REPORT

UK Air Quality Forecasting: Operational Report for January to March 2007

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/2438 Issue 1, May 2007

UK Air Quality Forecasting: Operational Report for January to March 2007

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/2438 Issue 1
May 2007

Title	UK Air Quality Forecasting: Operational Report for January to March 2007.
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
Confidentiality, copyright and reproduction	UNRESTRICTED Copyright AEA Technology plc. All rights reserved. Enquiries about copyright and reproduction should be addressed to the Commercial Manager, AEA Technology plc.
File reference	ED45099
Report number	AEAT/ENV/R/2438 Issue 1
Report status	Issue 1

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

AEA Energy & Environment is an operating division of AEA Technology plc
AEA Technology is certificated to BS EN ISO9001:(1994)

	Name		Date
Author	Andy Cook		02/05/2007
Reviewed by	Paul Willis		16/05/2007
Approved by	Jon Bower		04/06/2007

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 2007. 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 2007, there were 8 days on which HIGH air pollution was recorded. All of the HIGH measurements were due to PM_{10}. Seven HIGH days were the result of long-range transport from the east of particulates of non-UK origin. One HIGH day resulted from a localised bonfire near a single monitoring station. Only one of the HIGH day-incidents was forecast successfully in terms of numerical forecasts issued, in the north east of England, for reasons detailed within this report. Written texts were, however, issued to Defra and the media during the UK-wide particulate episode.

Overall forecast success rates for the HIGH band were therefore very low at below 10 % for both zones and agglomerations during this quarter. 100% accuracy was achieved for the HIGH band in zones; one forecast for the HIGH band agreed within 1 index band in one region to cause this result. Many MODERATE days were measured (mainly for PM_{10} but a considerable contribution from ozone) and were forecast with a moderate degree of success and accuracy (around 70%); the figures are likely to have been adversely effected by uncertainties surrounding the particulate episode in late March. 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 65 %)[1]. An average accuracy figure of around 60 % indicates that 40 % of the forecast MODERATE levels were not measured and either remained LOW or were elevated by more than one index band above the forecast for PM_{10} during the particulate episode. 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 31tst 2007.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	7	100	76	65
Agglomerations	0	0	66	53

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, in particular the NO_x->NO_2 conversion used in NAME, together with 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 2006. 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 230 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

A parallel air quality modelling system was implemented at the Met Office during this quarter and has been running successfully. Maps of species levels and index values are being produced from this system daily. Following three months of testing, this system is due to be phased into the operational workflow.

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

The Met Office contributed to analysis of elevated levels of PM_{10} that were measured over much of the UK during the period 25th to 28th March 2007, inclusive. In particular, the NAME model was used to investigate the source of the pollutant using forward and back runs and its dust model functionality. Model evidence suggested that fires over Russia and the Ukraine were a significant source of UK PM_{10} levels during this period. In addition, model results suggested that general pollution from continental Europe and Saharan dust were likely to have contributed to UK PM_{10} levels.

2.2 AEA ENERGY & ENVIRONMENT DEVELOPMENTS

During this quarter, two new Internet (WAP)-enabled mobile phones have been in use for forecasting from remote locations or locations where PC access is not possible; this follows a successful testing phase of the phones in the previous quarter. New software has also been developed specifically to maximise the functionality of the phones. As well as providing continuing direct access for important parties to the duty forecaster in emergency situations, the phones also reduce the need for the duty forecaster to have access to a PC at weekends to monitor or change the numerical forecast.

Towards the end of the particulate episode in late March, AEA Energy & Environment compiled a new suite of information sources, including satellite imagery databases, which will be invaluable for future pollution events of this kind. The Met Office has also agreed to undertake more frequent NAME source attribution runs during any events when air masses are from the east.

AEA Energy & Environment hosted a project review meeting on Wednesday 7th March at Harwell, with representatives of Defra and the Met Office attending. The progress of various draft reports was discussed, together with forthcoming operational changes to the modelling and software methodologies utilised within the project.

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 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 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	3	0	3	0	0	0	0	0	3	1	0	4	0	14
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	1	0	0	0	0	0	0	0	0	0	0	1
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	3	0	2	0	0	0	0	0	3	1	0	4	0	13
success %	100	100	100	0	100	33	100	100	100	100	100	0	0	100	0	100	7
accuracy %	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	100

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	5	2	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	3	5	2	0
success %	100	100	100	100	100	0	0	0	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	3	0	14
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	1	0	0	0	3	0	14
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.**

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	4	7	10	34	18	12	5	3	12	1	6	10	4	13	8	9	156
forecasted days	5	5	5	8	2	2	2	2	5	2	2	5	5	2	5	5	62
ok (f and m)	6	7	8	19	18	4	5	4	7	3	6	6	5	11	2	8	119
wrong (f not m)	0	1	1	5	0	0	0	0	2	0	0	3	1	0	5	1	19
wrong (m not f)	0	0	2	15	0	8	1	0	5	0	0	4	2	2	6	1	46
success %	150	100	80	56	100	33	100	133	58	300	100	60	125	85	25	89	76
accuracy %	100	88	73	49	100	33	83	100	50	100	100	46	63	85	15	80	65

