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STATISTICAL RELEASE **28 April 2011**

AIR QUALITY INDICATORS - 2010 FINAL UK RESULTS

The indicators measure annual UK levels of pollution from particulates (PM_{10}) and ozone (O_3), the two pollutants thought to have the greatest health impacts, as well as the number of days on which levels of any one of five pollutants were 'moderate or higher'. These results are an update of those published on 3 February 2011, following the full quality control process. The accompanying spreadsheet compares provisional and final results.

Headline results

- Overall, the results have changed very little from the provisional publication, although the average number of days of moderate or higher pollution at urban sites has decreased from 10 to 8 due to fewer ozone pollution days.
- The long-term decrease in urban background particulate concentrations has levelled off in the last two years, remaining at 19 micrograms per cubic metre (µg m^{-3}) since 2008. Roadside levels increased slightly in 2010 to 23 µg m^{-3}, although this followed a relatively large decrease in 2009, and there is an overall decreasing trend.
- Rural and urban background ozone concentrations both saw a drop in 2010, to 67 µg m^{-3} for rural (compared to 68 in 2009) and 53 µg m^{-3} for urban background (compared to 55 in 2009)
- The long-term increase in urban background ozone has shown signs of levelling off in recent years, and has now seen two consecutive years of decrease, to the lowest level since 2001. Rural ozone has also decreased for two consecutive years, although there is still no clear long-term trend.
- The average number of days of moderate or higher air pollution for rural sites decreased for a second consecutive year to an average of 22 days, the lowest since 1987. This is driven by a decrease in ozone pollution days. Results are however very variable over time, and there is no clear long-term trend.
- Urban sites saw an average of 8 pollution days, down from 10 in 2009 and the lowest since records began in 1993. This followed a larger decrease in 2009, although there is no clear long-term trend.

Background

The indicators cover pollutants that can have adverse effects on human health, and evaluate (a) annual concentrations of particulates (PM_{10}) and ozone; and (b) the number of days when levels of pollutants are moderate or higher, based on Air Pollution Information Service bandings.

The data are collected from the Automatic Urban and Rural Network (AURN), which continuously captures ambient air quality levels for selected pollutants throughout the UK. The Defra UK-AIR website contains further information, including site metadata. Only sites that meet data capture criteria (detailed in the footnotes to the tables) are included in calculation of the indicators, and the figures presented are UK average concentrations across these sites. Tables and charts can be found in the accompanying Excel spreadsheet.

The UK-AIR website provides the most up-to-date data for all measured pollutants in the UK, and the National Atmospheric Emissions Inventory compiles emissions estimates from various sources. Further summary information and statistics can be found on Defra's Environment Statistics website.

In the UK, action taken on air quality is driven by the objectives set out in the 2007 Air Quality Strategy. 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.

(a) Particulates and ozone

This indicator measures average annual UK concentrations of particulates and ozone (see Figure 1 below). It was introduced in light of increasing evidence suggesting that long-term exposure to even low levels of particulates (PM_{10}) may have a significant effect on public health. The annual average values for particulates are a useful measure of overall exposure to particulates at all concentrations

The impact of long term exposure to low levels of ozone is currently less clear, although it can irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases. The production of ozone is strongly influenced by the weather, more being created on hot, still, sunny days.

