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Air pollution and associated health impacts

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UCL

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Air pollution projects

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Air pollution is a PHE priority area

Current and planned HRPU projects include:

- Air pollution episode analyses based on syndromic surveillance and health impact assessments (spring 2014 as case study)
- UK analysis of short term effects of ozone, following recent COMEAP recommendations on coefficients and more extensive modelling
- Implementation of the WRF-Chem atmospheric chemistry model to study urban scale air pollution and the relationship with the urban heat island
- Joint project with HPRU on Health Impacts on Environmental Hazards to investigate effectiveness of interventions

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UK Air Pollution Episode March-April 2014.

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The Telegraph

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Smog shrouds London landmarks after 'perfect storm' increases pollution

Famous London landmarks hide behind the smog as high levels of air pollution causes problems across the east of England

NEWS

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Air pollution: High levels to spread across England

2 April 2014 | UK

theguardian

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Weather

UK air pollution: ambulance services report spike in 999 calls

Government helpline advises people to avoid exertion in areas of high pollution as experts warn smog will stay until weekend

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Observations

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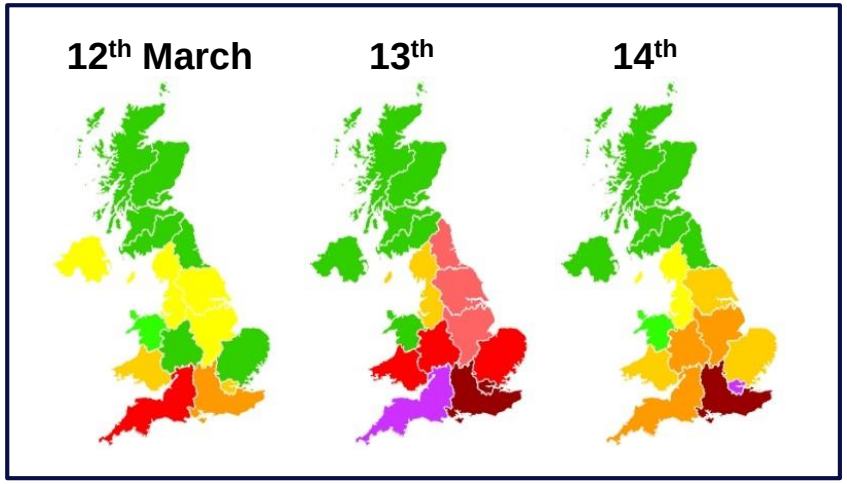
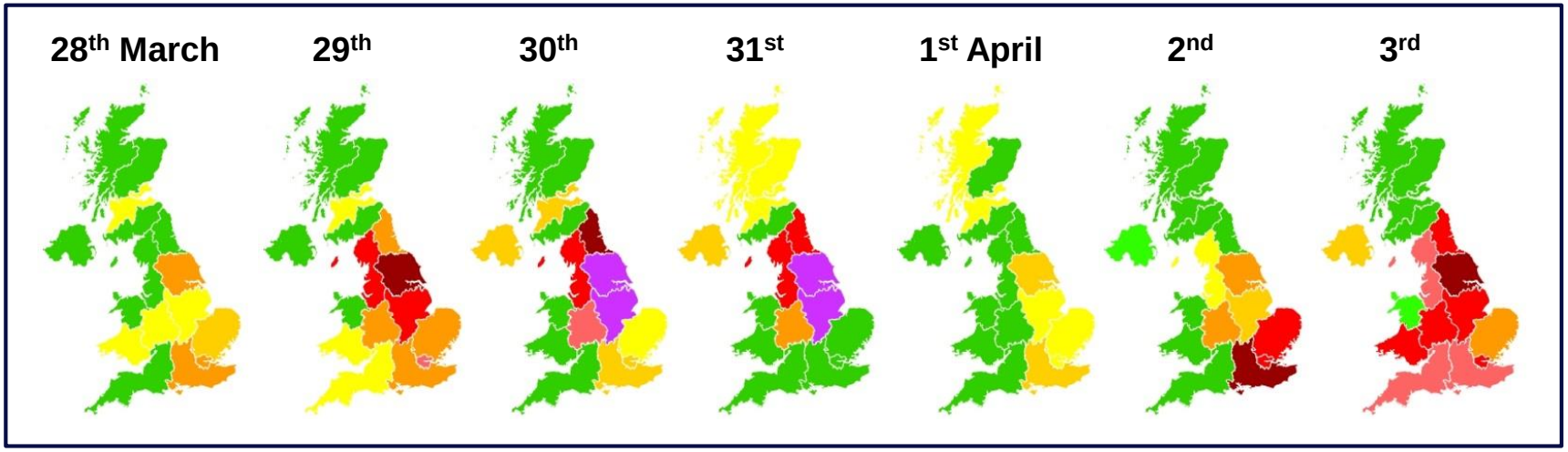
DAQI (Daily Air Quality Index) reached ‘high’ or ‘very high’ for several days across multiple regions in the UK.





