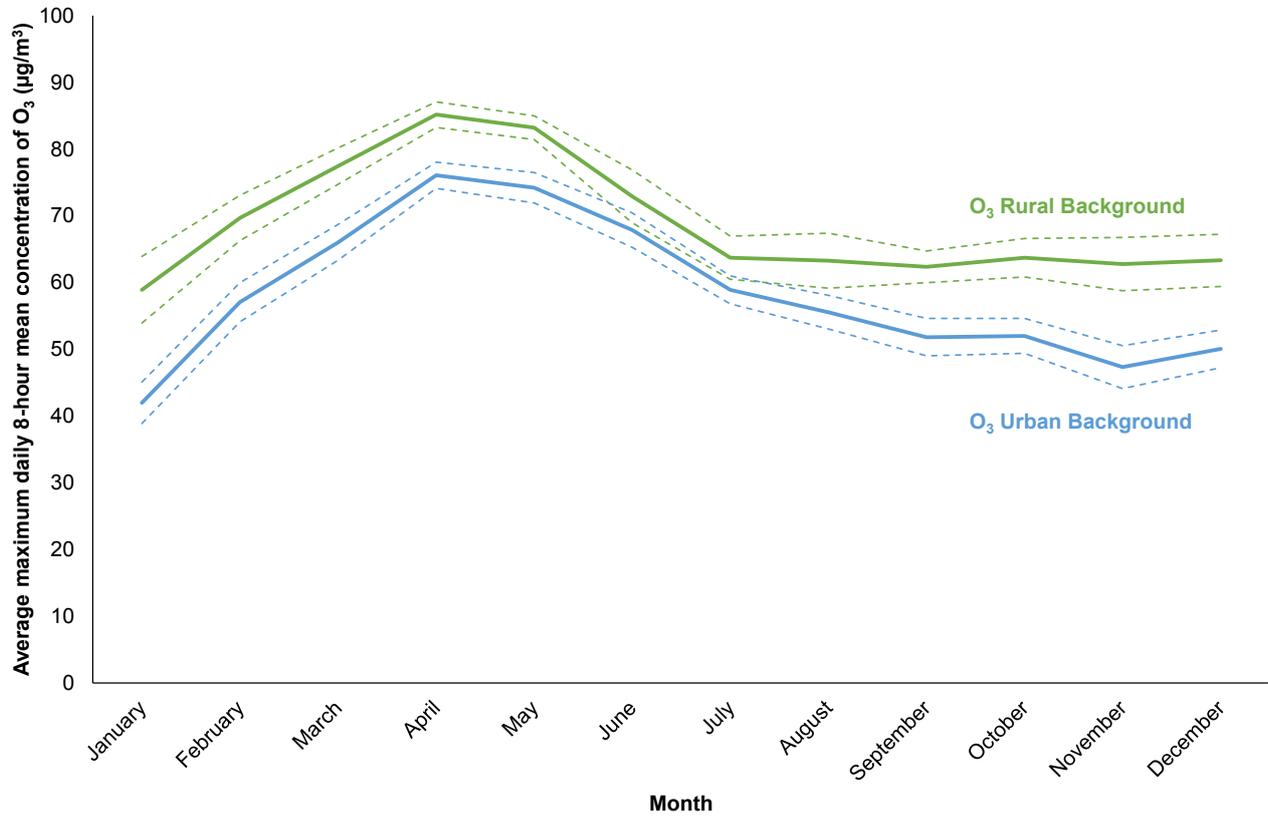
The overall trend in the rural indicator is a long-term decrease interrupted by several years where moderate pollution was more common; and the same is true for the urban background indicator but to a lesser extent. The long-term decrease and the recent reduction in volatility is likely driven by reductions in global emissions of substances that lead to the formation of ozone such as nitrogen oxides and volatile organic compounds.

Ozone concentrations are strongly influenced by weather, which contributes to the high variability over time and peaks such as in the hot summers of 2003 and 2006. This means

that long time series are required to distinguish between weather effects and the effect of changes in pollutant emissions.

