

Functionally Assembled Terrestrial Ecosystem Simulator

FATES round-up and update

Charlie Koven, Rosie Fisher, Ryan Knox, Jacquelyn Shuman, Adrianna Foster,
Greg Lemieux and FATES team and community

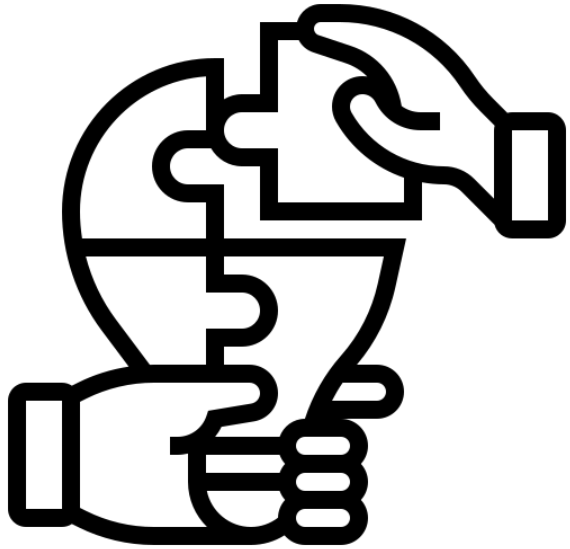


Jacquelyn Shuman
Climate and Global Dynamics, Project Scientist

Land winter meeting
February 7, 2023



Opportunities

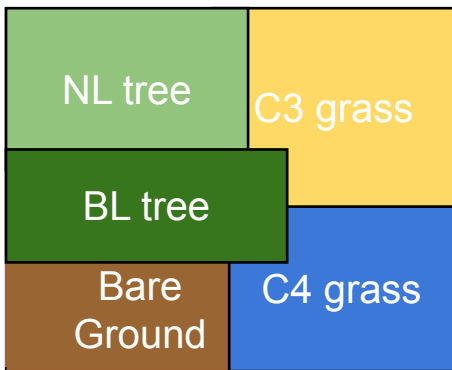


Can you add to FATES or collaborate?

