Heathrow Airwatch Quarterly Report
Quarterly report for July to September 2018

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1 Introduction

This is a quarterly summary report for Heathrow Airport Limited for the period July to September 2018. This is the PDF version of the report accompanying the dynamic HTML report.

2 Monitoring stations

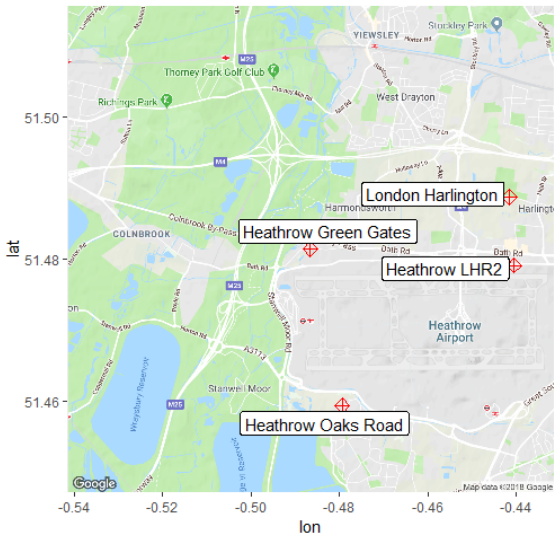A summary of site information is presented in the map and table below.

Figure 1: Site location.

Table 1: Site information summary.

Site name	Variable	Date Started	Date ended
Heathrow Green Gates	NO2	2001-07-01	Ongoing
Heathrow Green Gates	GE10	2001-05-04	Ongoing
Heathrow Green Gates	PM25	2002-04-19	Ongoing
Heathrow LHR2	PM25	2009-12-09	Ongoing
Heathrow LHR2	NO2	1993-01-01	Ongoing
Heathrow LHR2	GE10	1994-11-16	Ongoing
Heathrow Oaks Road	NO2	2001-07-01	Ongoing
Heathrow Oaks Road	GE10	2001-05-04	Ongoing
Heathrow Oaks Road	PM25	2002-04-19	Ongoing
London Harlington	NO2	2004-01-01	Ongoing
London Harlington	GE10	2004-01-01	Ongoing
London Harlington	O3	2004-01-01	Ongoing
London Harlington	PM25	2008-09-16	Ongoing

3 Data description

Data contained within this report are managed by Ricardo and stored in a dedicated, secure database. Data are ratified quarterly on a calendar year basis and according to a regular schedule of audits and calibrations. As a result, data are marked as either provisional (and subject to change) or ratified. The data within this report are [fully ratified/provisional pending final ratification].

Some of the plots provided in this report use associated meteorological data (typically wind speed and wind direction) in order to put measured pollutant concentrations in a dispersion context. The report uses the `worldmet` package to import met data.

Gaseous pollutant mass units are at 20 °C and 1013mb. NOx mass units are NOx as NO_2 μg m^{-3}. Particulate matter concentrations are reported at ambient temperature and pressure. Note that PM_{10} is referred to in the data tables and plots as 'GE10' if it is derived from an instrument that has demonstrated equivalence with the gravimetric reference method [1] (e.g. a TEOM FDMS, a FIDAS or a BAM with a correction factor applied).

3.1 Relevant pollution Limit Values

The European Air Quality Directive and Fourth Daughter Directive set out legal limits for different pollutants as Limit Values, Target Values or Long Term Objectives to protect human health. These are summarised in the table below. Local authorities don't typically measure ozone, benzene, B[a]P or metals that are captured within Defra's national networks. All pollutants measured have been included in this data summary for completeness, irrespective of their significance for local authority policy interests.

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[1]https://uk-air.defra.gov.uk/networks/monitoring-methods?view=pm-equivalence

Table 2: Legal limits for different pollutants.

Pollutant	Metric	Type	Legal value
NO2	1-hr	LV	200 µg m-3 (18 allowed)
NO2	Annual mean	LV	40 µg m-3
PM10	24-hr	LV	50 µg m-3 (35 allowed)
PM10	Annual mean	LV	40 µg m-3
PM2.5	Annual mean	LV (stage 1)	25 µg m-3
PM2.5	Annual mean	LV (stage 2)	20 µg m-3
SO2	1-hr	LV	350 µg m-3 (24 allowed)
SO2	24-hr	LV	125 µg m-3 (3 allowed)
CO	8-hr mean	LV	10 mg m-3
Ozone	Maximum daily running 8-hour mean	LV	100 µg m-3 (10 allowed)
Ozone	Maximum daily running 8-hour mean	LTO	120 µg m-3
Benzene	Annual mean	LV	5.0 µg m-3
Benzo[a]pyrene	Annual mean	TV	1.0 ng m-3
Arsenic	Annual mean	TV	6.0 ng m-3
Cadmium	Annual mean	TV	5.0 ng m-3
Nickel	Annual mean	TV	20.0 ng m-3
Lead	Annual mean	LV	0.5 µg m-3

4 Data Analysis

4.1 Summary statistics

The following tables present some basic pollutant statistics for the period selected in the report. The **Low**, **Moderate** and **High** indicates the percentage of times when pollution concentrations are in the corresponding AQI bands defined by DEFRA.

NO$_2$

Table 3: Summary statistics for NO_2.

Site	Mean	Data capture	Hourly maximum	Low	Moderate	High	Hours exceeding LV
Heathrow Green Gates	25.1	100.0%	150.0	99.9090%	0%	0%	0
Heathrow LHR2	40.6	100.0%	137.1	100.0000%	0%	0%	0
Heathrow Oaks Road	22.3	100.0%	109.4	100.0000%	0%	0%	0
London Harlington	25.9	90.0%	113.9	100.0000%	0%	0%	0

PM$_{2.5}$

Table 4: Summary statistics for $PM_{2.5}$.

Site	Mean	Data capture	Max 24-hour mean	Low	Moderate	High
Heathrow Green Gates	5.7	100.0%	12.5	100%	0%	0%
Heathrow LHR2	6.3	100.0%	14.5	100%	0%	0%
Heathrow Oaks Road	6.5	100.0%	14.0	100%	0%	0%
London Harlington	6.7	90.0%	14.3	100%	0%	0%

PM$_{10}$

Table 5: Summary statistics for PM_{10}.

Site	Mean	Data capture	Max 24-hour mean	Low	Moderate	High	Days exceeding LV
Heathrow Green Gates	11.1	100.0%	22.9	100%	0%	0%	0
Heathrow LHR2	12.0	100.0%	23.8	100%	0%	0%	0
Heathrow Oaks Road	13.1	100.0%	26.3	100%	0%	0%	0
London Harlington	13.9	90.0%	26.1	100%	0%	0%	0

O$_3$

Table 6: Summary statistics for O 3 .

Site	Data capture	Low	Moderate	High	Max 8-hour rolling mean
London Harlington	90.0%	97.5%	2.51%	0%	135.8

