MOVES-AIRPACT4 Integration 2012 Update

June 7, 2012

Northwest Airquest MOVES Workgroup

AIRPACT4 Domain and Counties

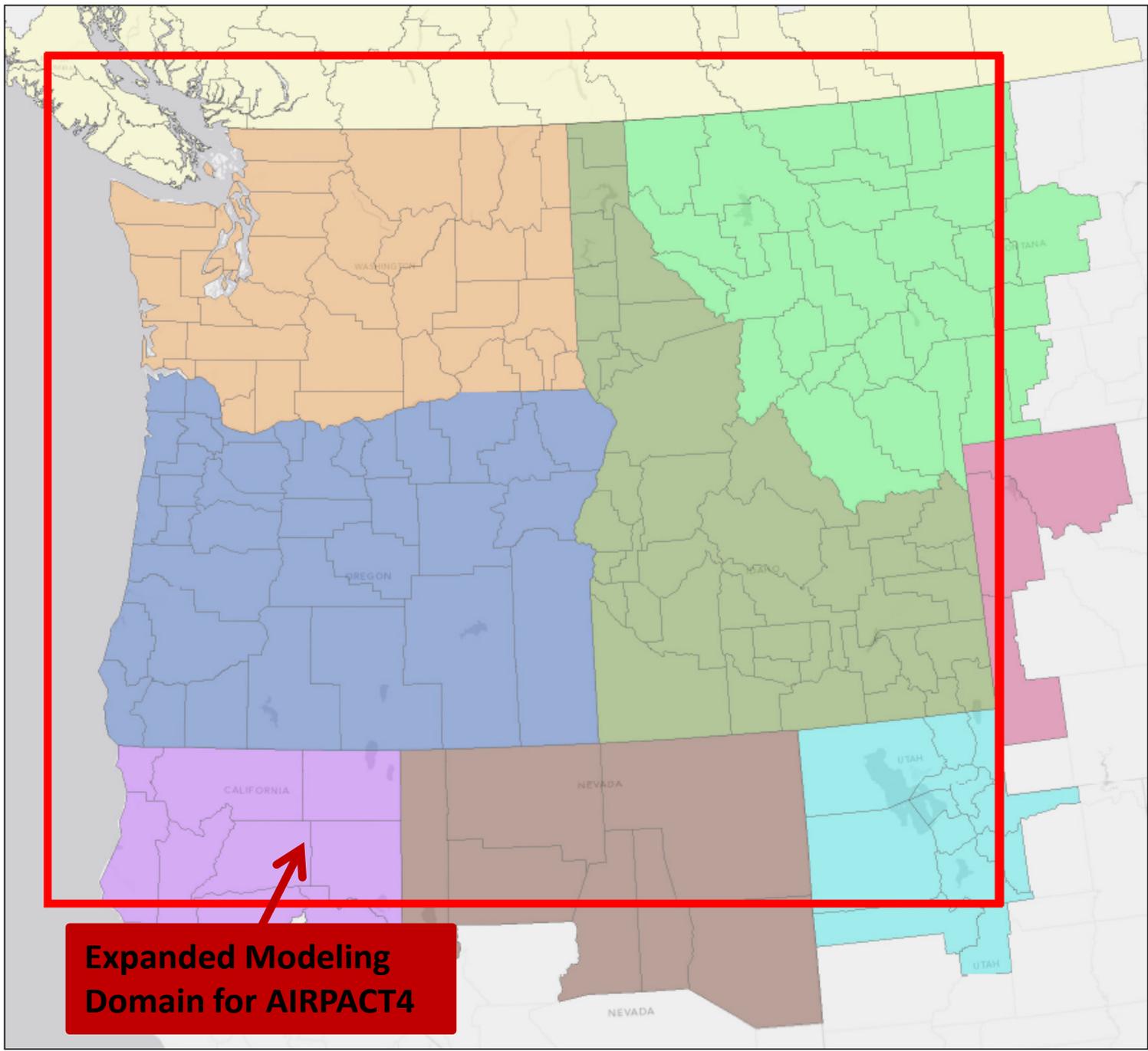Expanded Modeling Domain for AIRPACT4

AIRPACT4 domain

States
- California
- Idaho
- Montana
- Nevada
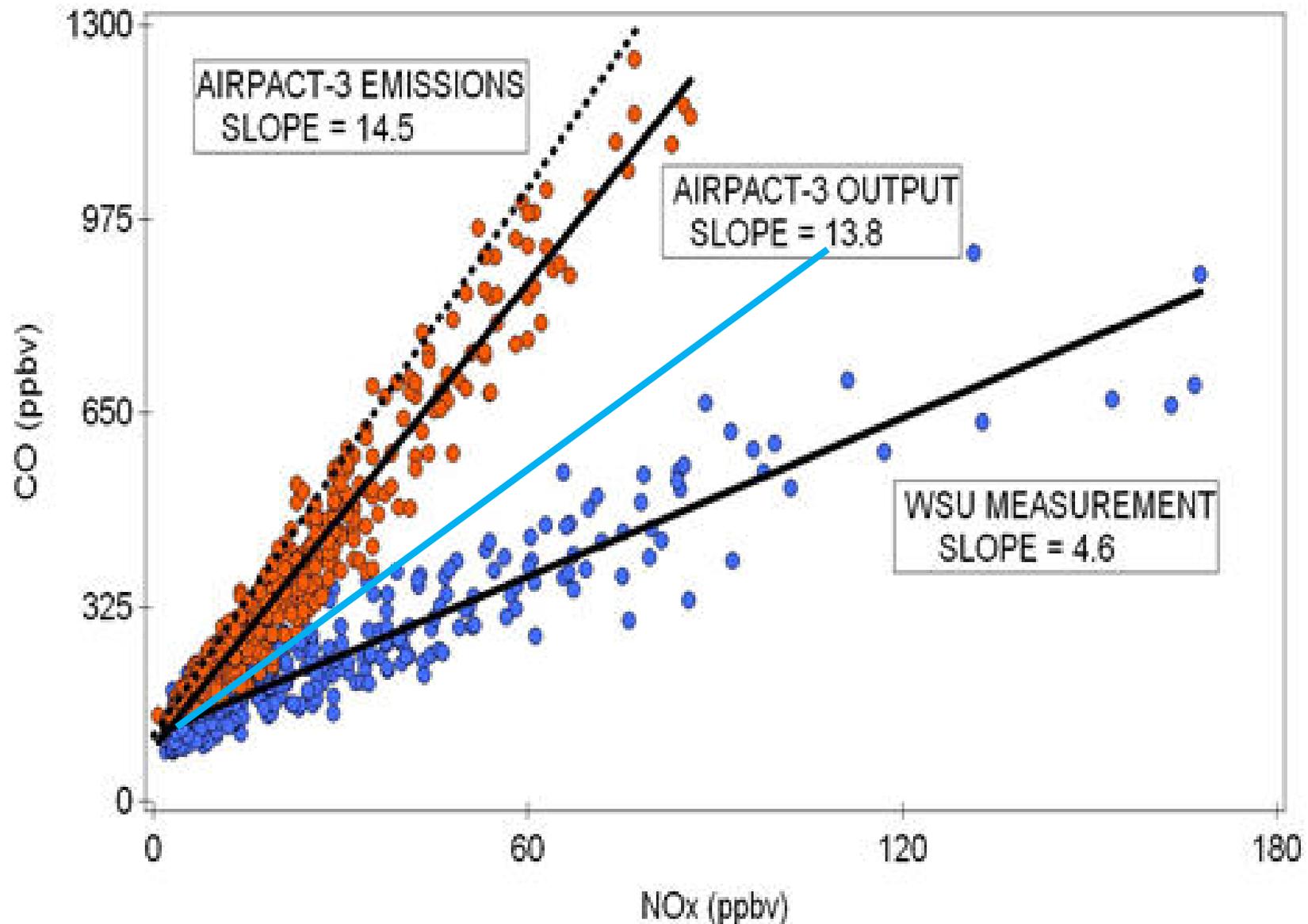- Oregon
- Utah
- Washington
- Wyoming
- Canada

150 Kilometers

N

# Why Switch Mobile Source Models?

- MOVES replaced MOBILE6.2 by EPA in March 2010
    - Required for regulatory purposes by March 2013

- MOVES model performance significantly improved compared to MOBILE6.2
    - WSU CO/NOx study highlighted problem in PNW

