Modeling Fire on the African continent

SPITFIRE in LPJ - GUESS

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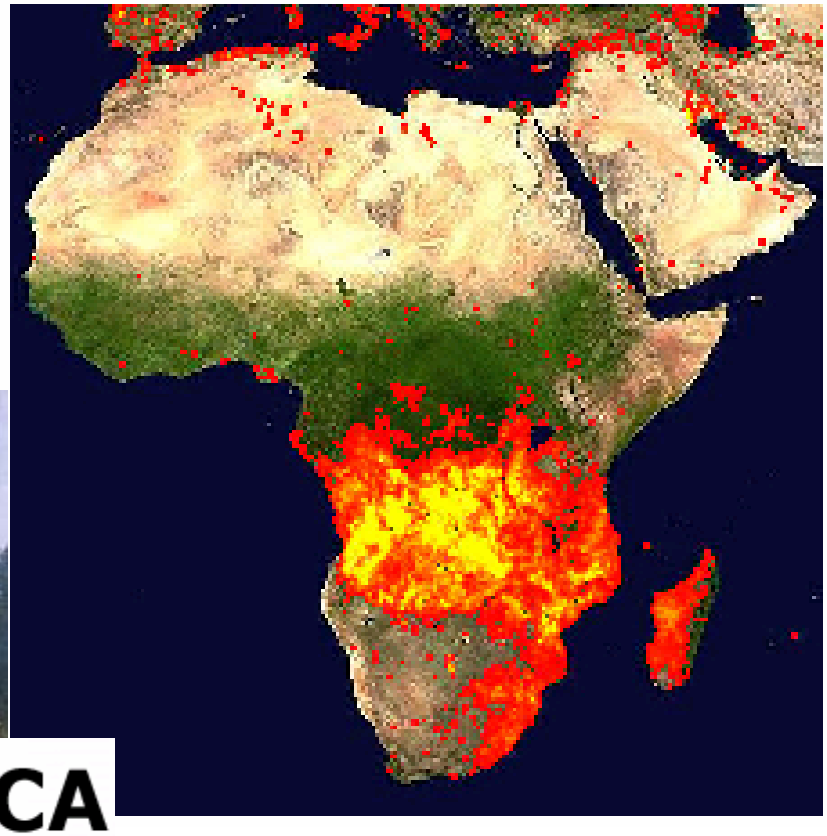

LUNDS UNIVERSITET

CARBOAFRICA

Quantification, understanding and prediction of carbon cycle and other GHG gases in Sub-Saharan Africa

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Objectives (amongst others):

Understand quantify and predict the GHG budget of Sub-Saharan Africa and its associated spatial and temporal variability LPJ Guess reproduces tree/grass mixtures badly Fire is suggested to be one of the main actor in maintaining vegetation structure in areas like savannas

Approach:

Integrated, considering flux measurements together with specific models

Results:

Will provide the knowledge elements necessary for reducing uncertainty and bias in GHG budget estimates

Aims: of implementing SPITFIRE fire module

(I) Vegetation modeling:

LPJ Guess reproduces tree/grass mixtures badly
Fire is suggested to be one of the main actor in maintaining vegetation structure in areas like savannas

(II) Fluxes:

Wild fires as well as fires for agricultural clearance produce fluxes of CO_2, CO, NOx VOC, methan….
while re-growth utilizes CO_2, hence there is only a limited long effect to be expected, other gas species depend strongly on the fire frequency, timing, fuel availability and combustion

LPJ vs LPJ GUESS: Population mode vs. Cohort mode

SPITFIRE

LPJ GUESS

Ignition

Propagation

Fire effects

Modeling results

Outlook

LPJ

Each PFT is represented by
a single ‘individual‘
no stochastic processes,
no age structure (establishment)
In some respects comparable
with TRIFFID.

LPJ GUESS

Each tree PFT can have
several individuals growing,
which represents an age-cohort.
To average out effects of
establishment and include
disturbances, several
realizations (patches) are
calculated and averaged.
In some ways comparable ED
but all tiles have equal size.

