UK Air Quality Forecasting: Operational Report for January to March 2008

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

AEA

AEAT/ENV/R/2651 Issue 1, June 2008

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Title	UK Air Quality Forecasting: Operational Report for January to March 2008.
Customer	Department for Environment Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and the Department of the Environment in Northern Ireland
Customer reference	EPG 1/3/179
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File reference	ED45099
Report number	AEAT/ENV/R/2651 Issue 1
Report status	Finalised

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

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	Name	Date
Author	Andy Cook	25/06/2008
Reviewed by	Paul Willis	16/07/2008
Approved by	Jon Bower	06/08/2008

Executive Summary

This report covers the operational activities carried out by AEA Energy & Environment and the Met Office under the UK Air Quality Forecasting Contract from January to March 2008. 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 first quarter of 2008, there were eleven days on which HIGH or above air pollution were recorded. All of the HIGH or above exceedences were due to PM_{10} and occurred as a result of 2 days of long range transport of dust from sandstorms in Africa, 7 days of winter episodic pollution conditions in February and 2 days as a result of localised waste combustion near the Wirral Tranmere AQM site.

Overall forecast success and accuracy rates for the HIGH band were low at 10 % and 25 % respectively as an average for zones and agglomerations during this quarter, due to the inherent difficulty of forecasting the intensity of these type of episodic, and sometimes localised, particulate events.

Many MODERATE days were measured (mainly for ozone and PM_{10} but with a smaller contribution from NO_2 and SO_2) and were forecasted with a high degree of success in both zones and agglomerations and a reasonable average accuracy figure of around 75 %. The forecast accuracy for the MODERATE band will have been affected by three pollution episodes (one as a result of long range transport of dust) which are inherently difficult to forecast in terms of their intensity. These MODERATE periods are recorded within the forecasting success and accuracy calculations. The forecasting success and accuracy for this quarter for HIGH and MODERATE episodes is summarised in Table 1 below.

Success figures for MODERATE forecasts issued show that a significant proportion of measured polluted days were successfully forecast (percentage above 100 %). An average accuracy figure of around 75 % is likely to indicate that a quarter of the forecast MODERATE levels were not measured and remained LOW. The accuracy figures often tend to be lower due to the precautionary approach that AEA Energy & Environment takes when issuing the daily forecasts- we intentionally 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 above 'HIGH' and above 'MODERATE', January 1st to March 31st 2008.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	0	0	121	84
Agglomerations	20	50	136	67

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

1. Investigating new approaches to 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, for example the chemical schemes for secondary PM_{10} 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_{10} 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 January and March; all bulletins were successfully delivered to the Air Quality Communications contractor on time.

Contents

1 Introduction

In collaboration with the Met Office, 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 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 analyses and reviews the media forecasts issued during the final quarter of 2007. Results from forecasting models are available each day and are used in constructing these forecasts. 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; this 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 cover up to 3 days ahead- and by also considering the long-term weather situation.

We continue to provide a comprehensive 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 AEA Energy & Environment for Defra and the Devolved Administrations. The BBC requires 5-day air pollution index forecasts for 337 UK towns and cities on their BBC Online service. The quality control checks are 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 MET OFFICE DEVELOPMENTS

During this quarter the Met Office introduced improved graphics for the forecast maps sent to the AEA forecasters and coordinated with AEA over the introduction of enhanced back trajectories for the ozone service and interpretation of air pollution events. These trajectories were immediately useful in the analysis of the Saharan dust event of 23-24 January 2008. The dust event has been summarised in section 3 of this report. To aid interpretation of this event, the dust scheme in NAME was run in a separate simulation and this clearly demonstrated transport of dust from the Sahara to the UK.

The Met Office's comparison of the different air quality model systems used during the contract was also completed in this quarter. The comparison was conducted over the period of June to August 2003 to remove the influence of improvements to the meteorology during the contract. Changes to the model chemistry were clearly identified in statistics comparing the model results to observations at 67 AURN sites. The most substantial improvements in model performance occurred when height information on the main polluting chimney stacks was included in the emissions data. Modelled sulphur dioxide was much closer to observations (root mean square error, RMSE, at Defra AQ sites improved from ±18ppb to ±5ppb), which highlights the importance of such height information for air quality forecasting.

2.2 AEA ENERGY & ENVIRONMENT DEVELOPMENTS

Our "Forecast Admin tools" software suite has been updated to include:

- PROMOTE ensemble forecasts (see figure 2.1)
- Improved back-trajectory plots (see figure 2.2)
- Additional dust forecast models (see figures 2.3 and 2.4)

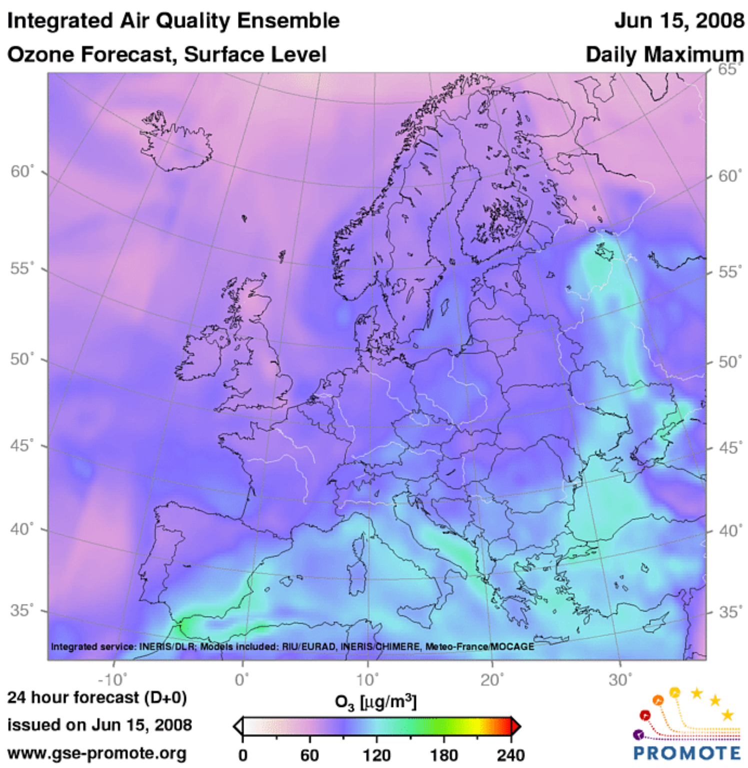


Figure 2.1: PROMOTE, 1 day ahead forecast issued on the 15th June for ozone.

