



SMOKE-MOVES Integration Tool

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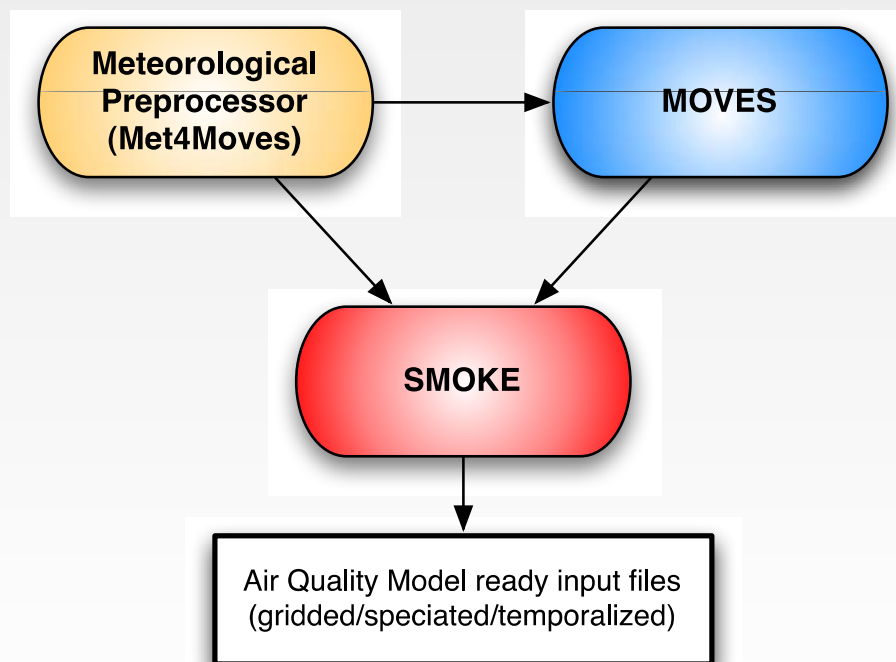


Introduction

- MOVES2010 is released on December 2009
- MOVES2010a is released on August 2010
- SMOKE-MOVES Integration Tool is released on July 2010
- SMOKE-MOVES Integration Tool is based on the “Emission Rate” output.
- (1) Meteorological Preprocessor (**Met4moves**)
- (2) MOVES Driver Script and Post-processing Script
- (3) SMOKE Modeling System (**Movesmrg**)



SMOKE-MOVES Integration Tool





Reference County

- To reduce the computational burden of running MOVES on every county in your modeling domain
- Represent a set of similar counties (i.e., inventory counties) called a **county group**.
- Key emission rates for the single reference county in MOVES can be utilized to estimate emissions for all counties in the **county group** through SMOKE.
- **Criteria** : Similar fuel parameters, fleet age distribution and I/M programs.
- Modeled at a range of speeds and temperatures to produce emission rate lookup tables (i.e., RatePerDistance, RatePerVehicle, RatePerProfile)
- **Key variables** : VMT (RPD), Vehicle Population (RPV and RPP), Roadway Speed, and Temperatures

