The Global Fire Emissions Database (GFED)

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Main Objective

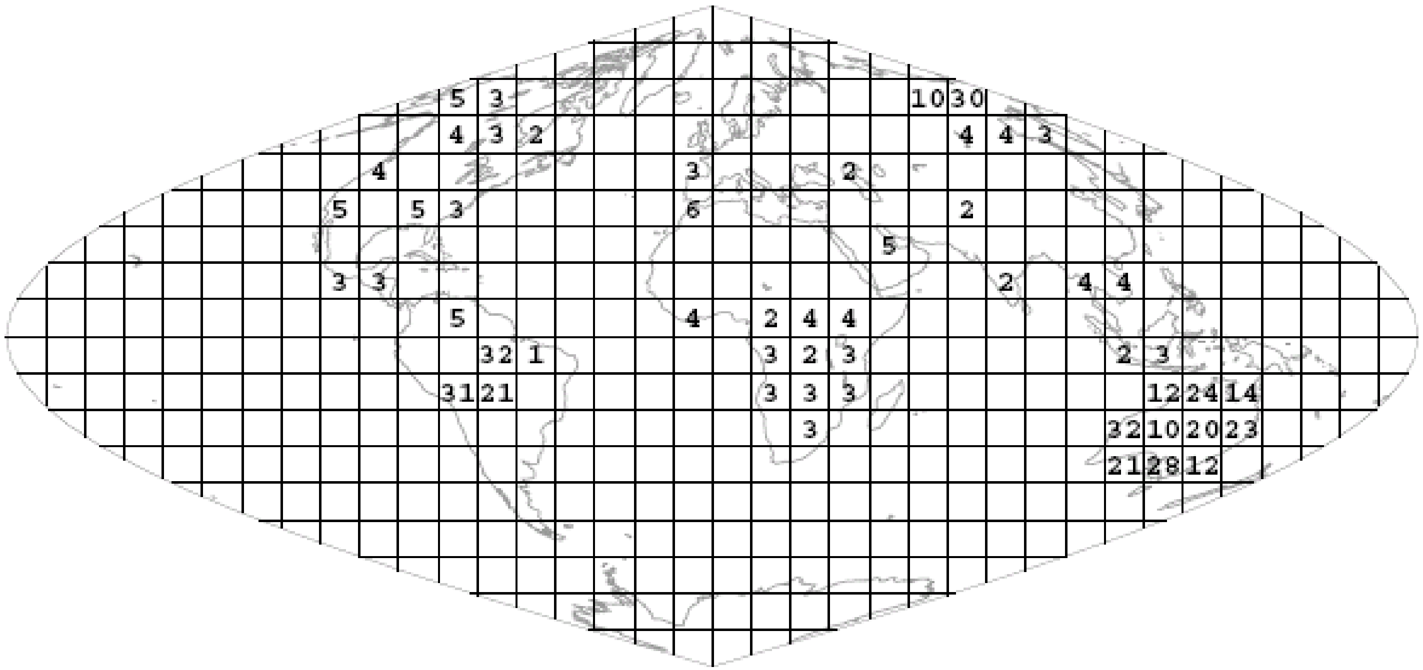
Quantify the amount of biomass burned on a global scale for several years, using the ‘Seiler & Crutzen’ Approach:

$$BB = \Sigma(\text{time,space})\ BA \times \text{Fuel loads} \times CC \times EF$$

(BB = biomass burned, BA = burned area, CC = combustion completeness, EF = emission factor)

Burned area

Using a ‘hybrid approach’ where we calibrate fire hot spots (MODIS, available globally) to burned area for selected regions (MODIS)