4.2 Rolling annual mean

NO$_2$

Figure below shows the rolling annual mean of NO$_2$ (calculated based on the preceding 12 monthly mean) for all the Heathrow sites from 2008.
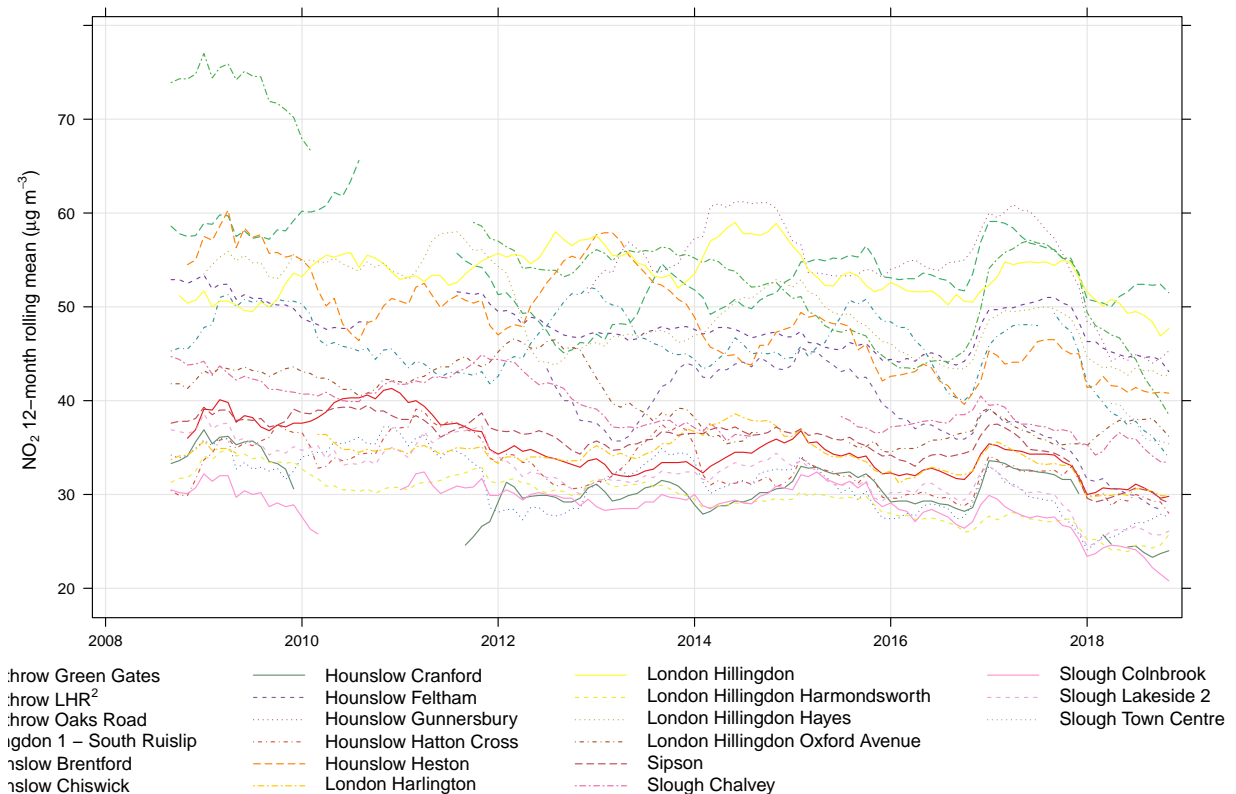
Figure 2: NO_2 12-month rolling mean for the Heathrow sites from 2008.

PM$_{2.5}$

Figure below shows the rolling annual mean of PM$_{2.5}$ (calculated based on the preceding 12 monthly mean) for all the Heathrow sites from 2008.

Figure 3: $PM_{2.5}$ 12-month rolling mean for the Heathrow sites from 2008.

PM$_{10}$

Figure below shows the rolling annual mean of PM$_{10}$ (calculated based on the preceding 12 monthly mean) for all the Heathrow sites from 2008.
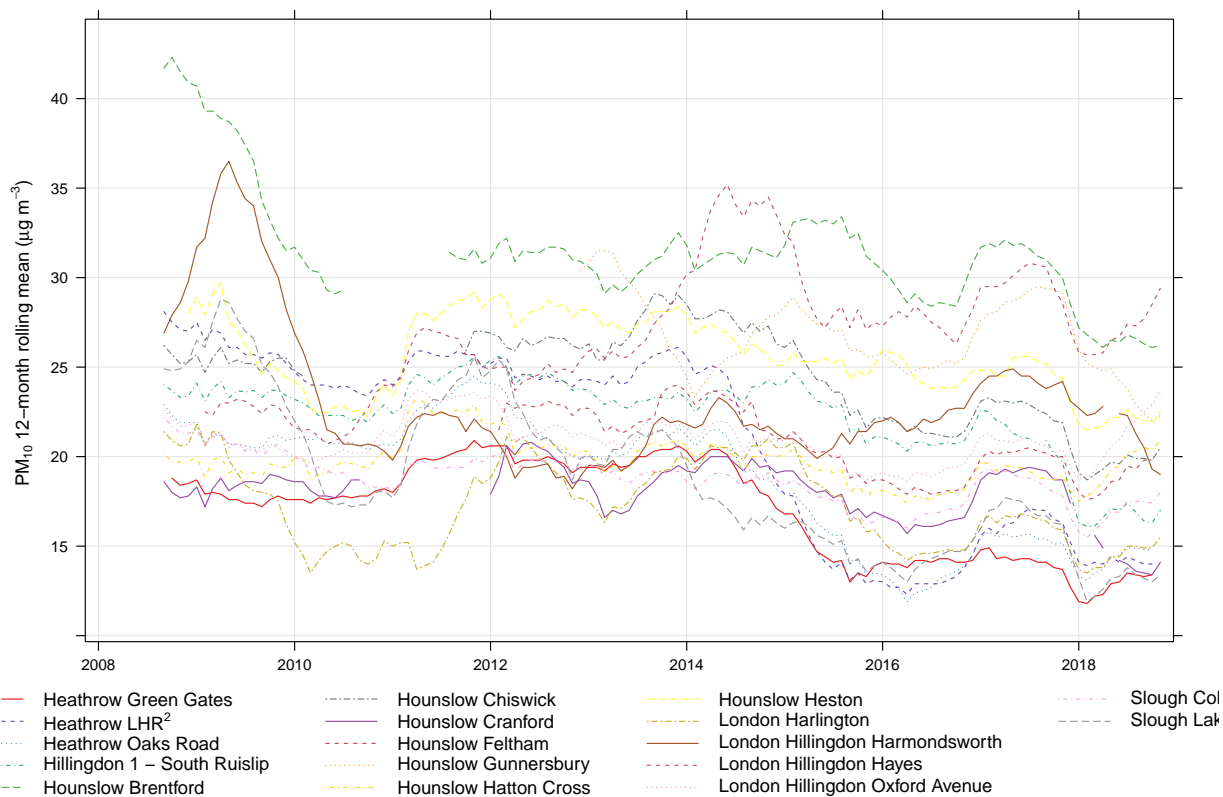
Figure 4: PM_{10} 12-month rolling mean for the Heathrow sites from 2008.

4.3 AQ index distribution

The plots below illustrate the distribution of AQ index values for each site by pollutant. It shows the number of occasions (hours) that each site reported concentrations are in each index. More information on the AQ Index is available from UK-Air [2]. Note that this summary presents data at hourly resolution which differs from Defra's Daily AQ Index (DAQI) which takes the worst across all pollutants and hours to represent each day.

NO₂

[2]https://uk-air.defra.gov.uk/air-pollution/daqi
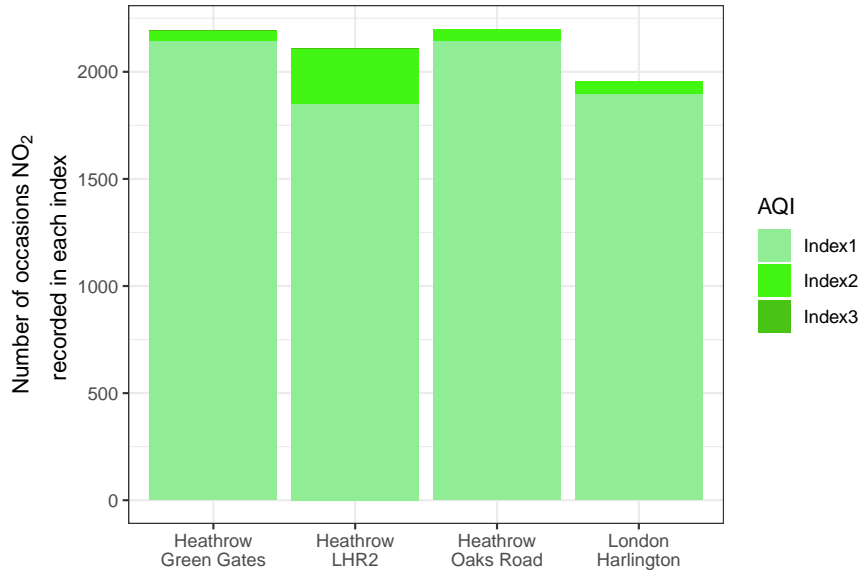
Figure 5: Distribution of AQI for NO_2.

