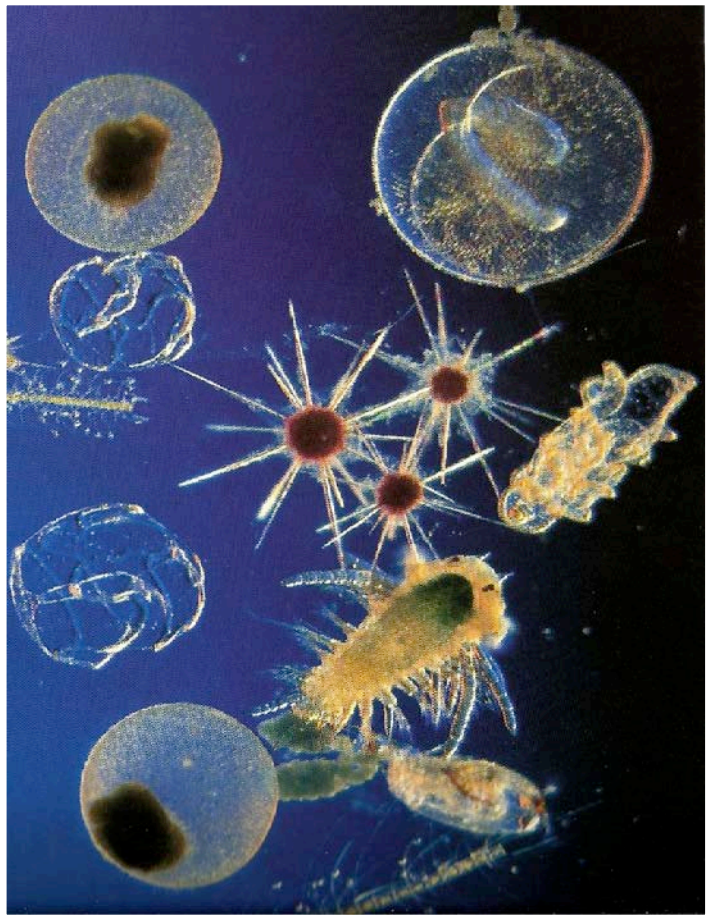
Representing life in the Earth system



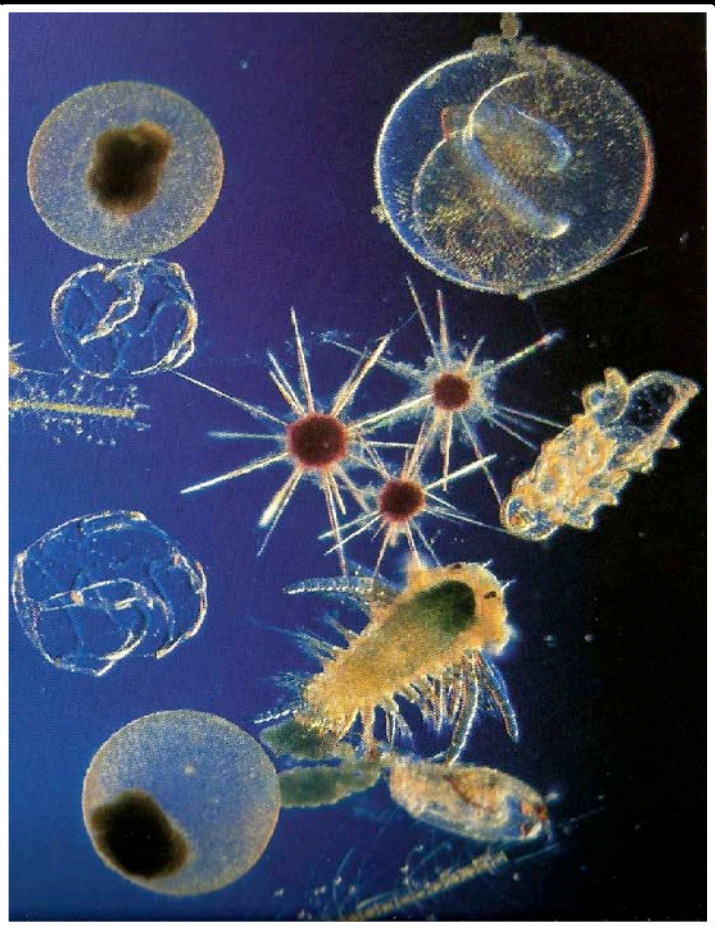
Will Wieder

Stuart Grandy, Cythia Kallenbach, Gordon Bonan

CESM Workshop June 2014

