A Novel Mobile Air Quality Measurement for Emerging Indoor Emission Sources

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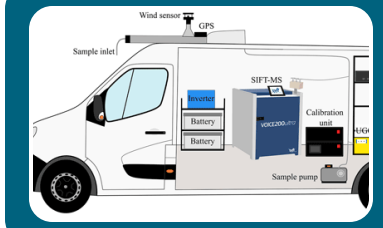
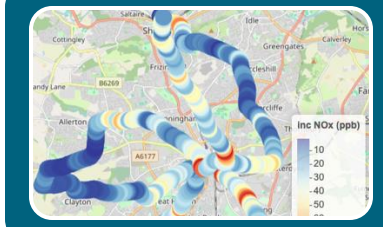
Outline

1. Background & Objectives



2. Methods



3. Results & Discussions

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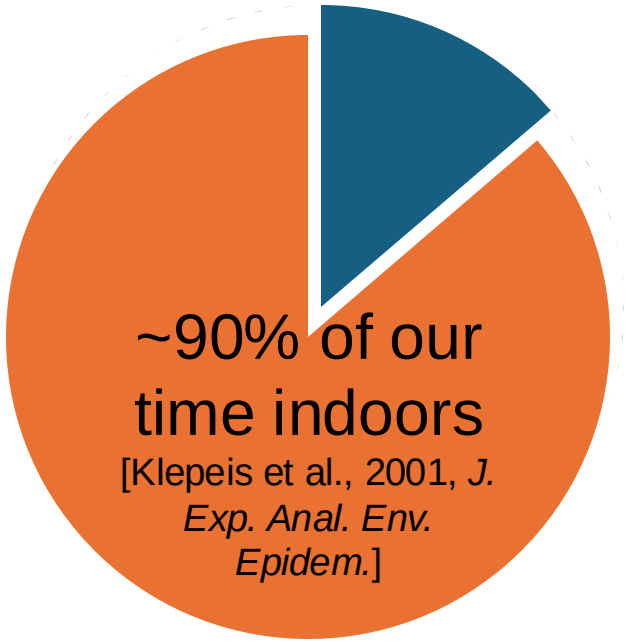
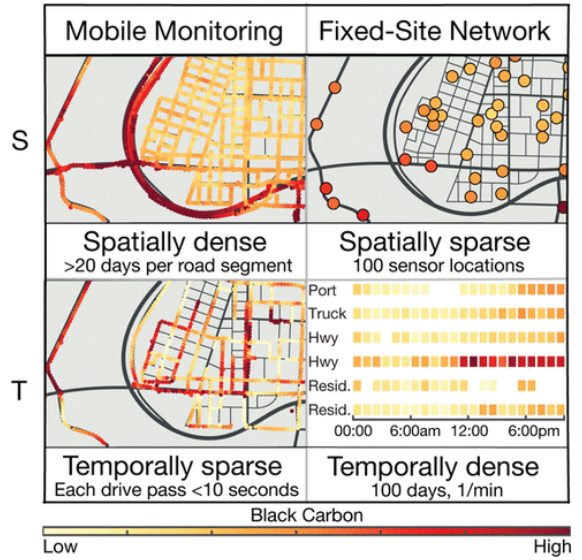
1. Background





[Chambliss et al., 2020, *Environ. Sci. Technol.*]

- The impact of indoor pollution sources on outdoor air quality is not well-identified, and assessment is challenging due to dispersion. [McDonald et al., 2018, *Science*; Wernis et al., 2022, *Atmos. Chem. Phys*.].

- Mobile monitoring offers rapid measurements of spatial gradients in PM [Chambliss et al., 2020, *Environ. Sci. Technol.*] and gaseous pollutants [Wilde et al., 2024, *Atmos. Environ. X*].

1. Objectives

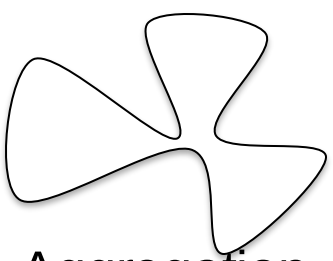
Previous studies fell short of characterising localised sources and assessing their significance over time or the combined impact of multiple sources

To undertake innovative **localised mobile measurements** in and around study **homes and buildings with distinct emission profile sources** to understand the impact of indoor sources on outdoor AQ and vice versa

2. Mobile measurement methods

Mobile measurements

Figure 1. WACL Atmospheric Sampling Platform (WASP).



Aggregation

Repeats & fast

BRADFORD	
Winter 26 Feb – 3 Mar 2023	Summer 26 Jun – 1 Jul 2023
YORK	
Winter 13 – 24 Feb 2023	Summer 12 - 15 Sep 2023

Morning (10:00 – 12:00)
Afternoon (13:00 – 15:00)
Evening (16:00 – 18:00)

Figure 2. Measurement routes in Bradford and York.

