

Air Pollution from Highway Vehicles: What MOVES Tells Us

Presentation for the International Emission Inventory
Conference
April 15, 2009

Megan Beardsley, Gary Dolce
U.S. EPA
Office of Transportation and Air Quality

The MOVES logo is displayed in a metallic, three-dimensional font with a brushed metal texture and a slight glow effect, set against a dark rectangular background.

Acknowledgments

- **The MOVES Team**

- William Aikman
- David Brzezinski
- Nanette Cooper
- Gary Dolce
- Chris Dresser
- Prashanth Gururaja
- Ed Glover
- Craig Harvey
- Sean Hillson
- Greg Janssen
- Ari Kahan
- John Koupal
- Howard Lin
- Ted Maciag
- Kathryn Schwende
- Gwo Shyu
- James Warila

- **Contractors**

- Wes Faler, The Reason Group
- Sierra Research
- Perrin Quarles Associates
- Pechan
- ERG

- **Students**

- Andrew Huang
- Amanda Valente
- George Scorra

- **Moved on**

- Ed Nam
- Mitch Cumberworth
- Larry Landman
- Sujana Srivastava
- Gertrude Venlet
- Kitty Walsh
- Gene Tierney



MOVES

- **MO**tor **V**ehicle **E**mission **S**imulator
- Estimates emissions from mobile sources
 - Criteria pollutants
 - Air toxics
 - Greenhouse gases & energy consumption
- Will replace current models (MOBILE & NONROAD)
- Expands capabilities
- Draft MOVES2009 is imminent

What makes MOVES better?

- New data
- New structure
- New capabilities

Significant new data in MOVES

- **New fleet & activity defaults**
 - National defaults:
 - Vehicle fleet from state registration data, VIUS
 - Vehicle Miles Traveled (VMT) from HPMS
 - Driving patterns from instrumented vehicle surveys
 - For local modeling, local data is likely to be most accurate & up-to-date
- **Updated emission rates**
 - Test results on millions of vehicles considered for MOVES
 - Passenger Cars & Trucks
 - Heavy Duty Trucks

Extensive analysis of Car & Light Truck emissions

- **HC/CO/NO_x rates based on ~ 70,000 vehicles randomly selected from Arizona I/M program**
 - Able to tease out emissions from I/M and non I/M areas
- **Checked against data from multiple sources**
 - I/M data from Illinois, New York, Missouri and Colorado
 - Roadside remote sensing data from several cities
 - Kansas City Study (slide 7)
- **Extended to newest technology vehicles using compliance data**
 - In-use emissions data manufacturers required to collect
 - About 2,000 laboratory tests per year

A focus on particulate emissions from gasoline vehicles

- **Landmark study conducted in Kansas City 2004-05 to address need for improved gas PM estimates**
 - Collaboration between EPA, DOE, DOT, States, Auto/Oils
- **496 gasoline light-duty cars and trucks tested**
 - Model Years 1968-2005
- **Summer and winter testing**
 - ~ half of the vehicles tested each season @ ambient temps
 - 43 vehicles tested in both winter and summer
- **More information at**

<http://www.epa.gov/otaq/emission-factors-research/>



What we've learned about Car & Light Truck emissions

- New standards have been successful in reducing deterioration of HC/CO/NOx emissions
- On-Board Diagnostic (OBD) systems are a contributing factor to lower deterioration
 - Owner response to repair identified malfunctions is better than MOBILE6 projected, particularly in non-I/M areas
- Gas PM emissions are much higher than MOBILE6 projected
 - Higher in-use deterioration
 - Significant increase at cold temperatures