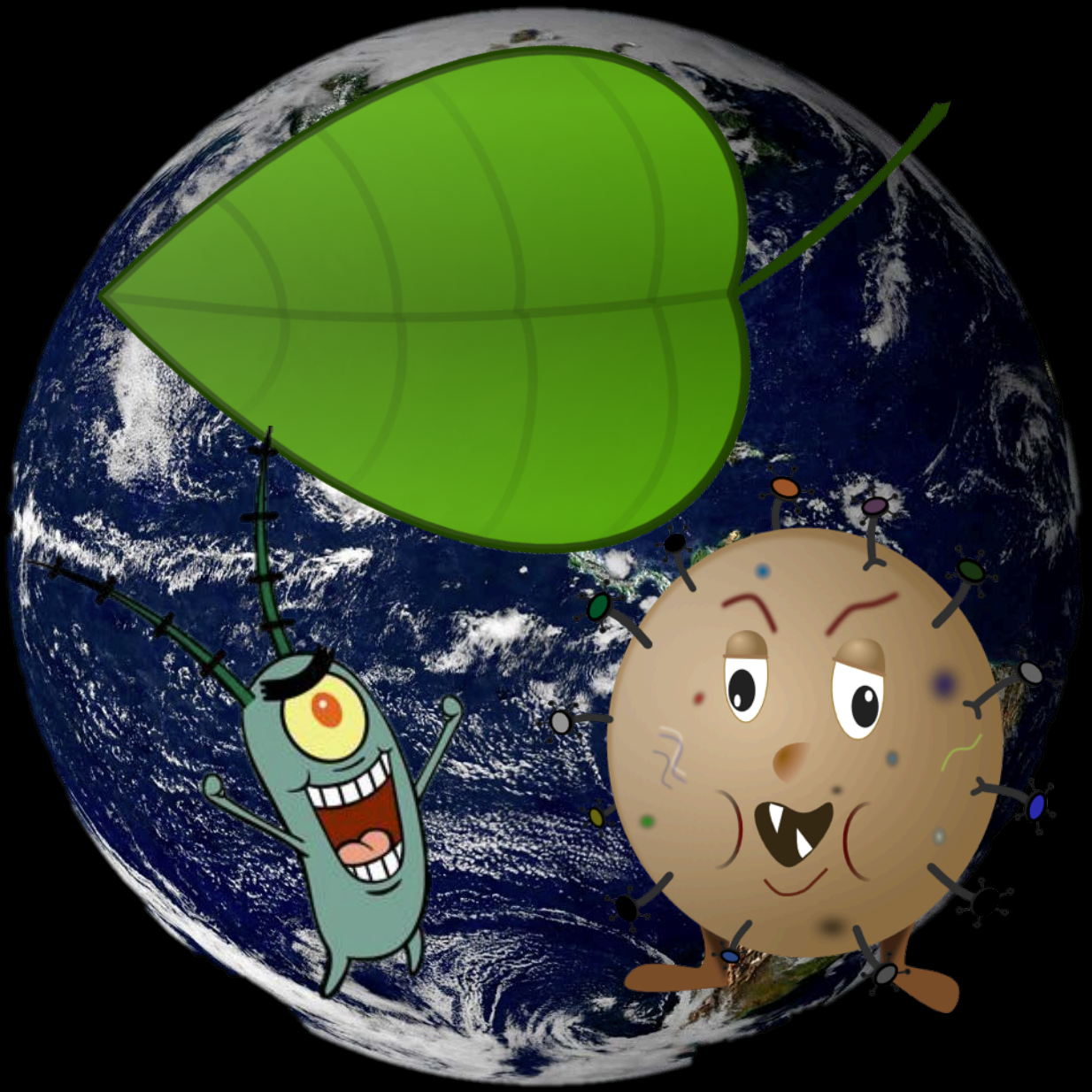
NCAR

We simulate **diversity** on land and sea



can we in **soils?**

Functional traits and the global C cycle



Diverse ways to make a living…

in **soil**

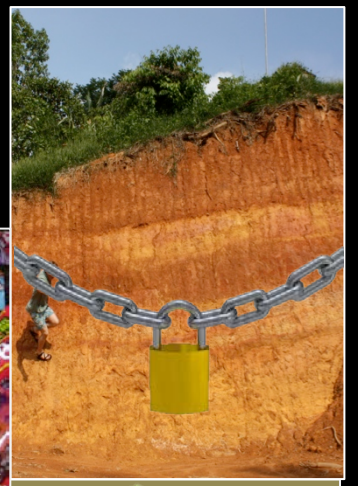
