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## United States Light and Heavy -Duty Fuel Specific On -Road NO and NO x Emission Factor Trends and Their Importance in Inventory Calculations (Presentation)

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Emission Factor Trends and Their Importance in Inventory Calculations  
(Presentation)**

**Publication Statement**

Public Domain

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# United States Light and Heavy-Duty Fuel Specific On-Road NO and NO<sub>x</sub> Emission Factor Trends and Their Importance in Inventory Calculations

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# Acknowledgments

Coordinating Research Council  
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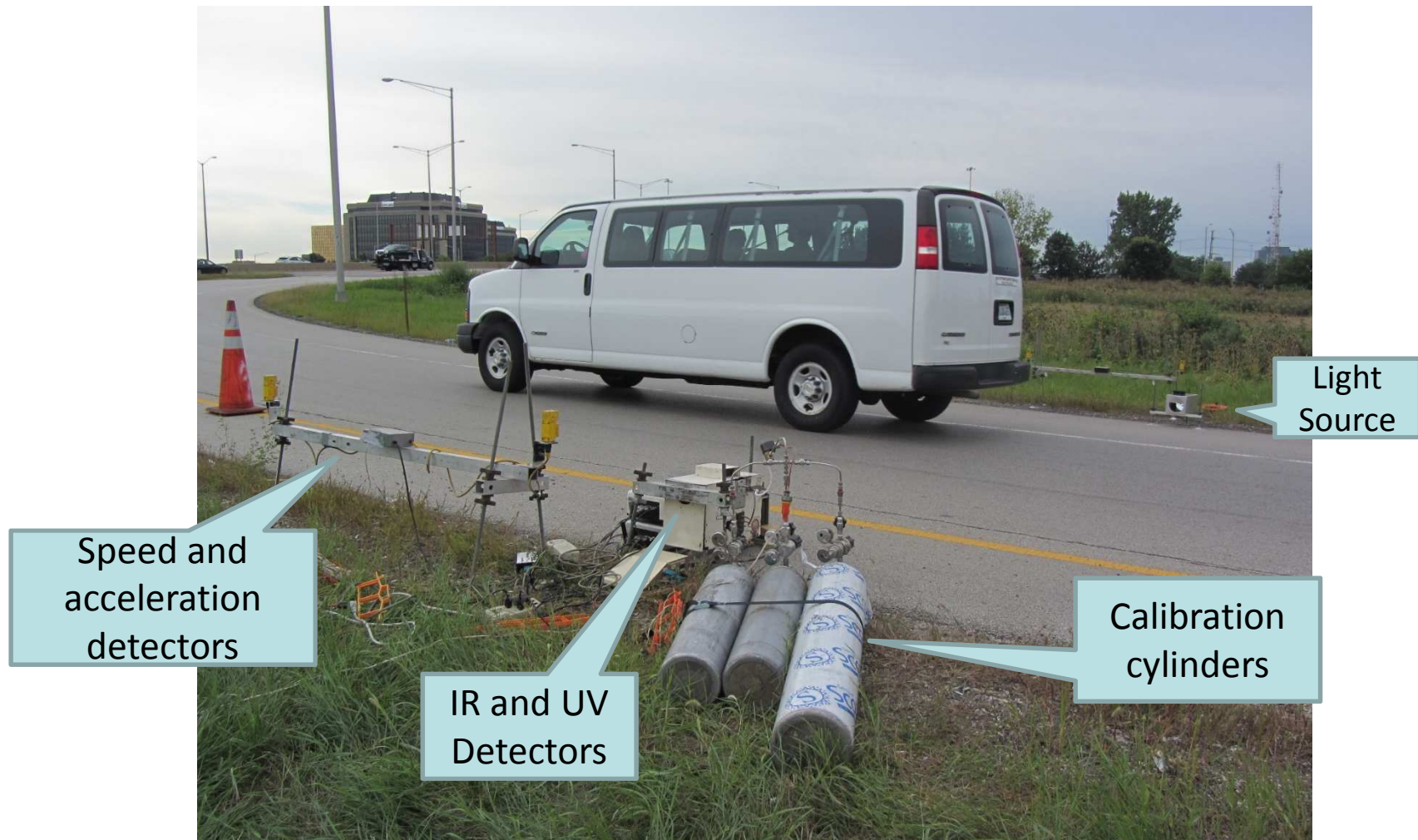
California Air Resources Board

Opus Inspections

University of Denver

The Late Dr. Donald H. Stedman

# Fuel Efficiency Automobile Test (FEAT)



Bishop and Stedman, Measuring the emissions of passing cars. *Acc. Chem. Res.* 1996, 29, 489-495.

# FEAT Measuring Heavy-Duty Vehicles



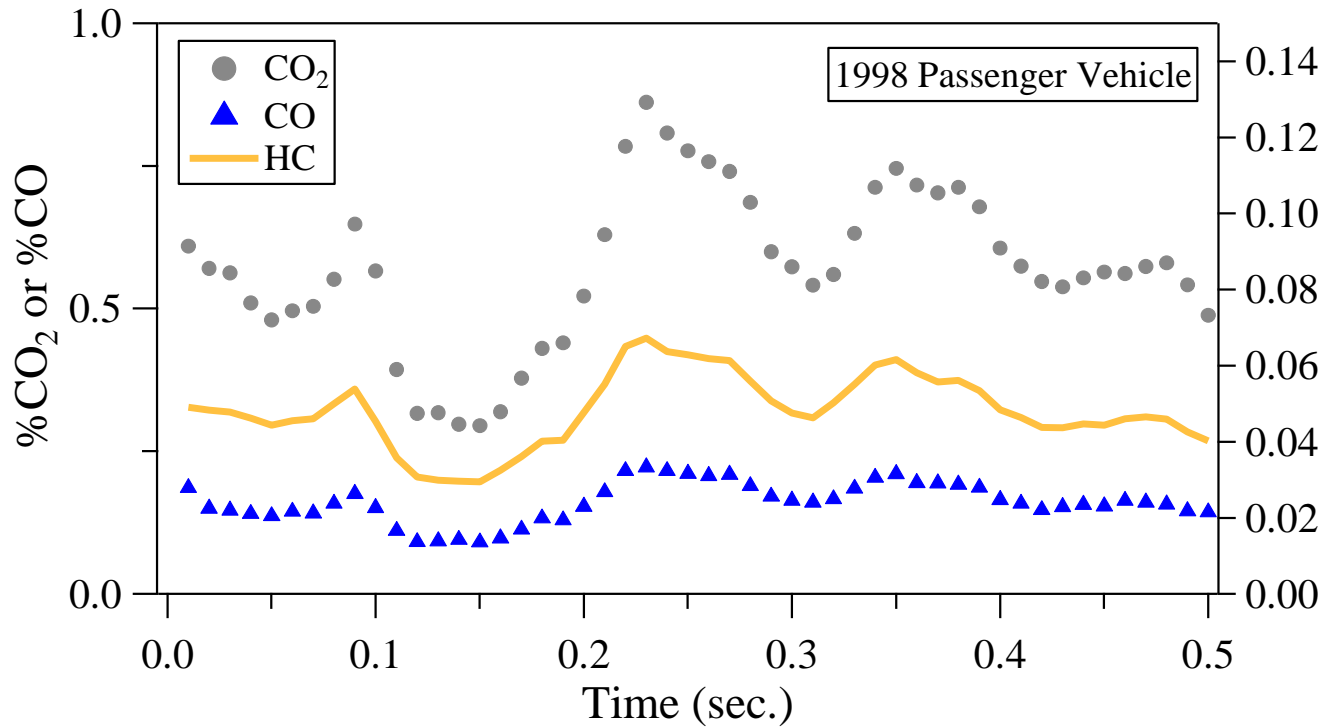
Bishop et al. Heavy-duty truck emissions in the South Coast Air Basin of California. *Environ. Sci. Technol.* **2013**, 47, (16), 9523-9529.

# On-Road Heavy-Duty Vehicle Emissions Monitoring System (OHMS)

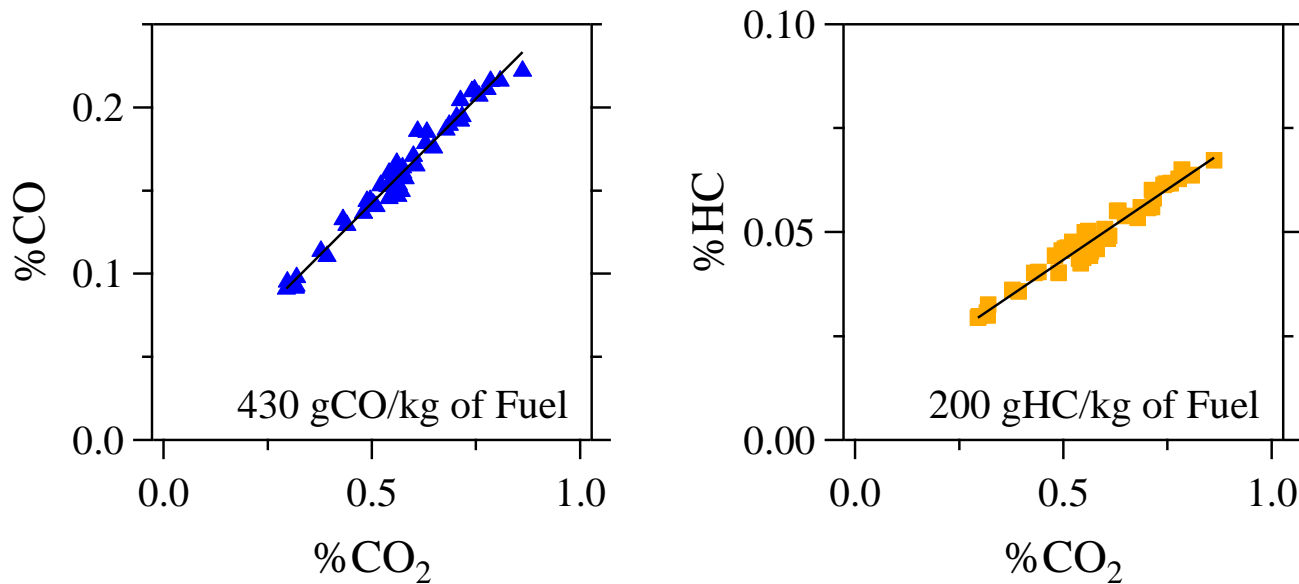


Haugen and Bishop. Repeat fuel specific emission measurements on two California heavy-duty truck fleets. *Environ. Sci. Technol.* **2017**, 51, (7), 4100-4107.

# How We Measure Fuel Specific Tailpipe Emissions



0.5 Second  
of exhaust  
behind  
vehicle





# Measurement Species and Techniques

## FEAT

Single Measurement St. dev.

NDIR – CO<sub>2</sub>  
CO ± 4 g/kg  
HC ± 4 g/kg  
% Opacity ± 0.8%

UV – NO ± 0.4 g/kg  
NO<sub>2</sub> ± 0.3 g/kg  
NH<sub>3</sub> ± 0.02 g/kg

Speed and Acceleration  
License Plate Photo

## OHMS

NDIR – CO<sub>2</sub> / CO  
FID – HC  
Chemi – NO / NO<sub>x</sub>  
Electrical Low Pressure  
Impactor – Total PM / PN  
Photoacoustic – Total BC

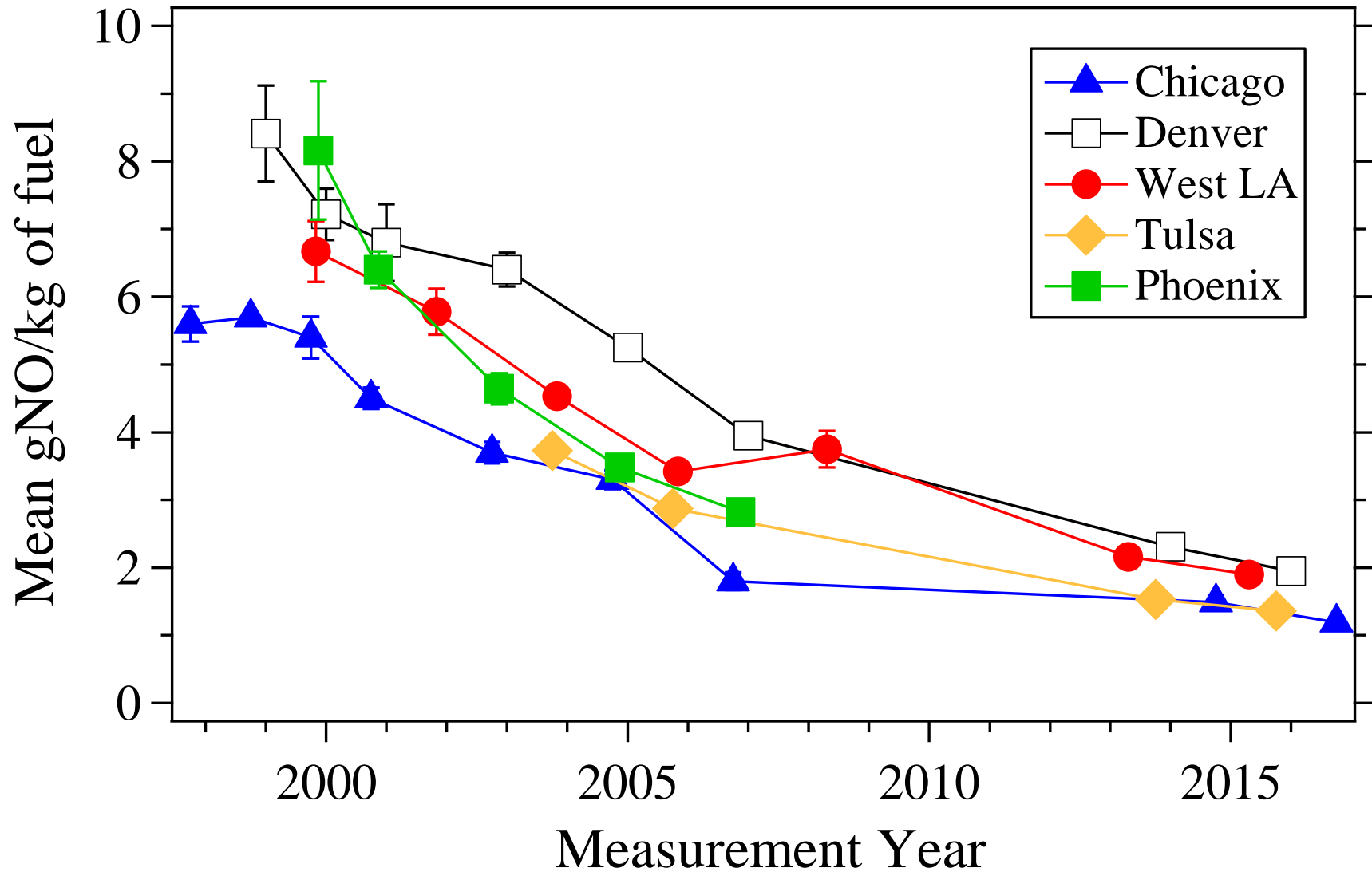
Speed and Acceleration  
License Plate Photo

# History of U.S. Light-duty NO Measurements (NO<sub>2</sub> since 2008)

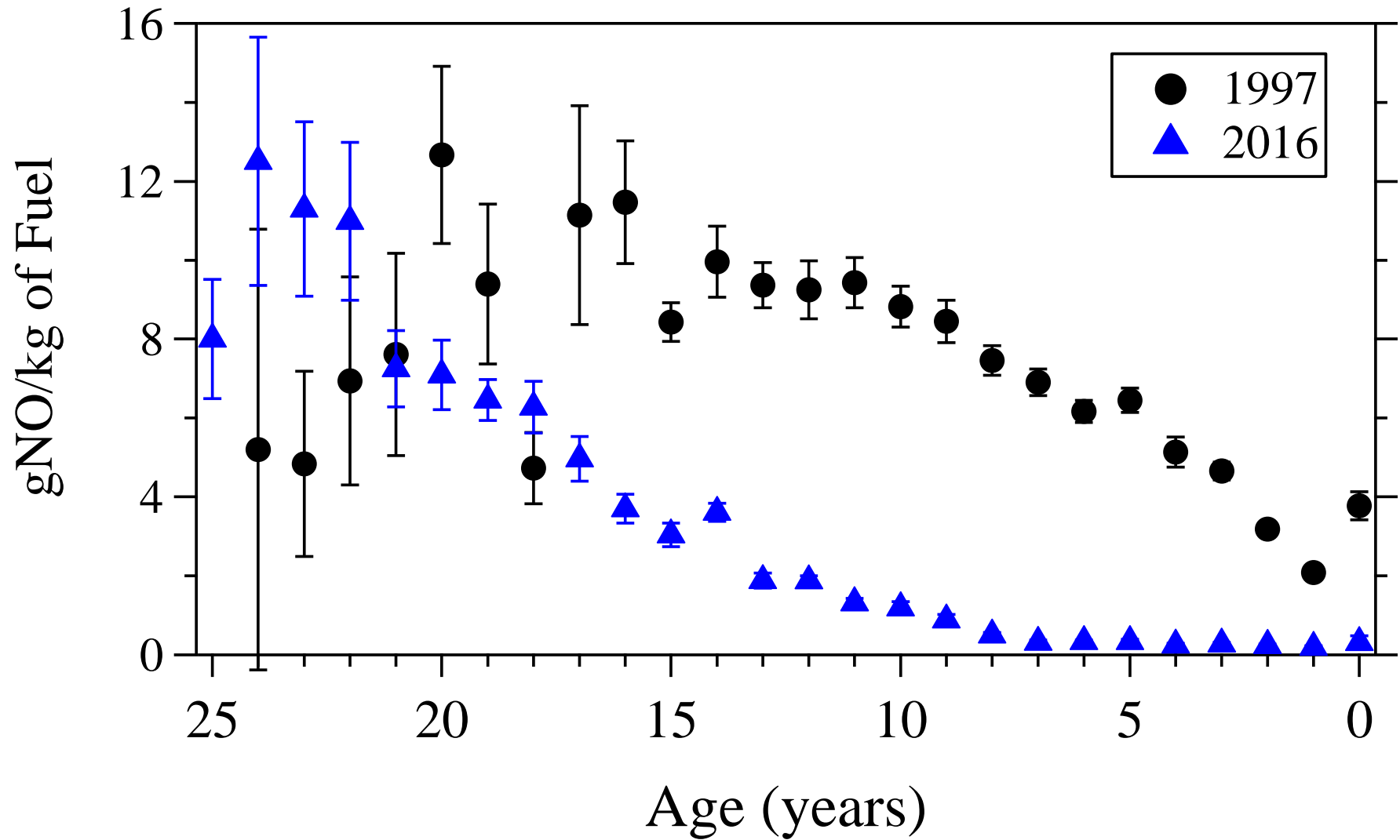
- Chicago, IL – 1997 - 2000, 2002, 2004, 2006, 2014, 2016
- Dallas, TX – 2002, 2003
- Denver, CO – 1999 - 2002 (2), 2003, 2005 (2), 2007, 2013, 2015
- Fresno, CA – 2008
- Grand Junction / Glenwood Springs, CO – 2001
- Omaha, NE – 2002, 2004
- Phoenix, AZ – 1998 - 2000, 2002, 2004, 2006
- Riverside, CA – 1999 - 2001
- Sacramento, CA – 1999
- San Jose, CA – 1999, 2008
- Tulsa, OK – 2003, 2005, 2013, 2015
- W. Los Angeles, CA – 1999, 2001, 2003, 2005, 2008, 2013, 2015
- Los Angeles 710, CA – 1999
- Van Nuys, CA – 2010

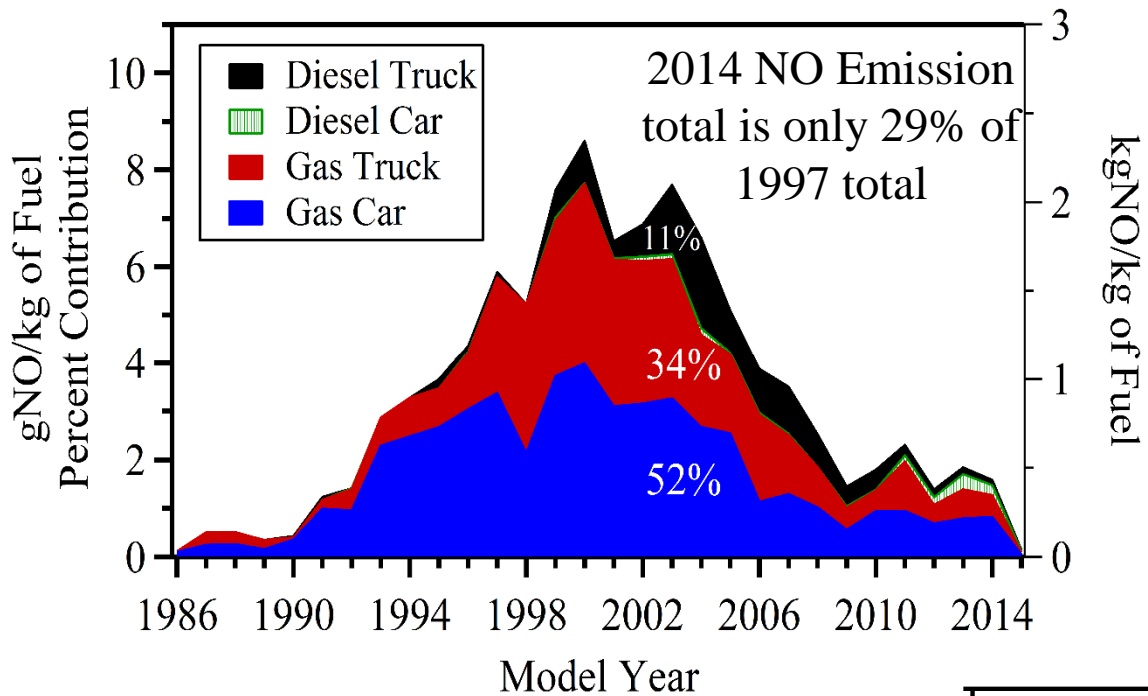
51 Campaigns, 1,039,000+ Emission Measurements,  
Data and Publications are Available at [www.feat.biochem.du.edu](http://www.feat.biochem.du.edu).

# Historical U.S. Light-duty NO Emission Trends

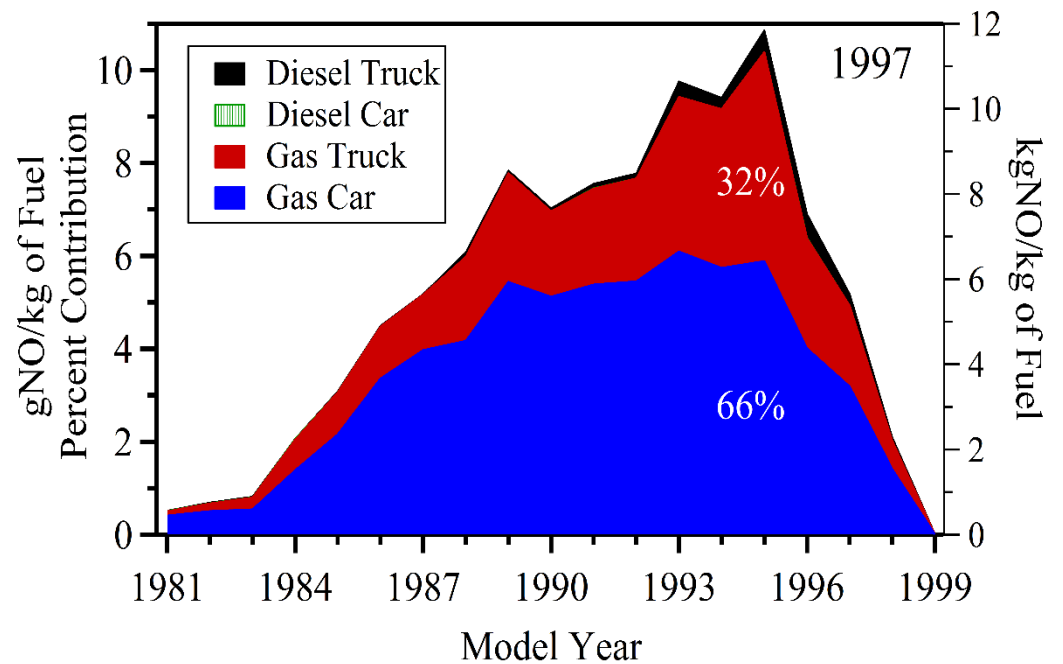
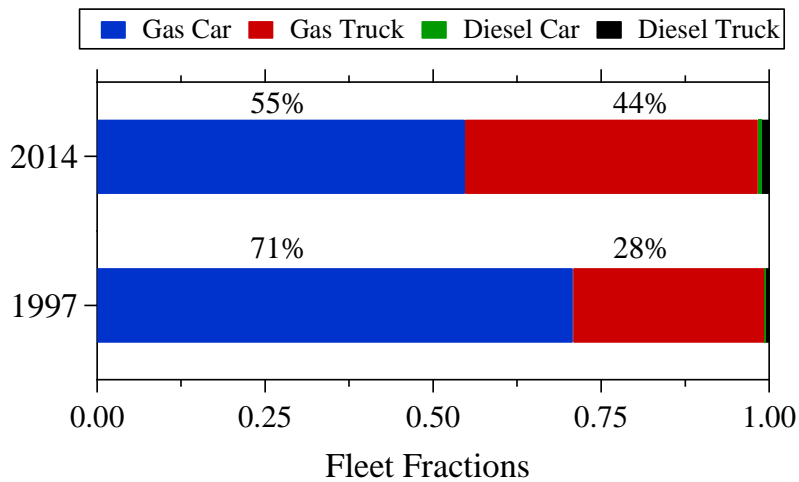


# Chicago NO Emissions Comparison

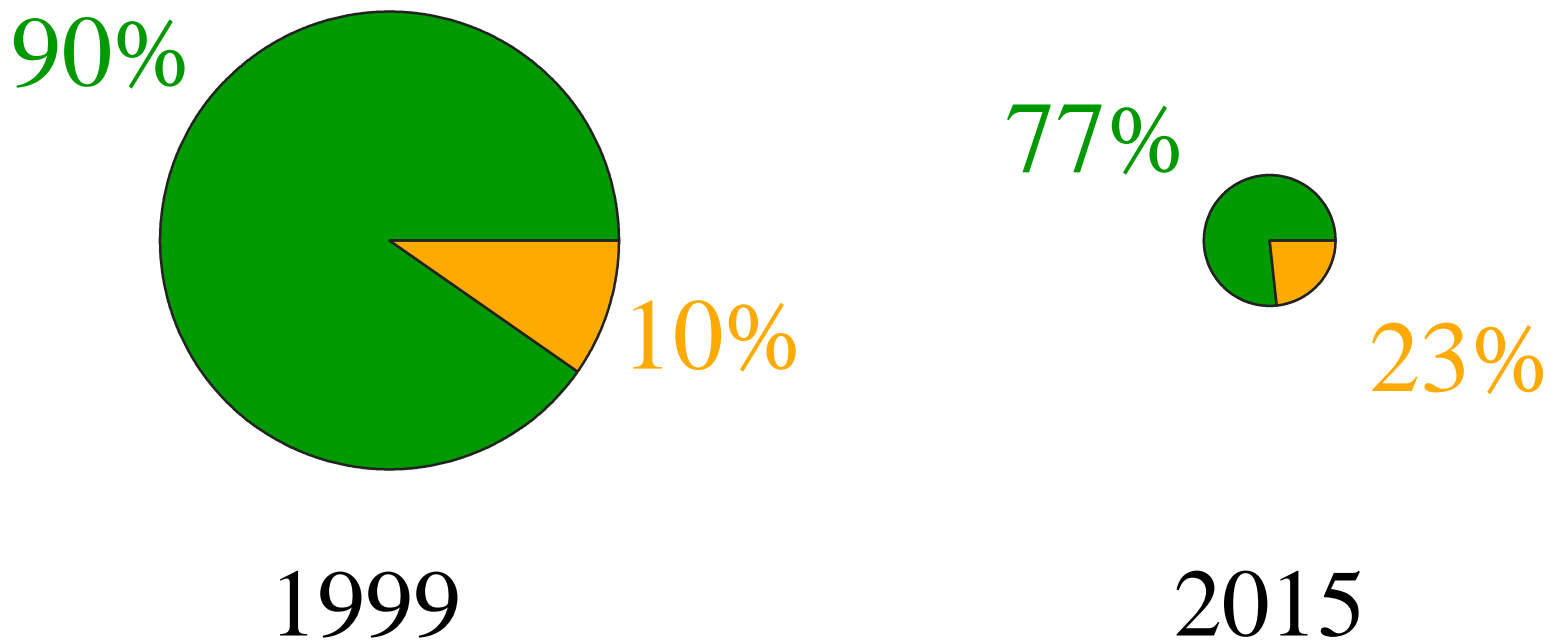




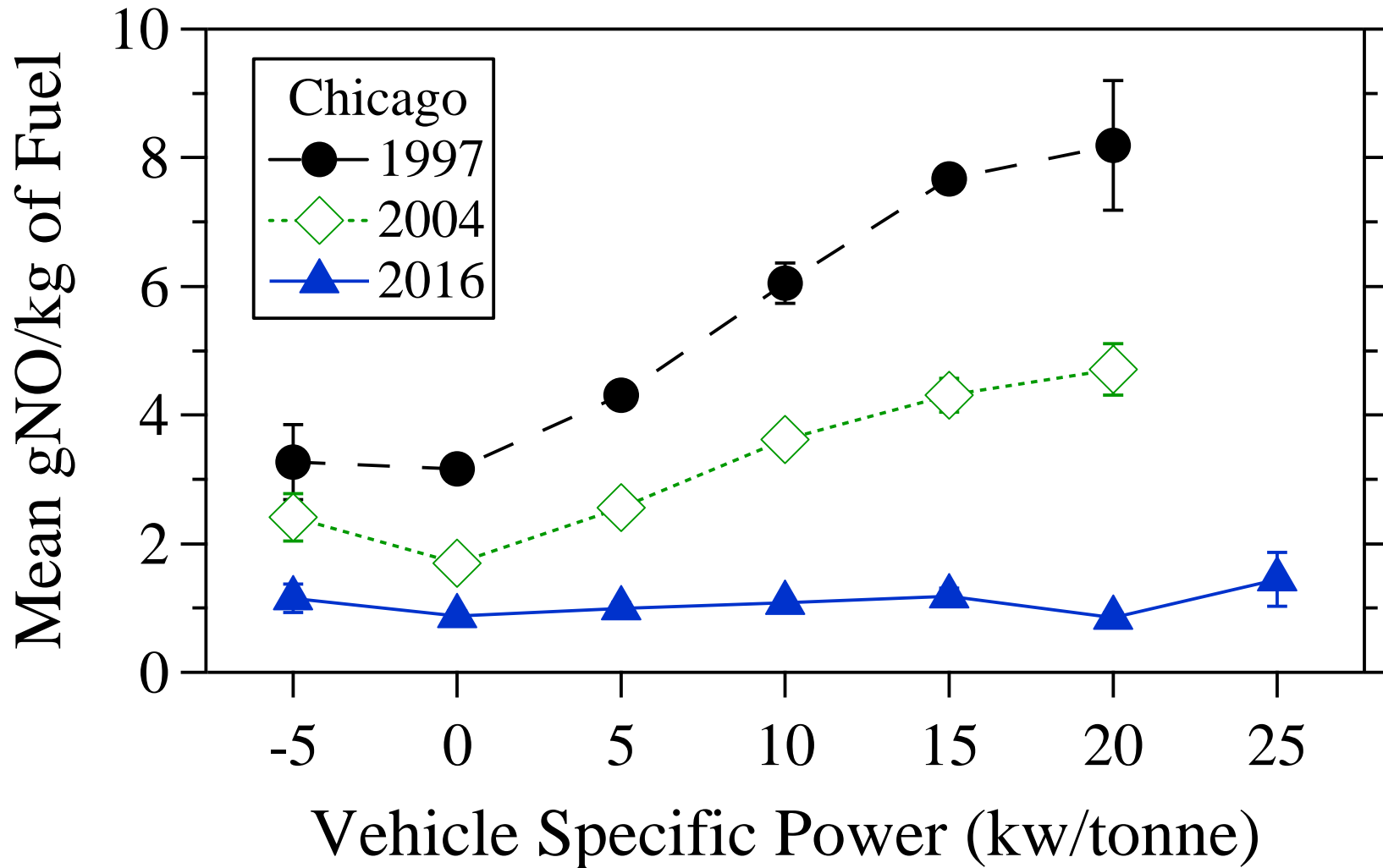
Light/Medium Duty  
NO Emissions  
Contribution Changes  
for the Chicago Fleet



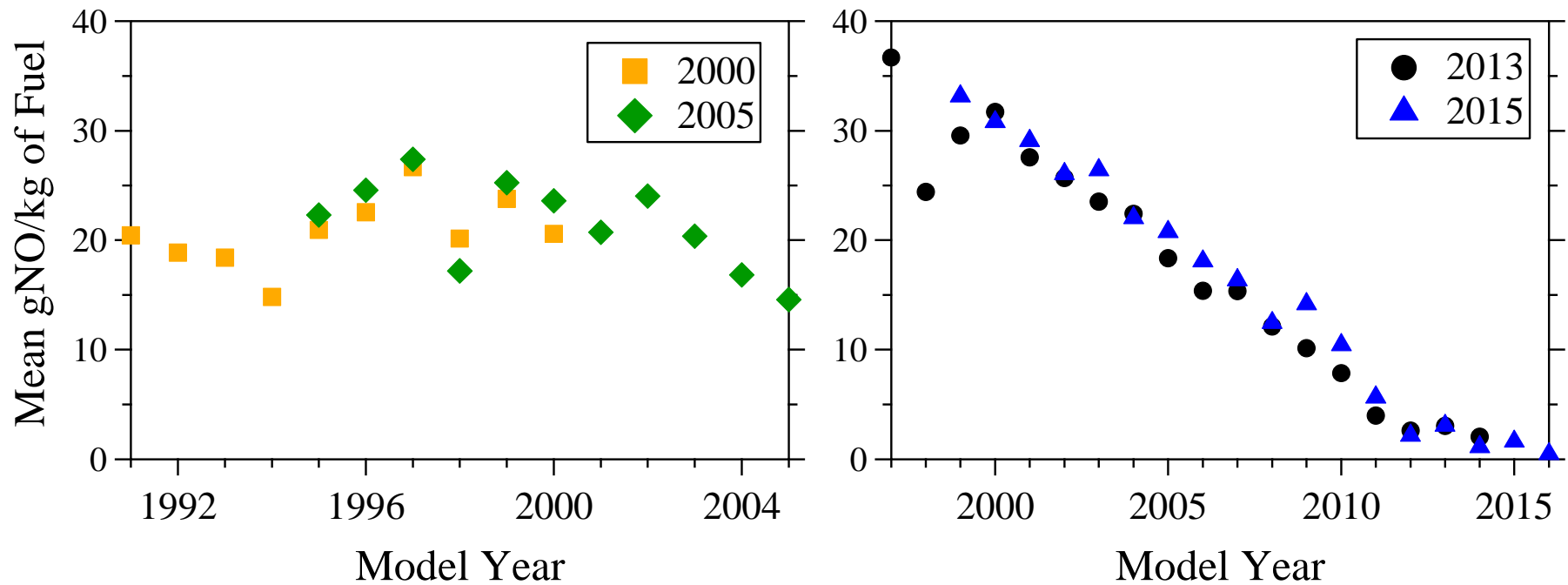
# West Los Angeles Percentage of NO<sub>x</sub> Contributed by the 99<sup>th</sup> Percentile



# Elimination of Driving Mode Effect For Fuel Specific Emissions



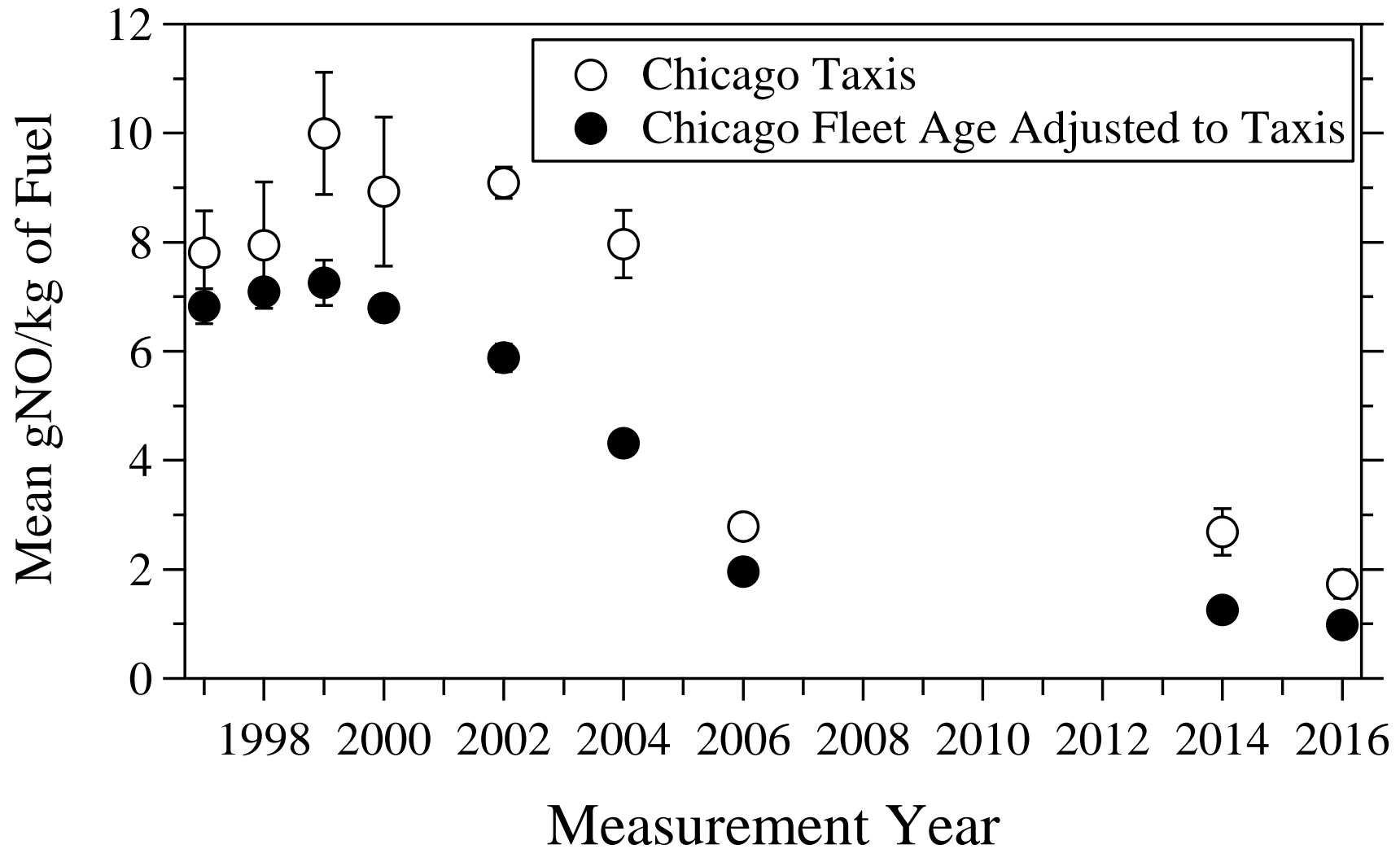
# Denver Fuel Specific NO Emission Trends for Light-Duty Diesel Powered Vehicles





# High Mileage Vehicle Emissions

## Not All Vehicles are Equal



# History of U.S. Heavy-duty NO and NO<sub>x</sub> Measurements

## FEAT

- Anaheim, CA – 1997, 2008 - 2010, 2012, (2017)\*
- Dumont, CO – 1999, 2005
- Golden, CO – 1999, 2005
- Port of Los Angeles, CA – 2008 - 2010, 2012
- Port of Houston, TX – 2009
- San Marcos, TX – 1998

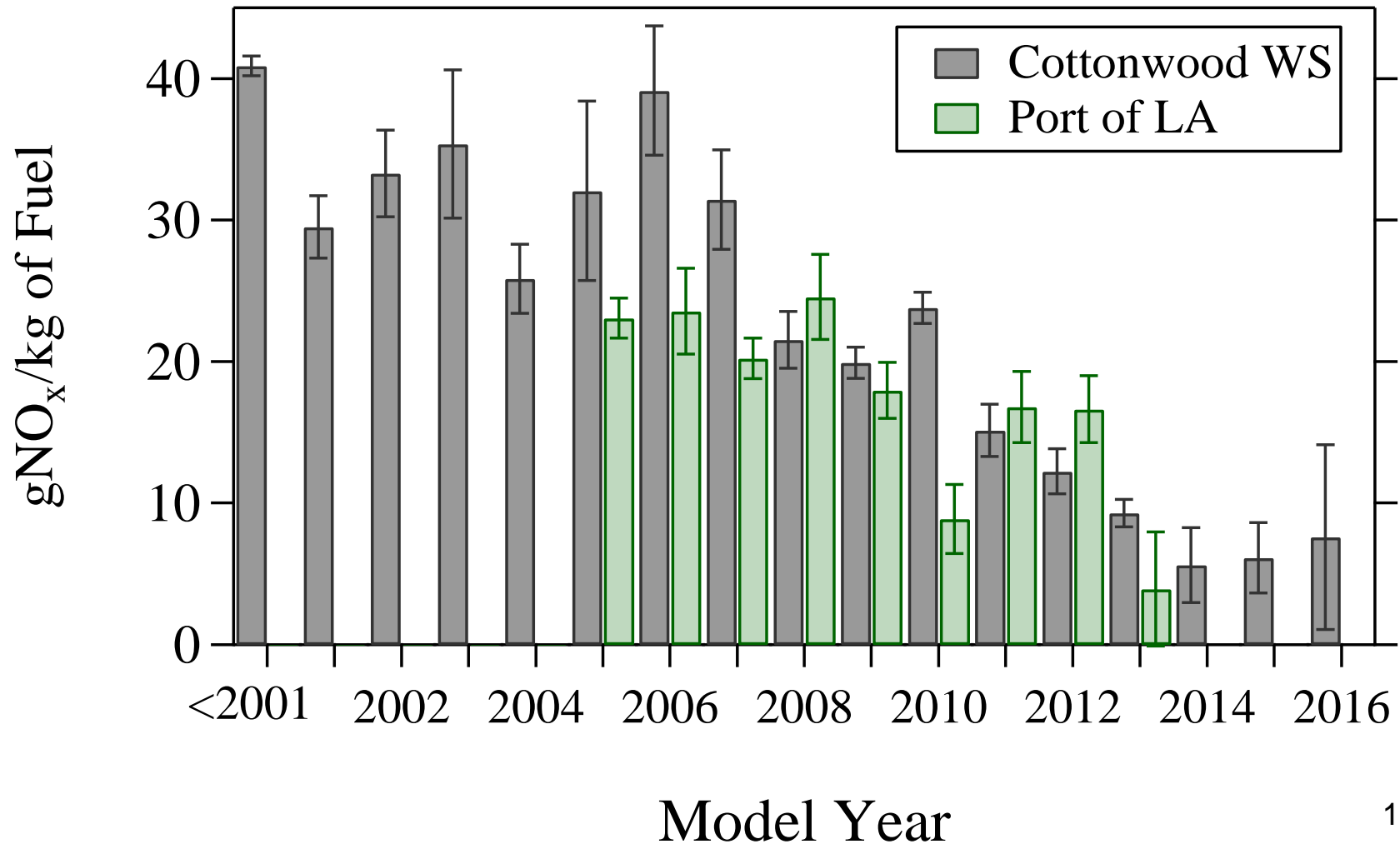
## OHMS

- Port of Los Angeles, CA – 2013, 2015, (2017)\*
- Cottonwood, CA – 2013, 2015, (2017)\*

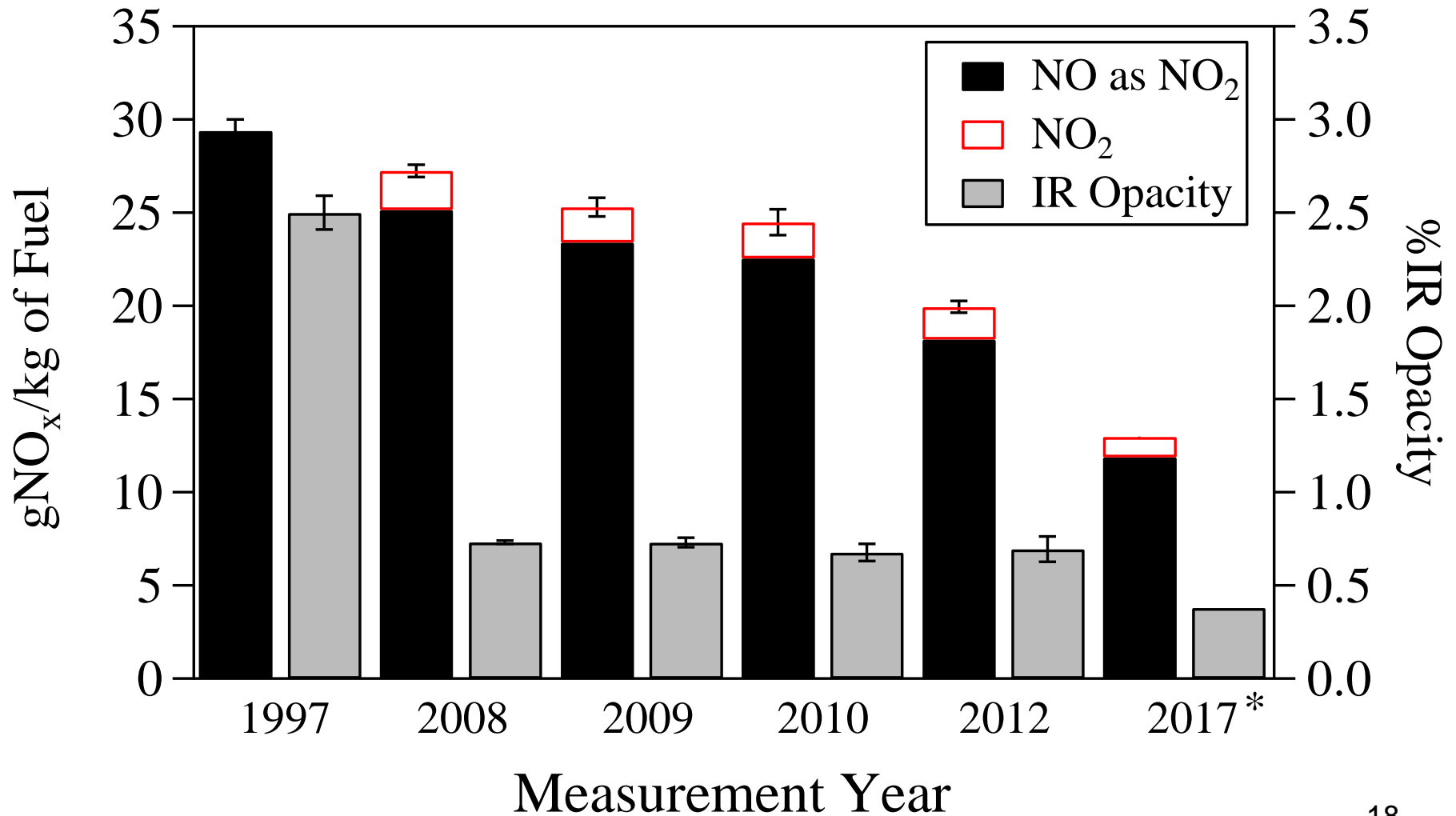
22 Campaigns, 32,000+ Emission Measurements,  
Data and Publications are Available at [www.feat.biochem.du.edu](http://www.feat.biochem.du.edu).

\*Measurements collected, data not final

# 2015 Heavy-duty Diesel Truck NO<sub>x</sub> Emissions by Model Year



# Historical HD Diesel Truck $\text{NO}_x$ Emissions, Peralta WS CA



# Conclusions

- Light-duty gasoline and diesel fleet  $\text{NO}_x$  emission reductions were late to the party but are now rapidly declining!
- Fuel specific LD truck and diesel emissions contributions are increasing, LD driving mode is no longer a factor and all vehicles do not contribute proportionally to the total.
- $\text{NO}$  distributions are more skewed today.
- Heavy-duty  $\text{NO}_x$  emissions are also declining but operating mode/catalyst temperatures can have a significant influence on levels.