AIR QUALITY MONITORING AT STANSTED AIRPORT 2024

Report for Manchester Airports Group plc

Ref. MAG03880 Amendment Number MAG 03

Ricardo ref. ED12982 Issue 1 19/05/2025

Ricardo, Gemini Building, Fermi Avenue, Harwell, Oxfordshire, OX11 0QR, UK | +44(0)1235 75 3000 | ee.ricardo.com
Registered company no. 08229264 | VAT no. GB 212 8365 24

Customer:
Manchester Airports Group – Stansted Airport

Customer reference:
MAG03880 AMENDMENT NUMBER MAG 03

Ricardo reference:
ED12982

Contact:
Nick Rand
Ricardo
Gemini Building, Harwell, Didcot, OX11 0QR, United Kingdom

T: +44 (0) 1235 75 8434
E: nick.rand@ricardo.com

Author:
Georgina McCarthy

Approved by:
Nick Rand

Signed

Date:
19 May 2025

Ricardo is certified to ISO9001, ISO14001, ISO27001 and ISO45001.

EXECUTIVE SUMMARY

This report provides details of air quality monitoring conducted around Stansted Airport during 2024. The work, carried out by Ricardo on behalf of Manchester Airports Group, is a continuation of monitoring undertaken at Stansted Airport since 2004. The aims of the programme are to monitor air quality around the airport, to assess compliance with relevant air quality objectives, and to investigate changes in air pollutant concentrations over time.

Automatic continuous monitoring was carried out at three fixed locations previously agreed with Uttlesford District Council and Natural England (in respect of Hatfield Forest) and are referred to as Stansted 3, Stansted 4 and Stansted 5. Stansted 3 is located to the southeast of the airport at High House, Stansted 4 is located to the north of the runway, and Stansted 5 is located in the National Trust office car park in the north-east corner of Hatfield Forest. All sites monitored oxides of nitrogen (nitric oxide and nitrogen dioxide), PM_{10} particulate matter and $PM_{2.5}$ particulate matter.

In addition to automatic monitoring, indicative monitoring of nitrogen dioxide was carried out using diffusion tubes. These were co-located with the continuous automatic monitor at Stansted 3 and also used at four other sites around Stansted, to the north, south, east and west of the airport. From August 2017, indicative monitoring of nitrogen dioxide has been carried out using diffusion tubes at nine locations around Hatfield Forest.

The minimum applicable data capture target of 85% (recommended in the European Commission Air Quality Directive[1] and Defra Technical Guidance LAQM.TG (22)[1]) was achieved for all pollutants in 2024 at Stansted 3 (NO_x, PM_{10} and $PM_{2.5}$) and Stansted 5 (NO_x, PM_{10} and $PM_{2.5}$), and for the NO_x concentrations at Stansted 4. Data capture for particulate matter concentrations at Stansted 4 did not meet this target, where data capture was 64.3% due to an analyser fault.

The UK AQS hourly mean objective for NO_2 is 200 µg m^{-3}, with no more than 18 exceedances allowed each year. There were no exceedances of this objective at Stansted 3, Stansted 4 or Stansted 5. **The UK AQS annual mean objective for NO_2 of 40 µg m^{-3} was met at the automatic monitoring sites of Stansted 3, Stansted 4 and Stansted 5 during 2024.**

The annual mean AQS objective for NO_2 was also met by all diffusion tube sites, including the five Stansted and the nine Hatfield Forest diffusion tube sites.

The annual mean objective for $PM_{2.5}$ is 25 µg m^{-3}. At Stansted 3, Stansted 4 and Stansted 5 annual mean $PM_{2.5}$ concentrations were 7 µg m^{-3} at each monitoring site. **Therefore, these sites met the AQS objective for $PM_{2.5}$ annual means during 2024.** Due to the low data capture at Stansted 4, care should be taken when comparing the annual mean to the AQS objective as the annual mean may not be representative of the entire year.

PM_{10} may exceed the 24-hour mean limit of 50 µg m-3 no more than 35 times per year to meet the AQS objective. There were no exceedances of this objective at Stansted 3 or Stansted 5 in 2024. Due to the low data capture at Stansted 4, a percentile value was calculated which indicated that there were likely less than 35 exceedances of the 24-hour AQS objective in 2024 at this site. **The annual mean AQS for PM_{10} of 40 µg m^{-3} was met at Stansted 3, Stansted 4 and Stansted 5 during 2024.** Due to the low data capture at Stansted 4, care should be taken when comparing the annual mean to the AQS objective as the annual mean may not be representative of the entire year.

Wind speed and direction data accessed via the National Oceanic and Atmospheric Administration (NOAA) were used to produce bivariate plots showing hourly mean pollutant concentrations against the corresponding weather conditions. The bivariate plots for NO_2 at all Stansted sites show elevated concentrations when wind speeds are low indicating that the sources of elevated NO_2 concentrations are located in close proximity to the sites. Furthermore, the bivariate plots indicate elevated NO_2 concentrations are measured under higher wind speeds from the east. There are also indications that activities around the airport terminal buildings may be affecting NO_2 concentrations at these sites, as well as other local sources.

The bivariate plots for $PM_{2.5}$ and PM_{10} indicate high concentrations under more unsettled conditions, especially from east and southwest directions which are likely attributed to long range transport of polluted air from the continent.

Average NO_2 concentrations are broadly similar to those from comparable urban background monitoring sites and have remained lower than concentrations at London Heathrow Airport.

In 2024, annual mean concentrations of NO_2 and PM_{10} measured at Stansted 3 and Stansted 5 have shown small decreases in comparison to concentrations measured in 2023. Annual mean NO_2 and PM_{10} concentrations at Stansted 4 have shown a small increase when compared to concentrations measured in 2023. $PM_{2.5}$ concentrations at Stansted 3 were shown to decrease in 2024. However, annual mean $PM_{2.5}$ concentrations at Stansted 4 and Stansted 5 remained similar to those measured in 2023.

TABLE OF CONTENTS

Appendices

1. INTRODUCTION

1.1 BACKGROUND

Stansted Airport is the third busiest international airport in London, handling over 29.8 million passengers in 2024. This is an increase of 6.4% compared to the number of passengers handled in 2023. Stansted Airport is situated outside the general urbanised area of Greater London, and its surroundings are rural.

Manchester Airports Group is required, under the terms of its Section 106 obligations to the Local Authority (Uttlesford District Council), to carry out monitoring of oxides of nitrogen and particulate matter at agreed locations. Prior to 2006, monitoring was required for three months per year; from 2006 onwards, continuous monitoring throughout the year has been required.

Ricardo was contracted by Manchester Airports Group to carry out the required programme of air pollution measurements for 2024, the nineteenth full year of continuous monitoring.

Provisional data are reported to Manchester Airports Group monthly throughout the year. This annual report presents and summarises the fully validated and quality-controlled dataset for the entire calendar year. Data in the annual report have been processed according to the rigorous quality assurance and quality control procedures used by Ricardo. These ensure the data are reliable, accurate and traceable to UK national measurement standards.

This report covers the period 1st January to 31st December 2024.

1.2 AIMS AND OBJECTIVES

The aim of this monitoring programme is to monitor concentrations of three important air pollutants around the airport. The results of the monitoring are used to assess whether applicable air quality objectives have been met, and how pollutant concentrations in the area have changed over time. The pollutants monitored were as follows:

- Oxides of nitrogen (nitric oxide NO and nitrogen dioxide NO_2), using automatic techniques at three locations: Stansted 3 (High House), Stansted 4 (Runway) and Stansted 5 (Hatfield Forest).
- Particulate matter (PM_{10}), using automatic techniques at three locations: Stansted 3 (High House), Stansted 4 (Runway) and Stansted 5 (Hatfield Forest).
- Particulate matter ($PM_{2.5}$) using automatic techniques at three locations: Stansted 3 (High House), Stansted 4 (Runway) and Stansted 5 (Hatfield Forest).

The automatic monitoring was supplemented by indicative monitoring of NO_2 using diffusion tubes at five locations around Stansted Airport, and an additional nine locations in Hatfield Forest.

Monitoring data collected at Stansted are compared in this report with:

- Relevant UK air quality limit values and objectives.
- Corresponding results from a selection of national air pollution monitoring sites.
- Statistics related to airport activity.

In addition, periods of relatively high pollutant concentrations are examined in more detail.

1.3 UK AIR QUALITY STRATEGY

This report compares the results of the monitoring survey with air quality limit values and objectives applicable in the UK. These are summarised below.

1.3.1 European Community

Throughout Europe, ambient air quality is regulated by the European Commission Directive on Ambient Air Quality and Cleaner Air for Europe (EU/2015/1480)[1]. This Directive (referred to as the Air Quality Directive) consolidated three previously existing Directives, which set limit values for a range of air pollutants with known health impacts including NO_2, PM_{10}, CO and benzene.

All Member States of the European Union are required to transpose the requirements of the Directive into their national law. The original Directives were transposed into UK law via the Environment Act 1995 and subsequent Statutory Instruments. With the UK's exit from the EU the UK's AQS is no longer tied to that of the EU, however the current objectives are at least as stringent as the EC limit values.

1.3.2 World Health Organisation

The World Health Organisation (WHO) issued non-mandatory, advisory, guidelines for a variety of pollutants in 2005 using currently available scientific evidence on the effects of air pollution on human health. New, updated, guidelines were introduced in September 2021 which significantly reduced the annual mean limit of NO_2 from 40 µg m^{-3} to 10 µg m^{-3} and the 24h mean being reduced to 25 µg m^{-3}.

In light of the growing evidence of harm that PM_{10} and $PM_{2.5}$ can cause the annual mean limits were reduced from 20 µg m^{-3} to 15 µg m^{-3} and 10 µg m^{-3} to 5 µg m^{-3} respectively.

1.3.3 The UK Air Quality Strategy

The Environment Act also placed a requirement on the Secretary of State for the Environment to produce a national Air Quality Strategy containing standards, objectives and measures for improving ambient air quality. The original Air Quality Strategy was published in 1997 and contained air quality objectives based on the recommendations of the Expert Panel on Air Quality Standards (EPAQS) regarding the levels of air pollutants at which there would be little risk to human health.

The Air Quality Strategy has since undergone several revisions. These have reflected improvements in the understanding of air pollutants and their health effects. They have also incorporated new European limit values, both for pollutants already covered by the Strategy and for newly introduced pollutants such as polycyclic aromatic hydrocarbons and $PM_{2.5}$ particulate matter. The latest version of the strategy was published by Defra in 2007[2].

All UK Air Quality Strategy (AQS) objectives were as stringent as the EC limit values until December 2024 when the EU published a new $PM_{2.5}$ target where concentrations must be measured under 10 µgm^{-3} by 2030. The current UK air quality objectives for the pollutants monitored at Stansted Airport are presented in Table 1. In some cases, Scotland, Wales or Northern Ireland have adopted different objectives: Table 1 shows the AQS objectives that apply in England.

Limit values (LV) are values which must not be exceeded. Limit values are established for individual pollutants and consist of a concentration value, an average measurement period, the number of permitted exceedances per year, if any, and an achievement date. Some pollutants have several limit values, each of which covers various endpoints or averaging periods. $PM_{2.5}$ has two stages to the limit value. Stage 1 is defined as a limit value of 25 µg m^{-3} is to be achieved by 2015 and Stage 2 is a limit value of 20 µg m^{-3} to be achieved by 2020 and upheld thereafter. Target values (TV) are similar to limit values and are to be reached, wherever possible, by doing all necessary actions that don't come at a disproportionate expense. Long term objectives (LTO) are not mandatory but are long term targets for specific pollutants.

Table 1: UK air quality objectives for protection of human health, July 2007

Pollutant	Metric	Type	Legal value
NO_2	1-hr	LV	200 µg m^{-3} (18 allowed)
NO_2	Annual mean	LV	40 µg m^{-3}
PM_{10}	24-hr	LV	50 µg m^{-3} (35 allowed)
PM_{10}	Annual mean	LV	40 µg m^{-3}
$PM_{2.5}$	Annual mean	LV (stage 1)	25 µg m^{-3}
$PM_{2.5}$	Annual mean	LV (stage 2)	20 µg m^{-3}
SO_2	1-hr	LV	350 µg m^{-3} (24 allowed)
SO_2	24-hr	LV	125 µg m^{-3} (3 allowed)

Pollutant	Metric	Type	Legal value
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} (25 allowed, averaged over three years)
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}

2. AIR QUALITY MONITORING

2.1 POLLUTANTS MEASURED

2.1.1 Nitrogen Oxides (NO_x)

Combustion processes emit a mixture of oxides of nitrogen – NO and NO_2 - collectively termed NO_x.

i) NO is described as a primary pollutant (meaning it is directly emitted from source). NO is not known to have any harmful effects on human health at ambient concentrations. However, it undergoes oxidation in the atmosphere to form the secondary pollutant NO_2.

ii) NO_2 has a primary (directly emitted) component and a secondary component, formed by oxidation of NO. NO_2 is a respiratory irritant and is toxic at high concentrations. It is also involved in the formation of photochemical smog and acid rain and may cause damage to crops and vegetation.

Of the NO_x emissions (including NO_2) considered to be airport-related within the UK aviation sector, the National Atmospheric Emissions Inventory (NAEI) states that over 50 % arise from aircraft during take-off and landing, with around two-thirds of all emissions occurring at some distance from airport ground-level. The Air Quality Expert Group (AQEG)[3] has stated that: "*Around a third of all NO_x emissions from the aircraft (including ground-level emissions from auxiliary power units, engine testing etc., as well as take-off and landing) occur below 100 m in height. The remaining two-thirds occur between 100 m and 1000 m and contribute little to ground-level concentrations. Receptor modelling studies … show the impact of airport activities on ground-level NO_2 concentrations. Studies have shown that although emissions associated with road traffic are smaller than those associated with aircraft, their impact on population exposure at locations around the airport are larger*". Based on 2023 calendar year emissions data from the 2025 submission of National Atmospheric Emissions Inventory (NAEI) data to the EU, civil aircraft taking off and landing (up to a height of 1000m) was estimated to contribute 2% to the total reported UK emissions of NO_x[4].

Previous rounds of review and assessment within the LAQM process have not highlighted any cases where airports appear to have caused exceedances of air quality objectives for particulate matter measured as PM_{10}. Therefore, in the context of LAQM, the key pollutant of concern from airports is NO_2. Local authorities whose areas contain airports with over 10 million passengers per annum must take these into account in their annual review and assessment of air quality[5].

2.1.2 Particulate Matter

Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. The term PM_{10} is used to describe particles with an effective size less than 10 µm. These are of greatest concern with regard to human health, as they are small enough to penetrate deep into the lungs. They can cause inflammation and a worsening of the condition of people with heart and lung diseases. In addition, they may carry surface absorbed carcinogenic compounds into the lungs. Larger particles, meanwhile, are not readily inhaled, and are removed relatively efficiently from the air by sedimentation.

The main sources of airborne particulate matter in the UK are combustion (industrial, commercial and residential fuel use). The next most significant source is road vehicle emissions. Based on 2022 calendar year emissions data from the 2024 submission of National Atmospheric Emissions Inventory (NAEI) data to the EU, civil aircraft taking off and landing (up to a height of 1000m) was estimated to contribute 0.1% to the total reported UK emissions of PM_{10} and 0.2% to the total reported UK emissions of $PM_{2.5}$[4].

Previous rounds of review and assessment within the LAQM process have not highlighted any cases where airports appear to have caused exceedances of air quality objectives for particulate matter measured as PM_{10}[5].

2.2 MONITORING SITES AND METHODS

2.2.1 Site Locations

Automatic monitoring was carried out at three sites in 2024. These are Stansted 3, Stansted 4 and Stansted 5 (the numbering of the sites continues the sequence used for previous short-term sites in earlier monitoring studies). Following definitions within the Defra Technical Guidance on air quality monitoring LAQM.TG(22)[5], the location descriptions of both Stansted 3 and Stansted 4 sites fall into the category "other" (i.e. "any special source-oriented or location category covering monitoring undertaken in relation to specific emission sources such as power stations, carparks, airports or tunnels") whilst Stansted 5 falls into the "rural" category.

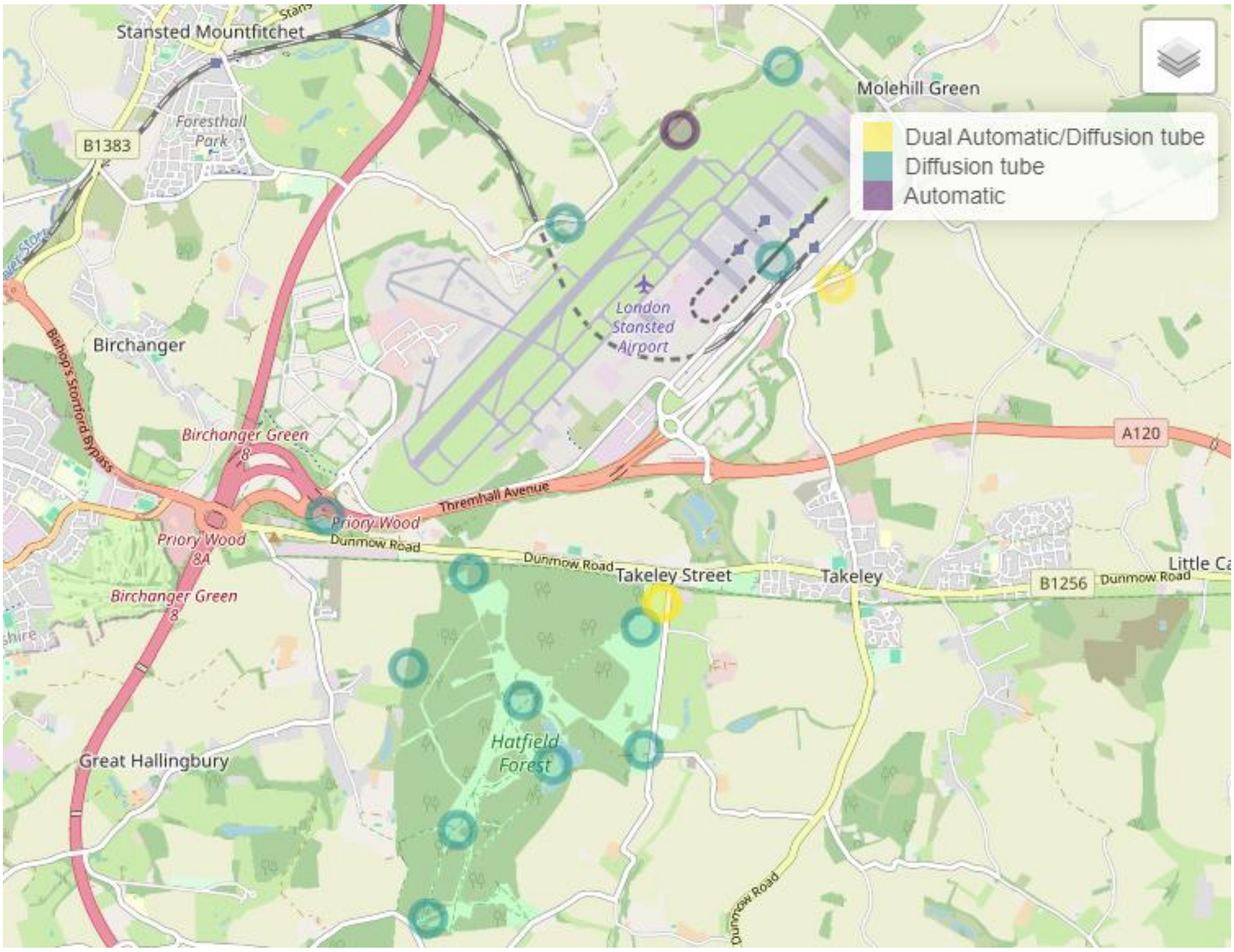
These automatic sites were supplemented by five sites at which diffusion tubes were used to monitor NO_2 on a monthly basis. These were located at the Stansted 3 automatic site, and four sites to the north, east, south and west of the airport. Further to this, an additional nine diffusion tube sites were located around Hatfield Forest.

Table 2 describes the monitoring locations. Figure 1 shows a map of the locations of all monitoring sites used in this study. Automatic monitoring sites are shown by purple dots, diffusive samplers by turquoise dots.

Table 2: Locations of air quality monitoring sites at Stansted and Hatfield Forest

Site name	Description	Parameters monitored	Grid reference
Stansted 3	East of High House	Automatic monitoring of NO_x, PM_{10} and $PM_{2.5}$. Diffusion tube monitoring of NO_2 monthly (co-located).	TL 558 233
Stansted 4	Grass area near runway	Automatic monitoring of NO_x, PM_{10} and $PM_{2.5}$.	TL 548 243
Stansted 5	National Trust office car park	Automatic monitoring of NO_x, PM_{10} and $PM_{2.5}$.	TL547 210
23 Approach	North lights, north end of runway	Diffusion tube monitoring of NO_2 monthly.	TL 555 248
Enterprise House	Enterprise House offices	Diffusion tube monitoring of NO_2 monthly.	TL 555 234
Pond B	Balancing pond south of site	Diffusion tube monitoring of NO_2 monthly.	TL 522 215
Ground Radar	Radar tower, Burton End	Diffusion tube monitoring of NO_2 monthly.	TL 536 235
Hatfield Forest 1	Southwest of National Trust office	Diffusion tube monitoring of NO_2 monthly.	TL 546 208
Hatfield Forest 2	South of B1256	Diffusion tube monitoring of NO_2 monthly.	TL 533 211
Hatfield Forest 3	Northeast of Bedlar's Green	Diffusion tube monitoring of NO_2 monthly.	TL 529 204
Hatfield Forest 4	Northwest of Hatfield Forest Lake	Diffusion tube monitoring of NO_2 monthly.	TL 537 202
Hatfield Forest 5	Shell House Café, Hatfield Forest	Diffusion tube monitoring of NO_2 monthly.	TL 540 198
Hatfield Forest 6	Southeast of Bedlar's Green	Diffusion tube monitoring of NO_2 monthly.	TL 533 193
Hatfield Forest 7	East of Bush End: St John the Evangelist	Diffusion tube monitoring of NO_2 monthly.	TL 546 199
Hatfield Forest 8	Southern edge of Hatfield Forest	Diffusion tube monitoring of NO_2 monthly.	TL 531 186
Hatfield Forest 9	National Trust office car park	Diffusion tube monitoring of NO_2 monthly.	TL 547 210

Figure 1: Locations of the Automatic and Diffusive air monitoring sites around Stansted Airport



The location of the automatic monitoring site at High House (Stansted 3) was agreed with Stansted Airport, Uttlesford District Council and Ricardo. It is located just outside the eastern perimeter of the airport. It is considered to be close enough to the airport to detect effects relating to airport emissions. It is also close to vulnerable receptors, being located in a nursery school car park. The A120 main road runs approximately 1.5 km to the south of the site. The monitoring apparatus is housed in a purpose-built enclosure. Figure 2 shows a photograph of the Stansted 3 site.

Figure 2: Photo of the Stansted 3 air monitoring site

Stansted 4 is located on a site also agreed with Uttlesford District Council at the north-eastern end of the main runway, within the airport perimeter. It is intended to monitor any effects on air quality related to airport emissions. The location of Stansted 4 is included in Figure 1, and a photograph is provided in Figure 3

Figure 3: Photo of the Stansted 4 air monitoring site

Stansted 5 is located in the National Trust office car park in the north-east corner of Hatfield Forest. The location was agreed with between Uttlesford District Council and Natural England. It is intended to monitor any effects of air quality in the Hatfield Forest area related to airport emissions.

Figure 4: Photo of the Stansted 5 air monitoring site

2.2.2 Automatic Monitoring

The following techniques were used for the automatic monitoring of NO_x (i.e. NO and NO_2) and PM:

- NO, NO_2 – Chemiluminescence.
- PM_{10} - Fine Dust Analysis Systems (FIDAS).
- $PM_{2.5}$ - Fine Dust Analysis Systems (FIDAS).

The particulate matter was measured using a FIDAS instrument with no correction required for PM_{10}. $PM_{2.5}$ data has a correction factor applied being divided by 1.06 as per the certification - MCERTS for UK Particulate Matter specification.

Further information on these techniques is provided in Appendix 3 of this report. These analysers provide a continuous output, proportional to the pollutant concentration. This output is recorded and stored every 10 seconds, and averaged to 15-minute mean values by internal data loggers. The analysers are connected to a web logger which sends data every hour to a remote server, Ricardo download data from the server hourly. The data are converted to concentration units at Ricardo then averaged to hourly mean concentrations.

2.2.3 Diffusive Samplers

Diffusion tubes were used for additional indicative monitoring of NO_2. These are "passive" samplers which work by absorbing the pollutants direct from the surrounding air and need no power supply.

Diffusion tubes for NO_2 consist of a small plastic tube, approximately 7 cm long. During sampling, one end is open and the other closed. The closed end contains an absorbent for the gaseous species to be monitored, in this case NO_2. The tube is mounted vertically with the open end at the bottom. Ambient NO_2 diffuses up the tube during exposure and is absorbed as nitrite. The average ambient pollutant concentration for the exposure period is calculated from the amount of pollutant absorbed.

Diffusion tubes were prepared by a commercial laboratory Gradko International Ltd throughout 2024. The tubes were supplied in a sealed condition prior to exposure. They were exposed at the sites for a set period of time. After exposure, the tubes were again sealed and returned to the laboratory for analysis. The exposure periods used were approximately equivalent to calendar months.

3. QUALITY ASSURANCE AND DATA CAPTURE

3.1 QUALITY ASSURANCE AND QUALITY CONTROL

In line with current operational procedures within the Defra Automatic Urban and Rural Network (AURN) [6], full intercalibration audits of the Stansted air quality monitoring sites took place at six-monthly intervals. Full details of these UKAS-accredited calibrations, together with data validation and ratification procedures, are given in Appendix 3 of this report. In addition to instrument and calibration standard checking, the air intake sampling systems were cleaned and all other aspects of site infrastructure were checked.

Following the instrument and calibration gas checking, and the subsequent scaling and ratification of the data, the overall accuracy and precision figures for the pollutants monitored at Stansted are summarised in Table 3.

Table 3: Estimated precision and accuracy of the data presented.

