REPORT

UK Air Quality Forecasting: Operational Report for April to June 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/2029 Issue 1
July 2005

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Title	UK Air Quality Forecasting: Operational Report for April to June 2005.
Customer	Department for Environment Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and the Department of the Environment in Northern Ireland
Customer reference	RMP 1902
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File reference	ED45099
Report number	AEAT/ENV/R/2029 Issue 1
Report status	Issue 1

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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 April to June 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 second quarter of 2005, there were 11 days on which HIGH air pollution was recorded. Within zones, the success rate for forecasting these HIGH days was high at 100% with an overall accuracy of 77 %; the HIGH measurements were all due to ozone, which can normally be predicted in advance within the forecasting process. Within agglomerations the success and accuracy rates were poor at 25 % and 22 % respectively. The reduced rates and were due to PM_{10}, a pollutant which is inherently more difficult to predict. Many MODERATE days were measured, as could normally be expected for this time of year. These were forecast with a high degree of success and accuracy during this quarter. The MODERATE periods are recorded within the forecasting success and accuracy calculations.

The overall 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 87 % indicates that only 13 % 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[1] above 'HIGH' and above 'MODERATE', April 1st to June 30th 2005.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	100	77	183	90
Agglomerations	25	22	196	84

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 $NO_x \rightarrow NO_2$ conversion used in NAME and the chemical schemes for secondary PM_{10} and ozone.
3. Improving the NAME model used for ad-hoc analyses. In particular, recent improvements have assisted with investigations of the possible long-range transport of PM_{10} pollution from forest fires in Russia and the long-range transport of particles from Saharan Dust Storms.
4. Improving and updating the emissions inventories used in our models.

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

[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.

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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 period from April to June 2005. 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 extend 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 THE FOURTH ANNUAL AIR POLLUTION FORECASTING SEMINAR

The Fourth Annual Air Pollution Forecasting Seminar was held on Wednesday 27th April 2005. It was hosted in Exeter by the Met Office on behalf of the Department for the Environment, Food and Rural Affairs (Defra) and the Devolved.

The seminar was the latest of an ongoing series of events, hosted by the Met Office and Netcen to report on improvements to the air-quality forecasting service commissioned by Defra and the Devolved Administrations.

More than 50 delegates and speakers attended the most recent event. These included delegates from:

- medical and health organisations,
- local authorities,
- scientific officers,
- environmental health and pollution control academics,
- consultants,
- representatives from defra and the devolved administrations,
- the Environment Agency.

The seminar provided a forum for organisations to present their latest research and to highlight any services which they provide in the field of air quality forecasting, air monitoring and modelling technology and health issues relating to air pollution. These presentations provoked much useful and informative discussion.

The success and accuracy rates of the national air pollution forecasts were discussed. Whilst there were some difficulties understanding the definitions of these measures, 2004 was reported by Netcen to have been typical in terms of the success and accuracy rates achieved for zones (predominantly ozone pollution in rural areas), but low for agglomerations (urban areas) due to the relatively high incidence of localised and difficult to forecast PM_{10} episodes during this year.

Discussion of the factors affecting the accuracy of the air quality forecasts was wide-ranging and covered:

- Weather forecasts.
- Local pollution sources.
- Unusual trans-boundary PM_{10} events (Saharan dust, forest fires, volcanic eruptions etc.)
- Emissions inventories.

It was reported that the UK is the only European country currently publishing the success rates of air pollution forecasting, based on 'actual' reported data and forecast meteorology. By discounting unusual events and using analysis met. data, it is possible to improve the reported performance of forecasting models.

There are several joint European initiatives to improve and co-ordinate air quality forecasts. These currently involve Netcen, the Met Office and Defra:

- Smog Warners co-ordinated by netcen since 1997 – see www.aeat.com/netcen/airqual/forecast/smogwarners

- Ozone Web operated as part of the EC's Clean Air for Europe (CAFE) programme- see http://ozone.eionet.eu.int/index.jsv?pk_lang=20
- A proposal from the Network of European Metereological Sevices (EUMETNET) see www.eumetnet.eu.org

The effects of air pollution on hospital admission and mortality rates encouraged much discussion and re-enforced the importance of research in this area. The Department of Health now has a unique database which contains details of all the research comparing hospital admission and mortality rates with background air pollution. It was reported that patients with some conditions were at much higher risk of premature death when air pollution increased. Statistically significant factors relating air pollution to hospital admission rates and mortality rates can be confirmed for all major pollutants. The only poor relationship was between increasing ozone and hospital admissions, and this was not fully understood. Published research into the numbers of increased deaths per $\mu g\ m^{-3}$ of pollution gives us a guide to the scale of the risks and confirms the value of this area of work.

The Met Office Health Forecasting team is seeking to encourage the NHS to take preventative action to protect susceptible patients when conditions are likely to adversely affect their health.

The latest evidence on the links between climate change and air pollution levels were presented and discussed. This is a complex area with many conflicting factors, and there was no simple answer as to whether climate change would make air pollution levels worse in the future. Indeed, emissions of some pollutants are expected to offset the effects of global warming by causing "global dimming".

Air Pollution Forecasting Seminar agenda:

Air Quality, Health and Climate Change

Wednesday 27th April 2005, Met Office, Exeter

Timetable	
10:30 – 10:45	Welcome and Introduction from Met Office/Defra
10:45 – 11:15	Air Quality Policy Overview Noel Nelson, Defra
11:15 – 11:45	UK Air Quality Forecasting - Project Update Paul Willis, AEAT netcen
11:45 – 12:15	Recent AQ & Health Research Dr Bob Maynard, Department of Health
12:15 – 12:30	Discussion
13:30 – 14:00	Presenting Environmental Information John Hammond, BBC Weather Centre
14:00 – 14:30	Practicalities of using a health forecast Mark Gibbs, Met Office
15:00 – 15:30	Climate Change & Air Quality Dr Bill Collins, Met Office
15:30 – 16:00	AQEG 3rd report – progress update and latest findings Professor Mike Pilling, Leeds University (AQEG Chair)
16:00 – 16:30	Discussion & Close

2.2 OZONE WEB

UK data went live on Ozone Web (http://ozone.eionet.eu.int/index.jsv) on the 22nd April. Data from 10 rural sites and one urban background site (London Bexley) are being submitted, giving good geographical coverage of the UK: in north to south order, the rural sites are:- Strath Vaich, Eskdalemuir, Lough Navar, High Muffles, Ladybower, Aston Hill, Sibton, Harwell, Lullington Heath and Yarner Wood. Only provisional data are submitted to this system. Users are able to view the latest hourly concentrations in terms of their bandings on the maps (see figure 2.1 below), station information (figure 2.2) and a bar graph of daily mean concentrations for each site going back over the last 2 weeks (figure 2.3 overleaf). There are up-to-date ozone concentrations on this site for a number of other European countries.

