

Air Pollution Forecasting: Ozone Pollution Episode Report (September 2003)

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23/9/2003

On the 17th September 2003, the UK rural and urban air quality monitoring networks recorded ozone levels in the Defra HIGH band (90-180 ppb, 180-360 $\mu\text{g m}^{-3}$). The purpose of this short report is to illustrate this episode in the context of historical late summer ozone episodes.

The final data for this period has yet to be ratified and all statistics and charts are based on provisional data as used in the actual forecasting process. Table 1 shows the number of UK sites in MODERATE, HIGH and VERY HIGH bands for ozone on each day as the episode builds from 13th to 17th September. The maximum exceedence concentration (hourly/ 8 hourly running mean, on which the ozone bandings are based) is also listed. Table 2 provides details of each network site involved in the episode (those which reported MODERATE concentrations or above). The number of days on which MODERATE, HIGH and VERY HIGH concentrations were reported are presented for each site, along with the maximum exceedence concentration measured at each site. Table 3 lists the latest ozone episode of each year to compare with the September 2003 episode. It includes the date of the latest episode in each year, the maximum hourly concentration (in ppb) and the site at which it was reported. Figures 1 to 3 are time series charts showing the changing hourly concentrations at all sites in September 1985 and 1982 (previous years of late September episodes) and September 2003 (to date) for the ten sites reporting the highest concentrations. Figures 3 and 4 are four day back trajectory charts showing the forecast origin of air masses affecting the UK over the period.

HIGH ozone levels on 17th September 2003 were recorded at only two sites (London Teddington and Wicken Fen) and only on this single day. The episode is summarised in tables 1 and 2. Bright sunshine, favourable back trajectories and high temperatures of up to 27.6 °C at 14.00 on that day (reported at Heathrow) were the causal factors. The forecast back trajectories in figure 5 illustrate the winds swinging round to bring continental air masses likely to be laden with ozone precursor chemicals (VOCs) to the UK. Figure 5 is the classic air mass back trajectory associated with ozone episodes in the UK.

The most notable aspect of this episode is the timing, being unusually late in the year. HIGH ozone episodes are uncommon in late September given the rapidly shortening days and low solar angle which rarely provides enough intense sunlight for the chemical reactions to generate HIGH levels. Table 3 shows that historically there have been very few ozone episodes that have occurred later in the year than this episode. Only 1985 recorded an episode later, when on 29th September HIGH levels were reported at the Central London air monitoring site. The only other comparably late summer episode, in 1982, was recorded on the same day of the year as the September 2003 episode and was of a slightly greater magnitude.

As figure 3 shows, the episode in September 2003 built over several days from 12th to 17th September as is typical for ozone episodes. Also typically for ozone episodes, it involved elevated levels across many sites in the UK (particularly in southern and eastern England) although only 2 sites reached HIGH levels. The latest ever summer episode in September 1985 did not build in this way. Instead, levels rose sharply over only a single day (29th September) and at a single site (Central London). The 1982 late September episode involved two sites (Sibton and Bottesford, both in the Eastern zone) which built progressively over a few days.

Table 1 – Ozone concentrations by date and band

Date	Number of MOD sites	Number of HIGH sites	Number of V HIGH sites	Maximum exceedence (ppb)
13/09/03	2	-----	-----	51
14/09/03	35	-----	-----	66
15/09/03	36	-----	-----	72
16/09/03	38	-----	-----	75
17/09/03	66	2	-----	92