Pollutant	Precision	Accuracy
Nitric Oxide (NO)	±2.5 μgm^{-3}	±14%
Nitrogen Dioxide (NO_2)	±6.9 μgm^{-3}	±15%
Particles (PM_{10})	±2 μgm^{-3}	±7.5%
Particles ($PM_{2.5}$)	±2 μgm^{-3}	±9.3%

When using diffusion tubes for indicative NO_2 monitoring, the LAQM Technical Guidance LAQM.TG(22)[5] states that correction should be made for any systematic bias (i.e. over-read or under-read compared to the automatic chemiluminescent technique, which is the reference method for NO_2). Throughout this study, diffusion tubes have been exposed alongside the automatic NO_x analyser at Stansted 3. These co-located measurements were used for bias adjustment of the annual mean diffusion tube data from the other sites.

The diffusion tube methodologies used for this monitoring programme provide data that are accurate to ± 25% for NO_2. The limits of detection vary from month to month, but typically equate to 0.03 $\mu g\, m^{-3}$ for NO_2. Diffusion tube results that are below 10 times the limit of detection have a higher level of uncertainty associated with them. All were above this threshold.

4. RESULTS AND DISCUSSION

4.1 SUMMARY STATISTICS

Significant data gaps for the automatic monitoring sites are shown in Table 4.

Overall data capture statistics along with summary statistics for Stansted 3, Stansted 4 and Stansted 5 are given in Table 5 to Table 7. These represent the percentage of valid data for the whole reporting period. A data capture target of 85% is recommended in the Defra Technical Guidance LAQM.TG(22)[5]. This target was achieved for all pollutants at Stansted 3 and Stansted 5, and the NO_x analyser at Stansted 4. However, this data capture target was not met for PM_{10} and $PM_{2.5}$ data at Stansted 4, where data capture was 64.3%. This was primarily due to an analyser fault which required the analyser to removed from site and returned to the manufacturer for repair.

Daily average and hourly time series plots of all pollutant data for the full year, as measured by the automatic monitoring site, are shown in Figures 5 – 10.

Table 4: Significant data gaps, 2024

Site	Pollutant	Start date	End date	No. of days	Reason
Stansted 5	PM_{10}, $PM_{2.5}$	01/01/24	20/02/24	50.48	Analyser removed for repair in December 2023.
Stansted 5	NO, NO_x, NO_2	02/01/24	08/01/24	6.09	Data Logger fault.
Stansted 5	PM_{10}, $PM_{2.5}$	23/02/24	24/02/24	0.99	Analyser fault.
Stansted 5	PM_{10}, $PM_{2.5}$	25/02/24	26/02/24	0.99	Analyser fault.
Stansted 5	PM_{10}, $PM_{2.5}$	28/02/24	28/02/24	0.32	Analyser fault.
Stansted 5	PM_{10}, $PM_{2.5}$	29/02/24	29/02/24	0.31	Analyser fault.
Stansted 5	PM_{10}, $PM_{2.5}$	06/03/24	06/03/24	0.30	Analyser fault.
Stansted 5	PM_{10}, $PM_{2.5}$	13/03/24	13/03/24	0.29	Analyser fault.
Stansted 3	NO, NO_x, NO_2, PM_{10}, $PM_{2.5}$	30/04/24	08/05/24	7.92	Site power fault.
Stansted 4	NO, NO_x, NO_2	02/06/24	09/07/24	37.59	Data rejected due to sample line blockage.
Stansted 4	PM_{10}, $PM_{2.5}$	07/06/24	26/06/24	18.76	Site powered down to due AC fault.
Stansted 3	NO, NO_x, NO_2	10/06/24	18/06/24	8.06	Data rejected due to excessive temperature at site.
Stansted 4	PM_{10}, $PM_{2.5}$	09/07/24	28/10/24	111.15	Analyser fault, removed for repair.
Stansted 3	NO, NO_x, NO_2, PM_{10}, $PM_{2.5}$	28/11/24	02/12/24	4.14	Site power fault.
Stansted 3	NO, NO_x, NO_2	29/12/24	01/01/25	2.79	Analyser fault, removed for repair.

Table 5: Summary statistics for Stansted 3

Stansted 3	NO ($\mu g\ m^{-3}$)	NO_2 ($\mu g\ m^{-3}$)	NO_x ($\mu g\ m^{-3}$)	PM_{10} ($\mu g\ m^{-3}$)	$PM_{2.5}$ ($\mu g\ m^{-3}$)
Maximum hourly mean	83	76	203	196	137
Maximum running 8-hour mean	35	55	100	64	48
Maximum running 24-hour mean	28	43	76	51	39
Maximum daily mean	27	41	75	50	38
Average	2	13	16	12	7
Data capture	93.5%	93.5%	93.5%	96.5%	96.5%

Table 6: Summary statistics for Stansted 4

Stansted 4	NO (µg m^{-3})	NO_2 (µg m^{-3})	NO_x (µg m^{-3})	PM_{10} (µg m^{-3})	$PM_{2.5}$ (µg m^{-3})
Maximum hourly mean	94	79	189	61	49
Maximum running 8-hour mean	35	57	104	55	45
Maximum running 24-hour mean	25	50	80	46	36
Maximum daily mean	25	39	68	45	36
Average	5	12	19	11	7
Data capture	89.7%	89.7%	89.7%	64.3%	64.3%

Table 7: Summary statistics for Stansted 5

Stansted 5	NO (µg m^{-3})	NO_2 (µg m^{-3})	NO_x (µg m^{-3})	PM_{10} (µg m^{-3})	$PM_{2.5}$ (µg m^{-3})
Maximum hourly mean	60	66	158	63	51
Maximum running 8-hour mean	22	44	69	56	46
Maximum running 24-hour mean	11	36	49	46	37
Maximum daily mean	8	33	39	46	37
Average	1	8	9	11	7
Data capture	97.7%	97.7%	97.7%	85.1%	85.1%

Figure 5: Hourly mean NO_2 timeseries, 2024

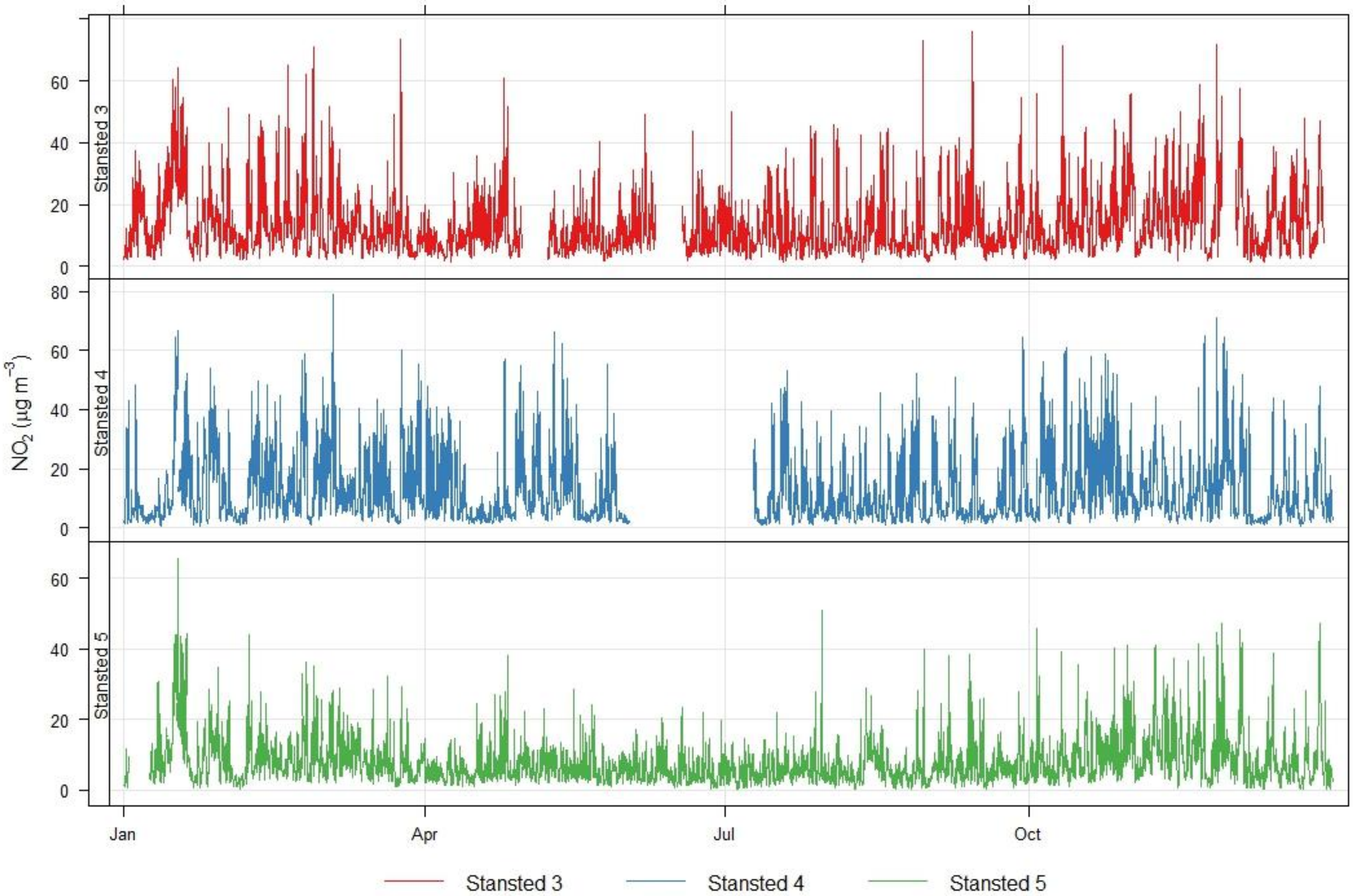


Figure 6: Daily mean NO_2 timeseries, 2024

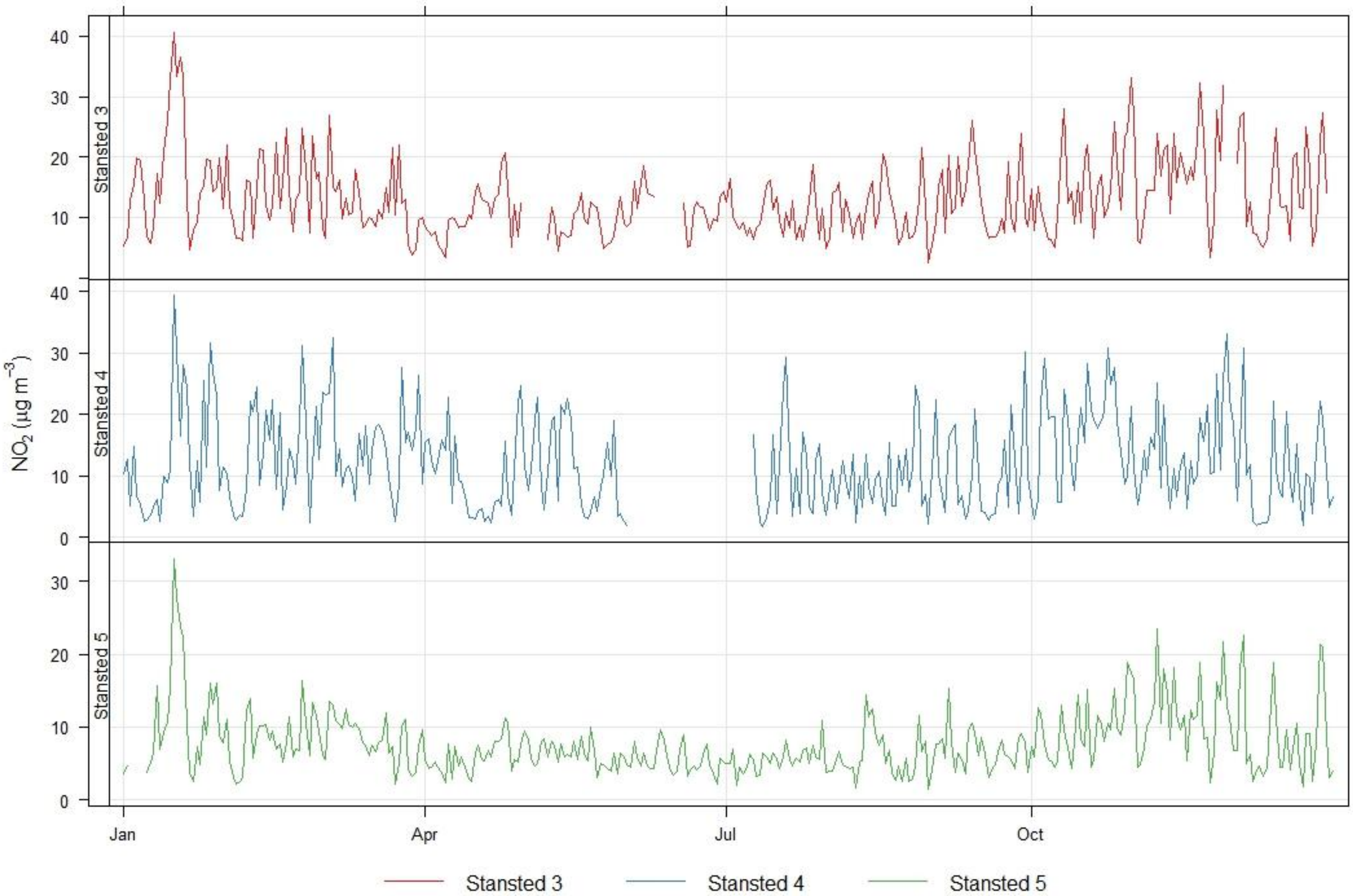


Figure 7: Hourly mean $PM_{2.5}$ timeseries, 2024

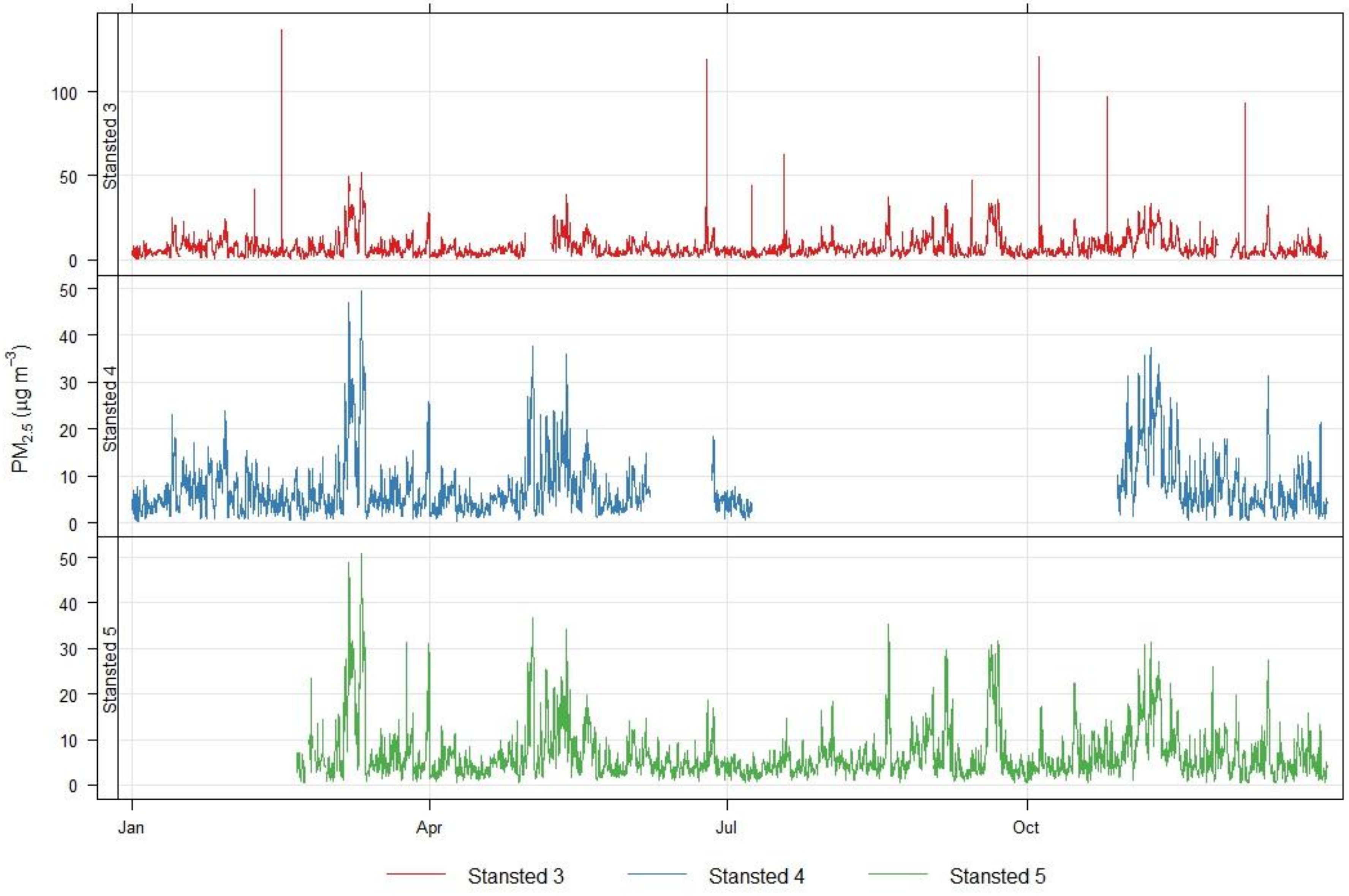


Figure 8: Daily mean $PM_{2.5}$ timeseries, 2024

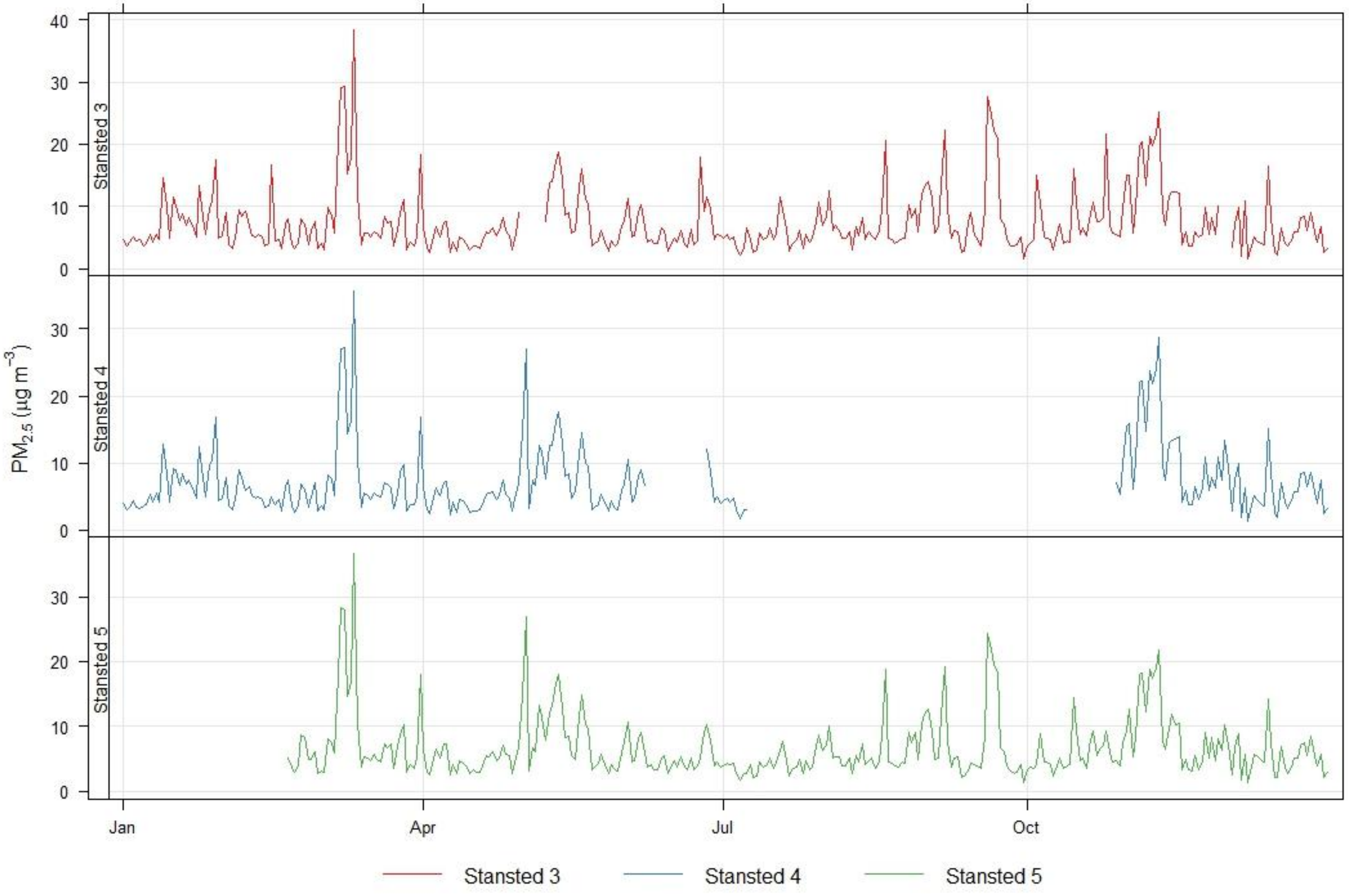


Figure 9: Hourly mean PM_{10} timeseries, 2024

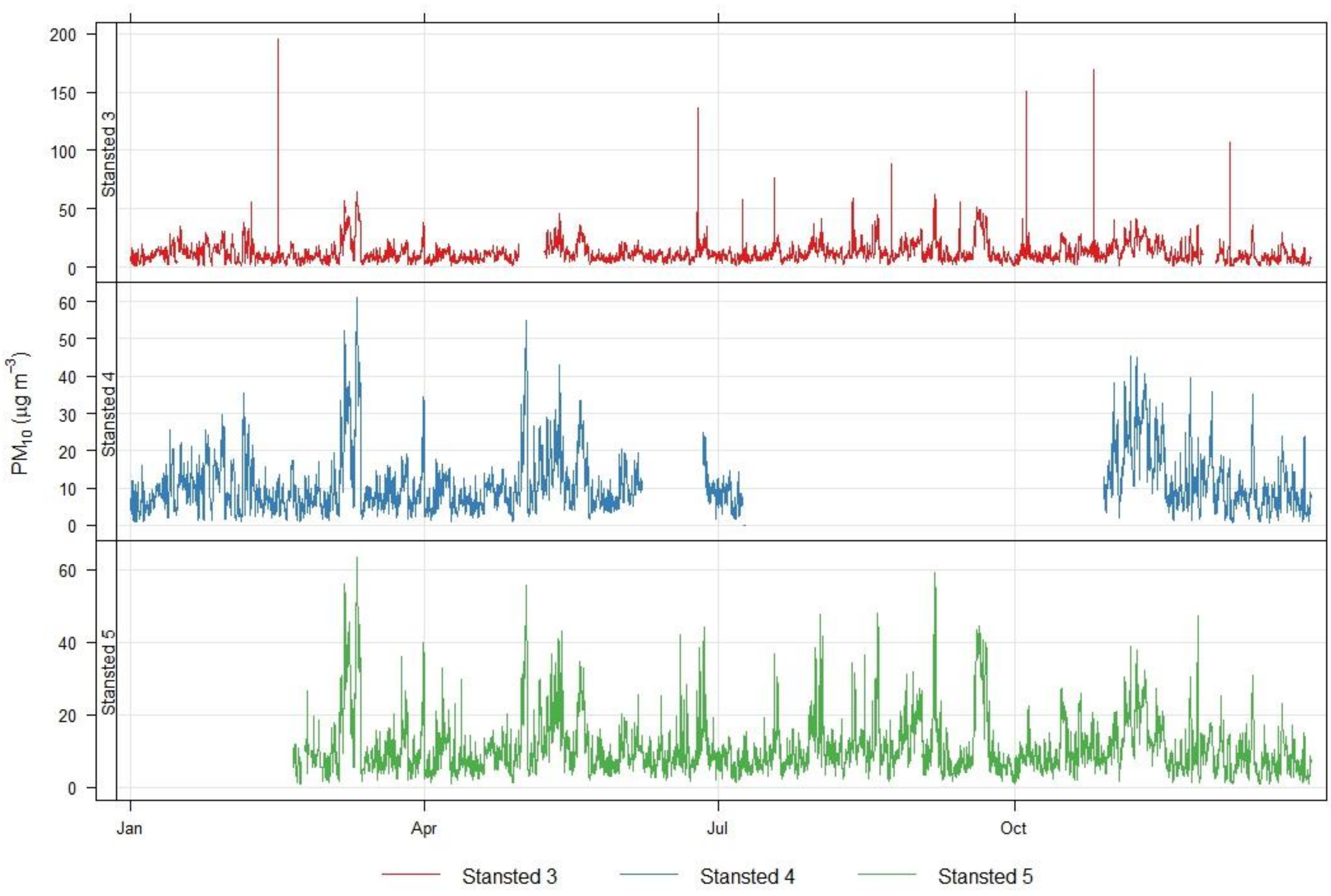
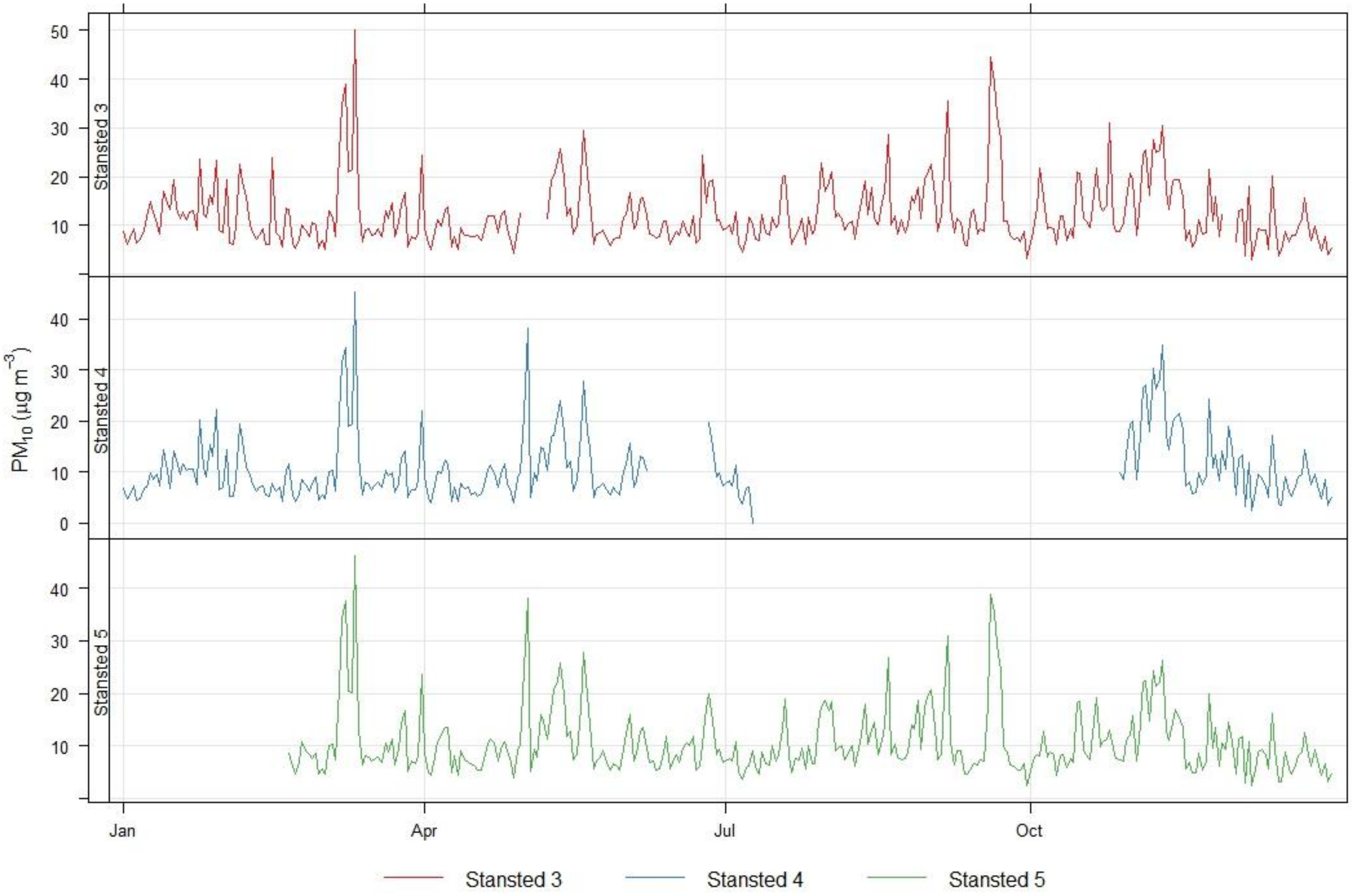


Figure 10: Daily mean PM_{10} timeseries, 2024



At Stansted 3, the highest hourly concentration of NO_2 (76.1 µg m^3) was recorded in September 2024. Peaks in daily concentrations were shown in January, October and November 2024. Stansted 3 also exhibits a peak in PM_{10} and $PM_{2.5}$ hourly concentrations of 195.7 µg m^3 and 137.1 µg m^3 respectively on 15th February 2024 with several other significant peaks in PM_{10} and $PM_{2.5}$ concentrations throughout the year. It is likely that these peaks in particulate matter concentrations are a result of agricultural activity due to the proximity of Stansted 3 to farming operations on nearby land, as described in previous years. Localised short-term episodes such as this are regularly reported in the national network and can be attributed to a range of operations such as agricultural activity, mechanical activity, or temporary establishments such as festivals. Air quality stations aim to be representative of a wider area and not influenced by local sources. Unfortunately, localised pollution episodes are a limitation of all national network and other air quality monitoring sites. During the air quality station siting process, the local environment is reviewed in detail with a view to minimise the effects of local activity.

