# Criteria Pollutant Impacts of Mid-Level Ethanol Blends (E15 and E20)

2012 International Emission Inventory Conference

August 16, 2012

Jeremy Heiken

Sierra Research

# Overview

- Quantify the criteria inventory impact of increased ethanol usage
- MOVES2010a context:
  - Ethanol content capped at 10 percent
  - Exhaust fuel corrections restricted to Tier 0 data
  - No ethanol exhaust impacts on THC and NOx exhaust beginning with MY2004

# Goals

- Develop Tier 1 and later vehicle exhaust fuel corrections for ethanol content up to E20
- Evaluate evaporative permeation ethanol impacts up to E20
- Apply results to July weekday, national average MOVES inventory

# Background

- *Energy Independence and Security Act of 2007* (i.e., "RFS2")
  - 7.5 billion gallons by 2012
  - 36 billion gallons by 2022
- E10 blendwall hit in 2012
- Two partial waivers granted to E15
- E15 first retailed in Lawrence, KS (July 2012)

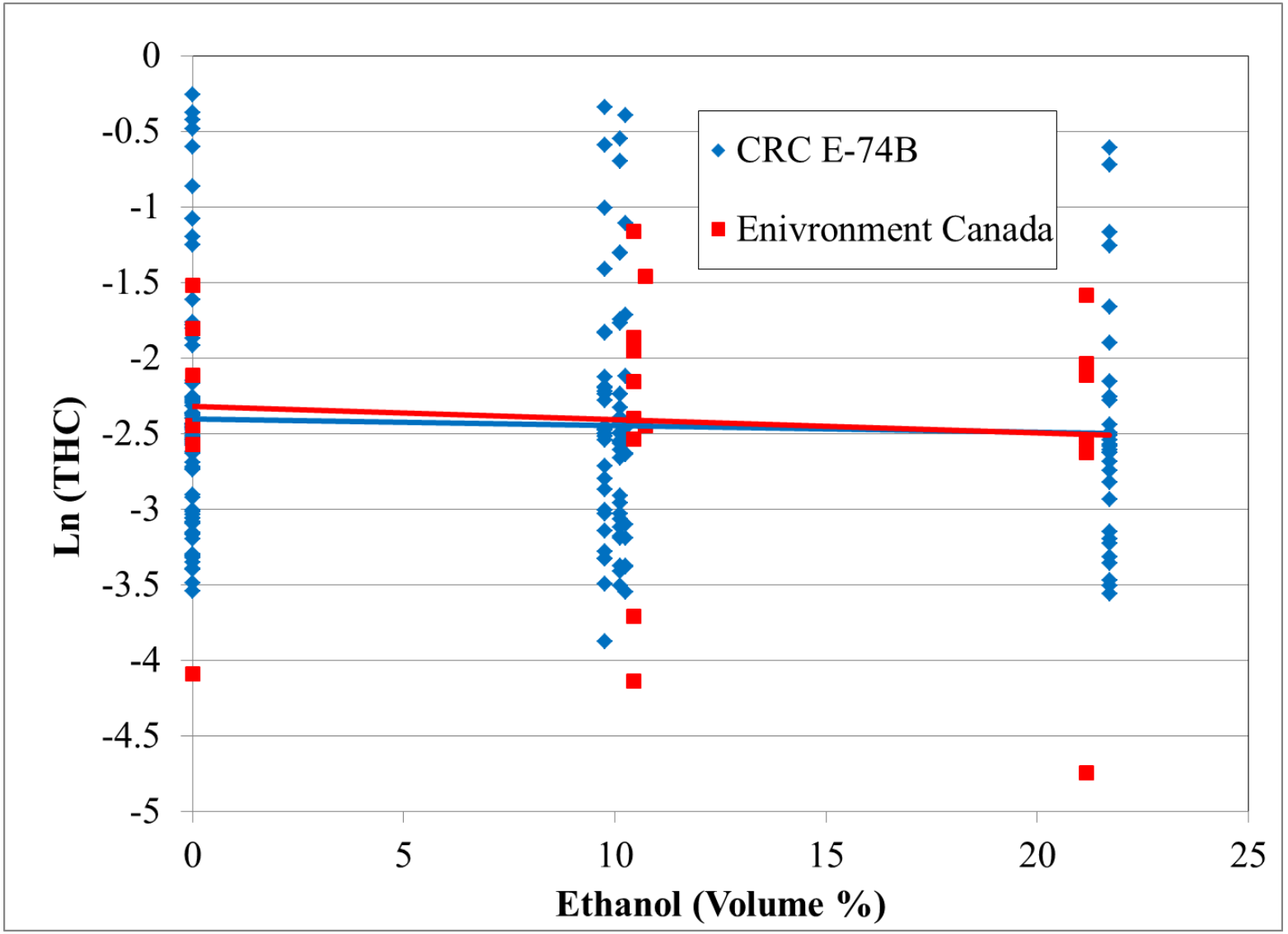
# E20 Data Sources

- Exhaust
  - Coordinating Research Council Project (CRC) E-74b (2007)
  - Environment Canada (2004)
- Evaporative Permeation
  - CRC E-65 (2006)
  - CRC E-77 (2010)