Table 2 – Ozone concentrations by band and duration

Site	Number days MODERATE	Number days HIGH	Number days VERY HIGH	Maximum hourly/ 8 hourly mean mean (ppb)
London Teddington	3	1	-----	92
Wicken Fen	4	1	-----	90
London Brent	4	-----	-----	88
Harwell	5	-----	-----	86
Thurrock	2	-----	-----	86
Rochester	2	-----	-----	84
London Westminster	4	-----	-----	82
Northampton	4	-----	-----	82
Bolton	5	-----	-----	81
Lullington Heath	3	-----	-----	81
Southend-on-Sea	2	-----	-----	80
London N. Kensington	4	-----	-----	79
Sibton	4	-----	-----	79
St Osyth	3	-----	-----	79
Bottesford	4	-----	-----	78
Cwmbran	4	-----	-----	76
London Haringey	2	-----	-----	76
Ladybower	4	-----	-----	75
Port Talbot	4	-----	-----	75
Weybourne	4	-----	-----	75
Somerton	4	-----	-----	74
Yarner Wood	4	-----	-----	74
London Bexley	3	-----	-----	74
Bournemouth	4	-----	-----	73
Coventry Memorial Park	4	-----	-----	73
Redcar	4	-----	-----	73
Leamington Spa	3	-----	-----	73
Liverpool Speke	4	-----	-----	72
Birmingham East	4	-----	-----	71
Portsmouth	4	-----	-----	71
London Bloomsbury	1	-----	-----	71
London Wandsworth	1	-----	-----	71
Great Dun Fell	3	-----	-----	70
Blackpool	2	-----	-----	70
Bristol Centre	2	-----	-----	69
Swansea	3	-----	-----	68
Aston Hill	2	-----	-----	68
Glazebury	2	-----	-----	68
Middlesbrough	4	-----	-----	67
Wolverhampton Centre	3	-----	-----	67
Bush Estate	1	-----	-----	67
Sheffield Centre	2	-----	-----	66
Norwich Centre	1	-----	-----	66
High Muffles	4	-----	-----	65
Eskdalemuir	1	-----	-----	65
London Southwark	2	-----	-----	64
Wigan Leigh	2	-----	-----	64
Southampton Centre	3	-----	-----	63
Sandwell West Bromwich	2	-----	-----	63
Leicester Centre	1	-----	-----	63
Preston	3	-----	-----	62
Salford Eccles	3	-----	-----	62
Wirral Tranmere	3	-----	-----	62
Strath Vaich	2	-----	-----	61
Nottingham Centre	1	-----	-----	61
Barnsley Gawber	2	-----	-----	57

Site	Number days MODERATE	Number days HIGH	Number days VERY HIGH	Maximum hourly/ 8 hourly mean mean (ppb)
Newcastle Centre	1	-----	-----	56
Stoke-on-Trent Centre	1	-----	-----	56
Plymouth Centre	1	-----	-----	55
Rotherham Centre	2	-----	-----	54
Lough Navar	1	-----	-----	54
Bradford Centre	1	-----	-----	53
Cardiff Centre	2	-----	-----	52
Belfast Centre	1	-----	-----	52
Edinburgh Centre	1	-----	-----	52
Aberdeen	1	-----	-----	51

N.B – In tables 1 and 2, in cases where levels progress through the MODERATE band and into the HIGH band over the course of a day, the occasion is counted in both the MODERATE and HIGH categories.

Table 3 – Historical latest episodes in the year

Year	Date	Max hourly concentration (ppb)	Site
1972	24-Aug	104	Central London
1973	09-Sep	104	Central London
1974	21-Aug	91	Central London
1975	01-Sep	95	Chilworth
1976	26-Aug	98	London Islington
1977	14-Sep	134	London Canvey
1978	30-Jul	91	Sibton
1979	30-Aug	108	Stevenage
1980	13-Jun	110	London Harrow
1981	10-Sep	111	Sibton
1982	17-Sep	102	Bottesford/ Sibton
1983	31-Aug	115	Stevenage
1984	27-Aug	93	Harwell
1985	29-Sep	101	Central London
1986	30-Jun	93	Stevenage
1987	16-Aug	96	Lullington Heath
1988	08-Sep	105	Glazebury
1989	07-Sep	95	Lullington Heath
1990	29-Aug	101	Sibton
1991	11-Sep	97	Yarner Wood
1992	01-Aug	98	Sibton
1993	30-Jun	99	High Muffles
1994	30-Jul	110	Sibton
1995	22-Aug	96	Middlesbrough
1996	19-Aug	94	Rochester
1997	21-Aug	90	Rochester
1998	11-Aug	120	Rochester
1999	11-Sep	95	Norwich Centre
2000	19-Jun	97	Norwich Centre
2001	28-Jul	93	London Teddington
2002	17-Aug	136	St. Osyth
2003*	17-Sep	92	London Teddington