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	4	3	0	1	6	12	10	7	1
forecasted days	2	2	2	2	2	5	5	2	2
ok (f and m)	2	4	2	2	6	2	3	3	1
wrong (f not m)	1	0	0	0	0	4	5	2	1
wrong (m not f)	3	0	0	0	0	10	7	4	0
success %	50	133	100	200	100	17	30	43	100
accuracy %	33	100	100	100	100	13	20	33	50

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	1	5	8	2	5	23	6	94
forecasted days	2	2	2	3	2	5	2	42
ok (f and m)	1	3	5	3	5	16	4	62
wrong (f not m)	1	0	0	1	2	1	0	18
wrong (m not f)	0	2	3	0	0	7	2	38
success %	100	60	63	150	100	70	67	66
accuracy %	50	60	63	75	71	67	67	53

*** 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 January to March 2007 (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	21	154	Southend on Sea +	Eastern zone	31/3/07	N/A
PM_{10} gravimetric equivalent	8	26	123	Manchester Piccadilly	Greater Manch. UA	28/3/07	4 % [28]
NO_2	0	7	542	Billingham	North East zone	7/3/07	N/A
SO_2	0	0	258	Grangemouth	Central Scotland zone	26/3/07	N/A
CO	0	0	4.8	Marylebone Road	London UA	2/3/07	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.
+ There is some concern that the Southend-on-Sea ozone instrument may be over-reading.

General Observations

There were 28 zone or agglomeration-day incidents of HIGH band pollution measured during this quarter, measured on 8 separate days for PM_{10} alone. Seven of the PM_{10} day-incidents were the result of an episode caused by global long-range transport of particulates from the east. One HIGH day was caused by a bonfire near the site at London Eltham.

Twenty-six MODERATE-only days were seen due to PM_{10}. The majority of these MODERATE days were measured at roadside sites or by the site at Port Talbot, situated near a steel works.

Twenty-one MODERATE days were measured for ozone during this quarter, from the end of February onwards. On the last day of March more than 50 sites entered the MODERATE band. Very few MODERATE band exceedences are normally measured at this time of the year, due to the usually low seasonal temperatures.

Seven MODERATE days were measured for nitrogen dioxide. Approximately half of these days were measured at two London roadside sites with the remainder observed at the urban-industrial designated Billingham site.

No MODERATE days were measured for SO_2 at network sites, which is unusual for a winter quarterly period, although 3 urban industrial sites measured a period 15-minute average maximum above 200 ug/m^3. Only two cold spells of weather occurred during this quarter: a few days in late January and a week in early February. The rest of the period was generally characterised by moderate or above wind speeds.

No MODERATE or above days were measured for CO during the reporting period. The highest 8-hour running mean calculated was 4.8 mg/m^3 at the London Marylebone site on a near-freezing morning when generally light wind speeds were prevalent.

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

Ten or more sites measured MODERATE levels on Tuesday 6th March, Sunday 18th March and, in general, from the 25th March onwards until the end of that month.

On 6th March, the wind direction was westerly, caused by an area of low pressure centred over the Atlantic, to the north west of the UK. Forecast air trajectories were similar on the previous day. The wind speed picked up on the afternoon of the 5th and the air temperature remained unusually constant at around 10C overnight, until the afternoon of the following day. The chronological pattern of ozone exceedences, which occurred overnight and were mainly measured at sites in England and Wales, corroborate the southwesterly forecast air trajectory data obtained. Ozone concentrations appear to have risen from the evening of the 5th and dropped back from the morning of the 6th. All the data obtained suggests that atmospheric turbulence was the most likely cause of the rise in ozone levels.

A similar observation was made on the morning of Sunday 18th March. All the exceedences were measured at sites in England overnight on the morning of the 18th. The rise in levels coincided with a change in wind direction from westerly to north westerly during a period of brisk winds. A centre of low-pressure air approached the UK from the Atlantic, from a northerly direction. Again the rise in concentrations is most likely to have been caused by atmospheric turbulence.

Between the 23rd and 24th March, air trajectories changed from northerly to easterly and remained that way until the 3rd April. The number of ozone exceedences did not rise significantly (i.e. above 20 sites) until Saturday 31st March, when more than 50 geographically spread sites entered the MODERATE band. This suggests that the full impact of pollution from Europe was not felt in the UK until the Saturday following a working week- a phenomenon which has been seen before. A similar number of sites exceeded on the 1st April, then on following days the number of sites with exceedences dropped quickly, during which time the wind turned northerly. It is interesting to note that, despite the apparent photochemical haze throughout this time, there was no increase in ozone concentrations until the end of this period.