This is a useful tool which can be used in air quality forecasting, particularly for reviewing when episodes are imminent or in progress. We hope that more countries, particularly Germany and France, will join the system in the near future.

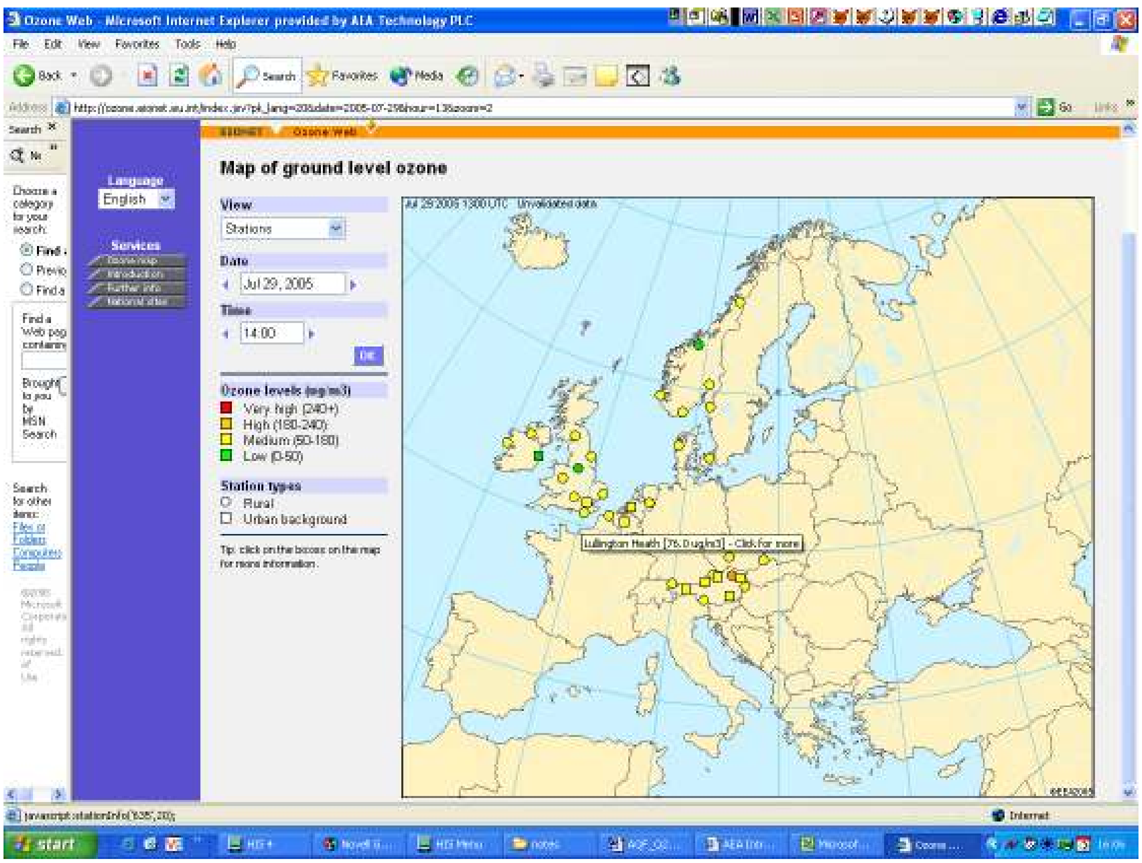


Figure 2.1 Map of ground level ozone from Ozone Web

Basic information

Station name	Ladybower
Station EU code	GB0037R
Station description	
Station type	rural
Station street	-
Station city	-
Station network	GB025A
Network description	
Station country	United Kingdom
Country ISO code	GB

Figure 2.2 Monitoring Station Information from Ozone Web

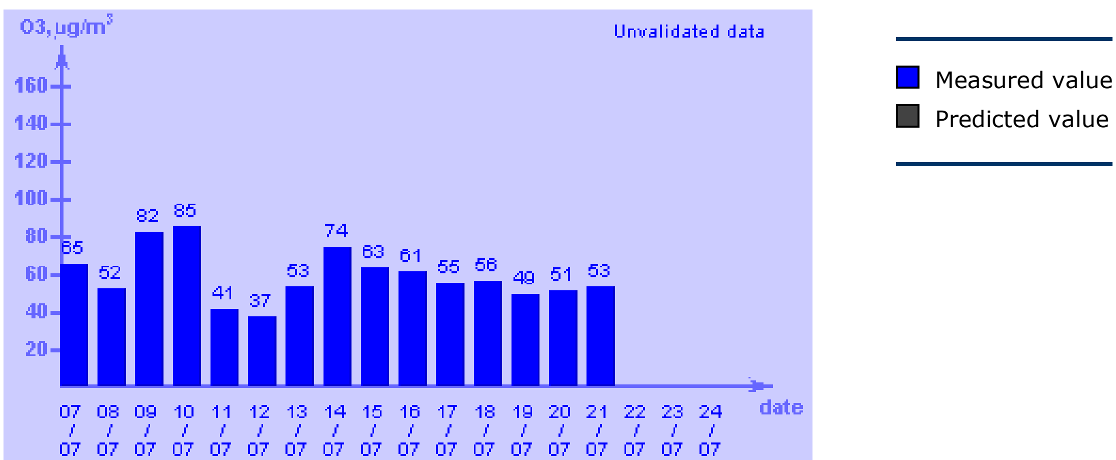


Figure 2.3 History graph: Daily averages from Ozone Web

2.3 MET OFFICE DEVELOPMENTS

Work is almost complete for the transfer of the Air Quality Forecast System (AQFS) to our Production Support Teams. When the acceptance period is over (expected to be at the end of August) this will mark the full integration of the AQFS into the main production processes of the Met Office. This transition also spreads knowledge and expertise about the AQFS, and the services it supports, across all areas of the Met Office: Business, Production, Development and Research, thereby affording greater resilience and forward development at all levels: customer requirements, support, software, hardware and advancements in modelling air quality.

