Air Pollution Forecasting: Ozone Pollution Episode Report (Friday 27th May 2005)

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INTRODUCTION

HIGH levels of air pollution were measured on Friday 27th May 2005 in the South East area and Greater London. The UK AURN network recorded ozone levels in index 7 of the Defra HIGH band (90-119 ppb, 180-239 μgm^{-3}) at seven stations. The highest hourly concentration of this short episode was 204 μgm^{-3} (index 7), which occurred at Portsmouth at 15.00. High levels (index 7) of ozone were measured during 5 consecutive hours at Lullington Heath between 12.00 and 16.00 (maximum hourly concentration was 202 μgm^{-3}).

The 3rd Daughter Directive (Directive 2002/3/EC) on ozone in ambient air established an alert threshold of 240 μgm^{-3} (120 ppb) as an hourly average over three consecutive hours. This alert threshold was not exceeded, during the episode.

DEFINING THE EPISODE

The episode reported in here covers the time between 12.00 and 18.00 on Friday 27th of May 2005. During this short period, seven stations in the AURN network in the South East and Greater London measured at least one hourly average above 180 μgm^{-3}. As can seen in Figure 1 below, the episode is localised on 27th July.

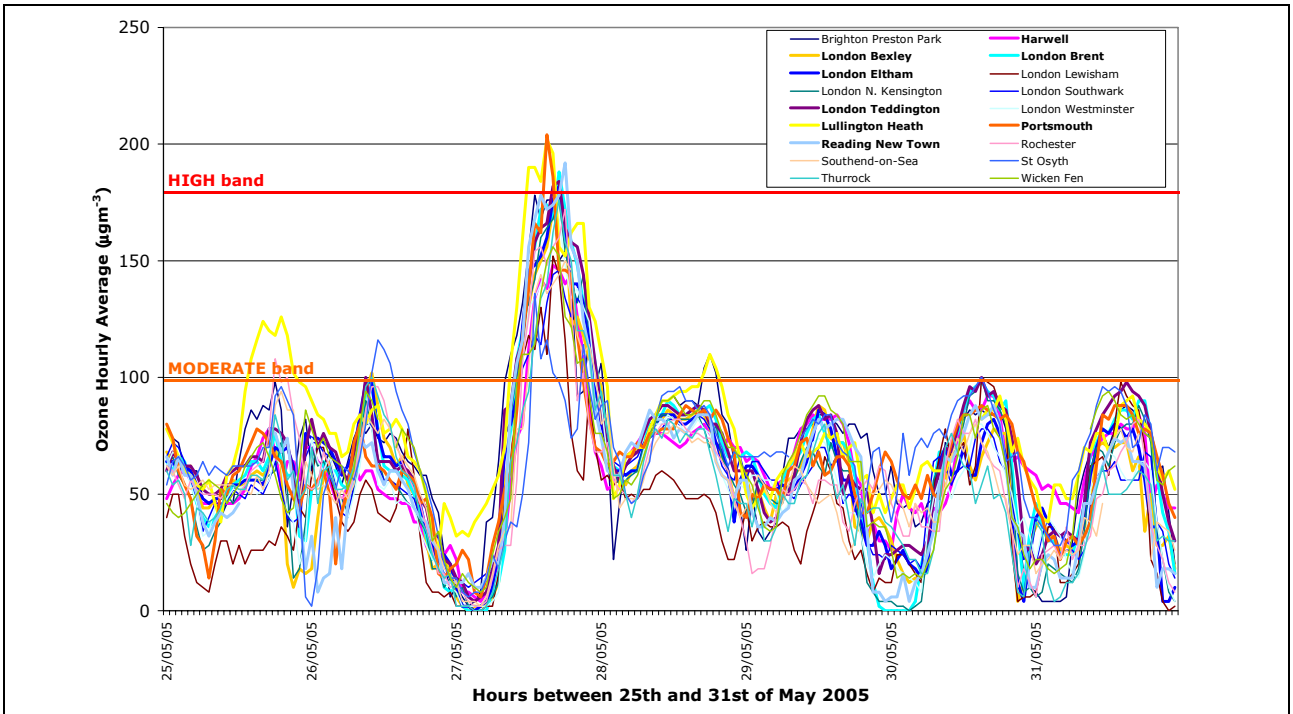

Figure 1. Hourly averages of stations in the South East and Greater London with levels MODERATE and HIGH between 25th and 31st May (*provisional data*).

THE OZONE EPISODE

During the short localised event, 7 stations in the AURN National network recorded HIGH levels of ozone. The highest hourly ozone concentration measured was 204 μgm^{-3} (index 7), which occurred at Portsmouth at 15.00. The longest event was measured at Lullington Heath was of 5 hours with a maximum value of 202 μgm^{-3} (index 7). As can be seen in table 1, the following stations measured HIGH: Reading New Town, London Brent, London Teddington, London Eltham and London Bexley.

