



Ricardo  
Energy & Environment

## UFP Monitoring at Heathrow

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SAQDM, Edinburgh, 24 January 2017



UNIVERSITY OF  
BIRMINGHAM

**Heathrow**  
Making every journey better

## Agenda

- UFP – Is there a problem?
- UFP monitoring at Heathrow - PhD plan
- A quick look at some of my data
- Future

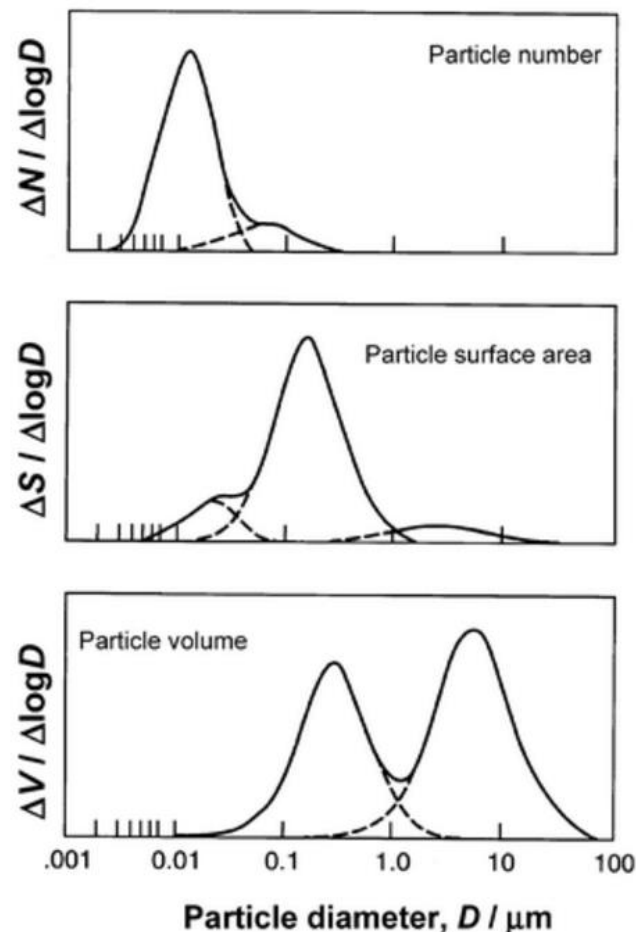


## UFP - An Overview

A definition: particles that are smaller than 0.2 microns in diameter

Have virtually no mass, but are very abundant

Produced in combustion and atmospheric processes

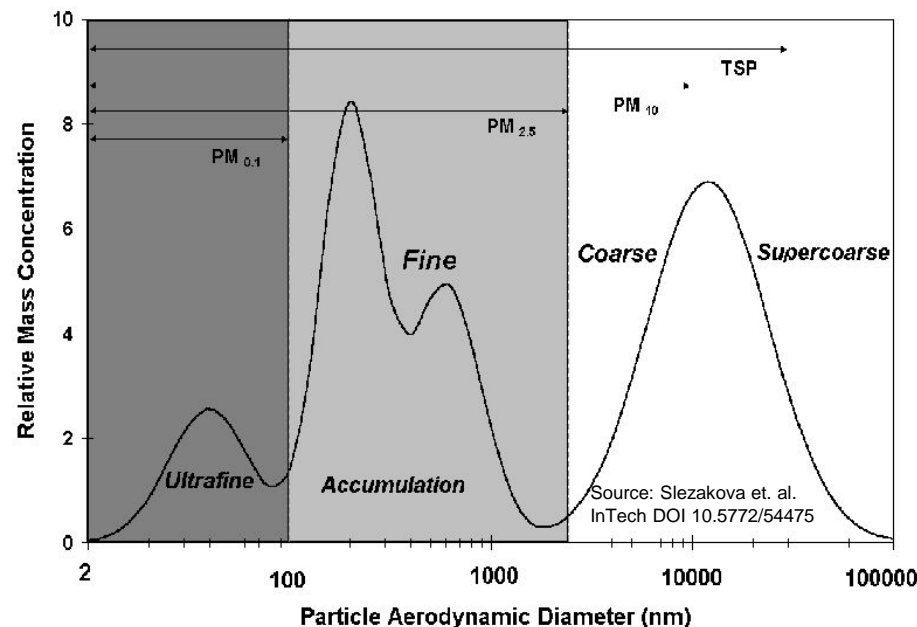


**Fig. 1** A typical ambient particle distribution as a function of particle size expressed by particle number, surface area, and volume. The latter is equivalent to a mass distribution when variation in particle density is small. Vertical scaling is individual to each panel.

Source: Heal et al, Chem. Soc. Rev., 2012, 41, 6606-6630

## UFP - An Overview (2)

- In ambient environment, UFP particles are largest component by numbers, but represent a minute proportion of the particle mass.
- Some evidence that UFP is injurious to health
- Are we using the right metric?



## UFP - An Overview (3)

- A number of ways to measure UFP:
- Count everything in a range
- Size and count
- Optical technique (usually with some kind of size enhancement technology)