At Stansted 4, the highest hourly NO_2 concentration of 79.0 µg m^3 was recorded in March. However, overall the month with the highest monthly mean concentrations was October. A maximum hourly PM_{10} concentration of 61.0 µg m^3 was recorded in March and the highest hourly $PM_{2.5}$ concentration of 49.4 µg m^3 was also recorded in March. However for both PM_{10} and $PM_{2.5}$, November was shown to be the overall highest month for both pollutants.

The highest hourly NO_2 concentration at Stansted 5 was measured to be 65.7 µg m^3 which was recorded in January 2024. At Stansted 5, NO_2 concentrations averaged the lowest of the three sites at 7.8 µg m^{-3}. This site also experienced peaks in daily PM_{10} and $PM_{2.5}$ in March of 63.4 µg m^{-3} and 50.9 µg m^{-3} respectively, similar to peaks exhibited at Stansted 4. The month with the highest mean concentration for PM_{10} was shown to be May, in comparison the month with the highest mean $PM_{2.5}$ concentration was March .

4.2 DIFFUSION TUBE DATA

Table 8 highlights the NO_2 diffusion tube results for 2024. Tubes were exposed in triplicates at all sites. The means of those replicate measurements are the results shown below. Diffusion tube data is provided by the analyst to two decimal places. In accordance with the reported uncertainty of the method, these values have been rounded to one decimal place in the table below and are quoted as integer values in this report. Monthly mean NO_2 concentrations at Stansted and Hatfield Forest diffusion tube sites are shown in the time series plots in Figure 11 and 12.

Table 8: NO_2 diffusion tube results for 2024 ($\mu g\ m^{-3}$).

Start date	End date	23 Approach	Enterprise House	Ground Radar	High House Nursery	Pond B	HF1	HF2	HF3	HF4	HF5	HF6	HF7	HF8	HF9
03/01/2024	30/01/2024	21.9	29.4	15.1	22.4	22.6	16.3	16.1	14.5	14.7	12.2	13.7	13.3	12.7	16
30/01/2024	05/03/2024	17.7	19.4	12.3	14.4	15	11.1	9.9	10	9.8	8.9	9.5	9.5	10.7	11.8
05/03/2024	04/04/2024	18.9	20.3	14.9	14.5	15.3	10.4	10.3	9.6	10.2	8.4	8.8	9	8.2	10.2
04/04/2024	30/04/2024	15.3	21.2	8.8	14.2	14.3	7.7	9.1	7.5	7.9	6.6	6.7	6.5	6.3	8.4
30/04/2024	05/06/2024	11.7	20.4	11.1	13.3	14.4	6.9	9.1	6.7	7.1	6.3	6.8	6.4	5.7	8.4
05/06/2024	01/07/2024	9.7	23.4	8.4	14	13.8	5.7	7.2	5.5	5.9	5.1	4.9	5.2	4.9	6.6
01/07/2024	29/07/2024	*NA*	22.1	10.3	13.9	13.4	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	6	*NA*	*NA*
01/07/2024	30/07/2024	*NA*	*NA*	*NA*	*NA*	*NA*	6.4	7.9	*NA*	7	5.8	5.7	*NA*	5.9	7.6
29/07/2024	02/09/2024	8.4	10.8	5.5	6.7	7.3	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	3.2	*NA*	*NA*
30/07/2024	02/09/2024	*NA*	*NA*	*NA*	*NA*	*NA*	3.4	3.9	3.3	3.3	2.9	*NA*	*NA*	3.4	3.7
02/09/2024	01/10/2024	14.3	24.4	8.5	15.4	18.1	8.3	10.5	8.2	8	6.8	7.2	7.3	7	9.4
01/10/2024	05/11/2024	18.8	22.5	16.1	17.2	18.1	10	11.1	9.3	10.6	9.2	9.3	8.1	9.1	11.7
05/11/2024	02/12/2024	19.6	27.4	15.5	21.9	21.9	14.3	14.7	12.8	13.1	11.7	11.6	11.9	11.7	15.4
02/12/2024	10/01/2025	18.8	26.2	10.7	17.5	17	12	12.4	11.7	11.2	9.6	10.4	10.7	11.4	12.2
Mean	**-**	**15.9**	**22.3**	**11.4**	**15.5**	**15.9**	**9.4**	**10.2**	**9.0**	**9.1**	**7.8**	**8.6**	**8.1**	**8.1**	**10.1**
Bias adjusted	**-**	**13.5**	**18.9**	**9.7**	**13.1**	**13.5**	**8.0**	**8.7**	**7.7**	**7.7**	**6.6**	**7.3**	**6.9**	**6.9**	**8.6**

Figure 11: Time series of monthly mean NO_2 at Stansted diffusion tube sites

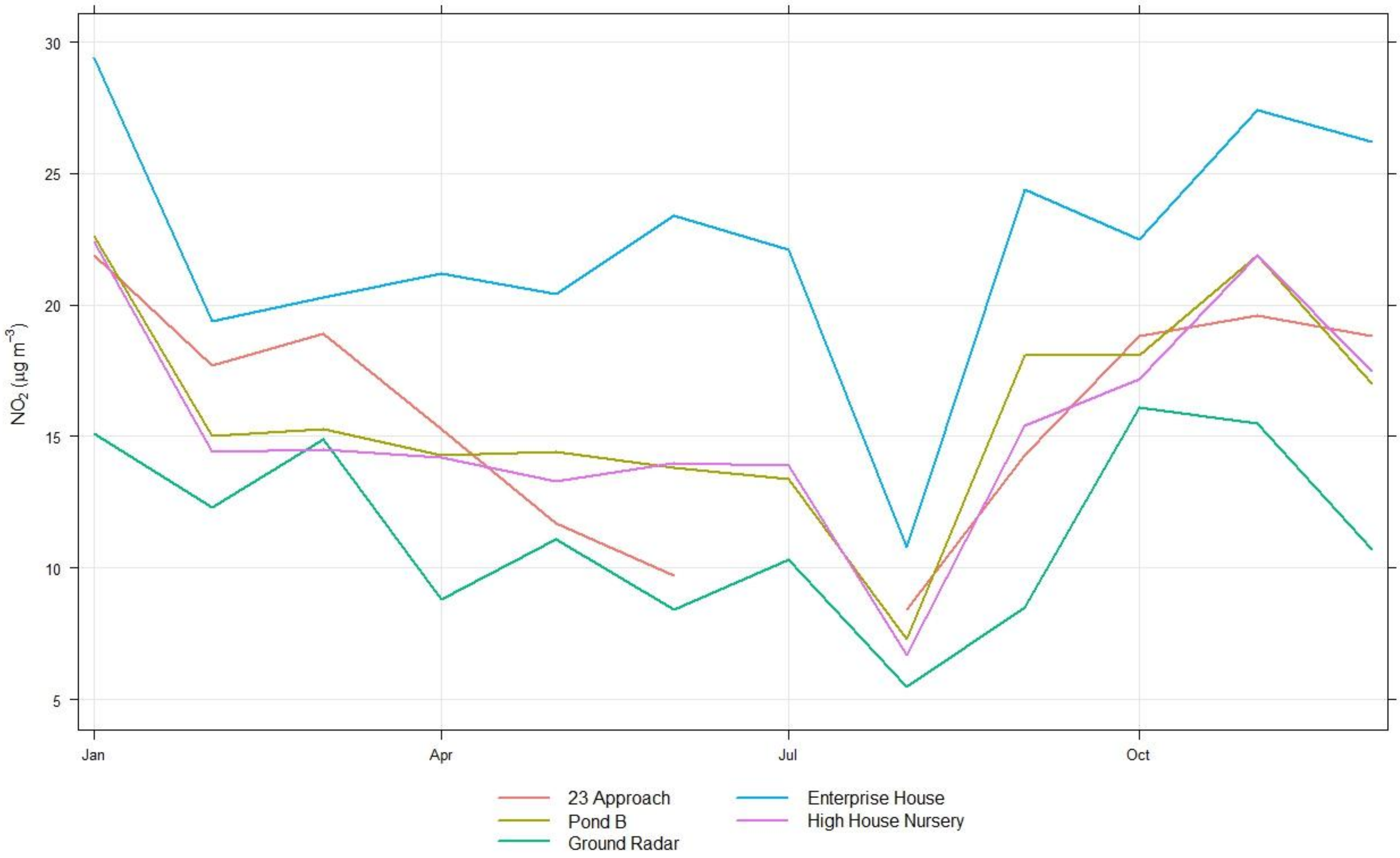
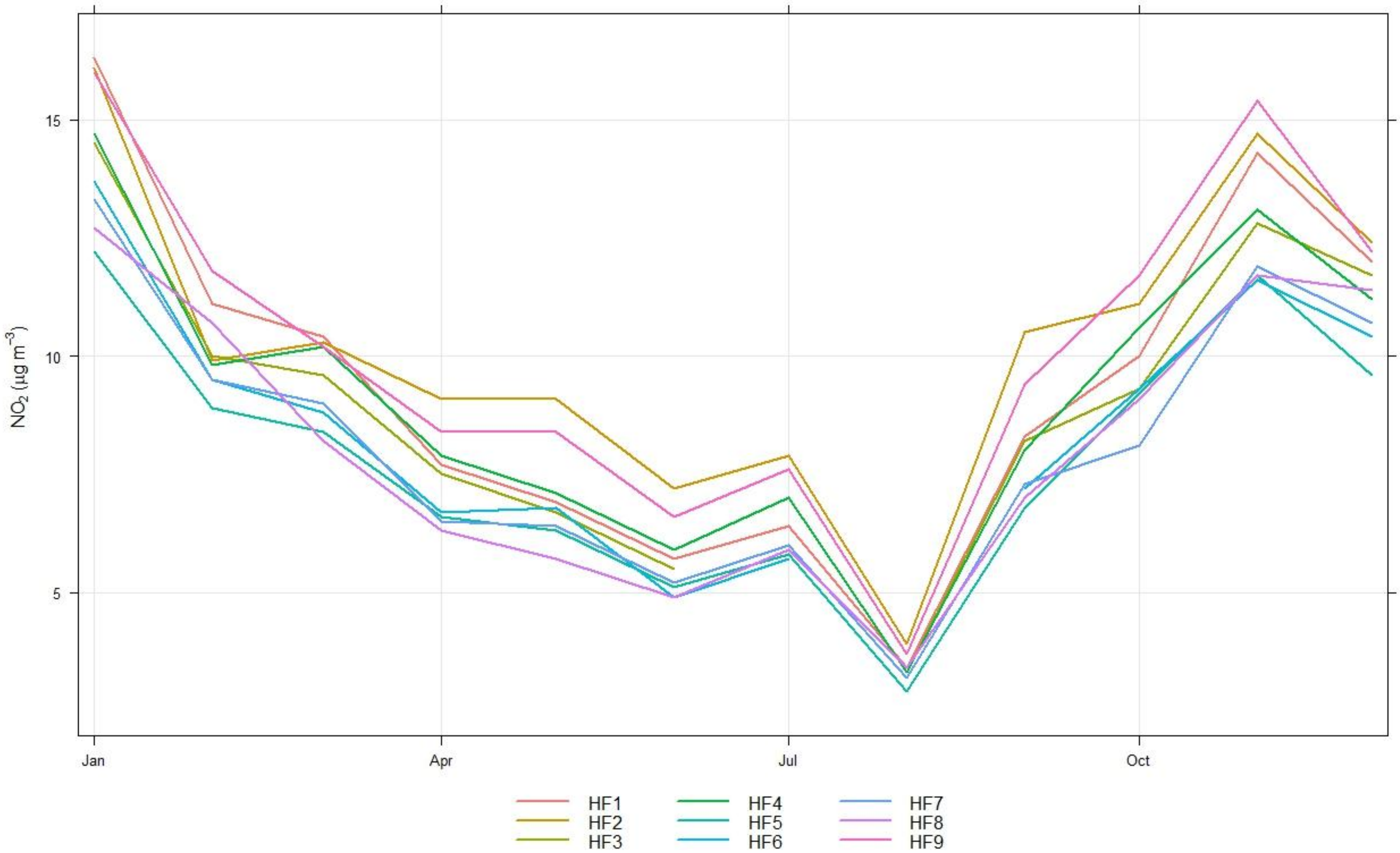


Figure 12: Time series of monthly mean NO_2 at Hatfield Forest diffusion tube sites



Fifteen results were rejected or were missing on collection. Rejected results were removed as they were suspected to be spurious, some due to environmental contamination and others were obvious outliers. Details of these results are shown in Table 9. All results considered to be "outliers", where the concentrations are much lower than those of the other two co-exposed tubes, were subsequently rejected. Tube 3 of the December exposure at Hatfield Forest 8 was found damaged upon collection and therefore unable to be analysed.

Table 9: Details of the NO_2 diffusion tube results rejected/missing during 2024.

Site	Month	Tube number	$[NO_2]$ (µg m^{-3})	Reason for rejection
Hatfield Forest 3	May	1	3.73	Tube found on floor and spider and web found in tube - Outlier compared to other two tubes at site.
Pond B	July	1	-	Missing on collection.
23 Approach	July	3	-	Missing on collection.
Hatfield Forest 3	July	3	1.3 2.49 17.00	Debris found inside tubes – Results from three tubes considered erroneous.
Hatfield Forest 4	August	1	-	Missing on collection.
Hatfield Forest 6	August	3	-	Missing on collection.
23 Approach	September	1	-	Missing on collection.
Hatfield Forest 6	October	1	6.09	Insect found inside tube – Outlier compared to other two tubes at site.
Hatfield Forest 8	December	1	-	Tube found damaged on collection – Results could not be analysed.

Diffusion tubes are affected by several artefacts, which can cause them to under-read or over-read with respect to the reference technique. It has therefore become common practice to calculate and apply a "bias adjustment factor" to annual mean NO_2 concentrations measured by diffusion tubes, using co-located diffusion tube and automatic analyser measurements. This bias adjustment factor is calculated as the ratio of the automatic analyser result to the diffusion tube result. This factor can then be used to correct the annual means measured at the other monitoring locations. The bias adjustment factor was calculated using unrounded values from all months. On this basis, the bias adjustment factor was calculated to be 0.85.

Bias adjusted annual mean NO_2 concentrations, measured with diffusion tubes, across the five Stansted sites range between 9.7 µg m^{-3} and 18.9 µg m^{-3}. Diffusion tube results from Stansted 3 (High House Nursery) can be directly compared to data from the automatic monitoring site. The annual mean NO_2 concentrations for the diffusion tubes and automatic NO_x analyser at Stansted 3, were both 13 µg m^{-3}.

Bias adjusted annual mean NO_2 concentrations, measured with diffusion tubes, at the nine Hatfield Forest sites ranged from 6.6 to 8.7 µg m^{-3}.

Please note:

i. Only the annual mean concentration (not individual monthly values) should be adjusted using the bias adjustment factor. This is because diffusion tube bias can vary considerably from month to month due to meteorological and other factors.
ii. Even after application of a bias adjustment factor, diffusion tube measurements remain indicative only.

4.3 COMPARISON WITH AIR QUALITY OBJECTIVE

Details of the UK air quality standards and objectives specified by Defra are provided in Appendix 1.

The AQS objective for hourly mean NO_2 concentration is 200 µg m^{-3} which may be exceeded up to 18 times per calendar year. There were no recorded hourly mean NO_2 concentrations in excess of 200 µg m^{-3} at Stansted 3, Stansted 4 and Stansted 5, these sites therefore met the AQS objective for this pollutant.

Stansted 3, Stansted 4 and Stansted 5 measured annual mean NO_2 concentrations of 13.0 µg m^{-3}, 12.2 µg m^{-3} and 7.8 µg m^{-3} respectively, during 2024. Therefore, all three automatic sites at Stansted Airport were within the annual mean AQS objective for NO_2 of 40 µg m^{-3} for protection of human health and the objective of 30 µg m^{-3} for protection of vegetation and ecosystems.

The bias-adjusted annual mean NO_2 concentrations measured at the five Stansted diffusion tube sites and nine Hatfield Forest diffusion tube sites were all within the AQS objective of 40 µg m^{-3}.

In 2024, $PM_{2.5}$ annual mean concentrations measured at Stansted 3 and Stansted 5 were 7.5 µg m^{-3} and 6.6 µg m^{-3} respectively. These annual means are well within the annual mean objective of 25 µg m^{-3}, therefore these sites met the AQS objective for annual means for $PM_{2.5}$. The annual mean $PM_{2.5}$ concentrations measured at Stansted 4 was 7.3 µg m^{-3}. However, due to the low data capture at Stansted 4, the annual mean may not be representative of the entire year and therefore care should be taken when comparing to the annual mean objective.

The AQS objective for 24-hour mean PM_{10} is 50 µg m^{-3}, not to be exceed more than 35 times. Stansted 3 and Stansted 5 did not exceed the 50 µg m^{-3} limit value in 2024 and therefore met the 24-hour mean PM_{10} objective. Defra Technical Guidance on air quality monitoring LAQM.TG(22)[5] recommends that when data capture is less than 85%, the 90.4th percentile should be reported for 24-hour PM_{10} data. As the data capture for PM_{10} at Stansted 4 was 64.3%, the 90.4th percentile is reported in comparison to the 50 µg m^{-3} 24-hour mean PM_{10} objective. The 90.4th percentile value was 21.2 µg m^{-3}, therefore indicating that if data capture had been 100% at this monitoring location, there have been less than 35 exceedances of the 50 µg m^{-3} limit value. Stansted 3 and Stansted 5 recorded PM_{10} concentrations less than the AQS annual mean objective of 40 µg m^{-3}, therefore this AQS objective was met at these sites. The annual mean concentration recorded at Stansted 4 was 10.8 µg m^{-3}, however due to the low data capture of this site in 2024, this annual mean may not be representative of the entire year and therefore care should be taken when comparing against the AQS objective.

4.4 SMOOTH TREND PLOTS

The figures below show smoothed time series plots of NO_2, PM_{10}, and $PM_{2.5}$. Points represent monthly concentrations and bold lines represent the trend modelled by Generalised Additive Model (GAM). The shaded pink area corresponds to 95% confidence interval.

Figure 13: Smooth trend plot of monthly mean NO_2 at Stansted 3, Stansted 4, and Stansted 5 during 2024

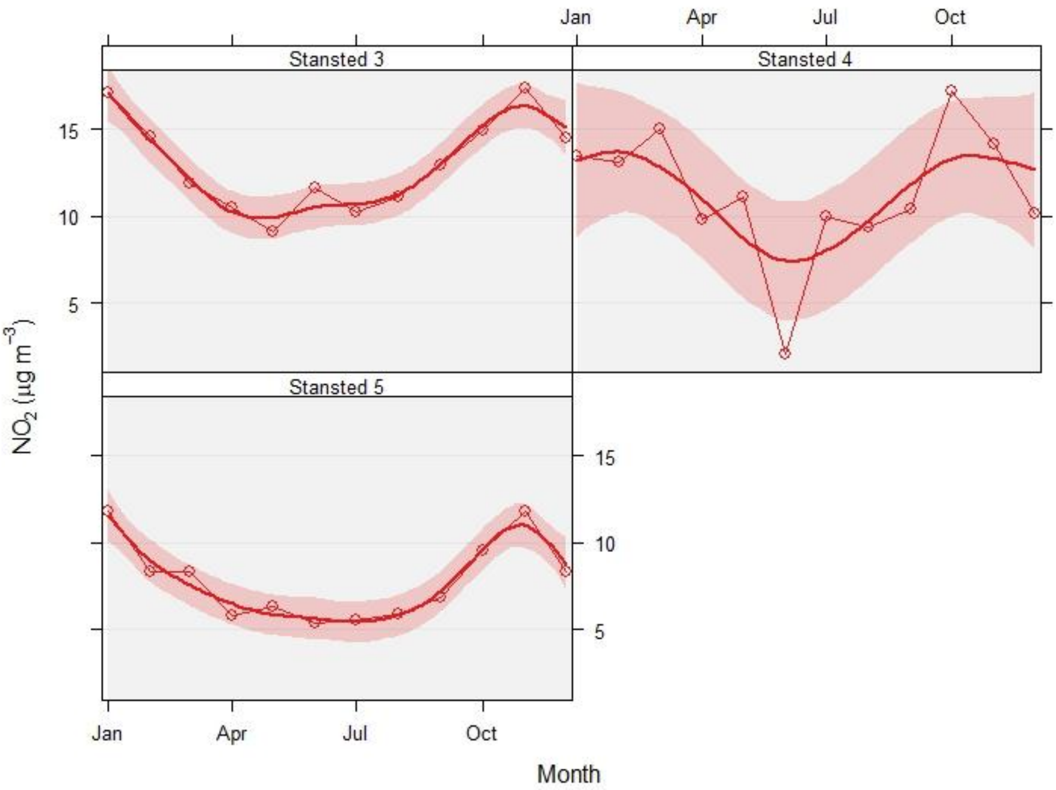


Figure 15: Smooth trend plot of monthly mean PM_{10} at Stansted 3, Stansted 4, and Stansted 5 during 2024