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

PM_{10}

There were 28 zone or agglomeration-day incidents of HIGH band pollution measured during this quarter, measured on 8 separate days for PM_{10} alone. Seven of the PM_{10} day-incidents were the result of an episode caused by the global long-range transport of particulates from the east. One HIGH day was caused by a bonfire near the site at London Eltham. Due to the inherently unpredictable and localised nature of PM_{10} episodes, the HIGH incident at London Eltham was not successfully forecast and was not considered to broadly represent ambient levels across the associated region, so was not accounted for during the forecasting process.

The seven days of HIGH particulate levels were generally not forecasted successfully; this was primarily due to the complex meteorological conditions seen during the incident and initial difficulties in locating the source of the long-range transport. MODERATE levels were forecast during the period of the episode but appear to have underestimated the exceedences observed by more than one index band throughout, based on later re-analysis of the numerical forecasts issued.

Approximately 7 sites entered the MODERATE band on both the 7th and 8th February, at the end of a cold spell, where daily average temperatures were around zero degrees C. Wind speeds were initially light and turned from southerly, through easterly on the 7th. Wind speeds picked up on the 8th and finally became westerly. The highest measurements were seen on the 7th and levels dropped in all areas on the 8th. The continuation of MODERATE band exceedences observed was due to the running 24-hour averaging procedure employed. Many of the sites entering the MODERATE band were situated in central London; other sites were geographically widespread roadside sites, showing that the primary cause was traffic related contributions in poor dispersion conditions. Simple air mass back-trajectory plots indicated that pollution from Europe contributed very little to UK levels over this period. The most consistent MODERATE sites were several London roadside sites, Glasgow Kerbside and industrial-designated Port Talbot.

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 measured in the Midlands at urban designated sites. Twenty-one sites entered the HIGH band in total, during seven days. A separate ad-hoc report is currently in production detailing the incident; this identifies possible causes and includes subsequent analysis of measurements made, including air mass back-trajectory analysis performed by the Met Office.

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

NO_2

Seven exceedences of the MODERATE band were seen, fairly evenly spaced chronologically throughout the period. Two MODERATE days were measured at both London's Marylebone Road and Tower Hamlets Roadside sites. The urban-industrial Billingham site measured 3 MODERATE days, two of these occurred at the end of February. A long time series plot revealed that this is an unusual occurrence at Billingham and this may therefore have been caused by a stationary vehicle or other local combustion source, if not proved to be an intermittent problem with the monitoring equipment.

SO_2

No MODERATE exceedences were measured during this quarter, which is an unusual, although increasingly common, occurrence for a winter quarter. The highest 15-minute average measurement during this quarter was 258 ug/m^3 at the Grangemouth site in central Scotland on 26th March, observed during a period of easterly air trajectories. A number of industrial chimneys are located nearby, to the east of the site, which are likely to have caused the elevated measurements of about a one hour's duration in the early afternoon.