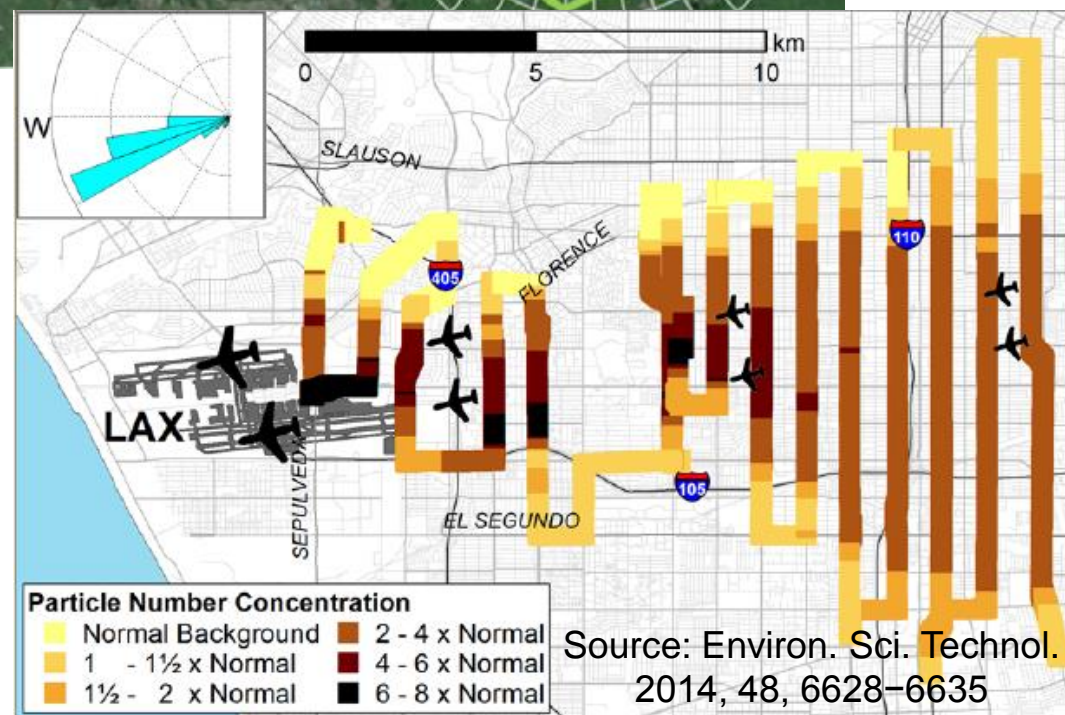
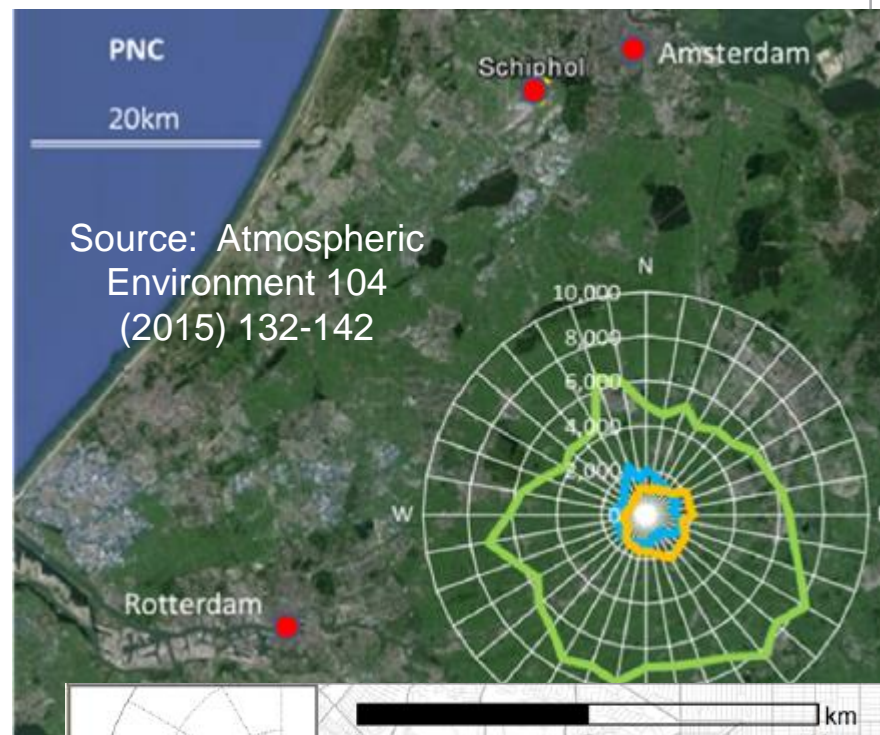
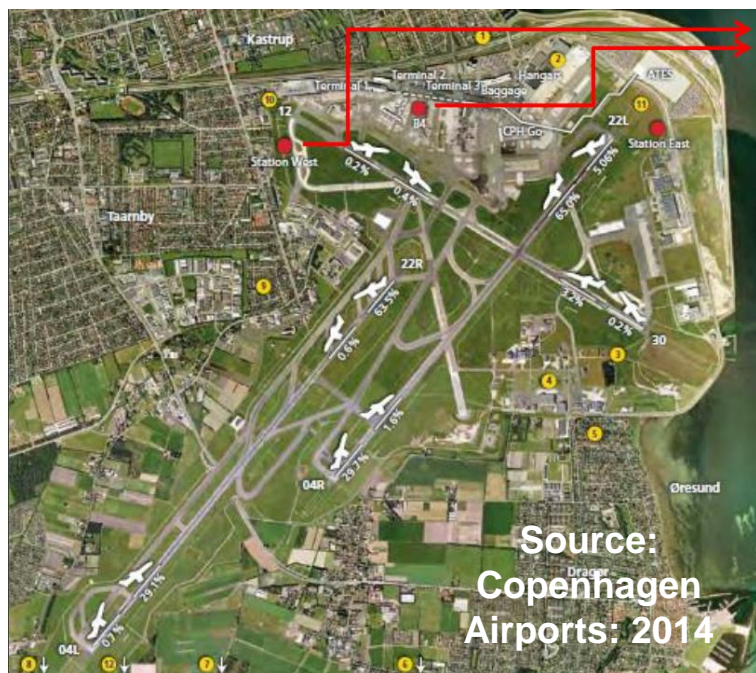
## UFP - An Overview (4)

- Emerging link with UFP and health
- Supported by studies in (e.g.) B, NL, D ([www.pmlab.eu](http://www.pmlab.eu))
- UK National network
- Interest from EU, COMEAP and AQEG
- Still not enough to establish ambient regulations (though legislation exists for engine emissions)
- Copenhagen UFP case
- Work at AMS, COP, and LAX airports



## UFP and Airports - An Overview

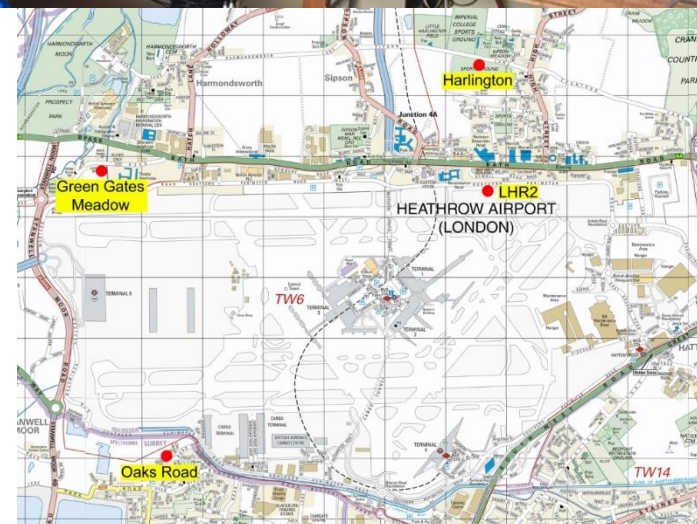
Frankfurt Airport report (Sep 16) summarises UFP concentrations close to airports “the same as a busy road” Plan to undertake measurements in 2017





