Guido van der Werf, Jim Randerson, Louis Giglio, Jim Collatz, Prasad Kasibhatla, Avelino Arellano. *JRC AeroCom 2004*

- Biomass burning: where, when, why
- Modeling approach
  - Burned area
  - Fuel load modeling
  - Combustion completeness
  - Emission factors
- Results
- Uncertainties
  - MOPITT CO: absolute values
  - NOAA/CMDL CO: interannual variability
- Summary / Conclusions / Discussion

Boreal / Temperate regions: regeneration

Photograph courtesy Brian Stocks, Canadian Forest Service

Tropical regions: Deforestation

Tropical regions: savanna / grassland maintenance

Photographs courtesy Global Fire Monitoring Center (GFMC)

Temperate regions: prescribed burning

Approaches to quantify biomass burning emissions

1. Determine fire return times and fuel loads (inventory, possibly scaled by fire proxy)
2. Assess burned area and fuel loads (satellite) ←
3. Measure emitted radiant energy from fires
4. Inverse modeling using atmospheric data ←

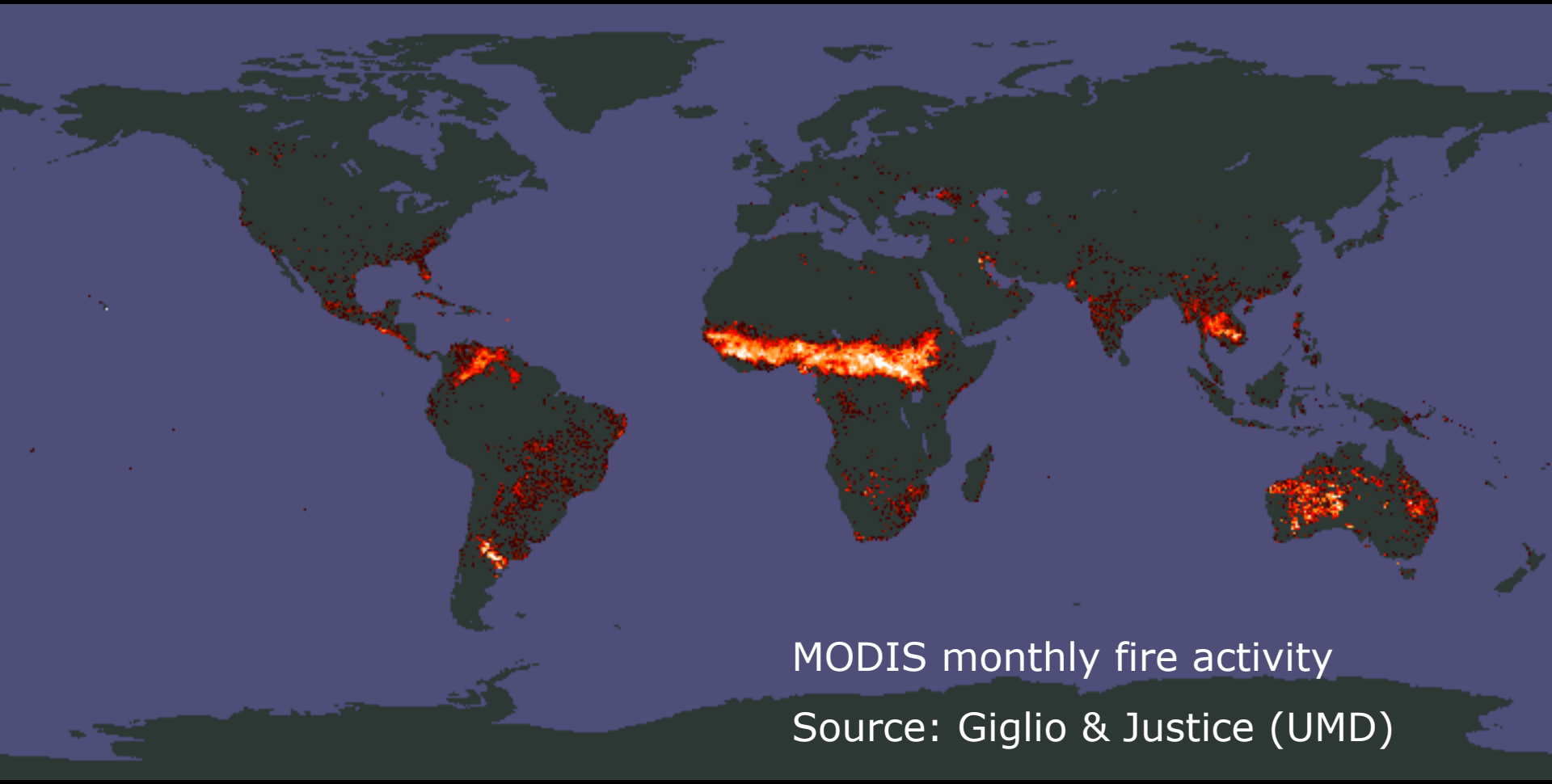
carbon emissions =

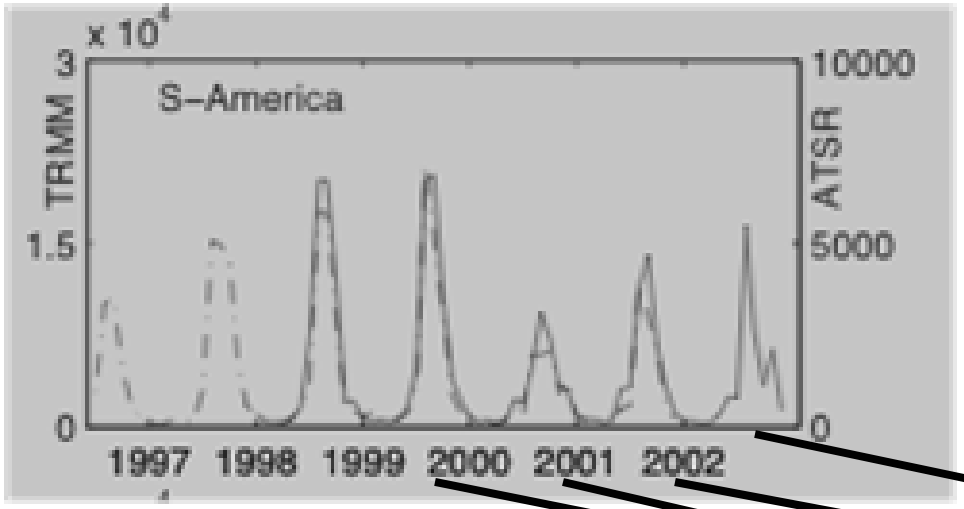
burned area * fuel load * combustion completeness

