A statistical burned area model for the use in dynamic vegetation models

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Effects of Wildfires:

Pyrogenic emissions of CO_2 and a variety of trace gas species

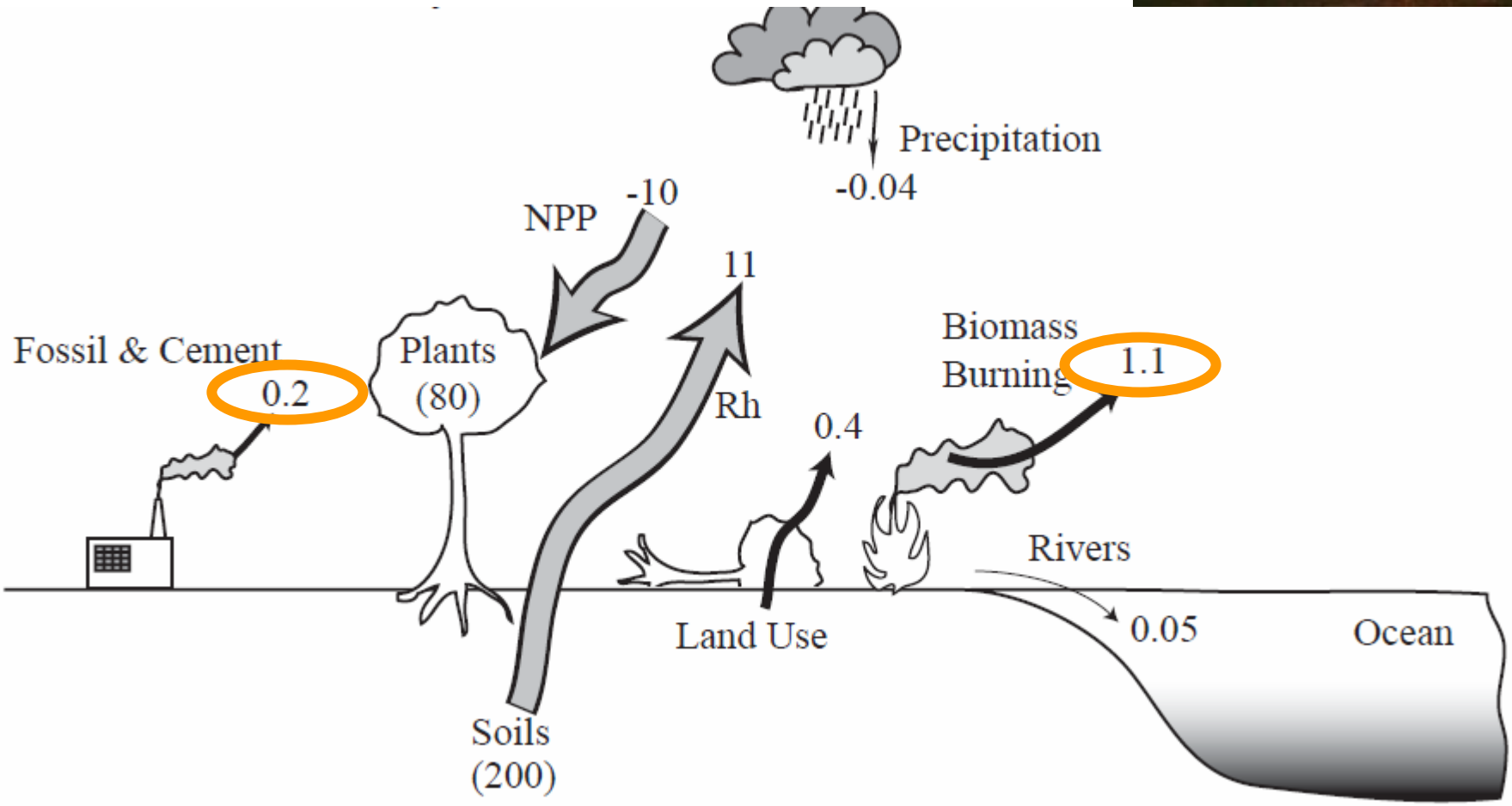
Effects on vegetation favoring fire resistant or early successional species

Effects on carbon stocks, albedo etc.

Need for global circulation models as well as dynamic vegetation models to take wildfires into account

Effects of Wildfires:

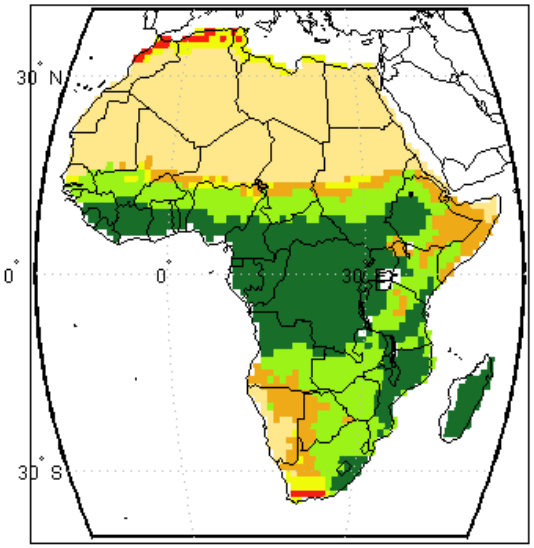
Estimates of continental carbon fluxes in PgC /y



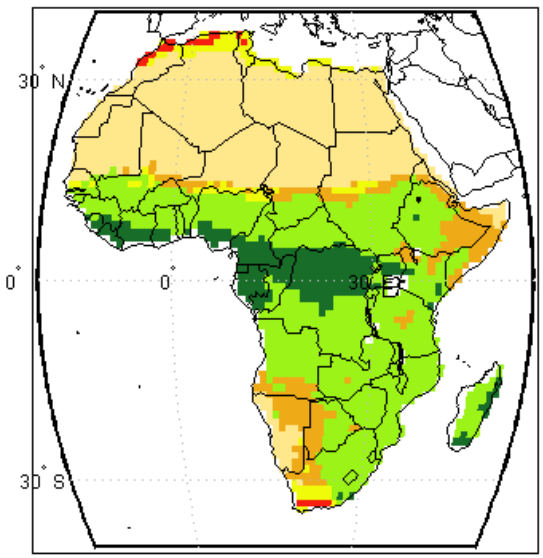
Williams *et al.* (2007) Africa and the global carbon cycle. *Carbon Balance and Management*, **2:3**

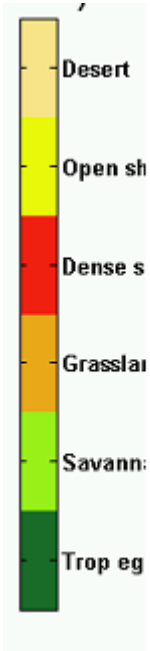
Effects of Wildfires:

Without fire



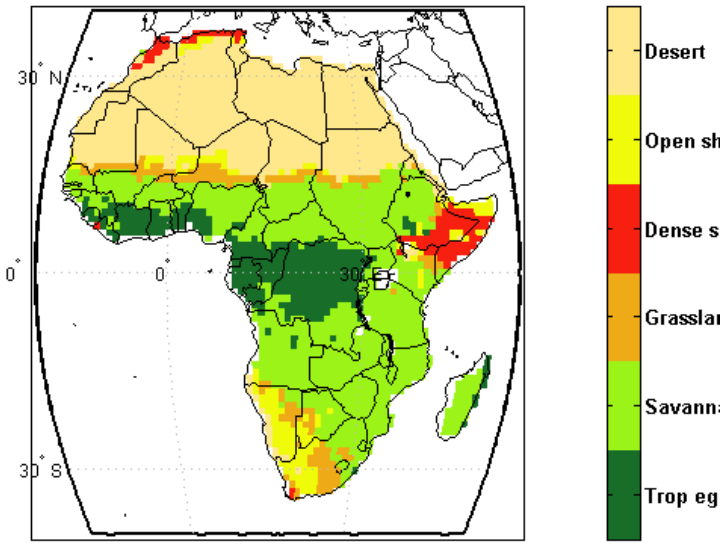
With fire (MODIS)



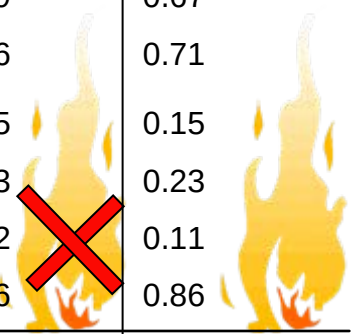


Continental vegetation simulation:

Potential vegetation according to Ramankutty and Foley (1999)



Biome	Kappa	Kappa
Tropical rain forest	0.49	0.67
Savanna / tr deciduous forest	0.46	0.71
Grassland / Steppe	0.15	0.15
Dense Shrubland	0.23	0.23
Open Shrubland	0.12	0.11
Desert	0.86	0.86
Total	0.53	0.64



eochemical Cycles **13**, 997-1027.

Ran

Lehsten, V., Arneth, A., Thonicke, K. & Spessa, A. (2009) Tree-Grass Coexistence in Savannahs: Testing Two Mechanisms. i*n review*

