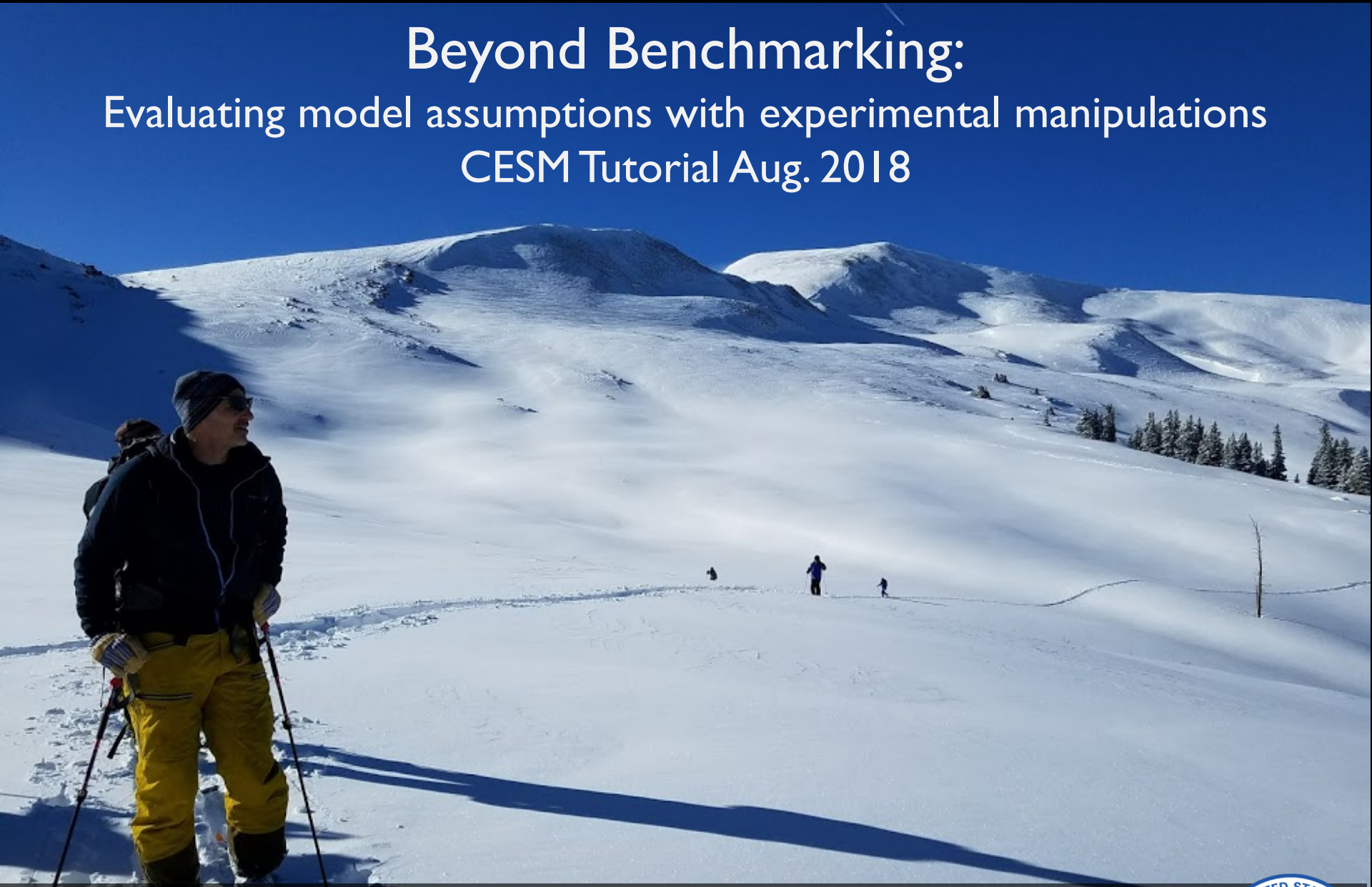
Beyond Benchmarking:

Evaluating model assumptions with experimental manipulations

CESM Tutorial Aug. 2018

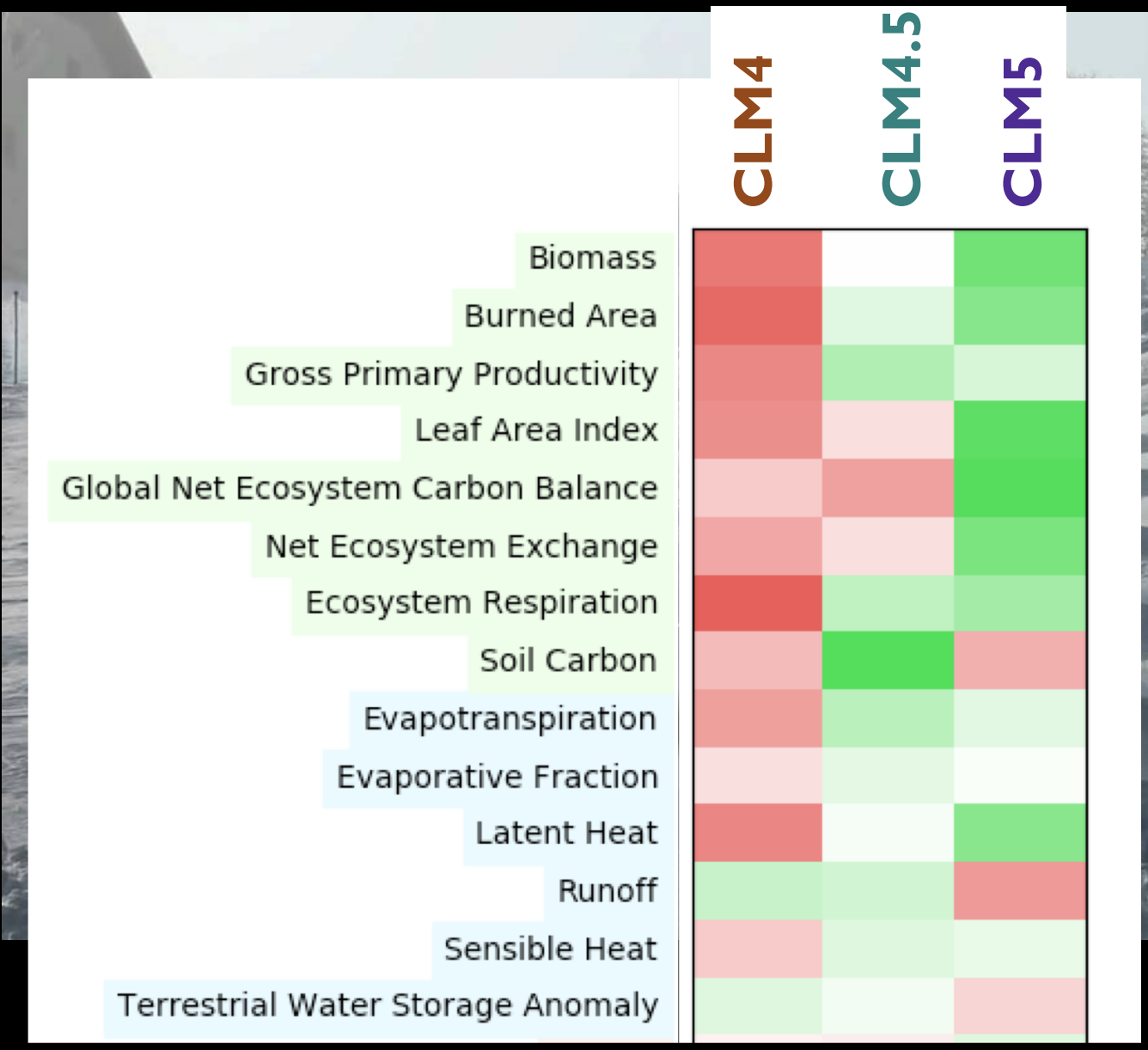


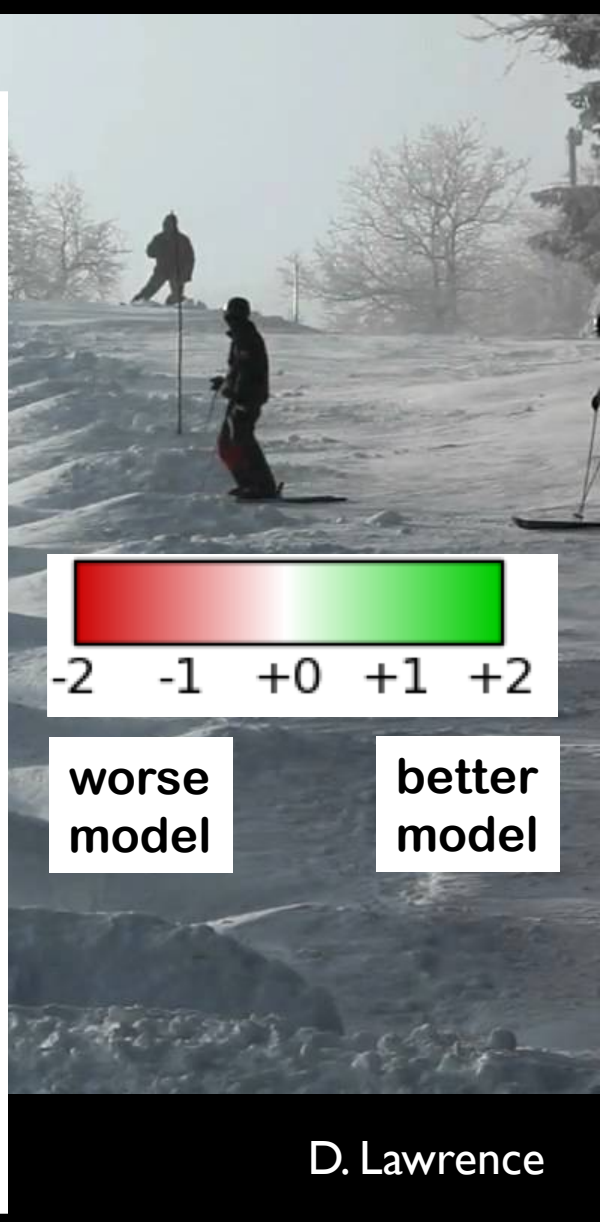
Will Wieder

D. Lawrence, R. Fisher, K. Oleson & many more

ILAMB Olympics

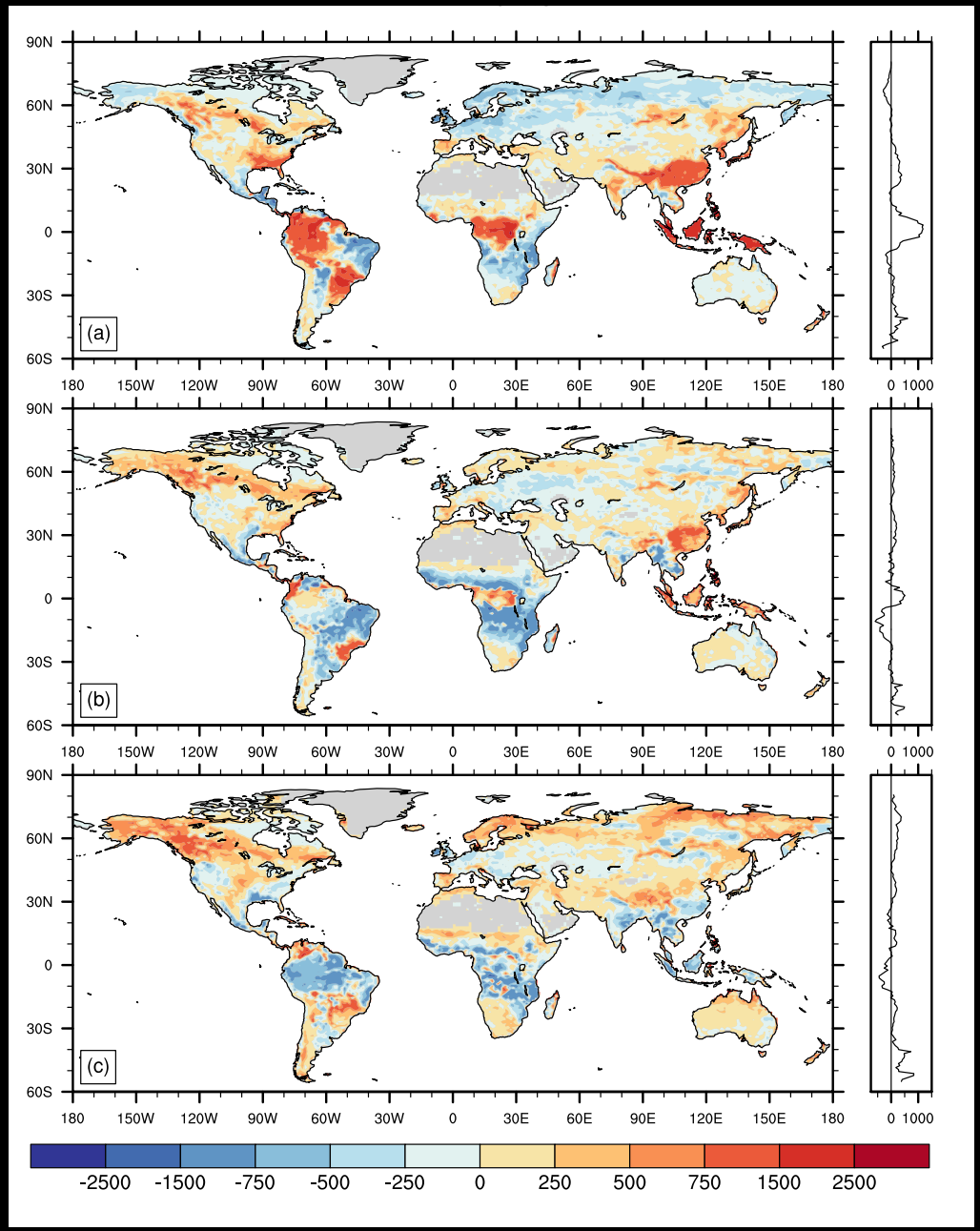
ILAMB Olympics





D. Lawrence

GPP Bias (Fluxnet MTE)

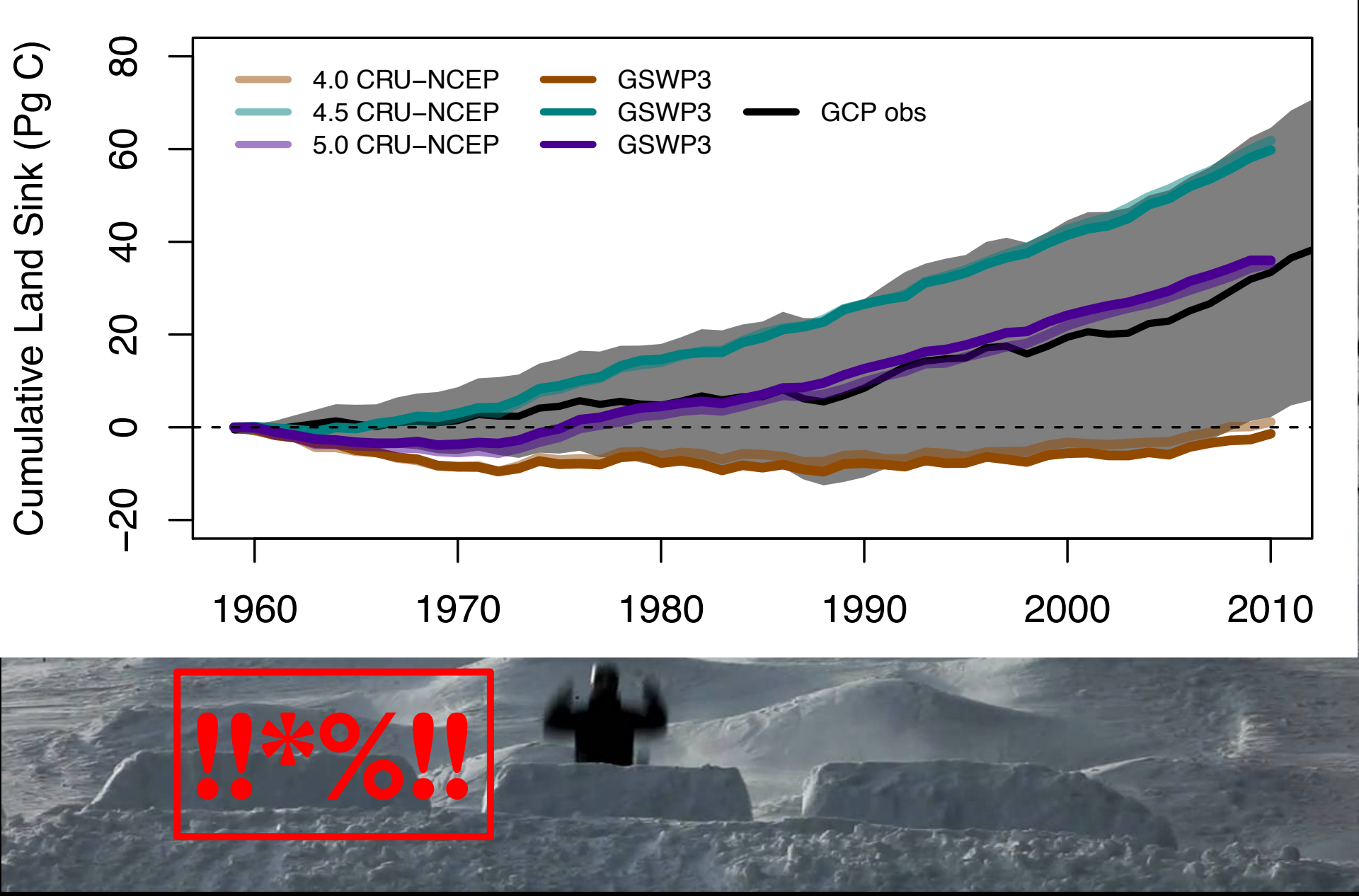


CLM 4.0
+14 Pg C y^{-1}

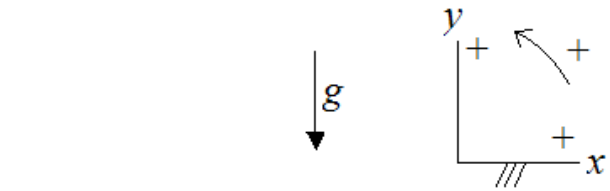
CLM 4.5
-2.9 Pg C y^{-1}

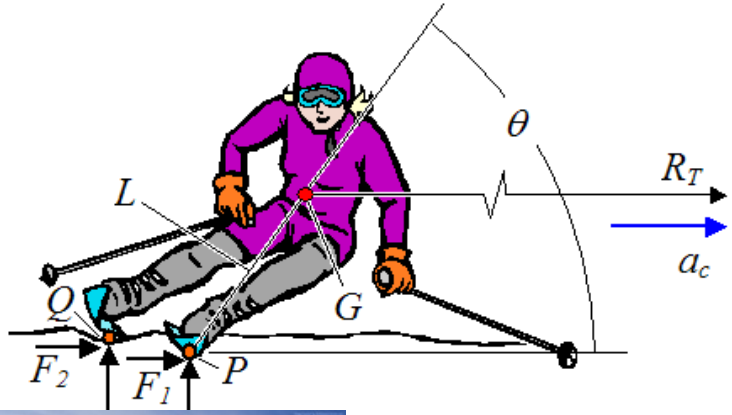
CLM 5.0
+2.4 Pg C y^{-1}

ILAMB Olympics


Cumulative Land Sink (Pg C)
80
60
40
20
0
−20
1960
1970
1980
1990
2000
2010
4.0 CRU−NCEP
4.5 CRU−NCEP
5.0 CRU−NCEP
GSWP3
GSWP3
GSWP3
GCP obs

