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Spatiotemporal Variations In Burned Areas And Biomass Burning Emissions Derived From Multiple Satellite-based Active Fires Across The USA

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Outline

1. Algorithm of biomass burning emissions
2. Burned area simulated from active fires observed from Hazard Mapping System (HMS)
3. Biomass burning emissions across the Contiguous USA
4. Summary

Model of Biomass Burning Emissions

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

E---biomass burning emissions (kg)

A---burned area (km^2) ← HMS fire products

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

C--fraction of combustion ← AVHRR moisture condition

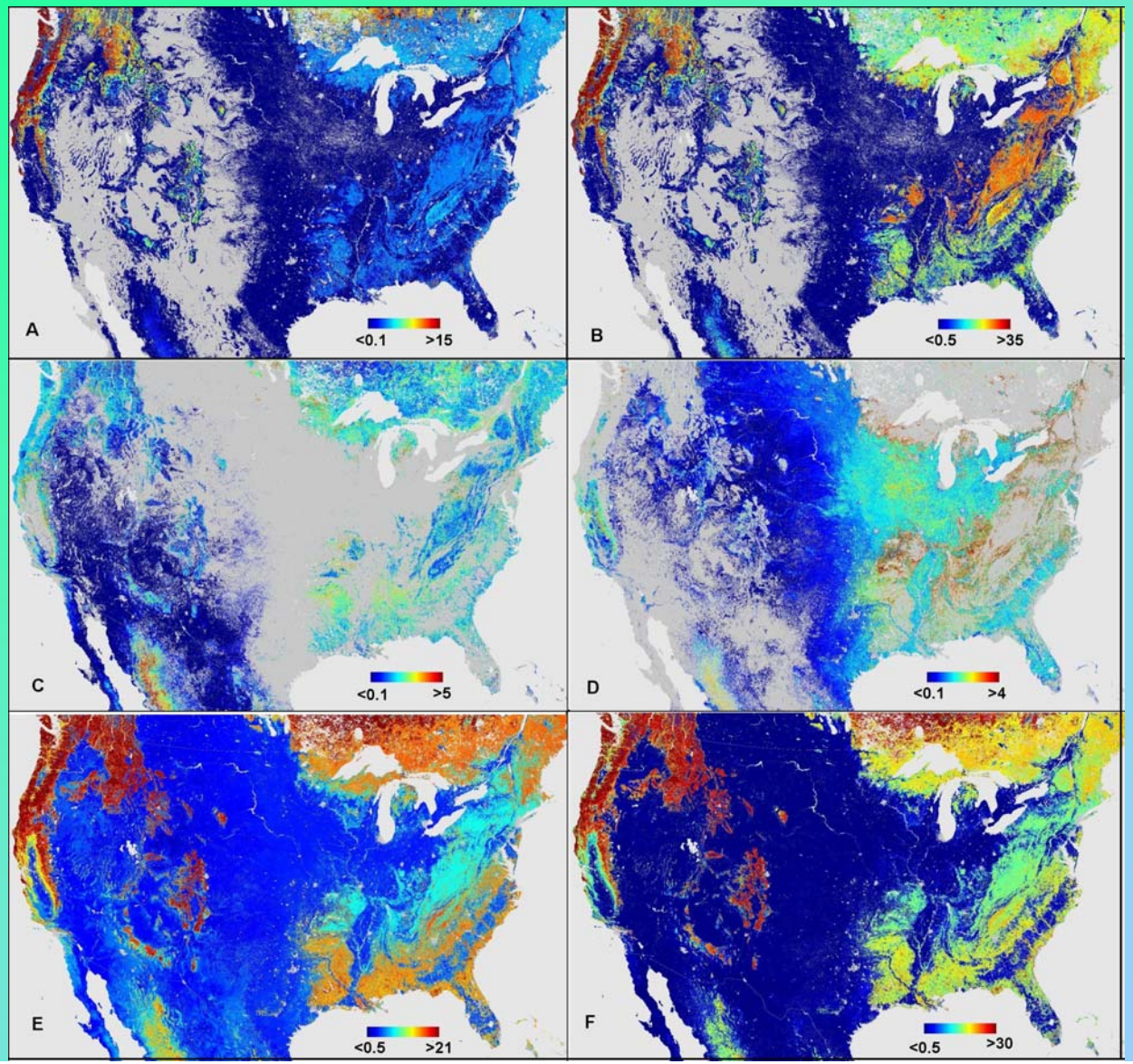
F--fraction of emission ← AVHRR moisture condition

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)

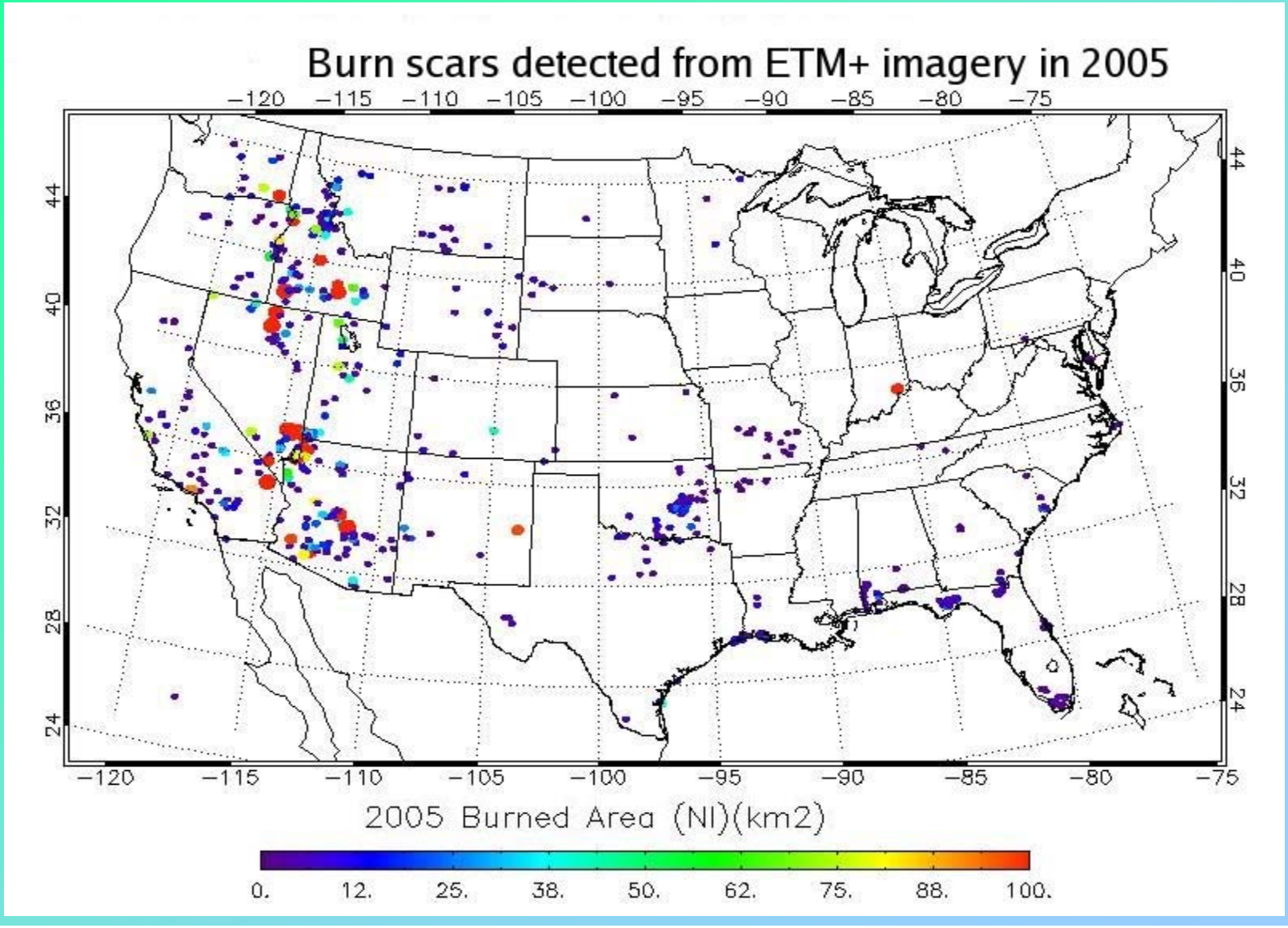


(A) forest foliage,
(B) forest branch,
(C) grass,
(D) shrub,
(E) litter,
(F) coarse woody detritus.

