UK Smoke and Sulphur Dioxide Network

Summary Report for January - December 2000

Prepared by the National Environmental Technology Centre as part of the Air Quality Research Programme of the Department for Environment, Food and Rural Affairs, the Scottish Executive, the National Assembly for Wales and the Department of Environment in Northern Ireland.

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Executive Summary

This report presents the results from the UK Smoke and Sulphur Dioxide Network for the calendar year 1st January to 31st December 2000, providing a summary of data from the 176 sites comprising the Network this year. These data are compared with the standards and objectives specified in the Air Quality Strategy, and with limit and guide values specified in applicable EC Directives on sulphur dioxide and suspended particles. Concentration trends and spatial distributions throughout the UK are also discussed.

The year 2000 is the first year for which the results from this Network have been reported on a calendar year basis; previously the reporting period has been the "pollution year", April to March. UK average concentrations for calendar year 2000 were 7.4μg m^{-3} for smoke and 15.4 μg m^{-3} for SO_2. These averages are slightly lower than the averages reported from this Network for the 12-month period April 1999- March 2000; 7.5μg m^{-3} for smoke and 16.1μg m^{-3} for SO_2.

Data for the calendar year January to December 2000 was compared with the 1st Daughter Directive (1999/30/EEC) 24-hour limit value for SO_2 (which is to be met by 2005). Only two Network sites exceeded the Daughter Directive 24-hour limit for SO_2 of 125μg m^{-3} on more than the three permitted occasions. These sites were BARNSLEY 8 and DUNMURRY 2.

The Air Quality Strategy (January 2000) contains a 24-hour limit for SO_2, which is the same as the Daughter Directive 24-hour limit. The same two sites exceeded this limit on more than the permitted three occasions in the calendar year January - December 2000. The AQS objective is to be met by 31 December 2004.

Both the Daughter Directive and the Air Quality Strategy now contain the same standards and objectives for particulate matter. These specifically apply to PM_{10}, not black smoke. However, black smoke data may be used by Local and Unitary Authorities in their review and assessment of PM_{10} concentrations. On the basis of smoke measurements during 2000, it is estimated that 10 Network sites are in locations that may have difficulty in meeting the Air Quality Strategy objective for PM_{10} in 2004. These are as follows: BRADFORD 6, HALIFAX 16, WAKEFIELD 26, MOIRA (LEICS) 1, SEDGLEY 5, LONDONDERRY 11, ISLINGTON 9, ILFORD 6, BARNSLEY 8 and STRABANE 2. At most of these sites the main source of particulate matter is likely to be traffic emissions rather than domestic fuel use - the exceptions being BARNSLEY 8 and STRABANE 2.

This report also examines trends in smoke and SO_2 concentration over the 37 years of monitoring by this Network and its predecessor the National Survey. There is a strong correlation between total UK emissions of these pollutants, and annual mean concentrations measured by the Network. This correlation is particularly strong in the case of black smoke.

Contents

Appendices

1 Introduction

This annual report of the Smoke and Sulphur Dioxide Network presents a description of the Network, and a summary and review of the data for calendar year 2000. Results are compared with applicable air quality standards and guide values. Trends, spatial distribution of smoke and sulphur dioxide concentrations throughout the UK, data reporting commitments and data usage are discussed. The main report is followed by Appendices providing details of the derivation and calculation of the statistics presented in the report (and on the DEFRA's Air Quality Archive on the World Wide Web) which can be accessed via www.defra.gov.uk/environment/index.htm.

This is the first occasion on which data from this Network have been reported on a calendar year (1st January to 31st December) basis. Previously, the "Pollution Calendar" year (April to March) was used. The change has been made for two reasons.

(i) Because both the first EC Daughter Directive (1999/30/EEC), covering SO_2, NO_2, PM_{10} and lead, and the Air Quality Regulations (2000) for England, Wales, and Scotland contain air quality limits based on a calendar year.

(ii) For consistency with the reporting periods used for other Networks operated on behalf of DEFRA.

2 Network Objectives

The UK Smoke and Sulphur Dioxide (SO_2) Network (Figure 1) serves two purposes. Firstly, the Network is intended to provide a long-term database of smoke and SO_2 measurements to assess trends in concentration and spatial distribution. For this purpose, a "core" subset of sites is used to provide a representative sample of monitoring locations in major population centres throughout the UK, with a wide spatial coverage of the whole country. A total of 176 Network sites were in operation during part or all of 2000 (see Figure 1). Of these sites, 125 comprised the "core" subset used to provide national trend statistics (see discussion in Section 4). However, in formally assessing compliance with applicable air quality limits and guidelines, analysis of *all* sites in the Network is undertaken.

Secondly, the Network monitors compliance with relevant air quality limits and guidelines. The original European Council Directive on Sulphur Dioxide and Suspended Particles (80/779/EEC)[1], in force since 1980, is now being superceded. The European Commission issued a Directive on Ambient Air Quality Assessment and Management [2] - the so-called "Framework Directive" in 1996. Under this framework, a number of "Daughter Directives" covering specific pollutants are being prepared. The first Daughter Directive (1999/30/EEC)[3] came into force in July 2001 and includes limit values for SO_2 and particulate matter, to be met by 1 January 2005. However, the standards for suspended particulate relate to PM_{10}, not black smoke. The existing standards for monitoring of black smoke will remain in force until 2005. The annual limits and guide values of Directive 80/779/EEC were based upon the "Pollution Calendar" year, which ran from April to March. Comparison of Network data with this Directive is now reported to DEFRA separately from this report.

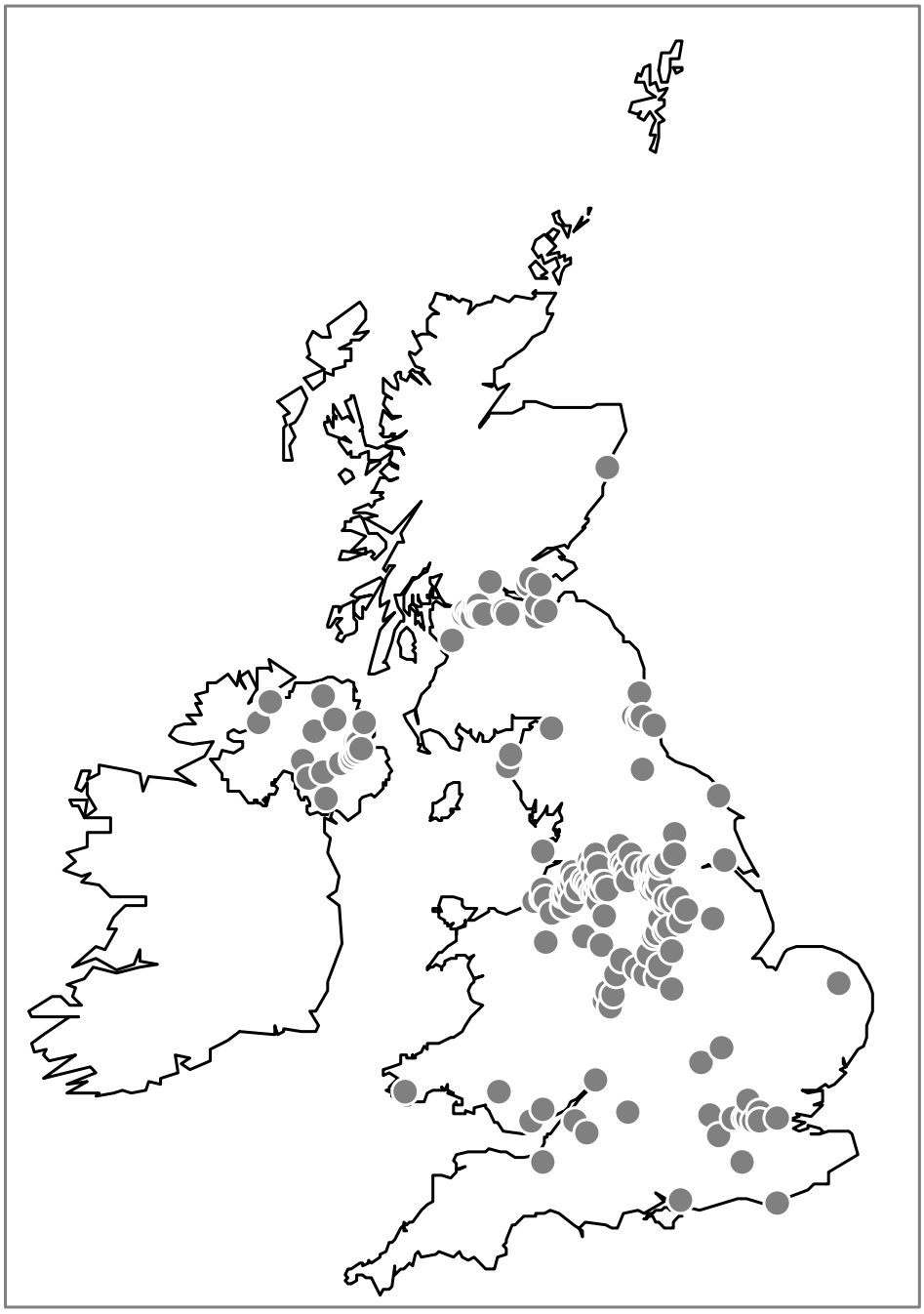


Figure 1. Location of Smoke and SO_2 Network Sites

3 Data Reporting and Use

The UK Smoke and SO_2 Network and its predecessor the National Survey provide one of the longest running databases of air quality measurements in the UK. The results have shown clearly the dramatic decrease in the concentrations of these pollutants in the UK over the last 37 years. With the exception of the UK Nitrogen Dioxide Diffusion Tube Network, the Smoke and SO_2 Network still constitutes the most widespread air quality monitoring programme in the UK.

3.1 STATUTORY REPORTING: EC DIRECTIVE

The UK Smoke and Sulphur Dioxide Network fulfils the statutory monitoring requirements of the EC Directive on Sulphur Dioxide and Suspended Particulates[1]. In June and July each year, the data from the previous pollution year (April - March) are analysed with respect to the requirements of the Directive. The results are supplied to the Department for Environment, Food and Rural Affairs for formal submission to the European Commission.

3.2 EC EXCHANGE OF INFORMATION

Under the terms of the EC Exchange of Information Decision[4], the Department for Environment, Food and Rural Affairs has agreed to supply to the Commission, full daily data for all sites in the Network, from 1997 onwards. The data are supplied to the European Topic Centre on Air Quality, for inclusion in their "AIRBASE" database, at **http://www.etcaq.rivm.nl/airbase/index.html**

3.3 PUBLIC DISSEMINATION

This report provides a major route for public dissemination of data from the Network. However, data are also summarised in the Digest of Environmental Statistics, published annually by the Stationery Office[5]. Also, ad hoc requests for data are serviced by retrievals from the database held at AEA Technology's National Environmental Technology Centre (NETCEN). These are normally provided free of charge.

A comprehensive archive of air quality measurements, including smoke and SO_2 data, has been prepared. This is available on the World Wide Web, via DEFRA's web site www.defra.gov.uk/environment/index.htm
Site information and summary data from 1963 onwards for the Smoke and SO_2 Network are available on the web site, with full daily data from 1990 onwards. These daily data are updated every three months; the annual statistics are updated yearly.

4 Results and Discussion

4.1 UNITS

Both smoke and sulphur dioxide concentrations are expressed in micrograms per cubic metre ($\mu g\ m^{-3}$) in this report and on the CD-ROM version.
(i) Smoke: in the UK, smoke concentrations are usually calculated according to the British Standard Smoke Stain (BS) Calibration. This report primarily uses the BS calibration, and all black smoke concentrations are in this form except where specified. However, elsewhere in Europe, the Organisation for Economic Co-operation and Development (OECD) Smoke Calibration Curve (OECD Publication no. 17913: 1964) is used. Concentrations given according to the BS calibration can be converted to OECD by dividing by 0.85. In any communication with the European Commission, it is normal to use the OECD calibration. OECD smoke concentrations have been included in this report where applicable, and are indicated as OECD and shown in *italics*.
(ii) SO_2: In this report, SO_2 concentrations are given primarily in $\mu g\ m^{-3}$. However, concentrations of gaseous pollutants are sometimes expressed as parts per billion by volume (abbreviated to "ppb"). For SO_2, the conversion factor used by the EC is as follows: **1 ppb = 2.66 $\mu g\ m^{-3}$, at a temperature of 20°C and 1013 mb pressure.** This **only** applies to SO_2; conversion factors are different for other gaseous pollutants.

