MOVES Review Work Group Update

May 22nd, 2018

Dr. Matthew Barth
Work Group Co-Chair
Director, Center of Environmental Research and Technology
Yeager Families Professor, University of California-Riverside

MOVES
Motor Vehicle Emission Simulator

EPA MOVES Model

- U.S. EPA's **Mo**tor **V**ehicle **E**mission **S**imulator estimates emissions and energy use from
  - Onroad vehicles: passenger cars, light- and heavy-duty trucks, buses, motorcycles
  - Nonroad equipment: construction, agricultural, industrial, lawn & garden, commercial, logging, airport support, oil & gas, mining, railroad service, recreational vehicles and boats
- MOVES accounts for national emission standards, vehicle populations and activity, local rules, fuels, and meteorology
- EPA uses MOVES to estimate emission impacts of mobile source emissions regulations and policies and to generate national inventories of air pollutants
- State and local agencies use MOVES to prepare emission inventories in State Implementation Plans and transportation conformity
- MOVES is also used in academic research and to model effects of policy choices

MOVES
Motor Vehicle Emission Simulator

MOVES Plans

- Currently using MOVES2014a
  - MOVES2014 released in October 2014; updated to MOVES2014a in November 2015

- Planning a minor update for summer 2018: **MOVES2014b**
  - Will not change onroad inventories
  - Improves nonroad emission estimates
    - NR engine population growth rates, NR Tier 4 emission rates, sulfur levels of NR diesel fuels
  - EPA is now testing and quantifying net impacts compared to MOVES2014a

- Next major version of MOVES
  - TBD, but 2019 at the earliest
  - Will include:
    - New data based on latest test programs and analyses
    - Latest vehicle population and activity data
    - Newer rules (e.g. Heavy-Duty Greenhouse Gas Phase 2)
    - Improved functionality and performance
  - Peer reviewed draft reports available

MOVES
Motor Vehicle Emission Simulator

MOVES Review Work Group

- Created by MSTRS to provide input on the development of MOVES
- Members have expertise in modeling emissions from highway and nonroad vehicles and represent a spectrum of stakeholders, including vehicle and engine manufacturers, fuel producers, state and local emission modelers, academic researchers, environmental advocates, and affected federal agencies
- From Fall 2016 – Fall 2018, EPA is presenting proposed updates to MOVES, including underlying data and analyses
- Starting in December 2017, presentations were invited by the work group committee members (Susan Collet, Chris Frey, Steve VanderGriend, Matt Barth, etc.)
- Work group members coordinate within their organizations and with their constituents to solicit specific comments on EPA's proposals
- The work group develops recommendations to the MSTRS based on the proceedings of work group meetings

MOVES
Motor Vehicle Emission Simulator

Work Group Discussion Topics

- June 2017 Meeting:
  - Revising Start/Soak Emissions for LDGV and HDV
  - Heavy Duty CNG category
  - Telematics: valuable for many aspects of MOVES
  - Updated Speciation Profiles
  - Updated Total Organic Gases
- September 2017 Meeting:
  - Updated NONROAD population rates
  - Updated LD Emission Rate Comparison
  - MOVES Future Fuel Supply Updates
- December 2017 Meeting:
  - Update for Tier-4 Nonroad Diesel Engines
  - Draft Tool to Model Ramps in Project Scale
  - Updates to MOVES HD Source Masses using VTRIS
  - Updates to HDV Fixed Mass Factor and Diesel PM rates
  - CRC 2017 and 2018 MOVES related projects
- March 2018 Meeting:
  - Ethanol Emission Effects in MOVES2014
  - Growth Energy Ethanol and Aromatics Testing
  - Trends and Needs for MOVES
- Future Topics:
  - Using MOVES for estimating shared, connected, and automated vehicle emissions
  - Inventory Impacts of MOVES2014b
  - Update on revising start-soak relationships for light-duty gasoline vehicles
  - Others, TBD