Monthly variations in O<sub>3</sub> concentrations

**Figure 16: Monthly mean O<sub>3</sub> concentrations for rural and urban background sites, 2017**



For O<sub>3</sub> the greatest average concentrations tend to occur during the spring months; which is commonly seen across the Northern Hemisphere, although peak hourly concentrations are often associated with summer months. In 2017 the month that had the greatest ozone concentrations was April for both rural and urban monitoring sites (with monthly mean concentrations of 85.2 µg/m<sup>3</sup> and 76.1 µg/m<sup>3</sup>).

## Days with moderate or higher air pollution

**Figure 17: Average number of days per site when air pollution is moderate or higher in the UK, 2010-2017**

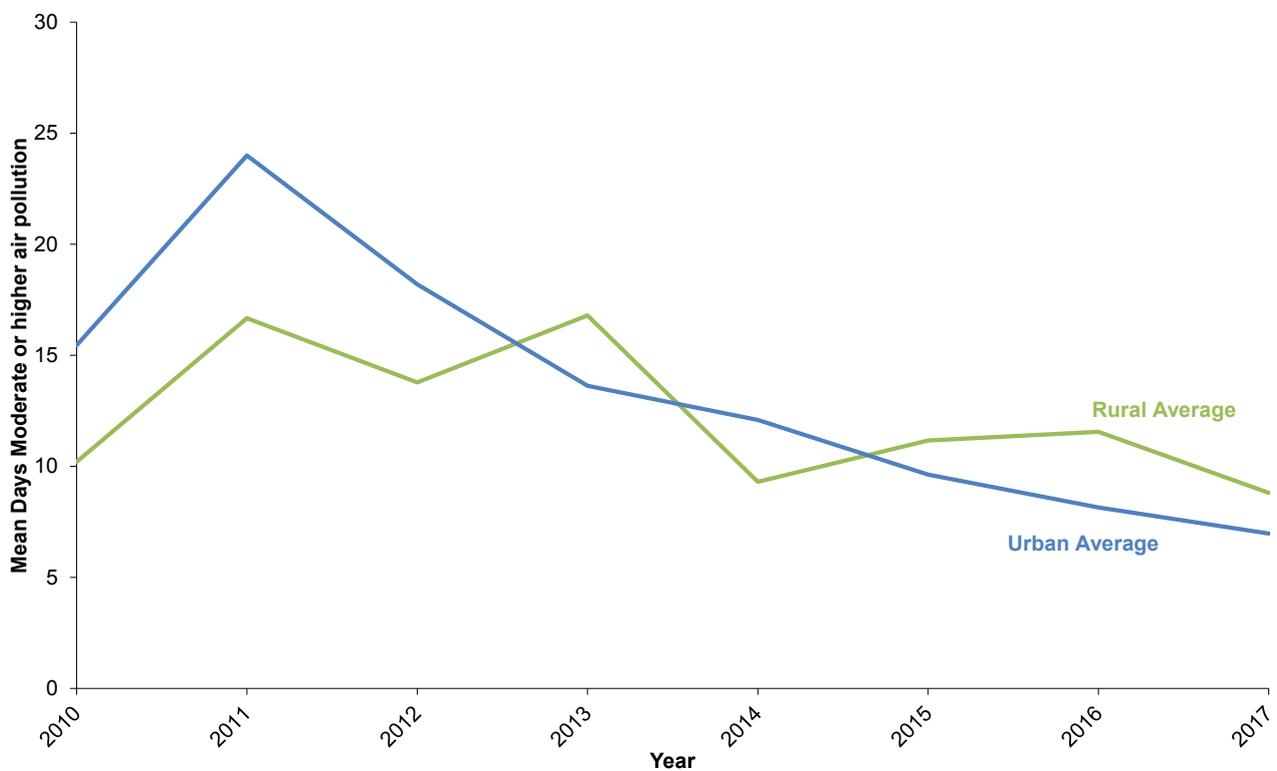
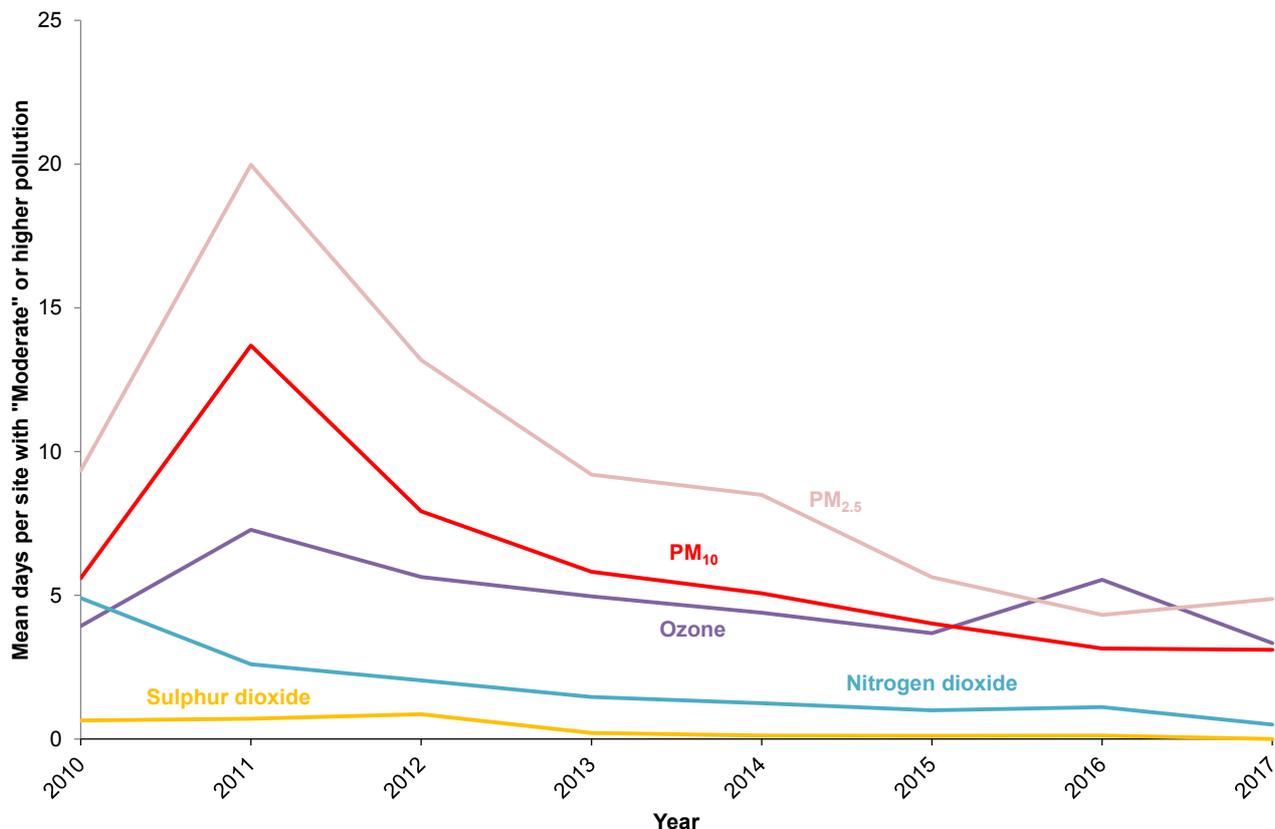