FATES as primary vegetation model

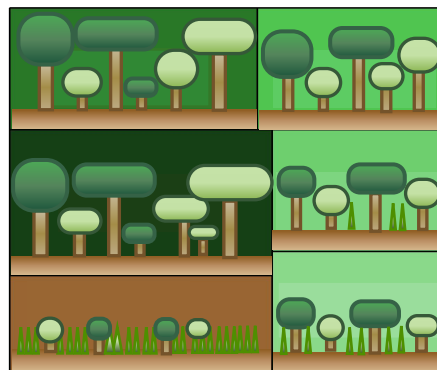
CLM

Big Leaf



FATES

Cohort Model



- Timber yields
- Wildfire risk
- Ecosystem vulnerability

FATES complexity modes

Satellite Phenology

One cohort and patch

Observed PFT LAI

No disturbance, growth, or mortality

No Competition

PFTs with fixed area

Growth & disturbance

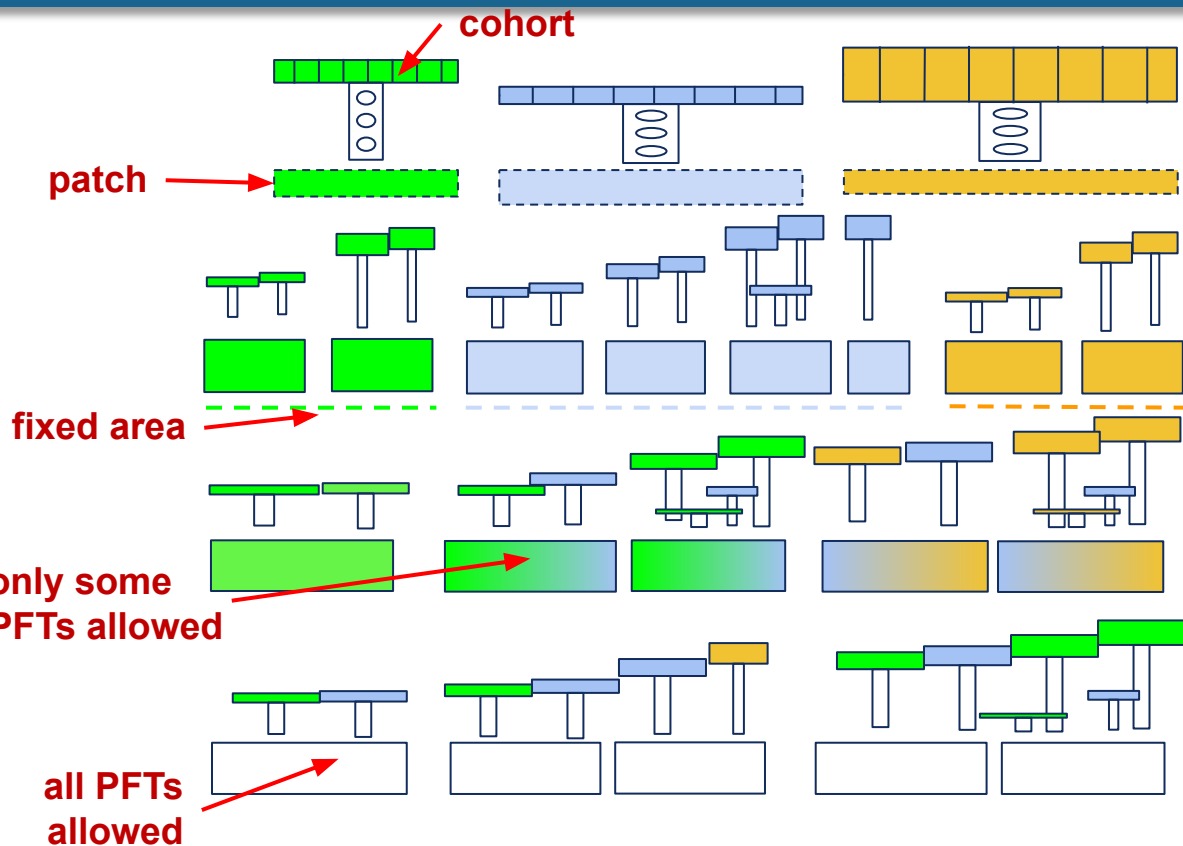
Fixed biogeography

Prescribed Biogeography

Growth, disturbance, and competition,
but only where PFT defined

Full FATES

Growth, disturbance, and
competition everywhere



FATES priorities

Land Use Land Cover Change

- Dynamic land units
- LUH2 data to FATES
- Crops separate from Nat Veg
- Forest management

Nutrients

- Implement CLM connections

Fire

- Fire emissions

MEGAN and Dry Dep

- Functional in FATES-SP
- Custom PFT and emissions

Calibration

- ILAMB testing
- Calibration Cascade
- PPE - scripts and testing
- Site- & Regional-level

FATES-SP

- Reduce output
- LAI streams

Infrastructure

- FATES compsets
- Coupling
- Restart files
- NEON (**functional**)
- HH (**functional**)

FATES priorities

Land Use Land Cover Change

- Dynamic land units
- LUH2 data to FATES
- Crops separate from Nat Veg
- Forest management (**Joshua R.**)

Nutrients (**Ryan K.**)

- Implement CLM connections

Fire (**Xiulin G., Jackie S.**)

- Fire emissions

MEGAN and Dry Dep

- Functional in FATES-SP
- Custom PFT and emissions

Calibration

- ILAMB testing (**Adrianna F.**)
- Calibration Cascade (**Marcos L. , Jessica N.**)
- PPE - scripts and testing
- Site- & Regional-level (**Polly B.**)

FATES-SP (**Rosie F.**)

- Reduce output
- LAI streams

Infrastructure (**Eva L. & Lasse K.**)

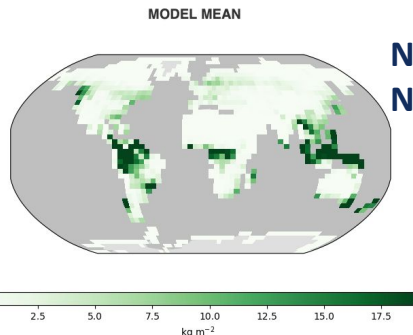
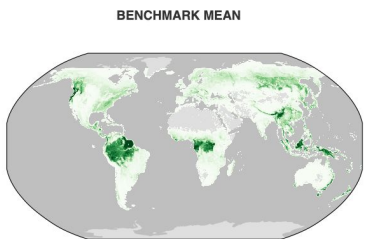
- FATES compsets
- Coupling
- Restart files
- NEON (**functional**) (**Adrianna F.**)
- HH (**functional**)

FATES ILAMB Testing

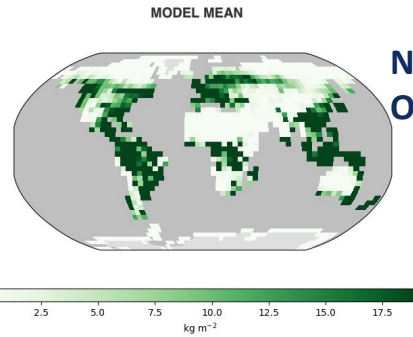
New parameter file from Jennifer Holm (api 24.1 vs. 25)

- Differences: DBH max height; SLA_{top} , V_{cmax} , freeze mortality tolerance, recruitment height, reproduction minimum DBH, wood density

Biomass



**No-competition mode
New parameters/API**



**No-competition mode
Old parameters/API**

	FATES-SP (old param)	FATES-SP (new param)	FATES no comp (old param)	FATES no comp (new param)	FATES fixed bio. (old param)	FATES fixed bio. (new param)
Ecosystem and Carbon Cycle						
Biomass						
Gross Primary Productivity						
Ecosystem Respiration						
Hydrology Cycle						
Evapotranspiration						
Latent Heat						
Sensible Heat						
Radiation and Energy Cycle						
Albedo						
Surface Upward SW Radiation						
Surface Net SW Radiation						
Surface Upward LW Radiation						
Surface Net LW Radiation						
Surface Net Radiation						