!!*%!!


y
+
+
+
g
x


θ
R_T
L
a_c
Q
G
F_2
F_1
P

CLM 4.0

CLM4.5

CLM5.0

Control (GSWP3)

+N (50 kg N ha^{-1} y^{-1})

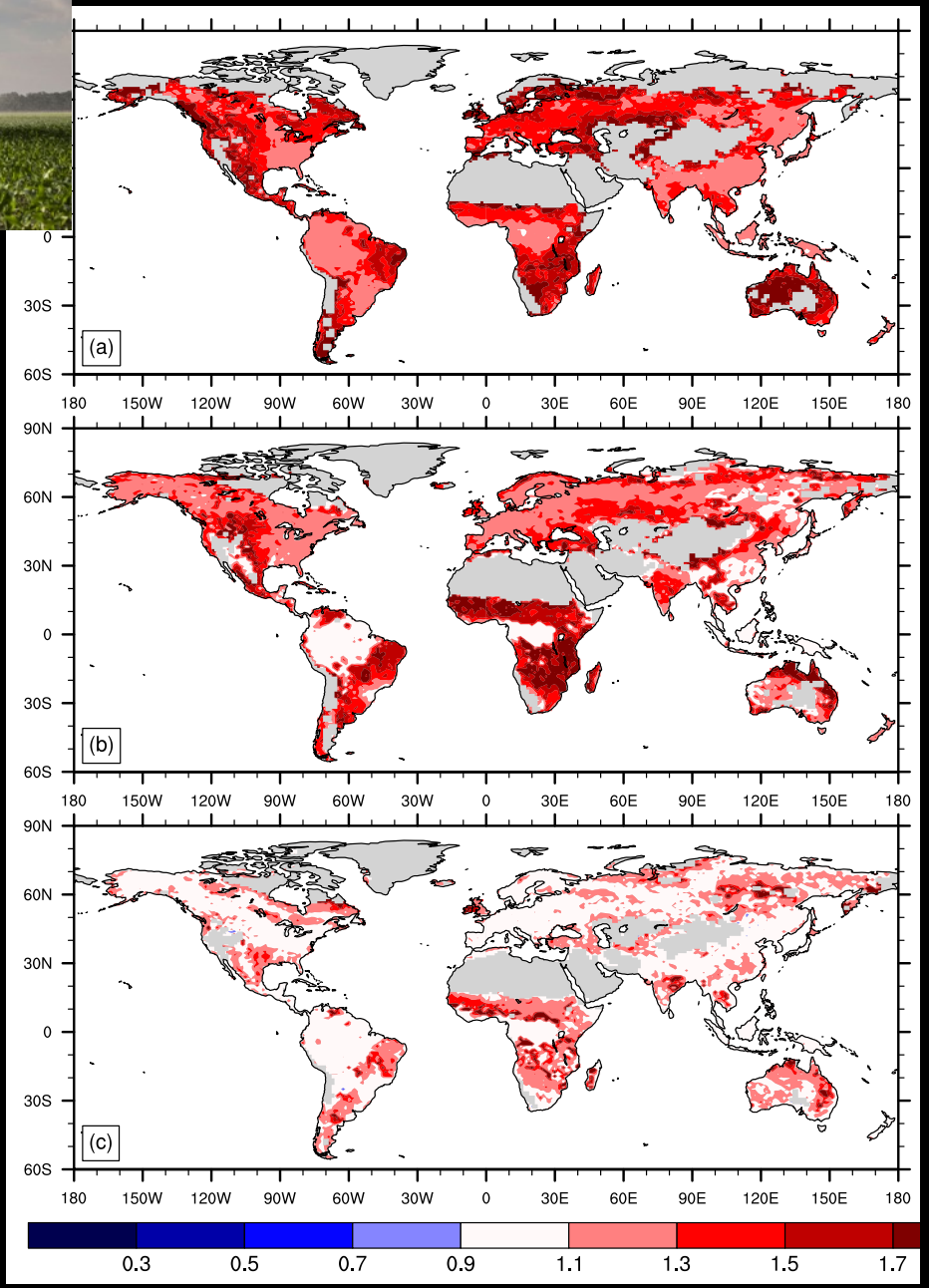
+CO_2 (200 ppm)

(treatment / control)

Medlyn et al. 2015 *Nature Clim. Change*

Wieder et al. In prep

GPP Response to +N (treatment / control)

