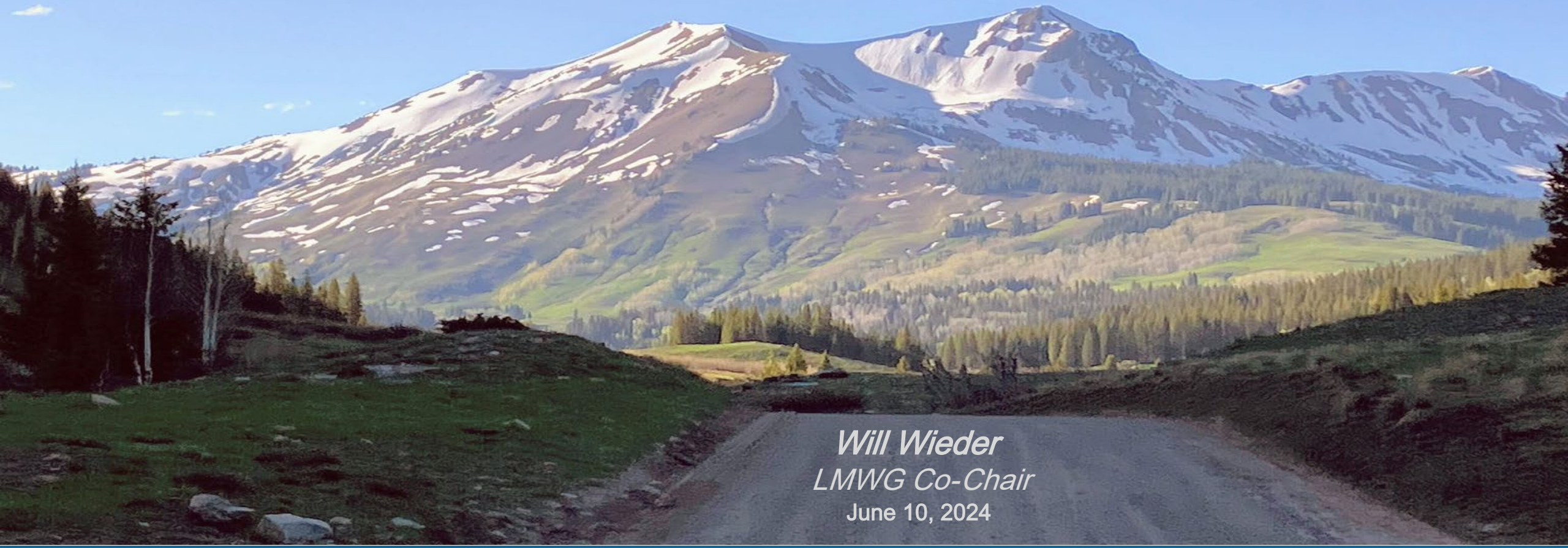
LWMG Progress Towards CLM6 & CESM3



Will Wieder
LMWG Co-Chair
June 10, 2024

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.

