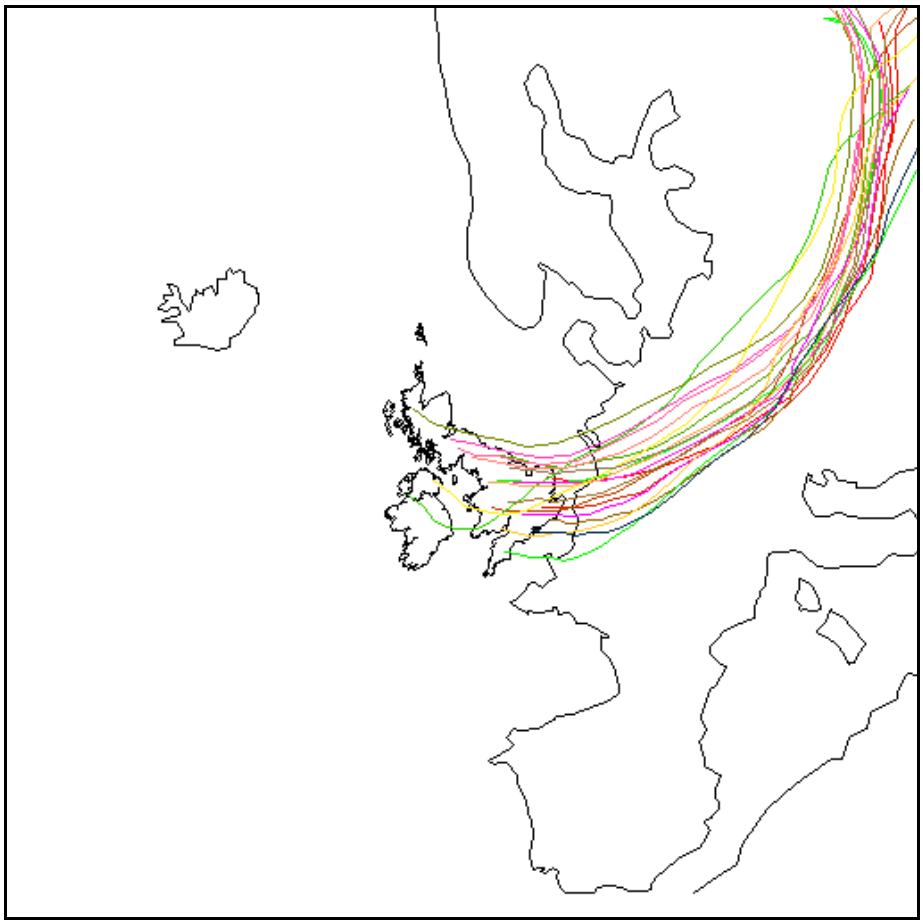
AEAT/ENV/R/2618 Issue 1

UK Air Quality Forecasting: Annual Report 2007

A report produced for the Department for Environment, Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and the Department for the Environment in Northern Ireland



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March 2008

AEA

Met Office

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AEA Technology plc
AEA Energy & Environment
Building 551.11
Harwell
Didcot
Oxfordshire
OX11 0QJ
UK
+44 (0) 870 190 6441 tel.
+44 (0) 870 190 6608 fax.

Andy.cook@aeat.co.uk

	Name	Signature	Date
Author	Andrew Cook		14/03/2008
Reviewed by	Paul Willis		29/04/2008
Approved by	Jon Bower		09/06/2008

Executive Summary

This report covers the operational activities carried out by AEA Energy & Environment and the Met Office on the UK Air Quality Forecasting Contract for the year 2007. The work is funded by the Department for Environment Food and Rural Affairs, the Scottish Executive, Welsh Assembly Government and the Department of the Environment in Northern Ireland.

During 2007, there was a total of twenty three days on which HIGH air pollution was recorded across the UK. All of these days were due to PM_{10} alone. There were no HIGH pollution days due to ozone.

The forecasting success and accuracy for this year is summarised in Table 1 below, together with the results from the previous calendar year. The overall forecasting success rate performance for HIGH episodes has fallen significantly compared to the previous year, mainly due to the lack of a summer ozone episode reaching the HIGH band in 2007, an unprecendented event in recent years. The success rate performance for the MODERATE band was high, as seen in previous years, with a considerable degree of accuracy. Please note that success rates are able to be greater than 100 %, as detailed in section 3.1.

Table 1 – forecast success/accuracy for incidents above 'HIGH' and above 'MODERATE' in 2007 *(and 2006)*

Region/Area	*HIGH*		*MODERATE*	
	% success	*% accuracy*	*% success*	*% accuracy*
Zones	19 *(114)*	15 *(63)*	119 *(143)*	83 *(81)*
Agglomerations	0 *(109)*	0 *(53)*	146 *(158)*	78 *(69)*

During this year, two ad-hoc reports were presented to Defra and the devolved administrations. These reports analysed pollution episodes, as detailed below:

- A UK Particulate Episode from 24 March to 2 April 2007 (Andy Cook, Paul Willis, Helen Webster, Mark Harrison).
- An ad-hoc report detailing the particulate episode experienced in November as a result of bonfire night celebrations.

Published episode reports can be found on the National Air Quality Archive (www.airquality.co.uk/archive/reports/list.php).

There were no reported breakdowns over the year and all bulletins were delivered to the Air Quality Communications contractor on time.

We continue to actively research ways of improving the air pollution forecasting system by:

1. Investigating the use of automatic software systems to streamline the activities within the forecasting process, thereby allowing forecasters to spend their time more efficiently in maximising forecast accuracy.
2. Researching the chemistry used in our models, in particular the $NO_x \rightarrow NO_2$ conversion used in NAME and the chemical schemes for secondary PM_{10} and ozone.
3. Improving the NAME model runs which can be used for ad-hoc analysis, in particular with regard to investigating the possible long-range transport of PM_{10}.
4. Improving and updating the emissions inventories used in our models.

Contents

1 Introduction

AEA Energy & Environment and the Met Office are contracted by The Department for Environment, Food and Rural Affairs (Defra), the Scottish Executive, the Welsh Assembly Government and the Department for the Environment in Northern Ireland to provide a 24-hour air pollution forecast which is widely disseminated through the media. The forecast allows individuals who may be affected by episodes of high air pollutant concentrations to take appropriate preventative measures. These can include increasing medication or taking steps to reduce exposure and dose.

A forecast of the following day's air pollution is prepared every day by AEA Energy & Environment. The forecast consists of a prediction of the air pollution descriptor for the worst-case situation in 16 zones and 16 agglomerations over the following 24-hours. Forecasts are disseminated in an number of ways to maximise public accessibility; these include Teletext, the World Wide Web and a Freephone telephone service.

Updates can occur at any time of day, but the most important forecast of the day is the "daily media forecast". This is prepared at 3.00 p.m. for uploading to the Internet and Air Quality Communications contractor before 4.00 p.m. each day. It is then included in subsequent air quality bulletins for the BBC, newspapers and many other interested organisations.

This report covers and analyses the media forecasts issued during the 12 months from January 1st to December 31st 2007. Results from forecasting models are available each day and are used in constructing the forecast. The forecasters issue predictions for rural, urban background and roadside environments but, for the purposes of this report, these have been combined into a single "worst-case" category.

Twice per week, on Tuesdays and Fridays, AEA Energy & Environment also provides a long-range pollution outlook. This takes the form of a short piece of text which is emailed to approximately sixty recipients in the Defra and other government Departments, plus the BBC weather forecasters. The outlook is compiled by examining the outputs from our pollution models, which currently extend to 3 days ahead for Defra and the DAs, and by assessing the long-term weather situation.

We continue to use a comprehensive quality control system in order to ensure that the 5-day forecasts provided by the Met Office to the BBC are consistent with the "daily media forecasts" and long-range pollution outlook provided by Netcen for Defra and the DAs. The BBC requires 5-day air pollution index forecasts for 337 UK towns and cities for use on its BBC Online service. The quality control review is carried out at 3.00 p.m. daily, with the resulting forecast updating onto the BBC Online Web site at 4.00 a.m. the following morning.

BSkyB have entered into a separate contract with AEA to provide a daily air pollution report and forecasts. These are aired twice-daily by the BSkyB weather presenters at peak viewing times**.** AEA ensures that these forecasts are consistent with the Defra and DA forecast.

Kentair forecasts were started by AEA in April 2007. Again we ensure that these are consistent with the national forecasts provided to Defra, the DAs, the BBC and BSkyB.

2 New developments during this year

A parallel air quality modelling system was implemented at the Met Office during the first quarter of 2007 and ran successfully. Maps of species levels and index values were being produced from the system daily.

Also at the beginning of the year two new Internet (WAP)-enabled mobile phones were commissioned for use by the AEA forecasting team to help with forecasting from remote locations or locations where PC access is not possible. New software was developed specifically to maximise the functionality of the phones.

The Met Office contributed to analysis of elevated levels of PM_{10} that were measured over much of the UK during an episode in late March. Towards the end of the particulate episode AEA Energy & Environment compiled a new suite of information sources from the internet related to PM_{10}, including satellite imagery databases, in anticipation of future particulate pollution events resulting from long range transport.

A new version of NAME was implemented in the development version of the air quality modelling system during the Spring by the Met Office. Time series plots of the forecast levels at all the Defra locations were being produced on a daily basis at that stage and a means of accessing and displaying these using internal web pages was being developed. During the same quarter a new system for producing the trajectories required for the ozone forecast had also been developed for testing. The new system extended the number of sites for which trajectories were produced and also the number of days ahead for which they would be available.

The Met Office provided an ad-hoc response to AEA following a fire at an industrial factory in Crewe in mid-June in which dust model data were presented. No definitive effect was seen on PM_{10} measurements made at air quality sites in the AURN, the plume of dust and smoke was modelled to have passed westwards across central Wales and not within the vicinity of any known air quality stations.

A higher resolution version of the forecast model was trialled by the Met Office but was initially found to be too slow. Some modifications to the forecast system were implemented though, including a change in the locations that data was output for. Considerable effort had also been put in by both AEA and the Met Office during the third quarter to increase the number of sites for which forecast data was provided to the BBC.

The Met Office carried out a series of model comparison runs during the final quarter using different configurations of the National Air Quality Forecasting system. Different versions of the NAME model, together with a variety of emissions data and model set-ups (e.g. spatial resolution) were run using the summer of 2003 as a test period. Initial results demonstrated an improvement in the system over the longer term of the forecasting contract.

A fire near the London Olympic site in early November was also modelled as an ad-hoc response, but air quality impacts from this appeared to be minimal so further work was not carried out.

During the last quarter several internet links were added to AEA's "AQ toolkit" spreadsheet which included a website detailing historical daily weather observations, an archive for historical synoptic pressure charts and a website resource for European satellite images.

3 Analysis of forecasting success rate

3.1 INTRODUCTION

Analysis of the forecasting performance is carried out for each of the 16 zones and 16 agglomerations used in the daily forecasting service. Further details of these zones and agglomerations are presented in Appendix 2. Forecasting performance is analysed for a single, general pollutant category rather than for each individual pollutant and has been aligned to the forecasting day (a forecasting day runs from the issue time, generally 3 pm). This analysis of forecasting performance is based on provisional data, as used in the daily forecasting process. Any obviously faulty data have been removed.

The analysis treats situations where the forecast index was within ±1 of the measured index as a successful prediction, as this is the target accuracy we aim to obtain in the forecast. Because the calculations of accuracy and success rates are based on a success being ±1 of the measured index, it is possible to record rates in excess of 100% rather than 'true' percentages. Further details of the text descriptions and index code used for the forecasting are given in Appendix 1.

The forecasting success rates for each zone and agglomeration for January - December 2006 are presented in Tables 3.1 (forecasting performance in zones) and 3.2 (forecasting performance in agglomerations) for 'HIGH' days. Table 3.5 provides a summary for each pollutant of the number of days on which HIGH and above pollution was measured, the maximum exceedence concentration and the day and site at which it was recorded. The forecasting performance Tables 3.1 and 3.2 give:

- The number of 'HIGH' days measured in the PROVISIONAL data
- The number of 'HIGH' days forecast
- The number of days with a correct forecast of 'HIGH' air pollution, within an agreement of ±1 index value. A HIGH forecast is recorded as correct if air pollution is measured HIGH and the forecast is within ±1 index value, or it is forecast HIGH and the measurement is within ±1 index value. For example measured index 7 with forecast index 6 counts as correct, as does measured index 6 with forecast index 7.
- The number of days when 'HIGH' air pollution was forecast ('f' in the tables) but not measured ('m') on the following day to within an agreement of 1 index value.
- The number of days when 'HIGH' air pollution was measured ('m') but had not been forecast ('f') to within an agreement of 1 index value.

The two measures of forecasting performance used in this report are the 'success rate' and the 'forecasting accuracy'.

The forecast success rate (%) is calculated as:
- (Number of episodes successfully forecast/total number of episodes measured) x 100

The forecast accuracy (%) is calculated as:
- (Number of episodes successfully forecast/[Number of successful forecasts + number of wrong forecasts]) x 100

3.2 FORECAST ANALYSIS FOR 2007

Table 3.1 - Forecast Analysis for UK Zones 'HIGH' band and above *

ZONES	Central Scotland	East Mids	Eastern	Greater London	Highland	North East	North Scotland	North Wales	North West & Merseyside	Northern Ireland	Scottish Borders	South East	South Wales	South West	West Midlands	Yorkshire & Humberside	Overall
Measured days	0	0	0	7	0	3	0	0	0	0	0	1	1	0	3	1	16 (!)
Forecasted days	0	1	1	1	0	0	0	0	0	0	0	1	0	0	1	0	5
Ok (f and m)	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	3
Wrong (f not m)	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	0	4
Wrong (m not f)	0	0	0	6	0	2	0	0	0	0	0	1	1	0	2	1	13
Success %	100	100	100	14	100	33	100	100	100	100	100	0	0	100	33	0	19
Accuracy %	0	0	0	14	0	33	0	0	0	0	0	0	0	0	25	0	15

Table 3.2 - Forecast Analysis for UK Agglomerations 'HIGH' band and above *

AGGLOMERATIONS	Belfast UA	Brighton/Worthing/ Littlehampton	Bristol UA	Cardiff UA	Edinburgh UA	Glasgow UA	Greater Manchester UA	Leicester UA	Liverpool UA
Measured days	0	0	0	0	0	3	2	0	0
Forecasted days	0	1	0	1	0	0	1	1	0
Ok (f and m)	0	0	0	0	0	0	0	0	0
Wrong (f not m)	0	1	0	1	0	0	1	1	0
Wrong (m not f)	0	0	0	0	0	3	2	0	0
Success %	100	100	100	100	100	0	0	100	100
Accuracy %	0	0	0	0	0	0	0	0	0

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	*Overall*
Measured days	0	1	0	0	0	4	0	10 (!)
Forecasted days	1	0	0	0	0	1	0	6
Ok (f and m)	0	0	0	0	0	0	0	0
Wrong (f not m)	1	0	0	0	0	1	0	6
Wrong (m not f)	0	1	0	0	0	4	0	10
Success %	100	0	100	100	100	0	100	0
Accuracy %	0	0	0	0	0	0	0	0

*** All performance statistics are based on provisional data. Obviously incorrect data due to instrumentation faults have been removed from the analyses. (!) FDMS PM_{10} datasets have been currently excluded from the analysis.**

Please refer to the start of section 3 for an explanation of the derivation of the various statistics, figures >100 % may occur.