## An History of AQM at Heathrow

- Began (properly) in 1986
- Permanent station in 1992
- Occasional monitoring campaigns
- Terminal 5 – 5 sites to west of airport from 2000 to 2007.
- Harlington from 2004
- 4 sites directly funded by HAL
- [heathrowairwatch.org.uk](http://heathrowairwatch.org.uk)





## UFP monitoring at Heathrow – The Plan

- 3 years in the planning...
- Phase 1 – Autumn 2016
- Phase 2 – Summer 2017
- Context – compare with national network data
- Aims and objectives
- Literature search
- Collaborative plans with other airports / consultants
- QA/QC



## UFP Monitoring at Heathrow – Measurement Campaigns

- Phase 1 - LHR2 / Oaks Road – 30/9 to 25/11/2016

Pollutant	Analyser	Averaging
UFP (14-680nm)	TSI 3775/3080 (Oaks Road) TSI 3775/3082 (LHR2)	2:15 sweep every 3 mins
PM <sub>10/2/5/1</sub>	Palas Fidas 200	15 min (1 min)
NO <sub>x</sub>	API T200	15 min (1 min)
BC	Magee AE33-7	15 min (1 min)
CO <sub>2</sub>	COZIR	15 min
Met	Lufft AS600 (LHR2)	15 min

# UFP Monitoring at Heathrow – Measurement Campaigns



- Phase 2 – LHR2 – Summer 2017, but plan not defined yet... will depend on the findings from Phase 1. Wish list currently:

Pollutant	Analyser	Averaging
UFP (4nm+)	TSI 3775/3082 (nano DMA)	1 minute if poss
UFP (tot)	TSI 3775 CPC	1 min
PM <sub>10/2/5/1</sub>	Palas Fidas 200	1 min
NO <sub>x</sub>	API T200	1 min
BC	Magee AE33-7	1 min
CO <sub>2</sub>	COZIR	1 min
Met	Lufft AS600	1 min
Others?	CPC, VOC, EC/OC, TOF GC/MS, SO <sub>2</sub> , new products?	?



## UFP Monitoring at Heathrow – Context, Aims and Objectives

- Context – how do airport UFP data compare with roadside, background and rural measurements? Are there differences upwind and downwind of the airfield? Particle size distribution?
- Does the pollutant mixture differ at the airport? e.g. BC:CO<sub>2</sub> ratio for different fuel types? Or when aircraft take off and land?
- Investigation of source apportionment – on airport and off airport.
- Assessment of airport contribution to local UFP
- QA/QC – Already in place for conventional pollutants – make sure it is just as robust for the UFP measurements
- Individual aircraft “fingerprinting”? i.e. is it possible to identify dirtier aircraft / engine configurations?
- Sell this expertise to other airports...

## A Sneak Peek At The Heathrow Measurement Data

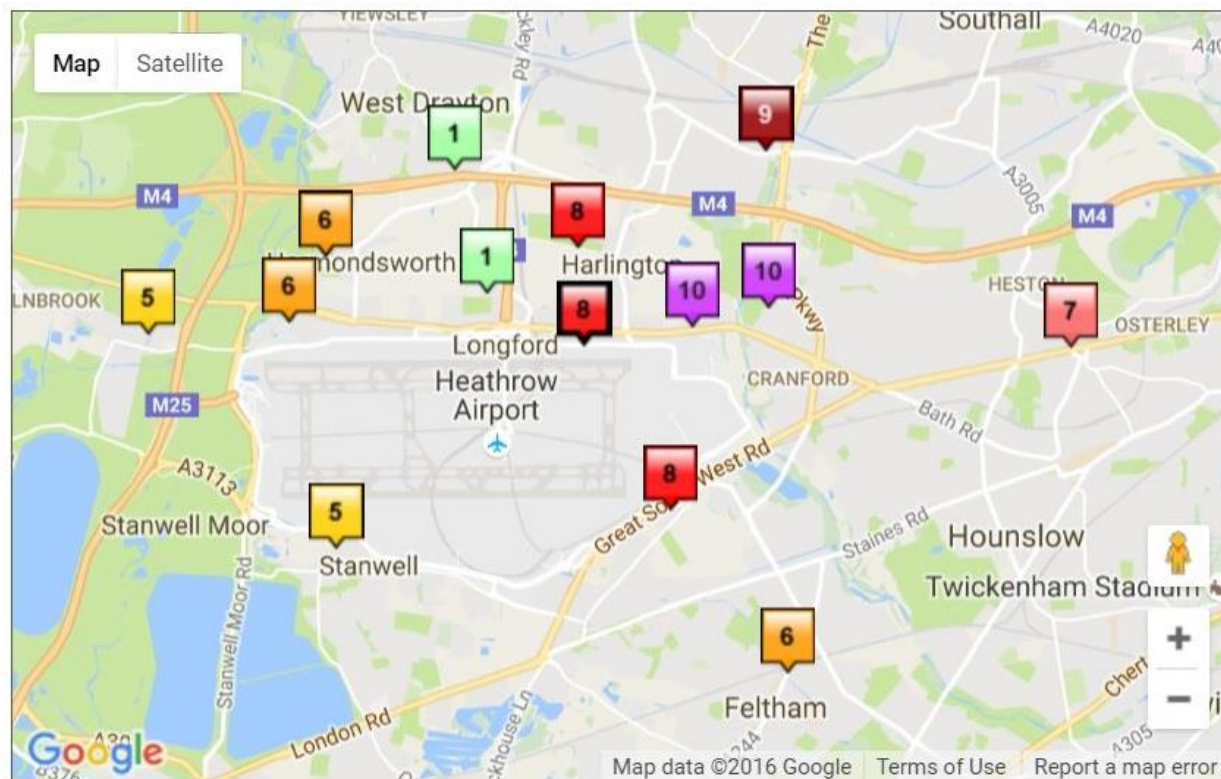
- 30<sup>th</sup> October brought some interesting results.
- Lovely clear, still day.
- Coincided with a weekend celebrating Diwali.



