UK Air Quality Forecasting: Operational Report for October to December 2008

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/2802 Issue 1, April 2009

UK Air Quality Forecasting: Operational Report for October to December 2008

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/2802 Issue 1
April 2009

Title	UK Air Quality Forecasting: Operational Report for October to December 2008.
Customer	Department for Environment Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and the Department of the Environment in Northern Ireland
Customer reference	EPG 1/3/179
Confidentiality, copyright and reproduction	UNRESTRICTED Copyright AEA Technology plc. All rights reserved. Enquiries about copyright and reproduction should be addressed to the Commercial Manager, AEA Technology plc.
File reference	ED45099
Report number	AEAT/ENV/R/2802 Issue 1
Report status	Finalised

AEA Technology plc
Building 551.11
Harwell
Didcot
Oxfordshire
OX11 0QJ
UK
+44 (0) 870 190 6441 tel.
+44 (0) 870 190 6608 fax.

Andy.cook@aeat.co.uk

AEA Technology is certificated to BS EN ISO9001:(1994)

	Name	Date
Author	Andy Cook	28/04/09
Reviewed by	Paul Willis	08/05/09
Approved by	Jon Bower	12/05/09

Executive Summary

This report covers the operational activities carried out by AEA Technology plc and the Met Office under the UK Air Quality Forecasting Contract from October to December 2008. 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 fourth quarter of 2008, there were three days on which HIGH air pollution was recorded. All the HIGH days were due to PM_{10} pollution, as measured by FDMS-TEOM instruments. Please note that the PM_{10} health bandings are yet to be defined for FDMS-TEOM monitoring equipment, therefore the HIGH exceedences have been calculated using the existing bands defined for indicative gravimetric equivalent TEOMs.

In total, thirty-six MODERATE calendar days were measured during the quarter. Three-quarters of the MODERATE days were due to PM_{10} pollution, 20% were due to NO_2 pollution.

Overall forecast success and accuracy rates for the HIGH band were not calculable for the reporting quarter because the PM_{10} health bandings are yet to be defined for the FDMS-TEOM monitoring equipment.

Thirty-six MODERATE days were measured (mainly for PM_{10} but also included a fair contribution from NO_2) and were forecasted with a high degree of success in both zones and agglomerations, and an average accuracy figure of around 30 %. Please note success rates above 100 % are possible, as detailed in section 3 of this report. 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 approximately 30 % is likely to indicate that 70 % 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 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', October 1st to December 31st 2008.

Region/Area	HIGH		MODERATE	
	% success	% accuracy	% success	% accuracy
Zones	n/c ^	n/c ^	161	43
Agglomerations	n/c ^	n/c ^	225	18

^ cannot be calculated at present

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 October and December; 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. 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 2008. 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 for Defra and the Devolved Administrations. The BBC requires 5-day air pollution index forecasts for 337 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.

The National forecasts are also quality controlled for consistency with forecasts issued by AEA for UK regions and individual local authorities.

2 New developments during this period

2.1 MET OFFICE DEVELOPMENTS

During this quarter the Met Office provided model forecasts to AEA as normal. A plan was implemented to upgrade the routines used in the post-processing of the model output to ensure compliance with changing Met Office software and increased computational efficiency.

2.2 AEA DEVELOPMENTS

AEA continued to work in collaboration with the Met Office on near-future developments.

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 OCTOBER 1ST TO DECEMBER 31ST 2008.

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 %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c (!)
accuracy %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c (!)

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 %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c
accuracy %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c

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	0 (!)
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	0
success %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c (!)
accuracy %	n/c	n/c	n/c	n/c	n/c	n/c	n/c	n/c (!)

*** All performance statistics are based on provisional data. Noticeably incorrect data due to instrumentation faults have been removed from the analyses. n/c = cannot be calculated or not applicable to calculate. (!) FDMS PM_{10} datasets have been currently excluded from the analysis.**

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	1	0	0	25	0	0	0	0	2	0	1	1	0	1	0	0	31 (!)
forecasted days	5	0	5	17	3	6	5	5	6	5	6	9	6	6	7	6	97
ok (f and m)	1	0	2	22	1	1	0	2	3	1	3	5	2	3	2	2	50
wrong (f not m)	5	0	3	5	2	5	5	3	3	4	4	4	4	3	5	4	59
wrong (m not f)	0	0	0	6	0	0	0	0	1	0	0	0	0	0	0	0	7
success %	100	n/c	n/c	88	n/c	n/c	n/c	n/c	150	n/c	300	500	n/c	300	n/c	n/c	161 (!)
accuracy %	17	n/c	40	67	33	17	0	40	43	20	43	56	33	50	29	33	43 (!)

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	1	0	0	0	0	3	3	0	0
forecasted days	5	8	6	6	5	6	8	6	5
ok (f and m)	1	4	0	0	0	3	4	0	0
wrong (f not m)	5	4	6	6	5	4	5	6	5
wrong (m not f)	0	0	0	0	0	1	0	0	0
success %	100	n/c	n/c	n/c	n/c	100	133	n/c	n/c
accuracy %	17	50	0	0	0	38	44	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	1	8 (!)
forecasted days	6	9	7	6	5	0	6	94
ok (f and m)	0	4	0	1	0	0	1	18
wrong (f not m)	6	5	7	5	5	0	6	80
wrong (m not f)	0	0	0	0	0	0	0	1
success %	n/c	n/c	n/c	n/c	n/c	n/c	100	225 (!)
accuracy %	0	44	0	17	0	n/c	14	18 (!)

*** All performance statistics are based on provisional data. Noticeably incorrect data due to instrumentation faults have been removed from the analyses. n/c = cannot be calculated or not applicable to calculate. (!) FDMS PM_{10} datasets have been currently excluded from the analysis.**

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 October to December 2008 (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	1	104	Lullington Heath	South East zone	12/10/08	N/c
PM_{10} gravimetric equivalent	3	32	112	Port Talbot Margam	Swansea UA	26/10/08	N/c ^ [3]
NO_2	0	9	348	Marylebone Road	London UA	22/10/08	N/c
SO_2	0	1	285	Grangemouth	Central Scotland zone	05/11/08	N/c
CO	0	0	3.5	Bristol St Paul's	Bristol UA	7/12/08	N/c

* 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.

^ two HIGH days were measured for PM_{10} by the FDMS-TEOM instrument at Port Talbot Margam. one HIGH day was measured by the FDMS-TEOM instrument at Liverpool Speke. FDMS PM_{10} datasets have been currently excluded from the analysis. N/c = not applicable to calculate.

