

# REPORT

## UK Air Quality Forecasting: Operational Report for October to December 2004

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



AEAT/ENV/R/1950 Issue 1  
March 2005

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# Executive Summary

This report covers the operational activities carried out by Netcen and the Met Office on the UK Air Quality Forecasting Contract from October to December 2004. The work is funded by the Department for Environment Food and Rural Affairs (Defra), the Scottish Executive, Welsh Assembly Government and the Department of the Environment in Northern Ireland.

During the fourth quarter of 2004, there were a total of four days on which HIGH air pollution was recorded. These HIGH periods are recorded within the forecasting success calculations. The forecasting success and accuracy for this quarter for HIGH and MODERATE episodes is summarised in Table 1 below.

The success of predicting these HIGH days in zones was poor for this quarter mainly due to the effects of one highly localised combustion activity measured at a single monitoring site and higher than anticipated levels measured at a second station as a result of Bonfire Night activities. HIGH levels were not measured in agglomerations during this period.

Success figures for MODERATE forecasts issued show that a large proportion of measured polluted days were successfully forecast (percentage above 100%)<sup>1</sup>. An average accuracy figure of 60 % indicates that only 40 % of the forecast MODERATE levels were not measured and remained LOW. The accuracy figures tend to be lower due to the precautionary approach that Netcen takes when issuing the daily forecasts- we issue a forecast for MODERATE pollution when there is only a small chance that it will be recorded.

**Table 1 – Forecast success/accuracy for incidents<sup>1</sup> above 'HIGH' and above 'MODERATE', October 1st to December 31<sup>st</sup> 2004.**

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	0	0	120	66
Agglomerations	100	0	128	56

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

1. Investigating ways of using automatic software systems to streamline the activities within the forecasting process, thus allowing forecasters to spend their time more productively considering the most accurate forecasts.
2. Researching the chemistry used in our models, in particular the NO<sub>x</sub>->NO<sub>2</sub> conversion used in NAME, and the chemical schemes for secondary PM<sub>10</sub> and ozone.
3. Improving the NAME model used for ad-hoc analyses. In particular, recent improvements have assisted with investigations of the possible long-range transport of PM<sub>10</sub> pollution from forest fires in Russia and the long-range transport of particles from Saharan Dust Storms.
4. Improving and updating the emissions inventories used in our models.

There were no reported breakdowns in the forecasting service between October and December; all bulletins were delivered to the Air Quality Communications contractor on time.

<sup>1</sup> Note that the calculations of accuracy and success rates are based on a successful prediction being  $\pm 1$  of the measured index; it is therefore possible to record rates in excess of 100% rather than 'true' percentages.

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# 1 Introduction

A forecast of the following day's air pollution is prepared every day by Netcen in collaboration with the Met Office. 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 can be updated and disseminated through Teletext, the World Wide Web and a Freephone telephone number 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, and is then included in subsequent air quality bulletins for the BBC, newspapers and many other interested organisations.

This report covers the media forecasts issued between 1<sup>st</sup> October and 31<sup>st</sup> December 2004. 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 every week, on Tuesdays and Fridays, we also provide a long-range pollution outlook. This takes the form of a short text message which is emailed to approximately sixty recipients in Defra and other Government Departments, together with the BBC weather forecasters. The outlook is compiled by careful assessment and review of the outputs from our pollution models, which currently run out to 3 days ahead, and by also considering the long-term weather situation.

We continue to provide a quality control system 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 230 UK towns and cities on their BBC Online service. The quality control work is carried out at around 3.00 p.m. daily, with the forecast updating onto the BBC Online Web site at 4.00 a.m. the following morning.

## 2 New developments during this period

### 2.1 FORECAST ANALYSIS SOFTWARE

The Netcen forecasting analysis software has been updated to include analysis for forecasting success and accuracy after data have been ratified, as well as accounting for alterations after the provisional, as-collected stage. The updated software compares forecasted levels from the date/ time of day issued (normally around 3 pm), with the most up to date data stored on the National Air Quality Archive for the 24 hours that followed the issue of each forecast. This helps to remove or reduce the incidence of obviously faulty data often seen in the as-collected data and therefore improves the overall quality of the analysis results.

### 2.2 QUARTERLY REPORT FORMAT

An enhanced format for quarterly reports has been agreed with Defra and the Devolved Administrations, including important new features such as:

- Clearer graphical formats
- Updated information in the text and
- Clearer explanation of the analysis results.

### 3 Analysis of Forecasting Success Rate

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). The analysis is based on latest data in the Air Quality Archive ([www.airquality.co.uk](http://www.airquality.co.uk)), so any obviously faulty data should have been removed.

The analysis treats situations where the forecast index was within  $\pm 1$  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  $\pm 1$  of the measured index, it is possible to record rates in excess of 100% rather than 'true' percentages. Appendix 1 provides a detailed description of the UK Air Pollution Index.

