UK Air Quality Forecasting: Operational Report for July to September 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

AEAT/ENV/R/2743 Issue 1, January 2009

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Executive Summary

This report covers the operational activities carried out by AEA Technology plc and the Met Office under the UK Air Quality Forecasting Contract from July to September 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 third quarter of 2008, there were six days on which HIGH or above air pollution were recorded. One HIGH day was due to ozone and five days were due to PM_{10}, as measured by an FDMS-TEOM instrument. Please note that the PM_{10} health bandings are yet to be defined for PM_{10} FDMS-TEOM monitoring equipment, therefore the five HIGH or above exceedences for PM_{10} have been calculated using the existing bands defined for indicative gravimetric equivalent TEOMs.

Overall forecast success and accuracy rates for the HIGH band were both 100 % for zones during this quarter. This was due to the HIGH band ozone exceedence at Hull Freetown being forecasted successfully to within 1 index point of the index 7 level reached. Success and accuracy rates are not yet calculable for FDMS TEOM instruments, therefore the five days of exceedences measured at Port Talbot Margam have not been calculated within this report.

Many MODERATE days were measured (mainly for ozone but also included a fair contribution from PM_{10}) and were forecasted with a high degree of success in both zones and agglomerations, and a reasonable average accuracy figure of around 80 %. Please note success rates above 100 % are possible, as detailed in section 3 of this report. 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 approximately 80 % is likely to indicate that 20 % 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 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', July 1st to September 30th 2008.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	100	100	130	86
Agglomerations	n/c^	n/c^	135	70

^ cannot be calculated

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 July and September; 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. 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 third quarter of 2008. 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 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.

The National forecasts are also quality controlled for consistency with forecasts issued by AEA for UK regions and individual local authorities.

2 New developments during this period

2.1 MET OFFICE DEVELOPMENTS

During this quarter the Met Office has obtained and finished processing emissions data for 2005 and 2006 for the UK (from the National Atmospheric Emissions Inventory) and Europe (from EMEP). The 2006 data is being implemented in the National Air Quality Forecast modelling system. Work is being carried out to upgrade the modelling system to use 12 km horizontal resolution met data. The improved resolution of meteorological features should lead to improved air quality forecasts.

A detailed reanalysis of the Nottingham sulphur dioxide pollution episode in September 1998 has been conducted during this period. This clearly highlights the benefits from including high time-resolution information on emission rates from large polluters, as well as information on stack heights etc. Increased availability of such data would be a substantial asset to future air quality modelling. More information on daily, weekly or seasonal cycles of emissions would almost certainly lead to improvements in the UK air quality forecast. The work also demonstrated the benefits from moving to higher resolution meteorology.

2.2 AEA DEVELOPMENTS

AEA continued to work in collaboration with the Met Office on near-future developments.

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 JULY 1ST TO SEPTEMBER 30TH 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	0	0	0	0	0	0	0	0	0	0	0	0	1	1
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	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0
success %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	100	100
accuracy %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	100	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	0	0	0	0
forecasted days	0	0	0	0	0	0	0	0	0
ok (f and m)	0	0	0	0	0	0	0	0	0
wrong (f not m)	0	0	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	0	0	0	0	0	0
success %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
accuracy %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	0	0	0	0 (!)	0	0	0	0 (!)
forecasted days	0	0	0	0	0	0	0	0
ok (f and m)	0	0	0	0	0	0	0	0
wrong (f not m)	0	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	0	0	0	0	0
success %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c (!)
accuracy %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c (!)

*** All performance statistics are based on provisional data. Noticeably incorrect data due to instrumentation faults have been removed from the analyses. N/c = cannot be calculated. (!) FDMS PM_{10} datasets have been currently excluded from the analysis.**

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

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

ZONES	Central Scotland	East Mids	Eastern	Greater London	Highland	North East	North East Scotland	North Wales	North West & Merseyside	Northern Ireland	Scottish Borders	South East	South Wales	South West	West Midlands	Yorkshire & Humberside	Overall
measured days	6	17	26	24	16	8	2	2	7	2	5	17	10	22	13	20	198
forecasted days	10	13	27	24	10	12	6	9	9	4	9	25	14	16	12	15	219
ok (f and m)	9	16	30	32	18	10	6	5	10	6	9	28	18	25	13	21	258
wrong (f not m)	1	2	1	1	0	3	1	6	0	0	2	1	1	3	2	3	30
wrong (m not f)	0	2	3	2	0	0	0	0	0	0	0	1	0	2	1	2	13
success %	150	94	115	133	113	125	300	250	143	300	180	165	180	114	100	105	130
accuracy %	90	80	88	91	100	77	86	45	100	100	82	93	95	83	81	81	86

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	14	6	5	2	2	8	11	5
forecasted days	3	21	11	8	6	5	10	9	8
ok (f and m)	1	19	11	9	7	5	8	9	6
wrong (f not m)	2	4	1	1	1	0	3	3	3
wrong (m not f)	0	3	0	0	0	0	1	2	0
success %	100	136	183	180	350	250	100	82	120
accuracy %	33	73	92	90	88	100	67	64	67

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	6	14	2	4	2	12	8	101
forecasted days	13	19	7	12	6	13	8	161
ok (f and m)	7	15	3	11	4	12	9	136
wrong (f not m)	6	5	4	4	3	4	2	48
wrong (m not f)	2	2	0	0	0	1	0	11
success %	117	107	150	275	200	100	113	135
accuracy %	47	68	43	73	57	71	82	70

*** All performance statistics are based on provisional data. Noticeably 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 July to September 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	1	39	182	Hull Freetown	Yorkshire and Humberside	27/07	100 % [1]
PM_{10} gravimetric equivalent	5	15	158	Port Talbot Margam	Swansea UA	02/08	n/c ^ [5]
NO_2	0	2	296	London Marylebone Rd	London UA	30/07	N/a
SO_2	0	2	396	Nottingham Centre	Nottingham UA	17/08	N/a
CO	0	0	3.8	Port Talbot Margam	Swansea UA	09/08	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.

^ all five HIGH days for PM_{10} were measured by the FDMS-TEOM instrument at Port Talbot Margam. FDMS PM_{10} datasets have been currently excluded from the analysis. N/c = not applicable to calculate.