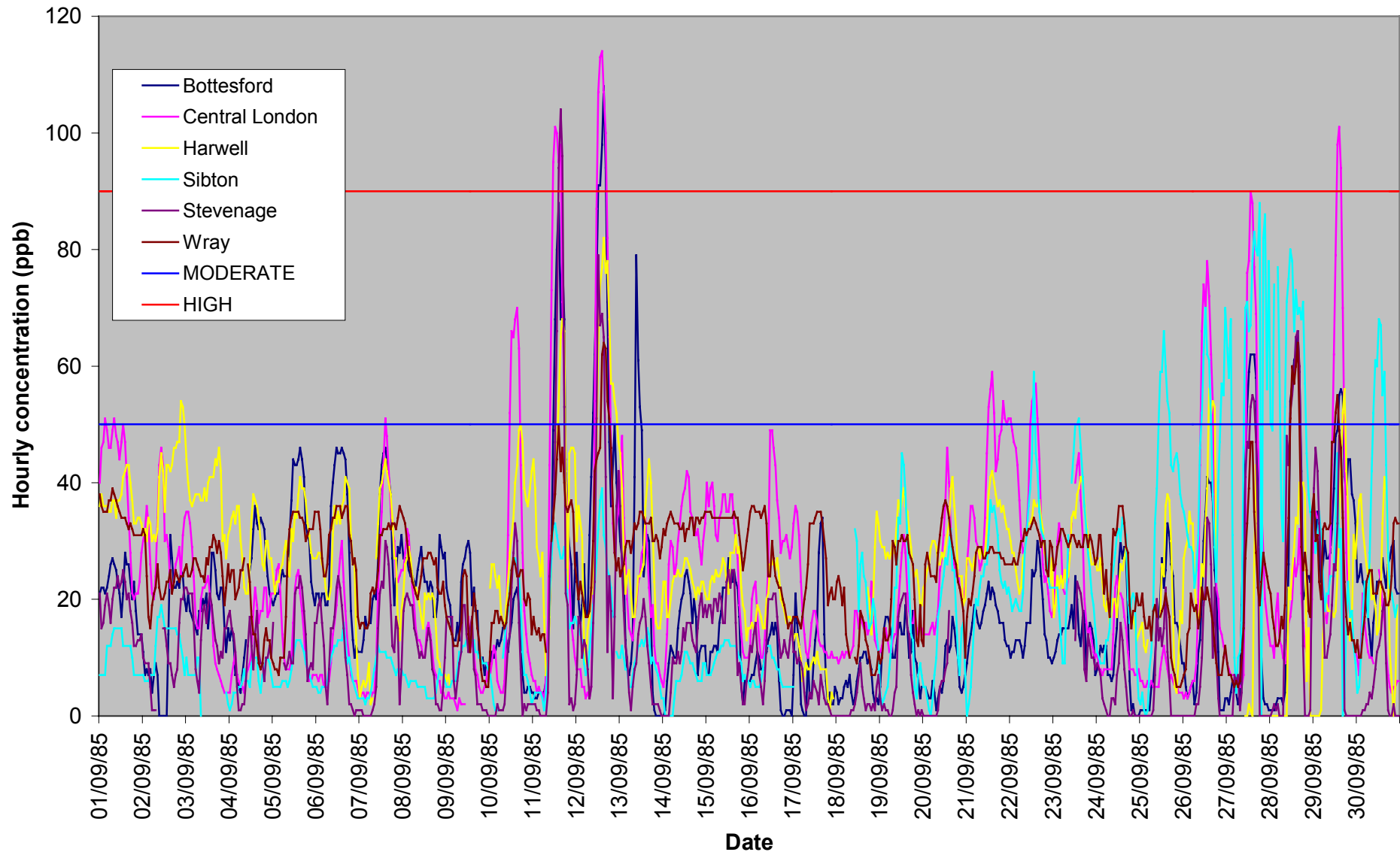


Figure 1 – time series chart of hourly ozone concentrations over September 1985

