Health burden disparities from unequal exposure to traffic-related air pollution in UK cities

Eloïse A. Marais (e.marais@ucl.ac.uk)[1], Eleanor Gershenson-Smith[1], Karn Vohra[2]

[1] Department of Geography, University College London, [2] School of Geography, Earth and Environmental Sciences, University of Birmingham

STUDY MOTIVATION and OBJECTIVE

Unfair exposure to urban air pollution needs quantification to identify the most impacted communities where interventions are urgently needed.

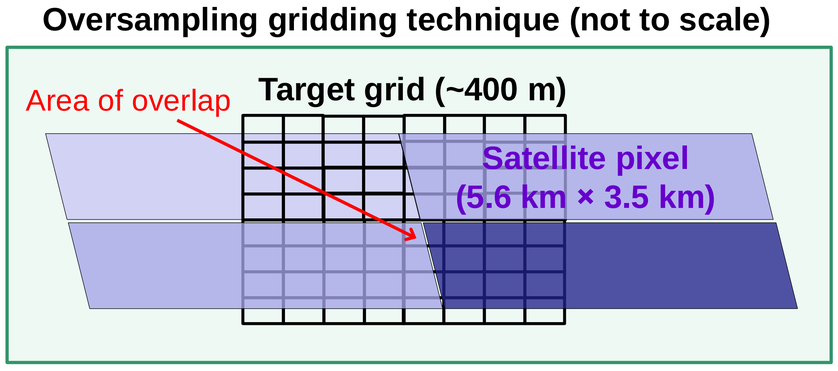
Datasets at suitable resolutions are limited to Greater London. Even then, the data become outdated and rely on uncertain emission estimates.

Here we use satellite observations of nitrogen dioxide (NO_2) to derive high spatial resolution surface concentrations for quantifying disparate exposures in NO_2 leading to childhood-onset asthma and TRAP leading to all-cause adult premature mortality.

STEP-BY-STEP APPROACH and PRELIMINARY RESULTS

Approach to derive all-day (24-hour) mean surface NO_2 concentrations from midday overpass TROPOMI informed by Lamsal et al. [2008]

Oversampling gridding technique (not to scale)

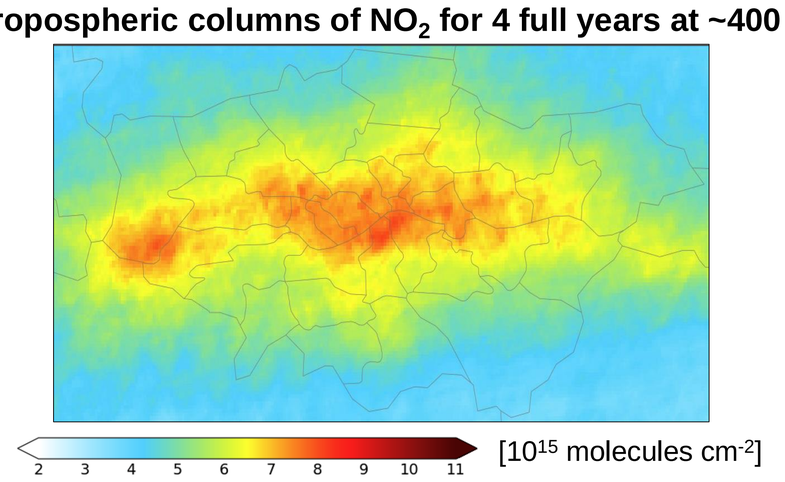


Weights by area of overlap. Fine resolution achieved because pixel location shifts with each overpass. Needs many years of data.

