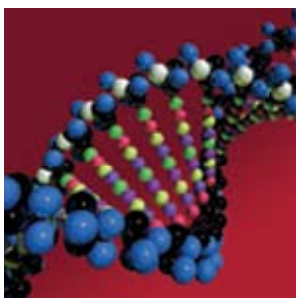
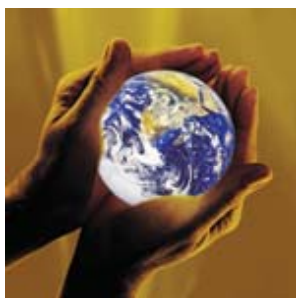


The Integration of MOVES and SMOKE: Development of Driver and Post-Processing Scripts to use MOVES Emission Factors in SMOKE



Presented by

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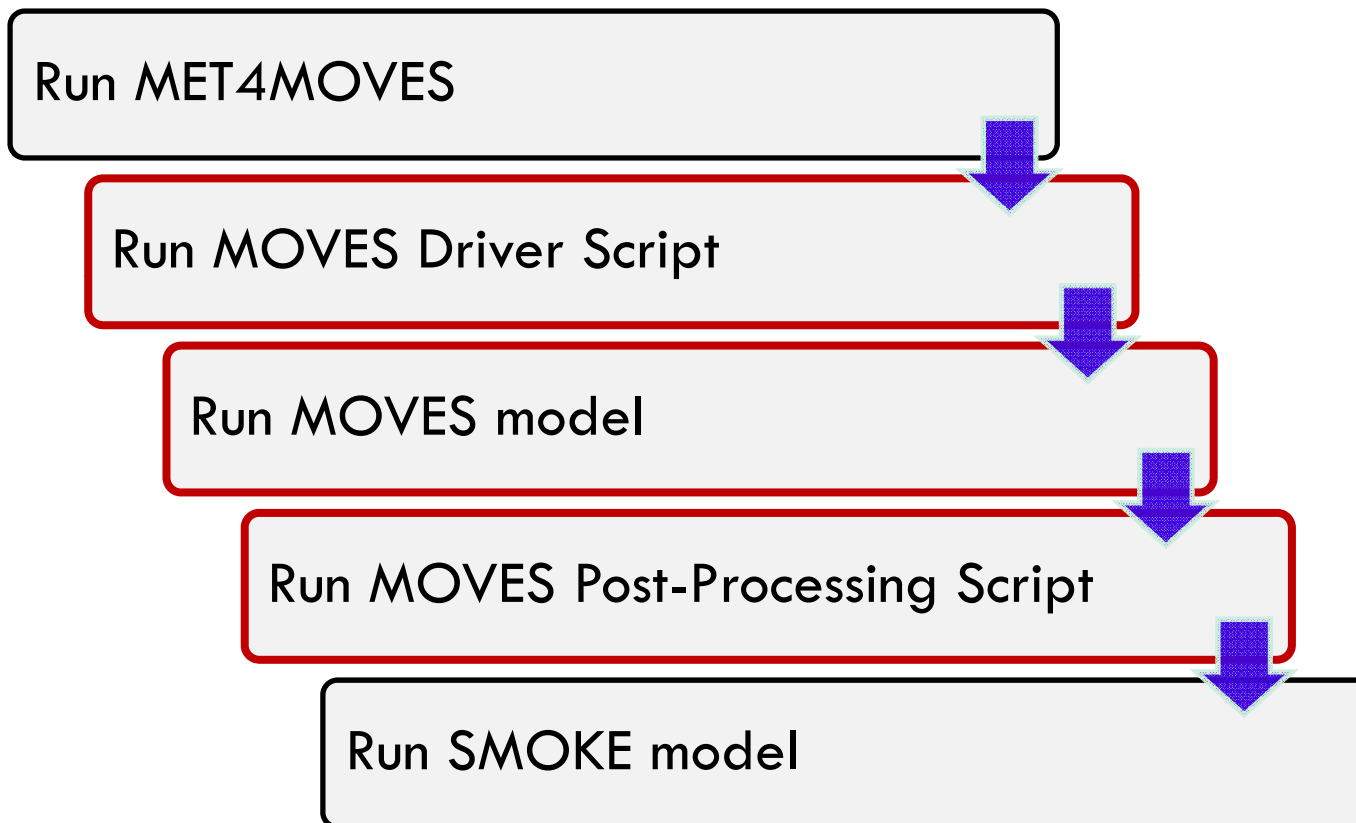
ENVIRON International Corporation

