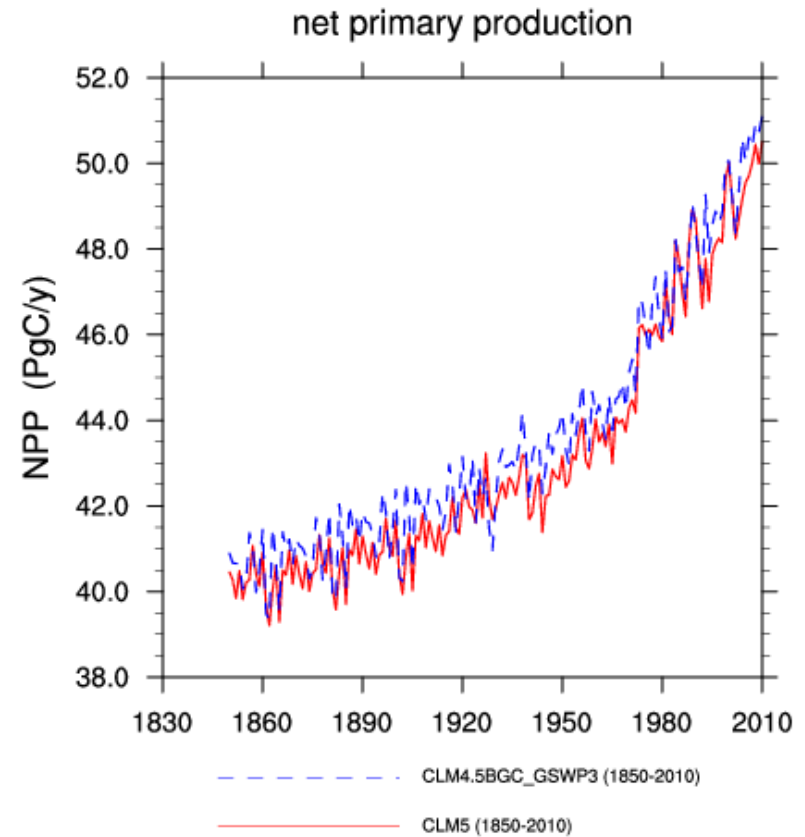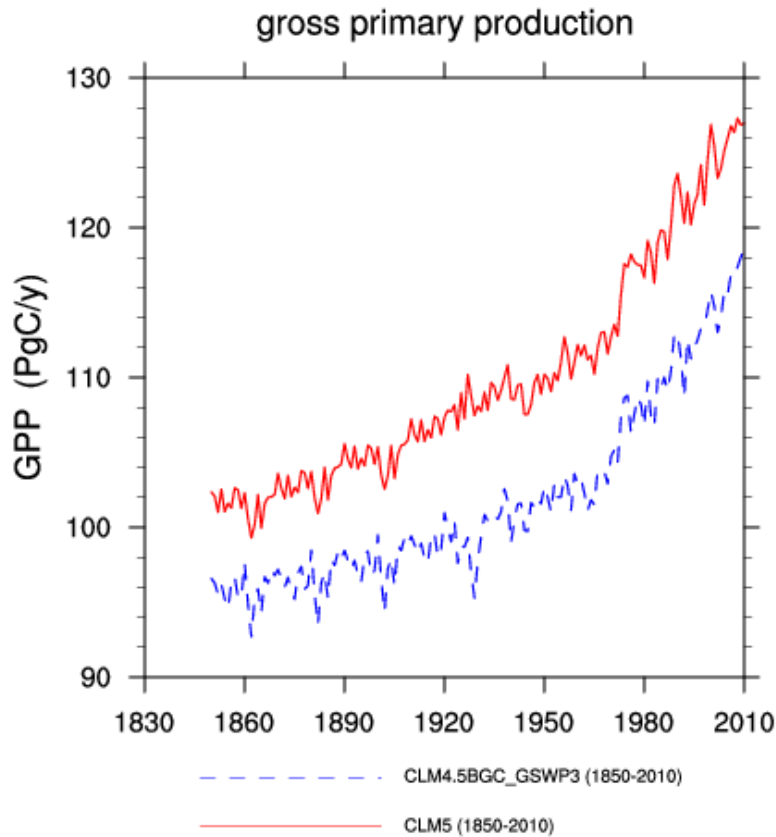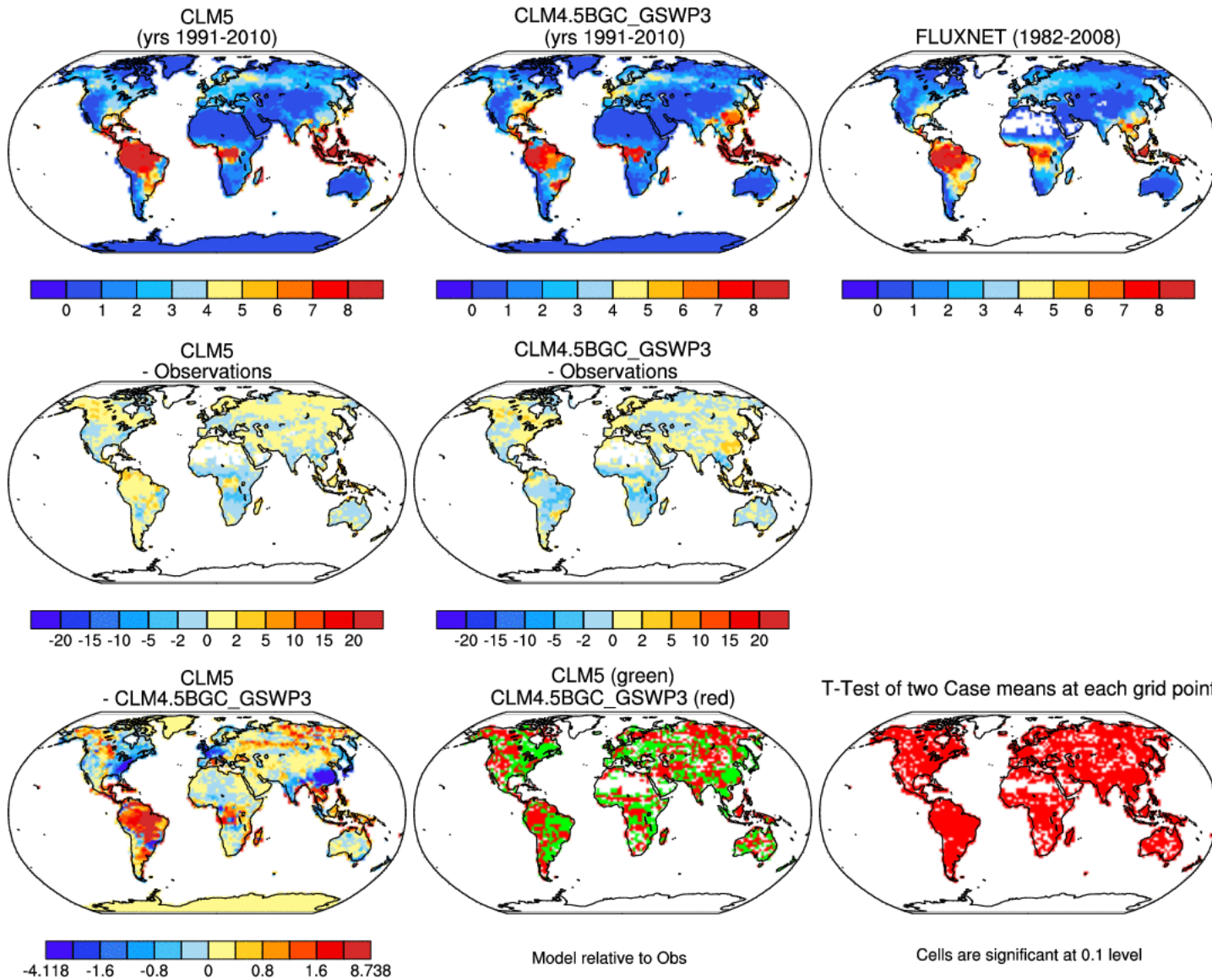# CLM5 Carbon Cycle

The CLM5 team

C. Koven

Lots of changes!

- New C-N coupling (LUNA, FlexCN, FUN)
- Plant hydraulics
- New soil hydrology and evaporative layer
- Switch from Ball-Berry to Medlyn stomatal conductance
- Parameter changes and some ambitious attempts at calibration
- Area-based to mass-based harvest methods
- Variable soil depth
- Faster spinup
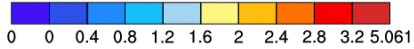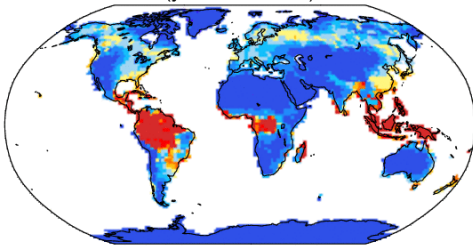
Increased GPP, but similar NPP

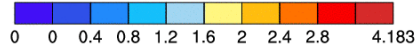gross primary production

net primary production

ANN GPP (gC/m^2/d)

CLM5
(yrs 1991-2010)

CLM4.5BGC_GSWP3
(yrs 1991-2010)

FLUXNET (1982-2008)

0 1 2 3 4 5 6 7 8

CLM5
- Observations

CLM4.5BGC_GSWP3
- Observations

-20 -15 -10 -5 -2 0 2 5 10 15 20

CLM5
- CLM4.5BGC_GSWP3

CLM5 (green)
CLM4.5BGC_GSWP3 (red)

