# LWMG Updates

## THE 27th ANNUAL CESM WORKSHOP

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*LMWG Co-Chairs*

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# LMWG Research Highlights

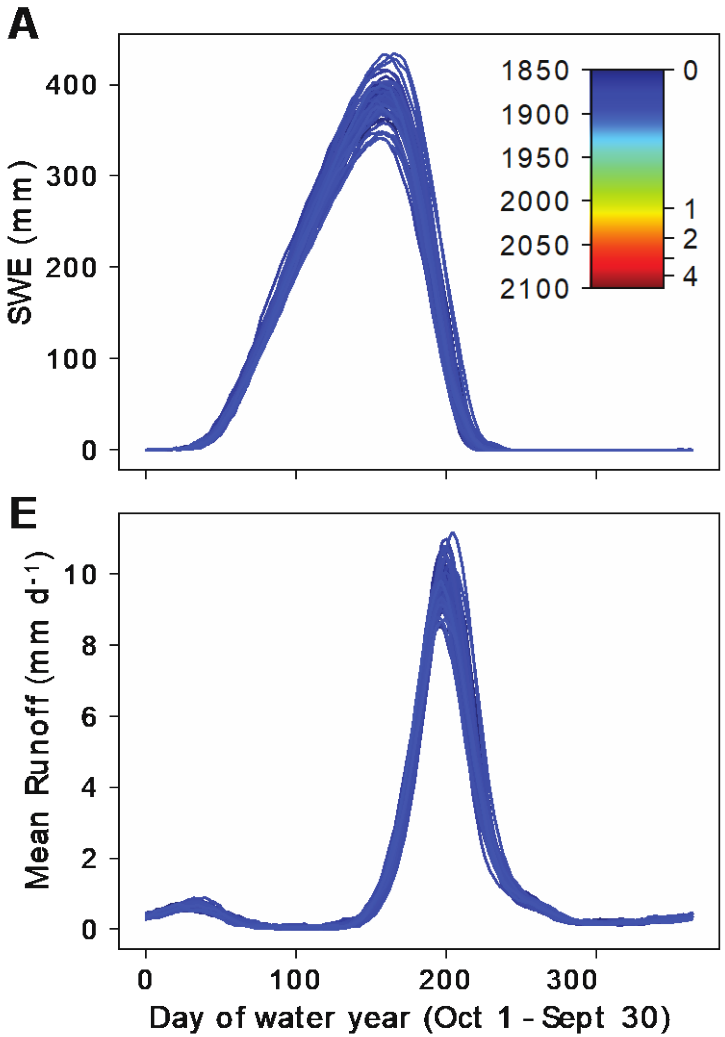
## Pervasive alterations to snow-dominated ecosystem functions under climate change

