Analysis of Long-Term Fire Dynamics and Impacts on the Amazon Using Integrated Multi-Source Fire Observations

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LBA-ECO Phase III - LC-35 group

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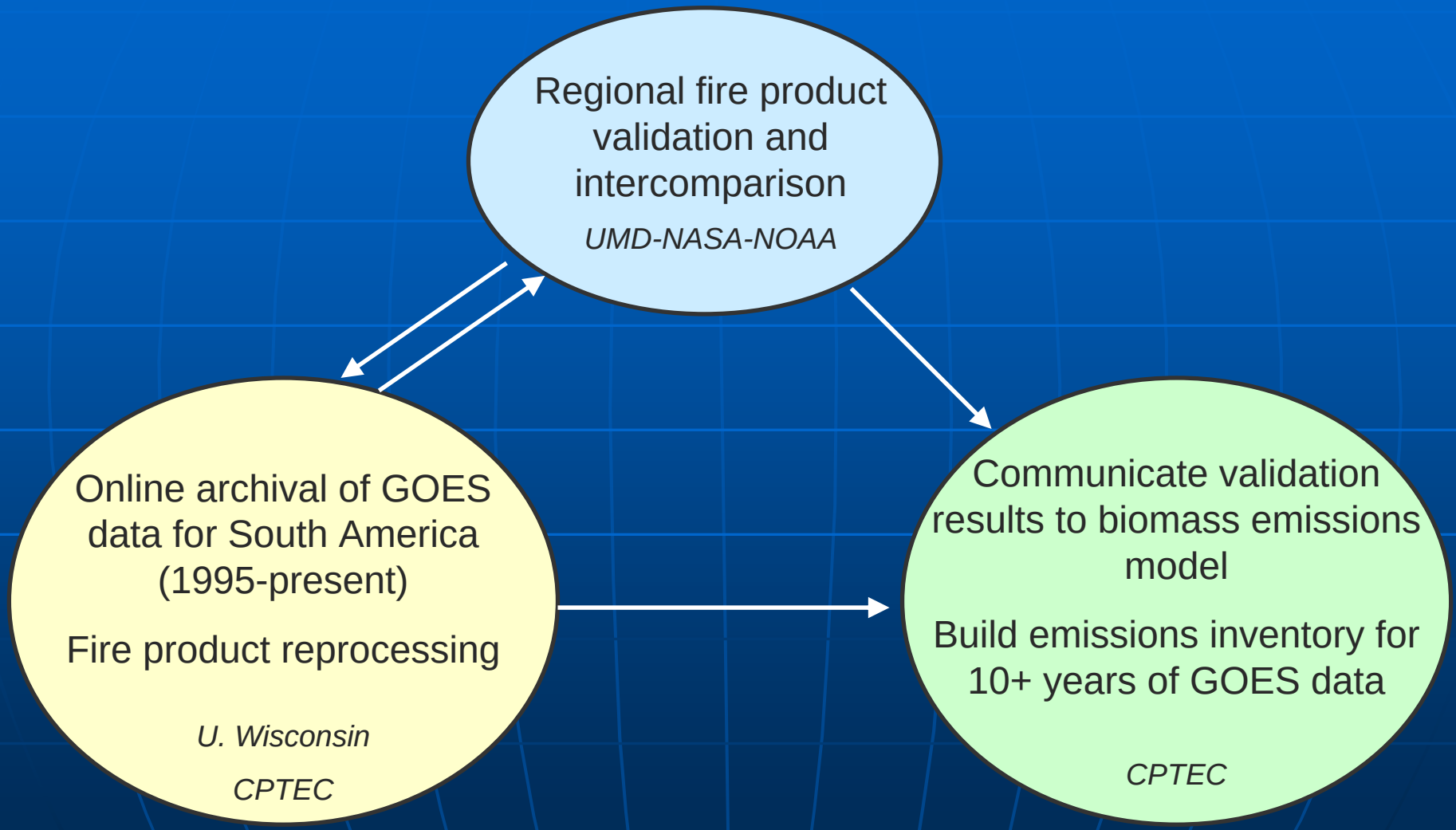
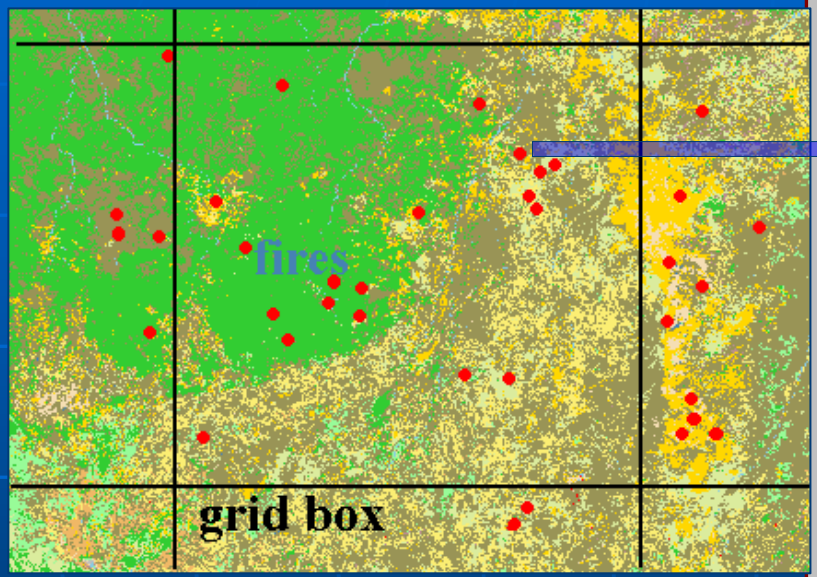
LC-35: Major Tasks



Source Emission Parameterization for biomass burning



- **Mass of the tracer emitted:**

$$M_{[\eta]} = \alpha_{veg} . \beta_{veg} . E f_{veg}^{[\eta]} . a_{fire}$$

α : aboveground biomass density (dry matter basis, kg m^{-2})

β : combustion factor (%)

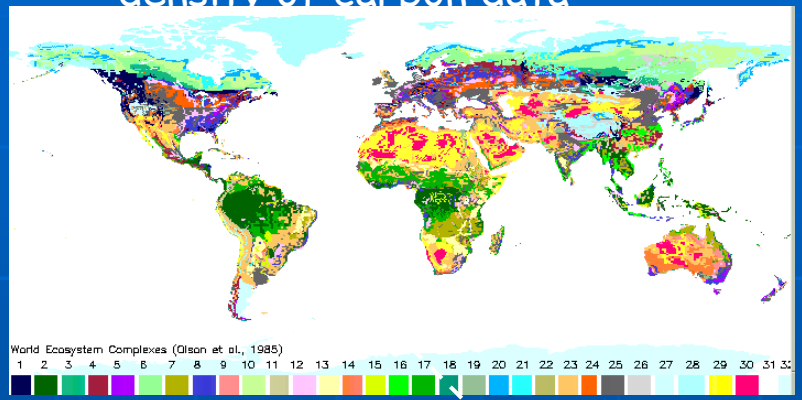
E_f : emission factor (g[η] / kg): gives the total amount of the tracer emitted in terms of the total biomass consumed

a_{fire} : burnt area

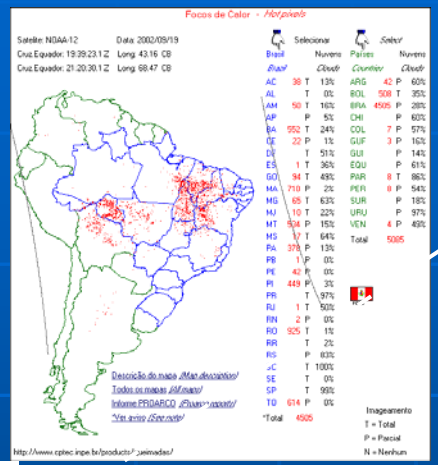
Biomass burning emissions inventory

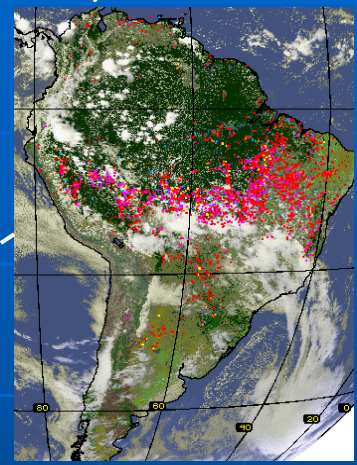
Regional scale – daily basis

density of carbon data

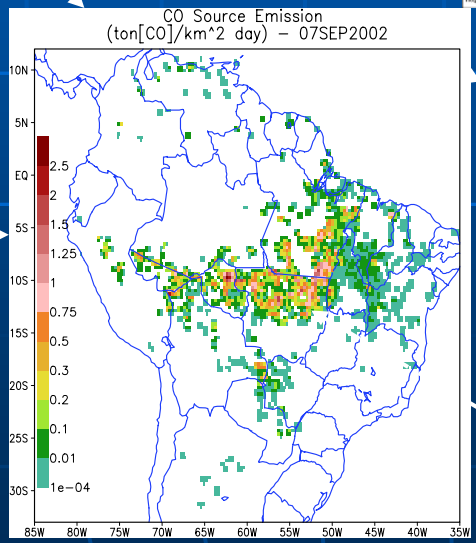


near real time fire product





land use data



CO source emission (kg $m^{-2}day^{-1}$)