Photographs courtesy Global Fire Monitoring Center (GFMC)

Aerosol / trace gas emissions =

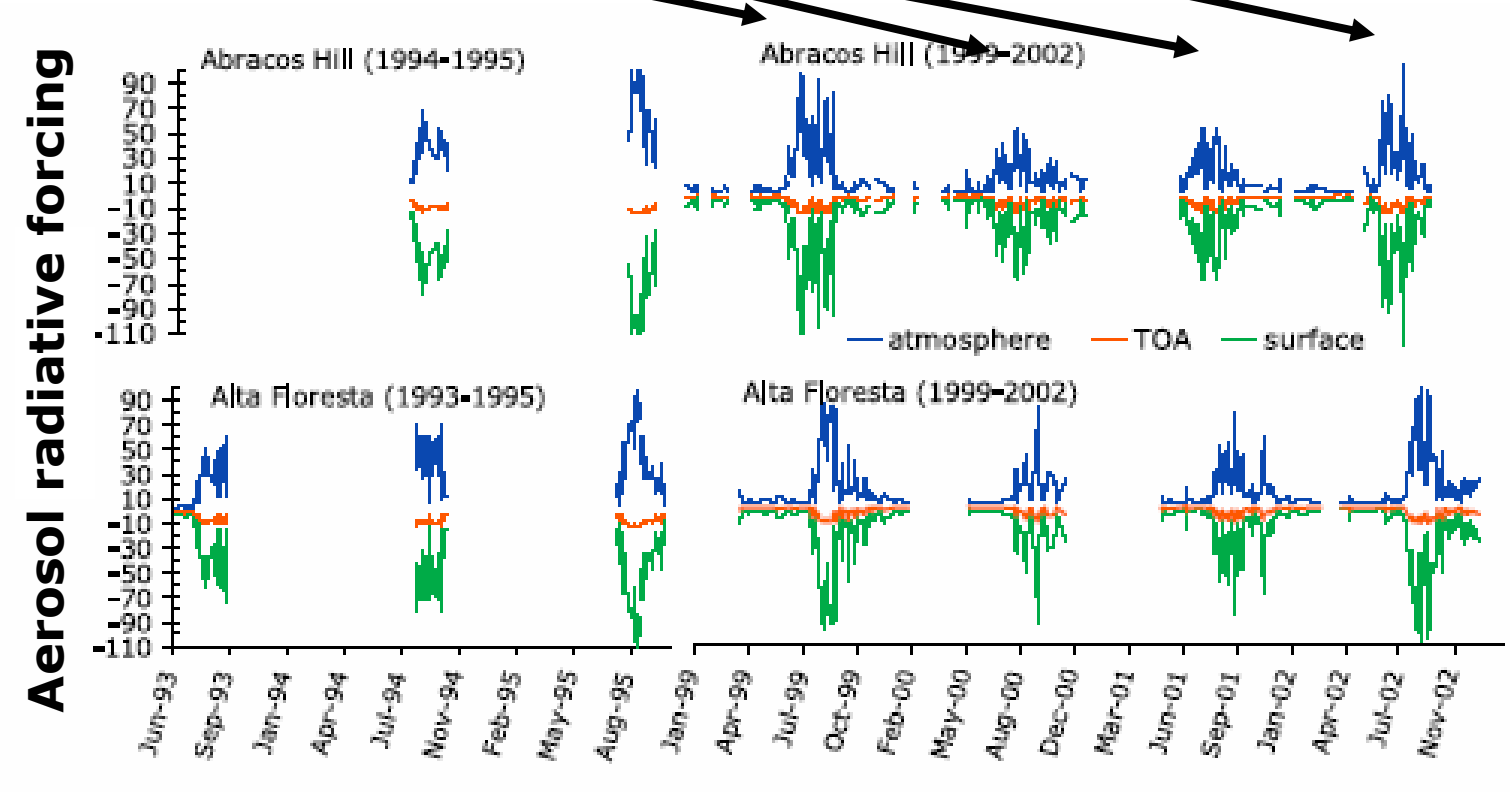
carbon emissions * emission factor


MODIS monthly fire activity
Source: Giglio & Justice (UMD)

