

# Nitrogen cycle in CLM5

*“If your main thought of nitrogen is as a boring corner of the periodic table, then it is time to look again.”*

Nitrogen and Climate Change: An Explosive Story

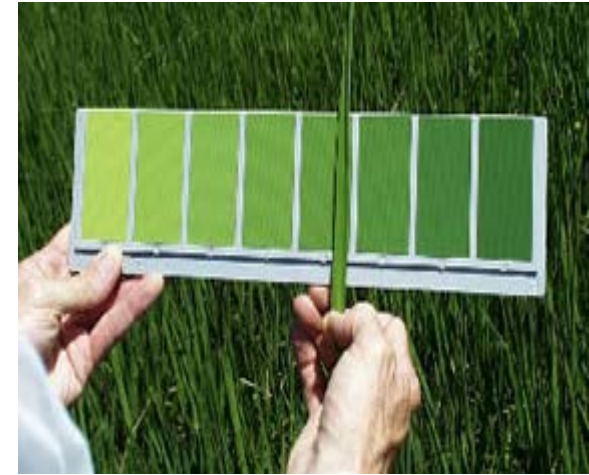
-Dave Reay



**Will Wieder, Rosie Fisher, Dave Lawrence,  
Erik Kluzek, Ben Andre & MANY, MANY more**

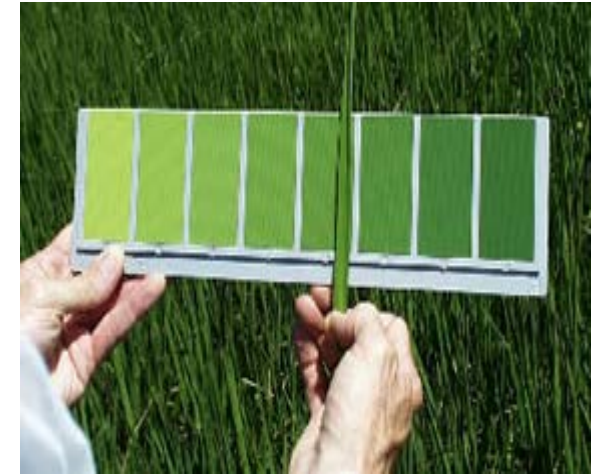
# N Assumptions in CLM4.0 & 4.5

1. Leaf nitrogen content is static & unrelated to stomatal conductance



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1. Photosynthetic capacity does not respond to the environment



# N Assumptions in CLM4.0 & 4.5

1. Leaf nitrogen content is static & unrelated to stomatal conductance



1. Photosynthetic capacity does not respond to the environment



1. Plants get nitrogen for free



# N Assumptions in CLM5.0

1. Leaf nitrogen content is dynamic & related to stomatal conductance



1. Photosynthetic capacity does respond to the environment



1. Plants pay C to get N

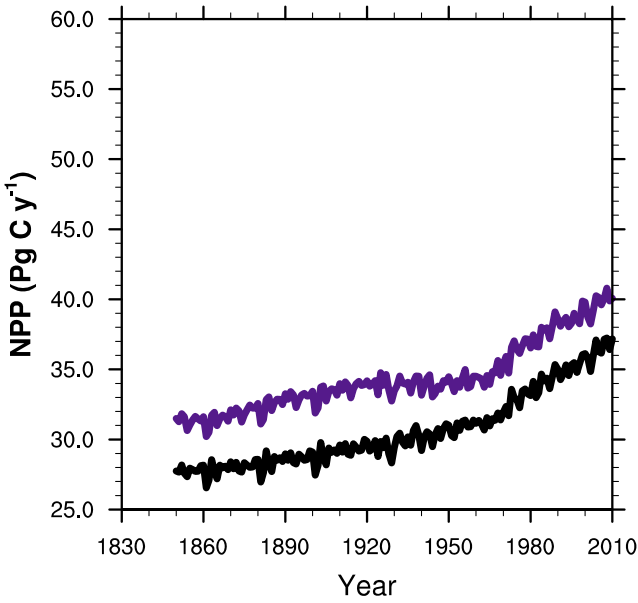
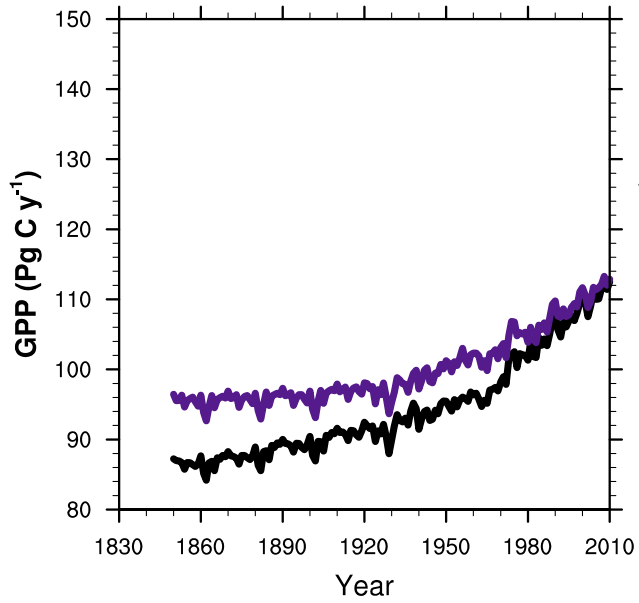


CLM5 Historical  
1850-2010, GSWP3  
+ FlexCN & LUNA

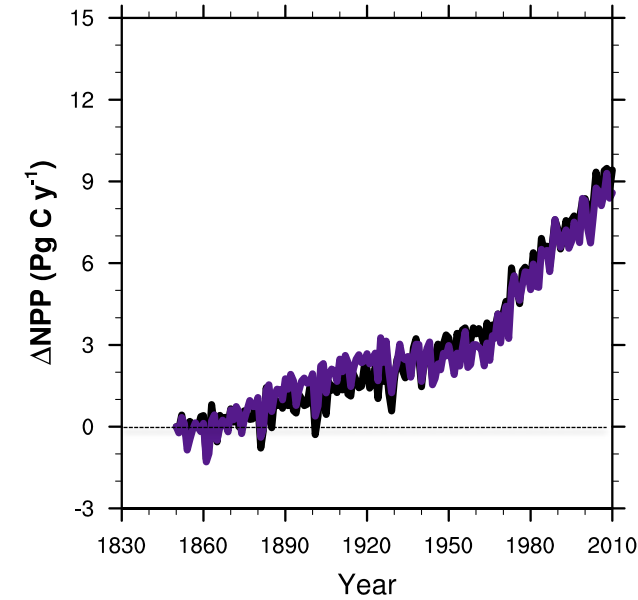
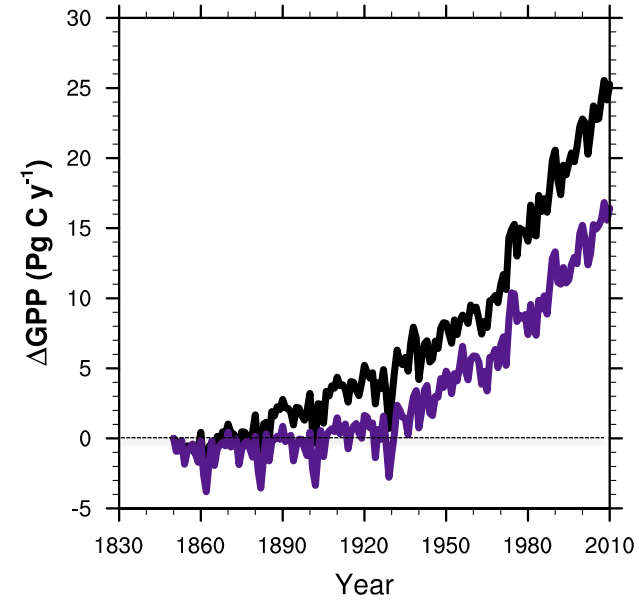
**CLM4.5N**