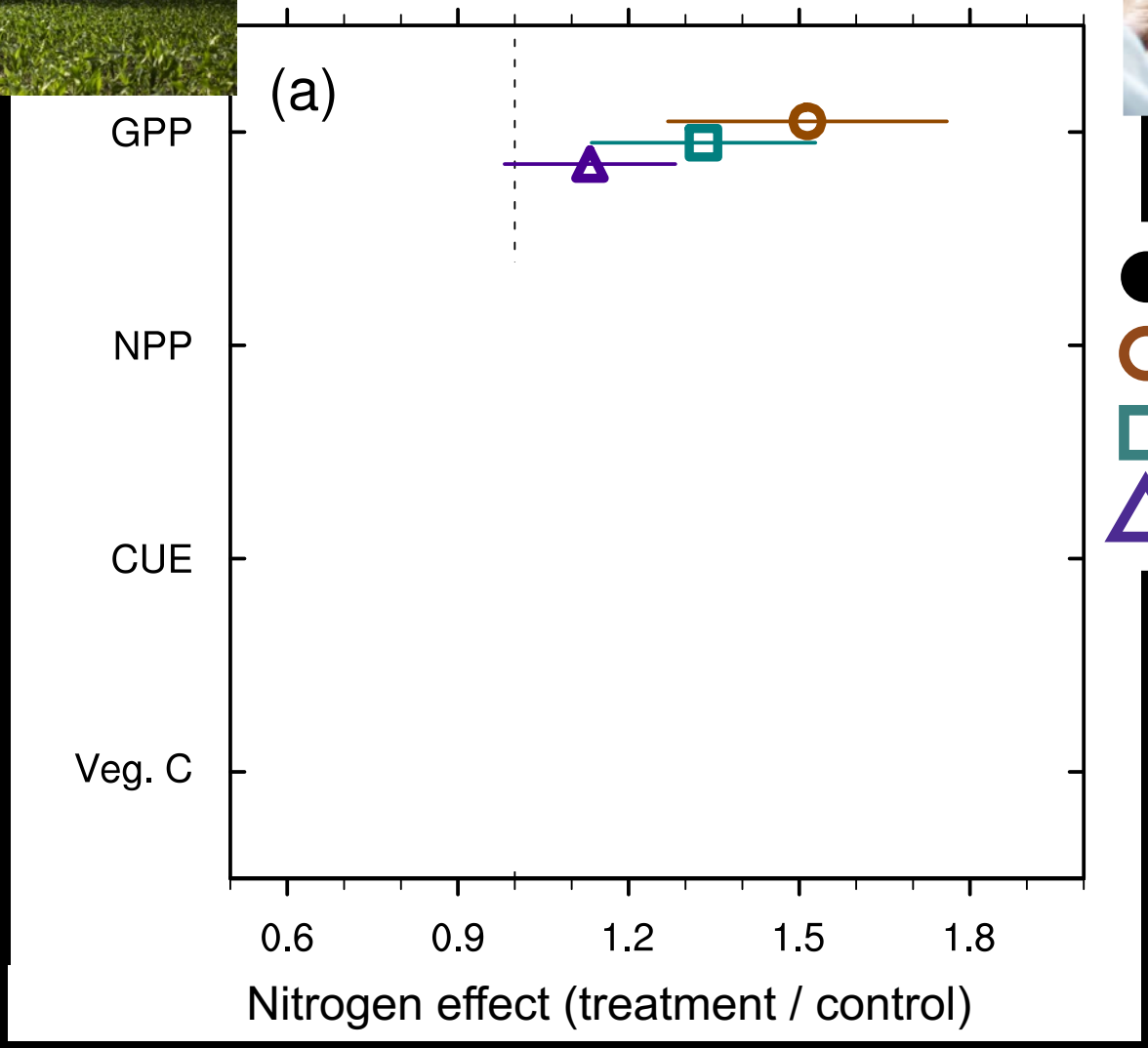


CLM 4.0

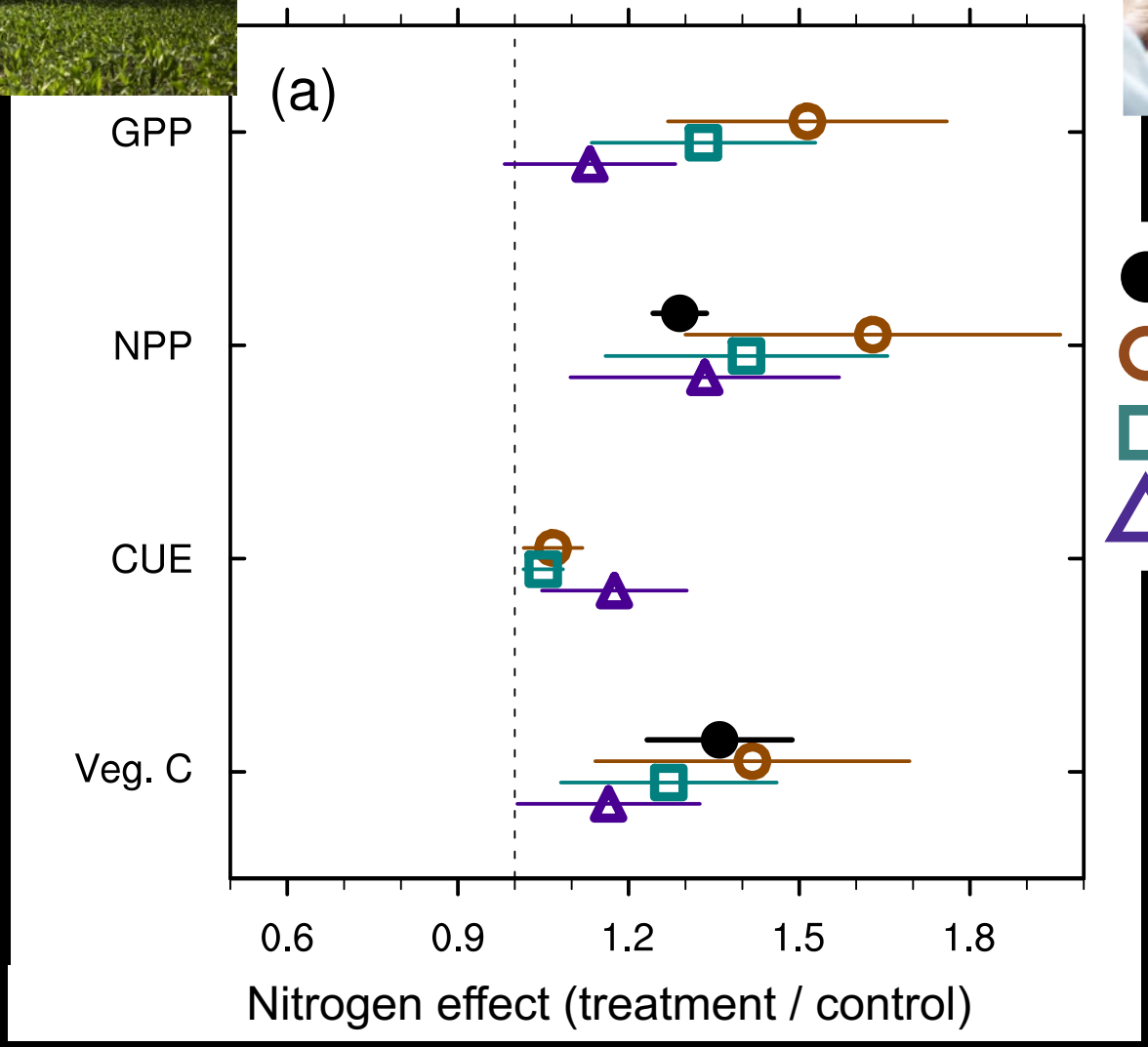
CLM 4.5

CLM 5.0

Response to +N

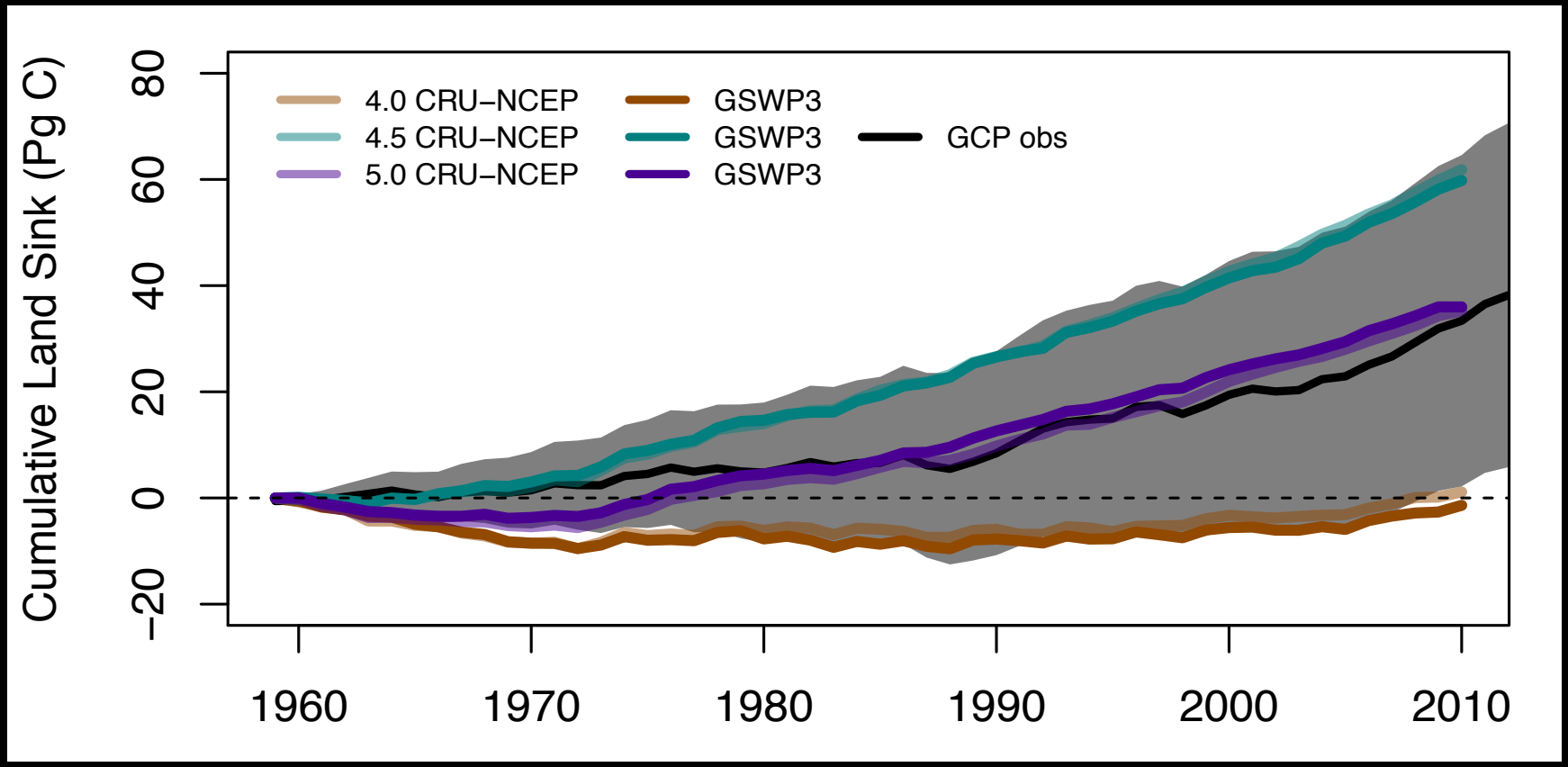


Response to +N



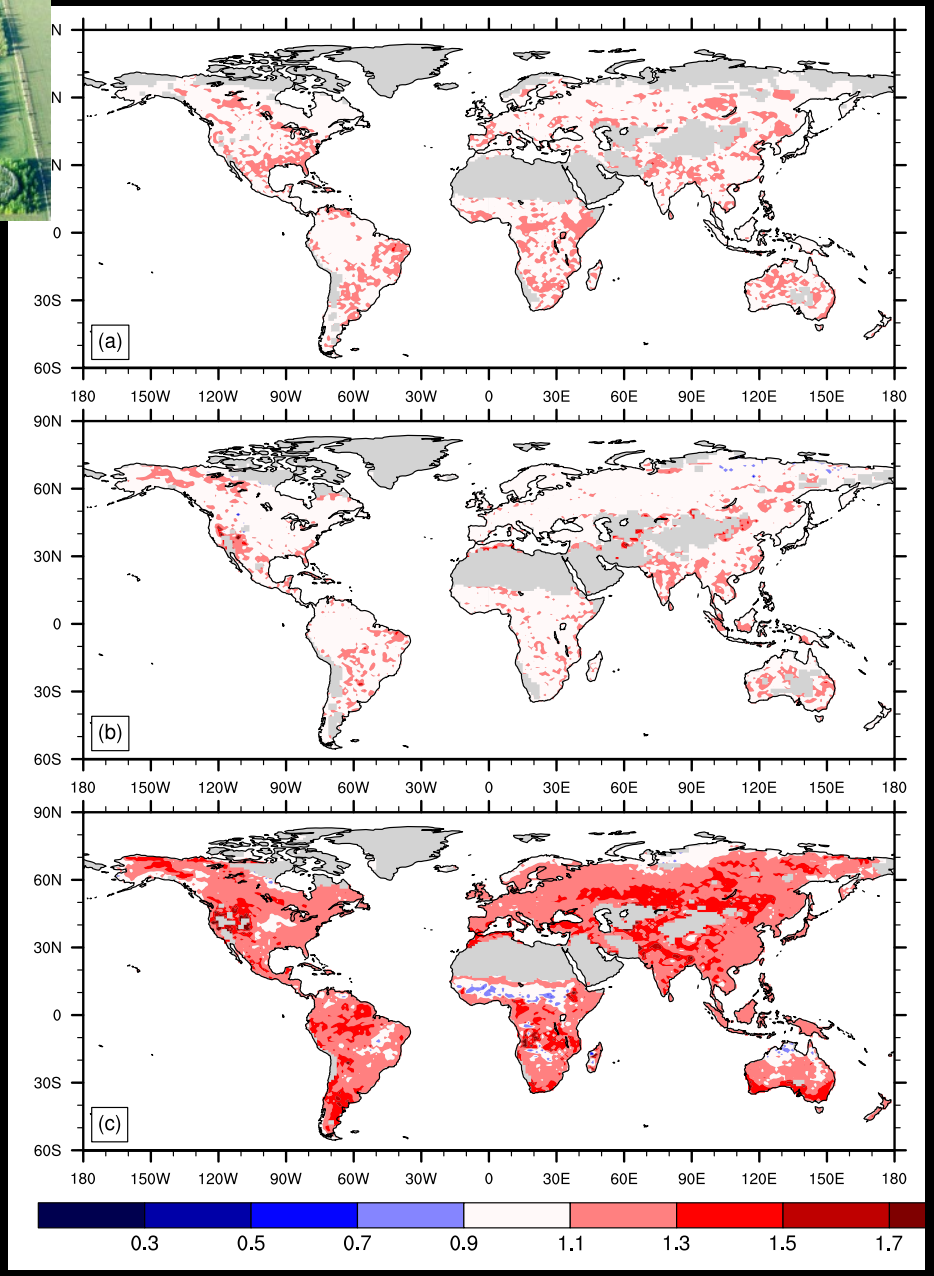
LeBauer & Treseder 2008
Liu & Greaver 2010
Lu et al. 2011

GPP Response to +CO_2?



