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Ultrafine Particle measurements – comparison of road traffic and airport environments

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Oxford Air Quality Meeting, 10 Jan 2020

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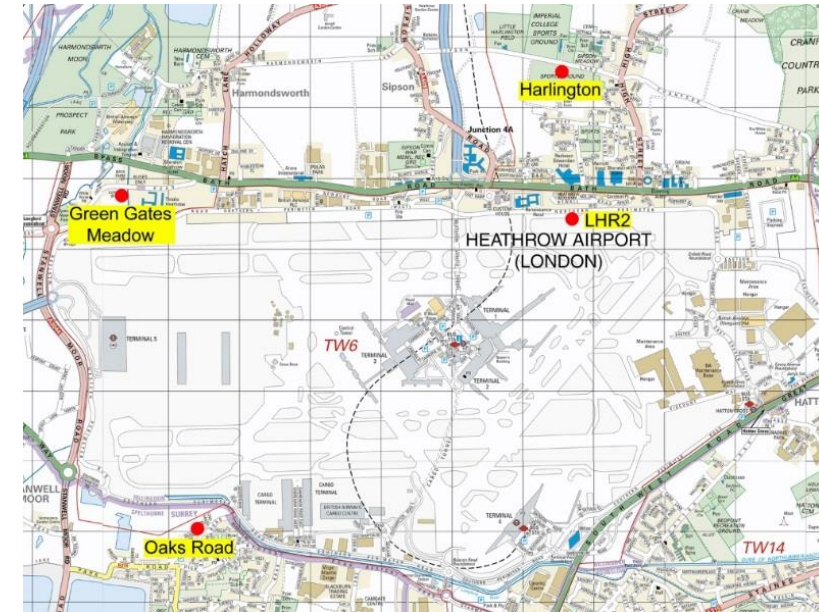


- AQM at Heathrow – History
- UFP
 - Background
 - At airports
- Monitoring data in context
- Follow up campaigns



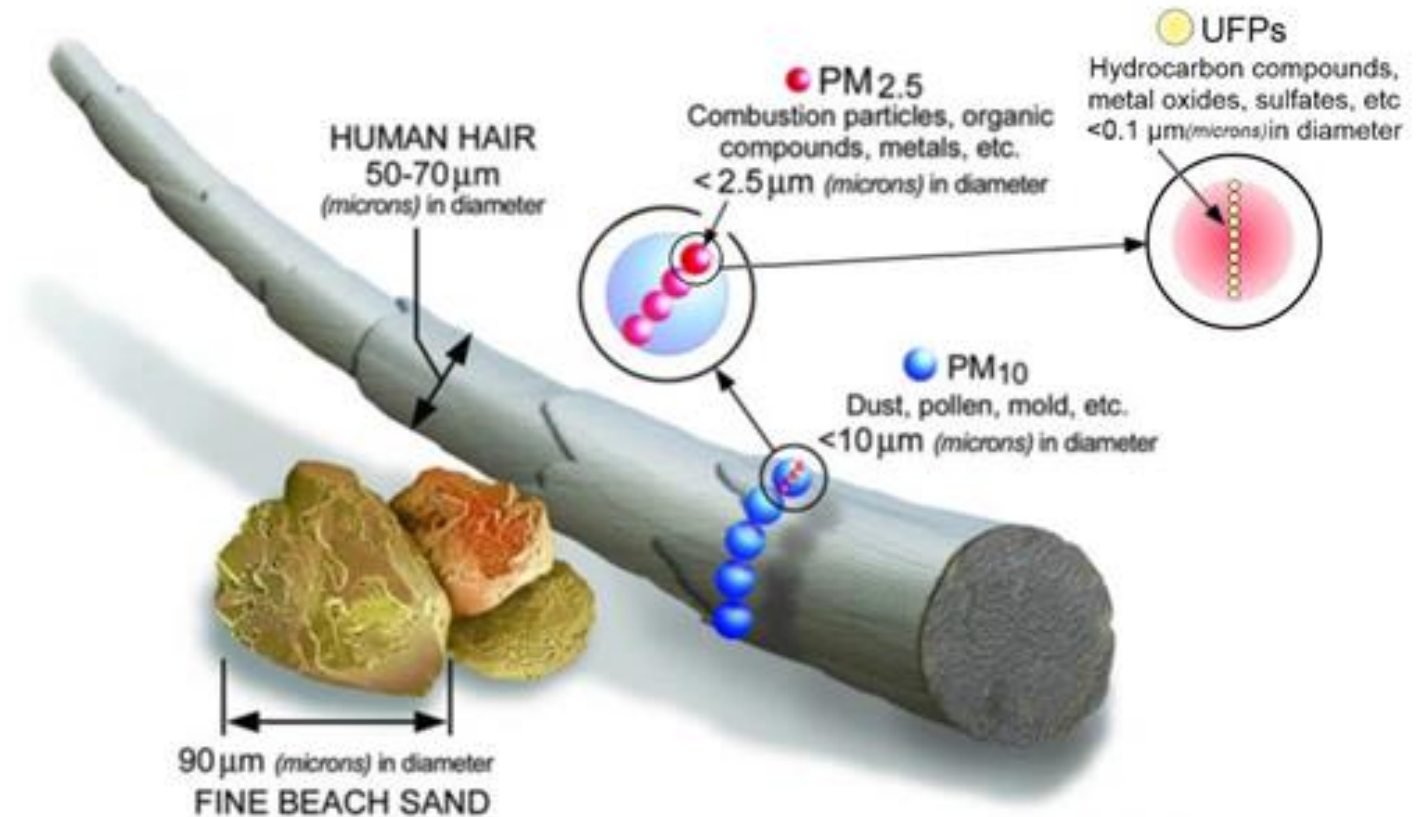
An History of AQM at Heathrow

- Began (properly) in 1986
- Permanent station in 1992
- Terminal 5 – 5 sites to west of airport from 2000 to 2007.
- Harlington from 2004
- Currently, 5 sites directly funded by HAL, ~20 operated by LAs
- heathrowairwatch.org.uk