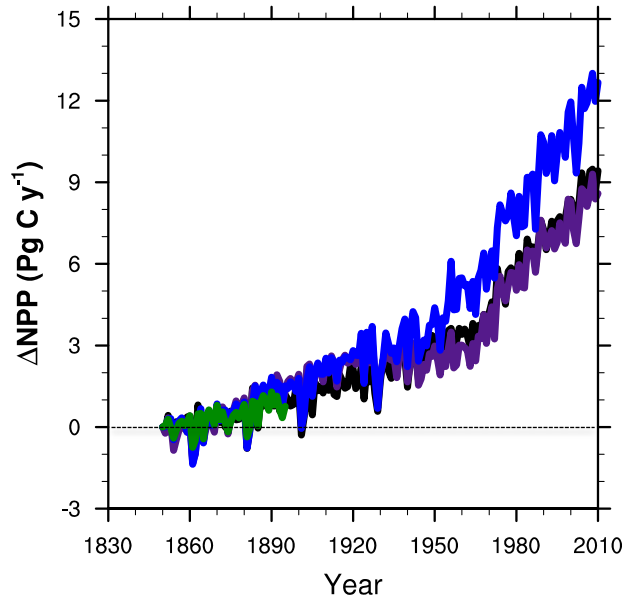
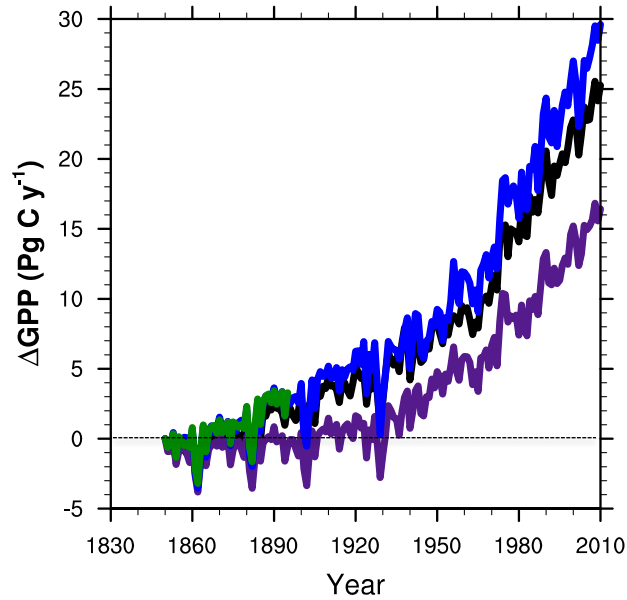
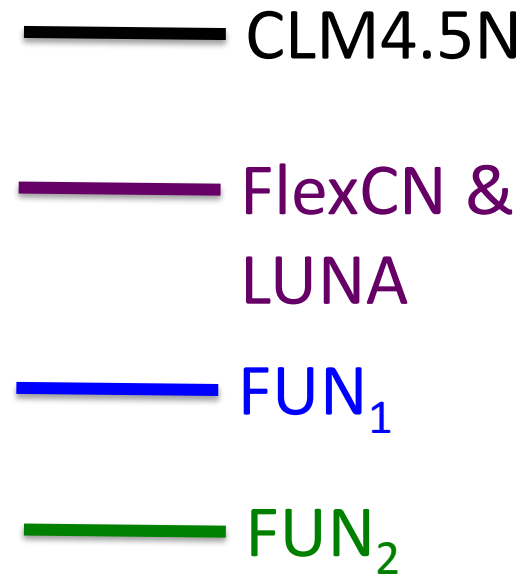
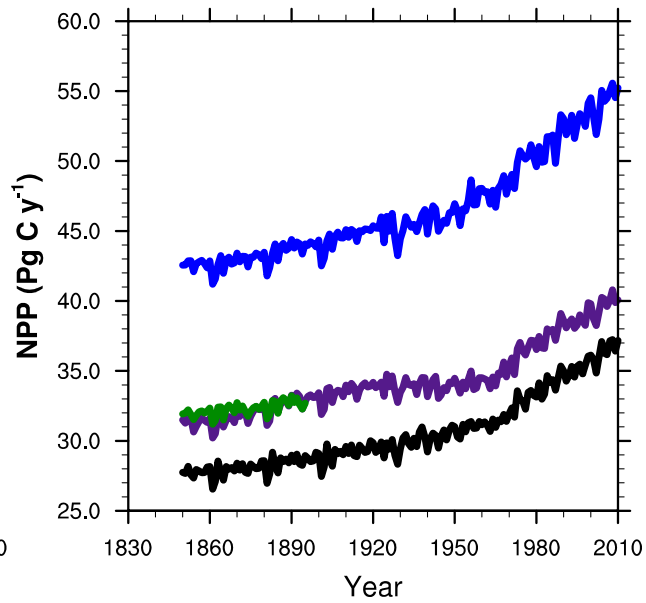
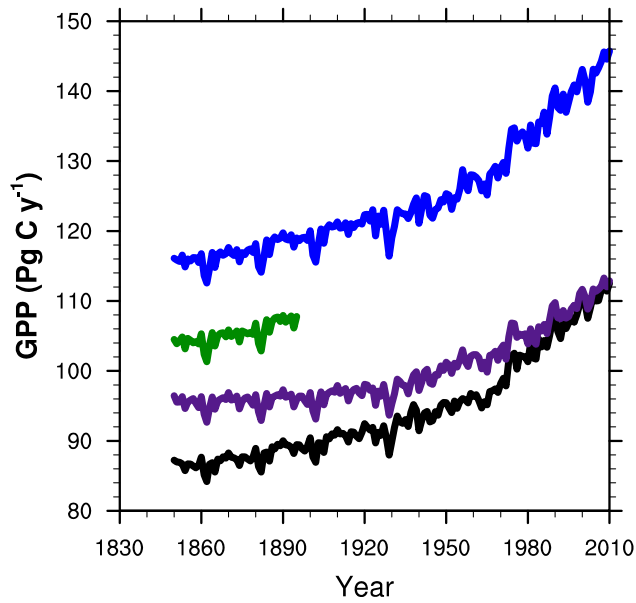
**+ FUN**





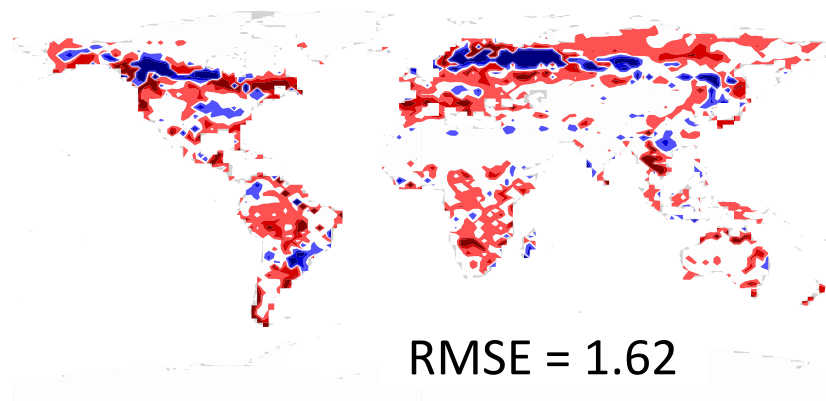
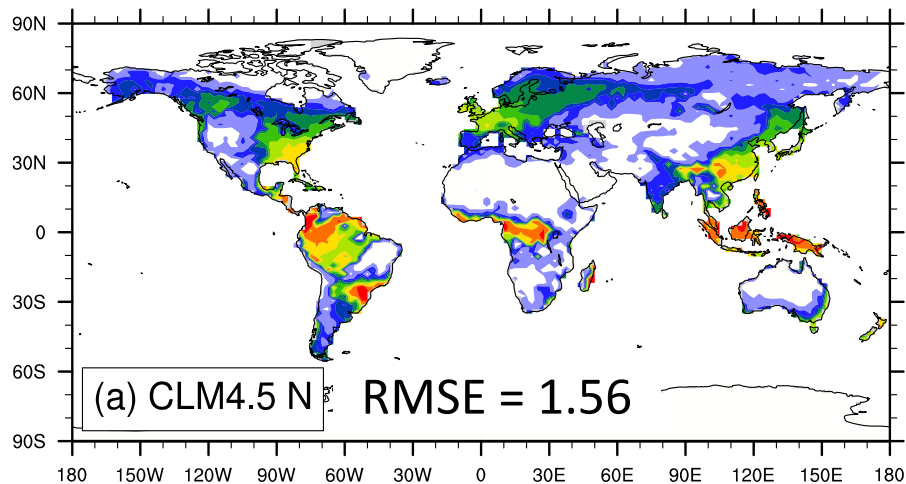
— CLM4.5N  
— FlexCN & LUNA



