State of CLM Update

David Lawrence and LMWG

LMWG Andrew Slater Award

The award will be given out annually for the "best student or postdoc performance" at the meeting. We hope that this award will help us all to remember the special way that Drew went about being a scientist and further that it will inspire young scientists to follow in his footsteps. Drew's way included a dedication to deep understanding of his research topics from theoretical, observational (fieldwork) and modelling angles, and also involved a certain irreverence for the status quo.

The Land Model Working Group

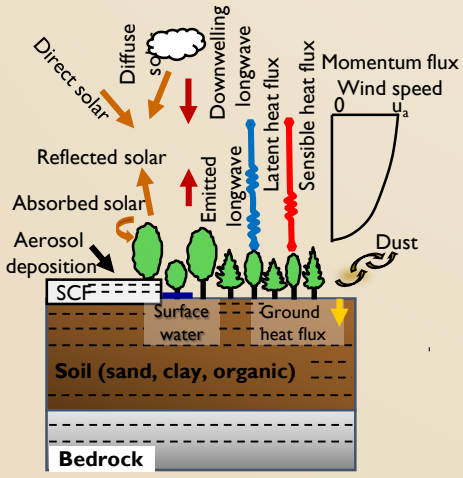
Andrew Slater Award

Is hereby granted to:

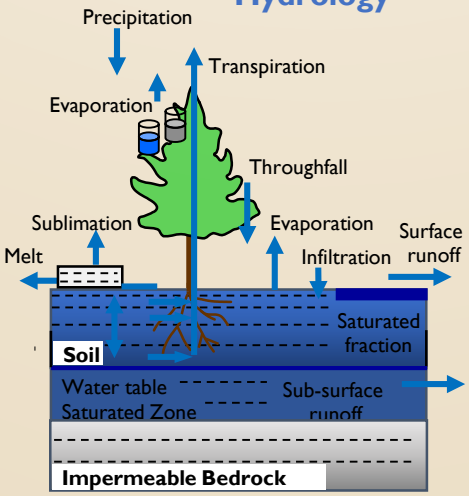
???

for best student or postdoc performance at 2018 LMWG Workshop

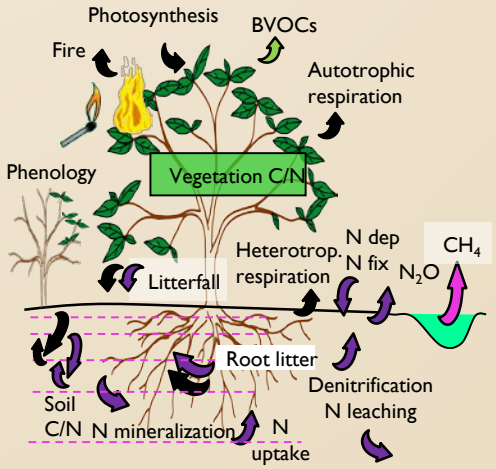
Surface energy fluxes



Hydrology



Biogeochemical cycles



CLM5 Release!

Mail

Move to Inbox | More

COMPOSE

Inbox (29)
Important
Sent Mail
Drafts (283)
Categories
Admin
Archives
Arctic
CCP

larches

Inbox x

Will Wieder <wwieder@ucar.edu> 10/6/17

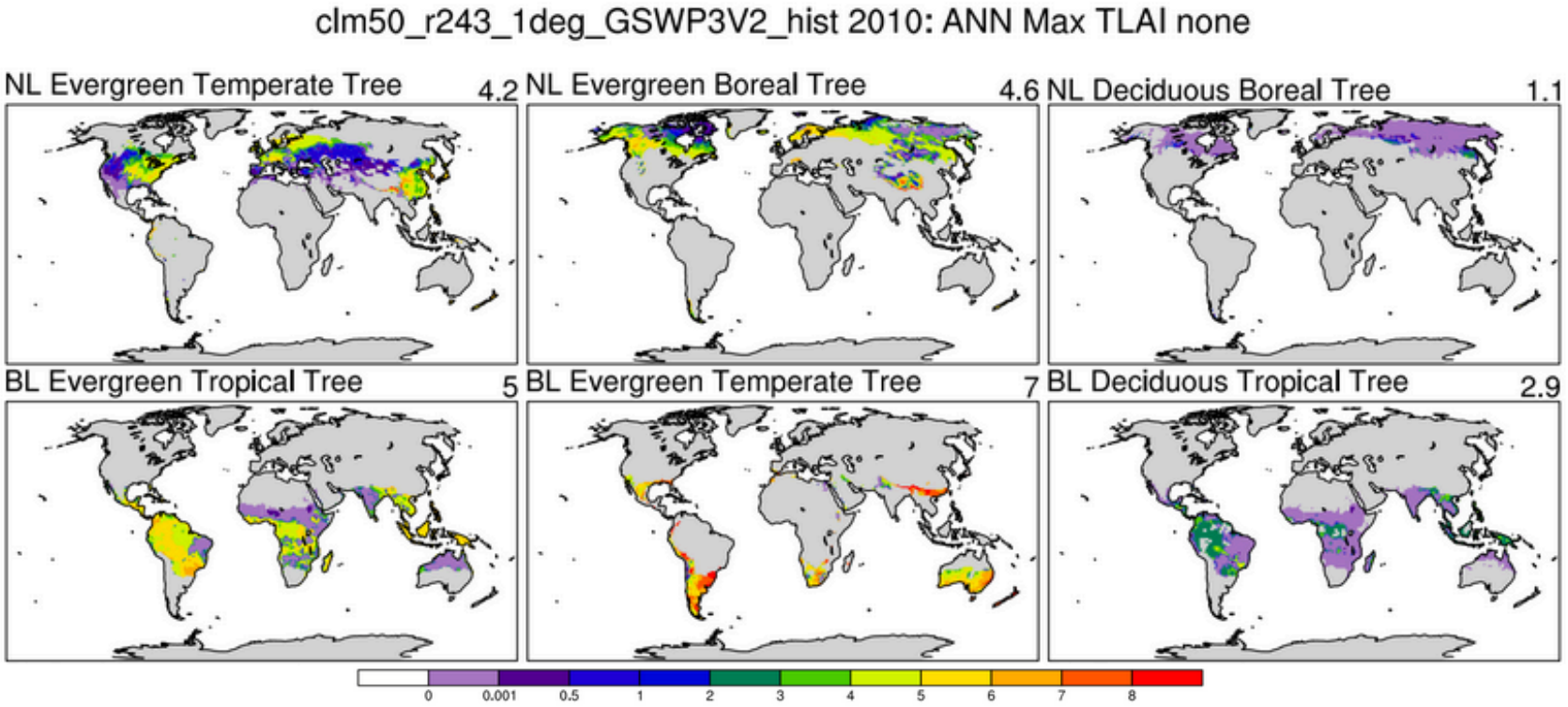
to me, Keith, Rosie

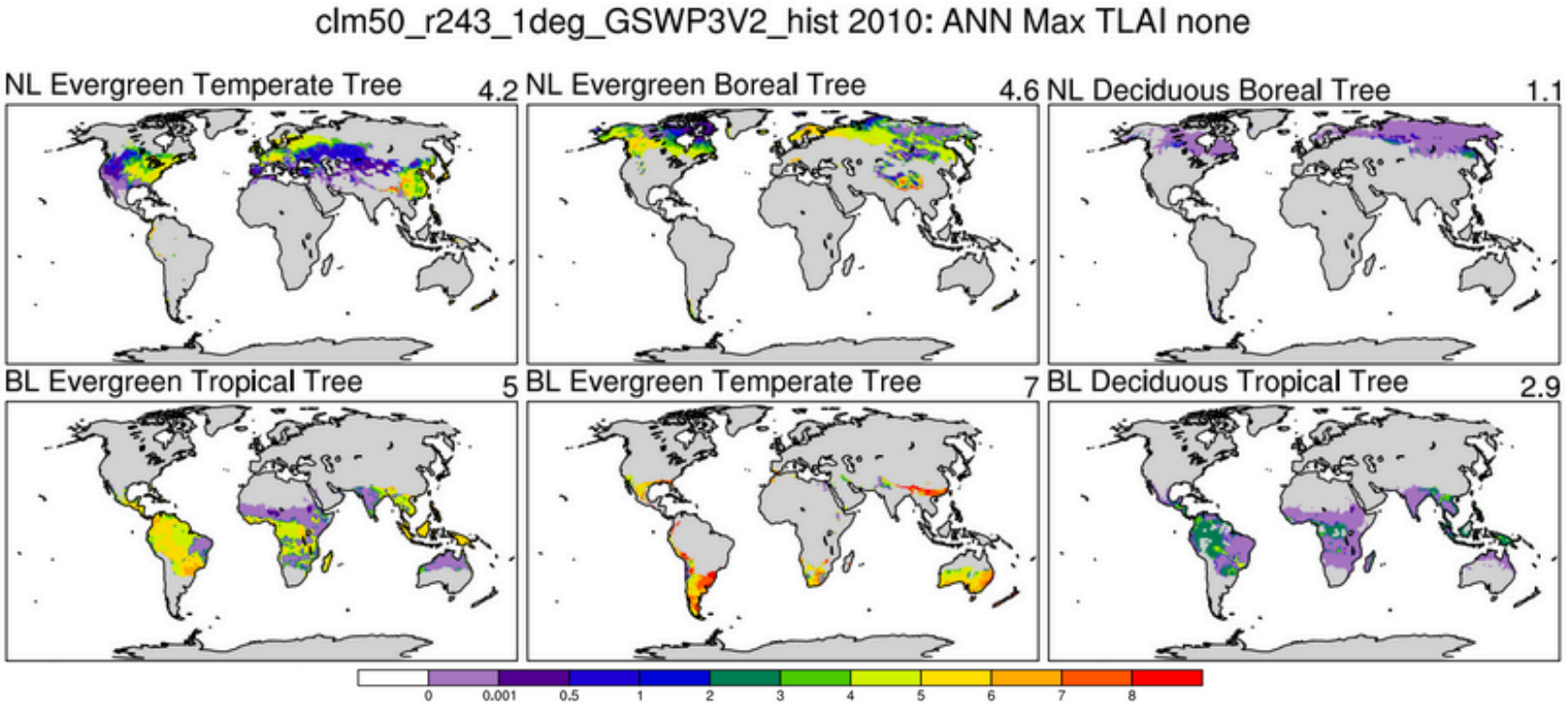
I'm afraid larches are dead again in clm5? Ditto for decid. tropical trees.

The first plot here shows the total area of each pft. The second shows the regions where max LAI is > 0.1 in 2010.

pages 3 & 4 show LAI in CLM5 and 4.5, respectively.

These are from Keith's 20th century control (tag 243) that I cloned for subsequent +CO2 and +N simulations





Parameter changes

stem_leaf from 1.5 to 1.0 for BL Deciduous Boreal Tree

stem_leaf from 0.12 to 0.24 for BL Deciduous Shrub and BL Deciduous Boreal Shrub

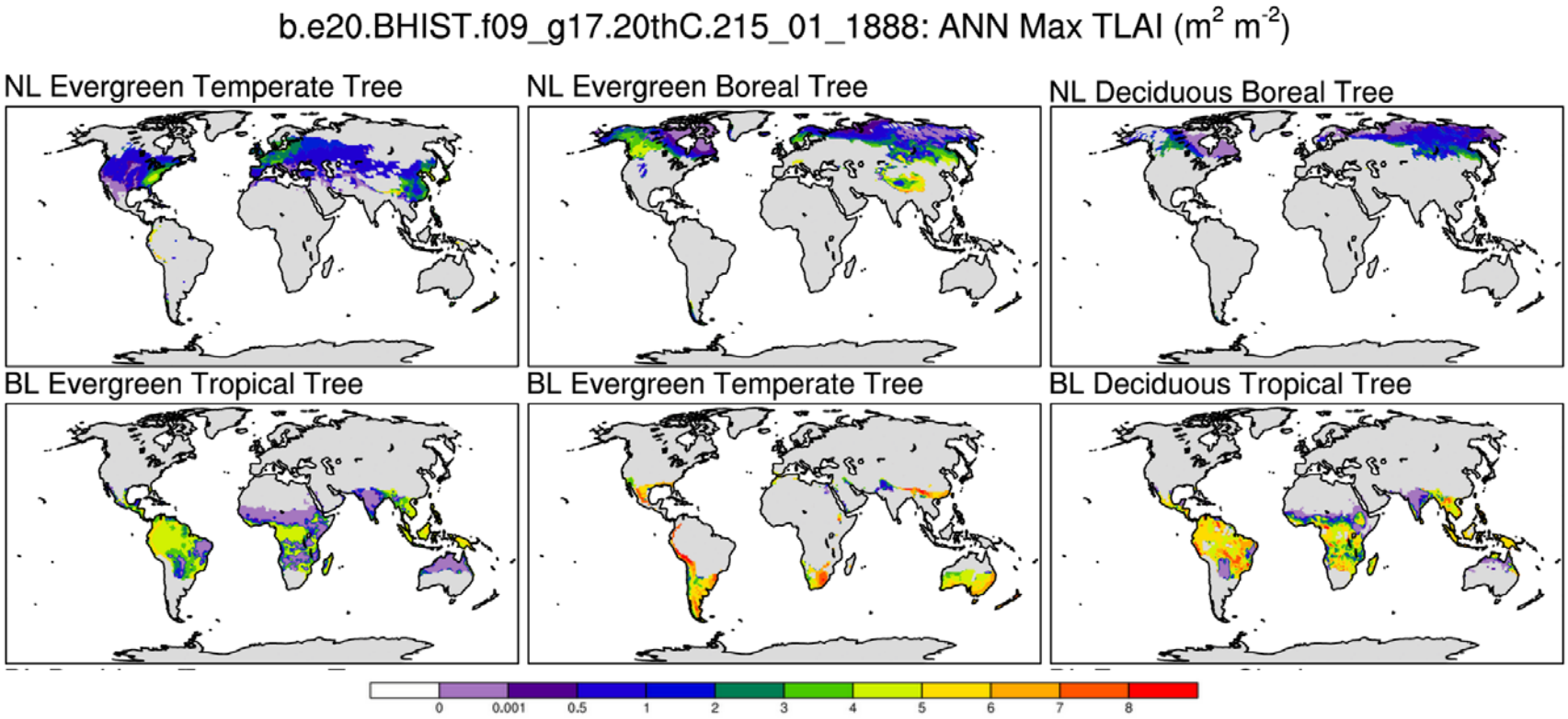
ekc_active from 0.36 to 0.036 for BL Deciduous Boreal Tree

ekn_active from 0.06 to 0.006 for BL Deciduous Boreal Tree

kn_nonmyc from 0.012 to 0.0012 for BL Deciduous Boreal Tree

stem_leaf from 2.3 to 1.0 for BL Deciduous Tropical Tree

psi50 from -270000 to -340000 for BL Deciduous Tropical Tree (same as C4 grass)



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COMPOSE

Inbox (29)
Important
Sent Mail
Drafts (283)
Categories
Admin
Archives

preliminary grain plots

Inbox x

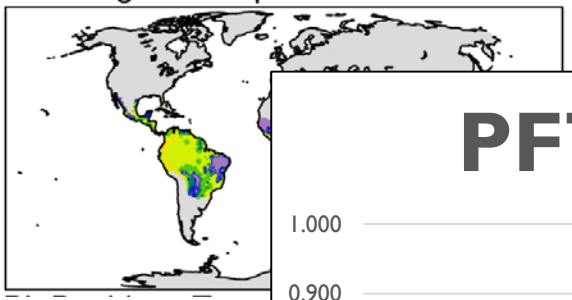
Danica Lombardozzi <dll@ucar.edu> 10/13/17

to me

Hi Dave,

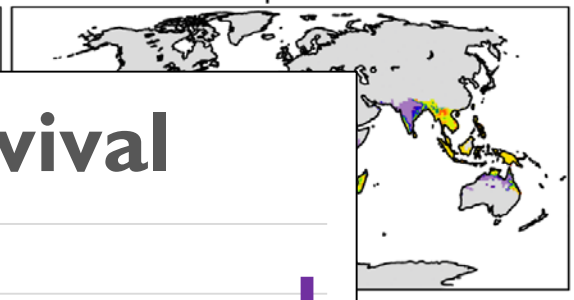
I have to leave in a few minutes, but I wanted to send some preliminary plots. I'm still trying to figure out the best units to use for the grain time series, and I was surprised by the fact that there are some increases in grain without irrigation (the calculation is (no irrigation - control)/control). I'll continue to work on these on Monday morning. I also have latent heat flux plotted, but I need to figure out some plotting problems.

