

# Air Pollution Forecasting: Ozone Pollution Episode Report (June-July 2005)

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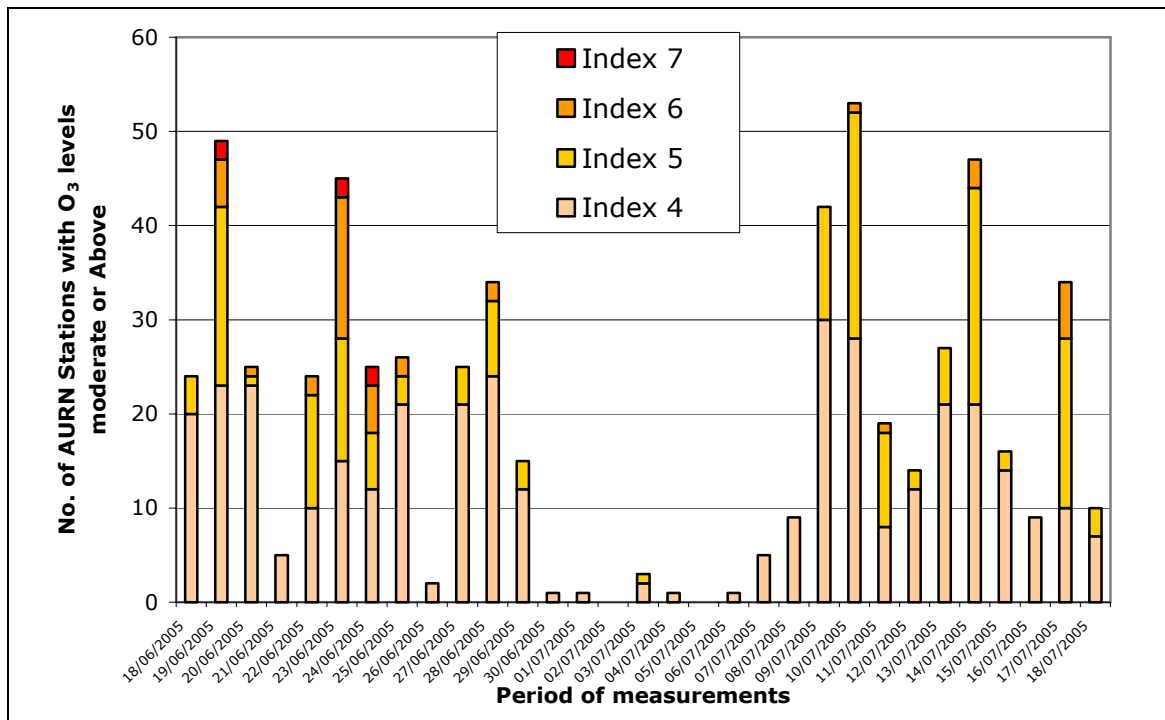
## INTRODUCTION

HIGH levels of air pollution were measured across the Automatic Urban and Rural Network (AURN) during June 2005. These were concentrated in the South East area and Greater London. The AURN recorded ozone levels in index 7 of the Defra HIGH band (90-119 ppb, 180-239  $\mu\text{g m}^{-3}$ ) at seven stations. The highest hourly concentration during June was 202  $\mu\text{g m}^{-3}$  (index 7), which occurred at Weybourne at 19.00 on the 24<sup>th</sup> June. High levels of ozone were measured during 5 consecutive hours at Weybourne between 18.00 and 23.00. In July, there was a period of elevated O<sub>3</sub> levels between 9<sup>th</sup> and 17<sup>th</sup>. However, the levels rarely reached MODERATE index 5.

The 3<sup>rd</sup> Daughter Directive (Directive 2002/3/EC) on ozone in ambient air established an alert threshold of 240  $\mu\text{g m}^{-3}$  as an hourly average over three consecutive hours. This alert threshold was not exceeded, during June-July 2005.

## DEFINING THE EPISODE

The episode reported in this report covers the period between 19<sup>th</sup> and 24<sup>th</sup> of June. During this, seven stations in the AURN measured at least one hourly average above 180  $\mu\text{g m}^{-3}$ . Summer ozone episodes can be hard to delimit because ozone levels are often in the MODERATE band during the summer season. Although the period has been identified in June, this report covers the period between 18<sup>th</sup> June and 18<sup>th</sup> July 2005.



**Figure 1. Ozone Episode Days – Number of Stations with MODERATE and HIGH levels between 18<sup>th</sup> June and 18<sup>th</sup> July 2005.**

As can be seen in figure 1, the episode started on 19<sup>th</sup> June, when more than 47 stations measured MODERATE levels of O<sub>3</sub> and 2 stations measured HIGH levels (index 7). The episode ended on 24<sup>th</sup> June, when only 23 stations measured levels in the MODERATE band and 2 stations measured HIGH levels (index 7). Although O<sub>3</sub> levels did not reach HIGH levels between the 9<sup>th</sup> and 17<sup>th</sup> of July, this period is also investigated in this report. During this second period, highest levels were measured in Wicken Fen at 172 µgm<sup>-3</sup> (index 6) on the 14<sup>th</sup> July.

