REPORT

UK Air Quality Forecasting: Operational Report for October to December 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/2565 Issue 1, March 2008

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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 October to December 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 fourth quarter of 2007, there were nine days on which HIGH or above air pollution was recorded. All of the HIGH or above exceedences were due to PM_{10} and occurred as a result of bonfire night celebrations on three days and the build up of traffic pollution in poor dispersion conditions on a further six days during episodes in November and December.

Overall forecast success and accuracy rates for the HIGH band were low at an average of 15 % and 0 % respectively 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 emissions.

Many MODERATE days were measured (mainly for PM_{10} but with a small contribution from NO_2 and ozone) and were forecasted with a high degree of success in both zones and agglomerations and a reasonable average accuracy figure of 50%. The forecast accuracy for the MODERATE band will have been affected by bonfire night celebrations and the periodic traffic-related episodes seen throughout this period, which are both 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 50 % is likely to indicate that half 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', October 1st to December 31st 2007.

Region / Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	17	13	104	66
Agglomerations	0	0	137	33

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 October and December; 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

The Met Office has carried out a series of model comparison runs during this quarter using different configurations of the National Air Quality Forecasting system. Different versions of the NAME model, together with a variety of emissions data and model set-ups (e.g. spatial resolution) have been run using the summer of 2003 as a test period. The runs represent the evolution of the forecasting system from the start of the contract period through to the current optimum set-up. Initial results demonstrate an improvement in the system over the term of the contract.

In November, the Met Office was invited to attend the AURN Annual Meeting and Claire Witham presented work on the impacts of Russian and Eastern European fires on UK air quality, which was well received. At a similar time the paper on which this presentation was based was published in Atmospheric Environment (Witham C. and Manning A., 2007, Impacts of Russian biomass burning on UK air quality, Atmospheric Environment 41(37), 8075-8090).

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

In response to letters in the Royal Meteorological Society's November Weather journal regarding Saharan dust and raised PM levels across the UK in March, a letter of reply was sent (and accepted) mentioning the potential contribution of fires and European anthropogenic pollution at this time.

2.2 AEA ENERGY & ENVIRONMENT DEVELOPMENTS

Several internet links have been added to the "AQ toolkit" spreadsheet which include a website detailing historical daily weather observations, an archive for historical synoptic pressure charts and a website resource for European satellite images.

AEA continued to work in collaboration with the Met Office on near-future developments such as enhanced air mass back-trajectory analysis plots.

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 OCTOBER 1ST TO DECEMBER 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	5	0	0	0	0	0	0	0	0	0	0	0	1	6
forecasted days	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	3
ok (f and m)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
wrong (f not m)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
wrong (m not f)	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	5
success %	100	100	100	20	100	100	100	100	100	100	100	100	100	100	100	0	17
accuracy %	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	13

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	2	0	0
forecasted days	0	0	0	0	0	0	1	1	0
ok (f and m)	0	0	0	0	0	0	0	0	0
wrong (f not m)	0	0	0	0	0	0	1	1	0
wrong (m not f)	0	0	0	0	0	0	2	0	0
success %	100	100	100	100	100	100	0	100	100
accuracy %	0	0	0	0	0	0	0	0	0

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	0	0	0	0	0	2	0	4
forecasted days	1	0	0	0	0	1	0	4
ok (f and m)	0	0	0	0	0	0	0	0
wrong (f not m)	1	0	0	0	0	1	0	4
wrong (m not f)	0	0	0	0	0	2	0	4
success %	100	100	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	0	0	20	32	11	0	0	0	0	0	0	0	0	0	1	5	69
forecasted days	0	8	12	24	0	2	0	1	2	0	0	10	5	4	7	3	78
ok (f and m)	0	1	21	29	5	0	0	1	1	0	0	4	1	2	2	5	72
wrong (f not m)	0	7	2	7	0	2	0	0	1	0	0	6	4	2	5	1	37
wrong (m not f)	0	0	0	11	6	0	0	0	0	0	0	0	0	0	1	1	19
success %	100	100	105	91	45	100	100	100	100	100	100	100	100	100	200	100	104
accuracy %	0	13	91	62	45	0	0	100	50	0	0	40	20	50	25	71	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	0	0	0	5	5	0	0
forecasted days	0	5	6	6	0	3	6	8	2
ok (f and m)	0	1	0	1	0	5	5	0	1
wrong (f not m)	0	4	6	5	0	1	3	8	1
wrong (m not f)	0	0	0	0	0	1	2	0	0
success %	100	100	100	100	100	100	100	100	100
accuracy %	0	20	0	17	0	71	50	0	50

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	0	0	0	0	0	5	4	19
forecasted days	8	4	5	6	2	7	4	72
ok (f and m)	0	1	3	2	1	3	3	26
wrong (f not m)	8	3	2	4	1	6	1	53
wrong (m not f)	0	0	0	0	0	2	2	7
success %	100	100	100	100	100	60	75	137
accuracy %	0	25	60	33	50	27	50	33

*** 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 2007 (Based on latest provisional data)

Pollutant	High or above days	Moderate days	Max. conc. (µg /m^3) *	Site with max. conc.	Zones or Agglomeration	Date of max conc.	Forecast success HIGH days (%)*** [no. incidents, zone or agglomeration days] **
Ozone	0	3	108	Lerwick	Highland Zone	5/12	N/a
PM_{10} gravimetric equivalent	9	35	218	Manchester Piccadilly	Greater Mancs UA	4/11	11 % [9]
NO_2	0	8	386	London N Kensington	London UA	12/12	N/a
SO_2	0	0	223	Port Talbot Margam	Swansea UA	20/10	N/a
CO	0	0	4.0	Bury RS	Greater Mancs UA	17/11	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 nine zone and agglomeration-day incidents of HIGH band pollution measured during this quarter for PM_{10} only. In total 35 MODERATE days were measured due to PM_{10}.

Three MODERATE-only days were seen due to ozone.

Eight MODERATE days were measured for nitrogen dioxide.

No MODERATE or above days were measured for SO_2, an unusual albeit increasingly common phenomenon for the fourth quarter of recent years.

