MOVES Update

Presentation to Mobile Source Technical Review Subcommittee
April 19, 2012

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Outline

- MOVES background
- What's next for MOVES?
- MOVES validation overview
- Revitalizing the MOVES Review Workgroup

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EPA's Mobile Source Emission Models - Background

- CAA requires EPA to review and (if necessary) revise emission factors at least every 3 years
- Used to support state implementation plans, transportation conformity, NEPA assessment, EPA regulations, etc.
- EPA began development of first on-road emission factor model, MOBILE, in 1970s
- NONROAD model followed in 1990s
- National Research Council reviewed EPA's mobile source modeling program in 2000, made several sweeping recommendations
- These recommendations formed the basis for EPA's new generation emissions model, MOVES

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Key National Research Council Recommendations

- **Develop finer scale modeling capability**
  - Emerging need to assess “hot spot” emissions
- **Improve characterization of “real world” emissions**
  - High emitters
  - Heavy-duty vehicles and Nonroad
  - PM and toxics
- **Evaluate model performance vs. independent data**
- **Update the model more frequently**
  - 8+ year gap between MOBILE5 and MOBILE6

Previous MOVES Versions

- **MOVES2004 (January 2005)**
  - Established model structure, look & feel
  - Focused on energy & GHG; allowed validation to fuel tax data
- **Draft MOVES2009 (April 2009)**
  - Gave users an early opportunity to learn about and comment on criteria pollutant version of MOVES
- **MOVES2010 (December 2009)**
  - First official release of the MOVES series
  - Required for use in SIPs, and conformity analyses after grace period

Current Version of MOVES

- **MOVES2010a (August 2010)**
  - Added light duty GHG and fuel economy rules
    - CAFE standards for MY 2008-2011
    - GHG/ CAFE standards for MY 2012-2016
  - Changes in GHG emissions, but insignificant changes in criteria pollutants
  - Also included some performance and usability improvements
  - For SIP and conformity purposes, we called this a minor revision
    - No new grace period
    - Users could use either MOVES2010 or MOVES2010a

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An Open Process for Informing Users and Getting Feedback

- Convened FACA workgroup to review MOVES development
- Conducted peer-review of MOVES technical documents
- Together with DOT, provided 25 hands-on training events to almost 700 users since release of MOVES2010
- Provided over 2500 responses to user questions submitted via e-mail
- Held a 2-day MOVES workshop in Ann Arbor attended by 230 state and local agency staff and contractors
- Provide ongoing support to AQ and transportation agencies about using MOVES in SIP development and conformity
- Have continued to work on model improvements based on user feedback from all of these sources

What's Next for MOVES?

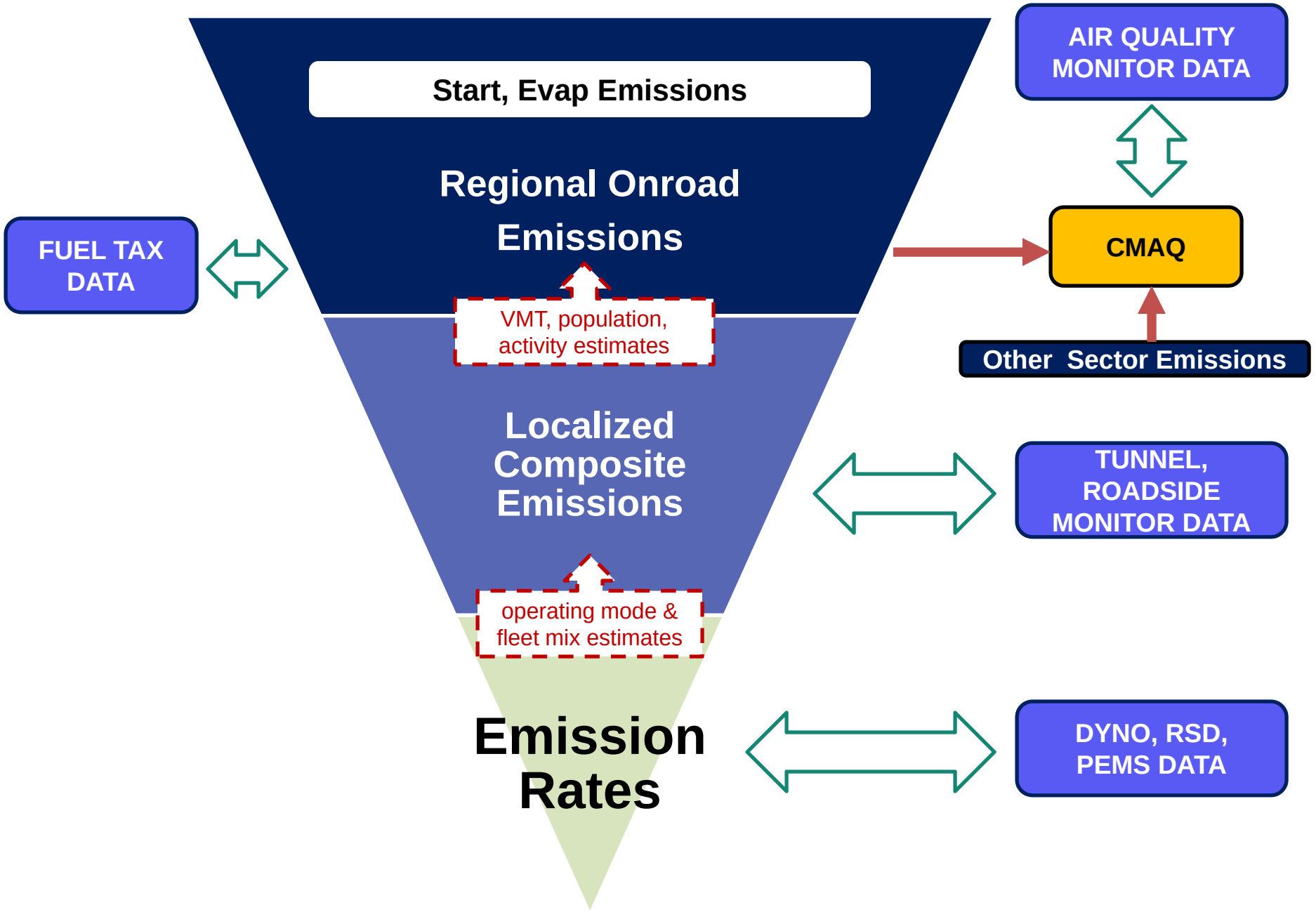
- **MOVES2010b**
  - A minor revision that does not change emissions – focus is improvements to user features, additional toxics
  - Use would be recommended but optional for SIPs and conformity analyses, no new grace period for conformity
  - Release is imminent
- **MOVES2013**
  - Major update incorporating new research & emission stds
  - Will be considered a new model for SIP and conformity purposes with a new conformity grace period
  - First draft of NONROAD implementation
- **MOVES International**
  - Version of MOVES that can be applied outside the U.S.

Updated MOVES Guidance

- **Recently posted draft technical guidance on using MOVES for GHG analysis**
  - http://www.epa.gov/otaq/stateresources/ghgtravel.htm
  - Discusses methods for estimating state or county level GHG emissions using MOVES
- **Will update MOVES Technical Guidance to reflect changes in MOVES2010b**

MOVES Validation

- **Ongoing validation has been an important element of MOVES design and implementation**
- **EPA's validation work on MOVES began with MOVES2004, focused on fuel consumption**
- **Validation of criteria pollutant version (MOVES2010a) has evaluated model performance using several methods**
  - Report on methodologies and results in process
- **Goal is to inform improvements to next version, and identify data gaps**


Start, Evap Emissions
Regional Onroad Emissions
VMT, population, activity estimates
Localized Composite Emissions
operating mode & fleet mix estimates
Emission Rates
FUEL TAX DATA
AIR QUALITY MONITOR DATA
CMAQ
Other Sector Emissions
TUNNEL, ROADSIDE MONITOR DATA
DYNO, RSD, PEMS DATA

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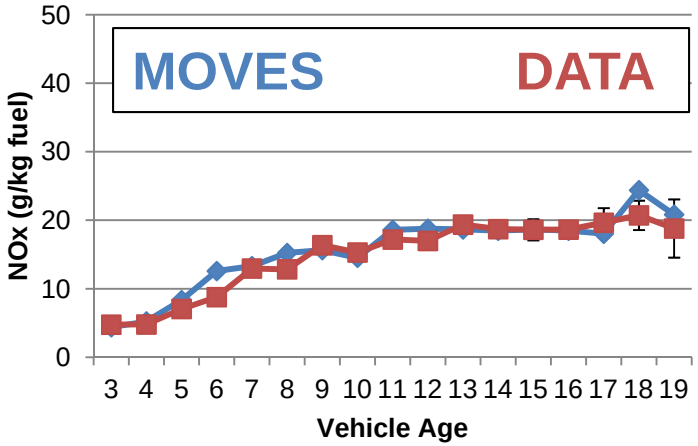
Emission Rate Validation

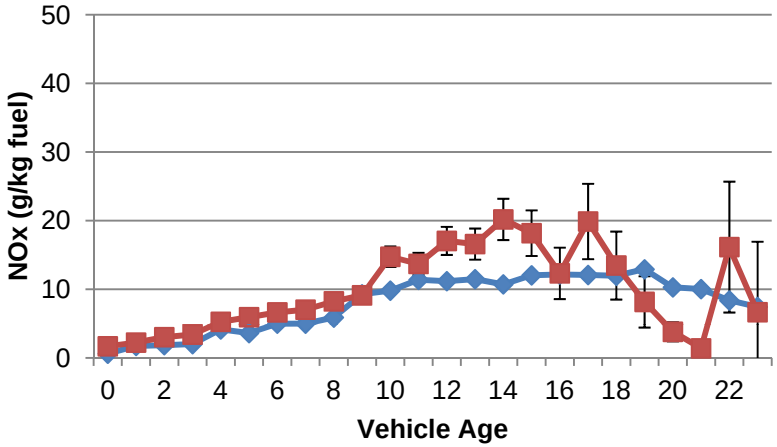
- **Light-duty sources of independent data for comparison**
  - Dynamometer (complete emission tests)
    - Chicago I/M (2000): ~74,000 tests on IM240 cycle (moderate)
    - E-69 Kansas City Program (2004-05): ~450 tests on LA92 (more aggressive)
  - Remote Sensing (1 second readings, or “hits”) – aka RSD
    - E-23 Chicago (2004): ~9,000 hits at low/moderate accel
    - Atlanta (2004 & 2008): ~ 150,000 hits at more aggressive accel
- **Heavy-duty sources of independent data for comparison**
  - Dynamometer (complete emission tests)
    - E-55/59 Research Program (2001-05): ~250 tests, multiple cycles covering range of operation
  - Remote Sensing
    - EPA/TCEQ/HGAC Houston Port Drayage Project (2009-10): ~3,200 hits at low speed/accel

Emission Rate Validation: LDV NOx

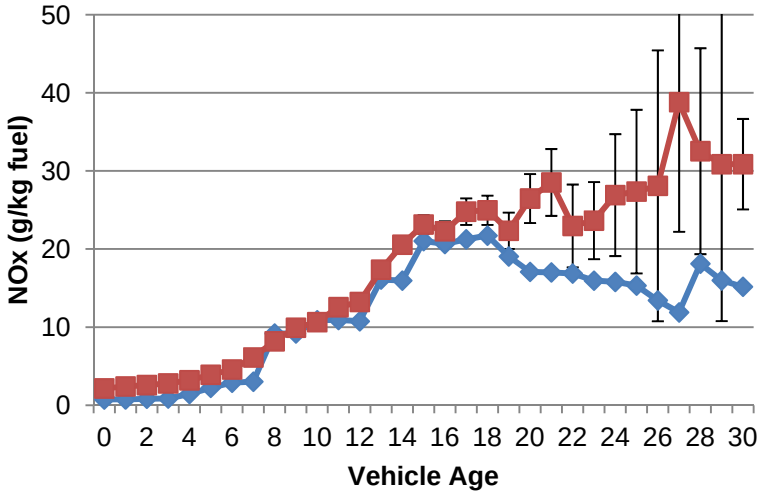
Chicago I/M (2000)



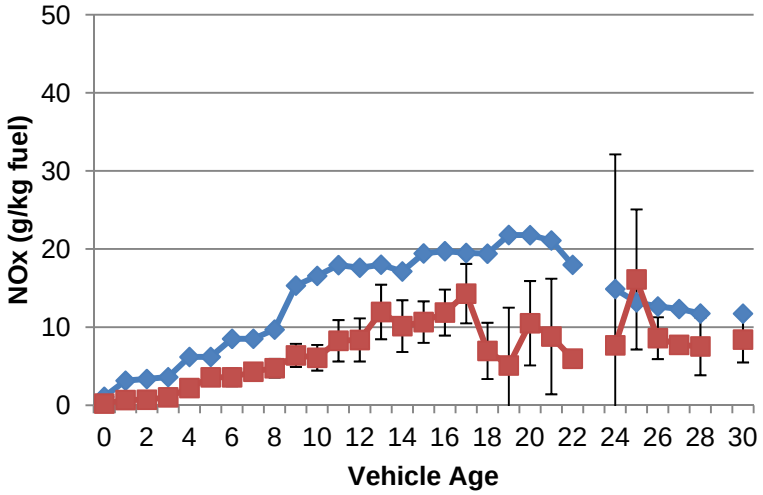
Chicago RSD (2004)



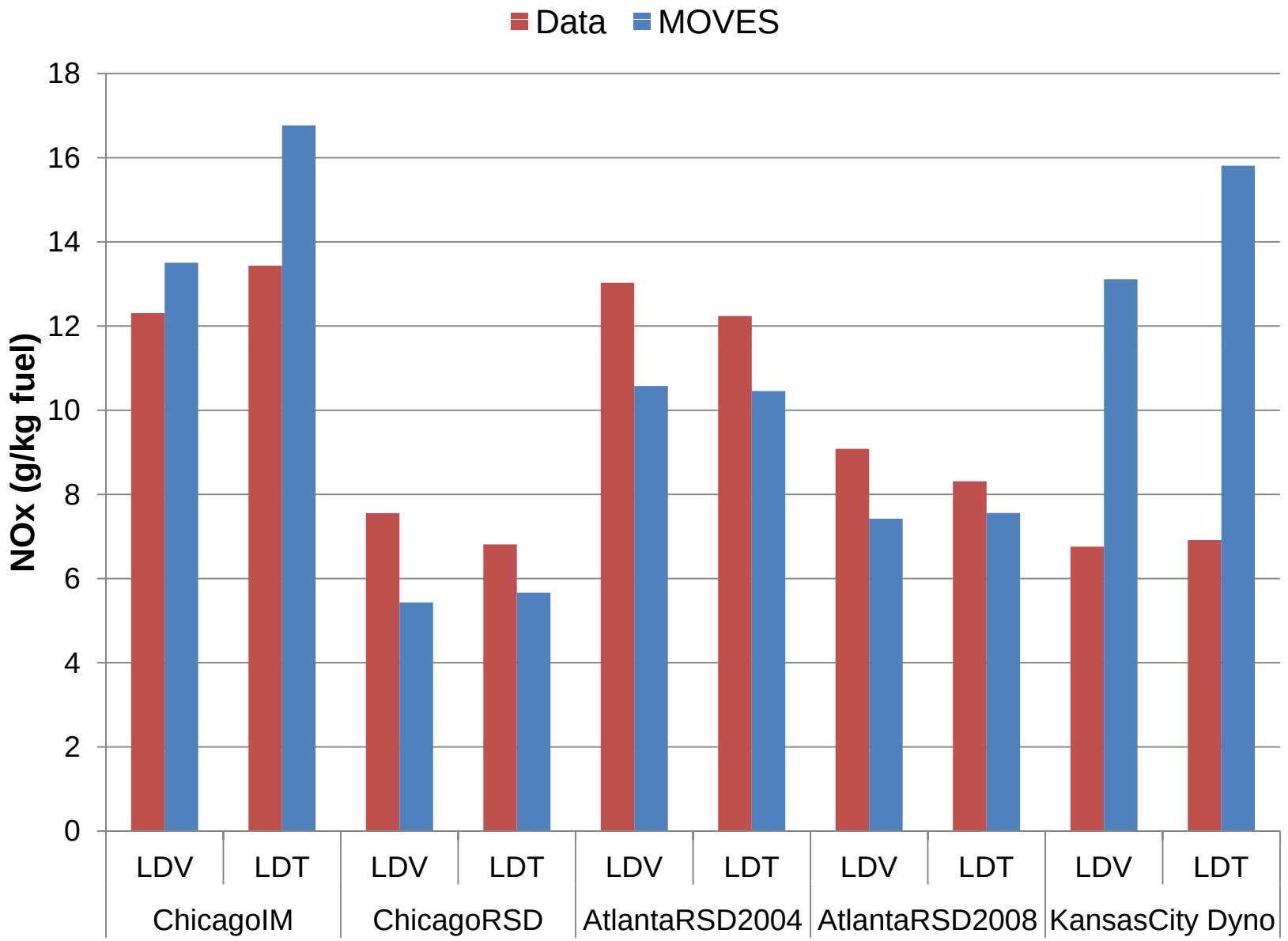
Atlanta RSD (2008)



Kansas City (2004)

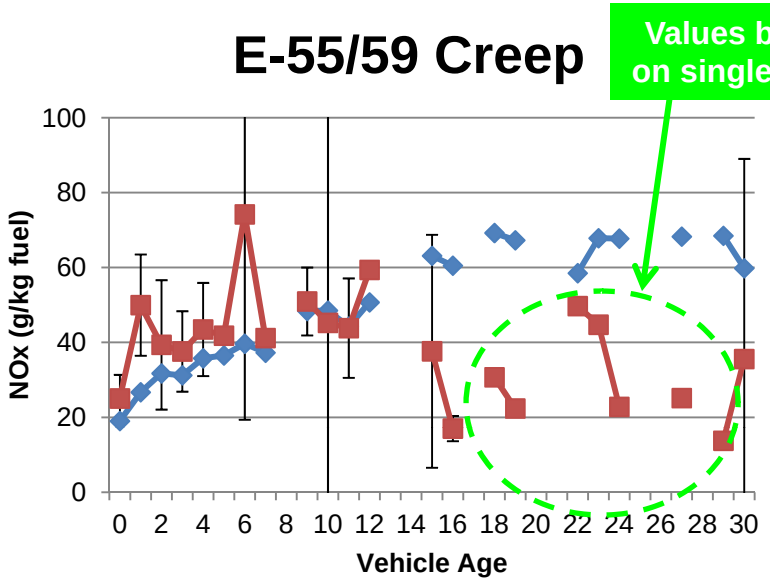


Light Duty Fleet Average Rates: NOx

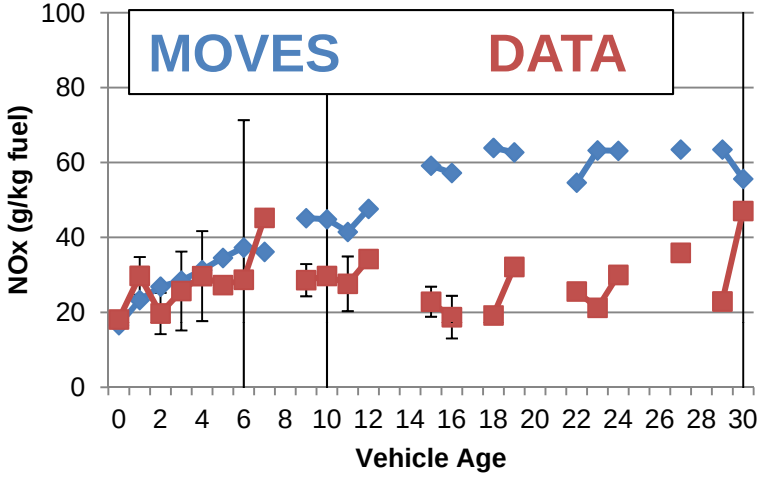


Emission Rate Evaluation: HDD NOx

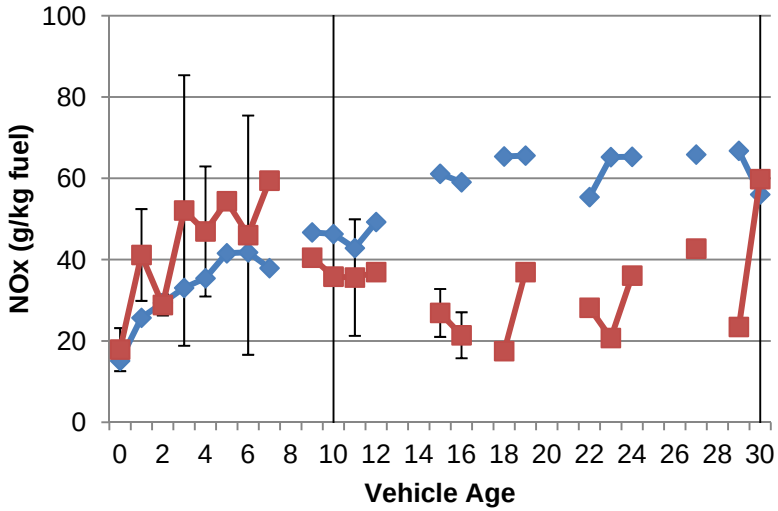
E-55/59 Creep



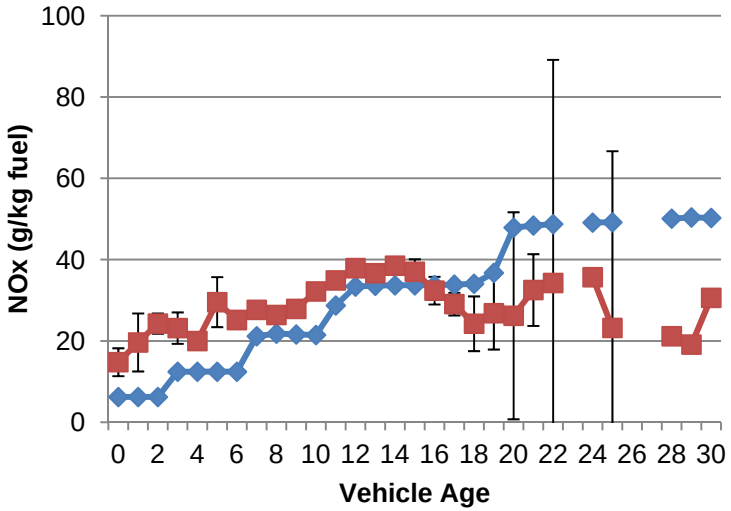
E-55/59 Transient



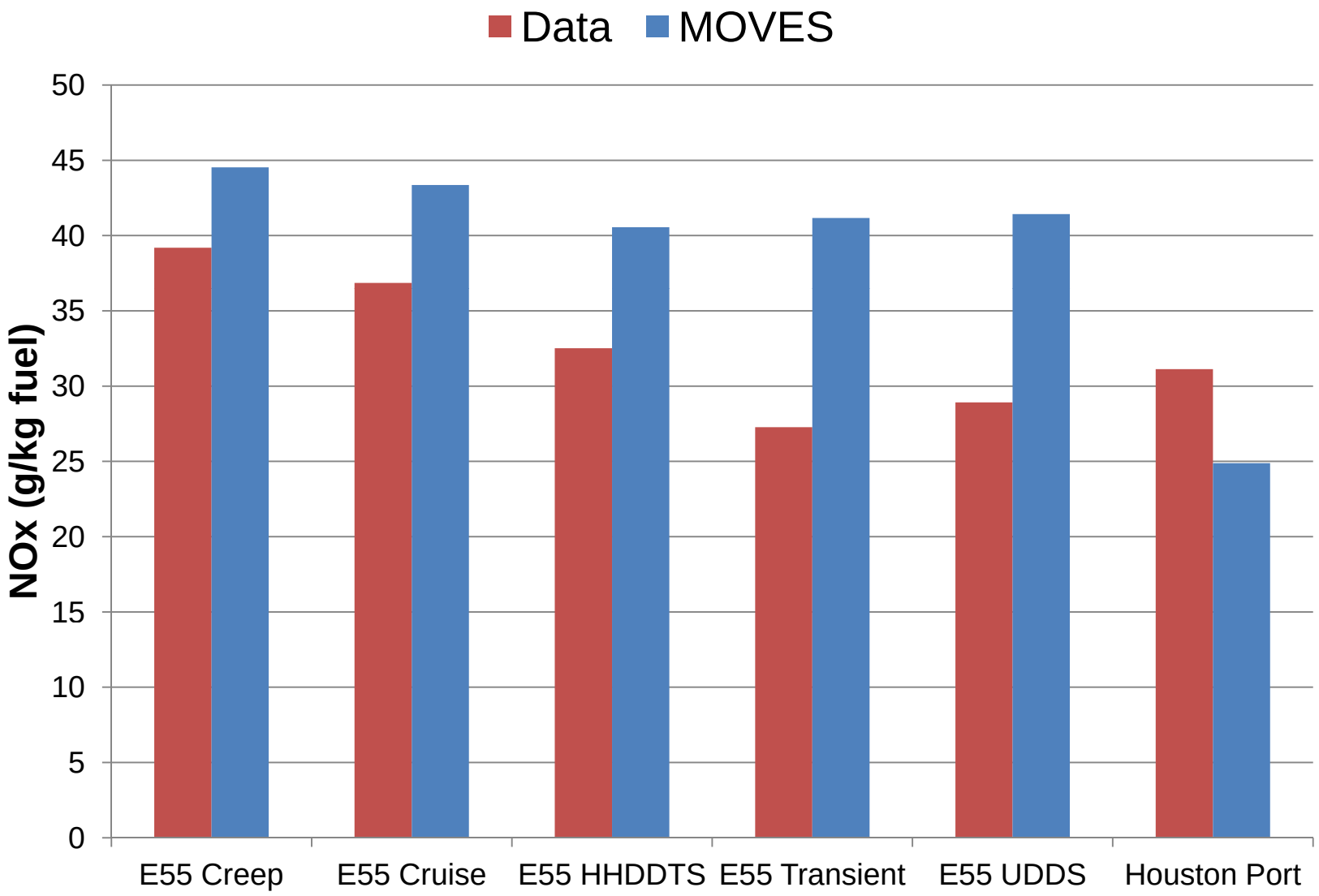
E-55/59 Cruise



Houston Port RSD



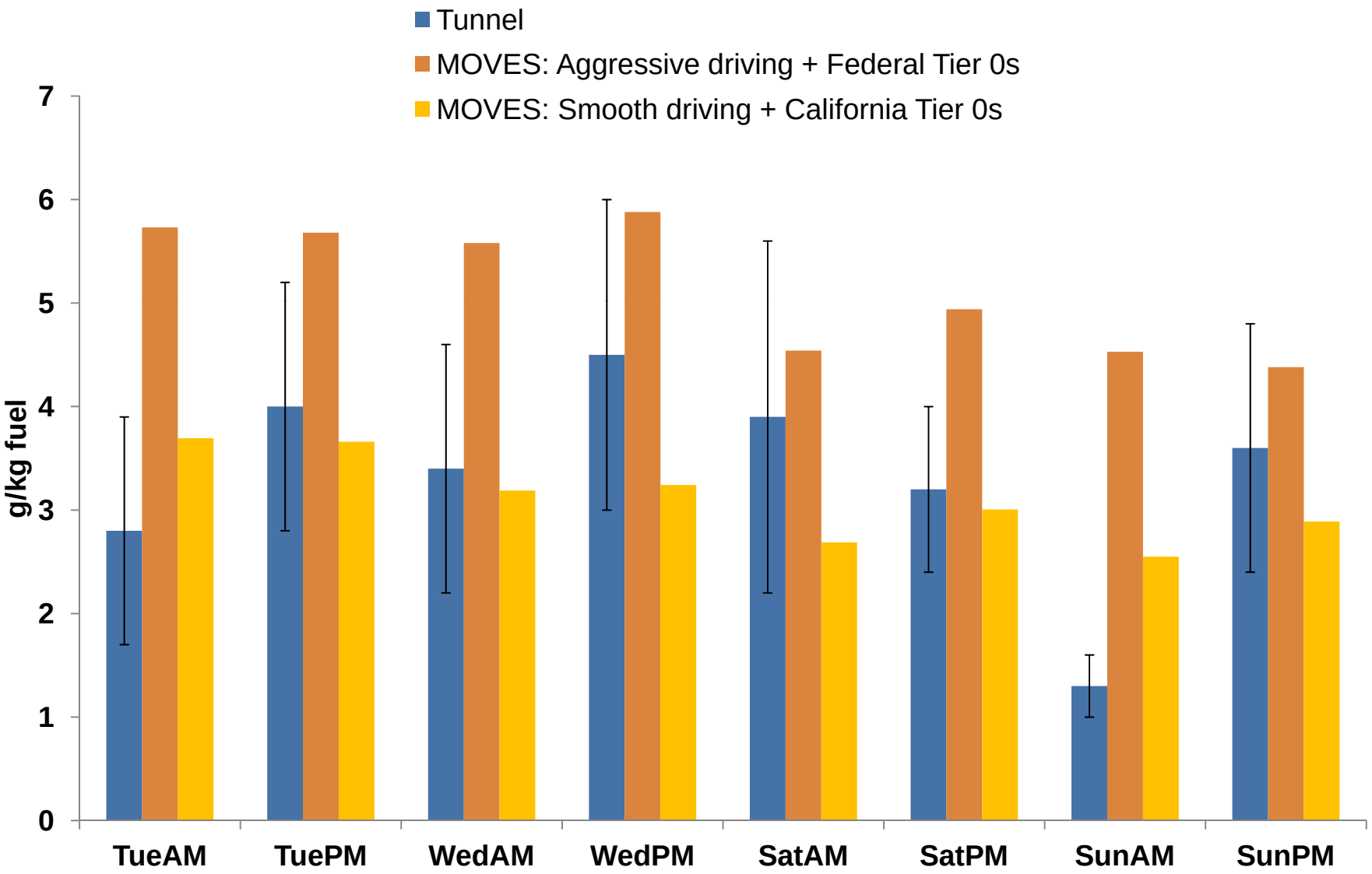
Heavy-Duty Fleet Average Rates: NOx



Comparisons to Tunnel & Roadside Monitoring Studies

- **Caldecott Tunnel (Bay Area)**
  - Ban-Weiss et. al, "Long-term changes in emissions of nitrogen oxides and particulate mater from on-road gasoline and diesel vehicles" *Atmospheric Environment* 42:220–232 (2008)
- **Van Nuys Tunnel (LA Area)**
  - Fujita, et. al: re-submitted publication to *J. Air & Waste Management Assoc.*
- **Borman Expressway (outside Chicago)**
  - Soliman and Jacko, "Development of an Empirical Model to Estimate Real-World Fine Particulate Matter Emission Factors: The Traffic Air Quality Model", *J. Air & Waste Manage. Assoc.* 56:1540-1549 (2006)
- **MOVES run to approximate conditions based on information reported in the studies**

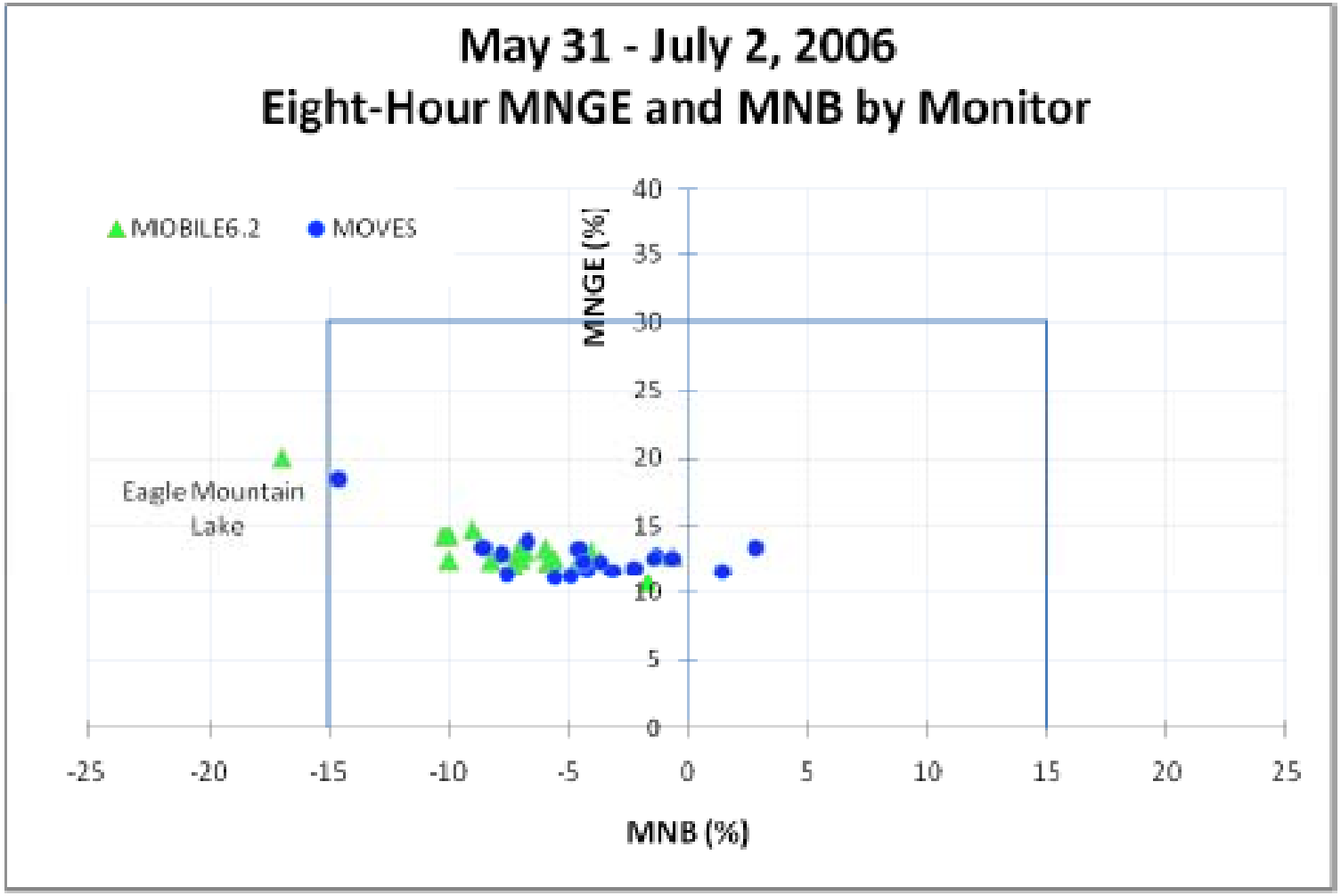
Range of MOVES NOx Predictions vs. Van Nuys Tunnel Measurements



Air Quality Model (CMAQ) vs. Monitor Evaluations Using MOVES

- **Heavy Duty GHG Rule (U.S. EPA)**
  - Compared 8-hour daily maximum ozone on monitors across U.S.
  - Normalized bias range -4 to +7% ; Normalized error within 15%
- **Simon, et. al, 2011 CMAS Conference (U.S. EPA)**
  - MOVES resulted in less NOx bias than MOBILE6 in Northeast during periods of cleanest onroad signal (urban/winter/am)
- **Kota, et. al, TRB Paper No. 12-4438 (Texas A&M)**
  - MOVES resulted in less O_3 and NOx bias than MOBILE6 for majority of monitor sites in Houston area
- **Boyer, Dallas-Fort Worth Attainment Demonstration (TCEQ)**
  - MOVES resulted in less O_3 and NOx bias than MOBILE6 across Dallas-Fort Worth area

