2021 CESM workshop

Fire in CLM5

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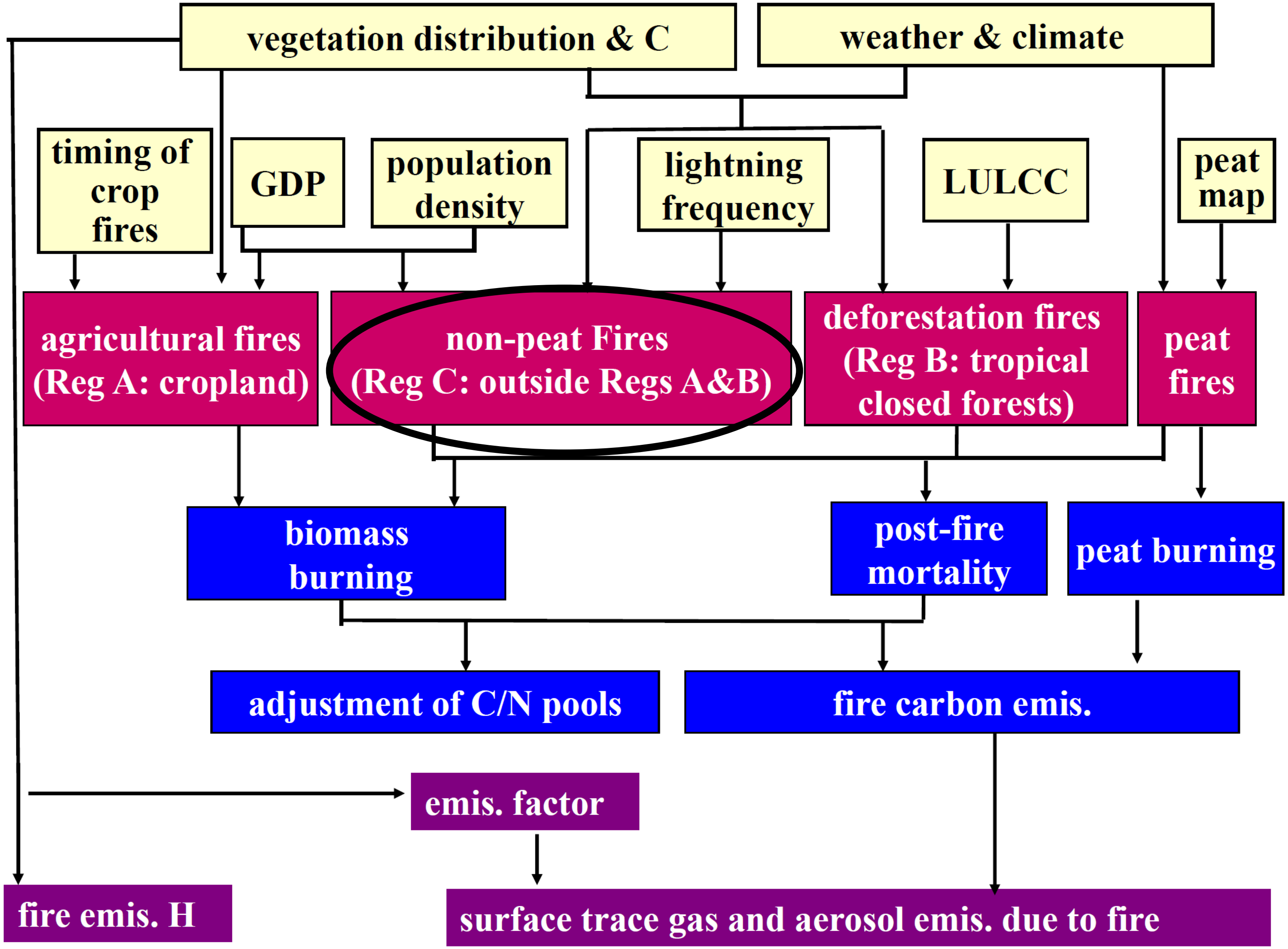
CLM fire scheme



vegetation distribution & C

weather & climate

timing of crop fires

GDP

population density

lightning frequency

LULCC

peat map

agricultural fires (Reg A: cropland)

non-peat Fires (Reg C: outside Regs A&B)

deforestation fires (Reg B: tropical closed forests)

peat fires

biomass burning

post-fire mortality

peat burning

adjustment of C/N pools

fire carbon emis.