Figure 17 illustrates that:

- **There were on average fewer days of moderate or higher pollution at urban pollution monitoring sites in 2017 compared with any other year under the current methodology:** the average number of pollution days declined from 24.0 days in 2011 to 7.0 days in 2017, which is below the previous lowest point of 8.1 days of moderate or higher air pollution days in 2016.
- **There is no clear trend in the number of days of moderate or higher air pollution at rural sites:** the average number of days decreased from 11.6 days in 2016 to 8.8 days in 2017.

*The data are presented in Table 2 of the Annex at the end of this statistical release.*

**Figure 18: Average number of days when levels of ozone, particulate matter, nitrogen dioxide and sulphur dioxide were moderate or higher at urban sites in the UK, 2010-2017**



Note: for the purposes of this chart, where more than one pollutant exceeds the moderate threshold on any given day, it is counted for each pollutant i.e. there is double counting.

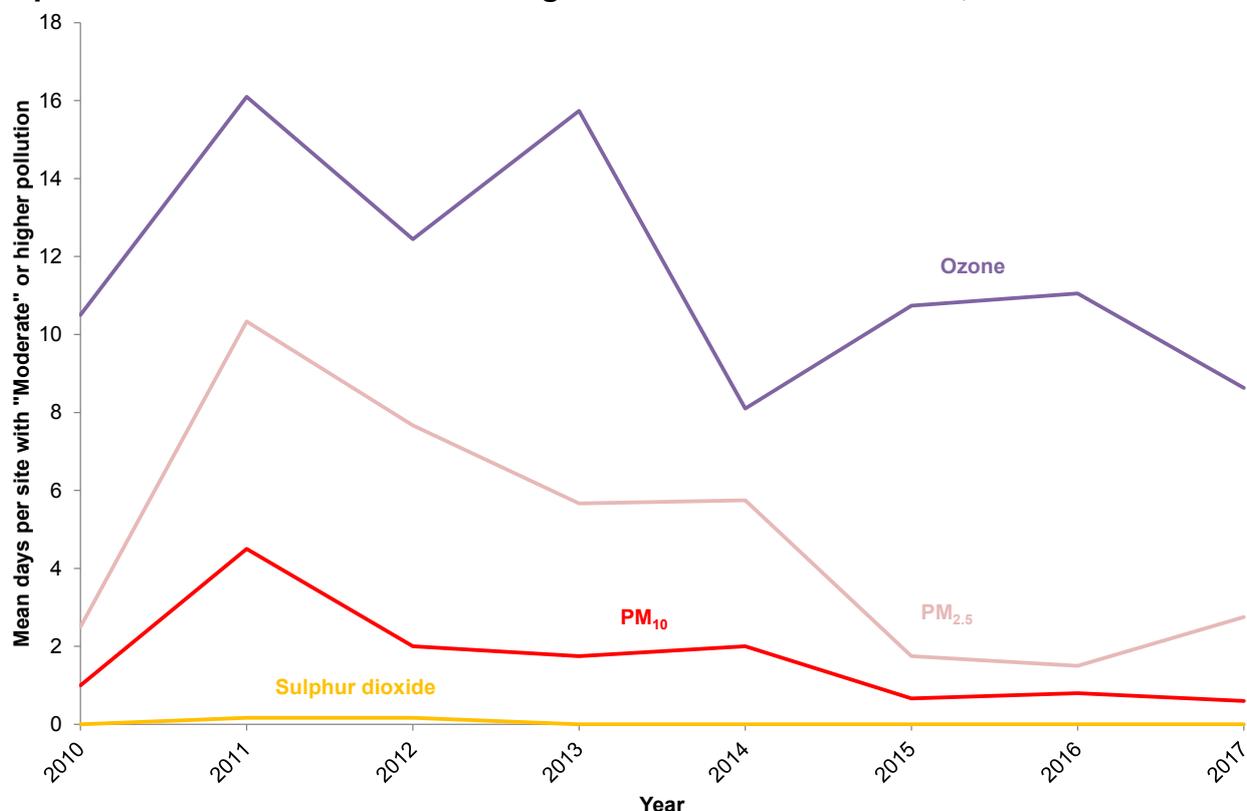
The data are presented in Table 3 of the Annex at the end of this statistical release

Figure 18 illustrates that:

- At urban sites the average number of days above the moderate threshold has decreased for PM<sub>10</sub> year-on-year since the peak in 2011. PM<sub>2.5</sub> had a small increase in this metric between 2016 and 2017.
- The ozone contribution has reduced to a level similar to 2015, after a small increase between 2015 and 2016. Levels of PM<sub>10</sub>, PM<sub>2.5</sub> and ozone are particularly influenced by weather, which contributes to the variability over time.
- Nitrogen dioxide has caused on average 0.5 days of moderate or higher pollution in urban areas during 2017; a new low for the time series. This represents a decline since 2010 which had 4.9 days per site of moderate or higher nitrogen dioxide pollution.

