REPORT

UK Air Quality Forecasting: Operational Report for July to September 2006

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/2333 Issue 1
October 2006

UK Air Quality Forecasting: Operational Report for July to September 2006

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/2333 Issue 1
October 2006

Title	UK Air Quality Forecasting: Operational Report for July to September 2006.
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	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/2333 Issue 1
Report status	Issue 1

AEA Technology plc
Netcen
Building 551
Harwell
Didcot
Oxfordshire
OX11 0QJ
UK
+44 (0) 870 190 6441 tel.
+44 (0) 870 190 6608 fax.

Andy.cook@aeat.co.uk

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

	Name	**Date**
Author	Andy Cook	11/10/2006
Reviewed by	Paul Willis	15/10/2006
Approved by	Jon Bower	20/10/2006

Executive Summary

This report covers the operational activities carried out by Netcen and the Met Office on the UK Air Quality Forecasting Contract from July to September 2006. 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 2006, there were 15 days on which HIGH air pollution was recorded. 97 % of the HIGH measurements were due to ozone, 3 % were due to PM_{10}. Around 94 % of the HIGH ozone day-incidents were forecast successfully and a 33 % success rate was achieved for PM_{10}. Overall forecast success rates for the HIGH band were excellent, at above 120 % for both zones and agglomerations, with a fair degree of accuracy at around 70 %. Many MODERATE days were measured (mainly for ozone but a considerable contribution from the other pollutants, particularly PM_{10}) and were forecast with a high degree of success and a reasonable accuracy. 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 large proportion of measured polluted days were successfully forecast (percentage above 100%)[1]. An average accuracy figure of 65 % indicates that only 35 % of the forecast MODERATE levels were not measured and remained LOW. The accuracy figures tend to be lower due to the precautionary approach that Netcen takes when issuing the daily forecasts- we issue a forecast for MODERATE pollution when there is only a small chance that it will be recorded.

Table 1 – Forecast success/accuracy for incidents above 'HIGH' and above 'MODERATE', July 1st to September 30th 2006.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	120	72	112	70
Agglomerations	159	70	113	59

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

1. Investigating ways of using automatic software systems to streamline the activities within the forecasting process, thus allowing forecasters to spend their time more productively considering the most accurate forecasts.
2. Researching the chemistry used in our models, in particular the NO_x->NO_2 conversion used in NAME, and 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 April and June; all bulletins were delivered to the Air Quality Communications contractor on time.

Contents

1 Introduction

A forecast of the following day's air pollution is prepared every day by Netcen in collaboration with the Met Office. The forecast consists of a prediction of the air pollution descriptor for the worst-case situation in 16 zones and 16 agglomerations over the following 24-hours. Forecasts can be updated and disseminated through Teletext, the World Wide Web and a Freephone telephone number at any time of day, but the most important forecast of the day is the "daily media forecast". This is prepared at 3.00 p.m. for uploading to the internet and Air Quality Communications contractor before 4.00 p.m. each day, and is then included in subsequent air quality bulletins for the BBC, newspapers and many other interested organisations.

This report covers the media forecasts issued during the second quarter. Results from forecasting models are available each day and are used in constructing the forecast. The forecasters issue predictions for rural, urban background and roadside environments but, for the purposes of this report, these have been combined into a single "worst-case" category.

Twice every week, on Tuesdays and Fridays, we also provide a long-range pollution outlook. This takes the form of a short text message which is emailed to approximately sixty recipients in Defra and other Government Departments, together with the BBC weather forecasters. The outlook is compiled by careful assessment and review of the outputs from our pollution models, which currently run out to 3 days ahead, and by also considering the long-term weather situation.

We continue to provide a quality control system to ensure that the 5-day forecasts provided by the Met. Office to the BBC are consistent with the "daily media forecasts" and long-range pollution outlook provided by Netcen for Defra and the DAs. The BBC requires 5-day air pollution index forecasts for 230 UK towns and cities on their BBC Online service. The quality control work is carried out at around 3.00 p.m. daily, with the forecast updating onto the BBC Online Web site at 4.00 a.m. the following morning.

2 New developments during this period

2.1 MET OFFICE DEVELOPMENTS

In the last quarter, the Met Office upgraded its external FTP servers. This has increased the robustness of the data transfer system, but required changes at both the Met Office and Netcen to maintain the delivery of products. The new servers are working successfully and no problems have been reported.

To improve the resilience of the forecast system, the Met Office is instigating a back-up system by which the model forecast files can be transferred to Netcen by FTP in addition to being sent by email. An FTP account has been set-up for this system, but further Met Office software development is required to get the transfer into the operational process. This will hopefully be completed within the next quarter.

Following development work in the last three quarters, the Met Office will be implementing an upgrade to the operational forecast system in the forthcoming quarter. This will include:

- A new version of NAME with enhanced nitrate and ozone chemistry schemes;
- A larger domain with higher resolution chemistry and output grids;
- 2003 emissions data incorporating adapted point source emission heights to represent plume rise;
- Re-instatement of the output of field files to enable plotting of the forecast and animation of this data.

