A traceability framework for terrestrial carbon cycle

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With contributions from Yiqi Luo, Chris Lu and others

Why a traceability?

- Models become more complex and observations increase rapidly;
- Assessment of model performance often is quite subjective;
- Most model inter-comparisons do not address WHY questions;.
- A traceability framework offers a better solution for model error attribution.

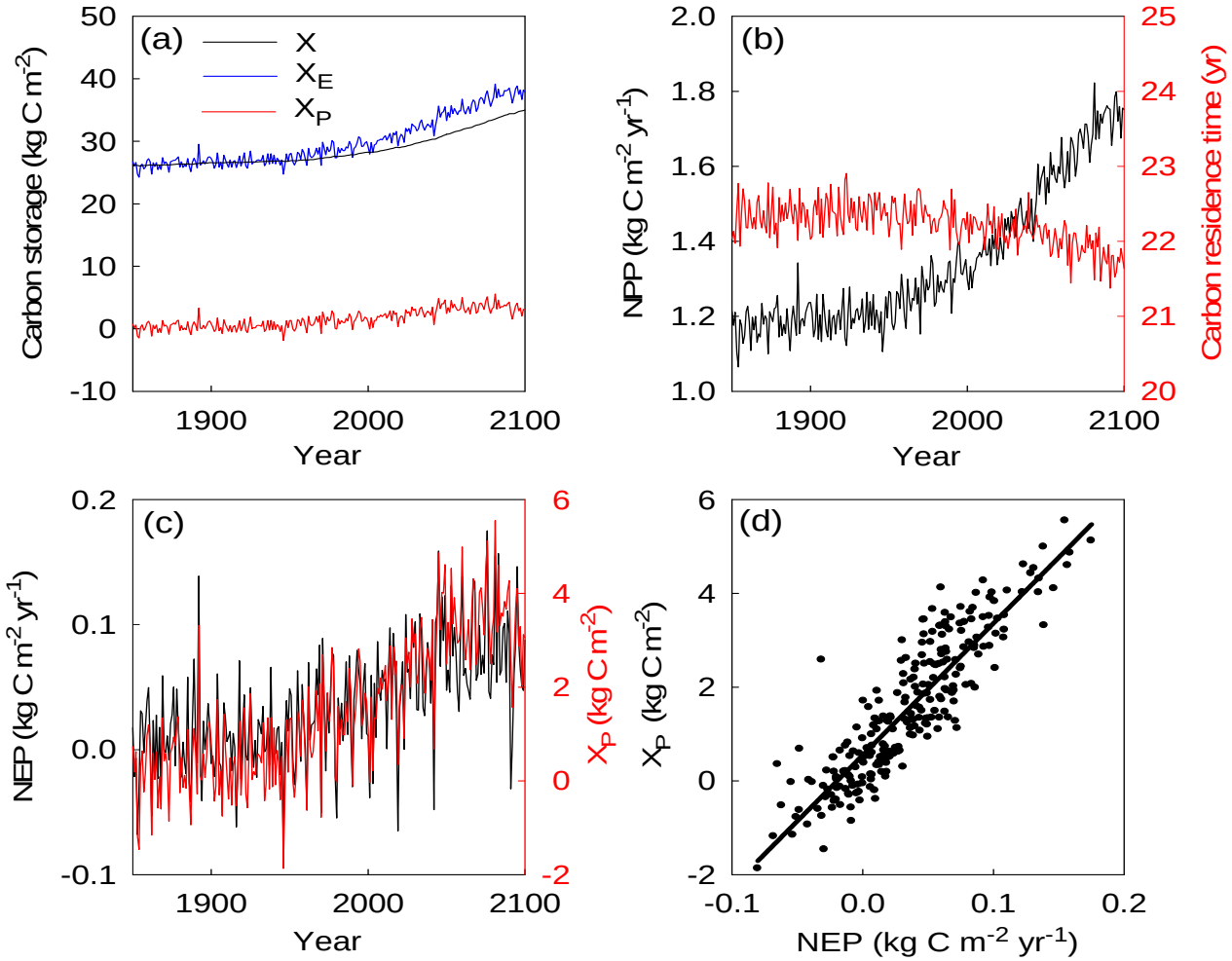
Ecosystem carbon dynamics (Luo et al. 2016)