PM$_{2.5}$
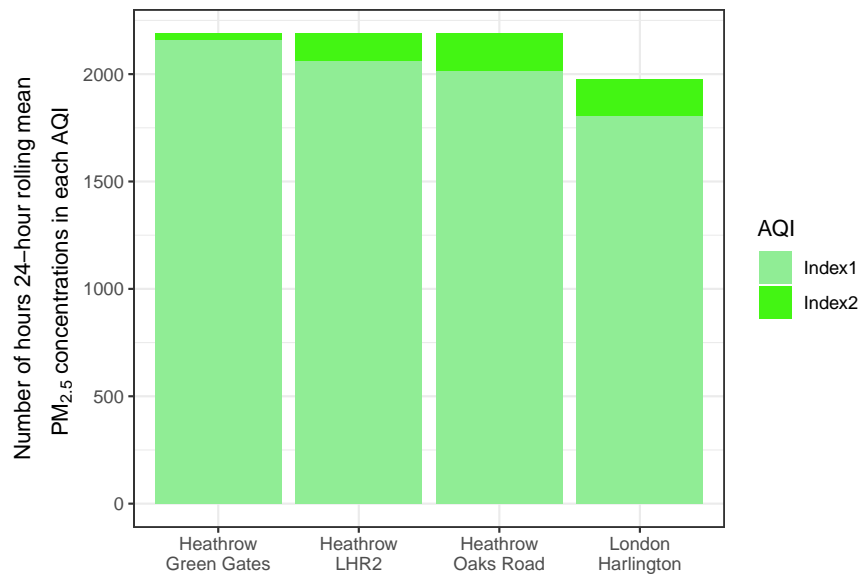
Figure 6: Distribution of AQI for $PM_{2.5}$.

PM$_{10}$
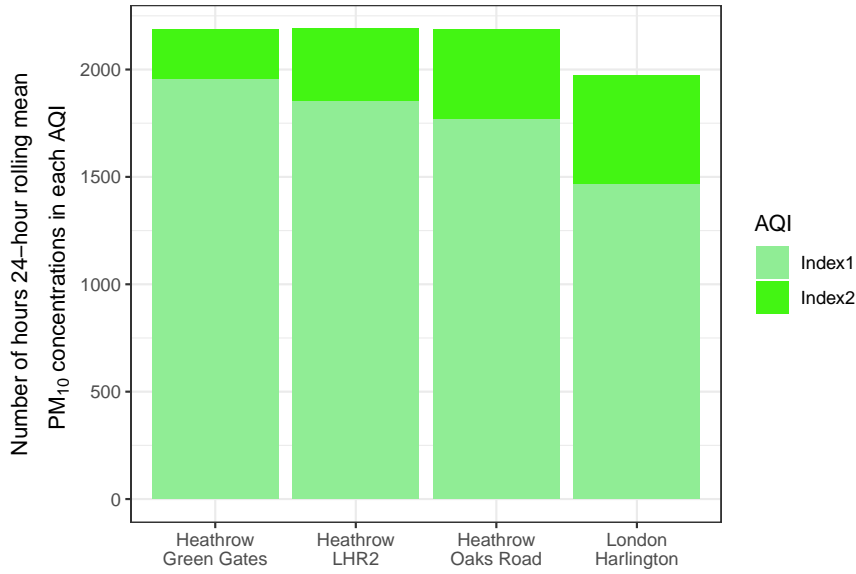
Figure 7: Distribution of AQI for PM_{10}.

O_3
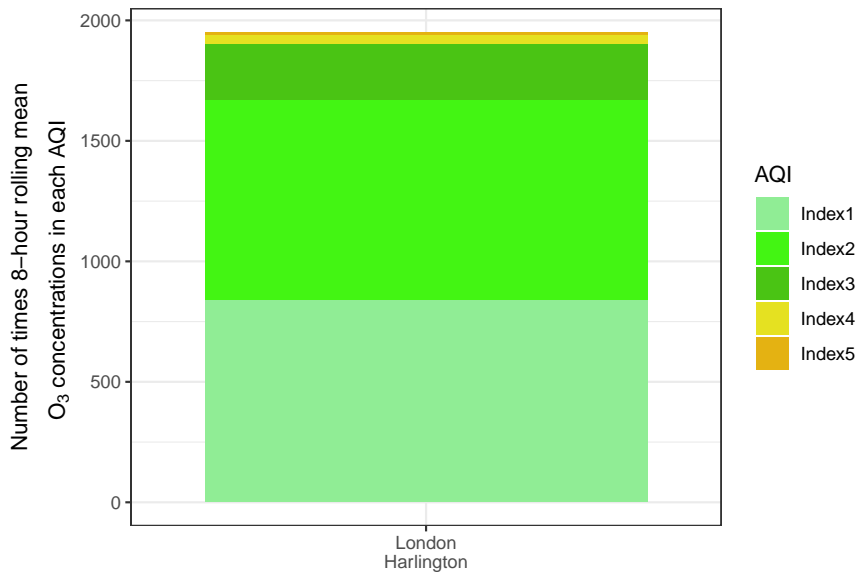
Figure 8: Distribution of AQI for O_3.

4.4 Boxplots

The plots below are box and whisker plots to show the distribution in concentrations for each monitoring station. The boxes demarcate the lower quartile, median and upper quartile. The whiskers extend to the maximum and minimum values within median $\pm$ 1.5 times interquartile range (IQR). Values outside the median $\pm$ 1.5 times IQR are generally considered as outliers.

NO_2
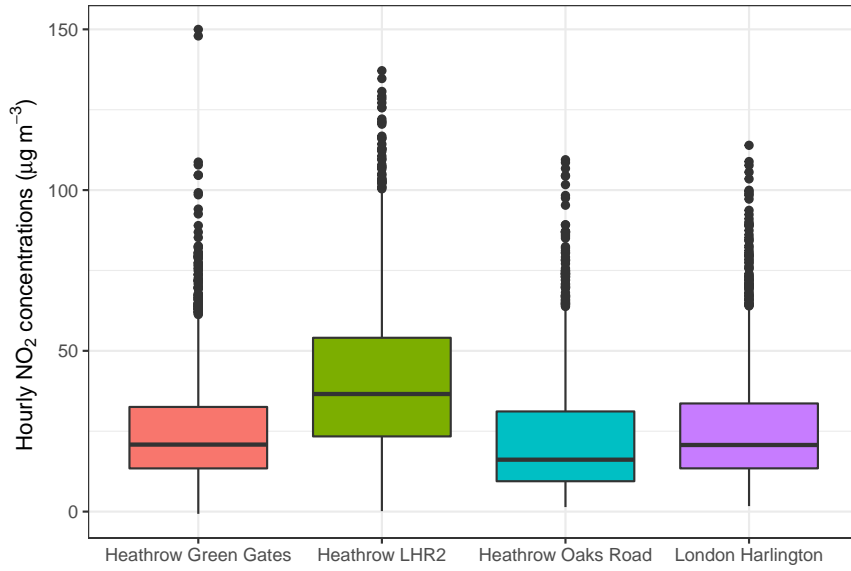
Figure 9: Boxplot for hourly NO_2 concentrations.

