DESPITE (SPITFIRE) simulating vegetation impact and emissions of wildfires

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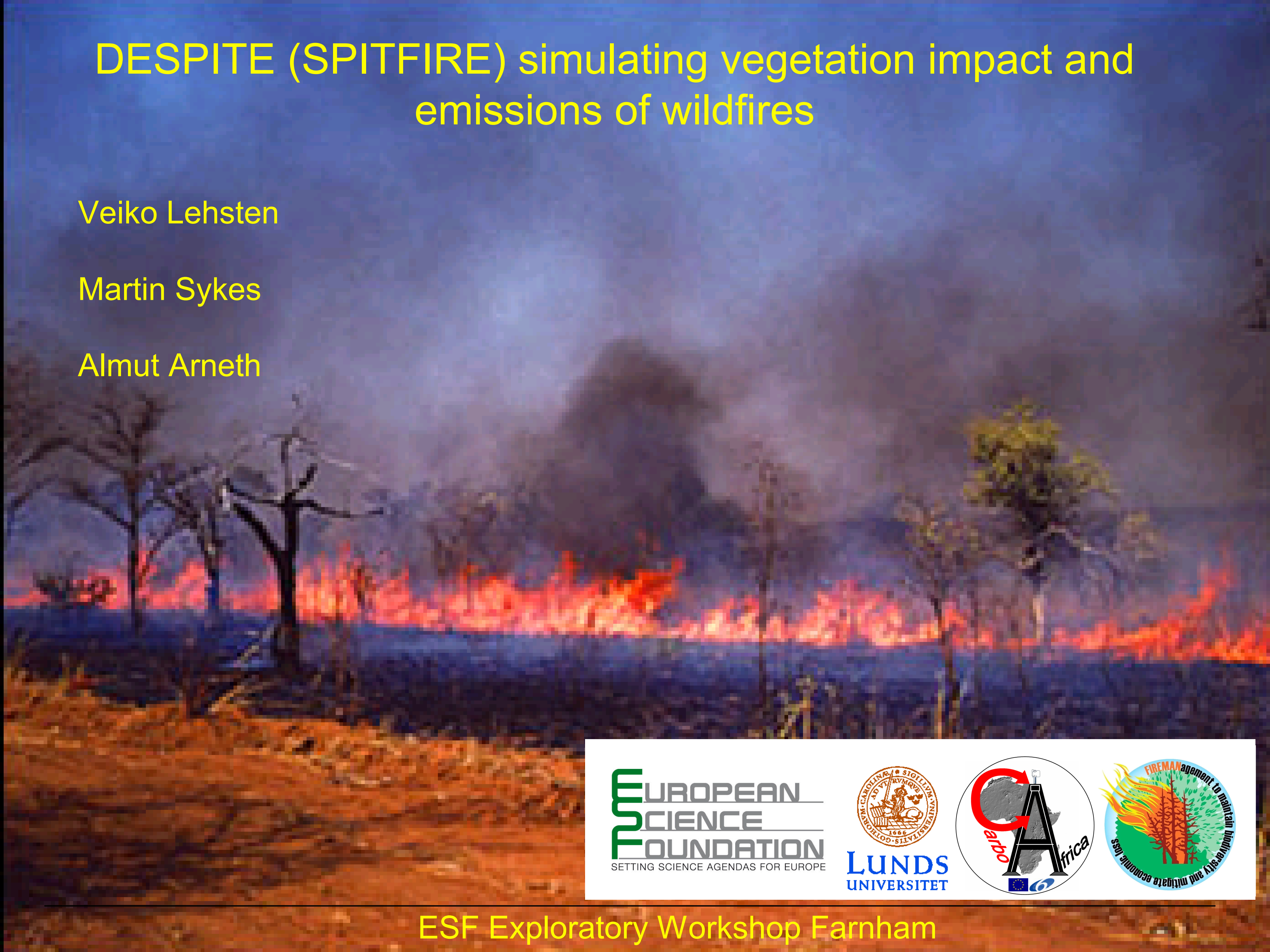
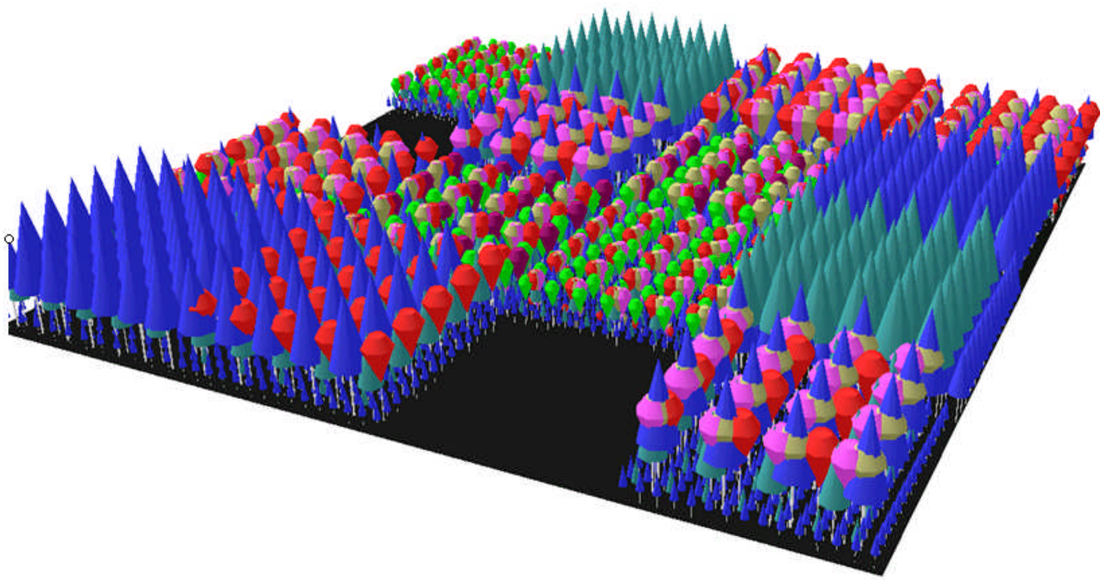


