REPORT

UK Air Quality Forecasting: Operational Report for July to September 2004

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/1831 Issue 1
October 2004

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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 2004. The work is funded by the Department for Environment Food and Rural Affairs, the Scottish Executive, Welsh Assembly Government and the Department of the Environment in Northern Ireland.

During this third quarter of 2004, there were a total of 7 days on which HIGH air pollution was recorded. These HIGH periods are recorded within the forecasting success calculations. The forecasting success and accuracy for this quarter for HIGH and MODERATE episodes is summarised in Table 1 below.

The success of predicting these HIGH days in zones and agglomerations has improved compared to the second quarter, mainly due to the occurrence of ozone episodes during this period and their greater predictability in comparison to localised events.

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 ie forecasting "Moderate" pollution when there's only a small chance that it will be recorded.

Table 1 – Forecast success / accuracy for incidents[1] above 'HIGH' and above 'MODERATE',July 1st to September 30th 2004.

Region / Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	164	47	125	70
Agglomerations	33	33	113	58

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 efficiently 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 and all bulletins were delivered to the Air Quality Communications contractor on time.

During this period, an ad-hoc report was presented to Defra and the Devolved Administrations: Air Pollution Forecasting: Ozone Pollution Episode Report (July- August 2004).

[1] Note that the calculations of accuracy and success rates are based on a successful prediction being ±1 of the measured index; it is therefore possible to record rates in excess of 100% rather than 'true' percentages.

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 between 1st July and 30th September 2004. 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.

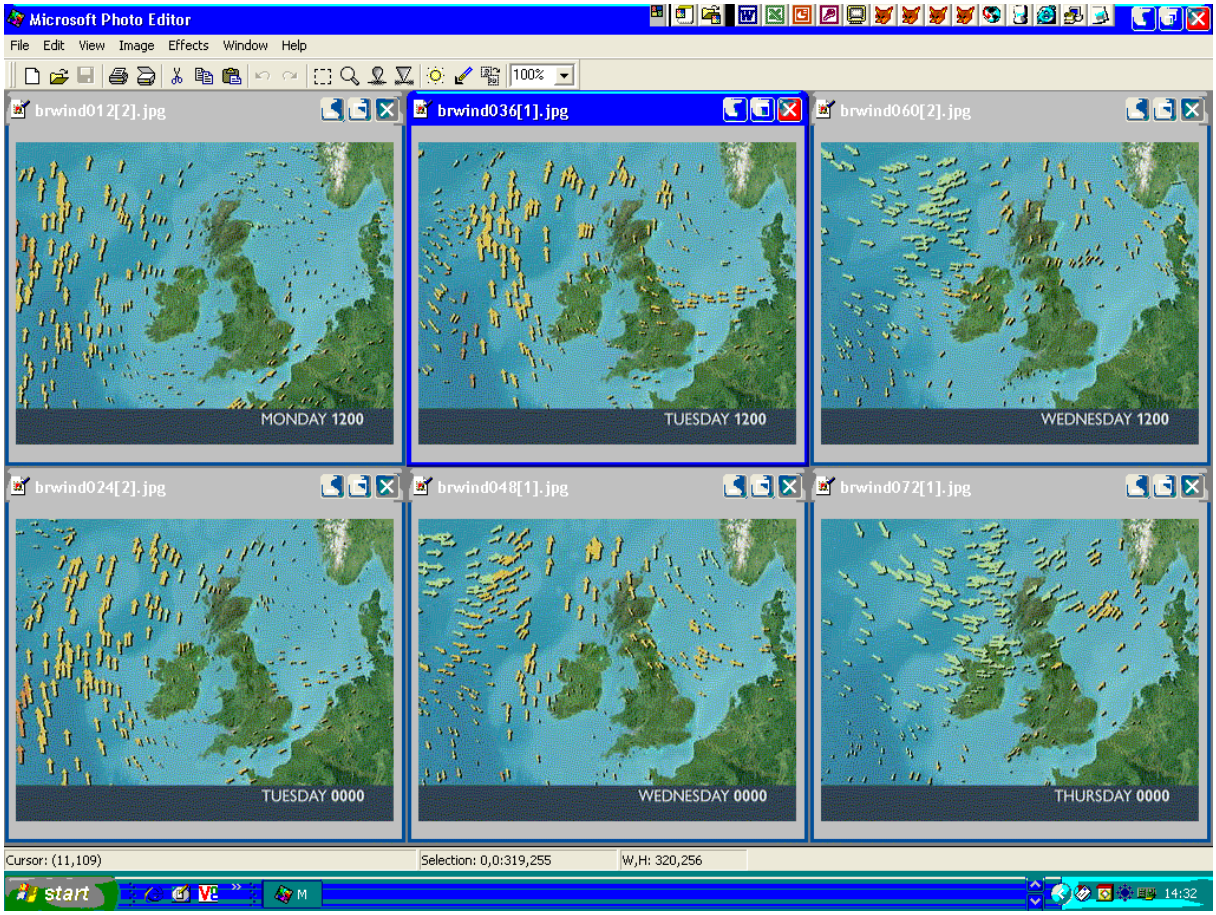
We continue to provide a quality control system to ensure that the 5-day forecasts provided by the Met. Office to the BBC are consistent with the “daily media forecasts” and long-range pollution outlook provided by Netcen for Defra and the DAs. The BBC requires 5-day air pollution index forecasts for 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

