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

FATES

NCAR

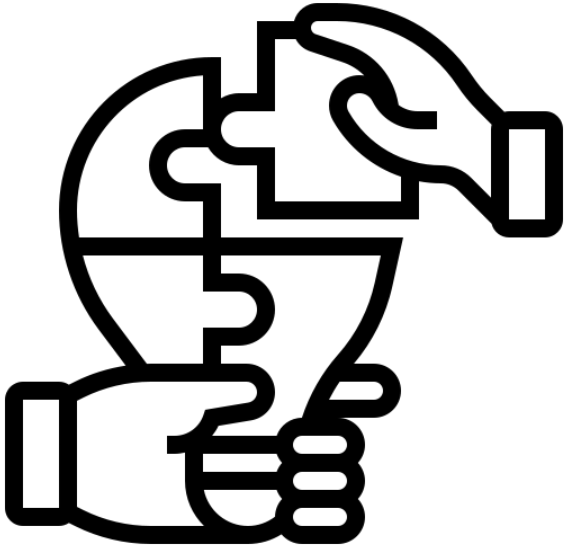
Jacquelyn Shuman

Climate and Global Dynamics, Project Scientist

Land winter meeting
February 7, 2023

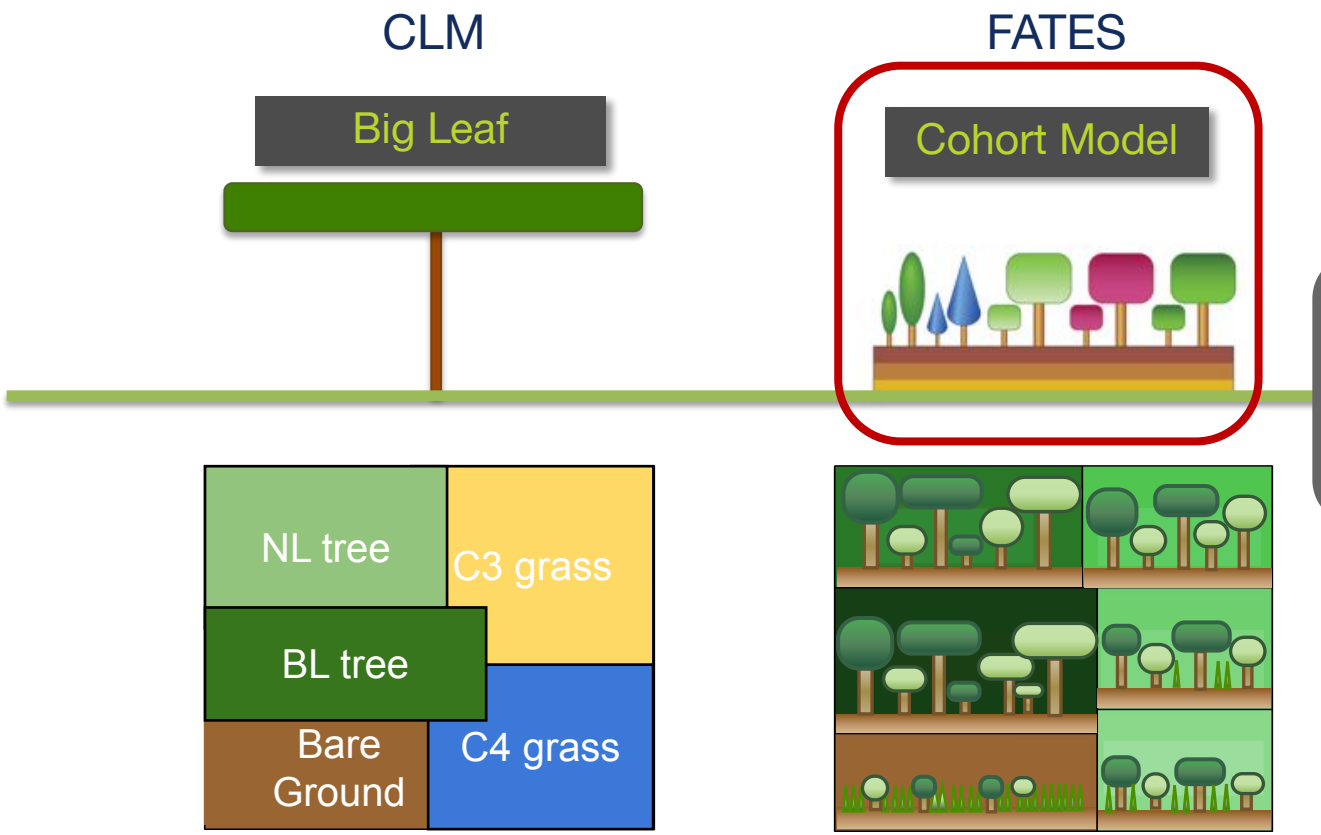
This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

Opportunities



Can you add to FATES or collaborate?