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Observations

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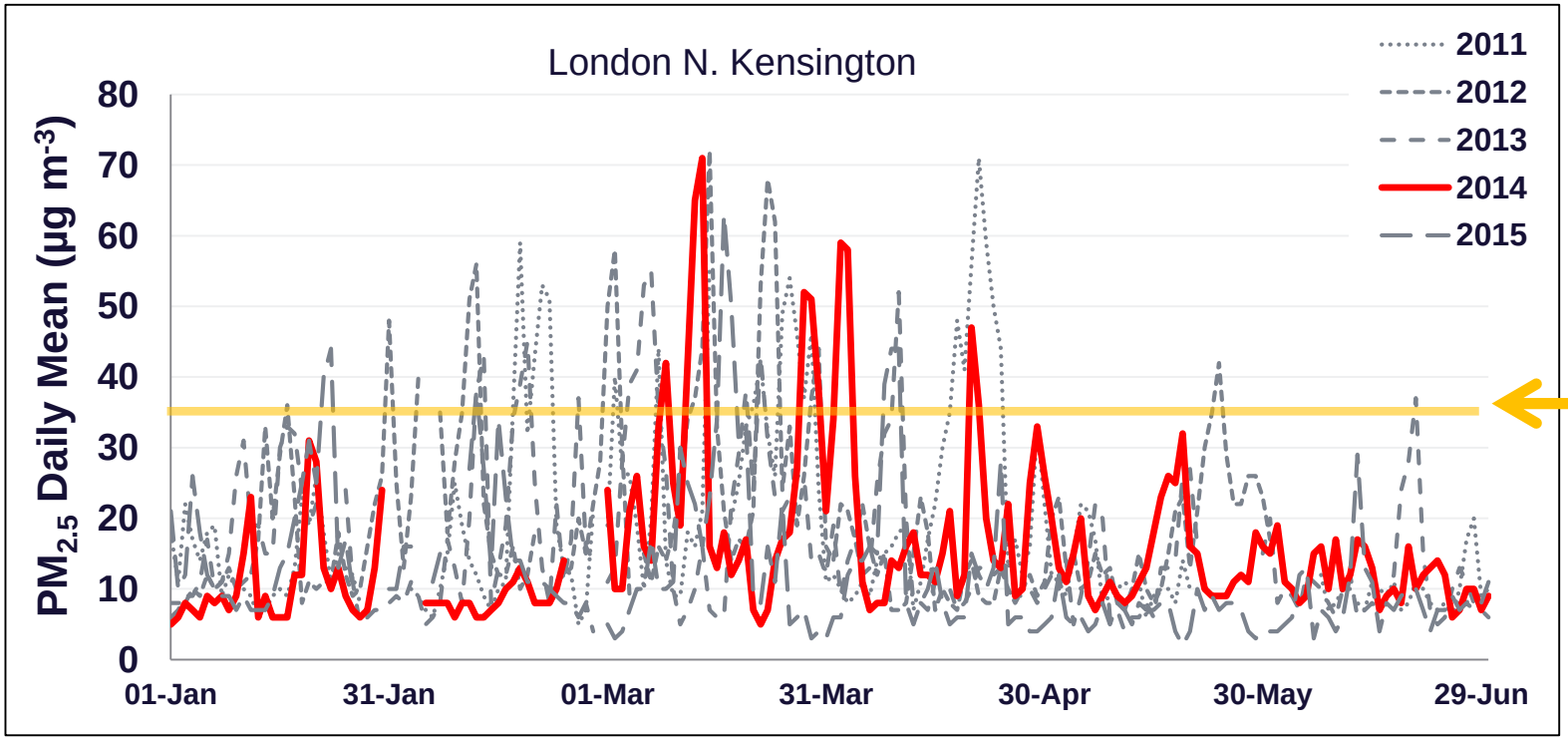
$PM_{2.5}$ levels reached over 80 µg m^{-3} at some urban background sites.

Daily mean $PM_{2.5}$ levels from Jan – Jun show springtime peaks (2011-15) at urban background sites.



