

# Terrestrial C-N in CLM5.0

Will Wieder, Bardan Ghimire,  
Mingjie Shi, Chonggang Xu + many more



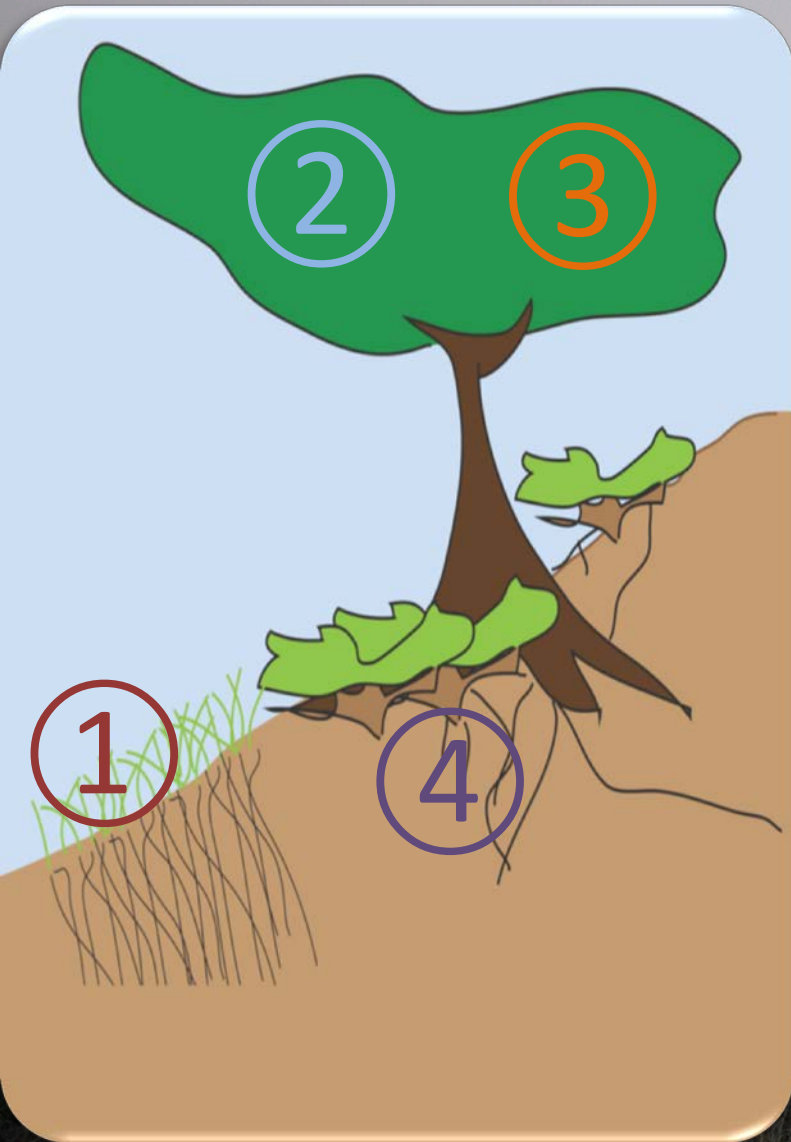


# CLM4cn.....

# CLM5?

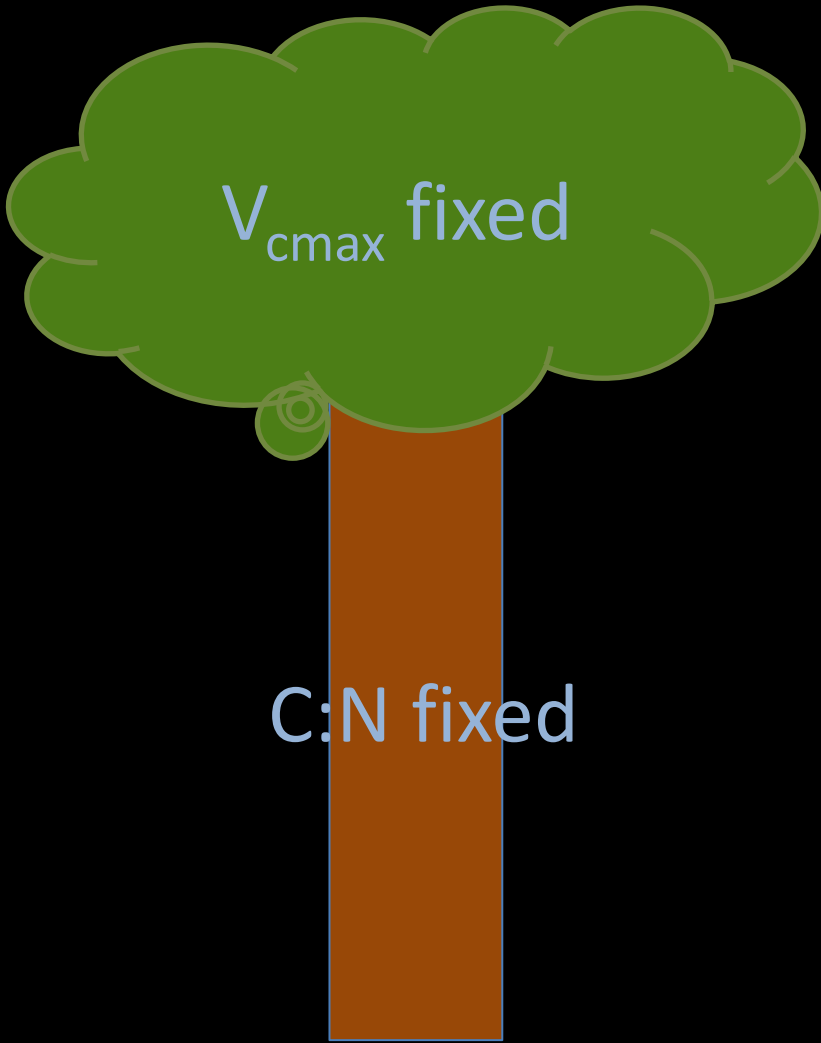


# New in CLM5.0\*



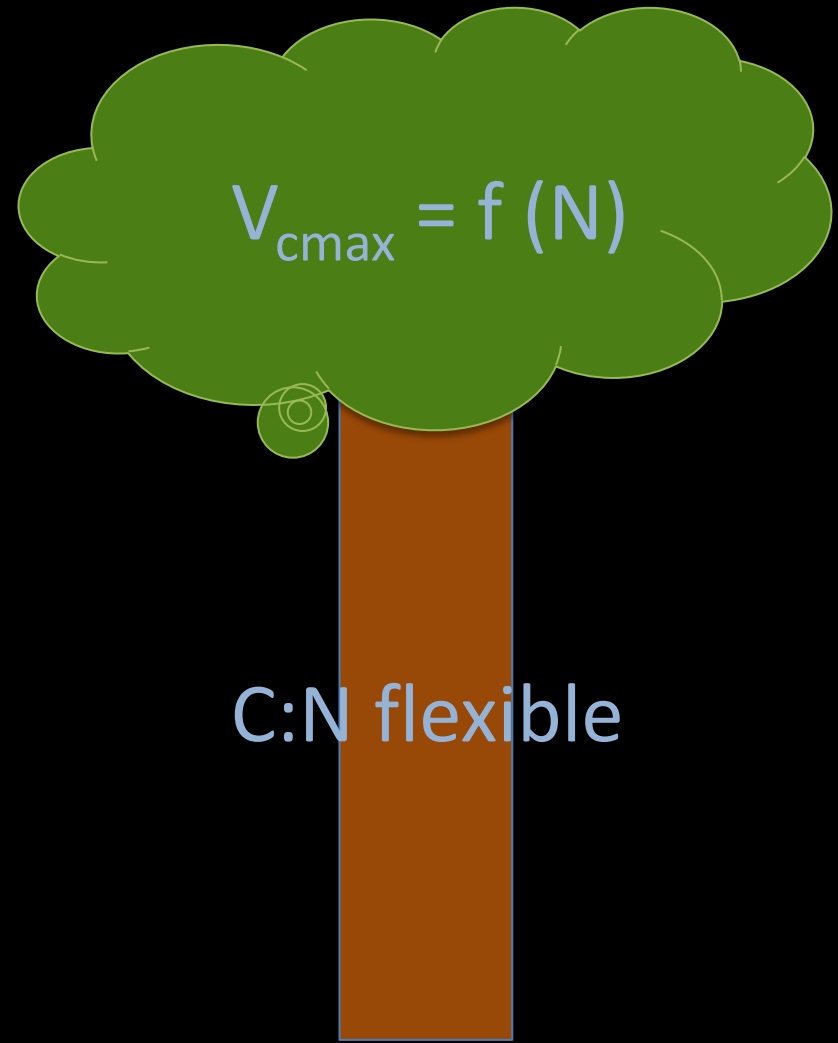
- ① Crops & Fertilizer
- ② LBL
  - Removes GPP down-regulation
- ③ LANL
  - Foliar N allocation
- ④ JPL (FUN)
  - C cost of N uptake