No MODERATE or above days were measured for CO during the reporting period. The highest 8-hour running mean calculated was 4.0 mg/m^3

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

Only one MODERATE day was measured during this quarter for more than one monitoring site on a single day. The 5th was a mild day in December, with areas of Scotland reaching up to about 10 degrees C. UK-incident air had been sourced from the vicinity of Iceland and had reached northerly regions from a north-westerly direction. The wind was generally breezy and a cold front had passed over during the course of the morning. The short duration MODERATE levels measured at the most remote, northerly network sites, Lerwick and Strath Vaich, were possibly as a result of turbulent air from the Atlantic passing over the very north of Scotland.

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

PM_{10}

During this quarter there were 35 days on which MODERATE levels of PM_{10} were measured. Twenty five MODERATE-only days were experienced at the London Marylebone kerbside AQM site, mainly as a result of traffic pollution. Other sites measuring more than 5 MODERATE or above days were Camden Kerbside (12 days), London N Kensington (7 days) and Reading New Town (7 days). These were also primarily due to traffic pollution. At Port Talbot Margam six MODERATE and two HIGH days were probably measured as a result of pollution from the nearby steelworks on south westerly winds.

This year the 5th of November was on a Monday, therefore municipal Bonfire celebrations were held primarily on the evenings of Saturday 3rd to Sunday 4th, with the likelihood of additional private firework displays also held on Friday 2nd and Monday 5th. An elevation in particulate levels was seen at some sites on the Friday and the Monday, however the bulk of the pollution was seen during the weekend. The evening temperatures on both the 4th and 5th were near freezing in central England with a very light breeze experienced. On the evening of Saturday 3rd an area of high pressure was centred over the north of England with stable, clear conditions, over much of the UK and mist formation in parts of the south of England. On the 4th November twelve sites, exclusively in the Midlands and the north of England, entered the HIGH band for PM_{10}. All of these appear to have been the result of site locations downwind of bonfires on the evening of the 3rd. A further 9 sites entered the MODERATE band on the same day, of which five were located in the north east of England, two in the Midlands, one in the south west and one in London. Please note the bandings for particulates are based on a running 24 hour mean, therefore there is a time delay until the effect of a pollution event is measured within the banding statistics. On Sunday evening England and Wales were beneath the high pressure centre, with unsettled conditions beginning to spread in to Scotland from the north-west. Mist and fog again formed in parts of the south of England. On the 5th November eleven sites entered the HIGH band, two in London and the remaining nine in the Midlands or the north of England. A further 17 sites entered the MODERATE band as a result of bonfires on the Sunday evening; five in London, two in the Midlands, six in the north of England, two in East Anglia and one in the south west. The location of the high pressure centre was therefore pivotal in determining where in the UK the bulk of particulate pollution was measured.

On Friday 16th and Saturday 17th November London Marylebone Road kerbside entered the HIGH band (at index 7) as a result of a build up of traffic pollution, which eventually dispersed during the course of the weekend. On the 16th high pressure was centred over England and Wales, and on the 17th over the south of England, while unsettled weather spread into the UK from the north west. Overnight conditions were frosty towards the end of that week with light wind speeds. A further five sites entered the MODERATE band on the 16th, three in London including the “airport”-designated London Harlington site, Birmingham Tyburn and Glasgow Kerbside, all of which appear to have been the result of a traffic-related pollution build up. On the 17th, before the pollution finally dispersed, four sites persisted in the MODERATE band including 3 roadside sites in London and London Harlington.

During two spells of cold weather before Christmas, over the weeks beginning Monday 10th December and Monday 19th pollution levels also built up. This also resulted in MODERATE band exceedences at two or more networks sites on Wednesday 12th to Friday 14th and Monday 19th to Thursday 22nd. High pressure was over England and Wales during the first spell up to the 16th, although the position of the pressure centre varied considerably over this period. 4-day air mass

back trajectory plots indicate that no significant contribution from European pollution occurred. London and the South East was the most affected area of the UK by the settled conditions. For the second week of pollution, high pressure was initially centred over the North Sea before moving southwards over France. 4-day air mass back-trajectories were from central continental Europe from the 18th to the 20th then from over central France on the 21st. After the 21st the incoming air began to turn westerly. A contribution from European pollution sources to UK levels was therefore very likely over the second episode. On the 12th December eleven sites entered the MODERATE band, six of these located in London (half of which were designated roadside or kerbside), two in the north of England (Bury Roadside and Leeds Centre), one in the Midlands (Birmingham Tyburn), and two in the south east (Thurrock and Reading). All of these appear to have been the result of primarily traffic emissions. London Marylebone Road and Camden Kerbside sites both entered the HIGH band at index 7. The build up of pollution continued on the following day with a slight decrease in the number of MODERATE sites including Norwich Centre, which again was the result of poor dispersion of traffic pollution. The majority of the episode's pollution occurred between the 11th and 13th December with dispersion conditions slowly improving on subsequent days.

The second episode build-up happened over the 19th to the 23rd December. On the 20th nine sites entered the MODERATE band. Six of these sites were located in London (two of which were kerbside designated). Two sites were in the South East (Reading and Southend on Sea, as seen during the previous episode in the same month). Of the sites exceeding during this second episode, the only new site compared to the previous episode in December was Bristol St Paul's, which again appeared to have been the result of primarily traffic sources. The number of sites exceeding on the following two days fell by about half and occurred again at sites in the south of England. The episode ended around Christmas Eve, partly as a result of a dramatic fall in traffic flows. The episode's maximum running 24-hour average was 95 ug/m^3 at Marylebone Road, very close to, but below, the HIGH band.

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

NO_2

Meteorological conditions at the end of October, mid November and during the two episodes in December caused a total of five sites in London (four of which were designated roadside or kerbside) to reach the MODERATE band on 8 days throughout the whole period. On the 12th December four London sites reached MODERATE, including Billingham in the North East which was likely to have been the result of a short term build up in traffic pollution.