2. Background and increment concentrations

Background:
Well-mixed pollution (= aged-local emission and transported)

Increment:
Localised and persistent emissions.

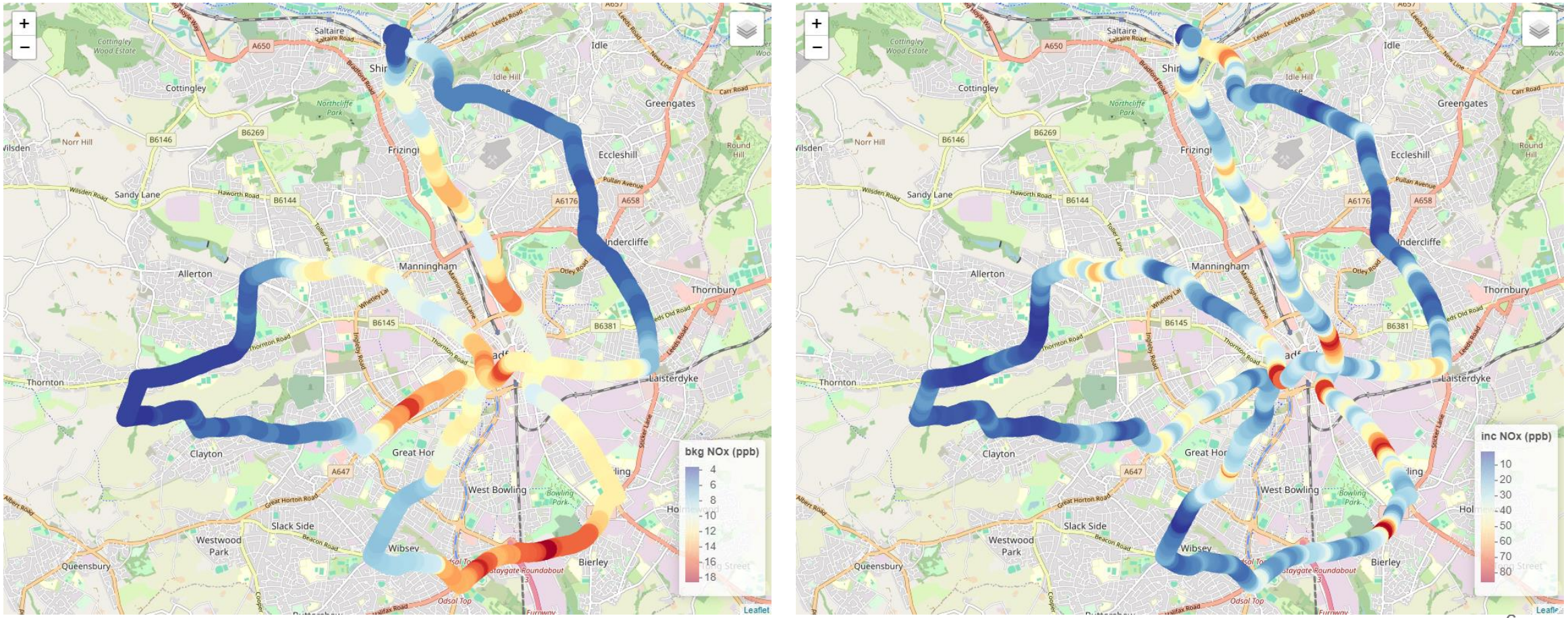


Figure 3. Spatial distribution of the medians of background and increment of NO_x.

2. Distinctive spatial distributions

Spatial distributions of the increment NO_x (traffic tracers) and Nonanal (cooking tracers [Coggon et al., 2024]) indicate localised sources and distinct tracer emissions.