4.2 SUMMARY OF RESULTS

Summary statistics for the year 2000 for each Network site are provided in Table 1. The sites are listed by Government region (Scotland, the North East, North West and Merseyside, Yorkshire and the Humber, East Midlands, West Midlands, Wales, Eastern, London, South East, South West and Northern Ireland). Table 1 is subdivided into 12 separate Tables, 1.1 to 1.12, for the 12 Regions. ***As Table 1 is large, it has been placed at the end of the text.*** Within each region, sites are grouped by the Local or Unitary Authority in whose area they are situated. In most cases, this Authority is responsible for the operation of the site, although a small number are operated by other organisations such as universities.

For sites in England, Wales and Scotland, Table 1 gives the location as an Ordnance Survey grid reference, to the nearest 100m. For sites in Northern Ireland, the Irish Grid is used.

The following abbreviations are used in Table 1:
1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

4.3 DATA CAPTURE

Table 1 shows both the number of valid days' data (in the column headed "Valid Days"), and the data capture expressed as a percentage (as Data Capt., %). The data capture statistics for the Network for 2000 were as follows. 100% data capture for both pollutants was achieved at 18% of sites, while 54% of sites had over 90% data. 29% of sites had less than 75% data capture. The average data capture was 81%, including sites that started or ceased operation part way through the year, or 86% if these sites are excluded. These statistics show similar data capture to that reported for the pollution year 1999- 2000, although slightly more sites achieved 100% data capture.

Data may be lost for a number of reasons. However, the Millennium holidays at the start of 2000 had an impact on data capture; for many site operators it proved impossible to keep the sampler in operation over this period, due to staff shortages or lack of access to buildings.

The data capture objective specified by Annex IV of the First Daughter Directive (1999/30/EEC) for indicative techniques is 90%; therefore this is the target for minimum data capture in the Network. Advice for site operators on dealing with equipment faults and improving data capture are given in the Instruction Manual. Copies of the Manual are available from AEA Technology, or via the World Wide Web, at web site **http://www.aeat.co.uk/netcen/airqual/reports/smkman/shead.html** Alternatively, site operators are welcome to contact NETCEN for advice on any aspect of smoke or SO_2 monitoring.

4.4 NATIONAL AVERAGE SMOKE AND SO_2 CONCENTRATIONS

Mean UK concentrations in 2000, based the "core" subset only (125 sites), were as follows:

- Smoke: 7.4 μg m^{-3} BS *(8.7 $\mu g\ m^{-3}$ OECD).*
- SO_2 : 15.4 μg m^{-3} .

As in previous years, these values were calculated by averaging the annual means from all core sites, regardless of data capture. They are slightly lower than the April 1999- March 2000 UK averages of 7.5 μgm^{-3} for smoke, and 16.1 μg m^{-3} for SO_2, as measured by this Network.

4.5 SEASONAL ANALYSIS

Smoke and SO_2 can exhibit a seasonal variation. Concentrations of both pollutants, but particularly black smoke, are typically higher in the winter months. This is partly because a major source of both pollutants is the combustion of coal and oil; this increases during winter, mainly because of domestic and industrial heating requirements. Also cold, still weather conditions may prevent dispersion.

Figure 2 shows a time series of UK daily mean concentrations of smoke and SO_2, for 2000. This plot shows the mean of all 176 sites in the Network, and is intended to illustrate typical seasonal variation in these pollutants. The seasonal pattern for smoke is clearly visible, with daily UK mean concentrations consistently higher during winter than during summer. For SO_2, the pattern is usually much less pronounced, and this year there was no clear seasonal variation: UK average daily means typically ranged between 15 and 20 μg m^{-3} throughout the year. UK mean values of above 25 μg m^{-3} occurred occasionally throughout the year. As Figure 2 shows, on several occasions both smoke and SO_2 were high. Days when the UK daily average smoke

concentration exceeded 20 μg m^{-3} occurred on the 25th January, 16th December and 27th to 29th December 2000. Peaks in SO_2 also occurred on these days (in particular January 25th), indicating that the high pollution levels were possibly due to meteorological conditions at the time. These peaks, particularly that on 25th January 2000, were also evident in daily average PM_{10} and SO_2 concentrations at numerous automatic monitoring sites in the Automatic Urban Network. A small peak of 14μg m^{-3}occurred around 4th-5th November, most likely a result of bonfire night celebrations.

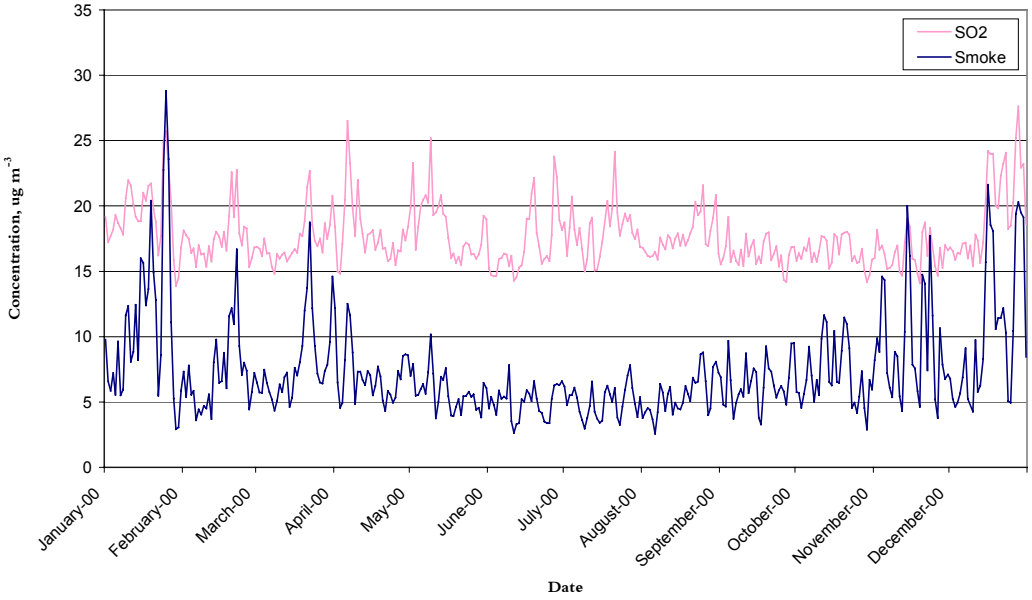


Figure 2. Seasonal Variation of Smoke and SO_2, Calendar Year 2000

It is interesting to compare these findings with pollution episodes during 2000 identified by the Automatic Urban Network. Many AUN sites also recorded a peak in daily mean PM_{10} and/or SO_2 concentration around 25th January, coinciding with that identified by the Smoke and SO_2 Network. This indicates that dark-coloured primary particulate matter was probably responsible for this winter peak. By contrast, a summer PM_{10} peak measured by many AUN sites in early May was not recorded in smoke data. This is likely to have been caused by secondary particulate matter (e.g particulate nitrate and sulphate) which is detectable as PM_{10}, but not by the black smoke method, because of its light colour.

4.6 NATIONAL AND REGIONAL ANALYSIS

Figures 3 and 4 show annual means of smoke and SO_2 respectively, for the entire Network. Only sites with at least 75% data capture are shown. The data for calendar year 2000 show a similar pattern to that observed in previous "pollution" years.