General Observations

There were six zone and agglomeration-day incidents of HIGH band pollution measured during this quarter. One day was for ozone alone and the remaining five were for PM_{10} alone (two of the PM_{10} exceedence days were measured in the VERY HIGH band). In total, forty MODERATE calendar days were measured during the quarter. Twenty three MODERATE days were measured for ozone alone, three days for PM_{10} alone and ten days for coincident ozone and PM_{10}. The remaining four days occurred as a result of other combinations of pollutants including nitrogen dioxide and sulphur dioxide.

No MODERATE or above days were measured for CO during the reporting period. The highest 8-hour running mean calculated was 3.8 mg/m^3 at the Port Talbot Margam site and was measured simultaneously with an increase in SO_2 and PM_{10}, suggesting that the nearby steel works was the source.

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 the week from the 24th to the 31st July. Ten MODERATE sites on the same day was also experienced periodically throughout the quarter, for example on the 1st and 2nd July, 30th August and the 20th/21st September.

The single widespread episode of the quarter was seen from the 24th to the 31st July. The wind direction in the south of England had been generally westerly between the 12th and 22nd July, with daytime temperatures in the south east remaining generally in the mid 20's degrees C. On Wednesday 23rd July a high pressure centre had formed over England, Wales and Northern France. By Thursday 24th the high pressure centre had moved away towards Scandinavia, bringing in air to the UK from over the Benelux countries. On Friday 25th the air reaching the UK had been sourced from large areas of the near-European coast, therefore bringing in secondary pollution from Europe. Saturday 27th was a day of mainly Atlantic air and the following day was similar, with some additional influence of air masses from over France. UK re-circulated air from the south of England was a feature of Monday 28th, however weather fronts were building to the west by that stage. By Tuesday 29th most of the UK was receiving air from the Atlantic, except Scotland which received air from central Europe; from the vicinity of Germany. On Wednesday 30th the UK again received air predominantly from the Atlantic, however, some circulation over France had occurred. A similar situation remained on the last day of the episode, Thursday 31st, with low pressure building to the west. By Friday 1st August low pressure was over the UK with westerly incident air masses. Daytime temperatures were persistently above 30 C in the south east between the 23rd to the 31st July, with the lightest wind speeds experienced on the 26th, 27th and 31st July. Between 40 and 60 AURN sites reached the MODERATE band daily between the 24th and the 28th July. One HIGH band measurement was made at Hull Freetown on Saturday 27th, possibly as a result of a small contribution of air masses from continental Europe bringing in ozone precursors, as produced by the working week's build up of pollution, in combination with a localised effect.

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

PM_{10}

Sites measuring the highest number of MODERATE or above days during the reporting period were London Maylebone Road (9 days) and Port Talbot Margam (8 days). The MODERATE exceedences at Marylebone Road were primarily the result of traffic pollution. The FDMS-TEOM instrument at Port Talbot Margam measured 3 HIGH days and 2 VERY HIGH days during periods when the local wind direction was south westerly, bringing in industrial emissions from the nearby steel works and dockyard. The Scunthorpe Town AQM site measured 3 MODERATE days, all were likely to have been the result of industrial emissions from a nearby industrial complex to the south east. The Stockton On Tees Yarm roadside AQM site measured three MODERATE days at the end of July, which were likely to have been the result of a build up of traffic pollution in warm, dry weather conditions. The Glasgow kerbside site also measured two MODERATE days during the warm spell in late July. On Saturday 31st August two sites in the South East; Portsmouth and Southend on Sea, measured a MODERATE band exceedence during a day on which air masses had arrived in the UK from over central continental Europe, bringing in secondary pollution from the end of the working week. On Sunday 28th September, a day when air masses reaching the south of the UK had originated from over the vicinity of Germany, the Bristol St Paul's AQM site measured a MODERATE exceedence. This is likely to have been the result of a combination of localised pollution and transport of secondary pollution from Europe.

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

NO_2

Two MODERATE days were measured during the reporting period. Both MODERATE days were measured at the London Marylebone Road site on the 5th and 30th July, both maximum hourly averages measured were just above 290 ug/m^3. The exceedence on the 30th July occurred towards the end of a warm spell of weather and was therefore likely to have been a combination of traffic pollution, weather conditions and photo-chemical effects. The exceedence on the 5th July is likely to have been the result of a short term localised build up of traffic pollution.

SO_2

Two MODERATE days were measured during the period. However, two sites had coincidentally entered the MODERATE band on one of the MODERATE days; therefore three sites in total measured a MODERATE band reading during the reporting quarter. On the 26th July Middlesbrough measured a 15 minute average of 314 ug/m^3 at 12:45 pm and Grangemouth measured a reading of 271 ug/m^3 at 3:30 am. The exceedence at Grangemouth coincided with a change in the wind direction to the north, the same direction as the nearby petro-chemical plant. A similar effect occurred at Middlesborough, which experienced a four day pollution event, including a correlated increase in NOx and CO measurements, seen from the 25th to the 28th July inclusive. The wind direction had moved to the north over the 26th and 27th July, which suggests the pollution on those days may have originated from industrial estates to the north. On the 17th August, a MODERATE band measurement of 396 ug/m^3 was made at 08:30 am at the Nottingham Centre AQM site. Bridge strengthening works and other roadworks were suggested as a possible cause for the exceedence, however only a relatively small proportion of PM_{10} was associated with the pollution measured.

Figure 3.3 shows the trends in NO_2 and SO_2 levels over this period.