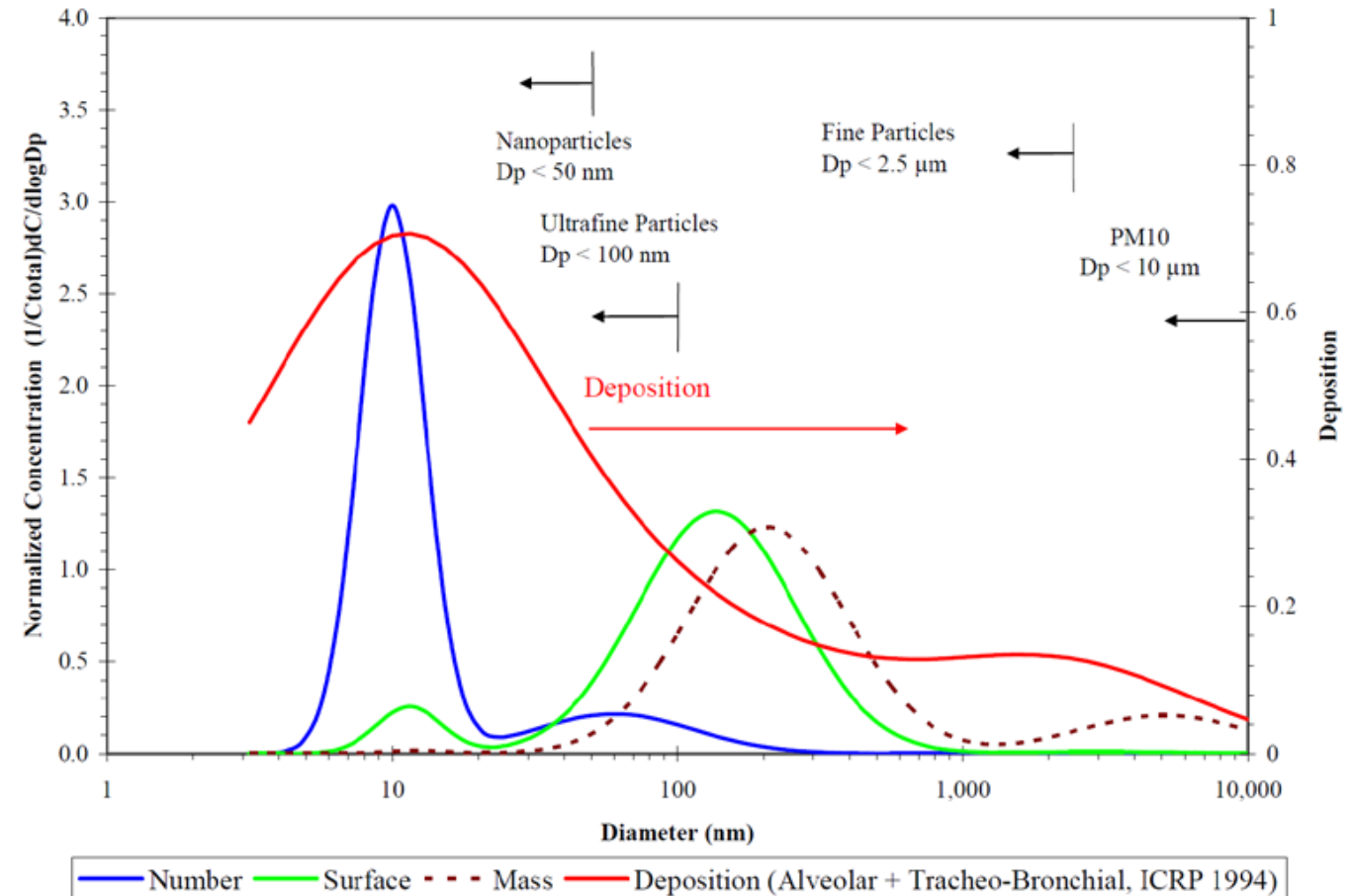


Particles - definitions

- PM_{10} ~ particles smaller than 10 microns (0.01mm)
- $PM_{2.5}$ ~ particles smaller than 2.5 microns
- UFP generally defined as smaller than 0.1 micron ($PM_{0.1}$)
- UFP from vehicles are typically smaller than 0.05 microns (50 nanometres)



- Huge numbers of UFP in atmosphere compared to PM_{10}
- Smallest particles weigh virtually nothing. So a tiny contribution to PM mass
- Measuring mass (e.g. PM_{10} , $PM_{2.5}$) not necessarily providing enough information about exposure