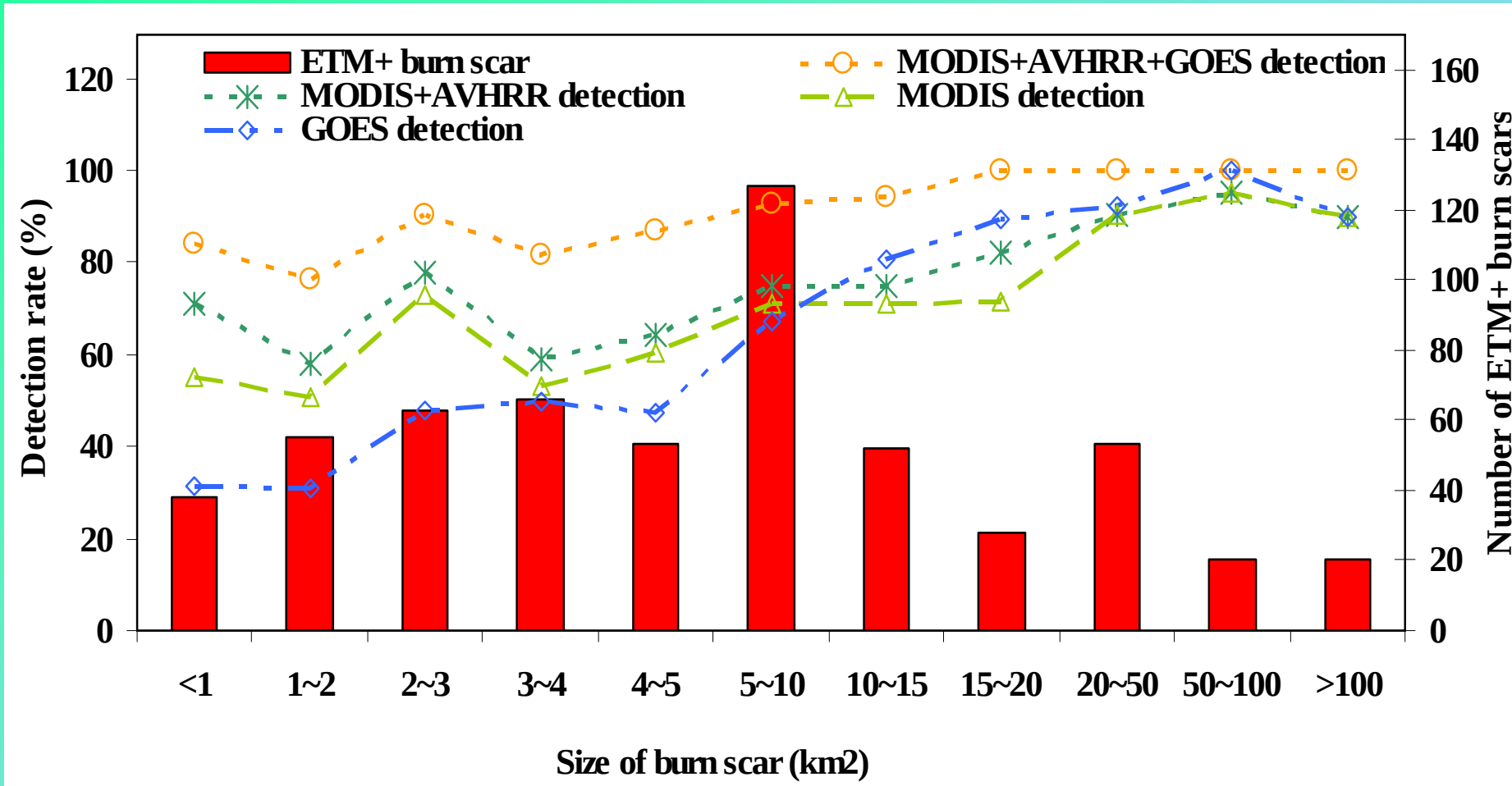
Simulation of Burned Area From HMS Fire Size

Instruments	Observation time	Spatial resolution
GOES-E	15 and 45 minutes	4 km
GOES-W	0 and 30 minutes	4km
Terra MODIS/NOAA-17	10:30 AM/PM	1km
Aqua MODIS/NOAA-18	1:30 AM/PM	1km
NOAA-15	6:00 AM/PM	1km

Evaluation of Fire Detections from Multiple Satellite Instruments using ETM+-Based Burn Scars



Detection Rate of ETM+-Based Burn Scars from Multiple Satellite Instruments



Conversion of Active Fire Size to Burned Area

$$A = \alpha \int_{t_s}^{t_e} F_t$$

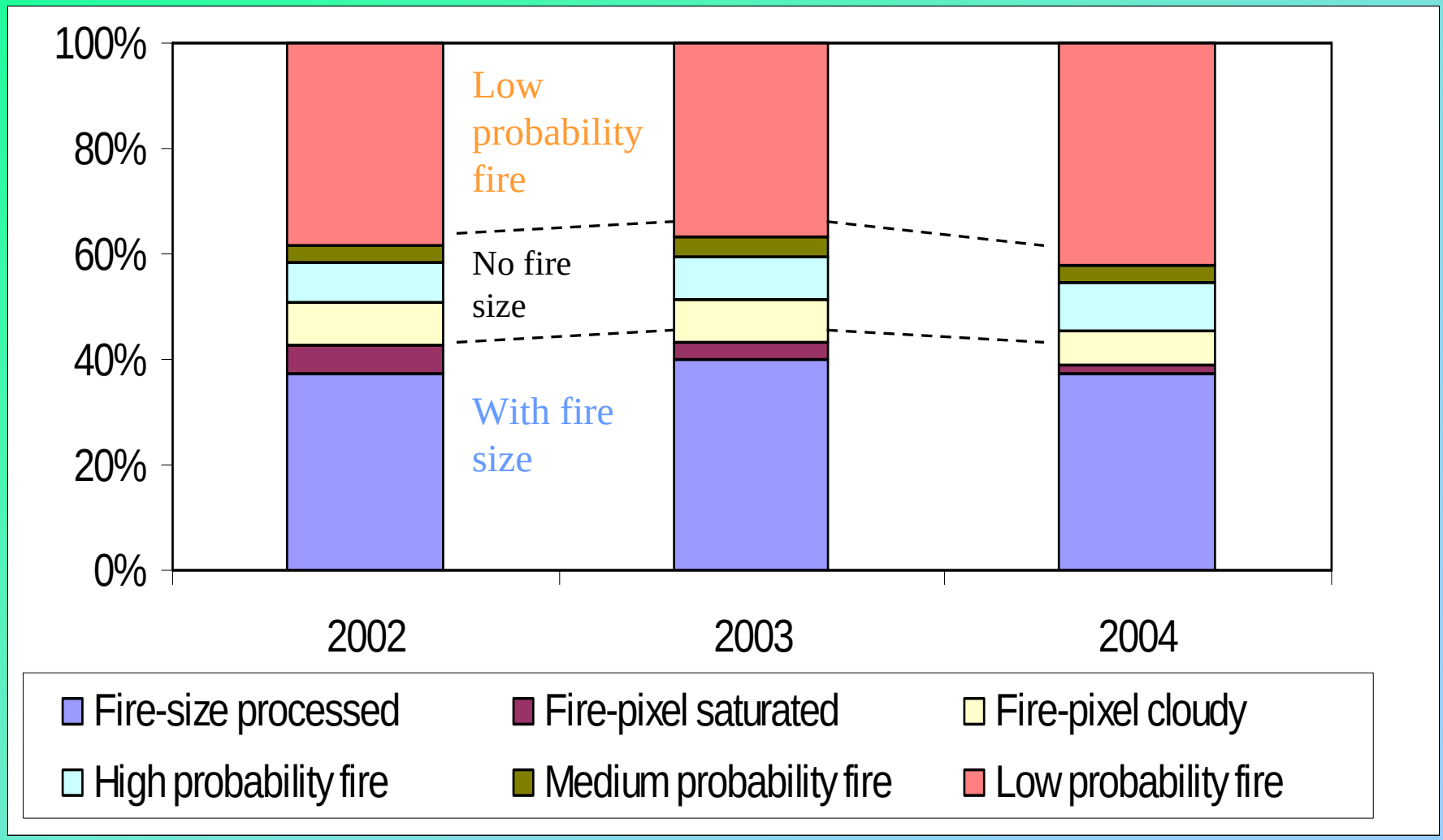
A -- area burned within a specified time period (km2)

F_t -- subpixel fire size (km2)

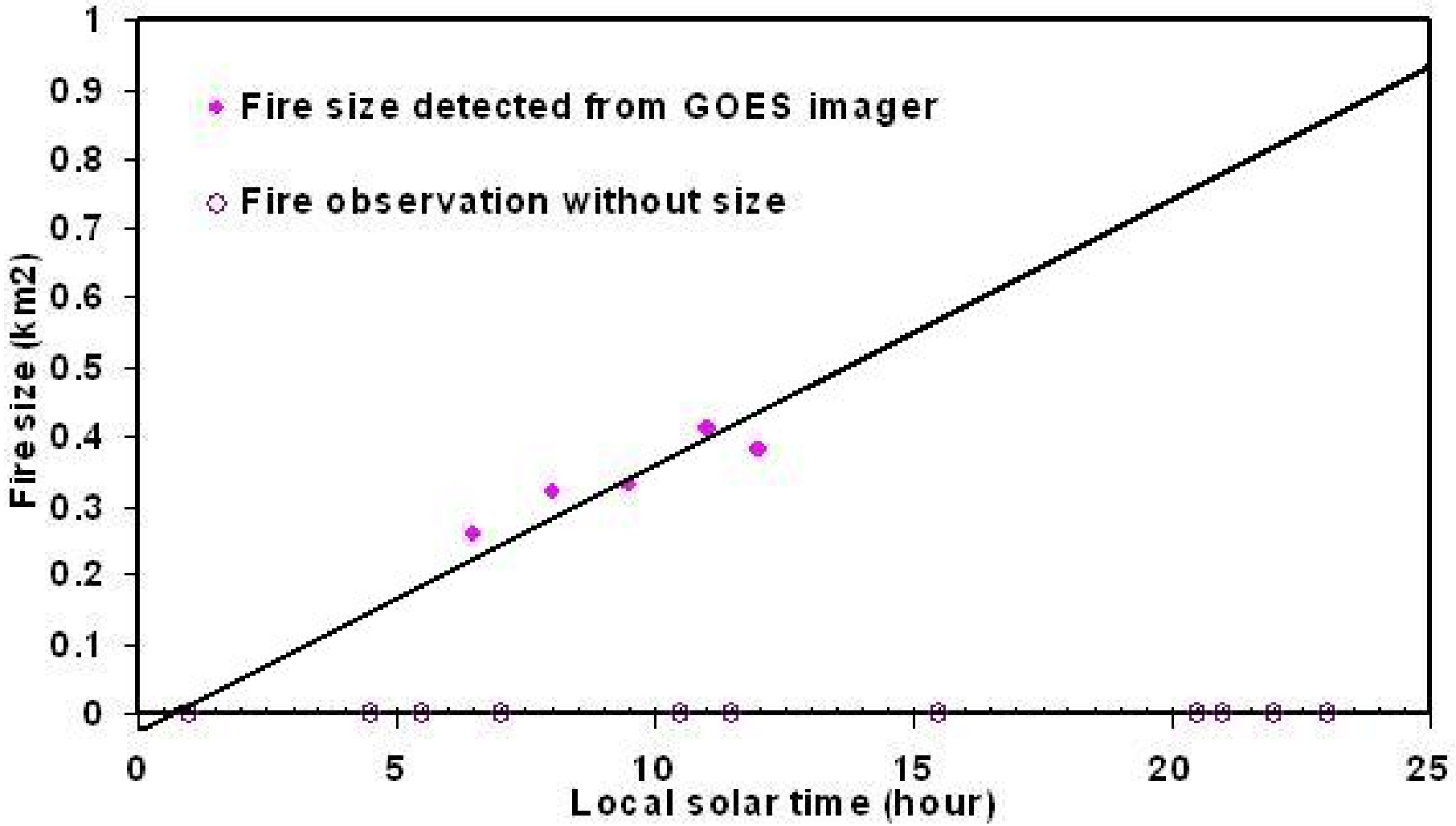
ts and *te* -- starting and ending time of a fire event, where the time step is set to half hours to match the temporal resolution of GOES satellite fire detection