## A Sneak Peek At The Heathrow Measurement Data

- PM measurements “High” or “Very High” across London (not just Heathrow)
- Perfect opportunity to explore all the relationships between pollutants

### LATEST AIR QUALITY SUMMARY

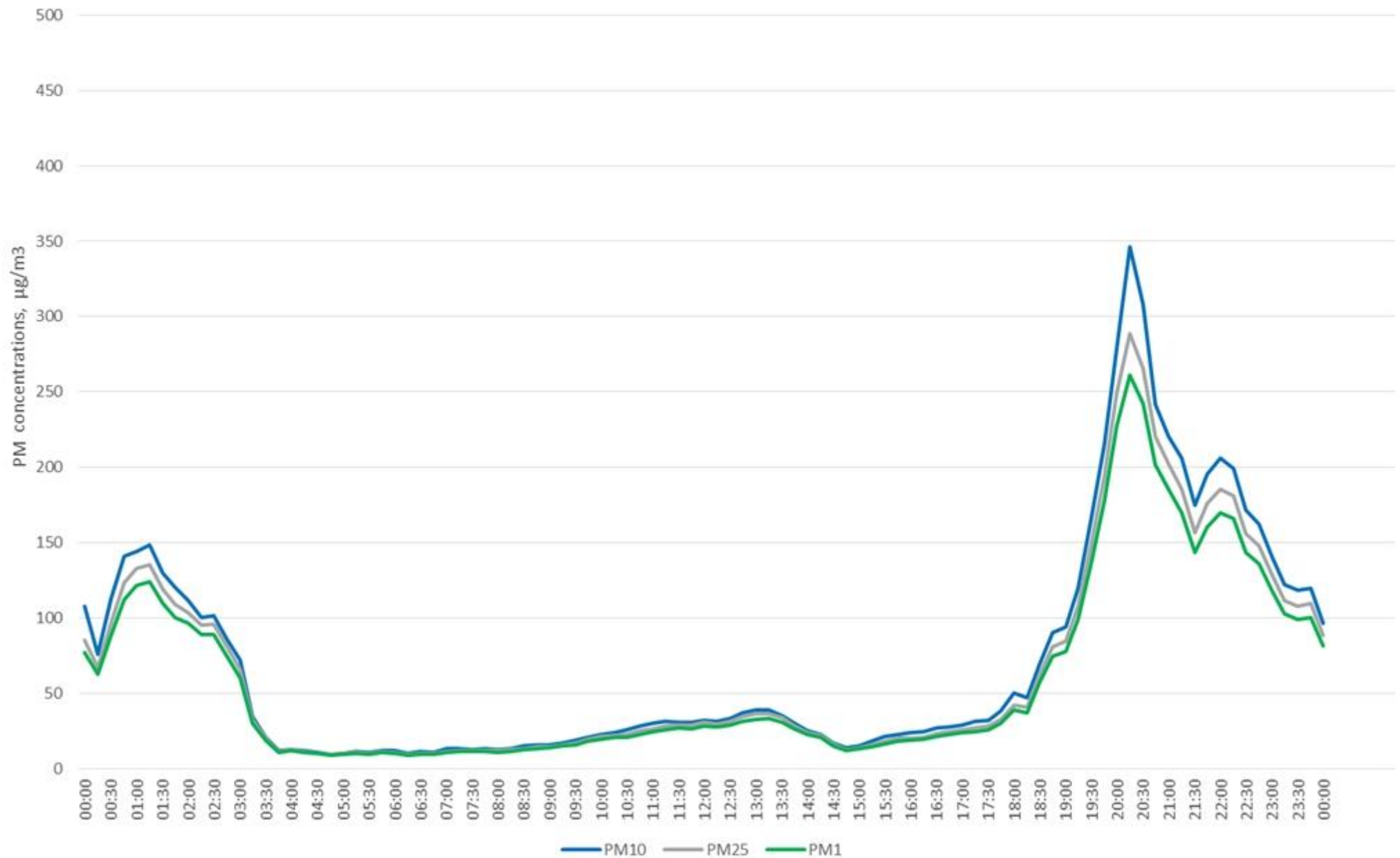


Low (1-3)
  Moderate (4-6)
  High (7-9)
  Very High (10)
  Offline

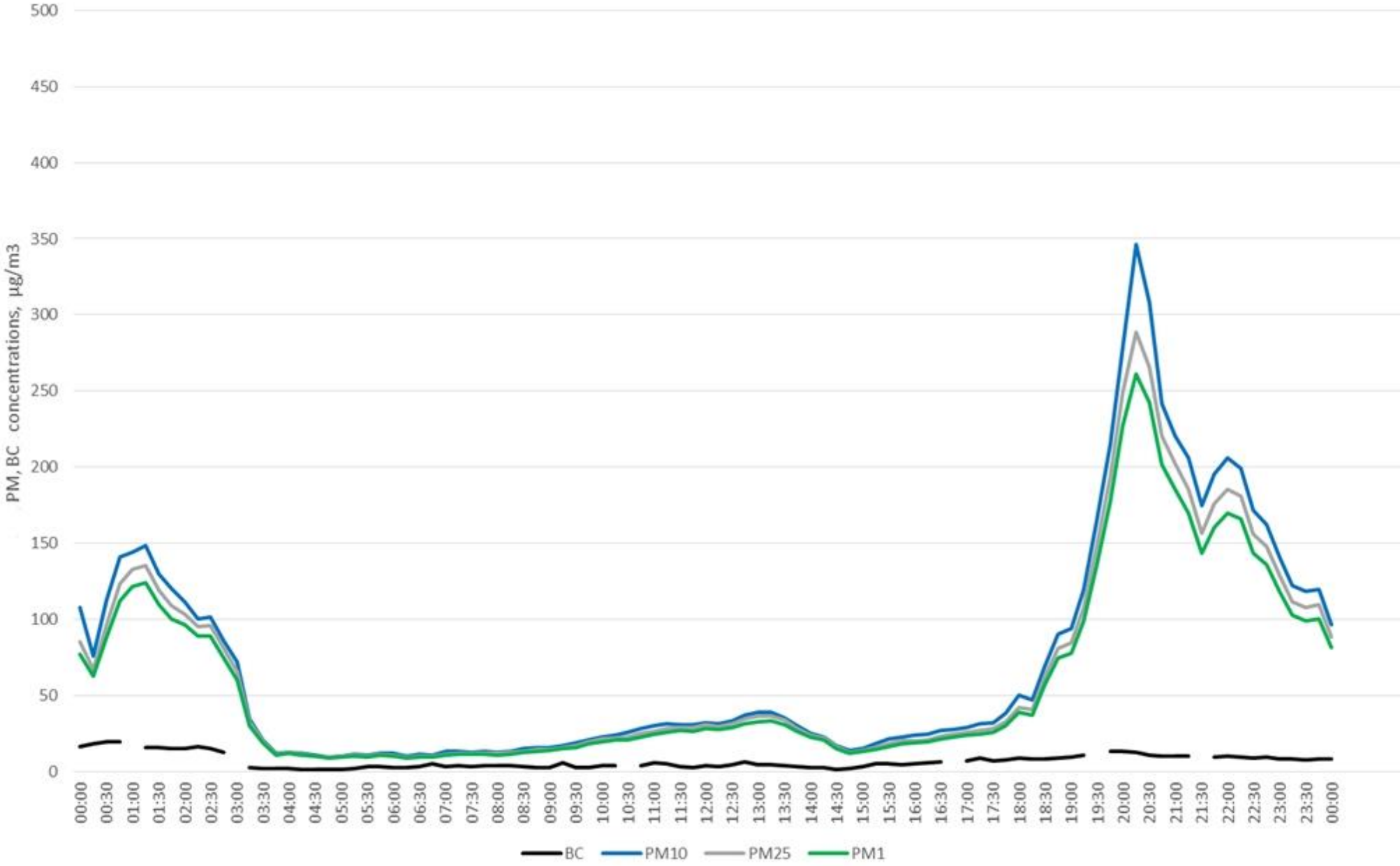
[Find out more about the air pollution index and bandings](#)



