GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Development of 2014 Georgia Wildland Fire Emission Inventory

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2017 International Emissions Inventory Conference
Baltimore, MD
August 18, 2017

OUTLINE

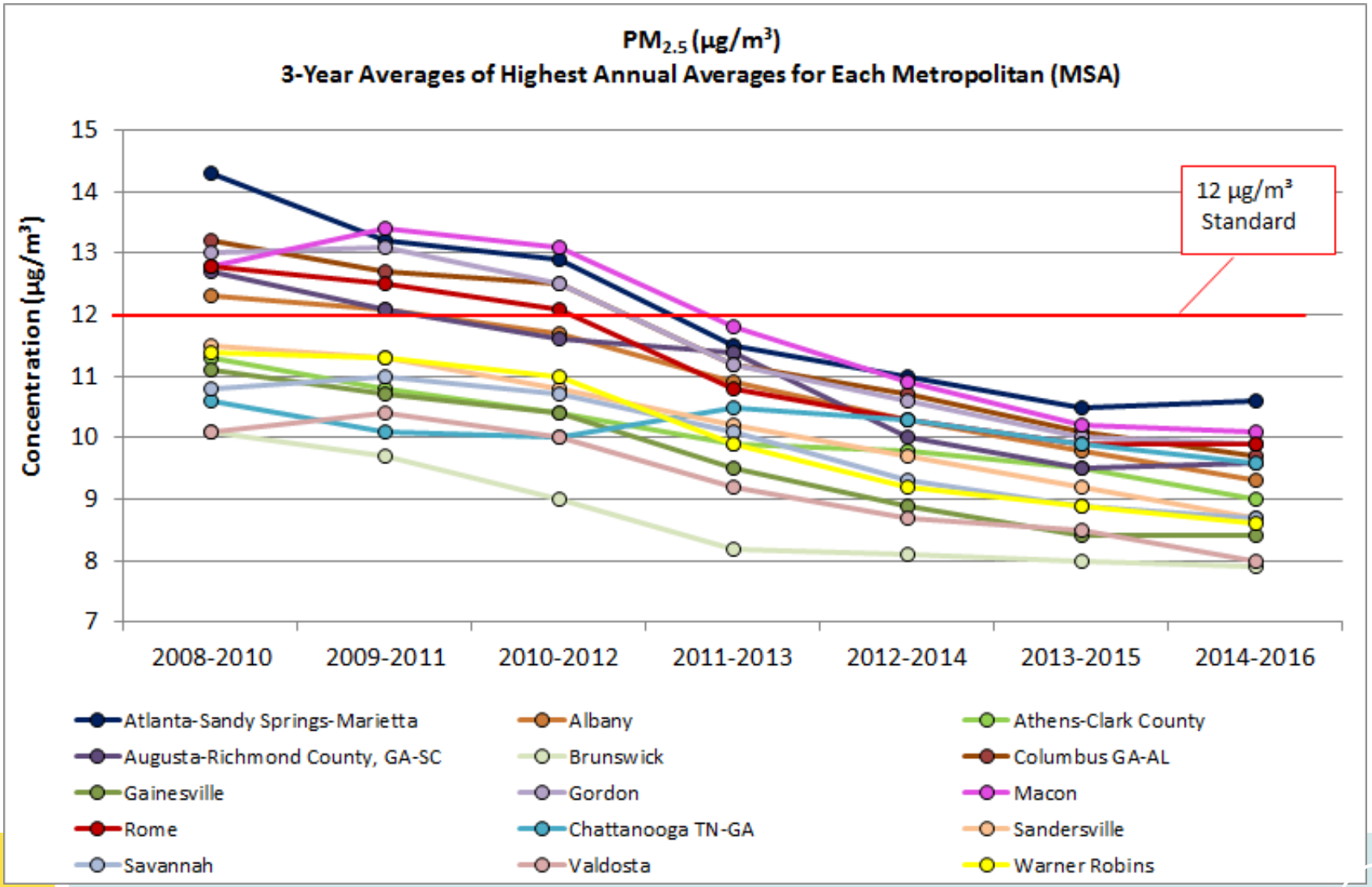
1. Wildland fires in Georgia and their impacts on air quality
2. Develop Georgia EPD's 2014 wildland fire inventory
3. Review EPA's 2014 National wildland fire Inventory
4. Future improvement plan
5. Summary

