UK Air Pollution

This Brochure has been produced by the National Environmental Technology Centre (Netcen) on behalf of Defra and the Devolved Administrations.

1 Introduction

The quality of the air that we breathe can have important impacts on our health and quality of life; it's therefore important to us all. Measuring and understanding air pollution provides a sound scientific basis for its management and control. Considerable effort is therefore devoted in the UK to the systematic measurement of levels of air pollution nationwide. This effort started in earnest following the infamous 'pea-souper' smogs of the 1950s and 60s, but has expanded massively in scope, coverage and sophistication since then.

Air quality monitoring, and the results presented in this brochure, should not be seen as an end in themselves; rather, they offer us the best way of understanding our pollution problems, so they can be tackled effectively at local, national and international level.

Monitoring air pollution in the UK has the following broad objectives:

- To provide a sound scientific basis for the development of cost-effective control policies and solutions
- To assess how far air quality standards and objectives are being met
- To evaluate potential impacts on population health and welfare
- To provide the public with reliable and up-to-date information on air pollution
- To determine the impacts of air pollution on ecosystems and our natural environment

This brochure aims to provide a simple guide, written in non-technical language, to what the latest measurements tell us about air pollution in the UK. In it, we'll:

- Summarise current UK and European efforts to tackle air pollution
- Review where and how air pollution is measured
- Examine major periods of elevated pollution that have occurred over recent years
- Evaluate air pollution impacts on our lives
- Investigate how pollution levels vary across the UK
- Assess long-term pollution trends and see why 2003 proved to be such an exceptional year
- Provide details on how you can find out more about air quality in your neighbourhood

2 The UK's policy for tackling air pollution

Air pollution is becoming an increasingly important focus of interest for local, national, European and international policy makers. This has been triggered in part by increasing evidence that air pollution may be strongly influenced by climate change; recent years have shown the dramatic impacts of a series of unusually hot summers throughout many parts of Europe. Some of these impacts have, in part, been a consequence of elevated levels of air pollution.

The European Union and other international organisations are acting to reduce global pollution. Within the European Community, a series of air quality Directives over the last decade has:

- Established Limit Values for key air pollutants and defined overall requirements for monitoring progress against these targets
- Defined the monitoring, modelling and air quality management obligations of Member States
- Set targets for pollutant emissions in different types of industry as well as in the transport sector
- Confirmed the need to communicate information on air quality to the public at large

Although the lethal smogs in London and other cities caused by coal burning have now gone for good, air pollution remains a problem in the UK. Medical evidence shows that many thousands of people die prematurely every year because of its effects, and this process can accelerate during extreme weather conditions. Many more become unwell or may require hospital treatment. The young and infirm are often particularly affected, as well as people living in deprived areas. The costs to individuals, families and the national economy are immense.

Air quality is therefore now one of the UK Government’s key headline indicators of sustainable development. These provide a ‘quality of life barometer’ measuring everyday concerns, and are intended to give a broad overview of whether we are achieving a better quality of life for everyone, now and for generations to come. We’ll be looking more closely at the latest air quality indicator levels in section 6 of this brochure.

The National Air Quality Strategy, published in March 1997 and revised in January 2000, set up a strong framework for tackling air pollution over the coming years. It established objectives for eight key air pollutants, based on the best available medical and scientific understanding of their effects on health. As our knowledge of these effects has deepened, the objectives have been progressively refined and strengthened. The current objectives are shown in Table 1 overleaf.

The UK’s air quality was dominated for centuries by domestic and industrial coal burning....

but road transport is now the major source of air pollution in UK cities

UK Air Pollution

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene All authorities	16.25 μg m^{-3}	Running annual mean	31.12.2003
England & Wales only	5.00 μg m^{-3}	Annual mean	31.12.2010
Scotland & N. Ireland	3.25 μg m^{-3}	Running annual mean	31.12.2010
1,3-Butadiene	2.25 μg m^{-3}	Running annual mean	31.12.2003
Carbon monoxide England, Wales & NI only	10.0 mg m^{-3}	Maximum daily running 8-hour mean	31.12.2003
Scotland only	10.0 μg m^{-3}	Running 8-hour mean	31.12.2003
Lead	0.5 μg m^{-3} 0.25 μg m^{-3}	Annual mean Annual mean	31.12.2004 31.12.2008
Nitrogen dioxide	200 μg m^{-3} not to be exceeded more than 18 times a year 40 μg m^{-3}	1 hour mean Annual mean	31.12.2005 31.12.2005
Particles (PM_{10}) (gravimetric) All Authorities	50 μg m^{-3}, 35 times a year 40 μg m^{-3}	24 hour mean Annual mean	31.12.2004 31.12.2004
Scotland only	50 μg m^{-3}, 7 times a year 18 μg m^{-3}	24 hour mean Annual mean	31.12.2010 31.12.2010
Sulphur dioxide	350 μg m^{-3}, 24 times a year 125 μg m^{-3}, 3 times a year 266 μg m^{-3}, 35 times a year	1 hour mean 24 hour mean 15 minute mean	31.12.2004 31.12.2004 31.12.2005

Table 1. Health–related air quality objectives in regulation, 2003

For reporting air quality and potential health effects to the public, the following banding system has been established:

Low (1-3)	Effects are unlikely to be noticed even by those who are sensitive to air pollution
Moderate (4-6)	Sensitive people may notice mild effects but these are unlikely to need action
High (7-9)	Sensitive people may notice significant effects and may need to take action
Very High (10)	Effects on sensitive people described for *HIGH* pollution,may worsen

Although its main focus is on protecting the health of the population at large, the UK's Air Quality Strategy has also established corresponding targets for the protection of vegetation, ecosystems and the natural environment. Air monitoring provides a key tool in assessing how far the health objectives and other environmental targets are being met throughout the UK.

Central Government and the Devolved Administrations in Scotland, Wales and Northern Ireland are responsible for overall policy and legislation affecting the environment, including air quality. However, over the last five years, Local Government has taken an increasingly important role in air quality management. Authorities are required regularly to review and assess air quality in their area and take decisive action when the objectives cannot be met.