Wieder et al. PNAS In press

# LMWG Research Highlights

## CESM2 - Large Ensemble

Wieder et al. PNAS In press



# CESM2 - Large Ensemble

# LMWG Research Highlights

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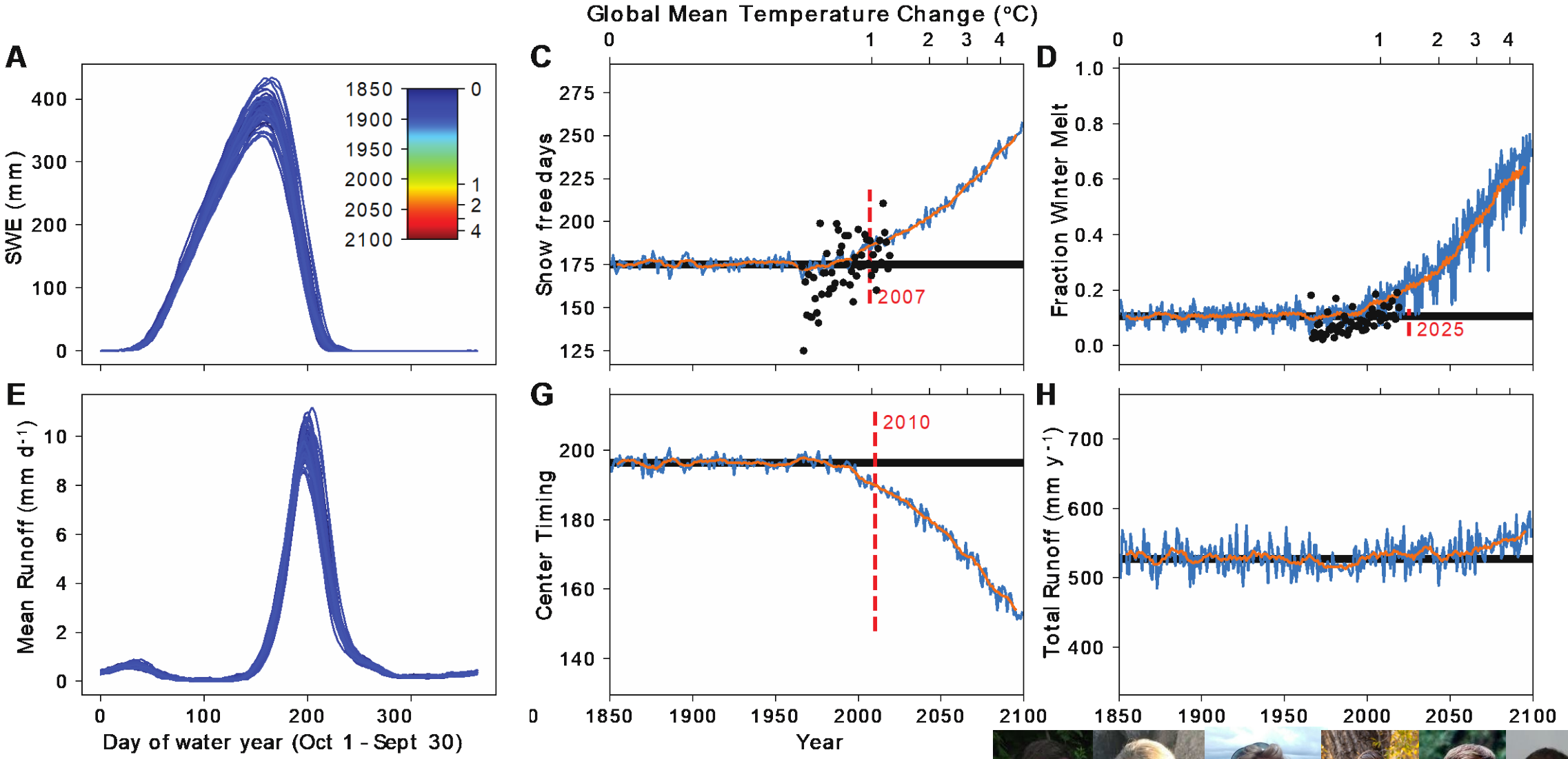



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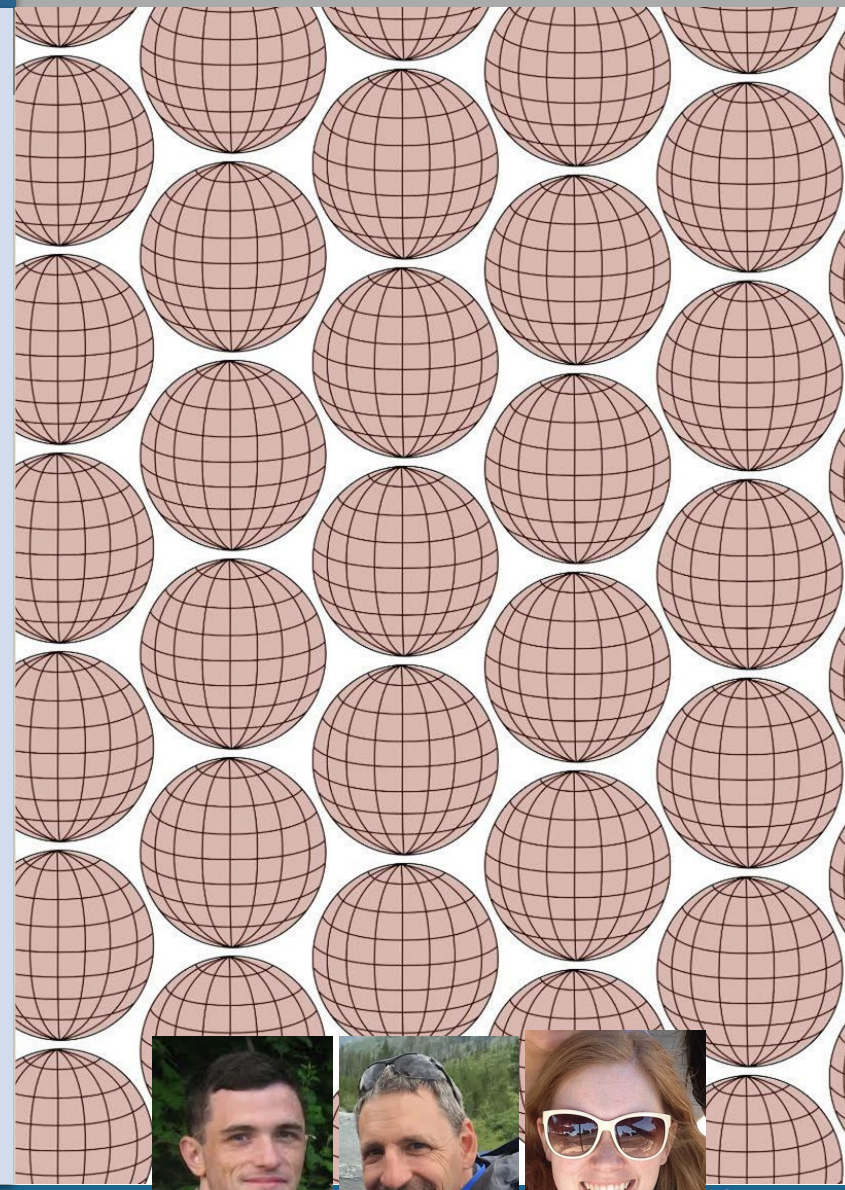
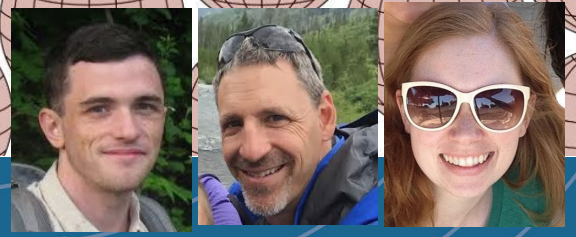
# The CTSM Parameter Perturbation Experiment (PPE)



