



Development of On-Road Emissions for the 2011 NEI

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Acknowledgments

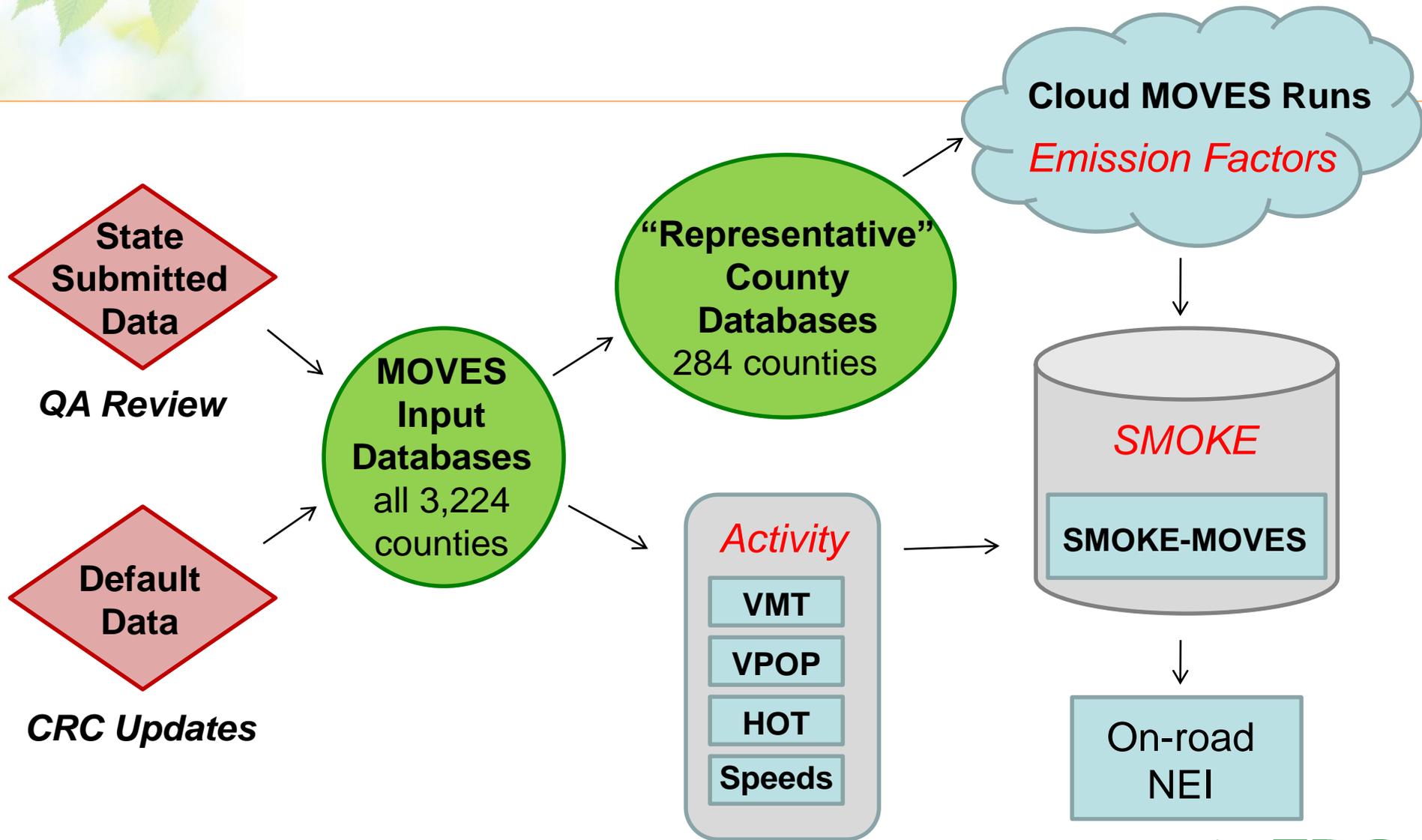
- States
- Coordinating Research Council (CRC)
Atmospheric Impacts Committee
 - Project Leads: Susan Collet (Toyota), Mark Janssen (LADCO)
- Fluid and Reason
 - Wes Faler
- ERG
 - Meredith Weatherby, Anita White, Sandeep Kishan



National Emissions Inventory (NEI) Overview

- NEI is compiled by EPA every 3 years, covering major pollutants for all sectors and U.S. counties
- Final 2011 estimates published March 2015
- 2011 is the first NEI relying solely on MOVES for on-road sources (outside CA)
- States given option to submit their own emissions, or MOVES County Database (CDB) inputs

NEI On-road Flow Diagram





Submittal Process

- States submitted data through the EIS (Emission Inventory System)
- County Databases (CDBs) of MOVES inputs
- Documentation
- QA check script results

What is Submitted?