emis. factor

fire emis. H

surface trace gas and aerosol emis. due to fire

(Li et al. 2012, 2013; Li and Lawrence 2017; Li et al. 2019; Li et al. in prep.)

Non-peat fires in Reg. C (process-based, Intermediate complexity)

•Fire occurrence

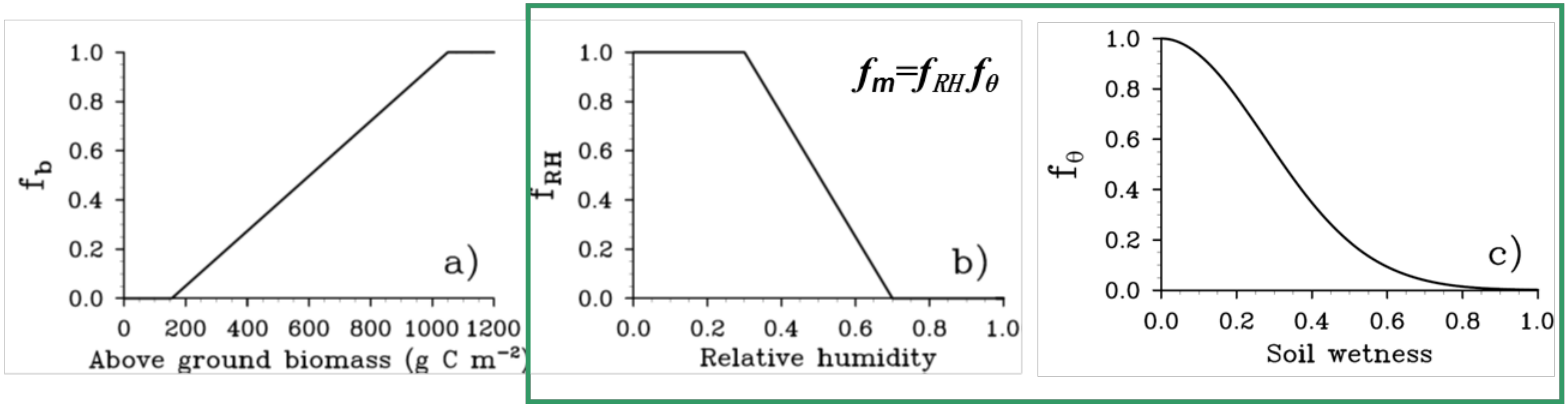
Fuel availability   Fuel combustibility

Fire counts in a grid cell :

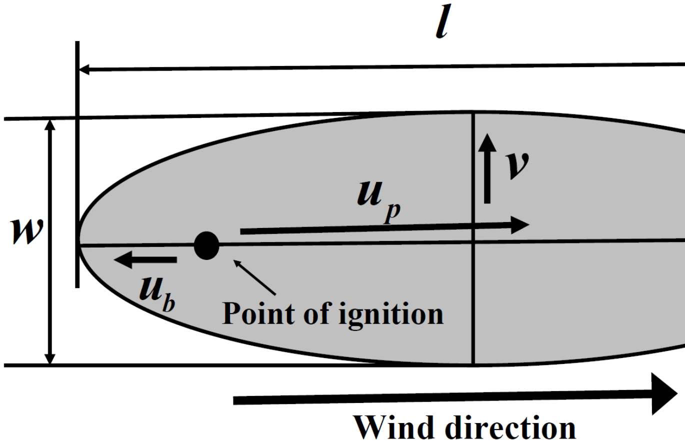
$$N_f = N_i f_b f_m \underbrace{f_{ns,PD} f_{ns,GDP}}_{\text{Non-suppression rate}}$$

