Plans for LULCC in FATES, plus some other steps on the path towards CLM6-FATES.

C. Koven, R. Fisher, R. Knox, M. Huang, Y. Xu, J. Shuman, and many others

Useful Resources:

FATES Github PAGE:
https://github.com/NGEET/fates

FATES Technical Documentation:
https://fates-docs.readthedocs.io/en/latest/index.html

FATES Practical Notes:
https://github.com/NGEET/fates/wiki/
Running-FATES:-A-Walk-Through:-February-2019

FAQ: "When will FATES run globally?"

**Short answer**: FATES already runs globally.

Longer Answer: While FATES does already run globally, there are a few things we need to get working in order to do CMIP, GCP/Trendy, or similar types of global change experiments. Foremost among these are the ability to ingest and work with global LULCC datasets.

Why LULCC in FATES should be different (and better) than in big-leaf CLM
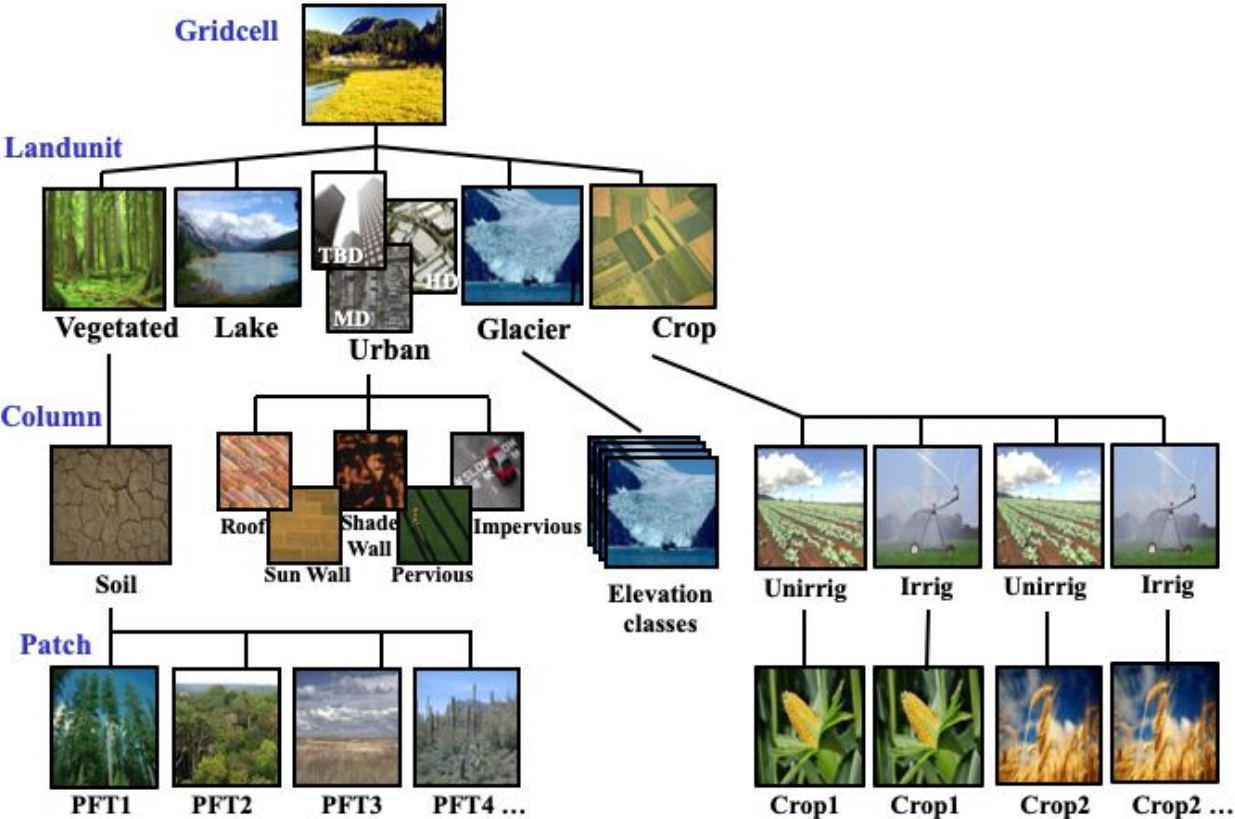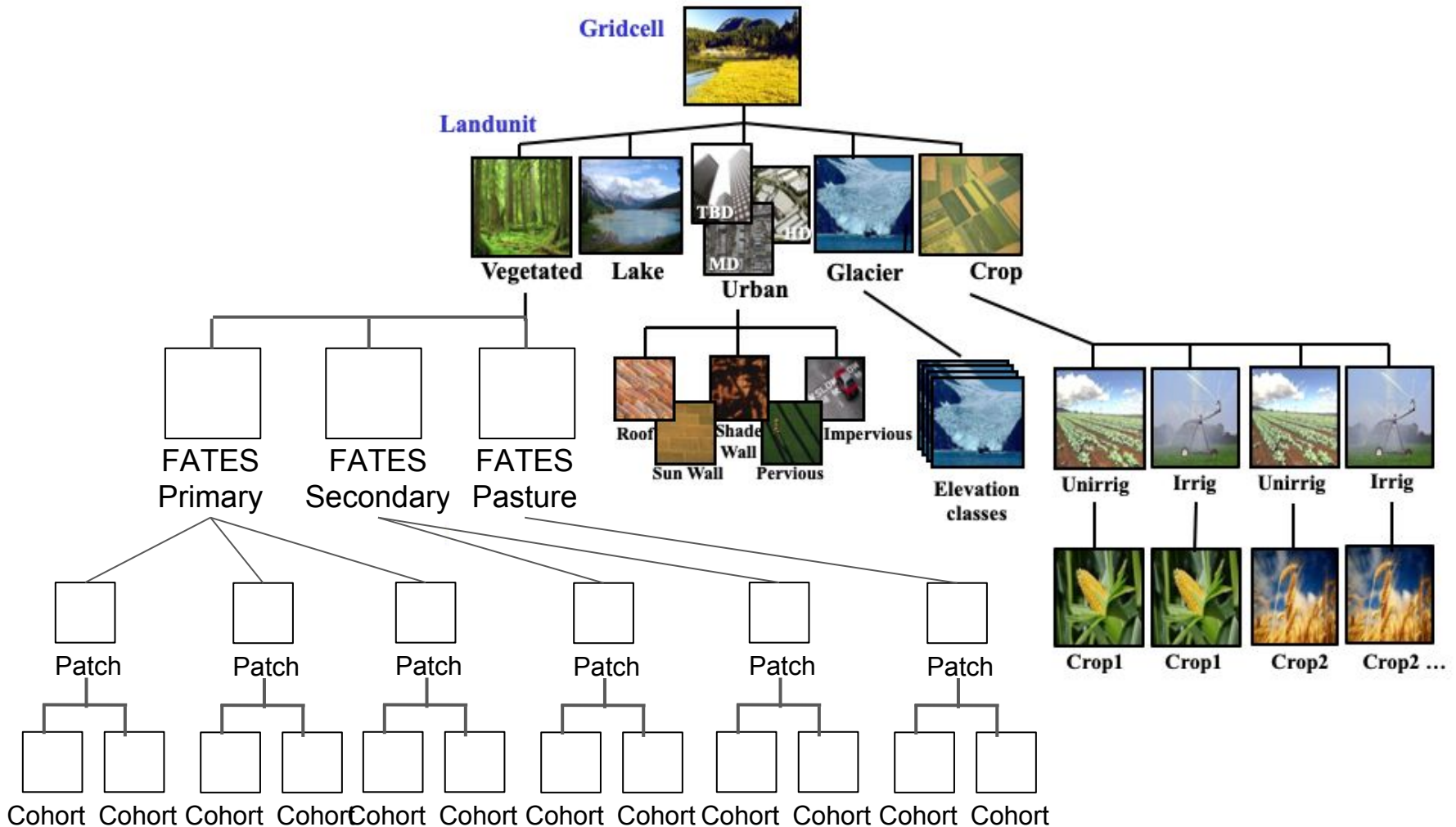
Plant Functional Type tiling
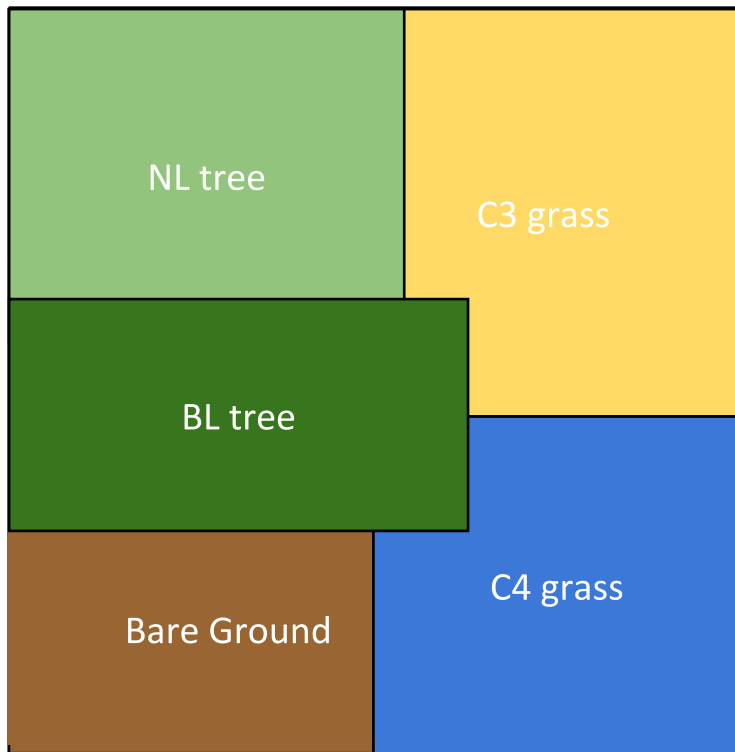
Time-Since-Disturbance tiling
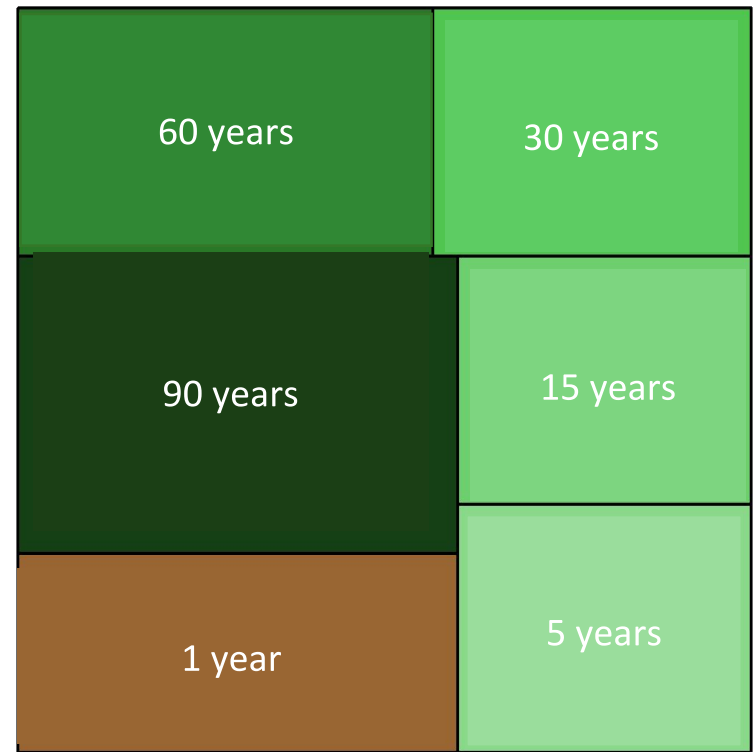
How does this translate to the full CLM subgrid hierarchy?