Results

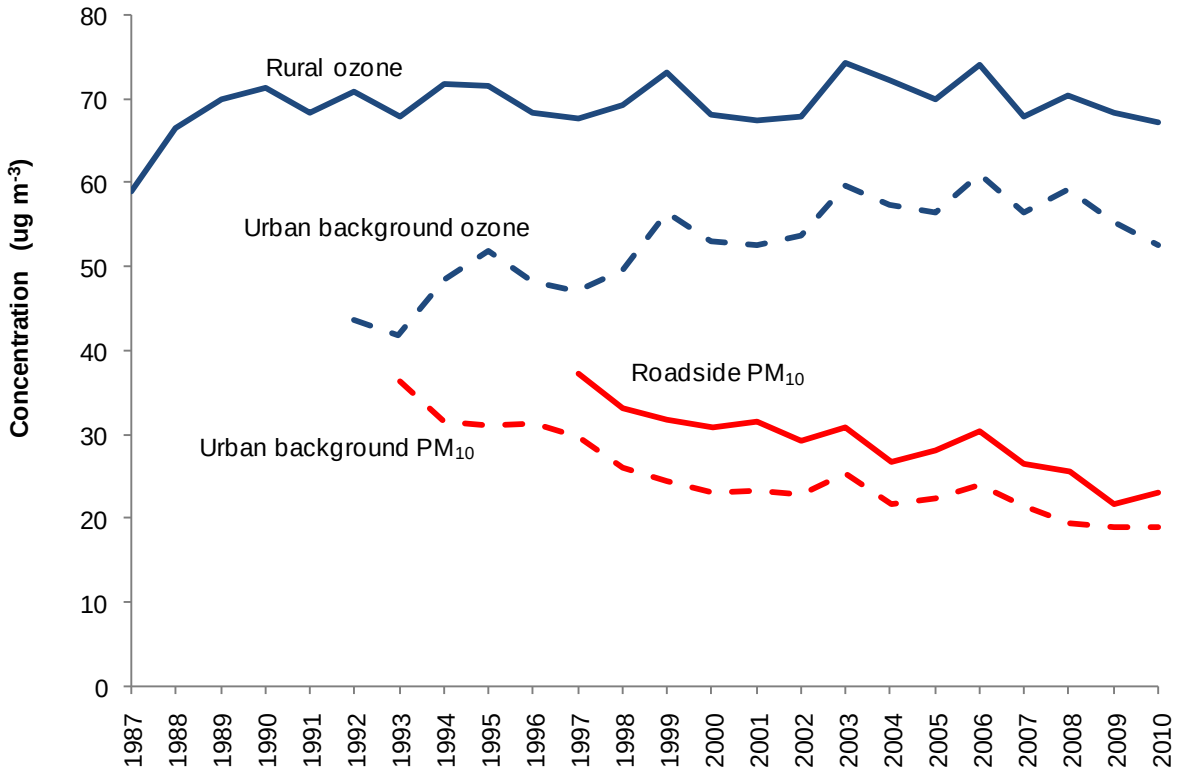
Results and underlying data are shown in Figure 1 and Table 1.

- The long-term decrease in urban background particulate concentrations has levelled off in recent years, remaining at 19 micrograms per cubic metre (µg m^{-3}) since 2008. Roadside levels increased slightly in 2010 to 23 µg m^{-3}, although this followed a relatively large decrease in 2009, and there is an overall decreasing trend.
- Emissions of PM_{10} steadily declined until around a decade ago (see 'UK Emissions of Air Pollutants – additional results'), since when they have remained largely unchanged, which reflects the lack of recent change in measured urban background concentrations presented here. The steady decline was due 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.

- Rural and urban background ozone concentrations both saw a drop in 2010, to 67 µg m^{-3} for rural (compared to 68 in 2009) and 53 µg m^{-3} for urban background (compared to 55 in 2009)
- The long-term increase in urban background ozone has shown signs of levelling off in recent years, and has now seen two consecutive years of decrease, to the lowest level since 2001. Rural ozone has also decreased for two consecutive years, although there is still no clear long-term trend.
- Ozone is formed from chemical reactions between precursors, including nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Emissions of these pollutants have reduced substantially in the time period covered by this indicator (see 'UK Emissions of Air Pollutants – 2009 results'), but this is not reflected in the long-term trend presented here.
- A similar lack of an apparent link between emissions and measured concentrations of PM_{10} and ozone in the air is observed Europe wide. The European Environment Agency present further analysis of European air quality.
- 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 needed to distinguish between weather effects and the effect of changes in pollutant emissions.
- Day-to-day changes in weather have a strong 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.

Figure 1: Annual average levels of ozone and PM_{10}, 1987-2010, UK



Notes:

The ozone index shows the annual mean of the daily maximum 8 hour running mean. The PM_{10} index shows the annual average.

