Annual Report for the UK Ambient Hydrocarbon Automatic Air Quality Monitoring Network, 2001

November 2002

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Title	Annual Report for the UK Ambient Hydrocarbon Automatic Air Quality Monitoring Network, 2001
Customer	Department for Environment, Food and Rural Affairs, The Scottish Executive, Welsh Assembly Government and Department of the Environment in Northern Ireland.
Customer reference	EPG 1/3/175
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File reference	EEQC 45010
Report number	AEAT/ENV/R/1250
Report status	Issue 3

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1 Introduction

This report contains information on the operation and performance of the UK Ambient Hydrocarbon Automatic Air Quality Monitoring Network (The UK Hydrocarbon Network). The presented information and data cover the monitoring period 1 January 2001 to 31 December 2001 with subsequent ratification.

The ratified data have been made available on the World Wide Web at:
http://www.airquality.co.uk/archive/data_and_statistics.php?f_group_id=7&action=step1&go=Step+1

This report contains:

- The definition of a Data Quality Code for each reported hydrocarbon.
- A summary of the Data Quality Codes assigned to the data presented on the web.
- The definition of the Target Data Capture Limits.
- A summary of the reasons for data loss where the Target Data Capture objectives were not achieved.
- Statistical information for each measured hydrocarbon for the whole year.
- Graphical plots of Rolling Annual Means and diurnal variations.

2 Hydrocarbon Data Quality

2.1 DEFINITION OF DATA QUALITY CODES

All hydrocarbon data are assigned a quality value. In general ratified hourly data have an uncertainty (at 95% confidence) of ± 10% for values above 0.1 ppb and ±0.01 ppb for values below 0.1 ppb. These data are termed 'good quality'.

In some cases, because of instrument problems, data cannot be described as 'good' quality, but the data may still be of use to the research community modellers and are therefore, included in the archive. This is termed 'acceptable' quality data, and has an uncertainty (at 95% confidence) of ± 25% above 0.2ppb and ± 0.05 ppb below 0.2 ppb.

Data that do not meet either the ‘good’ or ‘acceptable’ criteria do not appear in the archive.

Each month's data are assigned a Data Quality Code for each species as follows:

Data Quality Code	
A	all 'good' quality data
B	most (> 75%) data points 'good', remainder 'acceptable' quality
C	roughly equal numbers of 'good' and 'acceptable' quality data
D	some (< 25%) data points 'good' quality; remainder 'acceptable' quality
E	all points 'acceptable' quality

Some of the instrument problems that affect data quality, such as peak splitting, interference of unknown compounds and co-elution, are well documented. More detailed technical descriptions of these problems can be found in previous reports (The UK Hydrocarbon Monitoring Network Final Report, AEA/RAMP/18358030/13, July 1995)

2.2 SUMMARY OF ASSIGNED DATA QUALITY CODES

2.2.1 Cardiff

All data were assigned data quality codes A to D with the exception of the following compounds that were assigned data quality code E:

- Ethane because of possible natural gas contamination.
- Ethyne and 2-Methylpropane because of partial co-elution between these two compounds.
- n-Hexane and Isoprene because of partial co-elution between these two and other unknown compounds.
- n-Heptane, Toluene, Ethylbenzene, (m+p)-Xylene and o-Xylene because of variable trapping.
- All other compounds were assigned data quality code A.

2.2.2 Edinburgh

All data were assigned data quality codes A to D with the exception of the following compounds that were assigned data quality code E:

- Ethane and Ethene because of peak splitting.
- Ethyne and 2-Methylpropane because of partial co-elution between these two compounds.
- n-Hexane and Isoprene because of partial co-elution between these two and other unknown compounds.
- Ethylbenzene, (m+p)-Xylene and o-Xylene because of variable trapping.
- All other compounds were assigned data quality code A.

2.2.3 Harwell

All data were assigned data quality codes A to D with the exception of the following compounds that were assigned data quality code E:

- n-Hexane, Isoprene, Ethylbenzene, (m+p)-Xylene and o-Xylene because of partial co-elution between these and other unknown compounds.
- All other compounds were assigned data quality code A.

2.2.4 Marylebone Road

Data quality code E was assigned to all compounds for a period during March. The response of the PE/ATD400 to the injection of the on-site standard displayed a higher than usual degree of variability for this period. The degree of variability of the response resulted in a level of uncertainty (at 95% confidence) of greater than 10%.
All other compounds and periods were assigned data quality code A.

2.3 TARGET DATA CAPTURE LIMITS

The data capture is the number of ratified hourly data values expressed as a percentage of the number of hours in the specified period.
The network target data capture limits are set at 90% for Benzene and 1,3-Butadiene and at least 50% for the remaining compounds. This also takes into account the data quality objectives set for Benzene in the EU Daughter Directive.
Some of the instrument problems that affect data capture, such as peak splitting, interference of unknown compounds and co-elution, are well documented. More detailed technical descriptions of these problems can be found in previous reports (The UK Hydrocarbon Monitoring Network Final Report, AEA/RAMP/18358030/13, July 1995).

2.4 SUMMARY OF DATA CAPTURE

Tables 1.1 to 1.4, Appendix 1 contain statistical information relating to the ratified data, for each measured hydrocarbon, over the period 1 January 2001 to 31 December 2001. The tables list the percentage data capture, maximum concentration, mean concentration and minimum concentration of each hydrocarbon. The data capture is the number of ratified hourly data values expressed as a percentage of the number of hours in the specified period.

The periods when data for benzene and 1,3-butadiene were available, for all the sites, are plotted graphically in Figures 1 to 8, Appendix 2.

2.4.1 Cardiff

The data capture values for Benzene and 1,3-Butadiene were 92.7% and 90.8% respectively.
For Ethyne and 2-Methylpropane the data capture was 8.8% because of co-elution between these two compounds.
For o-Xylene the data capture was 40.6% because of co-elution with an unknown compound.
All other compounds had a data capture greater than 50%.

2.4.2 Edinburgh

The data capture value for Benzene was greater than 90%.
The data capture value for 1,3-Butadiene was 87.7%. This was affected by two problems. During November the on site hydrogen generator failed and could not be repaired. There was a period of data loss until it could be replaced with another generator.
There were some very low measured concentrations of 1,3-Butadiene throughout the year. At these levels the peak integration becomes unreliable and these data were rejected.
All other compounds had a data capture greater than 50%.

2.4.3 Harwell

The data capture values for Benzene and 1,3-Butadiene were 92.8% and 92.9% respectively.
The data capture values for cis-2-Butene was 28.2%, trans-2-Pentene 32.9%, cis-2-Pentene 10.2% and Isoprene 43.6%. There were some very low measured concentrations of these compounds throughout the year. At these levels the peak integration becomes unreliable and these data were rejected.
For o-Xylene the data capture was 45.0% because of co-elution with an unknown compound.
All other compounds had a data capture greater than 50%.

2.4.4 Marylebone Road

The data capture values for Benzene was 84.5% and for 1,3-Butadiene 86.1%.
Four faults resulted in loss of data:

- In March a fault occurred with the oven fan motor of the Perkin Elmer/ATD400. The oven fan motor was replaced under the terms of the service agreement. Within a number of days a second fault occurred with one of the heater elements. After replacement of the heater elements there appeared there was a fault with the replacement oven fan motor. A

second replacement fan motor was not immediately available. The delay in obtaining a second replacement motor resulted in a period of data loss totalling nearly a month.

- The cabin air conditioning unit developed a fault during July. The air temperature within the cabin was elevated on a number of occasions. The Perkin Elmer GC oven could not cool to the temperature required at the beginning the analytical cycle. This fault resulted in several periods of data loss. The air conditioning unit was replaced on 15 August.
- The GC cold trap developed a fault on 23 August and was replaced during a service visit on the 25 August.
- After the service visit on the 25 August parts of the generated chromatograms were affected by electrical noise. The source of the noise was traced to a faulty FID heater assembly. The FID was serviced and the heater assembly repaired on 25 September.

All other compounds had a data capture greater than 50%.

3 Discussion

3.1 ROLLING ANNUAL MEANS

The rolling annual means (RAMs) for benzene and 1,3-butadiene for the period January 1999 to December 2001are plotted in figures 1 to 4, Appendix 3. All the plots exhibit a significant decrease in the RAM for benzene. For 1,3-butadiene the reduction is less well pronounced, the smallest change being observed at the Edinburgh and Harwell sites.

