Forestry and land use impacts on land carbon storage

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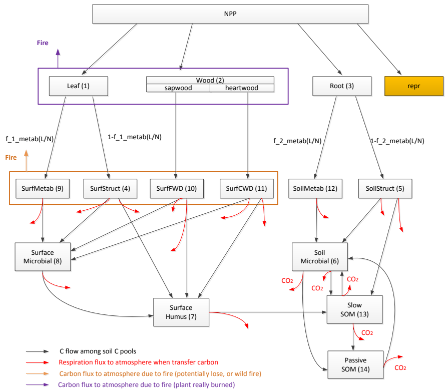
- A failed attempt to estimate LU impacts globally
- Decaying carbon
- An alternative way forward, old growth forests



Traceability framework

$$\frac{dX(t)}{dt} = BNPP(t) - \xi ACX(t)$$

First order kinetics

Change in pool size

Influx - outflux

Carbon pool

Influx of carbon

Turnover rate

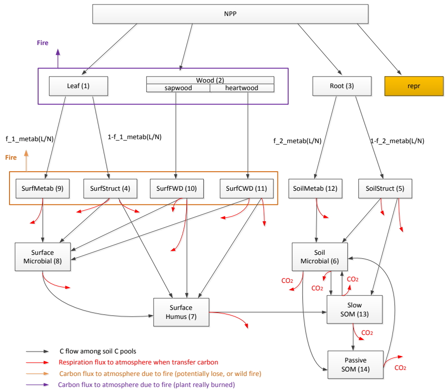
$$\frac{dC}{dt} = Influx - \tau C$$

Luo et al. 2003 GBC

Luo and Weng 2011 TREE

Luo et al. 2012

Xia et al. 2013 GBC



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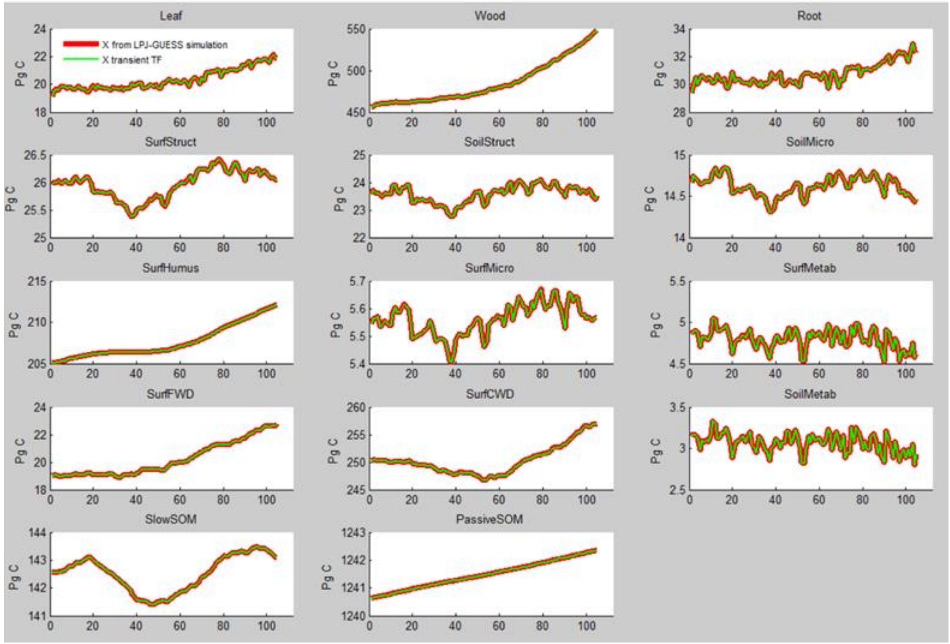
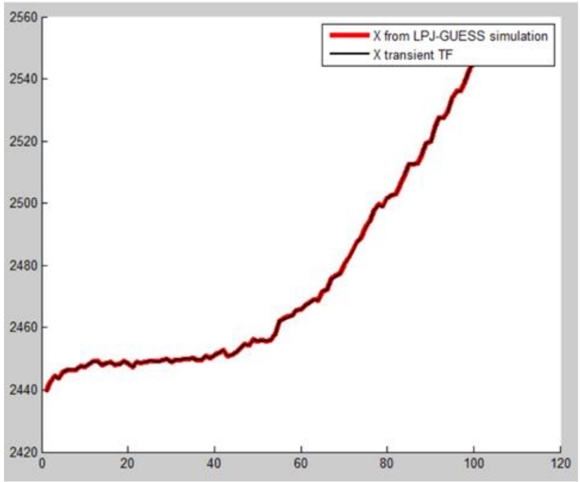
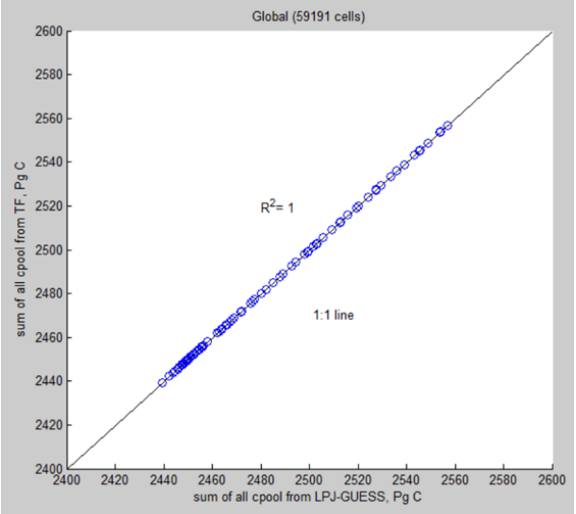


Terrestrial carbon

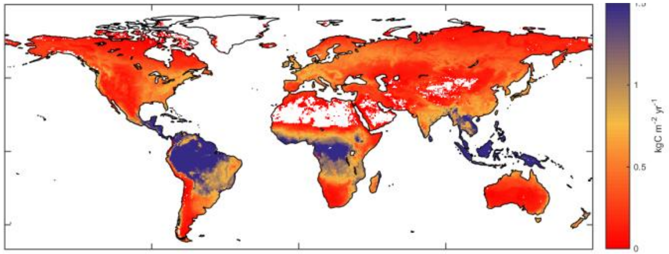


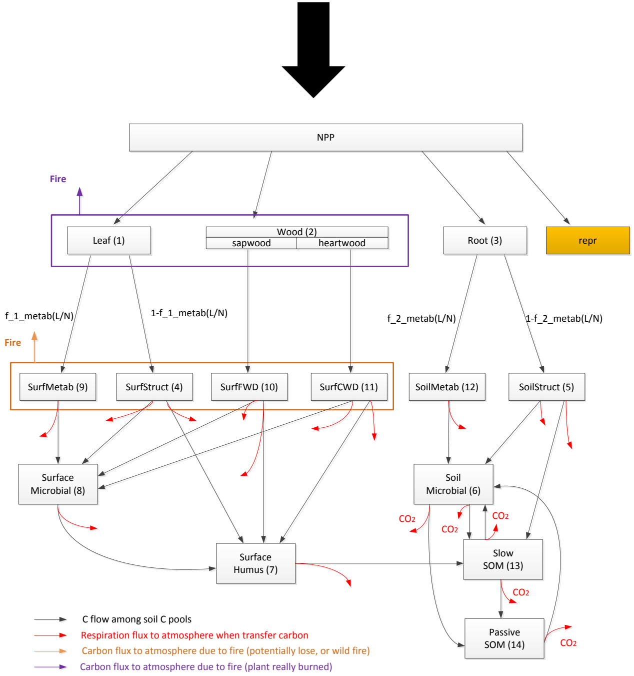
Gridcells, Traceability Framework



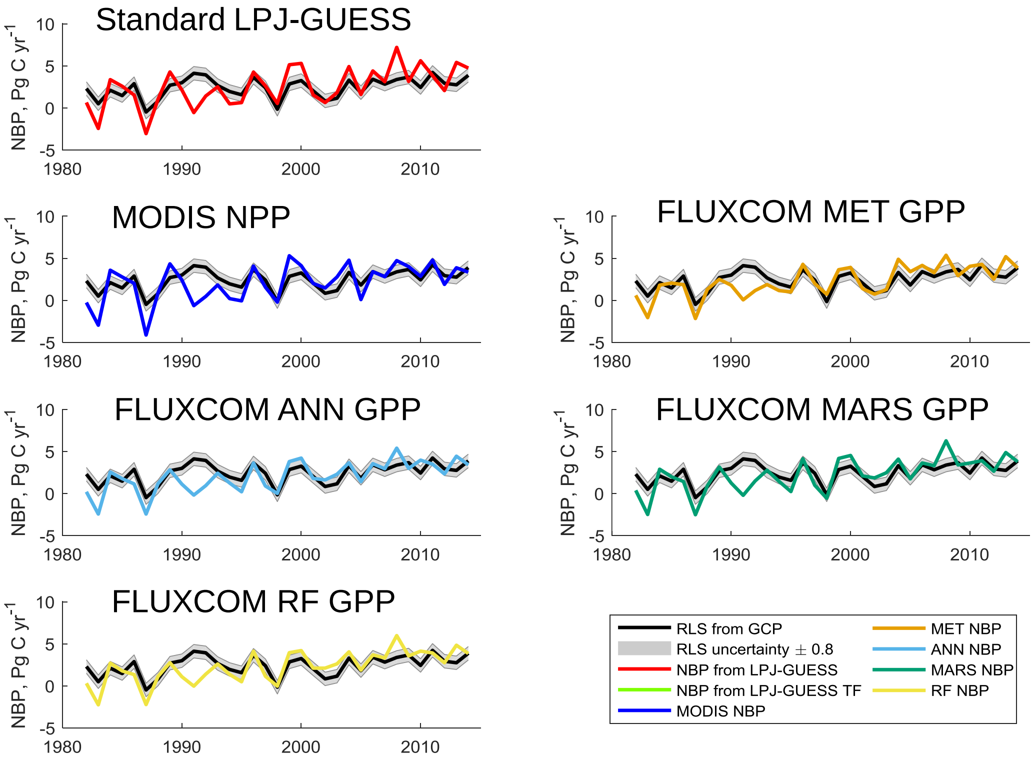
Gridcells, LPJ-GUESS

”Observations”