**19th International Emission Inventory Conference
September, 2010**

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SMOKE-MOVES Tool



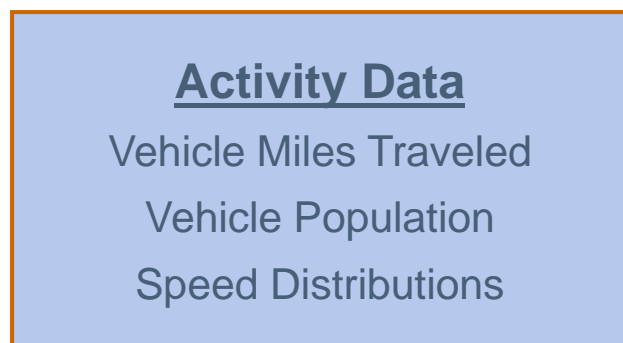
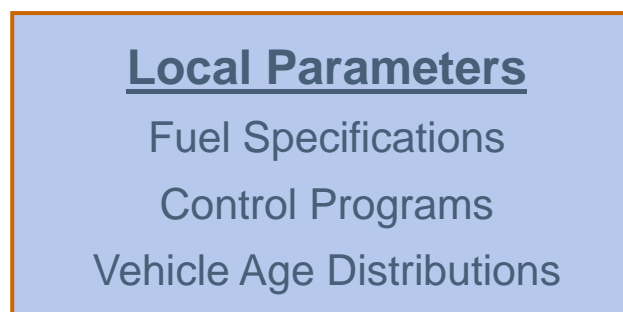


Overview

- MOVES Background
 - Inventory vs. Emission Rate Calculation Type
- Driver Script
 - MOVES run setups cover range of conditions
 - MOVES run conditions differ by emission process
- MOVES Post-Processing Script
 - PM speciation
 - Formatting for SMOKE



MOVES Inventory vs. Emission Rates



- 1) Inventory Calculation
 - Emission inventories by county

OR

- 2) Emission Rate Calculation
 - Lookup tables of emission factors
 - Running (g/mile)
 - Starts (g/vehicle-hour)
 - Extended Idle (g/vehicle-hour),
 - Evaporatives (g/vehicle-hour)



MOVES as an Emission Rate Model

Emission Process	RatePerDistance (grams/mile)	RatePerVehicle (grams/vehicle/hr)	RatePerProfile (grams/vehicle/hr)
Running Exhaust	X		
Crankcase Running Exhaust	X		
Brake Wear	X		
Tire Wear	X		
Evaporative Fuel Vapor Venting	X		X
Evaporative Permeation	X	X	
Evaporative Fuel Leaks	X	X	
Start Exhaust		X	
Crankcase Start Exhaust		X	
Extended Idle Exhaust		X	
Crankcase Extended Idle Exhaust		X	

- Lookup by speed, temperature, humidity, day type, year, month, county
- **Reference County** and **Fuel Month** as lookup



MOVES Driver Script

- Written in Perl
- Automates set up of MOVES runs
- Approach varies by lookup table type
- Input
 - Temperature and Humidity from MET4MOVES
 - File paths to other MOVES input data
- Output
 - Batchfile of data files for MOVES to import into MySQL
 - Batchfile of runspec files to MOVES to run