2009 WSU Winter PM$_{2.5}$ Boise Study
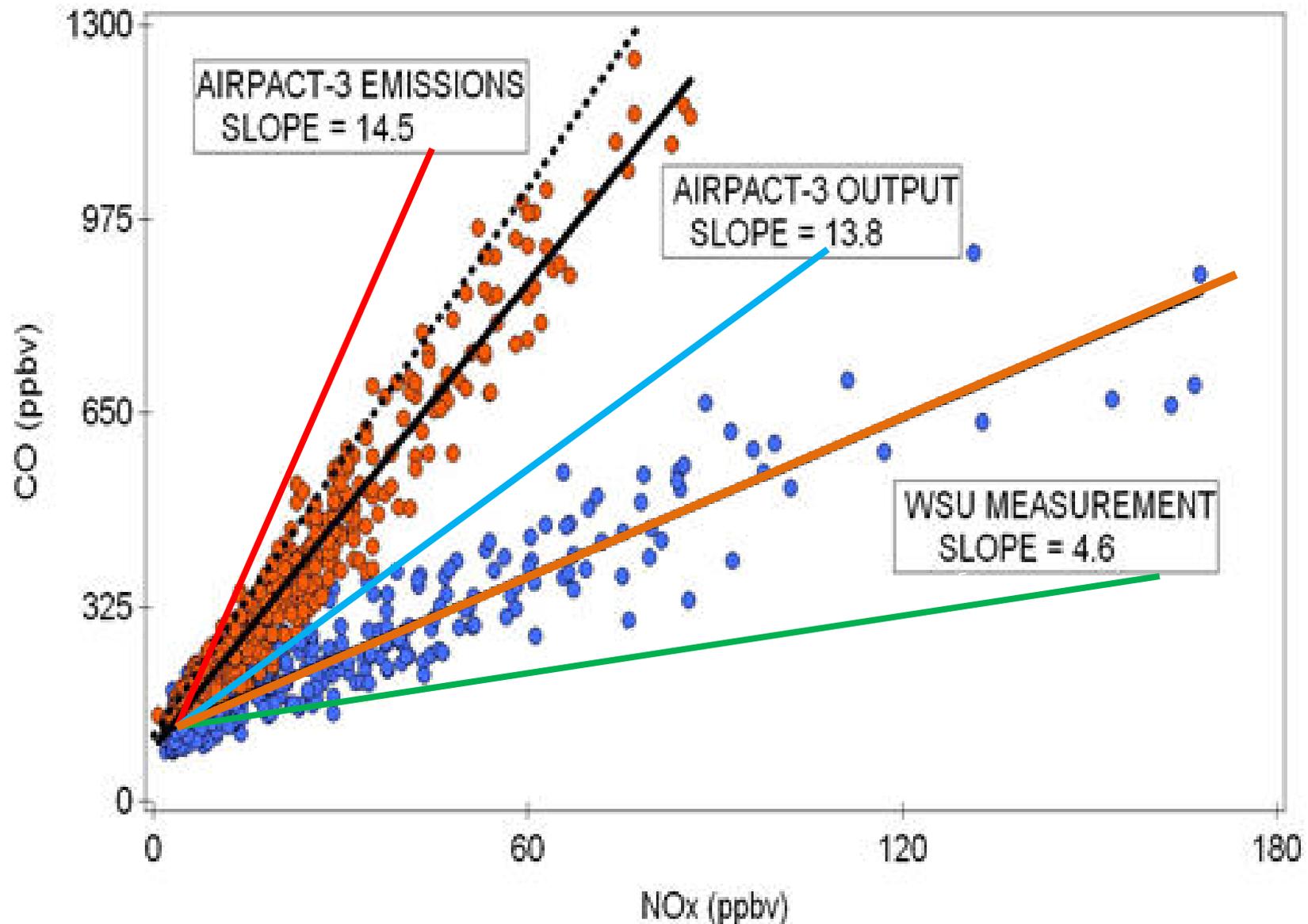

Source of base chart: Will Wallace, WSU, MOVES detail added by Idaho DEQ

Urban Arterials and Interstate dominate St. Lukes monitoring site
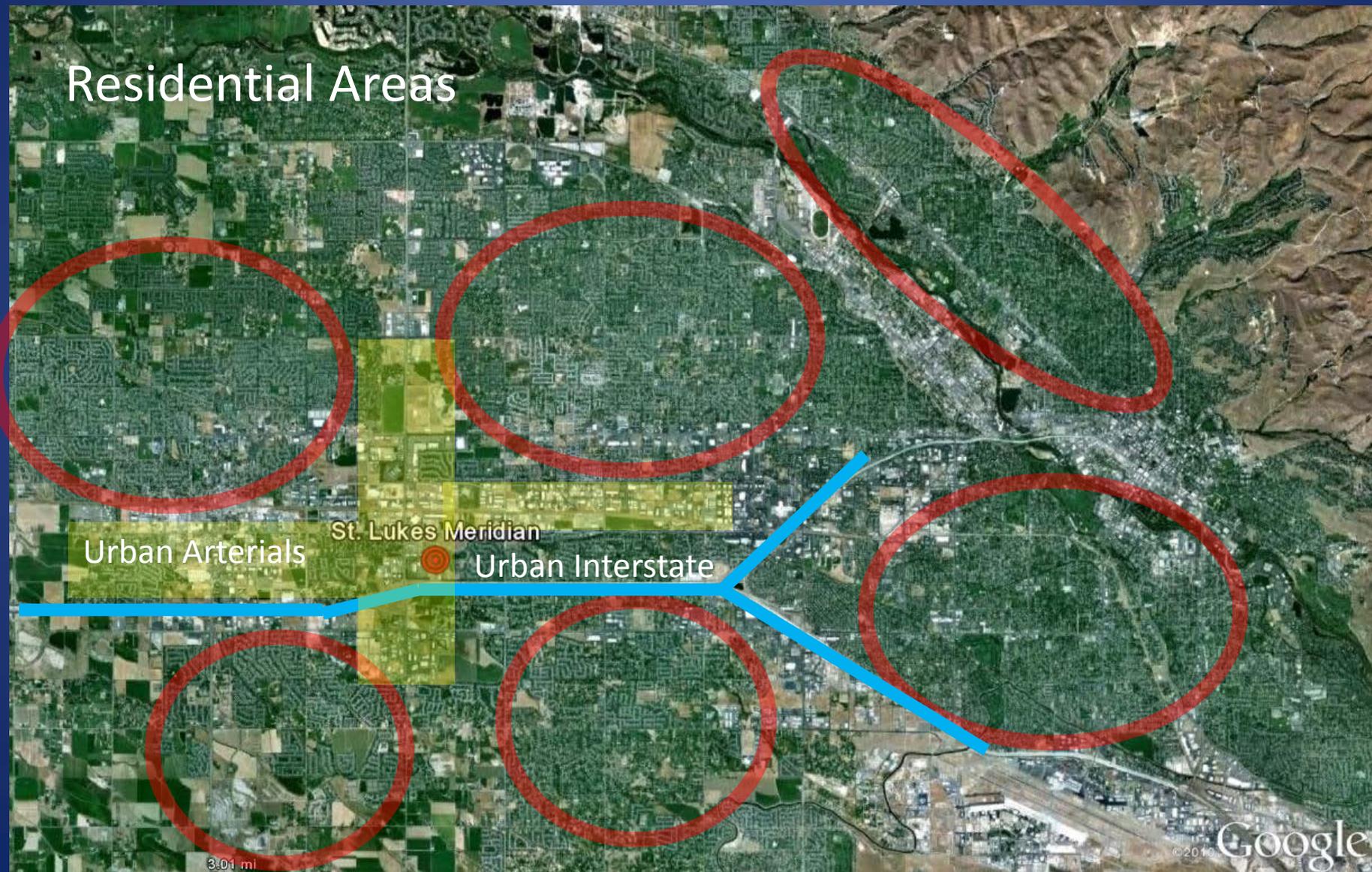
Residential Areas

Urban Arterials

St. Lukes Meridian

Urban Interstate

3.01 mi

Google

2009 WSU Winter PM$_{2.5}$ Boise Study

Source of base chart: Will Wallace, WSU, MOVES detail added by Idaho DEQ

MOVES Workgroup Activities To-Date

- MOVES Workgroup formed June 2011

- Developed model integration plan

- Defined "County Groups" and "Reference Counties"

- Defined "Fuel Months" for summer and winter seasons

- Generated input files based on MOVES default data

- Test run SMOKE-MOVES using the "standard approach"

- Work in progress to develop Temperature profiles for each County Group

- Work in progress to setup SMOKE-MOVES in AIRPACT4 approach

Plan

Step 1: Establish the SMOKE-MOVES integration process in AIRPACT4 using mostly "national default" inputs.

Step 2: Refine Input files using local specific data for MOVES and SMOKE

Reference Counties

Purpose:

"...to reduce the computational burden running MOVES on every county in your modeling domain."[1]

[1]User's Guide for the SMOKE-MOVES Integration Tool, July 14, 2010, USEPA OAQPS and UNC Institute for the Environment

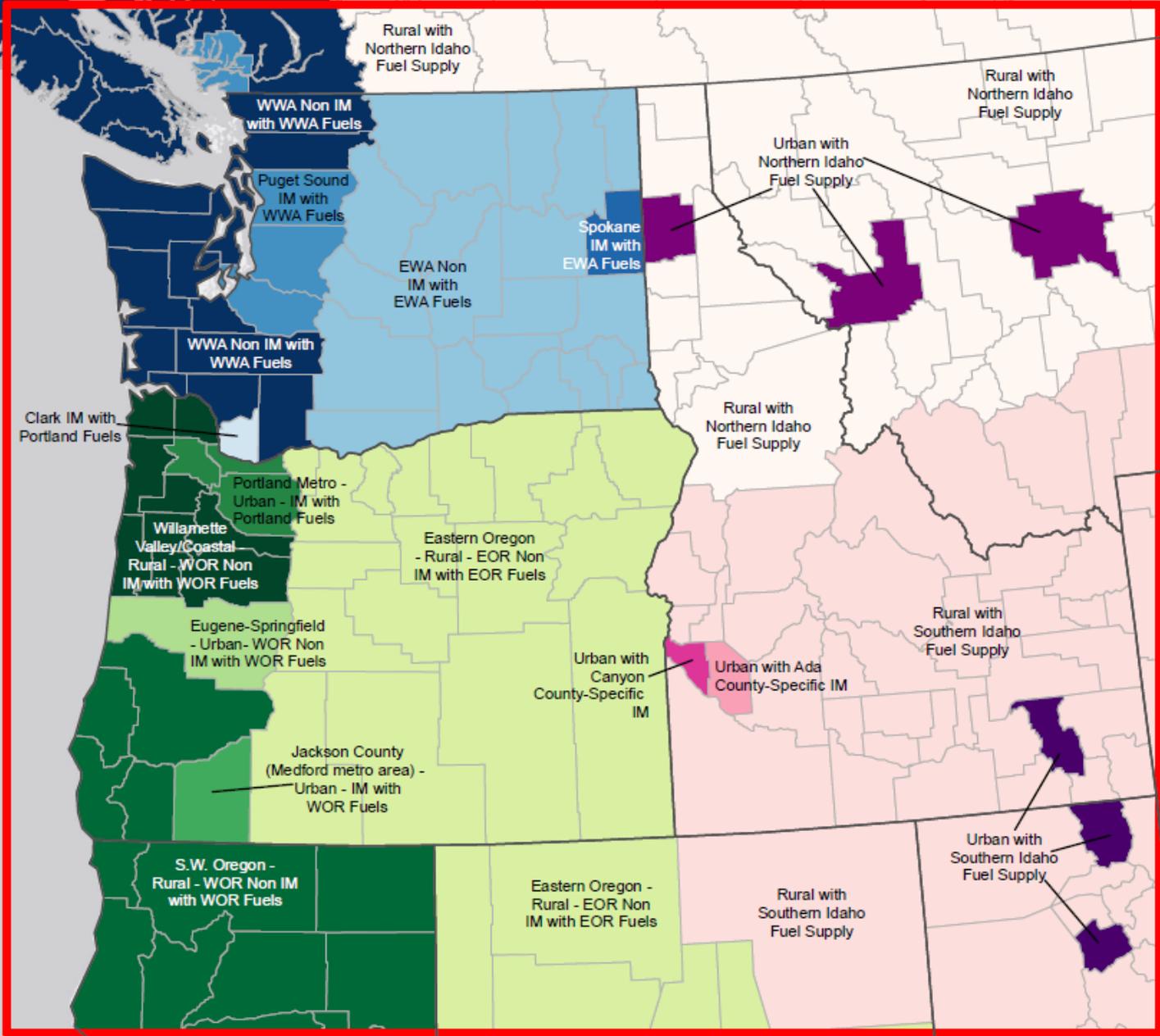# What *IS* a County Group/ Reference County Anyway?

