FATES Historical Land Use Dynamics

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With lots of help from lots of people, including (alphabetically):

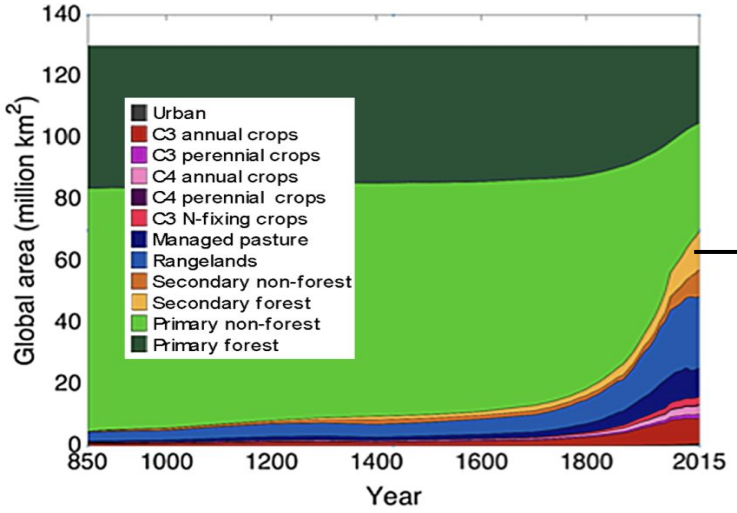
Alan Di Vittorio, Rosie Fisher, Adrianna Foster, Jennifer Holm, Michael Keller, Ryan Knox, Jenny Kowalczyk, David Lawrence, Peter Lawrence, Greg Lemieux, Marcos Longo, Jessie Needham, Sam Rabin, Shijie Shu, Anthony Walker

NGEE–TROPICS

NEXT-GENERATION ECOSYSTEM EXPERIMENTS

Incorporation of land use drivers into FATES

LUH2 (or LUH3) state and transition data



LUMIP: Lawrence et al., 2016

FATES land use types:
Primary, secondary, range, pasture, crop

Receiver Patch Type

Donor Patch Type

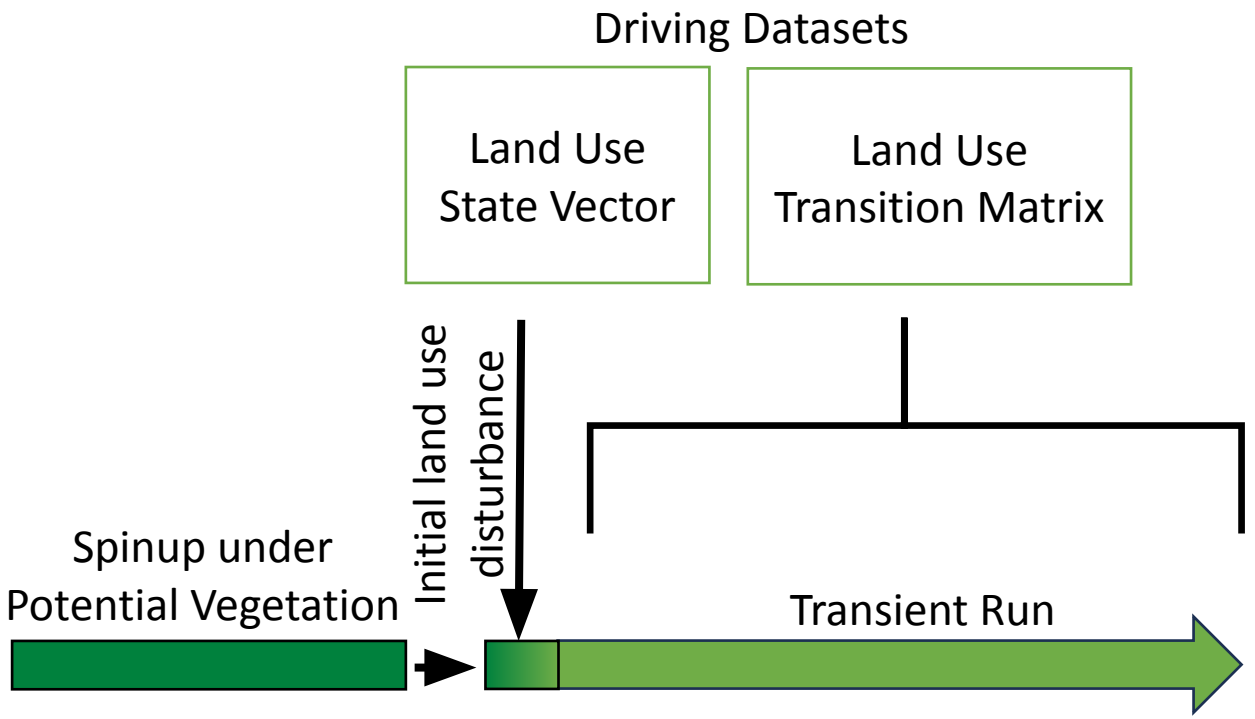
Primary *treefall, fire*	*harvest*	*Land use change*	*Land use change*	*Land use change*
	Secondary *harvest, treefall, fire*	*Land use change*	*Land use change*	*Land use change*
	Land use change	**Range** *treefall, fire*	*Land use change*	*Land use change*
	Land use change	*Land use change*	**Pasture** *fire*	*Land use change*
	Land use change	*Land use change*	*Land use change*	**Crop** *fire*