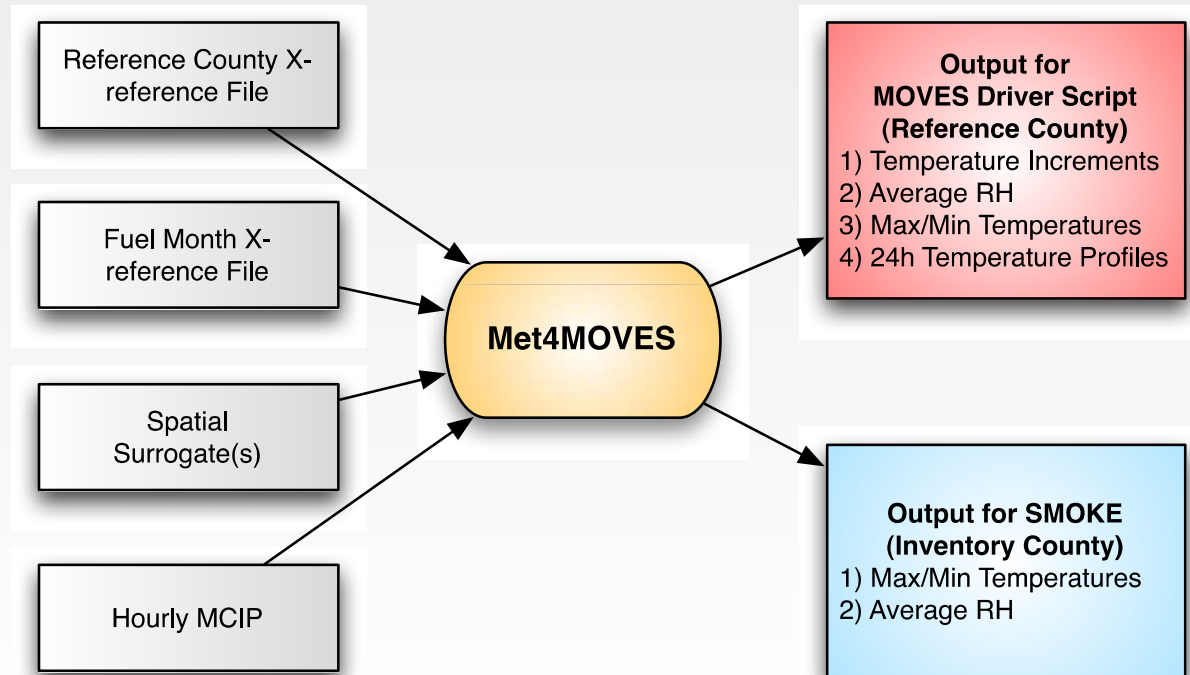


Fuel Month

- 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.
- Represent a particular set of fuel properties over the months used in MOVES
- **Criteria :** The State-provided fuel supply data in the MOVES database for each reference county
- Example: If January and February use the similar fuel types, model only one of the months



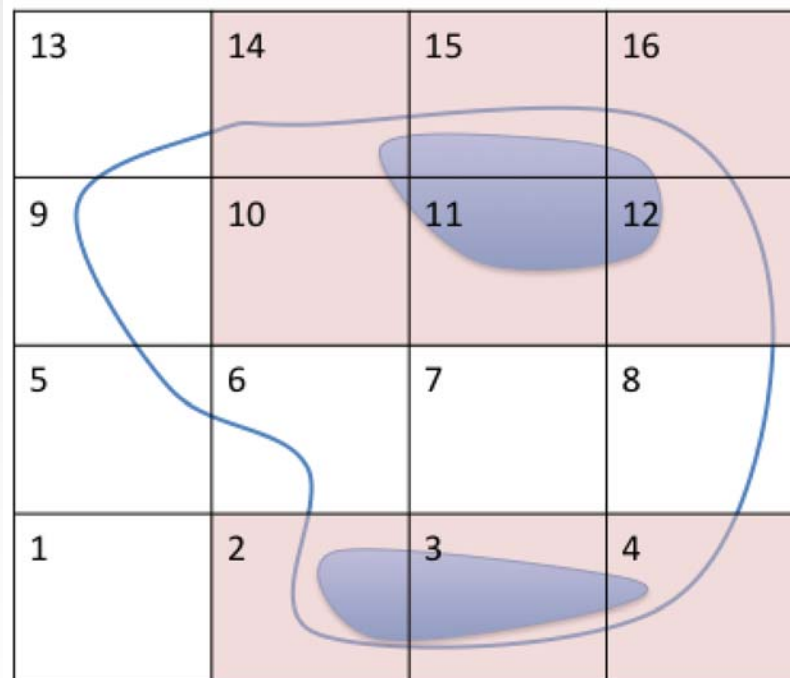
Meteorological Preprocessor : Met4moves





Meteorological Preprocessor : Met4moves

- No weighting averaging method
- Average across all grid cells that intersect with all county groups to represent reference county