Simulation of wildfires

Direct prescribing satellite data

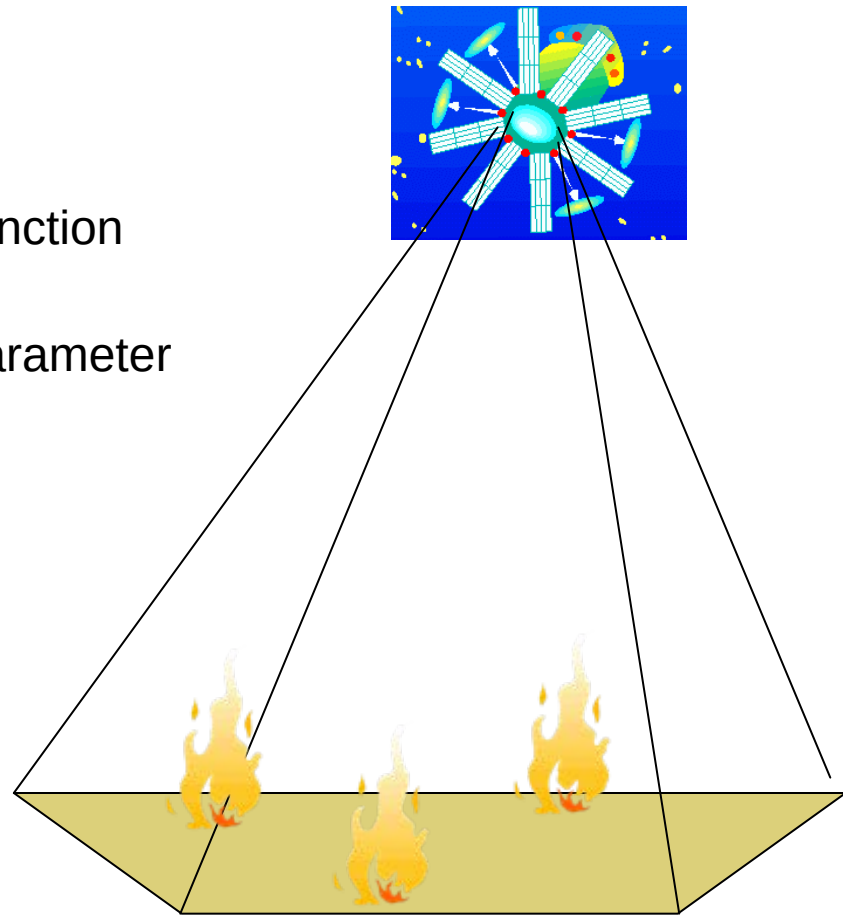
2000-now for burned area

Dynamic modelling:
simulation of ignition – spread – extinction

Highly uncertain variables and parameter in many processes

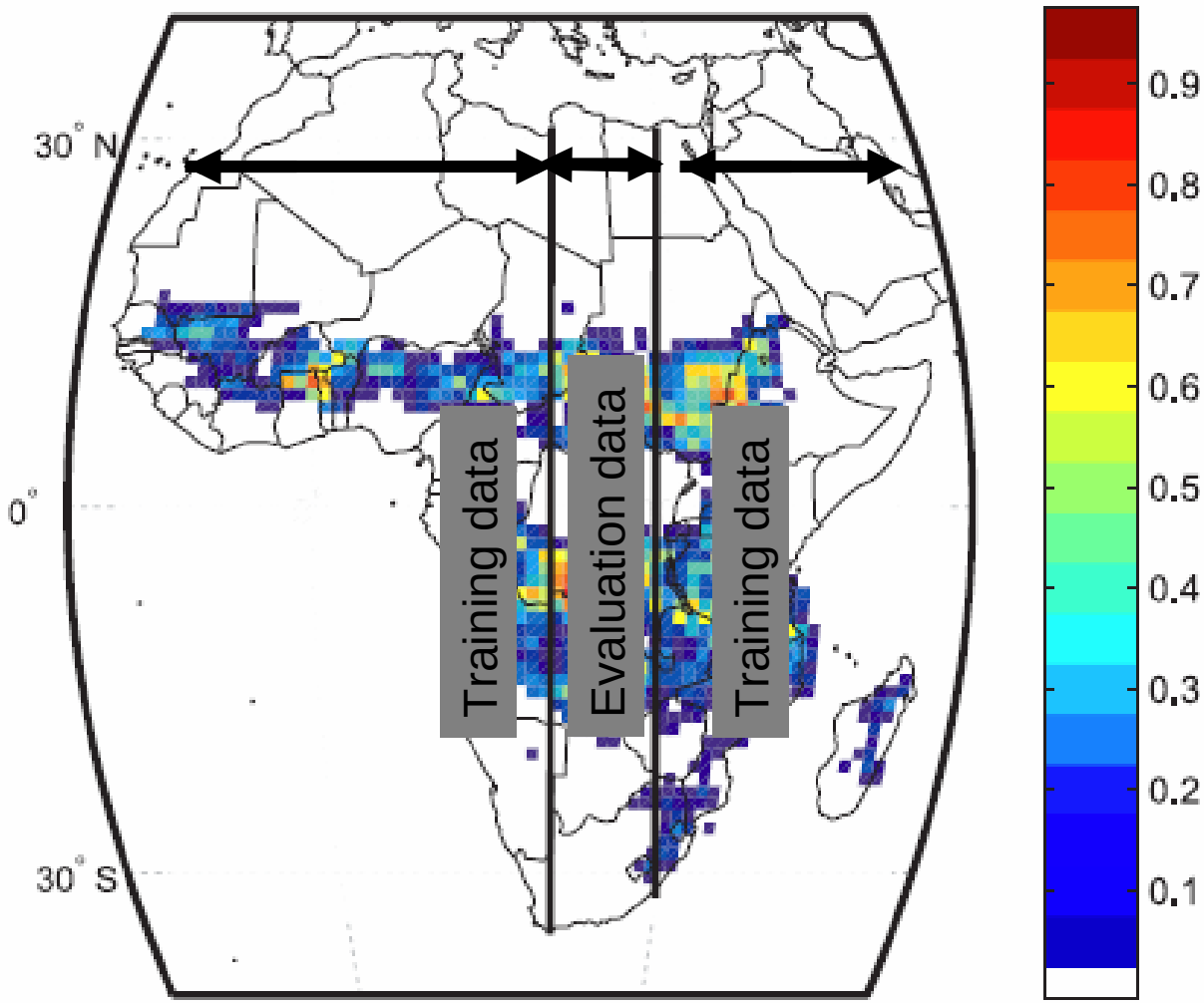
Statistical modelling

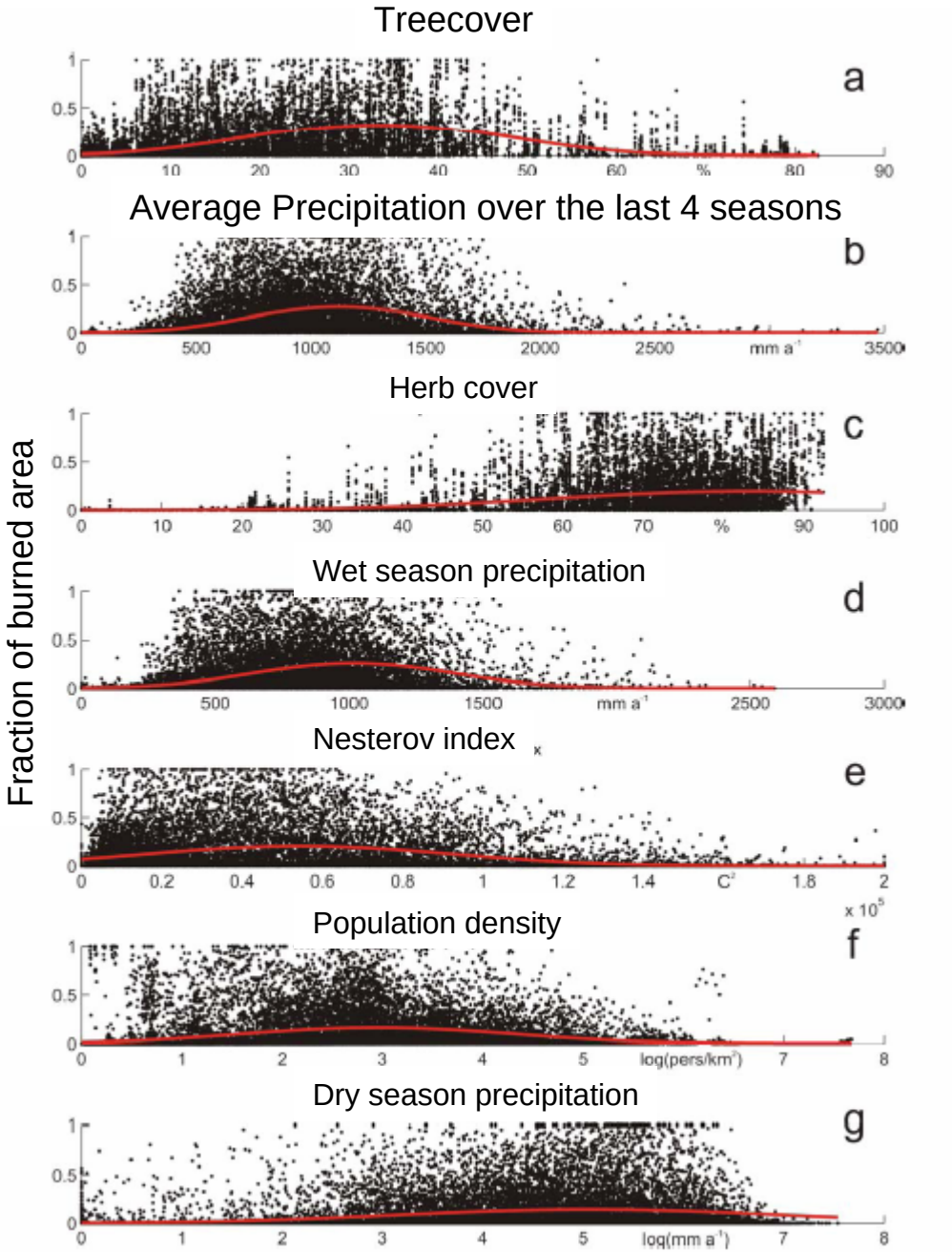
Limited applicability if conditions change strongly