Table 1. Ozone hourly average above 100µgm^{-3} at each station across AURN Network between 25/05/2005 to 31/05/2005 (*provisional data*)

Site	Site type	Number of exceedences	Number of days	Maximum exceedence µg m^{-3} (20'C 1013mb)
Portsmouth	URBAN BACKGROUND	**2**	**1**	**204***
Lullington Heath	RURAL	**5**	**1**	**202***
Reading New Town	URBAN BACKGROUND	**1**	**1**	**192***
London Brent	URBAN BACKGROUND	**1**	**1**	**188***
London Teddington	URBAN BACKGROUND	**2**	**1**	**184***
London Eltham	SUBURBAN	**1**	**1**	**182***
London Bexley	SUBURBAN	**1**	**1**	**180***
Brighton Preston Park	URBAN BACKGROUND	0	0	178
London N. Kensington	URBAN BACKGROUND	0	0	176
Thurrock	URBAN BACKGROUND	0	0	176
Coventry Memorial Park	URBAN BACKGROUND	0	0	172
Rochester	RURAL	0	0	172
Bournemouth	URBAN BACKGROUND	0	0	168
London Westminster	URBAN BACKGROUND	0	0	168
Northampton	URBAN BACKGROUND	0	0	166
Aston Hill	RURAL	0	0	158
Wicken Fen	RURAL	0	0	156
Cwmbran	URBAN BACKGROUND	0	0	154
Leamington Spa	URBAN BACKGROUND	0	0	152
Leicester Centre	URBAN CENTRE	0	0	152
London Lewisham	URBAN CENTRE	0	0	152
Somerton	RURAL	0	0	152
London Harlington	AIRPORT	0	0	150
Southend-on-Sea	URBAN BACKGROUND	0	0	150
Birmingham Tyburn	URBAN BACKGROUND	0	0	148
Harwell	RURAL	0	0	148
Birmingham Centre	URBAN CENTRE	0	0	146
Bristol Centre	URBAN CENTRE	0	0	146
London Southwark	URBAN CENTRE	0	0	146
Bottesford	SUBURBAN	0	0	144
Port Talbot	URBAN BACKGROUND	0	0	144
London Haringey	URBAN CENTRE	0	0	140
Weybourne	RURAL	0	0	140
Wolverhampton Centre	URBAN CENTRE	0	0	140
London Hackney	URBAN CENTRE	0	0	138
London Wandsworth	URBAN CENTRE	0	0	136
St Osyth	RURAL	0	0	136
Market Harborough	RURAL	0	0	134
Sandwell West Bromwich	URBAN BACKGROUND	0	0	130
Swansea	URBAN CENTRE	0	0	130
Norwich Centre	URBAN CENTRE	0	0	128
Yarner Wood	RURAL	0	0	116
Southampton Centre	URBAN CENTRE	0	0	110
Plymouth Centre	URBAN CENTRE	0	0	108
High Muffles	RURAL	0	0	100
Hull Freetown	URBAN CENTRE	0	0	100
Lough Navar	REMOTE	0	0	100
Manchester Piccadilly	URBAN CENTRE	0	0	100

**** Highlighted in bold those stations in defra's HIGH BAND***

REASONS FOR THE EPISODE

The one-day ozone episode was characterised by rising temperatures and air masses originating over France and Northern Spain. These conditions typically result in smog episodes as the ozone precursor chemicals react in the presence of sunlight.

Temperature

During the episode, maximum temperatures reached above *35*ºC, as can been seen in figure 2. This temperature was measured in South East England. Although, the maximum temperatures before the episode reached *circa* 30ºC, HIGH levels of ozone were not measured. This is due to the influence of air masses originating over Europe and over the UK, which is discussed below.