$$\frac{dC}{dt} = \boldsymbol{B} \times F_{npp} - A\xi KC$$

$$\boldsymbol{C}(t) = \overbrace{\underbrace{(A\xi K)^{-1}}_{\textbf{transfer matrix}} \quad \underbrace{\boldsymbol{B}}_{\textbf{NPP allocation}} \quad F_{npp}}^{\textbf{carbon storage capapcity: } C_E} - \overbrace{(A\xi K)^{-1}\frac{\boldsymbol{d}}{\boldsymbol{dt}}\boldsymbol{C}(t)}^{\textbf{carbon storage potential: } C_p}$$

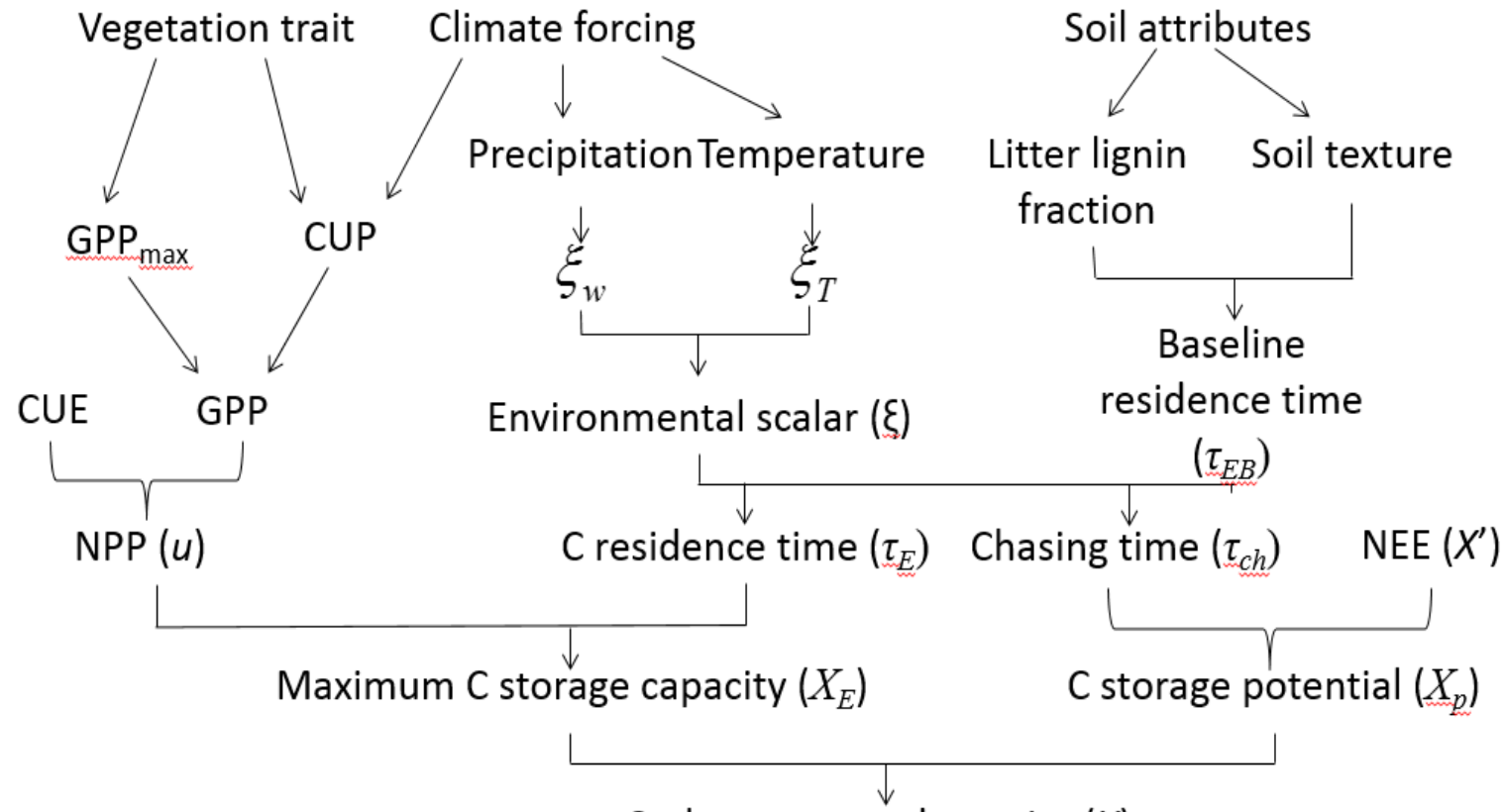
$$\sum C = \boldsymbol{C} \times \boldsymbol{I} = \tau_E F_{npp} - \tau_{ch} F_{nee}$$

Carbon pool size, potential and capacity dynamics



Luo et al. 2016

A traceability framework for terrestrial C cycle

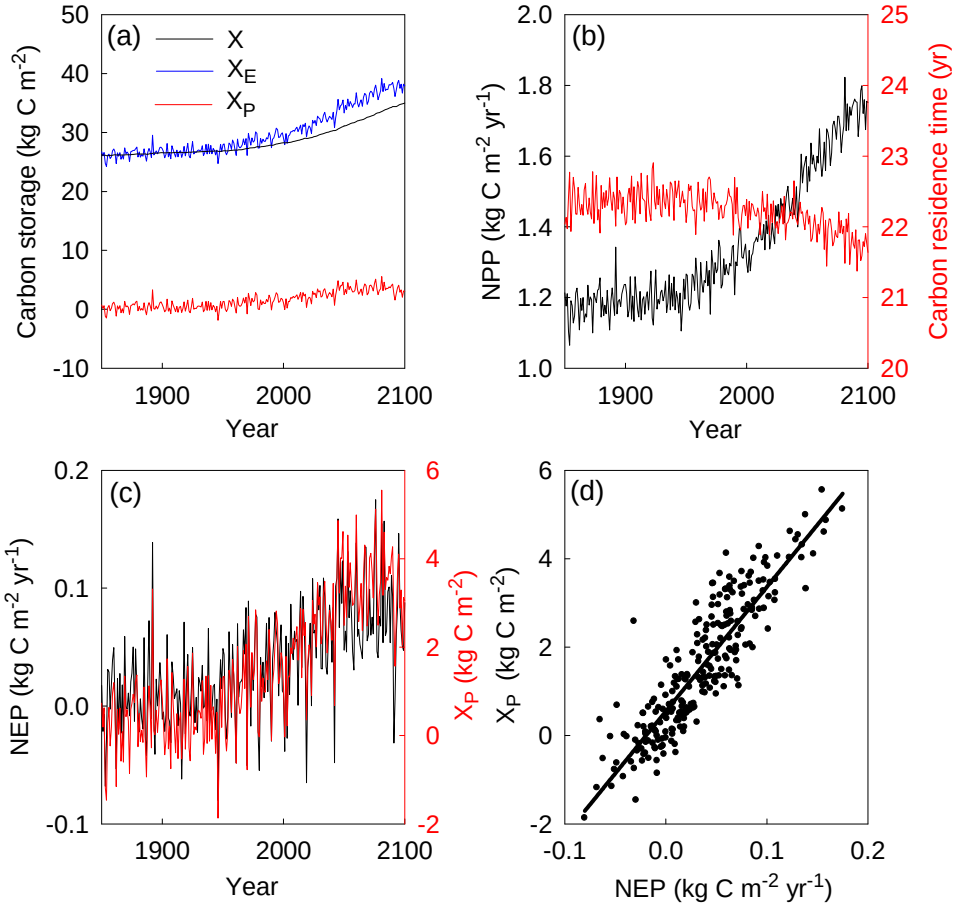


CUP – C uptake period