New Structure & Capabilities

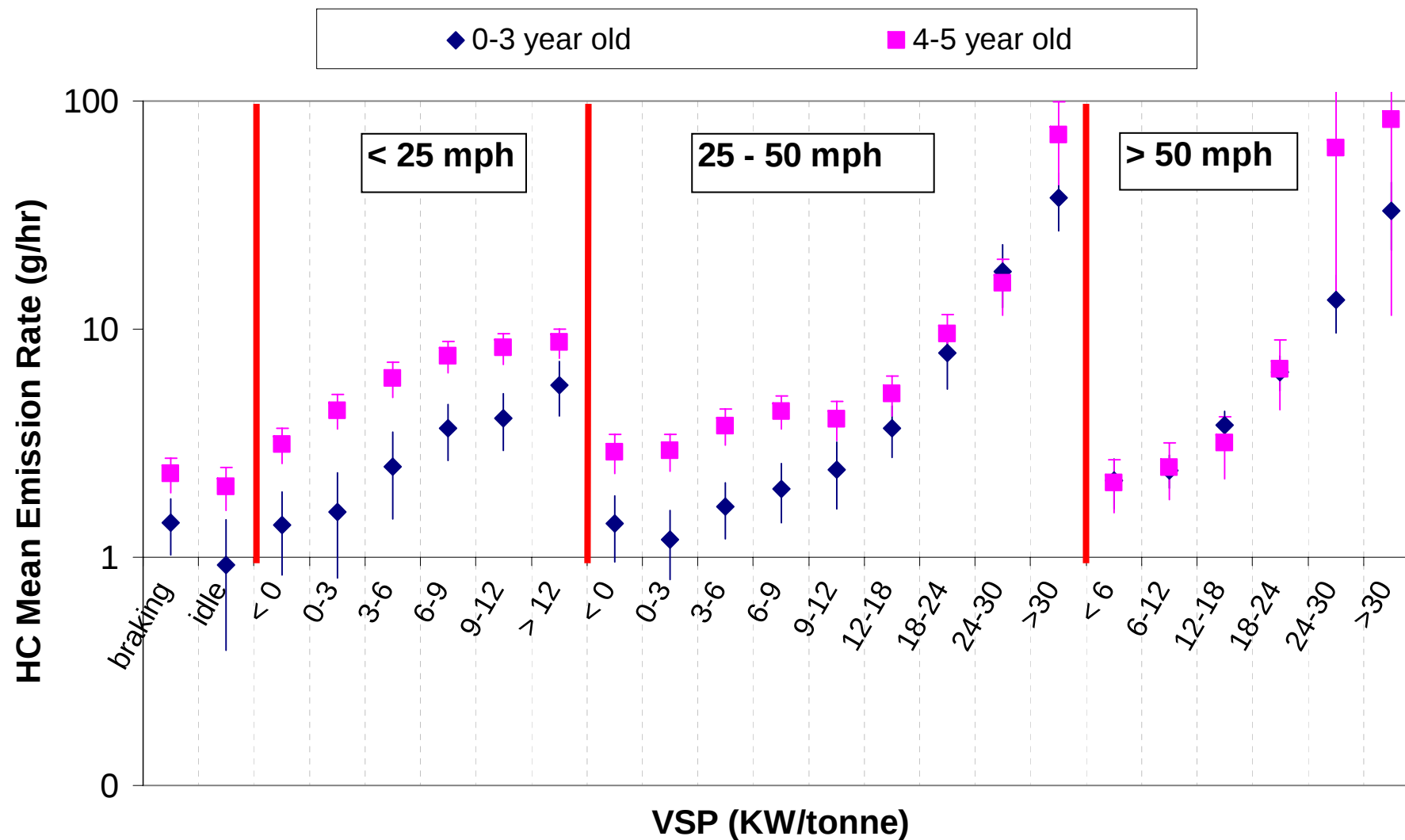
- **Improved modeling framework allows easier updates**
 - Improved software
 - Emission rates and other parameters stored in database
 - Menu-driven user interface (batch input available too)
- **Flexible modal structure**
 - Models aggregate emissions for regional estimates
 - Models detailed changes in driving behavior for project analysis