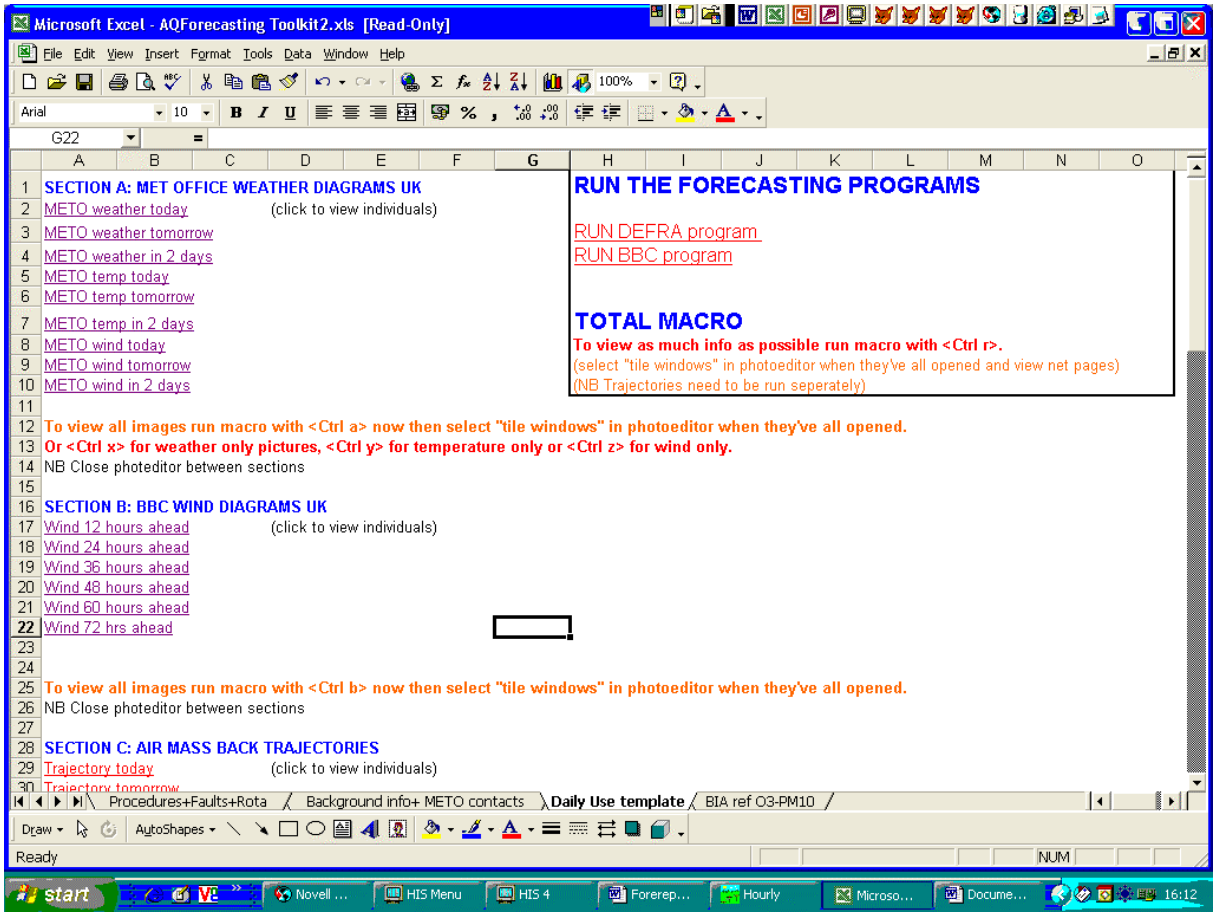
2.1 AIR QUALITY FORECASTING TOOLKIT

During the third quarter of 2004, an MS Excel spreadsheet has been developed (named the “AQ Forecasting Toolkit”) which allows faster access to relevant web images and current information used during the process of daily forecasting. All relevant links to information and run models have therefore been centralised.

Below is an illustration of 3-day wind diagrams, now viewed with two key presses:



Below is an illustration of the top third of the worksheet used during daily forecasting:



2.2 E-MAIL CIRCULATION LIST

The email circulation list for bi-weekly forecasts has been extended to over sixty recipients, including AURN network managers and equipment service units who expressed an interest. It is hoped that this will provide network end-users of the service with greater warning of air pollution episodes, so that calibrations and servicing can be rescheduled where necessary. This will hopefully minimize the loss of air pollution episode data.