When this happens, an Authority must declare an 'Air Quality Management Area' and introduce an Action Plan – which may include such measures as congestion charging, traffic management, planning and financial incentives – to tackle problems in the affected areas. By March 2004, 127 local authorities – over a quarter of those in UK – had established one or more AQMAs, most of these in urban areas and resulting from traffic emissions of nitrogen dioxide (NO_2) or fine particulates (PM_{10}).

Note that Management Areas are not designated as a result of high ozone levels, because concentrations of this pollutant are not controlled by local factors.

Through the process of Local Air Quality Management, tackling air pollution is progressively focussing more on local 'grass-roots' concerns, initiatives and actions. If you want to know more, why not follow the web link to:

www.airquality.co.uk/archive/laqm/laqm.php

to see if an AQMA has been established in your neighbourhood?

3 Where and how pollution is measured

The history of air monitoring in the UK goes back a long way. Primarily in response to the serious urban smogs of the 1950 and 60s black smoke and sulphur dioxide have been monitored on a national scale in the UK since 1961. Since that time, the coal-burning emissions responsible for this type of winter smog have decreased substantially, and road transport has now become the most important source of air pollution in most areas. In response to this historic change, the emphasis in monitoring has moved progressively to pollutants such as ozone, nitrogen dioxide and fine particulate matter (PM_{10}).

The UK's air monitoring networks have evolved and grown considerably over the past 10 years (Fig 3.1). This expansion has been driven by many factors, including increasing concern about health impacts, government's desire to inform the public of the quality of our air, the UK's Air Quality Strategy and a range of European commitments. There has also been considerable growth in the amount of monitoring undertaken by Local Authorities. Many of these sites now contribute data to nationally organised measurement programmes funded and supported by Central Government and the Devolved Administrations.

There are currently over 1300 national air quality monitoring sites across the UK, organised into several automatic and non-automatic networks with different objectives and coverage. 120 of these sites (Fig 3.2) operate automatically, providing hourly information on a range of pollutants that is communicated rapidly to the public. The non-automatic sites measure average concentrations over a specified sampling period (typically a week or month) instead of instantaneous concentrations, but still provide invaluable data for assessing levels and impacts of pollution across the country as a whole. The pollutants measured, site numbers and areas covered in the UK's nationally coordinated monitoring networks are summarised in Table 2.

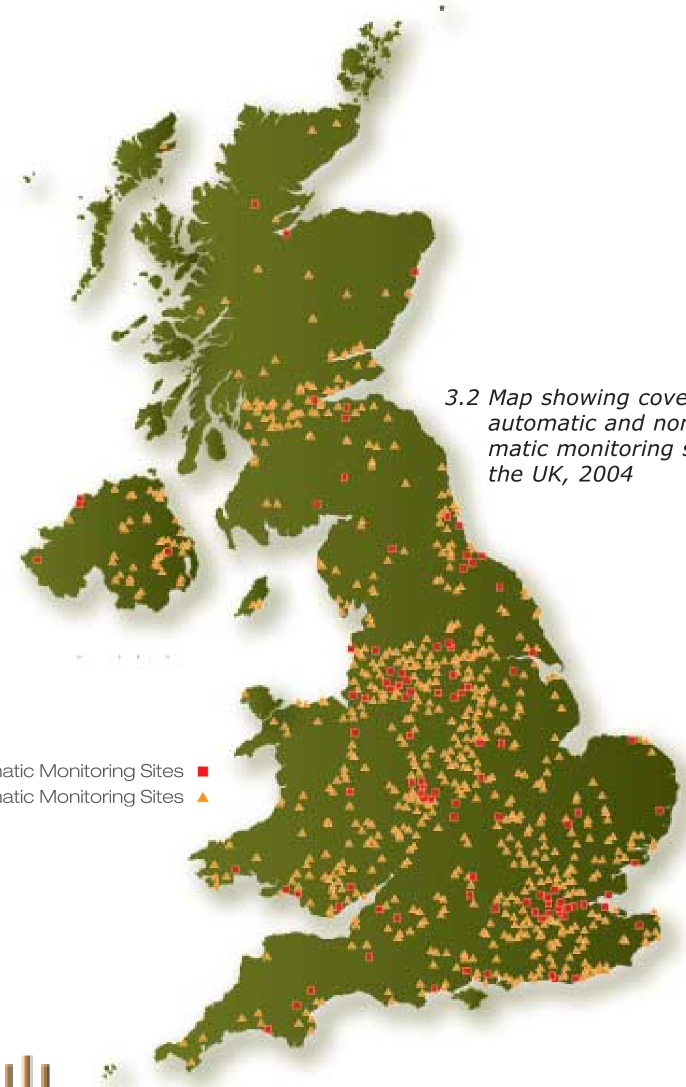
Air quality data from the UK automatic networks, together with twice-daily pollution forecasts, are widely disseminated by a range of electronic and web-based media; these include a free telephone service, TV, and Teletext, as well as globally via the World Wide Web. Information on UK air quality is also frequently exchanged with other countries in Europe, to enable us to track pollution being transported over long distances.

Pollutant	Major sources	Site numbers	Areas covered
Nitrogen dioxide (NO_2)	Road transport & industry	106 (Automatic) 1288 (Non-automatic)	Mostly urban
Ozone (O_3)	Sunlight & heat, acting on road transport & industrial emissions	65 (A)	All of UK - urban & rural areas
Particles (PM_{10} & $PM_{2.5}$)	Road transport, industry, construction, soil & natural sources	68 (A) 7 (NA, gravimetric) 123 (NA, black smoke)	Mostly urban
Sulphur dioxide	Industry & fuel combustion	76 (A) 123 (NA, net acidity)	Mostly urban
Carbon monoxide (CO)	Road transport	79 (A)	Urban
Volatile Organic Compounds (VOCs) & toxic air pollutants (TOMPS, PAHs)	Industry, transport, solvent use & some natural sources	5 (A) 35 (NA) 25 (NA)	Mostly urban
Metals (Pb, Cd, As, Ni & Hg)	Industrial & other processses	17	Urban & Industrial

