Southeastern State’s Experience with MOVES

Technical Challenges and Solutions

presented to
Tennessee Model Users Group

presented by
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Transportation leadership you can trust.
Overview

- MOVES Experience in the Southeast
- Overview of MOVES Challenges
- Technical Challenges & Solutions
  - Linking Travel Demand Models to MOVES Input Data (Emissions Preprocessor)
  - Linking Travel Demand Models to MOVES Output Data (Emissions Postprocessor)
- Additional Resources
MOVES Experience in the Southeast
Florida

Florida DOT Systems Planning Office:

- Developed first Air Quality Postprocessor in FL using MOVES as an emission rate model and integrated within Florida Standard Urban Transportation Model Structure (FSUTMS)
- Provided training to FDOT D3 and MPO staff

Hillsborough County MPO (Tampa):

- Using MOVES greenhouse gas (GHG) emission rates by speed to calculate GHG emissions for LRTP scenarios using Access based postprocessor
CS’ MOVES Experience in the Southeast (Cont’d)

**Georgia**

» Atlanta Regional Commission:
  - Providing guidance on how to update Cube air quality postprocessor to reflect MOVES
  - Provided training to ARC staff on running MOVES, input requirements, and data options.

**Tennessee**

» Chattanooga TPO:
  - Updating TransCAD air quality postprocessor to reflect MOVES
Overview of MOVES Challenges
The MOVES Model

- U.S. Environmental Protection Agency (EPA) model for estimating emissions from highway vehicles

- Required for State Implementation Plan (SIP) and transportation conformity emissions inventories after March 2012

Key Challenges

- New data input requirements
- New structure requires new methods of interfacing with travel demand models
## MOVES Input Data Requirements

### General Parameters
(minimum required to run MOVES)
- Description
- Scale
- Time Spans
- Geographic Boundaries
- Vehicles
- Road Type
- Pollutants/Processes
- General Output
- Output Emissions Detail

### County Data Manager
(required for SIPs and conformity)
- Meteorology
- Source Type Population
- Age Distribution
- Vehicle Type Vehicle Miles Traveled (VMT)
- Average Speed Distribution
- Road Type Distribution
- Ramp Fraction
- Fuel Supply
- Inspection and Maintenance (I/M) Program
Two Options for Applying MOVES

- Option 1: MOVES as an Emissions Inventory Model
  - Requires running of MOVES every time the travel demand model is modified
  - Uses output loaded network from travel demand model

- Option 2: MOVES as an Emissions Rate Model
  - Significantly reduces frequency of MOVES runs
  - Uses emissions rates from MOVES as inputs into travel demand model
What Options Are Other Regions Using?

Option 1: MOVES as an Emissions Inventory Model

» Metropolitan Washington COG (most work has been with MOVES as an inventory model, but still evaluating option 1 v. 2)

Option 2: MOVES as an Emissions Rates Model

» Chattanooga, TPO (TN)
» Atlanta Regional Commission (GA)
» Florida (statewide)
» Dallas-Fort Worth (TX)
» Houston (TX)
» Salt Lake City (UT)
» Baltimore (MD)
» Cincinnati (OH, KY, IN)
Technical Challenges & Solutions
Linking Travel Demand Models to MOVES Input Data (Emissions Preprocessor)
Data Requirements for County Data Manager

Likely Use Local VMT Population with MOVES National Default Vehicle Type Ratios

No National Defaults Available in MOVES (Must Use Travel Demand Model or HPMS Data)

National Defaults Available in MOVES (Obtain Interagency Approval to Use National Defaults)
Source (Vehicle) Type Population

- Number of vehicles in each year by 13 MOVES vehicle type categories
- Not required in MOBILE6
- Data source(s)
  - State Department of Motor Vehicles (registration data)
  - R.L. Polk data (cleaned up version of registration data)
  - MOVES defaults
- EPA converter available for areas that want to convert MOBILE6 vehicle types to MOVES
To predict vehicle population in future years

» EPA suggests scaling vehicle population in proportion to VMT or human population

» GA EPD method uses human population projections through 2030
Atlanta 13 County Vehicle Population

Source (Vehicle) Type

- 2002 - Polk Based
- 2002 - MOVES defaults
Age Distribution

- Distribution of vehicle population by age of vehicle

- Was required in MOBILE6

- Data source(s)
  - State Department of Motor Vehicles (registration data)
  - R.L. Polk data (cleaned up version of registration data)
  - MOVES defaults

- EPA converter available for areas that want to convert MOBILE6 vehicle types to MOVES
Vehicle Type VMT

- VMT traveled by vehicle type
  - As input to MOVES: VMT by 6 HPMS vehicle type categories
  - As used in AQPP: VMT by 13 MOVES vehicle types

- Optional in MOBILE6

- MOVES requires VMT by 6 HPMS vehicle types as an input, but outputs emission factors by 13 MOVES vehicle types