STEP 1: Grid TROPOMI to fine resolution

Achieve much finer resolution than native instrument resolution

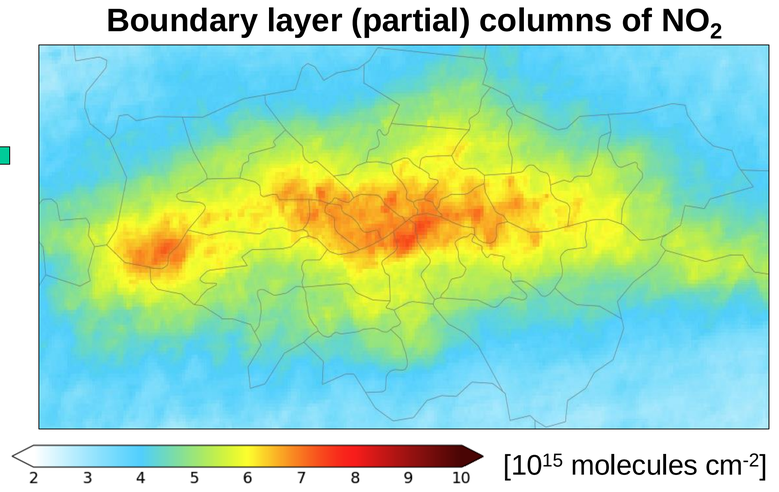
Tropospheric columns of NO_2 for 4 full years at ~400 m



STEP 2: Isolate boundary layer

Free-tropospheric NO_2 column calculated assuming uniform ~50 pptv NO_2 from Horner et al. (2024) and subtracted from tropospheric column

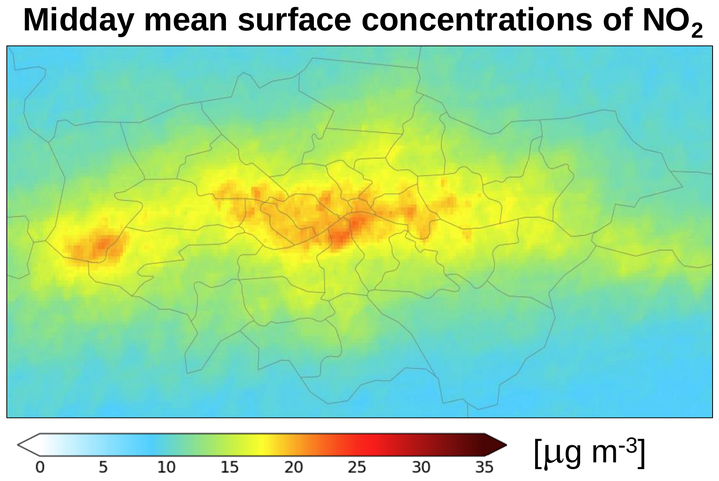
Boundary layer (partial) columns of NO_2



STEP 3: Convert to surface concentrations

Conversion uses equation from regressing boundary layer columns against midday mean in situ network measurements (**exp(0.21*Ω) + 0.92)**, where Ω are TROPOMI boundary layer column densities)

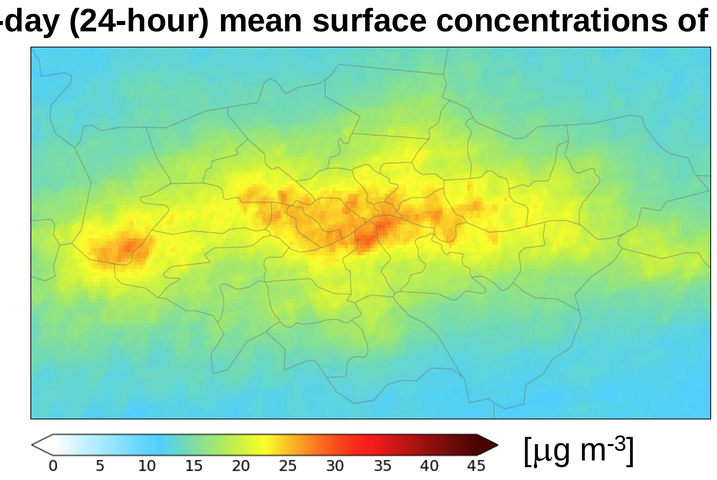
Midday mean surface concentrations of NO_2