Considering the relative concentrations of the benzene to 1,3-butadiene, there appear to be three distinct sections to the RAM plots.

- January 1999 to December 1999, the trends in the RAMS for benzene and 1,3-butadiene, although differing in magnitude, are similar at all sites.
- December 1999 to December 2000, the RAM for benzene decreases relative to the RAM for 1,3-butadiene at all sites.
- December 2000 to December 2001, the trends in the RAMs of benzene and 1,3-butadiene are similar at all sites.

The reduction in the plotted RAM for benzene relative to that of 1,3-butadiene may be due in part to the changes in the benzene content in petrol. Prior to 1 January 2000, legislation allowed a maximum concentration of 5% benzene in super-unleaded petrol and a maximum concentration of benzene of 2% in premium unleaded petrol. From 1 January 2000 the legislation was amended to allow a maximum concentration of benzene of 1% in all grades of petrol. The change in the benzene content of petrol, to meet the legislation, may well have occurred over a period of one to two months prior to the deadline. The plots of the RAMs would tend to smooth out any rapid changes in atmospheric concentrations.

Figure 1 is a plot of the monthly mean concentrations of the benzene and 1,3-butadiene concentrations and the benzene:1,3-butadiene ratio for data from the Marylebone Road site. The ratios of the concentrations indicate that the change in relative concentrations occurred over a 2 to 3 month period immediately prior to January 2000.

Considering the RAMs for benzene and 1,3-butadiene for January 2001 to December 2001. At the Marylebone Road site the RAMs have continued to decrease during 2001, the trends being very similar for benzene and 1,3-butadiene. For the other sites the RAMs for benzene and 1,3-butadiene either exhibit little change or increase slightly. The data for the Cardiff and Edinburgh sites exhibits little change, the data for the Harwell site exhibiting a slight increase. Therefore during 2001 the RAMs exhibited a decrease at the roadside site, were fairly stable at urban background sites and increase slightly at the rural site. It is not clear why the RAMs for 2001 are different for the four sites. The Marylebone Road site is subject to the highest concentrations due to the proximity to the primary source. Conversely the Harwell site is a rural site and will be least influenced by local sources.

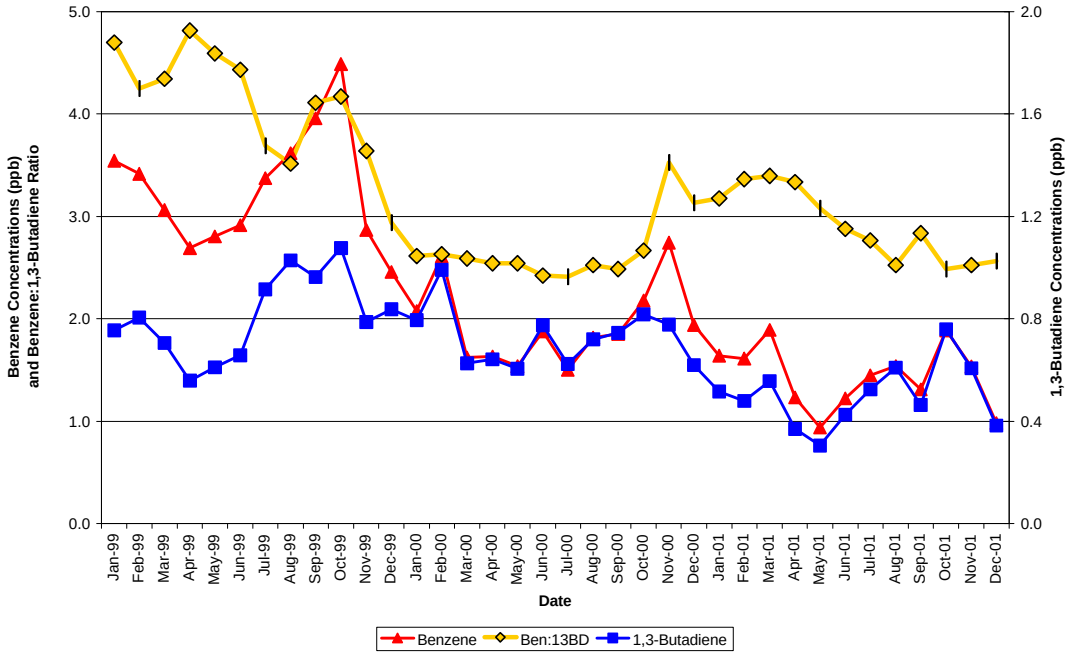

Figure 1. Monthly Mean Concentrations of benzene and 1,3-butadiene and the benzene:1,3-butadiene ratio at the Marylebone Road for the period January 1999 to December 2001.

3.2 EUROPEAN DAUGHTER DIRECTIVE FOR BENZENE

The Directive 2000/69/EC of the European Parliament and of the Council, which came into force on the 13 December 2000 defined a limit value for benzene. The defined limit value for benzene of 5 $\mu g/m^3$, expressed as an annual mean, is to be achieved by 1st January 2010. The limit value was given a margin of tolerance of 5 $\mu g/m^3$ (100%) on 13 December 2002, reducing on 1 January 2006 and every 12 months thereafter by 1 $\mu g/m^3$ to reach 0% by 1 January 2010.

The annual means for 2001 are listed in Table 1 below. All the listed annual means are below the European Union Directive limit value of 5$\mu g/m^3$. The highest annual mean was 4.55 $\mu g/m^3$ for the Marylebone Road site.

Table 1. Annual Means of measured Benzene Concentrations at each of the UK Automatic Hydrocarbon Sites for 2001

Monitoring Site	Annual Mean Concentration of Benzene ($\mu g/m^3$)
Cardiff	1.75
Edinburgh	1.33
Harwell	0.62
Marylebone Road	4.55

3.3 AIR QUALITY OBJECTIVES IN THE UK

3.3.1 Benzene

The Air Quality Strategy for the UK has set an Air Quality Objective for benzene in the UK. The objective is specified as a RAM of 16.25 $\mu g/m^3$ (5 ppb) to be met by the end of 2003 and a RAM of 1 ppb to be met by end of 2010.

The RAMs for benzene at the Cardiff, Edinburgh and Harwell sites are well below the objective of 16.25 $\mu g/m^3$ to be met by end of 2003 and also the objective of 1.54 $\mu g/m^3$ to be met by end of 2010. At Marylebone Road the RAM for benzene at the end of 2001 was approximately 4.55 $\mu g/m^3$ (1.40 ppb). The RAM was well below the objective of 16.25 $\mu g/m^3$ (5ppb) to be met by end of 2003 but close to the objective of 5 $\mu g/m^3$ (1.54 ppb) to be achieved by the end of 2010.

In August 2002 updated Air Quality Objectives were announced. Henceforth the Air Quality Objective for benzene will be 5 $\mu g/m^3$ as an annual mean to be met by end of 2010.

3.3.2 1,3-Butadiene

The Air Quality Objective for 1,3-butadiene is specified as a RAM of 2.25 $\mu g/m^3$ (1 ppb) to be met by the end of 2003.

The RAM of the measured concentrations of 1,3-butadiene at each of the sites is listed in Table 2 below. All the reported RAMs are well below the Air Quality Objective. The highest RAM being 1.12 $\mu g/m^3$ at the Marylebone Road site.

Table 2. Rolling Annual Mean Concentrations of 1,3-butadiene at the UK Automatic Hydrocarbon Network sites at the end of December 2001.

Monitoring Site	Annual Mean Concentration of 1,3-Butadiene ($\mu g/m^3$)
Cardiff	0.27
Edinburgh	0.20
Harwell	0.11
Marylebone Road	1.12

3.4 DIURNAL VARIATIONS OF BENZENE AND 1,3-BUTADIENE.

The diurnal average concentrations of benzene and 1,3-butadiene for 2001 are plotted in figures 1 to 4 Appendix 4. The diurnal plots are similar for the Cardiff, Edinburgh and Marylebone Road sites. The diurnal variation for the Harwell site is significantly different to those for the other three sites. The diurnal variations at the Cardiff, Edinburgh and the Marylebone Road site are well defined whereas the diurnal variations at the Harwell site are much less pronounced.