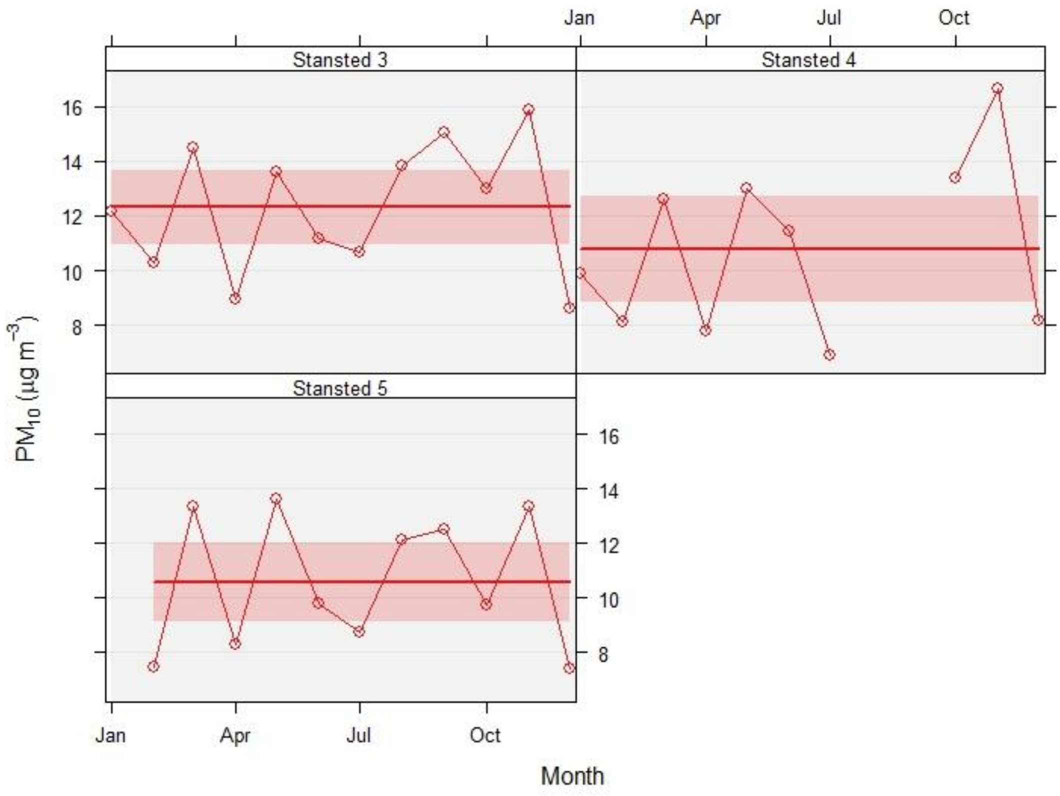
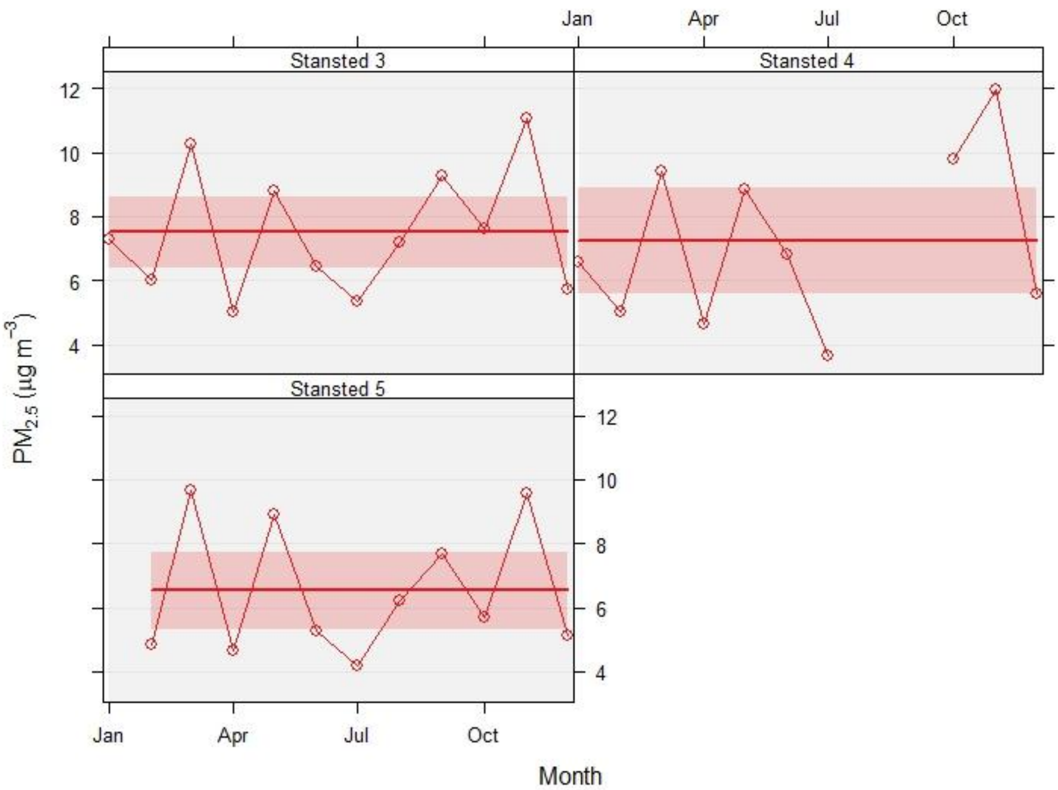


Figure 14: Smooth trend plot of monthly mean $PM_{2.5}$ at Stansted 3, Stansted 4, and Stansted 5 during 2024



4.5 TEMPORAL VARIATIONS IN POLLUTANT CONCENTRATIONS

4.5.1 Seasonal Variation

Figures 16, 17 and 18 show the average NO_2, PM_{10} and $PM_{2.5}$ concentrations during 2024 at Stansted 3, Stansted 4 and Stansted 5 for each hour on a given day (top), any hour (bottom left), each month (bottom centre) and any day (bottom right).

Figure 16 shows different temporal averages of NO_2 recorded at all three sites. Peaks in NO_2 concentrations are shown at all three sites during winter months, mainly January and November at Stansted 3 and Stansted 5, and March and October at Stansted 4. This pattern is expected as cold weather and relatively low wind speeds that occur during winter months reduce pollution dispersion.

Figure 17 shows different temporal averages of $PM_{2.5}$ recorded at all three sites. Elevated $PM_{2.5}$ concentrations are shown in March, May, and November. Elevated concentrations in March and November may be due to reduced pollutant dispersion as described above. The peaks in $PM_{2.5}$ concentrations in May may be due to the persistence of $PM_{2.5}$ molecules, where low wind speeds and air masses moving from the continent can cause elevated periods of $PM_{2.5}$ pollution. Peaks in PM_{10} concentrations at Stansted 3, Stansted 4 and Stansted 5 show similar trends to those seen in $PM_{2.5}$ concentrations, with March, May, and November showing elevated PM_{10} concentrations. At Stansted 3 and Stansted 5, PM_{10} concentrations are also shown to be more elevated in August and September. These elevations can also be explained by relatively low wind speeds and air masses moving from the continent.

4.5.2 Diurnal Variation

Bottom left graphs in Figure 16, Figure 17, and Figure 18 show diurnal variation in pollutant concentrations, as measured at Stansted 3, Stansted 4 and Stansted 5.

Figure 16 shows that all sites experienced significant peaks in NO_2 during the mornings, most prominently at around 06:00, which coincides with rush hour traffic usually experienced at this time. Following this peak, concentrations are shown to decrease during the middle of the day and then increase again to a peak at around 19:00. The peak associated with the morning rush is of higher magnitude when compared to the peak in the afternoon which is shown to be broader. This is due to NO_2 concentrations beginning to increase in the early afternoon. For much of the night, concentrations remain elevated which results in enhanced oxidation of NO to NO_2 due to increased concentrations of oxidising agents in the atmosphere (e.g. ozone) in the afternoon.

Figure 17 shows $PM_{2.5}$ concentrations at all sites demonstrate similar diurnal trends. Concentrations start to decrease between 04:00 and 05:00. Concentrations continue to decrease until around 13:00 after which they are shown to slowly increase again and return to similar concentrations exhibited in the morning, with the highest peak shown at 00:00. These diurnal changes can be attributed to primary particulate matter emissions. These patterns may also be due to emissions of sulphur dioxide and NO_x as these can react with other atmospheric chemicals to form secondary sulphate and nitrate particles. This can then result in concentrations of PM_{10} and $PM_{2.5}$ becoming elevated.

Diurnal patterns in PM_{10} varies between sites as shown in Figure 18. Diurnal patterns in PM_{10} concentrations at Stansted 4 are comparable to those of $PM_{2.5}$ at all sites. PM_{10} concentrations are shown to decrease through the morning to mid-afternoon where concentrations increase throughout the evening and night back to the morning peak. PM_{10} concentrations at Stansted 3 and Stansted 5 show a different pattern to that shown at Stansted 4, with small peaks shown in the morning and afternoon but less variability in concentrations throughout the day. These morning and afternoon peaks are likely attributed to the contribution of local emissions from vehicle activity within the car parks at both sites.

4.5.3 Weekly Variation

Analysis of weekly variations of NO_2 concentrations show that concentrations are lowest for all sites on Monday and at the weekend. NO_2 concentrations are highest on Friday at Stansted 3 and Stansted 4 compared to Stansted 5 where there are similarly high concentrations between Tuesday and Friday. PM_{10} and $PM_{2.5}$ concentrations show different weekly variations compared to NO_2. Both pollutants are generally shown to be highest on Thursday and/or Friday at all three sites.

Figure 16: Temporal variation in NO_2 concentrations during 2024 at Stansted 3, Stansted 4, and Stansted 5

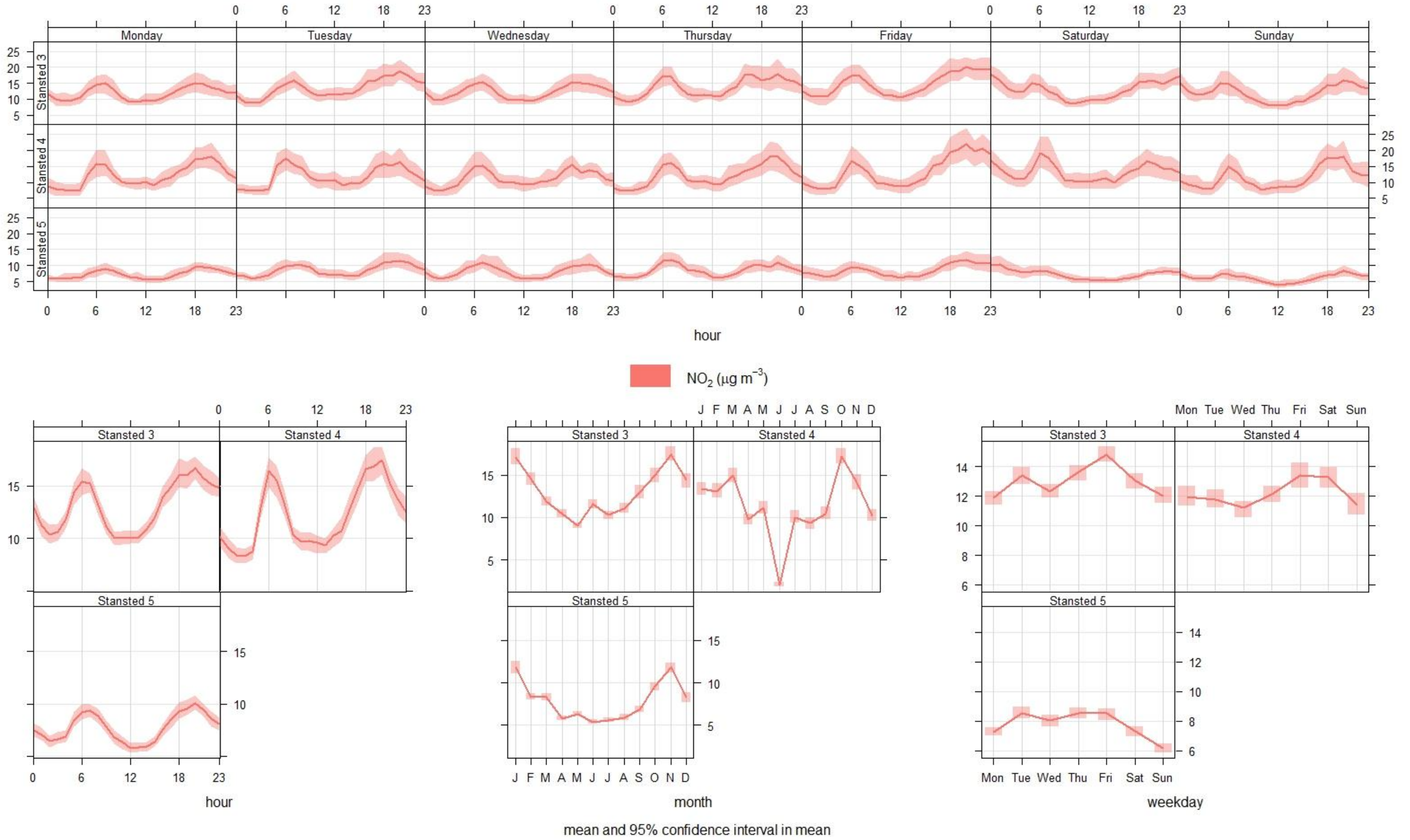


Figure 17: Temporal variation in $PM_{2.5}$ concentrations during 2024 at Stansted 3, Stansted 4, and Stansted 5

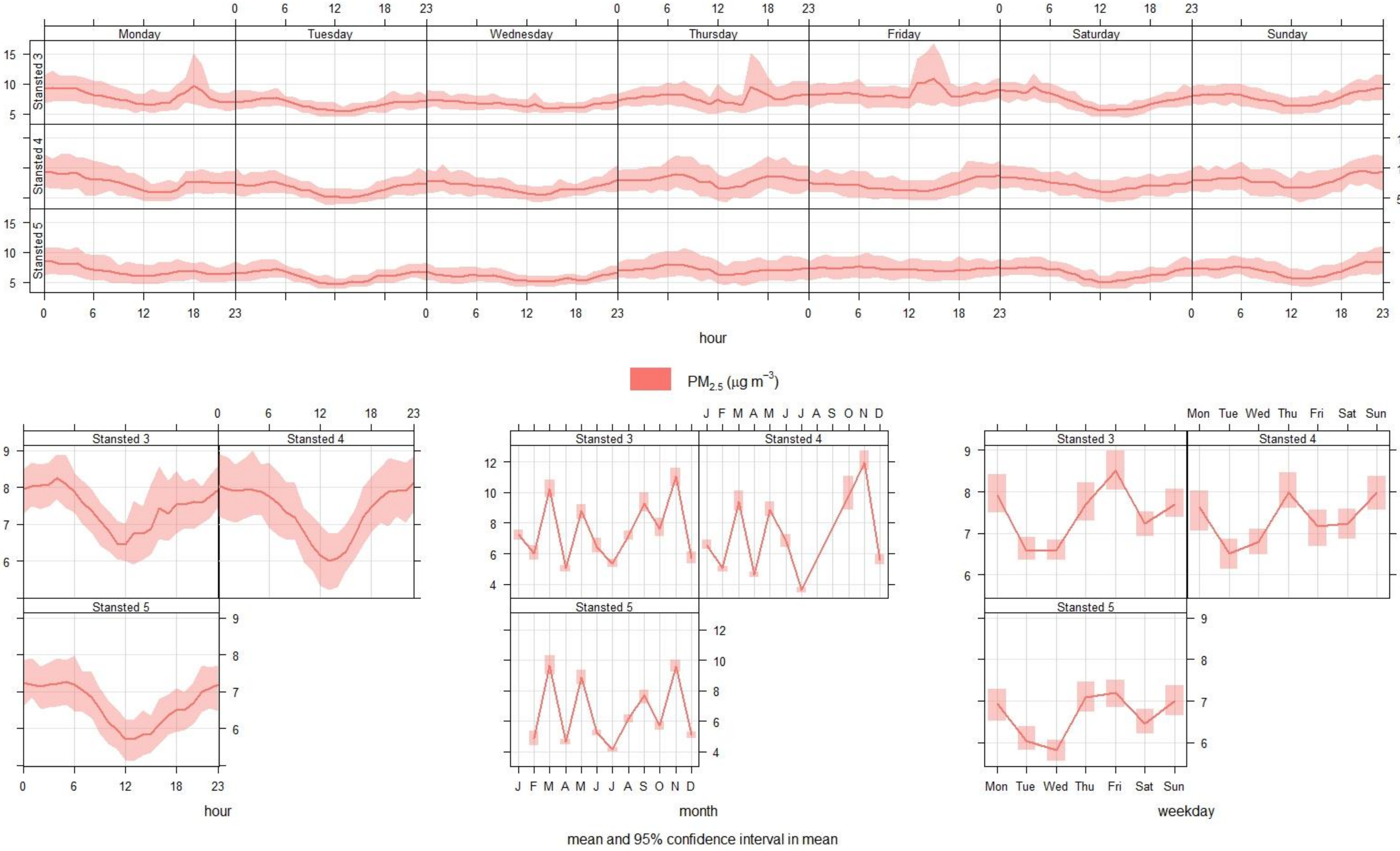
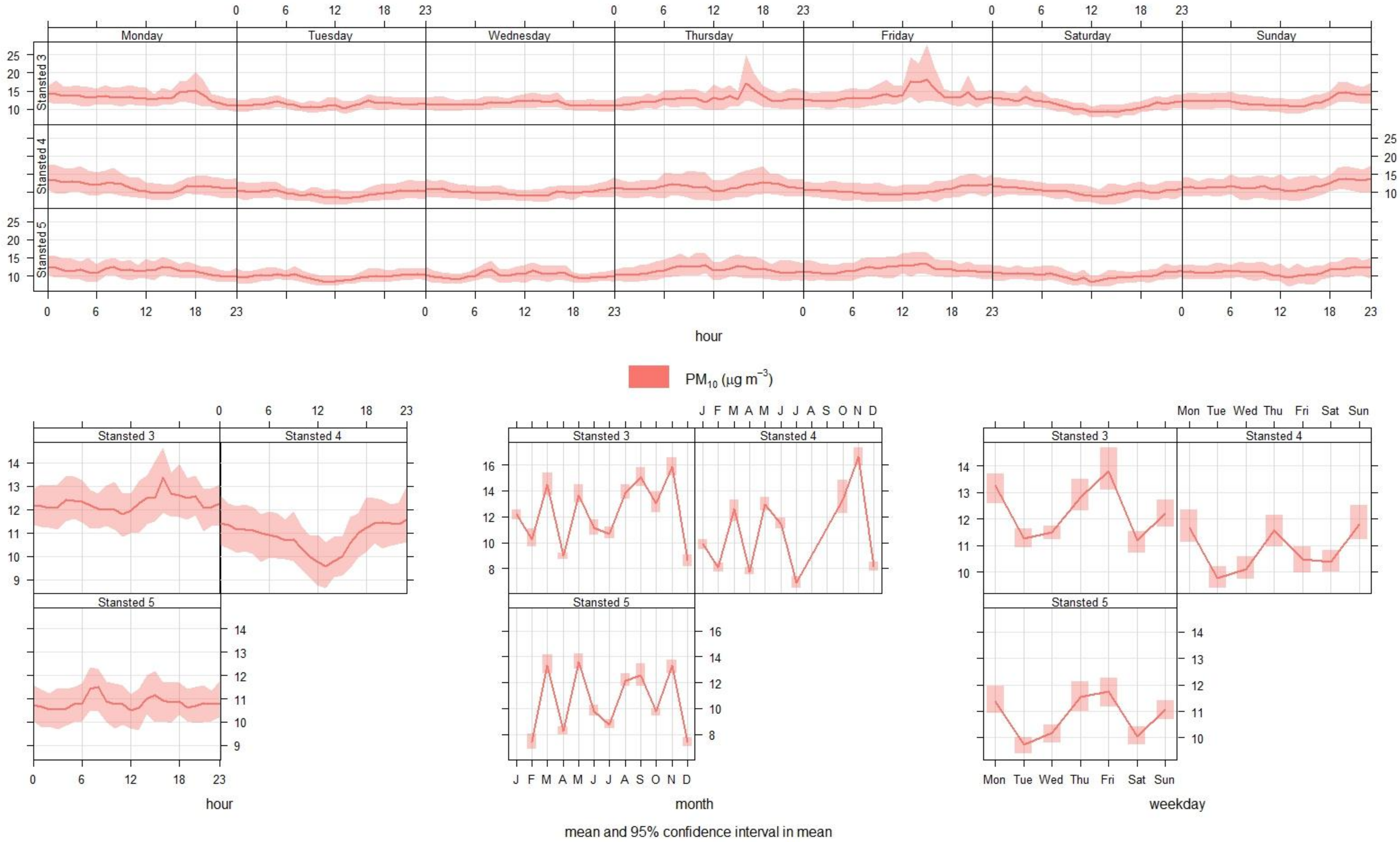


Figure 18: Temporal variation in PM_{10} concentrations during 2024 at Stansted 3, Stansted 4, and Stansted 5



4.6 PERIODS OF ELEVATED POLLUTANT CONCENTRATION

As well as the AQS Objectives, a Daily Air Quality Index (DAQI) is used in the UK to communicate information about current and forecast air quality to the public. The Index is based on a scale of 1-10, divided into four bands (Low, Moderate, High and Very High): this provides a simple indication of pollution levels, similar to the pollen index. Low air pollution is between 1 and 3, Moderate is between 4 and 6, High is between 7 and 9, and Very High is 10 on the scale. This is intended to allow sensitive people to take any necessary action.

The concentration ranges associated with each band within the index are presented in Appendix 1.

NO_2, PM_{10} concentrations at Stansted 3, Stansted 4 and Stansted 5 remained within the Low band throughout 2024. $PM_{2.5}$ concentrations at Stansted 3, Stansted 4 and Stansted 5 moved into the Moderate band on one occasion during 2024.

The historic Air Quality Index data presented at the Department of Environment, Food & Rural Affairs (Defra) UK-AIR website[8] shows air quality index bands that entered Moderate banding from 10th to 11th March and on various days throughout May and September (Figure 19). Air quality index bands also entered Moderate banding on 5th November. These pollution episodes are consistent with the period of elevated PM and NO_x concentrations measured at the three Stansted monitoring stations.

Moderate pollution was recorded across much of London and Eastern England in March and November 2024, due to settled weather conditions and temperature inversion leading to a build-up of pollution and poor pollution dispersion. This can be seen at Stansted 3, Stansted 4 and Stansted 5 where March and November were shown to have high monthly concentrations for most pollutants. Furthermore, Moderate pollution bandings were recorded across the South of England on 19th September which can be seen in the data recorded from all three Stansted automatic monitoring sites. This pollution episode is likely due to air masses imported from the continent which contained high concentrations of particulate matter.

Figure 19: DAQI for 5th November 2024

4.7 CALENDAR PLOTS

Figure 30 to Figure 38 show calendar plots for each site. The date is coloured by the NO_2, $PM_{2.5}$ and PM_{10} concentration (μg m^{-3}) for that day.