STEP 4: Convert to 24-hour means

Uses 24-hour-to-midday NO_2 ratio of 1.30 calculated using surface network sites

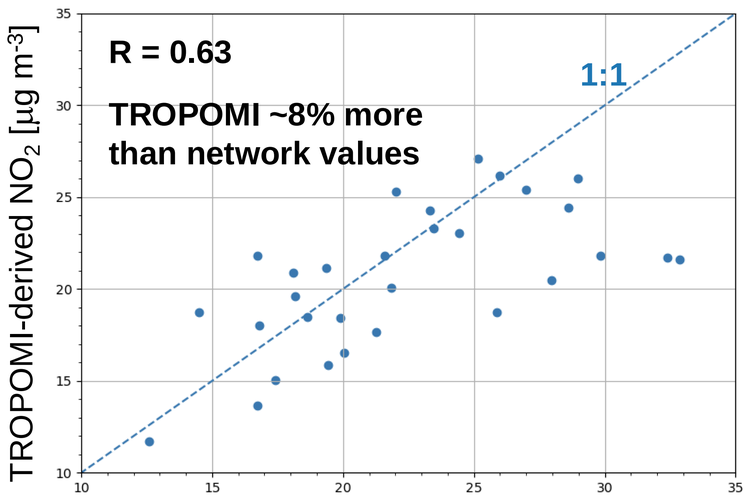
All-day (24-hour) mean surface concentrations of NO_2



STEP 5: Evaluate against surface network

Quasi-independent, as evaluation uses all-day means, whereas step 3 used midday means

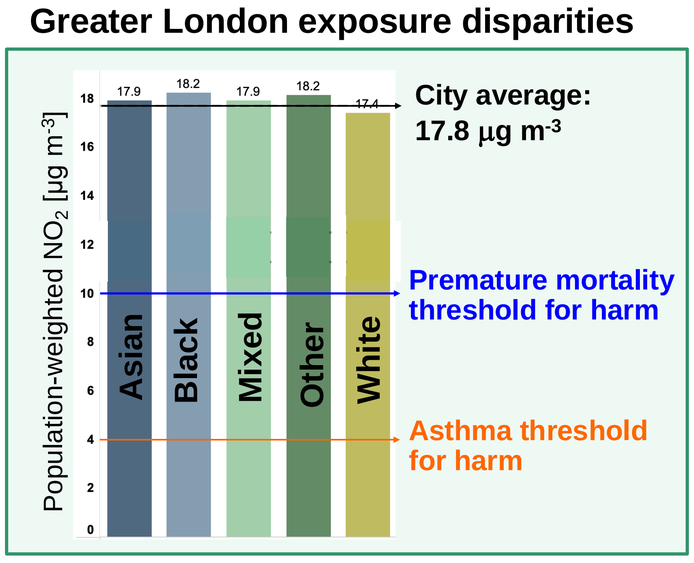
TROPOMI-derived vs network site NO_2



STEP 6: Determine city-scale exposure disparities

Uses TROPOMI-derived NO_2 and total population of each ethnic group as declared in the 2021 census

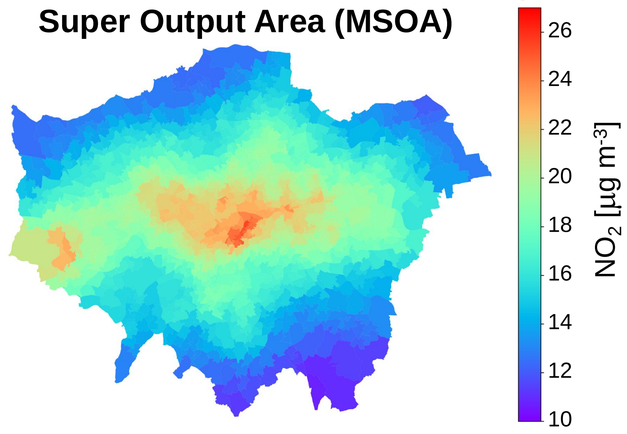
Greater London exposure disparities



STEP 7: Determine census-scale disparities (in progress)

Work in progress. TROPOMI-derived surface NO_2 gridded to large census areas (MSOAs) so far generated

NO_2 for each Greater London Middle layer Super Output Area (MSOA)



ACKNOWLEDGEMENTS, NEXT STEPS, and REFERENCES

This work is part funded by a European Commission ERC Starting Grant and by a UCL Knowledge Exchange Innovation & Enterprise Award

Work is underway to calculate disparities in asthma incidences and premature mortality for LSOAs and MSOAs of Greater London and other target UK cities.

References cited: Horner et al., 2024, doi:10.5194/acp-24-13047-2024; Lamsal et al., doi:10.1029/2007JD009235.