BL Evergreen Tropical Tree



BL Evergreen Temperate Tree

BL Deciduous Tropical Tree



PFT Percent Survival

CLM5 Release!

CLM5 Release!

CLM5 release webpage (www.cesm.ucar.edu/models/cesm2.0/land/)

CLM5 Documentation

Introduction

CLM5.0 is the latest in a series of land models developed through the CESM project. More information on the CLM project and access to previous released CLM model versions and documentation can be found via the CLM Web Page. Note that CLM4.5 biogeophysics and biogeochemistry can be run from this release code. A new river model (MOSART) is also included. This release is a land-only release. The capability to run CLM5.0 within CESM2.0 will be included in the CESM2.0 release.

The Functionally Assembled Terrestrial Ecosystem Simulator (FATES) is available within the CLM5 release as a research option.

Access

- CLM5.0 is publicly available through the Community Terrestrial System Model (CTSM) git repository
- Download the code by executing the following commands:

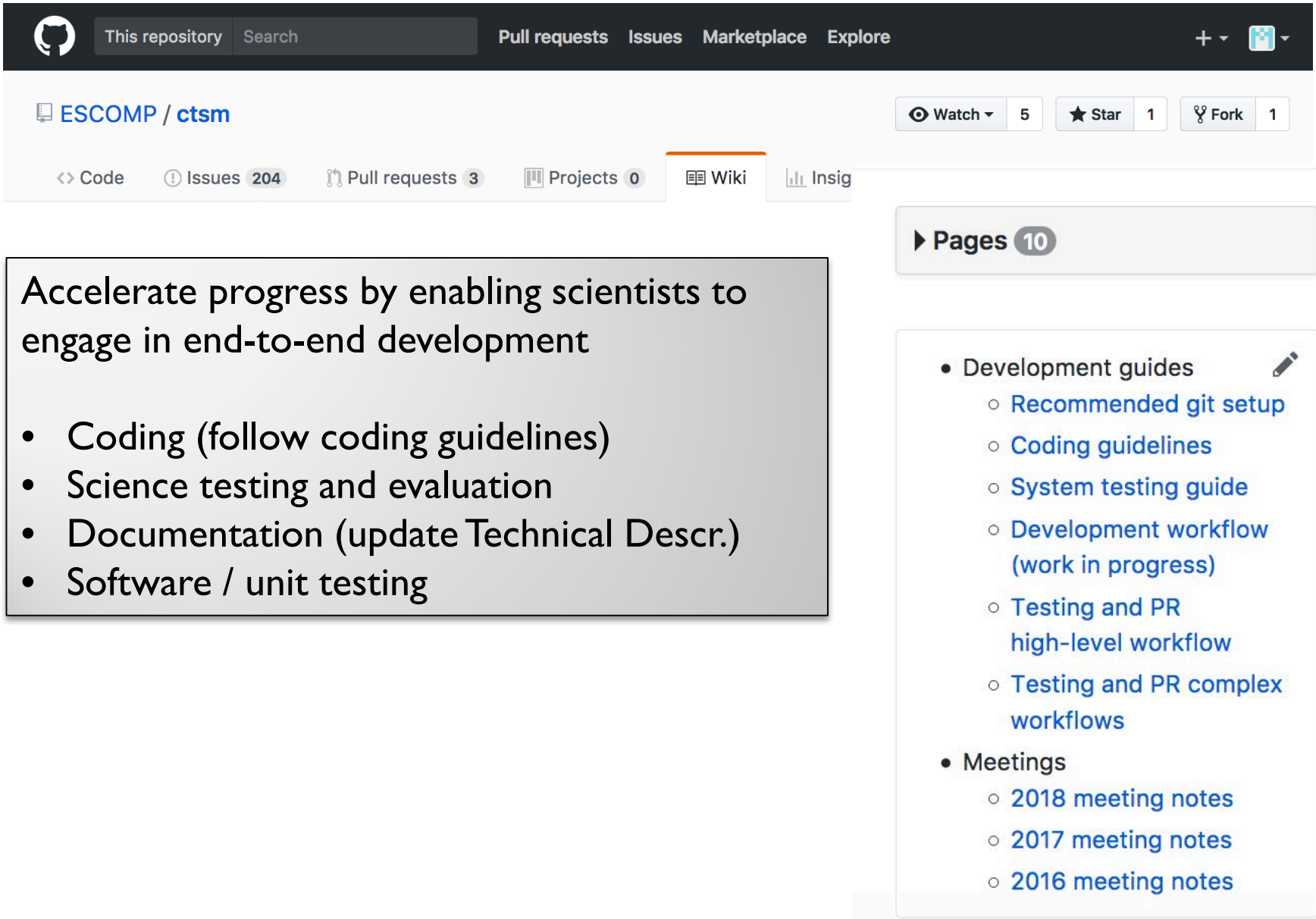
```
git clone -b release-clm5.0 https://github.com/ESCOMP/ctsm.git clm5.0
cd clm5.0
./manage_externals/checkout_externals
```

Documentation

- CLM5.0 Technical Description [html]
- What's new in CLM5.0 (text description), (list)

- CLM5.0 User's Guide (In development)
- Quickstart Guide (this is CESM2.0 Quick Start guide; note that same script commands used for CLM land-only)
- CIME documentation (CIME - pronounced "SEAM" - is the Common Infrastructure for Modeling the Earth provides a UNIX command-line-based interface for configuring, compiling and executing Earth system models including CLM)

Collaborative software development



Accelerate progress by enabling scientists to engage in end-to-end development

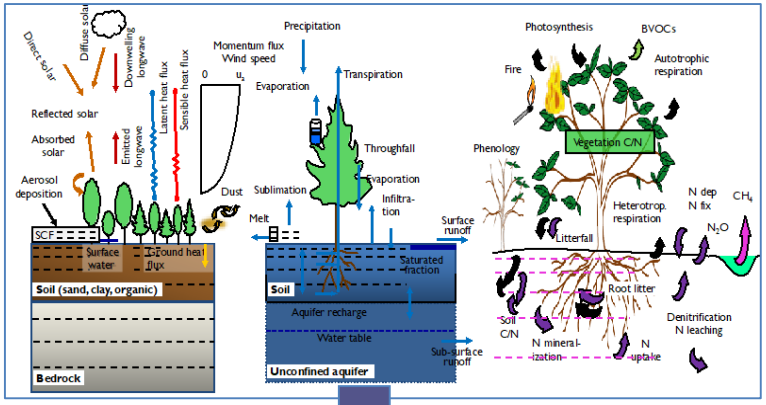
- Coding (follow coding guidelines)
- Science testing and evaluation
- Documentation (update Technical Descr.)
- Software / unit testing

The Community Terrestrial Systems Model

a model for research and prediction in climate, weather, water, and ecosystems

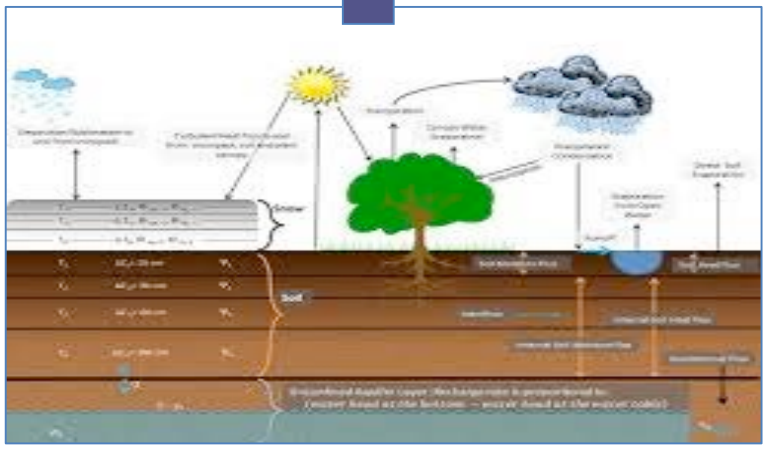
NCAR UCAR

CLM (CGD)



SUMMA concepts

CTSM



Noah-MP, WRF-Hydro (RAL)

Unify land modeling across NCAR

- More efficient use of NCAR and community resources
- Consistent with NCAR emphasis on unified modeling
- Extend NCAR leadership in community modeling
- Accelerate advances
- Increase flexibility and robustness of process representation, spatial disaggregation, and numerical solution (SUMMA concepts, modularization)
- Enable more hypothesis-driven science
- Integrate and expand land modeling research and development community
- Expand funding opportunities?

CLM5 release webpage (www.cesm.ucar.edu/models/cesm2.0/land/)

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February 2018

Technical Description of version 5.0 of the Community Land Model (CLM)

Coordinating Lead Authors

David Lawrence, Rosie Fisher, Charles Koven, Keith Oleson, Sean Swenson

Lead Authors

Ben Andre, Gordon Bonan, Bardan Ghimire, Leo van Kampenhout, Daniel Kennedy, Erik Kluzek, Ryan Knox, Peter Lawrence, Fang Li, Hongyi Li, Danica Lombardozzi, Yaqiong Lu, Justin Perket, William Riley, William Sacks, Mingjie Shi, Will Wieder, Chonggang Xu

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National Center for Atmospheric Research P. O. Box 3000, Boulder, Colorado 80307-300

LIST OF FIGURES

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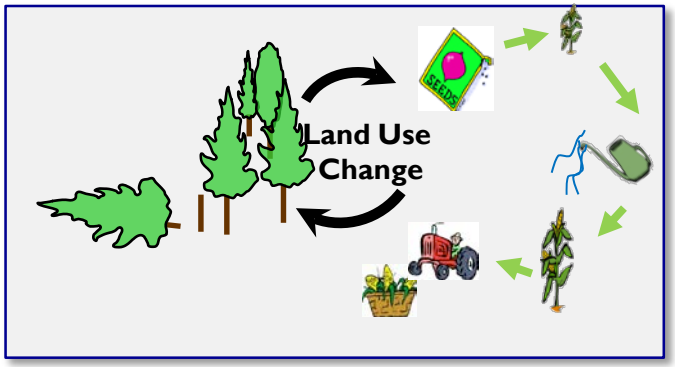
What's new in CLM5 since CLM4.5

Hydrology:	dry surface layer, spatially variable soil depth (0.4 to 8.5m) max depth, revised GW and canopy interception, adaptive time-stepping, increased soil layer resolution
Snow:	canopy snow, wind and T effects on snow dens., firn model (12 layers), glacier MEC
Rivers:	MOSART (hillslope → tributary → main channel)
Nitrogen:	New C-N coupling (flexible leaf C:N ratio, leaf N optimization, C cost for N)
Vegetation:	plant hydraulics and hydraulic redist, deep rooted tropical trees, Medlyn stomatal cond, Ecosystem Demography (FATES), prognostic roots, ozone damage
Fire:	updates, trace gas and aerosol emissions
Crops:	global crop model with transient irrigation and fertilization (8 crop types), grain product pool, revised irrigation scheme
Carbon:	revisions to carbon allocation and soil carbon decomposition
Land cover/use:	dynamic landunits, updated PFT-distribution, wood harvest by mass
Isotopes:	carbon and isotope enabled

CLM5 default configuration

CLM5 optional feature



Component Model Namelist Definitions for CLM4.5/5.0

Component tag: clm4_5_18_r274

CESM Version: CESM2.0

HTML created on: 2018-02-02

This page contains the complete list of CLM4.5/5.0 namelist variables available.

They are grouped by categories designed to aid browsing.

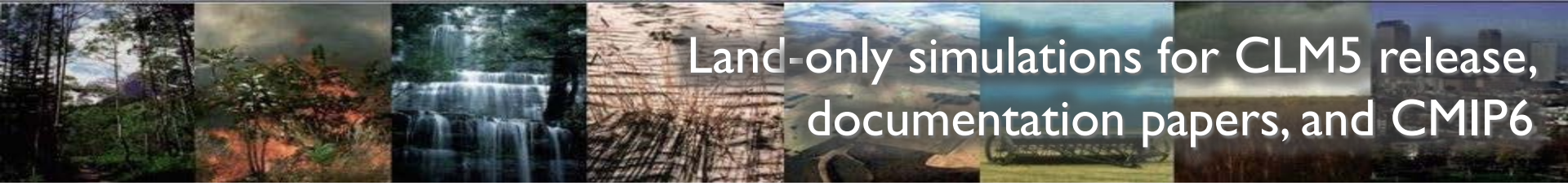
Clicking on the name of a variable will display additional descriptive information.

Click on the "Show Details" button and then cntl+F key to search for specific strings in this file.

Show Details | Hide Details

Category: bgc

denitrif_nitrateconc_coefficient Group: nitrif_inparm	Multiplier for nitrate concentration for max denitrification rates (ONLY us...
denitrif_nitrateconc_exponent Group: nitrif_inparm	Exponent power for nitrate concentrationfor max denitrification rates (ONLY...
denitrif_respiration_coefficient Group: nitrif_inparm	Multiplier for heterotrophic respiration for max denitrification rates (ONL...
denitrif_respiration_exponent Group: nitrif_inparm	Exponent power for heterotrophic respiration for max denitrification rates ...
k_nitr_max Group: nitrif_inparm	Maximum nitrification rate constant (1/s) (ONLY used if use_nitrif_denitrif...
use_century_decomp Group: clm_inparm	Use parameters for decomposition from the CENTURY Carbon model Requires the...
use_cn Group: clm_inparm	CLM Biogeochemistry mode : Carbon Nitrogen model (CN) (or CLM45BGC if phys=...
use_cndv Group: clm_inparm	CLM Biogeochemistry mode : Carbon Nitrogen with Dynamic Global Vegetation M...



Land-only simulations for CLM5 release, documentation papers, and CMIP6

	CLM4				CLM4.5				CLM5			
Forcing	SP	BGC	+N, +CO_2	no LULC C	SP	BGC	+N, +CO_2	no LULC C	SP	BGC crop	+N, +CO_2	no LULC C
GSWP3 v1	✔☐°	✔☐° ❄	✔☐	✔☐	✔☐	✔☐° ❄	✔☐	✔☐	✔☐°	✔☐° ❄	✔☐	✔☐
CRUNCEP v7		✔☐				✔☐			✔☐	✔☐° ❄		✔☐
WATCH/ WFDEI									✔☐$^{W}_{F}$	✔☐^{W}		

✔☐ **Historical simulation (1850-2014,^{W} 1850-2001,^{WF} 1979-2014)**

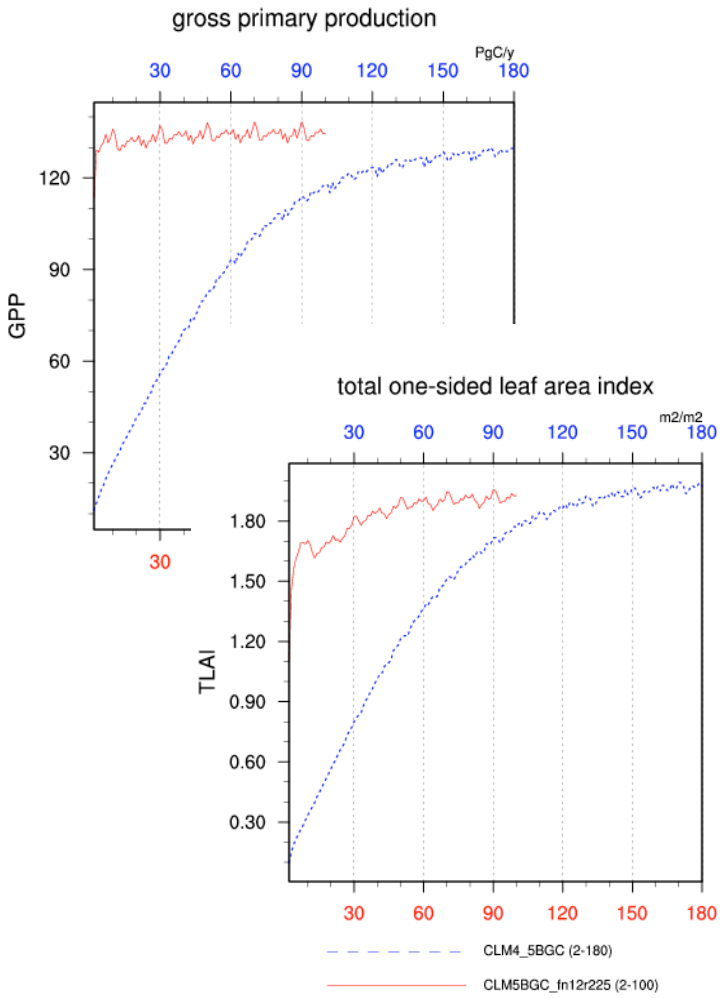
❄ **Projection period simulations (RCP8.5 2015-2300)**

