20th Century Carbon budgets in CLM4.0 and CLM4.5

C. Koven[1], S. Levis[2], D. Lawrence[2], G. Bonan[2], K. Oleson[2], S. Swenson[2], W. Riley[1], J. Tang[1], Z. Subin[1,3]

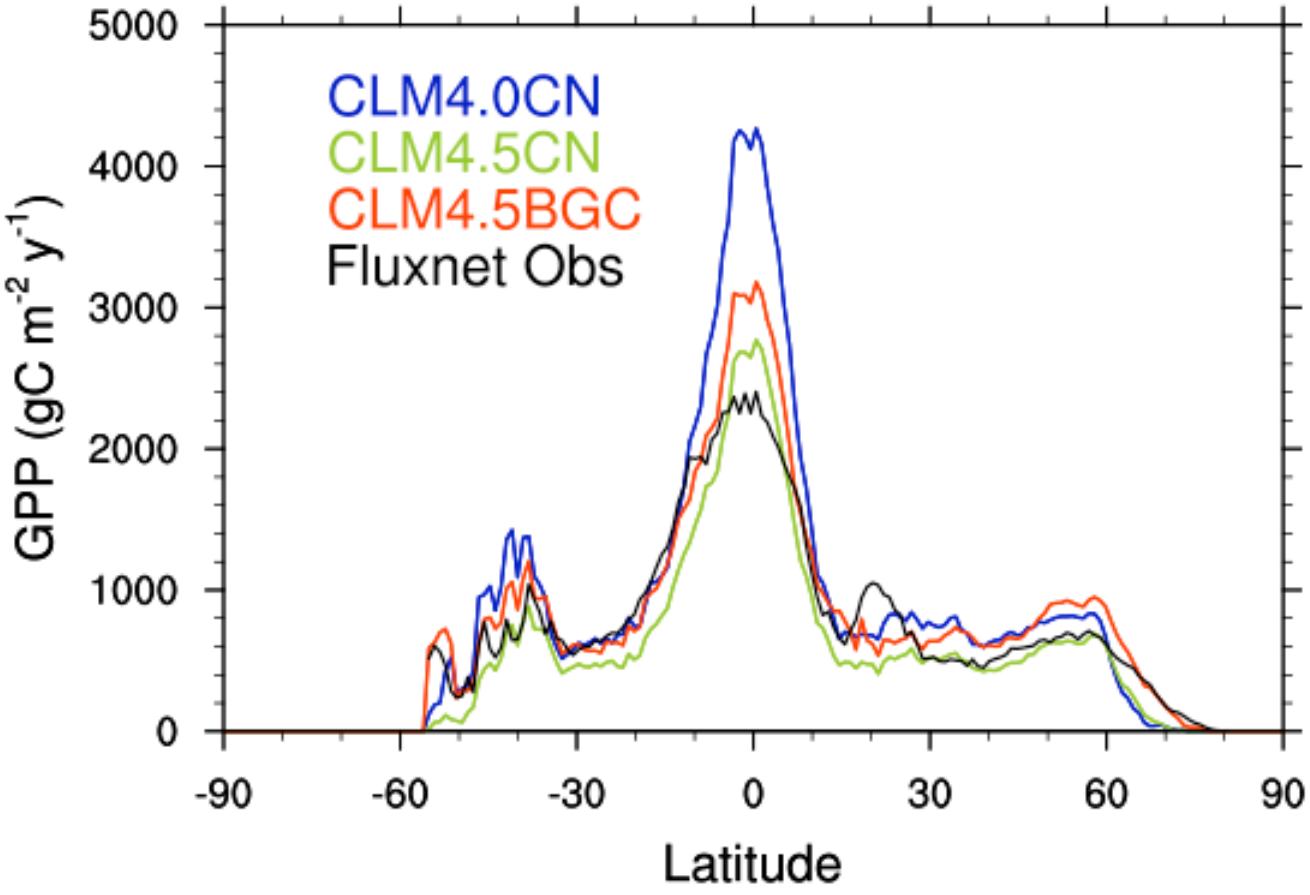
1: LBL
2: NCAR
3: Princeton Univ.

June 19, 2013, Breckenridge, CO

Differences between model versions

- CLM4.0CN -> CLM4.5CN
  - Updated physics: photosynthesis, hydrology, fire, many others
- CLM4.5CN -> CLM4.5BGC
  - Updated soil biogeochemistry: changed soil/litter decomposition rates; vertical resolution to soil C an N cycling; revised mineral N dynamics