Observed daily mean $PM_{2.5}$ at an urban background site during January-June from 2011 to 2015 inclusive. *(Data form AURN via Defra website)*

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Health Impact Assessment

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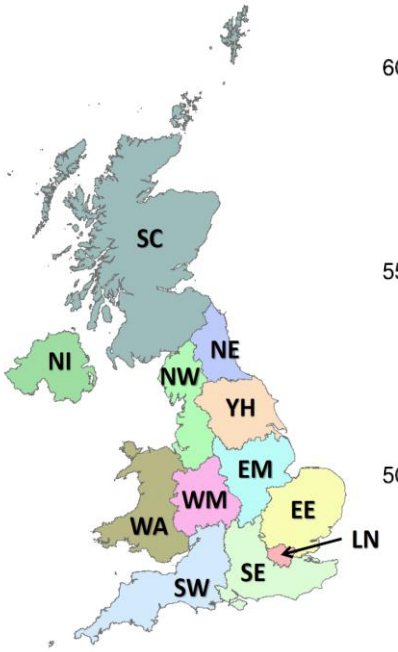
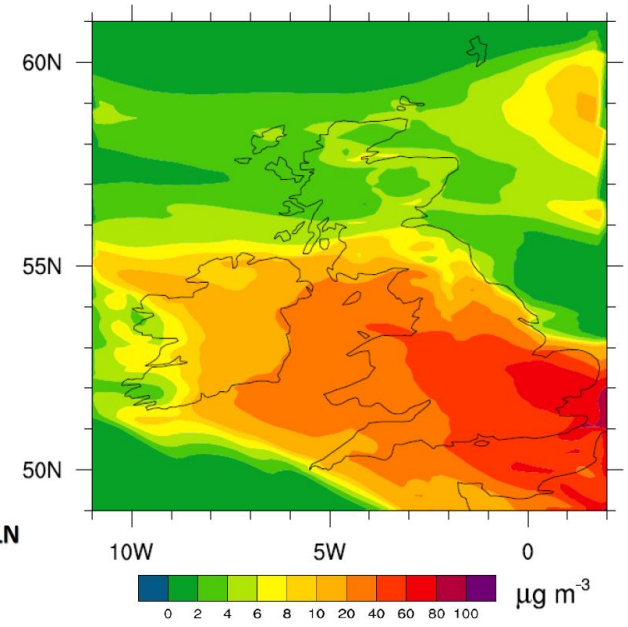
Focus on two episodes: 12th – 14th March, and 28th March – 3rd April 2014

- **$PM_{2.5}$ concentrations** from the AQUM met office model, 12 km (now used for the Defra air quality forecasts) [*Savage et al., 2013*].
- **Population** weighting of daily $PM_{2.5}$ using gridded 100 metre population.
- UK countries and 9 GOR.
- Daily **mortality** and **emergency hospital admissions**.
- Published **exposure-response coefficients** for short-term effects [*Atkinson et al., 2014*]. No threshold.





Modelled daily mean $PM_{2.5}$ across the UK for 2nd April 2014, from the AQUM. *(Calculated from hourly output provided by Met Office).*

Health outcome	R_e $PM_{2.5}$
Mortality (all-cause excluding external)	**1.04%** increase per 10 µg m^{-3}
Emergency respiratory hospitalizations	**0.96%** increase per 10 µg m^{-3}
Emergency cardiovascular hospitalizations	**0.90%** increase per 10 µg m^{-3}

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Mortality (all-cause)