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. 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 July - September 2004 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 2004

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	1	4	0	0	1	0	0	1	0	0	1	0	0	0	3	11
forecasted days	0	4	4	4	0	2	0	1	1	0	0	5	1	1	4	1	28
ok (f and m)	0	4	5	2	0	0	0	0	0	0	0	6	0	1	0	0	18
wrong (f not m)	0	1	0	2	0	2	0	1	1	0	0	0	1	0	4	1	13
wrong (m not f)	0	0	2	0	0	1	0	0	1	0	0	0	0	0	0	3	7
success %	100	400	125	100	100	0	100	100	0	100	100	600	100	100	100	0	164
accuracy %	0	80	71	50	0	0	0	0	0	0	0	100	0	100	0	0	47

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 %	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	1	0	1	0	1	0	3
forecasted days	0	1	0	0	0	0	0	1
ok (f and m)	0	1	0	0	0	0	0	1
wrong (f not m)	0	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	1	0	1	0	2
success %	100	100	100	0	100	0	100	33
accuracy %	0	100	0	0	0	0	0	33

*** All performance statistics are based on provisional data. Obviously incorrect data due to instrumentation faults have been removed from the analyses.**

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

Table 3.3 - 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	11	29	38	38	9	18	11	12	16	8	4	39	14	22	14	26	309
forecasted days	13	43	48	42	19	28	14	18	26	9	11	46	17	19	36	29	418
ok (f and m)	13	43	47	44	9	26	10	14	20	13	5	47	22	26	20	27	386
wrong (f not m)	6	5	7	7	11	6	8	6	8	2	6	4	3	1	16	7	103
wrong (m not f)	4	2	5	6	3	6	4	2	5	0	3	4	1	2	5	10	62
success %	118	148	124	116	100	144	91	117	125	163	125	121	157	118	143	104	125
accuracy %	57	86	80	77	39	68	45	64	61	87	36	85	85	90	49	61	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	0	3	10	12	7	11	13	7
forecasted days	7	12	11	13	10	18	16	22	9
ok (f and m)	3	0	7	12	11	14	14	17	7
wrong (f not m)	4	12	5	3	6	6	3	6	4
wrong (m not f)	3	0	1	2	3	0	5	2	3
success %	75	100	233	120	92	200	127	131	100
accuracy %	30	0	54	71	55	70	64	68	50

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	5	25	7	15	5	30	5	159
forecasted days	15	24	12	13	6	22	16	226
ok (f and m)	6	27	7	16	3	28	8	180
wrong (f not m)	9	2	5	3	3	4	9	84
wrong (m not f)	3	2	4	3	5	6	2	44
success %	120	108	100	107	60	93	160	113
accuracy %	33	87	44	73	27	74	42	58

*** 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 2004 (Based on latest provisional data)

Pollutant	High 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]
Ozone	4	44	192	Bournemouth	South	28/07/2004	77 % [13]
PM_{10} (teom)	4	9	110	Scunthorpe Town	NE England	09/08/2004	0 % [5]
NO_2	0	1	293	London Marylebone Road	London	15/09/2004	N/A
SO_2	0	7	378	London Westminster	London	11/09/2004	N/A
CO	-	-	-	-	-	-	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.

General Trends

The third quarter was characterised by some localised pollution events, with broken periods of regional 'MODERATE' levels due to summer ozone and additional 'HIGH' periods of ozone in late July/early August (see also previously released Ozone Pollution Episode Report (July – August 2004) at: http://www.airquality.co.uk/archive/reports/cat15/0409060809_03_episode_summer2004_final.pdf). There were three high days due to O_3 , three high days due to PM_{10} and one day where both were high. Moderate levels of PM_{10} and SO_2 were scattered through this period, due mainly to localised emissions. Ozone MODERATE levels were recorded sporadically throughout the quarter (only 50% of the days, lower than the previous quarter), mainly due to the predominance of less-settled weather patterns over the summer. 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

Ozone reached 'High' levels during this period in late July/early August; for more information, see the more detailed report referenced above. 77 % of the thirteen HIGH incidents were successfully forecast, those not successfully forecast were mainly attributable to a second onset of warm weather. Figure 3.1 shows the trends in ozone levels over this period.

PM_{10}

VERY HIGH band PM_{10} levels were recorded at two stations over this period: at Scunthorpe Town on the 8th and 9th August- correlating with a general increase in industrial activity on the 8th - and Preston (urban background environment) on the 10th and 11th September caused by a nearby bonfire.

For PM_{10} related HIGH episodes, which tend to dominate in forecast agglomerations where road traffic pollution, industry and construction are abundant, the success rate tends to be low due to the intrinsic unpredictability associated with such emissions (none of the 5 incidents in this quarter were forecast).

Any MODERATE measurements of PM_{10} over the period 28th July to 9th August are likely to be attributable to a European contribution to particulate levels associated with easterly air trajectories; there were several of these instances during the period.

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

NO_2

Nitrogen dioxide levels have remained below the 'High' band and only one incursion into the MODERATE band occurred; at London Marylebone Road on the morning of Wednesday 15th September; this appeared to be traffic-related.

SO_2

Sulphur dioxide levels did not reach the 'High' band during this period. 'Moderate' levels were measured at 7 sites including Aberdeen, Bury Roadside, Barnsley Gawber, Edinburgh, Grangemouth, Scunthorpe and London Westminster, probably as a result of local industrial emissions. The highest level was measured at London Westminster on Saturday 11th September, caused by the use of a diesel- powered industrial power- washer in close proximity to the site.