- **Phase 0:** Infrastructure development (fast spinup, expose parameters, identify parameter ranges, ensemble and analysis scripting)
- **Phase 1:** One-at-a-time parameter ensembles under range of environmental perturbations (low/high $CO_2$, PI and future climate, N-dep)
- **Phase 2:** Parameter interactions: Latin-hypercube ensemble → Neural network to emulate CLM output with parameters as input
- **Phase 3:** Optimize parameters for CESM3





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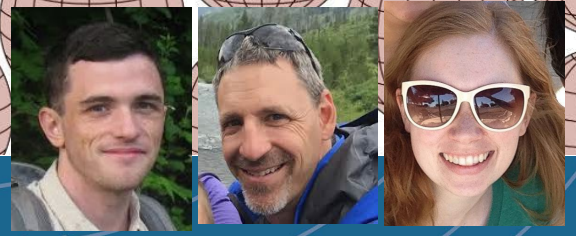
LEAP

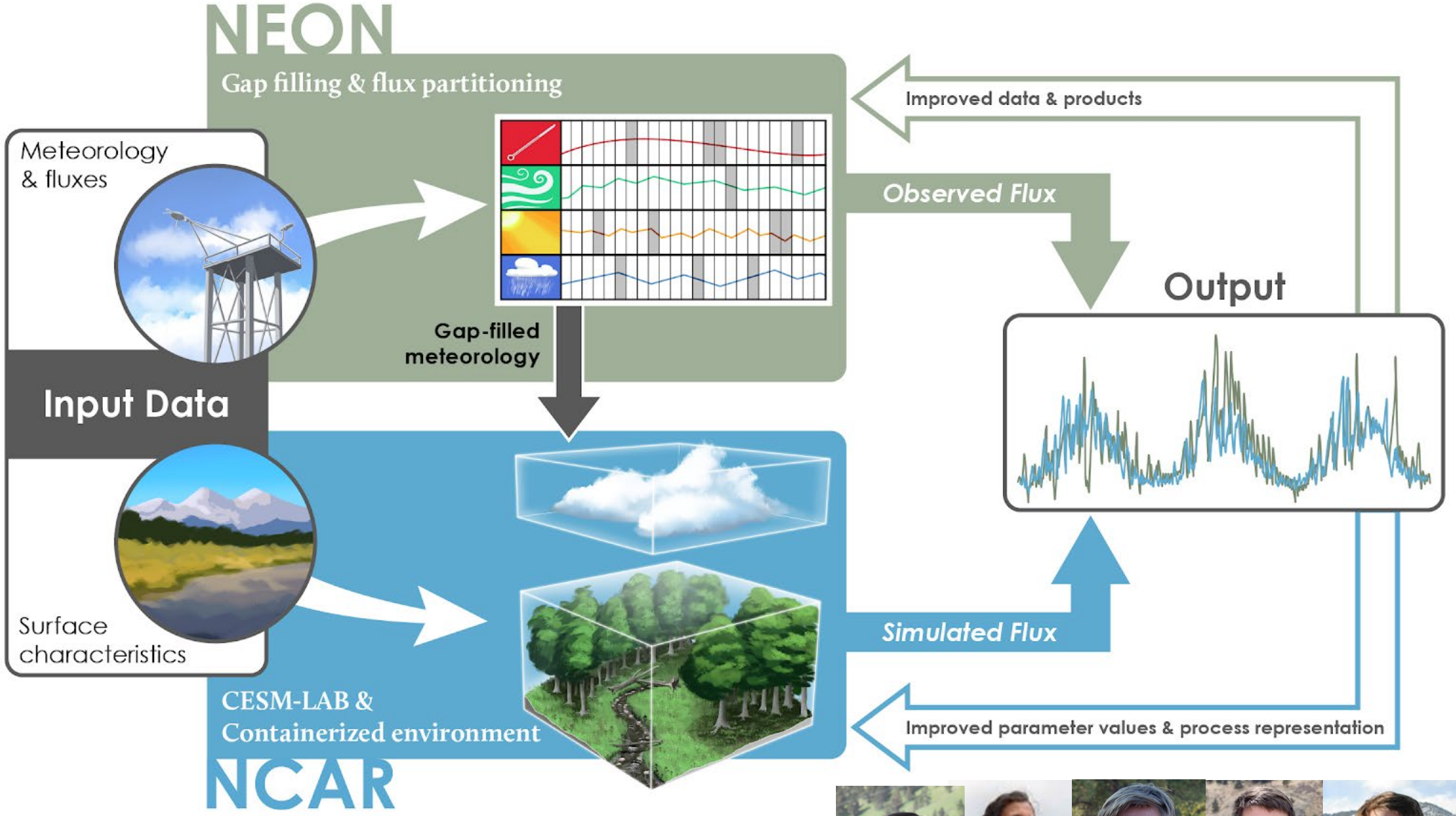
## CTSM PPE Spinoff Projects

- Land-atmosphere interactions (Univ Washington)
- NEON site calibration (Auburn Univ)
- ET recession timescales (Oregon State)
- Arctic river flow (RAL)
- Land influence on drought (CGD)
- Hydrologic sensitivity (Cornell Univ)
- Tropical carbon cycle interannual variability (JPL)
- GPP response to permafrost thaw (Northern Arizona Univ)
- CTSM-FATES calibration (CGD @ NEON sites)