PM$_{2.5}$
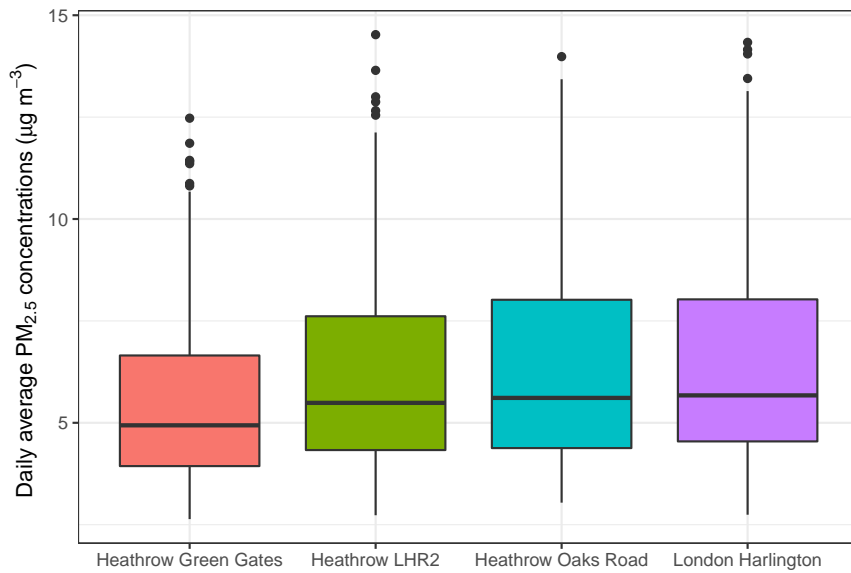
Figure 10: Boxplot for daily $PM_{2.5}$ concentrations.

PM$_{10}$
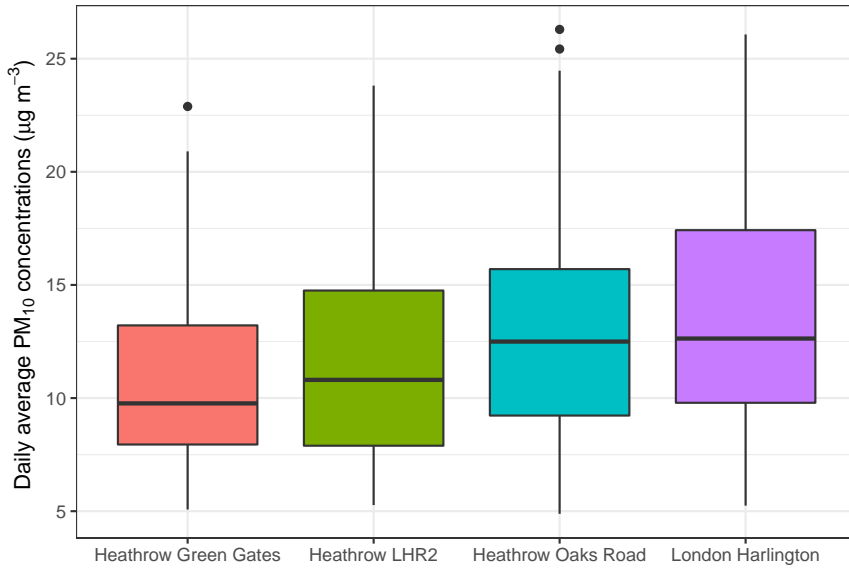
Figure 11: Boxplot for daily $PM_1 0$ concentrations.

O₃
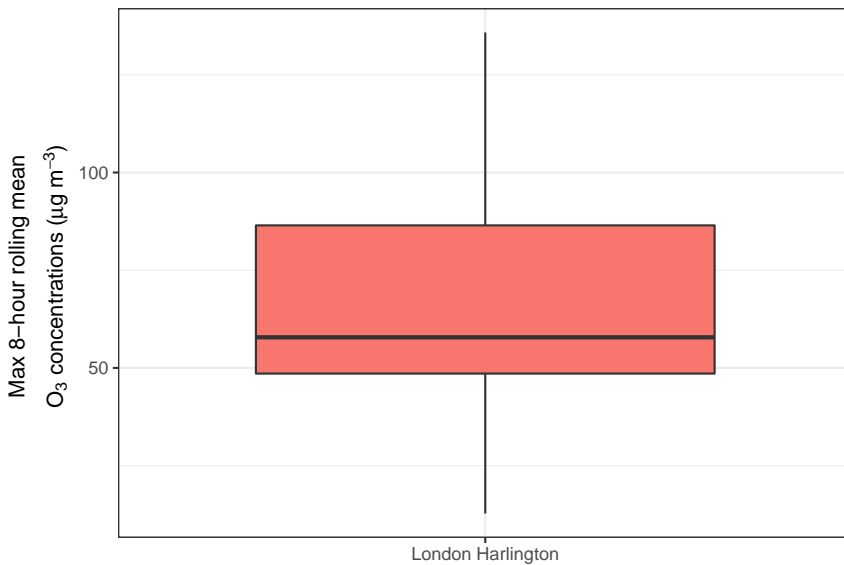
Figure 12: Boxplot for 8-hour rolling mean O 3 concentrations.

4.5   Time series plot

The plots below show the time series of concentrations. Each pollutant is presented on a different tab and all sites are shown on each plot for comparison. The period covered is the complete data record to show trends over the medium and long term. Each iteration of this regular report (e.g. monthly, or quarterly) has the most recent data appended to the plot (not implemented in the code yet). A daily average resolution has been chosen as the most appropriate metric over a variety of different time windows.

NO₂
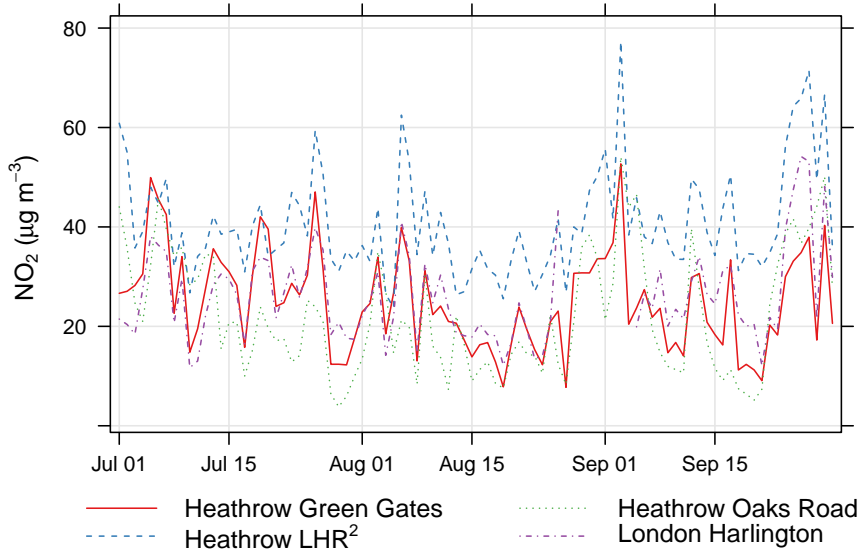
Figure 13: Time series plot of daily average NO_2 concentration.

PM$_{2.5}$
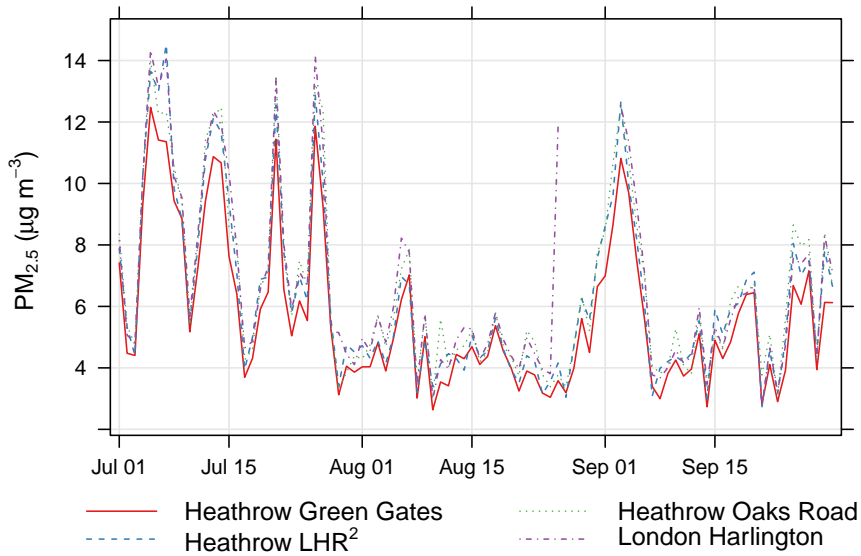
Figure 14: Time series plot of daily average $PM_{2.5}$ concentration.

