# The global impact of carbon-based logging in FATES
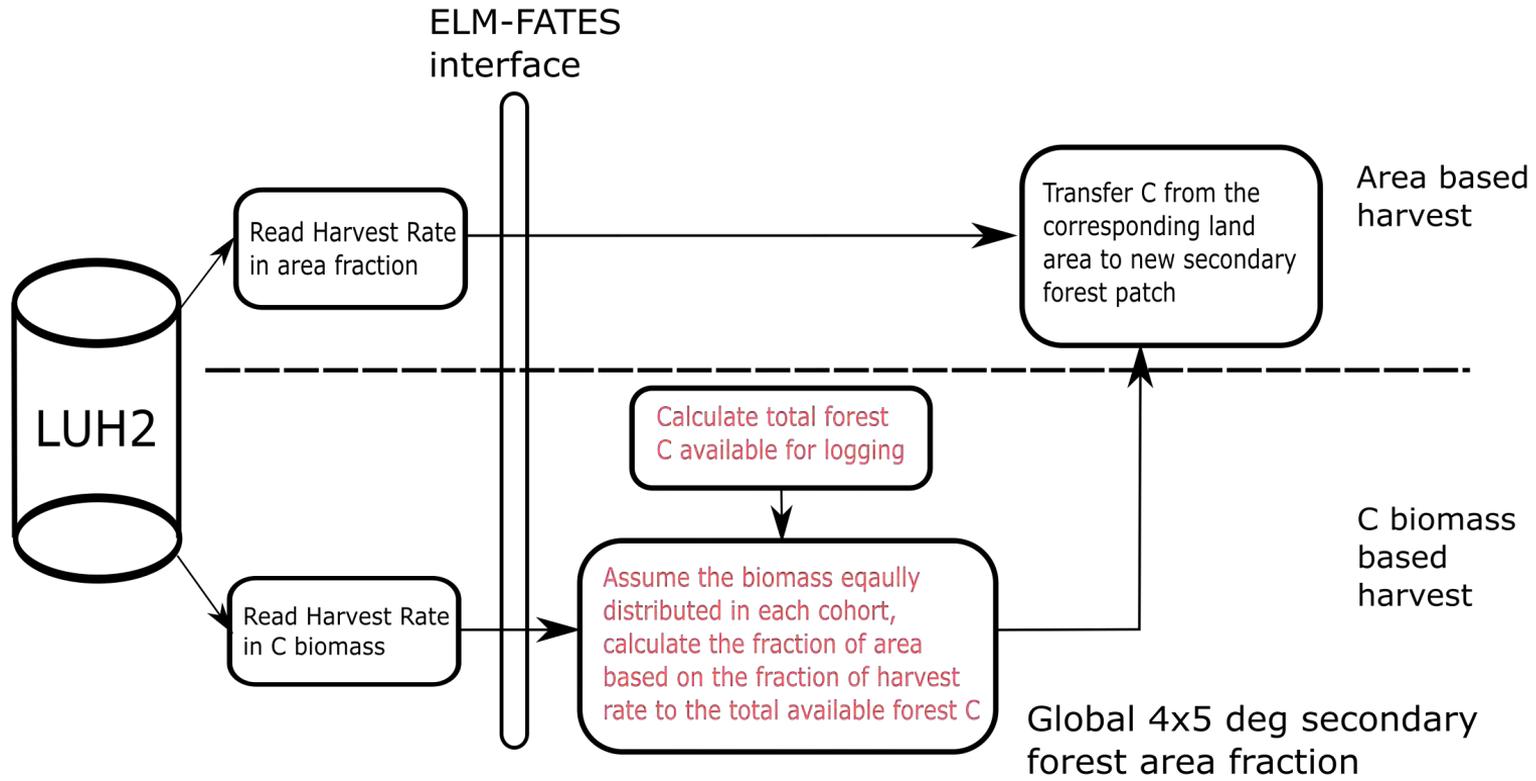
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**BERKELEY LAB**

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# Biomass C based FATES Logging

ELM-FATES interface

LUH2

Read Harvest Rate in area fraction

Transfer C from the corresponding land area to new secondary forest patch

Area based harvest

Calculate total forest C available for logging

C biomass based harvest

Read Harvest Rate in C biomass

Assume the biomass eqaully distributed in each cohort, calculate the fraction of area based on the fraction of harvest rate to the total available forest C