Table 2. Air pollutants monitored in UK national networks

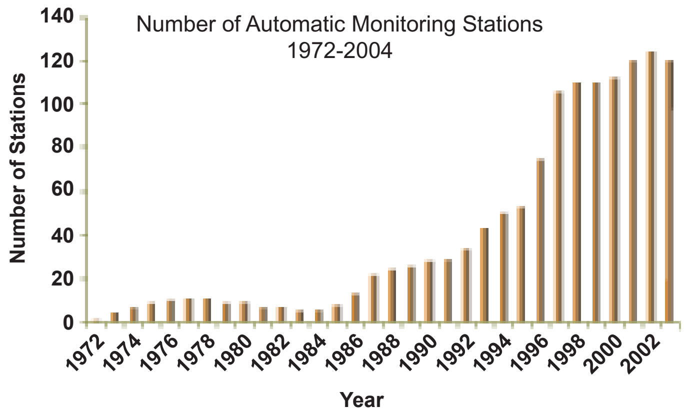
As highlighted in the next section, this long-range pollution can often have important impacts here in Britain.

The UK's award-winning air quality web site – **www.airquality.co.uk** – provides user-friendly and comprehensive access to information on all air pollutant concentrations and emissions, together with up-to-date bulletins, forecasts and measurements from all the UK national monitoring networks. It's therefore your best one-shop resource for reliable information covering all aspects of air quality in this country. To provide you with the most up-to-date information on local or regional issues, we list on the back page of this brochure the key data sources and information resources on UK air pollution.



3.2 Map showing coverage of automatic and non-automatic monitoring stations in the UK, 2004

3.1 Numbers of automatic air monitoring stations have risen dramatically over the last 10 years



An automatic air quality monitoring station in Harwell, Oxfordshire

4 High pollution episodes

Air pollution levels can vary considerably from day to day, as well as from one part of the country to another. In this section, we'll look at short-term variations over time, and in particular some recent periods when pollution levels were particularly high. These are usually referred to as *episodes*. In Section 5, we'll focus more on variations in pollution levels from area to area.

Pollution levels vary over time for two main reasons:

- Variations in pollutant emissions
- Changes in atmospheric conditions which allow pollution levels to build up or transport pollutants from other areas

All episodes occur because of a combination of these factors.

There are two main types of pollution episode in the UK. ***Winter smogs*** typically occur in cold, still and foggy weather; this traps pollution produced by motor vehicles, space heating and other sources close to the ground and allows it to build up over time. City areas - in particular those close to major roads - are usually worst affected, together with sheltered or low-lying parts of the country. Winter episodes are characterised by elevated levels of nitrogen dioxide (NO_2), particles (PM_{10}) and volatile organic compounds (VOCs) such as benzene. High sulphur dioxide levels can also occur in some industrial or coal-burning regions.

By contrast, ***summer smogs*** occur in hot, sunny and still weather. Sunlight and high temperatures accelerate chemical reactions in mixtures of air pollutants that are emitted from road vehicles, fuel burning and solvent usage. The pollutants that cause such an episode can often travel long distances - sometimes from other parts of Europe. During this large-scale air movement, they react together to produce high levels of ozone (O_3), together with other pollutants such as nitrogen dioxide and particles. Unlike the ozone layer in the upper levels of the atmosphere that protects us from ultraviolet radiation, ground level ozone produced in this way is harmful to human health and vegetation, as well as damaging some man-made materials.

Long-range transport of pollutants from Europe, or occasionally from North Africa, can on occasions cause another, third type of pollution episode. This tends to occur during the summer months, either in isolation or in combination with summer smog. Conversely, short-range transport can result in elevated concentrations of primary pollutants close to major emissions sources such as power stations or large industrial plant.

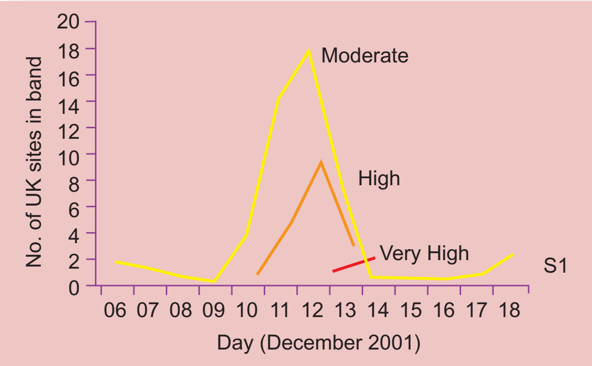
Air pollution episodes in the UK vary widely in terms of the areas they affect, duration and seriousness. Here we examine four episodes, one of each specific type described above.

1. Winter smog episode: December 2001

Historically, the first half of December is particularly associated with winter smogs in the UK; in fact, many of the most notorious coal-burning smogs occurred at this time of year. The historic London smog of 1952, which first galvanised Government and public action to tackle air pollution, occurred in the first week of December. As discussed in Section 6, where we examine long-term pollution trends, these smogs no longer occur in most of the UK. However similar episodes – albeit of reduced severity – can still occur in areas such as Northern Ireland, where coal is still widely burnt for domestic space heating.

The cold, stable weather that initiates winter smogs also allows pollutants from motor vehicles and other sources to accumulate over time. As a result, winter smogs can now be associated with elevated levels of a wide range of pollutants. A good example of winter smog associated with road transport emissions occurred between the 7th and 18th December 2001. The main pollutants involved were PM_{10} particles and nitrogen dioxide, although sulphur dioxide levels were elevated throughout the period in Belfast.

