Policies for London Nitrogen dioxide (NO_2) compliance

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Imperial College London
MRC Medical Research Council
Health Protection Agency
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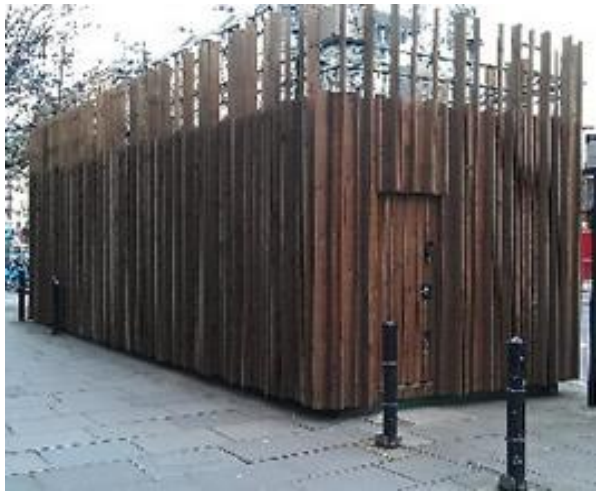
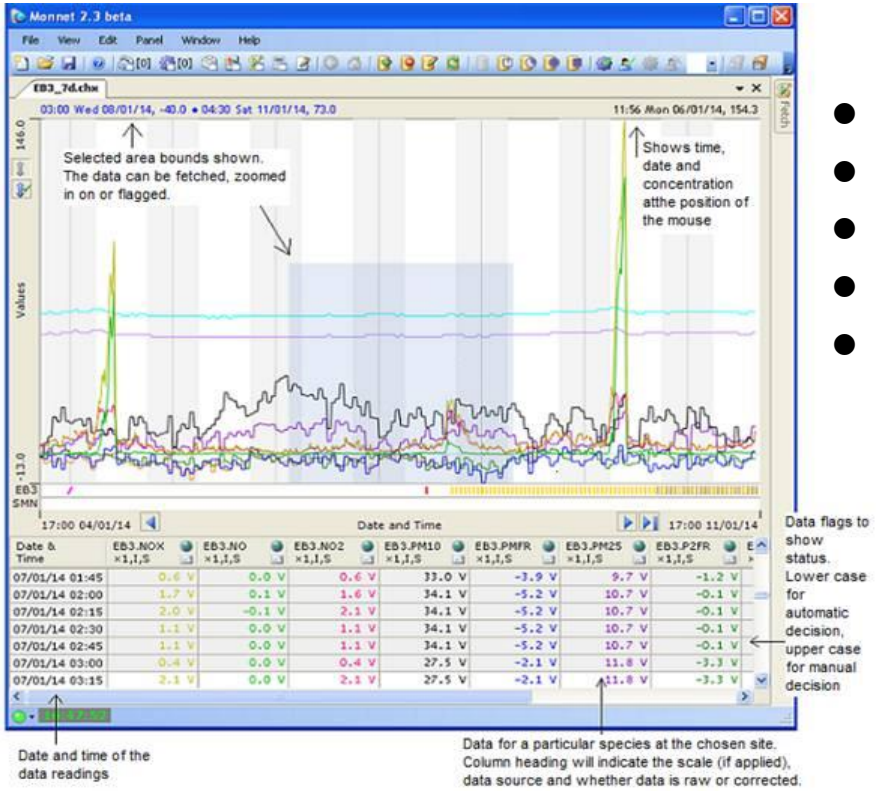
London Air Quality Network

http://www.londonair.org.uk/LondonAir/Default.aspx

- Compliance networks (>100 sites) - worlds biggest
- NO_X, NO_2, PMnumb, $PM_{2.5}$, PM_{10}, SO_2, O_3, CO, VOC's