FATES now has four distinct disturbance types:

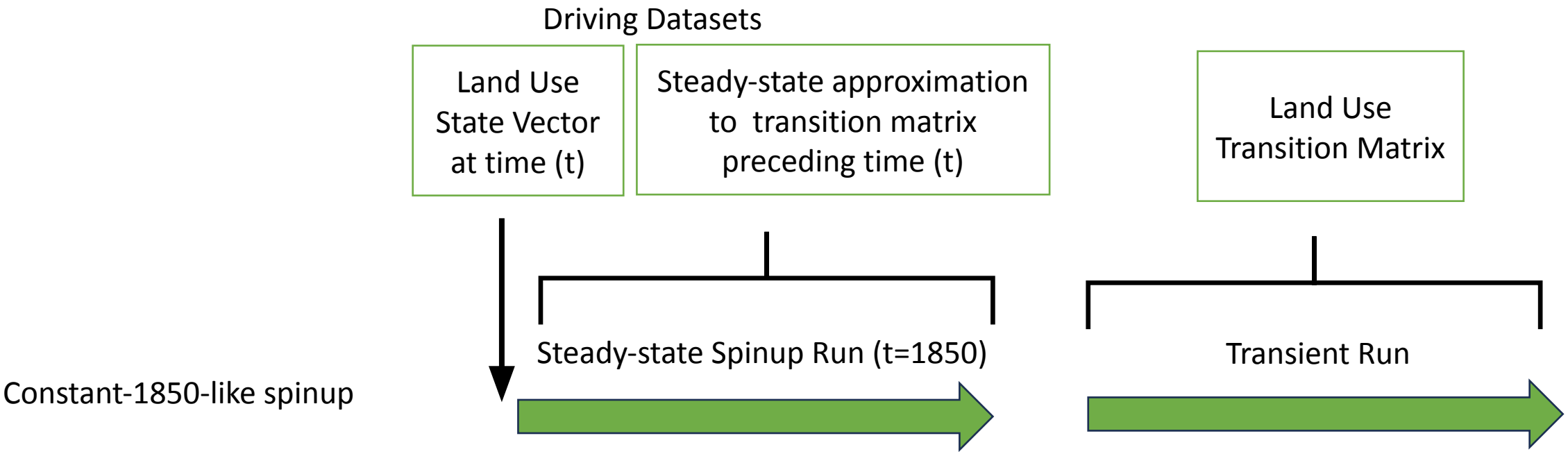
- *Treefall*
- *Fire*
- *Tree Harvest*
- *Land Use Change*

Spinup Problem: FATES is structured around tracking disturbance history. How do we capture the disturbance history that had occurred before the start of a simulation?

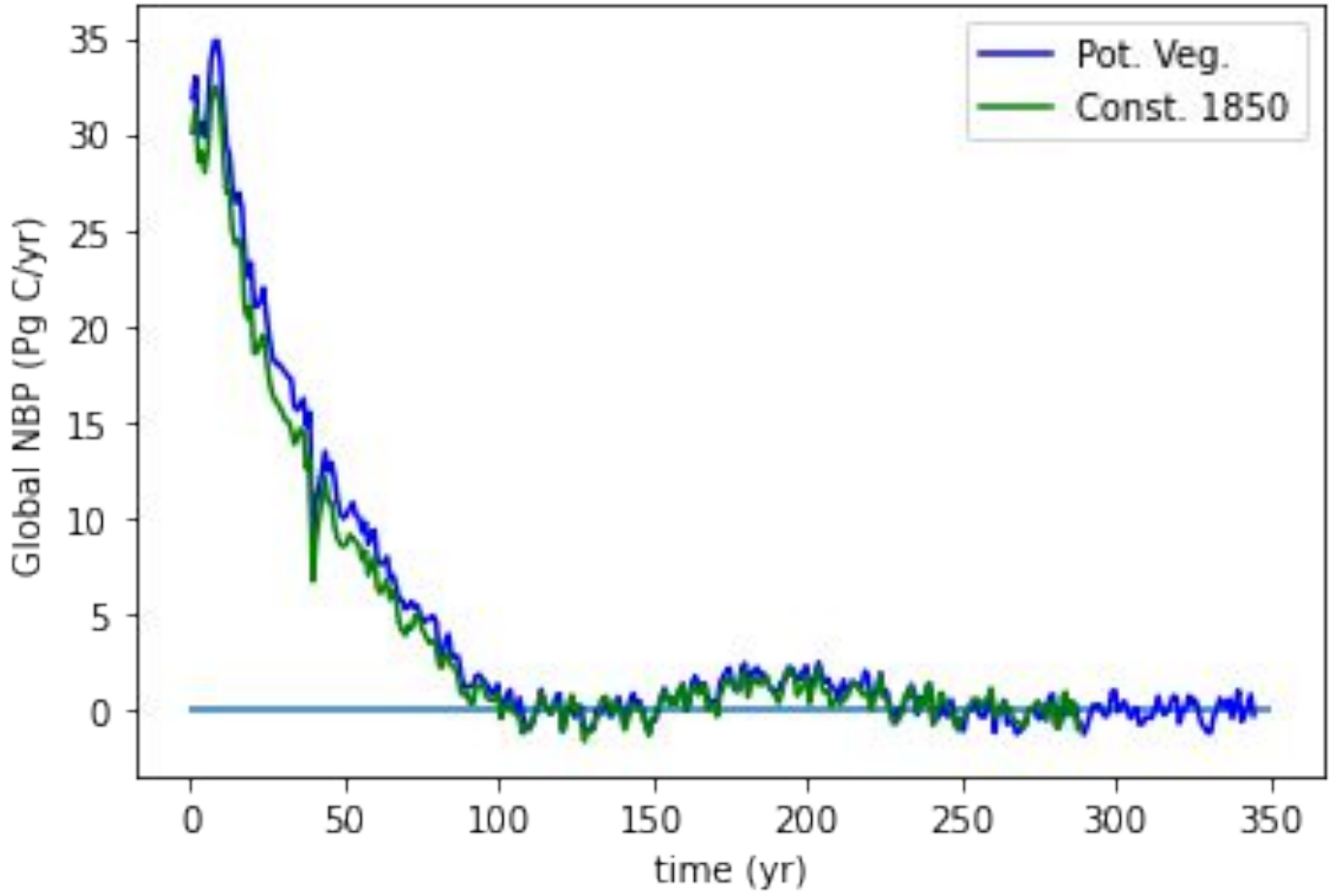
Solution 1: Spin up under no land use ("potential vegetation"), then start the run before the time period of interest, representing all prior historical land use on first timestep, to let the transient dynamics stabilize by start of run.