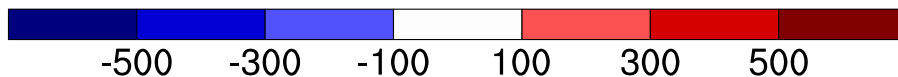
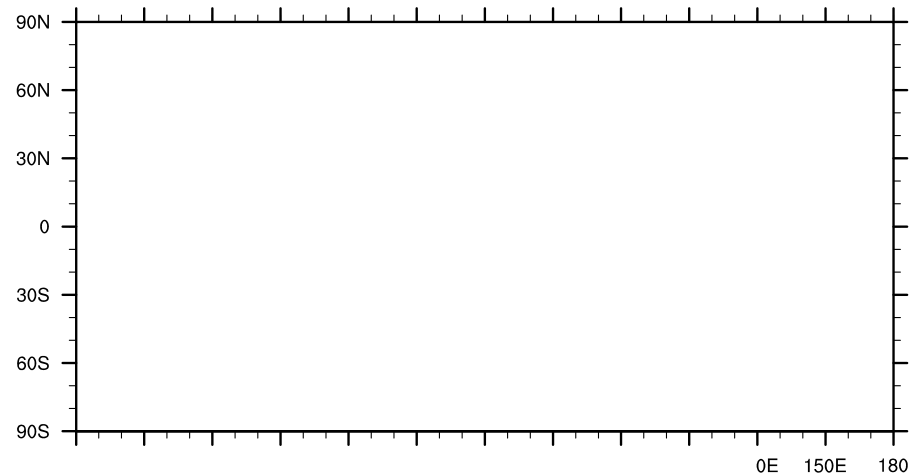


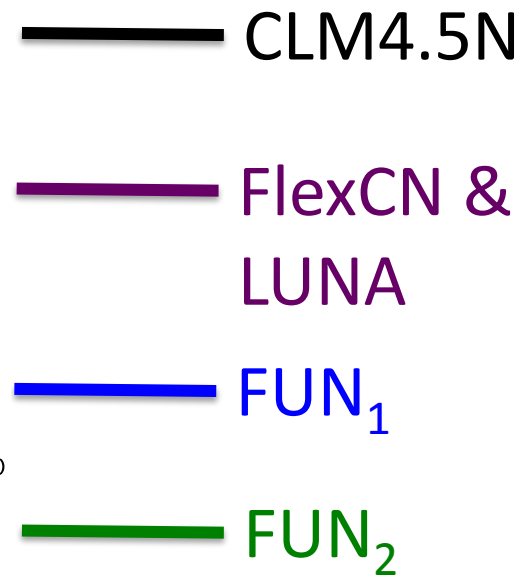
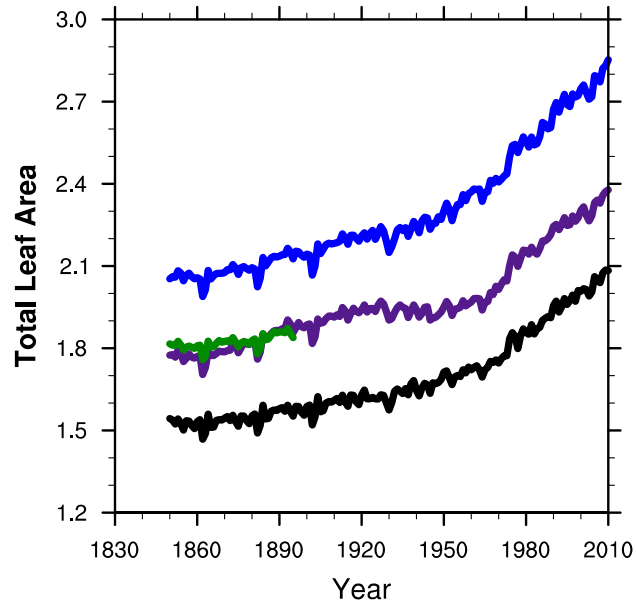
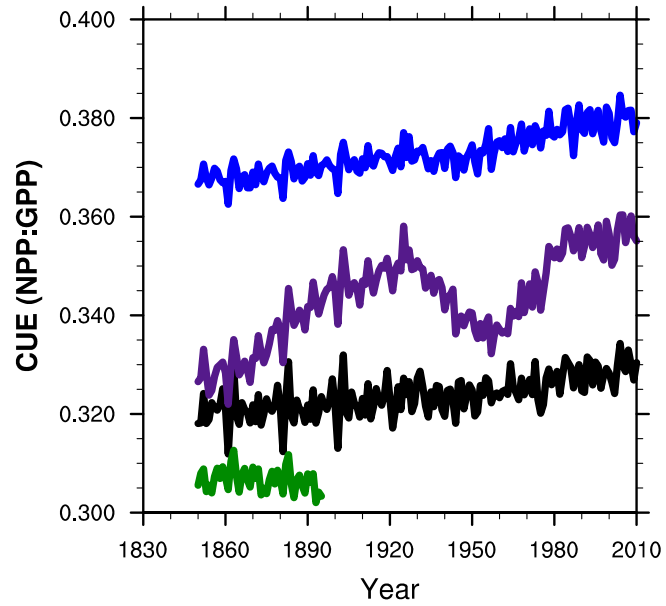


# Initial GPP ( $\text{gC m}^{-2} \text{y}^{-1}$ )

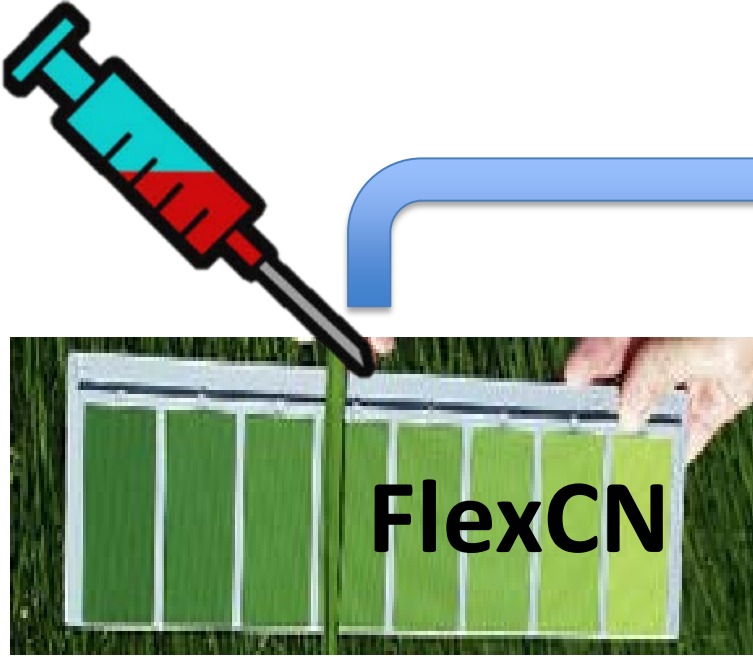


RMSE = 1.72





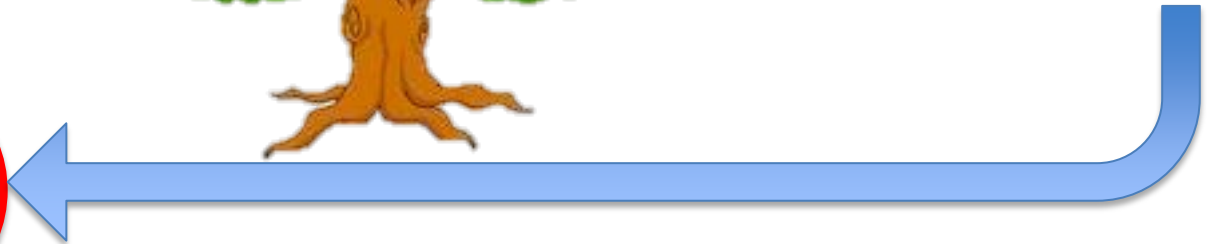
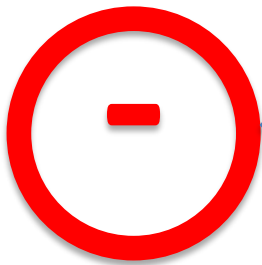
# Excess C

