

# **Review of Emissions Inventories for Wildland Fires in Georgia**

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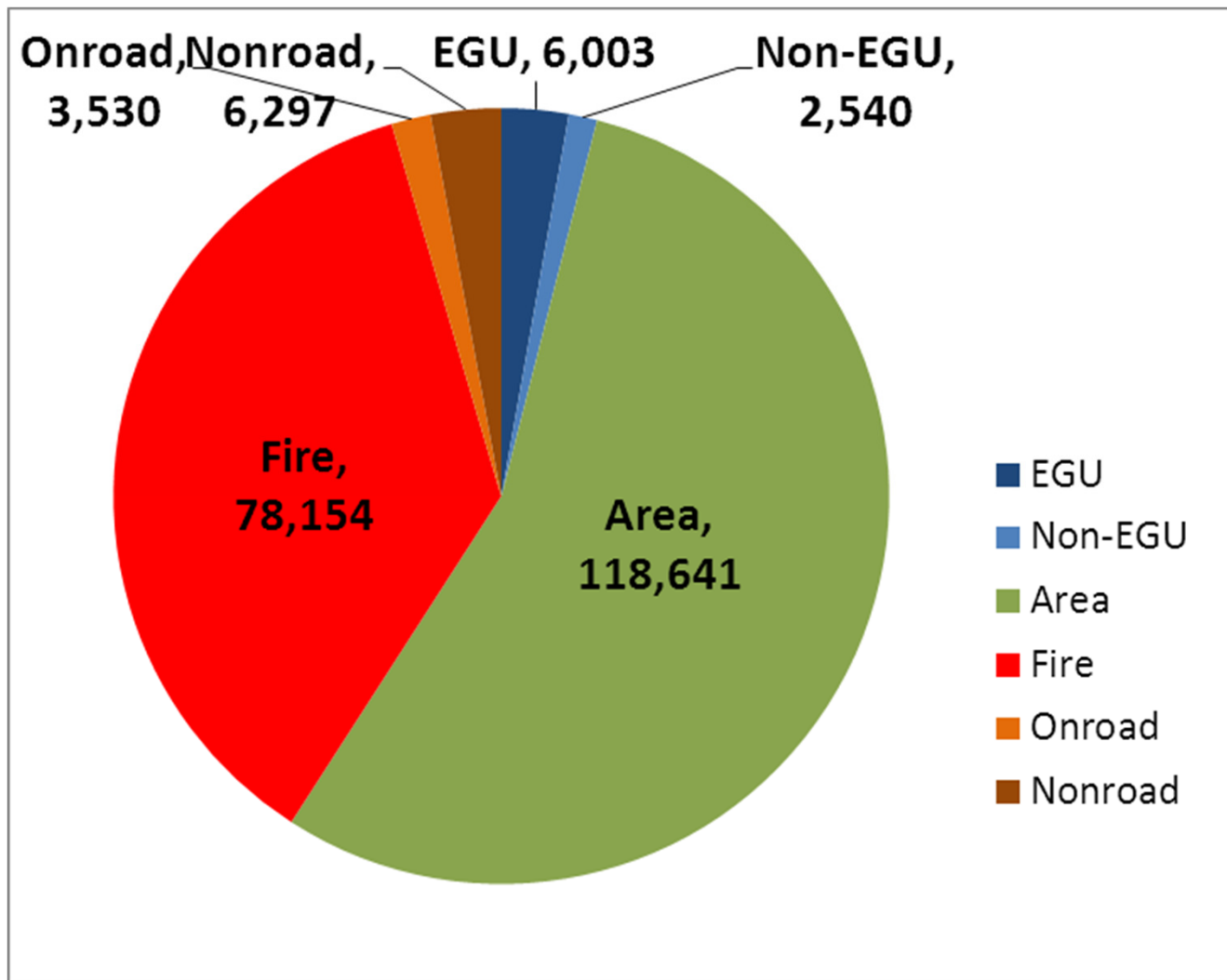
# Outline