Functional traits

Plant Litter

Microbes

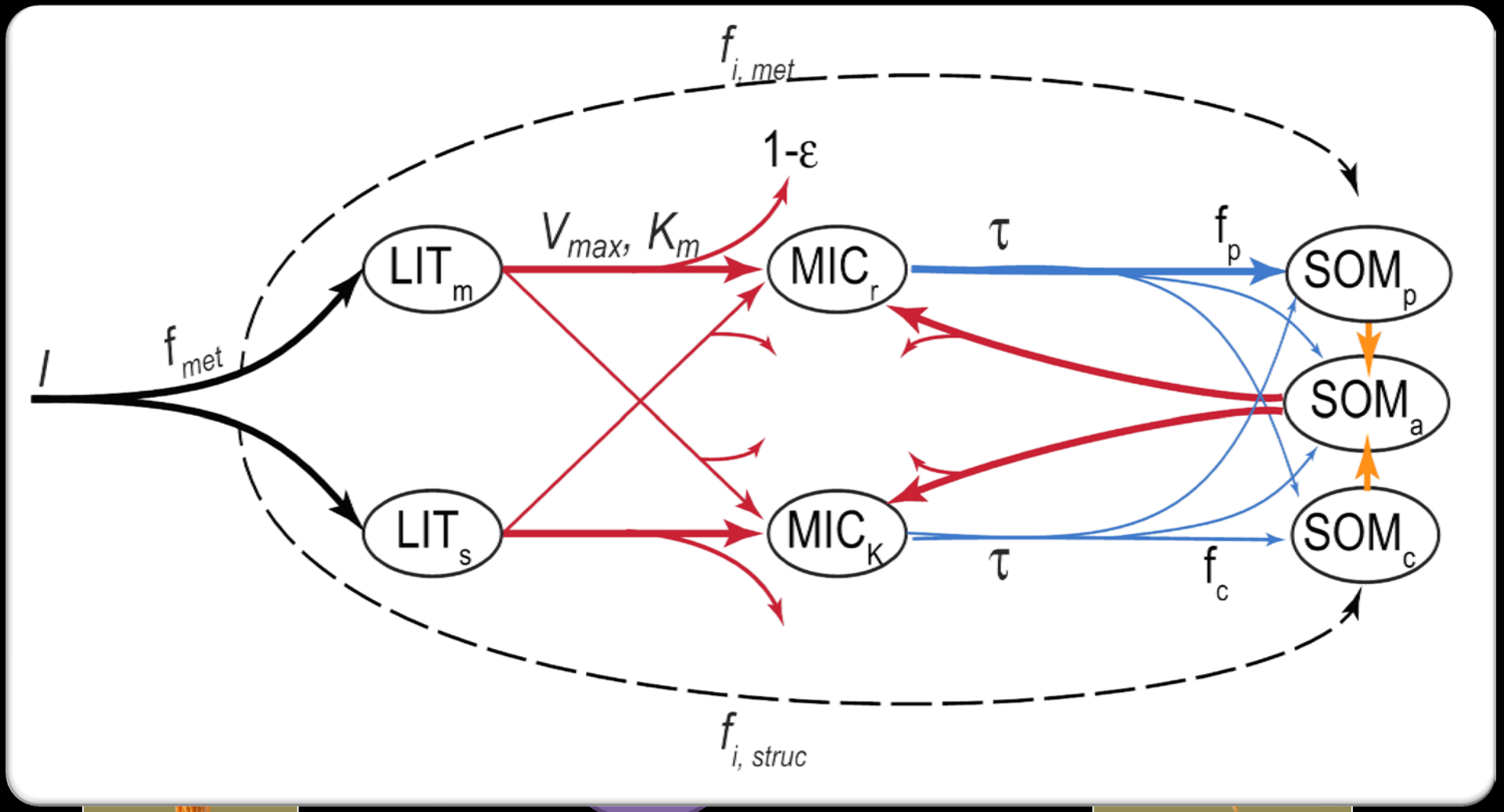
Soil Organic Matter

Fast



Slow

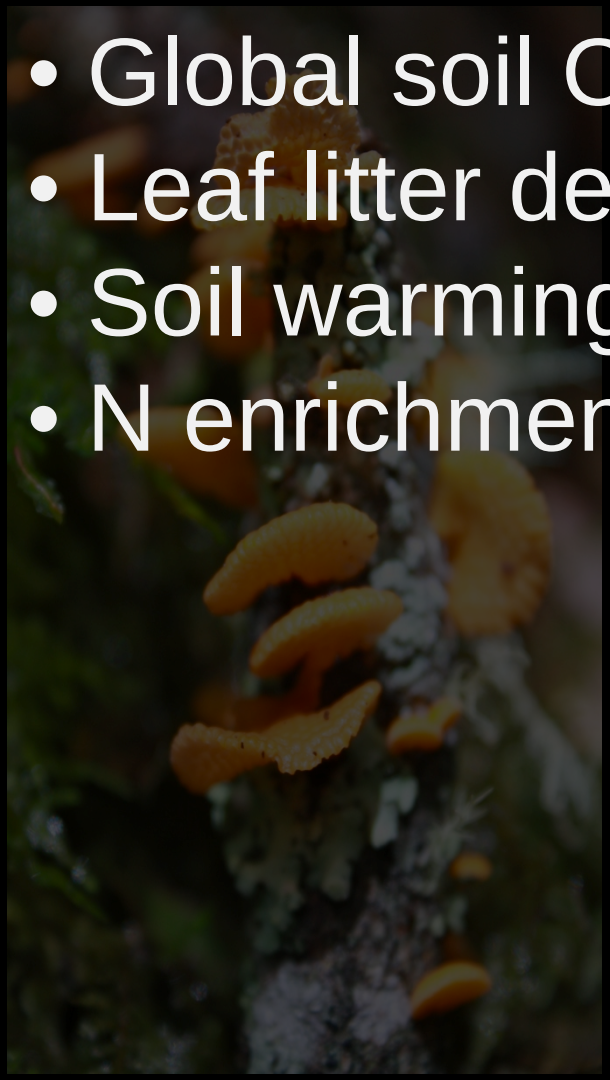
MIcrobial-**MI**neral **C**arbon **S**tabilization **MIMICS** model