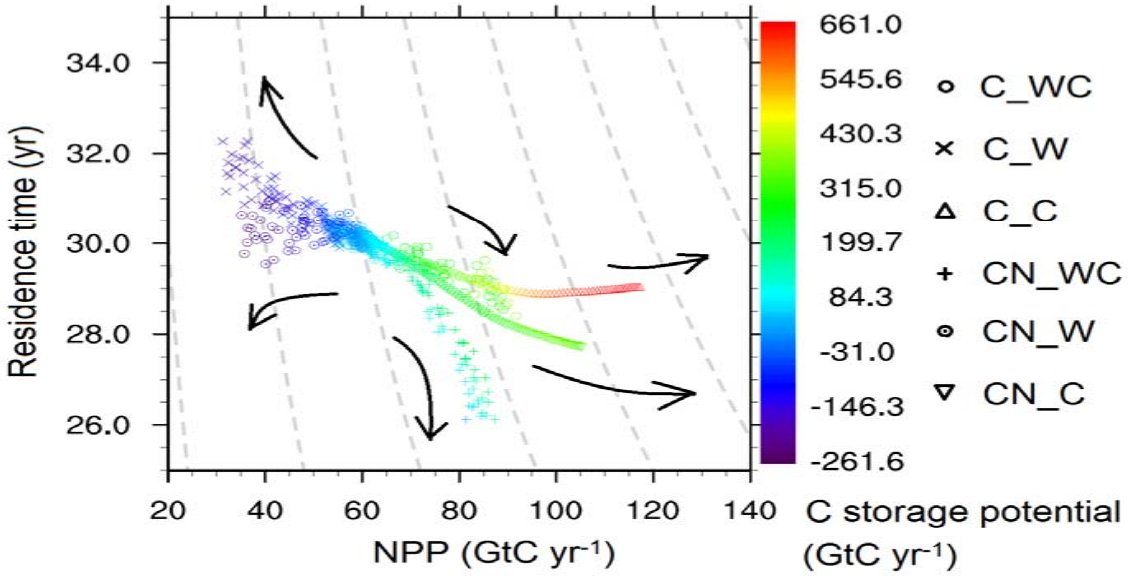
CUE – C use efficiency

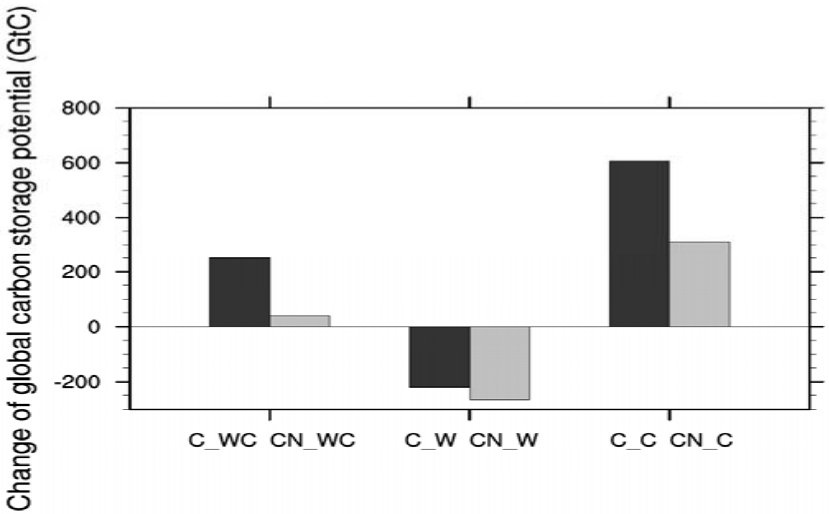
Lu et al. in prep

Decomposing carbon pool (X) into storage capacity (X_E) and potential (X_p): an example



