20th-23rd November

GWIS and GOFC Fire IT meeting

FRP-derived fuel consumption and vegetation productivity

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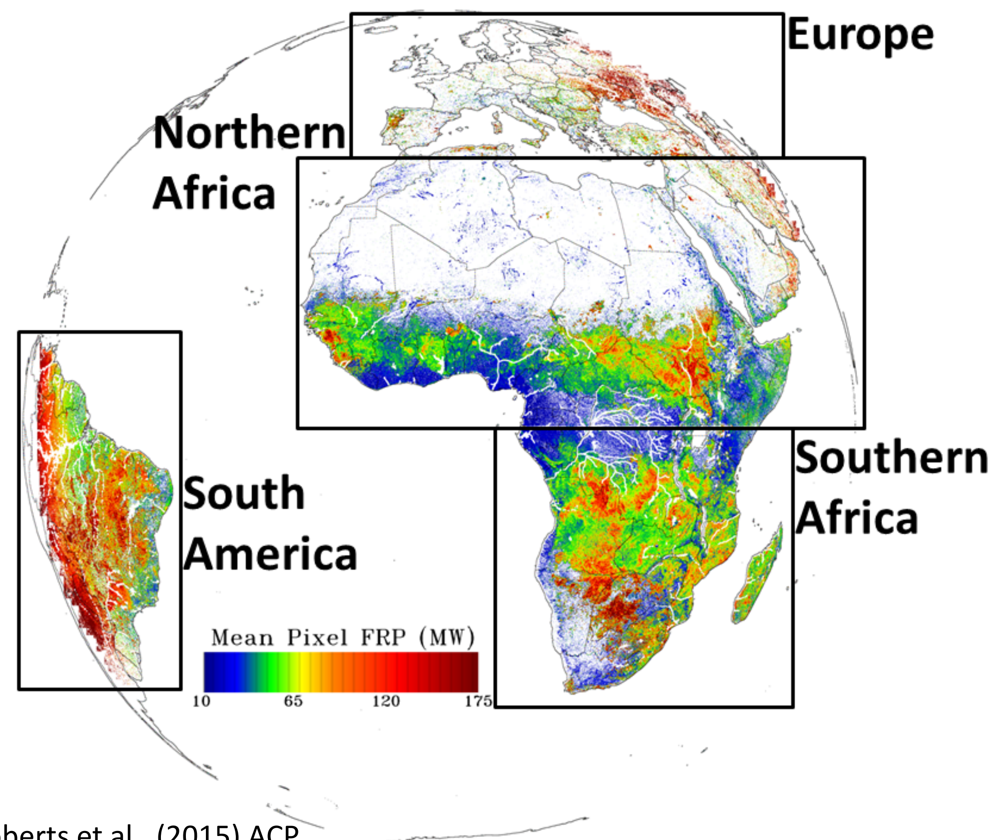
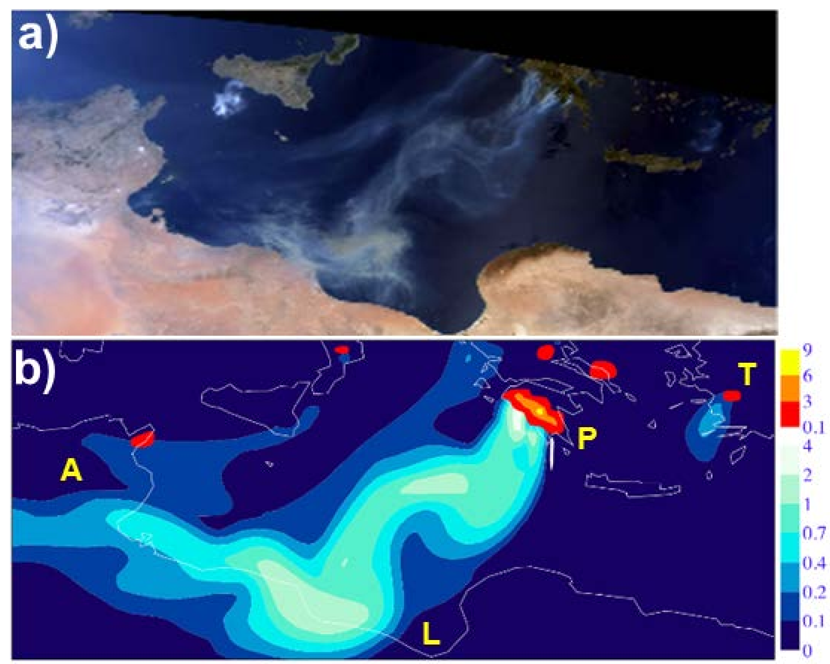
LSA-SAF SEVIRI FRP-PIXEL product

- Geostationary active fire dataset (2004–present)
  - Atm. corrected FRP over Earth disc
    - 3km spatial res. & 15min temporal res.
  - NRT emissions est. (e.g. Copernicus Global Fire Assimilation System;GFAS, Kaiser et al., 2012, ACP)