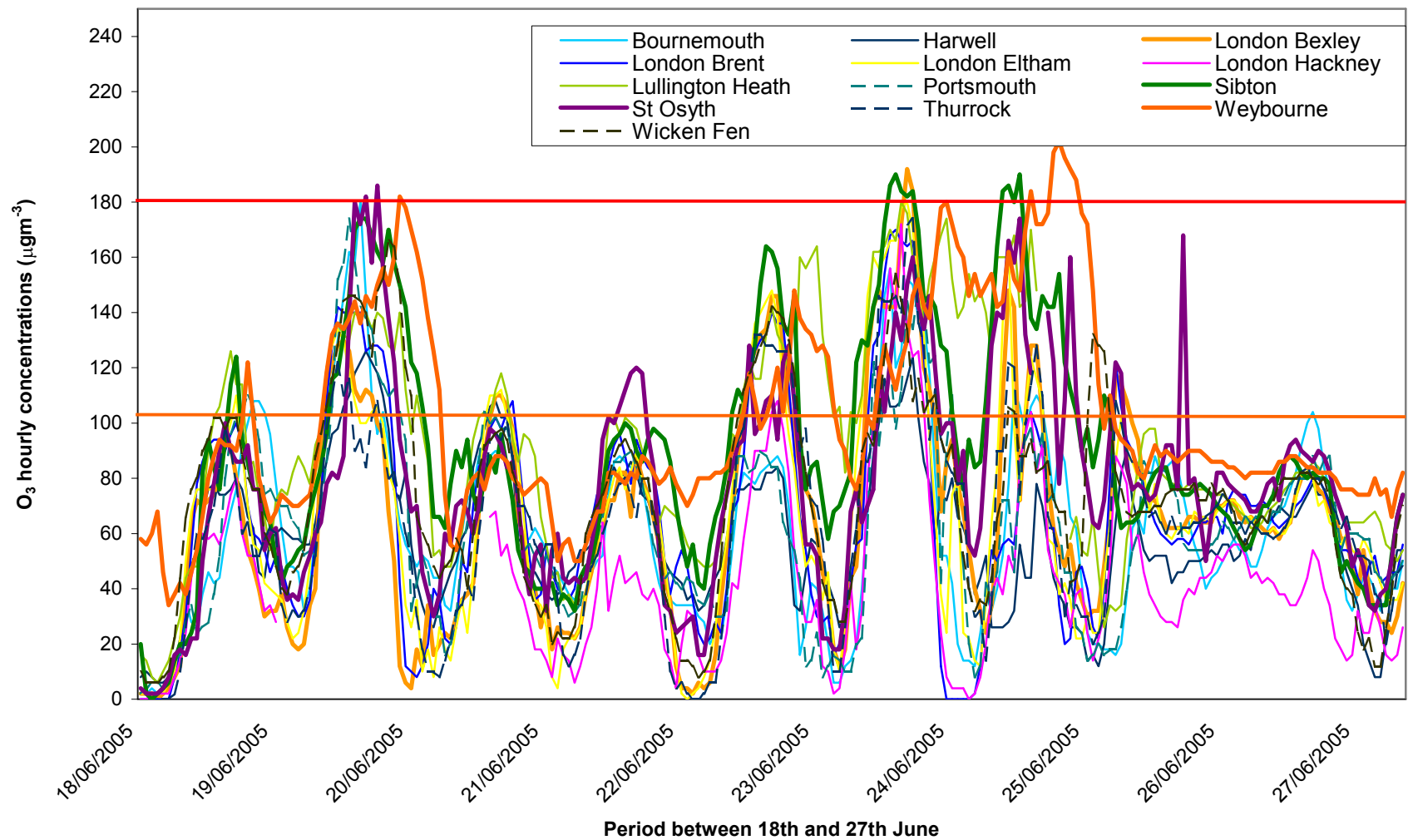
## THE OZONE EPISODE

During the episode, 7 stations in the AURN recorded HIGH levels of ozone. The highest hourly ozone concentration measured was 202 µgm<sup>-3</sup> at Weybourne on 24<sup>th</sup> June. Sibton also measured HIGH levels on this date. Three stations measured HIGH levels on 19<sup>th</sup> June: Weybourne, St Osyth and Bournemouth. On 23<sup>th</sup> of June, three stations again measured HIGH levels of ozone: Sibton, London Eltham and Lullington Heath. These are shown in table 1 and figure 2. The episode reported here covers the period between the 19<sup>th</sup> and the 24<sup>th</sup> of June. 2005.

**Table 1. Number days of Moderate and High levels at each station across the AURN**

Site	Number of Days		Max hourly if High (µgm <sup>-3</sup> ) <i>provisional</i>	Date of hourly max concentration
	Moderate	High		
Weybourne	18	2	202 & 192	24/06/05 & 19/06/05
Sibton	18	2	190	23/06/05 & 24/06/05
London Bexley	10	1	192	23/06/2005
St Osyth	17	1	186	19/06/2005
Bournemouth	16	0	180	19/06/2005
London Eltham	14	0	180	23/06/2005
Lullington Heath	16	0	180	23/06/2005
Portsmouth	10	0	-	-
Thurrock	11	0	-	-
London Hackney	3	0	-	-
Wicken Fen	14	0	-	-
London Brent	13	0	-	-
London Teddington	19	0	-	-
Norwich Centre	13	0	-	-
London N. Kensington	11	0	-	-
Southend-on-Sea	12	0	-	-
Birmingham Tyburn	14	0	-	-
Bottesford	14	0	-	-
Hull Freetown	8	0	-	-
Reading New Town	10	0	-	-
Brighton Preston Park	18	0	-	-
London Harlington	9	0	-	-
Yarner Wood	8	0	-	-
Coventry Memorial Park	14	0	-	-
London Westminster	6	0	-	-
Leicester Centre	11	0	-	-
London Haringey	5	0	-	-
Plymouth Centre	9	0	-	-
Barnsley Gawber	7	0	-	-
London Lewisham	11	0	-	-
Rochester	13	0	-	-

Somerton	9	0	-	-
Wigan Centre	5	0	-	-
Market Harborough	7	0	-	-
Rotherham Centre	4	0	-	-
Aston Hill	13	0	-	-
Port Talbot	9	0	-	-
Manchester Piccadilly	3	0	-	-
Salford Eccles	5	0	-	-
High Muffles	12	0	-	-
London Bloomsbury	2	0	-	-
Northampton	11	0	-	-
Sandwell West Bromwich	9	0	-	-
Bristol Centre	7	0	-	-
Cwmbran	9	0	-	-
Birmingham Centre	6	0	-	-
London Southwark	10	0	-	-
Swansea	7	0	-	-
Glazebury	7	0	-	-
Harwell	9	0	-	-
Liverpool Speke	6	0	-	-
Sheffield Centre	2	0	-	-
Bush Estate	1	0	-	-
Leamington Spa	9	0	-	-
London Wandsworth	3	0	-	-
Lough Navar	1	0	-	-
Manchester South	2	0	-	-
Wolverhampton Centre	9	0	-	-
Great Dun Fell	4	0	-	-
Leeds Centre	2	0	-	-
Nottingham Centre	6	0	-	-
Aberdeen	1	0	-	-
Bolton	4	0	-	-
Ladybower	5	0	-	-
London Hillingdon	4	0	-	-
Stoke-on-Trent Centre	4	0	-	-
Wirral Tranmere	3	0	-	-
Sunderland Silksworth	1	0	-	-
Belfast Centre	1	0	-	-
Edinburgh St Leonards	1	0	-	-
Redcar	3	0	-	-
Bury Roadside	2	0	-	-
Southampton Centre	2	0	-	-
Bradford Centre	1	0	-	-
Preston	2	0	-	-
Eskdalemuir	1	0	-	-
Exeter Roadside	1	0	-	-
Middlesbrough	1	0	-	-



**Figure 2. Hourly Ozone Concentration (µgm<sup>-3</sup>) over the episode for stations measuring elevated levels.**

## REASONS FOR THE EPISODE

The summer ozone episode was characterised by rising temperatures and air masses re-circulating over northern Europe and the UK. These conditions typically result in summer smog episodes as the ozone precursor chemicals react in the presence of sunlight. These are typical summer situations previously reported in Targa (2004) and Kent (2003).

It is important that both high temperatures and re-circulation of air masses over Europe and the UK are coupled together to result in a summer smog episode as discussed below.