The Met Office Atmospheric Dispersion Group (ADG) is developing a new model core for the AQFS, which is nearing completion. This core is based on the latest version of the NAME model, NAMEIII. Modifications specific to the AQFS include an updated version of the NAME chemistry scheme and a new speciation for VOCs based on the latest NAEI emissions data. New emissions source files have been created using the most recent emissions data for the UK and Europe, and the area of coverage has been increased. The particle resolution has also been increased to reduce data noise.

When the new core has been frozen, Development and Research teams will work together to integrate the new core into the AQFS, following which a period of parallel running will commence before operational implementation. ADG is also evaluating the benefits of using mesoscale meteorological data and producing higher spatial resolution output within the core of the AQFS.

The routine delivery of air quality monitoring data will be used to develop the air-quality skill index. The monitoring data will also be made available to our Health Forecast team that is providing services for resource & demand management within NHS. Discussions are in progress to ensure that the most up-to-date air quality forecast is available for dissemination to local and national media outlets.

2.4 BBC WEATHER UPDATED

In mid-May the BBC completed 'Project Storm' to update its TV and BBC Online weather presentations. We understand that, at present, there are no graphical presentations of air pollution information which can be used on the TV weather broadcasts. A simple three word headline can, however, be added to the graphics if there if is a high pollution alert in progress.

The BBC Online 5-day weather forecast pages now provide simple graphics with low, moderate, high and very high descriptors for air pollution, rather than the 1-10 air pollution index values which were presented previously. This is illustrated in Figure 2.4 below.

Figure 2.4 Screen shot of new-style BBC On-line 5-day weather forecast, including air pollution graphics.

Netcen and the Met Office are currently liasing with the BBC Weather Manager - Andrew Lane - to ensure that the BBC is using the correct air pollution index values to map to the descriptors that they present.

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 APRIL 1ST TO JUNE 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	3	2	0	1	0	0	0	0	0	3	0	1	0	0	10
forecasted days	0	1	2	2	0	0	0	0	0	0	0	3	0	1	0	0	9
ok (f and m)	0	0	3	3	0	0	0	0	0	0	0	3	0	1	0	0	10
wrong (f not m)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
wrong (m not f)	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	3
success %	100	100	100	150	100	0	100	100	100	100	100	100	100	100	100	100	100
accuracy %	0	0	100	100	0	0	0	0	0	0	0	75	0	50	0	0	77

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	2	0	2	0	0
forecasted days	0	1	0	0	0	0	0	0	0
ok (f and m)	0	1	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	2	0	2	0	0
success %	100	100	100	100	0	100	0	100	100
accuracy %	0	100	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	2	0	2	0	0	0	8
forecasted days	0	1	0	0	0	0	0	2
ok (f and m)	0	1	0	0	0	0	0	2
wrong (f not m)	0	0	0	0	0	0	0	0
wrong (m not f)	0	1	0	2	0	0	0	7
success %	100	50	100	0	100	100	100	25
accuracy %	0	50	0	0	0	0	0	22

*** 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	5	31	67	47	46	23	11	28	29	46	2	50	25	47	24	44	525
forecasted days	35	67	81	69	60	53	34	67	59	53	38	71	67	71	62	60	947
ok (f and m)	35	63	81	78	63	54	34	65	61	60	33	75	69	69	59	63	962
wrong (f not m)	1	7	4	2	4	5	2	12	3	3	6	5	5	9	7	4	79
wrong (m not f)	0	1	3	0	0	1	0	1	1	3	0	2	2	7	1	3	25
success %	700	203	121	166	137	235	309	232	210	130	1650	150	276	147	246	143	183
accuracy %	97	89	92	98	94	90	94	83	94	91	85	91	91	81	88	90	90

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	8	31	7	4	22	6	22	21	21
forecasted days	9	57	28	23	29	10	31	45	31
ok (f and m)	16	57	23	11	36	11	41	45	40
wrong (f not m)	0	6	9	14	0	4	2	4	3
wrong (m not f)	0	1	0	0	2	0	2	0	0
success %	200	184	329	275	164	183	186	214	190
accuracy %	100	89	72	44	95	73	91	92	93

AGGLOMERATIONS	Nottingham UA	Portsmouth UA	Sheffield UA	Swansea UA	Tyneside	West Midlands UA	West Yorkshire UA	Overall
measured days	7	24	8	29	6	43	11	270
forecasted days	25	55	27	46	22	47	24	509
ok (f and m)	20	53	23	54	19	58	23	530
wrong (f not m)	6	9	5	5	4	4	5	80
wrong (m not f)	0	5	1	4	0	1	4	20
success %	286	221	288	186	317	135	209	196
accuracy %	77	79	79	86	83	92	72	84

*** 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 April to June 2005 (Based on latest provisional data)

Pollutant	**High days**	**Moderate days**	**Max. conc. (µg /m³) ***	**Site with max. conc.**	**Zones or Agglomeration**	**Date of max conc.**	**Forecast success HIGH days (%)** [no. incidents, zone or agglomoration days] **
Ozone	4	75	204	Portsmouth	Portsmouth UA	27/5	77 % [11]
PM_{10} gravimetric	7	28	155	Edinburgh St Leonards	Edinburgh UA	21/5	0 % [7]
NO_2	0	4	520	London A3 Roadside	Greater London UA	13/5	N/A [0]
SO_2	0	2	290	Port Talbot	Swansea UA	4/4	N/A [0]
CO	0	0	6.3	Tower Hamlets Roadside	Greater London UA	30/6	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 agglomorations (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 18 incidents of HIGH band pollution measured during this quarter, on 11 separate days. Four of these days were due to ozone, seven due to PM_{10}. 77 % of the HIGH ozone measurements were forecasted successfully and all, except Portsmouth with the highest measurement of ozone, occurred within zones. None of the 7 PM10 incidents had been forecasted successfully and all of these had occurred within agglomerations.

Twenty eight MODERATE days were seen due to PM_{10} , measured at various locations. There were 75 MODERATE days due to ozone as is normally expected for this quarter, the majority of which were seen at rural stations.

Two MODERATE days were measured for sulphur dioxide at the Port Talbot monitoring site (steel works nearby) and four MODERATE days for nitrogen dioxide measured at three London stations, two of which are designated "roadside".

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

Four HIGH days were measured during this period: on 27th May and on June 19th, 23rd and 24th .