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

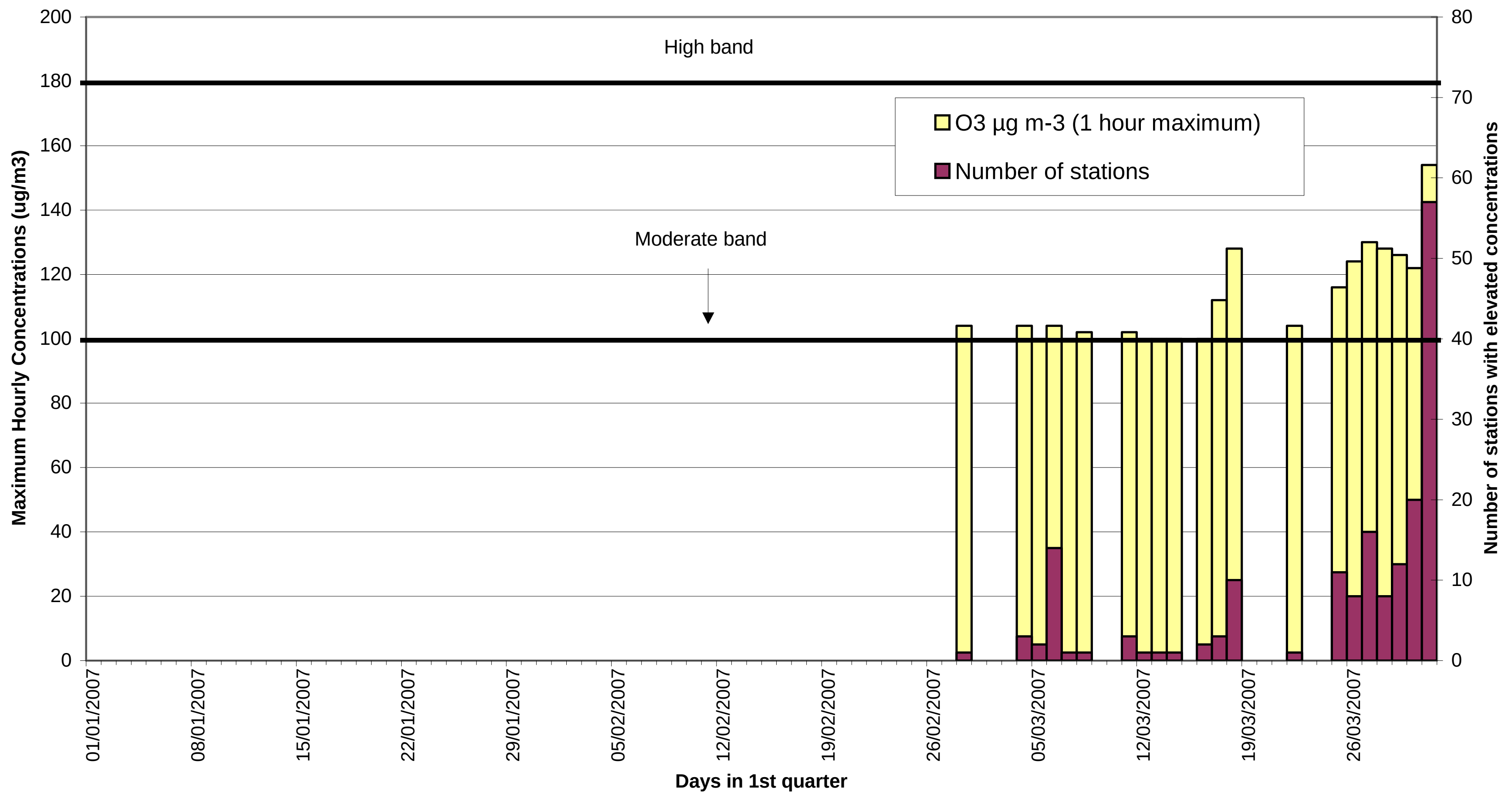


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 1st quarter 2007.

