Review of Emissions Inventories for Wildland Fires in Georgia

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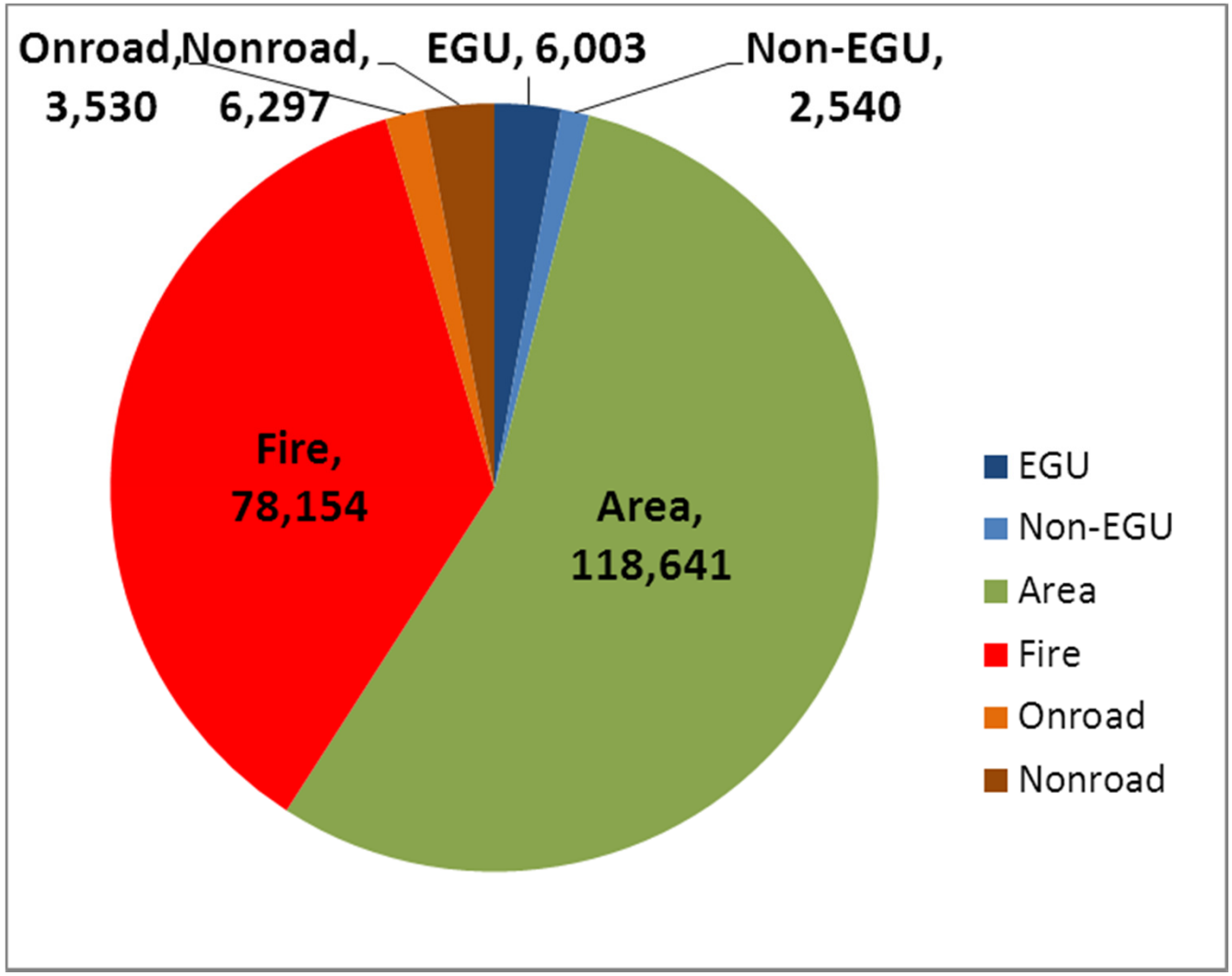
Outline

- Wildland fires
  - Air quality impacts from wildland fires in Georgia
- Available emissions inventories
  - Fire records and satellite data
  - Difference in emissions
  - Difference in fuel consumption and emission factors
- Emissions inventory development plan for 2011 wildland fires