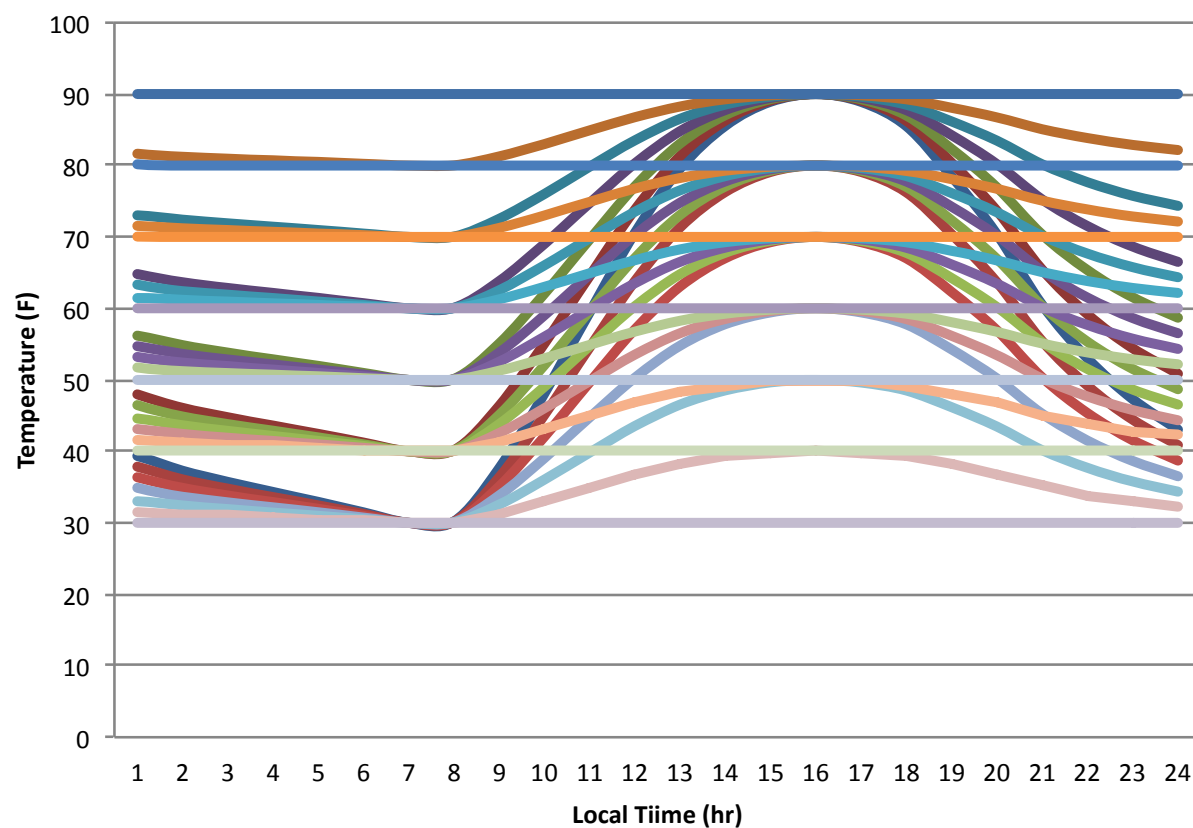


Met4moves: Output for SMOKE

Inventory County	fuelMonth	Month	julianDate	RH	Temp (Minimum)	Temp (Maximum)
13001	1	3	2009060	51.1	25.2	65.1
13002	1	3	2009060	55.2	29.1	58.9
13003	1	3	2009060	52.6	21.4	59.3
13005	1	3	2009060	51.7	25.8	62.1
...	...	...	...	...	...	...
13001	4	4	2009090	61.1	44.2	75.1
13002	4	4	2009090	66.6	39.9	63.7
13003	4	4	2009090	61.1	45.1	80.5
13005	4	4	2009090	56.2	46.2	79.5
...	...	...	...	...	...	...



Met4moves: Output for MOVES





MOVES Model Processing

- **Run_Spec_Generator Script : runspec_generator.pl**
 - PD_TEMP_INCREMENT : RPD mode in MOVES run
 - PV_TEMP_INCREMENT : RPV mode in MOVES run
 - Met4moves Output file : RPP mode in MOVES run
- **Post-processing Scripts : Moves2smkEF.pl**
 - Support MOVES2010 (December 2009) and MOVES2010a (August 2010)
 - MOVES2010 version performs SCC mapping (1.5 days per County/month)
 - MOVES2010a version requires SCC field in MOVES output tables
(a few minutes)



MOVES Post-processing Script



rateperdistance_smoke (RPD) (grams/mile)	ratepervehicle_smoke (RPV) (grams/vehicle/hour)	rateperprofile_smoke (RPP) (grams/vehicle/hour)
MOVESScenarioID	MOVESScenarioID	MOVESScenarioID
yearID	yearID	yearID
monthID	monthID	monthID
FIPS (countyID)	dayID	dayID
SCC	hourID	hourID
smokeProcID	FIPS (countyID)	FIPS (countyID)
avgSpeedBinID	SCC	SCC
temperature	smokeProcID	smokeProcID
relHumidity	temperature	Temperature
TOG	TOG	TOG
CO	CO	CO
NOX	NOX	NOX
...	...	...