Global 4x5 deg secondary forest area fraction

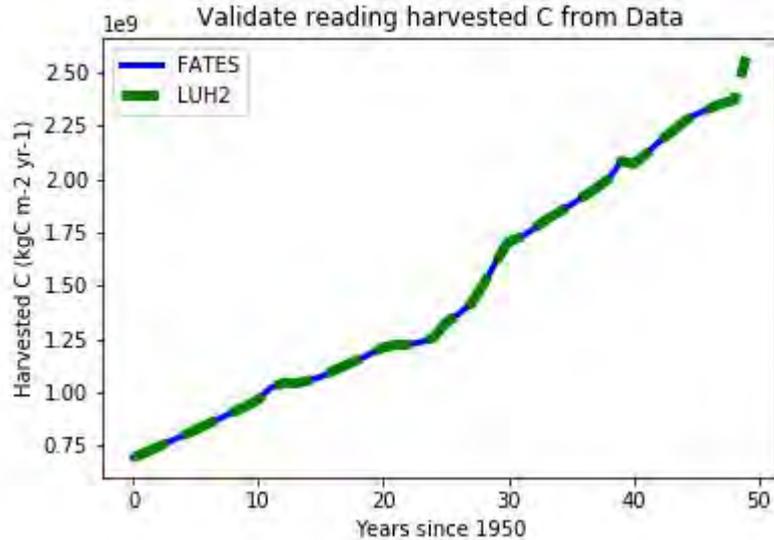https://github.com/NGEET/fates/issues/869
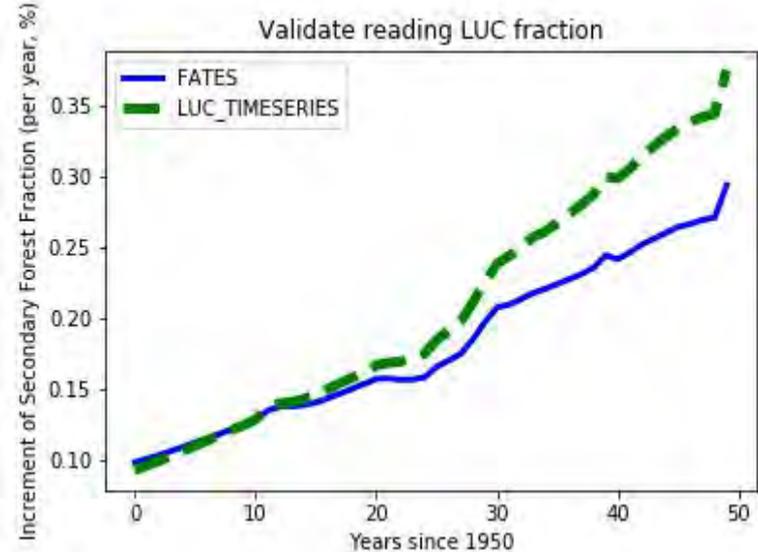
# Simulations set-up

1. Brazil site case (1x1_brazil): Spinup from zero for 200 years. Transient simulation starts from year 1950 directly to test the code and harvested C and area in primary forest land. **No secondary forest harvest for this site**.
2. Global 4x5 deg simulation (1890 - 2009) with LUH2 **forest** harvest rate data, non-forest harvest rate is excluded:
- Spinup from zero for 150 years under **fixed biogeography** settings.
- Phase 1 transient simulation starts from 1850 to 1890 to introduce initial secondary forest patches
- Phase 2 transient simulation starts from 1890 to check harvested C and area from both primary and secondary forest.