1. WILDLAND FIRES IN GEORGIA AND THEIR IMPACTS ON AIR QUALITY

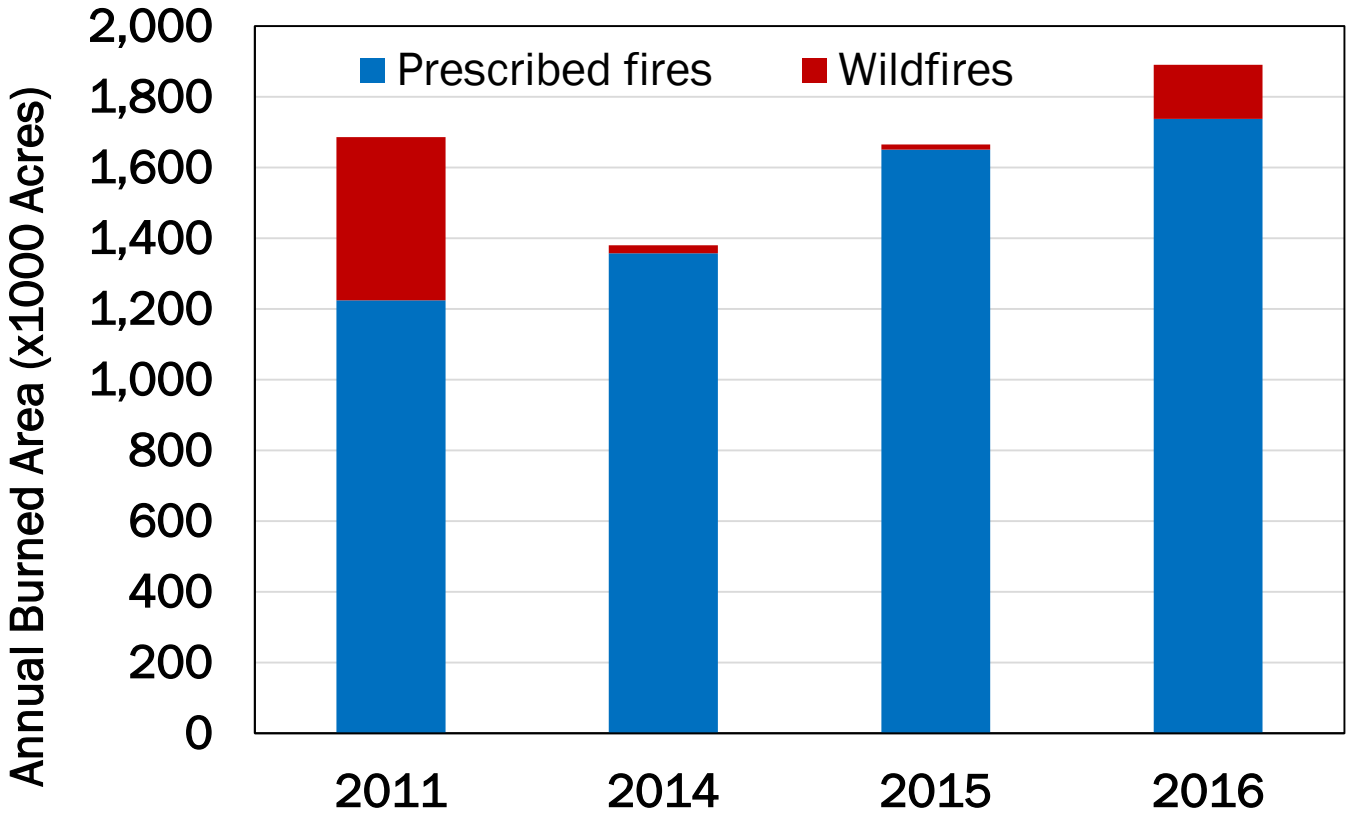
WILDLAND FIRES AND AIR QUALITY IN GEORGIA

- The long-term trend of $PM_{2.5}$ concentrations in Georgia is decreasing.
- The wildland fire activity in Georgia is increasing.
- Emissions from wildland fires are high in Georgia.
- Episodic $PM_{2.5}$ NAAQS exceedances events due to 2016 wildfires in Northern Georgia.
- Small prescribed fires can cause ozone exceedance in nearby monitors.