SO_2

No sites entered the MODERATE band. This is an unusual, albeit increasingly common phenomenon for any quarter, particularly during a winter quarter such as this reporting quarter which was more polluted by traffic sources than previous years as a result of the meteorological conditions experienced. The period maximum 15 minute average was 223 ug/m^3, measured at Port Talbot Margam on the 20th October during a swing in the wind direction from north westerly to easterly, bringing air in from the nearby steel works, situated to the south west of the site.

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

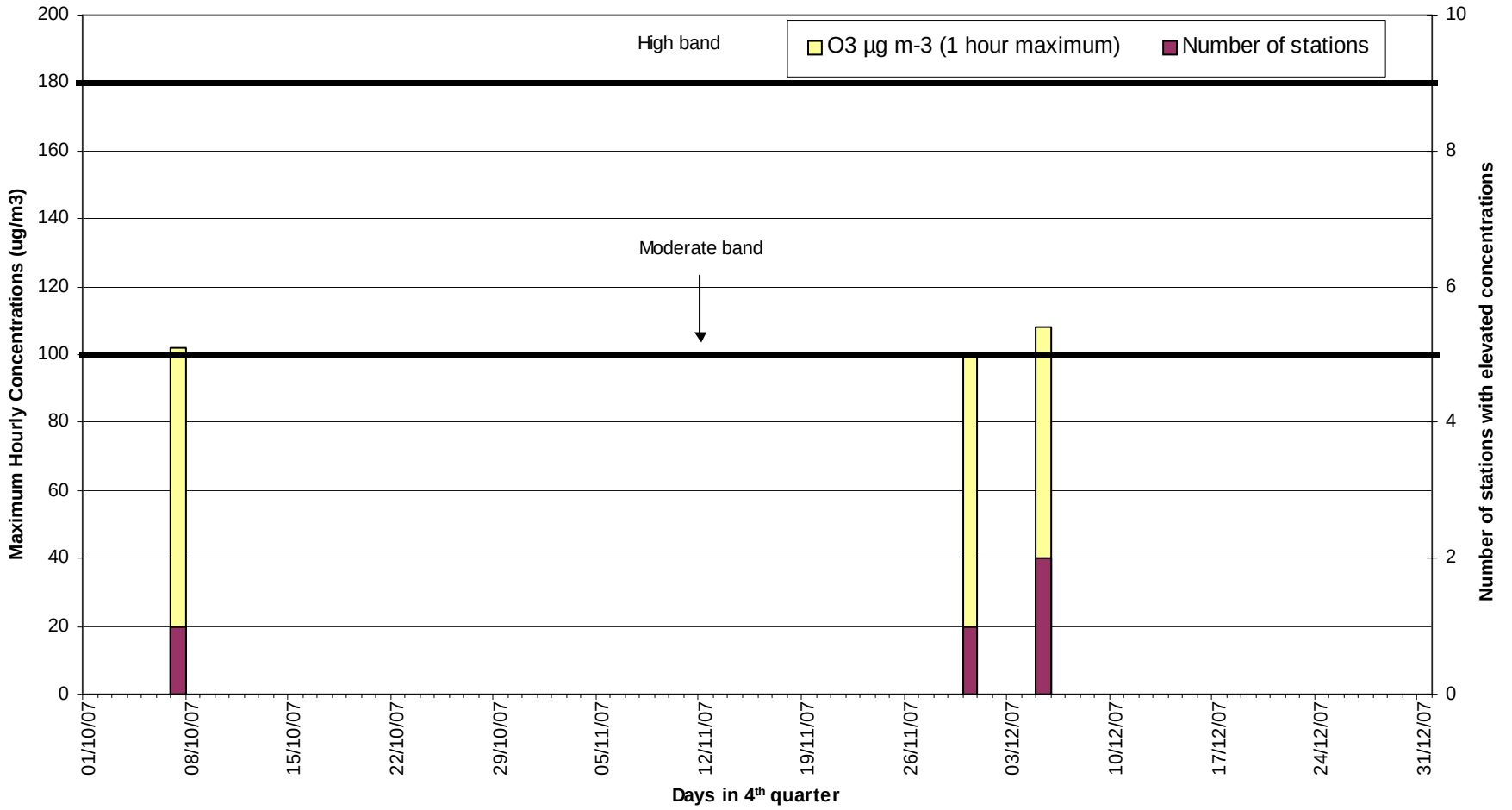


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 4th quarter 2007.