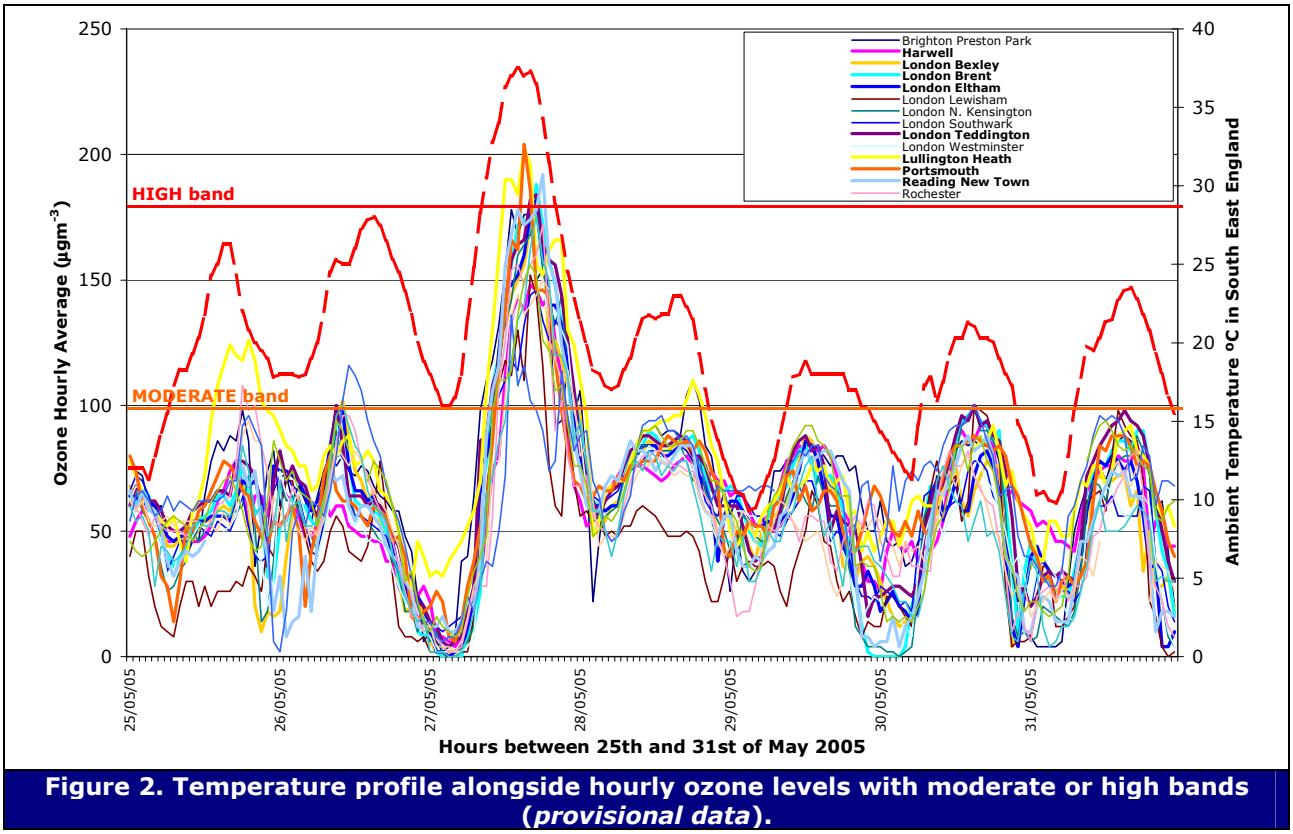

Figure 2. Temperature profile alongside hourly ozone levels with moderate or high bands (*provisional data*).

Origin of air masses

Figure 3 shows the 96 hours airmass back-trajectories on the important day over the episode and surrounding days. It is clear that the origin of air masses over Europe had a great influence on HIGH levels measured on that day, bringing continental ozone precursors to the UK.

This origin of the air masses, in conjunction with high temperatures was the main reason for ozone levels reaching Defra's HIGH band over Greater London Urban Area and the South East.