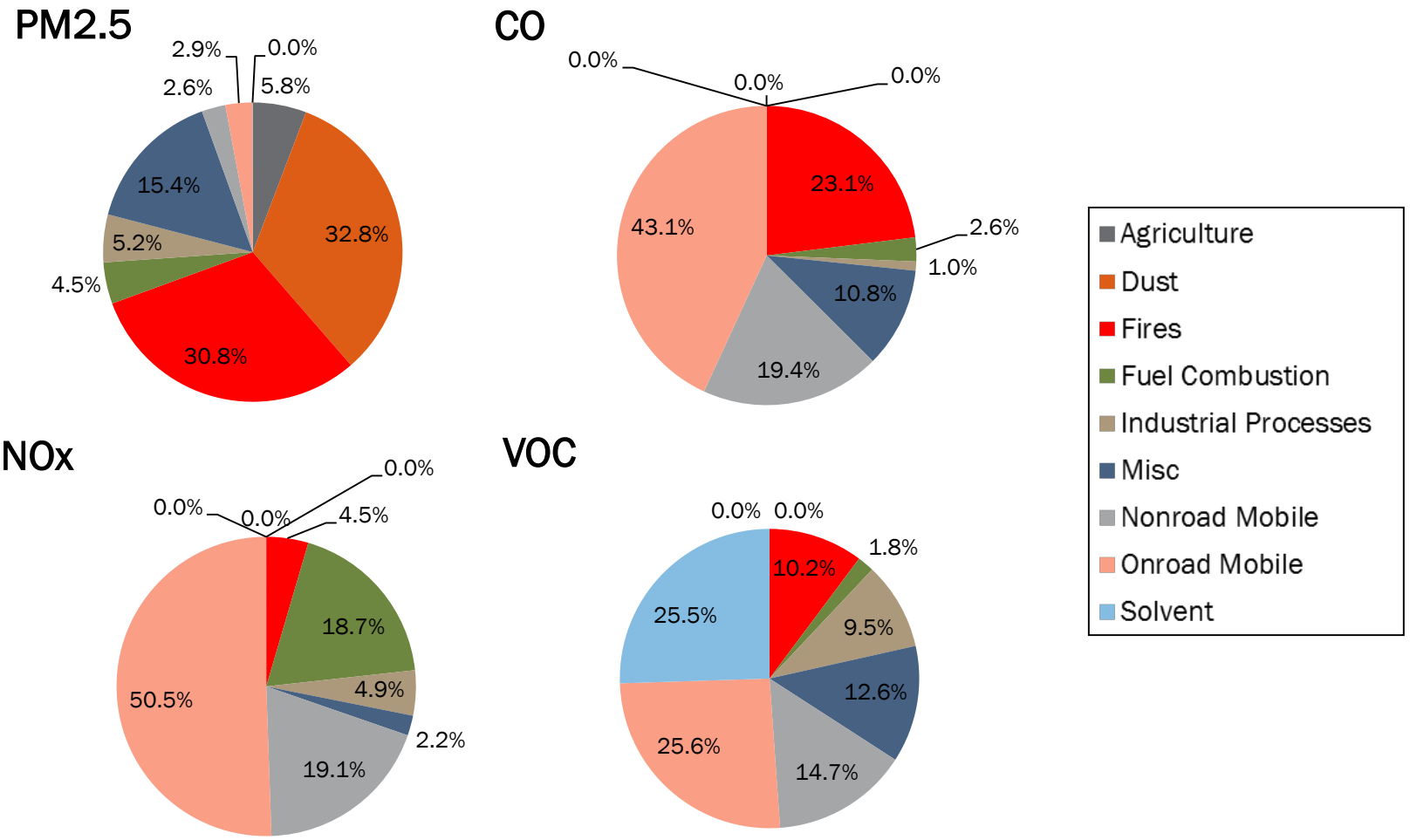
ANNUAL $PM_{2.5}$ DESIGN VALUE TRENDS



BURN ACRES IN GEORGIA



ANTHROPOGENIC EMISSIONS SUMMARIES (NEI2014 V1)



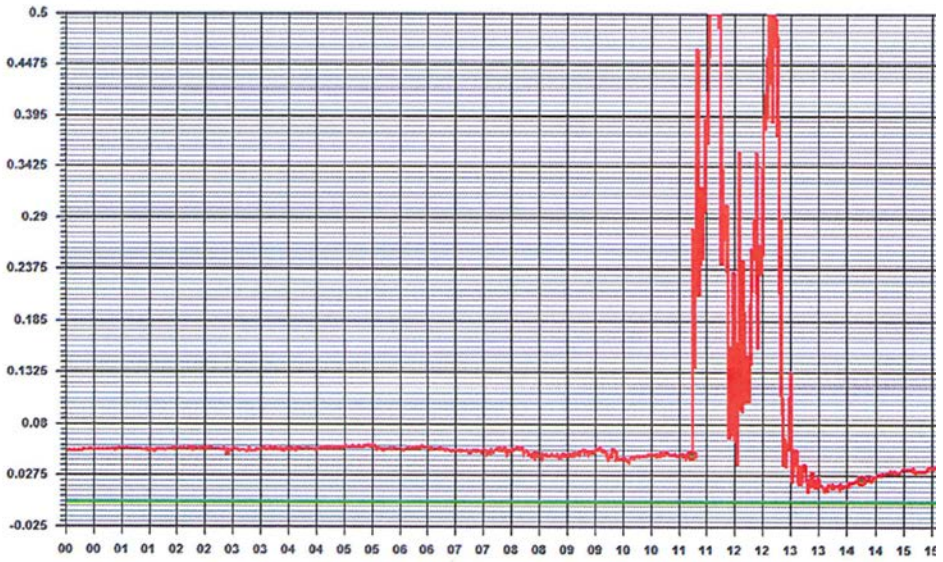
Fires have large contribution on PM2.5 (30.8%) and CO (23.1%), and small contributions on NOx (4.5%) and VOC (10.2%) in Georgia.

$PM_{2.5}$ MONITOR HITS (FRM)

AIRS	Monitor	County	Nov. 11	Nov. 12	Nov. 13	Nov. 14	Nov. 15	Nov. 16	Nov. 17	Nov. 18
13-021-0007	Macon-Allied	Bibb				**54.0**	**51.1**			
13-021-0012	Macon-Forestry	Bibb					**47.5**			
13-051-0091	Savannah-Mercer	Chatham						**51.4**		
13-059-0002	Athens	Clarke	**77.0**							
13-063-0091	Forest Park	Clayton				**53.3**				
13-067-0003	Kennesaw	Cobb				**51.1**				
13-089-0002	South DeKalb	DeKalb				**47.3**	**33.1**			
13-121-0039	Fire Station #8	Fulton				**53.2**				
13-121-0056	GA Tech Near Road	Fulton				**50.4**				
13-127-0006	Brunswick	Glynn						**36.8**	**46.7**	**34.2**
13-135-0002	Gwinnett Tech	Gwinnett				**54.1**				
13-139-0003	Gainesville	Hall	**48.5**			**62.9**				
13-153-0001	Warner Robins	Houston				**36.7**				
13-245-0091	Augusta	Richmond	**67.5**			**39.9**			**30.0**	
13-295-0002	Rossville	Walker				**84.3**				
13-303-0001	Sandersville	Washington				**37.3**				
13-319-0001	Gordon	Wilkinson				**55.5**				

Red bold values were flagged in AQS as possible exceptional events due to wildfires.

OZONE – FORT MOUNTAIN



- Prescribed fire (2 acres) on <u>April 24, 2015</u>
  - 8-hour daily maximum ozone concentration was 104 ppb
    - The next highest 8-hour ozone concentration at this site in 2015 was 67 ppb
  - Elevated 1-minute ozone concentrations (over 500 ppb) from 11:00 am to 1:00 pm
- Q/D = 0.174 tpd/km << 100 tpd/km
  - Emis_NOx: 0.0114 tons, Emis_VOC: 0.0151 tons, D = 0.15 km
  - Q/D > 100 tpd/km recommended by EPA to screen fire events with large air quality impacts in the "Guidance on the Preparation of Exceptional Events Demonstrations for Wildfire Events that May Influence Ozone Concentrations"

2. DEVELOP GEORGIA EPD'S 2014 WILDLAND FIRE INVENTORY

GEORGIA EPD WILDLAND FIRE EMISSION INVENTORY

Fire Emissions = Burned Area x Fuel Consumption x Emission Factor

- **Burned Area**
  - Ground Reports from Georgia Forestry Commission, military bases and federal agency
  - Share with EPA to support National Wildland Fire Inventory development (no satellite used for Georgia)
- **Fuel Consumption**
  - Fuel consumption table by fuel type developed during SEMAP project (including local knowledge for southeast)
- **Emission Factors**
  - Emission factor table by fuel type developed during SEMAP project (literature review)
  - EFs for air toxics are provided by EPA

