REPORT

UK Air Quality Forecasting: Operational Report for July to September 2005

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/2059 Issue 1
October 2005

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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 2005. 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 2005, there were 15 days on which HIGH air pollution was recorded. Within zones the success rate for forecasting these HIGH days was reasonable at 67 % with an accuracy of 43 %. More than 90 % of all HIGH measurements were due to PM_{10} but the forecasting success calculations are more likely to represent HIGH forecasts (index 7) issued in response to rising ozone levels in which levels reached index 6, particularly in the case of zones. Eight HIGH agglomeration-days were measured during the reporting period, all due to PM_{10}, none of these were forecast due to the unpredictable and localised nature of these (..often building related) events, reflected in the poor success and accuracy of forecasts within agglomerations (0%). Four agglomeration-days were forecast within the reporting period, likely to have been in response to rising ozone levels, none of these agreed with actual levels reached to within 1 index band. Many MODERATE days were measured, as could normally be expected for this time of year and were forecast with a high degree of success and reasonable accuracy during this quarter. 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 69 % indicates that only 31 % 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 2005.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	67	43	158	78
Agglomerations	0	0	152	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 July and September; 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 quarter reported on. 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

The Met Office have continued with the development of the model "NAMEIII" which is expected to be tested and operational during the fourth quarter.

On the 20th July 2005 Paul Willis (Netcen) sent a letter of complaint to the weather producer at the BBC, which had been endorsed by Defra. The letter explained that the AQ index value-to-banding conversion being employed by the BBC was not in line with accepted UK standard (in which banding changes occur every 3 index values, COMEAP AP Index, see Appendix 1 of this report). Two index values were being used for both the MODERATE and HIGH bands, and misleading data were therefore being published in all the associated BBC media locations. The BBC (Andrew Lane, BBC Weather Centre) wrote back immediately and agreed to implement the required changes.

A project review meeting was held at Netcen on the 7th September 2005. The following were present: Janet Dixon, Martin Meadows (Defra), Martin Cumper (Met Office), Paul Willis, Jon Bower (Netcen). Topics discussed / actions decided included:

- Defra were re-considering the basis for press releases to avoid degrading "newsworthiness" of air quality.
- Met Office were to check if air pollution episodes could be issued in the same form as severe weather warnings on the Met office and BBC web pages, as an alternative to press releases.
- Met Office were liasing with BBC over some delays in updating the 5-day forecast on the BBC web site.
- Netcen were to develop ideas and suggest dates for the next AQ forecasting seminar.

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 2005.

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	1	0	3	0	2	1	0	0	2	0	0	0	0	9
forecasted days	0	0	2	2	0	0	0	0	0	0	0	2	0	0	0	0	6
ok (f and m)	0	0	2	2	0	0	0	0	0	0	0	2	0	0	0	0	6
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	1	0	3	0	2	1	0	0	1	0	0	0	0	8
success %	100	100	100	200	100	0	100	0	0	100	100	100	100	100	100	100	67
accuracy %	0	0	100	67	0	0	0	0	0	0	0	67	0	0	0	0	43

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	2	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	2	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	0	0	0	0	0	0
success %	100	100	100	100	100	100	100	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	2	0	2	4	8
forecasted days	0	2	0	0	0	0	0	4
ok (f and m)	0	0	0	0	0	0	0	0
wrong (f not m)	0	2	0	0	0	0	0	4
wrong (m not f)	0	0	0	2	0	2	4	8
success %	100	100	100	0	100	0	0	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	3	20	39	37	6	16	2	22	16	2	4	30	18	28	12	17	272
forecasted days	12	43	48	54	18	25	12	26	24	13	14	56	29	41	39	26	480
ok (f and m)	7	34	48	55	17	22	7	29	23	6	12	53	28	44	16	28	429
wrong (f not m)	5	10	6	5	4	6	6	1	3	8	4	6	3	2	24	2	95
wrong (m not f)	1	2	4	4	0	5	0	2	3	0	0	3	1	0	2	1	28
success %	233	170	123	149	283	138	350	132	144	300	300	177	156	157	133	165	158
accuracy %	54	74	83	86	81	67	54	91	79	43	75	85	88	96	38	90	78