On Friday 27th May, during a short episode in which hot, aged air masses passed over the UK from Europe, seven sites measured HIGH concentrations, of which four were situated in suburban London, two in the south-east (one of which was a rural site) and one on the south coast (Portsmouth). 44 sites experienced MODERATE or above air quality due to ozone on this day.

During a further 3 hot days in June, HIGH readings were seen at Bournemouth (south) and St Osyth (rural East Anglia) on the 19th, London Bexley and Eltham, Lullington Heath (rural south east) and Sibton (rural East Anglia) on the 23rd and a further HIGH day occurred at Sibton on the

24th. The number of sites experiencing MODERATE or above air quality due to ozone on these days were 51, 45 and 27 sites respectively.

Two ad-hoc reports will be issued shortly on the National Air Quality Archive detailing the HIGH episodes.

PM_{10}

Seven HIGH days were seen over this quarter: two of the days on the 13th and 14th May at Wigan were caused by a period of elevated concentrations during the daytime on Friday 13th . No obvious explanation for this is known. VERY HIGH levels were measured on 21st and 22nd May at Edinburgh St Leonards. This is thought to have been caused by preparatory work for repaving a near-by car park on the 21st. The site located near the Port Talbot steel works measured 3 HIGH days as the result of elevated concentrations in 2 episodes.

Due to the localised nature of these occurrences, none of them could have been easily forecast.

Ten sites measured MODERATE or above levels on Friday 1st April; on that day temperatures were average for April but a southerly breeze is likely to have brought secondary PM_{10} contributions from Europe, where a high pressure centre over northern France was circulating polluted air in a westerly direction.

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

NO_2

Four MODERATE days were seen during this period: two at London A3 Roadside and one each at Marylebone Road and London Brent (all traffic related).

SO_2

Sulphur dioxide levels did not reach the HIGH band during this period. MODERATE levels were measured at Port Talbot on the 4th and 12th April, the highest measured this year as this site, as a result of emissions from the area of the nearby steel works. No other site experienced MODERATE band air quality for SO_2.

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

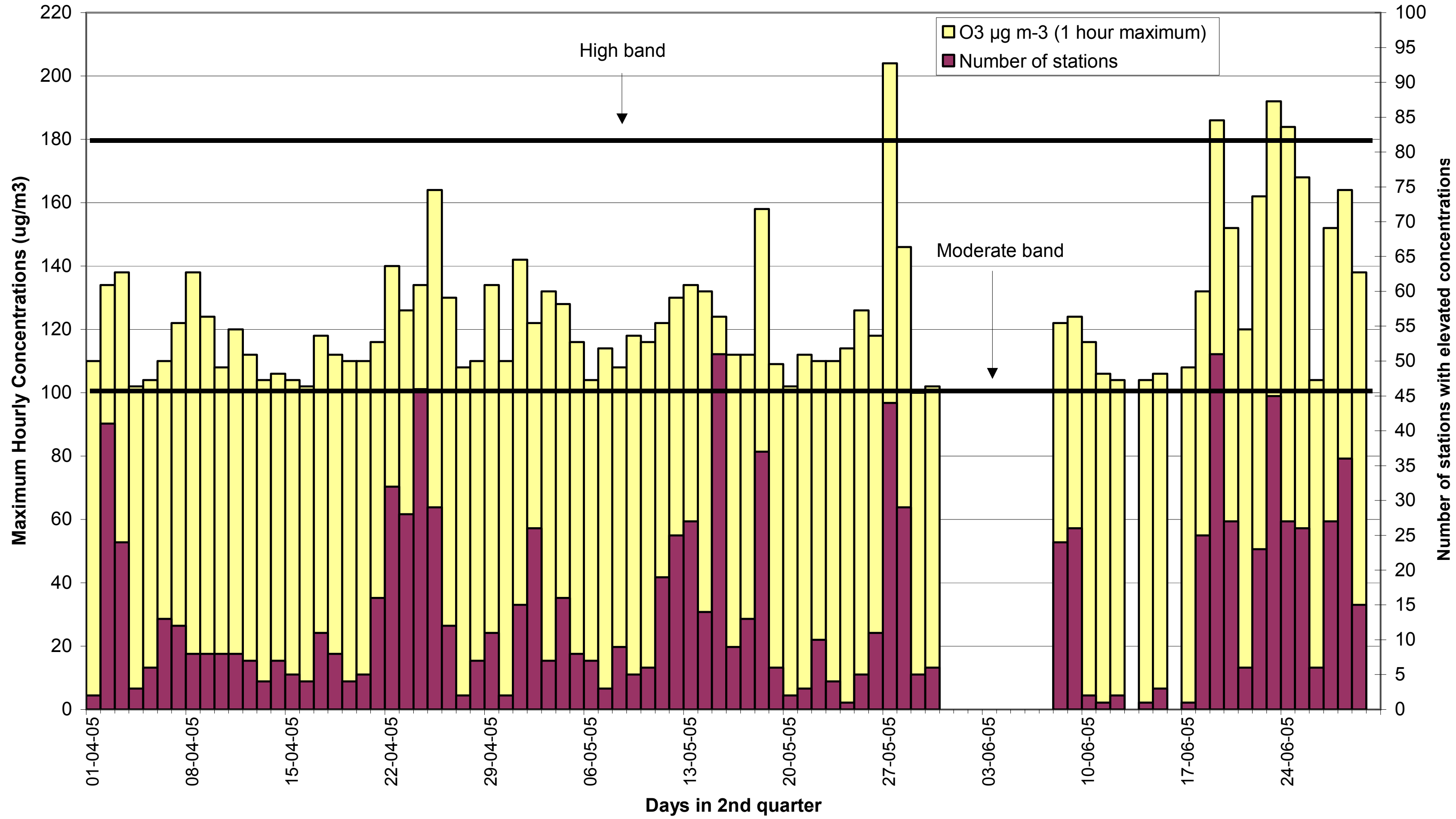


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring moderate or above levels of ozone over 2nd quarter 2005.