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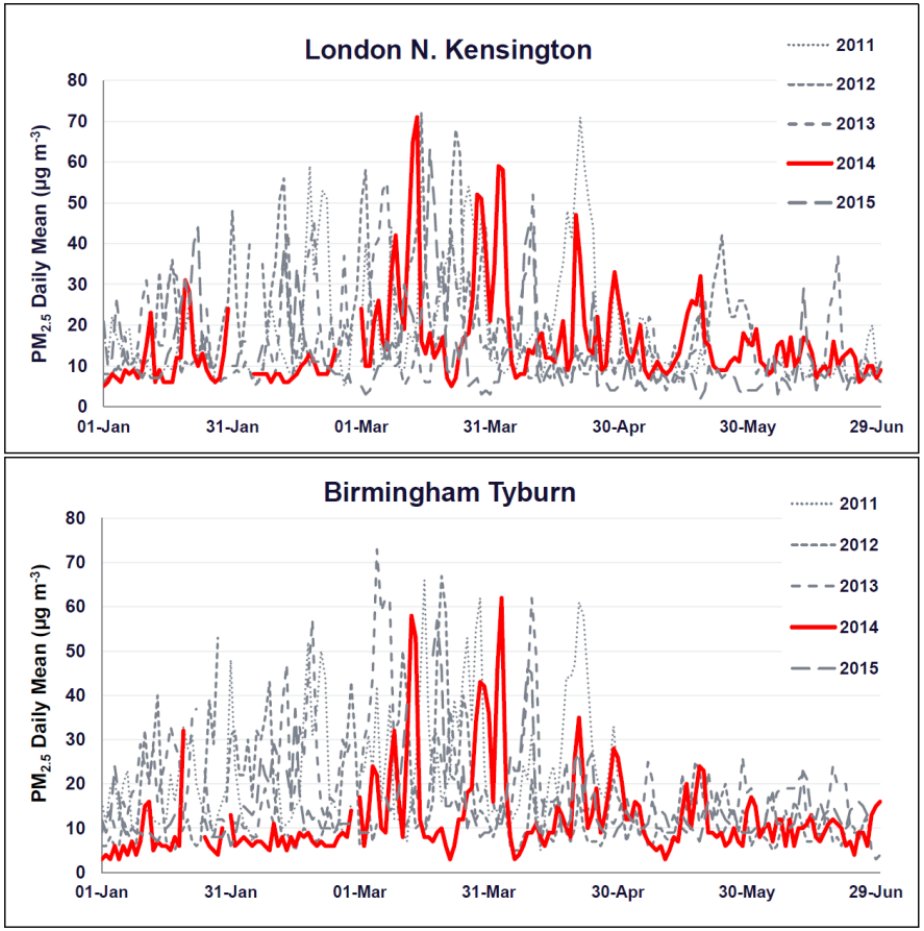
- Analysed 12th – 14th March and 28th March – 3rd April.
- Total of **604 deaths brought forward** associated with short-term exposure to $PM_{2.5}$ summed across the UK.
- Estimate that **302 of these would be expected** due to more typical levels of $PM_{2.5}$ (based on available measurements from urban background sites).
- Estimate a **two-fold increase** in mortality attributable to short-term exposure to $PM_{2.5}$.



Observed daily mean PM2.5 at an urban background site during January-June from 2012 to 2015 inclusive. ***(Data form AURN via Defra website)***

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Impact of the episodes

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- Impact of the presence of the episode based on more typical levels of $PM_{2.5}$ at this time of year is approximately double.
- Some regional variation due to differing levels of $PM_{2.5}$ and baseline mortality levels.

Region		Mean $PM_{2.5}$ concentration	Deaths brought forward associated with $PM_{2.5}$		
			Number	Percent of baseline	Increase in 2014 from typical levels
London	2014 episodes	49.1 µg m^{-3}	69	5.00 %	2.70
	Typical levels	18.0 µg m^{-3}	26	1.85 %	
West Midlands	2014 episodes	41.9 µg m^{-3}	60	4.23 %	2.13
	Typical levels	19.3 µg m^{-3}	29	1.99 %	
Scotland	2014 episodes	21.4 µg m^{-3}	31	2.21 %	1.96
	Typical levels	10.9 µg m^{-3}	16	1.13 %	
Wales	2014 episodes	34.5 µg m^{-3}	30	3.49 %	2.23
	Typical levels	15.1 µg m^{-3}	14	1.56 %	

*Typical levels calculated as mean of 1 March – 31 May, 2011, 2012, 2013, 2015. Analysis could not be performed for all urban background sites due to missing data.

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Summary

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- Air pollution episode in spring of 2014.
- Analysed 12th – 14th March and 28th March – 3rd April.
- Total of **604 deaths brought forward** associated with short-term exposure to $PM_{2.5}$ summed across the UK over these 10 days.
- Based on measurements from urban background observation sites, estimate **two-fold increase** in deaths brought forward associated with short-term exposure to $PM_{2.5}$.
- Similar results for emergency hospitalizations (respiratory and cardiovascular).
- May aid with future planning for air pollution events.

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THE UNIVERSITY OF EDINBURGH

COMEAP
COMMITTEE ON THE MEDICAL EFFECTS OF AIR POLLUTANTS

CEH Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Health impacts of short term exposure to surface ozone in England, Wales and Scotland from 2001-2011

