Emissions of Radical Precursors and Related Species from Traffic in Houston, Texas – Implications for Air Quality Modeling

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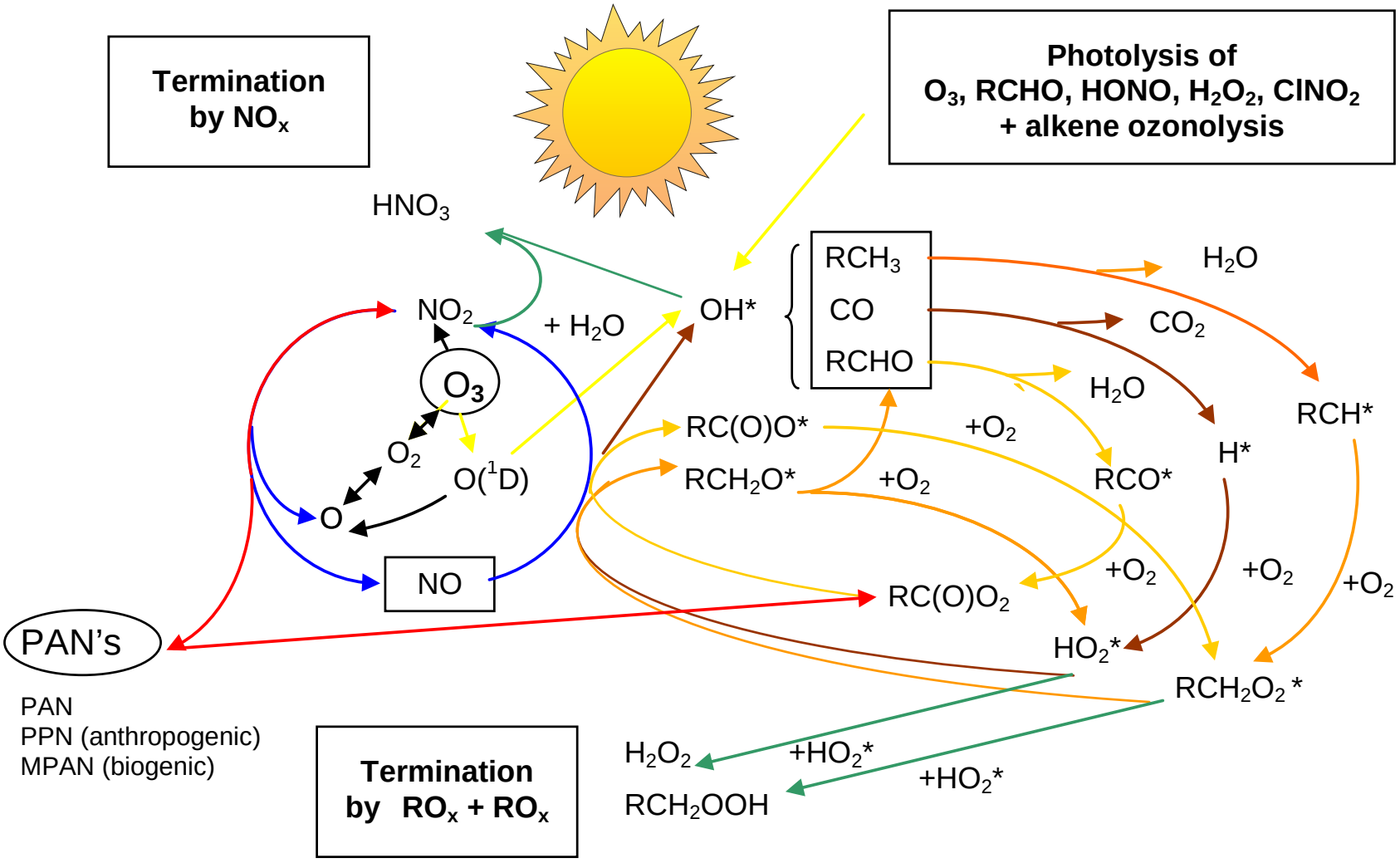
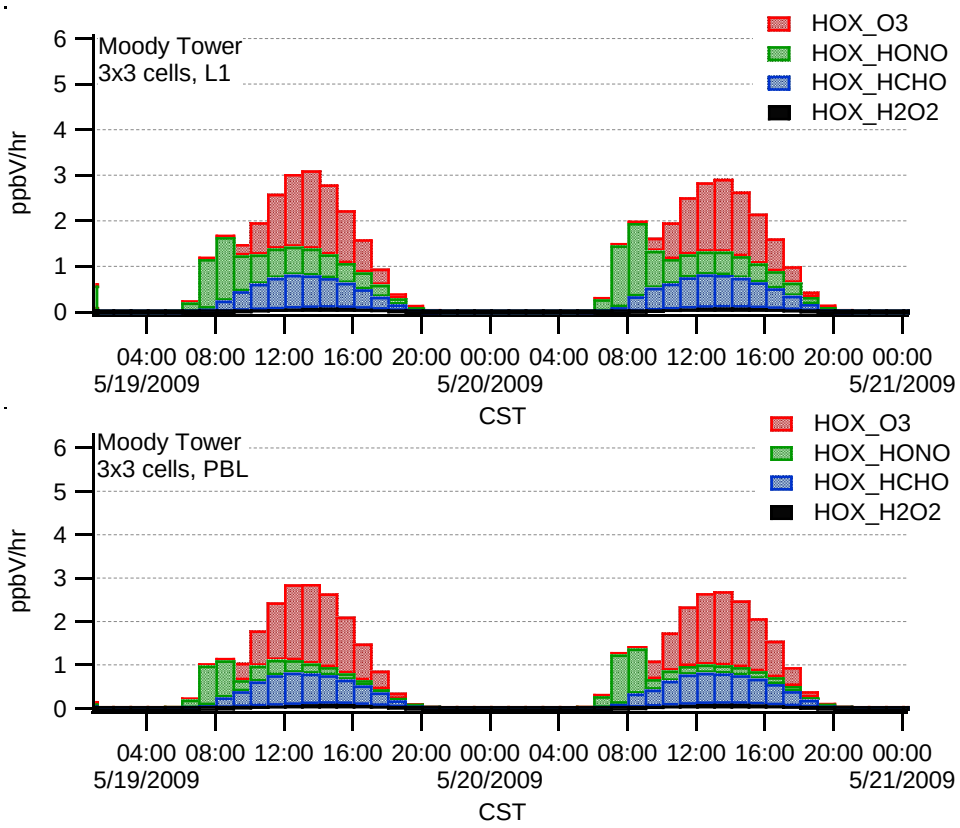
Background