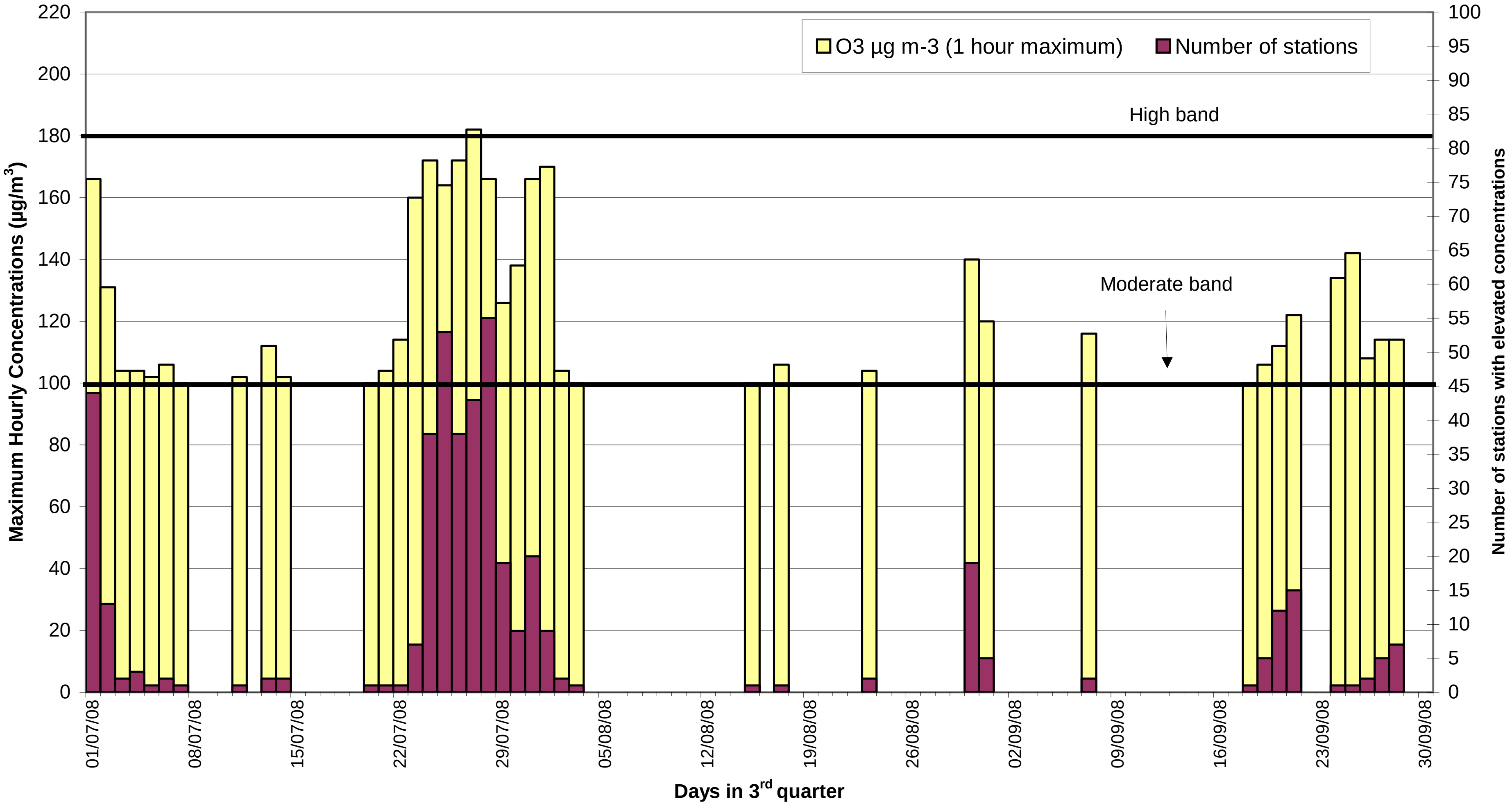


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 3rd quarter 2008.

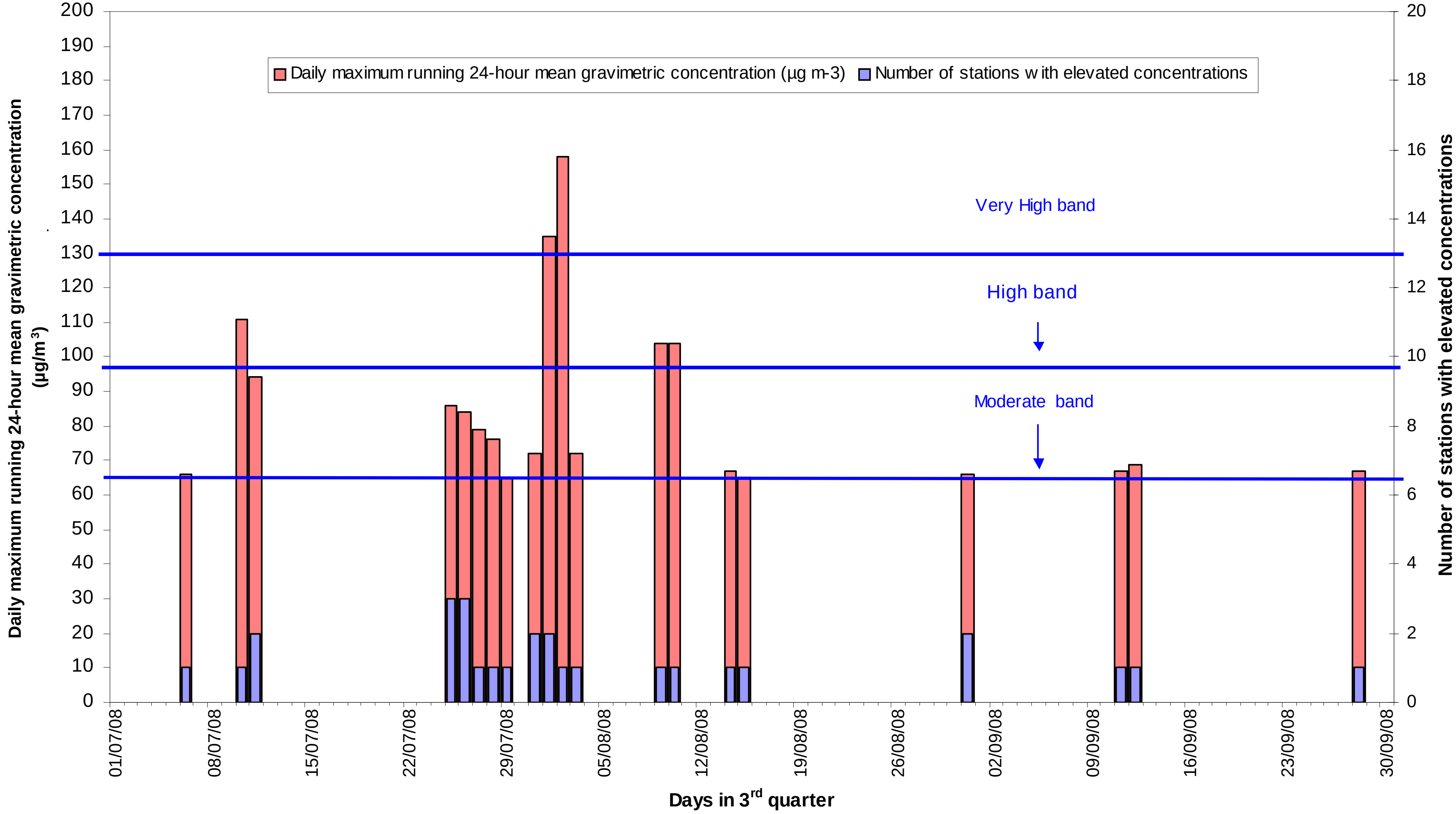


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2008.