General Observations

There were three zone and agglomeration-day incidents of HIGH band pollution measured during this quarter. All the HIGH incidents were due to PM_{10} pollution [as calculated for FDMS-TEOM instruments but based on indicative gravimetric equivalent TEOM health bandings]. In total, thirty-six MODERATE calendar days were measured during the quarter. 75% of the MODERATE days were due to PM_{10} pollution, 20% were due to NO_2 pollution.

No MODERATE or above days were measured for CO during the reporting period. The highest 8-hour running mean calculated was 3.5 mg/m^3 at the Bristol St Paul's monitoring site and was measured simultaneously with an increase in levels of all primary pollutants during a winter pollution episode in early December.

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

Only one MODERATE day was measured during this quarter, a similar number to that seen in the same quarter of 2007. The single MODERATE measurement was made at the rural site Lullington Heath, in the south east of England, on the 12th October, a day on which air reaching the South East had circulated over France. The 12th October had the warmest daily maximum temperature of the whole month, reaching above 20 degrees C in the South East.

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

PM_{10}

Twenty-two MODERATE days were measured at the London Marylebone Road monitoring site during the quarter, all primarily as a result of road traffic. Seven MODERATE days were measured at the Derry site and three at Port Talbot Margam, with the addition of two HIGH days at the latter. The MODERATE measurements made at the Derry site all occurred as a result of evening and overnight pollution on several days, in both November and December, in near-freezing temperatures and poor dispersion conditions. Hence all the exceedences appear to have been the result of emissions from domestic heating sources. The MODERATE and HIGH days measured at Port Talbot Margam, mainly in late October, coincided with a local south westerly wind direction, bringing in industrial emissions from the nearby steel works and dockyard.

Only six sites this year reached levels in the MODERATE band as a result of bonfire night celebrations. However, the site at Liverpool Speke measured one HIGH day as a result of the event. The 5th November was on a Wednesday this year, which normally results in some of the celebrations being held mid-week and other events held at both the proceeding and succeeding weekends. Thus the intensity of the effects of this event is normally lessened with a mid-week 5th November due to the spread of the celebrations over several days. Of the sites which measured in the MODERATE band, three were located in the north-west of England, two in South Wales and one in the west Midlands. The 5th November was a generally dull day. There was some light rain and drizzle in some eastern parts of UK, with further rain experienced in parts of south-east England during the evening. Overnight temperatures were above freezing everywhere, despite being chilly, and any overnight precipitation was mainly confined to north-east England and eastern Scotland. Dull weather continued across most areas on the following day. Destablised high pressure air had been over the UK during the 5th, however a weak weather front had passed over. Perhaps damp or wet conditions overnight in eastern areas of the UK had helped to suppress any build up of particulate levels in those areas. Wind speeds were higher during both the proceeding and succeeding weekends, with generally widespread showers experienced, which is likely to explain the lack of MODERATE exceedences during those weekends.

On the 31st December eight sites in the network measured PM_{10} levels in the MODERATE band. The site locations were spread across England, however the majority were situated in the south-east. Two sites were located in the north-west and one in the Midlands. The site at Derry, in Northern Ireland, also reached the MODERATE band, however this appears to have been primarily the result of pollution from domestic heating sources. All eight of the sites which reached the MODERATE band were designated “urban” sites and were measured using the FDMS-TEOM measurement technique. Further to this, all except one site (London Bloomsbury) were described as “urban background”. Normally when particulate episodes occur, elevated levels are seen at a relatively high proportion of roadside and kerbside sites, due to the additional contribution from traffic pollution. In this particular case no roadside or kerbside site entered the MODERATE band. Measurements made by the FDMS-TEOM technique, over the days 29th December to 2nd January, indicate that the volatile component of the particulate matter PM_{10} collected doubled or tripled in concentration at some sites, from an initial level of around 5 ug/m^3. The height of the event, in terms of volatile component, occurred in the early hours on the morning of the 2nd January. The volatile component approximately represents the additional contribution to UK particulate levels from long range transport of pollution from Europe. From the 26th December onwards, air masses reaching the UK had been forecasted as having originated from over Germany. From the 30th December until the 1st January the air masses had also been forecasted as having originated over continental Europe, with air from Germany reaching the east side of the UK and air from France reaching the west side. By the 2nd January the air had originated from a northerly direction. Generally cold or freezing conditions, with light wind speeds and fog in places, were likely to have contributed to the MODERATE exceedences measured in urban environments. Possibly pollution from domestic heating sources using coal, despite being far less in evidence in the modern day UK, may have contributed to the levels measured.

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

NO_2

Nine, fairly evenly distributed MODERATE days were measured during the quarter. Seven days were measured at the Marylebone Road kerbside site in London, mainly during days in October when pollution had built up as a result of busy traffic. One MODERATE exceedence was measured on Tuesday 9th December at Bath Roadside AQM site during the morning rush hour, in cool conditions and a light south-westerly breeze. The roadside site at Dumfries also measured an hour of MODERATE pollution at approximately midday on Sunday 2nd November. The 2nd had been a mild day for November. The wind direction had changed from south-westerly to easterly during that day, which may suggest that air had been drawn to the site from the vicinity of local traffic lights, situated 50 metres to the east.

SO_2

A single MODERATE day was measured at the Grangemouth AQM site on the 5th November. Elevated SO_2 pollution levels were experienced throughout the entire day, however only one exceedence was measured. The light northerly breeze experienced is likely to have brought air from the nearby petro-chemical plant past the monitoring site.

Figure 3.3 shows the trends in NO_2 and SO_2 levels over this period.