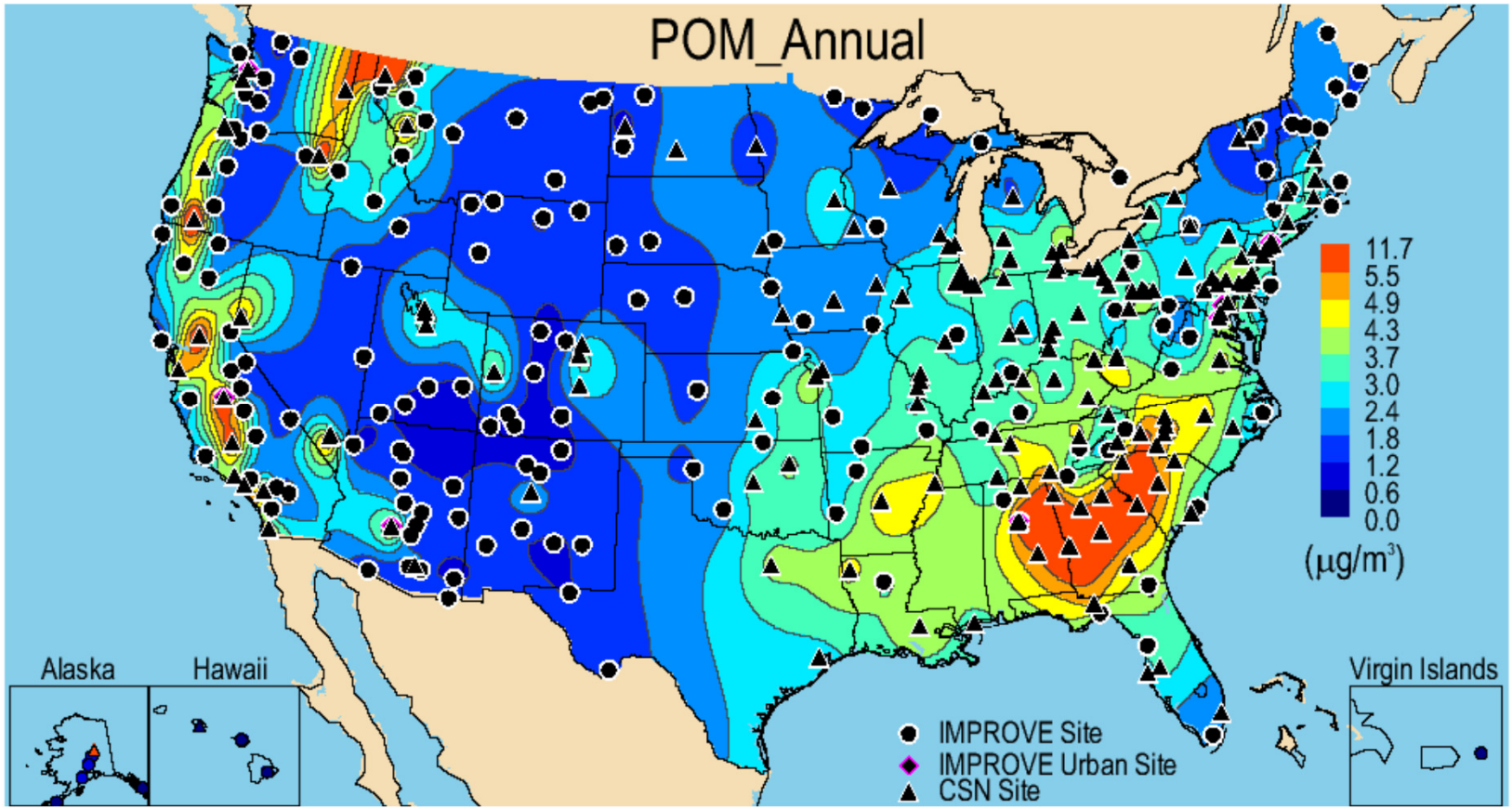
Wildland Fires

- Wildland fires can…
  - Maintain health in many ecosystems
    - Plant succession, fuel accumulation and decay, nutrient cycles and energy flows, control insects and disease, etc
  - Cause ecosystem damage and property loss, threaten human health and safety
- Emit large amounts of air pollutants, e.g. PM, VOC, NO_X, NH_3, etc
  - Carbonaceous mass is a substantial component of $PM_{2.5}$
- Previous $PM_{2.5}$ source apportionment studies indicate significant contributions