4.1. Pollution levels build up slowly during winter smogs (December 2001)

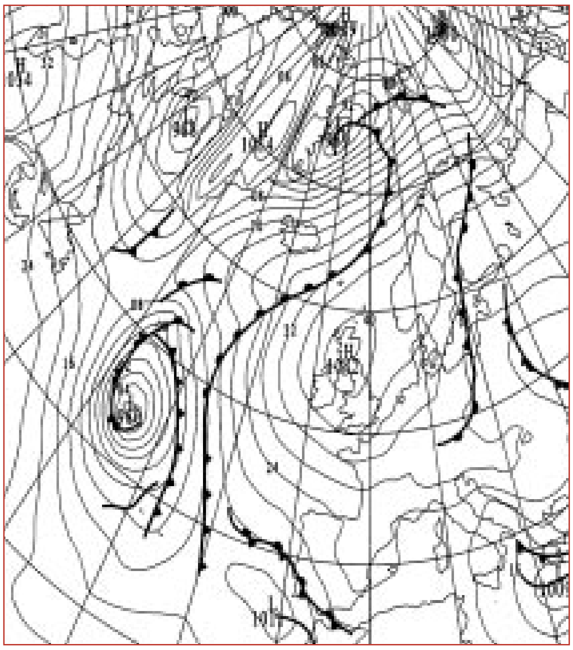


High atmospheric pressure dominated the UK weather patterns during this pollution event. This is a characteristic weather pattern for winter smogs; it is usually associated with low wind speeds, cold, misty or foggy conditions and well-defined atmospheric temperature inversion layers which act as a barrier to the dispersion of pollutants, trapping them close to the ground. As a result, pollutant concentrations during winter smogs tend to build up slowly over time – the longer the stable conditions last, the higher the levels of pollution reached. (Fig 4.1)

During the episode's peak from the 11th onwards, this high-pressure system was centred over Northern Britain (Fig 4.2), resulting in elevated concentrations of a range of pollutants over this part of the country, Central Scotland and Northern Ireland. Overnight levels of PM_{10} reached the **VERY HIGH** band in Glasgow (104 and 119 µgm^{-3}) and HIGH in Edinburgh, Manchester and Belfast. These levels were primarily attributable to road transport emissions, although local source influences (nearby construction and a Christmas Fayre) also influenced peak PM_{10} levels in Edinburgh. Domestic heating was an important factor at Belfast, resulting not just in elevated PM_{10} but also sulphur dioxide concentrations in the city.

From the 14th onward, wind directions shifted to northerly and speeds increased. The resulting improvement in atmospheric dispersion brought the episode to an end.

4.2. High-pressure systems like this on 12 December are closely associated with Winter smog episodes in the UK (Crown Copyright)



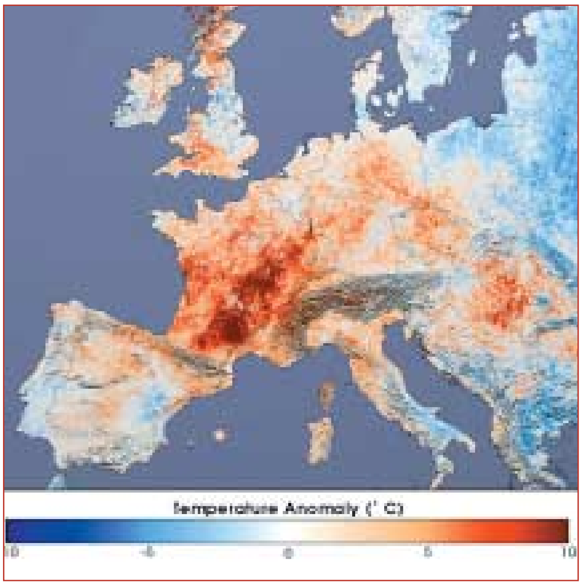
2. A summer smog episode: August 2003

2003 proved to be a record-breaking year for the UK and global climate. It was the sunniest on record for England and Scotland, the warmest ever in Scotland, and the second driest year in England and Wales since 1766. The highest ever UK temperature of 38.5°C was recorded in Faversham, Kent on August 10. Taken overall, 2003 was the fifth warmest for Britain as a whole since records began in 1659.

The extreme conditions were not just confined to the UK. 2003 was the third warmest year worldwide since global records began in 1861, and the hottest ever over many parts of Europe (Fig 4.3). It is interesting to note that all of the planet's ten hottest years have occurred since 1990, providing solid evidence of a worldwide climate trend.

These extreme weather conditions caused photochemical ozone production over large areas of UK and Europe. 2003 was notable both for very early (April) and late

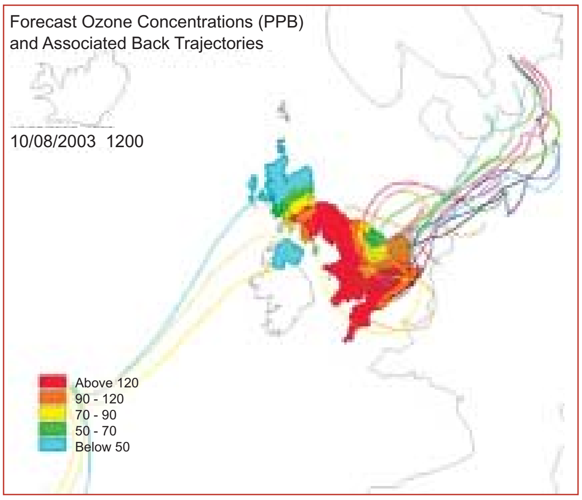
4.3. NASA analysis of MODIS satellite data showing excess temperatures across Europe during July 2003



(September) summer smogs in the UK. The most exceptional of these was the episode that occurred during the very hottest part of the year, the first half of August (Fig 4.4). During the period from 1 to 15 August, many rural and urban monitoring stations across England and Wales recorded hourly ozone levels in the HIGH (180-360 µgm^{-3}) band; the highest single hourly measurement was 238 µgm^{-3} at Portsmouth on the 9th,

4.4. London's Canary Wharf during the height of the August smog

4.5. Meteorological analysis showing transport of air from Continental Europe to different parts of the UK during the August 2003 summer smog



equalled at London, Brent on the 6th. Moreover, high concentrations were recorded for 10 consecutive days, an unusually long period for an ozone episode. During much of this period, air transported from continental Europe strongly influenced pollution levels over much of the UK (Fig 4.5)

However, despite record-breaking temperatures, cloudless skies, sunshine and a persistent, stable high pressure system - all conditions closely associated with photochemical episodes - corresponding pollution levels in August did not break UK records. In fact, comparisons with the similar 'heat wave' summer of 1976 showed that maximum hourly ozone concentrations in 2003 were approximately 50-60% of those recorded during that year. This is consistent with the marked UK and Europe-wide decline in emissions of 'precursor' pollutants (nitrogen oxides and volatile organic compounds) over that period.