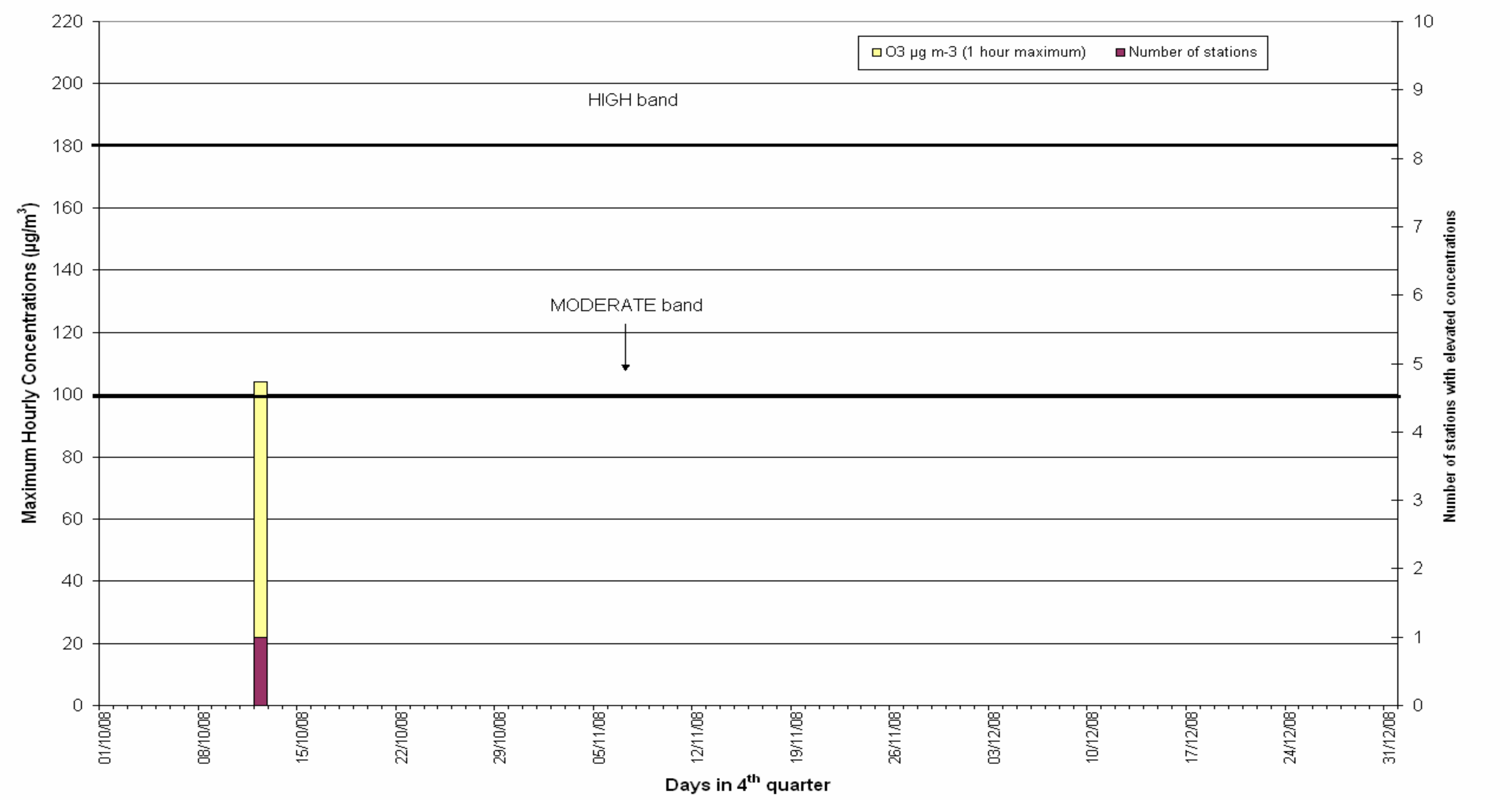


Figure 3.1 Daily maximum hourly ozone concentration across AURN Network with total number of stations measuring MODERATE or above levels of ozone over 4th quarter 2008.

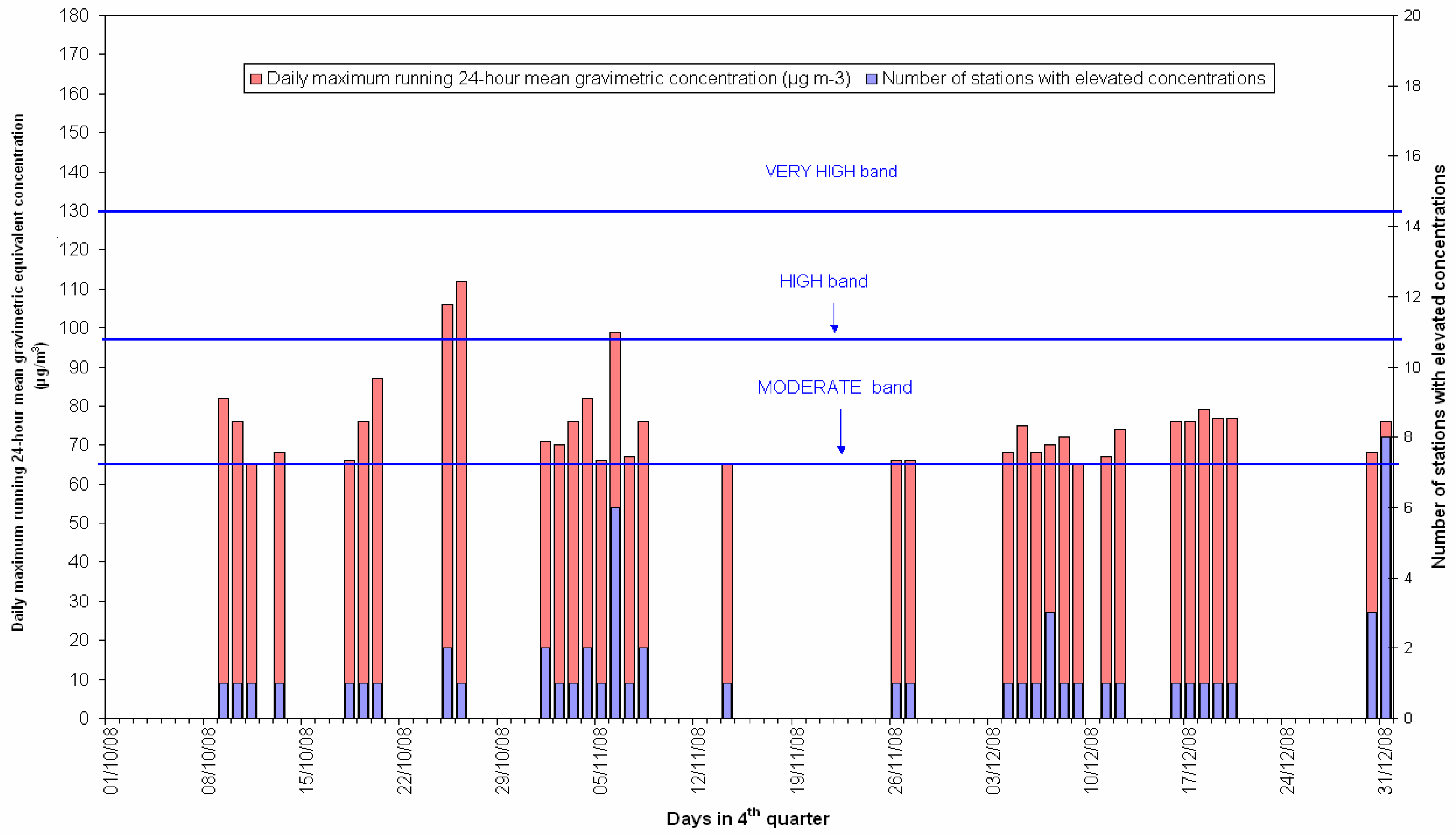


Figure 3.2 Daily maximum running 24-hour mean PM_{10} concentration across AURN Network with total number of stations measuring MODERATE or above levels over the 4th quarter 2008.