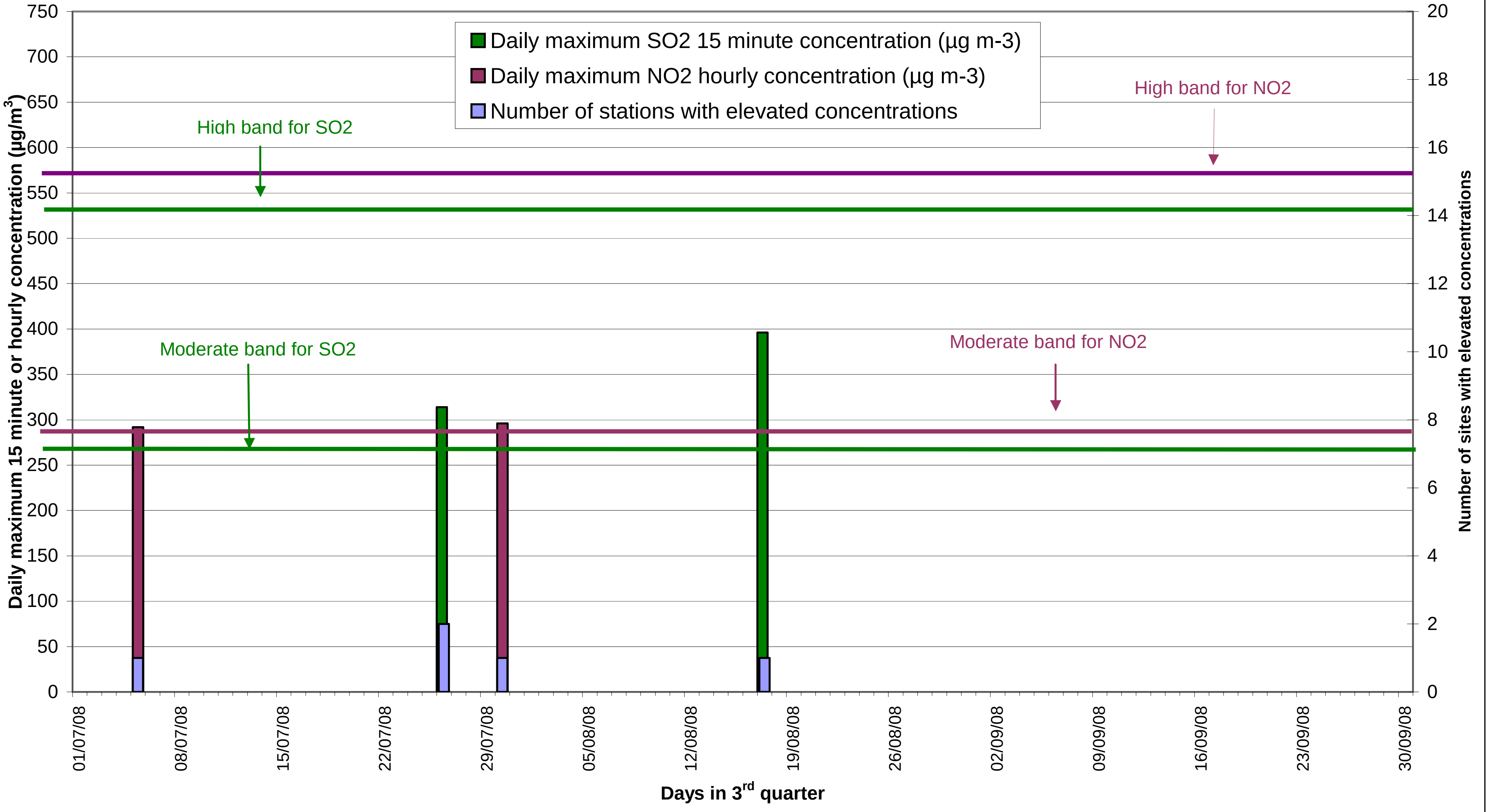


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO_2 across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2008.