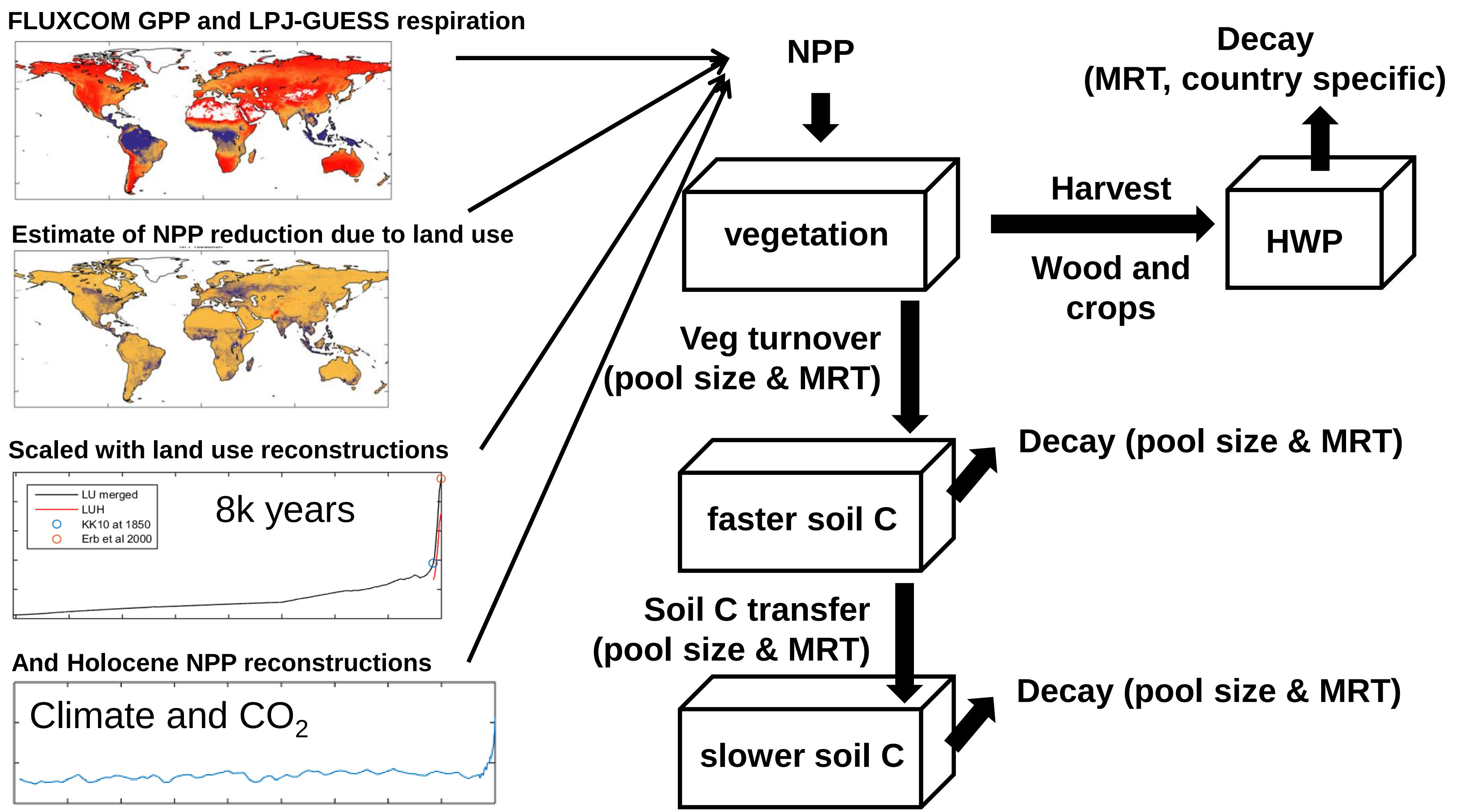




carbon cycle multiplier



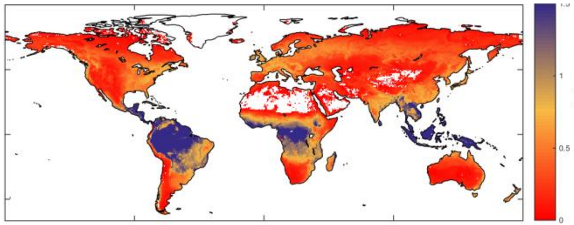
Wu et al, 2018, Scientific Reports



FLUXCOM GPP and LPJ-GUESS respiration
Estimate of NPP reduction due to land use
Scaled with land use reconstructions
LU merged
LUH
KK10 at 1850
Erb et al 2000
8k years
And Holocene NPP reconstructions
Climate and CO_2
NPP
vegetation
Veg turnover
(pool size & MRT)
faster soil C
Soil C transfer
(pool size & MRT)
slower soil C
Decay (pool size & MRT)
Decay (pool size & MRT)
Harvest
Wood and
crops
HWP
Decay
(MRT, country specific)

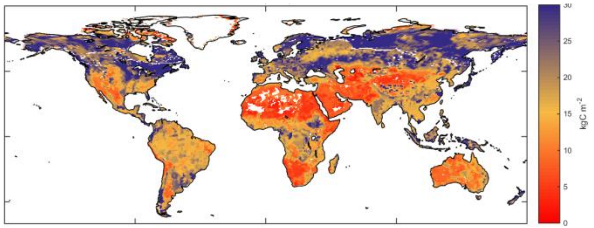
- **NPP**

Fluxcom GPP and LPJ-GUESS Ra



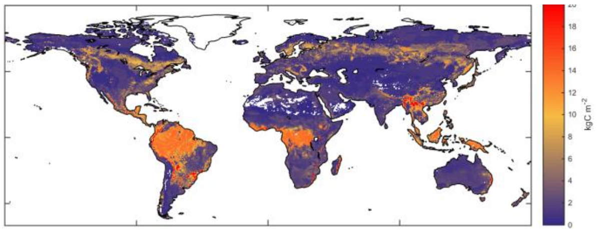
- **Soil C**

WISE ”equilibrium” C, excluding peat lands and permafrost



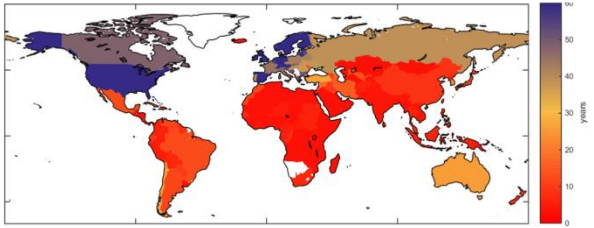
- **Veg C**

VOD -basedLiu et al 2015



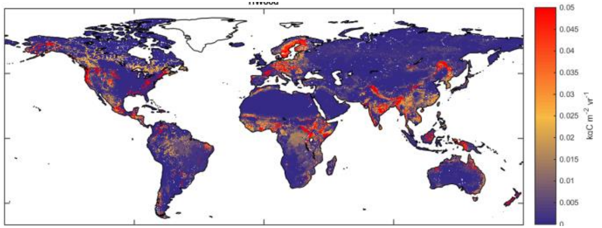
- **HWP MRT**

Calculated from Mason-Earles et al 2012



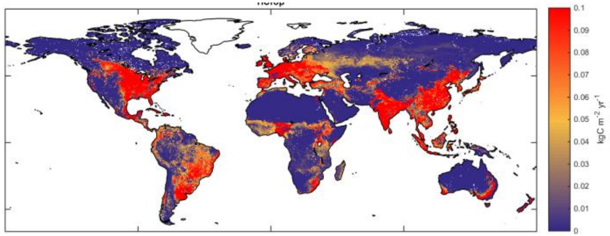
- **Wood harvest**

Redist of FAO stats



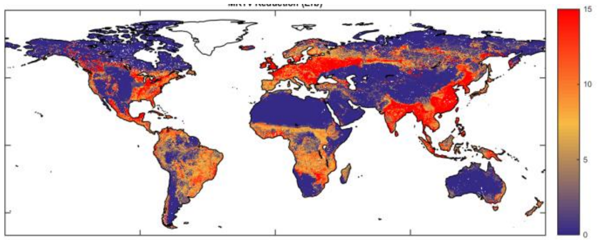
- **Crop harvest**

Redist of Erb et al

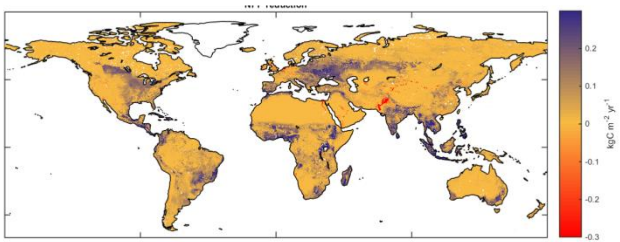


- **MRT veg reduction**

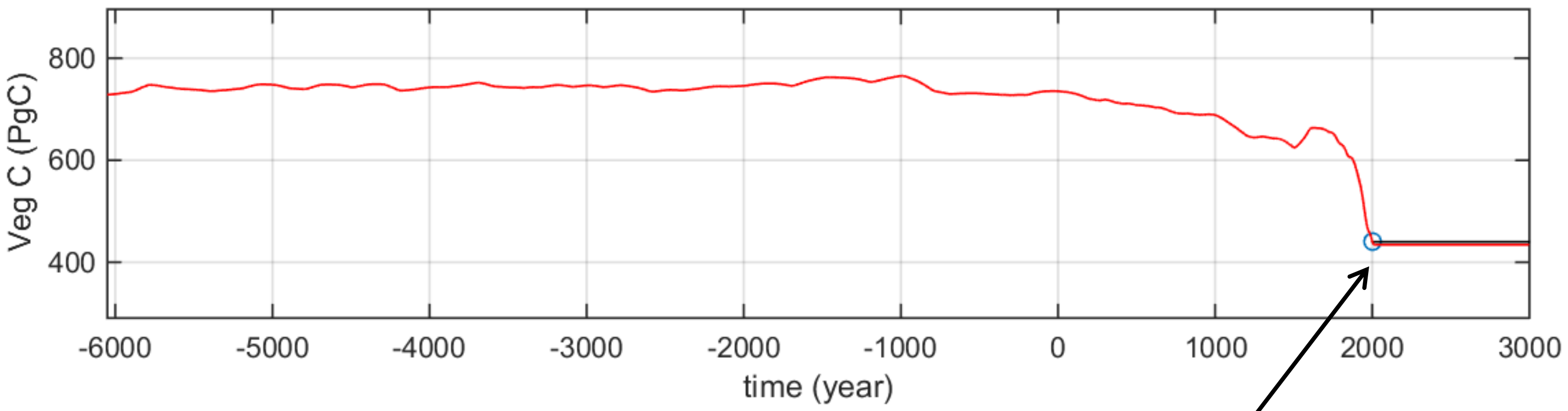
Erb et al 2016

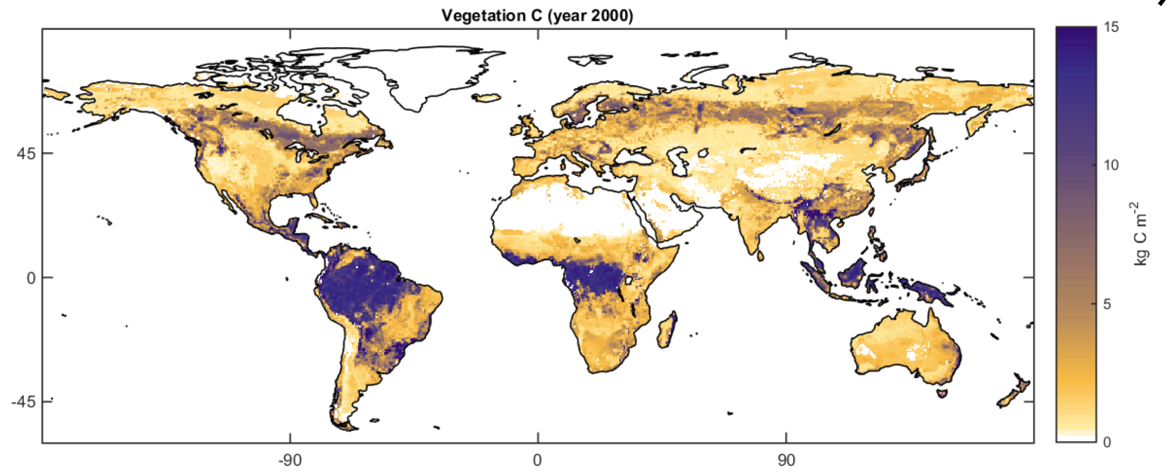


- **NPP redudction**



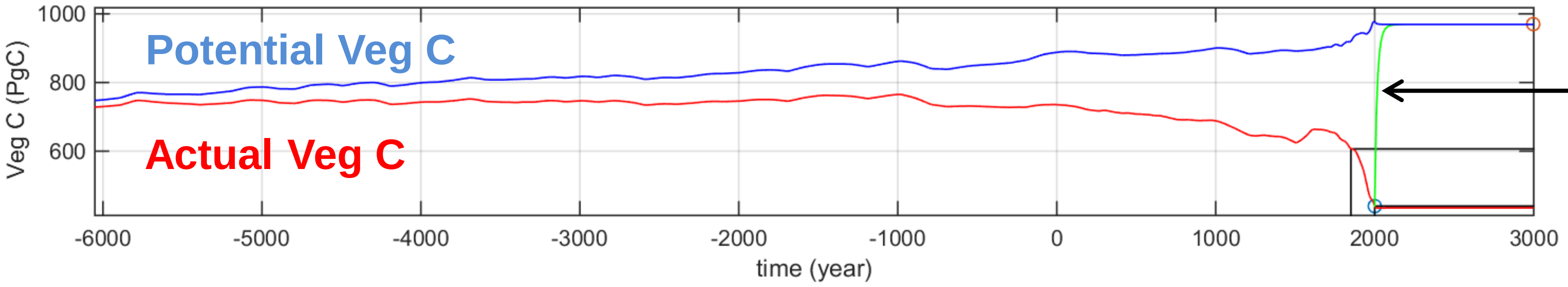
Optimised to match datasets on present C pools





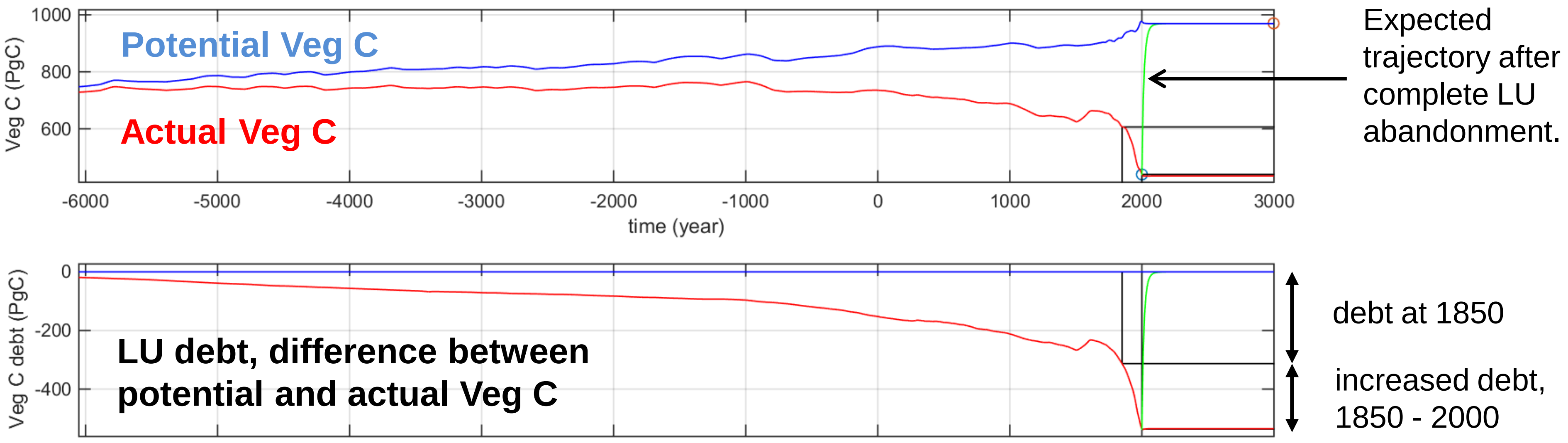
Present day biomass following Liu et al 2015, VOD-based.
(+ simulated root fractions)