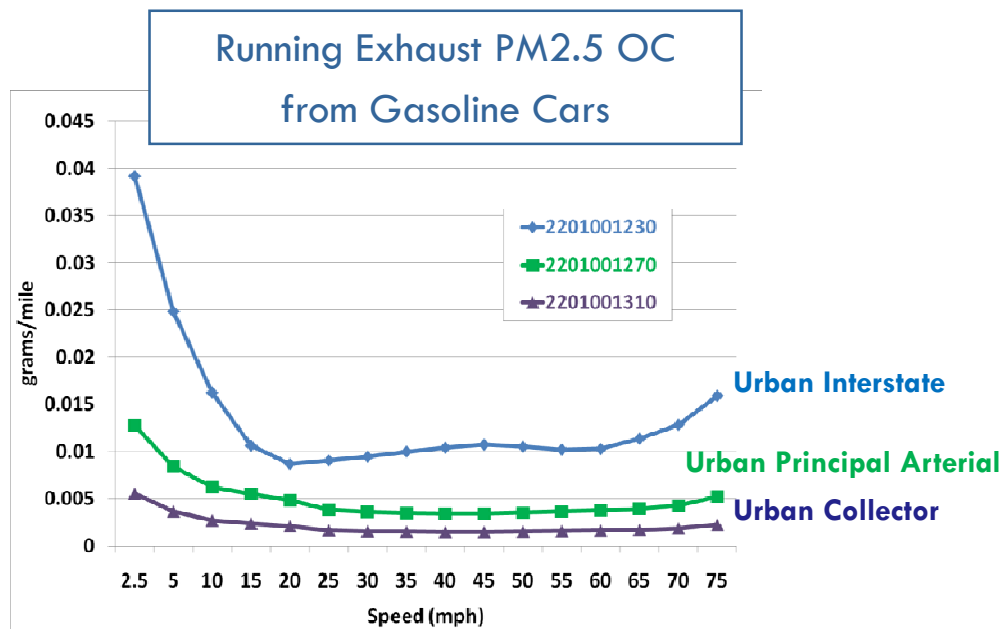
MOVES Driver Script

RatePerDistance Approach

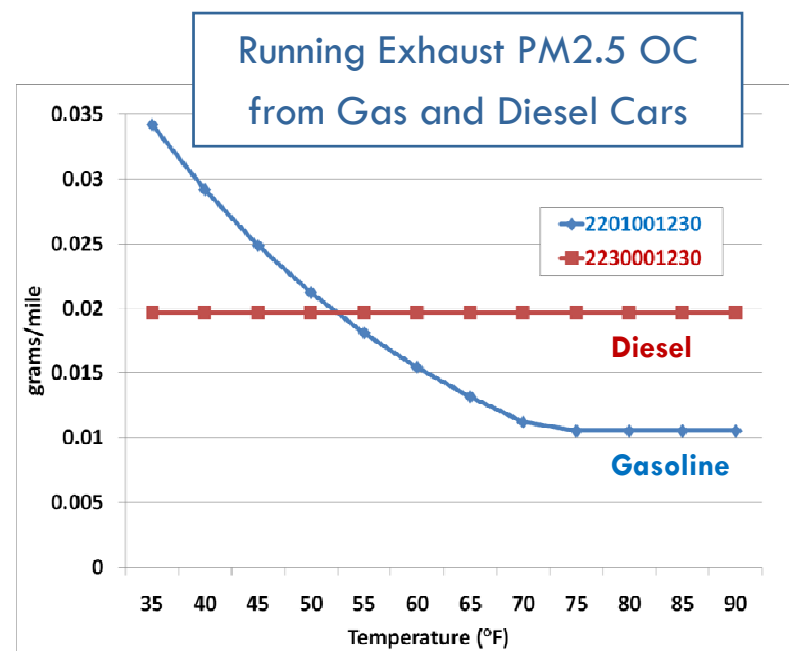
- Reads MET4MOVES output
 - Relative humidity
 - Minimum and maximum temperature
- Bin temperatures as (Max-Min)/Increment
 - Example: min/max $36.2^{\circ}\text{F}/88.7^{\circ}\text{F}$ and 5° increment
 - Temperature bins become $(35^{\circ}, 40^{\circ}, 45^{\circ}, \dots, 85^{\circ}, 90^{\circ})$
- Assigns binned temperatures to hours of the day