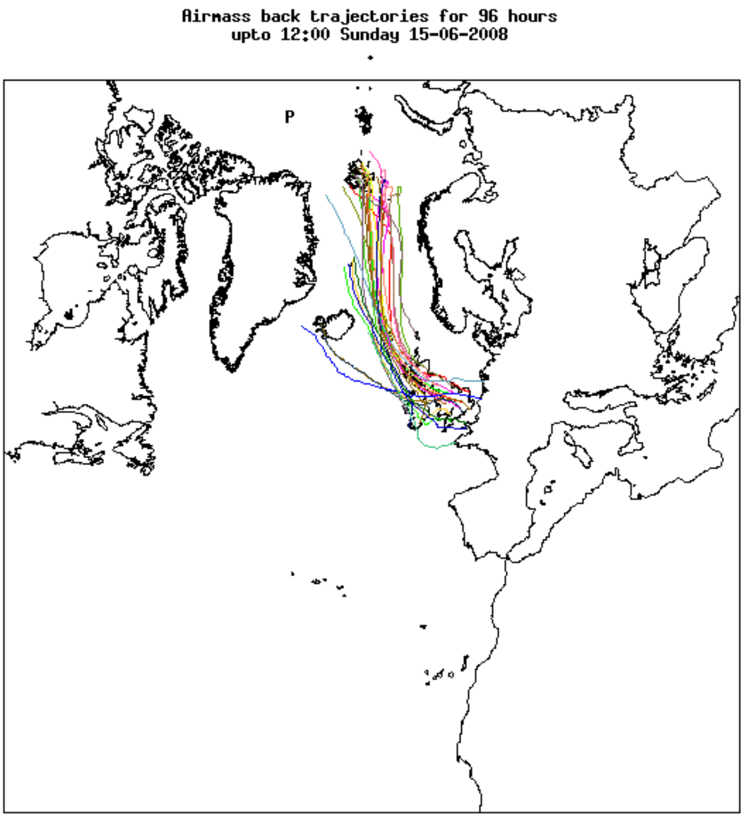


Figure 2.2: 4-day air mass back-trajectory plot issued on the previous day

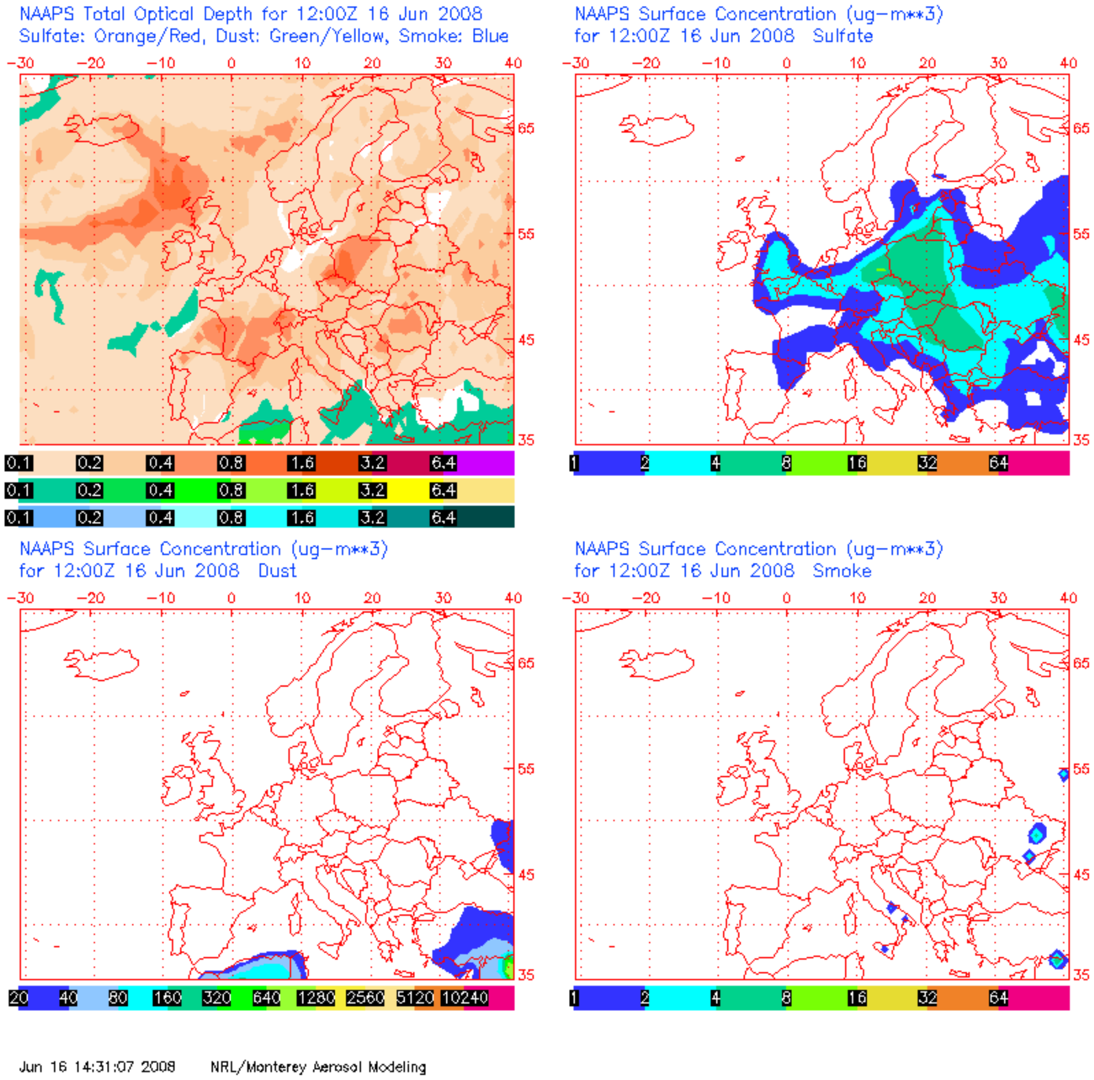


Figure 2.3: NAAPS model dust forecast (speciated) issued on the 15th June.

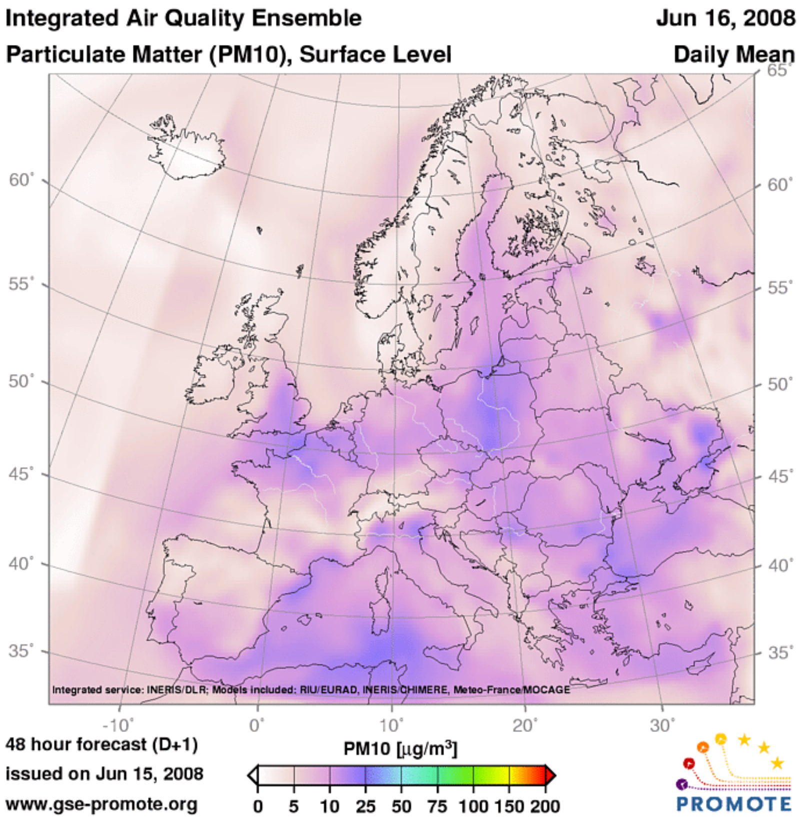


Figure 2.4: PROMOTE PM10 forecast issued on the 15th June.