NO_x **Nonanal**

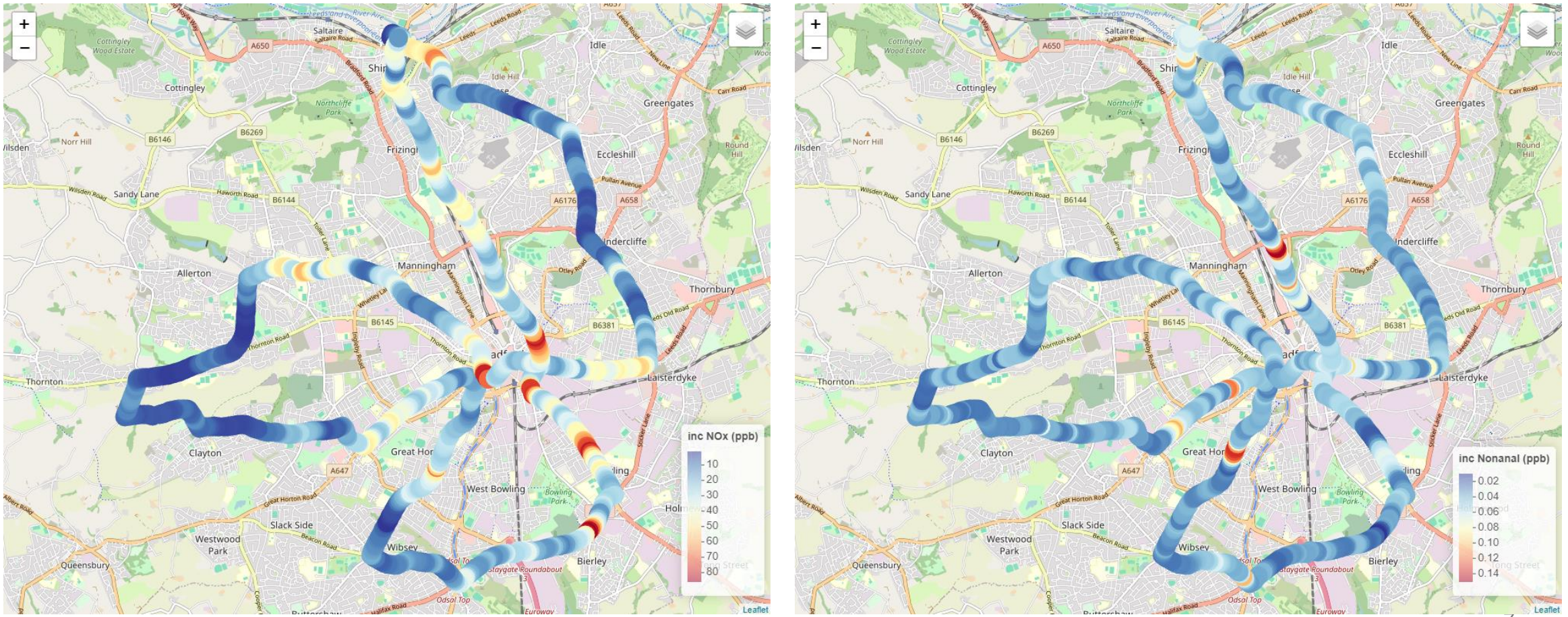


Figure 4. Comparing the spatial distribution of the median increment of NO_x and nonanal.

3. Identifying commercial indoor sources

576 restaurants

(cooking emissions)

255 salons

(PCPs emissions)