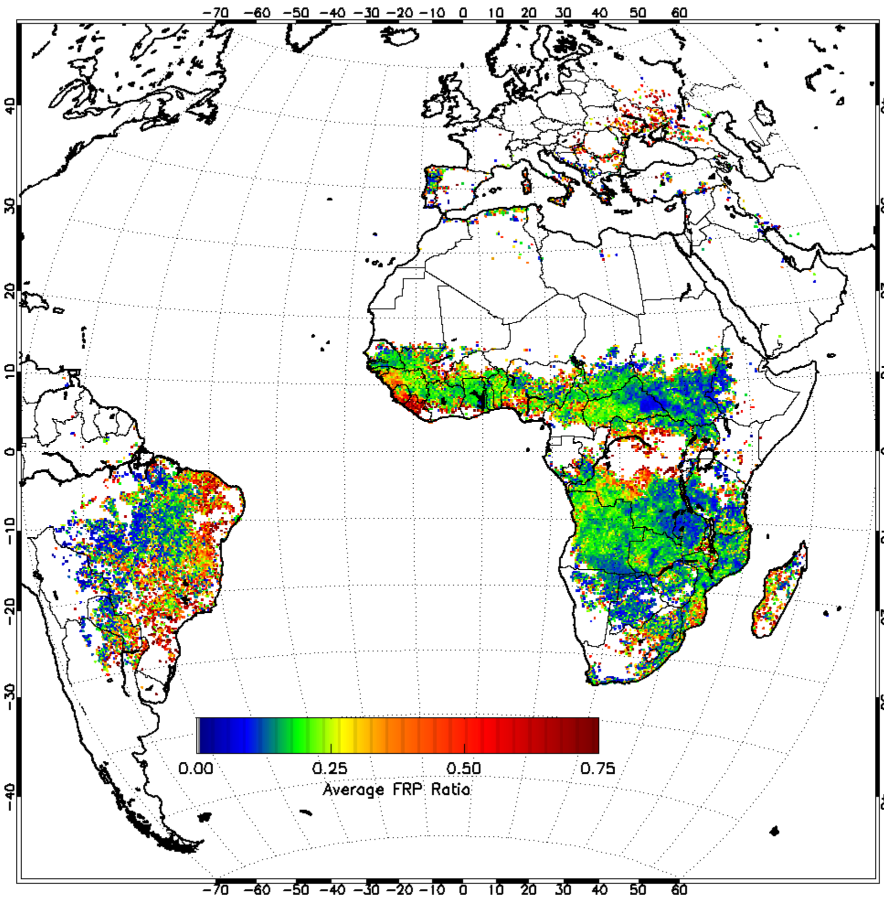


Roberts et al., (2015) ACP



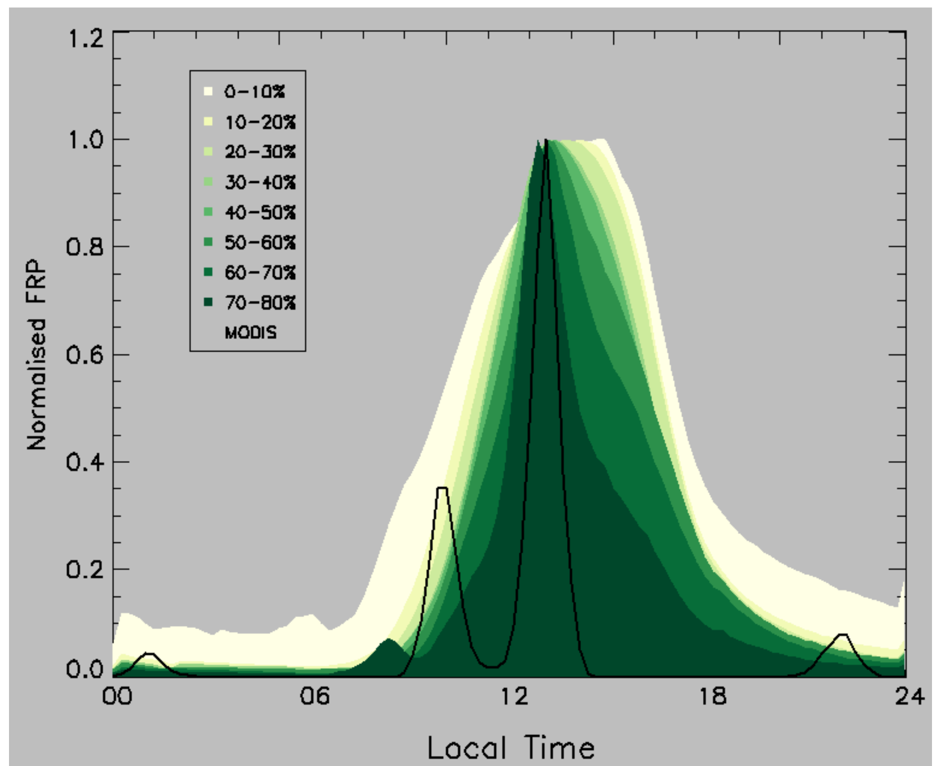
MODIS true colour image (a) and GFAS AOT emissions (blue) est. using SEVIRI FRP (red)

Diurnal Cycle of Fire Activity



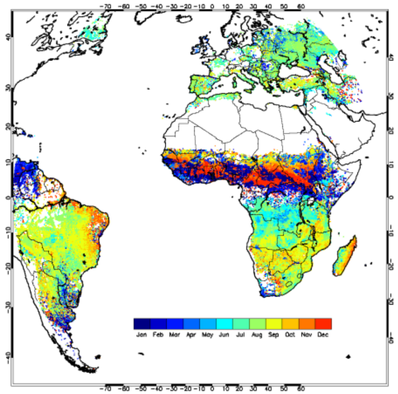
Ratio between SEVIRI FRP measured at MODIS overpass times and SEVIRI FRP measured over the full diurnal cycle

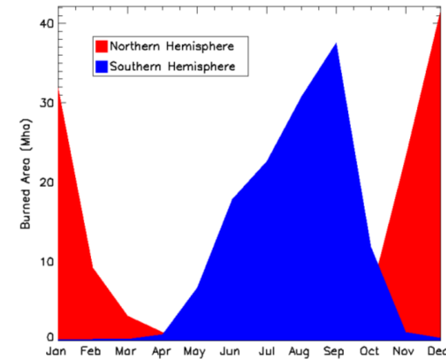
- ❑ Temporal frequency key advantage of geostationary sensors
- ❑ Vegetation characteristics play a role in diurnal dynamics of fire activity



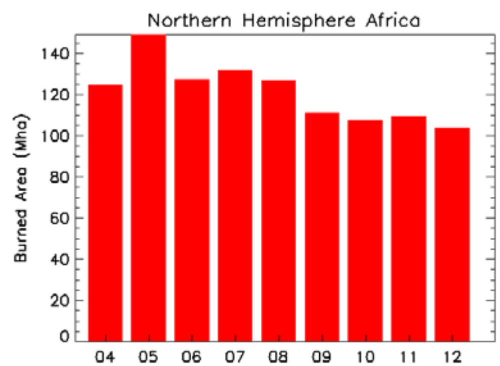
Africa : BB Temporal Dynamics

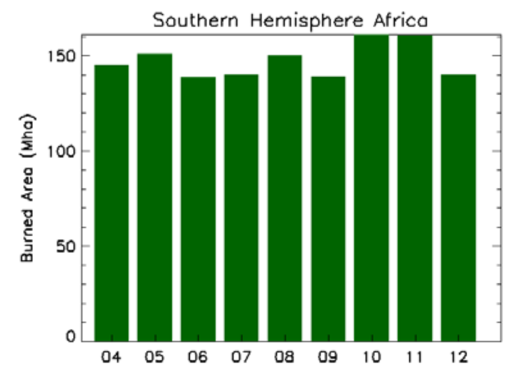
- ❑ Africa is large continental BB emissions source
- ❑ Strong seasonal and inter-annual variability





MCD64 Burned Area

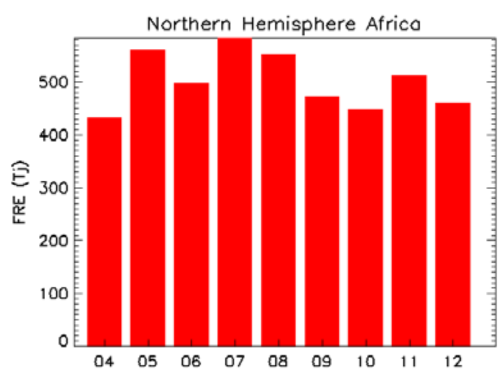


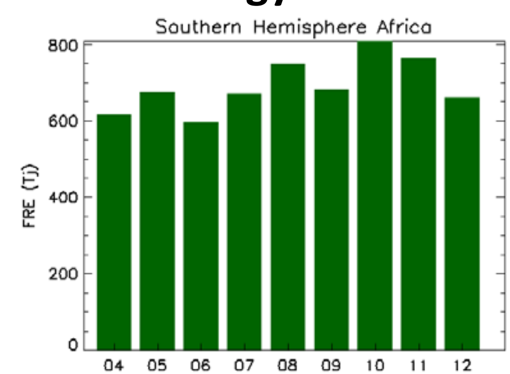


- ❑ Burned area activity :
  - Broadly consistent in SHA
  - General decrease in NHA
    - Increased agriculture

    (Andela and van der Werf, 2016)

SEVIRI Fire Radiative Energy





- ❑ FRE & fuel consumption
  - more variable in NHA
  - slight increase in SHA

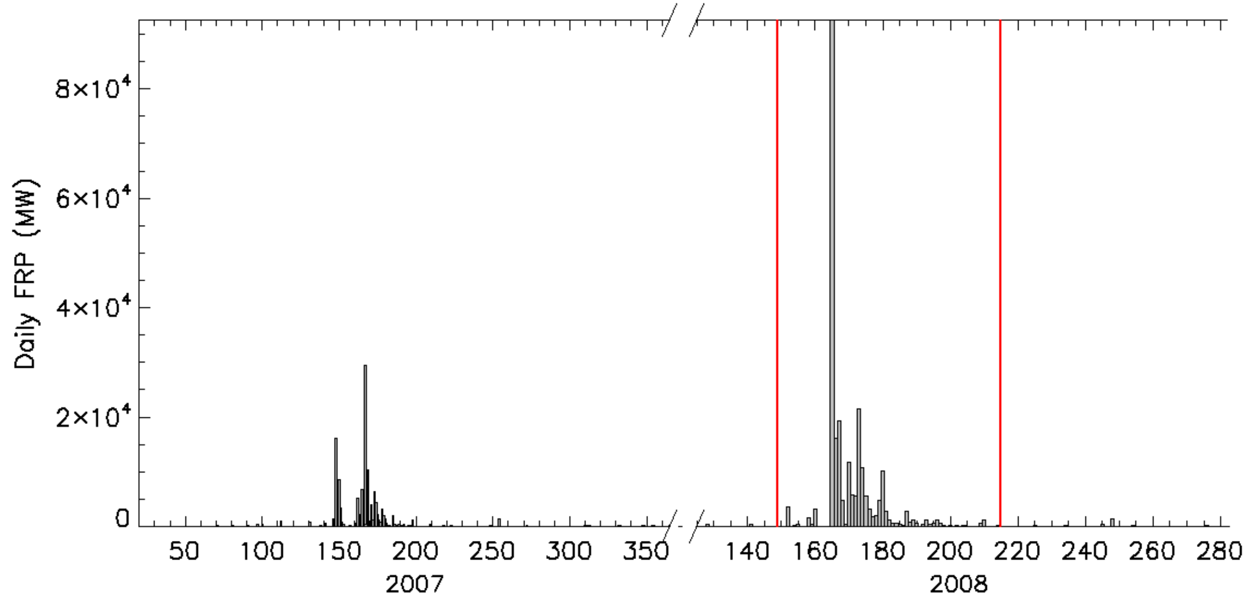
FRE-derived Fuel Consumption and Vegetation Productivity: Methodology

Vegetation Productivity

- MCD64 burned area product (Giglio et al., 2013)
  - Define burned area ‘clusters’
    - Identify areas which burn in successive years
  - Integrate 500m MODIS PSNnet
    - Date of last BA DOY (previous year) → date of first BA detection (current year)