GPP Response to +CO_2

(treatment / control)

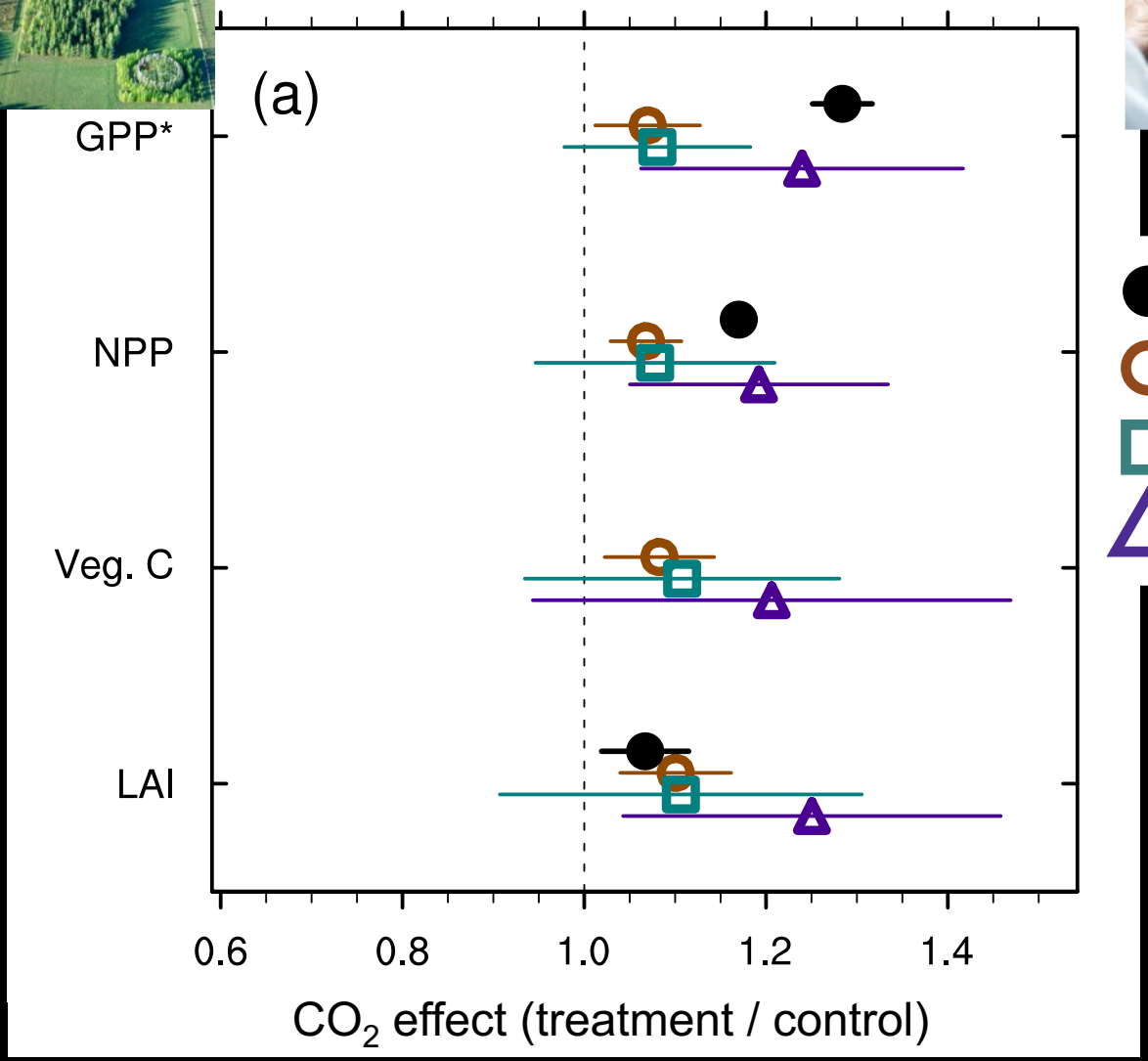


CLM 4.0

CLM 4.5

CLM 5.0

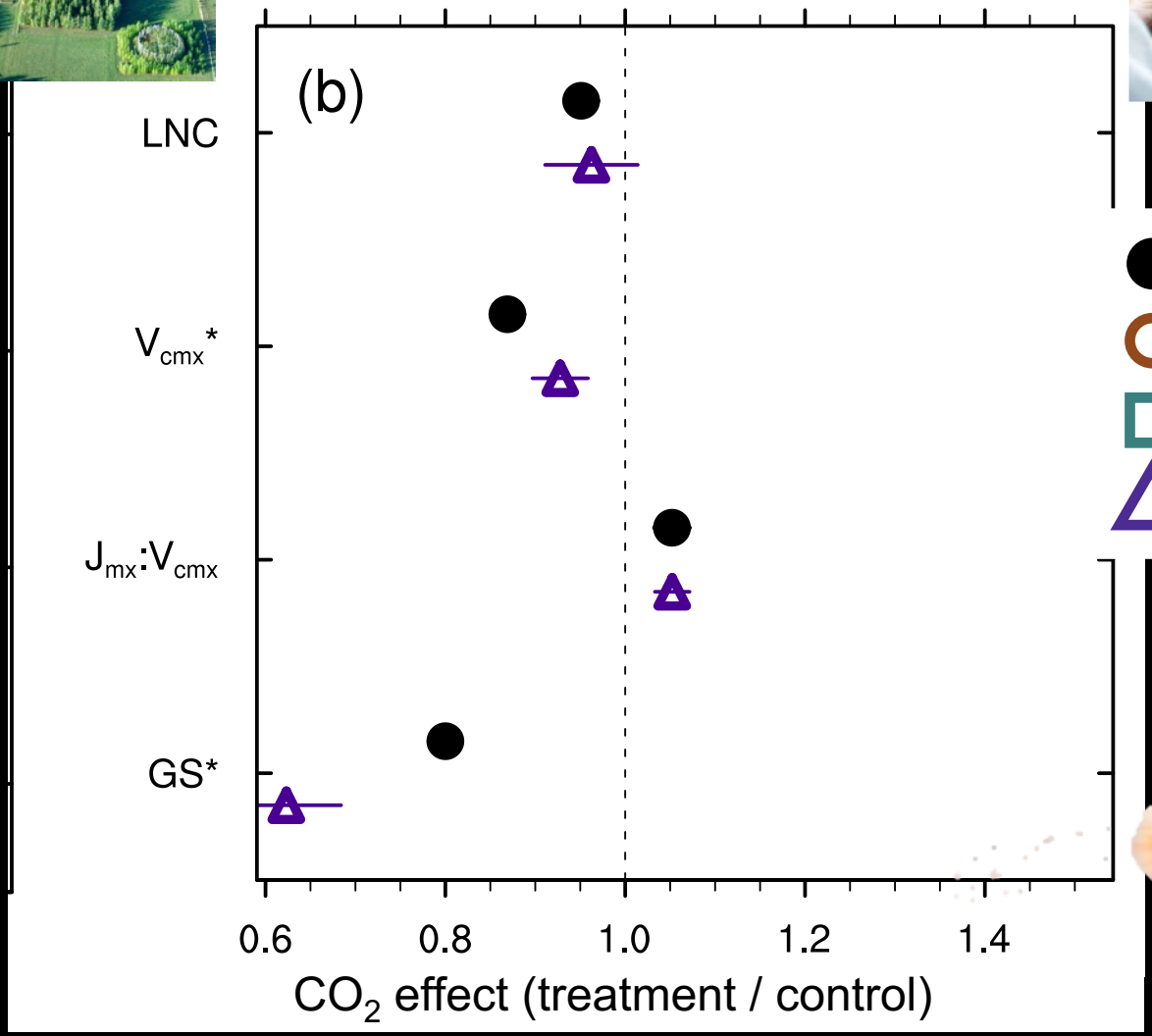
Response to +CO_2



* Monthly mean of maximum daily values

Obs from Ainsworth & Long 2005

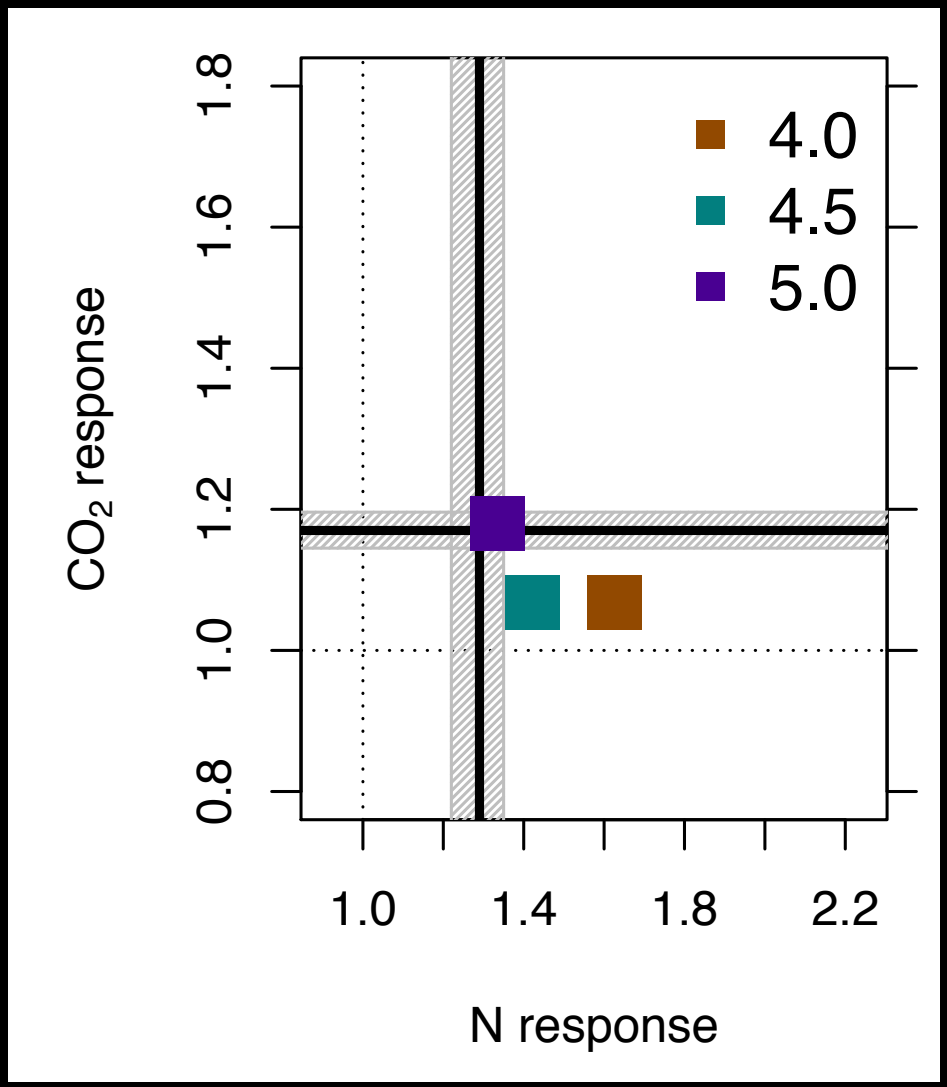