PM$_{10}$
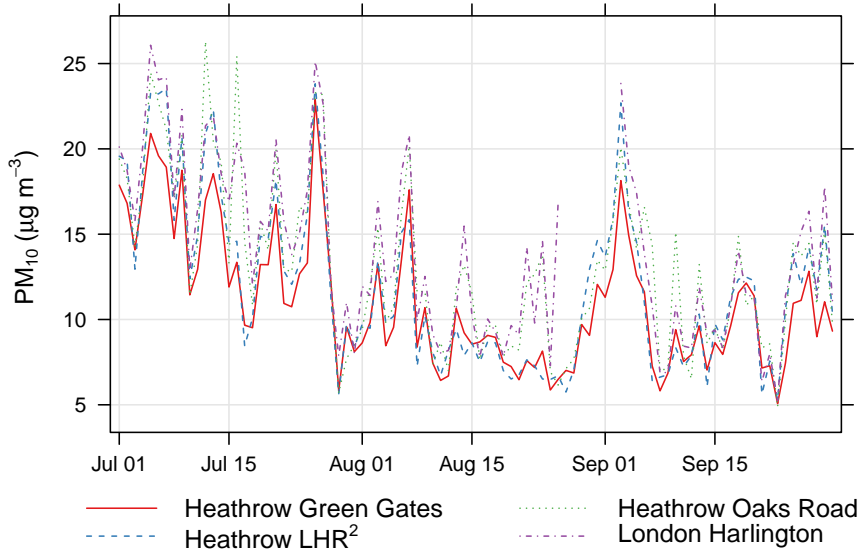
Figure 15: Time series plot of daily average PM_{10} concentration.
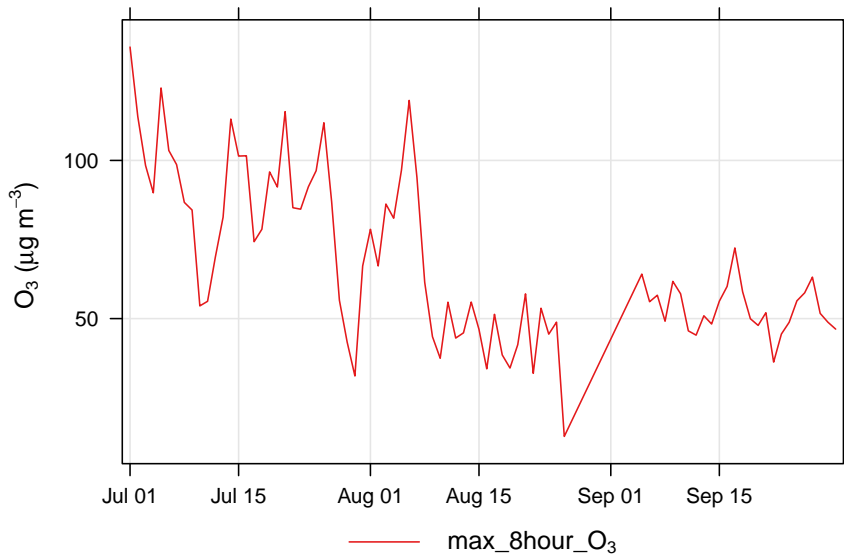
O₃

Figure 16: Time series plot of daily maximum 8-hour rolling mean O_3 concentration at London Harlington.

4.6 Time Variation plot

These plots show concentrations over different time intervals such as diurnal, day of week and month of year. The plot showing seasonal variation will show only the three months of the quarter or a dot showing one month depending on the time frame covered in this report. The topmost frame shows the concentrations as they vary by hour of the day and day of the week. The hour of the day variation is summarised on its own in the lower left pane and the variation by day of the week is shown in the lower right pane. These plots often help explain variations in concentration according to the emissions activity associated with them. For example, NOx concentrations at roadside sites tend to exhibit peaks according to morning and evening traffic rush hours and tend to decline over weekends when there is generally lower traffic volumes.
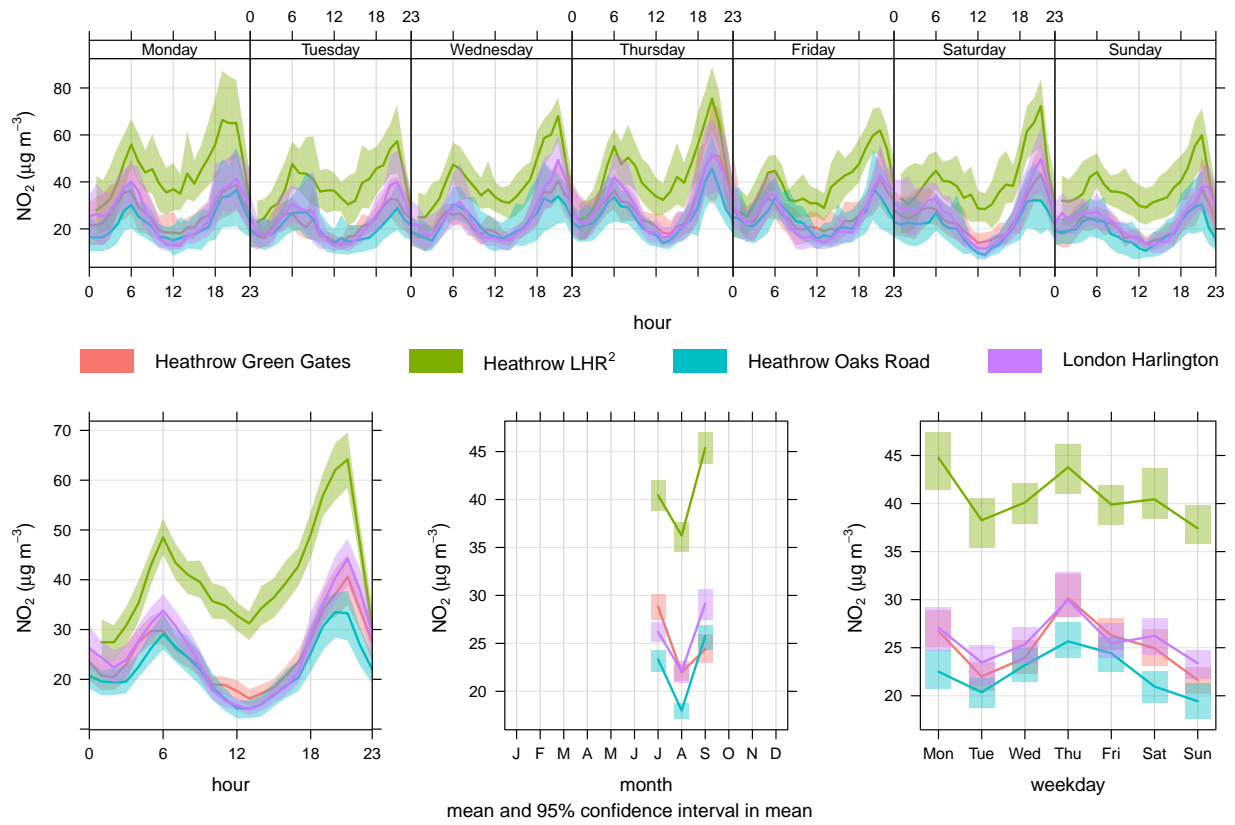
NO₂