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	25	10	0	4	2	12	11	8
forecasted days	10	44	30	18	10	10	25	33	19
ok (f and m)	3	37	17	0	9	5	20	15	19
wrong (f not m)	7	10	14	18	3	6	5	18	2
wrong (m not f)	0	3	0	0	0	0	0	3	0
success %	100	148	170	100	225	250	167	136	238
accuracy %	30	74	55	0	75	45	80	42	90

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	11	17	7	19	2	23	19	170
forecasted days	31	43	17	26	16	33	21	386
ok (f and m)	15	30	13	26	4	30	15	258
wrong (f not m)	18	14	7	5	13	6	9	155
wrong (m not f)	1	2	0	3	0	4	6	22
success %	136	176	186	137	200	130	79	152
accuracy %	44	65	65	76	24	75	50	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 2005 (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	1	47	182	Lullington Heath	South east zone	31/8/05	100 % [1]
PM_{10} gravimetric	15	22	145	Rochester	South east zone	4/8/05	0 % [16]
NO_2	0	9	329	London Marylebone Road	Greater London UA	14/7/05	N/A [0]
SO_2	0	0	212	Rochester	South east zone	16/8/05	N/A [0]
CO	0	0	4.9	Dumfries	Scottish borders	3/9/05	N/A [0]

* 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.
** 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)

General Observations

There were 17 seperate zone or agglomeration-day incidents of HIGH band pollution measured during this quarter, on 15 separate days. One of these days was due to coincident HIGH ozone and PM10, 14 days due to PM_{10} only. The HIGH ozone measurement was forecasted successfully. None of the 16 PM_{10} incidents had been forecasted successfully and over 60 % of these occurred within agglomerations.

Twenty two MODERATE days were seen due to PM_{10} , measured at geographically diverse locations. Just over half the days of this quarter were MODERATE days due to ozone as is normally expected for the summer period, the majority of which were seen at rural and urban background located stations.

Nine MODERATE days were measured for nitrogen dioxide at the London Marylebone Road station and no MODERATE or above days were measured for sulphur dioxide.

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

One HIGH measurement occurred over the reporting quarter; on 31st August at Lullington Heath in the south east, with many other sites in the south east zone, East Anglia and the Greater London Urban Area experiencing ozone levels closely approaching the HIGH band but remaining within index 6 (Upper MODERATE band) on that day. London Haringey data have been reprocessed following the AURN QA/QC procedures and have now found to have not reached the HIGH band. Of the 17 sites which measured in the upper MODERATE band, 35 % were each in the London and East Anglia areas, 18 % in the south east and the remaining 12 % in the Midlands. A warning for HIGH ozone levels was issued two days prior to the 31st , on a bank holiday Monday, after a

change in forecast weather patterns indicated air sourced from Europe approaching the UK combined with very warm temperatures (daytime maximum of 27 degrees C, rising to 29 C). The geographical location of the highest levels experienced on Wednesday was predicted with a high degree of accuracy, although the intensity of concentrations was overestimated by approximately one index band (ie index 7 or 8 predicted, index 6 and 7 was experienced), this may have been due to the diminishing solar intensity associated with the approach of the end of the summer season or inaccuracies in the air trajectory forecasts. Forecasts over that bank holiday weekend were based exclusively on data from London Air Quality Network sites (ie only approximately 10 % of AURN network sites) after a Casella management data problem developed on Saturday 27th August - which was finally resolved on Tuesday 1st September.

Other days seeing MODERATE levels at more than 50 network sites were 10th July (maximum of 160 ug/m^3 measured at Birmingham Tyburn), 14th July (maximum of 174 ug/m^3 measured at Wicken Fen in East Anglia), 18th August (maximum of 178 ug/m^3 measured at Norwich Centre) and 4th September (maximum of 148 ug/m^3 measured at London Hackney). Sunday 10th July was characterised by high pressure, incident Atlantic air with daytime temperatures in the high 20s C and was the first day of a "hot spell". Thursday 14th July saw the high pressure centre moving away, incident Atlantic air, temperatures again in the high 20's C, the highest temperature over the week-long hot spell was attained on this day. Temperatures were forecast for the mid 20s C on Thursday 18th August with air recirculated over the UK and passing over the fringes of Europe before reaching UK locations, this day was the hottest day in August except for the 31st. Sunday 4th September was the warmest day of September (ie the last hot day of summer), temperatures were again in the high 20s C, with air circulating to the UK from over Europe; thundery rain was approaching from the west but did not reach the south east until the evening.