Vegetation carbon

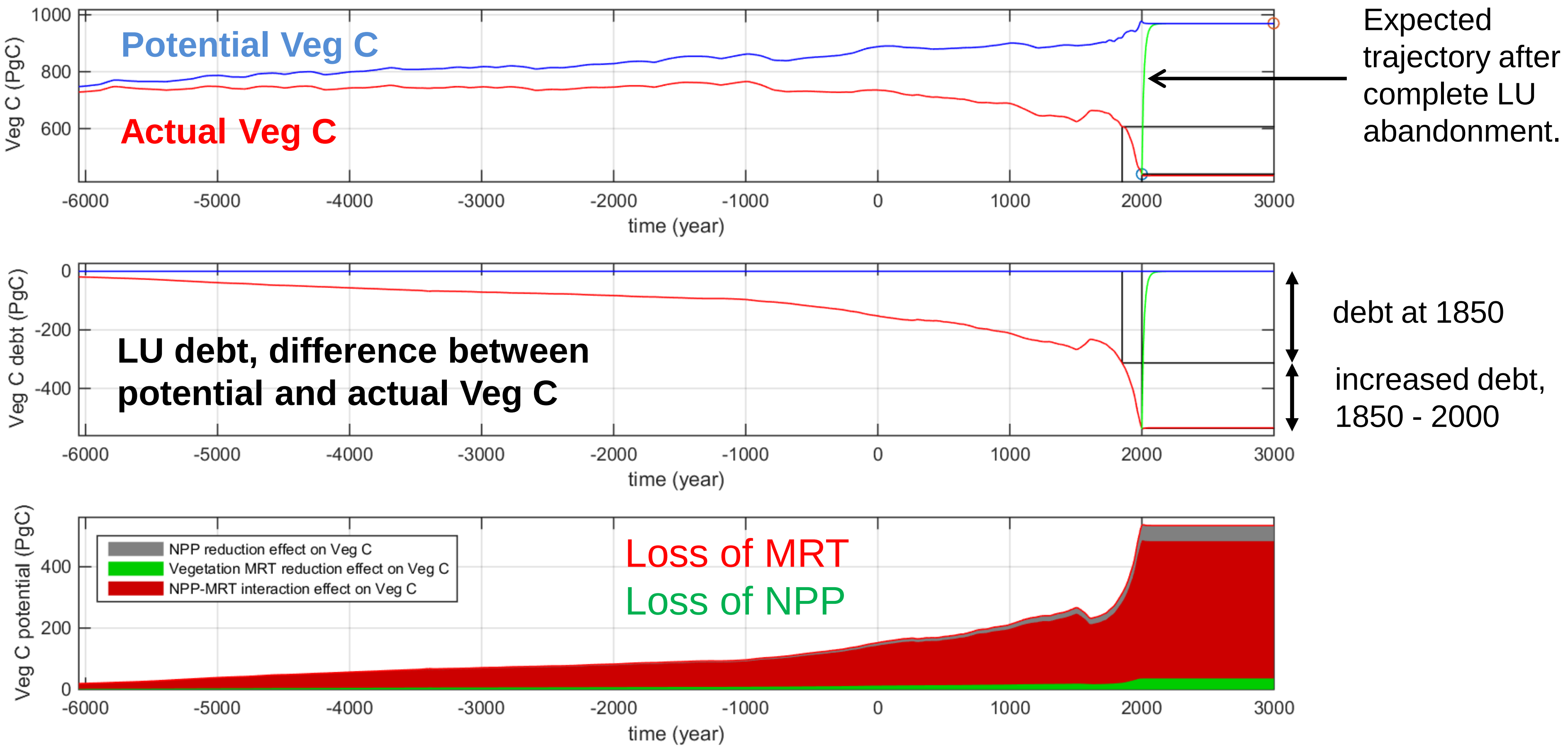


Expected trajectory after complete LU abandonment.

Vegetation carbon



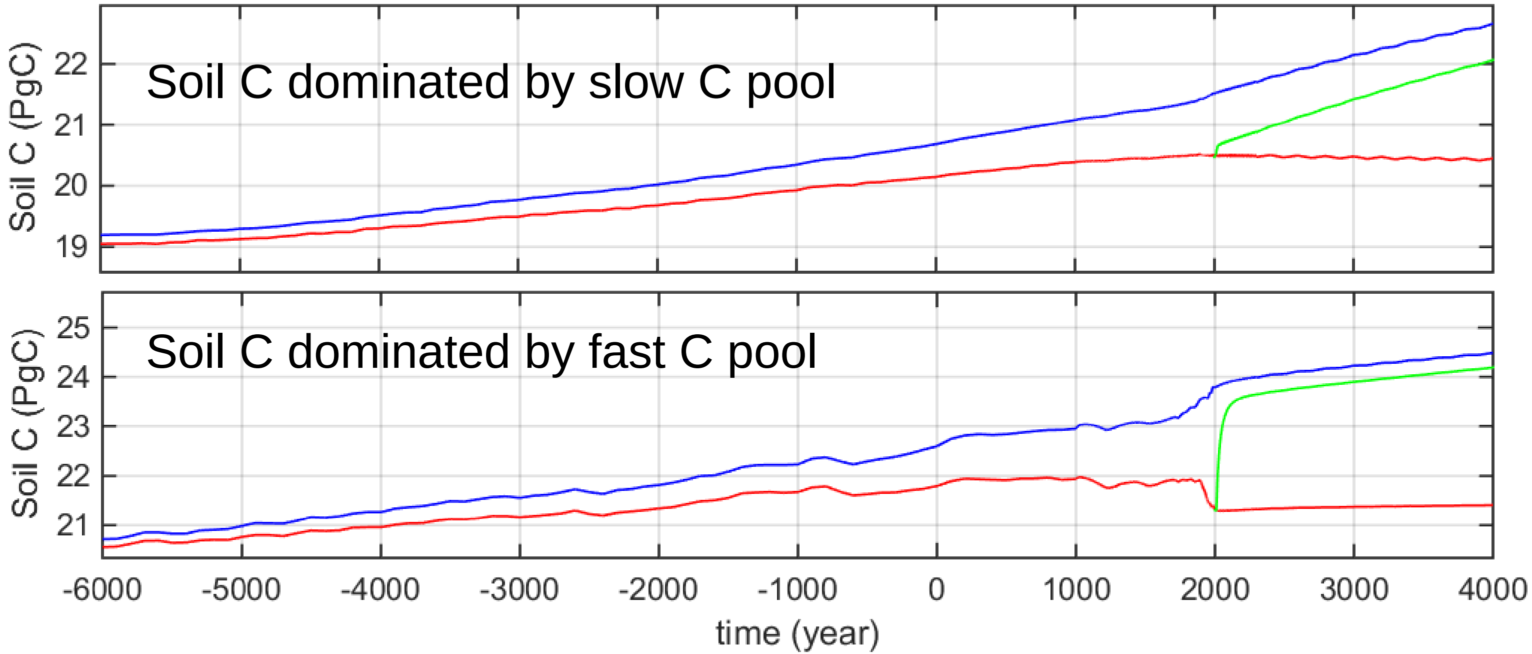
Vegetation carbon



Soil carbon

Soil carbon is more complex

Even if we knew bulk soil C age (e.g. Radiocarbon) and amount, soil C response to C influx (NPP, harvest) and decomposition rates (climate etc) can not be constrained!



