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HOURLY BIOMASS BURNING EMISSIONS INVENTORY DERIVED FROM GOES DATA

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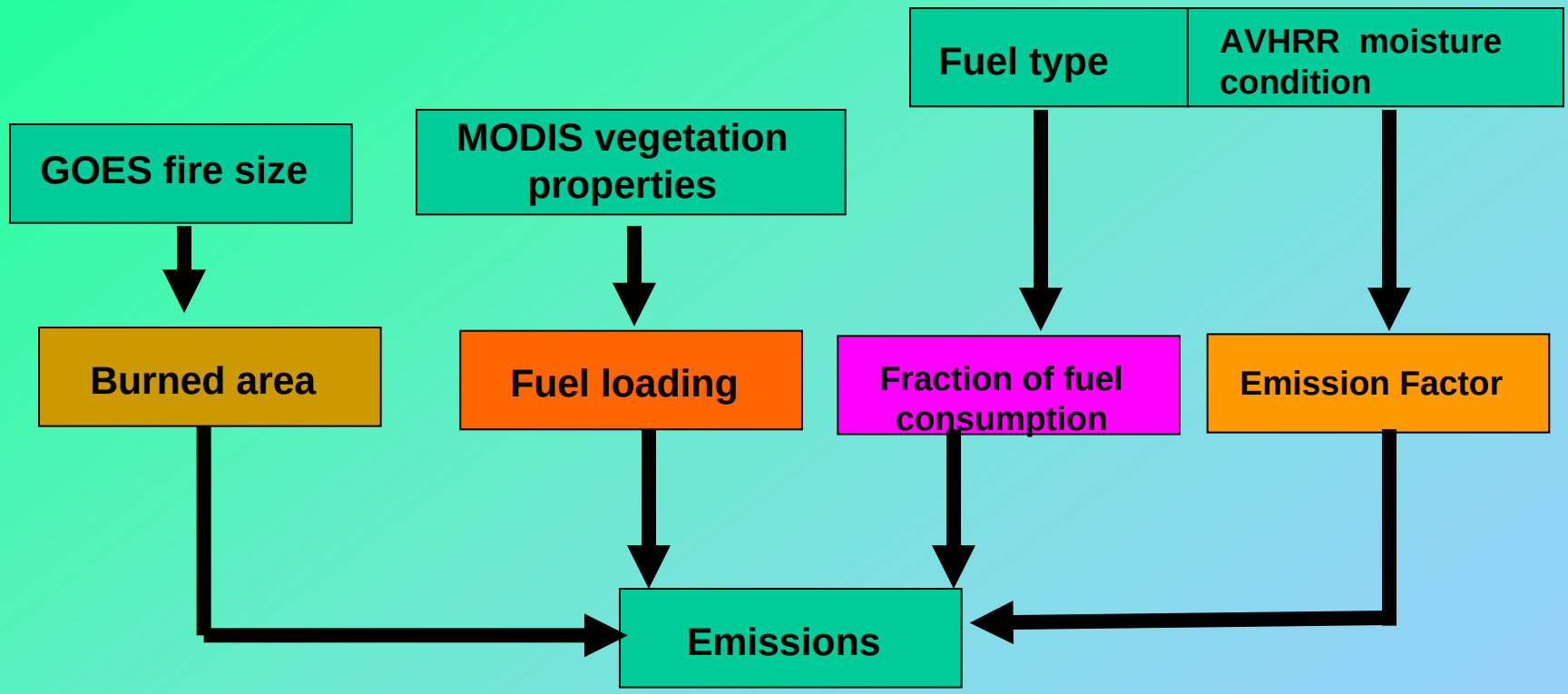
Outline

1. Fuel loading dataset derived from MODIS (Moderate Resolution Imaging Spectroradiometer) data
2. Burned area simulated from GOES (Geostationary Operational Environmental Satellites) fire data
3. Biomass burning emissions across the Continuous USA
4. Summary

Modeling Emissions from Biomass Burning



Model of Biomass Burning Emissions

$$E = \sum_{k=1}^{K} \sum_{l=1}^{L} \sum_{j=1}^{J} \sum_{i=1}^{I} A_{ijkl} M_{ijk} C_{ijkl} F_{ijkl} \qquad (1)$$

E---biomass burning emissions (kg)

A---burned area (km^2) ← GOES fire product

M--biomass density/fuel loading ($kg.km^{-2}$) ← MODIS vegetation properties

C--fraction of combustion ← AVHRR moisture condition

F--fraction of emission ← AVHRR moisture condition

i and *j* define the fire (pixel) locations

l is the fuel type

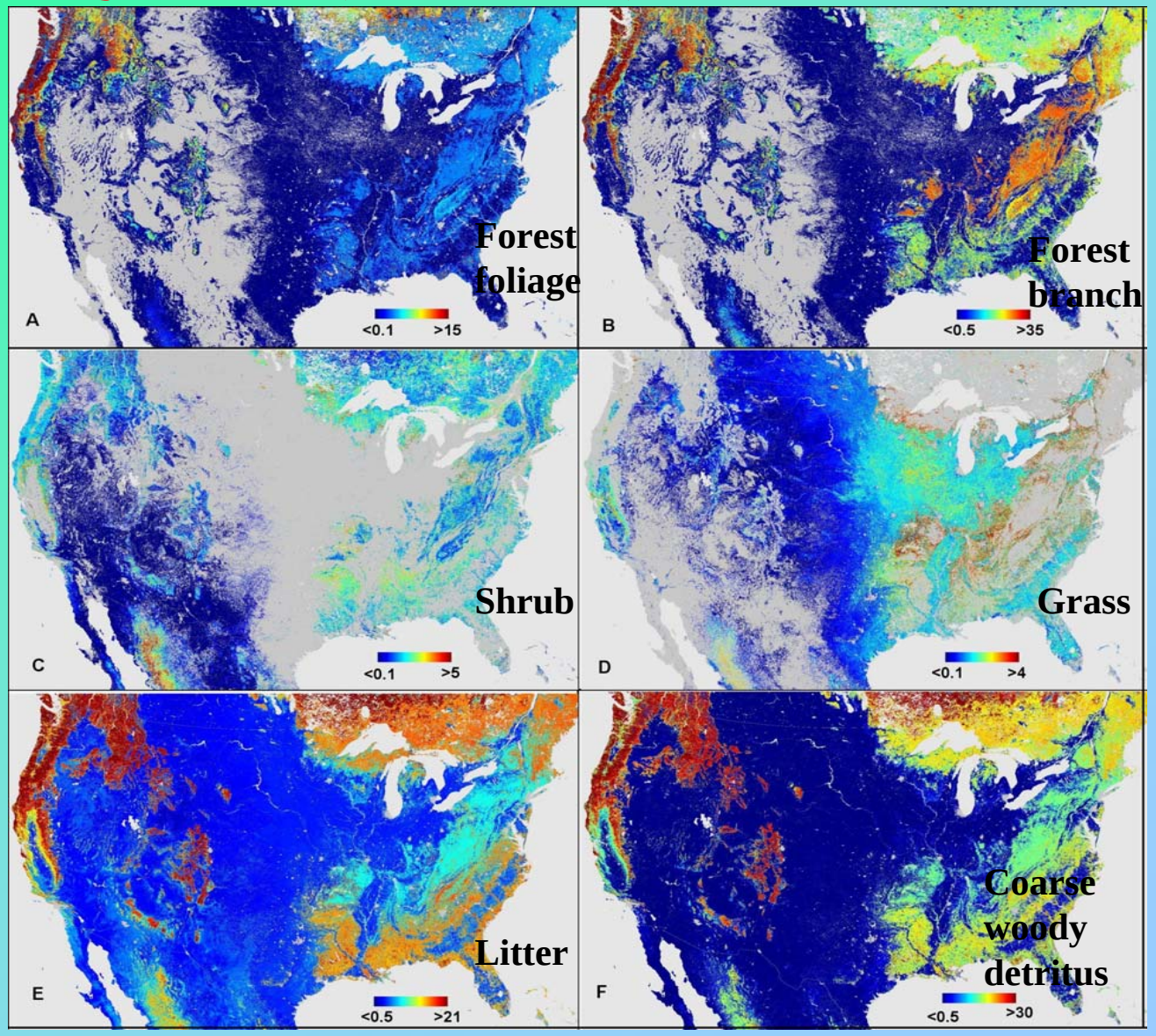
k is the time period

MODIS Vegetation Property-based Fuel System (MVPFS)

Vegetation Cover Fraction (MOD44B)

Land Cover Type (MOD12Q1)

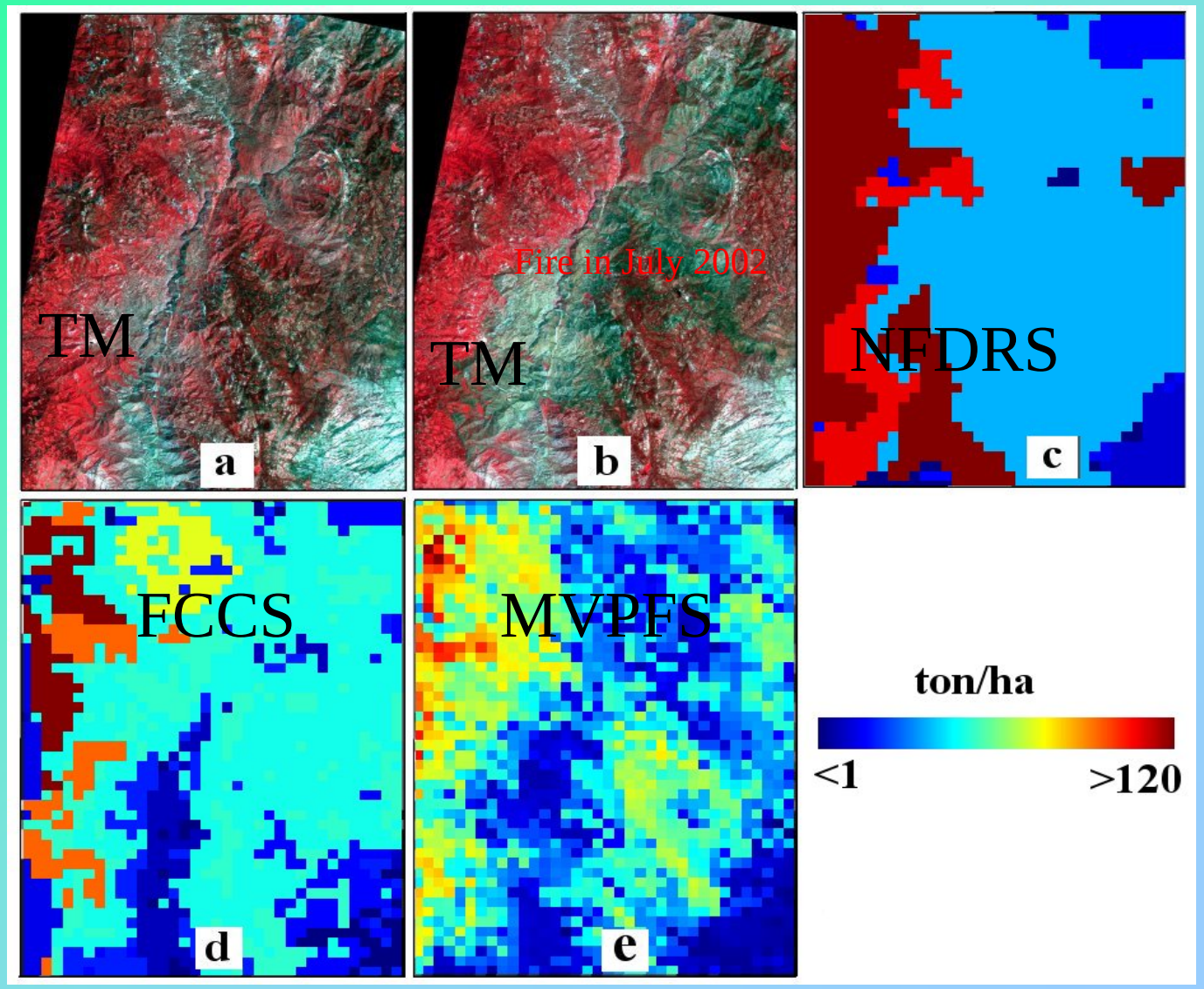
LAI (MOD15A2)



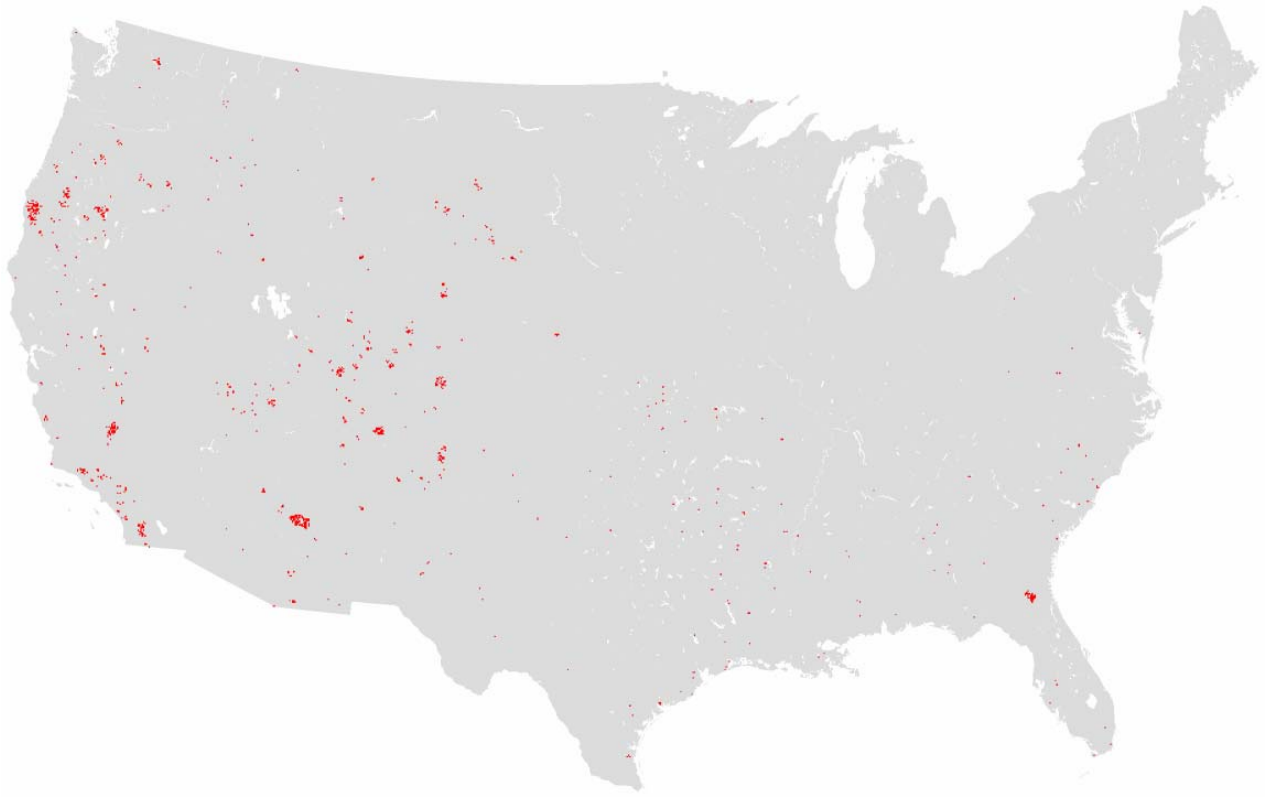
tons/ha

Comparison of Fuel Loadings from NFDRS, FCCS and MVPFS

McNally fire area (35º49’-36º18’N, 118º10’-118º37’W).



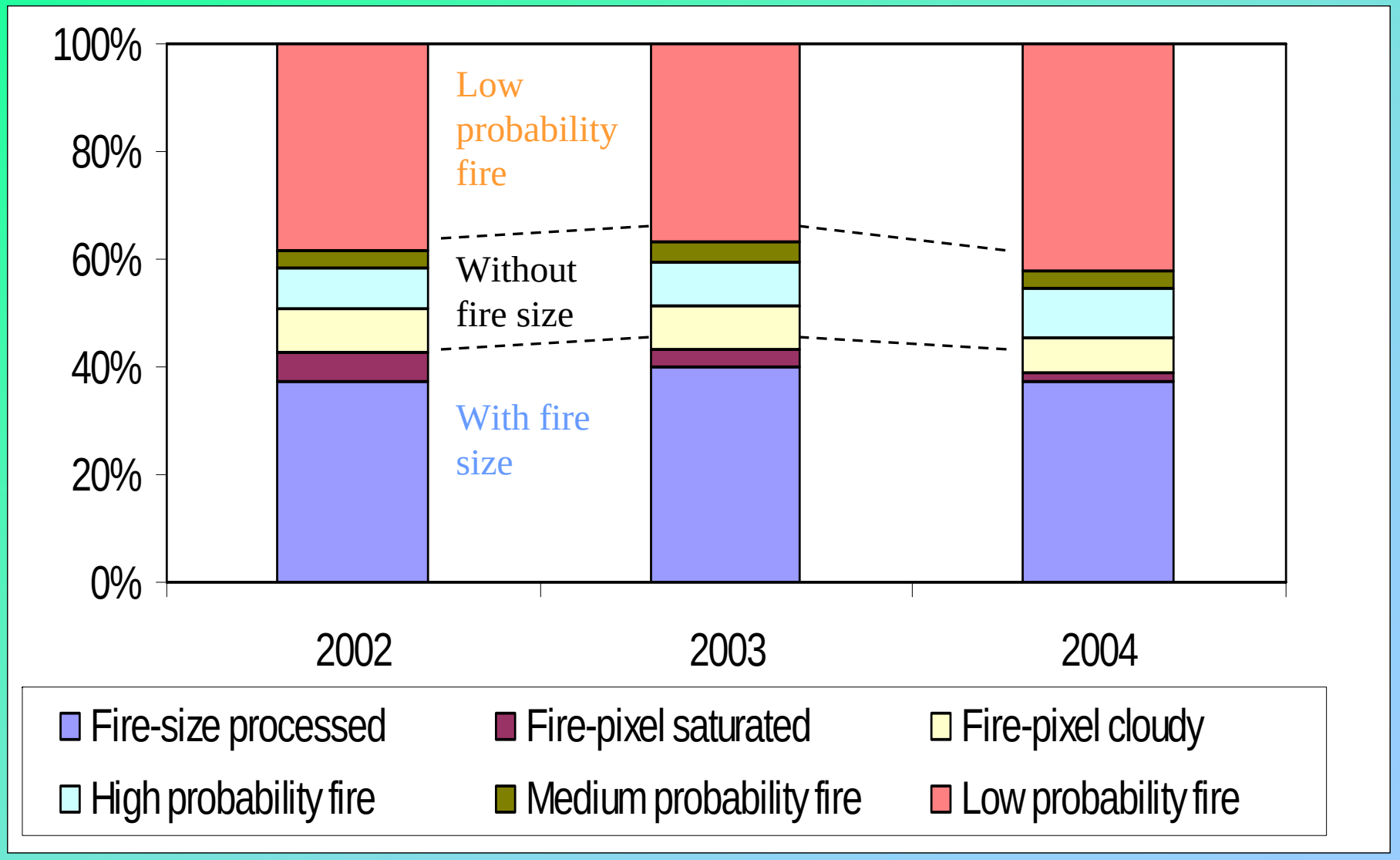
Simulation of Burned Area From GOES Fire Size



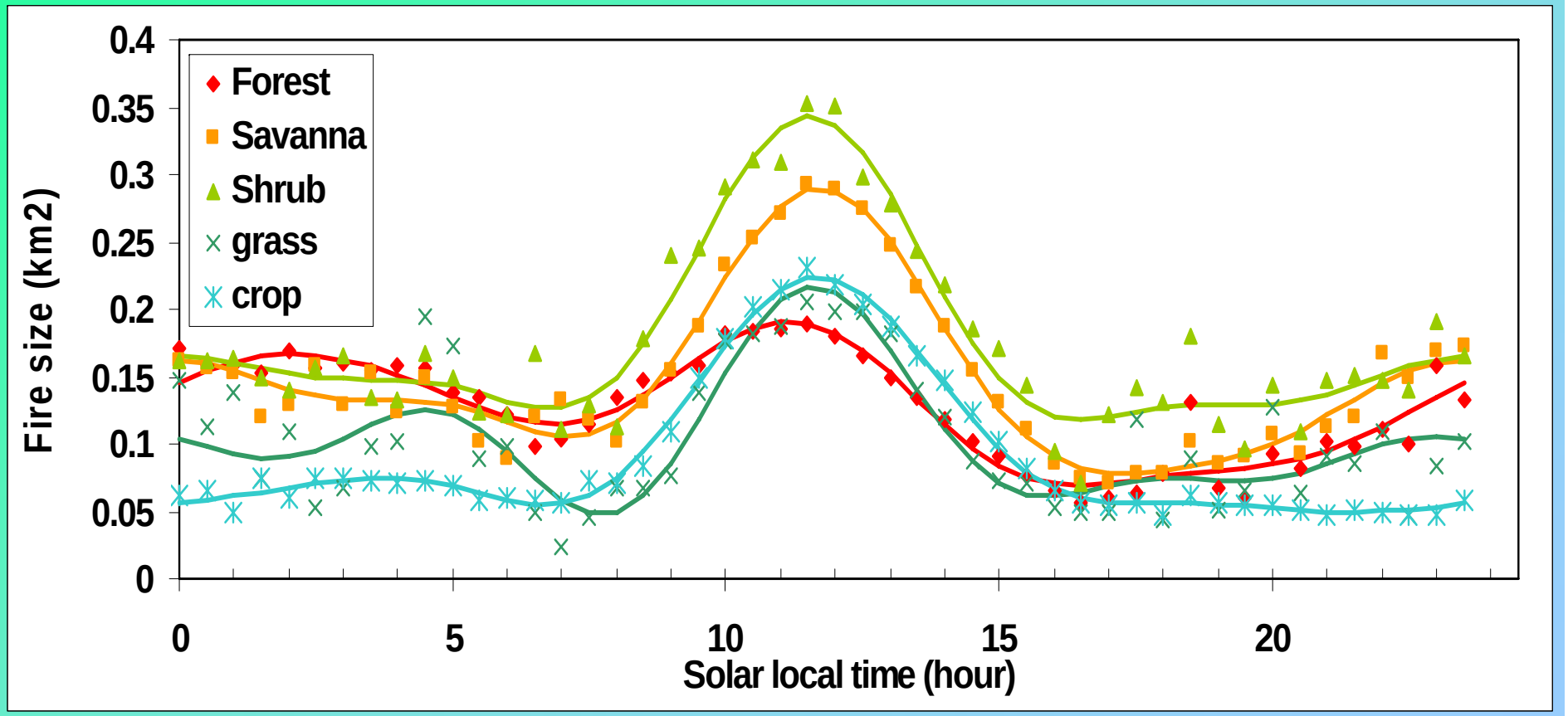
- Spatial resolution: 4km
- Temporal resolution: 30min
- Instantaneous fire sizes in subpixels detected from 3.9 µm and 10.7 µm infrared bands

Fire occurrences detected from GOES satellite in 2002

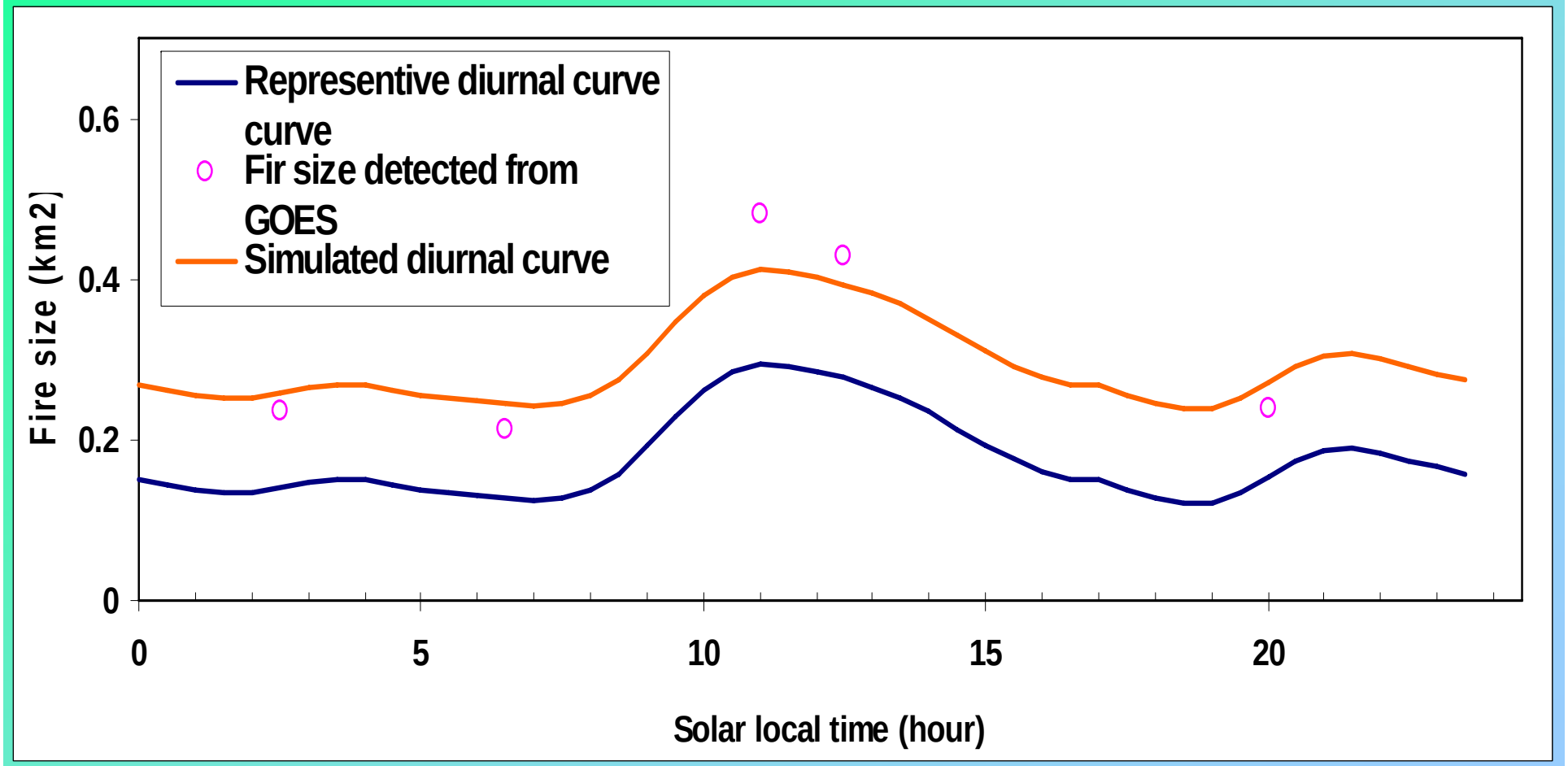
Subpixel fire size in GOES Fire Product



Fourier-Fitted Diurnal GOES Fire Sizes ---Representative diurnal curves



Fitting Diurnal Fire Size for Individual GOES Fire Pixels



Burned Areas Converted from GOES Fire Size

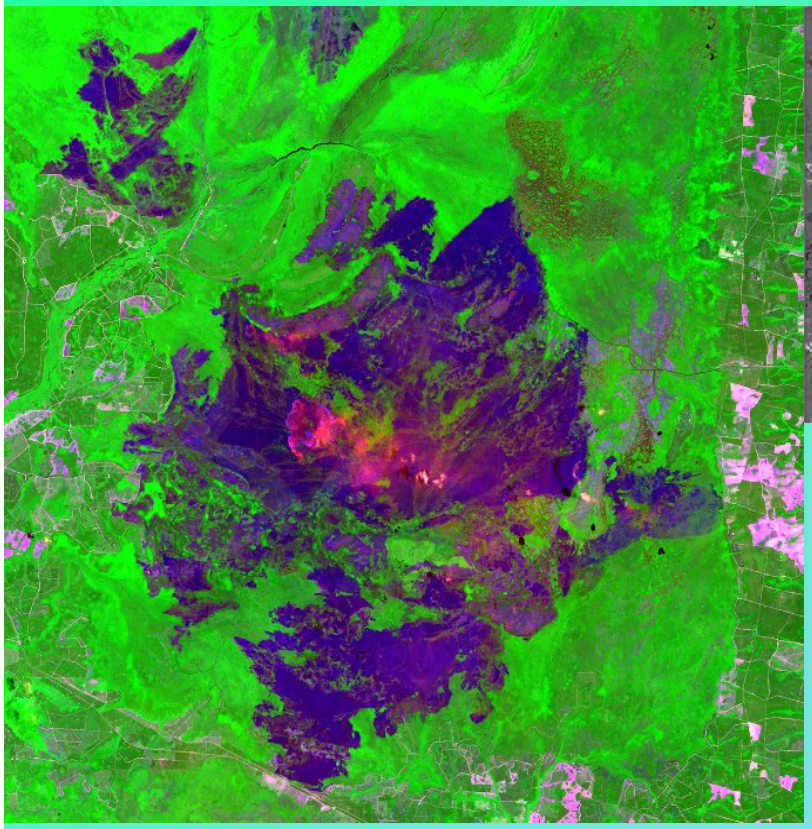
$$A = \alpha F$$

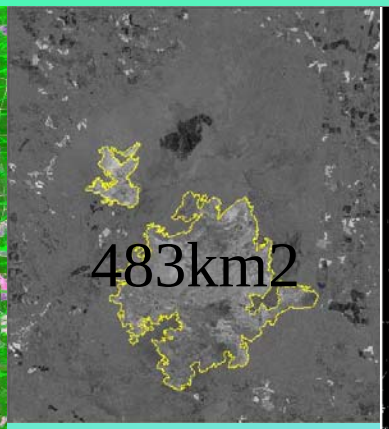
A -- the area burned within a specified time period (km^2)

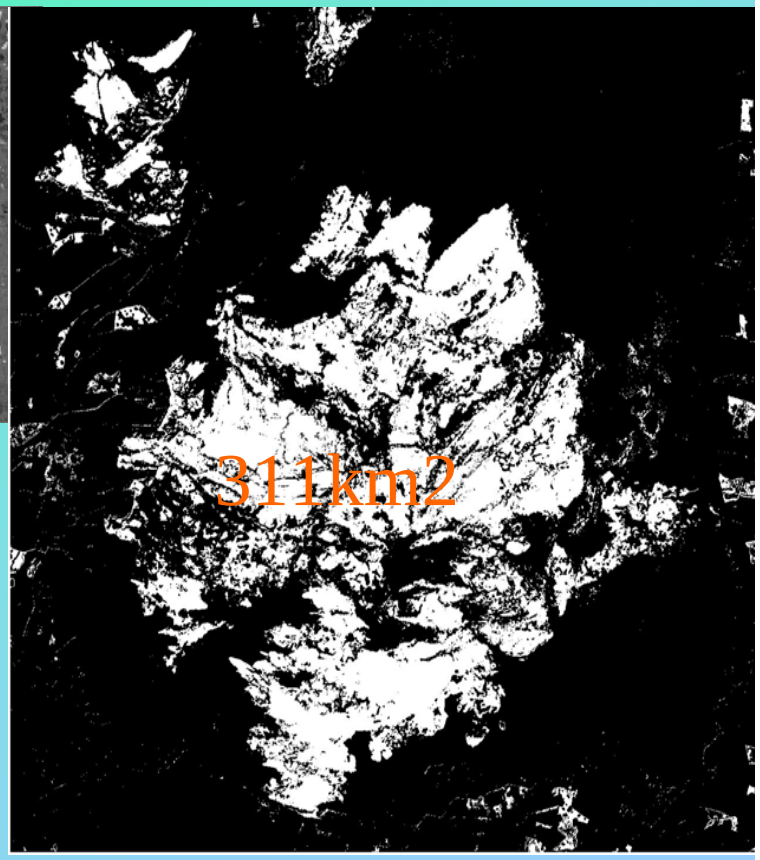
F -- the subpixel fire size (km^2)

α -- a constant coefficient

Training and Testing Burned Area Detected from TM Imagery



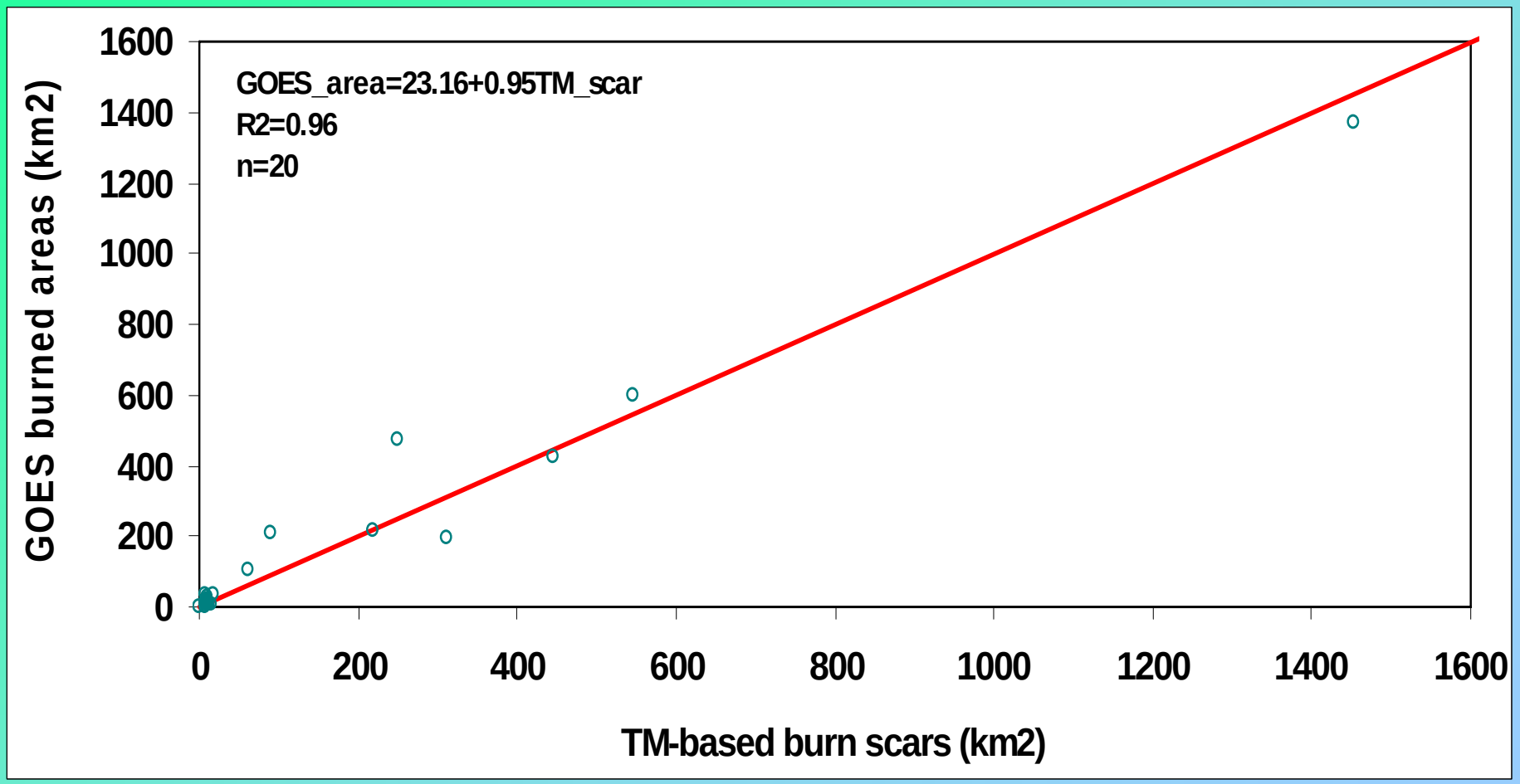




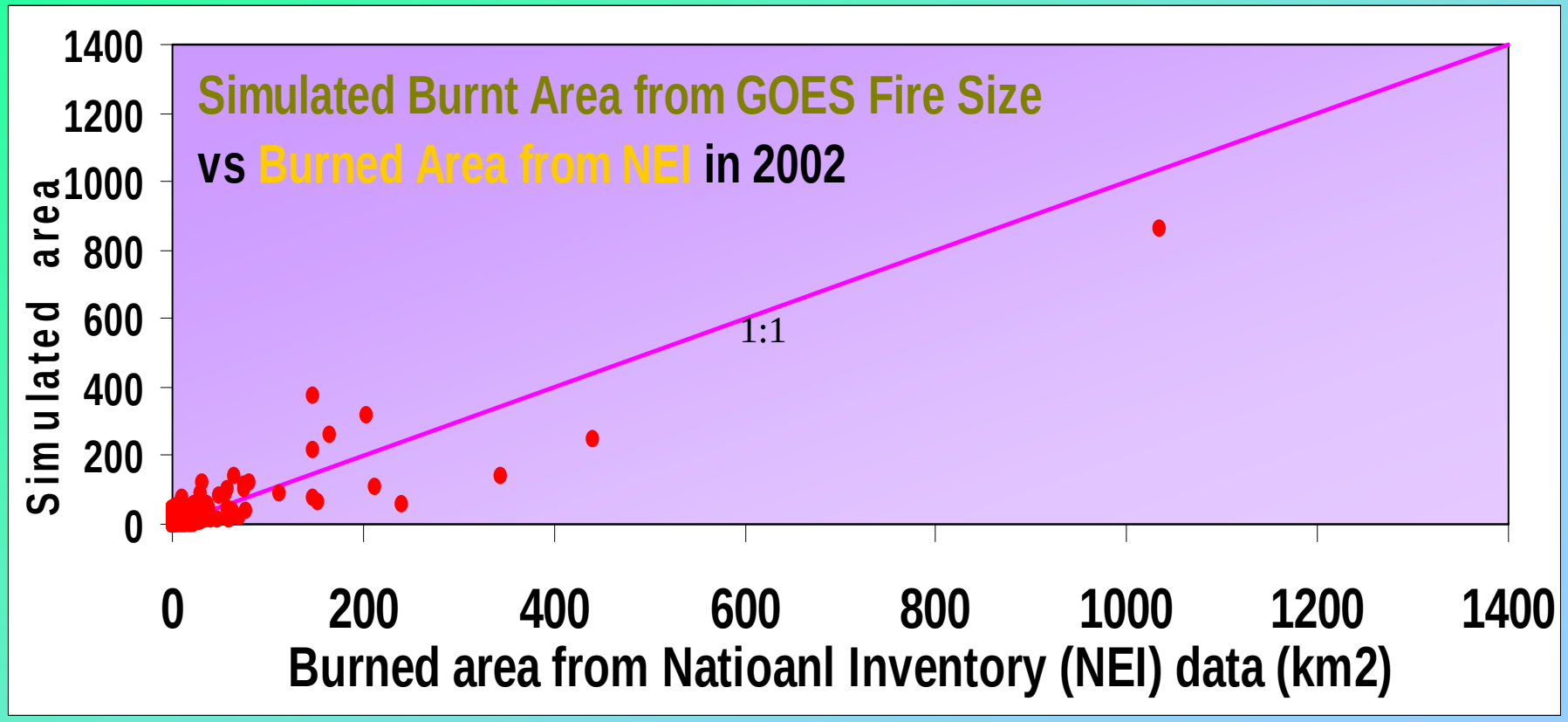
TM imagery and Fire Perimeter obtained from National Park Service-USGS National Burn Severity Mapping Project

Difference: (483-311)/311=55%

Comparison of Simulated GEOS Burned Areas with TM Burn Scars

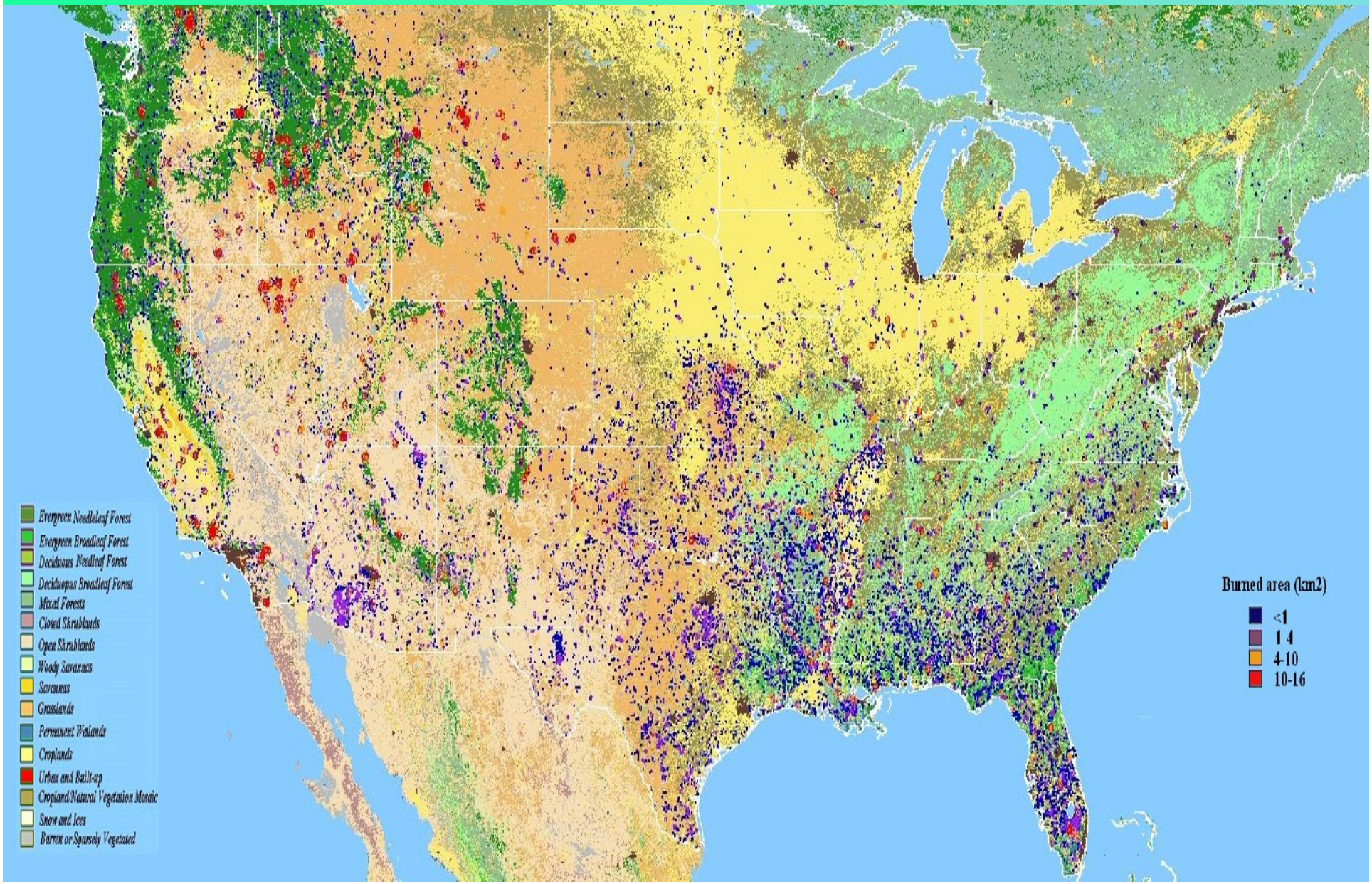


Comparison of Simulated GOES Burned Area with National Inventory

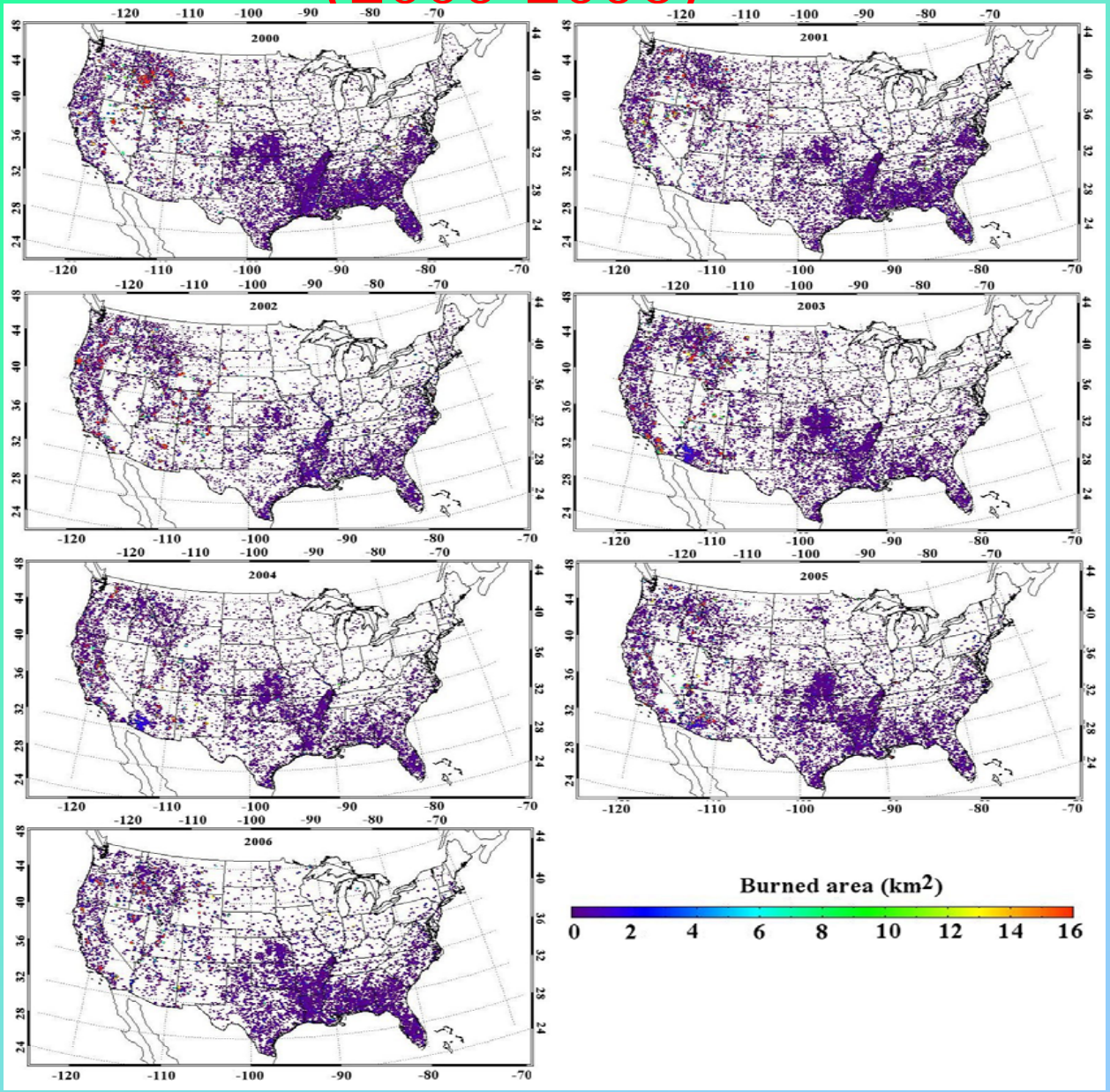


Burned Area Simulated from GOES Fire Size

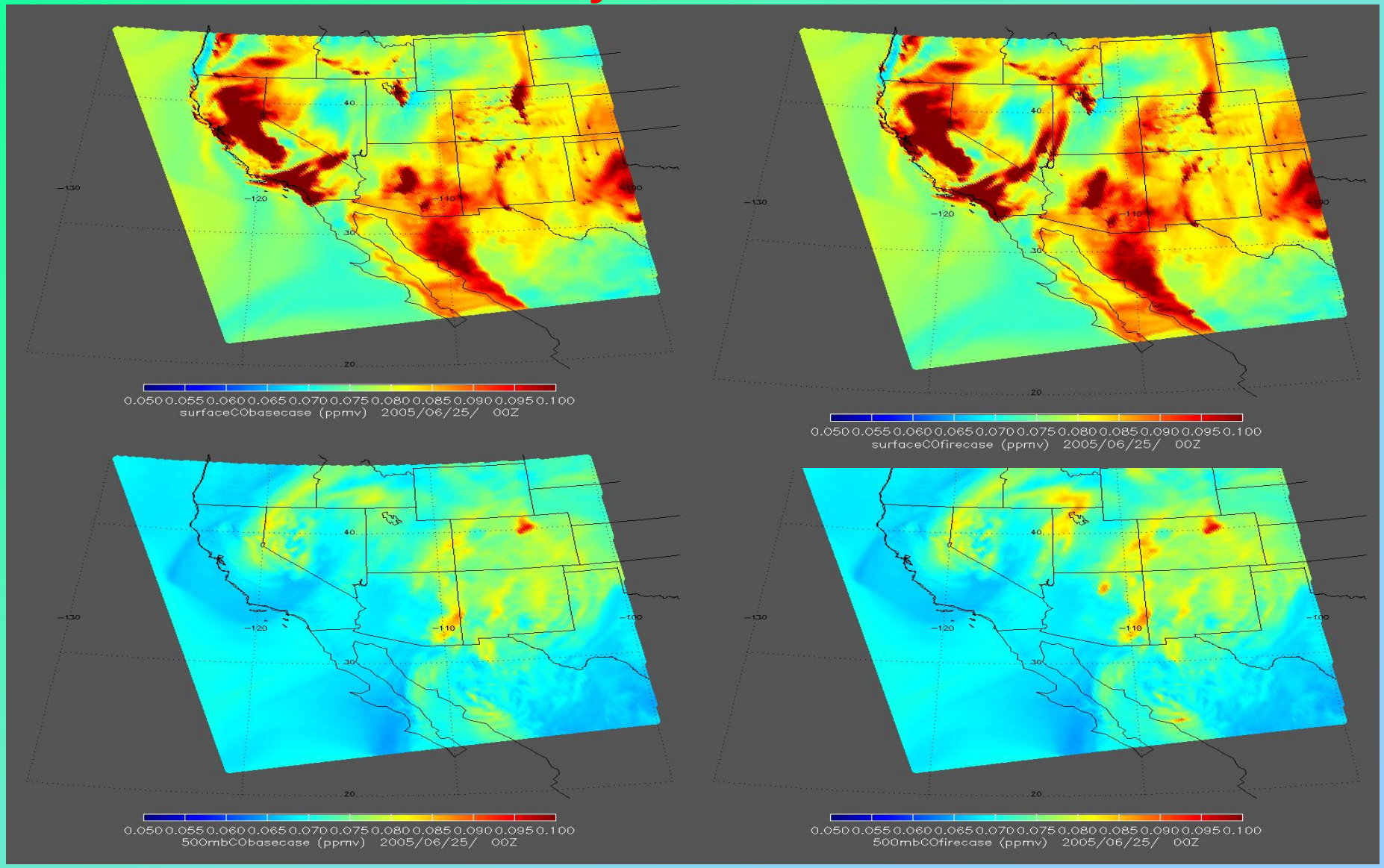
(2006)



GOES Pixel-based Burned Areas (2000-2006)

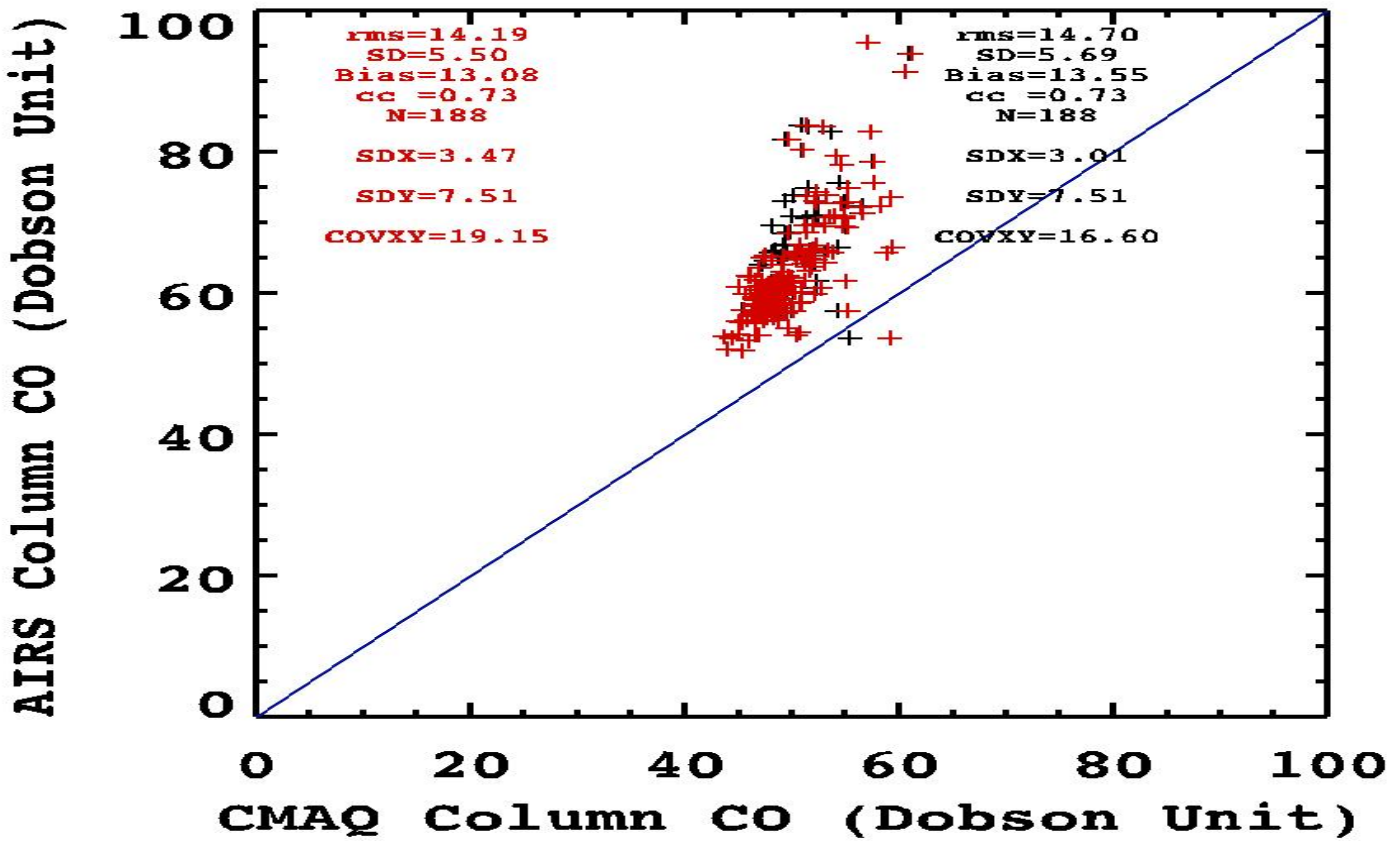


GOES Emission Evaluation: CMAQ-Based CO at 500 mb and Surface Layer

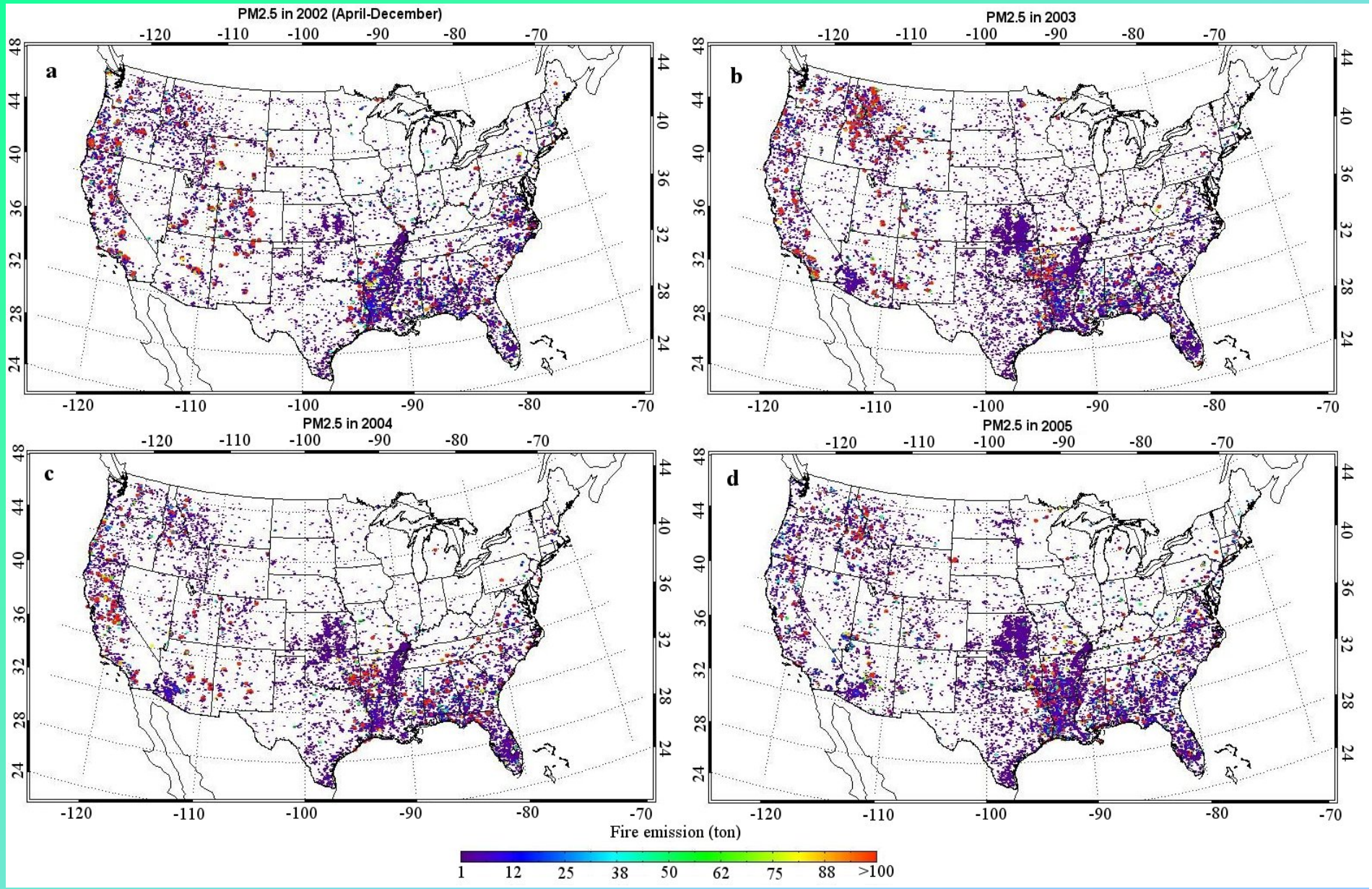


Provided by George Pouliot

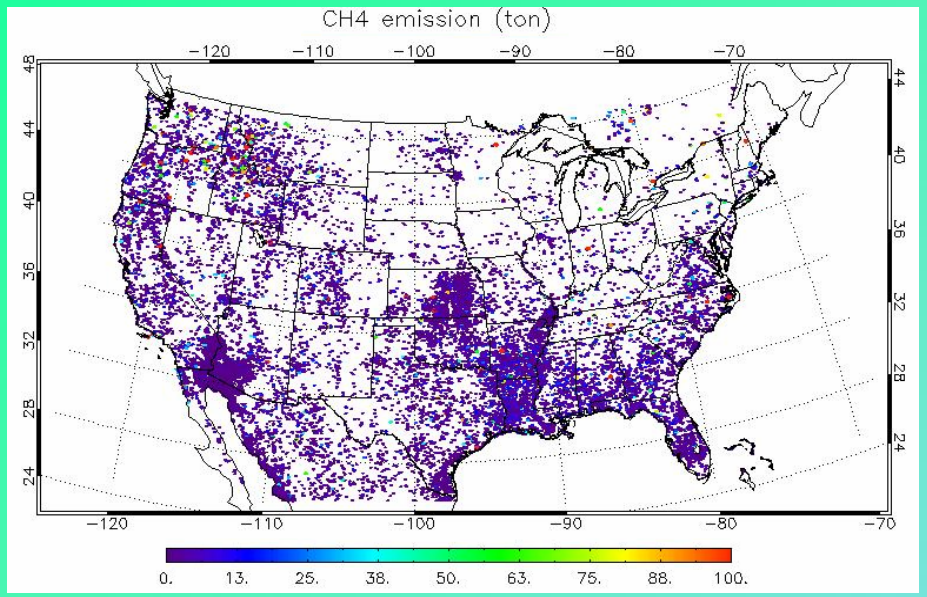
GOES Emission Evaluation: Comparison of AIRS CO with CMAQ (Atmospheric Infrared Sounder) CO Generated with and without Fire Emissions

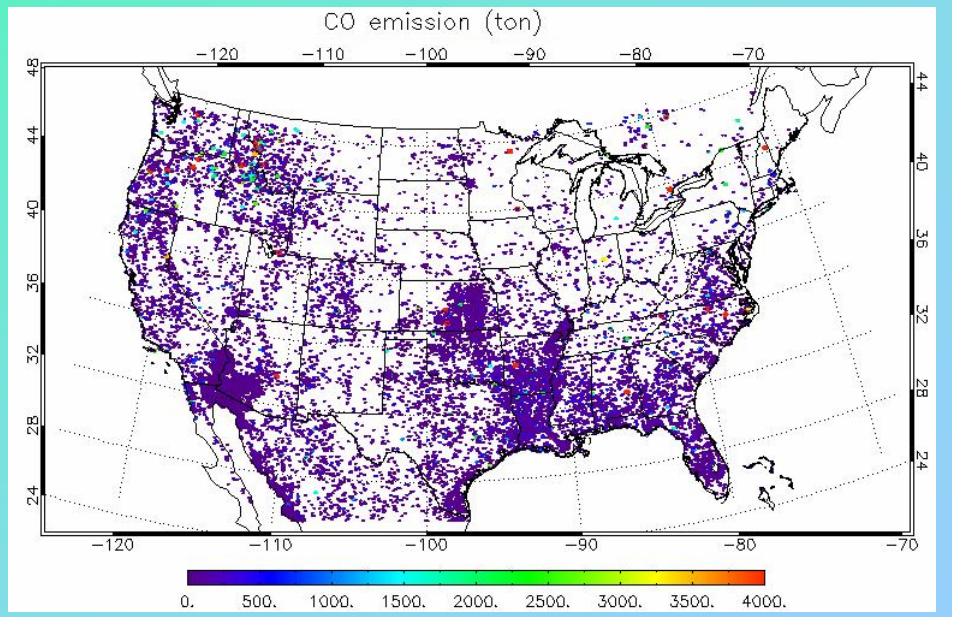


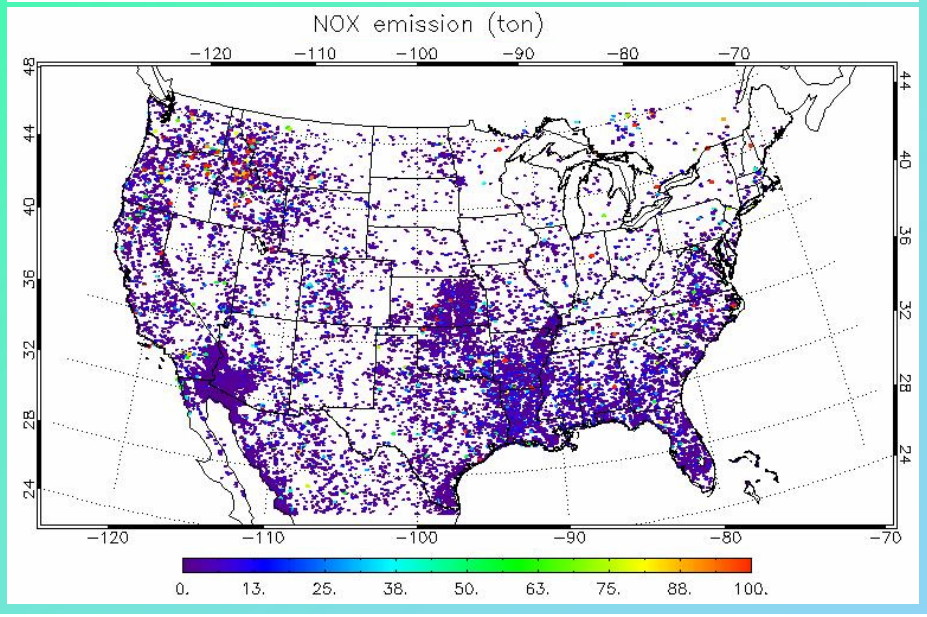
Annual PM2.5 Emissions



Biomass Burning Emissions (CH4, CO and NOX) in 2005



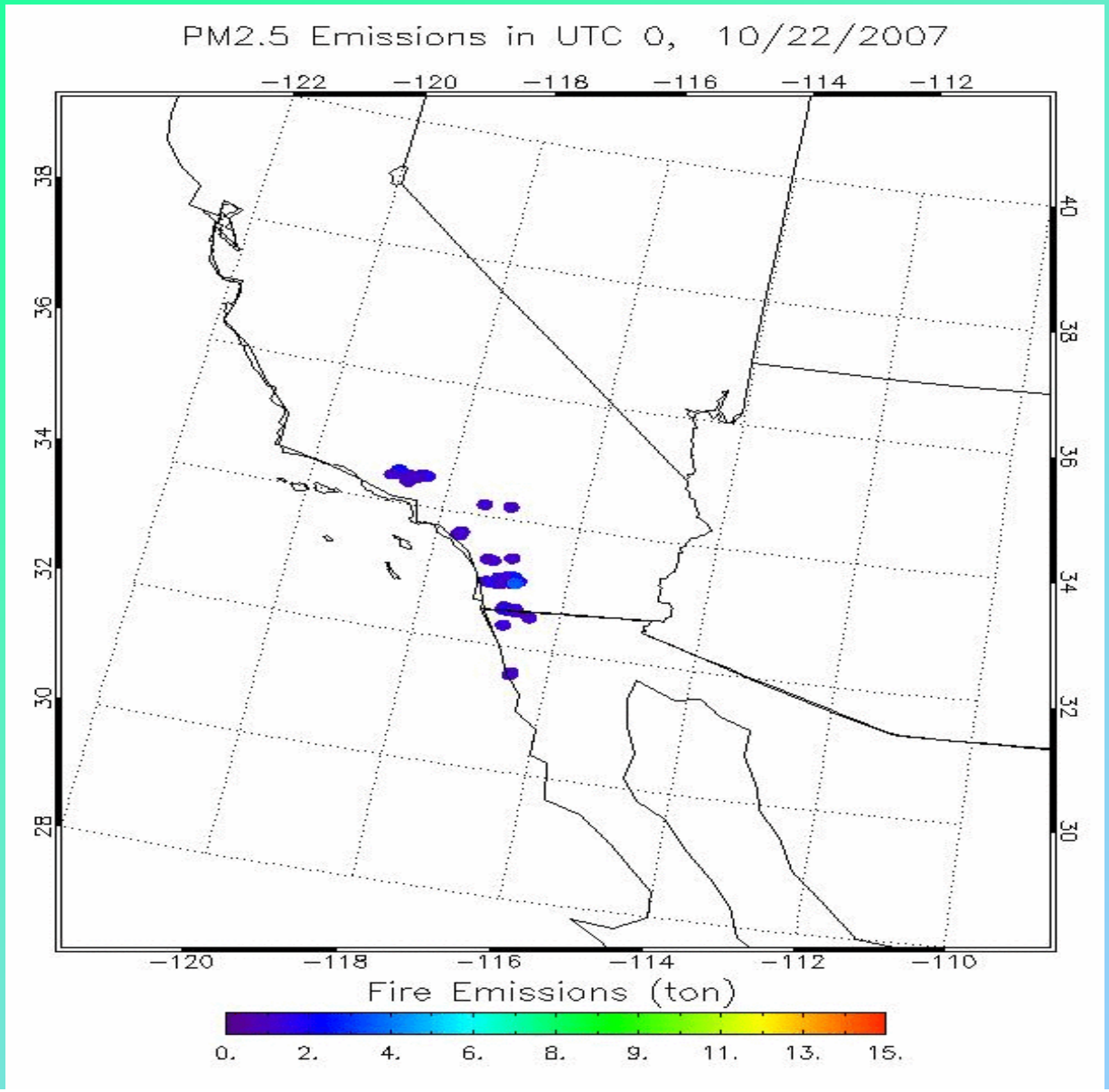




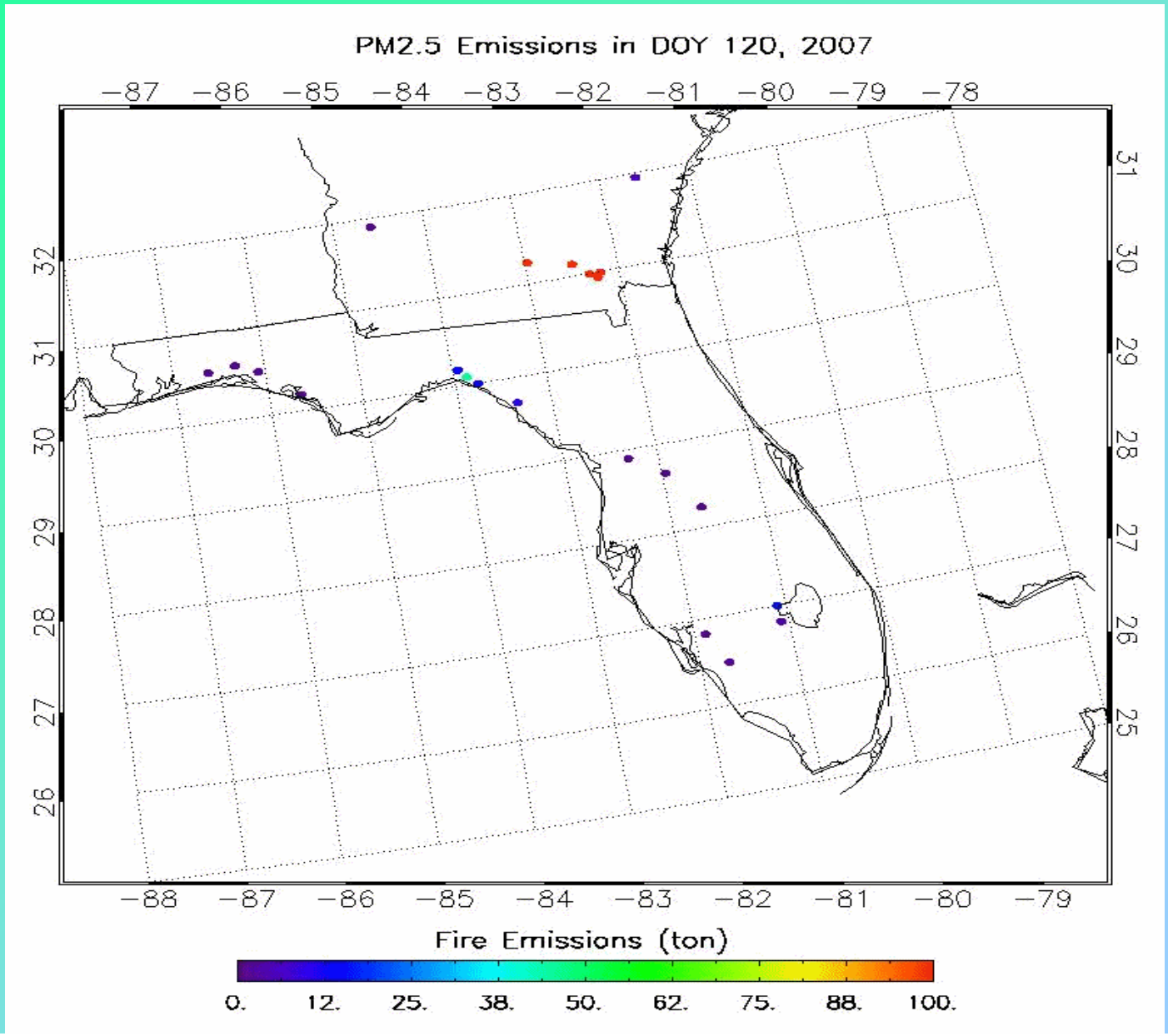
Annual Emissions for Different Species (10^6kg)

	2002	2003	2004	2005	2006
N2O	10.0	9.6	5.2	6.6	9.9
NH3	32.3	31.1	16.8	20.8	32.6
SO2	52.5	50.3	27.3	34.4	52.0
CH4	128.3	123.7	67.0	82.7	129.6
NOX	170.3	163.2	88.6	111.6	168.9
TNMHC	225.9	217.65	117.9	145.7	228.0
PM2.5	307.8	296.4	160.8	199.9	309.6
CO	3226.7	3109.5	1684.7	2081.3	3257.3

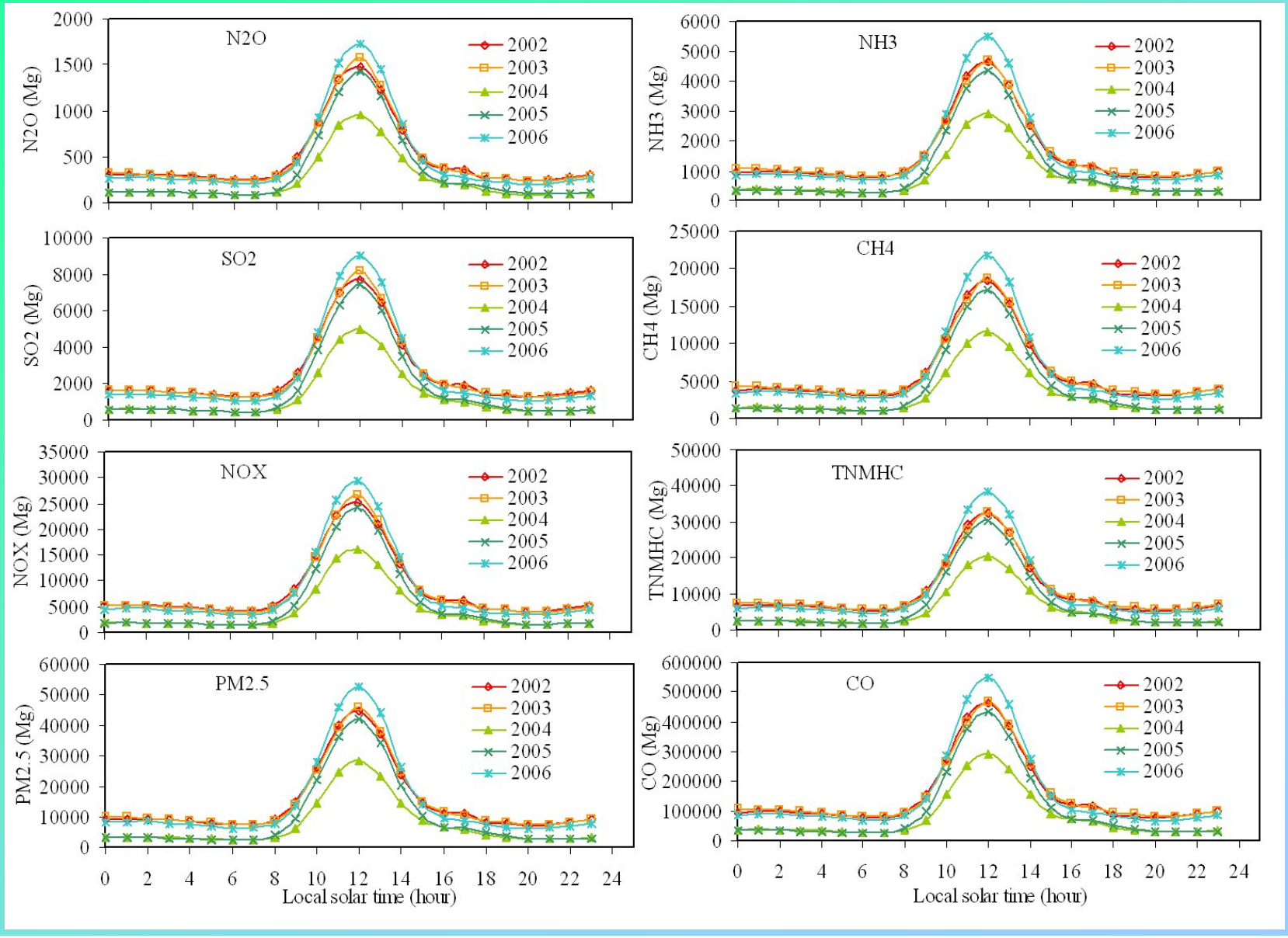
San Diego Fire Emissions in October 2007