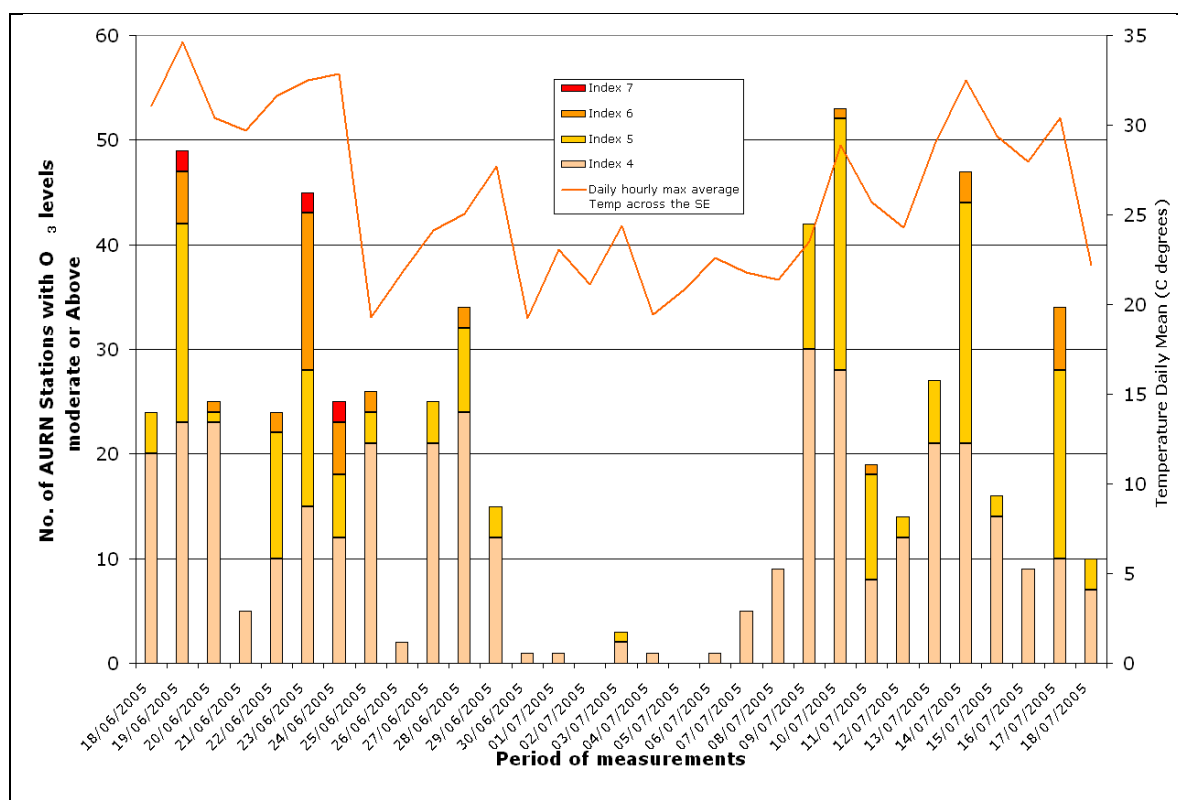
### Temperature

The report focuses on two periods of high ambient temperatures in the UK:

- 18<sup>th</sup> to 14<sup>th</sup> June (referred as first period)
- 10<sup>th</sup> to 15<sup>th</sup> July (referred as second period)

During the first period, maximum temperatures reached *circa* 35°C with a daily average *circa* 26°C as can be seen in Figure 3. These temperatures were measured in the South East. During the second period, maximum temperatures reached 29°C with a daily average *circa* 24°C. Although slightly lower, as can be seen in figure 3, both periods follow similar trends in temperatures with two higher peaks on the second and sixth day.

As shown in figure 3, only the first period of high temperatures resulted in HIGH levels of ozone. These were particularly important on 19<sup>th</sup>, 23<sup>rd</sup> and 24<sup>th</sup> June 2005. Apart from high temperatures the re-circulation of air masses of Europe and the UK were particularly important on those days (see following section).



**Figure 3. Ozone Episode Days – Number of Stations with MODERATE and HIGH levels between 18<sup>th</sup> June and 18<sup>th</sup> July 2005 with temperature profile across the South East.**

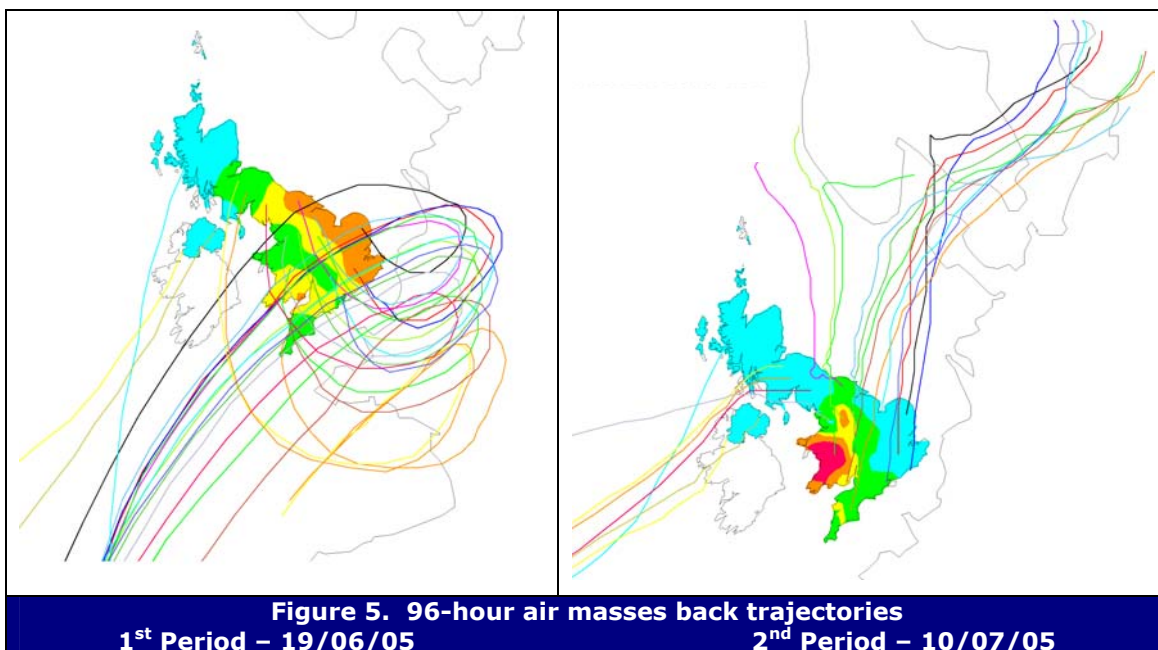
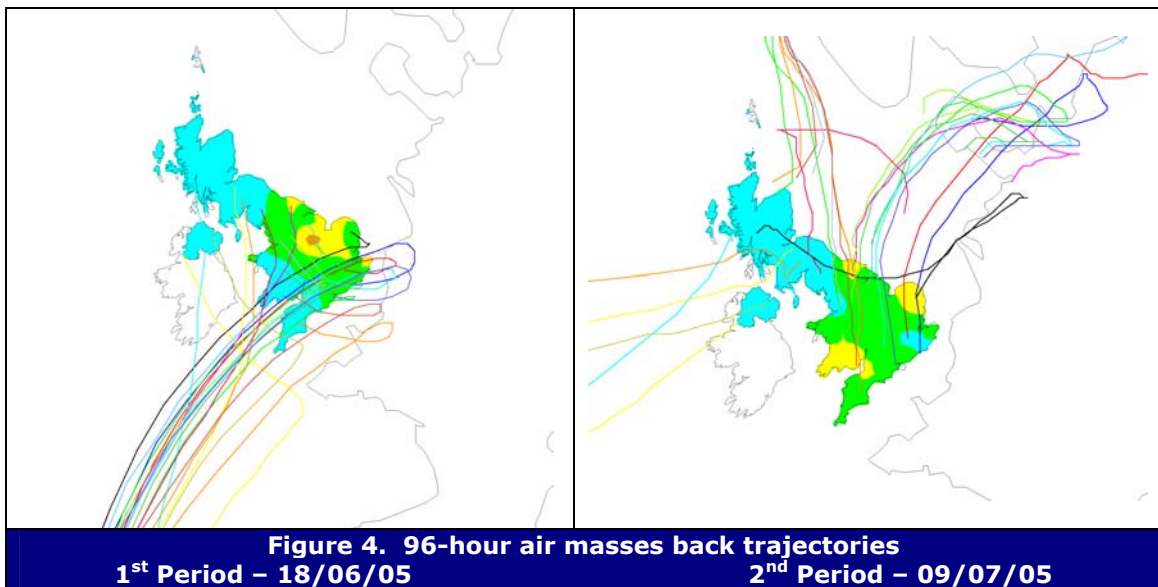
### Re-circulation of air masses