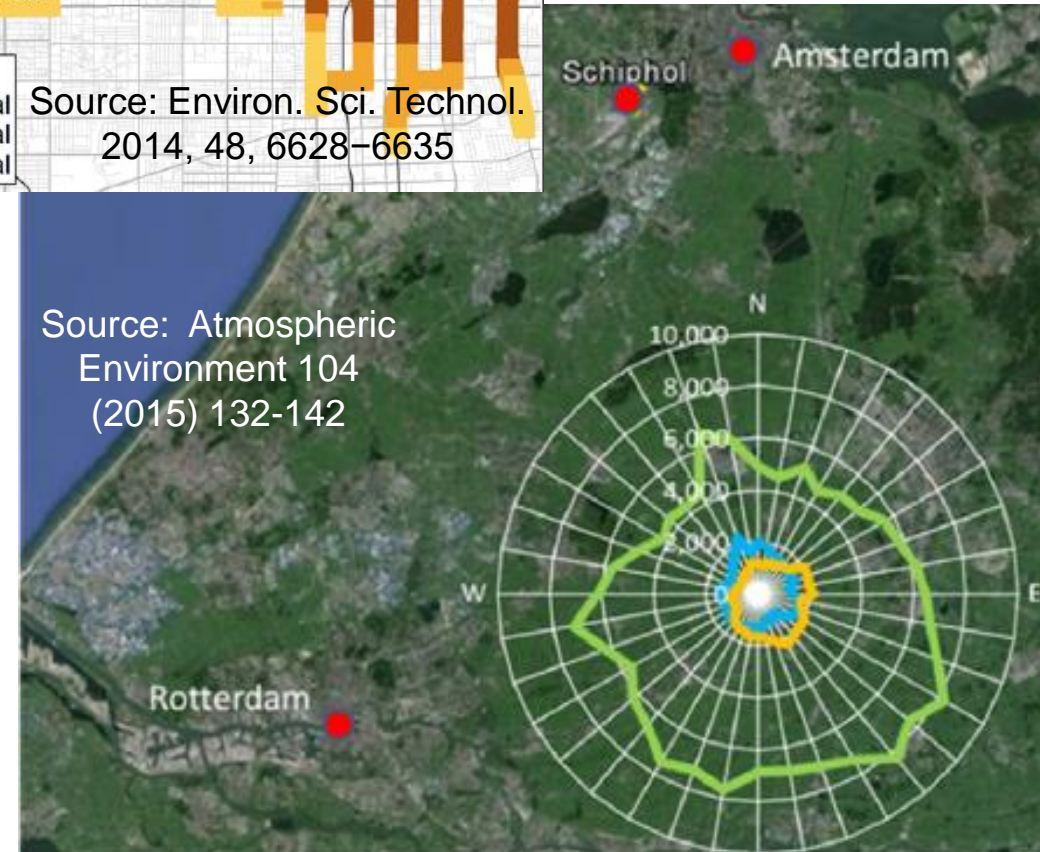
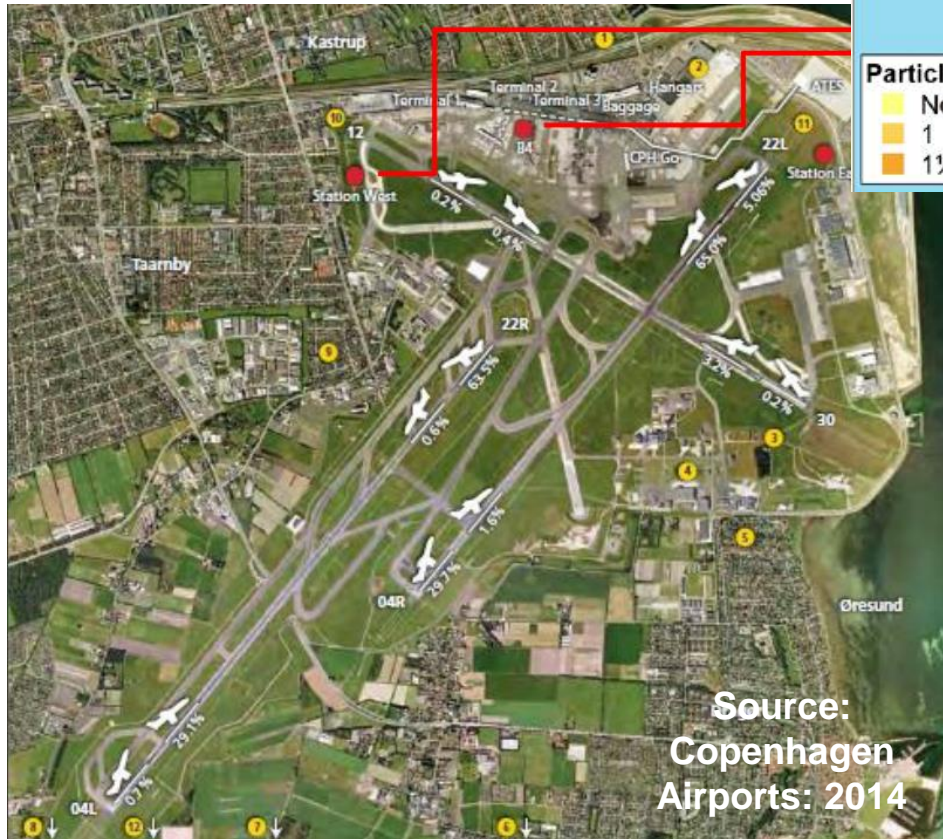
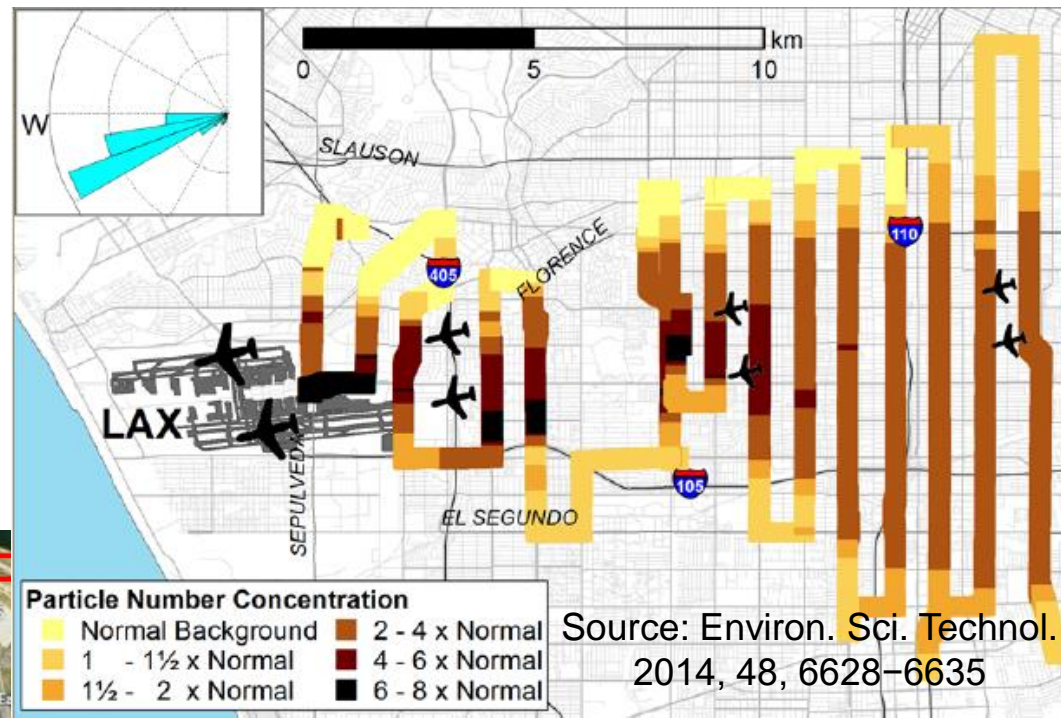
- Emerging evidence linking UFP and health
- Interest from EU, COMEAP and AQEG
- UK (and other MS) National network – not extensive
- Increasing evidence to suggest airport related UFP is different to typical urban UFP
- Research at airports in (e.g.) F, B, D, NL, DK, I, UK, US

BUT:

- There is no legislation to regulate Particle Numbers (PN), Particle Size Distribution (PSD) or particle speciation
- There is conflicting evidence relating to worsened health impact and exposure, especially around airports
- There's not much robust data to support creation of legislation

UFP - An Overview (3)

Evidence that high PN concentrations are associated with airport activity, even at some distance from the source.