# CLM4.5



$$U_N = f(GPP, C:N, N_{soil})$$

# CLM4.5-LBLmod



$$U_N = f(\text{Root}, C:N, N_{soil})$$

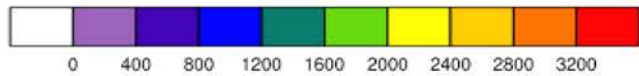
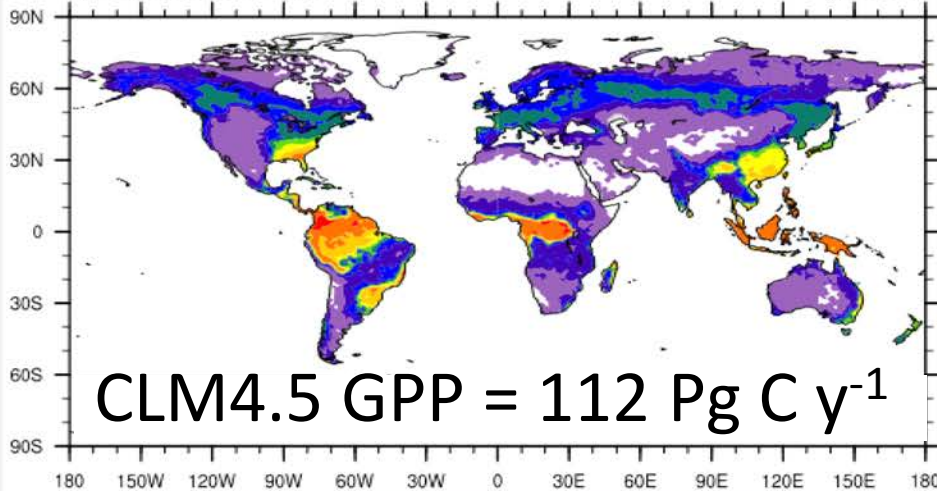


# CLM4.5

# CLM4.5-LBLmod

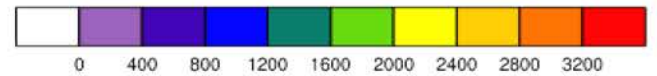
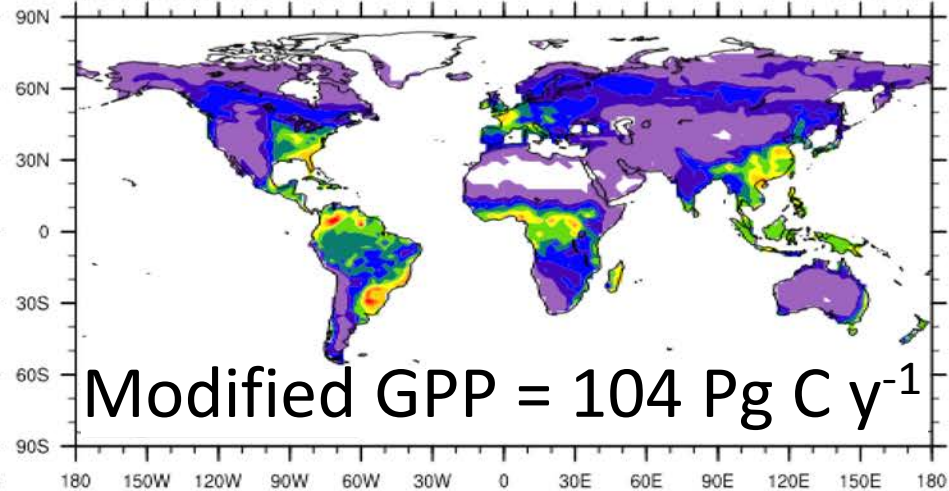
gross primary production

gC/m<sup>2</sup>/y



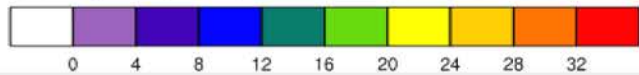
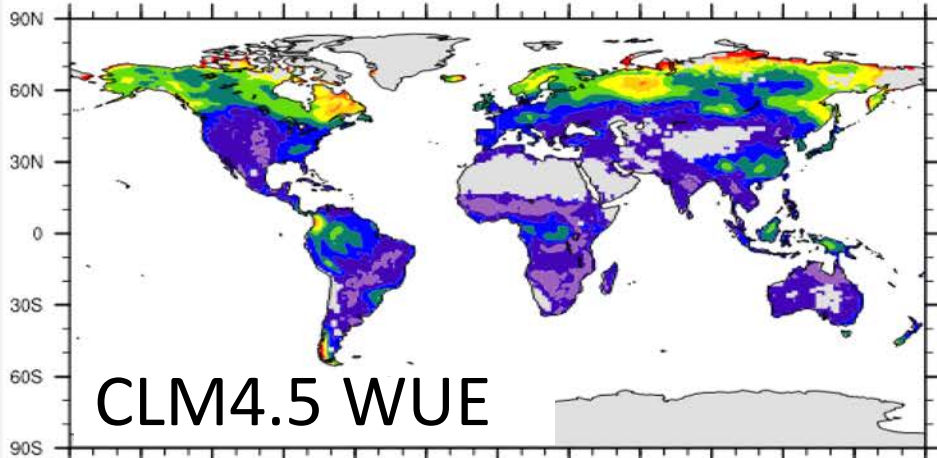
gross primary production