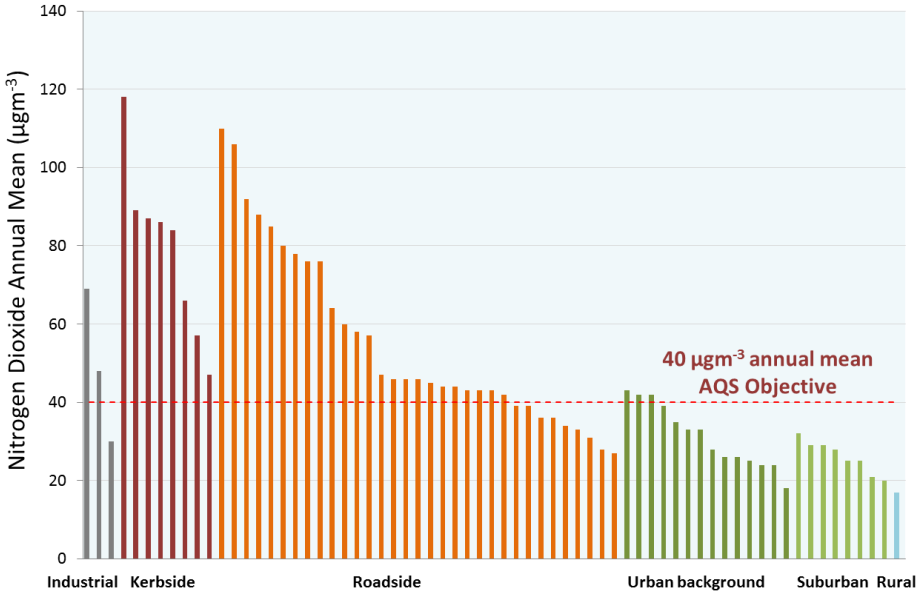
Marylebone Road super-site

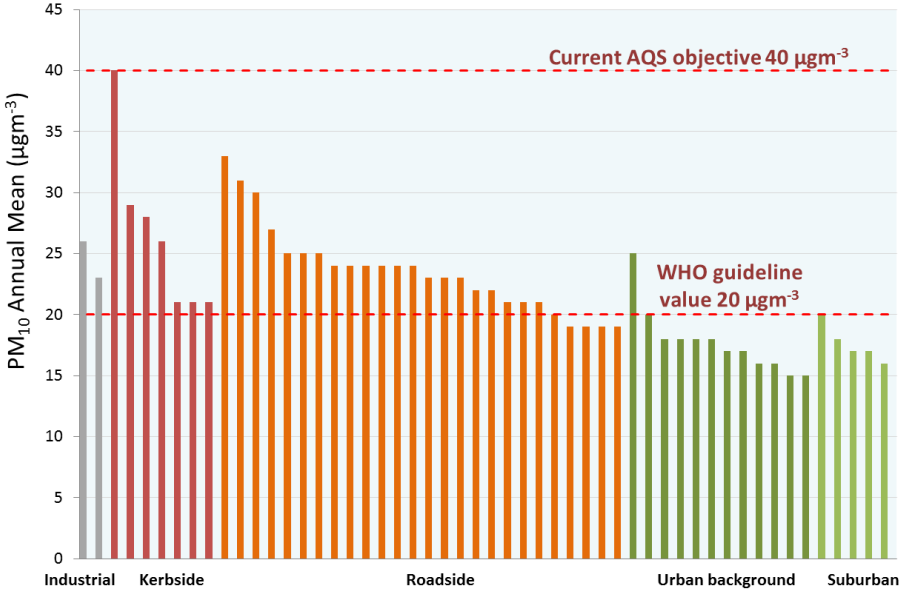


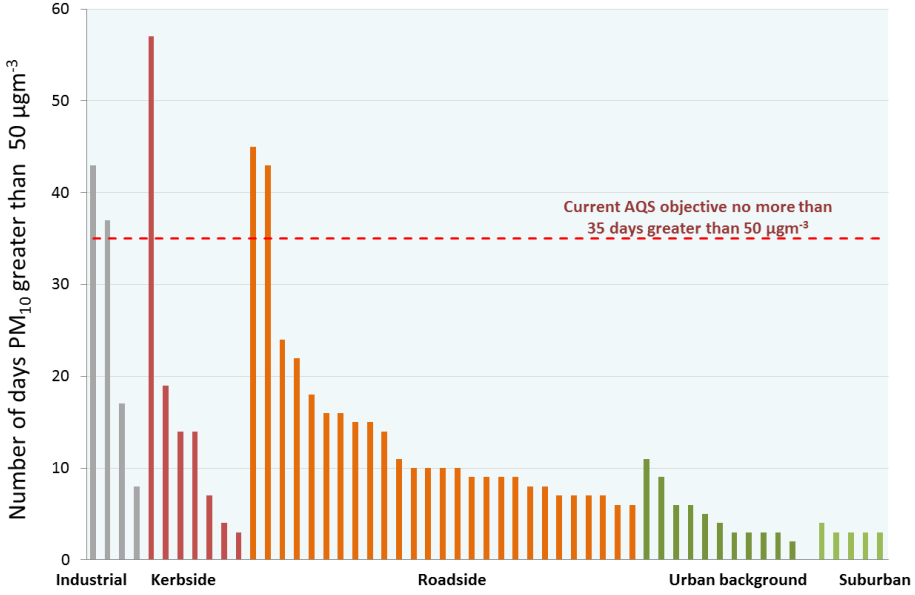
- reports
- nowcast
- forecasts
- data downloads
- site information

MONNET - Network management system

What is the AQ problem in 2016?







London's Air Quality Problems

- Policies and technology: **failed** to bring NO_2 below the legal limits
- **Reduced lung function** growth, increased symptoms of bronchitis in asthmatic children, **low birth weight** and **reduced life expectancy** associated with long-term exposure to NO_2
- Tackle air pollution: **legal obligation** and **protect public health**
- Over **9,000 Londoners died prematurely** from long-term exposure to air pollution in 2010
- Dieselisation of the UK fleet over the last 15 years has been prioritised by successive British Governments, with **road transport** responsible for **half of London's total NO_x emissions**
- ' **Dieselisation**' not been good for air quality!
- **Diesel cars and vans** predicted to make up **70%** of London's total road transport **NO_x emissions** by 2025
- Need for more ambitious **Air Quality Strategy**

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NO_x trends from 2000 to present