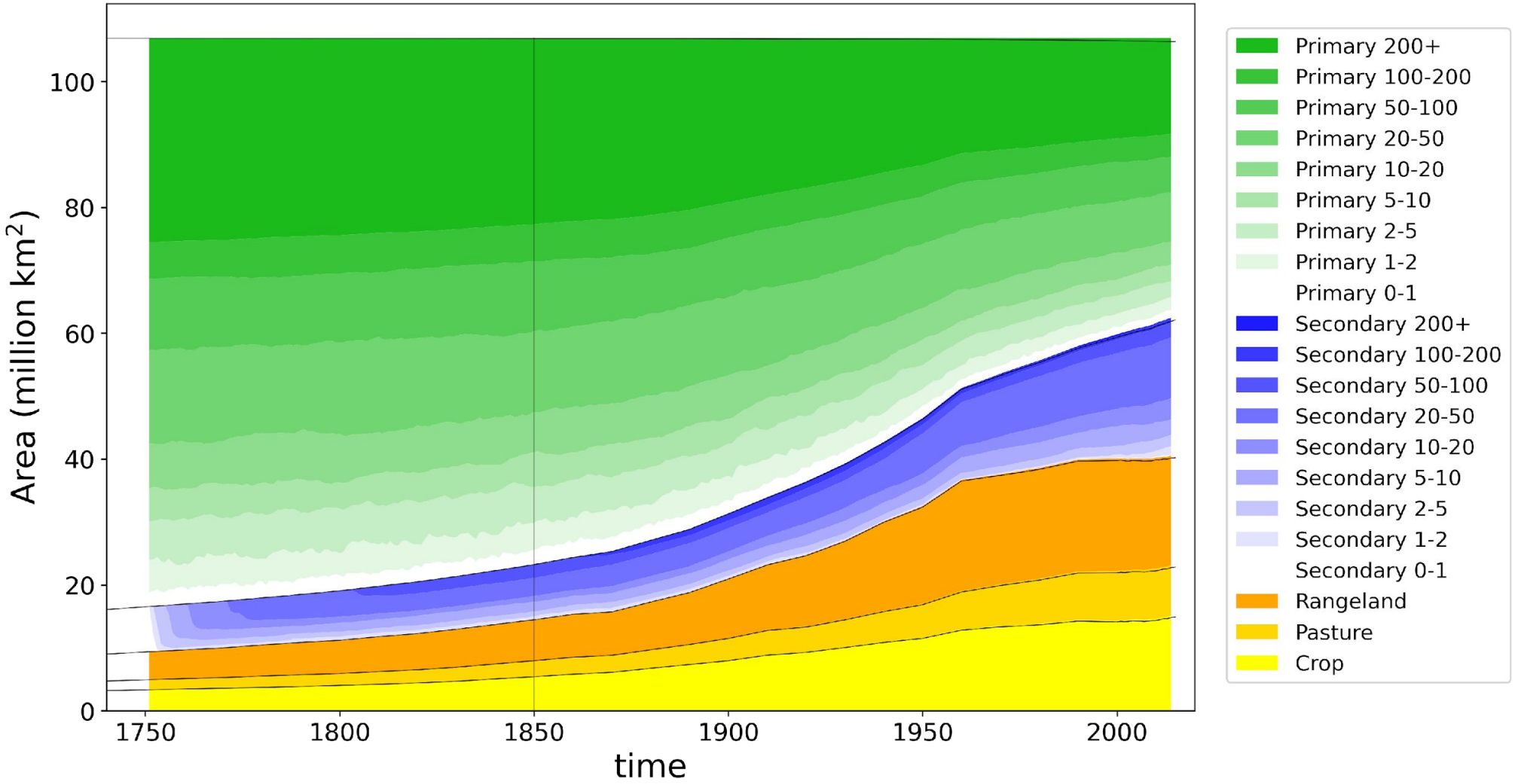
Solution 2: find a steady state transition matrix that leads to approximate 1850 conditions and spin up using that. (analogous to classic ELM/CLM I1850 compsets)



