Transportation Conformity
Hot-spot Analyses

TRB Near-Road Air Quality Workshop
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Overview

- Background
  - Near-road health effects
  - EPA's hot-spot analysis requirements
  - CO and PM monitoring information

- Lessons learned and best practices for future research

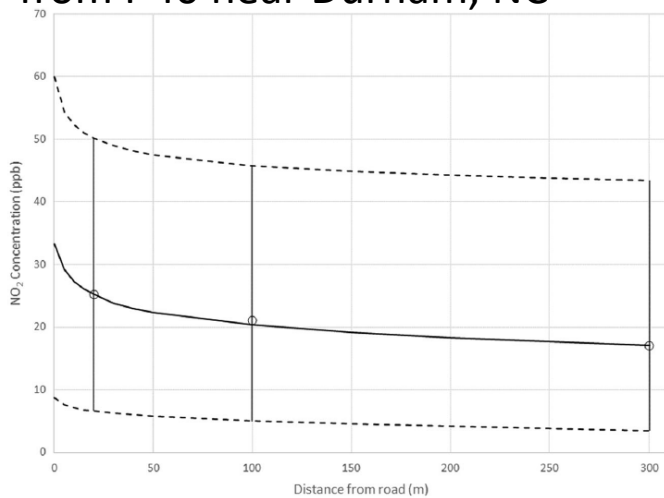# Background

Public Health Concerns

- Populations living near roads have elevated rates of health problems, including
  - Pediatric asthma onset and symptoms
  - Pediatric leukemia
  - Impaired lung function growth
  - Cardiovascular disease
  - Premature mortality
- Enormous body of literature has required periodic expert reviews
  - HEI
    - In 2010, published expert panel report on literature published through mid-2008
    - Now engaging new panel to review post-2008 literature, to be complete in late 2020
  - CDC: 2014 meta-analysis on child leukemia
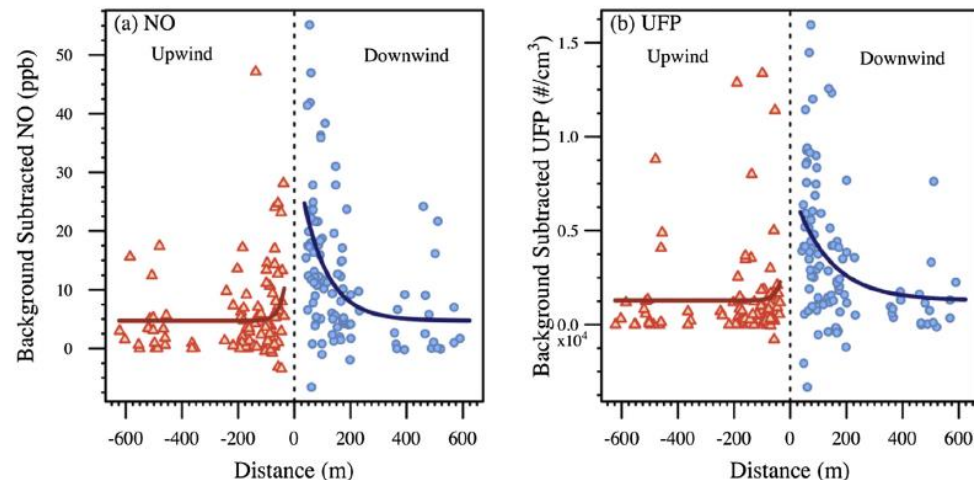 - NTP: recently published review of traffic pollution and pregnancy-associated hypertension
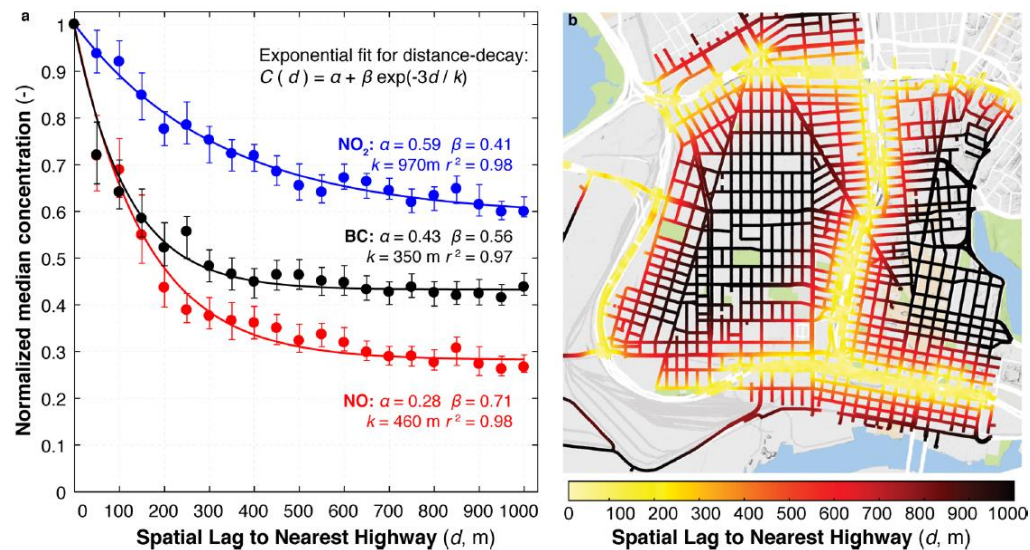