Table 3.3 - Forecast Analysis for UK Zones 'MODERATE' band and above *

ZONES	Central Scotland	East Mids	Eastern	Greater London	Highland	North East	North Scotland	North Wales	North West & Merseyside	Northern Ireland	Scottish Borders	South East	South Wales	South West	West Midlands	Yorkshire & Humberside	Overall
Measured days	18	57	112	115	49	40	15	30	56	17	20	60	31	69	59	38	786 (!)
Forecasted days	26	64	88	85	37	45	19	28	41	23	22	78	41	58	60	50	765
Ok (f and m)	35	66	118	108	58	51	29	38	60	31	33	76	36	76	70	52	937
Wrong (f not m)	0	14	8	15	6	5	0	3	4	0	1	14	12	4	10	7	103
Wrong (m not f)	0	4	8	26	3	6	0	3	6	0	2	6	7	5	5	2	83
Success %	194	116	105	94	118	128	193	127	107	182	165	127	116	110	119	137	119
Accuracy %	100	79	88	72	87	82	100	86	86	100	92	79	65	89	82	85	83

Table 3.4 - Forecast Analysis for UK Agglomerations 'MODERATE' band and above *

AGGLOMERATIONS	Belfast UA	Brighton/Worthing/ Littlehampton	Bristol UA	Cardiff UA	Edinburgh UA	Glasgow UA	Greater Manchester UA	Leicester UA	Liverpool UA
Measured days	18	53	29	22	17	24	33	30	10
Forecasted days	18	63	48	33	18	26	37	44	26
Ok (f and m)	26	65	42	31	28	27	43	39	27
Wrong (f not m)	1	13	9	9	0	8	5	15	3
Wrong (m not f)	4	5	3	3	0	11	4	3	2
Success %	144	123	145	141	165	113	130	130	270
Accuracy %	84	78	78	72	100	59	83	68	84

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	*Overall*
Measured days	21	46	26	29	13	40	23	434 (!)
Forecasted days	43	57	37	37	30	54	33	604
Ok (f and m)	39	63	40	40	33	52	39	634
Wrong (f not m)	12	8	6	8	3	14	1	115
Wrong (m not f)	1	4	4	4	1	7	4	60
Success %	186	137	154	138	254	130	170	146
Accuracy %	75	84	80	77	89	71	89	78

*** All performance statistics are based on provisional data. Obviously incorrect data due to instrumentation faults have been removed from the analyses (!) FDMS PM_{10} datasets have been currently excluded from the analysis.**

Please refer to the start of section 3 for an explanation of the derivation of the various statistics, figures >100 % may occur.

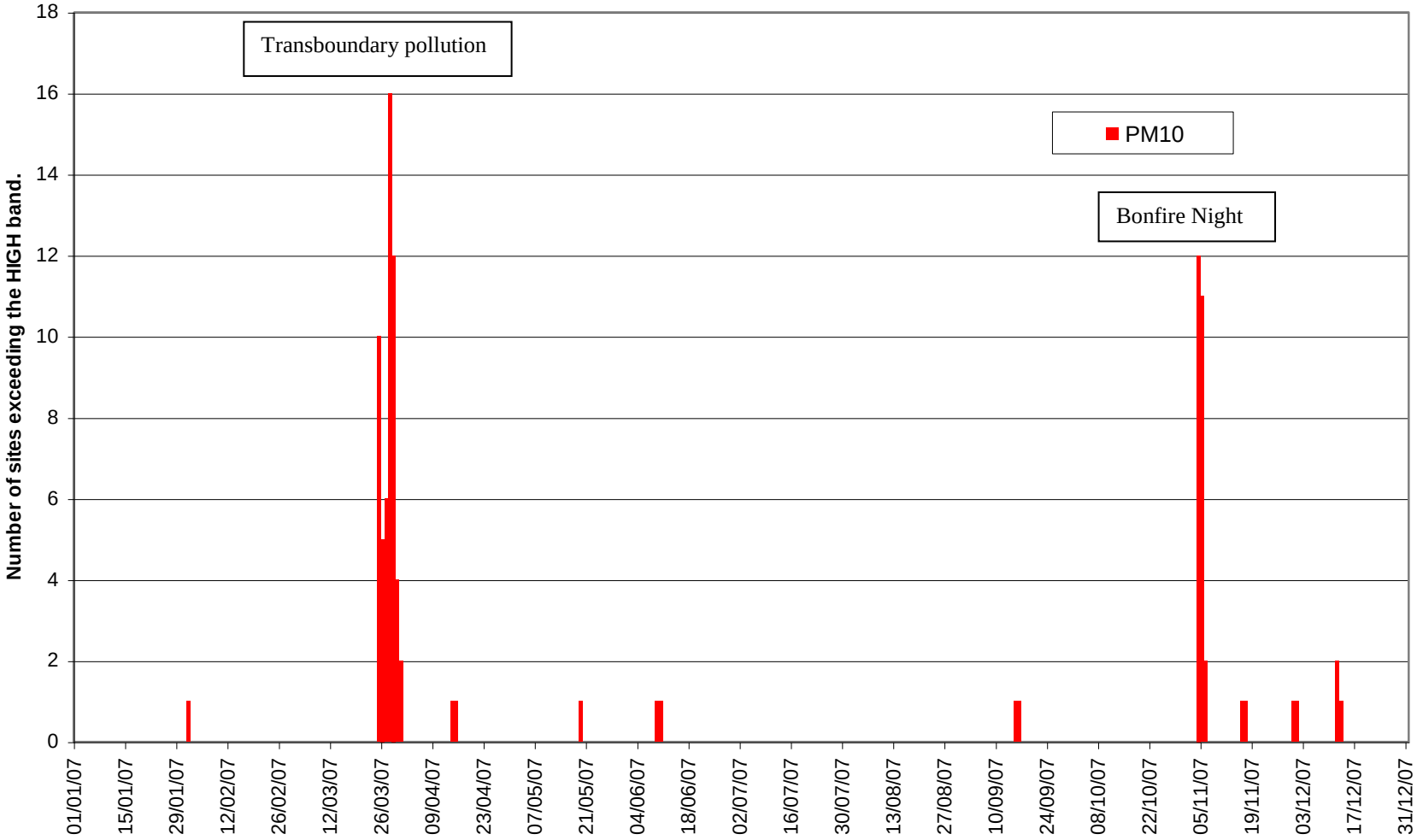


Figure 3.1 Number of stations with air pollution levels of HIGH and above for days throughout 2007.

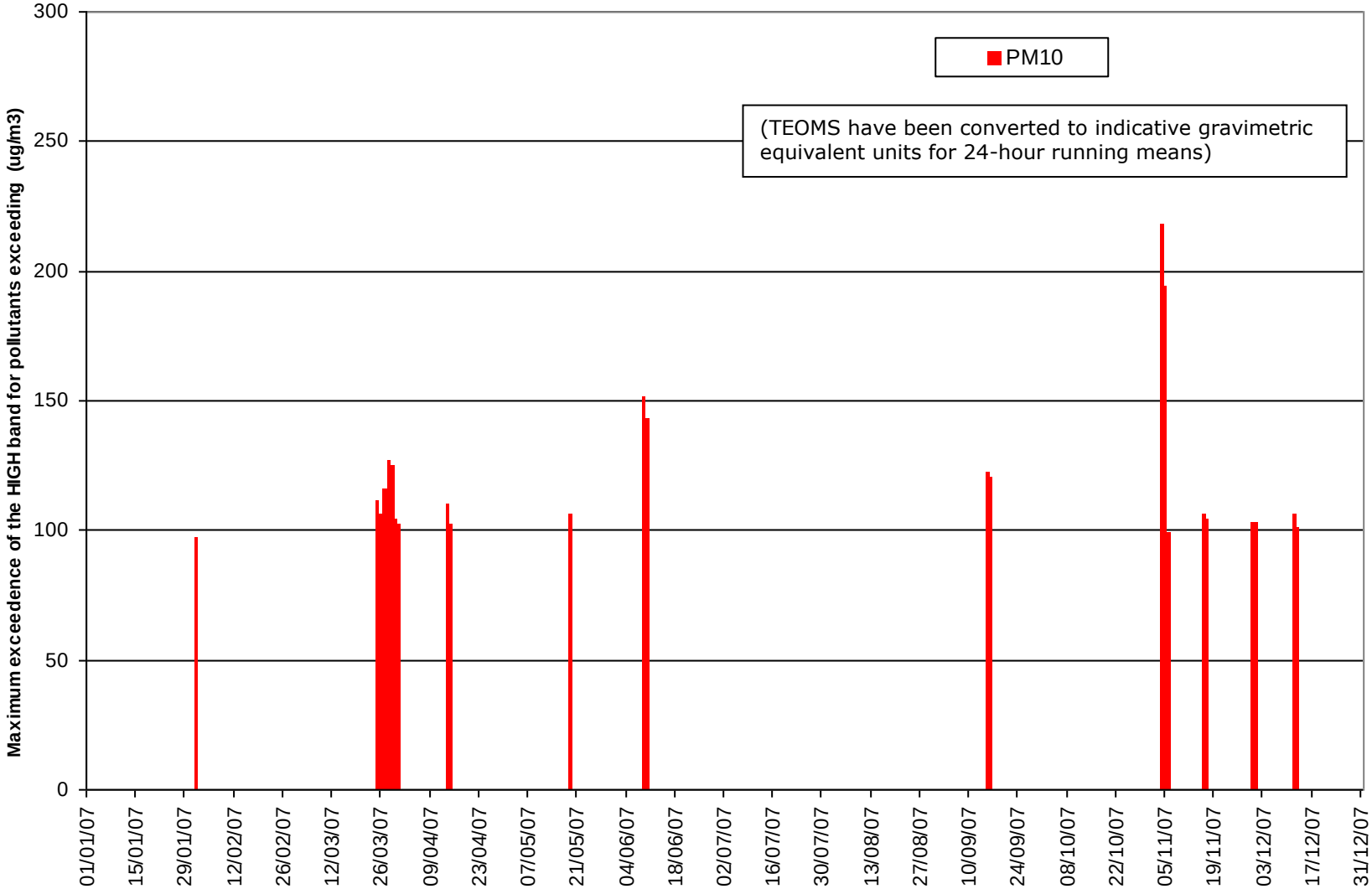


Figure 3.2 Maximum exceedence when air pollution levels were HIGH and above for days throughout 2007.

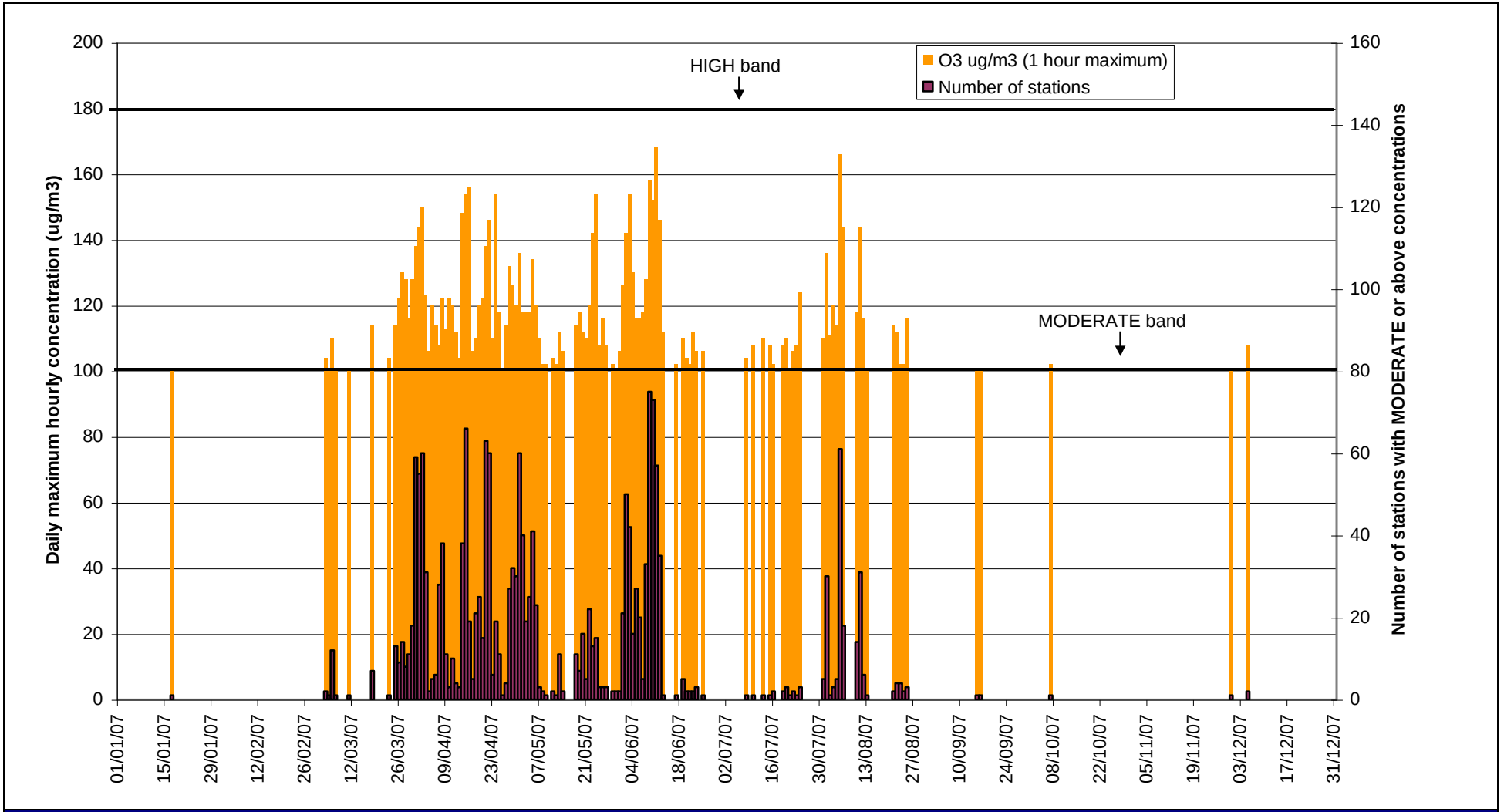


Figure 3.3 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring moderate or above levels of ozone over 2007.

