

ASSESSMENT OF IMPORTANT **SPECIATE** PROFILES IN EPA'S EMISSIONS MODELING PLATFORM

CASEY D. BRAY, MADELEINE STRUM, HEATHER SIMON, LEE RIDDICK, MIKE KOSUSKO, VENKATESH RAO

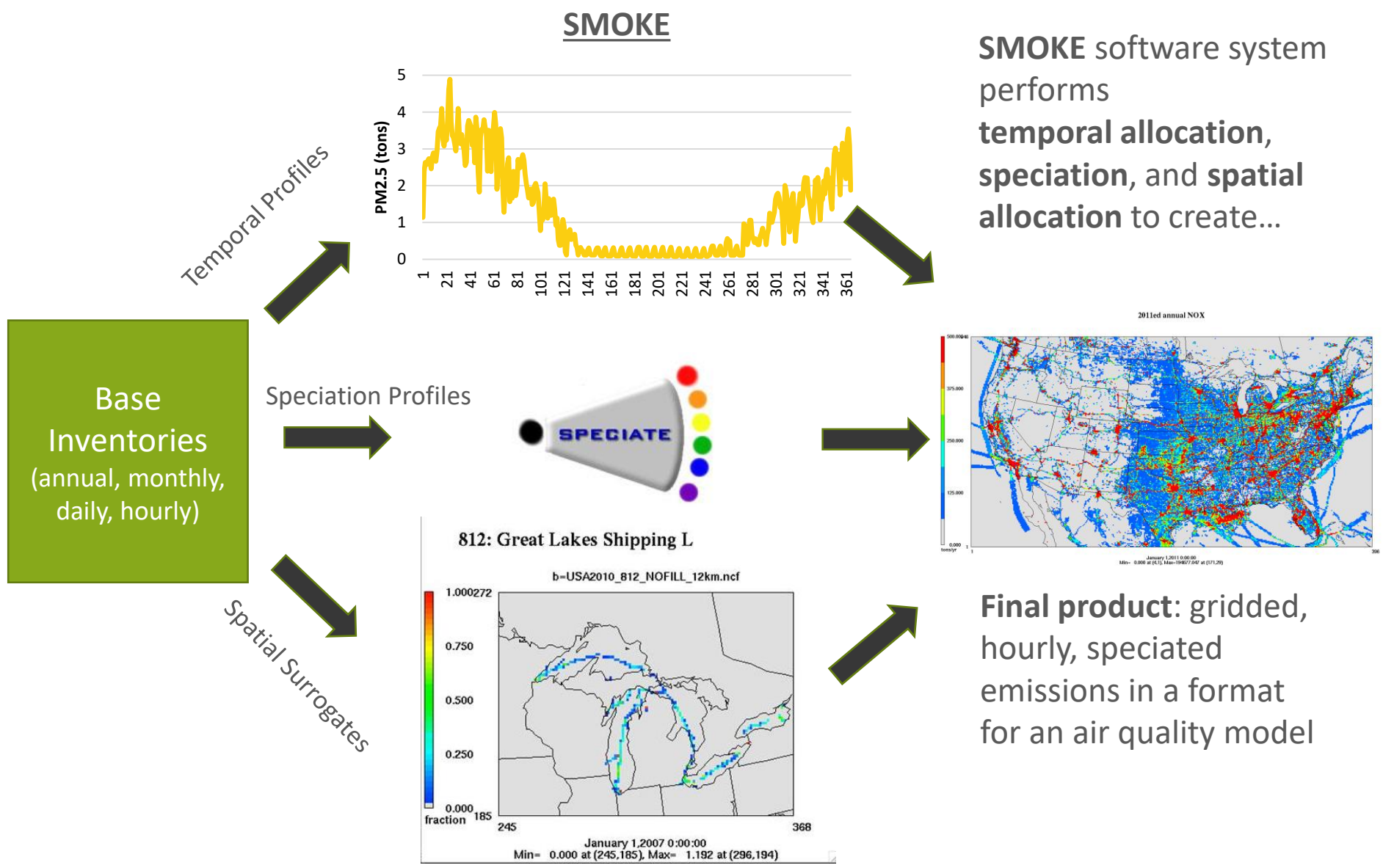
OVERVIEW

- What is SPECIATE?
- Why do we care?
- Project goals
- Steps so far
- Results
- Conclusions
- Future work

SPECIATE

- Database containing the speciation profiles from specific emissions source types for both volatile organic compounds (VOCs) as well as particulate matter (PM) emission sources. Includes fields specifying:
  - Emission source category
  - Weight fractions of PM/VOC chemical species
  - Test methods
  - Test year
  - Reference
  - etc
- Used for policy planning and research purposes

SPECIATE AS PART OF EMISSIONS MODELING



SMOKE software system performs **temporal allocation**, **speciation**, and **spatial allocation** to create…

Final product: gridded, hourly, speciated emissions in a format for an air quality model

- Total VOC and $PM_{2.5}$ need to be speciated into chemical components for photochemical modeling
- Each speciation profile is cross-referenced to an inventory source by SCC, pollutant, and potentially by region
- SCC-to-profile mapping is specific to the EPA modeling platform and is separate from the SPECIATE database itself
- Thousands of SCCS in the NEI are mapped to a few hundred profiles
- Onroad mobile source emissions species come directly from the EPA MOVES model

WHY WE CARE

$PM_{2.5}$

- Health impacts
  - Decreased lung function, asthma, irregular heart beat, heart attacks and even death in people with heart or lung disease
- Environmental impacts
  - Reduced visibility, acidification, depleting nutrients in soil, corrosion of metal, erosion of buildings/sculptures, etc.
- SPECIATE helps estimate black carbon – short term climate forcer

VOCS

- Health impacts
  - Irritation of the eyes, nose and throat, headaches, loss of coordination, nausea, damage to the liver, kidneys and central nervous system, visual disorders, visual impairment and some VOCs can even cause cancer
- Precursor for ozone
  - Ozone associated with number of health and environmental impacts