MOVES expands ability to quantify driving pattern impacts

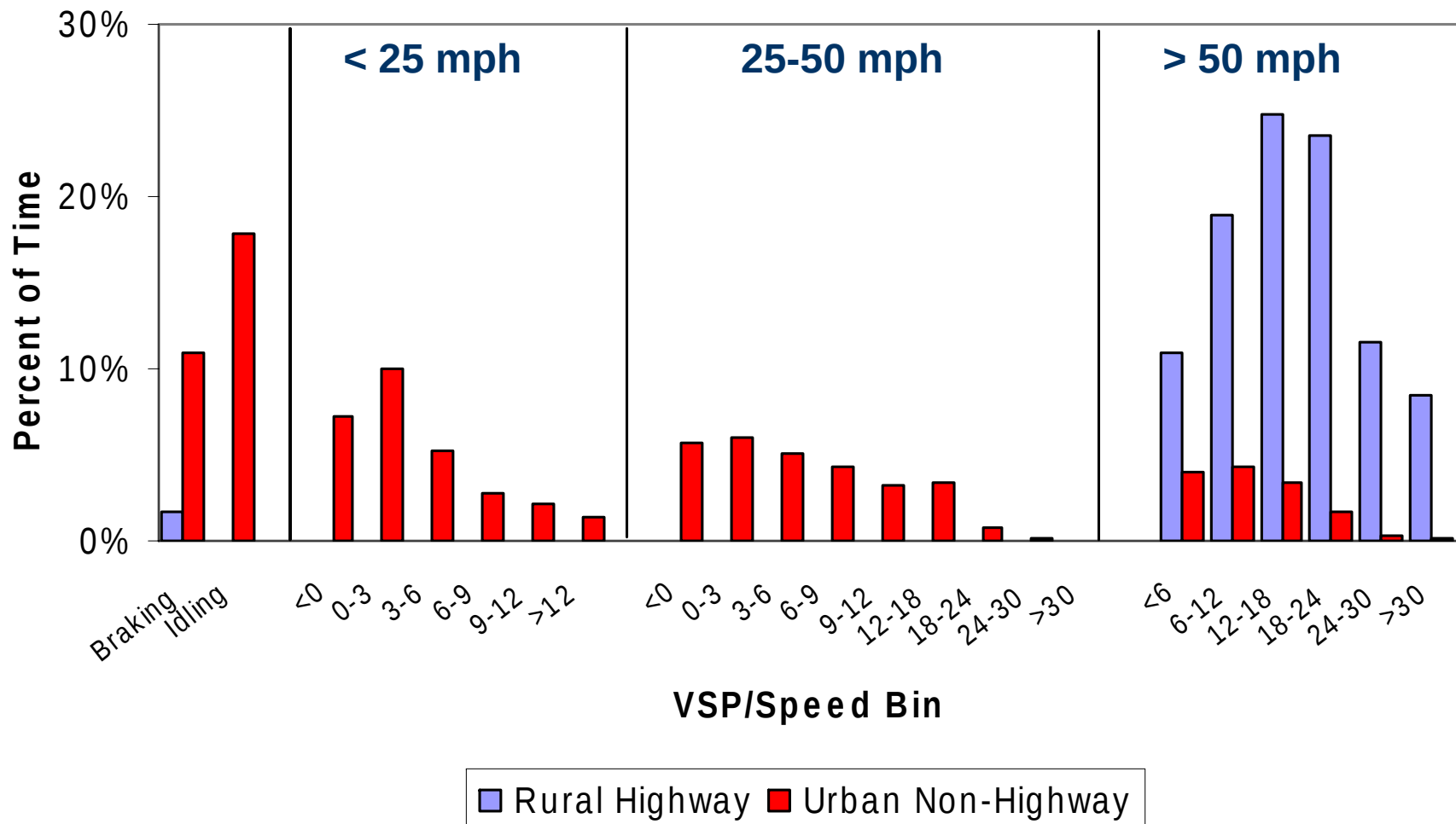
- **MOBILE6 was “driving cycle” based**
 - Emissions by speed characterized by set cycles
 - Lacked flexibility to analyze different driving patterns
- **MOVES is “modal” based**
 - Emissions averaged by operating mode “bin”
 - Operating mode bins defined by Vehicle Specific Power (VSP) and instantaneous vehicle speed
 - Allows estimation of emissions from any driving pattern
 - Driving patterns can be defined as the distribution of time spent in each operating mode bin (“operating mode distribution”)