- 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

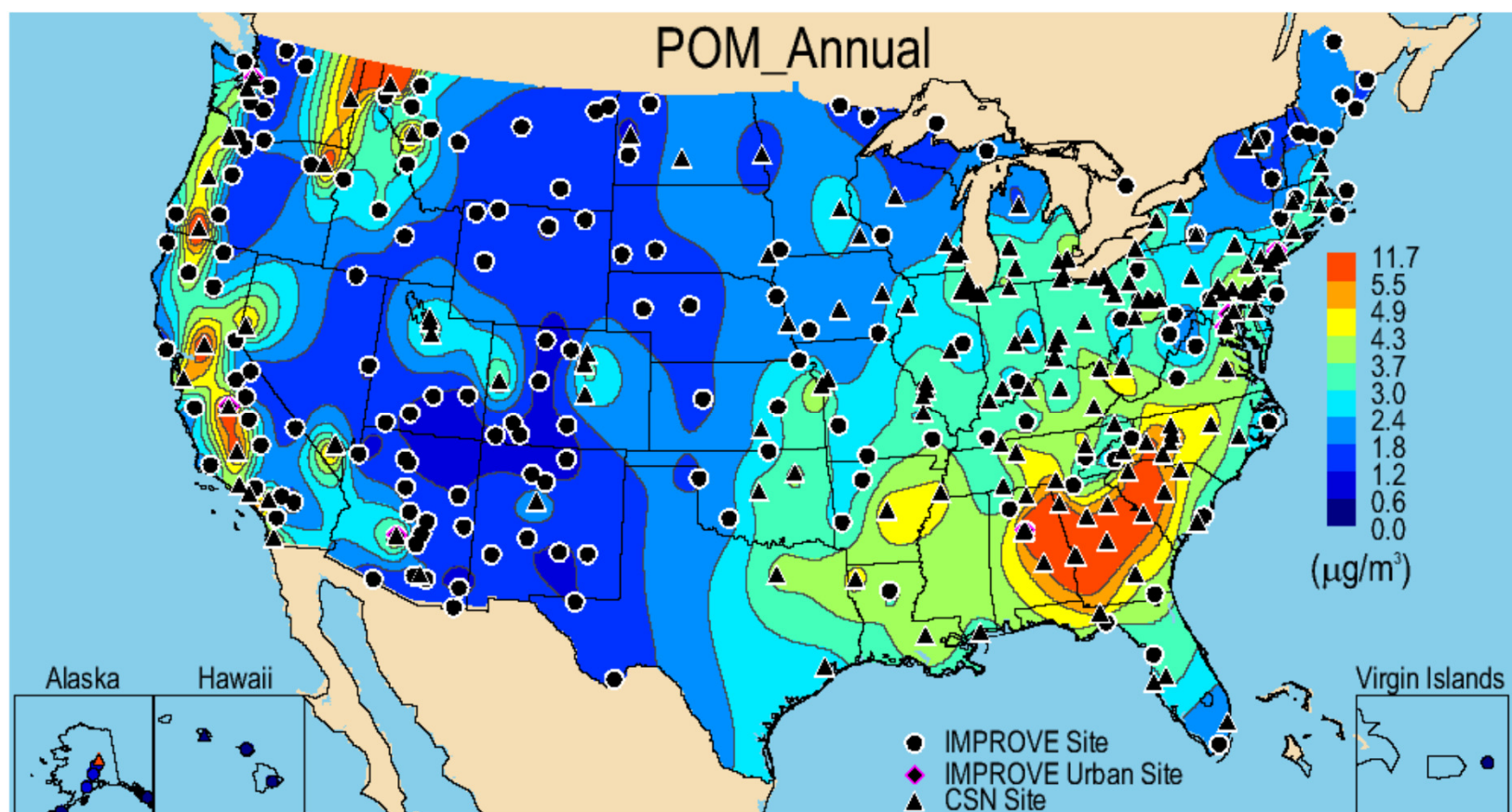
# Wildland Fires

- 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<sub>x</sub>, NH<sub>3</sub>, etc
  - Carbonaceous mass is a substantial component of PM<sub>2.5</sub>
- Previous PM<sub>2.5</sub> source apportionment studies indicate significant contributions

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

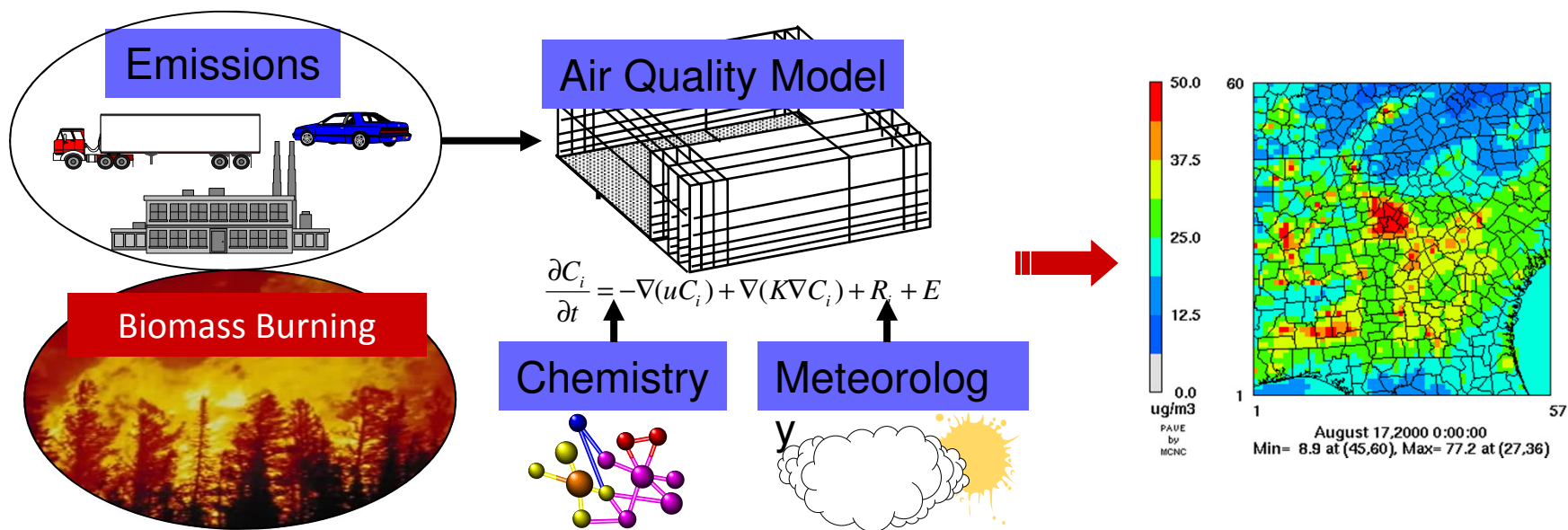


# IMPROVE and CSN 2005–2008 PM<sub>2.5</sub> particulate organic matter (POM) annual mean mass concentrations ( $\mu\text{g m}^{-3}$ )

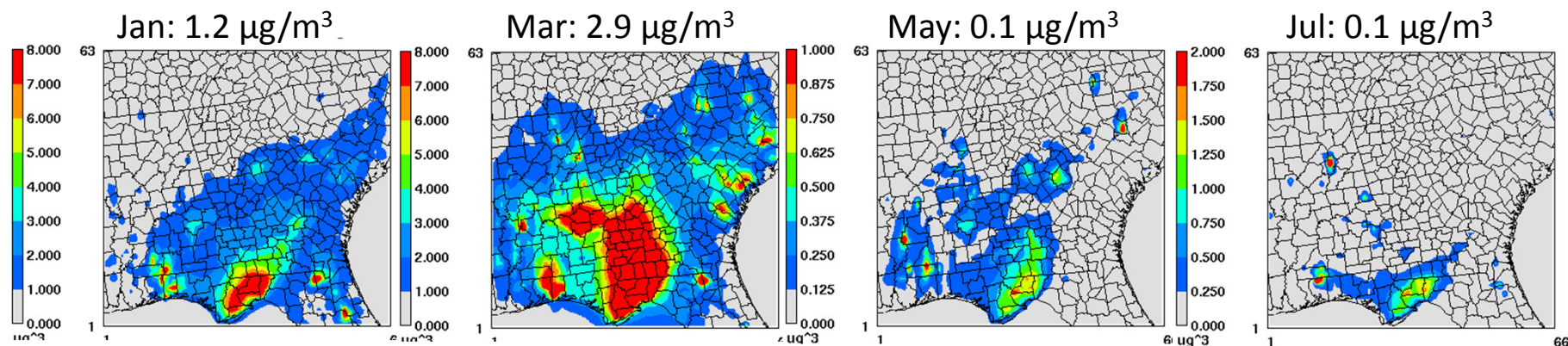


IMPROVE report V

(<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/BlueSky, USFS

# Emissions Calculation Method

- Emissions were calculated as

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

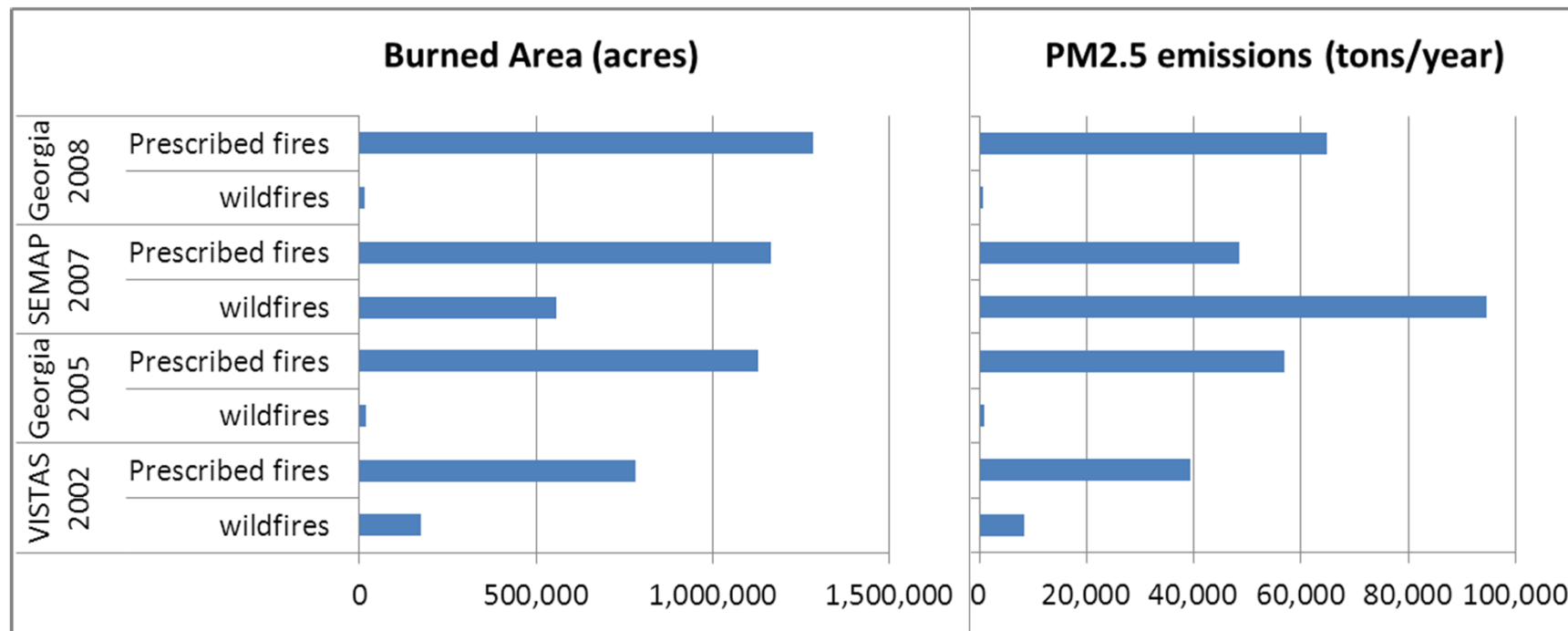
A: burned area (acres)  
 $F_a$ : fuel consumption (tons/acre)  
 $E_f$ : emission factor (lbs/ton)