T-Test of two Case means at each grid point

-4.118 -1.6 -0.8 0 0.8 1.6 8.738

Model relative to Obs

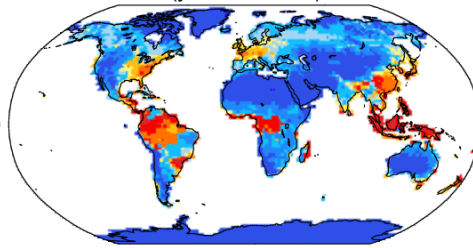Cells are significant at 0.1 level
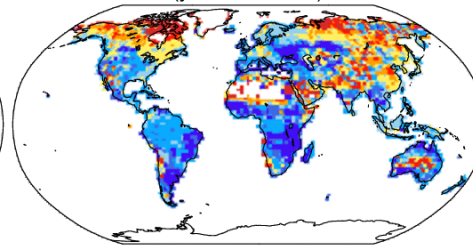
NPP and CUE

ANN NPP (gC/m^2/d)

CLM5
(yrs 1991-2010)

CLM4.5BGC_GSWP3
(yrs 1991-2010)

0   0   0.4 0.8 1.2 1.6 2   2.4 2.8 3.2 5.061
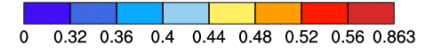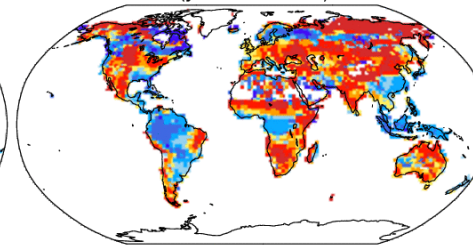
0   0   0.4 0.8 1.2 1.6 2   2.4 2.8 4.183

ANN CUE (NPP/GPP)

CLM5
(yrs 1991-2010)
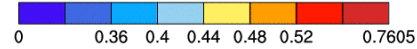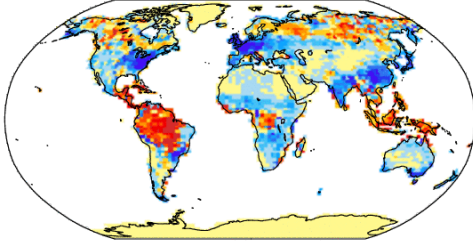
CLM4.5BGC_GSWP3
(yrs 1991-2010)

0   0.36 0.4 0.44 0.48 0.52   0.7605

0   0.32 0.36 0.4 0.44 0.48 0.52 0.56 0.863

CLM5
- CLM4.5BGC_GSWP3

T-Test of two Case means at each grid point

CLM5
- CLM4.5BGC_GSWP3

T-Test of two Case means at each grid point

-2.265   -0.8   -0.4   0   0.4   0.8   4.197

Cells are significant at 0.1 level

-0.6623   -0.2 -0.1   0   0.1   0.2   0.4318
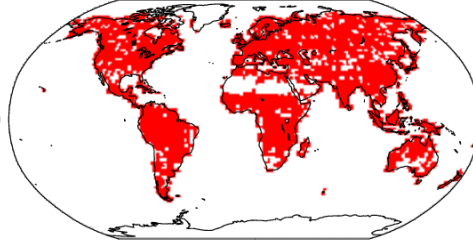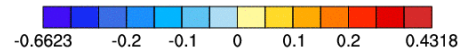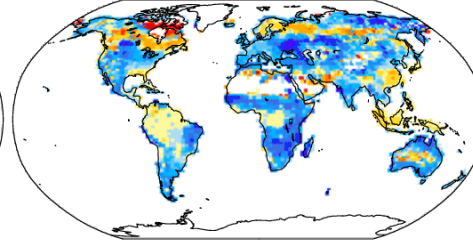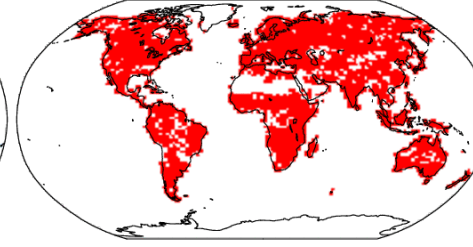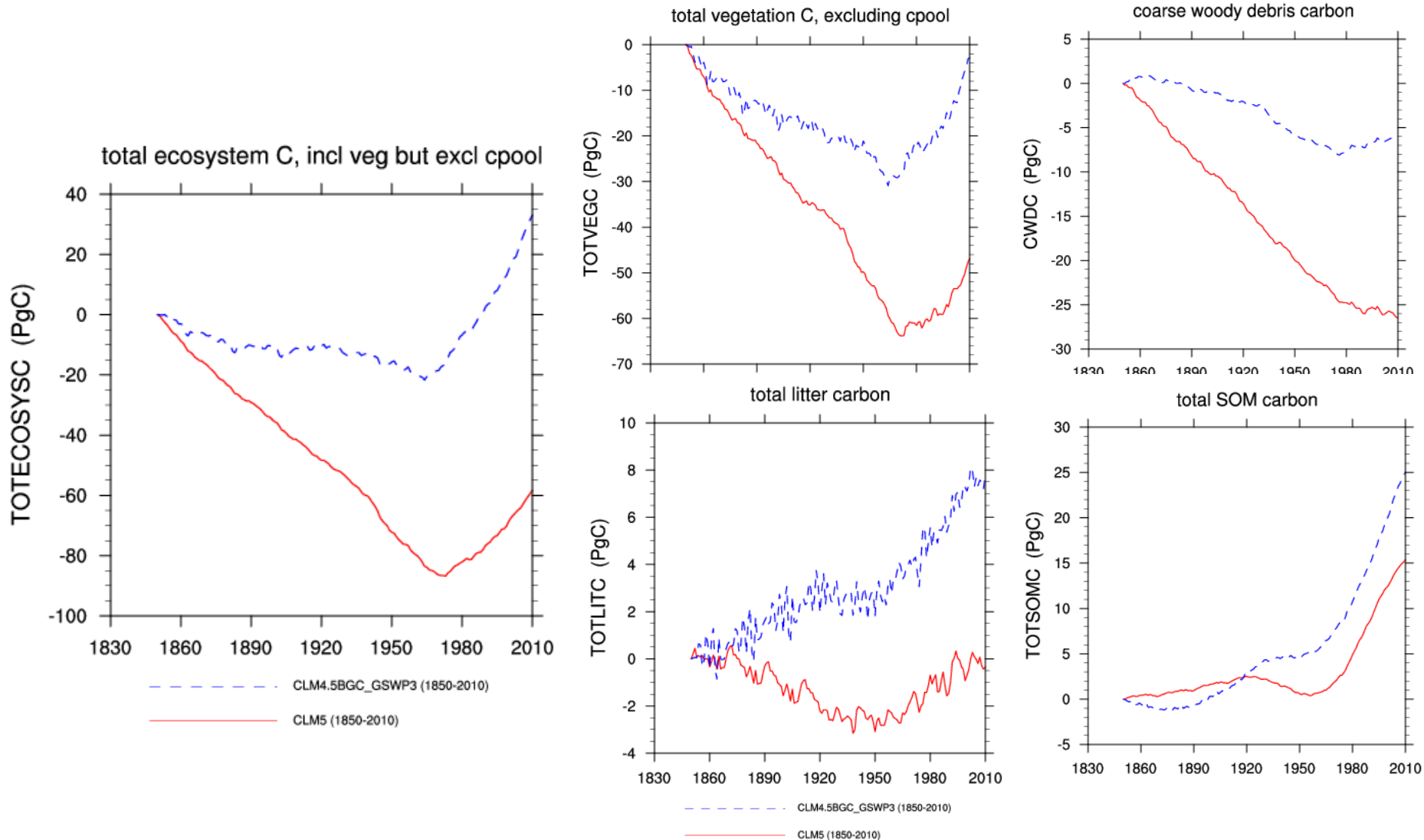
Cells are significant at 0.1 level

Historical global carbon budgets

total ecosystem C, incl veg but excl cpool

CLM4.5BGC_GSWP3 (1850-2010)