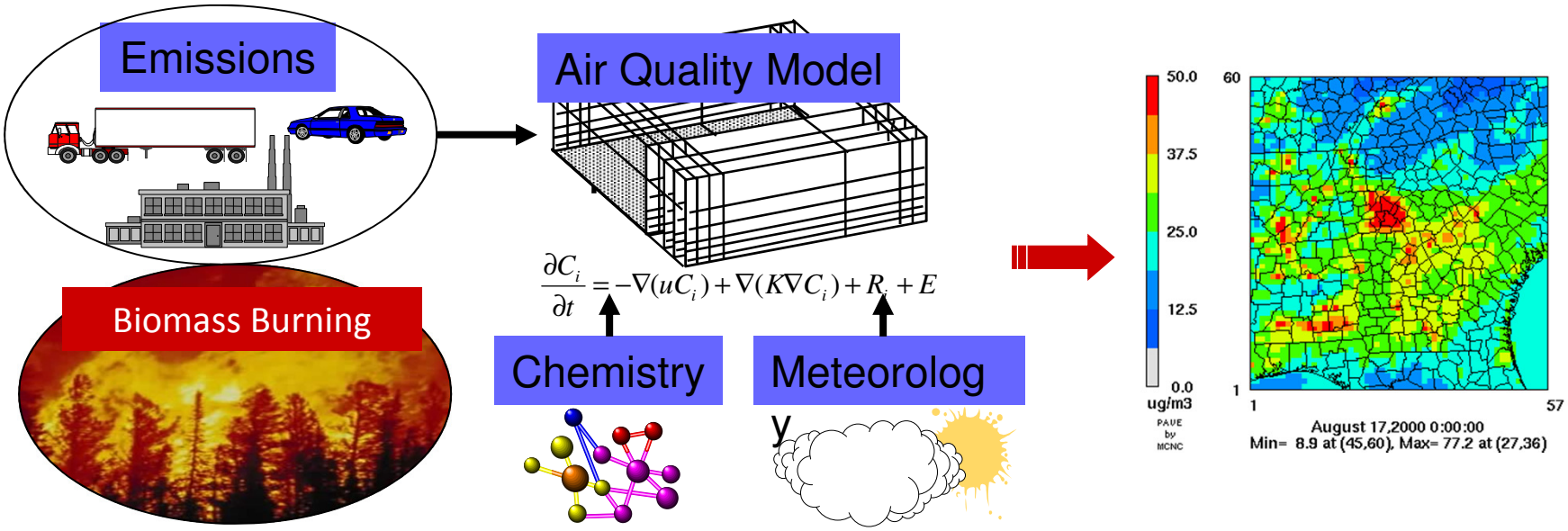
PM2.5 Emissions by Source Sectors in Georgia
NEI 2008, tons/year



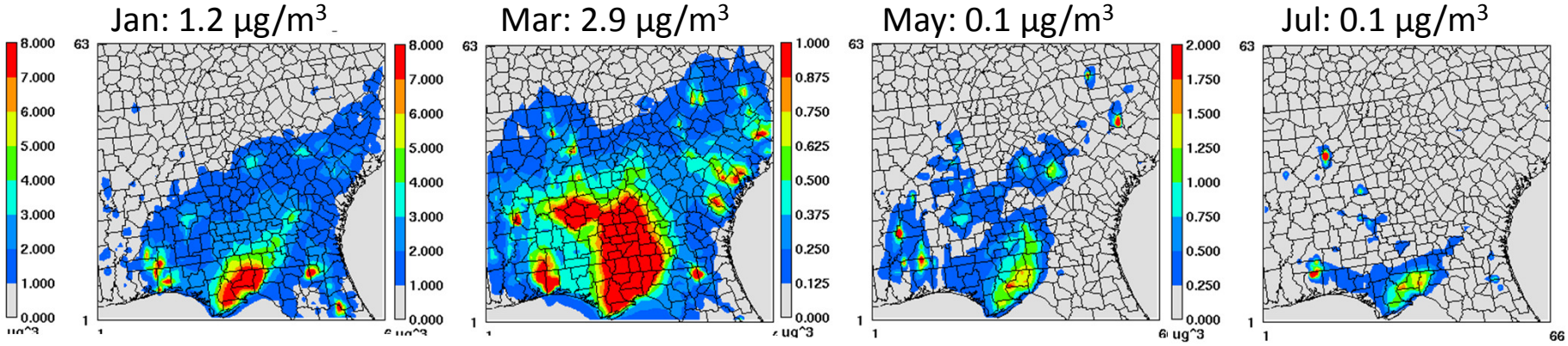
IMPROVE and CSN 2005–2008 PM2.5 particulate organic matter (POM) annual mean mass concentrations (μg m^{-3})