gC/m<sup>2</sup>/y



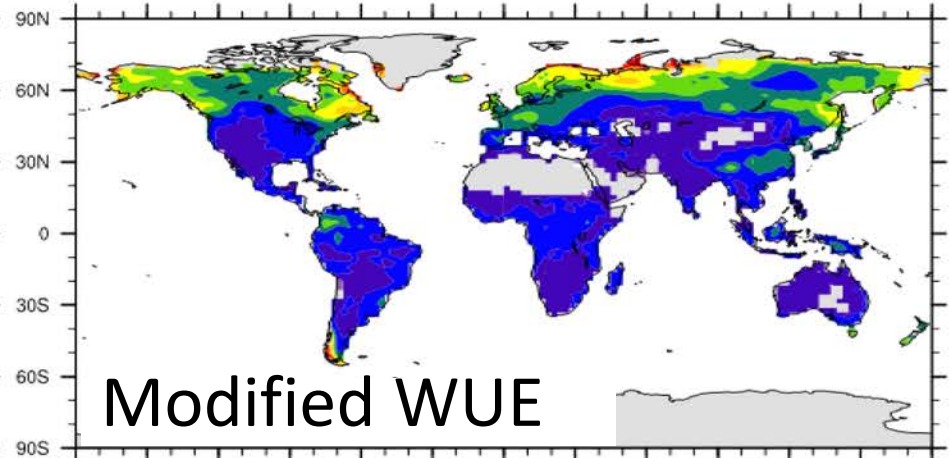
Water Use Efficiency

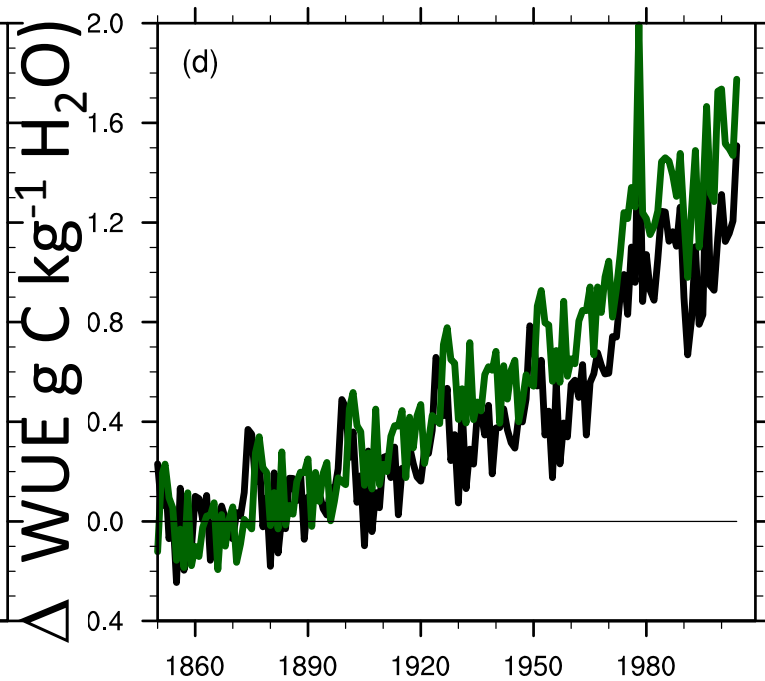
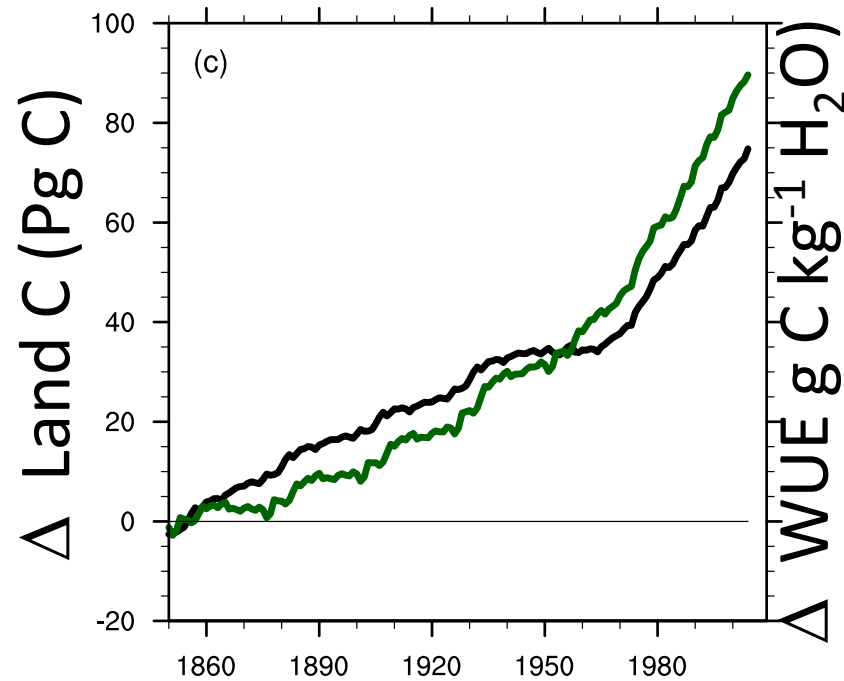
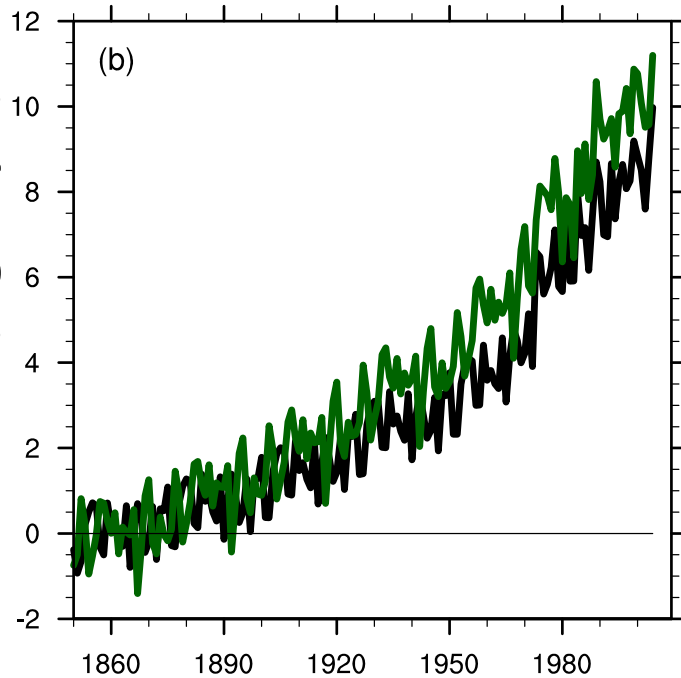
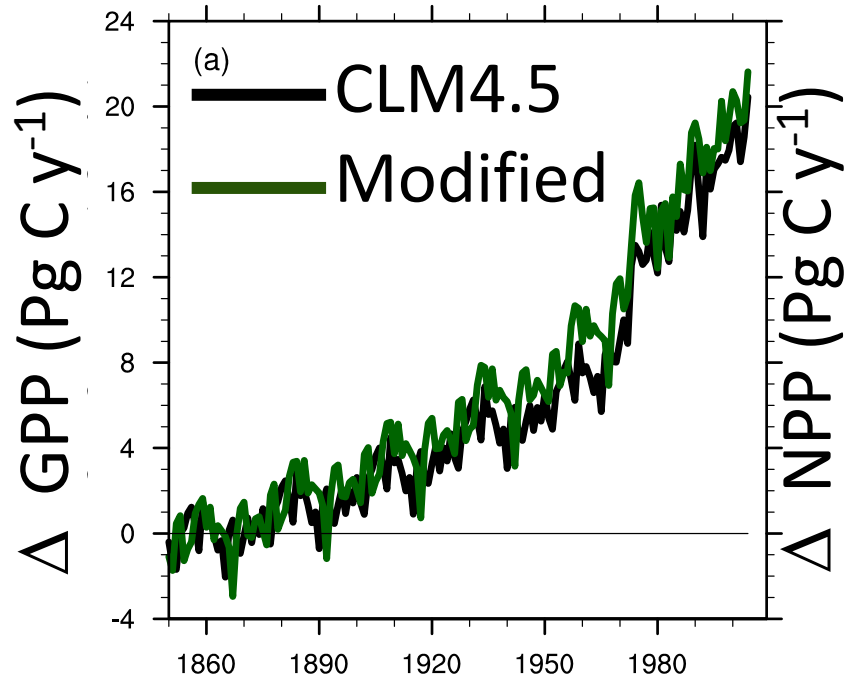
g C/kg H<sub>2</sub>O



Water Use Efficiency

g C/kg H<sub>2</sub>O







# Evaluation Metrics

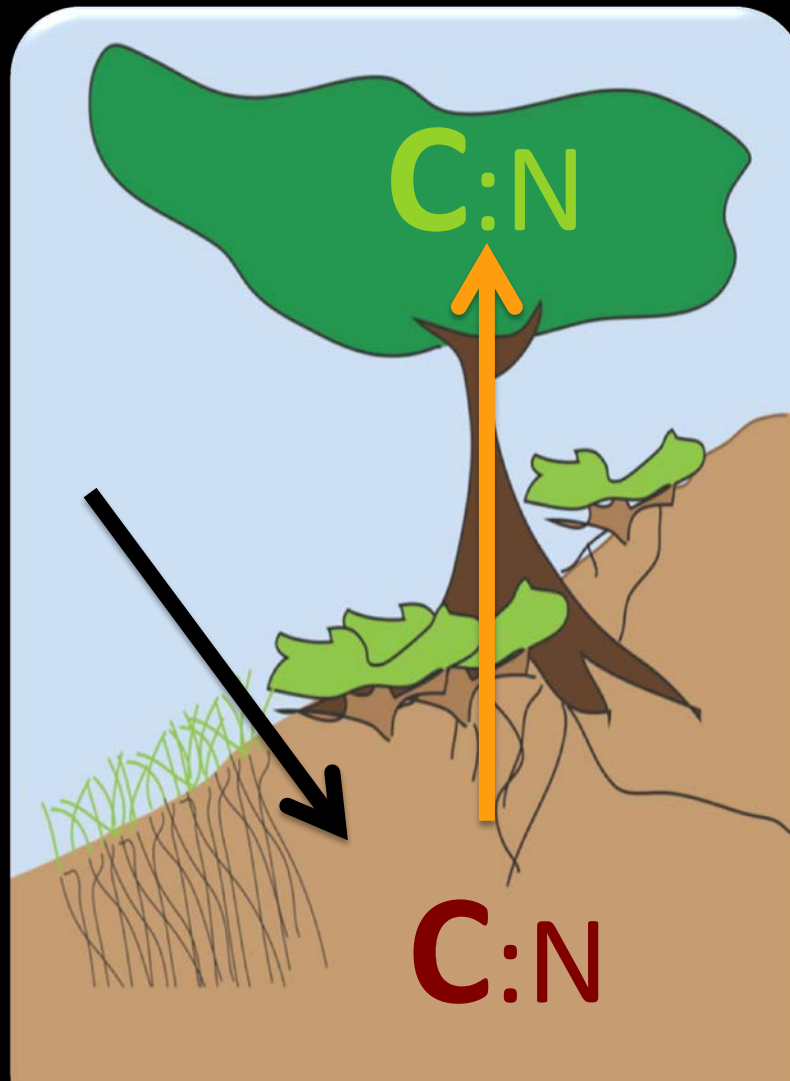
iLAMB Diagnostics: Other Experiments:

- ✓ GPP
- ✓ LAI
- ✓ WUE
- Veg Pools
- Soil Pools
- NEE
- ? Historical Land Sink
- ? Annual C cycle

*Global & Single Point*

- FACE
- N fertilization
- Others?