The change in skill brought about by these improvements is minor, but they represent an advance in the science. Test runs using mesoscale meteorology have not demonstrated substantial improvements and the extra run-time required has negated its implementation.

2.2 AQ FORECASTING PROJECT REVIEW MEETING

A project review meeting was held on 22nd September 2006 at Netcen's headquarters at Harwell, Oxfordshire. Members of both Netcen and DEFRA attended, the Met office sent apologies for absence. The main points of the meeting are shown below:

- A two year contract extension has been agreed up to May 2008.
- The particulate report for the May 06 episode had been recently updated and has now been reissued to DEFRA and DA's for further comment. Chemical or optical analysis of a particulate sample from an independent source was also considered and the results of any

analysis may be a late addition to the report, which is pending publication on the National Air Quality Archive.

- The June / July 2006 ozone episode report was scheduled to be published concurrently with a health study publication on the effects of the heatwave.

- A secondary particulate episode report was to be produced for a September 06 episode. This has now been done and released for comment to DEFRA, DA's and the Met Office.

- The problem with delayed updating of the BBC forecast has now been resolved.

- 75 people attended the Buncefield Seminar and there was a long follow-up article published. The debate on Emergency Response monitoring responsibility/capability is on-going.

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 2006.

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	8	12	9	2	3	0	5	12	2	0	8	6	7	9	6	89
forecasted days	1	13	14	14	0	9	0	8	10	2	2	14	10	9	12	9	127
ok (f and m)	0	12	14	14	2	3	0	6	10	2	2	10	8	8	9	7	107
wrong (f not m)	1	2	1	2	0	6	0	3	2	0	0	5	3	3	4	2	34
wrong (m not f)	0	1	1	0	0	0	0	0	2	0	0	0	0	0	0	3	7
success %	0	150	117	156	100	100	100	120	83	100	100	125	133	114	100	117	120
accuracy %	0	80	88	88	100	33	0	67	71	100	100	67	73	73	69	58	72

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	2	4	3	4	0	0	2	3	2
forecasted days	0	9	4	6	0	0	8	8	6
ok (f and m)	2	7	3	6	0	0	6	5	3
wrong (f not m)	0	2	2	1	0	0	3	3	3
wrong (m not f)	0	0	0	0	0	0	0	0	0
success %	100	175	100	150	100	100	300	167	150
accuracy %	100	78	60	86	0	0	67	63	50

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	1	8	0	4	0	6	0	39
forecasted days	7	9	3	6	3	8	2	79
ok (f and m)	5	9	1	6	1	7	1	62
wrong (f not m)	2	1	2	0	2	1	1	23
wrong (m not f)	1	0	0	1	0	1	0	3
success %	500	113	100	150	100	117	100	159
accuracy %	63	90	33	86	33	78	50	70

*** 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	16	33	57	44	26	25	10	21	31	6	20	39	23	27	28	31	437
forecasted days	26	45	58	49	24	32	23	26	27	19	26	58	26	31	45	29	544
ok (f and m)	24	41	65	44	32	25	14	23	23	10	23	51	24	28	33	28	488
wrong (f not m)	11	8	5	10	4	12	11	6	11	9	9	11	6	10	13	8	144
wrong (m not f)	1	3	4	4	2	7	2	2	11	1	2	6	4	6	5	6	66
success %	150	124	114	100	123	100	140	110	74	167	115	131	104	104	118	90	112
accuracy %	67	79	88	76	84	57	52	74	51	50	68	75	71	64	65	67	70

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	23	13	18	20	9	21	24	18
forecasted days	16	35	22	25	22	22	25	32	25
ok (f and m)	10	30	11	19	24	20	22	21	21
wrong (f not m)	7	7	14	10	5	6	7	17	7
wrong (m not f)	0	6	5	3	1	1	4	6	2
success %	250	130	85	106	120	222	105	88	117
accuracy %	59	70	37	59	80	74	67	48	70

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	16	29	12	20	15	20	23	285
forecasted days	29	35	25	25	27	33	26	424
ok (f and m)	15	37	9	19	17	23	23	321
wrong (f not m)	15	6	18	8	12	14	9	162
wrong (m not f)	4	6	5	6	4	4	3	60
success %	94	128	75	95	113	115	100	113
accuracy %	44	76	28	58	52	56	66	59

*** 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 July to September 2006 (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	13	48	278	Wicken Fen	Eastern Zone	19/7/06	94 % [124]
PM_{10} gravimetric	3	30	119	Port Talbot	Swansea UA	10/07/06	33 % [4]
NO_2	0	4	405	Marylebone Road	London UA	26/7/06	N/A
SO_2	0	5	412	London Bexley	London UA	17/706	N/A
CO	0	0	4.4	Marylebone Road	London UA	1/8/06	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 128 zone or agglomeration-day incidents of HIGH band pollution measured during this quarter, measured on 15 separate days. 97 % of these HIGH incidents were due to HIGH ozone levels, 3 % due to HIGH particulate PM_{10} levels. One HIGH day measured for ozone occurred on a HIGH day for PM_{10}. 94 % of the HIGH exceedences were forecast successfully for ozone, seven zone or agglomeration-day incidents were not forecast successfully. Three PM_{10} incidents were due to, primarily, industrial related sources and one as the result of, primarily, traffic emissions. Due to the inherently unpredictable and localised nature of PM_{10} episodes, the majority of these HIGH incidents were not successfully forecast and were not considered to broadly represent ambient levels across their associated regions, so were therefore not accounted for during the forecasting process.