Ignition counts

Ignition counts: N_i= lightning ignitions + human ignitions



• Fire spread



Average potential burned area of a fire (average fire duration τ =1day) :

$$a_1 = \pi \frac{l}{2}\frac{w}{2}\times 10^{-6} = \frac{\pi u_p^2 \tau^2}{4L_B}\left(1+\frac{1}{H_B}\right)^2 \times 10^{-6}$$

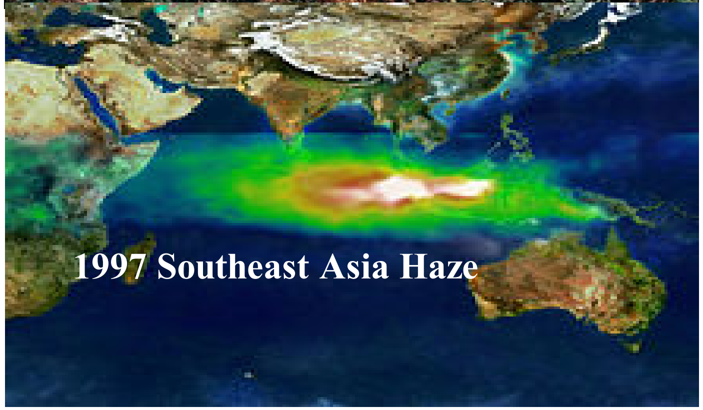
Fire spread rate in the downwind direction:

$u_p = f\,$(fuel wetness) g(wind speed)

Average spread area of a fire

$$a = a_1 \underline{F_{ns,\,PD}\; F_{ns,\,GDP}}$$

More developed /densely populated → higher firefightning capability



Agricultural fires (Reg. A)

Bruned area frac. Fire seasonality

$$\overset{\downarrow}{f_{ba}} = a \; \underset{\uparrow}{f_{se}} \; \overset{\downarrow}{f_t} \; f_{crop} \leftarrow \text{Area frac. of cropland}$$

Socioeconomic factor

Deforestation and degradation fires (Reg. B)