HC Emission Rates By Bin

Source Bin: LDV Gasoline / 1996 MY



Distribution of Time by Mode



Draft MOVES Results

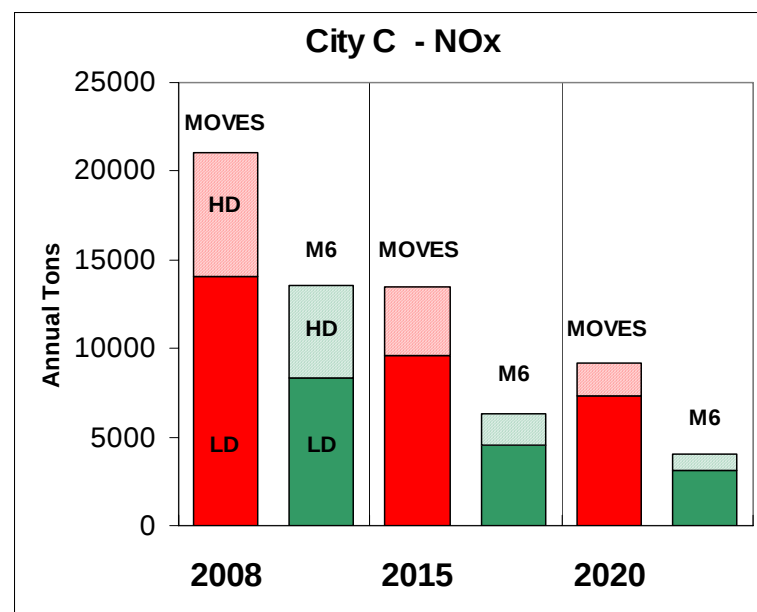
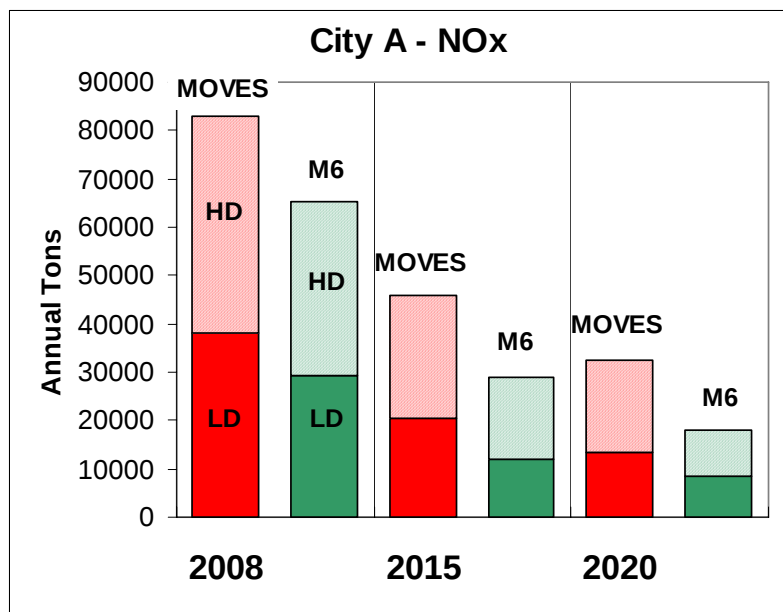
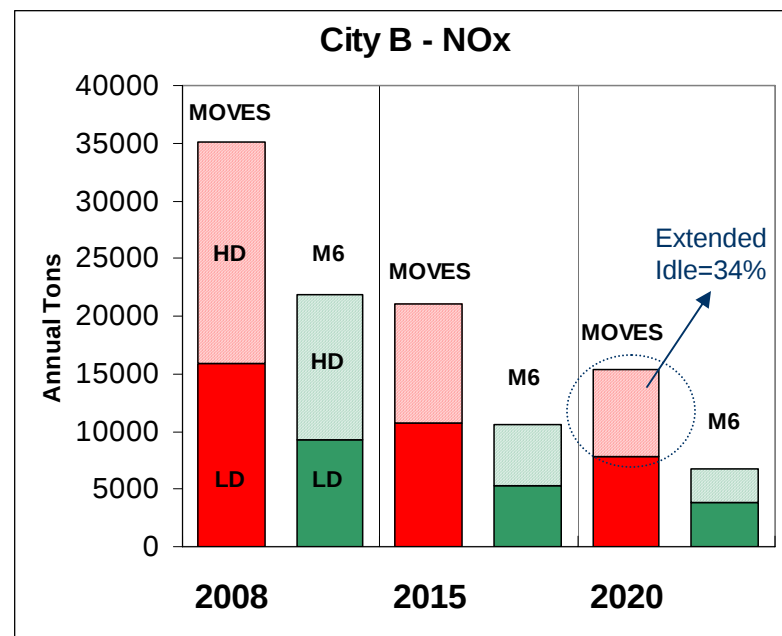
- **Data collected since MOBILE6 released drives differences between MOVES and MOBILE6**
- **National trends**
 - HC and CO emissions similar or lower than MOBILE6.2
 - Total NO_x emissions generally higher than MOBILE6.2
 - Total PM emissions substantially higher than MOBILE6.2
- **Local results may 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**
 - Limited local data, but approaches 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
- **Recent follow-up with more detailed analysis, more accurate representation of SIP inputs confirmed the findings shown here**