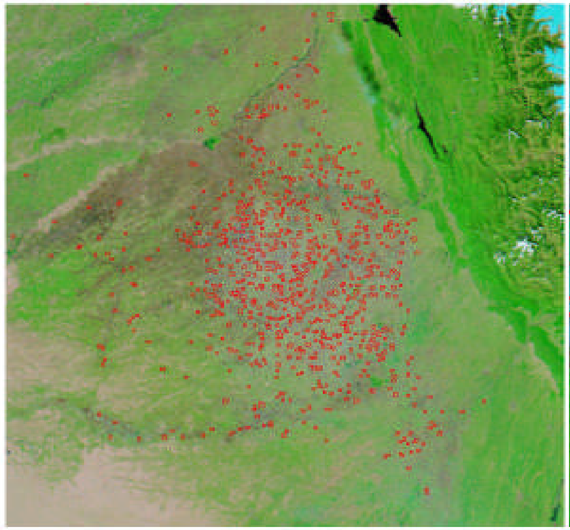


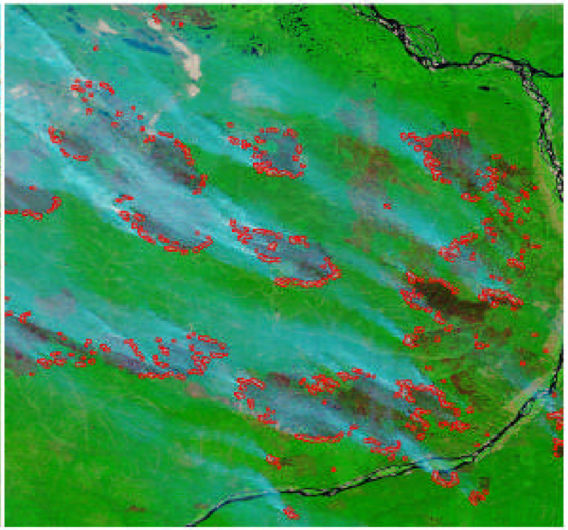
Regions where MODIS burned area was estimated, the numbers indicate the number of months that burned area was calculated

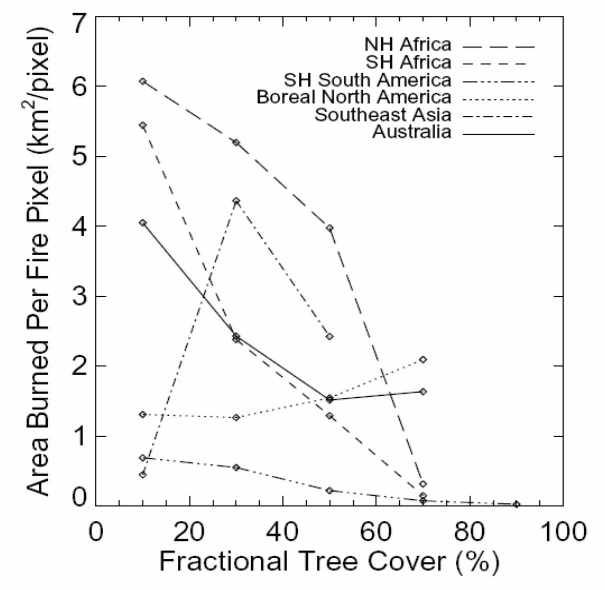
Giglio et al, 2005 ACPD

Burned area

We found that a large part of variability in the burned area per fire count relation could be explained by variations in fire cluster size, fractional tree cover, and region