*Before October!?*



New N

$\Delta$  Soil C:N

Redistribution

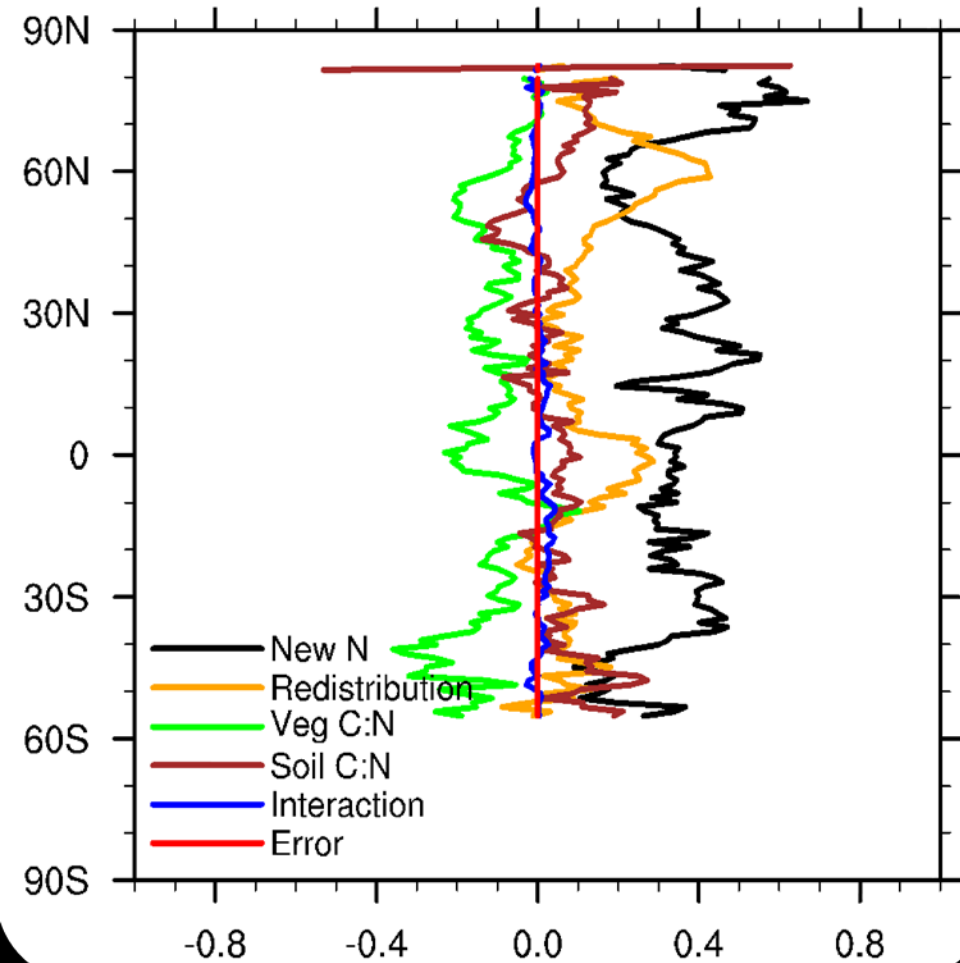
Interactions

$\Delta$  Veg C:N

Error



# CLM4.5 Full Transient



New N

Redistribution

$\Delta$  Veg C:N

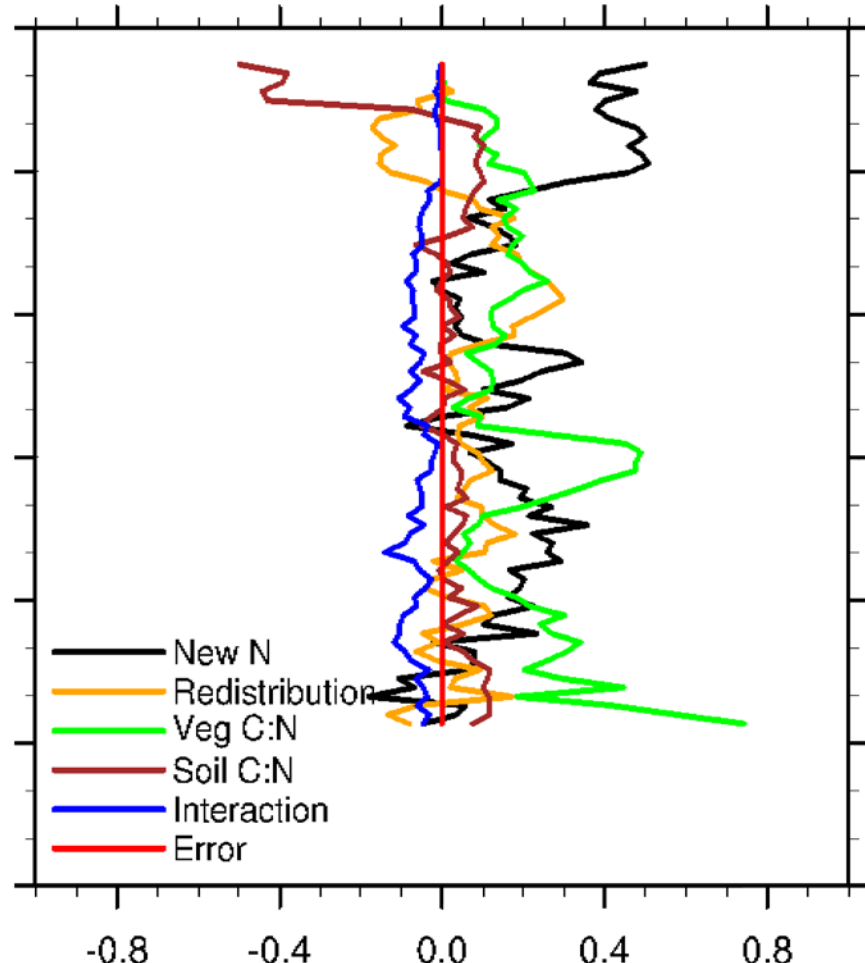
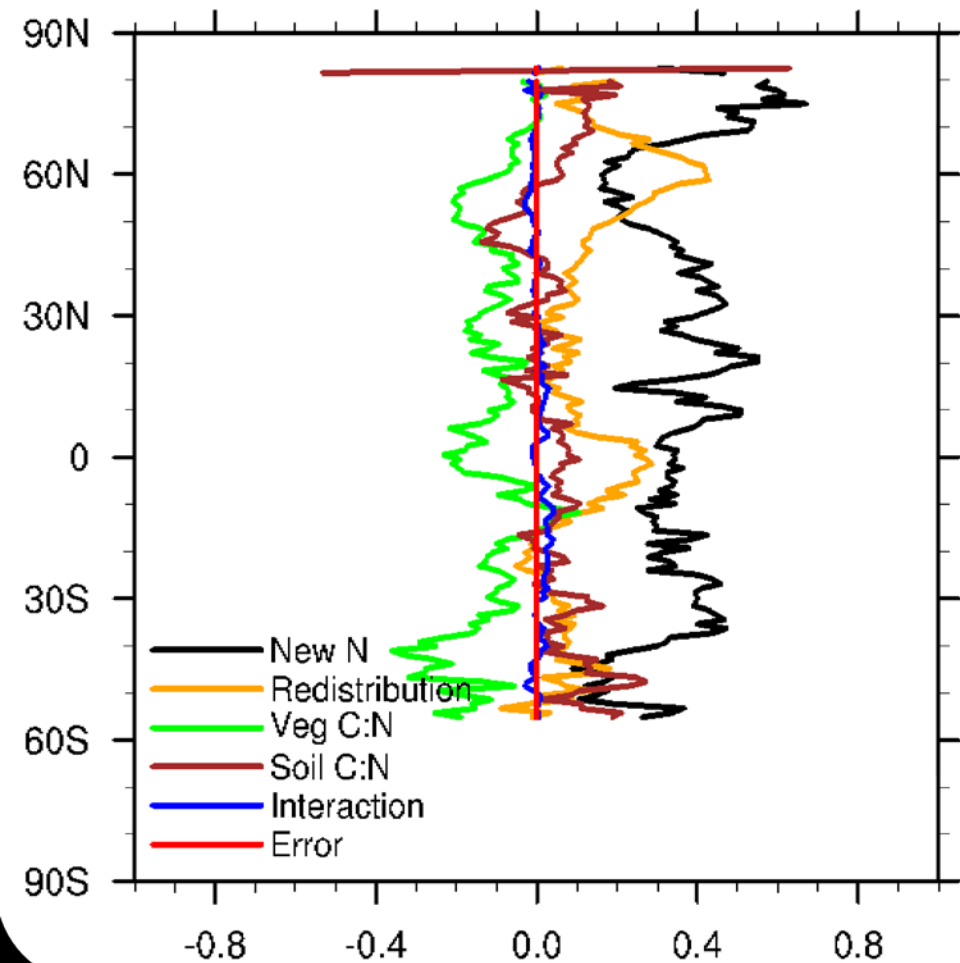
$\Delta$  Soil C:N