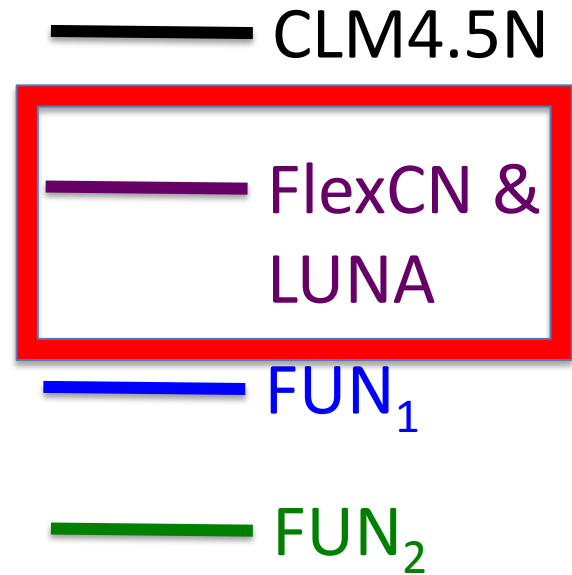
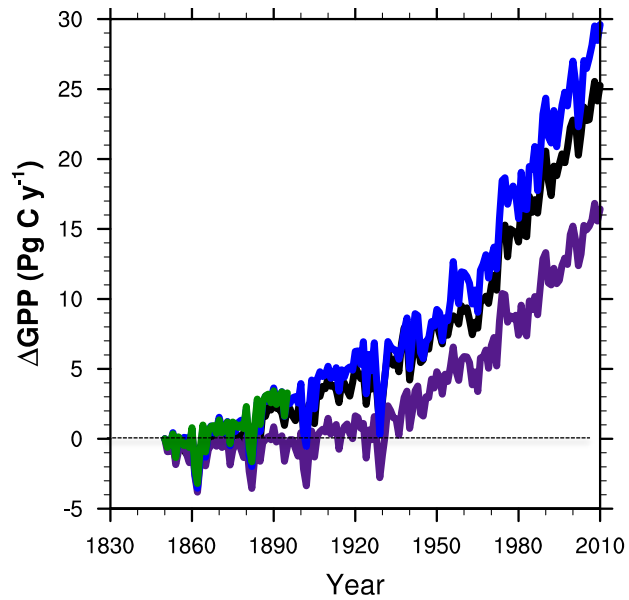
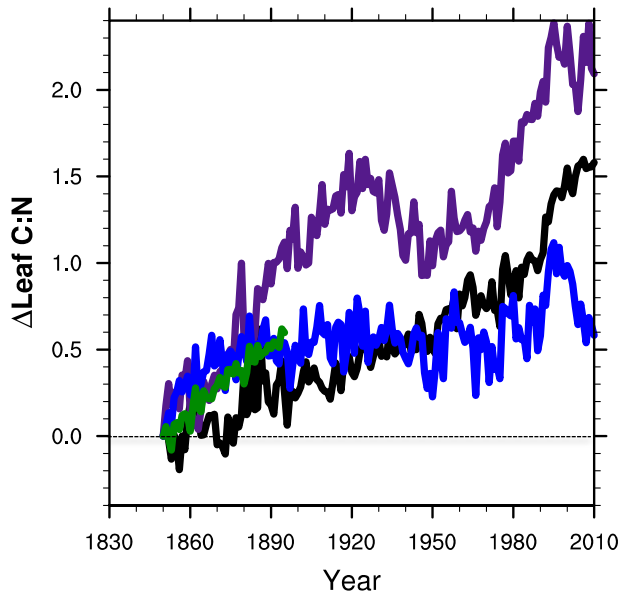