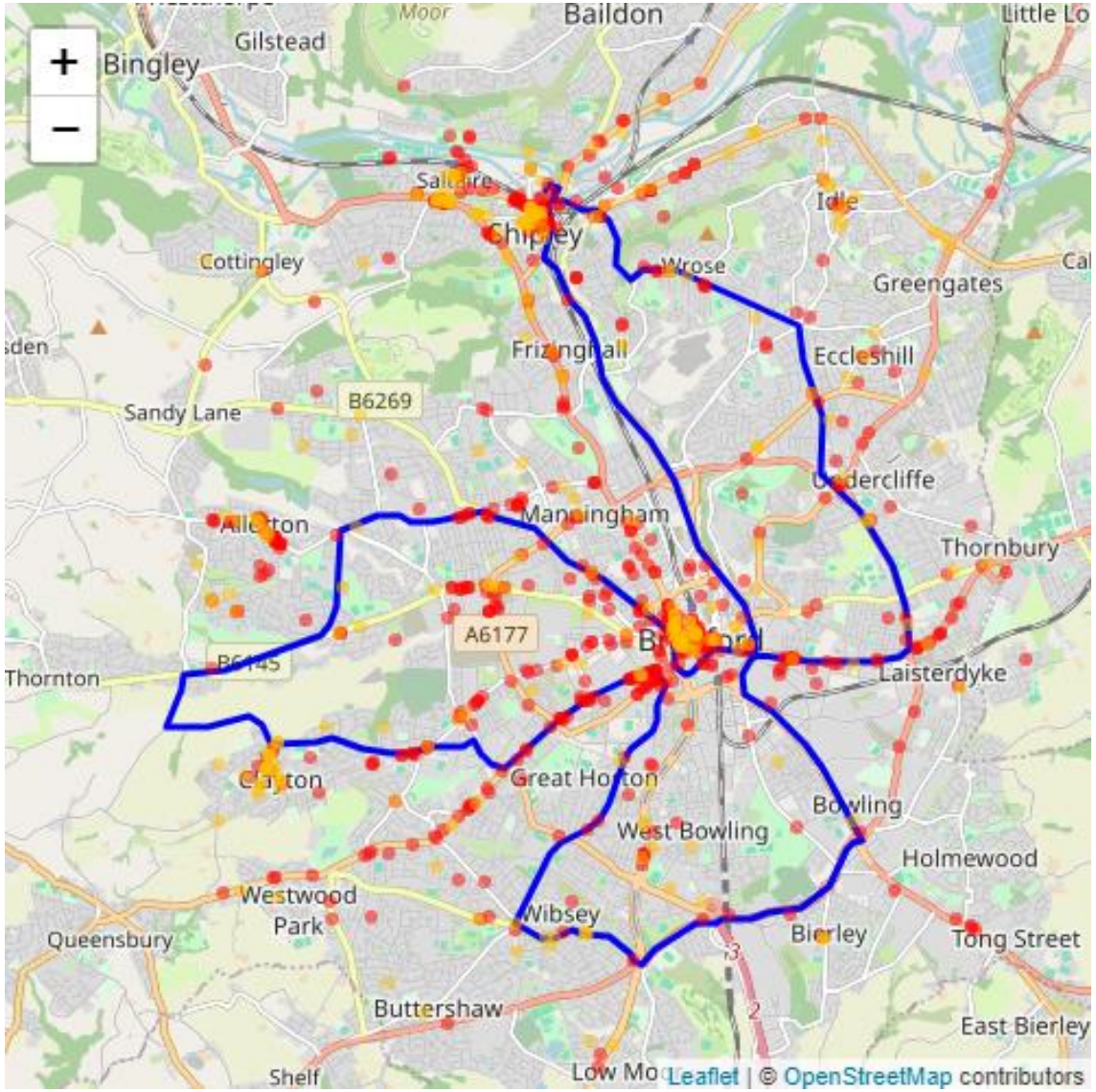


Figure 5. Potential sources of cooking and personal care products emissions.

3. Weighting commercial indoor sources

Sources are weighted according to the approximate dispersion of plumes from the individual source.

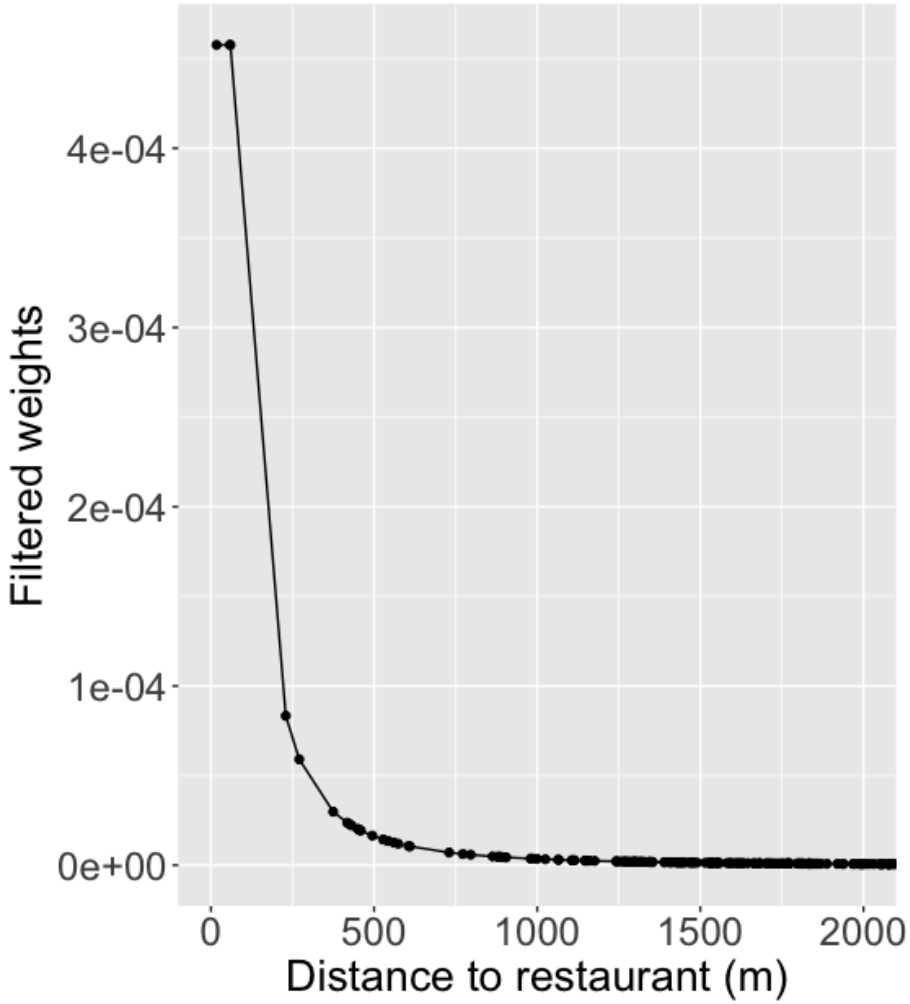


Figure 6. Contribution of one source type in the form of weight over source distance to a road point.

3. Weighting commercial indoor sources

Contributions from all commercial sources were summed to obtain a single weighting value.