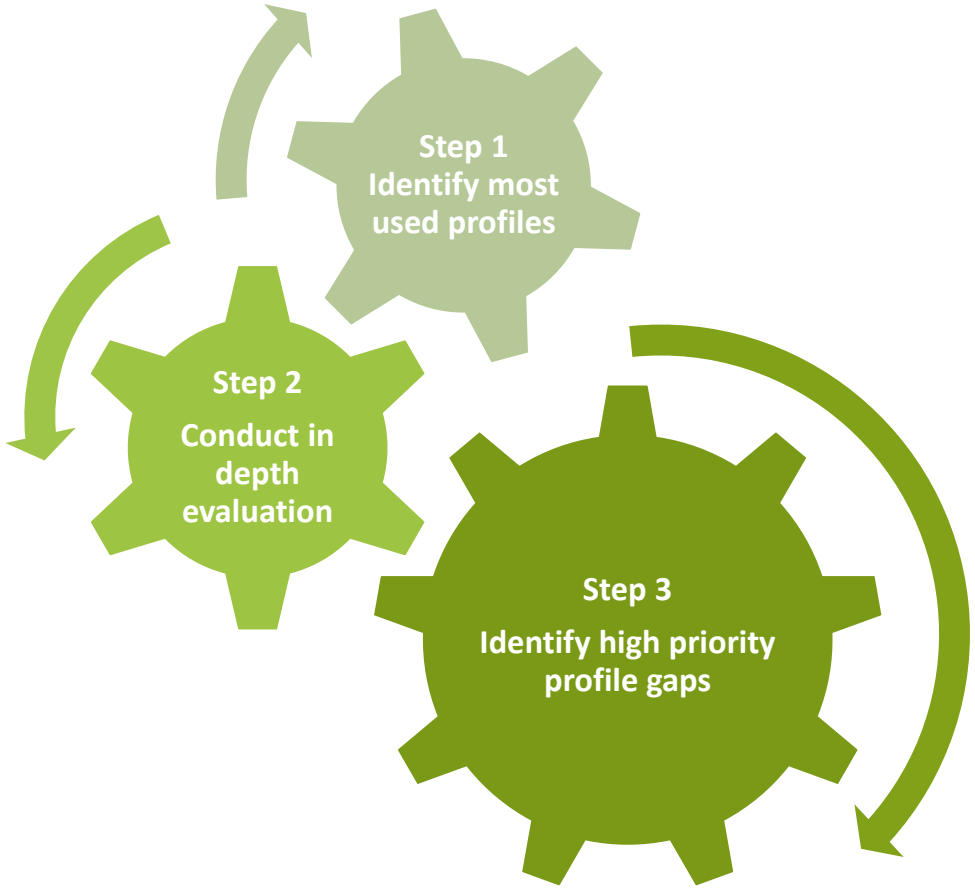
GOALS OF PROJECT

- **Objective:** Needs assessment to determine where the greatest need for new and/or improved emission profiles is

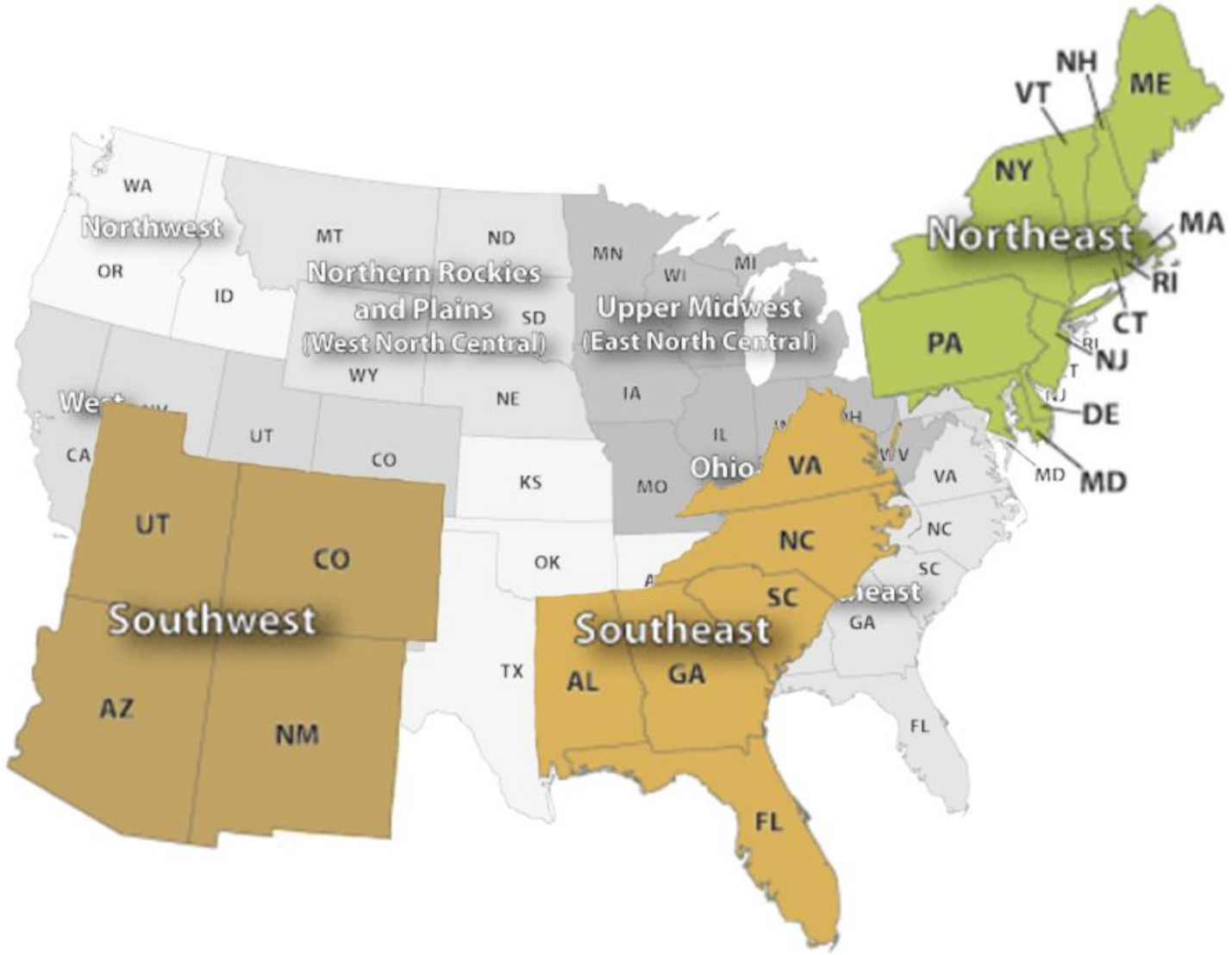
- 3 major goals:
  - **1. To determine the key profiles that are being used within the EPA 2014 modeling platform**
  - 2. To prioritize the running list of papers and reports that have been identified but not yet added to SPECIATE
  - 3. To identify gaps in the current literature in order to direct research groups, both within the EPA and external groups, to measure speciation from sources that will be the most beneficial to the US EPA's modeling and policy efforts.

STEPS SO FAR

- Step 1: Identify most used profiles
  - Ranked profiles by total mass assigned in EPA's most recent 2014 modeling platform
- Step 2: Conduct in depth evaluation
  - **Profile analysis criteria:** Top 90% of PM emissions (by mass) and top 65% of VOC emissions (by mass)
  - Further examinations:
    - Quality of profile
    - Age of profile
    - Appropriateness of profile
    - Region
- Step 3: Identify high priority profile gaps