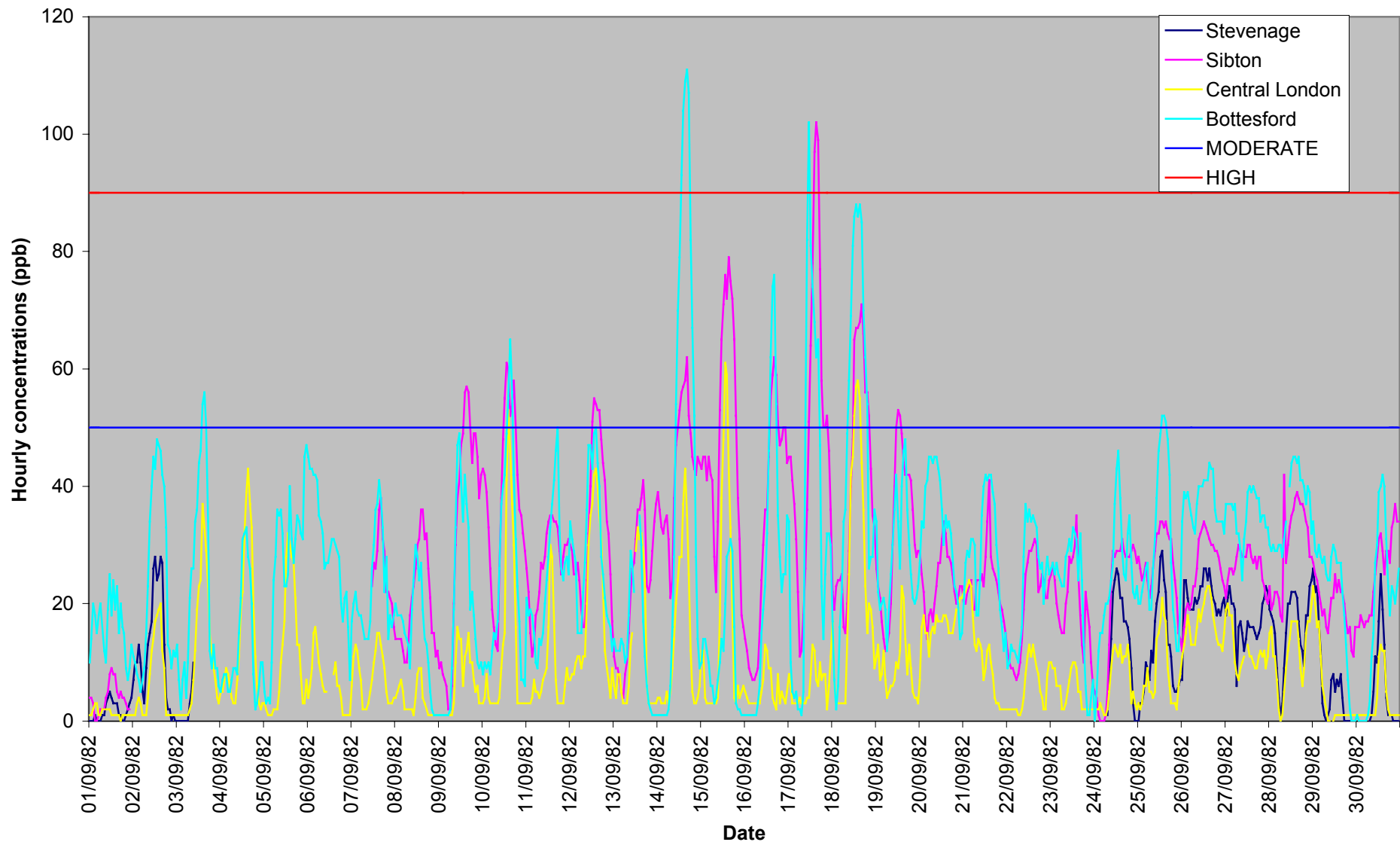


Figure 2 – time series chart of hourly ozone concentrations over September 1982

