Fire Emissions and SIP Modeling

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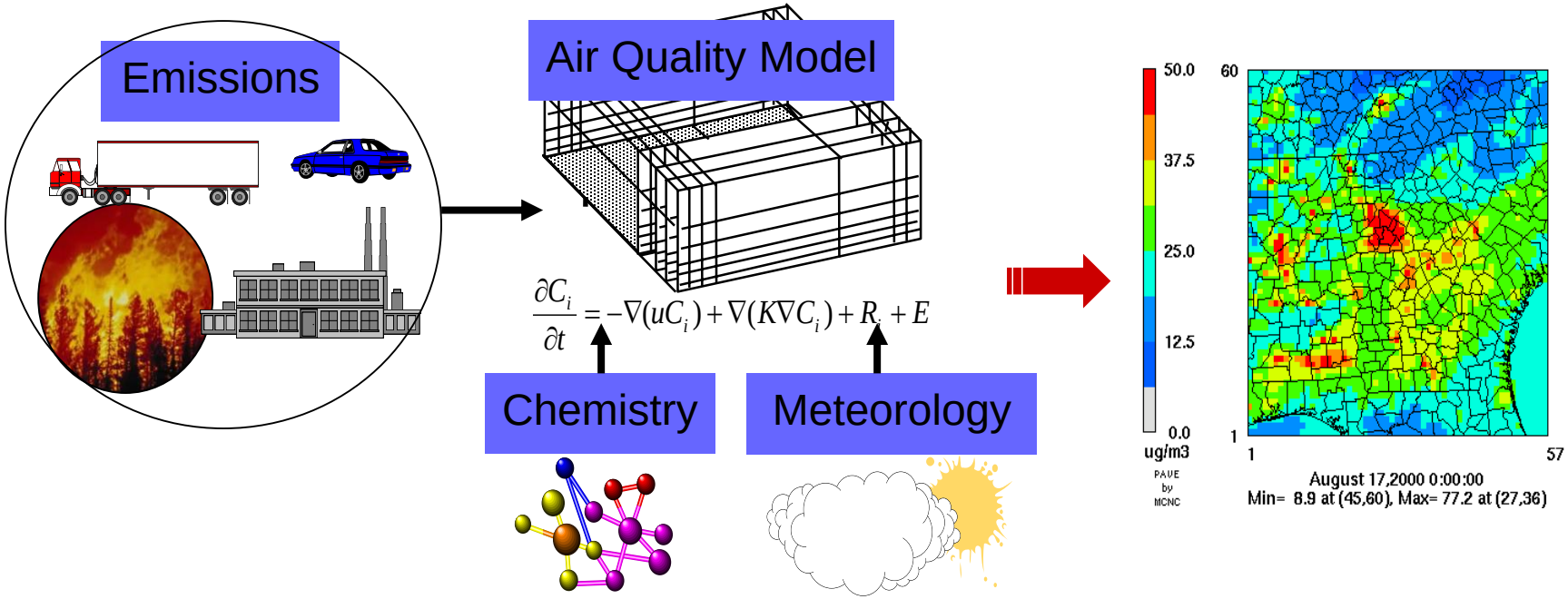
State Implementation Plan Development

- Ozone, PM2.5 and Regional haze
- Regional modeling efforts for the southeast
  - AL, FL, GA, KY, MS, NC, SC, TN, VA, WV
  - **S**outh**E**astern **M**odeling, **A**nalysis, and **P**lanning (SEMAP)
  - **A**ssociation for **S**outheastern **I**ntegrated **P**lanning (ASIP)
  - **V**isibility **I**mprovement **S**tate and **T**ribal **A**ssociation of the **S**outheast (VISTAS)
  - **S**outhern **A**ppalachian **M**ountains **I**nitiative (SAMI)
- SIP modeling includes:
  - Quantifying emissions from both natural and anthropogenic sources
  - Evaluating performance of the air quality modeling system
    - AQM reveals how air pollutant concentrations change with source emissions
  - Projecting future year air quality
    - Attainment demonstrations
    - Informing control strategy development

Air Quality Modeling System



- Emissions inventory
  - Point, nonpoint, mobile onroad and nonroad, fires
- Meteorology: WRF
- Emission processing: SMOKE
- Air quality model: CMAQ

Projecting Future Year Air Quality – SEMAP Example

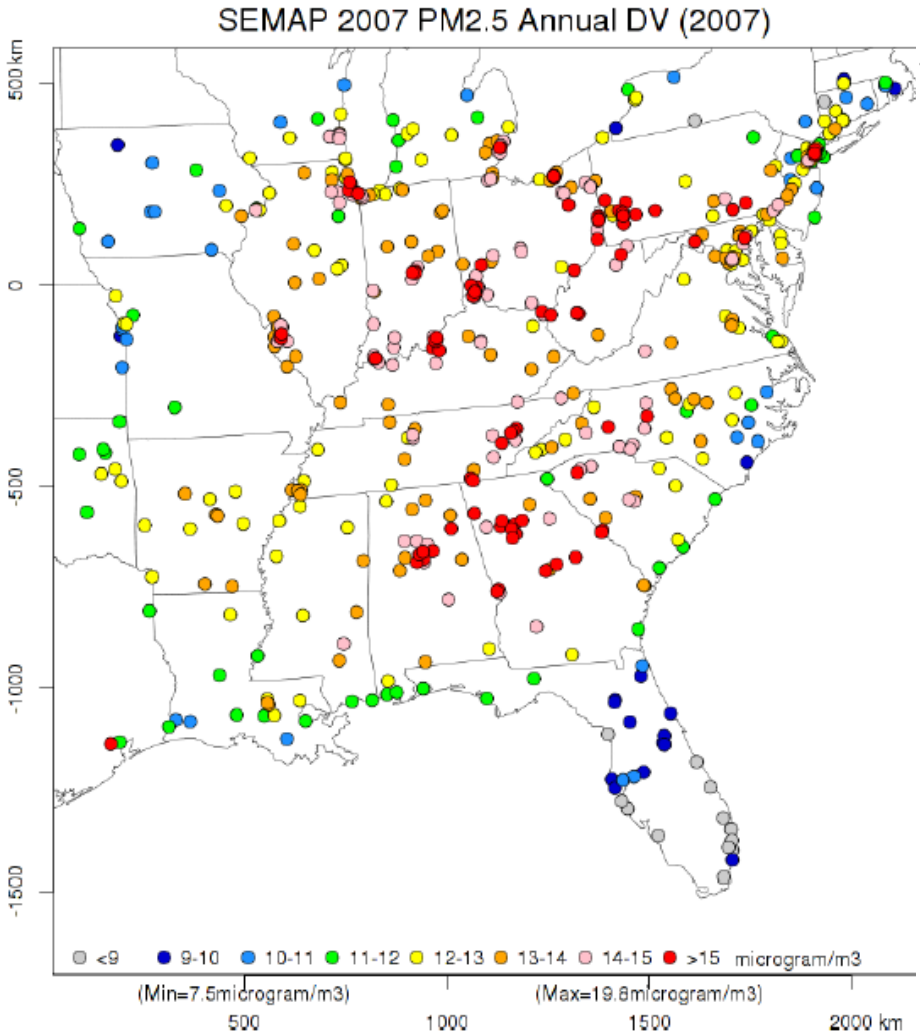


Figure 4-9 2007 Annual $PM_{2.5}$ DVC

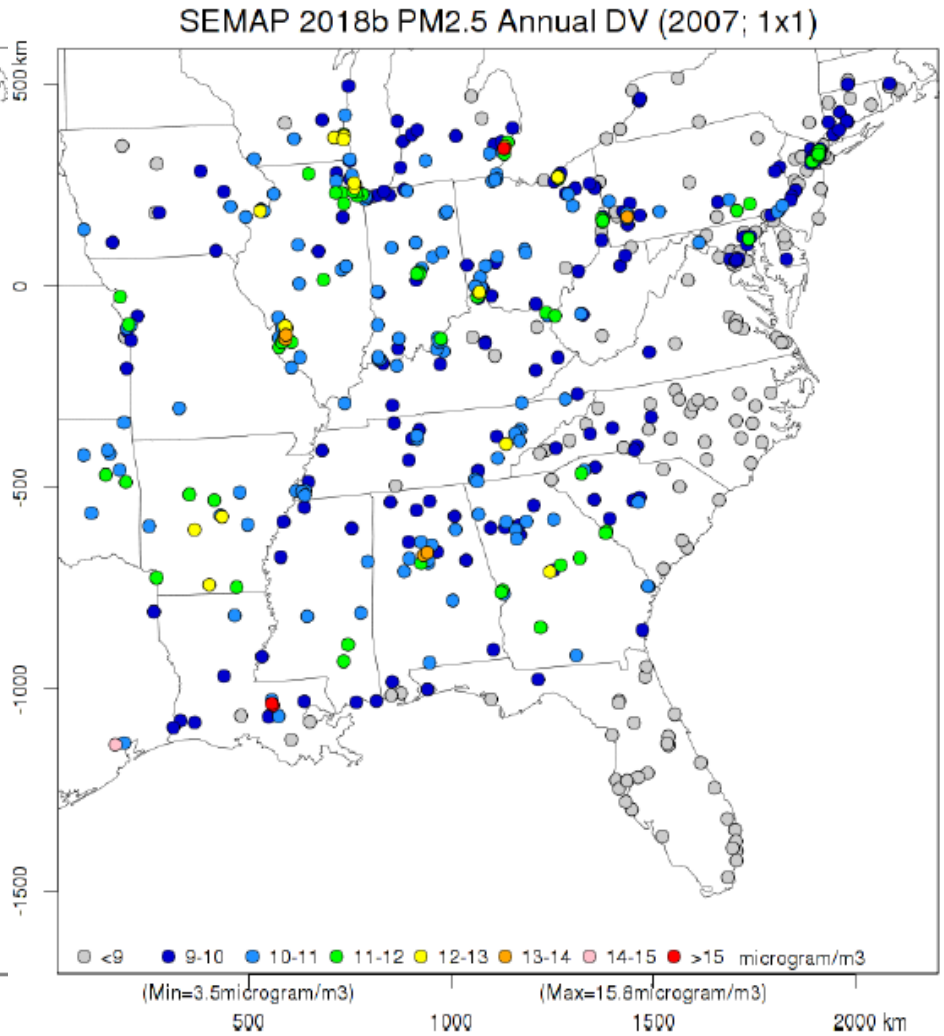
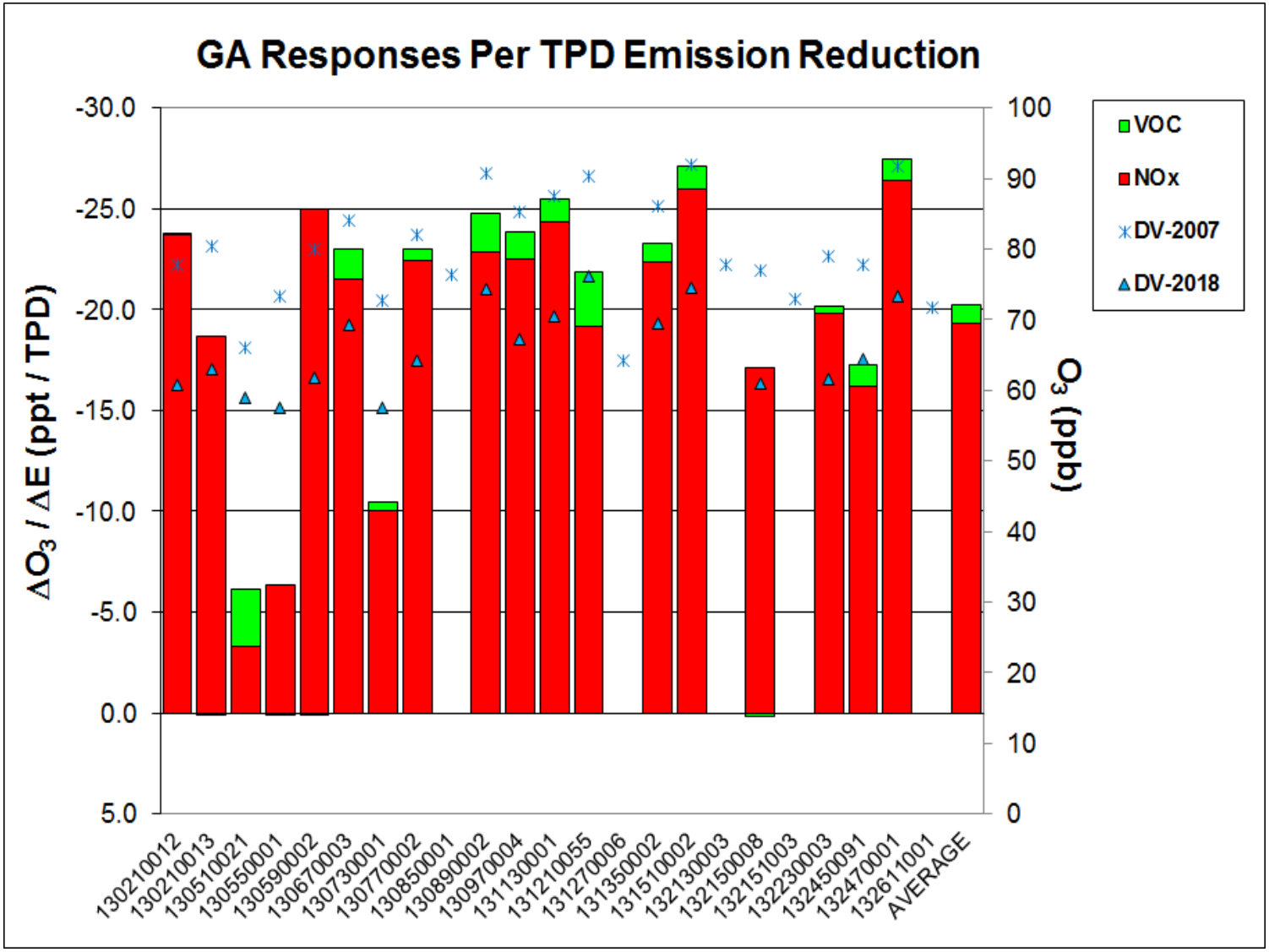


Figure 4-12 2018 Annual $PM_{2.5}$ DVFs: 1x1 RRF & 2007 DVC

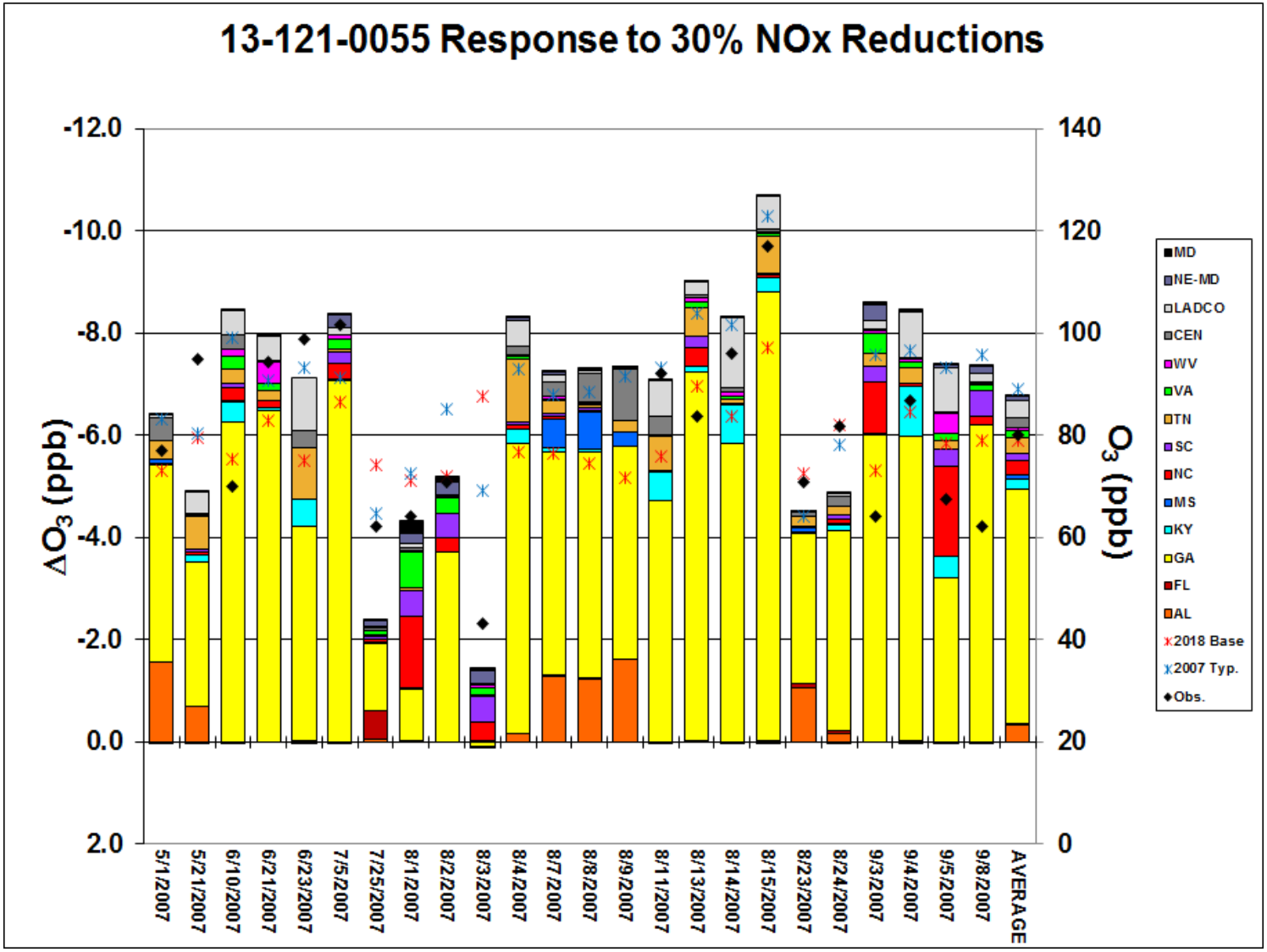
Informing Control Strategy Development (1)

- Normalized sensitivity of ozone to NOx and VOC emissions (ppt/TPD)



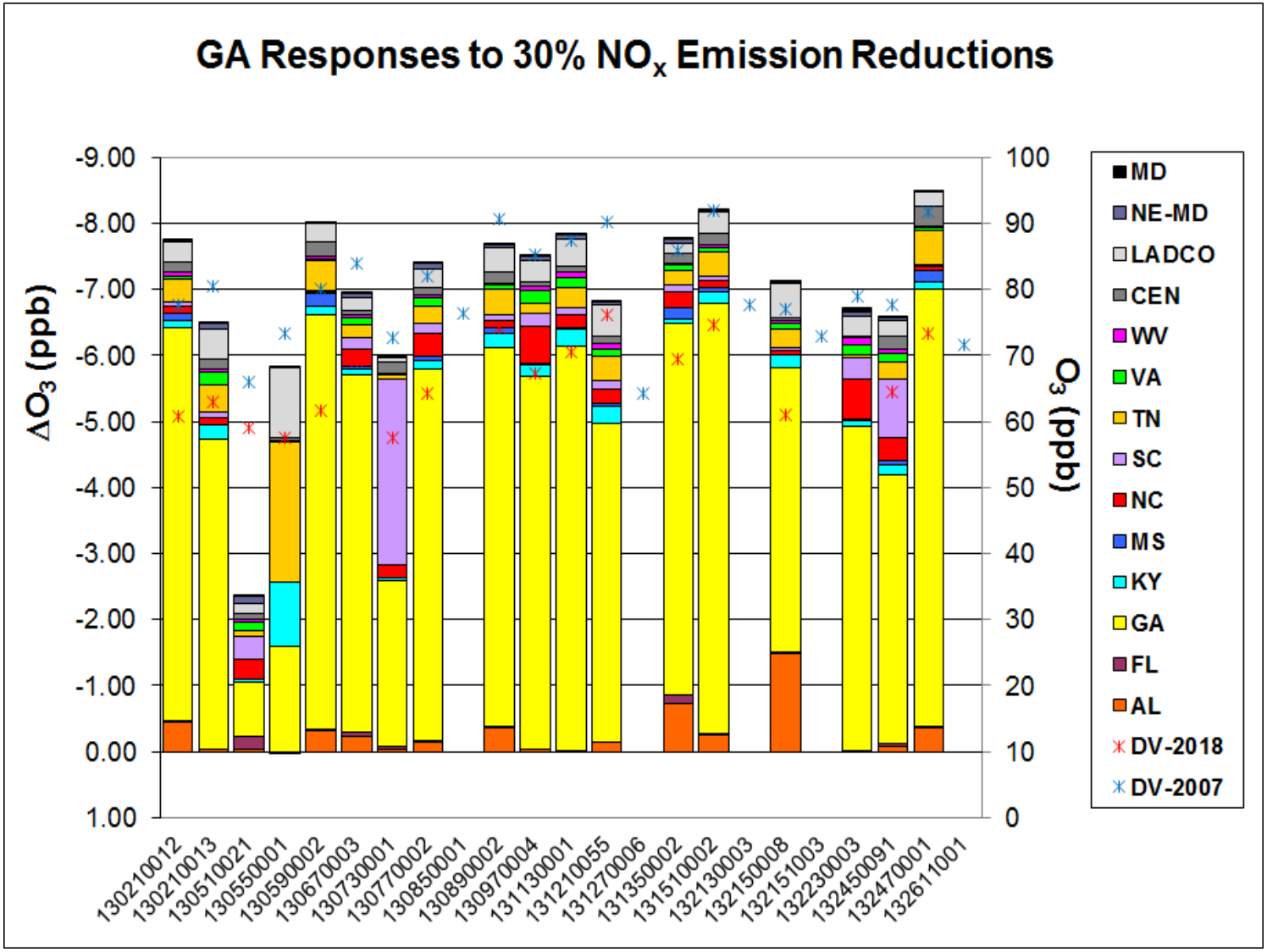
Informing Control Strategy Development (2)

- Temporal variability of local and interstate contributions from 30% NOx reductions.

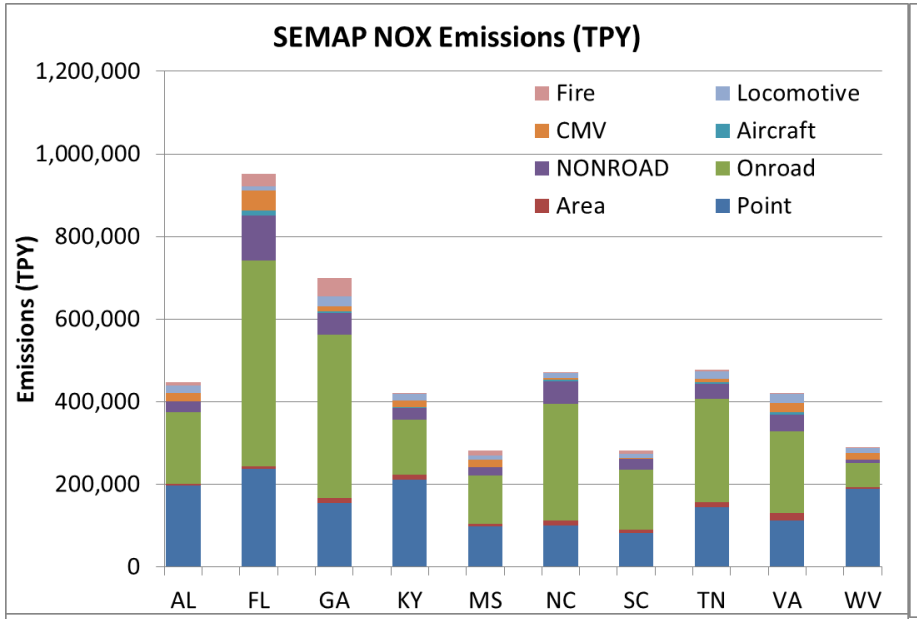


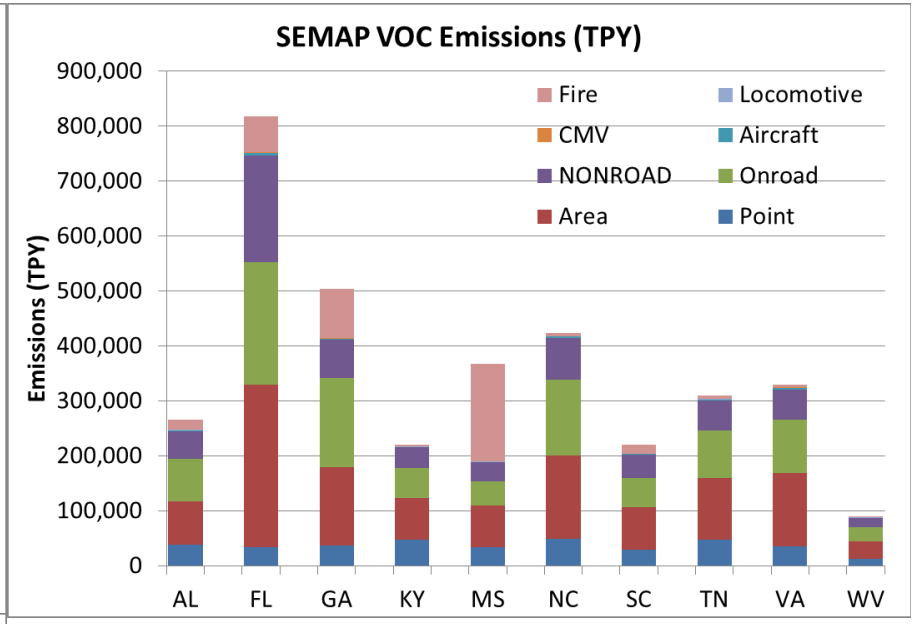
Informing Control Strategy Development (3)

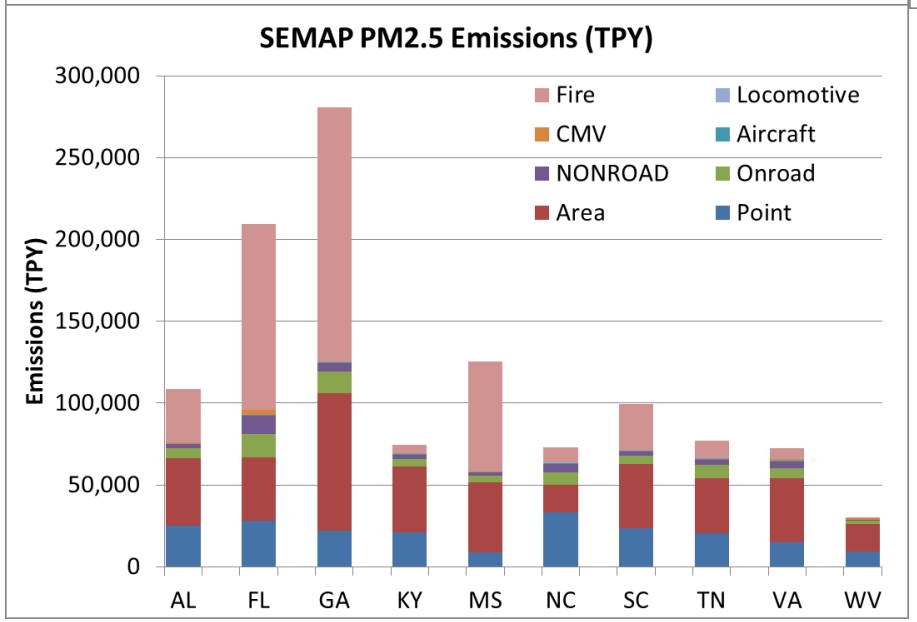
- Spatial variability of local and interstate contributions from 30% NOx reductions.



Quantifying Emissions



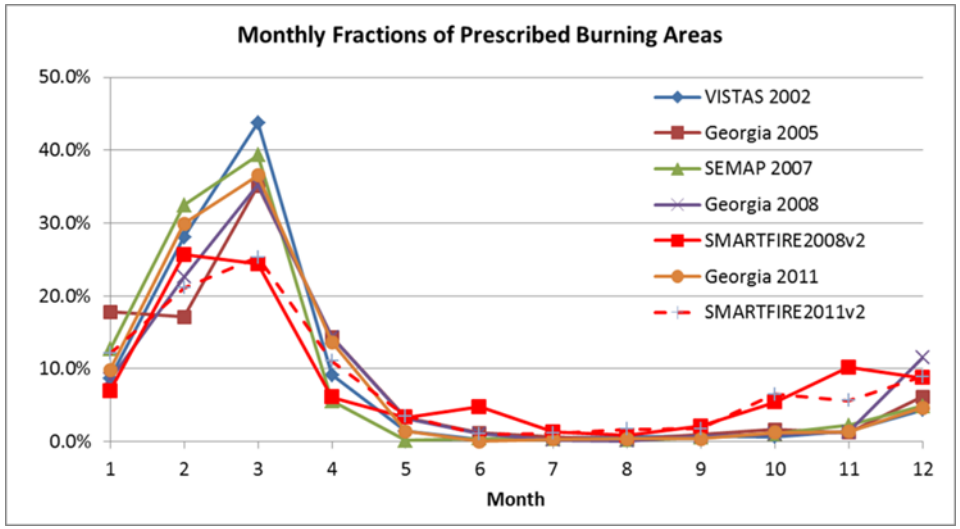




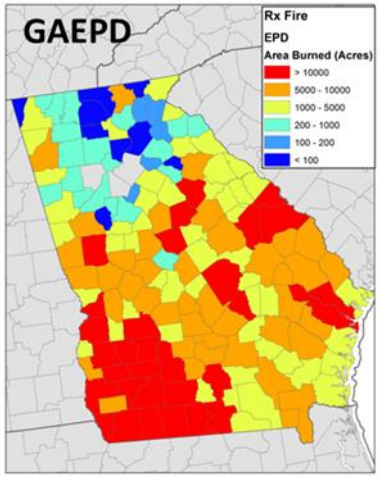
- SEMAP 2007 Emissions Summaries
- Fires emit large amounts of air pollutants
- SEMAP fire emission inventory is developed using fire records collected from state and federal agencies
- GA, FL, AL, SC have large fire emissions
- **SMARTFIRE data are used for MS**