Relative Scale

Worse Value Better Value

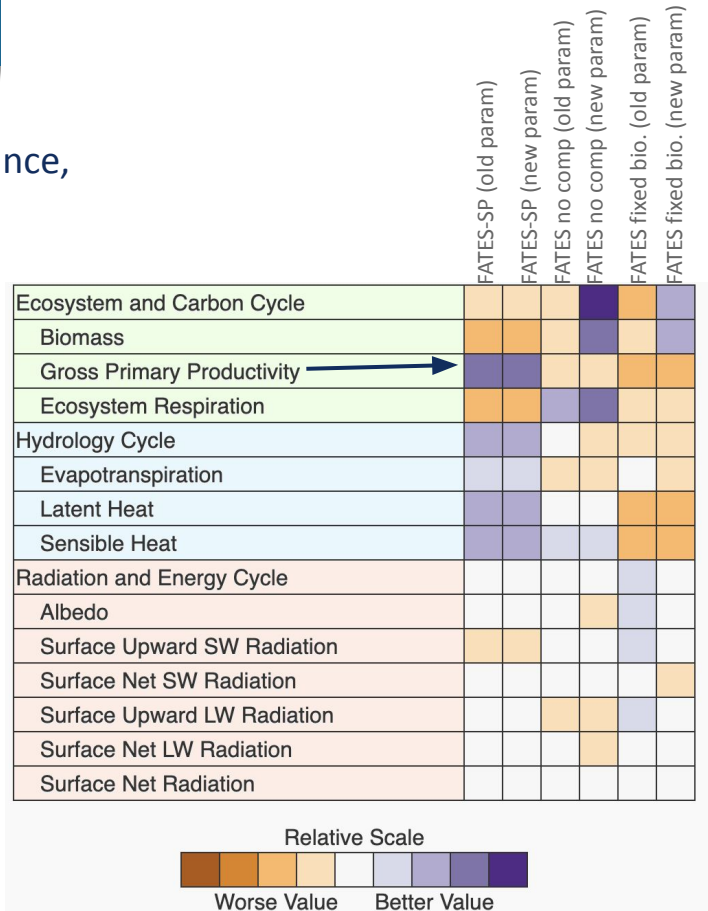
FATES ILAMB Testing

New parameter file from Jennifer Holm (api 24.1 vs. 25)

- Differences: DBH max height; SLA_{top} , V_{cmax} , freeze mortality tolerance, recruitment height, reproduction minimum DBH, wood density

GPP

Benchmark		Mean	Bias	RMSE	Score
CTSM5.1_FATES_fb_new	[-]	199.	0.338	0.386	0.544
CTSM5.1_FATES_fb_old	[-]	215.	0.298	0.390	0.531
CTSM5.1_FATES_nc_new	[-]	149.	0.385	0.433	0.568
CTSM5.1_FATES_nc_old	[-]	157.	0.363	0.432	0.562
CTSM5.1_FATES_SP_new	[-]	148.	0.474	0.524	0.656
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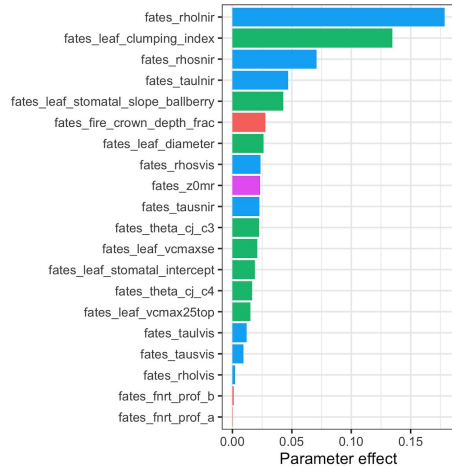
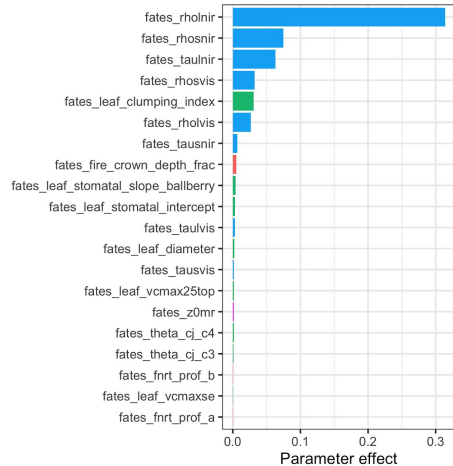
FATES global calibration across complexity modes



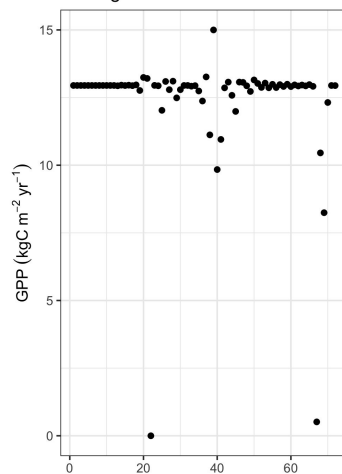
FATES PPE shows important parameters to calibrate