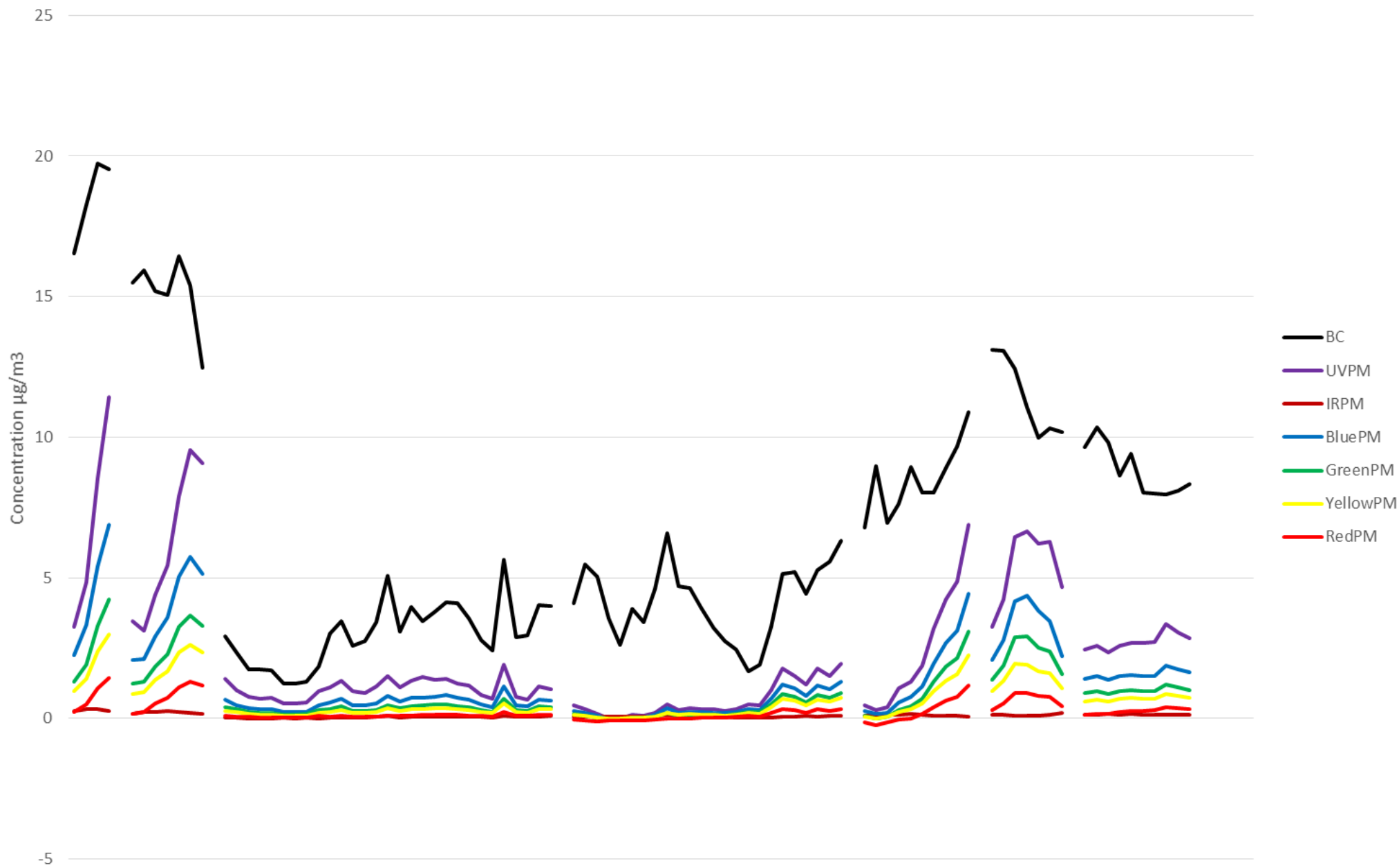
Pollution data, LHR2 30 October 2016



Pollution data, LHR2 30 October 2016

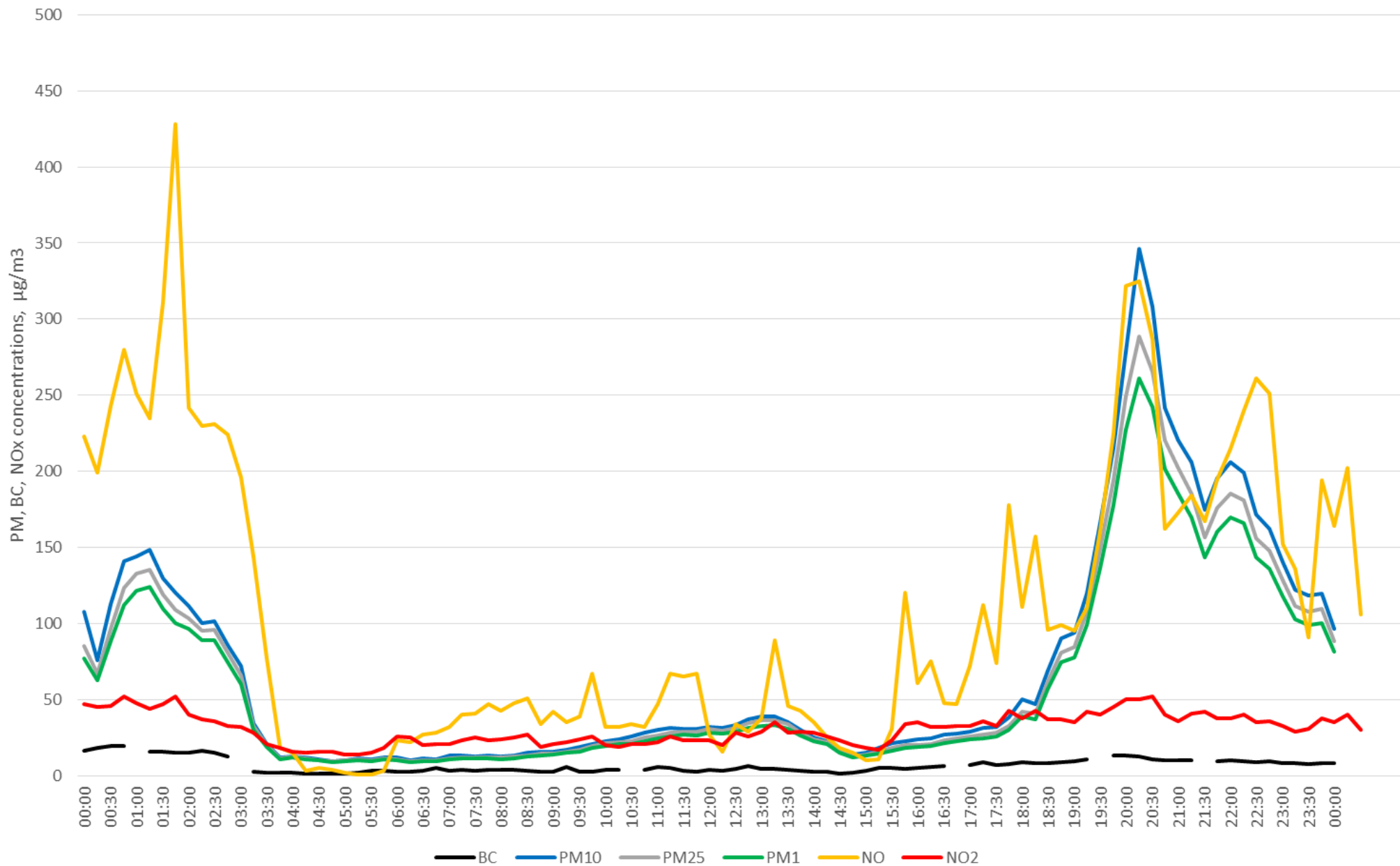