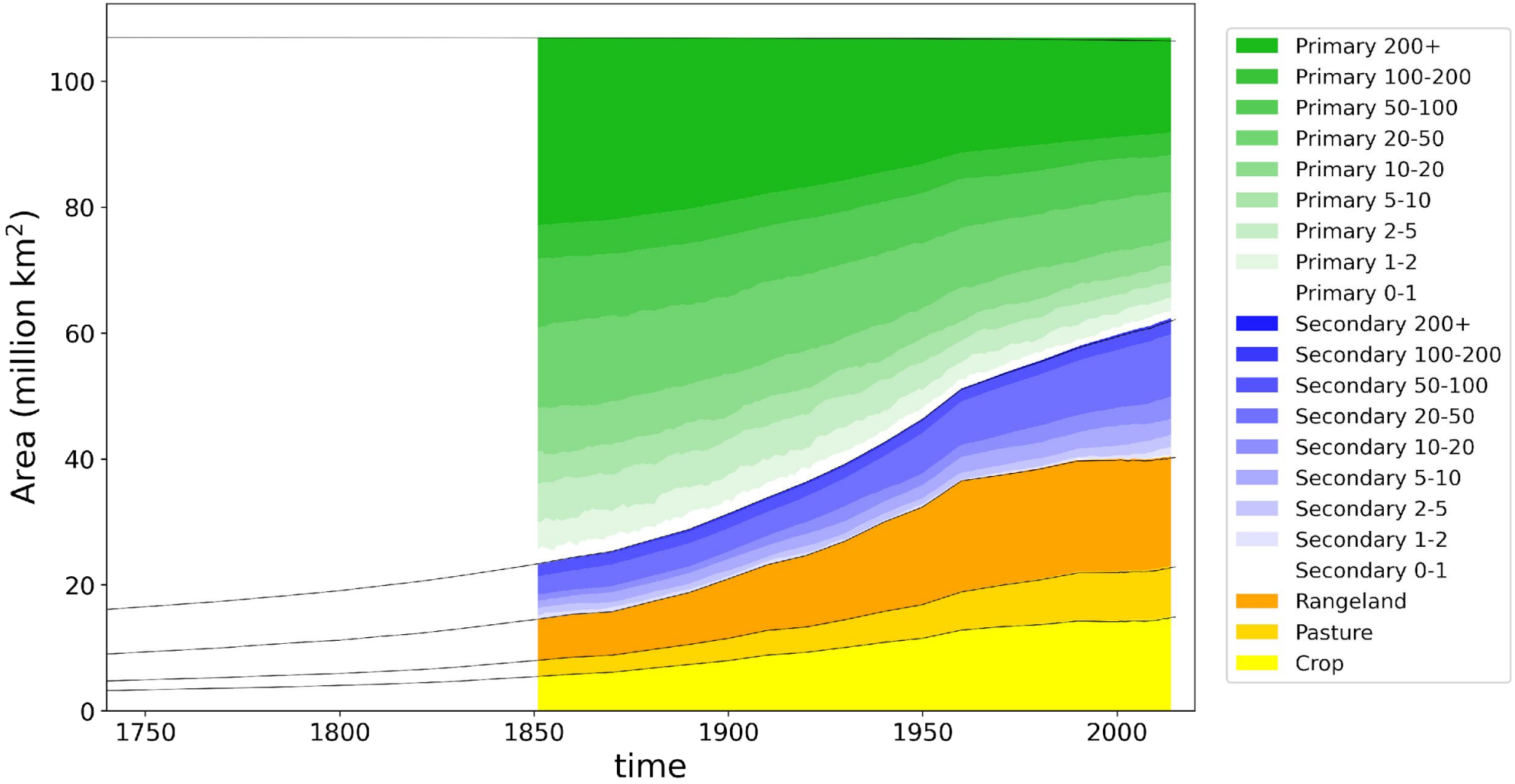
How long to spin up under AD before steady-state?