° **Daily and hourly output**

New features

- Online initial condition interpolation (use_init_interp = .true.)
- Much faster accelerated spin-up (biogeophysical land state comes into equil quickly)
  - CLM4, 2000+ years; CLM5, ~800 years
- Lots of namelist control
  - lnd_in: ~240 lines CLM5; 18 lines CLM4
- Anomaly forcing
  - Force CLM with climate anomalies
- Dynamic landunits

Configuration	Cost (pe-hrs/yr)
CLM4.0 CN	20
CLM4.5 BGC	80 (4x)
CLM5.0 BGC	120 (6x)
CLM5.0 BGC-crop	175 (8x)
CLM5.0 no BGC	50



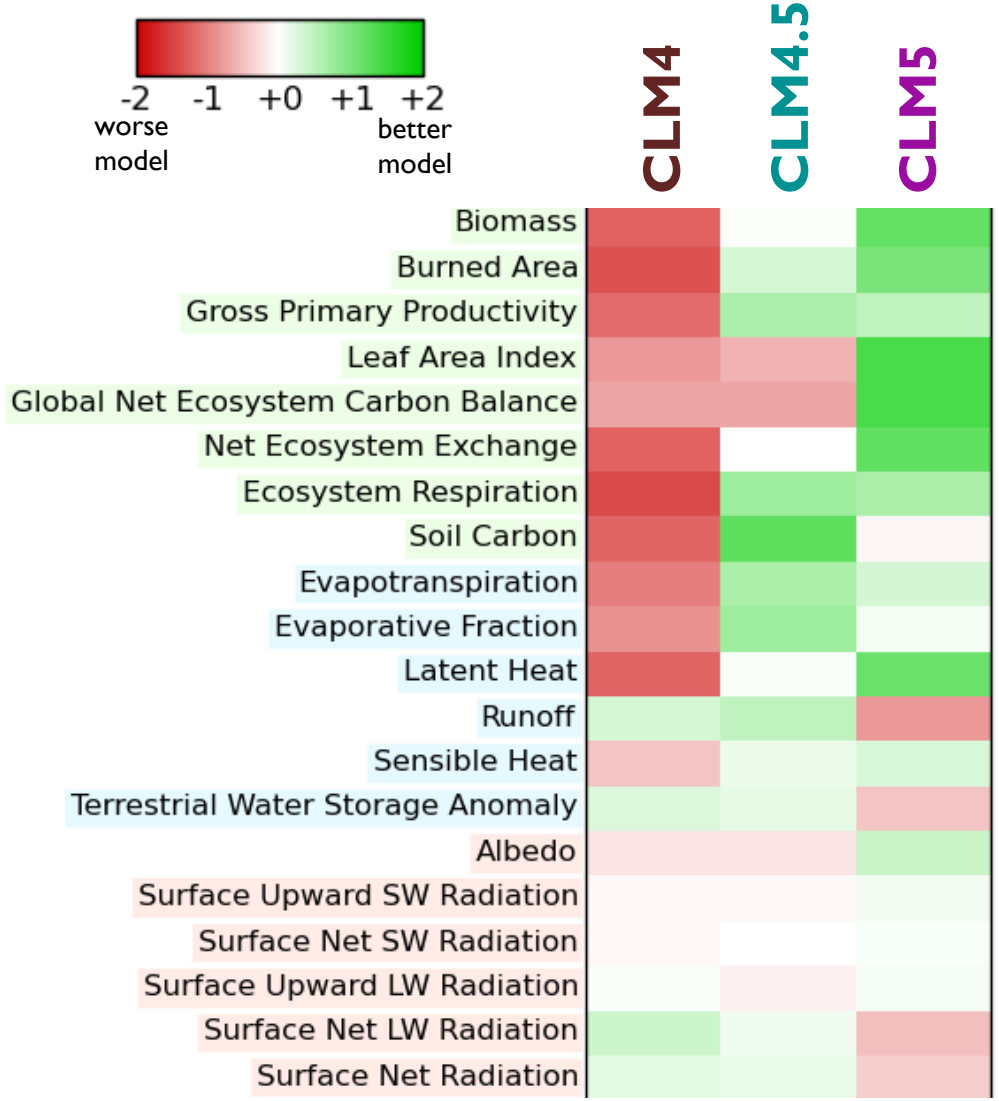
CLM4.0, CLM4.5, AND CLM5.0 0.9˚X1.25˚ "STAND-ALONE" (I COMPONENT SET) ILAMB DIAGNOSTICS

ILAMB (International Land Atmosphere Model Benchmarking) project

CESM2.0 Home Page

Models and (Forcing Datasets)	Regions	Diagnostics
CLM5SP (GSWP3,CRUNCEP,WFDEI)	Global Only	Plots
CLM5BGC (GSWP3,CRUNCEP,WATCH)	Global Only	Plots
CLM4BGC, CLM4.5BGC, CLM5BGC (GSWP3)	All	Plots
CLM4BGC,CLM4.5BGC,CLM5BGC (GSWP3,CRUNCEP); CLM4SP,CLM4.5SP,CLM5SP (GSWP3)	Global Only	Plots

CLM land-only forced with GSWP3 prognostic vegetation and carbon configuration

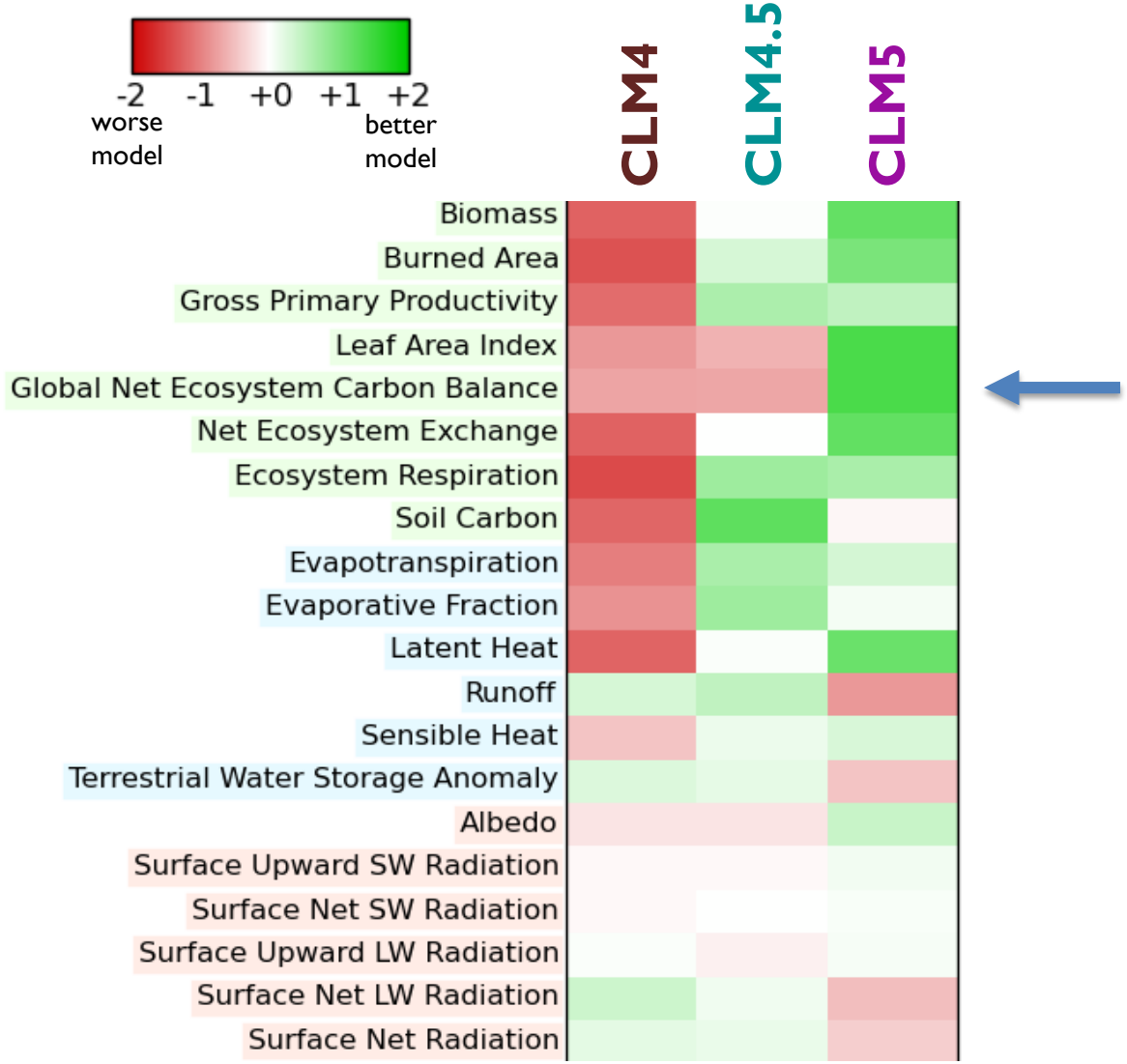


- For majority of variables, progression in simulation quality from CLM4 to CLM5
- Why?
  - Improvements in mechanistic treatment of processes (e.g., hydrology, biogeochemistry, land use)
  - But, many more moving parts

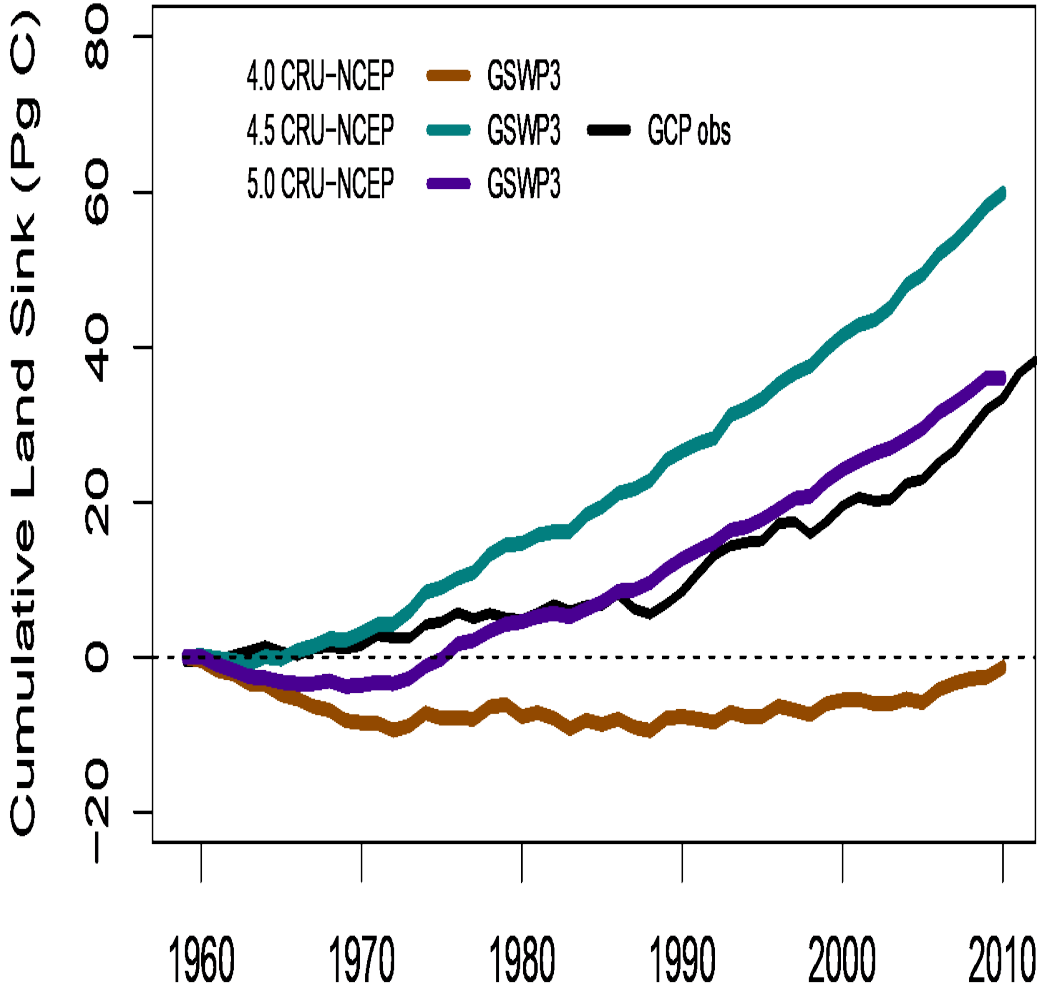
ILAMB Runoff Metrics Table

	Download Data	Period Mean [mm d-1]	Bias [mm d-1]	Bias Score [1]	Spatial Distribution Score [1]	Interannual Variability Score [1]	Overall Score [1]
Benchmark	[-]	0.825					
CLM4.0_CRUNCEP	[-]	0.525	-0.300	0.68	0.68	0.69	0.68
CLM4.0_GSWP3	[-]	0.769	-0.0568	0.81	0.93	0.68	0.81
CLM4.0SP_GSWP3	[-]	0.861	0.0353	0.81	0.97	0.64	0.81
CLM4.5_CRUNCEP	[-]	0.581	-0.244	0.72	0.87	0.67	0.75
CLM4.5_GSWP3	[-]	0.812	-0.0137	0.80	0.97	0.66	0.81
CLM4.5SP_GSWP3	[-]	0.836	0.0108	0.82	0.98	0.66	0.82
CLM5.0_CRUNCEP	[-]	0.581	-0.245	0.69	0.80	0.58	0.69
CLM5.0_GSWP3	[-]	0.913	0.0875	0.79	0.97	0.59	0.79
CLM5.0SP_GSWP3	[-]	0.888	0.0627	0.81	0.97	0.61	0.79

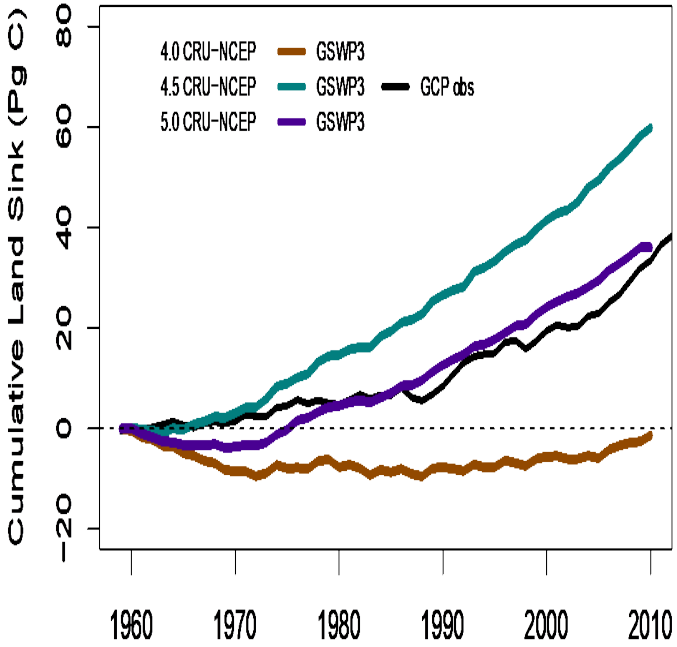
CLM land-only forced with GSWP3 prognostic vegetation and carbon configuration