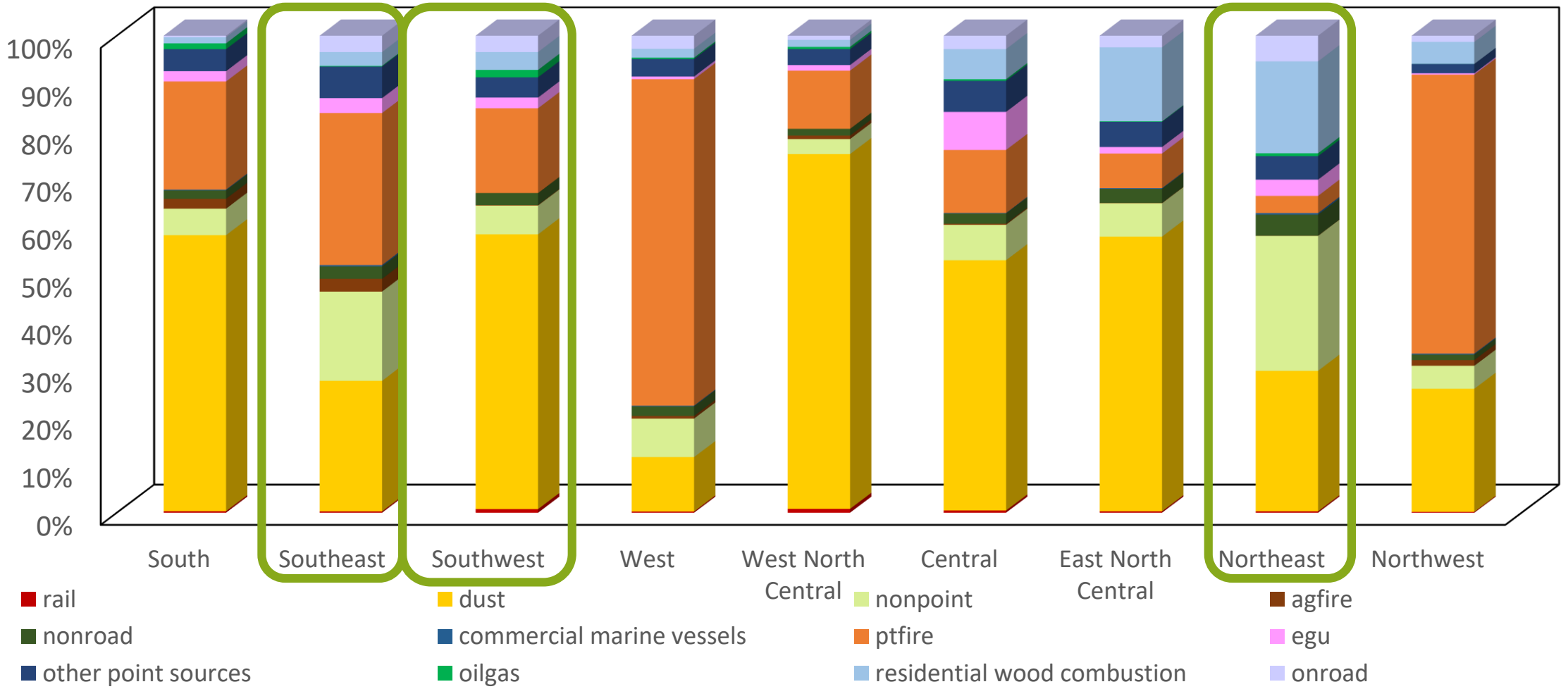


REGIONS

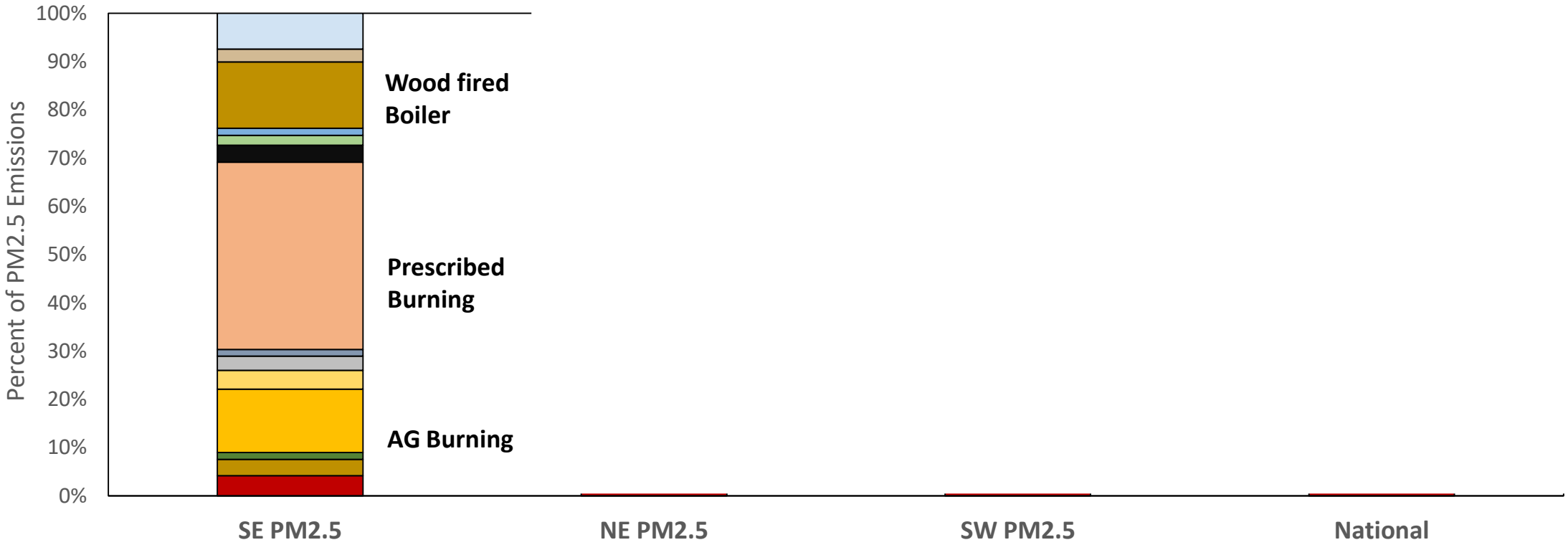


Source: NOAA

MAJOR $PM_{2.5}$ SECTORS

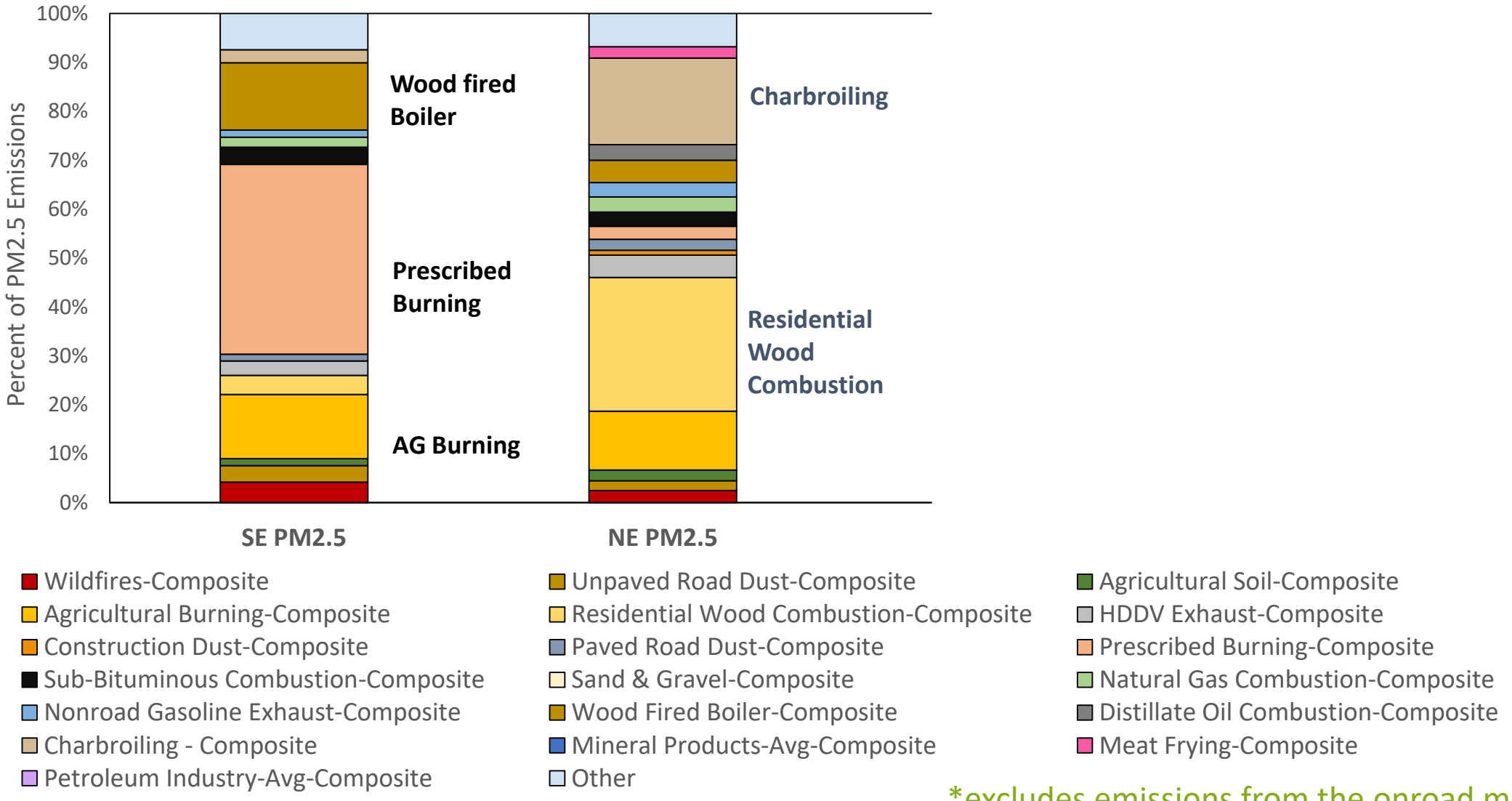


MAJOR $PM_{2.5}$ PROFILES (% OF MASS ASSIGNED IN 2014 EPA MODELING PLATFORM)*