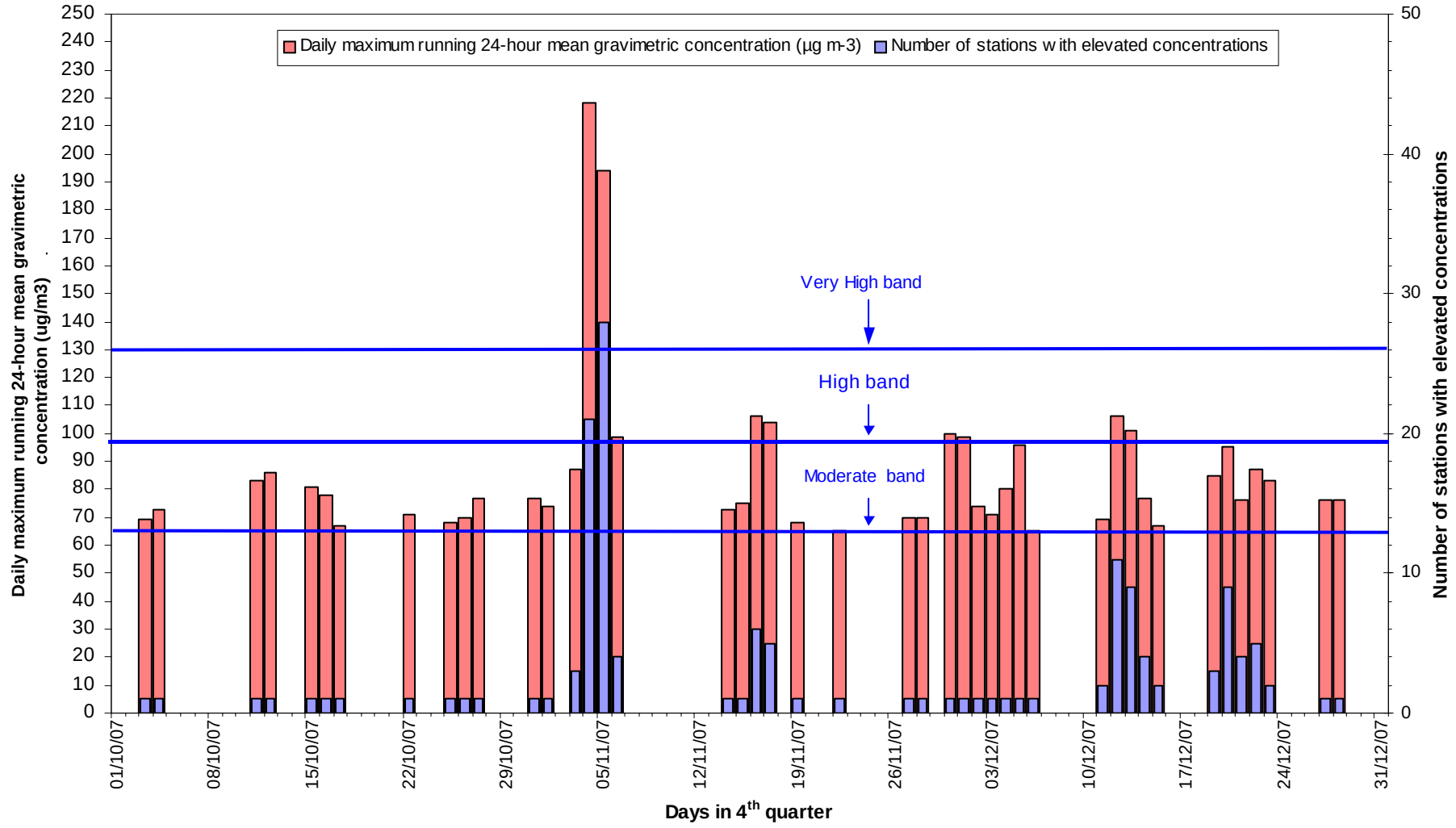


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 4th quarter 2007.

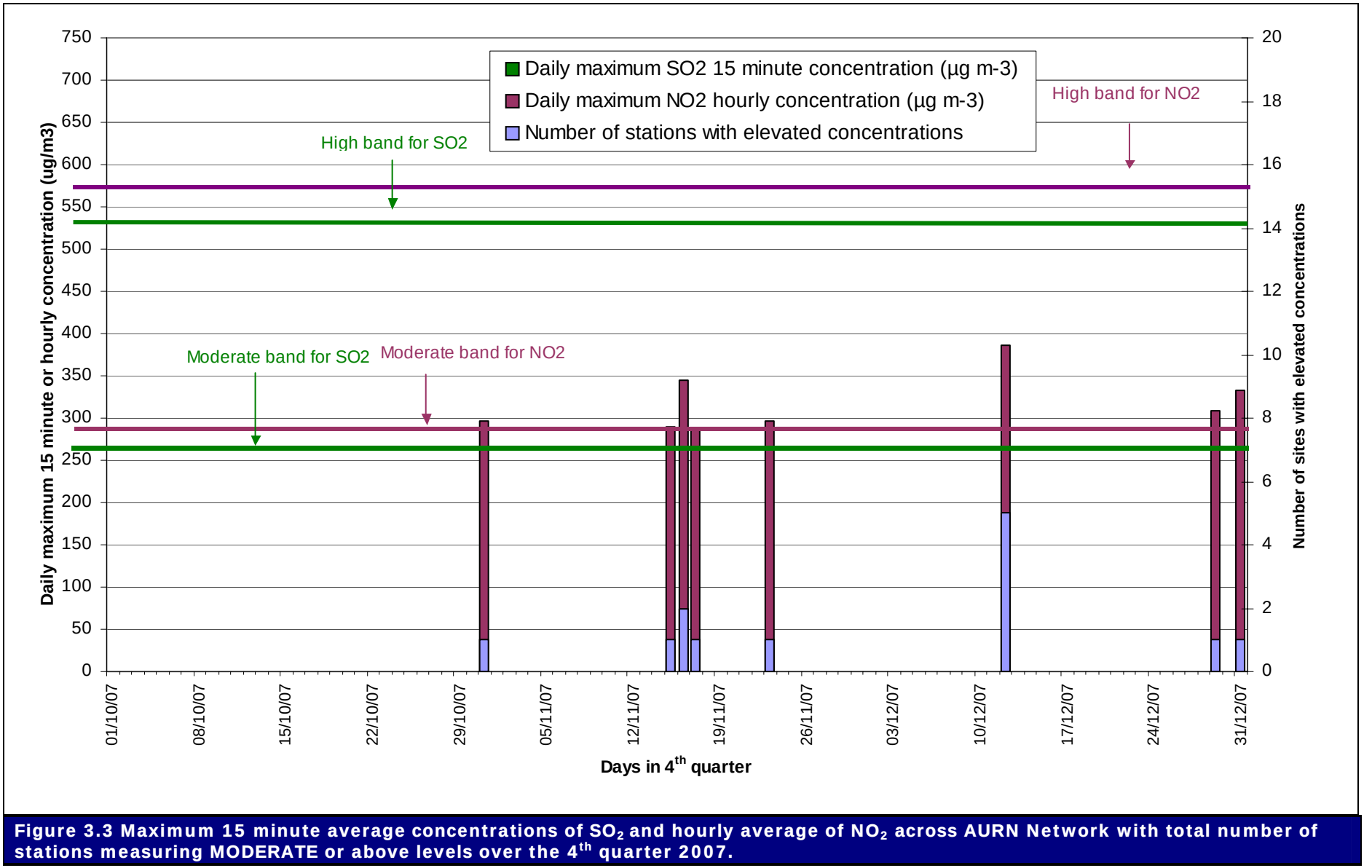


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO_2 across AURN Network with total number of stations measuring MODERATE or above levels over the 4th quarter 2007.