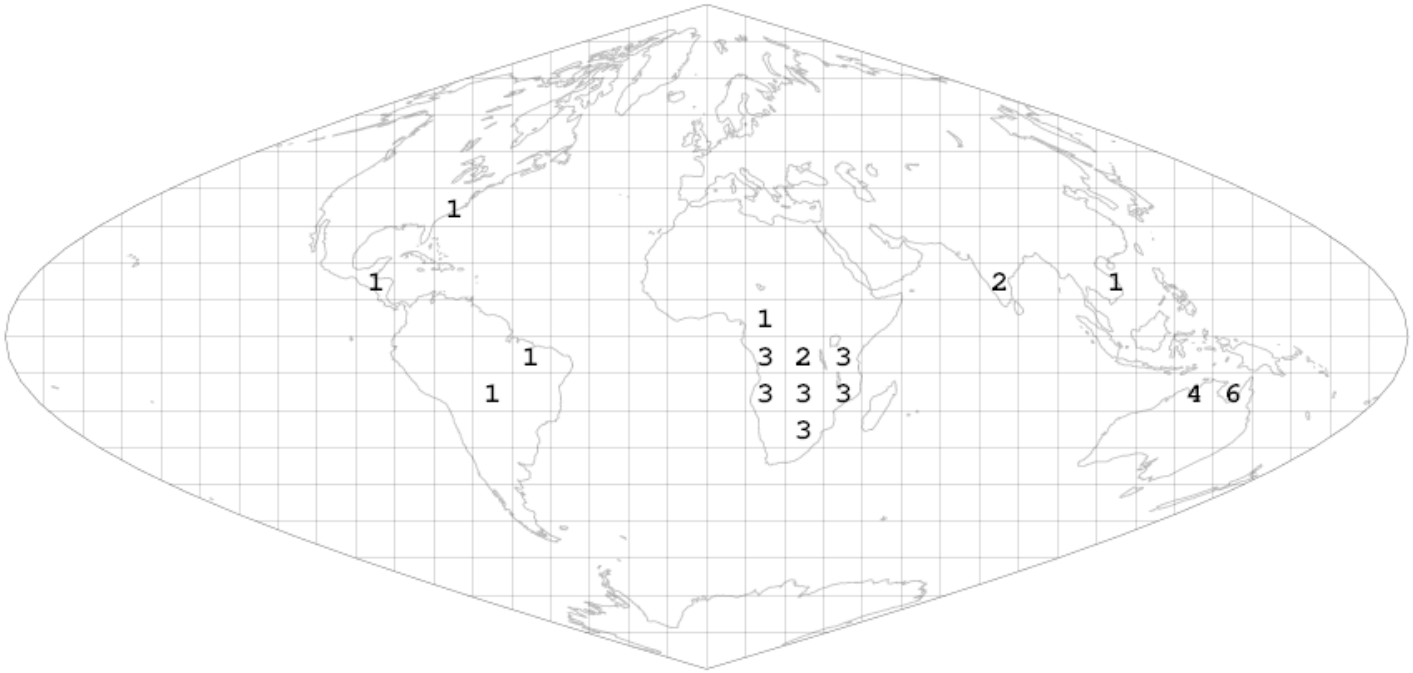


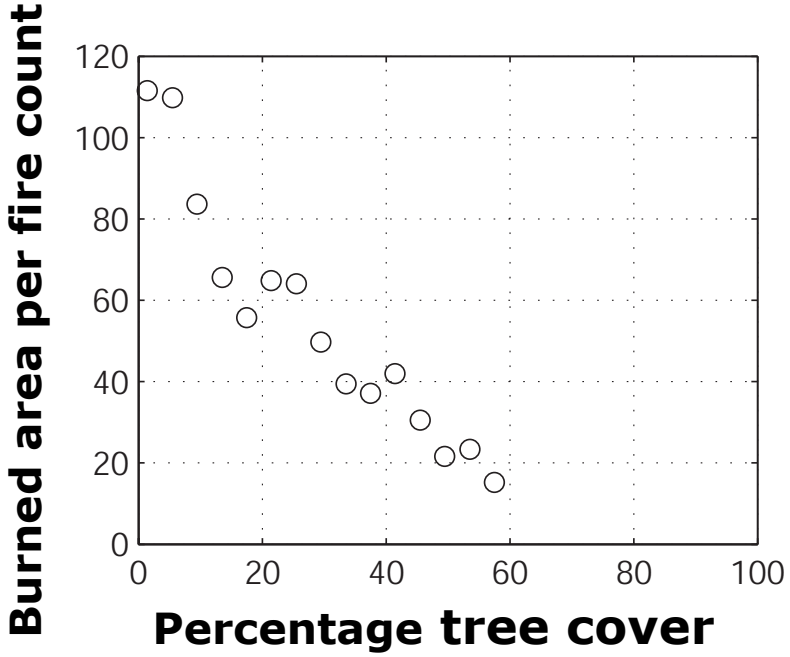
TRMM: Giglio et al.

ATSR: Arino et al.