LMWG priority areas

Ecosystems

Food

Water

Predictability

LMWG priority areas

Ecosystems

Food

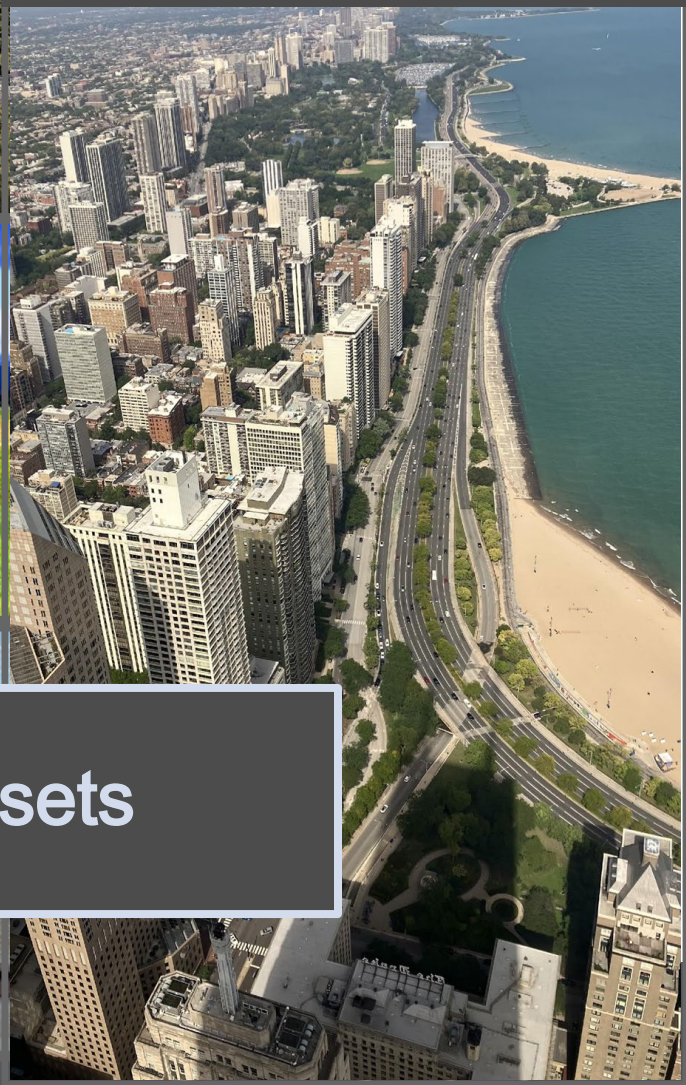
Water

Capabilities

Calibration

Datasets

Predictability

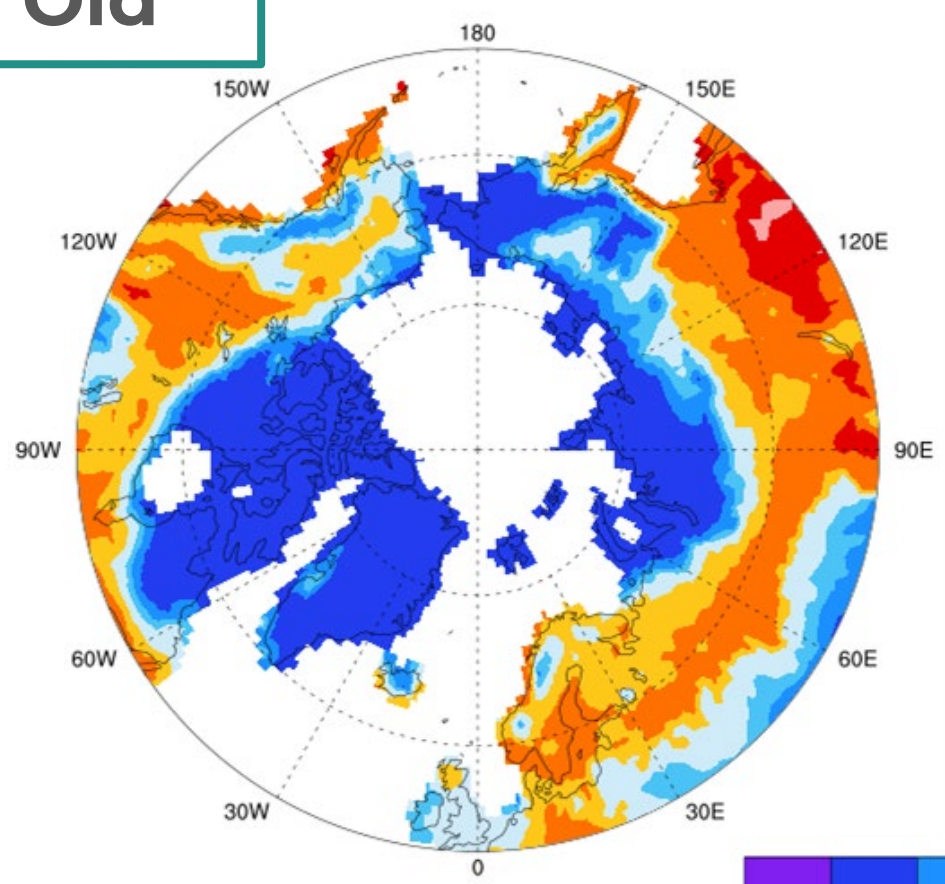


NSF NCAR Operated by UCAR

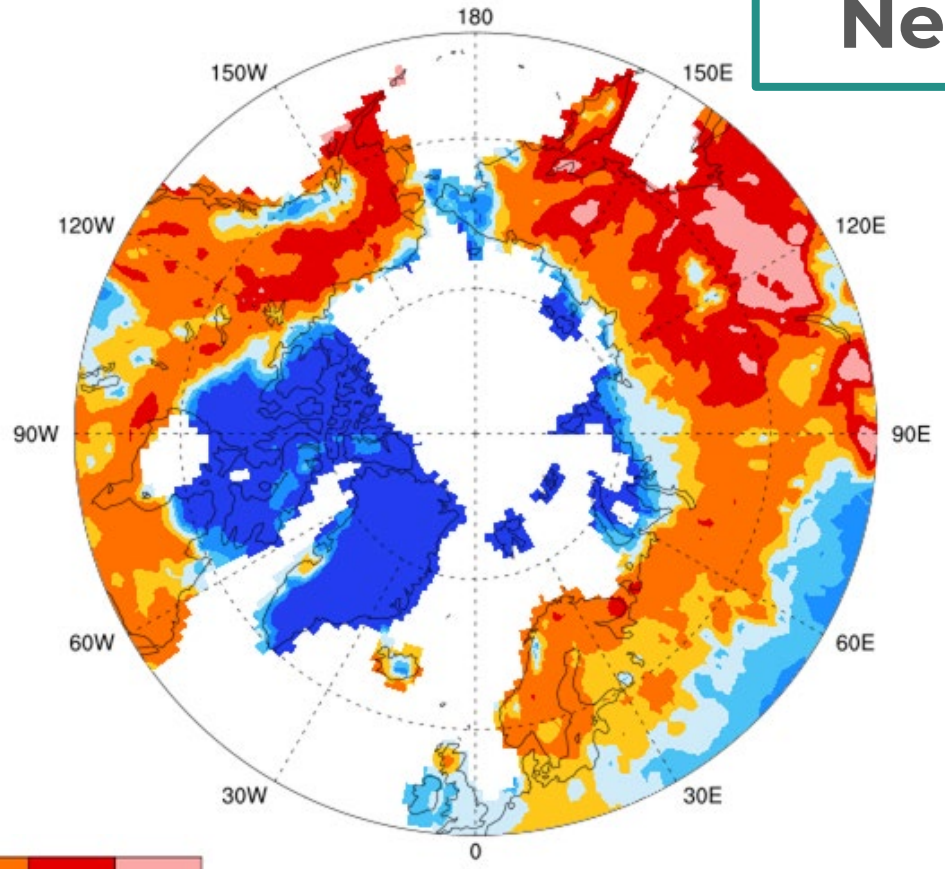