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

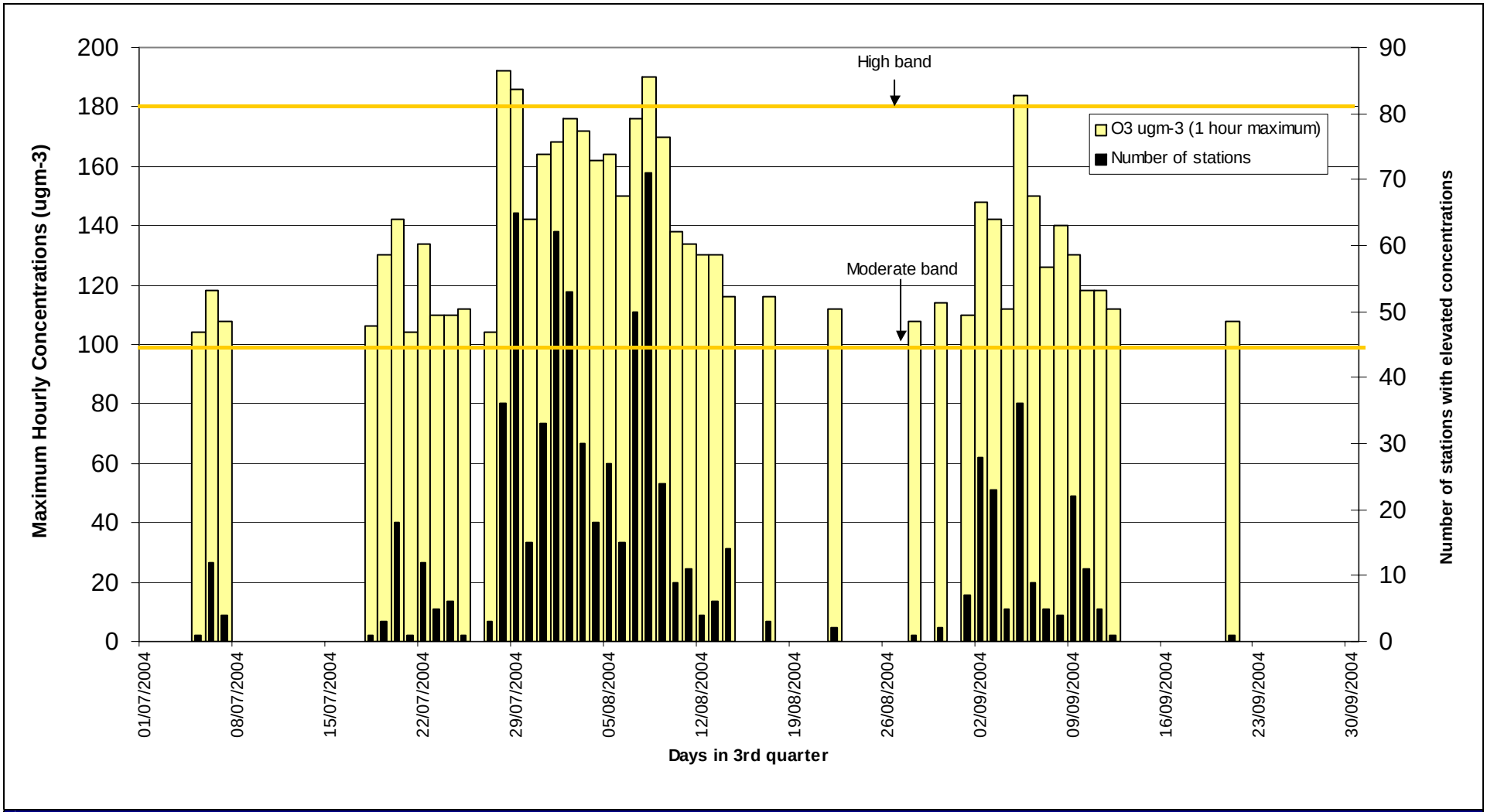


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring moderate or above levels of ozone over 3rd quarter 2004.