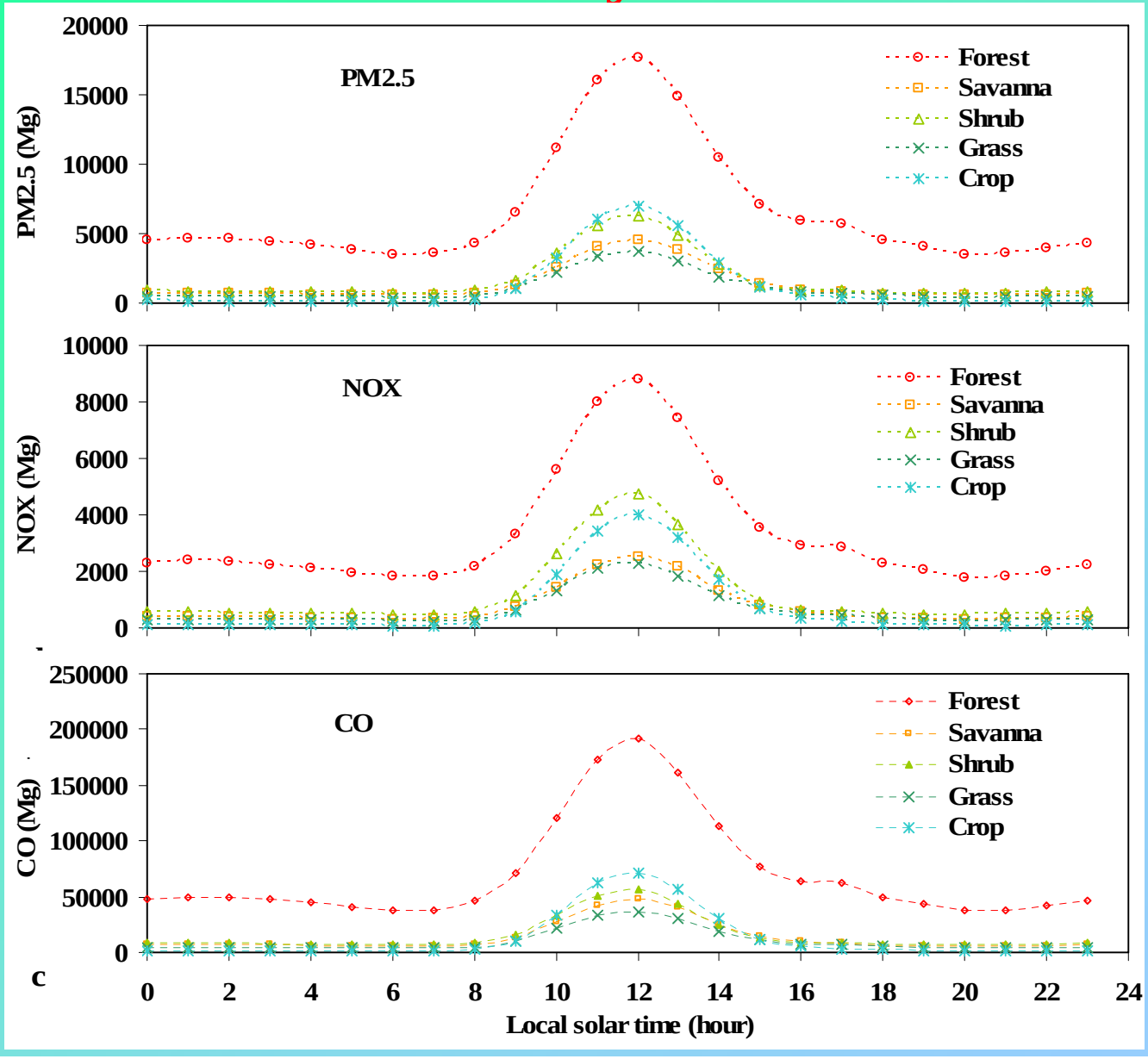
Florida Fire Emissions in May 2007



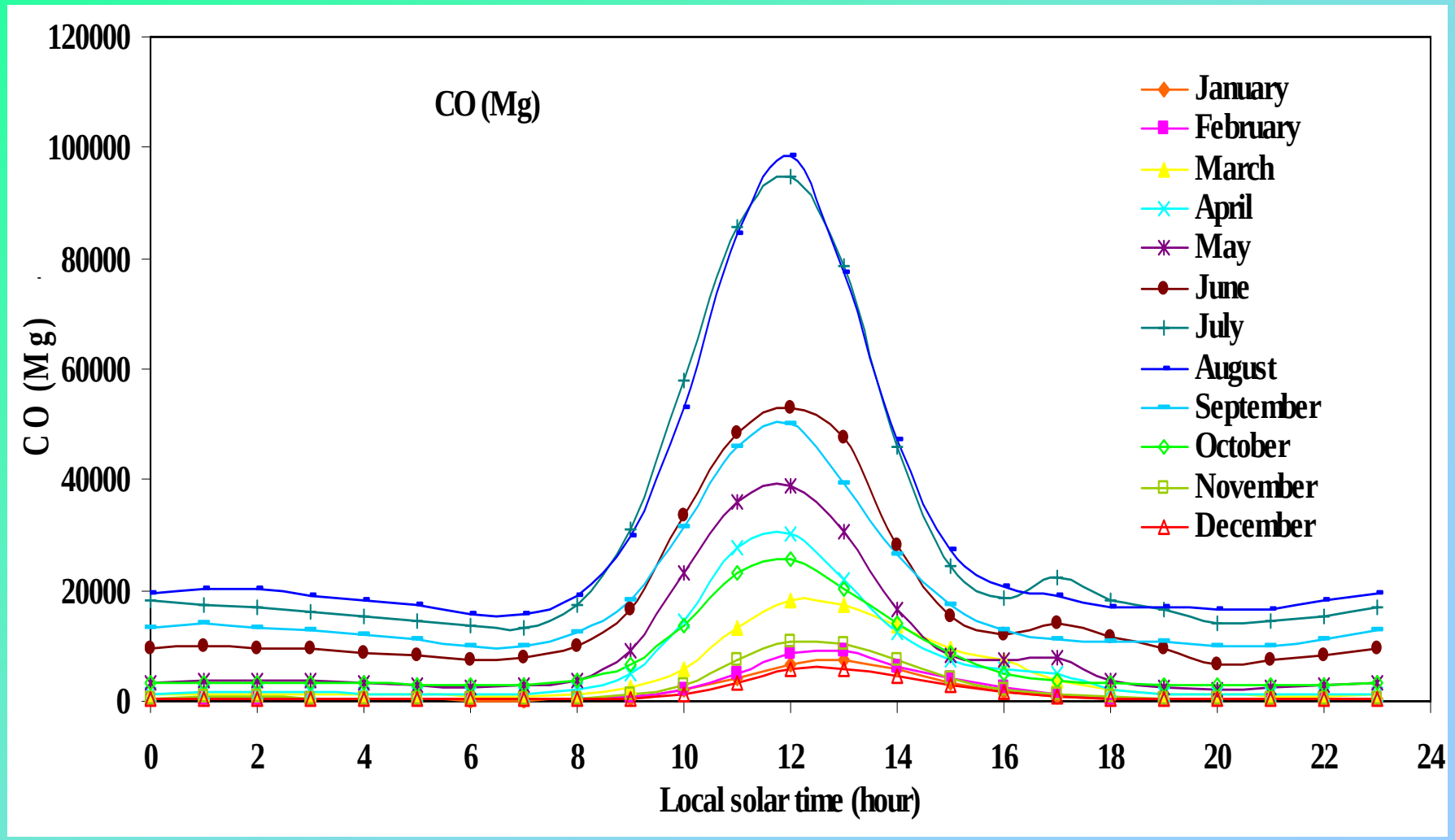
Diurnal Variations in Biomass Burning Emissions for Different Years



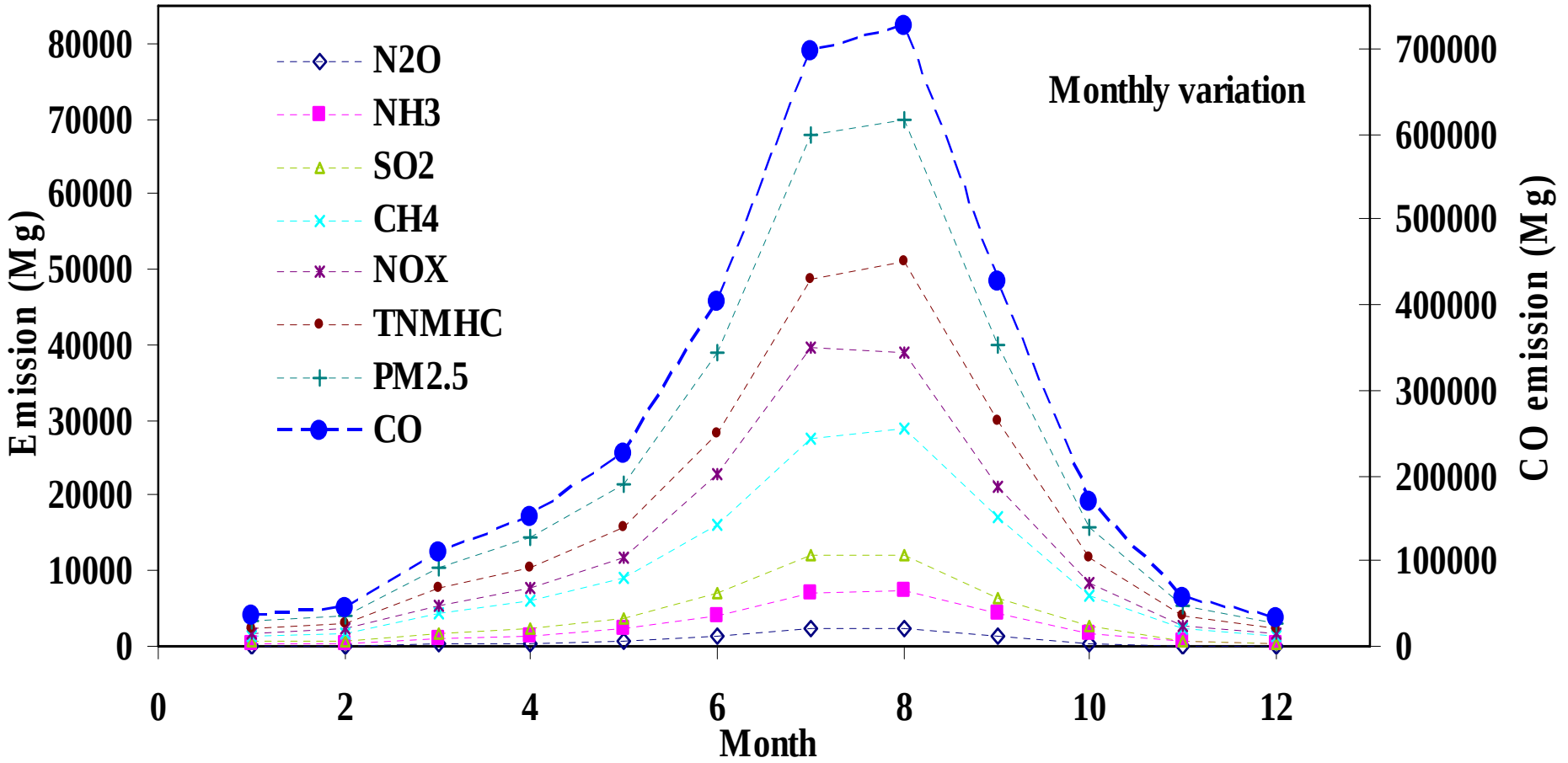
Diurnal Pattern in Emissions in Different Ecosystems