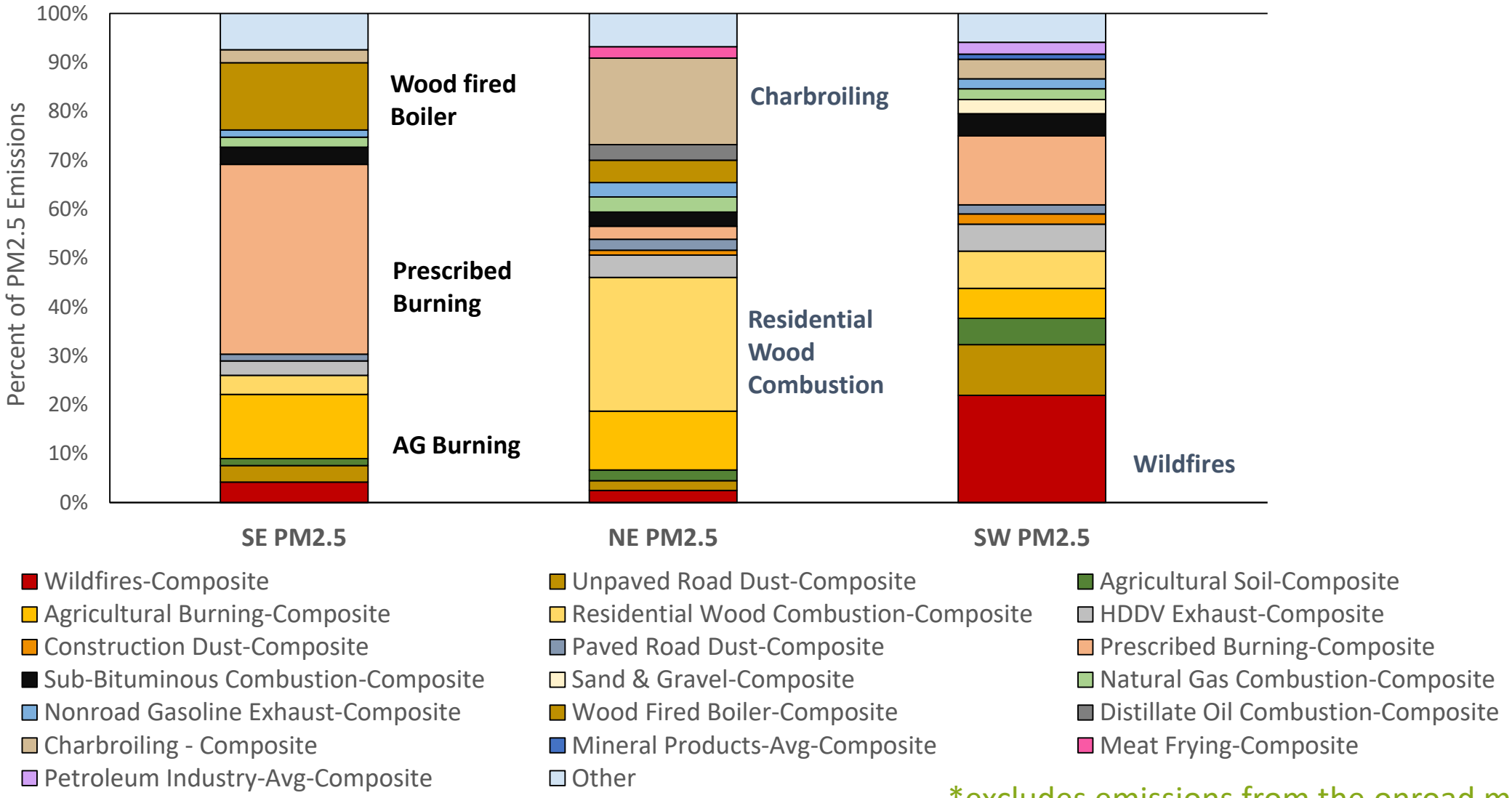
*excludes emissions from the onroad mobile sector

MAJOR $PM_{2.5}$ PROFILES (% OF MASS ASSIGNED IN 2014 EPA MODELING PLATFORM)*



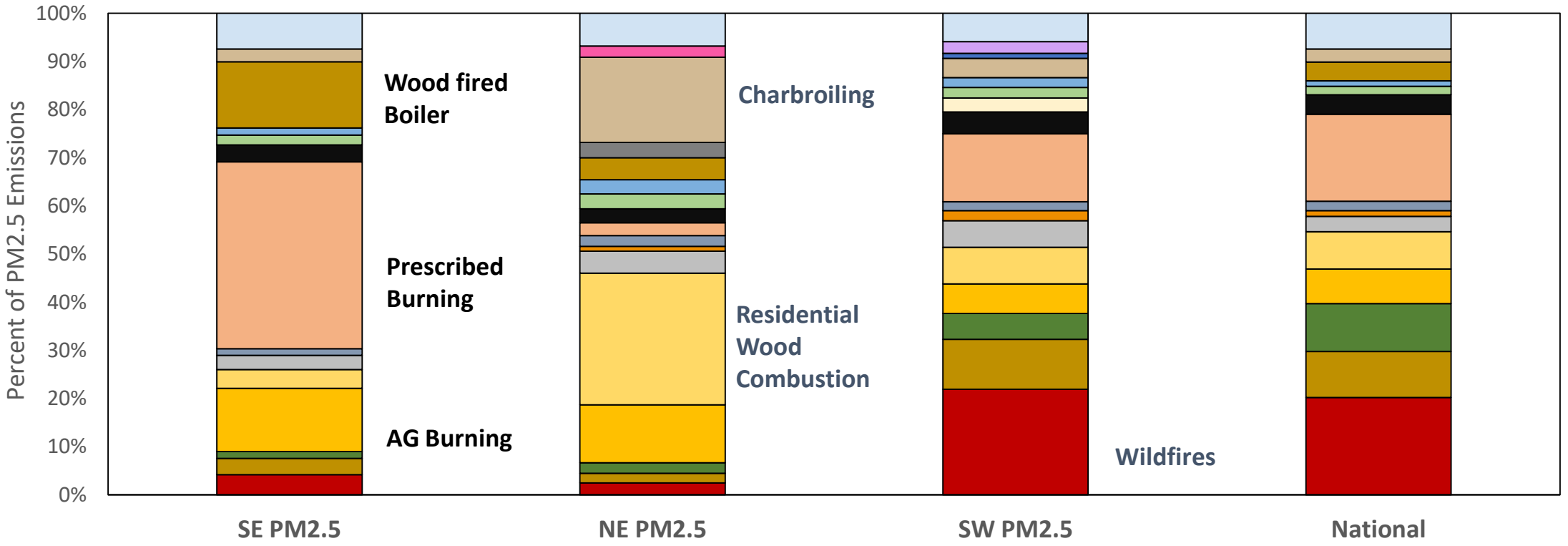
*excludes emissions from the onroad mobile sector

