

MOVES Briefing for NACAA

EPA Office of Transportation and Air Quality
March 3, 2009

MOVES



Outline

What is MOVES?

Functional comparison to MOBILE6.2

Model versions and schedule

Draft MOVES2009 results and implications

Next Steps

MOVES

- **MO**tor **V**ehicle **E**mission **S**imulator
- State-of-the-art modeling framework
- Will replace current models (MOBILE & NONROAD) and expand capabilities
- Designed to allow easier incorporation of large amounts of in-use data from a variety of sources
 - MOBILE structure limited ability to incorporate new emissions data

How is MOVES better than MOBILE6.2?

MOVES



MOBILE6.2 Uses Text Input and Output Files

```

example9.in - Notepad
File Edit Format View Help
MOBILE6 INPUT FILE
PARTICULATES      :
AIR TOXICS        :
POLLUTANTS        : HC CO NOX
SPREADSHEET       :
RUN DATA

>Example Run - Tests All M6.2 Pollutant Types
*
EXPRESS HC AS VOC :
EXPAND EVAP       :

SCENARIO REC      : Example Input File

CALENDAR YEAR     : 2002
*
SULFUR CONTENT    : 30.0
MIN/MAX TEMP      : 68.0  84.0
FUEL RVP          : 7.0

PARTICLE SIZE     : 10.0
PARTICULATE EF    : PMGZML.CSV PMGDRL.CSV PM
DIESEL SULFUR     : 500.0

GAS AROMATIC%    : 25.0
GAS OLEFIN%      : 15.0
GAS BENZENE%     : 1.5
E200             : 50.0
E300             : 85.0
OXYGENATE        : MTBE 15.1 0.50
                  : ETBE 17.6 0.05
                  : ETOH 10.0 0.45
                  : TAME 6.0 0.00
ADDITIONAL HAPS  : HAP_BASE.CSV
END OF RUN       :
    
```

```

EXAMPLE9 - Notepad
File Edit Format View Help
Calendar year: 2002
Month: Jan.
Altitude: Low
Minimum Temperature: 68.0 (F)