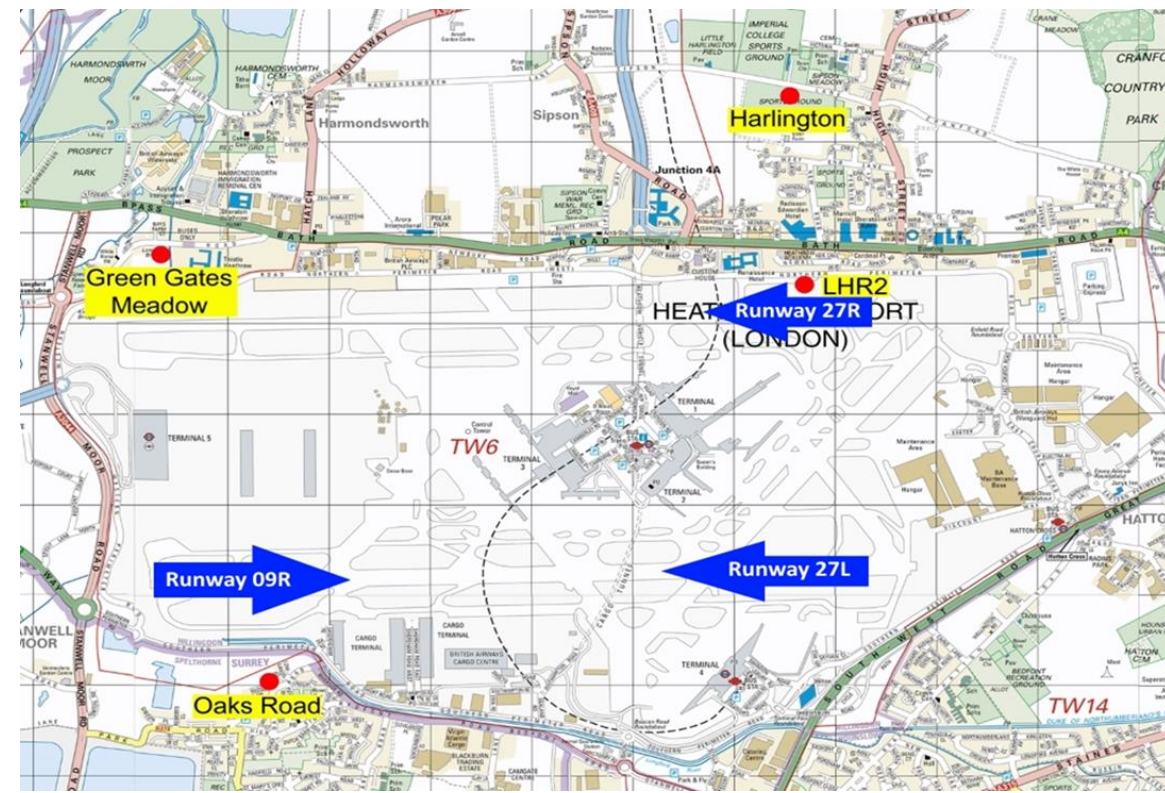


UFP Monitoring at Heathrow – Measurements

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

Compare data against reference locations

(Stacey et al, Atmos Env (2019) - <https://doi.org/10.1016/j.atmosenv.2019.117148>)



Pollutant	Analyser	Averaging
UFP (14-680nm)	TSI 3775/3080 (Oaks Road) TSI 3775/3082 (LHR2)	2:15 sweep every 3 mins
PM _{10/2.5/1}	Palas Fidas 200	15 min
NO _x	API T200	15 min
BC	Magee AE33-7	15 min
CO ₂	COZIR	15 min
Met	Lufft WS600 (LHR2)	15 min

2 other campaigns:

Autumn 2017 – 1 minute data at LHR2 (awaiting publication)

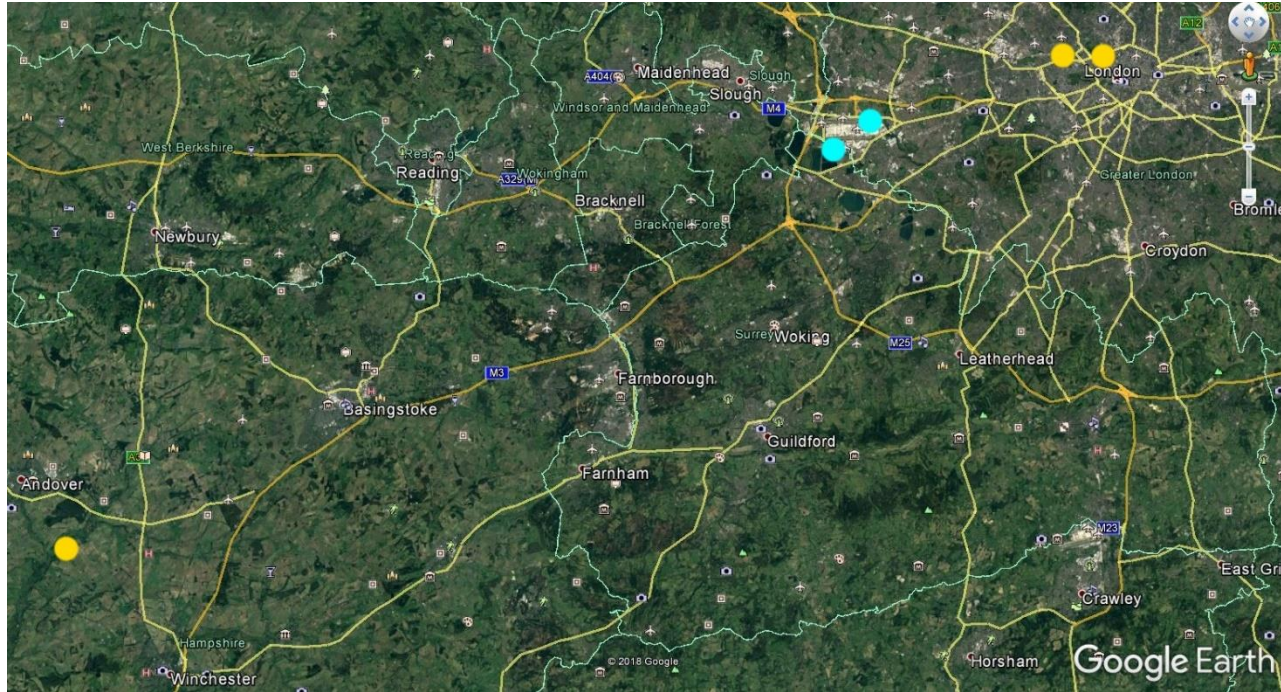
(Autumn 2018 – 1 second trial)

Summer 2019 – 1 second data at LHR2

UFP Monitoring at Heathrow – Measurements in Context – Autumn 2016

Headline:

Airport concentrations (mostly) between London traffic and London background

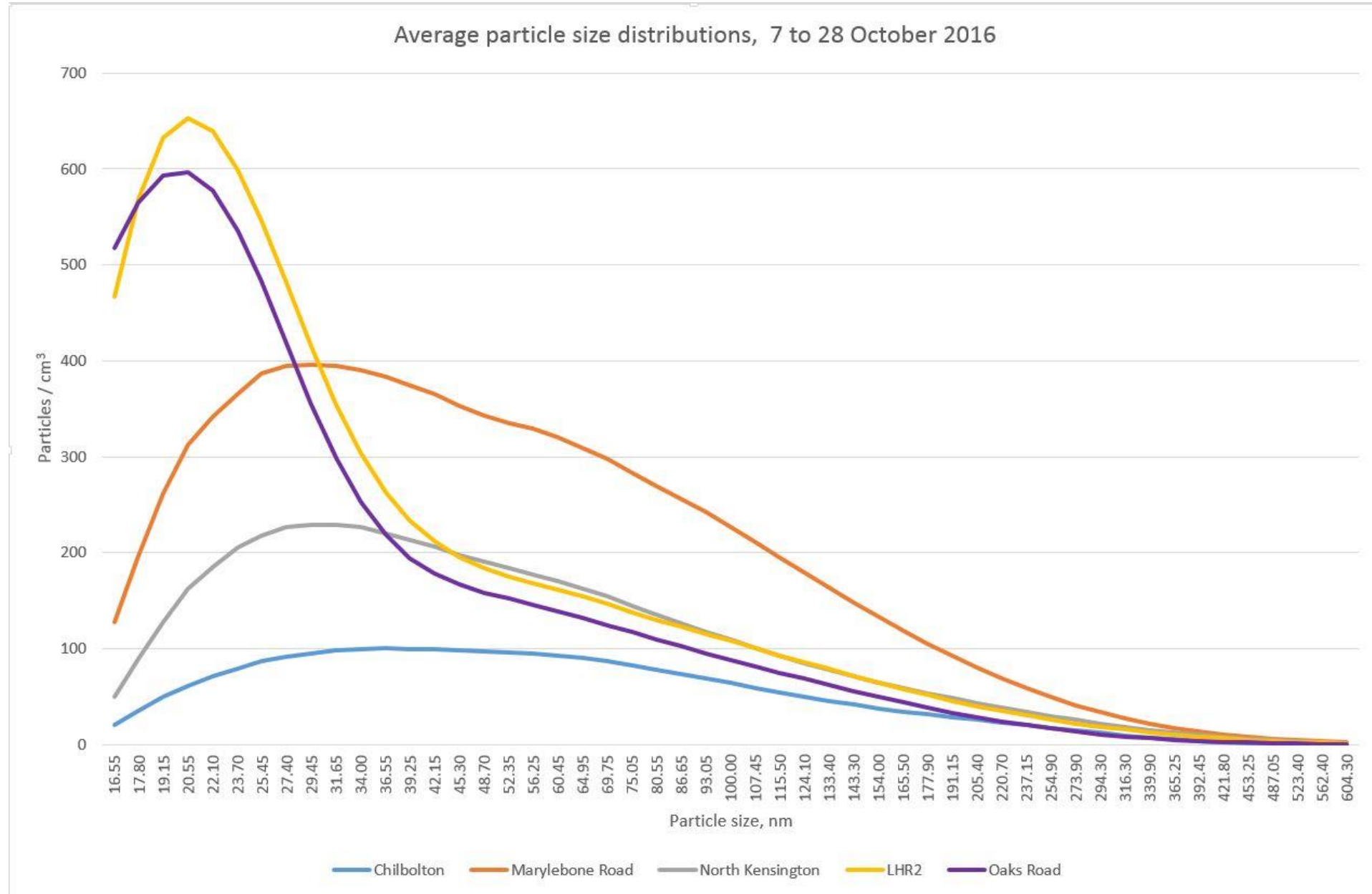


Pollutant	Marylebone Road	North Kensington	Chilbolton	LHR2	Oaks Road
NO, ppb	80.4	9.1	1.6	43.9	21.8
NO ₂ , ppb	39.2	18.9	8.4	27.5	20.7
PM ₁₀ , ug/m ³	21.6	17.1	13.4	15.9	13.8
PM _{2.5} , ug/m ³	12.8	11.1	7.3	9.5	9.4
BC, ug/m ³	3.787	0.912	0.620	2.901	1.792
UVPM, ug/m ³	0.305	0.198	0.277	0.615	0.537
Total PN, particles/cm ³	10046	5384	2637	9053	7964

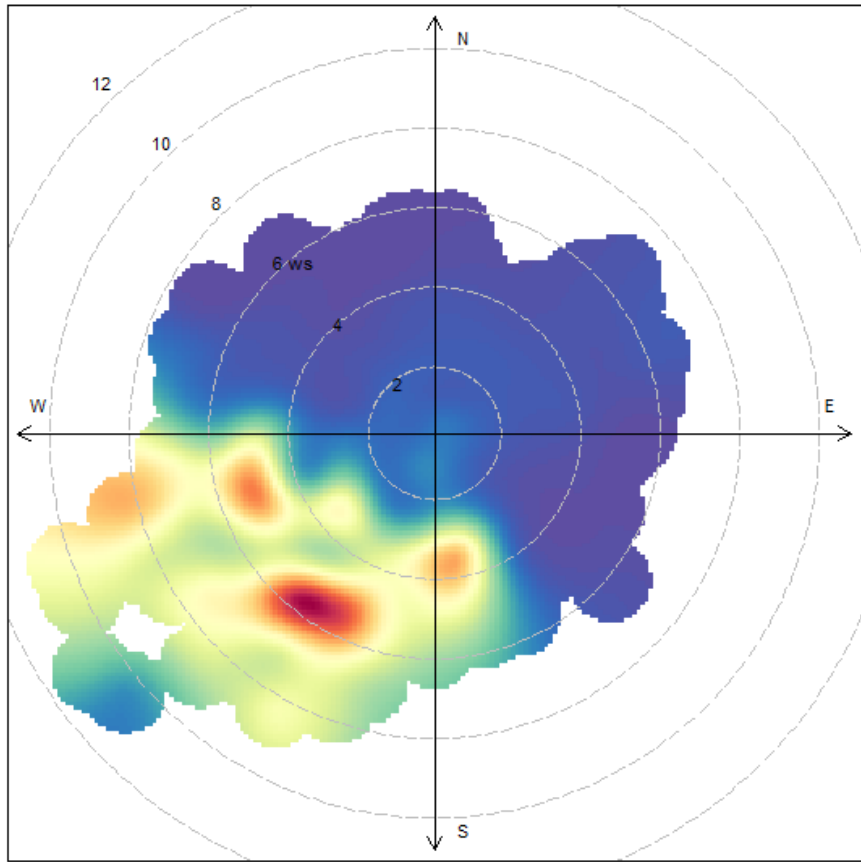
But:

Total particle numbers does not tell the whole story...