- Sulphur dioxide did not cause any moderate or higher pollution days for the first time in the time series. This reflects the large reductions in emissions from the early 1990s<sup>9</sup>.

**Figure 19: Average number of days when levels of ozone, particulate matter, and sulphur dioxide were moderate or higher at rural sites in the UK, 2010-2017**



Note: for the purposes of this chart, where more than one pollutant exceeds the moderate threshold on any given day, it is counted for each pollutant i.e. there is double counting. There were no days when levels of nitrogen dioxide were moderate or higher at rural sites in the UK between 2010 and 2017; hence data for this pollutant are not shown.

*The data are presented in Table 4 of the Annex at the end of this statistical release*

Figure 19 illustrates that:

- At rural sites in 2017 ozone was the main cause of moderate or higher pollution days, with a decrease from 11.1 days in 2016 to 8.6 in 2017. Sulphur dioxide and nitrogen dioxide did not directly contribute to the moderate or higher pollution days at rural sites, with no days of moderate or higher pollution attributed to these sources at any of the rural monitoring sites in 2017.

<sup>9</sup> See Statistical release: [Emissions of air pollutants in the UK, 1970-2016](#)

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- PM<sub>10</sub>, PM<sub>2.5</sub> and ozone caused all of the moderate or higher pollution days at rural sites in 2017, either separately or in combination with each other. Levels of these pollutants are particularly influenced by weather, which contributes to the variability over time.

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**Responsible Defra statistician: Philip Taylor**

## **Main notes**

1. The banding system used to determine moderate or higher air pollution is that of the UK Daily Air Quality Index. The version which has been used for this statistical release is displayed in Table 5 of the Annex.
2. More detailed data, site metadata and information are published on the [UK-AIR website](#).
3. Further information on air quality policy is available from the [Defra website](#).
4. Further details and data relating to UK air quality are available on Defra's [Air Quality Statistics website](#).

**Annex****Table 1: Annual average levels of PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub> and O<sub>3</sub> (µg m<sup>-3</sup>), 1987-2017**

| Year     | PM <sub>10</sub> |                  | PM <sub>2.5</sub> |                  | NO <sub>2</sub> |                  |                  | O <sub>3</sub>   |                  |
|----------|------------------|------------------|-------------------|------------------|-----------------|------------------|------------------|------------------|------------------|
|          | Roadside         | Urban background | Roadside          | Urban background | Roadside        | Urban background | Rural background | Rural Background | Urban background |
| 1987 (r) | -                | -                | -                 | -                | -               | -                | -                | 56               | -                |
| 1988 (r) | -                | -                | -                 | -                | -               | -                | -                | 66               | -                |
| 1989 (r) | -                | -                | -                 | -                | -               | -                | -                | 68               | -                |
| 1990 (r) | -                | -                | -                 | -                | -               | 54               | -                | 70               | -                |
| 1991 (r) | -                | -                | -                 | -                | -               | 59               | -                | 67               | -                |
| 1992 (r) | -                | 36               | -                 | -                | -               | 60               | -                | 68               | 40               |
| 1993 (r) | -                | 35               | -                 | -                | -               | 52               | -                | 65               | 40               |
| 1994 (r) | -                | 32               | -                 | -                | -               | 49               | -                | 69               | 48               |
| 1995 (r) | -                | 31               | -                 | -                | -               | 48               | -                | 70               | 51               |
| 1996 (r) | -                | 32               | -                 | -                | -               | 47               | -                | 67               | 46               |
| 1997 (r) | 37               | 30               | -                 | -                | 60              | 46               | 18               | 66               | 45               |
| 1998 (r) | 33               | 26               | -                 | -                | 59              | 41               | 15               | 68               | 48               |
| 1999 (r) | 32               | 24               | -                 | -                | 62              | 40               | 16               | 72               | 56               |
| 2000 (r) | 31               | 23               | -                 | -                | 57              | 36               | 14               | 67               | 52               |
| 2001 (r) | 31               | 23               | -                 | -                | 54              | 36               | 16               | 66               | 52               |
| 2002 (r) | 29               | 23               | -                 | -                | 49              | 33               | 13               | 67               | 53               |
| 2003 (r) | 31               | 25               | -                 | -                | 55              | 35               | 15               | 73               | 59               |
| 2004 (r) | 27               | 22               | -                 | -                | 52              | 32               | 11               | 72               | 57               |
| 2005 (r) | 28               | 22               | -                 | -                | 54              | 32               | 11               | 70               | 56               |
| 2006 (r) | 30               | 24               | -                 | -                | 54              | 32               | 10               | 74               | 61               |
| 2007 (r) | 27               | 22               | -                 | -                | 53              | 28               | 10               | 68               | 56               |
| 2008 (r) | 22               | 19               | -                 | -                | 50              | 28               | 9                | 70               | 59               |
| 2009 (r) | 20               | 19               | 13                | 12               | 46              | 29               | 9                | 68               | 55               |
| 2010 (r) | 22               | 19               | 14                | 13               | 46              | 31               | 9                | 67               | 52               |
| 2011 (r) | 23               | 20               | 16                | 14               | 41              | 27               | 9                | 68               | 57               |
| 2012 (r) | 20               | 17               | 14                | 13               | 41              | 27               | 10               | 66               | 55               |
| 2013 (r) | 20               | 17               | 13                | 12               | 39              | 25               | 9                | 69               | 59               |
| 2014 (r) | 19               | 17               | 13                | 12               | 38              | 25               | 8                | 69               | 60               |
| 2015 (r) | 17               | 15               | 11                | 10               | 37              | 23               | 7                | 71               | 61               |
| 2016 (r) | 19               | 16               | 11                | 10               | 38              | 23               | 9                | 67               | 56               |
| 2017 (r) | 17               | 14               | 10                | 10               | 34              | 22               | 7                | 69               | 58               |