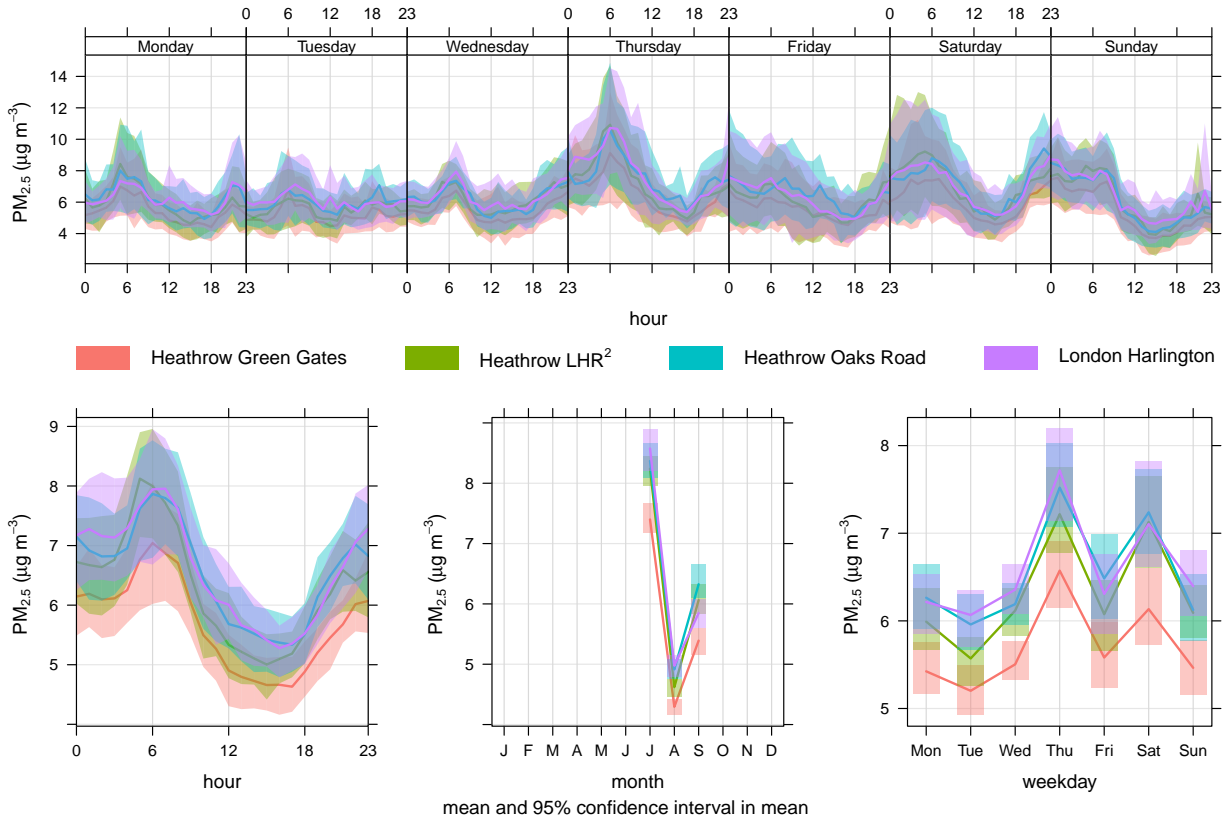Figure 17: Time variation of hourly NO_2 cocenctrations.

PM₂.₅

Figure 18: Time variation of hourly $PM_{2.5}$ cocenctrations.
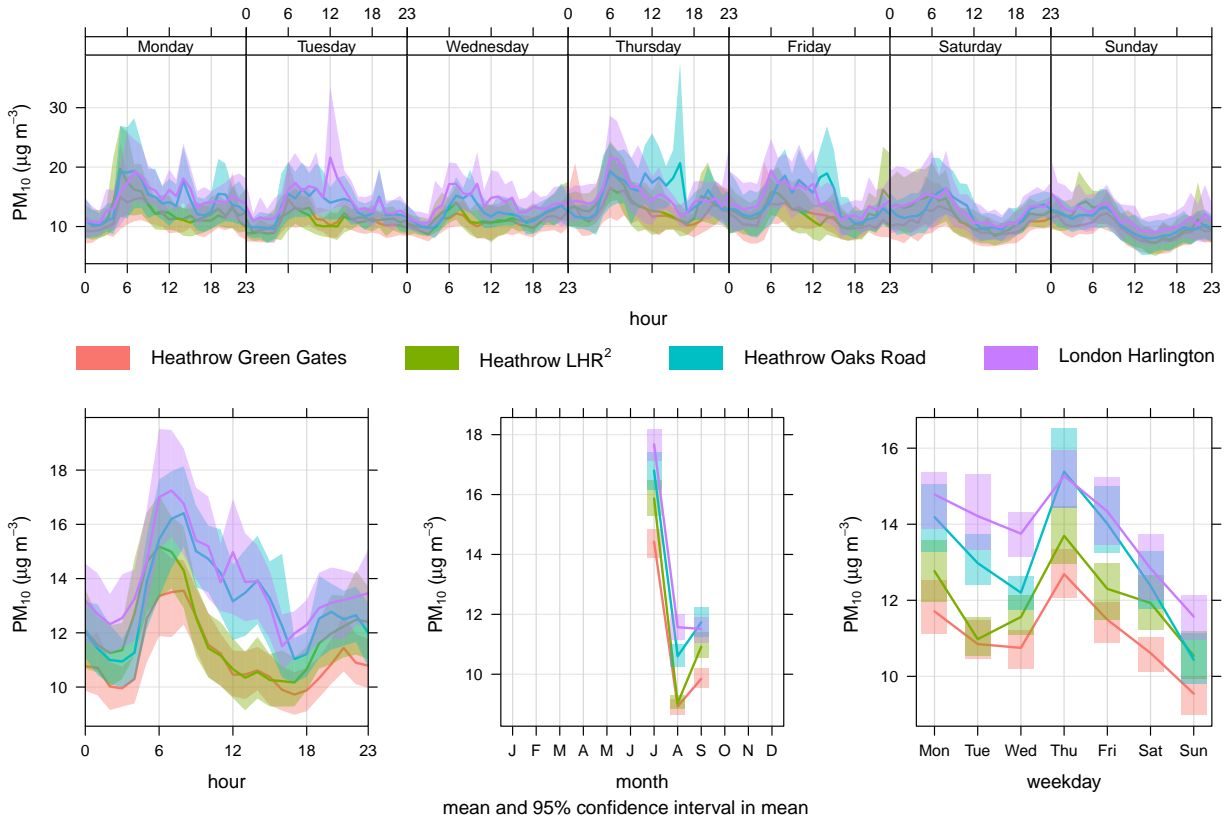
PM$_{10}$