MAJOR $PM_{2.5}$ PROFILES (% OF MASS ASSIGNED IN 2014 EPA MODELING PLATFORM)*



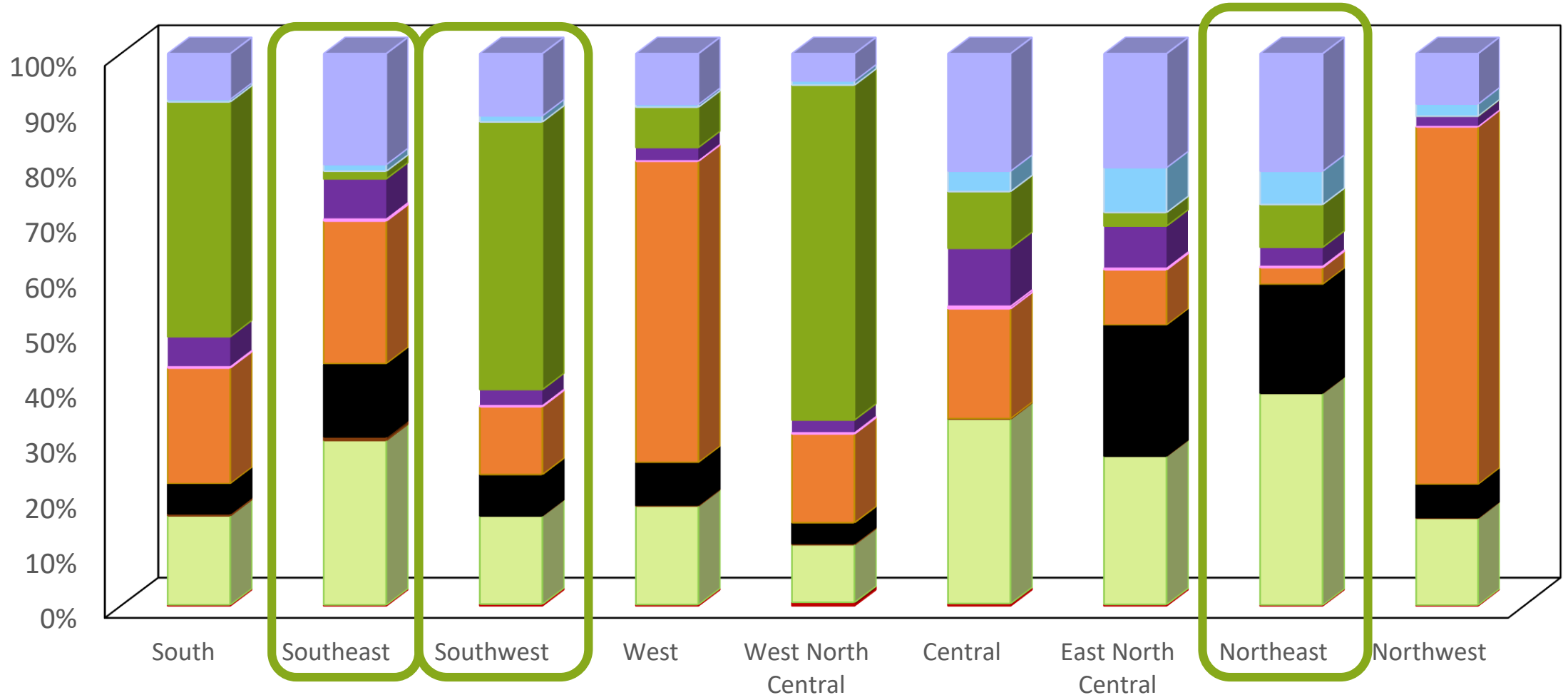
*excludes emissions from the onroad mobile sector

MAJOR $PM_{2.5}$ PROFILES (% OF MASS ASSIGNED IN 2014 EPA MODELING PLATFORM)*



*excludes emissions from the onroad mobile sector

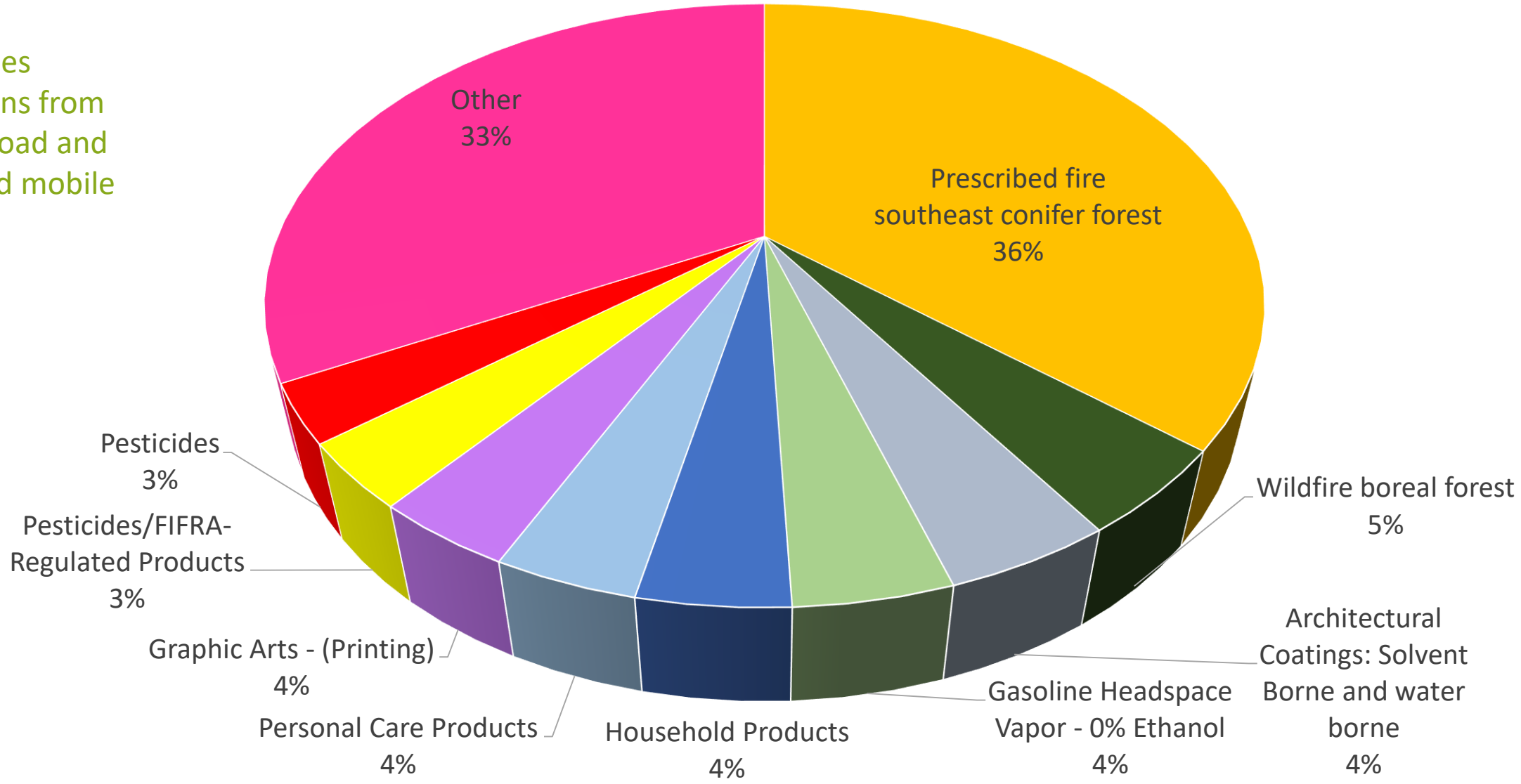
MAJOR VOC SECTORS



SE VOC PROFILES*

(1,493,173 tons/year)