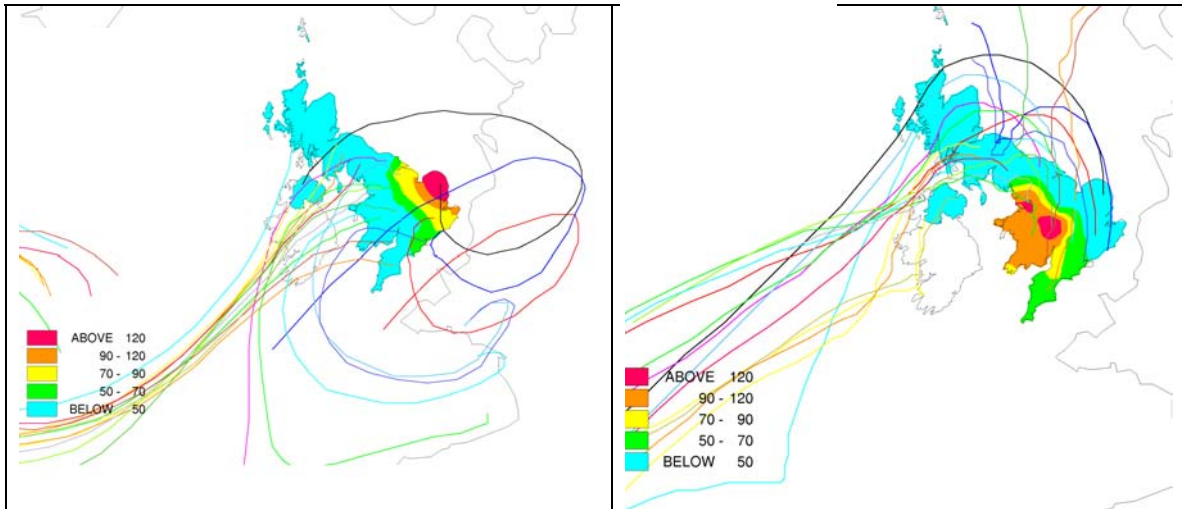
Figures 4-10 show the 96 hours airmass back-trajectories on the two periods of high temperatures between June and July. Each figure shows one back-trajectory from the first period and one for the second period. Although temperatures were a little higher in the first period, the back trajectories have been coupled to see the difference between both periods,

which resulted in Defra's HIGH levels of ozone measured in the first period (particularly the 19<sup>th</sup>, 23<sup>th</sup> and 24<sup>th</sup> June).

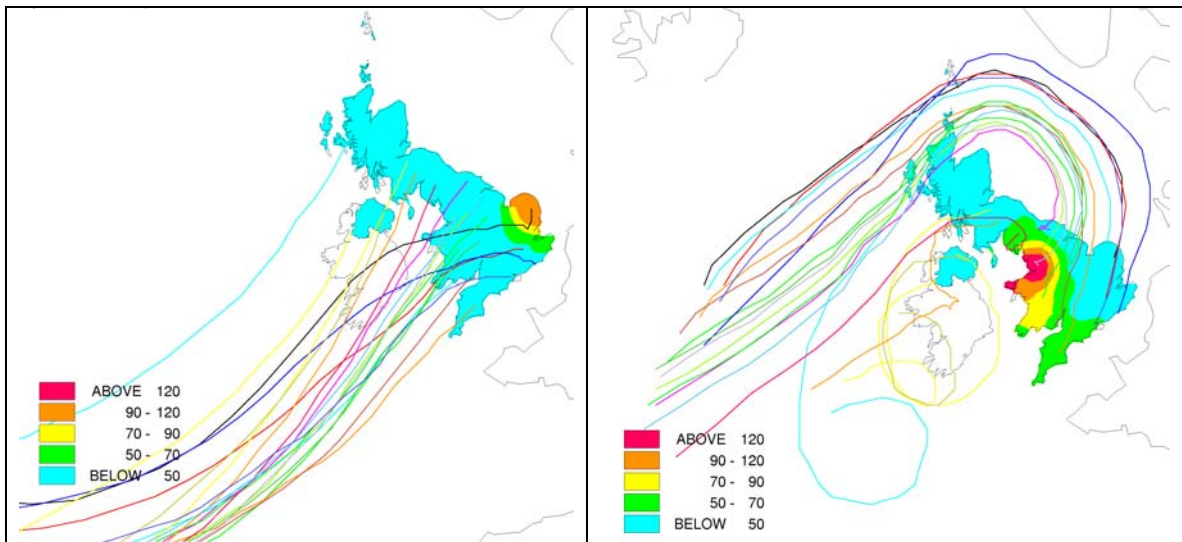
Figure 5, 9 and 10 show the importance of air masses re-circulating over Europe - and then over the UK - in reaching HIGH levels of ozone on the 19<sup>th</sup>, 23<sup>rd</sup> and 24<sup>th</sup> June. For the second period, despite the high temperatures, clean air masses originating in Scandinavia or in the Atlantic prevented ozone levels reaching HIGH levels. On the 10<sup>th</sup>, 14<sup>th</sup> and 15<sup>th</sup> July, ozone levels hardly reached Defra's MODERATE (index 6).

This re-circulation, in conjunction with high temperatures and UK ozone precursor emissions (specially over Greater London Urban Area), was the main reason for ozone levels reaching Defra's HIGH band.