Source: Luo et al 2016

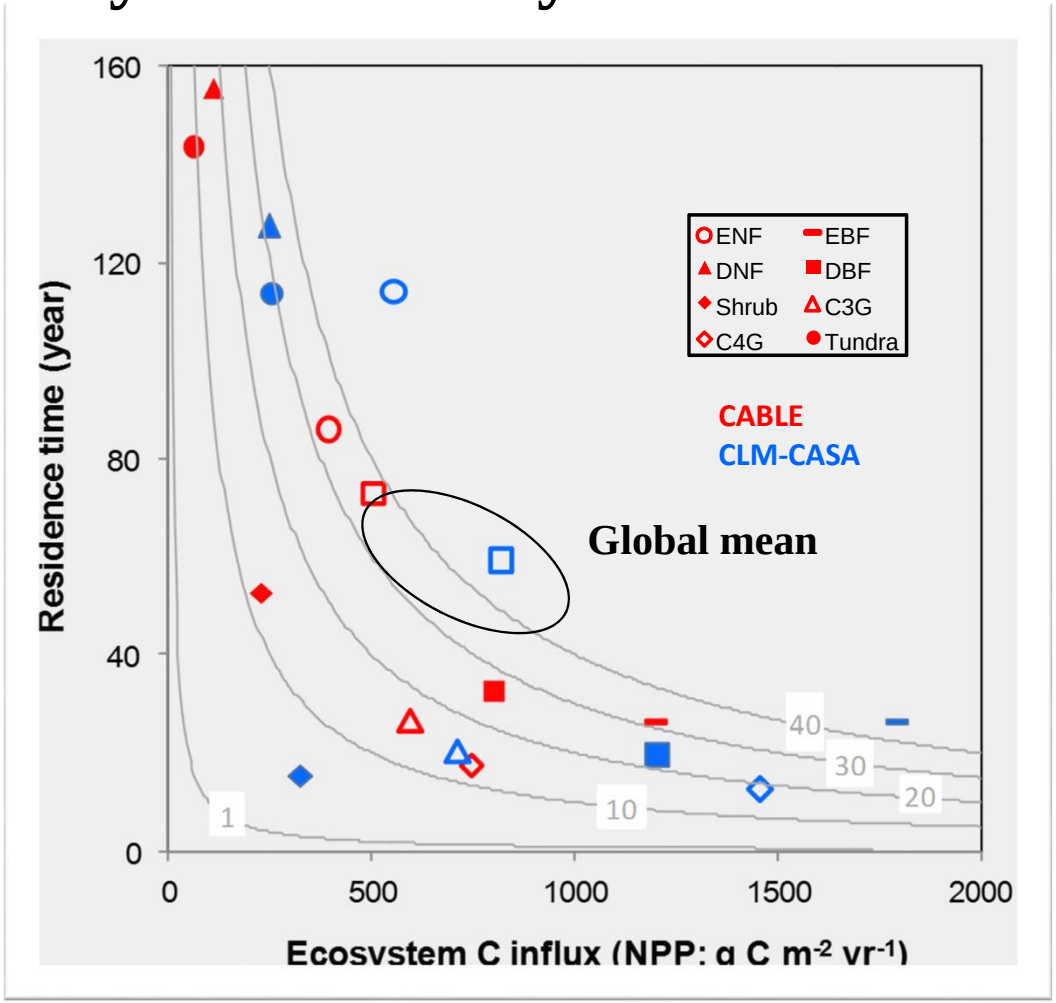




C_C	C cycle, constant climate and CO2 as 1901
C_W	C cycle, CO2 of 1901, variable climate 1901-2100
C_WC	C cycle, variable Co2 and climate
CN_C	CN cycle, constant climate and CO2 as 1901
CN_W	CN cycle, CO2 of 1901, variable climate 1901-2100
CN_WC	CN cycle, variable Co2 and climate