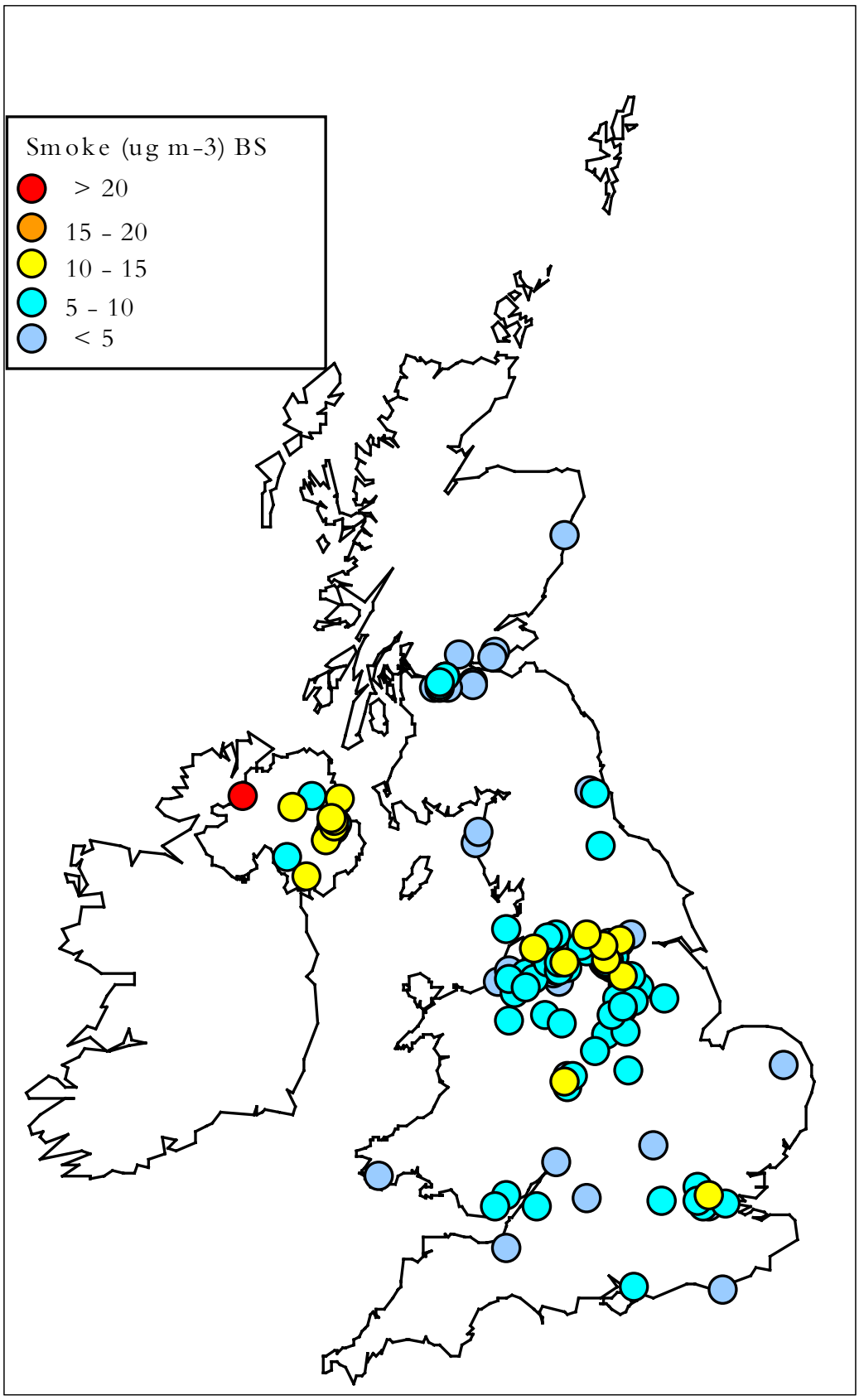


Figure 3. Annual Mean Smoke Concentrations, Jan-Dec 2000

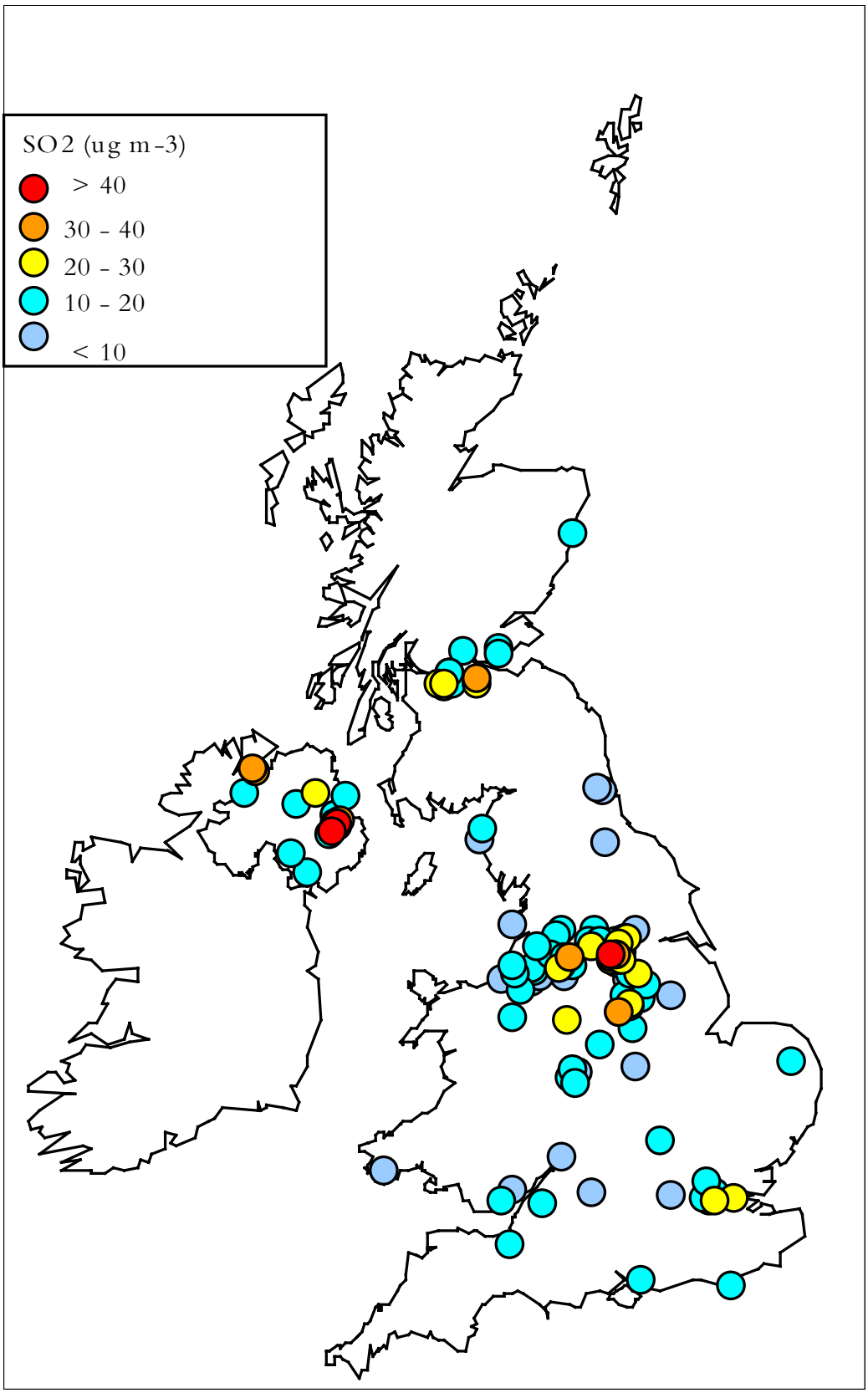


Figure 4. Annual Mean Sulphur Dioxide Concentrations, Jan-Dec 2000

Table 2 summarises key statistics for England, Scotland, Wales and Northern Ireland.

Table 2 Statistical Summary for England, Scotland, Wales and Northern Ireland

	England	*Scotland*	*Wales*	*N. Ireland*
Number of sites	***125***	***22***	***5***	***24***
Smoke ($\mu g\ m^{-3}$ BS)				
Min. Annual Mean	2	1	3	6
Ave. Annual Mean	7	4	6	11
Max. Annual Mean	14	6	8	27
SO_2 ($\mu g\ m^{-3}$)				
Min. Annual Mean	5	10	5	10
Ave. Annual Mean	16	18	11	27
Max. Annual Mean	46	34	19	82

Note: Max, Min and Mean based only on sites with at least 75% data capture – 88 in England, 14 in Scotland, 4 in Wales and 18 in N. Ireland.

4.6.1 England

Smoke in England: Annual mean smoke at English sites ranged from 2 $\mu g\ m^{-3}$ (e.g. at the coastal towns of Eastbourne and Whitehaven) to 14 $\mu g\ m^{-3}$ at the city centre site BRADFORD 6. The highest smoke concentrations occurred at sites of two types: firstly those in city centre locations where particulate emissions from traffic contribute, such as BRADFORD 6 above. Secondly, those in areas where the use of coal for domestic heating is prevalent (e.g. parts of South and West Yorkshire and the East Midlands). The average for all sites in England was 7$\mu g\ m^{-3}$, consistent with the mean of 7.4 $\mu g\ m^{-3}$ for the whole UK, based on core sites.

SO_2 in England: The highest SO_2 concentration in England, as measured by this Network, occurred at BARNSLEY 8, in an area where domestic coal use is prevalent. High SO_2 concentrations were also measured at OLDHAM 13 and ALFRETON 4 in Derbyshire. The annual mean SO_2 for all English sites was 16 $\mu g\ m^{-3}$, consistent with the mean of 15.4 $\mu g\ m^{-3}$ for the whole UK (based on core sites only).

4.6.2 Scotland

Smoke in Scotland: Annual mean smoke concentrations measured Scotland were less than 10 $\mu g\ m^{-3}$ at all sites except two (EDINBURGH 25 and KILMARNOCK 2) which had less than 75% data capture and were therefore not included in this analysis. The annual mean smoke concentration for all Scottish sites was 4 $\mu g\ m^{-3}$.

SO_2 in Scotland: No Scottish sites exhibited particularly high annual mean SO_2 concentrations. The highest (excluding one, COATBRIDGE 11 with less than 75% data capture) was 34$\mu g\ m^{-3}$, at ARMADALE 2. This is in a small town, but is close to industrial and domestic emission sources, and high SO_2 concentrations have been measured here in previous years. The majority of sites in Edinburgh and Glasgow had annual mean SO_2 in the range 16 to 25 $\mu g\ m^{-3}$. Elsewhere it was typically below 15$\mu g\ m^{-3}$. The mean for Scotland was 18 $\mu g\ m^{-3}$.

4.6.3 Wales

Smoke in Wales: There were only 5 sites in Wales during 2000, of which one had less than 75% data capture. Therefore, these statistics are unlikely to be representative of all urban areas in Wales. However, the measured data indicate that smoke concentrations at sites in Wales (which are predominantly located in the urban areas of South Wales) were typically low compared to the England and Northern Ireland, although slightly higher than in Scotland. Annual means

were less than 10 μg m^{-3} at all sites. The annual mean smoke for the four Welsh sites with data capture greater than 75% was 6 μg m^{-3} - marginally higher than that for Scotland.
SO_2 in Wales: Annual mean SO_2 concentrations in Wales ranged from 5 μg m^{-3} to 19 μg m^{-3} for sites with at least 75% data capture, although GLYNNEATH 1 (which only had 65% data capture) had an annual mean SO_2 concentration of 29μg m^{-3}.

4.6.4 Northern Ireland

Smoke in Northern Ireland: Annual mean smoke concentrations in Northern Ireland typically ranged from 6 μg m^{-3} to 15 μg m^{-3}. The average for Northern Ireland was 11 μg m^{-3}. An unusually high concentration of 27 μg m^{-3} was measured at STRABANE 2. This has been investigated, and appears to be genuine; the site is located on a housing estate with considerable domestic coal and oil burning, and local topography may impede dispersion.
SO_2 in Northern Ireland: Relatively high concentrations of SO_2 have been measured in Northern Ireland, particularly Belfast, for many years. Natural gas has limited availability for domestic heating in this region, so greater use is made of coal and oil. The overall annual mean SO_2 for all Network sites in Northern Ireland was 27 μg m^{-3}; considerably higher than the annual means obtained for the other Regions or for the UK as a whole. The highest annual mean SO_2 was 82 μg m^{-3}, measured at DUNMURRY 2. SO_2 concentrations at this site have always been high, as it is in a residential area where domestic coal and oil use is prevalent. However, SO_2 concentrations have recently increased, especially in the summer, and it was suspected that emissions from a nearby boiler chimney had begun to affect the site directly. This was confirmed by setting up a new site, DUNMURRY 3, a short distance away. SO_2 levels at this new site were lower, and comparable with those at nearby LISBURN 3. DUNMURRY 2 has now been discontinued.

4.7 IDENTIFICATION OF SITES WITH HIGH CONCENTRATIONS

Table 3 (below) lists the sites with the highest annual average smoke concentrations - defined here as those with an annual mean greater than 10 μg m^{-3}. Sites with less than 75% data capture for the year have been excluded.

Table 3 Sites with Highest Annual Mean Smoke Concentrations, 2000

Site Name	*Region*	*Annual Mean Smoke concentration* μg m^{-3} BS
STRABANE 2	Northern Ireland	**27**
NEWTOWNABBEY 2	Northern Ireland	**15**
BRADFORD 6	Yorkshire & Humber	**14**
NEWTOWNABBEY 1	Northern Ireland	**14**
SEDGLEY 5	West Midlands	**13**
BELFAST 33	Northern Ireland	**12**
WAKEFIELD 26	Yorkshire & Humber	**12**
BARNSLEY 8	Yorkshire & Humber	**11**
LISBURN 3	Northern Ireland	**11**
OLDHAM 13	North West & Mersey	**11**
DUNMURRY 3	Northern Ireland	**11**
MAGHERAFELT 1	Northern Ireland	**11**
LARNE 3	Northern Ireland	**11**

As in previous years, the highest annual mean smoke concentrations were measured predominantly at sites of two types. Firstly, sites in city centres or close to busy roads (e.g. BRADFORD 6, and SEDGLEY 5 near Dudley), where traffic emissions are likely to contribute to ambient concentrations of particulate matter. Secondly, sites in areas where the use of coal for domestic heating is still prevalent (e.g. South and West Yorkshire, Northern Ireland). It should be noted that annual mean smoke concentrations are lower in general than last year, being less than 10 $\mu g\ m^{-3}$ at the majority of sites.

STRABANE 2 (Northern Ireland), which started operation in October 1999, has a conspicuously high annual mean of 27 $\mu g\ m^{-3}$. The site is surrounded by domestic coal burning with no other combustion sources. As discussed above, it is possible that the local topography impedes dispersion from nearby domestic sources.

Table 4 (below) lists the sites with the highest annual mean SO_2 concentrations - defined for the purpose of this report as those with an annual mean greater than 30 $\mu g\ m^{-3}$ or more (again, those with less than 75% data capture have been excluded).

Table 4 Sites with Highest Annual Mean SO_2 Concentrations, 2000

Site Name	*Region*	*Annual Mean SO_2 concentration* $\mu g\ m^{-3}$
DUNMURRY 2	Northern Ireland	**82**
BARNSLEY 8	Yorkshire & Humber	**46**
BELFAST 33	Northern Ireland	**42**
BELFAST 42	Northern Ireland	**42**
BELFAST 13	Northern Ireland	**40**
OLDHAM 13	North West & Mersey	**39**
BELFAST 44	Northern Ireland	**39**
BELFAST 45	Northern Ireland	**37**
LONDONDERRY 12	Northern Ireland	**36**
LONDONDERRY 14	Northern Ireland	**36**
ARMADALE 2	Scotland	**34**
ALFRETON 4	East Midlands	**33**
CUDWORTH 2	Yorkshire & Humber	**32**
BELFAST 46	Northern Ireland	**31**

The table is dominated by sites in Northern Ireland and Yorkshire and the Humber. The most important factor here is coal and oil use. In Northern Ireland, due to limited availability of natural gas for domestic heating, use of coal and oil is higher. Likewise, areas of South Yorkshire in particular have long been associated with the coal industry, and domestic coal use is relatively prevalent. The high result at DUNMURRY 2, is unusual. This site, in a suburb of Belfast, has produced high SO_2 results for many years, being situated in a residential area where coal and oil use is widespread. However, as discussed above, increasing SO_2 concentrations (to 82 $\mu g\ m^{-3}$ in 2000), especially in summer, gave rise to suspicion that emissions from a nearby boiler chimney had begun to affect the site directly. DUNMURRY 2 has now been discontinued, and replaced by DUNMURRY 3, just a short distance away.