↑ C:N

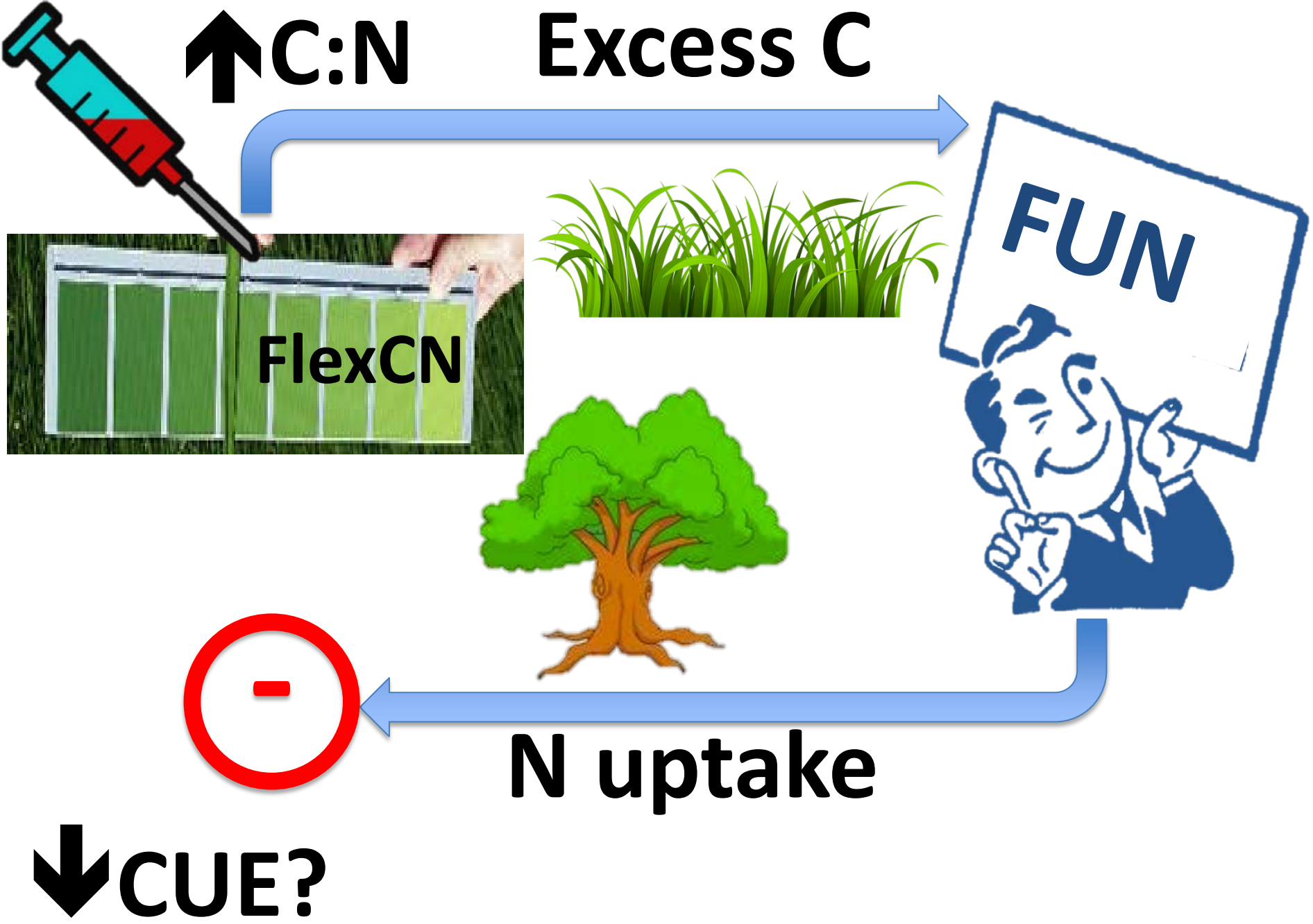
↓ GPP

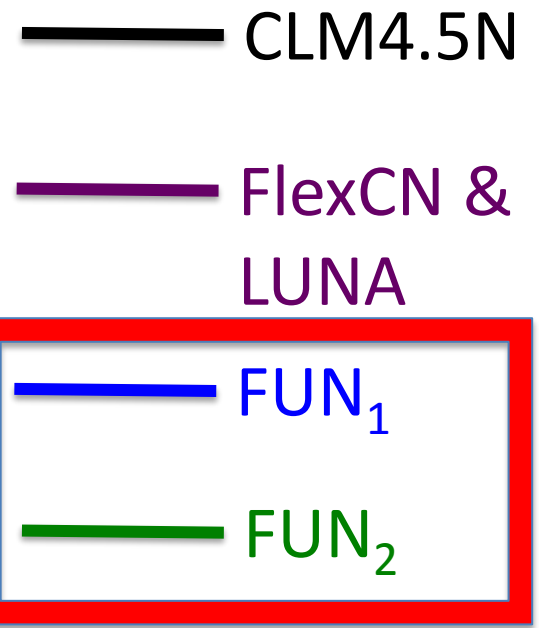
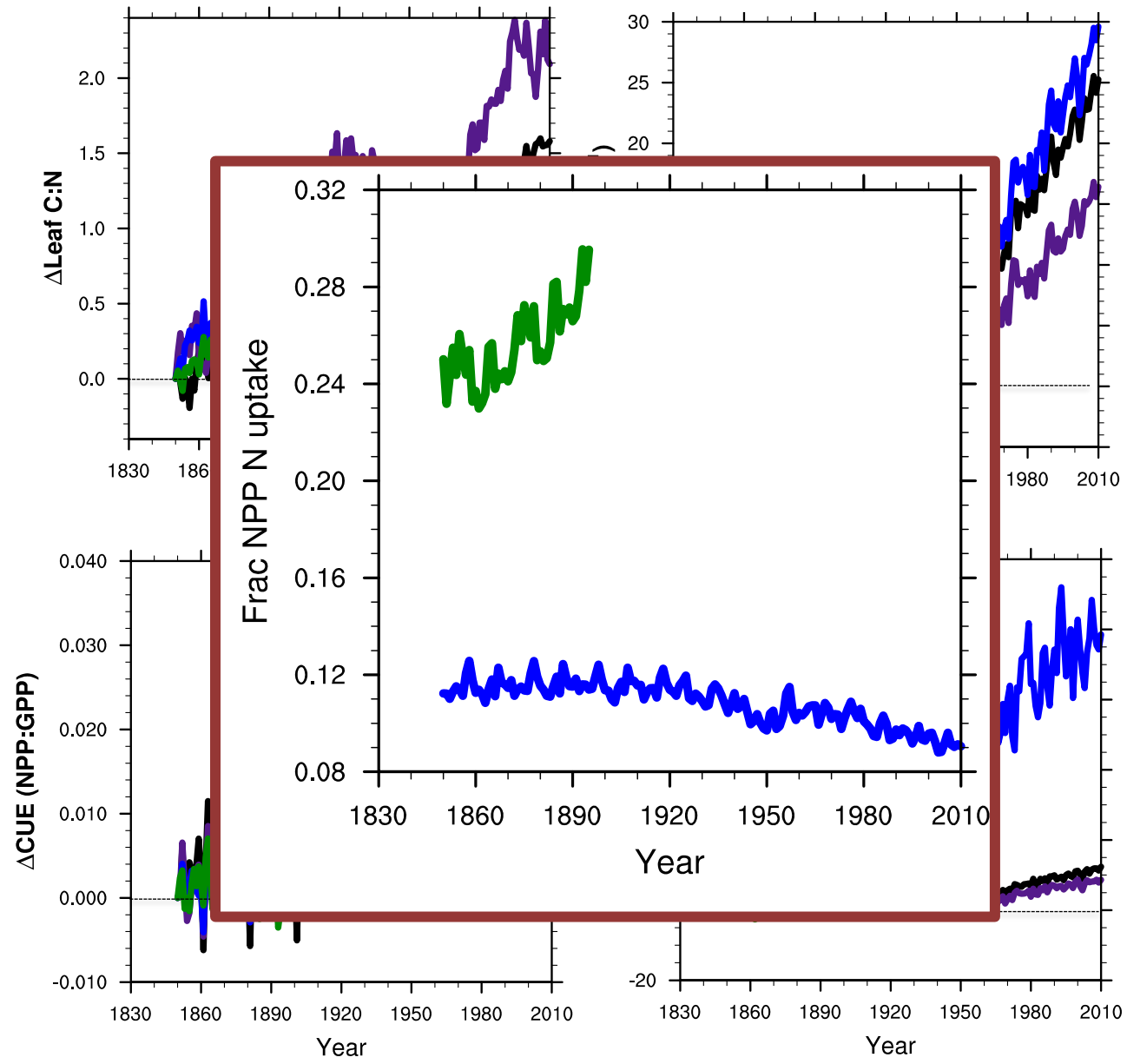
↓ CUE?





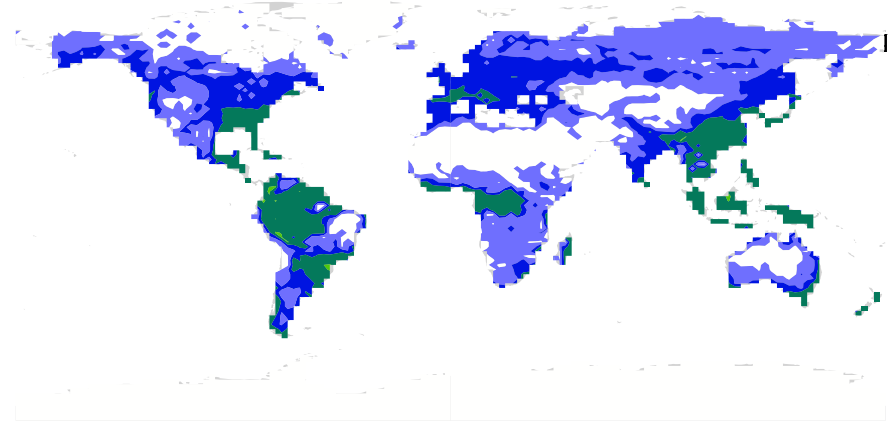
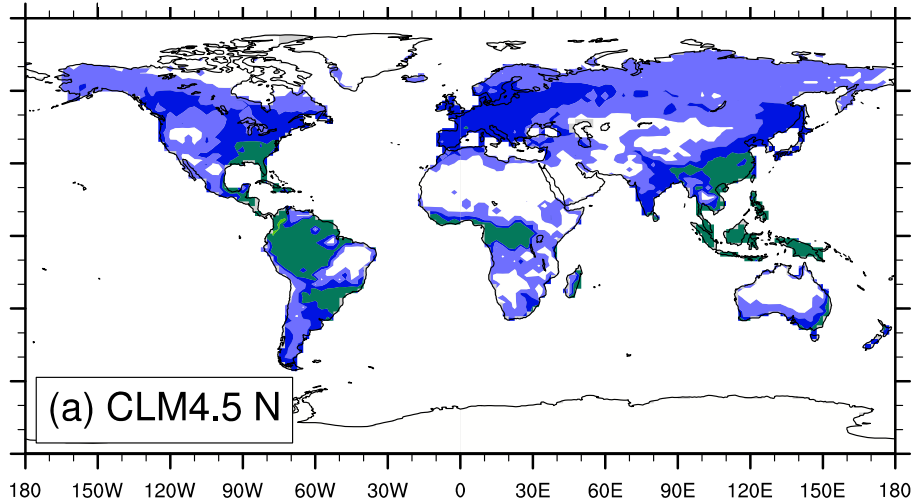
↑ C:N  
 ↓ GPP

