



Department for Environment, Food and Rural Affairs

STATISTICAL RELEASE: 26 April 2012

## AIR QUALITY STATISTICS IN THE UK, 1987 TO 2011 - FINAL

- **Urban background particulate pollution has shown long-term improvement but changed little recently:** average concentrations declined from a peak of 35 micrograms per cubic metre ( $\mu\text{g m}^{-3}$ ) in 1992 to 20  $\mu\text{g m}^{-3}$  in 2011. They changed little in the past four years and were also 20  $\mu\text{g m}^{-3}$  in 2010.
- **Roadside particulate pollution has shown long-term improvement but changed little recently:** average concentrations declined from a peak of 39  $\mu\text{g m}^{-3}$  in 1997 to 22  $\mu\text{g m}^{-3}$  in 2011. They changed little in the past four years and were 22  $\mu\text{g m}^{-3}$  in 2010.
- **Urban background ozone pollution has shown a long-term increase:** average concentrations increased from a low of 38  $\mu\text{g m}^{-3}$  in 1987 to 58  $\mu\text{g m}^{-3}$  in 2011 and increased from 53  $\mu\text{g m}^{-3}$  in 2010 after declining from a peak of 61  $\mu\text{g m}^{-3}$  in 2006.
- **Rural background ozone pollution has shown no clear long-term trend and changed little recently:** average concentrations increased from a low of 58  $\mu\text{g m}^{-3}$  in 1987 to 68  $\mu\text{g m}^{-3}$  in 2011, but changed little in the past five years, fluctuating between 67 and 70  $\mu\text{g m}^{-3}$  after declining from a peak of 74  $\mu\text{g m}^{-3}$  in 2006.
- **Days of moderate or higher air pollution in urban areas have shown a long-term improvement but increased in 2011:** average pollution days declined from a peak of 59 days in 1993 to 16 days in 2011, but increased from the lowest recorded level of 8 days in 2010 - driven by an increase in ozone and particulates pollution in urban sites.
- **Days of moderate or higher air pollution for rural areas have shown no clear trend but increased in 2011 compared with 2010:** average pollution days declined from a peak of 64 days in 2003 to 30 days in 2011, but increased from a low of 22 days in 2010.

The results shown are final and provide an update of provisional results published on 2 February 2012, following full quality assurance process. Overall, the results have changed very little from the provisional ones, with the exception that the average number of days of

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moderate or higher pollution at urban sites decreased from 17 to 16 owing to fewer ozone and particulate pollution days being determined in the final results.

## **Background**

### **Why measure air quality?**

There have been significant reductions in recent decades of emissions of air pollutants from power stations, transport, household heating, agriculture and industrial processes.

Estimates of the amount of pollutants emitted into the air are made in the [National Atmospheric Emissions Inventory](#) by making highly detailed assumptions on the amount of each air pollutant generated from different fuel use and activities in the UK. These estimates are published in a separate Defra National Statistics Release: Emissions of air pollutants in the UK<sup>i</sup>.

However, the relationships between emissions and air quality is complex and is strongly affected by weather. In addition UK air quality can be affected by pollutants blown across from mainland Europe. Day-to-day changes in weather 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 a wind starts to blow.

In order to monitor our 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. . [The UK-AIR website](#) provides further information and provides the most up-to-date data for all pollutants measured by Defra.

In the UK, actions taken on air quality are driven by the objectives set out in the 2007 Air Quality Strategy and are informed by the statistics derived from air quality monitoring. See [Defra's air quality website](#) for more information on this and air quality policies.

There is also substantial [EU legislation](#) (such as the Directive on Ambient Air Quality and Cleaner Air for Europe) in place to reduce pollution and to set limit and target values for air quality.

### **Understanding air quality statistics**

The statistics presented here summarise the results from the AURN monitoring. Only sites that meet data capture criteria are included in the calculation of the statistics, and the figures presented are UK average concentrations across these sites.

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<sup>i</sup> See statistical release: [Emissions of air pollutants in the UK, 1970-2010](#)

The statistical release covers **annual average concentrations** in the UK of:

- particulates (PM<sub>10</sub>); and
- ozone (O<sub>3</sub>)

which are the two pollutants thought to have the greatest health impacts.