Note: In global simulation the minimum dbh requirement is removed (the parameter value is set to zero) to maximize the forest C available for harvest in the primary forest land.
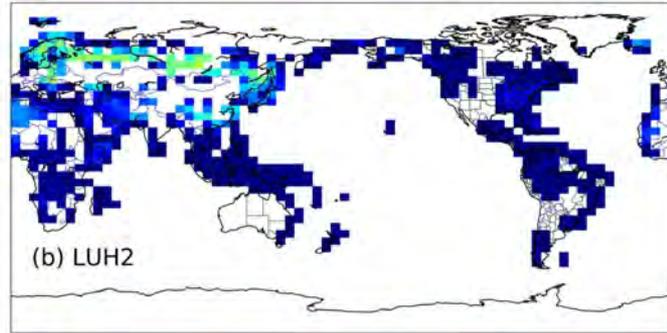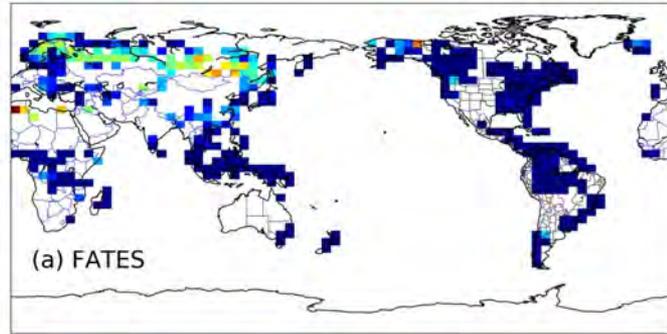
# Brazil site case



Checked the consistency between the harvested carbon from the dataset and the actual harvested carbon calculated.
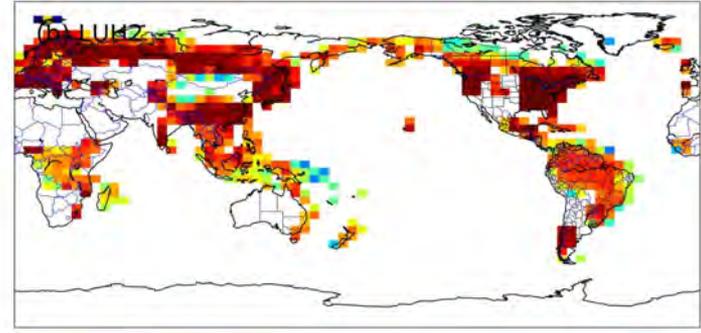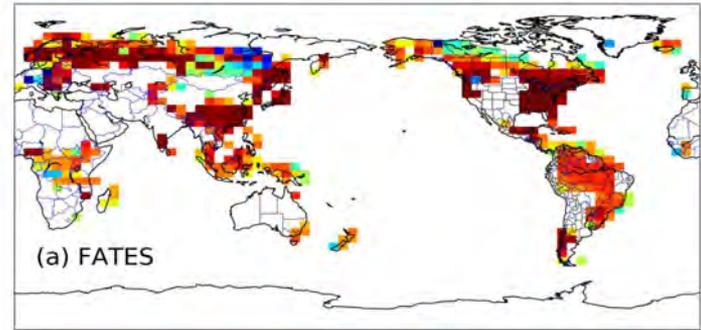
The calculated secondary forest fraction is less than the harvested area fraction by LUH2, which is possibly due to a higher biomass on the current site compared to the biomass data used by LUH2.