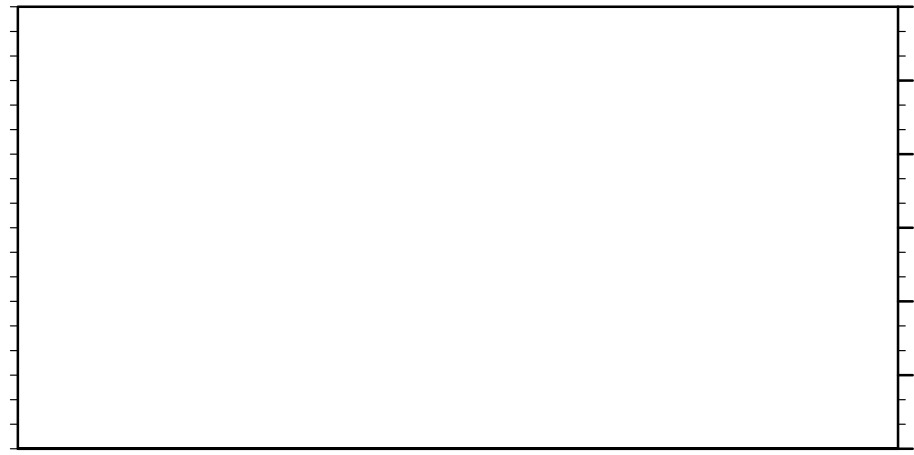
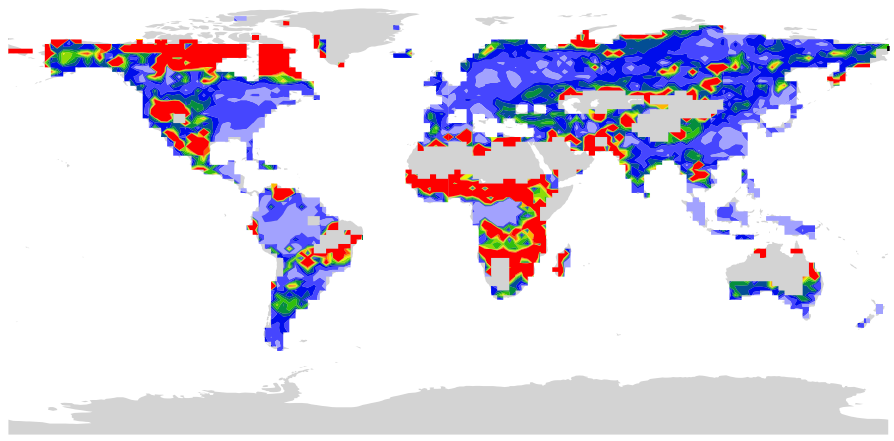




