REPORT

UK Air Quality Forecasting: Operational Report for July to September 2007

A report produced for the Department for Environment, Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and the Department of the Environment in Northern Ireland

AEA

AEAT/ENV/R/2547 Issue 1, November 2007

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Executive Summary

This report covers the operational activities carried out by AEA Energy & Environment and the Met Office under the UK Air Quality Forecasting Contract from July to September 2007. The work is funded by the Department for Environment Food and Rural Affairs (Defra), the Scottish Executive, Welsh Assembly Government and the Department of the Environment in Northern Ireland.

During the third quarter of 2007, there were two days on which HIGH or above air pollution was recorded. Both of the HIGH or above exceedences were due to PM_{10} and occurred as a result of a single pollution incident measured at the Bristol St Paul's AQM site due to its close proximity to a carnival event.

Overall forecast success and accuracy rates for the HIGH band were 0 % for agglomerations during this quarter due to the inherent difficulty of forecasting these type of localised particulate emissions. No HIGH measurements occurred in zones therefore the overall success rate for these areas is considered to be 100 % by default, with an associated 0 % of accuracy.

Many MODERATE days were measured (mainly for ozone) and were forecasted with a high degree of success and a very reasonable accuracy in both zones and agglomerations. These MODERATE periods are recorded within the forecasting success and accuracy calculations. The forecasting success and accuracy for this quarter for HIGH and MODERATE episodes is summarised in Table 1 below.

Success figures for MODERATE forecasts issued show that a significant proportion of measured polluted days were successfully forecast (percentage above 100 %). An average accuracy figure of around 85 % indicates that 15 % of the forecast MODERATE levels were not measured and remained LOW. The accuracy figures often tend to be lower due to the precautionary approach that AEA Energy & Environment takes when issuing the daily forecasts- we intentionally issue a forecast for MODERATE pollution when there is only a small chance that it will be recorded.

Table 1 – Forecast success/accuracy for incidents above 'HIGH' and above 'MODERATE', July 1st to September 30th 2007.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	100	0	135	91
Agglomerations	0	0	149	79

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

1. Investigating new approaches to using automatic software systems to streamline the activities within the forecasting process, thus allowing forecasters to spend their time more productively considering the most accurate forecasts.
2. Researching the chemistry used in our models, for example the chemical schemes for secondary PM_{10} and ozone.
3. Improving the NAME model used for ad-hoc analyses. In particular, recent improvements have assisted with investigations of the possible long-range transport of PM_{10} pollution from forest fires in Russia and the long-range transport of particles from Saharan Dust Storms.
4. Improving and updating the emissions inventories used in our models.

There were no reported breakdowns in the forecasting service between July and September; all bulletins were successfully delivered to the Air Quality Communications contractor on time.

Contents

1 Introduction

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

This report analyses and reviews the media forecasts issued during the third quarter of 2007. Results from forecasting models are available each day and are used in constructing these forecasts. The forecasters issue predictions for rural, urban background and roadside environments but, for the purposes of this report, these have been combined into a single "worst-case" category.

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

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

2 New developments during this period

2.1 MET OFFICE DEVELOPMENTS

The Met Office hosted a second technical meeting with AEA in October 2007. The status of actions and developments from the previous meeting were reviewed. These included the new trajectory system, from which output has started to be sent routinely to AEA every day. The final appearance of the forecast maps was agreed and these are now being sent by ftp to AEA on a daily basis. Example html code written by the Met Office for animating the images and displaying them on a website was also sent to AEA.

During this quarter a higher resolution version of the forecast model was trialled, but in a high PM period in early October was found to be too slow. Some modifications to the forecast system were implemented though, including a change in the locations that data is output for. Extra sites have been added that correspond to AURN observation sites to enable statistical analysis of the model. Considerable effort has also been put in by both AEA and the Met Office during this quarter to increase the number of sites for which forecast data is provided to the BBC.

2.2 AEA ENERGY & ENVIRONMENT DEVELOPMENTS

AEA have been working closely with the Met Office to develop and implement improvements in the data flow and presentation of the forecast systems.

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 2007.

Table 3.1 - Forecast Analysis for UK Zones 'HIGH' band and above *

ZONES	Central Scotland	East Mids	Eastern	Greater London	Highland	North East	North East Scotland	North Wales	North West & Merseyside	Northern Ireland	Scottish Borders	South East	South Wales	South West	West Midlands	Yorkshire & Humberside	Overall
measured days	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
forecasted days	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ok (f and m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
wrong (f not m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
wrong (m not f)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
success %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
accuracy %	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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

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

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

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

ZONES	Central Scotland	East Mids	Eastern	Greater London	Highland	North East	North East Scotland	North Wales	North West & Merseyside	Northern Ireland	Scottish Borders	South East	South Wales	South West	West Midlands	Yorkshire & Humberside	Overall
measured days	0	11	27	11	3	2	0	0	2	0	0	8	3	10	7	2	86
forecasted days	0	9	18	9	0	4	0	1	3	0	1	16	4	13	6	4	88
ok (f and m)	0	11	31	14	2	3	0	1	3	0	0	17	4	17	11	2	116
wrong (f not m)	0	2	1	1	0	1	0	0	0	0	1	2	1	0	0	2	11
wrong (m not f)	0	4	2	2	1	0	0	0	0	0	0	1	0	0	0	0	10
success %	100	100	115	127	67	150	100	100	150	100	100	213	133	170	157	100	135
accuracy %	0	65	91	82	67	75	0	100	100	0	0	85	80	100	100	50	91