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). 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. Appendix 3 shows a worked example of how accuracy and success rates are calculated. 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 the quarter reported on 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

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 JANUARY 1ST TO MARCH 31ST 2008.

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	0	4	0	0	0	0	2	0	0	1	2	0	0	0	9
forecasted days	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	4	0	0	0	0	2	0	0	1	2	0	0	0	9
success %	100	100	100	0	100	100	100	100	0	100	100	0	0	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	2	0	0	0
forecasted days	0	0	0	0	0	1	0	0	0
ok (f and m)	0	0	0	0	0	1	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	1	0	0	0
success %	100	100	100	100	100	50	100	100	100
accuracy %	0	0	0	0	0	100	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	0	2	5
forecasted days	0	0	0	0	0	0	1	2
ok (f and m)	0	0	0	0	0	0	0	1
wrong (f not m)	0	0	0	0	0	0	1	1
wrong (m not f)	0	1	0	0	0	0	2	4
success %	100	0	100	100	100	100	0	20
accuracy %	0	0	0	0	0	0	0	50

*** All performance statistics are based on provisional data. Obviously incorrect data due to instrumentation faults have been removed from the analyses. *Please note that FDMS-TEOM datasets were not included in the analysis due to uncertainty about the new banding limits to be employed for these type of instruments.***

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	2	19	12	36	40	0	2	31	18	9	0	9	21	41	6	26	283
forecasted days	10	17	10	26	27	4	9	16	16	10	5	14	17	11	12	17	232
ok (f and m)	11	26	17	35	41	4	10	31	23	13	3	17	27	38	14	23	342
wrong (f not m)	0	2	2	5	0	0	0	2	1	1	2	3	0	1	3	4	31
wrong (m not f)	0	4	2	8	0	0	0	0	3	3	0	2	2	3	1	4	35
success %	550	137	142	97	103	100	500	100	128	144	100	189	129	93	233	88	121
accuracy %	100	81	81	73	100	100	100	94	85	76	60	77	93	90	78	74	84

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	6	1	1	0	0	9	10	1	7
forecasted days	9	6	4	4	2	8	10	5	4
ok (f and m)	4	5	4	4	2	5	11	5	9
wrong (f not m)	6	2	1	0	0	4	3	1	2
wrong (m not f)	2	0	0	0	0	5	3	0	0
success %	67	500	400	100	100	56	110	500	129
accuracy %	33	71	80	100	100	36	65	83	82

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	1	13	6	8	0	9	17	89
forecasted days	6	11	6	15	4	9	10	113
ok (f and m)	3	15	10	18	2	12	12	121
wrong (f not m)	4	3	2	0	2	4	4	38
wrong (m not f)	0	2	0	0	0	0	9	21
success %	300	115	167	225	100	133	71	136
accuracy %	43	75	83	100	50	75	48	67

*** All performance statistics are based on provisional data. Obviously incorrect data due to instrumentation faults have been removed from the analyses. . *Please note that FDMS-TEOM datasets were not included in the analysis due to uncertainty about the new banding limits to be employed for these type of instruments.***

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 January to March 2008 (Based on latest provisional data)

Pollutant	High or above days	Moderate days	Max. conc. (µg/m³) *	Site with max. conc.	Zones or Agglomeration	Date of max conc.	Forecast success HIGH days (%)*** [no. incidents, zone or agglomeration days] **
Ozone	0	42	136	Yarner Wood	South West zone	29/03/08	N/a
PM_{10} gravimetric equivalent	11	33	160	Wirral Tranmere	North West and Merseyside zone	22/03/08	7 % [14]
NO_2	0	7	357	London N Kensington	London UA	13/02/08	N/a
SO_2	0	2	346	Grangemouth	Central Scotland zone	16/1/08	N/a
CO	0	0	5.4	Port Talbot Margam	Swansea UA	23/02/08	N/a

* 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 (CO units are mg/m3).
** the number of incidents is the total of the number of HIGH days in all zones and agglomerations (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.

General Observations

There were 14 zone and agglomeration-day incidents of HIGH band pollution measured during this quarter, all for PM_{10}. In total, 69 MODERATE days were measured. Forty-two MODERATE days were measured for ozone, thirty-three for PM_{10}, three for SO_2 and seven days for NO_2. Sixteen of the MODERATE days were due to more than a single pollutant on the same day.

No MODERATE or above days were measured for CO during the reporting period. The highest 8-hour running mean calculated was 5.4 mg/m^3 at the Port Talbot Margam site towards the end of a 3 day period of stable south westerly winds. A steel works is situated nearby, to the west of the monitoring site. SO_2 measurements made at the same time corroborate industrial related pollution was likely to have been the cause.

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_3

More than ten sites on the same day measured a MODERATE exceedence over three main periods of predominantly incoming Atlantic air during this reporting period. The dates of the three periods were: 29th February to 2nd March, 10th – 12th March and 20th – 30th March. Naturally occurring UK background levels of ozone are at their highest in the springtime and generally occur throughout March and April. Due to the higher background levels measured during the springtime, widespread MODERATE band exceedences are more likely to be experienced from relatively clean air sourced from the Atlantic compared to all other seasons. Between the 29th February and the 2nd March widespread rural and remote sites across the UK measured MODERATE exceedences. At the height of the episode on the 2nd March, four urban sites in the north of England and five in the Midlands contributed to the twenty three sites in the MODERATE band. At the height of the second episode on the 10th March, of the twenty (mostly background) sites in the MODERATE band, the majority were located in East Anglia, the south of England and Wales. At the height of the third episode, on the 21st March, twenty seven sites reached MODERATE. The MODERATE sites were UK widespread and mainly background sites. The last day in the reporting period with more than ten MODERATE sites on the same day was the 30th March. Of the twenty one sites exceeding, a contribution came from urban sites in the Midlands and the north of England, the rest were UK-widespread background sites.

The post-winter onset of MODERATE band ozone exceedences this year in the UK was well defined (as shown in figure 3.1). A further crude analysis of the post-winter onset dates over the longer term for AURN sites has suggested that, on average, the onset may have moved to earlier dates in the year by as much as one month over the last 20 years. Generally it is thought that the spring ozone phenomenon, in which the highest average background levels of ozone of each year are measured during the springtime in Europe, could be a result of continuing changes in the composition of the atmosphere due to anthropogenic activities.