- Most travel demand models output VMT by total passenger trips and sometimes, by truck type or SOV/HOV
Vehicle Type VMT (continued)

- EPA encourages the use of local data for the six HPMS vehicle types and discourages the use of national defaults unless it is used to further break down the six HPMS types into the 13 MOVES vehicle types*

- Peer Review
  - MWCOG using combination of truck model data, vehicle registration data, and HPMS data
  - NCTCOG ran sensitivity tests using some type of local data
  - Florida considering use of HPMS data, although concerned about data quality

### Categories Between Travel Demand Model & MOVES

<table>
<thead>
<tr>
<th>Travel Demand Model</th>
<th>Model Output Trips</th>
<th>Local Data</th>
<th>6 HPMS Veh. Types for MOVES Input</th>
<th>13 MOVES Veh. Types for AQPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARC Model</td>
<td>3 Vehicle Type Categories: SOV/HOV/Commercial, Medium Trucks, Heavy Trucks</td>
<td>Model VMT by 3 Vehicle Types</td>
<td>Apply MOVES defaults to Model VMT by 3 Vehicle Types</td>
<td>Apply MOVES defaults</td>
</tr>
<tr>
<td>Florida DOT District 3 Model</td>
<td>1 Vehicle Type Category: Total Passenger Trips</td>
<td>VMT % Dist among 6 HPMS Vehicle Types</td>
<td>Apply % Dist. (6 Vehicle Types) to Model VMT</td>
<td>Apply MOVES defaults</td>
</tr>
<tr>
<td>Chattanooga TPO Model</td>
<td>1 Vehicle Type Category: Total Passenger Trips *</td>
<td>VMT % Dist among 6 HPMS Vehicle Types</td>
<td>Apply % Dist (6 Vehicle Types) to Model VMT</td>
<td>Apply MOVES defaults</td>
</tr>
</tbody>
</table>

*Light-, Medium-, and Heavy-Duty Truck trips not validated
Vehicle Type VMT – Link from ARC Model to MOVES

- Passenger Trips
  - SOV, HOV, Commercial
    - Motorcycles
    - Passenger Cars
    - Light Trucks
    - Buses
      - Single Unit Trucks
      - Combination Trucks
  - Medium Trucks
  - Heavy Trucks

- ARC Model
- ARC Truck Model
- HPMS
- MOVES
Vehicle Type VMT – Link from FL and Chattanooga Models to MOVES

- **Passenger Trips**
  - **Motorcycles**
  - **Passenger Cars**
  - **Light Trucks**
  - **Buses**
  - **Single Unit Trucks**
  - **Combination Trucks**

- **Model**
  - MOVES
  - HPMS
  - Model

**Right Side**

- **Motorcycles**
- **Passenger Cars**
- **Passenger Trucks**
- **Light Commercial Trucks**
- **Intercity Buses**
- **Transit Buses**
- **School Buses**
- **Refuse Trucks**
- **Single Unit Short-Haul Trucks**
- **Single Unit Long-Haul Trucks**
- **Motor Homes**
- **Combination Short-Haul Trucks**
- **Combination Long-Haul Trucks**
Average Speed Distribution

- Percent of vehicle hours traveled (VHT) found in each of the 5 mph speed bins

- Optional in MOBILE6

- Data source(s)
  - Travel Demand Model

- A separate distribution into the speed bins is required for each combination of:
  - Road Type
  - Source Type
  - Hour of Day
EPA acknowledges that it may not be available at this level of detail

A converter is provided to convert VMT distribution to VHT distribution
Road Type Distribution

- Distribution of VMT by 5 MOVES road types

- Optional in MOBILE6

- A separate distribution is requested for each of the 13 MOVES vehicle types

- Data source(s)
  » Summarize travel model results using MOVES road type/model facility type equivalency table
## County Data Manager for MOVES Runs

<table>
<thead>
<tr>
<th>County Data Manager Inputs</th>
<th>Excel Sheet Tab Name</th>
<th>Atlanta</th>
<th>Florida</th>
<th>Chattanooga (Under Development)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Type Population</td>
<td>sourceTypeYear</td>
<td>2002 RL Polk Data</td>
<td>State Registration Data (DMV)</td>
<td>(Investigating)</td>
</tr>
<tr>
<td>Age Distribution</td>
<td>sourceTypeAge</td>
<td>2002 RL Polk Data</td>
<td>State Registration Data (DMV)</td>
<td>(Investigating)</td>
</tr>
<tr>
<td>Vehicle Type VMT</td>
<td>HPMSVTypeYear</td>
<td>Truck portion of TDM plus MOVES defaults</td>
<td>HPMS Vehicle Type Distribution</td>
<td>HPMS Vehicle Type Distribution (Investigating reliability)</td>
</tr>
<tr>
<td></td>
<td>MonthVMTFraction</td>
<td>National Defaults</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DayVMTFraction</td>
<td>National Defaults</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HourVMTFraction</td>
<td>National Defaults</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Speed Distribution</td>
<td>avgSpeedDistribution</td>
<td>13 Co. and 7 Co. Distribution from TDM</td>
<td>Distribution from TDM</td>
<td>Distribution from TDM</td>
</tr>
<tr>
<td>Road Type Distribution</td>
<td>roadTypeDistribution</td>
<td>13 Co. and 7 Co. Distribution from TDM</td>
<td>Distribution from TDM</td>
<td>Distribution from TDM</td>
</tr>
<tr>
<td>Ramp Fraction</td>
<td>RoadType</td>
<td>National Default (8%) checked against local TDM output</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Technical Challenges & Solutions
Linking Travel Demand Models to MOVES Output Data (Emissions Postprocessor)
Emissions Modeling Process
Simplified Structure