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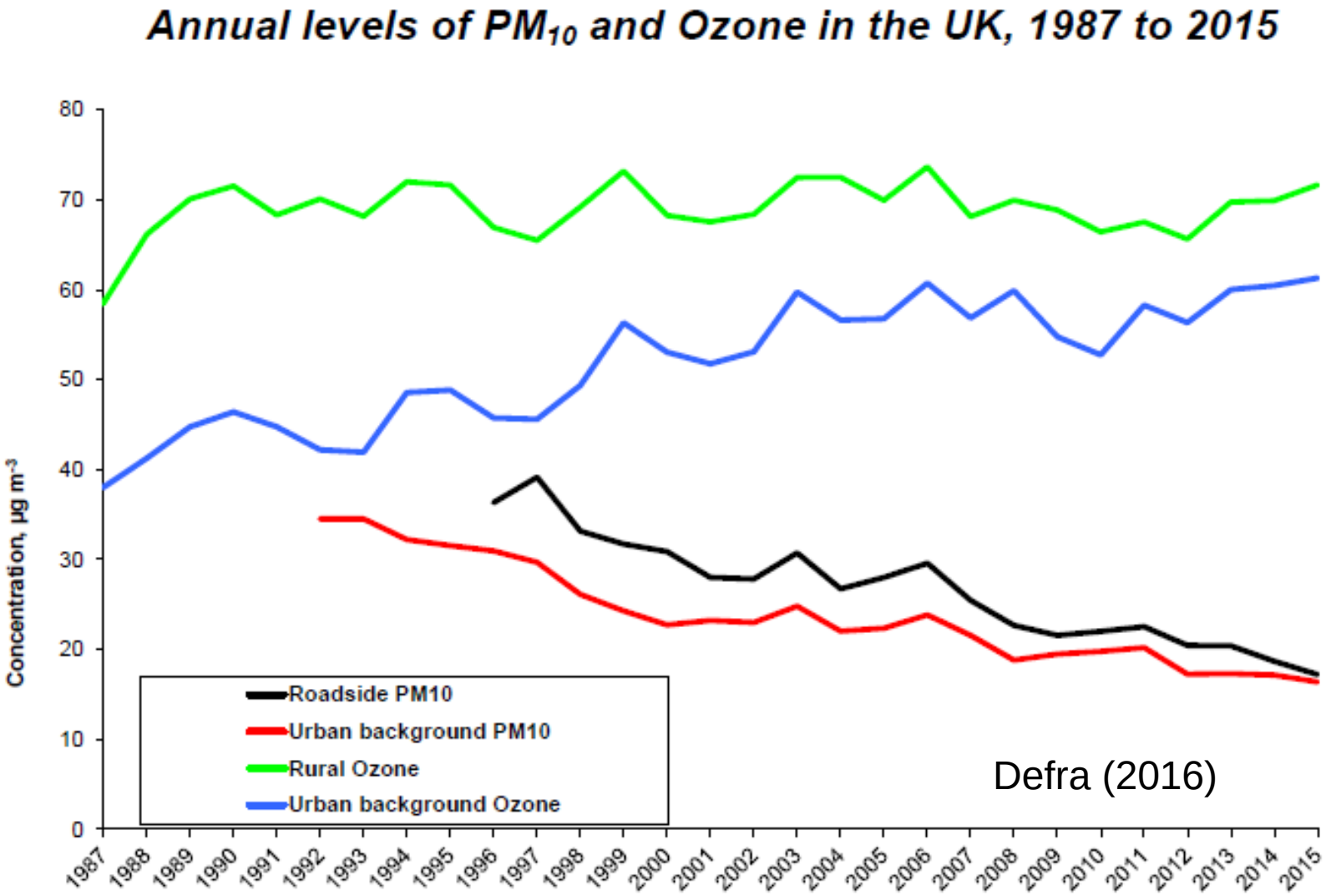
Ozone trends in the UK



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Recent developments for health effects

COMEAP (Committee on Medical Effects of Air Pollution) published an update to concentration-response coefficients for short term ozone exposure in 2015 (Department of Health 2015).

Coefficients for mortality and emergency respiratory hospital admissions updated

Coefficient for emergency cardiovascular admissions added

Recommendation is for no threshold (0 ppb cut off)

Health endpoint (all ages)	Concentration-response coefficient % increase per 10 $\mu g/m^3$ daily maximum 8-hour running mean ozone (95% confidence interval)
All-cause mortality	0.34%* (0.12, 0.56%)
Respiratory hospital admissions	0.75%** (0.30, 1.20%)
Cardiovascular hospital admissions	0.11% (-0.06, 0.27%)