5 Comparison with EC Directive Limits and Guide Values

In previous years, data from the UK Smoke and SO_2 Network have been compared with the European Council Directive[1] 80/779/EEC on sulphur dioxide and suspended particulates. This original Directive will remain in force until it is fully repealed in 2005. However, now that Network data are to be reported on a calendar year basis, comparison of results from the Smoke and SO_2 Network with this original Directive are reported separately to DEFRA each year.

This report compares results from the Smoke and SO_2 Network, for calendar year 2000, with applicable parts of the First Daughter Directive (1999/30/EEC).

5.1 THE 1ST DAUGHTER DIRECTIVE (1999/30/EEC)

The first Daughter Directive (1999/30/EEC), covering SO_2, NO_2, PM_{10} and lead[3] was published in April 1999 and came into force in July 2001. This Directive contains limit values for these pollutants, aimed at protection of human health and, in some cases, of ecosystems. Only the parts of the Daughter Directive relating to SO_2 and particulate will be discussed here; the limits are given in Table 5 and Table 6 below.

Table 5 Directive 1999/30/EEC Limit Values for SO_2

	Averaging period	*Limit value*	*Date by which limit is to be met*
1. Hourly limit value for protection of human health	1 hour	350 μg m^{-3} not to be exceeded more than 24 times per calendar year	1 January 2005
2. Daily limit value for protection of human health	24 hours	125 μg m^{-3} not to be exceeded more than 3 times per calendar year	1 January 2005
3. Limit value for the protection of ecosystems	calendar year and winter (1 Oct - 31 Mar)	20 μg m^{-3}	19 July 2001

There is also an "alert threshold" for SO_2 of 500 μg m^{-3}, measured over three consecutive hours at representative sites over at least 100 km^2 or an entire zone or agglomeration, whichever is smaller. Public warnings and advice are to be issued if this threshold is exceeded.

The Daughter Directive limits are accompanied by "upper and lower assessment thresholds", which specify what type of monitoring is required.

- The upper assessment threshold is the level below which a combination of measurements and modelling techniques may be used to assess air quality;
- the lower assessment threshold is the level below which modelling alone, or with objective estimation techniques, is considered sufficient for assessment of air quality.

This ensures that monitoring resources are targeted where they are most needed. Exceedence of these assessment thresholds is to be determined on the basis of data from the previous five years where available.

In the 1st Daughter Directive, an "exceedence" of an air quality limit or guide value is defined as a concentration "greater than" the limit or guide value, as opposed to "greater than or equal to". The Daughter Directive definition - "greater than" is therefore used in this report. It is clearly not possible to compare data from the Smoke and SO_2 Network with the hourly SO_2 limit. Nor is it relevant to compare data from this urban network with the annual and winter limits for protection of ecosystems, which are intended for protection of rural areas. However, it is possible to compare the daily data from the Network with the 24 hour limit, for protection of human health. In the calendar year January to December 2000, there were 2 sites with more than three days where the 24-hour average for SO_2 was greater than the limit of 125 $\mu g\ m^{-3}$: these were as follows:

BARNSLEY 8
DUNMURRY 2

As discussed in Section 4.7, DUNMURRY 2 was thought to be affected by emissions from a nearby boiler chimney, and has since been replaced by DUNMURRY 3.

Table 6 Directive 1999/30/EEC Limit Values for PM_{10}

	Averaging period	*Limit value*	*Date by which limit is to be met*
Stage 1			
1. 24-hour limit value for protection of human health	24 hour	50 $\mu g\ m^{-3}$ not to be exceeded more than 35 times per year	1 January 2005
2. Annual limit value for protection of human health	Calendar Year	40 $\mu g\ m^{-3}$	1 January 2005
Stage 2 ⋆			
1. 24-hour limit value for protection of human health	24 hour	50 $\mu g\ m^{-3}$ not to be exceeded more than 7 times per year	1 January 2010
2. Annual limit value for protection of human health	Calendar Year	20 $\mu g\ m^{-3}$	1 January 2010

⋆ *To be reviewed in the light of further information and experience.*

The Daughter Directive particulate limits relate to PM_{10}, not black smoke, and therefore Network data cannot be directly compared with these. The black smoke limits of the Smoke and SO_2 Directive will remain in force until 1 January 2005.

6 Comparison with the Air Quality Strategy

6.1 AIR QUALITY STRATEGY FOR SO_2

The Air Quality Regulations (2000) for England[6], Wales[7], and Scotland[8] include standards and objectives for SO_2. These are explained in the Air Quality Strategy (January 2000)[9], and summarised below:

- 266 μg m^{-3} for the 15-minute mean, not to be exceeded more than 35 times per year, to be achieved by 31 December 2005.
- 350 μg m^{-3} for the 1-hour mean, not to be exceeded more than 24 times per year, to be achieved by 31 December 2004.
- 125 μg m^{-3} for the 24-hour mean, not to be exceeded more than 3 times per year, to be achieved by 31 December 2004.

Data from the Smoke and SO_2 Network, which provides daily mean data, can only be directly compared with the standard for the 24-hour. This is identical to the Daughter Directive 24-hour limit. Data from calendar year 1 January - 31 December 2000 have been compared with this limit. The same 2 sites had 24 hour mean SO_2 concentrations greater than the 24-hour limit on more than three days during 2000:

BARNSLEY 8
DUNMURRY 2

As the hydrogen peroxide bubbler method of measurement used in this Network may underestimate peak SO_2 concentrations, a factor of 1.25 should be applied to *peak* data when using this relationship. Dividing the 24-hour limit of 125 μg m^{-3} by 1.25 to account for possible under-reading by the method used gives 100 μg m^{-3} for the maximum day. A total of fourteen sites had over three daily means greater than this value in calendar year January - December 2000: the above two plus BELFAST 42, BELFAST 13, BELFAST 44, BELFAST 46, BELFAST 45, LONDONDERRY 14, COATBRIDGE 11, ARMADALE 2, BELFAST 33, WAKEFIELD 26, BIRCOTES 1, GOLDTHORPE 1.

6.2 AIR QUALITY STRATEGY FOR PM_{10}

The Air Quality Strategy[9] also provides objectives for suspended particulate matter. The particulate objectives specifically apply to PM_{10}, not black smoke, and the Strategy acknowledges that these two techniques are not the same. The Air Quality Regulations (2000) for England, Wales and Scotland contain objectives which are the same as those in the EC Daughter Directive for PM_{10}, and are as follows:

- 40 μg m^{-3} as the annual mean, to be achieved by 31 December 2004
- 50 μg m^{-3} as a fixed 24 hour mean, maximum of 35 exceedences per year (approximately equivalent to the 90th percentile), also to be achieved by 31 December 2004.

The above limits are based on European reference method for PM_{10} (a gravimetric technique), or equivalent.

Although the above standards and objectives pertain to PM_{10}, black smoke data can be of use to Local Authorities in their review and assessment of PM_{10} concentrations with respect to these limits. This is described in "Assistance with the review and assessment of PM_{10} concentrations in relation to the proposed EU Stage 1 Limit Values" [10], produced for the Department. In this document, it is stated that the AQS 24-hour objective (which is the more stringent of the two) is highly unlikely to be exceeded in any given year if the annual mean PM_{10} for the same year does not exceed 28 μg m^{-3}. Where this threshold appeared likely to be exceeded in 2004, the document advised Local Authorities to undertake a 3rd Stage Review and Assessment.

Where domestic solid fuel use is likely to have a significant impact on local PM_{10} levels, a procedure has been developed[10] whereby black smoke data can be used to assess the impact of domestic solid fuel use. This is based upon an empirical relationship, and makes use of the following data:

- annual mean black smoke concentration in the area,
- Modeled 1996 annual mean background secondary PM_{10} concentration in the area, available on the World Wide Web at http://www.aeat.co.uk/netcen/airqual
- Estimated contribution from "coarse" PM_{10}, e.g. wind-blown dust.

In such areas, where black smoke data are available, the total annual mean PM_{10} concentration for the year 2004 can be predicted from the following relationship:

Total annual mean PM_{10} (2004) = 0.8 x annual mean secondary PM_{10} (1996) + coarse PM_{10} fraction + 0.8 x current annual mean black smoke.

The coarse component is assumed to be a constant 8 μg m^{-3}, as measured by TEOM method[10]. The document provides a graph from which the user can easily determine whether the predicted annual mean for 2004 exceeds 28 μg m^{-3}.

Most Local Authorities have by now completed their Review and Assessment, and will have identified any areas where exceedence of the PM_{10} standard in 2004 is likely. However, as in previous reports, the above relationship has been applied to sites in the Smoke and SO_2 Network.

Table 7 shows the Smoke and SO_2 Network sites for which this relationship predicts possible exceedence in 2004. These sites were identified by the following procedure.

1. First, the modeled 1996 annual mean background secondary PM_{10} concentrations were obtained from the www, for each site. These modeled concentrations are presented as ranges (e.g. 11 to 14 $\mu g\ m^{-3}$) so the upper limit of the range was used, to represent the worst case. For sites in the highest concentration band, " greater 14 $\mu g\ m^{-3}$ ", which covers London and parts of the Eastern and South East regions, the modeled 1996 secondary PM_{10} concentration was taken as 15 $\mu g\ m^{-3}$.
2. Using the above *worst case* modeled 1996 annual mean background secondary PM_{10} concentrations, the annual mean black smoke concentration for 2000, and a value of 8 $\mu g\ m^{-3}$ for the coarse component, a predicted total annual mean PM_{10} for 2004 was calculated for each site, from the relationship above.
3. Based on this, ten sites were identified at which the predicted total annual mean PM_{10} for 2004 was greater than 28$\mu g\ m^{-3}$.

Table 7 Sites for which current smoke concentrations may predict exceedence of PM_{10} Objective in 2004.

Region	*Number of sites*
Scotland	0
North East	0
North West and Merseyside	0
Yorkshire and the Humber	3 (BRADFORD 6, HALIFAX 16, WAKEFIELD 26, BARNSLEY 8)
East Midlands	1 (MOIRA (LEICS) 1)
West Midlands	1 (SEDGLEY 5)
Eastern	0
London	2 (ILFORD 6, ISLINGTON 9)
South East	0
South West	0
Wales	0
Northern Ireland	2 (LONDONDERRY 11, STRABANE 2)

All sites included in this analysis regardless of data capture.

The total of 10 sites is slightly greater than last year's total of 7 sites. There are four sites in Table 7 which were not identified last year: ILFORD 6, MOIRA (LEICS) 1 and WAKEFIELD 26.

As was the case last year, the majority of the sites identified, are influenced more by traffic emissions than by domestic coal burning. Only in the case of BARNSLEY 8 and STRABANE 2 are domestic emissions likely to be a major contributor to local PM_{10}. BRADFORD 6, HALIFAX 16, and WAKEFIELD 26 are all in city centre locations. MOIRA (LEICS) 1, SEDGLEY 5 and LONDONDERRY 11, ISLINGTON 9 and ILFORD 6 are all in areas where nearby heavy traffic is likely to contribute substantially to suspended particulate concentrations.

This assessment is of course indicative only; Local/Unitary Authorities will by now have made detailed assessments of their areas as part of the Review and Assessment process. However, it serves to highlight the type of location where problems might be expected.

7 Trends and Comparison with Emission Estimates

The timeseries of the annual mean smoke and sulphur dioxide concentrations for the UK as a whole are provided in Figure 5a and 5b respectively. The values shown in Figure 5a and 5b are averages from all sites in the network up to 1980, and thereafter from all sites in the core subset only. As explained in Section 2, this subset is intended to provide a representative selection of monitoring sites in urban areas throughout the UK. For consistency with previous years, the annual means shown in these figures are based upon the old "pollution calendar" years, which ran from April to March. The resulting graphs show the rapid decrease in concentrations in the 1960s and 1970s and the more gradual decrease through the 1980s and 1990s. Figure 5a and 5b also show estimated total UK annual emissions of smoke and SO_2 for calendar years 1970 - 1999 (data for 2000 are not yet available), taken from the National Atmospheric Emissions Inventory. The graphs clearly show that ambient concentrations of these pollutants reflect declining emissions over this 29-year period.