IMPROVE report V
(http://vista.cira.colostate.edu/improve/Publications/Reports/2011/2011.htm



Primary Organic Matter from Prescribed burning



* Monthly average, domain-wide average values, VISTAS2002 fire inventory

Tian, et al, 2009, Environmental Science and Technology, 43, 299-305

Five Available Emissions Inventories

- Two SIP fire inventories
  - VISTAS 2002: Visibility Improvement State and Tribal Association of the Southeast (VISTAS) 2002 Fire Inventory
  - SEMAP 2007: Southeastern Modeling Analysis and Planning (SEMAP) 2007 Fire Inventory
- Two AERR inventories
  - Air Emissions Reporting Requirements (AERR)
  - Developed by Georgia EPD for 2005 and 2008
    - Georgia 2005 and Georgia 2008
  - Submitted to U.S. EPA every three years
- SMARTFIRE2008v2
  - SMARTFIRE, USFS/U.S. EPA

Emissions Calculation Method

- Emissions were calculated as

$$E = A \times F_a \times E_f$$

A: burned area (acres)

F_a: fuel consumption (tons/acre)

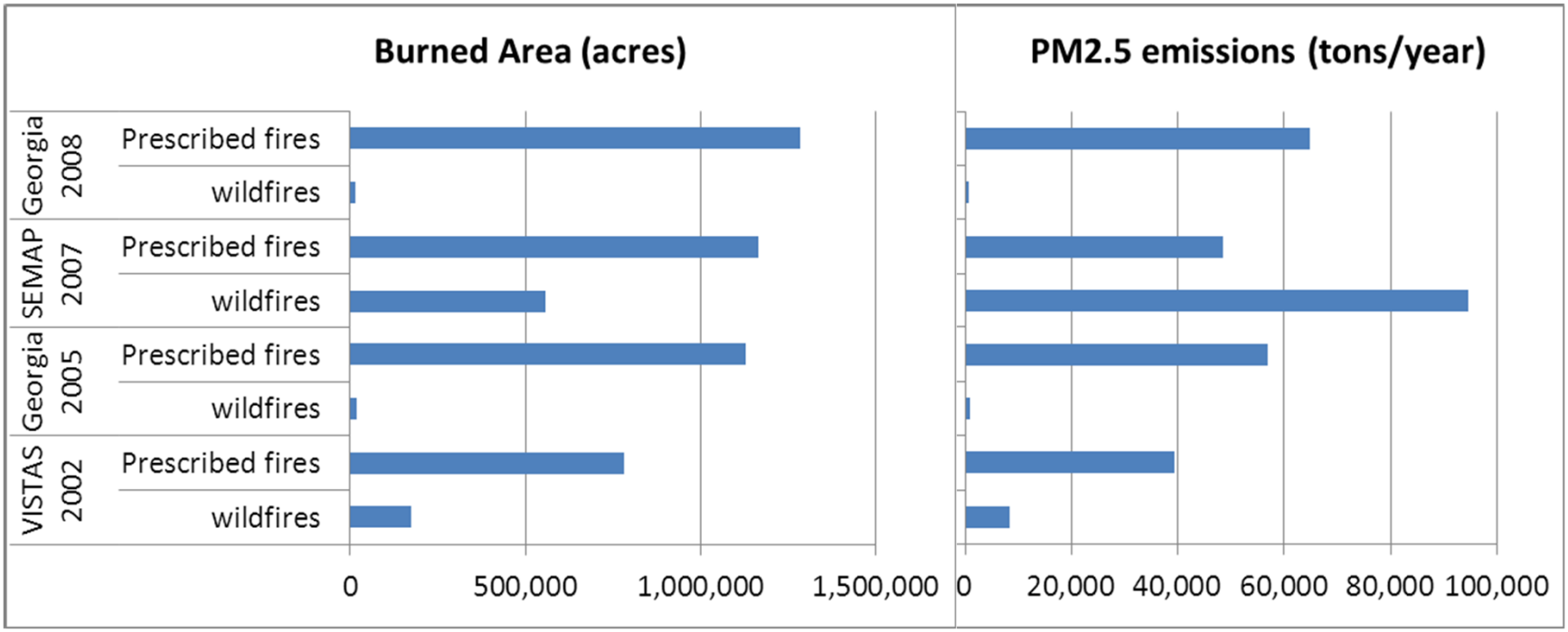
E_f: emission factor (lbs/ton)