In general, the smaller and lighter a particle is, the longer it will stay in the air. Larger particles (greater than 10 micrometres (µm) in diameter) tend to settle to the ground by gravity in a matter of hours. Chronic exposure to particulates contribute to the risk of developing cardiovascular and respiratory diseases, and there is increasing evidence suggesting that long-term exposure to even low levels of particulates may have a significant effect on health. The annual average concentrations for particulates are considered a useful measure of overall exposure to particulates at all concentrations.

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 precursor pollutants when in sunlight, with more being created on hot, still, sunny days. It can affect people's health and can damage wild plants, crops, forests and some materials. The impact of long term exposure to this gas is currently unclear, but if there is no lower limit on the levels which have a health impact then the average concentrations may give a reasonable indication of the level of exposure.

The statistical release also covers **the number of days when air pollution was 'moderate or higher'** for any one of five pollutants listed below. In the UK, most air pollution information services use the index and banding system recommended by the Committee on Medical Effects of Air Pollutants (COMEAP). The system uses an index numbered 1-10, divided into four bands, low to 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. The bandings have been updated from the 1<sup>st</sup> January 2012 and the new bandings will be reflected in the air quality statistics for 2012. The statistics for 2011 are based on the bandings in place up to the 31<sup>st</sup> December 2011 which are shown in Table 4 of the Annex at the end of the statistical release.

The five pollutants used in the assessment of air pollution levels are:

- carbon monoxide (CO)
- nitrogen dioxide (NO<sub>2</sub>)
- ozone (O<sub>3</sub>)
- particulates (PM<sub>10</sub>)
- sulphur dioxide (SO<sub>2</sub>)

These can directly have [adverse effects on human health](#), can react to form ozone or secondary particulate matter and or can cause harm to the environment through the creation of - in the case of SO<sub>2</sub> - acidic compounds (which can cause harm to vegetation and buildings, including as acid-rain); and - in the case of NO<sub>2</sub> - eutrophying compounds (which can affect the nutrient levels and diversity of species in sensitive environments).

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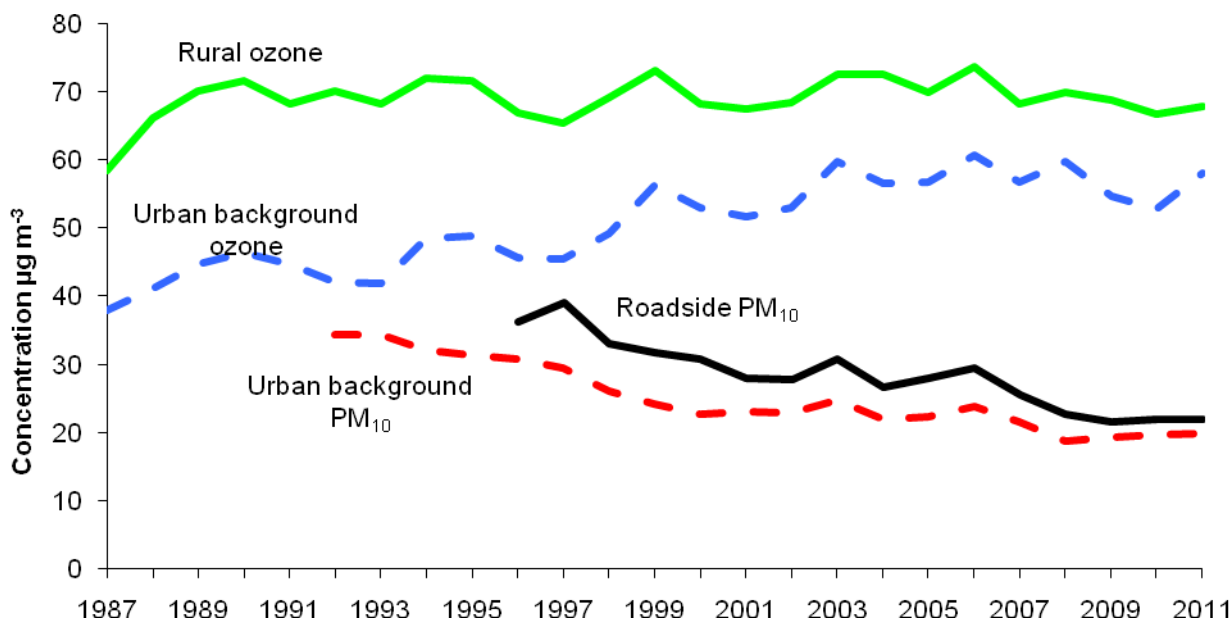
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## Particulate (PM<sub>10</sub>) and Ozone concentrations