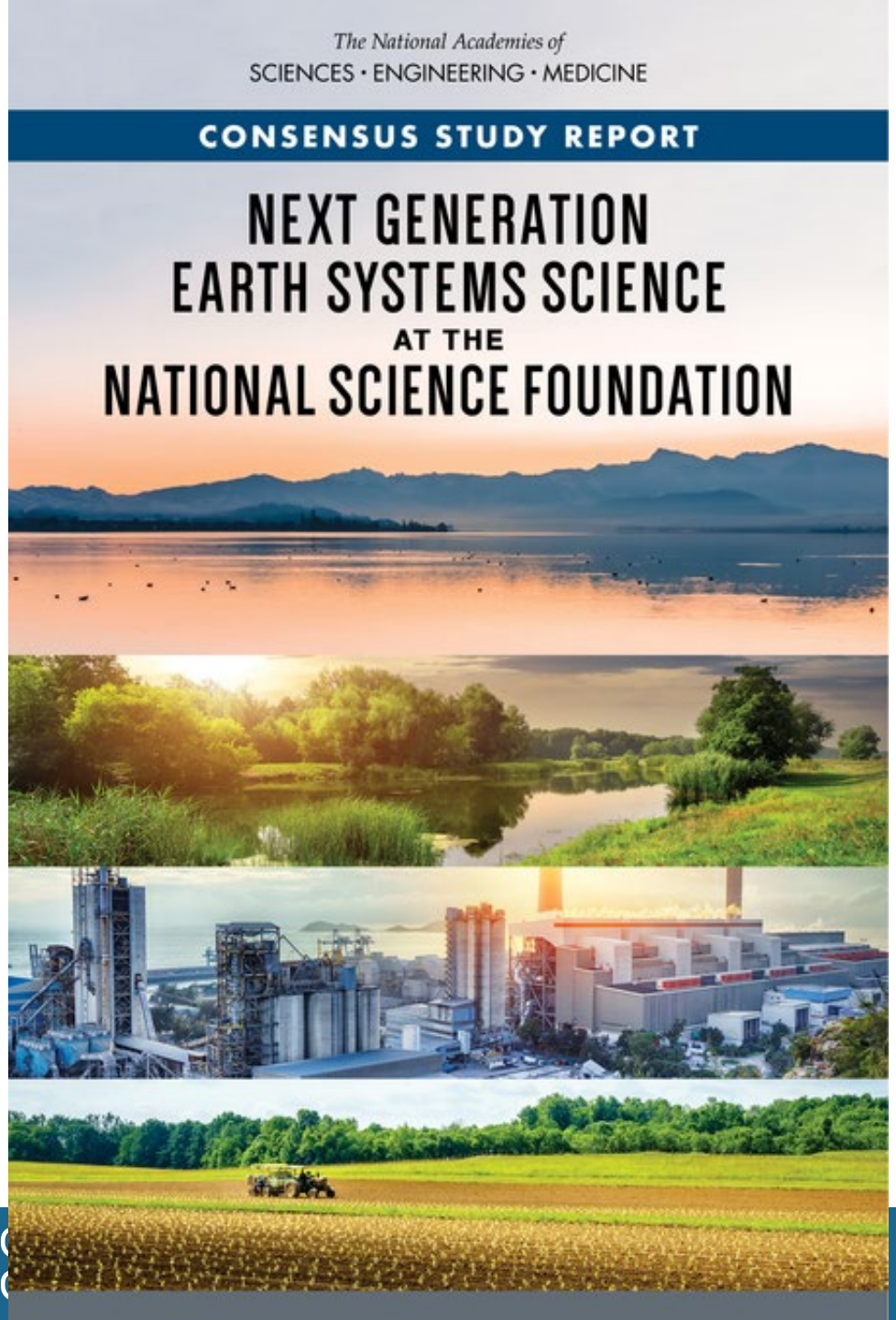


# NCAR-NEON **Data Exchange**

## LMWG **Infrastructure**



# LMWG **Infrastructure**




"An example of a synergy among facilities is that identified by NCAR and NEON to ***advance the capability of Earth system prediction to include terrestrial ecosystems and biological resources***."

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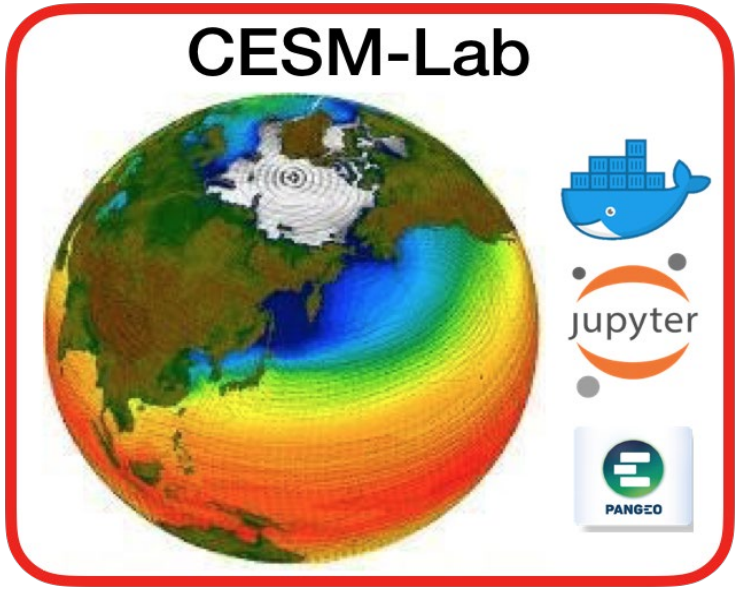