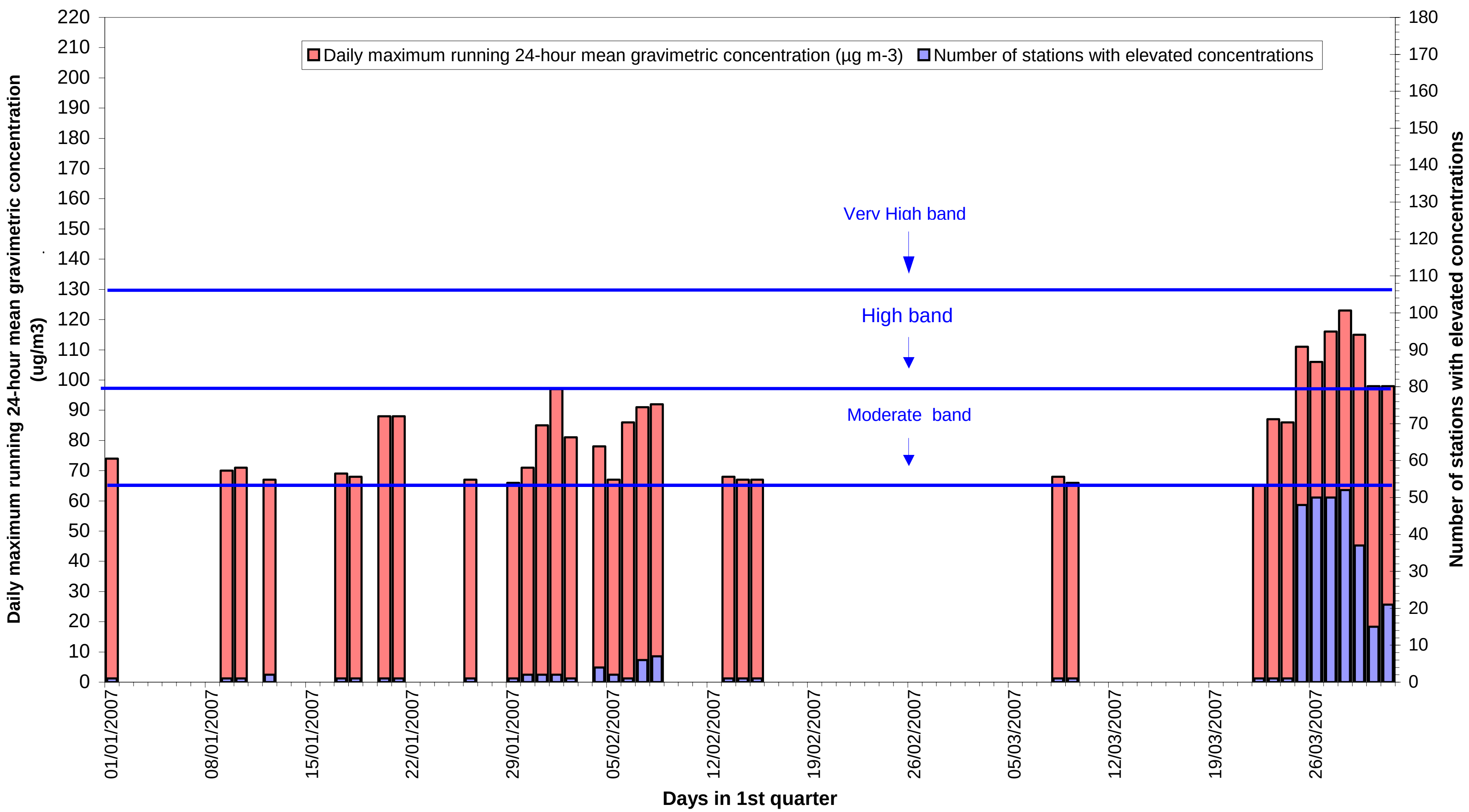


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 1st quarter 2007.

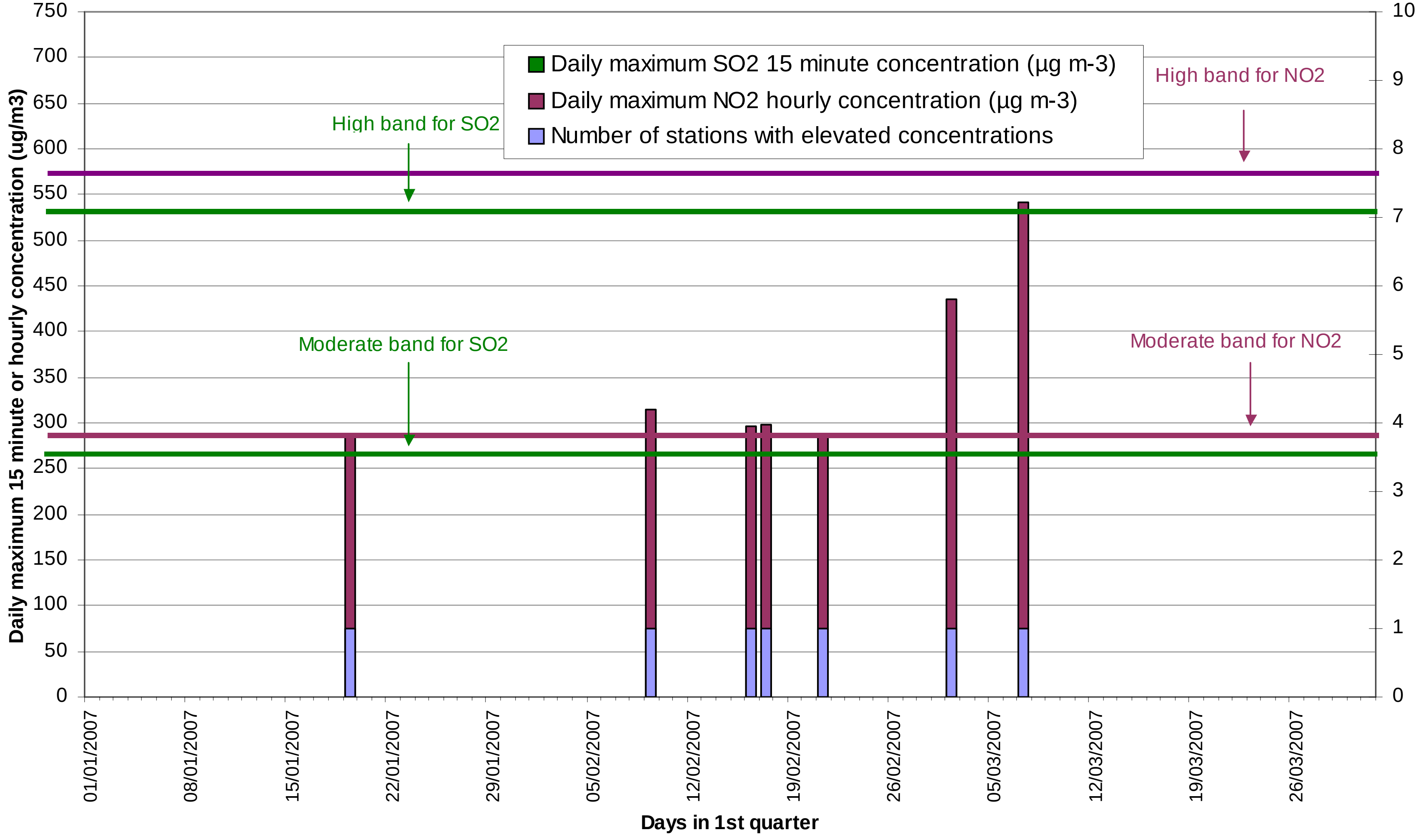


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO_2 across AURN Network with total number of stations measuring MODERATE or above levels over the 1st quarter 2007.