Interactions

Error

# CLM4.5 Full Transient

# Modified (LBL)



New N

Redistribution

$\Delta$  Veg C:N

$\Delta$  Soil C:N

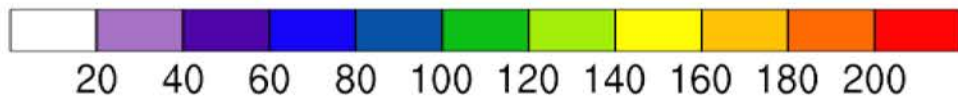
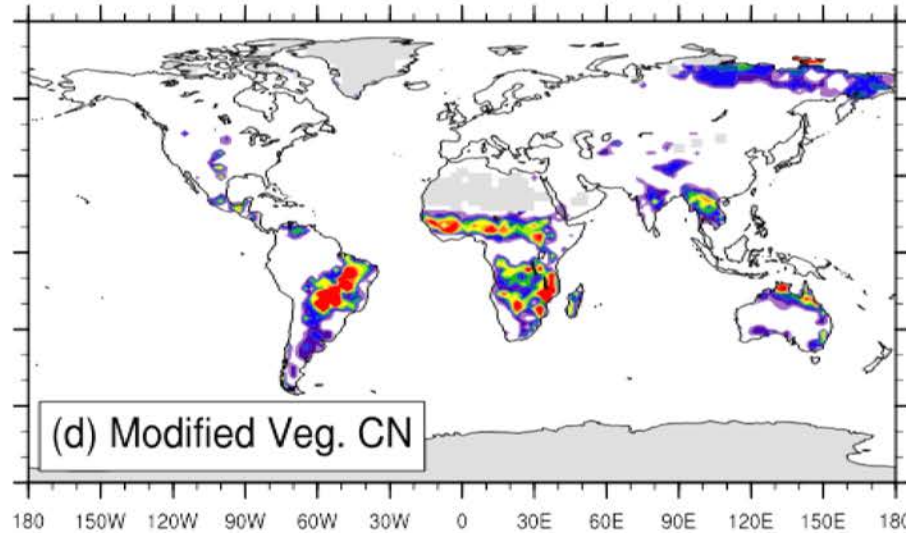
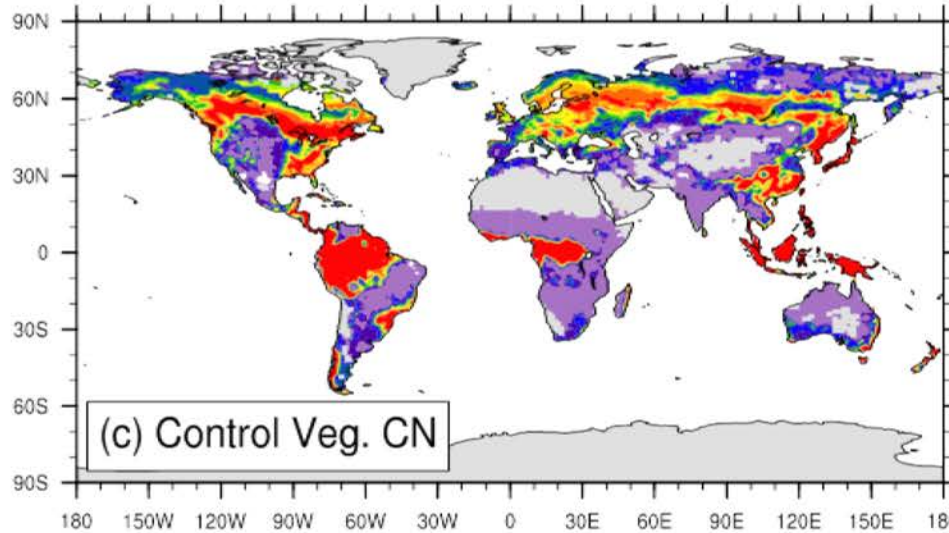
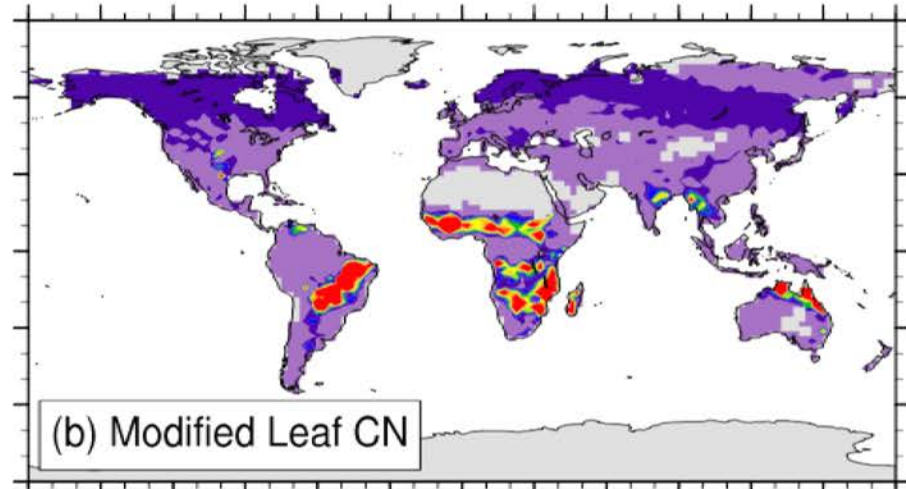
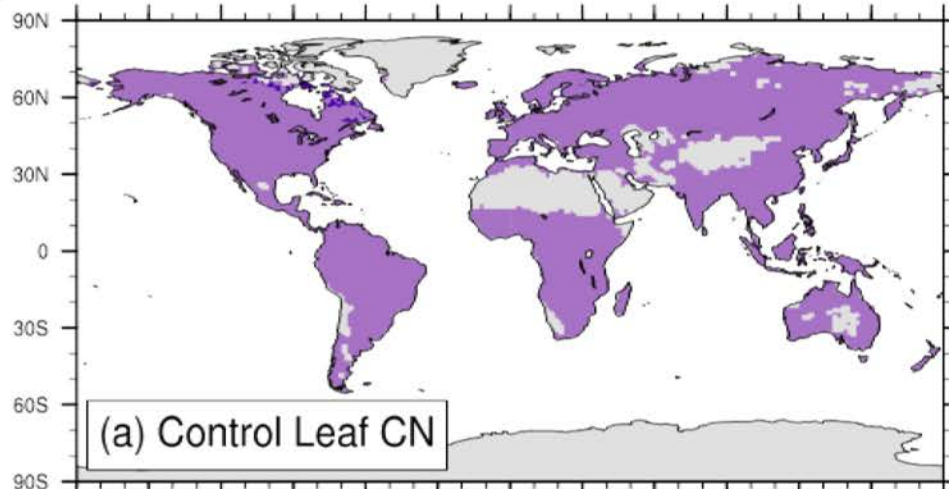
Interactions

Error

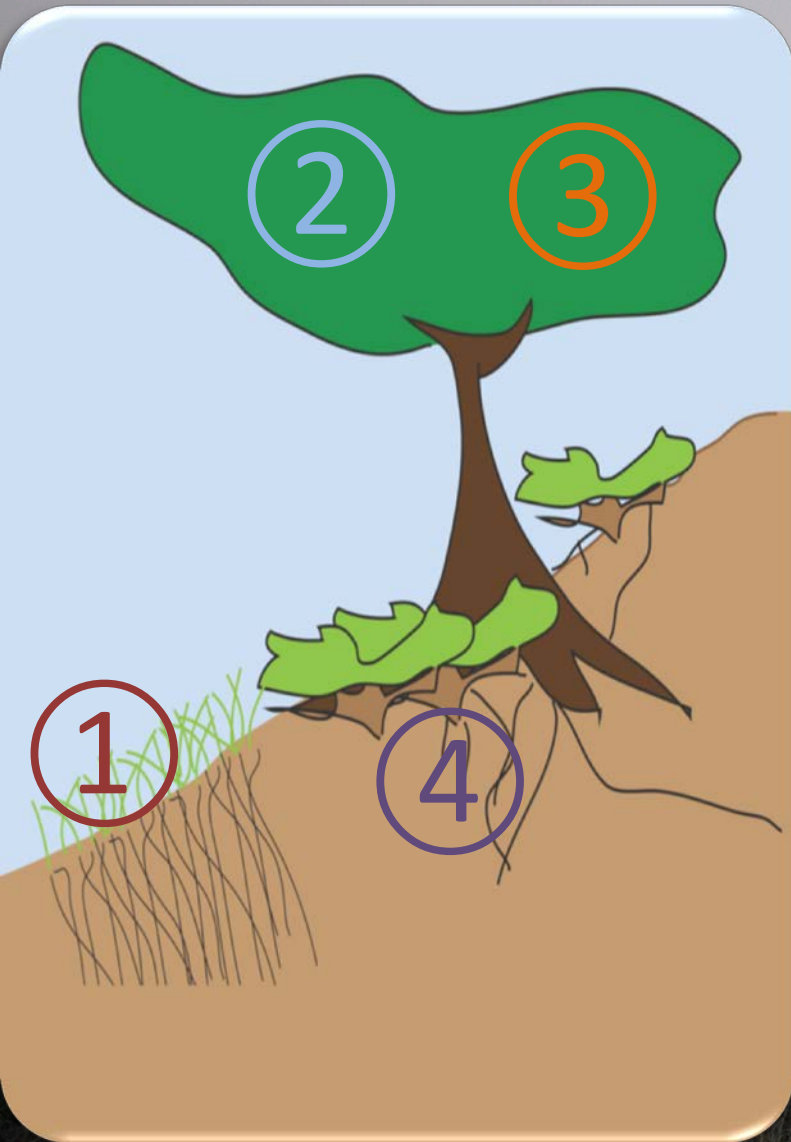


# CLM4.5

# CLM4.5-mod



# New in CLM5.0\*



- ① Crops & Fertilizer
- ② LBL
  - Removes GPP down-regulation
- ③ LANL
  - Foliar N allocation
- ④ JPL (FUN)
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# LANL leaf N allocation model

Predicts:

$J_{\max 25}$  [electron transport rate], &  
 $V_{c, \max 25}$  [carboxylation rate]

**\*Acclimation to  $e[\text{CO}_2]$ , warming, light**

N for light capture ( $PN_{chl}$ )	N for electron transport ( $1 - PN_{chl}$ )		
N for light harvesting ( $PN_{lh}$ )	N for carboxylation ( $1 - PN_{lh}$ )		
Photosynthetic nitrogen ( $PN_p$ )		Respiratory nitrogen ( $1 - PN_p$ )	
Growth nitrogen ( $PN_g$ )			Storage nitrogen ( $1 - PN_g$ )
Functional nitrogen			
			Structural nitrogen

Xu et al. 2012. Plos One, 7: e37914; Ali et al In Review.