Forty eight MODERATE days were measured for ozone during this quarter, measured at more than 50 sites on any one day over 15 individual days, during periods of predominantly easterly trajectories.

Thirty MODERATE days were seen due to PM_{10} , measured at geographically diverse locations (40 % were measured at sites in London, 32 % at roadside sites throughout the UK, 10 % at industrial sites), mainly as a result of air reaching the UK from Europe combined with localised traffic or industrial sources.

Four MODERATE days were measured for nitrogen dioxide at the London Marylebone Road kerbside site during warm days in July, no other site reached the MODERATE band.

Five MODERATE days were measured for SO2 at a few industrial-designated and urban background AQM sites, the majority of these occurred in July during the warm spell. Half of the incidents were

recorded at London sites, two of the London incidents happened on the same day, which was also one of the highest days measured for ozone in 2006. Half of the incidents were seen at industrial-designated sites.

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

Thirteen HIGH days were measured during the reporting period. The first episode period happened between 1st and 5th July, the second between 16th and 21st July, with a further two days on 25th and 26th July. Changes in weather patterns for August meant that HIGH levels were not experienced for the remainder of the summer. For the whole of August air masses arrived in the UK from the north or the west, therefore the few MODERATES which were measured in August tended to be at sites located in East Anglia and the south east of England, due to the eastwardly transport of UK-only pollution emissions. More than 40 sites measured in the MODERATE band on the same day on both the 10th September and 21st September. Both days were characterised by ambient temperatures above 30 degrees C in the south east of England and air masses from a southerly direction incident to the UK. On the 10th September the most persistent ozone levels were measured at rural sites in southern England, on the 21st the most persistent levels were seen at both urban and rural locations in the middle-west and north-west of England, in addition to sites in south-eastern England.

An ad-hoc report will be available shortly on the National Air Quality Archive website detailing the HIGH ozone episodes in June and July which have not been analysed in this report.

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

PM_{10}

For the majority of the reporting period when easterly air trajectories occurred, a significant number of sites measured a MODERATE or above day. A spate of exceedences were observed during the first week of July, from 17th to 27th July and a less well defined period during incident southerly air in mid/late September. Particulate contributions from continental European air is likely to have compounded industrial or roadside levels in combination with warm, dry ambient air and poorer dispersion conditions.

Eighteen sites measured MODERATE levels on 17th September. This was caused by polluted air, of European origin, becoming trapped behind a cloud front which had remained relatively stationary over the UK during the weekend of Saturday 16th and Sunday 17th September. A draft report detailing this incident has been submitted to DEFRA and the Devolved Administrations with a view to publication of this paper shortly on the National Air Quality Archive.

Three HIGH PM_{10} day-incidents were due to, primarily, industrial related sources and one as the result of, primarily, traffic emissions. One incident occurred at Port Talbot on the 9th and 10th July following several days of westerly air trajectories. A steel works is situated to the west of the air quality station so the high pollution is likely to have been caused by activities at the plant combined with meteorological conditions. The maximum running daily mean was 119 ug/m^3 over those two days. On the 19th July the Scunthorpe Town site measured a maximum daily running mean of 101 ug/m^3 during a period of easterly air trajectories. An industrial plant is located to the east of the site. Due to the inherently unpredictable and localised nature of PM_{10} episodes, the majority of these HIGH incidents were not successfully forecast and were not considered to broadly represent ambient levels across their associated regions, so were therefore not accounted for during the forecasting process.

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

NO_2

Four MODERATE days were measured at the London Marylebone Road kerbside site during warm days in July, this is likely to have been the result of poor dispersion conditions combined with photo-chemical effects. No other site reached the MODERATE band during this reporting quarter.

SO_2

Five MODERATE days were measured for SO2 at a few industrial-designated and urban background AQM sites, the majority of these occurred in July during warm weather. Half of the incidents were recorded at London sites, two of the London incidents happened on the same day, which was also one of the highest days measured for ozone in 2006. Half of the incidents were seen at industrial-designated sites.

The first MODERATE day chronologically was seen on 1st July at London Teddington. A similar concentration spike of SO_2 was seen at London Hillingdon, also located in the west London area, at the same time and seems to have marked the onset of higher SO2 measurements at many London sites for that day. This could have been caused by a power station or industrial plume and occurred during a period of light easterly air trajectories. The second incident was seen at Grangemouth on 14th July, likely to have been the result of meteorological conditions and activities from the petro-chemical plant to the north. The third, measured at London Bexley and Kensington on the 17th July, was also seen at the majority of London sites, albeit at lower levels, and marked the start of a 3 day period of elevated daytime concentrations in London. Light easterly air trajectories and a powerstation or industrial plume are likely to be responsible for this. Salford Eccles measured two MODERATE days on 25th July and 21st September coinciding with light easterly and southerly air trajectories respectively, suspected to have been the result of localised industrial emissions.