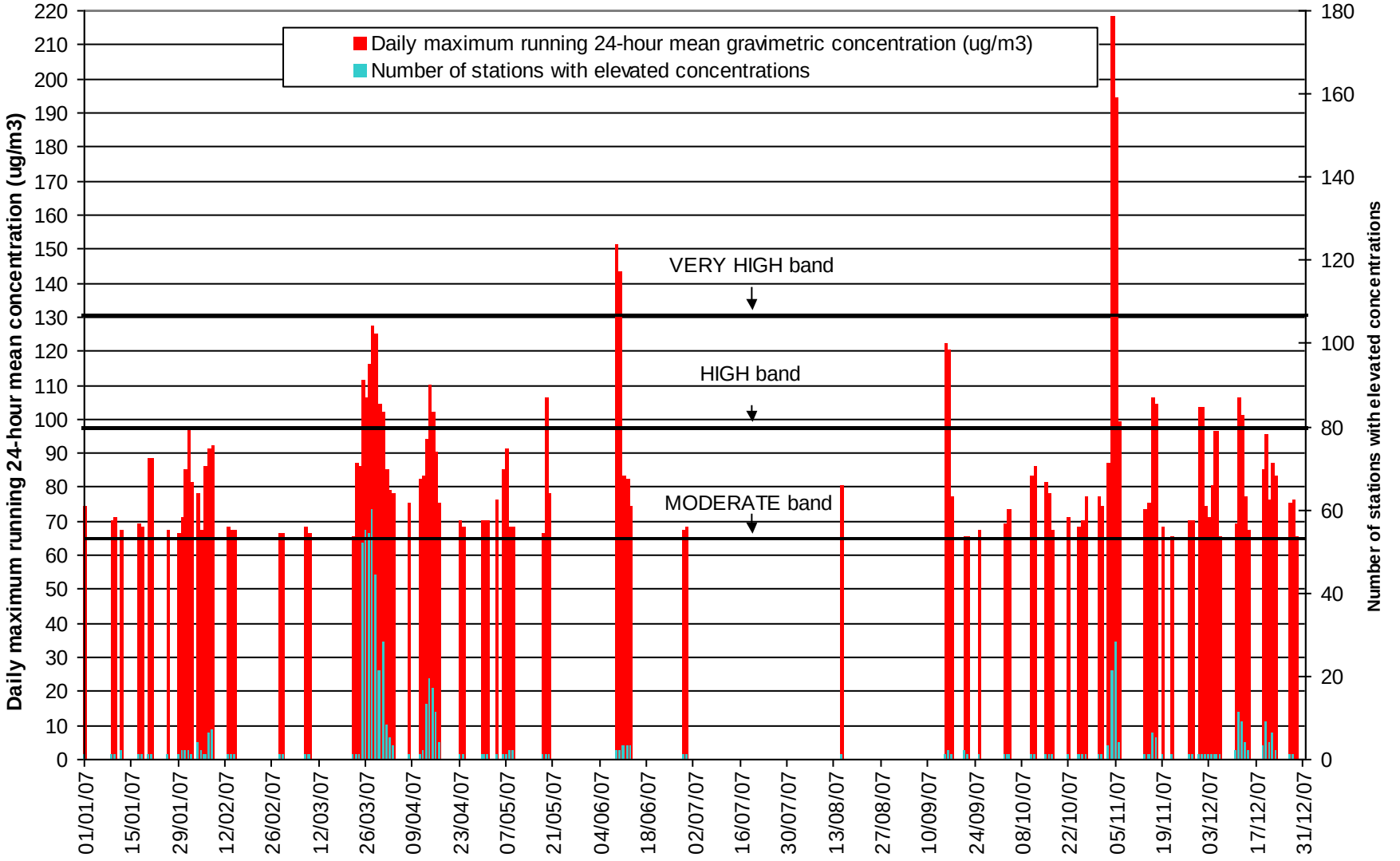


Figure 3.4 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring moderate or above levels over 2007

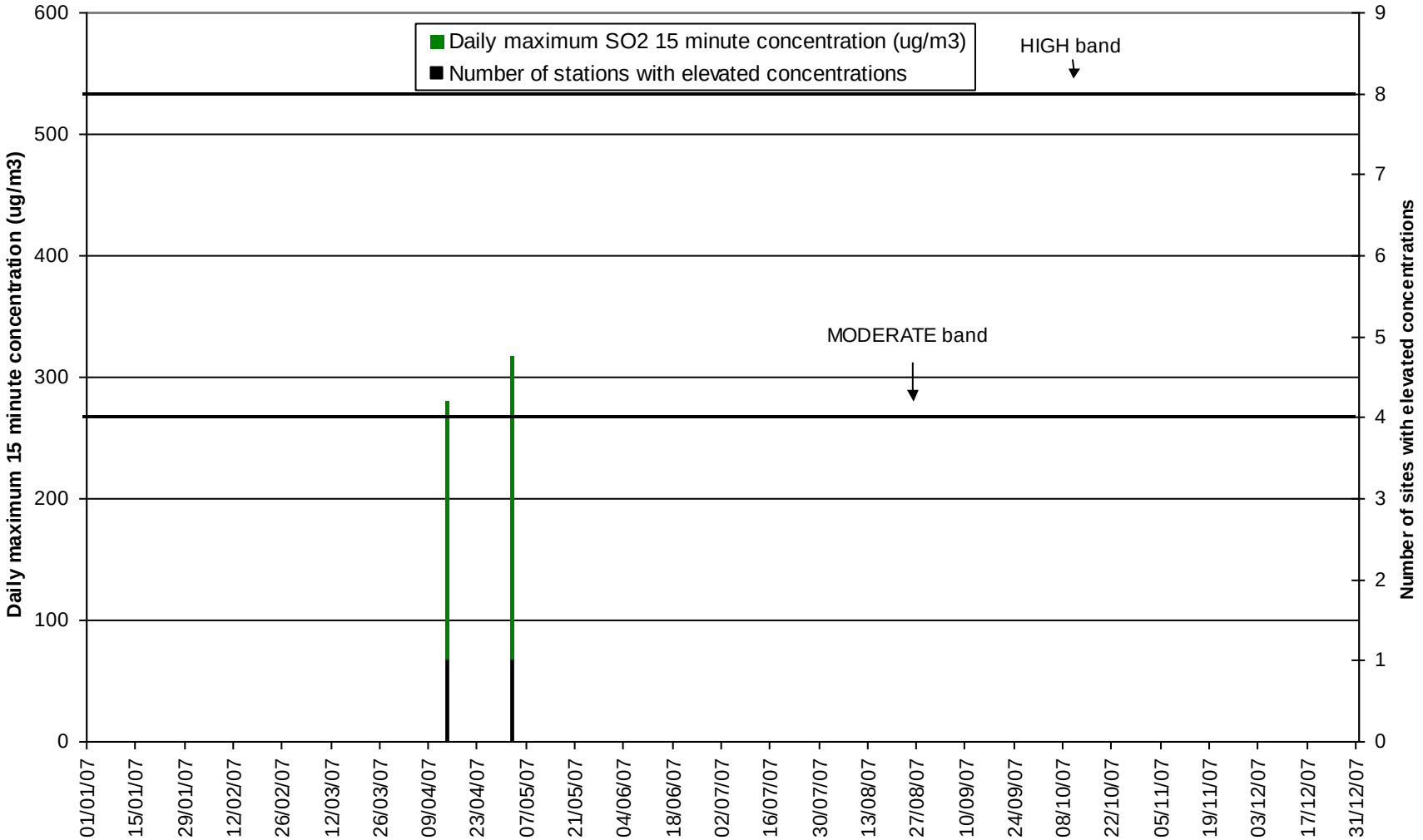


Figure 3.5 Maximum 15 minute average concentrations of SO_2 across AURN Network with total number of stations measuring moderate or above levels over 2007

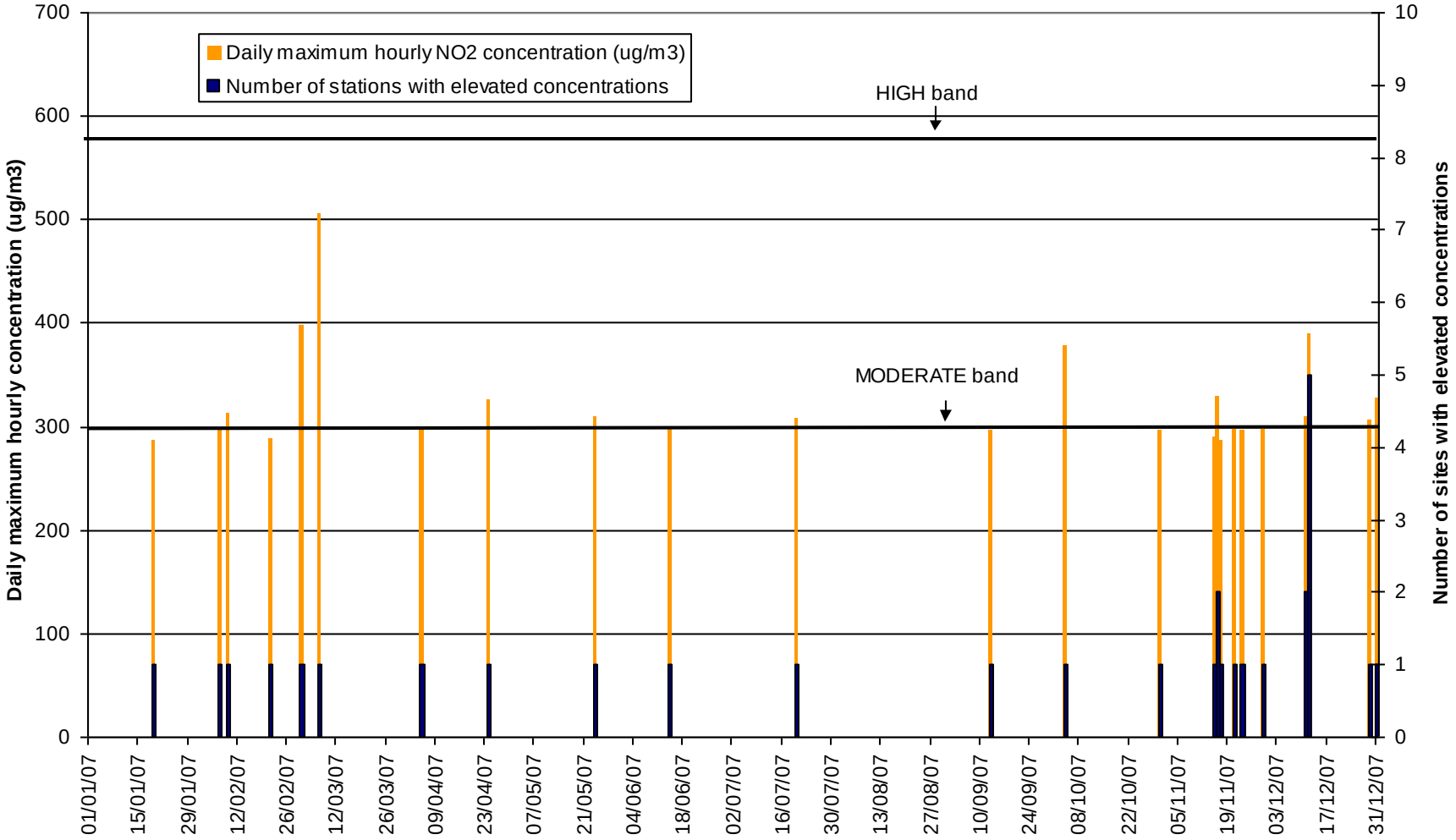


Figure 3.6 Daily Maximum hourly average of NO_2 across AURN Network with total number of stations measuring moderate or above levels over 2007

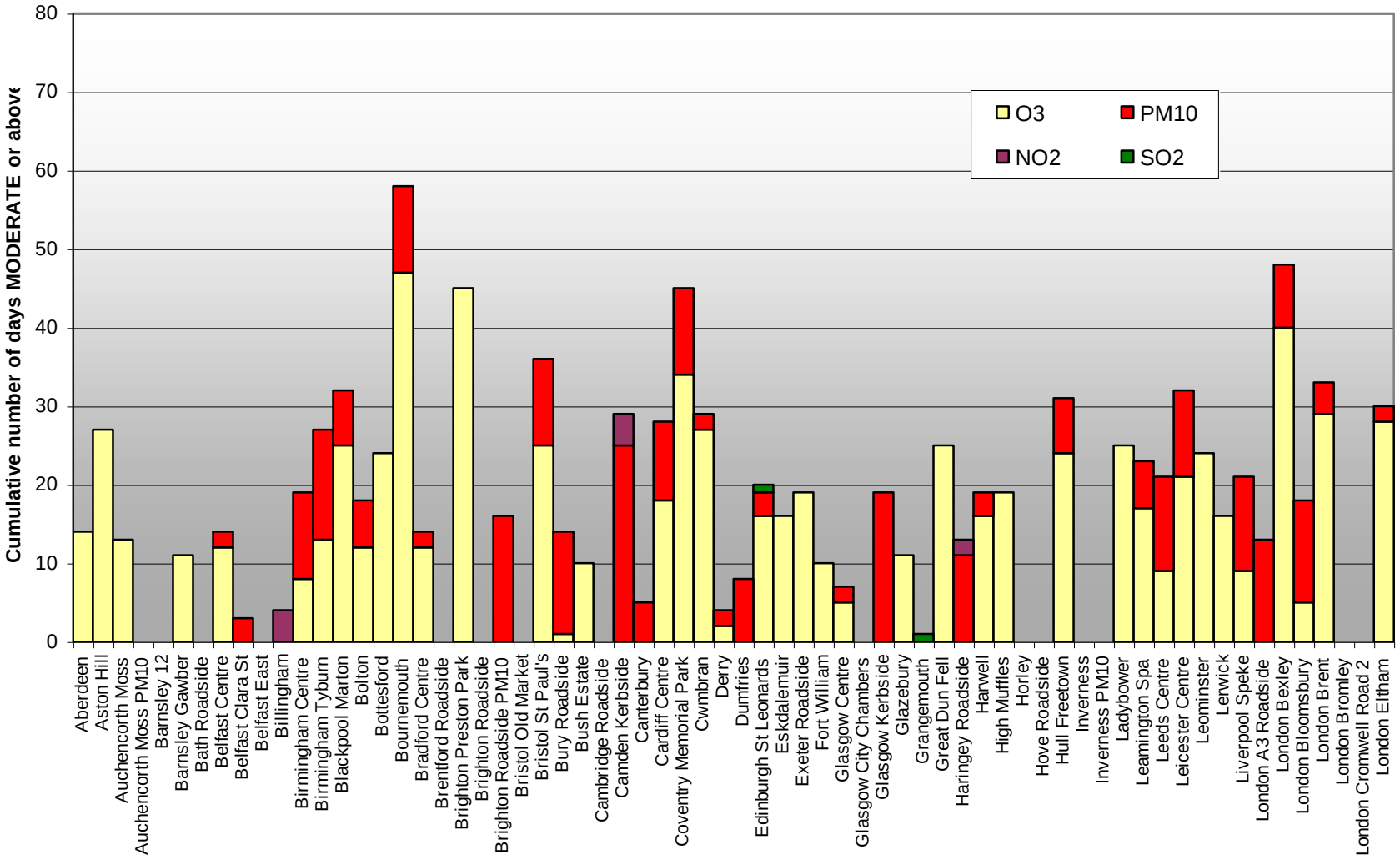


Figure 3.7a Number of days moderate and above for each AURN Network station over 2007 – provisional data