Figure 19: Time variation of hourly PM_{10} cocenctrations.
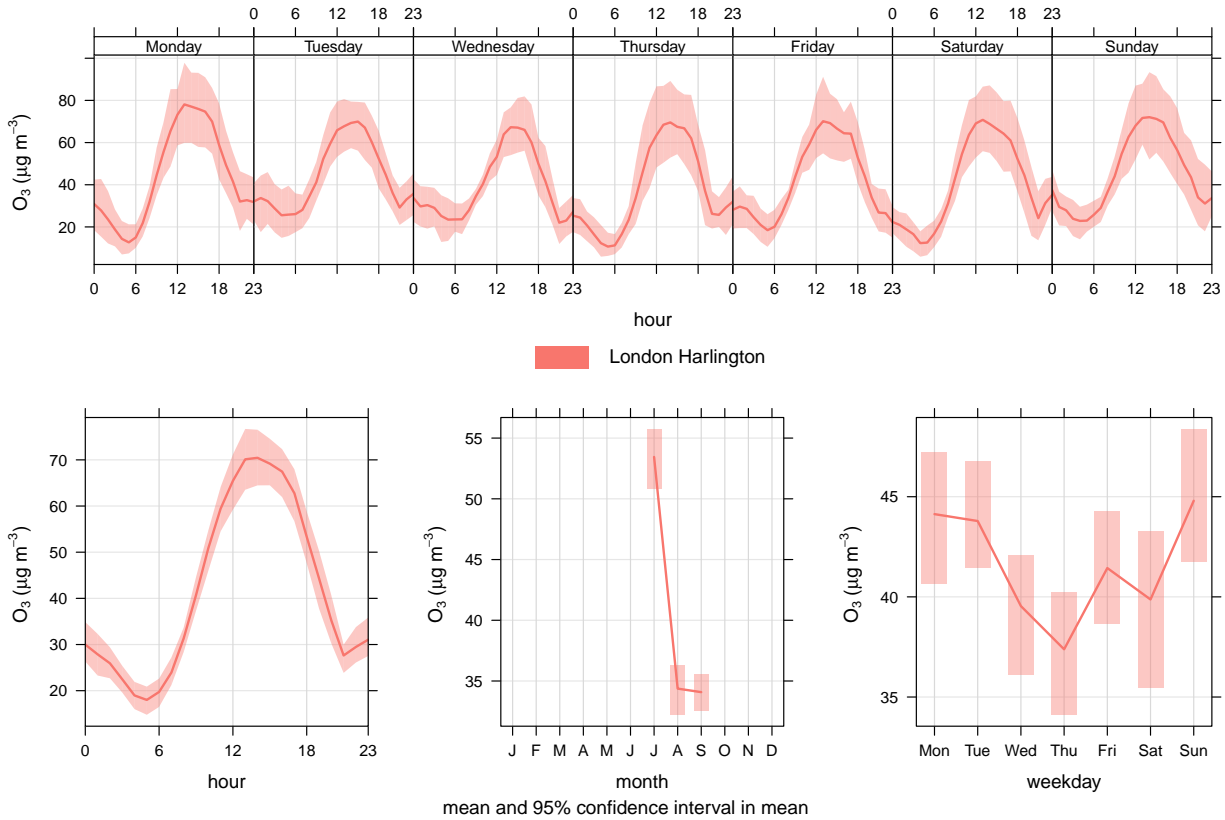
O₃

Figure 20: Time variation of hourly O_3 concentrations.

4.7 Calendar plot

The plot below shows daily variation in concentrations by pollutant (one on each tab) across the period of the report, as laid out in a calendar style. This allows intuitive viewing of day to day headline trends in the wider context of the period. The background colours shown for each day relate to the concentration. The date is coloured by the wind speed for that day.

The site with highest average concentrations is used to produce the calendar plot.
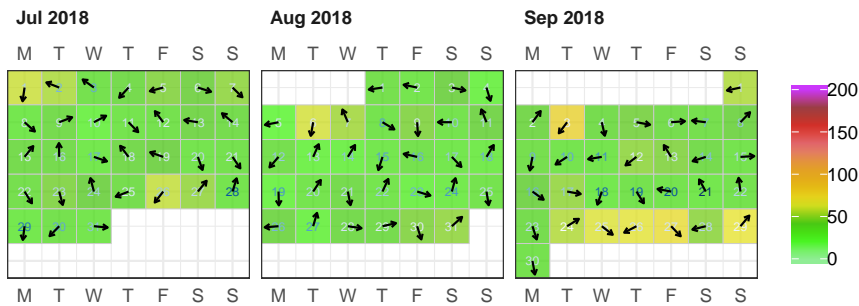
NO₂

Heathrow LHR2
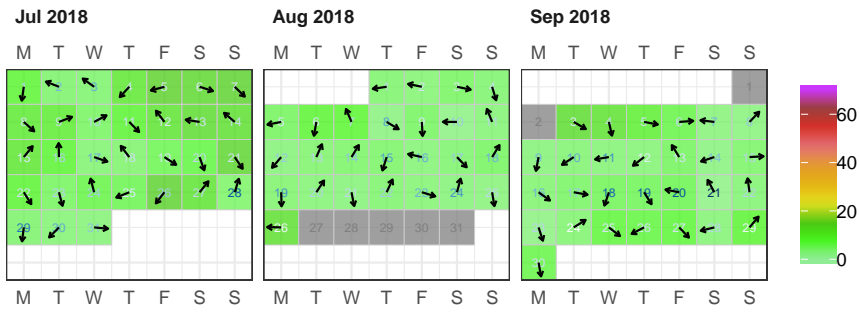

Figure 21: NO_2 calendar plot.

PM$_{2.5}$

London Harlington

Figure 22: $PM_{2.5}$ calendar plot.

PM$_{10}$

London Harlington
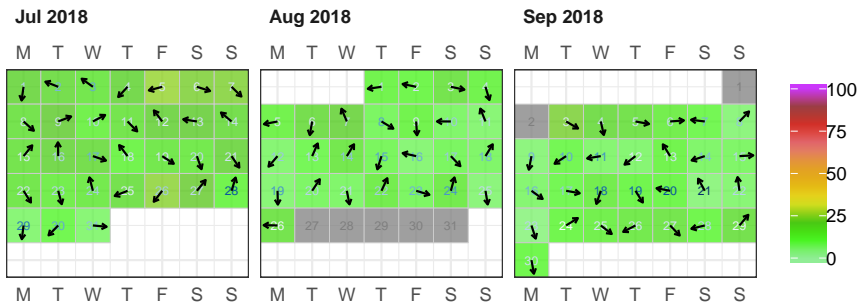

Figure 23: PM_{10} calendar plot.
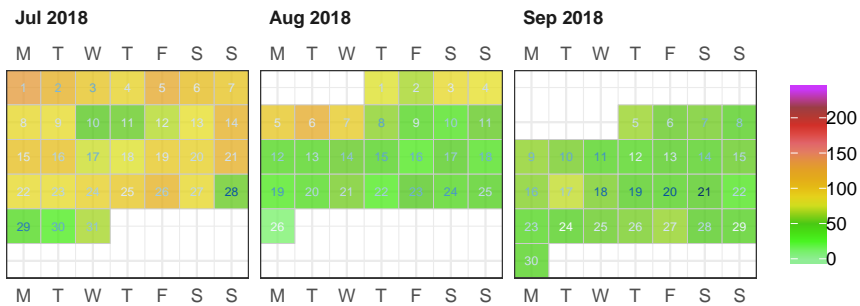
O$_3$

London Harlington

Figure 24: O_3 calender plot of daily maximum 8-hour rolling mean.

4.8 Back trajectory analysis

The back trajectory plot shows data from the HYSPLIT model (NOAA HYSPLIT [3]) run in analysis mode. This shows the air mass back trajectories for the period covered by the report. Three different kinds of plot are shown. One statistically groups the trajectories into simioklar clusters (six) and shows the proportion of time during the report period that each represents. (Currently code only plots the clusters for a whole year.) This is useful to get an overview of air mass origins during the report period. On additional tabs, the trajectories associated with exceedances of the LV (1-hr for NO2 and 24-hr for PM10) are shown. A plot of the trajectories associated with the top 10 measured concentrations is also presented.

4.8.1 Trajectory clusters

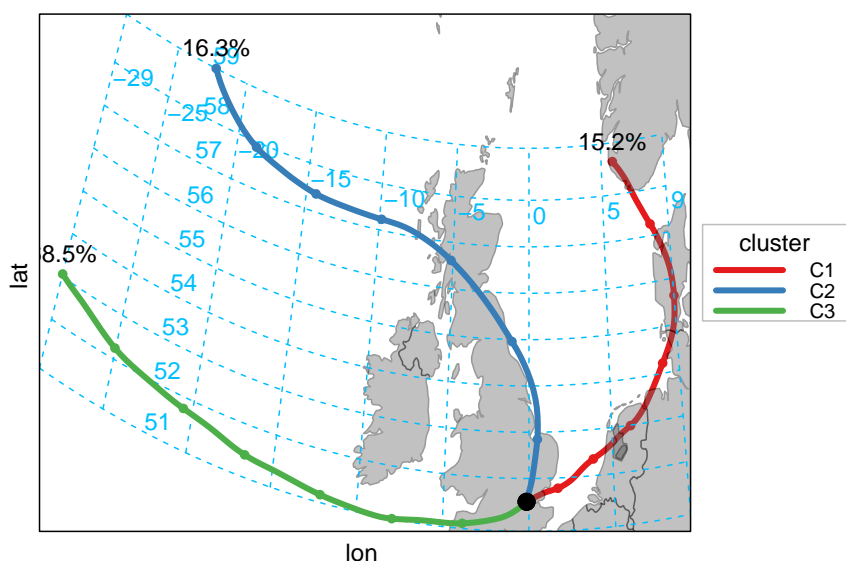4-day air mass back trajectories arriving at London for 2018 are grouped into 4 clusters.