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

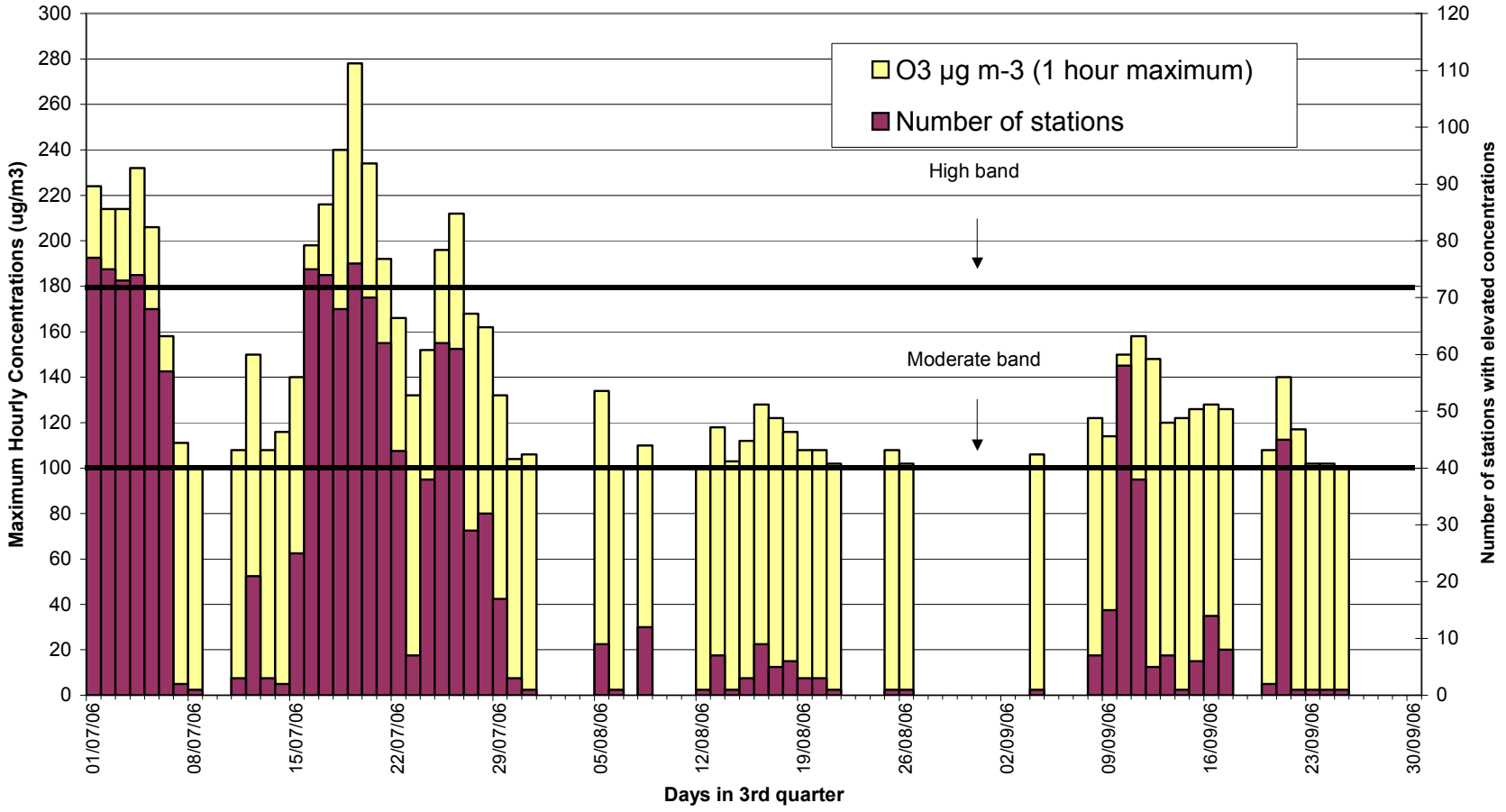


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 3rd quarter 2006.