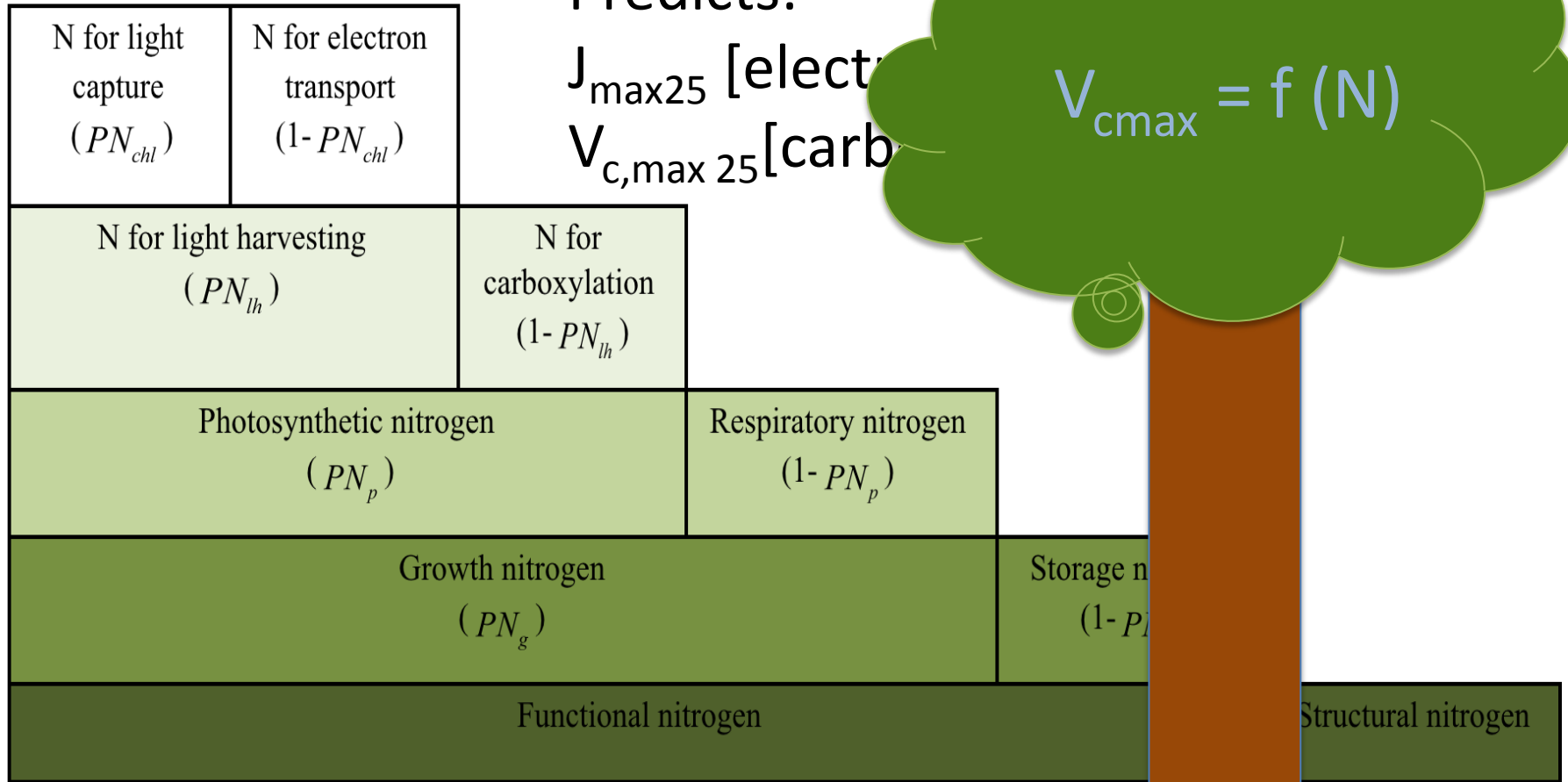
# LANL & LBNL Modifications

Predicts:

$J_{\max 25}$  [electrons]

$V_{c,\max 25}$  [carb]