Maximum Temperature: 84.0 (F)
Absolute Humidity: 75. grains/lb
Nominal Fuel RVP: 7.0 psi
Weathered RVP: 7.0 psi
Fuel sulfur content: 279. ppm

Exhaust I/M Program: No
Evap I/M Program: No
ATP Program: No
Reformulated Gas: NA (See Air Toxics output)

Ether Blend Market Share: 0.550 Alcohol Blend Market Share: 0.450
Ether Blend Oxygen Content: 0.027 Alcohol Blend Oxygen Content: 0.035
Alcohol Blend RVP waiver: No

Vehicle Type: LDGV LDGT12 LDGT34 LDGT LDDV LDDT HDDV MC All Veh
GvWR: <6000 >6000 (All)
VMT Distribution: 0.4638 0.3052 0.1042 0.0357 0.0008 0.0017 0.0827 0.0060 1.0000

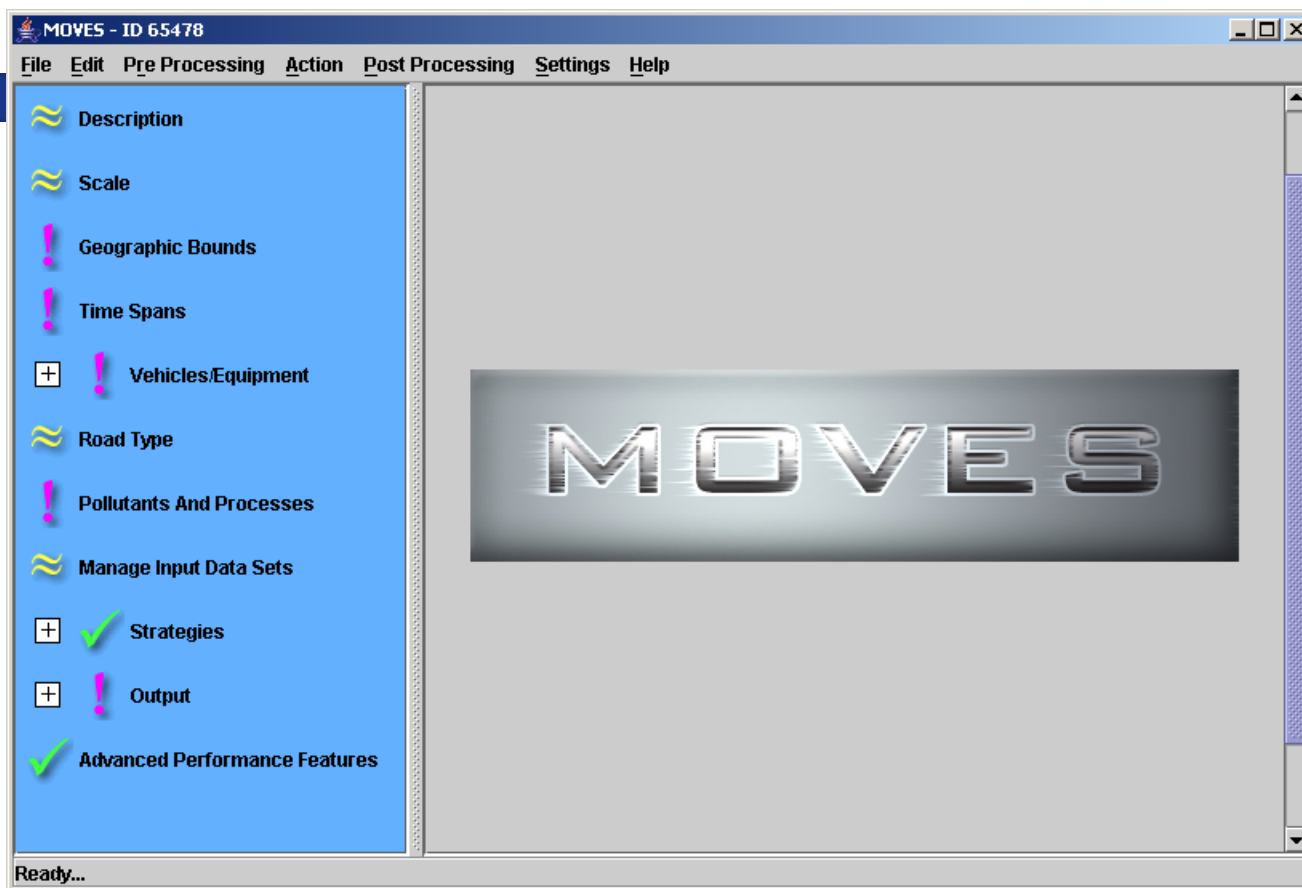
Composite Emission Factors (g/mi):
Composite VOC : 1.378 1.580 2.531 1.822 2.115 0.727 0.983 0.710 2.14 1.534
Composite CO : 14.10 17.32 25.48 19.39 19.82 1.713 1.704 3.687 11.77 15.568
Composite NOX : 1.172 1.352 1.745 1.452 5.137 1.650 1.699 16.061 1.23 2.661

Non-Exhaust Emissions (g/mi):
Hot Soak Loss: 0.157 0.119 0.193 0.138 0.212 0.000 0.000 0.000 0.109 0.138
Diurnal Loss: 0.019 0.018 0.031 0.022 0.036 0.000 0.000 0.000 0.006 0.019
Resting Loss: 0.128 0.119 0.206 0.141 0.256 0.000 0.000 0.000 0.379 0.128
Running Loss: 0.262 0.210 0.275 0.226 0.294 0.000 0.000 0.000 0.000 0.224
Crankcase Loss: 0.008 0.010 0.012 0.011 0.012 0.000 0.000 0.000 0.000 0.009
Refueling Loss: 0.093 0.157 0.222 0.174 0.338 0.000 0.000 0.000 0.000 0.126
Total Non-Exhaust: 0.667 0.634 0.938 0.714 1.148 0.000 0.000 0.000 0.494 0.645
    
```



MOVES

MOVES Has a Graphical User Interface



(MOVES can also be executed from a command line interface without use of the GUI, for batch or unattended operation)