The forecasting success rates for each zone and agglomeration for October - December 2004 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:

- u The number of 'HIGH' days measured in the PROVISIONAL data
- u The number of 'HIGH' days forecast
- u The number of days with a correct forecast of 'HIGH' air pollution, within an agreement of  $\pm 1$  index value. A HIGH forecast is recorded as correct if air pollution is measured HIGH and the forecast is within  $\pm 1$  index value, or it is forecast HIGH and the measurement is within  $\pm 1$  index value. For example measured index 7 with forecast index 6 counts as correct, as does measured index 6 with forecast index 7.
- u 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.
- u 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:

- u  $(\text{Number of episodes successfully forecast} / \text{total number of episodes measured}) \times 100$

The forecast accuracy (%) is calculated as:

- u  $(\text{Number of episodes successfully forecast} / [\text{Number of successful forecasts} + \text{number of wrong forecasts}]) \times 100$

The forecasting success rates for 'MODERATE' days or above for each zone and agglomeration are presented in Tables 3.3 (zones) and 3.4 (agglomerations). Table 3.3 and 3.4 give the same information as in Tables 3.1 and 3.2, but summarised for 'MODERATE' days and above.



### 3.1 FORECAST ANALYSIS FOR OCTOBER 1<sup>ST</sup> TO DECEMBER 31<sup>ST</sup> 2004

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

ZONES	Central Scotland	East Mids	Eastern	Greater London	Highland	North East	North East 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	1	2	0	0	0	0	2	0	0	0	0	0	0	0	5
forecasted days	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
ok (f and m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
wrong (f not m)	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2
wrong (m not f)	0	0	1	2	0	0	0	0	2	0	0	0	0	0	0	0	5
success %	100	100	0	0	100	100	100	100	0	100	100	100	100	100	100	100	0
accuracy %	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

**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	0	0	0	0
forecasted days	0	0	0	0	0	0	0	0	0
ok (f and m)	0	0	0	0	0	0	0	0	0
wrong (f not m)	0	0	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	0	0	0	0	0	0
success %	100	100	100	100	100	100	100	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	0	0	0	0	0	0	0
forecasted days	0	0	0	0	0	0	0	0
ok (f and m)	0	0	0	0	0	0	0	0
wrong (f not m)	0	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	0	0	0	0	0
success %	100	100	100	100	100	100	100	100
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.

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 East Scotland	North Wales	North West & Merseyside	Northern Ireland	Scottish Borders	South East	South Wales	South West	West Midlands	Yorkshire & Humberside	Overall
measured days	1	0	12	20	16	1	0	0	3	1	0	2	0	3	0	5	64
forecasted days	0	3	5	17	3	1	0	4	1	2	0	6	6	10	2	1	61
ok (f and m)	1	1	8	22	17	2	0	4	1	3	0	7	3	5	1	2	77
wrong (f not m)	0	2	3	4	2	0	0	0	1	0	0	1	3	5	1	1	23
wrong (m not f)	0	0	6	4	0	0	0	0	2	0	0	0	0	2	0	3	17
success %	100	100	67	110	106	200	100	100	33	300	100	350	100	167	100	40	120
Accuracy %	100	33	47	73	89	100	0	100	25	100	0	88	50	42	50	33	66

**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	0	0	4	1	0	3	6	0	1
forecasted days	2	2	8	3	3	5	7	1	0
ok (f and m)	1	0	7	2	0	4	7	0	0
wrong (f not m)	1	2	3	1	3	2	1	1	0
wrong (m not f)	0	0	0	0	0	1	2	0	1
success %	100	100	175	200	100	133	117	100	0
Accuracy %	50	0	70	67	0	57	70	0	0

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	0	0	0	6	0	2	6	29
forecasted days	1	5	0	3	0	3	5	48
ok (f and m)	0	1	0	6	0	3	6	37
wrong (f not m)	1	4	0	1	0	1	2	23
wrong (m not f)	0	0	0	1	0	0	1	6
success %	100	100	100	100	100	150	100	128
Accuracy %	0	20	0	75	0	75	67	56

\* All performance statistics are based on provisional data. Obviously incorrect data due to instrumentation faults have been removed from the analyses.  
 Please refer to the start of section 3 for an explanation of the derivation of the various statistics, figures >100 % may occur.

**Table 3.5 – Summary of episodes October to December 2004 (Based on latest provisional data)**

Pollutant	High days	Moderate days	Max. conc. ( $\mu\text{g}/\text{m}^3$ ) *	Site with max. conc.	Zones or Agglomeration	Date of max conc.	Forecast success HIGH days (%)
Ozone	0	20	118	St Osyth	Eastern	2/10/04	N/a
PM <sub>10</sub> gravimetric	4	28	139	Preston	North West and Merseyside	8/12/04	0
NO <sub>2</sub>	0	5	361	London Marylebone Road	Greater London	9/11/04	N/a
SO <sub>2</sub>	0	3	319	Southend on Sea	Eastern	13/12/04	N/a
CO	0	0	-	-	-	-	N/a

\* Maximum concentration relate to 8 hourly running mean or hourly mean for ozone, 24 hour running mean for PM<sub>10</sub>, hourly mean for NO<sub>2</sub>, 15 minute mean for SO<sub>2</sub> and 8 hour running mean for CO.