MOVES County Data Manager

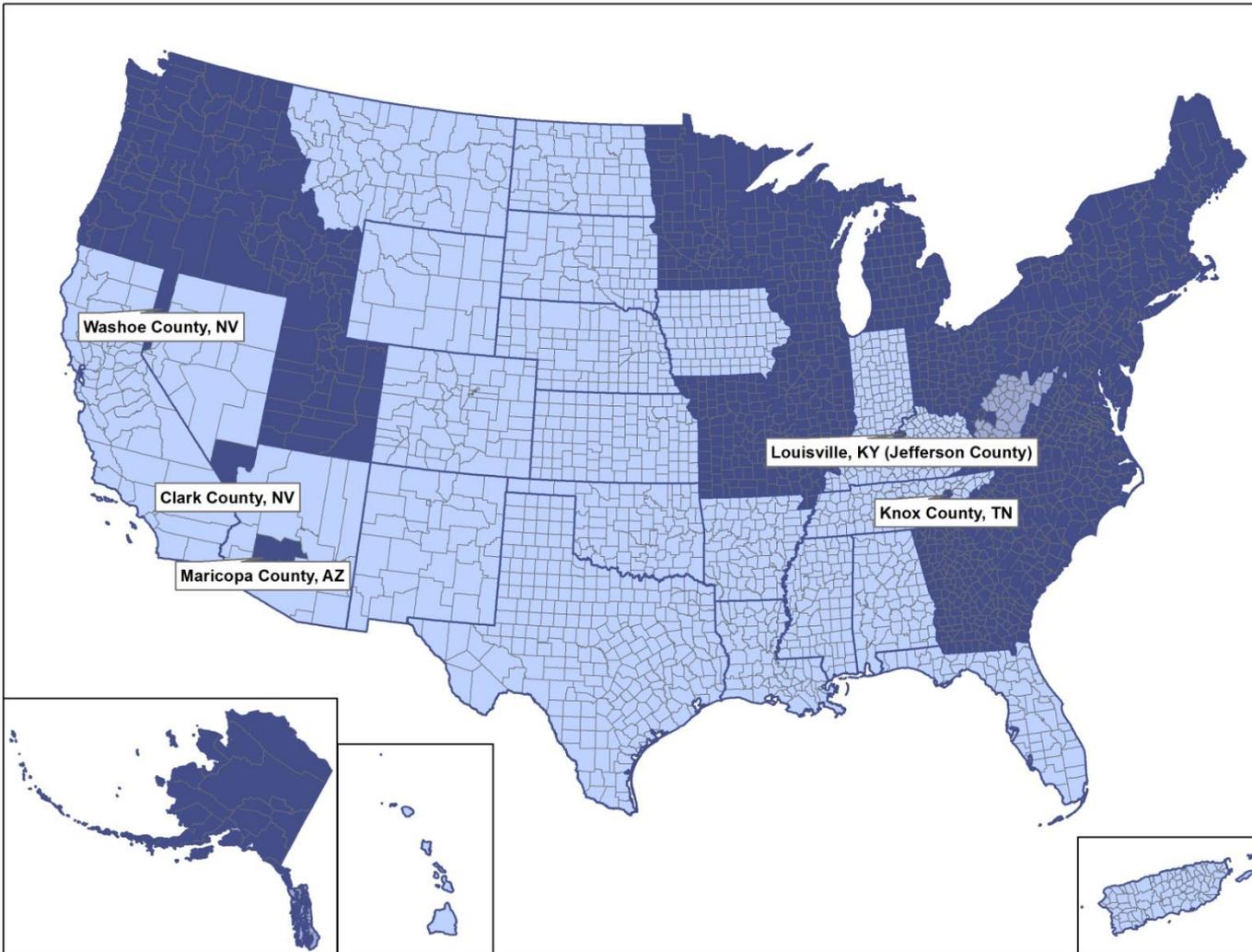
- County Data Manager (CDM) allows custom input for following parameters, through MS Excel tables

CDM interface



Data entered through CDM	“Best Practice” Sources
Vehicle Miles Travelled	HPMS, Travel models
Temperature & Humidity	Meteorology data
Vehicle Population	Registration data, fleets
Average Speed Distribution	Travel models
Vehicle Age Distribution	Registration data, fleets
Fuel Properties/Market Shares	Fuel surveys, fuel regulations
Road Type Distribution	HPMS, Travel models (VMT source)
Fuel Technology Mix	Registration data, fleets
I/M Compliance/Waiver Rates	Operating program data & history

MOVES CDBs Submitted (Dark Blue)



33 states provided data
(~1,400 counties)



Quality Checks on Submitted Data



Quality Assurance (QA) Checks

- Reviewed each table in the CDBs
- EPA's "Completeness" QA script
- ERG's "Reasonableness" QA script
 - Flags unusual patterns for further review
 - For example, gaps in model year coverage for I/M programs or unusually "old" age distribution
- In some cases, EPA asked states for revised data
- Updated the CDBs with corrections



Improvements to Default Data



Coordinating Research Council – Supplemental Projects

- CRC sponsored two projects to evaluate state-submitted data, and improve MOVES defaults used in the NEI
- CRC A-84 (also published as TRB14-2989)
 - Analysis of MOVES data submitted by states vs. defaults
 - MOVES sensitivity analysis to determine most influential state inputs
- CRC A-88 (also published as TRB 15-5129)
 - Identify reliable national datasets to improve default MOVES NEI inputs at the county level
 - Task 1: Identify promising inputs to update
 - Car/Light Truck Age Distribution, Population
 - Long-Haul Truck VMT
 - Passenger trip activity
 - Truck idle locations
 - Temporal VMT distributions
 - Task 2: Make updates for NEI
 - Age distribution, population; Long Haul VMT