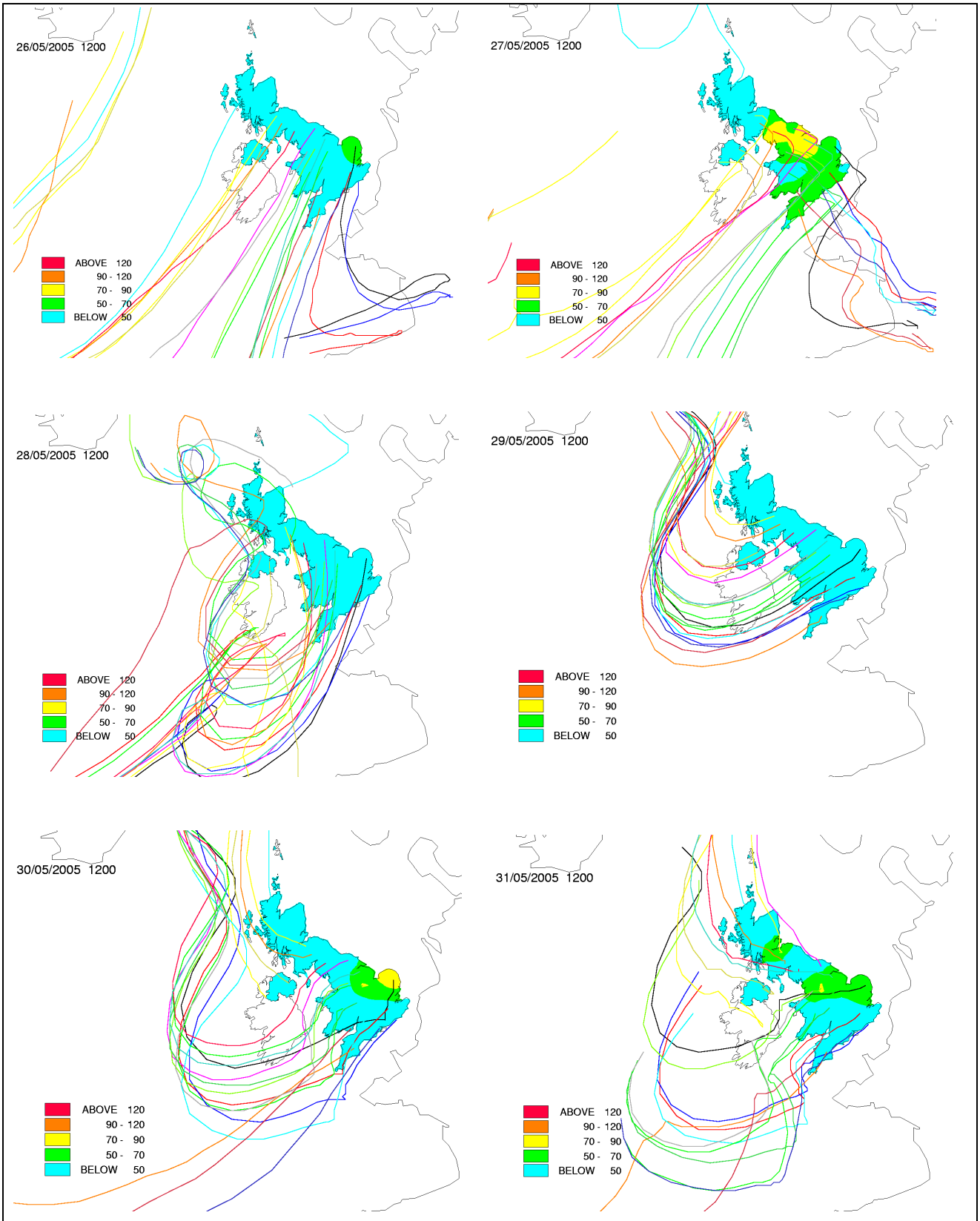

Figure 3. 96-hour air masses back trajectories for 26th to 31st of May 2005.

Detailed trajectory analysis from the Met Office for 27th May 2005

NAME particle back trajectories are calculated for representative locations using reanalysis meteorology to determine the source regions of air over the south of the UK during the 27 May 2005 ozone pollution event.

Comparison of the turbulent particle trajectory midday results to evening results shows that there was little change in the air mass source regions between these times (Fig. 4), with air coming from the continent at both instances (Fig. 5). Exeter was the only site experiencing clean air from the south west as forecast, although the turbulent trajectories show that, even here, some of the air was sourced from Western Europe (Fig. 6). The air over Portsmouth in the early evening had an increased component of clean air compared to that at midday (Fig. 7), which would explain the earlier timing of the HIGH pollution episode here compared to London.

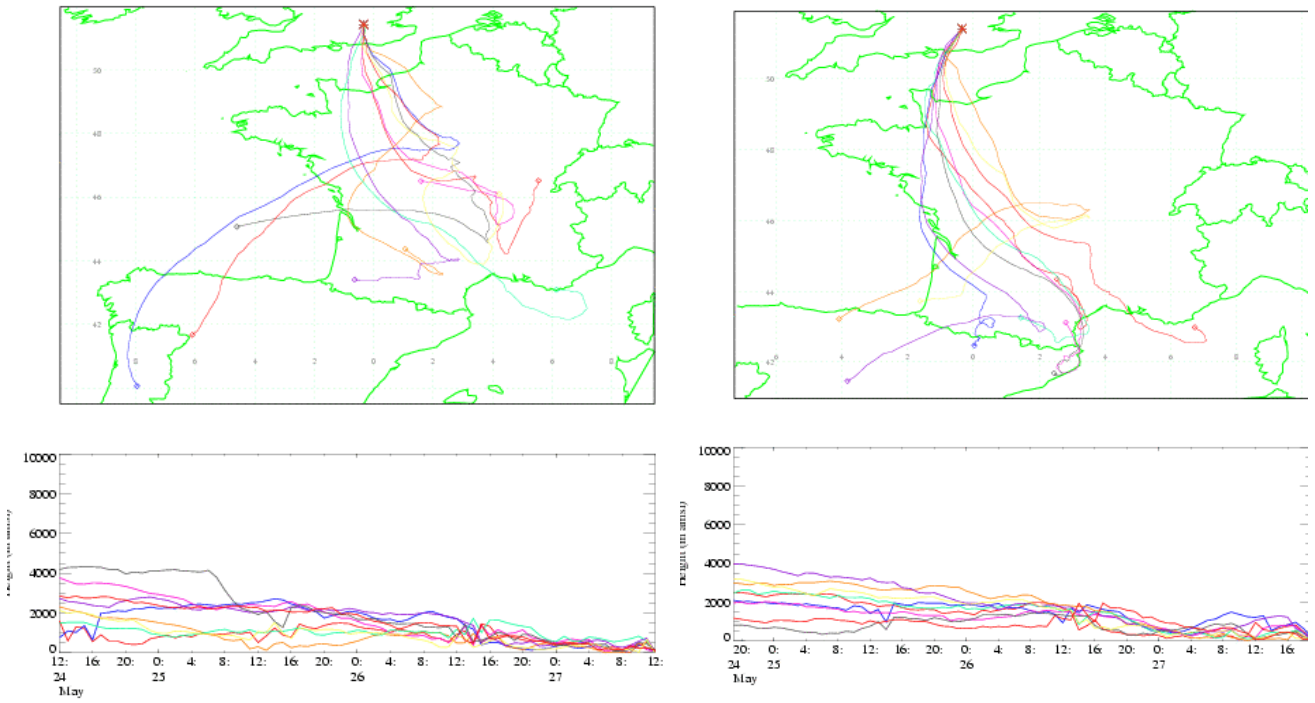

Figure 4: Particle back-trajectories for midday (left) and early evening (right) at Teddington demonstrating that air from both France and Spain contributed to the air mass over south-east England on 27 May 2005, allowing long transport of ozone precursors.