Albedo: average

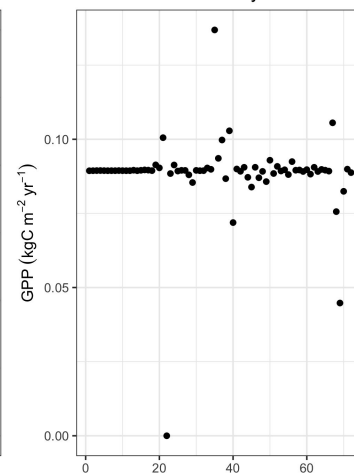
Albedo: IAV



Average

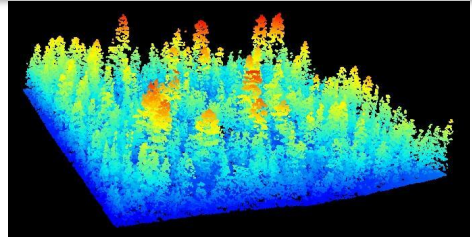
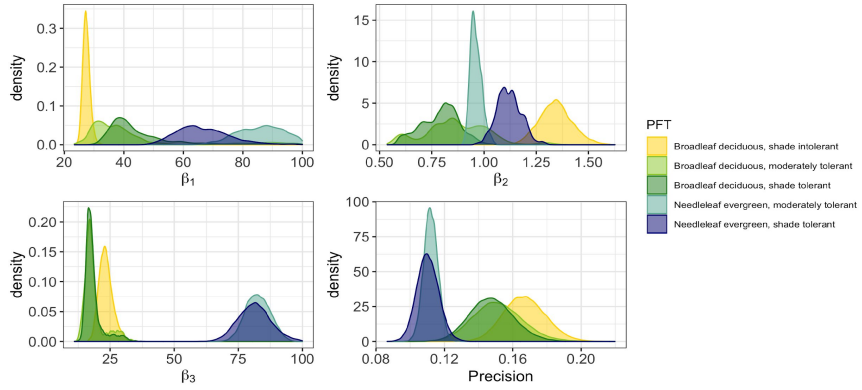


Interannual Variability

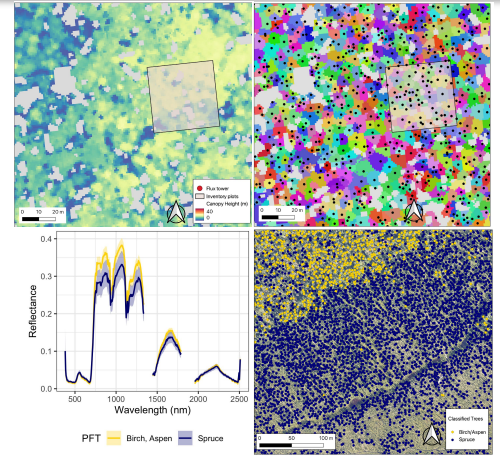


FATES single-point simulations at NEON sites

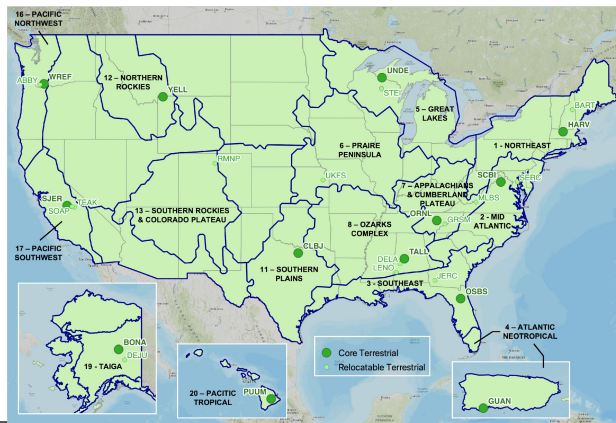
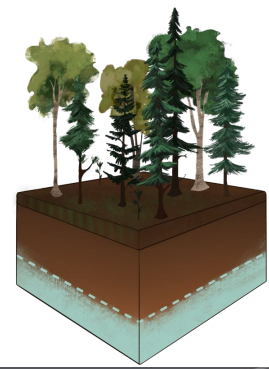
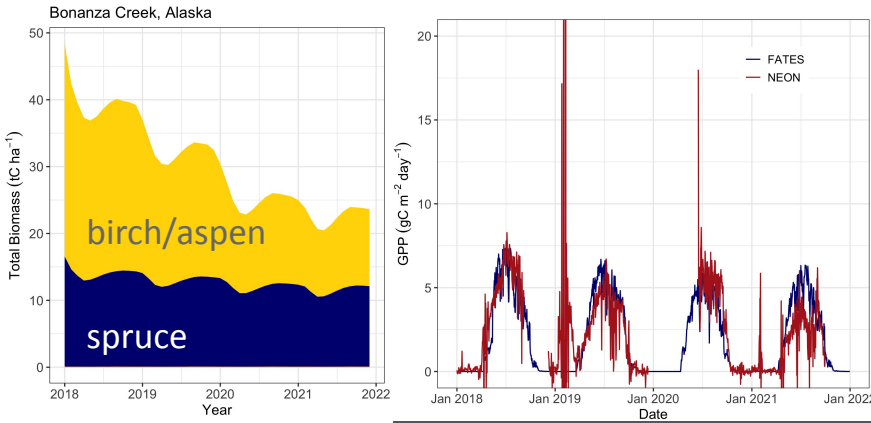
Parameter calibration & uncertainty using Bayesian statistical methods



Leveraging NEON aerial LiDAR and hyperspectral imagery for initializing with current forest conditions