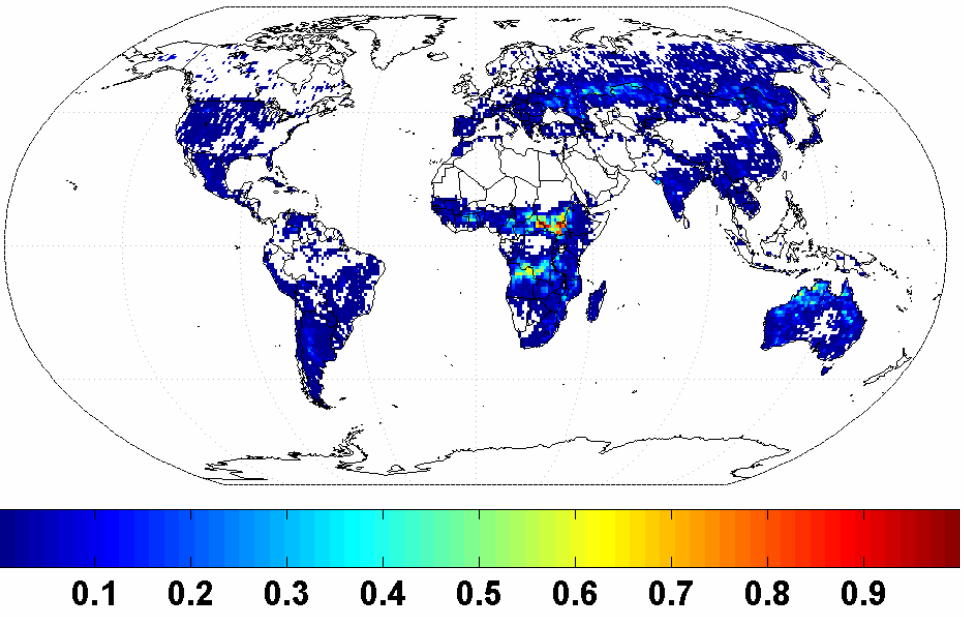


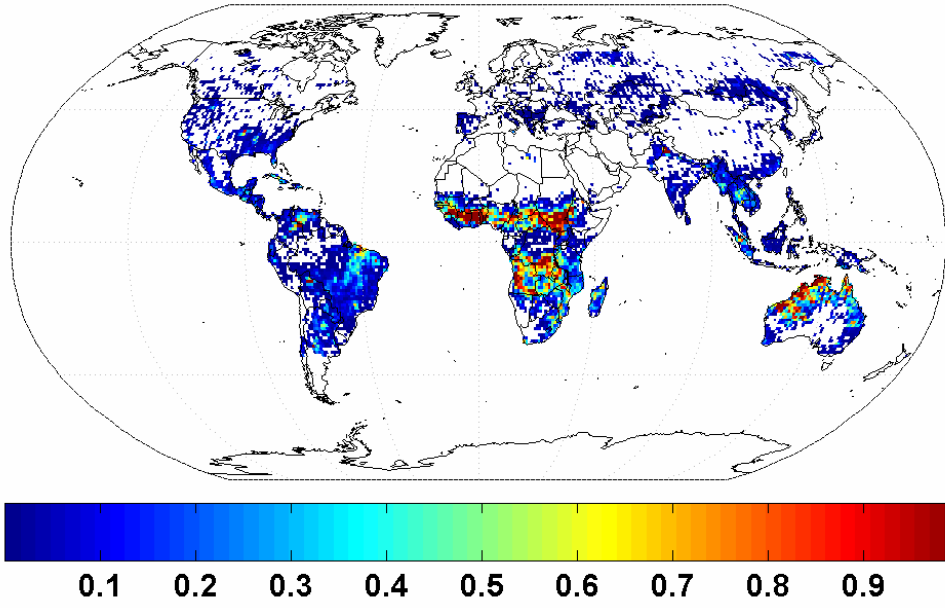
Procopio et al, GRL 2004





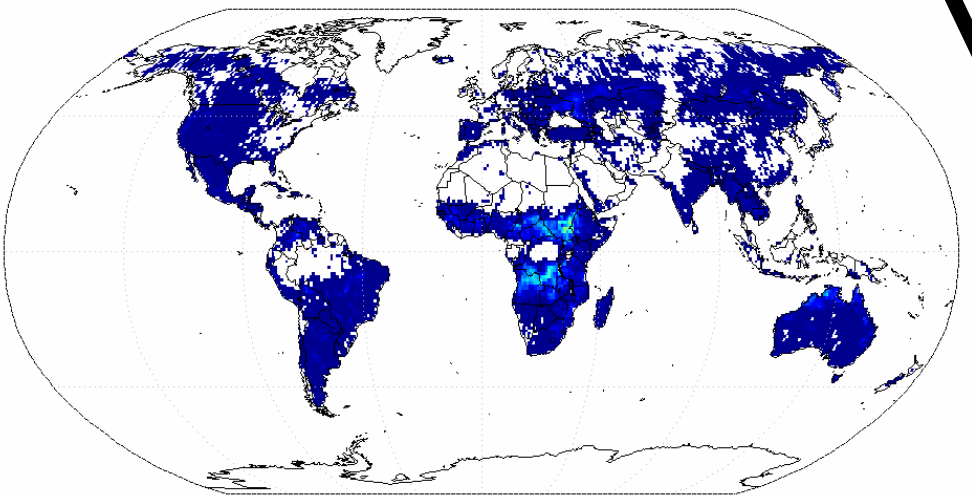
- **Burned area: MODIS 500m**
- **Fire counts**
  - **(Sub)tropics: TRMM**
  - **Extratropics: ATSR**





0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

Fraction burned



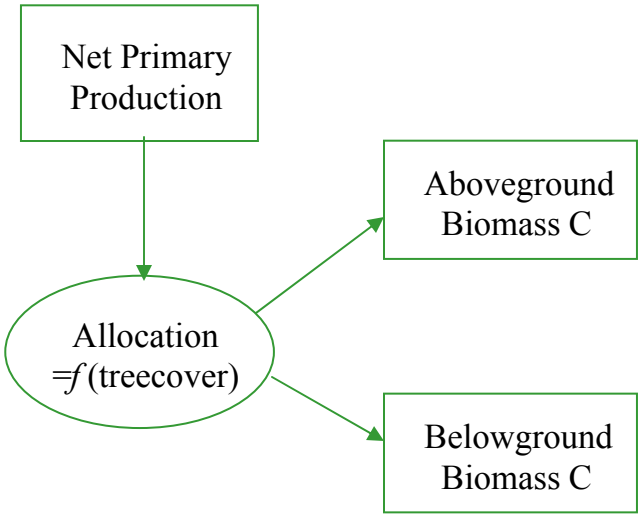
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

MODIS / TRMM / ATSR

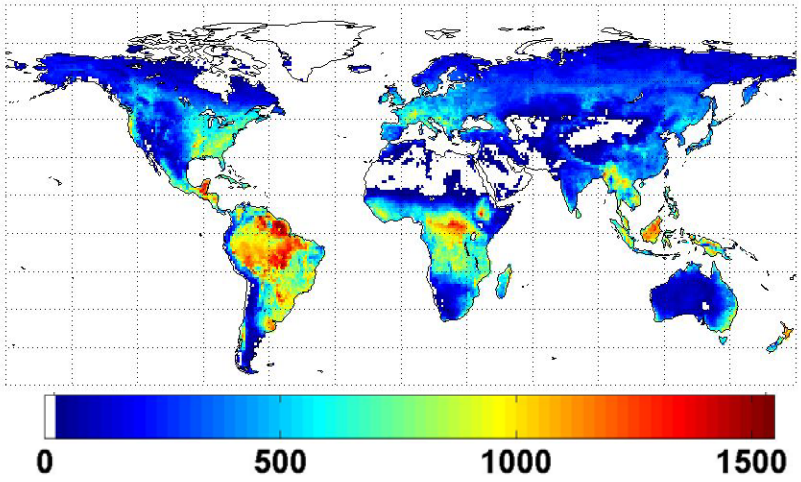
GBA2000 (JRC)