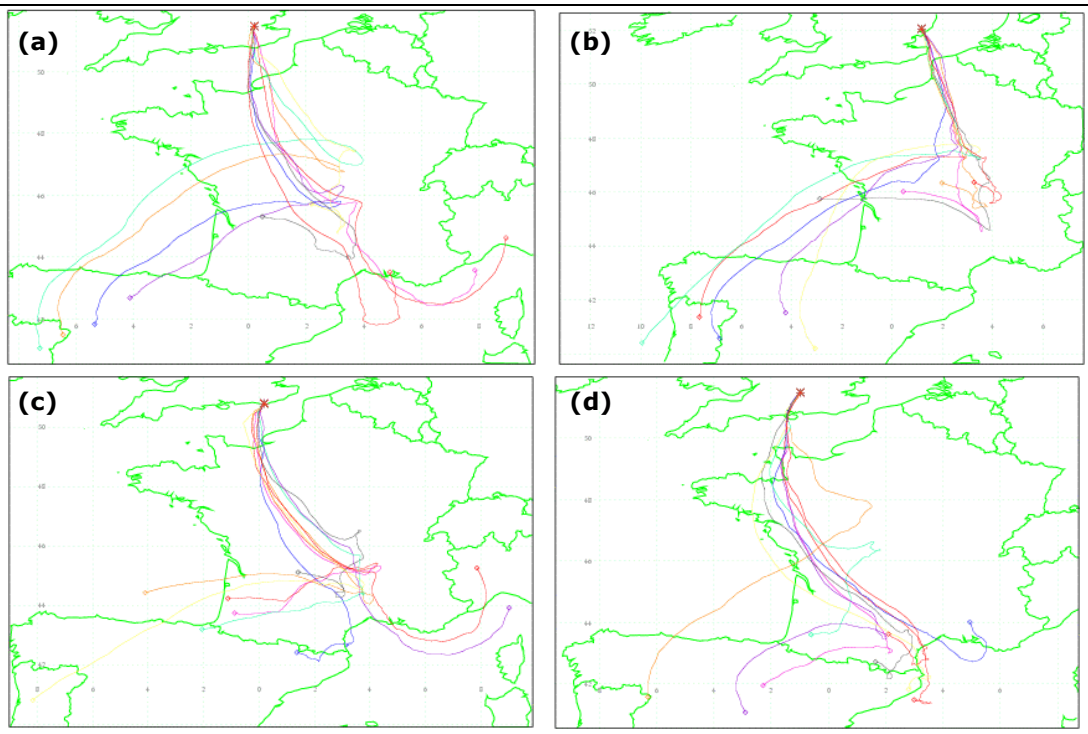

Figure 5: Particle back-trajectories for early evening at (a) Bexley, (b) Ipswich, (c) Lullington Heath and (d) Reading demonstrating similar results to those for Teddington (Fig. 4) and showing that the air mass over the south-east of England on 27 May 2005 had predominantly come from the continent.

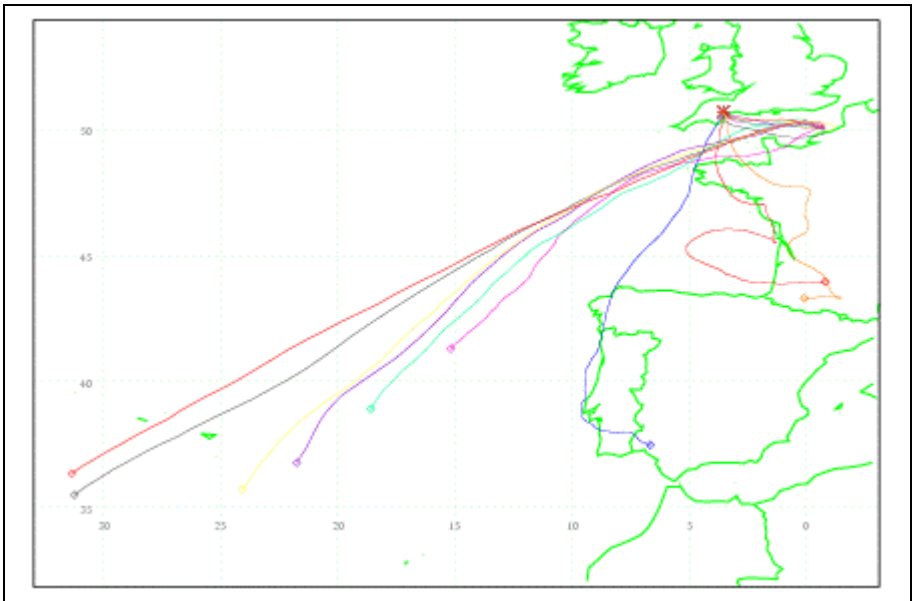

Figure 6: A selection of turbulent particle back-trajectories for a 72hr period with a midday arrival at Exeter on 27 May 2005.