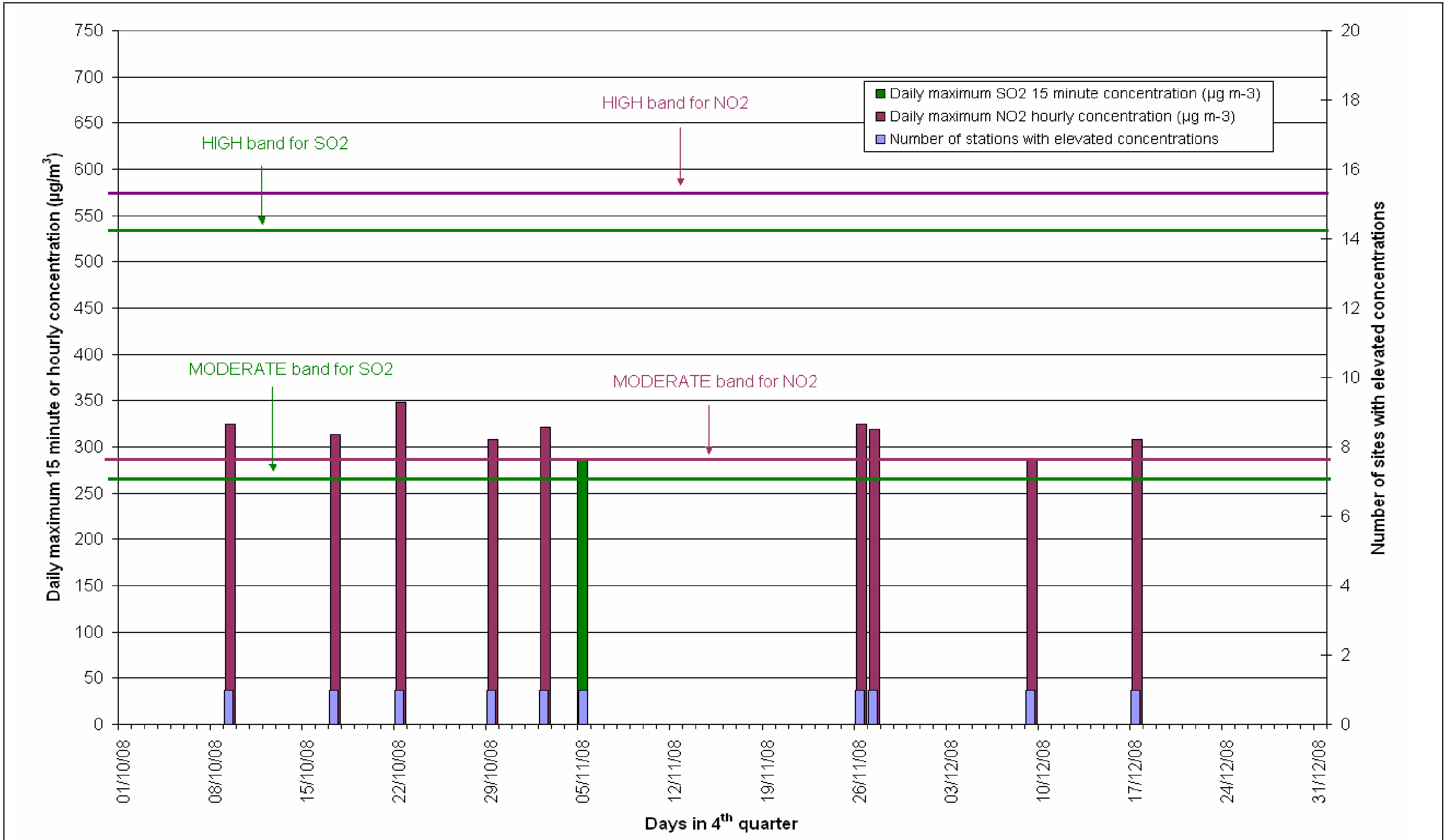


Figure 3.3 Maximum 15 minute average concentrations of SO_2 and hourly average of NO_2 across AURN Network with total number of stations measuring MODERATE or above levels over the 4th quarter 2008.