Figure 1: Annual levels of PM<sub>10</sub> and Ozone in the UK, 1987 to 2011



### Notes:

The ozone index shows the annual mean of the daily maximum 8 hour running mean. The PM<sub>10</sub> index shows the annual average.

- Urban background particulate pollution has shown long-term improvement but remained stable recently:** average concentrations declined from a peak of 35 micrograms per cubic metre ( $\mu\text{g m}^{-3}$ ) in 1992 to 20  $\mu\text{g m}^{-3}$  in 2011. They changed little in the past four years and were also 20  $\mu\text{g m}^{-3}$  in 2010.
- Roadside particulate pollution has shown long-term improvement but changed little recently:** average concentrations declined from a peak of 39  $\mu\text{g m}^{-3}$  in 1997 to 22  $\mu\text{g m}^{-3}$  in 2011. They changed little in the past four years and were 22  $\mu\text{g m}^{-3}$  in 2010.
- Urban background ozone pollution has shown a long-term increase:** average concentrations increased from a low of 38  $\mu\text{g m}^{-3}$  in 1987 to 58  $\mu\text{g m}^{-3}$  in 2011 and increased from 53  $\mu\text{g m}^{-3}$  in 2010 after declining from a peak of 61  $\mu\text{g m}^{-3}$  in 2006.
- Rural background ozone pollution has shown no clear long-term trend and changed little recently:** average concentrations increased from a low of 58  $\mu\text{g m}^{-3}$  in 1987 to 68  $\mu\text{g m}^{-3}$  in 2011, but changed little in the past five years, fluctuating between 67 and 70  $\mu\text{g m}^{-3}$  after declining from a peak of 74  $\mu\text{g m}^{-3}$  in 2006.

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*The data are presented in Table 1 of the Annex at the end of this statistical release*

Emissions of PM<sub>10</sub> steadily declined until around a decade ago<sup>ii</sup>, since when they have remained largely unchanged, which is reflected in the measured urban background concentrations. The steady decline was attributable to a move away from coal to gas in both electricity generation and domestic and commercial combustion; and also the introduction of emission standards for road vehicles.

Both particulate and 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.

Emissions of the pollutants that are the main precursors to ozone (including nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs)) have reduced substantially<sup>iii</sup>, but this is not reflected in the long-term trend in ozone concentrations. This may be partly explained by a proportion of the ozone experienced in the UK originating from releases of precursor pollutants that are blown over from mainland Europe.

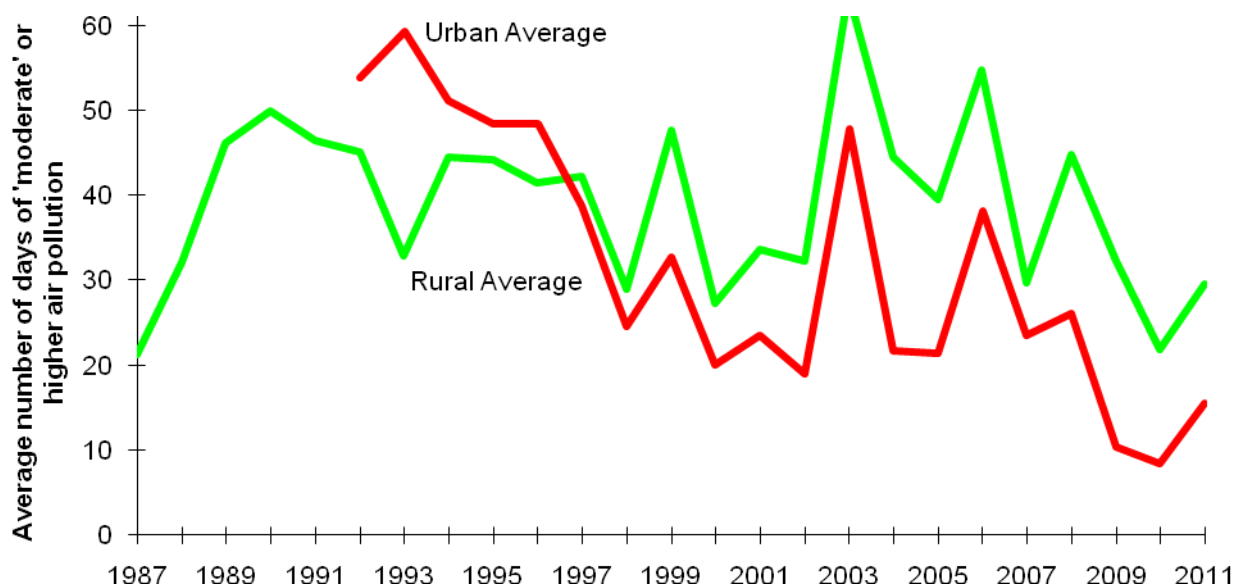
However, a similar lack of an apparent link between emissions and measured concentrations of ozone in the air is observed Europe wide. The European Environment Agency provides [further analysis of European air quality](#).