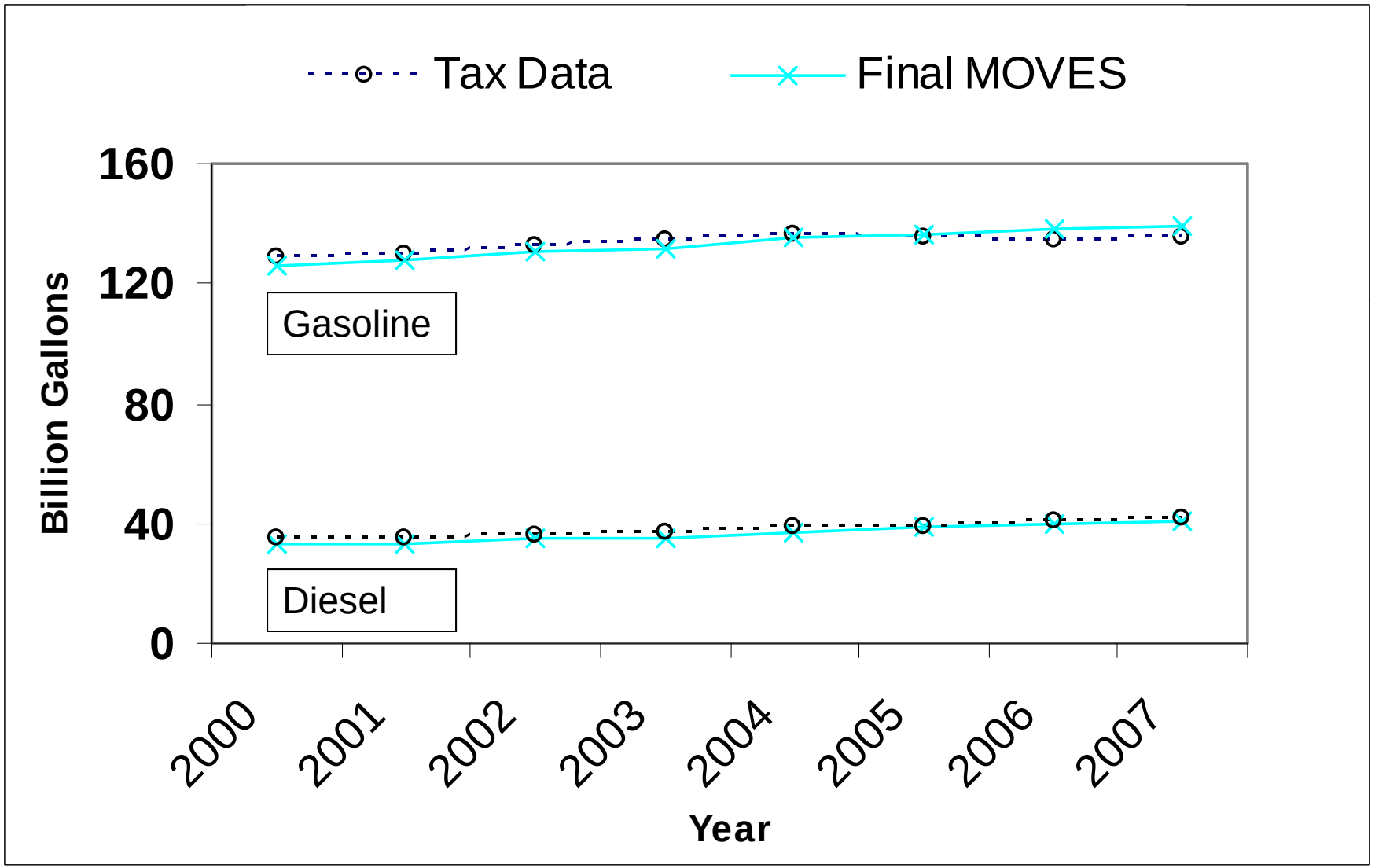
Air Quality Model Evaluation in Dallas-Fort Worth, TX



MOVES MOBILE6.2

Source: Texas Commission on Environmental Quality

Comparison of MOVES-based Fuel Consumption vs. Tax Data



Overview of Validation Results

- EPA has evaluated MOVES2010a predictions using several methodologies
- Emission rate comparison generally favorable
- Tunnel comparisons show consistent trends
- Air quality model evaluations using MOVES show low bias, improved performance vs. MOBILE6
- Validation work is ongoing – will inform improvements for next version of MOVES, and research needs

Revitalizing the MOVES Workgroup

- **Closed out workgroup following release of MOVES2010**
- **As ramp up work on MOVES2013, would like to revitalize the workgroup to review validation work and new research**
- **Proposed the same format as before**
  - Relatively small group – one rep. per trade group, etc.
  - Meeting every 2-3 months over next year

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Workgroup Process

- EPA presents MOVES modeling materials at meetings
- Meeting notes are taken and distributed
- Workgroup members poll their membership and provide feedback comments
- Comments are compiled, summarized, and distributed
- Workgroup discusses comments at next meeting with the goal of developing consensus recommendations to be forwarded to MSTRS
- Workgroup also reviews draft MOVES reports as they become available

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Previous Workgroup Membership

- **Industry Trade Groups**
  - AAM, Global Automakers, EMA, API
- **Environmental Groups**
  - NRDC, Environmental Defense
- **State and Local Government**
  - NACAA, AASHTO, CARB
- **Federal Government**
  - EPA, FHWA
- **Research Consortiums**
  - Coordinating Research Council
- **Academia**
  - UC Riverside, Georgia Tech, NC State, Cornell

Updating Workgroup Membership

- **Proposed that chairs remain the same**
  - John Koupal, U.S. EPA
  - Matt Barth, UC Riverside
- **Would like to coordinate membership around stakeholder groups rather than individuals**
- **Would previous stakeholder groups like to participate again?**
  - If so, please nominate representative
- **Would new stakeholder groups like to join?**
  - E.g. small engine trade groups, since MOVES adding NONROAD
- **Email koupal.john@epa.gov**

Summary

- **Updates to MOVES in the works**
  - MOVES2010b next revision – feature & performance improvements, coming soon
  - MOVES2013 next significant update
- **EPA has performed extensive validation of MOVES vs. independent data, using variety of methods**
  - Report in progress
- **Proposing to revitalize the MOVES Review Workgroup to provide input on MOVES2013**
- **Will share proposed membership list and schedule with MSTRS after we receive feedback**