The relationships between estimated annual emissions and measured annual mean concentrations have been explored further.

- **Smoke:** The plot shows a clear relationship between these two parameters over the 28 years. Regression analysis of the two parameters was carried out, giving a correlation coefficient (R^2) of 0.93. This is close to 1 and therefore indicates a very strong correlation.
- **SO_2:** The relationship between the two parameters is also strong in the case of SO_2: the correlation coefficient (R^2) of the regression equation is 0.87. The correlation is slightly weaker than for smoke, which may reflect the fact that the Network measures net acidity rather than SO_2.

Fig. 5a. Smoke only: Annual Emissions and Annual Mean Ambient Concentrations.

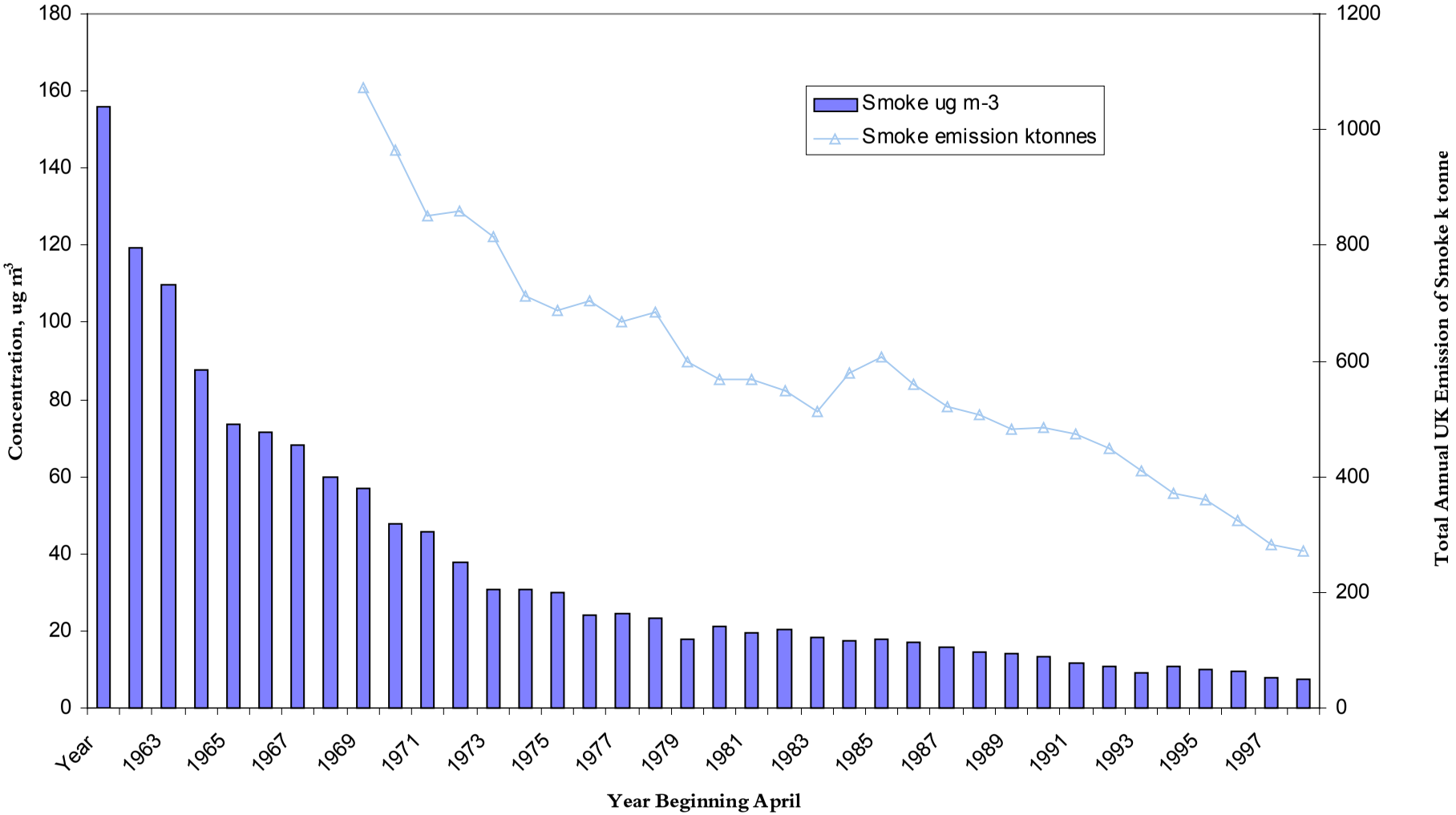
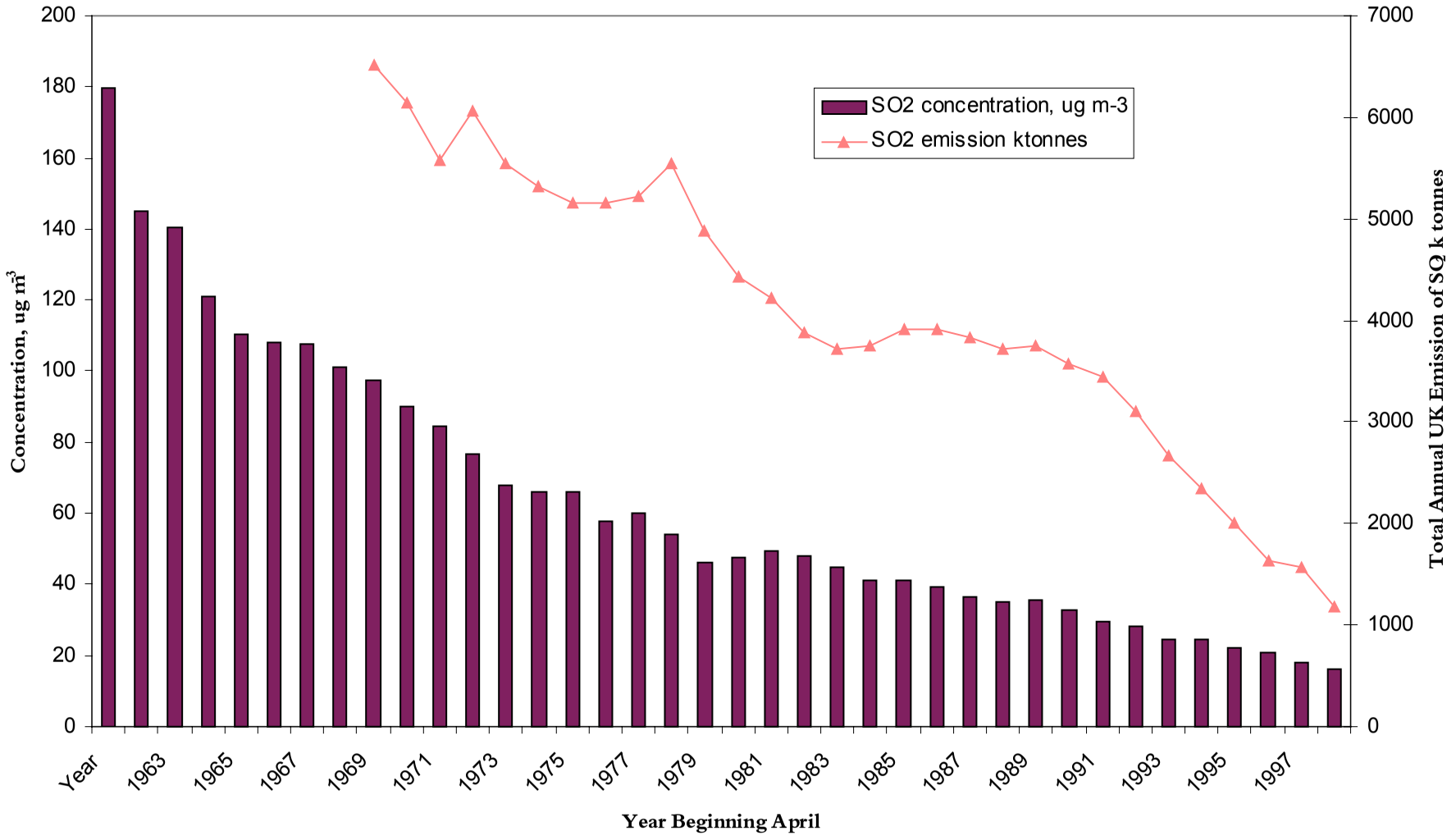


Fig. 5b. SO_2 only: Annual Emissions and Annual Mean Ambient Concentrations.



8 Acknowledgements

All data presented in this report have been obtained by participating Local Authorities and supplied to the National Environmental Technology Centre (NETCEN) as part of this study. This contribution and cooperation from the Local Authorities is gratefully acknowledged. The central organisation of the study, analysis and quality assurance of the data by NETCEN has been funded by the Department for Environment, Food and Rural Affairs, the Scottish Executive, the National Assembly for Wales and DoE Northern Ireland as part of their Air and Environmental Quality research programme (Contract No. EPG 1/3/71 (A)).

9 References

1. Council of European Communities Directive on Air Quality Limit Values and Guide Values for Sulphur Dioxide and Suspended Particulates (80/779/EEC)

2. Council Directive 96/62/EC on Ambient Air Quality Assessment and Management.

3. Council Directive 1999/30/EEC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. 22 April 1999.

4. Establishing a Reciprocal Exchange of Information and of Data from the Network and Individual Stations Measuring Ambient Air Pollution in Member States. Decision 97/101/EEC.

5. DEFRA Digest of Environmental Statistics (produced annually). The Stationery Office.

6. The Air Quality (England) Regulations 2000 (Statutory Instrument 2000 No. 928), March 2000.

7. The Air Quality (Wales) Regulations 2000 (Statutory Instrument 2000 No. 1940 (W.138)), July 2000.

8. The Air Quality (Scotland) Regulations 2000 (Scottish Statutory Instrument 2000 No. 97), March 2000.

9. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Working Together for Clean Air. The Stationery Office, January 2000.

10. Moorcroft S, Laxen D, Stedman J, Vawda Y, Conlan B, Abbott J. Assistance with the review and assessment of PM_{10} concentrations in relation to the proposed EU Stage 1 Limit Values. Produced for the Department of the Environment, Transport and the Regions, the Welsh Assembly and the Scottish Executive by Stanger Science and Environment, Air Quality Consultants, and NETCEN. March 1999.