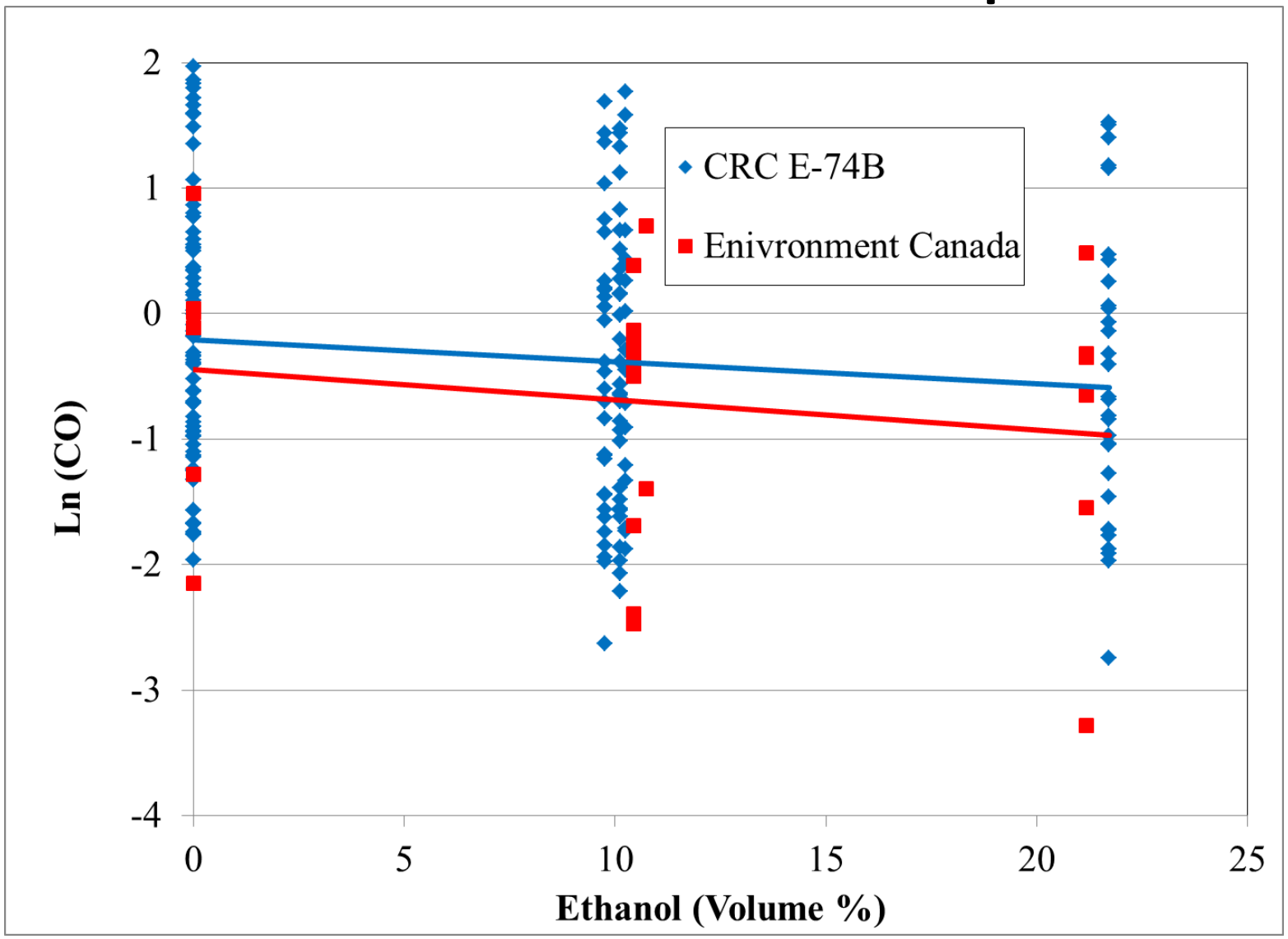
# Exhaust Methods

- CRC E-74b showed that oxygenate corrections statistically similar for 4 technology groupings
- Vehicles (15 + 4) – Tier 1 through Tier 2
- Fuels (7 + 8) – summer and winter blends
- Adjusted exhaust data to 9 PSI and 75 degrees
- FTP composite and bag results
- Each study individually and in combination
- First order and second order oxygen corrections