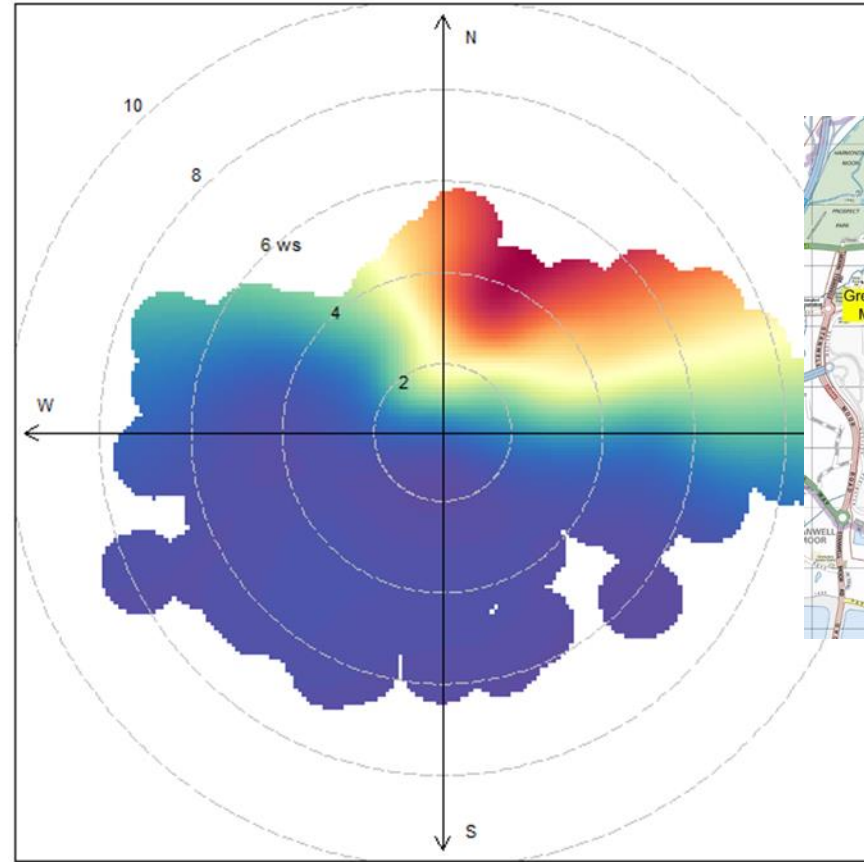
Context - Particle Size Distribution



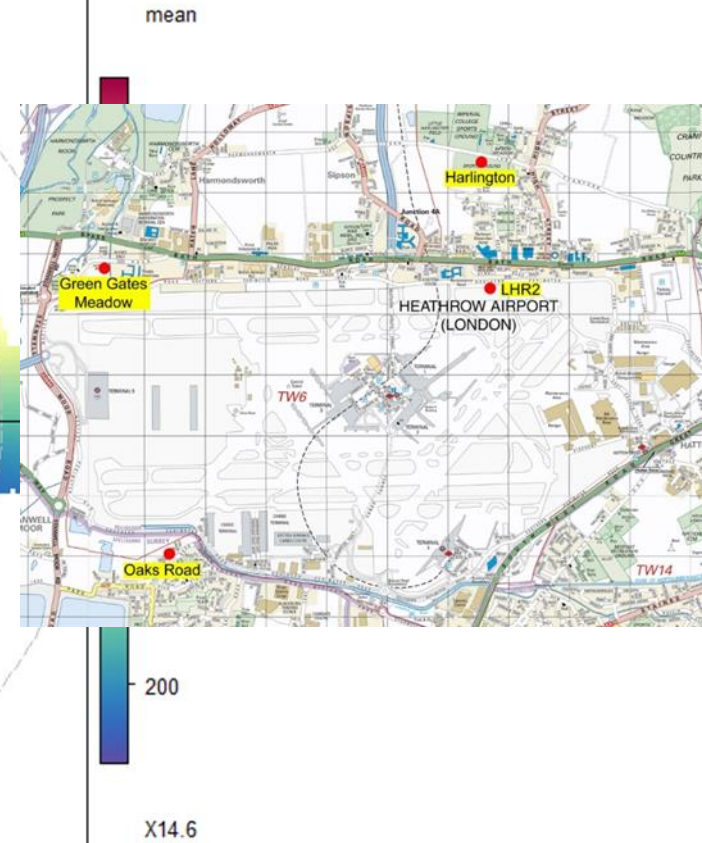
What is the source of these finest particles?