1. Run MOVES
   - Reformat Emission Factors
   - Prepare Model Links
   - Calculate and Summarize Emissions
Emissions Postprocessor Development

3-Step Process Within Travel Demand Modeling Platform:

1. Reformat running and non-running emission factors from MOVES SQL database

2. Prepare travel model links (adjust centroid connector speeds, calculate intrazonal VMT, append HPMS functional class codes, check for missing HPMS functional class codes, append MOVES Road Type code, calculate HPMS adjustment factors and apply to model VMT if appropriate)

3. Apply running emission factors by travel model link and non-running emission factors by vehicle population to calculate emissions inventory
### Sample Output Emissions Report

#### SUMMARY OF AIR QUALITY FOR BAY COUNTY

<table>
<thead>
<tr>
<th>DESCRIPTION, HPMS FUNCTIONAL, Daily Model,</th>
<th>Daily Model,</th>
<th>Daily Model,</th>
<th>Annual Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME, CLASSES, UNADJ. VMT, NOX (grams), VOC (grams), CO2EQ (grams)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rural Interstate, 1, 0, 0, 0, 0</td>
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<tr>
<td>Rural Principal Arterial, 2, 801745.5, 1821768.6, 293022.3, 153257849360.6</td>
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<tr>
<td>Rural Minor Arterial, 6, 212405.6, 303478.8, 86821.7, 35361813660.2</td>
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<tr>
<td>Rural Major Collector, 7, 9935.9, 14031.5, 3814.2, 1606928251.6</td>
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<tr>
<td>Rural Minor Collector, 8, 0, 0, 0, 0</td>
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<tr>
<td>Rural Local, 9, 99594.6, 192833.1, 60184.4, 21081605546.6</td>
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<tr>
<td>Urban Interstate, 11, 0, 0, 0, 0</td>
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<tr>
<td>Urban Freeway, 12, 0, 0, 0, 0</td>
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<tr>
<td>Urban Other Arterial, 14, 2007735.8, 3157573.0, 1000693.9, 368735338227.1</td>
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<td>Urban Minor Arterial, 16, 779261.0, 1119808.7, 375044.3, 134575825393.8</td>
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<td>Urban Collector, 17, 727976.4, 1251992.0, 344296.1, 133658453360.5</td>
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<tr>
<td>Urban Local, 19, 590519.5, 1096614.2, 392403.8, 127977315444.3</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total Running Emissions | 8958099.9 | 2556280.7 | 976255129244.8 |
| Total Non-Running Emissions | 12328330.9 | 20617200.8 | 26974821875.2 |
| Total Emissions including Non-Running | 21286430.8 | 23173481.5 | 1003229951120.0 |

#### HPMS VEHICLE DESCRIPTION, CLASSES, UNADJ. VMT, NOX (grams), VOC (grams), Ann. CO2EQ (grams)

<table>
<thead>
<tr>
<th>HPMS VEHICLE DESCRIPTION, CLASSES, UNADJ. VMT, NOX (grams), VOC (grams), Ann. CO2EQ (grams)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles, 10, 24424.3, 15667.6, 57675.9, 3172567270.3</td>
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<tr>
<td>Private Auto, 20, 3441990.1, 3290262.9, 1380807.4, 501607442968.1</td>
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<td>Light Trucks, 30, 1476647.1, 2433189.5, 840314.4, 301539489755.2</td>
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<tr>
<td>Buses, 40, 5118.1, 65545.0, 4689.2, 2411204242.3</td>
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<tr>
<td>Single Unit Trucks, 50, 153313.6, 1026547.9, 168430.0, 62756334168.8</td>
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<tr>
<td>Combination Unit Trucks, 60, 127681.0, 2126887.1, 104363.9, 104768090840.1</td>
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</tr>
</tbody>
</table>
Sample Output Network with Running Emissions
Additional Resources
Additional Resources

- U.S. EPA’s MOVES website
  - http://www.epa.gov/otaq/models/moves/index.htm

- U.S. EPA Converter Tools
  - http://www.epa.gov/otaq/models/moves/tools.htm

- FHWA/AMPO MOVES Model User Group Web Conferences
  - http://www.ampo.org/content/index.php?pid=32