

Development of Managed Burning and Wildland Fire Emission Estimates for VISTAS

William R. Barnard

MACTEC Engineering and Consulting, Inc.

404 S.W. 140th Terrace

Newberry, FL 32669-3000

352-333-6617

wrbarnard@mactec.com

Pat Brewer

VISTAS Technical Coordinator

2090 US Highway 70

Swannanoa, NC 28778

828-296-4541

Pat.Brewer@ncmail.net

Introduction

- Visibility - State and Tribal Association of the Southeast (VISTAS) is providing technical analyses for 10 VISTAS states in support of State Implementation Plans for regional haze.
- VISTAS 2002 emissions inventory will be used for emissions reporting and photochemical modeling of fine particulate matter and visibility.

Introduction

- Fires, both prescribed (managed) and wildfires, contribute to fine PM and regional haze.
- VISTAS has developed 2002 fire emission estimates for:
 - Prescribed
 - Wildfires
 - Agricultural burning
 - Land clearing of debris

2002 Fire Emissions Estimation

- Requested data spring 2003
 - State agencies for state and private lands
 - Federal agencies for Federal lands
 - Forest Service
 - Fish and Wildlife Service
 - National Park Service
 - Bureau of Land Management
 - Bureau of Indian Affairs

Data Requested: Wildfires

- Number of acres burned
- Date of fire
 - Actual fire days
 - At minimum, monthly totals
- Type of material burned (pine, oak, etc.)
- Fuel loading (tons/acre)
- Location of fire
 - Latitude/longitude preferred
 - At minimum, county or section/township/range
 - If fires spanned counties, breakdown acres per county

Data Requested: Prescribed fires

- Number of acres burned
- Date of fire
 - Actual fire days
 - At minimum, monthly totals
- Type of material burned
 - Short needle conifer, long needle conifer, logging slash debris, hardwood, palmetto, etc.
- Fuel loading (tons/acre)
- Location of fire
 - Latitude/longitude preferred
 - At minimum, county or section/township/range
 - Breakdown of acres per county

Data Requested

- Similar data requested for agricultural burning and land clearing
- VISTAS also requested estimates of percentage of fire area that occurred in flaming, smoldering, and actual fire stages.

Data Received – summer 2003

- Data received varied by State in both fire types (e.g., wildfires, prescribed, agricultural or land clearing) and level of detail
- Spatial
 - some states provided fire data by latitude and longitude
 - others provided only county location
- Temporal
 - some states provided data on individual fires
 - others provided only month of occurrence
- Fuels
 - some states provided fuel loading and vegetation type
 - others provide no fuels data

Data Received

- No States provided estimates on the smoldering or flaming stages of the fire
- Most States provided information in electronic format;
 - Some states only provided hard copy
 - Hard copy data were scanned and inserted it into spreadsheets.
 - Spreadsheets were reviewed and compared to original materials to ensure that data were translated correctly

State Supplied Fire Activity Data

| State | Agriculture | Prescribed/ Silviculture | Land Clearing | Wildfires |
|-------|-------------|-----------------------------|------------------|-----------|
| AL | ✓ | ✓ | ✓ | ✓ |
| FL | ✓ | ✓ | ✓ | ✓ |
| GA | ✓ | ✓ | ✓ | ✓ |
| KY | | | | ✓ |
| MS | | ✓ | | |
| NC | | | | ✓ |
| SC | ✓ | ✓ | ✓ | ✓ |
| TN | | | | ✓ |
| VA | | | | ✓ |
| WV | | | | ✓ |

Federal Agency Supplied Fire Activity Data

| Agency | Agriculture | Prescribed/ Silviculture | Land Clearing | Wildfires |
|--------|-------------|-----------------------------|------------------|-----------|
| USFS | | ✓ | | ✓ |
| FWS | | | | ✓ |
| NPS | | | | ✓ |
| BLM | | | | ✓ |
| BIA | | | | ✓ |

Data Manipulation/Augmentation

- MACTEC compiled the fire data into a master database containing:
 - fire location and date
 - data necessary to calculate emissions
- Data were augmented to ensure each record had:
 - Location information (Latitude/Longitude)
 - A Fuel Loading value for each fire
 - An emission factor
 - assigned from either AP-42, EPA report, or state fire experts
- This database was used to calculate fires on a fire-by-fire basis for all data submitted.

Fire Data Handling After Submittal

- Latitude/Longitude data processing
 - For data with only State and County FIPS codes, county centroid value added to file
 - All Lat/Long data converted to decimal degrees
 - Submittals included H:M:S, decimal degrees and Section, township, range
 - Insufficient resources to process section, township, range data
 - If only Lat/Long data submitted, county FIPS code added via GIS
 - Fires that fell outside of the State, in the ocean, or in the wrong State were dropped
 - Less than 3% of total acreage in all cases

Fire Data Handling After Submittal

- Fuel Loading assigned to each fire
 - Priority order for assigning fuel loading:
 - State-supplied data – if provided always used
 - National Fire Danger Rating System (NFDRS) Model value assigned fuel loading
 - Values provided by Bruce Bayle, USFS
 - Compared to EPA report
 - Revised values chosen
 - Material burned type used to assign a NFDRS value if the material burned could be easily matched to a NFDRS fuel model
 - State specific defaults calculated where no material burned type provided
 - For fires other than wildfires or prescribed burns, values assigned based on NFDRS code or material type or via AP-42 values

Fire Data Handling After Submittal

- Emission Factor assignment
 - Emission factors assigned from either AP-42 or from EPA report
 - "Data Needs and Availability for Wildland Fire Emission Inventories - Short-term Improvements to the Wildland Fire Component of the National Emissions Inventory" – Pace Report
 - Combined emission factors developed for some categories (e.g., State indicated that fire covered NFDRS fuel models D&E, averaged D&E emission factors)

Fire Files Documentation

- Logical fields used in database to indicate whether or not:
 - Lat/long was county centroid
 - Default fuel loading
 - Default material type
- Also included fields to identify for each record:
 - Data source for the fuel loading
 - Whether submittal from a Federal or State Agency

Fire Emissions Calculations

- Fire emissions calculated based on:
 - Emission Factors
 - Fuel Loadings
 - Acres burned
- Fire emissions calculated for each individual fire
 - Emissions calculated for all pollutants including NH₃, EC/OC and PM
 - PM-PRI and PM-FIL emissions assumed equal

Example Fuel Loadings

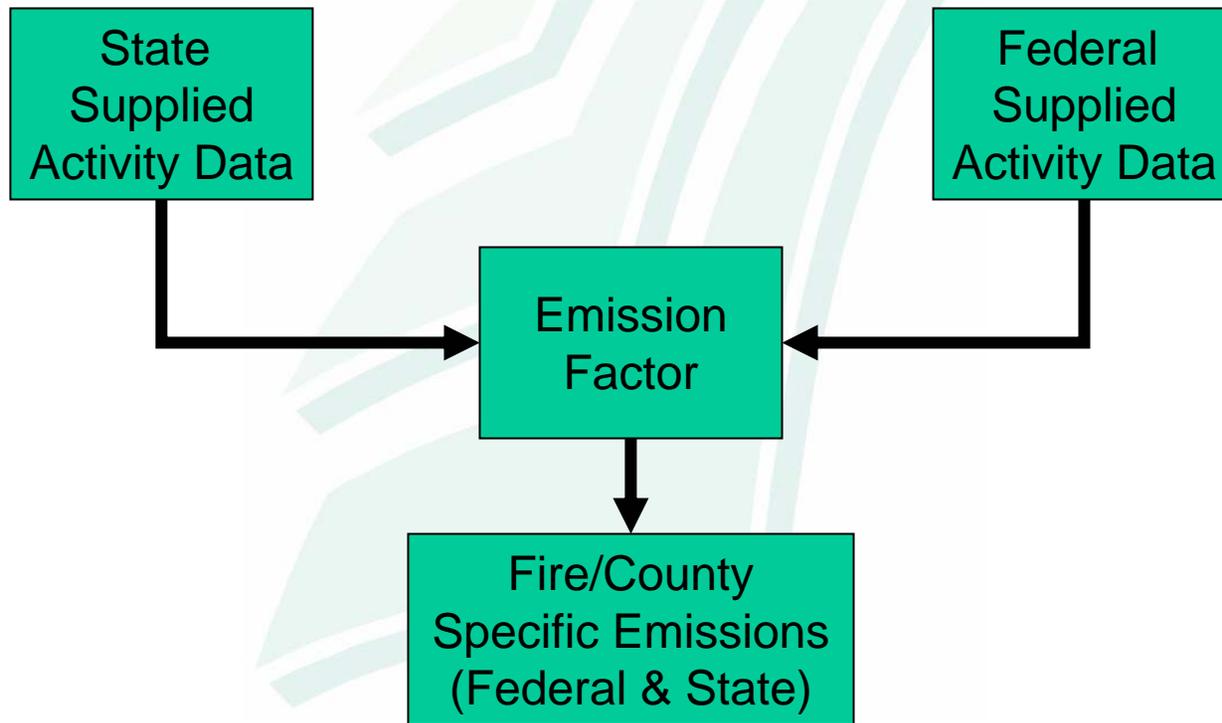
(tons/acre burned)

| NFDRS Fuel Model | Vegetation | average fuel loading | EPA wildfire loading | EPA prescribed loading | VISTAS (Bayle revised) |
|------------------|--|----------------------|----------------------|------------------------|------------------------|
| A | Annual grass and forbs | 0.23 | 0.5 | 0.5 | 0.5 |
| C | Open timber/grass | 1.68 | 4.7 | 4.7 | 2 |
| D | Southern rough | 4.275 | 15.6 | 10.6 | 4.275 |
| E | Hardwoods (winter) | 2.375 | | | 2.375 |
| F | Intermediate brush | 8.85 | 3.8 | 3.8 | 8.85 |
| G | Closed, short-needle conifer (heavy dead) | 8.45 | 73.5 | 25.6 | 8.45 |
| H | Closed, short-needle conifer (normal dead) | 3.95 | 27.5 | 15 | 3.95 |
| I | Heavy slash | 30.2 | 55.1 | 49.1 | 30.2 |
| J | Medium slash | 17.55 | 34 | 31.2 | 12 |
| K | Light slash | 6.25 | 14.4 | 13.1 | 6.25 |
| N | Sawgrass | 3.8 | 5 | 5 | 3.8 |
| O | Pocosin | 9.5 | 46.1 | 45.1 | 9.5 |
| P | Southern plantation | 2.5 | 16.4 | 10.2 | 2.5 |
| R | Hardwoods (summer) | 1.5 | 3.1 | 3.1 | 2 |

Approach to Filling Fire Data Gaps

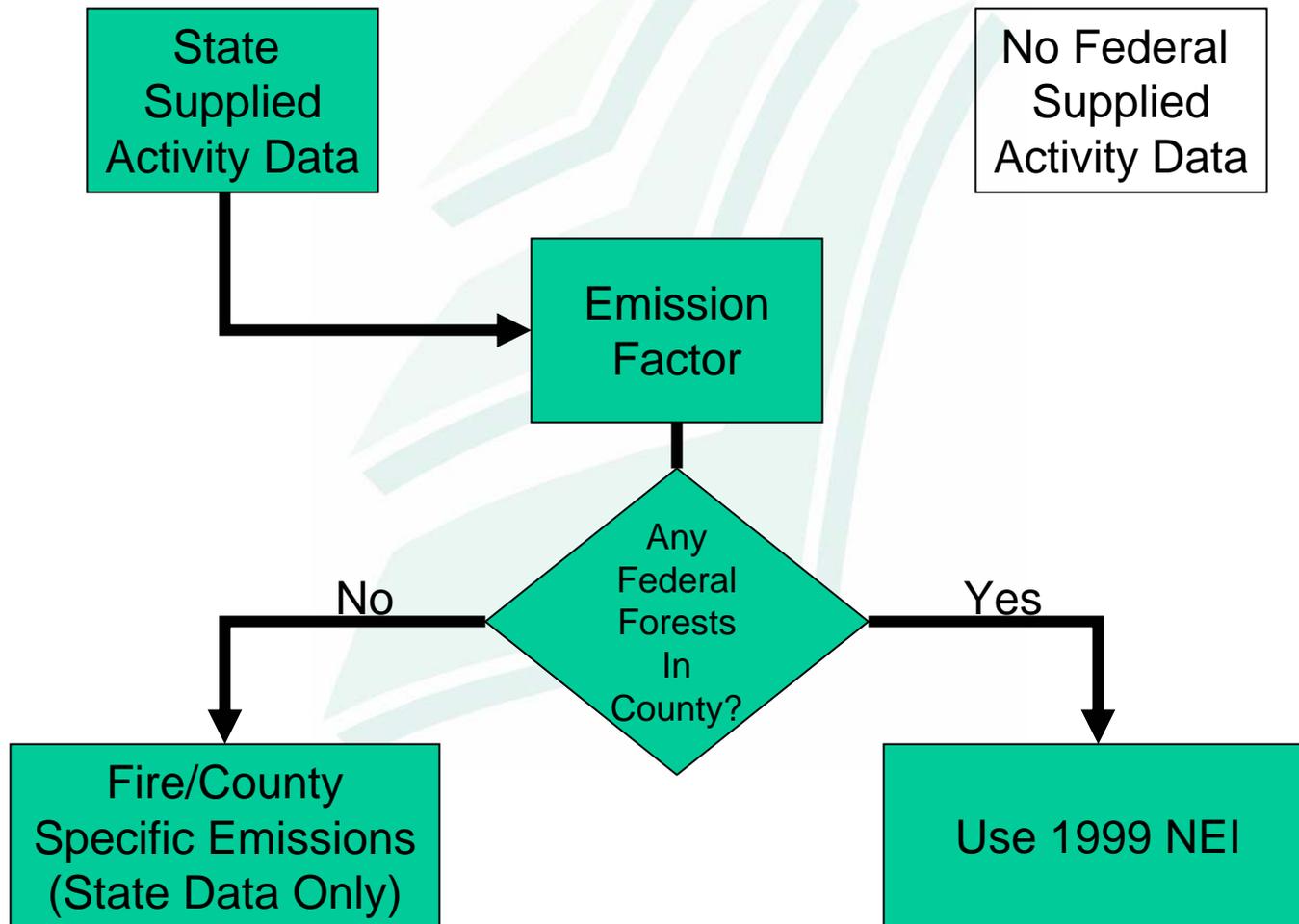
- Where State/Federal data not available, use 1999 NEI data
- 1999 NEI doesn't contain the geographic level of detail of State/Federal supplied data
 - Estimates at county level and annual summary
- For modeling purposes
 - Fires located at county centroid
 - Fires allocated seasonally using SMOKE default factors initially
 - Actual 2002 monthly allocations used for final inventory

Fires Approach (prescribed and wildfires)

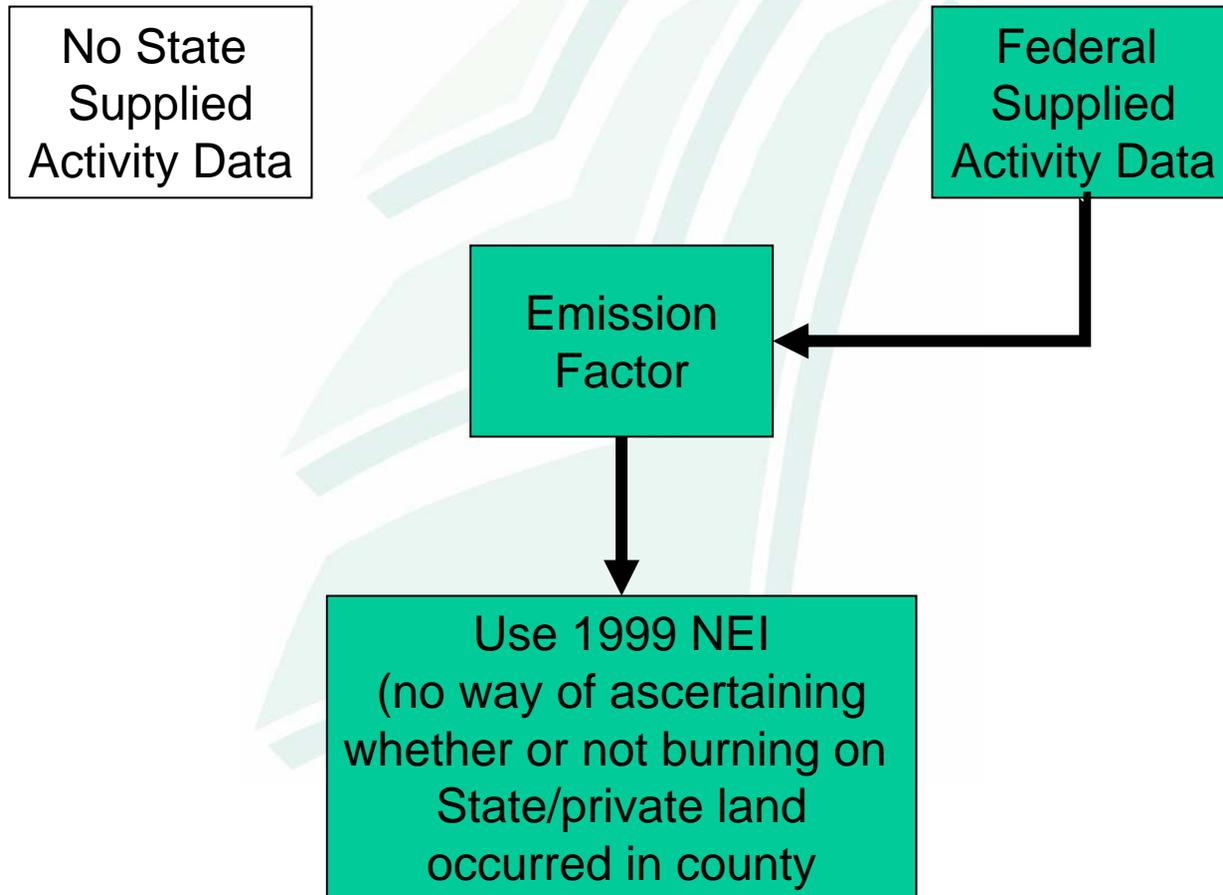


This general procedure applies to both prescribed and wildfires.

Approach if Federal Data Missing



Approach if State Data Missing



Review of Draft 2002 Fire Inventory

- Draft Inventory provided for review fall 2003 to VISTAS Fire workgroup and State forestry agencies
- States comments incorporated in revised 2002 fire inventory delivered winter 2004
- 2002 Fire emissions are being modeled as individual point sources wherever provided data sufficient to do so.

Results – Wildfires

(all values in tons)

| State | CO | NH3 | NOX | PM10-PRI | PM25-PRI | SO2 | VOC |
|--------------|----------------|--------------|--------------|---------------|---------------|--------------|---------------|
| AL | 16,132 | 73 | 346 | 1,568 | 1,345 | 95 | 759 |
| FL | 46,457 | 209 | 997 | 4,517 | 3,874 | 273 | 2,186 |
| GA | 100,389 | 452 | 2,154 | 9,761 | 8,372 | 590 | 4,724 |
| KY | 8,960 | 40 | 192 | 871 | 747 | 53 | 422 |
| MS | 30,429 | 126 | 869 | 2,826 | 2,543 | 33 | 4,173 |
| NC | 23,006 | 103 | 494 | 2,237 | 1,918 | 135 | 1,083 |
| SC | 22,551 | 101 | 484 | 2,193 | 1,881 | 133 | 1,061 |
| TN | 4,458 | 20 | 96 | 433 | 372 | 26 | 210 |
| VA | 16,650 | 75 | 357 | 1,619 | 1,388 | 98 | 783 |
| WV | 6,735 | 30 | 144 | 655 | 562 | 40 | 317 |
| Total | 275,766 | 1,230 | 6,133 | 26,680 | 23,002 | 1,476 | 15,718 |

Results – Prescribed

(all values in tons)

| State | CO | NH3 | NOX | PM10- PRI | PM25- PRI | SO2 | VOC |
|--------------|------------------|--------------|---------------|----------------|----------------|---------------|---------------|
| AL | 359,596 | 1,618 | 7,715 | 34,964 | 29,987 | 2,115 | 16,922 |
| FL | 701,932 | 3,157 | 15,059 | 68,250 | 58,535 | 4,129 | 33,032 |
| GA | 473,461 | 2,130 | 10,157 | 46,035 | 39,482 | 2,785 | 22,281 |
| KY | 2,940 | 8 | 55 | 412 | 371 | 2 | 140 |
| MS | 11,360 | 51 | 244 | 1,105 | 947 | 67 | 535 |
| NC | 2,543 | 7 | 47 | 357 | 321 | 1 | 121 |
| SC | 165,951 | 746 | 3,560 | 16,136 | 13,839 | 976 | 7,809 |
| TN | 580 | 2 | 11 | 81 | 73 | 0 | 28 |
| VA | 6,547 | 103 | 708 | 6,247 | 5,622 | 25 | 319 |
| WV | 30 | 0 | 1 | 3 | 3 | 0 | 1 |
| Total | 1,724,940 | 7,822 | 37,556 | 173,590 | 149,181 | 10,101 | 81,188 |

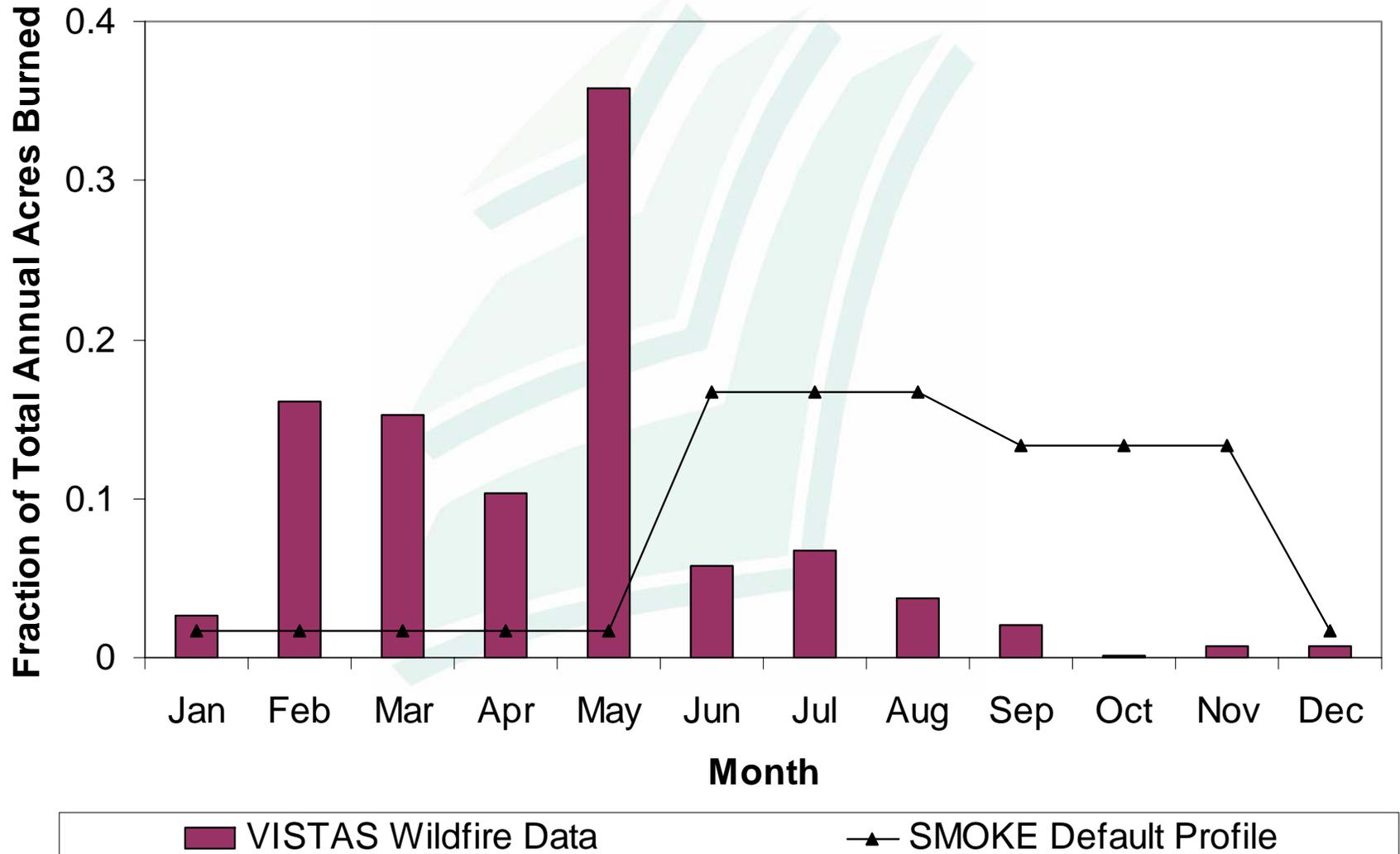
Top 10 2002 Wildfires in 10 VISTAS States

| State | Date | Acres |
|---------------|-----------|---------|
| GEORGIA | 5/1/2002 | 124,104 |
| GEORGIA | 5/2/2002 | 7,900 |
| FLORIDA | 5/3/2002 | 6,800 |
| WEST VIRGINIA | 3/21/2002 | 5,816 |
| GEORGIA | 3/20/2002 | 5,580 |
| FLORIDA | 5/16/2002 | 4,835 |
| FLORIDA | 7/31/2002 | 4,200 |
| FLORIDA | 8/3/2002 | 4,200 |
| VIRGINIA | 2/26/2002 | 4,150 |
| FLORIDA | 5/11/2002 | 4,000 |

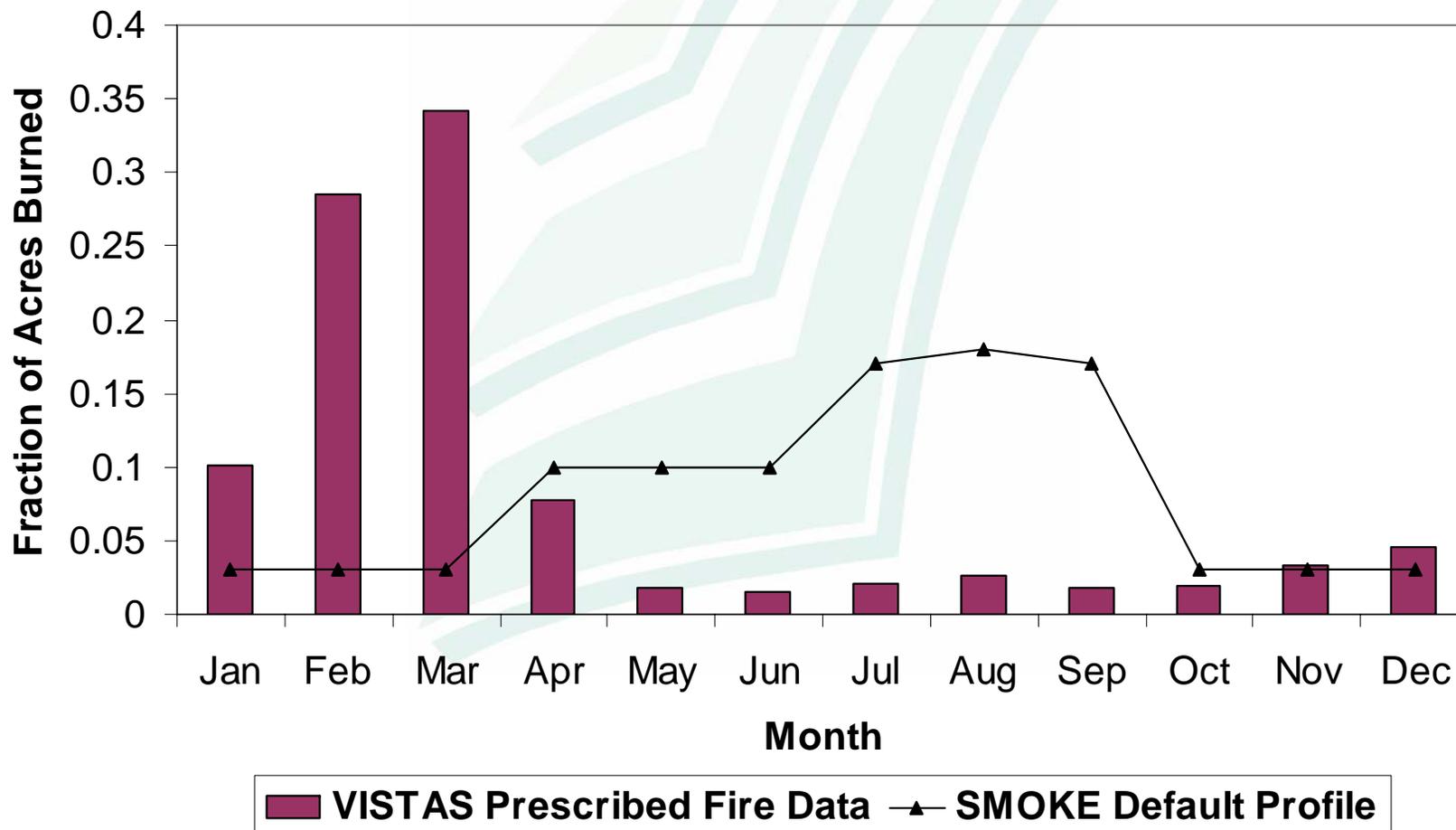
Top 10 2002 Prescribed Fires in 10 VISTAS States

| State | Date | Acres |
|--------------|-------------|--------------|
| GEORGIA | 3/1/2002 | 65,632 |
| GEORGIA | 3/1/2002 | 27,555 |
| GEORGIA | 3/1/2002 | 25,235 |
| GEORGIA | 3/1/2002 | 23,499 |
| GEORGIA | 3/1/2002 | 22,914 |
| GEORGIA | 2/1/2002 | 18,815 |
| GEORGIA | 3/1/2002 | 15,932 |
| GEORGIA | 2/1/2002 | 14,615 |
| GEORGIA | 4/1/2002 | 14,351 |
| GEORGIA | 3/1/2002 | 12,868 |

Monthly Fraction of Annual Wildfire Acres Burned - 2002 Actual and SMOKE Default Profile