# Aethalometer data, LHR2 30 October 2016

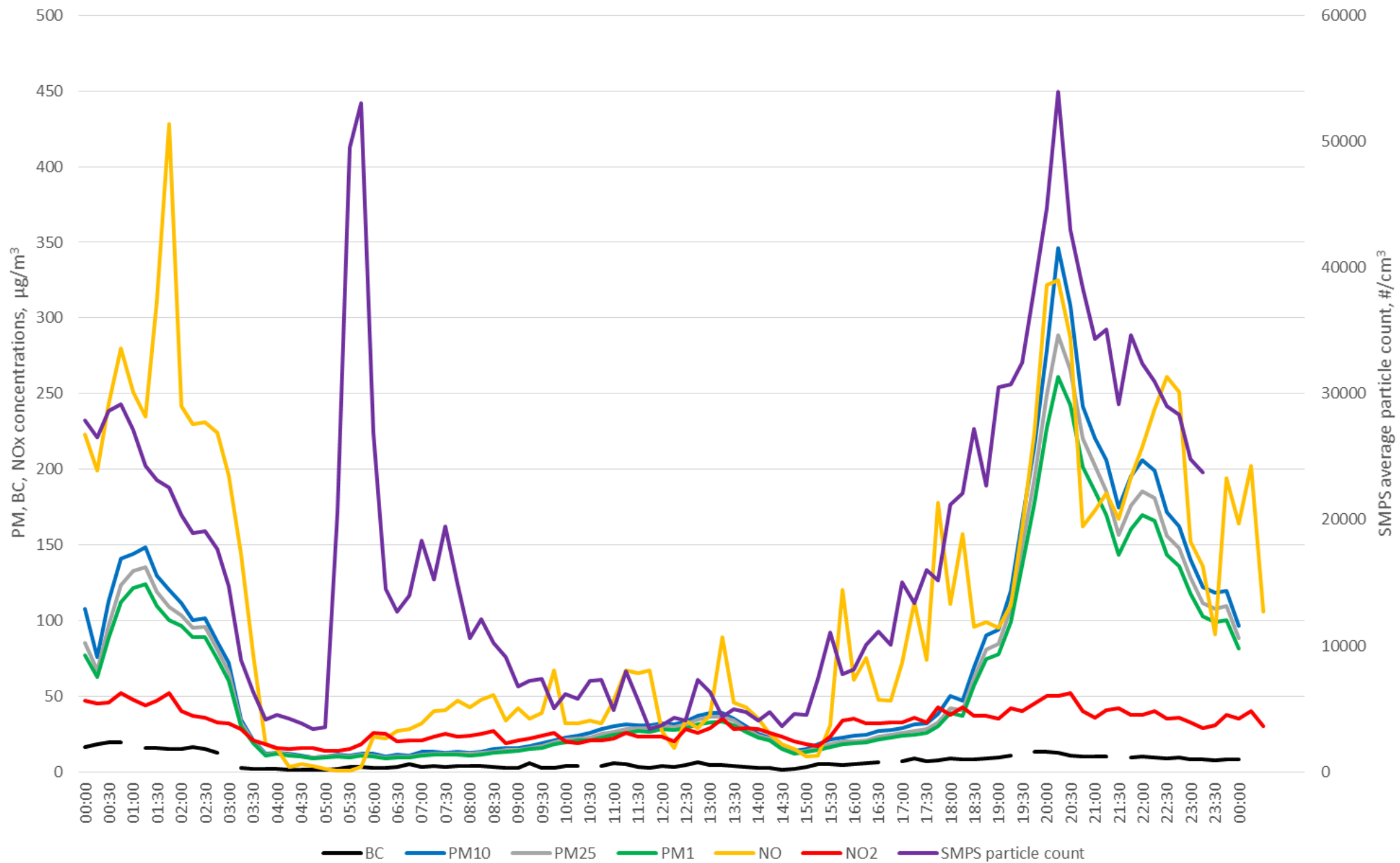




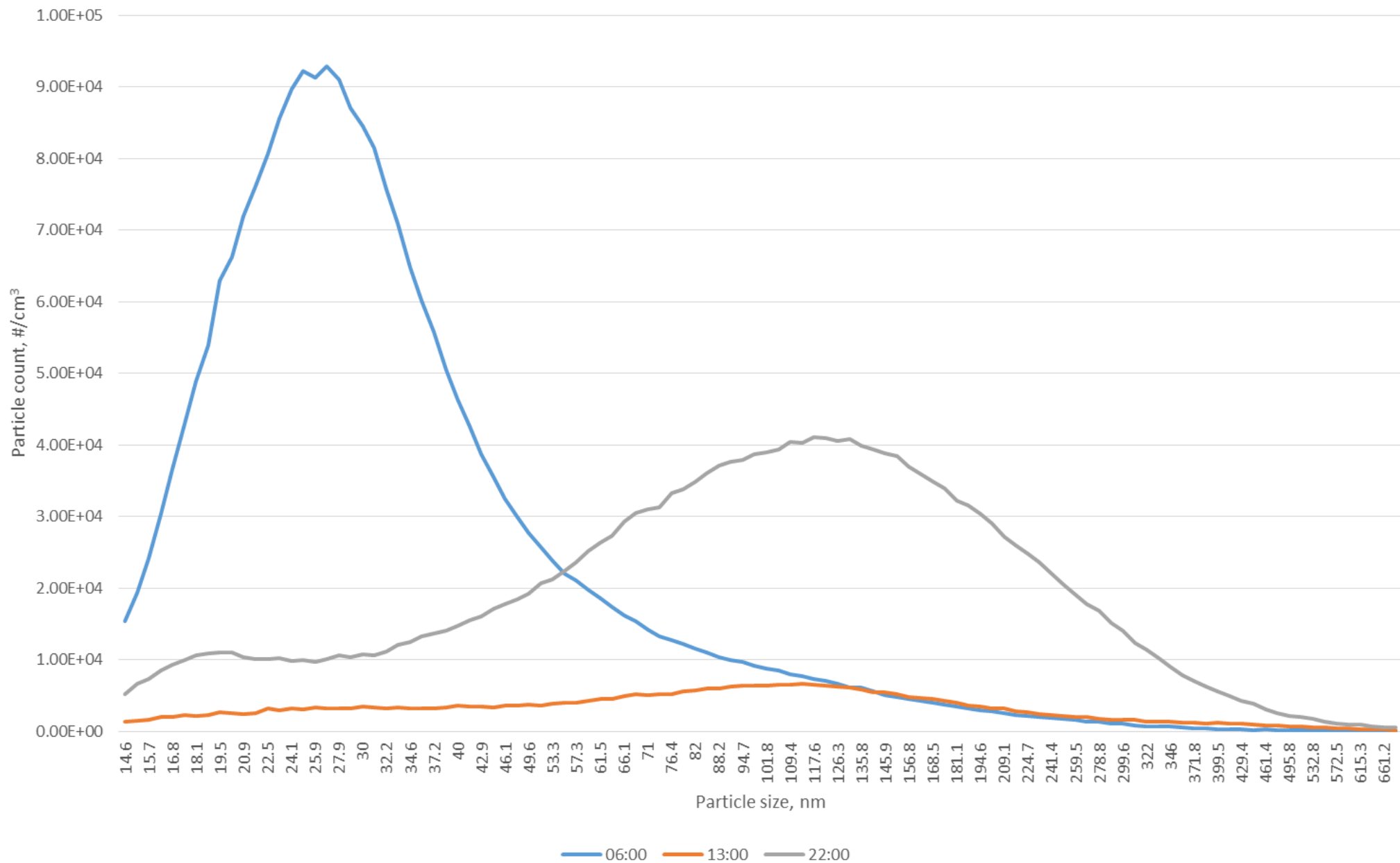