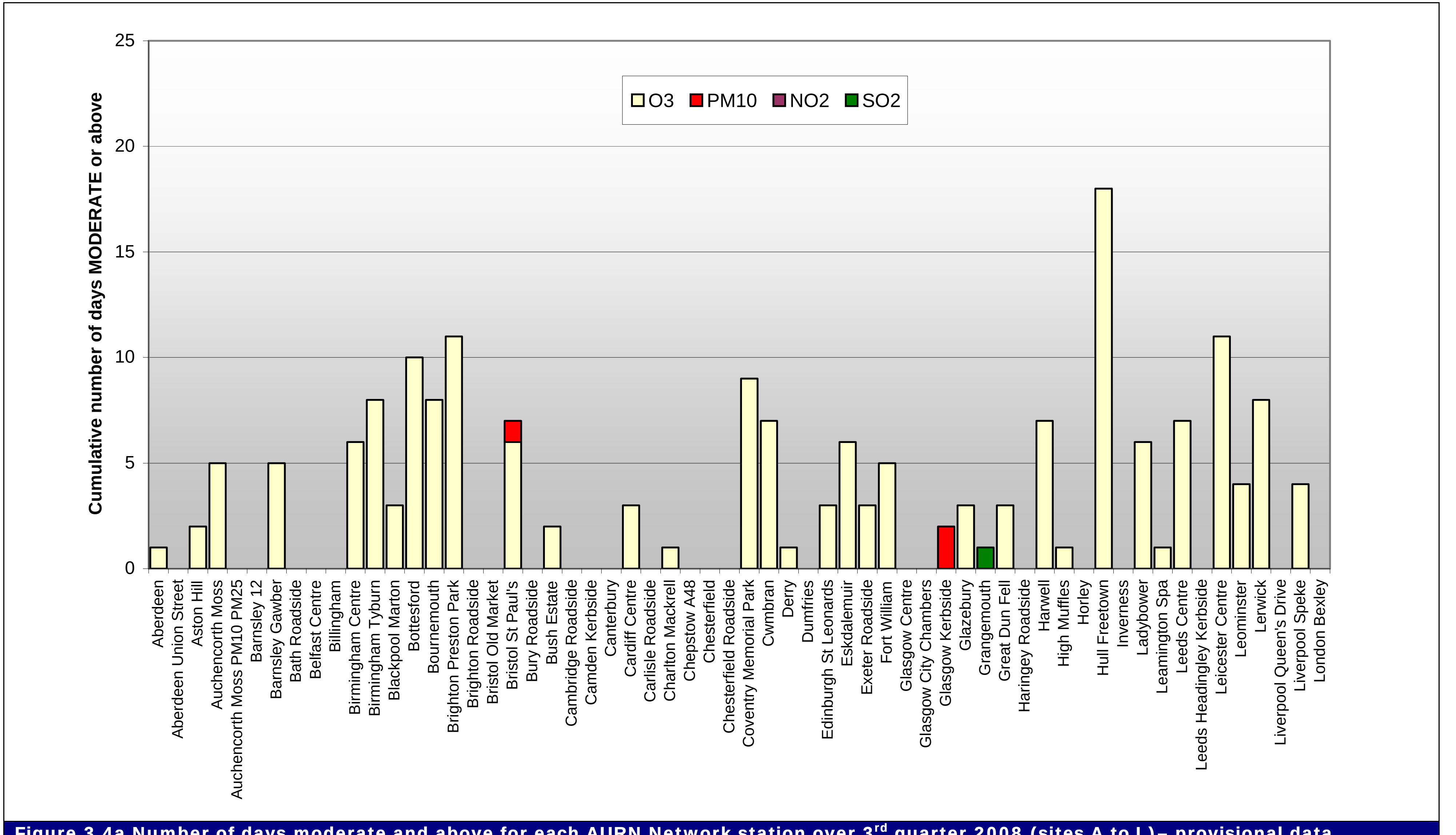


Figure 3.4a Number of days moderate and above for each AURN Network station over 3rd quarter 2008 (sites A to L)– provisional data

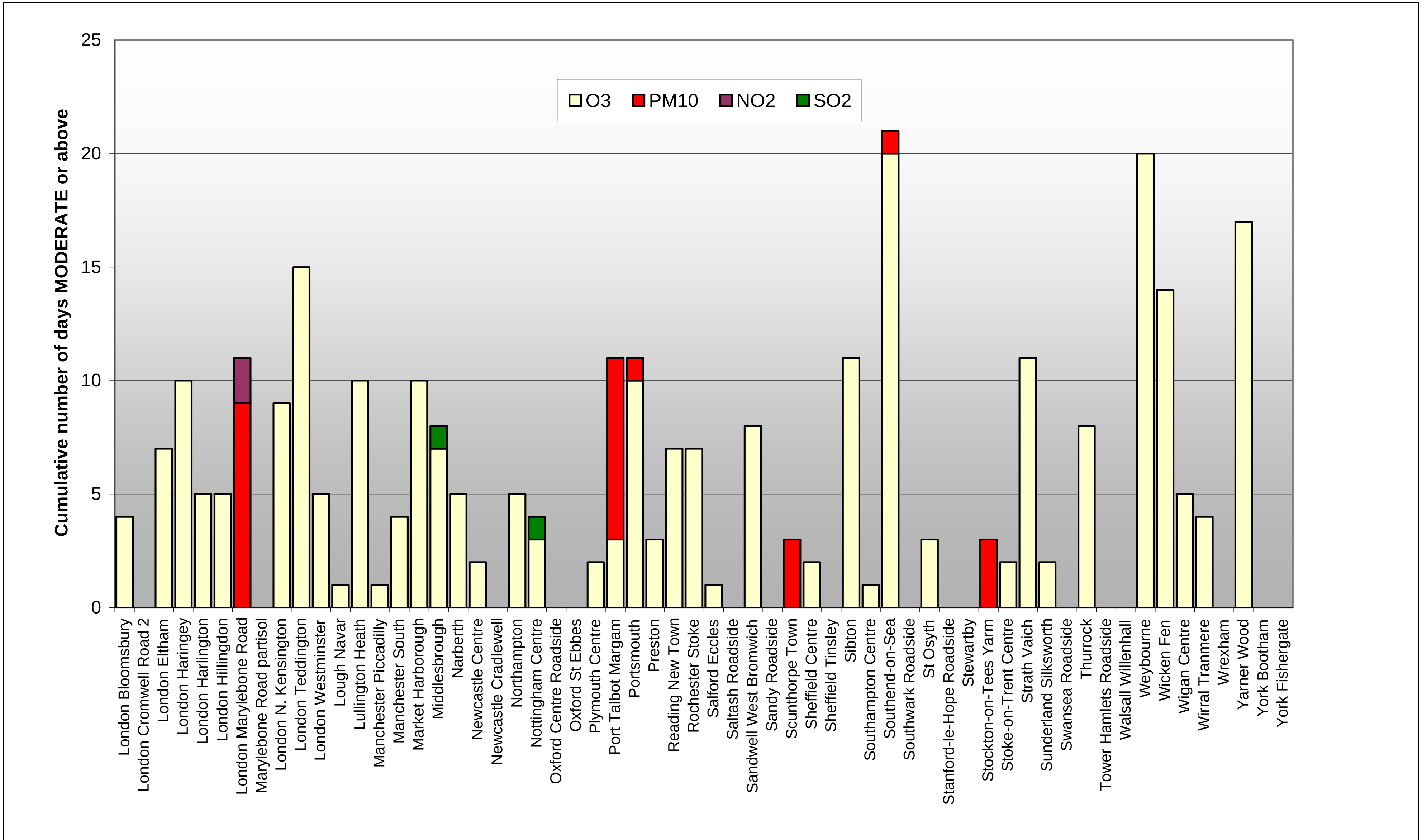


Figure 3.4b Number of days moderate and above for each AURN Network station over 3rd quarter 2008 (sites L to Y) – provisional data

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

There were two fire related incidents which occurred during the reporting period. The first occurred in early July near Glasgow, the second at the end of July at Weston-Super-Mare.

On the 8th July a major fire incident occurred in the afternoon and evening at Christie & Son scrap metal merchant, Renfrew. Figure 6.1 shows a picture taken from the Glasgow Harbour development at 2220 BST on the day.

Figure 6.1

Hourly averaged indicative gravimetric particulate measurements for PM_{10}, seen at monitoring sites in Glasgow, are plotted in figure 6.2.

Figure 6.3 shows the location of the sites in the city of Glasgow and figure 6.4 shows the location of the fire and the wind direction recorded between 18.00 - 19.00 BST.