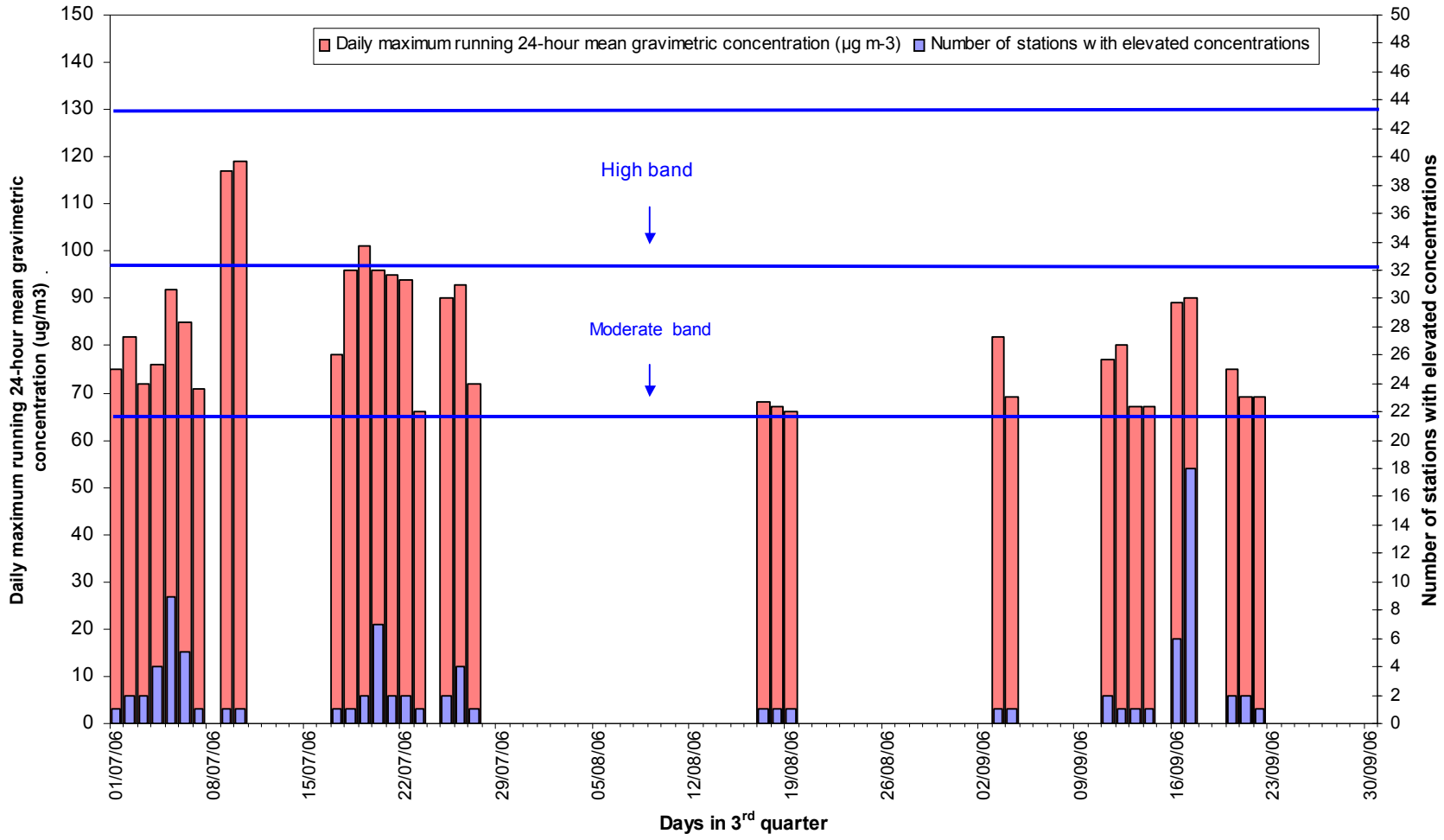


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2006.