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	9	3	3	0	0	0	2	0
forecasted days	0	9	6	3	0	0	1	4	1
ok (f and m)	0	15	5	2	0	0	1	2	1
wrong (f not m)	0	0	2	2	0	0	0	2	0
wrong (m not f)	0	0	0	1	0	0	0	0	0
success %	100	167	167	67	100	100	100	100	100
accuracy %	0	100	71	40	0	0	100	50	100

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	2	6	2	1	0	3	2	33
forecasted days	3	8	3	3	1	4	2	48
ok (f and m)	2	10	2	2	1	3	3	49
wrong (f not m)	1	2	1	1	0	2	0	13
wrong (m not f)	0	1	0	0	0	0	0	2
success %	100	167	100	200	100	100	150	149
accuracy %	67	77	67	67	100	60	100	79

*** 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 2007 (Based on latest provisional data)

Pollutant	High or above days	Moderate days	Max. conc. (µg /m^3) *	Site with max. conc.	Zones or Agglomeration	Date of max conc.	Forecast success HIGH days (%)*** [no. incidents, zone or agglomeration days] **
Ozone	0	30	166	Weybourne	Eastern zone	05/08/07	N/a
PM_{10} gravimetric equivalent	2	7	122	Bristol St Paul's	Bristol UA	15/9/07	0 % [1]
NO_2	0	2	308	London Marylebone Road	London UA	20/07/07	N/a
SO_2	0	0	234	Grangemouth	Central Scotland zone	09/08/07	N/a
CO	0	0	3.8	Bristol St Paul's	Bristol UA	15/9/07	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 two agglomeration-day incidents of HIGH band pollution measured during this quarter for PM_{10}, only. Both of these incidents were as a result of a single event on the 15th September due to proximity of a carnival to the Bristol St Paul's AQM site. Elevated levels of PM_{10} and CO were predominantly measured during the pollution event.

Seven MODERATE-only days were seen due to PM_{10}, split between a London kerbside site and a site in South Wales, located near a major steel works.

Thirty MODERATE days were measured for ozone during this quarter, an unusually low number for this period of the year.

Two MODERATE days were measured for nitrogen dioxide, all measured at a kerbside site in London.

No MODERATE or above days were measured for SO_2, an unusual occurrence for any quarter of the year.

No MODERATE or above days were measured for CO during the reporting period. The highest 8-hour running mean calculated was 3.8 mg/m^3 at Bristol St Paul's during a nearby carnival event, possibly as a result of a petrol generator or other combustion source.

Figures 3.1 – 3.3 show the trends of pollutants in graphical form. A site-by-site breakdown is given in Figures 3.4a and 3.4b.

O_3

No HIGH band exceedences were measured during this quarter or indeed for the whole summer of 2007. This reflected the unsettled weather with very many wet and windy days recorded. Maximum daytime temperatures reached above 30 degrees C in the south east of England on one day in early August and remained within the band 25 to 30 C for many days in early June and early August. The winds remained mainly in westerly directions during this quarter and were not stable and easterly for any length of time. Ten sites or greater, during any one day, measured MODERATE levels on the 1st, 5th – 6th and 10th – 11th August. On all other days only a small number of sites, or no sites at all, entered the MODERATE band.

On the 31st July air masses reaching the UK had been sourced directly from the vicinity of Iceland. On Wednesday 1st August the air masses briefly passed over the near continent before reaching the south of England, although remaining predominantly north-westerly in origin. Maximum daytime temperatures were in the high 20's and wind speeds were light. 30 sites entered the MODERATE band on that day, nine in London, five in East Anglia, four in the Midlands, five in the South West and seven in the South East of England. By the 2nd August the incoming air was no longer being partially sourced from Europe. The highest index value reached during this episode was index 5.

On the 4th August Atlantic air had reached southern areas of the UK from the south west. By Sunday 5th August air arriving in England and Wales had passed over France, whilst Scotland and Northern Ireland remained in an Atlantic air stream. Just over 60 sites reached the MODERATE band on the 5th. Twelve sites in London reached MODERATE, eight in the South East, five in East Anglia, fourteen in the Midlands, five in the South West, four in Wales and thirteen in the north of England. The intensity of ozone precursors arriving from Europe is usually at a height during weekends when easterly air trajectories occur, due to the travel-time of European working-week pollution emissions. By Monday the incident air again turned exclusively to the Atlantic and a drop in exceedences was seen, with 80% of the 17 sites exceeding located in either London, East Anglia or the South East, the 3 remaining sites in the Midlands. The maximum daytime temperature reached above 30 degrees C on the 5th August in the South East. The highest index value reached during this episode was index 6.