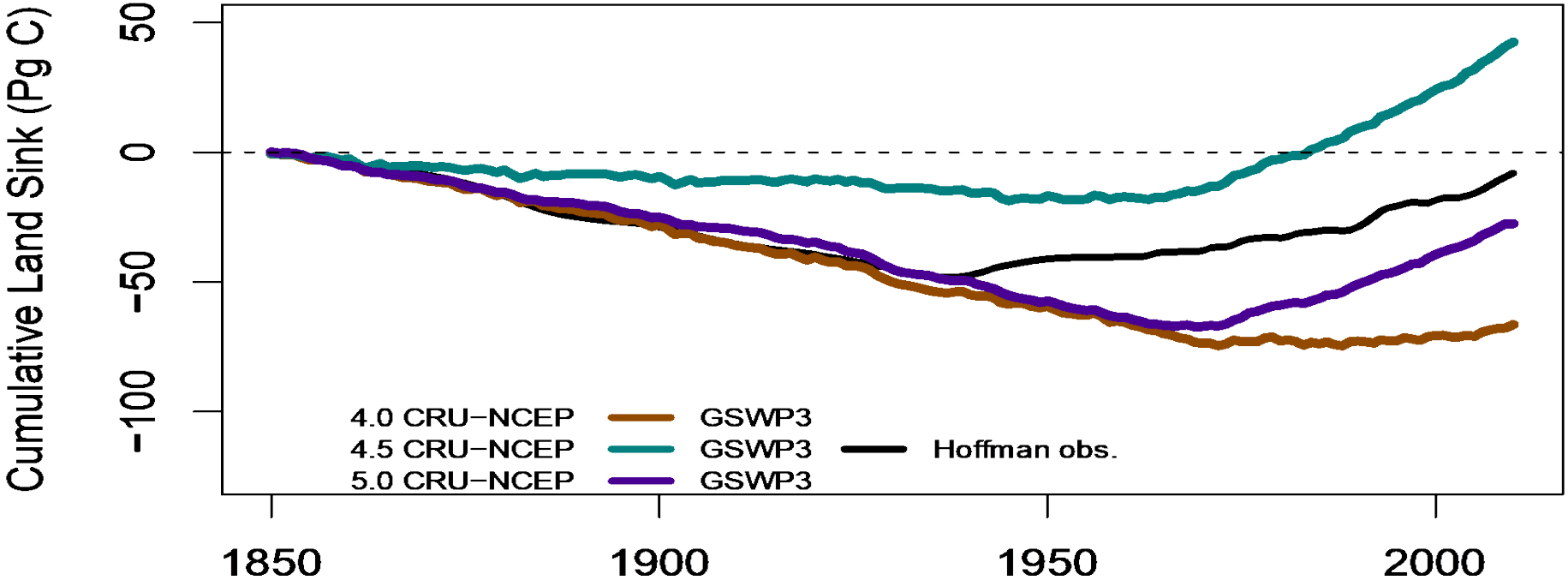


Cumulative historical land carbon fluxes

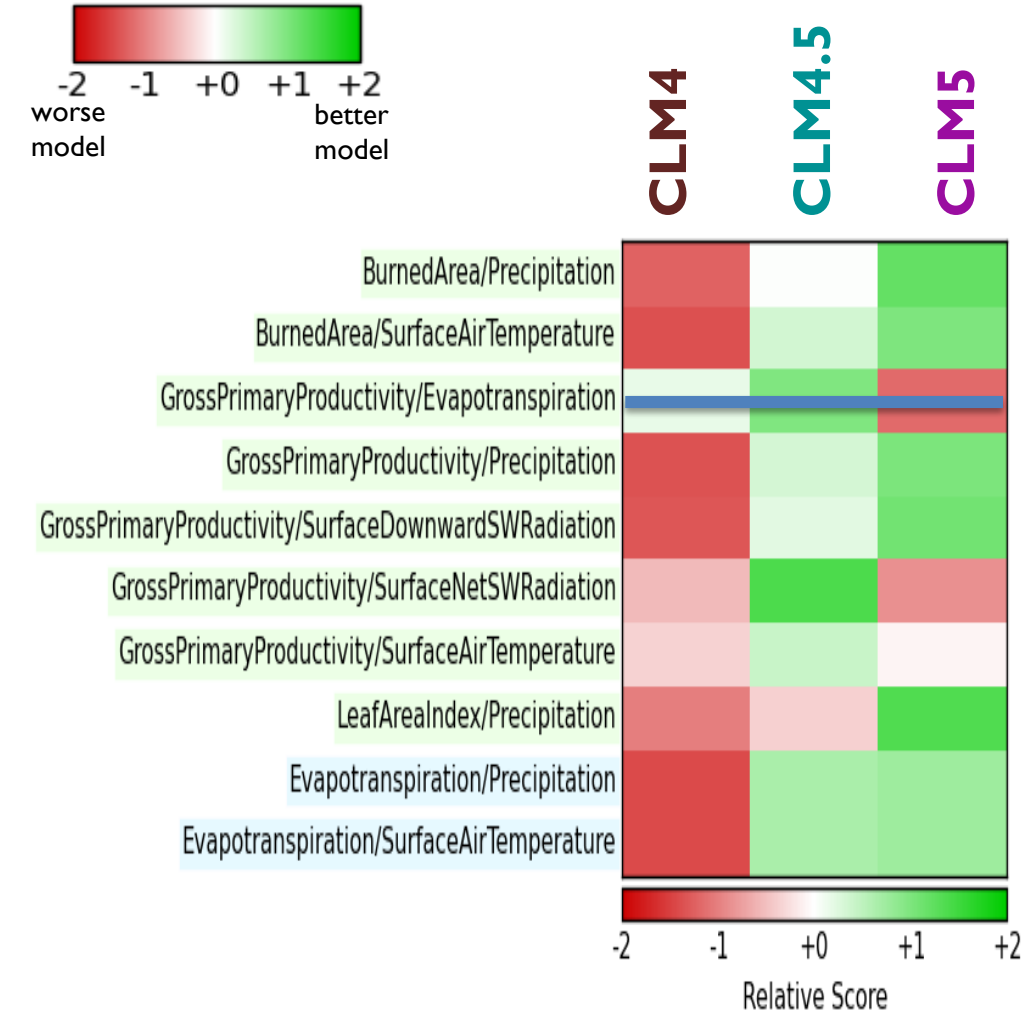


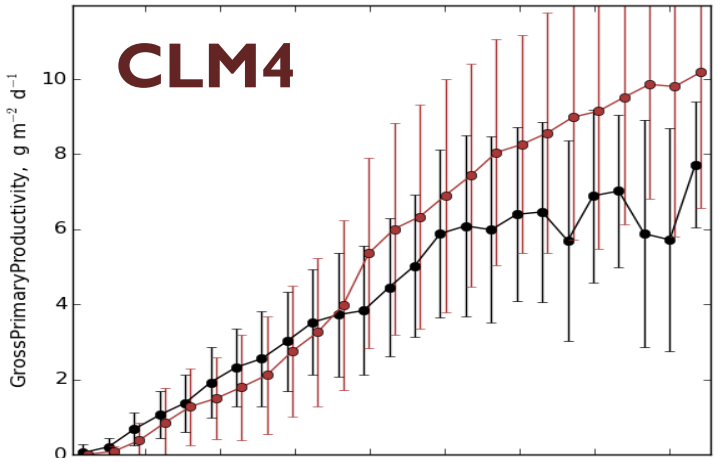
Cumulative historical land carbon fluxes

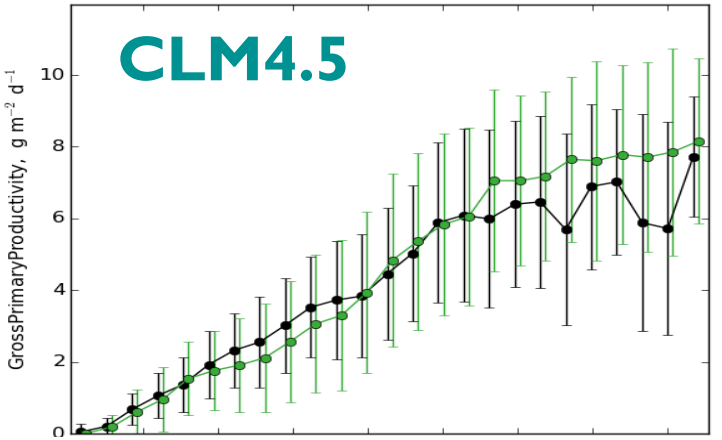


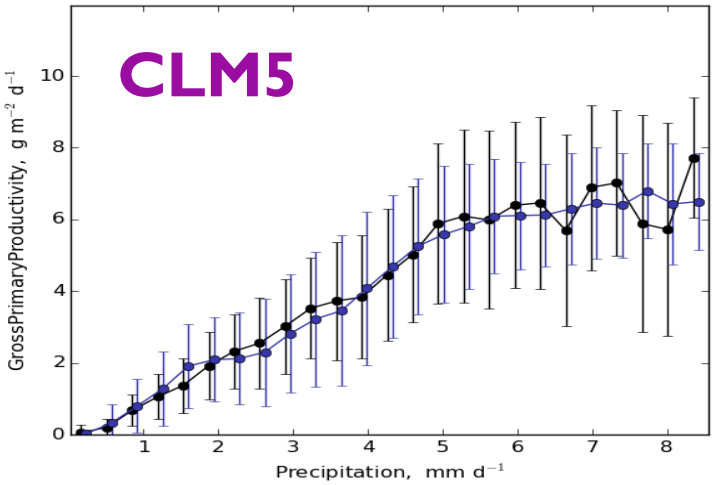


Functional Relationships: Summary diagram



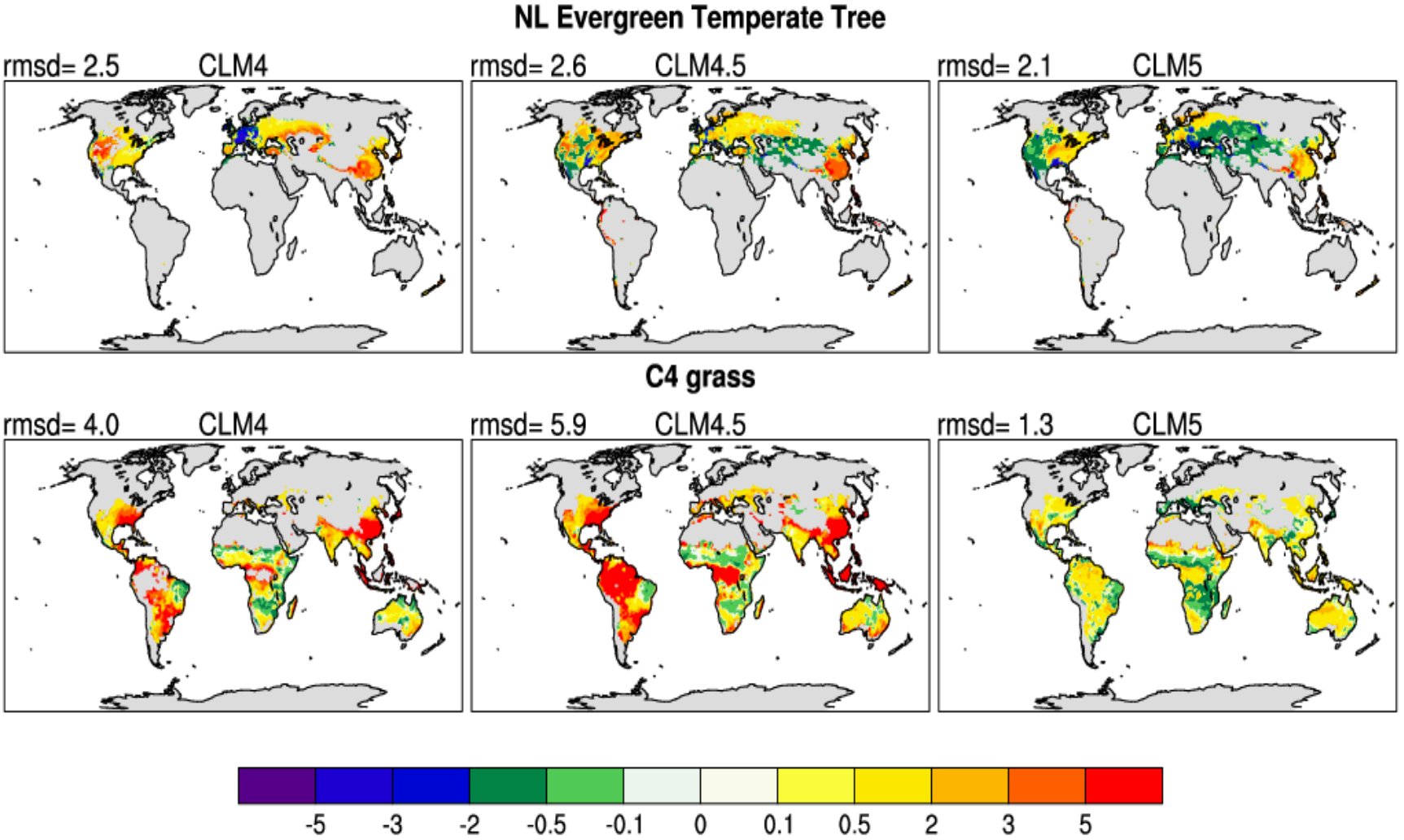




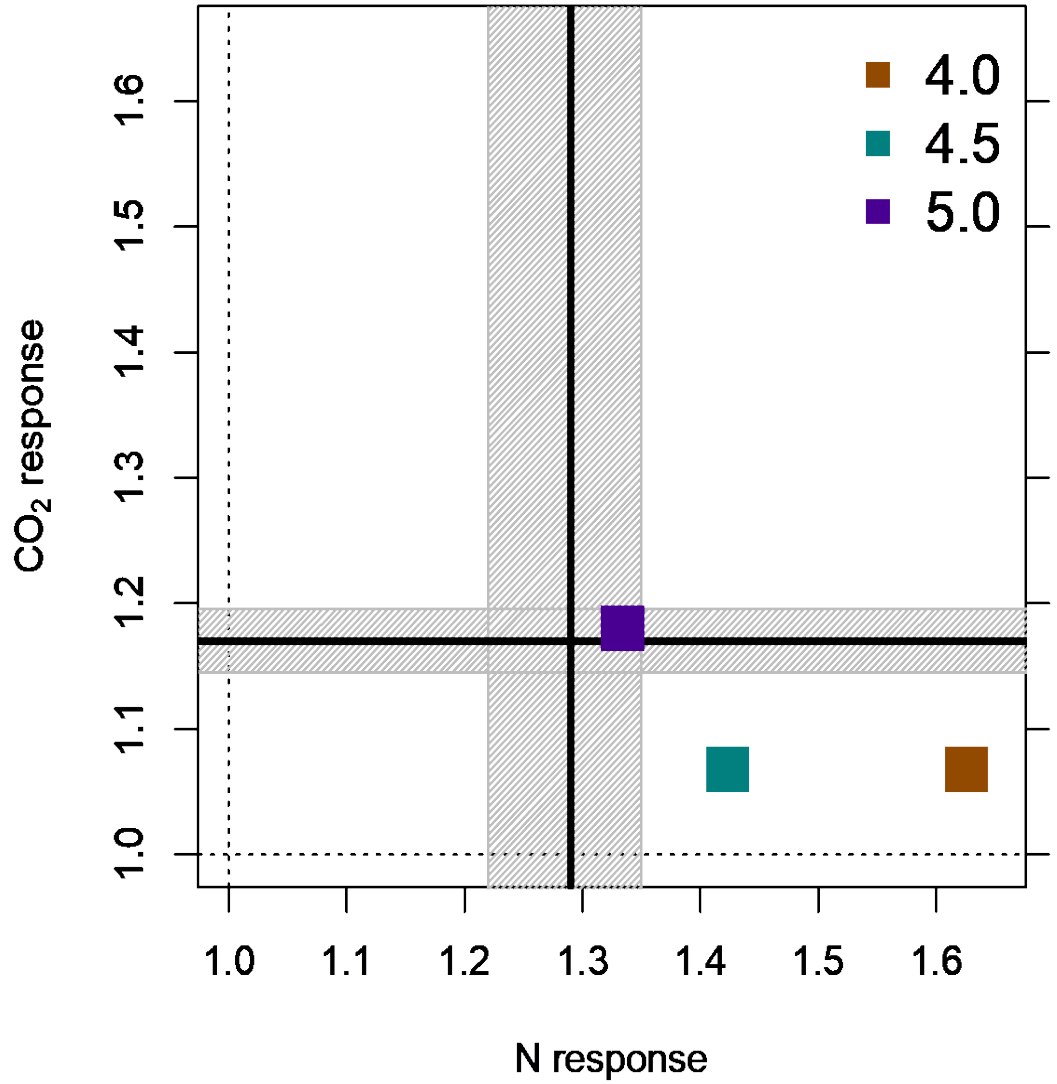


Future ILAMB diagnostics: Leaf Area Index (LAI) bias by Plant Functional Type

Reduced bias in 12 out of 15 PFTs



Future ILAMB metric:
Response to CO_2 doubling and N fertilization (preliminary)