- The Houston region is in non-attainment for the 1-hr, 1997 and 2008 8-hr ozone standard
- This study focus on ozone precursors: HONO, HCOH, CO, NO/NO2/NOx
- Observational data is compared to modeling data (MOBILE6 and MOVES) on an urban highway junction in Houston

Daytime Photochemical Process



CMAQ modeling of contributions of O3, HONO, HCOH and H2O2 to hourly OH formation in Houston TX



- HCOH contributes to OH formation on late morning hours
- HONO contributes to OH formation on early morning hours

Experimental Data

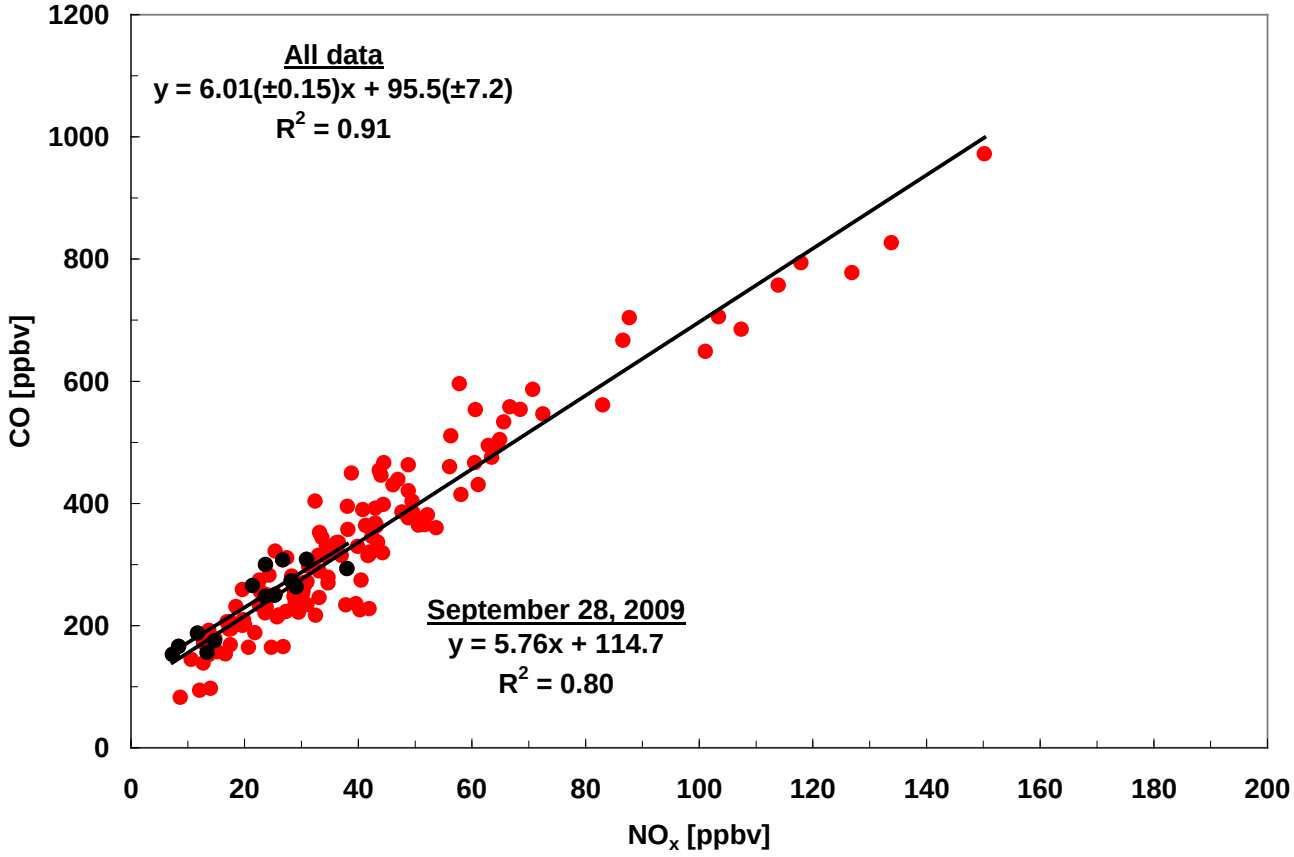
- Continuous ambient air measurements averaged to 10 min interval

Experimental Data

- The data was screened for:

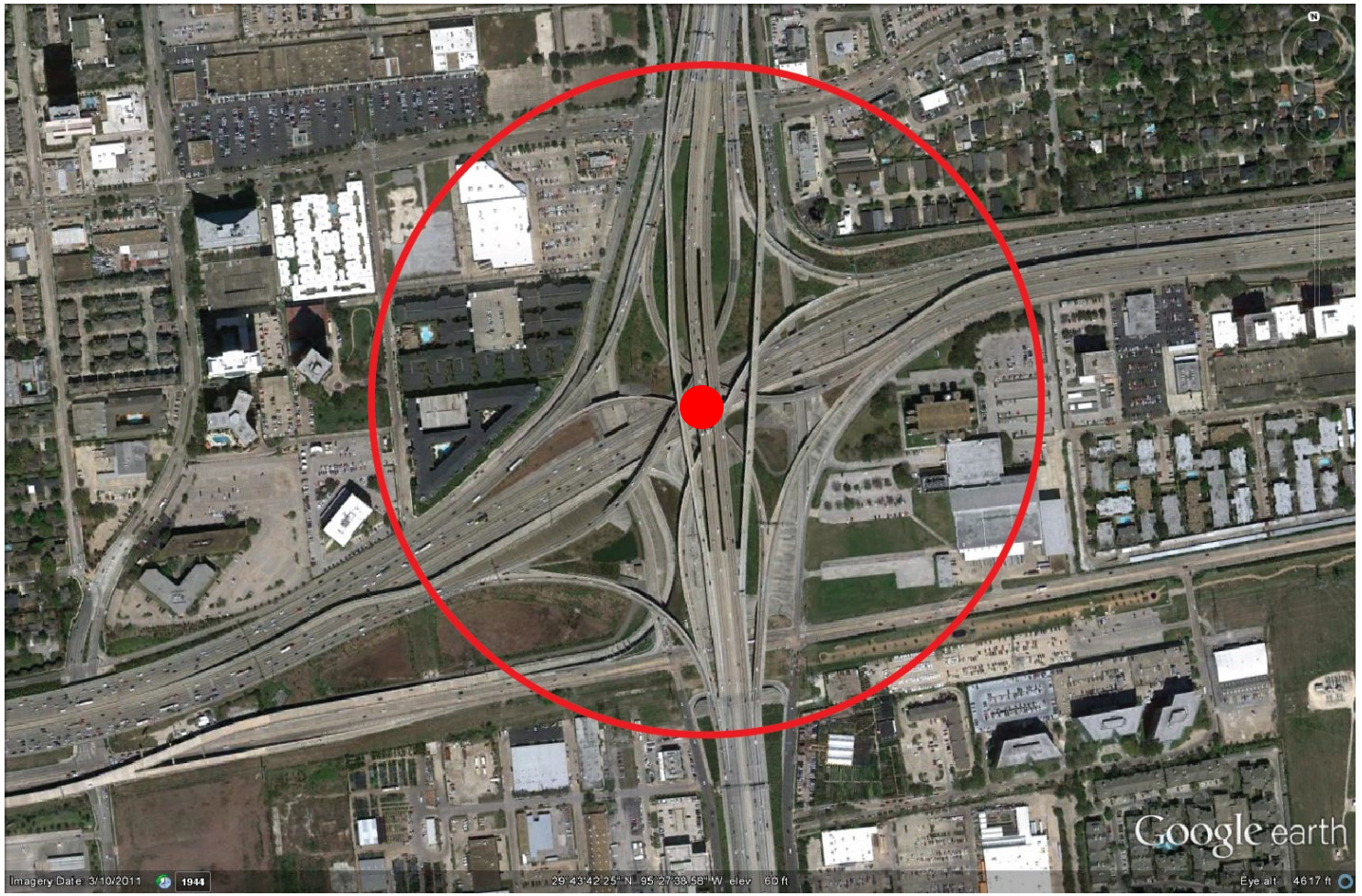
- weekdays
- Rush hour time 4-8 am CST
- Global radiation < 10 W/m^2
- PAN < 50 pptv
- No precipitation
- RH > 80%

Experimental Data



- Very good agreement with Parrish study for rush hour times in selected cities.

Emission Modeling



Emission Modeling

- **MOBILE6:** hourly Harris county emission factors for on-road
  - Observed meteorology at the Galleria site for the model day: September 28, 2009
  - 2009 local registration distribution
  - 2009 local diesel fractions
  - 2009 local VMT per hour
  - Local inspection and maintenance program
  - Anti-tampering program
  - Reformulated gasoline

Emission Modeling

- **MOVES:** MOVES2010a was used to calculate EF for on-road and off-network for NOx, CO, VOC, HCOH, CO_2 (atm), NO, NO_2. MOVES2010b was used to calculate HONO.

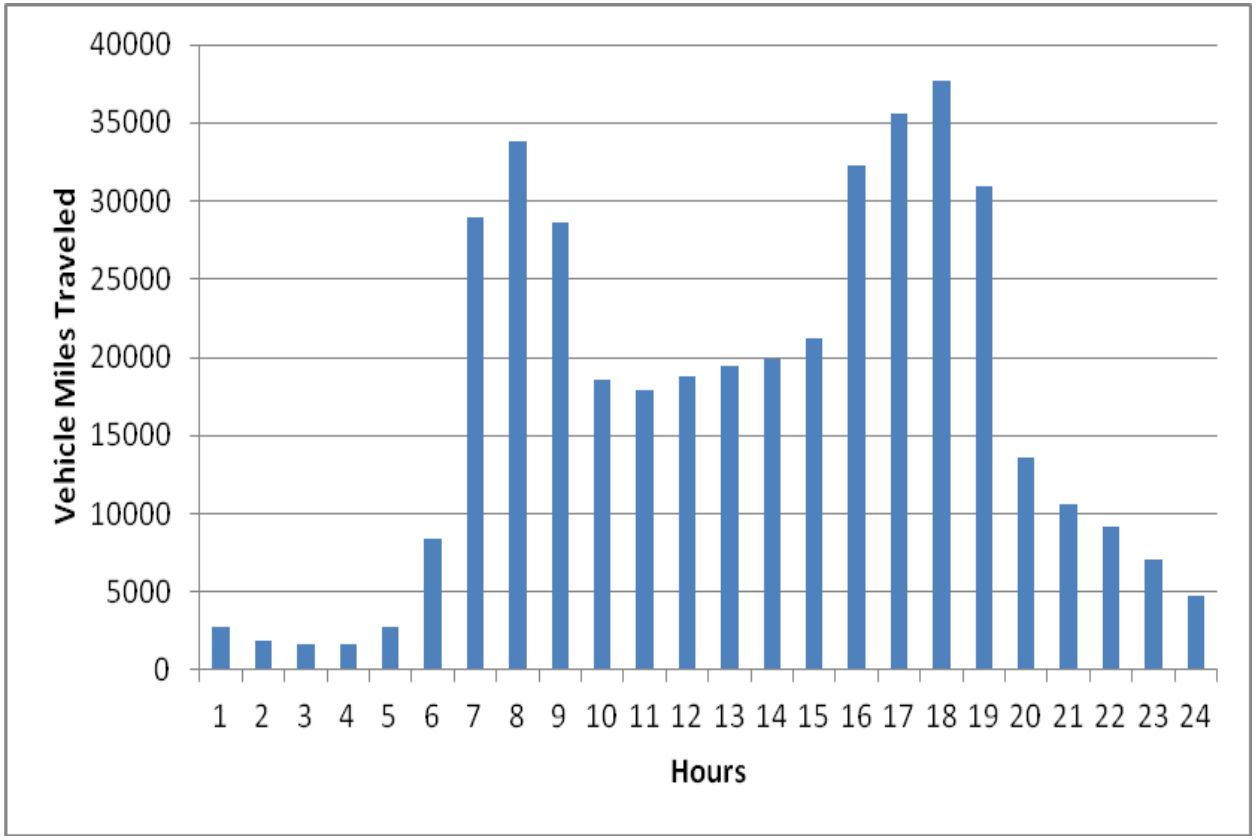
- The county data manager was used to enter the local data:
- Avgspeeddistribution
- Dayvmtfraction
- Fuelformulation
- Fuelengfraction
- Fuelsupply
- Hourvmtfraction
- Hpmsvtypeyear
- Imcoverage
- Monthvmtfraction
- Roadtypedistribution
- Sourcetypeagedistribution
- Sourcetypeyear
- Zonemonthhour