During the August heat wave, severe temperatures and elevated ozone levels were recorded in many parts of Europe, together with large numbers of reported deaths. It's often difficult to distinguish mortalities caused by heat stroke, dehydration and exhaustion from those due to air pollution. Very often, multiple factors are involved. The UK Office for National Statistics has reported an additional 2045 deaths in England and Wales for period from 4 to 13 August 2003, when compared against the 1998-2002 average mortality figures for that time of year. Using previously well-established medical data on the effects of ozone and PM_{10} on human-health, it has been estimated that between 423 and 769 of the excess deaths were associated with elevated concentrations of these pollutants. This represents between 21 and 38% of the total excess deaths recorded during this period.

3) An episode involving long-range transport: April 2003

On the 12th April, levels of both ozone and PM_{10} began to increase at many monitoring stations. This rise was associated with unusually warm and sunny weather for the time of year, combined with air transported from Scandinavia and Central Europe. From the 14th onwards, however, winds became stronger and more southerly and elevated PM_{10} levels up to the **VERY HIGH** band (118 μgm^{-3}) were recorded in Northern England. Images from the US SeaStar satellite, part of NASA's Earth Science Enterprise, provide a fascinating glimpse of global long-range transport of dust and pollution during this period (Fig 4.6). The images show the UK almost hidden beneath tan-coloured swirls of Saharan dust and grey haze associated with polluted continental air.

4.6. NASA SeaStar satellite image showing strong transport of air and dust from the south on 15 April 2003

As particle levels rose, so did those of ozone, reaching the **HIGH** band at several locations. As noted previously, April is unusually early for elevated levels of ozone to be observed in the UK. Long-range transport of air dominated throughout this period, bringing in continental ozone and its precursors, with particle levels also likely to have been influenced by the large-scale Saharan dust storms.

4) An episode involving short-range transport: May 2003

Short-term elevated levels of primary pollutants can be observed from time to time in the vicinity of major emission sources such as power stations, refineries or large industrial plant. Such episodes tend to be intermittent, highly localised and associated with rapidly fluctuating concentrations. Well-regulated plant is rarely associated with such events; in the case of sulphur dioxide, for instance, increasingly stringent emission controls and the move towards lower-sulphur or clean fuels such as natural gas mean that such events are now becoming increasingly rare. The most recent clearcut example of such a point-source episode for SO_2 was seen in May 2002 in Grangemouth, 300m from the nearby large refinery, where measured peak 15-minute average concentrations up to 506 μgm^{-3} were observed; these levels were nearly twice the relevant short-term UK objective for this pollutant.

5 How air pollution varies across the UK

Levels of air pollutants vary markedly across the country. Measurements from the national air monitoring networks clearly show that these patterns differ for each pollutant, depending on how they are formed and where their major sources are located.

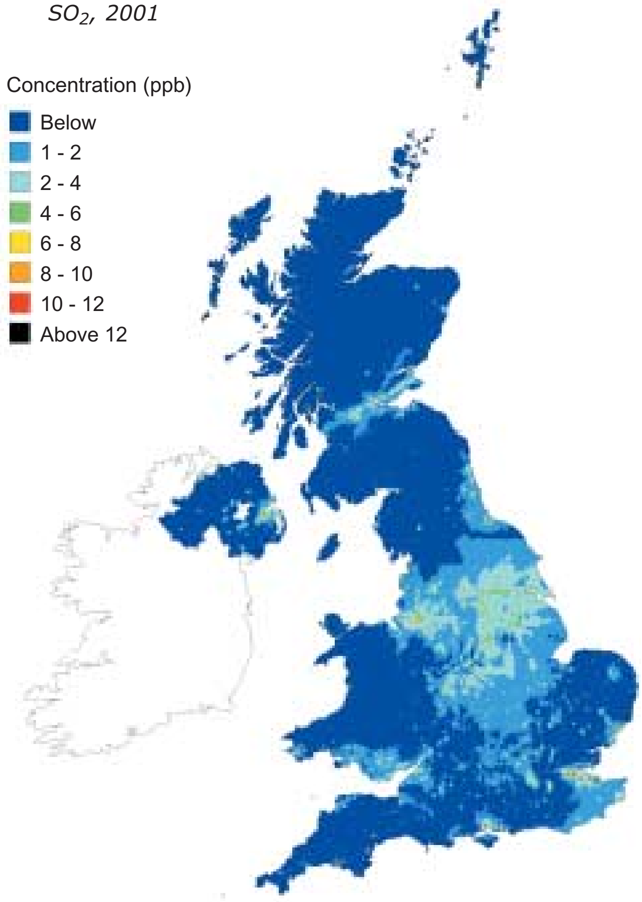
Levels of **primary pollutants**, those emitted directly into the atmosphere, tend to be highest around their sources; these are usually located in urban and industrial areas. Sulphur dioxide provides a good example of such a pollutant, with domestic or industrial fuel burning being its major sources nationwide. As illustrated in the last section, the highest sustained levels of this pollutant are often found during winter in parts of Northern Ireland, where solid fuel is still used extensively for domestic heating.

Measurements from the UK monitoring networks can be combined with detailed pollutant emissions data from the UK's National Atmospheric Emissions Inventory (NAEI). Together, these provide the basis for sophisticated pollutant models which now enable us to produce detailed maps (1km resolution) of average or peak pollutant concentrations across the country. These maps enable the UK to fulfil its European commitments to assess nationwide pollution patterns prior to implementing the European Air Quality Directives. They also provide an extremely powerful tool for identifying pollutant 'hot-spots' and managing UK-wide air quality problems in the most direct and cost-efficient manner.