In terms of magnitude of the observed concentrations the order of highest to lowest is Marylebone Road, Cardiff, Edinburgh and Harwell. Considering the three 3 urban sites, the Marylebone Road site exhibited the least well defined diurnal variation although the site did record the highest average concentrations. It is possible that high levels of traffic density are present for much longer periods of the day, whereas the Cardiff and Edinburgh sites have better defined 'rush hours'.

The Harwell monitoring site is in a rural location and some distance from a major road. The observed concentrations are the lowest of the four sites. The observed diurnal trend is different to that for the other three sites. The highest concentrations are observed from about 20:00 to about 03:00 Hrs, the lowest concentrations about 11:00 to 16:00 Hrs. The diurnal trend is probably a result of a combination of a minor 'rush hour' trend with that due to diurnal variation in atmospheric mixing.

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Summary Statistical Information

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Table 1.1 Percentage data capture maximum, mean and minimum values of ratified data from the Cardiff site of the UK Hydrocarbon Network, for the period 1 January 2001 to 31 December 2001

Compound	%data capture	Maximum concentration (ppb)	Mean concentration (ppb)	Minimum concentration (ppb)
Ethane	93.06	58.45	5.80	1.41
Ethene	93.06	46.19	2.99	0.20
Propane	93.08	68.81	2.42	0.33
Propene	93.08	11.01	1.11	0.21
Ethyne	8.84	7.22	1.36	0.12
2-Methylpropane	8.85	8.36	0.91	0.09
n-Butane	92.98	39.57	2.63	0.17
trans-2-Butene	92.97	1.37	0.15	0.02
1-Butene	83.68	2.14	0.14	0.01
cis-2-Butene	85.94	1.30	0.09	0.01
2-Methylbutane	92.72	23.72	1.76	0.06
n-Pentane	92.99	15.60	0.72	0.05
1,3-Butadiene	90.75	2.09	0.12	0.00
trans-2-Pentene	88.32	1.55	0.09	0.01
cis-2-Pentene	78.46	0.83	0.05	0.01
(2+3)-Methylpentane *	92.34	57.63	0.66	0.01
Isoprene	88.09	5.59	0.10	0.01
n-Hexane	92.92	109.70	0.31	0.01
n-Heptane	87.65	8.45	0.11	0.01
Benzene	92.67	6.41	0.54	0.05
Toluene	90.76	22.38	1.49	0.03
Ethylbenzene	72.19	3.51	0.33	0.02
(m+p)-Xylene *	74.91	11.28	0.83	0.02
o-Xylene	40.59	4.67	0.29	0.02

* (2+3)-Methylpentane and (m+p)-Xylene are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Table 1.2 Percentage data capture maximum, mean and minimum values of ratified data from the Edinburgh site of the UK Hydrocarbon Network, for the period 1 January 2001 to 31 December 2001

Compound	%data capture	Maximum concentration (ppb)	Mean concentration (ppb)	Minimum concentration (ppb)
Ethane	89.10	98.33	3.70	0.26
Ethene	89.25	47.47	1.33	0.04
Propane	91.51	291.30	3.59	0.18
Propene	91.45	103.00	1.06	0.24
Ethyne	71.67	52.91	1.60	0.11
2-Methylpropane	72.16	85.57	1.36	0.04
n-Butane	91.52	213.80	2.49	0.06
trans-2-Butene	91.45	2.64	0.16	0.01
1-Butene	86.30	3.07	0.09	0.01
cis-2-Butene	87.45	1.86	0.08	0.01
2-Methylbutane	91.61	54.50	1.11	0.03
n-Pentane	91.59	60.87	0.70	0.03
1,3-Butadiene	87.74	2.82	0.09	0.00
trans-2-Pentene	86.54	2.12	0.06	0.01
cis-2-Pentene	68.68	1.01	0.03	0.01
(2+3)-Methylpentane *	91.45	17.29	0.44	0.01
Isoprene	73.65	1.11	0.05	0.00
n-Hexane	91.54	14.49	0.37	0.01
n-Heptane	90.34	3.04	0.08	0.00
Benzene	91.55	7.61	0.41	0.10
Toluene	90.87	34.21	1.14	0.02
Ethylbenzene	81.80	5.68	0.19	0.00
(m+p)-Xylene *	84.20	20.32	0.66	0.01
o-Xylene	75.06	6.84	0.23	0.01

* (2+3)-Methylpentane and (m+p)-Xylene are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Table 1.3 Percentage data capture maximum, mean and minimum values of ratified data from the Harwell site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

Compound	%data capture	Maximum concentration (ppb)	Mean concentration (ppb)	Minimum concentration (ppb)
Ethane	92.79	11.45	1.75	0.15
Ethene	91.79	7.28	0.60	0.03
Propane	93.03	14.39	1.00	0.05
Propene	93.05	5.33	0.26	0.05
Ethyne	56.99	7.39	0.59	0.04
2-Methylpropane	56.53	3.89	0.27	0.01
n-Butane	92.99	12.87	0.63	0.02
trans-2-Butene	68.61	0.49	0.04	0.00
1-Butene	62.58	0.45	0.04	0.00
cis-2-Butene	28.26	0.99	0.03	0.00
2-Methylbutane	92.85	6.92	0.37	0.01
n-Pentane	90.76	1.84	0.14	0.01
1,3-Butadiene	92.87	0.98	0.05	0.01
trans-2-Pentene	32.96	0.60	0.02	0.00
cis-2-Pentene	10.27	0.27	0.01	0.00
(2+3)-Methylpentane *	84.27	1.77	0.13	0.00
Isoprene	43.61	0.35	0.03	0.00
n-Hexane	72.47	0.82	0.04	0.00
n-Heptane	70.83	0.87	0.04	0.00
Benzene	92.77	2.04	0.19	0.01
Toluene	85.58	7.99	0.36	0.02
Ethylbenzene	58.08	0.78	0.07	0.00
(m+p)-Xylene *	65.75	2.56	0.18	0.00
o-Xylene	45.02	0.98	0.08	0.00

* (2+3)-Methylpentane and (m+p)-Xylene are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Table 1.4 Percentage data capture maximum, mean and minimum values of ratified data from the Marylebone Road site for the period; 1 January 2001 to 31 December 2001

Compound	%data capture	Maximum concentration (ppb)	Mean concentration (ppb)	Minimum concentration (ppb)
Ethane	85.82	78.74	7.96	1.45
Ethene	85.80	66.92	8.91	0.31
Propane	84.63	298.20	3.41	0.31
Propene	85.33	17.35	2.91	0.06
Ethyne	85.50	35.60	5.24	0.15
2-Methylpropane	85.81	53.80	3.53	0.18
n-Butane	85.91	90.53	7.20	0.02
trans-2-Butene	86.06	4.88	0.42	0.01
1-Butene	85.99	4.42	0.51	0.02
cis-2-Butene	86.05	3.51	0.34	0.01
2-Methylbutane	86.11	60.21	6.30	0.25
n-Pentane	86.12	11.46	1.61	0.10
1,3-Butadiene	86.11	3.44	0.50	0.02
trans-2-Pentene	86.10	3.41	0.39	0.01
cis-2-Pentene	85.97	1.72	0.21	0.01
2-Methylpentane	81.97	27.89	1.73	0.07
3-Methylpentane	81.94	6.25	0.95	0.04
Isoprene	76.52	1.62	0.28	0.01
n-Hexane	75.33	2.92	0.51	0.02
n-Heptane	77.93	2.29	0.28	0.01
Benzene	84.54	8.81	1.40	0.02
Toluene	84.69	45.67	5.38	0.14
Ethylbenzene	85.10	6.67	0.93	0.02
(m+p)-Xylene *	85.15	24.19	3.22	0.03
o-Xylene	85.23	8.47	1.20	0.01
1,3,5-Trimethylbenzene	82.32	13.41	0.34	0.00
1,2,4-Trimethylbenzene	82.68	42.01	1.11	0.01

* (m+p)-Xylene are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Appendix 2
Time Series Plots of Hydrocarbon Concentrations

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Figure 1. Time series plot of the ratified Benzene data from the Cardiff site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