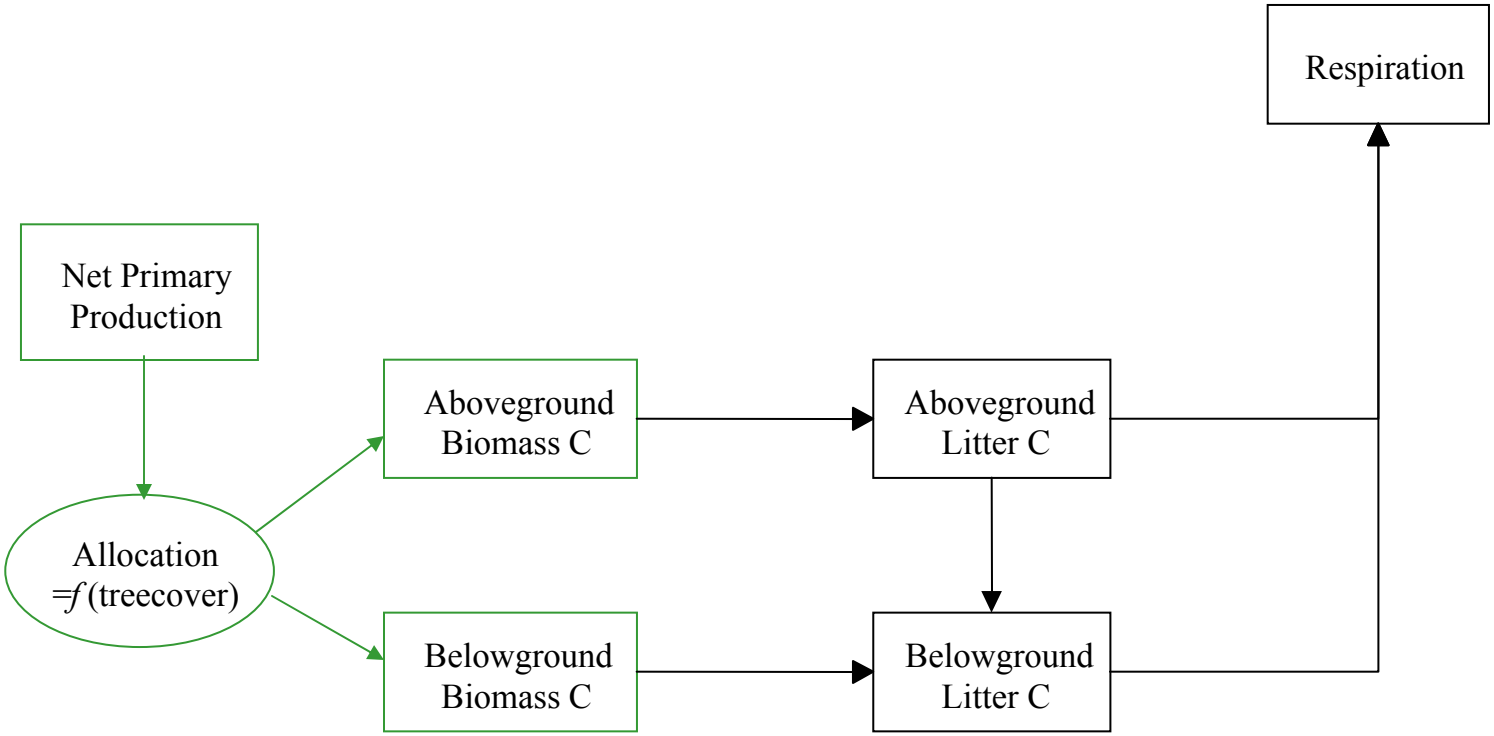
GLOBSCAR (ESA)