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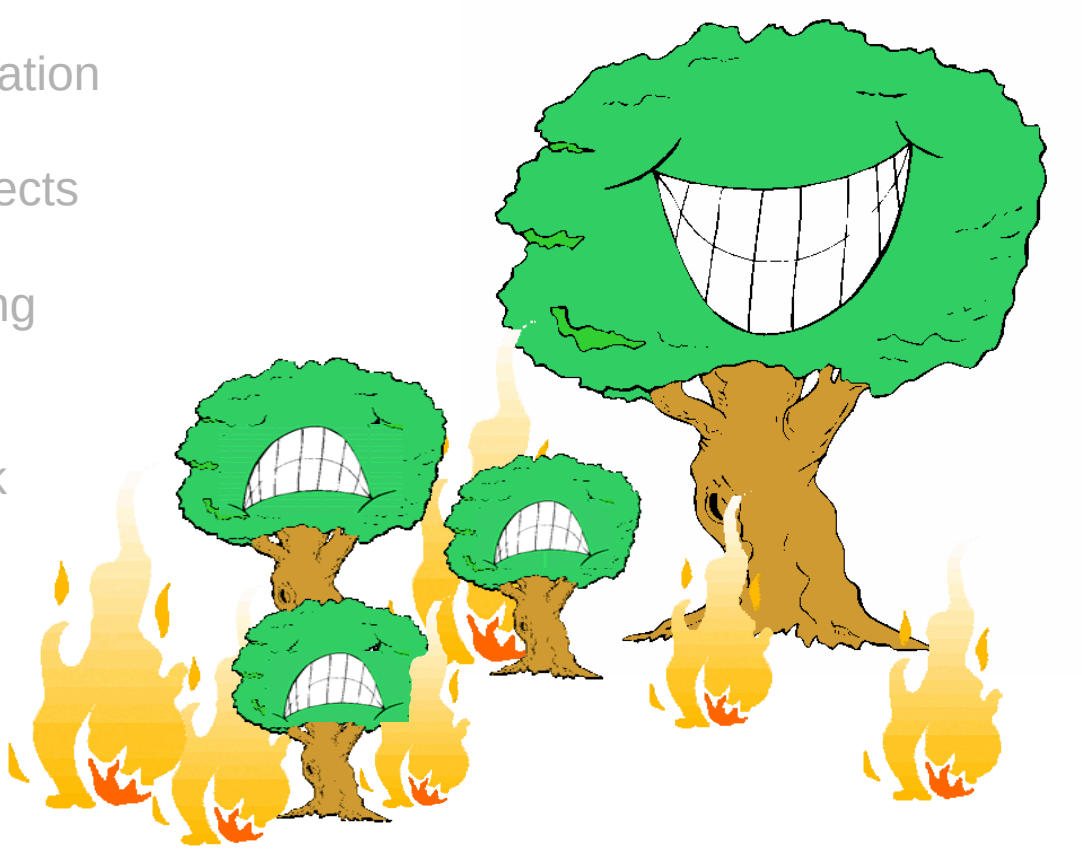
Aims using SPITFIRE in the Cohort mode

Fire affects young (small) cohorts stronger-
size related mortality ->could maintain tree grass mixture
as hypothesized by several authors



SPITFIRE: SPread and InTensity of Fire

SPITFIRE

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SPITFIRE simulates fires depending on:

- above ground fuel load
- climatic conditions / litter moisture
- human ignition pattern

SPITFIRE Fires cause in LPJ GUESS

- Post fire plant mortality
- Biomass reduction due to burning

SPITFIRE

LPJ GUESS

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Propagation

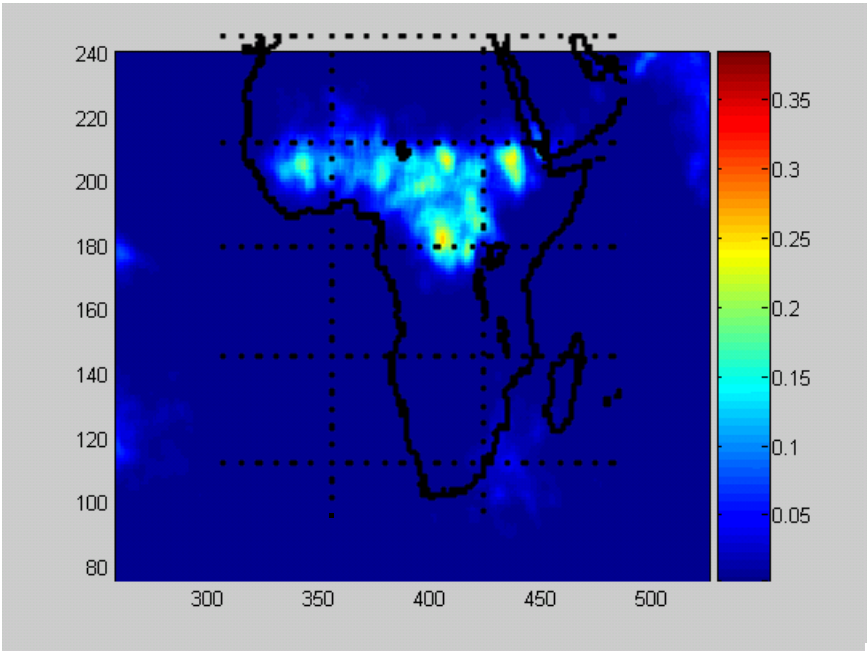
Spitfire Natural Ignition: Lightning

Satellite based climatology of lightning

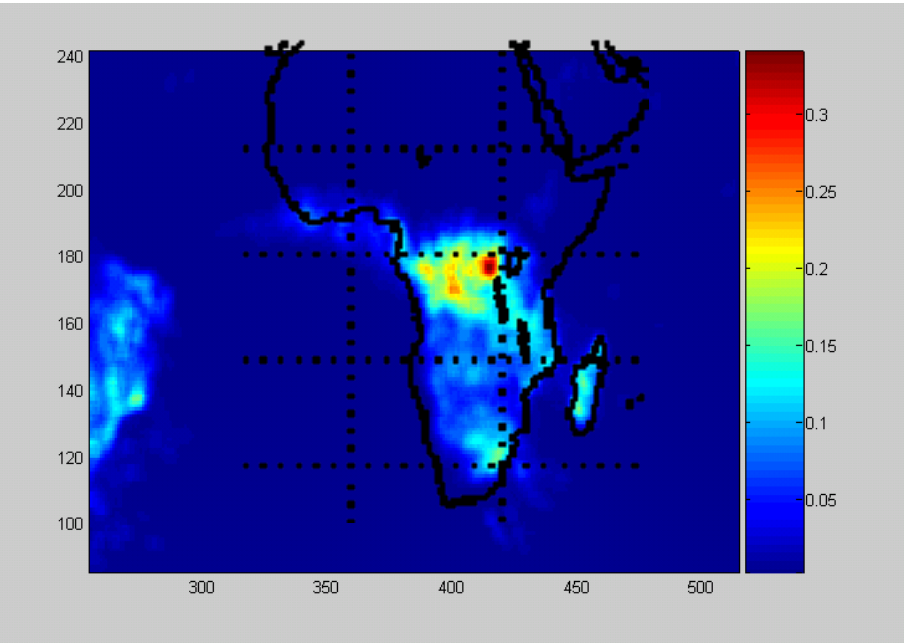
From OTD/LS; correction ratio by Price (1999)

HRMC 0.5 degree monthly climatology [flashes per km^2 and day]

July



January



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SPITFIRE Fire Spread

Fire spread

depends on fuel availability:
calculated by LPJ GUESS (litter)
litter subdivided into fuel size classes according
to fixed ratio per PFT fuel size classes 1hr 10hr 100hr 1000hr

also influenced by fuel moisture (soil moisture)
and wind speed

fuel bulk density (PFT specific)

Fire is assumed to form an elliptical shape

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Human influence on fire regime

99% of all fires are anthropogenic

Human caused fires can

be directly prescribed

→ to calculate recent emissions and vegetation

be scaled to human population density, land use and climatic conditions

→ to simulate scenarios

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Fire effects:

Fire intensity depends on fuel availability and environmental conditions

leads to crown scorching and cambial damage and hence to post fire mortality

Results: Total burned area spatial and variation: prescribed and nat. fire

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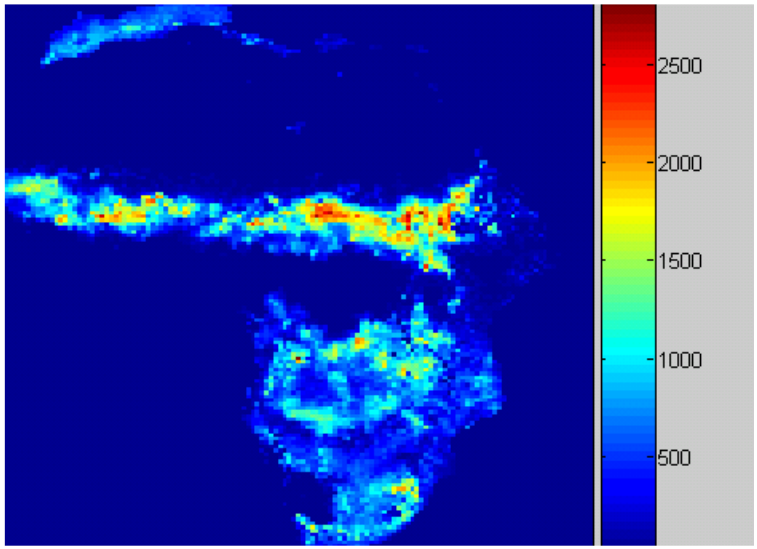