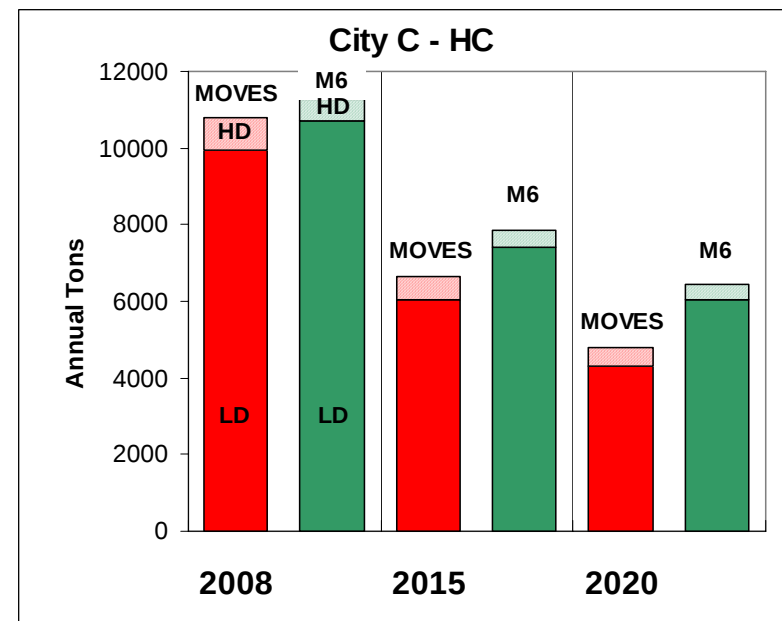
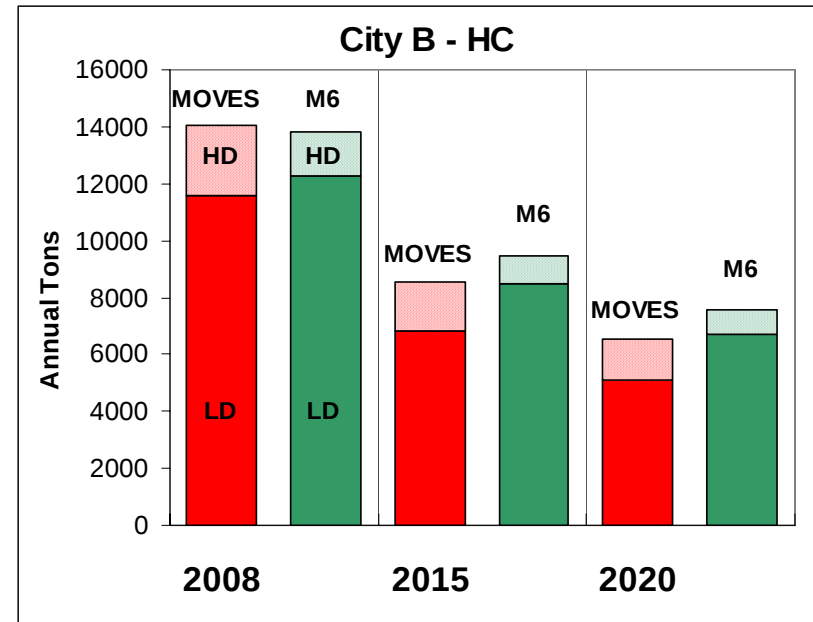
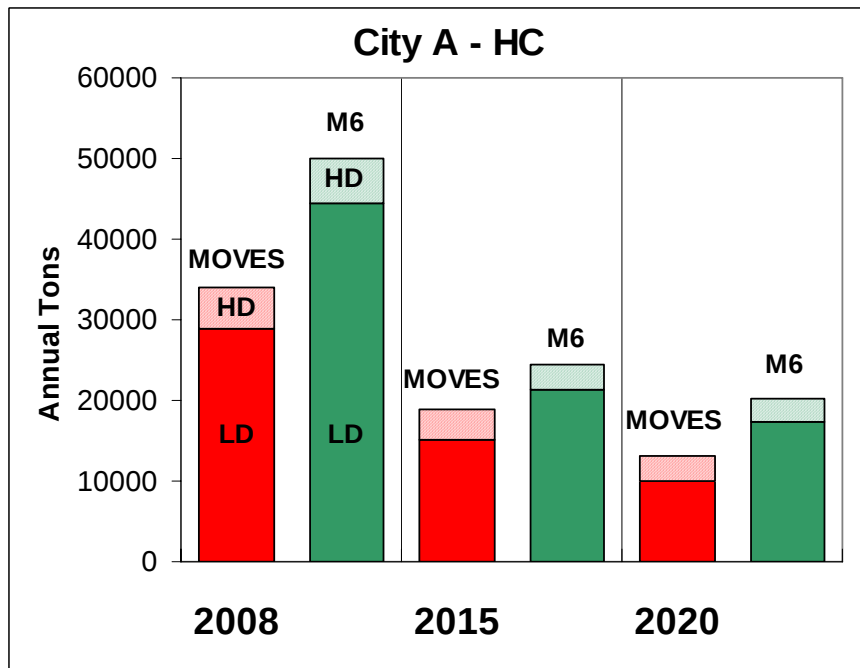
NO_x