### General Observations

The fourth quarter was characterised by some localised pollution events, wider-spread effects over Bonfire Night weekend and two periods of elevated particulate levels measured in foggy, still weather.

Four HIGH days were seen for PM<sub>10</sub> during this period, two of these were as a result of Bonfire Night celebrations on the evenings of 5<sup>th</sup> and 6<sup>th</sup> November. HIGH days were also measured on the 8<sup>th</sup> and 9<sup>th</sup> December during a period of still, foggy weather at Preston, due to localised combustion activities. Bonfire Night was not considered to be a special pollution event this year when compared with measurements made from the last five years.

Three MODERATE days were measured for sulphur dioxide at three separate locations and five MODERATE days for nitrogen dioxide at Marylebone Road over this quarter. Marylebone Road also measured 13 MODERATE days due to particulates.

Ozone MODERATE levels were recorded sporadically throughout the quarter but remained mainly LOW at the majority of sites, as could be expected for the time of year.

Figures 3.1 – 3.3 show the trends of pollutants in graphical form. A site-by-site breakdown is given in Figures 3.4a and 3.4b.

### O<sub>3</sub>

Ozone reached the MODERATE band at only two rural sites- Strath Vaich and St Osyth. Weather conditions over this quarter were not conducive to significant ozone formation, as expected for autumn and winter months.

### PM<sub>10</sub>

The two highest particulate 24-hour running means associated with Bonfire Night celebrations were calculated to be 117  $\mu\text{g}/\text{m}^3$  (gravimetric PM10) on 6<sup>th</sup> November and 112  $\mu\text{g}/\text{m}^3$  on the 7<sup>th</sup>, both for London Hillingdon as a result of celebrations held on the evening of Saturday 6<sup>th</sup>. These measurements corresponded to Index 8 (HIGH band), index 6 (MODERATE band) was forecast for the London area over that weekend. Eight sites measured MODERATE levels of particulate PM10 on the 5<sup>th</sup> November, five of these in London and at an additional 5 sites (ie 13 sites in total) on the 6<sup>th</sup> November in terms of 24-hour running means.

An area of high pressure was situated to the south-west of the UK during the Bonfire Night weekend, with unsettled weather moving in from the north. MODERATE levels were also measured

at Port Talbot, Cardiff and four additional London sites due to the celebrations and settled weather over that weekend. Middlesbrough was the only site in the north of England to measure MODERATE PM10 due to firework celebrations. The Plymouth site also measured MODERATE levels over that period due to an unconnected event (paving works). MODERATE levels were predicted with a fair degree of accuracy in the forecasting process, with a good agreement on the regional trends experienced over the Bonfire Night weekend .

Five sites measured MODERATE levels of PM<sub>10</sub> on the 8<sup>th</sup> and 11<sup>th</sup> of December, during foggy and cloudy weather conditions in a period when an area of high pressure lay to the south-east of the UK. Exceedences were geographically widespread on the 8<sup>th</sup>, but were mainly confined to the London area on the 11<sup>th</sup>. VERY HIGH band concentrations (index 10) were calculated for the 8<sup>th</sup> and 9<sup>th</sup> December at Preston as a result of a series of very large hourly average measurements on the evening of the 8<sup>th</sup> (maximum gravimetric 24-hr running mean calculated to be 139 ug/m<sup>3</sup> on the 8<sup>th</sup>); a localised combustion activity was identified as the source. This was not successfully forecasted to within one index band.

Figure 3.2 shows the trends in PM<sub>10</sub> levels over this period.

### **NO<sub>2</sub>**

Nitrogen dioxide levels rose into the MODERATE band on five days at London Marylebone Road; these appeared to be traffic-related measurements.

### **SO<sub>2</sub>**

Sulphur dioxide levels did not reach the HIGH band during this period. MODERATE levels were measured at 3 sites: Grangemouth (271 ug/m<sup>3</sup> on 10<sup>th</sup> October), Thurrock (279 ug/m<sup>3</sup> on the evening of 9<sup>th</sup> December) and Southend on Sea (319 ug/m<sup>3</sup> on 13<sup>th</sup> December with elevated concentrations for most of that day), probably as a result of local industrial emissions for all examples and still, settled weather for the December incidents.

Figure 3.3 shows the trends in SO<sub>2</sub> levels over this period with NO<sub>2</sub> also included.