CLM5 (1850-2010)
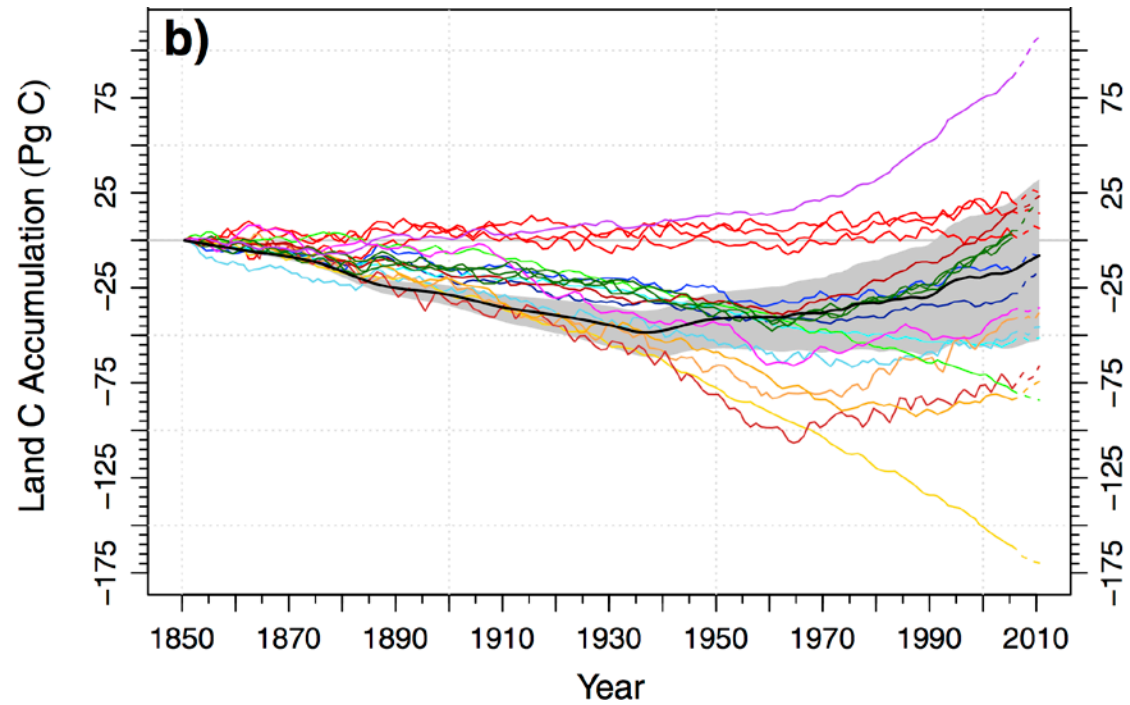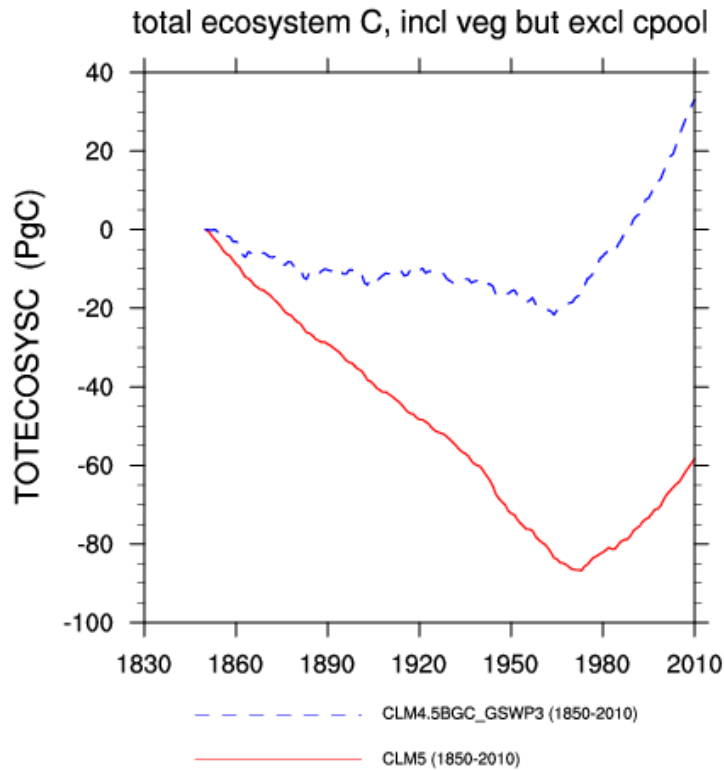
Hoffman et al., 2014

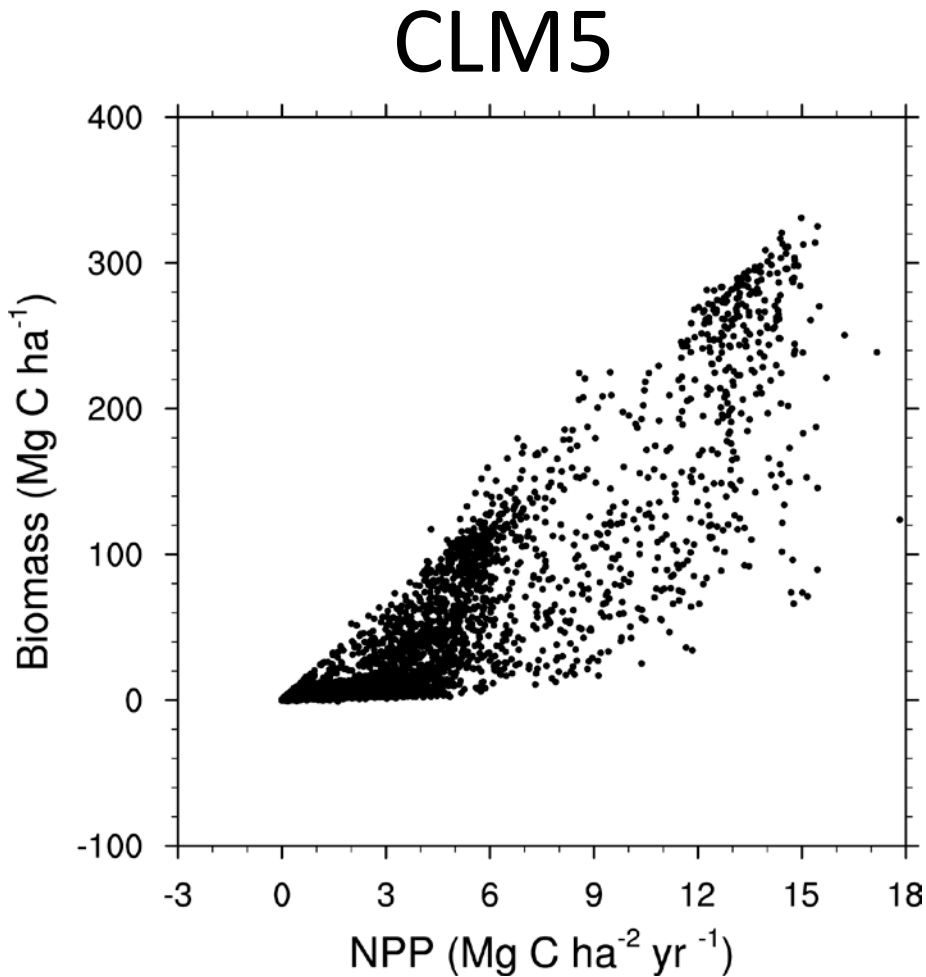# Historical global carbon budgets

Veg Carbon Stocks Increased

total vegetation C, excluding cpool

TOTVEGC (PgC)

- - - CLM4.5BGC_GSWP3 (1850-2010)
——— CLM5 (1850-2010)

ANN TOTVEGC (KgC/m^2)

CLM5
(yrs 1991-2010)

CLM4.5BGC_GSWP3
(yrs 1991-2010)

-0.06 0   2   4   6   8   10 12 14 16 33.5

0   2   4   6   8   10 12 14 16

CLM5
- CLM4.5BGC_GSWP3

T-Test of two Case means at each grid point

-20.656 -3 -2 -1 0 1 2 3 17.871

Cells are significant at 0.1 level
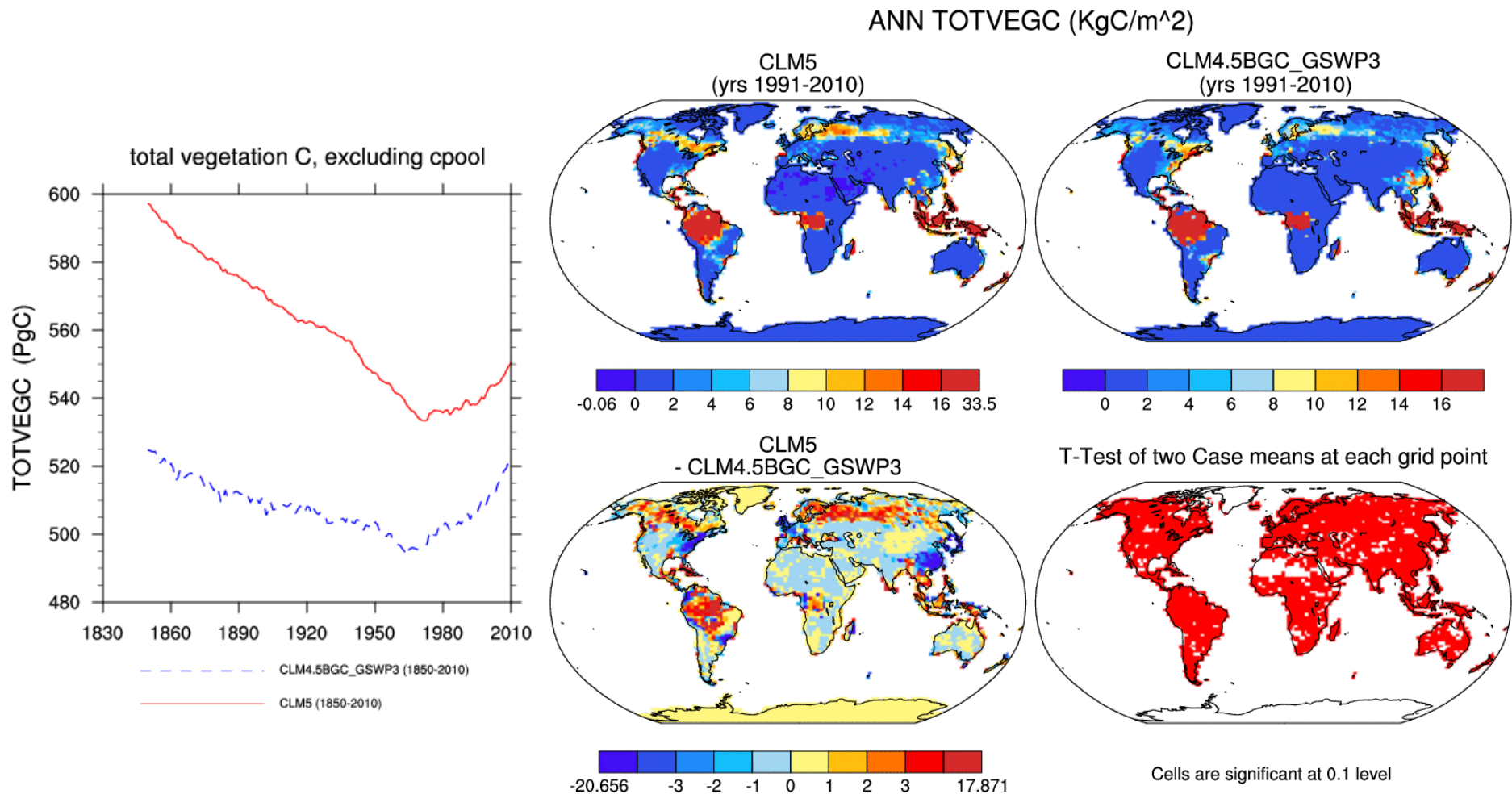
Are Veg C stocks reasonable?
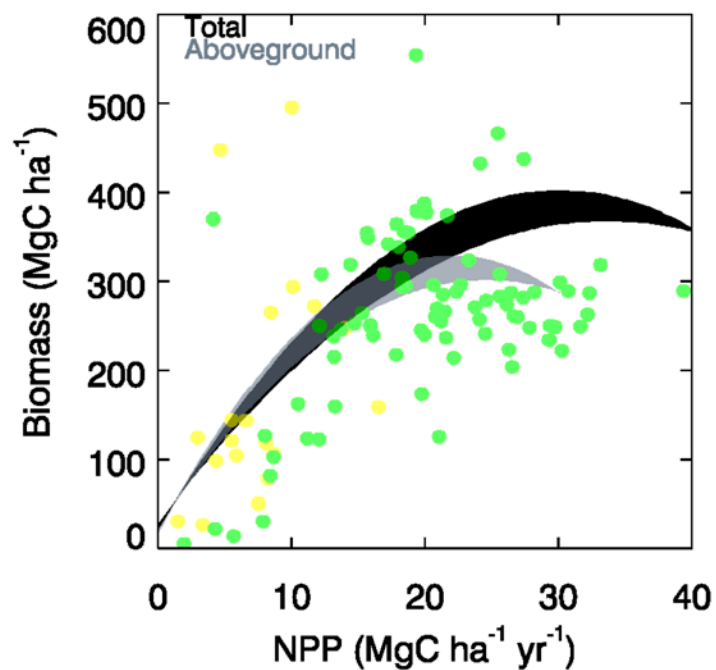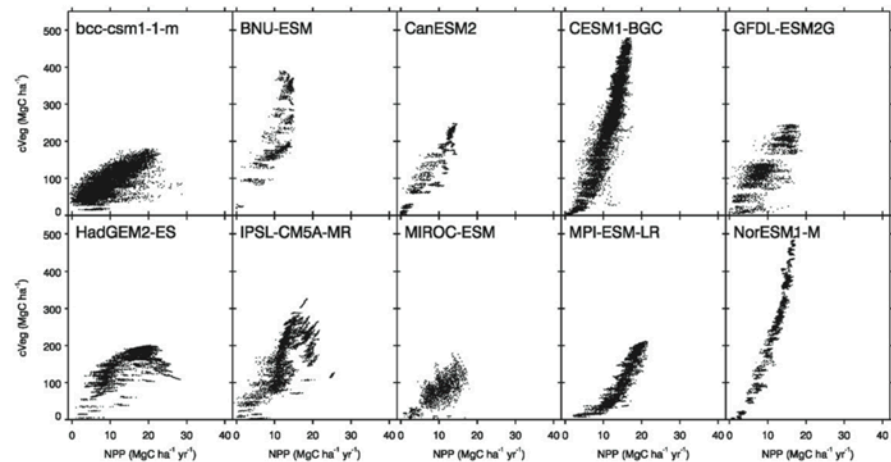
CLM5