- Emissions from wildland fires vary with
  - fuel conditions, weather, topography, the way fires are applied, forest management
- Three different methods
  - Group 1: VISTAS 2002, Georgia 2005, Georgia 2008
  - Group 2: SEMAP 2007
  - Group 3: SMARTFIRE2008v2

Comparison Between the Five Available Inventories

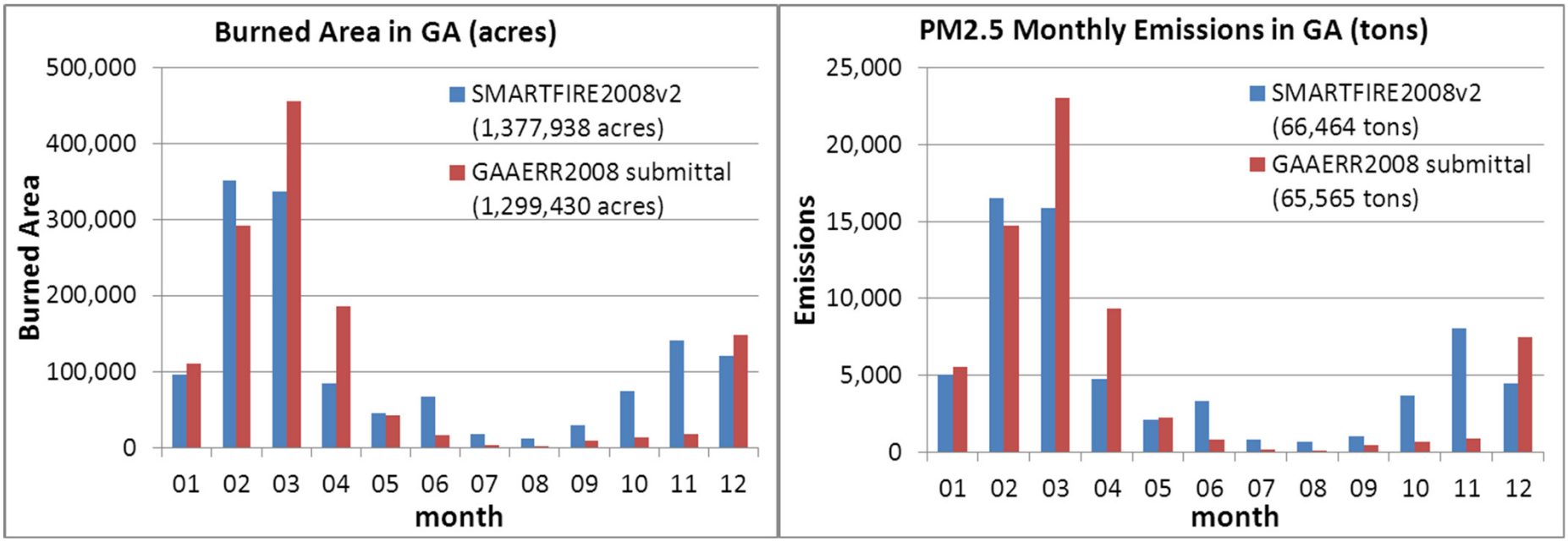
- Group 1 (VISTAS 2002, Georgia 2005 and Georgia 2008)
  - Burned area: fire records kept by Georgia Forestry Commission and military bases
  - Fuel consumption and Emission factors: NFDRS, Pace report, experts judgement
- Group 2 (SEMAP 2007)
  - Similar, but with updated fuel consumption and emission factors
- Group 3 (SMARTFIRE2008v2)
  - Burned area: Satellite fire detects and ground reports (ICS 209)
  - Fuel consumption and Emissions factors: BlueSky (CONSUME/FEPS)