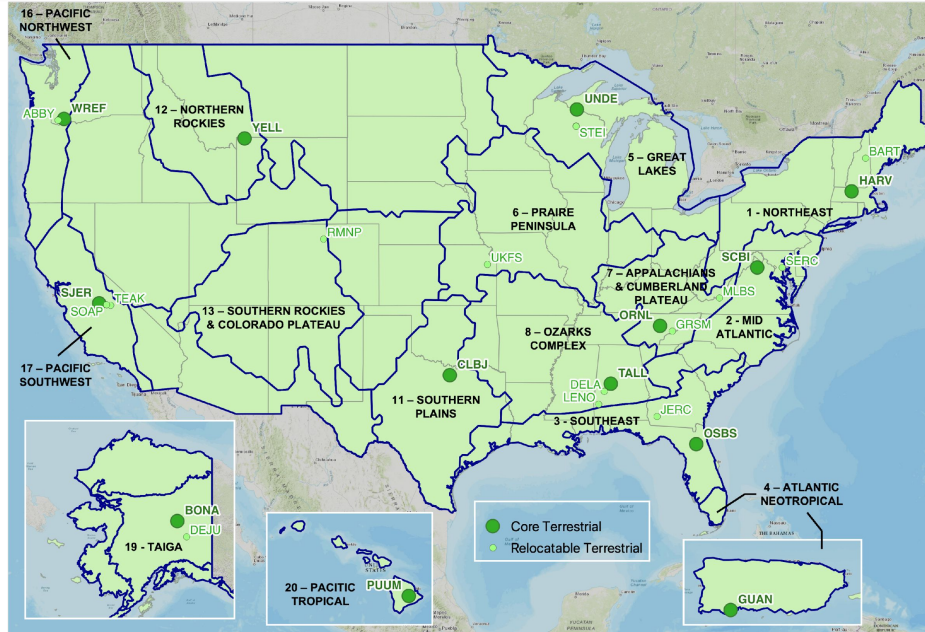


Comparison to NEON observations



Adrianna Foster, NCAR

You can now run FATES at 45 NEON sites!



Please test FATES
and let us know
how we can
improve!

Initial conditions files
planned for the future

Command to create a job:

```
./create_newcase --case $job_name --res CLM_USRDAT --compset I1PtCIm51Fates
```

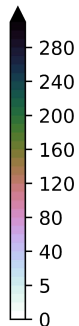
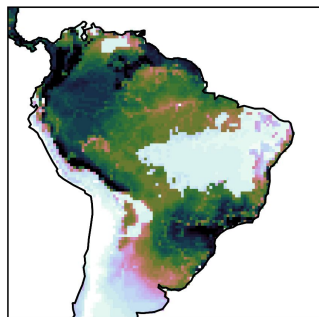
```
--user-mods-dir CTSM/cime_config/usermods_dirs/NEON/FATES/${NEON_SITE} --run-unsupported
```

Check out CTSM PR #1932 for more information

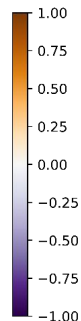
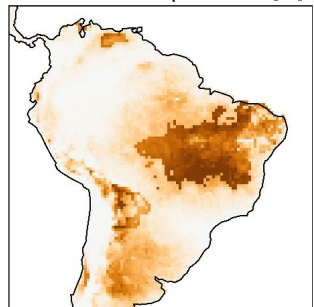
<https://github.com/ESCOMP/CTSM/pull/1932>

FATES impact of fuel drying and interactive fire

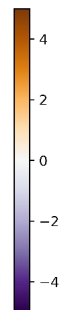
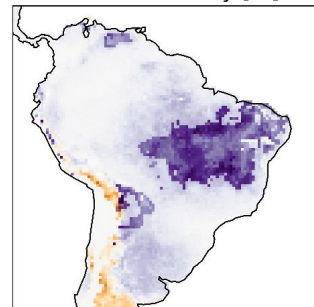
FATES, high dry



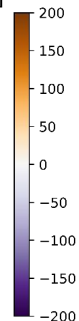
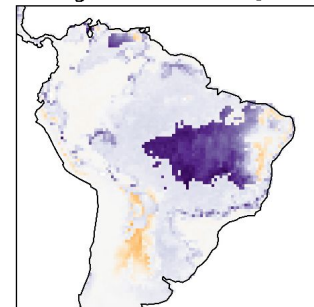
minimum temperature [C]



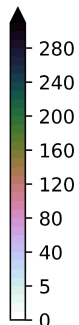
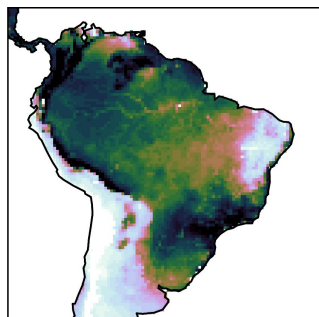
relative humidity [%]



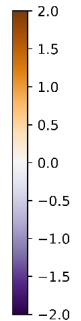
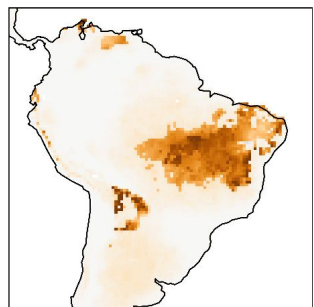
aboveground biomass [tC/ha]



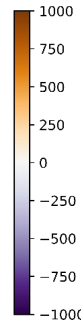
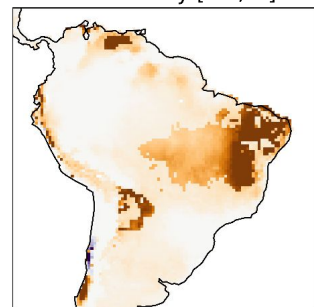
FATES, low dry