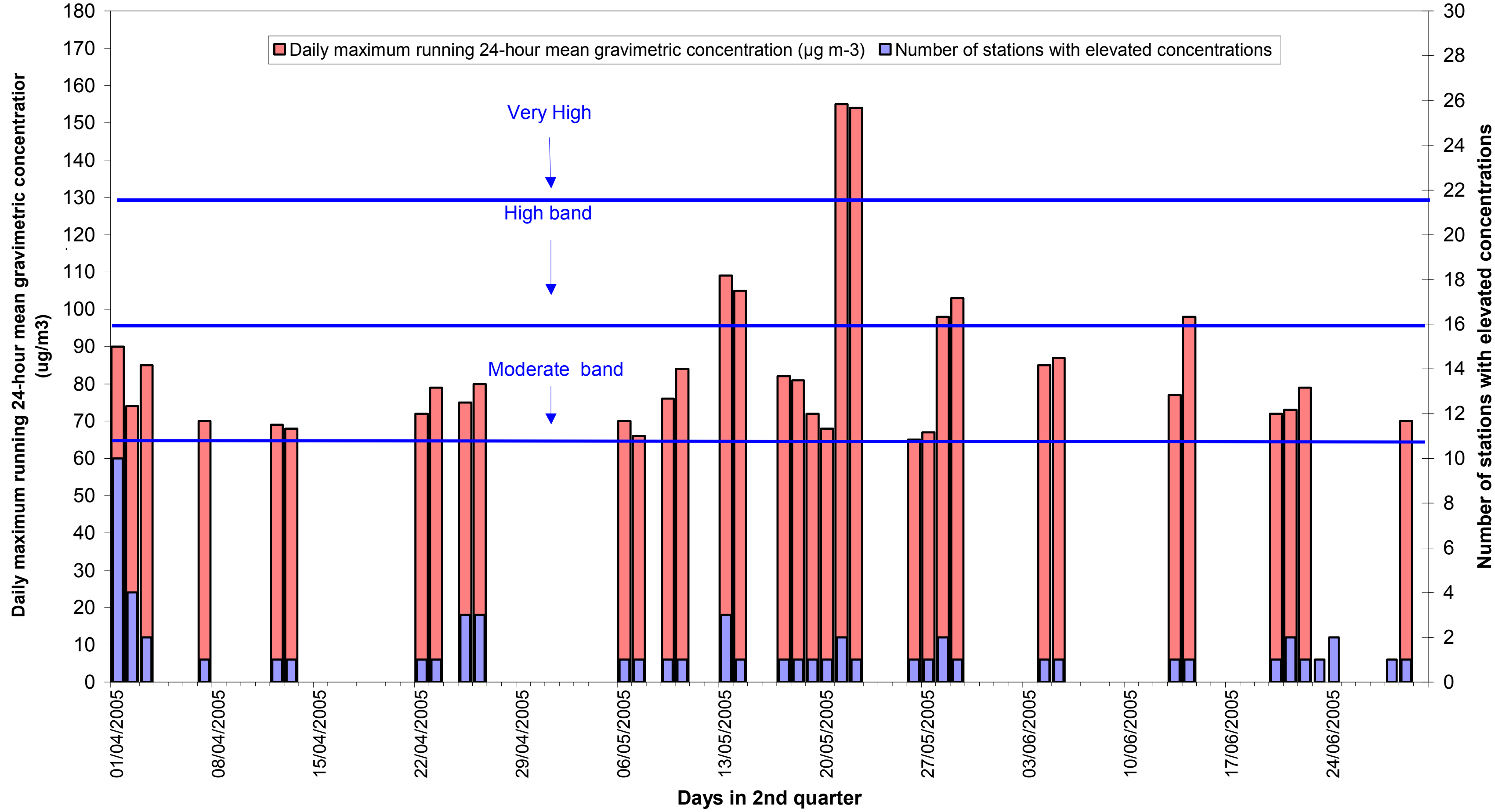


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring moderate or above levels over the 2^{nd} quarter 2005