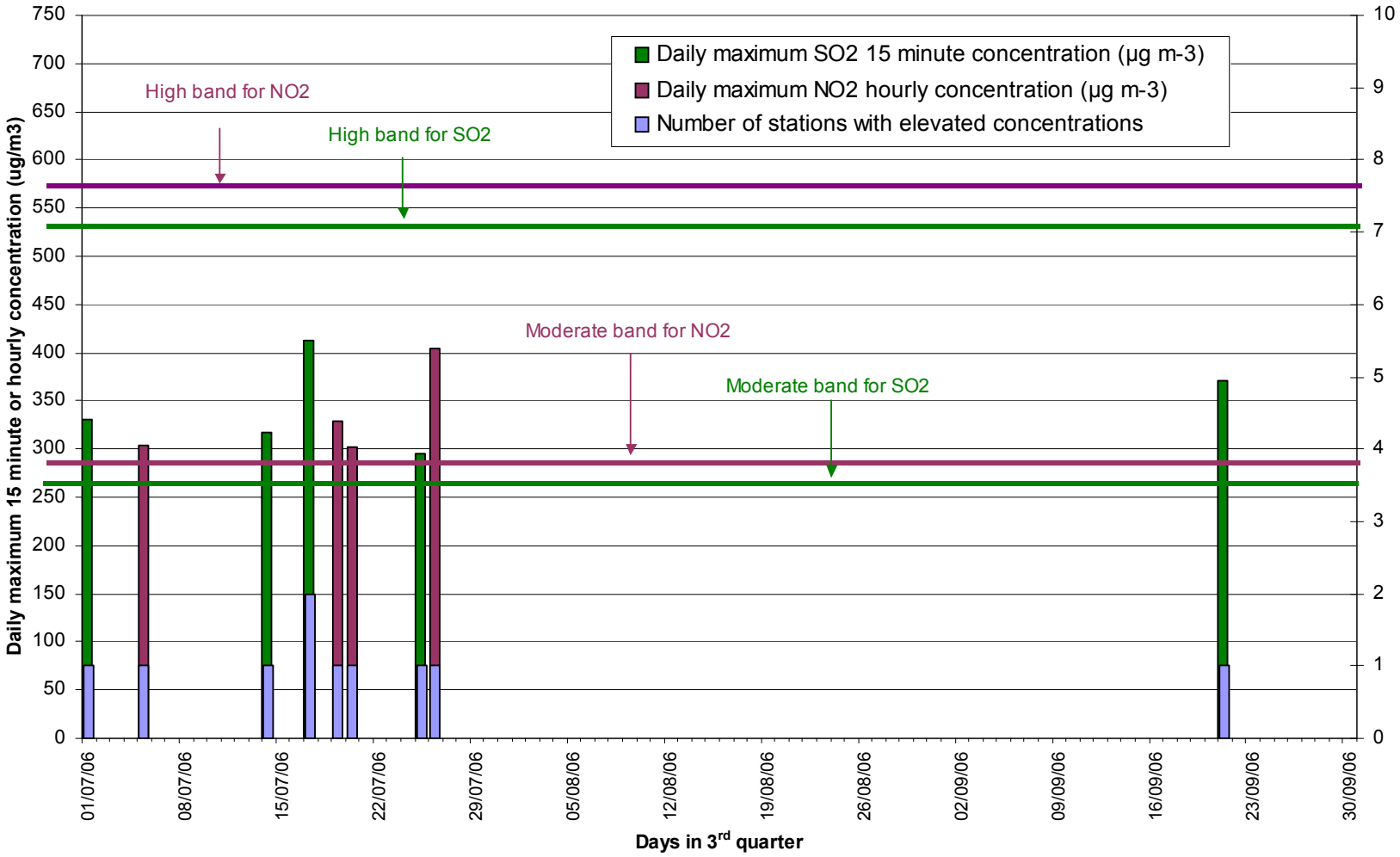


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO2 across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2006.