European Science Foundation
SETTING SCIENCE AGENDAS FOR EUROPE
Lunds Universitet
CarboAfrica
FIREMANagement to maintain biodiversity and mitigate economic loss

ESF Exploratory Workshop Farnham

LPJ-GUESS
(Lund Potsdam Jena General Ecosystem Simulator)



Dynamic vegetation model

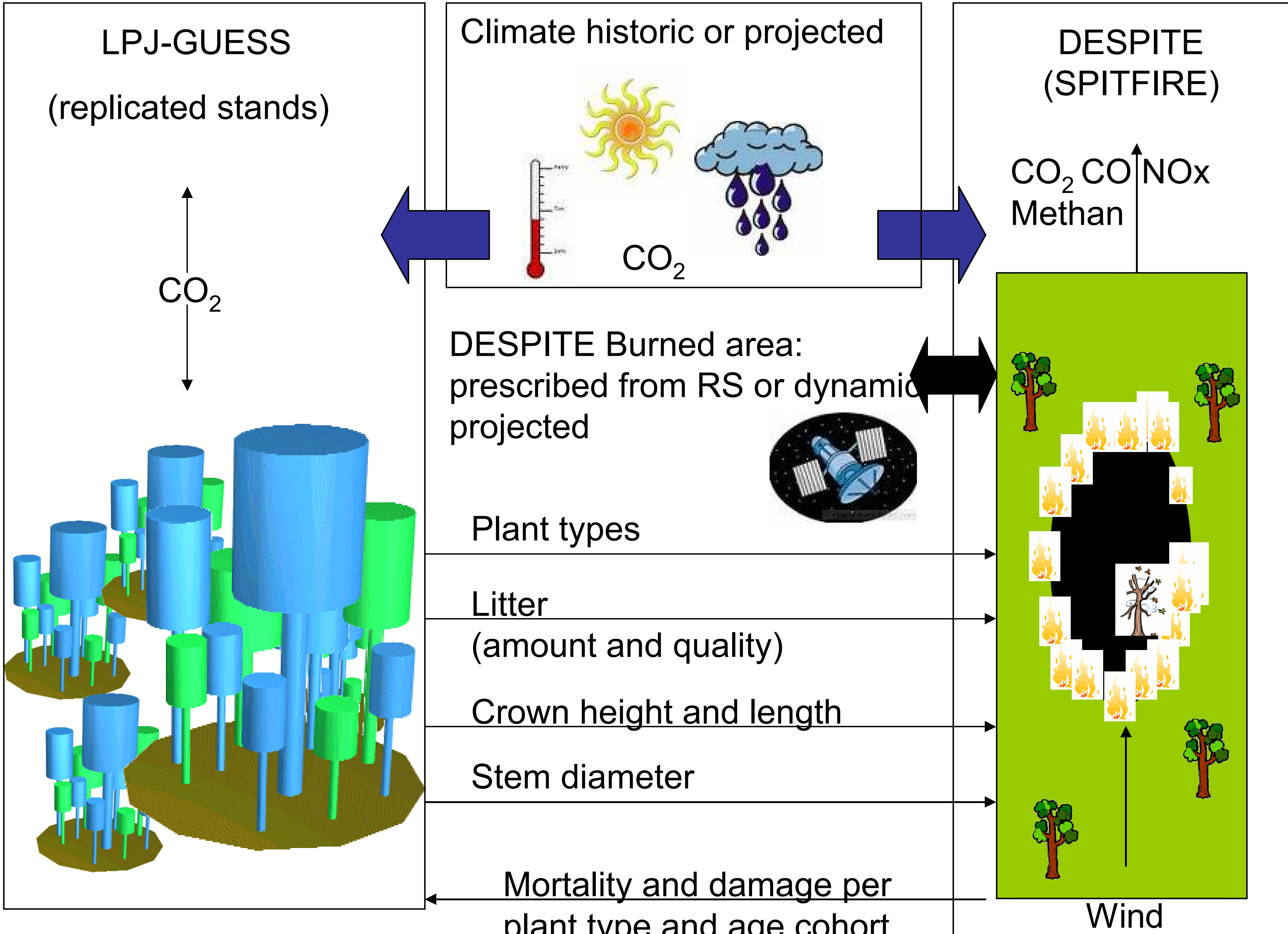
Simulates vegetation depending on:

Precipitation
Temperature
Radiation
Soil

Vegetation
simulated in age cohorts of plant functional types e.g. tropical broad-leafed raingreen tree or C4 grass of patches of ca. 1000m^2

Stochastic effects (disturbance, senescence)
covered by repeated simulation of single patches and averaging

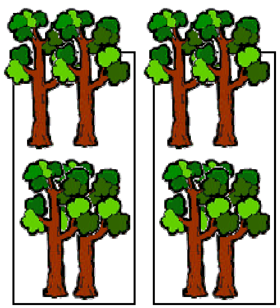
Smith B et al. (2001) *Global Ecology and Biogeography* **10**, 621-637.



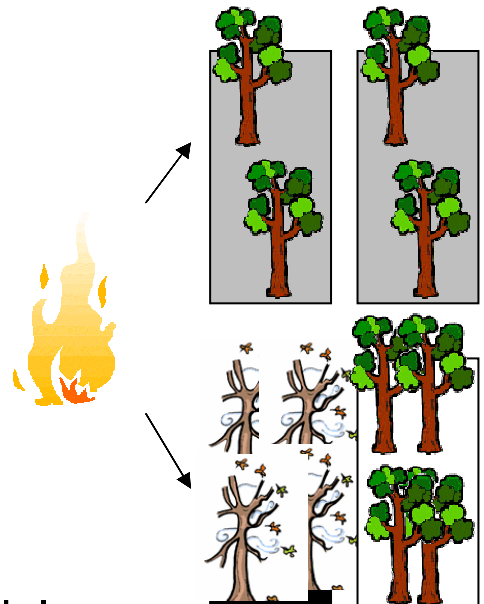
SPITFIRE developed by Kirsten Thonicke and Allan Spessa

Burning of simulated cells in LPJ-GUESS-DESPITE

To account for stochastic processes several replicates of each cell are simulated.



50% burned area



Very limited effect on vegetation

Both cells burn 50%, results in more resources for all surviving trees.

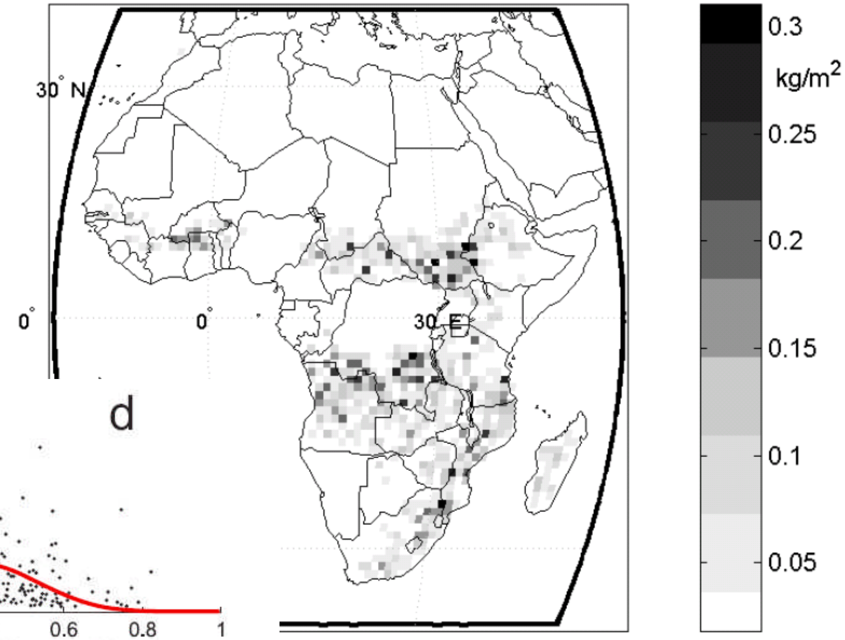
One cell burns 100%, the other does not burn surviving trees at unburned replicates have not more resources available.