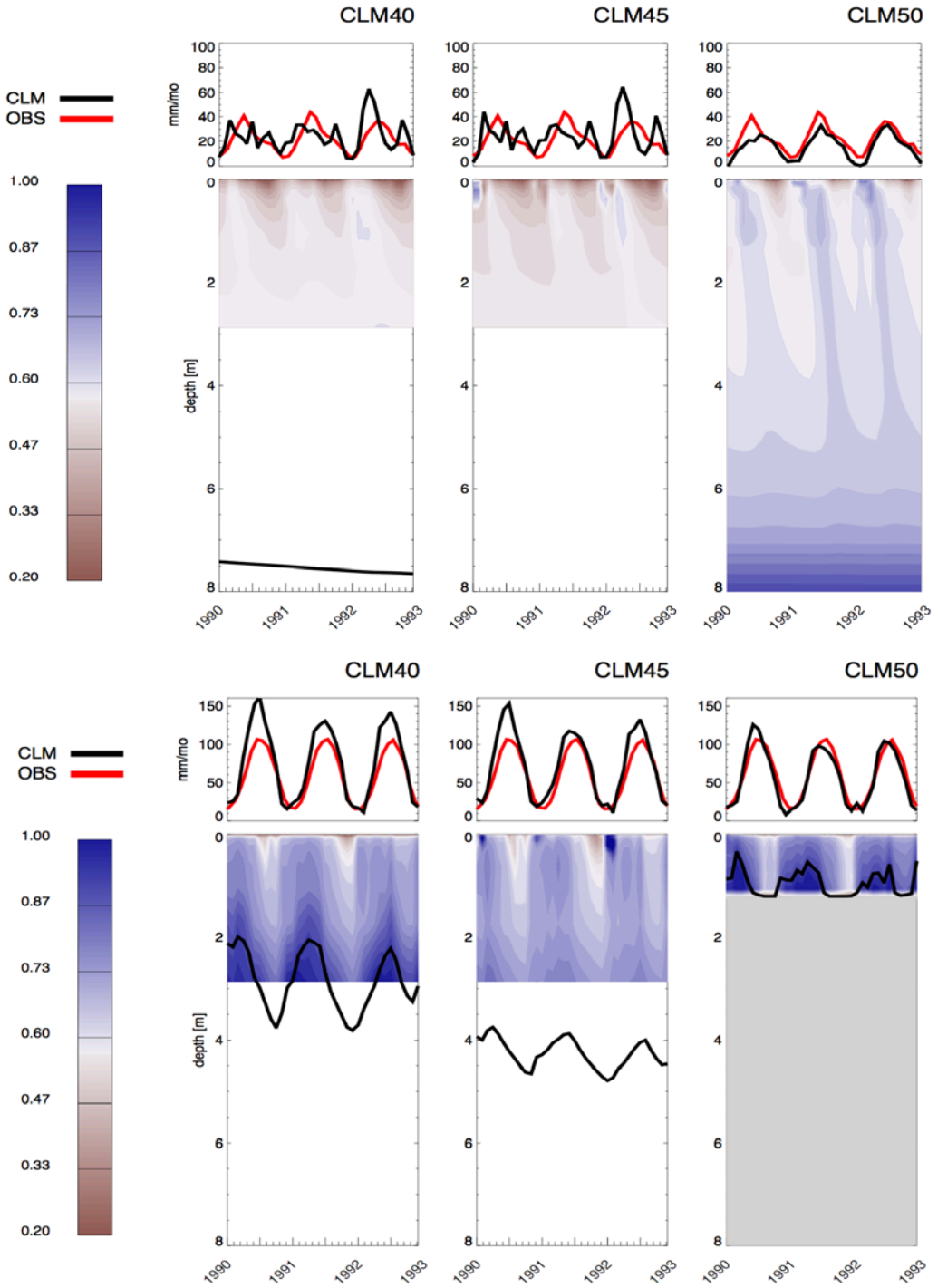


- +5 gN/m^2 globally
- +200 ppm CO^2

- N fertilization obs (ANPP) from Lebauer & Treseder, 2008
- CO_2 obs from Ainsworth and Long, 2005

Figure from Will Wieder

Soil moisture and ET



Southwest US grid cell

Eastern US grid cell

CLM5 documentation papers for CESM2 special issue

CLM5 model overview and technical description	Lawrence et al.	JAMES
CLM5 C-N coupling	Fisher et al.	JGR-Biogeosciences
N and CO_2 fertilization	Wieder et al.	GBC
Plant Hydraulic Stress	Kennedy et al.	JAMES
Land use and land cover change	Lawrence et al.	JAMES
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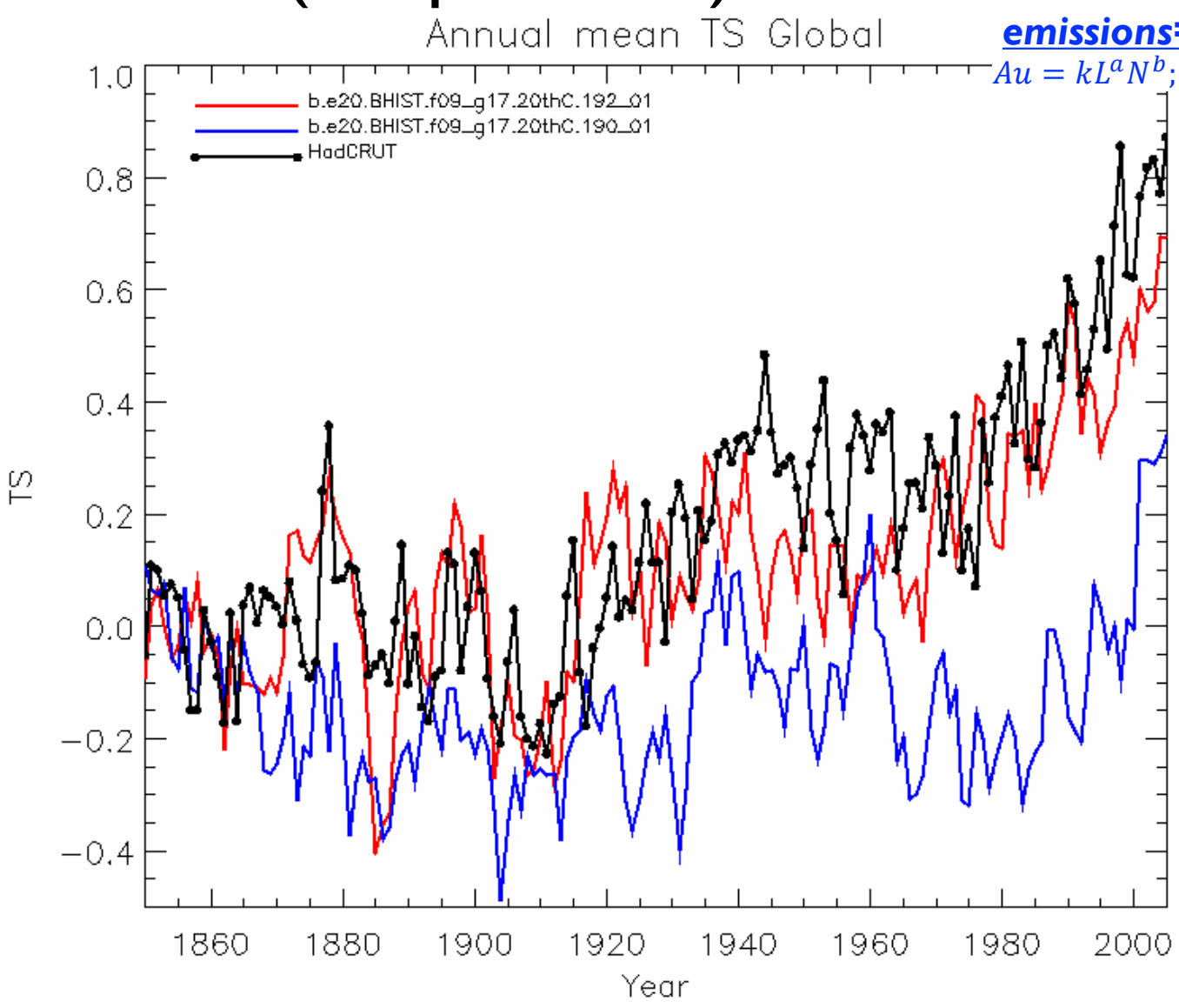
CESM2 update
where CESM2 stood in Sept 2017

- Good 20thC simulation with CMIP5 emissions, not so much with CMIP6

Simulation forced with CMIP6 emissions doesn't warm much (w/resp HadCRUT)

emissions=CMIP5
$Au = kL^aN^b$; with $b = -1.1$

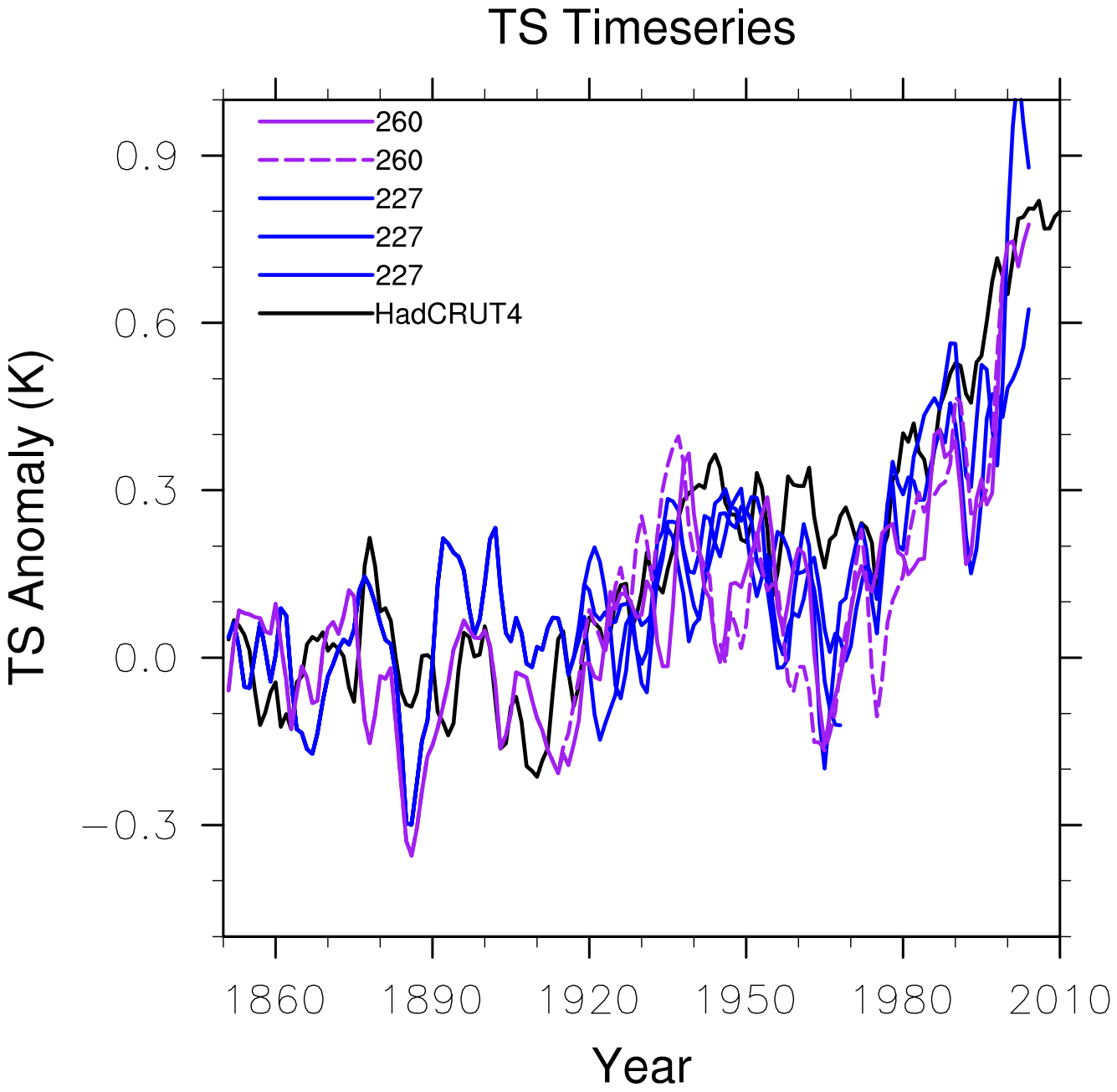
emissions=CMIP6
$Au = kL^aN^b$; with $b = -1.1$



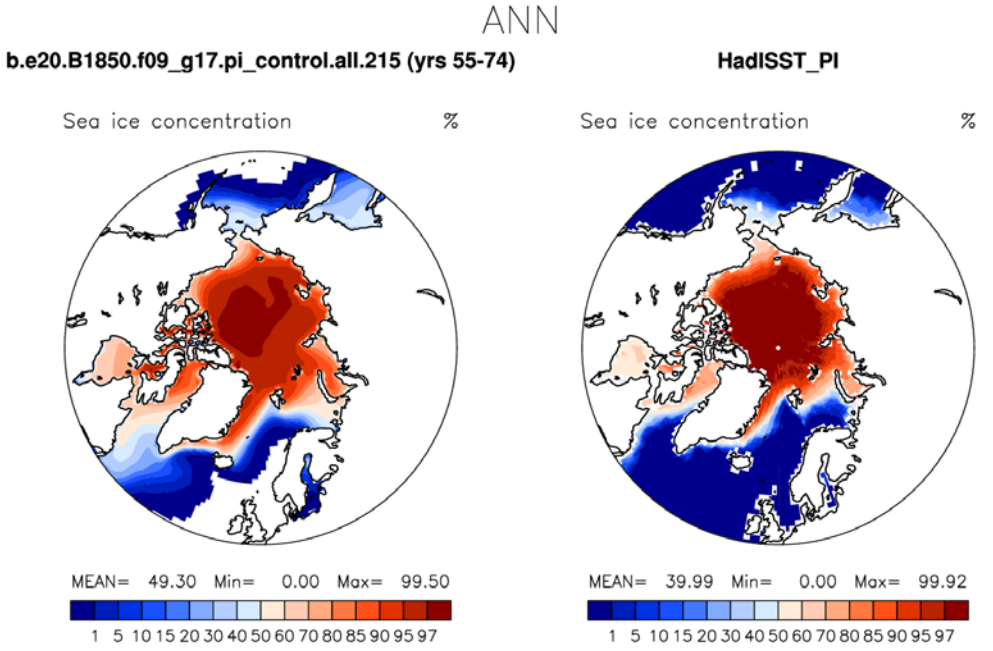
Further development since September

- Then, uncovered bug in microphysics
  - Bug led to enhanced rain re-evaporation
  - Fixing bug degraded mean precip, MJO and ENSO
- Increased convective rain re-evaporation to compensate for bugfix *(leads to warmer model overall)*
- Decrease lifetime of SO2

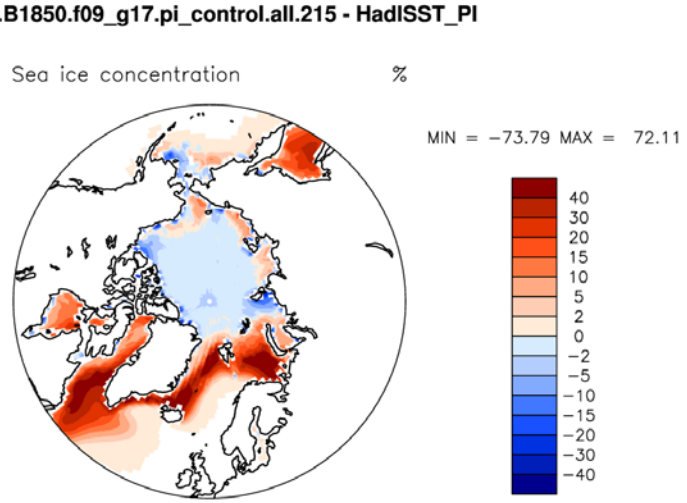
Thinner stratus help with 20th C simulation:



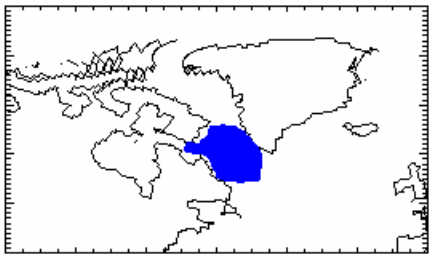
Sea-ice concentrations

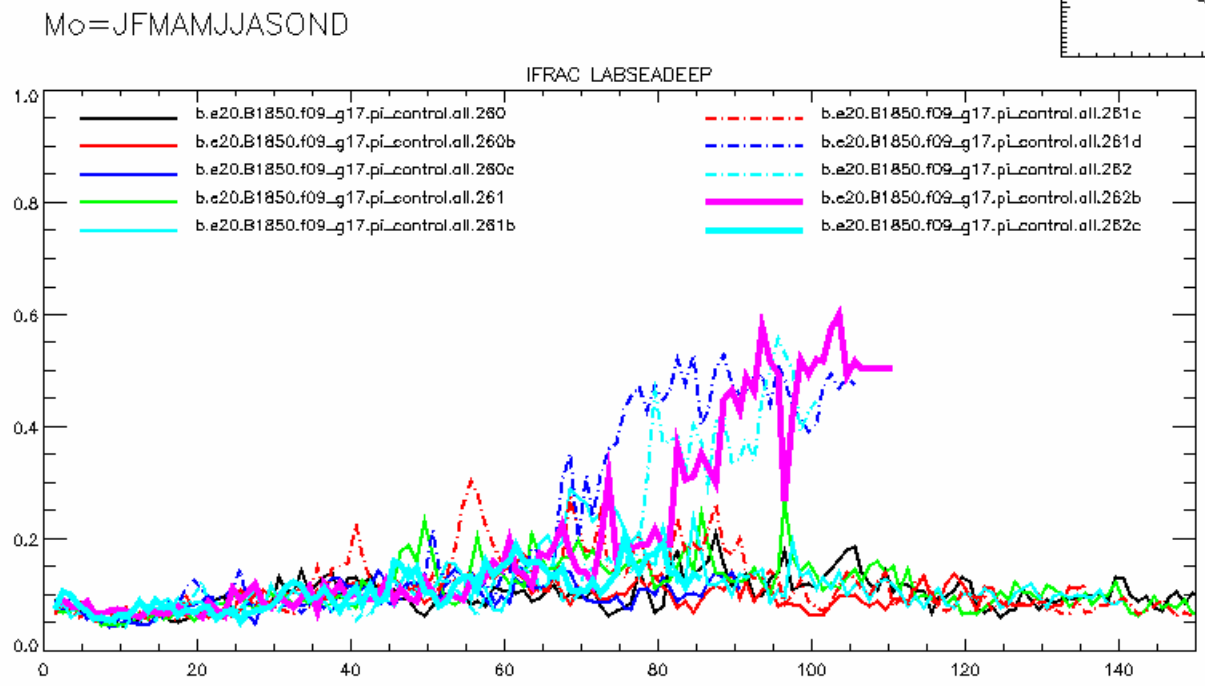


Labrador Sea Freeze!!!