County Group

- A set of similar counties within a larger geographic area:
  - Fuel parameters
  - Fleet age distribution
  - Inspection and maintenance (I/M) programs

Reference County

- A county chosen to represent each County Group
- Chosen for their "averageness" with respect to the vehicle age distribution weighted by vehicle populations
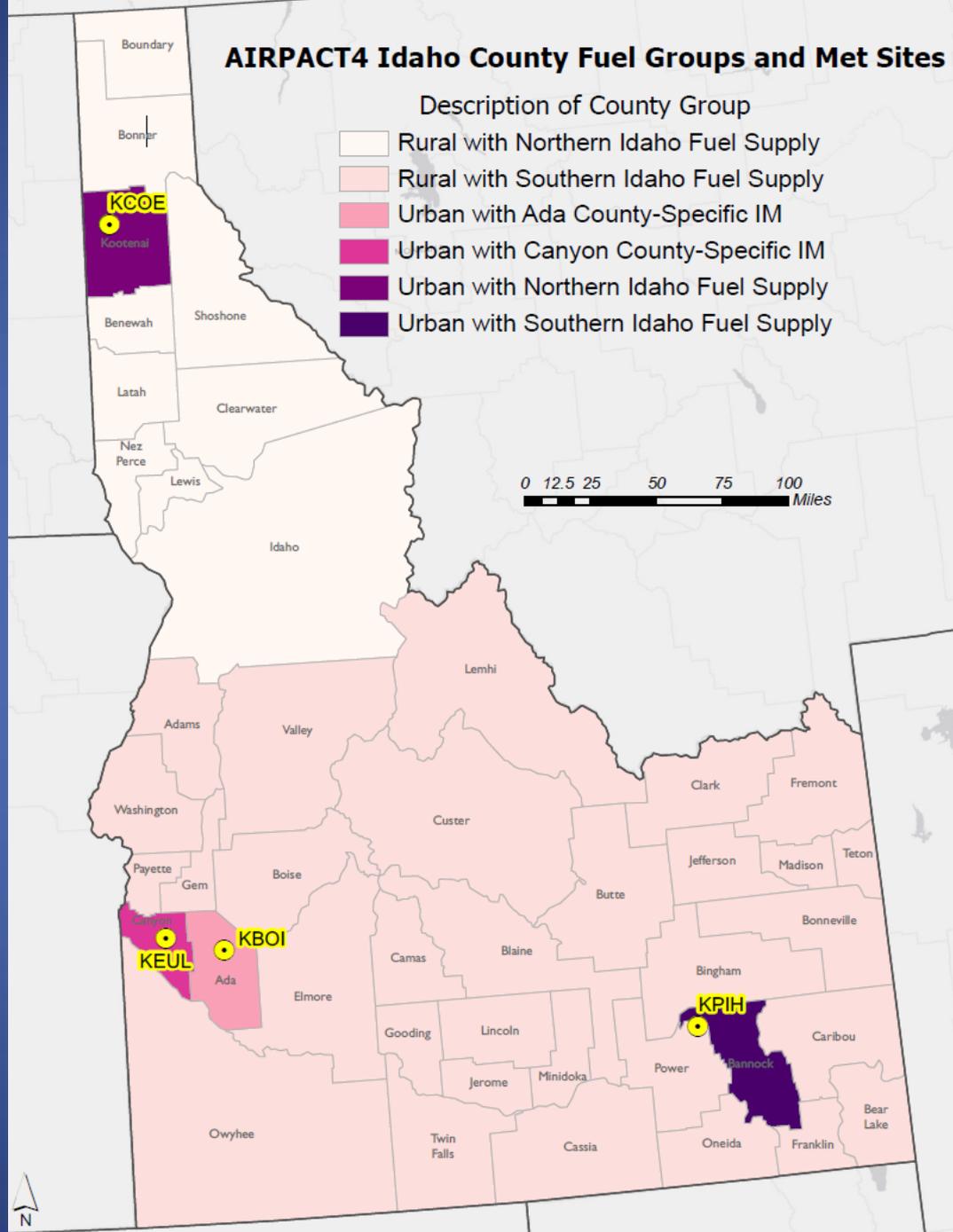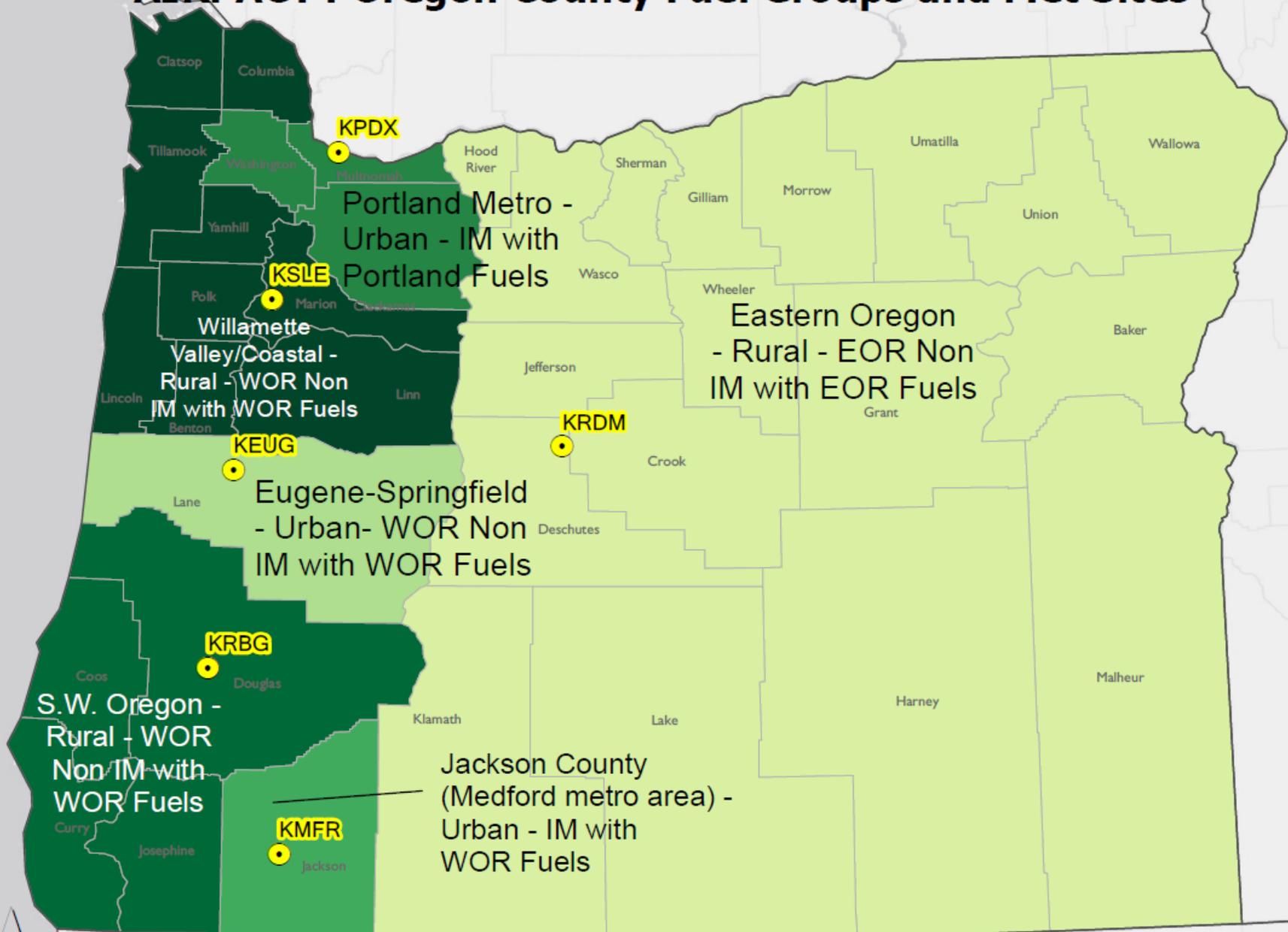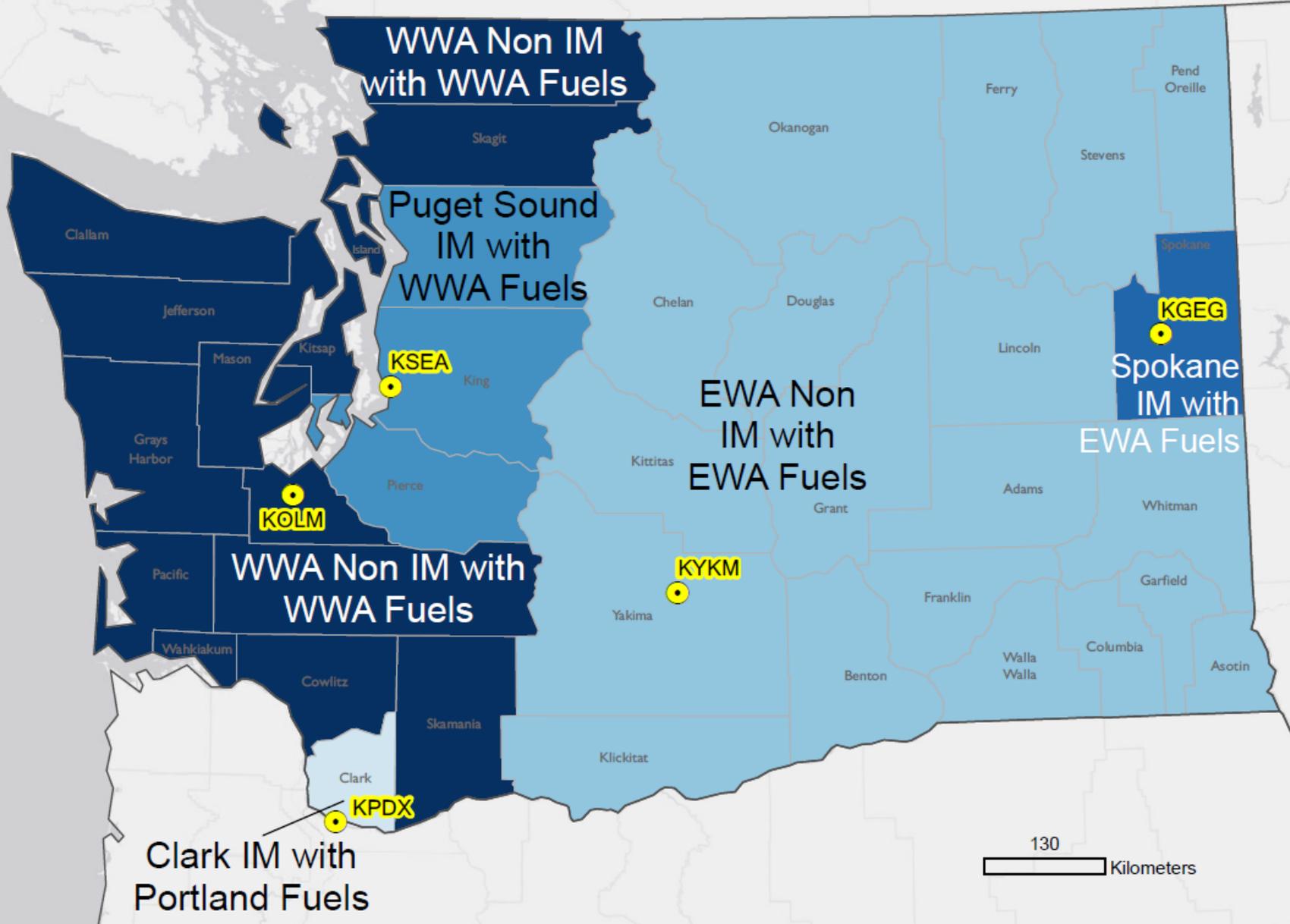
AIRPACT4 County Fuel Groups