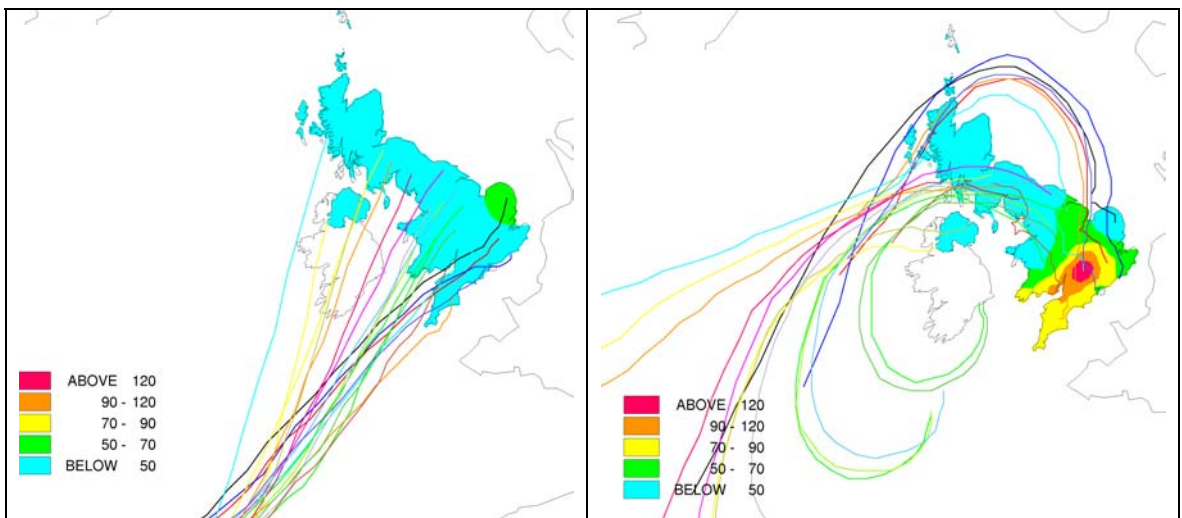




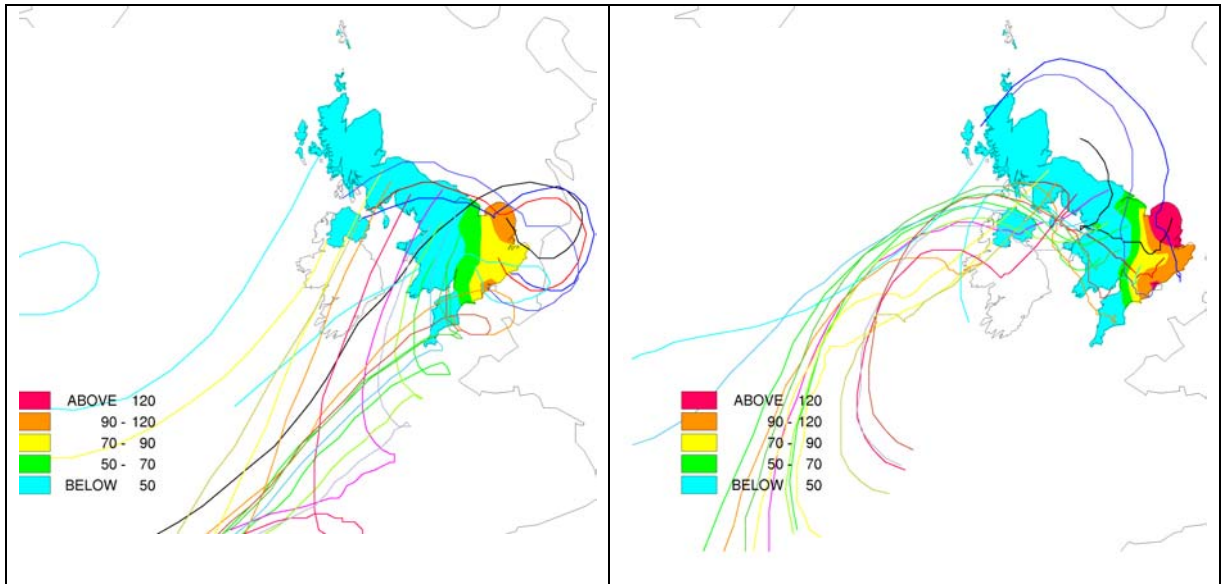
**Figure 6. 96-hour air masses back trajectories**  
**1<sup>st</sup> Period – 20/06/05** **2<sup>nd</sup> Period – 11/07/05**



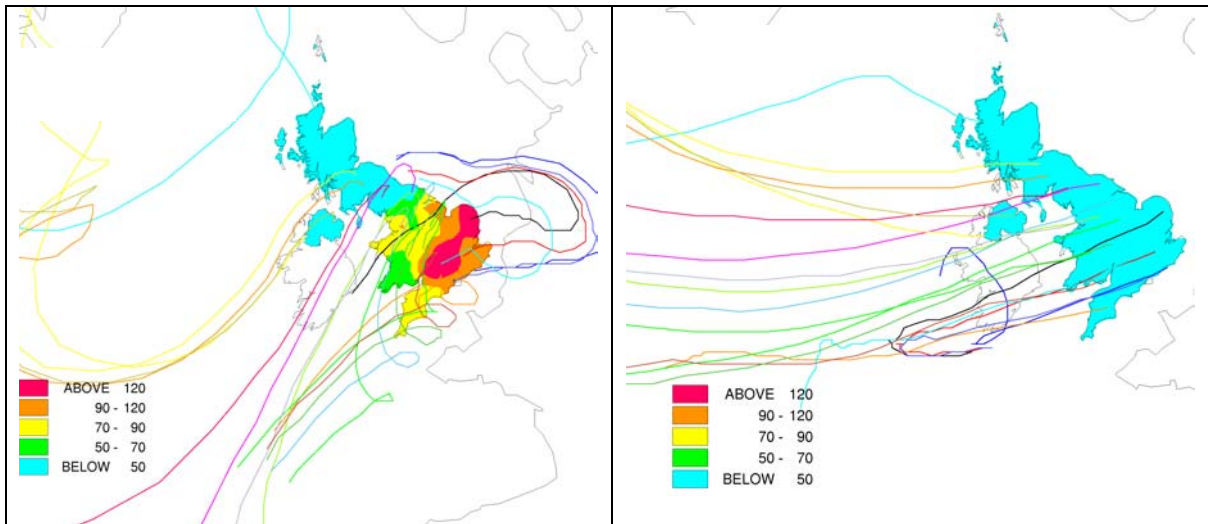
**Figure 7. 96-hour air masses back trajectories**  
**1<sup>st</sup> Period – 21/06/05** **2<sup>nd</sup> Period – 12/07/05**



**Figure 8. 96-hour air masses back trajectories**  
**1<sup>st</sup> Period – 22/06/05** **2<sup>nd</sup> Period – 13/07/05**



**Figure 9. 96-hour air masses back trajectories**  
**1<sup>st</sup> Period – 23/06/05** **2<sup>nd</sup> Period – 14/07/05**



**Figure 10. 96-hour air masses back trajectories**  
**1<sup>st</sup> Period – 24/06/05** **2<sup>nd</sup> Period – 15/07/05**



## EPISODE ACROSS LOCAL NETWORKS

The ozone episode was also measured across three local networks in the South East : Kent Air Quality Network, London Air Quality Network (LAQN) and the Herts. & Beds. Air Pollution Monitoring Network (BAPMN).

As can be seen in Table 2, the highest hourly average was measured at Sevenoaks 2 Urban Background (UB) station at 195 on the 24<sup>th</sup> June.

HIGH levels of O<sub>3</sub> were measured at Sevenoaks 2 UB and Greenwich 4 stations on the 23<sup>rd</sup> June, at Sevenoaks 2 UB, Bromley 4, Luton Background (UB) and Folkestone Suburban on the 24<sup>th</sup> June and at Mid Beds Silsoe (Rural) on the 14<sup>th</sup> July.