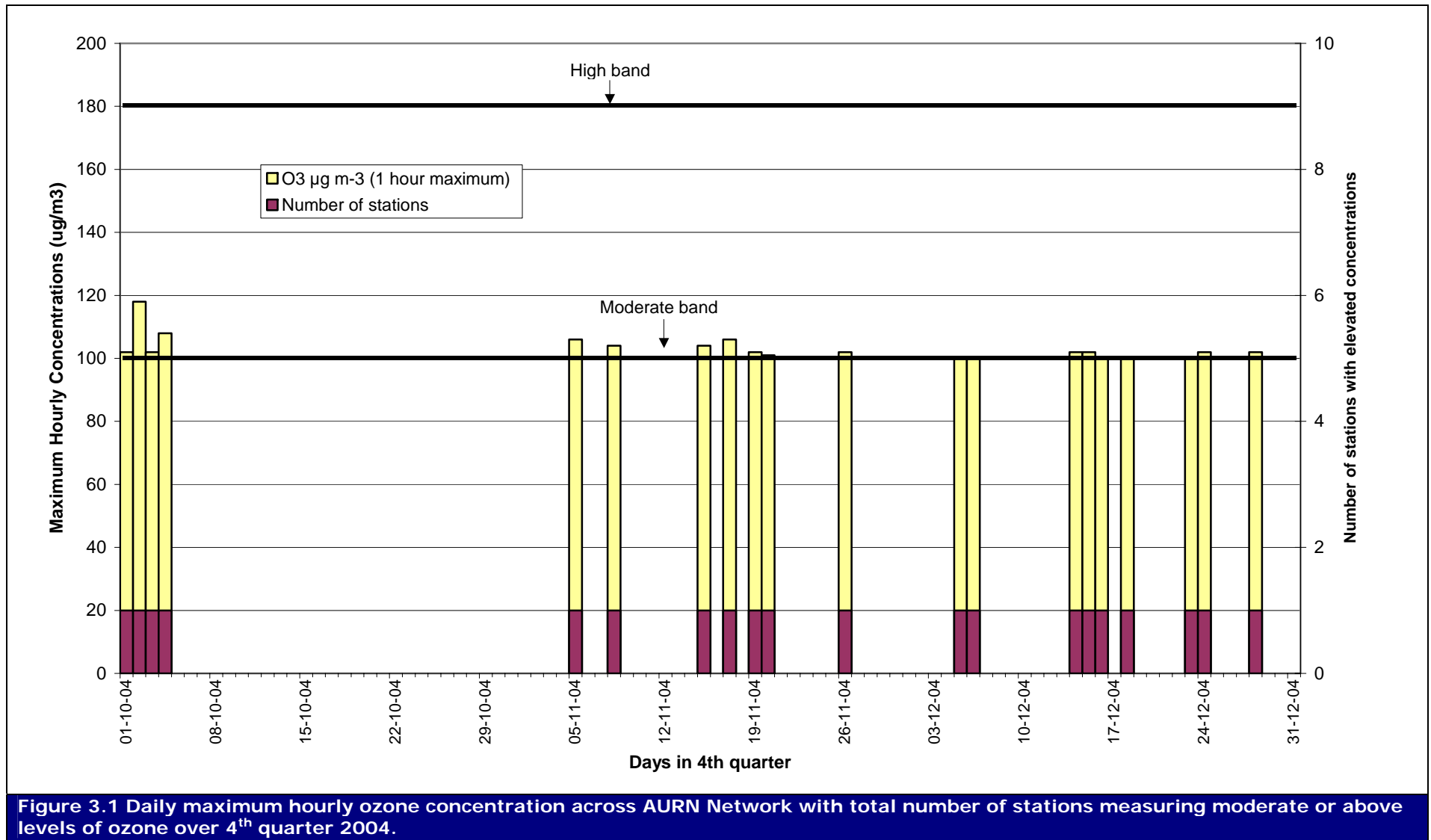


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring moderate or above levels of ozone over 4<sup>th</sup> quarter 2004.