MOVES-SMOKE Emissions Processes

Emission Rate Lookup Table	Units	SMOKE ProcesID	Emissions Process
RatePerDistance	Gram/mile	EXR	Running Exhaust
		CXR	Crankcase Running Exhaust
		TIR	Tire Wear
		BRK	Brake Wear
		EVP	On-road Evaporative Permeation (roadTypeID=2,3,4,5)
		EFL	On-road Evaporative Fuel Leaks (roadTypeID=2,3,4,5)
RatePerVehicle	Gram /vehicle /hour	EFV	On-road Evaporative Fuel Vapor Venting (roadTypeID=2,3,4,5)
		EXS	Start Exhaust
		CXS	Crankcase Start Exhaust
		EVP	Off-network Evaporative Permeation (roadTypeID=1)
		EFL	Off-network Evaporative Fuel Leaks (roadTypeID=1)
		CEI	Crankcase Extended Idle Exhaust
RatePerProfile	Gram /vehicle /hour	EXT	Extended Idle Exhaust
		EFV	Off-network Evaporative Fuel Vapor Venting (roadTypeID=1)



List of Pollutants by Emissions Processes

SMOKE Name	ProcessIDs												
	EXR (1)	EXS (2)	CXR (15)	CXS [16]	CEI [17]	EXT [90]	EVP [11]	EFV [12]	EFL [13]	BRK [9]	TIR [10]	RFV [18]	RFS [19]
TOG	!	!	!	!	!	!	!	!	!			!	!
VOC	!	!	!	!	!	!	!	!	!			!	!
CO	!	!	!	!	!	!							
NOX	!	!	!	!	!	!							
NH3	!	!	!	!	!	!							
NO	!	!	!	!	!	!							
NO2	!	!	!	!	!	!							
SO2	!	!	!	!	!	!							
PM10OM	!	!	!	!	!	!							
PM10EC	!	!	!	!	!	!							
PM10SO4	!	!	!	!	!	!							
PM10BRAKE										!			
PM10TIRE											!		
PM25OM	!	!	!	!	!	!							
PM25OC	!	!	!	!	!	!							
PM25EC	!	!	!	!	!	!							
PM25SO4	!	!	!	!	!	!							
PM25BRAKE										!			
PM25TIRE											!		
BENZENE	!	!	!	!	!	!	!	!	!			!	!
MTBE	!	!	!	!	!	!	!	!	!			!	!
NAPHTH	!	!	!	!	!	!	!	!	!			!	!
BUTADIE	!	!	!	!	!	!							
FORMALD	!	!	!	!	!	!							
ACETALD	!	!	!	!	!	!							
ACROLEI	!	!	!	!	!	!							



Chemical Speciation

MEPROC Input file for SMOKE Speciation (**Spcmat**)

VMT	EXR	CO NOX TOG S02 PM250C PM25EC PM25S04 NH3 BENZENE MTBE BUTADIE \
		FORMALD ACETALD ACROLEIN
VPOP	EXS	CO NOX TOG BENZENE MTBE BUTADIE FORMALD ACETALD ACROLEI
VMT	EVP	TOG PM250M PM100M
VPOP	EVP	TOG
VMT	EFL	TOG PM250M PM100M
VPOP	EFL	TOG
VMT	EFV	TOG PM250M PM100M
VPOP	EFV	TOG
VMT	CXR	TOG PM250M PM100M
VPOP	CXS	TOG
VPOP	CEI	TOG
VMT	BRK	PM25 BRAKE PM10BRAKE
VMT	TIR	PM25 TIRE PM10TIRE