# promote community **Engagement,** expand **Access,** & broaden **Participation**

***The NCAR-NEON project opens opportunities for communities:***

- *Without access to advanced computing resources or with little modeling experience*
- *By extending the reach of NEON data products*

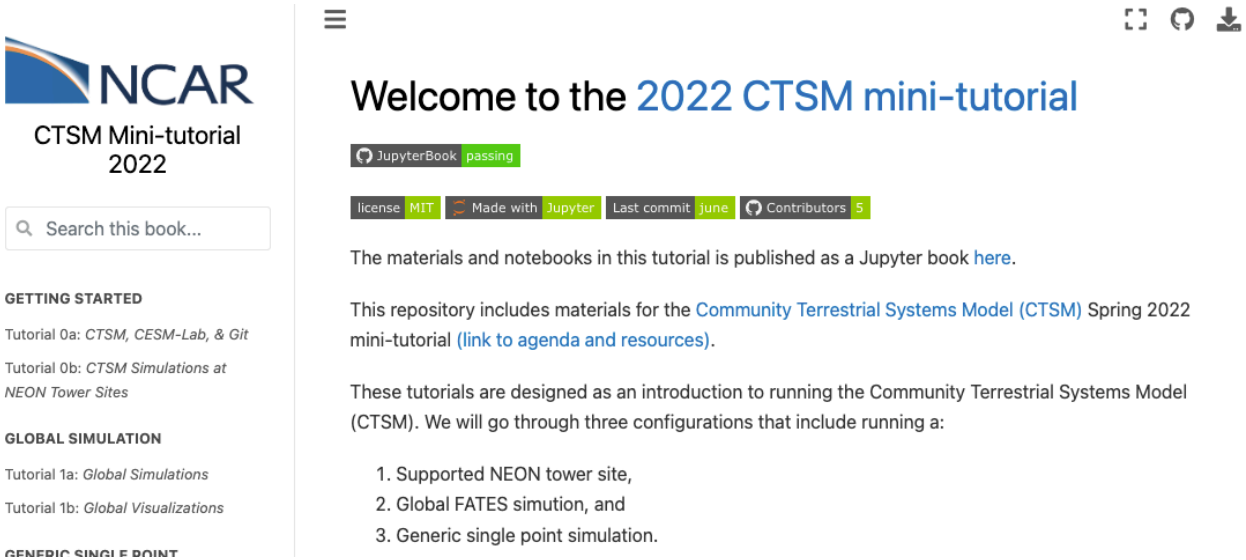
**CTSM tutorials** extend this effort, in May 2022 we hosted:

- 60 **virtual** participants in 2 day mini-tutorial who used
- **Cloud computing** with CESM-Lab to complete
- Practical exercises via **Jupyter notebooks**



# LMWG Training

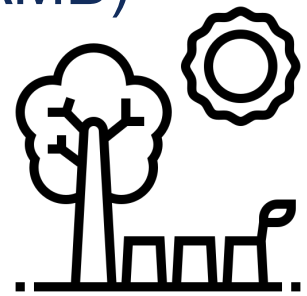
Modular
Extensible
Repeatable
System independent
More frequent engagement
Model for CESM?

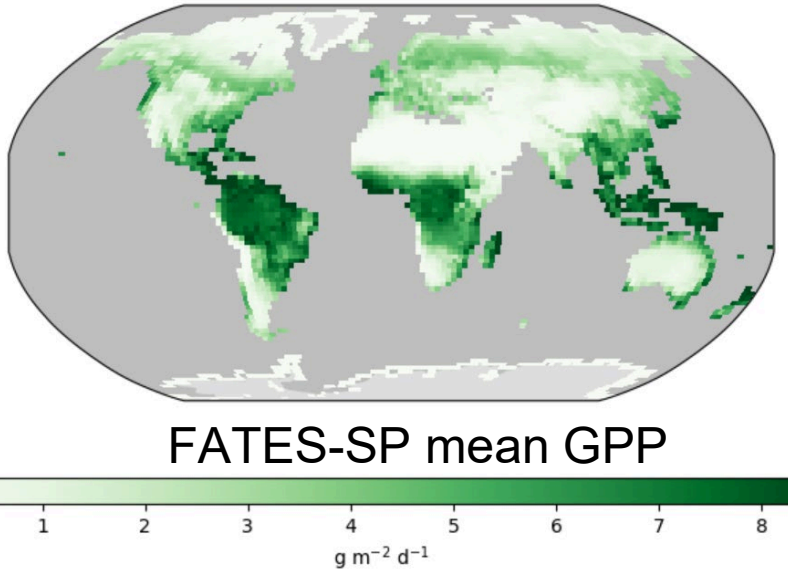



https://github.com/NCAR/CTSM-Tutorial-2022

# Global

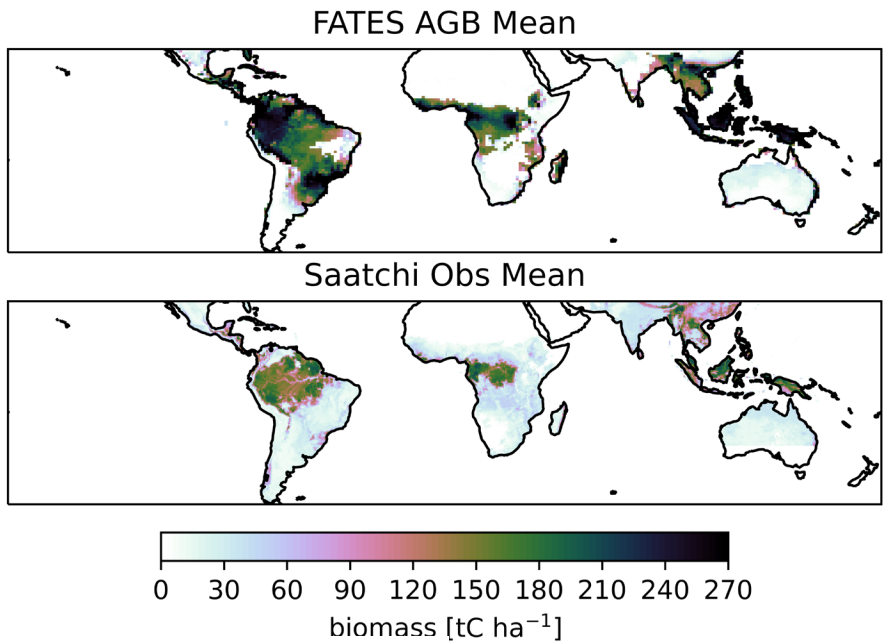
- Reduced Complexity modes
- Diagnostic testing (ILAMB)
- Land use harvest