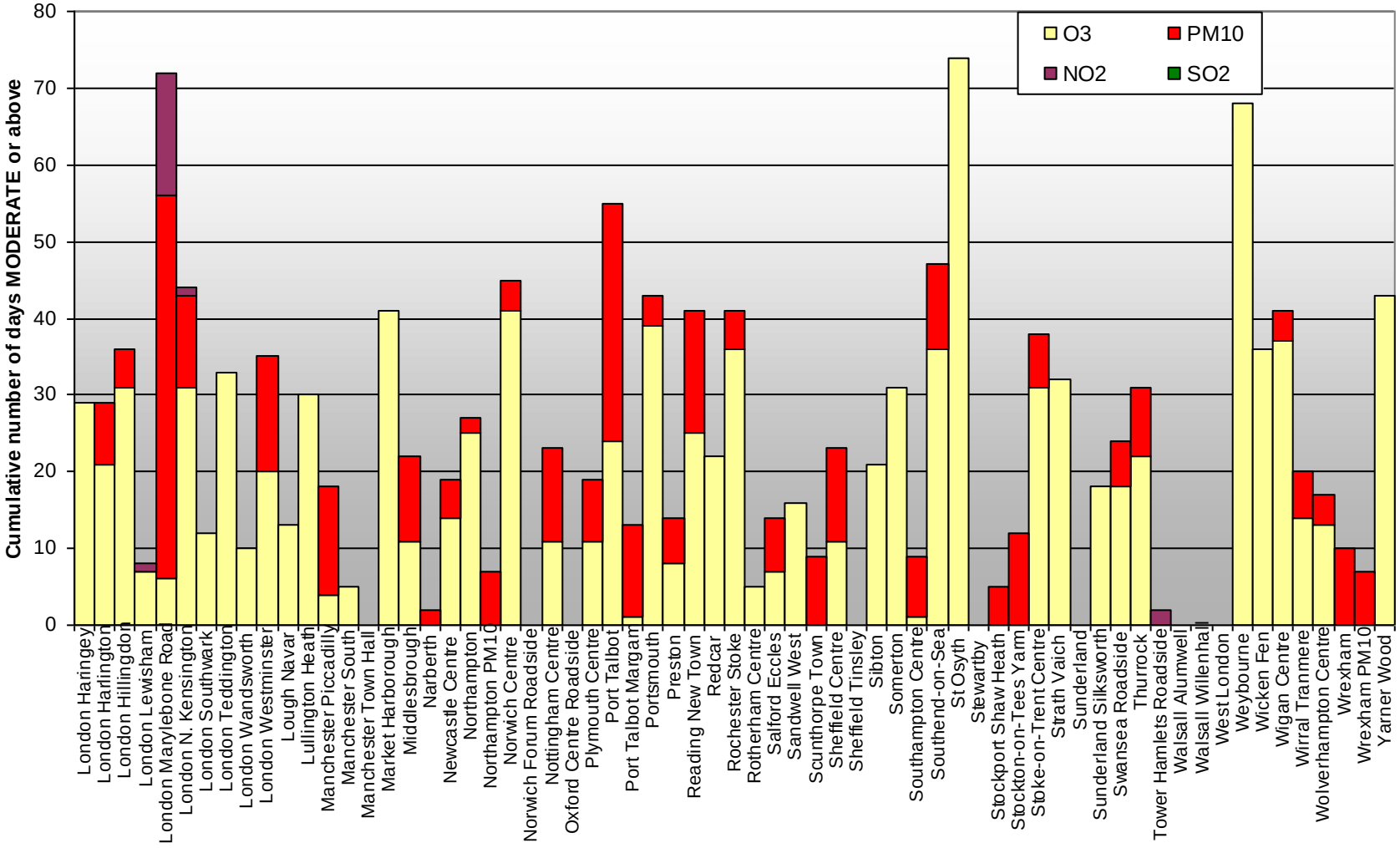


Figure 3.7b Number of days moderate and above for each AURN Network station over 2007 – provisional data

Table 3.3 – Summary of HIGH episodes year 2007

Pollutant	*No. of HIGH days*	*No. of MODERATE days ^*	*Maximum concentration* (Index)*	*Site with max concentration*	*Zone or Agglomeration*	*Date of max conc.*	*Forecast success HIGH days (%)**** [no. incidents, zone or agglomoration days] **
Ozone	0	123	168 (Index 6)	Blackpool	North West & Merseyside Zone	11/6	N/A [0]
PM_{10}	23	93	218 indicative gravimetric (Index 10)	Manchester Piccadilly	Greater Mancs. UA	4/11	12 % ! [81]
NO_2	0	24	506 (Index 6)	Billingham	North East Zone	7/3	N/A [0]
SO_2	0	2	317 (Index)	Edinburgh St Leonards	Edinburgh UA	3/5	N/A [0]
CO	0	0	4.0 (Index)	Bury Roadside	Greater Mancs. UA	17/11	N/A [0]

* *Maximum concentration relate to 8 hourly running mean or hourly mean for ozone, 24 hour running mean for PM_{10}, hourly mean for NO_2, 15 minute mean for SO_2 and 8 hour running mean for CO. Units ug/m3 throughout, except CO units mg/m3.*
*** the number of incidents is the total of the number of HIGH days in all zones and agglomorations (ie a HIGH day on the same day in many zones or agglomerations is counted as many incidents, not just one)*
**** The success rates for the number of HIGH days in table 3.5 have been calculated using calendar days (ie midnight to midnight) and therefore may not necessarily agree with the success rates calculated within the forecast analysis tables 3.1 and 3.2, which are calculated based on media forecast days starting generally at 3 pm each day.*
^ a MODERATE day is not counted on any HIGH day.
! the forecast success rate for PM_{10} has been calculated using TEOM measurements only due to current uncertainty over the limits to be set for the new FDMS-PM_{10} instruments. Twenty six HIGH TEOM- PM_{10} zone or agglomeration days were measured during the year, eighty one zone or agglomeration days were measured in total by both FDMS and TEOM instruments.

General trends

No HIGH days were recorded for ozone this reporting year, in contrast to the exceptional levels measured during the summer of 2006.

There were five major PM_{10} episodes experienced in 2007, two in the spring time, two during December and one as a result of bonfire night celebrations. In total 23 HIGH days were measured throughout the year.

Only two MODERATE SO_2 days were measured during the whole calendar year, both occurred in the springtime.

MODERATE NO_2 days were measured at an approximate frequency of once per month. Five sites reached the MODERATE band on the same day on one occasion during a cold spell in December.

Particulate matter

There were five major widespread PM_{10} episodes experienced in 2007.

The first occurred at the end of March, thought to have been the result of long range transport of particulates from de-forestation fires in Russia and the Ukraine, combined with a contribution of European secondary PM_{10} pollution and also dust from sandstorms in North Africa.

For the first 4 days of the particulate episode at the end of March, approximately 50 sites entered the MODERATE band or above on a daily basis. At the height of the episode, on the 28th March, 11 sites entered the HIGH band. The HIGH sites were geographically widespread, although the majority were located in the Midlands and were urban-designated sites. Twenty-one sites entered the HIGH band in total, during seven days. A separate ad-hoc report has been published (as noted in section 6) detailing the incident and analysis of data obtained from various sources.

A significant number of sites experienced MODERATE levels during a period of European sourced air in mid April. The episode lasted from the 13th to 17th April. At its height, on the 14th, nineteen sites reached the MODERATE band. Port Talbot was the only site to measure levels in the HIGH band during this period and was likely to have been compounded by localised contributions from the nearby steelworks.

This year the 5th of November was a Monday, therefore municipal Bonfire celebrations were held primarily on the evenings of Saturday 3rd to Sunday 4th. An elevation in particulate levels was seen at some sites on the Friday and the Monday, however the bulk of the pollution was seen during the weekend. The evening air temperature on both the 4th and 5th was near freezing in many areas of the UK with a very light breeze experienced. On the evening of Saturday 3rd an area of high pressure was centred over the north of England with stable, clear conditions, over much of the UK. On the 4th November twelve sites, exclusively in the Midlands and the north of England, entered the HIGH band for PM_{10}. All of these appear to have been the result of sites located downwind of bonfires on the Saturday evening. A further 9 sites entered the MODERATE band on the same day, many in central England. Please note the bandings for particulates are based on a running 24-hour mean, therefore there is a time delay until the effect of a pollution event is measured within the banding statistics. On Sunday evening England and Wales were beneath the high pressure centre, with unsettled conditions beginning to spread in to the UK from the north-west. On Monday 5th November eleven sites entered the HIGH band, two in London and the remaining nine in central or northern England. A further 17 sites entered the MODERATE band, also as a result of bonfires on the Sunday evening; five in London and the majority of the remainder in central or northern England. The location of the high pressure centre was therefore pivotal in determining where in the UK the bulk of particulate pollution was experienced.

During two spells of cold weather before Christmas, over the weeks beginning Monday 10th and Monday 19th December, pollution levels built up resulting in MODERATE band exceedences at two or more sites in the network on Wednesday 12th to Friday 14th and Monday 19th to Thursday 22nd December.

High pressure air was over England and Wales during the first spell up to the 16th. 4-day air mass back trajectory plots indicated that no significant secondary contribution of pollution from European sources had occurred. The most affected areas of the UK by the settled conditions were London and the South East. For the second week of pollution, high pressure was initially centred over the North Sea before moving southwards over France. Modelled 4-day air mass back-trajectories indicated that the air had been

sourced from central continental Europe from the 18th to the 20th then from over central France on the 21st. After the 21st the incoming air began to turn westerly. A contribution from European pollution sources to UK levels was therefore very likely over the second episode.

On the 12th December eleven sites entered the MODERATE band, six of these were located in London, with the remainder dispersed over England. All of these appear to have been primarily the result of traffic emissions. A further two kerbside sites in London entered the HIGH band. The majority of the episode's pollution occurred between the 11th and 13th December with dispersion conditions slowly improving on subsequent days.

The second episode's build up happened over the 19th to the 23rd. On the 20th nine sites entered the MODERATE band. Six of these sites were located in London. The sites exceeding during this second episode were almost identical to those of the previous episode, earlier in December. The episode ended around Christmas Eve, partly as a result of a dramatic fall in traffic flows, and partly due to a change in meteorology.

Other HIGH concentrations were measured periodically throughout 2007 at localized locations, for example:

- Birmingham Tyburn AQM site due to nearby car park resurfacing works
- Port Talbot monitoring site due to its proximity to a steel works

Typical contributory factors to localised elevated PM_{10} levels include:

- Local emissions from industrial or construction sources.
- Poor dispersion due to low wind speeds, including recirculation of air over the UK and possible formation of secondary particulates from UK emissions.
- Easterly winds bringing secondary pollution across from Europe, particulalry during warm settled weather.

Bonfire night "weekend" celebrations yielded a higher number of HIGH band exceedences this year in comparison to all previous years from 2000 onwards and was also the second highest year for MODERATE exceedences, with only 2006 producing a greater number. Figure 3.8 below shows a comparison of exceedences with these earlier years.

Additionally figure 3.9 shows the overall number of PM_{10} exceedences annually from all pollution sources from the year 2000 onwards, indicating that this year has been the second highest for elevated particulate levels in recent years.

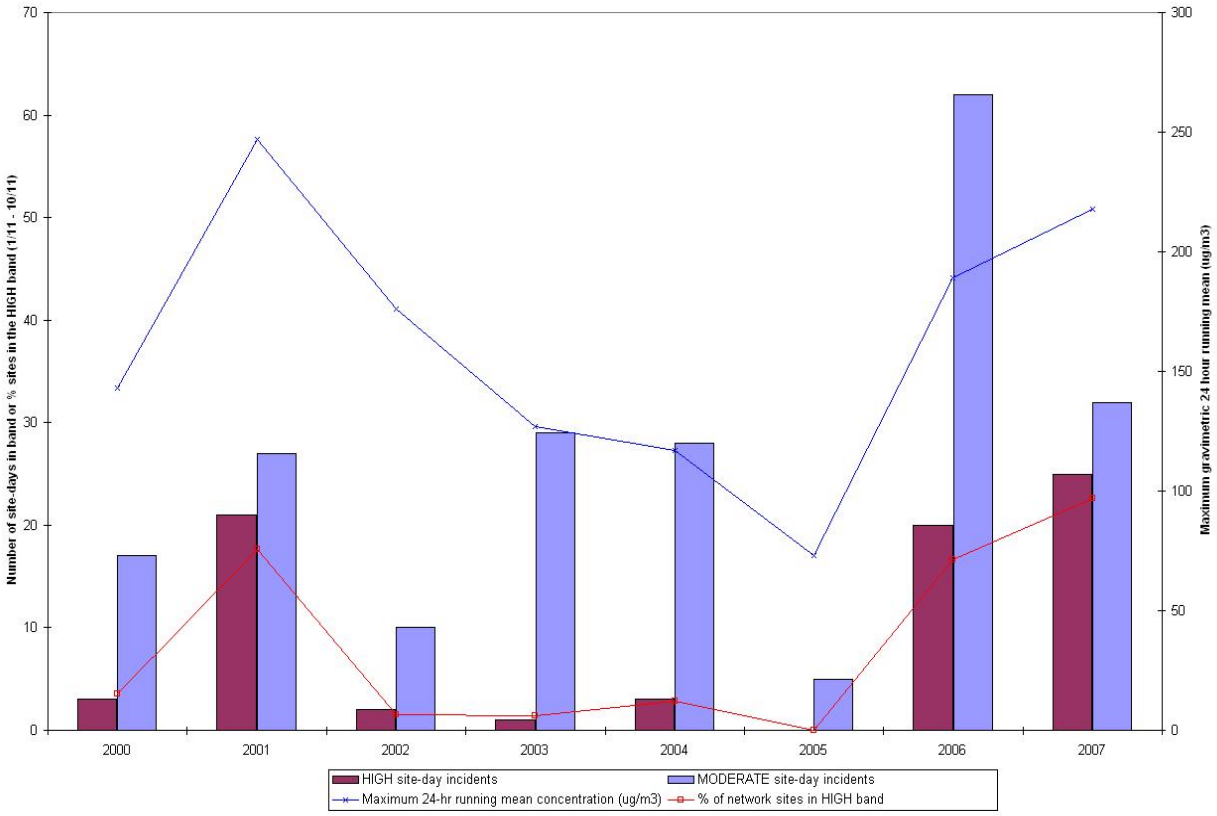


Figure 3.8: Number of sites exceeding the MODERATE and HIGH PM_{10} bands over 1st November to 10th November annually from the year 2000 onwards with additional descriptive statistics.