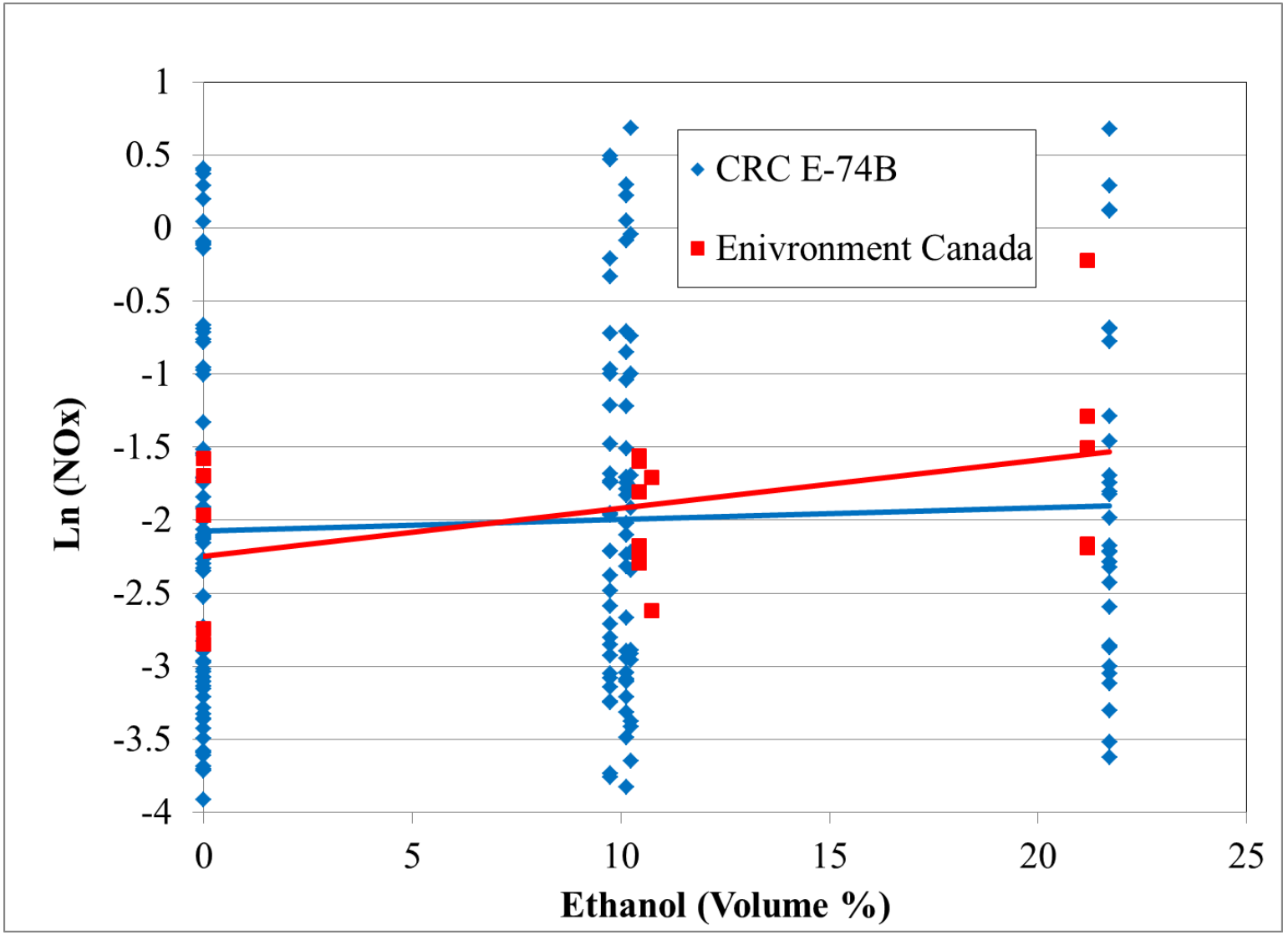
# THC Exhaust – FTP Composite



# CO Exhaust – FTP Composite



# NOx Exhaust – FTP Composite



# Exhaust Correction Factors

- First order oxygenate correction, FTP-composite

| % Change in Exhaust Relative to E0 | | | |
|---|---|---|---|
| | THC | CO | NOX |
| E10 | -5% | -17% | 12% |
| E15 | -8% | -24% | 19% |
| E20 | -10% | -31% | 26% |

# Permeation Methods

- CRC E-65 and E-77 overlap with MOVES
- New analysis
  - Include E-77-2c
  - Include E20
  - Review individual evaporative standards

# Permeation Correction Factors

- No difference between E6, E10 and E20
- Enhanced evaporative and Tier2/LEV2 distinct

| % Change in Permeation Relative to E0 | | |
|---|---|---|
| | MOVES (E6-E10) | This Study (E6-E20) |
| Enhanced | 114% | 116% |
| Tier2/LEV2 | | 75% |

# Inventory Analysis

- Combine new correction factors with MOVES2010a national inventory estimates
- July weekday
- 2012 and 2016
- Gasoline passenger car, passenger light truck, light commercial truck
- E15/E20 use in 2001-and-newer MYs

# Inventory Results

| National July Weekday Inventory (Tons) | | | | | |
|---|---|---|---|---|---|
| Year | Pol/Process | MOVES E10 | Updated E10 | E15 | E20 |
| 2012 | Exhaust VOC | 3,431 | 3,412 | 3,396 | 3,380 |