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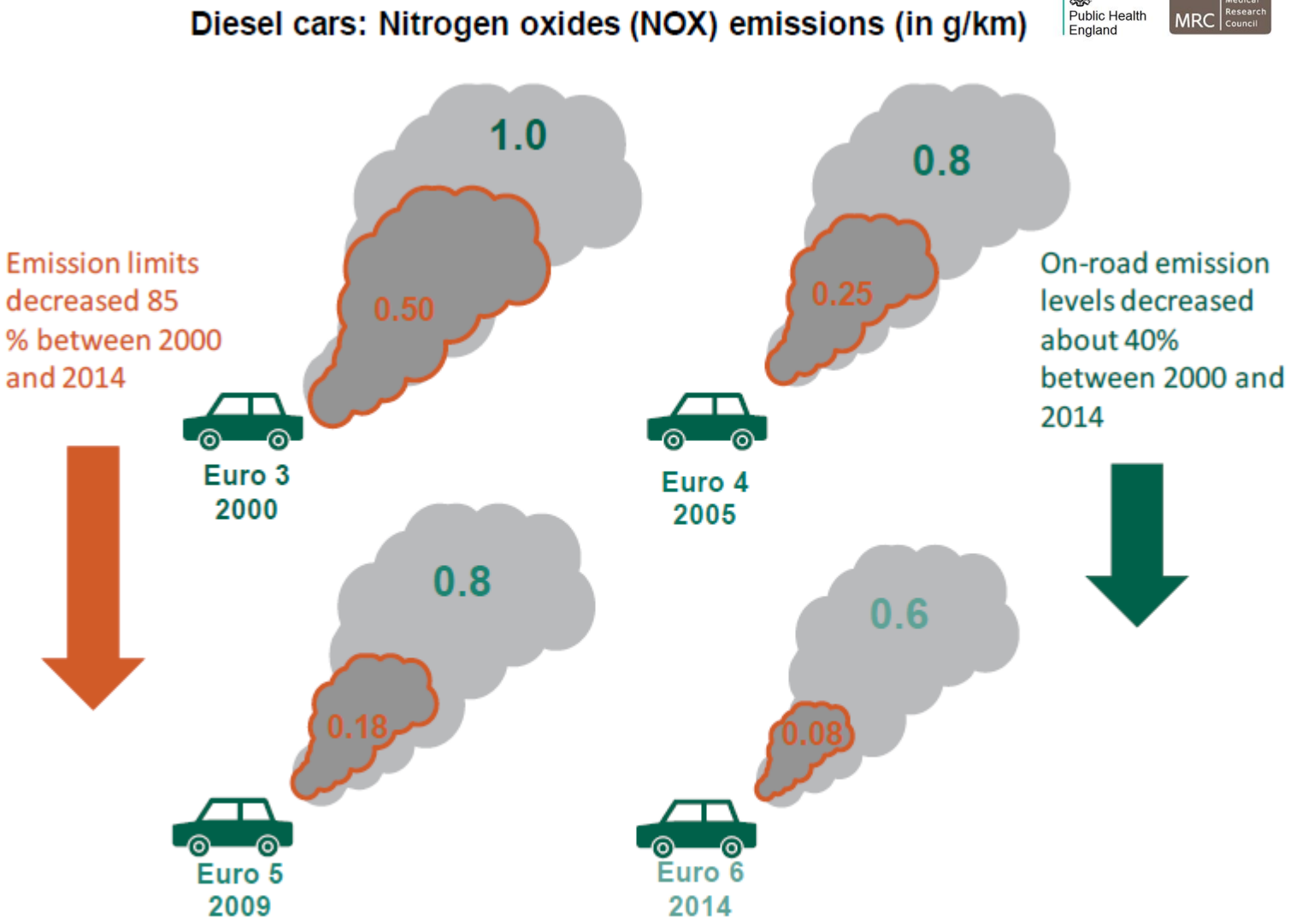
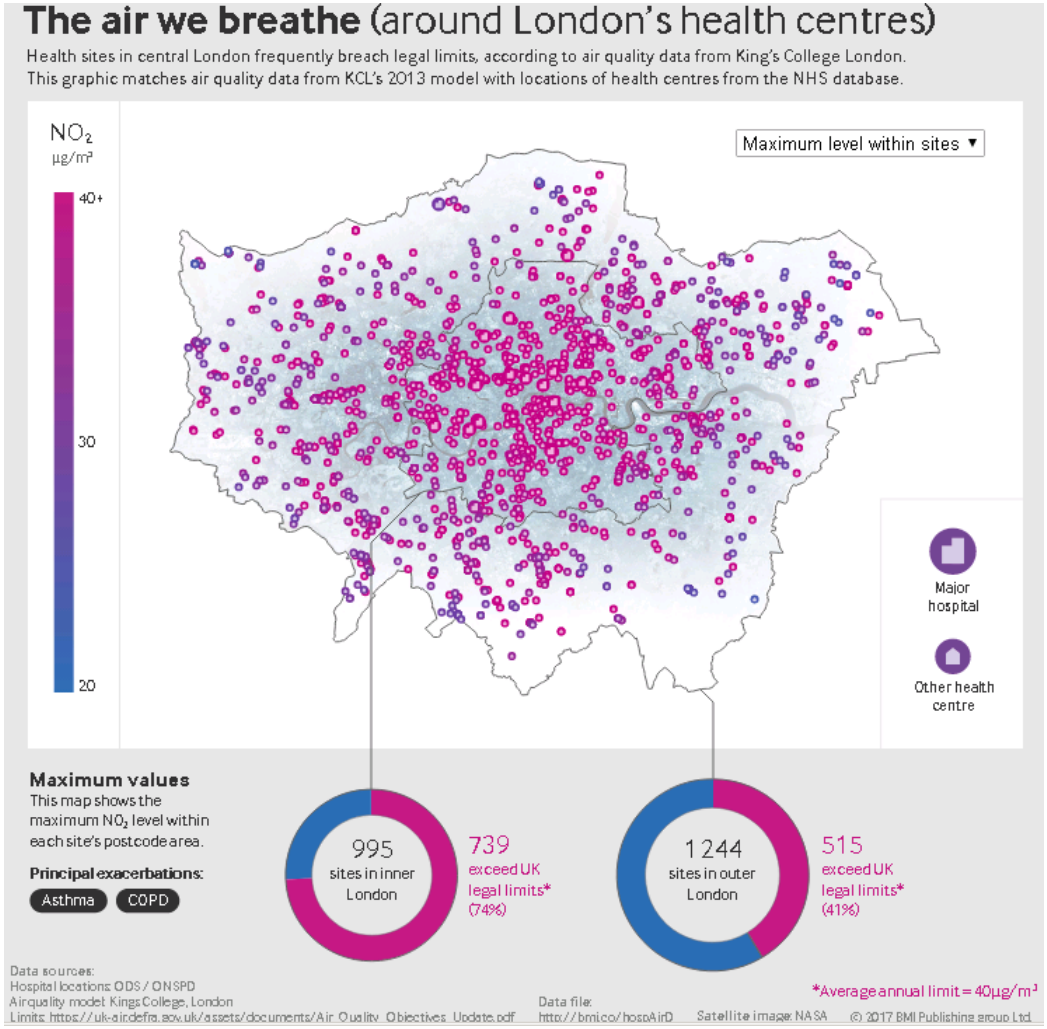


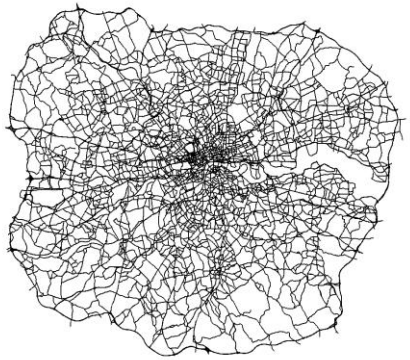
Figure 2-2 Difference between emissions limits and on-road measured values (sources: Carslaw 2011, ICCT, 2014)