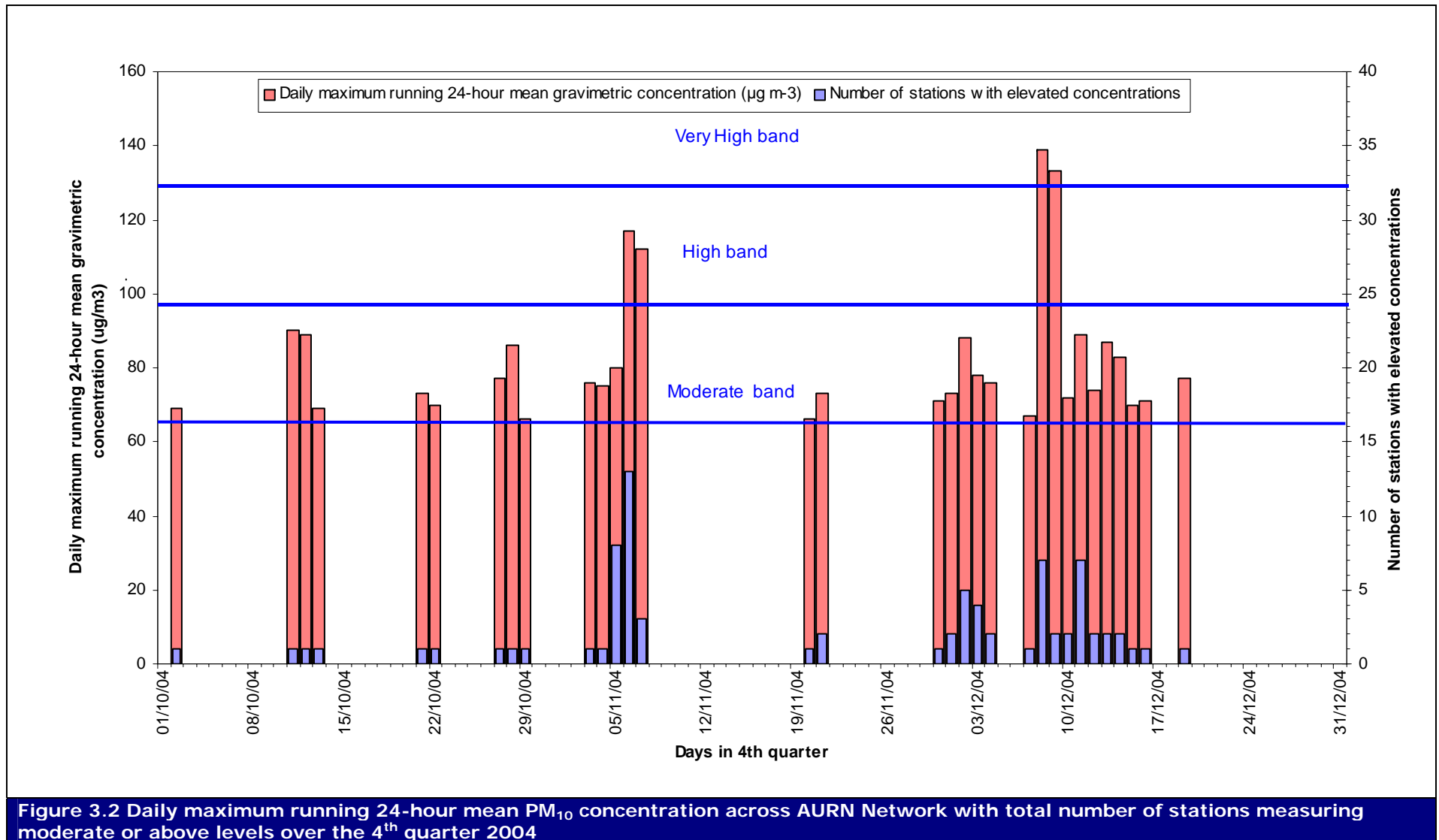
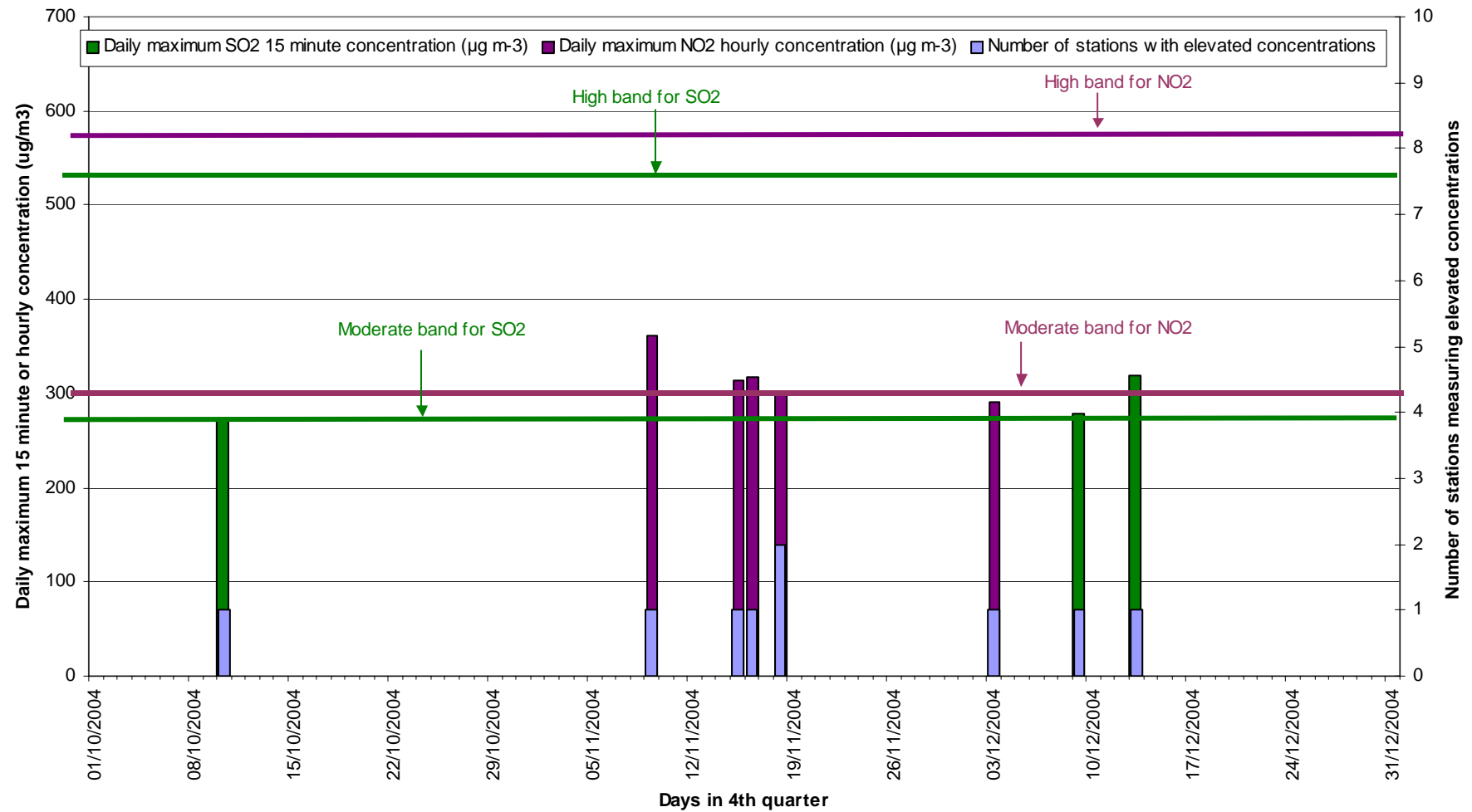