Rural with Northern Idaho Fuel Supply

Rural with Northern Idaho Fuel Supply

WWA Non IM with WWA Fuels

Puget Sound IM with WWA Fuels

Urban with Northern Idaho Fuel Supply

EWA Non IM with EWA Fuels

Spokane IM with EWA Fuels

WWA Non IM with WWA Fuels

Clark IM with Portland Fuels

Portland Metro - Urban - IM with Portland Fuels

Willamette Valley/Coastal - Rural - WOR Non IM with WOR Fuels

Eastern Oregon - Rural - EOR Non IM with EOR Fuels

Rural with Northern Idaho Fuel Supply

Eugene-Springfield - Urban- WOR Non IM with WOR Fuels

Urban with Canyon County-Specific IM

Urban with Ada County-Specific IM

Rural with Southern Idaho Fuel Supply

Jackson County (Medford metro area) - Urban - IM with WOR Fuels

S.W. Oregon - Rural - WOR Non IM with WOR Fuels

Eastern Oregon - Rural - EOR Non IM with EOR Fuels

Rural with Southern Idaho Fuel Supply

Urban with Southern Idaho Fuel Supply

130 Kilometers

N

AIRPACT4 domain boundary

Idaho

AIRPACT4 Idaho County Fuel Groups and Met Sites

AIRPACT4 Oregon County Fuel Groups and Met Sites

KPDX

Portland Metro - Urban - IM with Portland Fuels

KSLE

Willamette Valley/Coastal - Rural - WOR Non IM with WOR Fuels

KEUG

Eugene-Springfield - Urban- WOR Non IM with WOR Fuels

Eastern Oregon - Rural - EOR Non IM with EOR Fuels

KRDM

KRBG

S.W. Oregon - Rural - WOR Non IM with WOR Fuels

Jackson County (Medford metro area) - Urban - IM with WOR Fuels

KMFR

130 Kilometers

N

AIRPACT4 Washington County Fuel Groups and Met Sites

Fuel Months

Concept:

"…is used to indicate when a particular set of fuel properties should be used in a MOVES simulation."[1]

and

"…similar to the reference county, the fuel month reduces the computational time of MOVES by using a single month to represent a set of months."[1]

[1]User's Guide for the SMOKE-MOVES Integration Tool, July 14, 2010, USEPA OAQPS and UNC Institute for the Environment

Fuel Month Designations

- Two Fuel Months chosen for MOVES-AIRPACT Integration

    - January
        - Represents Winter (November -- April)

    - July
        - Represents Summer (May -- October)

Basic SMOKE-MOVES Integration Tool Flowchart
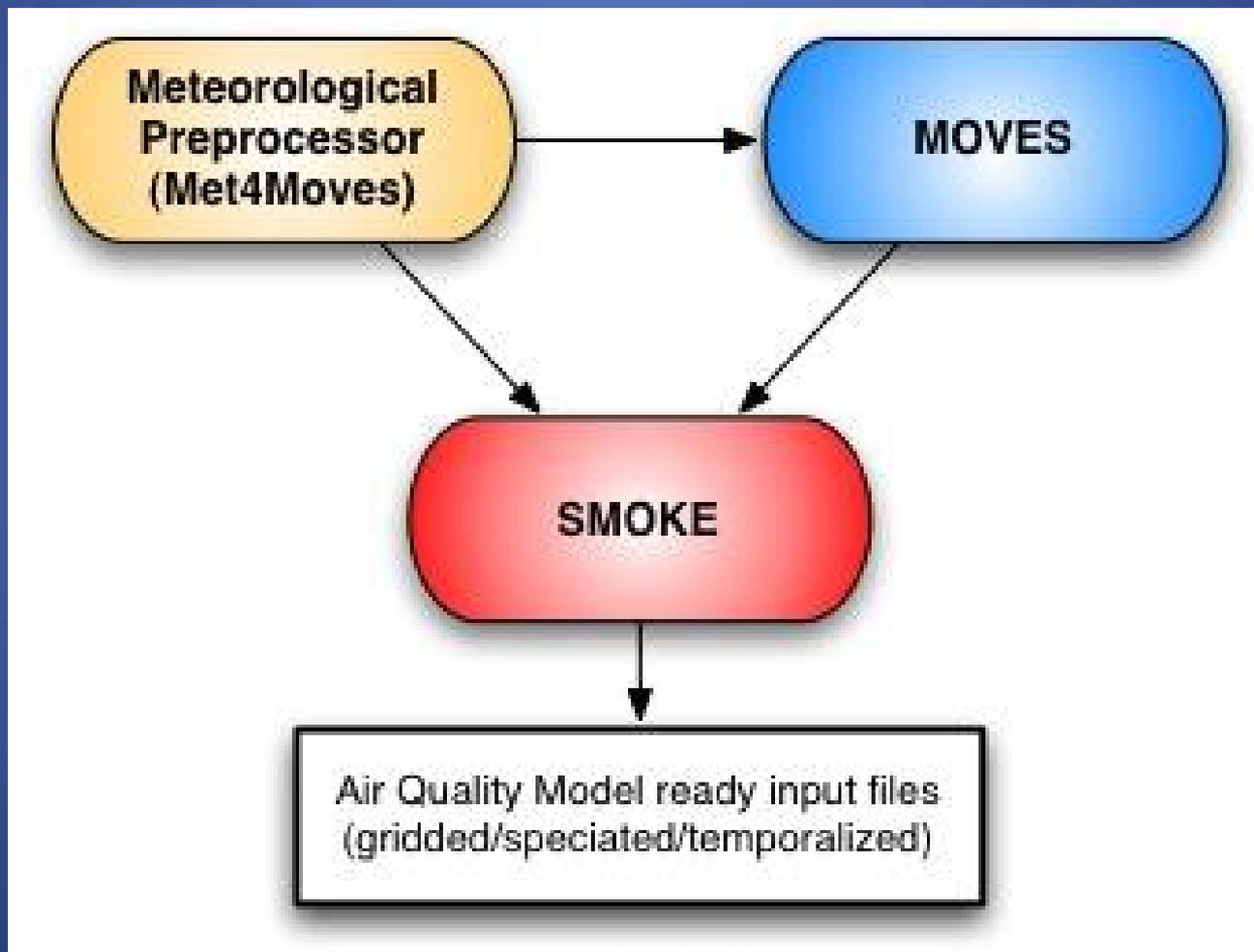
SMOKE MOVES PROCESS CATEGORY