What do we want the LULCC in FATES to look like ultimately?

Current Status of LULCC in FATES:
Logging module

Maoyi Huang and Yi Xu (PNNL) have led the development of a preliminary logging module.

Allows specification of discrete event-based logging treatment, with the following parameters:

- *Harvest frequency and date*
- *Harvest Intensity*
- *Minimum diameter of trees harvested*
- *PFT to be harvested*
- *Fraction of forest area killed by logging infrastructure*
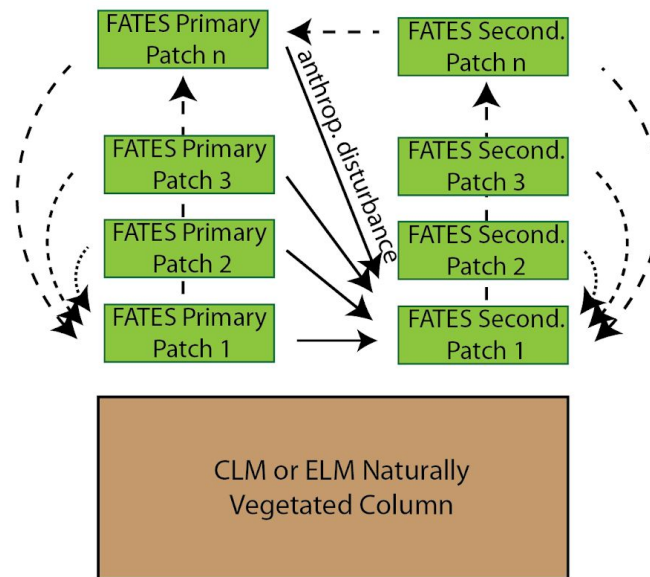- *Understory mortality rate in logged areas*

Manuscript incl. comparison with data near Manaus, in prep

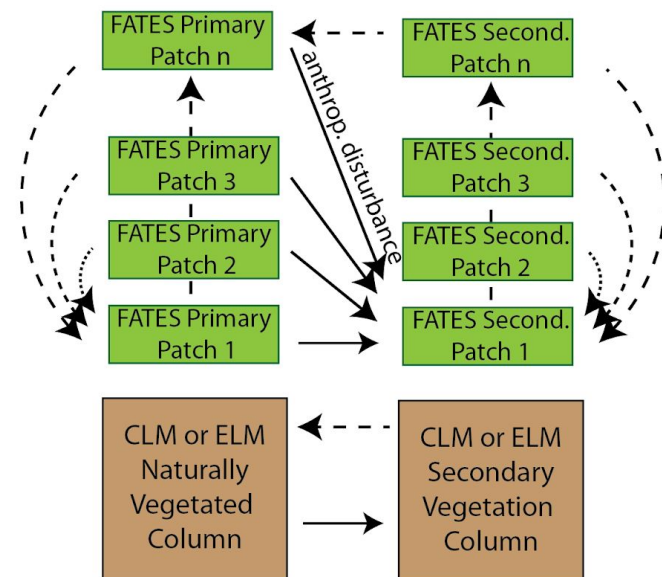# Structured land use representation in FATES
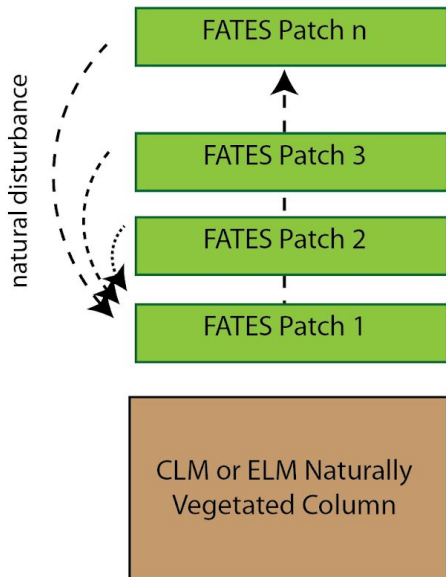
Collaborative meeting on path forwards for FATES in CESM & E3SM

- "Task force" discussion at AGU with J. Holm, K. Calvin, B. Bond-Lamberty, M. Huang, G. Bisht, M. Longo, R. Fisher, R. Knox, J. Shuman, P. Lawrence, D. Lawrence, C. Koven

- Articulated strategy shared across projects to get land use working

- The Plan

  - Follow the earlier schematic, with drivers for land use being as close to the LUH2 datasets as possible, and CLM and ELM passing this driver info to FATES which drives the LULCC dynamics

Initial testing of FATES output to track secondary forest area:

- Annual Logging event
- 15% of all trees with DBH > 50cm harvested
- All crown area of harvested trees becomes secondary forest
- Currently the surviving trees remain in primary forest — still need to update disturbance routines so that unharvested trees adjacent to the logged trees also become secondary forest
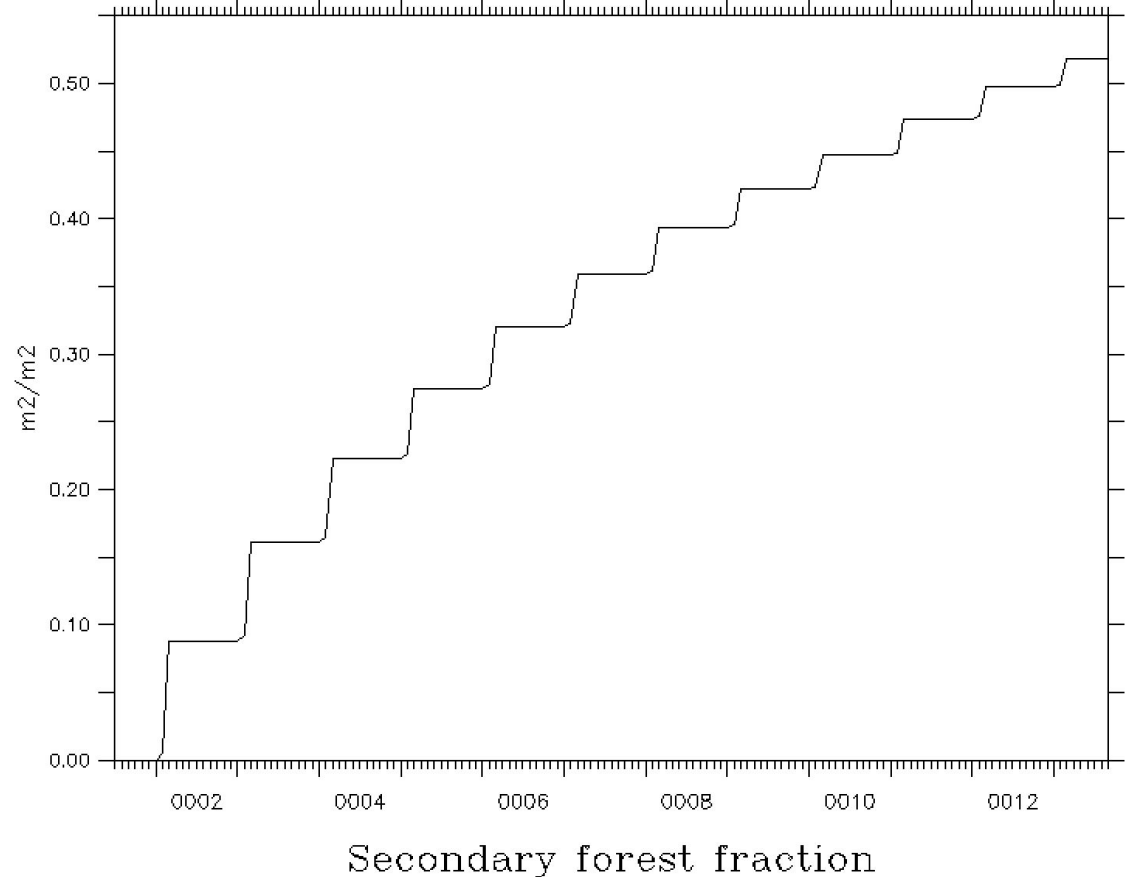
A proposed LULCC Information Flow