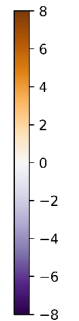
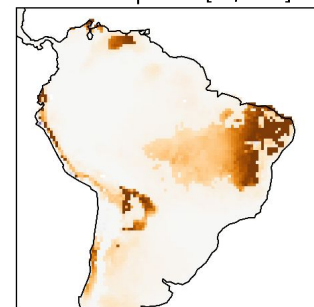
burned fraction



fire intensity [kW/m]



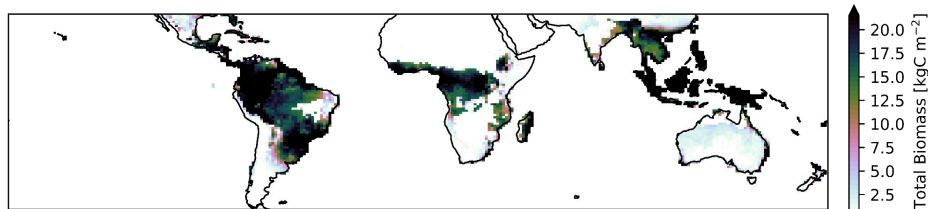
rate of spread [m/min]



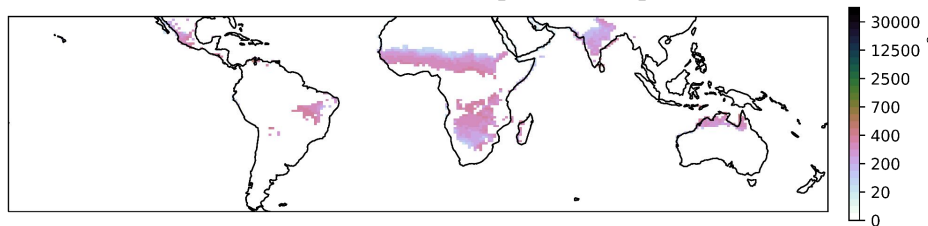
Difference between high fuel drying and low fuel drying (high dry - low dry)

FATES tropical application

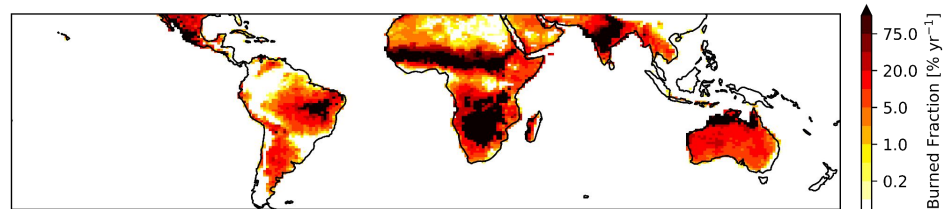
Total biomass [kgC m⁻²]



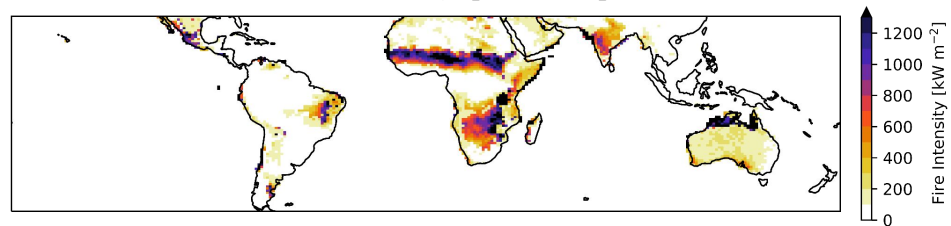
C4 grass biomass [kgC m⁻²]



Burned fraction [% yr⁻¹]