PubMed Articles with Keywords, "Traffic Pollution Epidemiology"

count — cumulative since 1968
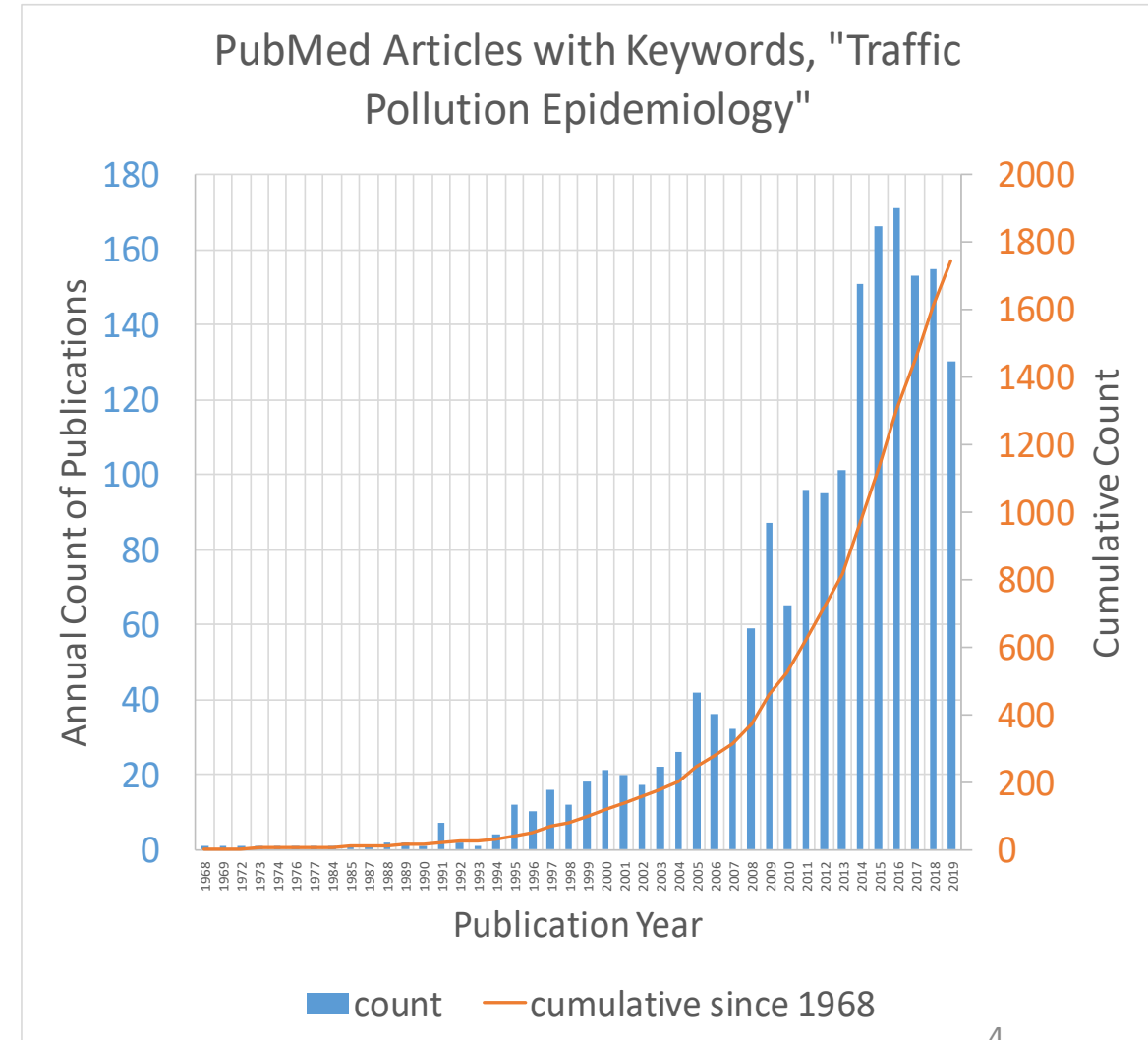
Examples of Recent Research
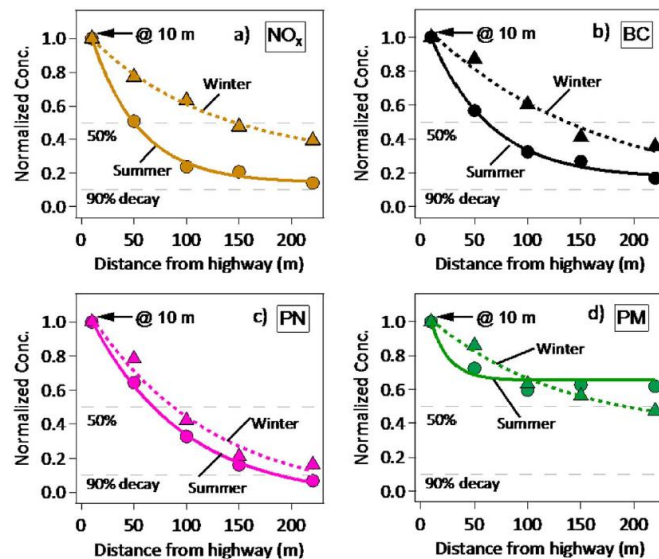
Saha et al., 2018 – Field data from I-40 near Durham, NC