CESM3 Updates

60% less dead Arctic veg than CESM2 piControl

Old



New



dead

cranking

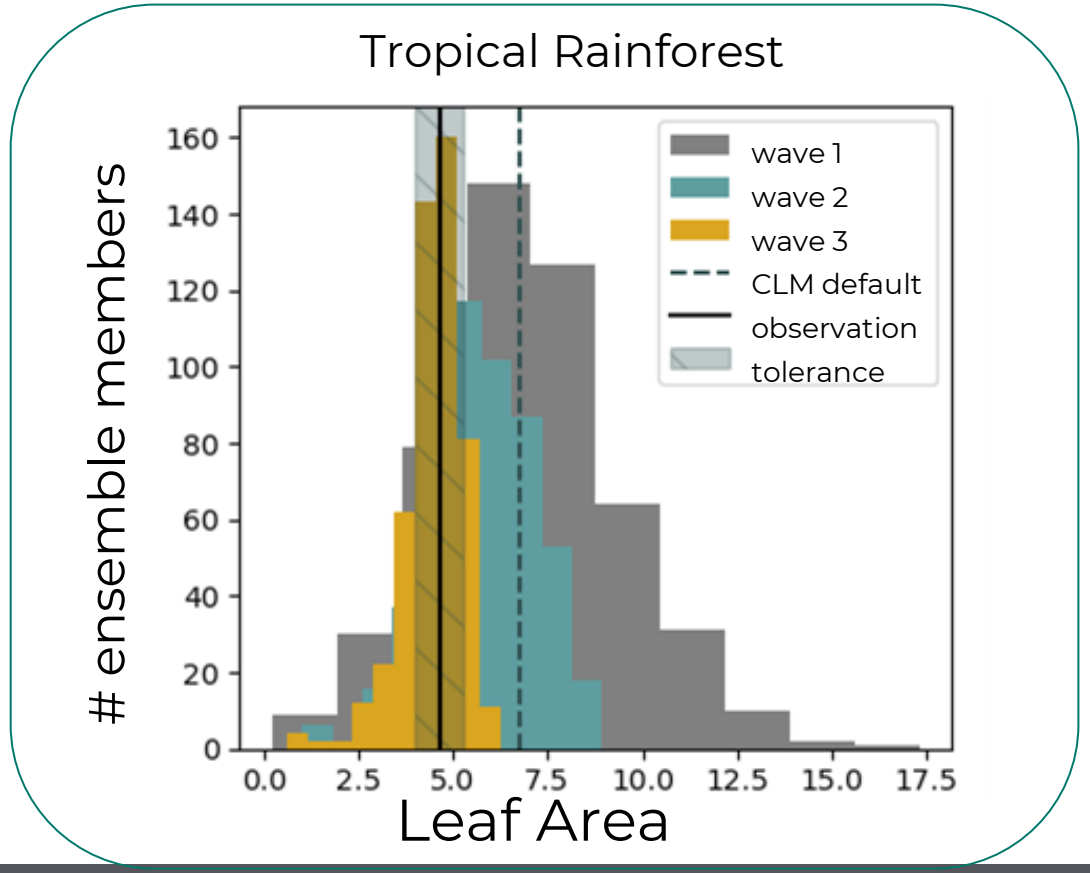
Summer LAI (m^2 m^{-2})

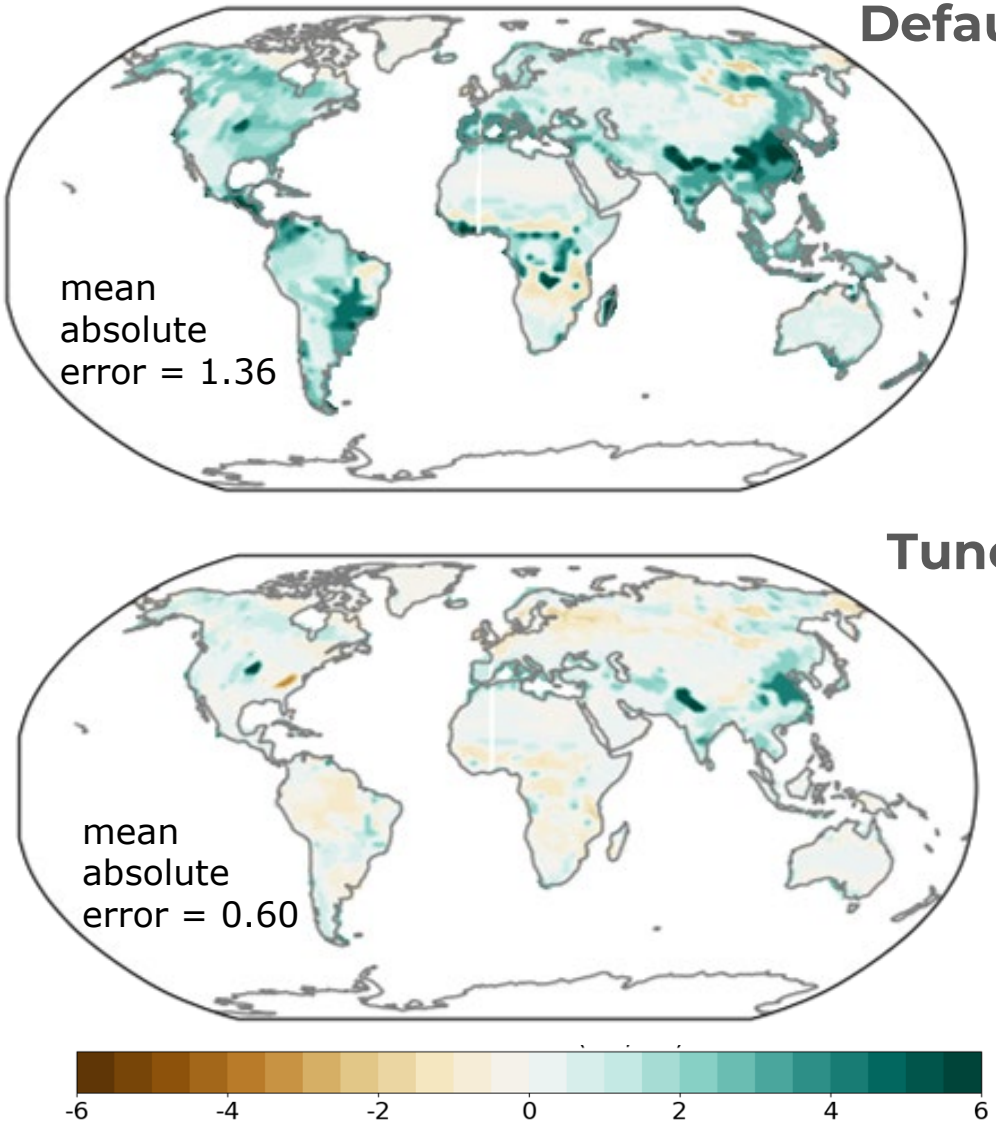
Thanks Oleson & Levis

Systematic tuning of CLM parameters

Method for tuning PFT parameters independently.

- Three iterations of history matching
- Constrained parameter space by >99%
- Emulation is robust enough for calibration



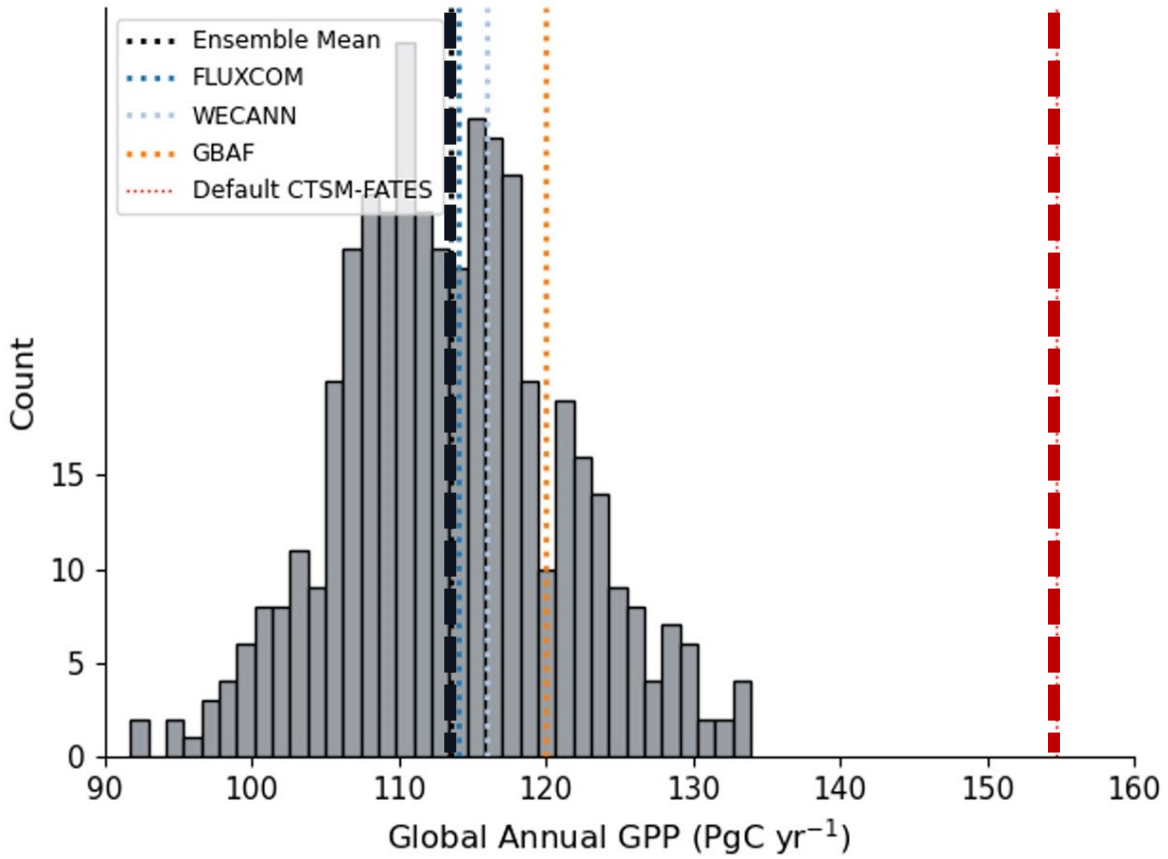


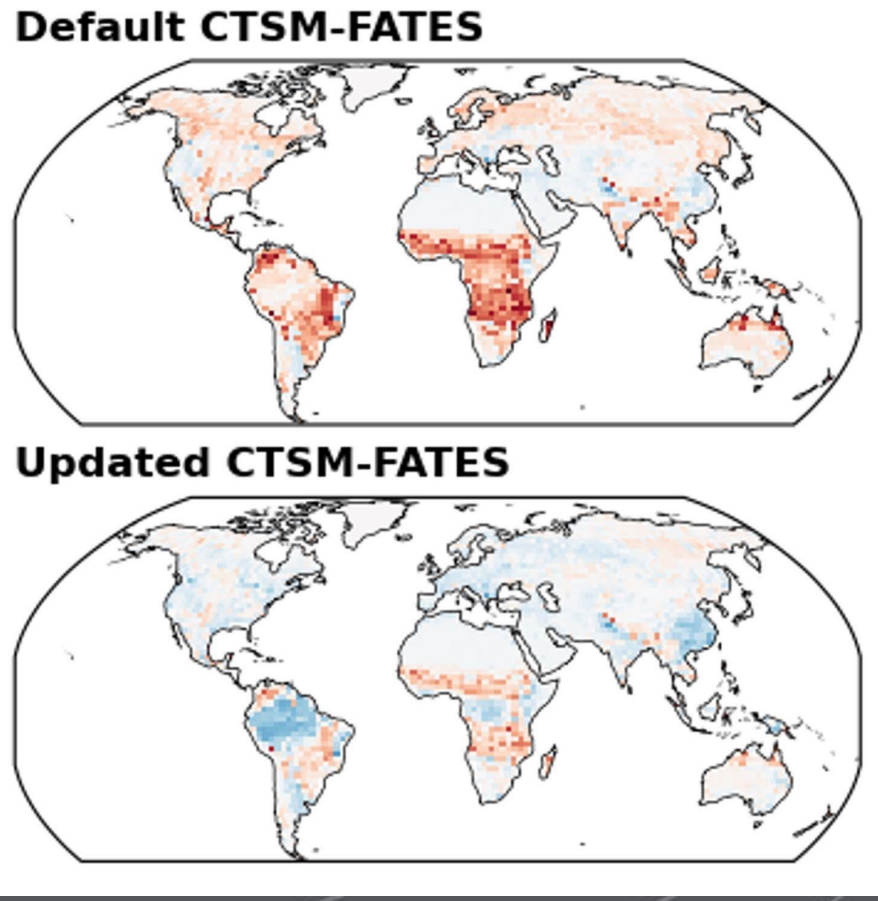
Hawkins, Kennedy, Dagon, et al., (in prep)