Negron-Juarez et al., 2015

Soil Carbon Stocks Decreased

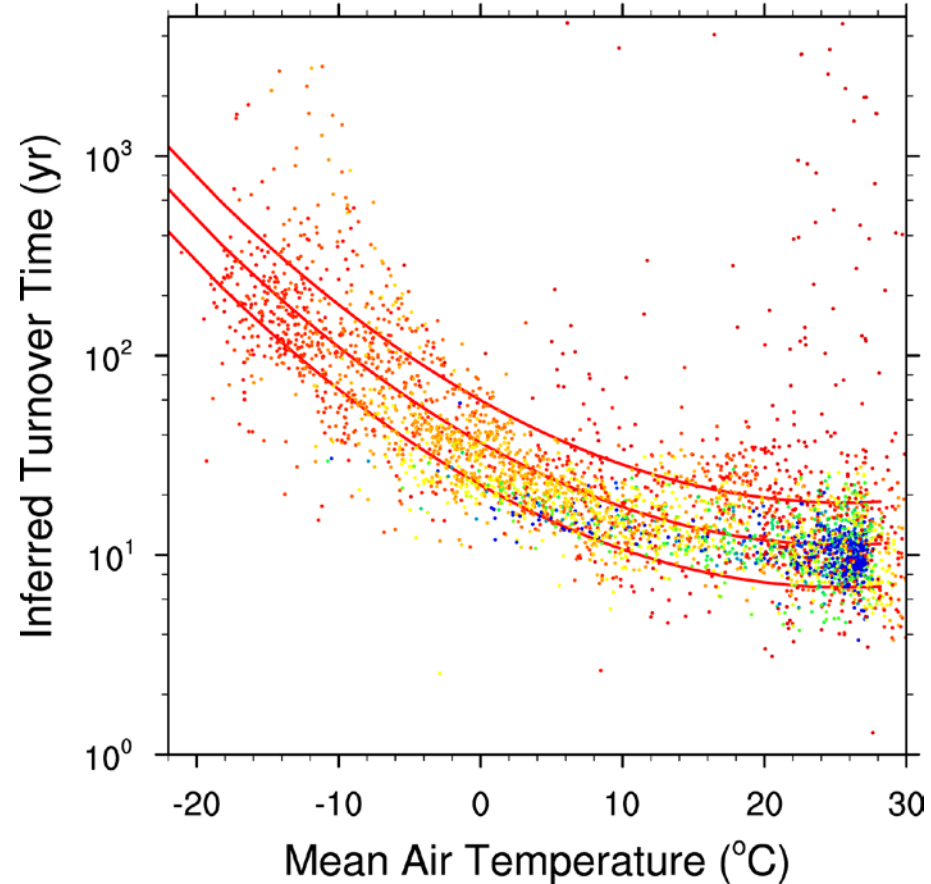ANN TOTSOMC_1m (kgC/m^2)
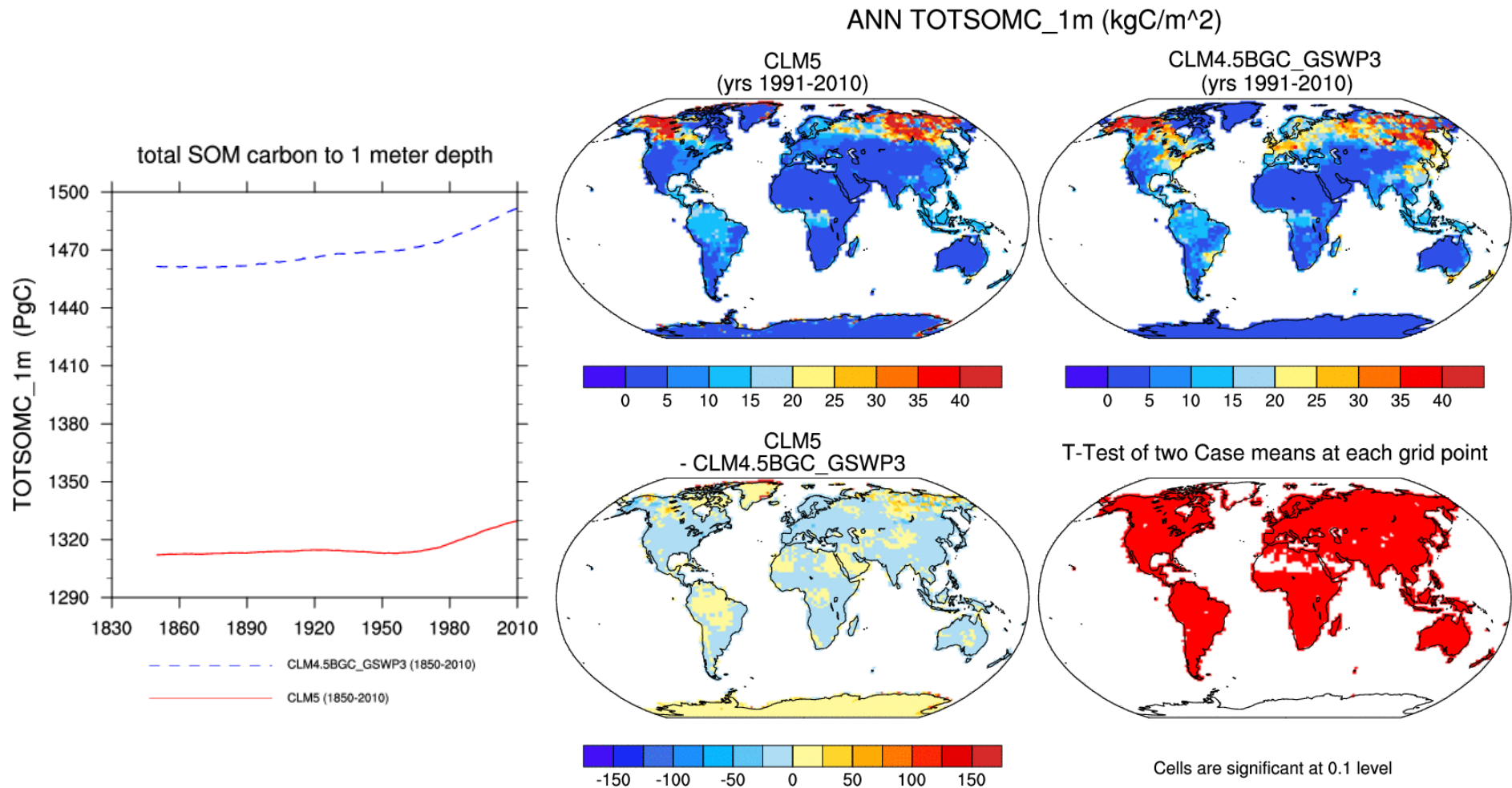
Deep Soil Carbon Stocks Decreased