emission & combustion factors

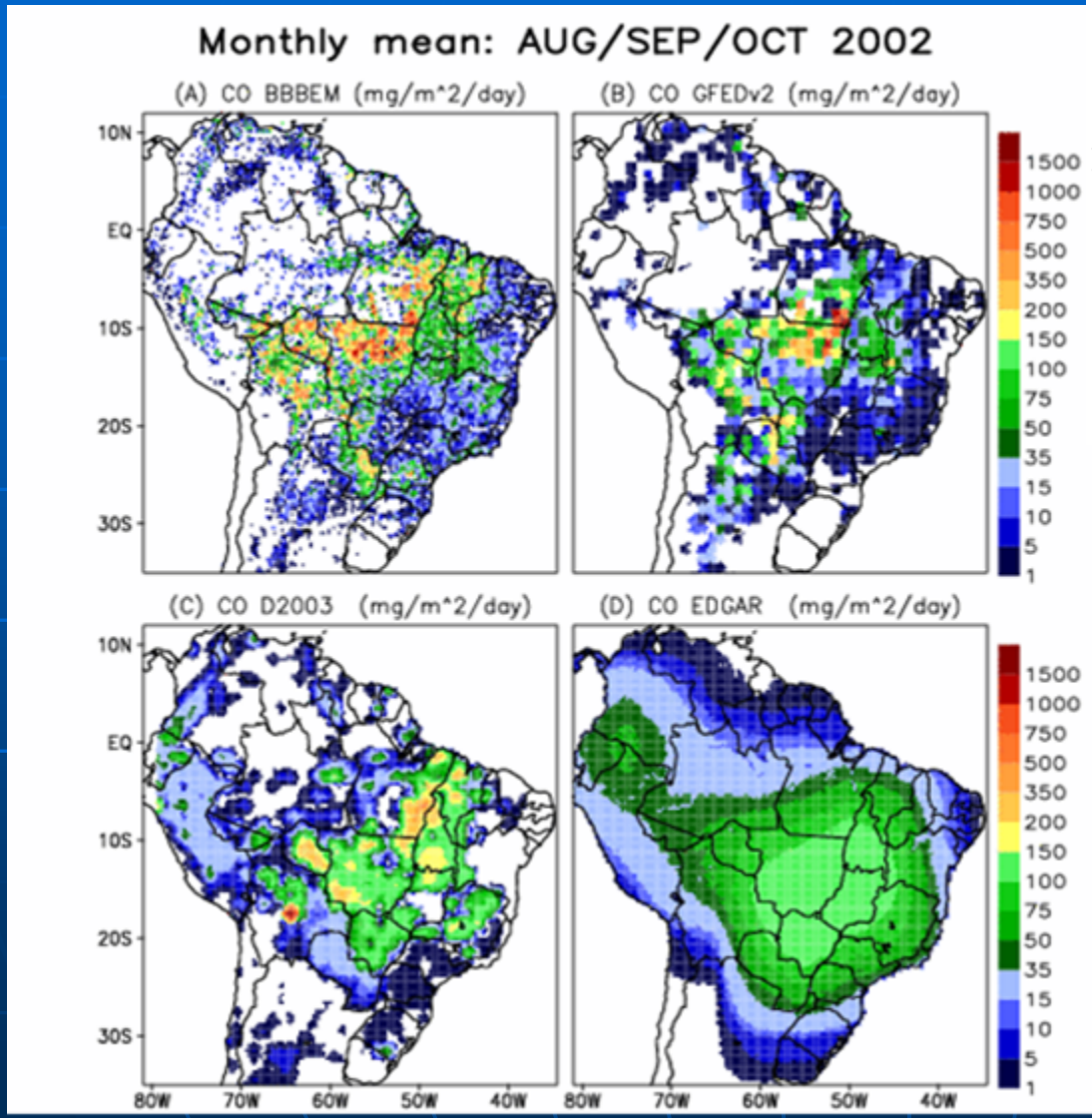
Biome category	Emission Factor for CO (g/kg)	Emission Factor for PM2.5 (g/kg)	Aboveground biomass density (α, kg/m^2)	Combustion factor (β, fraction)
Tropical forest[1]	110.	8.3	20.7	0.48
South America savanna[2]	63.	4.4	0.9	0.78
Pasture[3]	49.	2.1	0.7	1.00

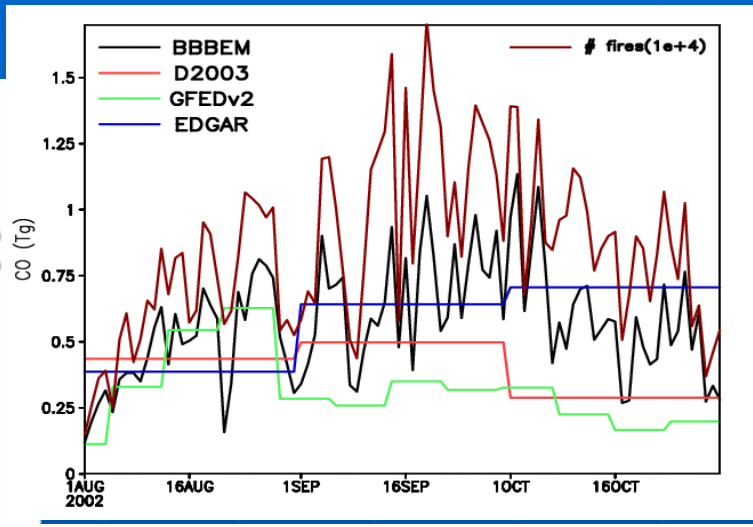
[1] Average values for primary and second-growth tropical forests, [2] Average values for campo cerrado (C3) and cerrado sensu stricto (C4), [3] value for campo limpo (C1). All numbers are from Ward et al.,

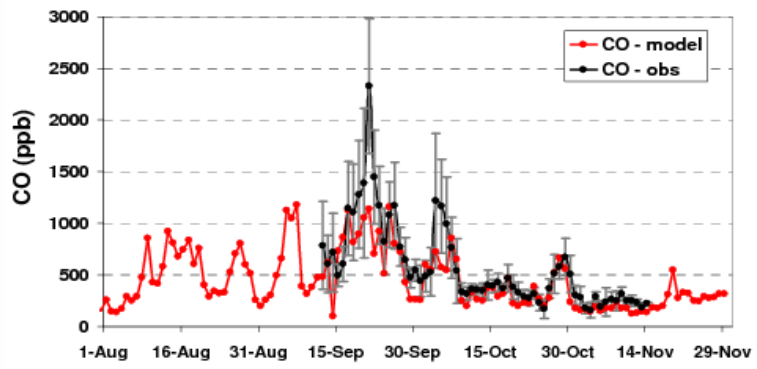
mass estimation

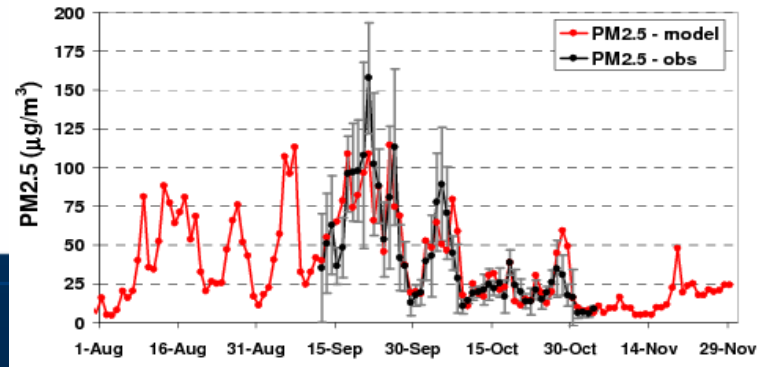
$$M_{[\eta]} = \alpha_{veg} . \beta_{veg} . \mathrm{E}f_{veg}^{[\eta]} . a_{fire}$$

Brazilian Biomass Burning Emission model, daily resolution









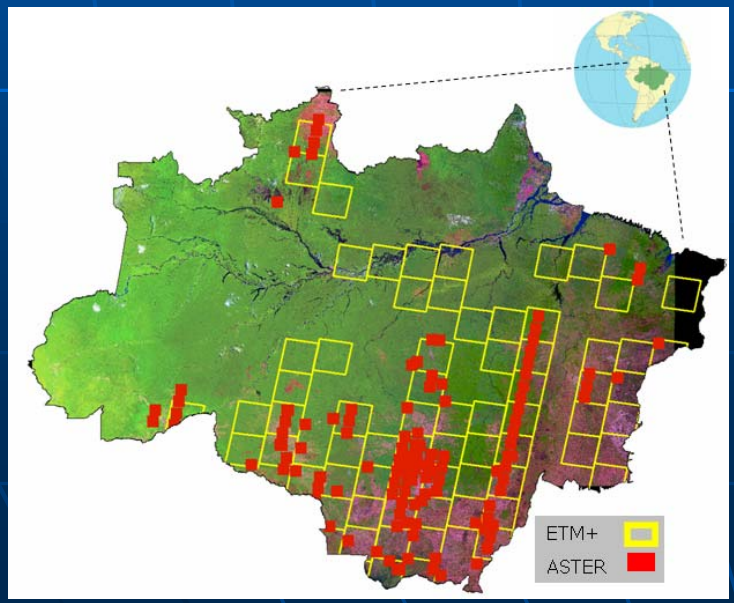
Validation – rates of omission and commission

162 ASTER Scenes:

2001 – 06	Jan: 14
2002 – 66	Feb: 5
2003 – 52	Mar: 0
2004 – 29	Apr: 0
2005 – 08	May: 12
	Jun: 8
	Jul: 3
	Aug: 65
	Sep: 32
	Oct: 19
	Nov: 4
	Dec: 0

122 ETM+ Scenes:

2000 – 1	Jan: 3
2001 – 49	Feb: 3
2002 – 61	Mar: 2
2003 – 12	Apr: 5
	May: 5
	Jun: 7
	Jul: 15
	Aug: 47
	Sep: 21
	Oct: 13
	Nov: 1
	Dec: 1



ASTER data available free of cost through EOS Data Gateway (special NASA affiliated user account)

ETM+ data available free of cost through GLCF (57) and INPE (65)

Higher Resolution imagery used to validate:

119 GOES 8 and 12 images

17,300 fire pixels analyzed

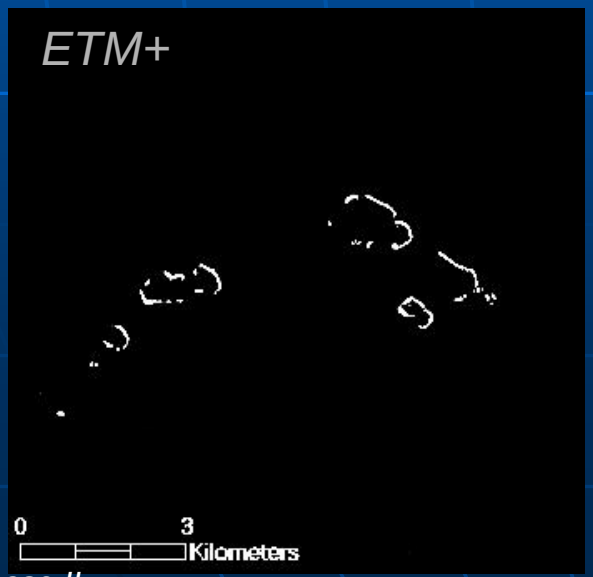
563 WF-ABBA fire detections

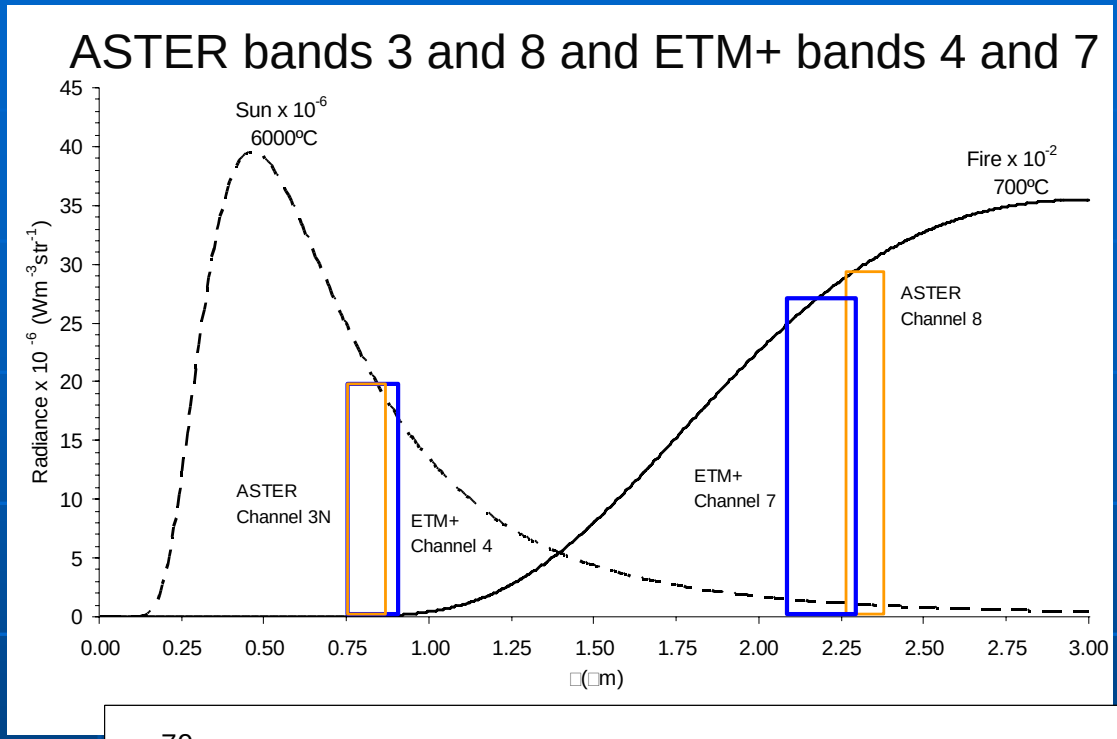
135 MODIS Terra images

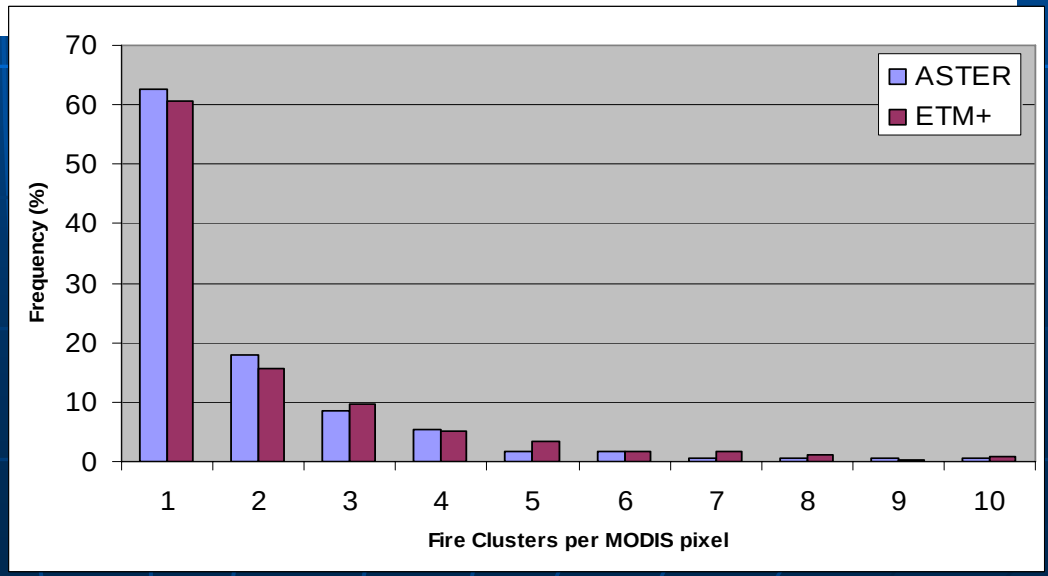
7,300 fire pixels analyzed

1,640 MOD14 fire detections

Generating ETM+ Active Fire Masks

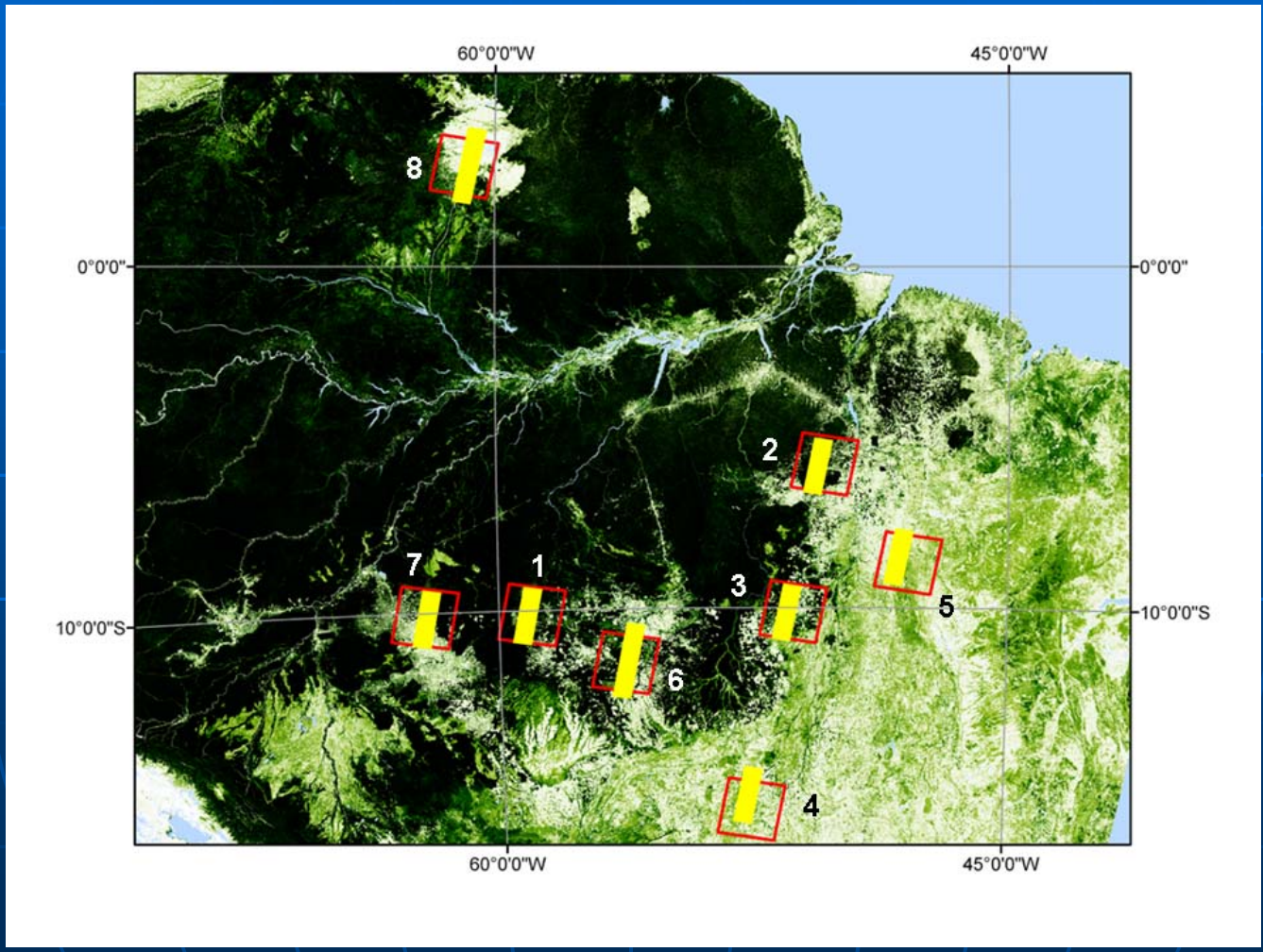






Phase II

Validation: impact of non-simultaneous reference data

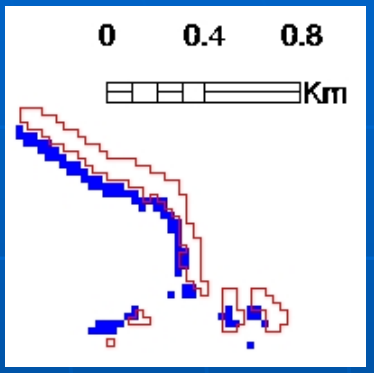


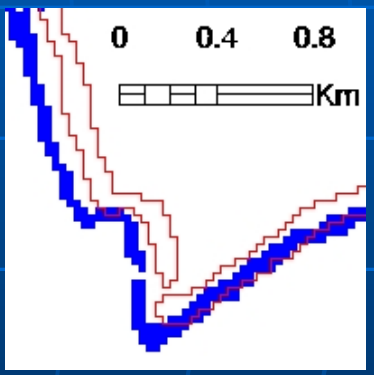
Same-day ASTER (10:30) and Landsat-7 (10:00) imagery

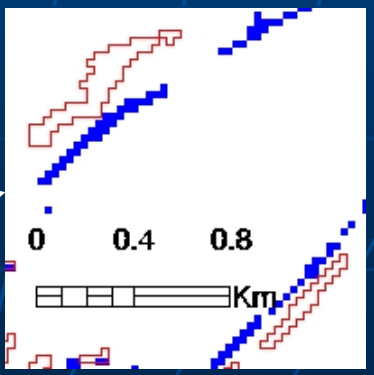
(Csiszar and Schroeder, submitted)

Same-day ETM+ and ASTER

Location on map	Date	WRS-2 path/row	ASTER time (UTC)	Vegetation type
1	8/13/2001	229/067	14:27:35	forest interface
			14:27:43	forest interface
			14:27:52	forest interface
2	8/29/2002	224/064	13:49:16	forest interface
			13:49:25	forest interface
			13:49:34	forest interface
3	8/29/2002	224/067	13:50:27	forest interface
			13:50:36	forest interface
			13:50:45	forest interface
4	8/29/2002	224/071	13:51:55	cerrado
			13:52:04	cerrado
			13:52:13	cerrado
5	8/31/2002	222/066	13:37:36	cerrado
			13:37:45	cerrado
			13:37:54	cerrado
6	10/5/2002	227/068	14:08:52	forest interface
			14:09:01	forest interface
			14:09:10	forest interface
			14:09:19	forest interface
7	10/17/2002	231/067	14:33:18	forest interface
			14:33:27	forest interface
			14:33:36	forest interface
8	1/28/2003	232/058	14:35:59	grassland
			14:36:08	grassland