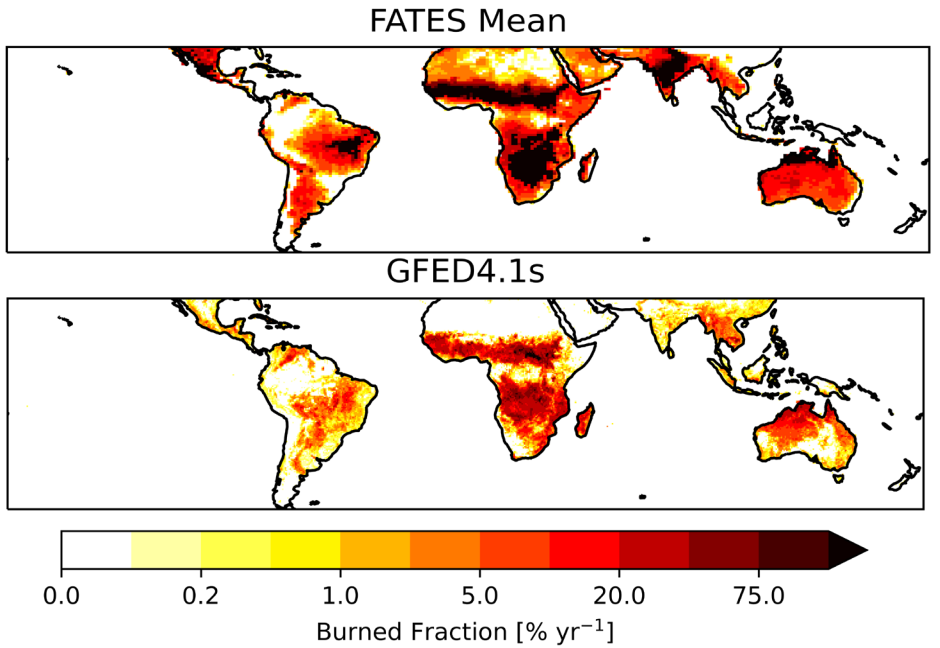




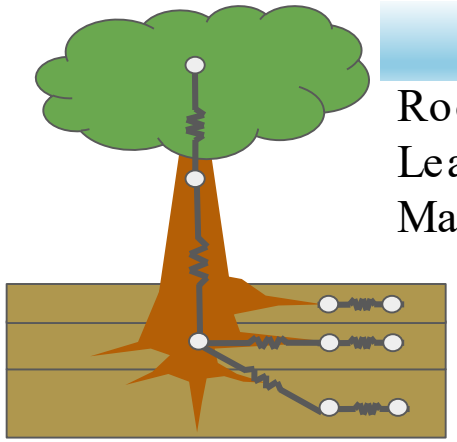

# Regional

- FATES captures dynamic biogeography and biomass
- Fire feedbacks determine plant survival
- Critical for tropics simulation
- Testing in California (LBNL)



FATES



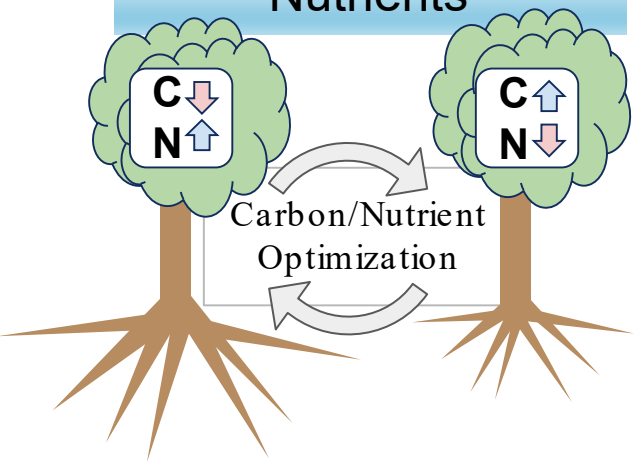
## Plant Hydraulics

Root layers and plant-size root depth
Leaf humidity, stomata set transpiration
Mass balance at root nodes