A map showing average SO_2 levels across the country, derived in this way, is shown in Fig 5.1. It clearly shows the impact of power station and industrial emissions in NW England, the Thames Estuary and Forth Valley, as well as domestic emissions focussed around Belfast in Northern Ireland.

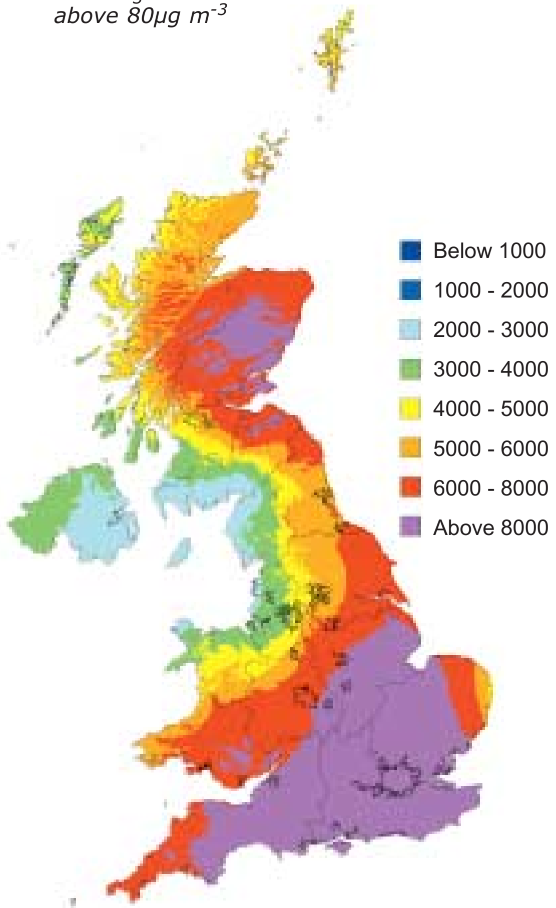
Motor vehicles are now a major source of air pollution in many large cities. In particular, most of the carbon monoxide, nitrogen dioxide, and volatile hydrocarbons such as benzene and 1,3-butadiene are emitted from traffic, together with a significant proportion of particles (PM_{10}). Concentrations of all these pollutants are therefore usually highest in built-up urban areas.

5.1. Background SO_2, 2001



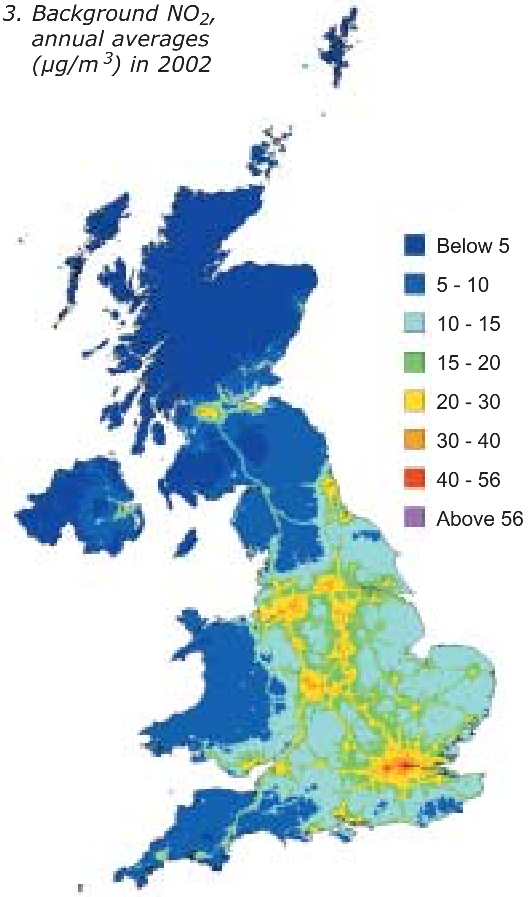
In general, patterns of **secondary pollutants** such as ground-level ozone - which are formed by chemical reaction in the atmosphere - are markedly different from those of primary pollutants; they are characteristically less dependent on emission patterns, and tend to be more strongly influenced by meteorology and atmospheric chemistry. As a result, they also change more from year to year than those of primary pollutants. UK-wide concentrations of two of the most important secondary pollutants, ozone and nitrogen dioxide are shown in Figures 5.2 and 5.3.

5.2. Total O_3 hours above 80µg m^{-3}



As highlighted previously, ground-level ozone is formed by a series of chemical reactions involving oxygen, oxides of nitrogen and hydrocarbons - so called precursor pollutants. Ultraviolet radiation drives these reactions and, as a result, ozone production rates are highest in hot, sunny weather. Ozone formation can take from hours to days to complete. Consequently, high levels of ozone can often be formed considerable distances downwind of the original pollution sources in UK or Europe.

5.3. Background NO_2, annual averages (µg/m^3) in 2002



UK-wide patterns of ground-level ozone are also influenced by other factors. Concentrations in busy urban areas are often lower than in the surrounding countryside. This is because road transport emissions react very quickly with ozone to remove it from the atmosphere. Because ozone is very reactive, it is also readily deposited onto the ground or adsorbed onto vegetation. These removal processes tend to be more important in sheltered, lowland areas than exposed higher altitudes. As a result, ozone levels are usually higher on elevated ground.

The net result of all these effects, acting together is shown in Figure 5.2. The highest summer ozone concentrations (here graphed as accumulated total hours over 80µgm^{-3} for 2001) are seen in the rural parts of South and South East England; these areas tend to be hotter and sunnier than other parts of the UK, and are often downwind of polluted areas of Northern Europe. Elevated concentrations are also seen in parts of Central/Eastern Scotland, a function of its altitude. However, the fine detail in these annual ozone maps changes from year to year, and other years have shown evidence of elevated concentrations in elevated parts of Wales.