*previously 0.3% **previously 0.7%

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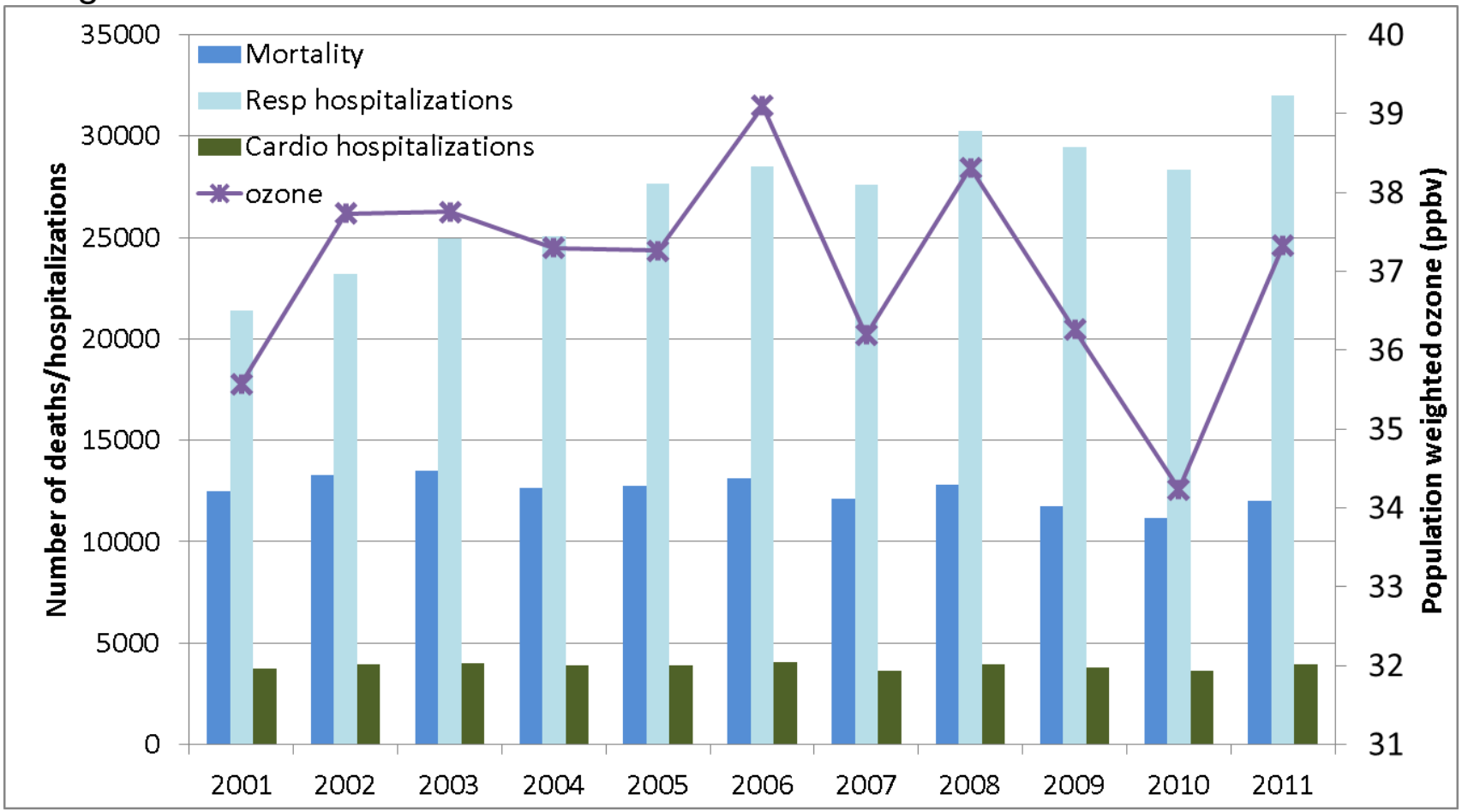
Results – Mortality, emergency respiratory and cardiovascular hospitalizations (England & Wales)



- Mean annual mortality from daily ozone was **12,500** from 2001-2011
- Range: from **11,100** in 2010, to **13,500** in 2003
- Mean annual **respiratory admissions** from daily ozone: **27,100** from 2001-2011
- Mean annual **cardiovascular admissions** from daily ozone: **3,900** for same period

Joint HPRU project: "Walking to school" study

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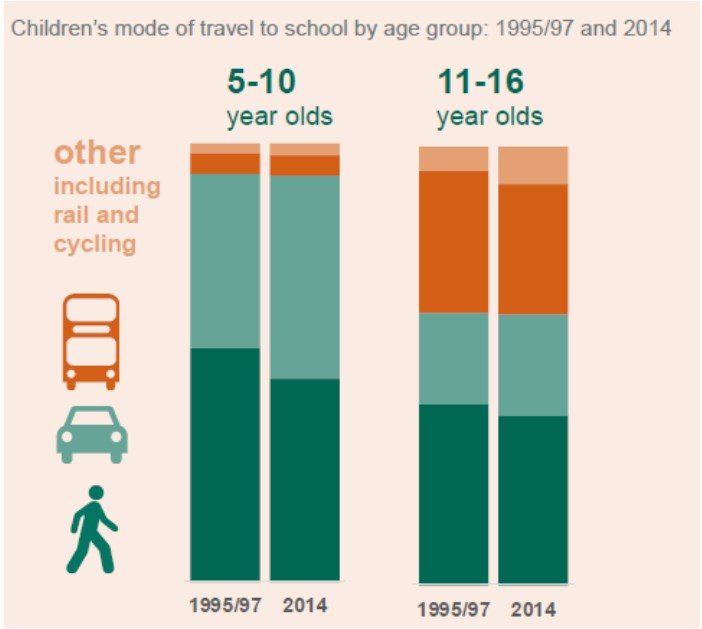
The proportion of young children walking to school has been decreasing



Source: National travel Survey England 2014

Research question: How does the mode of travelling to school (walk, cycle, car, bus) affect school-going children's health?

