nature portfolio

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Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☒	☐	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☒	☐	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☒	☐	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☒	☐	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☒	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	The WRF-CMAQ two-way model source code used for this numerical model study can be downloaded here (WRF: https://www2.mmm.ucar.edu/wrf/users/download/get_sources.html; CMAQ: https://github.com/USEPA/CMAQ). Simulations were conducted using WRF-CMAQ v5.2 and WRF v3.8. The 2016 SMOKE Beta platform was used for allocating emissions to a 1.3km grid with county total emissions from the 2016v7.2 NEI and 1.3 km spatial surrogated provided by the Lake Michigan Air Directors Consortium (LADCO) and available on request. State boundaries are obtained using Cartopy v0.18.0 (https://doi.org/10.5281/zenodo.8216315) while Chicago shapefiles are available from the Chicago Data Portal via https://data.cityofchicago.org/. All other related code used for our Vehicle-to-EGU Electricity Assignment and Emission Remapping Algorithm, health impacts and environmental justice implications can be found here: https://doi.org/10.5281/zenodo.8234544
Data analysis	All analysis was conducted using: R Version 4.2.2, Python Version 3.8.12 with the GeoPandas package for determining census tract level air pollution concentrations Version 0.9.0 and Microsoft Excel Version 16.66.1. All scripts are available here (https://github.com/NU-CCRG/Camilleri-et-al-2022_WRFCMAQ-eHDVstudy)

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

As inputs to our Vehicle-to-EGU Electricity Assignment and Emission Remapping Algorithm we use: a grid gross loss across the U.S. from EPA (2021), the eGRID-2016 database for EGU details related to location, age and capacity with shapefiles from U.S. Census Cartographic boundary shapefiles and NERC. Model output is hosted on Northwestern's servers. Due to model output size limitation, specific model output requests can be made to the corresponding author. For our health and equity impacts, population and demographic data was obtained from the American Community Survey (ACS 2015-2019) and can be downloaded from here: http://doi.org/10.18128/D050.V17.0, baseline all-cause mortality incidence rates were obtained from Industrial Economic, Incorporated (IEc 2010-2015) and are available on request, β values were obtained from the Health Effects Institute report (HEI, 2022) for NO2 and PM2.5 and from Turner et al. (2016) for O3.

Human research participants

Policy information about studies involving human research participants and Sex and Gender in Research.

Reporting on sex and gender	This is not a study involving human research participants
Population characteristics	This is not a study involving human research participants
Recruitment	This is not a study involving human research participants
Ethics oversight	This is not a study involving human research participants

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☐ Behavioural & social sciences ☒ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	This is a numerical modeling study. All our analysis and findings are based on simulated data from sensitivity experiments.
Research sample	We conduct a total of 3 experiments: (a) A baseline simulation (no vehicles are electric) (b) Sensitivity experiment 1 - Electrifying 30% of heavy duty vehicles with not changes to the electric grid (c) Sensitivity experiment 2 - Electrifying 30% of heavy duty vehicles assuming all additional energy demand is met by renewables
Sampling strategy	Each experiment was run for a total of 4 months. Annual means presented in this study represent the average of the 4 simulated months.
Data collection	Model simulations were performed by Anastasia Montgomery and Sara F. Camilleri with output hosted on Northwestern's servers.
Timing and spatial scale	Each model simulation was run for a total of 4 months (Jul 2018, Oct 2018, Jan 2019 and April 2019) and focus our analysis to the region surrounding North America's largest freight hub, Chicago, Illinois. Simulations are conducted a spatial resolution of 1.3km.
Data exclusions	The first 10 days of each simulation was not included in the analysis to all for model spin up.
Reproducibility	All simulations are numerical modeling experiments
Randomization	Temporal constraints
Blinding	Blinding was not included as this is a numerical modeling study

Did the study involve field work? ☐ Yes ☒ No

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging