Development of 2014 Georgia Wildland Fire Emission Inventory

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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
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

3-Year Averages of Highest Annual Averages for Each Metropolitan (MSA)

PM$_{2.5}$ ($\mu$g/m$^3$)

Concentration ($\mu$g/m$^3$)


12 $\mu$g/m$^3$ Standard

- Atlanta-Sandy Springs-Marietta
- Augusta-Richmond County, GA-SC
- Gainesville
- Rome
- Savannah
- Albany
- Brunswick
- Gordon
- Macon
- Columbus GA-AL
- Chattanooga TN-GA
- Sandersville
- Warner Robins
- Valdosta

5
BURN ACRES IN GEORGIA

- Annual Burned Area (x1000 Acres)
- 2011: 1,600 acres
- 2014: 1,400 acres
- 2015: 1,600 acres
- 2016: 1,800 acres

Legend:
- Prescribed fires
- Wildfires
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)

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<tr>
<th>AIRS</th>
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<td>13-245-0091</td>
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<td>Richmond</td>
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<td>Walker</td>
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<td>Washington</td>
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<td>13-319-0001</td>
<td>Gordon</td>
<td>Wilkinson</td>
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Red bold values were flagged in AQS as possible exceptional events due to wildfires.
Prescribed fire (2 acres) on April 24, 2015
  - 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

<table>
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<tr>
<th>BA/10</th>
<th>PM25</th>
<th>PM10</th>
<th>CO/10</th>
<th>NOx</th>
<th>NH3</th>
<th>SO2</th>
<th>VOC</th>
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Fire Emission (Tons)
GA EPD used smaller EFs than US EPA EFs.
EMISSION RATES (PRESCRIBED FIRES)

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

<table>
<thead>
<tr>
<th>Area (acres)</th>
<th>PM2.5</th>
<th>PM10</th>
<th>CO</th>
<th>NOx</th>
<th>NH3</th>
<th>SO2</th>
<th>VOC</th>
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<tr>
<td>GA</td>
<td>0.041</td>
<td>0.046</td>
<td>0.339</td>
<td>0.011</td>
<td>0.002</td>
<td>0.003</td>
<td>0.022</td>
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<tr>
<td>EPA</td>
<td>0.052</td>
<td>0.061</td>
<td>0.564</td>
<td>0.012</td>
<td>0.009</td>
<td>0.006</td>
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<tr>
<td>GA/EPA</td>
<td>158.3%</td>
<td>78.1%</td>
<td>75.1%</td>
<td>60.2%</td>
<td>92.4%</td>
<td>25.3%</td>
<td>55.1%</td>
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</table>

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)

<table>
<thead>
<tr>
<th></th>
<th>VOC</th>
<th>CO</th>
<th>PM2.5</th>
<th>NH3</th>
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<tr>
<td>GA EPD</td>
<td>12.38</td>
<td>152.18</td>
<td>22.78</td>
<td>1.38</td>
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<tr>
<td>Urbanski 2014</td>
<td>32.08 (21.76)</td>
<td>152 (30)</td>
<td>25.16 (7.98)</td>
<td>0.24 (0.24)</td>
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</table>

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
  ▪ 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

<table>
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<tr>
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<th>Georgia EPD</th>
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<tr>
<td>Flaming</td>
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<td>Residual smoldering</td>
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<td>Residual smoldering</td>
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</table>
NEI2014 FIRE EMISSIONS
— FLAMING AND SMOLDERING PHASES

Flaming Phase Emissions

Smoldering Phase Emissions
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 converts 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

GA EPD
1.38 million Acres

EPA SMARFIRE
0.88 million Acres
GA FIRE SPATIAL DISTRIBUTIONS IN 2014

Prescribed fires

Wildfires
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 managers
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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