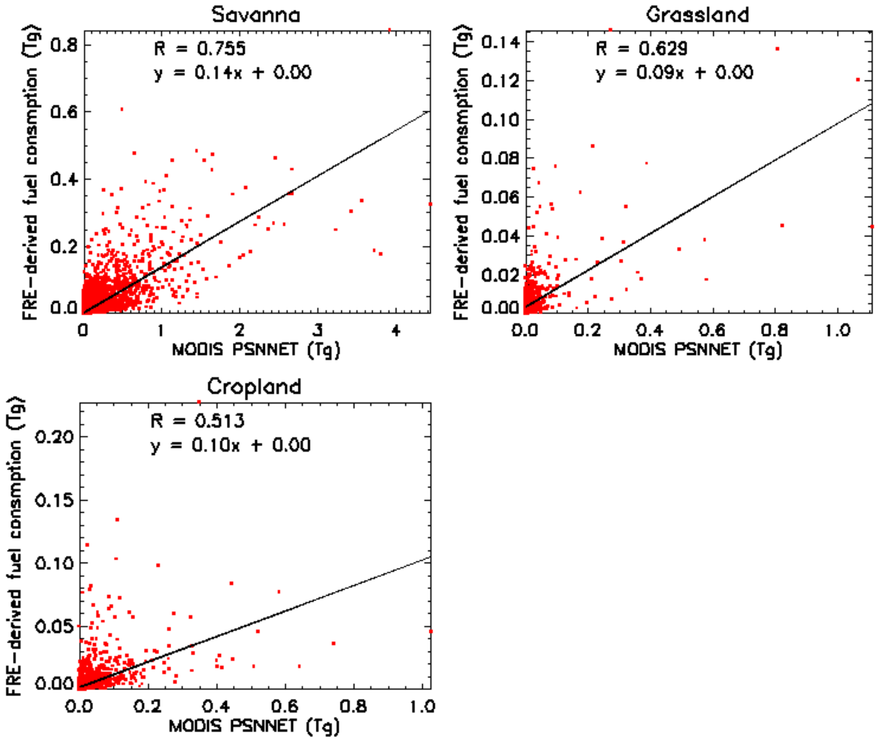
SEVIRI FRP

- Integrate FRP over burned area
  - date of first BA detection → date of last BA detection (current year)
- Est. FRE and total fuel consumption
  - FRP conversion factor 0.368 (Wooster et al., 2005)

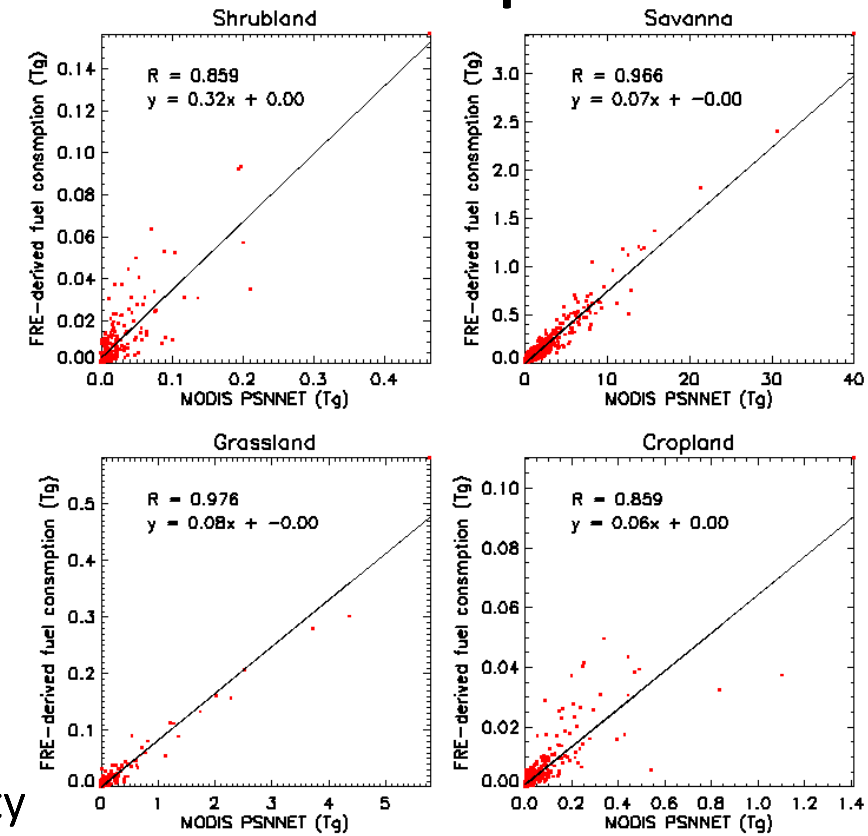


Fuel Consumption (FC) and Productivity

Northern Hemisphere Africa



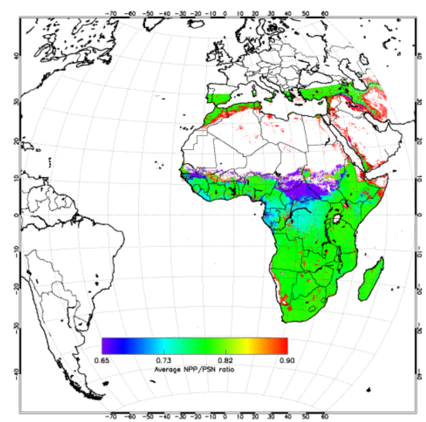
Southern Hemisphere Africa



- Correspondence between FC and productivity
  - Low and variable in northern hemisphere
  - Better in southern hemisphere

- FC typically < 10% of productivity :
  - Combustion completeness
  - PSNnet - maintenance respiration of live wood and growth respiration are not accounted for