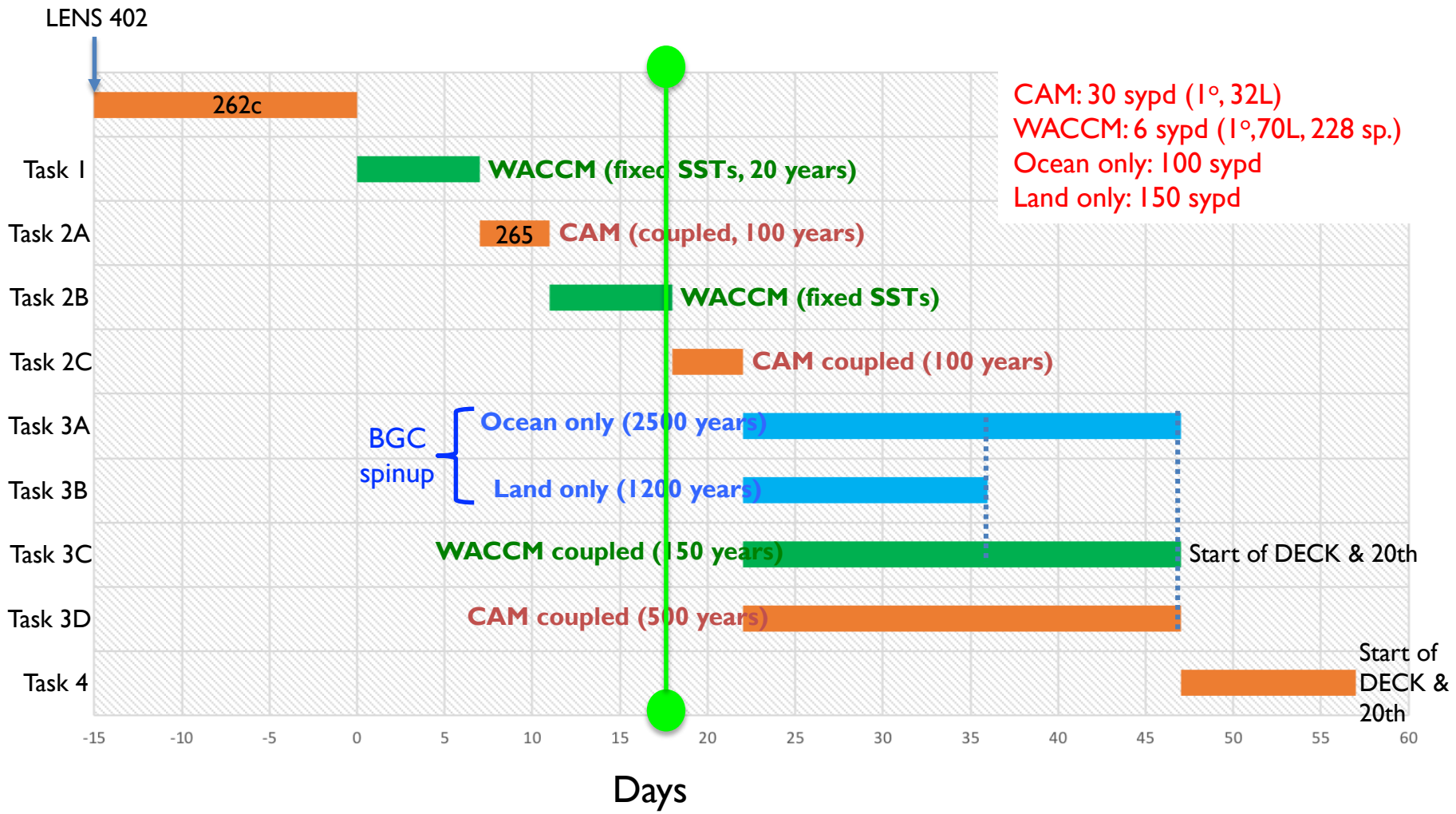
~4/10 chance of freeze when starting from current ICs



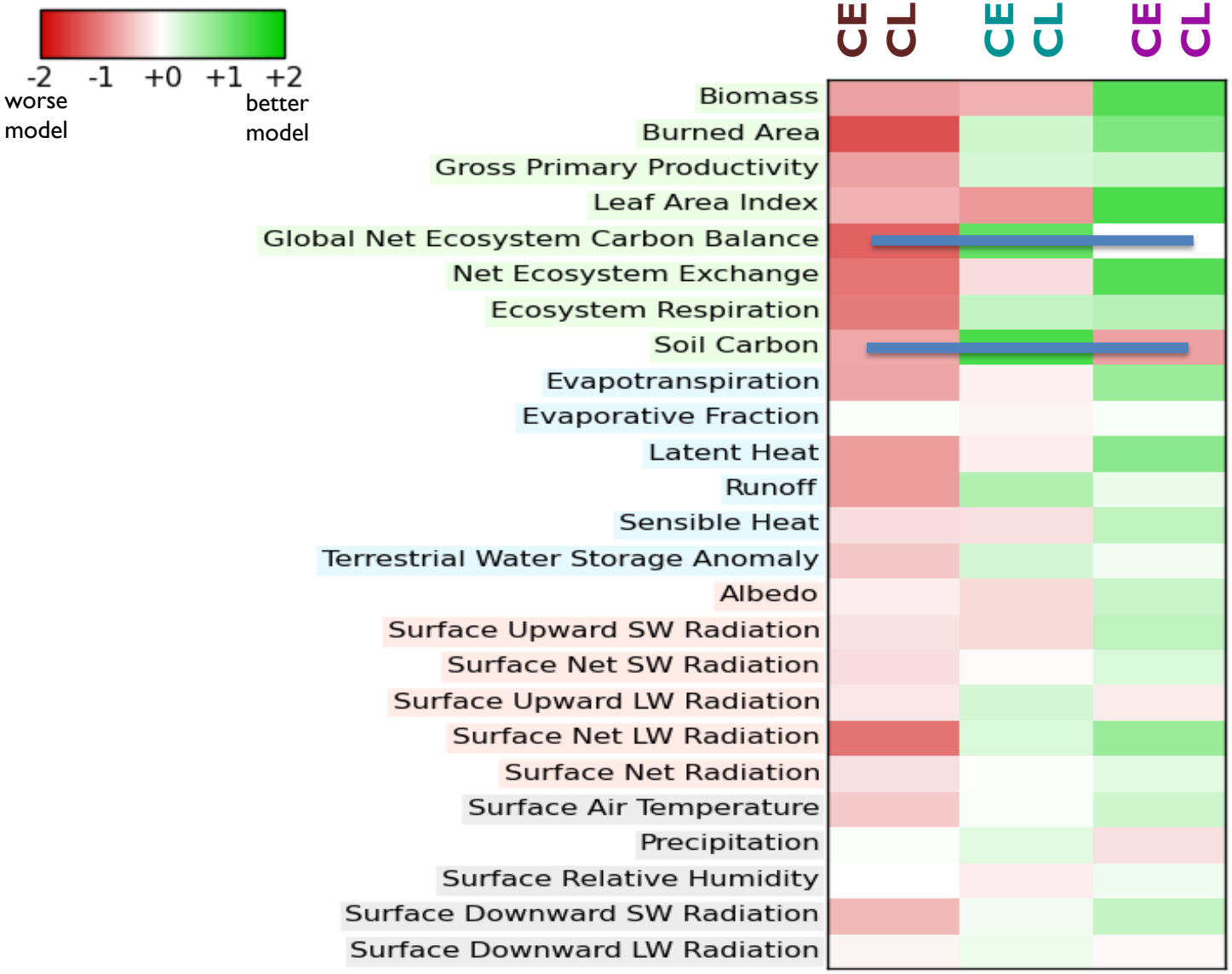


Lab sea freezing is a problem because deep water formation is interrupted

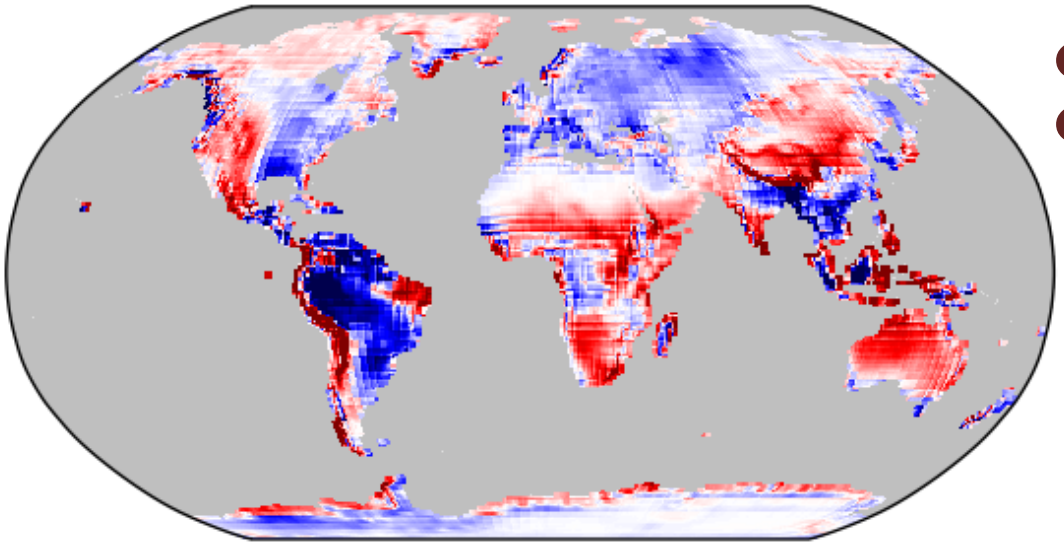
Tasks for PI control



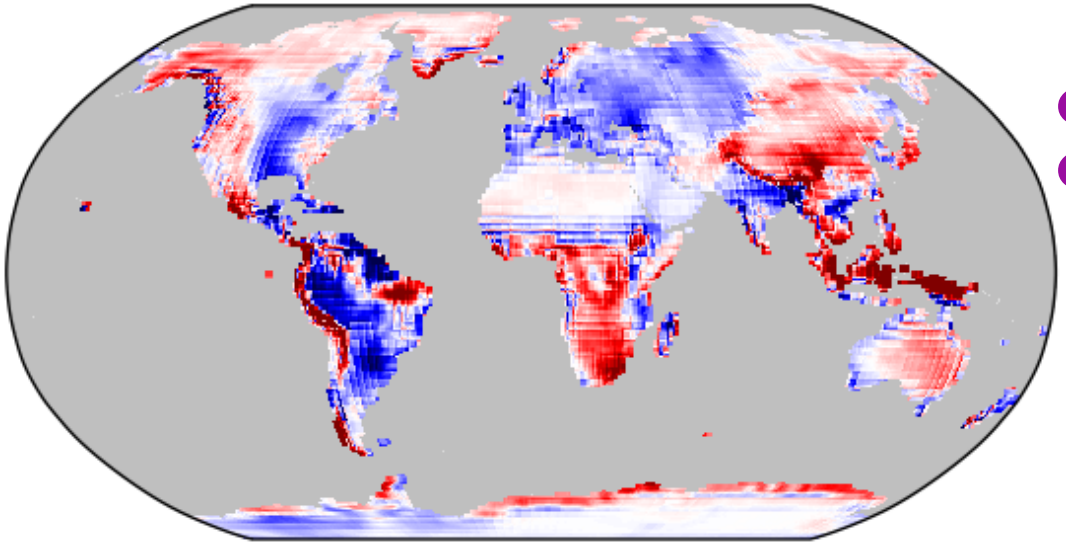
Preliminary land simulations assessment in fully coupled CESM2



Precipitation biases (GPCP2)



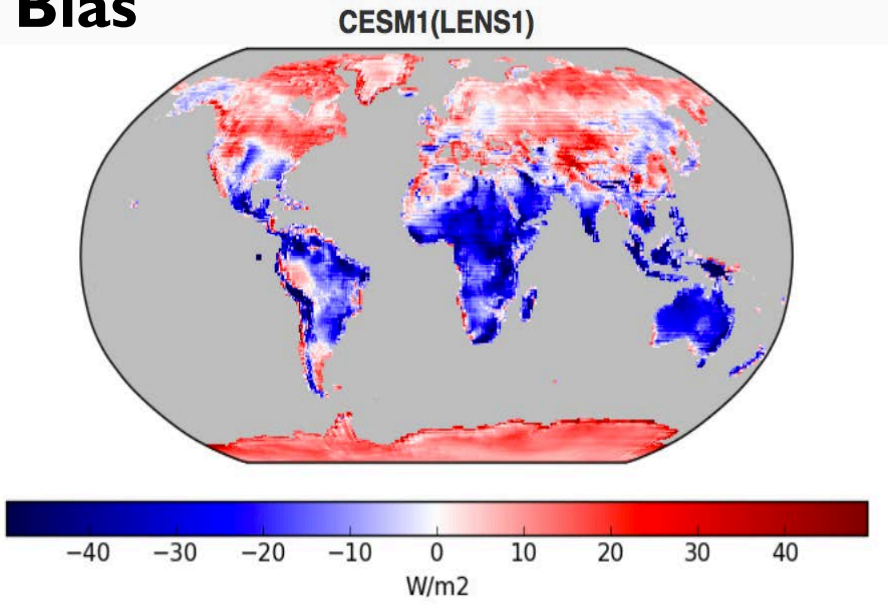
CESM1
CLM4



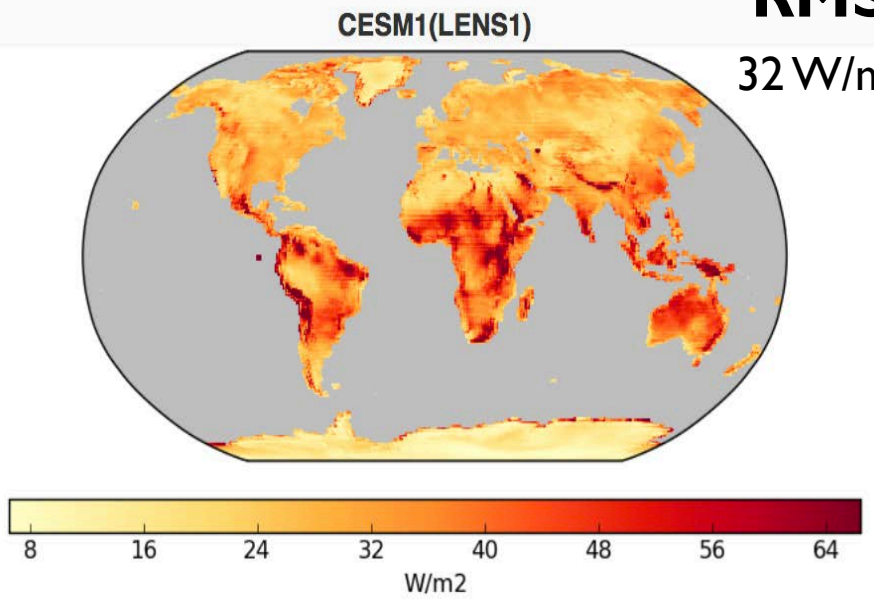
CESM2 (227)
CLM5

Solar radiation biases and RMSE (CERES)