Statistical Analysis : Data

Burned area MODIS MCD45 2000-2009 re-gridded to one degree



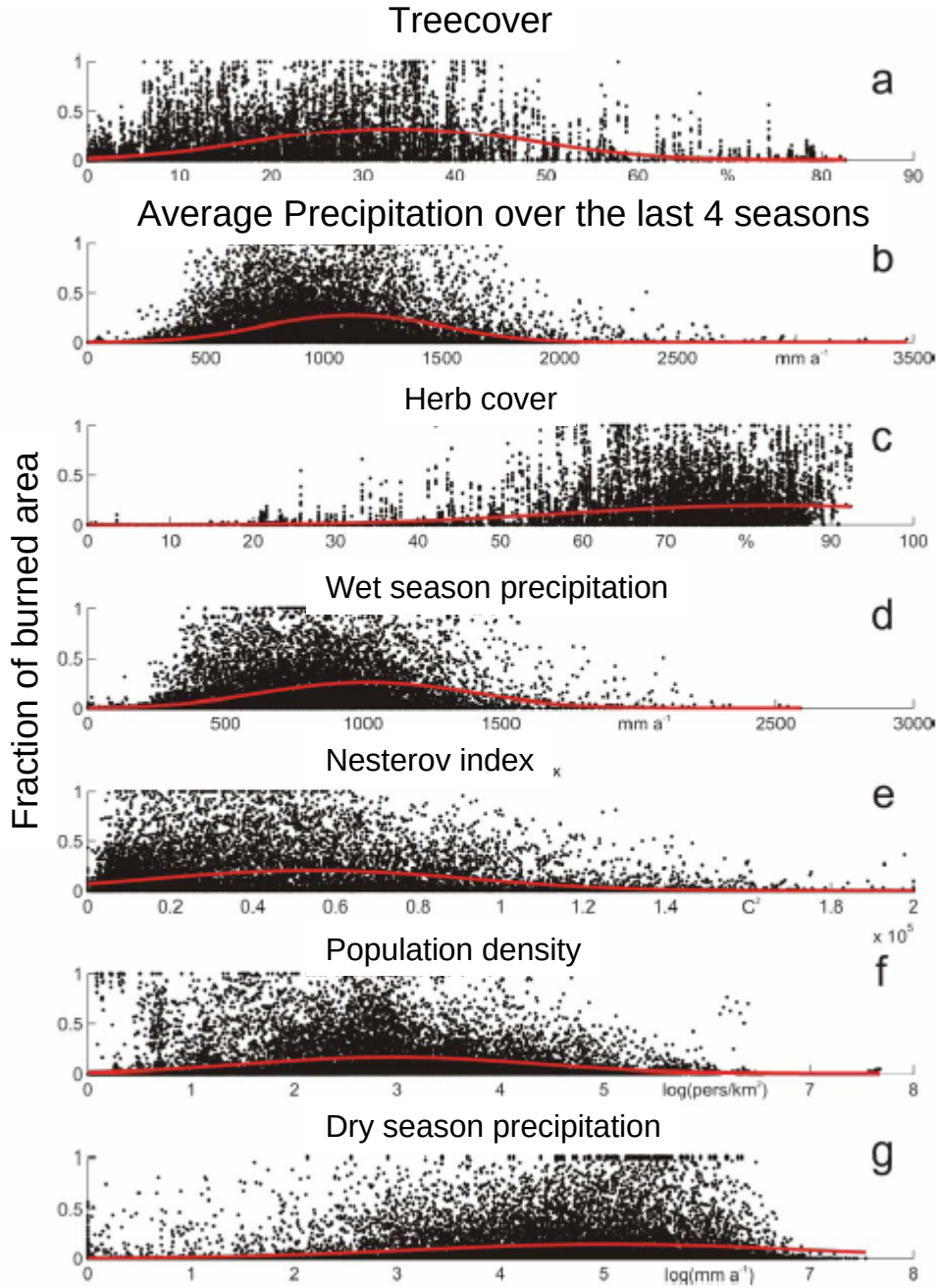


Relationship of ratio of burned area and single climate driver.

All uni-modal shaped

Correlation factor (r)

Tree-cover	0.53
Mean Precipitation last 4 seas	0.49
Herb-cover	0.43
Precipitation Rain-season	0.46
Nesterov maximum	0.39
log(Population density)	0.27
log(Precipitation Dry-season)	0.26



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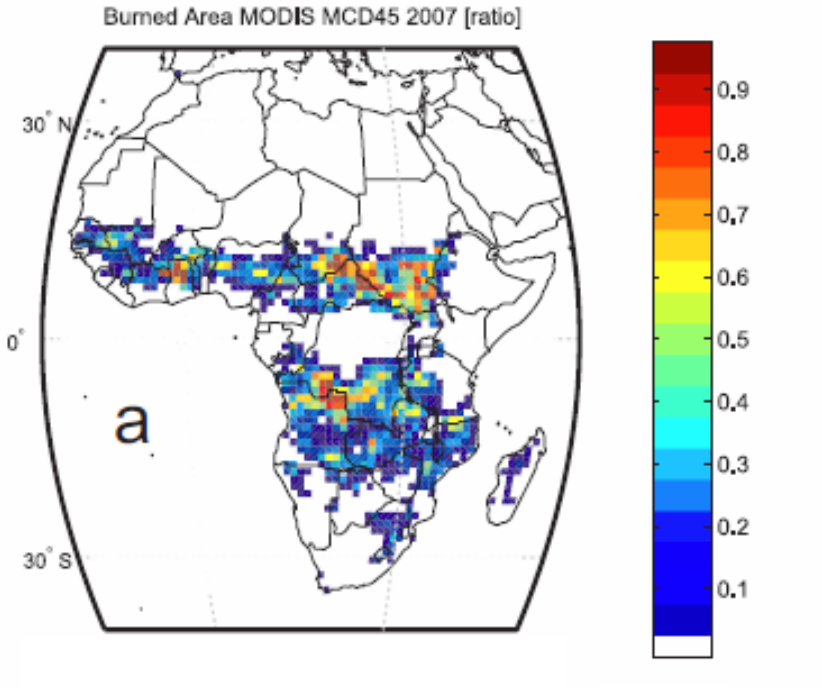
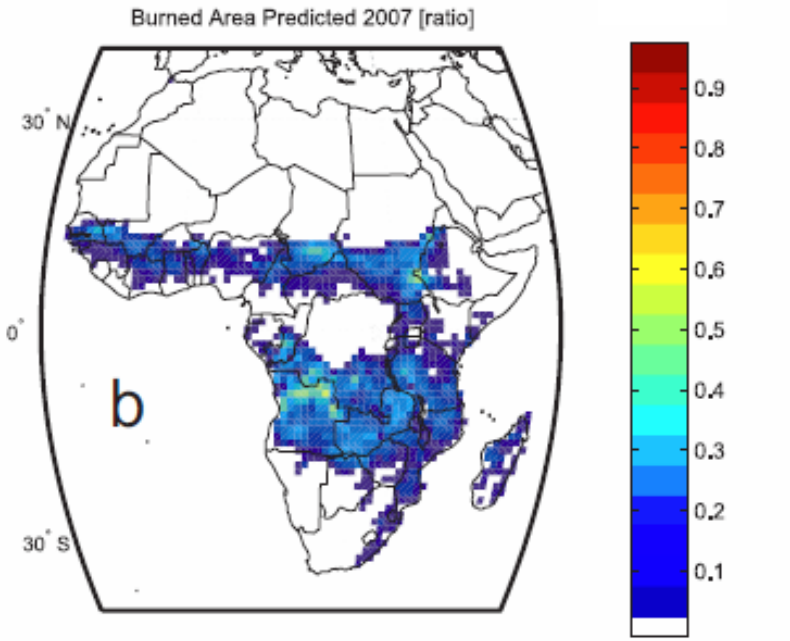
Using a combined model resulted in an r value of 0.7