MOVES Lookup Table	Units	smokeProcID	Emissions Process
RatePerDistance (RPD)	Grams/mile	EXR CXR TIR BRK EPM EFL EFV	Running Exhaust Crankcase Running Exhaust Tire Wear Brake Wear On-road Evaporative Permeation On-road Evaporative Fuel Leaks On-road Evaporative Fuel Vapor Venting
RatePerVehicle (RPV)	Grams/vehicle/hour	EXS CXS EPM EFL CEI EXT	Start Exhaust Crankcase Start Exhaust Off-network Evaporative Permeation Off-network Evaporative Fuel Leaks Crankcase Extended Idle Exhaust Extended Idle Exhaust
RatePerProfile (RPP)	Grams/vehicle/hour	EFV	Off-network Evaporative Fuel Vapor Venting

Possible Approaches for AIRPACT-4 MOVES Integration

- Standard SMOKE Process Approach
  - Run MOVES on fly
  - No program changes for SMOKE process
  - Running time is not acceptable
    - Take ~26 days to generate lookup tables using 8 workers/CPUs for one day forecast

- Static Lookup Table Approach
  - Generate static lookup table in advance (one time deal, take long time to run)
  - Need to change SMOKE program and scripts
  - Shorten day to day process time significantly

Generate Lookup Table

Standard Way

Meteorology Data (MCIP)

↓

Meteorology Processing (Met4moves)

↓

MOVES Driver Script

↓

MOVES

↓

MOVES Post Processing

↓
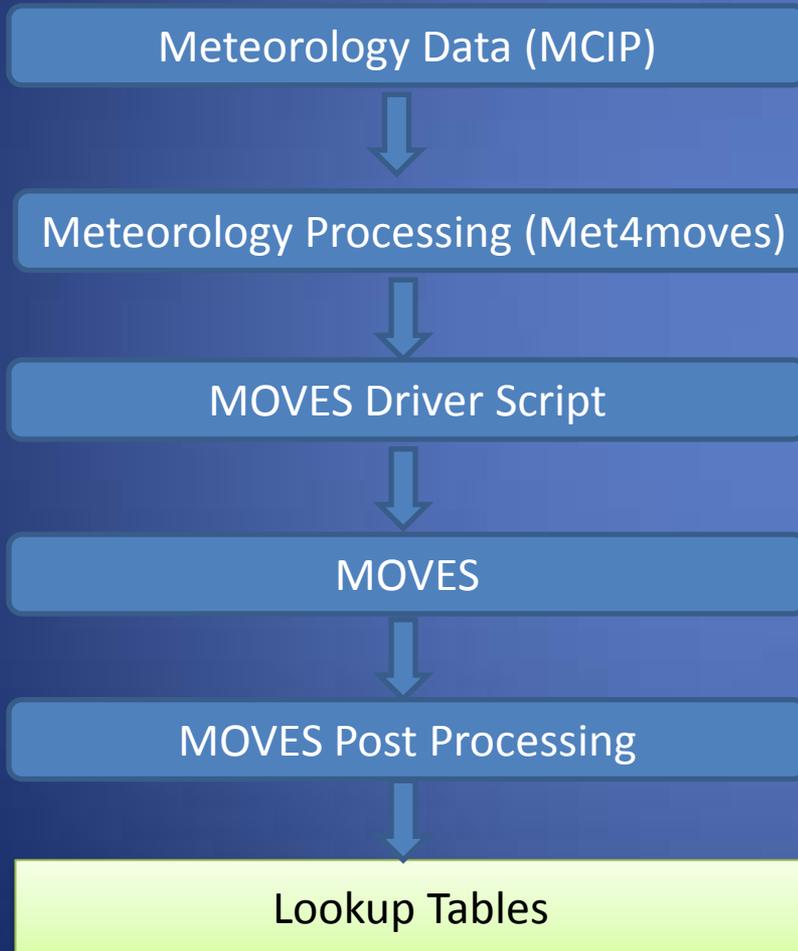
Lookup Tables

AIRPACT4 Way

Historical Observed Meteorology Data

↓

Static Met4moves

↓

MOVES Driver Script

↓

MOVES

↓

MOVES Post Processing

↓

Static Lookup Tables
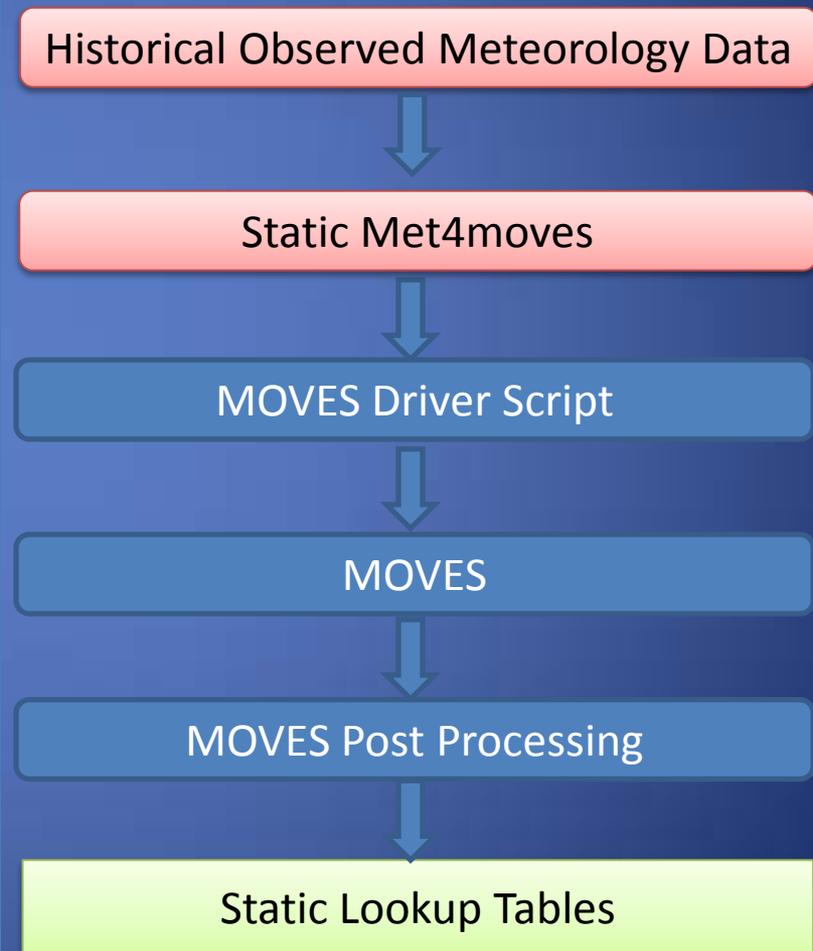
Historical Observed Meteorology

Historical Temperature Range will determine number of bins in Look-up tables.
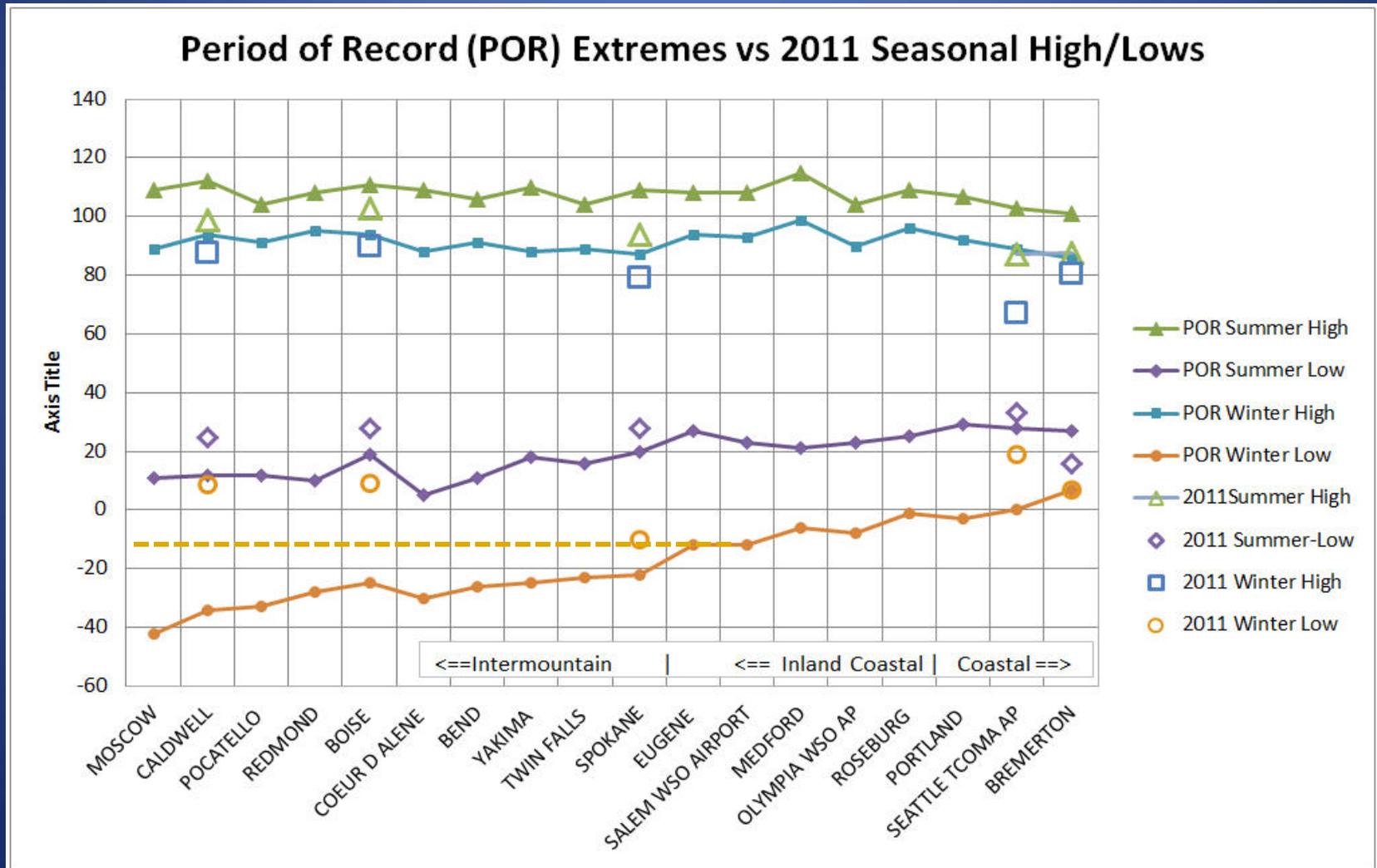
Historical Observed Meteorology