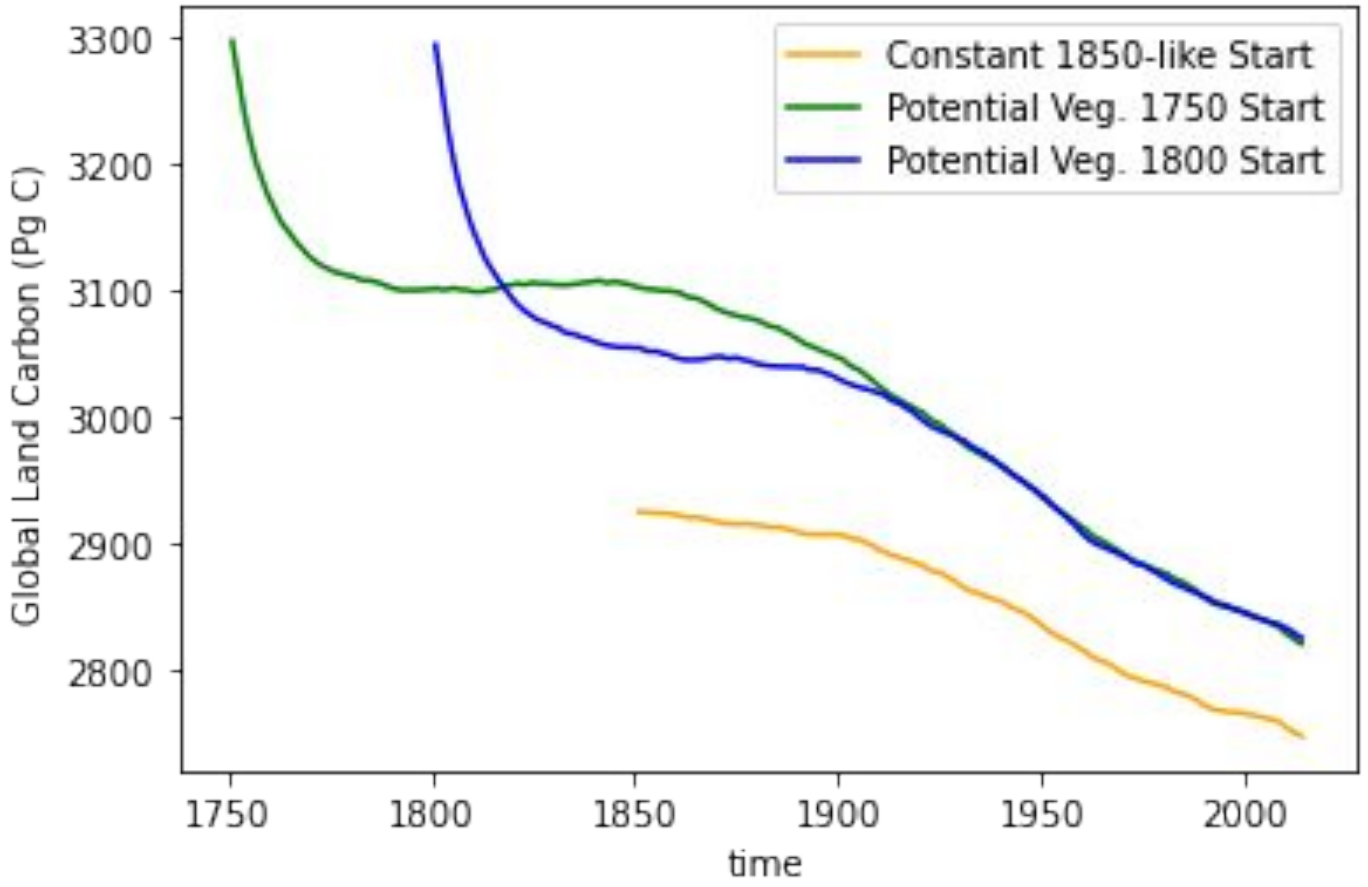
Transient case: Land use areas and age distribution starting from potential veg



Transient case: Land use areas and age distribution starting from constant-1850 LU