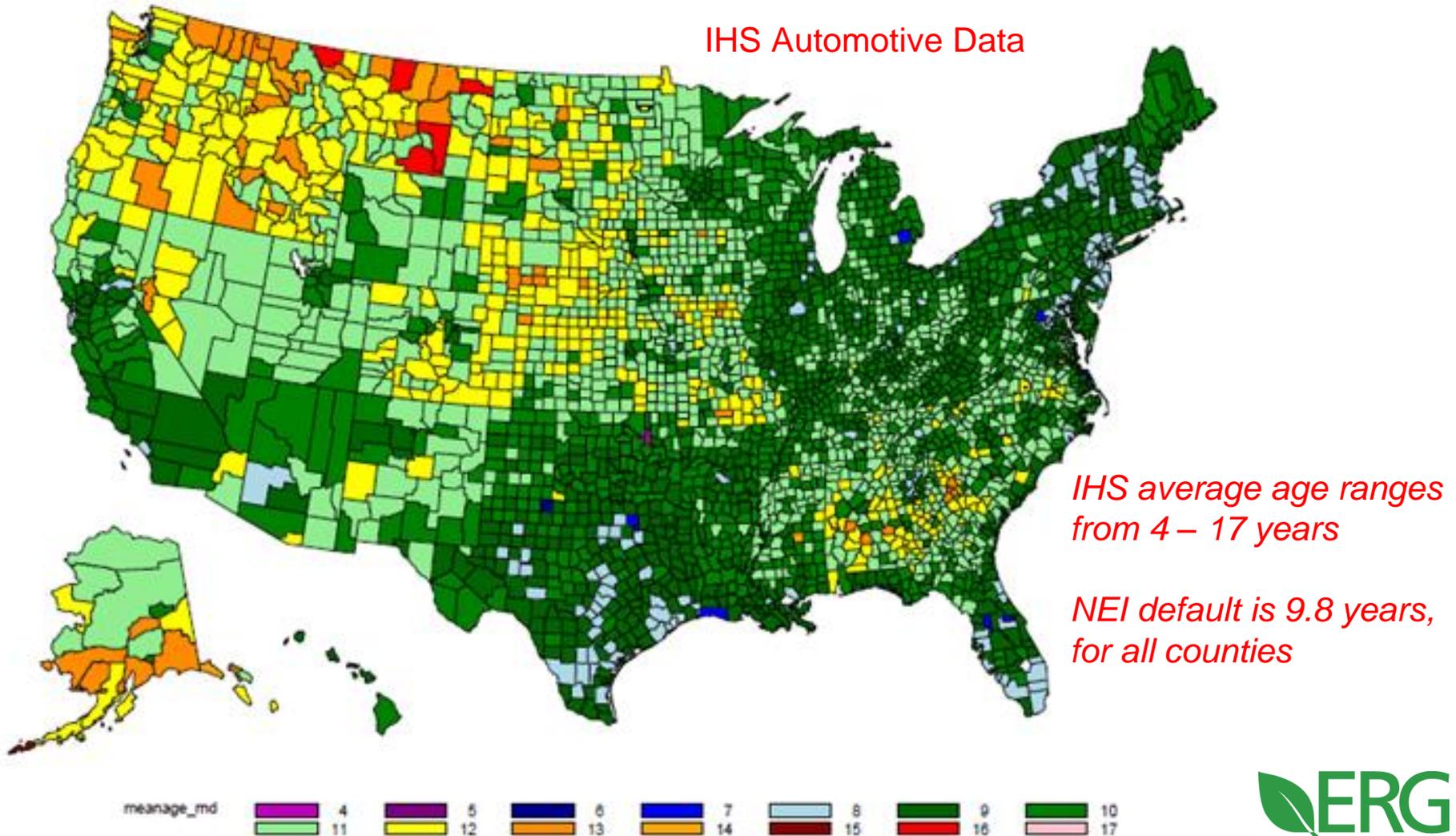
HC		
Source Type/Cluster	Input Varied	Total Increase
Passenger Car	Age Distribution	24%
Passenger Truck	Age Distribution	22%
Passenger Truck	Population Fraction	16%
Passenger Truck	VMT Fraction	14%
Passenger Car	Population Fraction	12%
CO		
Source Type/Cluster	Input Varied	Total Increase
Passenger Truck	VMT Fraction	30%
Passenger Truck	Age Distribution	25%
Passenger Car	VMT Fraction	22%
Passenger Car	Age Distribution	21%
Light Commercial Truck	Population Fraction	11%
NOx		
Source Type/Cluster	Input Varied	Total Increase
Combination Long Haul Truck	VMT Fraction	39%
Passenger Truck	VMT Fraction	22%
Combination Short Haul Truck	VMT Fraction	20%
Urban Unrestricted_Day	Average Speed	18%
Passenger Car	VMT Fraction	12%
PM		
Source Type/Cluster	Input Varied	Total Increase
Combination Long Haul Truck	VMT Fraction	79%
Combination Short Haul Truck	VMT Fraction	35%
Urban Unrestricted_Day	Average Speed	18%
Rural Unrestricted_Day	Average Speed	14%
Combination Long Haul Truck	Age Distribution	13%