# Global case
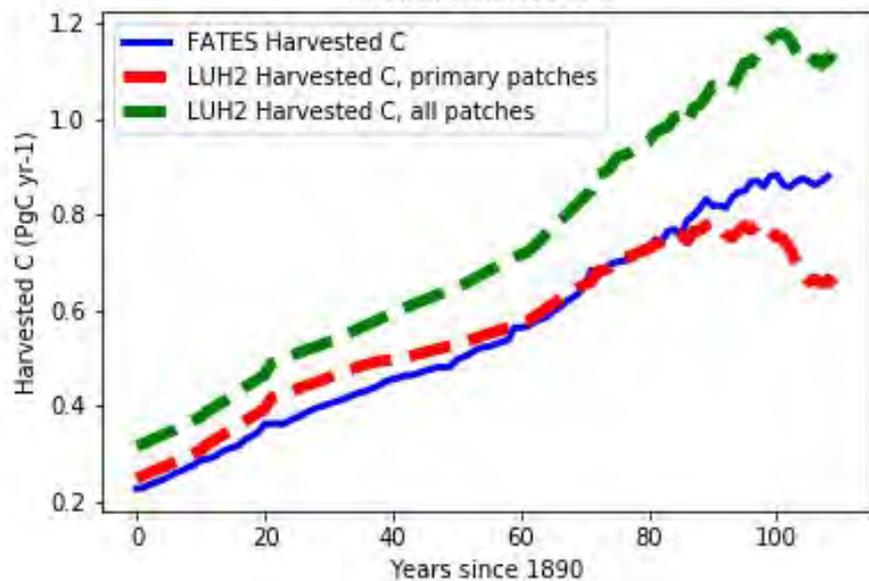
Secondary forest area (2009, fraction of grid area)

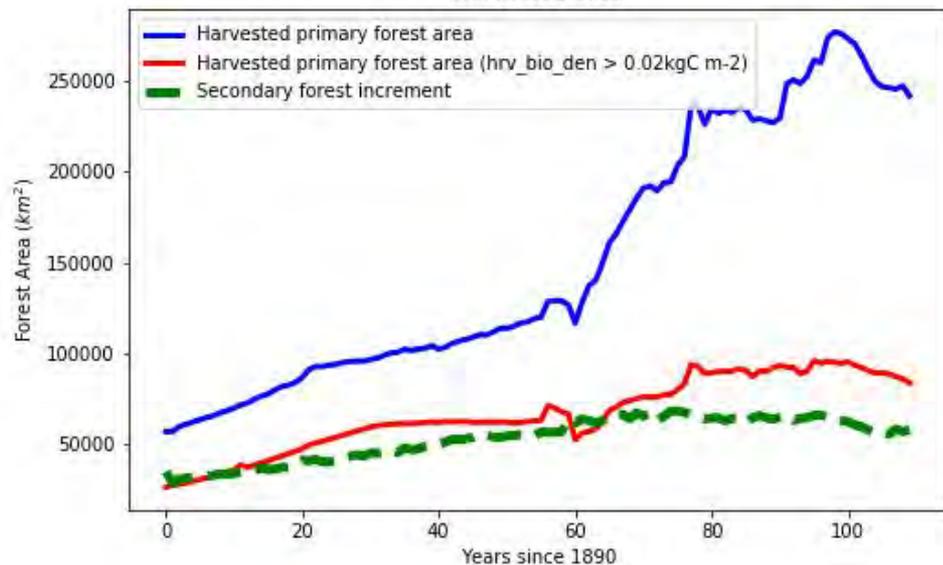Primary forest harvested C (2009, in kgC



(a) FATES

(b) LUH2

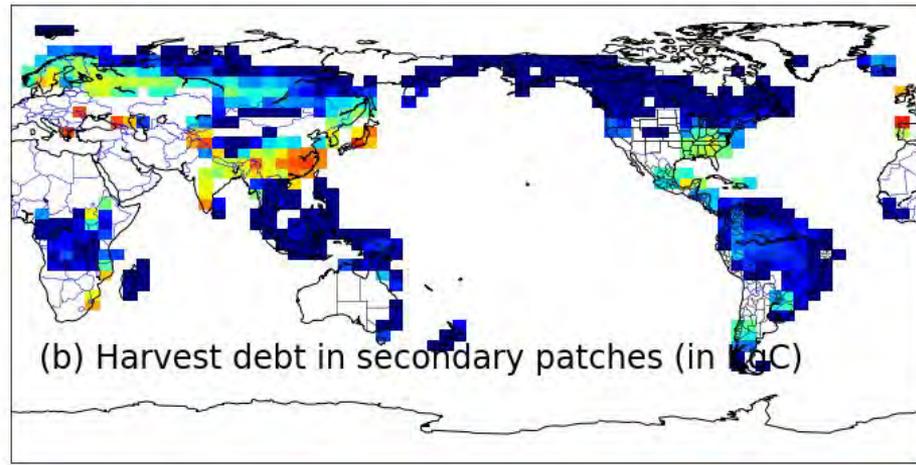(a) FATES

(b) LUH2

# Global case



Global harvested C

FATES Harvested C
LUH2 Harvested C, primary patches
LUH2 Harvested C, all patches

Harvested area

Harvested primary forest area
Harvested primary forest area (hrv_bio_den > 0.02kgC m-2)
Secondary forest increment

Global case

Harvest debt (primary vs. secondary, 2009)



(b) Harvest debt in primary patches (in KgC)

(b) Harvest debt in secondary patches (in KgC)

Harvest debt: Carbon amount not harvested successfully due to less biomass than the harvest rate