**Table 2. Defra's HIGH O<sub>3</sub> levels measured across Local Networks in the South East**

Station Name	Type	Network	Date & hour	O <sub>3</sub> Hourly average (µgm <sup>-3</sup> ) <i>provisional</i>
Sevenoaks 2 - Greatness	Urban Background	Kent AQN	24/06/2005 11:00	195
Luton Background	Urban Background	Kent AQN	24/06/2005 11:00	189
Luton Background	Urban Background	Kent AQN	24/06/2005 10:00	187
Mid Beds Silsoe	Rural	HBAPMN	14/07/2005 16:00	185
Folkestone Suburban	Suburban	Kent AQN	24/06/2005 17:00	184
Bromley 5 – Biggin Hill	Suburban	LAQN	24/06/2005	184
Sevenoaks 2 - Greatness	Urban Background	Kent AQN	23/06/2005 16:00	183
Greenwich 4 – Eltham	Urban Background	LAQN	23/06/2005	180

## EPISODE ACROSS EUROPE

The ozone episode on the 23<sup>rd</sup> and 24<sup>th</sup> of June was measured in Belgium and the Netherlands<sup>1</sup>. Figures 11 to.15 show the following sequence of hourly ozone measurements in the UK, Belgium and the Netherlands (note that this data is provisional):

- 19<sup>th</sup> June between 15:00 and 23:00,
- 23<sup>rd</sup> June between 12:00 and 23:00 and
- 24<sup>th</sup> June between 09:00 and 23:00

The episode on the 19<sup>th</sup> June was only measured in the UK (South East England) while the 23<sup>rd</sup> and 24<sup>th</sup> affected both Europe and the UK.

The re-circulation of air masses between the UK and Europe presented in figure 4 and 10, in conjunction with high temperatures across the UK and Europe explain the reason for this transboundary episode.

<sup>1</sup> The EA Ozone web site does not include data from France.

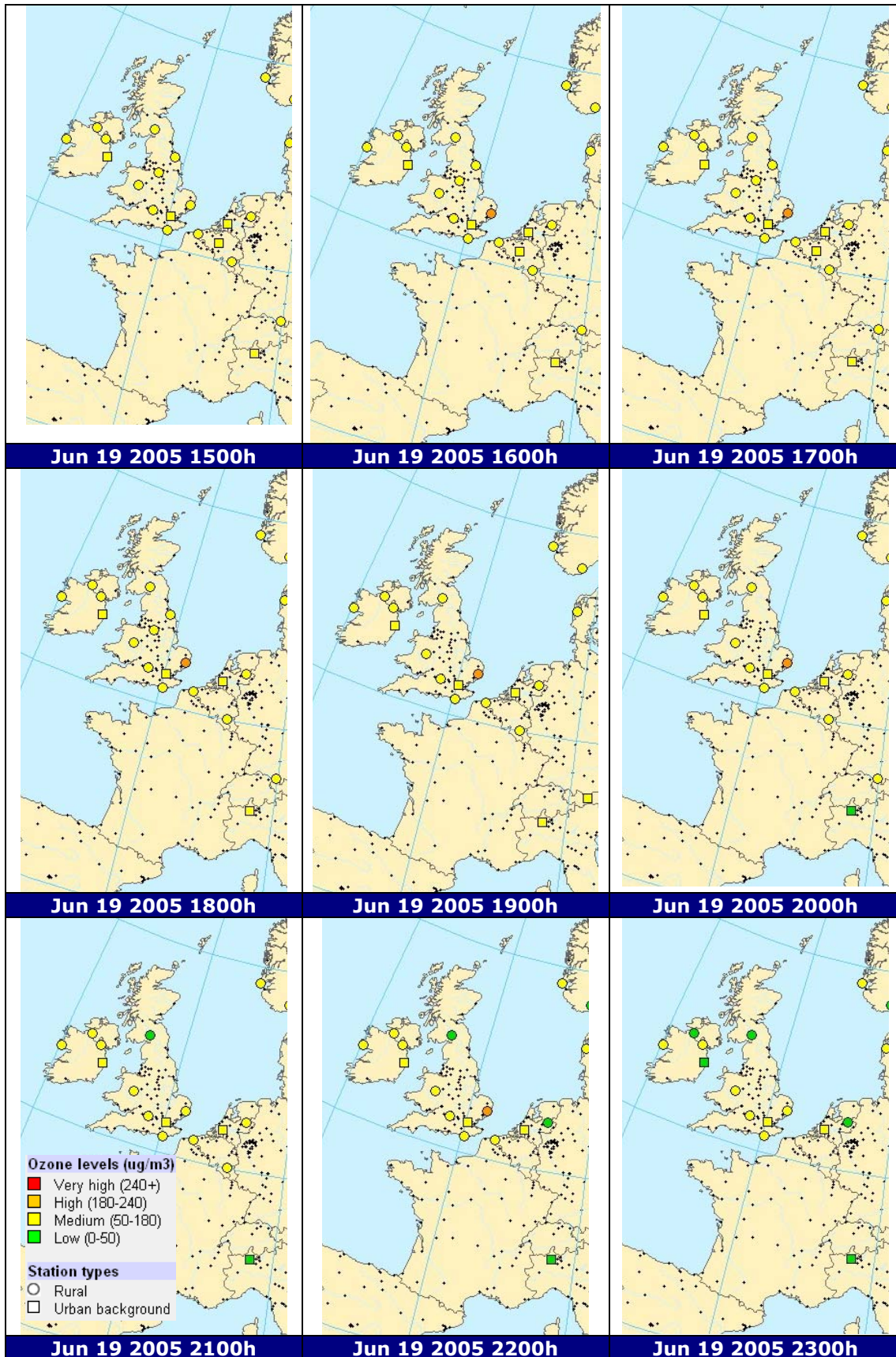
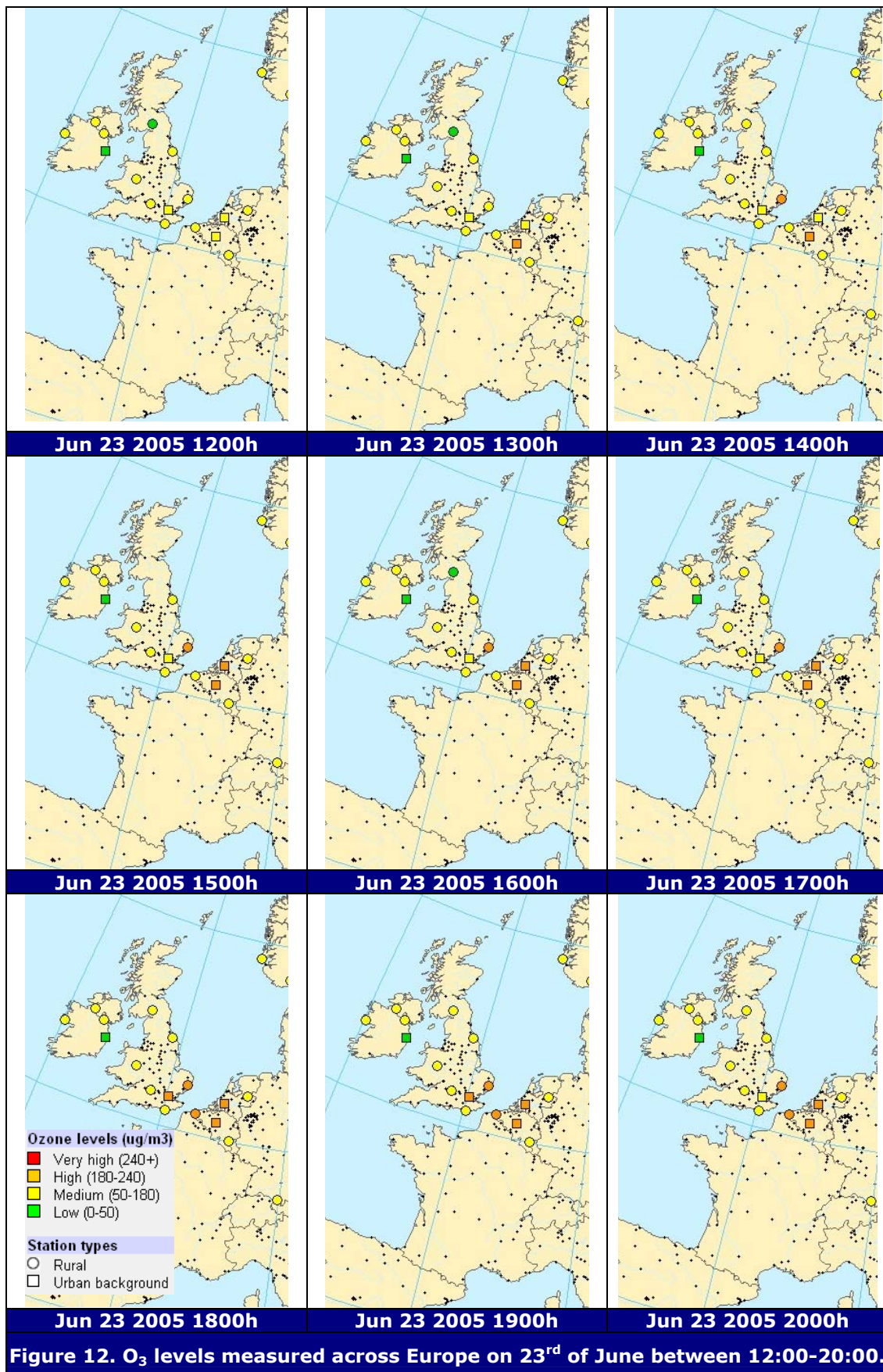