CRC A-84 Results: Most influential MOVES inputs by pollutant

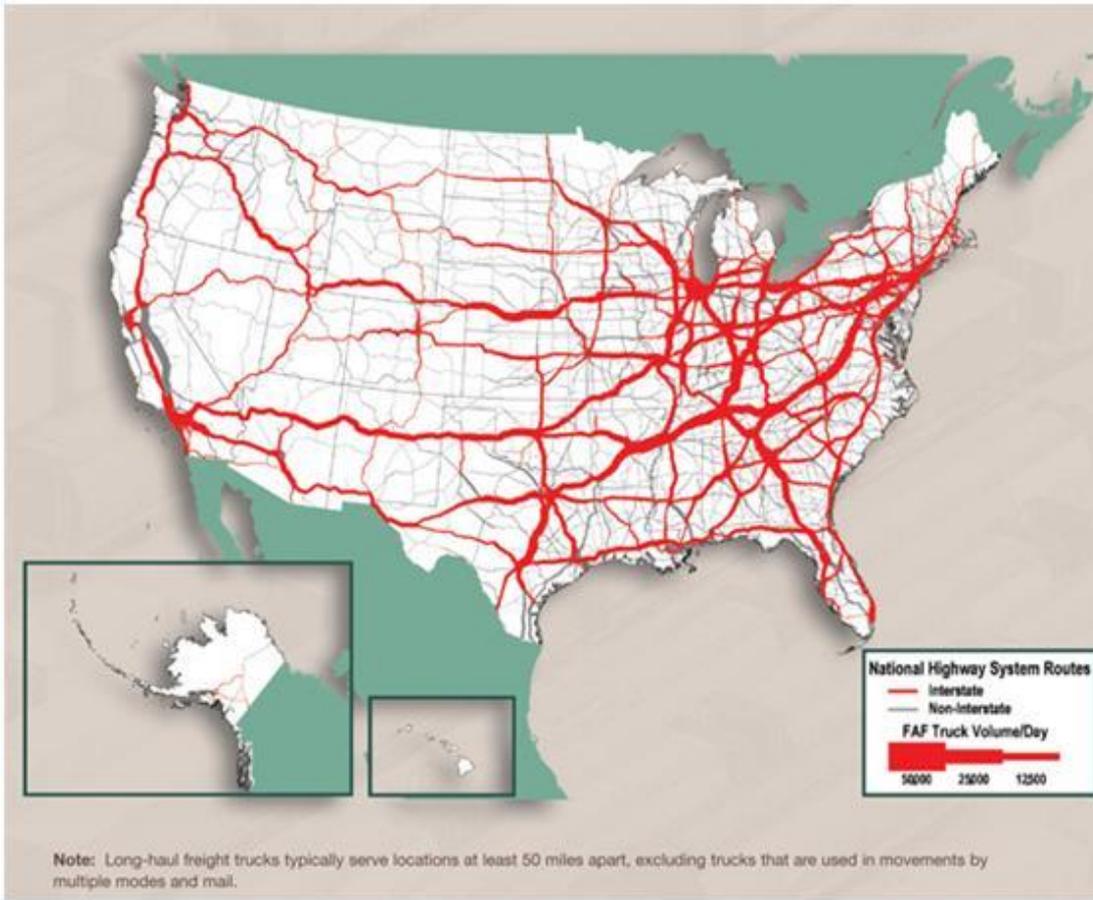
Percent change in total emissions when input was changed from 10th to 90th percentile of state-supplied data



Average Passenger Car age by county, 2011



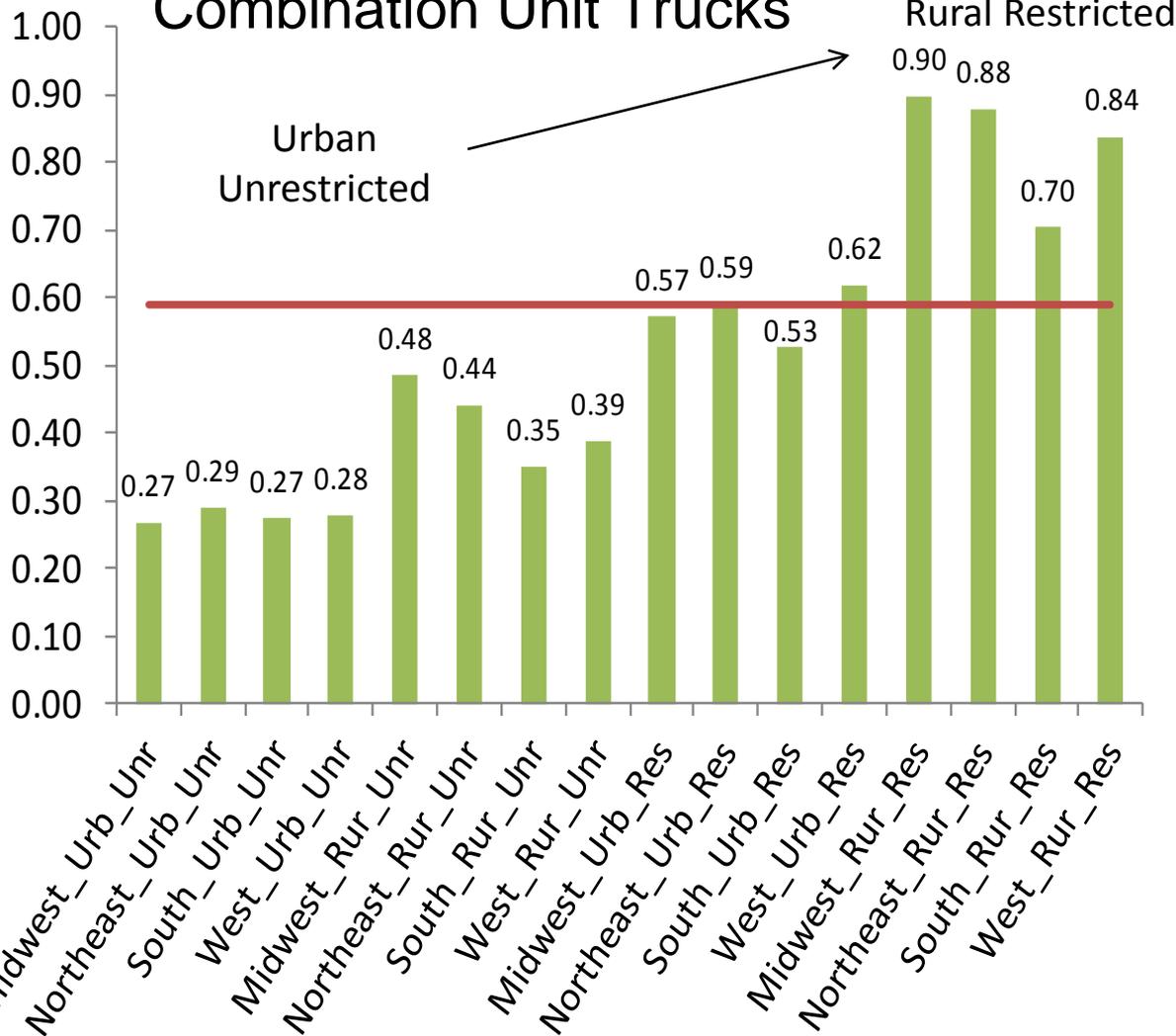
Freight Analysis Framework 1 of 2



- Estimates long-haul VMT for all major road segments
- Joins several datasets
 - VMT
 - Commodity Flow
 - Network Capacity
 - Truck Trip Lengths