Example: EXR__CO, EXR__NOX, EXR__TOG,EFV__TOG,,,,



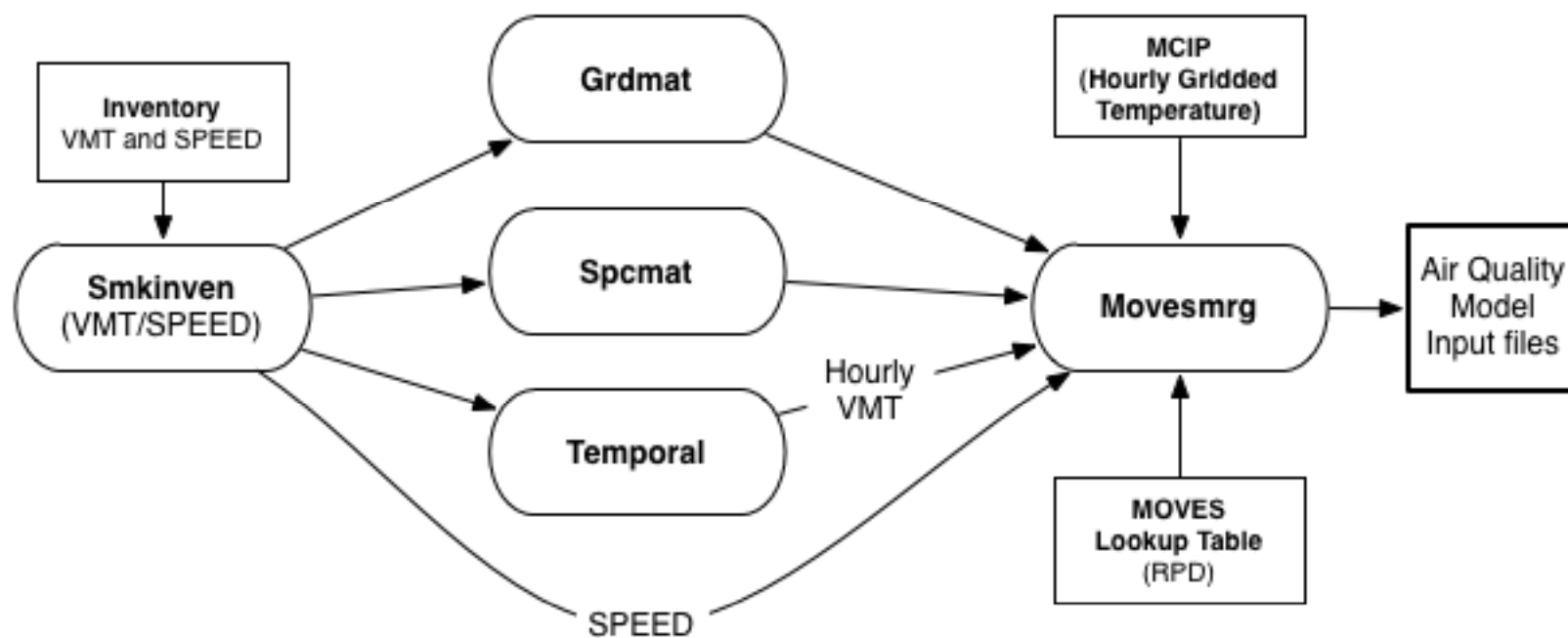
SMOKE Modeling System

- RPD (grams/miles) : On-roadway Emission Process EFs
 - Lookup Fields: Average speed (optional 24-hr Speed profiles), Fuel month, and Temperature.
 - Running exhaust (EXR), crankcase running exhaust (CXR), brake wear (BRK), tire wear (TIR), on-road evaporative permeation (EVP), on-road evaporative fuel leaks (EFL), and on-road evaporative vapor venting (EFV).
- RPV (grams/vehicle/hour) : Off-network Emission Process EFs
 - Lookup Fields: Fuel month, Temperature, and Local time hourID.
 - Start exhaust (EXS), crankcase start exhaust (CXS), off-network evaporative permeation (EVP), off-network evaporative fuel leaks (EFL), extended idle exhaust (EXT), and crankcase extended idle exhaust (CEI)
- RPP (grams/vehicle/hour) : Off-network Vapor Venting EP EFs
 - Lookup Fields: Fuel month, Temperature, and Local time hourID.
 - Estimate emissions for off-network fuel vapor venting (EFV) when the vehicle is parked.
 - Includes diurnal (when the vehicle is parked during the day) and hot soak (immediately after a trip when the vehicle parks) emissions types.