Figure 30: NO_2 calendar plot for Stansted 3 during 2024

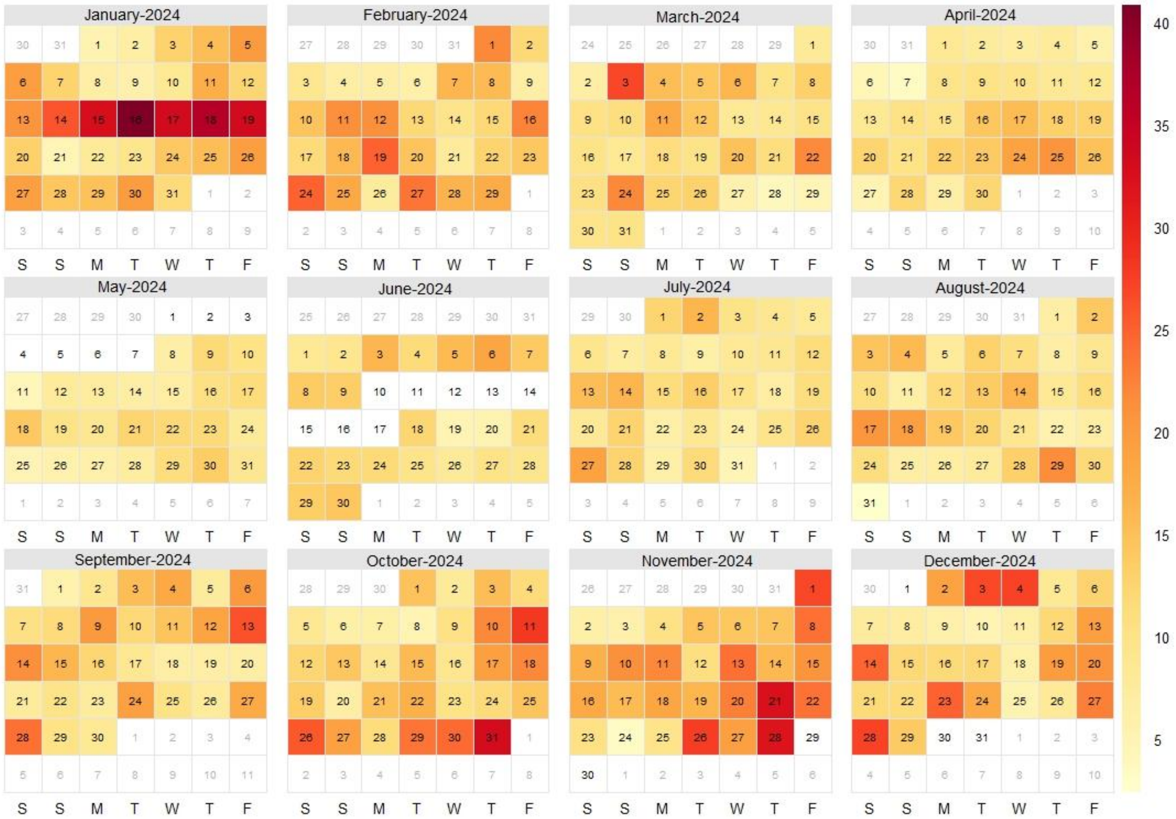


Figure 31: NO_2 calendar plot for Stansted 4 during 2024

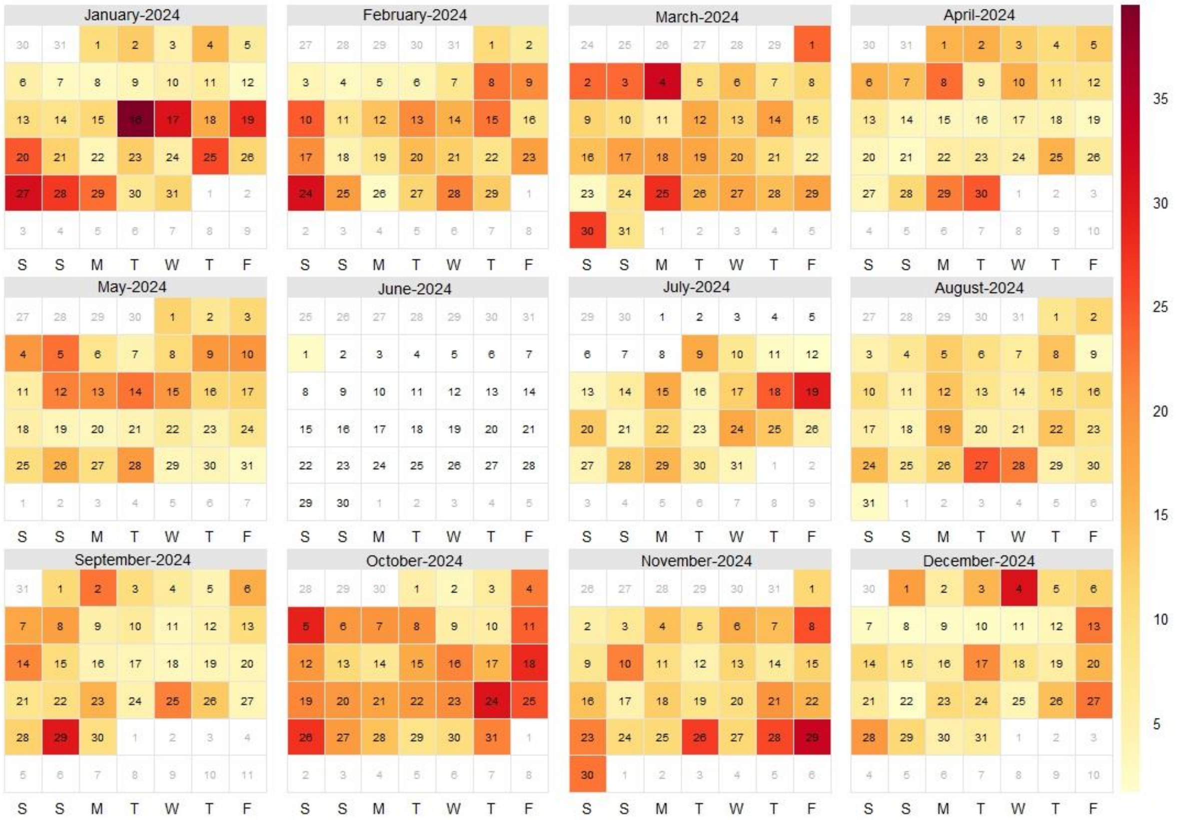


Figure 32: NO_2 calendar plot for Stansted 5 during 2024

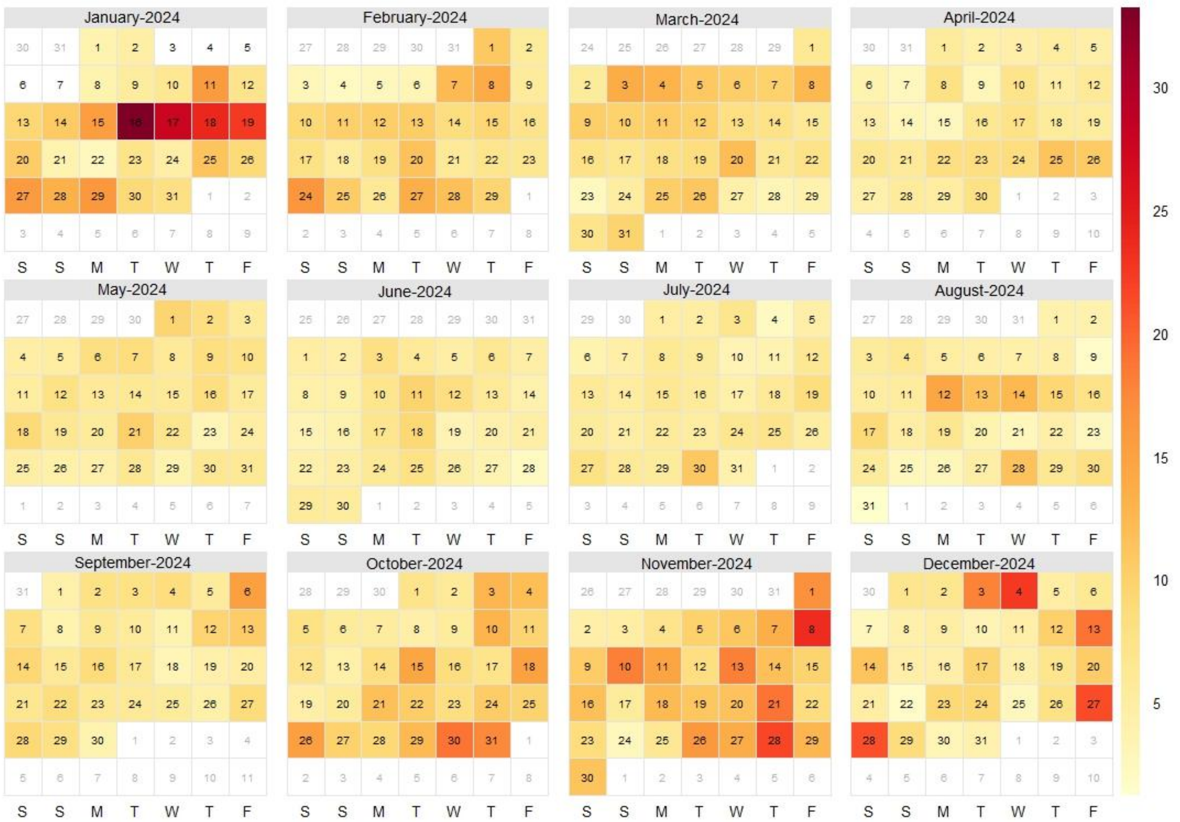


Figure 33: $PM_{2.5}$ calendar plot for Stansted 3 during 2024

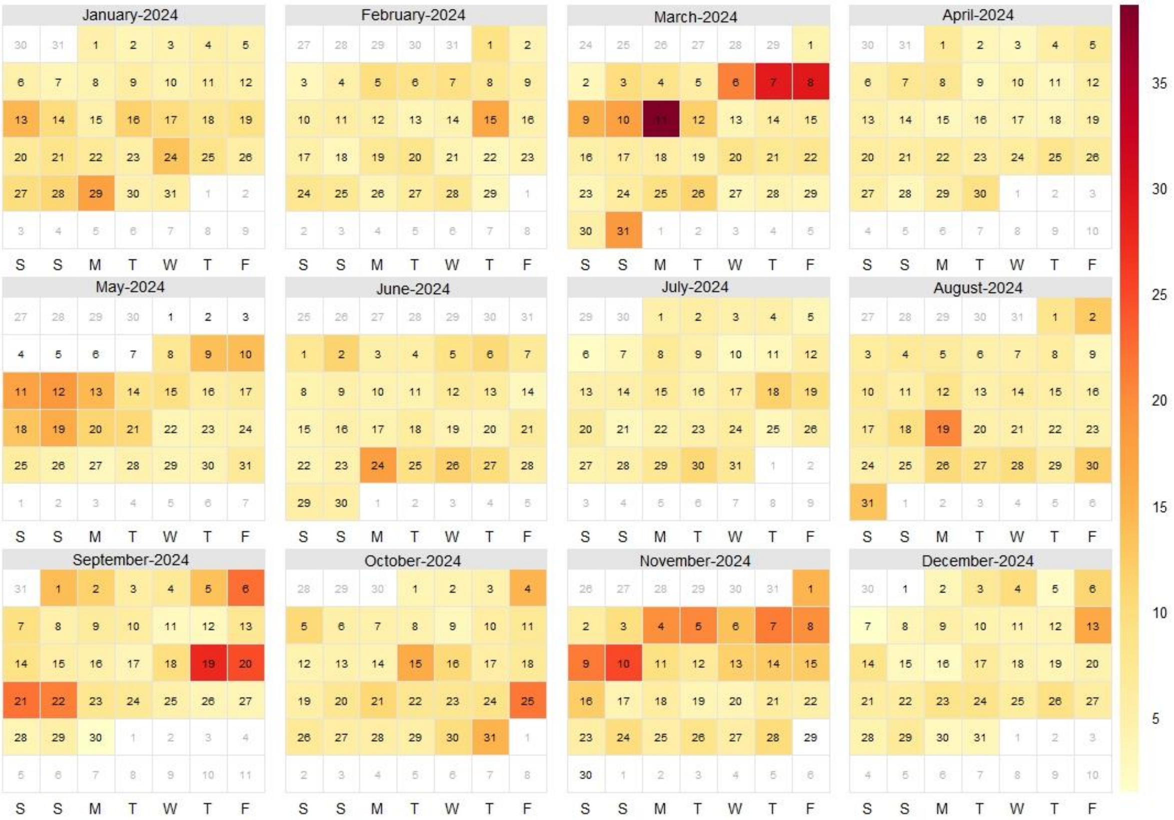


Figure 34: $PM_{2.5}$ calendar plot for Stansted 4 during 2024

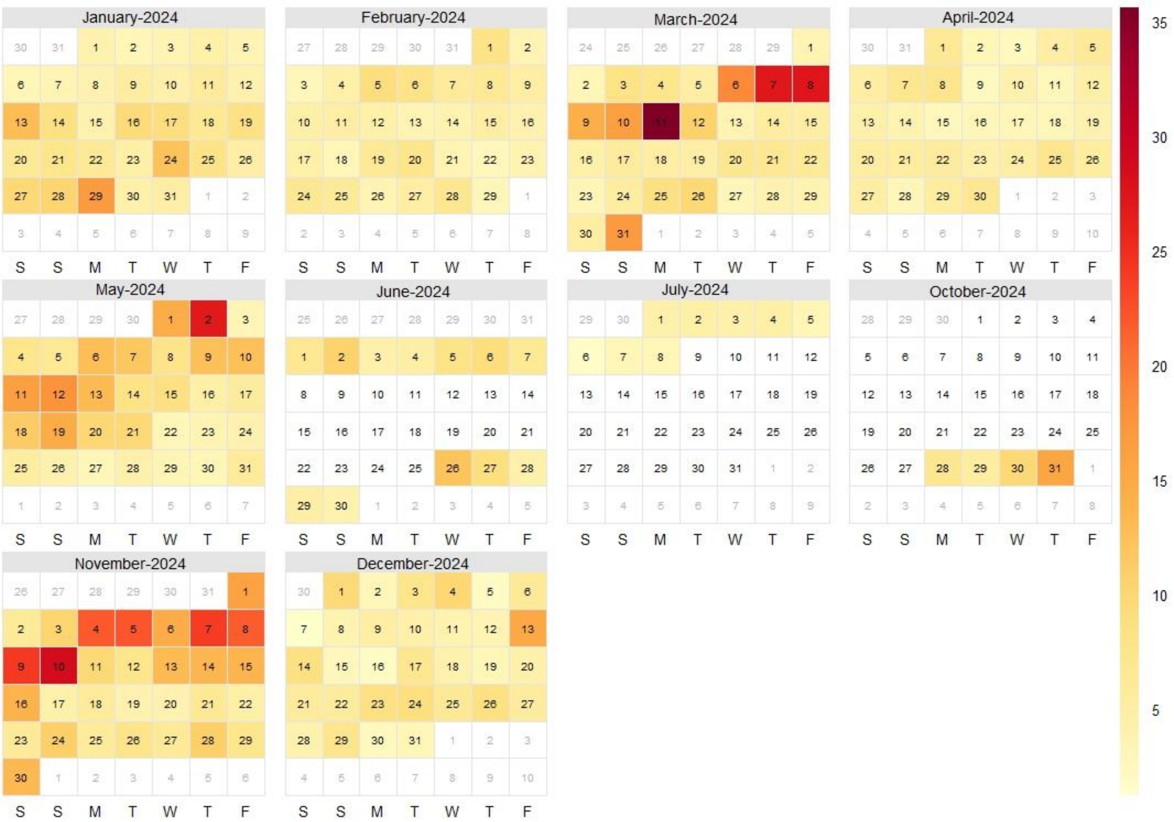


Figure 35: $PM_{2.5}$ calendar plot for Stansted 5 during 2024

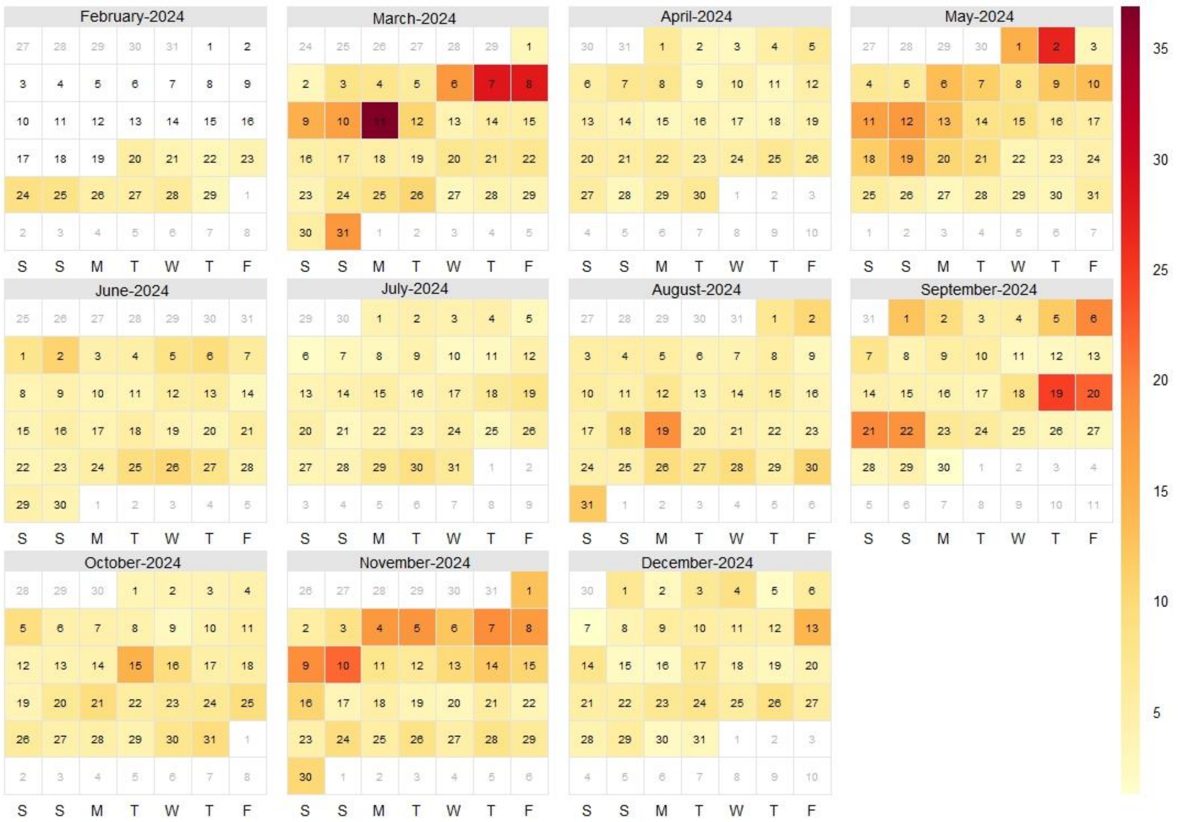


Figure 36: PM_{10} calendar plot for Stansted 3 during 2024

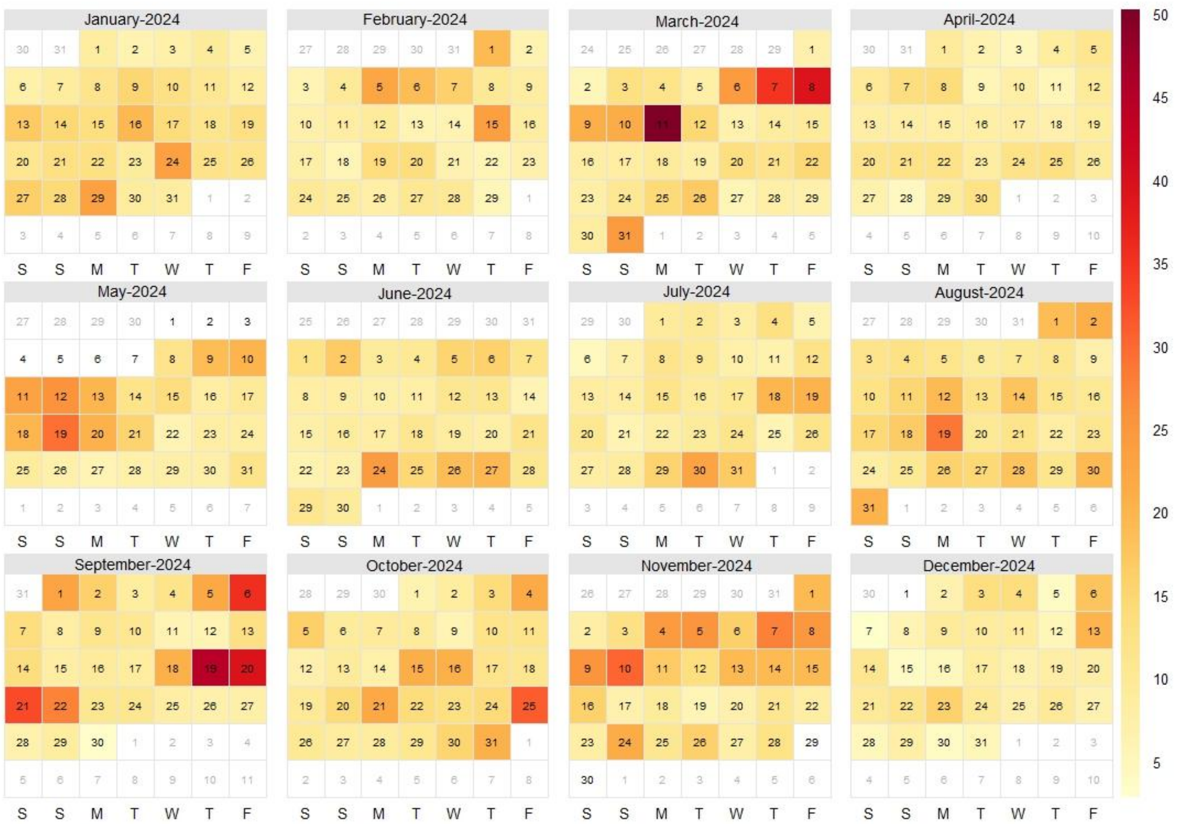


Figure 37: PM_{10} calendar plot for Stansted 4 during 2024

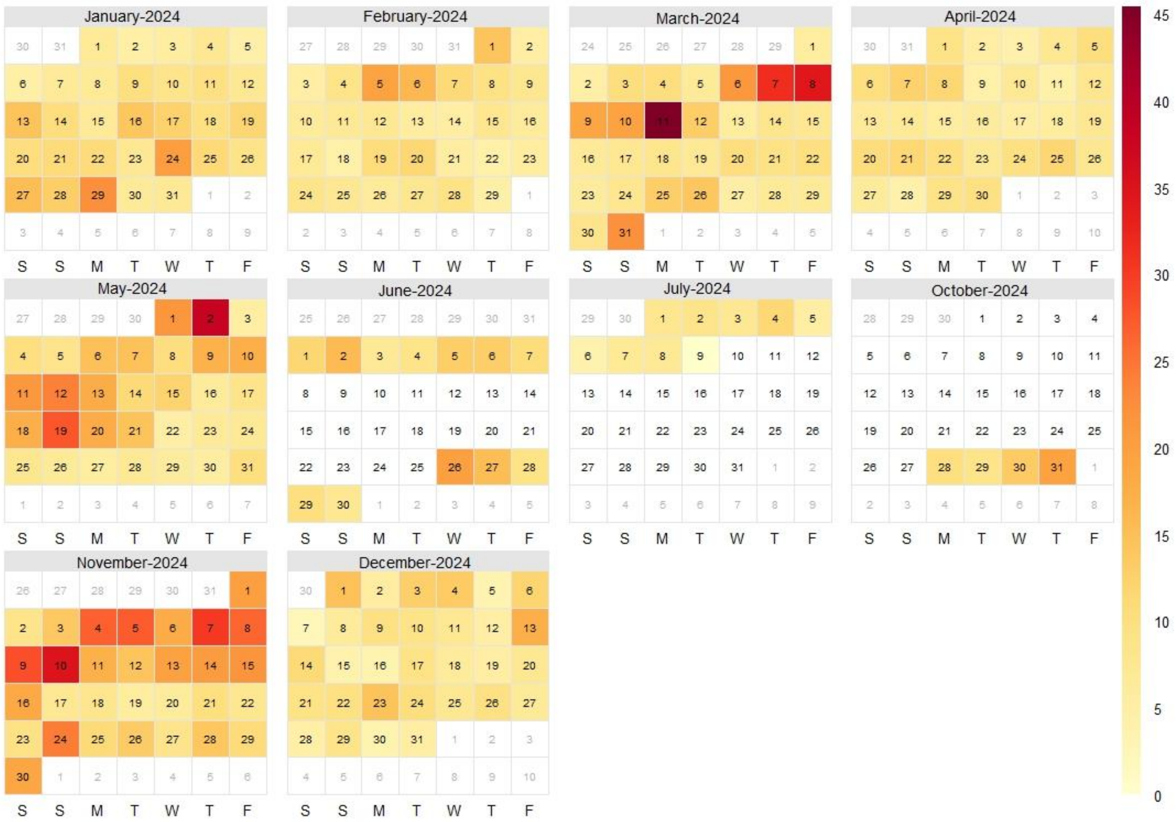
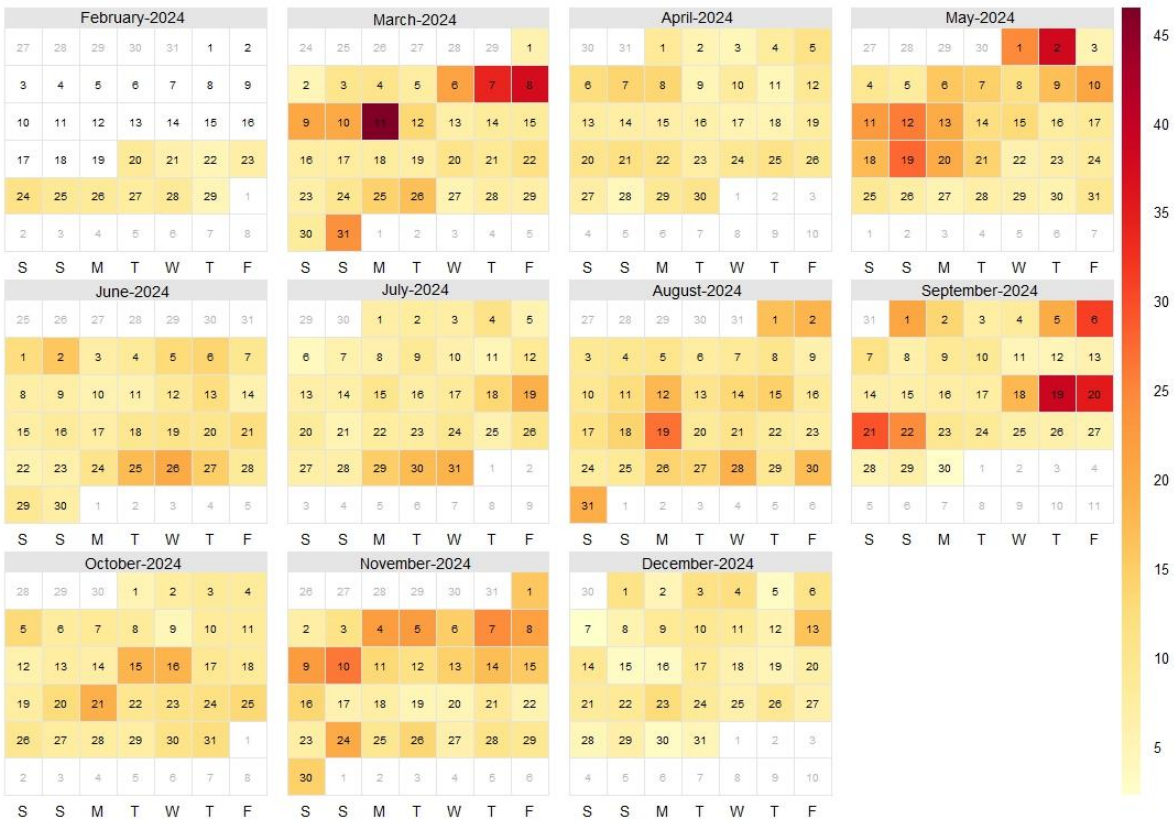


Figure 38: PM_{10} calendar plot for Stansted 5 during 2024



4.8 BACK TRAJECTORY ANALYSIS

The average daily concentration for each pollutant across all the sites have been calculated, with the top 10 most polluted days (the redder coloured lines) identified and linked to its back trajectory data in the plots below. Figures 23 to 28 illustrate the origins of the pollution episodes in March, September and November as described above, demonstrating wind sources primarily from southern and western Europe for particulate matter concentrations.