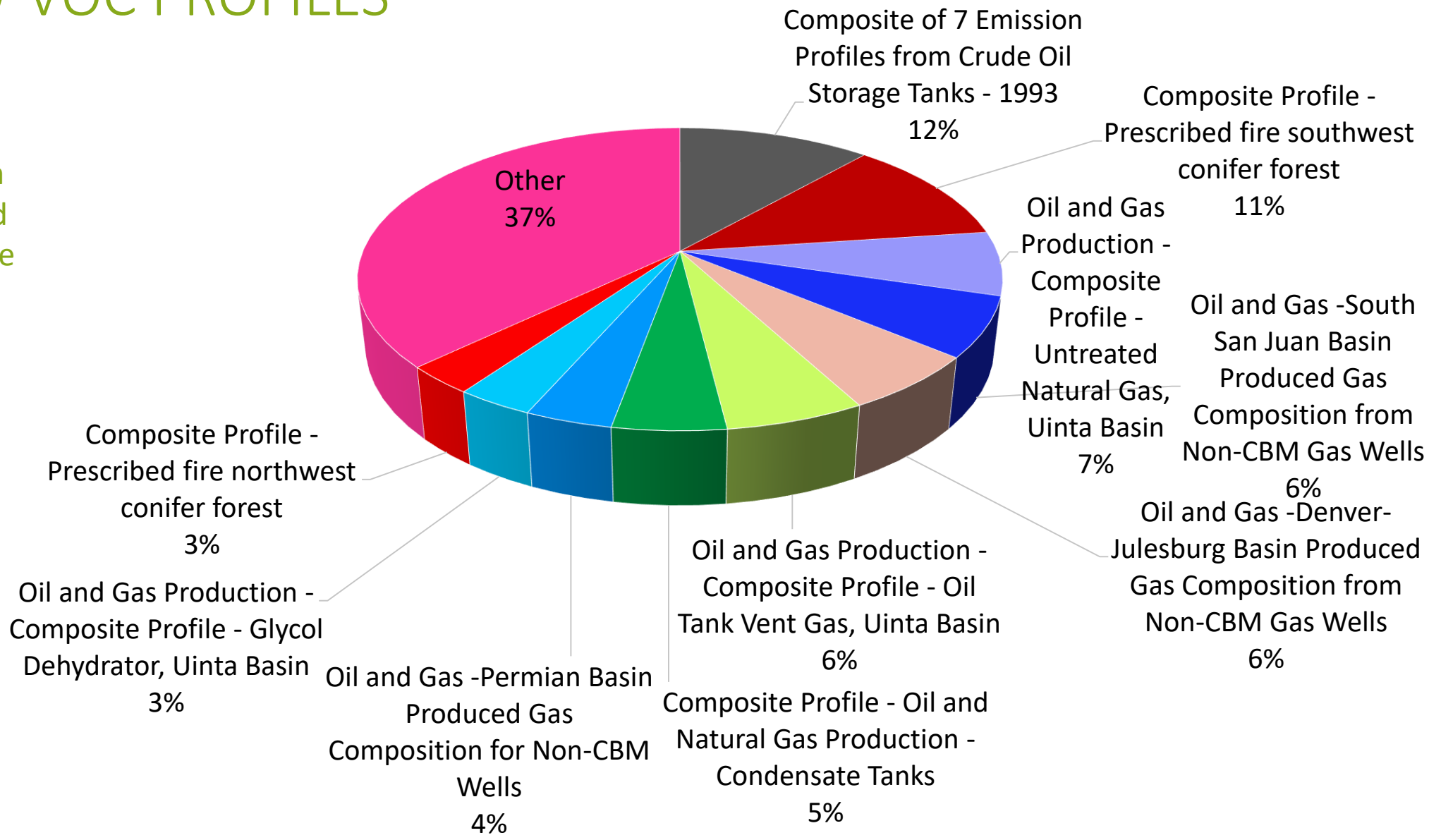
*excludes emissions from the onroad and nonroad mobile sectors



SW VOC PROFILES*

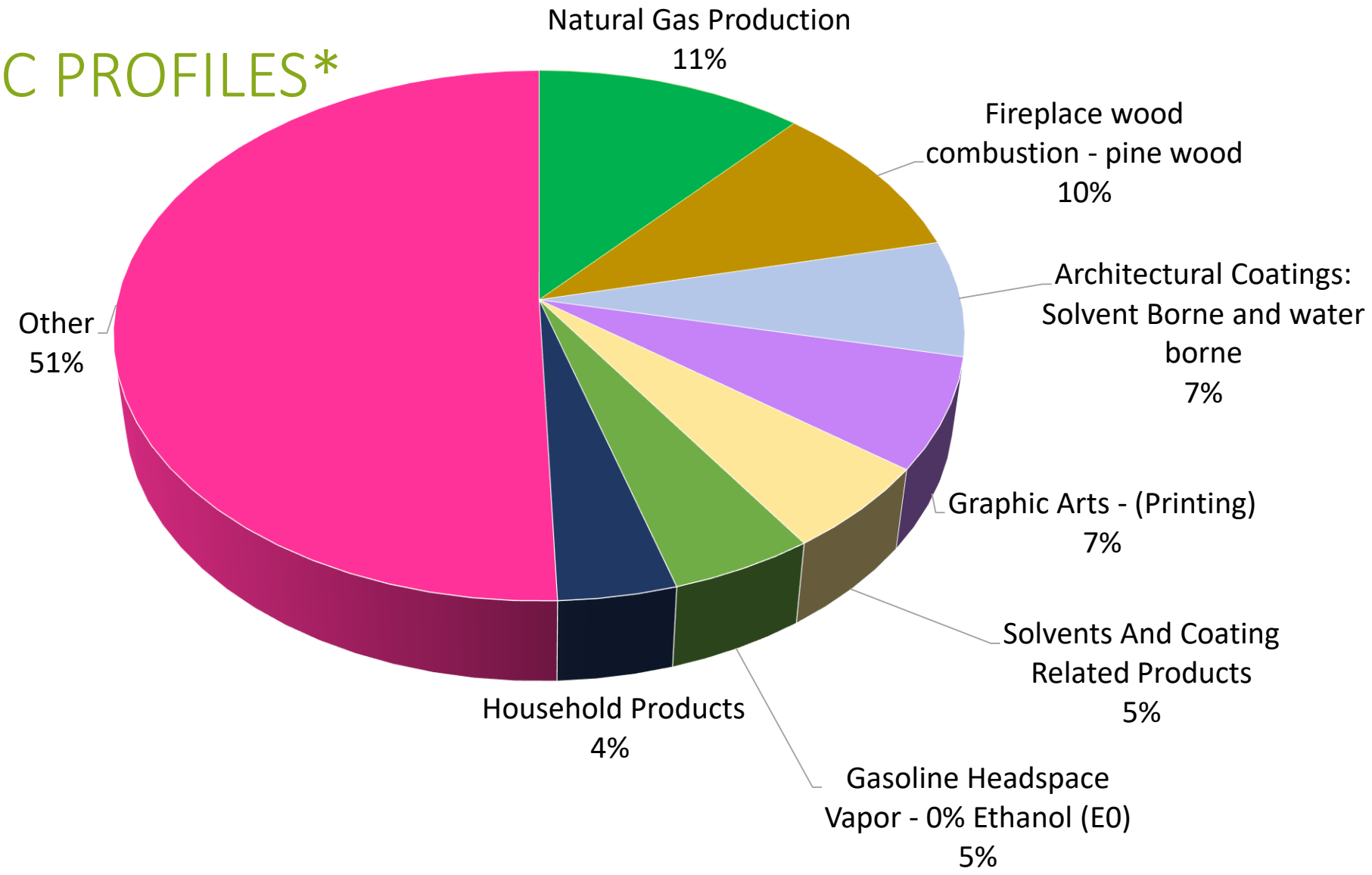
(953,352 tons/year)