Figure 2. Time series plot of the ratified 1,3-Butadiene data from the Cardiff site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

Figure 3. Time series plot for the ratified Benzene data from the Edinburgh site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

Figure 4. Time series plot for the ratified 1,3-Butadiene data from the Edinburgh site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

Figure 5. Time series plot for the ratified Benzene data from the Harwell site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

Figure 6. Time series plot for the ratified 1,3-Butadiene data from the Harwell site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

Figure 7. Time series plot for the ratified Benzene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

Figure 8. Time series plot for the ratified 1,3-Butadiene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

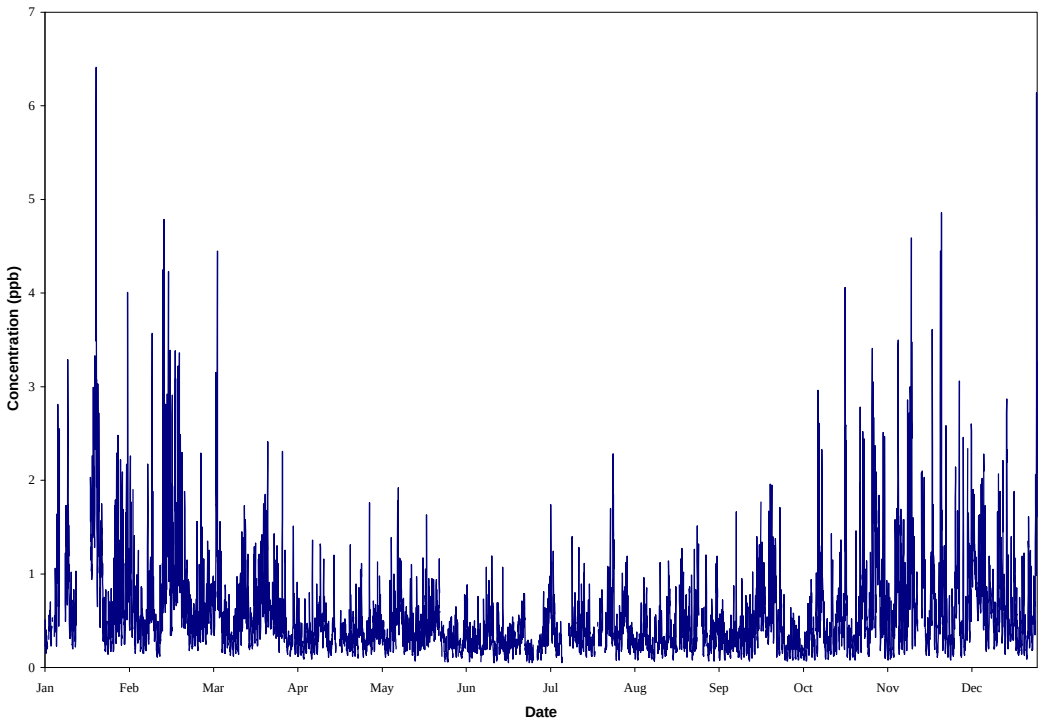

Figure 1. Time series plot of the ratified Benzene data from the Cardiff site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

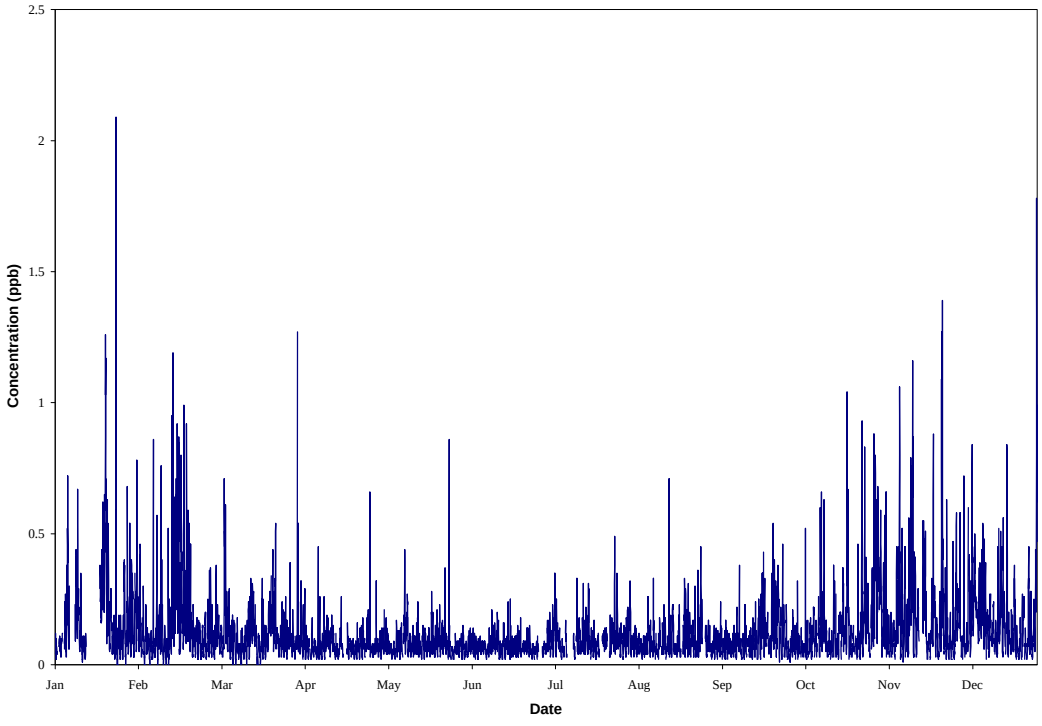

Figure 2. Time series plot of the ratified 1,3-Butadiene data from the Cardiff site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

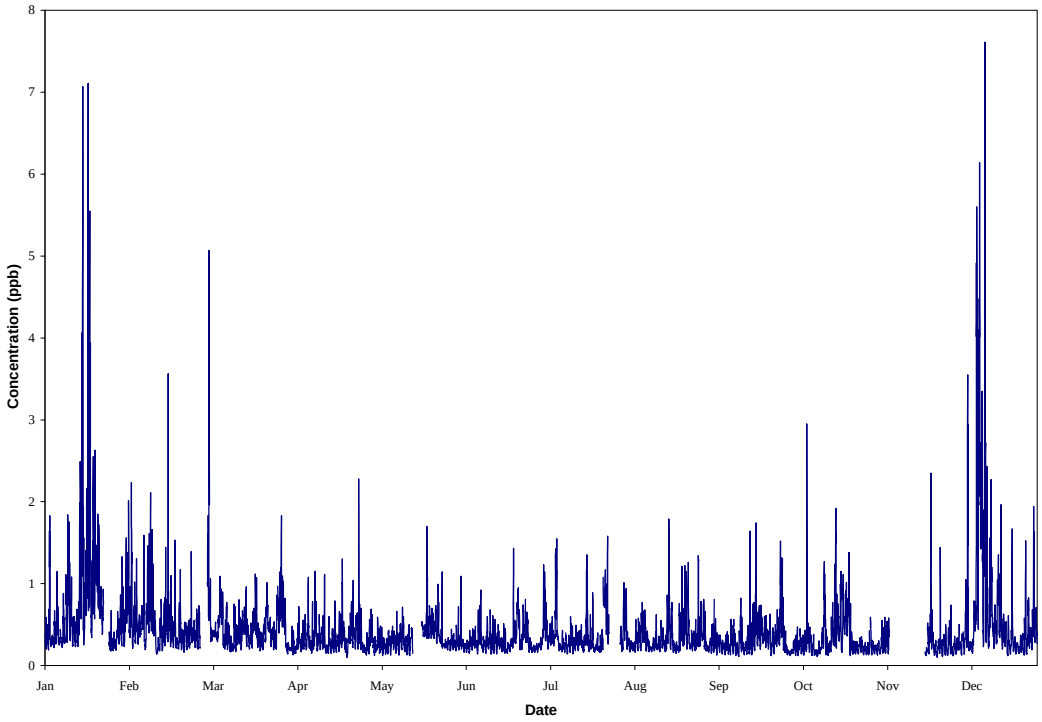

Figure 3. Time series plots for the ratified Benzene data from the Edinburgh site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