Baldwin et al., 2015 – From mobile monitoring in Detroit, MI in Winter 2012

Richmond-Bryant et al., 2017 – Field data from Las Vegas monitors around I-15

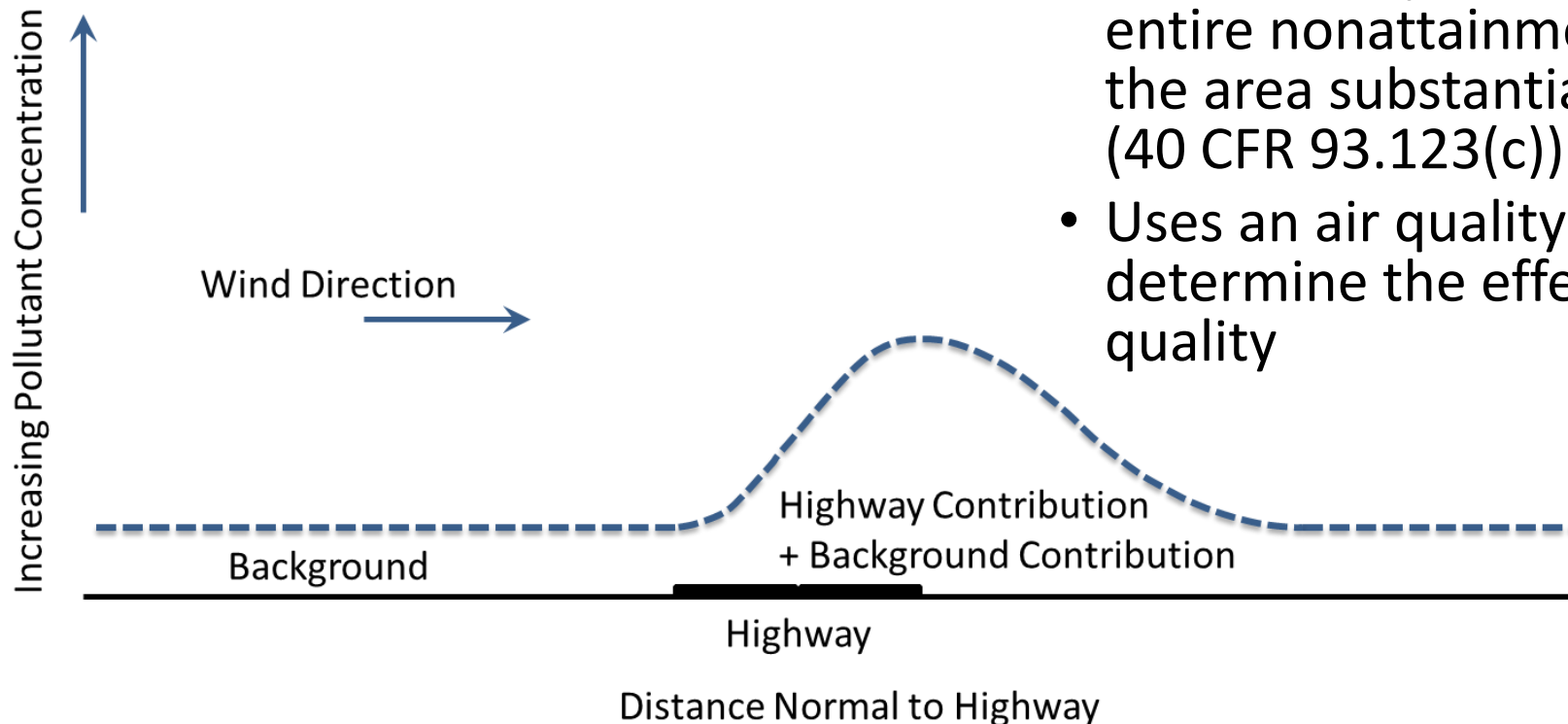Apte et al., 2017 – Using mobile monitors in Google's StreetView cars

5

EPA's Hot-Spot Analysis Requirements

- CAA section 176(c) requires that federally supported transportation plans, transportation improvement programs (TIPs) and projects in nonattainment and maintenance areas cannot:
  - Cause or contribute to new air quality violations,
  - Worsen existing violations, or
  - Delay timely attainment of the national ambient air quality standards (NAAQS) or interim milestones

- Transportation conformity determinations are required for non-exempt projects that receive either FHWA or FTA funding or approval

- For project-level conformity determinations, sometimes a hot-spot analysis is required:
  - In $PM_{2.5}$ and PM_{10} areas, only for those projects with a significant number or a significant increase in diesel vehicles
  - All projects in CO areas need some type of hot-spot analysis

What is a hot-spot analysis?