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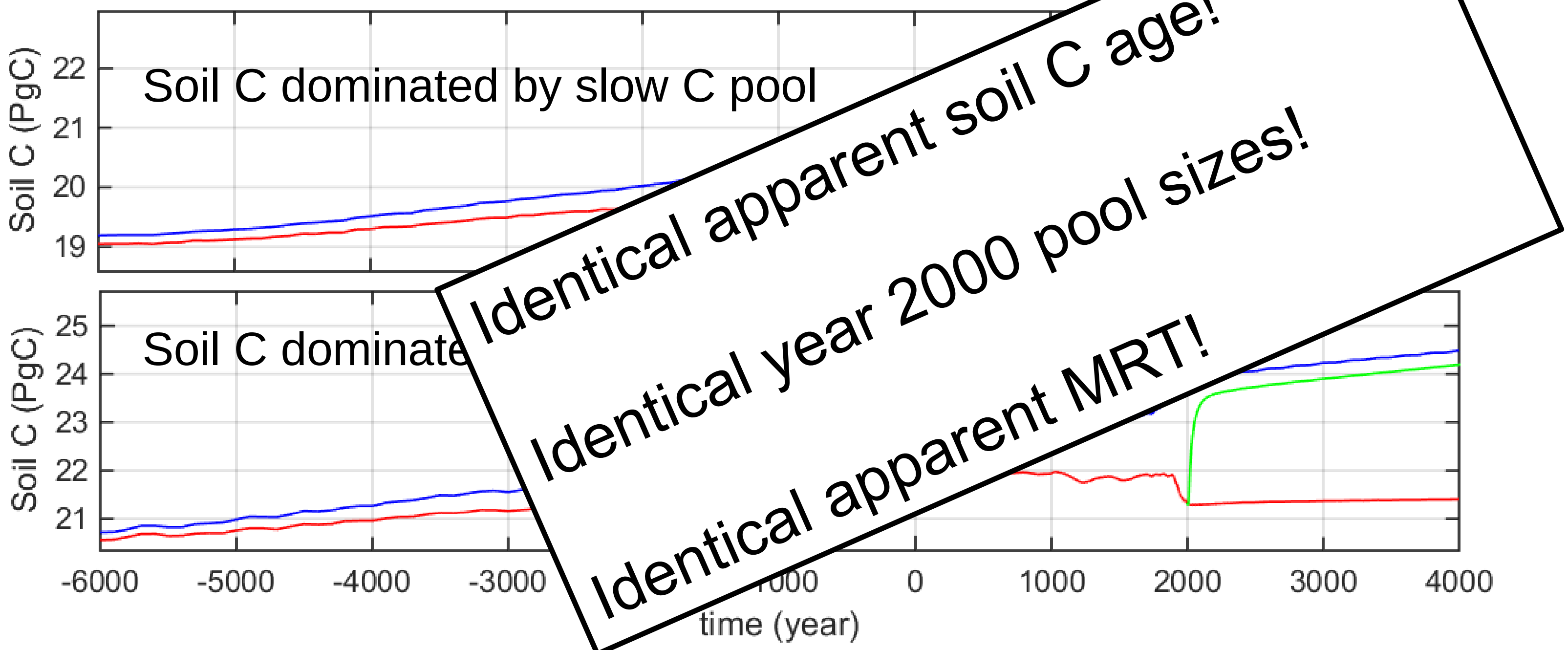
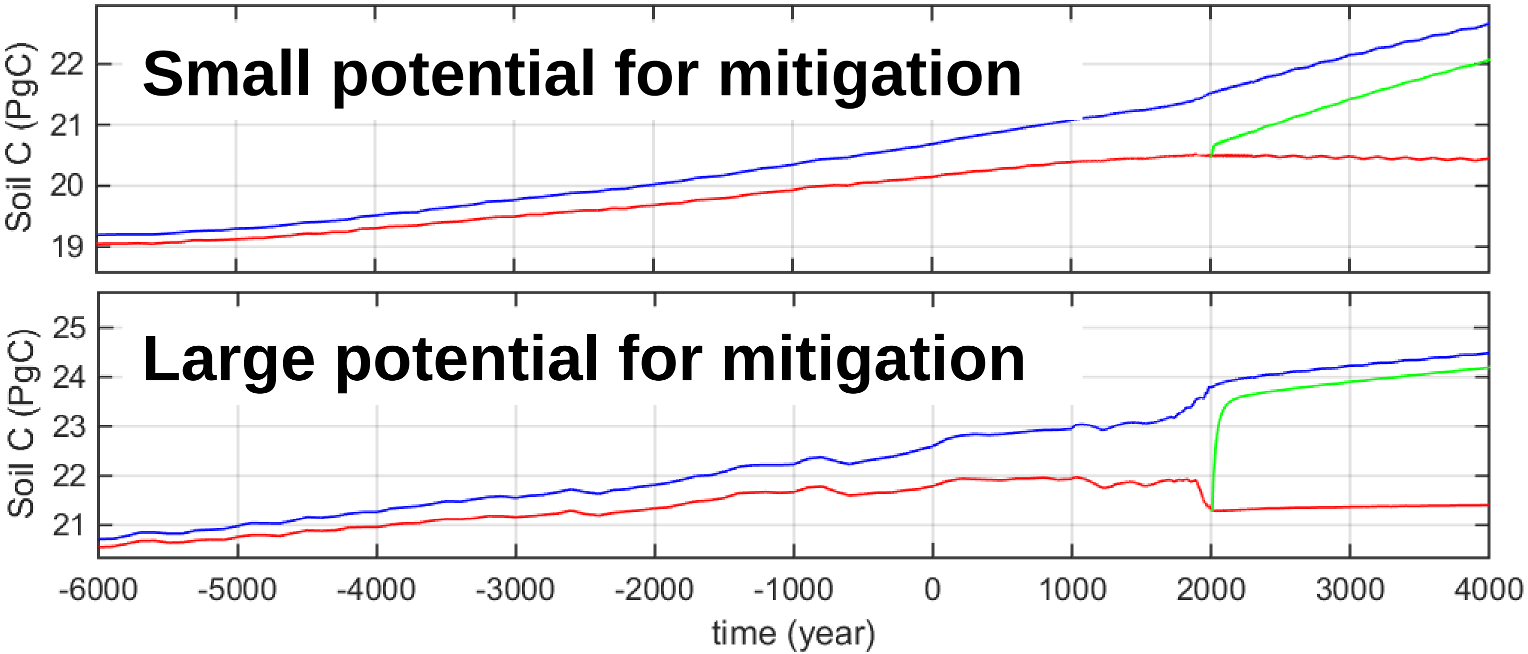


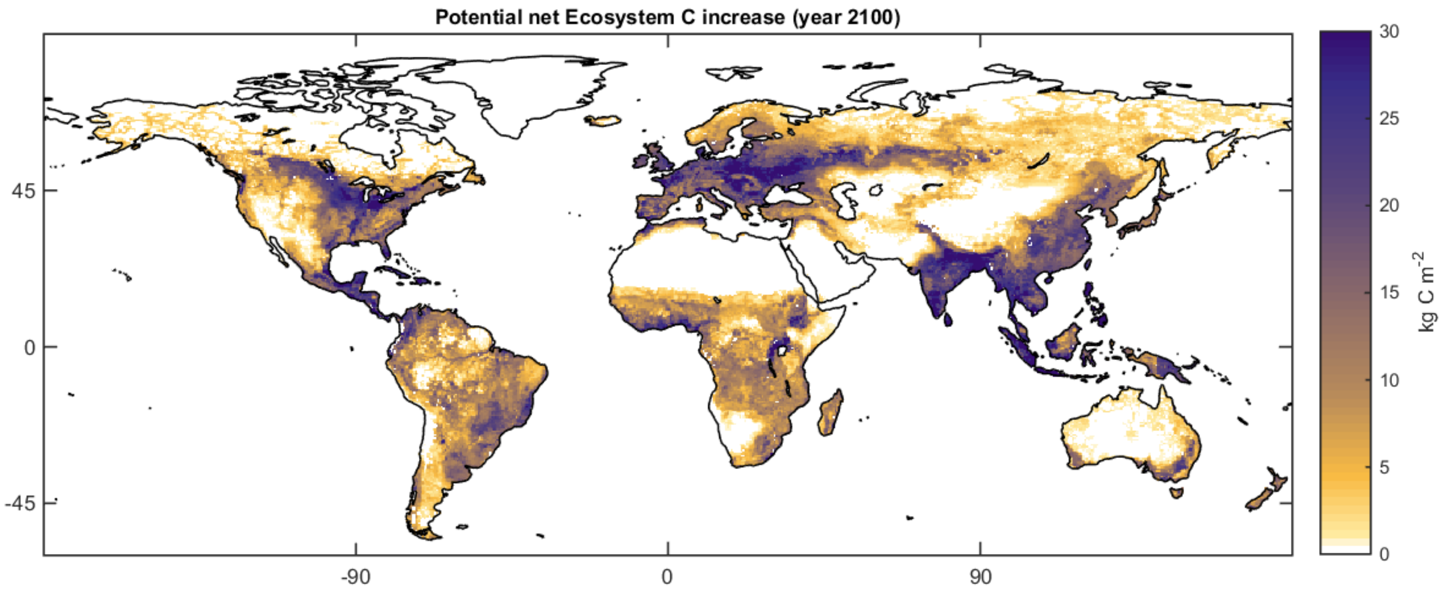
Soil carbon



Small potential for mitigation
Large potential for mitigation
Soil C (PgC)
Soil C (PgC)
22
21
20
19
25
24
23
22
21
-6000
-5000
-4000
-3000
-2000
-1000
0
1000
2000
3000
4000
time (year)

We can still make a map

- Potential land uptake can not be constrained Pg C
- Perhaps it would look something like this? 800 Pg C, the model would pass global benchmarks perfectly!



Decaying carbon

Decaying carbon

A carbon pool

Influx of carbon

Turnover rate

Change in pool size

$$\frac{dC}{dt} = Influx - \tau C$$

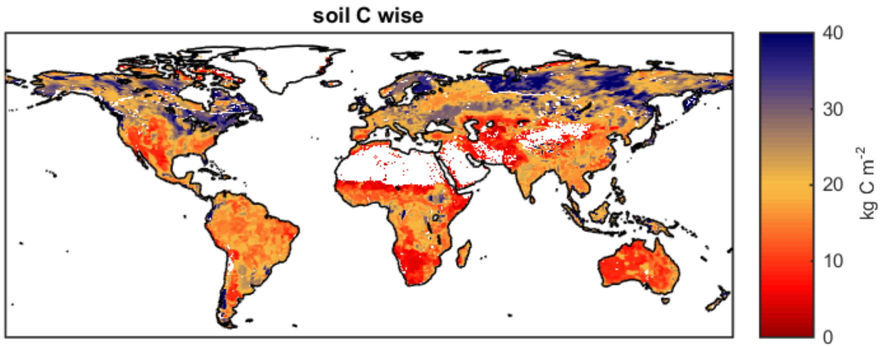
Turnover rate (τ) is the fraction leaving the pool over a time step, defined as 1/turnover time.