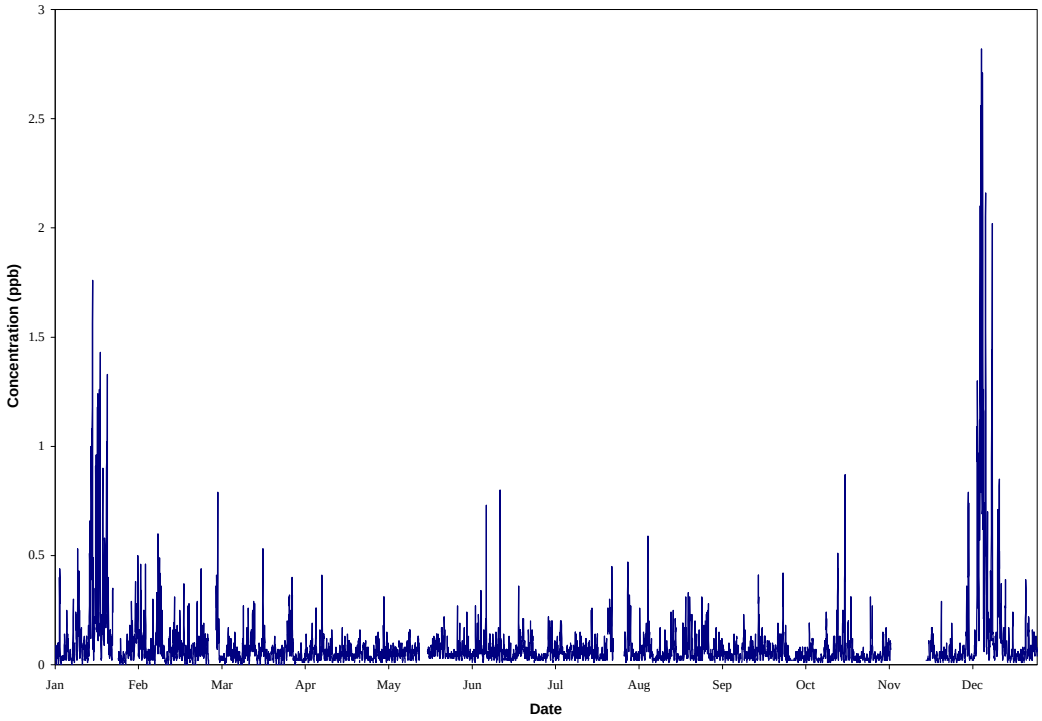

Figure 4. Time series plots for the ratified 1,3-Butadiene data from the Edinburgh site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

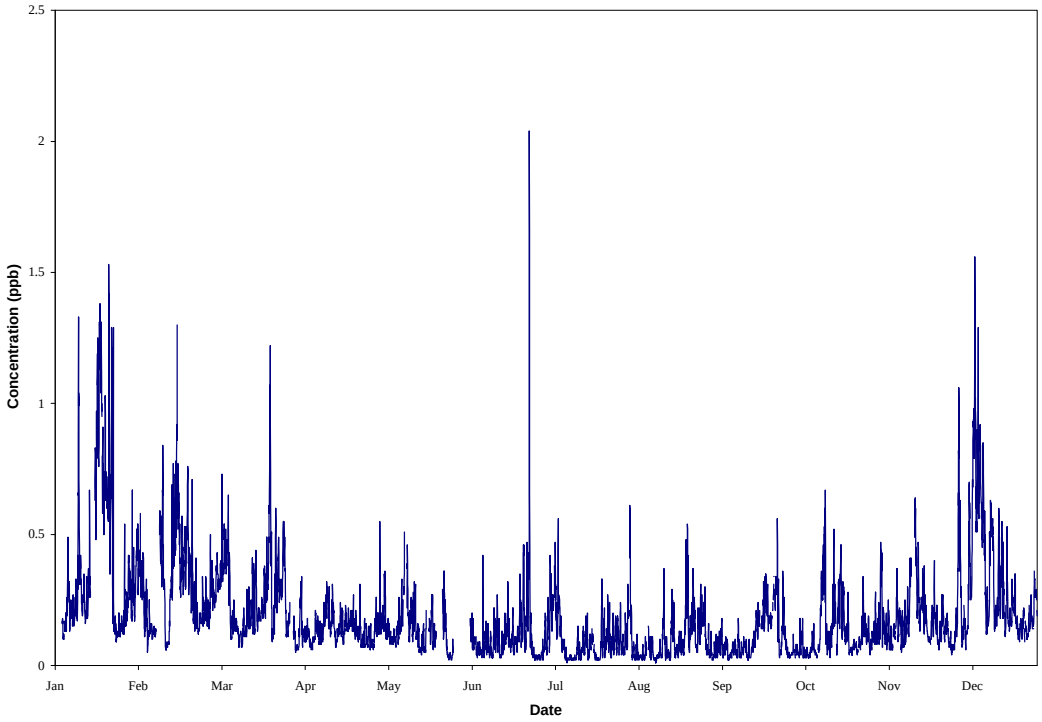

Figure 5. Time series plots for the ratified Benzene data from the Harwell site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

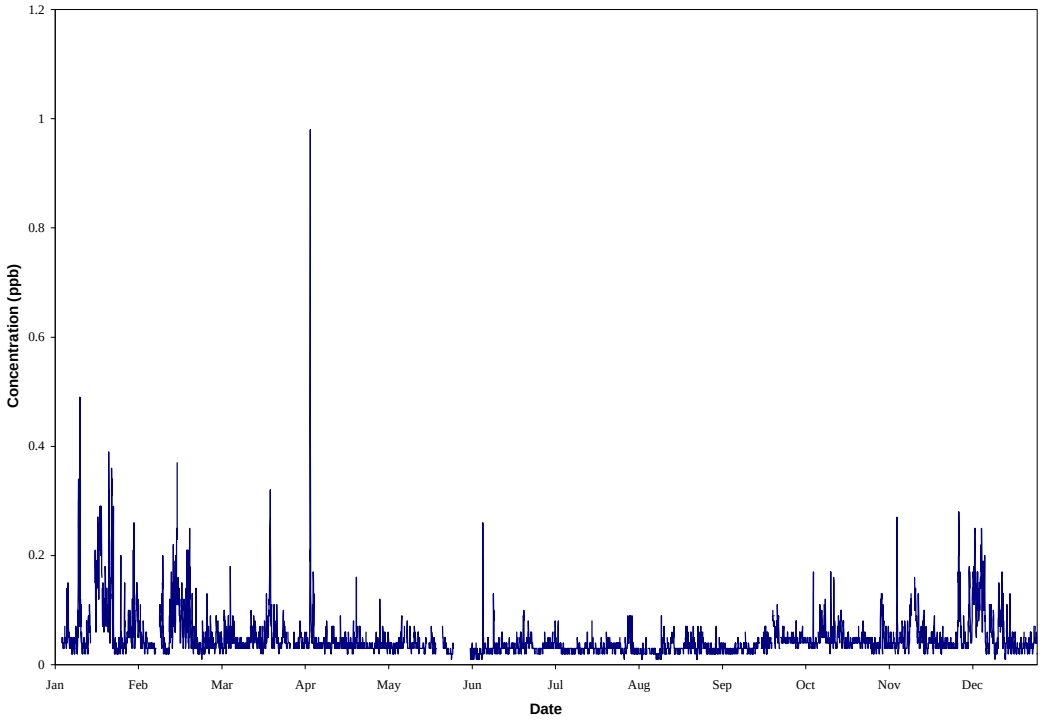

Figure 6. Time series plots for the ratified 1,3-Butadiene data from the Harwell site of the UK Hydrocarbon Network, for the period;
1 January 2001 to 31 December 2001