α -- coefficient of conversion, which is defined as 1

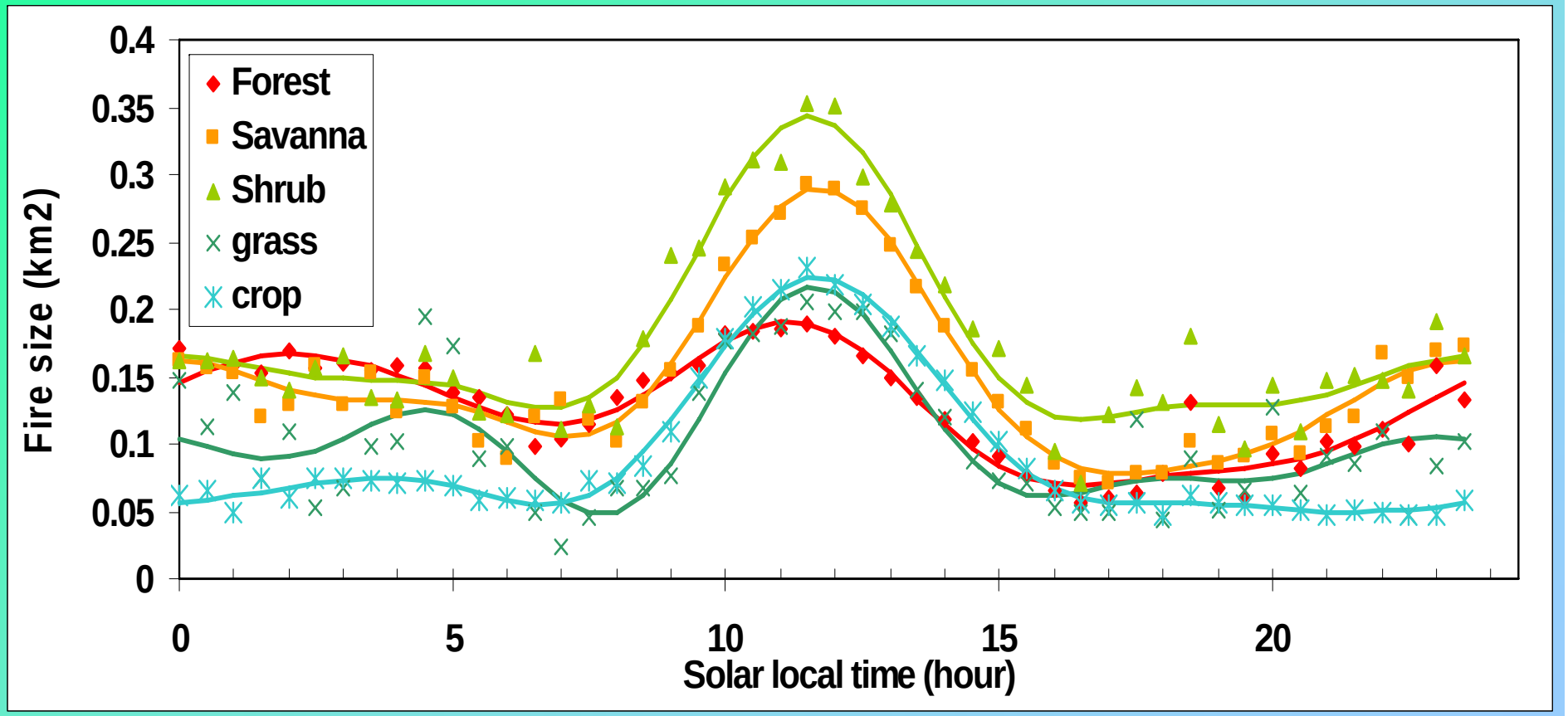
Quality in GOES Fire Product



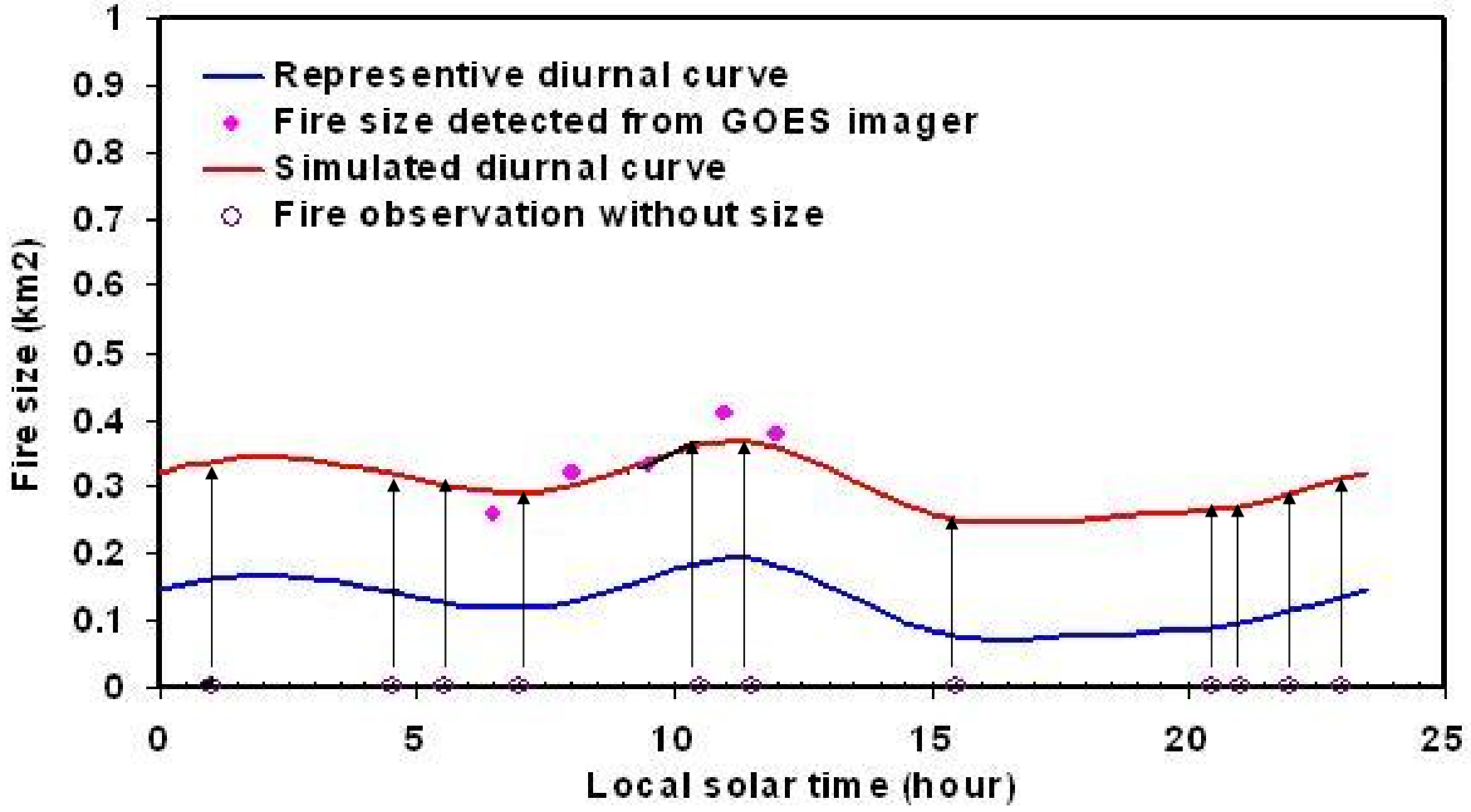
Diurnal Fire Size in An Individual Fire Pixel