Response to +CO_2



* Monthly mean of maximum daily values

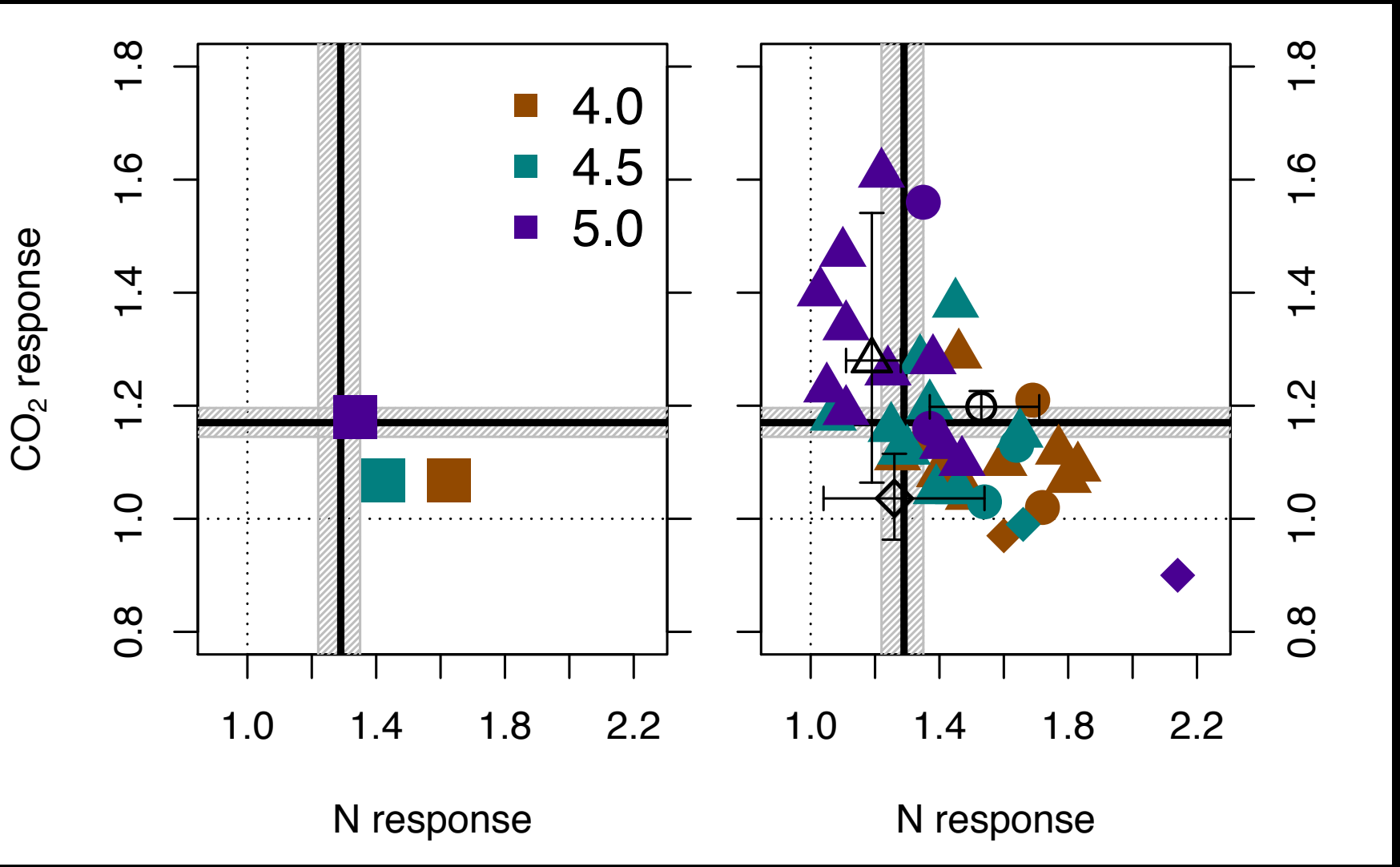
Obs from Ainsworth & Long 2005

NPP Response



LeBauer & Treseder 2008
Ainsworth & Long 2005

NPP Response



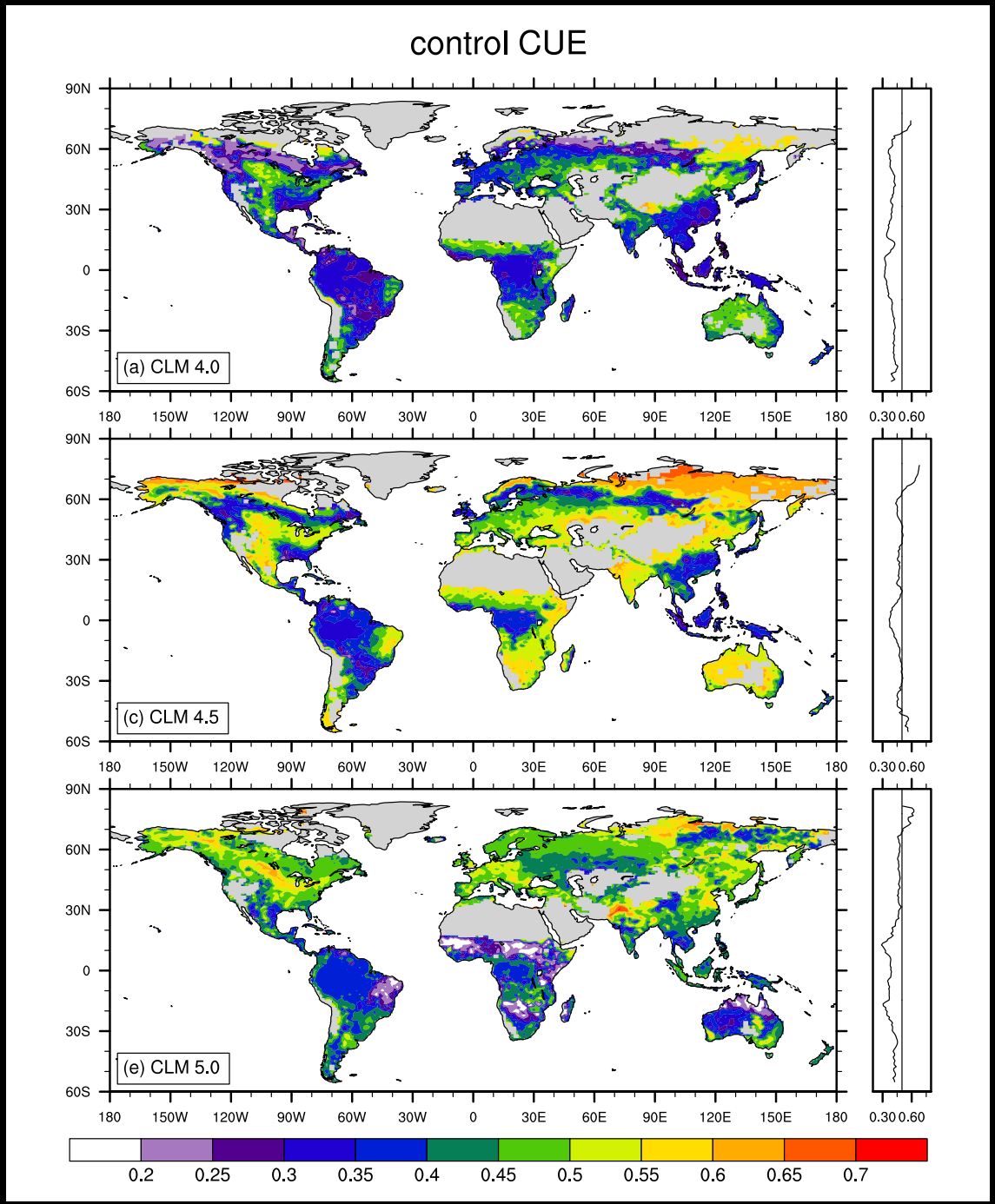
LeBauer & Treseder 2008
Ainsworth & Long 2005