ANN TOTSOMC (kgC/m^2)
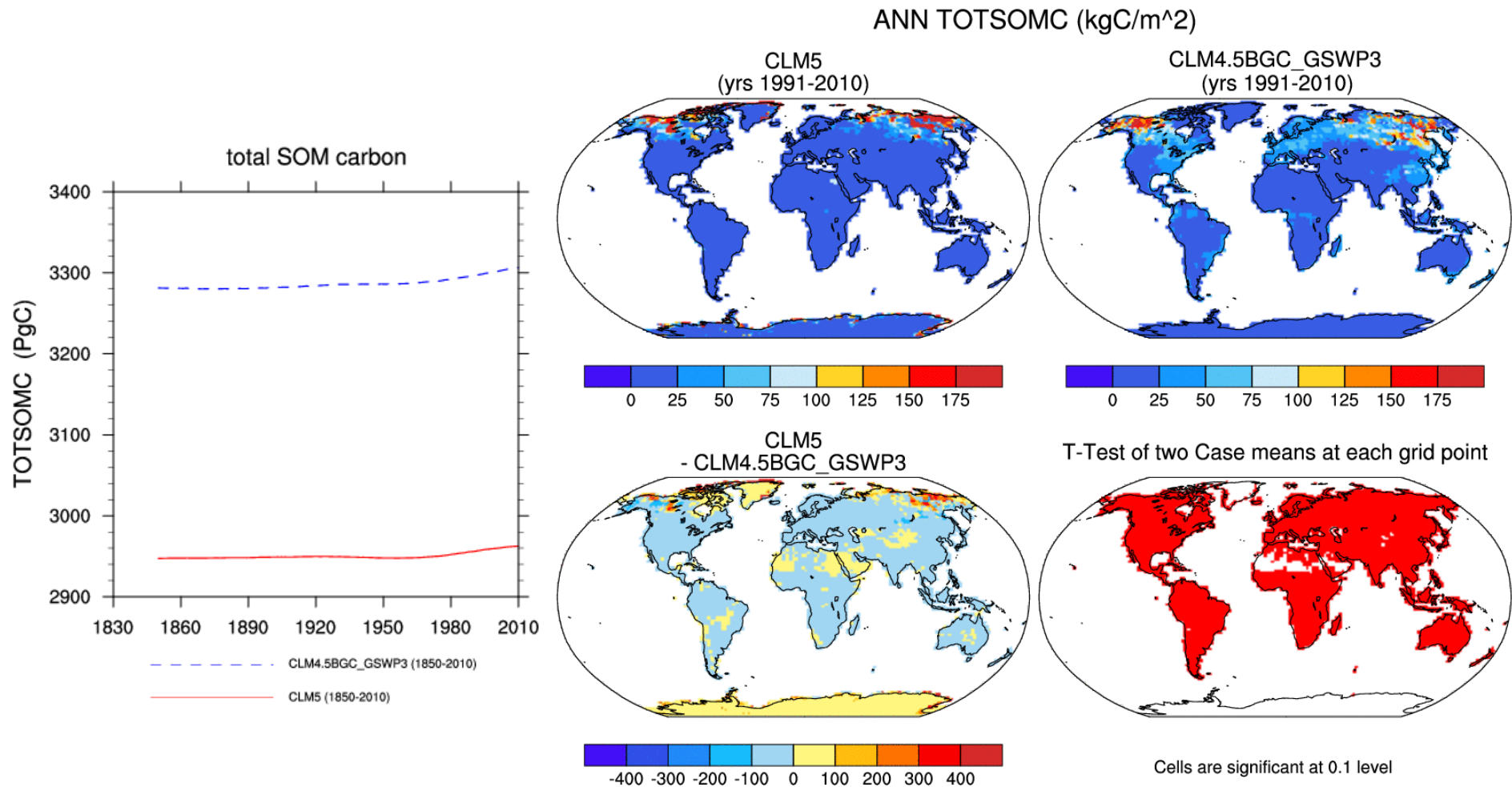
Soil carbon turnover times: comparison against observations

Observation-based estimate
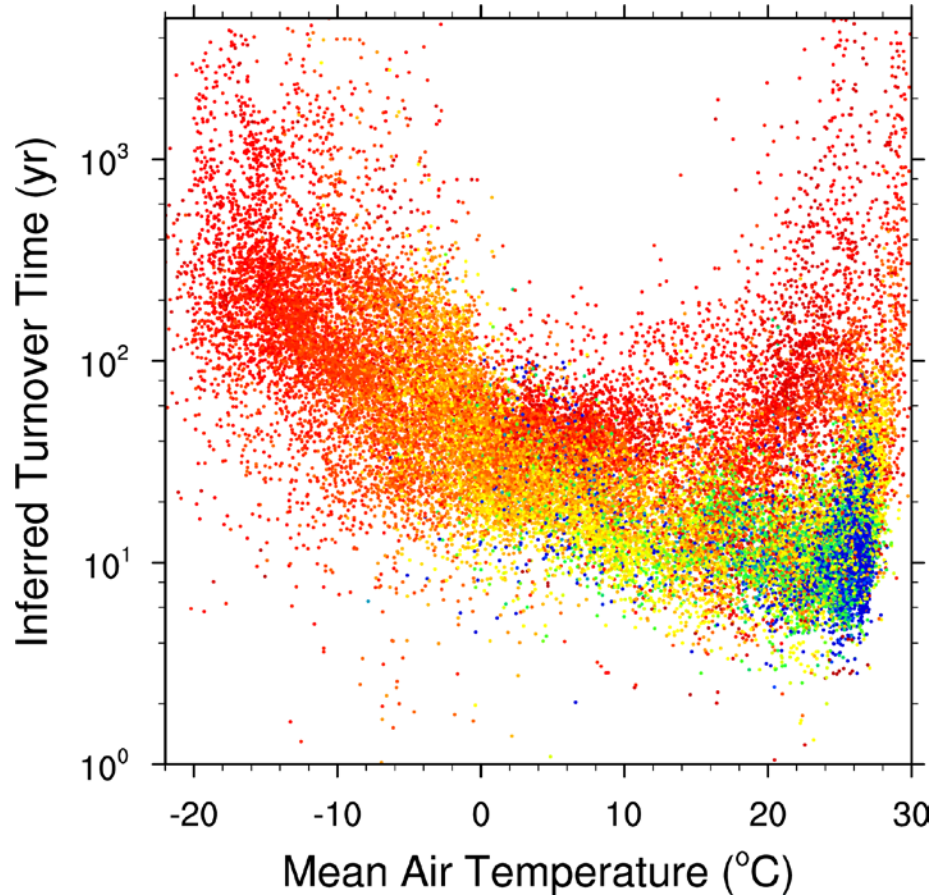
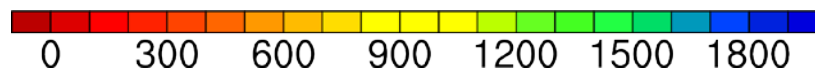fclm50params_n12clm5r225_2deg_scssd_pklai_hist

Koven et al., *in review*

Precipitation (mm/yr)

PFT Survival probabilities:

1: Default PFT coverage maps
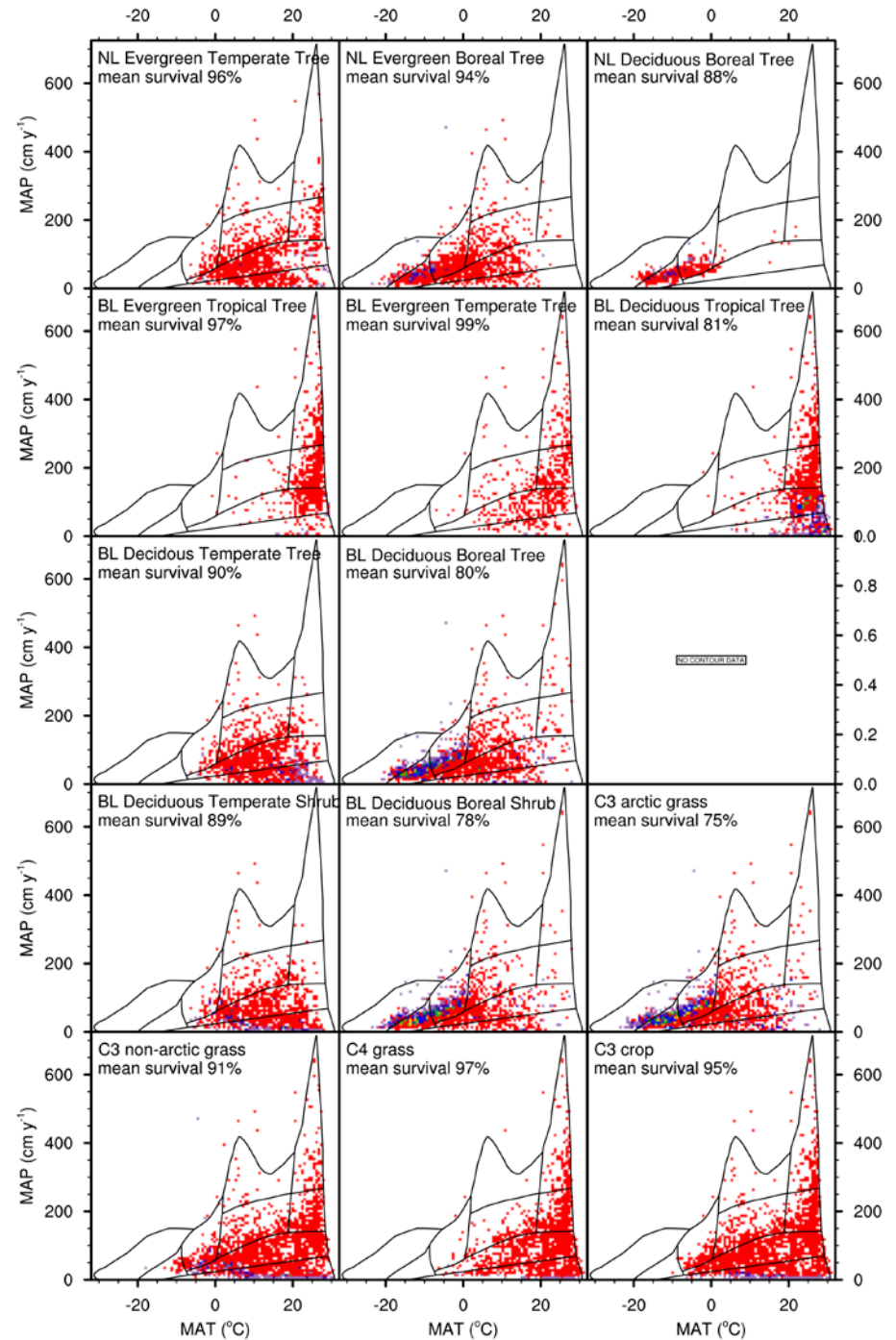
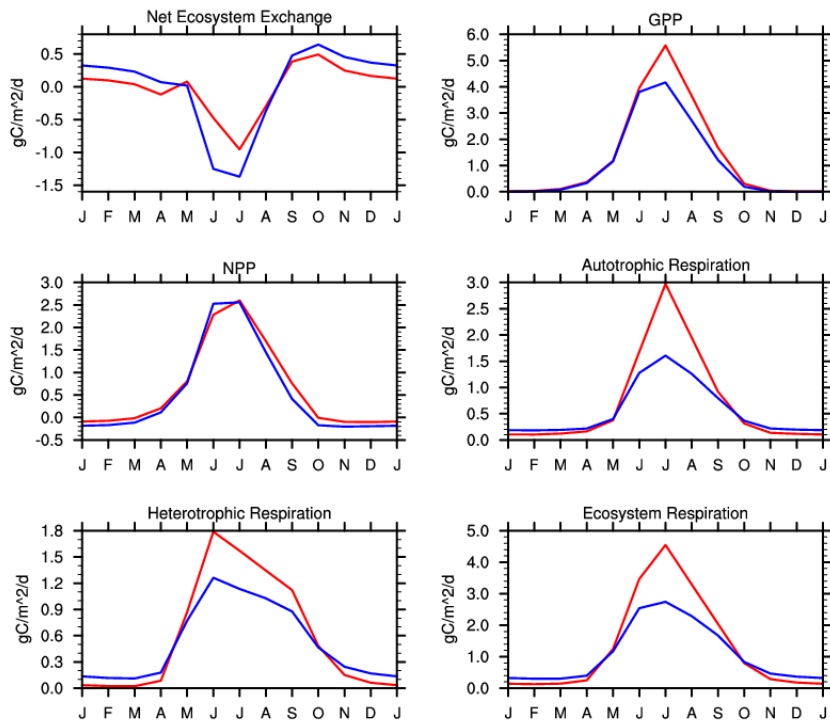# PFT Survival probabilities:

2: New restricted PFT coverage maps
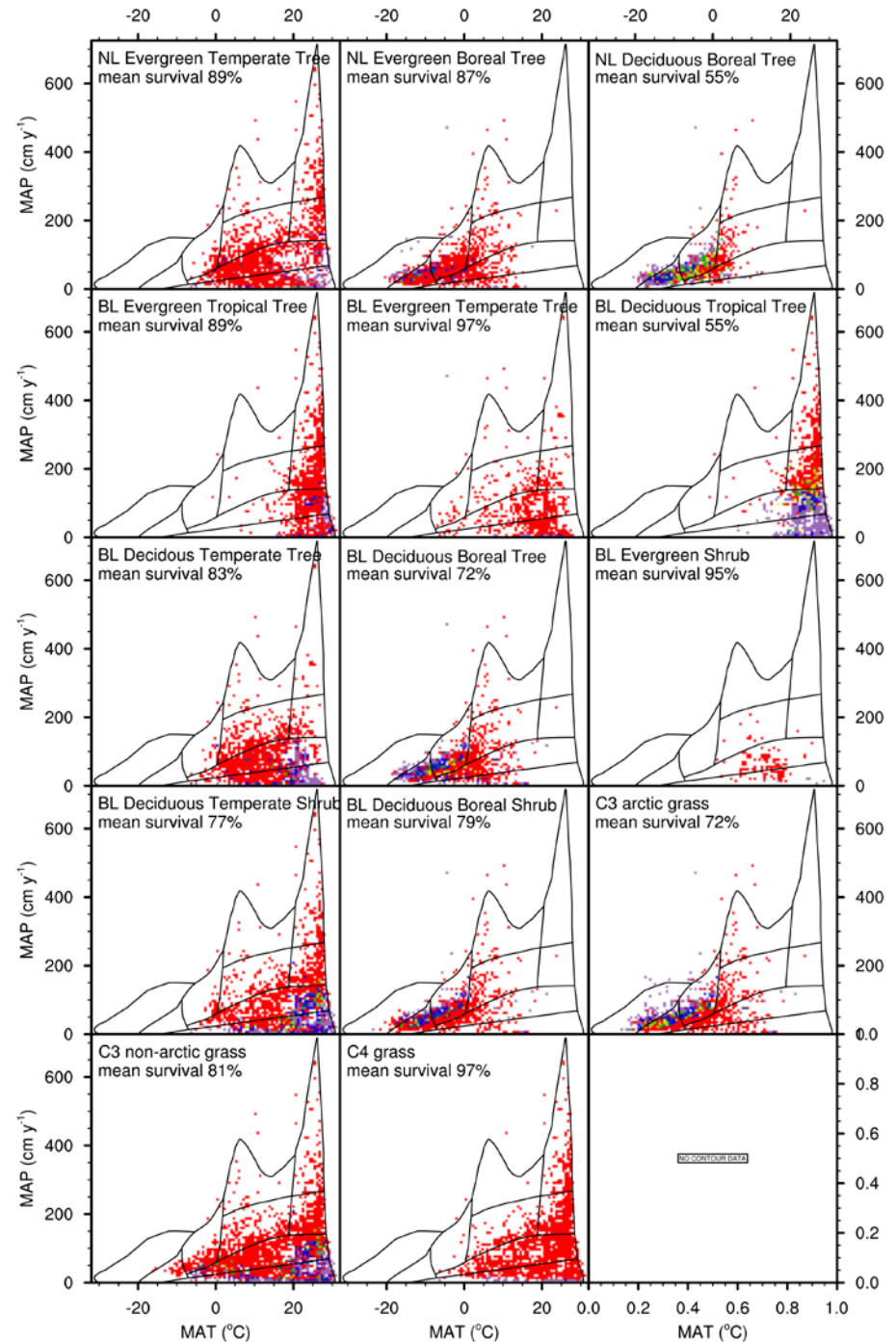
Seasonal cycles of carbon fluxes in some important places
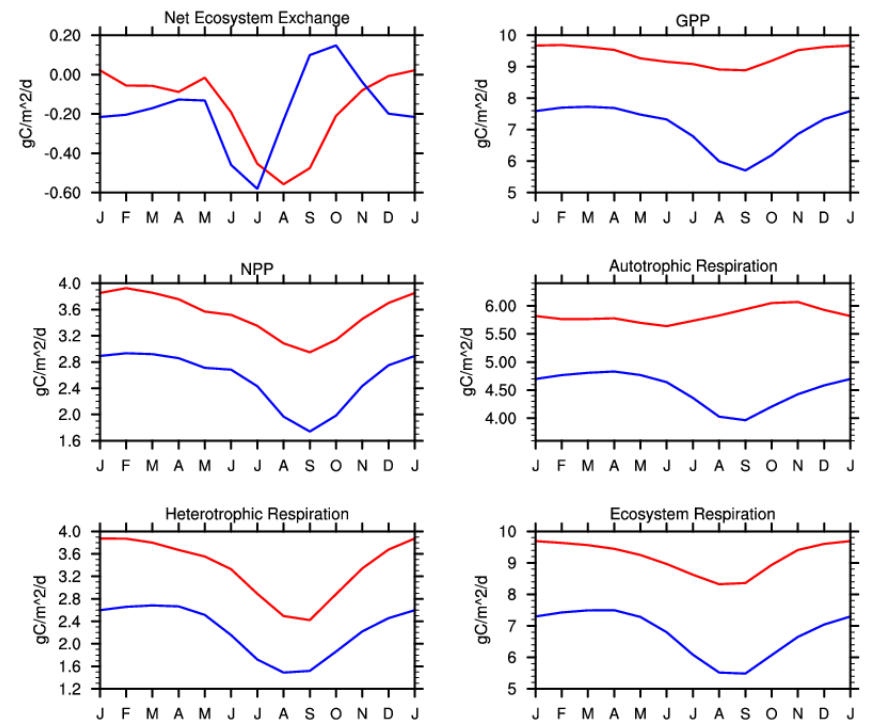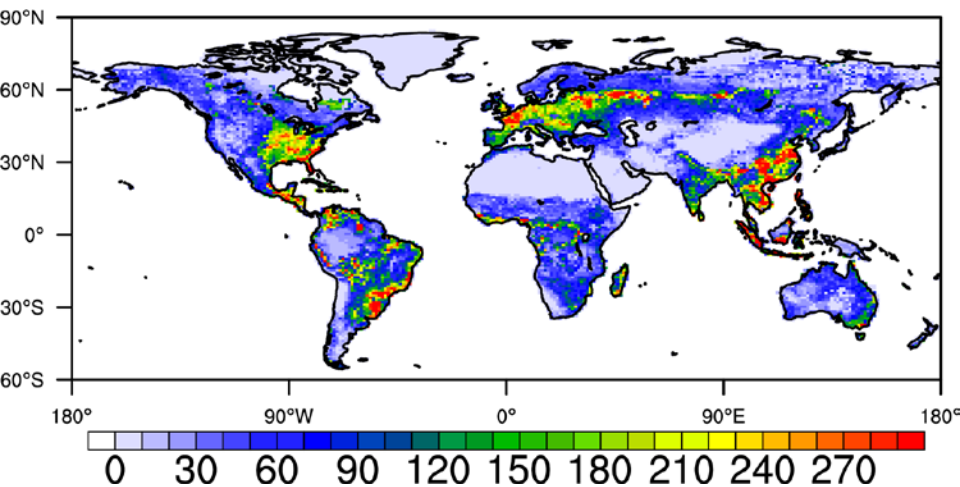