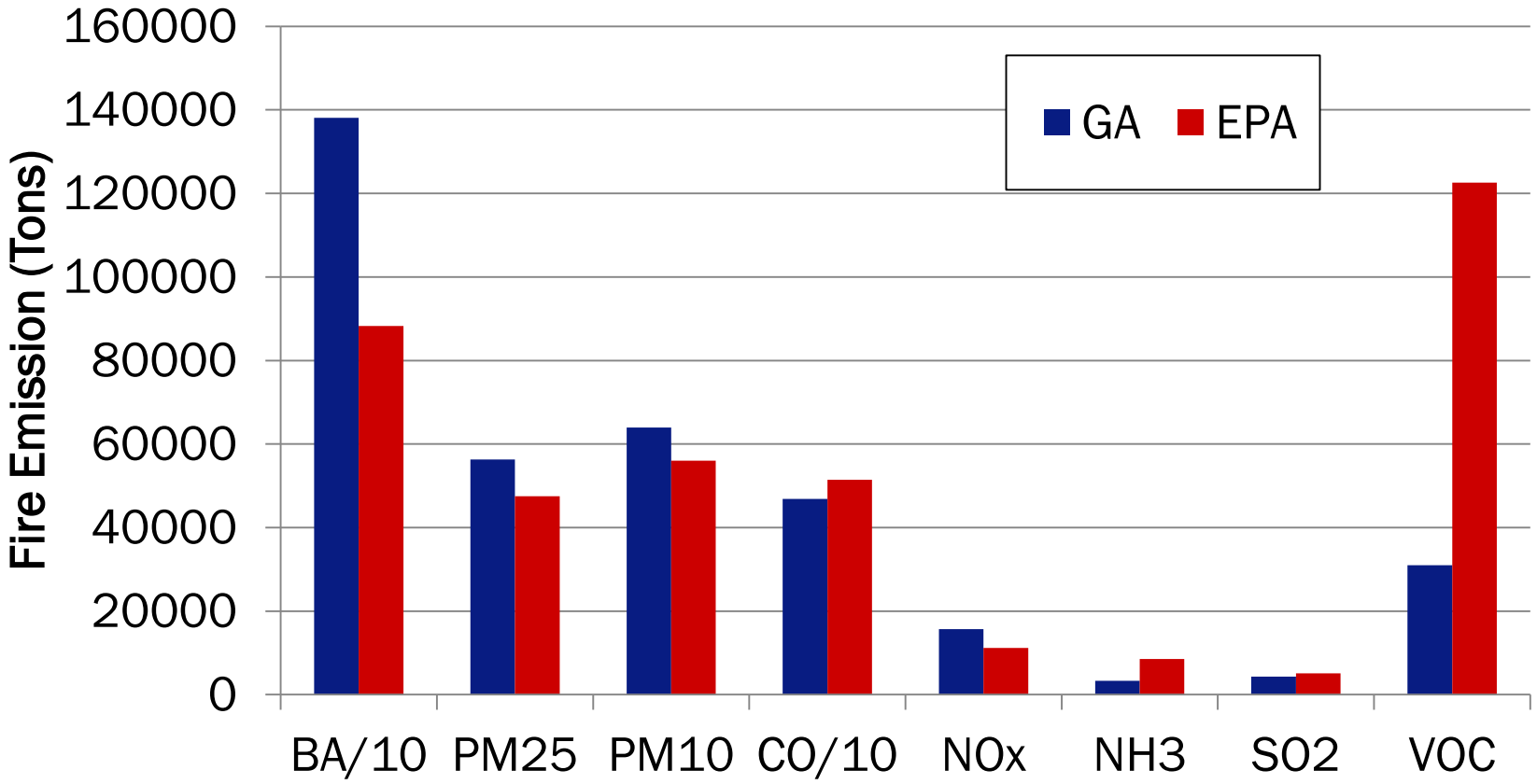
EMISSIONS SPLIT FOR FLAMING/SMOLDERING

- EPA requires states to submit wildland fire emissions by flaming and smoldering for NEI2014
- Different fuel combustion and emission factors by combustion phases
- CONSUME model was used to split emissions into flaming and smoldering phases.
  - Three burning phases in CONSUME: Flaming, Smoldering, and Residual smoldering.
  - Coexistence of flaming and smoldering
  - Flaming: Flaming and smoldering in CONSUME
  - Smoldering: Residual smoldering in CONSUME
  - Few emissions during residual smoldering for prescribed fires in the southeast