On Thursday 9th August Atlantic air sourced from Iceland was reaching the UK. On the three subsequent days, Friday and the weekend, the air reaching most of the UK had circulated round to the south, although contributions from air which had passed over Europe remained low based on forecast 4-day air mass back-trajectory plots. A spate of exceedences were measured on these days reaching a peak of 31 sites on Saturday 11th. Of the 31 sites exceeding on the peak day twelve were located in London, three in East Anglia, seven in the South East, six in the Midlands, two in the South West and one in a rural area of Wales. By the 13th air trajectories had returned to the west. The highest index value reached during this episode was index 5.

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

PM_{10}

As mentioned previously there were two agglomeration-day incidents of HIGH band pollution measured due to a localised event.

Seven MODERATE-only days were seen due to PM_{10}. These MODERATE exceedences were split between the sites of London Marylebone Road kerbside, as a result of pollution from predominantly traffic sources and the site at Port Talbot Margam due to the proximity of a major steel works. Nearly all the elevated periods occurred at the end of September and coincided with moderate wind speeds from the south west. The steel works at Port Talbot lies approximately east of the monitoring site, explaining the increase in levels. Marylebone Road is north-east / south-west orientated therefore a breeze was blowing along the street during the days of elevated pollution.

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

NO_2

Two MODERATE days were measured at the London Marylebone Road kerbside site. Both of these pollution events coincided with a change in the wind direction to south westerly, approximately the same orientation as the road alignment.

SO_2

No MODERATE or above days were measured at any site in the network, this is unusual for any quarter. The highest 15 minute measurement made was 234 ug/m^3 (index 3) on 9th August at the urban industrial site Grangemouth in Scotland.

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

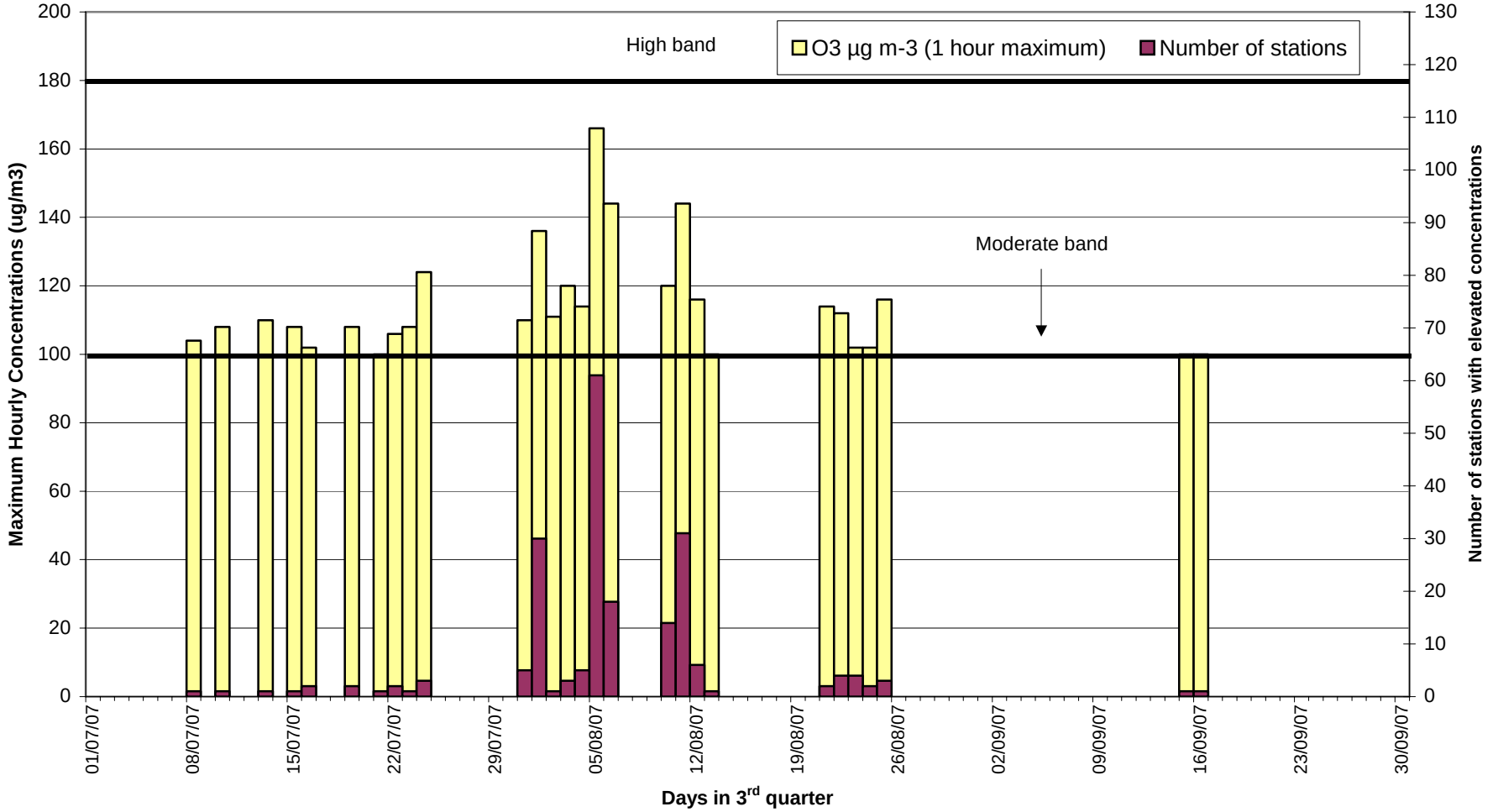

Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 3rd quarter 2007.