Figure 20: Trajectory plot for top ten highest daily NO_2 concentrations in 2024 at Stansted 3

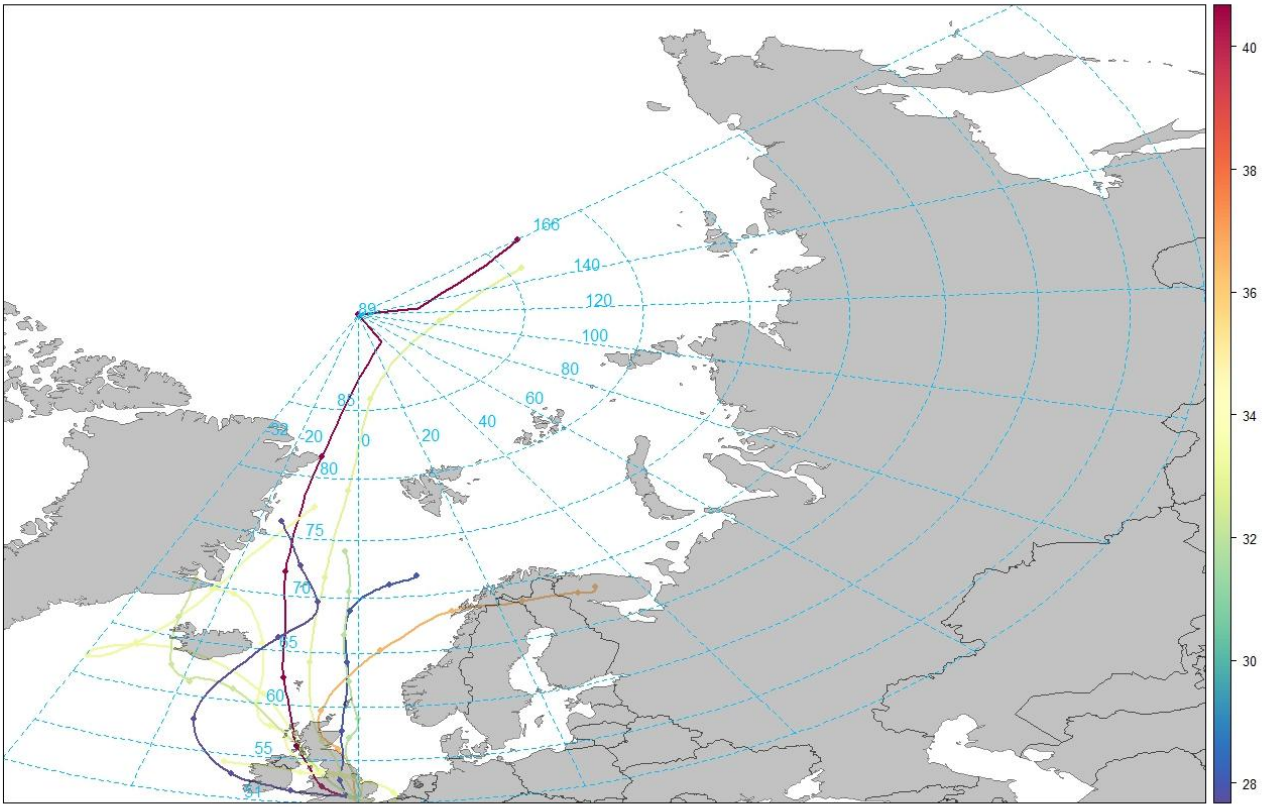


Figure 21: Trajectory plot for top ten highest daily NO_2 concentrations in 2024 at Stansted 4

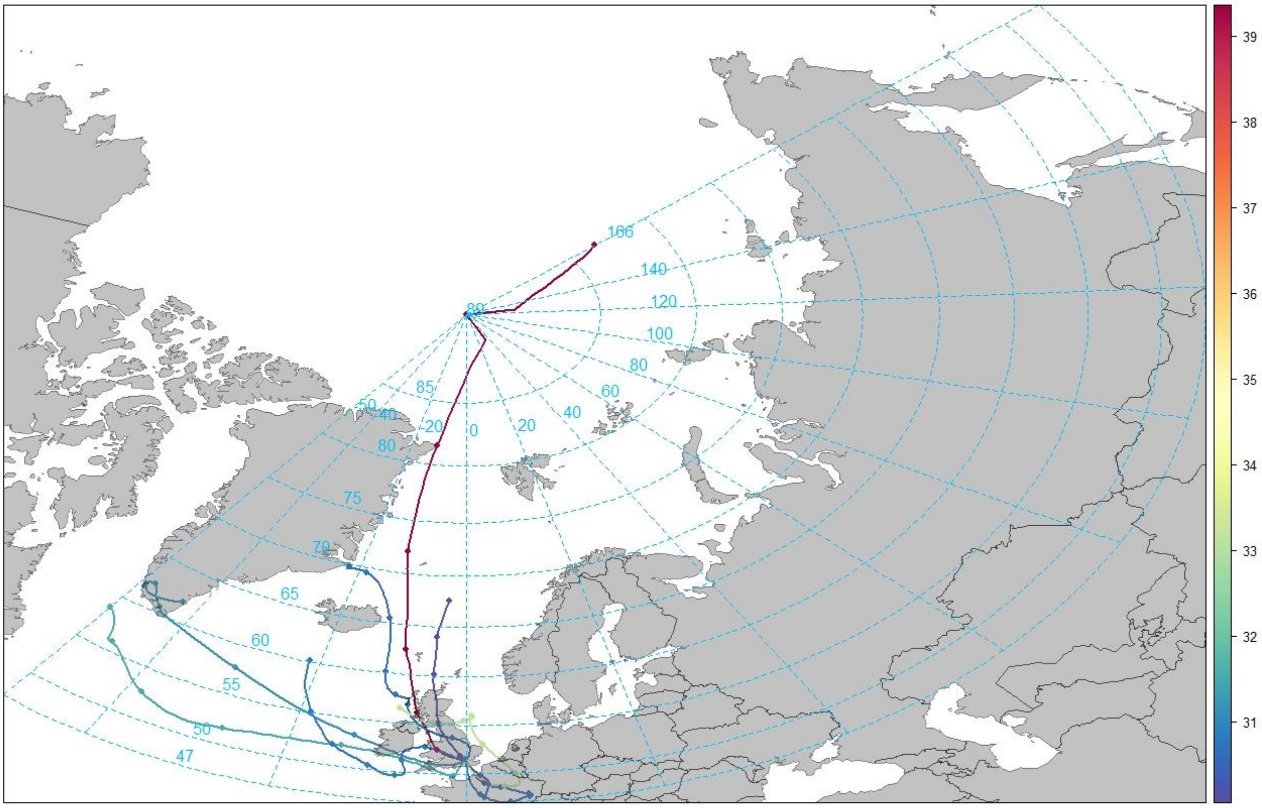


Figure 22: Trajectory plot for top ten highest daily NO_2 concentrations in 2024 at Stansted 5

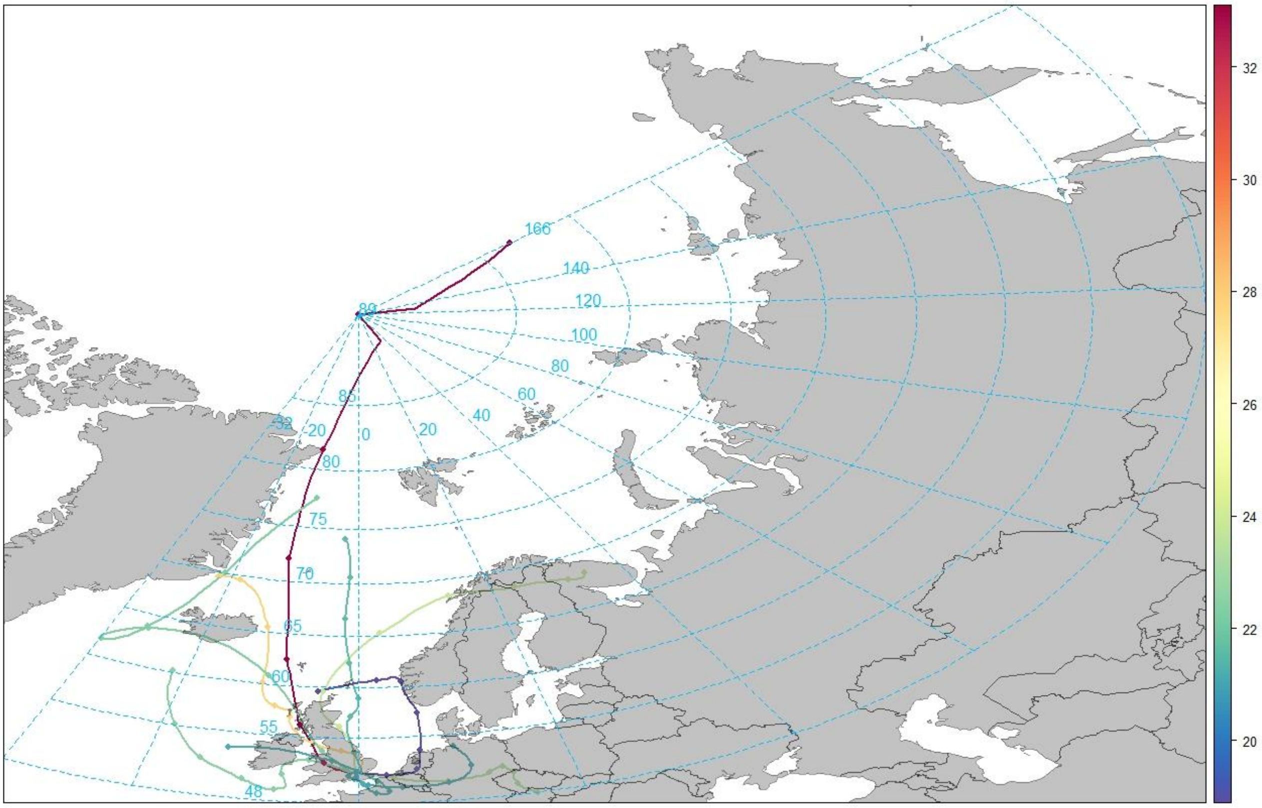


Figure 23: Trajectory plot for top ten highest daily $PM_{2.5}$ concentrations in 2024 at Stansted 3

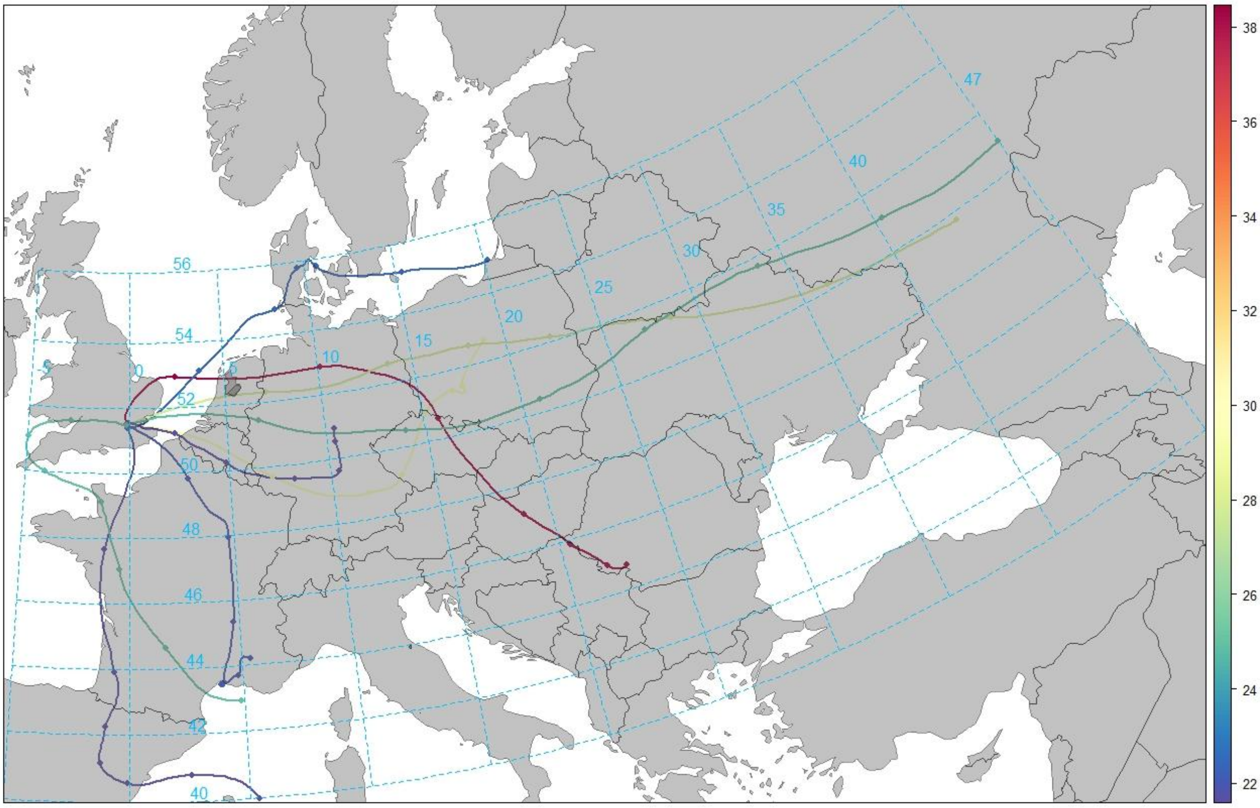


Figure 24: Trajectory plot for top ten highest daily $PM_{2.5}$ concentrations in 2024 at Stansted 4

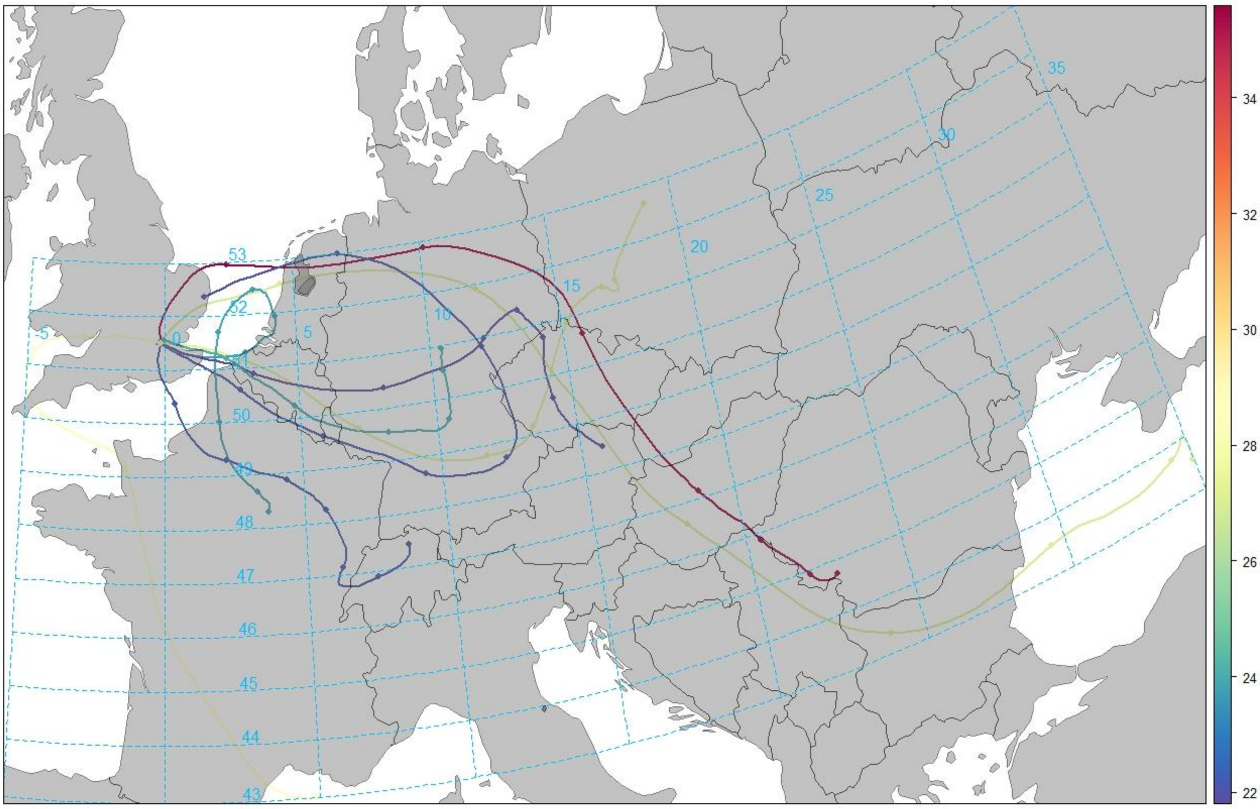


Figure 25: Trajectory plot for top ten highest daily $PM_{2.5}$ concentrations in 2024 at Stansted 5

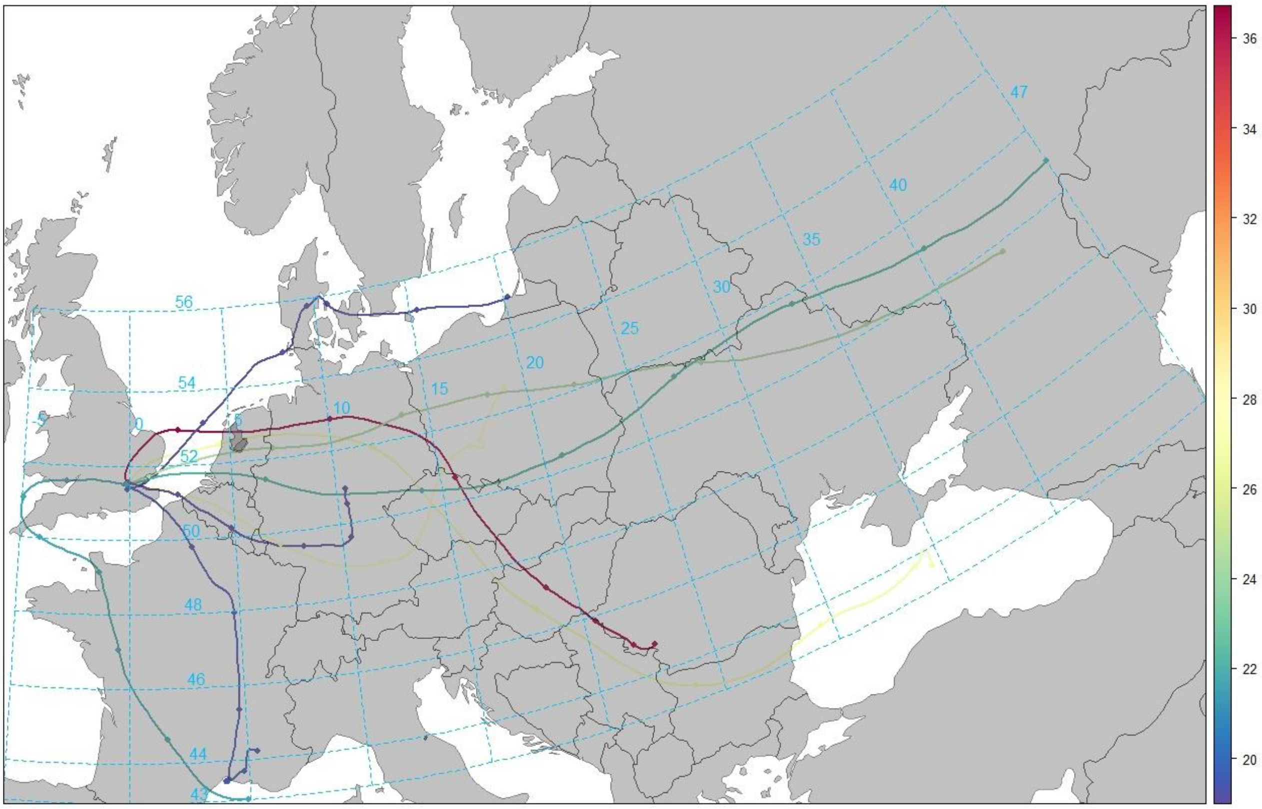


Figure 26: Trajectory plot for top ten highest daily PM_{10} concentrations in 2024 at Stansted 3

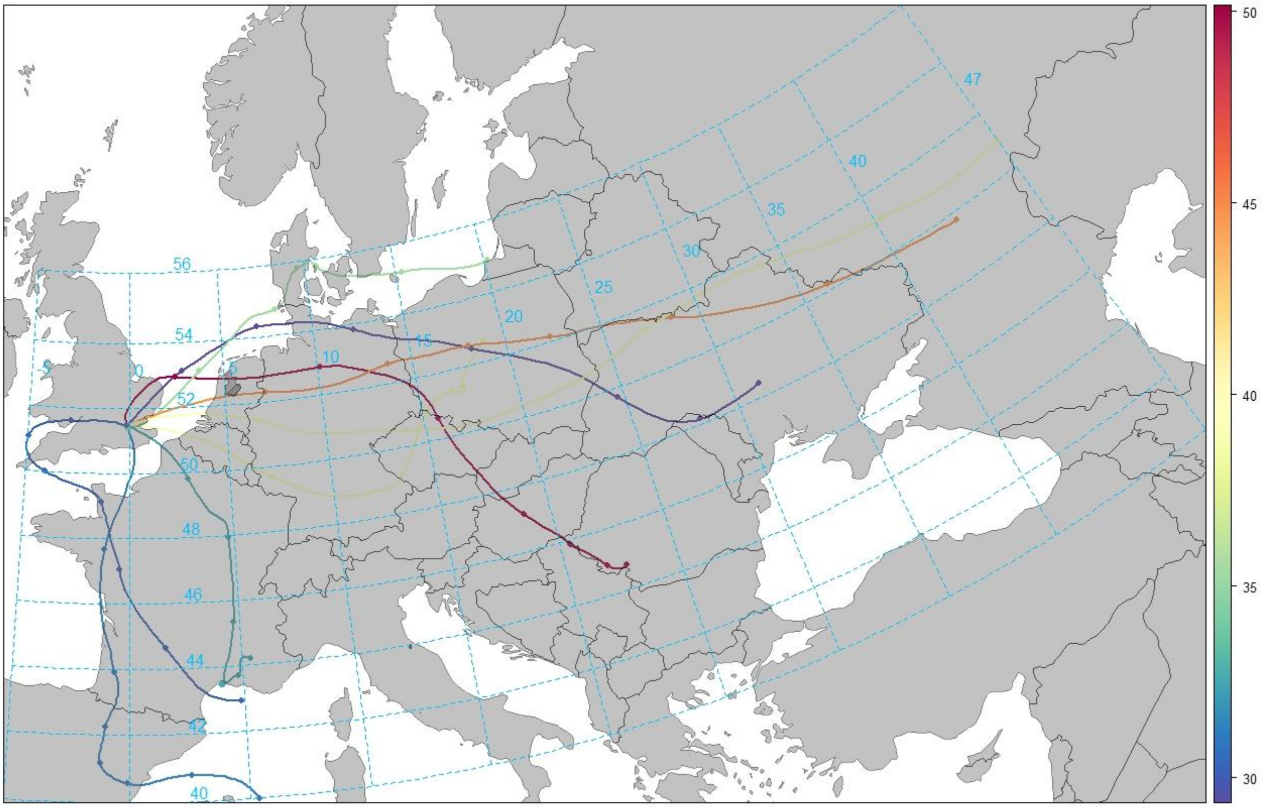


Figure 27: Trajectory plot for top ten highest daily PM_{10} concentrations in 2024 at Stansted 4

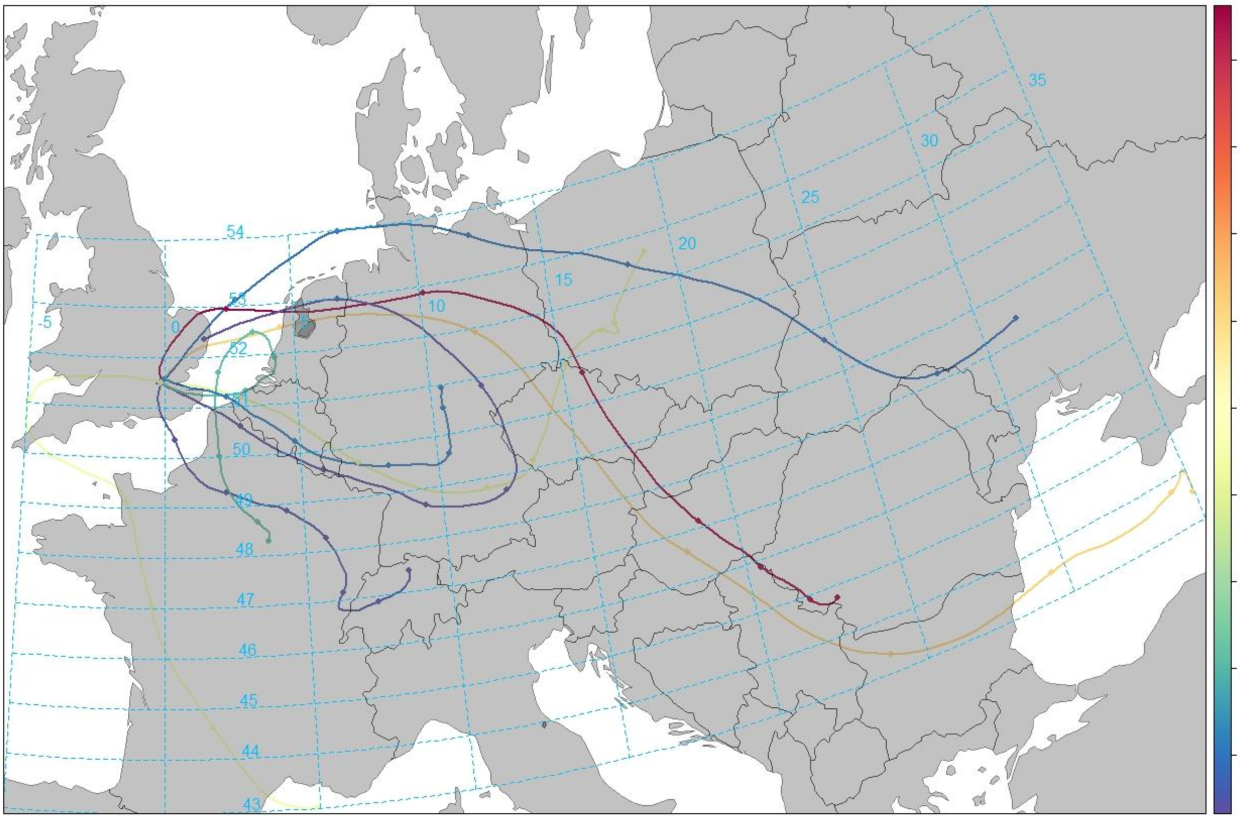
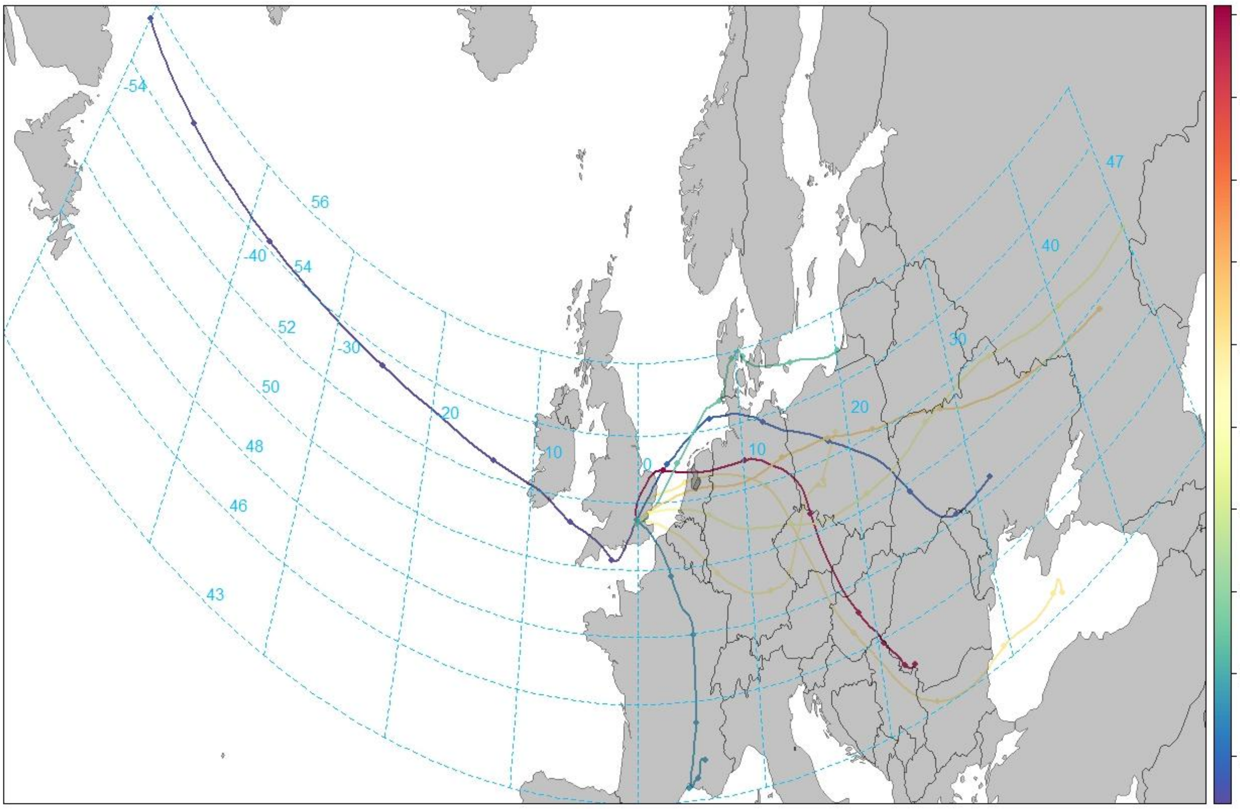


Figure 28: Trajectory plot for top ten highest daily PM_{10} concentrations in 2024 at Stansted 5

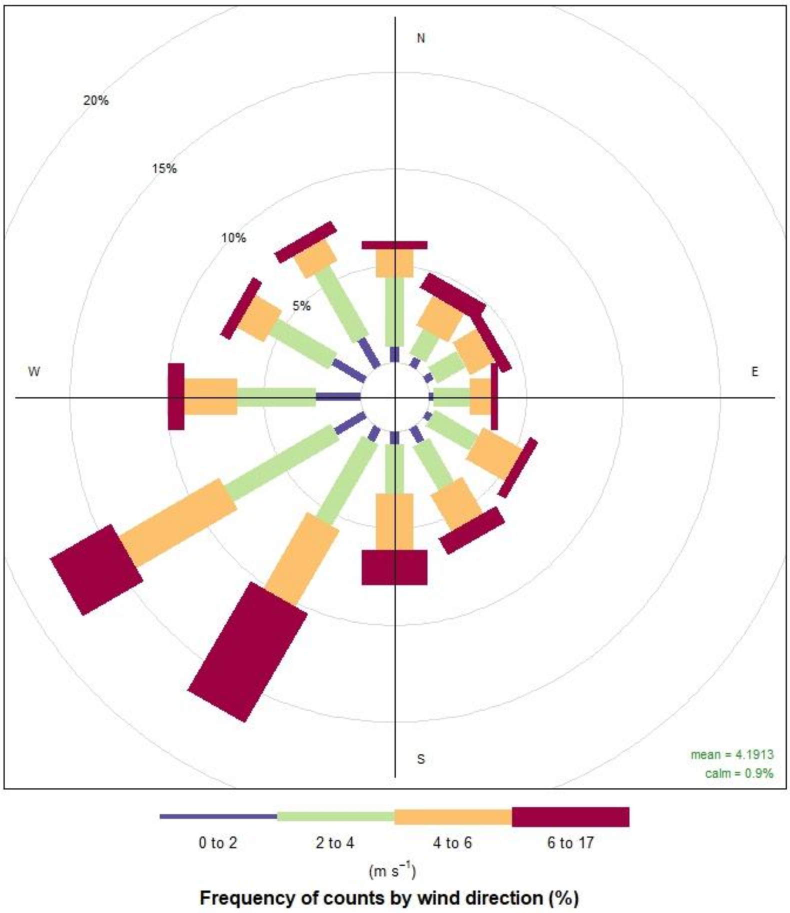


4.9 SOURCE INVESTIGATION

Meteorological data have been used to add a directional component to air pollutant concentrations measured at Stansted Airport to aid investigation of the possible sources of air pollution. Wind speed and direction data was gathered using data from the National Oceanic and Atmospheric Administration (NOAA) meteorological database. The QA/QC procedures for checking of these data are not known.