FATES SP Calibration

Progress for FATES calibration cascade

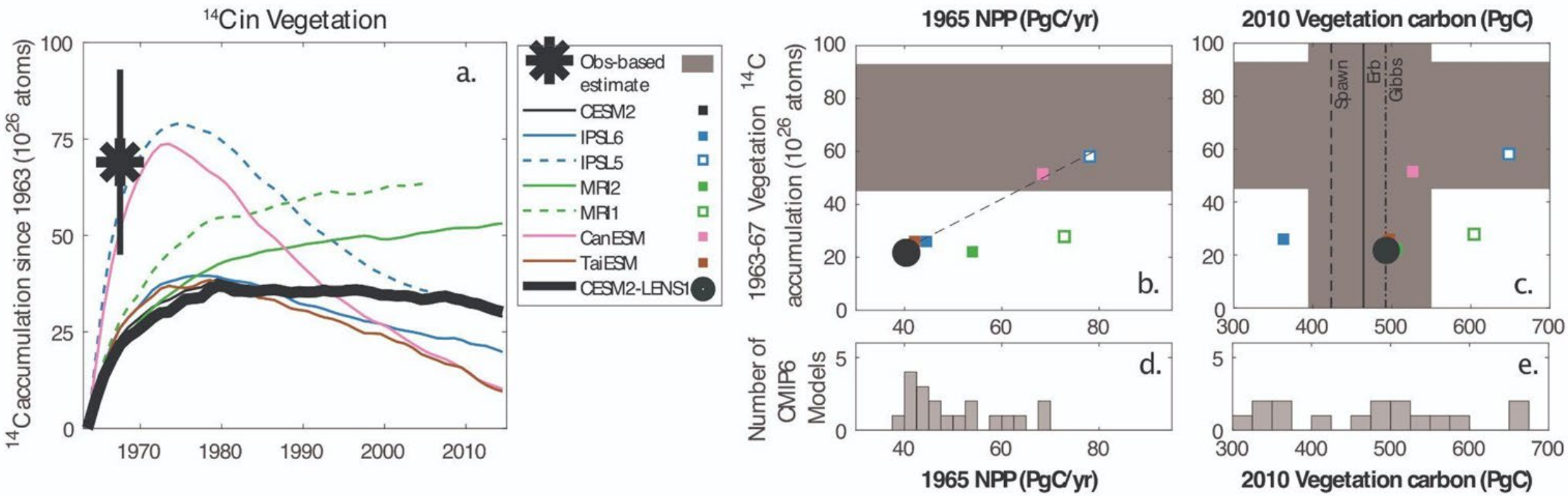
- History matching in SP mode using emulators (GPP, latent heat flux, sensible heat flux)
- Calibration at PFT-specific “dominant grid cells”
- Improved GPP