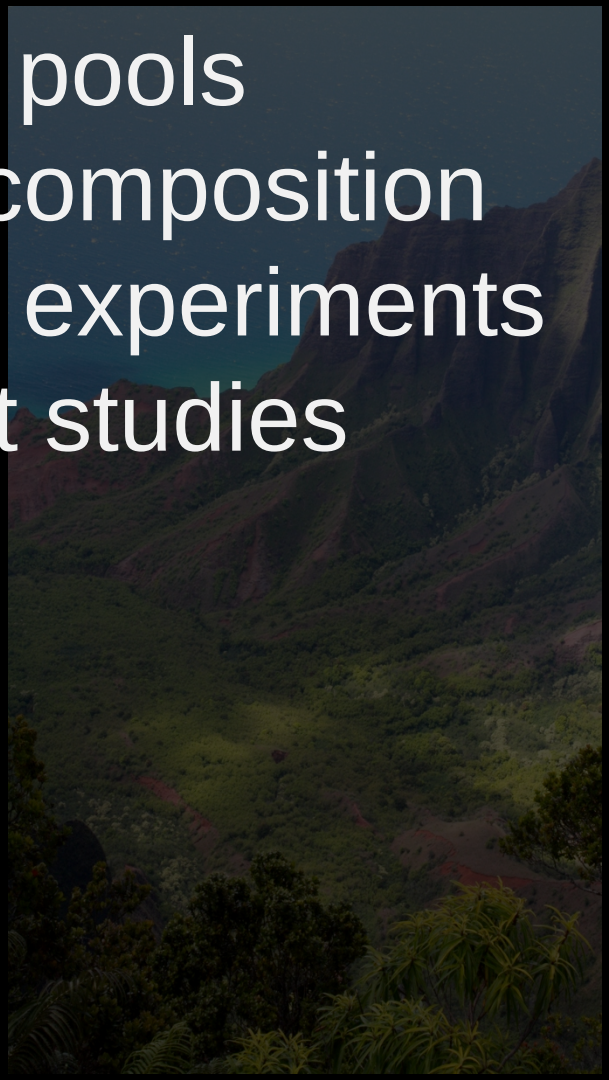


Wieder et al. *Biogeosciences* 2014

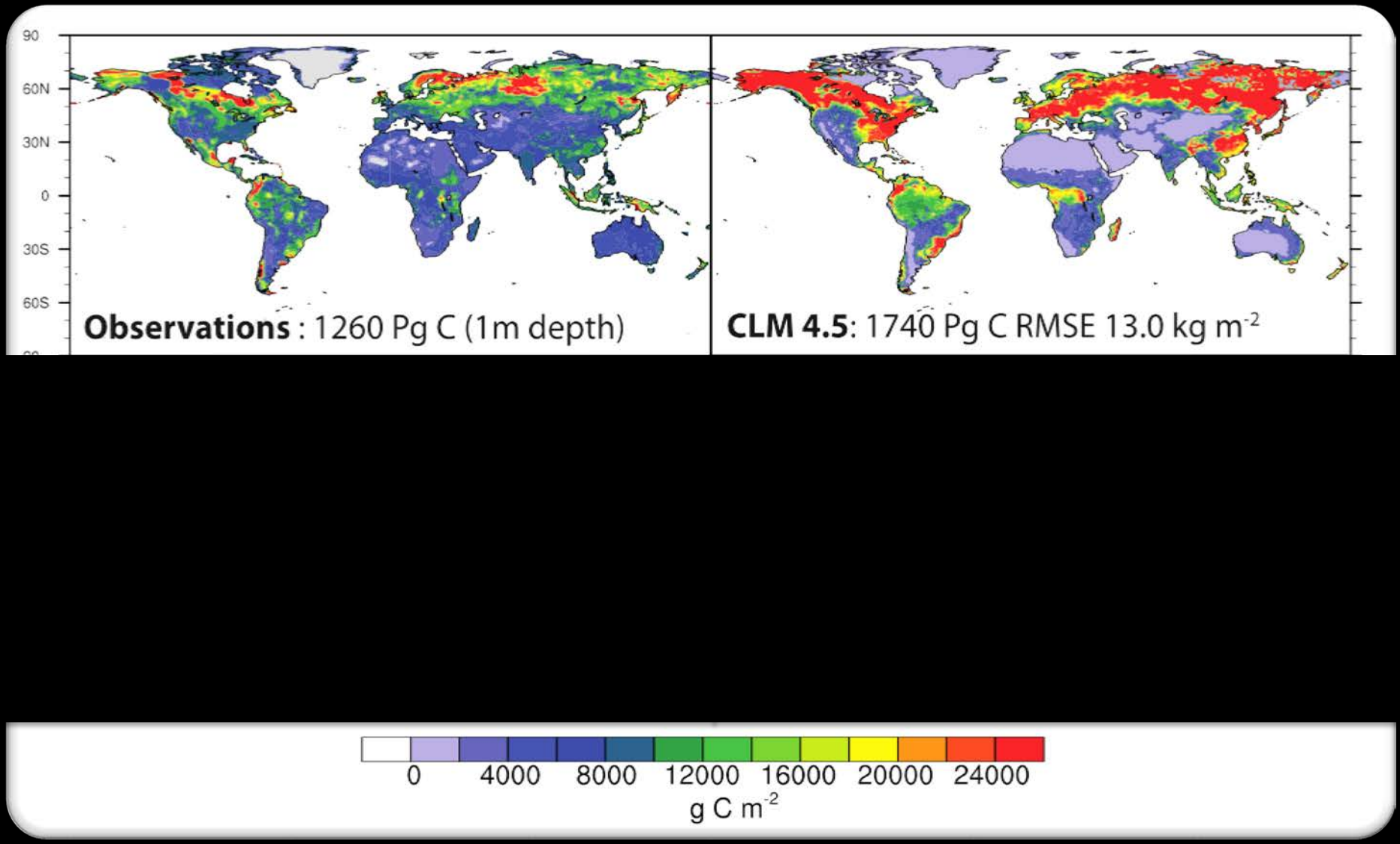
Evaluation across scales

- Global soil C pools
- Leaf litter decomposition
- Soil warming experiments
- N enrichment studies