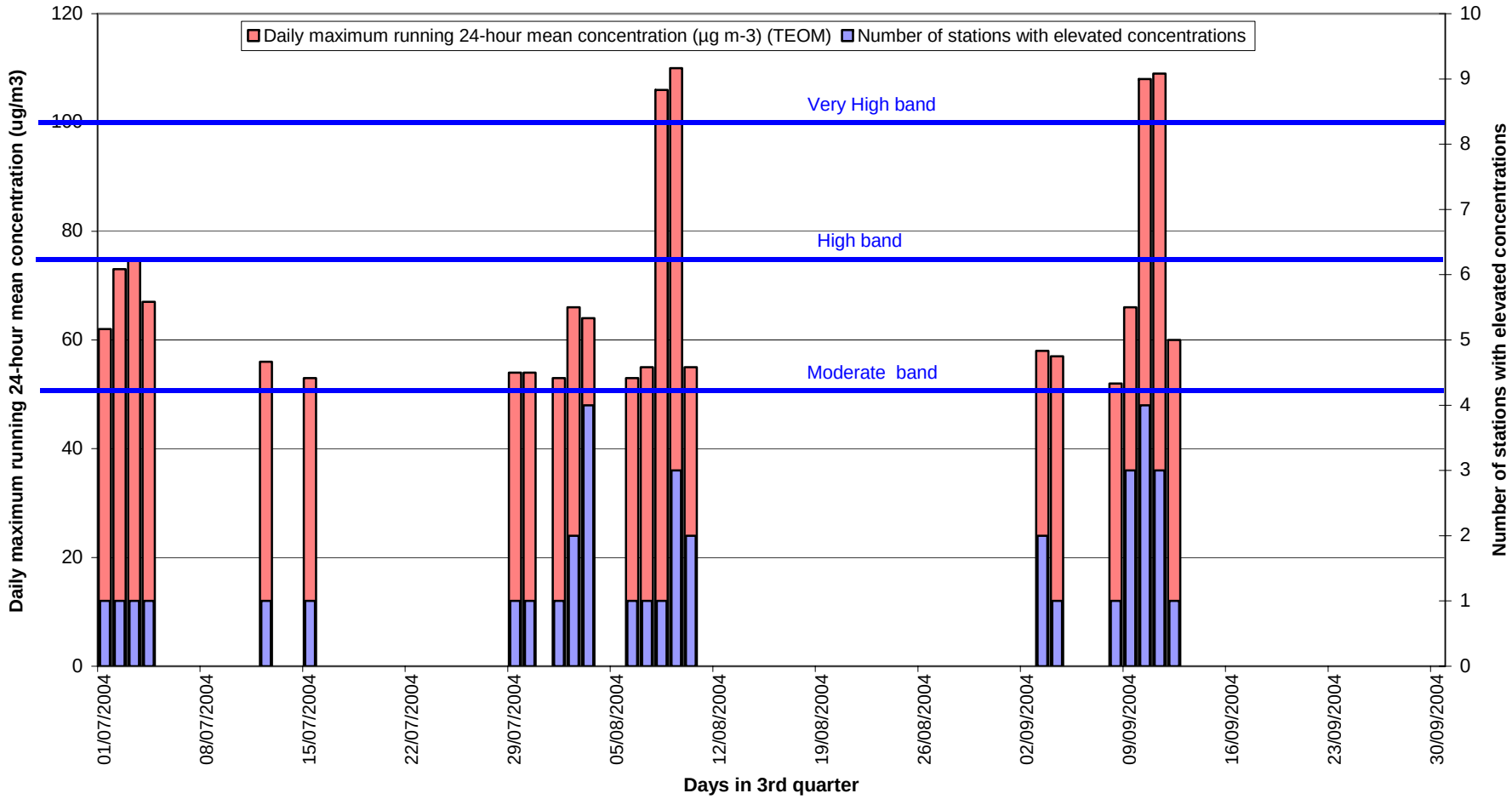


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring moderate or above levels over the 3rd quarter 2004