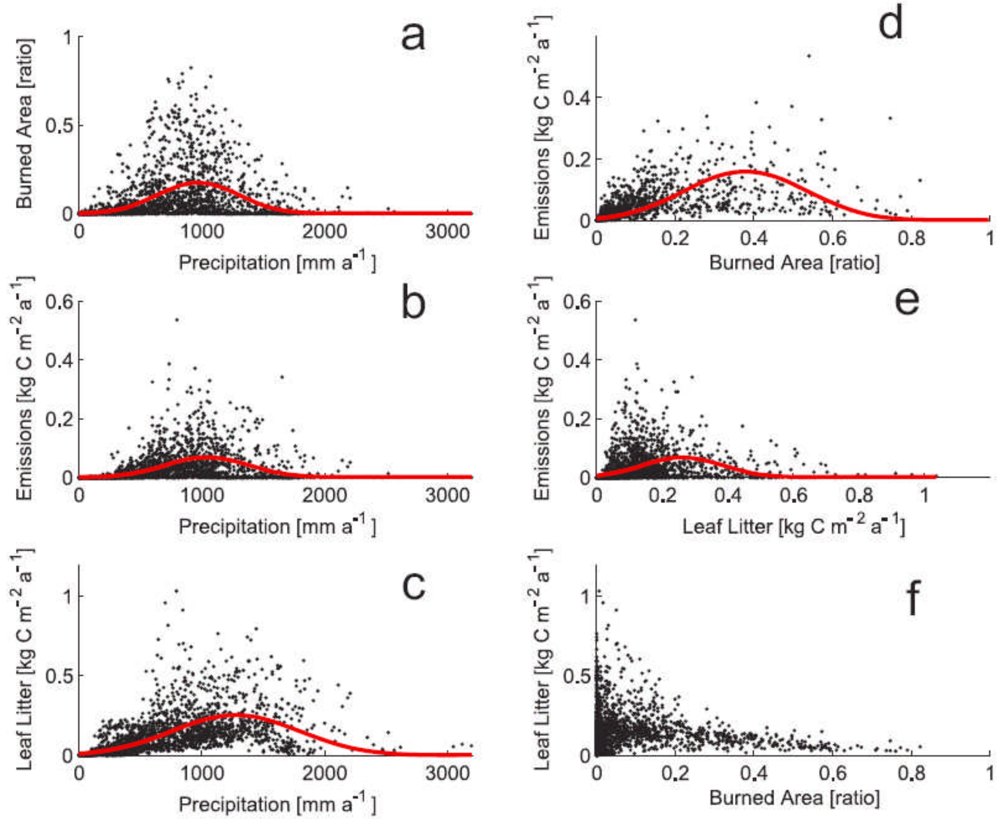
Strong effect on vegetation of the burned patches

LPJ-GUESS is a point model, there is no spatial heterogeneity within a cell.

Emissions: Results annual averages for Africa using L3JRC burned area (RS data)

	Our estimate	van der Werf (2005)
NHA	274±37	627±75 [Tg *C* a-1]
SHA	448±75	576±72 [Tg *C* a-1]





High burned area ratios
lead to low accumulation of fuel

Fire effects: Emissions (Fire flux):

LPJ-GUESS (Globfirm)
Emissions=emission factor(PFT, trace gas)*Biomass burned (PFT)

Emission of trace gases

depend on fire intensity

different in smoldering vs. burning

Additionally to the standard emission factors, the 'mixed fuel' is incorporated.

$$\text{Emission factor} = f\left(\frac{combusted\_grass}{combusted\_litter + combusted\_grass}\right)$$

Fire flux =f(fuel load, fire speed,
FBD, wind, fuel moisture, fuel composition)

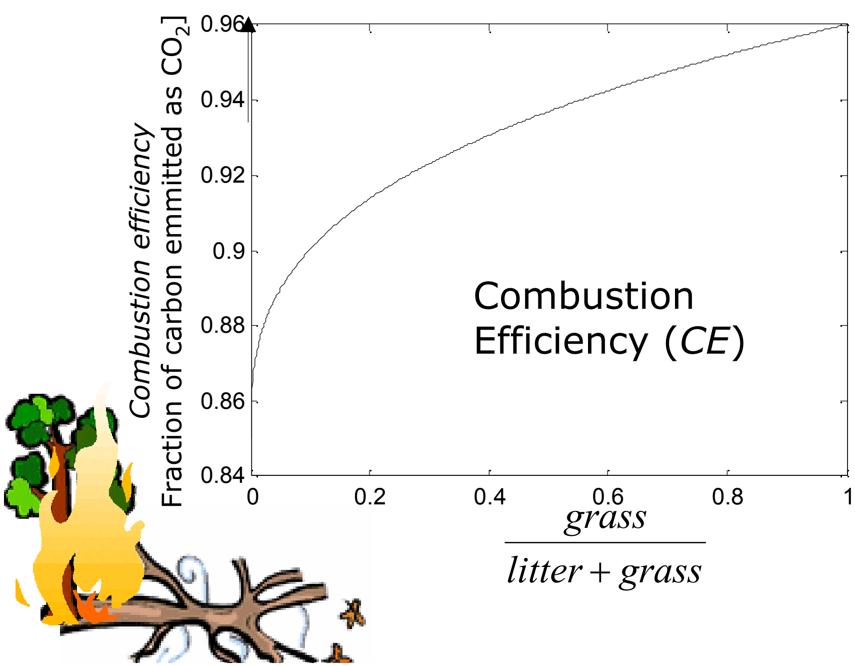
Fire Fluxes: The mixed fuel model[1]
Emission Factor =f(mix of combusted fuel)