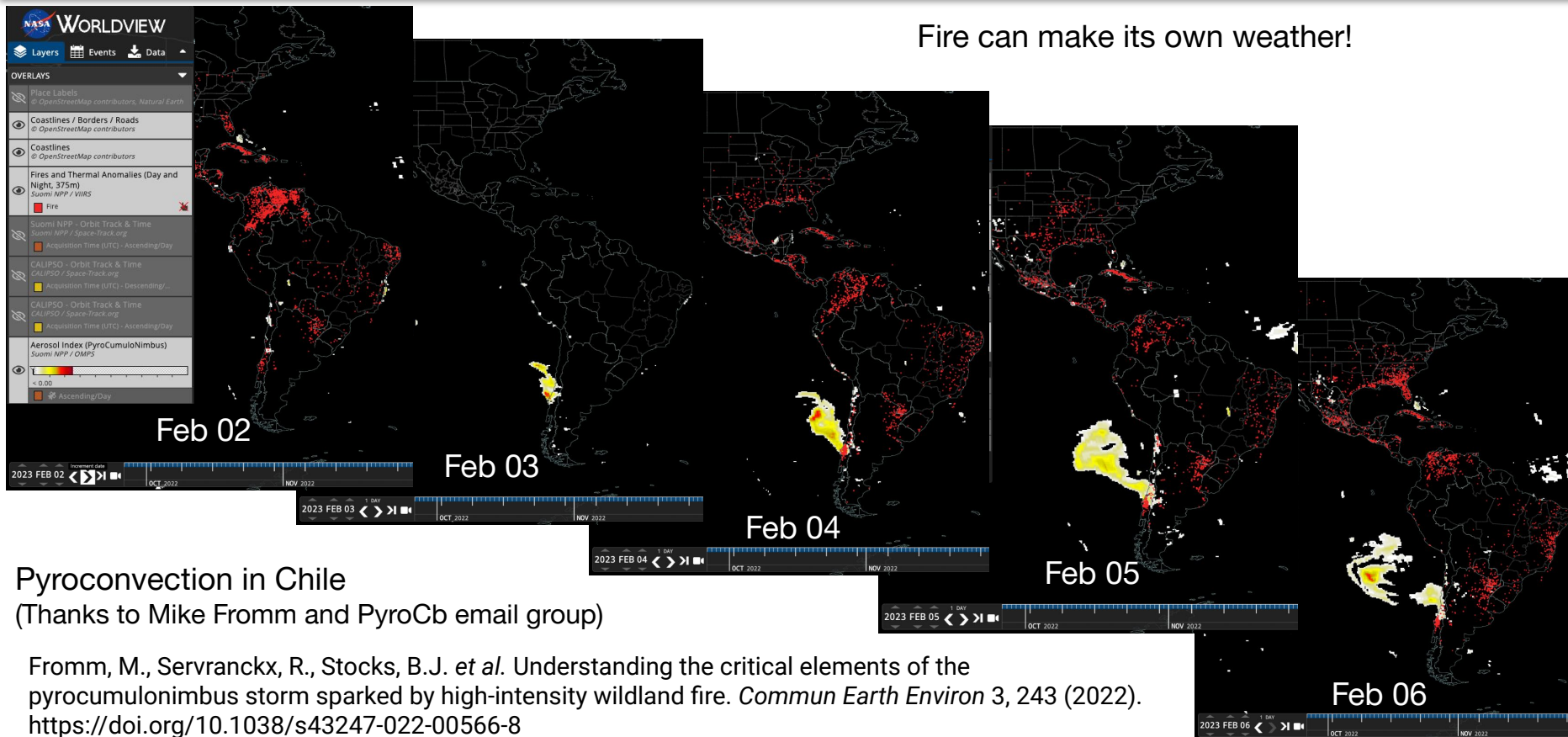
Fire intensity [kW m⁻¹]



Fire effects (fire intensity) create biogeography
Drying of fine fuels important
Anthropogenic (LULCC) impacts are essential (not in this version)

Importance of climate-fire-vegetation interactions

Fire can make its own weather!



Pyroconvection in Chile
(Thanks to Mike Fromm and PyroCb email group)

Fromm, M., Servranckx, R., Stocks, B.J. *et al.* Understanding the critical elements of the pyrocumulonimbus storm sparked by high-intensity wildland fire. *Commun Earth Environ* 3, 243 (2022).
<https://doi.org/10.1038/s43247-022-00566-8>

FATES code and information

<https://github.com/NGEET/fates/wiki>

Home

Gregory Lemieux edited this page on Mar 10 · 24 revisions

The Functionally Assembled Terrestrial Ecosystem Simulator (FATES)

This repository houses the development of the Functionally Assembled Terrestrial Ecosystem Simulator (FATES). FATES is a numerical terrestrial ecosystem model. The funding for this project is supported by Department of Energy's Next Generation Ecosystem Experiment - Tropics (NGEE-T) project. The conceptual design is based off of the original Ecosystem Demography model (ED, Moorcroft et al. 2001, Hurtt et al. 2002, Fisher et al. 2015). This model is designed so that it works as a library that can be called from a selection of driver models including Earth System Models (ESM) such as

Documentation

- FATES technical documentation
- FATES User's Guide

NCAR
CTSM Mini-tutorial 2022

GETTING STARTED

- Tutorial 0a: CTSM, CESM-Lab, & Git
- Tutorial 0b: CTSM Simulations at NEON Tower Sites

GLOBAL SIMULATION

- Tutorial 1a: Global Simulations
- Tutorial 1b: Global Visualizations

GENERIC SINGLE POINT SIMULATION

Technical Documentation
&
User's Guide

Tutorial materials



Welcome to the 2022 CTSM mini-tutorial

JupyterBook `passing`

license MIT Made with Jupyter Last commit last saturday Contributors 5

The materials and notebooks in this tutorial is published as a Jupyter book [here](#).

This repository includes materials for the Community Terrestrial Systems Model (CTSM) Spring 2022 mini-tutorial ([link to agenda and resources](#)).

These tutorials are designed as an introduction to running the Community Terrestrial Systems Model (CTSM). We will go through three configurations that include running a:

1. Supported NEON tower site,
2. Global FATES-SP simulation, and
3. Generic single point simulation.

We'll also learn how to:

Acknowledgment

A portion of this research was supported as part of the Next Generation Ecosystem Experiments-Tropics, funded by the U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research.

Thank You! Questions?