Figure 11. O<sub>3</sub> levels measured across Europe on 19<sup>th</sup> of June between 15:00-23:00

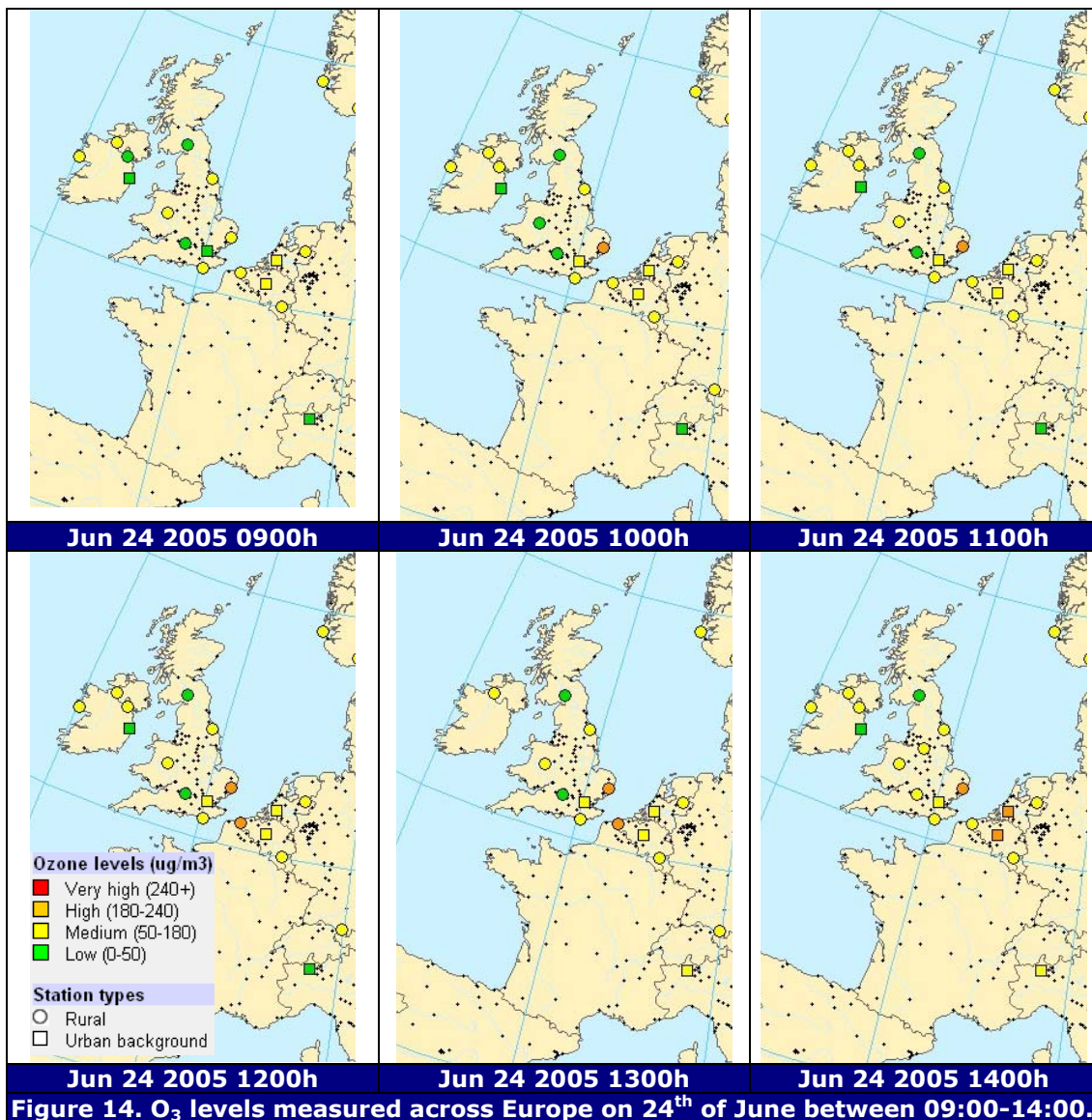
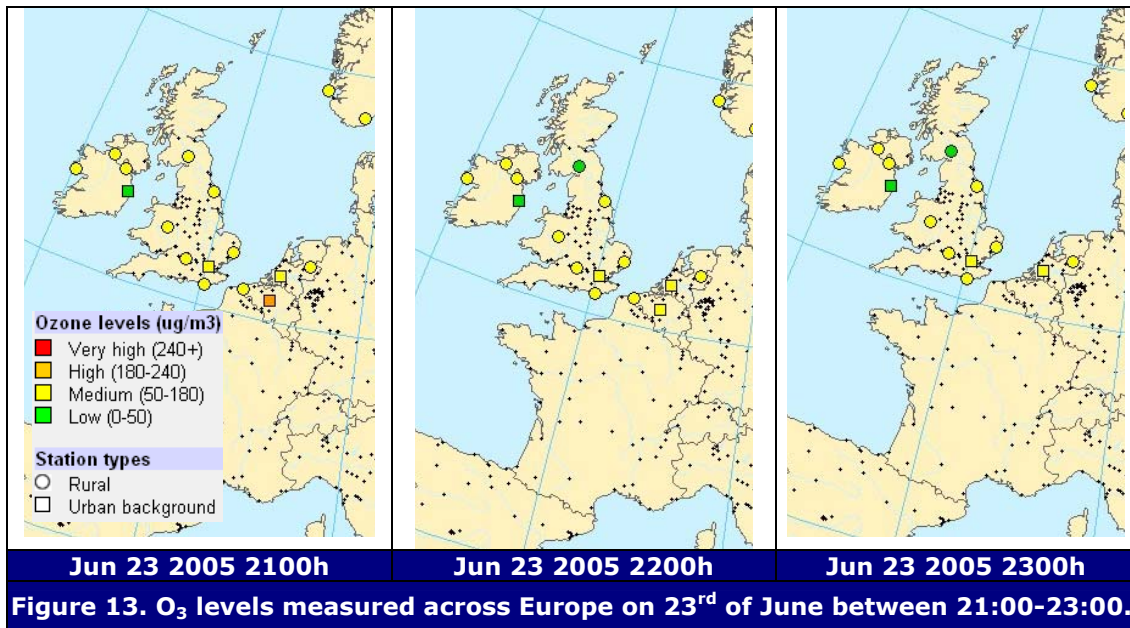
\* Data and maps from <http://ozone.eionet.eu.int>