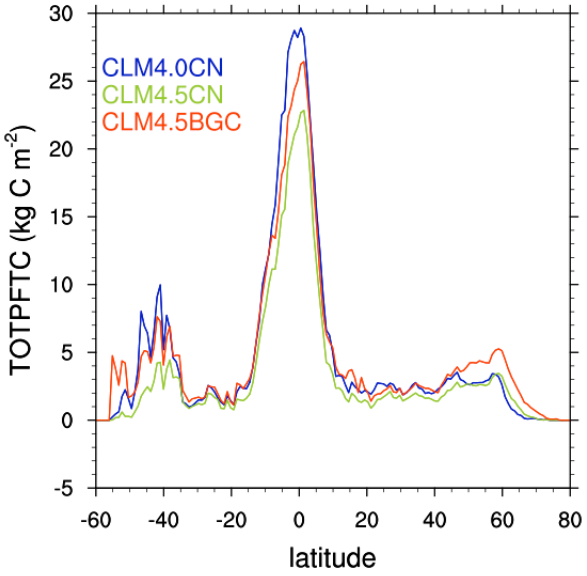
Latitude profiles of GPP



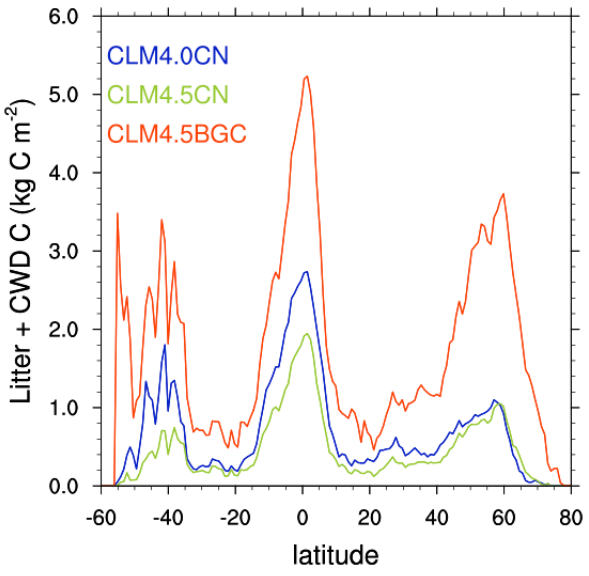
Fluxnet curve from Beer et al., 2010 dataset