The summer saw many periods of exceptionally warm weather but we only experienced one period where air was sampled from a mainly easterly direction, which led to a HIGH reading on the 31st August.

PM_{10}

There were 15 HIGH days due to PM_{10} during the reporting period. Three of these days were due to measurements made as the result of activities from the steel works at Port Talbot combined with meteorology from the 11th to the 14th July (spans from Monday to Thursday). Possible ongoing building works were responsible for four HIGH days measured at the Middlesbrough AQM Site as the result of daytime activities on Tuesday 19th July and Monday 5th September. The possibility of the ploughing of fields or other suspended soil-related activities may have generated high PM_{10} levels on the 3rd August, corroborated by the expected north-easterly wind direction and a far lower response from the co-located $PM_{2.5}$ instrument. Ongoing stone cutting or building activities are likely to have been responsible for a high spike on Tuesday 23rd August measured at the Wolverhampton AQM site. Possible ongoing stone cutting activities have led to 5 days of exceedences, mainly in September, after the Bradford site had been relocated a minor distance from its original location.

Of the 22 MODERATE days also seen for PM_{10} only a few are likely to have been influenced by a direct European contribution, namely over the periods 30th-31st August and 2nd–4th September therefore the majority are more likely to have been the result of localised activities or meteorology.

None of the HIGH band exceedences were forecast due to their localised and unpredictable nature.

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

NO_2

Nine MODERATE days were seen during this period, 90 % of these measured at Marylebone Road (all likely to have been traffic related).

SO_2

Sulphur dioxide levels did not reach the MODERATE band during this period. The highest measurement was recorded at Rochester (212 ug/m^3 on 16th August).