- 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

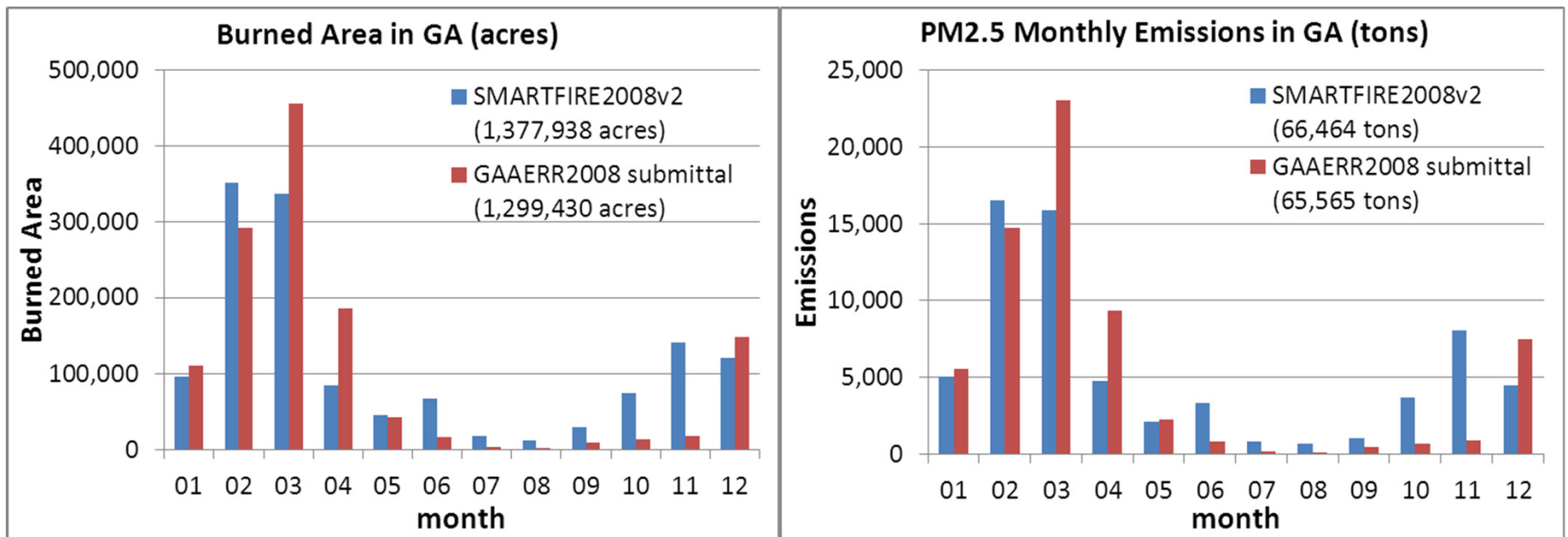
- Group 1 (VISTAS 2002, Georgia 2005 and Georgia 2008)
  - Burned area: fire records kept by Georgia Forestry Commission and military bases
  - Fuel consumption and Emission factors: NFDRS, Pace report, experts judgement
- Group 2 (SEMAP 2007)
  - Similar, but with updated fuel consumption and emission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