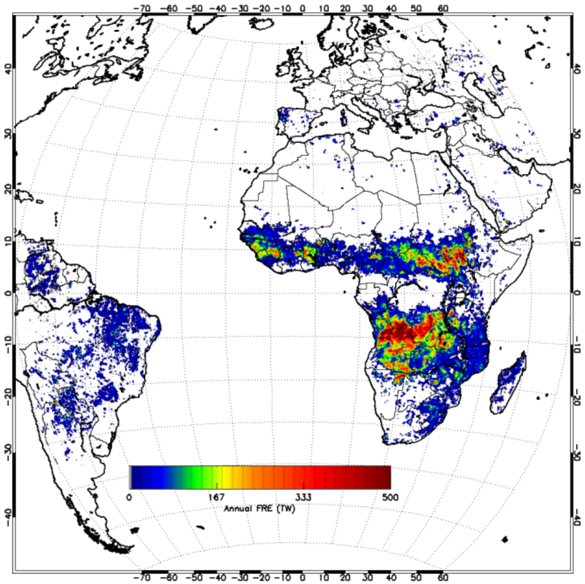
Ratio annual NPP and PSNnet



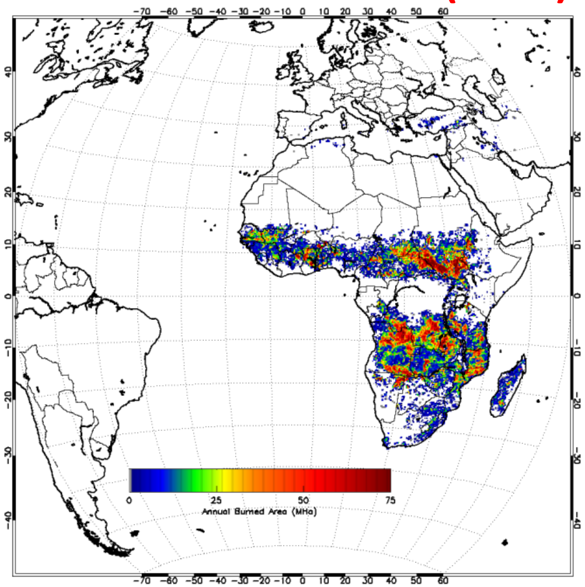
Fuel Consumption Estimation : Methodology

- Fuel Consumption (kg/m^2) estimation :
  - MCD64 burned area product (Giglio et al., 2013, Biogeosciences)
    - Daily resolution @ 500m
      - Remapped to SEVIRI grid
  - SEVIRI FRP (MW)
- Assumes FRP +/- 7 days of a MODIS burn detection is same fire
  - Integrate to est. FRE
  - Est. fuel consumption per pixel
- Calculate fuel consumption per 0.25°

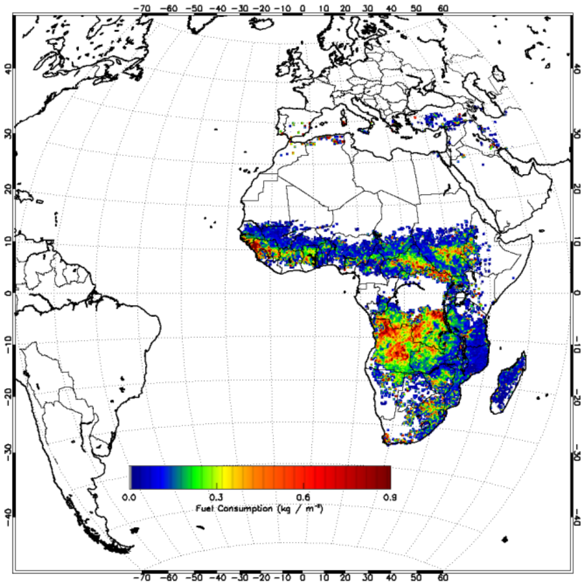
Annual FRE (2009)



Annual Burned Area (2009)

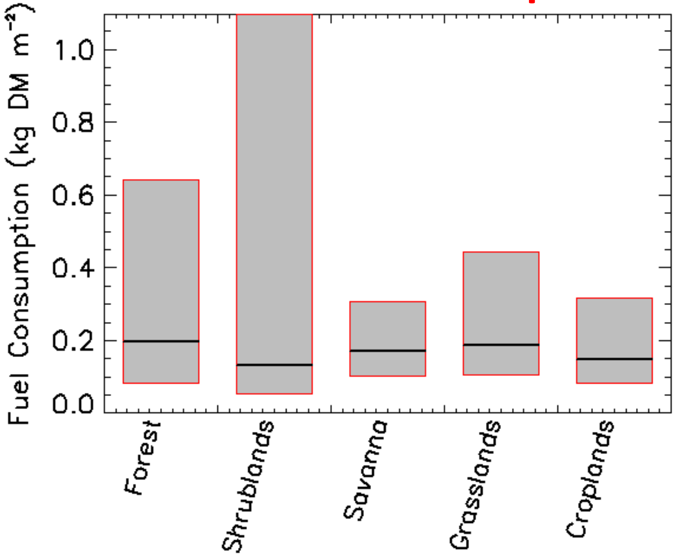


Annual FC (2009)

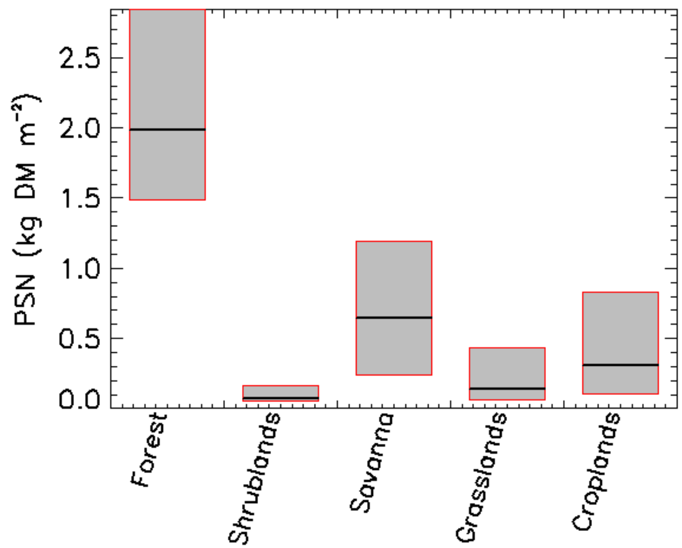


FRE-derived Fuel Consumption (FC)