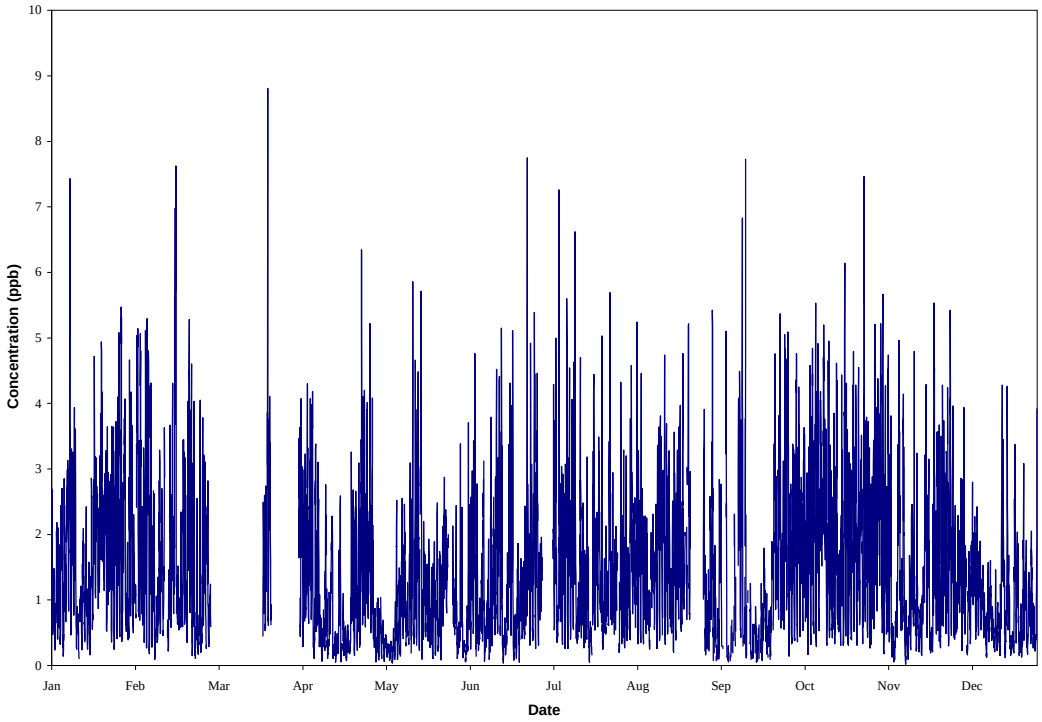

Figure 7. Time series plots for the ratified Benzene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

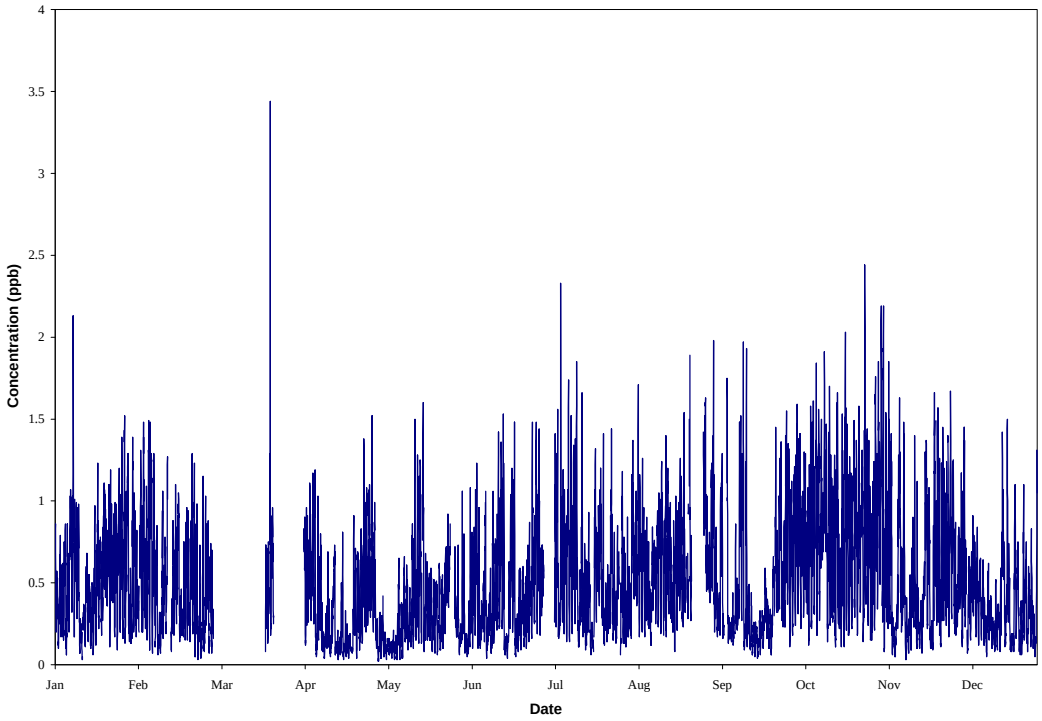

Figure 8. Time series plots for the ratified 1,3-Butadiene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001

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Figure 4. Time series plot of the rolling annual mean for Benzene and 1,3-Butadiene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; January 1999 to December 2001.

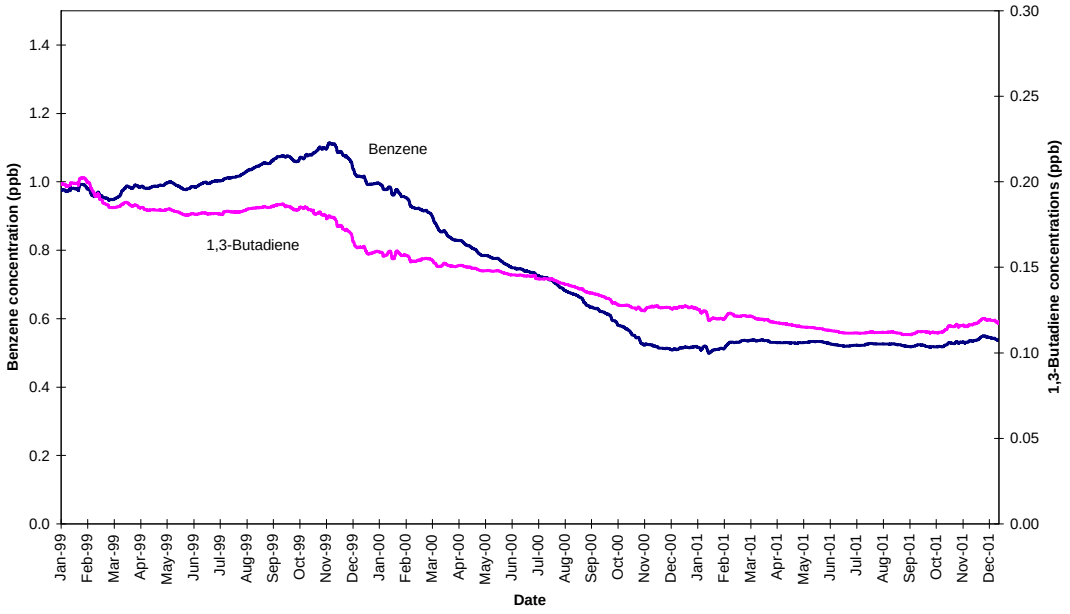

Figure 1. Time series plot of the rolling annual mean for Benzene and 1,3-Butadiene data from the Cardiff site of the UK Hydrocarbon Network, for the period; January 1999 to December 2001.

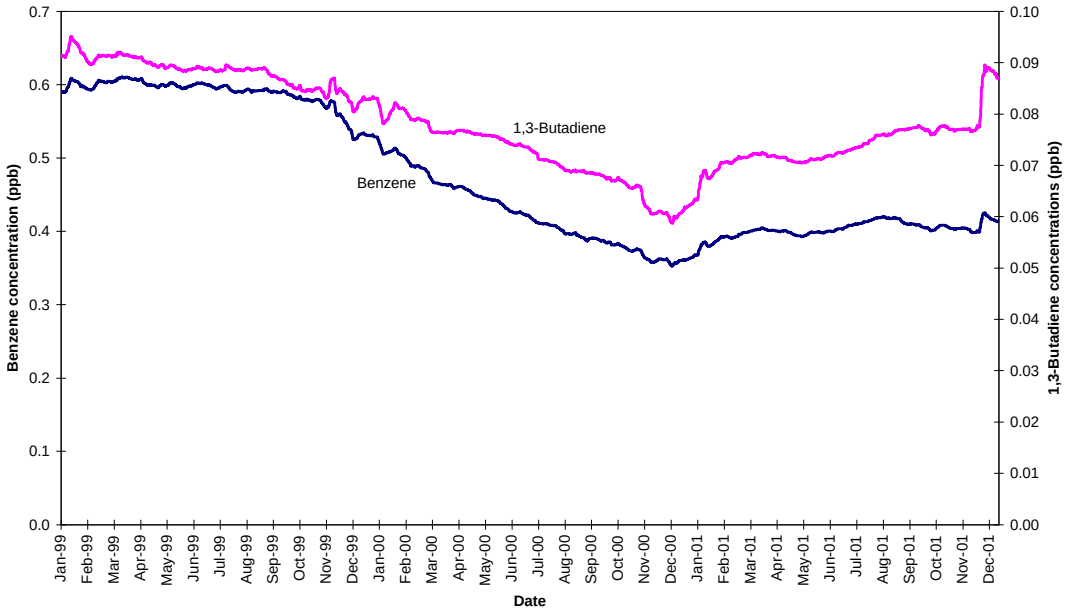

Figure 2. Time series plot of the rolling annual mean for Benzene and 1,3-Butadiene data from the Edinburgh site of the UK Hydrocarbon Network, for the period; January 1999 to December 2001.