FATES as primary vegetation model



- Timber yields
- Wildfire risk
- Ecosystem vulnerability

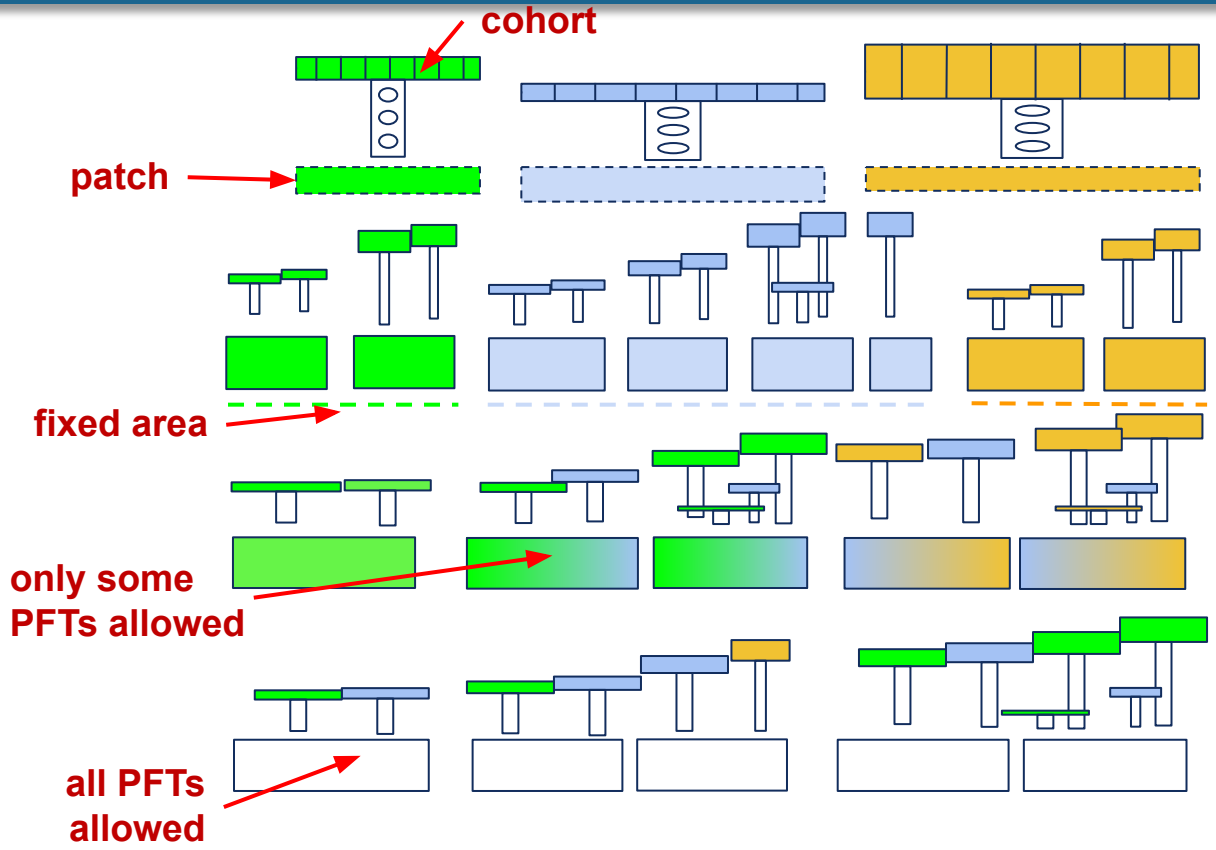
FATES complexity modes

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.)**

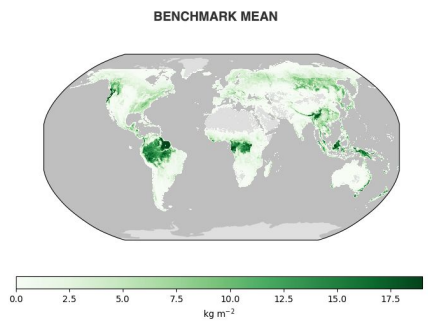
- FATES compsets
- Coupling
- Restart files
- NEON **(functional) (Adrianna F.)**
- HH **(functional)**

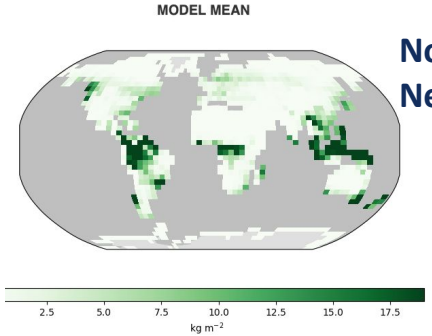
FATES ILAMB Testing

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

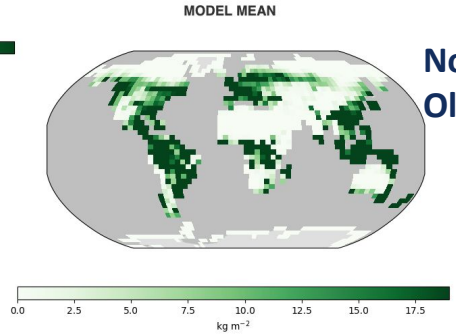
- Differences: DBH max height; SLA_{top}, V_{cmax}, freeze mortality tolerance, recruitment height, reproduction minimum DBH, wood density

Biomass





No-competition mode
New parameters/API



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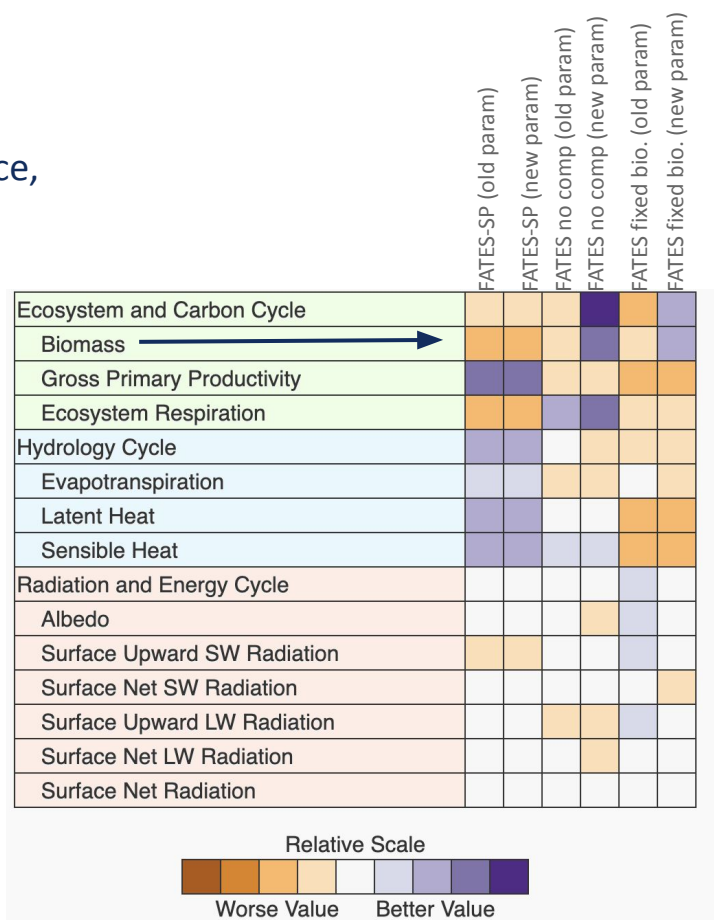

14 PFTs, GSWP3 1965-2014
Years: SP = 100(50, 50); NoC = 300(250,50); FBG= 150(100, 50)

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

Mean

Benchmark	[-]	114.	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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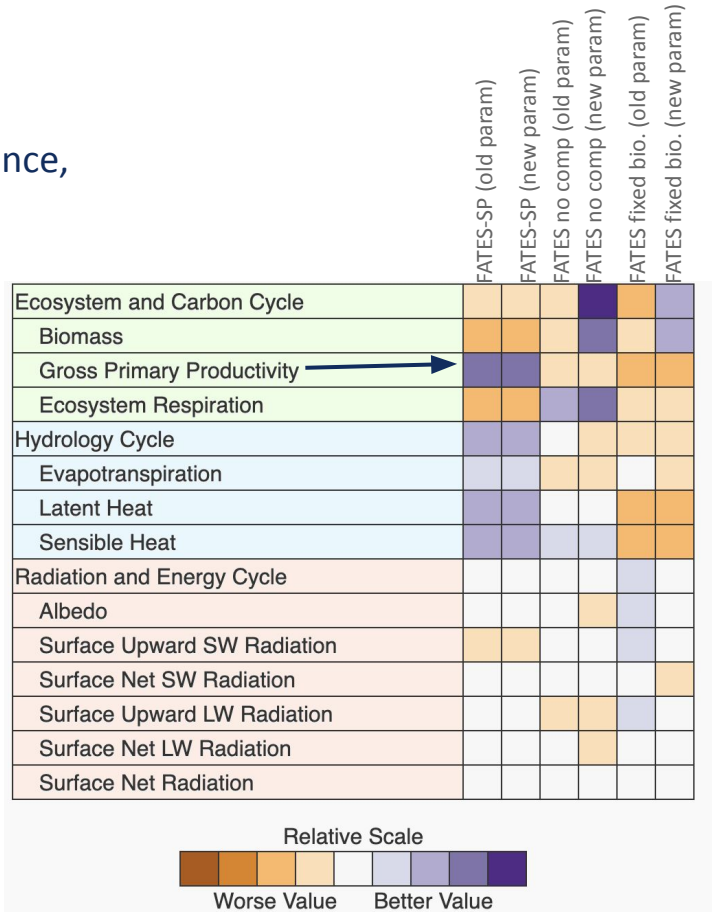

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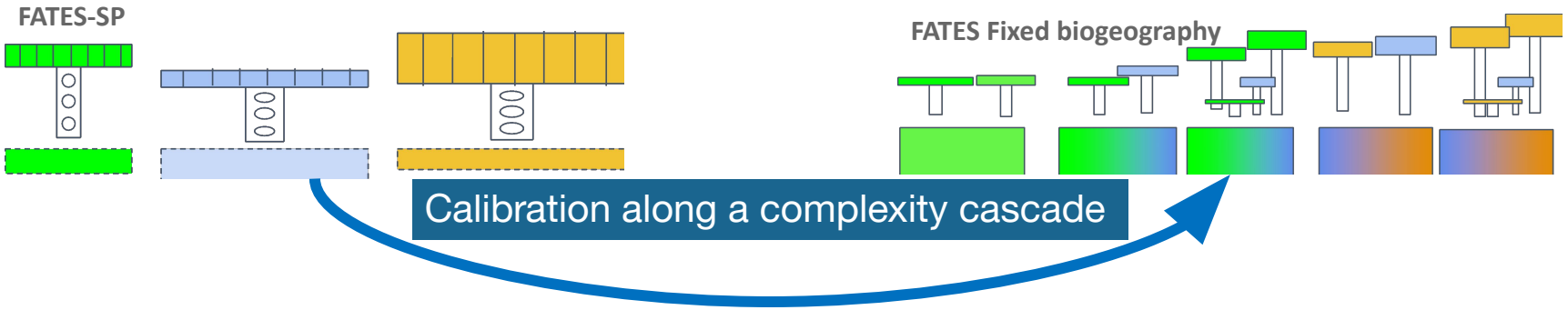
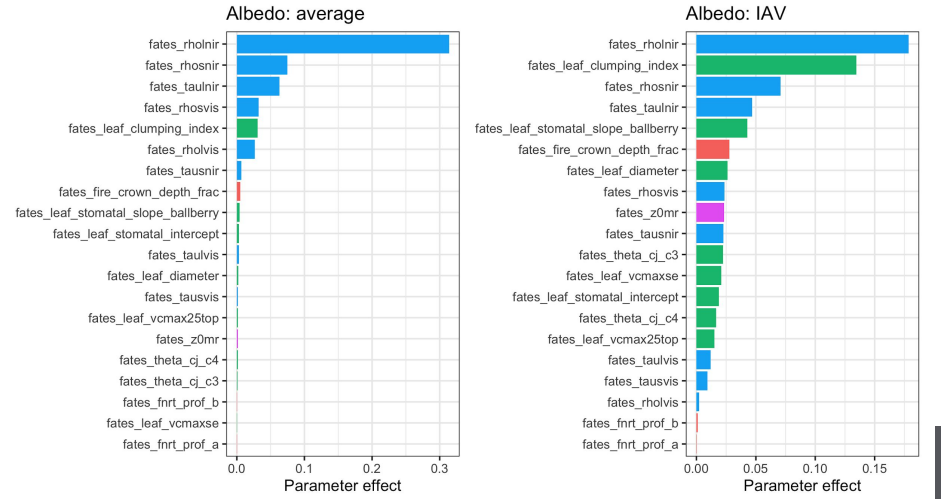
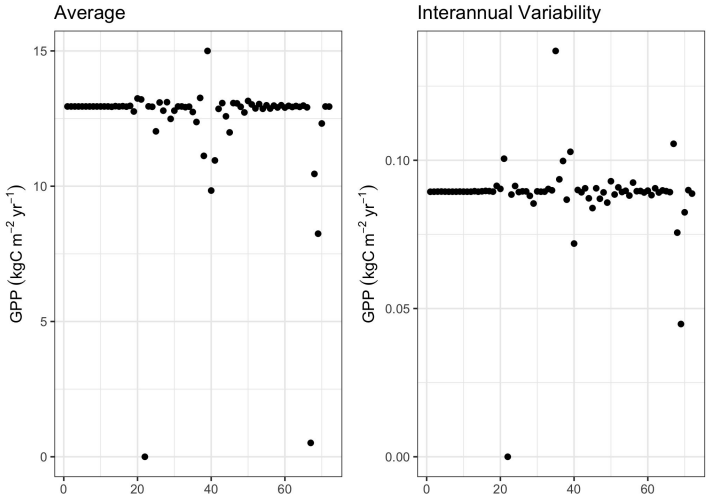
FATES global calibration across complexity modes



FATES PPE shows important parameters to calibrate

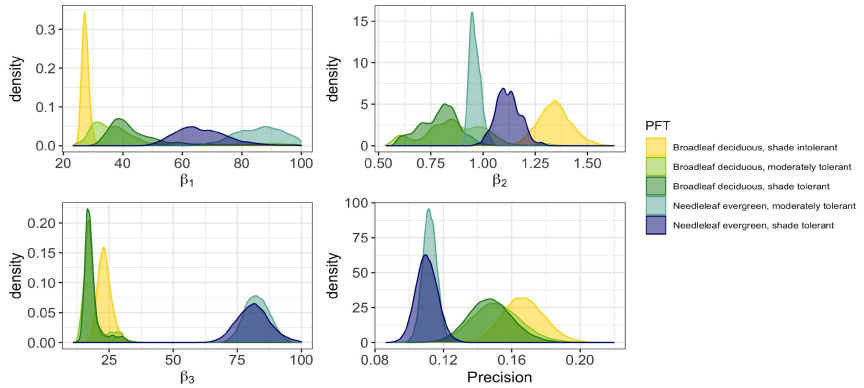


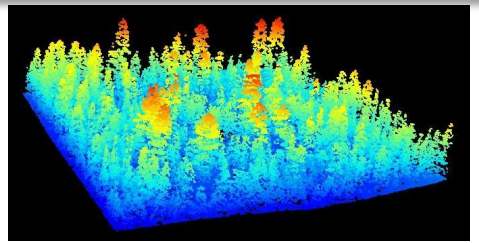


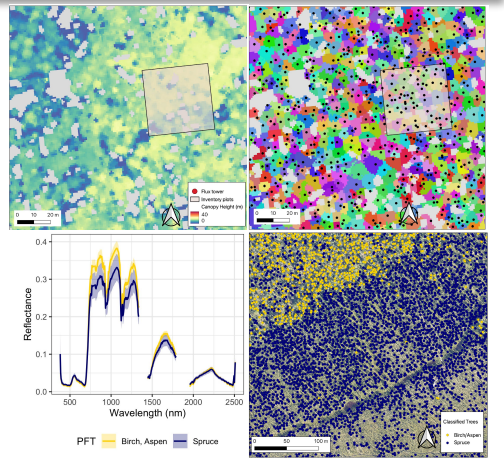
Adrianna Foster, NCAR

FATES single-point simulations at NEON sites

Parameter calibration & uncertainty using Bayesian statistical methods

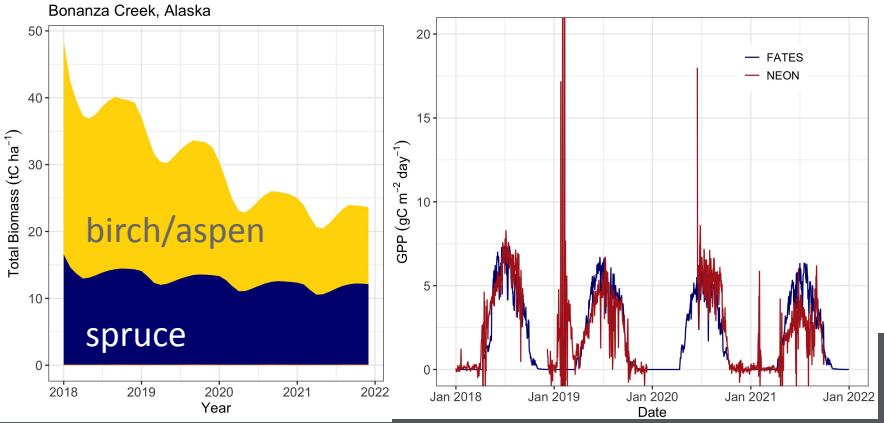


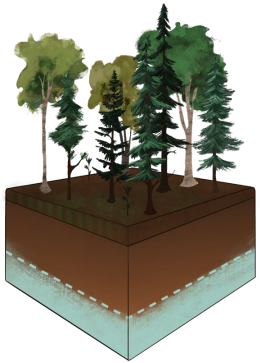


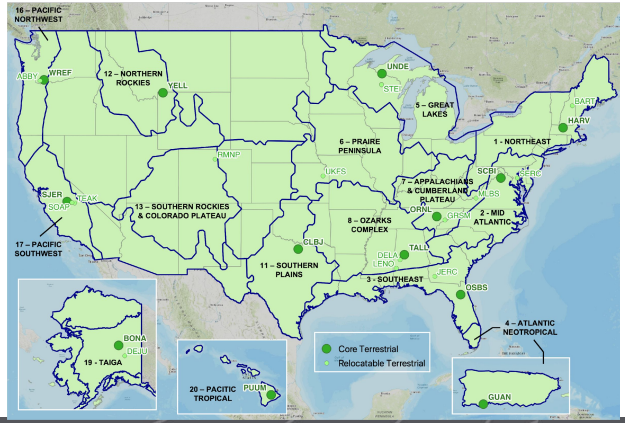


Leveraging NEON aerial LiDAR and hyperspectral imagery for initializing with current forest conditions

Comparison to NEON observations

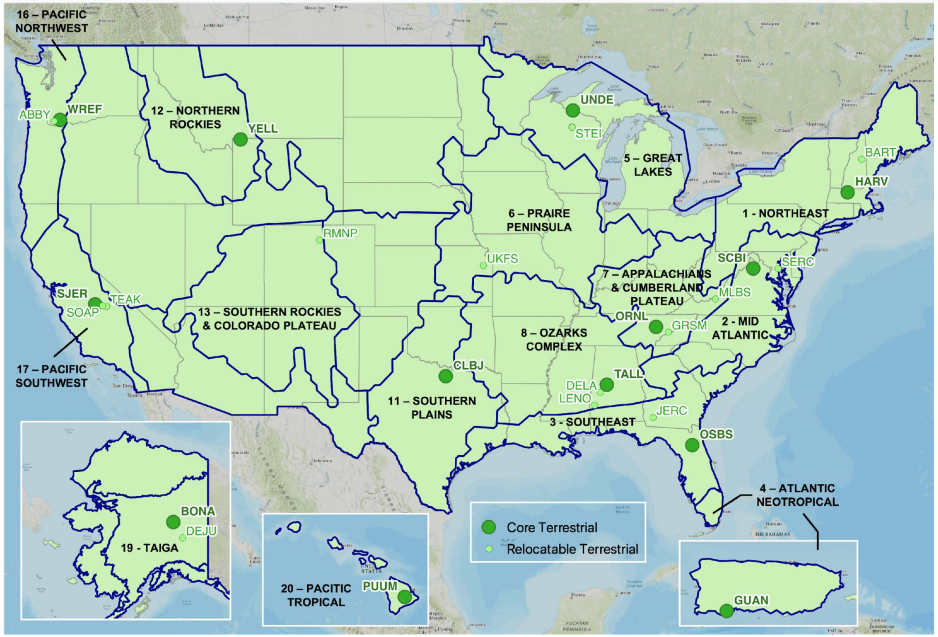






Adrianna Foster, NCAR

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

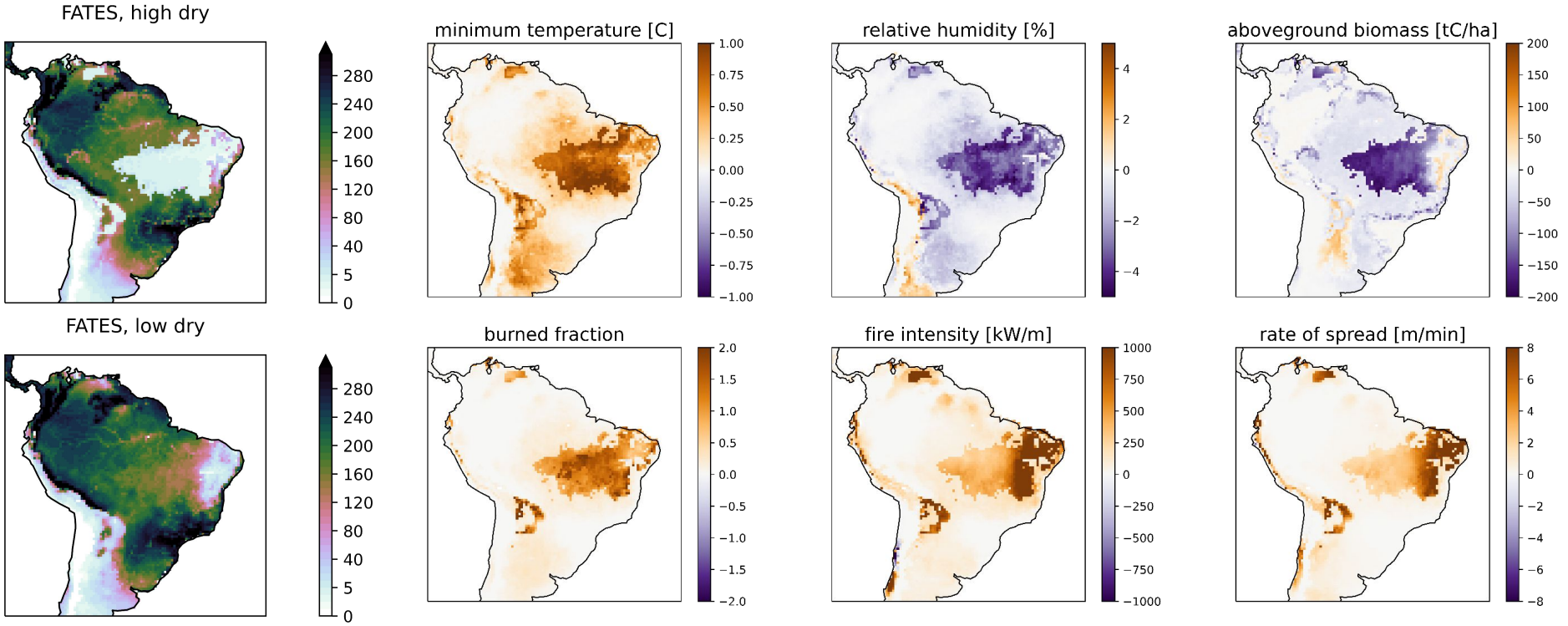
Command to create a job:

./create_newcase --case $job_name --res CLM_USRDAT --compset I1PtClm51Fates --user-mods-dir CTSM/cime_config/usermods_dirs/NEON/FATES/${NEON_SITE} --run-unsupported

Check out CTSM PR #1932 for more information

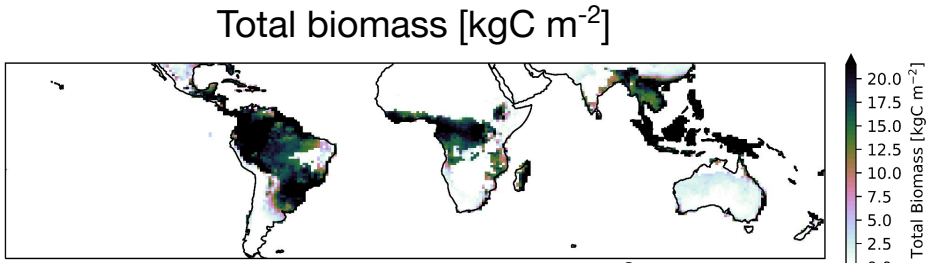
https://github.com/ESCOMP/CTSM/pull/1932

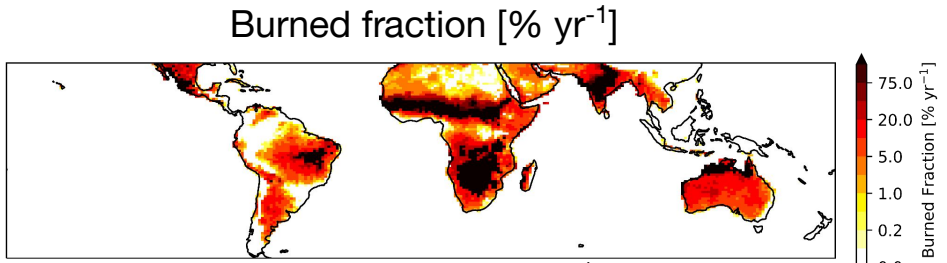
FATES impact of fuel drying and interactive fire

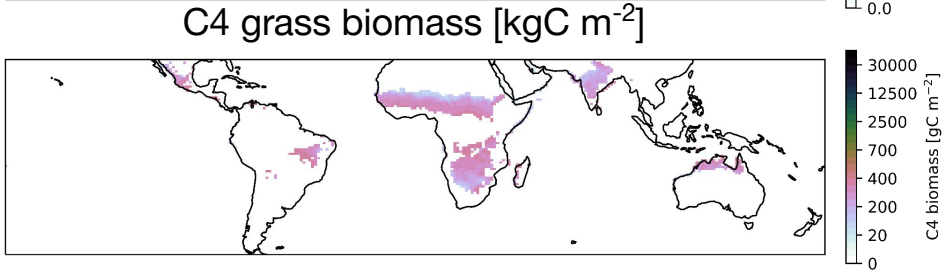


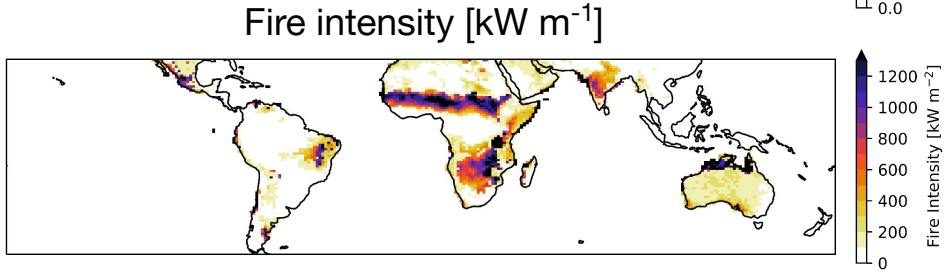
Difference between high fuel drying and low fuel drying (high dry - low dry)