Figure 29 shows wind speed and wind direction data for Stansted Airport during 2024. The lengths of the "spokes" against the concentric circles indicate the percentage of time during the year that the wind was measured from each direction. The prevailing wind direction is shown to be from the south-west (180° to 270°). Each "spoke" is divided into coloured sections representing wind speed intervals of 2 m s^{-1}, followed by a final interval of 11.0 s^{-1}, as shown by the scale bar in the plot. The maximum hourly wind speed measured at Stansted Airport was 17.0 m s^{-1} and the mean wind speed measured was 4.2 m s^{-1}. The highest wind speeds were shown to occur in January and November 2024.

Figure 29: Wind rose showing wind speed and direction from the on-field anemometer at Stansted Airport in 2024



4.10 POLAR PLOTS

Figure 39, Figure 40 and Figure 41 show bivariate plots, ''pollution roses'' of hourly mean pollutant concentrations against the corresponding wind speed and wind direction. These plots should be interpreted as follows:

- The wind direction is indicated as in the wind rose above (north, south, east, and west are indicated).
- The wind speed is indicated by the distance from the centre of the plot: the concentric circles indicate wind speeds in 5 ms^{-1} intervals.
- The pollutant concentration is indicated by the colour (as indicated by the scale).

These plots therefore show how pollutant concentration varies with wind direction and wind speed.

The primary source of NO_2 at all three sites is indicated to be close the monitoring sites, as shown in Figure 39, with the highest NO_2 concentrations occurring at low wind speeds. At higher wind speeds, up to 10 m s^{-1}, there is shown to be a mild source to the northwest of Stansted 3, and significant sources to the southeast and southwest of Stansted 4 at all windspeeds. It is possible that these may be due to activities around the airport terminal building, runway and surrounding access roads. Local NO emissions reacting with ozone may be the cause of this NO_2 source, with increased wind speeds causing a faster reaction. At Stansted 3 and Stansted 5, there are indicated to be moderate signatures at moderate wind speeds from the east. Long range transport of NO_2 could explain these signatures.

Figure 40 shows $PM_{2.5}$ concentrations are shown to be high at all three sites at moderate wind speeds between 4 m s^{-1} and 10 m s^{-1}. These elevated concentrations are likely due to transboundary movement of polluted air from the continent. All sites also show moderate signatures from the southwest when wind speed is above 10 m s^{-1} which is likely due to this being the prevailing wind direction in 2024 and may also indicate $PM_{2.5}$ pollution being transported from areas such as London. Small signatures are shown at Stansted 3 and Stansted 4 under calm conditions which likely indicates a source close to the monitoring sites such as local emissions from vehicles in close proximity to the site.

PM_{10} concentrations at Stansted 3, Stansted 4 and Stansted 5 show similar trends to those exhibited by $PM_{2.5}$, with a strong signature indicated at high wind speeds to the east of each site, likely due to long-range transport of pollution (Figure 41). All sites also show elevated PM_{10} concentrations under high wind speeds (between 12 and 18) from the southwest, these signatures are stronger than those shown for $PM_{2.5}$ concentrations but are also likely associated with long range transport of pollution. The UK-wide trans-boundary pollution episodes, previously mentioned on this report, and some agricultural activity related to harvesting, may explain high PM_{10} concentrations at higher wind speeds from a variety of wind directions.

Figure 39: NO_2 polar plot for Stansted 3, 4 and 5 during 2024 (µg m^{-3})

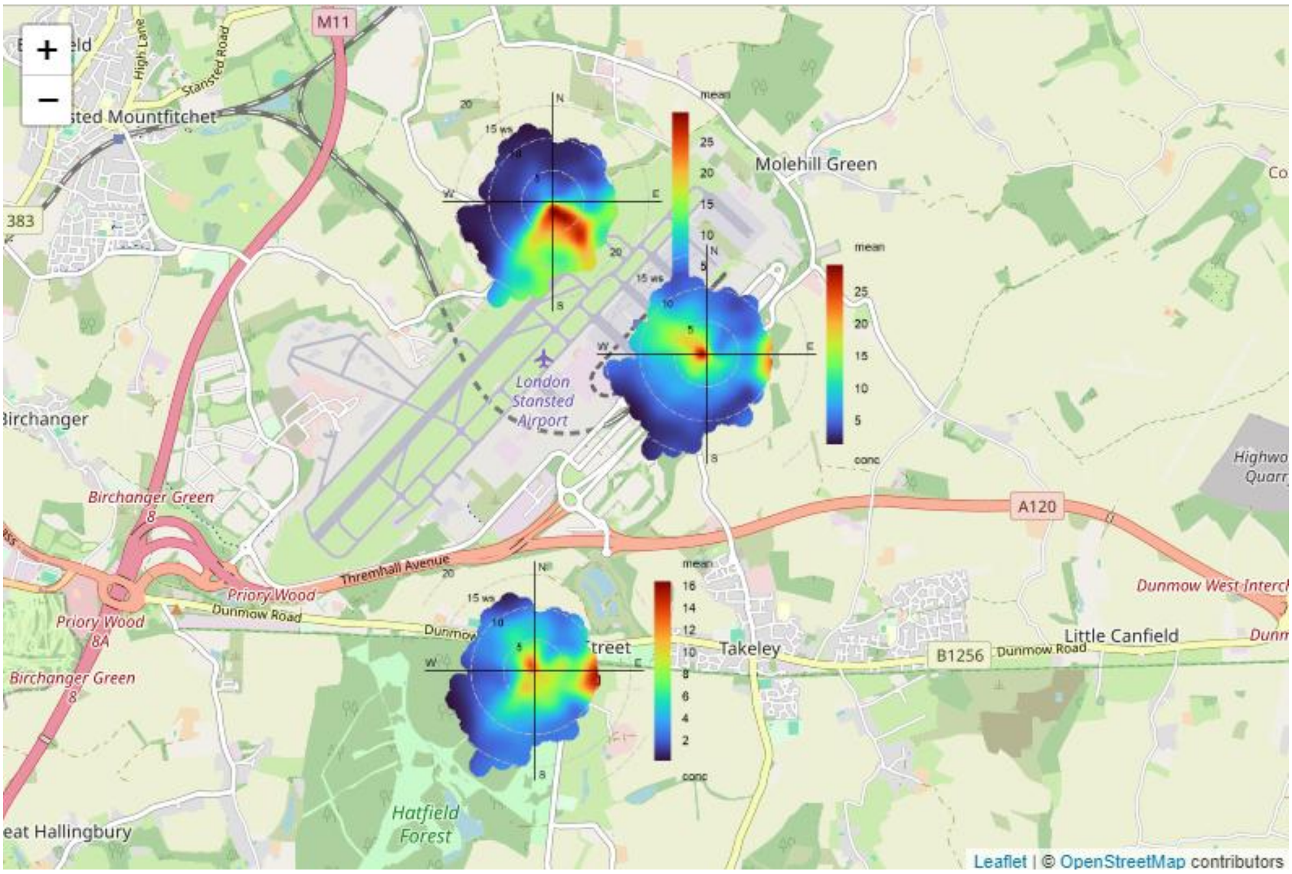


Figure 40: $PM_{2.5}$ polar plot for Stansted 3, 4 and 5 during 2024 (µg m^{-3})

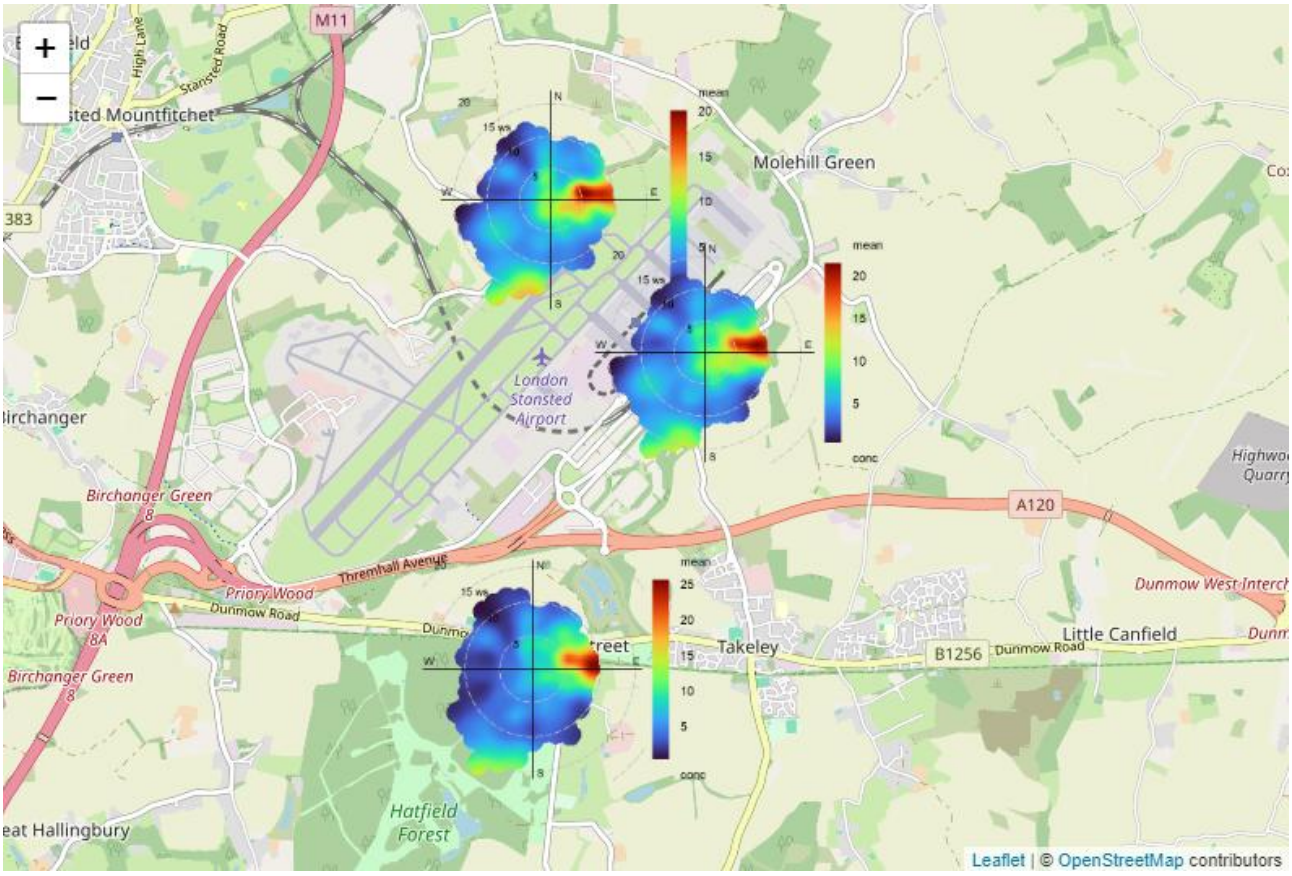
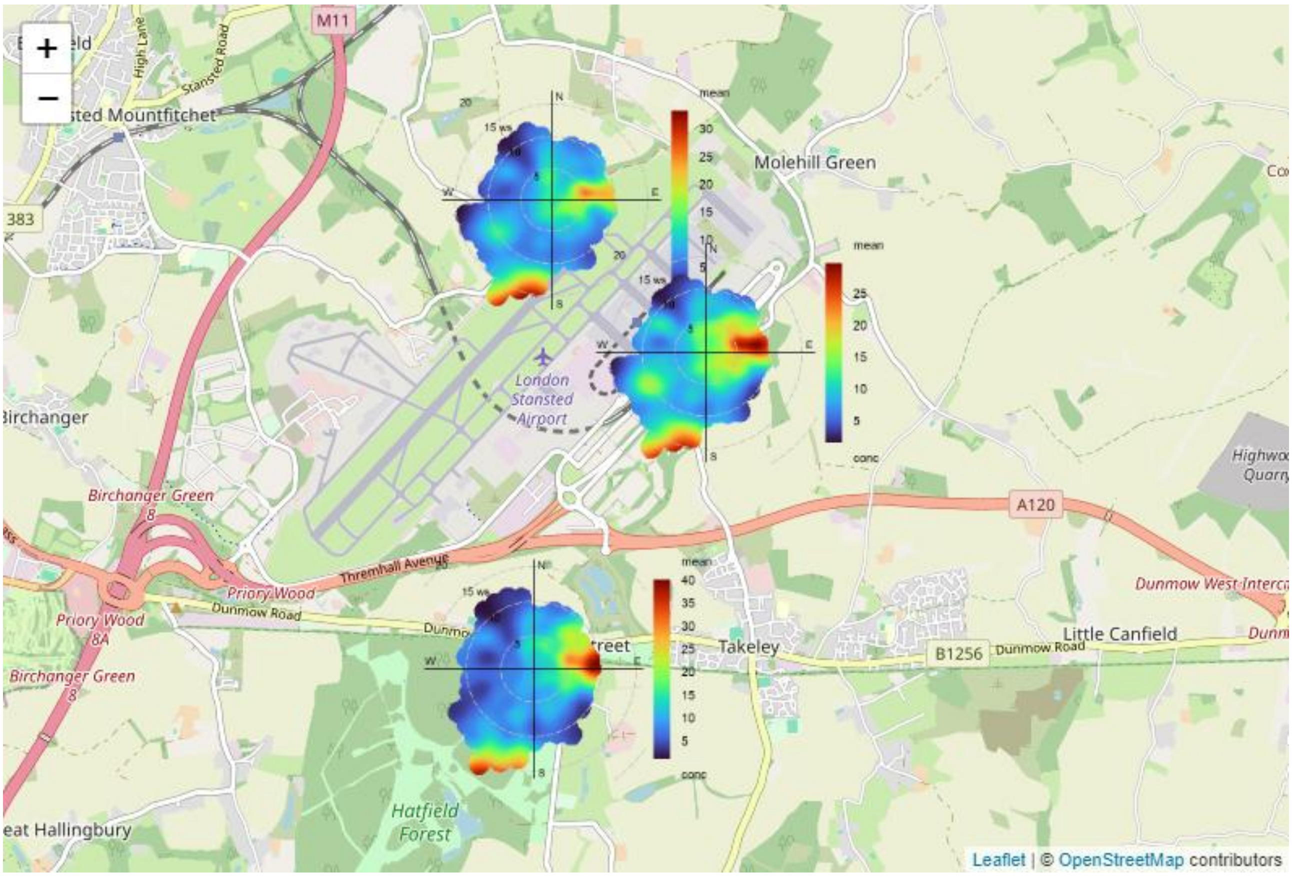


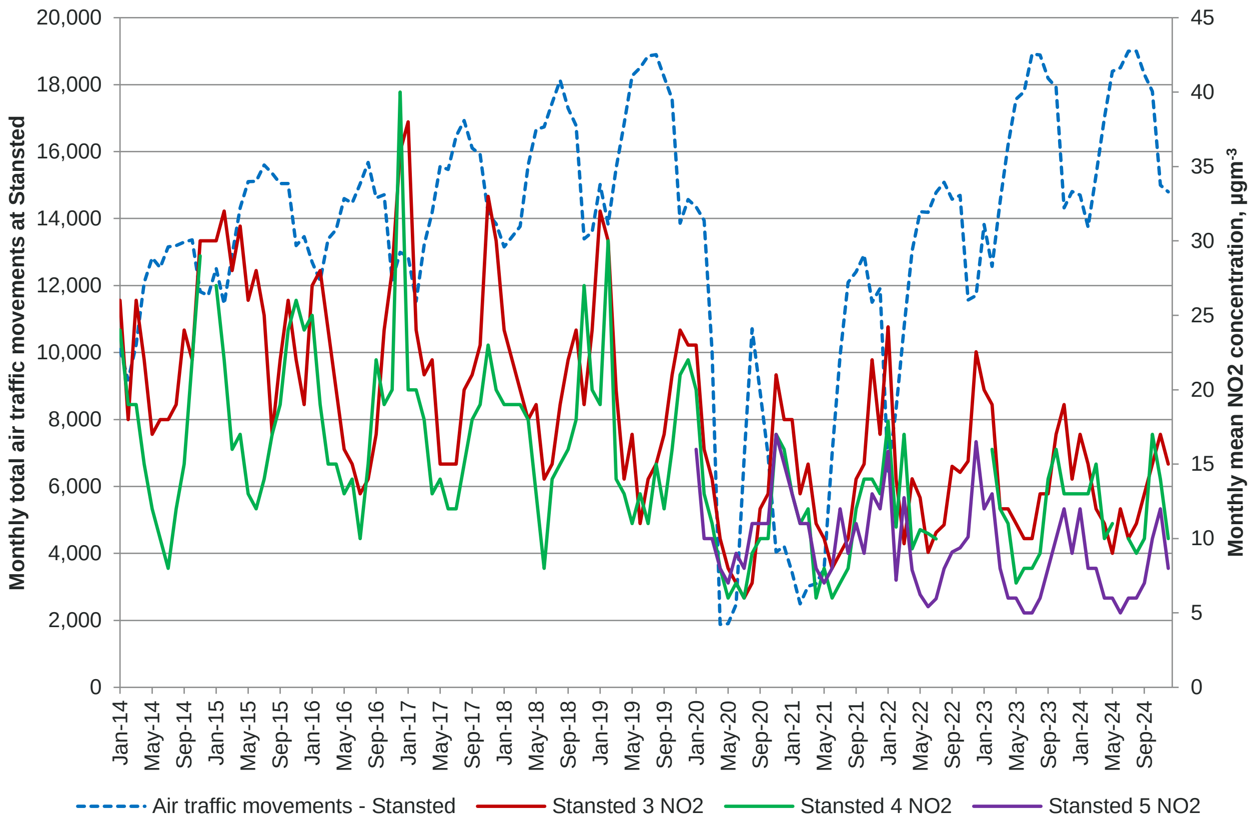
Figure 41: PM_{10} polar plot for Stansted 3, 4 and 5 during 2024 (μg m^{-3})



4.11 RELATIONSHIP WITH AIRPORT ACTIVITY

Figure 42 shows monthly total aircraft movement at Stansted Airport, compared to monthly mean concentrations of NO_2 at Stansted 3, Stansted 4 and Stansted 5 between January 2014 and December 2024. Air movement numbers at Stansted Airport exhibit a clear seasonal pattern showing higher numbers in summer months and lower numbers in winter months. Comparatively, NO_2 concentrations are generally shown to be highest in winter months and lowest in summer months. Air traffic movements documented at Stansted Airport in 2024 are shown to be 3% higher compared to those measured in 2023. Similarly, average NO_2 concentrations at Stansted 4 increased by 3% between 2023 and 2024. Although airport emissions can be an important contributor to local NO_2 concentrations, it is also important to note that ambient pollution concentrations vary seasonally due to widespread factors such as meteorological conditions.

Figure 42: Monthly total air traffic movements compared with monthly mean pollutant concentrations 2014 - 2024



4.12 COMPARISON WITH OTHER UK SITES

Figure 43 compares annual mean NO_2 concentrations at the three Stansted sites and measurements recorded at six other monitoring sites. Five of these are other AURN monitoring sites in the south and east of England and the sixth is in the vicinity of a major airport. These sites are listed below:

- Canterbury - an urban background site approximately 1.5 kilometres from the centre of Canterbury.
- Thurrock - an urban background site in the town of Thurrock, Essex, approximately 35 metres from the kerb of a busy road.
- Cambridge Roadside - roadside site in the city of Cambridge, where vehicle emissions are the major pollution source.
- Southend-on-Sea - an urban background site situated in an urban public park in a residential area.
- London Harlington - a background monitoring station approximately 1 km northeast of the perimeter of Heathrow airport.
- LHR2 - a long-term airside monitoring station at Heathrow, 180 metres north of runway 27R and northeast of the central terminal area. This site is not part of the AURN, but data are made available to the public through the Heathrow Airwatch website.

Annual mean NO_2 concentrations measured at Stansted 3, Stansted 4 and Stansted 5 are comparable to concentrations measured at urban background sites in recent years. For example, concentrations measured at Stansted 3 are shown to be similar to those measured at Southend-on-Sea. Additionally, Stansted 4 and Stansted 5 compare well with Canterbury, with all three sites showing measuring comparable concentrations in recent years. Stansted 3, Stansted 4 and Stansted 5 have consistently reported concentrations lower than those measured at London Harlington, Heathrow LHR2, and Cambridge Roadside. Overall, Stansted 3, Stansted 4 and Stansted 5 show a general decreasing trend of 57%, 43% and 27% respectively, since the first year of operation for each site. Furthermore, Stansted 3 and Stansted 5 have both shown a decrease in annual mean NO_2 concentrations when compared to 2023. The 2024 annual mean NO_2 concentration at Stansted 4 shows a small increase compared to 2023, measuring a similar concentration to that measured in 2022.

Figures 44 and 45 compare annual mean $PM_{2.5}$ and PM_{10} concentrations recorded at each Stansted site and three other monitoring stations. The additional two monitoring sites used to supplement this are listed below:

- Leamington Spa – an urban background site located approximately 50 meters from a busy road.
- London North Kensington – an urban background site, located in the grounds of a school, situated in a mostly residential area.

Annual mean $PM_{2.5}$ concentrations measured at Stansted 4, Heathrow LHR2 and Leamington Spa are all shown to be similar between 2020 and 2024. Between 2019 and 2020, all sites showed a noticeable decrease in $PM_{2.5}$ concentrations likely due to restrictions imposed during the Coronavirus Pandemic. In 2024, $PM_{2.5}$ concentrations measured at Stansted 4 and 5 are shown to have remain similar to concentrations measured in 2023. $PM_{2.5}$ concentrations at Stansted 3 have shown a decrease when compared to the annual mean concentration measured in 2023. Since operation of Stansted 3 and Stansted 4 began, concentrations have shown to decrease by 22% at both monitoring locations. At Stansted 5, annual mean $PM_{2.5}$ concentrations have shown a little change since the first year of operations. $PM_{2.5}$ is a widely dispersed pollutant; this can therefore offer a possible explanation to the similarities in averages seen between all sites.

Annual mean PM_{10} concentrations measured at Stansted 4 are shown to be similar to those measured at Heathrow LHR2 between 2019 and 2021. However, since 2022, concentrations measured at Stansted 4 have been shown to be consistently lower than those measured at Heathrow LHR2. Data measured at Stansted 4 and Heathrow LHR2 are most comparable due to the proximity of both sites to the runway at each airport and Stansted 4 is influenced less by as many local factors as Stansted 3 and Stansted 5. Both Stansted 3 and Stansted 5 have shown a decrease in annual mean PM_{10} concentrations when compared to 2023, with the most significant decrease experienced at Stansted 3 in 2024. Similar to NO_2 concentrations at Stansted 4, annual mean PM_{10} concentrations have shown a small increase compared to 2023. However, Stansted 3 and 4 have shown overall decreases in PM_{10} concentrations of 8% at both sites since operations began, and PM_{10} concentrations measured at Stansted 5 have shown a little change since the first year of operations.