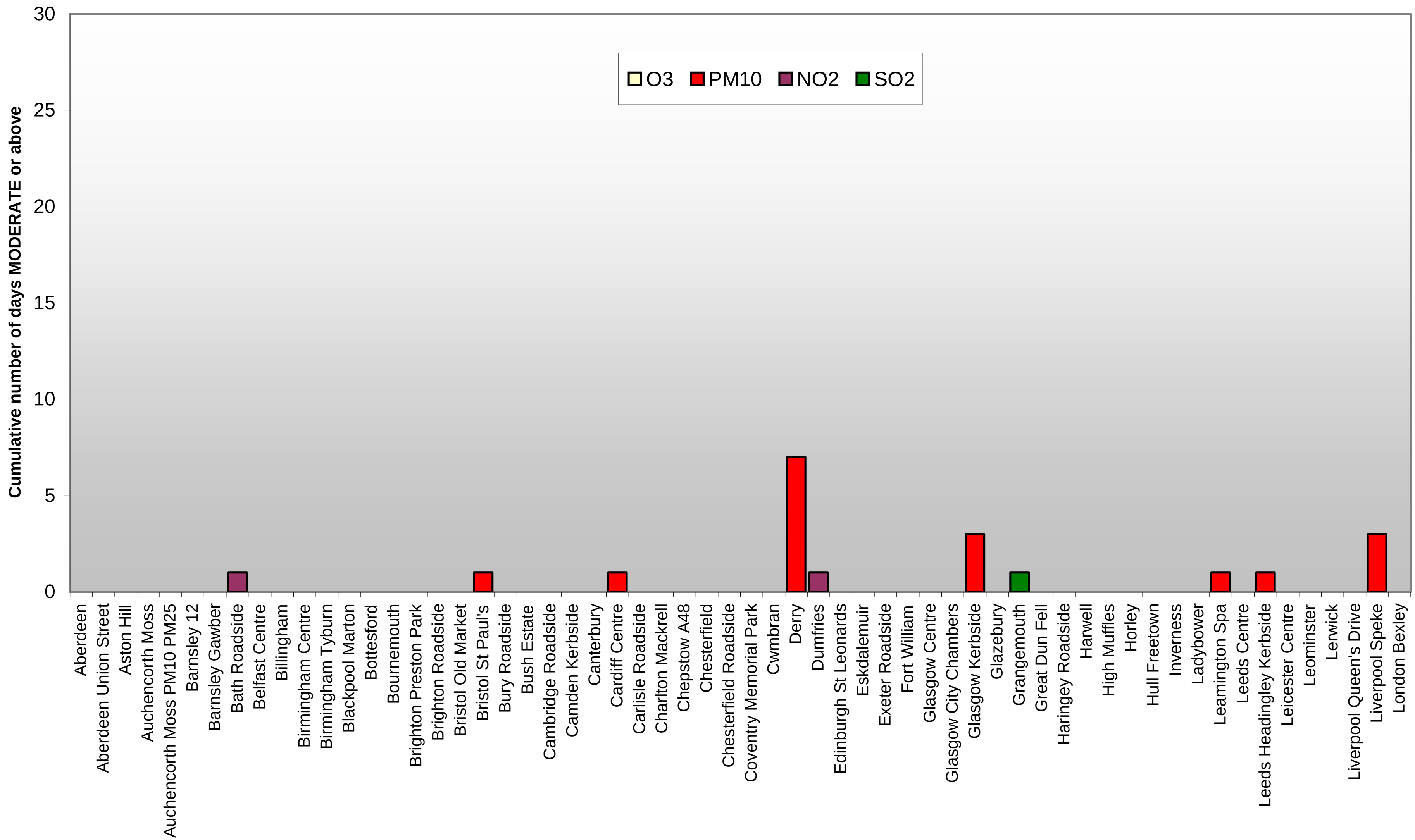


Figure 3.4a Number of days moderate and above for each AURN Network station over 4th quarter 2008 (sites A to L)– provisional data

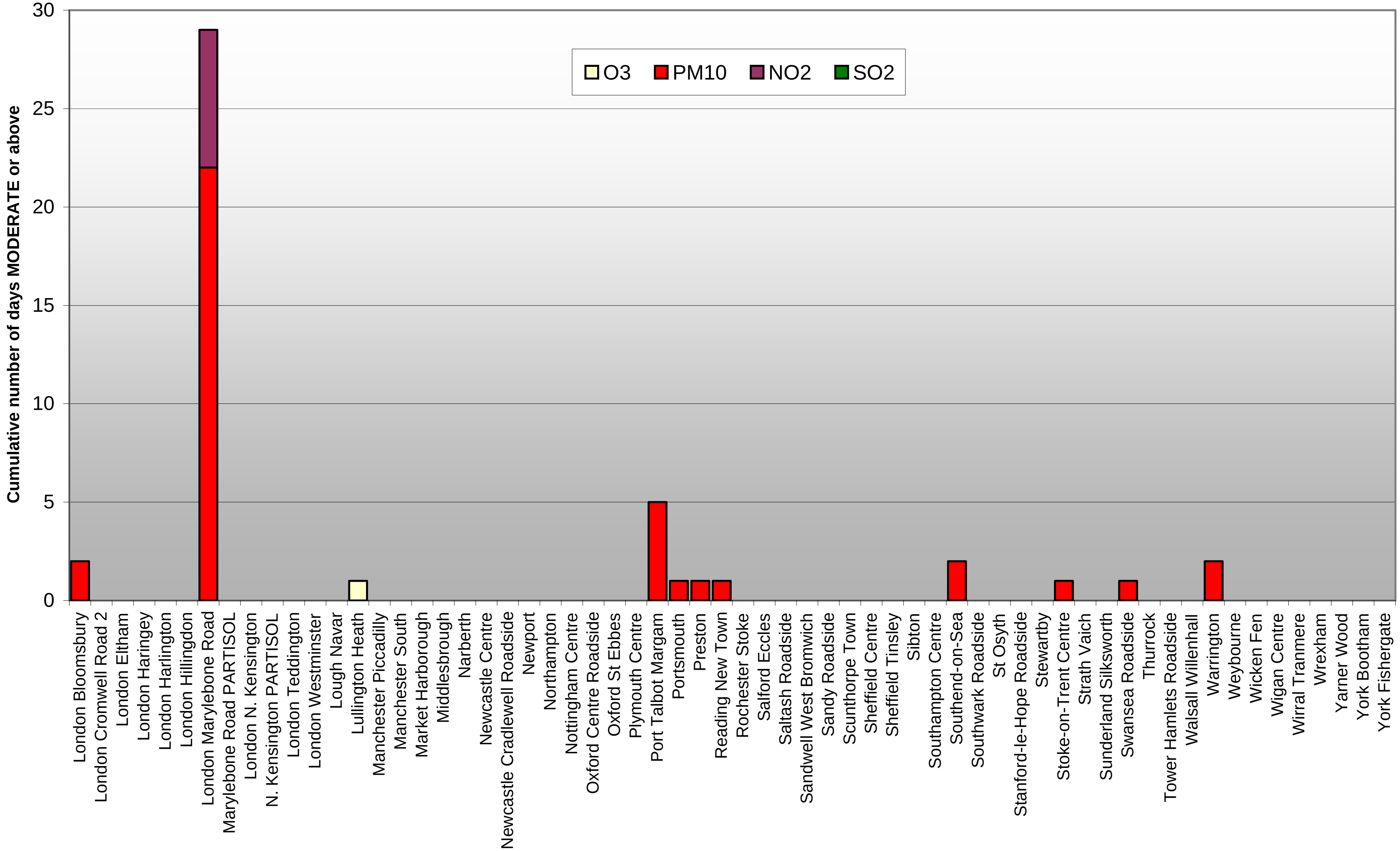


Figure 3.4b Number of days moderate and above for each AURN Network station over 4th quarter 2008 (sites L to Y) – provisional data

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

An intrusion of North African dust over the south east of England, had been predicted by two particulate forecasting models, both of which are freely accessible on the internet. The two models were called “Skiron” (owned by the University of Athens) and “NAAPS” (property of the Naval Research Laboratory, California).

Figure 6.1 shows the ground level surface area total dust load, exclusively modelled for the intruding dust, predicted over the South East on the 13th October by the Skiron model.

Figures 6.2 to 6.5 show the progress of the long range transport of dust after the original storm over North Africa, using annotated, interpolated satellite imagery which were obtained freely from Dundee University for the days leading up to the forecasted event in the UK.