A peak in PM_{10} concentrations at about 19.00 BST was clearly seen at all the West End and City Centre sites - Abercromby Street, Broomhill, Glasgow Centre, Glasgow Kerbside (Hope St), Anderston and Byres Road.

The sites on the Southside of Glasgow – Nithsdale Road and Battlefield Road, were not affected.

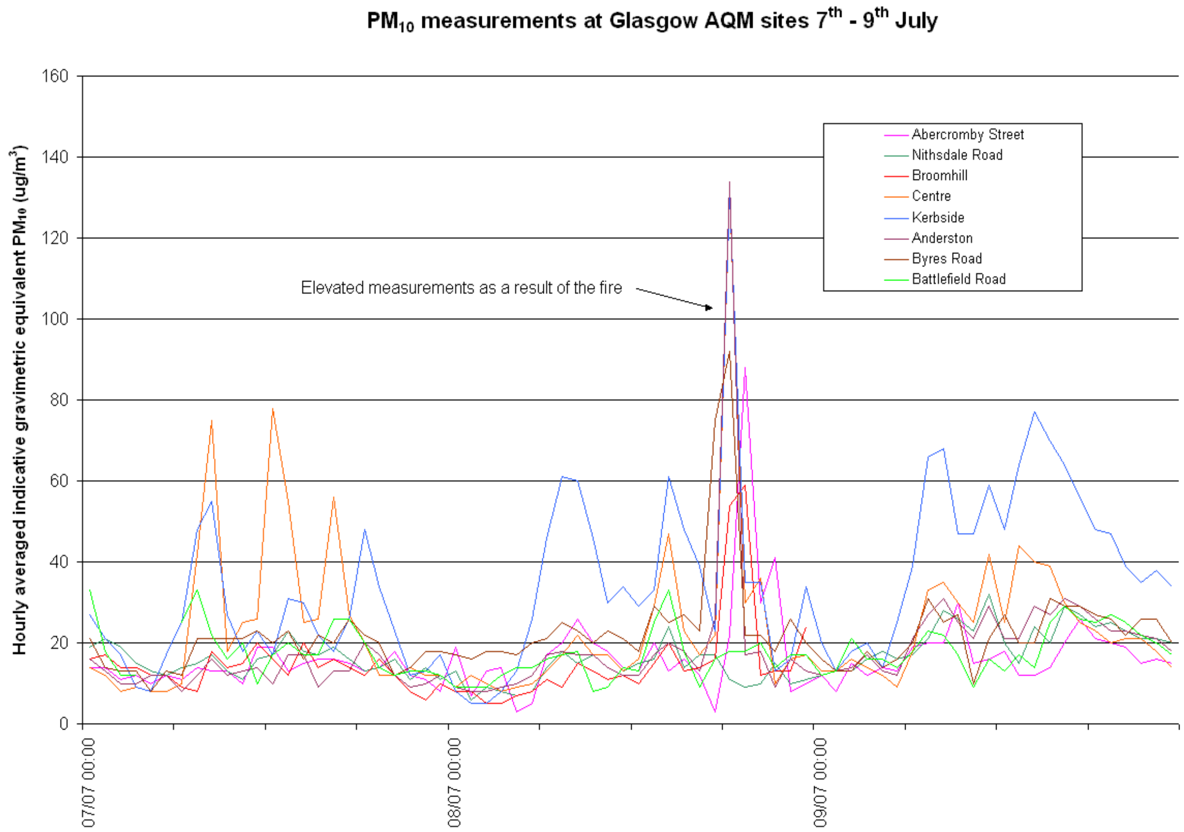


Figure 6.2

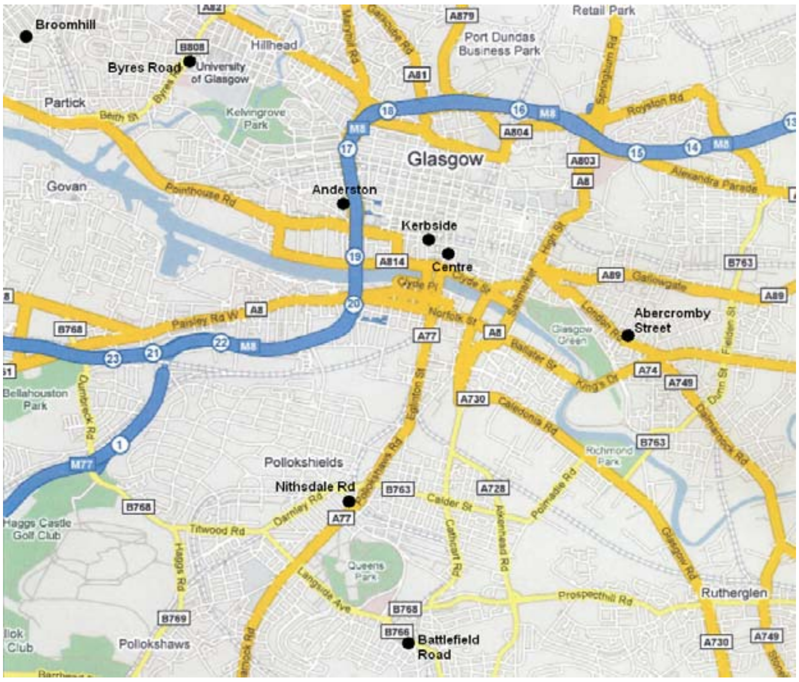


Figure 6.3

Map showing the site of the fire with respect to Glasgow's PM10 monitoring stations - arrow shows wind direction at the time of the greatest PM10 measurements (18:00 – 1900 GMT)