3. REVIEW EPA'S 2014 NATIONAL WILDLAND FIRE INVENTORY

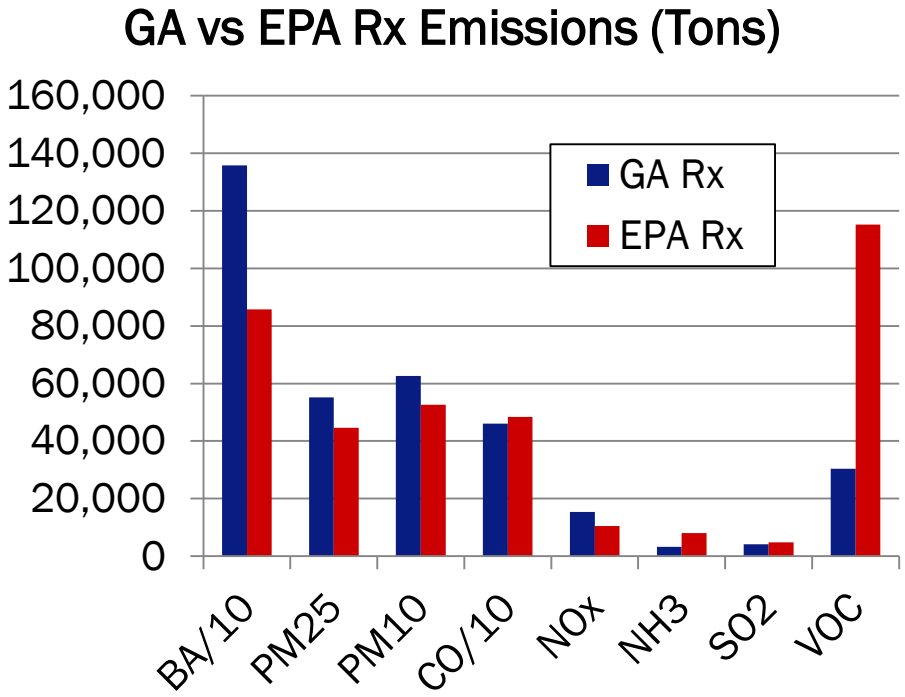
NEI2014 FIRE EMISSIONS

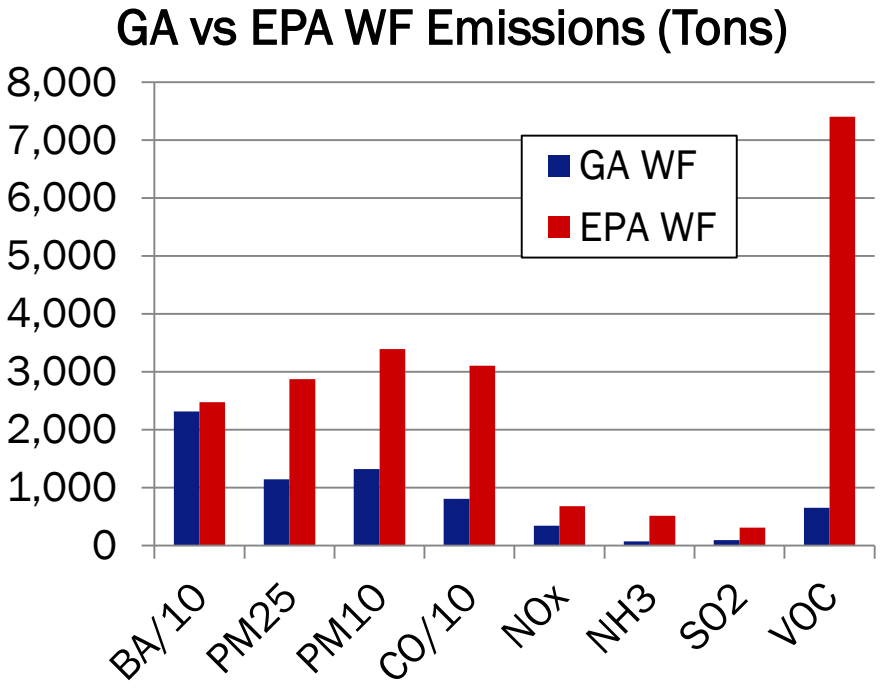
— TOTAL EMISSIONS



NEI2014 FIRE EMISSIONS

— PRESCRIBED AND WILDFIRES





GA EPD used smaller EFs than US EPA EFs.

EMISSION RATES (PRESCRIBED FIRES)

Overall Average Emission Rates (tons/acre) by GAEPD and SMARTFIRE

	Area (acres)	PM2.5	PM10	CO	NOx	NH3	SO2	VOC
GA	1,357,606.4	0.041	0.046	0.339	0.011	0.002	0.003	0.022
EPA	857,667.4	0.052	0.061	0.564	0.012	0.009	0.006	0.134
GA/EPA	158.3%	78.1%	75.1%	60.2%	92.4%	25.3%	55.1%	16.7%

In SMARTFIRE, 1) ~5 times high emission rates : VOC and NH3
2) ~2 times high emission rates : CO and SO2

Emission Factors by GAEPD and Urbanski 2014 (unit: lbs/ton)

	VOC	CO	PM2.5	NH3
GA EPD	12.38	152.18	22.78	1.38
Urbanski 2014	32.08 (21.76)	152 (30)	25.16 (7.98)	0.24 (0.24)

In comparison, 1) similar emission factors : CO and PM2.5
2) higher emission factor : VOC
3) lower emission factor: NH3

HIGH VOC EMISSIONS IN EPA'S ESTIMATES

- **Higher CO, NH3 and VOC emissions in EPA's National Wildland Fire Inventory than Georgia EPD's fire inventory**
  - Overestimated fuel consumption during smoldering phase
  - High VOC emission factor
- **Comparing EFs with EFs for Prescribed fire southeast conifer forest in Urbanski 2014**
  - CO – Similar, NH3 – lower, VOC – higher
  - VOC: 52 lbs/ton, 32 lbs/ton (without unidentified species), 13-15 lbs/ton (GAEPD/SEMAP).
  - Should VOC for unidentified species in Urbanski 2014 be used in the emission calculation??
  - Much higher emission factors for Stumps and logs or temperate forest duff/organic soil, need to identify such fires