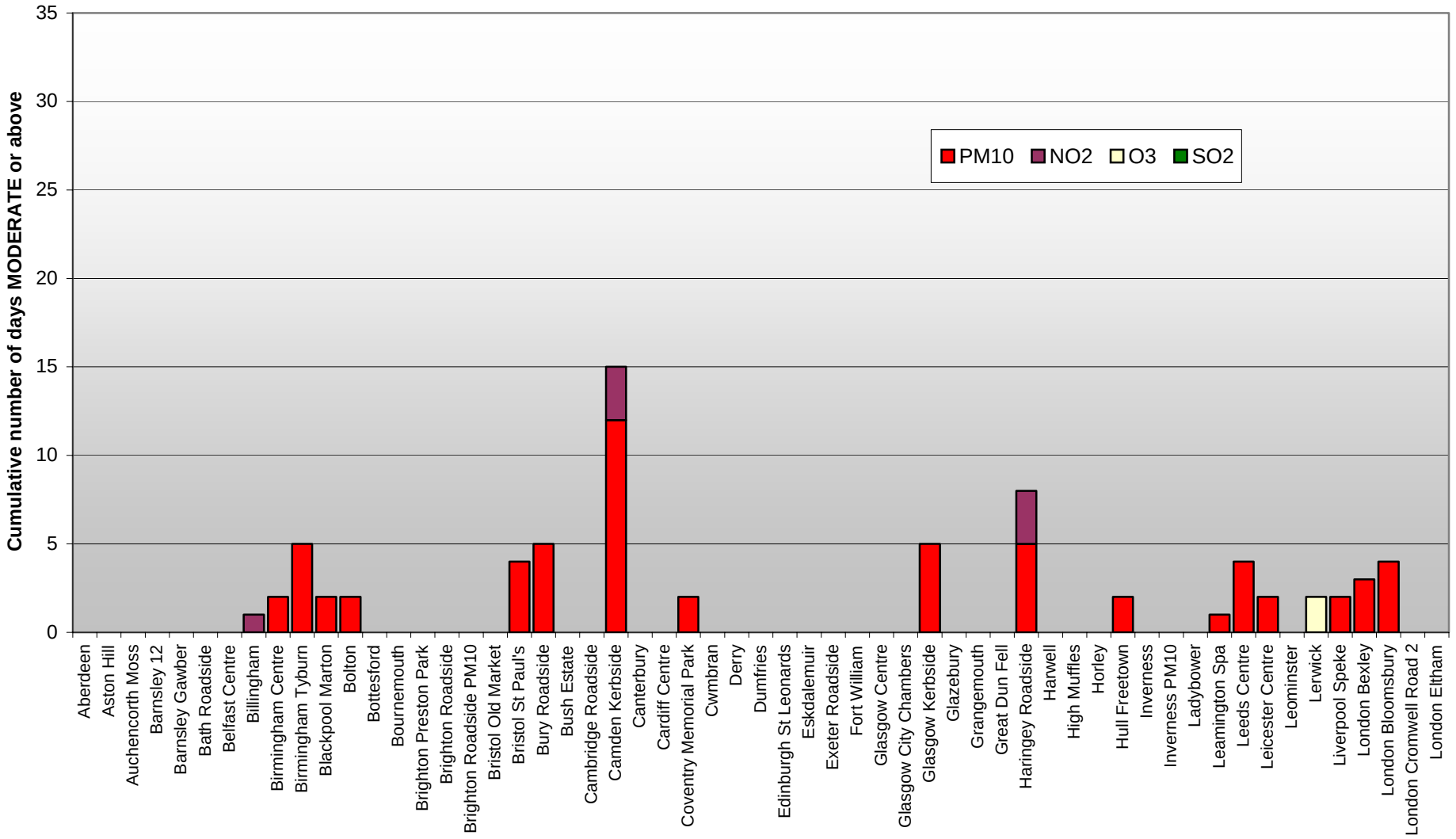


Figure 3.4a Number of days moderate and above for each AURN Network station over 4th quarter 2007 – provisional data