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



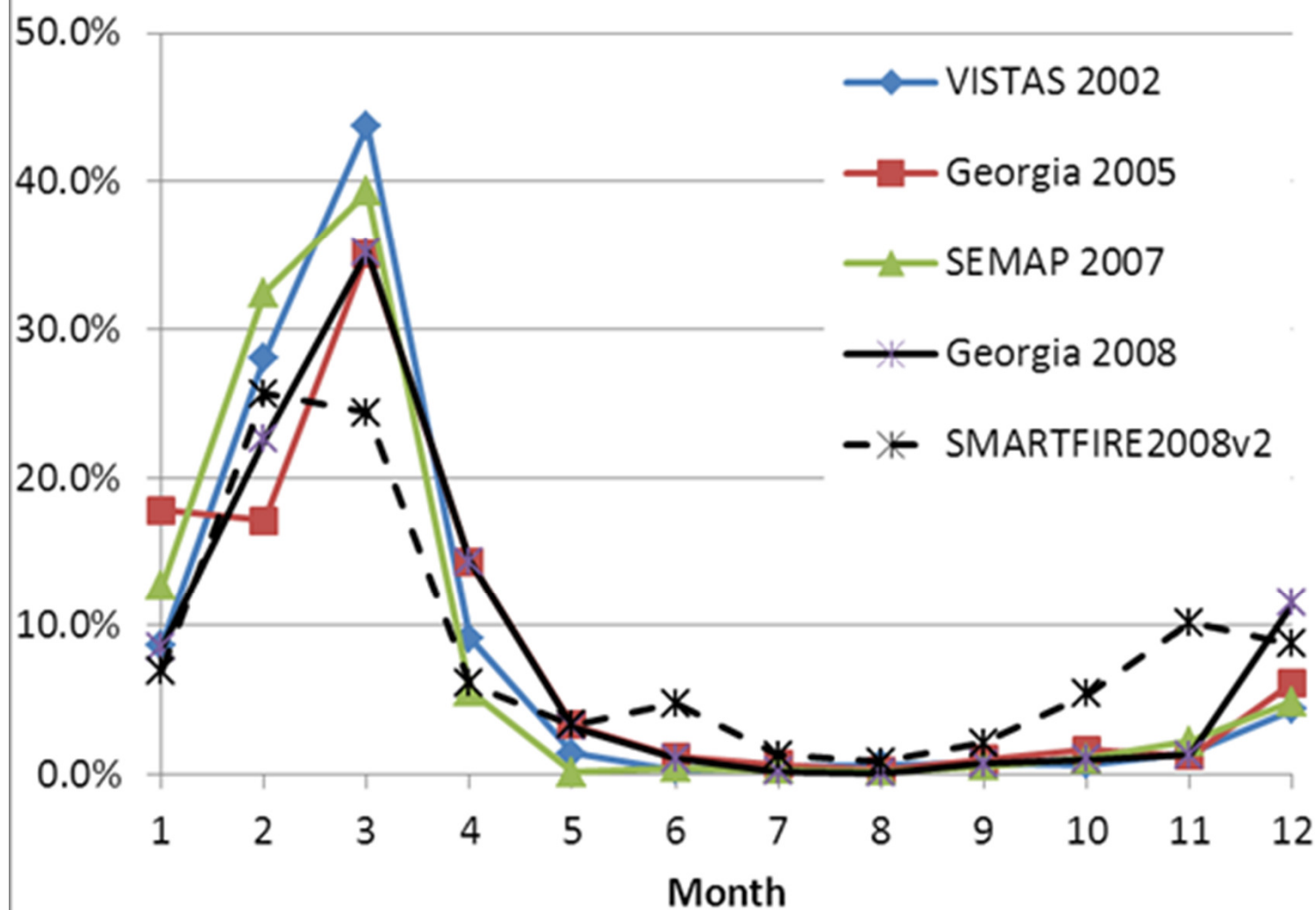
- 1) Prescribed fires burn more areas than wildfires;
- 2) Prescribed fires burn more acres through years;
- 3) Wildfires have large yearly variation;
- 4) Prescribed fires burn less acres in Georgia 2005 compared with SEMAP 2007, but emit more PM2.5 emissions due to different fuel consumption and emission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