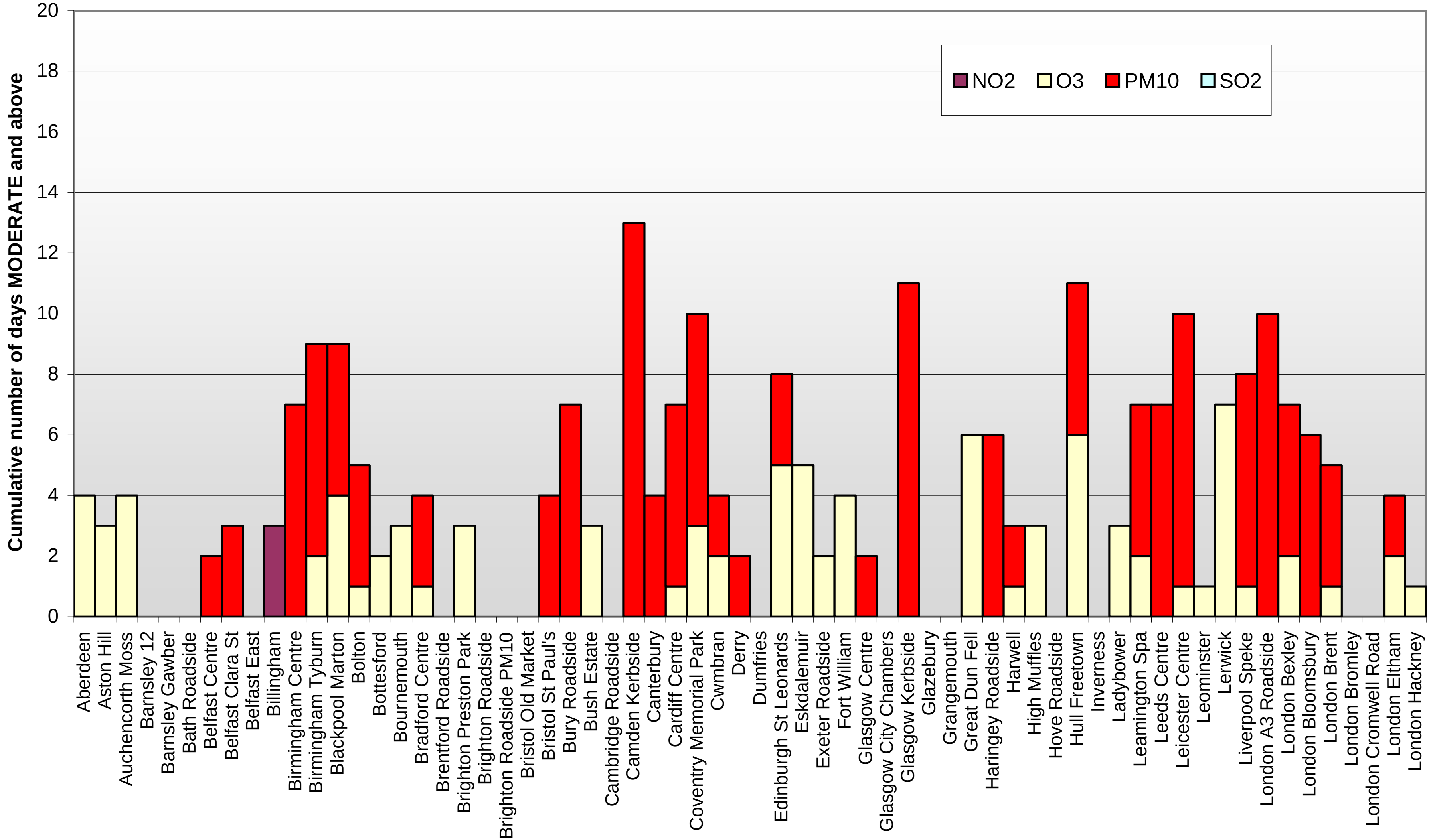


Figure 3.4a Number of days moderate and above for each AURN Network station over 1st quarter 2007 – provisional data