Figure 3.1 shows the trends in O_3 levels over this period.

PM_{10}

On Wednesday 23rd and Thursday 24th January more than twenty sites per day reached the MODERATE band or higher. Eight of the network sites measured levels of PM_{10} particulate matter at air pollution index 7 (HIGH) or above, and two of those sites also went on to record VERY HIGH pollution at index 10. Over the same period a further eighteen individual monitoring sites recorded MODERATE PM_{10} air pollution at index 4 to 6. The cause of this particulate episode was found to have been long range transport of dust as a result of sandstorms in Africa, with a possible albeit unlikely contribution from forest fires, also in Africa but further south. Of the eight sites measuring PM_{10} at index 7 or above, three were located in London, two in the South East and three in South Wales. In addition to three roadside sites reaching the HIGH band, index 7 or above was measured at one remote site in Wales, one urban centre and one rural site in the south of England and an urban centre site in London. No significant increase in airborne particulate matter was recorded across Scotland or Northern Ireland over the duration of the episode. In total twenty seven sites measured PM_{10} air pollution in the MODERATE or HIGH bands over the 2-day episode and these were all considered to have been primarily the result of the long range transport of particulate matter.

Two winter pollution episodes occurred during February. During the first episode, from Sunday 10th to Wednesday 13th, more than about 10 sites reached or exceeded the MODERATE band daily on each of the four days. The episode happened as a result of a build up of traffic related, and in some areas industrial related, pollution in below freezing overnight temperatures and very low wind speeds. At the height of the episode, on the 13th, eighteen sites reached the MODERATE band and a further five sites went on to reach the HIGH band. The MODERATE sites were a mixture of urban and roadside sites in London, several urban sites in the Midlands, a mixture of urban / industrial and roadside sites in the north of England, Glasgow Centre, Bristol St Paul's AQM site and urban sites in Northern Ireland as a result of domestic fuel burning used for heating. Of the five HIGH sites, three were urban centre sites in the north of England (Nottingham, Sheffield and Leeds). The monitoring site in Leeds may have recorded contributions from local industry. Birmingham Centre and Glasgow Kerbside also reached the HIGH band. The highest running 24-hour mean recorded was 130 ug/m^3 (the threshold of the VERY HIGH band) at Leeds Centre on the 13th.

Over the second episode, between Monday 18th and Wednesday 20th, during average daily temperatures near freezing in England and overnight temperatures well below zero in many parts of the UK, twenty sites or more reached or exceeded the MODERATE band daily. At the height of the episode, on the 20th, thirty sites reached the MODERATE band and a further seven sites reached the HIGH band. The MODERATE sites were a mixture of urban and roadside sites widely distributed over England and Wales. The HIGH sites were predominantly roadside sites (for example Glasgow Kerbsite, London Marylebone Road kerbside, Brighton, Carlisle and Wrexham roadside sites) and two urban sites (Sheffield Centre and London Westminster). The site at Westminster is situated in a confined car parking area, surrounded by residential properties and taller buildings and is therefore likely to be affected significantly by winter episodes. The site at Sheffield Centre may have measured contributions from local industrial emissions. The highest 24-hour running mean measured on the 20th was 111 ug/m^3 at Sheffield Centre.

The site at Wirral Tranmere measured a VERY HIGH and HIGH day respectively on the 22nd and 23rd March as a result of green waste burning over the bank holiday weekend.

Other MODERATE days were measured throughout the reporting period, the majority of which were experienced at the London Marylebone Road kerbside site, with a total of twenty nine MODERATE or higher days measured at that single location as a result of traffic related pollution.

Figure 3.2 shows the trends in PM_{10} levels over this period.

NO_2

Seven MODERATE days were measured during the reporting period. Five of the days were measured at the London Marylebone Road kerbside site, mainly during the winter episodes in late February. On Tuesday 12th February three sites entered the MODERATE band during the first winter pollution episode of the month. These sites were Glasgow Kerbside, Leeds and Birmingham Centre. Please note the MODERATE exceedences have been calculated from provisional datasets and therefore are subject change. During the following day, Wednesday the 13th, London North Kensington AQM site and Stoke On Trent Centre both measured MODERATE exceedences. The pollution episode was characterised by below freezing overnight temperatures and a very light or no breeze. These conditions, normally associated with limited vertical dispersion in the troposphere, encourage the build up of primary and secondary pollution from traffic and other sources.

SO_2

The urban industrial site at Grangemouth measured two MODERATE days over the reporting quarter. These days were Tuesday 15th and Wednesday 16th January and coincided with a cold easterly breeze, with the wind bringing air in from the nearby major petro-chemical complex.

An unlikely MODERATE day was also measured at the rural Ladybower AQM site in the Peak District, East Midlands on the 13th February, however these data were subsequently rejected during the data ratification process.

No other MODERATE days were measured, an increasingly common phenomenon during the winter months in the AURN network.

Figure 3.3 shows the trends in SO_2 levels over this period with NO_2 also included.