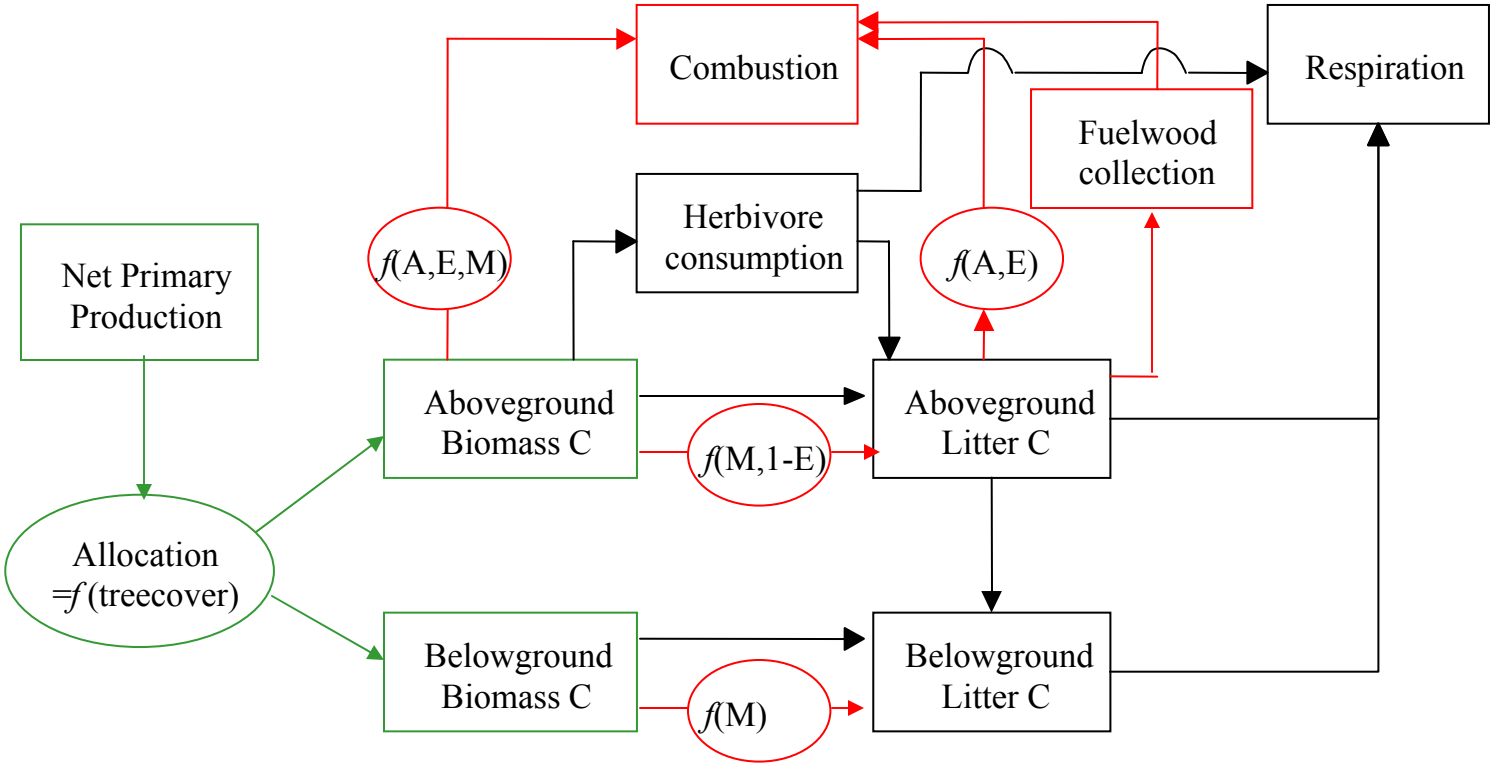
The CASA biogeochemical model



$$NPP = \varepsilon_{(T,P)} * FPAR * PAR$$




Respiration
Net Primary Production
Aboveground Biomass C
Aboveground Litter C
Allocation =f (treecover)
Belowground Biomass C
Belowground Litter C