Table 1: Annual average levels of ozone and PM_{10} ($\mu g\ m^{-3}$), 1987-2010, UK

Table 1: Annual average levels of Ozone and PM_{10} ($\mu g\ m^{-3}$)

Year	PM_{10}		Ozone	
	Urban Background	Roadside	Urban Background	Rural
1987	..	..	..	59
1988	..	..	..	67
1989	..	..	..	70
1990	..	..	..	71
1991	..	..	..	68
1992	..	..	44	71
1993	36	..	42	68
1994	31	..	48	72
1995	31	..	52	72
1996	31	..	48	68
1997	30	37	47	68
1998	26	33	50	69
1999	24	32	57	73
2000	23	31	53	68
2001	23	31	53	67
2002	23	29	54	68
2003	25	31	60	74
2004	22	27	57	72
2005	22	28	57	70
2006	24	30	61	74
2007	22	27	57	68
2008	19 (19) [1]	26 (22) [1]	59	71
2009	19 (19) [1]	22 (21) [1]	55	68
2010	19	23	53	67

Notes:

1.Since 2008, upgrade of numerous PM_{10} 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. VCM corrections for 2010 will be available later in the year.

PM_{10}: 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 $PM_{10,}$ 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 (1 April - 30 September) 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 was excluded in 2008 due to low data capture for PM_{10} caused by faulty new measuring instruments.

(b) Days with moderate or higher air pollution

Part (b) of the indicator measures days of moderate or higher pollution according to the Air Pollution Information Service bandings used in air pollution forecasting. The bandings are based on five pollutants- carbon monoxide, nitrogen dioxide, ozone, particulates (PM_{10}) and sulphur dioxide. These are recognised as the most important for causing short term health effects. At the moderate level, the effects of pollution may start to be noticeable to sensitive people. For a given site, a 'pollution day' is counted when one or more of the five pollutants is recorded as moderate or higher. The national figure is the average number of pollution days across all sites meeting data capture criteria (see footnote to Table 2).

Results

Results and underlying data are presented in Figure 2 and Table 2

- The average number of days of moderate or higher air pollution at rural sites decreased for a second consecutive year to 22 days, the lowest since 1987. This is driven by a drop in ozone 'pollution days'. There is however no clear long-term trend.
- Urban sites saw an average of 8 pollution days, down from 10 in 2009 and the lowest since records began in 1993. This followed a larger decrease in 2009, although there is no clear long-term trend.
- Although currently at relatively low levels, both rural and urban results are highly variable over time.
- The rural results are most strongly driven by ozone, and the urban results by ozone and PM_{10}. Both these pollutants are influenced by weather, which contributes to the variability over time. See 'Causes of air pollution' below for further information.

Figure 2: Average number of days per site when air pollution was moderate or higher, 1987-2010, UK