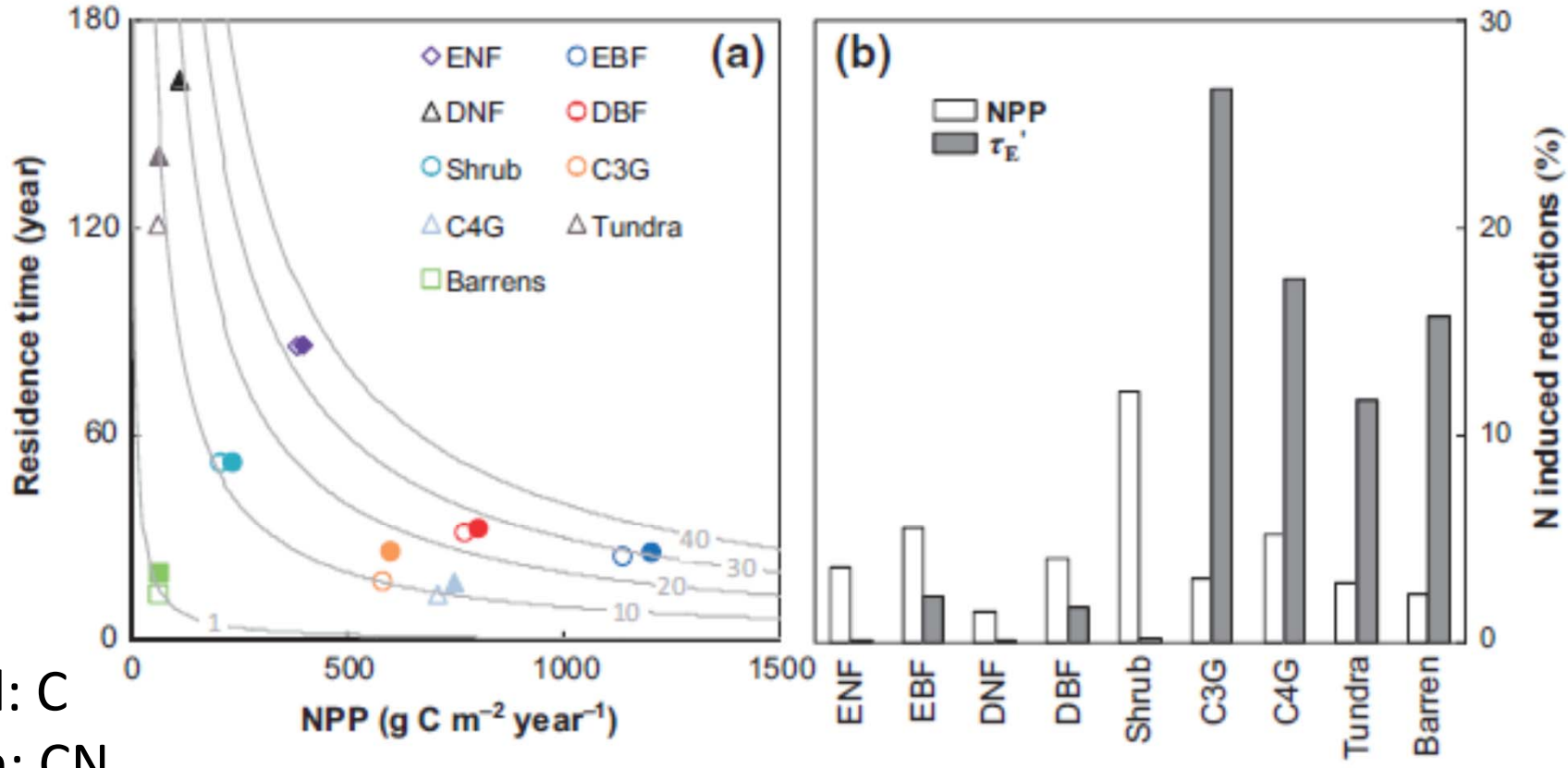
Lu et al. in prep

Application 1: diagnosing the differences in carbon storage capacity simulated by CABLE and CLM-CASA'