Pollution data, LHR2 30 October 2016



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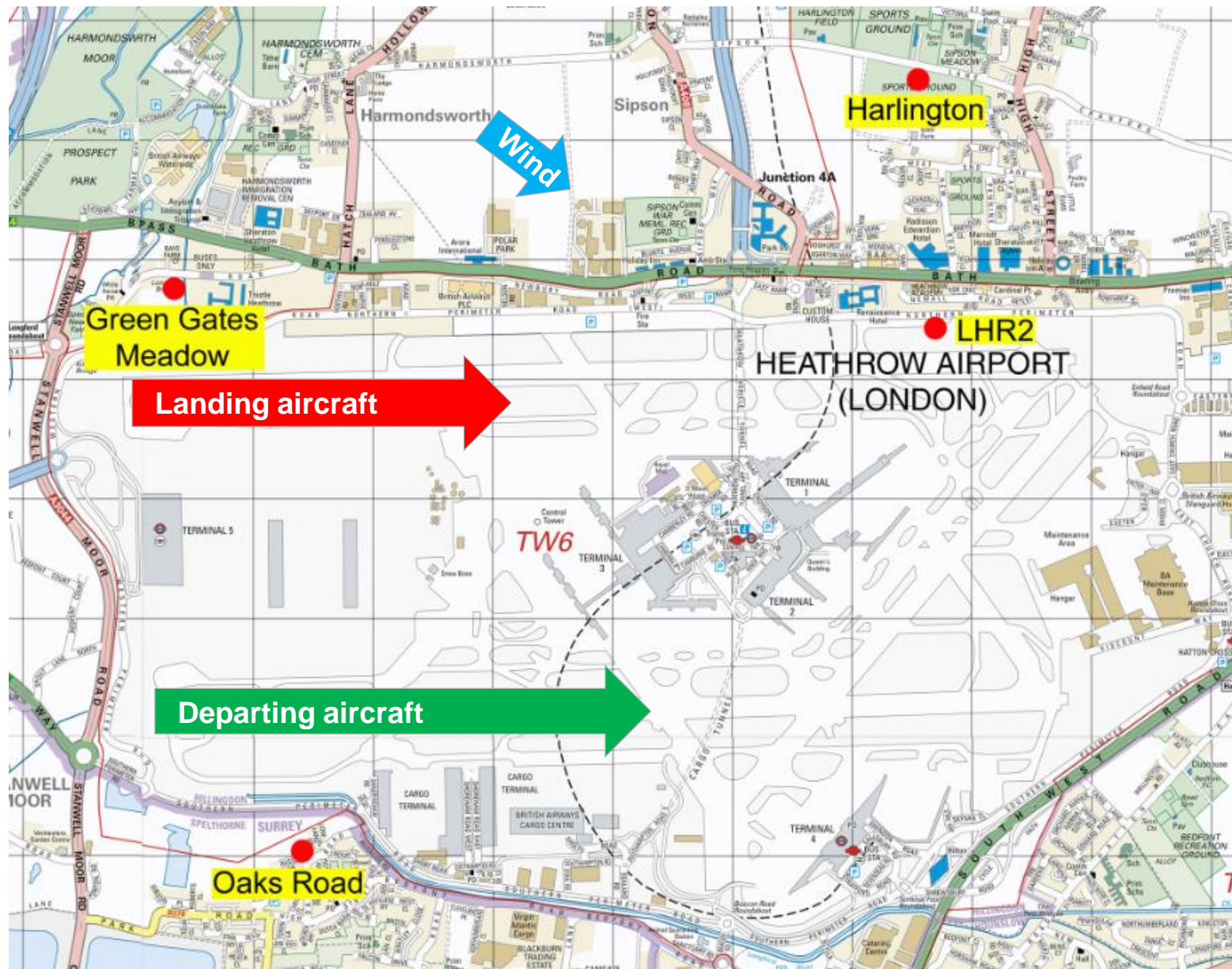