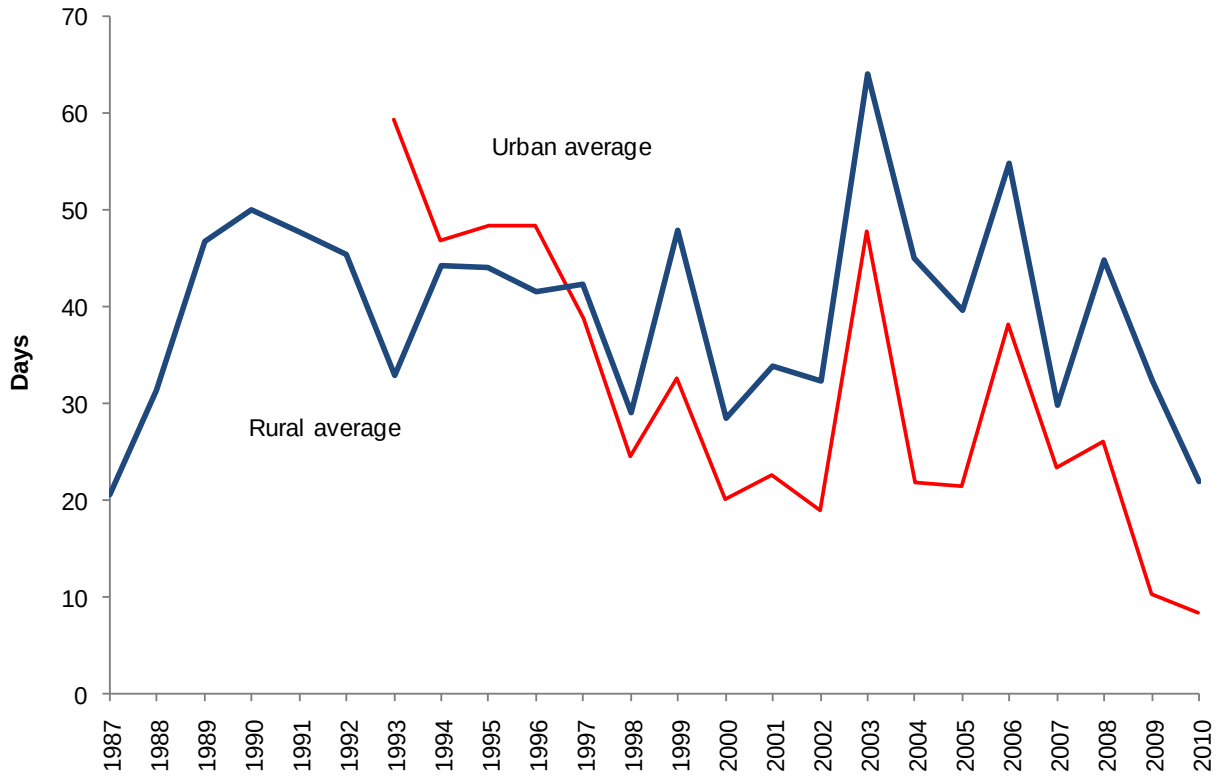


Table 2: Average number of days per site when air pollution was moderate or higher, 1987-2010, UK

Year	Urban sites	Rural sites
1987	..	21
1988	..	31
1989	..	47
1990	..	50
1991	..	48
1992	..	45
1993	59	33
1994	47	44
1995	48	44
1996	48	41
1997	39	42
1998	25	29
1999	33	48
2000	20	28
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

Notes:

.. not available because of insufficient data

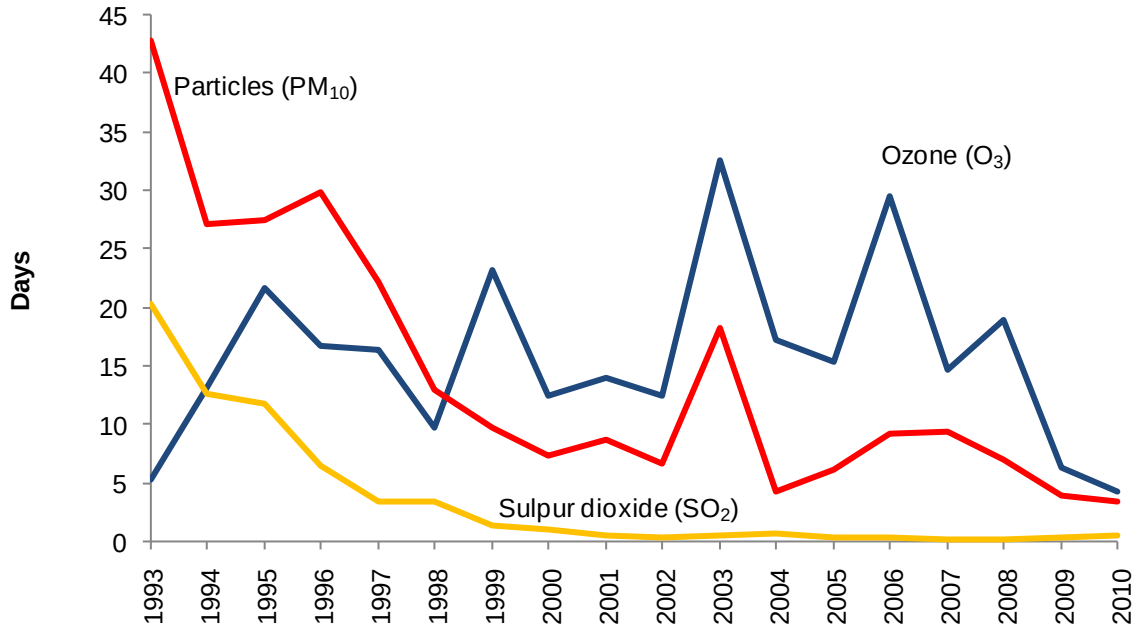
Not every site in the automatic monitoring network is included. Sites must also meet certain data capture targets to be used in the index. Urban sites are required to monitor PM_{10} and rural sites are required to monitor ozone. For the required pollutants, 1987-97 data capture should be more than or 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 was excluded in 2008 due to initial problems with new measuring instruments.