CLM4.5BGC_GSWP3 (yrs 1991-2010)

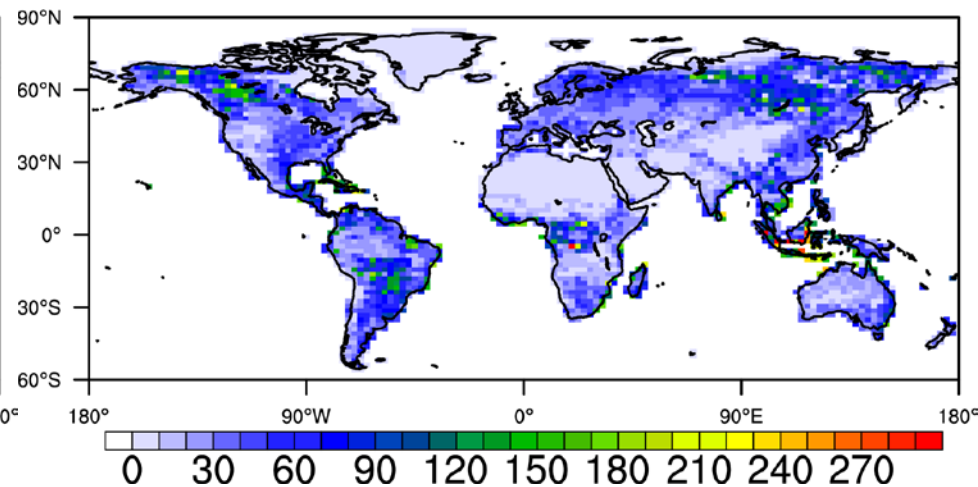CLM5 (yrs 1991-2010)

Interannual Variability
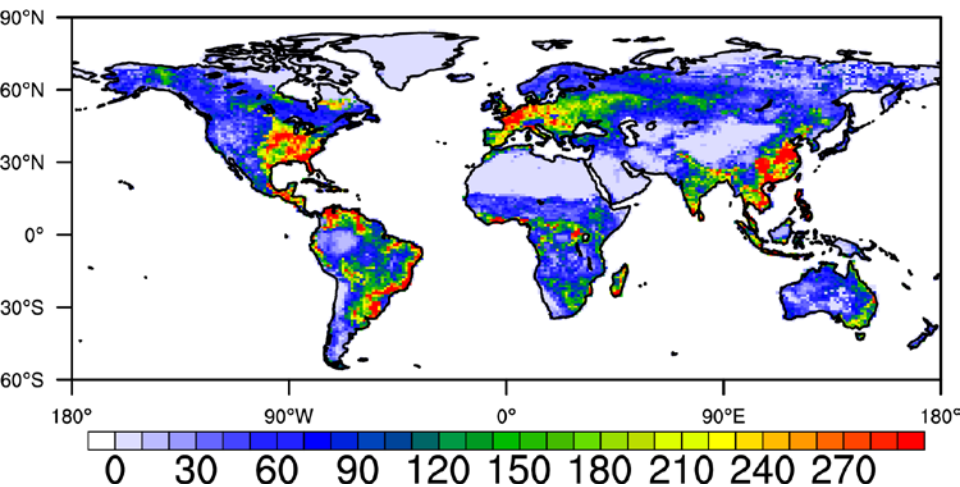# NBP

CLM4.5 NBP STD(IAV) [gC m^{-2} yr^{-1}]

CLM5 NBP STD(IAV) [gC m^{-2} yr^{-1}]

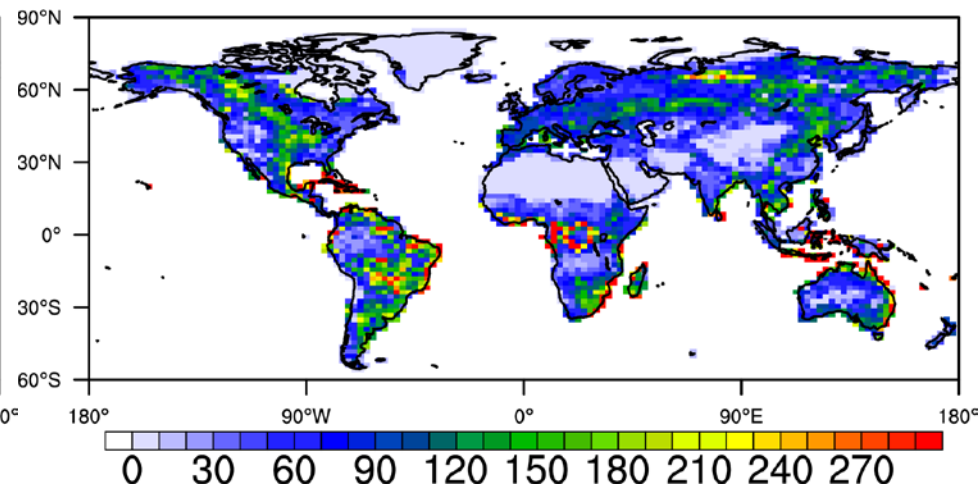0 30 60 90 120 150 180 210 240 270

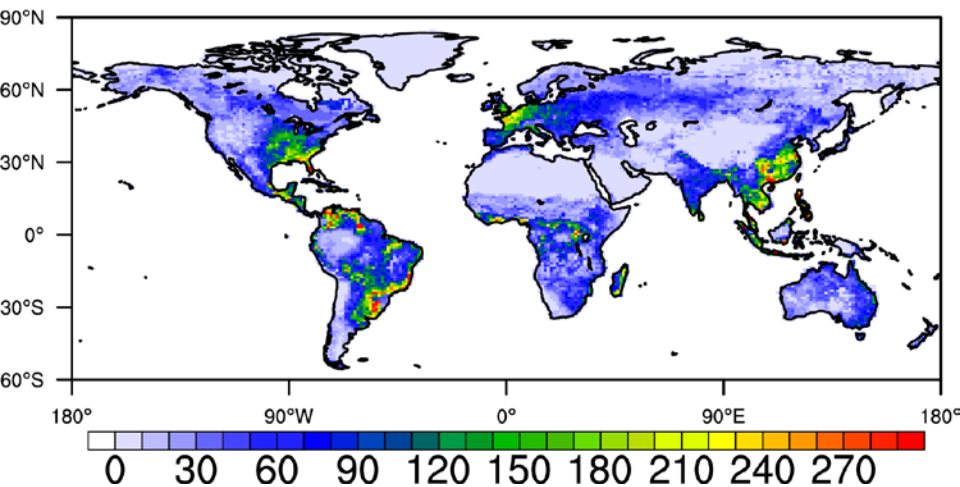# Interannual Variability
GPP

CLM4.5 GPP STD(IAV) [gC m^{-2} yr^{-1}]

CLM5 GPP STD(IAV) [gC m^{-2} yr^{-1}]

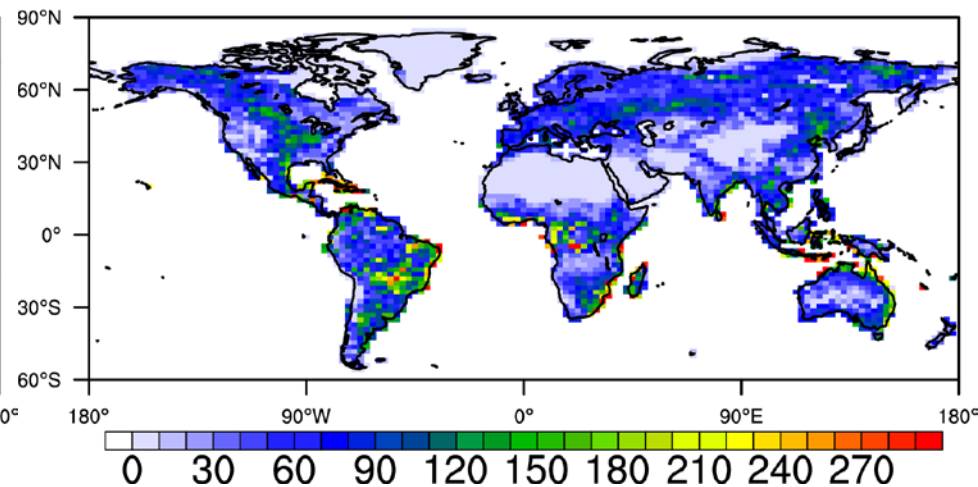# Interannual Variability
AR

CLM4.5 AR STD(IAV) [gC m^{-2} yr^{-1}]

CLM5 AR STD(IAV) [gC m^{-2} yr^{-1}]