Monitoring sites in the south east of England measured a steady increase in particulate PM_{10} levels leading up to the 13th October, however only one site (London Marylebone Road) reached the MODERATE band on the 13th October. The single exceedence at Marylebone Road was likely to have been primarily a result of traffic pollution. The majority of the dust passed over continental Europe, according to the particulate models.

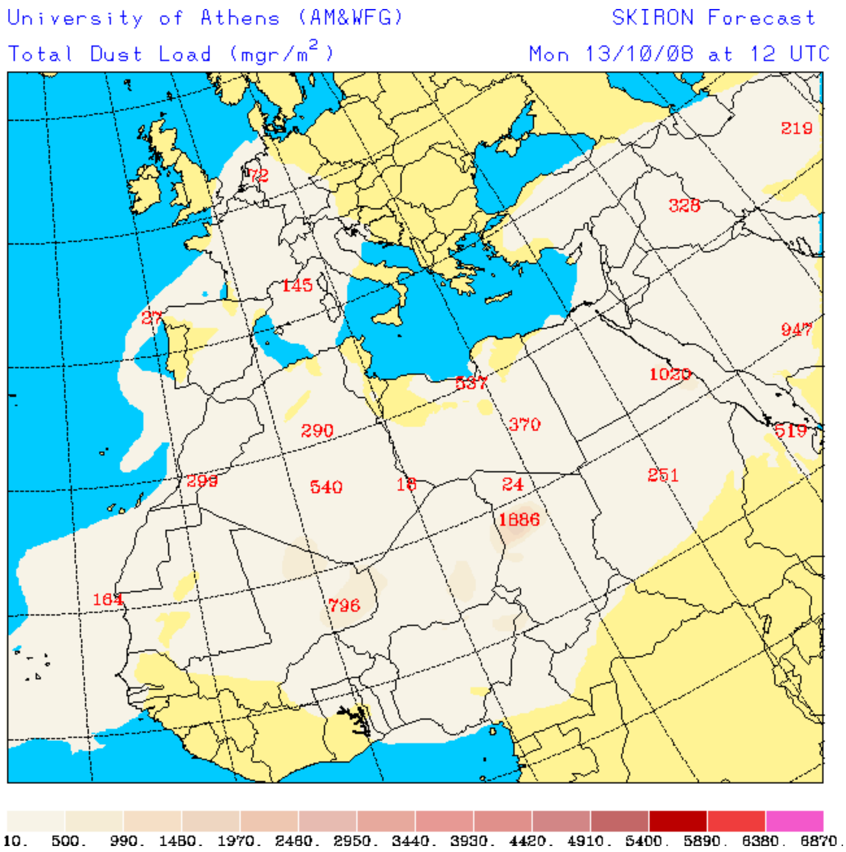


Figure 6.1

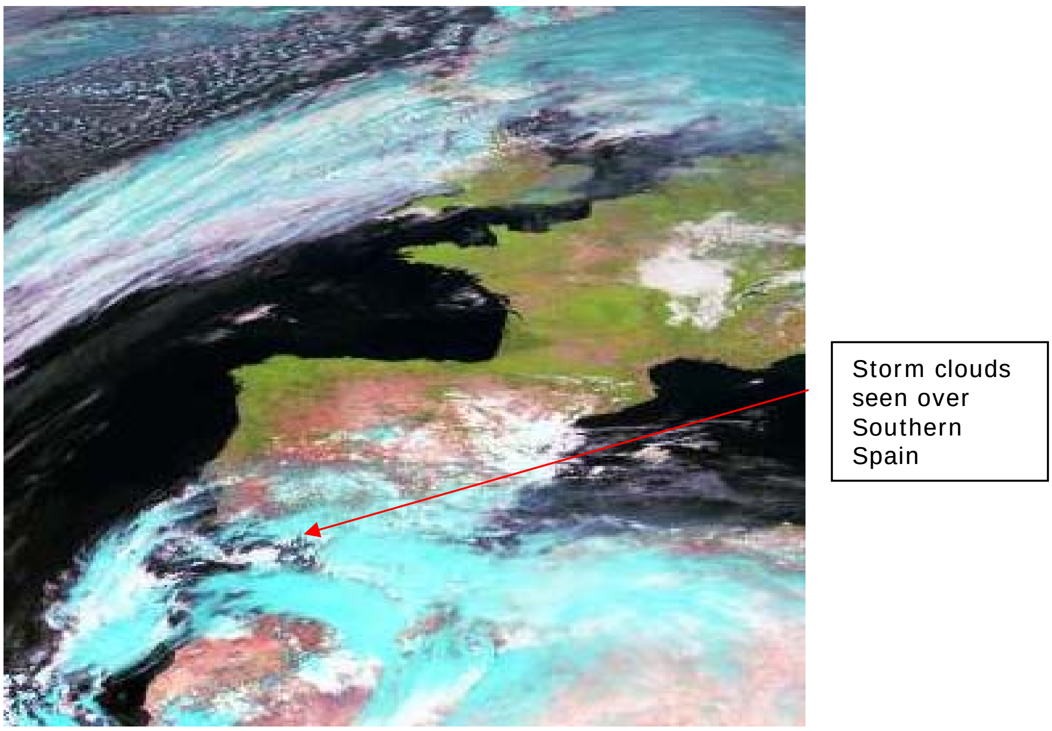


Figure 6.2: Friday 10th October

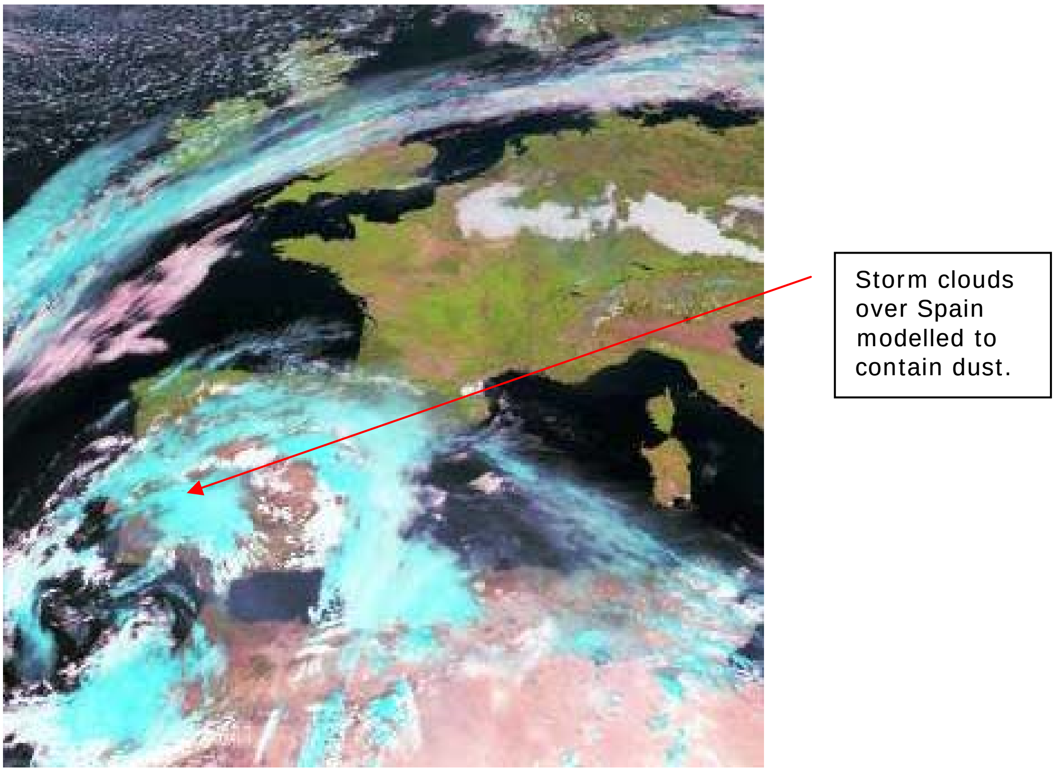