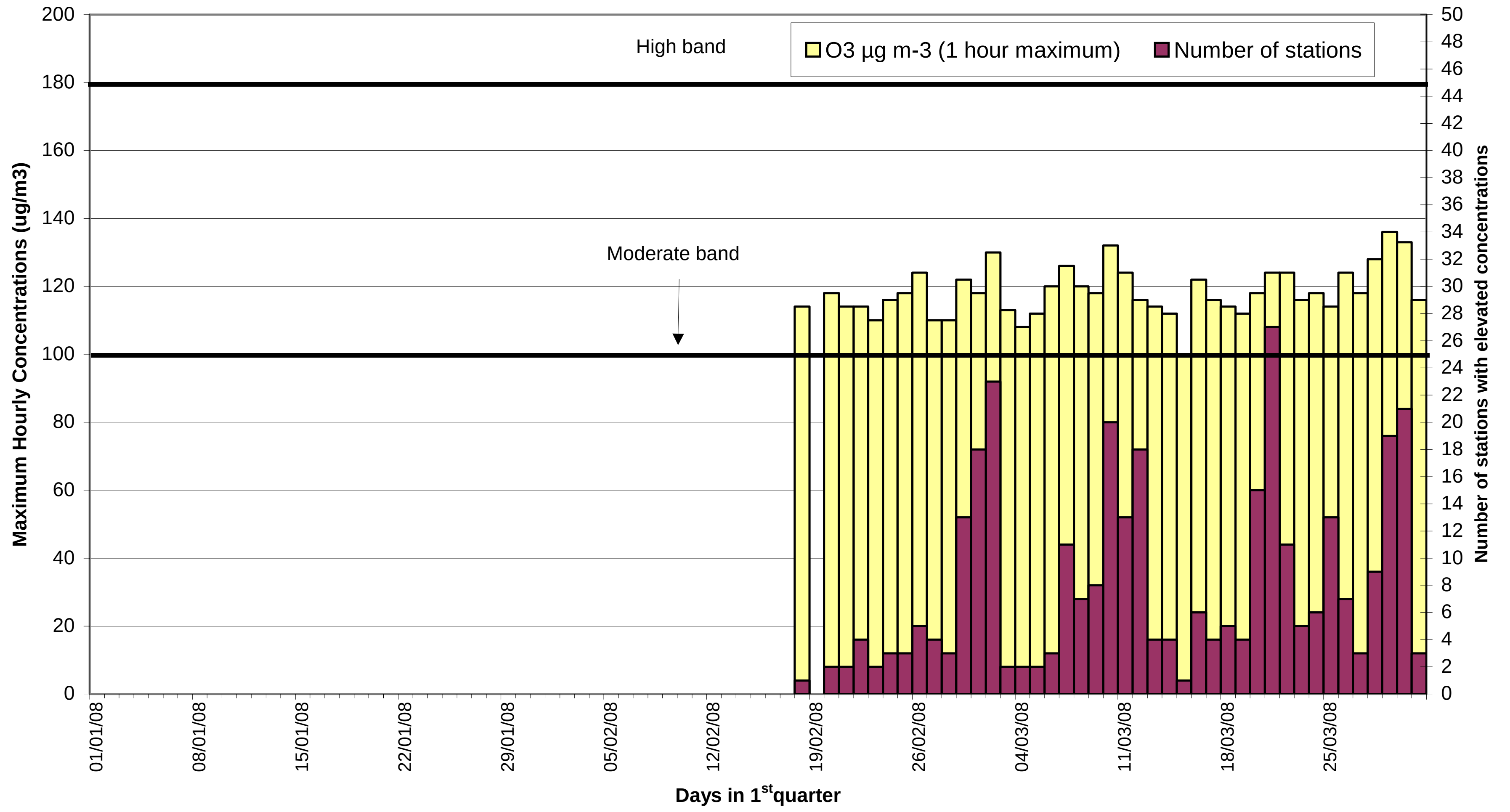


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 1st quarter 2008.

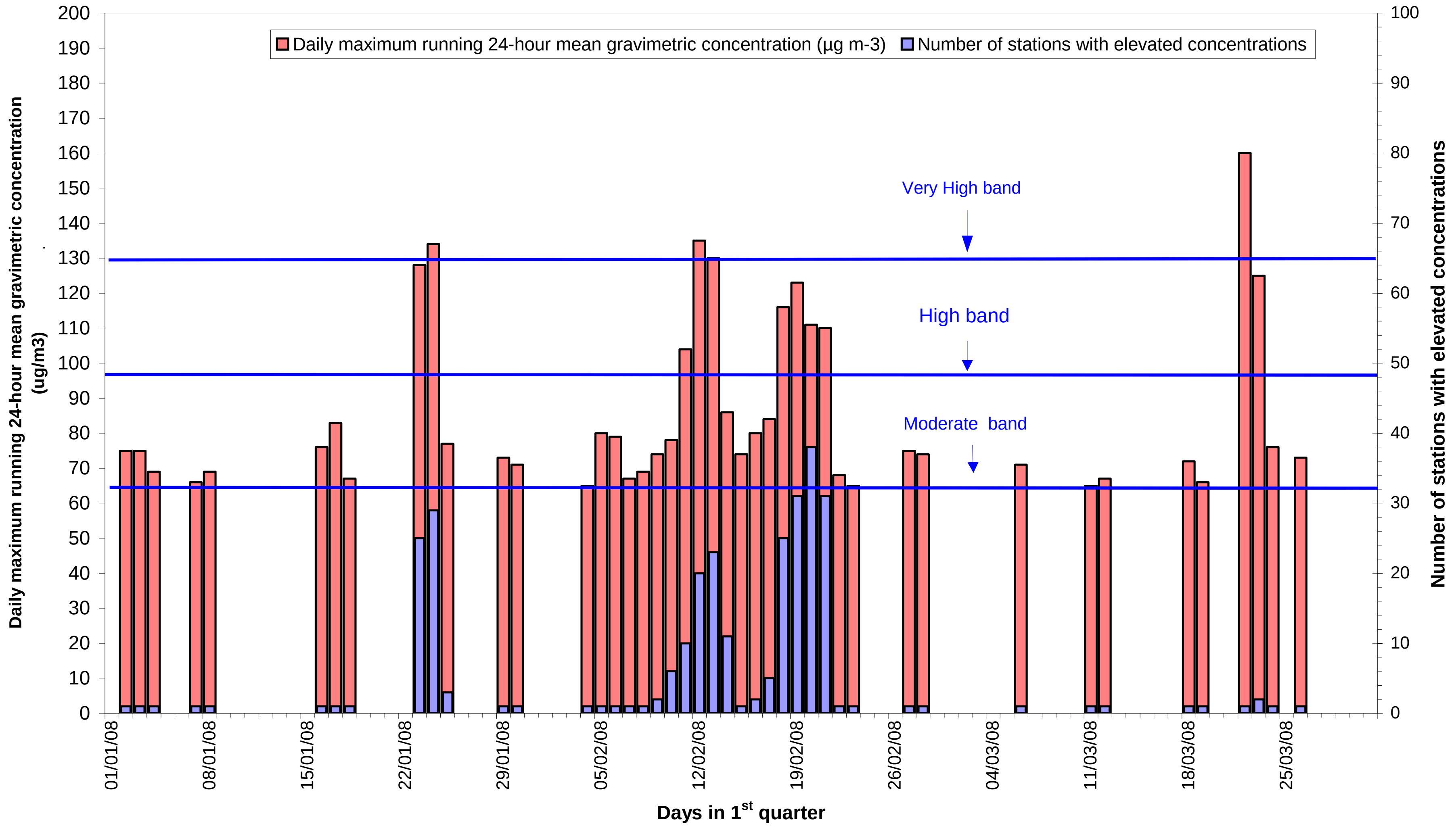


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 1st quarter 2008.