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

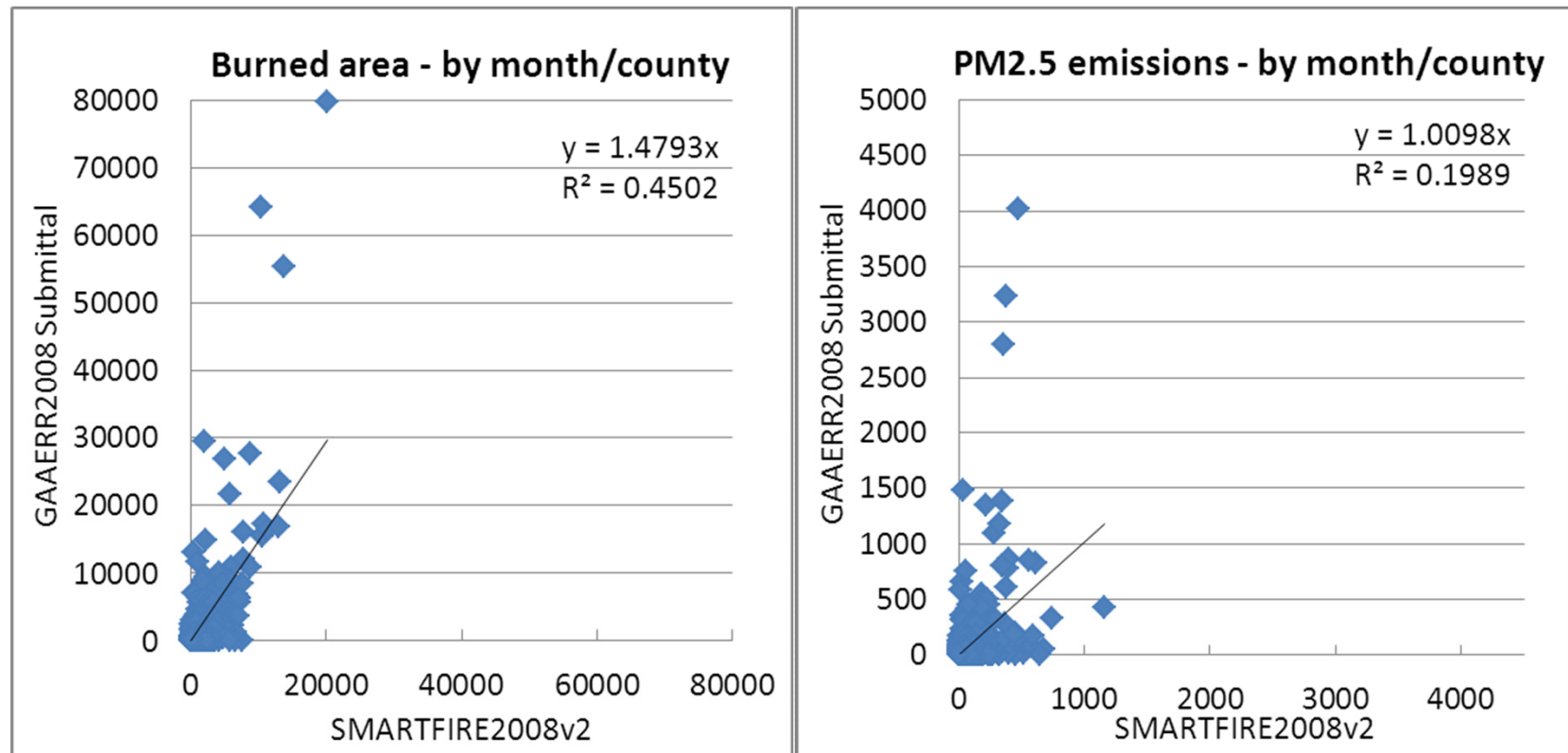


- 1) Total burned area and PM2.5 emissions match well;
- 2) SMARTFIRE2008v2 shows significant burning activities in fall, when fuels are still wet and thus not suitable for prescribed burning;
- 3) SMARTFIRE2008v2 underestimates fire activities in Jan, Mar, Apr, and Dec.

## Monthly Fractions of Prescribed Burning Areas



## 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/CONSUME  | 1.1 | 23  |
| Wildfires        | VISTAS2002      | NFDRS         | 0.3 | 12  |
|                  | SEMAP2007       | NFDRS         | 0.7 | 25  |
|                  | SMARTFIRE2008v2 | FCCS/CONSUME  | 3.6 | 36  |

- 1) The range of fuel consumption values for wildfires is larger than for 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 |      | NO <sub>x</sub> |     |
|------------------|------------|---------------|------|------|-----------------|-----|
| 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
- EPA/USFS, SMARTFIRE/BlueSky
  - New alternative method proposed by USFS
  - Satellite data
  - 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/state/local air quality and forest managers, and research communities
  - Financial supports
  - e.g. new fire detection algorithm for prescribed fires, more field measurement for fuel consumptions, etc
  - 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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