Small cluster (agricultural fires): low BA per FC

Large cluster (extensive fires): high BA per FC

Forests: little BA per FC, grasslands: high BA per FC

Giglio et al, 2005 ACPD

Burned area

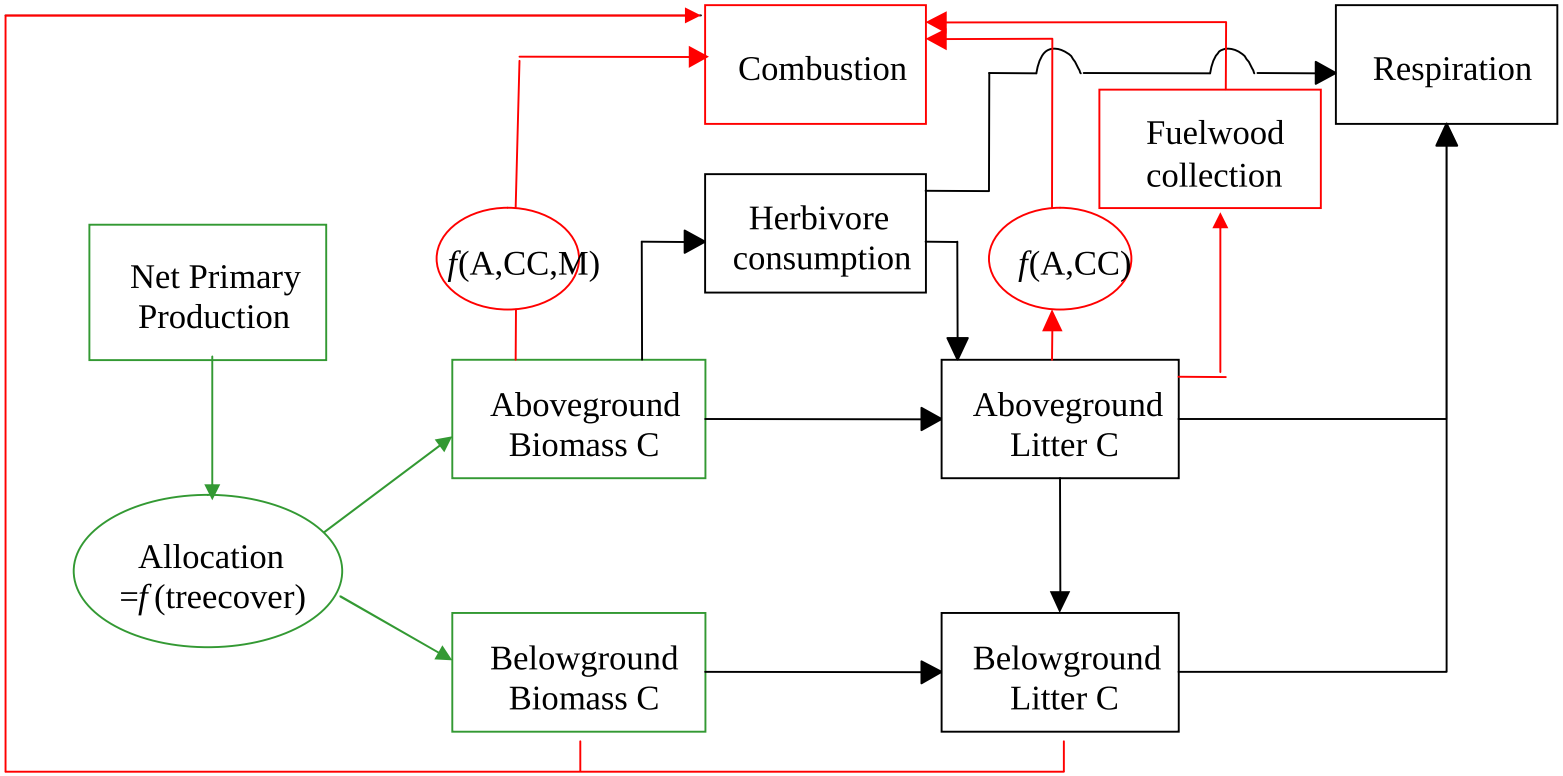
- Using regression trees, we derived the fire hot spot to burned area relation for several regions depending on fractional tree cover and cluster size. In combination with global hot spot data we derived global burned area
- This was done for the 2001 – 2004 period
- Burned area agrees reasonably with independent measurements, although our numbers are often somewhat higher
- Burned area per fire count in deforestation were boosted using fire persistence measurements to account for clumping of fuels and multiple ignitions by humans
- Pre – MODIS burned area (1997 - 2000) derived using ATSR and TRMM-VIRS hot spots, calibrated to the 2001-2005 burned area product

Giglio et al, 2005 ACPD

Fires embedded in the CASA satellite-driven biogeochemical model to estimate fuel loads

- Burned area used *within* the CASA model
- Plant productivity derived from FPAR, PAR, and a light use efficiency
- For each month, fuel loads are calculated as a function of:
    - fuel loads of previous months
    - input from plant productivity
    - output from respiration, herbivory, and fuel wood collection
    - fire induced plant mortality (e.g., savanna trees usually survive a fire)
- Emissions then calculated as burned area x fuel load x combustion completeness (CC)
- CC is a modeled as a function of:
    - fuel type (leaf, stem, fine litter, coarse litter, peat)
    - moisture conditions (dry fuels have higher CC)