Most London hospitals exceed air pollution limits



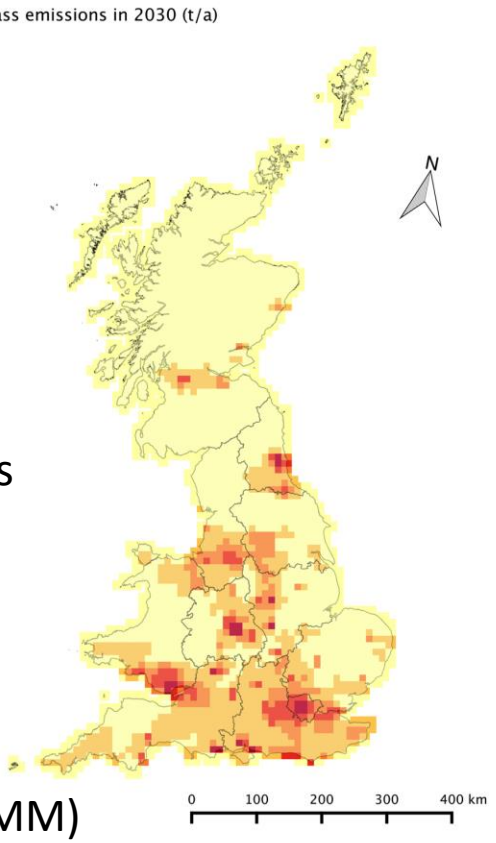
London's poor NO_2 air quality is disproportionately affecting the most vulnerable people around schools, nurseries and hospitals

Atmospheric emissions inventories

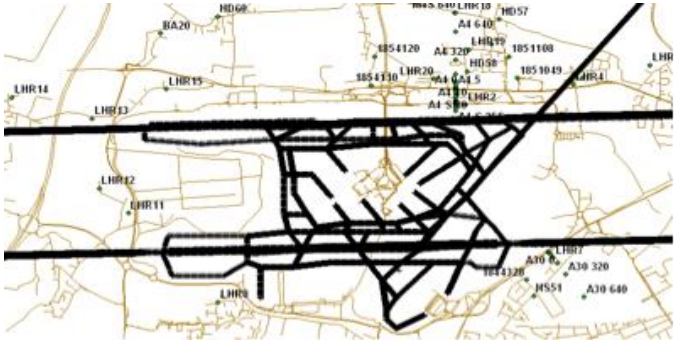


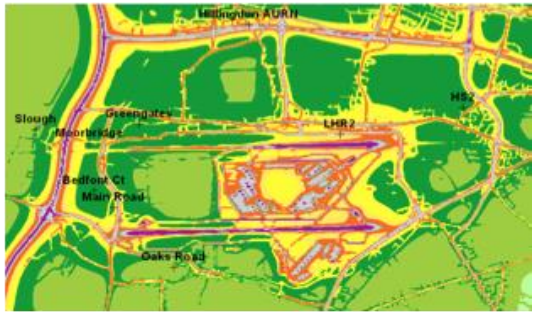
Road transport

- Traffic counts/models
- Traffic speed (GPS)
- Traffic stock (ANPR)
- UK and European Methods



- Biomass emissions
- Cooking
- Railway
- Gas, oil, coal
- Industry
- Shipping
- Construction (NRMM)





Airports

- Aircraft emissions
- Airside vehicle emissions
- Landside vehicles emissions
- Stationary emissions

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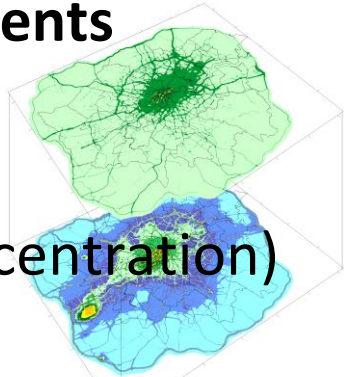
What is King's recipe for mapping London's Air pollution?

- Emission sources in London (we use LAEI)

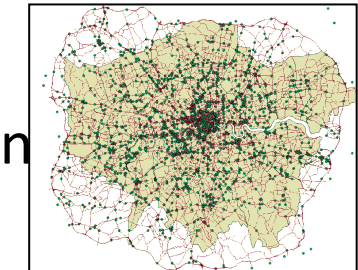


- Dispersion Model using **hourly meteorological measurements**



The model sums together three source categories:

- **First**, sources outside the model domain (background concentration)
  For NO_X, we use rural measurements
  For PM, we use rural and regional sources (secondary PM and natural)
- **Second**, within the model domain, but greater than 500m from a receptor location (London background)
  All London sources represented as volumes sources
- **Third**, for those sources within 500m of a receptor location
  Detailed treatment of local road/gas/rail/aircraft sources



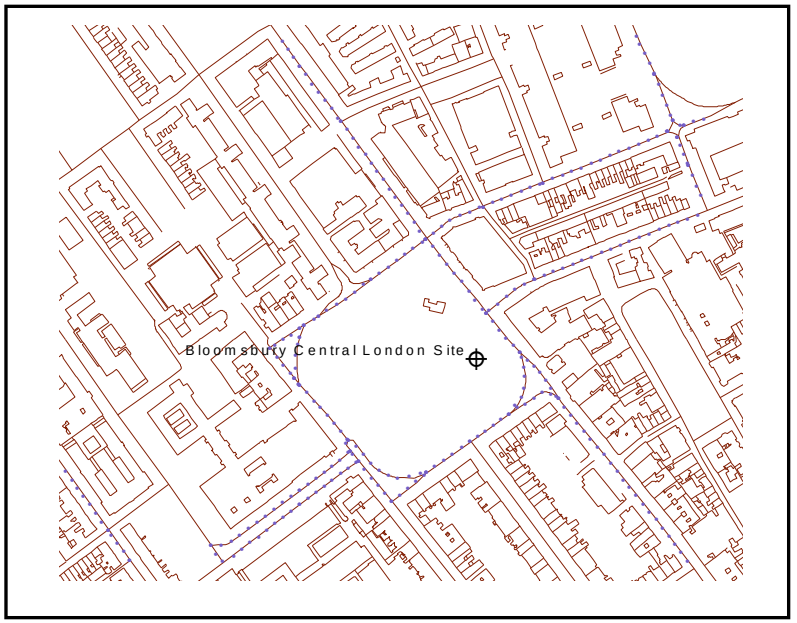
Representing road sources

- King's London Emission Toolkit (LET) provides detailed and flexible traffic emissions required to run LAQT
- Road emissions are modelled as a series of road links 10 m long
- Based on geographically accurate Ordnance Survey road map data

Six road categories (and associated kernels):