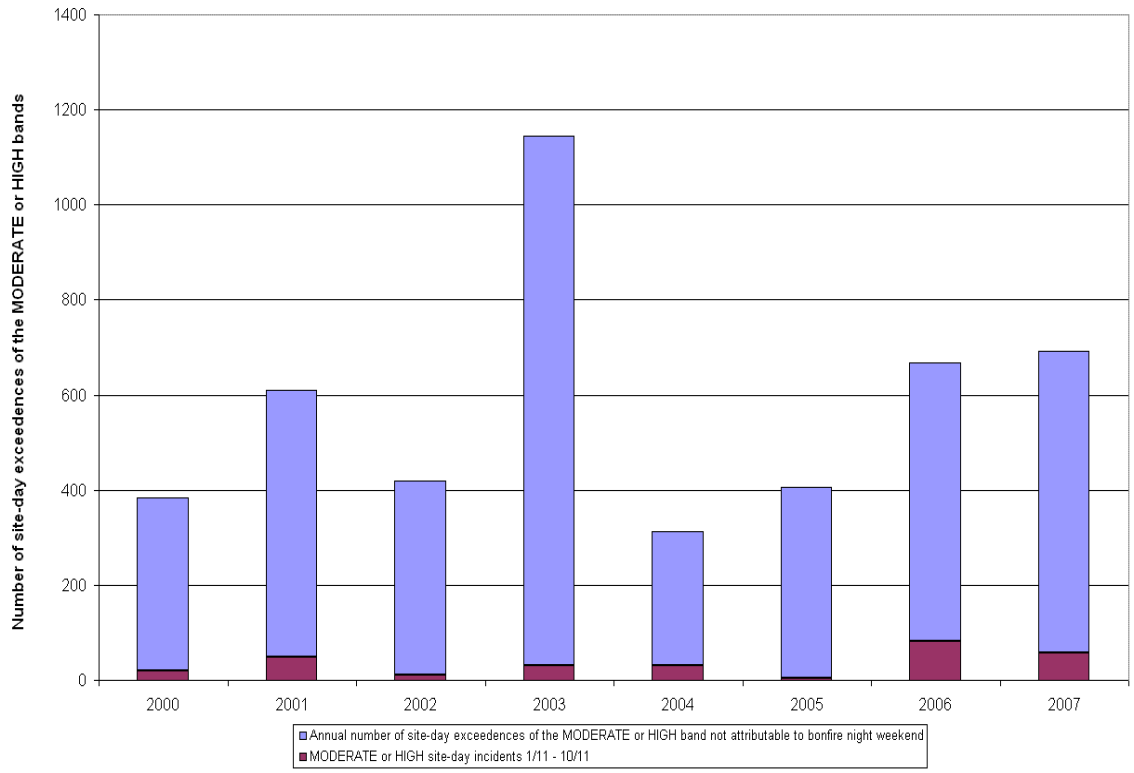


Figure 3.9: Annual number of site-day exceedences of the MODERATE or HIGH PM_{10} band for 2000 – 2007.

Ozone

MODERATE days were measured at a substantial number of network sites between the end of March and mid June. A second intense period of MODERATE ozone days occurred during the first two weeks of August.

Figure 3.10 below shows that 2007 has been the lowest year yet recorded for elevated ozone levels since the year 2000 in terms of all statistics for the HIGH band; no HIGH days were measured and the highest hourly measurement was around 30 ug/m^3 lower than the lowest of all previous years.

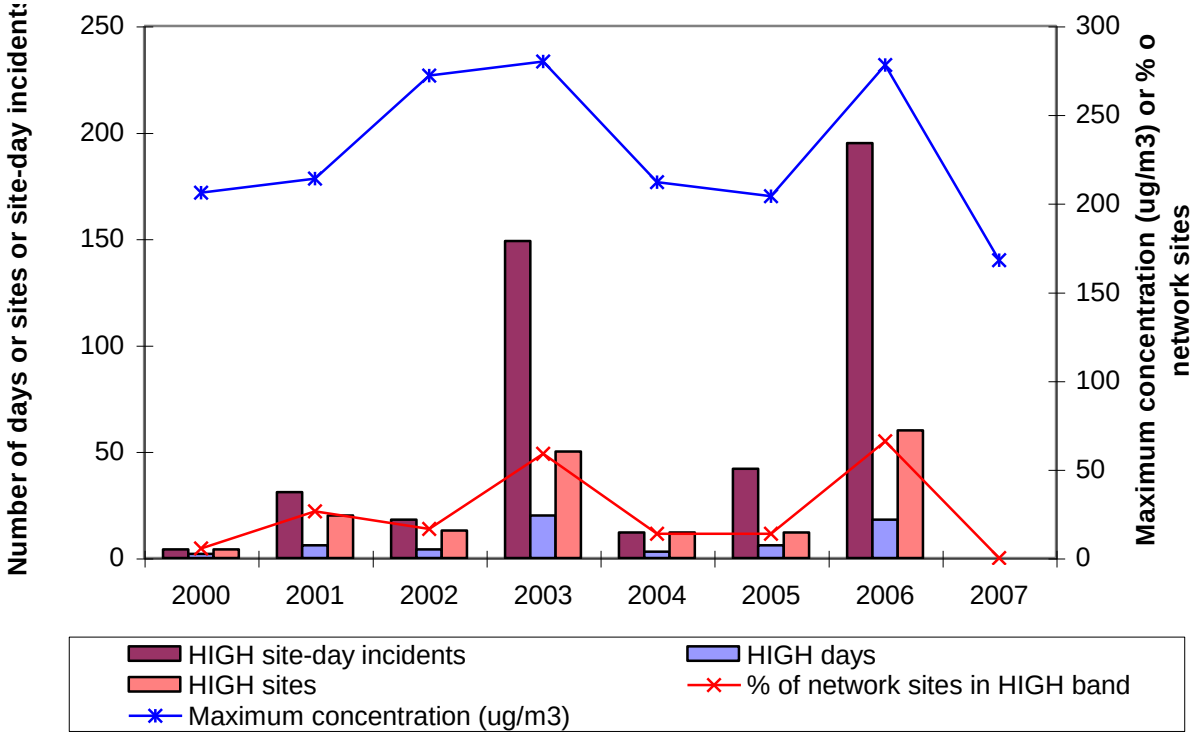


Figure 3.10: UK ozone episodes summarized for years 2000 onwards.

Sulphur Dioxide

The number of SO_2 measuring sites in the network was reduced from around 75 to 40 (a reduction of approximately 45%) from October 2007 onwards, however data from recent years indicates that the final quarter of any calendar year has not been a significant factor in terms of MODERATE exceedences measured. The number of MODERATE or above days per annum measured in the network is shown in figure 3.11 from the year 2000 onwards. The number of days of exceedences per year has fallen dramatically over the last 7 years, by as much as about 90% using an average based on the last 3 years.

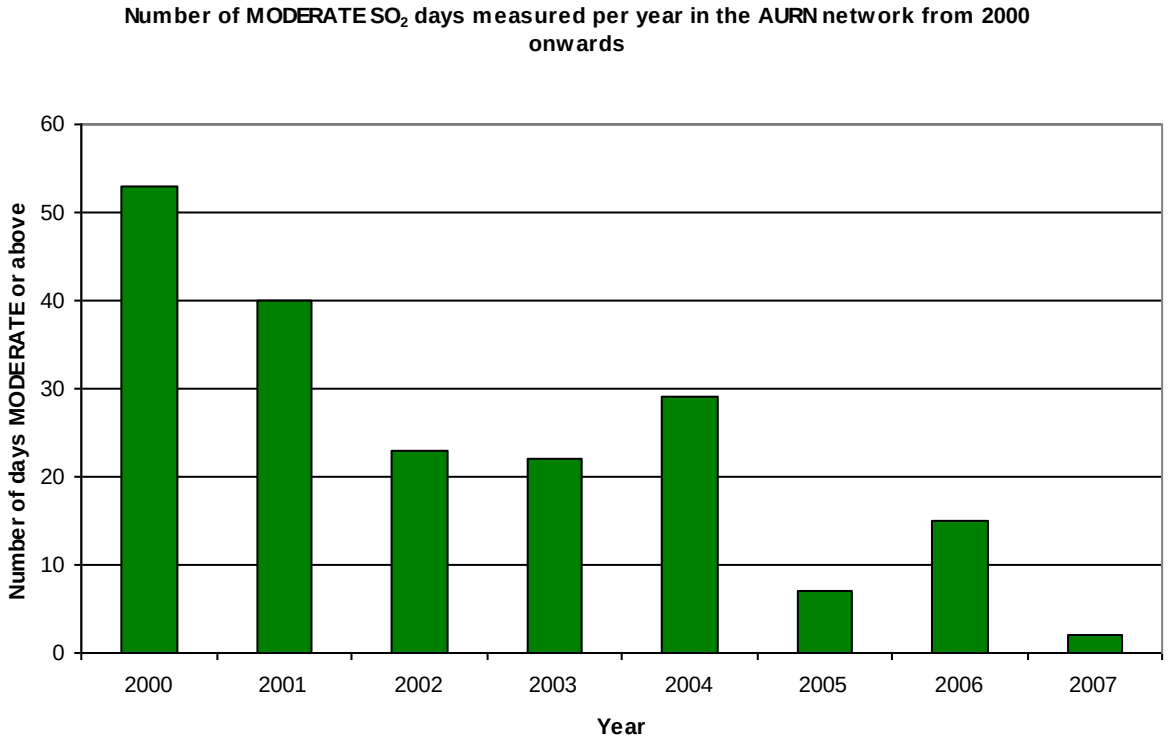


Figure 3.11: Number of MODERATE SO_2 days measured per annum

The significant reduction in the number of exceedences over the last 7 years is likely to be the result of an improvement in and proliferation of abatement technologies to control the release of suphur dioxide and other pollutant species coupled with a downturn in the use of coal for power production and domestic heating.

Nitrogen Dioxide

Twenty four MODERATE days were measured during the year. The majority of these were experienced at the kerbside London Marylebone site, not during UK episodes, with nearly all of the remainder measured at other London roadside sites as a result of two cold spells of weather in mid November and mid December. These are all expected to have been the result of traffic emissions and meteorological conditions unfavourable for atmospheric dispersion. The urban industrial site Billingham measured exceedences on five days, mainly during colder weather in both February and December.

3.3 COMPARISON WITH YEARS 2003 ONWARDS

FORECASTING SUCCESS RATE

Figure 3.11 below shows the forecasting success rates for the whole of the UK for years 2002 to 2007. This is the percentage of HIGH days that were correctly forecast.

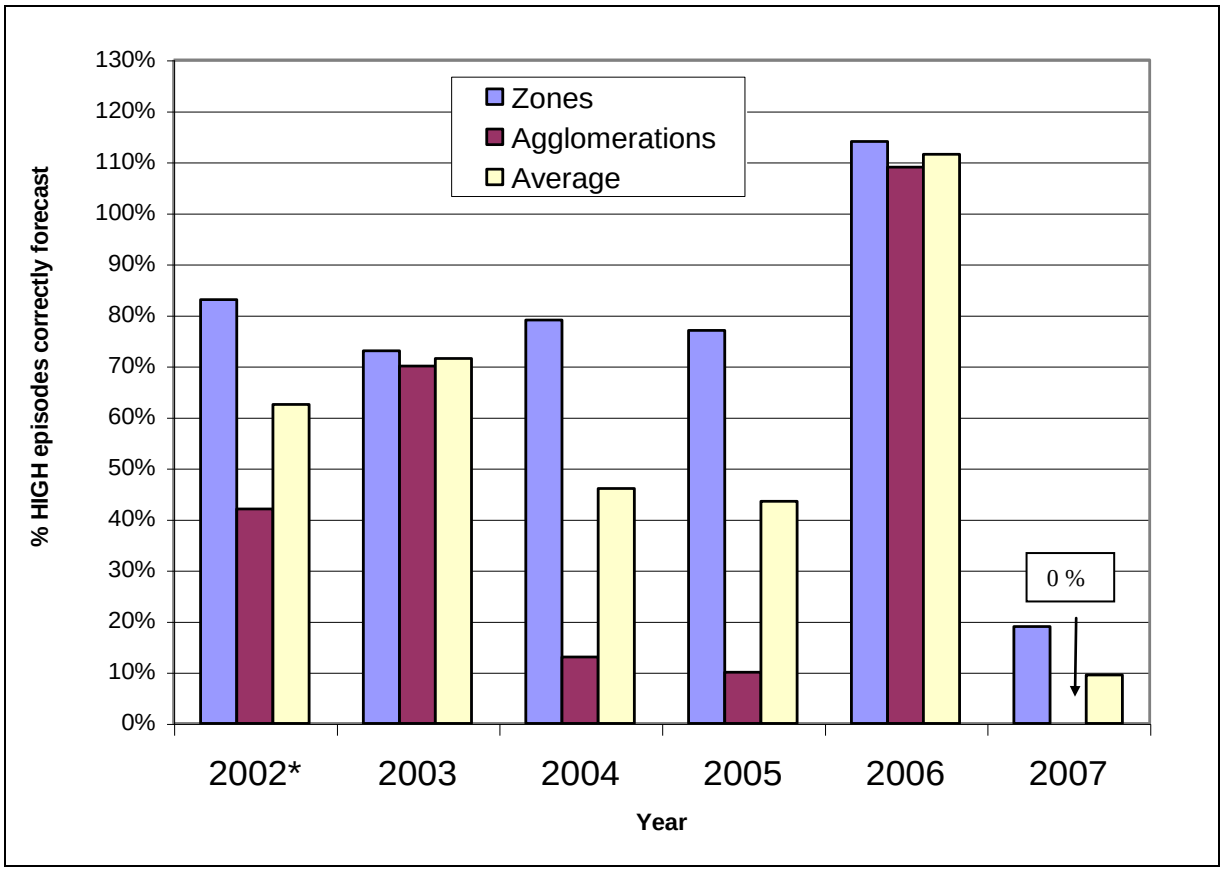


Figure 3.11 - Forecasting Success Rates for the whole of the UK, 2003-2007
*** 2002 was a partial year for forecasting analysis calculations.**

The overall forecasting success rate, including that for both zones and agglomerations, for the HIGH band in 2007 was the lowest seen (by about 40%) since forecasting analysis began, in 2002.

The low success rate for 2007 was primarily the result of no HIGH band ozone episodes seen during the summer, an unprecedented event over the 6 years of forecasting analysis. Historically ozone episodes have been forecasted with a reasonably high degree of success due to the quality of our ozone forecast models. Another major contribution to the low success rate was the Russian fires/ Saharan sandstorms-related particulate episode at the end of March and the significant effects of bonfire weekend celebrations this year. Our capacity to successfully predict elevated PM_{10} levels is less than that for ozone using the forecast models we presently have access to, although this has begun to be addressed in 2008 by using various European particulate model run results which are freely available for public access on the internet.

Figure 3.12 shows that although 2007 was significant in terms of total MODERATE and HIGH band exceedences for PM_{10} it was conversely one of the lowest recent years for HIGH band-only measurements.