# Global case

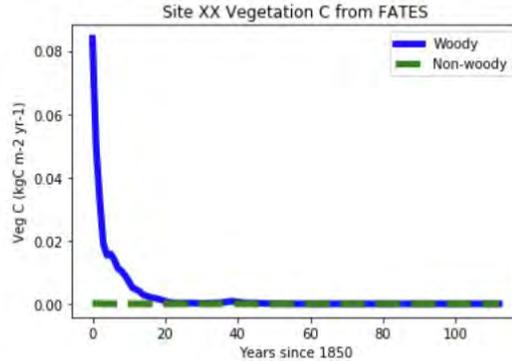## Causes of shortage in the secondary forest C



(a) Causes

- 0. Secondary forest did not reach maturity
- 1. No cohorts survived
- 2. Low growth rate (Change of secondary biomass lower than the harvest rate)
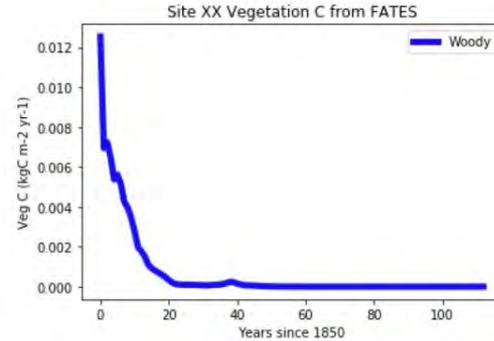- 3. Too tiny secondary forest area (<1% of gridcell)
- No color. Other reasons

0       1       2       3

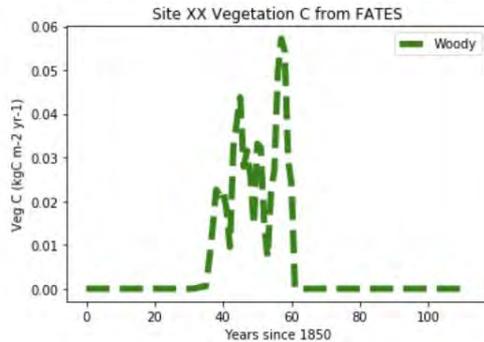# A site case near Sahara (1. no cohorts survived)

- No vegetation survived
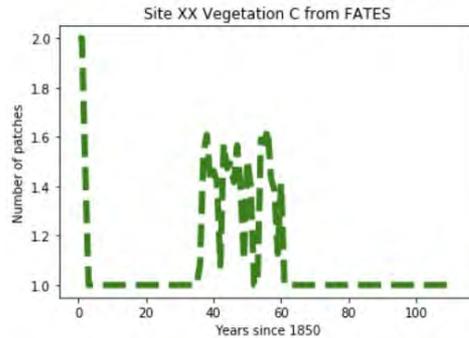- Zero cohort thus all veg C checks and calculations are skipped
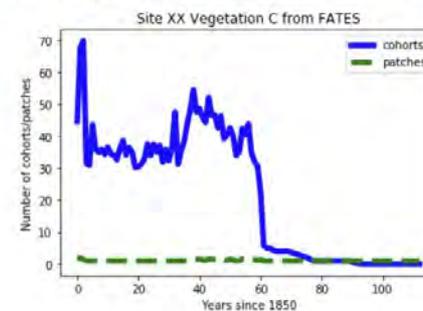