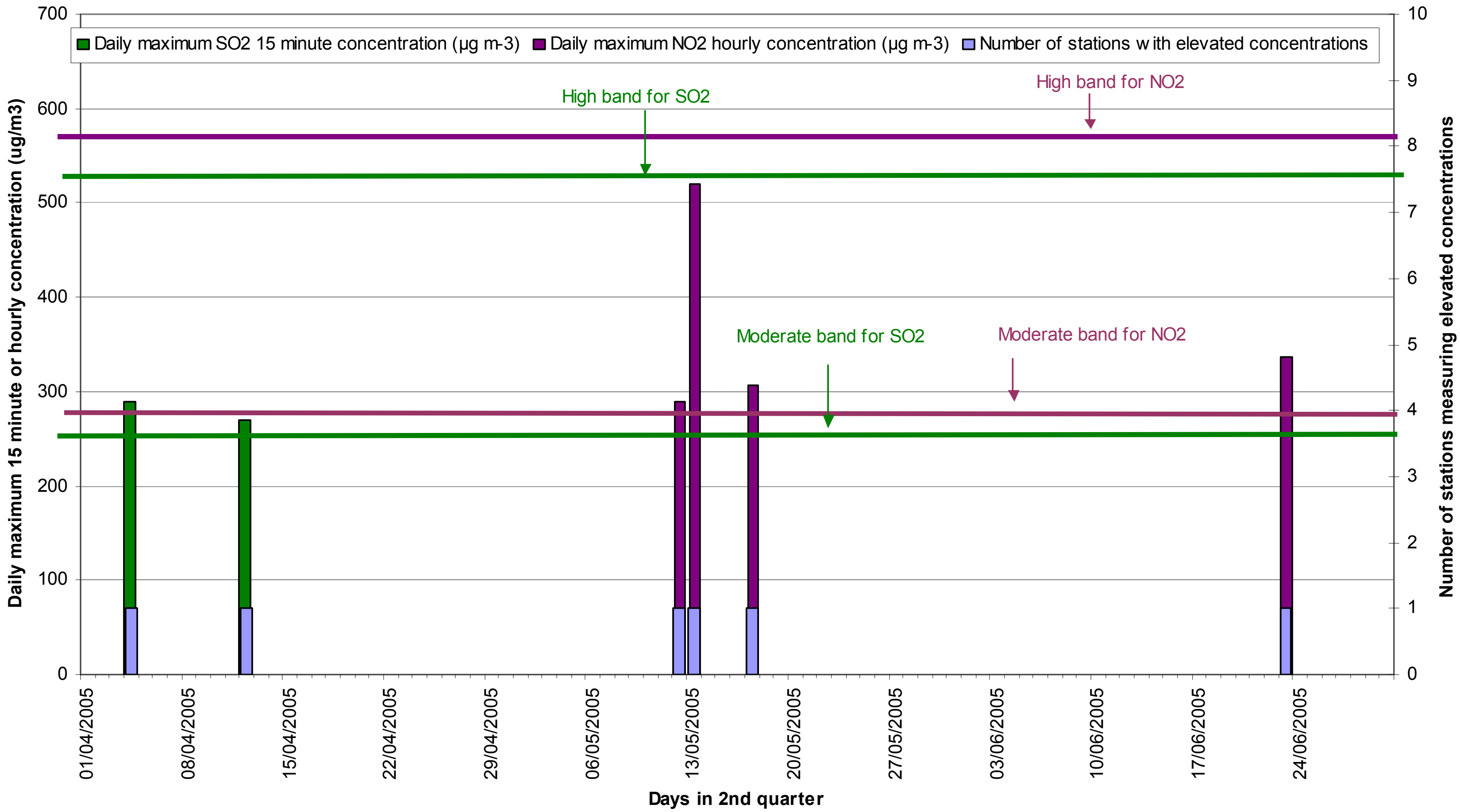


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO2 across AURN Network with total number of stations measuring moderate or above levels over the 2nd quarter 2005

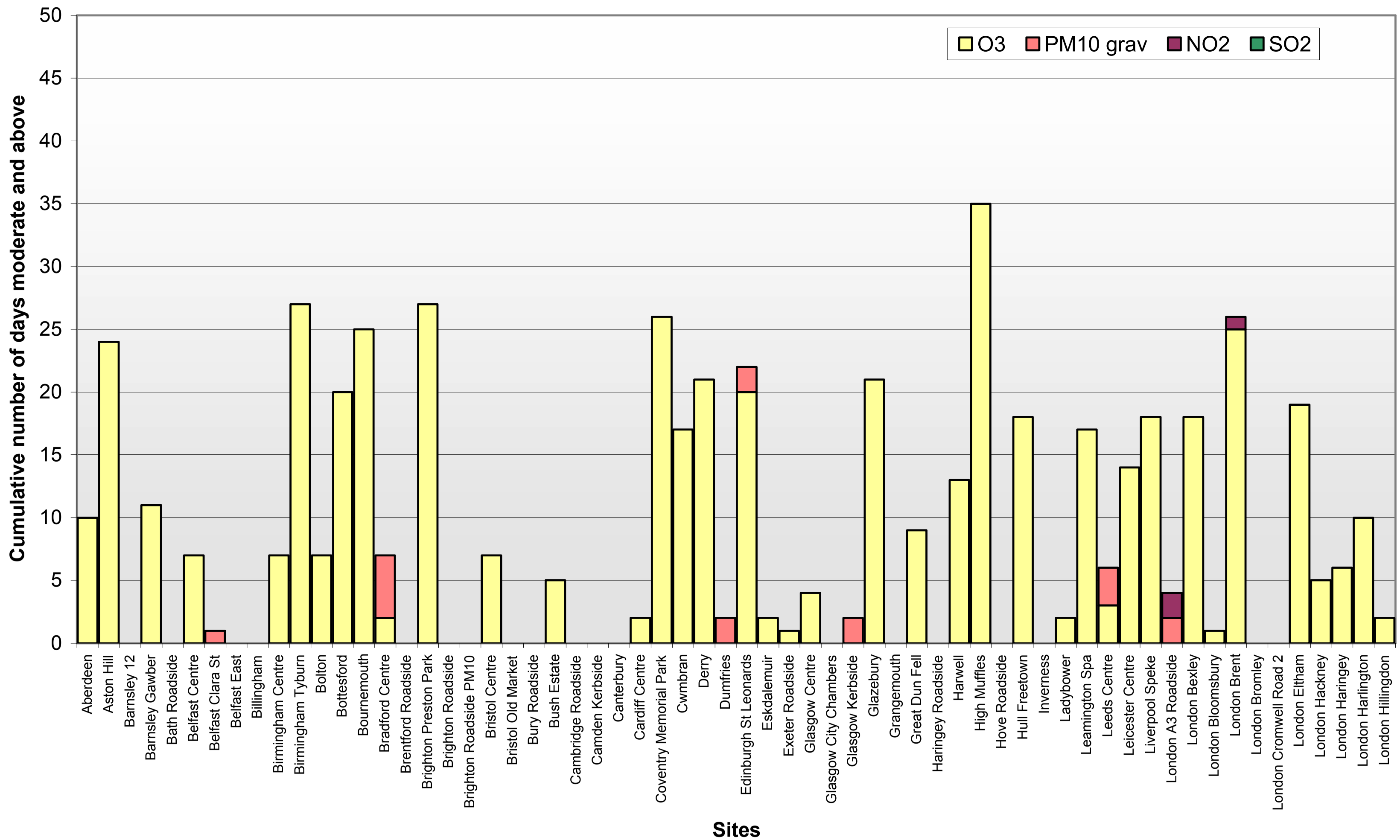


Figure 3.4a Number of days moderate and above for each AURN Network station over 2nd quarter 2005 – provisional data