FATES tropical application



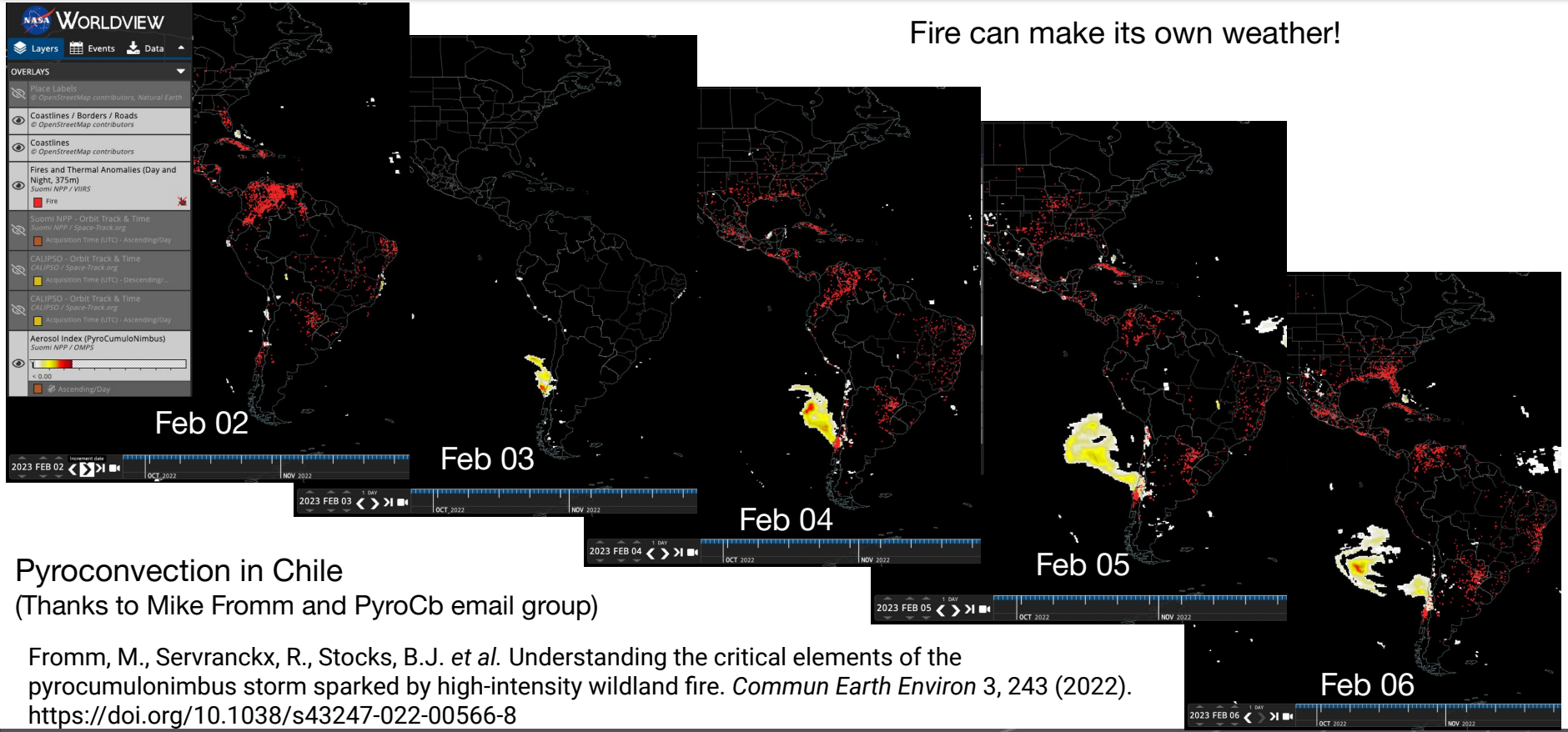






Fire effects (fire intensity) create biogeography
Drying of fine fuels important
Anthropogenic (LULCC) impacts are essential (not in this version)

Importance of climate-fire-vegetation interactions



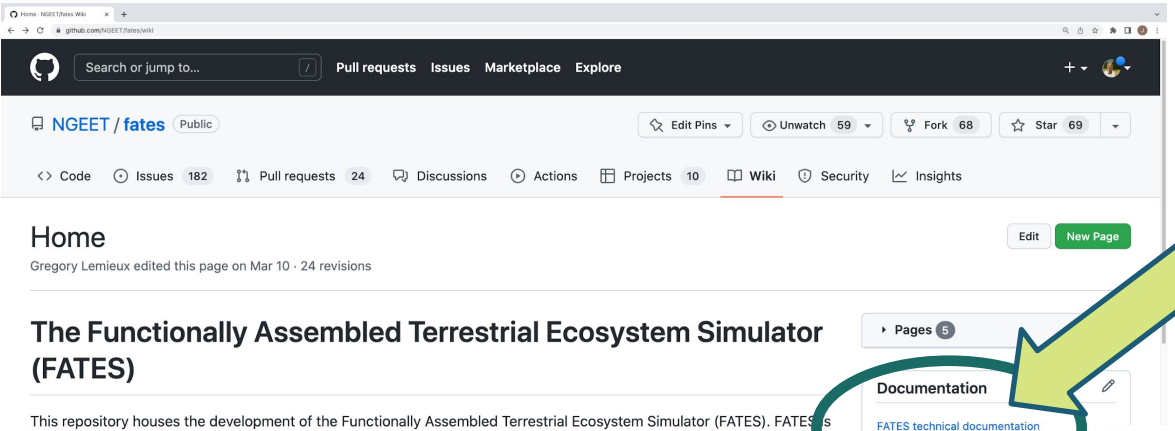
Fire can make its own weather!

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



Technical Documentation
&
User's Guide

Tutorial materials

https://ncar.github.io/CTSM-Tutorial-2022/README.html

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?

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Jacquelyn Shuman jkshuman@ucar.edu

NGEE–TROPICS
NEXT-GENERATION ECOSYSTEM EXPERIMENTS–TROPICS

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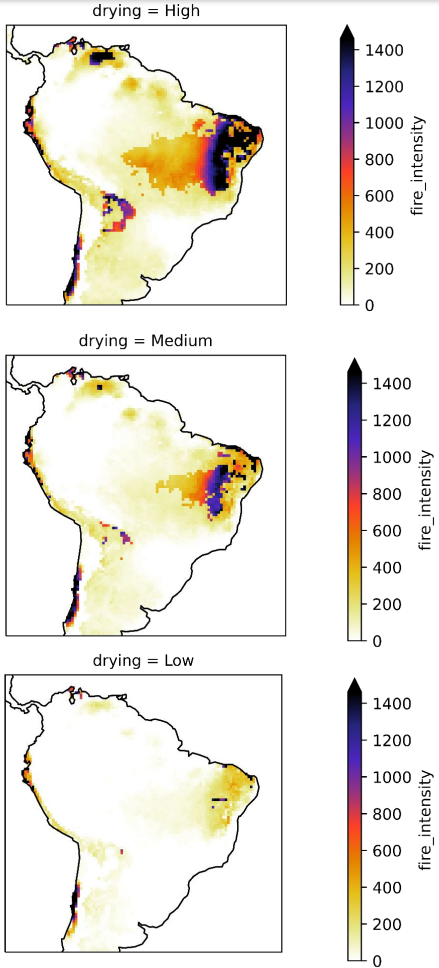