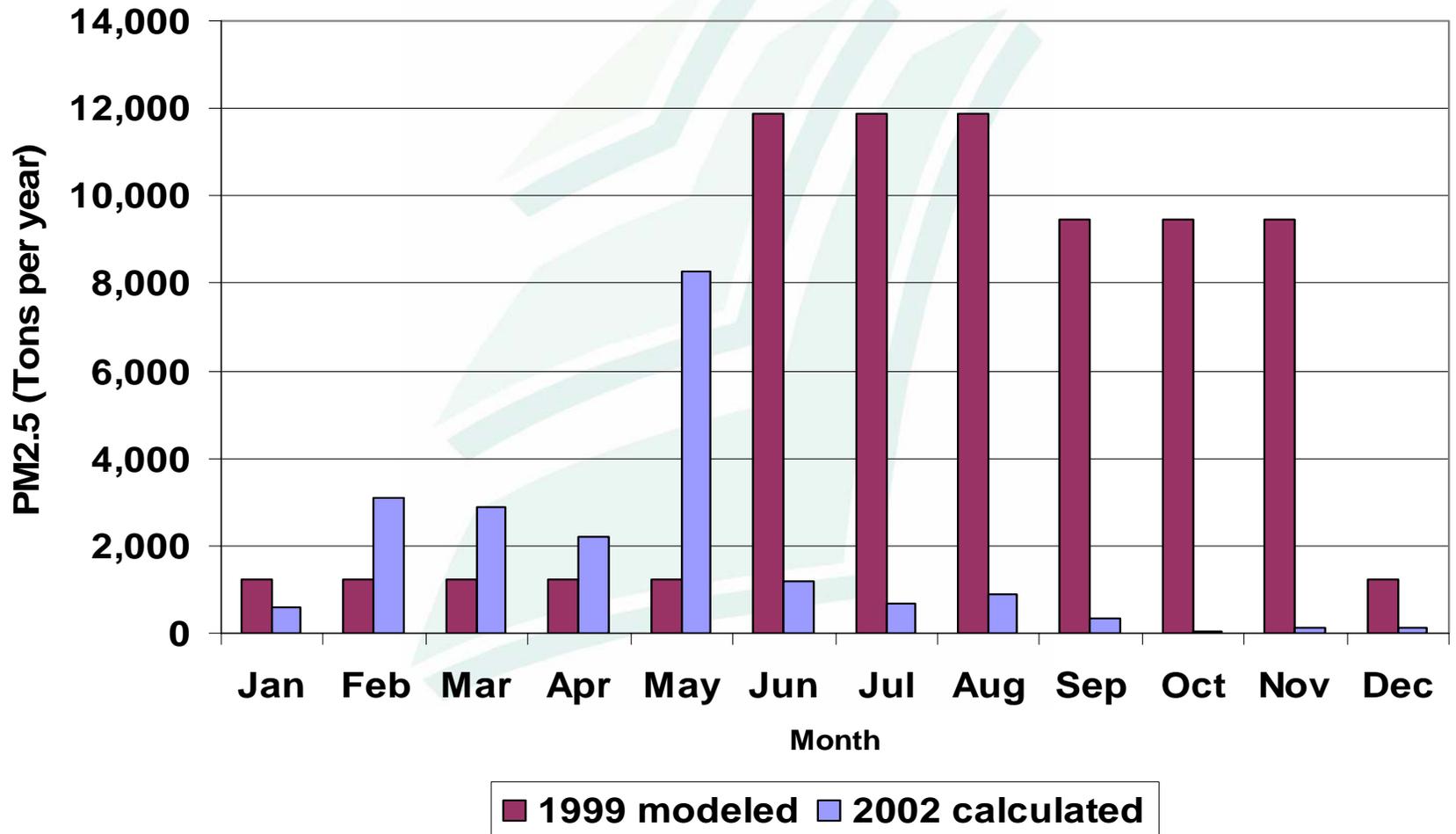


Monthly Fraction of Annual Prescribed Acres Burned - 2002 Actual and SMOKE Default Profile