Rafique *et al*. 2016

Application 2: effect of nitrogen limitation



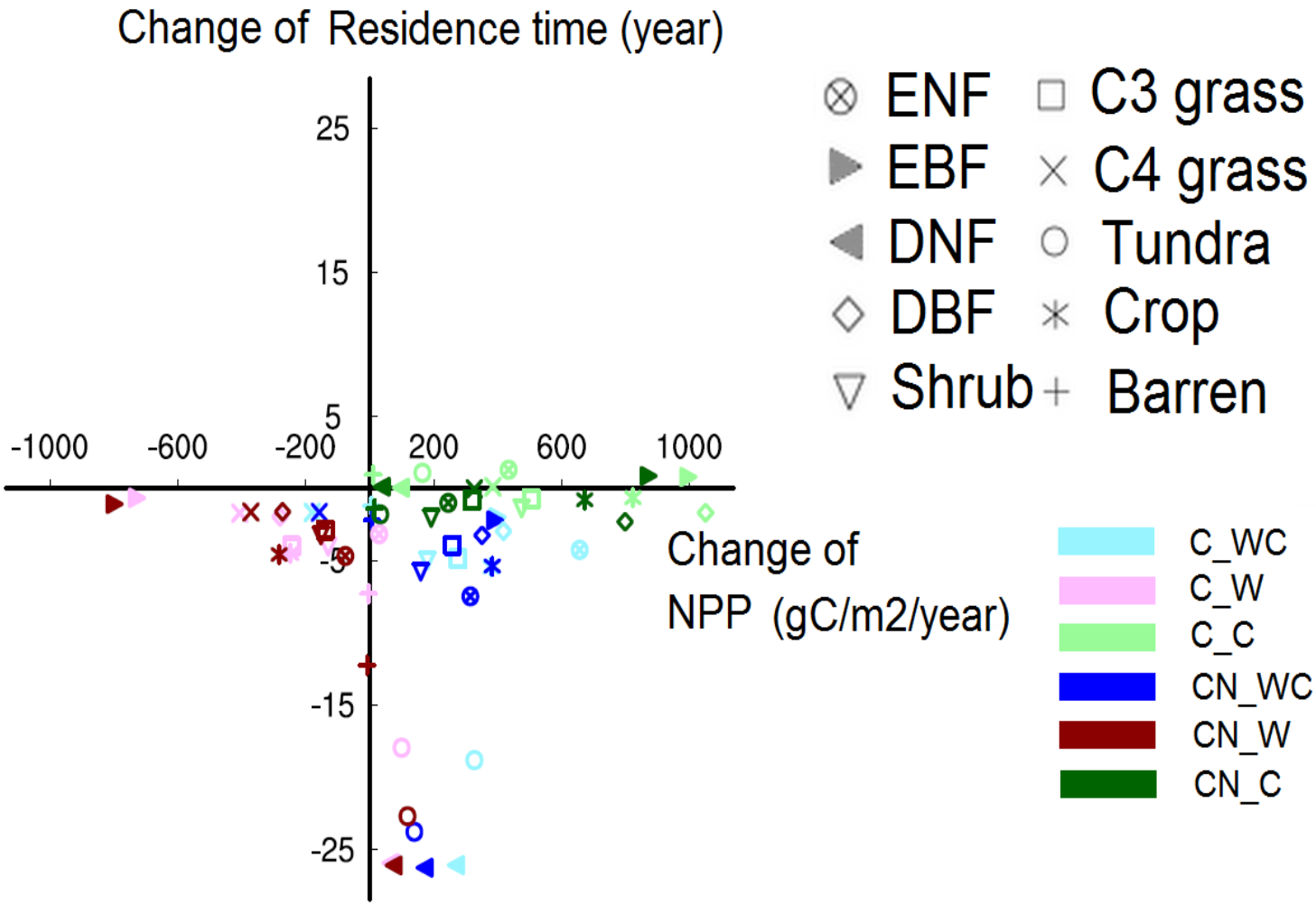
Filled: C

Open: CN

Source: Xia et al. 2013

Key papers/manuscripts

- Exbrayat et al. (2013) *Biogeosciences*, 10:7095-7108.
- Xia et al.(2013) *Global Change Biology,* 19, 2104-2116.
- Xia et al. (2015) *PNAS*, 112:2788-2793.
- Luo et al. (2016) *Global Biogeochemical Cycles,* 30:40-56.
- Rafiqu et al (2016) *Earth Syst. Dynam., 7:649-658.*
- Luo et al. (2016) *Biogeosciences Discuss*, doi:10.5194/bg-2016-377.
- Lu et al. in prep
- Xia et al. in prep.


Change of Residence time (year)
25
15
5
-5
-15
-25
-1000
-600
-200
200
600
1000
Change of
NPP (gC/m2/year)
ENF
EBF
DNF
DBF
Shrub
C3 grass
C4 grass
Tundra
Crop
Barren
C_WC
C_W
C_C
CN_WC
CN_W
CN_C