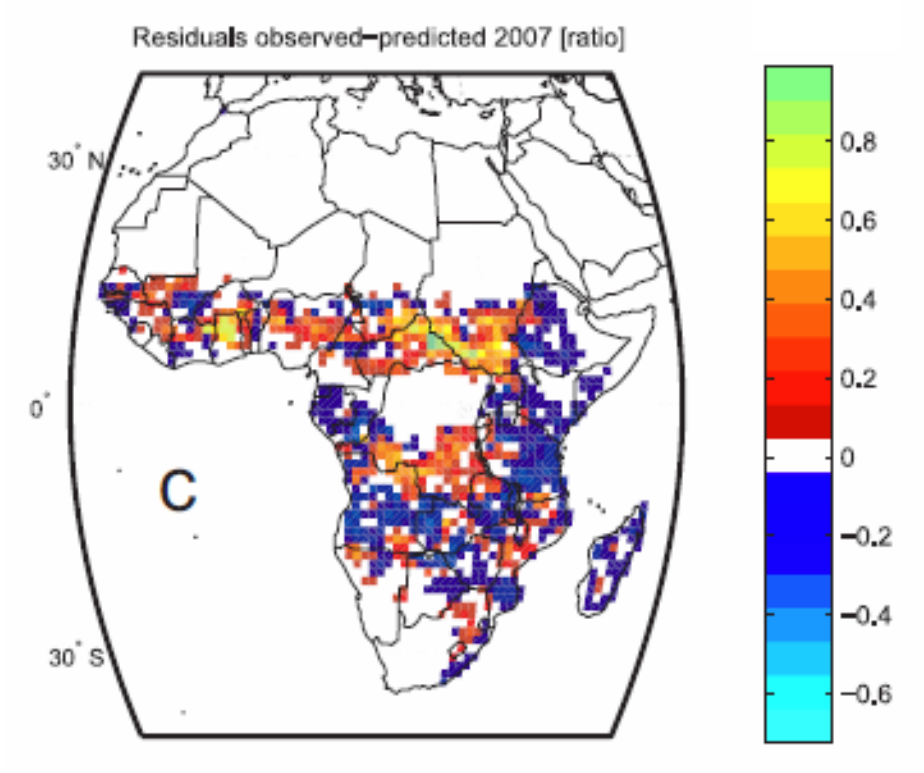


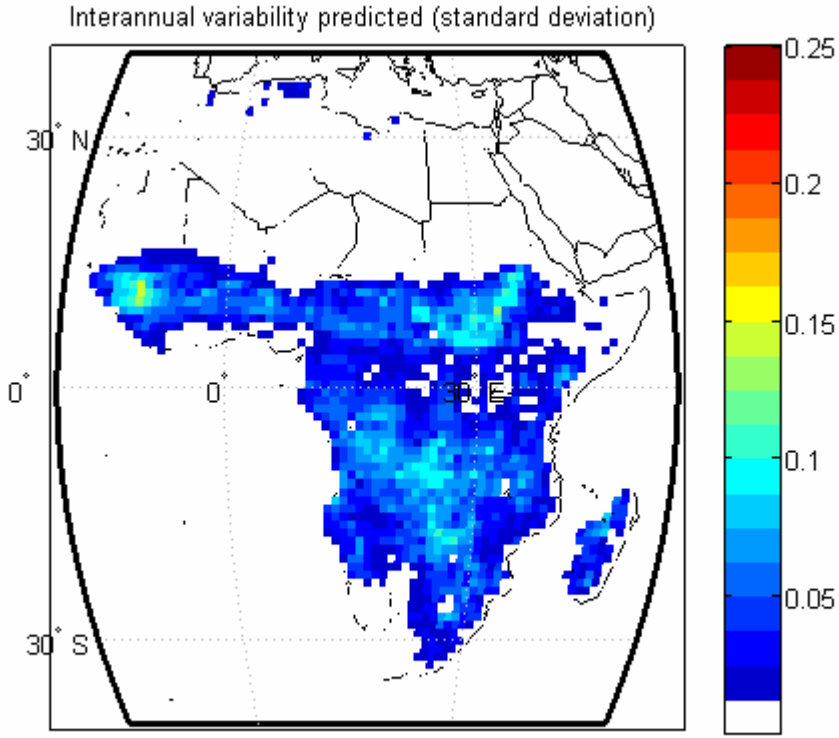


Spatial extend is well represented

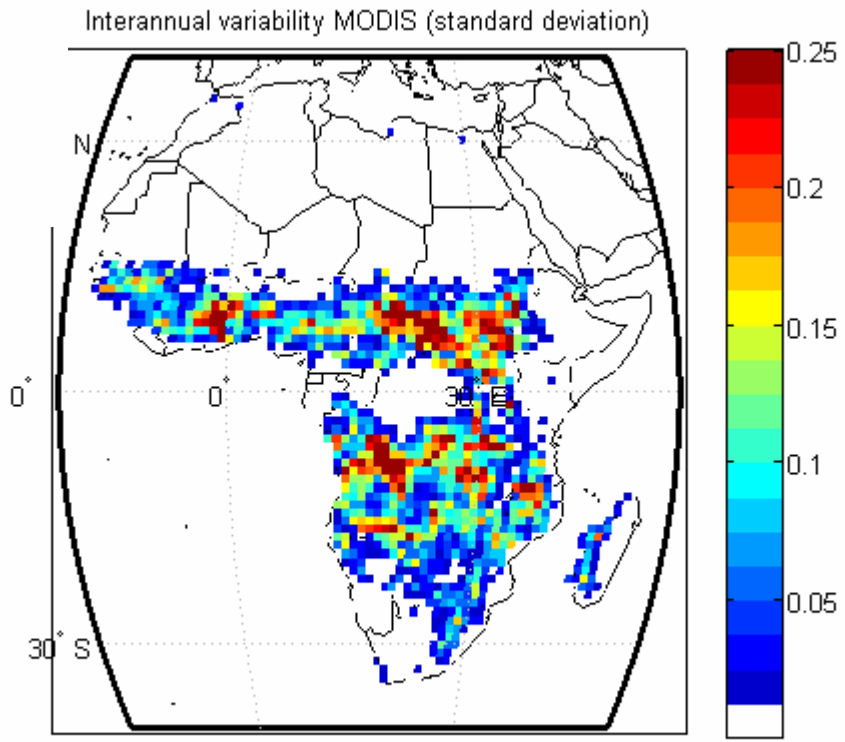
Spatial variability is strongly underestimated

Climate date resolution?
Additional factors? Soils? Farming systems?