The transportation conformity regulation (40 CFR 93.101) defines *hot-spot analysis* as an estimation of likely future localized pollutant concentrations and a comparison of those concentrations to the relevant NAAQS

- Assesses impacts on a scale smaller than the entire nonattainment or maintenance area - the area substantially affected by the project (40 CFR 93.123(c))
- Uses an air quality dispersion model to determine the effects of emissions on air quality

Increasing Pollutant Concentration

Wind Direction

Background

Highway Contribution
+ Background Contribution

Highway

Distance Normal to Highway

PM Hot-spot Analyses to Date

- Requirement for quantitative hot-spot analyses in effect since 2012
- Since then, there have been about a dozen PM hot-spot analyses done for transportation conformity purposes
- Examples include
  - I-70 expansion in Denver;
  - Gordie Howe International Bridge in Detroit;
  - South Mountain Freeway in Phoenix;
  - I-69 Section 5 in Indianapolis

For More Information

- EPA web site for project-level conformity and hot-spot analyses:
  - https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses
- Includes links to:
  - PM Hot-spot Guidance
  - Guidance on Using MOVES for Project-level CO Analyses
  - FHWA's Categorical Hot-spot Finding (for CO)
  - Guidance on New R-LINE Additions to AERMOD
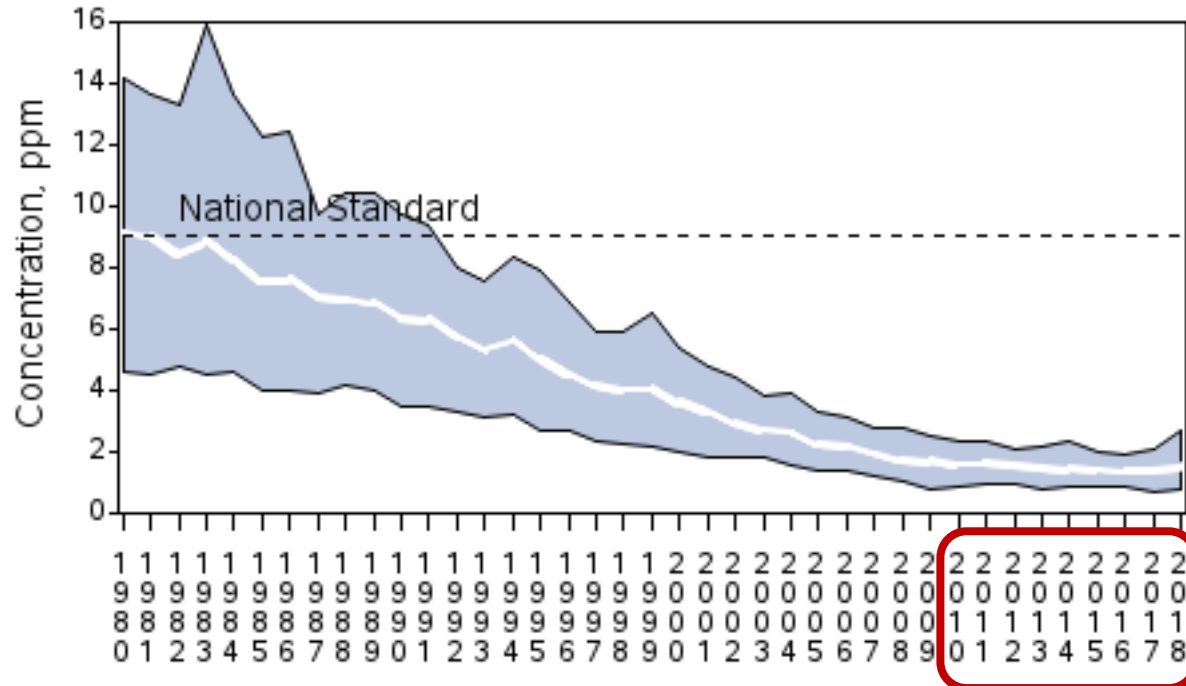 - Hot-spot training information
  - FAQs