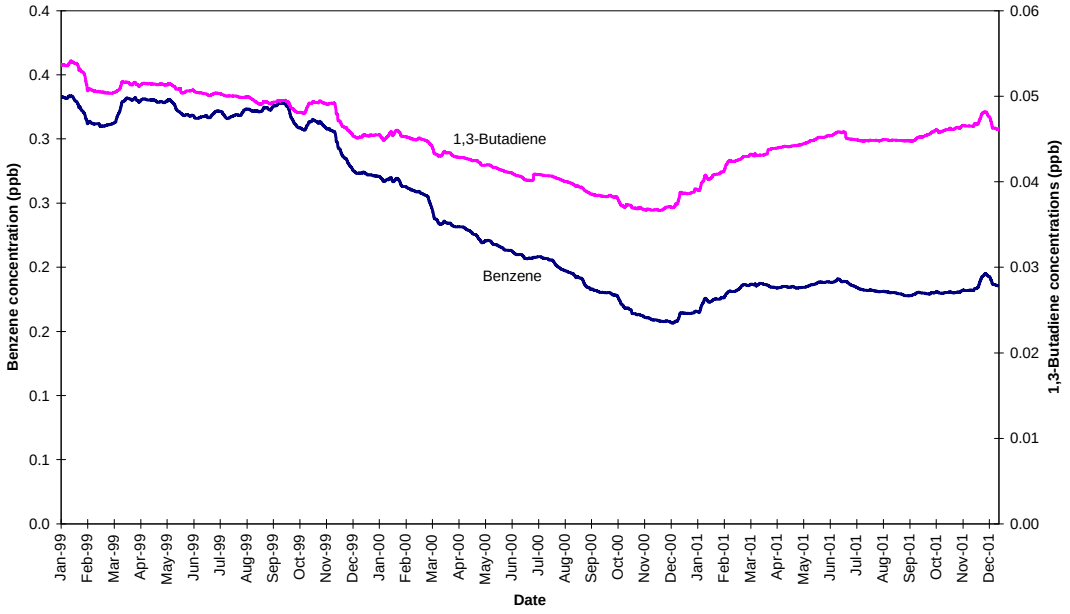

Figure 3. Time series plot of the rolling annual mean for Benzene and 1,3-Butadiene data from the Harwell site of the UK Hydrocarbon Network, for the period; January 1999 to December 2001.

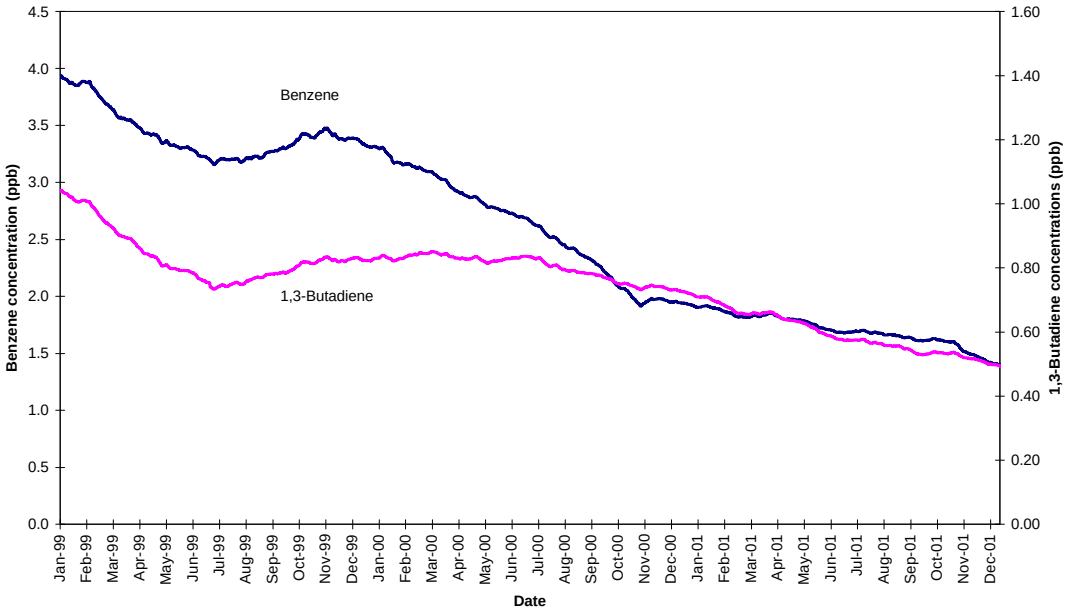

Figure 4. Time series plot of the rolling annual mean for Benzene and 1,3-Butadiene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; January 1999 to December 2001.

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Figure 4. Diurnal average concentrations from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

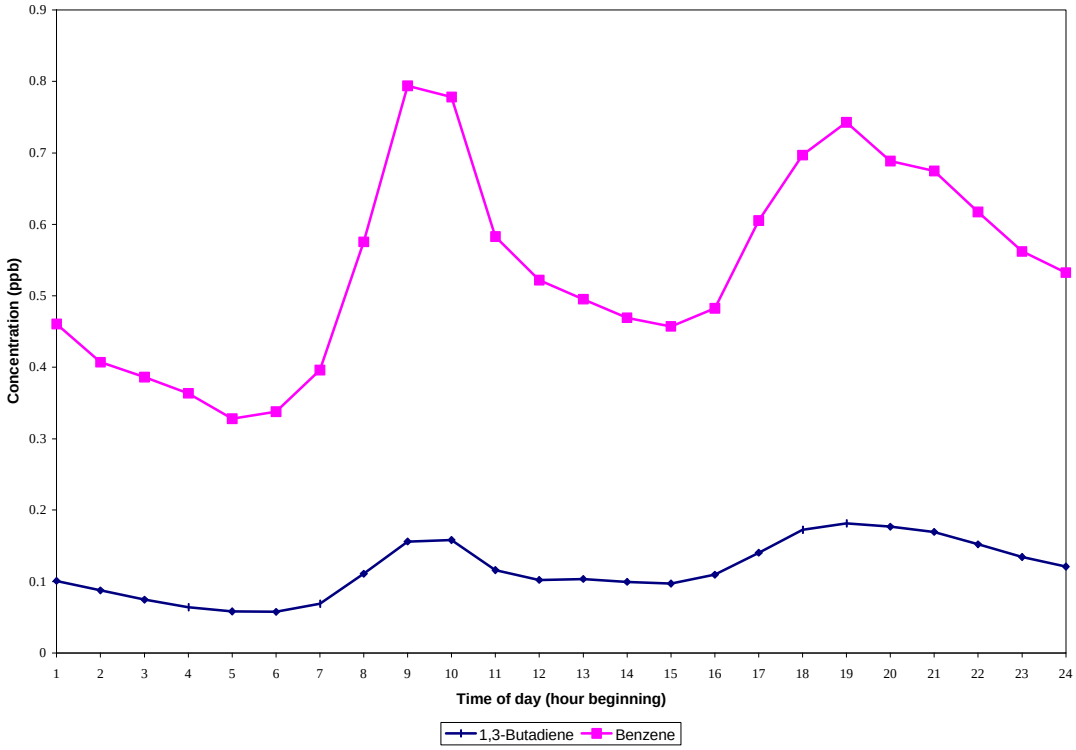

Figure 1. Diurnal average concentrations from the Cardiff site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