Emission Modeling

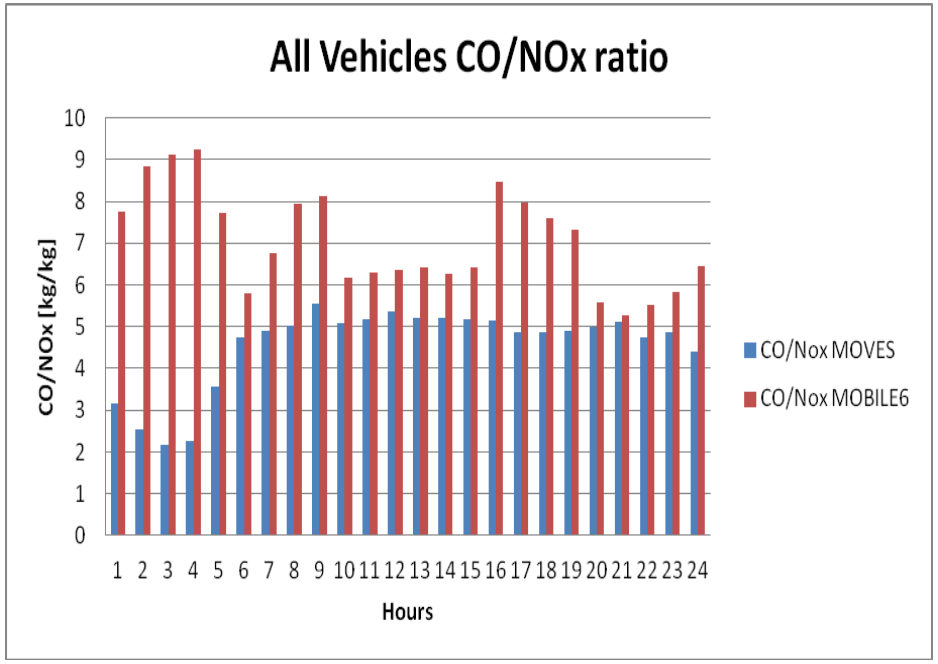
Using the Texas Transportation Institute suite of programs:

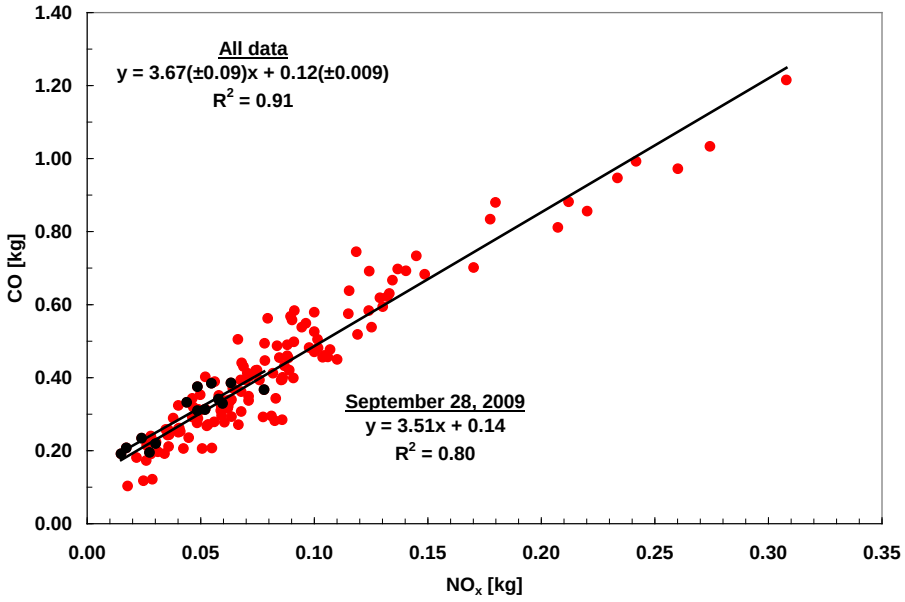
- The EFs were adjusted for TxLED and the motorcycle rule
- The emissions were calculated multiplying the hourly adjusted emission factors (according to speed) by the hourly VMT per link, using the 2009 hourly VMT mix.
- The output is link-level emissions by vehicle type