Fire Emissions Have large Impacts on AQM Performance

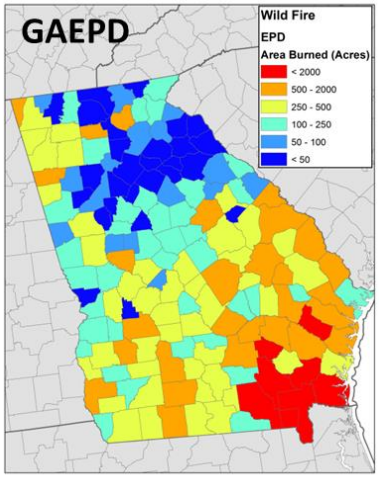
Fire emissions have large temporal and spatial variation



Prescribed Fires

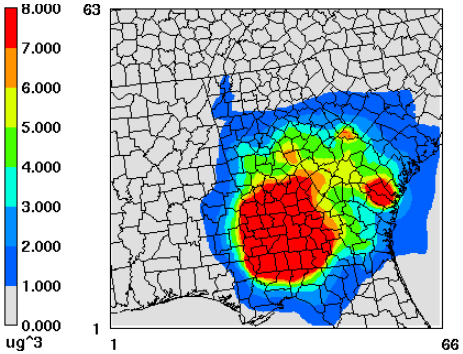


Wildfires

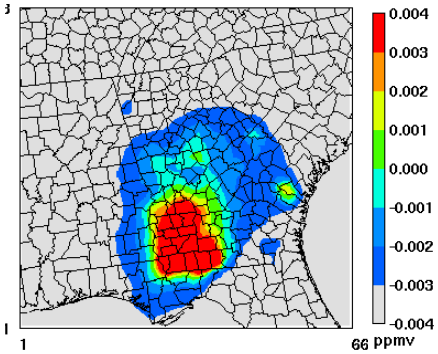


The same fire emissions emitted during different months have different impacts on $PM_{2.5}$ and O_3(Peaks of daily maximum 8-hr ozone)

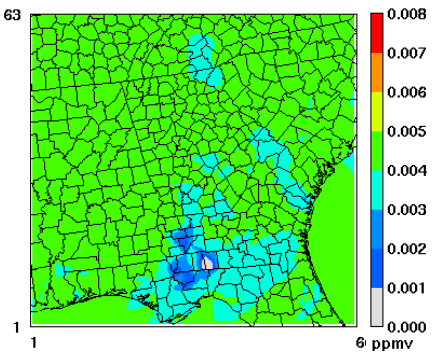
$PM_{2.5}$ Jan: 7.3 µg/m^3



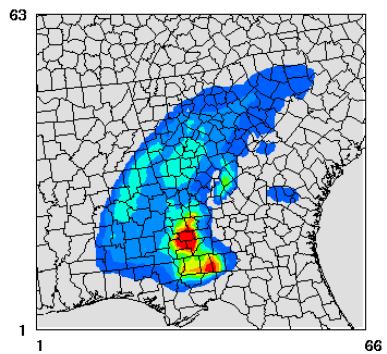
$PM_{2.5}$ May: 3.4 µg/m^3



Ozone Jan: 0.18 ppbv



Ozone May: 2.4 ppbv



* $PM_{2.5}$ Values are monthly averages for Georgia, and ozone values are averages for Atlanta metropolitan area.

Developing Typical Fire Emissions (1)

- Future year air quality projection and control strategy development using AQMs need fire emissions representing the typical emission and air quality conditions
  - Large year-to-year variation in wildland fire activity, unlike other anthropogenic sources
  - Year-specific inventory might not be representative
- Air quality modeling projections
  - $DV_F = DV_C * RRF$
  - $RRF = Model_{future} / Model_{base}$
  - If the fire emissions inventory includes large wildfires fires near a monitor that last for weeks or months, the relative response factors (RRFs) become unresponsive to anthropogenic emission controls because the base year and future year modeled concentrations are dominated by fire emissions.
  - Air quality responses to emission reductions can't be properly simulated by the AQM.