Latitude profiles of C pools

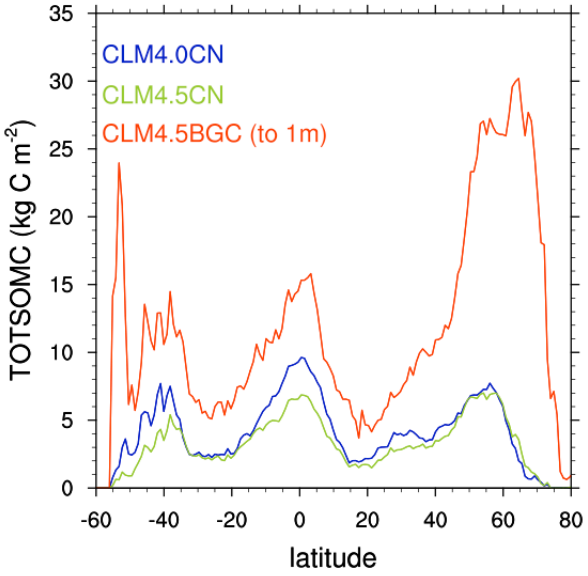
Vegetation



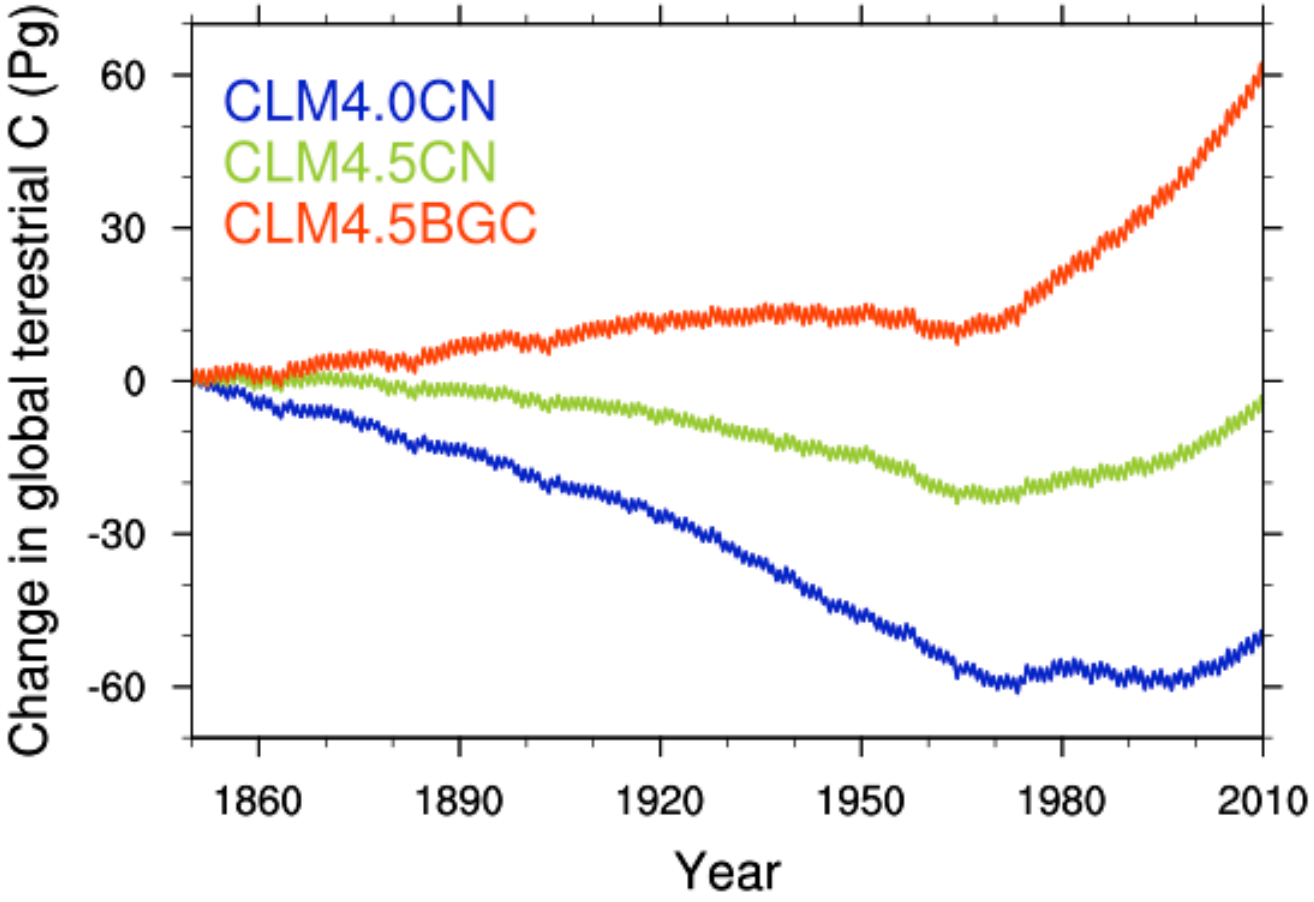
Litter + CWD



Soil Organic Matter

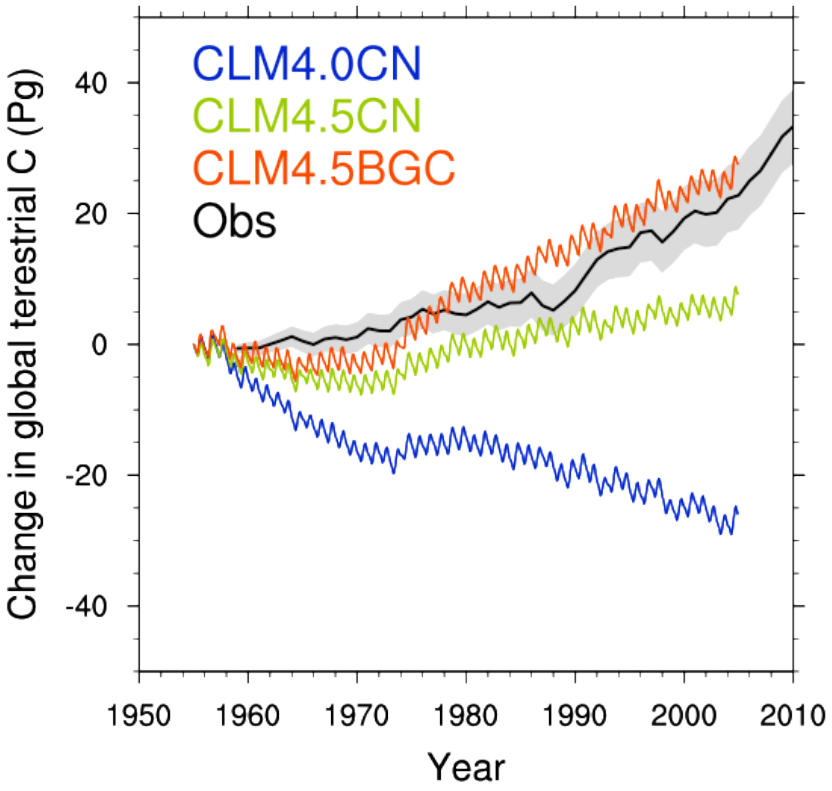


Full Control run C budget

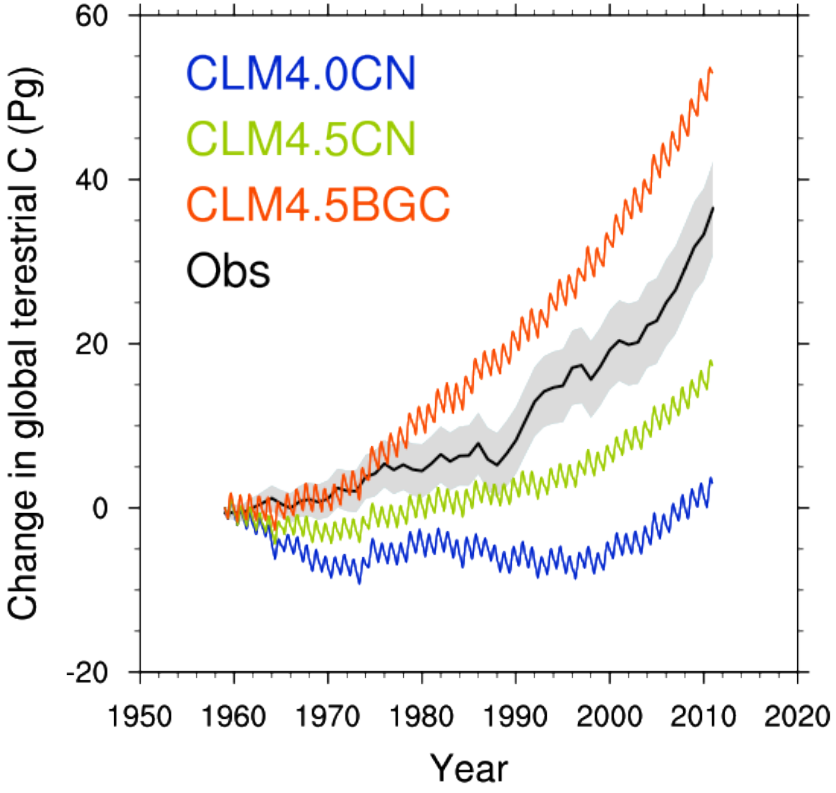


Late 20th century terrestrial C budget and comparison to Global Carbon Project reconstructed budget