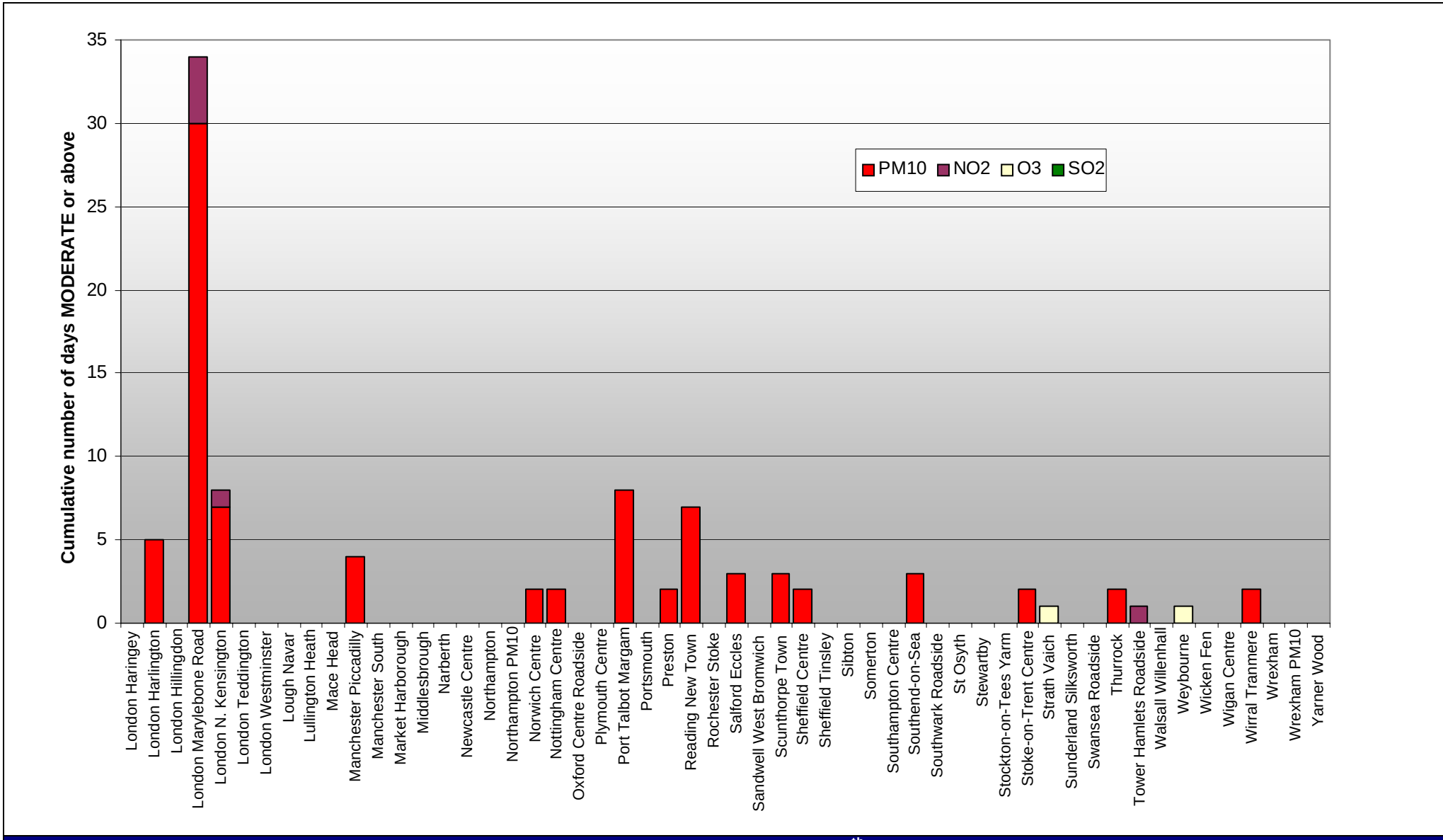


Figure 3.4b Number of days moderate and above for each AURN Network station over 4th quarter 2007 – provisional data

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 LATE MARCH 2007

The final version of this ad-hoc report was published on the National Air Quality Archive in late January 2008.

6.2 FIRE IN LONDON ON MONDAY NOVEMBER 12TH

A fire broke out in a disused warehouse on the site of the 2012 London Olympics, in Greenwich, on Monday 12th November. Flames up to a height of 100 feet or more were described by passers-by. The smoke from the fire was seen to drift south eastwards on a north westerly breeze and therefore passed directly into Kent without traversing much of urban London. No MODERATE exceedences were measured at AURN sites as a result of the plume, however elevated levels of PM_{10} were measured at non AURN sites in the south east in the evening of the 12th, at a maximum hourly average of around 50 ug/m^3 indicative equivalent gravimetric units. Due to the initial buoyancy of the plume, elevated particulate levels in London were less likely to have been experienced than locations further from the source, in this case areas of Kent. Modelling studies of the plume performed by the Met Office during the incident also confirmed the direction of travel of the plume towards the south-east. Figures 6.2 a to c show the geographical position of the fire, the intensity of the smoke drifting over the Thames near Tower Bridge and an aerial photograph showing the source of the fire respectively. All of these images were sourced from the BBC website. Figure 6.2d shows 15 minute PM_{10} measurements made at Maidstone Rural (non-AURN site) located in mid Kent on the same day as the outbreak of the fire and figures 6.2e to g show run results from the Met Office's NAME model for the resulting plume at 1 pm, 4 pm and 6 pm respectively on the day of the fire.