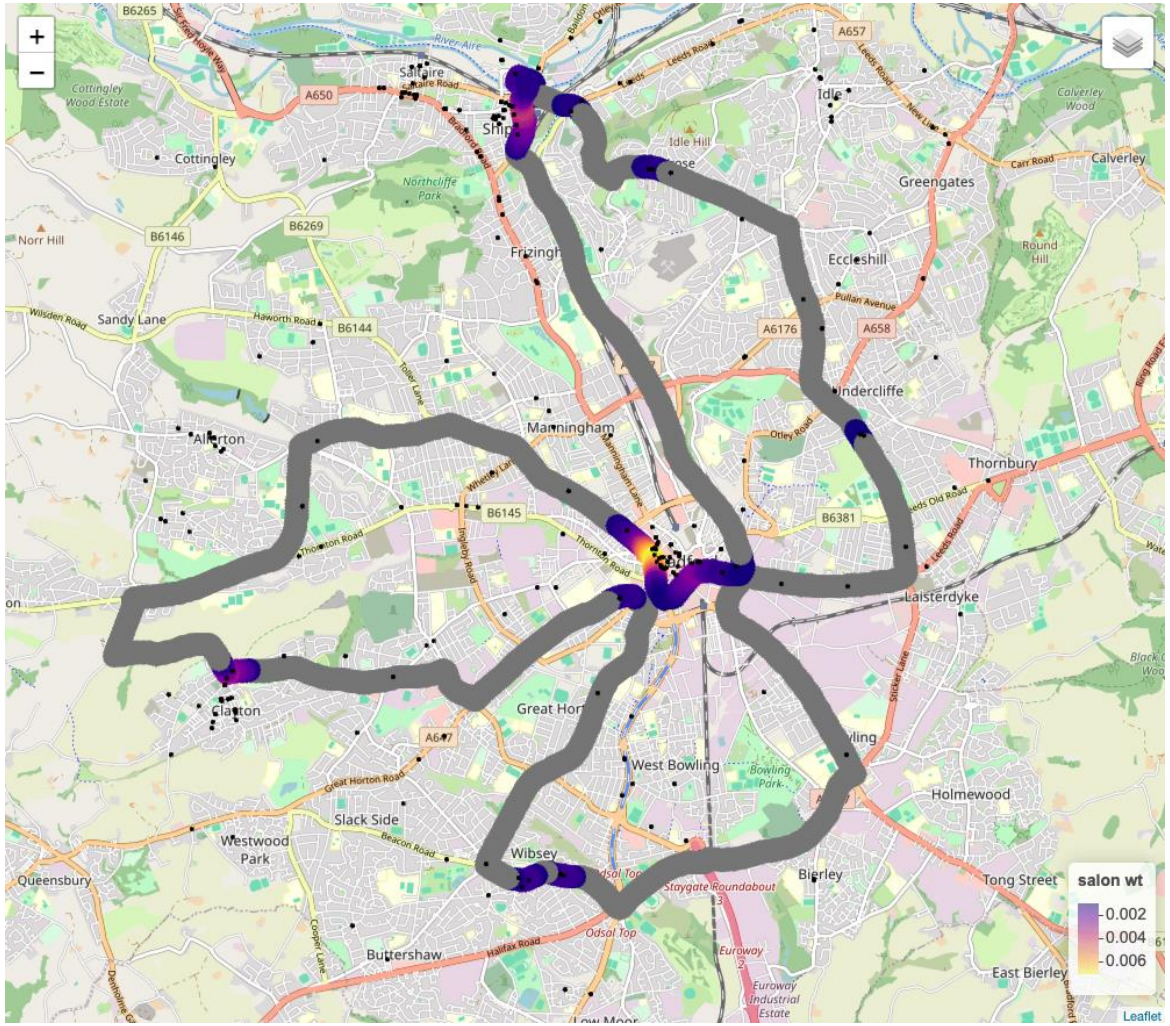


Figure 7. Spatial distribution of beauty salon weighted contribution.

3. Beauty salons contribution to outdoor

- Dense population at Bradford's and Shipley's Centre.
- Strong correlations between beauty salon's tracers (acetone) and sum of weights.

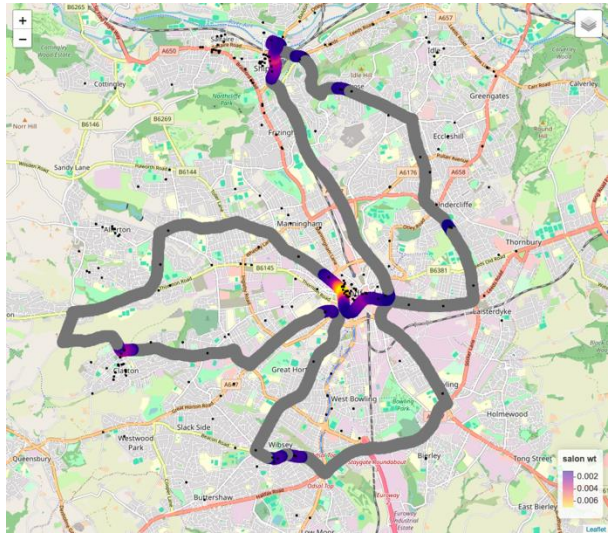


Figure 7. Spatial distribution of beauty salon weights.