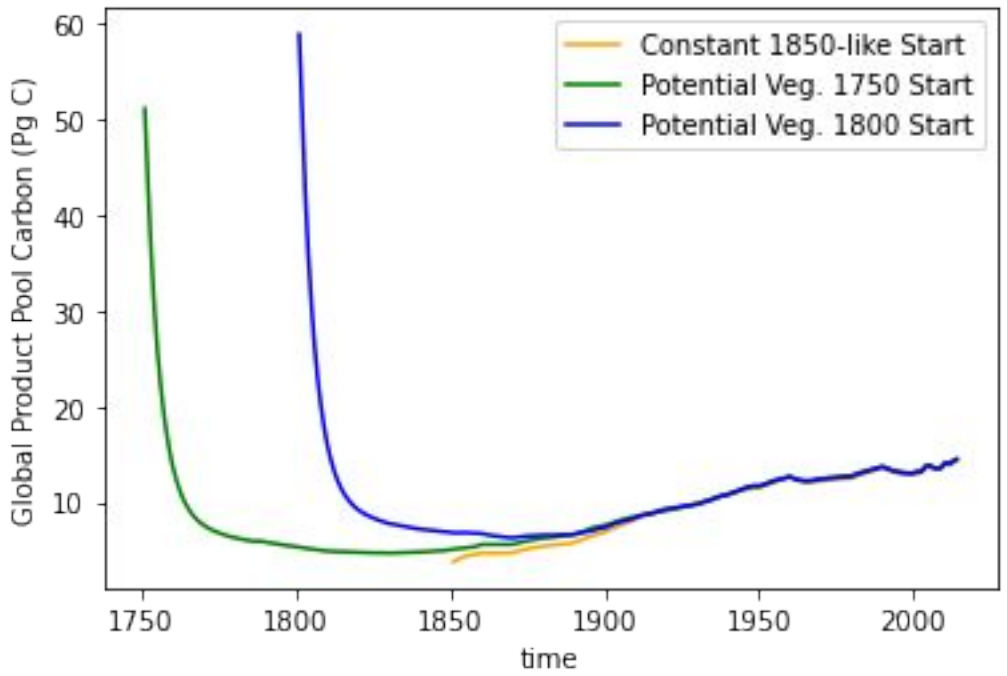


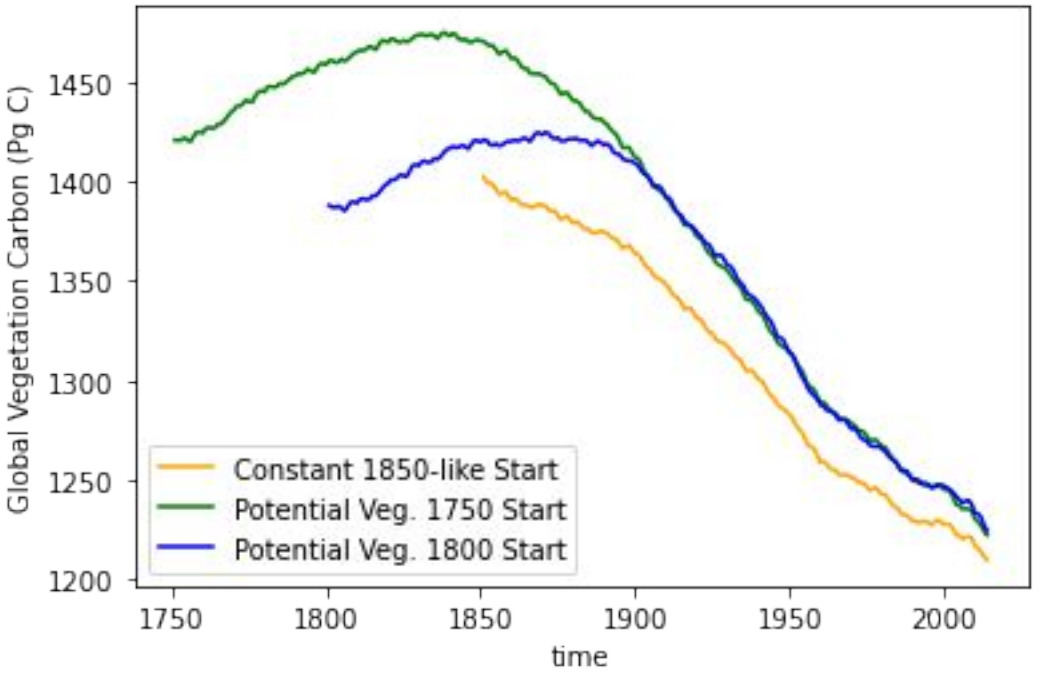
Transient Carbon Cycle Dynamics constant climate, constant CO_2, transient land Use