Fires embedded in the CASA satellite-driven biogeochemical model to estimate fuel loads

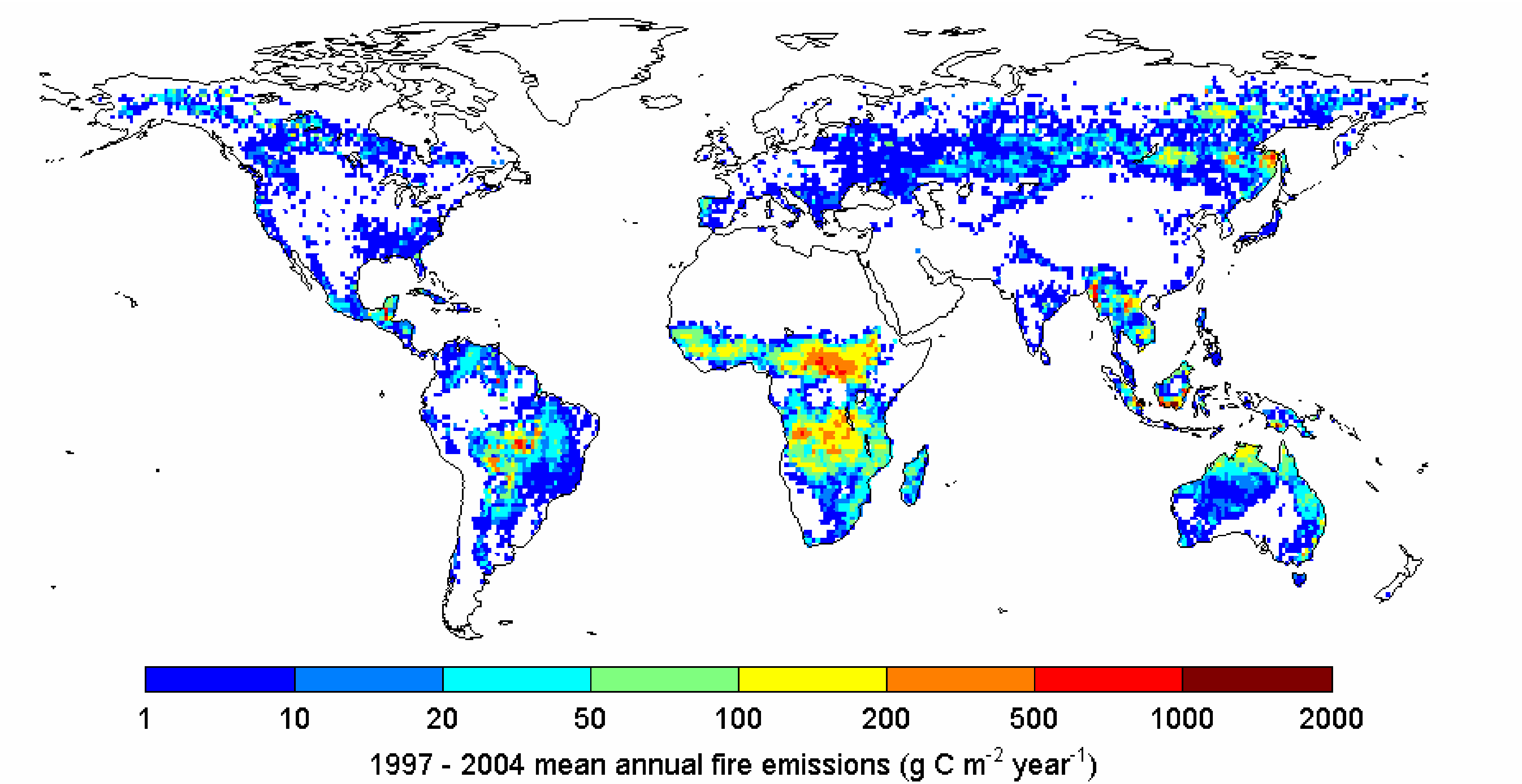


A = area burnt

CC = combustion completeness