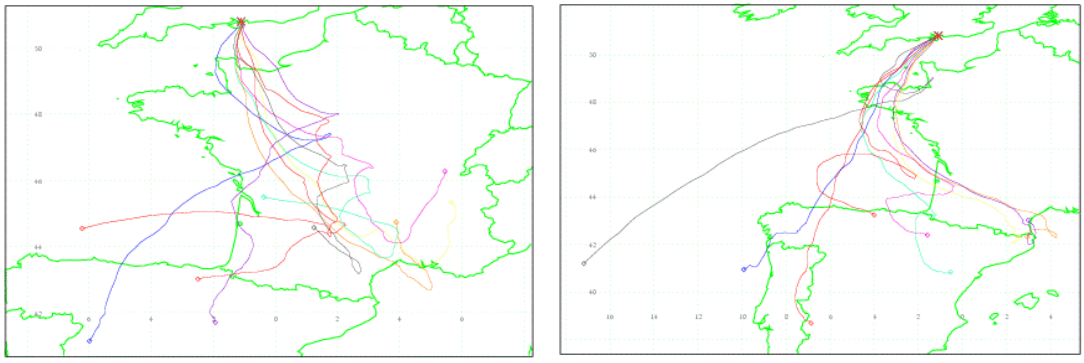

Figure 7: Particle back-trajectories for Portsmouth, demonstrating air transport from France at midday (left), but an increased component of cleaner air in the evening (right).

Reanalysis met Trajectory model results for both 1200 and 1800 concur with the general picture from the turbulent particle trajectories that the air mass over south-east England came from France (Fig. 8), whilst that over the south-west was cleaner. This provides some confidence in the current Trajectory model. The results from the two different trajectory times are generally similar at each location.

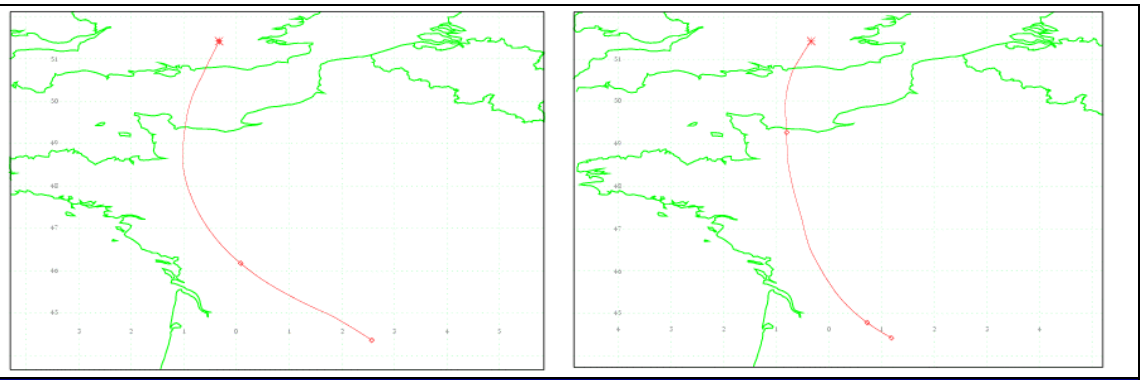

Figure 8: Trajectory model results for (left) 1200 and (right) 1800 back-trajectories at Teddington.

Both types of trajectory results are consistent with the meteorology at the time (Fig. 9) and the locations of increased levels of ozone pollution across the UK appear to have been strongly influenced by the position of the front over the south of the country. The predicted position of this front in the forecast meteorology used to initiate the Air Quality model on 26 May 2005 would have had a strong impact on the forecast trajectories.

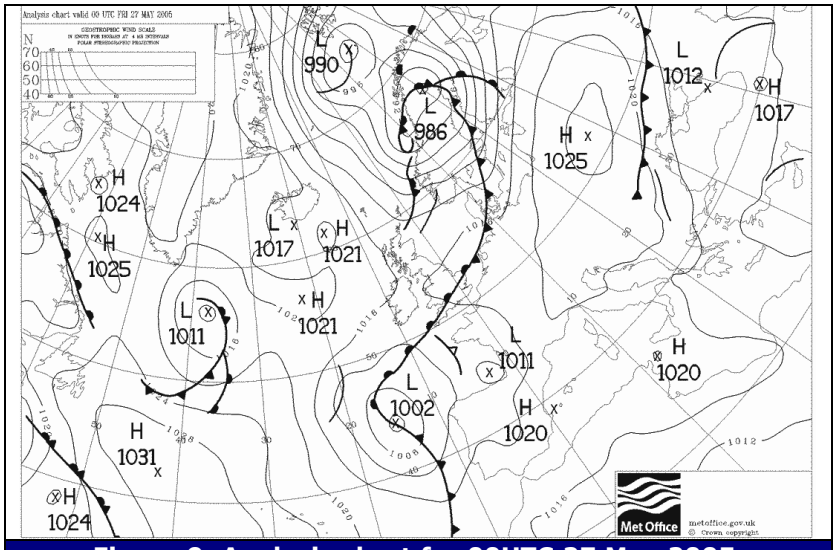

Figure 9: Analysis chart for 00UTC 27 May 2005.