\*\*All data is provisional



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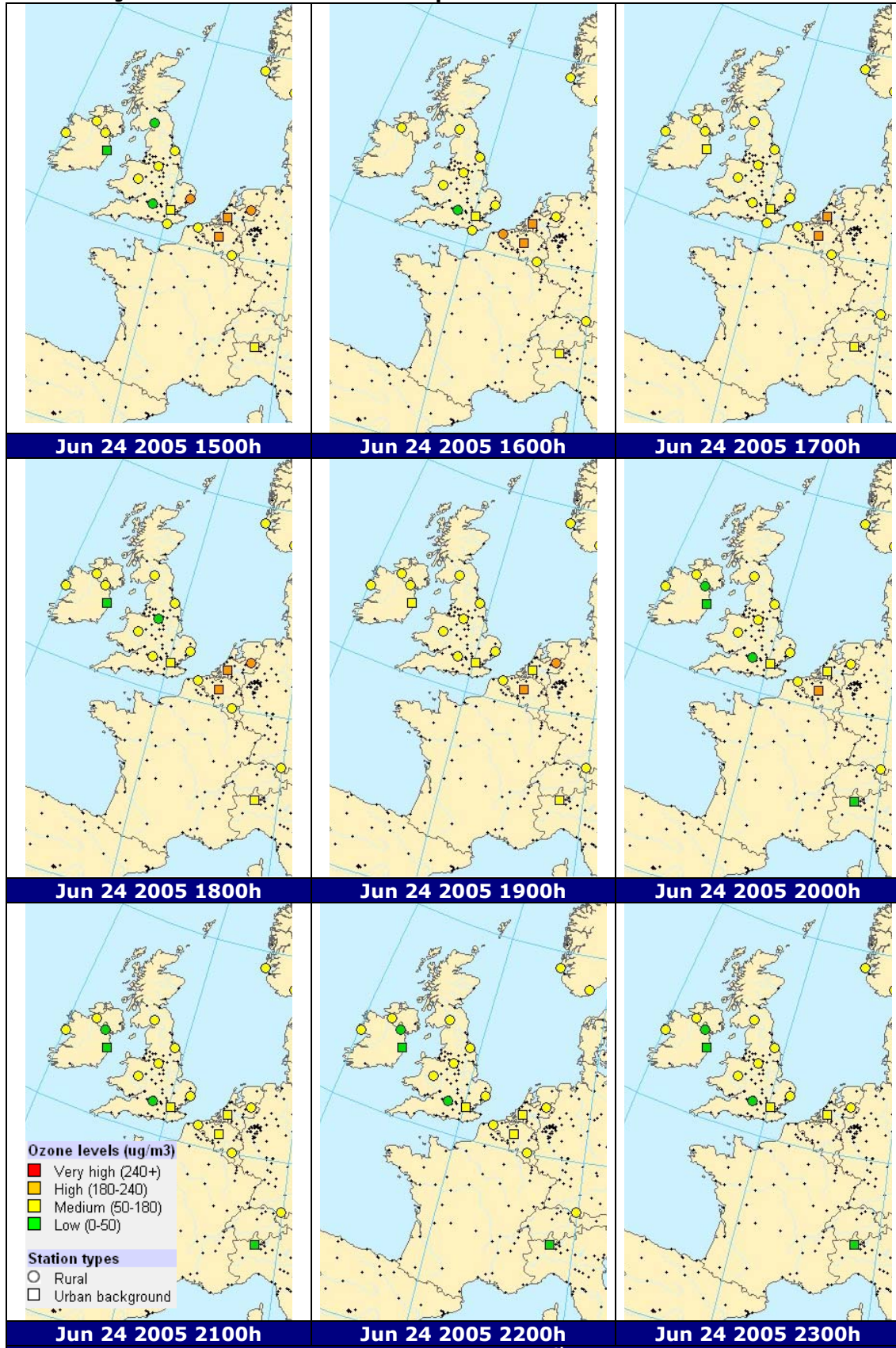
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**Table 7. O<sub>3</sub> levels measured across Europe on 24<sup>th</sup> of June between 15:00-23:00.**



**Figure 15. O<sub>3</sub> levels measured across Europe on 24<sup>th</sup> of June between 15:00-23:00.**

\* Data and maps from <http://ozone.eionet.eu.int>

\*\*All data is provisional

## SUMMARY

The main features of the June/July 2005 ozone episode may be summarised as follows:

- High summer temperatures and re-circulating air over Europe and the UK resulted in the first prolonged ozone episode of 2005 (in June).
- The June episode was also measured across Europe in Belgium and the Netherlands.
- High summer temperatures in July did not result in HIGH levels of ozone due to the lack of re-circulation of air over Europe or the UK.
- The area affected by the June episode was limited to the south east England and Greater London.
- Changes of airmass back trajectories brought the episode to an end as clean air arrived from the Atlantic
- The highest hourly average ozone concentration recording during the episode was  $202 \mu\text{g m}^{-3}$  (index 7), which occurred at Weybourne on 24<sup>th</sup> June.
- Measured ozone levels during the June episode did not exceed the Directive 2002/3/EC alert threshold of  $240 \mu\text{g m}^{-3}$  (120 ppb) as an hourly average over three consecutive hours.

## REFERENCE:

Targa, J (2004) **Air Pollution Forecasting: Ozone Pollution Episode Report (July-August 2004)**

Kent, A (2003) **Air Pollution Forecasting: Ozone Pollution Episode Report (August 2003)**