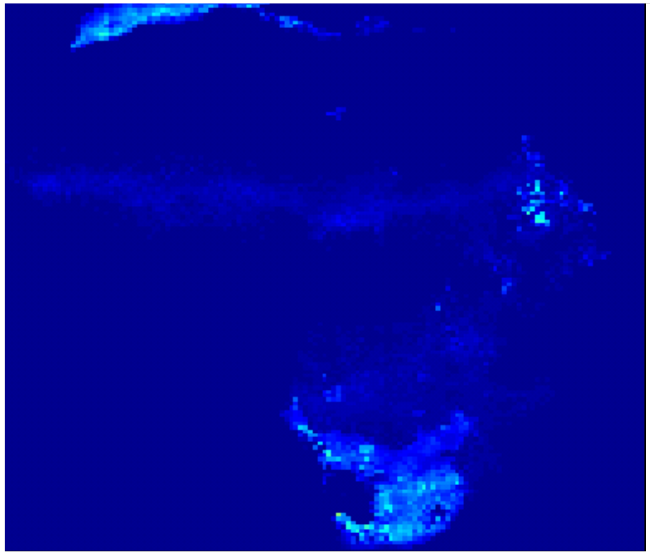

km^2 burned area per 0.5 degree cell (3080 km^2 total)

Southern Hemisphere A.:
total burned area:

Guess presc fire $1.83*10^6$ km^2
Guess nat. fire only $0.90*10^6$ km^2

Ito et al. (2007) $2.3*10^6$ km^2
Giglio et al. (2006) $0.81*10^6$ km^2
Scholes et al. (1996) $1.68*10^6$ km^2

A slightly changed Giglio et al. (2006) alg. was used for the prescribed fire.

Burned area natural ignition

Results: emissions : prescribed and nat. fire

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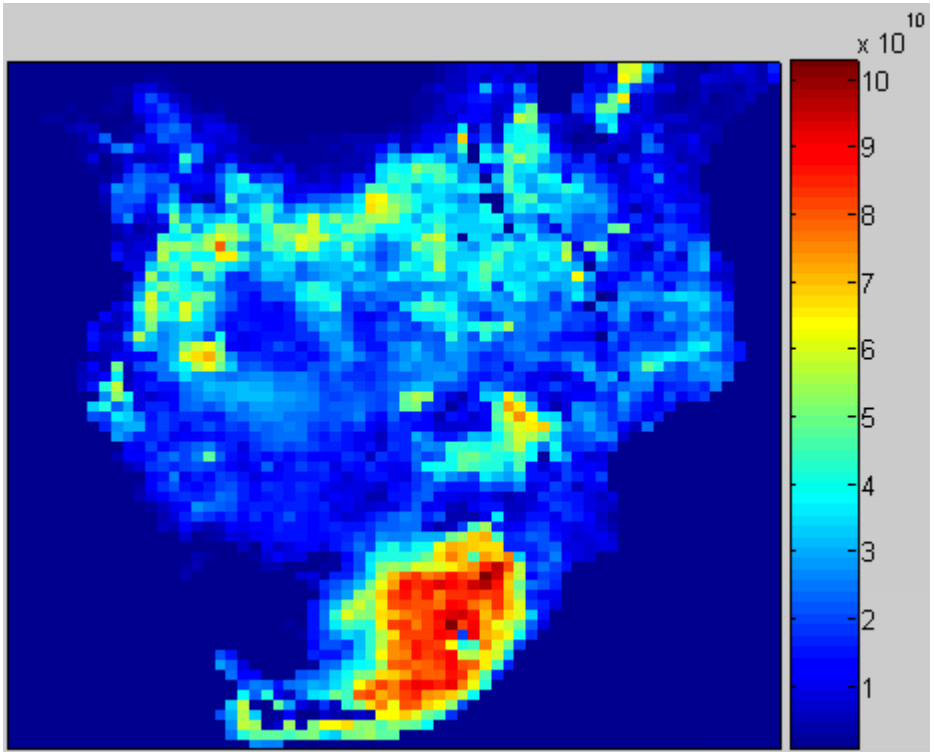
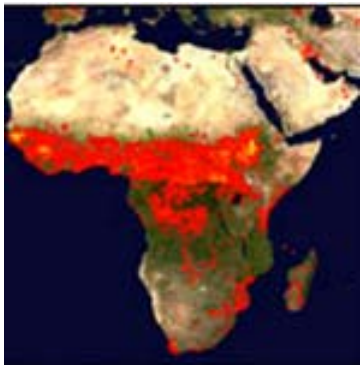


CO emissions per pixel (g/year)

Southern Hemisphere A.: CO emissions

Guess prescr. fire	70 Tg
Guess nat. fire only	38 Tg
Ito et al. (2007)	60 Tg

Perspective Milestones



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Flux calculation CO_2 & trace gases :
Site (7 local CarboAfrica flux stations) with site climate and continental runs

Incorporation of fire intensity related versus PFT specific emission factors

Calculation of projected emissions and vegetation according to IPCC scenarios