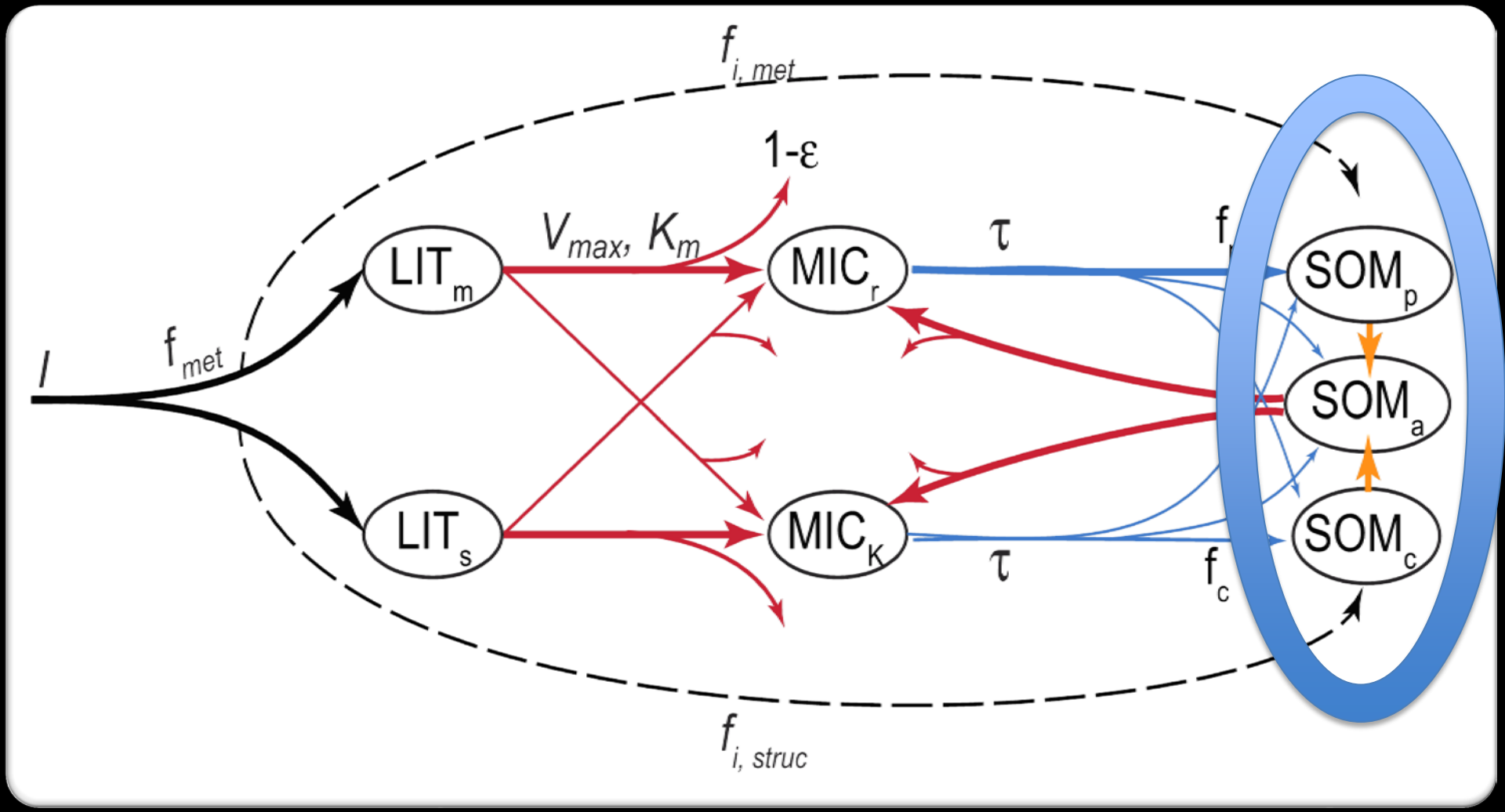


a) Global carbon pools



* 0-100cm, all models w/ same forcing from CLM4.5 output

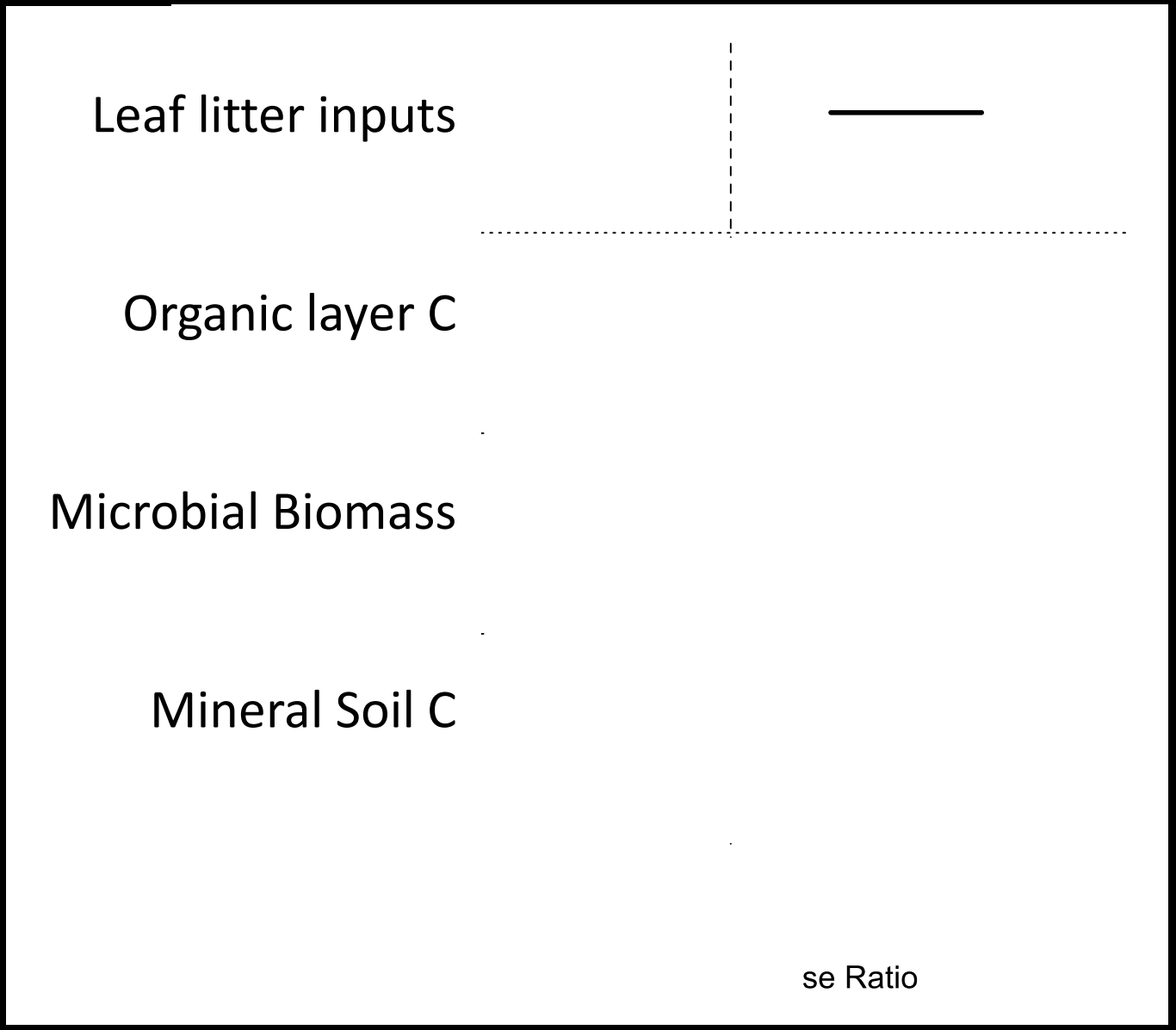
a) Global carbon pools



b) Response to N enrichment