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<sup>ii iii</sup> See Statistical release: [Emissions of air pollutants in the UK, 1970-2010](#)

## Days with moderate or higher air pollution

**Figure 2: Average number of days per site when air pollution is moderate or higher in the UK, 1987-2011**



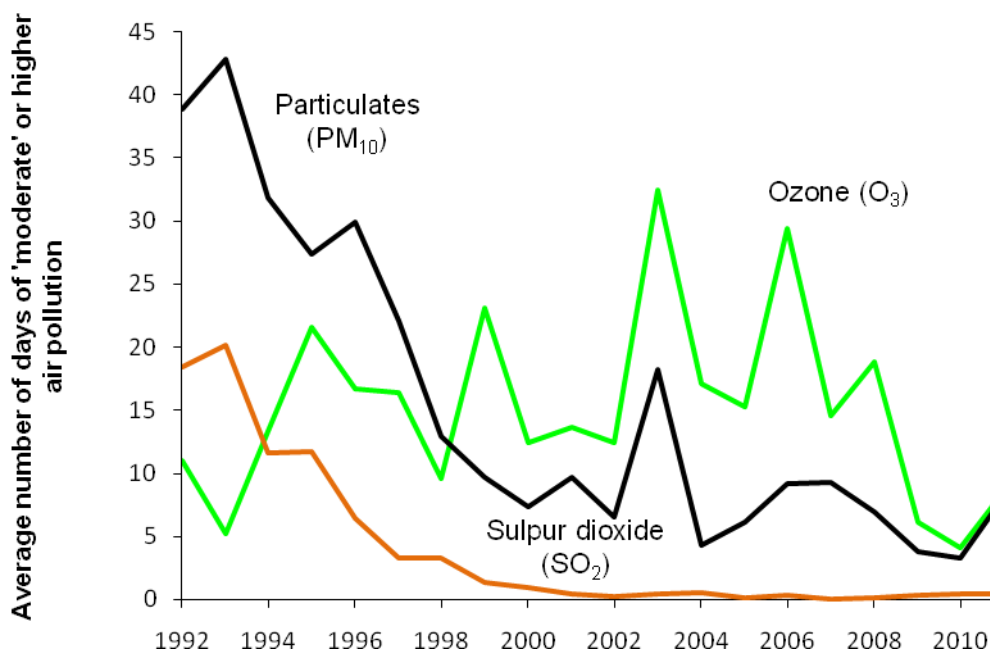
- **Days of moderate or higher air pollution in urban areas have shown a long-term improvement but increased in 2011:** average pollution days declined from a peak of 59 days in 1993 to 16 days in 2011, but increased from the lowest recorded level of 8 days in 2010 - driven by an increase in ozone pollution days (from 4 to 8 days) and particulates pollution days (from 3 to 8 days) in urban sites between 2010 and 2011.
- **Days of moderate or higher air pollution for rural areas have shown no clear trend but increased in 2011 compared with 2010:** average days declined from a peak of 64 days in 2003 to 30 days in 2011, but increased from a low of 22 days in 2010.