**Notes:**

1. Each time series has been revised to reflect that sites can only contribute to the annual mean if they had at least 75% data capture.
2. PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>2</sub>: annual mean, averaged across all included sites.
3. Ozone: annual mean of the daily maximum 8 hour running mean: average across all included sites
4. '-' not available because of insufficient data
5. (r) Revised figures

**Table 2: Average number of days of moderate or higher air pollution per site, 2010-2017**

| Year     | Rural Average | Urban Average |
|----------|---------------|---------------|
| 2010     | 10.2          | 15.4          |
| 2011     | 16.7          | 24.0          |
| 2012     | 13.8          | 18.2          |
| 2013     | 16.8          | 13.6          |
| 2014     | 9.3           | 12.1          |
| 2015     | 11.2          | 9.6           |
| 2016 (r) | 11.6          | 8.1           |
| 2017     | 8.8           | 7.0           |

**Notes:**

Not every site in the automatic monitoring network is included. Sites must also meet certain data capture targets to be used in the index. Urban sites are required to monitor PM<sub>10</sub> and rural sites are required to monitor ozone. For the required pollutants data capture should be more than or equal to 75% of the year. For ozone this applies to both the full year and the summer period in isolation.

(r) Revised figures

**Table 3: Average number of days of moderate or higher air pollution at urban sites caused by each of the basket of 5 pollutants, 2010-2017**

| Year     | O <sub>3</sub> | NO <sub>2</sub> | SO <sub>2</sub> | PM <sub>10</sub> | PM <sub>2.5</sub> |
|----------|----------------|-----------------|-----------------|------------------|-------------------|
| 2010     | 3.9            | 4.9             | 0.6             | 5.6              | 9.3               |
| 2011     | 7.3            | 2.6             | 0.7             | 13.7             | 20.0              |
| 2012     | 5.6            | 2.0             | 0.9             | 7.9              | 13.2              |
| 2013     | 5.0            | 1.5             | 0.2             | 5.8              | 9.2               |
| 2014     | 4.4            | 1.2             | 0.1             | 5.1              | 8.5               |
| 2015     | 3.7            | 1.0             | 0.1             | 4.0              | 5.6               |
| 2016 (r) | 5.5            | 1.1             | 0.1             | 3.1              | 4.3               |
| 2017     | 3.3            | 0.5             | 0.0             | 3.1              | 4.9               |

**Notes:**

Not every site in the automatic monitoring network is included. Sites must also meet certain data capture targets to be used in the index. Urban sites are required to monitor PM<sub>10</sub> and rural sites are required to monitor ozone. For the required pollutants data capture should be more than or equal to 75% of the year. For ozone this applies to both the full year and the summer period in isolation.