Interannual Variability
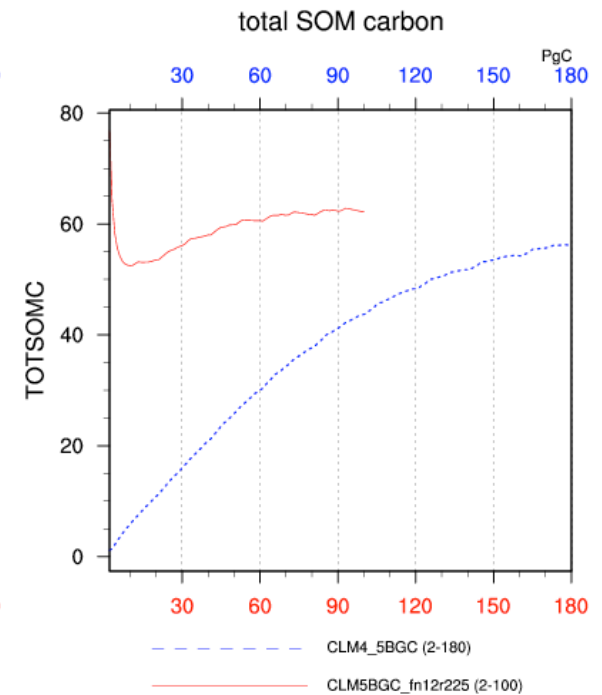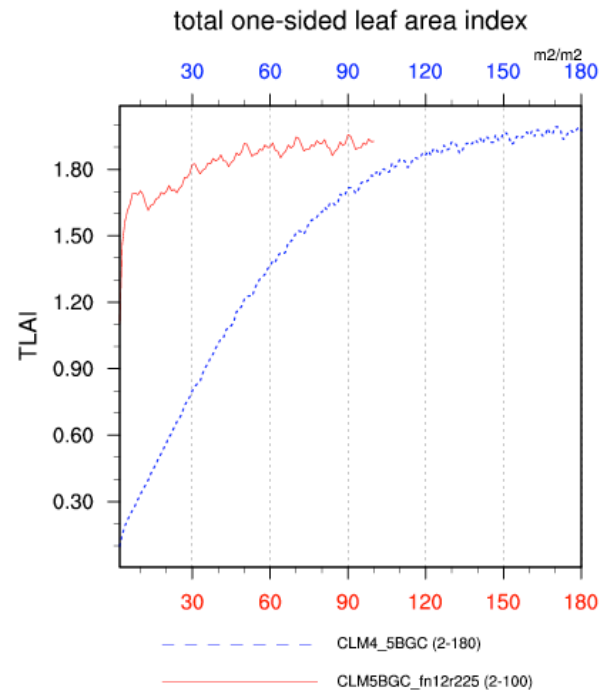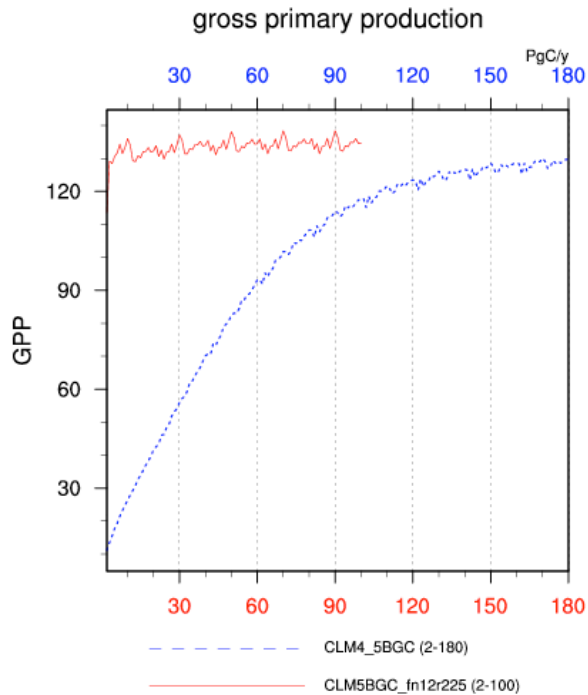# HR
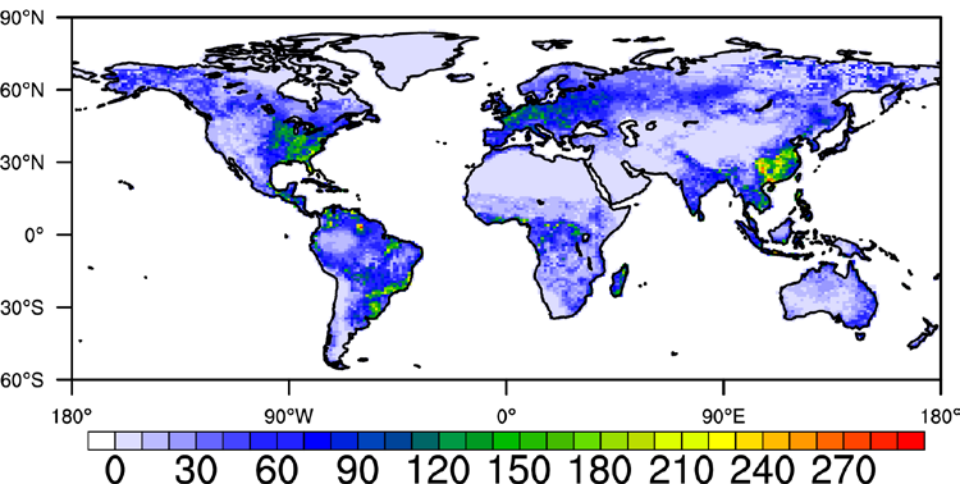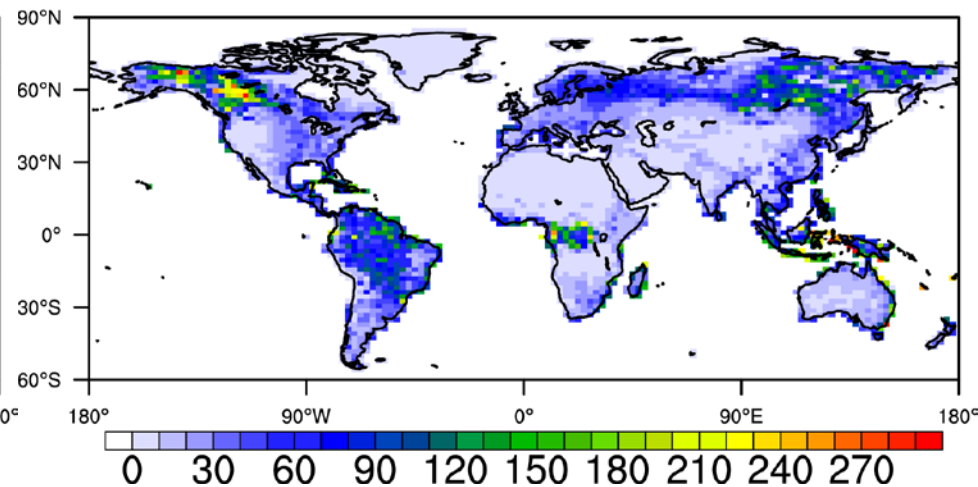
Interannual Variability
Fire

CLM4.5 COL_FIRE_CLOSS STD(IAV) [gC m^{-2} yr^{-1}]

CLM5 COL_FIRE_CLOSS STD(IAV) [gC m^{-2} yr^{-1}]

gross primary production

total one-sided leaf area index

total SOM carbon
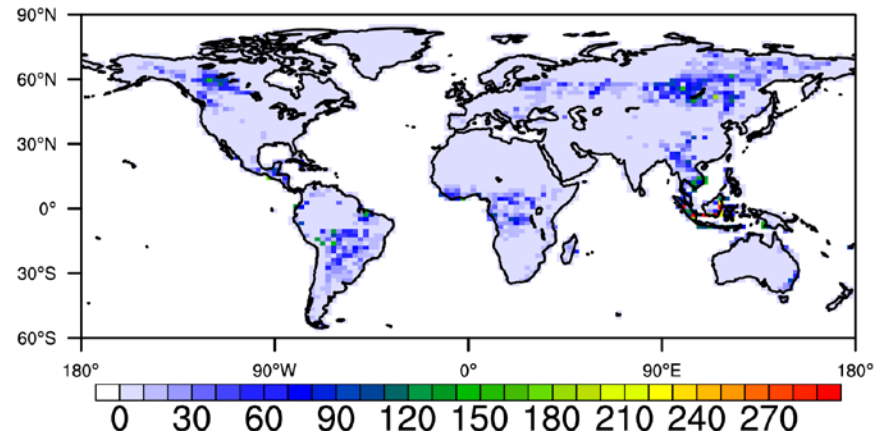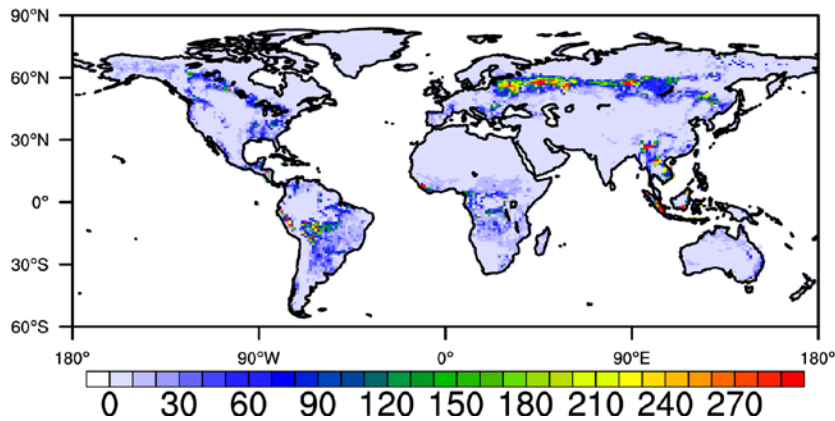
Spinup time reduced from ~2000 model years to ~500
GGP, LAI spinup quickly, allowing more rapid turnaround for testing

Much still to explore in this model. Thanks to everyone who pulled it together!