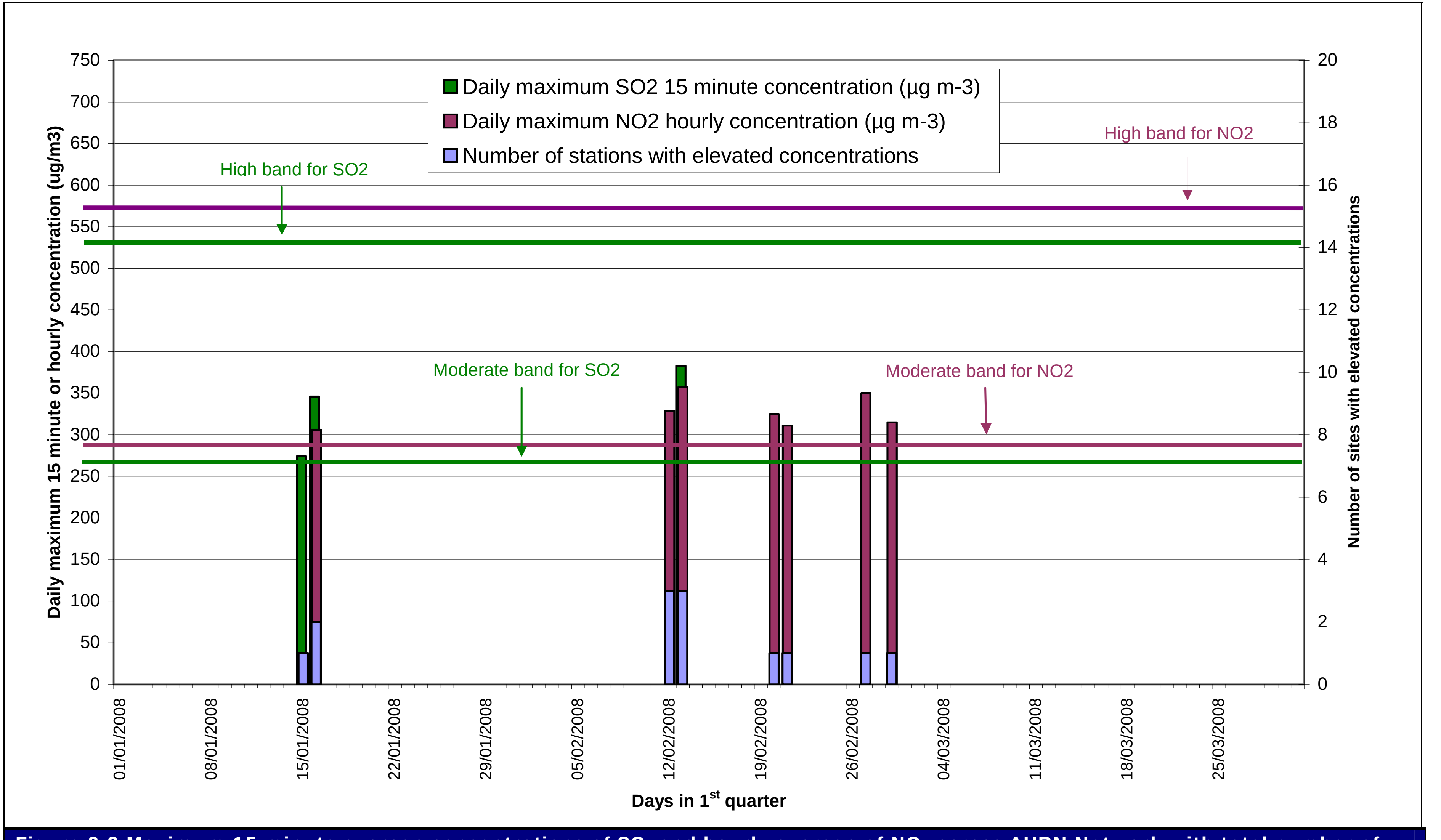


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO_2 across AURN Network with total number of stations measuring MODERATE or above levels over the 1st quarter 2008.

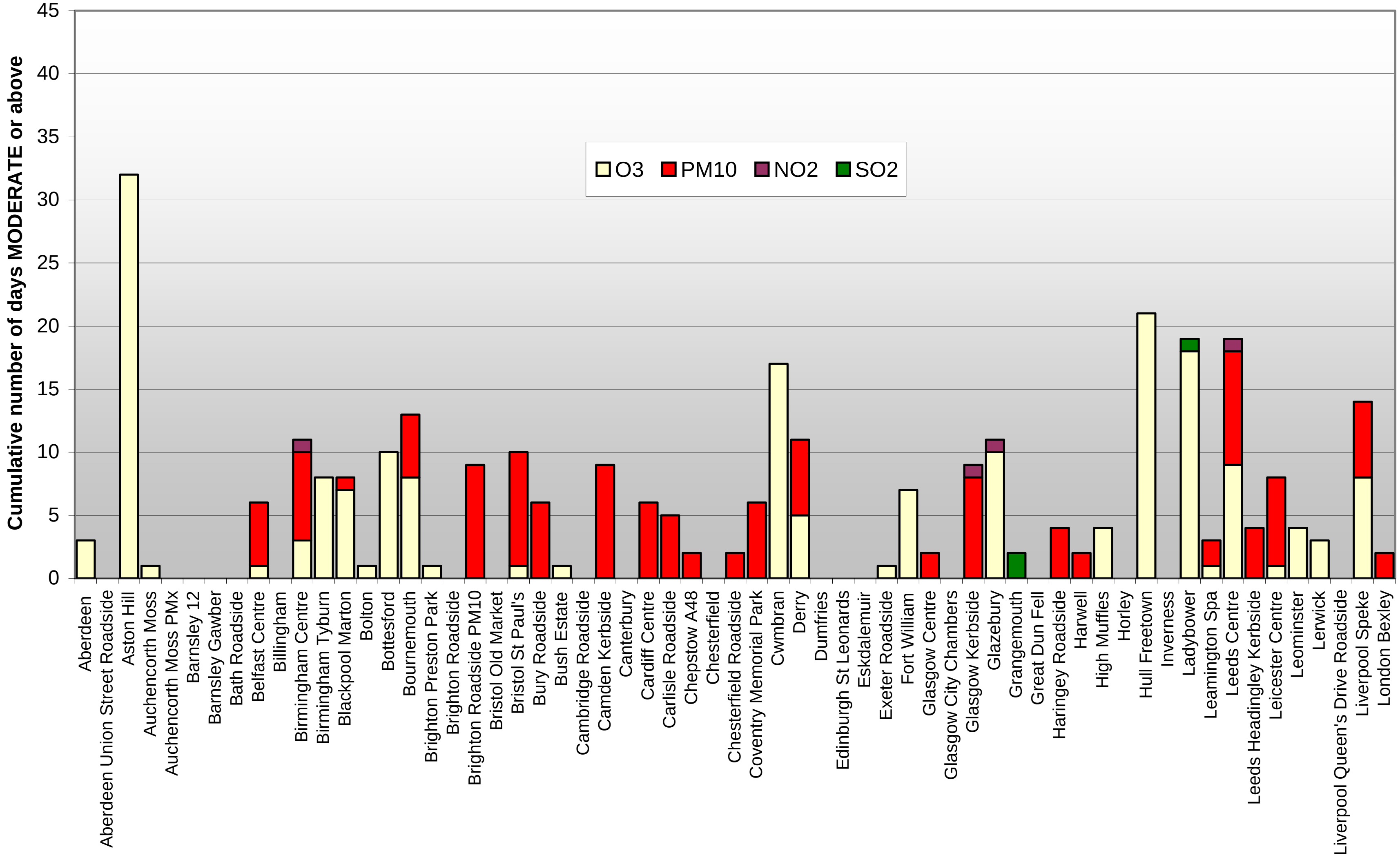


Figure 3.4a Number of days moderate and above for each AURN Network station over 1st quarter 2008 – provisional data