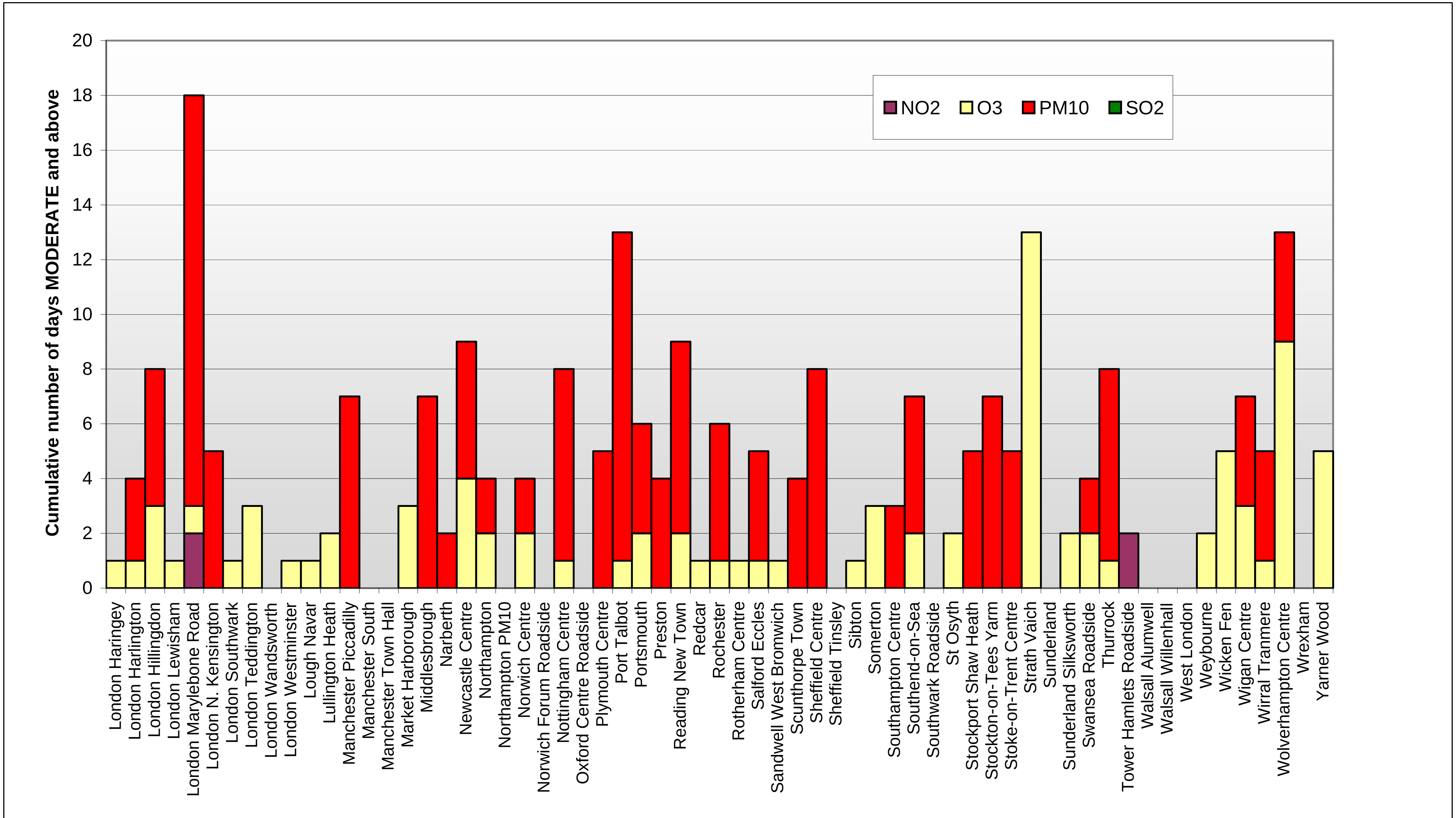


Figure 3.4b Number of days moderate and above for each AURN Network station over 1st quarter 2007 – provisional data

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

6.1 PARTICULATE CLOUD FROM EASTERN SOURCES IN EARLY MAY AND IN MID SEPTEMBER 2006

Ad-hoc reports will shortly be available on the National Air Quality Archive, detailing the elevated particulate measurements experienced at UK sites in early May 2006 and in mid September 2006.

6.2 PARTICULATE CLOUD FROM EASTERN SOURCES IN LATE MARCH 2007

An ad-hoc report is currently in production detailing this episode. This includes global satellite imagery, measurements made, and subsequent NAME model runs performed by the Met Office to analyse various scenarios.

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, 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 Forward work plan for April to June 2007

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 2005 report, 2006 quarterly reports and three ad-hoc reports on the Air Quality Archive Web Site.
- The Annual Air Quality Forecasting seminar is to be held at the Met Office's headquarters on May 16^{th}.