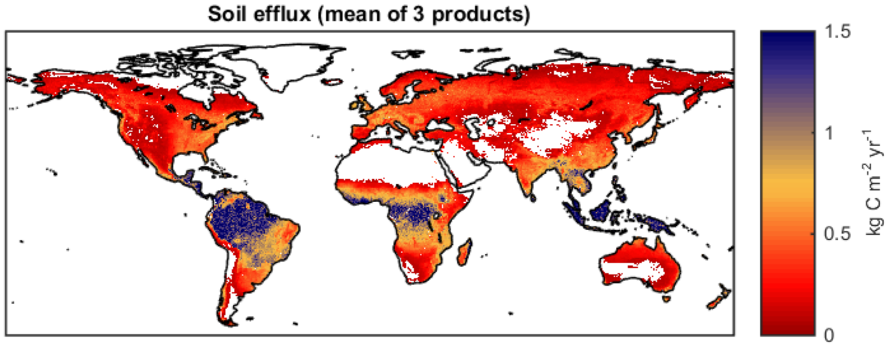
In steady state the carbon pool size do not change why influx = losses:

$$\frac{dC}{dt} = 0 \quad \rightarrow \quad Influx - \tau C = 0 \quad \rightarrow \quad C_{steady\ state} = \frac{\overline{Influx}}{\bar{\tau}}$$

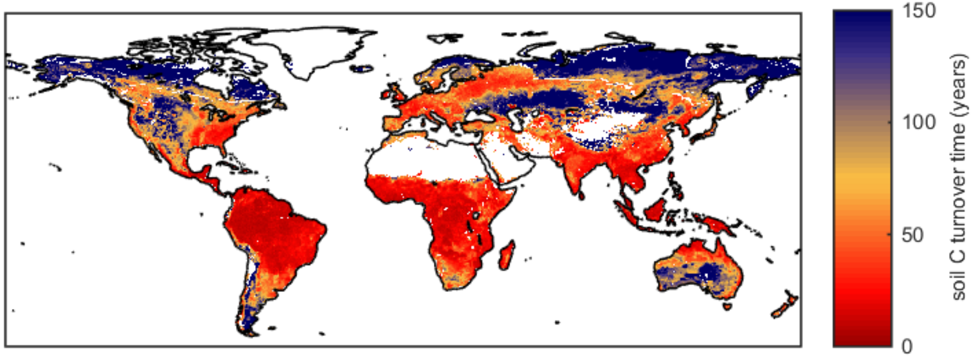
$$\overline{turnover\ time} = \frac{C_{pool}}{\overline{Efflux}}$$

Ecosystem decaying biomass turnover time



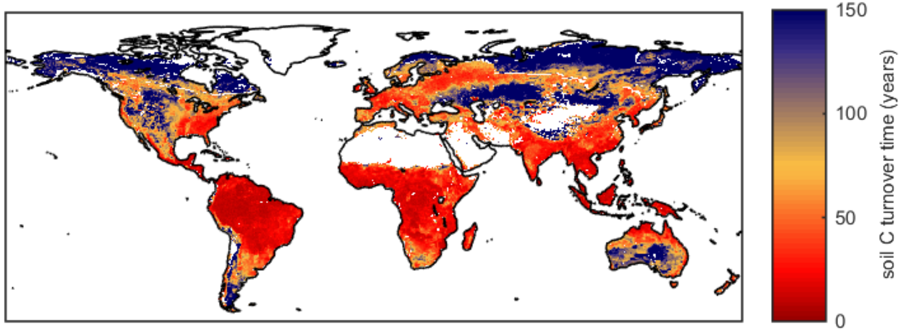


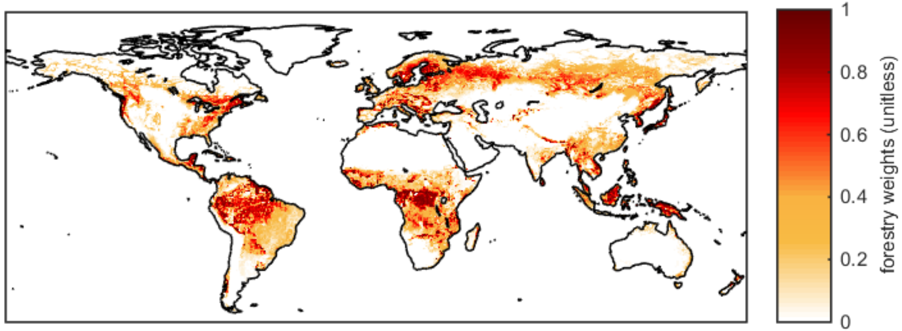
Turnover time
$= C_{pool} / C_{efflux}$



Ahlström et al. In review

Ecosystem decaying biomass turnover time





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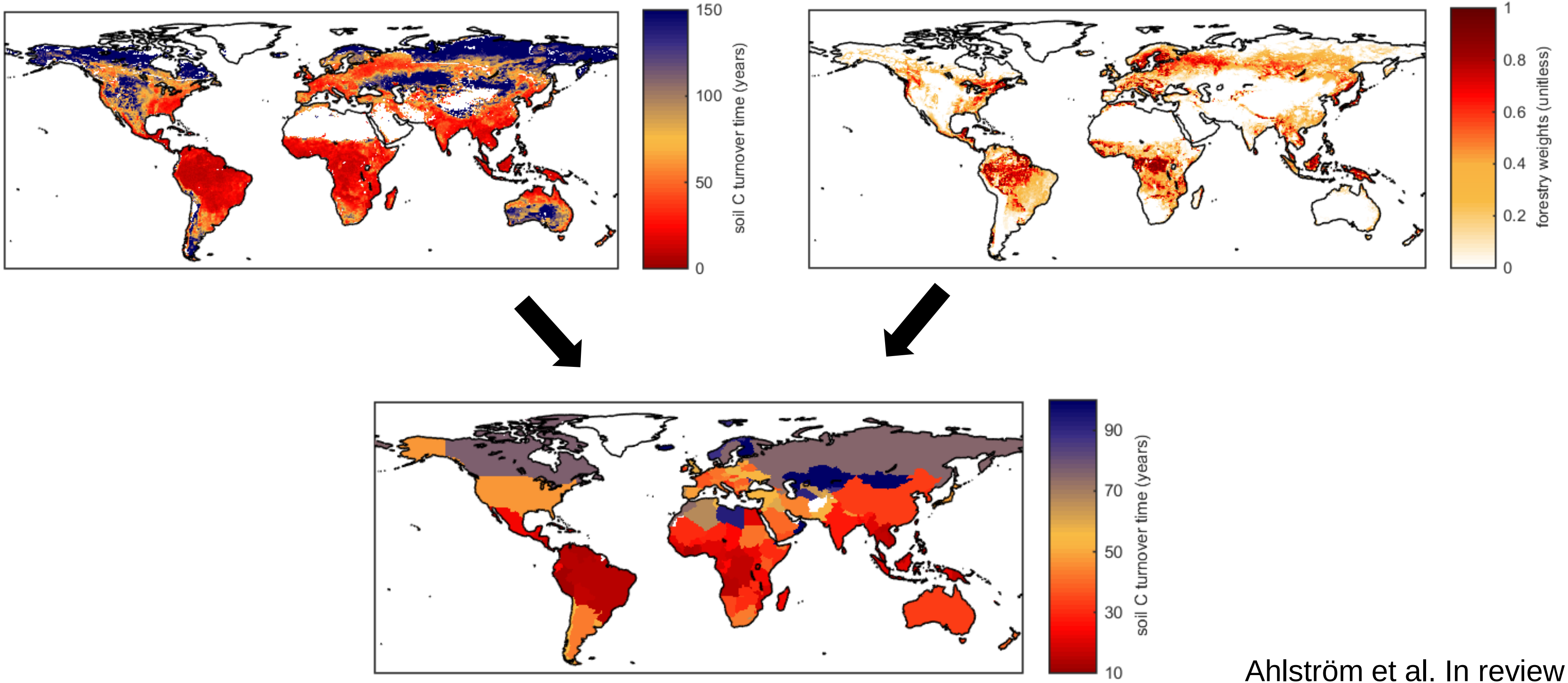
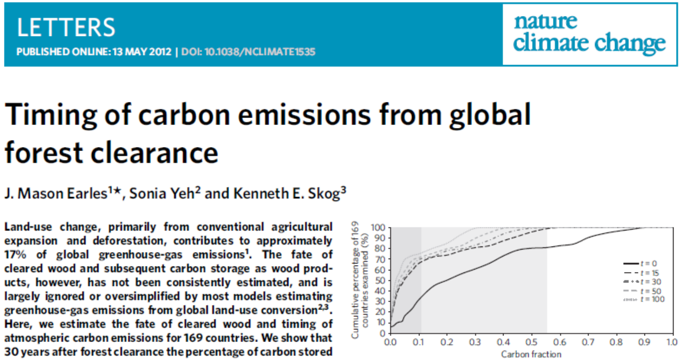


Ahlström et al. In review

HWP decaying biomass turnover time



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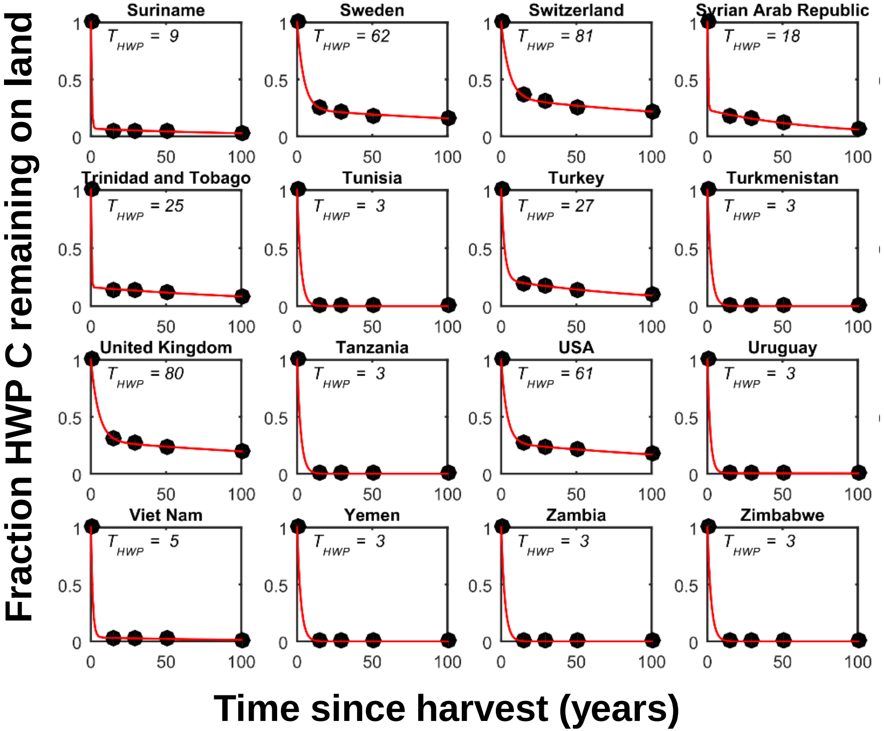
nature climate change

