Transportation Conformity Hot-spot Analyses

TRB Near-Road Air Quality Workshop
January 16, 2020

Laura Berry
Transportation and Climate Division, Office of Transportation and Air Quality, U.S. EPA
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"](image-url)
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

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

![Diagram showing wind direction and pollutant concentration over distance normal to highway.](image)
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:

- 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

90% of sites have concentrations below this line

National Standard

Average among all sites

10% of sites have concentrations below this line

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

National Standard

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

National Standard

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

https://www.epa.gov/air-trends/particulate-matter-pm10-trends
PM2.5 Air Quality, 2000 - 2018
(Seasonally-Weighted Annual Average)
National Trend based on 412 Sites

2000 to 2018: 39% decrease in National Average

PM2.5 Air Quality, 2010 - 2018
(Seasonally-Weighted Annual Average)
National Trend based on 649 Sites

2010 to 2018: 16% decrease in National Average

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