$$CE = 0.85 + 0.11 * \left(\frac{grass}{litter + grass} \right)^{0.34}$$

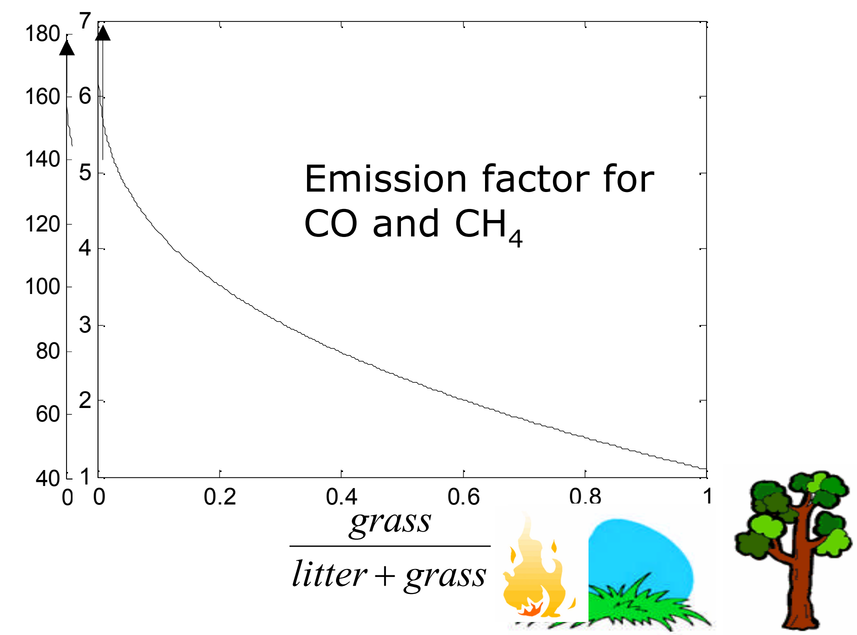
$$E_s = a_s + b_s * CE$$

CE : fraction of carbon emitted as CO_2 relative to total carbon emission
grass : combusted grass litter [dry weight]
litter + *grass:* total combustion [dry weight]

E_S : specific emission factor
a_S;b_S: trace gas spec. parameter

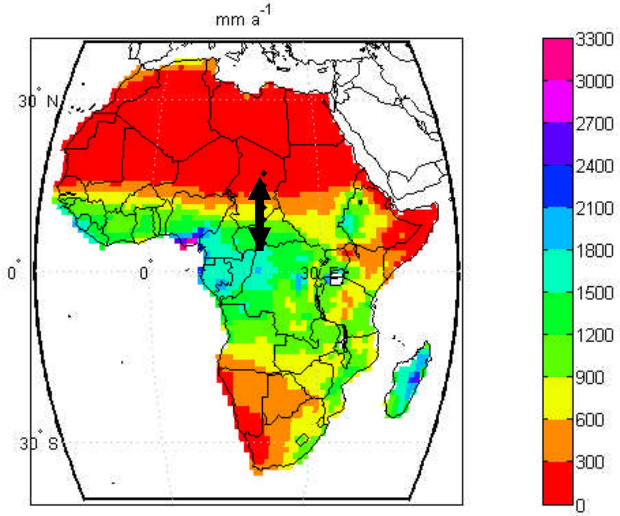


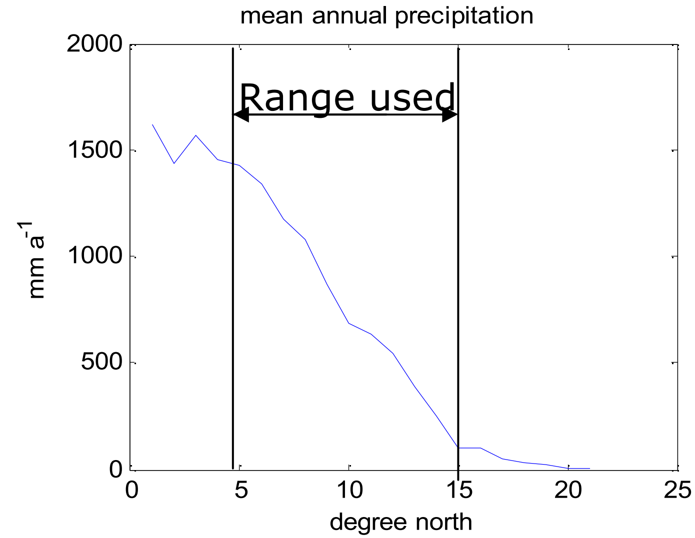
CO CH_4 [g/kg]