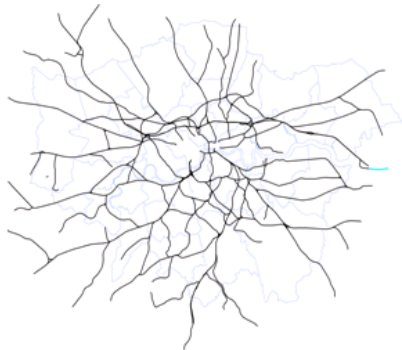
- Open roads (motorway)
- Typical roads
- Street canyon (by orientation)

- LAQT covers over 2 million 10m road sources



Representing railway sources

- Treated in the same way as for roads but using rail network



Model Evaluation NO_X and NO_2

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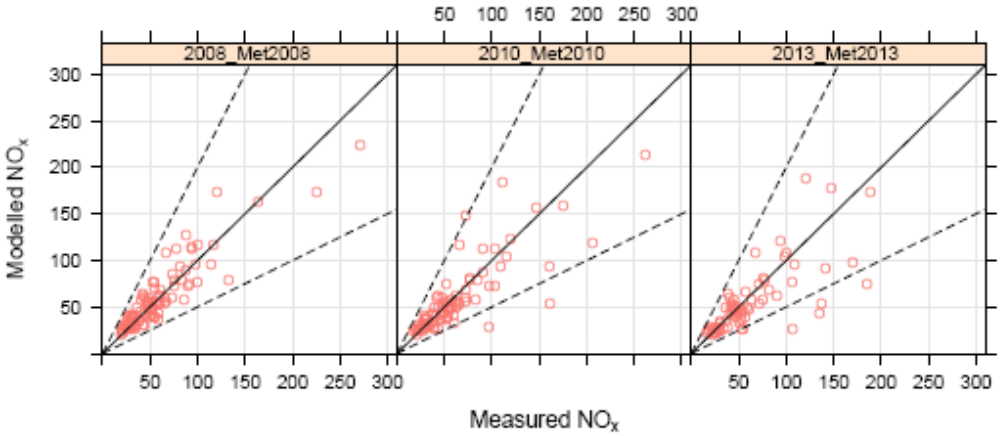
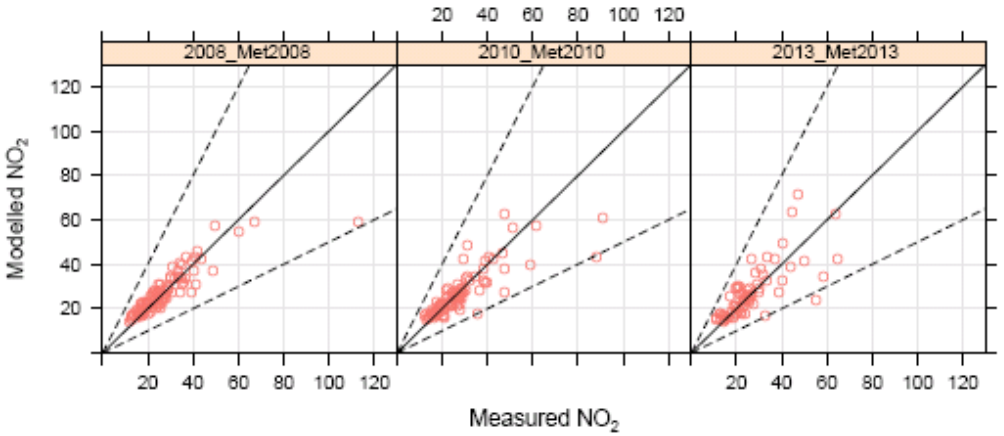
LAQM – NO_X, Annual Average, all sites



Type	n	FAC2	MB	MGE	NMB	NMGE	RMSE	r	IOA
2008_Met2008	100	1.00	0.6	11	0.010	0.19	16	0.91	0.79
2010_Met2010	89	0.97	−4.6	14	−0.075	0.23	25	0.82	0.75
2013_Met2013	71	0.92	−7.6	17	−0.124	0.27	29	0.74	0.73