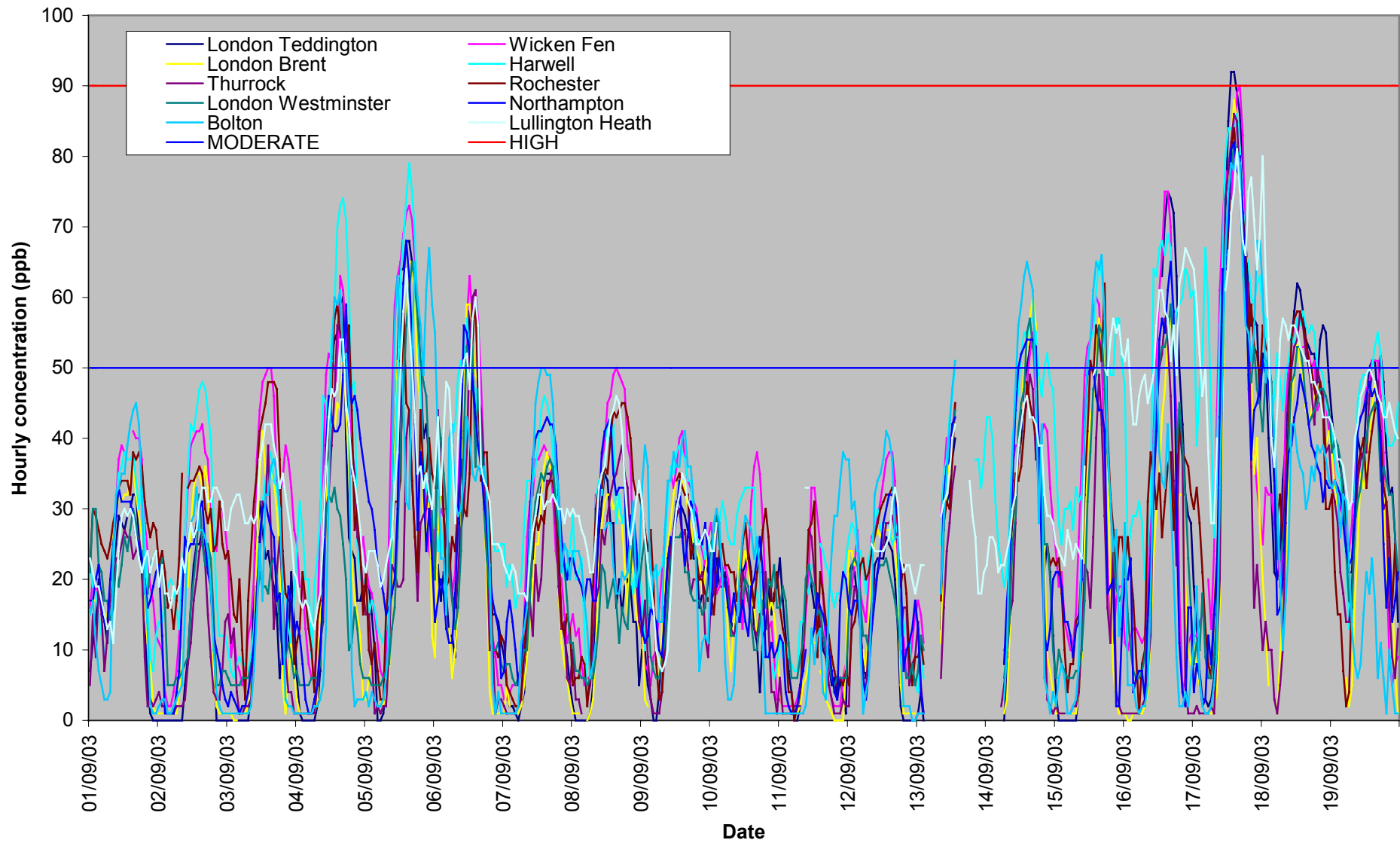


Figure 3 – time series chart of hourly ozone concentrations over September 2003 (to date)