2-degree Qian forcing



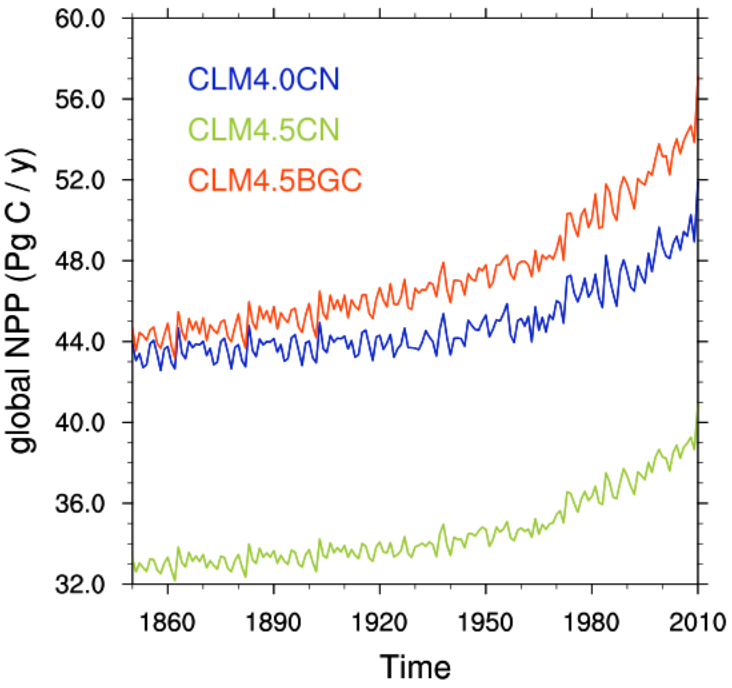
1-degree CRUNCEP forcing

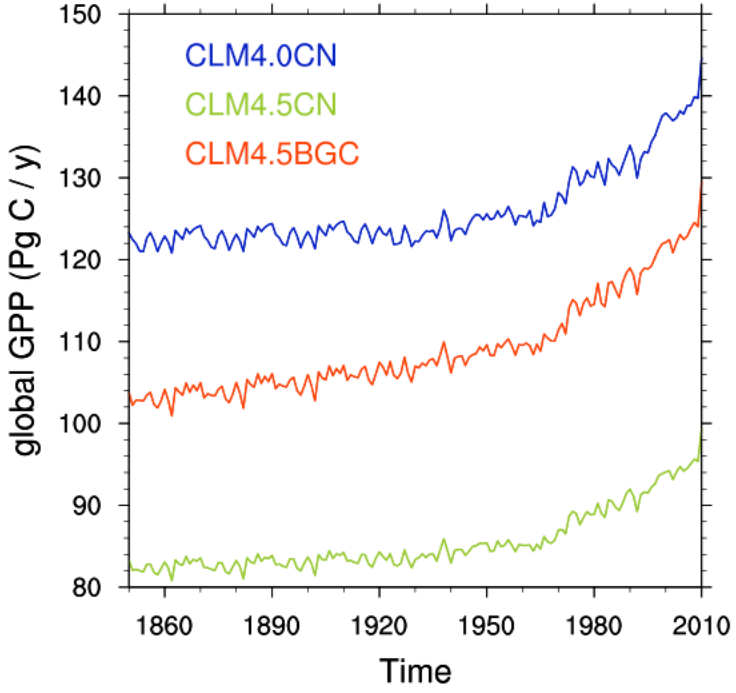


GCP curve: sum of land-use change and land sink from Le Quere et al., 2013

GCP Land error assumptions here assumes interannual errors are uncorrelated

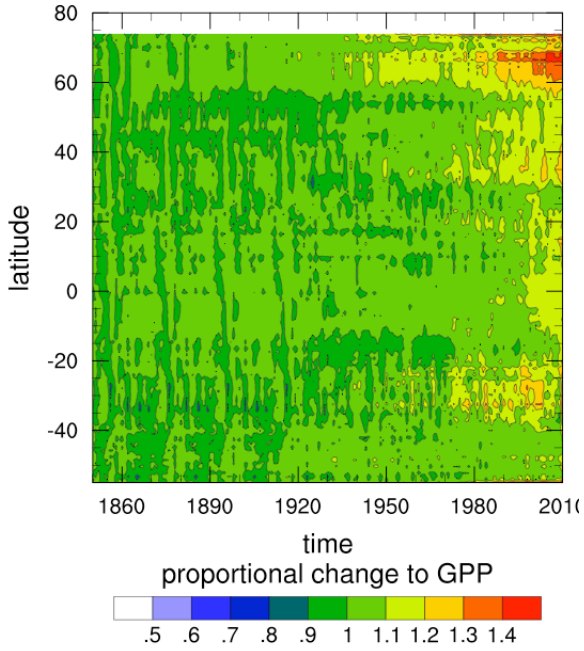
Integrated changes of GPP,NPP