Methodological steps:

- Select 2-3 scenarios to explore the impact of introducing a modal shift intervention in a typical London school.
- Estimate the emissions released from the school trips (DEFRA Emission toolkit);
- Calculate the pollutant concentrations (NO_2, PM) in the local environment around schools (OSPM model);
- Apply INDAIR/EXPAIR modelling framework to estimate population exposure of "school going children", considering also the indoor environment;
- Assess potential risks/benefits resulted from: a) changes in exposure to the above pollutant concentrations, b) active travel – walk, cycle, c) road accidents (use of WebTag or similar toolkit);
- Scale up to a larger number of schools with different configurations

Potential funding sources: Defra, DH, DoE, GLA

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Conference presentations

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Clare Heaviside, Massimo Vieno, Rachel Beck, Stefan Reis, Sotiris Vardoulakis, Mathew Heal, Heather Walton, Sani Dimitroulopoulou, John Stedman, Nicola Carslaw, Debbie Jarvis, Ross Anderson. **Assessing the health impacts of short-term exposure to ground-level ozone in the UK 2001-2011**. Quadrennial Ozone Symposium, September 2016, Edinburgh, UK

Clare Heaviside, Massimo Vieno, Rachel Beck, Stefan Reis, Sotiris Vardoulakis, Mathew Heal, Heather Walton, Sani Dimitroulopoulou, John Stedman, Nicola Carslaw, Debbie Jarvis, Ross Anderson. **Assessing the health impacts of short-term exposure to ground-level ozone in the UK 2001-2014**, (Poster) PHE Annual Conference, 12-14 September 2016, Warwick, UK.

Helen Macintyre, Clare Heaviside, Lucy Neal, Paul Agnew, John Thornes, Sotiris Vardoulakis, **Mortality and emergency hospitalizations associated with atmospheric particulate matter episodes across the UK in spring 2014**, (Poster) 2016 Annual UK Review Meeting on Outdoor and Indoor Air Pollution Research, 26-27 September 2016, Solihull, UK.

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Publications

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Atkinson RA, Butland BK, Dimitroulopoulou C, Heal MR, Steadman JR, Carslaw N, Jarvis D, Heaviside C, Vardoulakis S, Walton H, Anderson HR. (2016) **Long-term exposure to ambient ozone and mortality: a quantitative systematic review and meta-analysis of evidence from cohort studies** *BMJ Open*; 6:e009493.

Macintyre, H. L., C. Heaviside, L. S. Neal, P. Agnew, J. Thornes, and S. Vardoulakis (2016), **Mortality and emergency hospitalizations associated with atmospheric particulate matter episodes across the UK in spring 2014**, *Environment International*, *online*.

Elliot, A. J., S. Smith, A. Dobney, J. Thornes, G. E. Smith, and S. Vardoulakis (2016), **Monitoring the effect of air pollution episodes on health care consultations and ambulance call-outs in England during March/April 2014: A retrospective observational analysis**, *Environmental Pollution*, *214*, 903-911.

Salmond, J. A., Tadaki, M., Vardoulakis, S., Arbuthnott, K., Coutts, A., Demuzere, M., et al. (2016). **Health and climate related ecosystem services provided by street trees in the urban environment**. *Environmental Health, 15*(1), 95-111.

Smith, G. E., Z. Bawa, Y. Macklin, R. Morbey, A. Dobney, S. Vardoulakis, and A. J. Elliot (2015), **Using real-time syndromic surveillance systems to help explore the acute impact of the air pollution incident of March/April 2014 in England**, *Environmental Research*, *136*, 500-504.