CO and PM Monitoring Information
Key for next slides

https://www.epa.gov/air-trends/air-quality-trends-how-interpret-graphs
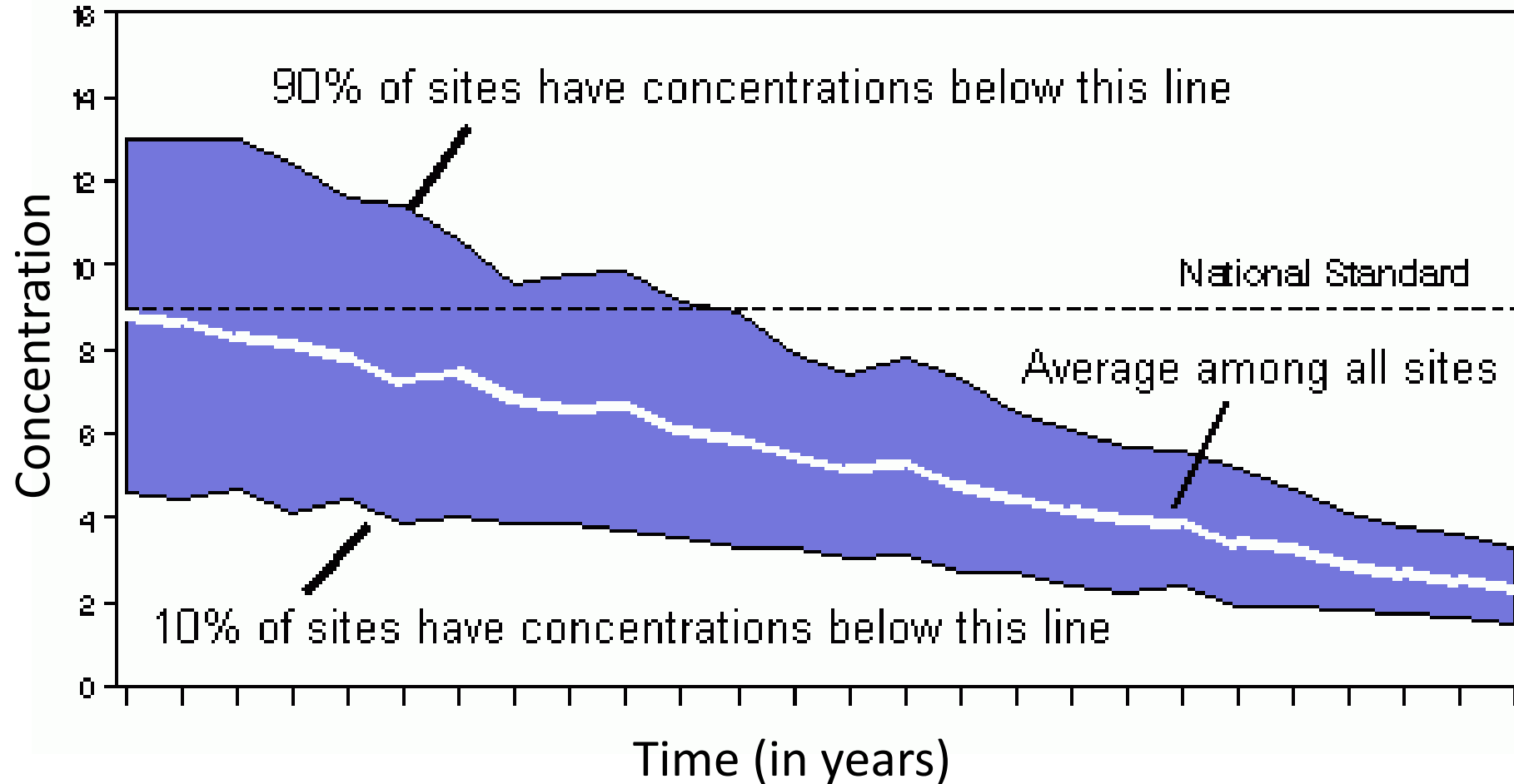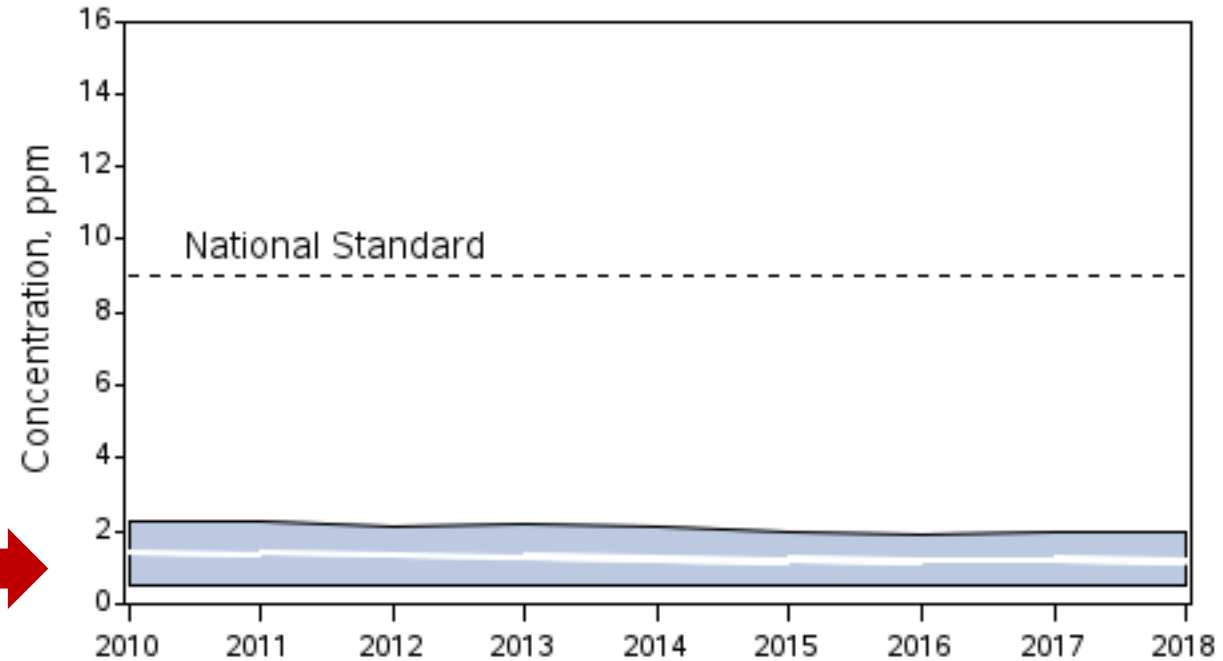
CO Air Quality, 1980 - 2018
(Annual 2nd Maximum 8-hour Average)
National Trend based on 44 Sites