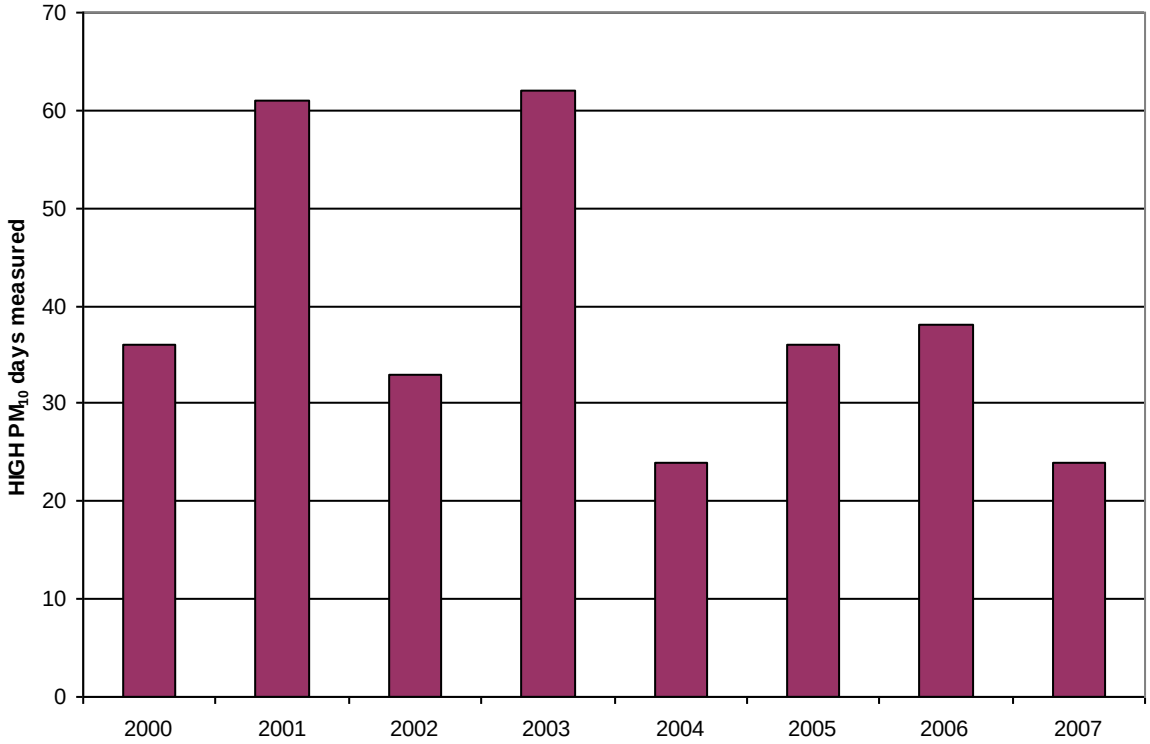


Figure 3.12 – Number of HIGH band measurements in the UK, 2000-2007.

LOCALISED INFLUENCES

In addition to the problems of interpreting and forecasting the weather patterns, there are also occasional difficulties in forecasting accurately in areas where local effects on pollution are significant and unpredictable. The following are examples of such sites that reported HIGH concentrations during 2007:

- Scunthorpe is surrounded by local heavy industry, which often results in unpredictable elevated concentrations of PM_{10}.
- Port Talbot monitoring station is located to the north east of the Corus Steelworks. As a result, emissions from the works are known to contribute to local PM_{10} concentrations when winds are southwesterly.
- Glasgow Kerbside regularly reports elevated PM_{10} concentrations as a result of its kerbside location. In addition, there is a taxi rank nearby and vehicles with idling engines for long periods may contribute to local levels.
- Birmingham Tyburn AQM site was affected for a few days by nearby car park resurfacing works.

OVERALL CONTRIBUTION FROM UK AND EUROPE IN SUMMER

A similar contribution from European sources was seen this year when compared to 2006, although only around a half of the MODERATE ozone exceedences were measured as a result of non European sourced air in 2007 compared with the previous year. This is likely to be a reflection of the poorer weather conditions experienced in the summer of 2007 compared to the exceptionally warm weather seen the previous year. No HIGH band measurements were made this year for ozone.

Figure 3.12a shows the number of MODERATE site-days for ozone as a result of air from Europe or recirculated air from the UK/incident Atlantic air in 2007. The data in the chart was derived by "per-region" analysis of simple 96-hour forecast air mass back-trajectory plots for all MODERATE days from early May to the end of September. Only days with five or more sites exceeding were counted. The chart indicates that, as expected, a far larger number of MODERATE site-days were measured as a result of European air. Figure 3.12b shows a similar analysis for 2006, however it must be taken into account that all the HIGH exceedences measured in 2006 were removed from this analysis which exclusively examines the MODERATE band.

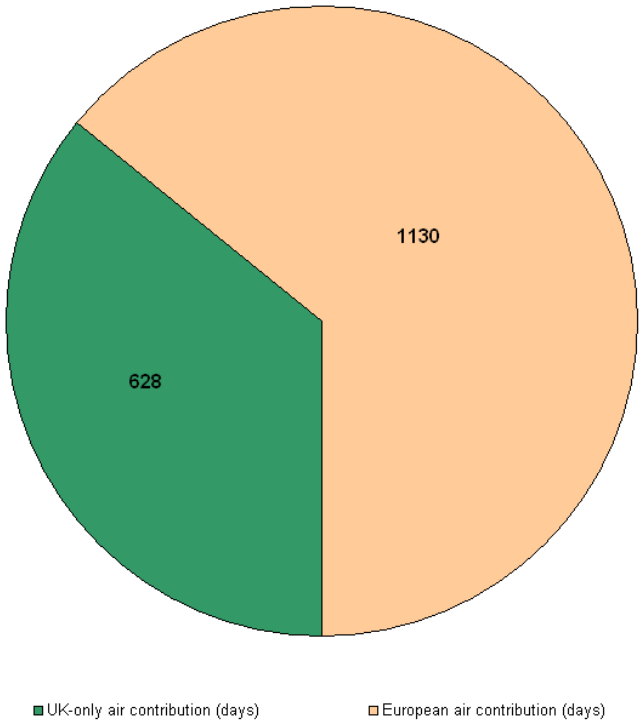


Figure 3.12a – contributions for MODERATE band exceedences of ozone in 2007.

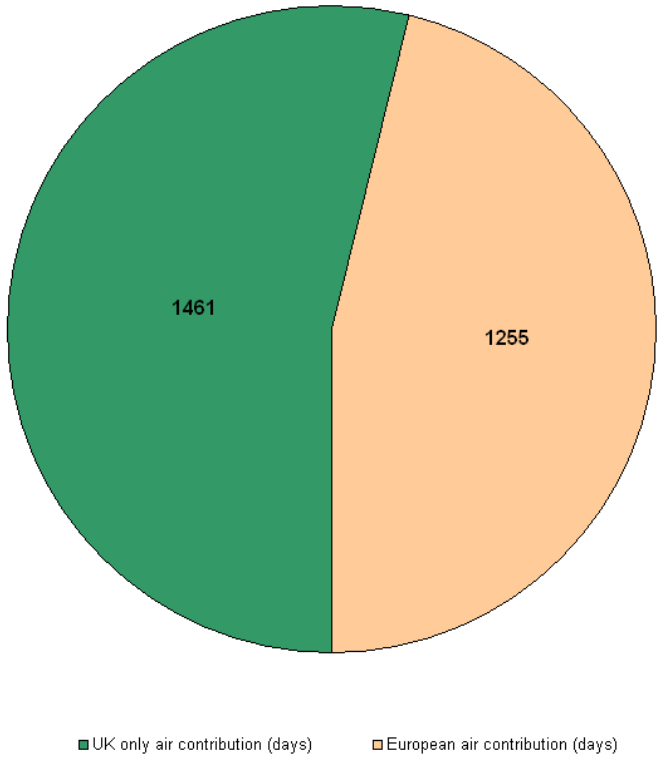


Figure 3.12b – contributions for MODERATE band exceedences of ozone in 2006.

Figure 3.13 shows the number of network days measured above various thresholds for ozone over the summers of the last seven years. The total number of days in the MODERATE band was very similar to that seen in the year 2000, formally the lowest year for ozone exceedences over the last 7 years.

Figure 3.14 shows the percentage contribution of air masses reaching the UK from either Europe or recirculated air from the UK/incident Atlantic air, for days of ozone at MODERATE or above during the summers of 2000 onwards. The data for this chart was derived by software automated "per-region" analysis of simple 96-hour forecast air mass back-trajectory plots for all MODERATE days from April to the end of September. The chart indicates that 2007 has been the lowest year seen so far, over the past 7 years, for European air masses in terms of percentage contribution.

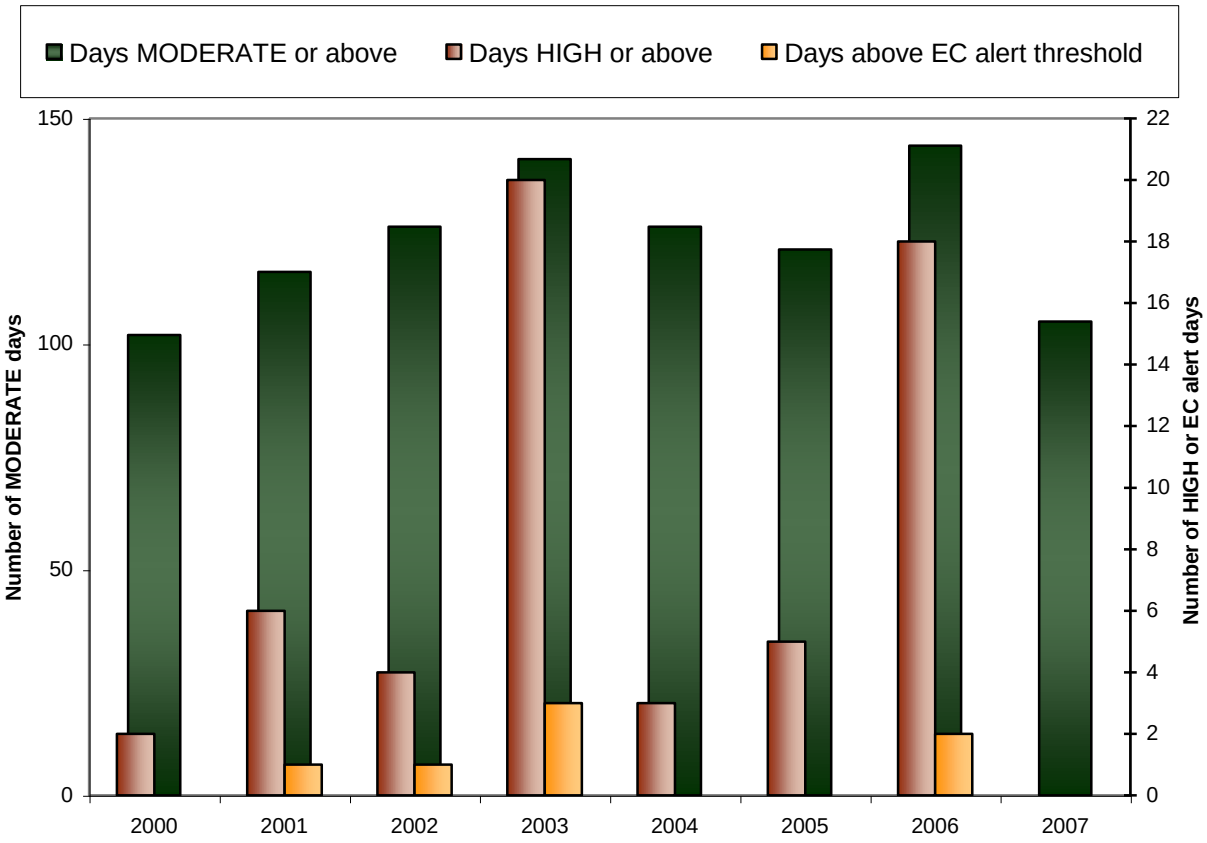


Figure 3.13 –Total network days exceeding various thresholds for ozone over the summers of 2000 onwards.

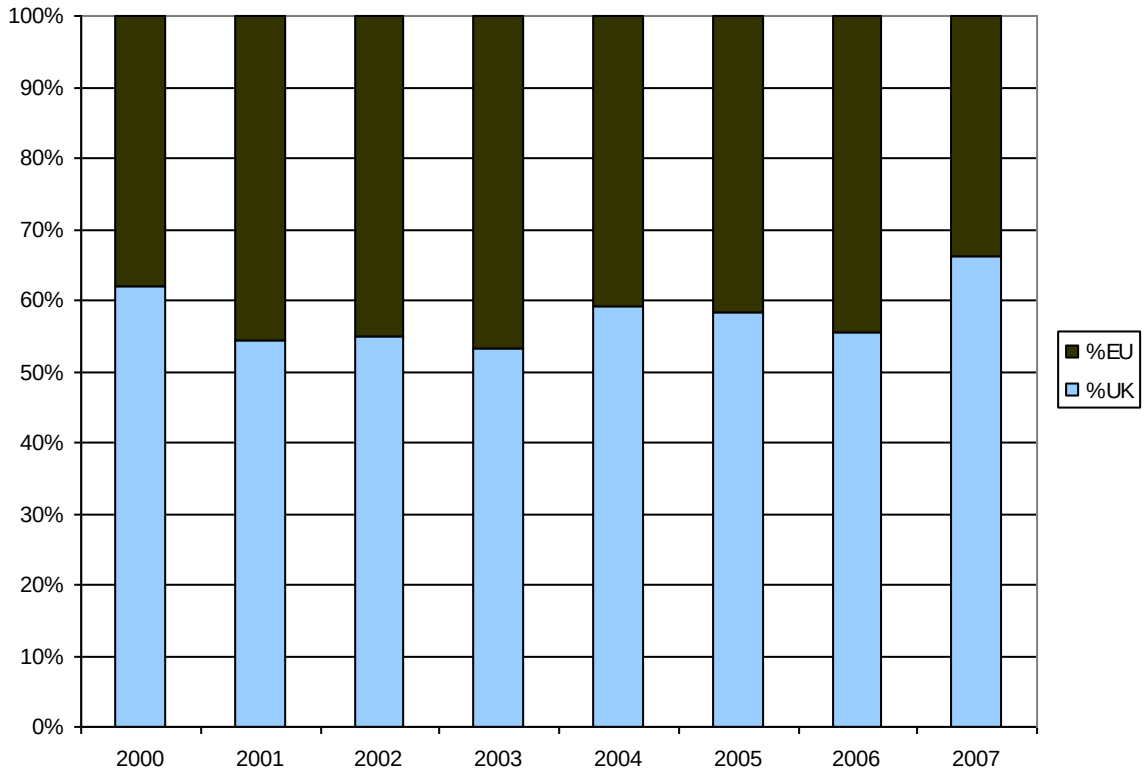


Figure 3.14 – source contributions for MODERATE or above exceedences of ozone over summers from 2000 onwards.

4 Breakdowns in the service

All bulletins were successfully delivered to the Air Quality Communications contractor on time and there were **no reported breakdowns** in the service over the year.

There was a **100% success rate** in uploading the forecast bulletins to the Air Quality Communications contractor and no breakdowns in the service were reported during the rest of the year.

5 Additional or enhanced forecasts

No formal enhanced forecasts can be issued until the format of the new service has been agreed with Defra and the Devolved Administrations. Nevertheless, there have been numerous informal discussions by email and telephone between the AEA Energy and Environment forecasters and Defra during this period. In particular, these were frequent during the particulate episode in late March.

The air pollution forecast is always re-issued to Teletext, Web and Freephone services at 10.00 a.m. local time each day, but this is only updated when the pollution situation is changing.

The bi-weekly air pollution outlooks have continued to be delivered successfully to Defra and other government departments by email on Tuesdays and Fridays.

6 Ad-hoc Services

During this year, two ad-hoc reports were presented to Defra and the devolved administrations. This detailed the extent and circumstances of pollution episodes and are listed below:

- A UK Particulate Episode from 24 March to 2 April 2007 (Andy Cook, Paul Willis, Helen Webster, Mark Harrison).
- An ad-hoc report detailing the particulate episode experienced in November as a result of bonfire night celebrations.

All episode reports which have been published can be found on the National Air Quality Archive at (www.airquality.co.uk/archive/reports/list.php).

In addition to these formal reports, regular contact was maintained with Defra and the Devolved Administrations throughout regarding possible 'HIGH' pollution levels over the UK.