Wieder et al. In prep

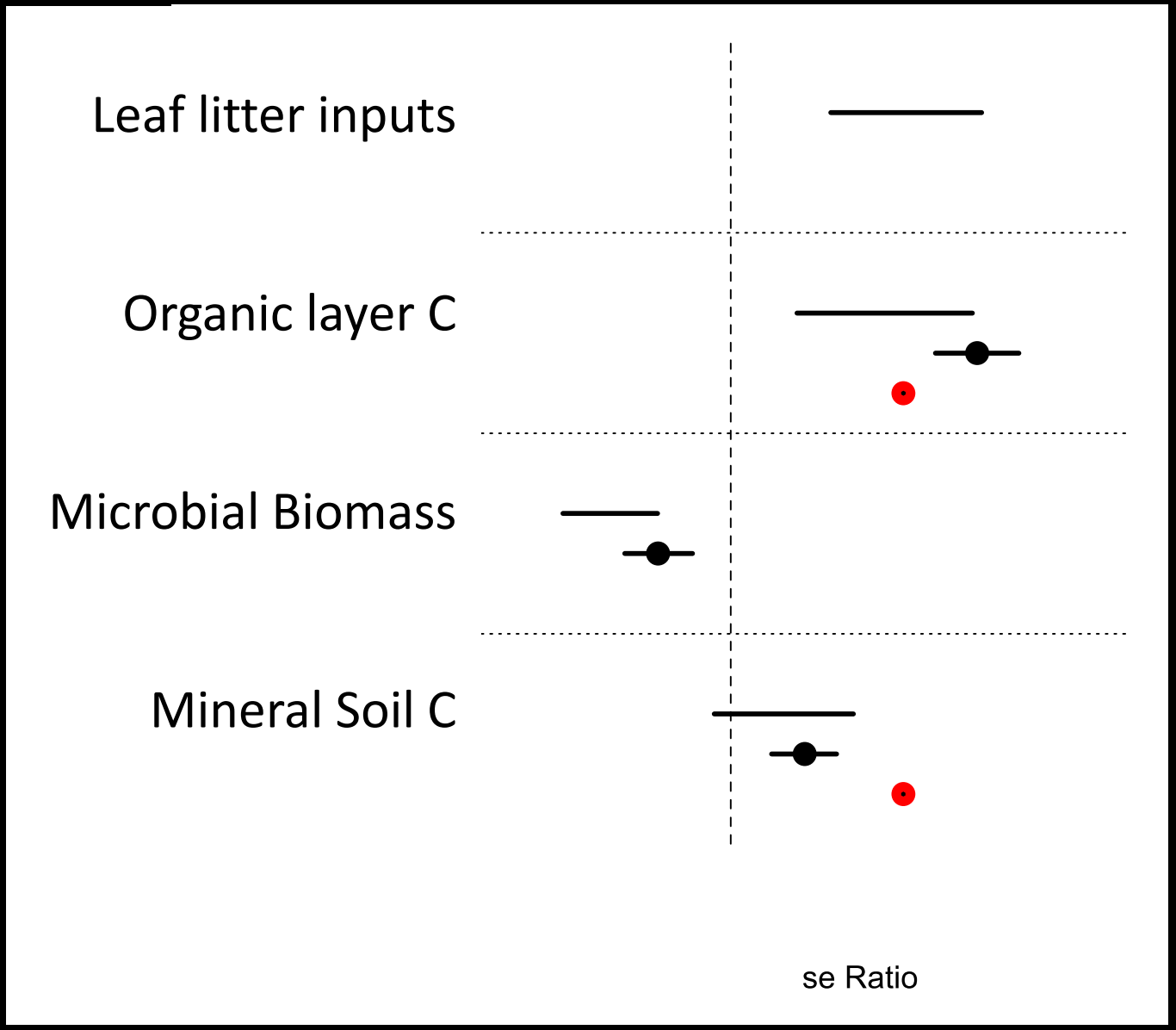
b) Response to N enrichment



Observed
MIMICS
DAYCENT

Wieder et al. In prep
Liu & Greaver *Eco. Lett*. 2010

b) Response to N enrichment