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

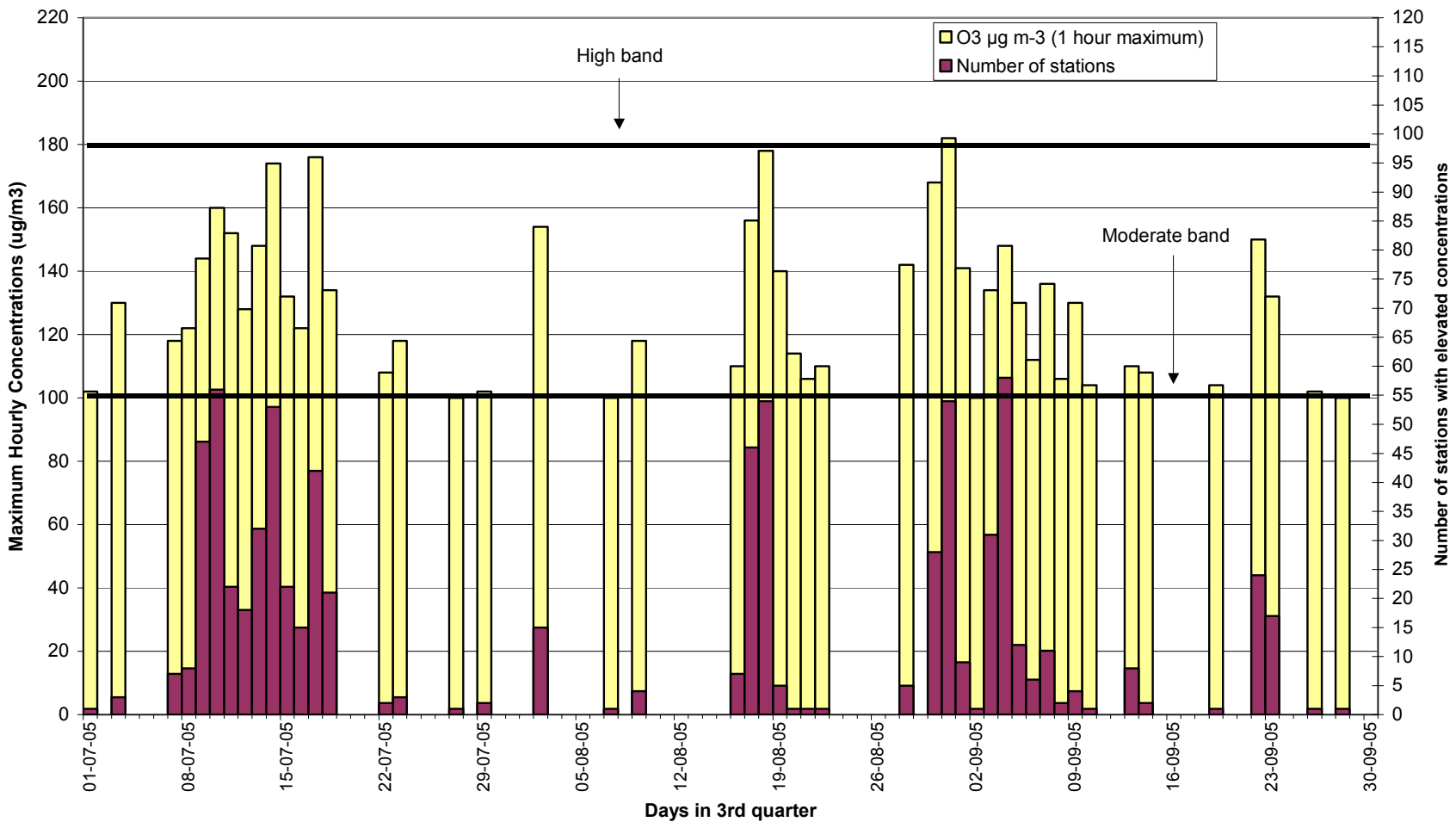

Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 3rd quarter 2005.