RatePerDistance Emission Rates



Temperature = 75 F Relative Humidity = 63.5 %



Speed = 50 mph Relative Humidity = 63.5 %

RatePerDistance emission rates depend on:

- Temperature
- Speed
- Humidity



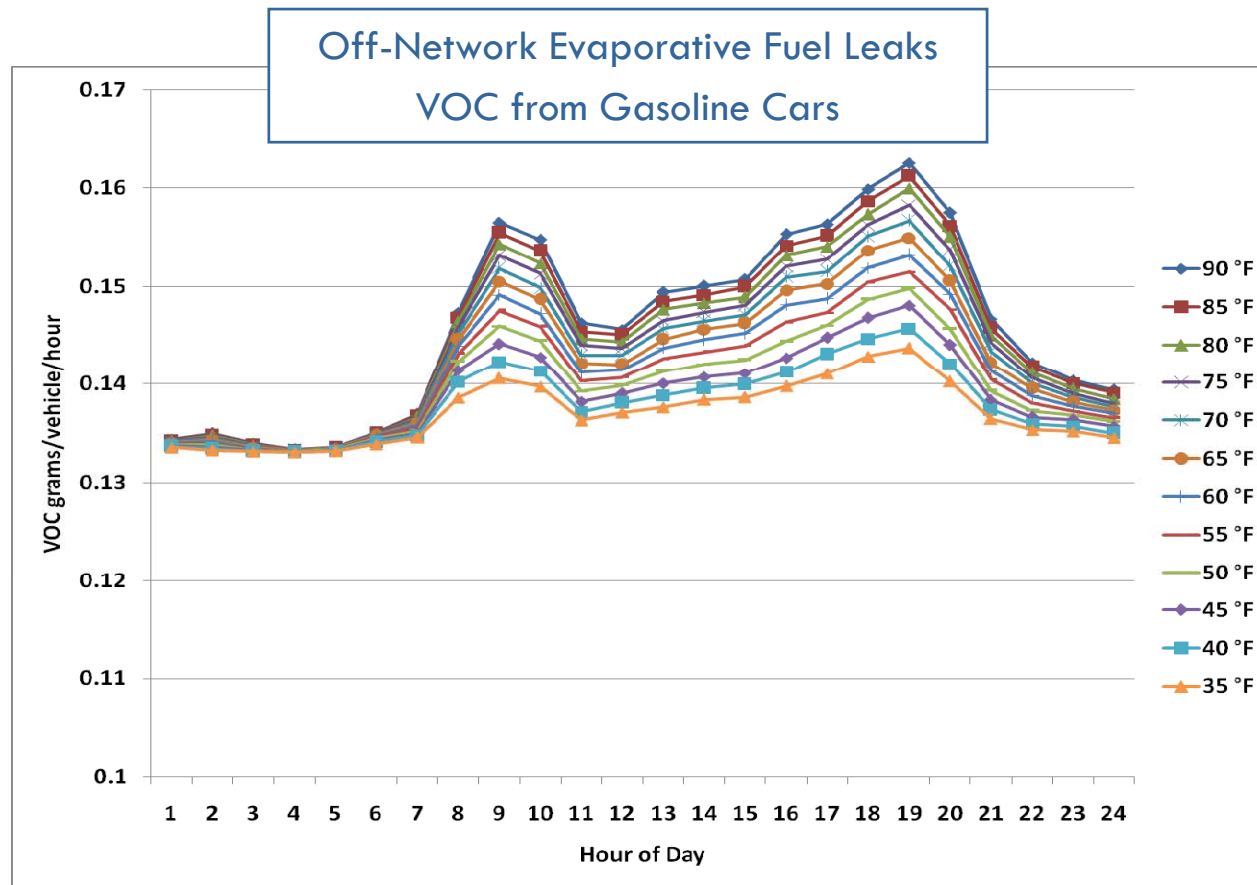
MOVES Driver Script

RatePerVehicle Approach

- MET4MOVES min/max temperature, average RH
 - Temperature binning increment different by MOVES table
- Assigns each binned temperature to all hours of a run day
- Number of MOVES run days equals number of temperature bins
- Interaction of hour and temperature important