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Particulate Air Pollution

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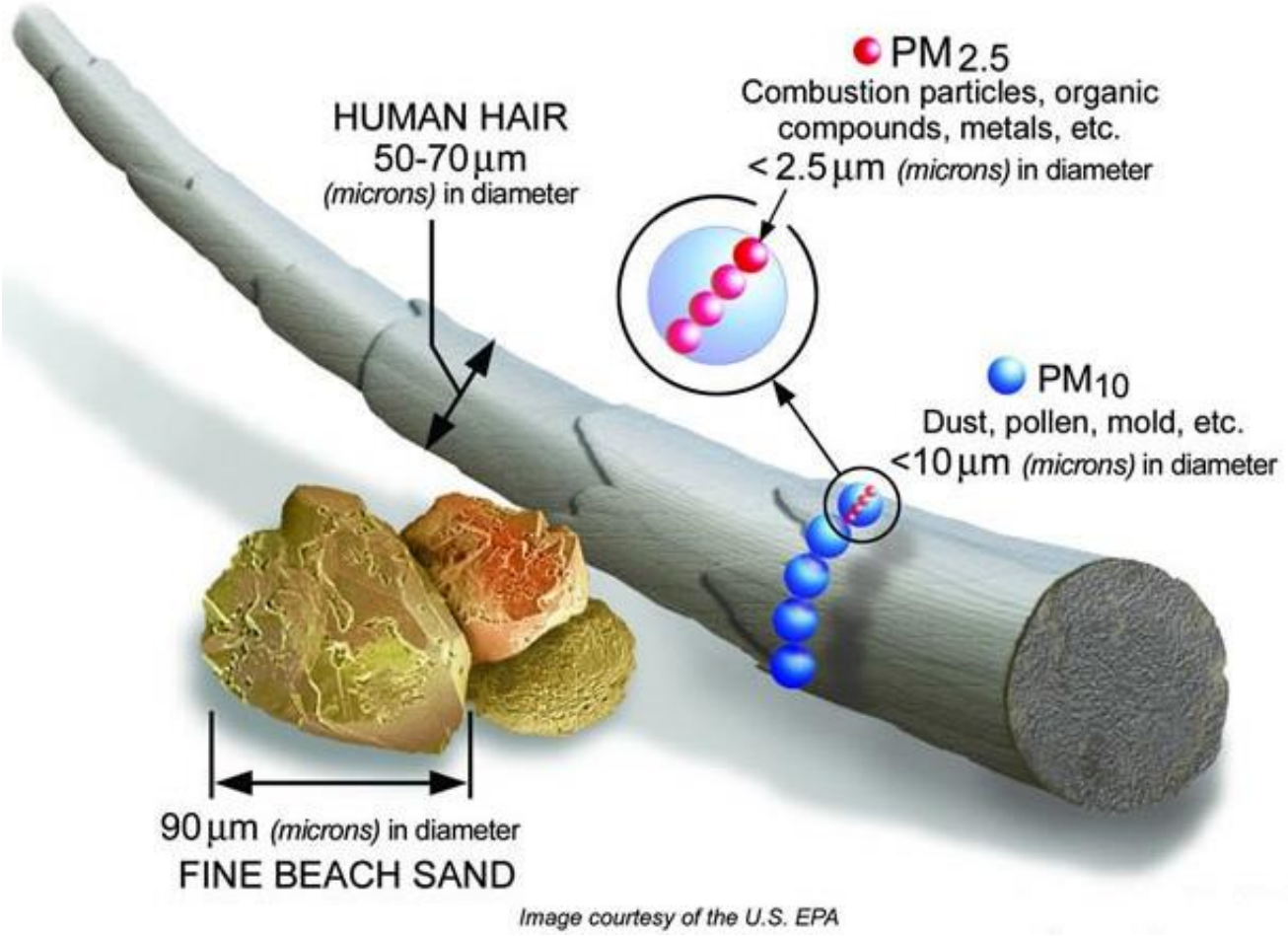

Particulate air pollution

- Particles smaller than 2.5 µm in diameter; $PM_{2.5}$
- Range of sources; combustion, dust, chemical reactions; natural and man-made.
- Finer particles more dangerous as they penetrate deeper into the lungs.

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Air Pollution and Health

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Long term exposure to particulate air pollution has an effect on health equivalent to 29,000 deaths across the UK annually [COMEAP].

Short-term exposure to air pollution episodes also has negative effects on health.

- Increased respiratory symptoms; sore throat and eyes, cough; emergency hospitalizations for respiratory and cardiovascular conditions.
- Asthma.
- Cardiac arrhythmias; heart attacks.

Sensitive groups

- People with pre-existing lung or heart conditions, e.g. asthma.
- Older adults, children.

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Emergency hospital admissions

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Total of **1,566** emergency respiratory and cardiovascular hospitalizations associated with short-term exposure to $PM_{2.5}$ (out of ~45,000)

- Respiratory emergency admissions: **838** across the UK. Estimate that **419** would be from more typical $PM_{2.5}$ levels.
- Cardiovascular emergency admissions **728** across the UK. Estimate that **364** would be from more typical $PM_{2.5}$ levels.