Figure 3.2 Daily maximum running 24-hour mean PM<sub>10</sub> concentration across AURN Network with total number of stations measuring moderate or above levels over the 4<sup>th</sup> quarter 2004



**Figure 3.3 Maximum 15 minute average concentrations of SO<sub>2</sub> and hourly average of NO<sub>2</sub> across AURN Network with total number of stations measuring moderate or above levels over the 4<sup>th</sup> quarter 2004**

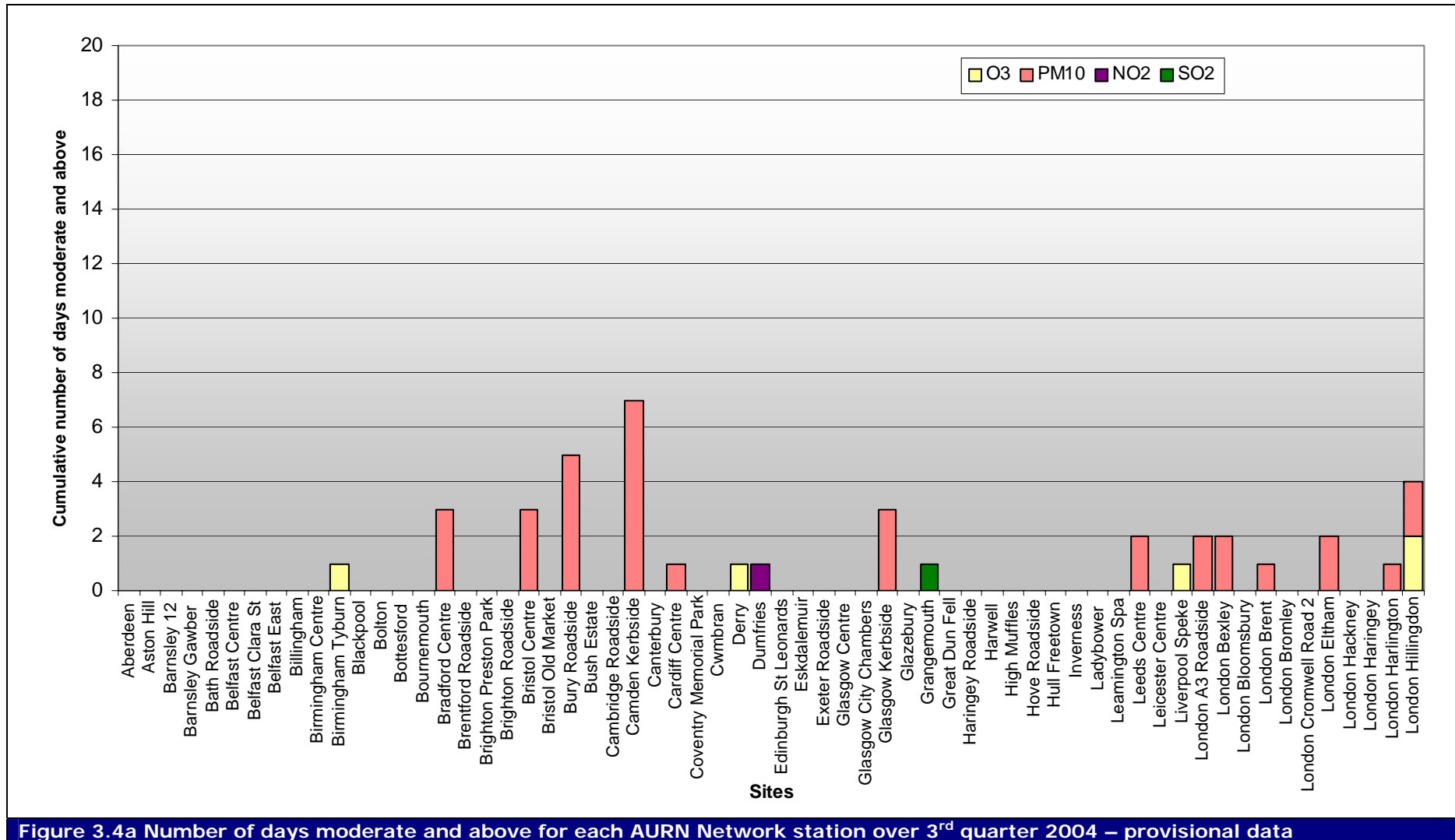


Figure 3.4a Number of days moderate and above for each AURN Network station over 3<sup>rd</sup> quarter 2004 – provisional data