# UFP concentrations and size distribution, 30 October 2016

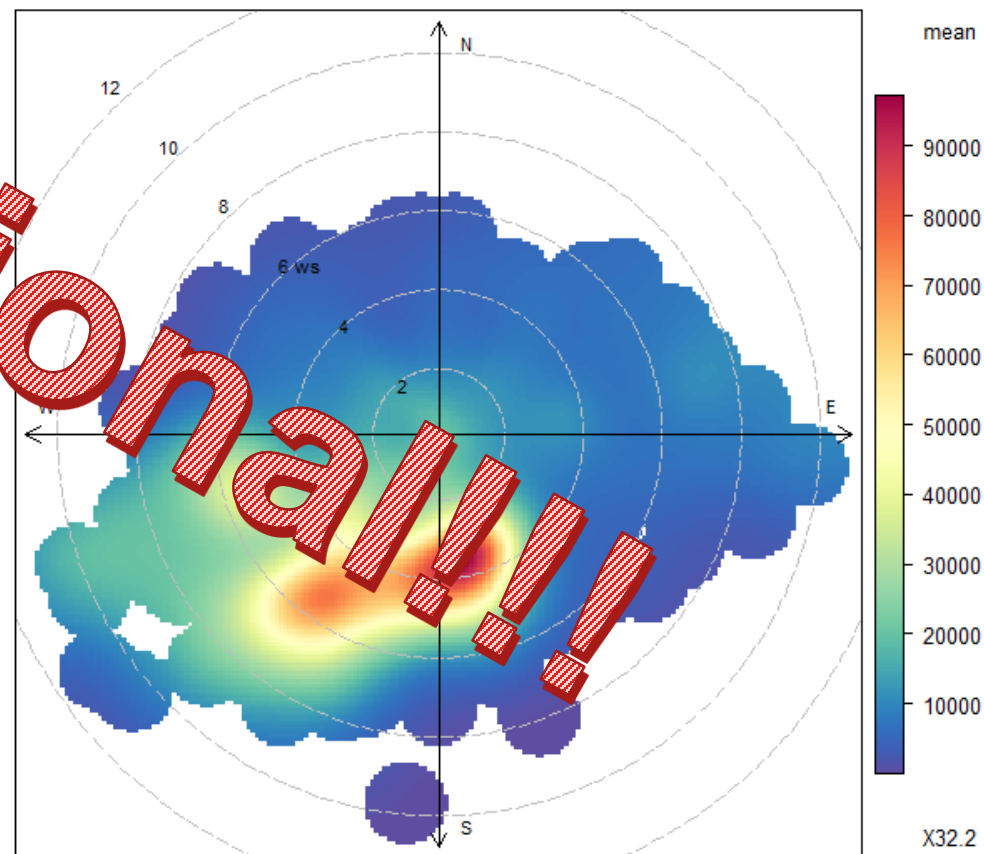
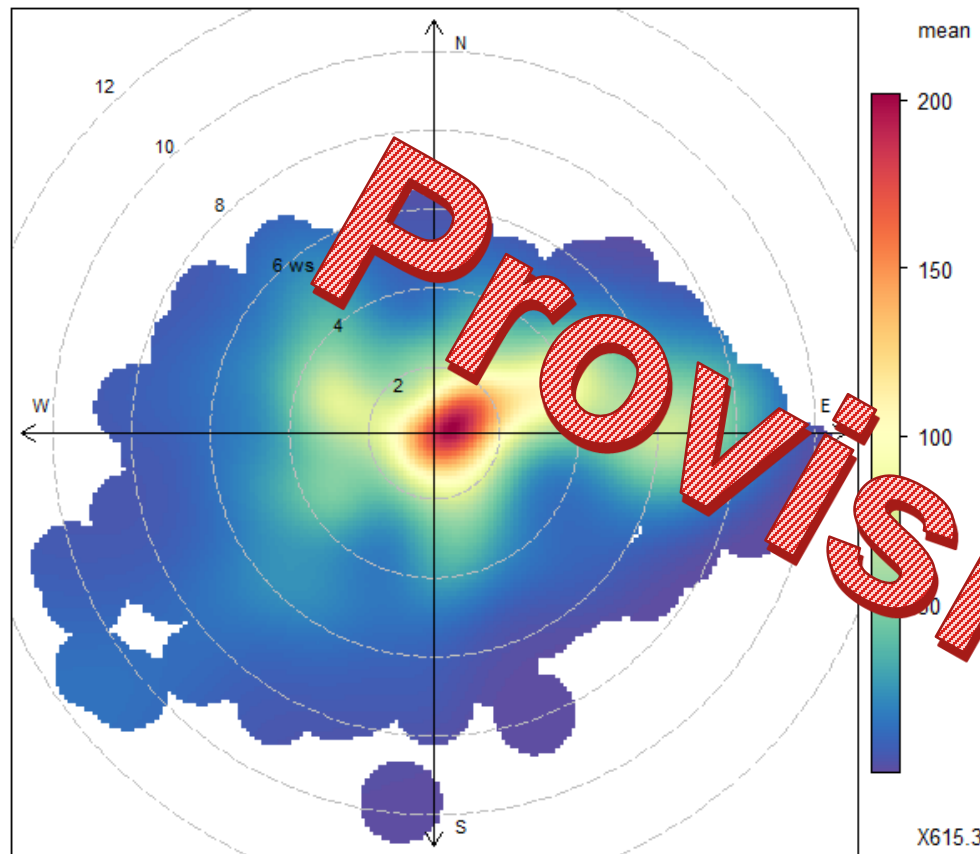




## What was going on at 6am?



# Initial analysis of particle distribution



## What's next?



- Loads of analysis and interpretation!
- Plan the summer campaign
- Network!
- Review the objectives: are they realistic?  
Have I missed anything? Feedback from  
stakeholders! Update the plan...

## How does this fit with SAQDM?

- A bit of crystal ball gazing
- No regulations, but definitely of interest
- Some evidence that highest exposure nearest roads
- Very little (and often conflicting) evidence about aircraft
- Considerable opportunities for strategic research – measurements and health impacts – to help drive development of standard methods and exposure recommendations
- Review of legislation? At least 5 years away

## Thanks for listening

Thanks to Professor Roy Harrison, University of Birmingham

Thanks to Andrew Chen, Heathrow Airport Limited

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Thanks in advance to Dr Paul Quincey and David Butterfield, NPL

## Any questions?

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