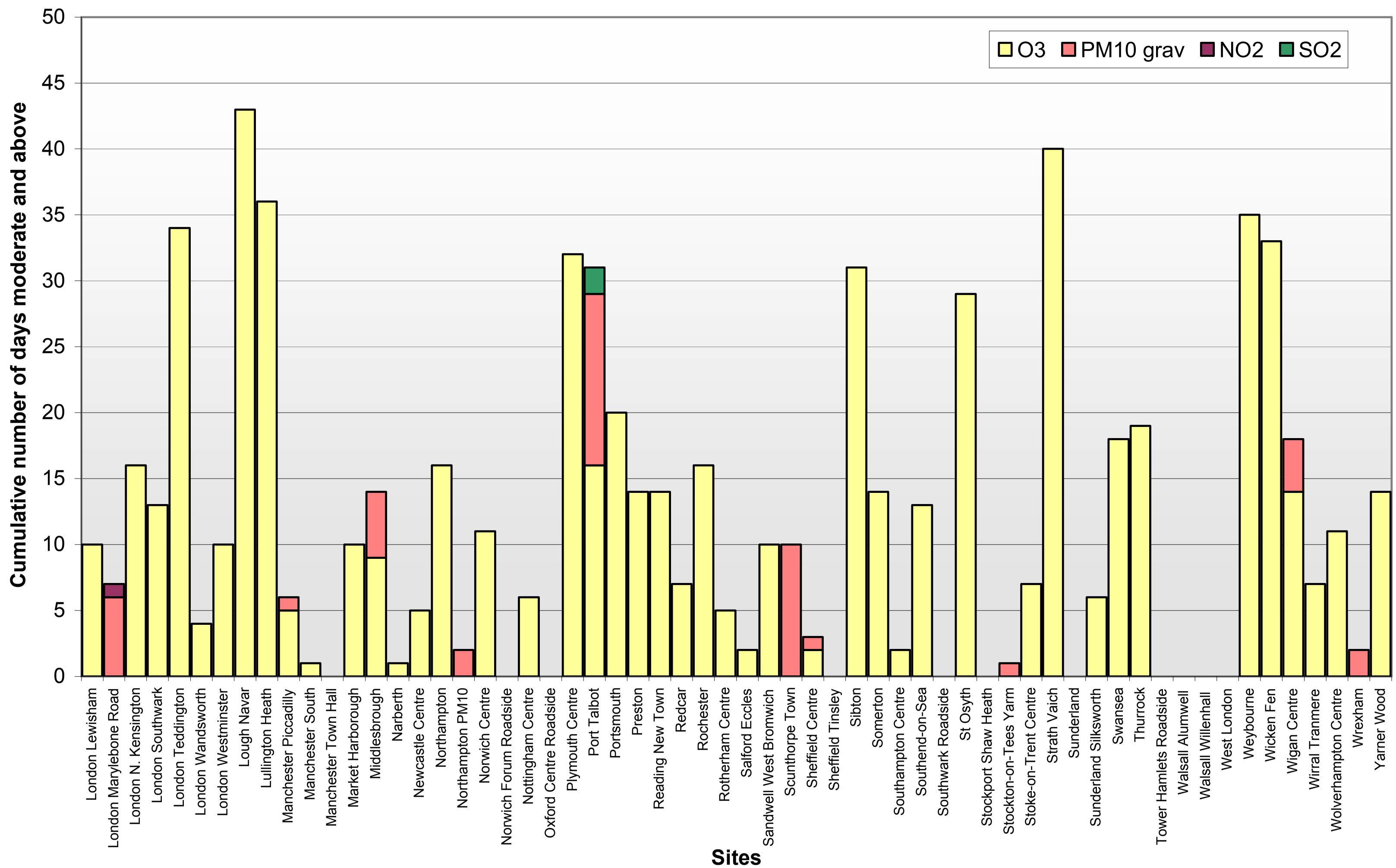


Figure 3.4b Number of days moderate and above for each AURN Network station over 2nd quarter 2005 – provisional data

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 REPORTS

Two ad-hoc reports will be shortly issued on the National Air Quality Archive, the first of which is:

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

6.2 ANALYSIS OF A STRATOSPHERIC INCURSION

Possible Stratospheric Incursion measured at Great Dun Fell.

During the process of data ratification of AURN AQM data during the reporting quarter, an unusual period of ozone measurements were spotted on the evening of Saturday 19th March at the Great Dun Fell AQM Site. These measurements did not correlate with ozone data taken from other sites in that region.

15-minute averaged ozone concentrations began to rise at 10:30 pm on the evening of the 19th March up to a maximum of 59 ppb at 23:45, falling rapidly from midnight to a minimum of 5 ppb a few hours later, at 2:30 am. Concentrations then increased again to levels more normally expected at the site, reaching a better agreement from 5 am onwards. The stability of the response of the instrument has been verified over that period, by viewing the relevant chart recording trace.

As conditions are unfavourable for ozone formation during the hours of darkness, there is a strong possibility that the ozone measured was caused by a stratospheric incursion, a rare phenomenon in which air from the stratosphere mixes down into the troposphere, contributing to increased ambient ozone and ground level as a consequence.

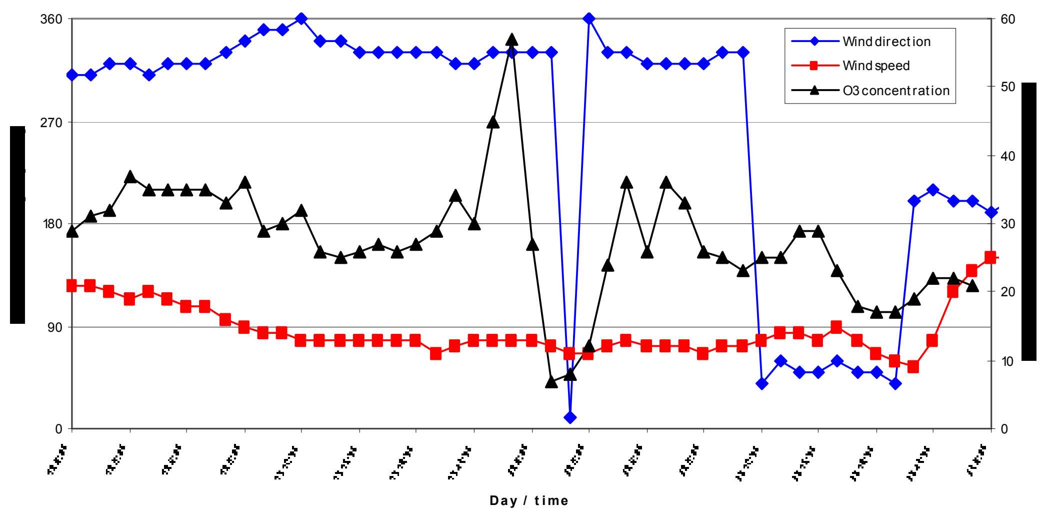
Data were obtained from the Met Office for investigation of this period. Wind direction and speed measurements were available for the Great Dun Fell site itself, with air temperature/pressure and relative humidity available for two other nearby sites in Cumbria (Shap and Warcop). The Great Dun Fell site is situated 850 m above sea level, an altitude which often lies above the planetary boundary layer 'mixing ceiling' (the two reference sites are at 250 m).

The UK had been under the influence of high pressure centred over France for many days up to that point and the weather patterns had been stable, the UK lying within a warm sector. On the evening of the 19th March, air pressure was again relatively stable, slowly falling by around 3 mbars in a one-day period to 1025 mbar on that evening, as measured at the Shap site.

Wind direction and speed measurements taken at Great Dunn Fell indicate steady wind speeds throughout the period of this unusual phenomenon, the only indication of any significant changes being a sudden swing in wind direction to north-north-east at 2 am for about an hour, from a previous stable north-westerly direction. The wind direction then continued northwesterly. The swing to the north-north-east is likely to have been at least partly responsible for the very low ozone measurements made from midnight onwards, through the sampling of ozone-depleted air from another area or direction below the planetary boundary layer .