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

The urban results are most strongly driven by ozone and PM<sub>10</sub>, and the rural results by ozone. Both these pollutants are influenced by weather, which contributes to the variability over time.

## Causes of air pollution

**Figure 3: Average number of days when levels of ozone, particulates and sulphur dioxide were moderate or higher at urban sites in the UK, 1992-2011**



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*

At urban sites in 2011, two of the five pollutants, ozone and particulates, caused over 95 per cent of the moderate or higher pollution days, either separately or in combination with each other.

Between 1992 and 2011, the average number of days of pollution at urban sites caused by particulates, solely or in combination with other pollutants, fell from an average per site of 39 days to 8 days per year.

Since 1999, ozone has caused more days of moderate or higher pollution in urban areas than particulates, as pollution by particulates has declined. However, the number of pollution days caused by ozone has no clear long-term trend. Weather conditions contribute to variability over time, with more ozone produced on hot, sunny days, as was the case during 2003 and 2006. However, low summer ozone pollution was also seen [Europe-wide in 2009](#), despite the average temperature being similar to the hot summer in Europe in 2003. This could indicate that reductions in emissions of ozone precursors have contributed to the lower pollution days caused by ozone levels in recent years.



From 2001, sulphur dioxide has caused less than one pollution day per site on average, either solely or in combination with other pollutants. This reflects the large reductions in emissions from the early 1990s. Carbon monoxide has not contributed to the number of pollution days since 1993. Nitrogen dioxide has impacted very rarely, at a maximum of 1 day per year.

For rural areas, ozone is the cause of the majority of pollution days - a breakdown by pollutant is not therefore presented for rural sites.

**A National Statistics publication**

**National Statistics are produced to high professional standards set out in the Code of Practice for Official Statistics. They undergo regular quality assurance reviews to ensure they meet customer needs.**

**Responsible Defra statistician: Stephen Hall**

**Main notes**

1. The banding system used for determine moderate or higher air pollution is that of UK Daily Air Quality Index. The UK air quality bandings were updated on 1<sup>st</sup> January 2012. The data presented in Table 4 of the Annex are based on the previous bandings in place up to 31<sup>st</sup> December 2011<sup>iv</sup>.
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 [Environment Statistics website](#).

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<sup>iv</sup> See 'Table 4: UK Air quality bandings used up until 31<sup>st</sup> December 2011' at the end for more details.



**Annex****Table 1: Annual average levels of PM<sub>10</sub> and Ozone ( $\mu\text{g m}^{-3}$ ), 1987-2011 (Final), UK**

| Year | PM <sub>10</sub>     |                      | Ozone |                  |
|------|----------------------|----------------------|-------|------------------|
|      | Roadside             | Urban Background     | Rural | Urban Background |
| 1987 | ..                   | ..                   | 58    | 38               |
| 1988 | ..                   | ..                   | 66    | 41               |
| 1989 | ..                   | ..                   | 70    | 45               |
| 1990 | ..                   | ..                   | 72    | 46               |
| 1991 | ..                   | ..                   | 68    | 45               |
| 1992 | ..                   | 35                   | 70    | 42               |
| 1993 | ..                   | 35                   | 68    | 42               |
| 1994 | ..                   | 32                   | 72    | 49               |
| 1995 | ..                   | 32                   | 72    | 49               |
| 1996 | 36                   | 31                   | 67    | 46               |
| 1997 | 39                   | 30                   | 65    | 46               |
| 1998 | 33                   | 26                   | 69    | 49               |
| 1999 | 32                   | 24                   | 73    | 56               |
| 2000 | 31                   | 23                   | 68    | 53               |
| 2001 | 28                   | 23                   | 68    | 52               |
| 2002 | 28                   | 23                   | 68    | 53               |
| 2003 | 31                   | 25                   | 72    | 60               |
| 2004 | 27                   | 22                   | 73    | 57               |
| 2005 | 28                   | 22                   | 70    | 57               |
| 2006 | 30                   | 24                   | 74    | 61               |
| 2007 | 25                   | 22                   | 68    | 57               |
| 2008 | 23                   | 19                   | 70    | 60               |
| 2009 | 22 (19) <sup>1</sup> | 19 (22) <sup>1</sup> | 69    | 55               |
| 2010 | 22 (22) <sup>1</sup> | 20                   | 67    | 53               |
| 2011 | 22                   | 20                   | 68    | 58               |

**Notes:**

1. Since 2008, upgrading of numerous PM<sub>10</sub> monitoring instruments has enabled correction of measurements taken from sites using older equipment, by using the Volatile Correction Model (VCM). These results are shown in parentheses. Non-VCM corrected data for 2008 and 2009 are retained here for the purpose of year-on-year comparison.