Freight Analysis Framework 2 of 2

Combination Unit Trucks



*Fractions are ratio of VMT:
long-haul/ (long-haul + short-haul)*

*NEI default is 59% for combination
unit trucks
(12% for single unit trucks, not shown)*

A-88 Update
MOVES default

Use of CRC A-88 to update the NEI defaults

IHS Data

- Age distribution
- Population
- More representative counties

ID	Source Use Type
11	Motorcycle
21	Passenger Car
31	Passenger Truck
32	Light Commercial Truck
41	Intercity Bus
42	Transit Bus
43	School Bus
51	Refuse Truck
52	Single Unit Short-haul Truck
53	Single Unit Long-haul Truck
54	Motor Home
61	Combination Short-haul Truck
62	Combination Long-haul Truck

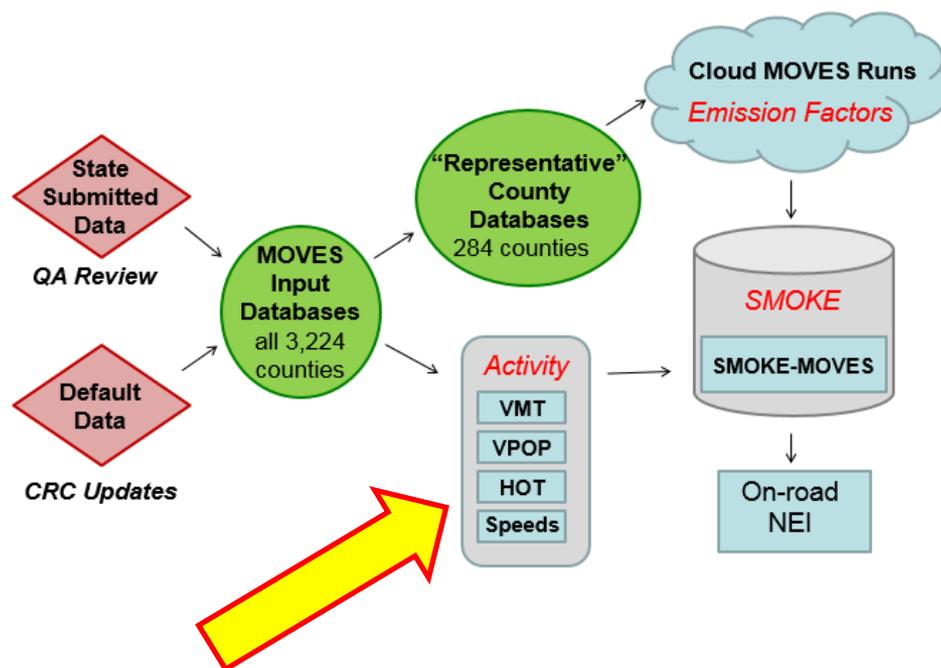
FAF Data

- Long-Haul VMT fractions
- Updated hotelling hours (*source type 62*)

Datasets (posted on www.crcao.org)

- Populations & Age Distribution for every U.S. County
- Long-Haul / Short-Haul VMT Fractions
- Truck idle locations – national GIS database

Creating SMOKE activity files

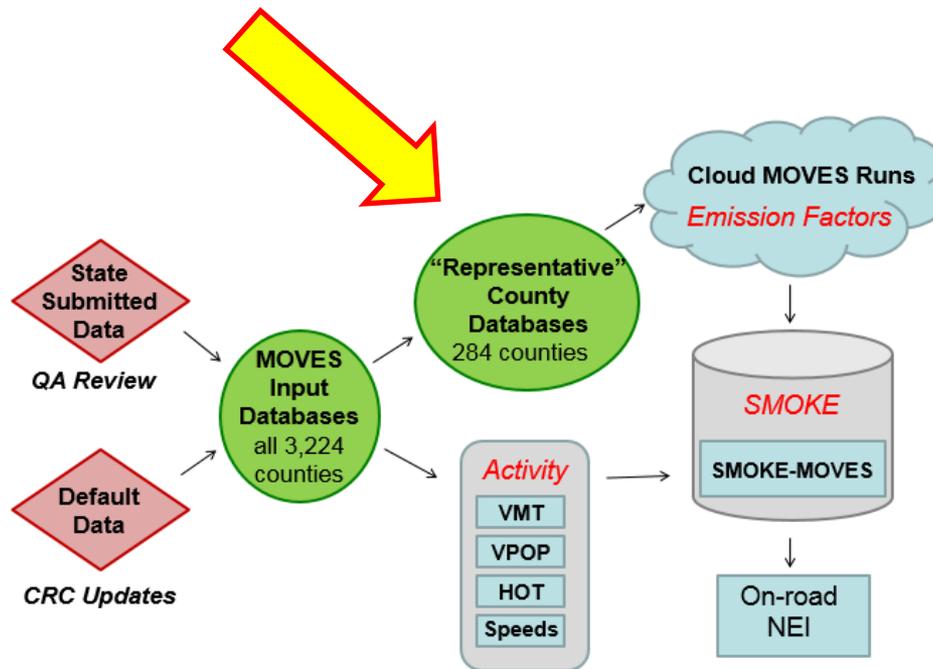




SMOKE Activity Files

- NEI on-road emissions are calculated inside SMOKE
- SMOKE requires FF10-formatted activity
 - VMT, Population, Hoteling, Speeds
 - By county and SCC
- OTAQ and ERG developed scripts take inputs from submitted CDB tables and output FF10 tables ready for SMOKE