New Software Structure

- **MOBILE6.2**
 - Written in Fortran, runs in DOS
 - Many data elements hard-coded (difficult to modify/update)
- **MOVES**
 - Java/MySQL software
 - Data elements stored in database tables (easy to modify/update)

More Flexibility

- **MOBILE6.2**
 - Gram/mile emission factors
 - Fixed output formats
- **MOVES**
 - Gram/mile emissions factors (grams/time for some processes)
 - Total emissions: inventories for specific areas and time periods
 - Easily customizable output (many levels of aggregation/disaggregation possible)

Multiple Geographic Scales

- **MOBILE6.2**
 - Emissions rates based on regional-scale trip patterns (no specific geographic area)
- **MOVES**
 - Emissions inventories can be calculated at the national level, county level, or project level
 - Lookup table option for emission rates

Modal Emissions

- **MOBILE6.2 rates based on aggregate driving cycles**
- **MOVES rates based on “operating modes”**
 - Second-by-second activity is captured by the model (does not need to be provided by users, but can be)

MOVES will be largely shaped by data collected since release of MOBILE6

✓ Activity

- In-use vehicle trip patterns
- Rural area activity data

✓ Light-duty vehicles

- Assessed millions of light-duty vehicles
- Landmark gasoline PM study (Kansas City)
- Remote Sensing Data

✓ Heavy-duty vehicles

- More than 100 in-use vehicles from WVU (E-55 plus)
- New on-board real-world driving data from over 300 vehicles

MOVES versions and schedule

MOVES



What have we done so far?

- **Released Draft MOVES2004 (1/2005)**
 - Includes energy consumption, greenhouse gases
- **Released MOVES Demo (5/2007)**
 - Basic structure of MOVES without criteria pollutant emission factors
 - Received and responded to comments on model function from several states
- **Previewed details of MOVES to FACA group**
 - Briefed stakeholders on MOVES details over several meetings of MOVES Review Workgroup since May 2007
 - NACAA reps: Mike Sheehan (NY), Chris Bovee (WI)

Draft MOVES2009

- **Developing Draft MOVES2009 for release at end of March 2009**
 - Adding criteria pollutant emission factor databases
 - Adding more features to simplify regional and project-level analysis for SIPs and conformity
- **Will be a draft model**
 - No official use requiring Draft MOVES2009
 - Cannot be used for SIPs or conformity analyses
 - Followed by public review, training, and EPA guidance development
 - May not include all data or features planned for official MOVES2009

New Features in Draft MOVES2009

- **Improving modeling of different domain sizes**
 - Adding GUI for county level (nonattainment area) and project level analysis to allow users to specify local inputs
- **Developing data importers which will:**
 - Allow input of data as Excel files
 - Ease conversion of MOBILE inputs to MOVES inputs
- **Result - Adding detailed local input data is much simpler in Draft MOVES2009 than in MOVES Demo**

Official MOVES2009

- **Official MOVES2009 planned for release at end of 2009**
 - Essential to allow states to use in next round of SIPs (due 2012 and 2013)
- **Will be official emissions model for on-road vehicles outside of California**
- **Use will be required for:**
 - State Implementation Plans (SIPs)
 - Regional conformity analysis
 - Following regional conformity grace period of 3 to 24 months
 - Project level conformity analysis for PM and CO
 - Following project level conformity grace period which could be shorter than regional conformity grace period
 - NEPA analysis (e.g., air toxics)