Timing of carbon emissions from global forest clearance

J. Mason Earles[1]*, Sonia Yeh[2] and Kenneth E. Skog[3]

Land-use change, primarily from conventional agricultural expansion and deforestation, contributes to approximately 17% of global greenhouse-gas emissions[1]. The fate of cleared wood and subsequent carbon storage as wood products, however, has not been consistently estimated, and is largely ignored or oversimplified by most models estimating greenhouse-gas emissions from global land-use conversion[2,3]. Here, we estimate the fate of cleared wood and timing of atmospheric carbon emissions for 169 countries. We show that 30 years after forest clearance the percentage of carbon stored



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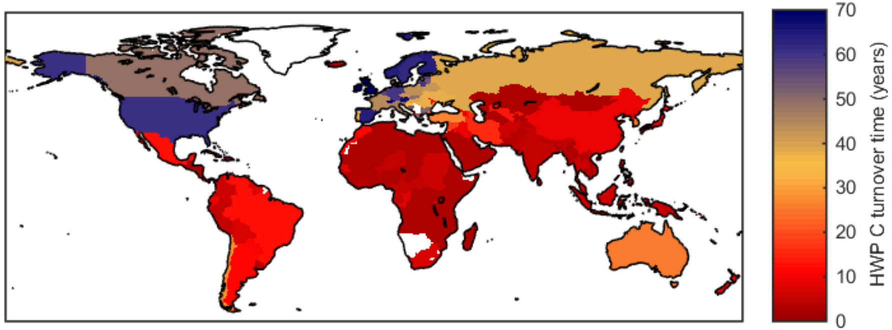
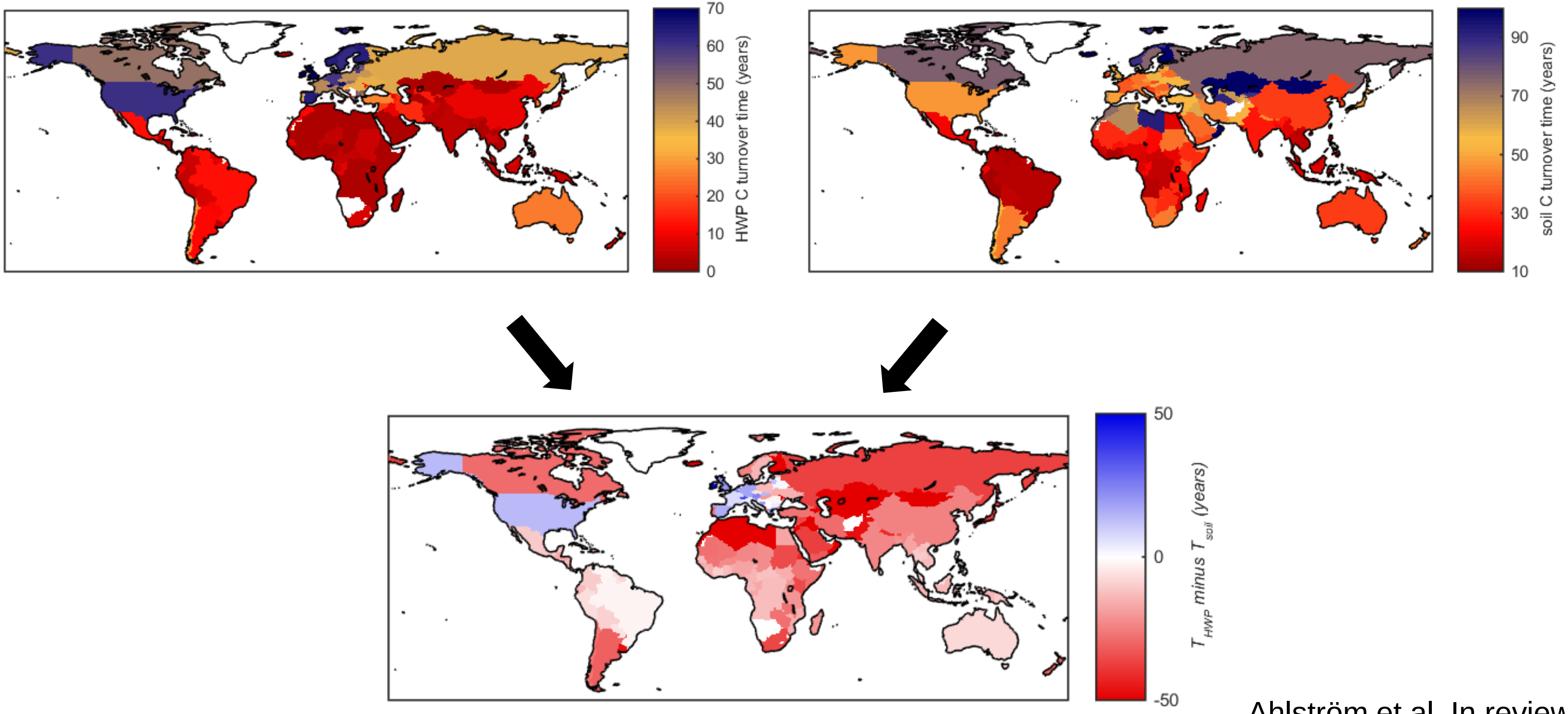
Anthropogenic VS natural turnover times