CLM5

CLM5 Tech Note
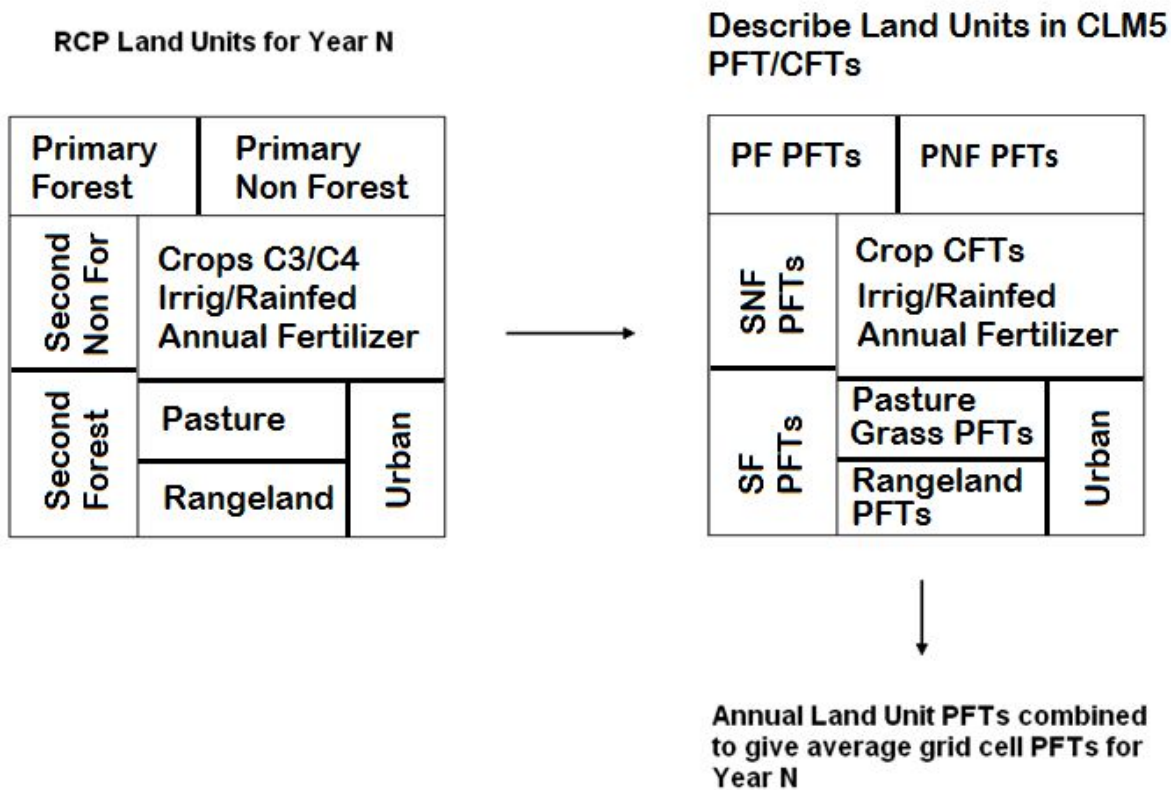
A proposed LULCC Information Flow

CLM-FATES

RCP Land Units for Year N

Primary Forest	Primary Non Forest	
Second Non For	Crops C3/C4 Irrig/Rainfed Annual Fertilizer	
Second Forest	Pasture	Urban
	Rangeland	

→

LUH2 defines FATES primary/secondary land transitions directly

Forest/non-forest allowed to emerge from PFT competition

Crops / Urban defined as before

Pasture / Rangeland defined as FATES LU type and given management treatments

Steps towards a FATES-LULCC

1. Directly **read harvest time-series** (either in mass or area), pass to FATES, and use to drive FATES logging module, which generates primary/secondary forest fractions

2. Diversify logging logic to **allow different types of harvest** (selective, clearcut, etc, with different parameters for different harvest types)

3. Directly **read full land use transition matrix,** pass to FATES, and use to drive FATES transitions. Keep all primary/secondary patches on same column.

4. **Separate primary and secondary FATES land** onto distinct columns, allowing primary columns to pass ecosystem structure to secondary columns during transitions.

What other things do we need?
(to make FATES a versatile scientific tool)

- **Fixed vegetation mode**:
    - Read in a surface dataset and define multiple columns running FATES that allow only a subset of PFTs within each FATES column

- **PFT competition across key biome boundaries** (which?)

- **Crop model** (Software coexistence with FATES)

- **Nutrients** (in the works for NGEE-tropics Phase II)

- **Satellite Phenology** within FATES

- **Benchmarks**:
    - Standard ILAMB +
    - Biome boundary datasets
    - Canopy height distributions from remote sensing
    - …

- **What else?**

Ongoing and planned FATES projects (non-exhaustive!)

- NGEE-tropics (DoE/LBL -led tropics-focused project. Phase II proposal ongoing)
    - Nutrient cycling, allocation
    - Fire, Gas Exchange,ysiology testbeds
    - Tropical forest testbeds
    - Coexistence & trait filtering
    - FATES-Hydro testing & calibration
    - Tropical phenology
    - Radiation transfer

- E3SM
    - Land-use implementation (LUH2)
    - Global PFT calibrations

- California/LBL proposals
    - Parameters for Western US forests
    - Wildfire simulation & benchmarking
    - FATES x Hillslope model
    - Regeneration parameterization

- University of Oslo (EMERALD, NorESM)
    - High latitude PFTs & processes
    - Moss PFTs

- LANL
    - Insect dynamics, wetlands, fire-atmosphere interactions

- University of Washington (Abby & Marlies)
    - Competitive dynamics under high CO_2

Biweekly FATES teleconferences
starting soon
+Thurs, 11am Pacific; 12am MDT, 8pm CET:
+Sign up for alerts at:
Fates_model google group