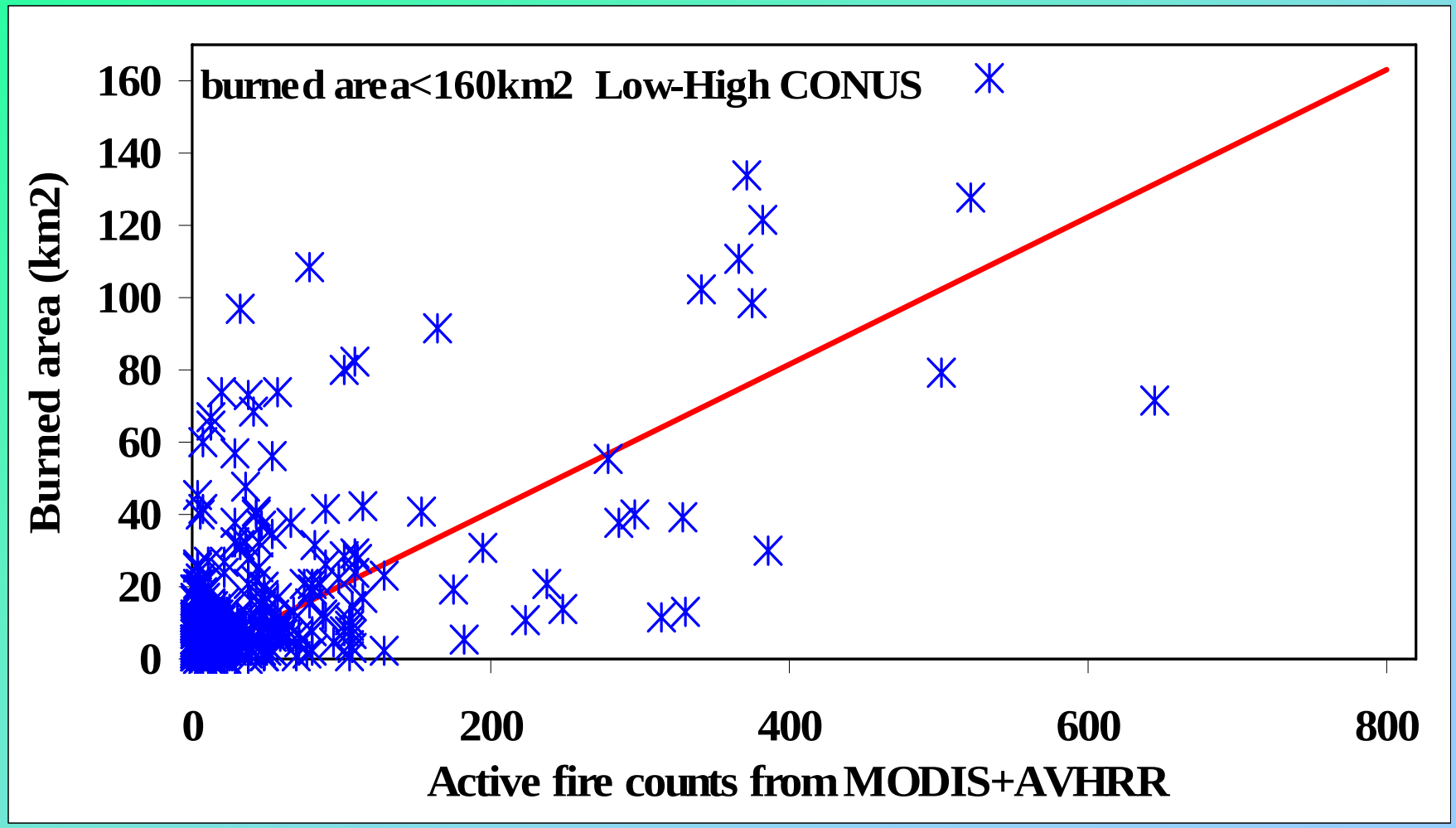
Fourier-Fitted Diurnal GOES Fire Sizes ---Representative diurnal curves