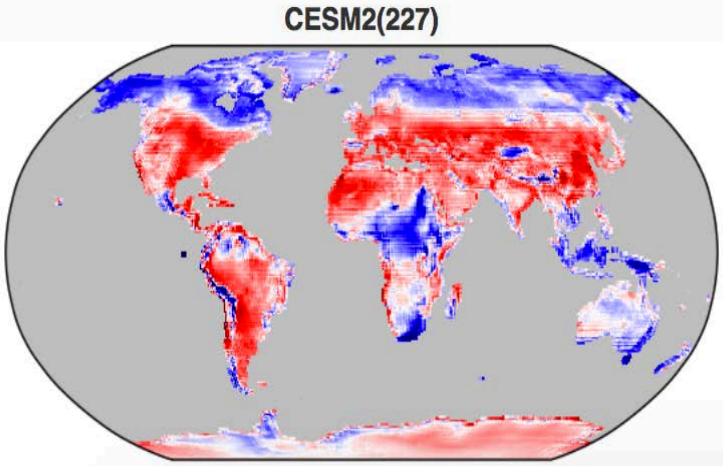
Bias

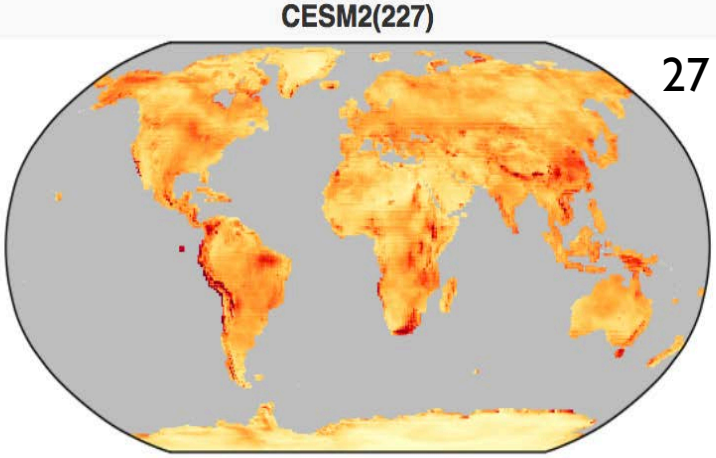


RMSE



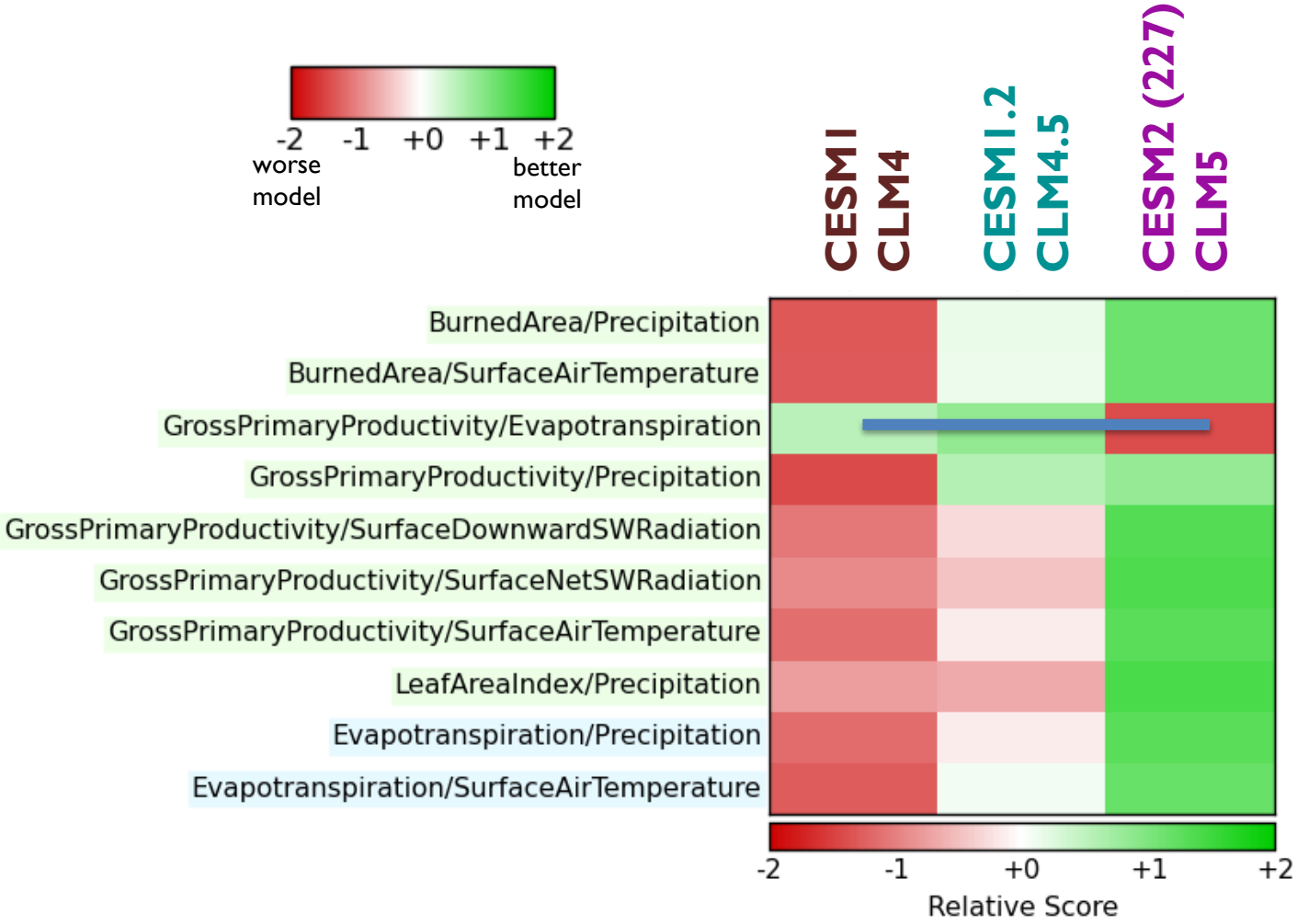
32 W/m^2





27 W/m^2

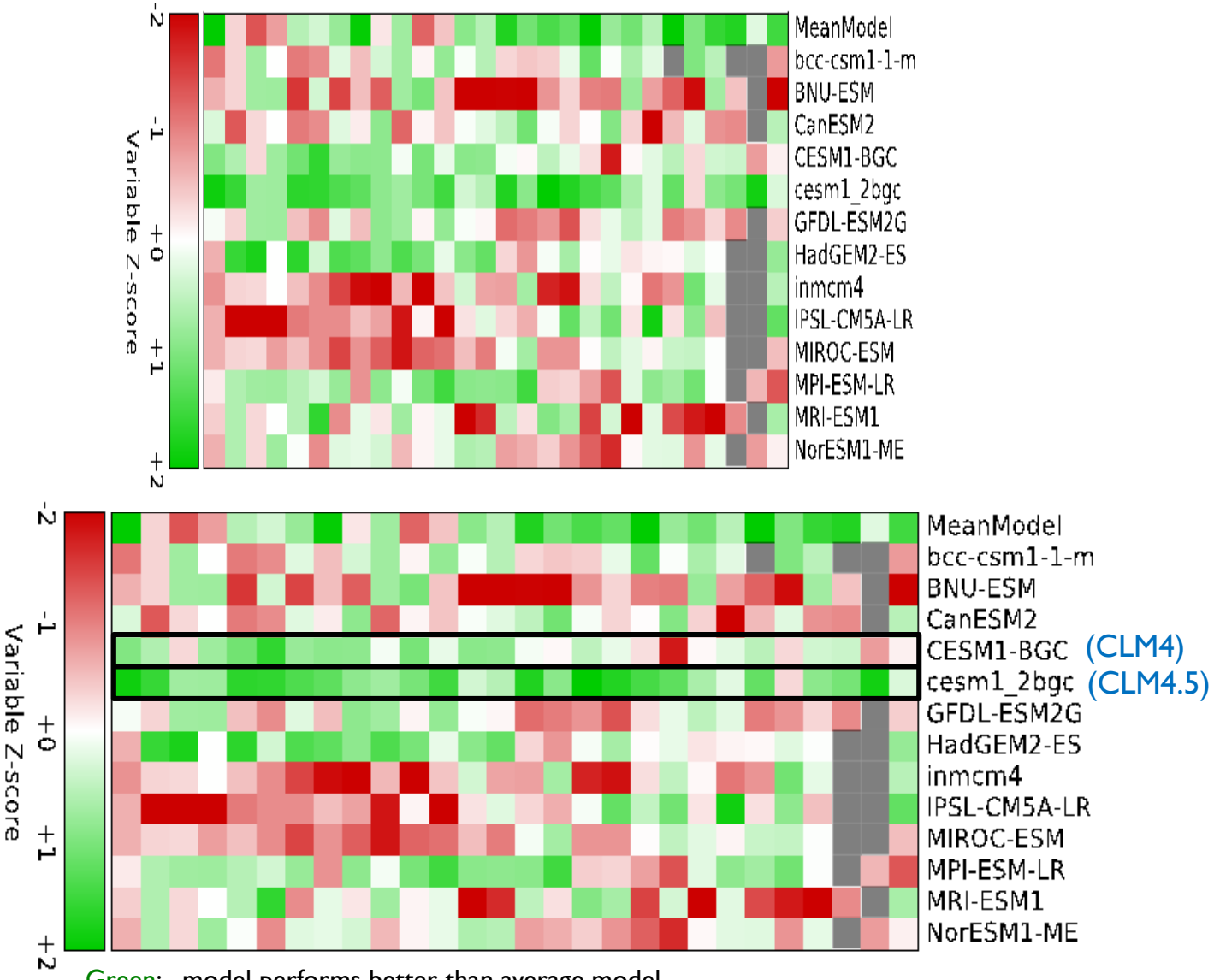
Preliminary assessment in fully coupled CESM



Thanks
Questions or comments?

International LAnd Model Benchmarking (ILAMB) project

scores for RMSE, interannual variability, pattern correlation, variable-to-variable comparisons, +



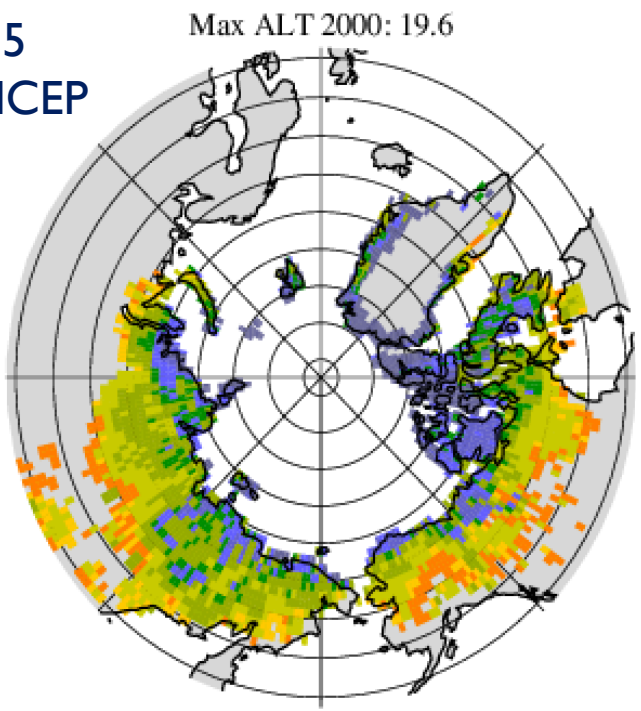
Green: model performs better than average model

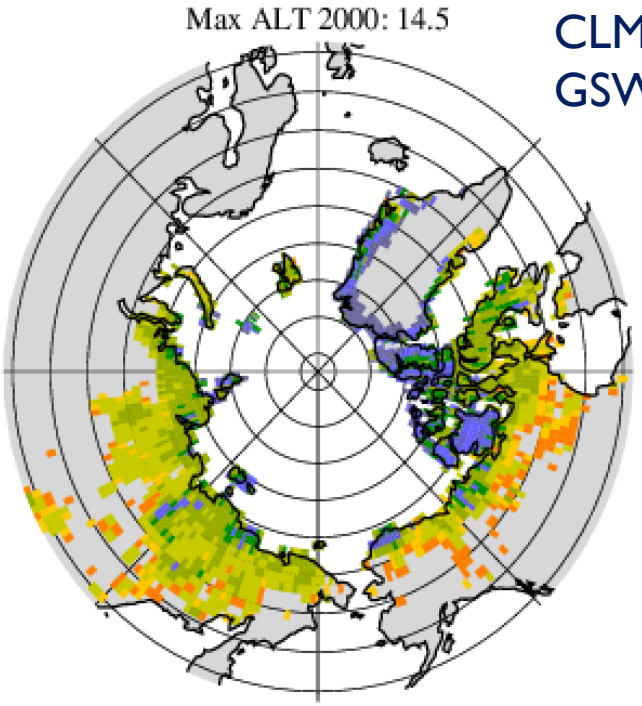
Red: model performs worse than average model

CLM4.5
CRUNCEP

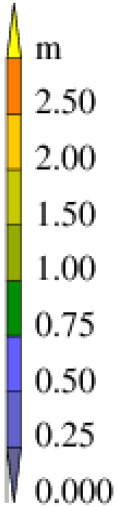
Permafrost Distribution

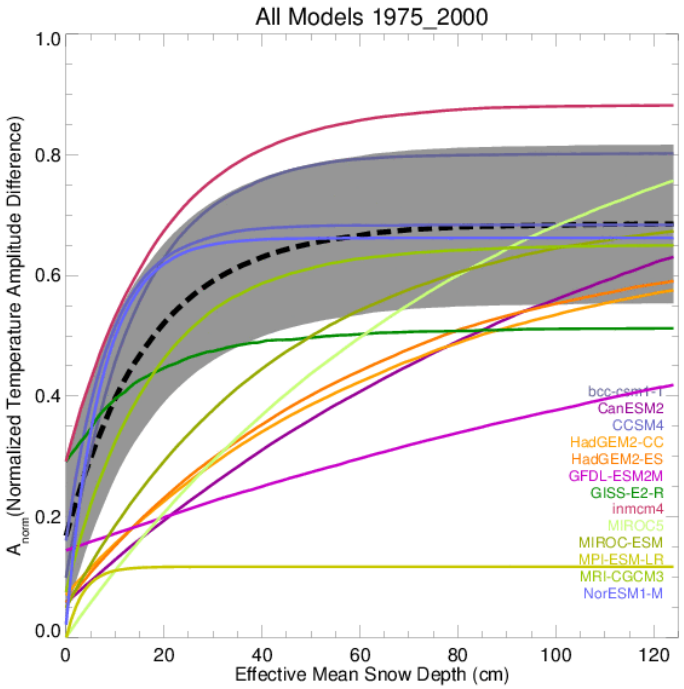
~15-16 million km^2
(obs)