Early Draft MOVES2009 Results

MOVES



Early Draft MOVES Results

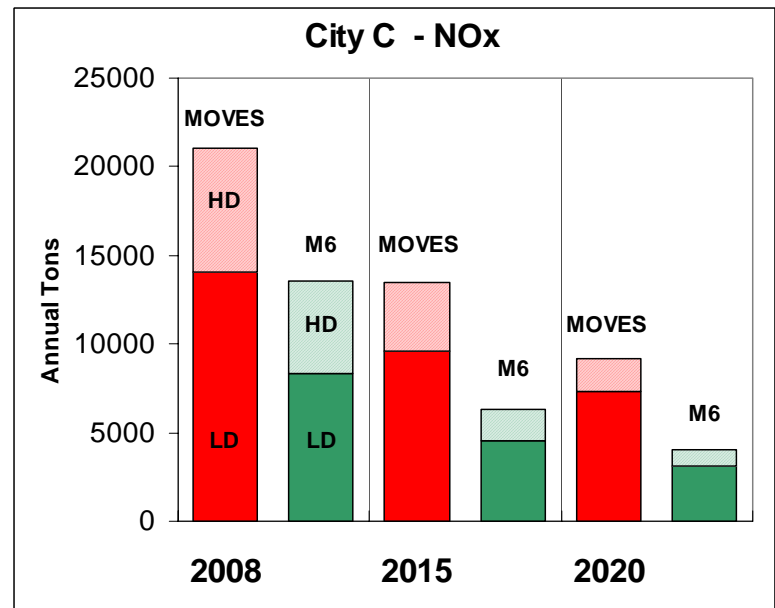
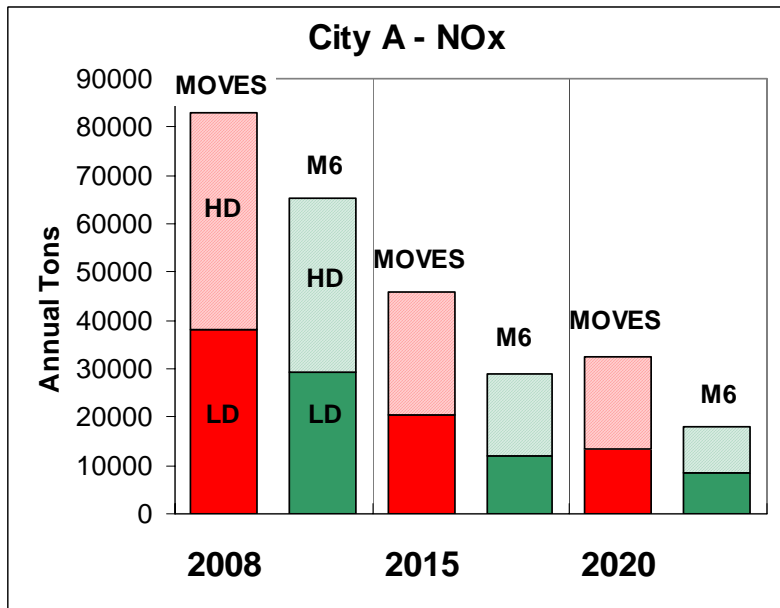
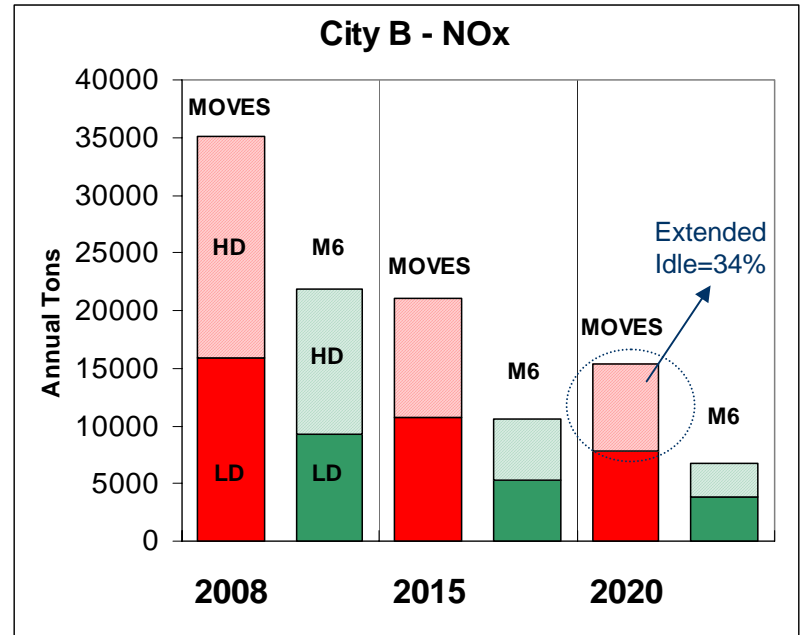
- **Data collected since MOBILE6 released drives differences between MOVES and MOBILE6**
- **National trends**
 - HC and CO emissions similar or lower than MOBILE6.2
 - Total NOx emissions moderately higher than MOBILE6.2
 - Total PM emissions substantially higher than MOBILE6.2
- **Local results may vary**
 - Local fleet mix, fuels, activity are important
 - Temperature drives PM emissions
- **For attainment analysis, relative change in emissions between base year and attainment year is more important than absolute emissions**