Foster et al. in prep

Radiocarbon constraints on the land carbon cycle



CESM2: Published C isotope data in CMIP6

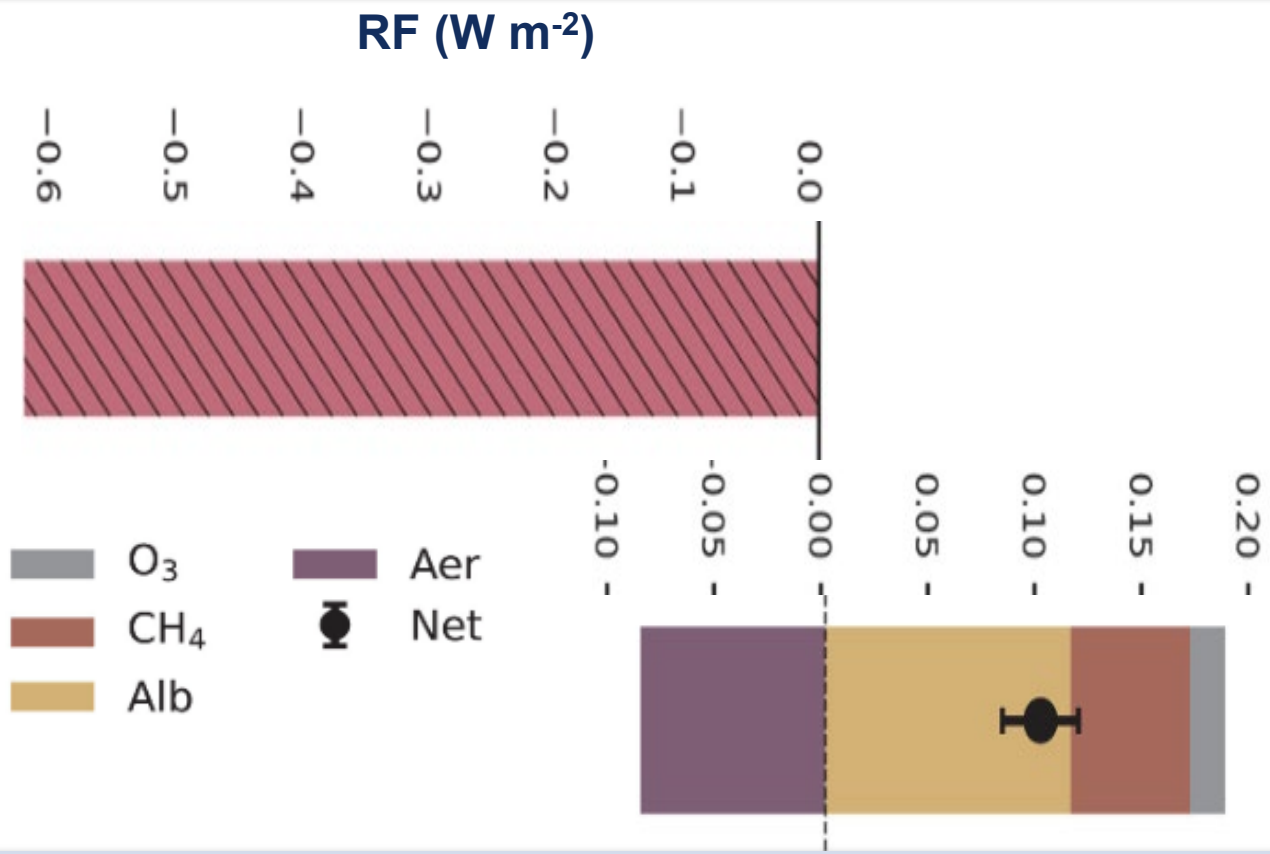
Underestimates ^{14}C accumulation &

Misallocates C to pools with fast turnover times

Earth System Response to Reforestation

RF from CO_2 removal

RF from other sources



Full understanding of climate impacts from reforestation requires ESMs

Changes in albedo and BVOC emissions from reforestation offset ⅓ of radiative forcing (RF) from CO_2 removal in CESM2

Weber et al *Science*, 2024.

Urban Updates

- **New Urban Extent (2000-2100)**: Gao and O'Neill (2020), Gao and Pesaresi (2021), replaces static circa-2000 Jackson et al. (2010)
- **Dynamic Urban Capability** - changes in urban extent over time (Fang et al. 2024)
- **Improved Urban Properties:** Oleson and Feddema (2019), modifies Jackson et al. (2010)
- **Explicit Air Conditioning Adoption**: Li et al. (2023)