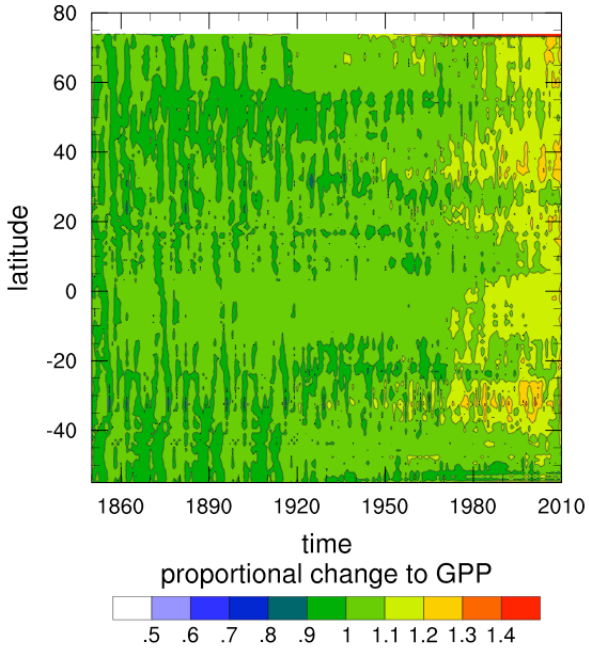


Where is GPP increasing: latitude/time fields for each run

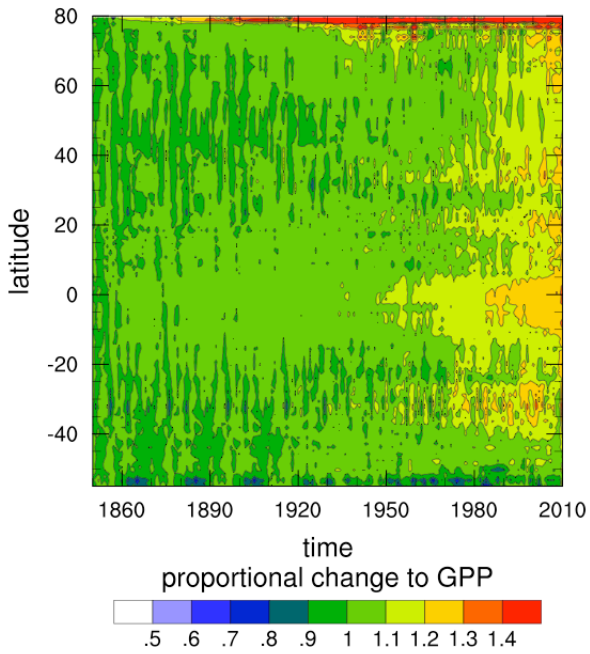
CLM4.0CN



CLM4.5CN

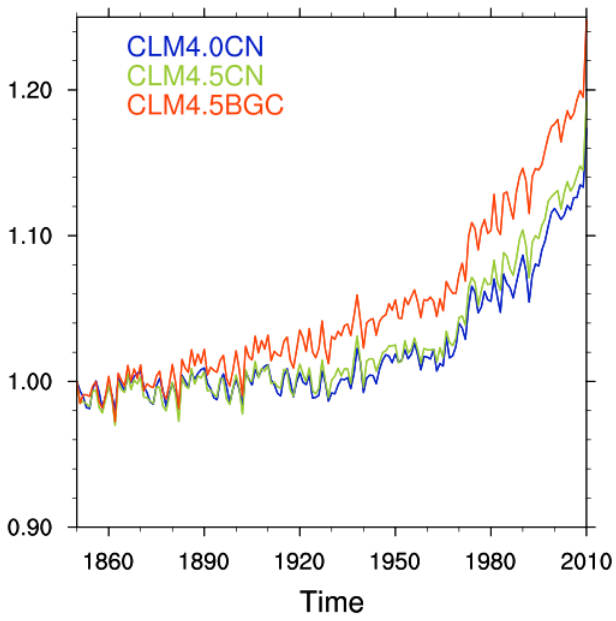


CLM4.5BGC

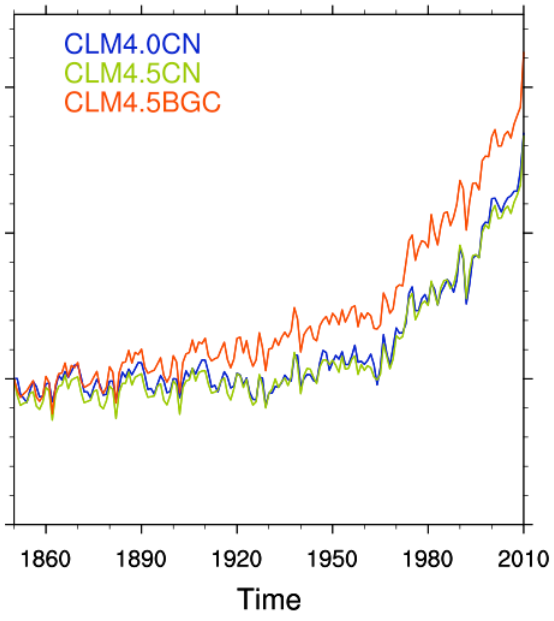


Relative changes to C flux terms

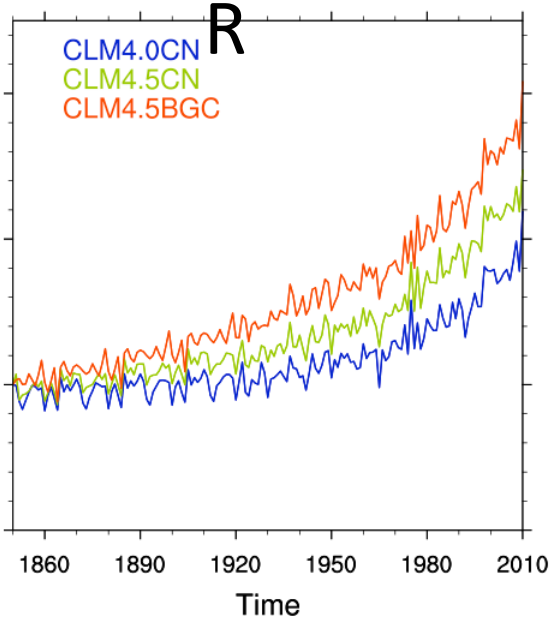
GPP



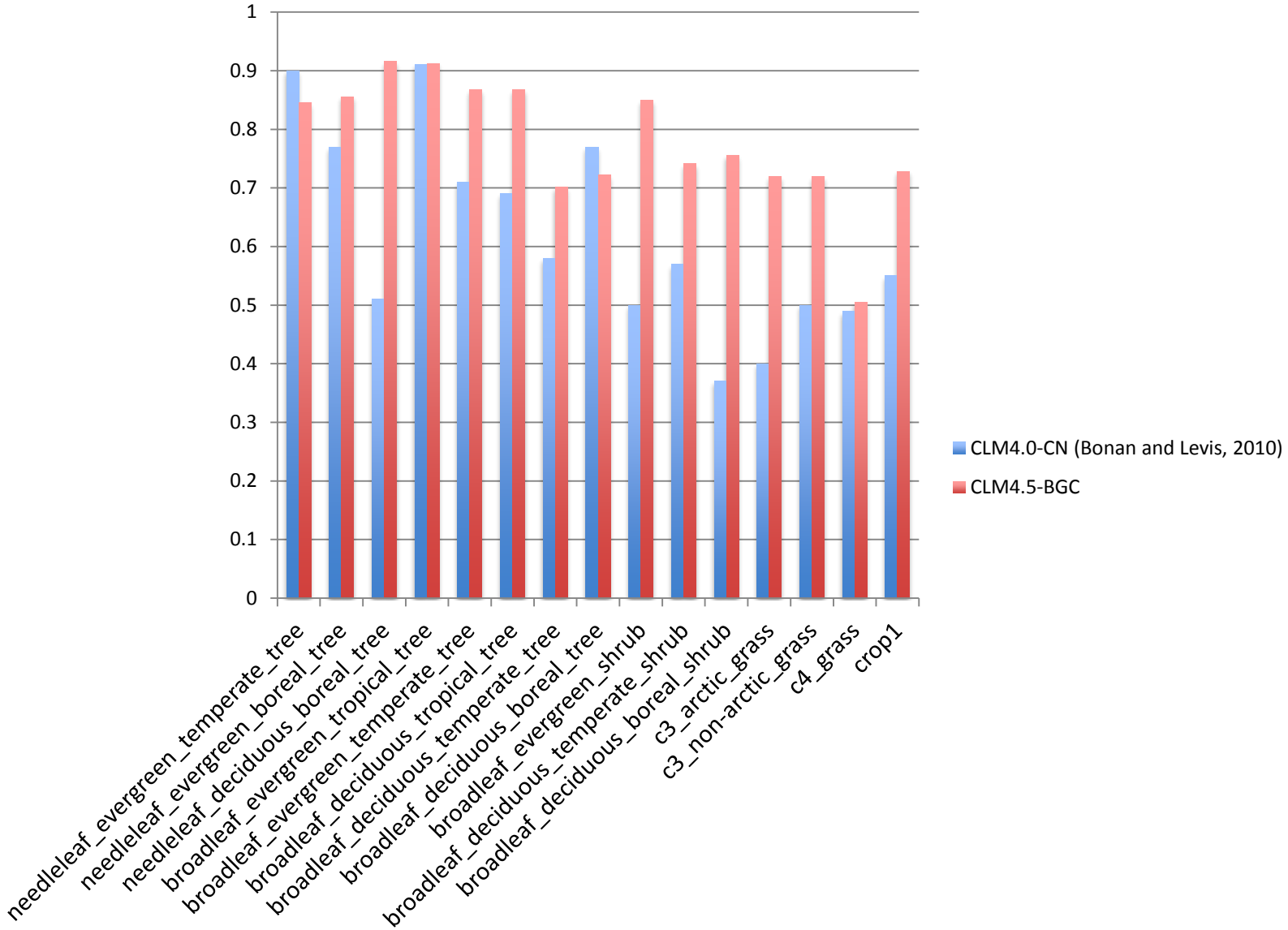
AR