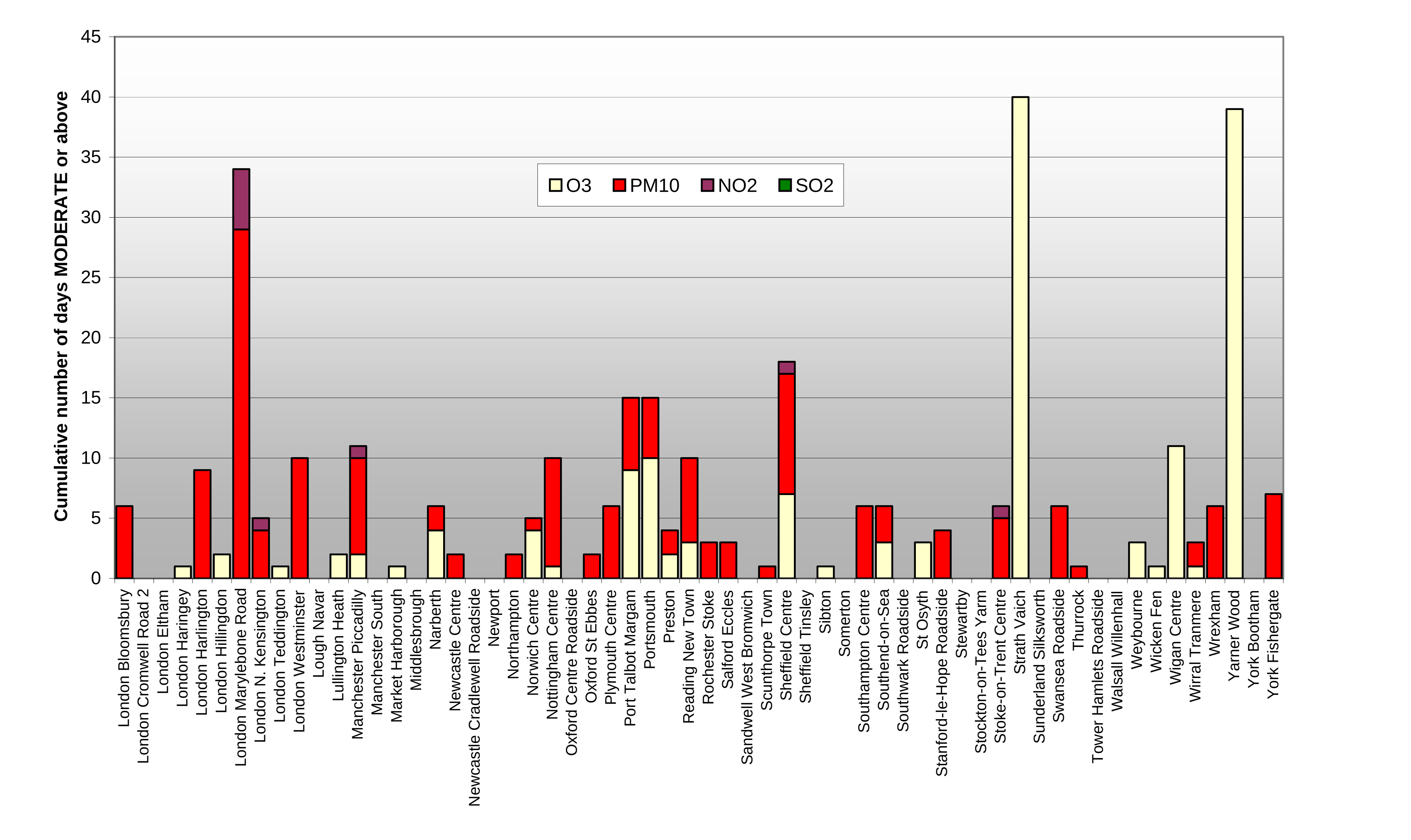


Figure 3.4b Number of days moderate and above for each AURN Network station over 1st quarter 2008 – provisional data

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 and analysis

A report detailing the UK particulate episode in January, as a result of long-range transport of dust from sandstorms in north-west Africa, was drafted during the reporting quarter and submitted to Defra and the Devolved Administrations.

7 Ongoing research

AEA Energy & Environment 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, for example 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 Forward work plan for April to June 2008

Major tasks include:

- Ongoing daily air pollution forecasting activities.
- Ongoing improvements to the NAME model, including:
    - Increase in the horizontal model domain
    - An upgrade providing enhanced chemistry modelling for ozone, nitrates and sulphates.
    - Update of emissions inventory used in the model.
- Publication of the annual 2007 report, several 2007 quarterly reports and an ad-hoc report detailing a UK particulate episode in January 2008 on the Air Quality Archive Web Site.
- Organisation of the 2008 annual AQ Forecasting seminar, which is to be held in London on the 14th May.

9 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 currently being used on this project is owned by Defra or the Devolved Administrations.

Appendix 1 - Air Pollution Index

CONTENTS

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_{10} Particles 24-Hour Mean*
		μgm^{-3}	ppb	μgm^{-3}	ppb	μgm^{-3}	ppb	mgm^{-3}	ppm	gravimetric μgm^{-3}
LOW										FDMS limits / TEOM limits
	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
MODERATE										
	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
VERY HIGH										
	10	≥ 360 μgm^{-3}	≥ 180 ppb	≥ 764 μgm^{-3}	≥ 400 ppb	≥1064 μgm^{-3}	≥ 400 ppb	≥ 23.2 mgm^{-3}	≥ 20 ppm	≥ 128 / ≥ 130μgm^{-3}

Old Banding	New Index	Health Descriptor
LOW		
	1	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
	2	
	3	
MODERATE		
	4	Mild effects unlikely to require action may be noticed amongst sensitive individuals
	5	
	6	
HIGH		
	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	
VERY HIGH		
	10	The effects on sensitive individuals described for “HIGH” levels of pollution may worsen.

* the PM10 banding and index thresholds were revised in June 2007 to accommodate the introduction of a new, enhanced measurement technique (FDMS).