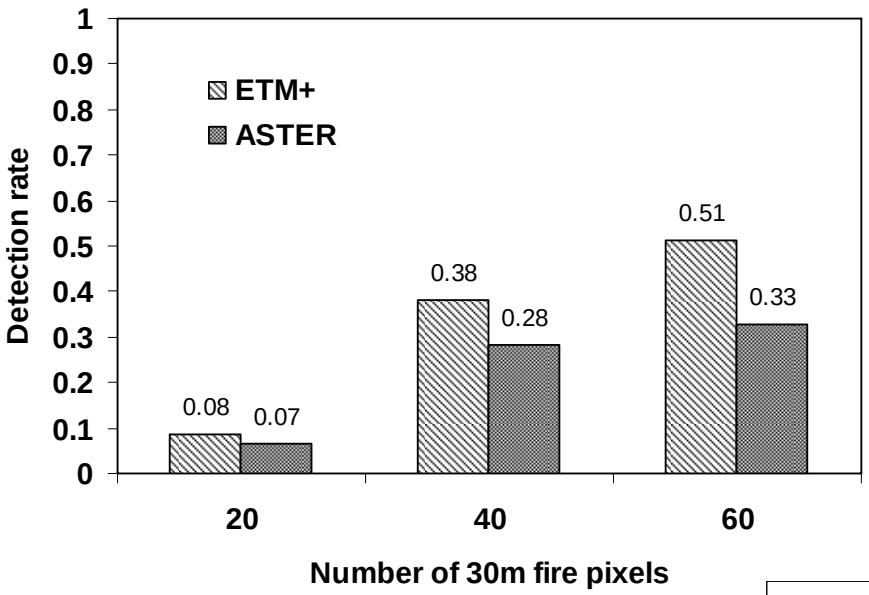


Red: ASTER

Blue: TM+

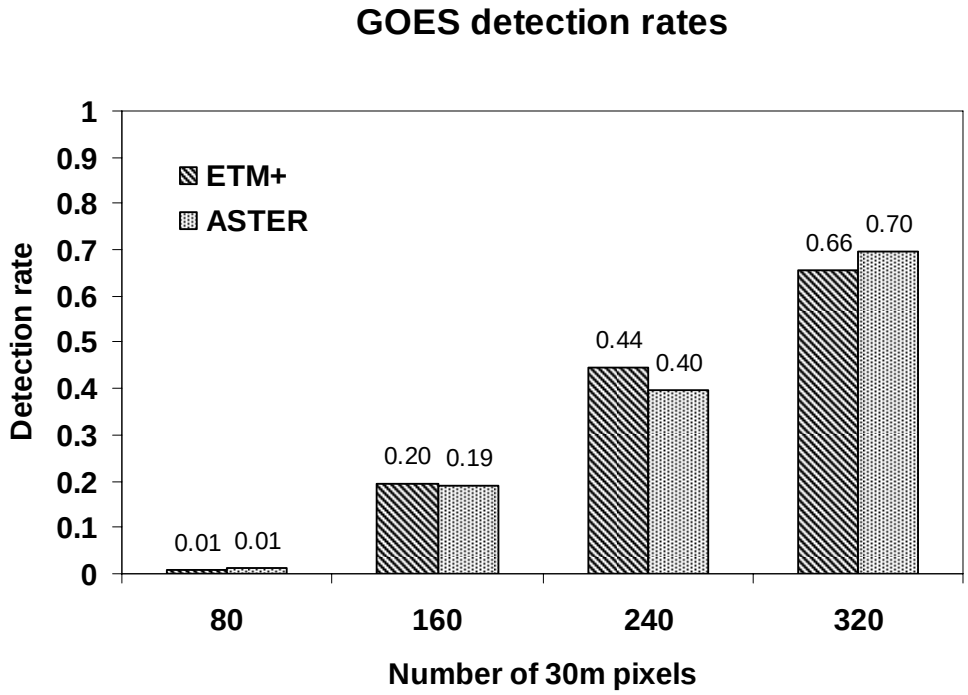
Validation: impact of non-simultaneous reference data

Temporally unbiased



ETM+: temporally biased
ASTER: simultaneous

Detection rates as a function of the number of 30m pixels within the pixel footprint



Validation and product intercomparison: what we have learned so far

- Hot spot counts and detection rates from daily aggregated GOES detections are comparable with those from lower frequency, higher resolution observations

- Many false detections are associated with land clearing
  - false alarm rates lower in the afternoon
  - scale-dependent – different for MODIS and GOES

Online GOES Data Archival and Reprocessing

- The GOES-8 data base for 1995 – 1999 has been retrieved from archive tape and reprocessing has started at SSEC.
  - 1995 and 1996 data are found to be noisy – correction necessary
  - NCEP model output data are used in reprocessing effort
- Version 6.5 of the GOES WF_ABBA code provides additional parameters and meta data:

  - opaque cloud product

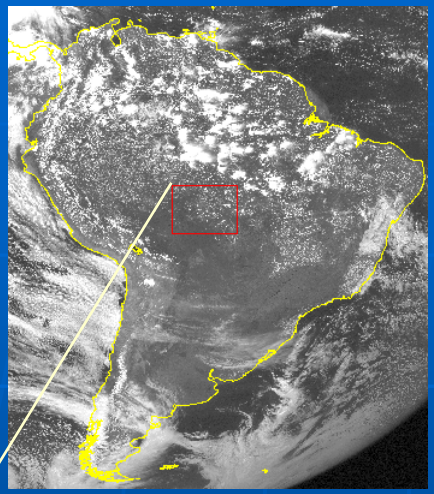
  - Fire Radiative Power (FRP) product in addition to Dozier output of instantaneous estimates of fire size and temperature

  - block-out zones due to solar reflectance, clouds, extreme view angles, biome type, etc.

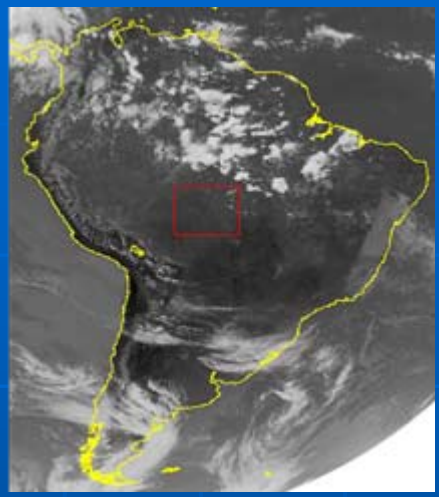
  - fire/meta data mask

  - revised ASCII fire product output: latitude, longitude, satellite view angle, pixel size, 4 and 11 micron brightness temperatures, fire size and temperature, FRP, biome type, fire confidence flag

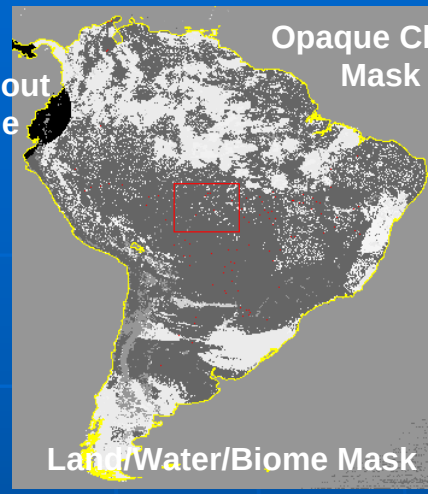
Application of GOES WF_ABBA (version 6.5)



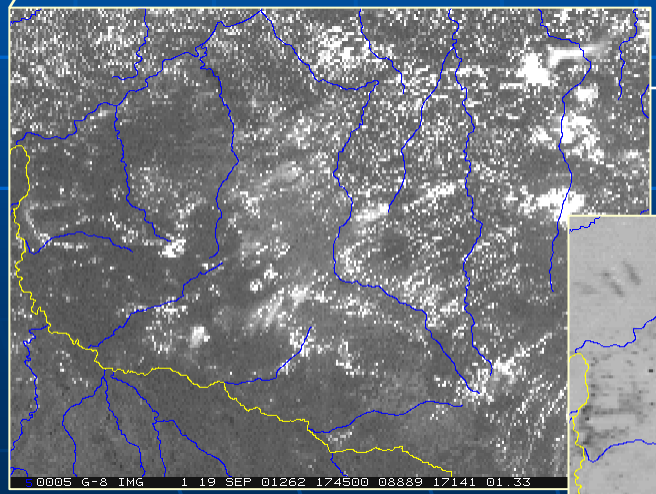
GOES visible image



GOES 11 micron image



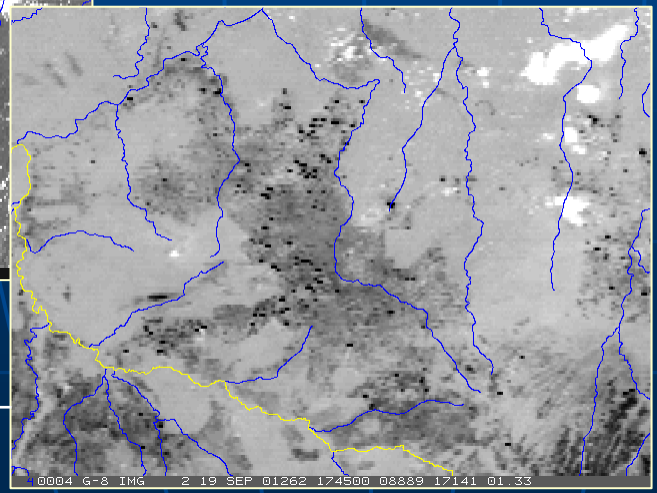
Fire Mask

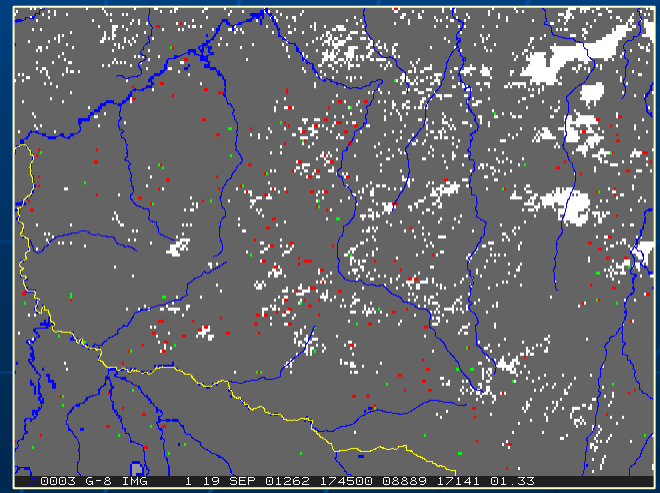


GOES visible image

Fire Mask
(fire location/confidence, opaque clouds, land/water mask, other biome masks, block-out zones, bad data indicator, processing region, etc.)