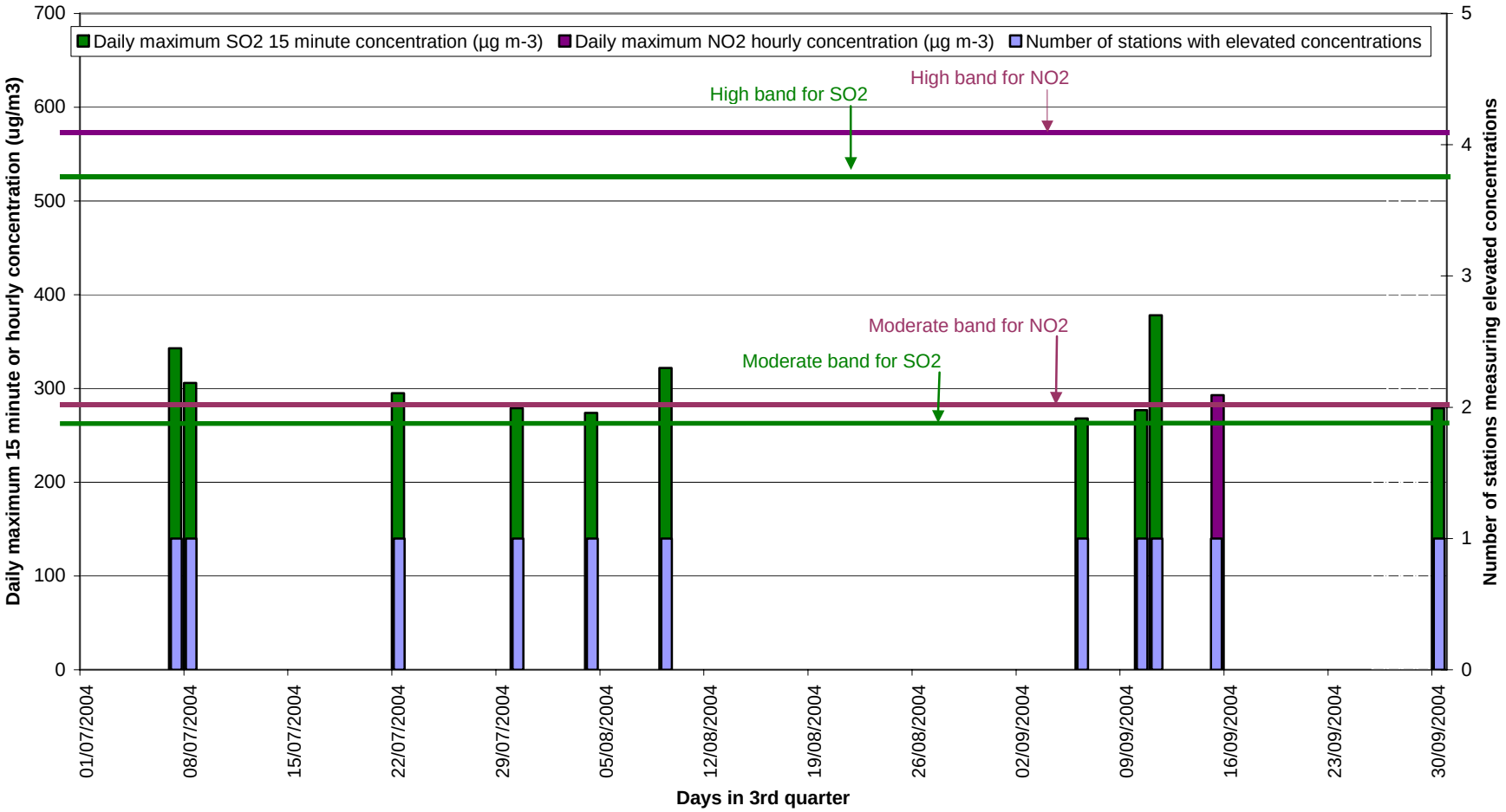


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO2 across AURN Network with total number of stations measuring moderate or above levels over the 3rd quarter 2004

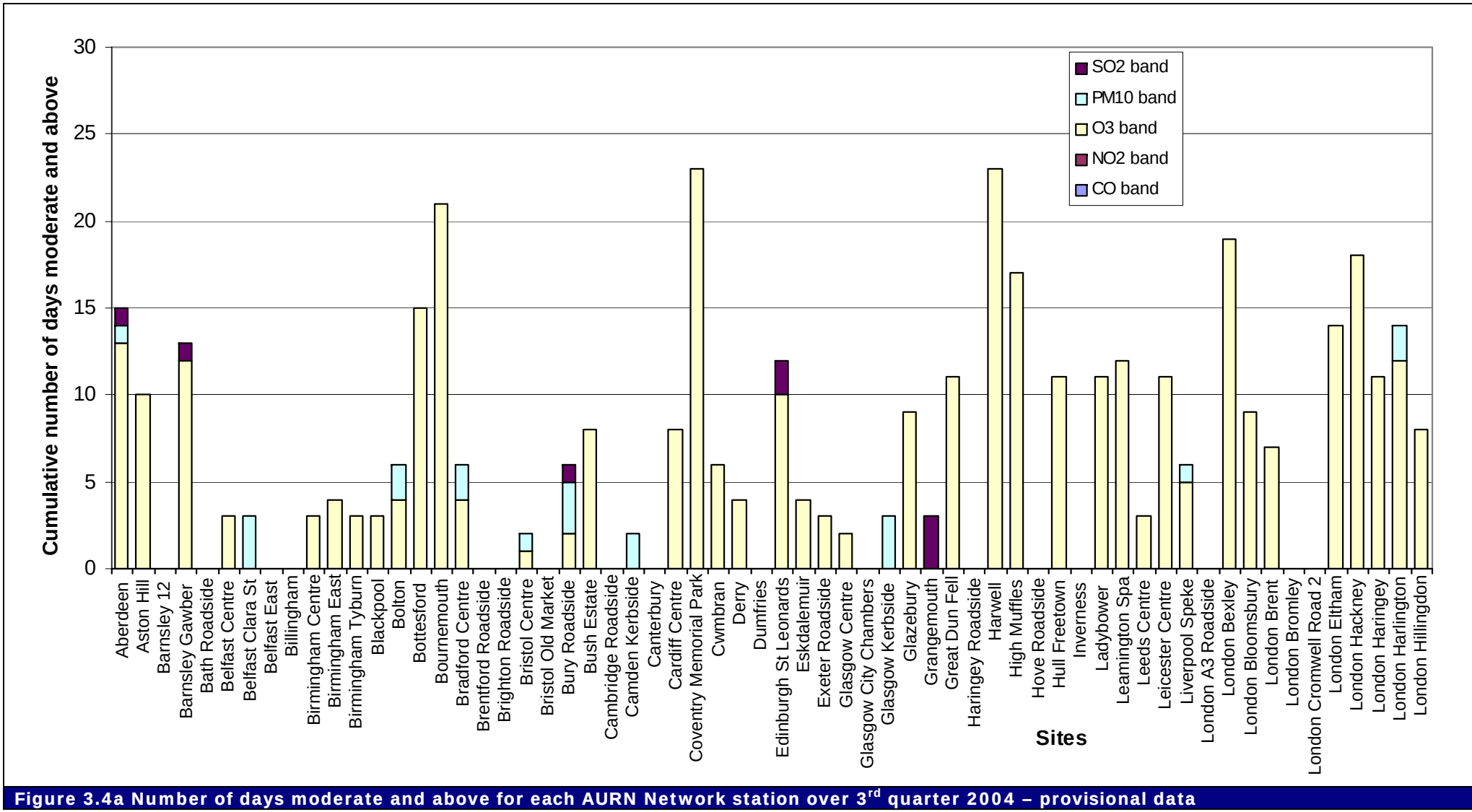


Figure 3.4a Number of days moderate and above for each AURN Network station over 3rd quarter 2004 – provisional data