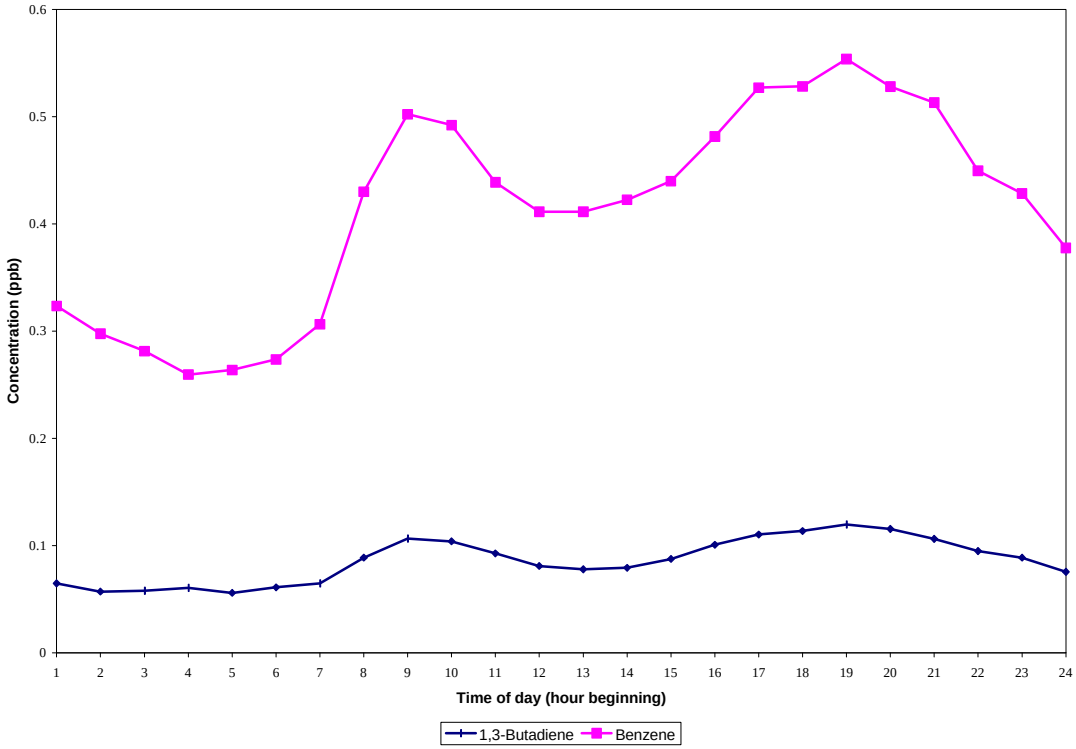

Figure 2. Diurnal average concentrations from the Edinburgh site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

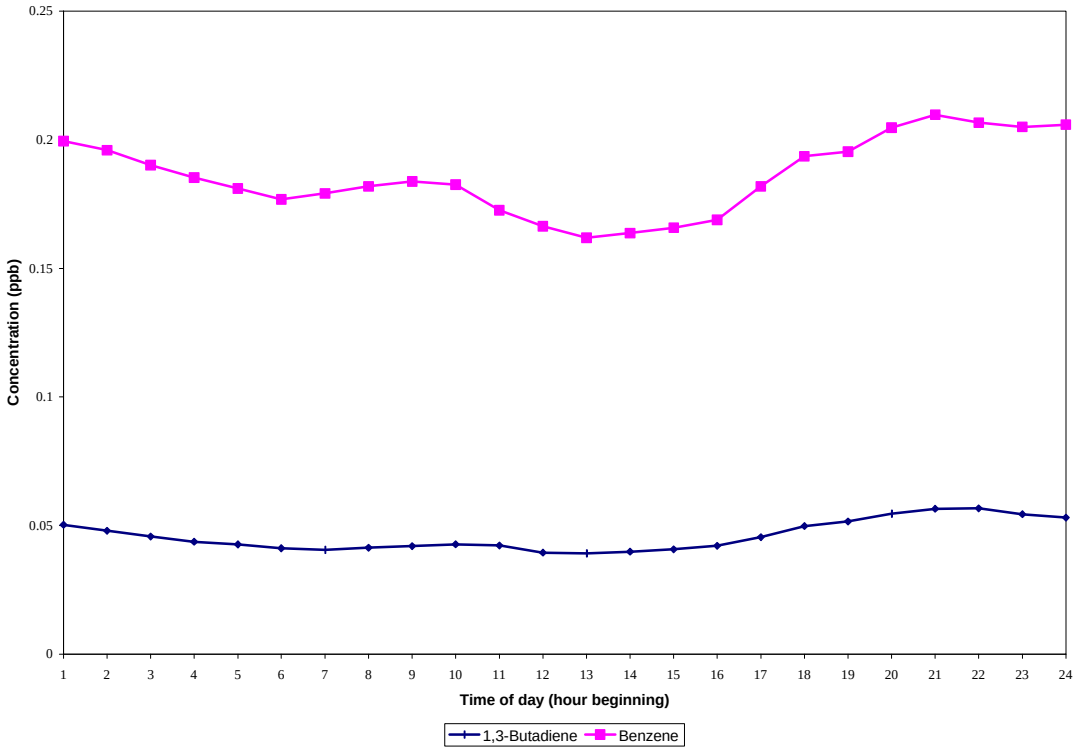

Figure 3. Diurnal average concentrations from the Harwell site of the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.

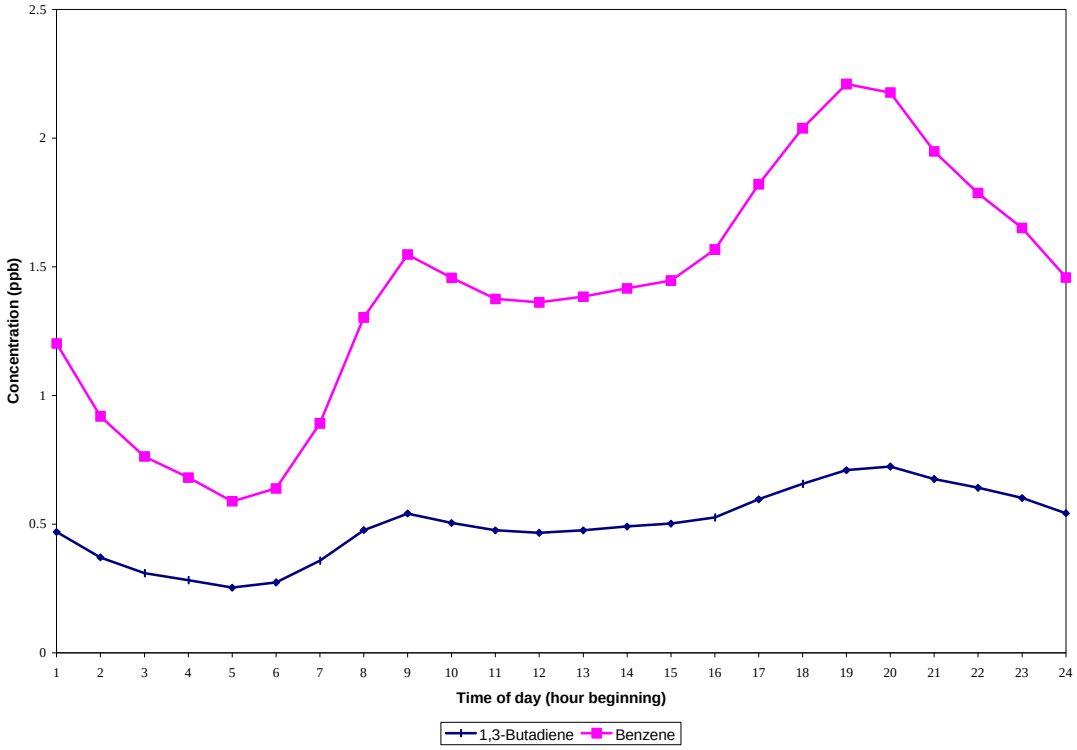

Figure 4. Diurnal average concentrations from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2001 to 31 December 2001.