Figure 25: Clusters of daily back trajectories based on their similarity.

Air mass back trajectories over these spatial scales do not vary locally so the receptor location used in this report has been selected from a range of national receptor locations maintained by Ricardo Energy & Environment. The receptor point is used here is London Bridge Place.

4.8.2 Trajectories associated with top ten most polluted days

The average daily concentration for each pollutant across all the sites is calculated, with the top 10 most polluted days identified and linked to its back trajectory data in the plot below.
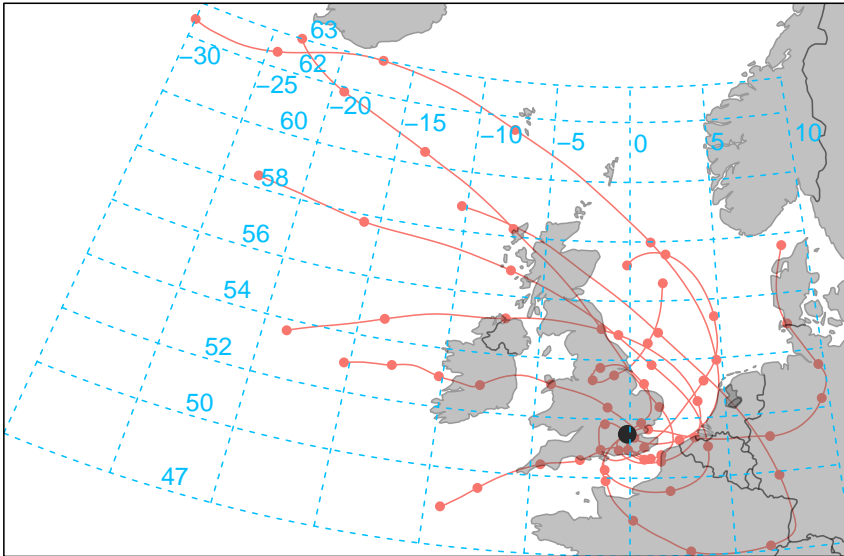
4.8.2.1 NO$_2$

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[3]https://www.arl.noaa.gov/hysplit/hysplit/

Figure 26: Trajectory plot for top ten highest daily NO_2 concentrations.
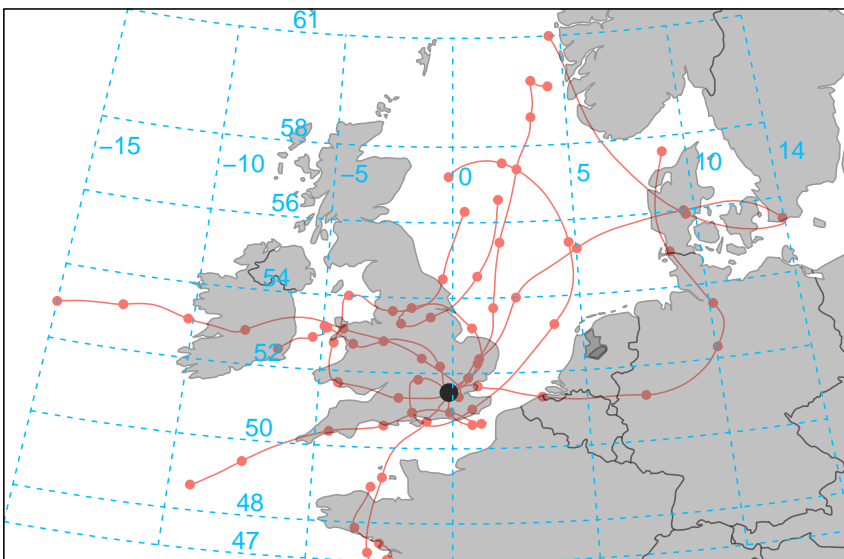
4.8.2.2 PM$_{2.5}$

Figure 27: Trajectory plot for top ten highest daily $PM_{2.5}$ concentrations.
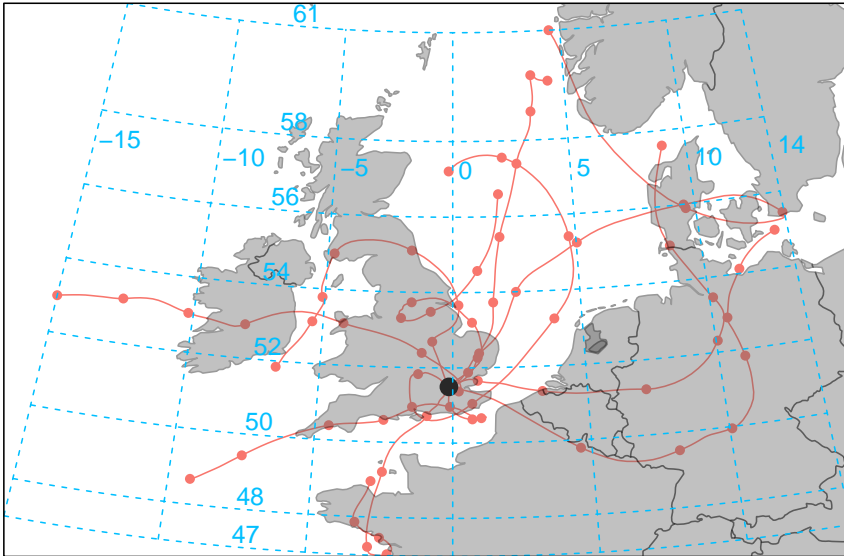
4.8.2.3 PM$_{10}$

Figure 28: Trajectory plot for top ten highest daily PM_10 concentrations.
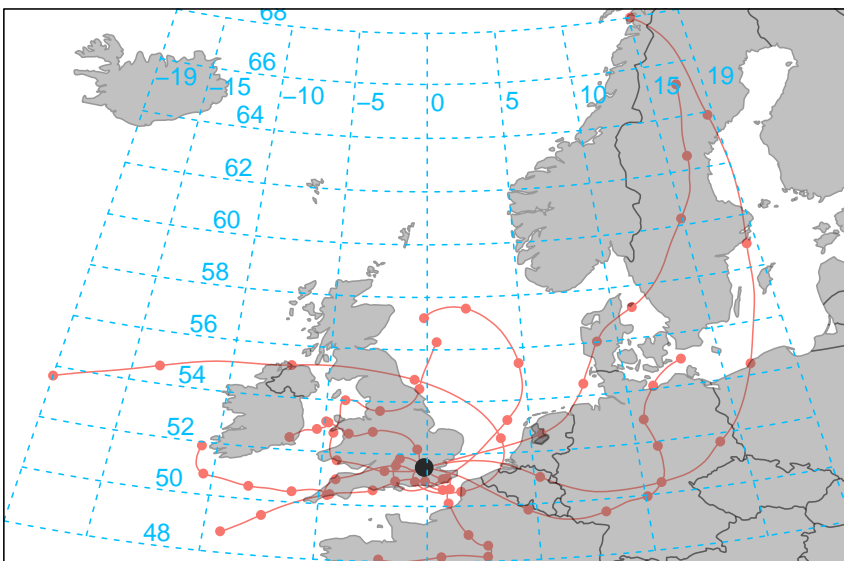
4.8.2.4 O$_3$

Figure 29: Trajectory plot for top ten highest daily O_3 concentrations.

4.9 Polar plot map

Please refer to the HTML version of this report to view the polar plots overlayed on the map.

For further information, please contact:

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