Fitting Diurnal Fire Size for Individual Fire Pixels

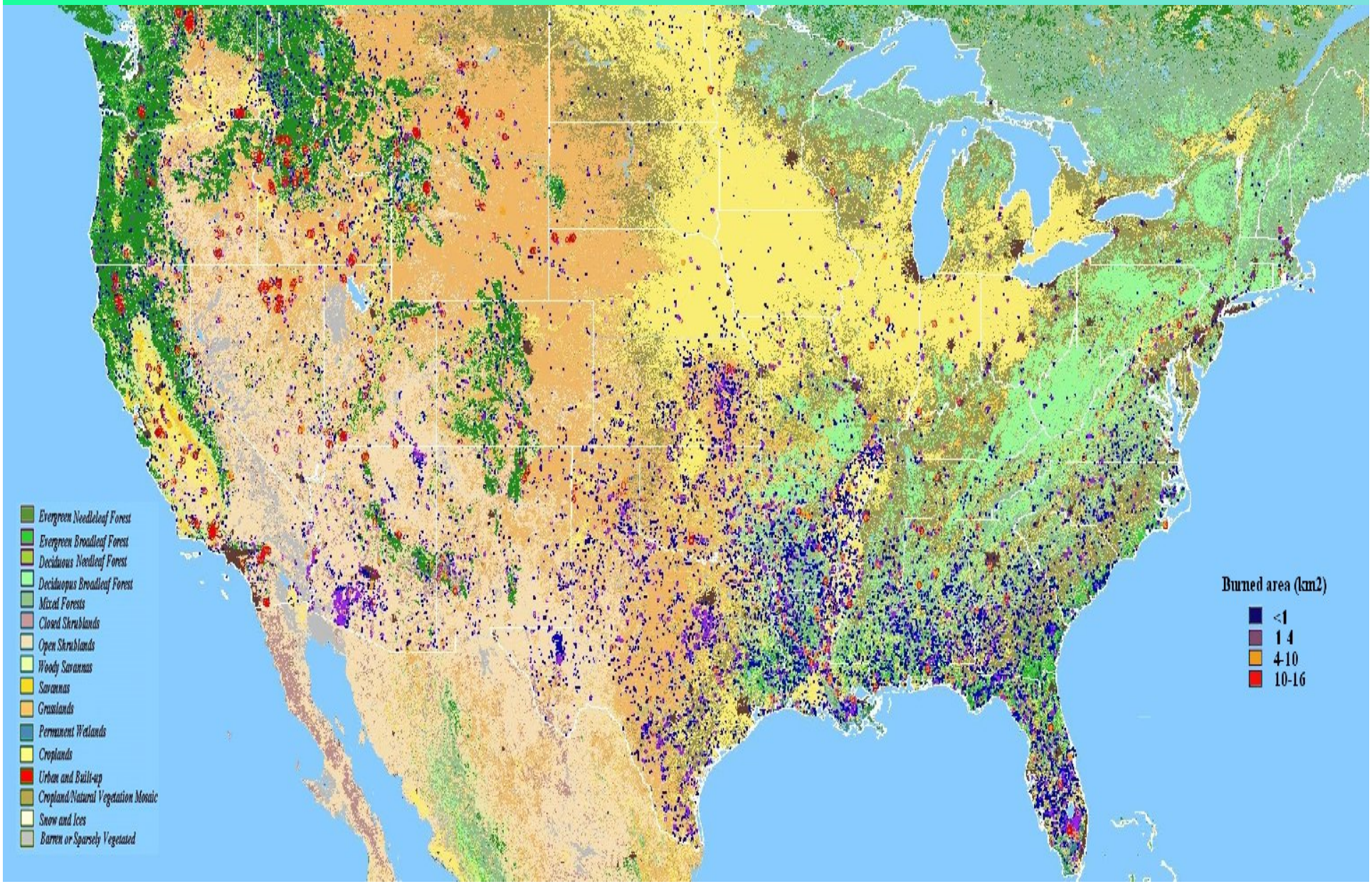


Fire Size for MODIS + AVHRR Observation

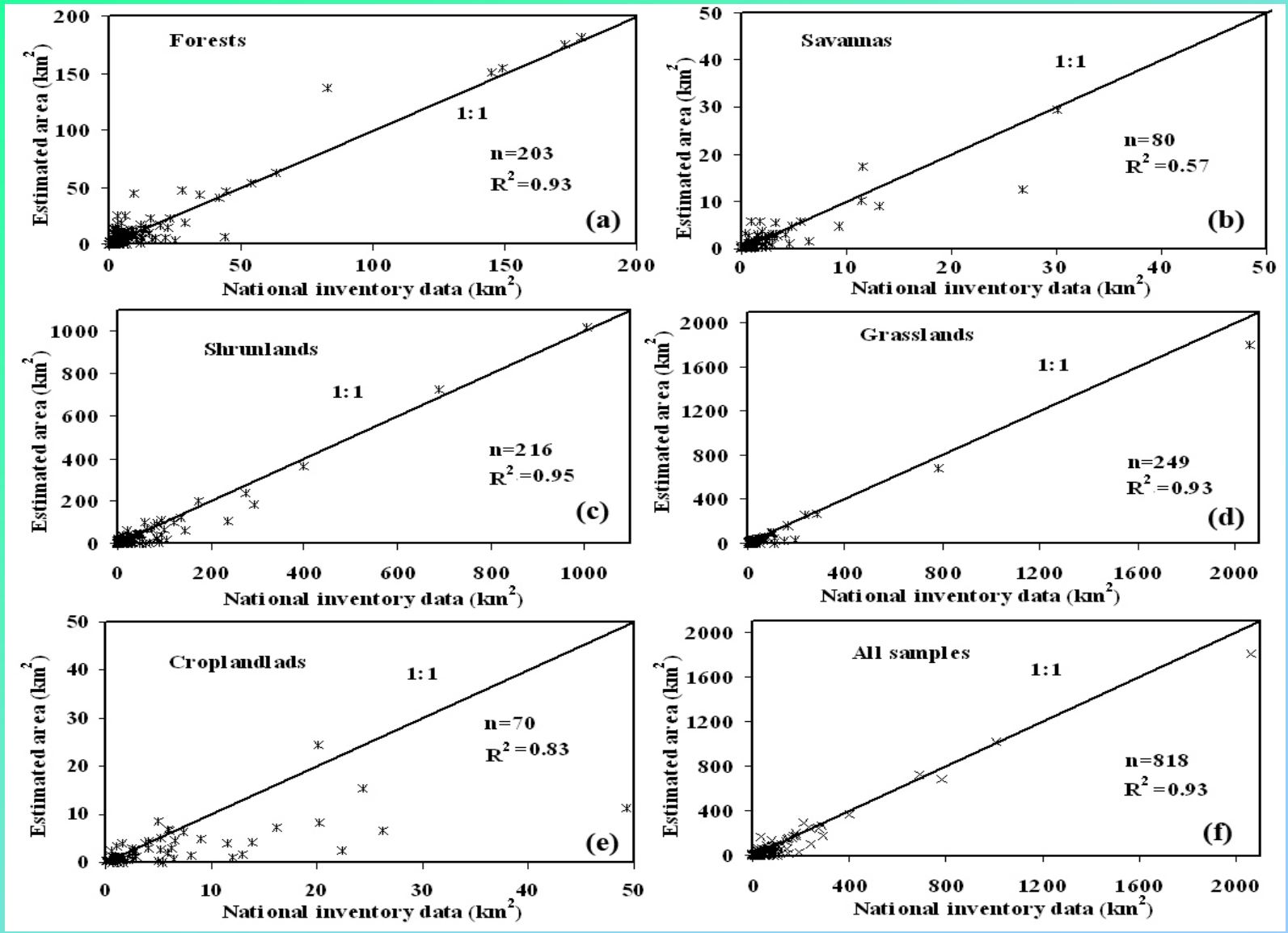


Burned Area Simulated from GOES Fire Size

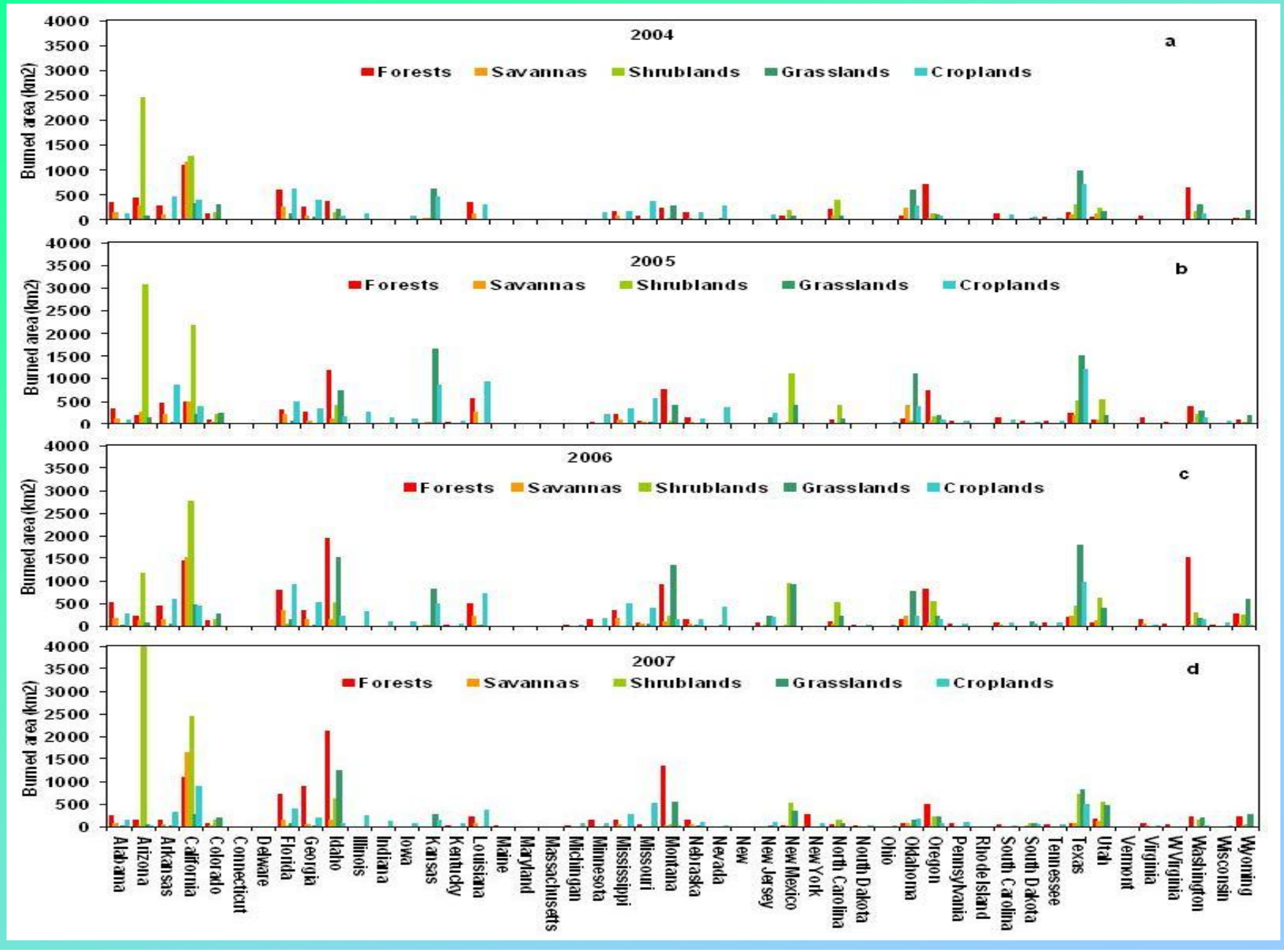
(2006)



Validation of Burned Areas from Multiple Satellite Hotspots using National Fire Inventory Data in 2005



Burned Area in Individual States

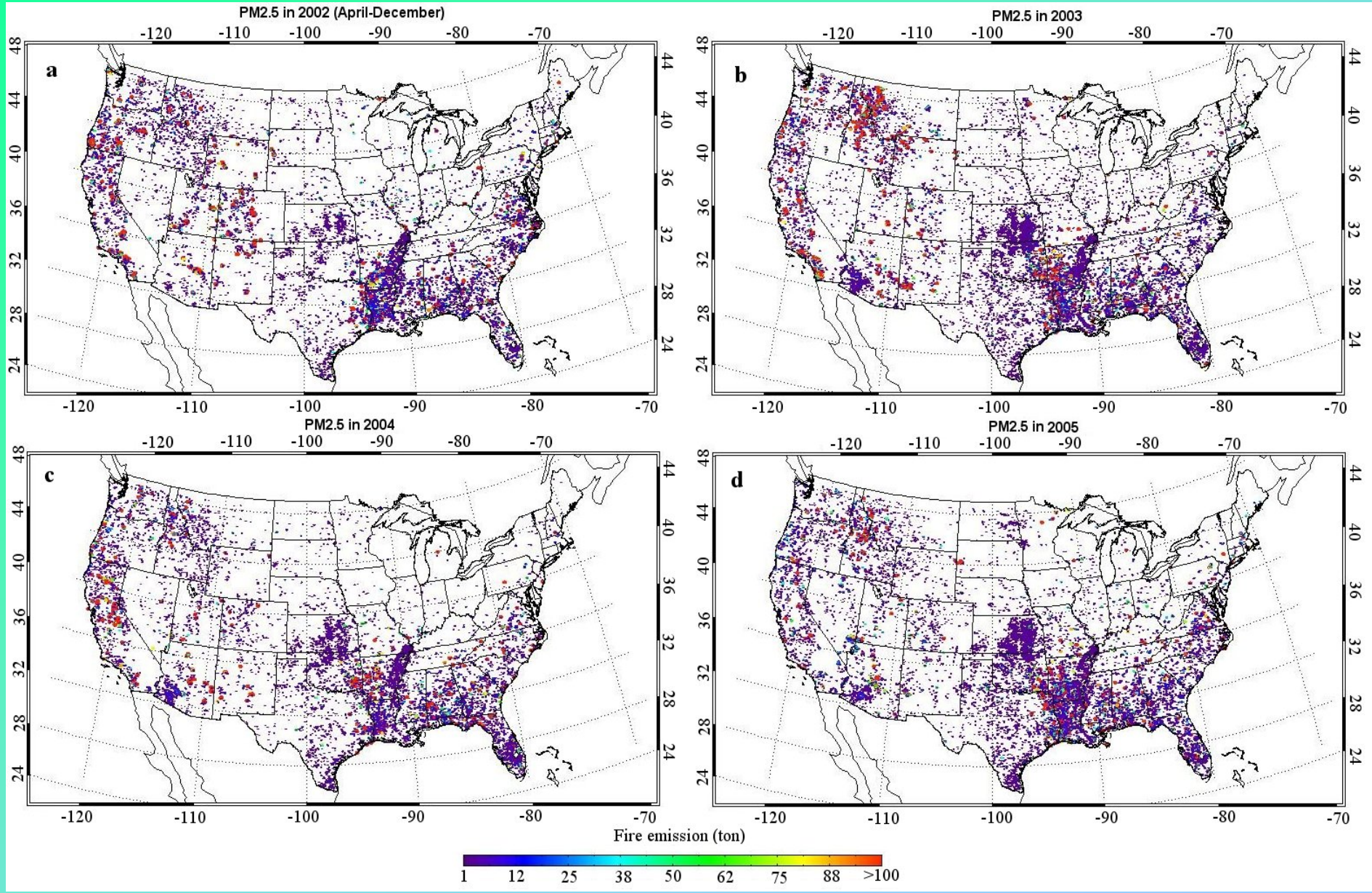


Calculation of Biomass Burning Emissions

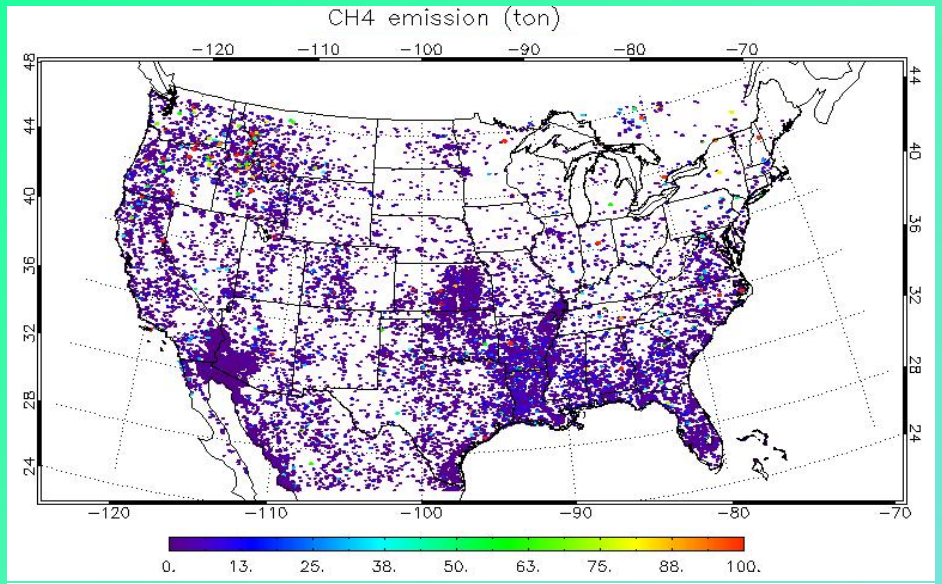
$$E = \sum_{k=1}^{K} \sum_{l=1}^{L} \sum_{j=1}^{J} \sum_{i=1}^{I} A_{ijkl} M_{ijk} C_{ijkl} F_{ijkl}$$