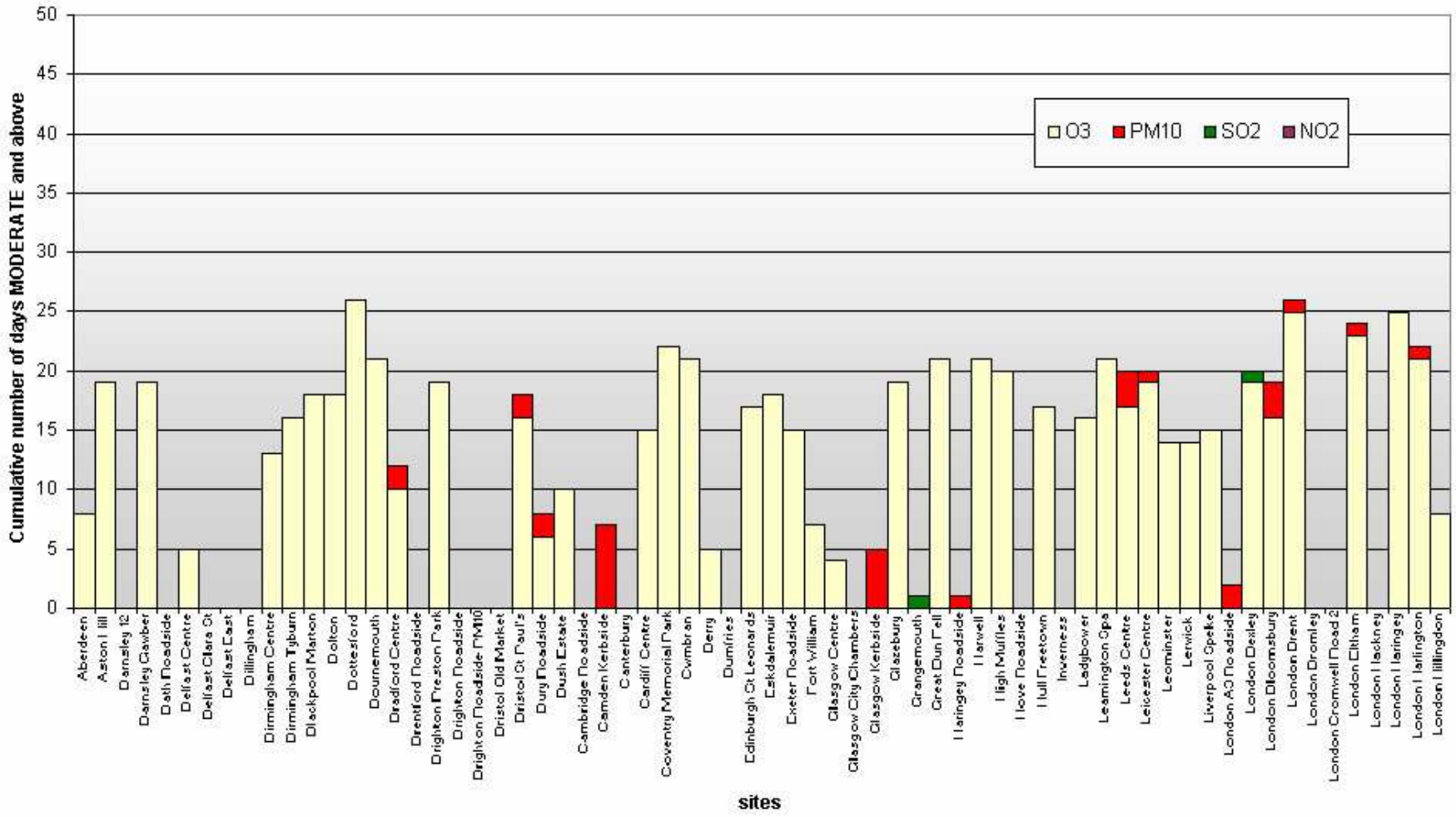


Figure 3.4a Number of days moderate and above for each AURN Network station over 3rd quarter 2006 – provisional data

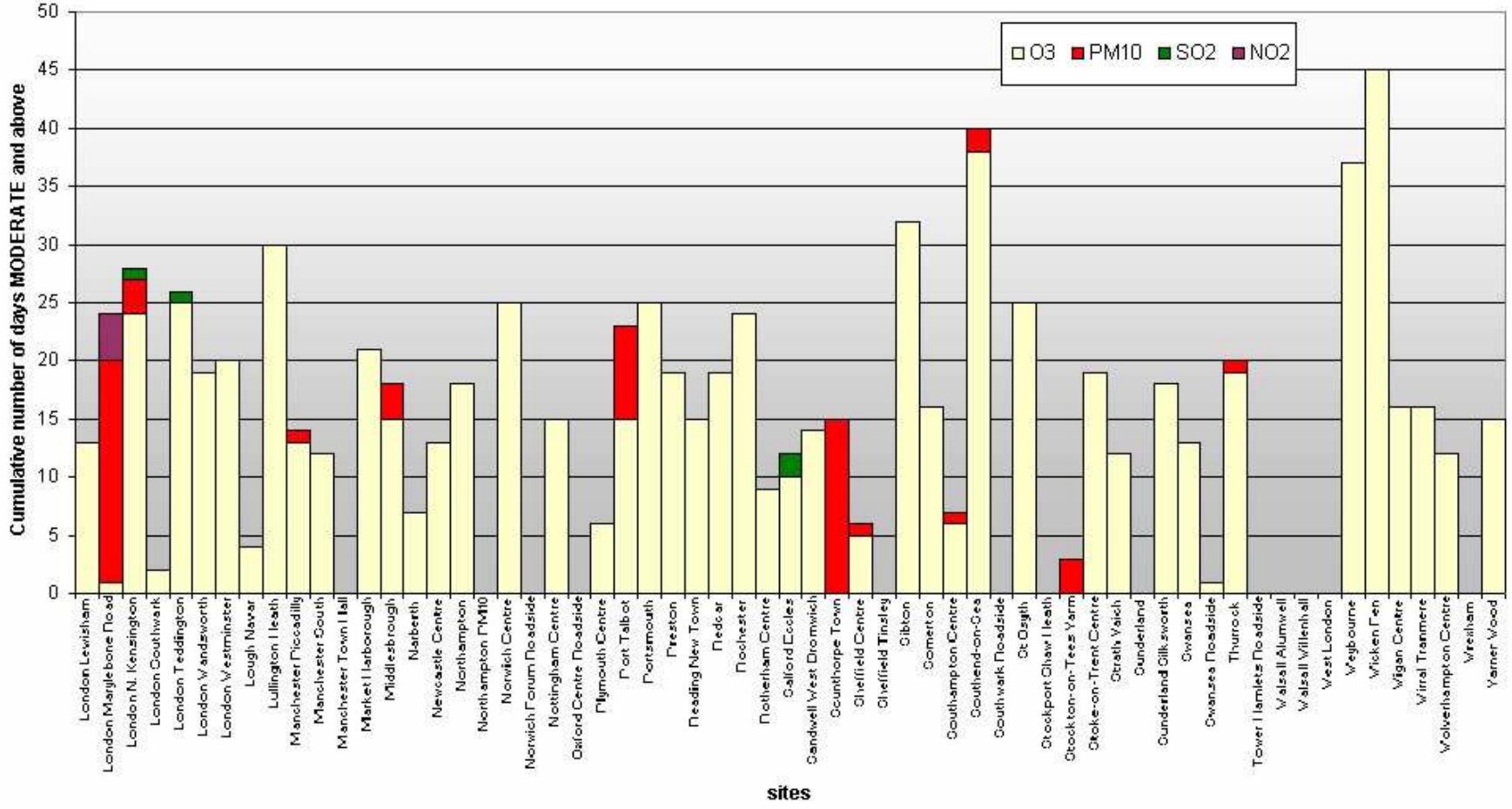


Figure 3.4b Number of days moderate and above for each AURN Network station over 3rd quarter 2006 – provisional data

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

An ad-hoc report will be shortly available on the National Air Quality Archive detailing the elevated particulate measurements experienced at UK sites in early May. Further optical or chemical analysis of particulate samples collected over that period is also likely to be performed.