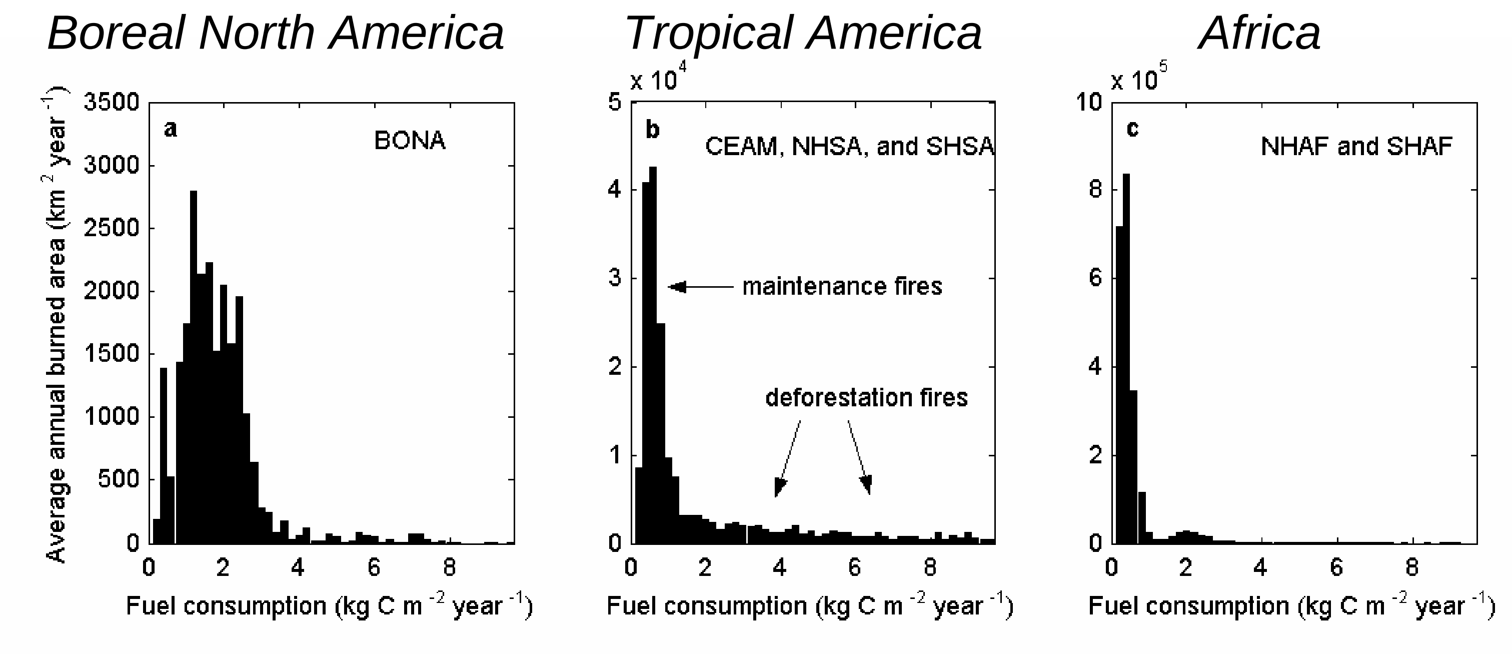
M = fire induced mortality

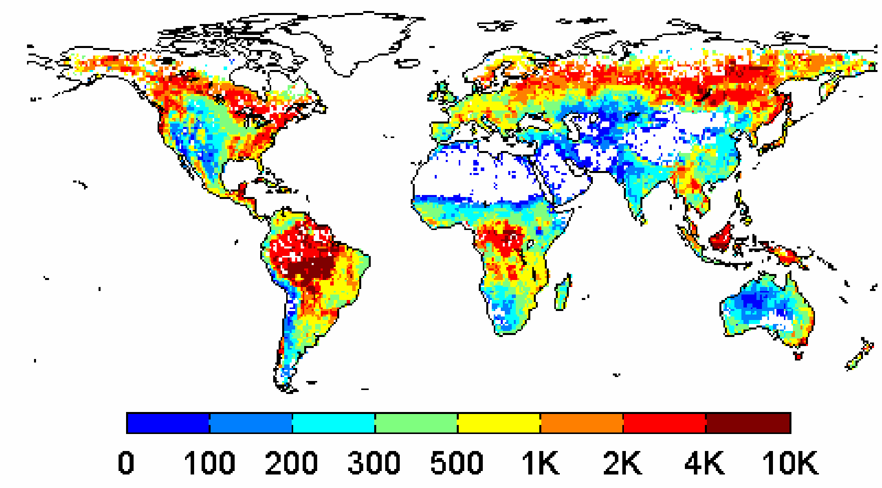
Annual fire emissions, averaged over the 1997 – 2004 period