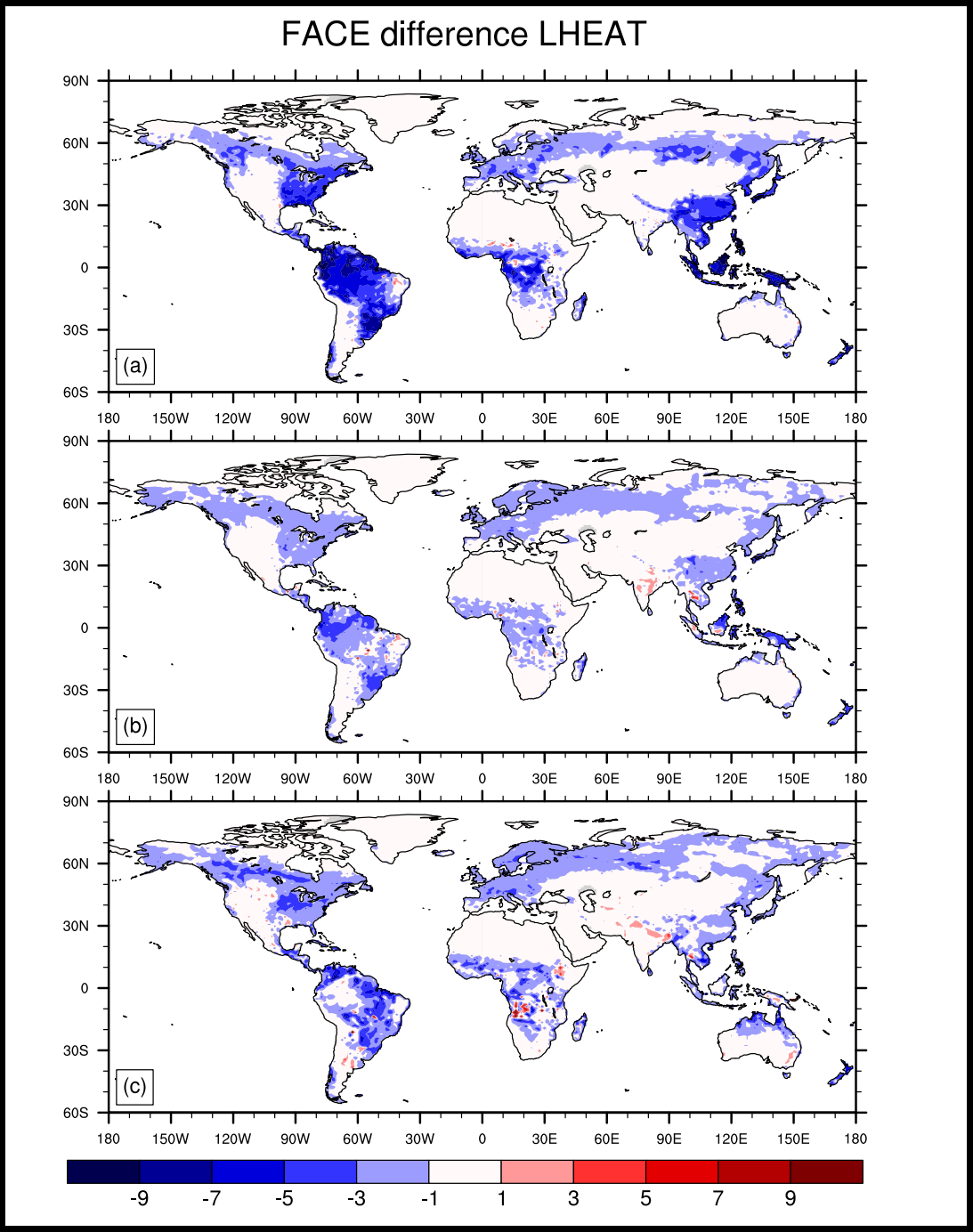
CLM5 has:

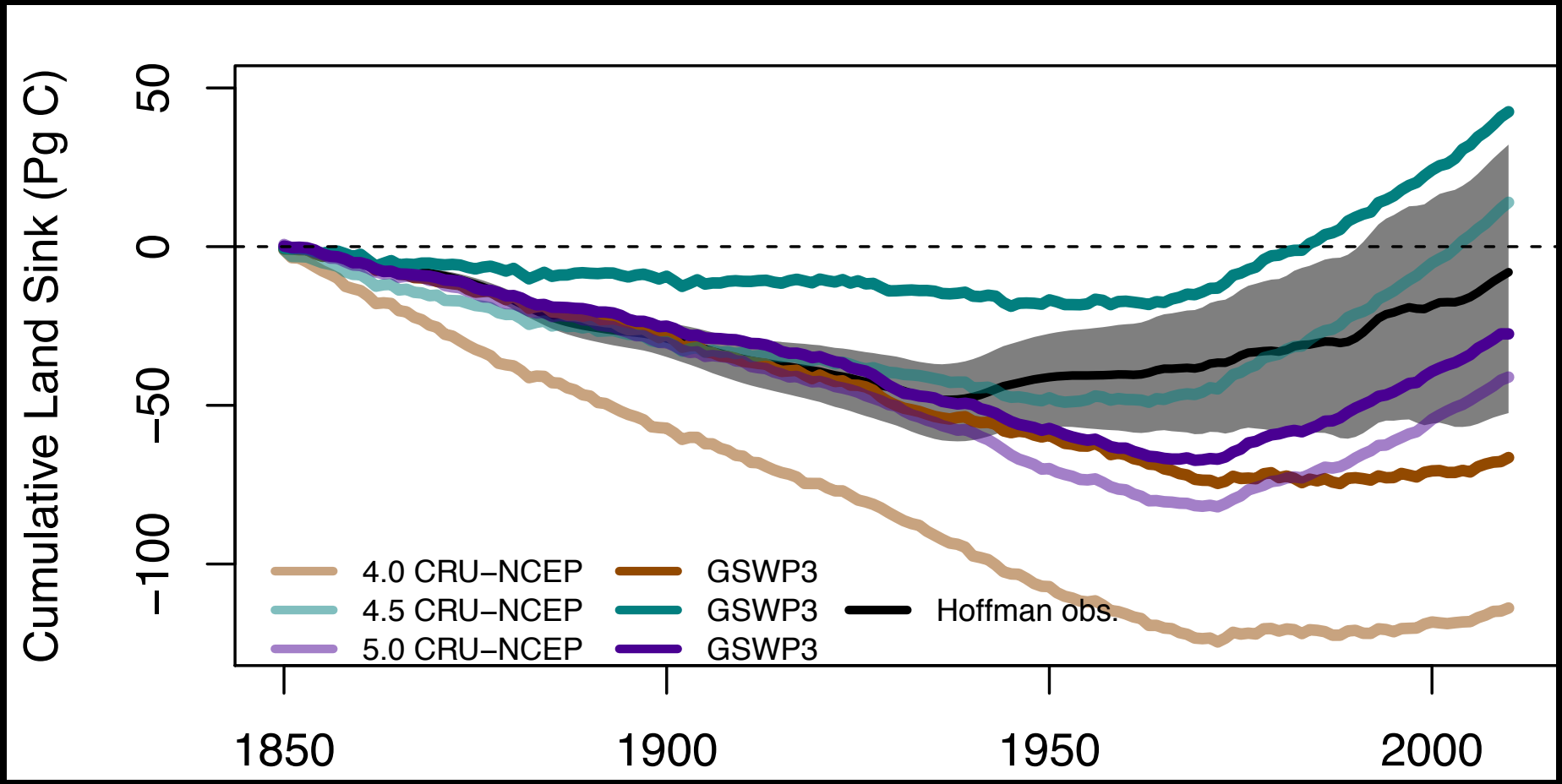
- Better ILAMB scores
- Poleward shift in productivity
- Lower N sensitivity
- Increased CO_2 sensitivity
- Greater ecological realism

CLM5+ needs:

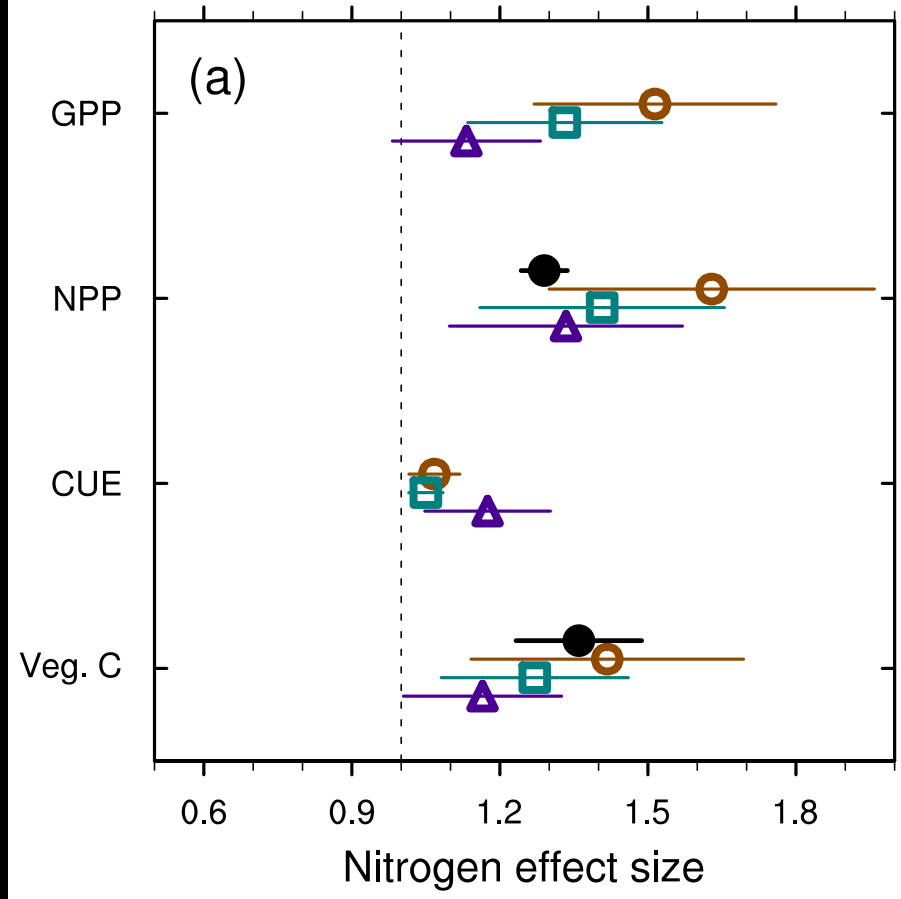
- Revisions to allocation scheme
- Adjustments to FUN costs
- Real competition for inorganic N