1980 to 2018 : 83% decrease in National Average

CO Air Quality, 2010 - 2018
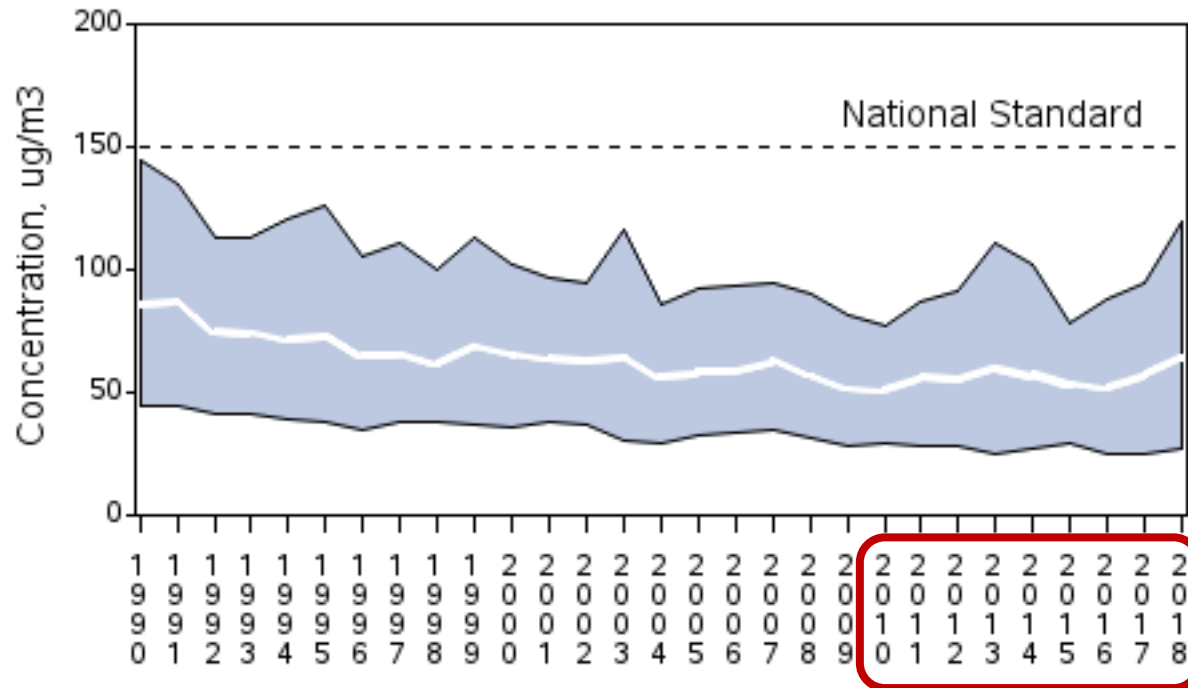(Annual 2nd Maximum 8-hour Average)
National Trend based on 213 Sites

2010 to 2018 : 15% decrease in National Average

https://www.epa.gov/air-trends/carbon-monoxide-trends

PM10 Air Quality, 1990 - 2018
(Annual 2nd Maximum 24-Hour Average)
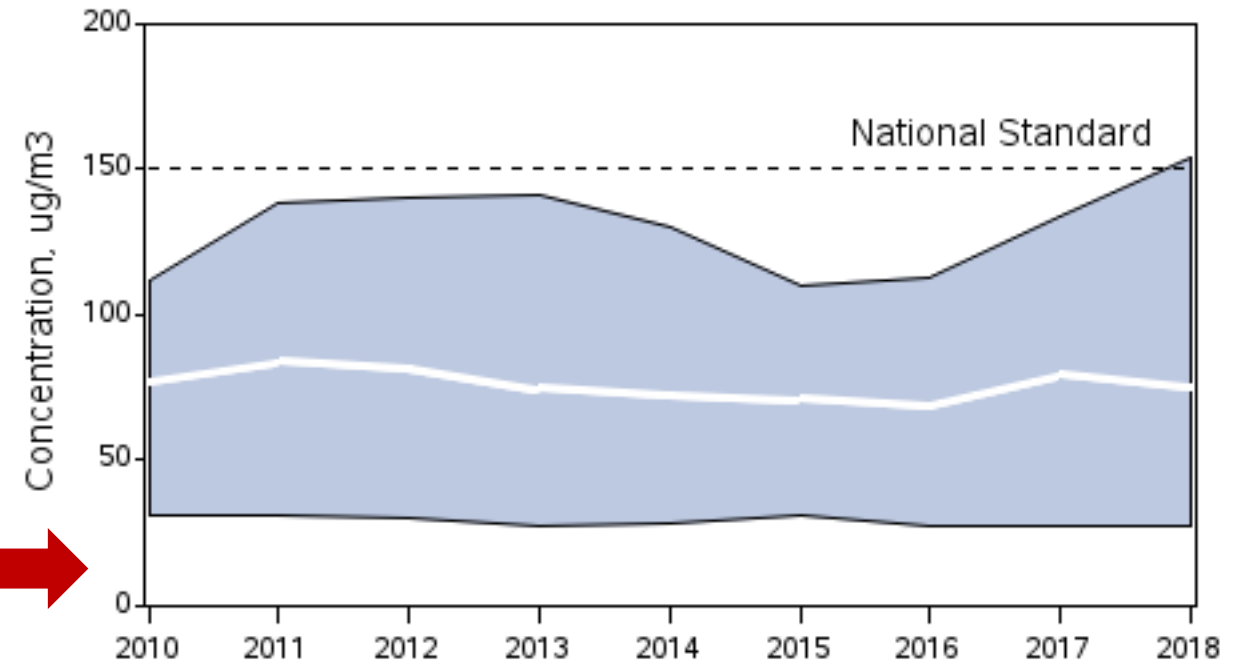National Trend based on 121 Sites