Diurnal variation of VMT for the Galleria site study area September 28, 2009



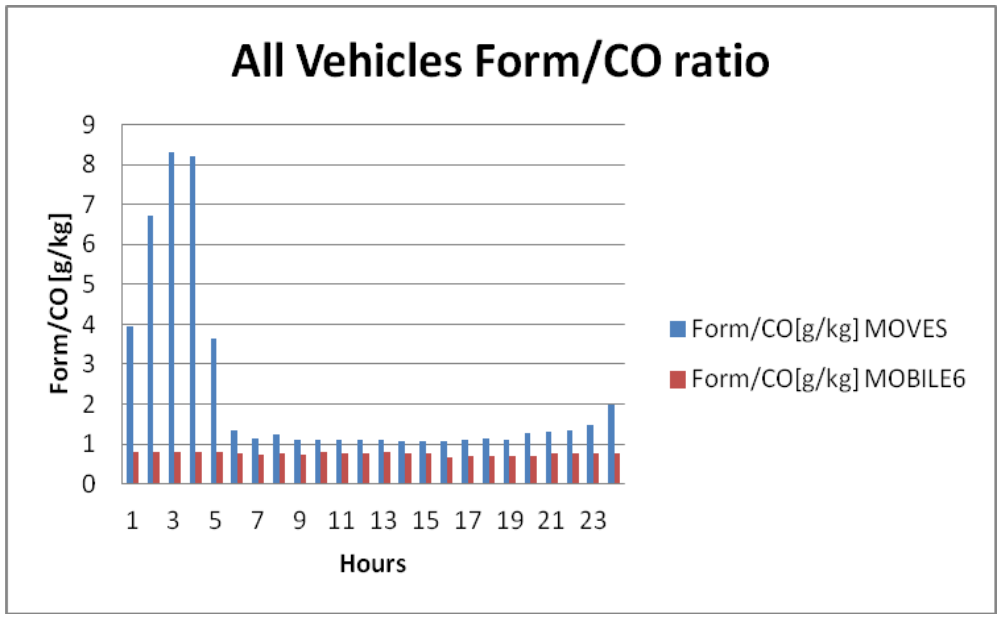
Results

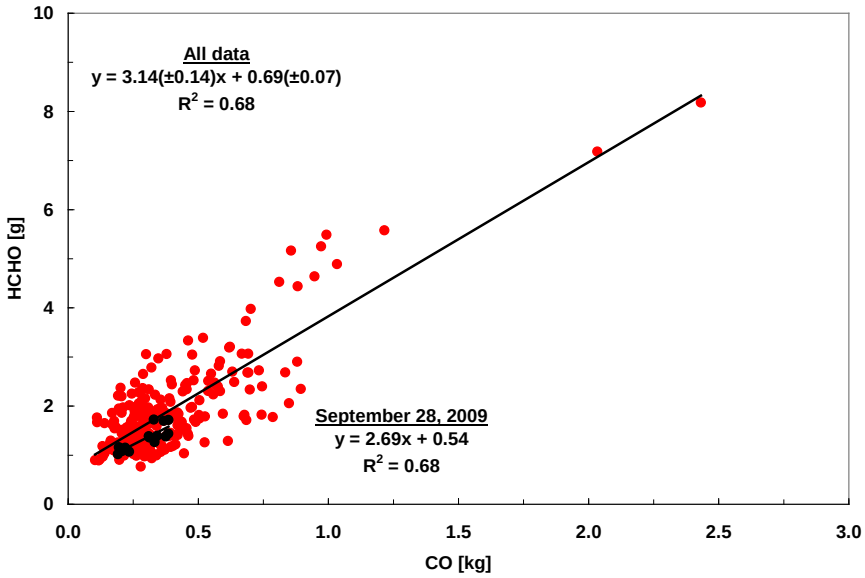




- For the morning rush hour, MOBILE6 overestimates the CO/NOx ratio by almost a factor of 2, while MOVES is 30% higher

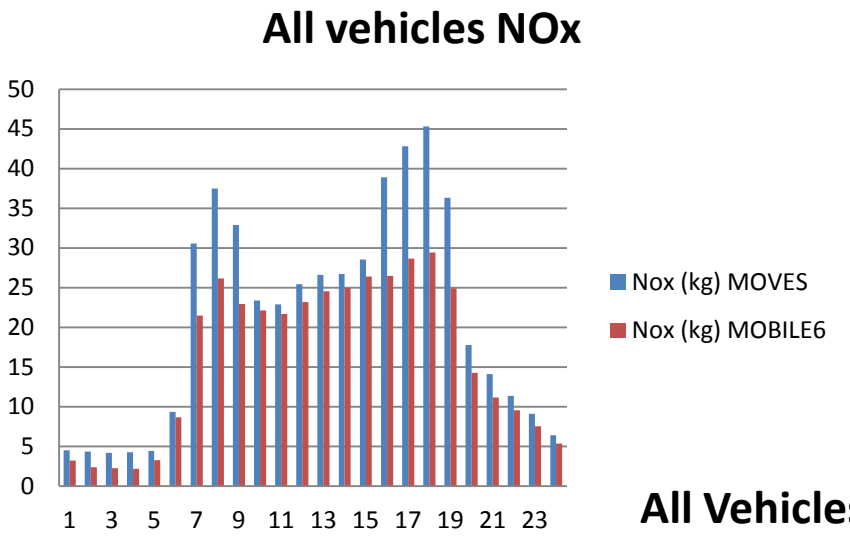
Results

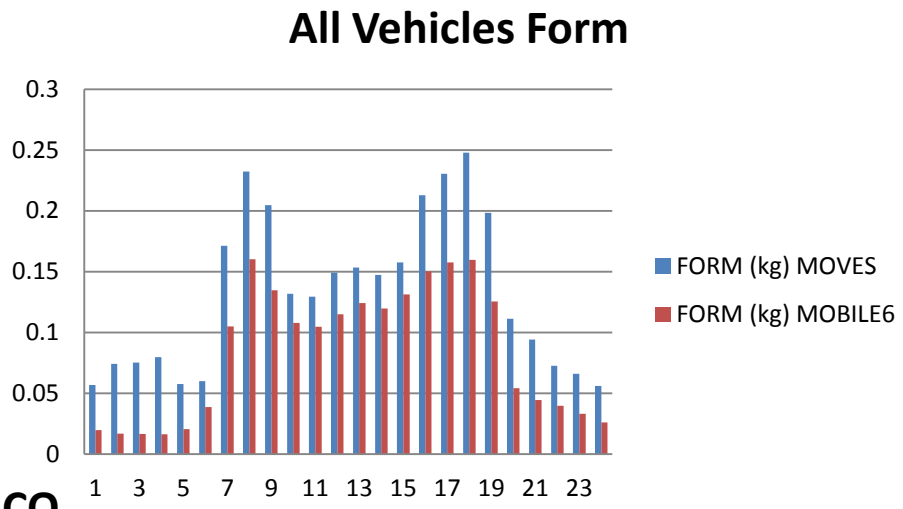


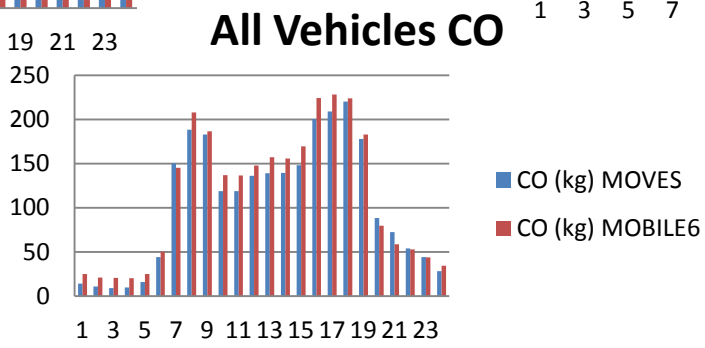


- MOBILE6 largely underestimates Form/CO ratio
- MOVES calculates a very high ratio for very early morning due to heavy duty diesel off-road emissions (idling and starting trucks)