NHA fuel consumption

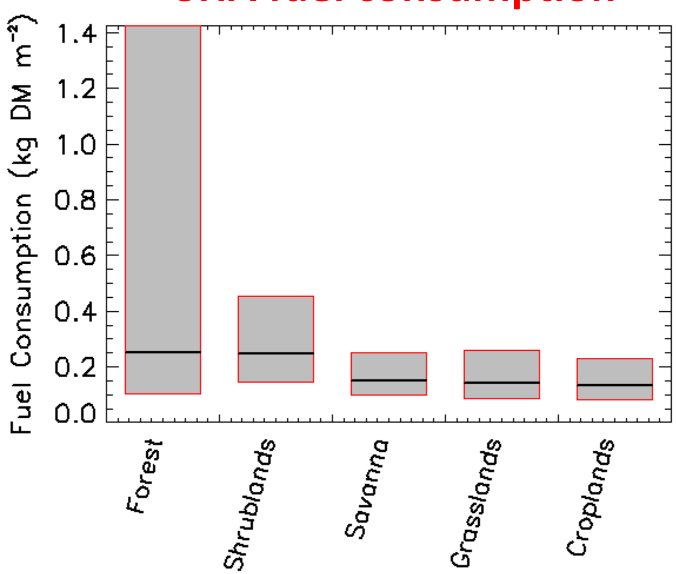


NHA PSNnet

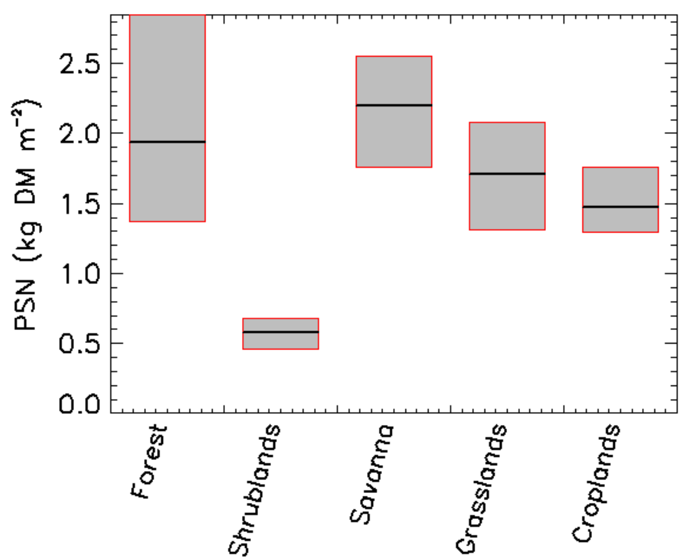


Field measurements for Savanna
137-528 g.m^{-2} (Hoffa *et al.*, 1999)
146 - 404 g.m^{-2} (Hely *et al.*, 2003)

SHA fuel consumption



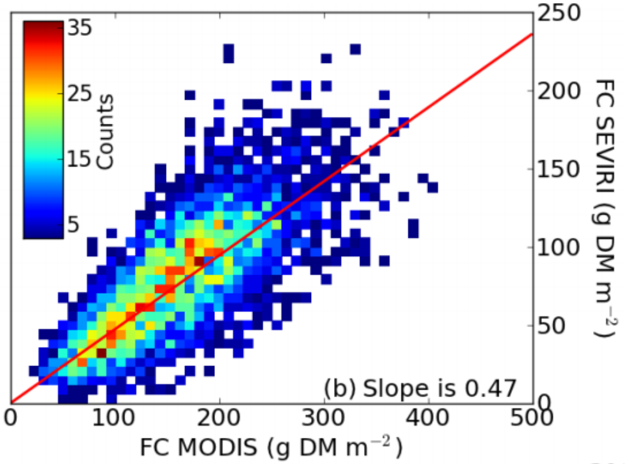
SHA PSNnet

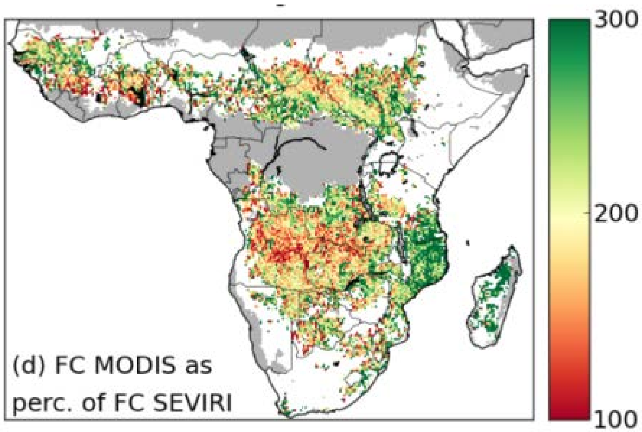


FRE-derived FC (m^{-2})
~10% of productivity estimates

FRE-derived Fuel Consumption (FC)

- FRE-derived FC
  - most reliable in regions of :
    - high fuel loads
    - larger fires





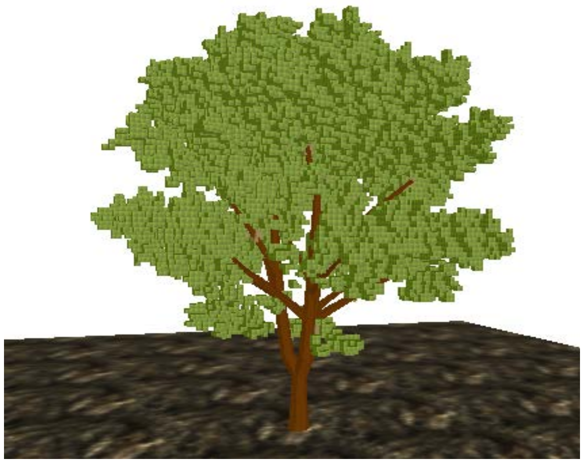
Andela et al., (2016). Biogeosciences

- FRE-derived FC effected by :
  - Sensor (e.g. SEVIRI pixel area, PSF\FIR filter, temporal sampling)
  - Environment characteristics (e.g. fire size, intensity, fuel moisture content, cloud\smoke obscuration)
    - **Canopy structure**