Observed
MIMICS
DAYCENT

Fast

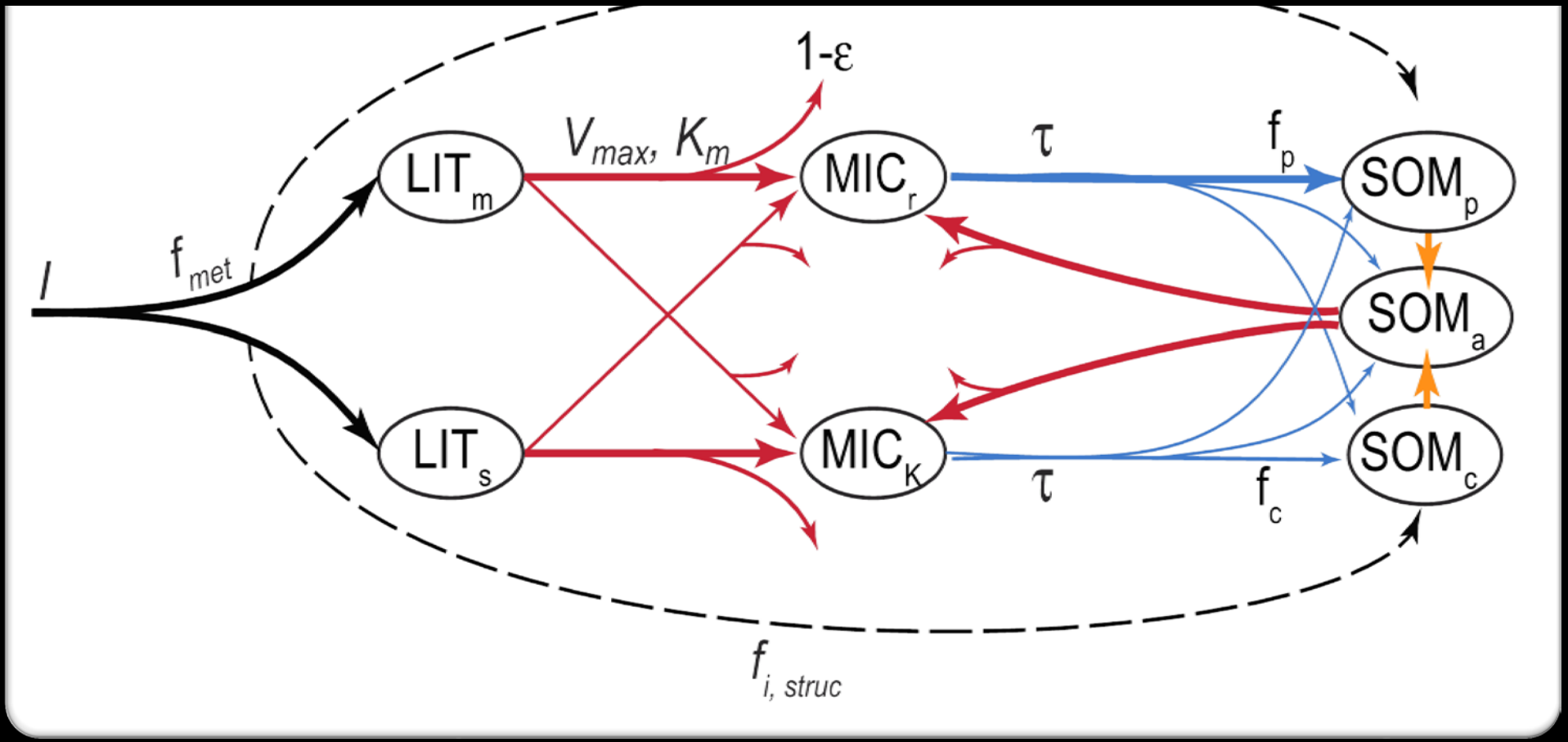
Slow

Wieder et al. In prep

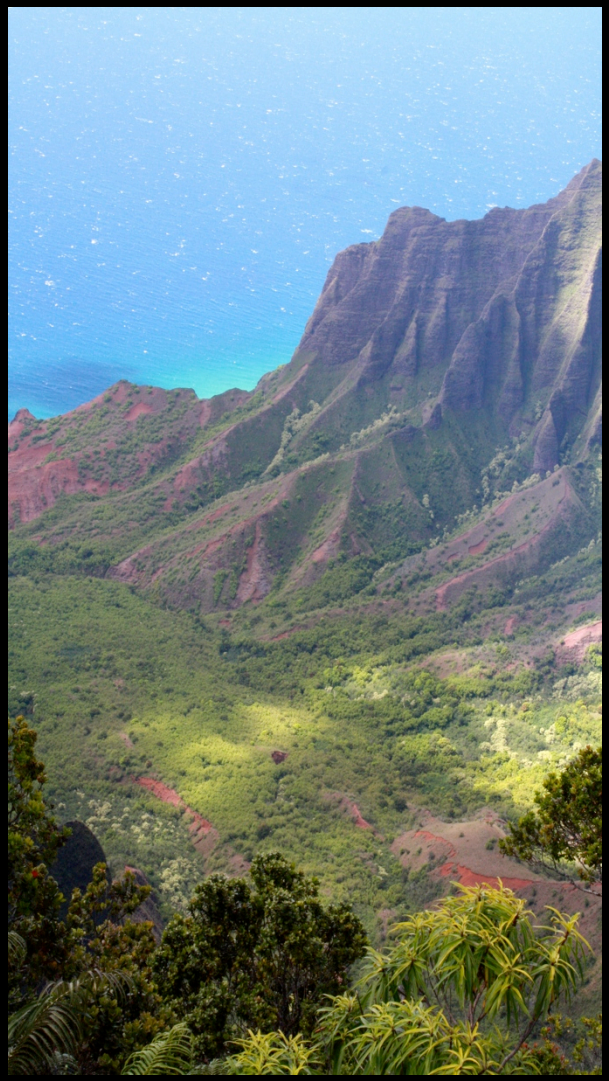
Liu & Greaver *Eco. Lett*. 2010

b) Response to perturbations