Results

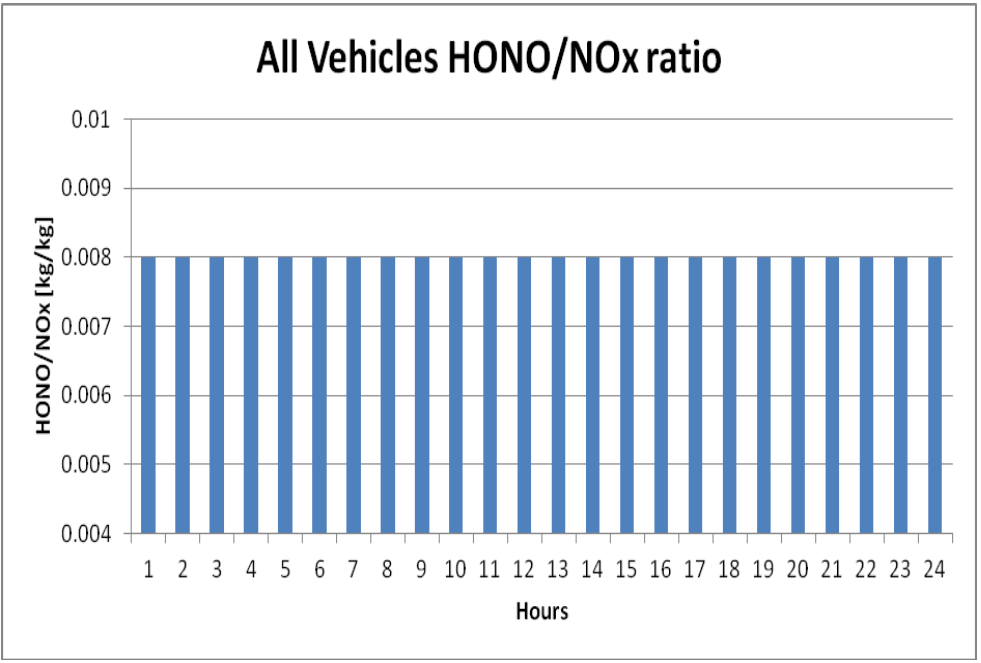


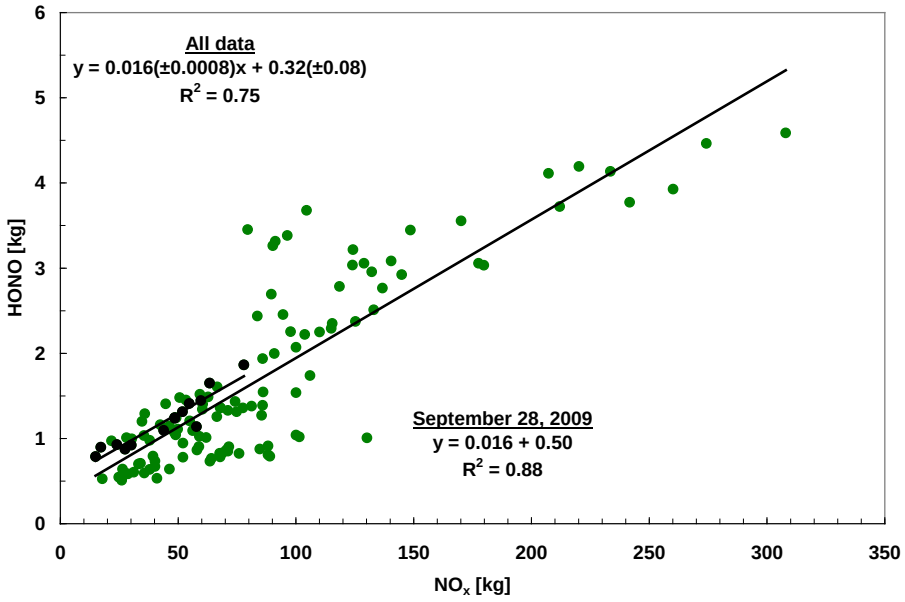




- The differences in CO/NOx and HCOH/CO ratios are largely due to higher NOx and HCOH in MOVES (30% and 57% more than in MOBILE6) while CO emissions are about the same for both models.