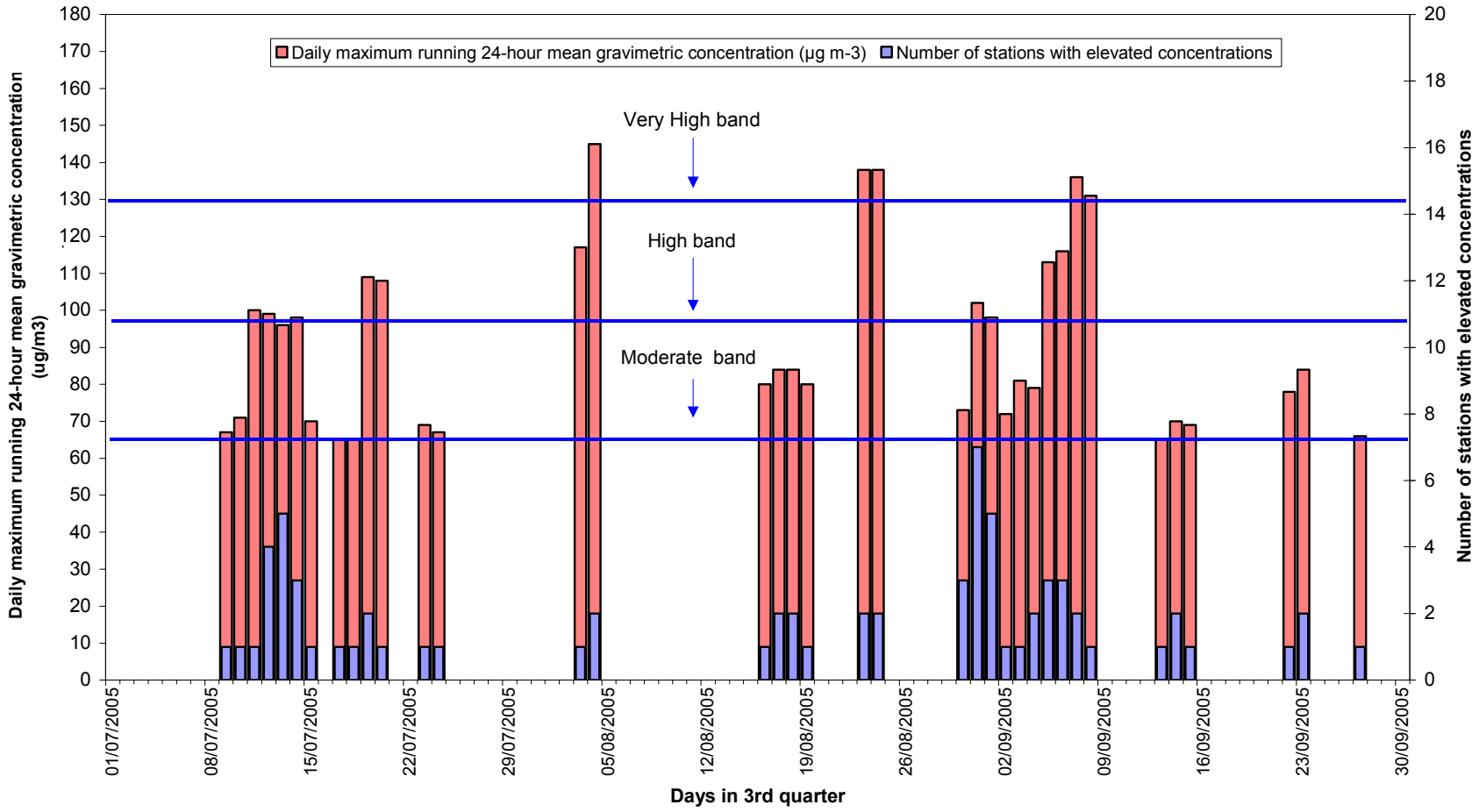

Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2005

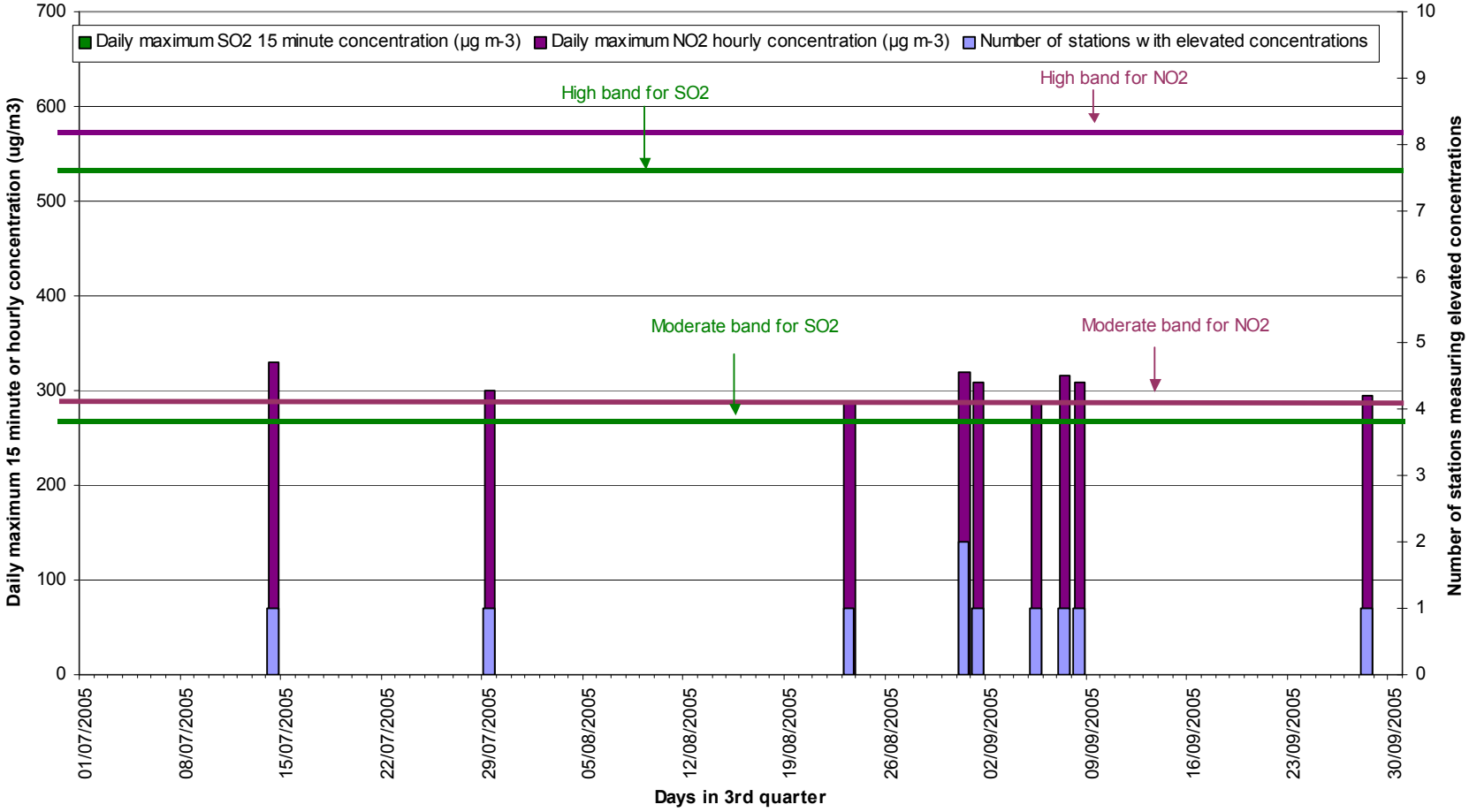

Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO2 across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2005