Developing Typical Fire Emissions (2)

- Consistent with Design Value (DV) calculations
  - Ozone and PM2.5 DVs for attainment with NAAQS
    - Average of 3 years of measurements (e.g., DV2011 based on 2009-2011)
  - Ozone and PM2.5 DVs for model attainment demonstrations
    - Average of 3 DVs (e.g., DV2011, DV2012, DV2013 for base year 2011)
    - (2009 + 2010*2 + 2011*3 + 2012*2 + 2013)/9
  - Regional haze projections for 20% best and 20% worst days
    - 5-year straight average (e.g., 2009-2013 for base year 2011)
- Typical fire emissions should be representative of either 3 years or 5 years for ozone and PM2.5, and 5 years for regional haze
  - Remove fires classified as exceptional events by U.S. EPA
  - Scale county-by-county base year actual emissions by the ratios of multi-year average of acreage burned and base year acreage burned
- Future fire emissions can either be kept constant with the base year typical fire emissions or adjusted for projected growth

SEMAP Example

- Two SEMAP 2007 emission inventories: 2007actual and 2007typical
- SEMAP 2007actual: best estimates for emissions during 2007
  - Used for model performance evalustions
- SEMAP 2007typical: same as 2007 actual emissions, except fires
  - Removed exceptional events and average fire activity during 2006-2008
- Two CMAQ runs were performed with 2007actual or 2007typical fire emissions with emissions from other anthropogenic and natural sources

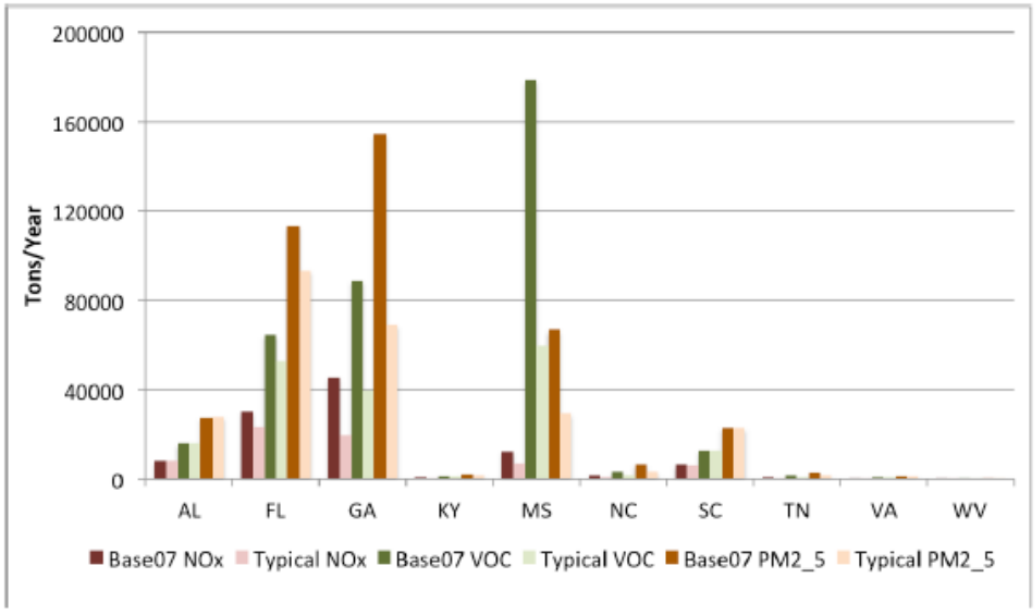
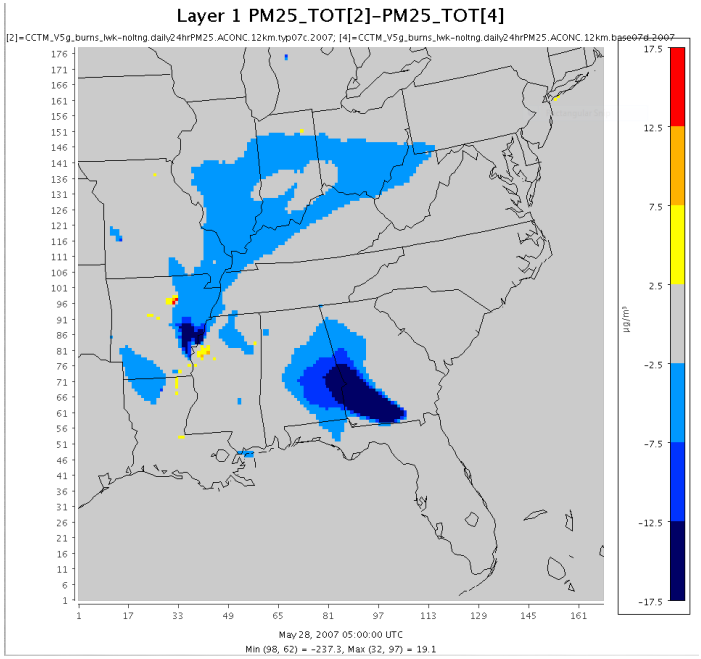


Figure 2-37. SESARM base 2007 and typical annual total fire emissions of NOx, VOC, and PM2.5



Summary

- There are large emissions from wildland fires in the Southeast and they have large impacts on the air quality.
- Fire emissions have large impacts on the AQM performance.
  - Total emissions, when and where
- Future year air quality projection and control strategy development using AQMs need fire emissions representing the typical emission and air quality conditions
  - Typical base year fire emissions: removed exceptional events and average fire activity during 3 or 5 years period
  - Future fire emissions can either be kept constant with the base year typical fire emissions or adjusted for projected growth