Table 1.1. Summary of Smoke and Sulphur Dioxide Results for Scotland, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	SCOTLAND															
10003	ABERDEEN 3	Aberdeen City	3931	8062	364	100	4	3	12	38	361	99	20	19	48	56
1100025	EDINBURGH 25	City of Edinburgh	3258	6731	215	59	11	10	25	32	211	58	24	21	43	50
1300020	GLASGOW 20	City of Glasgow	2595	6653	366	100	5	5	14	21	366	100	25	25	44	57
1300051	GLASGOW 51	City of Glasgow	2533	6641	366	100	4	3	17	42	364	100	22	19	38	50
1300069	GLASGOW 69	City of Glasgow	2568	6663	76	21	6	4	29	39	76	21	22	24	41	41
1300073	GLASGOW 73	City of Glasgow	2612	6627	366	100	5	3	19	53	366	100	16	19	37	43
1300095	GLASGOW 95	City of Glasgow	2679	6642	366	100	5	3	21	46	366	100	17	18	32	49
1300098	GLASGOW 98	City of Glasgow	2611	6678	366	100	6	4	24	47	366	100	19	20	34	46
1685002	KILMARNOCK 2	East Ayrshire	2427	6380	131	36	13	11	26	31	134	37	9	6	13	19
1725008	KIRKINTILLOCH 8	East Dumbartonshire	2670	6741	341	93	6	4	23	55	341	93	10	7	31	76
1725009	KIRKINTILLOCH 9	East Dumbartonshire	2654	6732	334	92	6	4	25	66	334	92	13	13	37	74
1725010	KIRKINTILLOCH 10	East Dumbartonshire	2659	6741	335	92	4	3	17	47	335	92	20	20	40	74
155002	BALLINGRY 2	Fife	3178	6978	366	100	1	1	3	5	366	100	14	13	25	32
820301	COWDENBEATH 1	Fife	3165	6912	366	100	2	1	3	7	366	100	14	14	21	27
900301	DALKEITH 1	Midlothian	3341	6670	206	56	7	5	29	32	206	56	25	24	48	49
2514001	PENICUIK 1	Midlothian	3240	6606	222	61	2	2	7	9	222	61	18	16	38	44
760005	COATBRIDGE 5	North Lanarkshire	2712	6638	265	73	6	5	23	42	266	73	22	23	43	70
760011	COATBRIDGE 11	North Lanarkshire	2738	6652	210	58	6	4	29	53	217	59	43	26	111	118
3070005	STIRLING (BURGH) 5	Stirling	2797	6946	351	96	4	3	16	35	320	88	12	13	25	38
1721006	KIRKCALDY 6	West Fife	3265	6933	243	67	3	3	12	20	243	67	10	12	24	30
69502	ARMADALE 2	West Lothian	2945	6681	343	94	2	1	4	5	343	94	34	28	78	116
3559003	WHITBURN 3	West Lothian	2948	6650	365	100	2	2	8	14	365	100	20	19	32	39

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.2. Summary of Smoke and Sulphur Dioxide Results for the North East, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	NORTH EAST															
915013	DARLINGTON 13	Darlington	4291	5145	357	98	9	9	25	29	357	98	5	6	18	24
1290010	GATESHEAD 10	Gateshead	4256	5619	125	34	3	3	12	15	108	30	12	12	20	24
2370002	NEWBURN 2	Newcastle Upon Tyne	4199	5671	362	99	4	3	15	22	362	99	8	7	20	39
2390024	NEWCASTLE UPON TYNE 24	Newcastle Upon Tyne	4285	5650	255	70	4	3	18	30	255	70	5	7	14	20
2390027	NEWCASTLE UPON TYNE 27	Newcastle Upon Tyne	4251	5645	351	96	8	6	21	29	351	96	8	6	24	37
3170008	SUNDERLAND 8	Sunderland	4391	5585	115	32	6	4	19	89	115	32	16	13	45	53
85005	ASHINGTON 5	Wansbeck	4272	5877	254	70	5	4	16	23	245	67	19	18	43	54

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.3. Summary of Smoke and Sulphur Dioxide Results for the North West and Merseyside, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	NORTH WEST & MERSEYSIDE															
3700003	WORKINGTON 3	Allerdale	2999	5287	316	87	4	2	22	28	316	87	13	13	25	33
380006	BLACKPOOL 6	Blackpool	3317	4367	364	100	7	5	27	54	365	100	9	6	19	24
400024	BOLTON 24	Bolton	3715	4092	366	100	8	7	29	52	366	100	13	13	26	46
1230008	FARNWORTH 8	Bolton	3739	4061	317	87	9	6	30	56	317	87	11	12	25	49
1550001	HORWICH 1	Bolton	3637	4118	352	96	7	6	26	37	352	96	10	12	18	30
500012	BURNLEY 12	Burnley	3841	4324	304	83	7	6	26	40	303	83	10	12	20	33
510009	BURY 9	Bury	3819	4116	228	62	6	5	21	50	228	62	22	23	41	47
555013	CARLISLE 13	Carlisle	3398	5550	87	24	10	7	41	68	87	24	2	0	7	7
555014	CARLISLE 14	Carlisle	3397	5551	215	59	7	6	17	30	215	59	1	0	7	7
715006	CHORLEY 6	Chorley	3585	4178	287	79	10	8	35	79	285	78	14	13	33	40
3563005	WHITEHAVEN 5	Copeland	2974	5178	308	84	2	1	9	17	308	84	8	6	13	19
840009	CREWE 9	Crewe and Nantwich	3703	3550	273	75	7	5	30	54	270	74	21	18	60	78
1130012	ELLESMERE PORT 12	Ellesmere Port	3398	3759	353	97	5	4	18	32	350	96	17	18	30	36
2781510	RUNCORN 10	Halton	3511	3833	332	91	9	7	29	66	332	91	9	7	20	27
20005	ACCRINGTON 5	Hyndburn	3758	4285	360	99	9	8	29	34	360	99	11	12	24	31
1850016	LIVERPOOL 16	Liverpool	3345	3908	338	93	8	7	25	30	338	93	19	18	37	54
2232507	MACCLESFIELD 7	Macclesfield	3926	3733	264	72	8	9	13	15	263	72	17	18	36	37
2280011	MANCHESTER 11	Manchester	3838	3981	366	100	7	6	20	49	366	100	13	12	25	31
2280015	MANCHESTER 15	Manchester	3875	3985	366	100	9	8	28	45	366	100	10	12	25	25
2280021	MANCHESTER 21	Manchester	3847	4023	363	99	9	6	32	51	363	99	9	6	19	31
2470013	OLDHAM 13	Oldham	3920	4057	281	77	11	11	23	25	280	77	39	39	77	90
2320003	MIDDLETON 3	Rochdale	3871	4063	337	92	9	8	28	55	336	92	19	18	36	43
150005	BACUP 5	Rossendale	3868	4231	239	65	8	5	30	59	239	65	10	6	26	33
2650007	RAWTENSTALL 7	Rossendale	3812	4229	239	65	11	9	36	72	239	65	12	12	32	37

Table 1.3 continued over page.

Table 1.3. *Continued* - Summary of Smoke and Sulphur Dioxide Results for the North West and Merseyside, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	NORTH WEST & MERSEYSIDE - *continued*															
3230007	SWINTON & PENDLEBURY 7	Salford	3774	4018	150	41	4	2	17	35	146	40	7	6	19	25
855003	CROSBY 3	Sefton	3321	3990	343	94	4	3	15	24	343	94	19	19	33	49
2800036	ST HELENS 36	St Helens	3534	3936	328	90	6	5	23	31	327	90	11	12	18	30
2800043	ST HELENS 43	St Helens	3512	3955	342	94	8	5	27	78	339	93	12	13	26	33
625006	CHEADLE & GATLEY 6	Stockport	3859	3886	275	75	4	3	12	13	274	75	6	6	19	25
90008	ASHTON-UNDER-LYNE 8	Tameside	3939	3992	366	100	9	7	24	59	360	99	11	6	33	40
3314601	TRAFFORD 1	Trafford	3810	3958	366	100	4	3	17	39	360	99	24	24	43	63
3430017	WARRINGTON 17	Warrington	3607	3890	362	99	9	7	31	67	357	98	10	12	25	31
88201	ASHTON-IN-MAKERFIELD 1	Wigan	3576	3991	216	59	3	3	10	15	216	59	2	0	10	19
1800004	LEIGH 4	Wigan	3662	3999	247	68	6	4	28	69	247	68	6	6	19	26
3610008	WIGAN 8	Wigan	3592	4056	251	69	5	4	23	44	251	69	3	0	13	19
3360009	WALLASEY 9	Wirral	3316	3909	33	9	5	3	23	33	32	9	6	6	13	13
3532002	WEST KIRBY 2	Wirral	3212	3874	294	81	3	2	7	12	287	79	8	7	27	48

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.4. Summary of Smoke and Sulphur Dioxide Results for Yorkshire and the Humber, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	YORKSHIRE AND THE HUMBER															
190008	BARNSLEY 8	Barnsley	4348	4094	366	100	11	7	48	63	366	100	46	32	158	202
190012	BARNSLEY 12	Barnsley	4342	4067	366	100	6	4	18	31	366	100	29	30	48	60
190013	BARNSLEY 13	Barnsley	4375	4054	235	64	7	6	22	38	222	61	18	18	42	48
877502	CUDWORTH 2	Barnsley	4387	4091	275	75	10	7	32	37	275	75	32	29	65	83
1308701	GOLDTHORPE 1	Barnsley	4462	4043	366	100	8	7	29	46	366	100	29	26	58	103
1344002	GRIMETHORPE 2	Barnsley	4414	4091	366	100	9	7	34	48	366	100	30	27	50	68
1560006	HOYLAND NETHER 6	Barnsley	4377	4007	181	50	5	5	14	18	181	50	27	24	48	67
2208501	LUNDWOOD (BARNSLEY) 1	Barnsley	4372	4069	361	99	10	8	35	42	361	99	28	27	59	66
3670002	WOMBWELL 2	Barnsley	4401	4030	352	96	9	8	29	40	352	96	23	25	38	57
3715002	WORSBROUGH BRIDGE 2	Barnsley	4356	4040	366	100	6	5	21	35	366	100	27	25	50	62
430006	BRADFORD 6	Bradford	4163	4329	330	90	14	14	34	43	321	88	11	12	25	32
1650011	KEIGHLEY 11	Bradford	4061	4412	75	21	10	8	28	30	84	23	9	7	20	27
1120002	ELLAND 2	Calderdale	4109	4209	331	91	9	9	24	43	331	91	13	13	26	76
1360016	HALIFAX 16	Calderdale	4093	4254	205	56	16	15	41	52	206	56	12	13	27	46
1690019	KINGSTON-UPON-HULL 19	Kingston Upon Hull	5082	4284	205	56	9	6	34	120	207	57	17	13	39	50
962512	DEWSBURY 12	Kirklees	4235	4212	341	93	6	4	23	46	341	93	17	14	39	62
1515005	HOLMFIRTH 5	Kirklees	4144	4085	190	52	6	4	26	35	189	52	29	27	47	66
1570019	HUDDERSFIELD 19	Kirklees	4143	4164	339	93	9	7	27	43	338	93	22	20	39	60
445001	BRAMPTON 1	Rotherham	4414	4019	365	100	8	5	25	119	358	98	16	13	66	85
965004	DINNINGTON 4	Rotherham	4528	3861	366	100	6	5	21	30	358	98	8	6	25	54
2270002	MALTBY 2	Rotherham	4530	3922	328	90	10	10	25	34	322	88	18	13	66	99
3465006	WATH-UPON-DEARNE 6	Rotherham	4433	4009	366	100	7	5	23	34	355	97	12	6	44	69
2839001	SCARBOROUGH 1	Scarborough	5036	4885	239	65	8	6	27	64	239	65	10	12	22	24

Table 1.4 continued over page.

Table 1.4 *Continued*. Summary of Smoke and Sulphur Dioxide Results for Yorkshire and the Humber, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	YORKSHIRE AND THE HUMBER- *continued*															
2872505	SELBY 5	Selby	4612	4322	337	92	4	2	21	28	337	92	10	6	24	36
22501	ACKWORTH 1	Wakefield	4440	4167	366	100	7	5	26	37	366	100	22	19	44	74
580011	CASTLEFORD 11	Wakefield	4519	4255	366	100	10	8	35	54	366	100	24	20	55	82
1235001	FEATHERSTONE 1	Wakefield	4429	4195	344	94	8	6	27	37	344	94	25	21	68	80
1450003	HEMSWORTH 3	Wakefield	4428	4134	366	100	7	6	24	31	363	99	20	18	49	61
1732003	KNOTTINGLEY 3	Wakefield	4497	4239	366	100	8	7	25	34	366	100	24	20	56	81
2415004	NORMANTON 4	Wakefield	4388	4228	366	100	5	4	20	26	365	100	13	12	33	69
2533509	PONTEFRACT 9	Wakefield	4455	4220	59	16	7	5	20	20	59	16	11	13	27	33
2966301	SOUTH KIRKBY 1	Wakefield	4456	4112	366	100	9	8	29	62	366	100	22	19	49	74
3350026	WAKEFIELD 26	Wakefield	4331	4208	364	100	12	9	40	59	362	99	12	13	33	110
2533510	PONTEFRACT 10	Wakefield	4473	4217	307	84	5	3	18	27	306	84	12	13	33	41
3750009	YORK 9	City & County of York	4601	4521	243	67	5	4	10	15	243	67	16	13	40	64