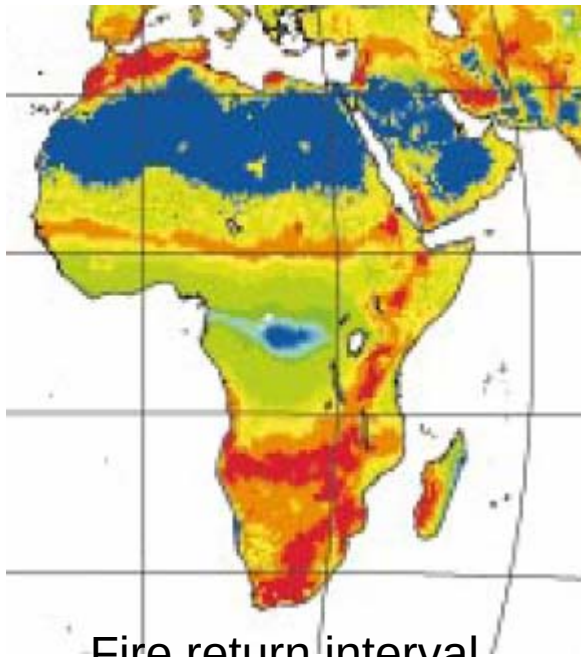




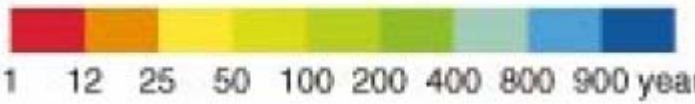
The same is true for temporal variability



However, the final model still does a reasonable job

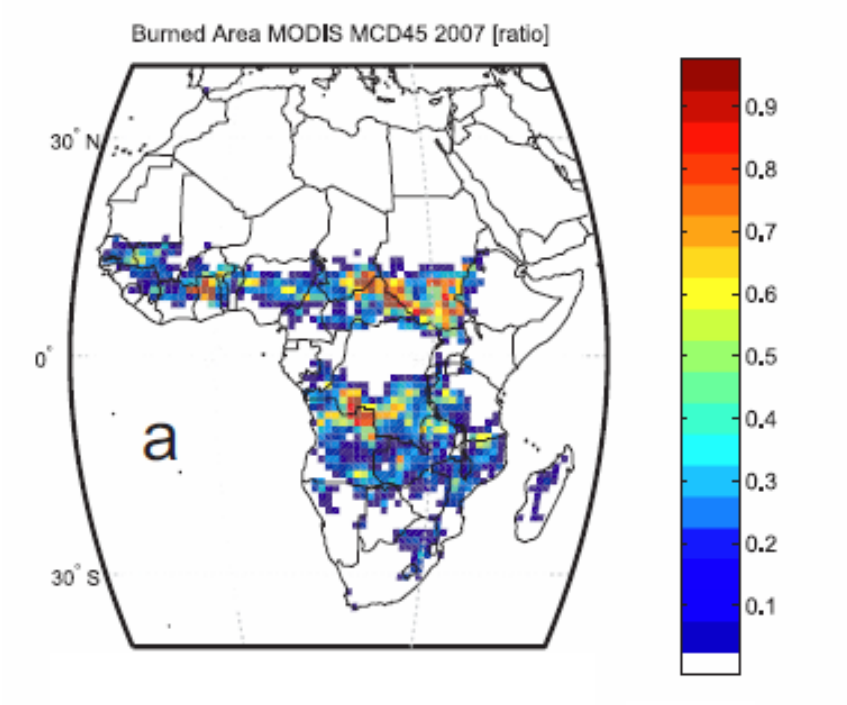


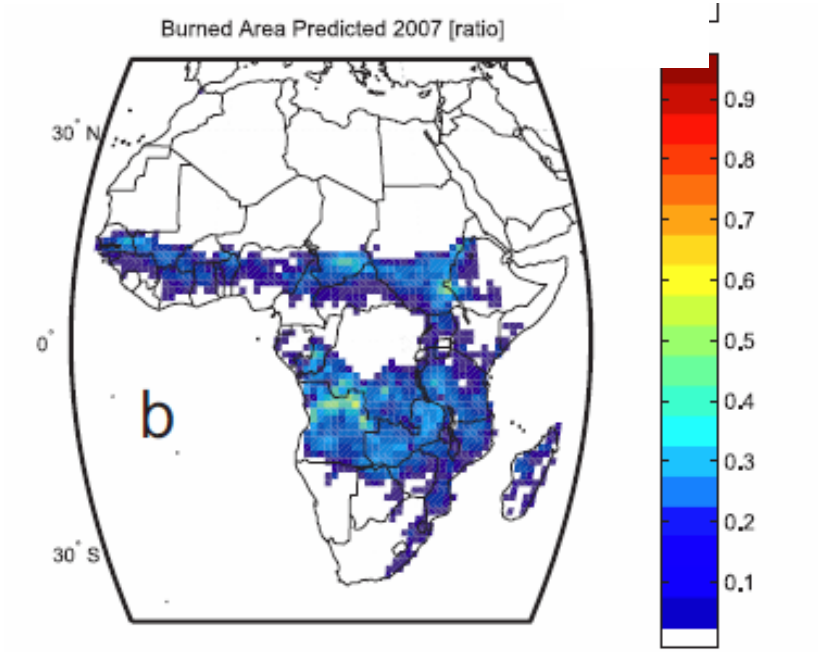
Fire return interval



LPJ SPITFIRE, (dynamic fire model)

(Thonicke et al. 2006)