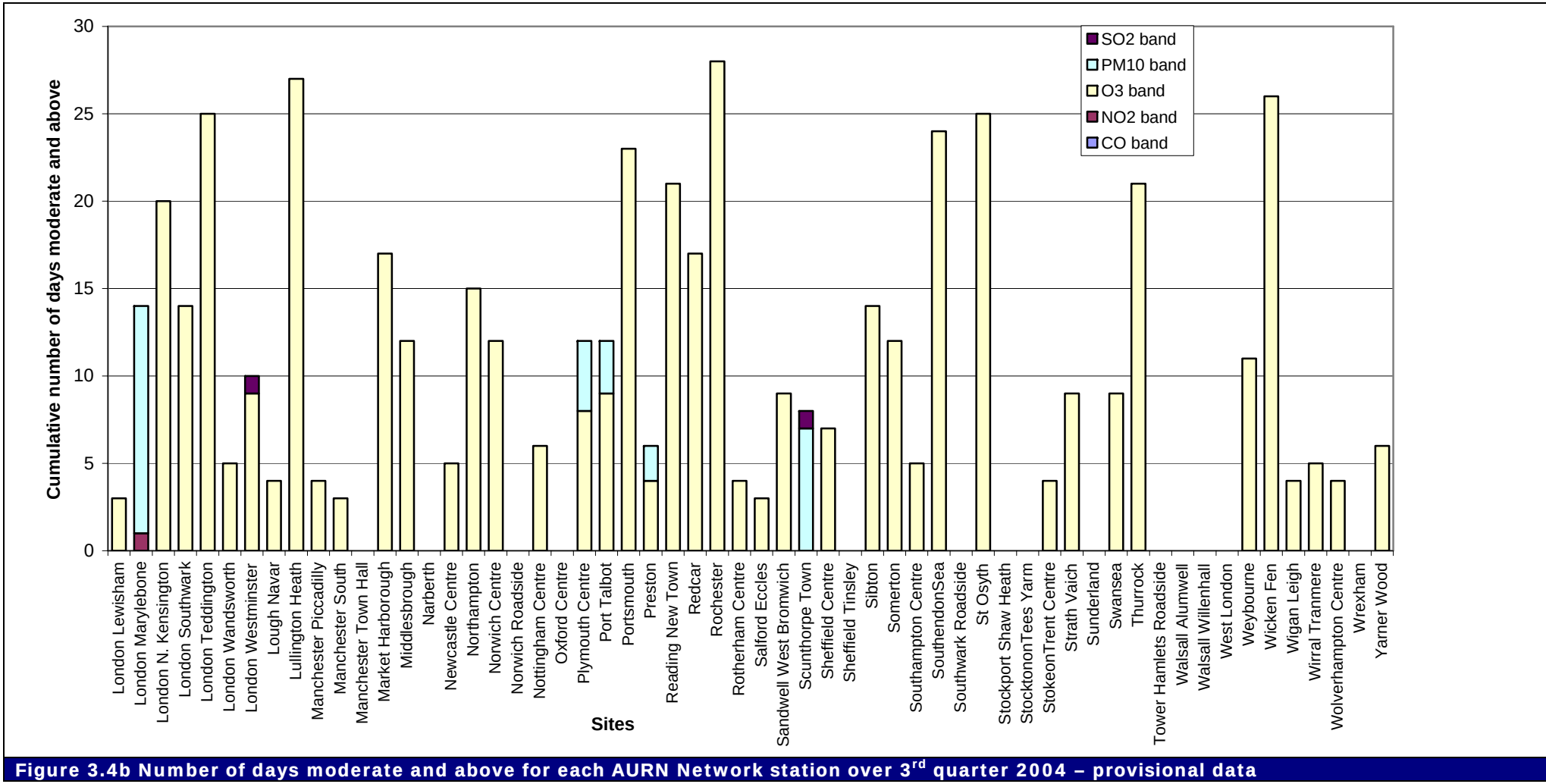


Figure 3.4b Number of days moderate and above for each AURN Network station over 3rd quarter 2004 – provisional data

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

In late August a report was issued detailing a summer pollution episode. The report can be found at:

http://www.airquality.co.uk/archive/reports/cat15/0409060809_03_episode_summer2004_final.pdf

7 Ongoing research

NAME Air Quality Skill Index

How good are we at forecasting air quality?

The output from the NAME[2] model contributes to the overall process to create the National Air Quality Forecast, a service that is funded by Defra and the Devolved Administrations[3]. This service is provided by the Met Office and Netcen partnership.

Presently, the method used to assess our ability to forecast air quality uses a hit/miss score- that is, performance is measured by how many times the forecast is correct and how many times the forecast is incorrect with respect to observations. These measures provide an indication of "successful" forecasts or the "hit-rate", i.e., when the forecast and observation agree, e.g., a high

[2] NAME – Numerical Atmospheric dispersion Model Environment
[3] Devolved Administrations – Scottish Executive, Welsh National Assembly, Northern Ireland Assembly

index is forecast and a high index was measured; and a measure of the "false alarm rate", i.e., when the forecast and subsequent observation disagree, e.g., a high index is forecast and a low index was measured. However, this method of performance measure does not provide us with sufficient detail to assess what contributes to an accurate forecast for air quality. In particular, which part of the forecasting processes contributes most to the forecast accuracy?