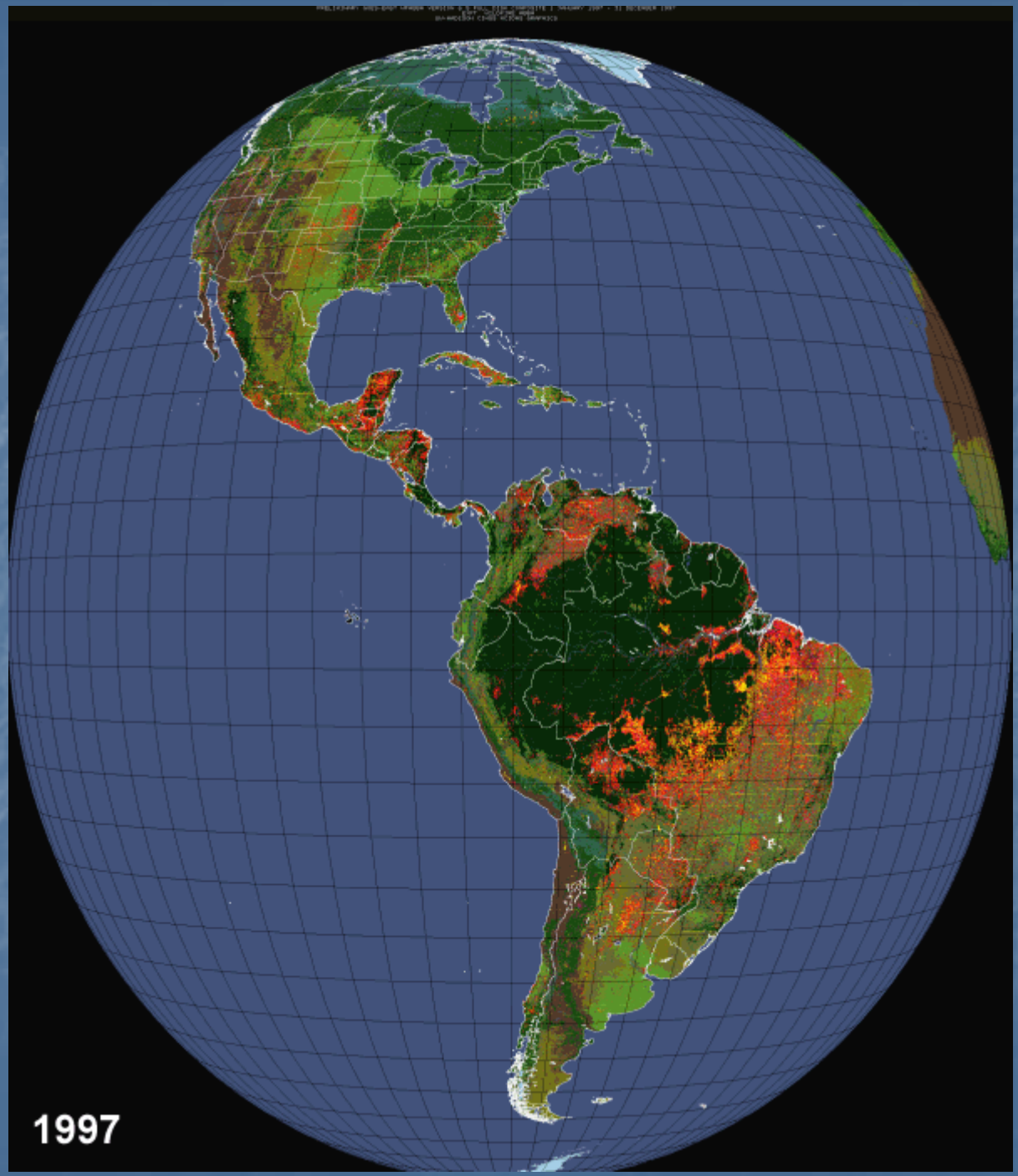
GOES 3.9 micron image





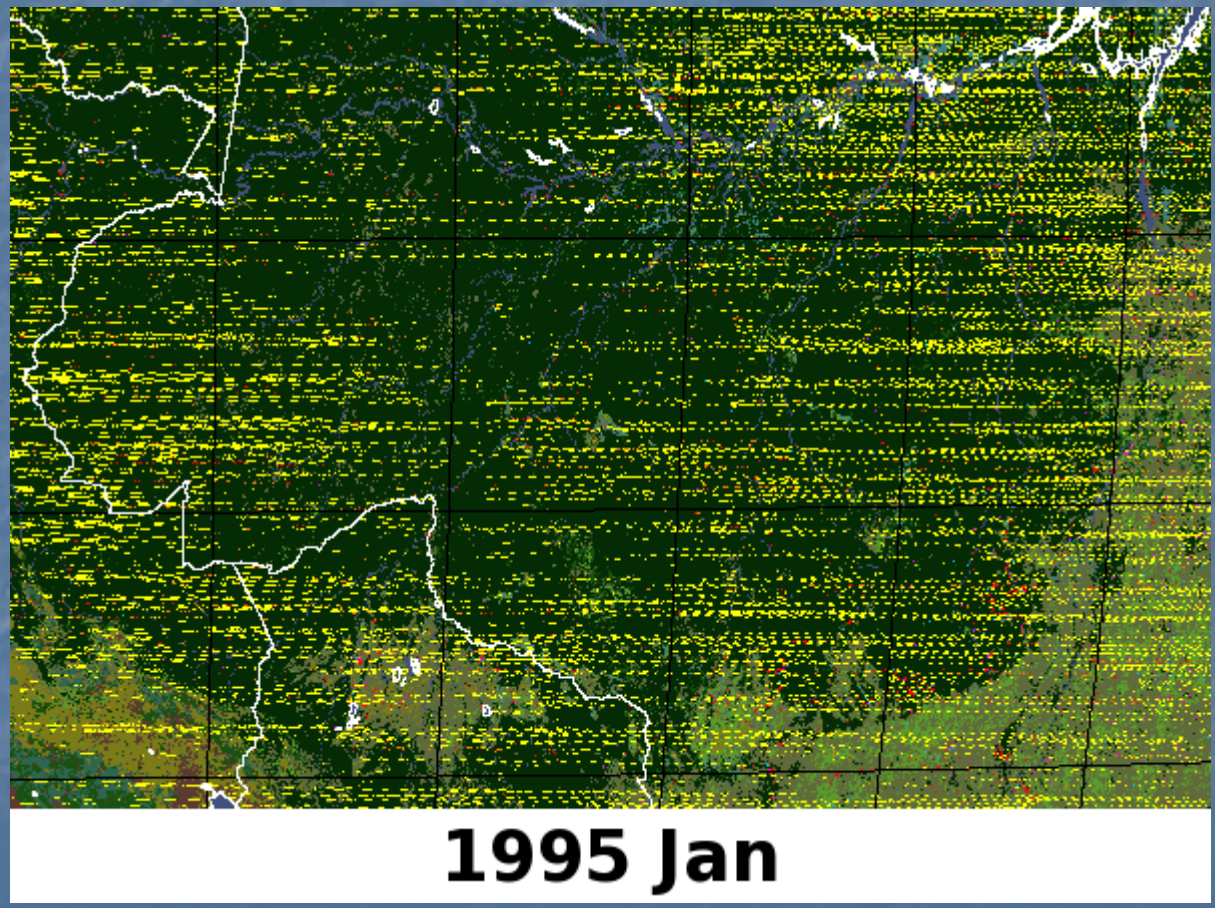
Three years of GOES fire data

- Data noisy in first two years
- Further corrections are necessary
  - Noisy data
  - Cloud obscuration
  - Angular effects



Twelve years of GOES fire data (2/1)

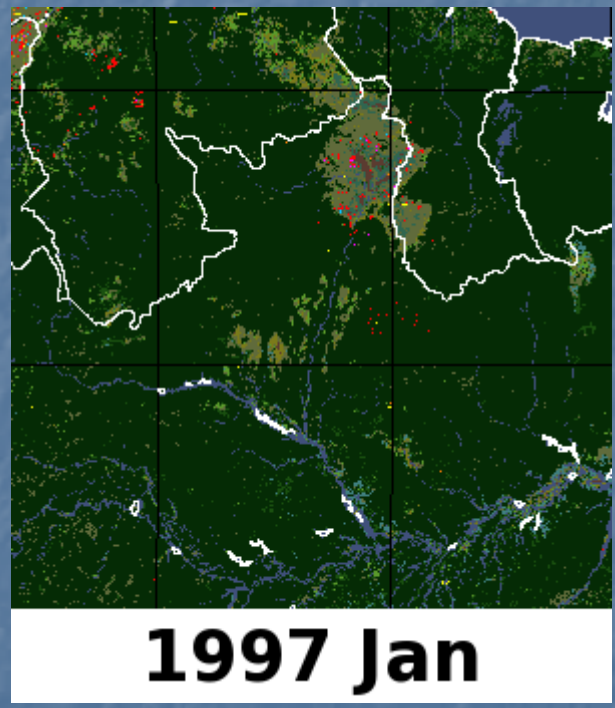
- Data noisy in first two years
- Further corrections are necessary
  - Noisy data
  - Cloud obscuration
  - Angular effects