Causes of air pollution

- Ozone is the cause of the majority of pollution days in rural areas. Therefore a breakdown by pollutant for part (b) of the indicator is not presented for rural sites.
- At urban sites in 2010, two of the five pollutants, ozone and particulates, caused approximately 88 per cent of the pollution days, either separately or in combination with each other (see Figure 3 below).
- A large decrease in the number of pollution days caused by ozone was responsible for much of the decrease in the overall number of pollution days seen in 2009, dropping slightly further in 2010.
- A proportion of the ozone experienced in the UK originates from releases of precursor pollutants which form ozone that are blown over from mainland Europe.
- Weather conditions also 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 decrease.
- Between 1993 and 2010, the average number of days of pollution at urban sites caused by particulates, solely or in combination with other pollutants, has fallen from an average per site of 43 days to 3 days per year. The majority of this decrease occurred in the 1990s, reflecting the decline in emissions of PM_{10} until around a decade ago (see 'UK Emissions of Air Pollutants – additional results'), since when there has been little change. Particulates come from various man-made and natural sources, and can be generated in the UK or transported from abroad.
- From 2001, sulphur dioxide has not caused any pollution days on average, either solely or in combination with other pollutants. This reflects the large reductions in emissions from the early 1990s (see 'UK Emissions of Air Pollutants – 2009 results' for further details).
- Carbon monoxide has not contributed to the number of pollution days since the series began. Nitrogen dioxide has impacted very rarely, at a maximum of 1 day. For this reason these pollutants are not included in Figure 3.
- Since 1999, ozone has caused more days of moderate or higher pollution in urban areas than have particulates, as pollution by particulates has declined. However, the number of days caused by ozone pollution has no clear long-term trend.

Figure 3: Average number of days per site when levels of ozone, particulates and sulphur dioxide were moderate or higher, 1993-2010, urban sites, UK



Note: Where a pollution day is caused by more than one pollutant, it is counted for each pollutant i.e. there is double counting.

Table 3: Average number of days per site of moderate or higher air pollution for each of the 5 pollutants, 1993-2010, urban sites, UK

Year	Ozone	Nitrogen dioxide	Carbon monoxide	Sulphur dioxide	Particulates (PM_{10})
1993	5	0	0	20	43
1994	13	0	0	13	27
1995	22	1	0	12	27
1996	17	0	0	6	30
1997	16	0	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	9
2002	12	0	0	0	7
2003	33	0	0	0	18
2004	17	0	0	0	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

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_{10} 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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Where a pollution day is caused by more than one pollutant, it is counted for each pollutant i.e. there is double counting.

Appendix 1 - Notes

1. The banding system used in part (b) of the indicator is that of the Air Pollution Information Service.
2. More detailed data, site metadata and information are published on the Defra UK-AIR website.
3. Information about the health effects of air pollution can be found in the leaflet 'Air Pollution - what it means for your health'. This leaflet is available on the Defra website, along with further information on the Air Quality Strategy.
4. Further details and summary data relating to UK air quality are available on Defra's Environment Statistics website.

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