| 2012 | Exhaust CO | 61,970 | 61,970 | 59,541 | 55,494 |
| 2012 | Exhaust NOx | 8,438 | 8,600 | 8,787 | 9,193 |
| 2012 | Permeation | 430 | 417 | 417 | 417 |
| 2016 | Exhaust VOC | 2,515 | 2,484 | 2,465 | 2,445 |
| 2016 | Exhaust CO | 50,441 | 50,441 | 47,486 | 42,561 |
| 2016 | Exhaust NOx | 5,746 | 5,970 | 6,160 | 6,572 |
| 2016 | Permeation | 315 | 294 | 294 | 294 |

# % Change from MOVES E10

| National July Weekday Inventory (Tons) | | | | |
|---|---|---|---|---|
| Year | Pol/Process | Updated E10 | E15 | E20 |
| 2012 | Exhaust VOC | -0.6% | -1.0% | -1.5% |
| 2012 | Exhaust CO | N/A | -3.9% | -10.5% |
| 2012 | Exhaust NOx | 1.9% | 4.1% | 8.9% |
| 2012 | Permeation | -2.9% | -2.9% | -2.9% |
| 2016 | Exhaust VOC | -1.2% | -2.0% | -2.8% |
| 2016 | Exhaust CO | N/A | -5.9% | -15.6% |
| 2016 | Exhaust NOx | 3.9% | 7.2% | 14.4% |
| 2016 | Permeation | -6.7% | -6.7% | -6.7% |

# Implications

- “Preview of Coming Attractions” – MOVES2013 expected to address updated ethanol blend fuel effects
- NOx will continue to increase with increasing ethanol
- CO will continue to decrease with increasing ethanol

# Final Caveat

- Exhaust emissions will be sensitive to multiple fuel properties; we've only isolated ethanol content.
- Representativeness of E20 blends in exhaust studies is yet TBD.