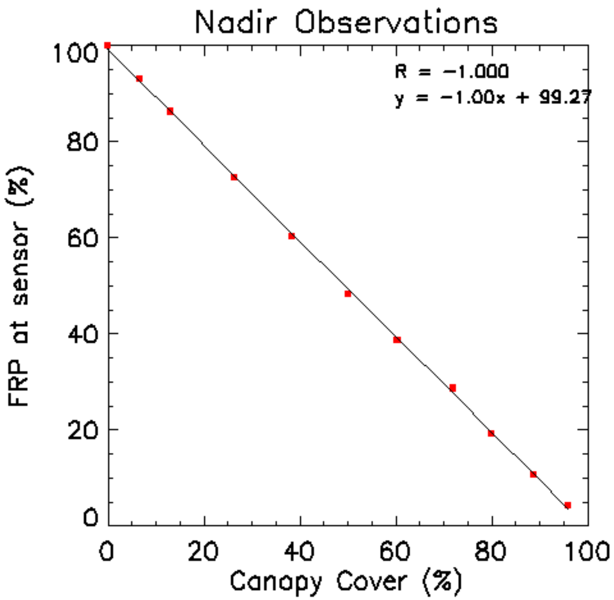
Impact of Canopy Structure

- DART model simulates radiative transfer in visible-thermal wavelengths (Gastellu-Etchegorry et al., 1996)
  - assess impact of :
    - canopy cover
    - LAI

- Scene simulated in MWIR :
  - uniform (1000K) heat source
  - canopy simulated using a turbid tree canopy
    - randomly distributed in scene
  - %canopy cover varied between 7-96%