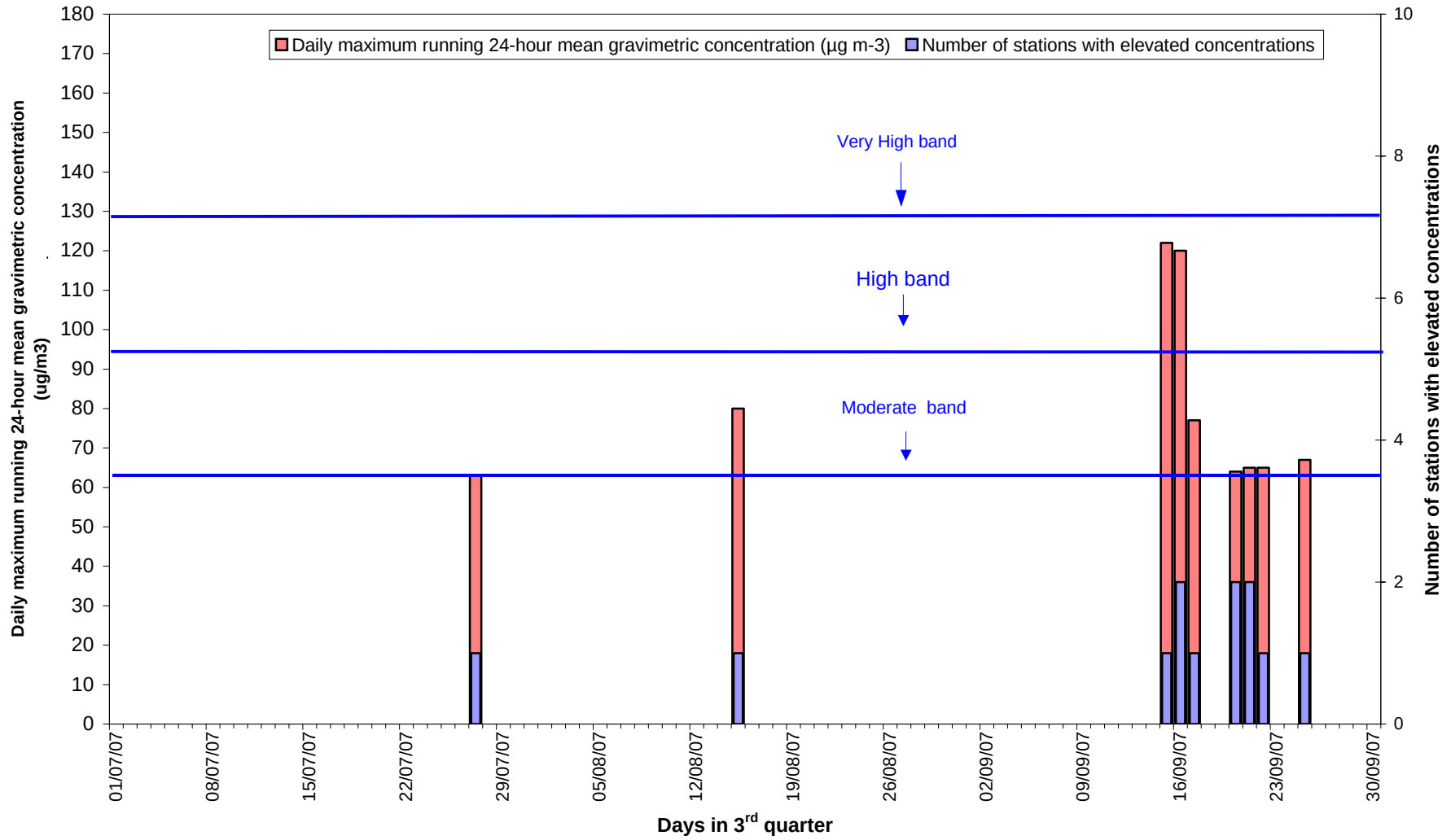

Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2007.