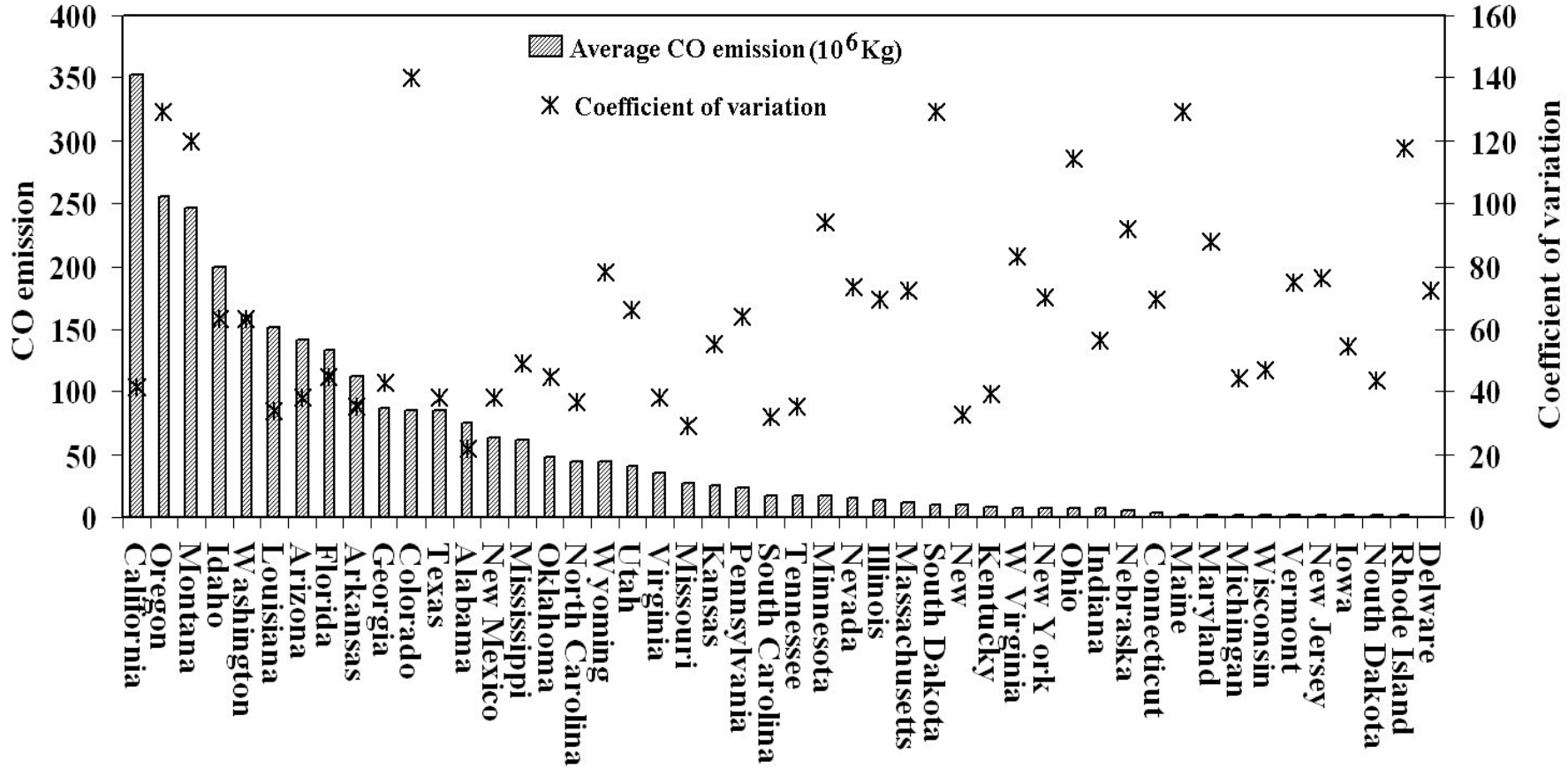
Seasonal Shift of Diurnal Patterns in Burning Emissions.



Seasonal Variations in Monthly Emissions.

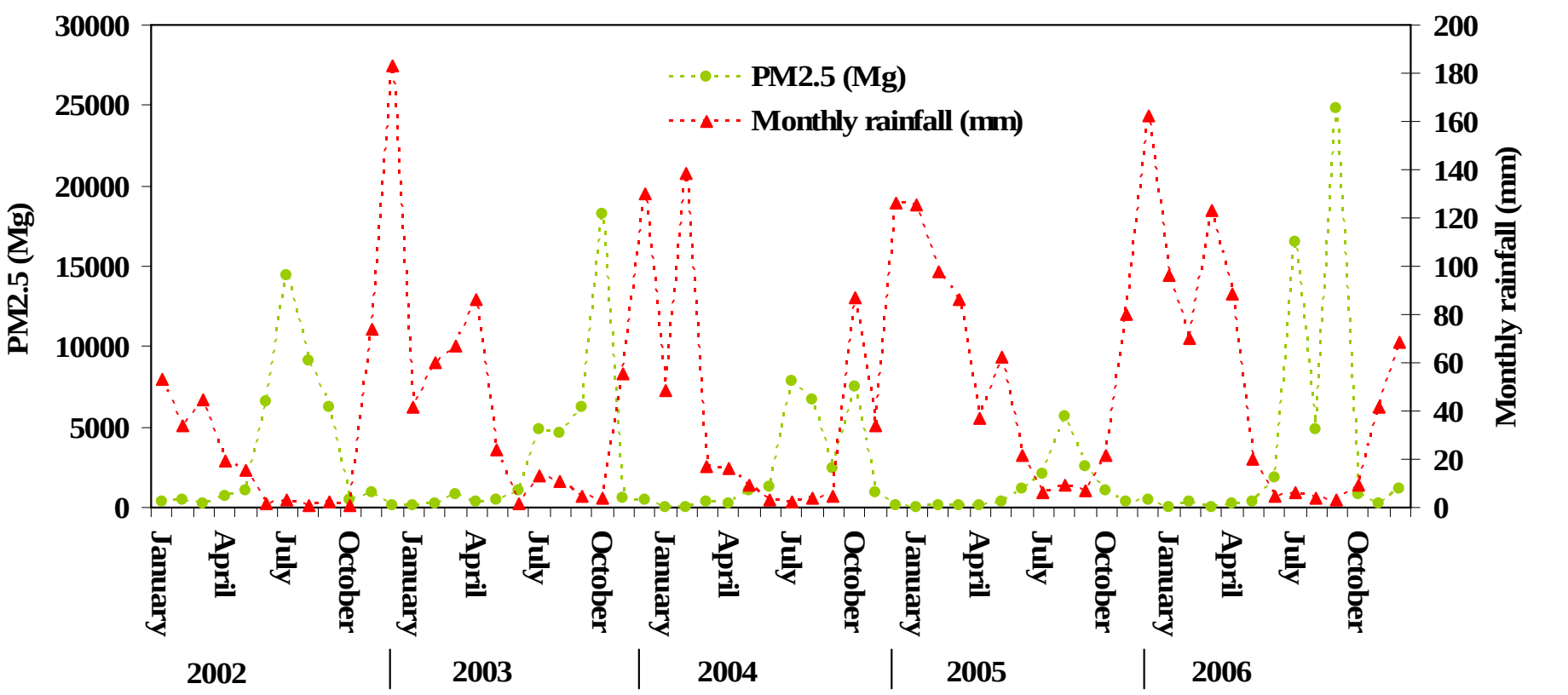


Variations in Biomass Burning Emissions (CO) for Different States

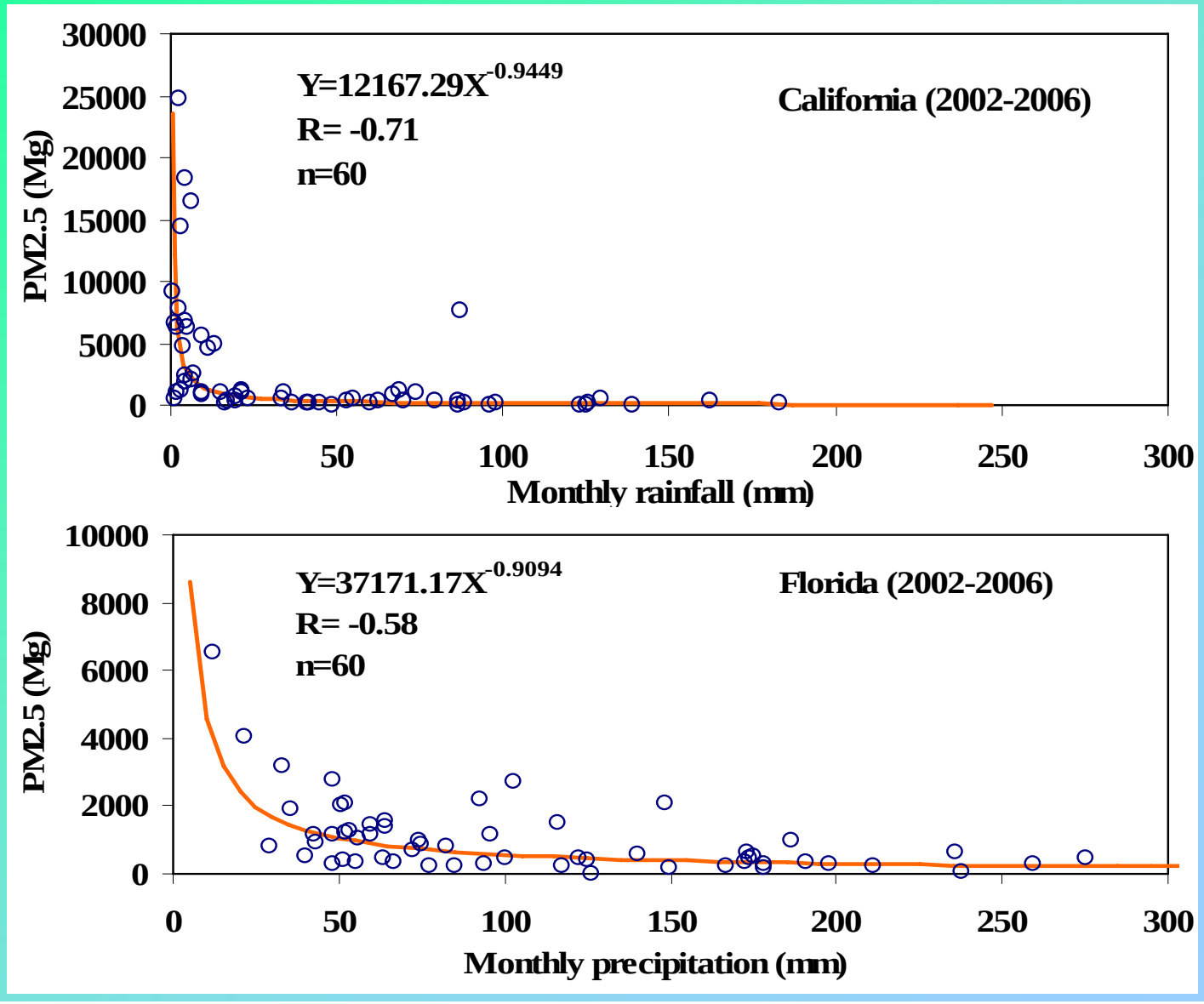


Month with Severe Biomass Burning Emissions from 2002-2006

Correlation of Times Series of PM2.5 Emissions with Precipitation in California



Controls of Drought on Biomass Burning Emissions



Summary

- MODIS Vegetation Property-based Fuel System (MVPFS) provides realistic fuel loading data and can be updated easily.
- Burned area at high temporal and spatial resolution can be simulated from GOES active fire observations with a reliable quality.
- Hourly biomass burning emissions (PM2.5, CH4, CO, N2O, NH3, NOX, SO2, and TNMHC) inventory can be created in near real time from satellite-based fuel data and burned area.
- Biomass burning emissions inventory developed in this study reveals distinct variations in diurnal, seasonal, and interannual patterns and spatial shifts in states and ecosystems.