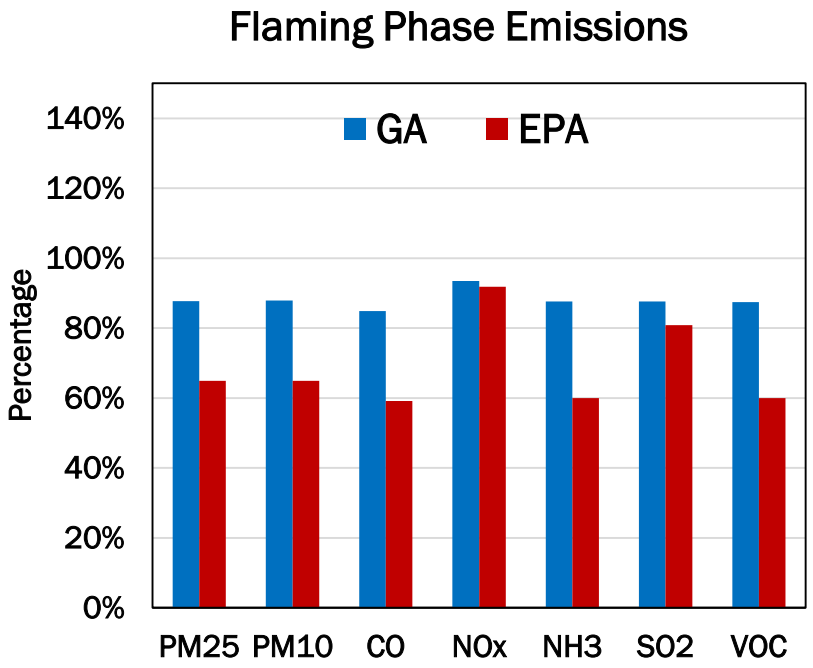
EMISSIONS SPLIT FOR FLAMING/SMOLDERING

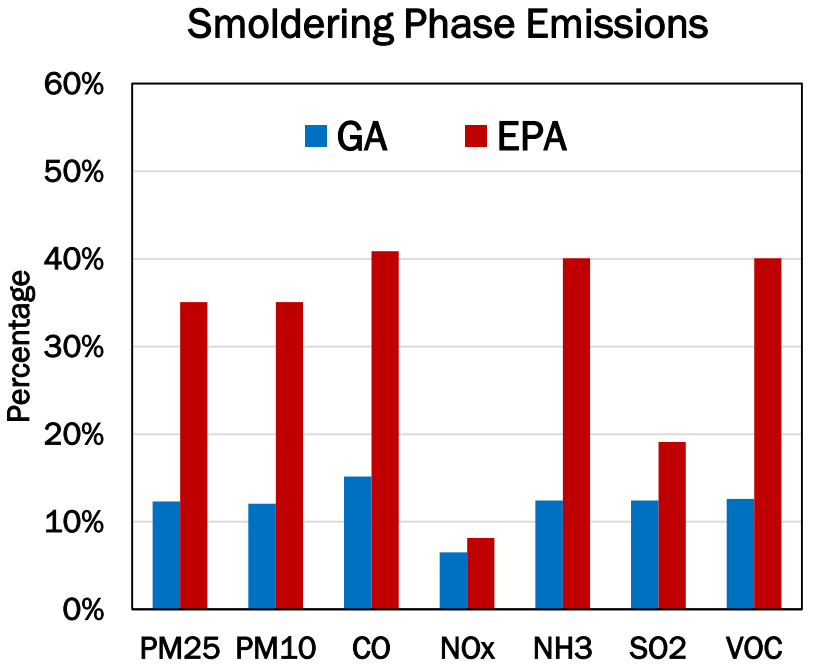
- Three burning phases in CONSUME: Flaming, Smoldering, and Residual smoldering.
- Different definition by Georgia EPD and EPA
- Coexistence of flaming and smoldering/Plume rise

	Georgia EPD	EPA
Flaming	Flaming Smoldering	Flaming
Smoldering	Residual smoldering	Smoldering Residual smoldering

NEI2014 FIRE EMISSIONS

— FLAMING AND SMOLDERING PHASES





GROUND REPORTS VS SATELLITE FIRE DETECTION

- **Coverage**
  - Satellite fire detection is continuous with large spatial coverage (cloud/canopy interferences)
  - Ground data is continuous with good coverage (human errors/missing reports)
- **Data Uncertainty**
  - Satellite detects radiance and convert it to fire size, ground pixel size is >100m.
  - Ground data is a direct estimate of fire size, no size limit, but with uncertainties in fire size/location.
- **Possible Error**
  - Satellite fire detection: fire size, cloud interference, false alarm
  - Ground report: human error, including missing report, fire size&location

Statistically, there are certain correlation between the two fire products in the whole state, but lacking correlations for individual fires. (Zeng et al., Atmos. Environ., 2015; Hu et al., JGR, 2016)