PM<sub>10</sub>: annual mean, average across all included sites.

Ozone: annual mean of the daily maximum 8 hour running mean: average across all included sites

.. not available because of insufficient data

Not every site in the automatic monitoring network is included. Sites must also meet certain data capture targets to be used in the index. For both ozone and PM<sub>10</sub>, from 1987-97 data capture should be more than or equal to 50% of the year and from 1998 onwards it 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.

Cardiff Centre and Manchester Piccadilly were excluded in 1994 and 2001 respectively, because stone cutting adjacent to sites caused unrepresentative results. Narberth was excluded in 2004 and 2007 due to incorrect measurements. Great Dun Fell was excluded until 2001 due to sample lines being frozen. Reading New Town has been excluded in 2008 due to low data capture for PM<sub>10</sub> caused by faulty new measuring instruments.

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**Table 2: Average number of days of moderate or higher air pollution per site, 1987-2011 (Final), UK**

| Year | Urban Average | Rural Average |
|------|---------------|---------------|
| 1987 | ..            | 21            |
| 1988 | ..            | 32            |
| 1989 | ..            | 46            |
| 1990 | ..            | 50            |
| 1991 | ..            | 47            |
| 1992 | 54            | 45            |
| 1993 | 59            | 33            |
| 1994 | 51            | 45            |
| 1995 | 48            | 44            |
| 1996 | 48            | 42            |
| 1997 | 39            | 42            |
| 1998 | 25            | 29            |
| 1999 | 33            | 48            |
| 2000 | 20            | 27            |
| 2001 | 23            | 34            |
| 2002 | 19            | 32            |
| 2003 | 48            | 64            |
| 2004 | 22            | 45            |
| 2005 | 21            | 40            |
| 2006 | 38            | 55            |
| 2007 | 23            | 30            |
| 2008 | 26            | 45            |
| 2009 | 10            | 32            |
| 2010 | 8             | 22            |
| 2011 | 16            | 30            |

**Notes:**

.. not available because of insufficient data

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, 1987-97 data capture should be more than or equal to 50% of the year, and from 1998 onwards it 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.

Cardiff Centre and Manchester Piccadilly were excluded in 1994 and 2001 respectively, because stone cutting adjacent to sites caused unrepresentative results. Narberth was excluded in 2004 and 2007 due to incorrect measurements. Great Dun Fell was excluded until 2001 due to sample lines being frozen. Reading New Town has been excluded in 2008 due to initial problems with new measuring instruments.

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**Table 3: Average number of days of moderate or higher air pollution at urban sites caused by the each of the basket of 5 pollutants, 1992 to 2011 (Final), UK**

| Year | Ozone | Nitrogen dioxide | Carbon monoxide | Sulphur dioxide | Particulates (PM <sub>10</sub> ) |
|------|-------|------------------|-----------------|-----------------|----------------------------------|
| 1992 | 11    | 1                | 1               | 19              | 39                               |
| 1993 | 5     | 0                | 0               | 20              | 43                               |
| 1994 | 13    | 1                | 0               | 12              | 32                               |
| 1995 | 22    | 1                | 0               | 12              | 27                               |
| 1996 | 17    | 0                | 0               | 6               | 30                               |
| 1997 | 16    | 1                | 0               | 3               | 22                               |
| 1998 | 10    | 0                | 0               | 3               | 13                               |
| 1999 | 23    | 0                | 0               | 1               | 10                               |
| 2000 | 12    | 0                | 0               | 1               | 7                                |
| 2001 | 14    | 0                | 0               | 0               | 10                               |
| 2002 | 12    | 0                | 0               | 0               | 7                                |
| 2003 | 33    | 0                | 0               | 0               | 18                               |
| 2004 | 17    | 0                | 0               | 1               | 4                                |
| 2005 | 15    | 1                | 0               | 0               | 6                                |
| 2006 | 29    | 0                | 0               | 0               | 9                                |
| 2007 | 15    | 0                | 0               | 0               | 9                                |
| 2008 | 19    | 1                | 0               | 0               | 7                                |
| 2009 | 6     | 0                | 0               | 0               | 4                                |
| 2010 | 4     | 1                | 0               | 0               | 3                                |
| 2011 | 8     | 0                | 0               | 0               | 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, 1987-97 data capture should be more than or equal to 50% of the year, and from 1998 onwards it 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.