Appendix 2 - Forecasting Zones and Agglomerations

CONTENTS

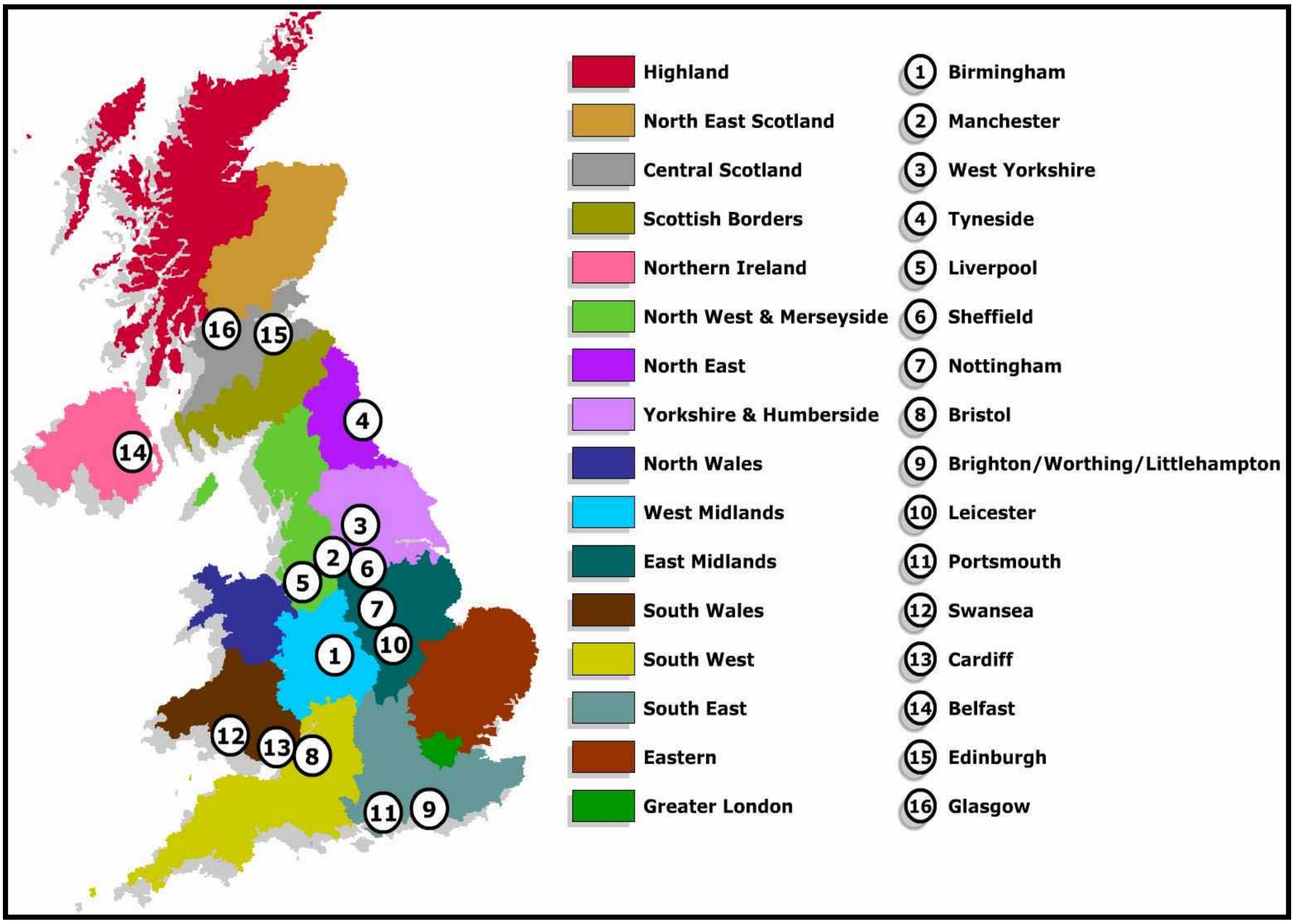
Forecasting Zones

Zone	Population
East Midlands	3084598
Eastern	5119547
Greater London	8278251
North East	1635126
North West and Merseyside	3671986
South East	6690881
South West	4364704
West Midlands	2970505
Yorkshire and Humberside	2816363
South Wales	1578773
North Wales	720022
Central Scotland	1813314
Highland	380062
North East Scotland	1001499
Scottish Borders	254690
Northern Ireland	1104991

Forecasting Agglomerations

Agglomeration	Population
Brighton/Worthing/Littlehampton	461181
Bristol Urban Area	551066
Greater Manchester Urban Area	2244931
Leicester	441213
Liverpool Urban Area	816216
Nottingham Urban Area	666358
Portsmouth	442252
Sheffield Urban Area	640720
Tyneside	879996
West Midlands Urban Area	2284093
West Yorkshire Urban Area	1499465
Cardiff	327706
Swansea/Neath/Port Talbot	270506
Edinburgh Urban Area	452194
Glasgow Urban Area	1168270
Belfast	580276

Map of UK forecasting zones and agglomerations



Appendix 3 – Worked Example of How UK Forecasting Success and Accuracy Rates are Calculated.

CONTENTS

A worked example showing how forecasting accuracy and success rate are defined and calculated in this report

This analysis is based on an imaginary period of high pollution concentrations in South East England – which occurred during warm weather and resulted in the formation of photochemical ozone. There were 4 days on which HIGH concentrations were measured; 29th July, 30th July, 1st August and 2nd August. Over the slightly longer period from 29th July – 3rd August, there were 6 days on which HIGH levels were either measured or forecast. During the whole reporting period, there were no other observations of HIGH band measurements, either forecast or actual. 31st July was a cooler day and measurements did not reach the HIGH band, despite being forecasted. Measured air pollution and previous day forecast are shown below for each day during this period, in terms of index and descriptive bands:

Date	**28/7**	**29/7**	**30/7**	**31/7**	**1/8**	**2/8**	**3/8**	**4/8**
Measured Index value (M)	**5** (MOD)	7 (HIGH)	7 (HIGH)	6 (MOD)	7 (HIGH)	7 (HIGH)	5 (MOD)	5 (MOD)
Forecast Index value (F)	5 (MOD)	6 (MOD)	7 (HIGH)	7 (HIGH)	8 (HIGH)	5 (MOD)	7 (HIGH)	6 (MOD)

Based on the figures above, the success and accuracy of predicting HIGH episodes (>= Air Pollution index 7) for the South East Zone may be analysed as shown below:

Date	**28/7**	**29/7**	**30/7**	**31/7**	**1/8**	**2/8**	**3/8**	**4/8**
Measured Index value (M)	**5** (MOD)	7 (HIGH)	7 (HIGH)	6 (MOD)	7 (HIGH)	7 (HIGH)	5 (MOD)	5 (MOD)
Forecast Index value (F)	5 (MOD)	6 (MOD)	7 (HIGH)	7 (HIGH)	8 (HIGH)	6 (MOD)	7 (HIGH)	6 (MOD)
HIGH forecast or measured	No, so not used in calculations	Yes	Yes	Yes	Yes	Yes	Yes	No, not used in calcs
OK- Agreement of F and M to +/- 1 index band	N/A	Yes	Yes	Yes	Yes	Yes	No	N/A

HIGH days measured	4
HIGH days forecast	4
OK (M and F) [i.e. Agreement of F and M to +/- 1 index band	5
Wrong (F not M)	1
Wrong (M not F)	0

The forecasting **success** during this period is calculated as:

[OK (M and F) / HIGH days measured]*100 = [5/4]*100 **= 125 %**

The corresponding **accuracy** is calculated as:

[OK (M and F) / {OK (M and F) + Wrong (M not F) + Wrong (F not M)}]*100

= [5 / {5+0+1}]*100 = [5/6]*100 = **83**

The analysis is then repeated for each of the 16 UK zones and 16 UK agglomerations.