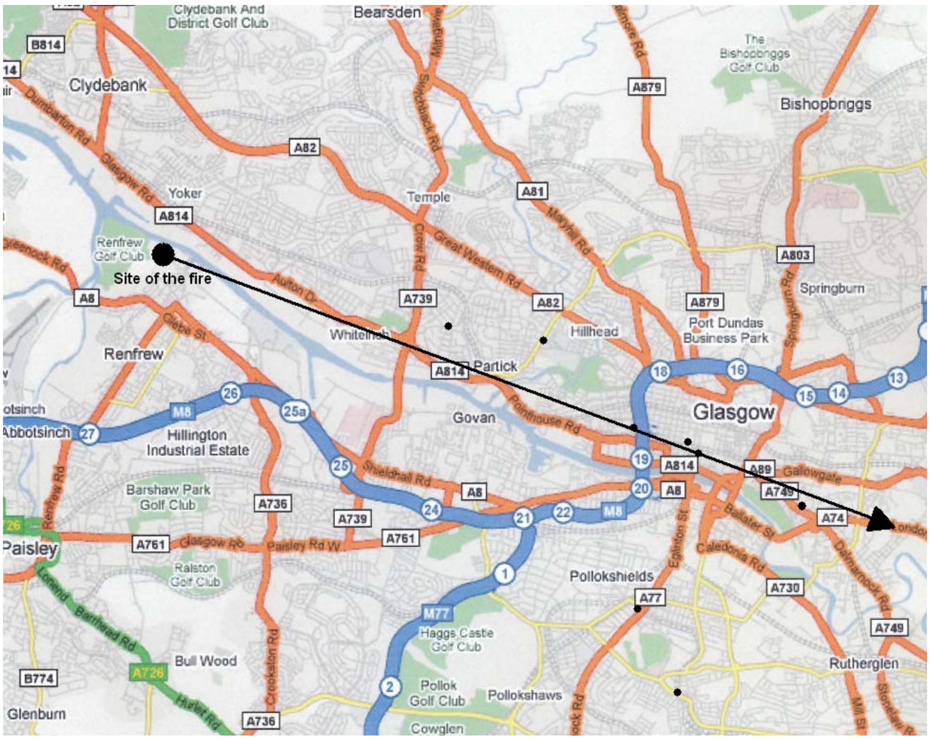


Figure 6.4

A fire took hold of the partly wooden pier at Weston-Super-Mare, in North Somerset, at approximately 07:00 BST on the 28th July. The fire was thought to have started in an area containing deep fat fryers. Black smoke, as shown in figure 6.5, was visible more than ten miles away.

Figure 6.5

The Met Office ran the NAME III particulate release dispersion model forwards, with Weston-Super-Mare as the origin and an estimated release time of 4 hours, starting from 06:00 GMT (which is equivalent to 07:00 BST). The model run results, as shown in figure 6.6, indicated that the resulting plume of smoke had passed over parts of Cardiff, the Vale of Glamorgan and Port Talbot.

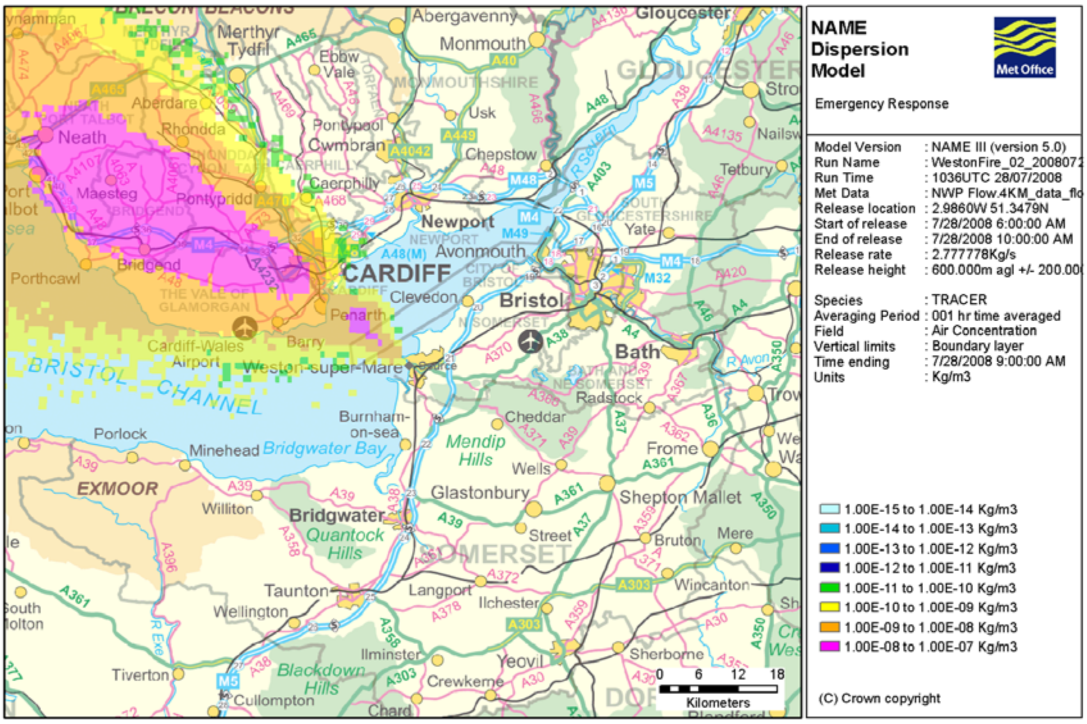


Figure 6.6

No urban or roadside PM_{10} monitoring site in South Wales showed an obvious, extraordinary measurement as a result of the plume of smoke passing overhead, which is likely to suggest that the plume was hot and buoyant enough to stay above ground level for most of the time. However, interesting measurements were taken at the rural monitoring site in Cwmbran on that day, as shown in figure 6.7. The plot also includes measurements from Cardiff Centre and the rural site Narberth. A 15-minute averaged peak of approximately 70 ug/m^3 (in indicative gravimetric equivalent units) was seen at Cwmbran at around 08:00 BST, approximately one hour following a smaller, albeit hourly averaged, peak at Cardiff Centre. Cwmbran was situated to the east and outside of the modeled path of the plume, however the plot suggests the possibility that some of the plume may have broken away and had traveled to the north of the fire's origin. An alternative, localised pollution source cannot be completely ruled out near the Cwmbran site on that morning. Other, less well defined, peaks were measured at all three of the monitoring sites plotted during the afternoon, including Narberth, located towards the south west corner of Wales. These peaks may have been related to the fire being extinguished during the course of the day, combined with local wind direction effects.