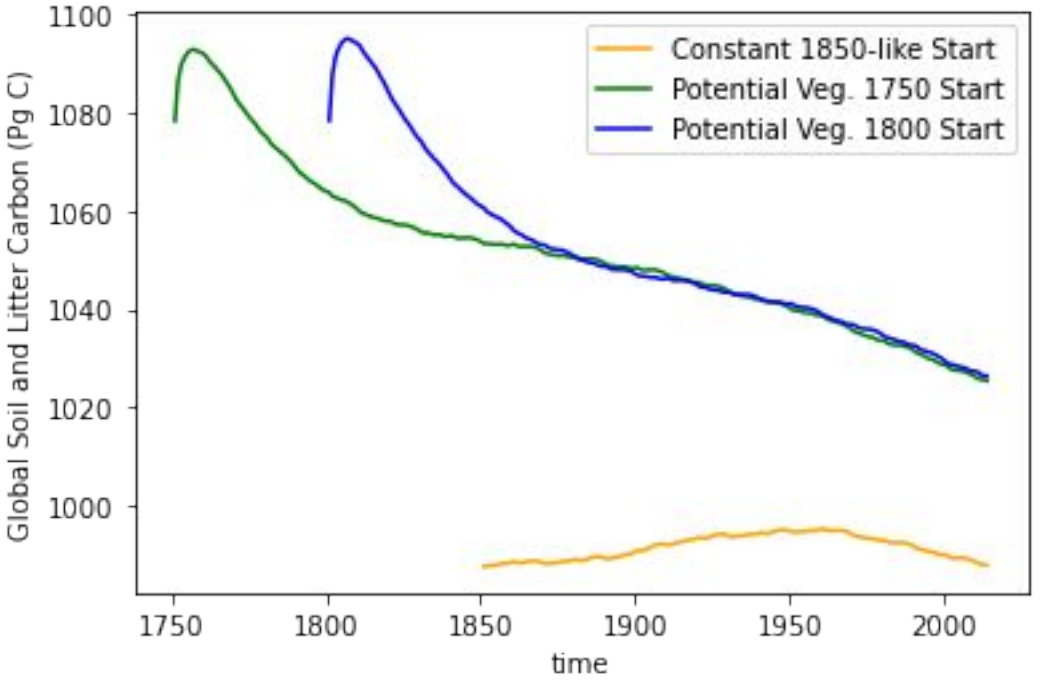


Caveat here and in subsequent slides: C3 grasses were basically dead in this run, which amplifies differences between cases. Currently re-running with healthier C3 grasses.