The forecast process requires the air quality forecaster to assimilate and synthesise several streams of information. The weather forecast, i.e., forecasts of sunshine, rain and winds, as these affect atmospheric chemistry, transport and deposition of air pollutants. The forecast of the origin of air masses, i.e., whether the air has traversed the European continent or the oceans, as this determines the extent of trans-boundary pollution. The recorded values of concentrations of air pollutants – whether the peaks are due to local, non-local or industrial sources. Finally there is the forecast air concentrations of pollutants produced by the NAME model, which the Met Office uses. It is the need to discriminate the performance of the NAME model that has prompted a new performance measure to be proposed by the Met Office and Netcen partnership.

NAME is under constant development to improve the scientific basis of its underlying model. This includes atmospheric chemistry, atmospheric turbulence and transport schemes. Such is the complexity of the model that it is inevitable that changes in one area, e.g. revising the free-tropospheric turbulence scheme, may influence another aspect of the model, e.g., atmospheric chemistry. Several questions then arise for the overall performance of the model. If the forecast has improved, then what aspect of the preceding model development contributes to the improvement? Similarly, if the forecasts deteriorate, then which changes to the model generate this effect?

It would also be useful to know how much the output from NAME contributes to the air quality forecast process. What weighting do the air quality forecasters place on the NAME forecast? Is it used for guidance only or used extensively because it is reasonably reliable? Under what circumstances are NAME forecasts good or bad? What is the tendency to under or over predict air concentrations, i.e., the model's bias? Before operational implementation of an upgrade to NAME, thorough tests will have been undertaken. NAME is tested using standard scenarios such as the EPA's Kincaid observations or the Nottingham sulphur dioxide episode. However, these tests provide only discrete measures of NAME performance. What these tests do not measure is the day-to-day performance of NAME forecasts as part of a forecasting process across the whole country. To address this need, the Met Office plans to implement a new method of measuring NAME's performance, the air quality forecast skill index.

The air quality forecast (AQ) skill index will be used to assess the forecast accuracy of NAME output. Regular comparisons between observed air concentrations recorded at a selection of monitoring stations and NAME forecasts will be undertaken. In addition, a skill score will be calculated; this will be a composite value obtained using statistical measures for mean and bias values of modelled vs. observed air concentrations. The implementation of the skill score has already begun – the first step to obtain routinely the measured air concentrations stored in the national air quality archive (www.airquality.co.uk) has been completed. The next stage is in progress, to clean the observational data and convert it to a suitable format for the suite of analysis tools. The following stages will be the selection of individual or clusters of monitoring stations and routine graphical presentations for use by air quality forecasters and researchers within the Met Office and Netcen partnership.

The intention of the AQ skill score is not only to measure current performance, but also to identify which aspects of the NAME model require further development, and to assess impacts on model performance from such development. In addition, the skill score would provide a quantitative measure of confidence in the overall scientific basis that underlies the NAME model.

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 2004

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 the July to September 2004 report 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

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	μgm^{-3}
LOW										
	1	0-32	0-16	0-95	0-49	0-88	0-32	0-3.8	0.0-3.2	0-16
	2	33-66	17-32	96-190	50-99	89-176	33-66	3.9-7.6	3.3-6.6	17-32
	3	67-99	33-49	191-286	100-149	177-265	67-99	7.7-11.5	6.7-9.9	33-49
MODERATE										
	4	100-126	50-62	287-381	150-199	266-354	100-132	11.6-13.4	10.0-11.5	50-57
	5	127-152	63-76	382–477	200-249	355-442	133-166	13.5-15.4	11.6-13.2	58-66
	6	153-179	77-89	478-572	250-299	443-531	167-199	15.5-17.3	13.3-14.9	67-74
HIGH										
	7	180-239	90-119	573-635	300-332	532-708	200-266	17.4-19.2	15.0-16.5	75-82
	8	240-299	120-149	636-700	333-366	709-886	267-332	19.3-21.2	16.6-18.2	83-91
	9	300-359	150-179	701-763	367-399	887-1063	333-399	21.3-23.1	18.3-19.9	92-99
VERY HIGH										
	10	≥ 360 μgm^{-3}	≥ 180 ppb	≥ 764 μgm^{-3}	≥ 400 ppb	≥1064 μgm^{-3}	≥ 400 ppb	≥ 23.2 mgm^{-3}	≥ 20 ppm	≥ 100 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	2923045
Eastern	4788766
Greater London	7650944
North East	1287979
North West and Merseyside	2823559
South East	3702634
South West	3728319
West Midlands	2154783
Yorkshire and Humberside	2446545
South Wales	1544120
North Wales	582488
Central Scotland	1628460
Highland	364639
North East Scotland	933485
Scottish Borders	246659
Northern Ireland	1101868

Forecasting Agglomerations

Agglomeration	Population
Brighton/Worthing/Littlehampton	437592
Bristol Urban Area	522784
Greater Manchester Urban Area	2277330
Leicester	416601
Liverpool Urban Area	837998
Nottingham Urban Area	613726
Portsmouth	409341
Sheffield Urban Area	633362
Tyneside	885981
West Midlands Urban Area	2296180
West Yorkshire Urban Area	1445981
Cardiff	306904
Swansea/Neath/Port Talbot	272456
Edinburgh Urban Area	416232
Glasgow Urban Area	1315544
Belfast	475987

Map of forecasting zones and agglomerations