MOVES
Motor Vehicle Emission Simulator

Recommendations to MSTRS

- Short-Term Recommendations since May 2017: *(decisions that need to be made now to start coding for the next public version of MOVES)*
  - Incorporate additional data on LD & HD starts, including GDI PM and LD diesel (CARB data, etc.)
  - Add more options for CNG vehicles
  - Use the best data available to estimate nonroad equipment populations and technologies
  - Maximize use of emerging telematics data wherever possible
  - Reconsider how to handle Fixed Mass Factors for different model year groups
  - Use certification data to decide how to model pre-MY2010 particulate matter from HD vehicles

MOVES
Motor Vehicle Emission Simulator

Recommendations to MSTRS

Long-Term Recommendations: *Improve MOVES Current Capabilities with Updated Data & Analysis*

- Update modeling of Heavy Duty Diesel vehicles in MOVES:
  - Activity – incorporate latest heavy-duty vehicle project data sets, modify operating modes, and add road grade
  - Emissions – update with latest real-world data, including tampering, malfunction, and mal-maintenance.
- Invest in a robust data collection program to gather information on how vehicles are actually used in-use and associated emissions and emission control technology
  - Collect more data on light-duty & heavy-duty starts, including particulate matter and LD diesel.
  - Improve IM and non-IM rates
  - Make use of huge vehicle activity datasets that are becoming available (connected vehicle data, telematics) to improve driving cycles, starts activity and other defaults
- Update modeling of air conditioning impacts
- Improve modeling of brake and tire wear
- Update MOVES default fuel parameters and fuel effects, including ethanol effects in Tier 3 and GDI vehicles
- Evaluate MOVES estimates with comparisons to real-world data

MOVES
Motor Vehicle Emission Simulator

Recommendations to MSTRS

Long-Term Recommendations: *Expand MOVES Capabilities by Collecting New Data and Adding New Features*

- Improve modeling of alternative fuels and technology (ethanol, biodiesel, natural gas, electric vehicles, hybrid electric vehicles, gas direct injection, flex fuels), for both tailpipe and evaporative emissions.
- Better account for secondary organic aerosol (SOA)-precursors and ultra-fine particles
- Account for role of lubricating oil with respect to particle emissions
- Allow additional user inputs such as vehicle load or weight
- Improve MOVES capabilities for project level analyses:
  - Consider incorporating a true modal emissions model
  - Improve linkages with traffic models
  - Limit modeling of road grades to realistic levels
  - Continue improving the MOVES Ramp Tool, and create similar tools for acceleration and deceleration links for congested (arterial street) intersections
  - Consider adding libraries of vocational duty cycles
  - Make vehicle load a user input variable in MOVES
  - Add tools to help model project level activity, such as tools to calculate travel fraction by model year

MOVES
Motor Vehicle Emission Simulator

Recommendations to MSTRS

Long-Term Recommendations: *Make MOVES Easier to Use*

- Simplify MOVES onroad Source Types: e.g., combine some source types, converge with FHWA vehicle types
- Provide explicit output of diesel particulate matter
- Consider different interfaces for different uses (multiple graphical user interfaces)
- Create a “Scenario Manager” to allow users to better manage modeling multiple runs, compare incremental results, and automate post-processing
- Establish better methods of connecting MOVES to other models (SMOKE, etc.)
- Incorporate new options for improving processing time: e.g., consider pre-calculating look-up tables for cities or regions
- Provide documentation on how MOVES can be used as part of Life-Cycle Emissions Analysis
- Improve software installation and update processes, including providing test files that users can run to ensure that they have MOVES installed correctly and are generating valid results

MOVES
Motor Vehicle Emission Simulator

Additional Resources

- For more information on MOVES, please see the MOVES web page:

  https://www.epa.gov/moves

- Questions: Contact the MOVES Team at mobile@epa.gov

MOVES
Motor Vehicle Emission Simulator