Analysis of Local Area Impacts

- **Did preliminary comparison of MOVES and MOBILE6 using surrogate local data to represent 3 different urban counties**
 - Local data very limited, may not be consistent with what states will actually use
- **Local data varied by:**
 - Fleet age distribution
 - Fraction of light and heavy duty VMT
 - Local fuel specifications
 - Meteorology
 - Other input factors
- **Working with New York, Wisconsin, Georgia, Utah to develop real local area comparisons with current, detailed local data**
 - Results available later this month

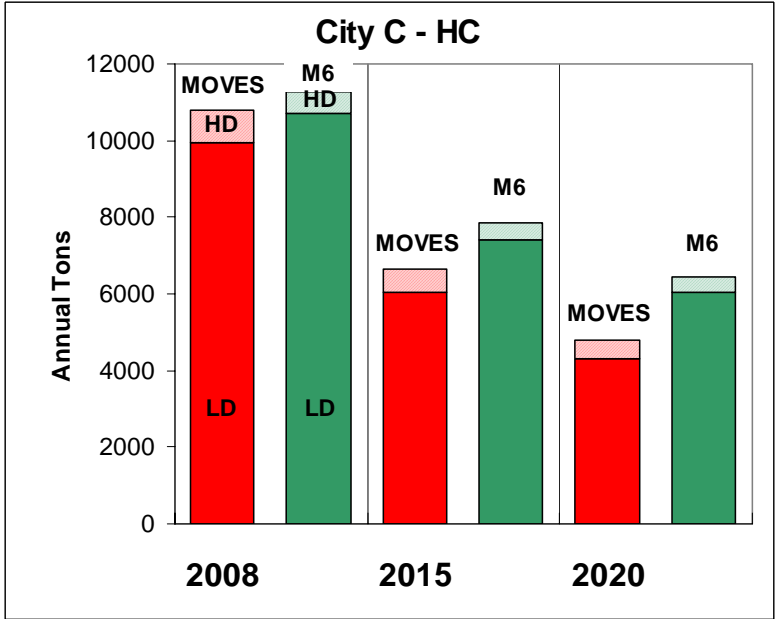
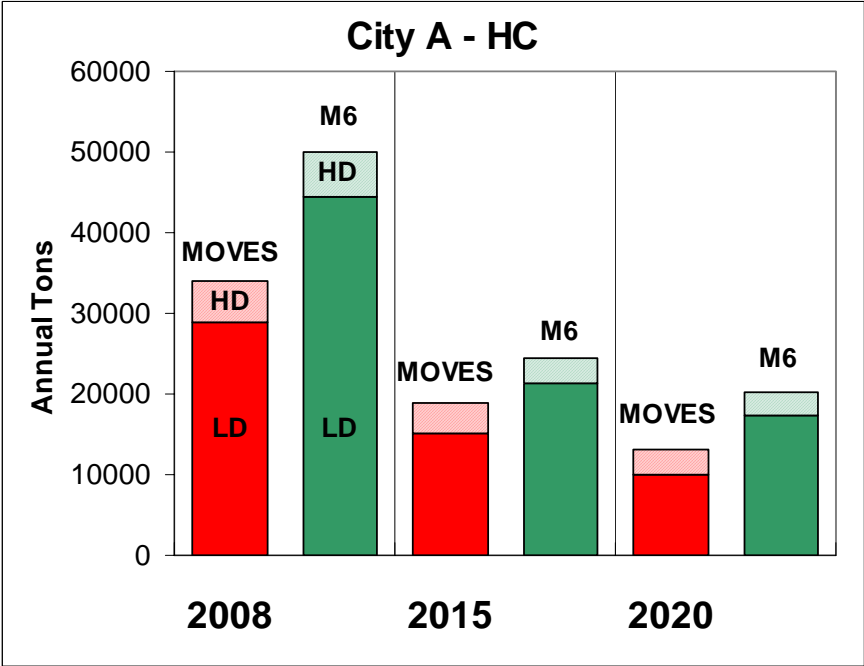
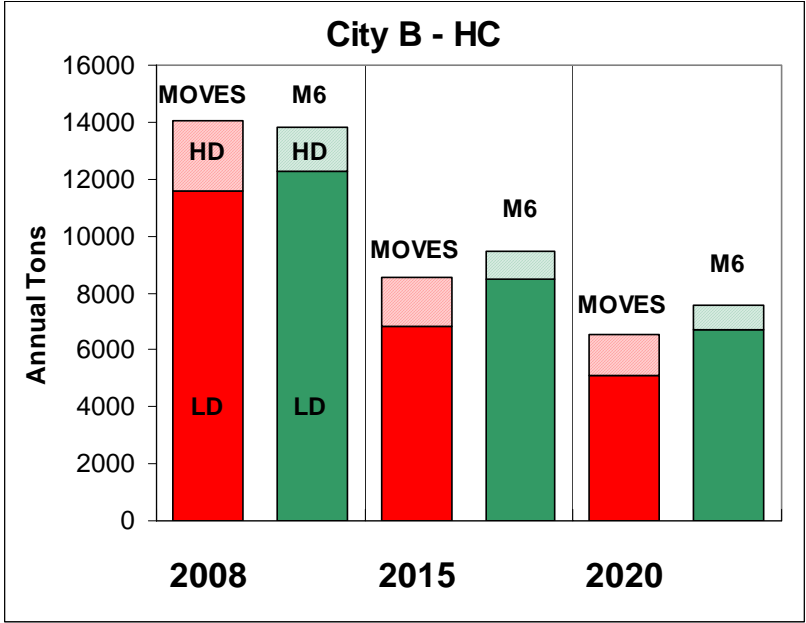
NO_x