Results

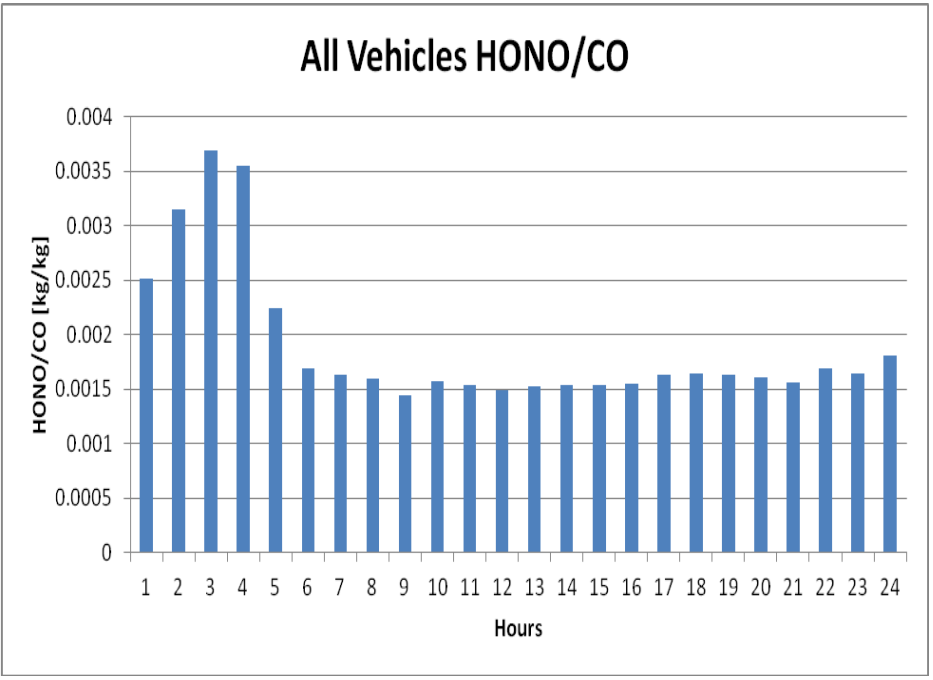


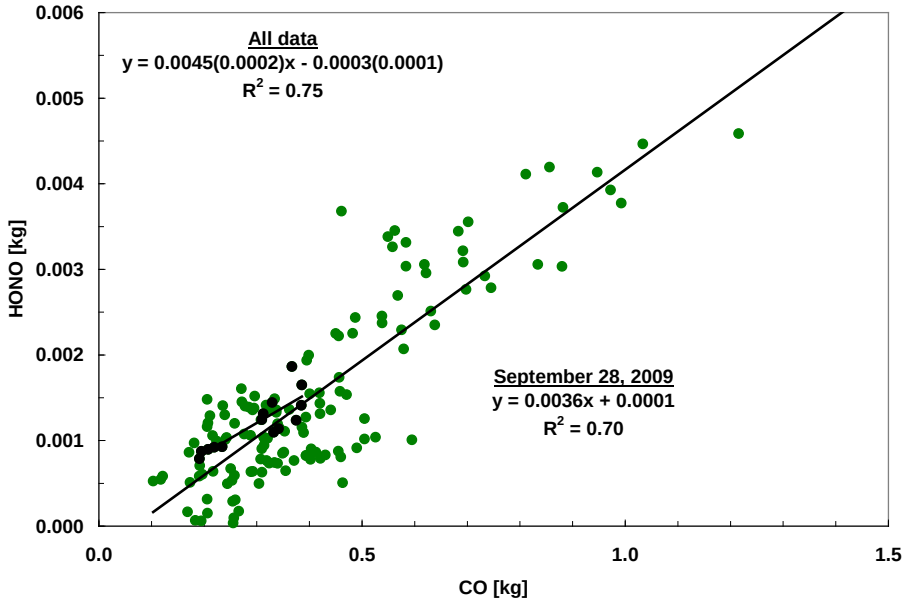


MOVES shows a constant HONO/NOx ratio from a tunnel study done more than 15 years ago.

The observed HONO/NOx ratio is twice the modeled.

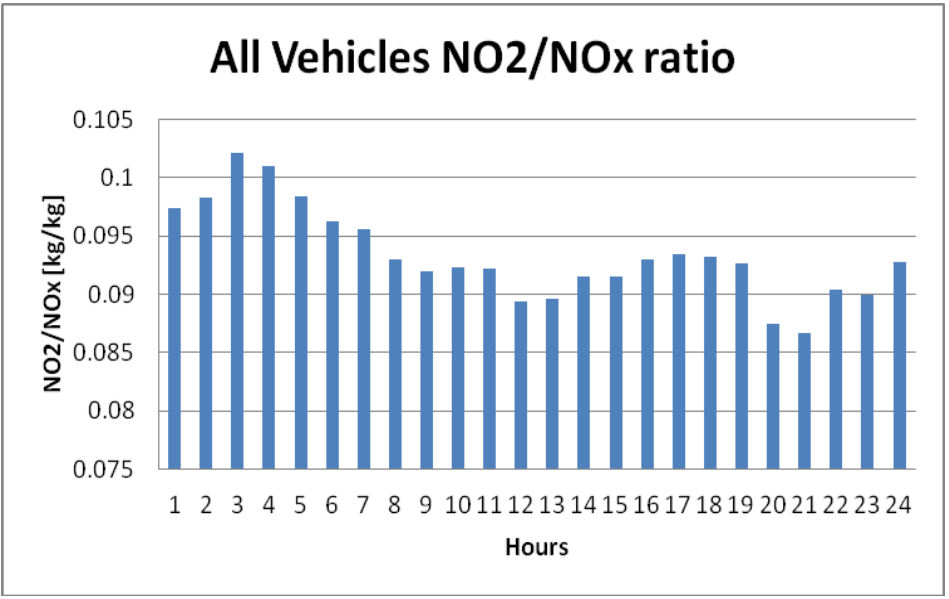
Results

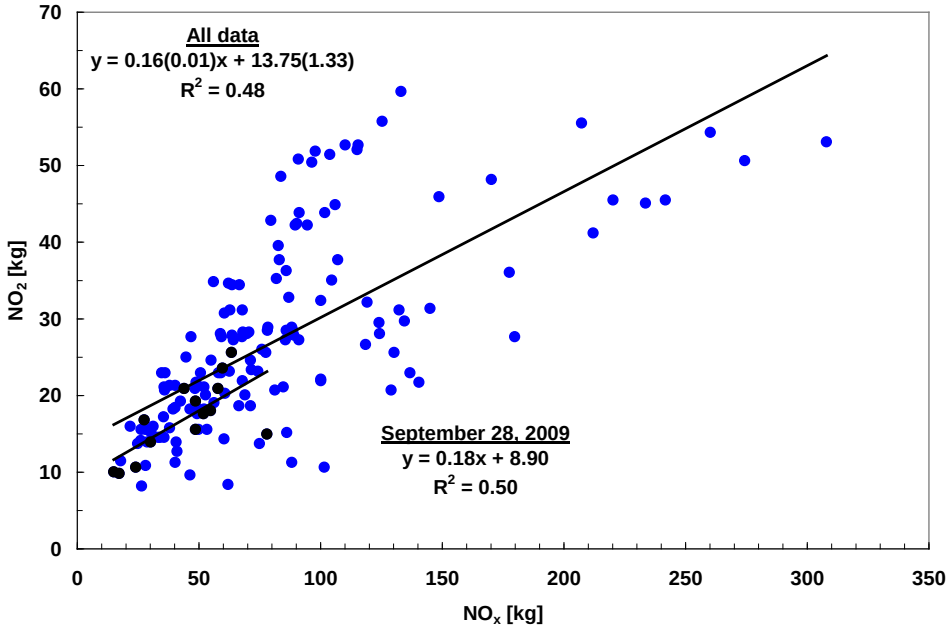




- As expected due to the underestimation of HONO/NOx, the MOVES also underestimates the HONO/CO ratio, except at very early morning hours.