Note static background land cover map

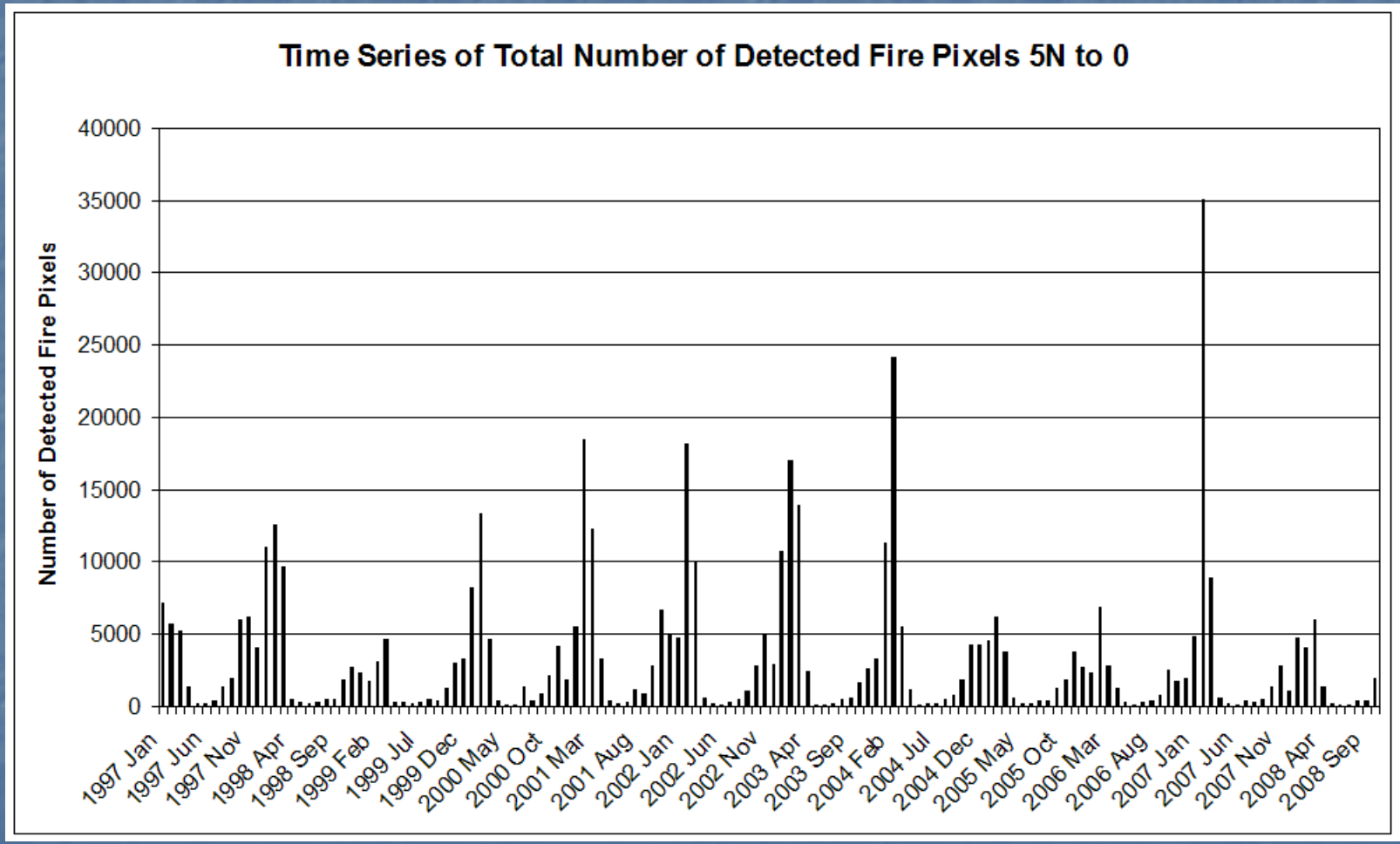
Twelve years of GOES fire data (2/2)

- Data noisy in first two years
- Further corrections are necessary
  - Noisy data
  - Cloud obscuration
  - Angular effects



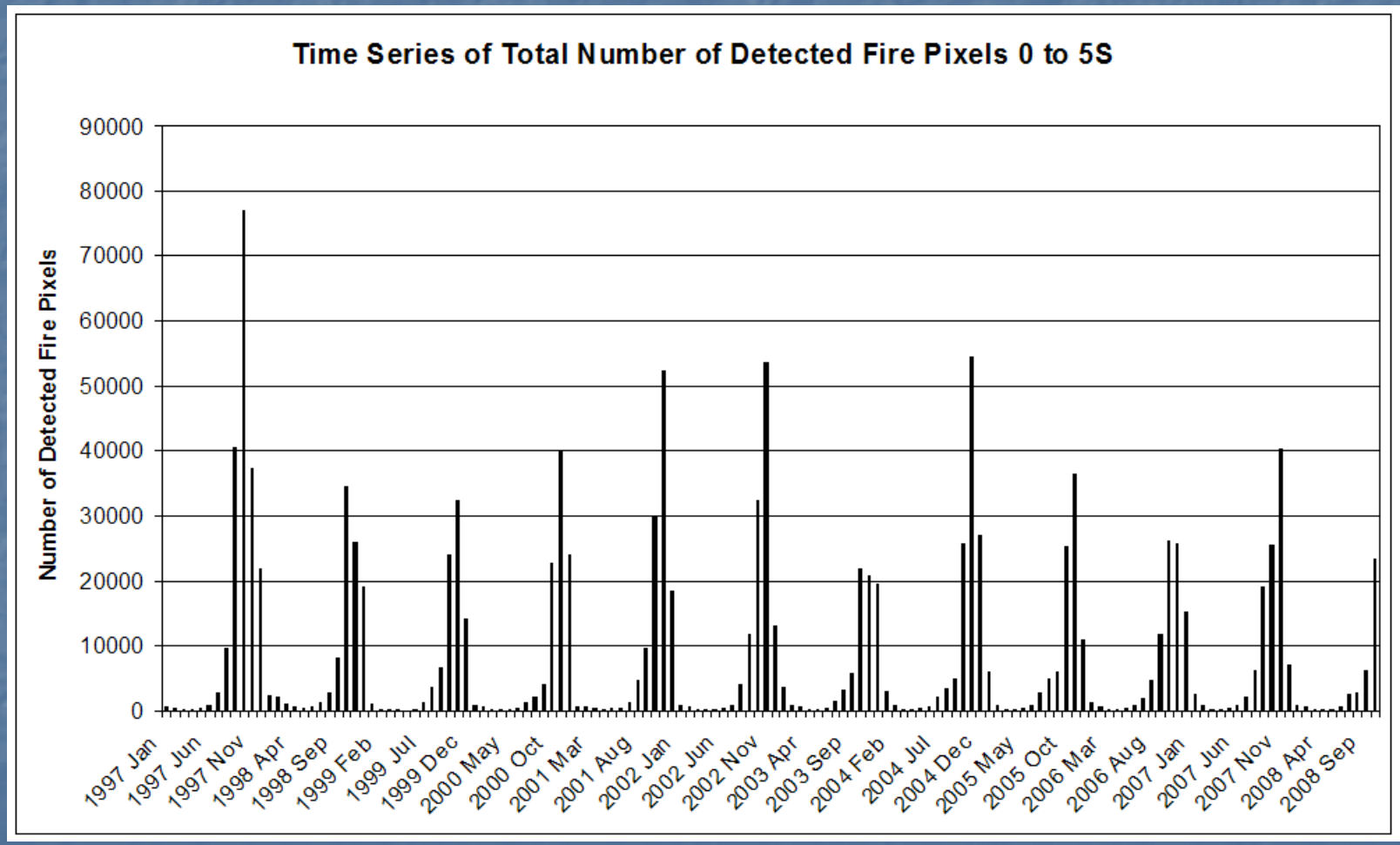
Note static background land cover map

Time series of GOES detections



Based on medium and high possibility fire pixels; no coverage correction

Time series of GOES detections



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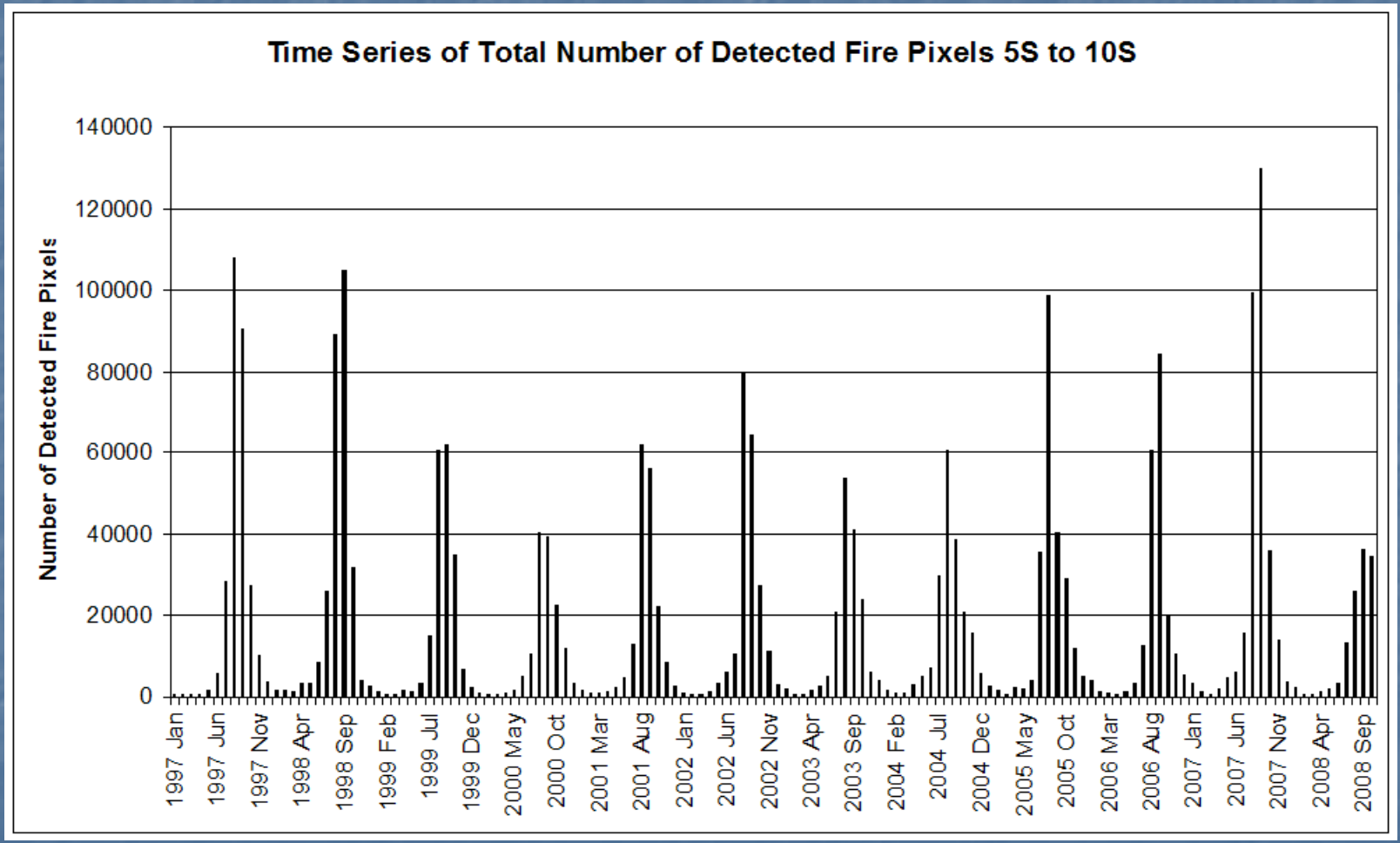
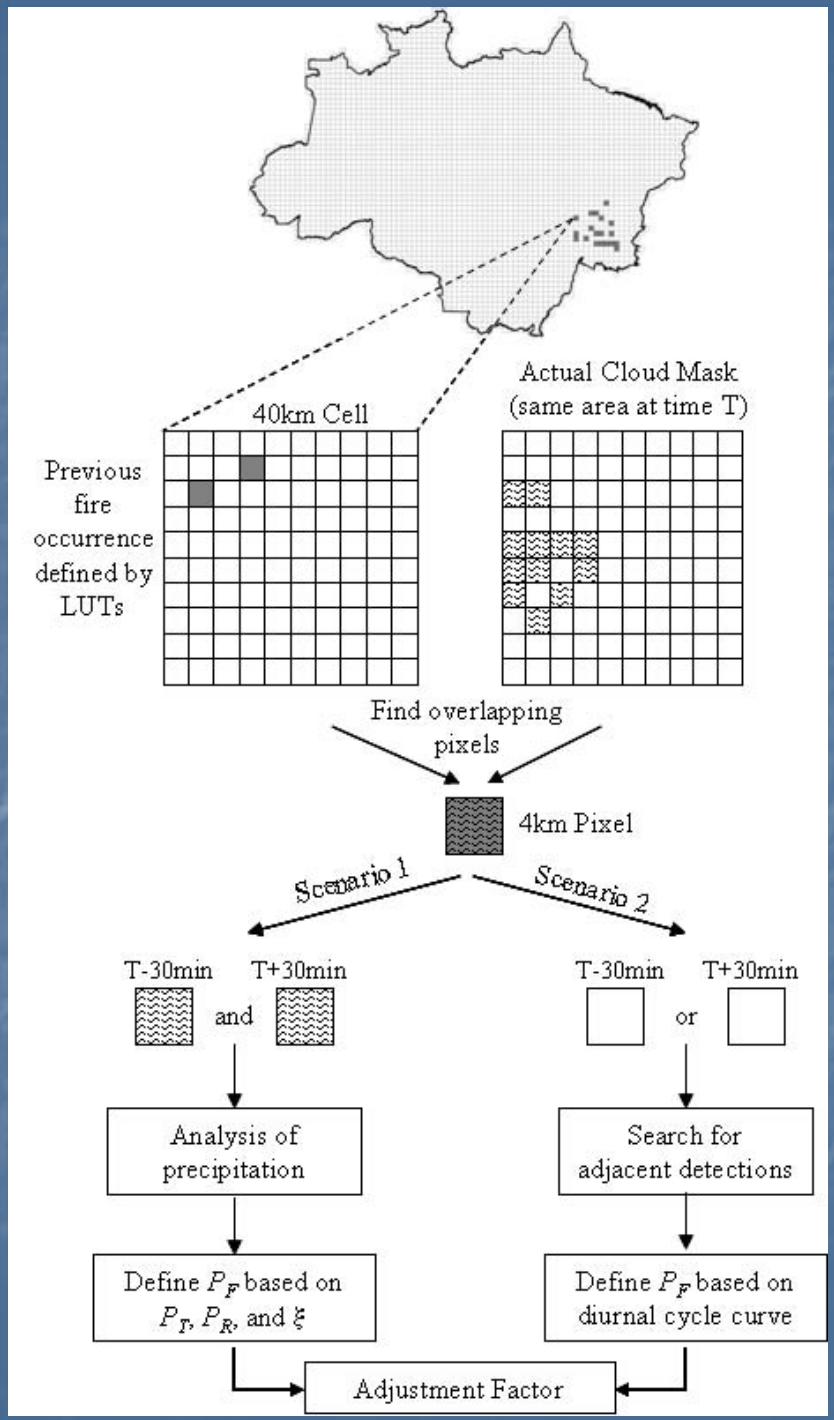
Time series of GOES detections