- I/M program data shows MOBILE6 underestimated NO_x emissions from light trucks
- On-road data on heavy trucks shows higher emissions than MOBILE6 estimated from cert data
- Extended idle emissions become significant share of heavy-duty inventory in future



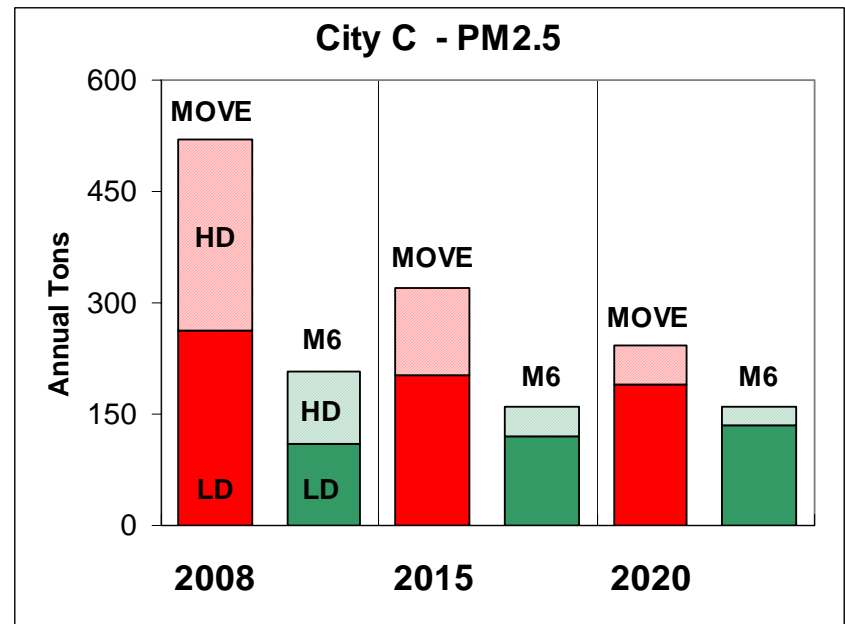
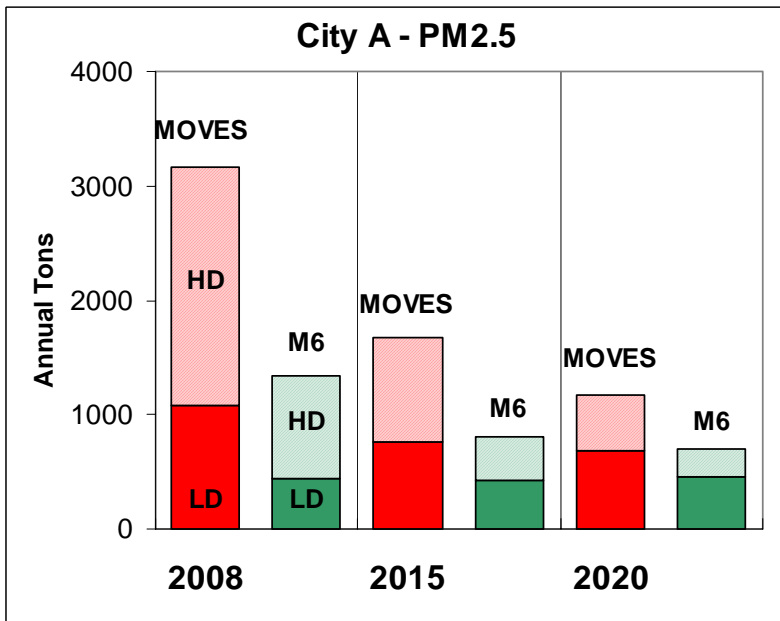
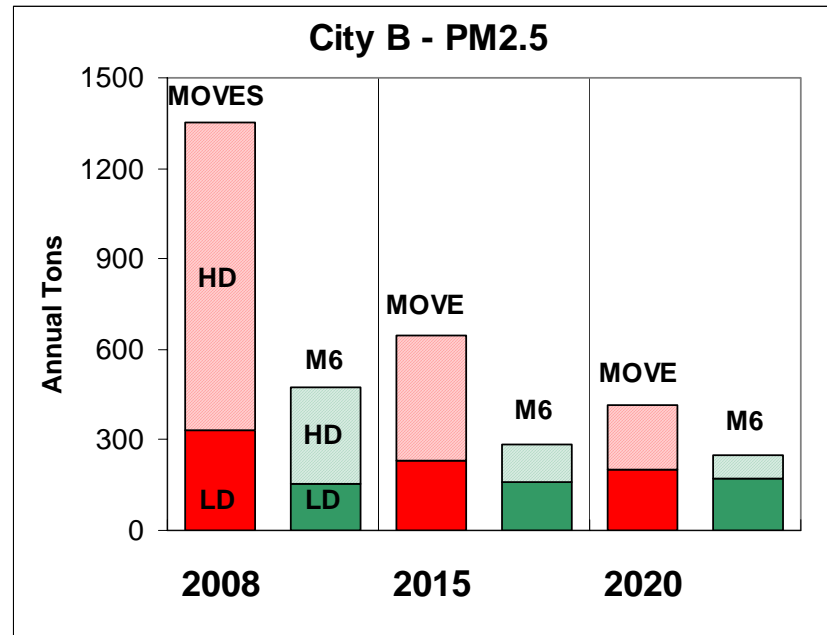
HC

- I/M program data shows MOBILE6 overestimated HC emissions from newer technology cars
- Evaporative emissions on newer technology vehicles very low; re-evaluating leak emissions for final model



PM_{2.5}

- Kansas City program found high gas PM emissions esp. at cold temps
- New data on heavy trucks shows higher deterioration than MOBILE6
- MOVES accounts for impact of vehicle speed – MOBILE did not



Percent Reduction in On-Road Emissions 2008 to 2015

	City A		City B		City C	
	MOVES	MOBILE6	MOVES	MOBILE6	MOVES	MOBILE6
HC	50%	50%	39%	32%	38%	31%
NOx	54%	56%	40%	52%	36%	53%
PM2.5	57%	40%	52%	40%	38%	23%