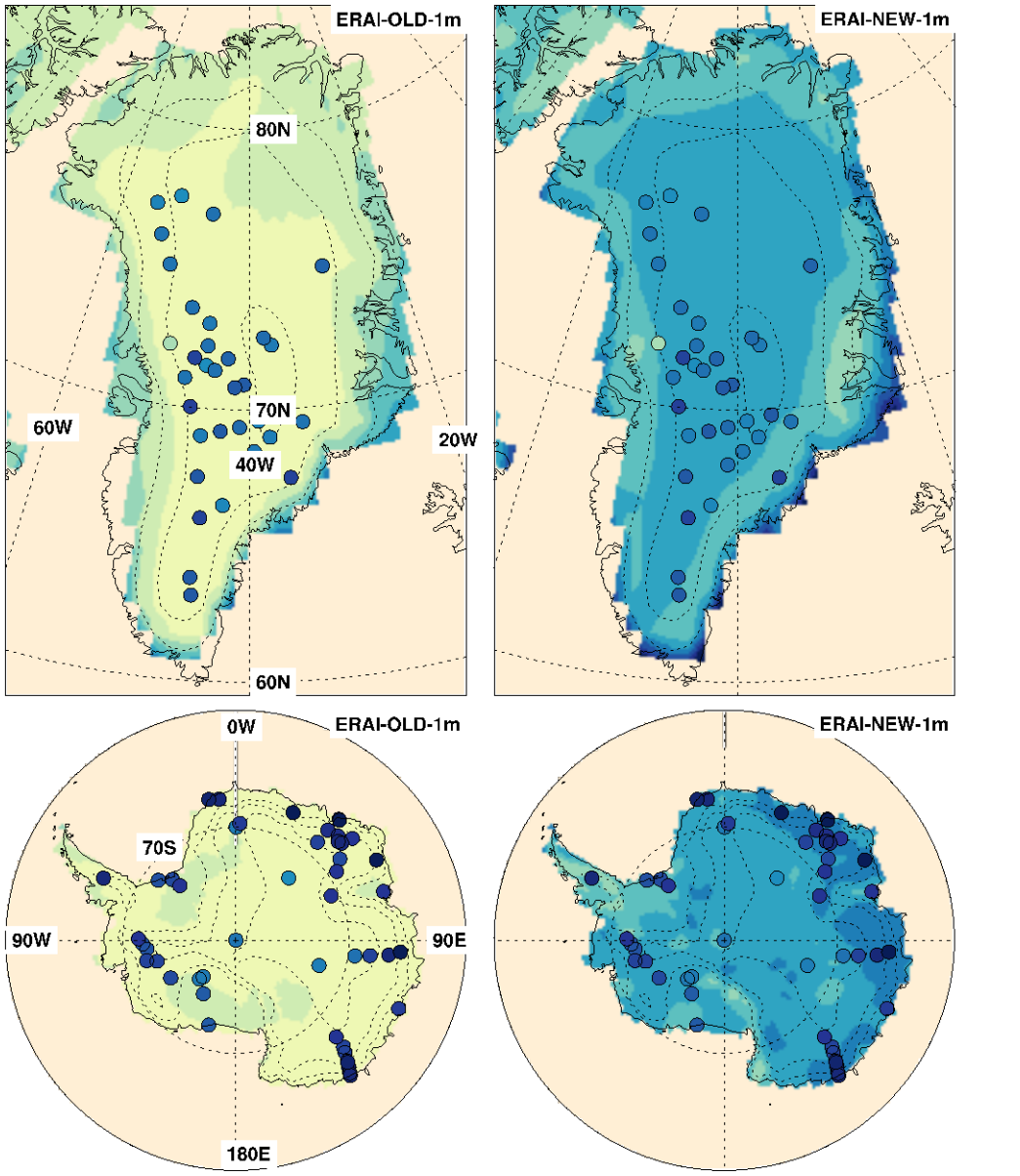


CLM4.5
GSWP3





Slater et al. 2017



CLM5 snow density

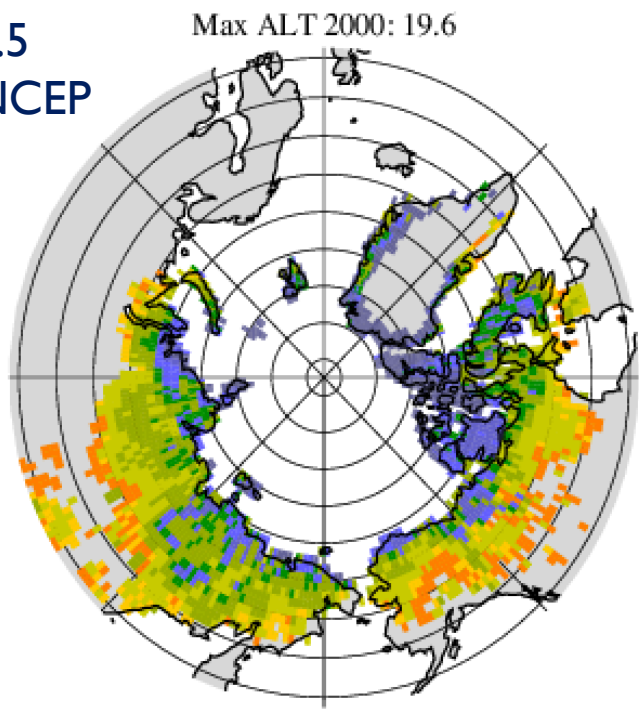
Revised fresh snow density with improved temperature and wind effects
Lead to increased and more realistic snow density and less thermal insulation

Figure courtesy L. Van Kampenhout

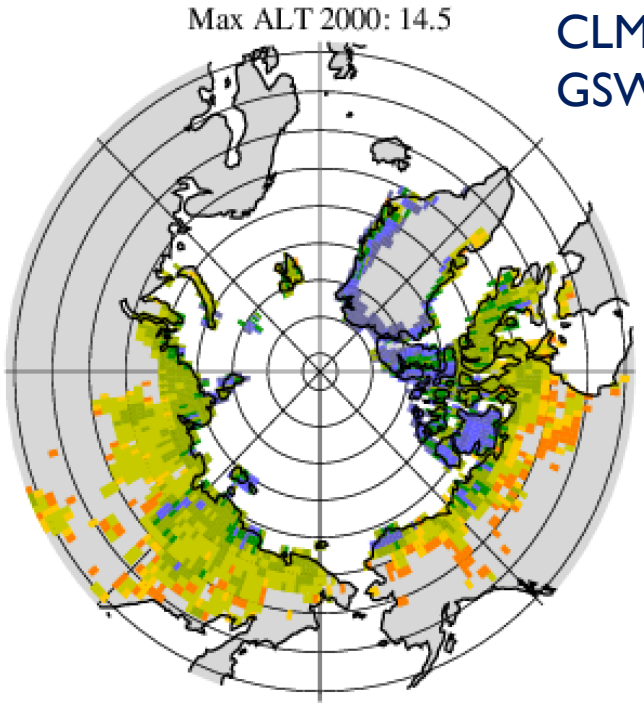
Permafrost Distribution

~15-16 million km^2 (obs)

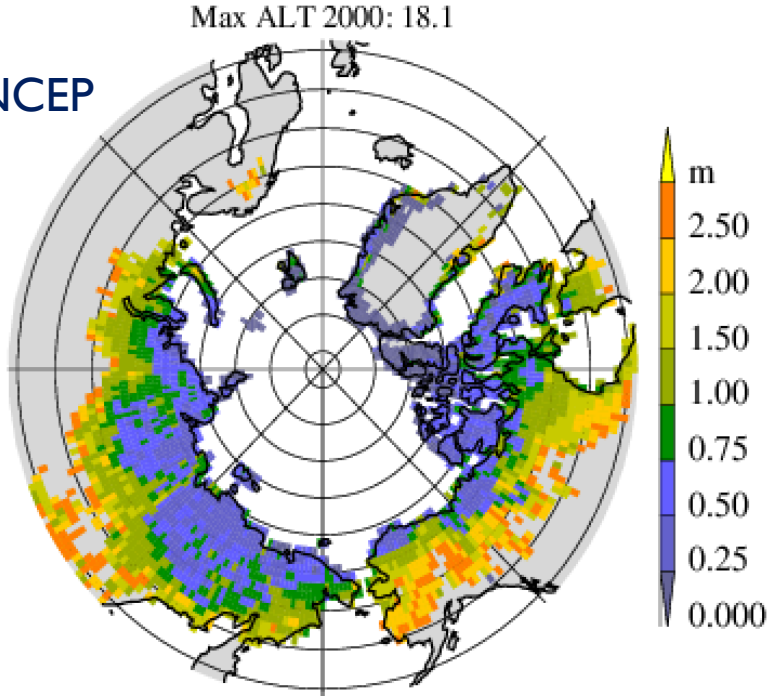
CLM4.5 CRUNCEP



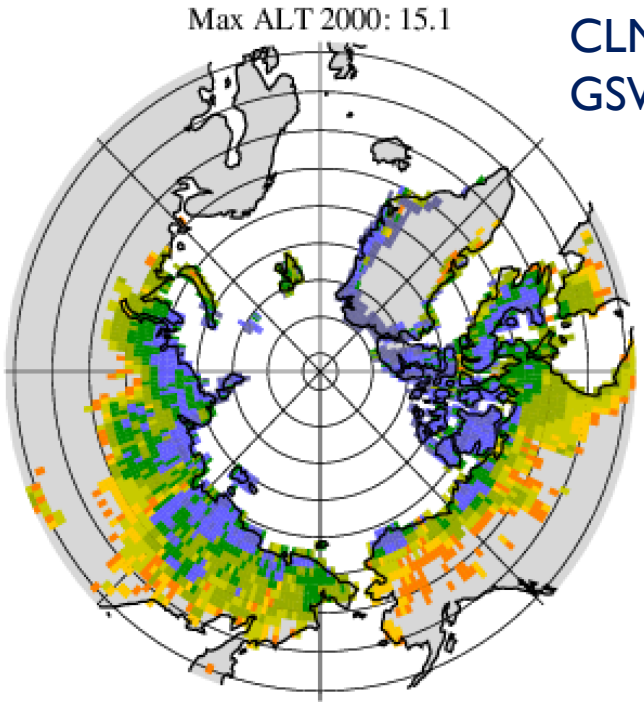
CLM4.5 GSWP3



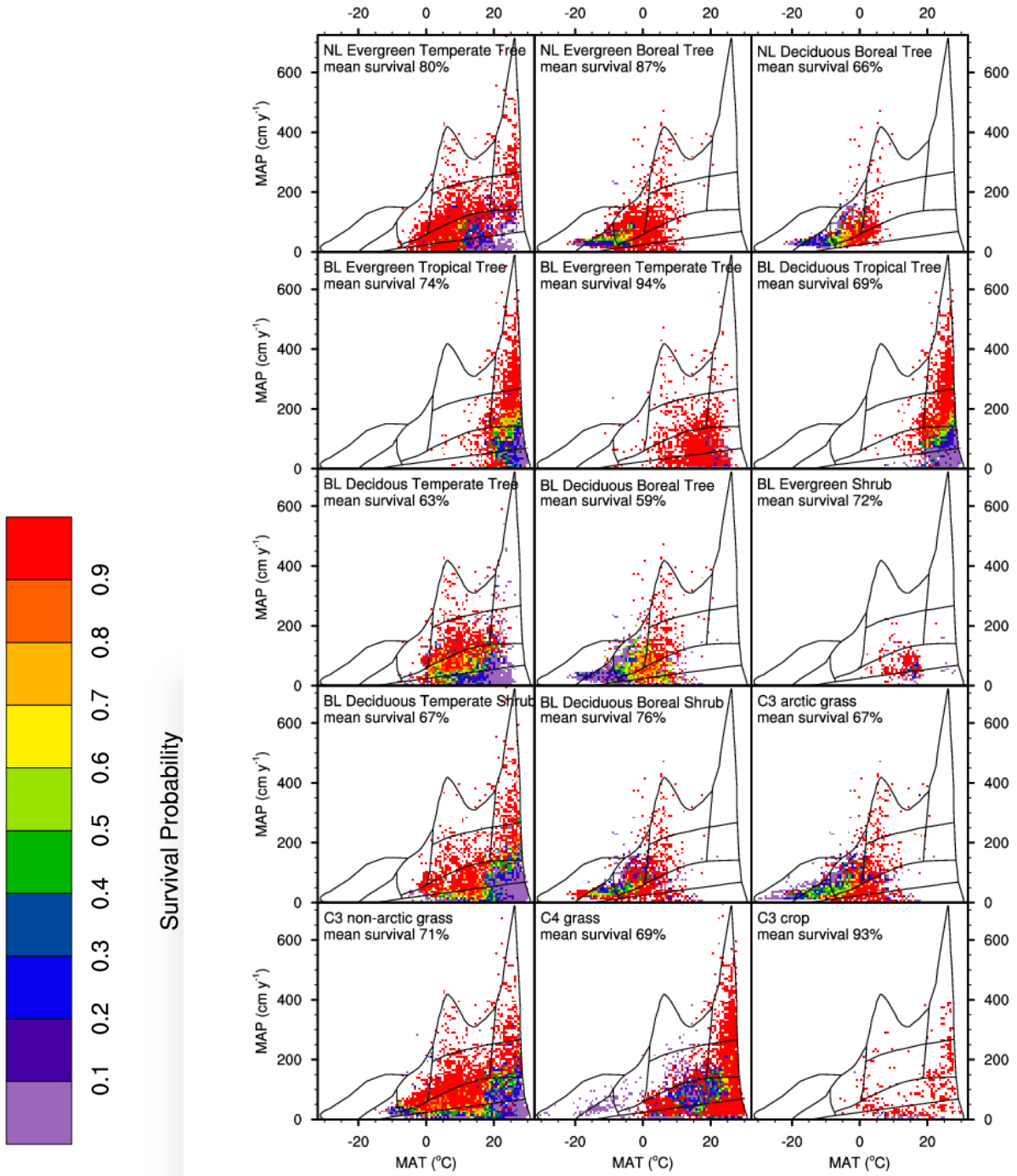
CLM5 CRUNCEP



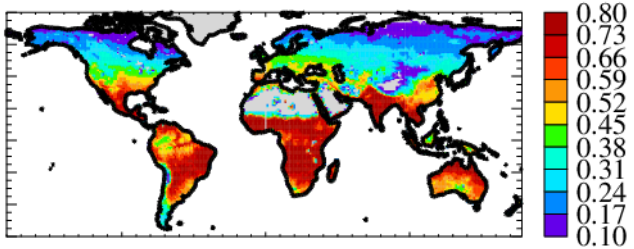
CLM5 GSWP3



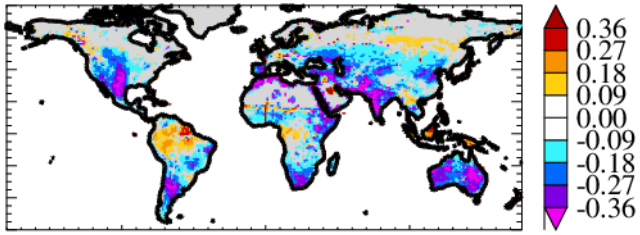

ART


NL Evergreen Temperate Tree
mean survival 80%
NL Evergreen Boreal Tree
mean survival 87%
NL Deciduous Boreal Tree
mean survival 66%
BL Evergreen Tropical Tree
mean survival 74%
BL Evergreen Temperate Tree
mean survival 94%
BL Deciduous Tropical Tree
mean survival 69%
BL Decidous Temperate Tree
mean survival 63%
BL Deciduous Boreal Tree
mean survival 59%
BL Evergreen Shrub
mean survival 72%
BL Deciduous Temperate Shrub
mean survival 67%
BL Deciduous Boreal Shrub
mean survival 76%
C3 arctic grass
mean survival 67%
C3 non-arctic grass
mean survival 71%
C4 grass
mean survival 69%
C3 crop
mean survival 93%
MAP (cm y-1)
MAT (°C)
Survival Probability
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

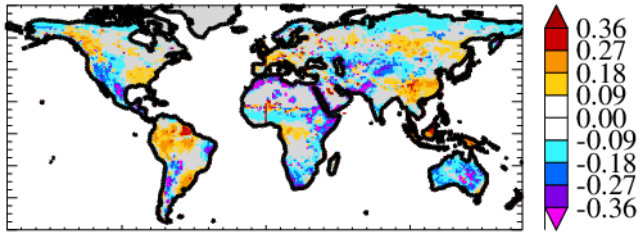
Transpiration fraction
WECANN (obs)



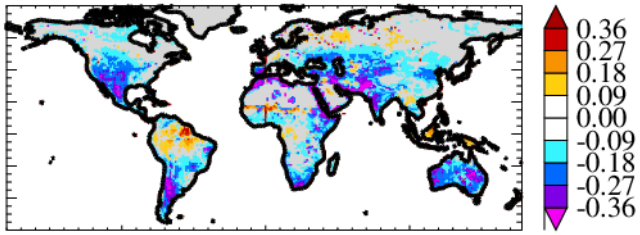
CLM4SP



CLM4BGC



CLM4.5SP



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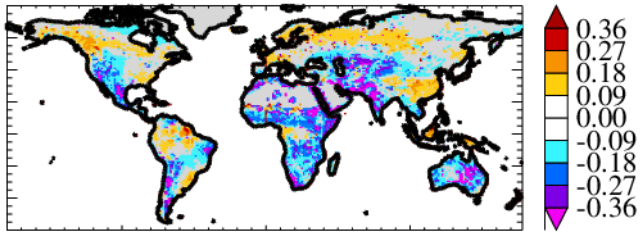
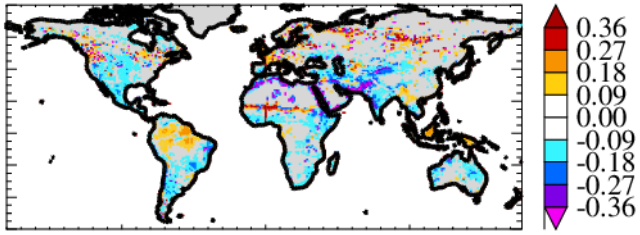


CLM5SP



CLM5BGC