Based on medium and high possibility fire pixels; no coverage correction

Correction for Omission Errors from Cloud Obscuration



- **Simple approach:**

probability of fire under cloud cover

=

probability of fire over cloud-free areas

- Correction based on cloud fraction

↓

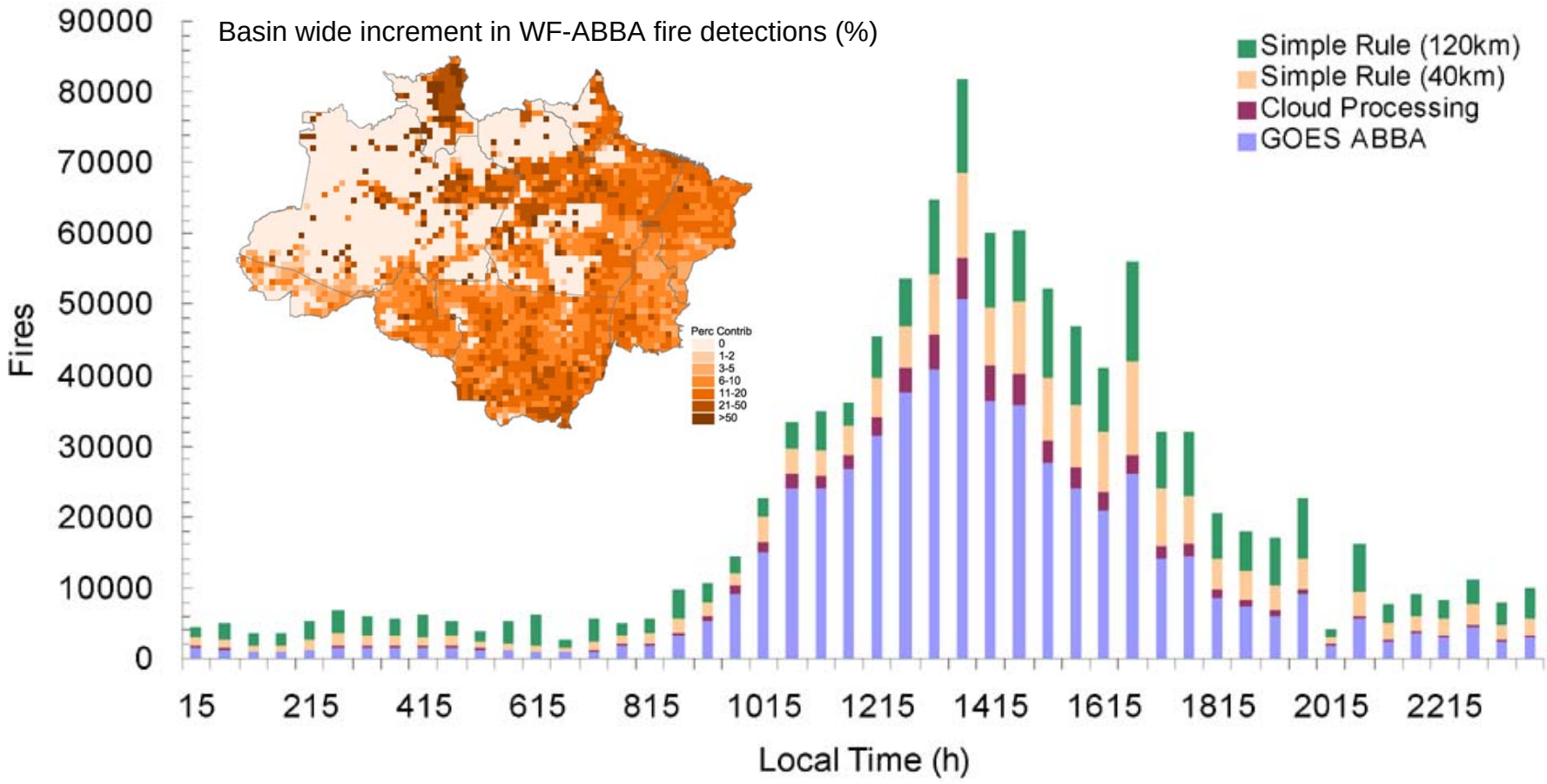
- **Probabilistic estimation:**
  - Fire climatology
  - Precipitation
  - Diurnal fire cycle

Correction for Omission Errors from Cloud Obscuration

Results for WF-ABBA 2005

-Cloud processing analysis 11% increment

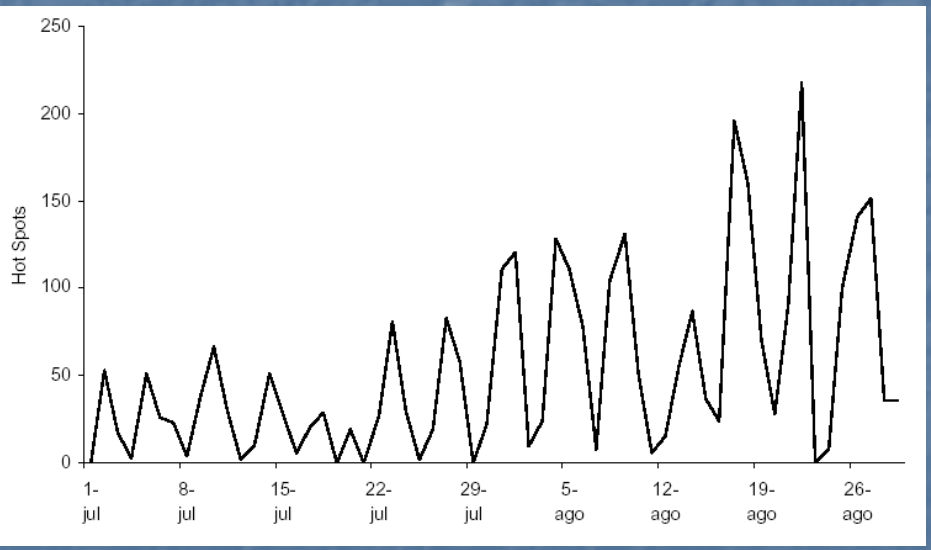
- Simple rule approach: 33% / 40% increments for 40 /120km sampling areas



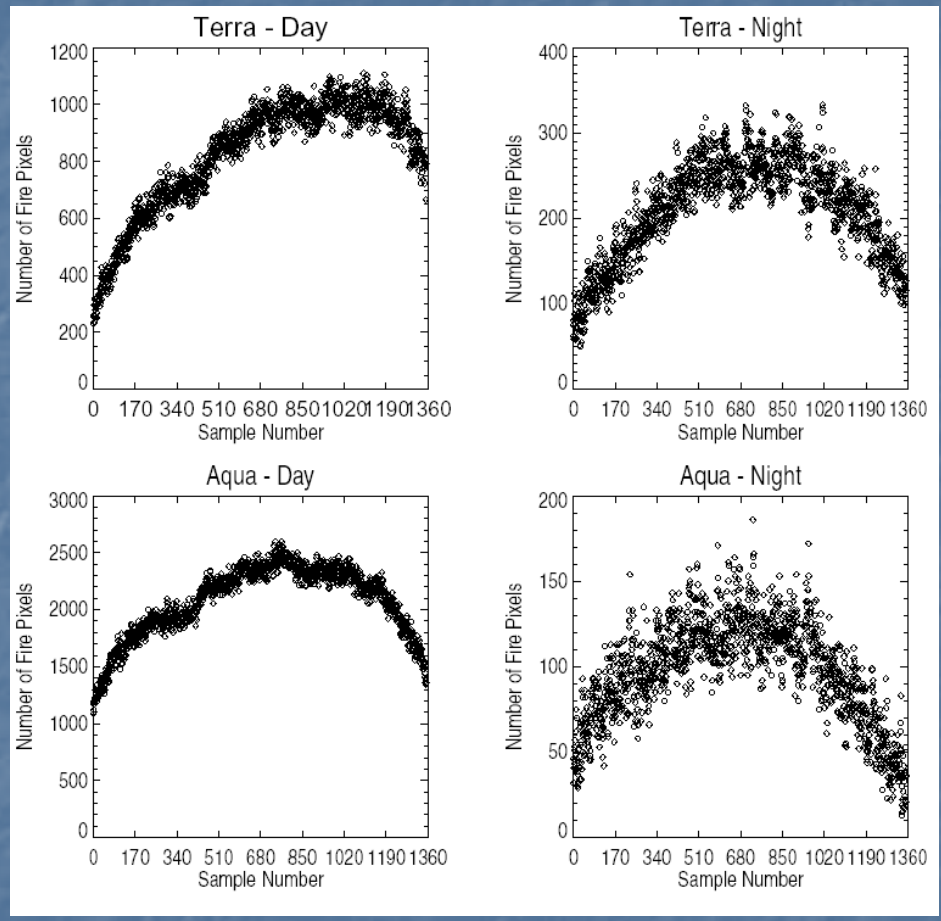
(Schroeder et al., 2008)