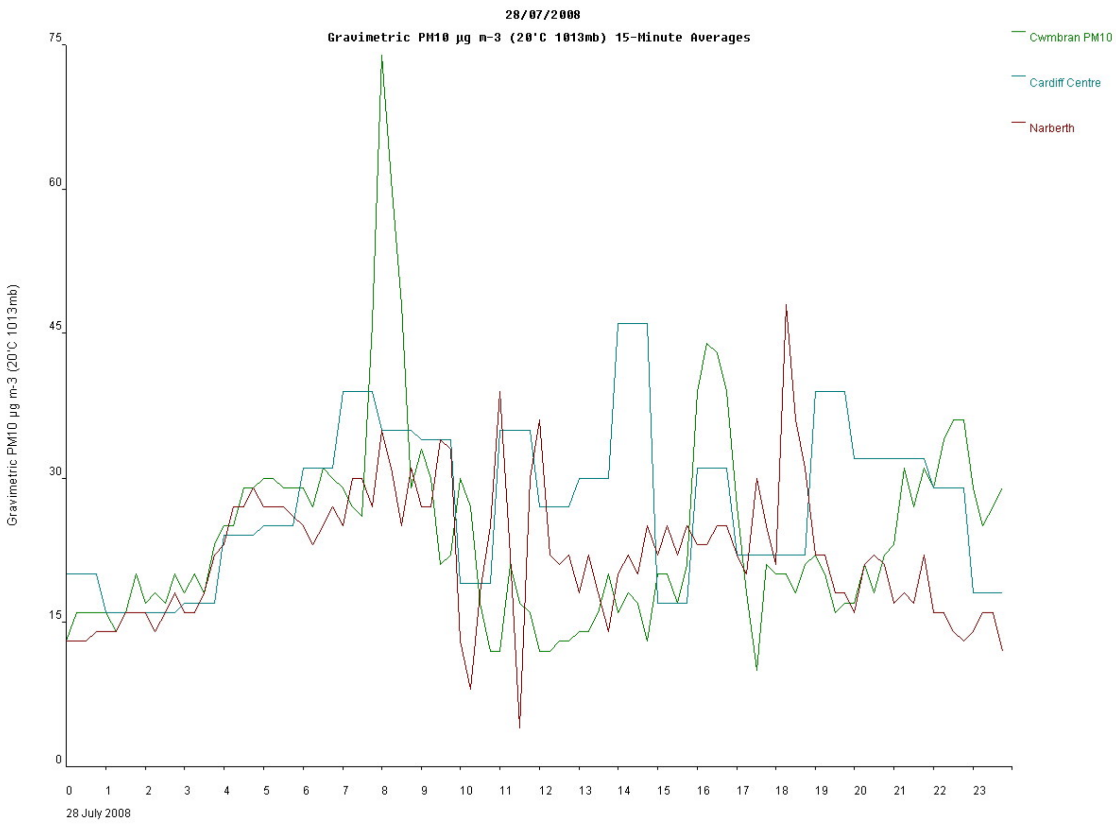


Figure 6.7

7 Ongoing research

AEA 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 Project and other related meetings

No meetings were held over the reporting period.

9 Forward work plan for October to December 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 an ad-hoc report detailing a UK particulate episode in January 2008 on the Air Quality Archive Web Site and two quarterly operational reports issued during 2008.

10 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

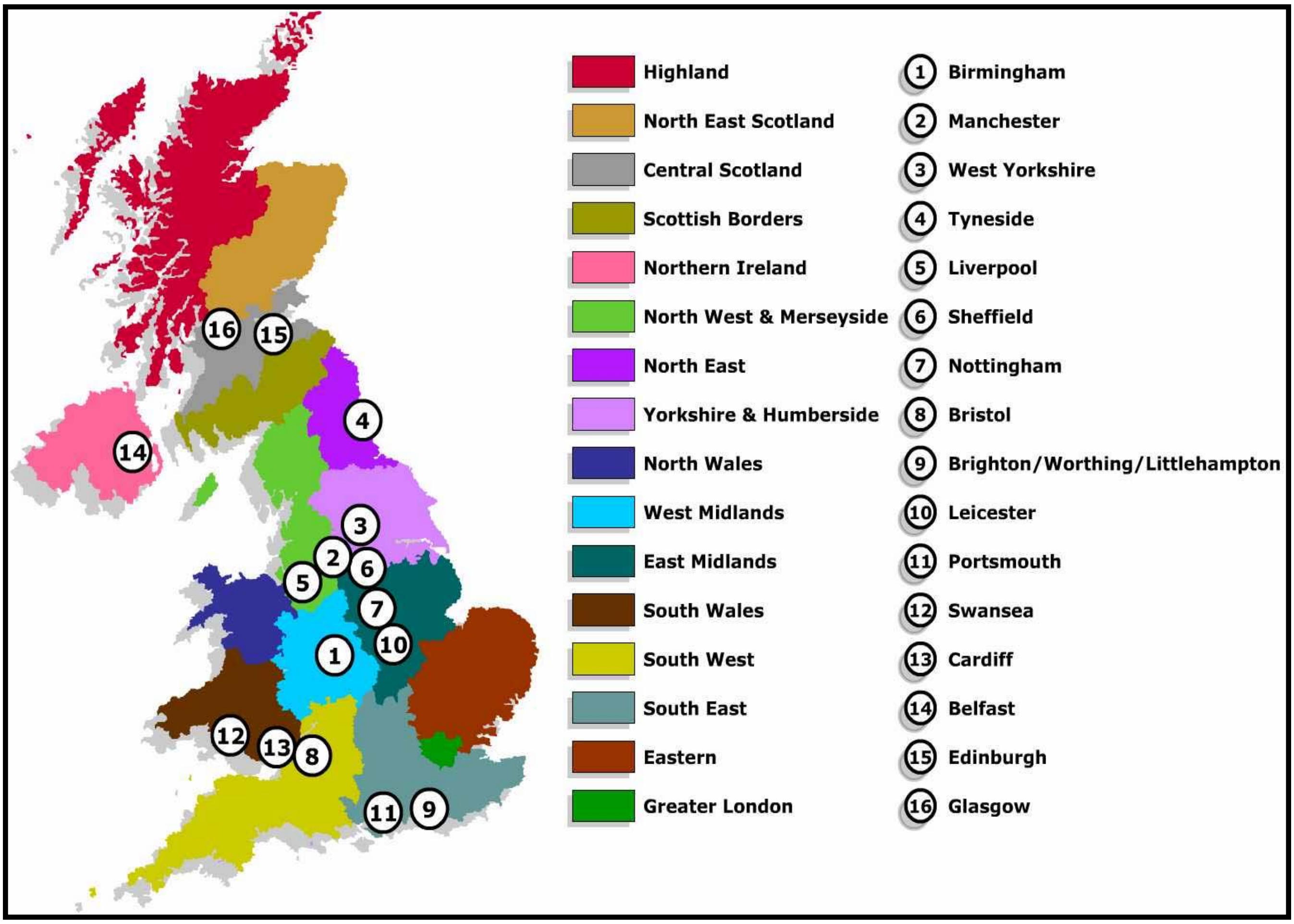
Forecasting Zones

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.