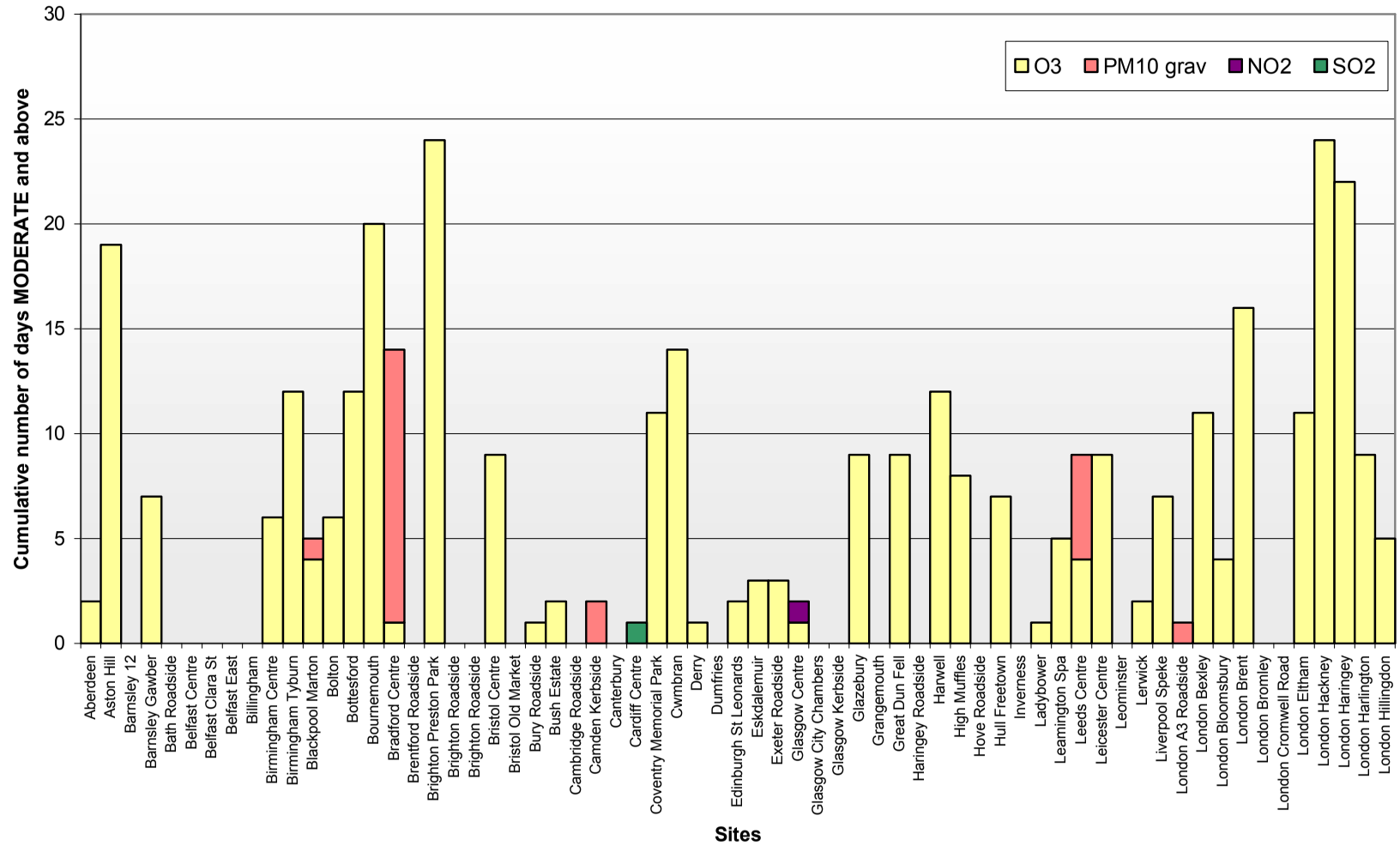

Figure 3.4a Number of days moderate and above for each AURN Network station over 3rd quarter 2005 – provisional data