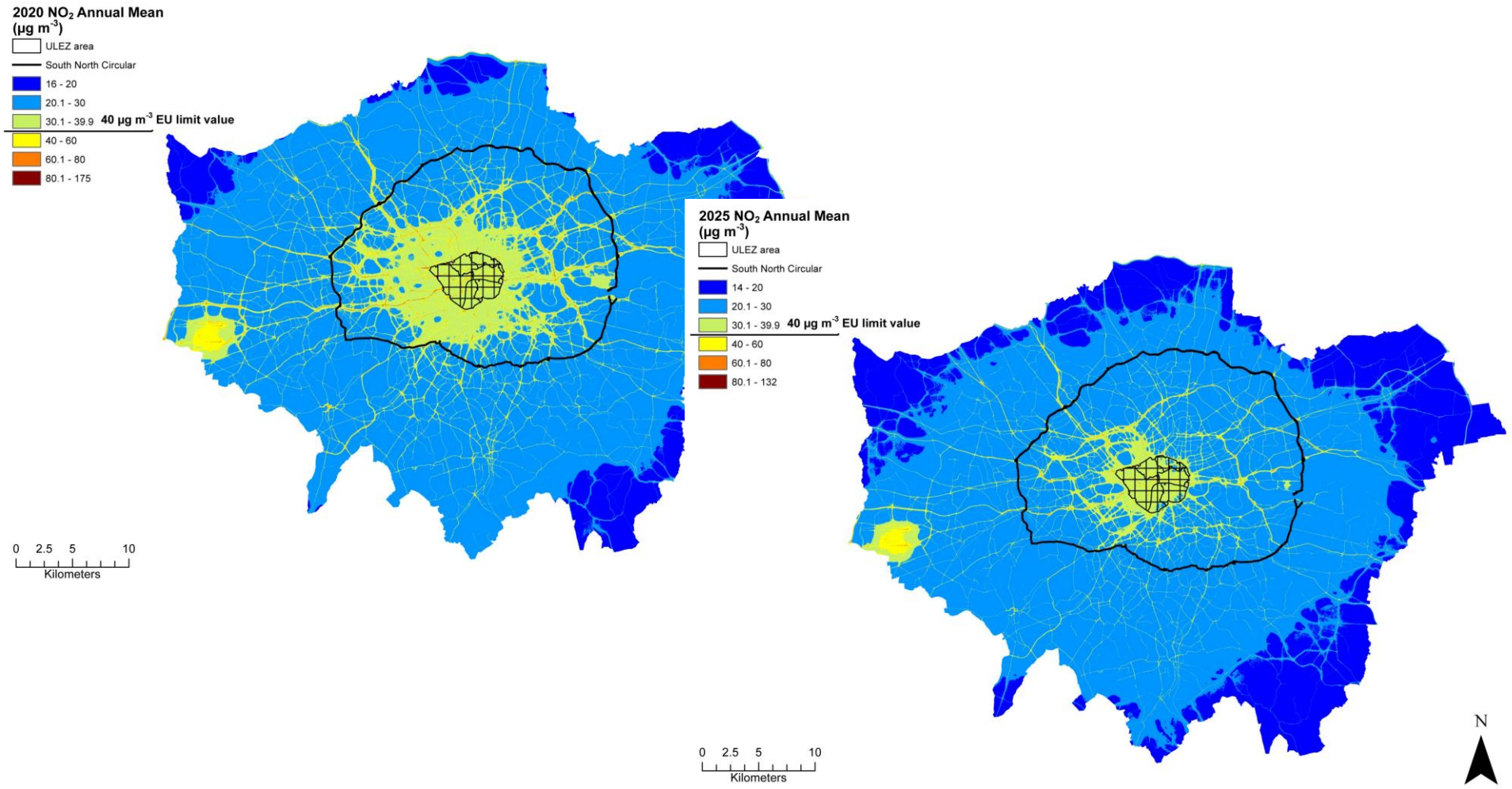
LAQM – NO_2, Annual Average, all sites



Type	n	FAC2	MB	MGE	NMB	NMGE	RMSE	r	IOA
2008_Met2008	100	1.00	0.12	3.6	0.0043	0.14	6.7	0.88	0.79
2010_Met2010	89	0.98	−1.32	4.5	−0.0471	0.16	8.1	0.82	0.76
2013_Met2013	71	0.99	0.39	5.3	0.0147	0.20	8.3	0.76	0.70

2020/2025 Baseline

- Based upon the **previous London administration's** 2020 ULEZ
- All vehicles driving in central London from 2020 meet emission standards Euro 4 (petrol) and Euro 6 (diesel) including additional requirements for TfL buses (mix of hybrid and zero emission), new taxis ZEC from 2018



2025 Scenario

- In partnership with PX, IPPR and GP
- **Targeted policies for London, the UK and the EU**
- Focused on reducing NOx emissions but mindful of PM and CO_2

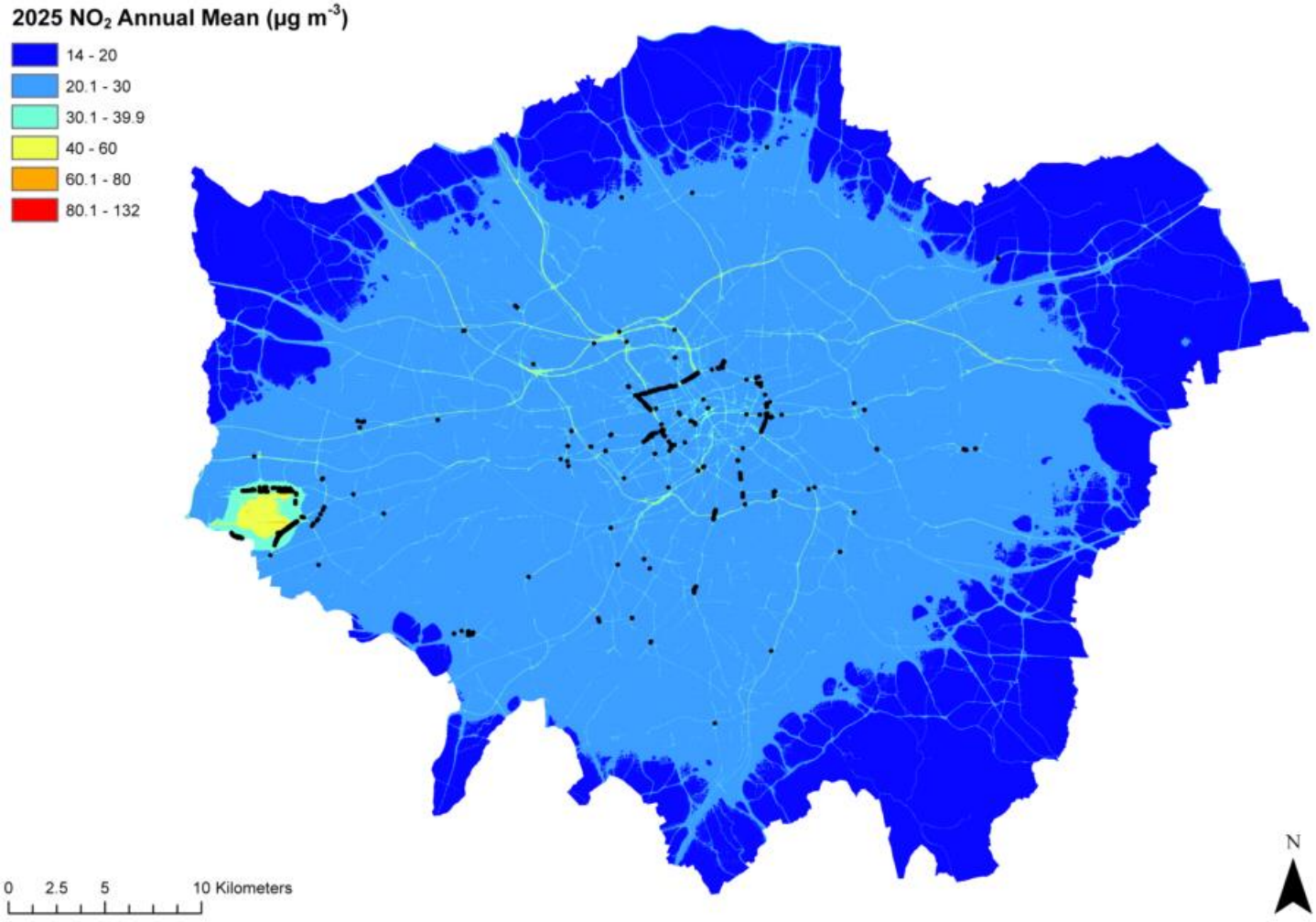
Builds on the 2025 baseline and the following set of assumptions:

- **Better Conformity Factor** (CF) for diesel cars: CF of 1.5 (0.12 gkm^{-1}) for new Euro6 bought between 2018 and 2020 and CF of 1 (0.08 gkm^{-1})
- **Diesel cars phasing out**: from 57% (baseline) to 5% diesel cars in Inner area by 2025 (97% of diesel cars assumed a CF of 1) and from 53% (baseline) to 29% in the rest of London
- **ZEC taxis**: 100% ZEC taxis everywhere in London by 2025
- **Better buses**: Zero emissions LT buses in the central area and a mixture of Euro6/Euro6 hybrid/Zero emissions in the rest of London
- **Others** (Petrol cars: 15% hybrid and 1.25% LPG across all of London; Electric cars: 6% inside Inner area and 2.8% in the rest of London; Diesel vans: from 98% (baseline) to 75% in all London; Petrol/Electric vans: remaining 25% split between 12.5% petrol and 12.5% electric in all London; Domestic and commercial gas: reduction of domestic gas by 20% from 4,025 to 3,236 tonnes and commecial gas by 7% from 3,374 to 3,129 tonnes in 2025

2025 Scenario Result

Impressive NO_X (45%) and primary NO_2 (56%) emissions reductions (CO_2 7% PM 2%)

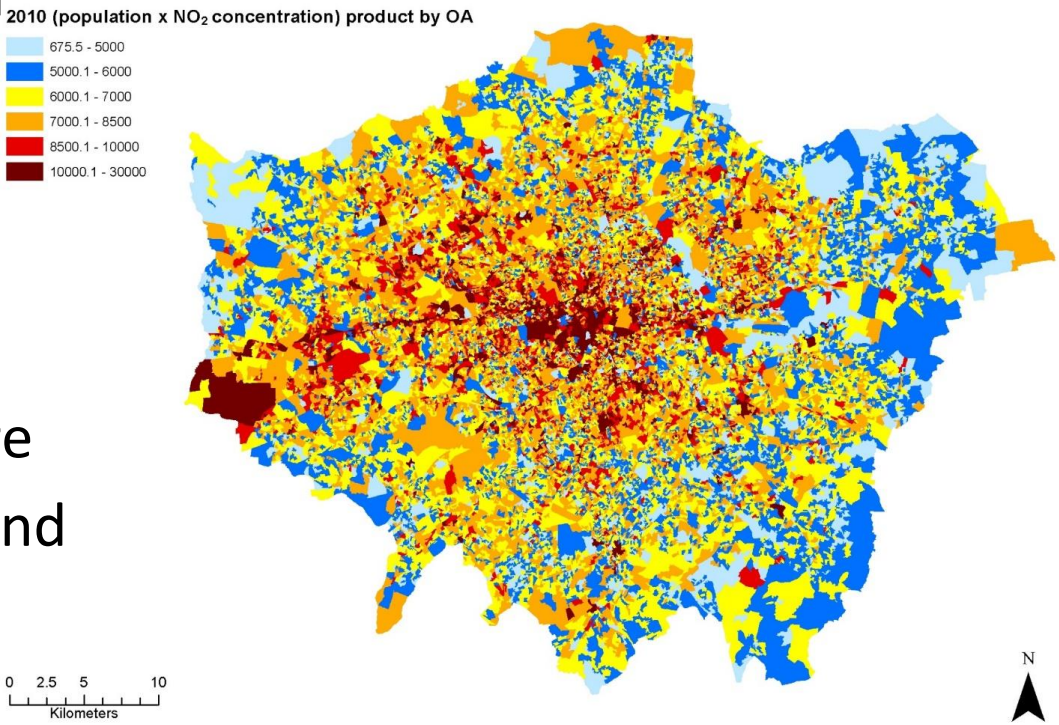
Areas with NO_2 concentrations lower than 20 μgm^{-3} increased from 16% in the 2025 baseline to 36% in the scenario. Important: still health impacts below the limit value



HIA method for long term exposure to NO_2

Full Impact methodology

- Uses **life tables** of pop. and death in 2010 by single year age group
- Uses EPA **lag** 30% effect first year, 12.5% years 2-5, 20% years 5-20
- 20m x 20m modelling averaged up to pop weight at UK Census OA
- Compare baseline and scenario in 2025
- Follow life tables through for a lifetime 105 years to 2129, with **new birth cohorts**
- Impact of future reduction scenarios on Life Years and life-expectancy
- Economic assessment: LYL were valued, increased, discounted and annualised



Policy Conclusion

- Our scenario delivered **significant progress** towards achieving NO_2 limit

Most importantly,

- It resulted in considerable NO_2 concentration reductions, down to **healthier levels** in all parts of London.
- In the Greater London area, 81% of the scenario's total NO_X emissions reduction stems from **diesel cars**
- In the central area only, the main NO_X emissions reduction relate to **diesel cars** (46%), **taxis** (26%) and **buses** (26%).
- Life-expectancy: gain of up to **1.6 months** for those born in 2025
- Life Years: up to **1.4 million LY gained** across London
- Economic impact: annualised monetary benefit up to **£800 million**

We found the most **effective strategies** to be

- the **switch away from diesel** toward cleaner cars, taxis and buses
- **tighter emissions standards**

We advocate a combination of policy changes at **local level** (a ban of diesel vehicles in city centre), **UK** (the upward trajectory of diesel vehicle's market share must be reversed) and **EU level** (tighten emissions standard)

FUTURE: dynamic exposure model Versus old ‘static’ exposure methods

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London journey's

The Open Route Service API (www.openrouteservice.org) was used to simulate walking trips (shortest-path), Project OSRM API (www.project-osrm.org) to simulate car trips (quickest-path), Google Directions (https://developers.google.com/maps/documentation/directions/) to simulate cycling (quickest-path), and the TfL Journey Planner (journeyplanner.tfl.gov.uk) to simulate public transport trips (overground train, the London underground, the Docklands Light Railway and bus).