*excludes emissions from the onroad and nonroad mobile sectors



NE VOC PROFILES*

(823,885 tons/year)

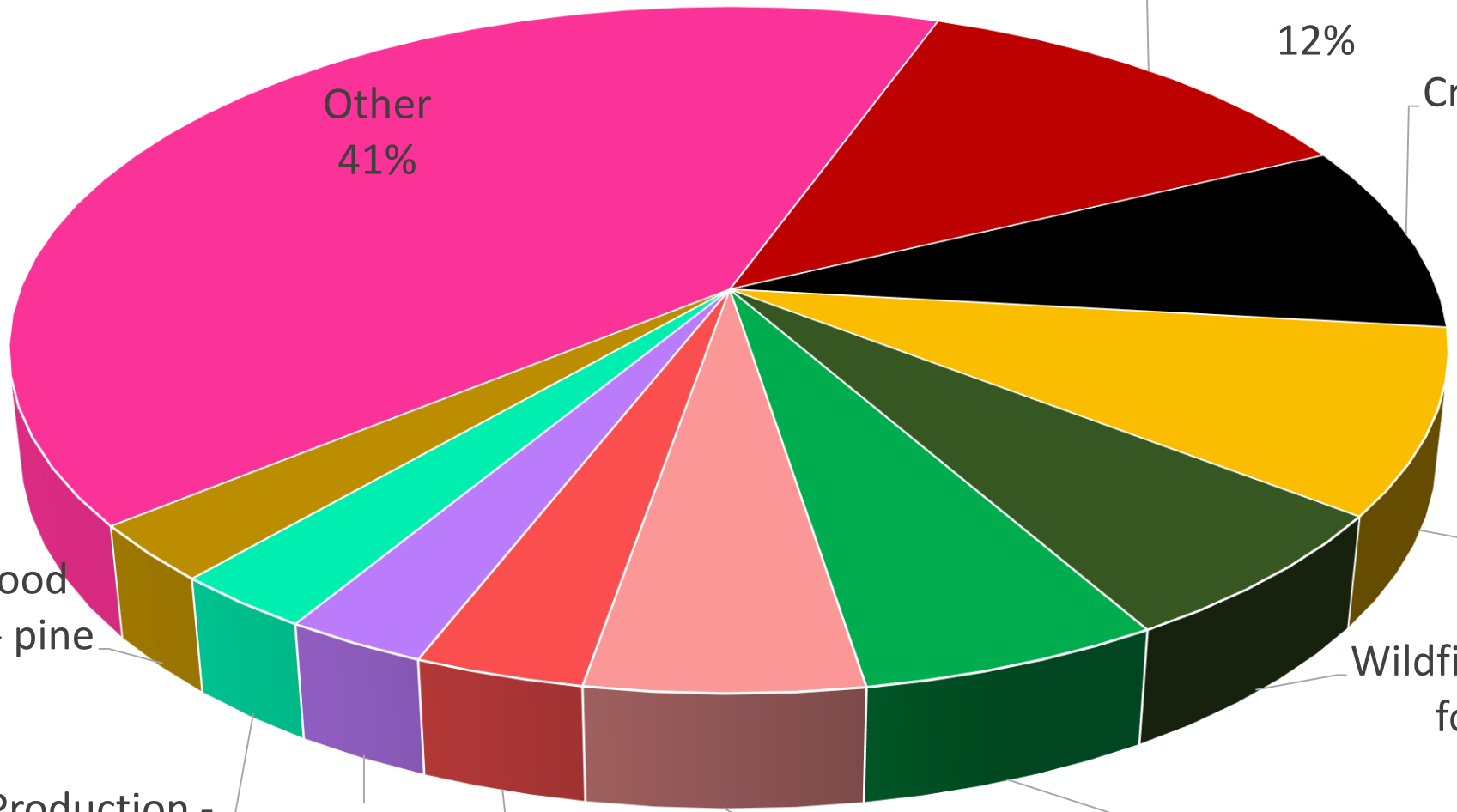


*excludes emissions from the onroad and nonroad mobile sectors

NATIONAL VOC PROFILES*

(112,324,887 tons/year)

*excludes emissions from the onroad and nonroad mobile sectors



PRIORITIZATION OF PROFILES

- Need to assess the quality and appropriateness of profiles
- Criteria assessed:
  - Age
  - Reliability of reference
  - Study region versus profile region
  - SCCs to which profile is applied (appropriateness, match in specificity)
  - Prevalence of profile in the EPA modeling platform
  - Any notes on the profile
- Those criteria were then assigned point values and used to create priority rankings for $PM_{2.5}$ and VOC source profiles in need of updates

PROFILE PRIORITIZATION RANKING SYSTEM

Criteria		Points assigned
Age	Old	1
	New	0
Reliability of Reference	Low	2
	Med	1
	High	0
SCC issue?	No	0
	Minor	1
	Major	2
% Weight	>12%	4
	8-12%	3
	4-8%	2
	<4%	1
Error in data?	No	0
	Yes	2
Study region applicable?	Yes	0
	No	1

EXAMPLE OF A LOW PRIORITY NEED

- **Profile:** Composite Profile – Prescribed fire southwest conifer forest
- **Species:** VOC
- **Year:** 2010
- **Test Method:** Both in-situ and lab measurements
- **Control Methods:** Uncontrolled
- **QA:** Peer reviewed
- **SCCs:** OK
- **Reference:** Urbanski et al., 2010
- **Weight:**
  - NE: -%
  - SE: -%
  - SW: 10%
  - **NAT: 11%**

Criteria		Points assigned	This Profile
Age	Yes	1	
	No	0	X
Reliability of Reference	Low	2	
	Med	1	
	High	0	X
SCC issue?	No	0	
	Minor	1	X
	Major	2	
% Weight	>12%	4	
	8-12%	3	X
	4-8%	2	
	<4%	1	
Error in data?	No	0	X
	Yes	2	
Study region applicable?	Yes	0	X
	No	1	

Total Score: 4


Fulton
Fulton

PRIORITY RANKING FOR PM2.5 SOURCE PROFILES IN NEED OF UPDATES

Profile	Profile Name	Score	Ranking
91102	**Wildfires - Composite**	**9**	**1**
91103	**Agricultural Burning - Composite**	**9**	**1**
91106	HDDV Exhaust - Composite	8	2
91110	Sub-Bituminous Combustion - Composite	7	3
91113	Nonroad Gasoline Exhaust - Composite	7	3
91109	Prescribed Burning - Composite	7	3
91101	Agricultural Soil - Composite	6	4
91112	Natural Gas Combustion - Composite	5	5
91108	Paved Road Dust - Composite	4	6
91100	Unpaved Road Dust - Composite	4	6
91105	Residential Wood Combustion – Composite	3	7
91116	Charbroiling – Composite	3	7