RatePerVehicle Emission Rates



RatePerVehicle emission rates depend on:

- Temperature
- Humidity
- Hour
- Day Type



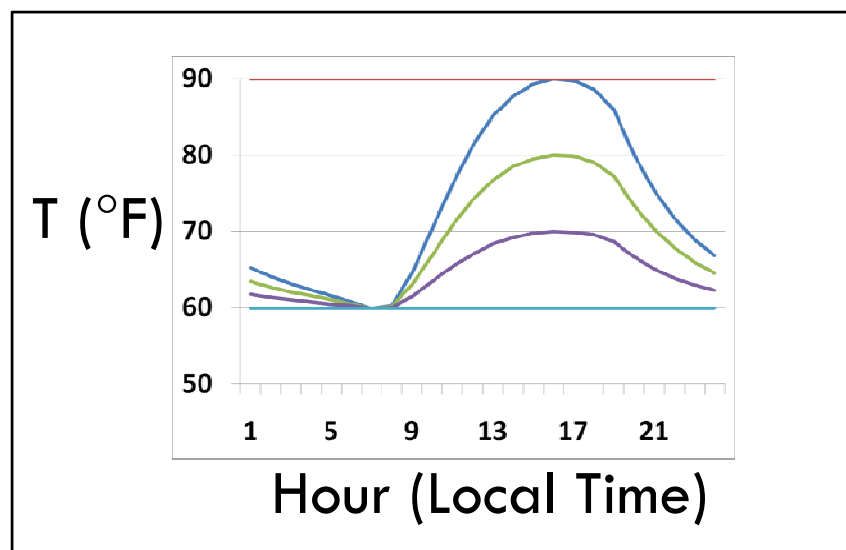
MOVES Driver Script

RatePerProfile Approach

- Evaporative Fuel Vapor Venting emissions affected by temperatures in previous hours
- MET4MOVES diurnal temperature profiles
 - Geographic average → normalized 24-hour temperature profile
 - Normalized shape fitted with binned range of min/max temperatures