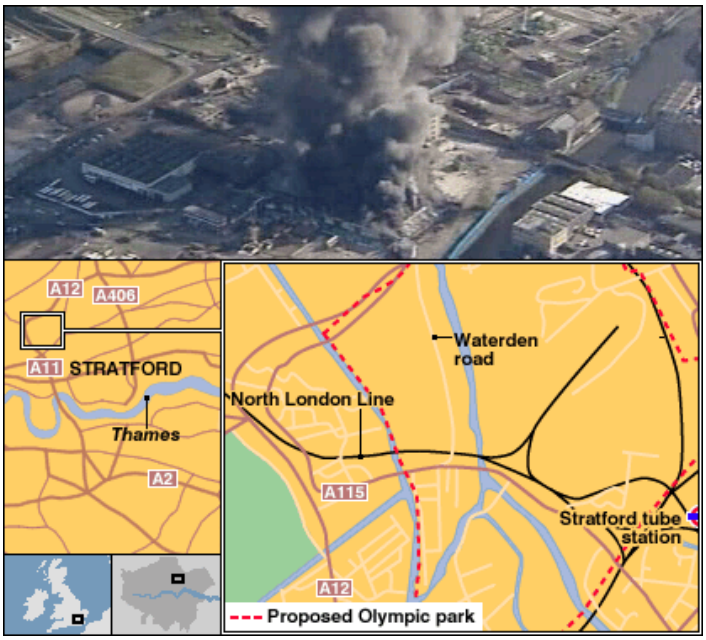


Figure 6.2a

Figure 6.2b

Figure 6.2c

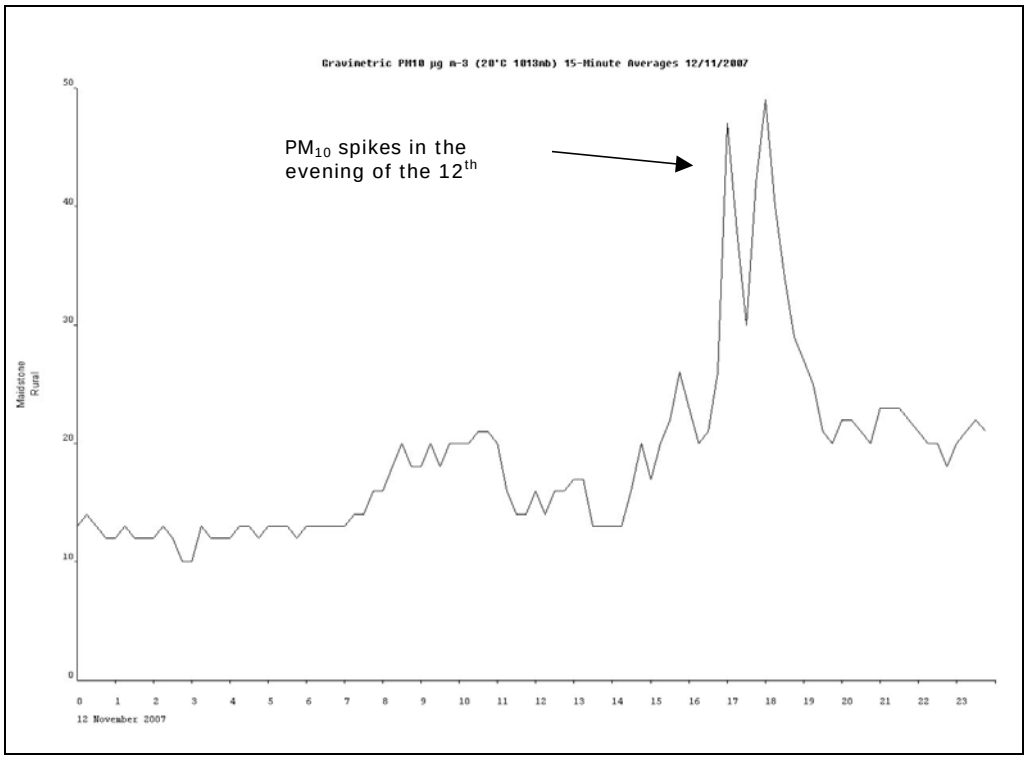


Figure 6.2d

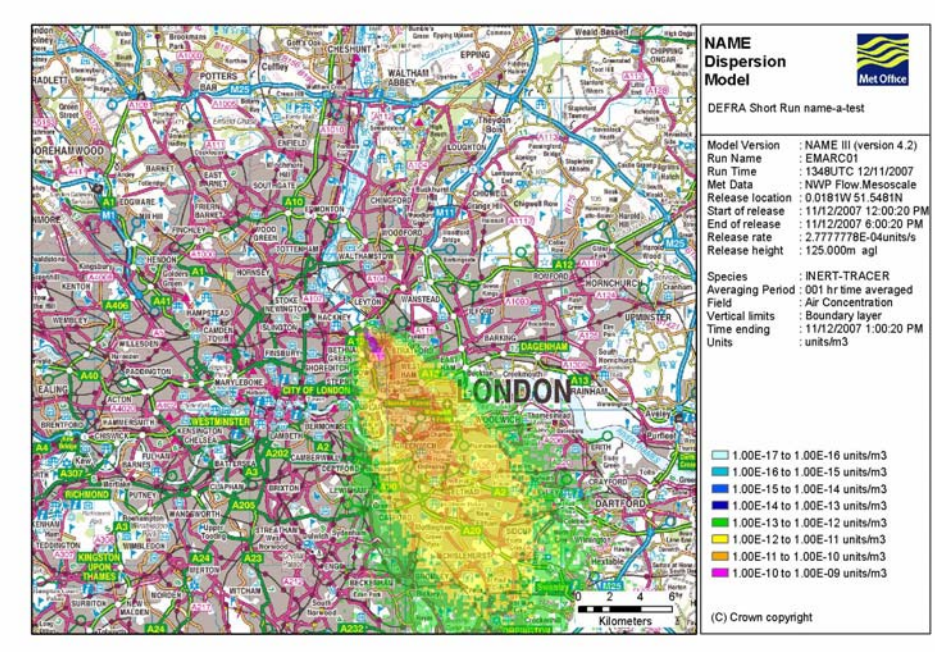


Figure 6.2e

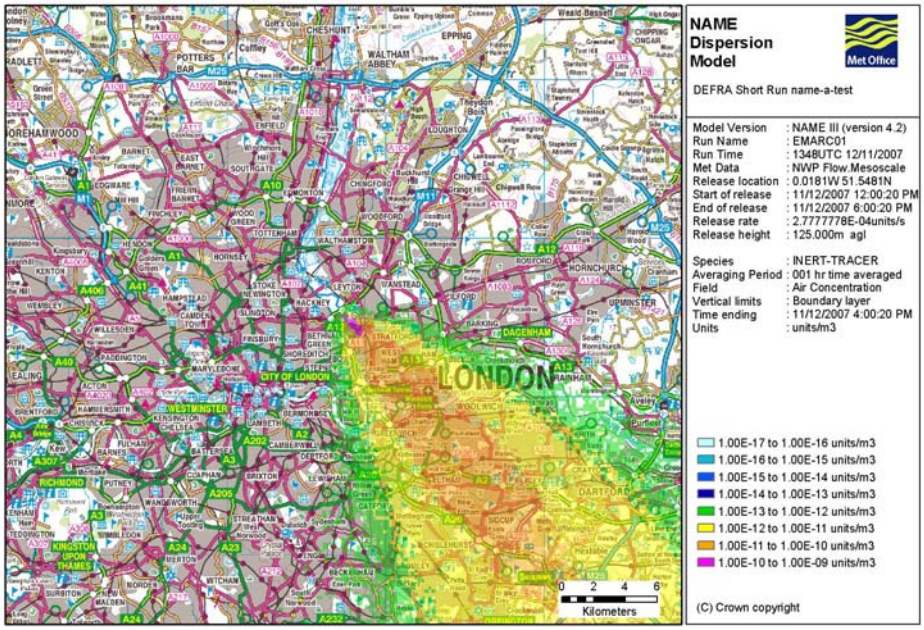


Figure 6.2f

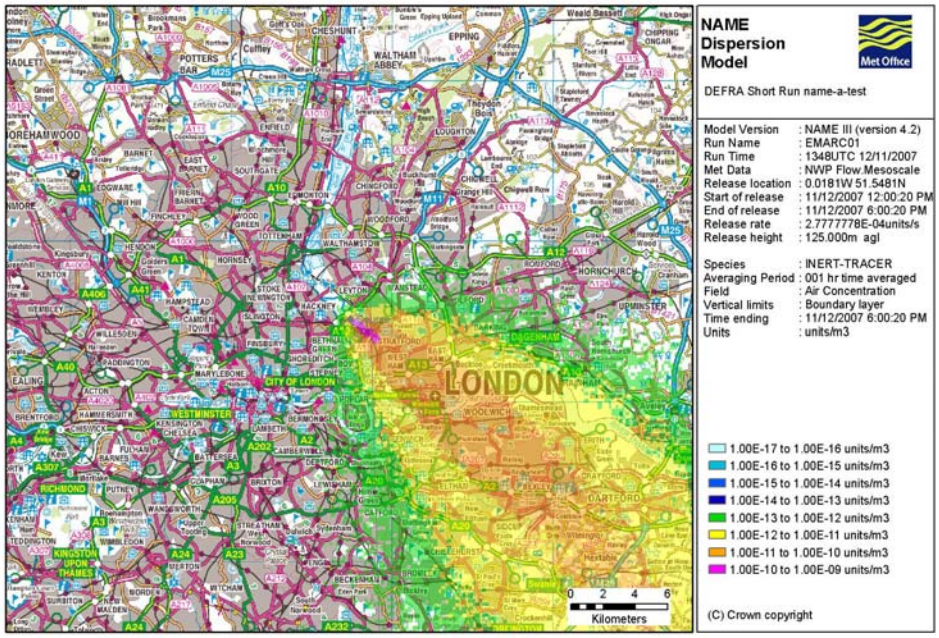


Figure 6.2g

6.3 BONFIRE NIGHT WEEKEND 2007

A report has been drafted for review by DEFRA and the Devolved Administrations detailing the levels of PM_{10} measured at AURN sites between the 4th and 6th November.

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 January to March 2008