Figure 43: Time series of annual mean NO_2 concentrations at nearby sites, 2001 onwards

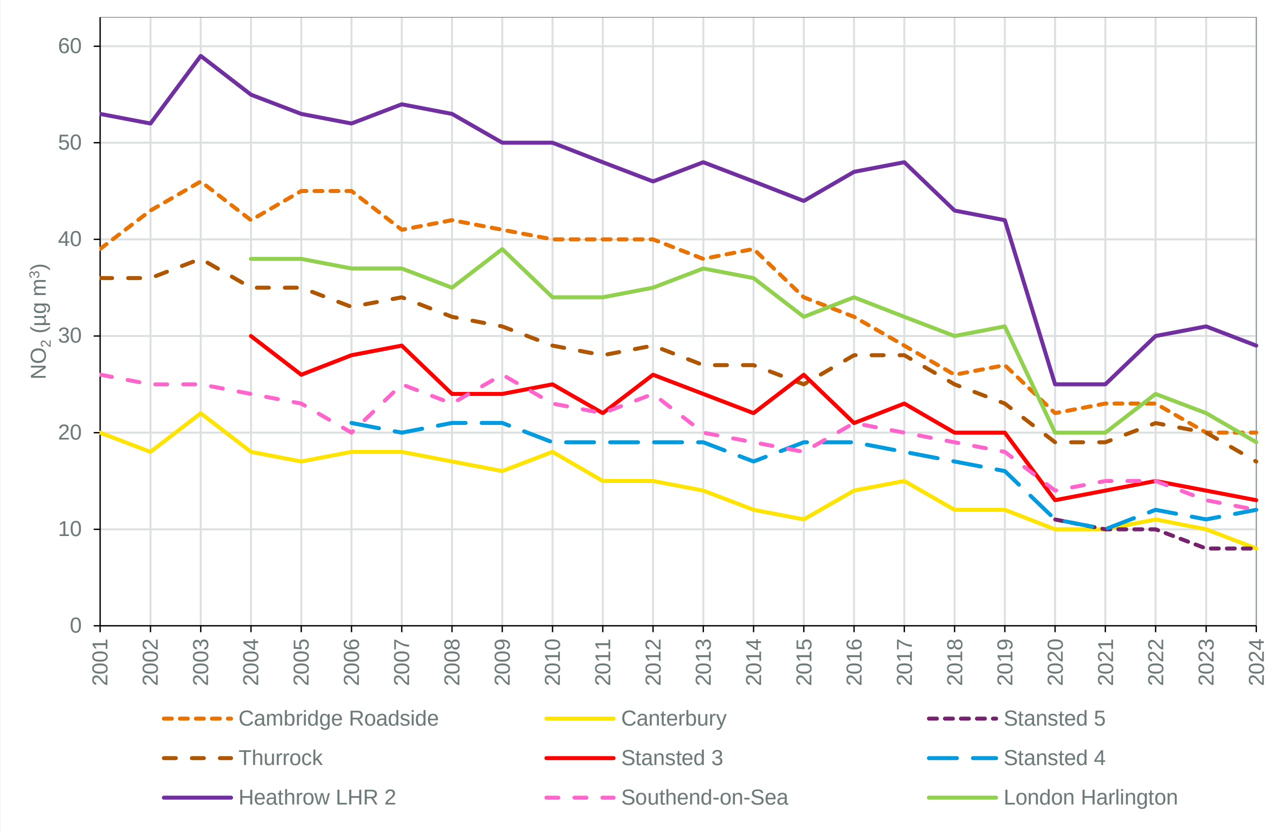


Figure 44: Time series of annual mean $PM_{2.5}$ concentrations at nearby sites, 2018 onwards

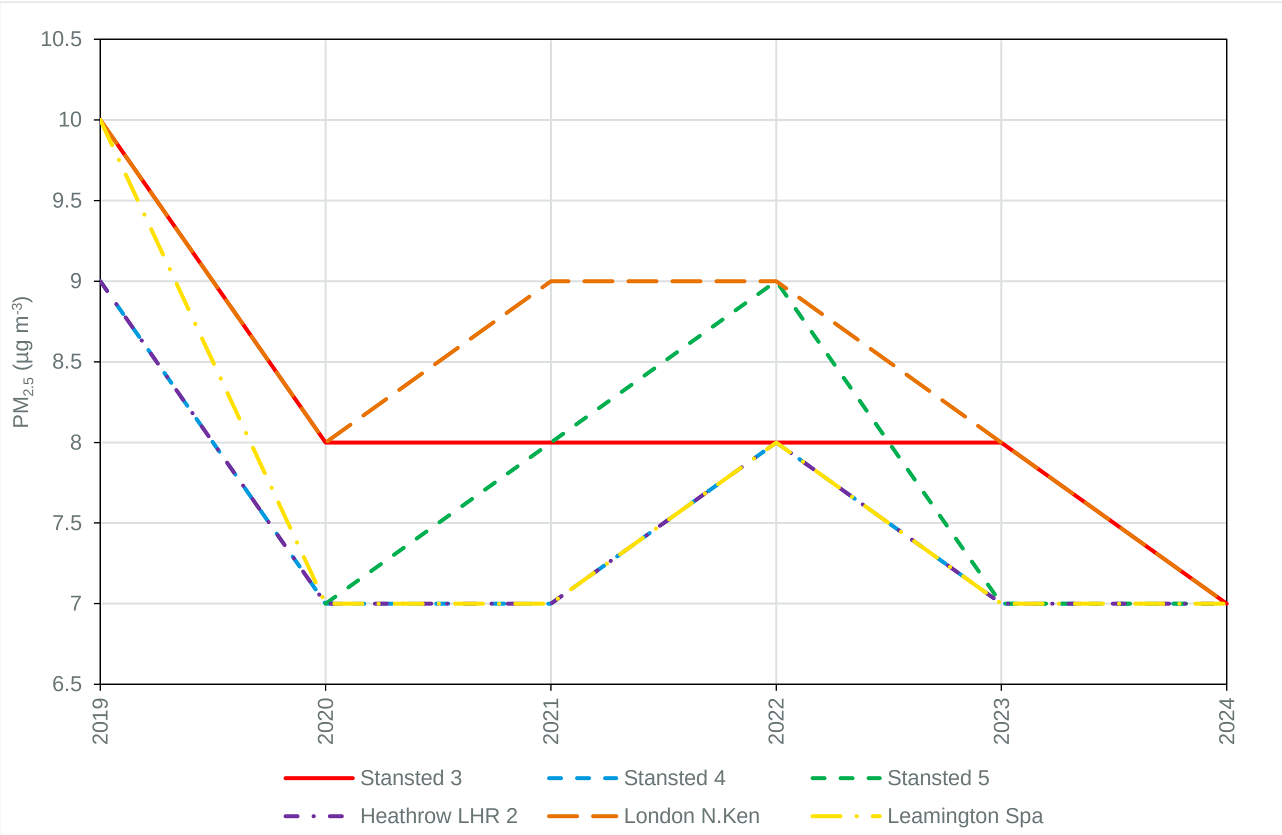
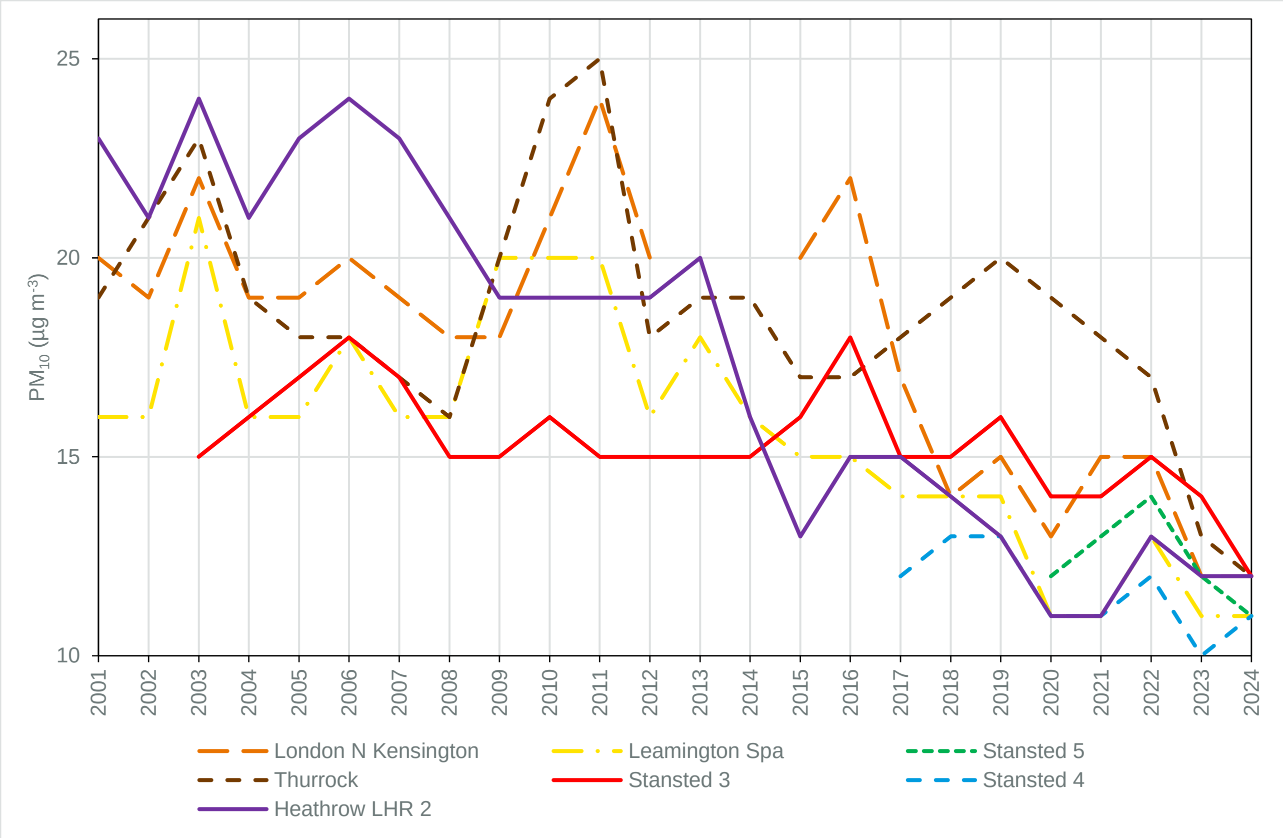


Figure 45: Time series of annual mean PM_{10} concentrations at nearby sites, 2001 onwards (Stansted 3 data is "as measured" without VCM correction for data until the end of 2016).



5. CONCLUSIONS

The following conclusions have been drawn from the results of air quality monitoring at Stansted Airport during 2024.

1. The data capture target of least 85% was achieved for all the measured pollutants at Stansted 3 and Stansted 5. All pollutants at all sites had data capture greater than 90%. This target was also met for the NO_x analyser at Stansted 4, however due to an analyser fault, data capture for particulate matter at Stansted 4 was 64.3% and therefore this target was not met.

2. Stansted 3, Stansted 4 and Stansted 5 met the AQS objectives for 1-hour mean NO_2 concentrations. All sites also met the annual AQS objective for NO_2 concentrations.

3. All fourteen NO_2 diffusion tube sites met the AQS annual mean NO_2 objective.

4. Stansted 3, Stansted 4 and Stansted 5 met the AQS annual mean objective for $PM_{2.5}$. However, due to the low data capture at Stansted 4, care should be taken when comparing the annual mean to the AQS objective as the annual mean may not be representative of the entire year.

5. Stansted 3, Stansted 4 and Stansted 5 met the AQS objectives for annual mean PM_{10} concentrations. However, due to the low data capture at Stansted 4, care should be taken when comparing the annual mean to the AQS objective as the annual mean may not be representative of the entire year.

6. Stansted 3 and Stansted 5 met the AQS 24-hour objective for 24-hour PM_{10} concentrations with no exceedances recorded in 2024. Due to the low data capture at Stansted 4, a percentile value was calculated which indicated that there were likely less than 35 exceedances of the 24-hour AQS objective in 2024 at this site.

7. NO_2 concentrations were higher during the winter months at Stansted 3, Stansted 4 and Stansted 5, an annual profile that is in contrast to that of the annual air traffic movement profile. This is a typical pattern for urban sites. PM_{10} and $PM_{2.5}$ concentrations were generally shown to peak in March, May and November 2024.

8. Concentrations of NO_2 followed a characteristic diurnal pattern, with peaks coinciding with the morning and evening rush hour periods. PM_{10} and $PM_{2.5}$ concentrations showed less pronounced morning and evening peaks.

9. Bivariate plots of pollutant concentrations against meteorological data indicated that sources of NO_2 were located close to the monitoring sites and were probably associated with the airport.

10. Analysis bivariate plots shows higher $PM_{2.5}$ concentrations are associated with unsettled meteorological conditions from east and southwest wind directions. This is likely attributed to long range transport of polluted air masses from the continent.

11. Bivariate plots indicate that elevated PM_{10} concentrations were also most commonly associated unsettled conditions, likely influenced by transboundary movement of polluted air from the continent.

12. Annual mean NO_2 concentrations at Stansted 3 and Stansted 5 were shown to decrease compared to 2023. At Stansted 4, annual mean NO_2 concentrations showed a small increase compared to 2023.

13. At Stansted 3, annual mean $PM_{2.5}$ concentrations were shown to decrease compared to 2023, and Annual mean $PM_{2.5}$ concentrations at Stansted 4 and Stansted 5 remained similar to those measured in 2023.

14. Annual mean concentrations of PM_{10} at Stansted 3 and Stansted 5 were shown to decrease compared to concentrations measured in 2023. At Stansted 4, annual mean PM_{10} concentrations showed a small increase compared to 2023.

6. REFERENCES

1 - EC (2015) **Commission Directive (EU) 2015/1480 of 28 August 2015 amending several annexes to Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council laying down the rules concerning reference methods, data validation and location of sampling points for the assessment of ambient air quality**. [online]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015L1480 (Accessed 7 March 2025). And **Commission Directive (EU) 2015/1480 of 28 August 2015 amending several annexes to Directives 2004/107/EC and 2008/50/EC of the European Parliament and of the Council laying down the rules concerning reference methods, data validation and location of sampling points for the assessment of ambient air quality (Text with EEA relevance)**. Available from http://data.europa.eu/eli/dir/2015/1480/oj (Accessed 7 March 2025).

2 - Department for Environment, Food and Rural Affairs (2007). **The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1)**. Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. July 2007. https://www.gov.uk/government/publications/the-air-quality-strategy-for-england-scotland-wales-and-northern-ireland-volume-1 (Accessed 7 March 2025).

3 - Air Quality Expert Group (2004) **Nitrogen dioxide in the United Kingdom** [online]. London, UK: Department for Environment, Food and Rural Affairs. Available at: https://uk-air.defra.gov.uk/library/assets/documents/reports/aqeg/nd-chapter2.pdf [Accessed 7 March 2025]

4 - Elliot, M., Ingledew, D., Richmond, B., Del Vento, S., Hows, S., Karagianni, E., Kelsall, A., Pang, Y., Passant, N., Pearson, B., Richardson, J., Stewart, R., Thistlewaite, G., Tsagatakis, I., Wakeling, D., Wiltshire, J. & Wong, J., 2025. *UK Informative Inventory Report (1990 to 2023),* London: NAEI.

5 - Department for Environment, Food and Rural Affairs (2022). **Part IV of the Environment Act 1995. Local air quality management - Technical Guidance LAQM.TG (22)** [online]. London, UK: Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland. Available from: https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf [Accessed 7 March 2025].

6 - Department for Environment, Food and Rural Affairs (2009). **QA/QC procedures for the UK Automatic and Urban Rural Air Quality Monitoring Network (AURN)** [online]. London, UK: Department for Environment, Food and Rural Affairs and the Devolved Administrations. Available at: https://uk-air.defra.gov.uk/assets/documents/reports/cat13/0910081142_AURN_QA_QC_Manual_Sep_09_FINAL.pdf (Accessed 7 March 2025).

7 – Department for Transport (2021) **Transport use during the coronavirus (COVID-19) pandemic** [online]. Available at: https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic (Accessed 7 March 2025).

8 - Department for Environment, Food and Rural Affairs (2024) (online). Available at https://uk-air.defra.gov.uk/ (Accessed 7 March 2025)

7. ACKNOWLEDGEMENTS

Ricardo would like to thank Stansted Airport for their assistance with this work and for providing air traffic movement and passenger number data for this report.

8. APPENDICES

Appendix 1: Air Quality objectives and index bands

Table A1: UK air quality objectives for protection of human health, July 2007

Pollutant	Air Quality objective	Date do be achieved by	Pollutant
	Concentration	Measured as	
Benzene All authorities	16.25 µg m^{-3}	Running annual mean	**Benzene** All authorities
England and Wales only	5.00 µg m^{-3}	Annual mean	England and Wales only
Scotland and Northern Ireland	3.25 µg m^{-3}	Running annual mean	Scotland and Northern Ireland
1,3-Butadiene	2.25 µg m^{-3}	Running annual mean	**1,3-Butadiene**
Carbon monoxide England, Wales and Northern Ireland	10.0 mg m^{-3}	Maximum daily running 8-hour mean	**Carbon monoxide** England, Wales and Northern Ireland
Scotland	10.0 mg m^{-3}	Running 8-hour mean	Scotland
Lead	0.5 µg m^{-3}	Annual mean	**Lead**
	0.25 µg m^{-3}	Annual mean	
Nitrogen dioxide	200 µg m^{-3} not to be exceeded more than 18 times a year	1-hour mean	**Nitrogen dioxide**
	40 µg m^{-3}	Annual mean	
Particles (PM_{10}) (gravimetric) All authorities	50 µg m^{-3}, not to be exceeded more than 35 times a year	24-hour mean	**Particles (PM_{10}) (gravimetric)** All authorities
	40 µg m^{-3}	Annual mean	
Scotland	50 µg m^{-3}, not to be exceeded more than 7 times a year	24-hour mean	Scotland
	18 µg m^{-3}	Annual mean	
Particles ($PM_{2.5}$) (gravimetric)* All authorities	25 µg m^{-3} (target)	Annual mean	**Particles ($PM_{2.5}$) (gravimetric)*** All authorities
	15% cut in urban background exposure	Annual mean	
Scotland only	12 µg m^{-3} (limit)	Annual mean	Scotland only
Sulphur dioxide	350 µg m^{-3}, not to be exceeded more than 24 times a year	1-hour mean	**Sulphur dioxide**
	125 µg m^{-3}, not to be exceeded more than 3 times a year	24-hour mean	

Pollutant	Air Quality objective	Date do be achieved by	Pollutant
	266 µg m^{-3}, not to be exceeded more than 35 times a year	15-minute mean	
PAH*	0.25 ng m^{-3}	Annual mean	**PAH***
Ozone*	100 µg m^{-3} not to be exceeded more than 10 times a year	8-hour mean	**Ozone***

** Not included in regulations.*

Table A2: UK air quality objective for protection of vegetation and ecosystems, July 2007

Pollutant	Air Quality objective		Date do be achieved by
	Concentration	Measured as	
Nitrogen oxides measured as NO_2	30 µg m^{-3}	Annual mean	31st December 2000
Sulphur dioxide	20 µg m^{-3}	Annual mean	31st December 2000
	20 µg m^{-3}	Winter average (October to March)	31st December 2000
Ozone	18 µg m^{-3}	AOT40+, calculated from 1-hour values May to July. Mean of 5 years, starting 2010	1st January 2010

+ AOT40 is the sum of the differences between hourly concentrations greater than 80 µg m^{-3} (= 40 ppb) and 80 µg m^{-3} over a given period using only 1-hour averages measured between 08:00 and 20:00.

Table A3: Air pollution bandings and descriptions

Band	Index	Health descriptor
Low	1 to 3	Effects are unlikely to be noticed even by individuals who know they are sensitive to air pollutants.
Moderate	4 to 6	Mild effects, unlikely to require action, may be noticed amongst sensitive individuals.
High	7 to 9	Significant effects may be noticed by sensitive individuals and action to avoid or reduce these effects may be needed (e.g. reducing exposure by spending less time in polluted areas outdoors). Asthmatics will find that their 'reliever' inhaler is likely to reverse the effects on the lung.
Very High	10	The effects on sensitive individuals described for 'High' levels of pollution may worsen.

Table A4: Air pollution bandings and descriptions

Band	Index	O_3	NO_2	SO_2	$PM_{2.5}$	PM_{10}
		Daily max 8-hour mean (µg m-3)*	Hourly mean (µg m 3)	15-minute mean (µg m 3)	24-hour mean (µg m-3)	24-hour mean (µg m 3)
Low	1	0-33	0-67	0-88	0-11	0-16

Band	Index	O_3	NO_2	SO_2	$PM_{2.5}$	PM_{10}
	2	34-66	68-134	89-177	12-23	17-33
	3	67-100	135-200	178-266	24-35	34-50
Moderate	4	101-120	201-267	267-354	36-41	51-58
	5	121-140	268-334	355-443	42-47	59-66
	6	141-160	335-400	444-532	48-53	67-75
High	7	161-187	401-467	533-710	54-58	76-83
	8	188-213	468-534	711-887	59-64	84-91
	9	214-240	535-600	888-1064	65-70	92-100
Very High	10	241 or more	601 or more	1065 or more	71 or more	101 or more

Appendix 2 Monitoring apparatus and techniques

The following continuous monitoring methods were used at the Stansted air quality monitoring stations:

- NO, NO_2: chemiluminescence with ozone.
- PM_{10} and $PM_{2.5}$: Fine Dust Analysis Systems (FIDAS).

These methods were selected in order to provide real-time data. The chemiluminescence analyser is the European reference method for ambient NO_2 monitoring.

Each analyser provides a continuous output, proportional to the pollutant concentration. This output is recorded and stored every 10 seconds, and averaged to 15-minute averages by the instrument onboard loggers. The on-site web logger sends the data to a web server every hour, Ricardo contact the server and download data hourly. The data are then converted to concentration units and averaged to hourly mean concentrations.

The chemiluminescence analysers for NO_x are equipped with an automatic calibration system, which is triggered daily under the control of the data logger. Fully certificated calibration gas cylinders are also used at each site for manual calibration.

The FIDAS unit employs a white light LED light scatter method that offers additional information on both particle size distribution from 0.18 to 30 microns (PM_1, $PM_{2.5}$, PM_4, PM_{10} and Total Suspended Particles (TSP).

All of the air quality monitoring equipment at both sites are housed in purpose-built enclosures. The native units of the analysers are volumetric (e.g. ppb). Conversion factors from volumetric to mass concentration measurement for gaseous pollutants are provided below:

- NO 1 ppb = 1.25 $\mu g\ m^{-3}$
- NO_2 1 ppb = 1.91 $\mu g\ m^{-3}$

In this report, the mass concentration of NO_x has been calculated as follows:

NO_x $\mu g\ m^{-3}$ = (NO ppb + NO_2 ppb) x 1.91.

This complies with the requirements of the Air Quality Directive3 and is also the convention generally adopted in air quality modelling.

Appendix 3 Quality assurance and quality control

Ricardo operates air quality monitoring stations within a tightly controlled and documented quality assurance and quality control (QA/QC) system. These procedures are documented in the AURN QA/QC manual[8].

Elements covered within this system include: definition of monitoring objectives, equipment selection, site selection, protocols for instrument operation calibration, service and maintenance, integrity of calibration gas standards, data review, scrutiny and validation.

All gas calibration standards used for routine analyser calibration are certified against traceable primary gas calibration standards at the Gas Standards Calibration Laboratory at Ricardo. The calibration laboratory operates within a specific and documented quality system and has UKAS accreditation for calibration of the gas standards used in this survey.

An important aspect of QA/QC procedures is the regular six-monthly intercalibration and audit check undertaken at every monitoring site. This audit has two principal functions: firstly to check the instruments and the site infrastructure, and secondly to recalibrate the transfer gas standards routinely used on-site, using standards recently checked in the calibration laboratory. Ricardo's audit calibration procedures are UKAS accredited to ISO 17025.

In line with current operational procedures within the Defra AURN, full intercalibration audits take place at the end of winter and summer. At these visits, the essential functional parameters of the monitors such as noise, linearity and, for the NO_x monitor, the efficiency of the NO_2 to NO converter are fully tested. In addition, the on-site transfer calibration standards are checked and re-calibrated if necessary, the air intake sampling system is cleaned and checked, and all other aspects of site infrastructure are checked.

All air pollution measurements are reviewed daily by experienced staff at Ricardo. Data are compared with corresponding results from AURN monitoring stations and with expected air pollutant concentrations under the prevailing meteorological conditions. This review process rapidly highlights any unusual or unexpected measurements, which may require further investigation. When such data are identified, attempts are made to reconcile the data against known or possible local air pollution sources or local meteorology, and to confirm the correct operation of all monitors. In addition, the results of the daily automatic instrument calibrations (see Appendix 2) are examined to identify any possible instrument faults. Should any faults be identified or suspected, arrangements are made for Ricardo personnel or equipment service contractors to visit the site as soon as possible.

At the end of every quarter, the data for that period are reviewed to check for any spurious values and to apply the best daily zero and sensitivity factors, and to account for information which only became available after the initial daily processing. At this time, any data gaps are filled with data from the data logger back-up memory to produce as complete a data record as possible.

Finally, the data are re-examined on an annual basis, when information from the six-monthly intercalibration audits can be incorporated. After completion of this process, the data are fully validated and finalised, for compilation in the annual report. Following these three-stage data checking and review procedures allows the overall accuracy and precision of the data to be calculated. The accuracy and precision figures for the pollutants monitored at Stansted are summarised in Table A5.

Table A4: Estimated accuracy and precision of the data presented.

Pollutant	Precision	Accuracy
NO	± 2.5	± 15 %
NO_2	± 6.9	± 15 %
PM_{10}	± 4	Estimated* accuracy of a TEOM □ 30% or better. With VCM correction, estimated as □ 25 %.

T: +44 (0) 1235 75 3000
E: enquiry@ricardo.com
W: ee.ricardo.com