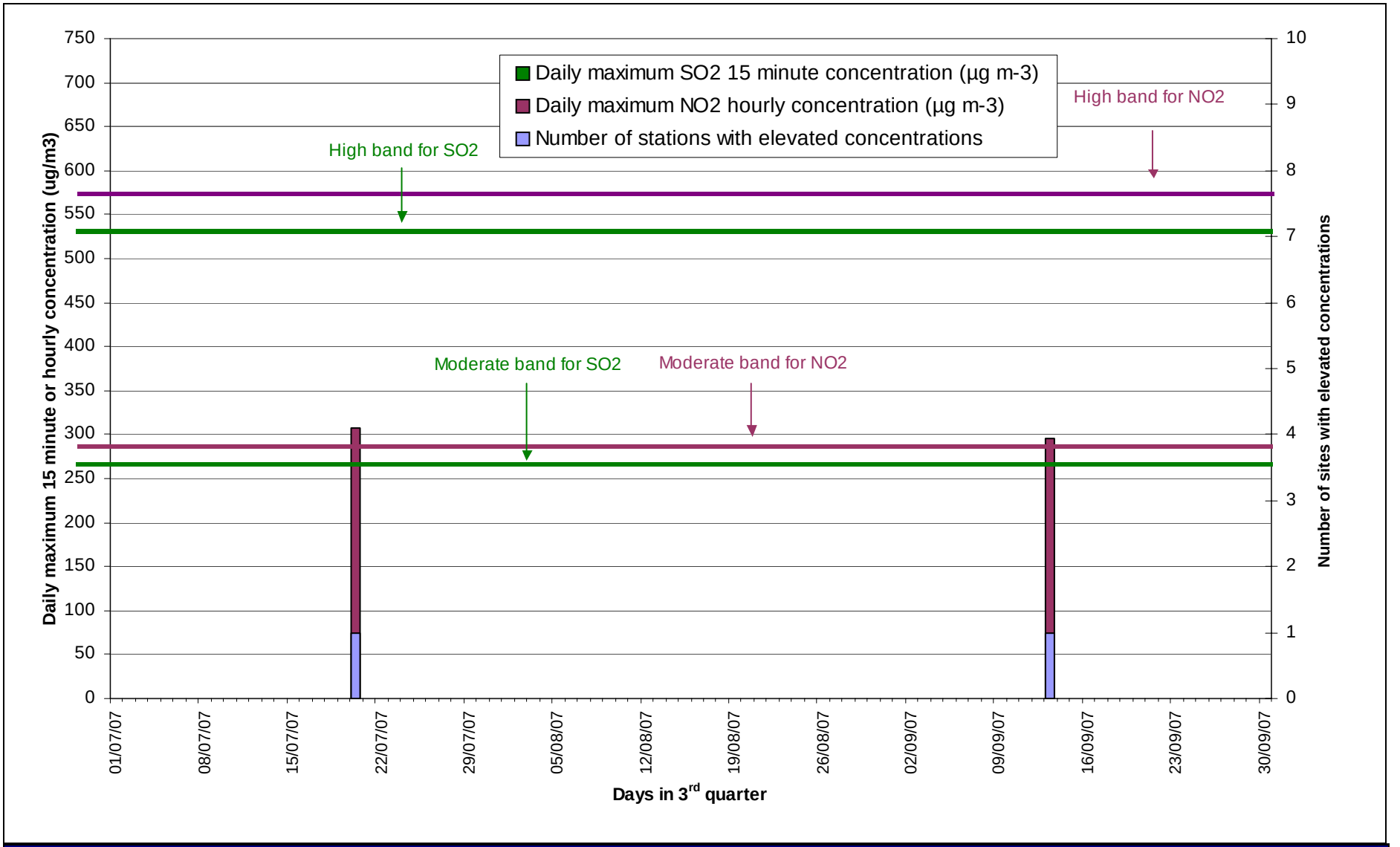

Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO_2 across AURN Network with total number of stations measuring MODERATE or above levels over the 3rd quarter 2007.