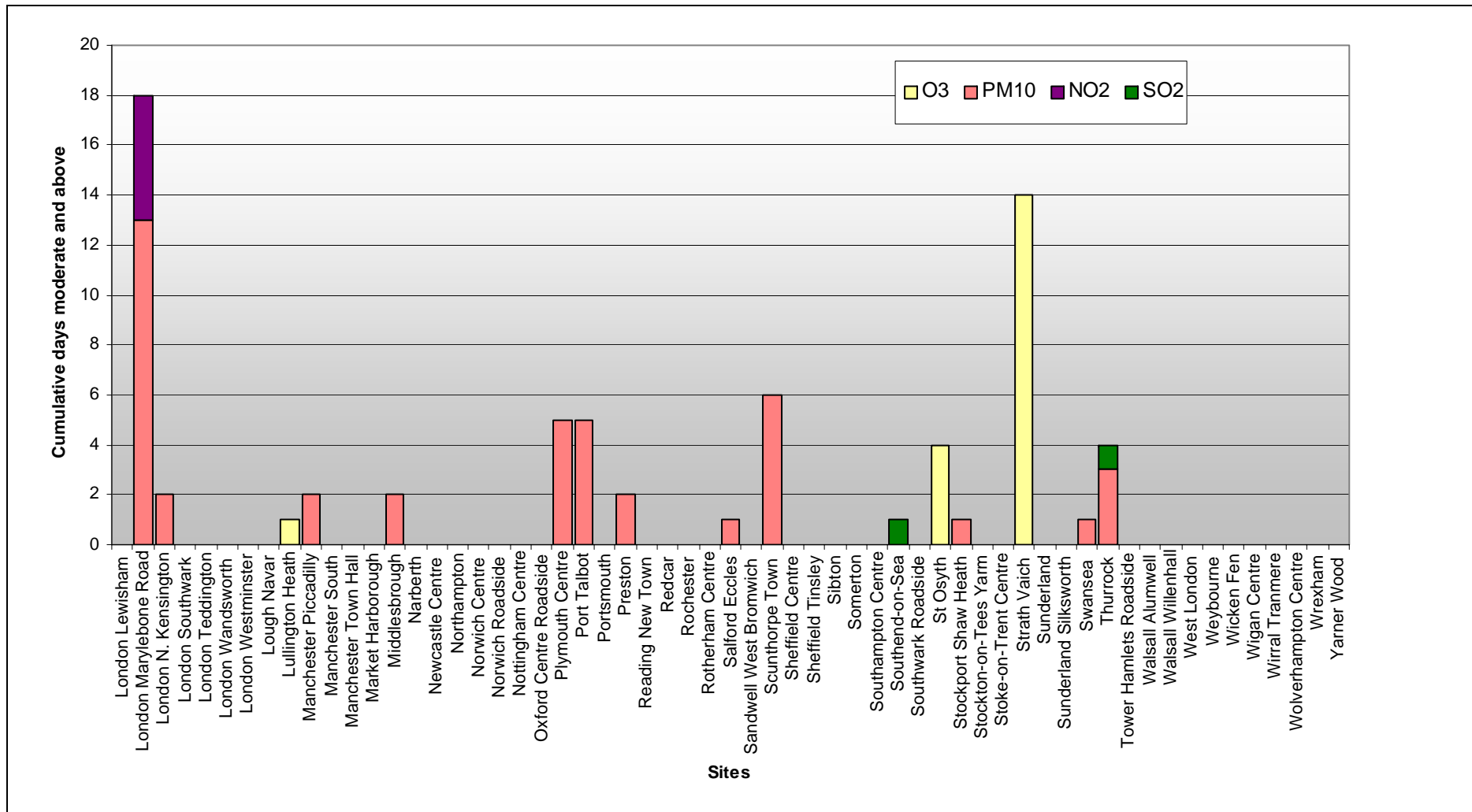


Figure 3.4b Number of days moderate and above for each AURN Network station over 4<sup>th</sup> quarter 2004 – provisional data

## 4 Breakdowns in the service

All bulletins were successfully delivered to the Air Quality Communications contractor on time. There were no reported breakdowns in the service over this three-month period.

## 5 Additional or enhanced forecasts

No formal enhanced forecasts can be issued until the format of the enhanced service has been agreed with Defra and the Devolved Administrations.

The air pollution forecast is always re-issued to Teletext, Web and Freephone services at 10.00 local time each day, but will only be 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

No ad-hoc reports were issued this period, although a summary email was produced detailing measurements made over the Bonfire Night weekend.

## 7 Ongoing research

Netcen and the Met office will also 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  $\text{NO}_x \rightarrow \text{NO}_2$  conversion used in NAME, and the chemical schemes for secondary  $\text{PM}_{10}$  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  $\text{PM}_{10}$  pollution from forest fires in Russia and the long-range transport of particles from Saharan Dust Storms.
4. Improve and update the emissions inventories used in our models.

## 8 Forward work plan for January to March 2005

Major tasks include:

- Ongoing daily air pollution forecasting activities.
- Ongoing improvements to NAME model, including:
  - Improved modelling over steep topographical gradients
  - Higher resolution model runs with reduced statistical noise
  - Update of emissions inventory used in the model.
- Publication of quarters 1 to 4 2004 reports on the Air Quality Archive Web Site.

## 9 Hardware and software inventory

Defra and the Devolved Administrations own the code for the ozone and secondary PM<sub>10</sub> 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.