7 Ongoing Research

7.1 INCREMENTAL DEVELOPMENTS

AEA Energy & Environment and the Met office will continue to:

1. Investigate ways of using automatic software systems to streamline the activities within the forecasting process, thus allowing forecasters to spend their time more efficiently considering the most accurate forecasts.

2. Research the chemistry used in our models, in particular the NO_x->NO_2 conversion used in NAME, and the chemical schemes for secondary PM_{10} and ozone.

3. Improve the NAME model runs that can be used for ad-hoc analyses, in particular with regard to investigating the possible long-range transport of PM_{10} pollution from European sources and the long-range transport of particles from Saharan Dust Storms.

4. Improve and update the emissions inventories used in our models.

8 Project and other related meetings

8.1 PROJECT MEETINGS

In January, the Met Office organised and hosted a meeting between the technical and scientific staff of AEA and the Met Office. The meeting was designed to improve the transfer of data between the two organisations and also to discuss recent technical developments. The meeting led to a targeted programme of change and model enhancement in both organisations.

AEA Energy & Environment hosted a project review meeting with Defra in early March 2007. Latest project developments were discussed, together with forthcoming operational changes to the modelling and software systems.

AEA Energy & Environment hosted a second project review meeting with Defra in the summer at Harwell. Recent transboundary air pollution episodes were discussed, together with generic operational issues and further proposed changes to the modelling and software systems used within the project.

The Met Office hosted a second technical meeting with AEA in October. The status of actions and developments from the previous meeting were reviewed. These included the new trajectory system, from which the output has started to be sent routinely to AEA on a daily basis. The final appearance of the forecast maps was agreed and these were being sent to AEA daily.

In November, the Met Office was invited to attend the AURN Annual Site Operators Meeting and Claire Witham presented work on the impacts of the 2007 Russian and Eastern European fires on UK air quality.

8.2 COST ES0602

COST ES0602 – "Towards a European Network on Chemical Weather Forecasting and Information Systems".

This COST Action was conceived following an EUMETNET workshop looking at the feasibility of running ensemble air quality forecasts in a similar formal manner to those run by ECMWF for weather forecasting.

A proposal was developed by Mikhail Sofiev of FMI to look at the following three Work Programmes (WPs) within the Action:

WP1 Exchange of AQ forecasts and input data: e.g., requirements on data exchange frequency, data formats, possibility to use existing infrastructure, such as WMO and EEA networks. Means of combining forecast data and Near Real Time (NRT) observations in a single system. Provisions for quality checks.

WP2 Multi-scale forecasting, multi-model ensemble, boundary data: Scientific ground for multi-model AQ assessments and forecasting. QA/QC issues: operational skill, model inter-comparison, evaluation protocols. Ways to define ensemble. Feasibility of emission scenarios (short term abatement).

WP3 Dissemination and visualization: Streamlining dissemination of AQ information to users. Assessing what information to display with harmonization possibilities: separate pollutants vs. AQ index; level of detail of maps, etc. Inventory of national systems including their links with other activities and organisations.

A cross-cutting activity for all WPs was planned to be to coordinate with other organisations (EEA, EUMETNET/WG-ENV, WMO, etc.) and ongoing activities (such as GEMS and PROMOTE).

The proposal was accepted by COST in November 2006 and Paul Willis of AEA together with Paul Agnew of the Met Office were nominated to be the UK representatives.

During 2007 there were two meetings of this COST group:

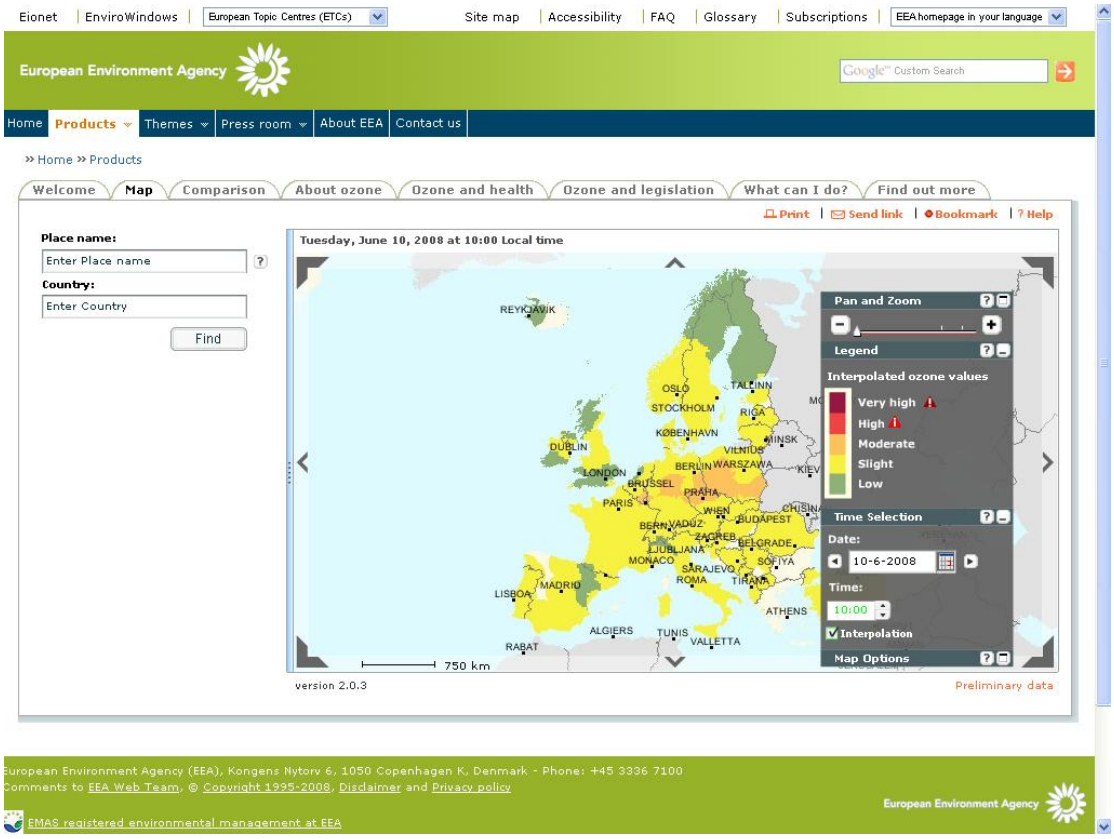
1) Inception meeting of the Action ES0602 on 19 April 2007, at the COST office in Brussels.
This was mainly an administrative meeting, to set up the management group, leaders and membership of each of the working groups.

2) COST ES0602 2nd MC and WG Meetings, at FMI in Helsinki, Finland, 4-5 October 2007.
The first meeting of the working groups to set up their aims and scope, review the existing technology and systems and how we could approach optimizing these in the future to recommend a more co-ordinated approach.

COST funds the T&S of the participants but no additional time. The main purpose of the meetings is to promote discussion between the different representatives and collation of existing work and information into papers and future recommendations.

8.3 OZONEWEB DEVELOPMENT

The EEA Ozoneweb near real-time public information system for Europe is now well-developed and fully available to the public at http://www.eea.europa.eu/maps/ozone/welcome, as illustrated in the figure below.



During 2007 Jaume Targa of AEA continued to assist the EEA in encouraging more countries and regions to provide ozone data to the system. This was funded through the EEA's Air and Climate Change Topic Centre contract and continues to target the following countries:

- Romania
- Bulgaria
- Iceland
- Luxemburg
- Turkey
- Italy - Southern and Central regions
- Spain - Consolidate some regions + EMEP
- Greece – increase coverage

During 2008 the Ozoneweb is also planned to be extended to cover the member state summer ozone reporting requirements of the European Air Quality Directive.

In parallel, the scope of the Ozoneweb project was extended in 2007 to include a Pilot Study to cover NO_2 and PM_{10}. A number of countries have already begun to supply these data voluntarily.

On behalf of Defra, Paul Willis attended an expert group meeting at NILU in Oslo in September 2007 to look at the best method for reporting harmonised near real-time PM_{10} data across Europe. This had particular reference to:

- The issues around combining data from different PM monitoring instruments and the use of correction factors for gravimetric equivalent data.
- Whether it is feasible to interpolate PM data to produce a map of latest concentrations across Europe.
- The best averaging period for reporting data and how this could be incorporated into a new or existing colour-coded air quality index.

The most significant conclusion was that it would be best for the member states to report data which were already corrected to gravimetric equivalent using their own local factors.

9 Related projects

During 2007 AEA entered into separate contracts with BSkyB and the Kent Air Quality Partnership to provide text based air quality forecasts for the whole of the UK and the Kent area respectively. AEA ensures that these forecasts issued under the separate contracts are consistent with the national forecasts for Defra, the DAs and the BBC.

The BSkyB forecast is issued daily as a 1-day ahead descriptive text summary of the pollution levels expected for the following day across the whole of the UK. The air quality forecast is aired live on Sky News twice daily at peak viewing times in combination with the regular weather forecast.

The KentAir forecast is issued as a short piece of descriptive text detailing the pollution levels expected in the Kent area for the current and following day. In addition to the AURN network sites, air quality levels measured at sites in the Kent AQ network are also taken into account when making an assessment of the forecast for the region. The forecast issued is also sent to the KentAir website at http://www.kentair.org.uk. .

10 Scientific Literature Review

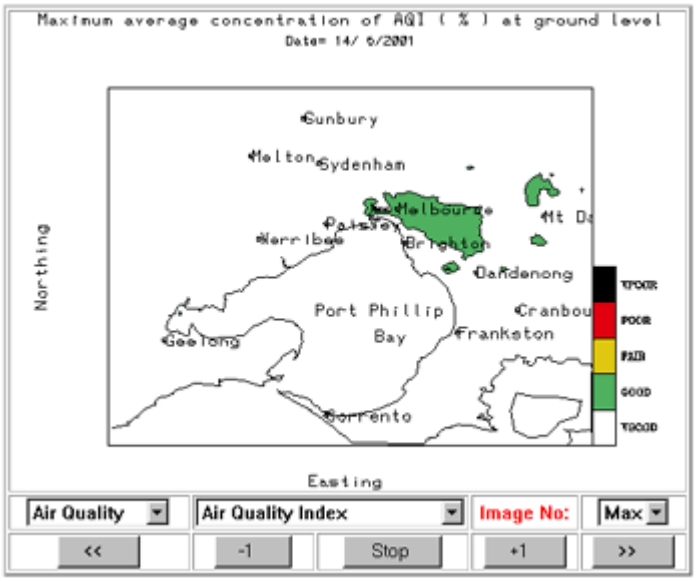
This section reviews a selection of the scientific literature available in the public domain that is relevant to air quality forecasting. A list of reports produced by the UK Met Office during 2007 is also provided at the end of this section.

Recent literature concerned with air quality forecasting is summarised below.

10.1 AUSTRALIAN AIR QUALITY FORECASTING SYSTEM

The Australian Air Quality Forecasting System (AAQFS) is a state of the art modelling system which forecasts the following day's air quality. Meteorological and emissions information are entered into the model, which aims to accurately forecast air pollution. The result is an hour-by-hour forecast of air quality. The AAQFS is currently used in Melbourne, Sydney and Adelaide.

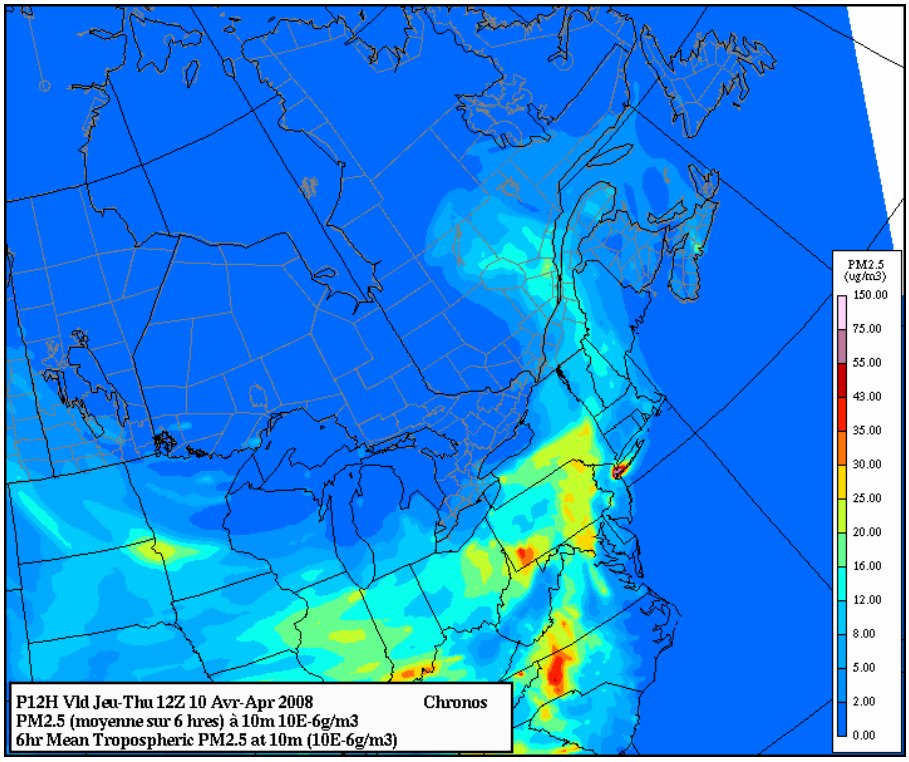
The AAQFS uses advanced calculation using supercomputers to forecast air quality for a whole suite of standard pollutants. EPA (Environmental Protection Agency) uses information provided by the AAQFS to assist with forecasting the next day's air quality. EPA's forecasting method uses historical weather and air quality data, and watches for particular weather conditions known to be associated with poor air quality. Statistical forecast techniques are used in this method. The AAQFS was developed by the Bureau of Meteorology, "CSIRO" and EPA. An illustrative map showing the maximum index value forecasted over Melbourne on one day is shown below.



More information can be found at: http://www.epa.vic.gov.au/Air/AAQFS/default.asp

10.2 THE CHRONOS MODEL USED IN CANADA

The MSC (Meteorological Service of Canada) uses a chemical transport model called CHRONOS (Canadian Regional and Hemispheric Ozone and NO_x System) to make real-time predictions of air quality over Canada for several future days. Animations are produced to show the model-simulated fields of ground-level ozone. CHRONOS forecasts the ground level ozone concentration at 10, 50 and 500 metres in height. Maps of particulate matter showing the levels of $PM_{2.5}$ and PM_{10} are also be available, as illustrated below for a $PM_{2.5}$ forecast over Eastern Canada on one day.



More information can be found at: http://www.msc-smc.ec.gc.ca/aq_smog/chronos_e.cfm

10.3 CAMBRIDGE ENVIRONMENTAL RESEARCH CONSULTANTS – THE "ADMS-URBAN" MODEL

CERC's air quality forecasting system is based around the "ADMS-Urban pollution dispersion modelling system". Using this software, the emissions from a variety of urban and industrial sources can be examined, to give concentrations at a high degree of spatial accuracy across the city.