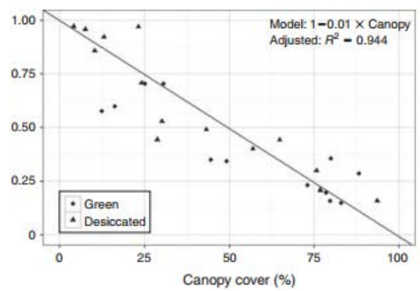


Impact of Canopy Structure

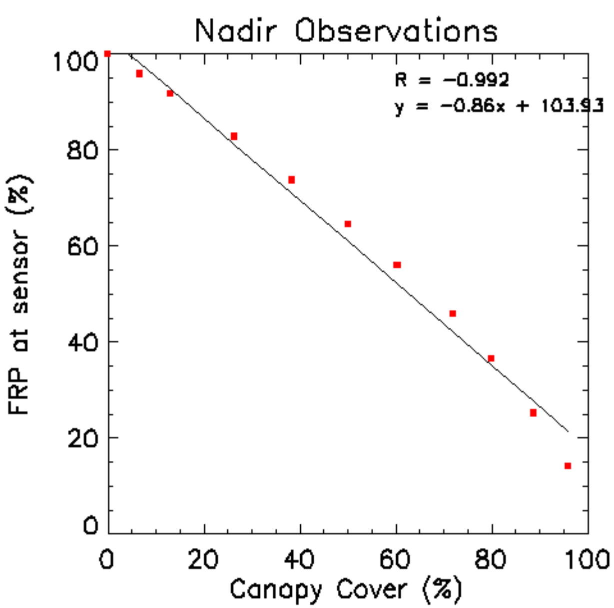


Opaque Canopy

FRP interception a fcn of canopy cover

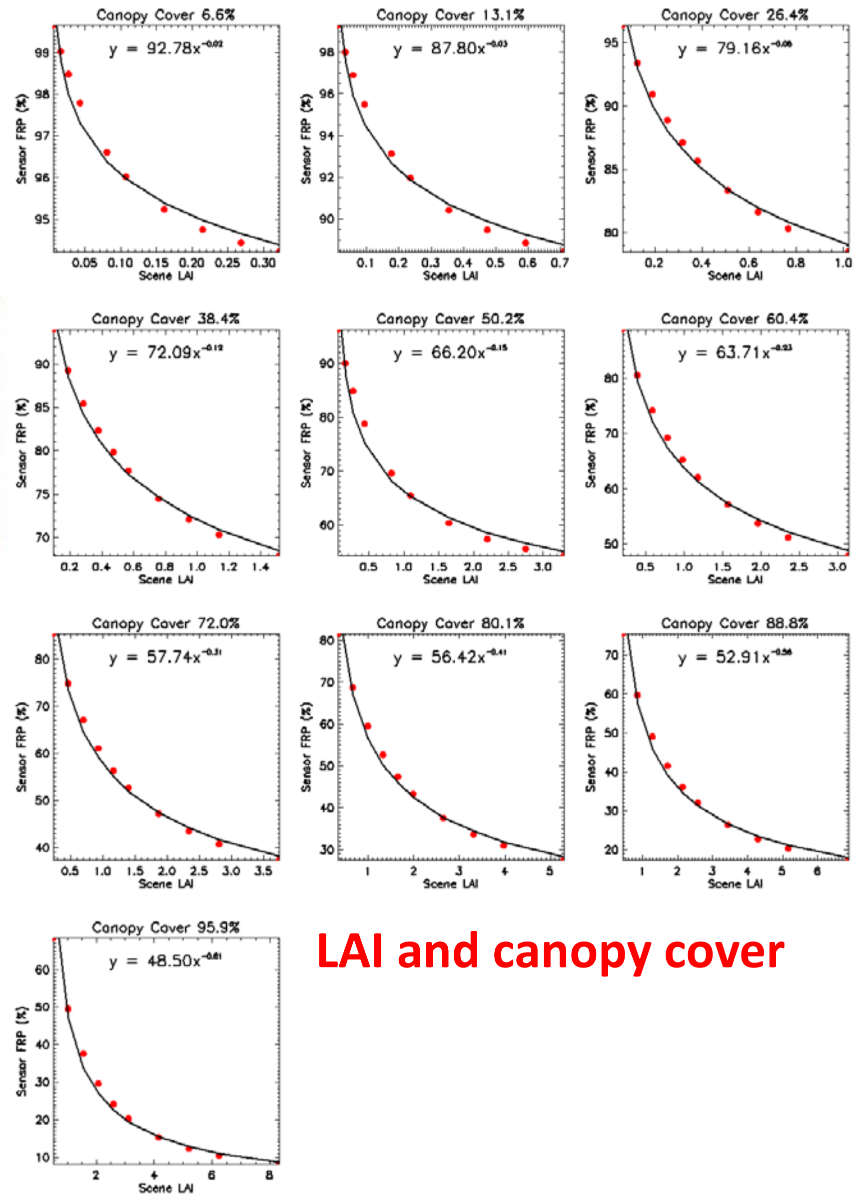


Mathews et al., (2016)



Turbid Canopy

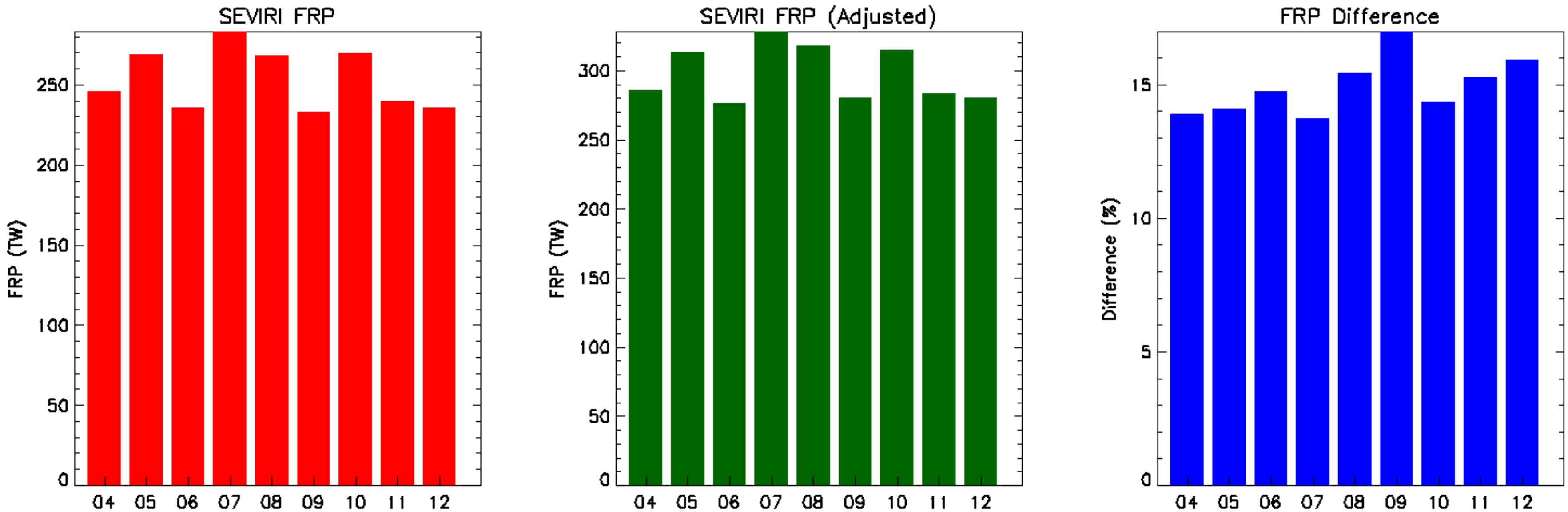
FRP interception remains high

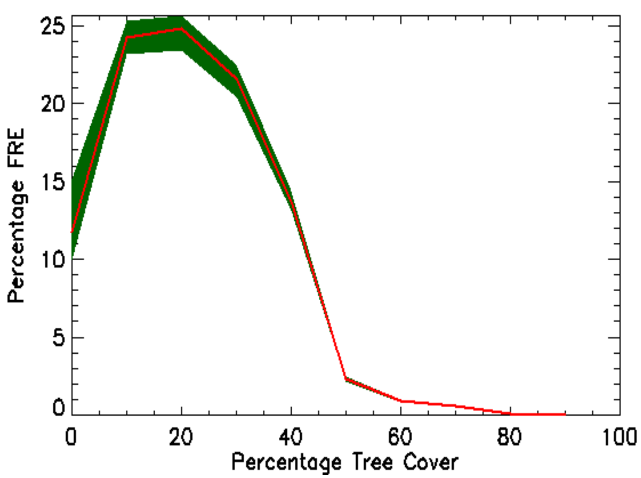


LAI and canopy cover

Impact of Canopy Structure

- Correcting SEVIRI FRP for impact of canopy cover and LAI
  - 14-17% increase





- Most fire activity in Africa occurs in <40% cover
- Correction for canopy cover \ LAI assumes :
  - fire occurs under canopy
  - uniform dist. of %cover within pixel
  - nadir vzen correction
- LAI (upper and lower surface fuel)

Conclusion

- FRP-derived FC underestimated
  - more variable in the northern hemisphere
  - better agreement in southern hemisphere
  - doesn’t account for CC, respiration

- FRE-derived FC underestimation for num. reasons

- DART simulations indicate large reduction in sensor FRP with >% cover

- Correcting for canopy cover and LAI results in a ~15% increase in SEVIRI FRP over Africa