Comparison of total burned areas and PM2.5 emissions from wildland fires in the state of Georgia

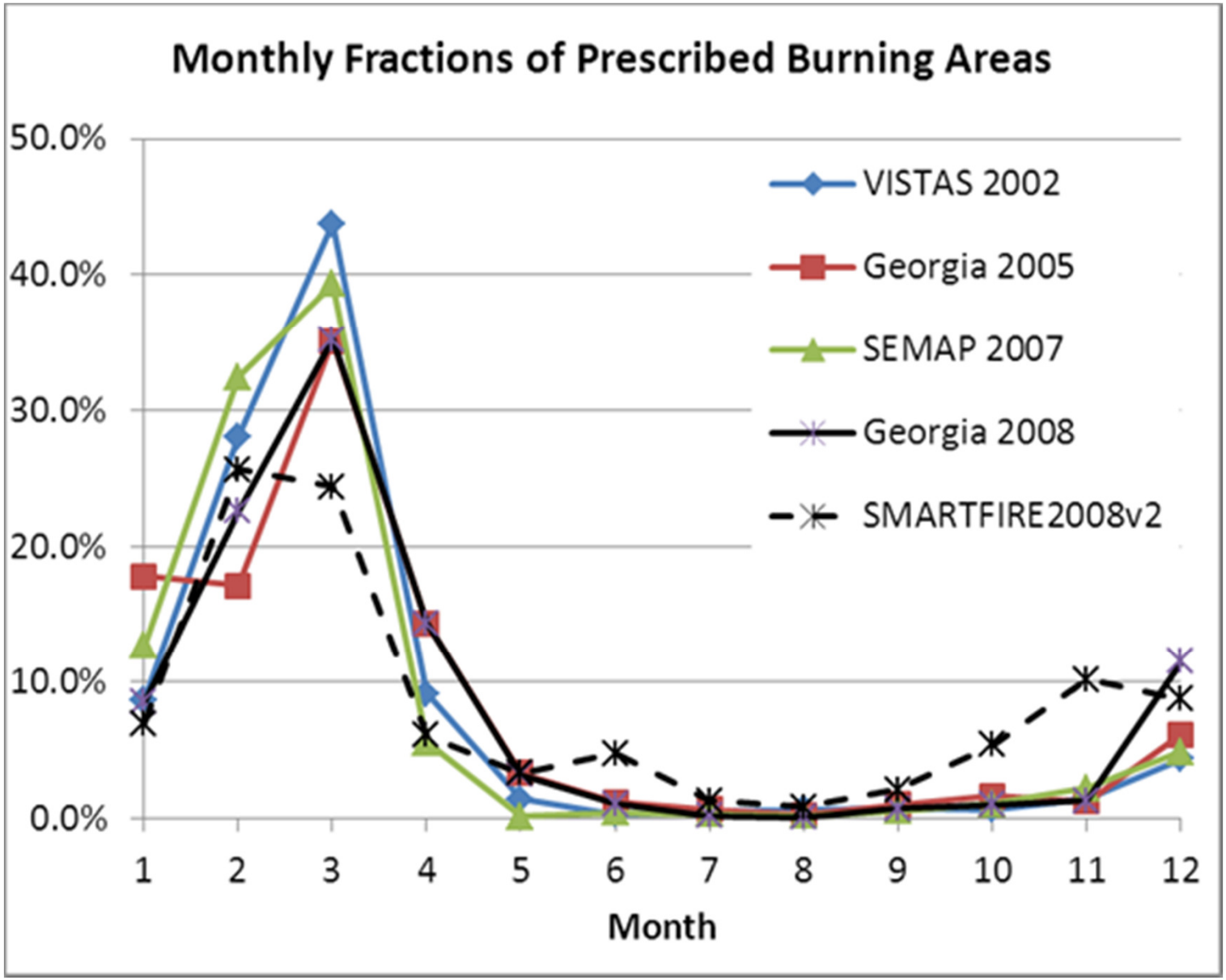


1) Prescribed fires burn more areas than wildfires;
2) Prescribed fires burn more acres through years;
3) Wildfires have large yearly variation;
4) Prescribed fires burn less acres in Georgia 2005 compared with SEMAP 2007, but emit more PM2.5 emissions due to different fuel consumption and emission factors used.