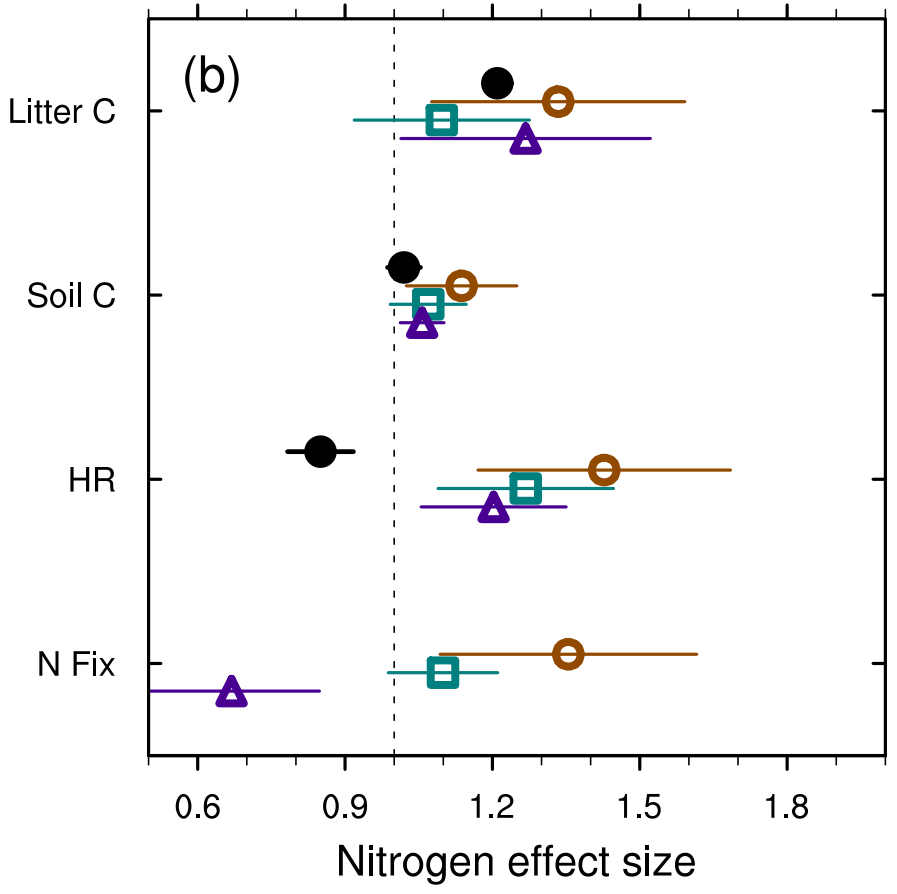

control CUE
90N
60N
30N
0
30S
60S
(a) CLM 4.0
(c) CLM 4.5
(e) CLM 5.0
180
150W
120W
90W
60W
30W
0
30E
60E
90E
120E
150E
180
0.30 0.60
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7


FACE difference LHEAT
90N
60N
30N
0
30S
60S
(a)
(b)
(c)
180
150W
120W
90W
60W
30W
0
30E
60E
90E
120E
150E
180
-9
-7
-5
-3
-1
1
3
5
7
9

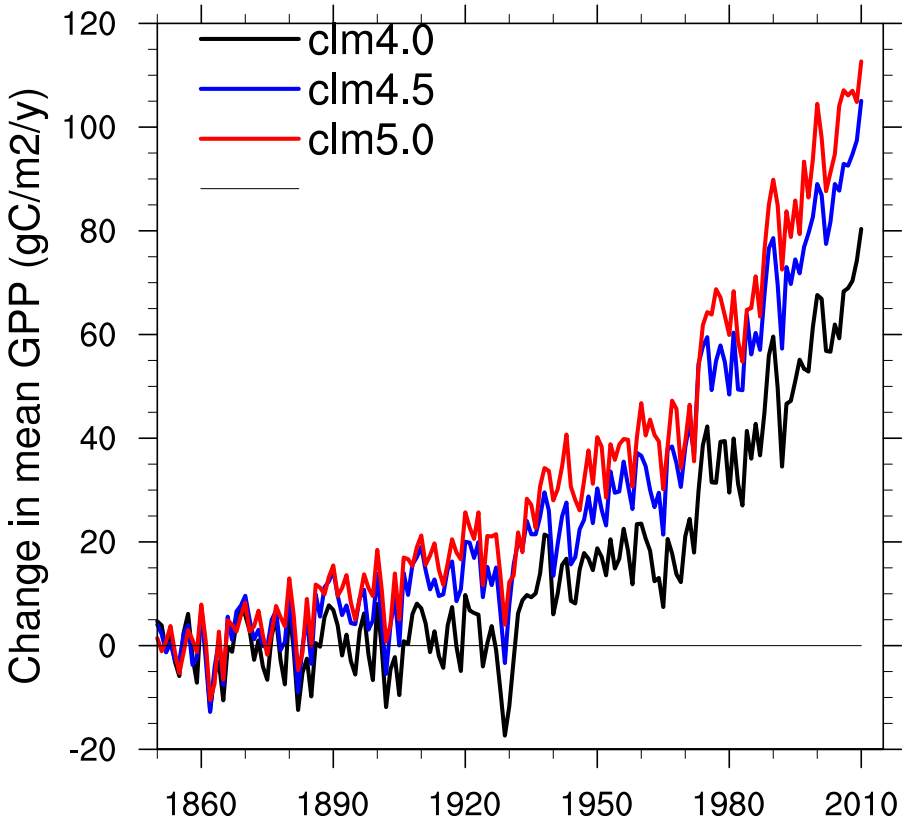

Cumulative Land Sink (Pg C)
50
0
−50
−100
1850
1900
1950
2000
4.0 CRU−NCEP
4.5 CRU−NCEP
5.0 CRU−NCEP
GSWP3
GSWP3
GSWP3
Hoffman obs.

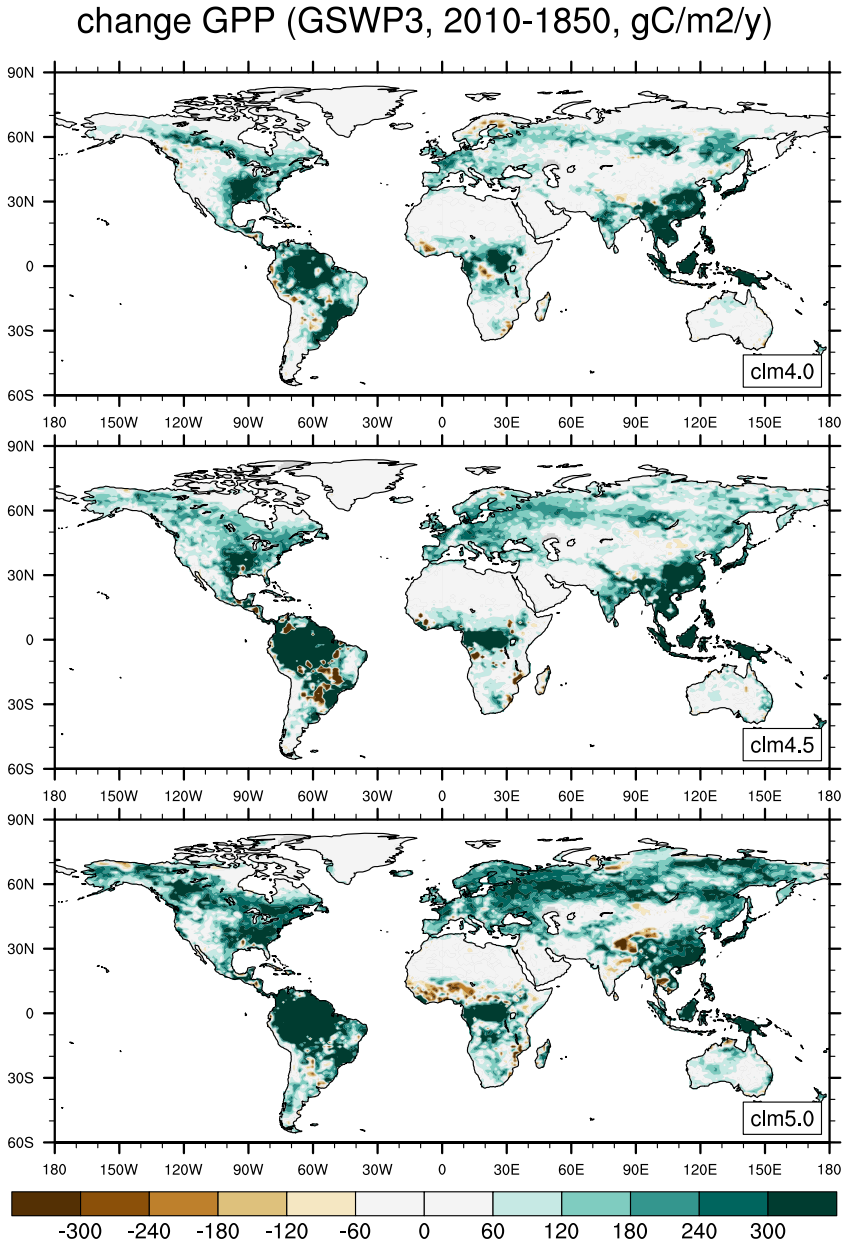
Response to +N





ΔGPP


clm4.0
clm4.5
clm5.0
Change in mean GPP (gC/m2/y)
120
100
80
60
40
20
0
-20
1860
1890
1920
1950
1980
2010


change GPP (GSWP3, 2010-1850, gC/m2/y)
clm4.0
clm4.5
clm5.0
90N
60N
30N
0
30S
60S
180
150W
120W
90W
60W
30W
0
30E
60E
90E
120E
150E
180
-300
-240
-180
-120
-60
0
60
120
180
240
300