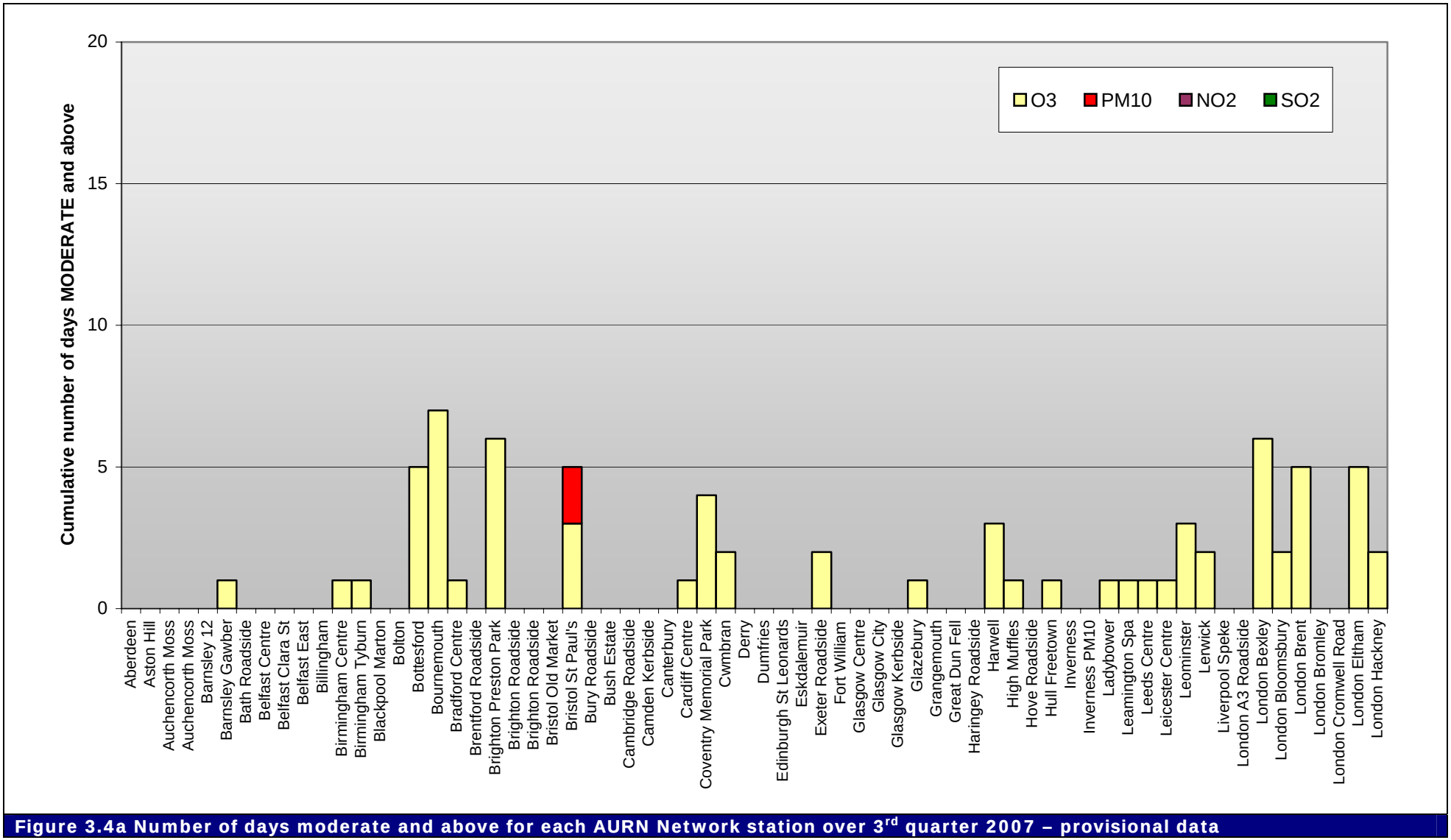

Figure 3.4a Number of days moderate and above for each AURN Network station over 3rd quarter 2007 – provisional data