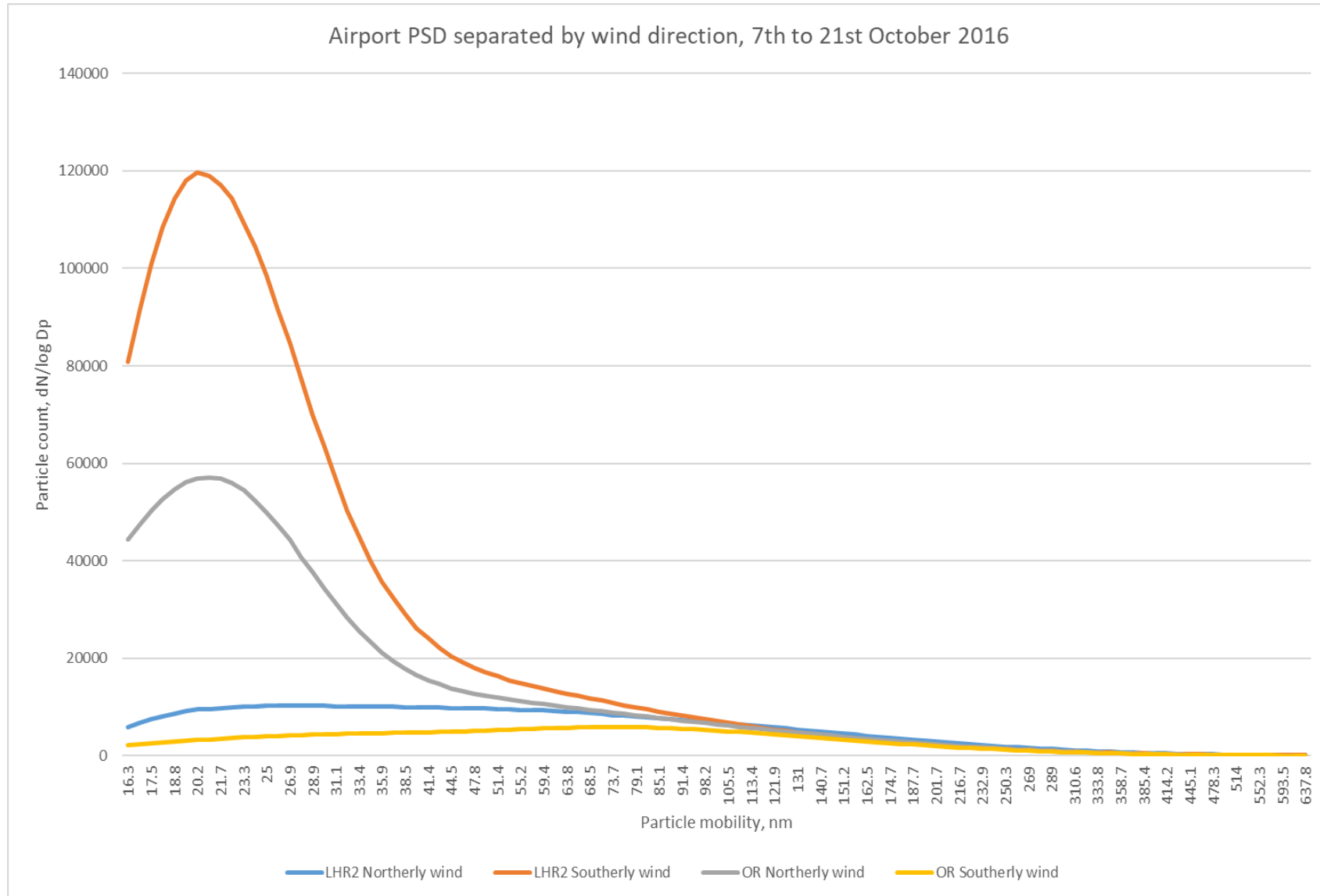
LHR2



Oaks Road

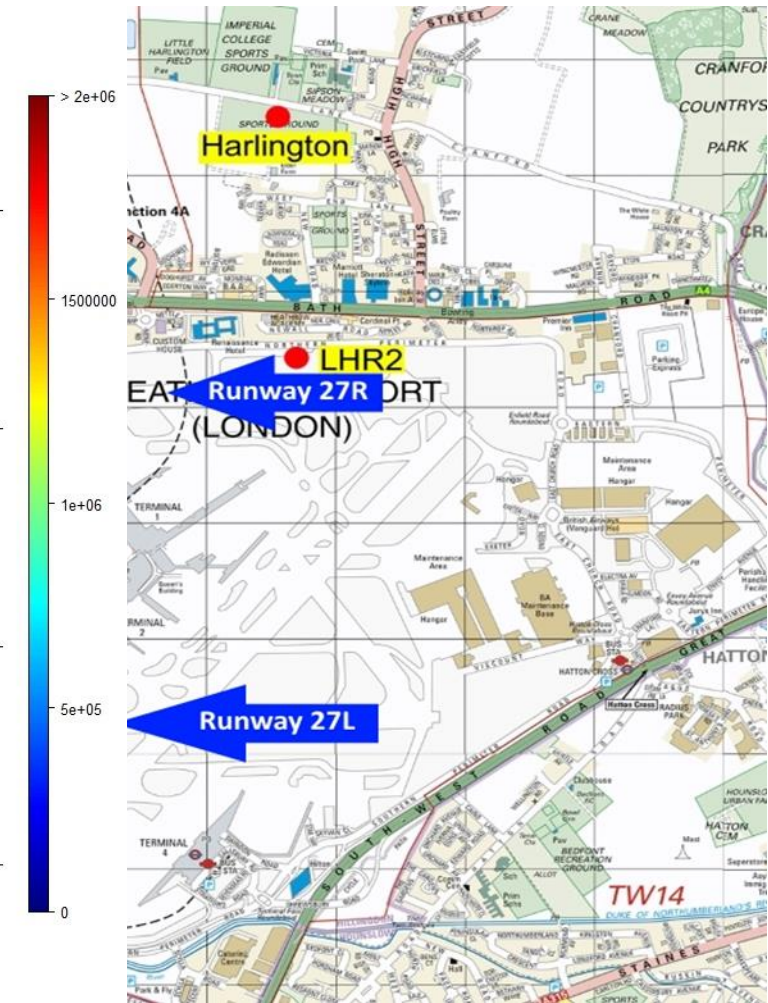
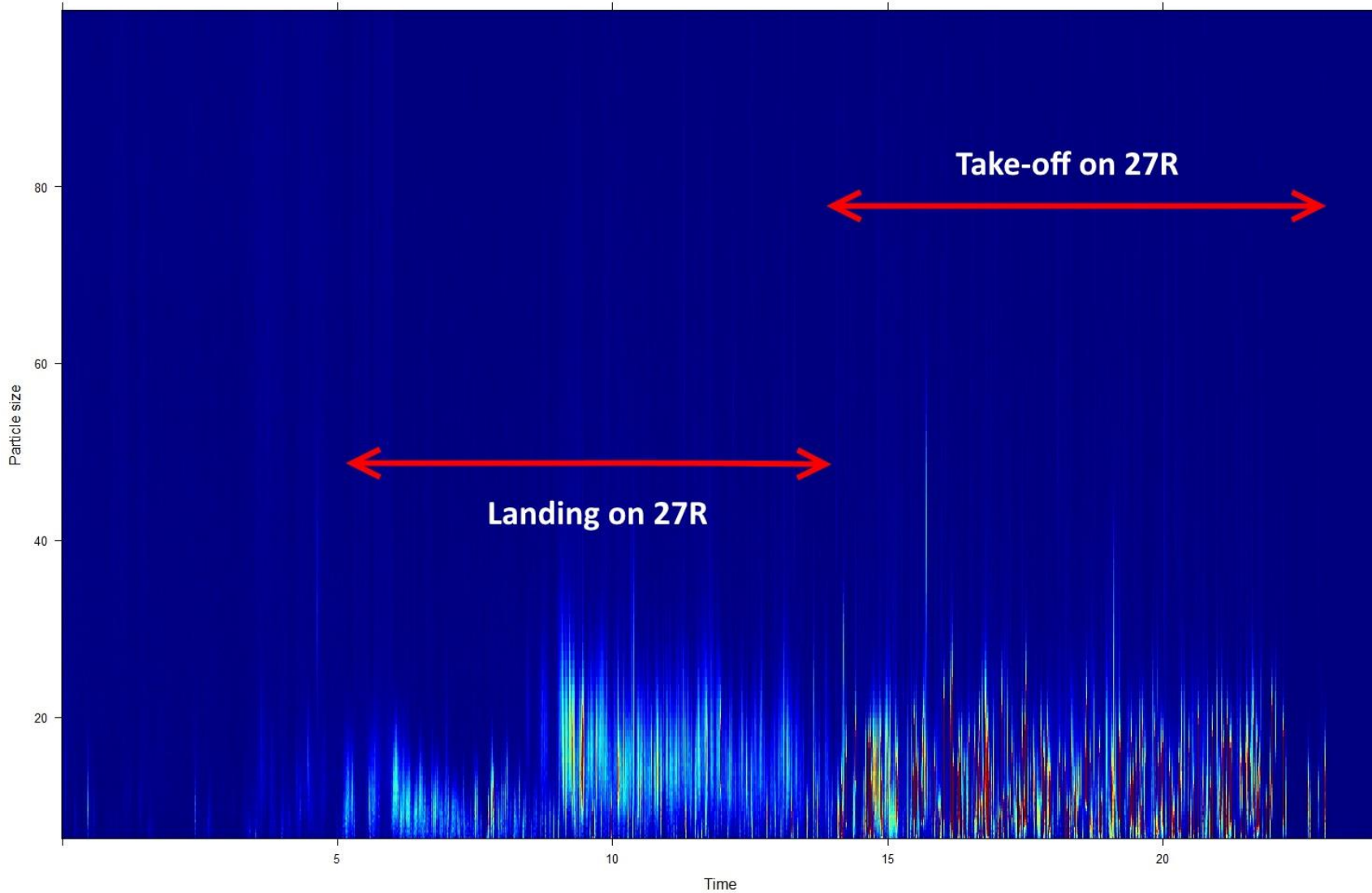