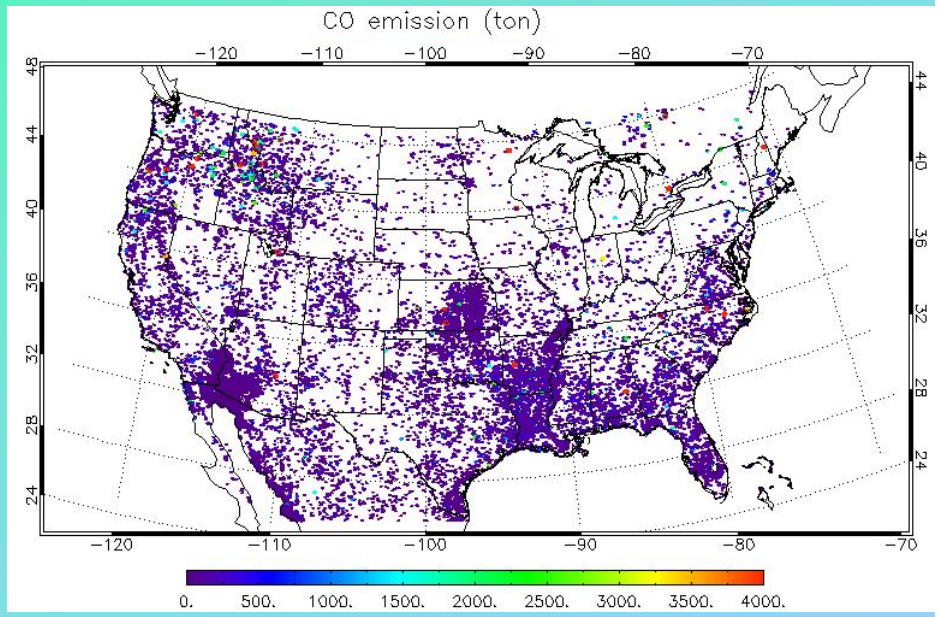
E---biomass burning emissions (kg)
A---burned area (km^2)
M--biomass density/fuel loading ($kg.km^{-2}$)
C--fraction of combustion
F--fraction of emission
i and *j* define the fire (pixel) locations
l is the fuel type
k is the time period

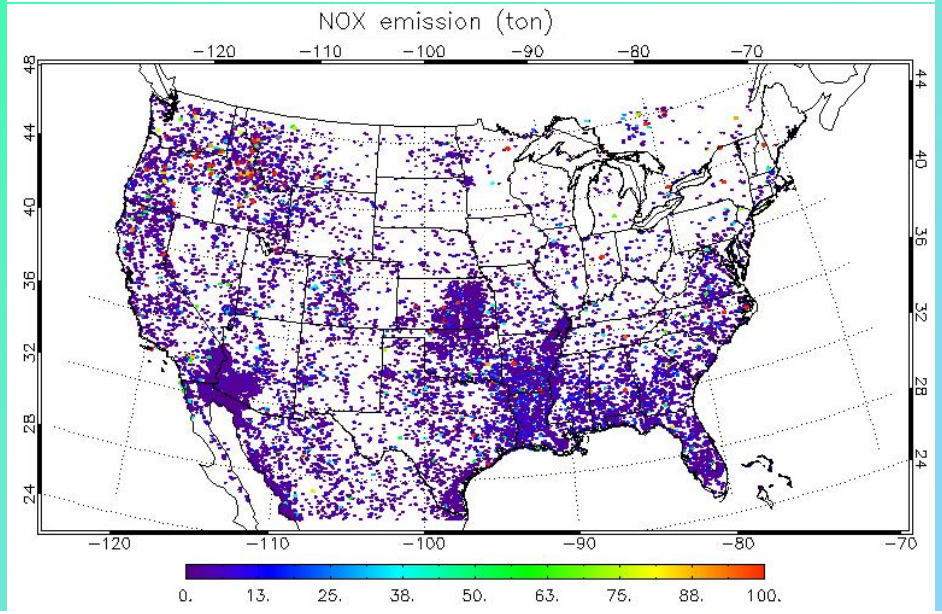
Annual PM2.5 Emissions Released from Fires



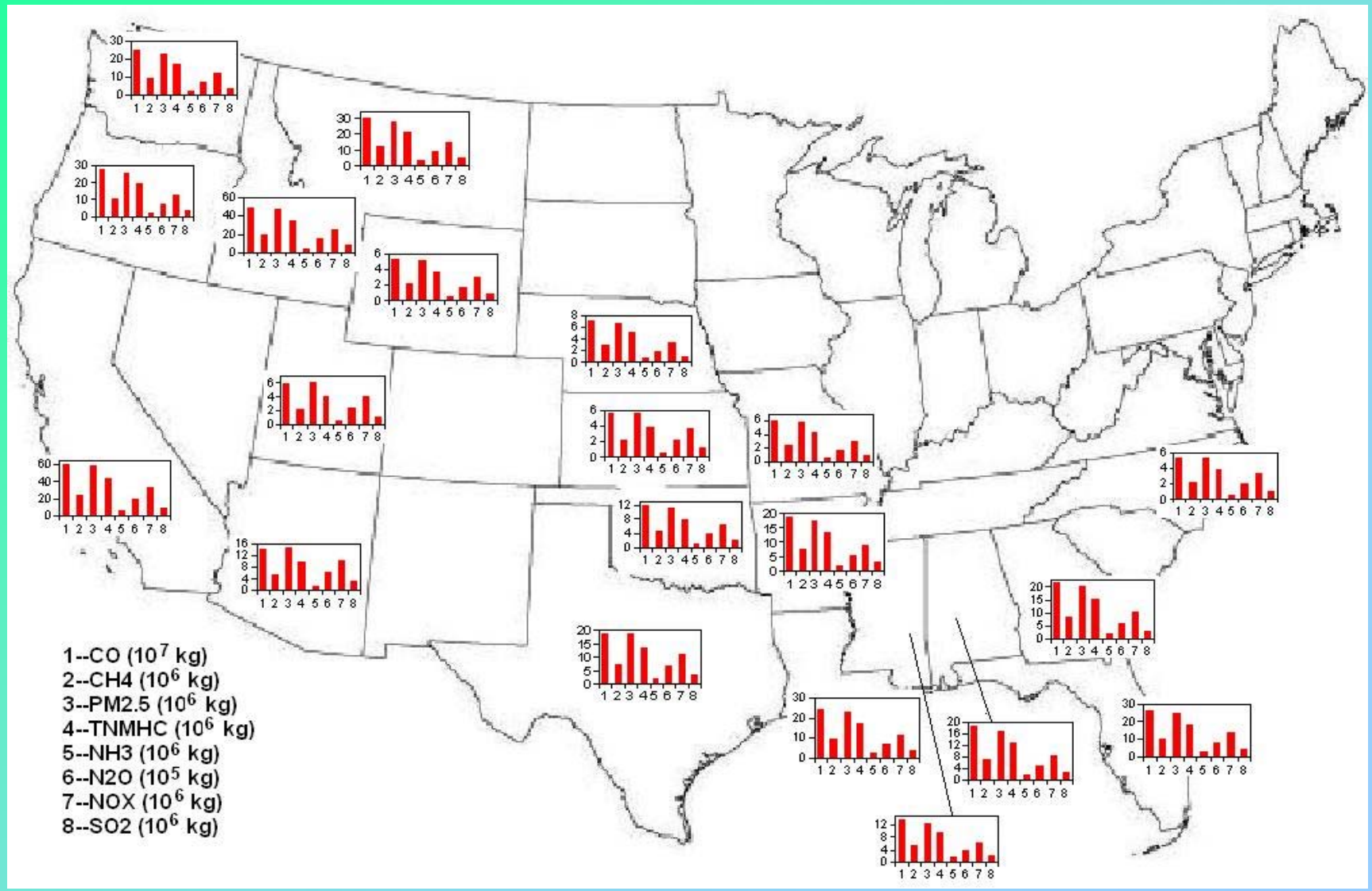
Biomass Burning Emissions (CH4, CO and NOX) in 2005