Wildfire PM2.5 Emissions for 9 VISTAS States*

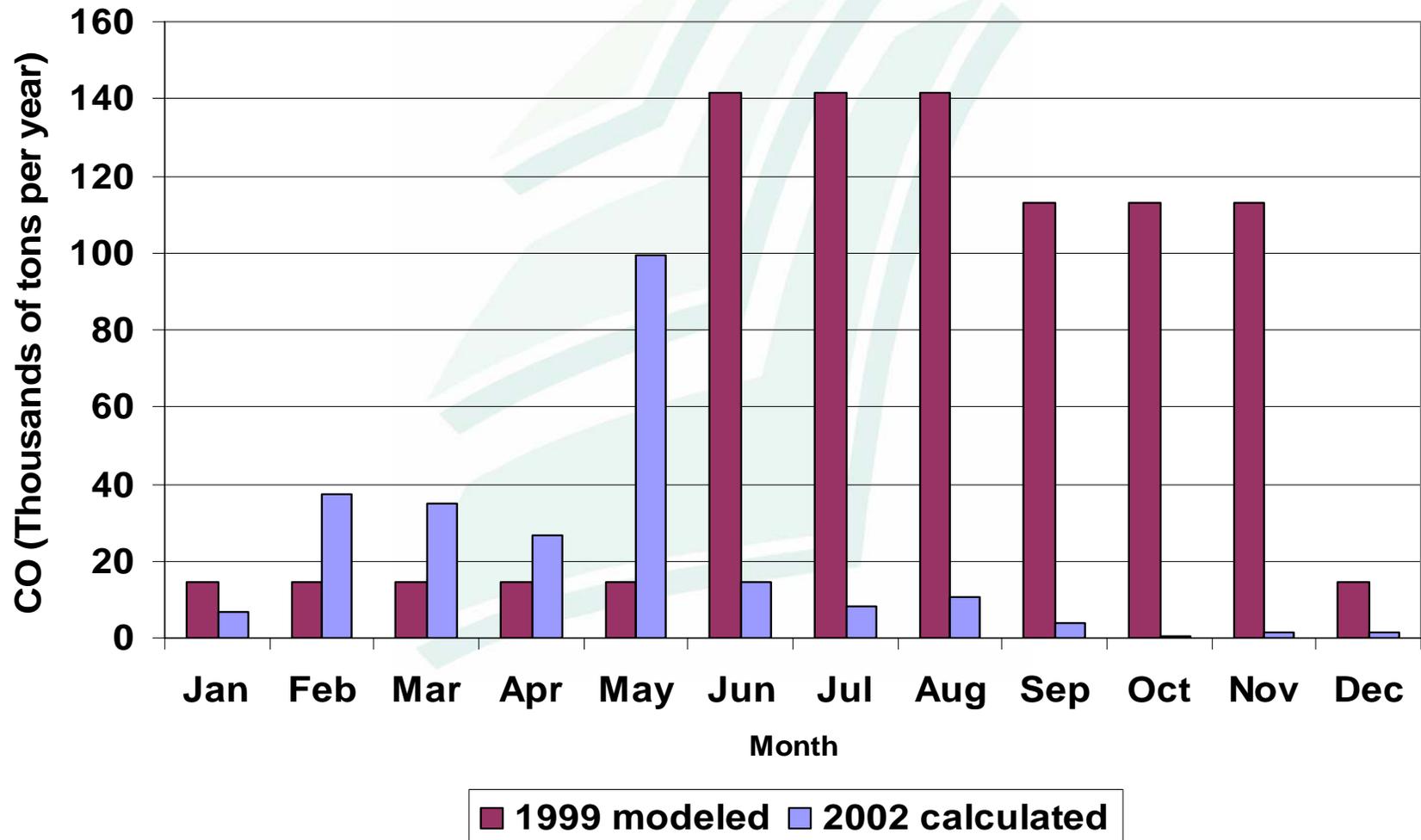
1999 Modeled vs 2002 Calculated



*AL, FL, GA, KY, NC, SC, TN, VA, WV; MS did not submit wildfire data

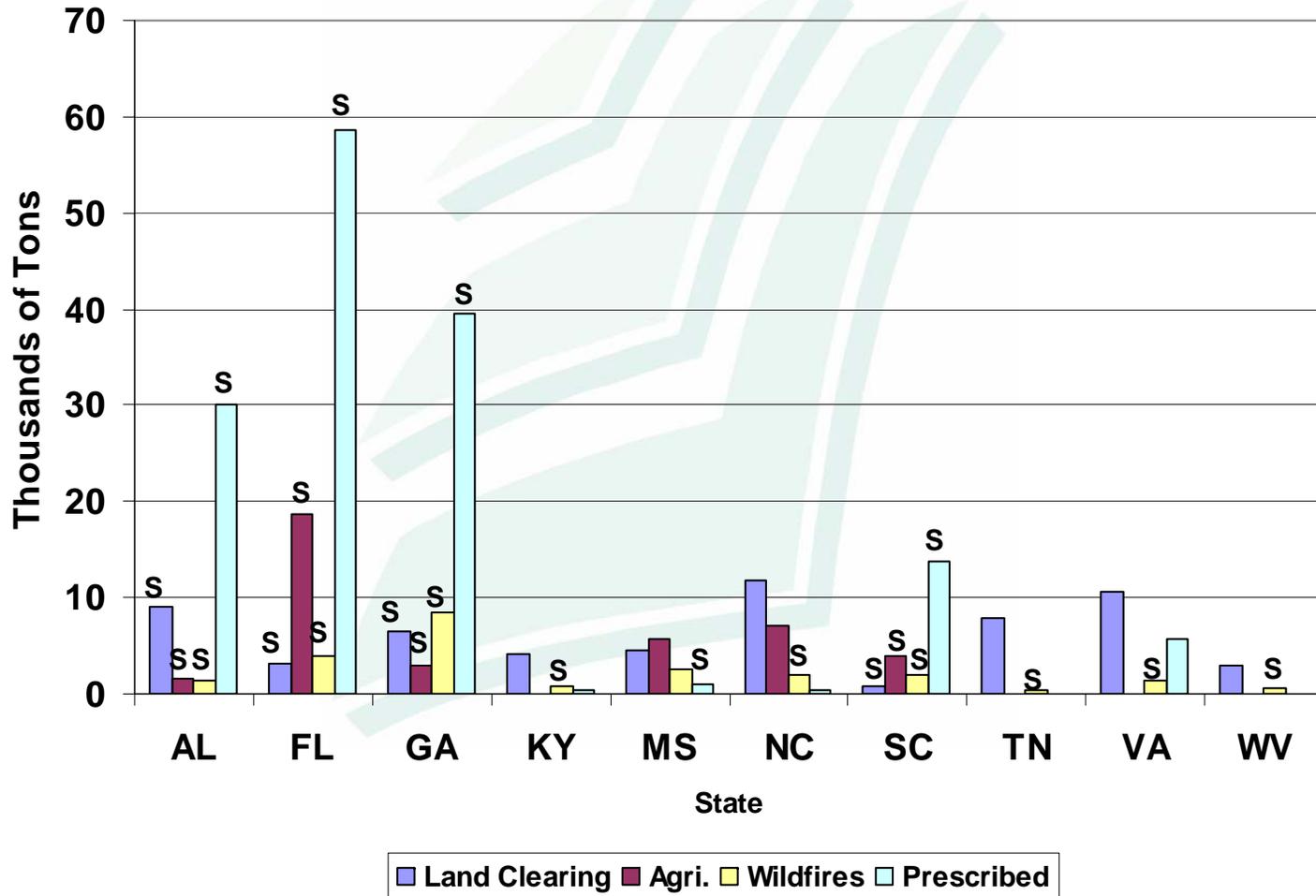
Wildfire CO Emissions for 9 VISTAS States*

1999 Modeled vs 2002 Calculated Values



*AL, FL, GA, KY, NC, SC, TN, VA, WV; MS did not submit wildfire data

2002 VISTAS PM2.5 Emissions from Fire Sources



Conclusions

- VISTAS has developed a fire-by-fire inventory for 2002 wherever possible
 - Fire emissions calculated for wildfires, prescribed burns, agricultural burning and land clearing of debris
 - Large data collection and data augmentation effort required to calculate emissions
- Monthly emissions profiles for prescribed and wildfires were significantly different than default values used by the SMOKE model
- Prescribed fires are significantly higher emission contributors for 2002 than wildfires
 - Majority of prescribed fire emissions from three States (AL, FL, GA)

Future Efforts

- Convert section, township and range data submitted by state agencies to latitude/longitude for improved location information.
- If only county identifier, apply GIS land use coverage to restrict fire emissions to forested areas of the county.
- Report largest fires as point sources.
- For selected large fires, meteorological data could be combined with fire size and fuel loading to improve temporal distribution of emissions over life of the fire.
- Look at use of alternative fuel consumption models
- Develop 2018 “typical” year emissions