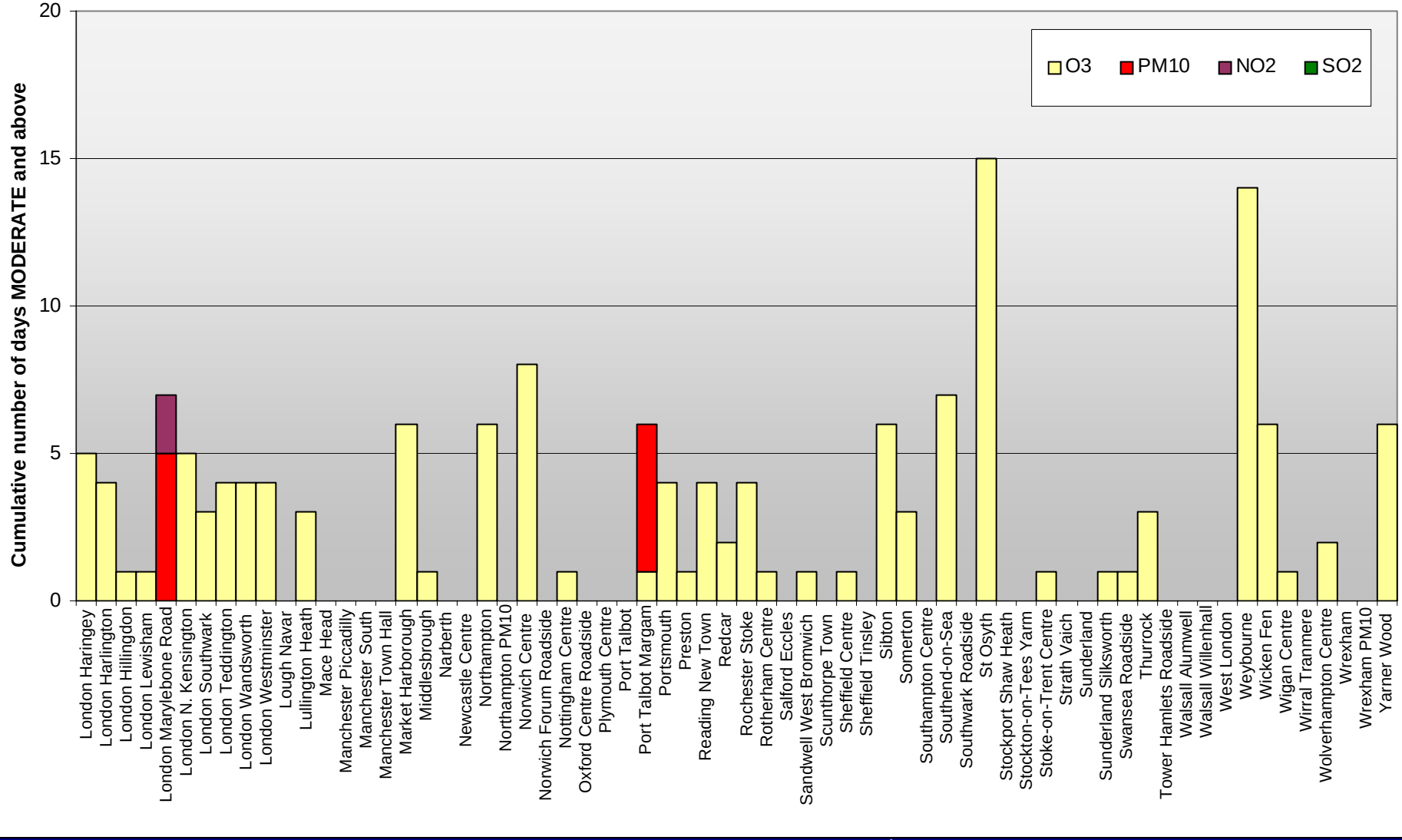

Figure 3.4b Number of days moderate and above for each AURN Network station over 3rd quarter 2007 – provisional data

4 Breakdowns in the service

All bulletins were successfully delivered to the Air Quality Communications contractor on time. There were no reported breakdowns in the service over this three-month period.

5 Additional or enhanced forecasts

No formal enhanced forecasts can be issued until the format of the enhanced service has been agreed with Defra and the Devolved Administrations.

The air pollution forecast is always re-issued to Teletext, Web and Freephone services at 10.00 local time each day, but will only be updated when the pollution situation is changing.

The bi-weekly air pollution outlooks have continued to be delivered successfully to Defra and other government departments by email on Tuesdays and Fridays.

6 Ad-hoc services and analysis

6.1 PARTICULATE CLOUD FROM EASTERN SOURCES IN LATE MARCH 2007

A draft version of an ad-hoc report was submitted for comment by Defra and the DAs detailing this episode. Following the submission alterations have been made on request of the co-authors at the Met Office to enhance the report's readability and scientific acumen prior to publication.

7 Ongoing research

AEA Energy & Environment and the Met office will also continue to:

1. Investigate ways of using automatic software systems to streamline the activities within the forecasting process, thus allowing forecasters to spend their time more efficiently considering the most accurate forecasts.
2. Research the chemistry used in our models, for example the chemical schemes for secondary PM_{10} and ozone.
3. Improve the NAME model runs that can be used for ad-hoc analyses, in particular with regard to investigating the possible long-range transport of PM_{10} pollution from European sources and the long-range transport of particles from Saharan Dust Storms.
4. Improve and update the emissions inventories used in our models.

8 Forward work plan for October to December 2007

Major tasks include:

- Ongoing daily air pollution forecasting activities.
- Ongoing improvements to the NAME model, including:
  - Increase in the horizontal model domain
  - An upgrade providing enhanced chemistry modelling for ozone, nitrates and sulphates.
  - Update of emissions inventory used in the model.
- Publication of the annual 2006 report, 2007 quarterly reports and one ad-hoc 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 currently being used on this project is owned by Defra or the Devolved Administrations.

Appendix 1 - Air Pollution Index

CONTENTS

The UK Air Pollution Indices

Old Banding	Index	Ozone 8-hourly / Hourly mean		Nitrogen Dioxide Hourly Mean		Sulphur Dioxide 15-Minute Mean		Carbon Monoxide 8-Hour Mean		PM_{10} Particles 24-Hour Mean*
		μgm^{-3}	ppb	μgm^{-3}	ppb	μgm^{-3}	ppb	mgm^{-3}	ppm	gravimetric μgm^{-3}
LOW										FDMS limits / TEOM limits
	1	0-32	0-16	0-95	0-49	0-88	0-32	0-3.8	0.0-3.2	0-19 / 0-21
	2	33-66	17-32	96-190	50-99	89-176	33-66	3.9-7.6	3.3-6.6	20-40 / 22-42
	3	67-99	33-49	191-286	100-149	177-265	67-99	7.7-11.5	6.7-9.9	41-62 / 43-64
MODERATE										
	4	100-126	50-62	287-381	150-199	266-354	100-132	11.6-13.4	10.0-11.5	63-72 / 65–74
	5	127-152	63-76	382–477	200-249	355-442	133-166	13.5-15.4	11.6-13.2	73-84 / 75–86
	6	153-179	77-89	478-572	250-299	443-531	167-199	15.5-17.3	13.3-14.9	85-94 / 87-96
HIGH										
	7	180-239	90-119	573-635	300-332	532-708	200-266	17.4-19.2	15.0-16.5	95-105 / 97-107
	8	240-299	120-149	636-700	333-366	709-886	267-332	19.3-21.2	16.6-18.2	106-116 / 108-118
	9	300-359	150-179	701-763	367-399	887-1063	333-399	21.3-23.1	18.3-19.9	117-127 / 119-129
VERY HIGH										
	10	≥ 360 μgm^{-3}	≥ 180 ppb	≥ 764 μgm^{-3}	≥ 400 ppb	≥1064 μgm^{-3}	≥ 400 ppb	≥ 23.2 mgm^{-3}	≥ 20 ppm	≥ 128 / ≥ 130μgm^{-3}