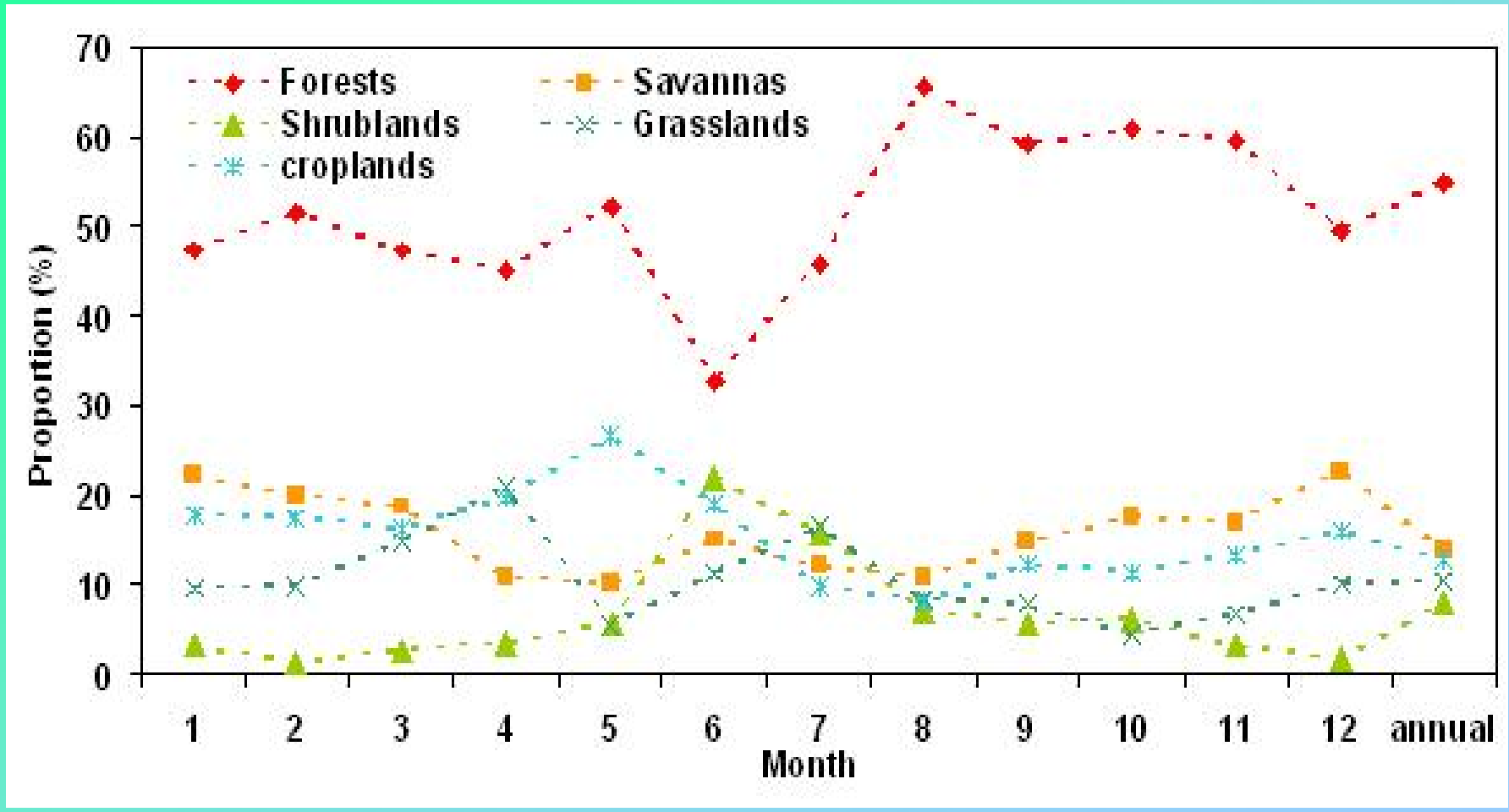




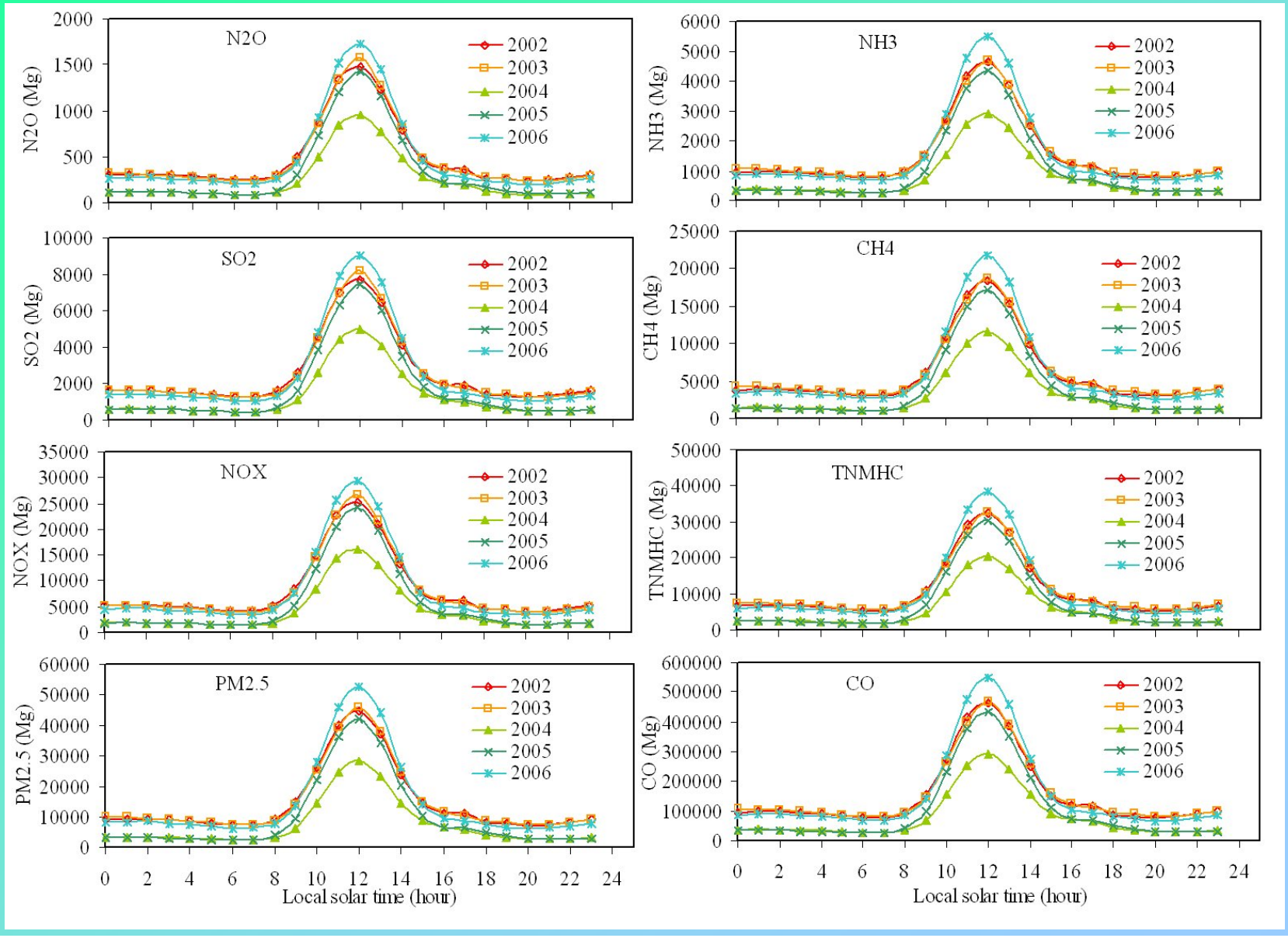
Biomass burning Emissions in Top 20 States



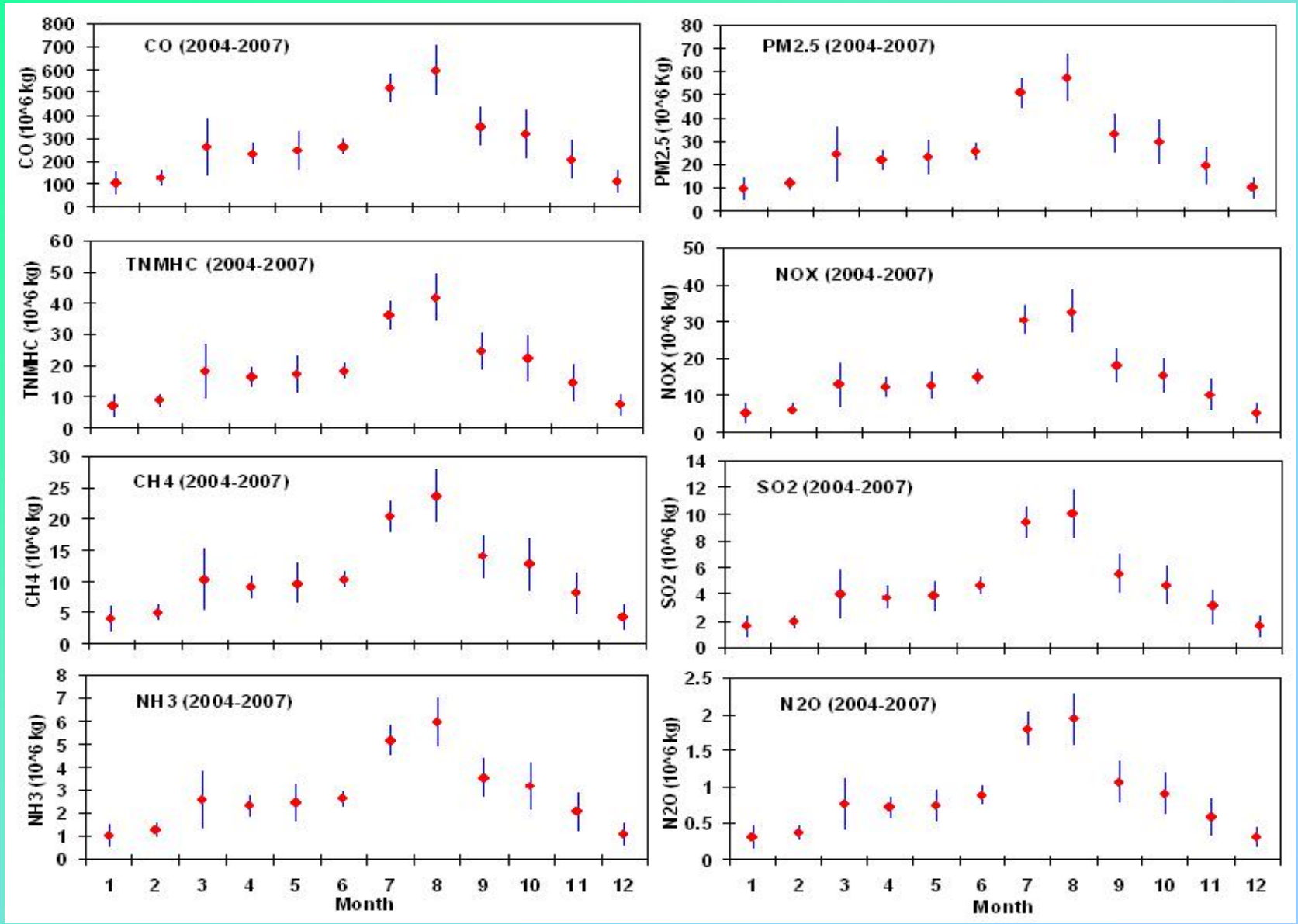
Biomass Burning Emissions Varying with Ecosystems