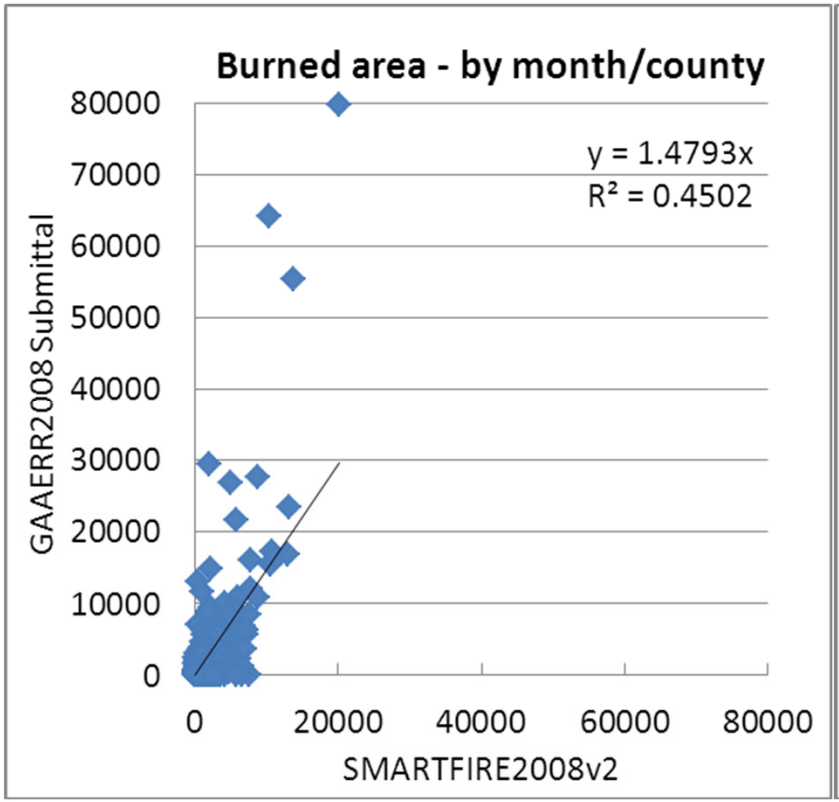
Comparison of monthly burned areas and PM2.5 emissions from wildland fires in the state of Georgia in Georgia 2008 and SMARTFIRE2008v2