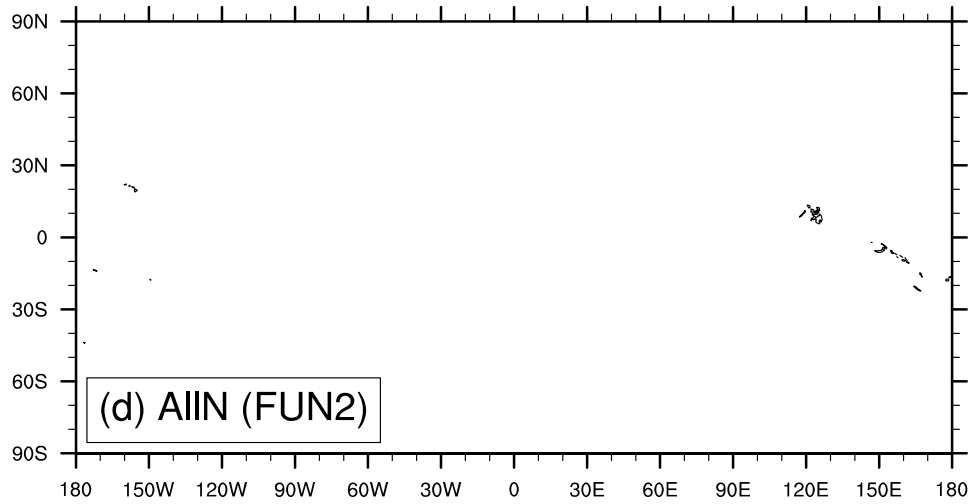
↑ C:N  
 ↑ N<sub>uptake</sub>  
 ↓ CUE

# Initial N fixation ( $\text{gN m}^{-2} \text{y}^{-1}$ )

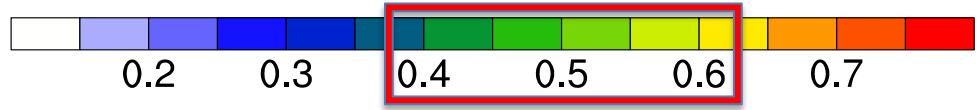




$fNPP N_{up}$



CUE





0.4

0.6

0.8

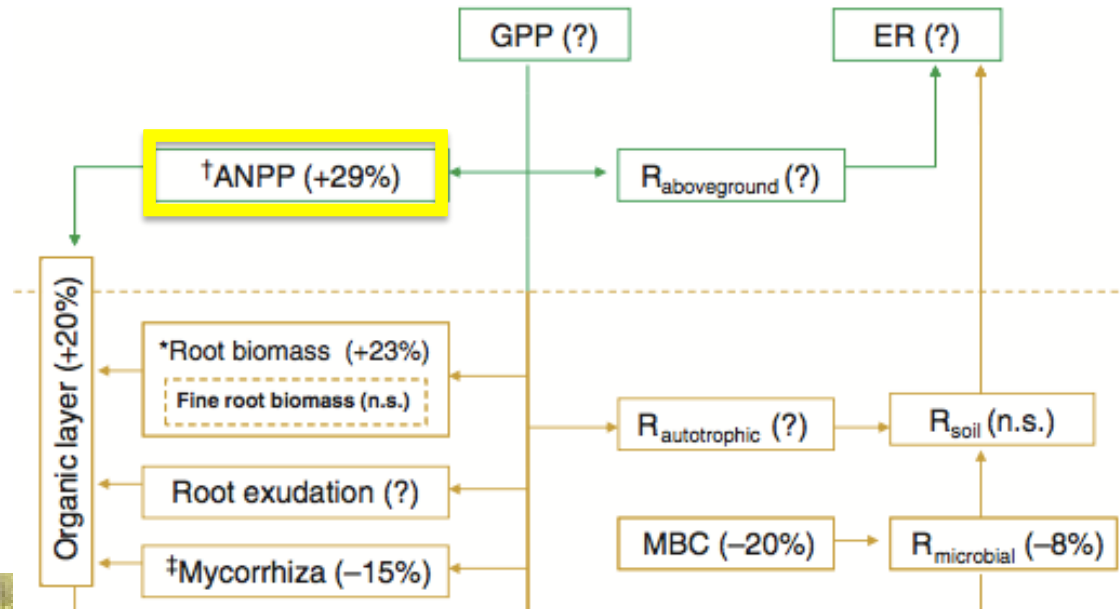
1

1.2

1.4

1.6

## Fertilized / Control

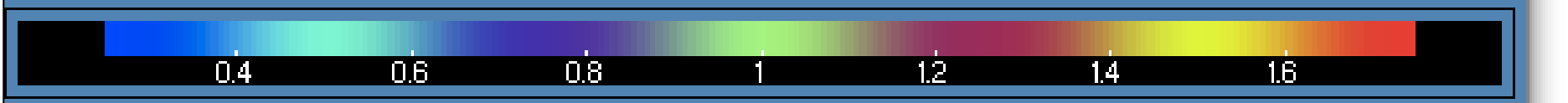


Liu & Greaver 2010 *Eco Let*

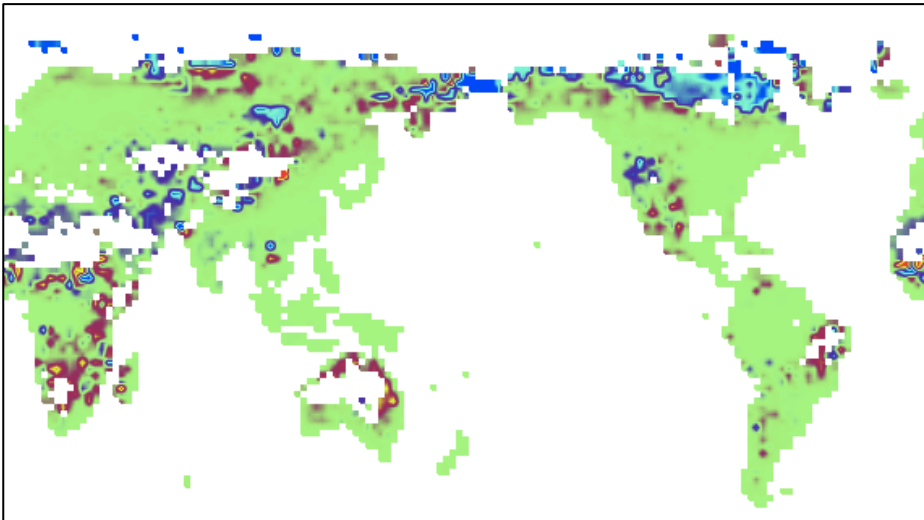
Janssens et al. 2010 *Nat Geo*

Yue et al. 2016 *Sci Rep*

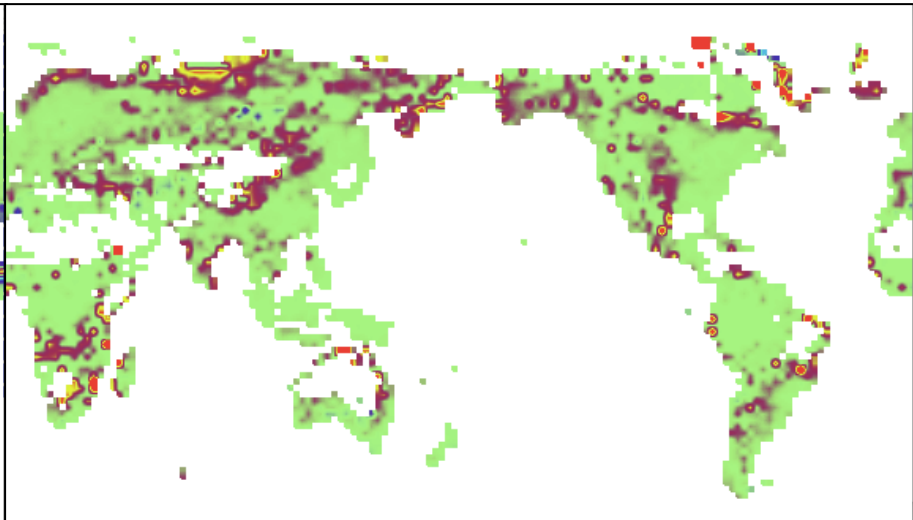




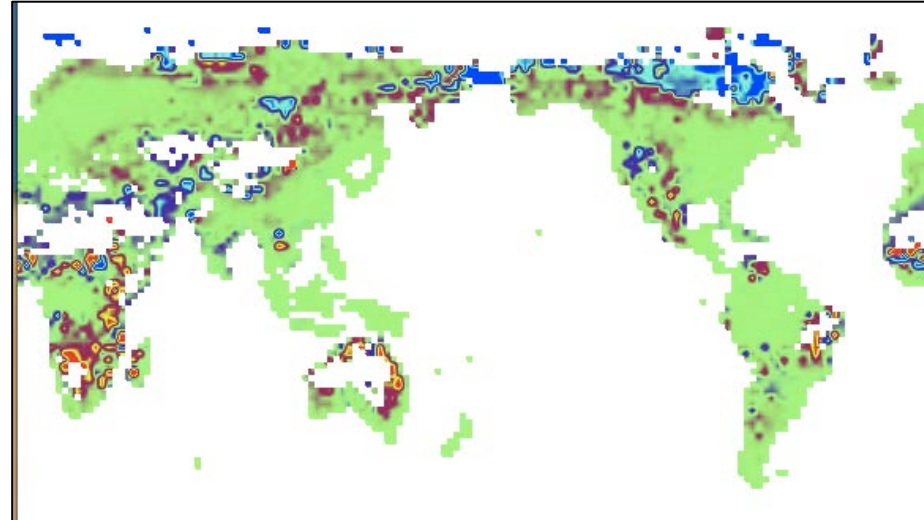
FUN<sub>1</sub> GPP



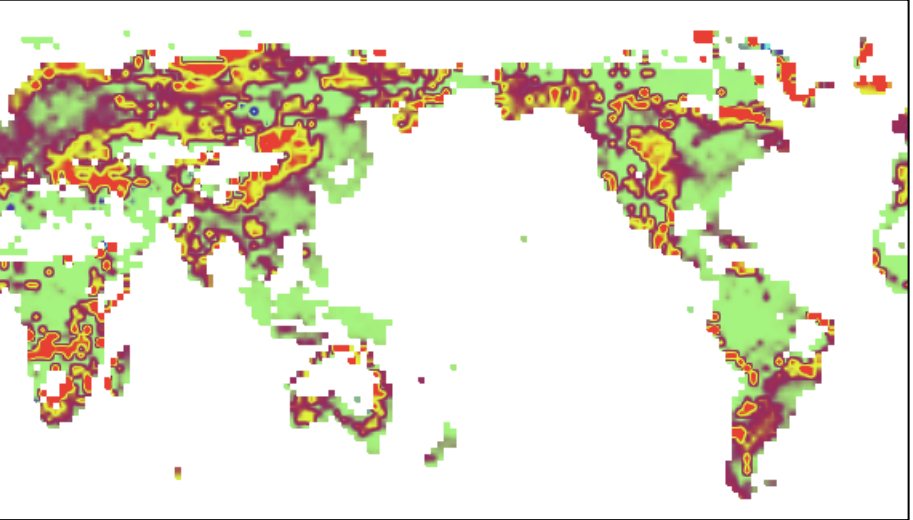
FUN<sub>2</sub> GPP



FUN<sub>1</sub> NPP

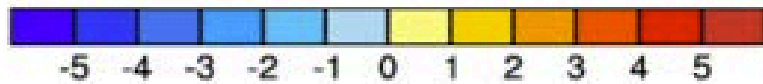
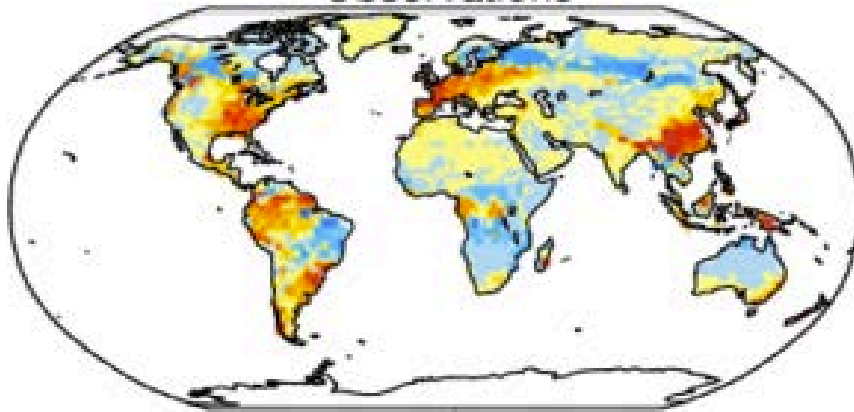


FUN<sub>2</sub> NPP

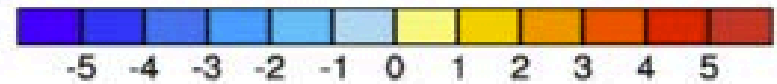
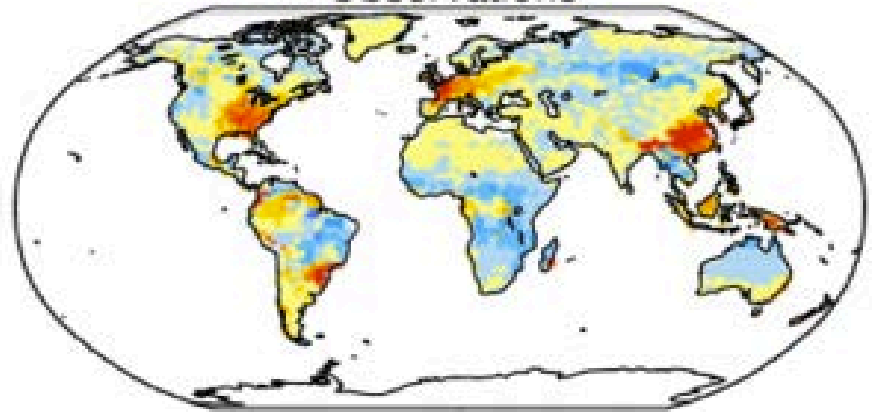