1990 to 2018 : 26% decrease in National Average

PM10 Air Quality, 2010 - 2018
(Annual 2nd Maximum 24-Hour Average)
National Trend based on 556 Sites
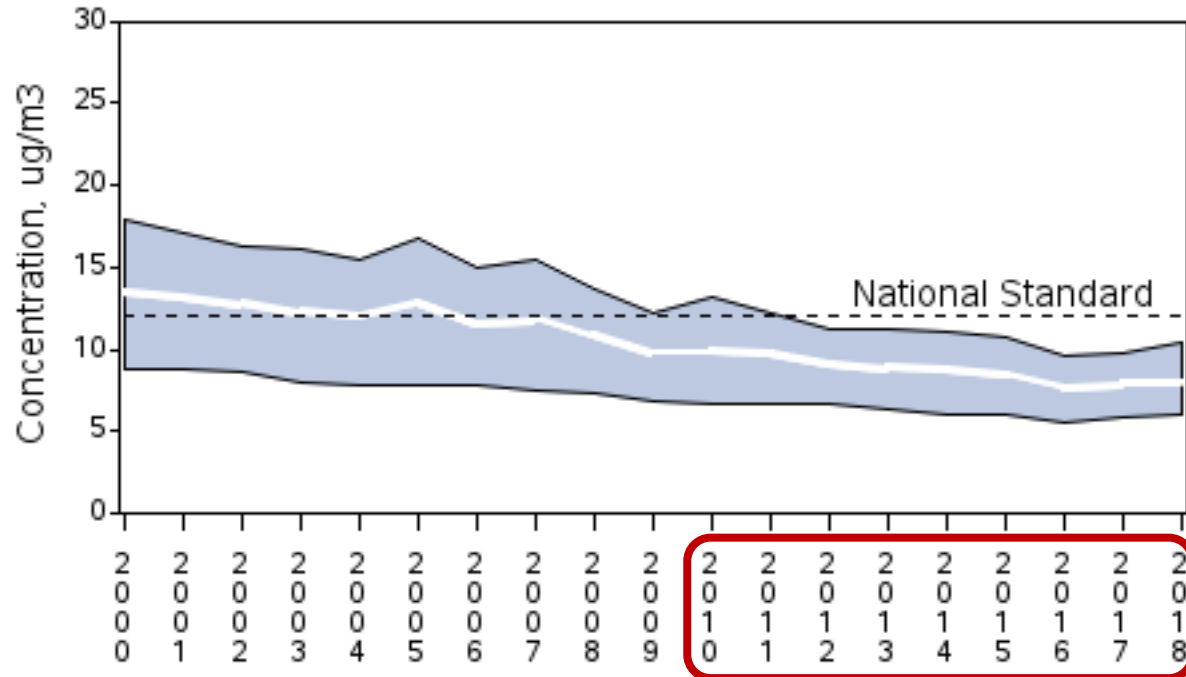
2010 to 2018 : 2% decrease in National Average

https://www.epa.gov/air-trends/particulate-matter-pm10-trends

https://www.epa.gov/air-trends/particulate-matter-pm25-trends
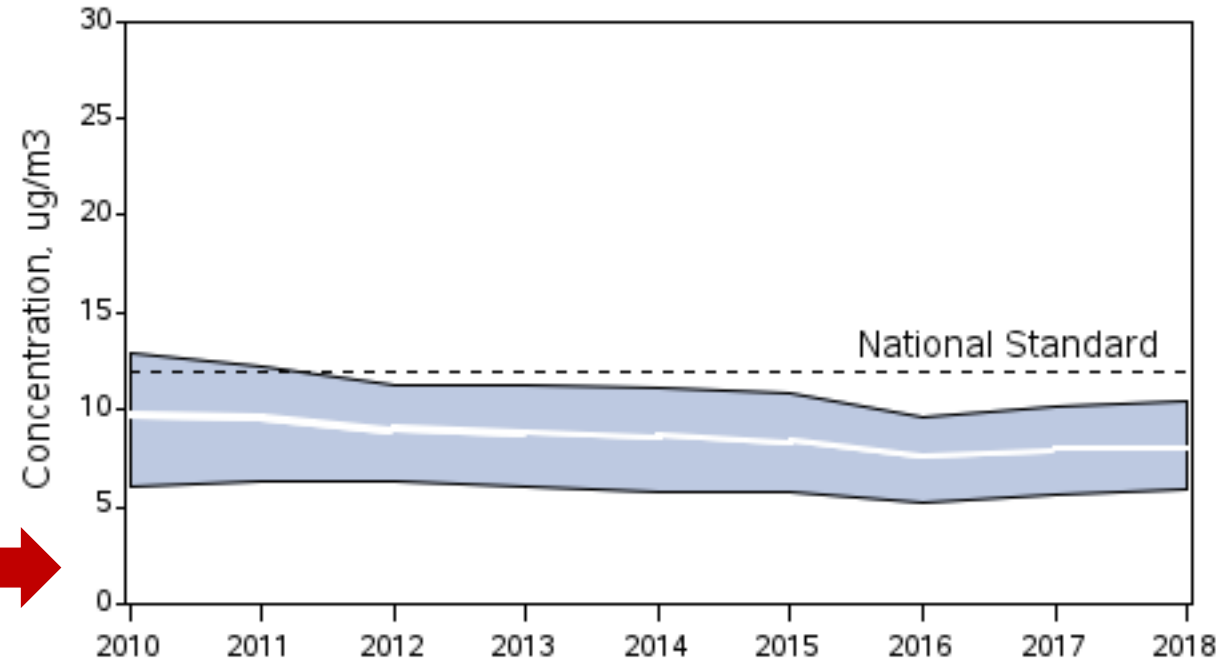
Lessons Learned and Best Practices for Future Research