Wind Direction is critical!



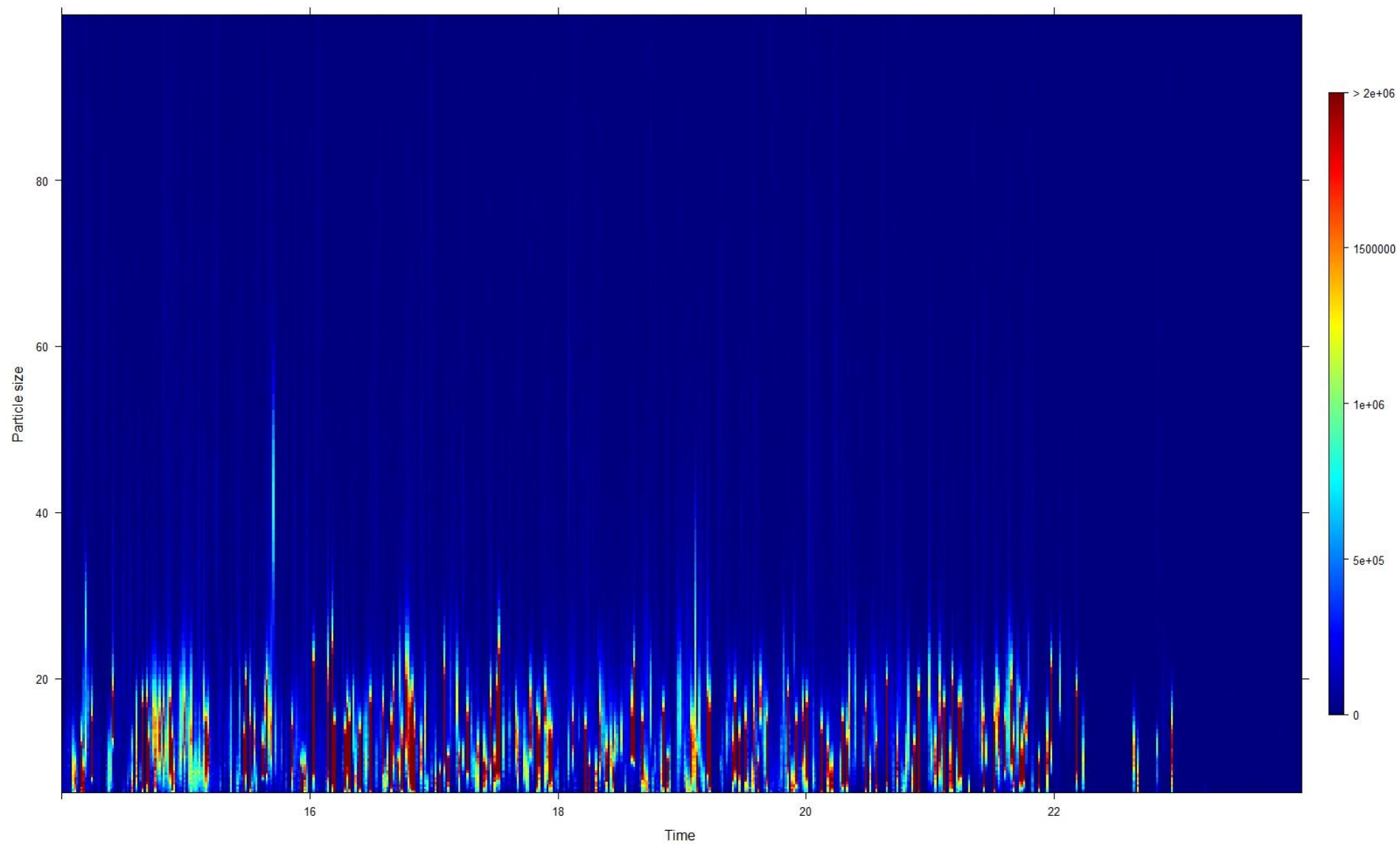
Individual Aircraft – different runway modes (Phase 2, 2017)

LHR² 16 Oct 2017



Can individual aircraft be identified?

LHR² 16 Oct 2017



UFP Monitoring at Heathrow – Measurement Campaigns

- Phase 3 – LHR2 – August to October 2019

Pollutant	Analyser	Averaging
UFP (5-1000nm)	Cambustion DMS500	1 second
PM _{10/2.5/1}	Palas Fidas 200	1 min
(NO _x)	(API T200)	(1 min)
BC	Magee AE33-7	1 min
Ultrafine samples (0-2500nm)	Nano-MOUDI	Weekly samples - 14 size fractions
Met	Lufft WS600	1 min



Nothing to report yet – over 10GB of data to process!

- Total PN concentrations at Heathrow fits profile of other pollutants measured (Road > Airport > Background)
- But UFP near Heathrow very different in size distribution to rest of London
- Finest particles originate from aircraft emissions.
- Highest concentrations are associated with departing aircraft
- 1 minute data not fast enough to identify individual aircraft. 2019 campaign will address this.
- No legislation, research will feed into health guidance



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Thanks for listening

Thanks to:

Professor Roy Harrison, Professor Francis Pope, University of Birmingham
Andrew Chen, Heathrow Airport Limited
Ricardo, Shoreham (for the DMS500 loan)

Any questions?

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