6.2 SUMMER OZONE EPISODE

An ad-hoc report will be shortly available on the National Air Quality Archive detailing the elevated ozone measurements experienced at UK sites in June and July 2006.

6.3 PARTICULATE CLOUD FROM EUROPEAN SOURCES IN MID SEPTEMBER

An ad-hoc report has been written and submitted to Defra and the devolved administrations detailing the elevated particulate measurements experienced at UK sites in mid September.

7 Ongoing research

Netcen and the Met office will also continue to:

1. Investigate ways of using automatic software systems to streamline the activities within the forecasting process, thus allowing forecasters to spend their time more efficiently considering the most accurate forecasts.
2. Research the chemistry used in our models, in particular the 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 October to December 2006

Major tasks include:

- Ongoing daily air pollution forecasting activities.
- Ongoing improvements to 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.

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 being used on this project is currently owned by Defra and 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	≥ 360 μgm^{-3}	≥ 180 ppb	≥ 764 μgm^{-3}	≥ 400 ppb	≥1064 μgm^{-3}	≥ 400 ppb	≥ 23.2 mgm^{-3}	≥ 20 ppm	≥ 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

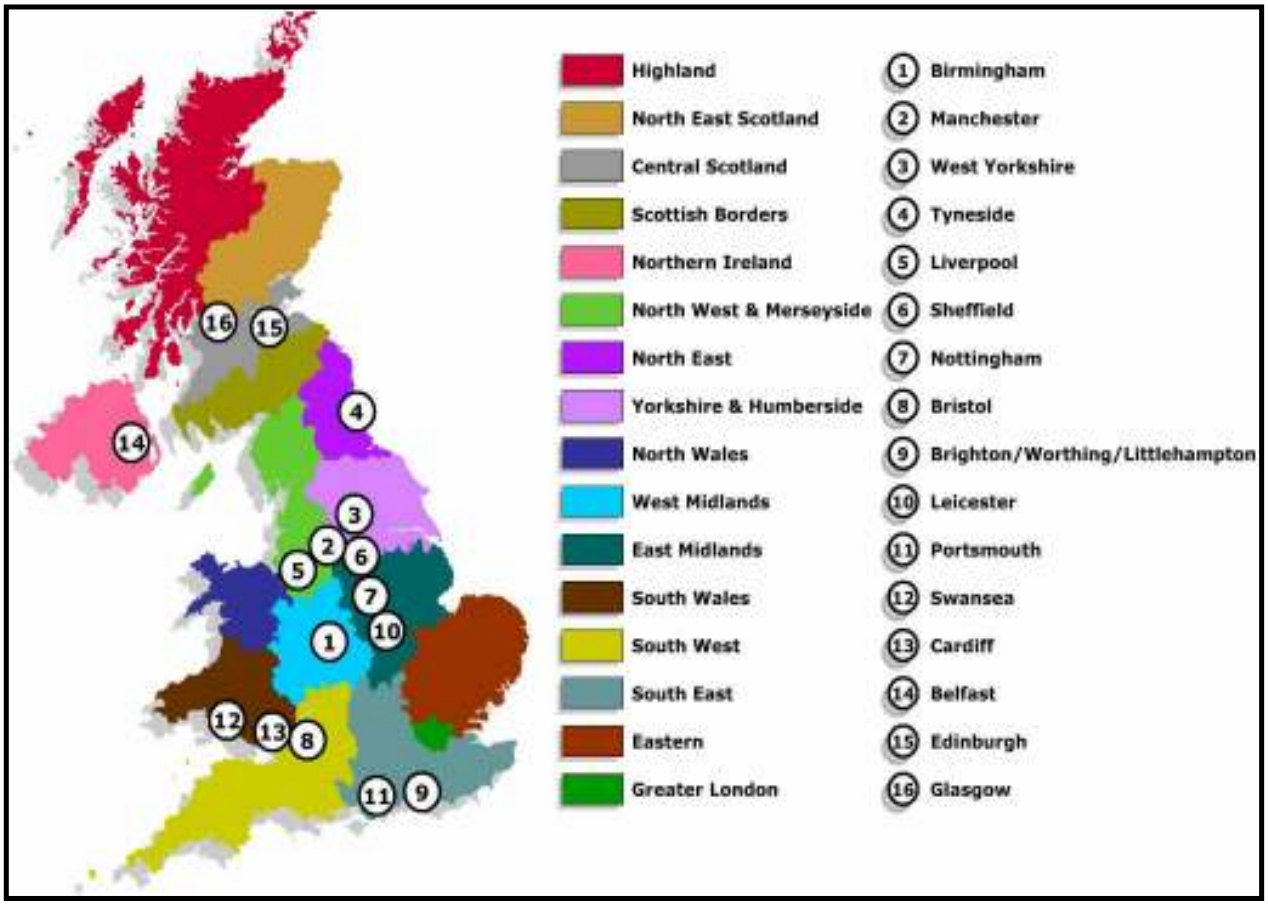
Forecasting Zones

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.