SMOKE : On-roadway Processing (RPD)

On-roadway Emissions Processes





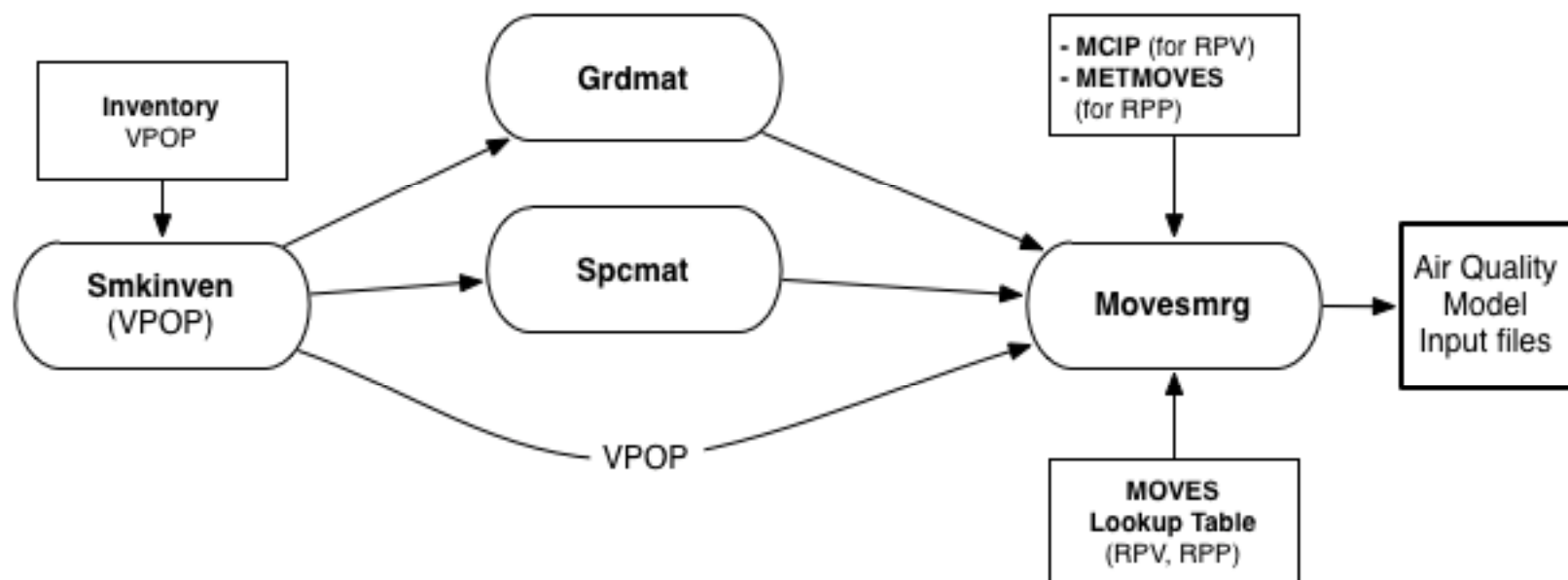
MOVESMRG: RPD

- RPD mode (grams/mile)
- Loop over reference county
- Stores EFs by SCC, speed bin, temperature value, process, and pollutant
- Estimates emissions hourly emissions for every grid cell in the domain using hourly gridded MCIP files
- Emissions = EF * hourly VMT * Grid cell fraction * Speciation fraction



SMOKE : Off-network Processing (RPV,RPP)

Off-network Emissions Processes





MOVESMRG : RPV and RPP

- RPV mode : Store EFs by weekday/weekend, SCC, local hour, temperature value, process, and pollutant
- RPP mode : Store EFs by weekday/weekend, SCC, local hour, temperature profile, process, and pollutant
- RPV estimates hourly emissions for every grid cell in the domain using hourly gridded MCIP files
- RPP estimates emissions using appropriate temperature profile interpolation factors based on **Met4Moves** output file.
- Emissions = EF * Vehicle populations * Grid cell fraction * Speciation fraction



Final Merging

- Run 3 times (**Onroad-RPD, Offroad-RPV, Offroad-RPP**)
- RPD, RPV are running for every day using hourly gridded MCIP files
- RPP are running for average day (one day per month) using averaged meteorological output file from Met4Moves
- Computation time is a function of number of sources, size of grid cell, and domain
- **Two reference counties in GA and 43*32 grid cells**
RPD : 4-5 min/day, RPV : 2-3 min/day, RPP : 1 min/day



Future Enhancements

- Supporting weekday/weekend hourly speed profiles for RPD [ongoing]
- Create various types of QA reports from Movesmrg
 - County-SCC, Non-speciated reports
- Integrations with Smkreport (SMOKE QA program)
- National scale annual VMT, Speed, Vehicle population inventory development
- Updating Emission Processing Input Data
 - Chemical speciation profiles and cross-reference input files
 - Temporal profiles and cross-reference files
 - Surrogates