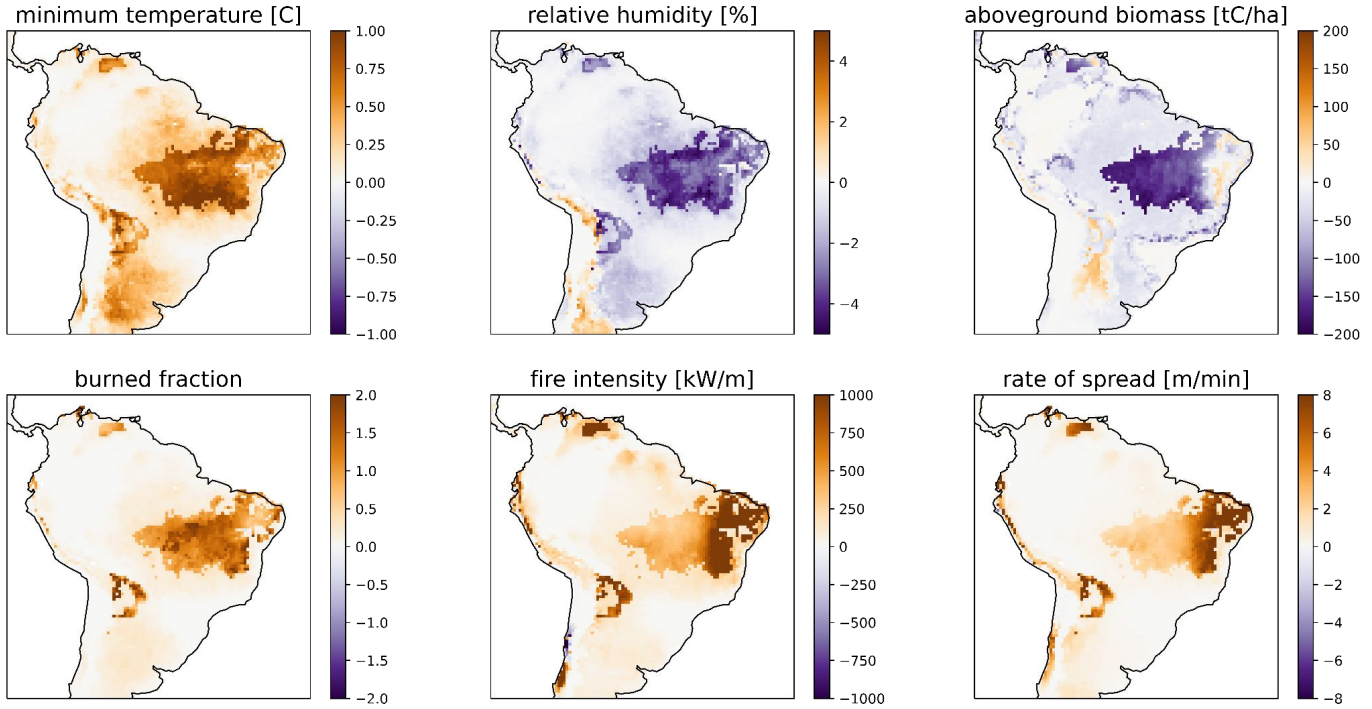

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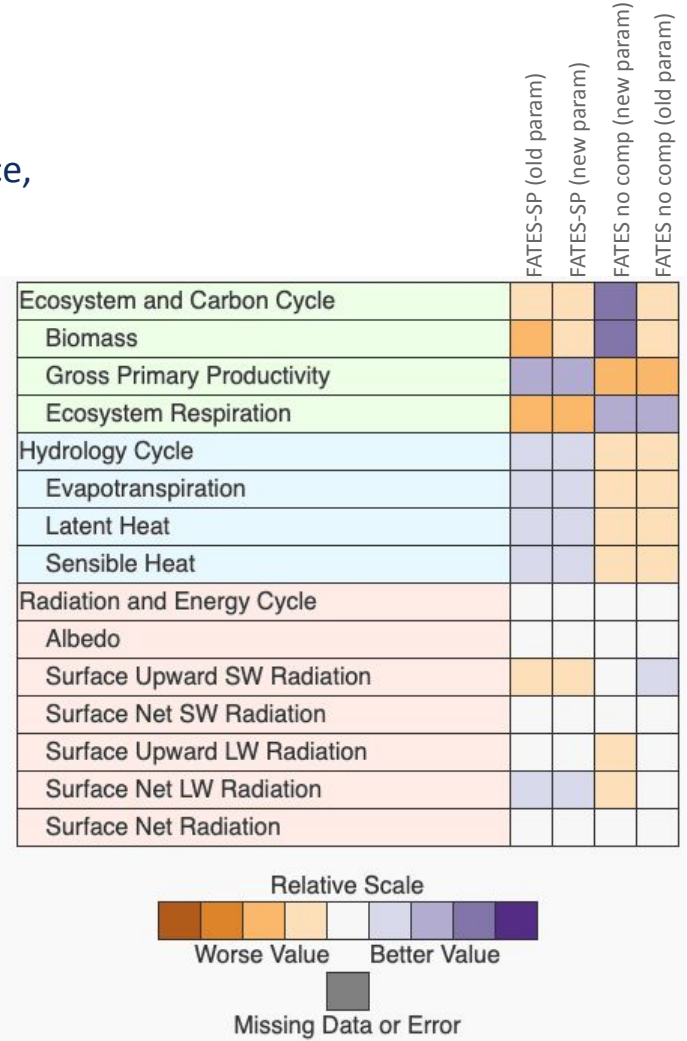
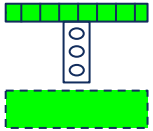
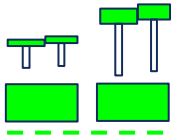


Calibration cascade



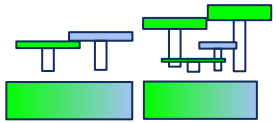
Satellite Phenology

Photosynthesis, leaf, hydrology parameters, soil parameters



No Competition

Allometry and allocation parameters, growth & mortality parameters



Fixed Biogeography

Environmental sensitivity, competition for resources