# Appendix 1 - Air Pollution Index

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## CONTENTS

1	Table showing the Air Pollution index
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## The UK Air Pollution Indices

Old Banding	Index	Ozone 8-hourly/ Hourly mean		Nitrogen Dioxide Hourly Mean		Sulphur Dioxide 15-Minute Mean		Carbon Monoxide 8-Hour Mean		PM <sub>10</sub> Particles 24-Hour Mean
		µgm <sup>-3</sup>	ppb	µgm <sup>-3</sup>	ppb	µgm <sup>-3</sup>	ppb	mgm <sup>-3</sup>	ppm	µgm <sup>-3</sup>
<b>LOW</b>										
	1	0-32	0-16	0-95	0-49	0-88	0-32	0-3.8	0.0-3.2	0-16
	2	33-66	17-32	96-190	50-99	89-176	33-66	3.9-7.6	3.3-6.6	17-32
	3	67-99	33-49	191-286	100-149	177-265	67-99	7.7-11.5	6.7-9.9	33-49
<b>MODERATE</b>										
	4	100-126	50-62	287-381	150-199	266-354	100-132	11.6-13.4	10.0-11.5	50-57
	5	127-152	63-76	382-477	200-249	355-442	133-166	13.5-15.4	11.6-13.2	58-66
	6	153-179	77-89	478-572	250-299	443-531	167-199	15.5-17.3	13.3-14.9	67-74
<b>HIGH</b>										
	7	180-239	90-119	573-635	300-332	532-708	200-266	17.4-19.2	15.0-16.5	75-82
	8	240-299	120-149	636-700	333-366	709-886	267-332	19.3-21.2	16.6-18.2	83-91
	9	300-359	150-179	701-763	367-399	887-1063	333-399	21.3-23.1	18.3-19.9	92-99
<b>VERY HIGH</b>										
	10	≥ 360 µgm <sup>-3</sup>	≥ 180 ppb	≥ 764 µgm <sup>-3</sup>	≥ 400 ppb	≥ 1064 µgm <sup>-3</sup>	≥ 400 ppb	≥ 23.2 mgm <sup>-3</sup>	≥ 20 ppm	≥ 100 µgm <sup>-3</sup>

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

# Appendix 2 - Forecasting Zones and Agglomerations

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## CONTENTS

- 1 Table showing the Air Pollution Forecasting Zones and Agglomerations, together with populations (based on 1991 Census).
- 2 Map of Forecasting Zones and Agglomerations.

**Forecasting Zones**

<b>Zone</b>	<b>Population</b>
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**

<b>Agglomeration</b>	<b>Population</b>
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 UK forecasting zones and agglomerations