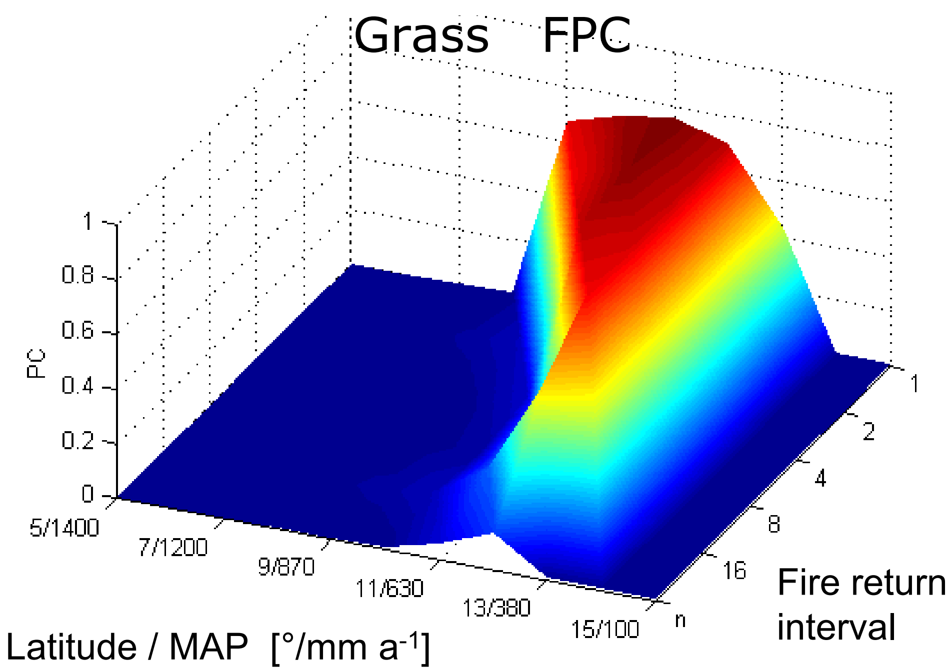


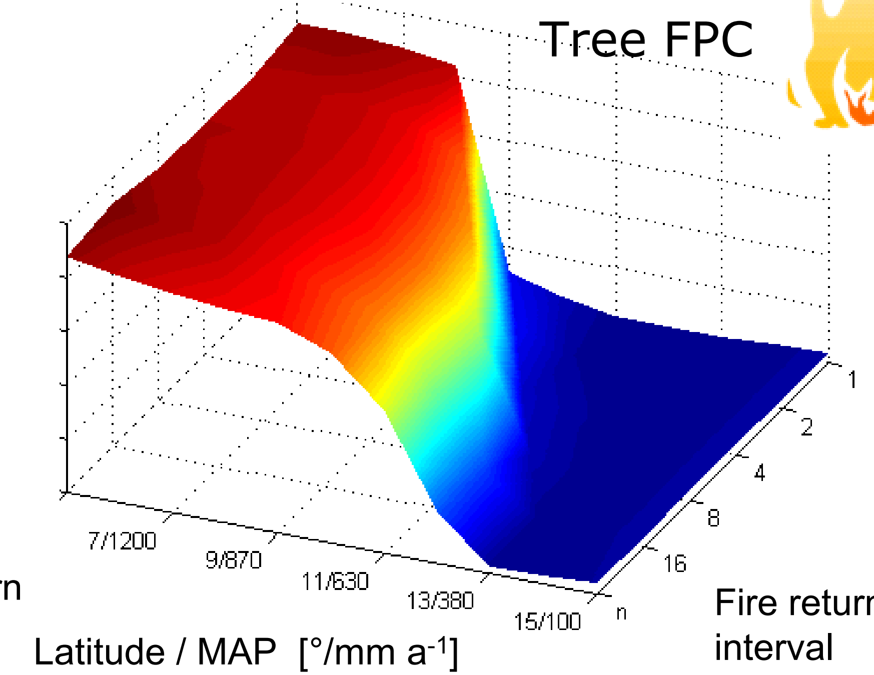
[1]Scholes, R. J., et al. (1996), Emissions of trace gases and aerosol particles due to vegetation burning in southern hemisphere Africa, *JGR-Atmospheres*, *101*, 23677-23682.