Contact details:

Jacquelyn Shuman jkshuman@ucar.edu



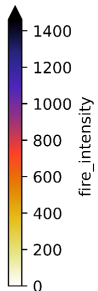
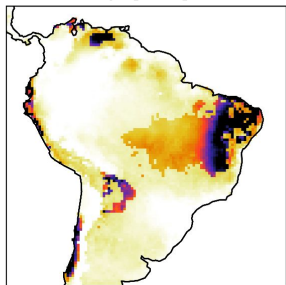
NGEE-TROPICS
NEXT-GENERATION ECOSYSTEM EXPERIMENTS-TROPICS



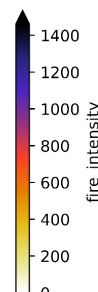
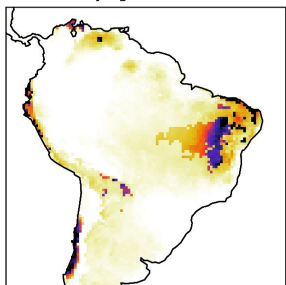


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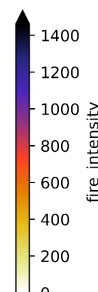
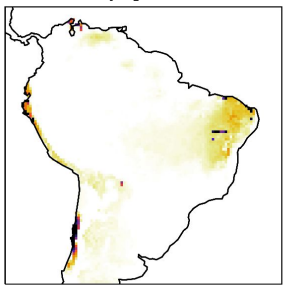
drying = High



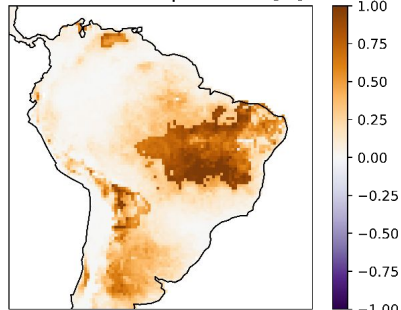
drying = Medium



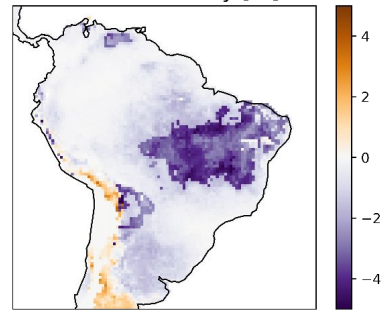
drying = Low



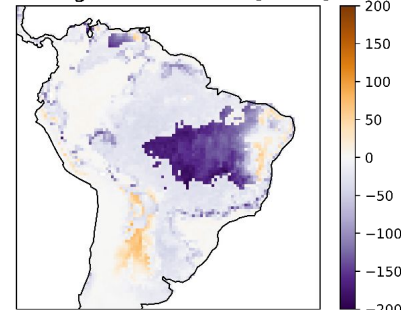
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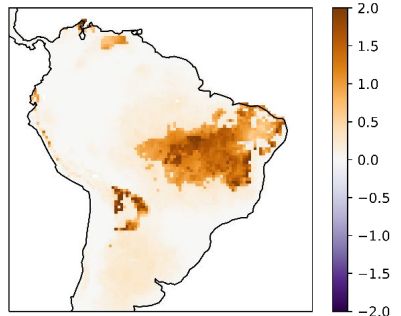
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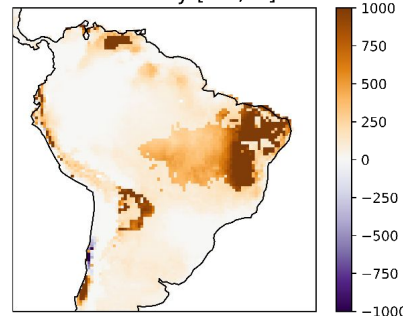
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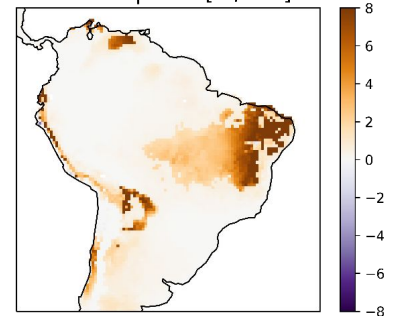
burned fraction



fire intensity [kW/m]



rate of spread [m/min]



Difference between high fuel drying and low fuel drying (high dry - low dry)

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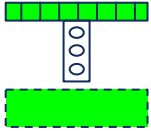
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Ecosystem and Carbon Cycle	Orange	Orange	Dark Purple	Orange
Biomass	Orange	Orange	Dark Purple	Orange
Gross Primary Productivity	Dark Purple	Dark Purple	Orange	Orange
Ecosystem Respiration	Orange	Orange	Dark Purple	Dark Purple
Hydrology Cycle	Dark Purple	Dark Purple	Orange	Orange
Evapotranspiration	Dark Purple	Dark Purple	Orange	Orange
Latent Heat	Dark Purple	Dark Purple	Orange	Orange
Sensible Heat	Dark Purple	Dark Purple	Orange	Orange
Radiation and Energy Cycle				
Albedo				
Surface Upward SW Radiation	Orange	Orange		Dark Purple
Surface Net SW Radiation				
Surface Upward LW Radiation			Orange	
Surface Net LW Radiation	Dark Purple	Dark Purple	Orange	
Surface Net Radiation				

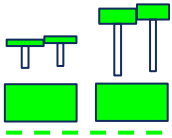


Calibration cascade



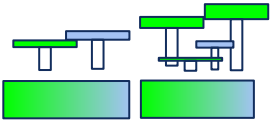
Satellite Phenology

Photosynthesis, leaf, hydrology parameters, soil parameters



No Competition

Allometry and allocation parameters, growth & mortality parameters



Fixed Biogeography

Environmental sensitivity, competition for resources