Adding Representative Counties



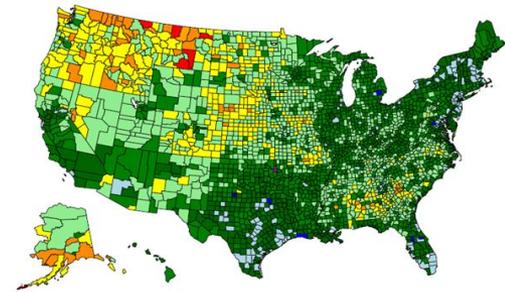


What is a representative county?

- A representative county is one that shares similar emission factor-determining properties as other counties
- Representative county emission factors mapped to similar counties for the inventory calculation
- NEI uses MOVES runs results for 284 counties to represent all 3,224 counties

Why add more representative counties?

- CRC A-88 project brought new default light-duty age distributions to NEI
 - Average age ranges 4 to 17 years old
 - New variation at the county level
- Ramp Fraction data added to criteria for grouping “similar” counties
 - Ramp Fraction is the fraction of highway driving time spent on ramps
 - Variation in submitted county data ranges 0 to 0.15, plus some outliers with higher fractions

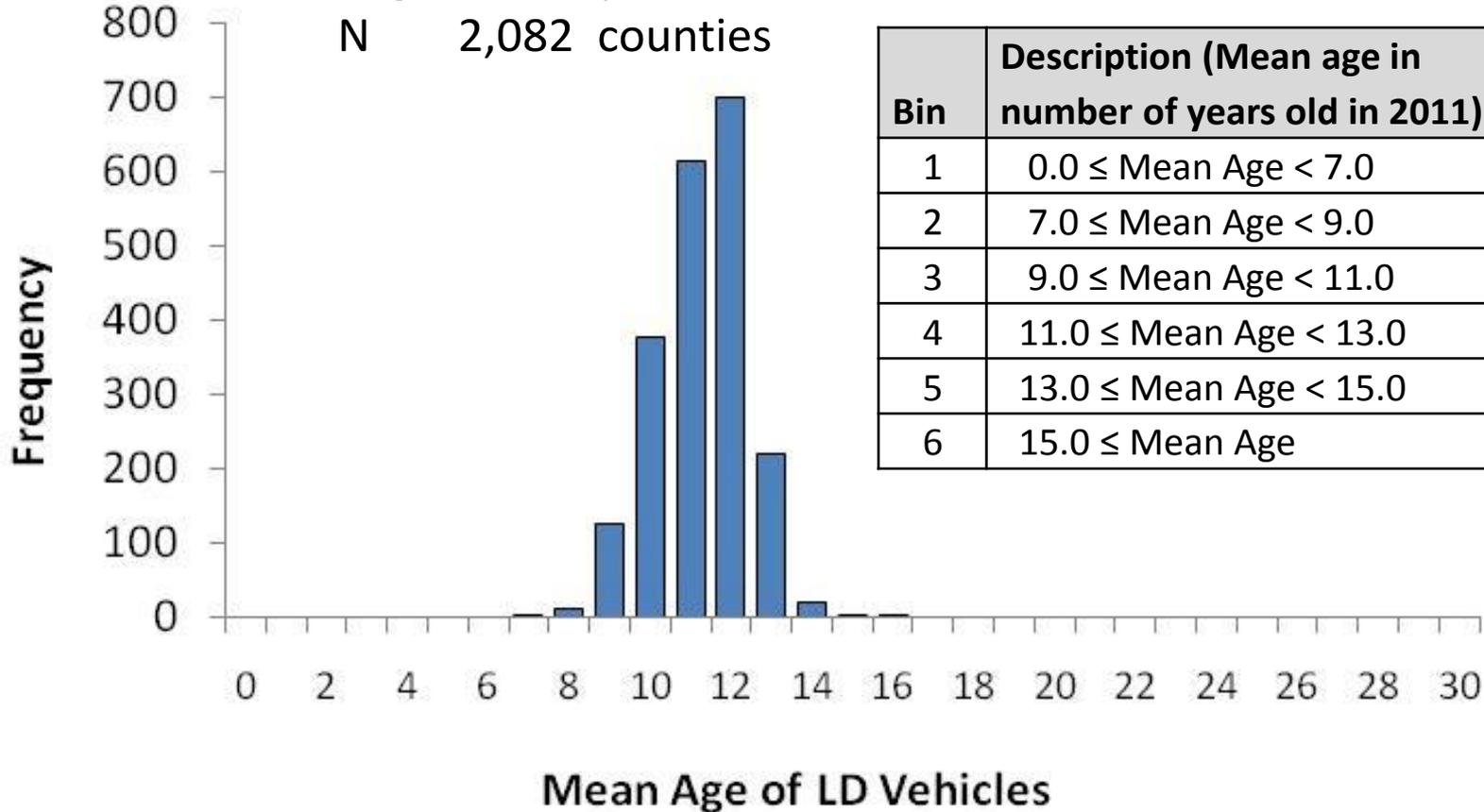


Adding Representative Counties

1 of 2

Light-duty age distributions

Average 10.8 years old
N 2,082 counties

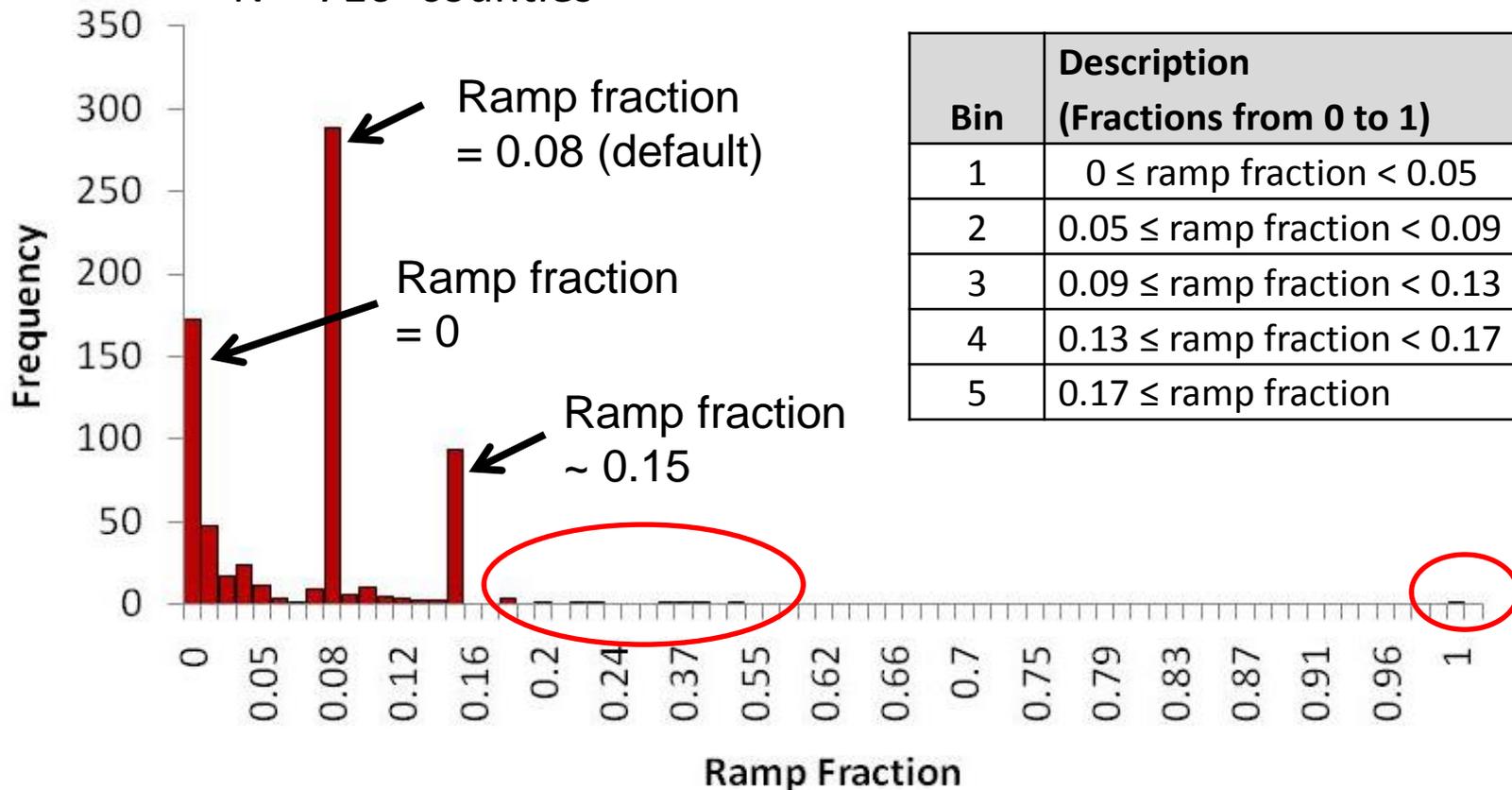


Adding Representative Counties

2 of 2

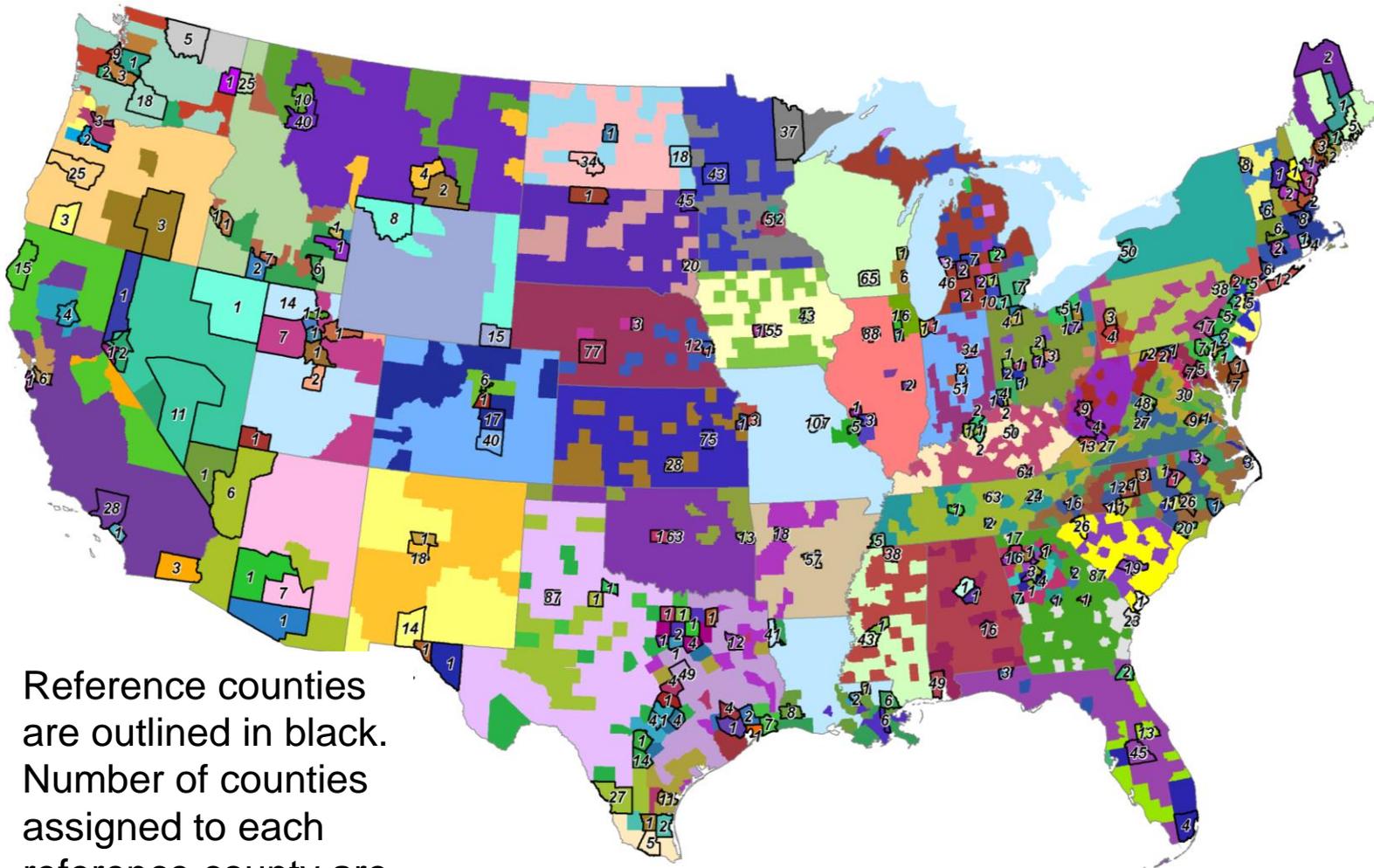
Ramp fractions in the submitted data

N = 716 counties



NEI 2011 v2

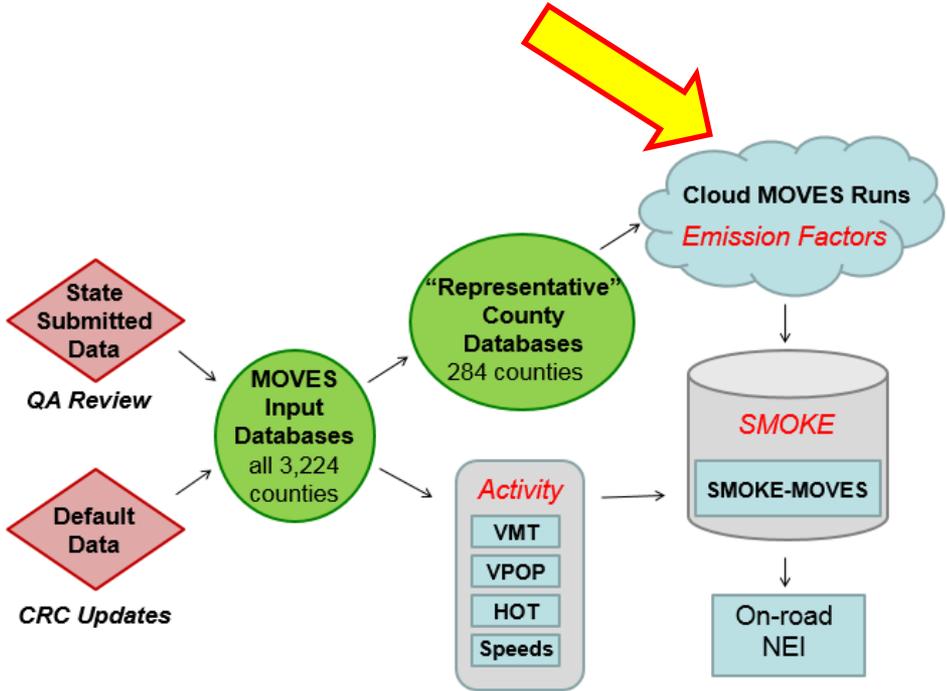
284 Representative Counties



Reference counties are outlined in black. Number of counties assigned to each reference county are labeled.



Executing MOVES runs in the Cloud





MOVES in the Cloud

- Generated the lookup tables needed for nationwide emission inventory in SMOKE
 - Emission factor lookup tables
 - Range of temperature/humidity conditions
- Cloud CPUs rented by processing time
 - 568 instances in parallel (284 representative counties, 2 months)
- Computing Time
 - Execution time 48-60 hours
 - Total processing time 30,000 hours
 - ~3.5 years on a single machine



Summary of on-road emissions development for NEI

- NEI 2011 is the first to solely use MOVES
- Submittal process invites states to provide CDB(s)
- QA checks rely on EPA and ERG scripts
- CRC A-88 data was introduced to improve default data in the NEI
- FF10 activity files for SMOKE are consistent with state submitted activity and MOVES internal calculators
- Cloud environment critical to support large-scale MOVES modeling