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Table 4: UK Air quality bandings applicable until 31<sup>st</sup> December 2011

| Band             | Index | Ozone                            |             | Nitrogen Dioxide     |             | Sulphur Dioxide      |             | Carbon Monoxide       |            | PM10 Particles                         |                                       |
|------------------|-------|----------------------------------|-------------|----------------------|-------------|----------------------|-------------|-----------------------|------------|--|---------------------------------------|
|                  |       | Running 8 hourly or hourly mean* |             | hourly mean          |             | 15 minute mean       |             | Running 8 hourly mean |            | Running 24 hour mean                   |                                       |
|                  |       | $\mu\text{g m}^{-3}$             | ppb         | $\mu\text{g m}^{-3}$ | ppb         | $\mu\text{g m}^{-3}$ | ppb         | $\text{mg m}^{-3}$    | ppm        | $\mu\text{g m}^{-3}$<br>(Grav. Equiv.) | $\mu\text{g m}^{-3}$<br>(Ref. Equiv.) |
| <b>Low</b>       |       |                                  |             |                      |             |                      |             |                       |            |  |                                       |
|                  | 1     | 0-33                             | 0-16        | 0-95                 | 0-49        | 0-88                 | 0-32        | 0-3.8                 | 0.0-3.2    | 0-21                                   | 0-19                                  |
|                  | 2     | 34-65                            | 17-32       | 96-190               | 50-99       | 89-176               | 33-66       | 3.9-7.6               | 3.3-6.6    | 22-42                                  | 20-40                                 |
|                  | 3     | 66-99                            | 33-49       | 191-286              | 100-149     | 177-265              | 67-99       | 7.7-11.5              | 6.7-9.9    | 43-64                                  | 41-62                                 |
| <b>Moderate</b>  |       |                                  |             |                      |             |                      |             |                       |            |  |                                       |
|                  | 4     | 100-125                          | 50-62       | 287-381              | 150-199     | 266-354              | 100-132     | 11.6-13.4             | 10.0-11.5  | 65-74                                  | 63-72                                 |
|                  | 5     | 126-153                          | 63-76       | 382-477              | 200-249     | 355-442              | 133-166     | 13.5-15.4             | 11.6-13.2  | 75-86                                  | 73-84                                 |
|                  | 6     | 154-179                          | 77-89       | 478-572              | 250-299     | 443-531              | 167-199     | 15.5-17.3             | 13.3-14.9  | 87-96                                  | 85-94                                 |
| <b>High</b>      |       |                                  |             |                      |             |                      |             |                       |            |  |                                       |
|                  | 7     | 180-239                          | 90-119      | 573-635              | 300-332     | 532-708              | 200-266     | 17.4-19.2             | 15.0-16.5  | 97-107                                 | 95-105                                |
|                  | 8     | 240-299                          | 120-149     | 636-700              | 333-366     | 709-886              | 267-332     | 19.3-21.2             | 16.6-18.2  | 108-118                                | 106-116                               |
|                  | 9     | 300-359                          | 150-179     | 701-763              | 367-399     | 887-1063             | 333-399     | 21.3-23.1             | 18.3-19.9  | 119-129                                | 117-127                               |
| <b>Very High</b> |       |                                  |             |                      |             |                      |             |                       |            |  |                                       |
|                  | 10    | 360 or more                      | 180 or more | 764 or more          | 400 or more | 1064 or more         | 400 or more | 23.2 or more          | 20 or more | 130 or more                            | 128 or more                           |

\* For ozone, the maximum of the 8 hourly and hourly mean is used to calculate the index value.

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