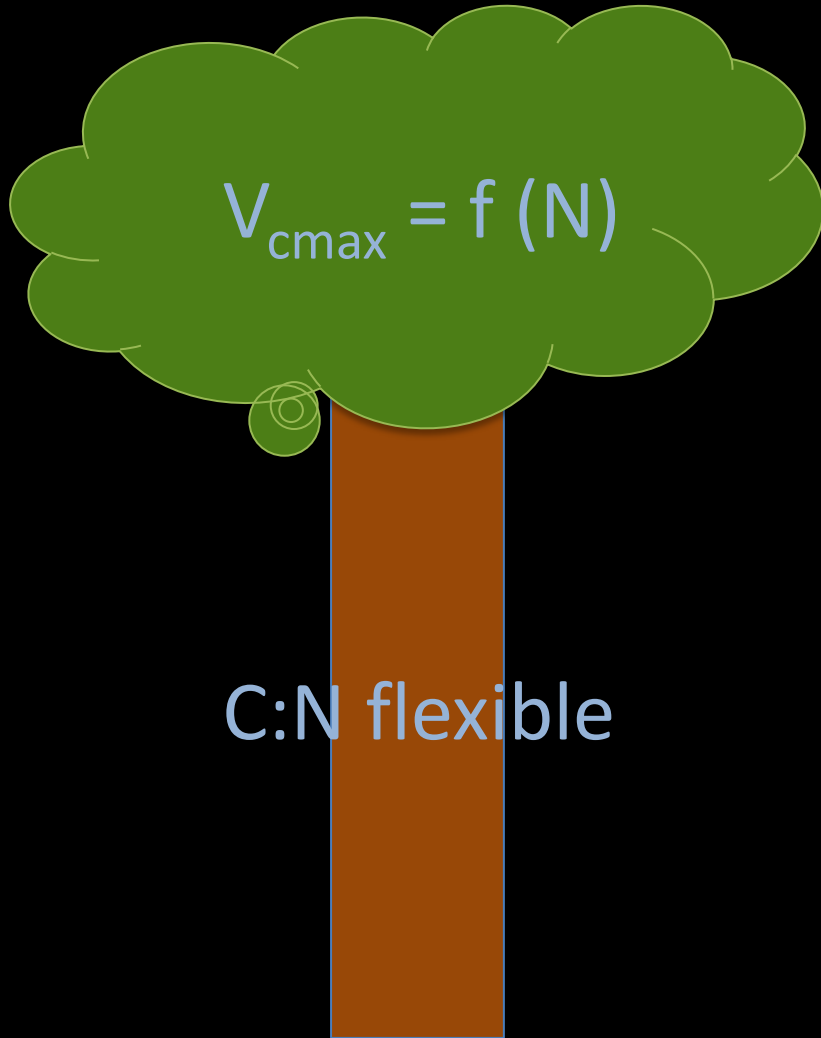
$$V_{c,\max} = f(N)$$



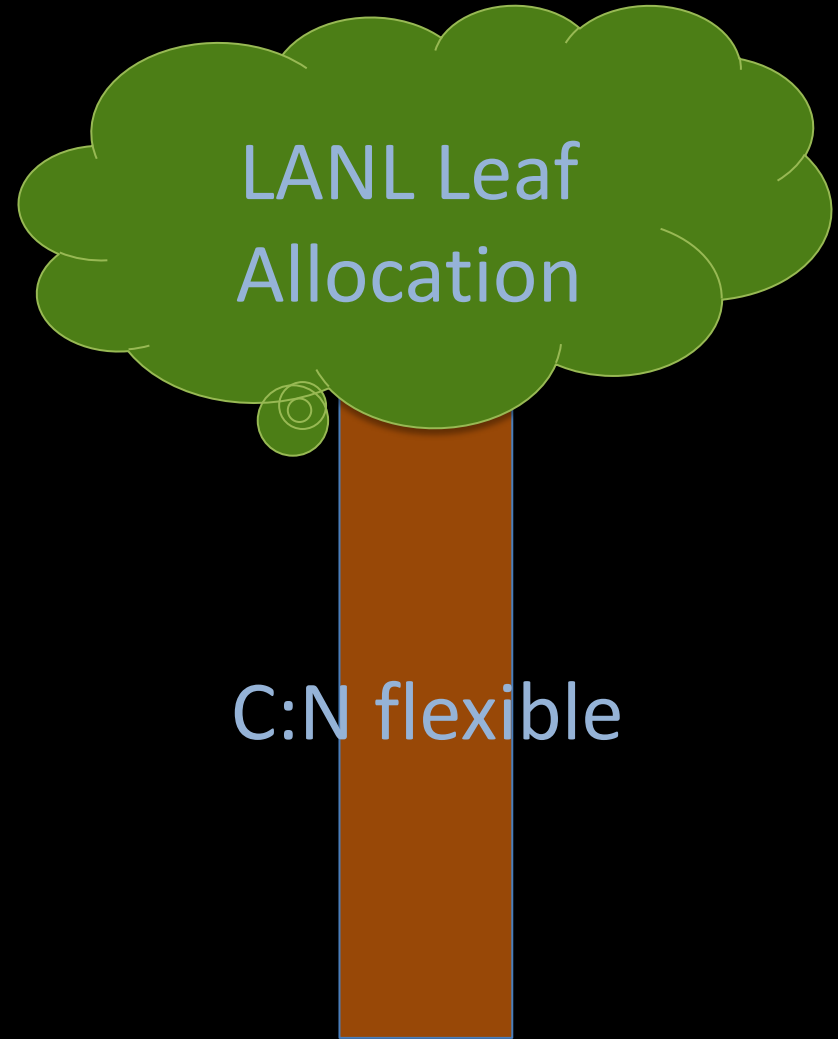
Xu et al. 2012. Plos One, 7: e34811. Li et al In Review.



# CLM5.0 Modifications



$$U_N = f(\text{Root}, \text{C:N}, N_{\text{soil}})$$



FUN Uptake

# Additionally...

- ① N inputs ( $\text{NH}_4^+$ ,  $\text{NO}_3^-$ )
- ② Free-living N fixation
- ③ Crop N fixation (soy)

- ④ FUN + dynamic roots (Beth's changes)
- ⑤ Soil C & FUN





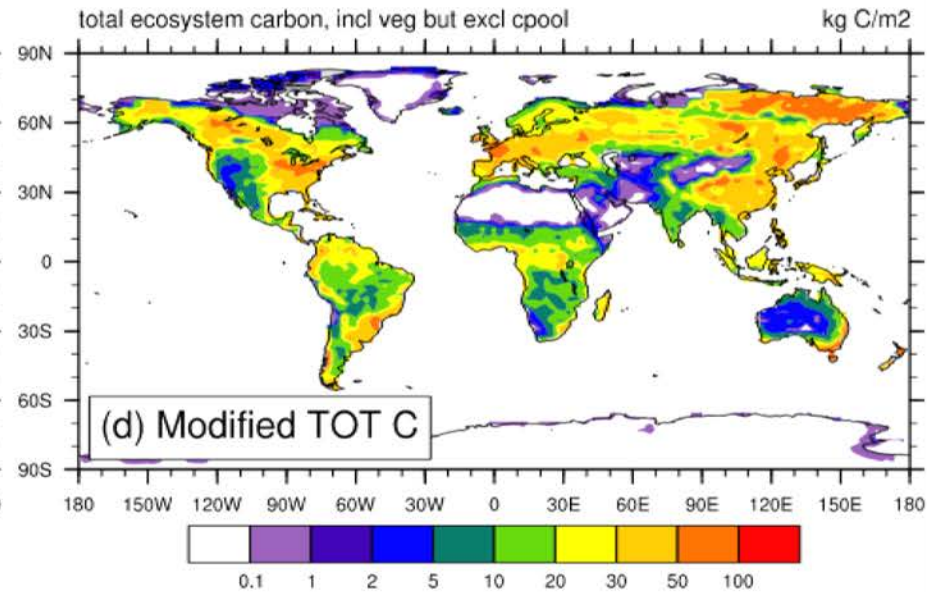
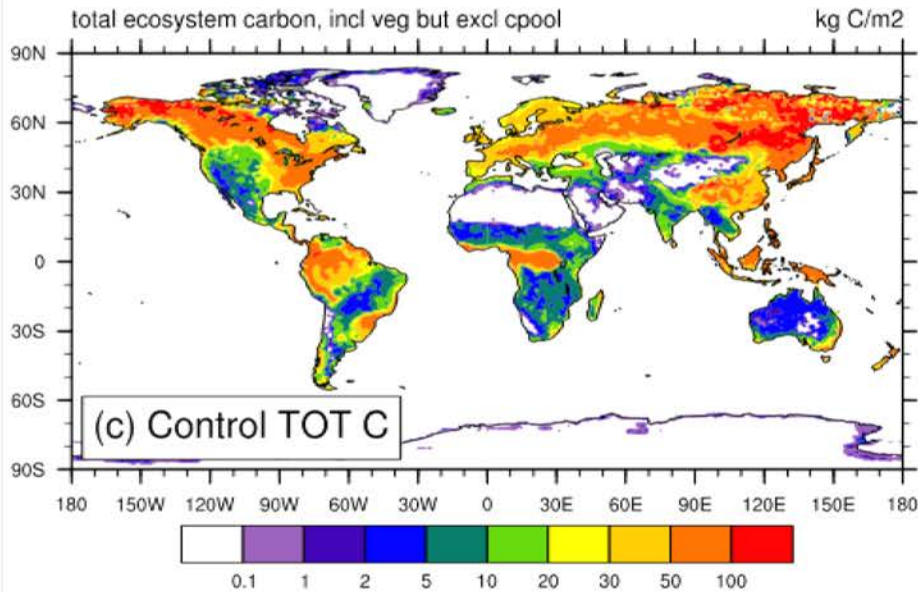
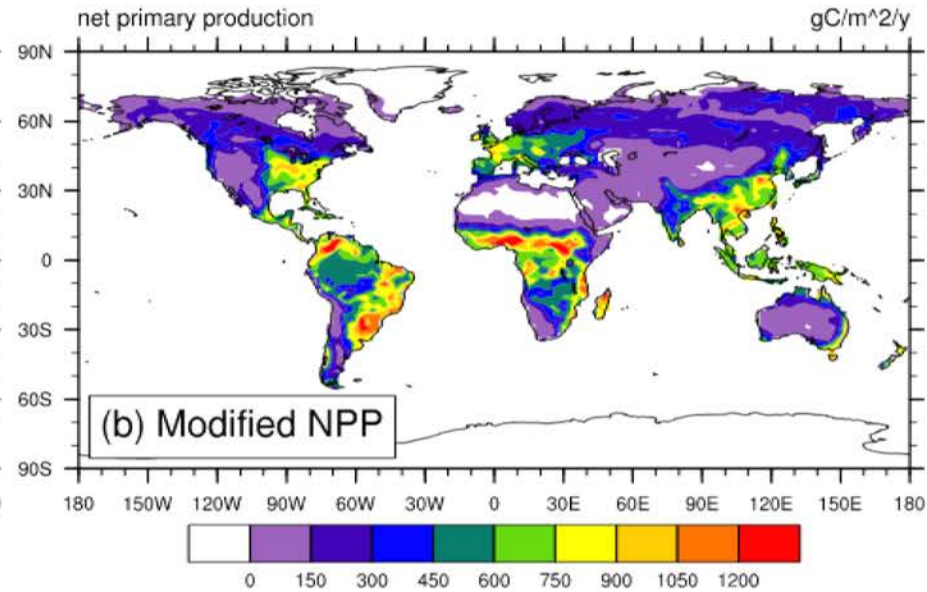
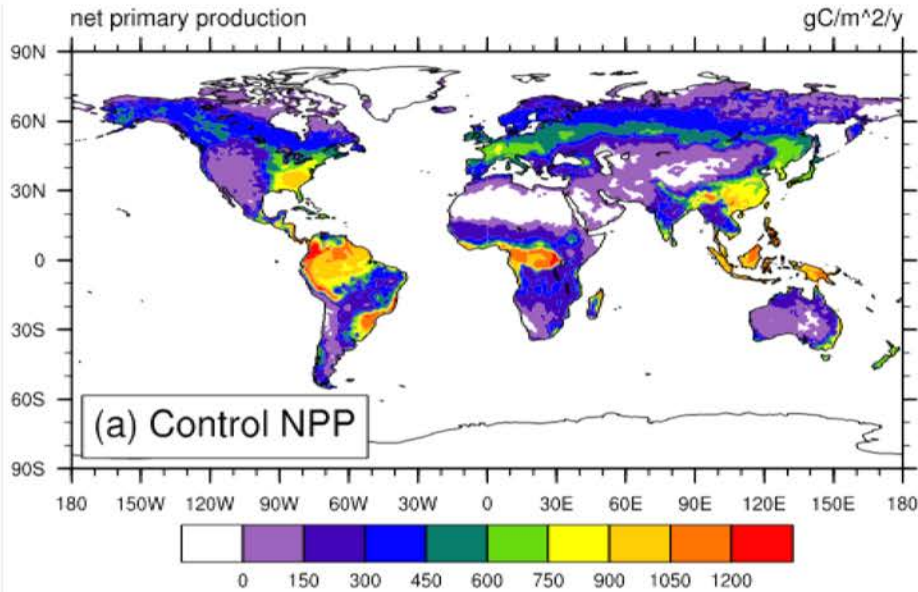
# LARGER Considerations (CLM5.5)

- ⑥ Manure &  $\text{NH}_3$   
(Hess, Cornell)
- ⑦  $\text{N}_2\text{O}$  &  $\text{NO}$  losses  
(Saikawa, Emory)
- ⑧ Leaching losses  
(Nevison, CU)
- ⑨ DON Losses  
(?)