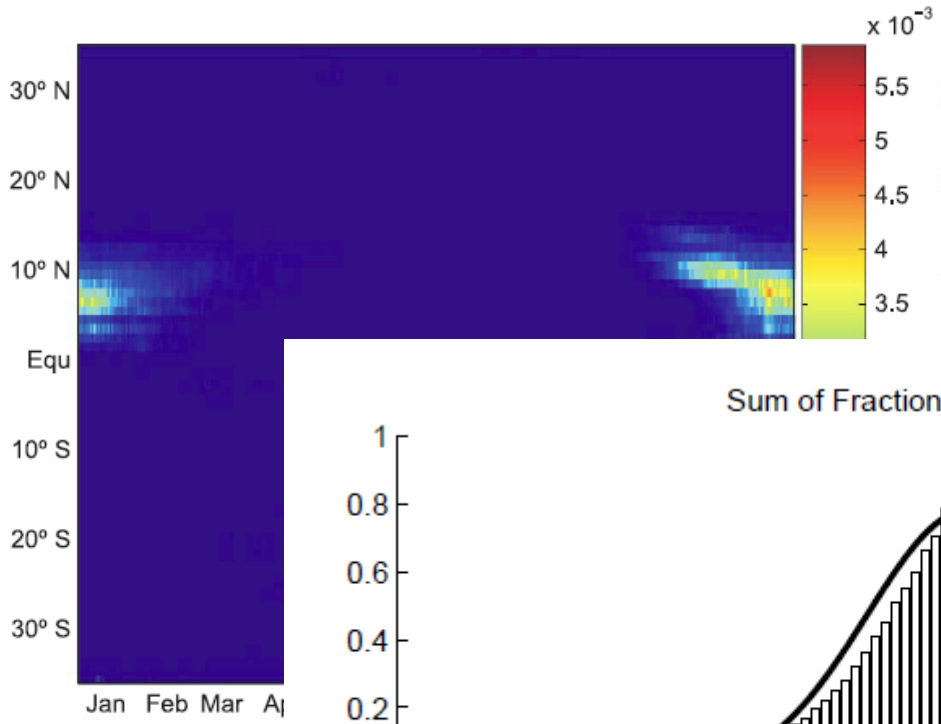
Intra-annual variability

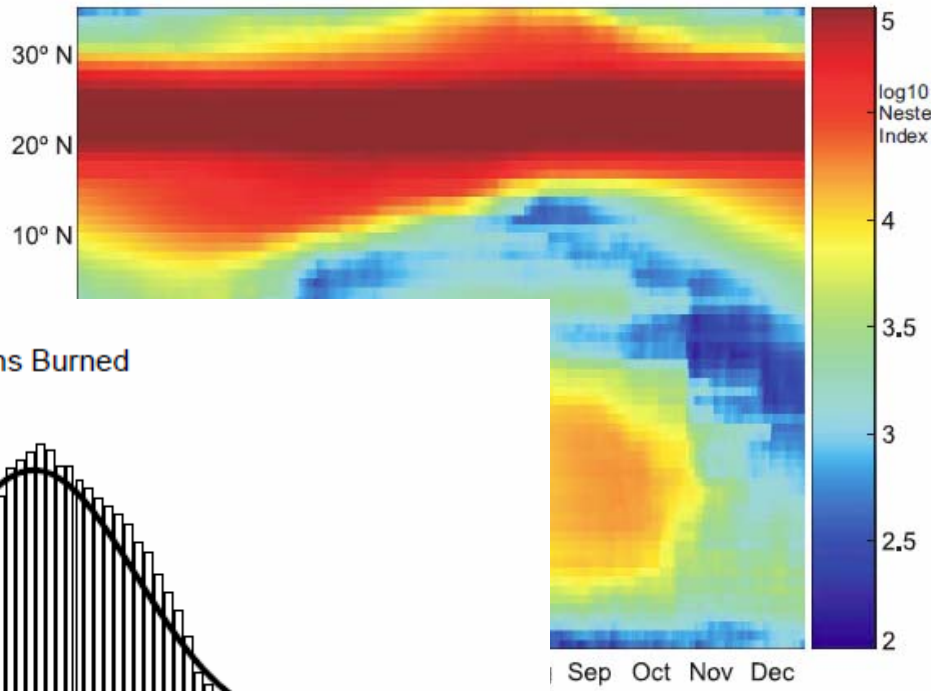
Fire activity can be directly related to the Nesterov index, a cumulative dryness index which drops to zero after a 3 mm rain event.

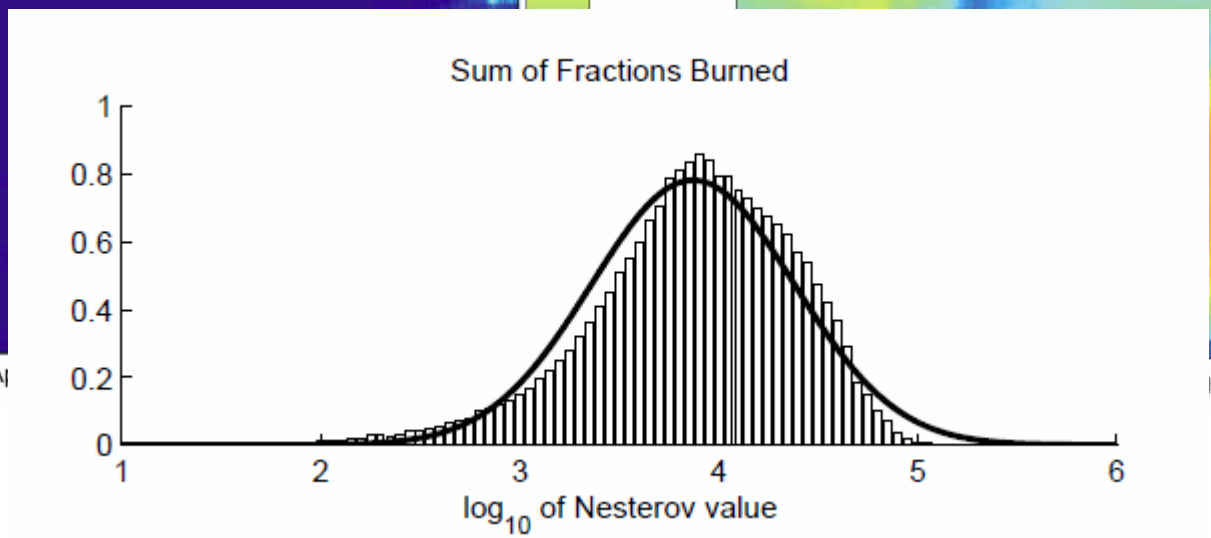
The majority of fires happen in the beginning of the dry season