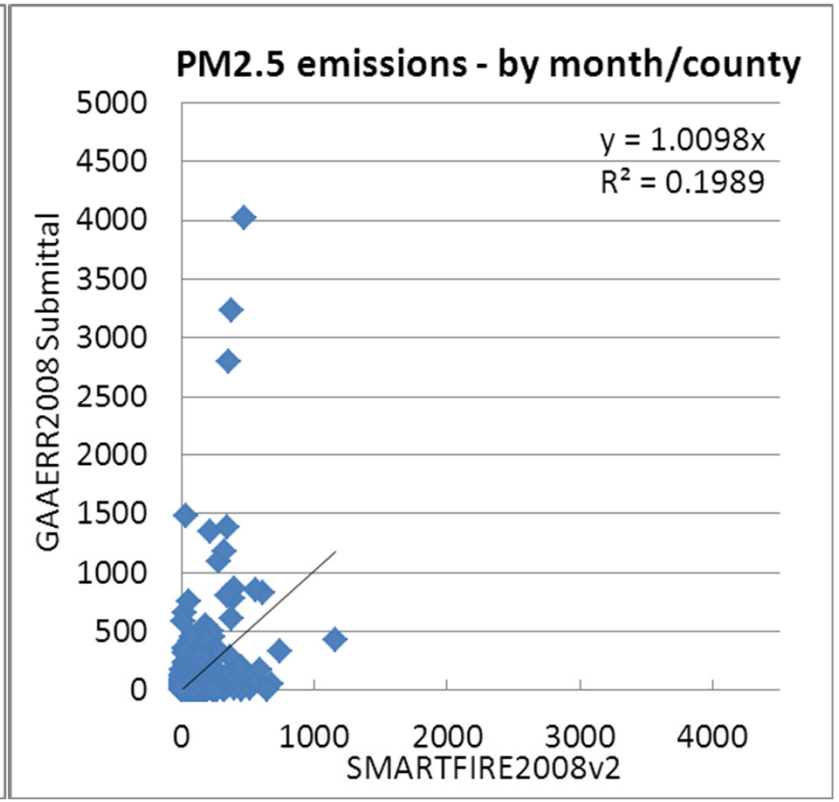


1) Total burned area and PM2.5 emissions match well;
2) SMARTFIRE2008v2 shows significant burning activities in fall, when fuels are still wet and thus not suitable for prescribed burning;
3) SMARTFIRE2008v2 underestimates fire activities in Jan, Mar, Apr, and Dec.


Monthly Fractions of Prescribed Burning Areas
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
1
2
3
4
5
6
7
8
9
10
11
12
Month
VISTAS 2002
Georgia 2005
SEMAP 2007
Georgia 2008
SMARTFIRE2008v2

Scatter plots of monthly county-level burned areas and PM2.5 emissions from wildland fires in the state of Georgia in Georgia 2008 and SMARTFIRE2008v2





1) Reasonable correlations for burned areas though not perfect;
2) Degraded correlation in PM2.5 emissions due to different emission estimation methods.

Comparison of Fuel Consumption Values

Fire Type	Inventory	Fuel Type	Min	Max
Prescribed fires	VISTAS2002	State average	4	4
	SEMAP2007	State average	4	4
		NFDRS	1.7	4.3
	SMARTFIRE2008v2	FCCS	1.1	23
Wildfires	VISTAS2002	NFDRS	0.3	12
	SEMAP2007	NFDRS	0.7	25
	SMARTFIRE2008v2	FCCS	3.6	36

1) The range of fuel consumption values for wildfires is larger than fore prescribed fires;
2) Difference between three different emission estimation methods is large
3) Prescribed fires have been applied every 2~5 years in the southeast
4) Fuel consumption factors for prescribed fires also vary with burning frequency and burning purposes
5) Limited measurements in the southeast, and need more measurement

Comparison of Emissions Factors

			PM25		NOx	
Fire Type	Inventory	Fuel Type	min	max	min	max
Prescribed fires	VISTAS2002	NFDRS	25.2		6.5	
	SEMAP2007	State average	22.5		6.5	
		NFDRS	20.7	26.1	4.5	6.7
Wildfires	VISTAS2002	NFDRS	24.1	28.2	6.2	7.3
	SEMAP2007	NFDRS	20.7	24.2	6.2	7.3

1) Difference in emissions factors between different inventories is much smaller than that in fuel consumption factors;
2) Better understanding.

NEI 2011 Fire Emissions Inventory Development for Georgia Wildland Fires

- Burning activity records
  - Georgia Forestry Commission Electronic Tracking system (burning dates and locations), Military bases, USFS, FWS
  - Invalid timing and location information
  - Satellite data
- EPA/USFS, SMARTFIRE
  - Fuel consumption and emissions factors representative for prescribed fires in the southeast should be developed in BlueSky system.
  - SEMAP

Summary

- Information about the size, timing and location of wildland fires is the basis for developing a high quality fire inventory.
- Need for improved satellite fire products for prescribed fires
  - Prescribed fires usually have lower burning temperature, shorter duration and smaller burning scales than wildfires, and they are often understory burning
  - The average size of prescribed fires is 46 acres, corresponding to 23,513 fires and 1,075,729 acres in Georgia during 2008.

Summary (continued)

- Large uncertainties in fuel consumption factors
  - Limited field measurements in the southeast
  - Fuel consumption difference due to burning frequency
  - Burning purposes: site preparation, wildlife management and hazard reduction
  - Need more field measurement
- Better understanding of emissions factors
- Uncertainties in the wildland fire inventories will always exist
  - Air quality modeling, observations

Collaboration IS Important

- Federal/sate/local air quality and forest managers, and research communities
  - Financial supports
  - e.g. more field measurement for fuel consumptions
  - All states in the southeast
- Acknowledgement
  - Georgia Forestry Commission
    - Dan Chan, Ken Wilt, Alan Dozier
  - Federal agency
    - Vince Carver, Cindy Huber, Anthony Matthews, Tesh Rao

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