Figure 6.3: Saturday 11th October

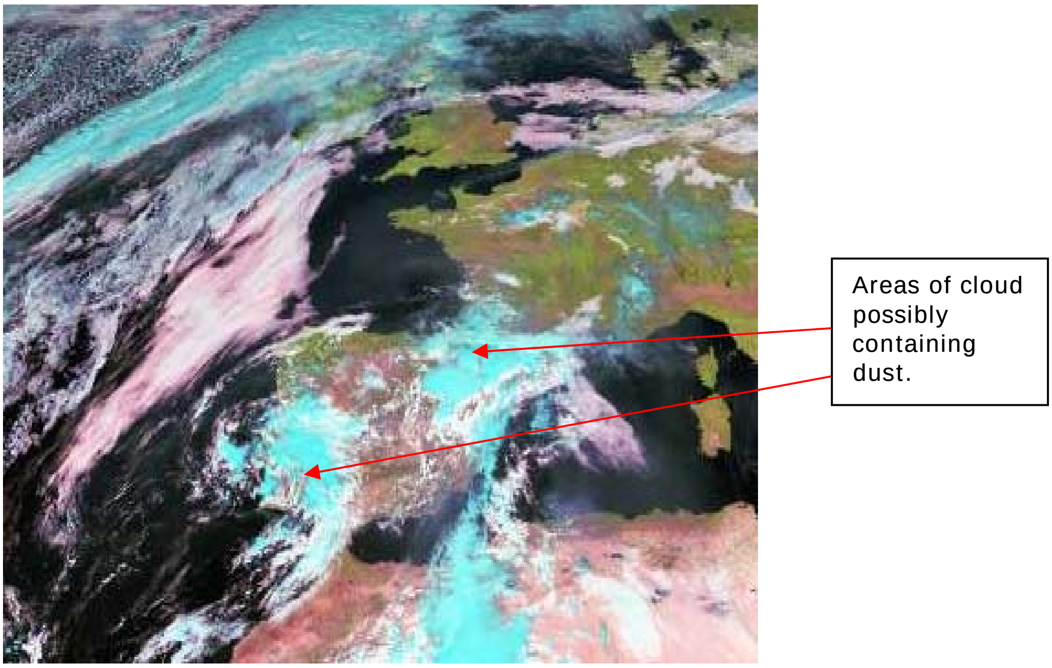


Figure 6.4: Sunday 12th October

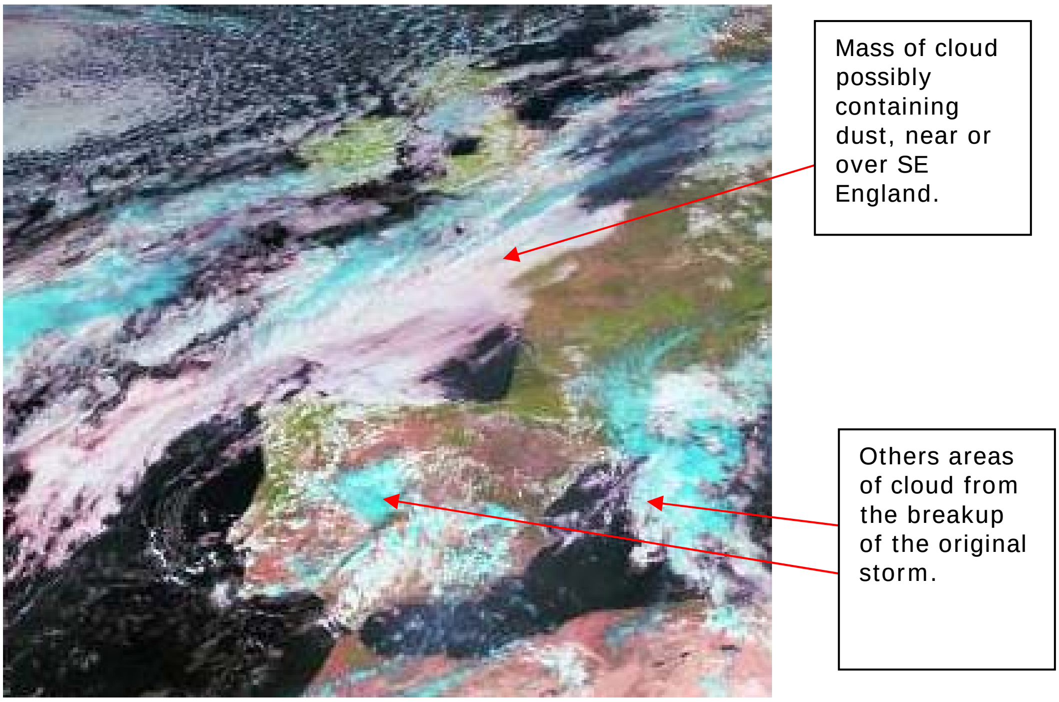


Figure 6.5: Monday 13th October

7 Ongoing research

AEA 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 Project and other related meetings

No meetings were held over the reporting period.

9 Forward work plan for January to March 2009

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 an ad-hoc report detailing a UK particulate episode in January 2008 on the Air Quality Archive Web Site and three quarterly operational reports issued during 2008.