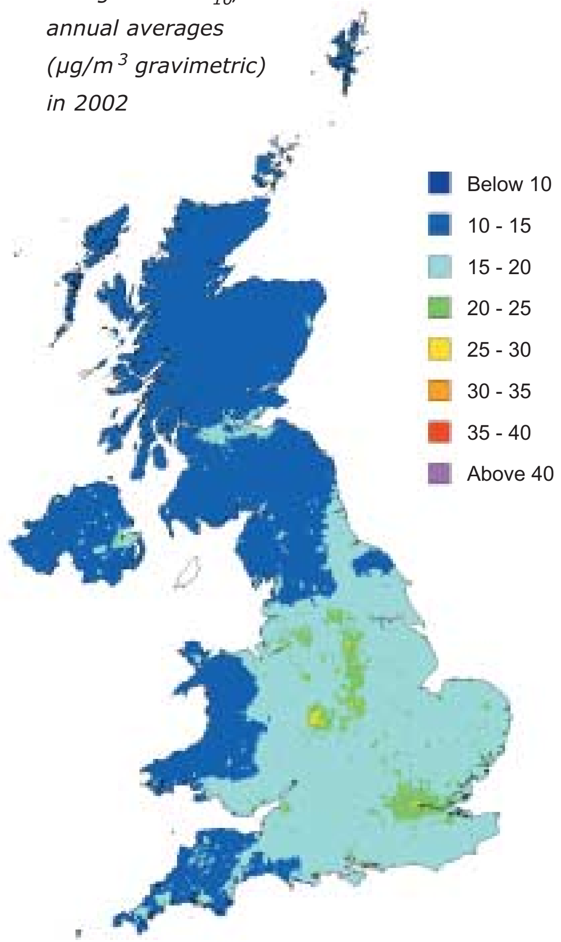
The vast majority of Air Quality Management Areas (AQMAs) in the UK are due to current or predicted exceedences of air quality objectives for nitrogen dioxide (NO_2) or PM_{10} particles. We'll now examine UK-wide patterns of these pollutants more closely.

UK-wide patterns of nitrogen dioxide concentration shown in Figure 5.3 are markedly different from those of ozone or sulphur dioxide. Although some NO_2 is emitted directly from vehicles or other sources, most is formed by rapid chemical reaction in the atmosphere. Concentrations of nitrogen dioxide therefore tend to be highest in urban areas where traffic densities are high, such as in London. Although the data mapped in the figure are background rather than roadside pollution levels, they clearly follow closely the country's major motorways and road network infrastructure.

Particles are not a distinct chemical species like the other pollutants measured in the automatic networks; rather, they consist of material from many sources and are usually classified on the basis of size and not chemical composition. In the UK automatic networks, particles of average diameter less than 10 microns (where one micron is a thousandth of a millimetre) are measured. These fine particle fractions can be inhaled deep into the lungs, and therefore provide a better indication of potential health impacts than coarser particle size ranges.

The sources of PM_{10} particles are diverse. They are produced from motor vehicles, fuel burning, building work, industrial emissions, soil and road dust and quarrying. A significant proportion of PM_{10} particles are secondary, formed by the reaction of gases in the air. Particles of ammonium sulphate and nitrate are produced by the same photochemical reactions that give rise to ozone. Like ozone, secondary particles can therefore be formed considerable distances from the emission sources. This diversity of PM_{10} source types and influences is reflected in the map of average concentrations in Figure 5.4, which shows markedly less variation across the country than for the other pollutants assessed here.

5.4. Background PM_{10}, annual averages ($\mu g/m^3$ gravimetric) in 2002

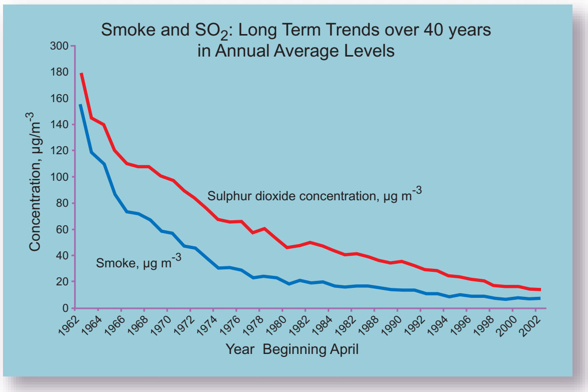


6 How air pollution has changed over time

As highlighted in previous sections, the concentrations of air pollutants in the atmosphere can vary over the course of a day, the seasons of a year and from year to year. In this section, we focus on long-term trends in the UK's Air Quality, and attempt to answer the perennial question - 'are things getting better or worse?' As always, the answer to such a straightforward question is not clearcut. It really depends on what pollutants we're examining, and over what timescales.

Very reliable indications of long-term trends can be derived from UK monitoring data. As noted previously, large-scale national measurements of black smoke and sulphur dioxide began in the early 1960s. This national network, established in response to the recurring serious smogs of that era, was probably the earliest air quality measurement programme of this scale and sophistication in the world. At its peak, it included over 1200 measurement sites. The main objectives of this network were to assess nationwide levels of these ingredients of coal smog, and to analyse how these have changed over time; over the 40 years of its operation, both of these network goals have been met in full.

Figure 6.1.



In Figure 6.1, we show annual average levels of both pollutants from the establishment of the network to the present day. The picture shown here is most encouraging. It demonstrates that overall levels of sulphur dioxide have fallen nearly 10-fold, and smoke levels 20-fold. Corresponding measurements from later automatic measurements since 1970 tell the same story, with urban background SO_2 levels now barely distinguishable from those in rural areas.

The dramatic decline in atmospheric concentrations of these pollutants mirrors closely the fall in national emissions of both pollutants. This is because far less coal is used for domestic and small-scale heating, smoke control measures have been universally applied through a series of Clean Air Acts, and cleaner fuels and fuel-burning technologies have been widely adopted. Overall, the successful regulation and taming of coal burning and its emissions represent a remarkable success story for Air Quality Management in the UK.