# TLAI, FlexLuna vs. CLM45 N (2010)

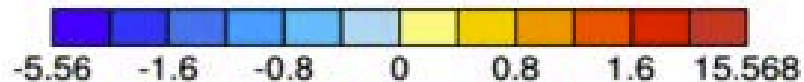
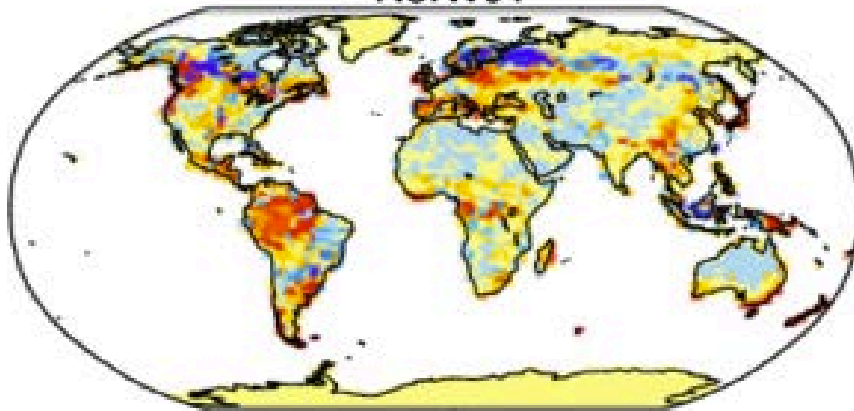
FlexLunav01  
- Observations



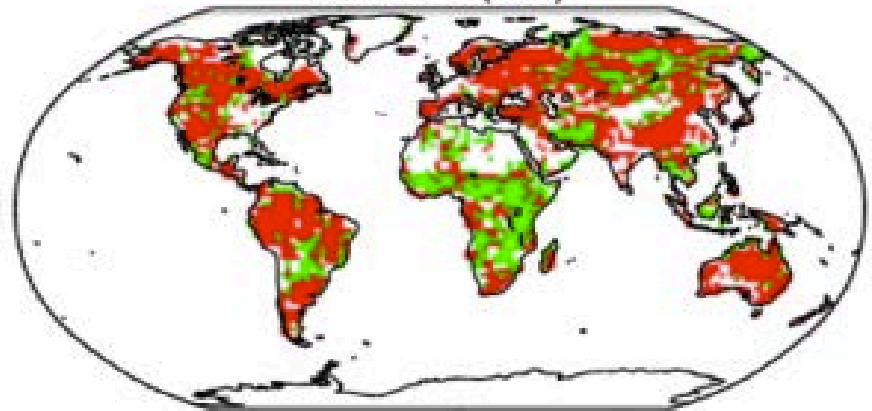
NoNv01  
- Observations



FlexLunav01  
- NoNv01



FlexLunav01 (green)  
NoNv01 (red)



Model relative to Obs

# Next Steps

## **Tuning**

- FUN (Rosie)
- AR & allocation?

## **Evaluation**

- Historical
- N Fertilization
- FACE

## **Sensitivity**

- Target C:N
- FUN cost functions

## **Soil N**

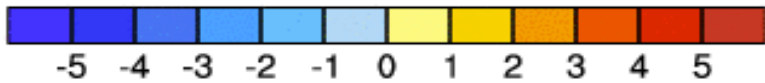
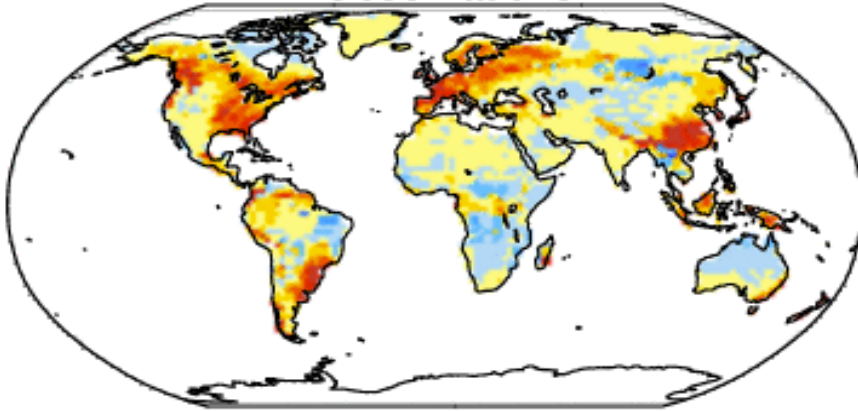
- Transformations
- Competition
- Loss

## **C for N uptake (fate in soils)**

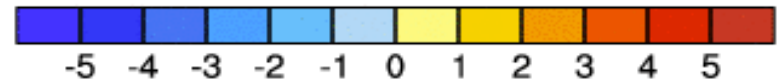
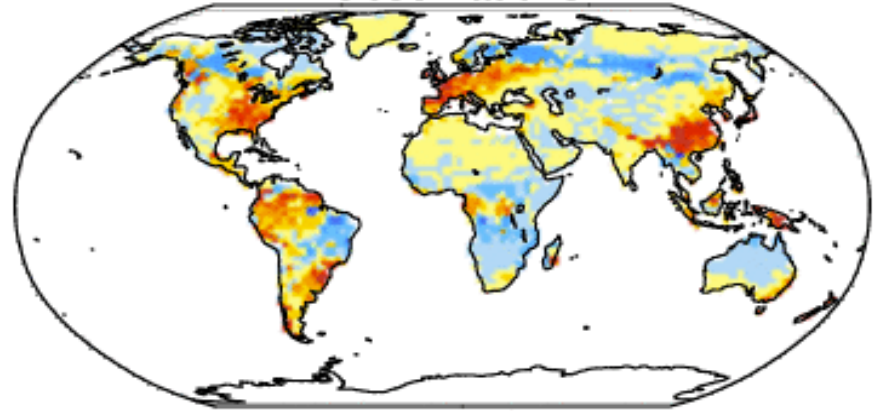


# TLAI, AIN vs. FlexLuna (2010)

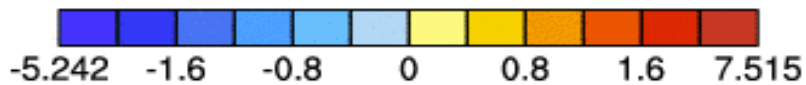
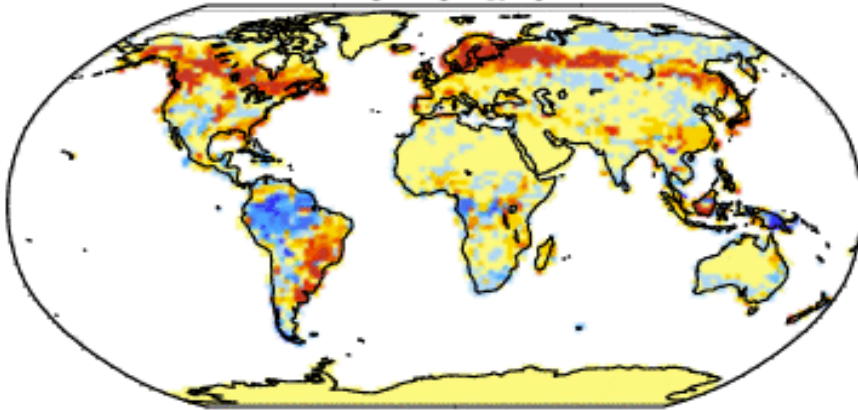
AINv01  
- Observations



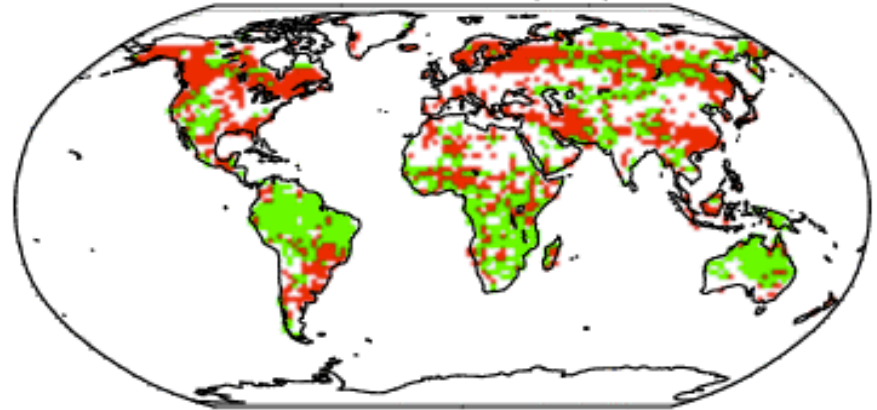
FlexLunav01  
- Observations



AINv01  
- FlexLunav01



AINv01 (green)  
FlexLunav01 (red)



Model relative to Obs