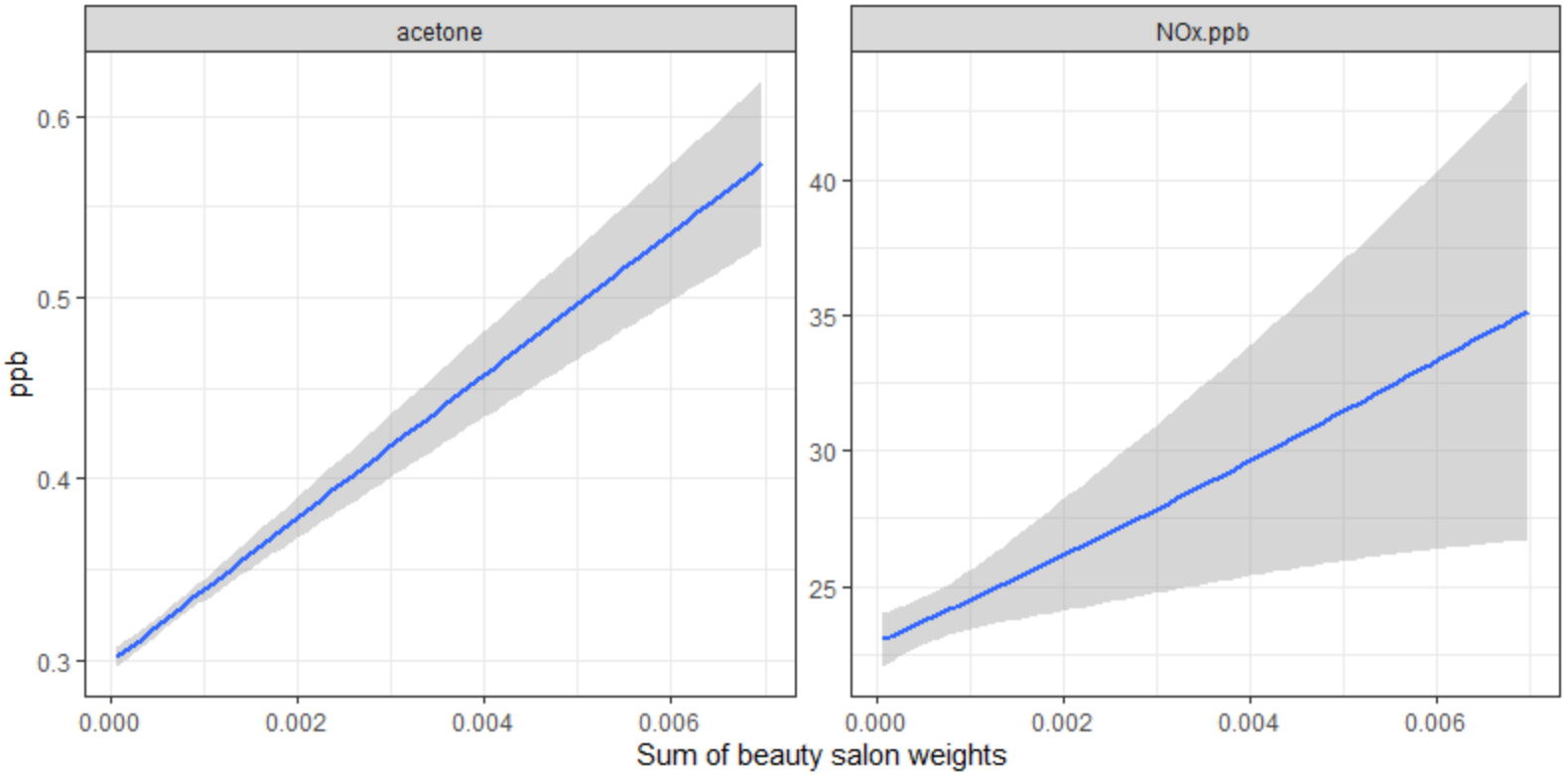


Figure 8. Comparing beauty salon's tracers (acetone) and traffic tracers (NO_x) correlation with sum of weights.

3. Restaurants contribution to outdoor

- Dense population in City Centre and urban streets.
- Complexity to deconvolute tracers emitted in close proximity.

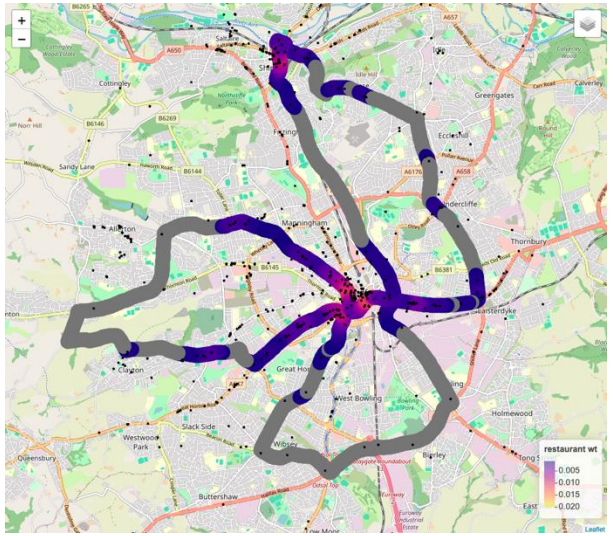


Figure 9. Spatial distribution of restaurant weights.