EPISODE ACROSS LOCAL NETWORKS

The influence of UK emissions on the episode has been investigated by examining ozone levels on a cross section of the Greater London Urban Area. In contrast with the ozone episode in 2004, the influence of UK emissions on daily maximum hourly concentrations over the episode is unclear. The one-day ozone episode was also measured across the three local networks in the South East and Greater London: Kent Air Quality Network, the HBAPMN[1] and the London AQ Network.

As can be seen in figure 10, Folkestone Suburban and Luton Background stations in the Kent Air Quality Network measured levels above defra's HIGH band for one and two hours respectively. In the HBAPMN, Mid Beds Silsoe (Rural) reached HIGH band during two hours (see figure 11).

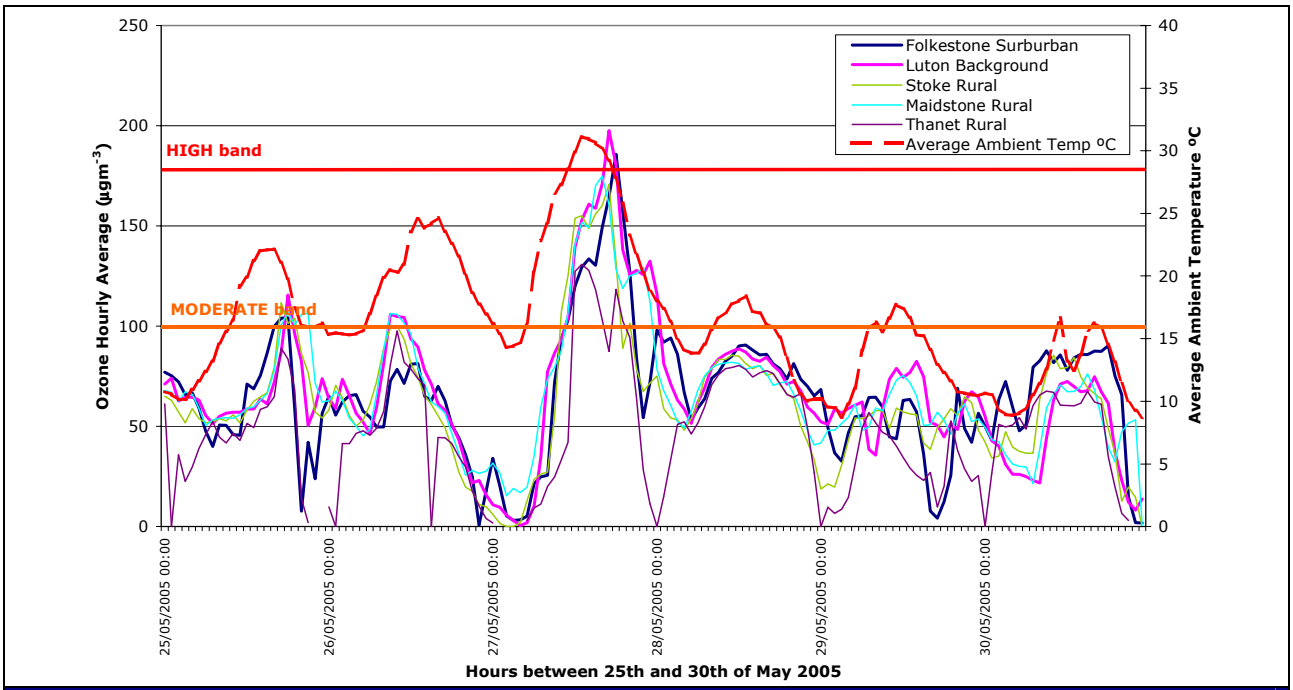

Figure 10. Ozone and temperature in the Kent Air Quality Network (*provisional data*).