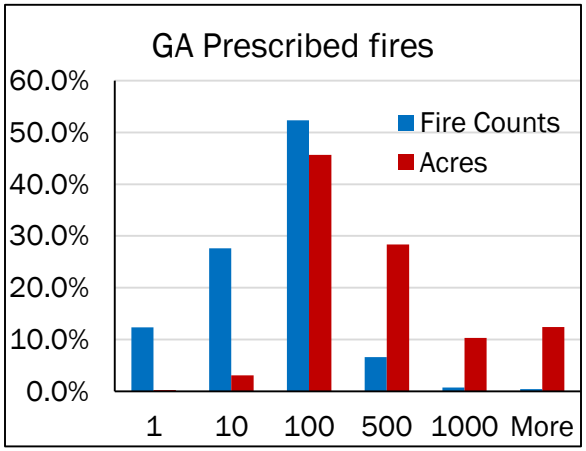
GA FIRE SIZE AND COUNT DISTRIBUTION

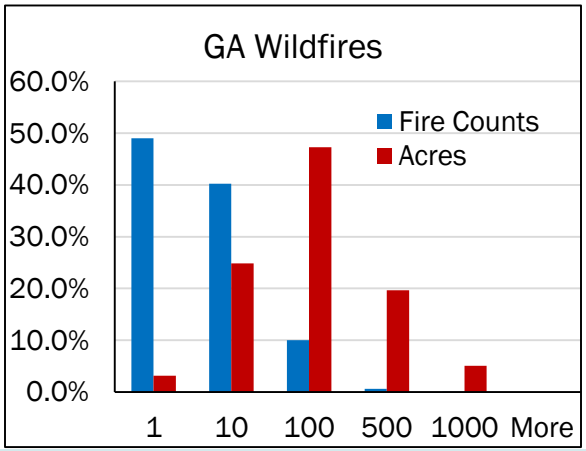
2014 Burned Area

GAEPD
1.38 million Acres

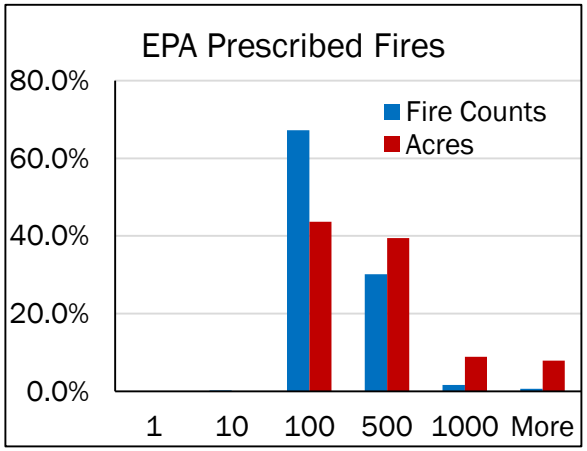
EPA SMARFIRE
0.88 million Acres

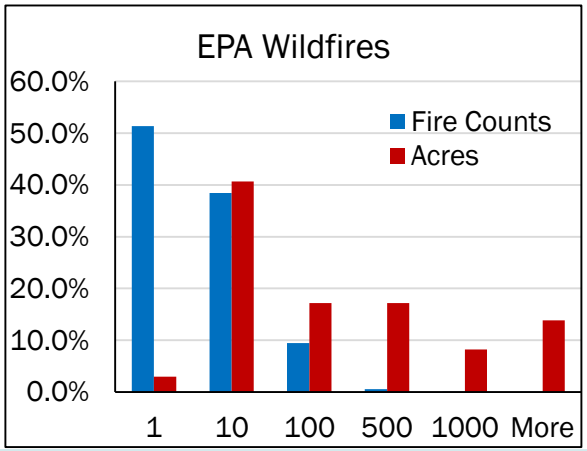
GA EPD





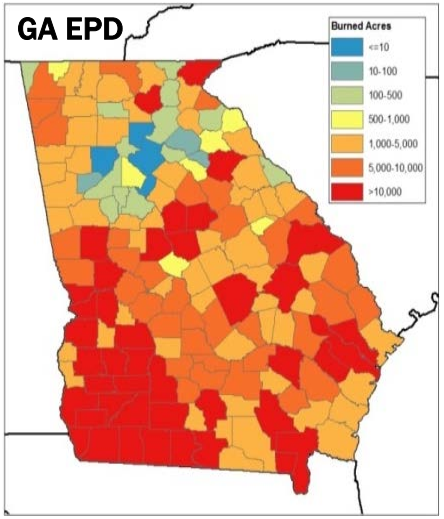
SMARTFIRE v1

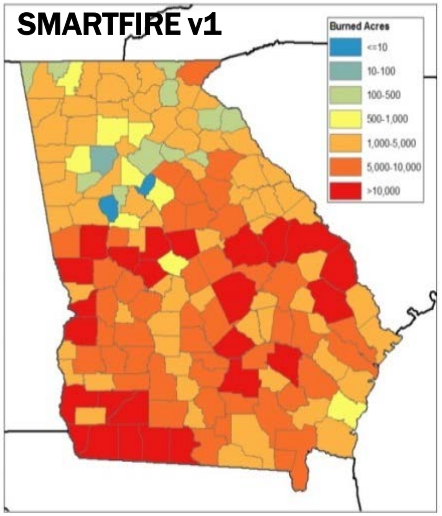




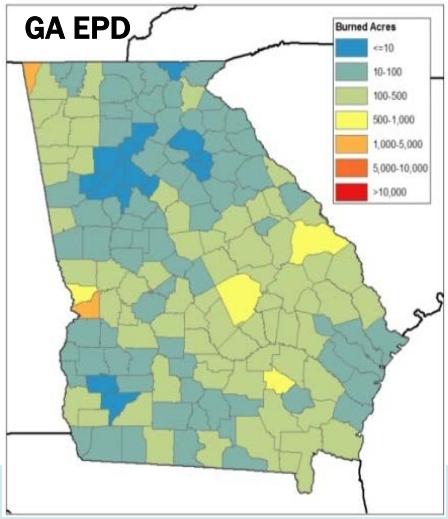
GA FIRE SPATIAL DISTRIBUTIONS IN 2014

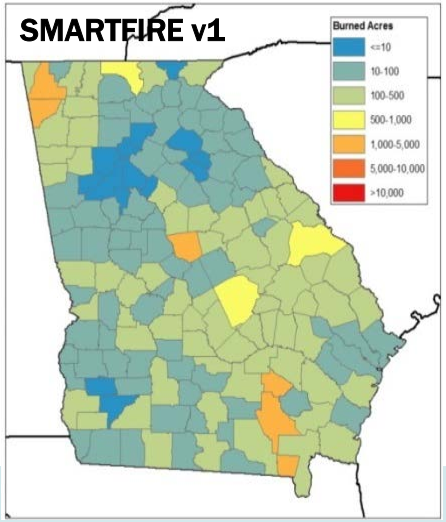
Prescribed fires



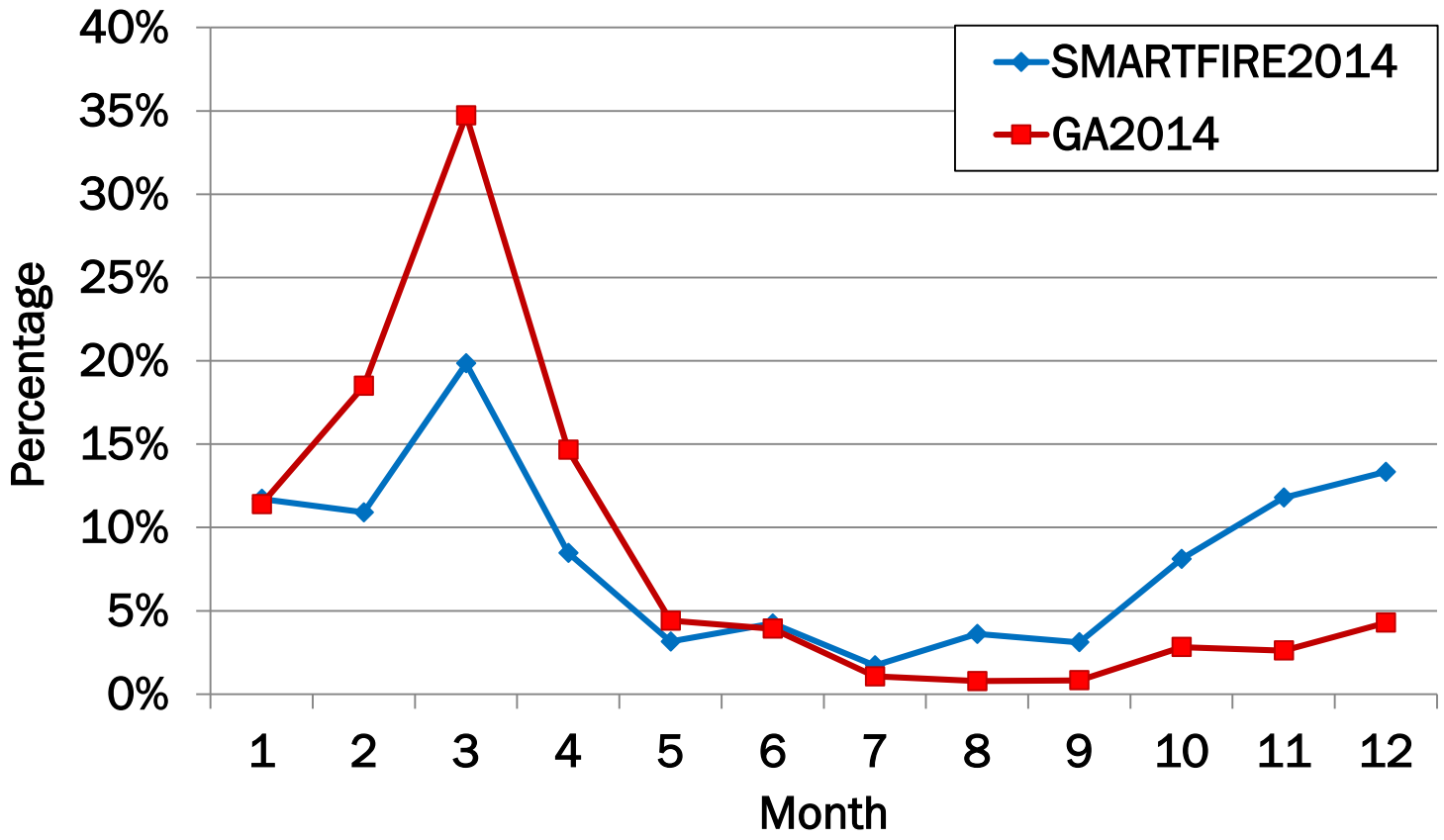


Wildfires





GA FIRE SEASONAL PATTERN



SMARTFIRE overestimates fire activities in October-December and underestimated fire activity in February- April. Similar pattern for 2011 (not shown).

4. FUTURE IMPROVEMENT PLAN

PRESCRIBED BURN PERMIT TRACKING SYSTEM

- Plan to develop a new web-based Prescribed Burn Permit Tracking System together with Georgia Forestry Commission
- Collect detailed/accurate prescribed burn information that was not available before
  - Burned area, timing, location (latitude and longitude), fuel type and conditions, post-burn information such as actual burned area and burned percentage of shrub for each prescribed burn permit issued by GFC.
- Will not significantly increase prescribed burn permit issuance time

IMPROVE FUEL CONSUMPTION INFORMATION

- **Large uncertainties in fuel consumption values**
  - Fuel consumption information for a fire is often unavailable.
  - The inferred fuel type based on fire location and fuel maps is often not correct
- **Collect fuel type information in the future Prescribed Burn Permit Tracking System**
  - Fuel consumption for log slash burning is much higher than other burns.
- **Develop Georgia typical fuel consumption tables**
  - 5-10 major fuel types will be identified for each county/district using FCCS fuel map and local knowledge by local forest managers
  - Include impacts from fuel conditions (e.g. years since last burn, fuel moisture levels, burned percentage of shrub, etc)
  - Include local knowledge from local forest mangers

SUMMARY

1. Annual fire activity in GA is increasing. It is dominant by prescribed fires. Their air quality impacts are large.
2. GAEPD developed 2014 wildland fire emission inventory and would like to work with EPA to continue improve methodology used to develop National Wildland Fire Inventory.
   - High VOC emissions
   - Emission split for flaming/smoldering
3. Future permit tracking system to collect more information to improve emission inventory quality
4. Develop typical fuel types and fuel consumption table

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