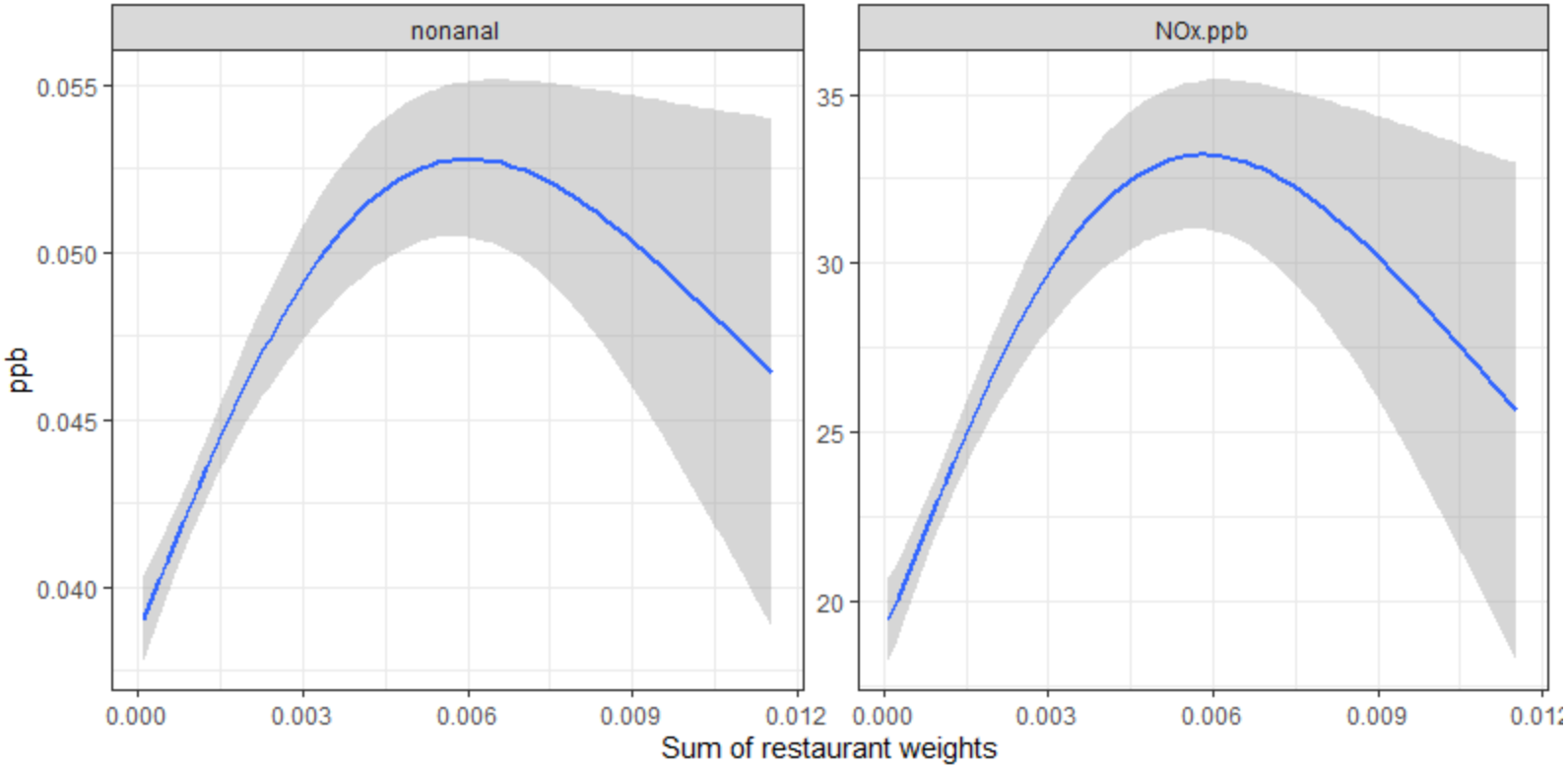


Figure 10. Comparing restaurant's tracers (nonanal) and traffic tracers (NO_x) correlation with sum of weights.

3. Residential contribution to outdoor

- Sprawling urban areas.
- Strong correlations between acetonitrile (cooking & cleaning tracers) and population density.