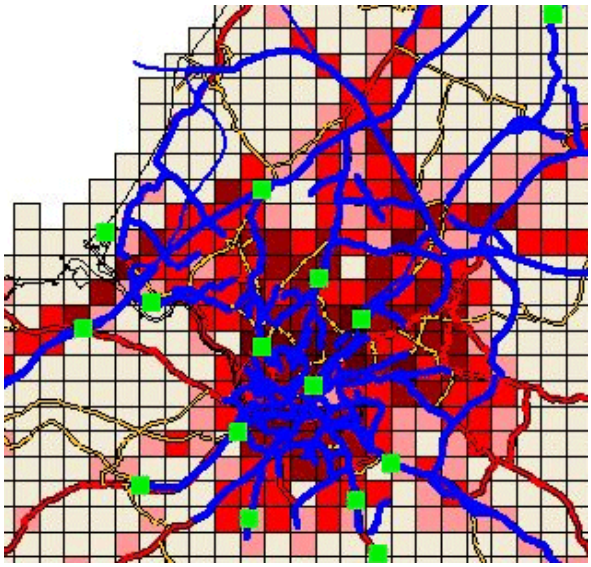
CERC are able to provide air quality forecasting at the urban and local scale throughout the UK and in other countries. airTEXT is a free air quality information service for people who live or work in London. People who sign up for airTEXT will receive voice or text message alerts when air pollution is forecast to be higher than normal. The service is aimed at people

who suffer from heart and breathing problems, whose health or quality of life may be affected by air pollution. The airTEXT web site provides further details.

Current areas CERC provide forecasts to are:

- The City of York, website address: http://www.cerc.co.uk/york/ -
- Parts of the south west of England, website address: http://www.cerc.co.uk/avon/ -
- Wakefield, in the central north of England, website address: http://www.cerc.co.uk/YourAir/Wakefield/index.asp
- The City of Budapest in Hungary, website address: http://members.chello.hu/dasy.kft/forecast/Budapest.htm

The ADMS-Urban model is in use in most of the urban areas of the UK, and its outputs have been validated in a number of studies published in scientific literature. The base pollution data used in the system are collated from national emissions records and local inventories currently in use. Forecasts for all the major pollutants are calculated by looking at vehicle flows on major roads, outputs from industry, releases from residential and commercial areas and pollution that drifts over the UK from continental Europe.



An emissions inventory, including grid and road sources in a city.
Green squares represent the location of receptor points.

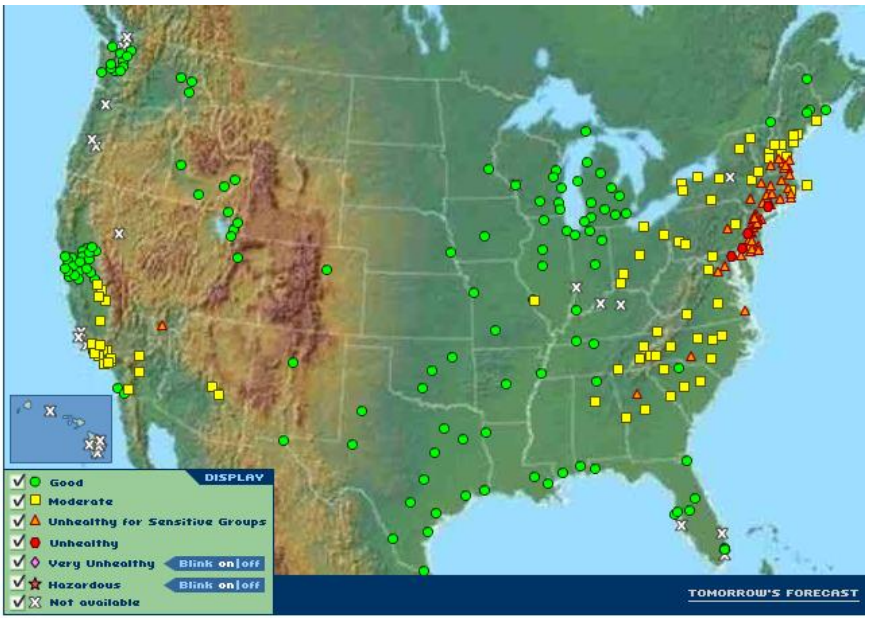
In order to produce air quality forecasts, emissions are run in conjunction with predicted levels of key meteorological parameters, for example wind data, temperature and cloud cover. This allows the generation of a data file which indicates air quality levels over the next 3 days. The forecast data is used as the basis for a variety of maps, animations, tables and summaries. A major advantage offered is the ability to generate high resolution maps either in the form of colour-coded air quality "contour" over-lays on a map or as labels over specific streets, suburbs or towns.

10.4 THE SAN JOAQUIN VALLEY AIR POLLUTION CONTROL DISTRICT AND THE AIRNOW PROGRAM

The San Joaquin Valley Air Pollution Control District is made up of eight counties in California's Central Valley: San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings Tulare and the Valley portion of Kern. The Control District is committed to improving the health and quality of life for all Valley residents through effective and cooperative air quality programs. The air quality forecast data provided to the San Joaquin Valley District is fed through from the AIRNow collaborative project.

The U.S. EPA (Environmental Protection Agency) , NOAA (National Oceanic & Atmospheric Administration) , NPS (National Park Service), tribal, state, and local agencies developed the AIRNow Web site to provide the public with easy access to national air quality information. There are well over 100 contributing participants. The website offers daily air quality forecasts as well as real-time measurements for over 300 cities across the US, and provides links to more detailed State and local air quality websites.

An overall map of areas provided is shown below.



The EPA calculates an air quality index value for five major air pollutants regulated by the Clean Air Act in the United States of America: ground-level ozone, particulate matter, carbon monoxide, sulphur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health.

Further information on the AIRNow project can be found at
http://airnow.gov/index.cfm?action=airnow.national

10.5 HAMPSHIRE AIR QUALITY FORECASTS AND THE MIRACLES PROJECT

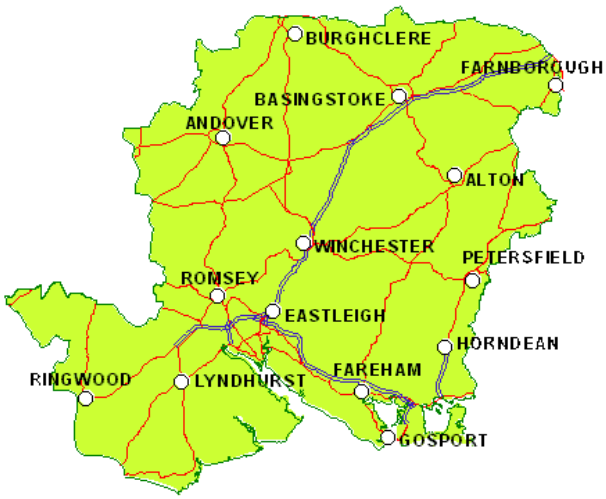
MIRACLES is a project that assembles four major European cities: Rome (Italy), Barcelona (Spain), Winchester (United Kingdom) and Cork (Ireland). The Miracles project responds to the initiative of the European Commission for increasing the urban transport system's sustainability and efficiency through radical strategies for Clean Urban Transport.

The four involved sites all strive to achieve four strategic goals with the support of the MIRACLES project which are:

- Reduction of transport-related environmental impacts at the local level;
- Increased urban accessibility;
- Enhanced economic efficiency through better transport management;
- Overall improvement of citizens' quality of life

Air quality forecasts in 14 different locations across Hampshire, of which Winchester is one, are made using NAME (Numerical Atmospheric Dispersion Modeling Environment), the Met Office's medium-to-long-range atmospheric dispersion model. It was originally developed as a nuclear accident model following the Chernobyl incident in 1986, but has since evolved into an all-purpose dispersion model capable of predicting the transport, transformation and deposition of a wide class of airborne materials.

A map of the towns covered by the Hampshire air quality forecasts is shown below.



More information on the Hampshire air quality forecasts can be found at:

http://www.metoffice.gov.uk/environment/aq/hants/index.html

Information on the MIRACLES project can be found at:

http://www.civitas-initiative.org/project_sheet?lan=en&id=8

10.6 SUSSEX-AIR

Air Alerts are issued by the Environmental Research Group, King's College London, whenever 'Moderate' or higher air pollution levels are expected over the next day or during a weekend within the area of Sussex Local Authorities. The airAlert service sends messages to mobile or home telephones and via email at times when poor air quality is predicted. The airAlert-4-schools service allows the information to be sent direct to teachers via text and email so that pupils may be informed when a pollution episode is expected. Seperate Air Alerts are produced for each district, predicting levels in rural and urban locations, and those close to busy or congested roads. The Air Alerts utilise monitoring data from within and around Sussex and are based on the Government's Air Pollution Banding System. The forecasted levels are also described by an associated probability factor.

AirALERT is provided by the Sussex Air Quality Steering Group; a consortium of local authorities and primary care trusts and was piloted up the summer of 2006 when it finally went live.

A map of the areas covered by the Sussex air quality forecasts is shown below.

More information on SUSSEX-Air can be found at
http://www.sussex-air.net/air_quality.html

Reports and publications produced by the UK Met Office during 2007 are listed below.

Webster H.N., Carroll E.B., Jones A.R., Manning A.J. and Thomson D.J., 2007, The Buncefield oil depot incident: a discussion of the meteorology, Weather 62(12), 325-330.

Webster H.N., Beare R.J., Devenish B.J., Haywood J.M., Lock A.P. and Thomson D.J., 2007, Using plume rise schemes to model highly buoyant plumes from large fires, In: David J Carruthers and Christine A McHugh (Eds.), Eleventh international conference on harmonisation within atmospheric dispersion modelling for regulatory purposes, p 220-224.

Witham C. and Manning A., 2007, Impacts of Russian biomass burning on UK air quality, Atmospheric Environment 41(37), 8075-8090.

Witham C., 2008, Southern England dustfall, Weather, 63(4), 109-110.

11 Forward work plan for 2008

- The current contract expires on November 30th 2008.
- The two tables below summarise both the weekly and annual planned activity for 2008/2009 (Table 10.1 and 10.2 respectively).

Table 10.1 Weekly Activity Chart

1 Task	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Daily Forecast							
Forecast Outlook Summary							

Table 10.2 Annual Activity Chart

2 Task	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Quarterly Reports												
Quarterly Progress Meetings												
Annual reports												
Seminars												

12 Hardware and software inventory

Defra and the Devolved Administrations own the code for the ozone and secondary PM_{10} models, but not the graphical interface for these. Defra and the Devolved Administrations own the software for delivering the air pollution forecast to the Air Quality Communications system. Defra and the Devolved Administrations also own the web pages used to display the forecasts.

No computer hardware being used on this project is currently owned by Defra and the Devolved Administrations.

13 References/Internet links

UK Air Quality Foreacsting reports on the National Air Quality Archive:
www.airquality.co.uk/archive/reports/list.php

Eleventh international conference on harmonisation within atmospheric dispersion modelling for regulatory purposes:

http://www.cerc.co.uk/HARMO11/index.htm

Weather journal:
http://www.rmets.org/

Atmospheric Environment Journal:
http://www.uea.ac.uk/~e044/ae_newpages/atmosenv.html

The KentAir website:
http://www.kentair.org.uk/pollutionlevels.php

Miscellaneous References:

http://www.metoffice.gov.uk/environment/aq/hants/index.html

http://www.civitas-initiative.org/project_sheet?lan=en&id=8

http://airnow.gov/index.cfm?action=airnow.national

airTEXT web site

http://www.cerc.co.uk/york/

http://www.cerc.co.uk/avon/

http://www.cerc.co.uk/YourAir/Wakefield/index.asp

http://members.chello.hu/dasy.kft/forecast/Budapest.htm

http://www.msc-smc.ec.gc.ca/aq_smog/chronos_e.cfm

http://www.epa.vic.gov.au/Air/AAQFS/default.asp

Appendix 1 - Air Pollution Index

CONTENTS

Old Banding	Index	Ozone 8-hourly/ Hourly mean		Nitrogen Dioxide Hourly Mean		Sulphur Dioxide 15-Minute Mean		Carbon Monoxide 8-Hour Mean		PM_{10} 24-Hour Mean
		μgm^{-3}	ppb	μgm^{-3}	ppb	μgm^{-3}	ppb	mgm^{-3}	ppm	gravimetric μgm^{-3} Proposed FDMS limits / TEOM limits
LOW										
	1	0-32	0-16	0-95	0-49	0-88	0-32	0-3.8	0.0-3.2	0 –19 / 0–21
	2	33-66	17-32	96-190	50-99	89-176	33-66	3.9-7.6	3.3-6.6	20–40 / 22-42
	3	67-99	33-49	191-286	100-149	177-265	67-99	7.7-11.5	6.7-9.9	41-62 / 43-64
MOD										
	4	100-126	50-62	287-381	150-199	266-354	100-132	11.6-13.4	10.0-11.5	63-72 / 65-74
	5	127-152	63-76	382–477	200-249	355-442	133-166	13.5-15.4	11.6-13.2	73-84 / 75-86
	6	153-179	77-89	478-572	250-299	443-531	167-199	15.5-17.3	13.3-14.9	85-94 / 87-96
HIGH										
	7	180-239	90-119	573-635	300-332	532-708	200-266	17.4-19.2	15.0-16.5	95-105 / 97-107
	8	240-299	120-149	636-700	333-366	709-886	267-332	19.3-21.2	16.6-18.2	106-116 / 108-118
	9	300-359	150-179	701-763	367-399	887-1063	333-399	21.3-23.1	18.3-19.9	117-127 / 119-129
V. HIGH										
	10	≥ 360 μgm^{-3}	≥ 180 ppb	≥ 764 μgm^{-3}	≥ 400 ppb	≥1064 μgm^{-3}	≥ 400 ppb	≥ 23.2mgm^{-3}	≥ 20 ppm	≥ 128 / 130 μgm^{-3}

Old Banding	New Index	Health Descriptor
LOW		
	1	
	2	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
	3	
MODERATE		
	4	
	5	Mild effects unlikely to require action may be noticed amongst sensitive individuals
	6	
HIGH		
	7	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be
	8	needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their
	9	"reliever inhaler is likely to reverse the effects on the lung.
VERY HIGH		
	10	The effects on sensitive individuals described for "HIGH" levels of pollution may worsen.

Appendix 2 - Forecasting Zones and Agglomerations

CONTENTS

Forecasting Zones

Zone	*Population*
East Midlands	2923045
Eastern	4788766
Greater London	7650944
North East	1287979
North West and Merseyside	2823559
South East	3702634
South West	3728319
West Midlands	2154783
Yorkshire and Humberside	2446545
South Wales	1544120
North Wales	582488
Central Scotland	1628460
Highland	364639
North East Scotland	933485
Scottish Borders	246659
Northern Ireland	1101868

Forecasting Agglomerations

Agglomeration	*Population*
Brighton/Worthing/Littlehampton	437592
Bristol Urban Area	522784
Greater Manchester Urban Area	2277330
Leicester	416601
Liverpool Urban Area	837998
Nottingham Urban Area	613726
Portsmouth	409341
Sheffield Urban Area	633362
Tyneside	885981
West Midlands Urban Area	2296180
West Yorkshire Urban Area	1445981
Cardiff	306904
Swansea/Neath/Port Talbot	272456
Edinburgh Urban Area	416232
Glasgow Urban Area	1315544
Belfast	475987

Map of forecasting zones and agglomerations