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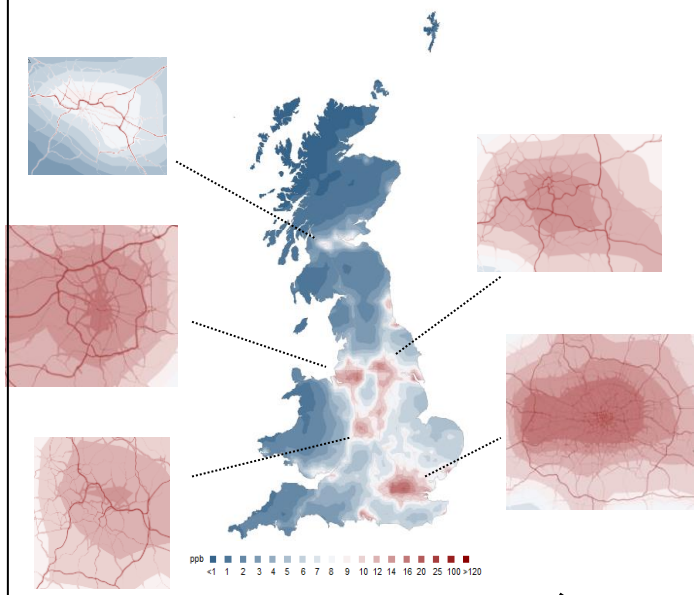
Human exposure modelling for public health policy

http://www.londonair.org.uk/research/Modelling-Air/custom/index.html

Outdoor air quality

CMAQ-urban air quality model (outdoor concentrations)



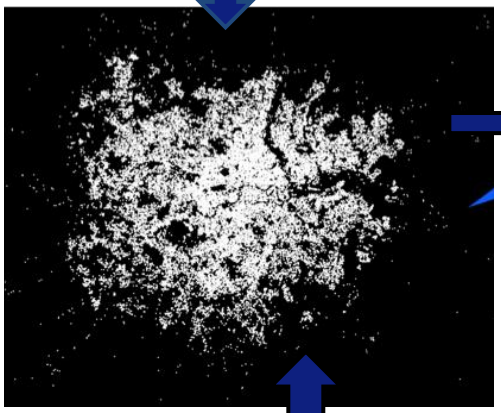
In-vehicle air quality

Micro-environmental modelling: in-vehicle (bus, car, train, tube), cycle, walk, indoors (I/O exchange - J Taylor (UCL))

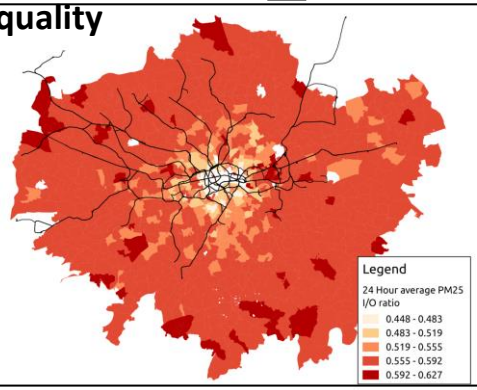
$$\frac{dC_{in}}{dt} = \lambda_{win}(C_{out} - C_{in}) - n\lambda_{HVAC}C_{in} - V_g\left(\frac{A}{V}\right)C_{in} + \frac{Q}{V}$$

London Travel Demand Survey: Trips by transport mode: Age, gender and socio-economic status

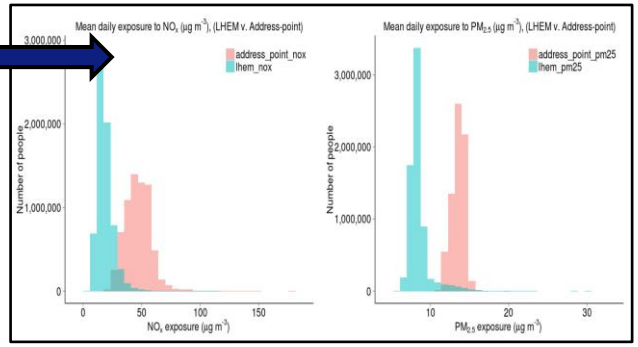
Travelling



Indoor air quality



Personal exposure



The average LHEM exposure is estimated to be 37% lower for $PM_{2.5}$ and 61% lower for NO_x ($NO+NO_2$), than at the residential address

Smith et al., 2016. The London Hybrid Exposure Model (LHEM): Improving human exposure estimates to NO_2 and $PM_{2.5}$ in an urban setting. ES&T

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Conclusions

- People want to **live in healthy areas**
- Companies want to invest in areas where people want to live
- The technology is here but **past policies** (shift towards diesel and periods of inaction) have **failed Londoners**
- Our publications have generated **high media attention**, a better understanding of the health impacts of air pollution
- Air quality issues have now risen **up the political agenda**
- The **new London administration** is drafting a new and **ambitious strategy** (T-charge in 2017, ULEZ in 2019/2020/2021, meet WHO standards by 2030, all taxis ZEC by 2033, all buses zero emissions by 2037, best AQ of any major city by 2050, zero carbon city by 2050)
- **Policies** at **London level** need to be complemented by immediate action at **UK and EU scale**

Solutions to London's Air Quality Problems

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In light of the evidence that **no exposure is safe**, **pollution** must be reduced to **negligible levels** using a **policy package** which could include

- **Priority**: phasing out the **most polluting vehicles**
- **Shifting all diesel vehicles** in favour of the cleanest available alternative
- Introducing **diesel scrappage schemes** (offering free public transport)
- Increase tax on **new diesel** purchase
- Accelerating **fiscal incentives** and **rollout of EV** (free parking)
- Increasing the number of **smart charging systems (SLIDE IN** potential**)**
- Reducing vehicle km driven, **freight consolidation**, **reduce road space**, providing better public transport, **sustainable alternatives** (walking/cycling)
- Introducing **tougher laws and regulations** on vehicle manufacturers
- Accelerating **development of new technologies** such as regenerative braking
- Promoting **eco-driving**, increasing **vehicle occupancy** (exempt Charging Zone)
- Maximising reduction in air pollution from **climate change** and energy strategy

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Thanks for your attention…

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