PRIORITY RANKING FOR PM2.5 SOURCE PROFILES IN NEED OF UPDATES

Profile	Profile Name		
91102	**Wildfires - Composite**		
91103	**Agricultural Burning - Composite**		
91106	HDDV Exhaust - Composite		
91110	Sub-Bituminous Combustion - Composite		
91113	Nonroad Gasoline Exhaust - Composite		
91109	Prescribed Burning - Composite		
91101	Agricultural Soil - Composite		
91112	Natural Gas Combustion - Composite		
91108	Paved Road Dust - Composite	4	6
91100	Unpaved Road Dust - Composite	4	6
91105	Residential Wood Combustion – Composite	3	7
91116	Charbroiling – Composite	3	7

- One study included fencepost profiles – not representative of wildfire
- Single profile currently being used for all wildfire and prescribed fire emissions including:
  - Flaming and smoldering
  - Fires in all regions of the country despite varying fuel types

PRIORITY RANKING FOR PM2.5 SOURCE PROFILES IN NEED OF UPDATES

Profile	Profile Name		
91102	**Wildfires - Composite**		
91103	**Agricultural Burning - Composite**		
91106	HDDV Exhaust - Composite		
91110	Sub-Bituminous Combustion - Composite		
91113	Nonroad Gasoline Exhaust - Composite		
91109	Prescribed Burning - Composite		
91101	Agricultural Soil - Composite		
91112	Natural Gas Combustion - Composite		
91108	Paved Road Dust - Composite		
91100	Unpaved Road Dust - Composite	4	6
91105	Residential Wood Combustion – Composite	3	7
91116	Charbroiling – Composite	3	7

- Old profiles used in composite
- Only representative of crops in the west – regional profiles may be better for this profile
- SCCs cover more than just agricultural burning (i.e. open burning)

PRIORITY RANKING FOR VOC SOURCE PROFILES IN NEED OF UPDATES

Profile	Name	Total	Rank
121	**Open Burning Dump - Landscape/Pruning**	**6**	**1**
4642	Fireplace wood combustion - pine wood	5	2
2487	Composite of 7 Emission Profiles from Crude Oil Storage Tanks - 1993	5	2
8949	Natural Gas Production	5	2
95421	Composite Profile - Prescribed fire southeast conifer forest	5	2
3145	Consumer Products Composite: Pesticides/FIFRA-Regulated Products	4	3
3146	Consumer Products Composite: Household Products	4	3
3147	Consumer Products Composite: Personal Care Products	4	3
95425	Composite Profile - Wildfire boreal forest	4	3
95422	Composite Profile - Prescribed fire southwest conifer forest	4	3
1191	Graphic Arts - (Printing)	3	4

PRIORITY RANKING FOR VOC SOURCE PROFILES IN NEED OF UPDATES

Profile	Name		
121	**Open Burning Dump - Landscape/Pruning**		
4642	Fireplace wood combustion - pine wood		
2487	Composite of 7 Emission Profiles from Crude Oil Storage Tanks - 1		
8949	Natural Gas Production		
95421	Composite Profile - Prescribed fire southeast conifer forest		
3145	Consumer Products Composite: Pesticides/FIFRA-Regulated Prod		
3146	Consumer Products Composite: Household Products		
3147	Consumer Products Composite: Personal Care Products	4	3
95425	Composite Profile - Wildfire boreal forest	4	3
95422	Composite Profile - Prescribed fire southwest conifer forest	4	3
1191	Graphic Arts - (Printing)	3	4

- This profile based on open burning of vegetative debris is being used for trash burning and other SCCs
- Old profile (circa 1970s)
- Likely an estimated profile – not based on actual measurements

PRIORITY RANKING FOR VOC SOURCE PROFILES IN NEED OF UPDATES

Profile	Name	Total	Rank
121	**Open Burning Dump - Landscape/Pruning**	**6**	**1**
4642	Fireplace wood combustion - pine wood	5	2
2487	Composite of 7 Emission Profiles from Crude Oil Storage Tanks - 1993		
8949	Natural Gas Production		
95421	Composite Profile - Prescribed fire southeast conifer forest		
3145	Consumer Products Composite: Pesticides/FIFRA-Regulated Products		
3146	Consumer Products Composite: Household Products		
3147	Consumer Products Composite: Personal Care Products		
95425	Composite Profile - Wildfire boreal forest		
95422	Composite Profile - Prescribed fire southwest conifer forest		
1191	Graphic Arts - (Printing)		

- Consumer products profiles are based on a 1997 survey from CARB
- Composition of products in California may not be representative for other regions of the US (California specific regulations)
- Product composition may have changed in the last 20 years (new regulations and technology)

PRIORITY RANKING FOR VOC SOURCE PROFILES IN NEED OF UPDATES

Profile	Name		nk
121	**Open Burning Dump - Landscape/Pruning**		
4642	Fireplace wood combustion - pine wood		
2487	Composite of 7 Emission Profiles from Crude Oil Storage Tanks -		
8949	Natural Gas Production		
95421	Composite Profile - Prescribed fire southeast conifer forest		
3145	Consumer Products Composite: Pesticides/FIFRA-Regulated Proc		
3146	Consumer Products Composite: Household Products		
3147	Consumer Products Composite: Personal Care Products		
95425	Composite Profile - Wildfire boreal forest		
95422	Composite Profile - Prescribed fire southwest conifer forest	4	3
1191	Graphic Arts - (Printing)	3	4

- Old profile
- Specific for pine, but SCCs not specific for pine
- Measurement region not necessarily a good representation for country

CONCLUSIONS

- The most used $PM_{2.5}$ profiles (on a mass basis) include road dust (paved, unpaved), fires (prescribed, wild), combustion (natural gas, coal, wood), nonroad gasoline exhaust and charbroiling
- The most used VOC profiles (on a mass basis) are much more diverse – graphic arts, open burning, gasoline vapor, spark ignition exhaust, consumer care products (i.e. personal care products, pesticides, household products, ect.)
- Many of the profiles used for both $PM_{2.5}$ and VOC are derived from fairly old measurements and are not applied to the appropriate SCCs
- Highest priority profiles for $PM_{2.5}$ are wildfires and agricultural burning
- Highest priority profile for VOC is open burning dump – landscape/pruning

FUTURE DIRECTIONS

- Expand study regions to each NOAA Climate region and conduct analysis again
- Add VOC reactivity analysis
- For each region, continue project:
  - Step 4: Determining if there are existing SPECIATE profiles added to SPECIATE versions after SPECIATE4.0 that may be better than what is currently being used or if a composite of existing SPECIATE profiles be better
  - Step 5: Browse the current literature, including the existing reference list, to identify existing profiles that could satisfy needs identified in step 3 and recommend that those receive high priority for inclusion into SPECIATE.
  - Step 6: Communicate with ORD and external research community (journal article/presentations at conference, etc.) about high-priority sources for which no appropriate profiles exist in the literature.

JUST KIDDING – ASK AWAY☺

CONTACT INFO:

Bray.casey@epa.gov

ACKNOWLEDGEMENTS

SPECIATE WORK GROUP, NEI MODELING GROUP, OAQPS MPG, ACE PROGRAM,

NC STATE AIR QUALITY RESEARCH GROUP