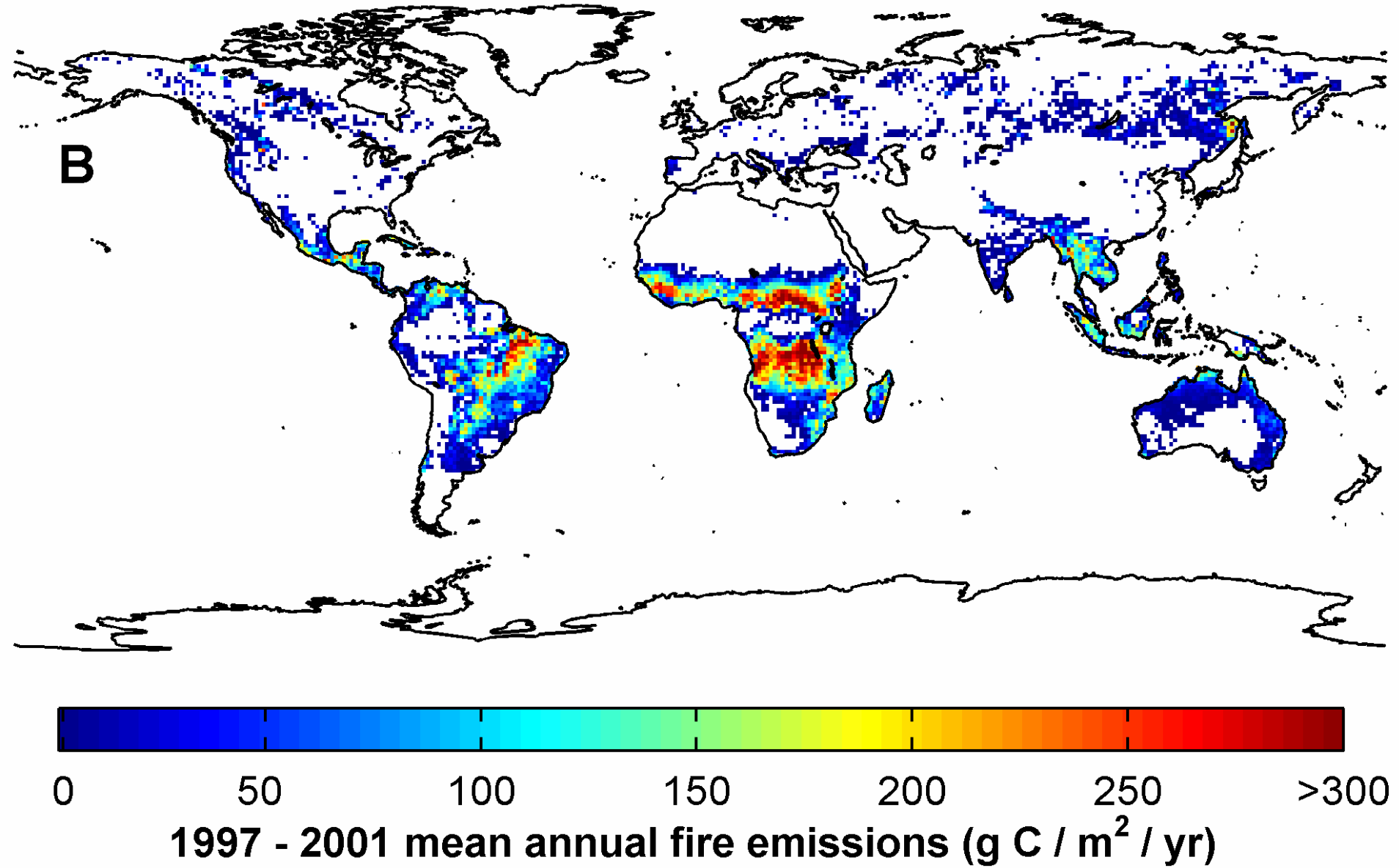


A = area burnt

E = combustion completeness

M = fire induced tree mortality

Forward modeling results: carbon emissions

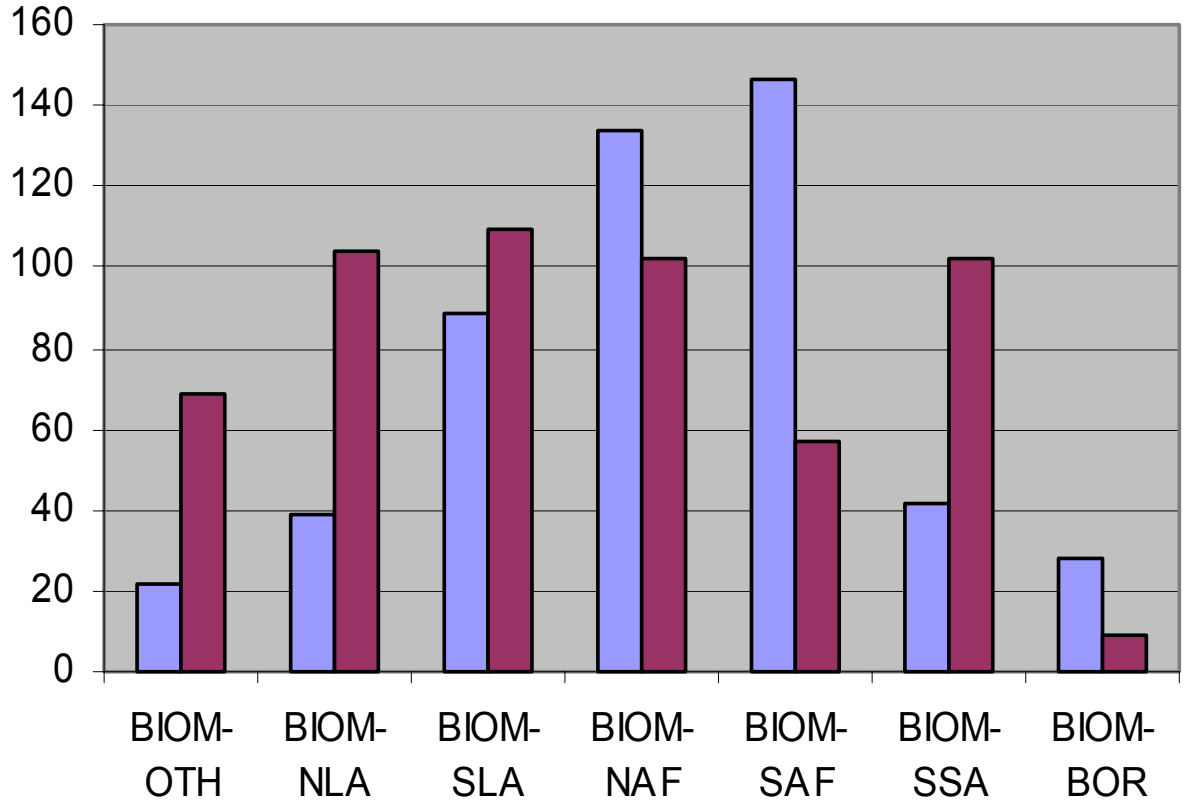


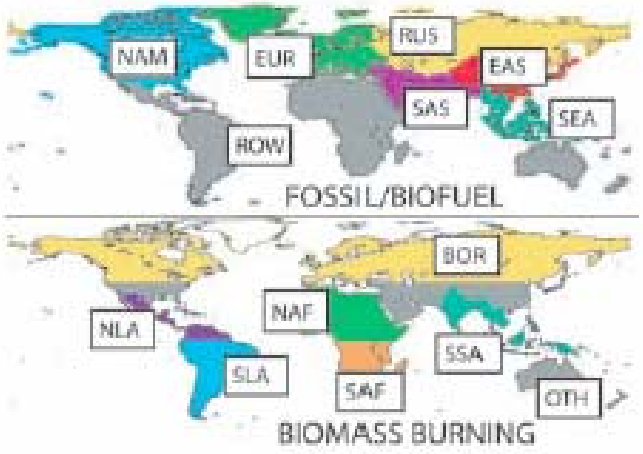
Inversion studies to constrain forward modeling

1) *Absolute values*: CO emissions for 2000 (MOPITT)

2) *Anomalies*: CO emission anomalies 1997-2001 (NOAA-CMDL)

