PM Hot-spot Modeling: Lessons Learned in the Field

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Overview

- Background
- State and local lessons learned so far
- Summary and conclusions for future air quality modeling implementation
Conformity Requirements

- CAA and transportation conformity rule (40 CFR Part 93) require that federally supported transportation projects in nonattainment and maintenance areas cannot:
  - Cause or contribute to new air quality violations,
  - Worsen existing violations, or
  - Delay timely attainment of the NAAQS or interim milestones

- A hot-spot analysis is an estimation of likely future localized pollutant concentrations and a comparison to the CO, PM$_{2.5}$, and PM$_{10}$ NAAQS
  - In PM areas, required for major new or expanded highways, intersections, or terminals that significantly increase diesel traffic

- A project meets conformity, if at each appropriate receptor:
  - PM concentration of build $\leq$ NAAQS, or
  - PM concentration of build $\leq$ PM concentration of no-build
In December 2010, EPA released original PM Hot-spot Guidance
  » Developed through Agency-wide effort and stakeholder involvement
  » EPA’s November 2013 guidance update supersedes the 2010 guidance

Provides first-of-its-kind method for estimating air quality impacts of specific transportation projects
  » Emissions from EPA’s MOVES model → input to AQ model (AERMOD)
  » Estimate a project’s impact on air quality concentrations
  » Relevant for other modeling applications
Example of Project Needing a PM Hot-spot Analysis
In general, MOVES is being successfully used for PM hot-spot analyses

General observations include:

- Modeling based on all four quarters (i.e., 16 MOVES runs)
- Meteorology based on temperature and humidity from regional conformity analysis for county where projected located
- Average speed option is being used for highway analyses
- Some questions regarding fleet mix (see next slide)

Interagency consultation has been important to determine appropriate MOVES inputs (including available data)
Some questions about fleet mix

- Fleet mix (linksourcetype input) should be based on latest regional conformity analysis or SIP
- LD/HD mix should be specific to the project

Weight regional fleet mix by project-specific LD/HD mix

- LD = 11,21,31,32
- HD = 41,42,43,51,52,53,54,61,62
## Selecting an Appropriate Air Quality Model

<table>
<thead>
<tr>
<th>Type of Project</th>
<th>Recommended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway and intersection projects</td>
<td>AERMOD, CAL3QHCR</td>
</tr>
<tr>
<td>Transit, freight, and other terminal projects</td>
<td>AERMOD</td>
</tr>
<tr>
<td>Projects that involve both highway/intersections and terminals, and/or nearby sources</td>
<td>AERMOD</td>
</tr>
</tbody>
</table>

- Recommendations are consistent with EPA’s current recommended models in 40 CFR Part 51, App. W, approved models on SCRAM

- PM hot-spot analyses are refined analyses; CAL3QHC is not appropriate for modeling refined PM hot-spot analyses

**Guidance Reference:**
- Exhibit 7-2 & Sec. 7.3.1
Characterizing Emission Sources

<table>
<thead>
<tr>
<th>Line Source</th>
<th>Point Source</th>
<th>Area Source</th>
<th>Volume Source</th>
</tr>
</thead>
</table>
| Different source types can be used in a hot-spot analysis to represent... | • Highways and intersections | • Bus garage or transit terminal exhaust stacks | • Transit or freight terminals  
• Parking lots  
• Highways and intersections |

Model | AERMOD*  
CAL3QHCR | AERMOD | AERMOD |

*AERMOD can simulate line sources using a series of adjacent area or volume sources.

*Note: Only approved versions of models on SCRAM can be used for PM hot-spot analyses.

Guidance Reference:  
Sect 7.3.2, 7.4, App J.3.3-3.5
Air Quality Modeling Issues in Field

- Characterizing area and volume sources
- Obtaining representative meteorological data
- Specifying receptors in project area
- Running the air quality model

Note: Interagency consultation has been important for determining appropriate air quality model, methods, and data
Area Source Characterization

\[(X_1, Y_1), (X_2, Y_2) = \text{Coordinates of area source end-points}\]

\[W = \text{Roadway width}\]

\[S_{\text{init}} = \text{Initial depth of plume}\]

- Area sources create a uniform emission characterization of a roadway
- Note: A warning will be generated in AERMOD if the aspect ratio is greater than 100 – this can be ignored
Area Source Characterization

- Most projects will include many roadway links
- Area sources may be easier to use:
  - $(X_1,Y_1),(X_2,Y_2)$ defined for each source
- GIS software is essential for this process
A Highway Link as a Series of **Volume** Sources

- Xs, Ys = Coordinates of volume source center
- Syinit = Initial lateral dispersion coefficient (W / 2.15)
- Szinit not shown

**Exclusion zone** (radius = Syinit * 2.15 + 0.99 m)
Volume Sources

Issues to consider when using volume sources:

1. Source width

2. Spacing
Volume Sources: Appropriate Width

- Receptors should not be placed within exclusion zone
  - based on EPA guidance from OAQPS
  - concentrations are not calculated within it

- Receptors should be sited as near as 5 m from a source (e.g., the edge of a traffic lane)

- Because of the exclusion zone, the width of a volume source should be $\leq 8 \text{ m}$
  - Typical highway lane = 12 ft (3.6 m)

- Model any 3 lane or larger highway using
  - Volume sources for each lane, or
  - Area sources

Guidance Reference:
Section 7.6.2
Incorrect Volume Source Width

- Volume sources are too wide, excluding area where receptors should be placed
- $W = \text{Link width}$
Correct Volume Source Width

- Volume sources are no more than 8 m wide
  - Receptor A is no longer in the exclusion zone
Incorrect Volume Source Spacing

- Volume sources are spaced too far apart, which creates a non-uniform emission characterization.
- Adjacent receptors, depending on their proximity to the center of a volume source, are over/underestimated.

MOVES emission rate (e.g. 3.2E-04 g/s)
Correct Volume Source Spacing

- Adjacent volume sources, spaced properly, create an even emissions characterization

MOVES emission rate
(e.g. 8.0E-05 g/s)
Obtaining Met Data

- Use most recent 5 consecutive years of representative off-site data (most common)
  - Assess representativeness based on latest AERMOD Implementation Guide
  - State air quality agency has experience providing met data for NSR/PSD permitting applications, will likely have pre-processed data available

- Surface station data should be from an ASOS station
  - Met data should be processed with AERMINUTE and the most recent version of AERMET
  - Appropriate threshold value: 0.5 m/s (Consistent with OAQPS guidance in March 8, 2013 memo)

- Most PM hot-spot analyses will be done in urban or suburban areas, where URBANOPT should be used
Placing Receptors for AQ Modeling

- Receptor spacing should be of sufficient resolution to capture concentration gradients around the locations of maximum modeled concentrations
  - Receptors should begin 5 m from roadway edge, extending out ~500 m
  - Dense spacing (e.g., 25 m) near areas of potential high concentrations (near-road), less dense (e.g., 100 m) further away from high emitting sources

- Place receptors in locations public can access (e.g., sidewalks, neighborhoods, parks)

- Consider excluding locations where public cannot access (e.g., fenced private property, within right-of-way, on-facility)

Guidance Reference: Sections 7.5 and 7.6
Defining Receptors
Running the Model

- Hot-spot analyses may cover large geographic areas (e.g., a 15 mile long highway expansion) and include hundreds of sources and potentially thousands of receptors.

- EPA recommends the following strategy to minimize AERMOD run-times:
  - Modeling the areas of highest likely impact:
    - May be evident from traffic volumes, emission rates
    - Can be determined from an iterative modeling process (using FASTALL and/or coarse receptor grid)

- Some users have expressed interest in parallel processing:
  - Use of commercial software is covered in a Dec 2007 EPA clarification memo
  - Decisions on the use of third-party software is the EPA Region’s responsibility
EPA created an interface between the MOVES emission model and the AERMOD dispersion model.

- Designed specifically for use in PM Hot-spot Analyses – Available only for **Area** sources at this time
  - Uses output from 16 MOVES runs (representative time periods)
  - Produces SEASONHR EMISFACT table that can be used directly in an AERMOD input file

- Script can be run through the MOVES GUI

- Download package available on the MOVES Tools website: [http://www.epa.gov/otaq/models/moves/tools.htm](http://www.epa.gov/otaq/models/moves/tools.htm)
Other EPA PM Hot-spot Tools

- **Emission Rate Post-processing Tool (now in MOVES2010b)**
  - Automates the summing of MOVES emissions for PM or CO project-level analyses (e.g., PM grams/hour or grams/mile)

- **24-hour PM$_{2.5}$ NAAQS Design Value Tool**
  - Automates a computationally intensive process for this NAAQS
  - Design value calculations for other PM NAAQS are less complicated and can be done using a spreadsheet

- If you have suggestions for other tools, contact EPA at: conformity-hotspot@epa.gov
For More Information

- See EPA’s conformity project-level website for:
  - Regulations, policy guidance, FR notices, training
  - [www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm](http://www.epa.gov/otaq/stateresources/transconf/projectlevel-hotspot.htm)

- See EPA’s MOVES website for:
  - Software, MOVES MySQL scripts, technical documentation, and other helpful background materials
  - [www.epa.gov/otaq/models/moves/](http://www.epa.gov/otaq/models/moves/)

- Questions?
  - Specific questions on a particular project analysis
    - Contact appropriate EPA Region or DOT field office
  - General questions on PM hot-spot guidance and training
    - patulski.meg@epa.gov
  - Technical questions about guidance document
    - conformity-hotspot@epa.gov