Fuel combustibility

$$f_{ba} = b \; \underset{\uparrow}{f_{lu}} \; \overset{\downarrow}{f_{cli,d}}$$

Response to deforestation rate

Peat fires

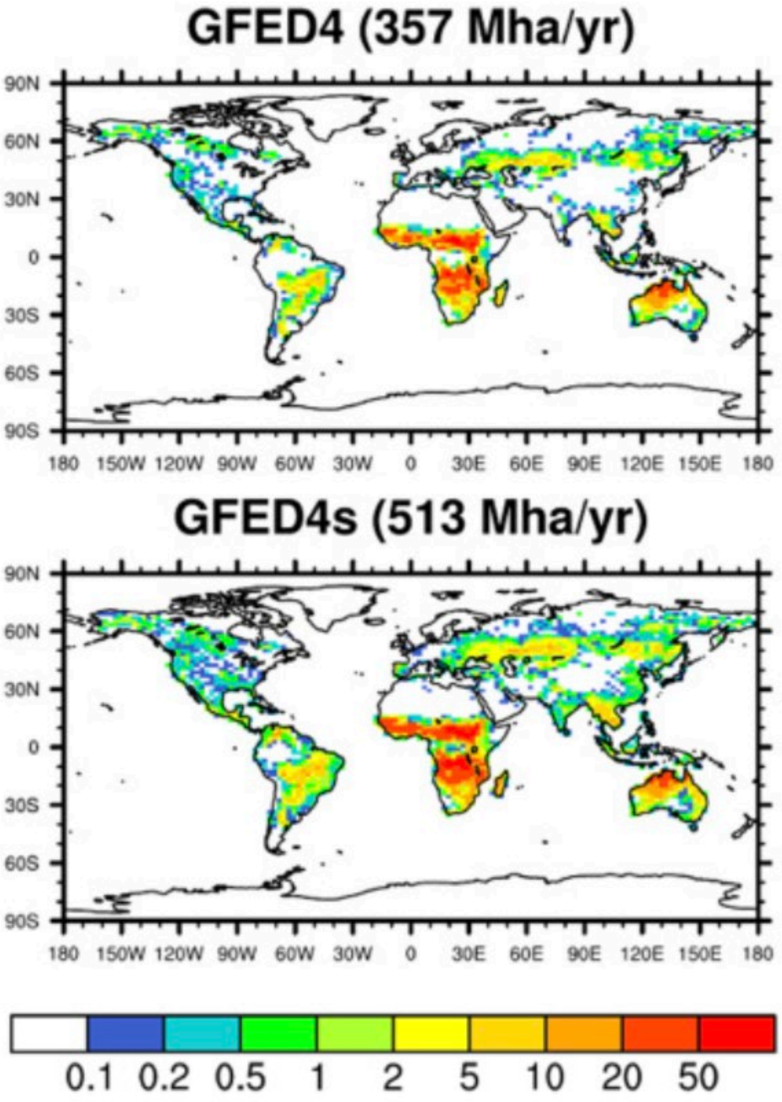
Fuel combustibility Area frac. of peatland

$$f_{ba} = c\overset{\downarrow}{f}_{cli,p} (1 - \underset{\uparrow}{f_{sat}}) \overset{\downarrow}{f}_{peat}$$

Frac. area with water table at the surface or higher

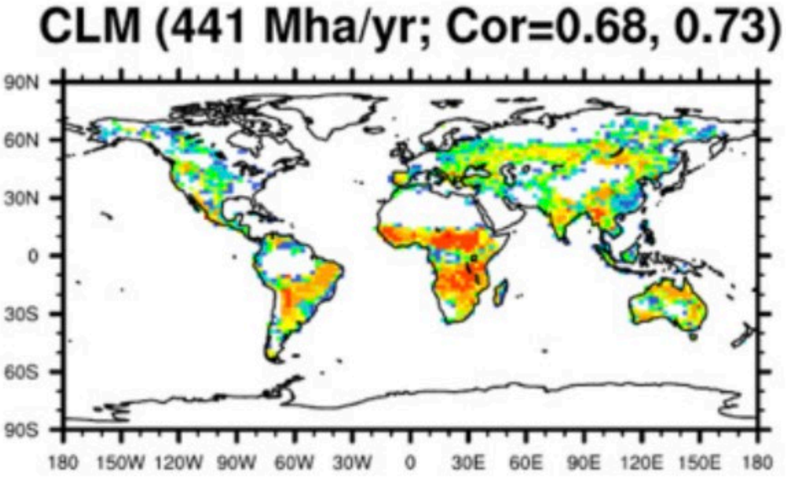
(Li et al. 2013)

Comparison to GFED



GFED4 (357 Mha/yr)

GFED4s (513 Mha/yr)



CLM (441 Mha/yr; Cor=0.68, 0.73)

	% Burned Area/yr
GFED4s	0.32
CLM4	0.08
CLM4.5	0.22
CLM5	0.28
CESM2	0.29

- Recalibrate Eqs. and parameters for all fire types
  (v1 used GFED3; v2 uses GFED4s and Fire Atlas)

- Deforestation and degradation fires: Recalibrate the fire response to deforestation rate (deforestation rate obs. in the Amazon are available now)

- Peat fires: Update peat map, improve parameterization of fuel combustibility, update the prescribed peat burning per burned area or realize simulation (i.e. coupled with soil C/N) if possible

- Interactive fire: improve emis. height and emis. factor table