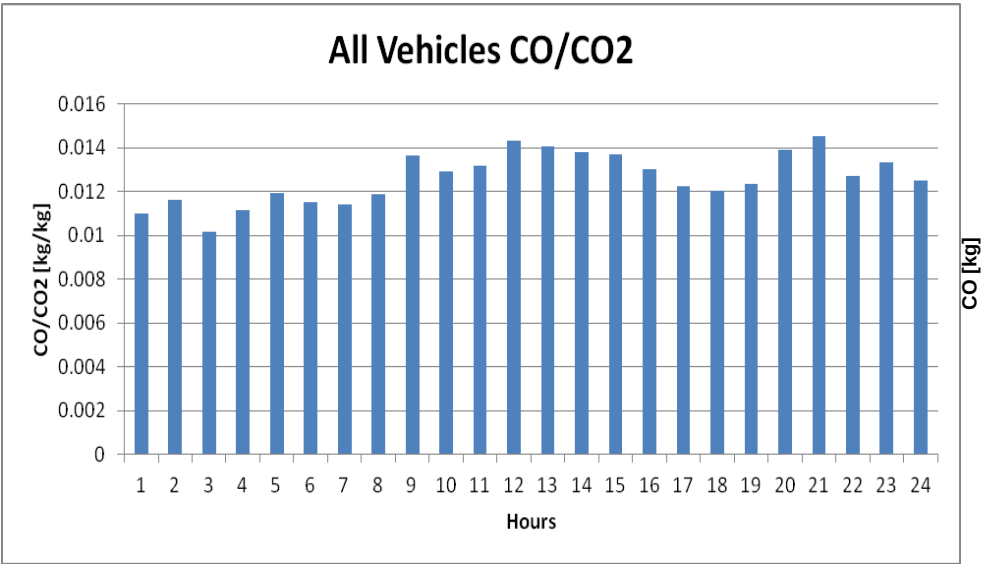
Results

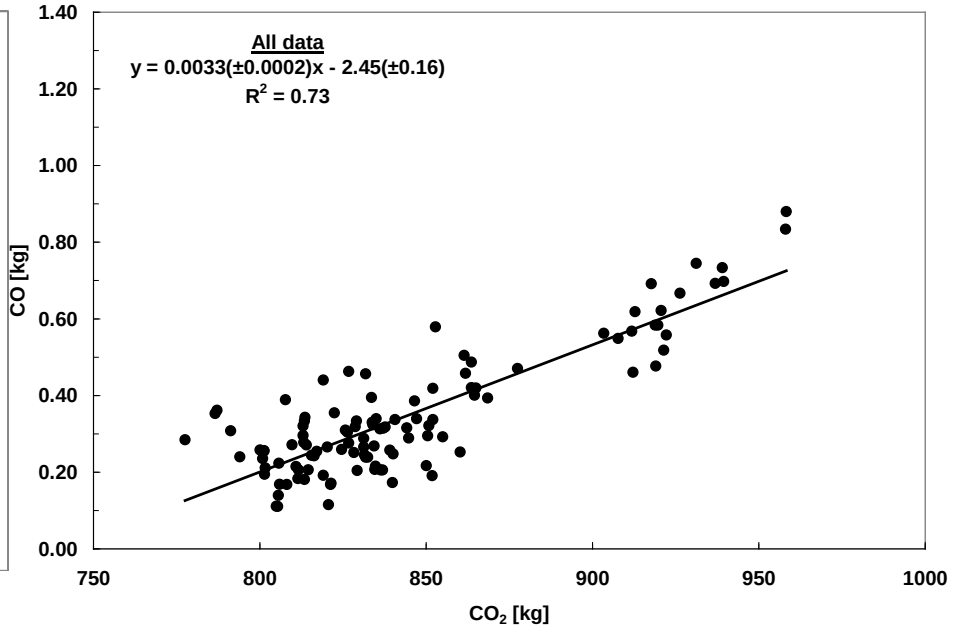




- Earlier studies showed a NO2/NOx ratio of 5%
- MOVES shows a ratio 9.3% for rush hour time
- The observation ratio is about twice

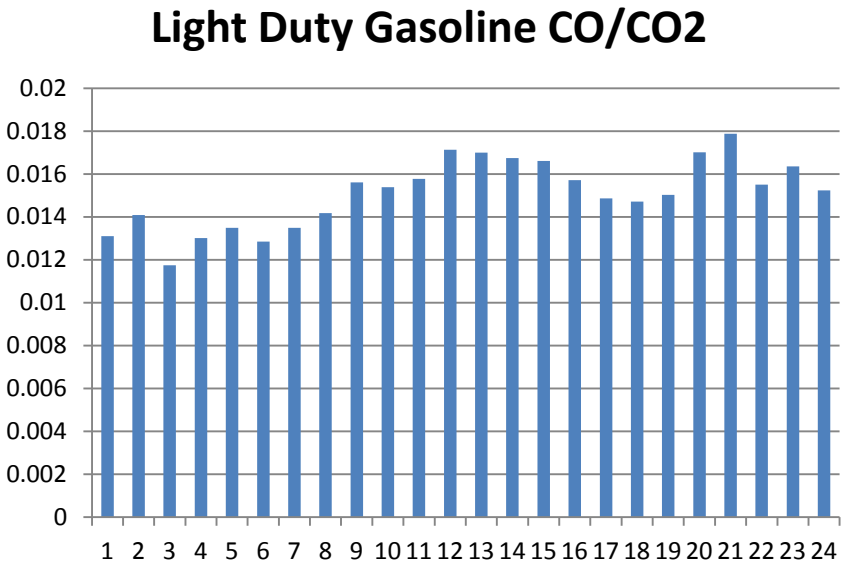
Results

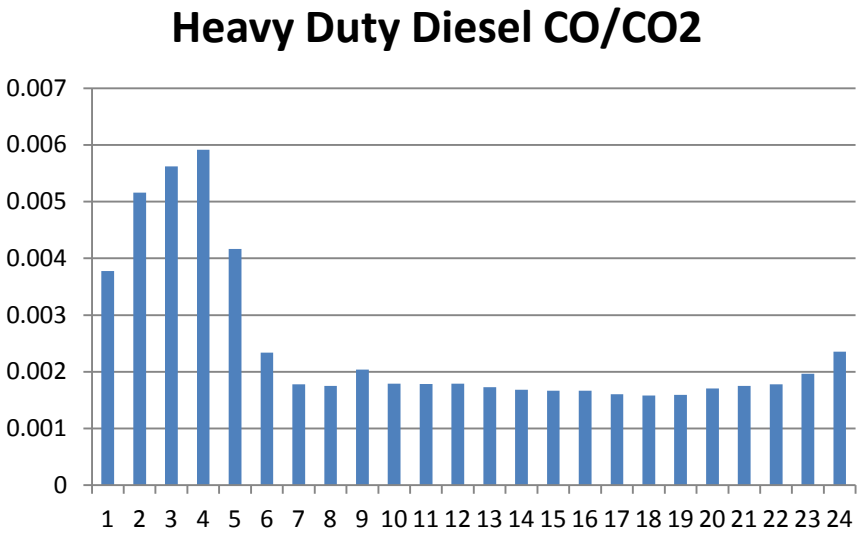




- MOVES calculates 3 times higher CO/CO2 than observed.
- It seems that MOVES overestimates the CO/CO2 ratio from light duty gasoline vehicles

Results


Light Duty Gasoline CO/CO2
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


Heavy Duty Diesel CO/CO2
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Conclusions

- MOVES is a big improvement versus MOBILE6
- The above findings indicate an overestimation of CO/CO2 for light duty gasoline vehicles and an underestimation of HONO/NOx, HCOH/CO, NO2/NOx for heavy duty diesel vehicles in MOVES.