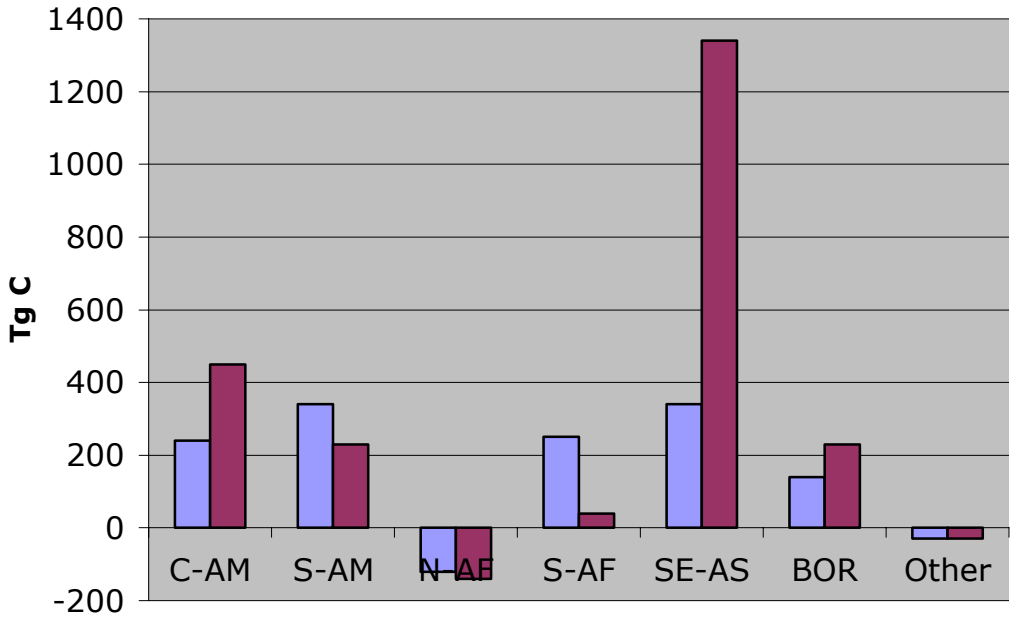
CO emissions per region





Arellano et al., GRL 2004

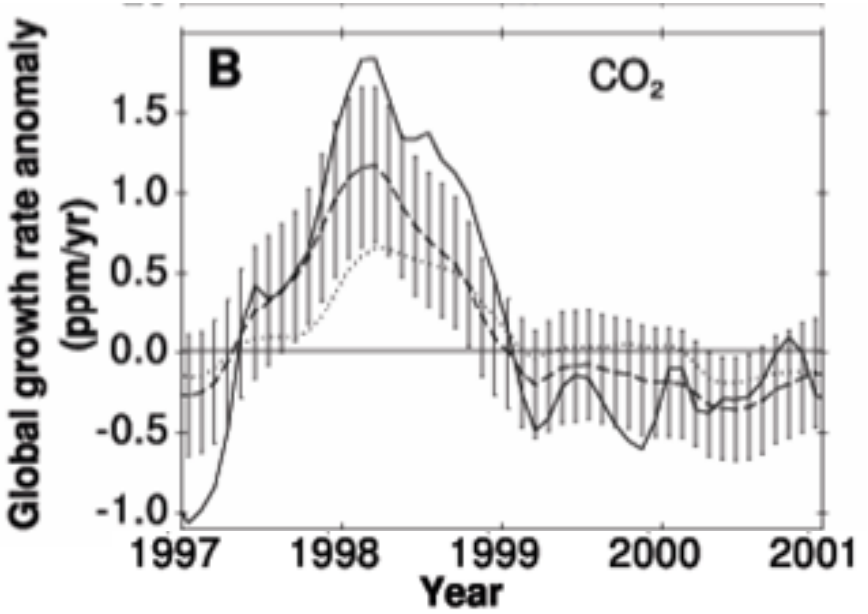
'97-'98 El Nino anomalies



Blue: a priori

Red: posteriori

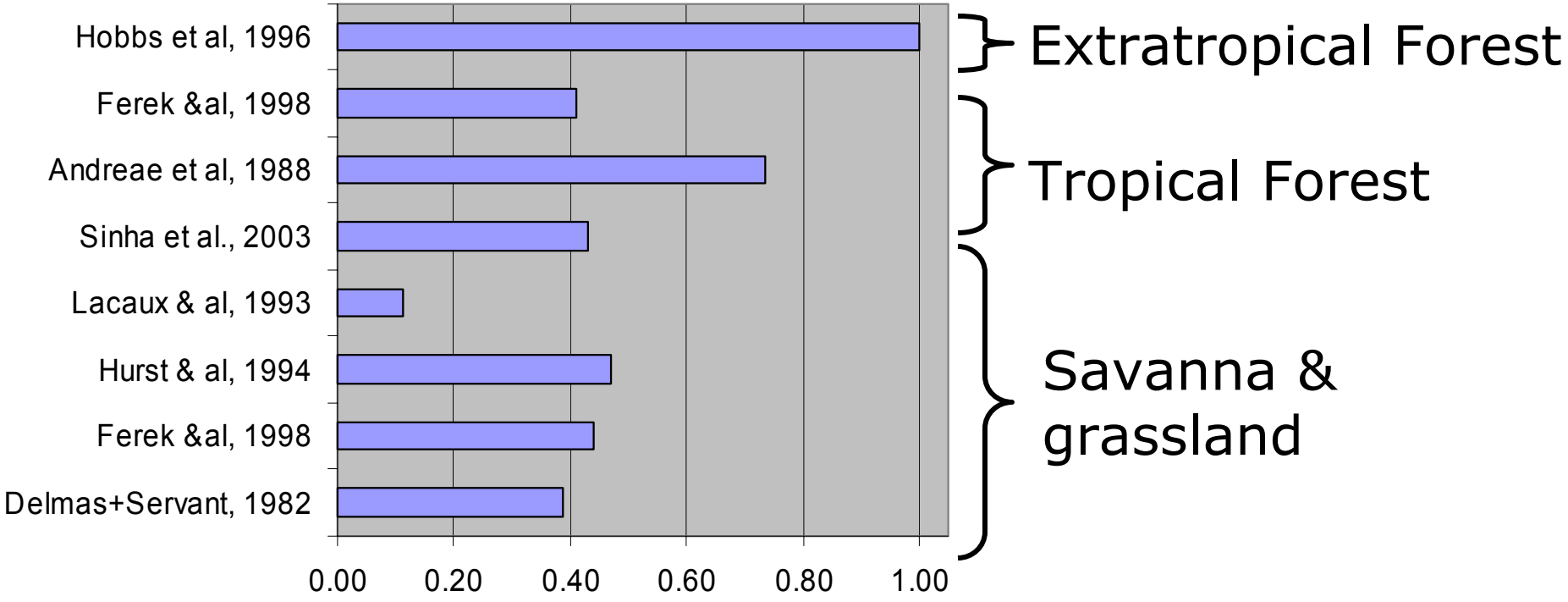
- underestimate SE-Asia: (peat burning)
- Overestimate S-Africa



Van der Werf et al., Science 2004

Species	Savanna and Grassland[b]
CO_2	1613 ± 95
CO	65 ± 20
CH_4	2.3 ± 0.9
Total nonmethane hydrocarbons	3.4 ± 1.0
C_2H_2	0.29 ± 0.27
C_2H_4	0.79 ± 0.56
C_2H_6	0.32 ± 0.16
C_3H_4	0.022 ± 0.014
C_3H_6	0.26 ± 0.14
C_3H_8	0.09 ± 0.03
1-butene	0.09 ± 0.06

Emission Factors for SO2



Andreae & Merlet, GBC 2001

Summary

- High confidence in timing and location of fires
- Quantifying emissions, however, still suffers from relatively large uncertainties in burned area, fuel loads, and emission factors
- Our model seems to overestimate emissions from savanna regions, and underestimate tropical forest emissions (peat, deforestation)
- Southern Africa (too high) and Southeast Asia (too low) estimates are probably the most uncertain regions
- Large interannual variability in emissions -especially in forested regions- linked to ENSO. Year 2000 low fire activity

Future plans

what has priority for AeroCom?

- Full MODIS based estimates for 2000➡
  - Higher spatial resolution
  - Higher temporal resolution
- 500 meter resolution 'problem-fixing' case studies (Amazon, southern Africa)
- Separate different sources (human vs. natural)
- Whole AVHRR record emission estimates (JRC) ??
- Injection heights (LSCE)

Email: guido@Ltpmailx.gsfc.nasa.gov