Veg C (all PFTs) during spinup



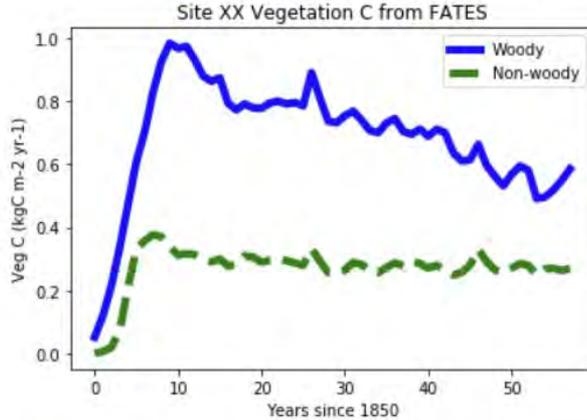PFT = 2, needleleaf_evergreen_extratrop_tree
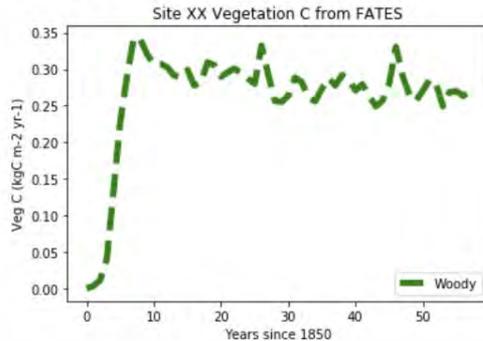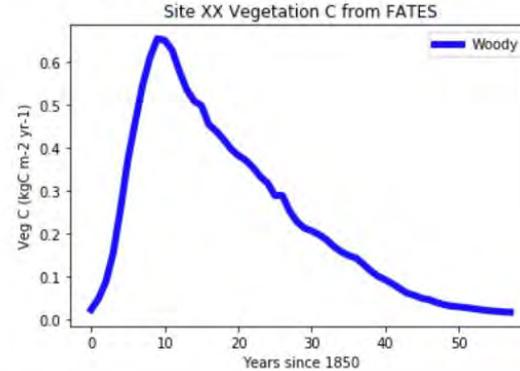


PFT = 12, c4_grass



Number of patches



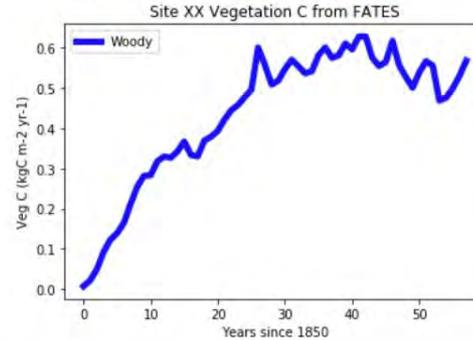Patches/Cohorts

# A site case from Siberia (2. Low growth rate)



Veg C (all PFTs) during spinup



PFT = 2, needleleaf_evergreen_extratrop_tree
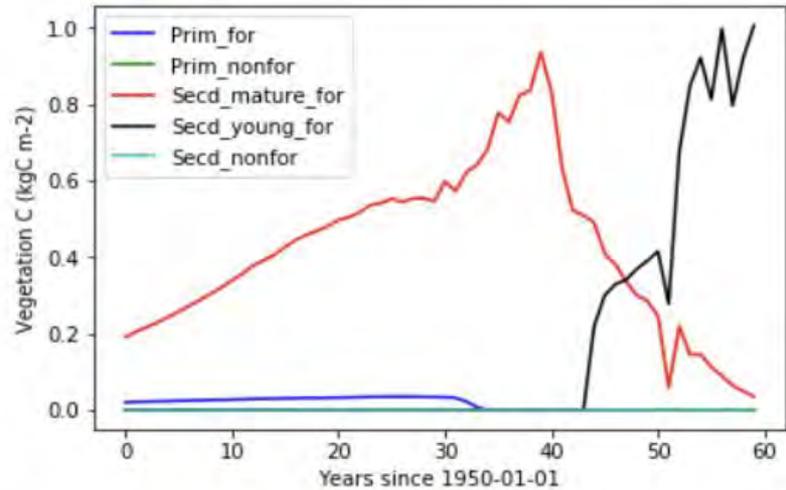


PFT = 10, arctic_c3_grass



PFT = 9, broadleaf_colddecid_extratrop_shrub

# A site case from India (2. Low growth rate)

Total Veg C

LUH2 Harvest rate in C
(converted to m-2)

## Challenges:

1) Mismatch of primary forest distribution on the map even under fixed biogeography mode. Major cause is that certain PFTs cannot survive under the current climate envelope, thus cannot build enough forest C for harvest.

2) Secondary forest harvest is substantial even from the beginning of the transient simulation. We tested a 2 phases transient simulation plan to generate secondary forest patches after the spin-up stage. Other strategies can also be applied such as initialize secondary forest patches through inventory.

3) The regrown secondary forests patches shares the similar traits with the same PFTs as primary patches. Nutrient cycle shall also be introduced to simulated nutrient-limited secondary forest.

# Backup Slides