## Fire

Live fuel moisture
Crown fire

## Nutrients

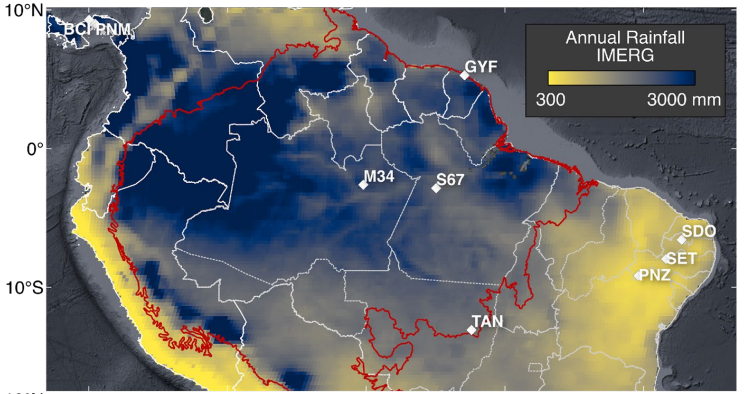


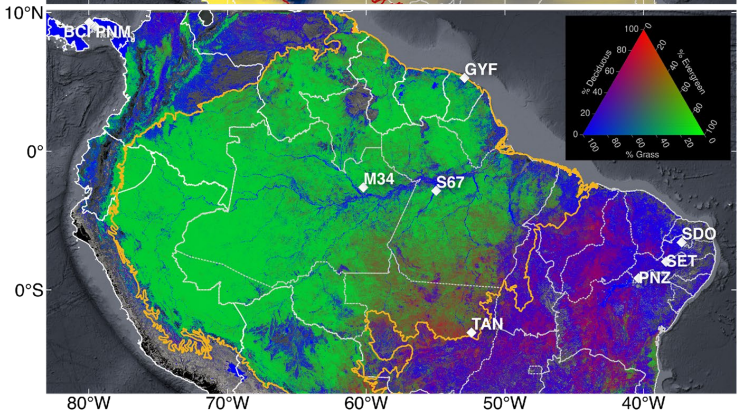

## User Interface

Tutorial in jupyter
User's guide
Technical document

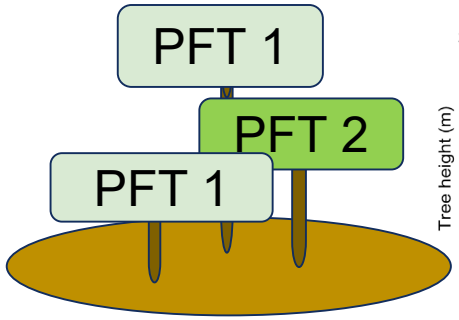
## Deciduous Phenology

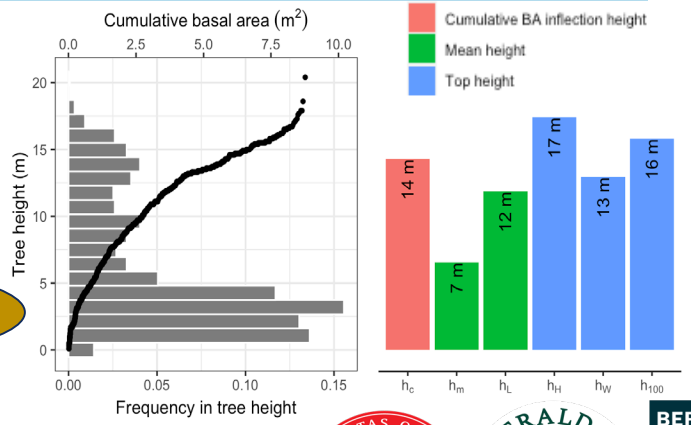
Forest resilience to drought




## Canopy turbulence for mixed vegetation




## Moss

Data from DeFries et al. (2000) *GCB*
*Figure credit Marcos Longo, LBNL*

# LMWG **Development Goals** for CTSM6 & CESM3 [short]

## Atmospheric Fluxes

- Dust emissions [Longlei Li & Danny Leung]
- BVOC emissions from MEGANv3.1 [Hui Wang]
- Ozone deposition [Danica Lombardozzi & others]
- Lightning fluxes from CAM? [Dave Lawrence]
- Surface roughness [Ronnie Meier, Keith Oleson]
- Dynamic Urban, datasets, & parameterization [Keith Oleson]

## Hydrology

- Representative Hillslope model [Sean Swenson]
- mizuRoute [Naoki Mizukami & Erik Kluzek]

## Ecosystems & Biogeochemistry

- FATES fixed biogeography [Rosie Fisher, Charlie Koven, Jackie Shuman, Adrianna Foster & more]
- MIMICS soil BGC model [Will Wieder, Sam Levis]

## Crop Model

- Shifting cultivation [Peter Lawrence]
- Crop planting dates [Sam Rabin]
- APSIM crop phenology [Bin Peng & Bill Sacks]

## Features

- Perturbed Parameter Experiment [Daniel Kennedy, Dave Lawrence, & Katie Dagon]
- Simple Land Model, SLIM [Marysa Lague, Erik K.]
- Updated surface dataset [Many contributors]
- CLASP [Meg Fowler]?
- Simplified enthalpy fluxes [Dave, Keith, Sean]?

## Notes

- Projects are relatively independent
- Some features may be available for particular compsets.