Van der Werf et al., in press (ACPD)

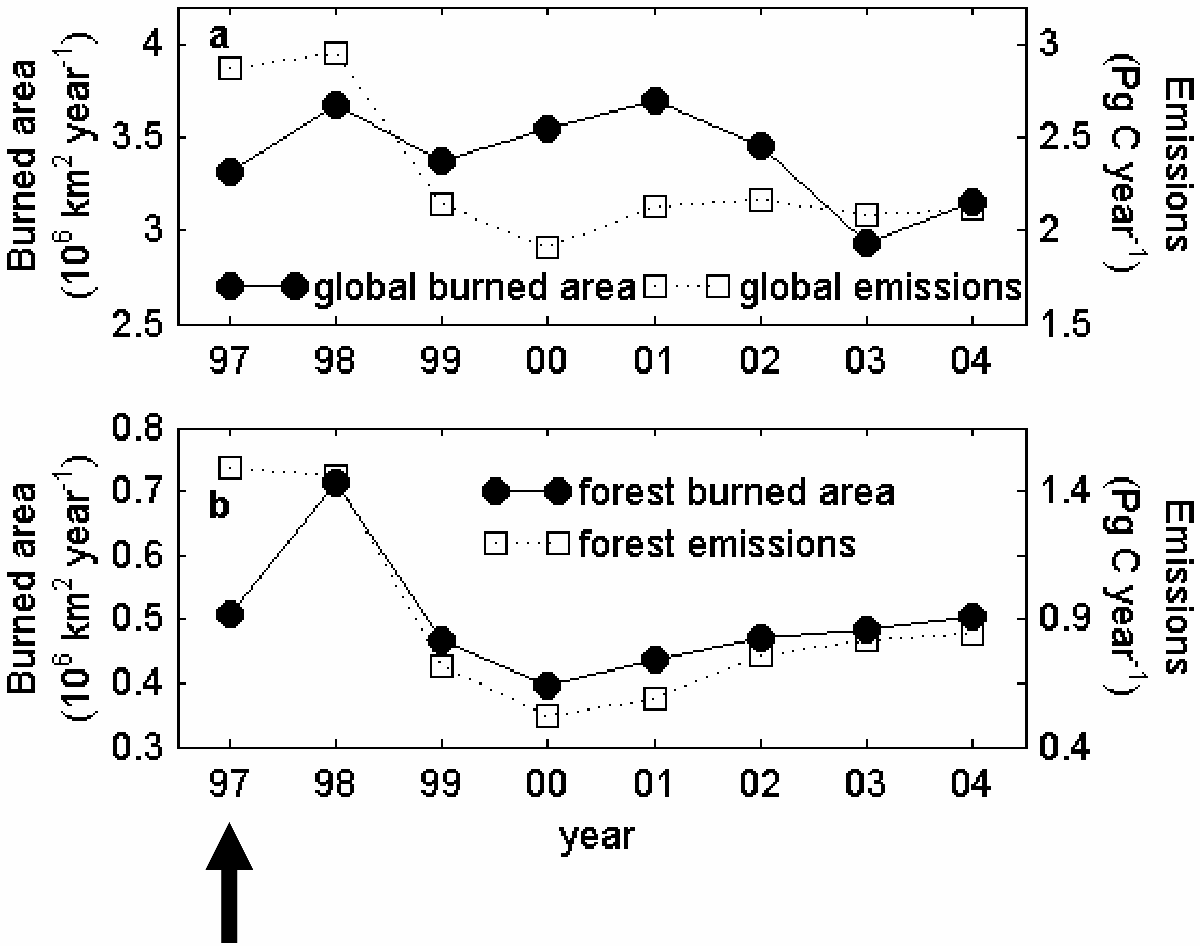
Fuel consumption as calculated by CASA





Emission (g)
per m^2 burned

On a global scale, IAV in burned area and emissions are decoupled

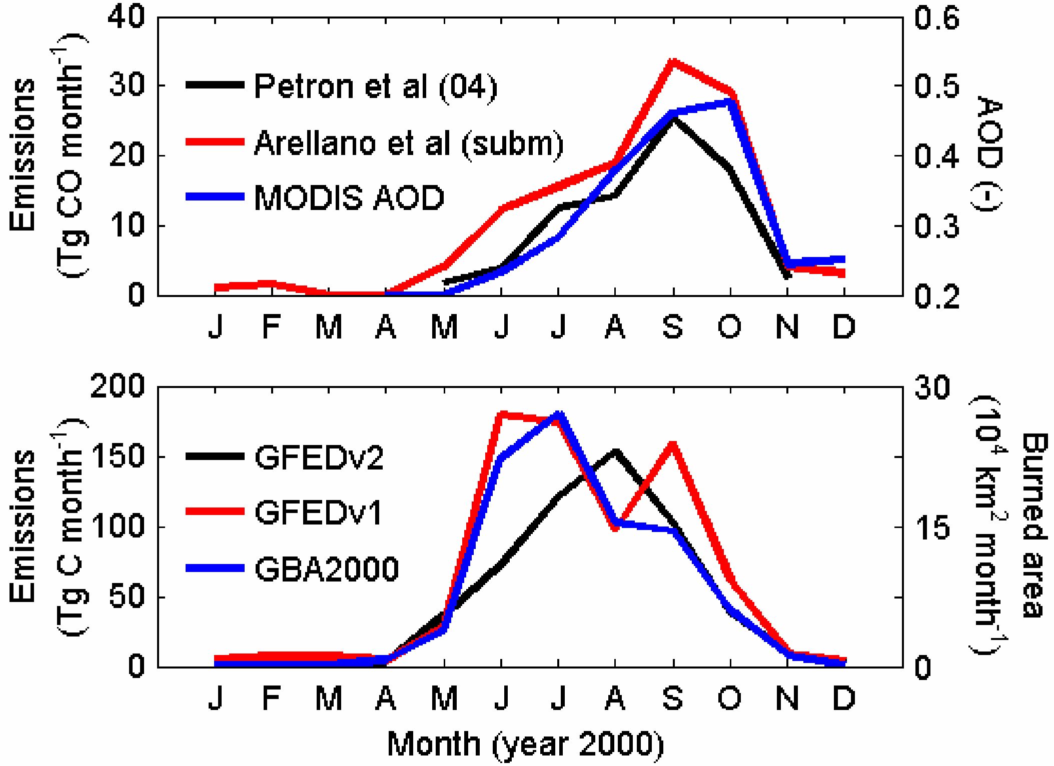


BA driven by savannas

Emissions driven by forest fires (including deforestation)

1997 peat burning in Asia

Mismatch in seasonality between top-down and bottom-up observations (mostly in southern Africa)



Atmosphere: peak in September - October

Satellite surface observations: peak in June – July - August

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Concluding remarks

1. GFED version 2 estimates global C emissions of ~2.5 Pg C, at the higher end of most satellite emission studies, but still lower than indicated by CO inverse studies.
2. Interannual variability is large, with high emissions in 1997-1998 from peat burning in Indonesia. Lowest emissions in 2000
3. Interannual variability in fire emissions is dominated by IAV in forest fires. Implications:
   - Burned area and emissions are decoupled
   - IAV in CO and CH_4 is larger than IAV in C or CO_2
4. The second version of GFED has an improved seasonality, better representation of interannual variability thanks to the incorporation of peat burning (compared to CO inverse studies), but probably underestimates emissions stemming from deforestation.
5. All products (burned area, emissions (C, CO2, CH4, CO etc), fuel loads, CC) can be downloaded from Jim Randerson's website @ http://www.ess.uci.edu/~jranders/