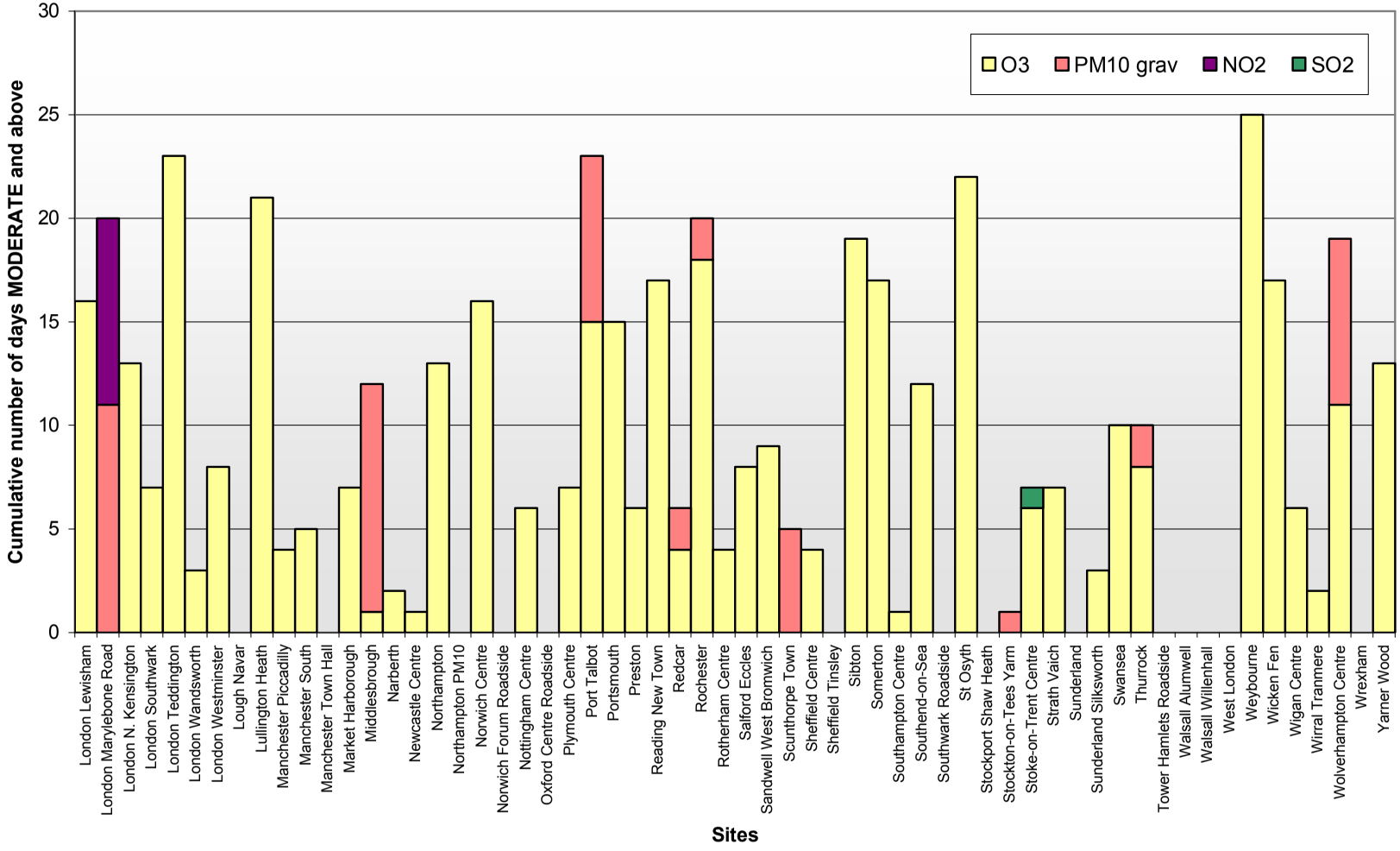

Figure 3.4b Number of days moderate and above for each AURN Network station over 3rd quarter 2005 – provisional data

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 AD-HOC REPORT

One ad-hoc report was issued on the National Air Quality Archive during the reporting period:

Air Pollution Forecasting: Ozone Pollution Episode Report (Friday 27th May 2005) by Targa (netcen) and Witham (Met Office) 17/06/2005.