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50^{th} percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.5. Summary of Smoke and Sulphur Dioxide Results for the East Midlands, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	EAST MIDLANDS															
40004	ALFRETON 4	Amber Valley	4417	3555	340	93	8	5	37	63	340	93	33	31	49	61
348001	BIRCOTES 1	Bassetlaw	4627	3920	350	96	7	5	26	38	350	96	20	18	49	109
1754501	LANGOLD (BASSETLAW) 1	Bassetlaw	4586	3873	258	71	5	4	19	34	257	70	14	14	35	42
2677503	RETFORD 3	Bassetlaw	4707	3811	348	95	5	3	21	34	348	95	19	19	39	71
395005	BOLSOVER 5	Bolsover	4475	3706	329	90	7	5	19	37	312	85	12	12	37	56
2967002	SOUTH NORMANTON 2	Bolsover	4442	3564	333	91	7	5	22	42	338	93	9	6	31	44
960024	DERBY 24	Derby City	4354	3369	278	76	8	7	22	34	222	61	12	14	31	49
1790019	LEICESTER 19	Leicester City	4588	3041	332	91	7	5	20	40	318	87	9	6	22	31
1840005	LINCOLN 5	Lincoln	4974	3714	344	94	6	4	24	34	344	94	9	6	25	50
2281010	MANSFIELD 10	Mansfield	4532	3607	364	100	8	6	26	35	363	99	19	18	42	59
2281102	MANSFIELD WOODHOUSE 2	Mansfield	4538	3642	328	90	8	6	27	38	323	88	26	25	52	77
2364502	NEW OLLERTON 2	Newark	4664	3682	360	99	8	6	25	48	360	99	16	13	49	84
577501	CASTLE DONINGTON 1	N.W. Leicestershire	4448	3275	243	67	9	8	26	41	235	64	10	7	34	61
750005	COALVILLE 5	N.W. Leicestershire	4428	3142	56	15	5	5	11	20	55	15	12	14	27	27
2324001	MOIRA (LEICS) 1	N.W. Leicestershire	4328	3168	137	38	11	10	30	39	132	36	25	21	60	78
2440020	NOTTINGHAM 20	Nottingham	4575	3403	326	89	8	6	23	36	320	88	16	18	36	60

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.6. Summary of Smoke and Sulphur Dioxide Results for the West Midlands, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	WEST MIDLANDS															
2775021	RUGELEY 21	Cannock Chase	4043	3173	20	5	6	5	17	19	20	5	17	18	24	24
2870005	SEDGLEY 5	Dudley	3919	2934	354	97	13	14	30	40	354	97	13	13	37	56
507513	BURTON-UPON-TRENT 13	East Staffordshire	4242	3233	303	83	8	7	25	42	310	85	18	13	46	51
3342501	UTTOXETER 1	East Staffordshire	4088	3332	167	46	6	4	28	31	175	48	27	26	59	64
2752503	ROWLEY REGIS 3	Sandwell	3964	2879	361	99	5	4	17	38	361	99	15	13	25	32
3090020	STOKE-ON-TRENT 20	Stoke-On-Trent	3888	3475	340	93	10	8	31	57	333	91	22	19	38	58
3380018	WALSALL 18	Walsall	4014	2987	338	93	7	6	24	33	338	93	6	6	30	60
3470002	WEDNESFIELD 2	Wolverhampton	3946	3002	364	100	5	4	17	30	363	99	13	12	53	80

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50^{th} percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.7. Summary of Smoke and Sulphur Dioxide Results for Wales, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	WALES															
540012	CARDIFF 12	Cardiff County	3193	1773	366	100	8	5	25	55	366	100	19	19	32	40
1305301	GLYNNEATH 1	Neath & Port Talbot	2880	2066	240	66	4	3	12	29	239	65	29	32	51	65
2400026	NEWPORT (MON) 26	Newport	3313	1878	362	99	7	5	22	40	361	99	6	6	13	19
2414001	NEYLAND 1	Pembrokeshire	1964	2052	329	90	3	2	10	20	327	90	5	6	12	18
3732510	WREXHAM 10	Wrexham County Boro.	3324	3501	329	90	6	5	19	26	329	90	16	18	31	43

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.8. Summary of Smoke and Sulphur Dioxide Results for the Eastern region, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	EASTERN															
240010	BEDFORD 10	Bedford	5056	2486	217	59	7	7	18	26	210	58	8	7	20	27
2430007	NORWICH 7	Norwich	6233	3099	332	91	5	3	17	46	332	91	10	7	27	47
3265013	THURROCK 13	Thurrock	5622	1791	359	98	6	4	23	51	359	98	21	21	38	45

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.9. Summary of Smoke and Sulphur Dioxide Results for the London region, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	LONDON															
1060007	EALING 7	Ealing	5174	1807	136	37	7	5	19	44	132	36	8	7	18	21
1140014	ENFIELD 14	Enfield	5338	1958	338	93	8	5	30	54	338	93	19	19	38	63
1343709	GREENWICH 9	Greenwich	5382	1773	337	92	6	5	16	22	329	90	17	12	43	49
3696009	WOOLWICH 9	Greenwich	5441	1769	347	95	5	4	14	25	338	93	22	19	43	51
1633509	ISLINGTON 9	Islington	5316	1842	265	73	11	7	33	82	265	73	13	12	31	31
1950016	LONDON CITY 16	City of London	5324	1814	360	99	9	8	24	56	349	96	17	18	37	56
1590006	ILFORD 6	Redbridge	5440	1864	366	100	10	9	34	63	366	100	19	18	30	48
3541517	WESTMINSTER 17	Westminster	5298	1789	13	4	6	5	19	20	13	4	5	6	12	13

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50^{th} percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.10. Summary of Smoke and Sulphur Dioxide Results for the South East, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	SOUTH EAST															
829004	CRAWLEY 4	Crawley	5273	1378	269	74	5	4	23	43	268	73	15	12	30	36
1080005	EASTBOURNE 5	Eastbourne	5607	988	327	90	2	1	11	16	325	89	10	6	24	36
390302	BLETCHLEY 2	Milton Keynes	4857	2337	323	88	4	3	11	20	323	88	11	13	19	31
2560010	PORTSMOUTH 10	Portsmouth	4652	1019	304	83	5	4	17	55	304	83	12	12	25	49
26001	ADDLESTONE 1	Runnymede	5052	1646	230	63	6	4	22	40	229	63	14	14	27	48
2940016	SLOUGH 16	Slough	4962	1819	327	90	8	7	17	36	327	90	9	6	18	18

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50^{th} percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.11. Summary of Smoke and Sulphur Dioxide Results for the South West, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	O.S. Grid Ref. To 100m East	O.S. Grid Ref. To 100m North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	SOUTH WEST															
205006	BATH 6	Bath & NE Somerset	3754	1656	111	30	10	6	39	47	111	30	12	12	18	19
470026	BRISTOL 26	Bristol	3634	1763	339	93	6	4	20	52	334	92	19	19	38	50
1305004	GLOUCESTER 4	Gloucester	3832	2179	366	100	5	3	19	55	365	100	9	7	20	26
453003	BRIDGWATER 3	Sedgemoor	3298	1373	355	97	4	2	13	48	355	97	13	12	30	54
3220002	SWINDON 2	Swindon	4147	1858	312	85	5	4	20	39	312	85	9	7	19	19

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.12 Summary of Smoke and Sulphur Dioxide Results for Northern Ireland, Calendar Year 2000. Concentrations in ug m^{-3}

Code	Site Name	Authority	*Irish* Grid Ref. To 100m East	North	Summary of Smoke Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Summary of SO_2 Data 2000 Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
	NORTHERN IRELAND															
69701	ARMAGH 1	Armagh	2877	3450	308	84	7	4	27	67	306	84	11	13	21	28
160003	BALLYMENA 3	Ballymena	3103	4029	336	92	7	5	45	118	327	90	30	24	74	89
161504	BALLYMONEY 4	Ballymoney	2954	4259	18	5	15	10	44	49	15	4				0
270012	BELFAST 12	Belfast	3324	3737	361	99	9	6	37	50	361	99	19	18	47	55
270013	BELFAST 13	Belfast	3357	3740	366	100	9	8	33	48	366	100	40	38	83	166
270033	BELFAST 33	Belfast	3346	3755	366	100	12	9	40	68	366	100	42	38	85	115
270042	BELFAST 42	Belfast	3322	3748	366	100	10	8	36	88	366	100	42	38	81	172
270044	BELFAST 44	Belfast	3338	3740	366	100	9	7	28	68	366	100	39	38	81	153
270045	BELFAST 45	Belfast	3335	3723	366	100	8	7	31	51	366	100	37	32	77	128
270046	BELFAST 46	Belfast	3803	3334	366	100	6	4	19	79	366	100	31	26	64	140
2551504	PORTADOWN 4	Craigavon	3012	3538	235	64	6	4	21	25	235	64	8	6	18	24
2190011	LONDONDERRY 11	Derry City	2431	4170	63	17	17	13	56	72	63	17	35	32	50	55
2190012	LONDONDERRY 12	Derry City	2438	4200	245	67	5	4	15	39	314	86	36	38	51	58
2190014	LONDONDERRY 14	Derry City	2443	4174	257	70	6	4	19	41	327	90	36	33	66	120
1025001	DUNGANNON 1	Dungannon	2802	3629	168	46	5	4	12	40	146	40	16	14	35	35
1757703	LARNE 3	Larne	3400	4029	352	96	11	9	34	59	352	96	17	18	25	25
1032502	DUNMURRY 2	Lisburn	3289	3679	327	90	8	6	34	76	314	86	82	74	188	250
1032503	DUNMURRY 3	Lisburn	3287	3875	289	79	11	7	47	81	269	74	19	18	49	55
1845003	LISBURN 3	Lisburn	3263	3636	330	90	11	7	62	118	318	87	17	14	49	70
2233501	MAGHERAFELT 1	Magherafelt	2896	3901	359	98	11	8	42	62	358	98	12	13	20	33
2410003	NEWRY 3	Newry and Mourne	3078	3268	350	96	10	6	62	142	351	96	10	6	30	33
2412501	NEWTOWNABBEY 1	Newtownabbey	3349	3824	322	88	14	9	46	70	321	88	13	12	24	42
2412502	NEWTOWNABBEY 2	Newtownabbey	3318	3825	361	99	15	11	50	96	361	99	12	13	25	38
3111502	STRABANE 2	Strabane	2351	3972	320	88	27	23	76	129	318	87	12	13	21	28

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. " Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Appendices

CONTENTS

Appendix 1
Calculation of Results and Statistics

CONTENTS

Period Covered by Observations

This report covers the calendar year 1st January to 31st December 2000.

The UK Smoke and Sulphur Dioxide Network is operated on the basis of the "Pollution Calendar". The pollution year always begins on the Tuesday nearest to 1 April, and contains twelve months, each of exactly 4 or 5 weeks, all beginning on Tuesdays. Pollution months April to September make up the summer period, and October to March constitute the winter period. While this "Pollution Calendar" is for operational purposes, to conveniently divide the year up into 'months' comprising whole numbers of weeks (as the samplers are normally visited weekly), data are now reported on a calendar year basis, in line with all other Networks operated on behalf of DEFRA. Details of the pollution calendar are available from NETCEN on request.

Derivation of Results

The data are processed by computer, from daily measurements made by the participating Local Authorities and other organisations. The formulae used for calculation of smoke concentrations, i.e. for relating blackness of the filter to the mass of smoke per unit volume of air sampled, have been used since winter 1961-62. The formula used for calculating SO_2 concentrations has never been changed.

As in previous years, the validity of the original readings has been checked by means of an editing program.

Significance of Results

It is important to note that in making comparisons of pollution in different towns, careful account must be taken of the details of the sites for which measurements are available in relation to the geographical structure of the town. That is, to the situation, extent and types of industrial, residential and commercial areas. Local variations in fuel type and quality can also have a significant effect on the measurements.

Formulae used in Calculating Concentrations

(a) Smoke

Smoke concentrations have been calculated by the use of the British Standard Smoke Calibration Curve (BS 1747: Part 2: 1991).