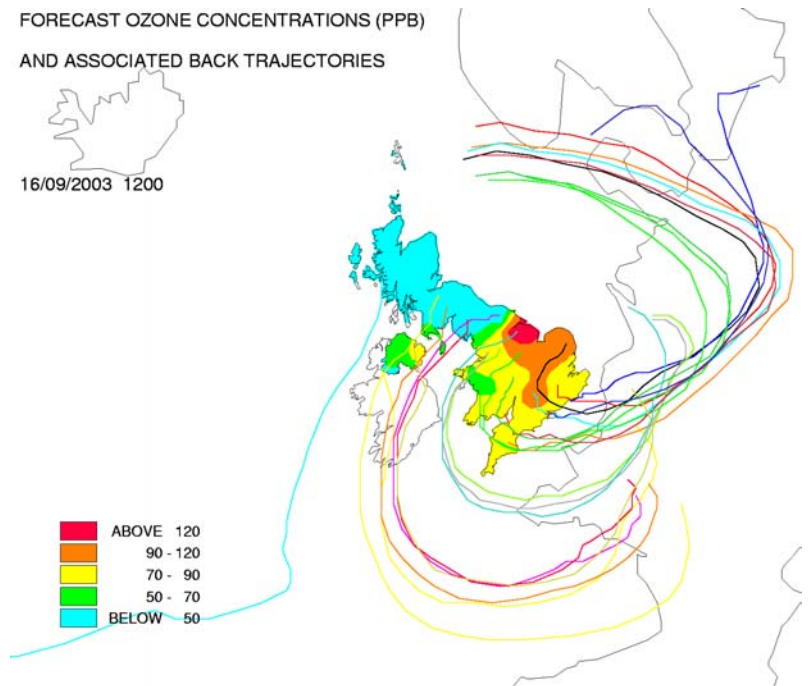


Figure 4 – Four day forecast back trajectories UK, 16th September 2003

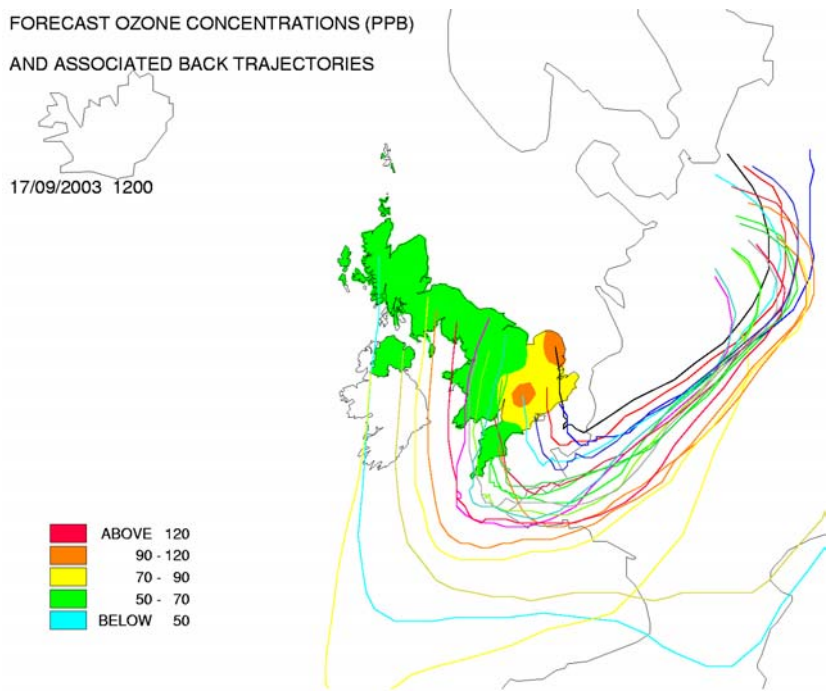


Figure 5 – Four day forecast back trajectories UK, 17th September 2003