Artificial imposed fire frequency along a precipitation gradient









Simulation with 1000 years spinup, 100 patches

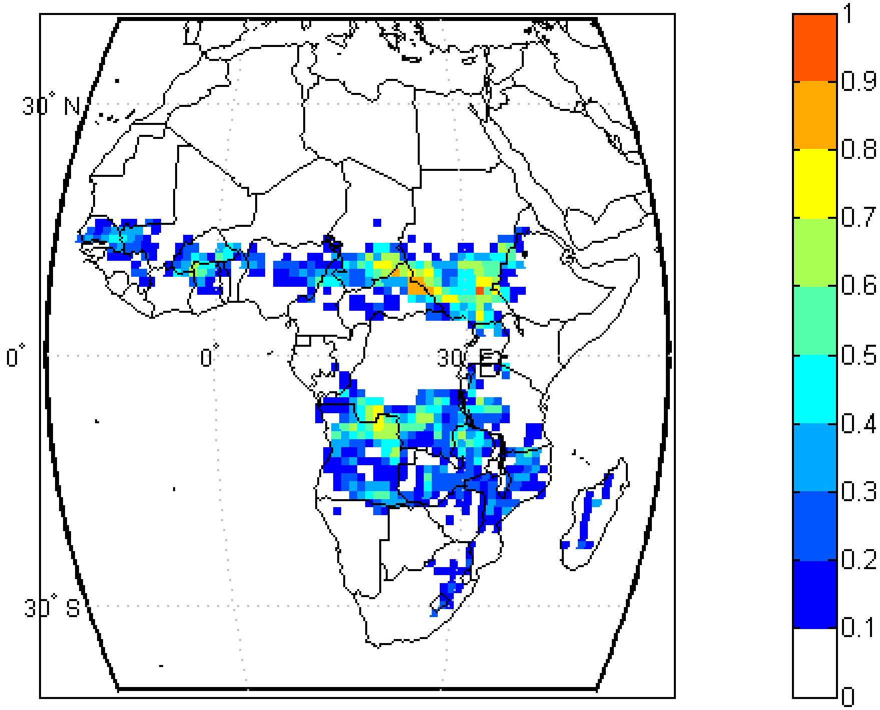
Better understanding of mechanisms can lead to increased performance in the simulation of vegetation types

Burn Frequency Average 2000-2007 MCD45

Simulation of vegetation at continental scale

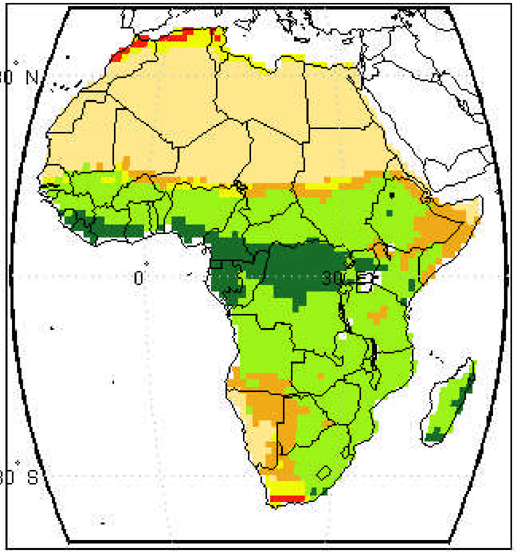
Fire:
Prescribing MODIS burned area MCD45 transformed to fire frequencies per 1 degree grid cell

Rooting: LPJ Standard

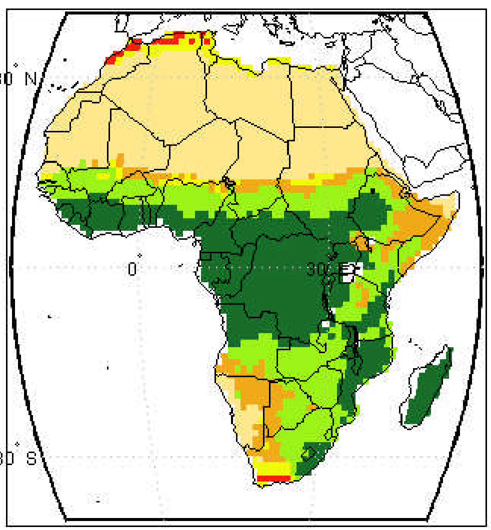


Continental vegetation simulation:

With fire (MODIS)

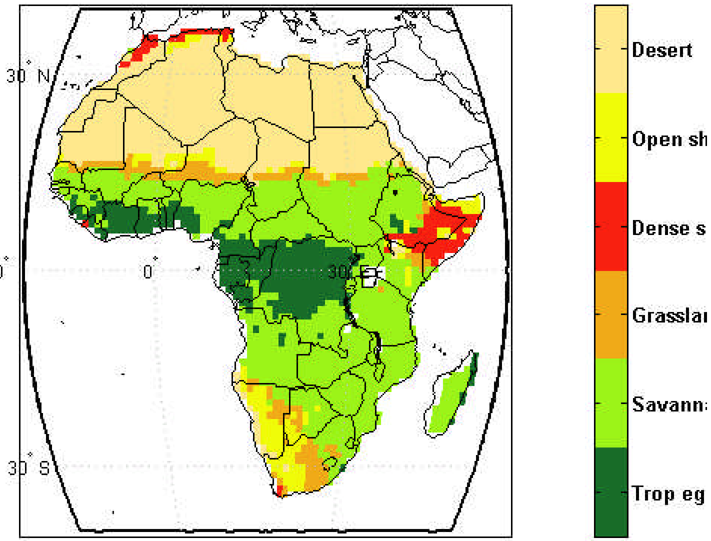


Without fire



Fire frequency
Prescribed from
Remote sensing
MODIS MCD45

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

Ramankutty et al. (1999) *Global Biogeochemical Cycles* **13**, 997-1027.