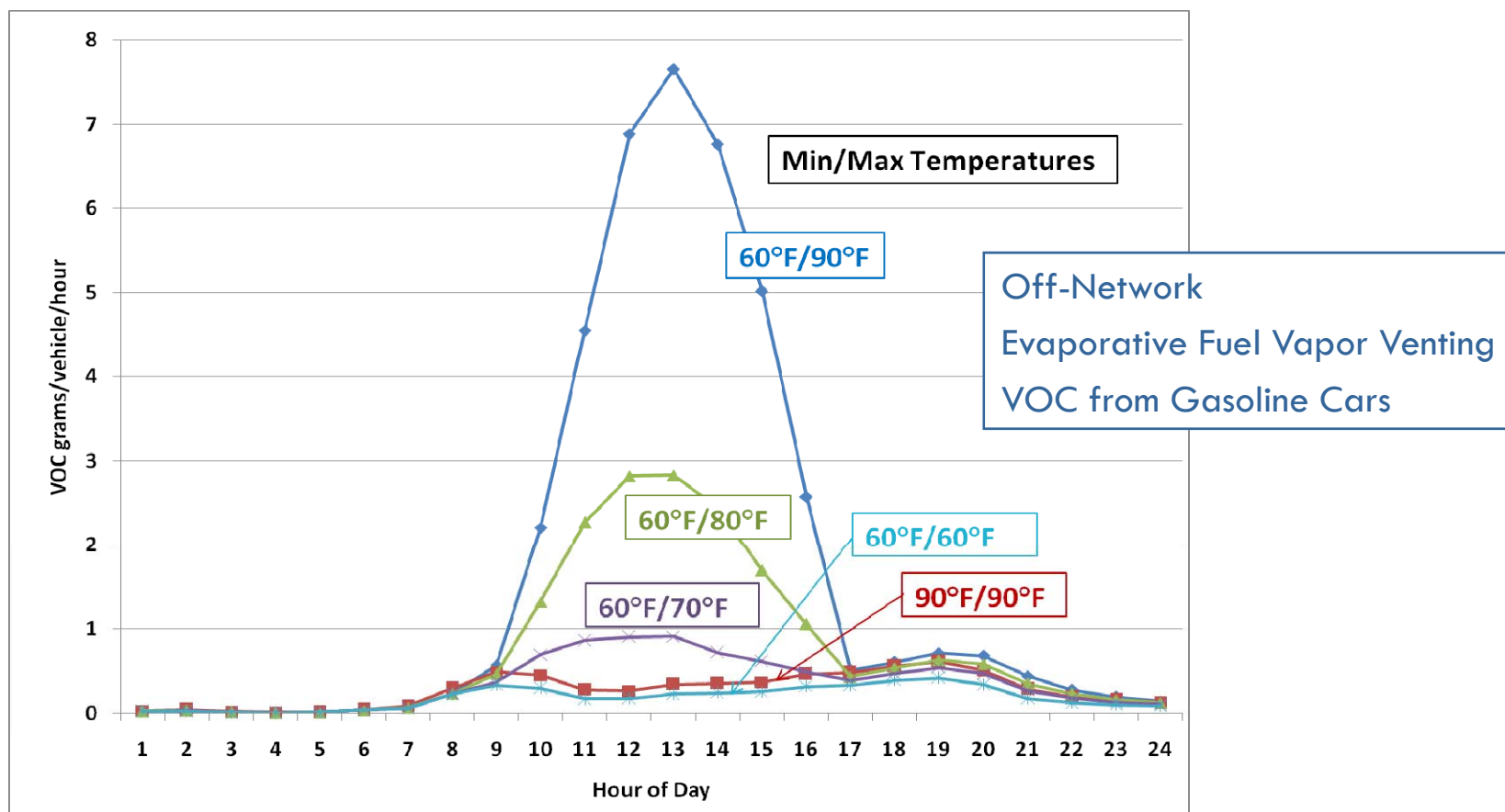
(min, max) temperatures:

(30, 30) (40, 40) (50, 50) (60, 60) (70, 70) (80, 80) (90, 90)
(30, 40) (40, 50) (50, 60) (60, 70) (70, 80) (80, 90)
(30, 50) (40, 60) (50, 70) (60, 80) (70, 90)
(30, 60) (40, 70) (50, 80) (60, 90)
(30, 70) (40, 80) (50, 90)
(30, 80) (40, 90)
(30, 90)





RatePerProfile Emission Rates



RatePerProfile emission rates depend on:

- Temperature
- Diurnal Temperature Gradient
- Hour
- Day Type



MOVES Post-Processing Script

- Written in Perl
- Interfaces with MySQL database
- Input
 - Raw MOVES lookup tables: RatePerDistance, RatePerVehicle, and RatePerProfile
- Outputs
 - Modified lookup tables: RatePerDistance_smoke, RatePerVehicle_smoke, and RatePerProfile_smoke
 - Revisions include
 - PM speciation
 - Formatting for SMOKE



MOVES Post-Processing Script: PM Speciation

- Fully speciates partially speciated PM_{2.5} from MOVES
 - MOVES outputs EC, OC, SO₄
 - Script adds PNO₃, METAL, NH₄, PEC, POC, PMFINE, PMC
- Equations developed by EPA OAQPS
- Uses the MOVES EC/OC split rather than using the sum of EC+OC the past method



MOVES Post-Processing Script: Formatting for SMOKE

- Reduces file size
 - Cross-tab query on emissions by pollutant
 - Pollutant IDs in rows become additional field headings; emissions in rows moved to columns
- Other reformatting
 - Parse 5-digit county FIPS code from other fields
 - Assigns MOVES emission process ID (integer) to SMOKE ID (3-character text string)
 - Data sorting
- MySQL tables written to ASCII files



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Questions?