Shape of Diurnal Temperature Profile affects the "Rate Per Profile" evaporative venting emissions – one set for each Reference County/Fuel Month Group
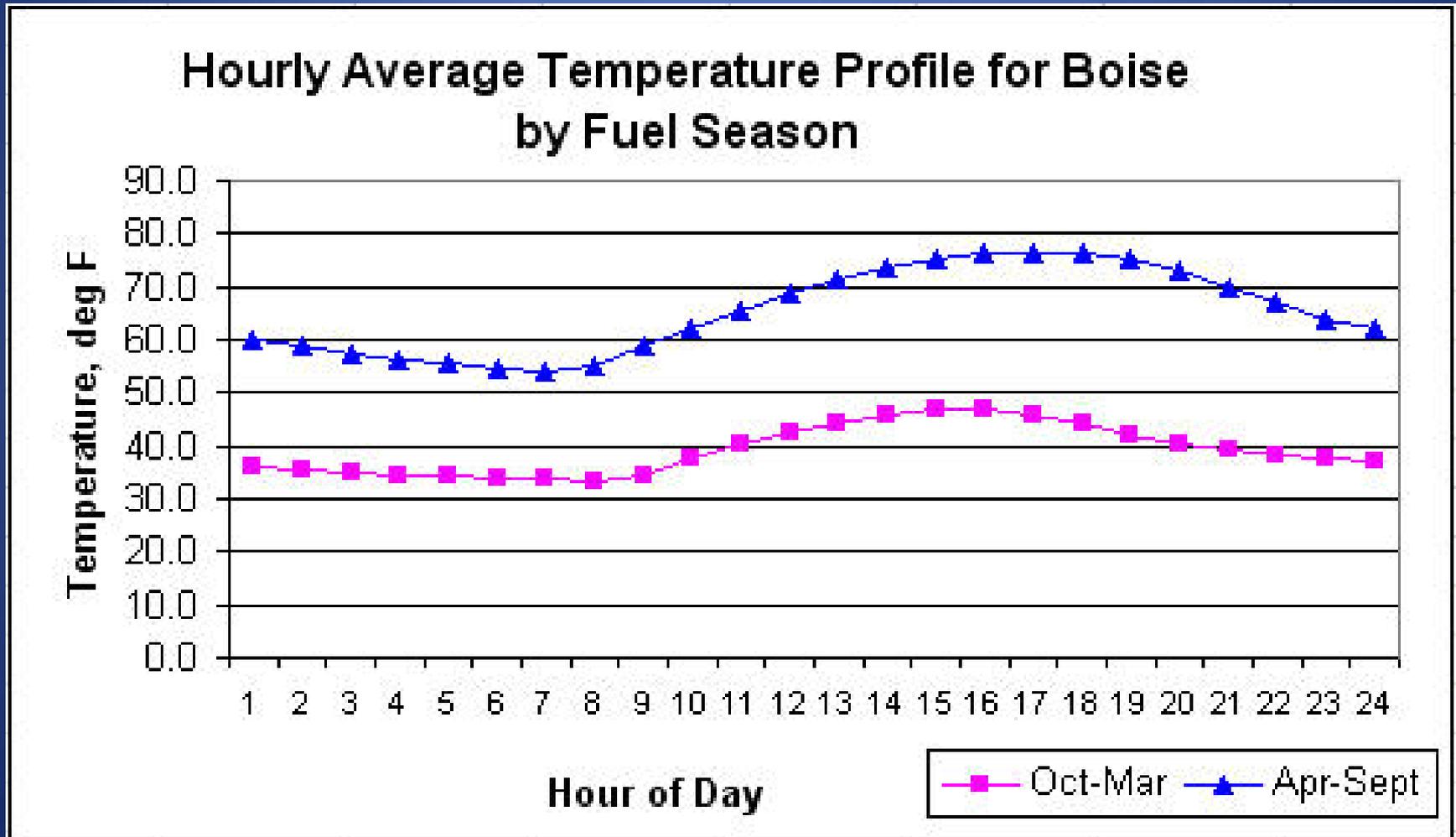
RatePerDistance (On-Network)

Standard Way
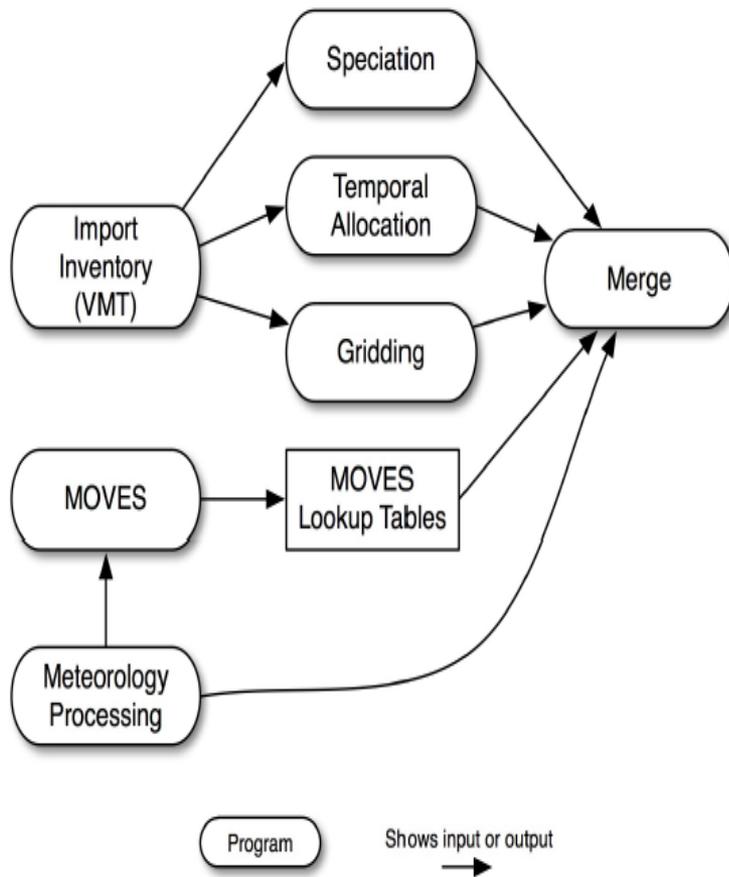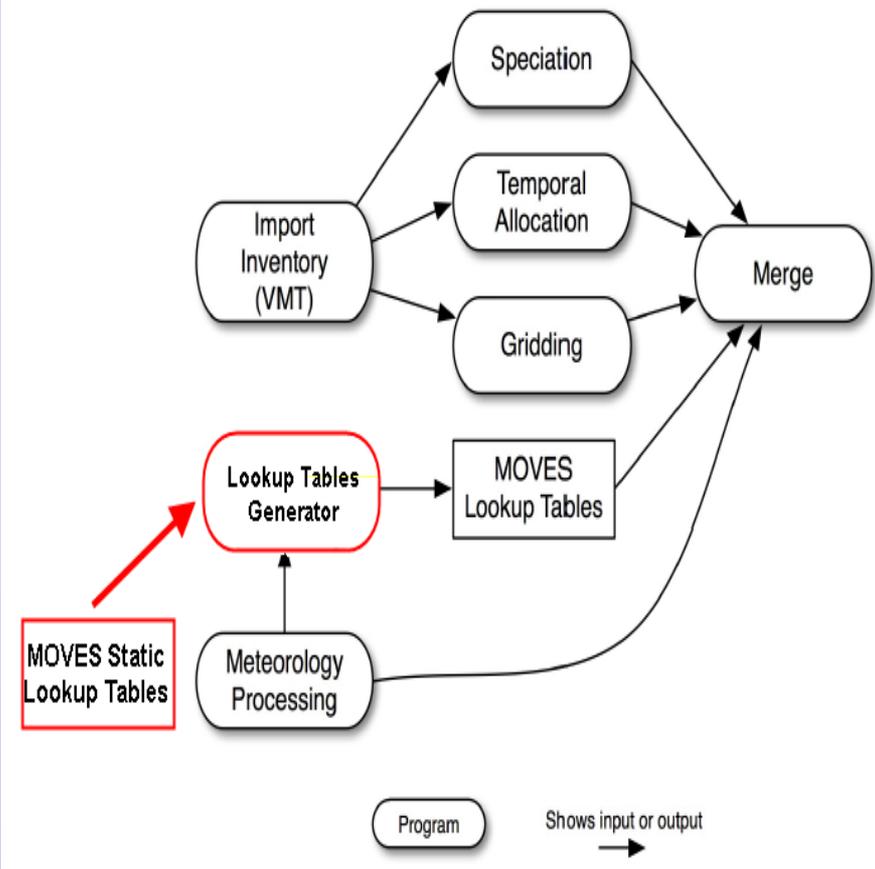
AIRPACT4 Way

RatePerVehicle and RatePerProfile (Off-Network)