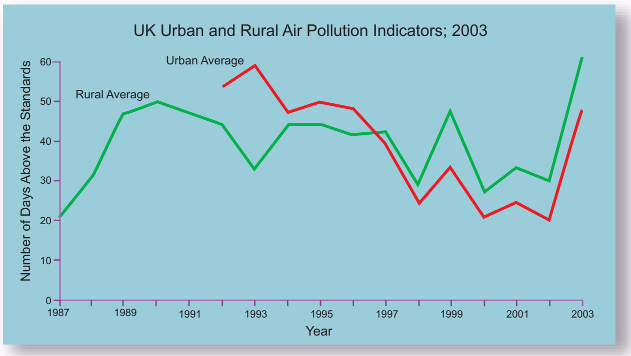
However, this did not mark the end of air pollution problems in the UK. Road transport and industry remain major sources of pollution, with vehicle emissions being the most important factor affecting air pollution in our cities. The shift from an air pollution climate dominated by coal burning to one most influenced by road transport has occurred in countries world-wide. In many parts of China, for instance, we see pollution climates in a state of transition, with coal burning and a burgeoning vehicle fleet both adding to the urban air quality burden.

Long-term trends of a wide range of air pollutants can be tracked in Britain since the early 1970s; this was when automatic measurements of many other species – including secondary pollutants and those produced primarily by road transport – commenced in earnest. Even clearer trends have become apparent since the massive expansion of the scale and coverage of national measurements over recent years.

In Figure 6.2, we graph the UK Government's air quality headline indicator of sustainable development since 1987; urban and rural trends are shown separately. This graph shows the average number of days on which levels of any one of a basket of five pollutants (carbon monoxide, nitrogen dioxide, ozone, fine particles and sulphur dioxide) were 'moderate or higher' according to the Air Pollution Information Service bandings listed earlier in Section 2 of this brochure.

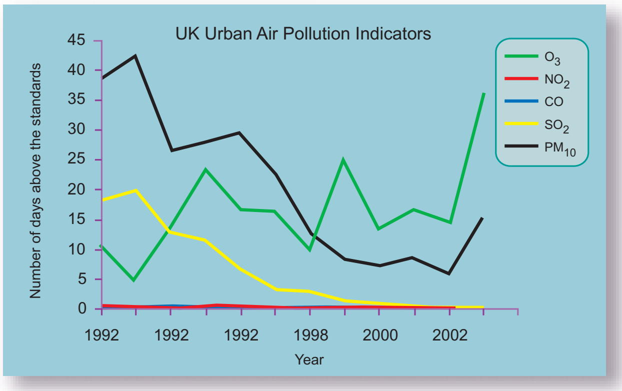
These five pollutants are recognised as the most important for causing short term health effects.

Figure 6.2.



To supplement this information, we graph separately in Figure 6.3 the average number of days of pollution at urban sites since 1993 caused by each individual pollutant.

Figure 6.3.



There is a wealth of information contained in these figures, from which we can extract a number of key conclusions. Firstly, it's clear that 2003 was an exceptional year as regards both weather conditions and air pollution. Although the headline indicator had been showing an overall downward trend in UK urban areas since the early 1990s, 2003 showed a sharp rise, due primarily to an increased number of poor ozone days. In urban areas, ozone accounted for approximately 70% of the increase over previous years, with the remainder due to PM_{10} particles. The increase in the rural indicator figures was due overwhelmingly to ozone.

The main causes of days of moderate or higher air pollution at urban sites are now ozone and fine particles (PM_{10}). The number of days caused by ozone pollution has fluctuated markedly from year to year in both rural and urban areas. As noted previously, the production of ozone is strongly influenced by the weather; as a result, the exceptionally hot, sunny summer in 2003 led to the greatest number of days of moderate or higher ozone pollution since this modern air quality indicator series began in 1987.

Ozone is responsible for the overwhelming majority of pollution days in rural areas but, since 1999, it has also caused more days of poor air quality in urban areas than particles or any other pollutants. Between 1993 and 2002, the average number of days of pollution at urban sites caused by fine particles, solely or in combination with other pollutants, fell from an average per site of about 43 days to 6 days per year, but rose again to 17 days in 2003. UK-wide emissions of particles have declined substantially in recent years, but the number of pollution days can still fluctuate from year to year due to variations in weather conditions and the impacts of long-range transport.

Sulphur dioxide, which used to make a significant contribution to the index, has now fallen to relatively very low levels. Short-term levels of the other two pollutants included in the index, carbon monoxide and nitrogen dioxide, have very rarely reached moderate or higher levels since 1993. However, long-term exposure to nitrogen dioxide remains a problem in many parts of the UK; this is why it triggers the declaration of Air Quality Management Areas in many urban areas with high traffic densities.

7 How to find out more

Current and forecast air quality (national & local)

This is rapidly available in a user-friendly form from:

Teletext: page 156

The Air Pollution Information Service:
freephone 0800 556677

The UK Air Quality Archive:
www.airquality.co.uk

General information on Air Quality

The UK Air Quality Information Archive:
www.airquality.co.uk

The National Atmospheric Emissions Inventory:
www.naei.org.uk

The Defra air quality information web resource:
www.defra.gov.uk/environment/airquality/index.htm

The Scottish Executive Air Quality pages:
www.scotland.gov.uk/about/ERADEN/ACEU-AQT/00016215/homepage.aspx

The Welsh Assembly Government Environment link:
www.wales.gov.uk/subienvironment/index.htm

The Northern Ireland Environment and Heritage Service website:
www.ehsni.gov.uk/environment/environment.shtml

A companion report to this brochure entitled:
Air Quality in the UK, 2003 is available from Defra at:

Defra Publications
Admail 6000
London SW1A 2XX
Tel: 08459 556000, Fax: 020 8957 5012
e-mail: defra@iforcegroup.com

Health Effects of Air Pollution

A concise brochure entitled: Air Pollution, what it means for your health is available to download from the Defra air quality information web resource listed above or free of charge from Defra publications.

Local Air Quality Issues

For further information on air quality issues in your area, please contact:
The Environmental Health Department at your local District Council office.

Further information on Local Air Quality Management may also be found at:
www.defra.gov.uk/environment/airquality/laqm.htm *and*
www.airquality.co.uk/archive/laqm/laqm.php

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