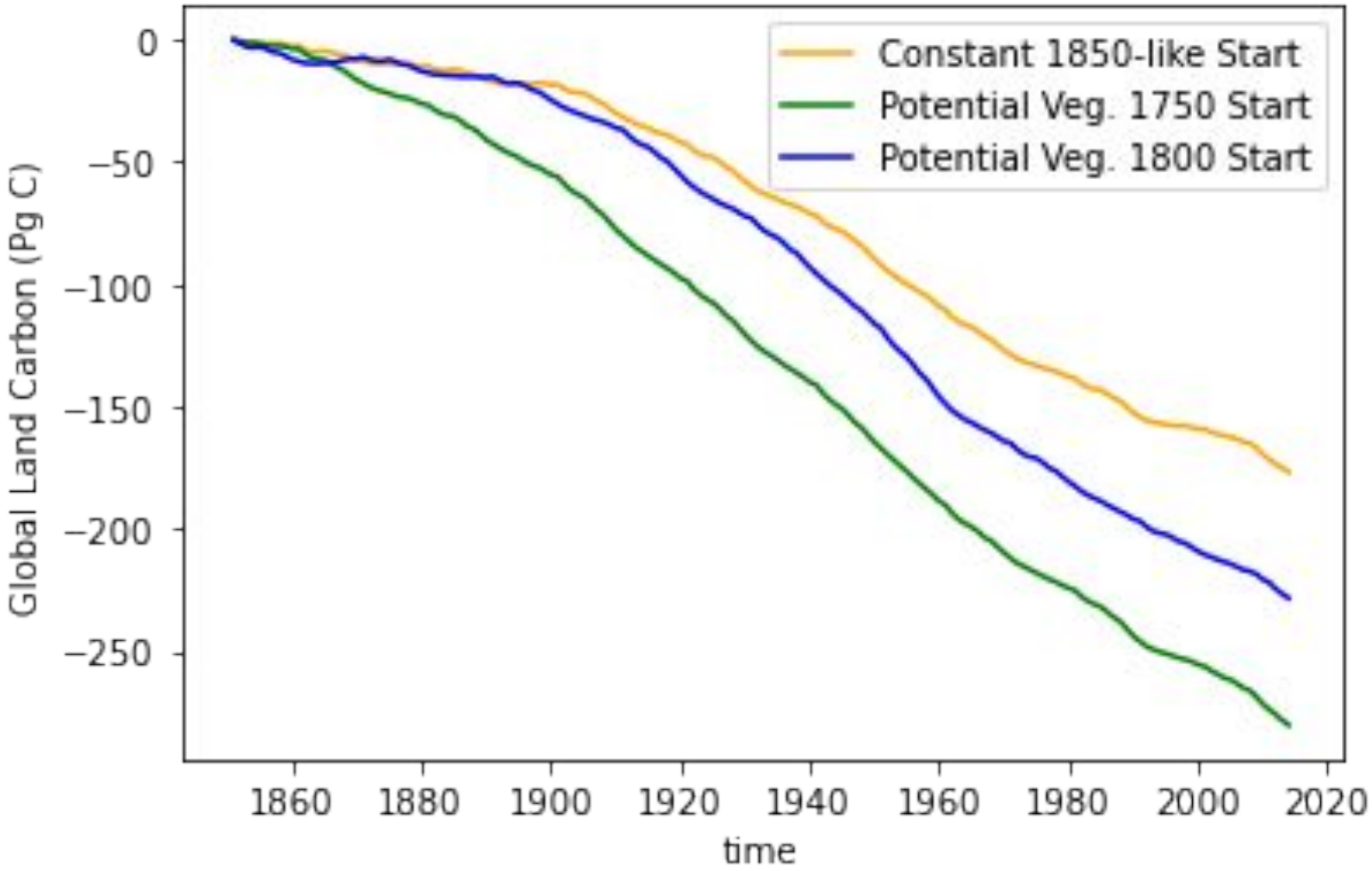
Transient dynamics by carbon pools



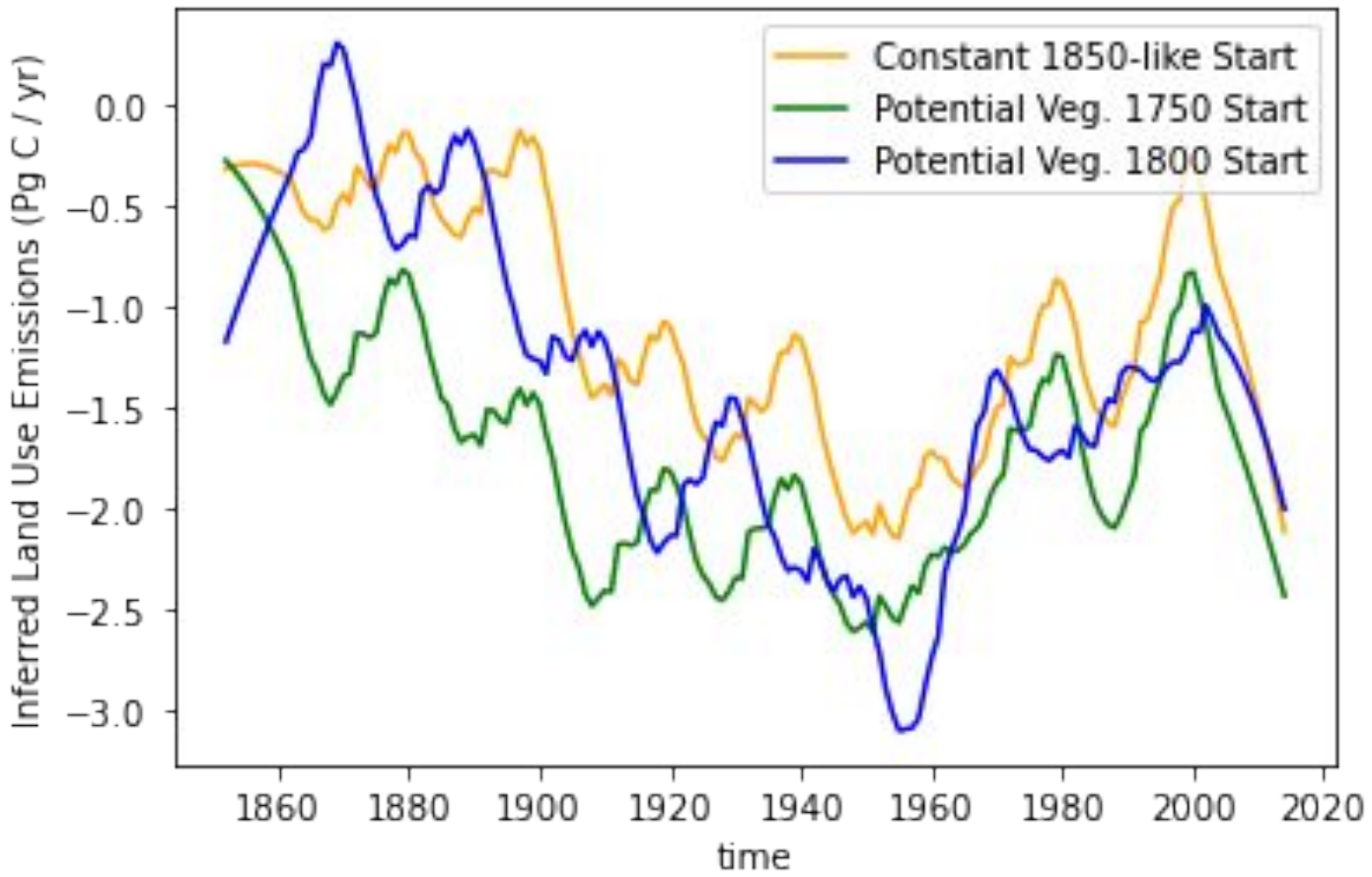




Change in carbon from 1850



Estimate of land use change, calculated as derivative of carbon stocks



Summary

- FATES global nocomp spinup requires around 300 years to reach steady-state under current approach
- Vegetation carbon dynamics similar between spinup approaches after ~100 years of transient dynamics
- Two different land-use spinup approaches lead to somewhat different outcomes, particularly for soil carbon
- Persistent soil carbon differences lead to long-term difference in inferred land use change flux, even to present
- Which approach is more realistic? I tend to think that, though each represents an endmember approach, with reality likely in between, the constant-1850 approach is likely more realistic because it allows the deficit in soil carbon to already be present at the start of the historical simulation.

Next Steps

- Currently rerunning under slightly different regime:
  - C3 grasses healthier
  - Grazing active
  - Updated forcings from LUH2 historical to LUH3 historical
  - Following closer to a TRENDY-like protocol to vary climate and CO2, so that land-use change emissions are calculated in the presence of other transient dynamics
- Otherwise:
  - Land-use change machinery appears to be working
  - Once done, can start with more formal benchmarking using ILAMB, and iterate…