Standard Way
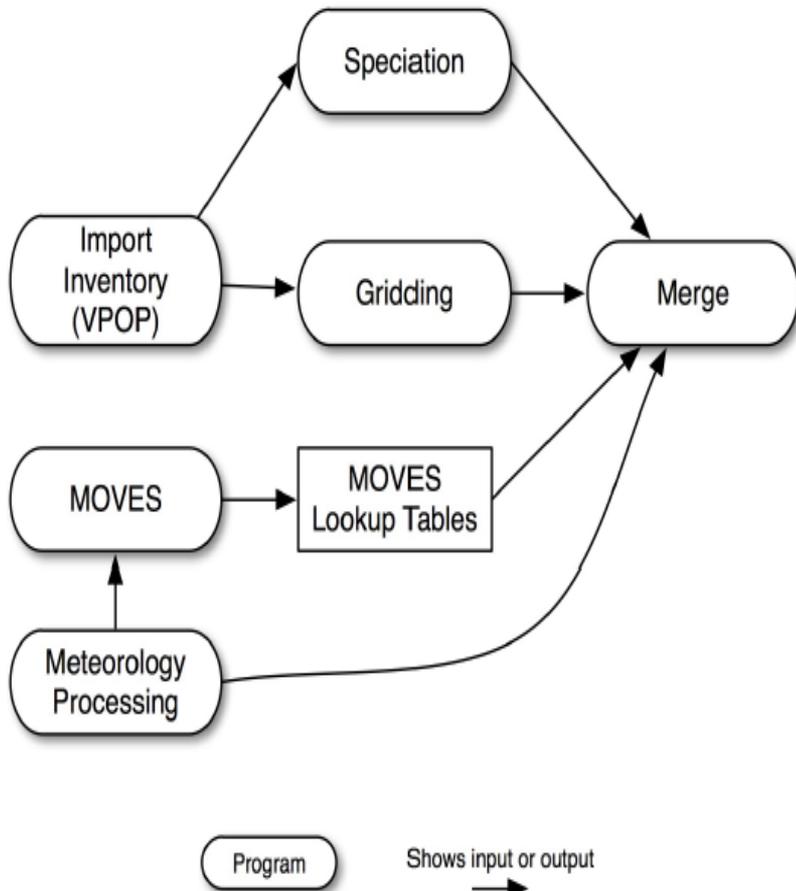
AIRPACT4 Way
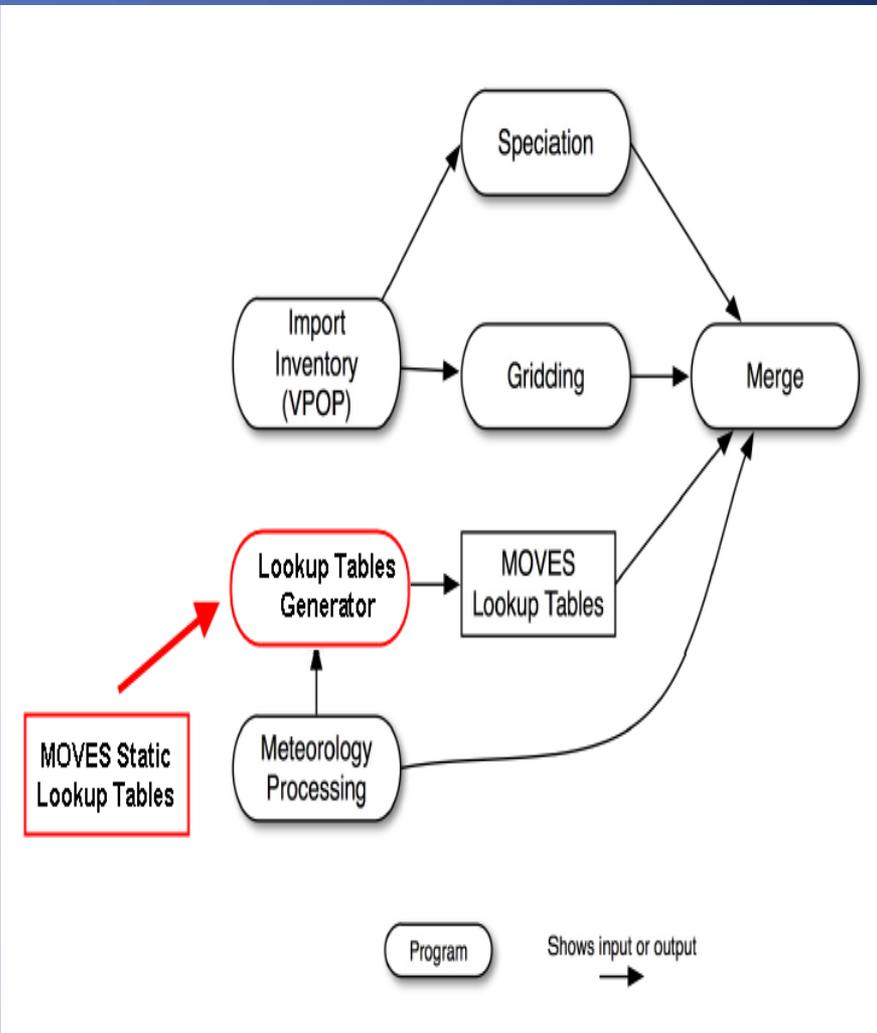
Test Run Result (Sunday, 4/1/2012) RatePerDistance
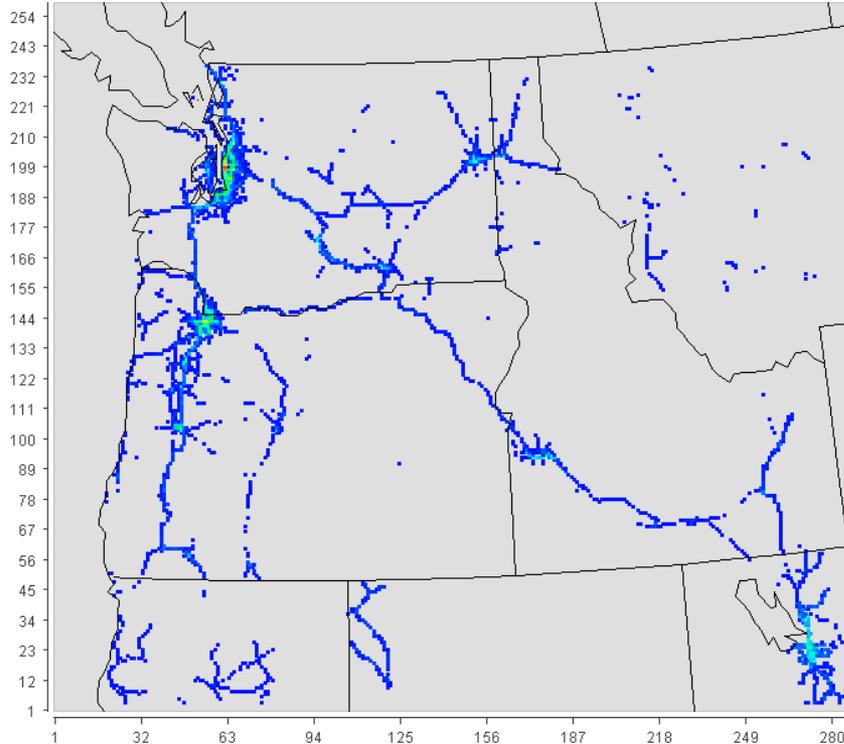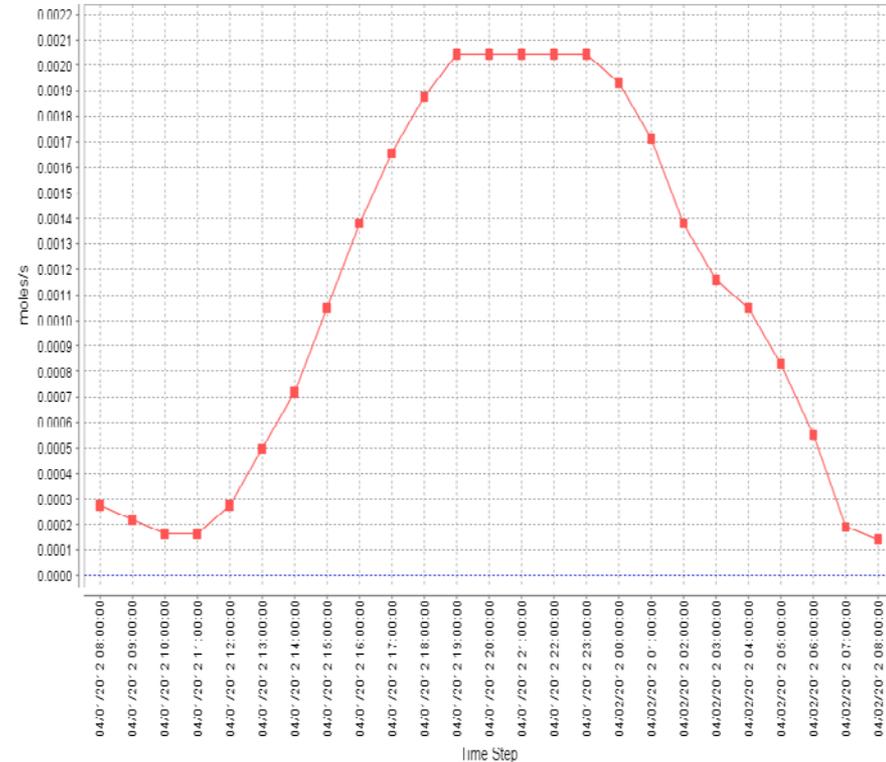
Test Run Result (Sunday, 4/1/2012) RatePerVehicle
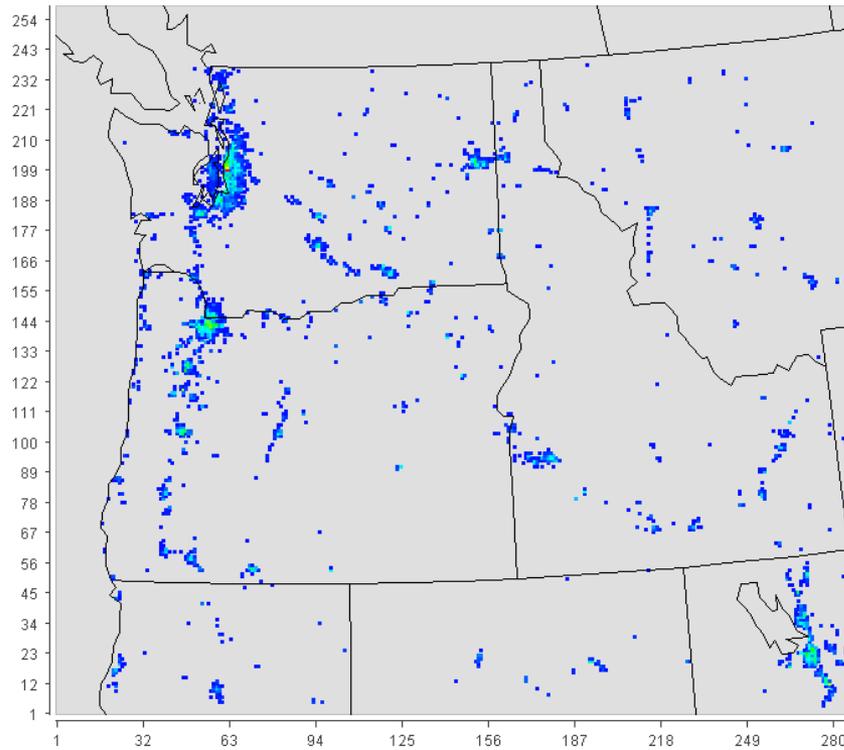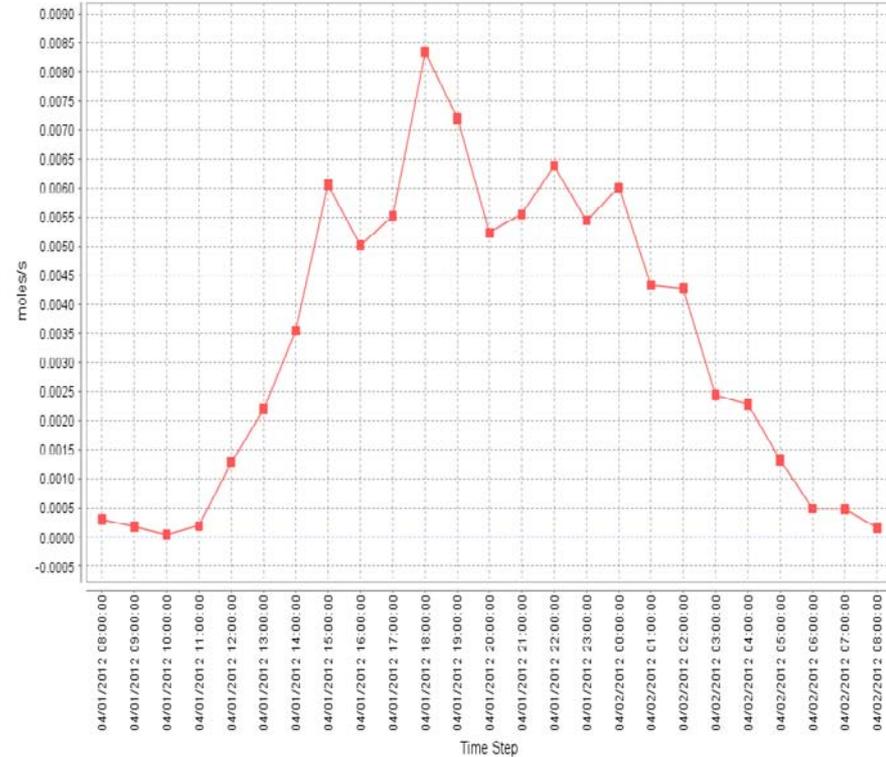
Test Run Result (Sunday, 4/1/2012) RatePerProfile
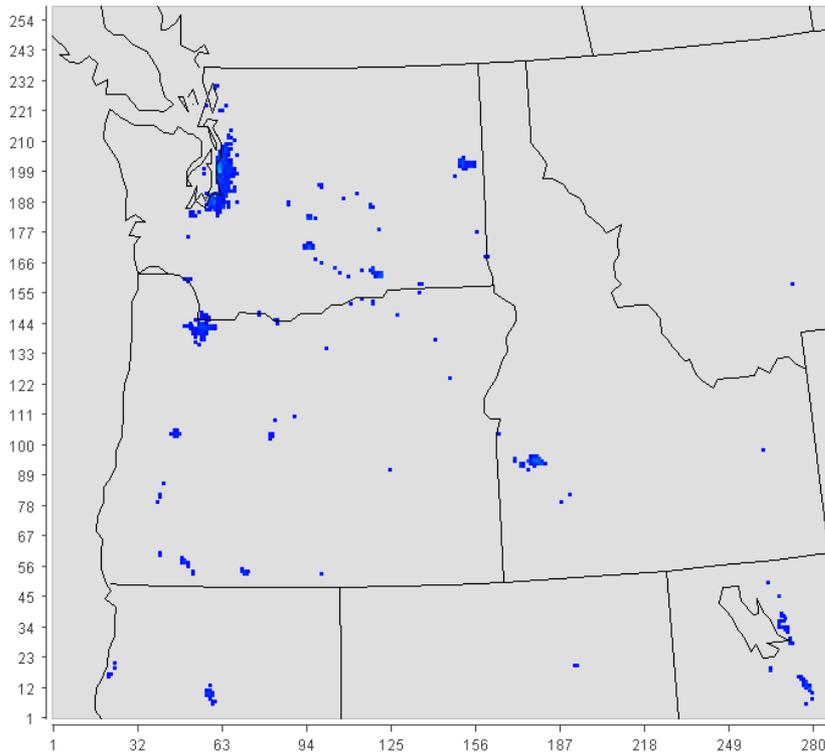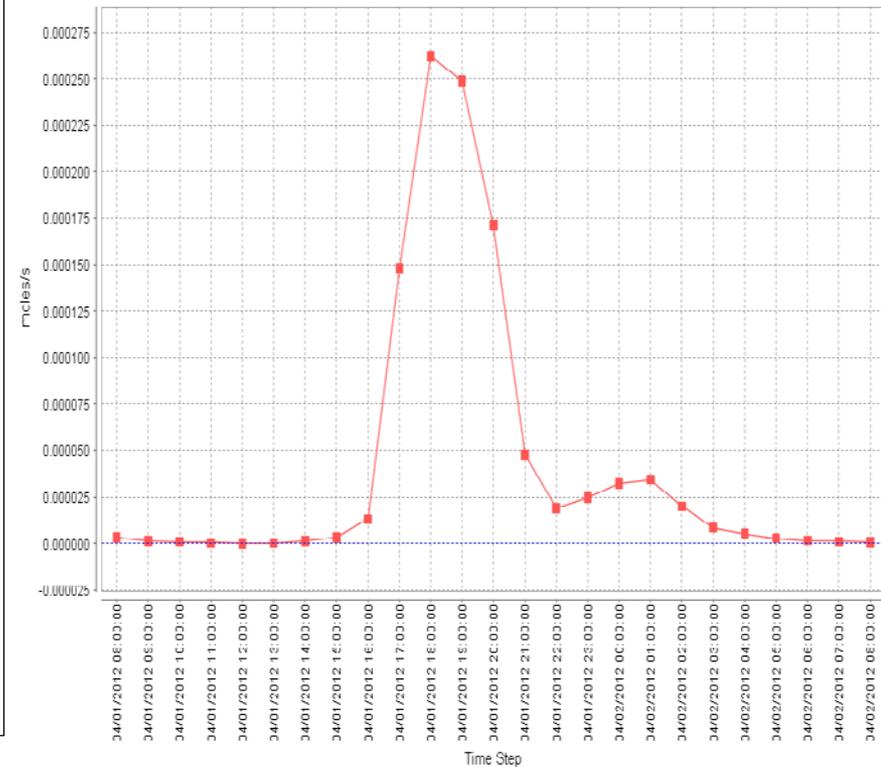
Test Run Running Time