Average burned area per day/per 1 deg

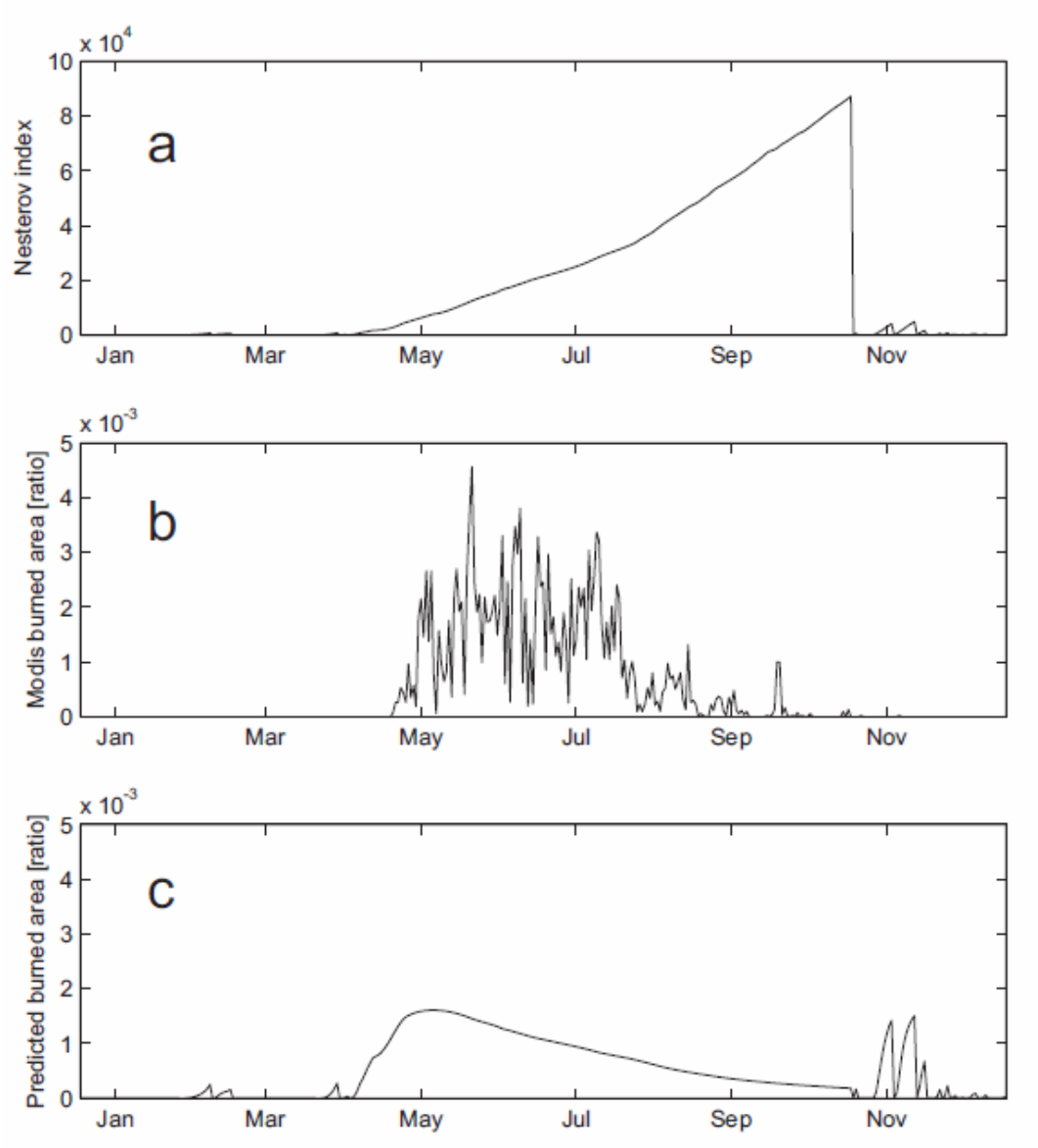
Nesterov -index





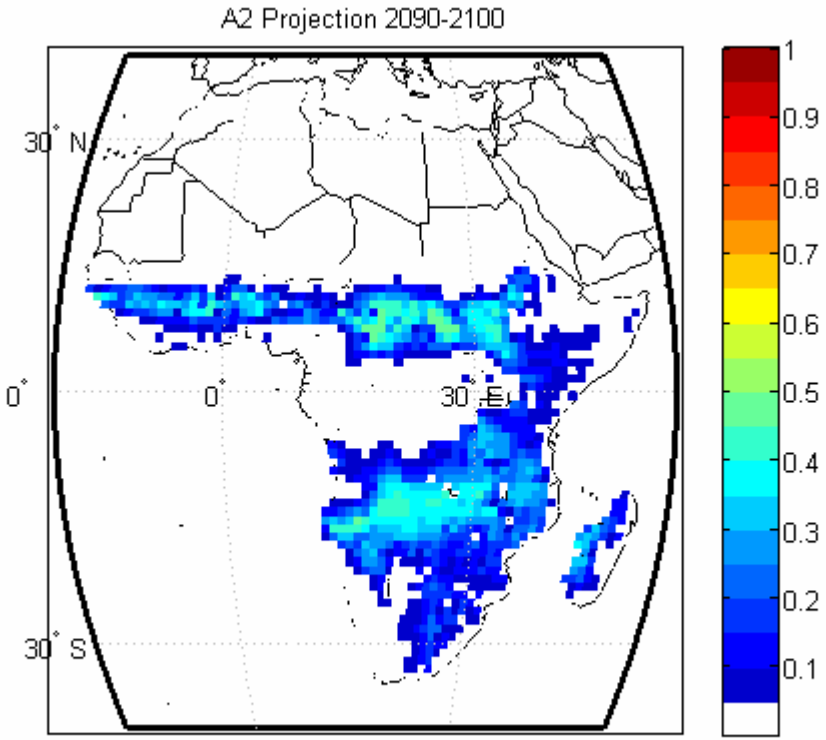


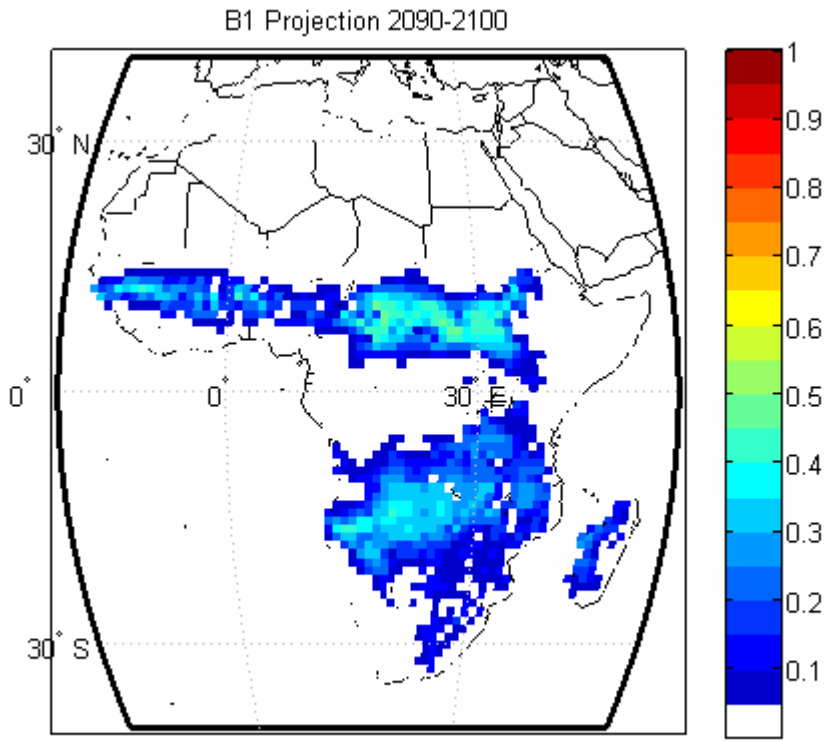
Implementing the Nesterov-Burned area relationship for the intra-annual variation of burned area



Generating a reduced model using only climate variables (r=0.54) allows to Simulate the response of burned area to climate change scenarios

This is a first step into an implementation into a dynamic vegetation model.





Thank you!