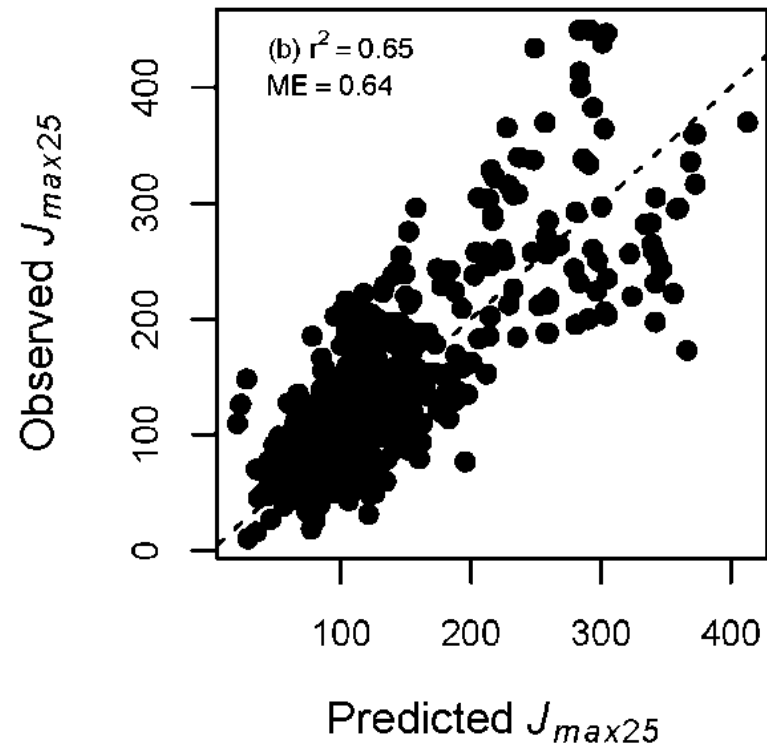
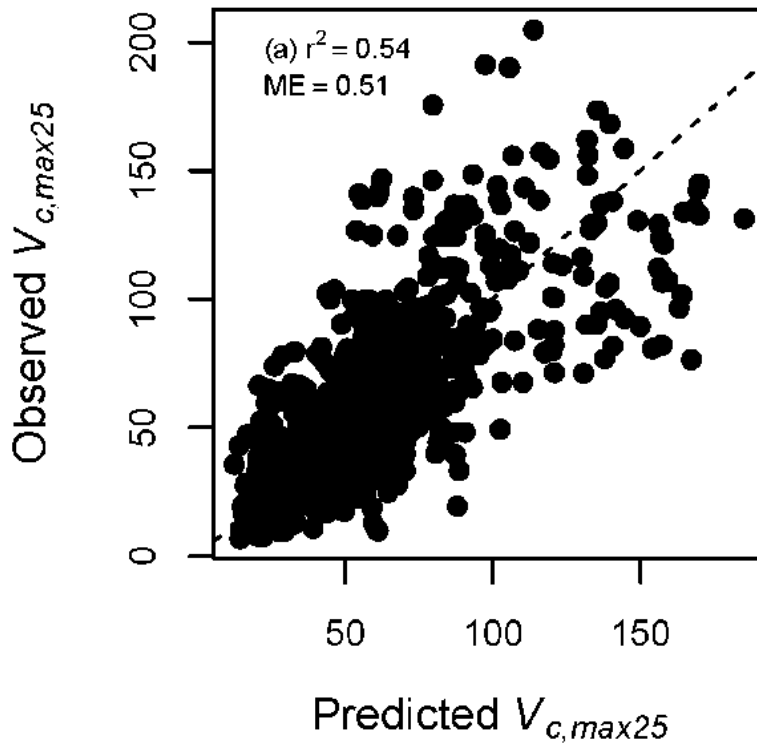




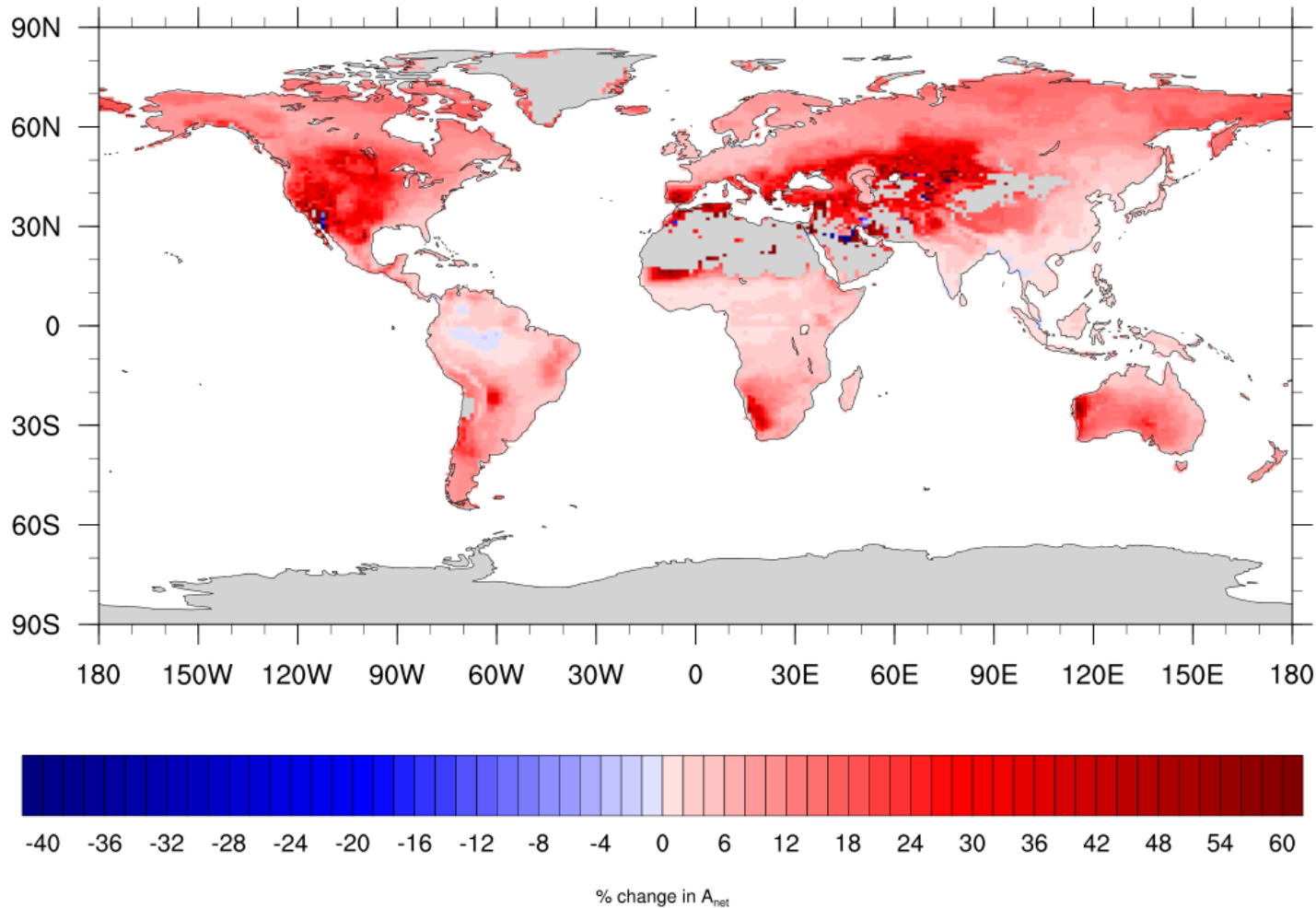
# 1850 Qian Forcing



# Nitrogen allocation model fitting using differential evolution adaptive metropolis (DREAM)



# Potential impact on future net photosynthesis on the top leaf layer



Global overestimation of  $A_{net}$  at the top canopy layer for about **9.4%**.

Percentage change of  $A_{net}$  by using  $V_{cmax25}$  and  $J_{max25}$  as it is in the past compared to that predicted by our model using future climate conditions under RCP 8.5