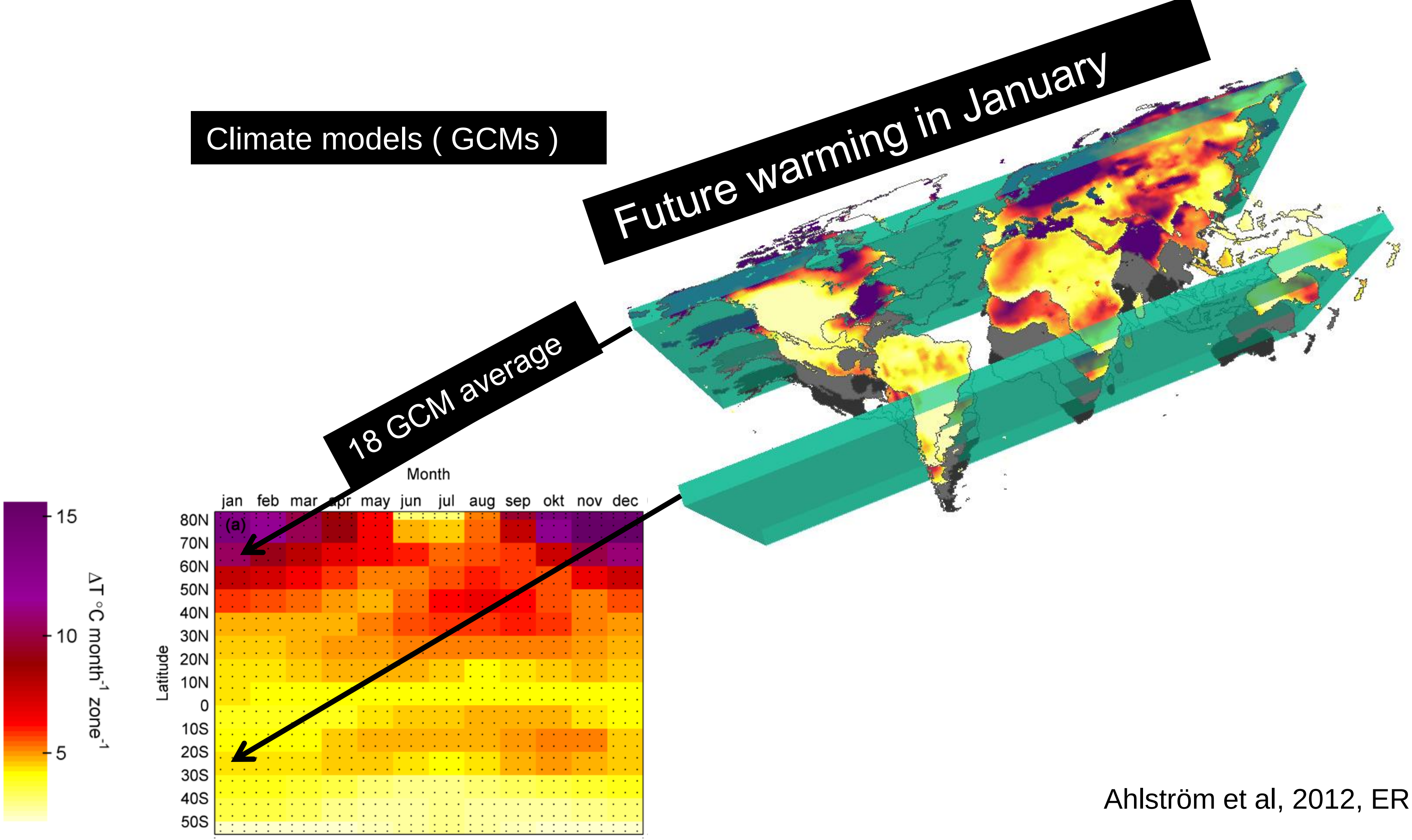


Ahlström et al. In review

Anthropogenic VS natural turnover times

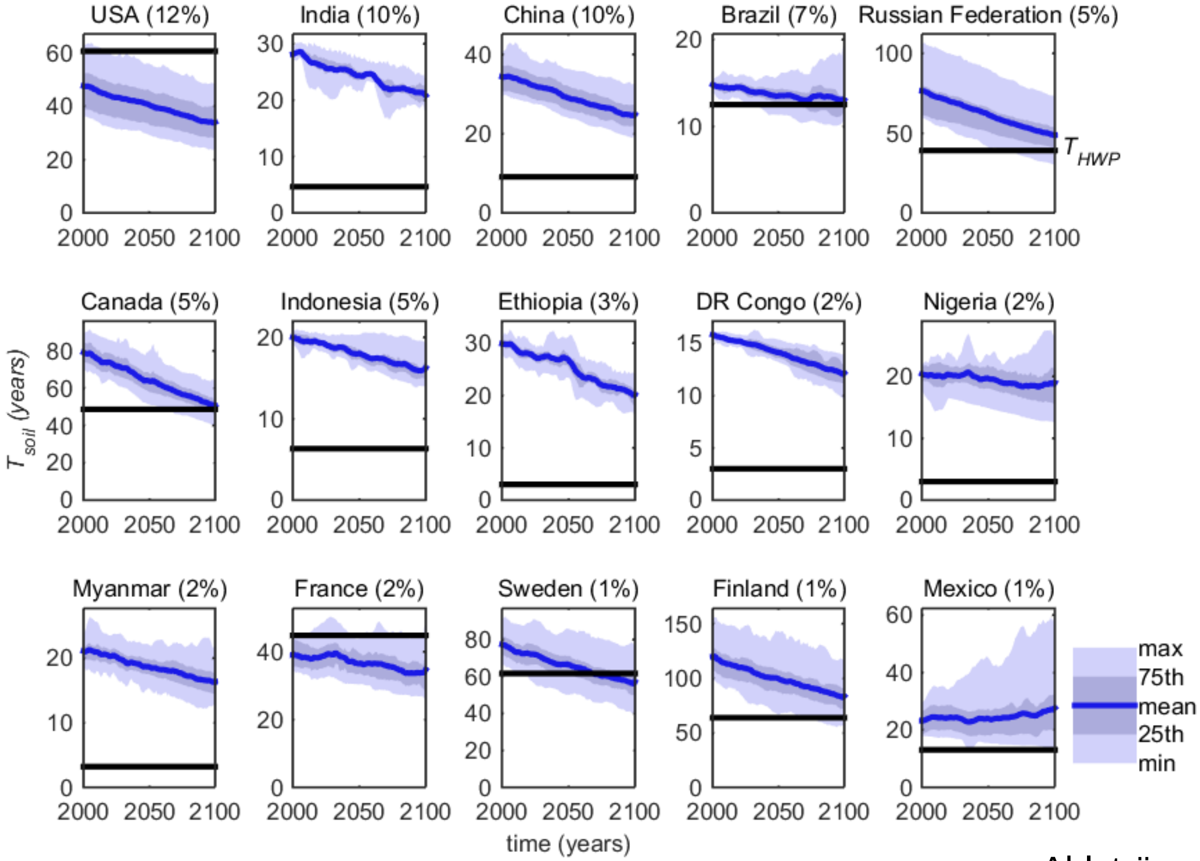


Ahlström et al. In review



Ahlström et al, 2012, ERL.

Anthropogenic VS natural turnover times



Wooden house: ~70 years

Paper: ~1-3 years

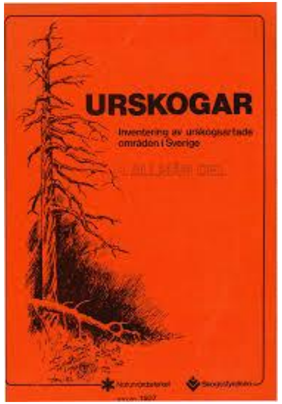
Bioenergy: 0-1 years

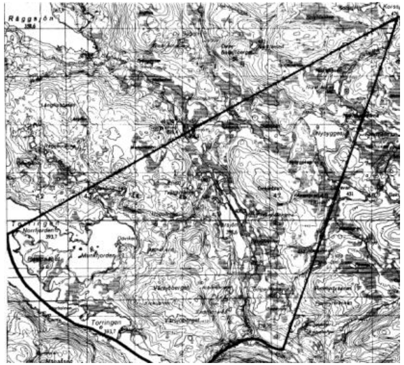
Waste to energy?

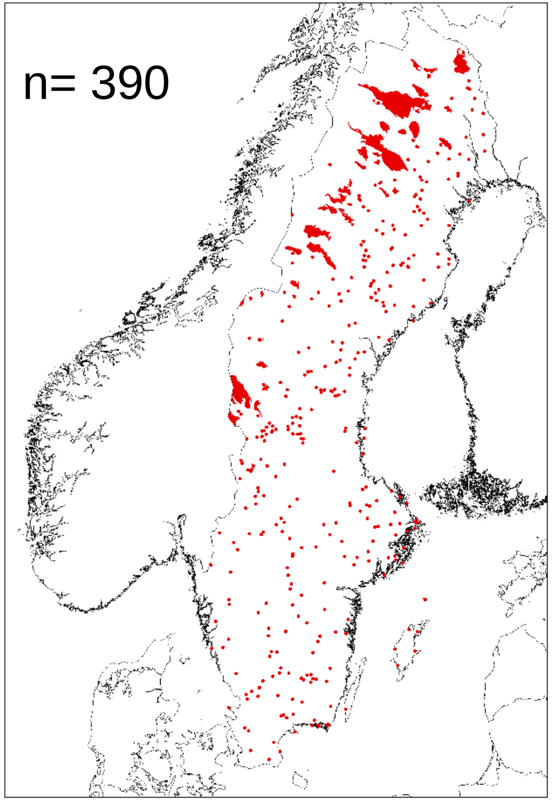
Landfills?

Ahlström et al. In review

Old growth forests







Geerte De Jong
Master thesis student

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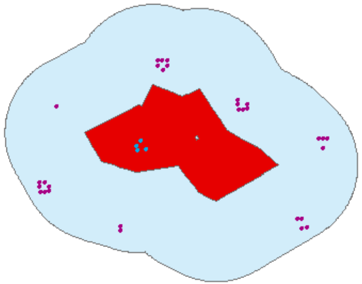
De Jong et al. In prep

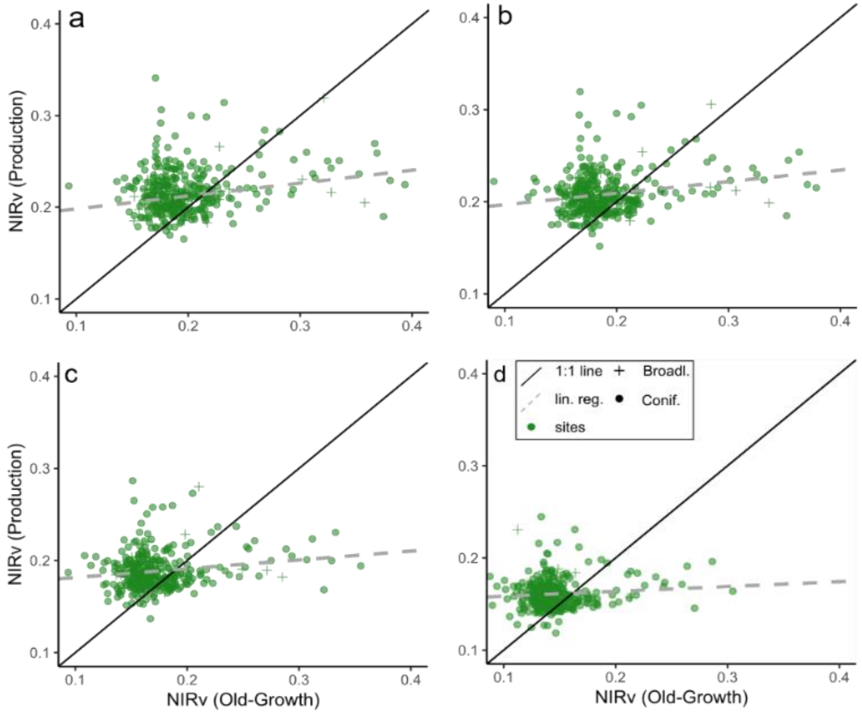
Old growth forests

Paired analysis:

Data points within the old growth forests are comapred to data points in a spatial buffer around the old growth forest



Percentiles of the annual distribution (99th to 70th)



De Jong et al. In prep

Thank you