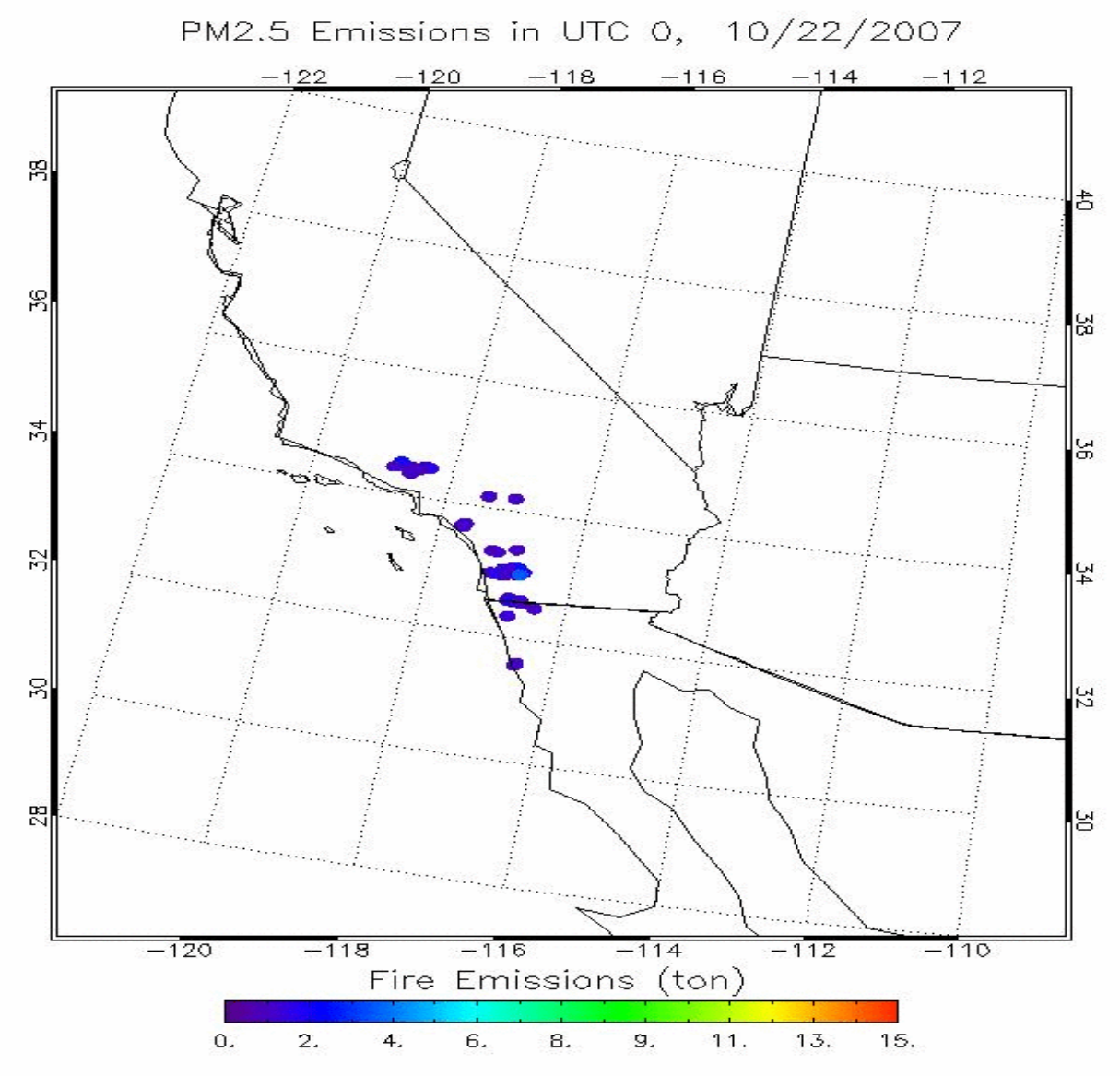
Diurnal Variations in Biomass Burning Emissions for Different Years



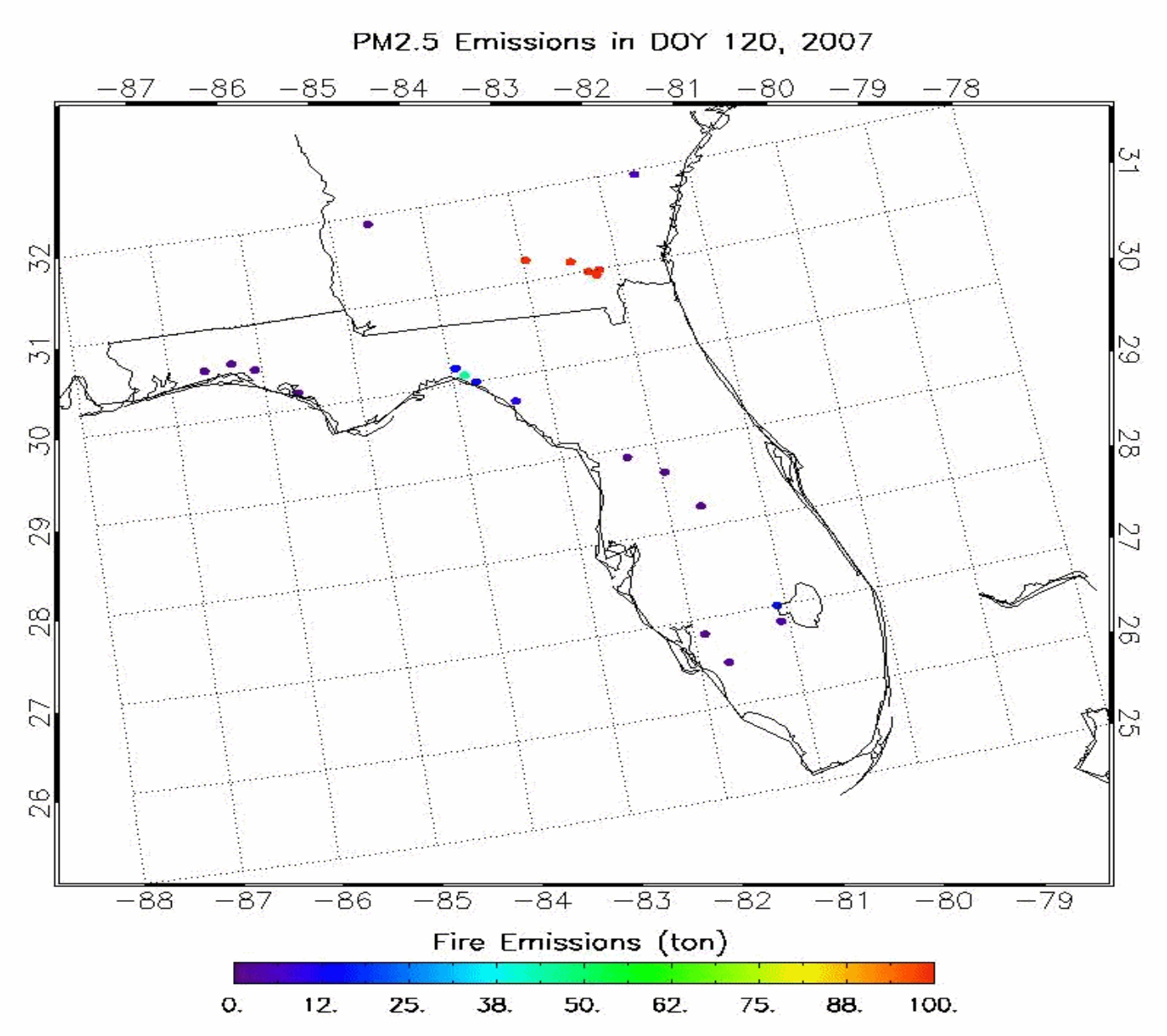
Monthly Variations in Biomass Burning Emissions



San Diego Fire Emissions in October 2007



Florida Fire Emissions in May 2007



Summary

- MODIS Vegetation Property-based Fuel System (MVPFS) provides realistic fuel loading data
- Burned area can be reasonably estimated by blending active fire observations from MODIS, AVHRR, and GOES instruments
- Hourly biomass burning emissions (PM2.5, CH4, CO, N2O, NH3, NOX, SO2, and TNMHC) inventory can be created in near real time using multiple satellite data