Linux Machine, 2.3GHz CPU
Exclude lookup table generation

RatePerDistance		RatePerVehicle		RatePerProfile	
SMOKE Program	Running Time	SMOKE Program	Running Time	SMOKE Program	Running Time
SMKINVEN	< 1 minute	SMKINVEN	< 1 minute	SMKINVEN	< 1 minute
SPCMAT	< 1 minute	SPCMAT	< 1 minute	SPCMAT	< 1 minute
GRDMAT	~3 minutes	GRDMAT	~3 minutes	GRDMAT	~3 minutes
TEMPORAL	~2 minutes				
MOVESMRG	~150 minutes	MOVESMRG	~23 minutes	MOVESMRG	~3 minutes

Challenges in Current Approach

- MOVES doesn't contain default input data for Canada

- No SMOKE SAPRC99 speciation profile and cross reference files for SMOKE-MOVES integration
  - Only available for CB4 or CB5

- Run time issues
  - Generating one static lookup table, ~26 days run time
  - Daily run time ~ 2.7hrs (mostly MOVES Merge program ~2.5hrs)

Possible Speed-up Approaches to reduce daily run time

- Reduce look-up table size.
  - Change temp bin size from 5 deg to 10 or 20 deg
  - Reduce species to PM2.5 & ozone precursors
    - (remove GHG and toxics for now)
- Faster processor
- Wait for planned EPA speed-up for MOVES-Merge program in SMOKE

Up Next...

- Finalize setting up SMOKE-MOVES in AIRPACT4 approach

- Try to reduce daily run time

- Produce the specific local input for MOVES and SMOKE

- Generate new lookup tables and integrate them into daily process