Changes in Mortality in Response to Decreases in Ozone and PM2.5 Concentrations Across the United States from 1999 to 2019

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BACKGROUND

- It is estimated that between 1990 and 2018, maximum daily 8 hour average (MDA8) ozone (O_3) concentrations decreased by 25%, and from 2000 to 2019 yearly average $PM_{2.5}$ concentrations decreased by 43% (4).
- We assess the health impacts of decreasing air pollutant concentrations across the United States by using multiple concentration datasets to estimate all-cause mortality attributable to PM2.5 and respiratory mortality attributable to O_3 in the continental United States from 1999 to 2019
- To achieve this, we use air pollution concentration data from:
  - CMAQ simulations from the North American Chemical Reanalysis (NACR) project (2009-2015), used here
  - 21-year CMAQ (1990-2010) simulation from EPA (4)
  - Satellite-derived PM2.5 data (SAT) from Dalhousie University (2000-2018)
  - An 18-year (1999-2018) kriging dataset (BME) created for this study using ground monitoring data, shown here
- We aim to investigate whether trends in mortality are consistent across different concentration datasets and to account better for uncertainty.
- We use annual county-level mortality statistics from the US Centers for Disease Control and Prevention (CDC) to assess annual ozone-attributable respiratory mortality and $PM_{2.5}$-attributable all-cause mortality for every year.

MATERIALS & METHODS

DATA

- The NACR project combined MODIS AOD observations and surface monitoring stations with a global air quality model through geographically weighted regression (GWR) to produce a 7-year simulation of ambient air quality.
- The CMAQ dataset is a 21-year simulation of $PM_{2.5}$ and O_3 concentrations on a 36-km grid from EPA for 1990-2010.
- The SAT dataset combined satellite observations and GWR to visualize $PM_{2.5}$ concentrations on a 1-km grid between 2000 and 2018.
- The BME dataset was created using Bayesian Maximum Entropy kriging of annual average ground monitoring observational data from EPA Air Quality System for $PM_{2.5}$, and Tropospheric Ozone Assessment Report maximum daily 8-hour average (MDA8) data for O_3.

MATERIALS & METHODS

METHODS

- Annual county-level population and baseline mortality data from CDC are regridded to the grid of the concentration datasets.
- We estimate mortality in12 km grid cells using yearly pollutant, population, and mortality rate data:

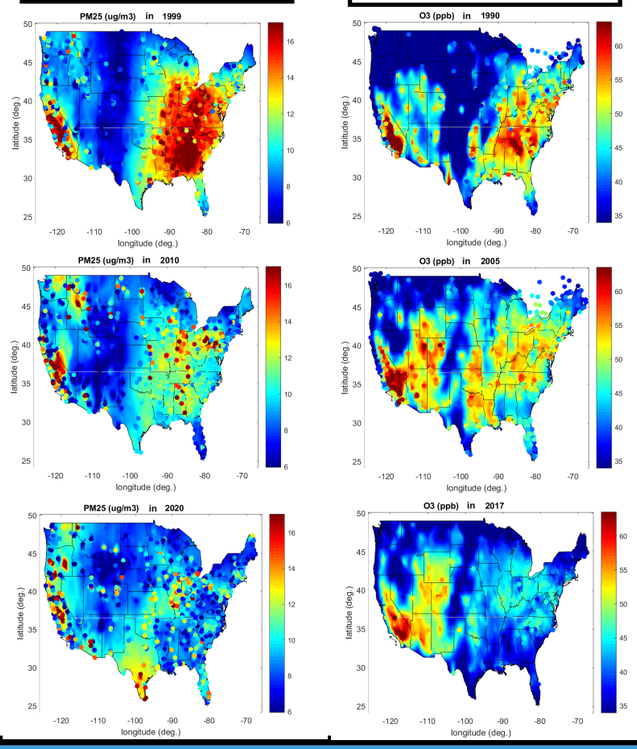
$$Y = Y_0 (1-\exp(-\beta \Delta X)) * Pop$$

- Beta for $PM_{2.5}$ is from Krewski et al. (2009) (RR=1.060, [1.040, 1.080]) for all-cause mortality, and for O3 from Jerrett et al. (2009) for respiratory mortality (RR=1.040, [1.010,1.067])

RESULTS

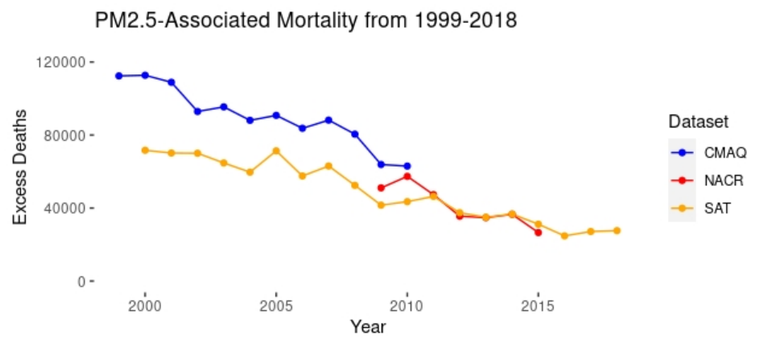
BME CONCENTRATION DATASET

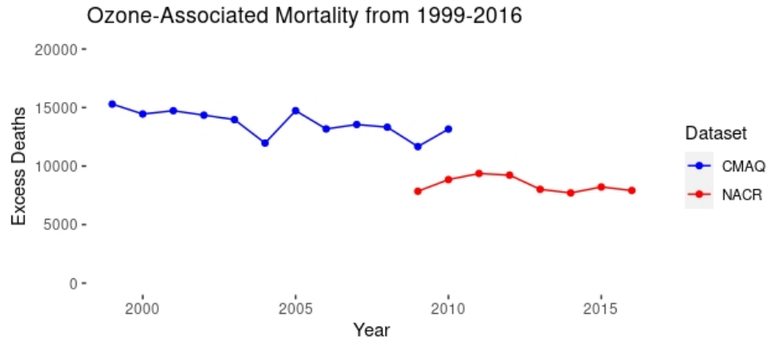
$PM_{2.5}$ (1999-2020) | O_3 (1990-2017)



RESULTS

TRENDS IN MORTALITY





FUTURE WORK

- Mortality will also be calculated using the BME dataset, in addition to the full time period for the NACR dataset.
- The BME dataset will be improved upon and better account for uncertainty through data fusion with modeled values.
- Separate trends in mortality by population change, concentration change, and baseline mortality rates.

References

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