For reflectometer readings of 40 to 99 the following formula is used:

$$C = \frac{F}{V}(91{,}679.22 - 3{,}332.0460\,R + 49.618884\,R^2 - 0.35329778\,R^3 + 0.0009863435\,R^4)$$

where

C = concentration in micrograms per cubic metre

V = volume of air sampled, in cubic feet (in the majority of cases, a metric meter is used, and the volume in cubic metres is converted to cubic feet by multiplying by 35.315)

F = a factor relating to the sampler clamp size, as follows:

0.288 for $^1/_2$ inch clamp,
1.00 for 1 inch clamp,
3.68 for 2 inch clamp, or
12.80 for 4 inch clamp

R = reflectometer reading

This formula represents the calibration curve to within ± 1.3% over the range of reflectometer readings between 40 and 90. When used to calculate concentrations from reflectometer readings between 91 and 98 the results may be underestimated by as much as 6%.

For darker stains with reflectometer readings between 40 and 20 the formula used is:

$$C = \frac{F}{V}(214{,}245.1 - 15{,}130.512\,R + 508.181\,R^2 - 8.831144\,R^3 + 0.0628057\,R^4)$$

For stains with reflectometer readings of less than 20 this formula gives only an approximation to the concentration, the result being well below the true value. Reflectometer readings of less than 10 are impossible to assess accurately and hence the results are calculated as if the reading had been 10, which at least gives a minimum value. However, such low

reflectometer readings, corresponding to very high smoke concentrations, are now rare in the UK.

(b) Sulphur Dioxide

Sulphur dioxide concentrations have been calculated by the method described in BS 1747: Part 3: 1991. The formula used to calculate sulphur dioxide concentrations is:

$$\mathbf{C} = \frac{4520}{V}\ \mathbf{m}$$

where

C = concentration in micrograms per cubic metre

m = volume of 0.002M (N/250) di-sodium tetraborate used, in millilitres,

V = volume of air sampled, in cubic feet (again, in the majority of cases, a metric meter is used, and the volume in cubic metres is converted to cubic feet by multiplying by 35.315)

Formulae Used In Calculating Annual Statistics

(a) Arithmetic Mean (AM)

$$AM = \frac{\sum_{i=1}^{N} C_i}{N}$$

where

AM is annual arithmetic mean

C_i is daily concentration for day i

N is number of results available for the year

(b) Percentiles (50%, 98% etc.) Note - the median is the 50th percentile.

Daily concentrations are sorted into ascending order of concentration value, C_1, C_2, C_3, ..., C_i, ..., C_N and the associated percentile value for each concentration value is found from

$$P_i = \left(\frac{i}{N+1}\right)100$$

where

P_i is the percentile for the ith concentration in the sorted set, that is, P_i% of the concentrations will be **equal to or less than** C_i

N is the number of results available for the year

The concentration values for the fixed percentile values quoted are obtained by linear interpolation between the concentration values for the nearest percentile values on either side.

For example, in the sets

P_1, P_2, ..., P_i, ..., 98.8, 99.3, ..., P_N

C_1, C_2, ..., C_i, ..., 150, 160, ..., C_N

the 99th percentile would be 154 μg m^{-3}

Units

The unit employed for expressing both smoke and sulphur dioxide concentrations from this Network, both in this report and on the disk, is the microgram per cubic metre (μg m^{-3}). However, concentrations of gaseous pollutants such as SO_2 are sometimes expressed as parts per billion by volume (abbreviated to "ppb").

For SO_2, the conversion factor is as follows:

1 ppb = 2.62 micrograms per cubic metre (for SO_2 only)
- at a temperature of 25°C and 1013 mb pressure.
1 ppb = 2.66 micrograms per cubic metre (for SO_2 only)
- at a temperature of 20°C and 1013 mb pressure.

The conversion factor is different for other gaseous pollutants.

Appendix 2
Data Files for 2000

CONTENTS

Data Files

The full year's dataset, for all Network sites, is supplied on the same CD ROM as this report (or for printed copies, on the disk inside the back cover). The data are presented in **comma separated value** (CSV) format, a form which can be read into most spreadsheets. The data are provided in several files;

1. file "site2000": a summary of site details. The data are tabulated in rows, one per site, with columns as follows.

- Site code - the site's unique identification number of upto 7 digits.
- Site name and number - the name and number by which the site is usually known, eg. "ABERDEEN 3".
- Grid reference easting, given to the nearest 100m.
- Grid reference northing, given to the nearest 100m. Note; for sites in Northern Ireland the grid reference refers to the Irish Grid, and both the easting and northing are preceded by a "9" to indicate this.
- Site address.
- Site Environment. The surroundings of each site are classified by a code according to the following scheme:

A1	Residential area with high-density housing (probably terraced), or with medium-density housing in multiple occupation, in either case surrounded by other built-up areas.
A2	Predominantly A1, but interspersed with some industrial undertakings.
A3	Residential area with high-density housing or medium-density housing in multiple occupation surrounded by, or interspersed with, other areas with low potential air pollution output (parks, fields, coast).
B1	Residential area with medium-density housing, typically an inner suburb or housing estate, surrounded by other built-up areas.
B2	Predominantly B1, but interspersed with some industrial undertakings.
B3	Residential area with medium-density housing surrounded by or interspersed with areas with low potential air pollution output (parks, fields, coast), or any residential area with low-density housing.
C1	Industrial area without domestic premises.
C2	Industrial area interspersed with domestic premises of high density or in multiple occupation.
D1	Commercial area or one with predominantly central heating.
D2	Town centre with limited commercial area, possibly mixed with old residential housing and/or minor industry.
E	Smoke control area or smokeless zone (the letter to be added to the primary classification).
R	Rural community.
O1	Open country but not entirely without source(s) of pollution, e.g. airfields.
O2	Completely open country; no sources within at least 400 metres.
X	Unclassified site, or mixed area.

- Equivalent DEFRA Site Type. The Smoke and SO_2 Network site classifications differ considerably from those used by DEFRA to categorise their automatic sites. However, the nearest equivalent is given here. Smoke and SO_2 sites of types A1, A2, and A3 will mostly fall into DEFRA site types Suburban (SU) or Urban Background (U4), being predominantly in urban residential areas. B1, B2 and B3 will be Suburban (SU). C1 and C2 will be roughly equivalent to Urban Industrial (U5), and D1 and D2 Urban Centre (U3) or Urban Background (U4). R, O1 and O2 sites can all be treated as Rural (R).
- Unitary Authority. The name of the Local or Unitary Authority in whose area the site lies. In most cases this Authority is responsible for the operation of the site, although a small number of sites are operated by other organisations such as universities.
- Government Region Code. The twelve regions are assigned code numbers from 1 to 12.
- Government Region Name.
- County name. The name of the county in which the site lies.

2. file "smk2000": full daily black smoke data, 1st January to 31st December 2000, for all sites. One column per site, with one row per day. Values are in $\mu g\ m^{-3}$. Black smoke concentrations have been calculated according to the British Standard calibration, as used in the UK. For communications with organisations elsewhere in Europe, the concentrations should be converted to the OECD calibration, by dividing by 0.85

3. file "so22000": full daily sulphur dioxide data, 1st January to 31st December 2000, for all sites. One column per site, with one row per day. Values are in $\mu g\ m^{-3}$.

4. file "smksumm2000": this contains the smoke summary data as in Table 1, but in CSV format. The data are tabulated as follows. The top row contains column headings.

- Site code number
- Site name.
- Region name (e.g. North East).
- Local or Unitary Authority in whose area the site lies.
- Grid reference easting.
- Grid reference northing.
- Number of valid days' smoke data
- Data capture expressed as a percentage
- Arithmetic mean of daily smoke measurements
- Median (50th percentile) of daily smoke measurements
- 98th percentile of daily smoke measurements
- Maximum daily value.

There is one row of data per site, and they are presented by region.

5. file "so2summ2000": this contains the SO_2 summary data as in Table 1, but in CSV format. The data are tabulated in the same manner as the smoke data in "smksumm2000.csv" described above. Again, the top row contains column headings. All these details are also given in the text file "readme.txt" which is also provided on disk.

Appendix 3
Sites Comprising 'Core' Subset

CONTENTS

10003 ABERDEEN 3
20005 ACCRINGTON 5
26001 ADDLESTONE 1
69701 ARMAGH 1
85005 ASHINGTON 5
90008 ASHTON-UNDER-LYNE 8
150005 BACUP 5
160003 BALLYMENA 3
190012 BARNSLEY 12
205006 BATH 6
240010 BEDFORD 10
270013 BELFAST 13
270042 BELFAST 42
270046 BELFAST 46
380006 BLACKPOOL 6
390302 BLETCHLEY 2
395005 BOLSOVER 5
400024 BOLTON 24
430006 BRADFORD 6
453003 BRIDGWATER 3
470026 BRISTOL 26
500012 BURNLEY 12
507513 BURTON-UPON-TRENT 13
510009 BURY 9
540012 CARDIFF 12
555013 CARLISLE 13
555014 CARLISLE 14
577501 CASTLE DONINGTON 1
580011 CASTLEFORD 11
625006 CHEADLE & GATLEY 6
715006 CHORLEY 6
750005 COALVILLE 5
760011 COATBRIDGE 11
829004 CRAWLEY 4
840009 CREWE 9
855003 CROSBY 3
915013 DARLINGTON 13
960024 DERBY 24
1025001 DUNGANNON 1
1032503 DUNMURRY 3
1060007 EALING 7
1080005 EASTBOURNE 5
1100025 EDINBURGH 25
1130012 ELLESMERE PORT 12
1140014 ENFIELD 14
1230008 FARNWORTH 8
1290010 GATESHEAD 10
1300020 GLASGOW 20
1300051 GLASGOW 51
1300073 GLASGOW 73
1300095 GLASGOW 95
1300098 GLASGOW 98
1305004 GLOUCESTER 4
1343709 GREENWICH 9
1360016 HALIFAX 16
1450003 HEMSWORTH 3
1515005 HOLMFIRTH 5

1550001 HORWICH 1
1570019 HUDDERSFIELD 19
1590006 ILFORD 6
1633509 ISLINGTON 9
1650011 KEIGHLEY 11
1685002 KILMARNOCK 2
1690019 KINGSTON-UPON-HULL 19
1721006 KIRKCALDY 6
1757703 LARNE 3
1790019 LEICESTER 19
1800004 LEIGH 4
1840005 LINCOLN 5
1845003 LISBURN 3
1850016 LIVERPOOL 16
1950016 LONDON CITY 16
2190011 LONDONDERRY 11
2190012 LONDONDERRY 12
2232507 MACCLESFIELD 7
2233501 MAGHERAFELT 1
2270002 MALTBY 2
2280011 MANCHESTER 11
2280015 MANCHESTER 15
2280021 MANCHESTER 21
2281010 MANSFIELD 10
2320003 MIDDLETON 3
2324001 MOIRA (LEICS) 1
2370002 NEWBURN 2
2390024 NEWCASTLE UPON TYNE 24
2390027 NEWCASTLE UPON TYNE 27
2400026 NEWPORT (MON) 26
2412501 NEWTOWNABBEY 1
2412502 NEWTOWNABBEY 2
2414001 NEYLAND 1
2430007 NORWICH 7
2440020 NOTTINGHAM 20
2470013 OLDHAM 13
2533510 PONTEFRACT 10
2551504 PORTADOWN 4
2560010 PORTSMOUTH 10
2650007 RAWTENSTALL 7
2677503 RETFORD 3
2752503 ROWLEY REGIS 3
2781510 RUNCORN 10
2800036 ST HELENS 36
2800043 ST HELENS 43
2839001 SCARBOROUGH 1
2870005 SEDGLEY 5
2872505 SELBY 5
2940016 SLOUGH 16
3070005 STIRLING (BURGH) 5
3090020 STOKE-ON-TRENT 20
3220002 SWINDON 2
3230007 SWINTON & PENDLEBURY 7
3265013 THURROCK 13
3314601 TRAFFORD 1
3342501 UTTOXETER 1
3350026 WAKEFIELD 26

3380018 WALSALL 18
3430017 WARRINGTON 17
3470002 WEDNESFIELD 2
3532002 WEST KIRBY 2
3541517 WESTMINSTER 17
3610008 WIGAN 8
3670002 WOMBWELL 2
3696009 WOOLWICH 9
3700003 WORKINGTON 3
3732510 WREXHAM 10
3750009 YORK 9