Old Banding	New Index	Health Descriptor
LOW		
	1	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants
	2	
	3	
MODERATE		
	4	Mild effects unlikely to require action may be noticed amongst sensitive individuals
	5	
	6	
HIGH		
	7	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their "reliever inhaler is likely to reverse the effects on the lung.
	8	
	9	
VERY HIGH		
	10	The effects on sensitive individuals described for "HIGH" levels of pollution may worsen.

* the PM10 banding and index thresholds were revised in June 2007 to accommodate the introduction of a new, enhanced measurement technique (FDMS).

Appendix 2 - Forecasting Zones and Agglomerations

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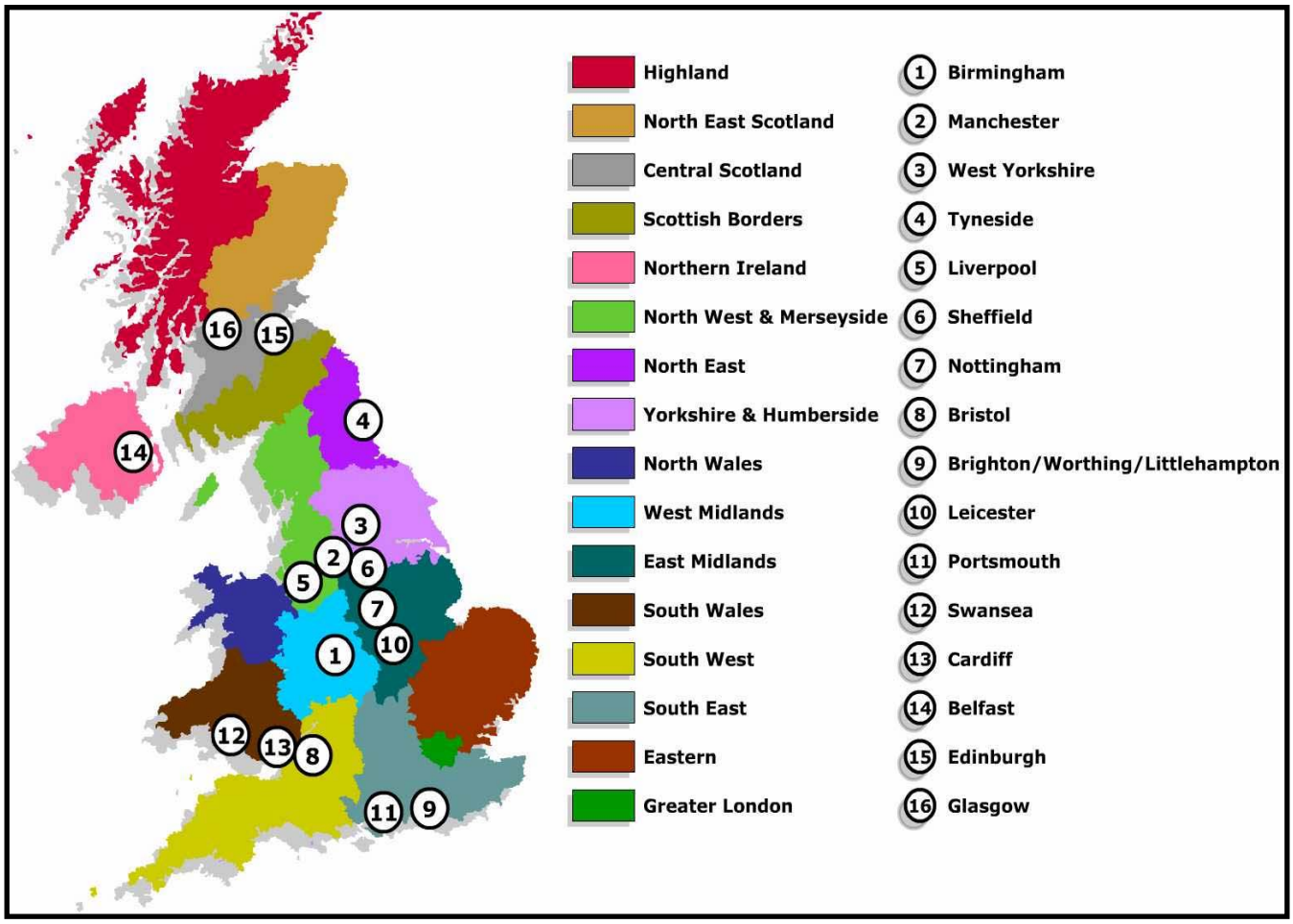
Forecasting Zones

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.