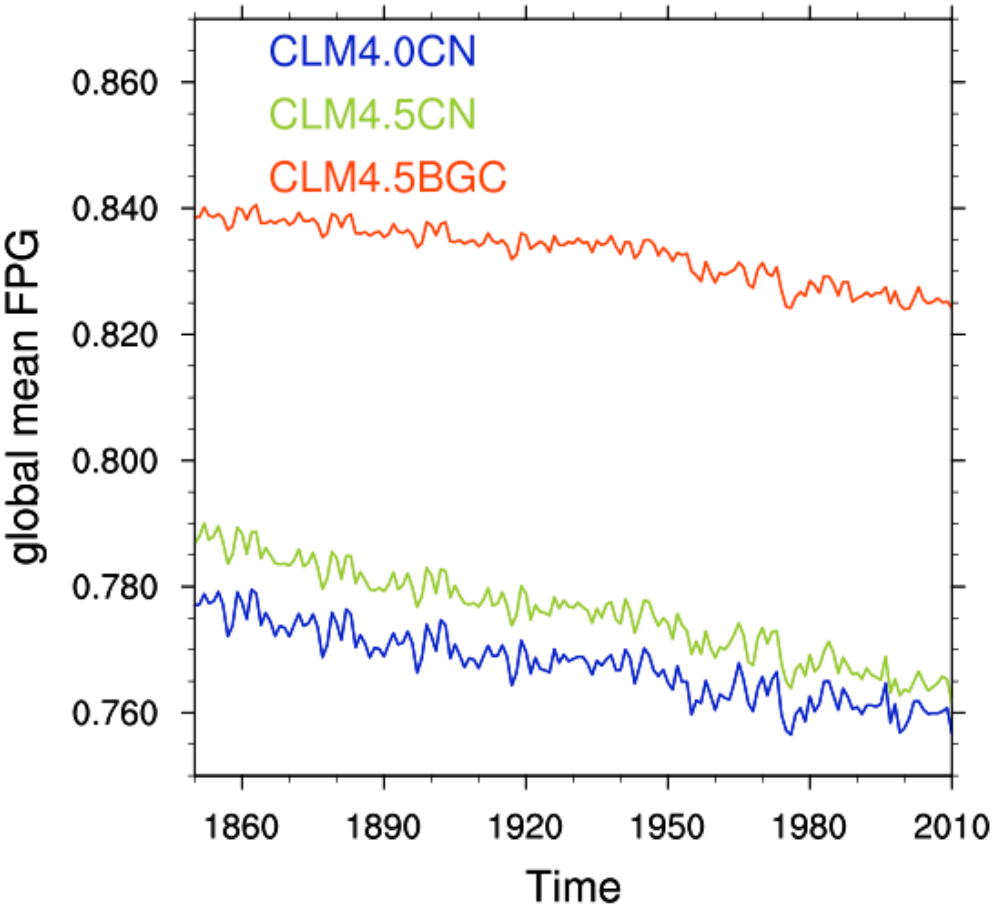
H
R



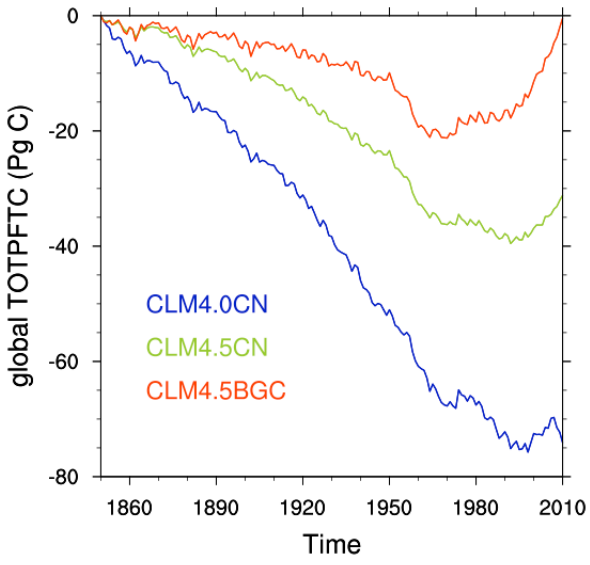
N downregulation factors

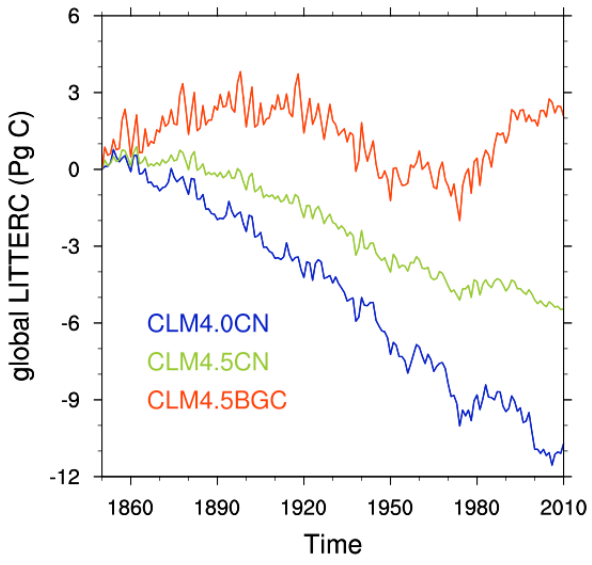


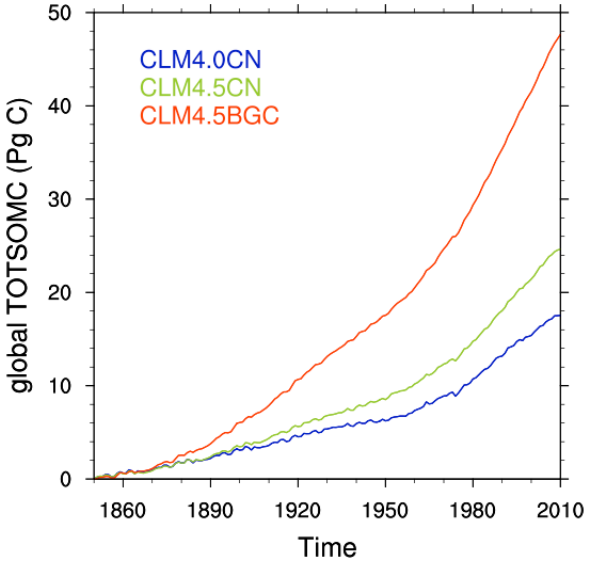
Comparison of N effects on GPP: mean instantaneous N downregulation (FPG)



Where is the carbon going?



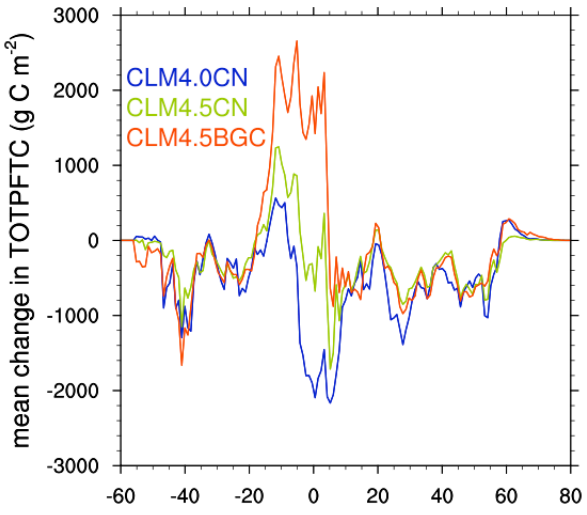




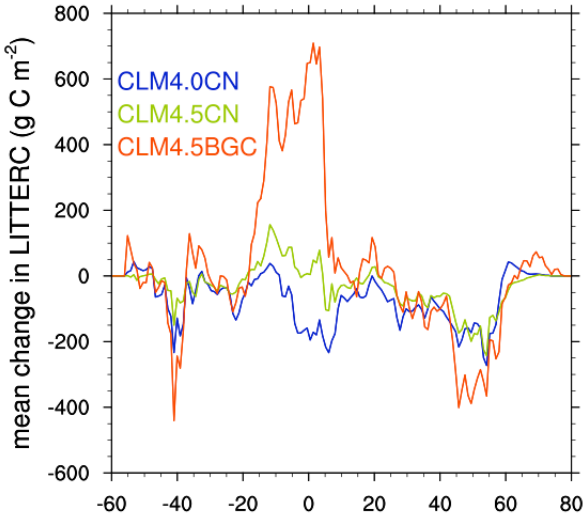