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 forest fires in Russia 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 2005

Major tasks include:

- Ongoing daily air pollution forecasting activities.
- Ongoing improvements to NAME model, including:
  - Improved modelling over steep topographical gradients
  - Higher resolution model runs with reduced statistical noise
  - Update of emissions inventory used in the model.
- Publication of quarters 2 and 3 2005 reports on the Air Quality Archive Web Site.
- Plan the next AQ forecasting seminar to be held by Netcen in April 2006

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

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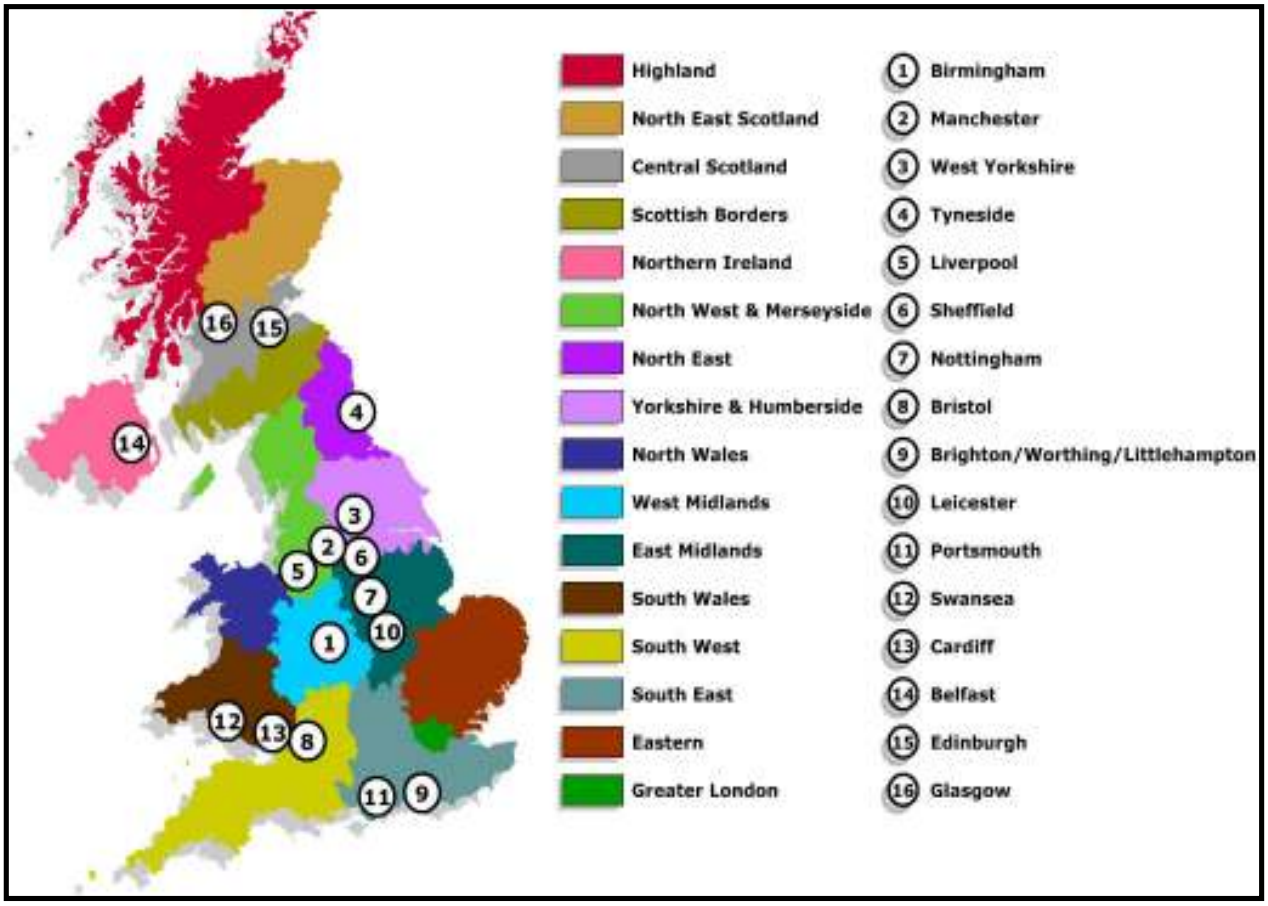
Forecasting Zones

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.

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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.