10 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

CONTENTS

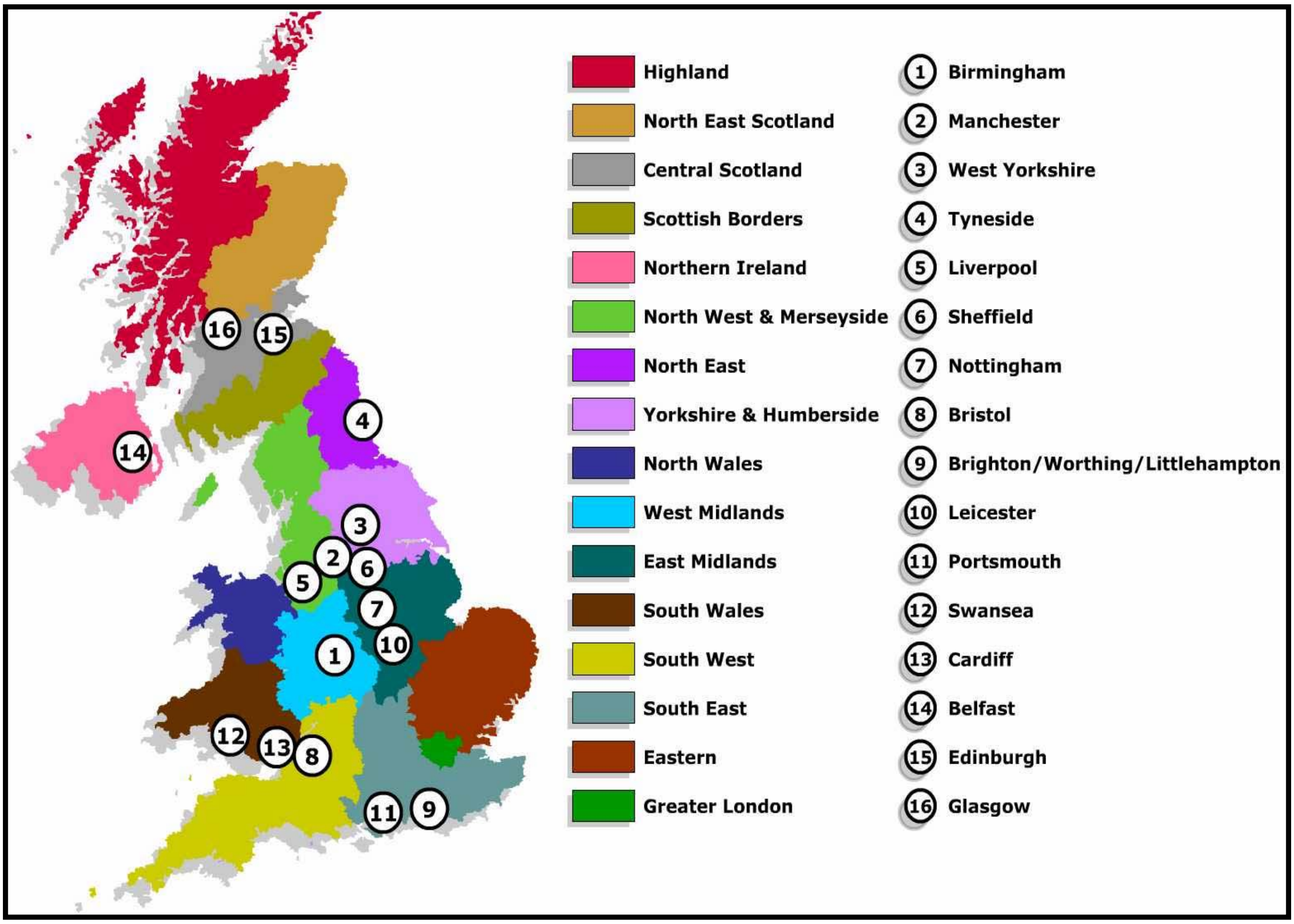
Forecasting Zones

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

Forecasting Agglomerations

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

Map of UK forecasting zones and agglomerations



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

CONTENTS

A worked example showing how forecasting accuracy and success rate are defined and calculated in this report

This analysis is based on an imaginary period of high pollution concentrations in South East England – which occurred during warm weather and resulted in the formation of photochemical ozone. There were 4 days on which HIGH concentrations were measured; 29th July, 30th July, 1st August and 2nd August. Over the slightly longer period from 29th July – 3rd August, there were 6 days on which HIGH levels were either measured or forecast. During the whole reporting period, there were no other observations of HIGH band measurements, either forecast or actual. 31st July was a cooler day and measurements did not reach the HIGH band, despite being forecasted. Measured air pollution and previous day forecast are shown below for each day during this period, in terms of index and descriptive bands:

Date	28/7	29/7	30/7	31/7	1/8	2/8	3/8	4/8
Measured Index value (M)	**5** (MOD)	7 (HIGH)	7 (HIGH)	6 (MOD)	7 (HIGH)	7 (HIGH)	5 (MOD)	5 (MOD)
Forecast Index value (F)	5 (MOD)	6 (MOD)	7 (HIGH)	7 (HIGH)	8 (HIGH)	5 (MOD)	7 (HIGH)	6 (MOD)

Based on the figures above, the success and accuracy of predicting HIGH episodes (>= Air Pollution index 7) for the South East Zone may be analysed as shown below:

Date	28/7	29/7	30/7	31/7	1/8	2/8	3/8	4/8
Measured Index value (M)	**5** (MOD)	7 (HIGH)	7 (HIGH)	6 (MOD)	7 (HIGH)	7 (HIGH)	5 (MOD)	5 (MOD)
Forecast Index value (F)	5 (MOD)	6 (MOD)	7 (HIGH)	7 (HIGH)	8 (HIGH)	6 (MOD)	7 (HIGH)	6 (MOD)
HIGH forecast or measured	No, so not used in calculations	Yes	Yes	Yes	Yes	Yes	Yes	No, not used in calcs
OK- Agreement of F and M to +/- 1 index band	N/A	Yes	Yes	Yes	Yes	Yes	No	N/A

HIGH days measured	4
HIGH days forecast	4
OK (M and F) [i.e. Agreement of F and M to +/- 1 index band	5
Wrong (F not M)	1
Wrong (M not F)	0

The forecasting **success** during this period is calculated as:

[OK (M and F) / HIGH days measured]*100 = [5/4]*100 **= 125 %**

The corresponding **accuracy** is calculated as:

[OK (M and F) / {OK (M and F) + Wrong (M not F) + Wrong (F not M)}]*100

= [5 / {5+0+1}]*100 = [5/6]*100 = **83**

The analysis is then repeated for each of the 16 UK zones and 16 UK agglomerations.