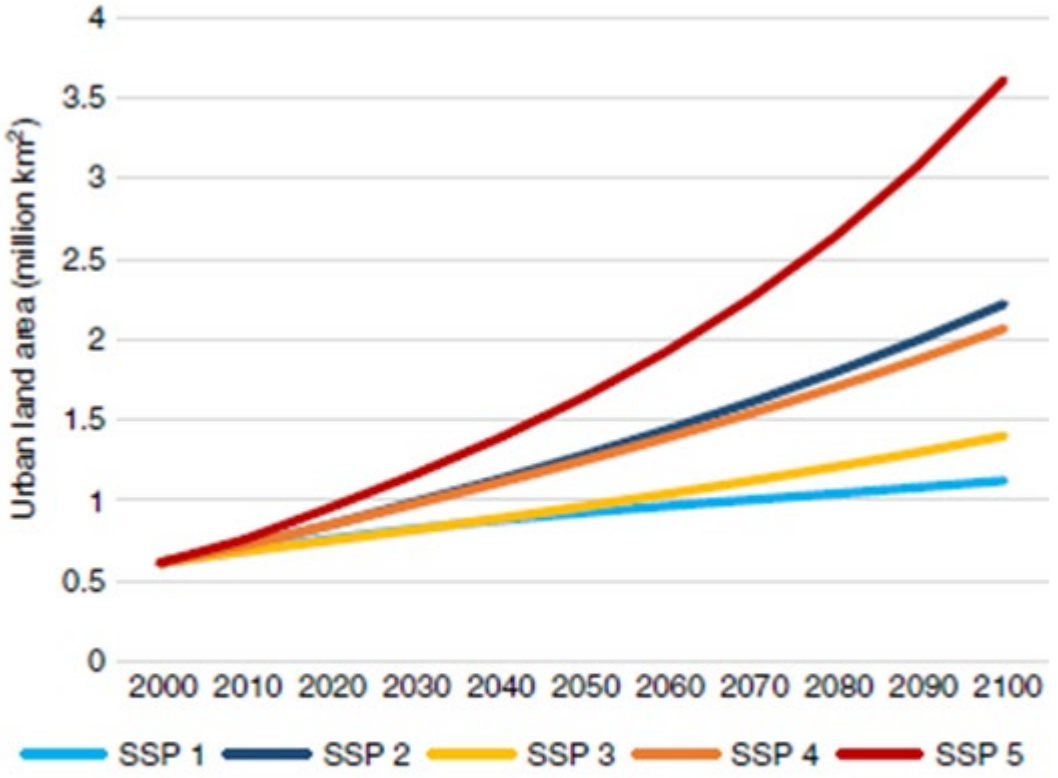
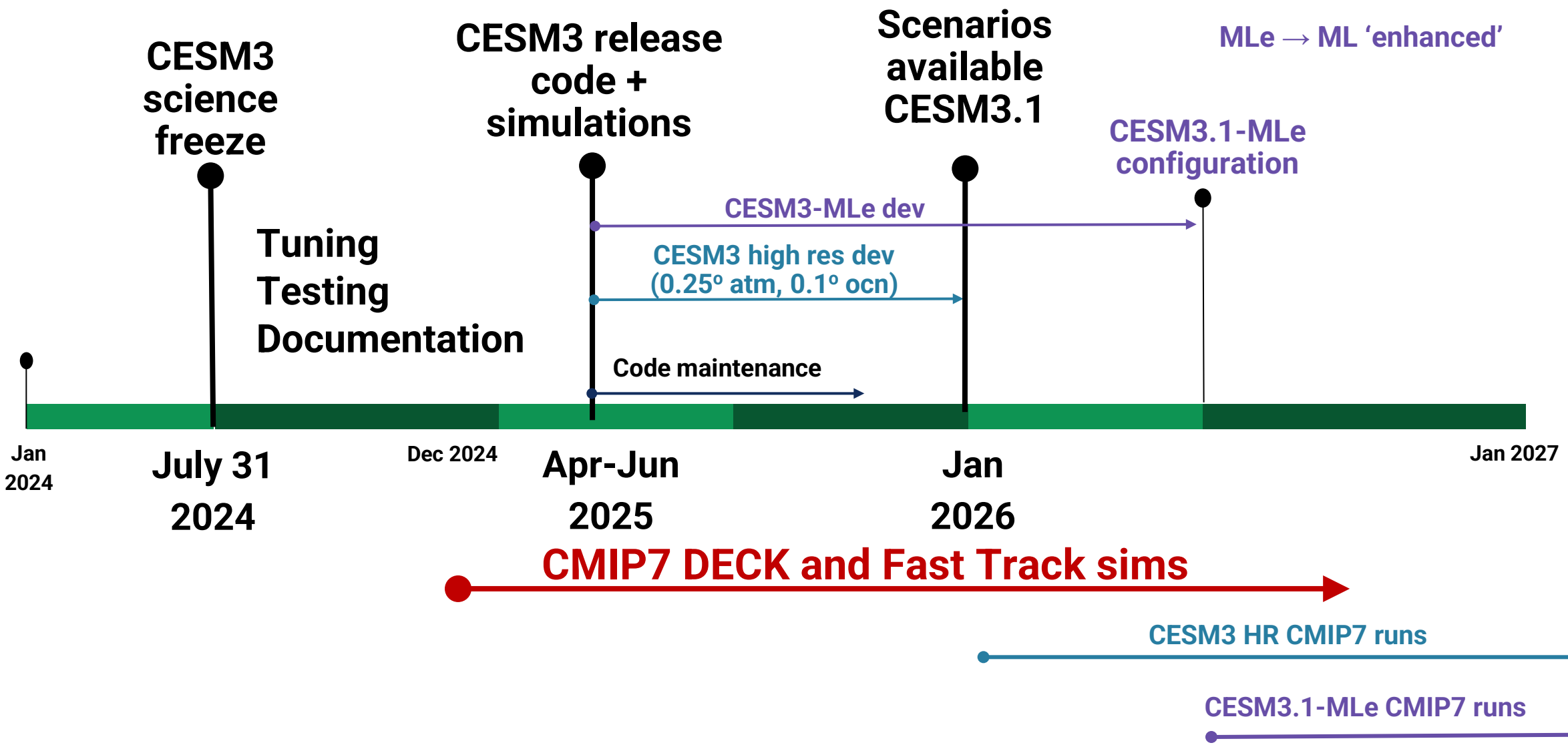


Fig. 1 Global total amount of urban land under different scenarios over the 21st century. The scenarios correspond to the five Shared Socioeconomic Pathways (SSPs 1-5): sustainability, middle of the road, regional rivalry, inequality, and fossil-fueled development.

Proposed CESM3 Timelines (as of Spring 2024)



LMWG Priorities before science code freeze

Done

CTSM5.1 datasets

Hillslope hydrology

… much more …

Required

Dust (Erik)

Negative runoff (Bill)

MOSART tags (Mariana, Sam L)

Desired

Matrix-CN & PPE branch merge (Sam L)

Crop Calendar (Sam R)

Urban Air conditioning (Keith)

CTSM5.3 datasets (Peter, Sam L)?

Megan updates?

FATES LUH2v2 (Sam R)

PLUMBER2 capabilities (Teagan)

Soil NOx scheme?

Fire model updates?

CLM6 Compsets: Start small

Scientifically supported compsets:

= initial conditions

= evaluation / diagnostics

= aliases

Alias: IHistClm60BgcCrop

- Atm: CRUJRA (TRENDY)
- Land: SP & BGC-CROP options
- River: MOSART
- Glacier: DGLC-No-Evolve

Functionally tested compsets

Atmosphere: GSWP3, CPLHIST, NLDAS2**, **1PT****

Land: CLM60: FATES-SP, FATES-nocomp, … more
SP-Hillslope, BGC-Hillslope,
SP-noAnthro, BGC-noAnthro