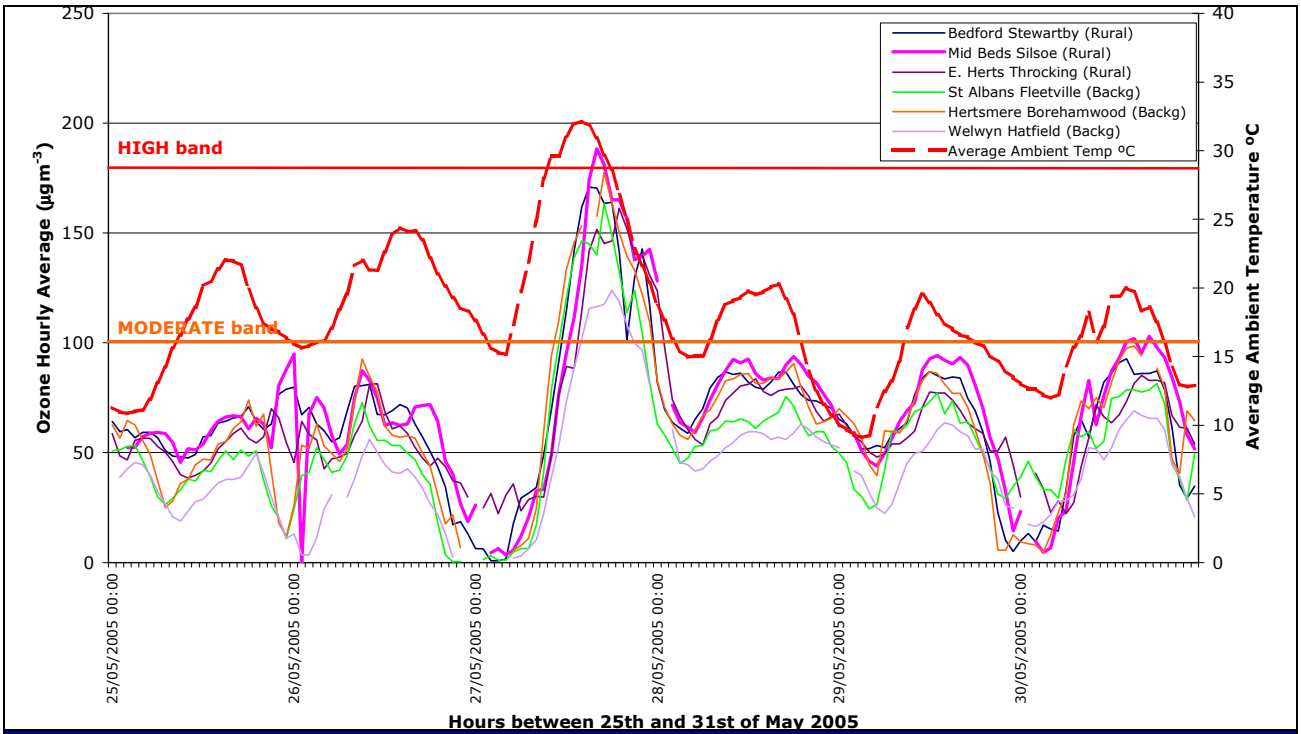

Figure 11. Ozone and temperature in HBAPM Network (*provisional data*).

[1] Herts. & Beds. Air Pollution Monitoring Network - http://www.seiph.umds.ac.uk/hbnet.htm

In the London AQ Network, four stations out of twenty-four stations with valid data reached above defra's HIGH band. These include Bromley 5, Bexley 8, Tower Hamlets 1 and Greenwich 4 (see Table 2). For the London AQ Network, plots like figure 10 and 11 have not been drawn as hourly data was not downloadable from the website.

Table 2. Maximum Ozone hourly average between 25th and 30th of May 05 in the London AQ Network in defra's Moderate and above band.

SiteCode	SiteName	Maximum daily hour average (μgm^{-3}) (*provisional data*)
BY5	**Bromley 5 - Biggin Hill**	**187***
BX8	**Bexley 8 - Thames Rd South**	**184***
TH1	**Tower Hamlets 1 - Poplar**	**180***
GR4	**Greenwich 4 - Eltham**	**180***
RI2	Richmond 2 - Barnes Wetlands	178
GB6	Greenwich Bexley 6 - A2 Falconwood	176
HS2	Hounslow 2 - Cranford	176
KC1	Kens and Chelsea 1 - North Kensington	176
CR3	Croydon 3 - Thornton Heath	169
ST3	Sutton 3 - Carshalton	168
RB1	Redbridge 1 - Perth Terrace	162
EN3	Enfield 3 - Salisbury School Ponders End	157
LW1	Lewisham 1 - Catford	152
BX7	Bexley 7 - Thames Rd North	146
EA1	Ealing 1 - Ealing Town Hall	146
WA2	Wandsworth 2 - Town Hall	144
CT1	City of London 1 - Senator House	143
HG2	Haringey 2 - Priory Park	142
KT1	Kingston 1 - Chessington	141
HK4	Hackney 4 - Clapton	134
SK1	Southwark 1 - Elephant and Castle	134
EA2	Ealing 2 - Acton Town Hall	128

**** Highlighted in bold those stations in defra's HIGH BAND***

SUMMARY

The main features of the 27th of May 2005 ozone episode may be summarised as follows:

- Rising temperatures and air masses originating over France and Northern Spain were determined to be the cause of this 'High' ozone episode.
- The area affected by the episode was limited to south-east England and Greater London.
- Turbulent particle trajectories and "traditional" trajectory model results show that air reaching the south-east of England on 27 May 2005 had previously travelled over France. This air movement would have allowed long-range transport of ozone precursors to this region, which would have complemented existing local pollution sources and enhanced ozone pollution at this time leading to the HIGH and MODERATE observations in the south-east region.
- Changes of airmass back trajectories and lower temperatures did not allow the episode to persist beyond a single day.
- The highest hourly average ozone concentration recording during the episode was 204 μgm^{-3}, (index 7), which occurred at Portsmouth.
- The Directive 2002/3/EC on ozone in ambient air establishes an alert threshold of 240 μgm^{-3} (120 ppb) as an hourly average over three consecutive hours. This alert threshold was not exceeded.