FUME

Forest fires under climate, social and economic changes in Europe, the Mediterranean and other fire-affected areas of the world

FUME

- 33 project partners (incl. USA, Australia, South Africa)
- Coordinator: Universidad Castilla-La Mancha (José Moreno)
- Status: in negotiation, expected to commence in 2010
- FP7, Large-scale integrating project
- Chief goals & objectives: (i) Analyse past interactions of climate, socioeconomy, LULC change, on fire regimes

  (ii) Develop new climate/socioeconomic scenarios for future projections of fire regimes (fire danger, vegetation type, fuel load, intensity, seasonality…); identify possible new fire prone areas

  (iii) Adaptation potential, fire management – strategies for fire prevention and planning, including cost assessment and new policies

FUME

3 modules, reflecting these chief objectives:

Recent trends in landscape change and fire occurrence: disentangling the role of climate and other factors on fire (Mod. 1)

Projections of future fire risk and fire regime due to climate and other social and economic changes (Mod. 2)

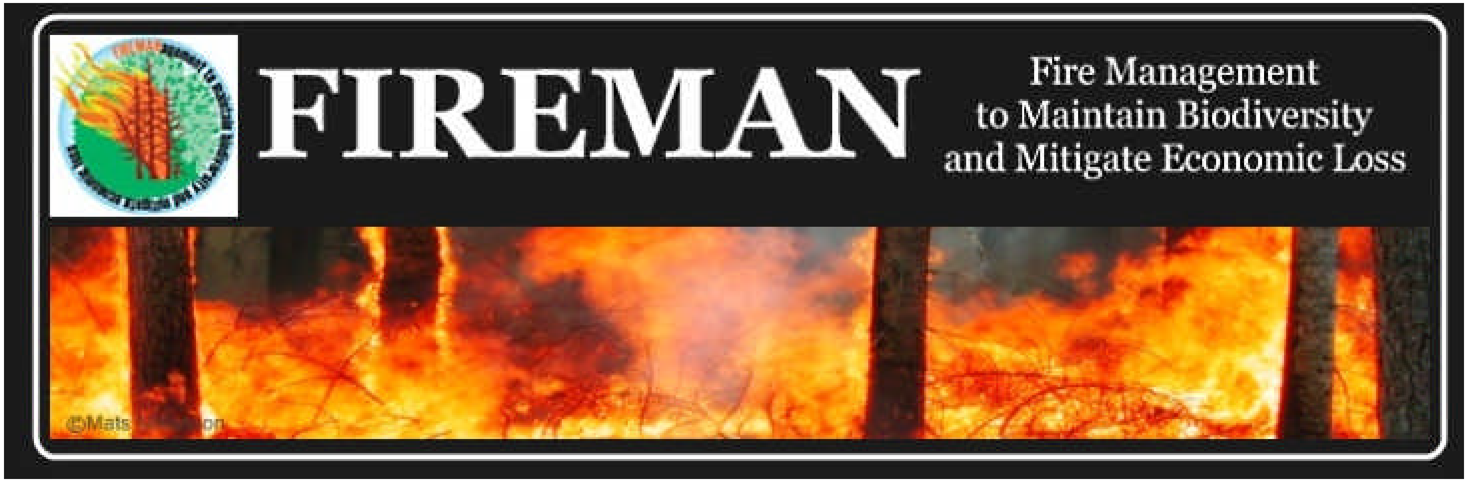
Adapting to change: new approaches and procedures to manage risks and landscapes under climate and social change to reduce vulnerability to fire (Mod. 3)

FUME

- Main target region: Mediterranean Europe, from spot to landscape level; rural/urban interface
- Europe as a whole with boreal and central Europe as expected new fire-prone regions
- Include specifically climate extremes

ULUND: coupled detailed vegetation model (LPJ-GUESS) + Spitfire to reproduce past and assess future fire regimes, specifically vegetation-climate-fire interactions

Spin-off (note: fire-chemistry interactions are not within the scope of the IP): fire emissions



Aims of DESPITE application:
vegetation and emission simulation for fire scenarios for Europe with focus areas:
Peak District,
Mediterranean areas and
boreal forests

Final aim is the application of simulation results in a decision making tool for politicians to inform about the expected effects of climate change and fire management, e.g. fires to reduce fire risk or fire onset at different times of the year

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Benefits from future research:

Improved emission factors
related to burning conditions:
Fuel type (PFT & Size)
Fuel moisture
Wind

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Validation of the simulations of recent:
emissions
combustion completeness and efficiency

Validation of recent emissions is required for scenario simulations

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