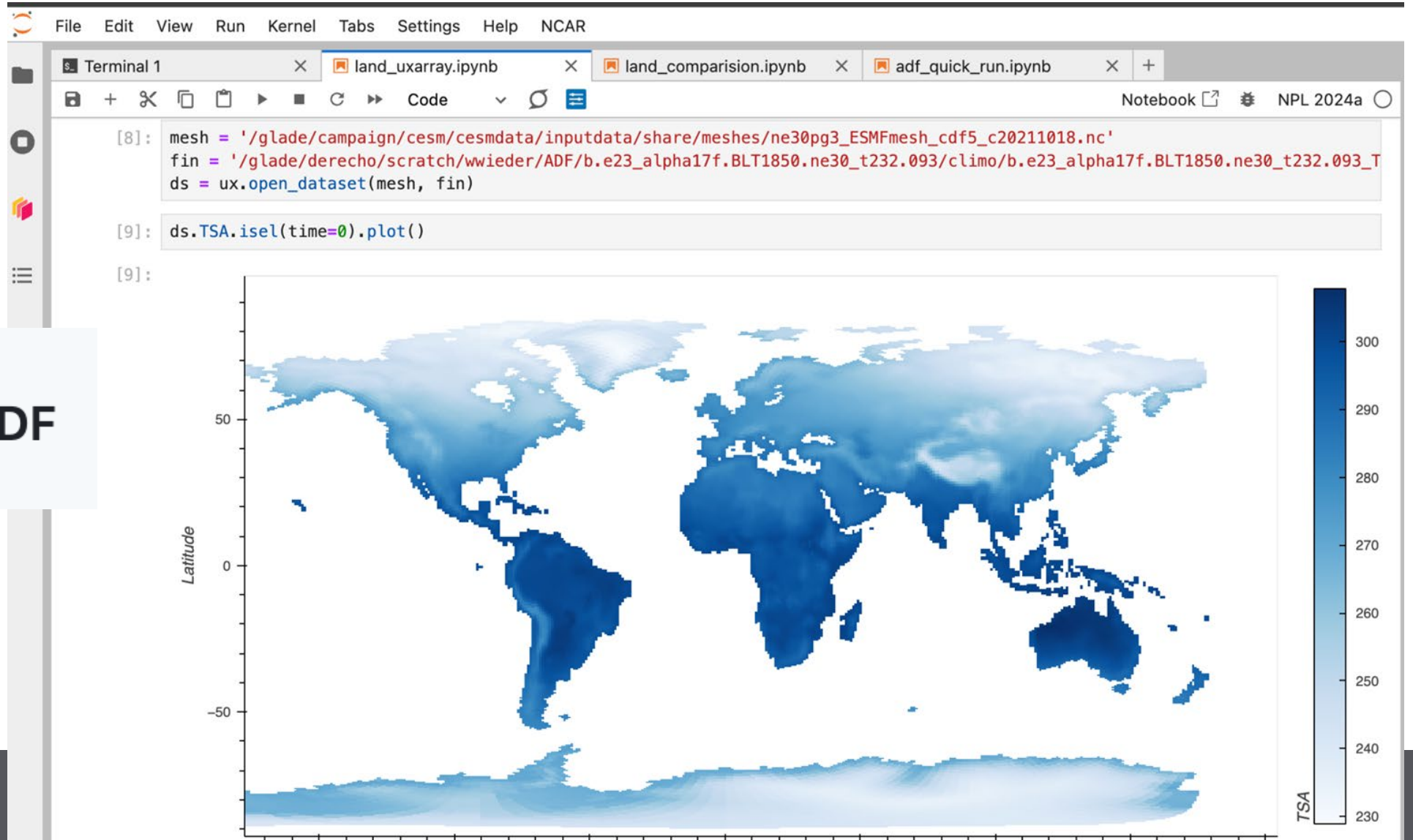
River: mizuRoute RTM

Glacier: AIS-evolve & GRIS-evolve

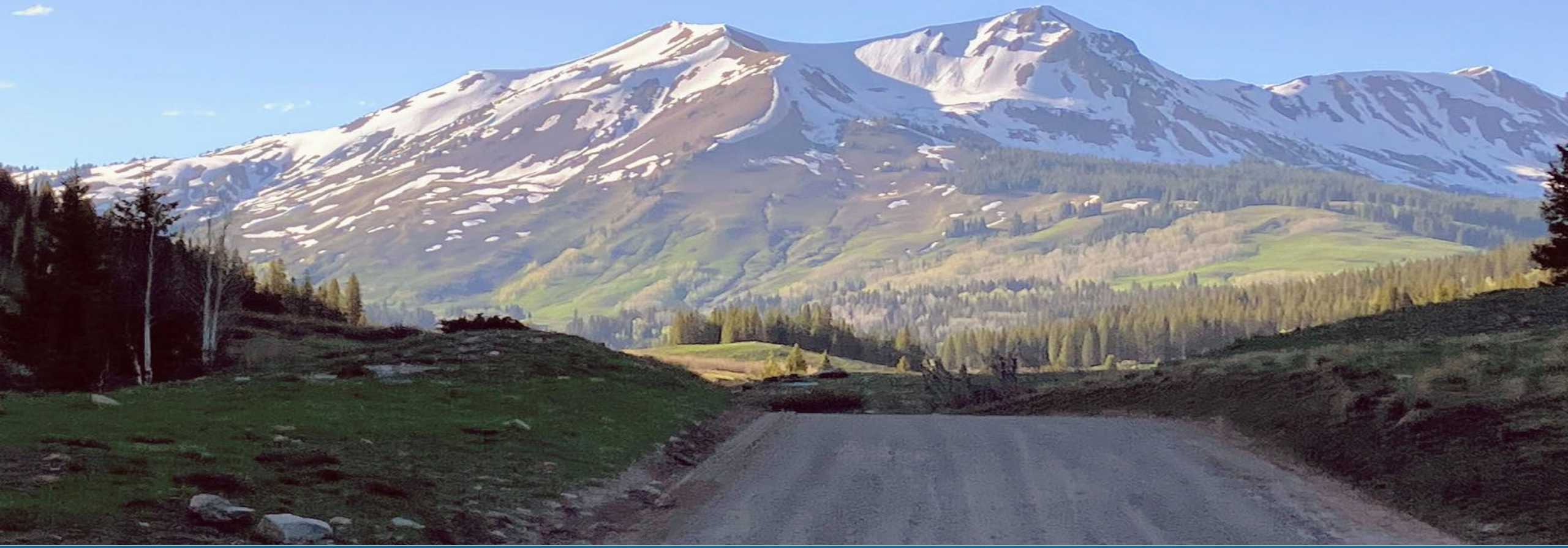
Land Model Diagnostics

CUPiD: CESM Unified Postprocessing and Diagnostics

NCAR / ADF



Discussion



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