- 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



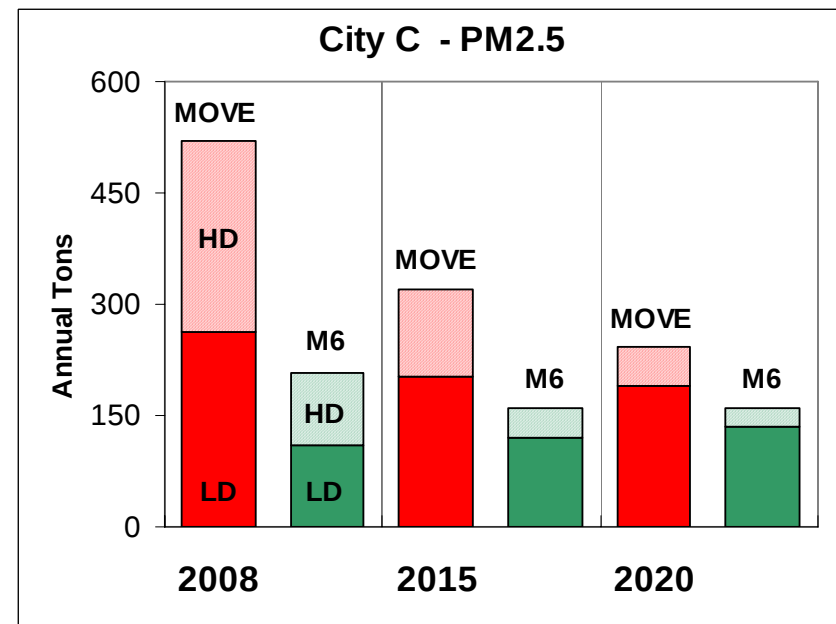
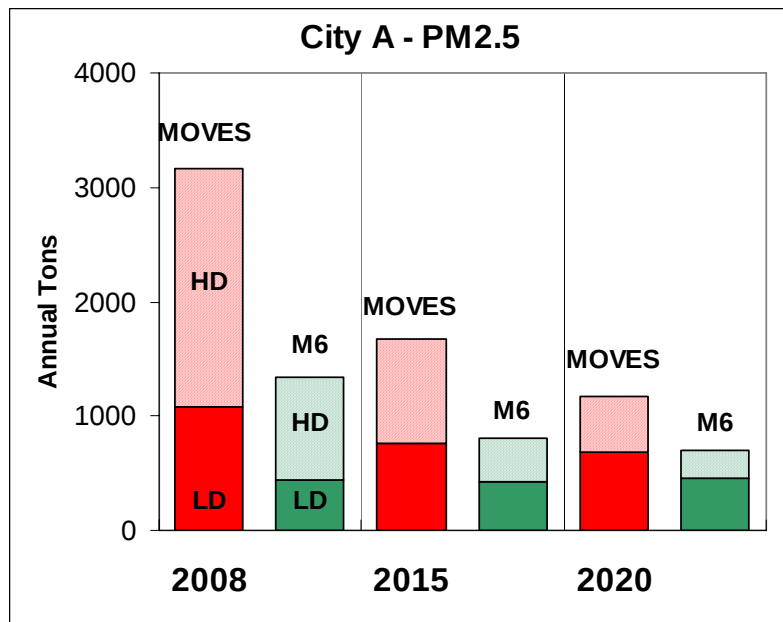
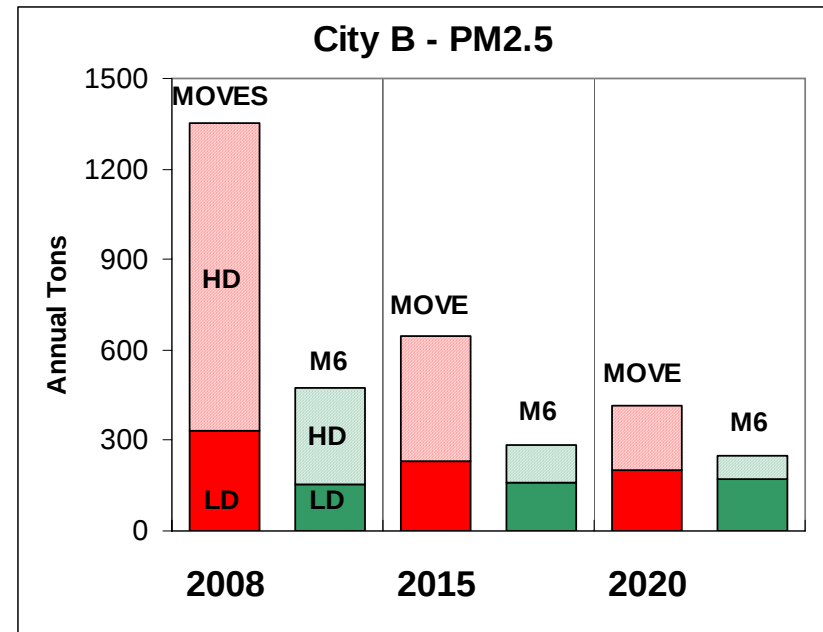
HC

- 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 analysis of heavy trucks shows higher deterioration than MOBILE6
- MOVES accounts for impact of vehicle speed – MOBILE did not



What It Means for Local Areas

- Higher NOx and PM emissions mean mobile sources have bigger role in air quality modeling & 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

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%
NO _x	54%	56%	40%	52%	36%	53%
PM _{2.5}	57%	40%	52%	40%	38%	23%

Next steps

MOVES



Draft MOVES2009

- **Released April 9, 2009**
 - MOVES website: <http://www.epa.gov/otaq/ngm.htm>
 - Followup postings announced via MOBILENEWS email list
 - Subscription info: <http://www.epa.gov/otaq/models/mobilelist.htm>
- **Improves on previous versions**
 - Adds criteria pollutant emission factor databases
 - Adds features to simplify regional and project-level analysis for SIPs and conformity
- **A draft model**
 - No official use requires Draft MOVES2009
 - Cannot be used for SIPs or conformity analyses
 - Followed by public review, training, and EPA guidance development
 - Does not include all data or features planned for official MOVES2009

Official MOVES2009

- **Official MOVES2009 planned for release at end of 2009**
 - Timed to allow 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)

Feedback

- We need your comments and ideas for improving MOVES
- Comment Period:
 - Comments are most effective when obtained early
 - Recommend sending by July 2009
- Send email to mobile@epa.gov