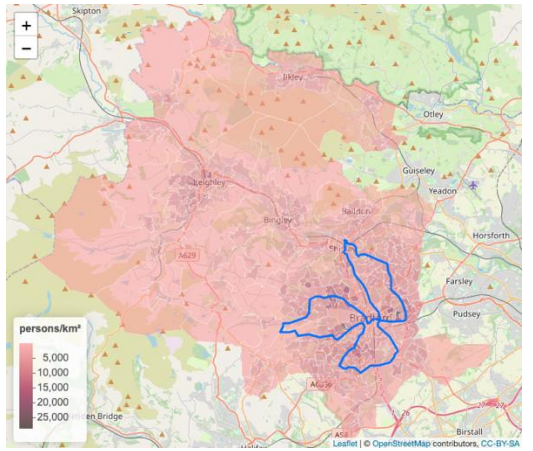


Figure 11. Population densities in Bradford.

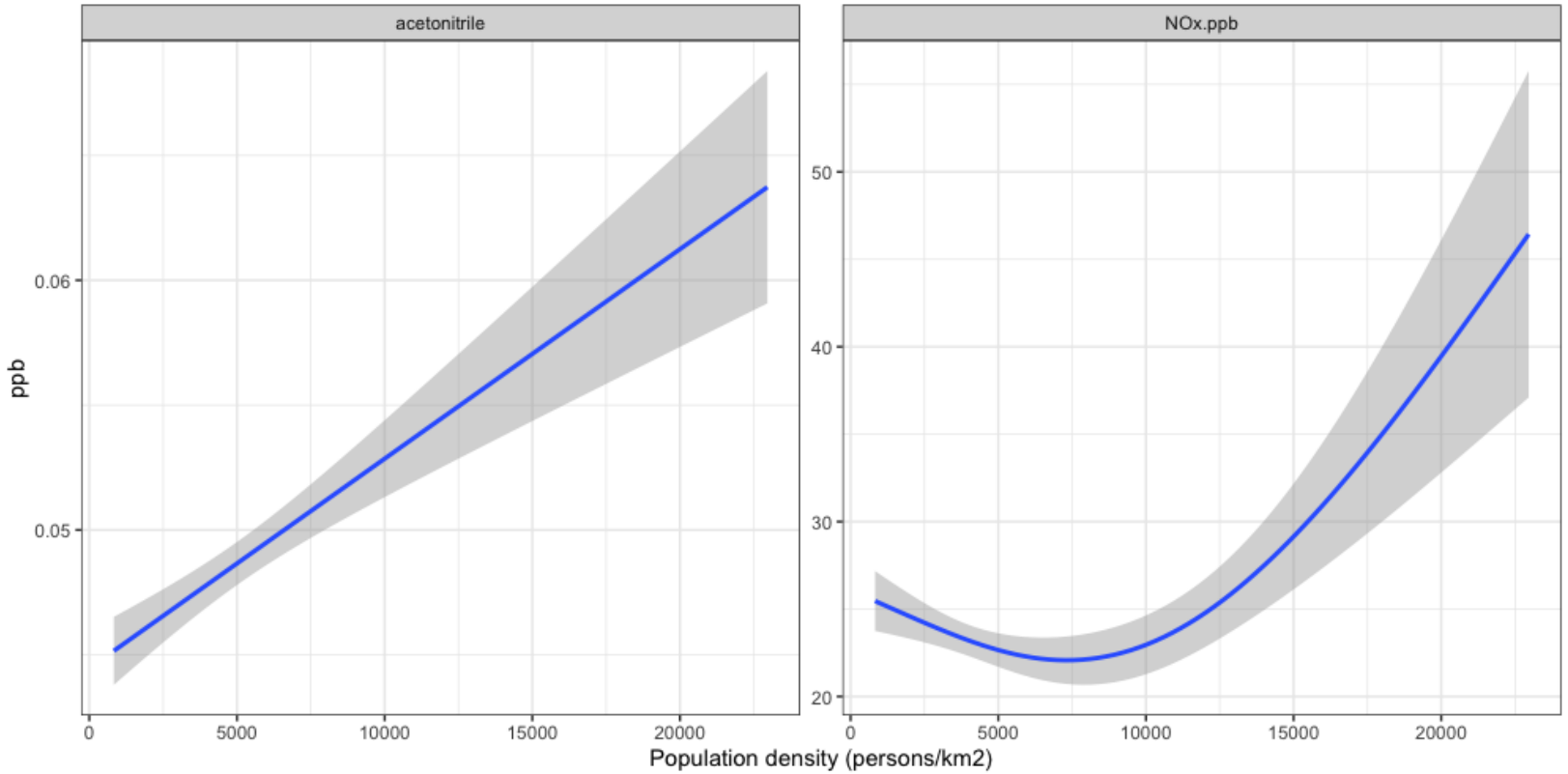


Figure 12. Comparing acetonitrile and NO_x correlation with population density.

Summary and Future Work

We developed metrics to evaluate the relationship between indoor sources and outdoor observation.

We will estimate the contribution of indoor sources to outdoor pollutants concentration.

UNIVERSITY of York

INGENIOUS
Understanding Air Pollution in Homes

UKRI Natural Environment Research Council

ROYAL SOCIETY OF CHEMISTRY

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