Angular effects

number of fires detected depends on the position of target area within swath



Time series of AVHRR fire counts (nine-day periodicity of view angles)

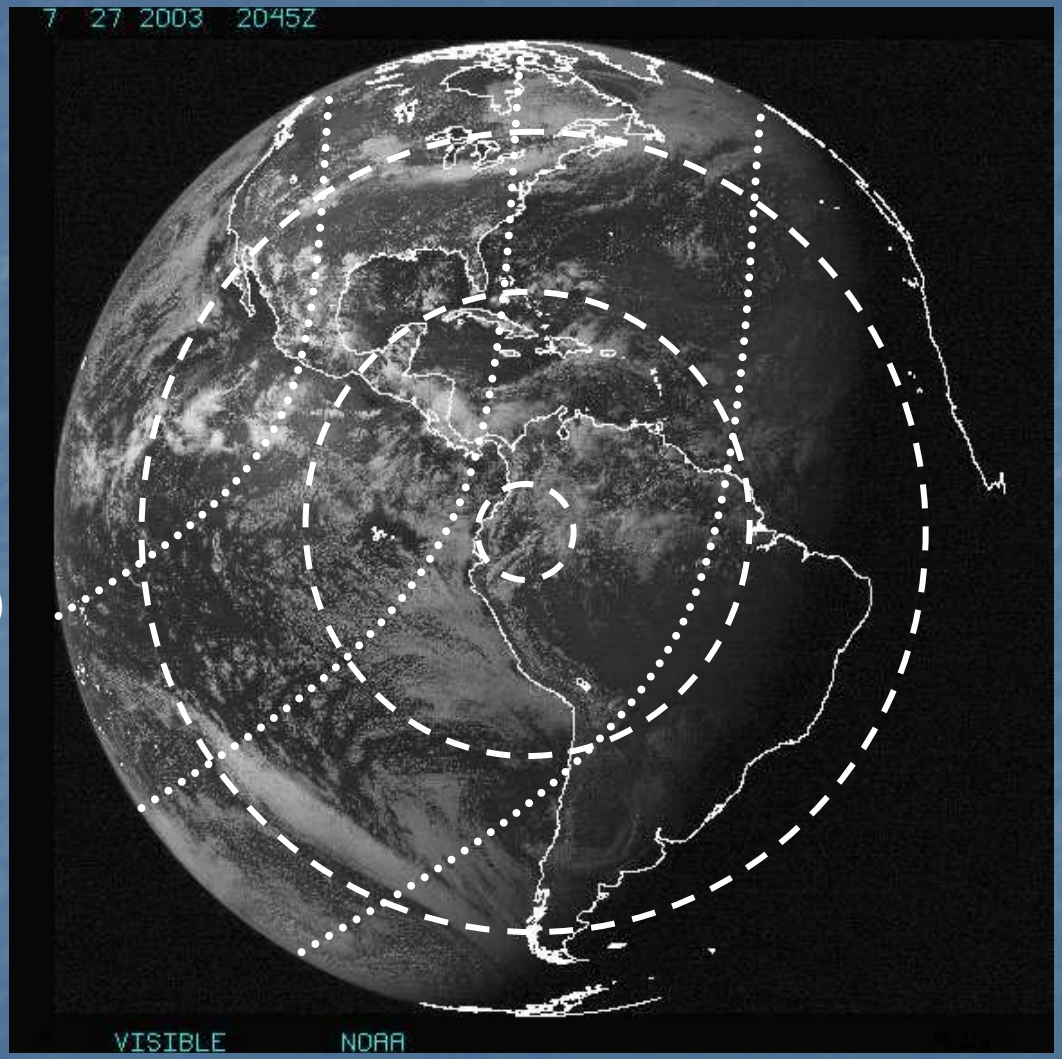


Number of MODIS fire pixels vs. sample number within scanline

Geostationary imagery: geometrical considerations

Viewing angles
Topography effects
(fixed over time)

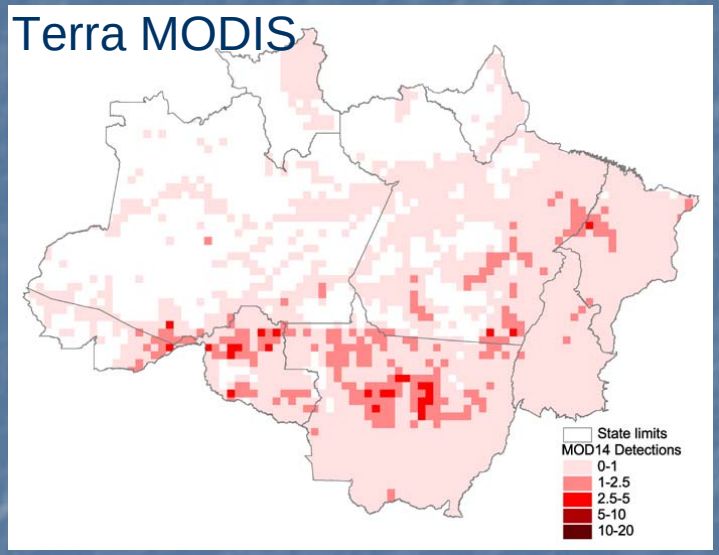
Sun angle, glint
(changes over time)

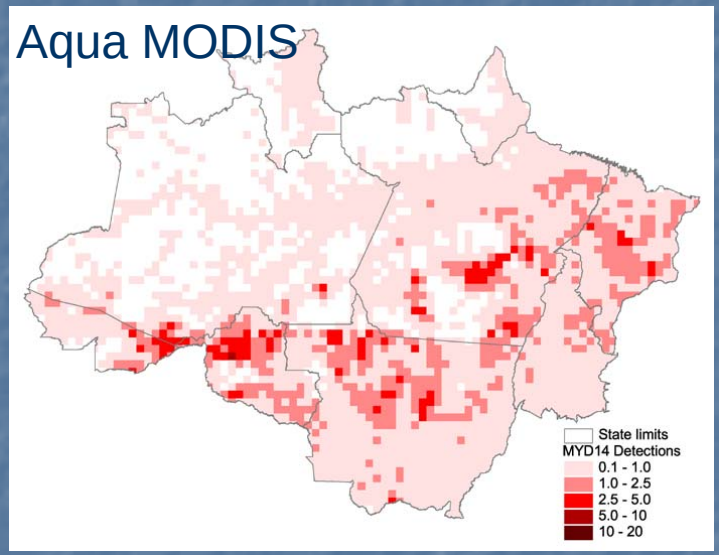


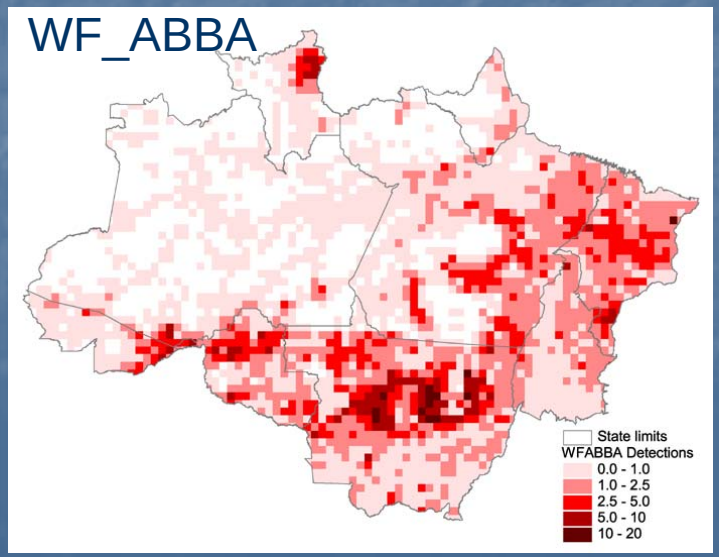
Different seasons

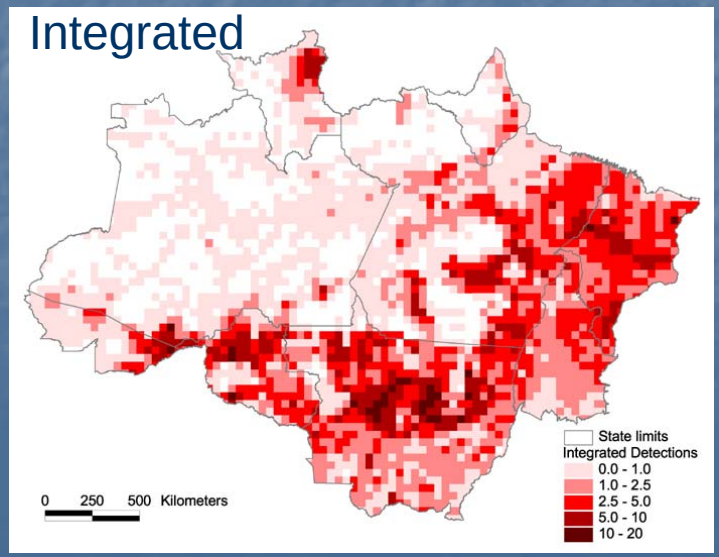
Different local times

Product integration









Yearly detections

Integrated product:

correction for

cloud obscuration

and

commission errors

Future plans

- Complete reprocessing 2000-2005 GOES data with version 6.5
- Generate fully corrected time series
- Compare / intercalibrate GOES-only vs. merged product for 2000-2005
- Evaluate GOES area retrievals using 30m data
- Derive statistics of instantaneous burning using 30m observations
- Generate emission time series

Related activities

- Extend GOES system to global geostationary network
- FRP validation
- Transition to GOES-R and VIIRS
- GOFC-GOLD
  - Long-term time series, geo network, transition
- CGMS
  - Sensor characterization
- CEOS
  - Calibration/validation