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										
	1	0-32	0-16	0-95	0-49	0-88	0-32	0-3.8	0.0-3.2	0-21
	2	33-66	17-32	96-190	50-99	89-176	33-66	3.9-7.6	3.3-6.6	22-42
	3	67-99	33-49	191-286	100-149	177-265	67-99	7.7-11.5	6.7-9.9	43-64
MODERATE										
	4	100-126	50-62	287-381	150-199	266-354	100-132	11.6-13.4	10.0-11.5	65-74
	5	127-152	63-76	382–477	200-249	355-442	133-166	13.5-15.4	11.6-13.2	75-86
	6	153-179	77-89	478-572	250-299	443-531	167-199	15.5-17.3	13.3-14.9	87-96
HIGH										
	7	180-239	90-119	573-635	300-332	532-708	200-266	17.4-19.2	15.0-16.5	97-107
	8	240-299	120-149	636-700	333-366	709-886	267-332	19.3-21.2	16.6-18.2	108-118
	9	300-359	150-179	701-763	367-399	887-1063	333-399	21.3-23.1	18.3-19.9	119-129
VERY HIGH										
	10	$\geq$ 360 μgm^{-3}	$\geq$ 180 ppb	$\geq$ 764 μgm^{-3}	$\geq$ 400 ppb	$\geq$1064 μgm^{-3}	$\geq$ 400 ppb	$\geq$ 23.2 mgm^{-3}	$\geq$ 20 ppm	$\geq$ 130 μgm^{-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.

Appendix 2 - Forecasting Zones and Agglomerations

CONTENTS

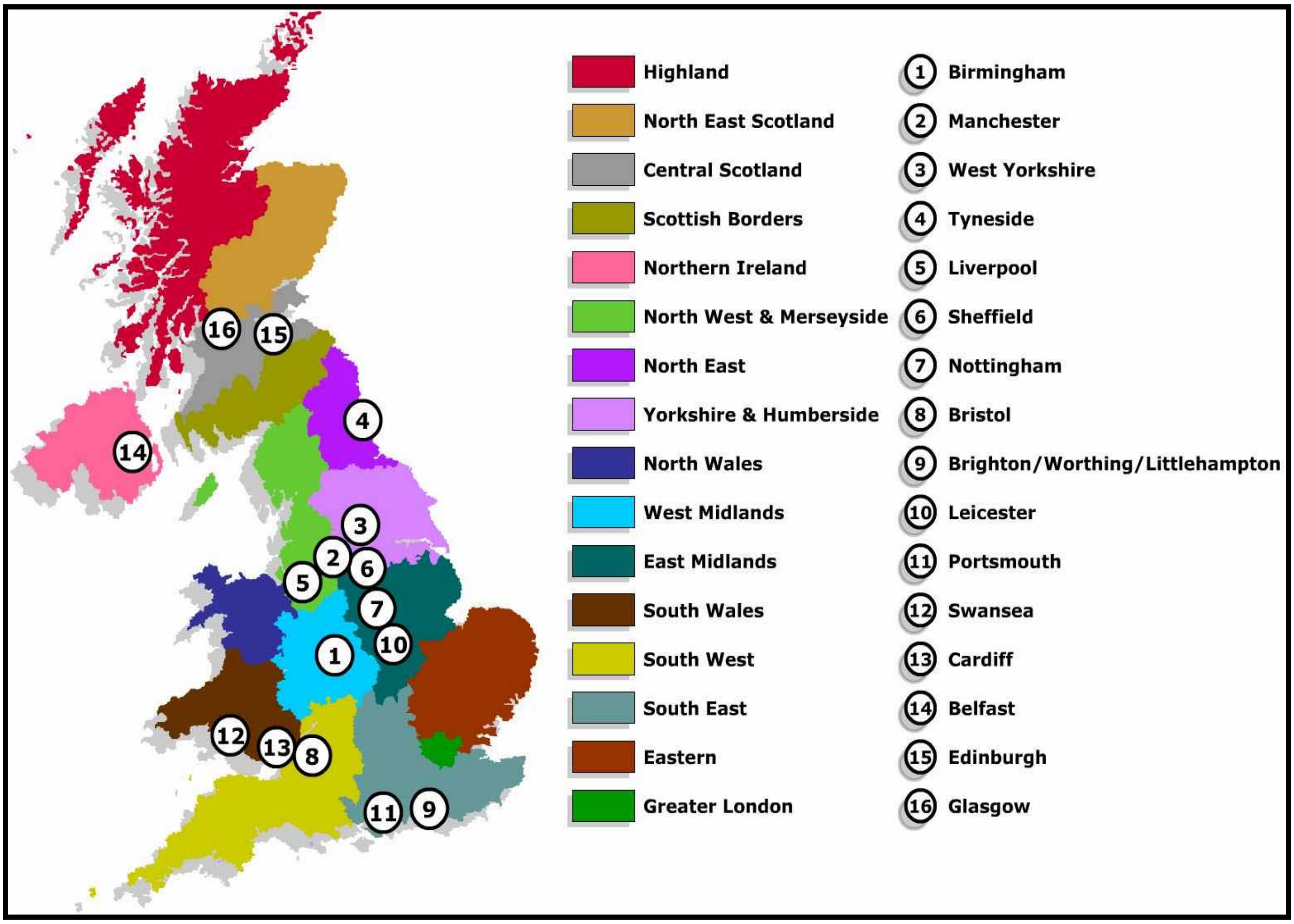
Forecasting Zones

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.