Largest change in carbon between model runs is in the biomass pools

Latitude profiles of ΔC pools

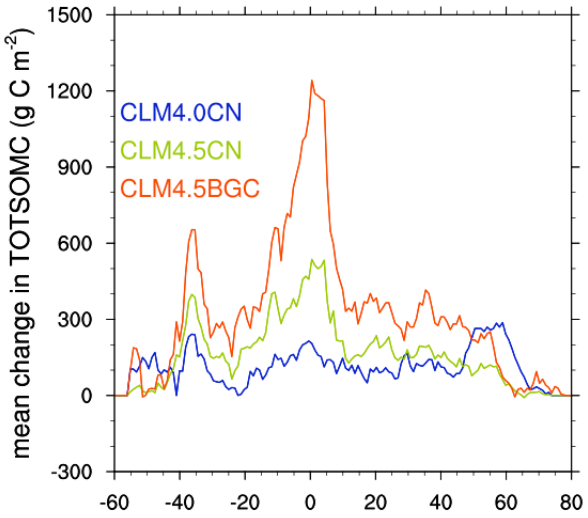
Vegetation



Litter + CWD



Soil Organic Matter



Modes of C vs. N limitation

- Trend is to shift from highly N-limited to less so
  - CLM4CN -> CLM4.5CN: reduced intrinsic GPP requires less N downregulation
  - CLM4.5CN -> CLM4.5BGC: reduced denitrification leads to less N downregulation
- This leads to higher land uptake over 20th century
- Possible that nutrient limitation may be too weak in CLM4.5BGC; but why is CLM prediction of global C budget so sensitive to poorly-resolved processes like denitrification?
- Future development: shift from nutrient presence limitation to nutrient availability limits?