What It Means

- **Higher NOx and PM emissions mean mobile sources have bigger role in attainment**
- **Percent reduction from base year is key to attainment analysis**
 - PM2.5 shows higher overall emissions and higher % reductions
 - Effect on attainment demonstrations could be positive
 - NOx shows higher overall emissions but lower % reduction
 - Harder to show attainment
 - Future NOx control measures will have a bigger impact
- **States may need to redo some motor vehicle emissions budgets to meet conformity requirements with MOVES**

I/M Effects In MOVES

- **Benefits are comparable to MOBILE6 now, but will shrink over time.**
 - Conservative M6 OBD assumptions not supported by data
 - CRC did comprehensive survey of MIL response in non-I/M areas
 - Found high response even after warranty
 - Our analysis of I/M program data confirms that OBD works

Other Impacts

- **MOVES has new input requirements and new output formats**
 - States will need to learn MOVES, develop new input data, and adapt post-processing systems
- **We have a draft training plan with DOT**
 - Training sessions planned using EPA and DOT staff at about a dozen locations across the country
 - Picking locations to minimize state travel
 - Also training at several national or regional conferences
 - First training at Emission Inventory Conference, Baltimore, April 16-17
 - Training will begin immediately after draft release

Next steps

MOVES



Future Guidance Documents

- **EPA expects to release several guidance documents that will help with the transition for final MOVES**
 - MOVES Technical Guidance for SIPs and conformity
 - Project Level Conformity Guidance for PM
 - MOVES SIP and Conformity Policy Guidance
- **Will release draft guidance for comment sometime after release of Draft MOVES2009**
- **Final guidance documents will be available when Official MOVES2009 is released**

What Should You Do Now?

- **Plan to attend MOVES training events after release of Draft MOVES2009**
- **Provide feedback on Draft MOVES2009**
 - Early feedback gives more time to make revisions
- **Update computer hardware**
 - Dual-core processor (faster is better)
 - At least 1 GB memory (more is better)
 - At least 40 GB storage (more is better, output files can be very large)
 - Consider setting up a distributive network (specs of “master” computer are key)
 - Windows XP or 32-bit Vista
 - **Current version of MySQL does not work on 64-bit Vista**

What Should You Do Now?

- **Build staff expertise in relational databases and MYSQL**
 - Not needed for simple runs
 - Some basic knowledge gives users flexibility to customize outputs and view inputs
 - In-house expert would be helpful for more advanced analysis
- **Subscribe to MOBILENEWS email list for MOVES updates**

<http://www.epa.gov/otaq/models/mobilelist.htm>

Feedback

- We need your comments and ideas for improving MOVES
- Comment Period:
 - Begins when Draft MOVES2009 is released
 - Comments are most effective when obtained early
- Send an email to mobile@epa.gov

Visit the MOVES website:
<http://www.epa.gov/otaq/ngm.htm>

The screenshot shows a Microsoft Internet Explorer browser window displaying the MOVES website. The browser's address bar shows the URL <http://www.epa.gov/otaq/ngm.htm>. The website header includes the U.S. Environmental Protection Agency logo and the text "U.S. ENVIRONMENTAL PROTECTION AGENCY" and "Modeling and Inventories". A search bar is present with the text "Search: All EPA This Area" and a "Go" button. Below the search bar, the breadcrumb trail reads: "You are here: EPA Home » Transportation and Air Quality » Modeling, Testing, and Research » Modeling and Inventories » MOVES (Motor Vehicle Emission Simulator)". The main content area features the heading "MOVES (Motor Vehicle Emission Simulator)" followed by a detailed paragraph describing the system's purpose and capabilities. A sidebar on the left lists various models: "Mobile Source Emissions - Past, Present, and Future", "MOBILE Model (On-road Vehicles)", "NONROAD Model (Nonroad Engines, Equipment, and Vehicles)", "NMIM (National Mobile Inventory Model)", "MOVES (Motor Vehicle Emission Simulator)", and "Fuels Models". At the bottom of the page, there are contact details for further information, including an email address (mobile@epa.gov) and a phone number (734) 214-4636.

- Software, technical documentation, conference and meeting presentations, and other helpful background materials