Major tasks include:

- Ongoing daily air pollution forecasting activities.
- Implementation of the recently developed enhanced air mass back-trajectory plots for daily forecasting.
- 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 2006 report and several 2007 quarterly reports on the Air Quality Archive Web Site.
- Organisation of the 2008 annual AQ Forecasting seminar, which is to be held in London.

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

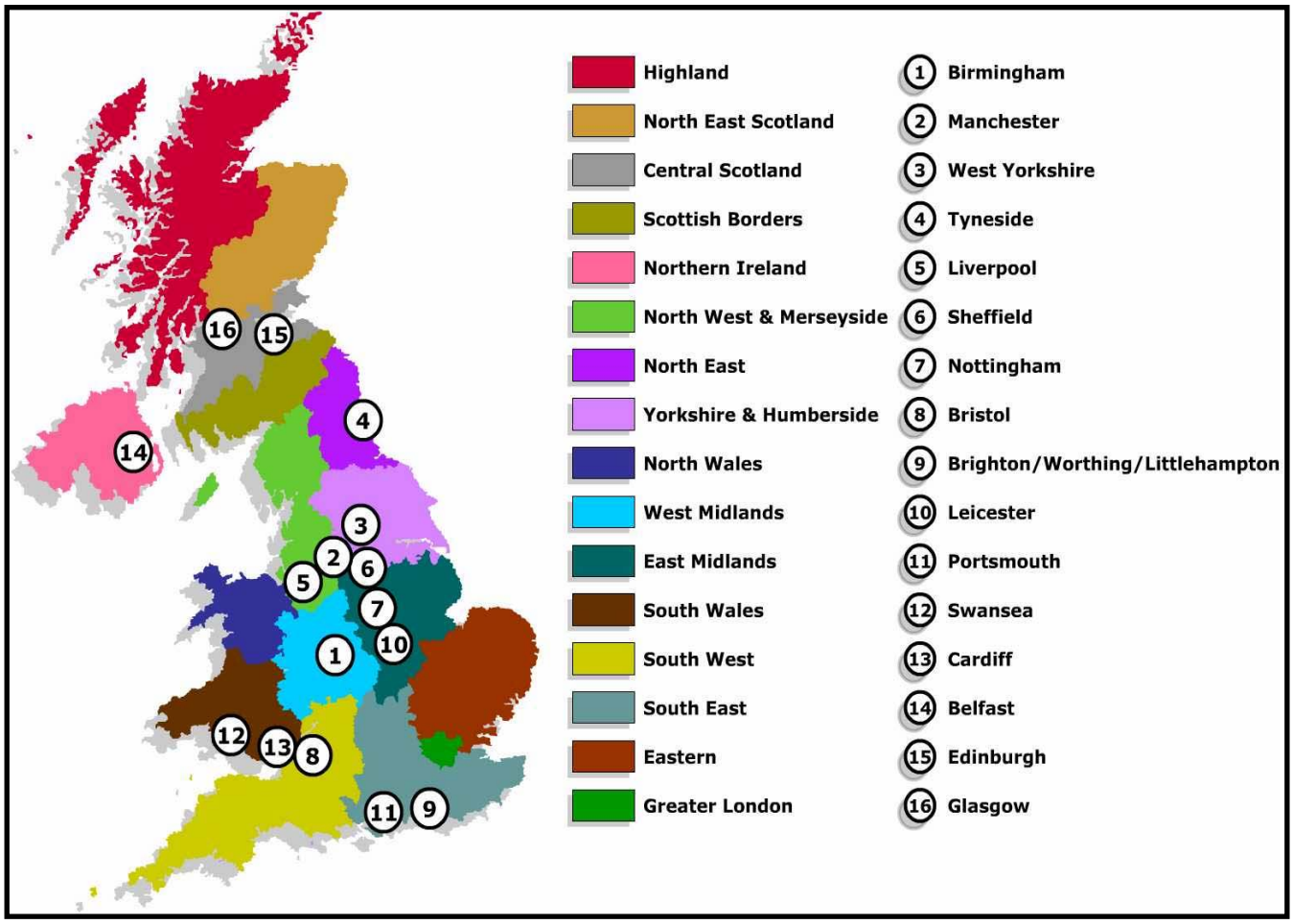
Forecasting Zones

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.