The figure below shows the trends in ozone concentrations and met data all measured at Great Dun Fell over the period 19th – 20th March 2005.

Great Dun Fell - Ozone and met data over 19th - 20th March 2005 (as hourly means)



Without further data being available relating to the Great Dun Fell site itself, no further conclusions can be reached with respect to the conditions favouring this particular incursion. However, it still remains a noteworthy event.

7 Ongoing research

Netcen and the Met office will 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 July to September 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 the quarter 1 2005 reports on the Air Quality Archive Web Site.

9 Hardware and software inventory

Defra and the Devolved Administrations own the code for the ozone and secondary PM_{10} models, but not the graphical interface for these. Defra and the Devolved Administrations own the software for delivering the air pollution forecast to the Air Quality Communications system. Defra and the Devolved Administrations also own the web pages used to display the forecasts.

No computer hardware being used on this project is currently owned by Defra and the Devolved Administrations.

Appendix 1 - Air Pollution Index

CONTENTS

1 Table showing the Air Pollution index

The UK Air Pollution Indices

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

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

Appendix 2 - Forecasting Zones and Agglomerations

CONTENTS

1	Table showing the Air Pollution Forecasting Zones and Agglomerations, together with populations (based on 2001 Census).
2	Map of Forecasting Zones and Agglomerations.

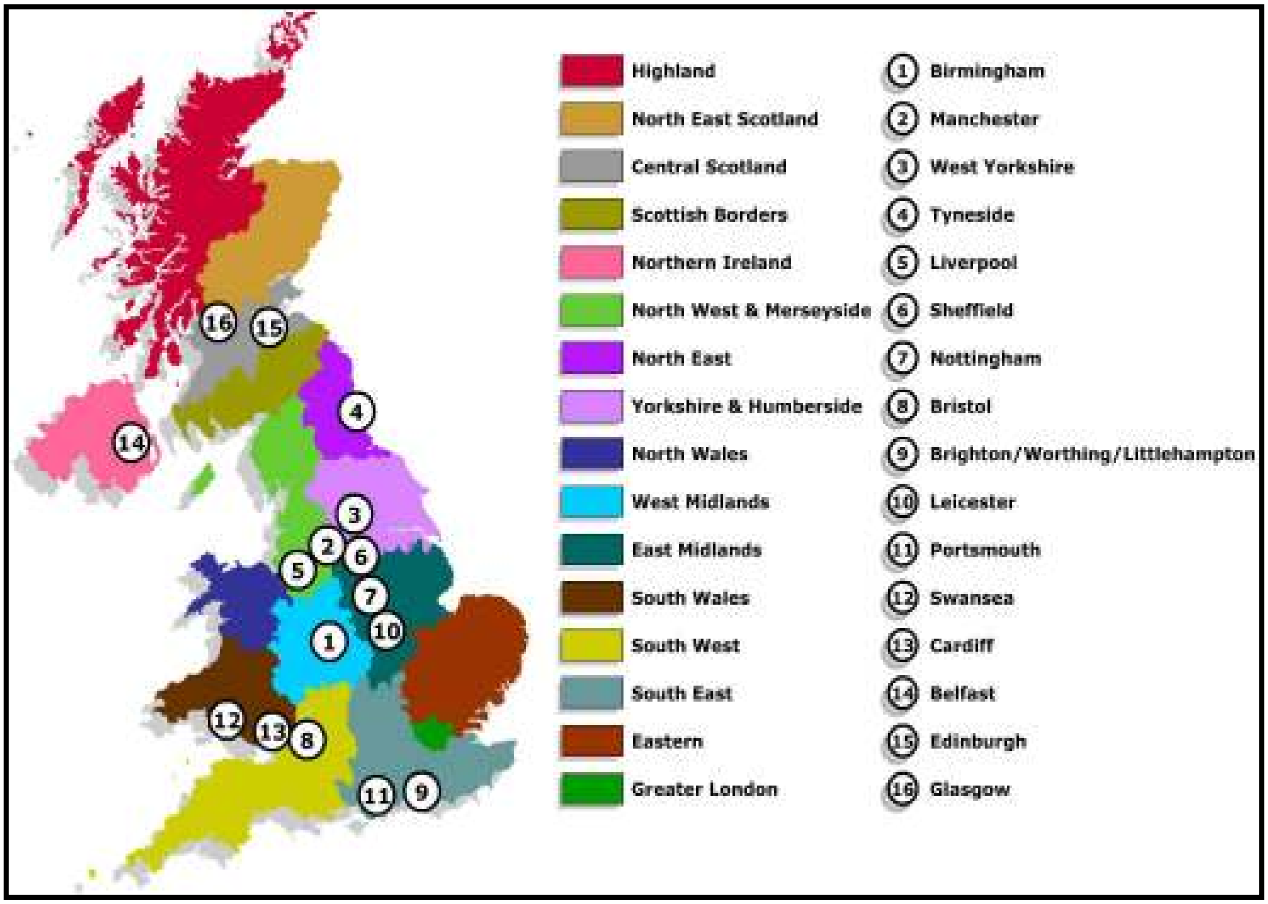
Forecasting Zones

Zone	Population
East Midlands	3084598
Eastern	5119547
Greater London	8278251
North East	1635126
North West and Merseyside	3671986
South East	6690881
South West	4364704
West Midlands	2970505
Yorkshire and Humberside	2816363
South Wales	1578773
North Wales	720022
Central Scotland	1813314
Highland	380062
North East Scotland	1001499
Scottish Borders	254690
Northern Ireland	1104991

Forecasting Agglomerations

Agglomeration	Population
Brighton/Worthing/Littlehampton	461181
Bristol Urban Area	551066
Greater Manchester Urban Area	2244931
Leicester	441213
Liverpool Urban Area	816216
Nottingham Urban Area	666358
Portsmouth	442252
Sheffield Urban Area	640720
Tyneside	879996
West Midlands Urban Area	2284093
West Yorkshire Urban Area	1499465
Cardiff	327706
Swansea/Neath/Port Talbot	270506
Edinburgh Urban Area	452194
Glasgow Urban Area	1168270
Belfast	580276

Map of UK forecasting zones and agglomerations



Appendix 3 – Worked Example of How UK Forecasting Success and Accuracy Rates are Calculated.

CONTENTS

1 Worked Example

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.