(r) Revised figures

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**Table 4: Average number of days of moderate or higher air pollution at rural sites caused by the each of the basket of 5 pollutants, 2010-2017**

|      | O <sub>3</sub> | NO <sub>2</sub> | SO <sub>2</sub> | PM <sub>10</sub> | PM <sub>2.5</sub> |
|------|----------------|-----------------|-----------------|------------------|-------------------|
| 2010 | 10.5           | 0.0             | 0.0             | 1.0              | 2.5               |
| 2011 | 16.1           | 0.0             | 0.2             | 4.5              | 10.3              |
| 2012 | 12.4           | 0.0             | 0.2             | 2.0              | 7.7               |
| 2013 | 15.7           | 0.0             | 0.0             | 1.8              | 5.7               |
| 2014 | 8.1            | 0.0             | 0.0             | 2.0              | 5.8               |
| 2015 | 10.7           | 0.0             | 0.0             | 0.7              | 1.8               |
| 2016 | 11.1           | 0.0             | 0.0             | 0.8              | 1.5               |
| 2017 | 8.6            | 0.0             | 0.0             | 0.6              | 2.8               |

**Notes:**

Not every site in the automatic monitoring network is included. Sites must also meet certain data capture targets to be used in the index. Urban sites are required to monitor PM<sub>10</sub> and rural sites are required to monitor ozone. For the required pollutants data capture should be more than or equal to 75% of the year. For ozone this applies to both the full year and the summer period in isolation.

(r) Revised figures

**Table 5: Daily Air Quality Index, updated April 2013**

| Band             | Index | Ozone                 | Nitrogen Dioxide  | Sulphur Dioxide   | PM <sub>2.5</sub> Particles | PM <sub>10</sub> Particles |
|------------------|-------|-----------------------|-------------------|-------------------|-----------------------------|----------------------------|
|                  |       | Running 8 hourly mean | hourly mean       | 15 minute mean    | 24 hour mean                | 24 hour mean               |
|                  |       | µgm <sup>-3</sup>     | µgm <sup>-3</sup> | µgm <sup>-3</sup> | µgm <sup>-3</sup>           | µgm <sup>-3</sup>          |
| <b>LOW</b>       |       |                       |                   |                   |                             |                            |
|                  | 1     | 0-33                  | 0-67              | 0-88              | 0-11                        | 0-16                       |
|                  | 2     | 34-66                 | 68-134            | 89-177            | 12-23                       | 17-33                      |
|                  | 3     | 67-100                | 135-200           | 178-266           | 24-35                       | 34-50                      |
| <b>MODERATE</b>  |       |                       |                   |                   |                             |                            |
|                  | 4     | 101-120               | 201-267           | 267-354           | 36-41                       | 51-58                      |
|                  | 5     | 121-140               | 268-334           | 355-443           | 42-47                       | 59-66                      |
|                  | 6     | 141-160               | 335-400           | 444-532           | 48-53                       | 67-75                      |
| <b>HIGH</b>      |       |                       |                   |                   |                             |                            |
|                  | 7     | 161-187               | 401-467           | 533-710           | 54-58                       | 76-83                      |
|                  | 8     | 188-213               | 468-534           | 711-887           | 59-64                       | 84-91                      |
|                  | 9     | 214-240               | 535-600           | 888-1064          | 65-70                       | 92-100                     |
| <b>VERY HIGH</b> |       |                       |                   |                   |                             |                            |
|                  | 10    | 241 or more           | 601 or more       | 1065 or more      | 71 or more                  | 101 or more                |