Lessons Learned to Date

- Model-to-monitor studies based on emissions from traffic are difficult to do well:
  - Since traffic data underlies the entire analysis, study should focus on obtaining detailed and accurate data
  - Analysis of data must be done appropriately, e.g., averaging data such as vehicle speeds, temperatures, or wind speeds not appropriate
- These studies are not conducted in same way or for same purpose as a hot-spot analysis
- For advancing the science of modeling, the most useful research would focus on
  - traffic data and vehicle operating modes, and
  - tracer gas studies

Model-to-Monitor Studies

- These studies seek to compare model results with measured data
- Two main types, based on either
  - emissions from traffic, or
  - tracer gas
- Each of these types of studies has advantages and disadvantages
  - Important to consider before embarking on research

Model-to-Monitor Studies

Based on emissions from traffic:

- May be able to use data sources established for other purposes, e.g., near road monitoring data or traffic monitoring data

- Uncertainty about emissions: even with good data for speed and number of vehicles, usually need to make assumptions, e.g., vehicle types, ages, fuel used, drive cycles

- Uncertainty about background: even with a monitor representing background, there may be other sources influencing concentrations

- May need to match averaging periods when using traditional PM monitors

Based on tracer gas:

- Source emissions rate and other characteristics are known: reduces uncertainty in traffic, emissions, and background concentrations

- Usually more monitors deployed, so greater spatial coverage

- Limited by length of study, number of met conditions evaluated, and logistics of making sure wind is the "right" direction

- Expertise needed, e.g., outfitting vehicles to release tracer gas correctly

What can model-to-monitor studies inform?

- Studies based on traffic emissions:
  - Because of inherent uncertainty, not as well-suited for assessing model accuracy
  - May be more useful for evaluating gradients predicted, i.e., rate of decrease in concentration the model predicts over distance
  - May be more useful for evaluating what contributes to error: are errors larger in certain hours, under certain meteorological or traffic conditions?
  - May be useful for evaluating sensitivity to assumptions
- Studies based on tracer gas:
  - Can generate data either for model algorithm development or evaluation

Best Practices for Studies Based on Emissions from Traffic

- Robust traffic data collection is needed:
    - If the plan is to model each lane as a source, data by lane is necessary
    - Need to know not only counts, but vehicle types, speeds
    - Even when known, speed data does not reveal operating mode
- Ideally, use video and analyze it to obtain information about both vehicle type and activity
    - Activity should not be averaged: at any moment, some vehicles accelerating, some decelerating, some cruising
    - Hour by hour congestion will differ, which will affect vehicle numbers, speeds, and activity
- License plate studies, connected to VINs, would be helpful to characterize the fleet as accurately as possible
    - Could identify actual vehicle types and fuel type used (e.g., are some passenger cars diesel? Are some electric? Which trucks are gasoline vs. diesel? Etc.)
    - Could indicate whether high-emitters are present (one or two could skew results)
    - Would provide accurate age distribution
    - If not available, need to think carefully about whether county average is appropriate

Best Practices for Studies Based on Emissions from Traffic, continued

- High-resolution meteorological data is needed
  - On-site meteorological data is important: met data, such as wind speed and direction, can differ across small distances
  - Even hourly data may be too coarse: some hours may not be clearly upwind or downwind
  - Wind vectors should not be averaged across a day
- If upwind monitors are measuring higher concentrations than downwind monitors, these data should not be used in the comparison
  - "Downwind" monitors can be higher due to other sources around them
  - Dispersion models cannot produce negative numbers due to mass conservation

What type of research would be valuable?

- More research and data collection about traffic: composition, age, activity
  - Currently difficult to QA/QC traffic data
  - For hot-spot analysis, would be useful to have operating mode distributions for various types of traffic conditions
- More research about travel modeling: how well do these models predict future traffic volumes and speeds?
  - How can these models and their inputs be improved?
  - What are the best ways to communicate model choices transparently?
  - How can the features of the most accurate models be available to more agencies?
- Additional tracer gas studies
  - Producing independent data sets for use in developing model algorithms, or for evaluation of AERMOD algorithms still ALPHA or BETA