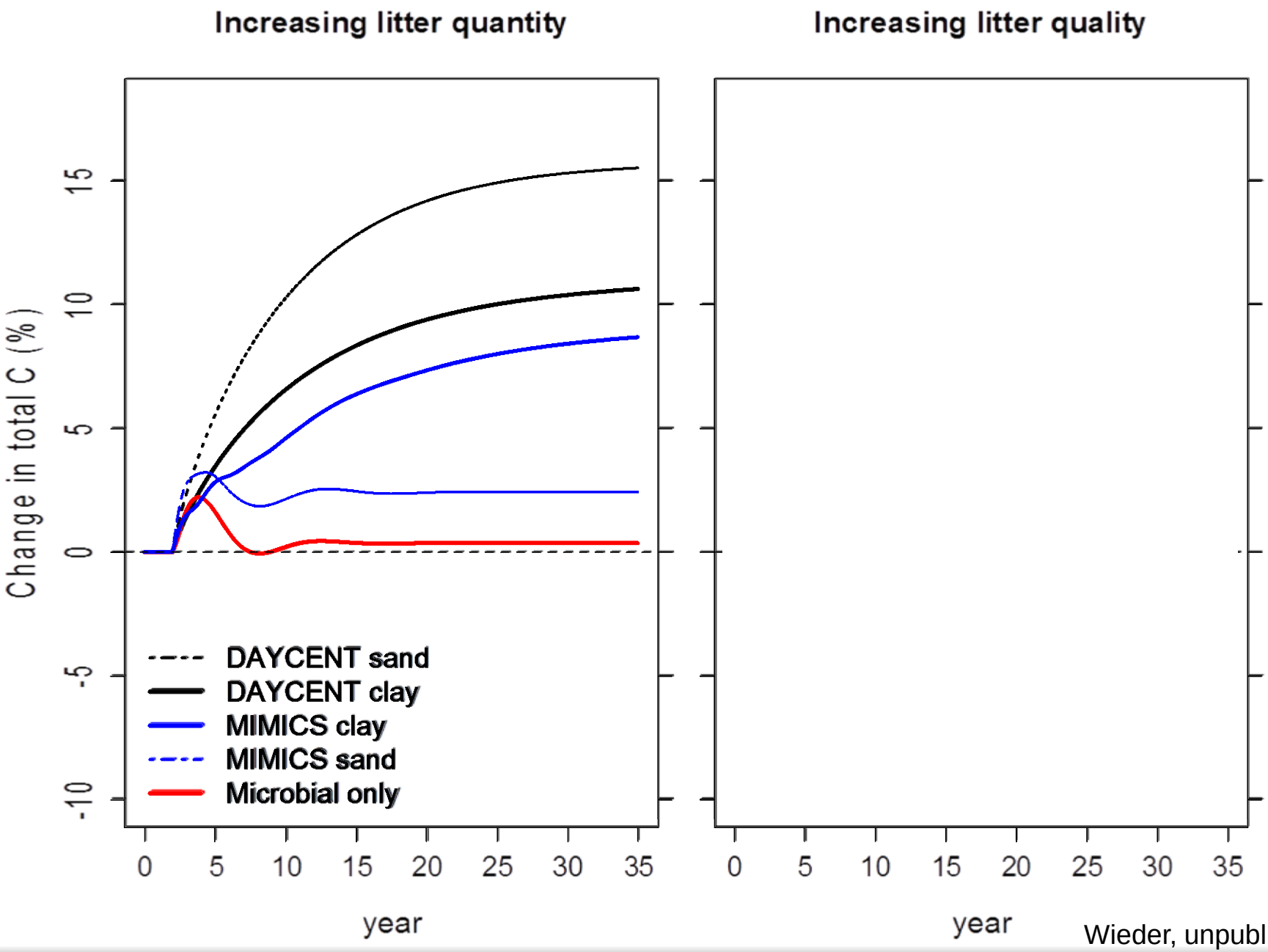
\+ \+ - +



Evaluation across scales…

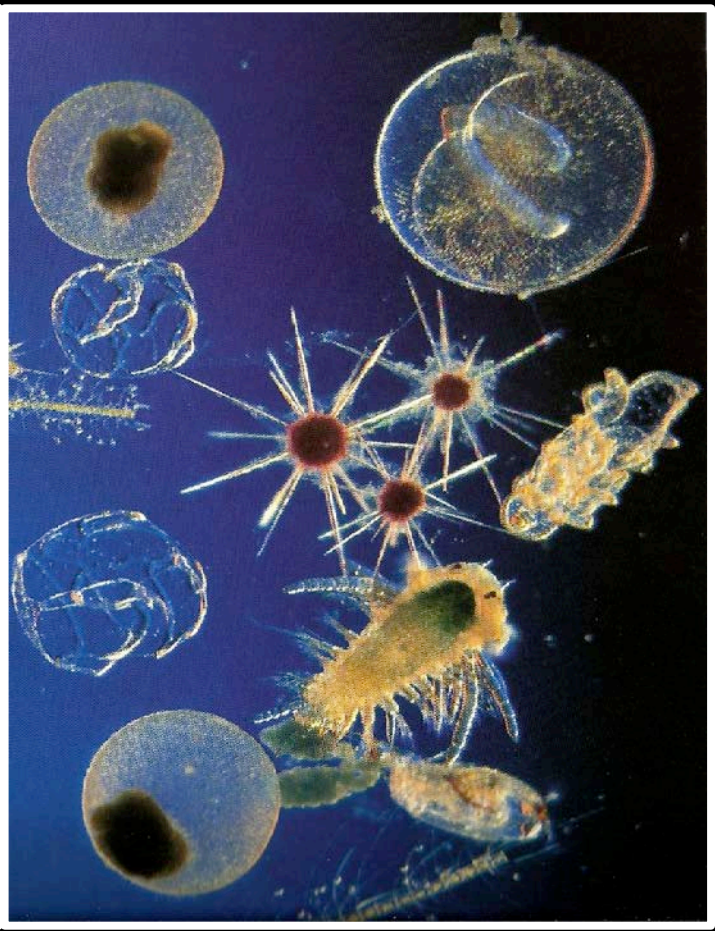


Response to perturbations



Wieder, unpublished

We simulate **diversity** on land and sea

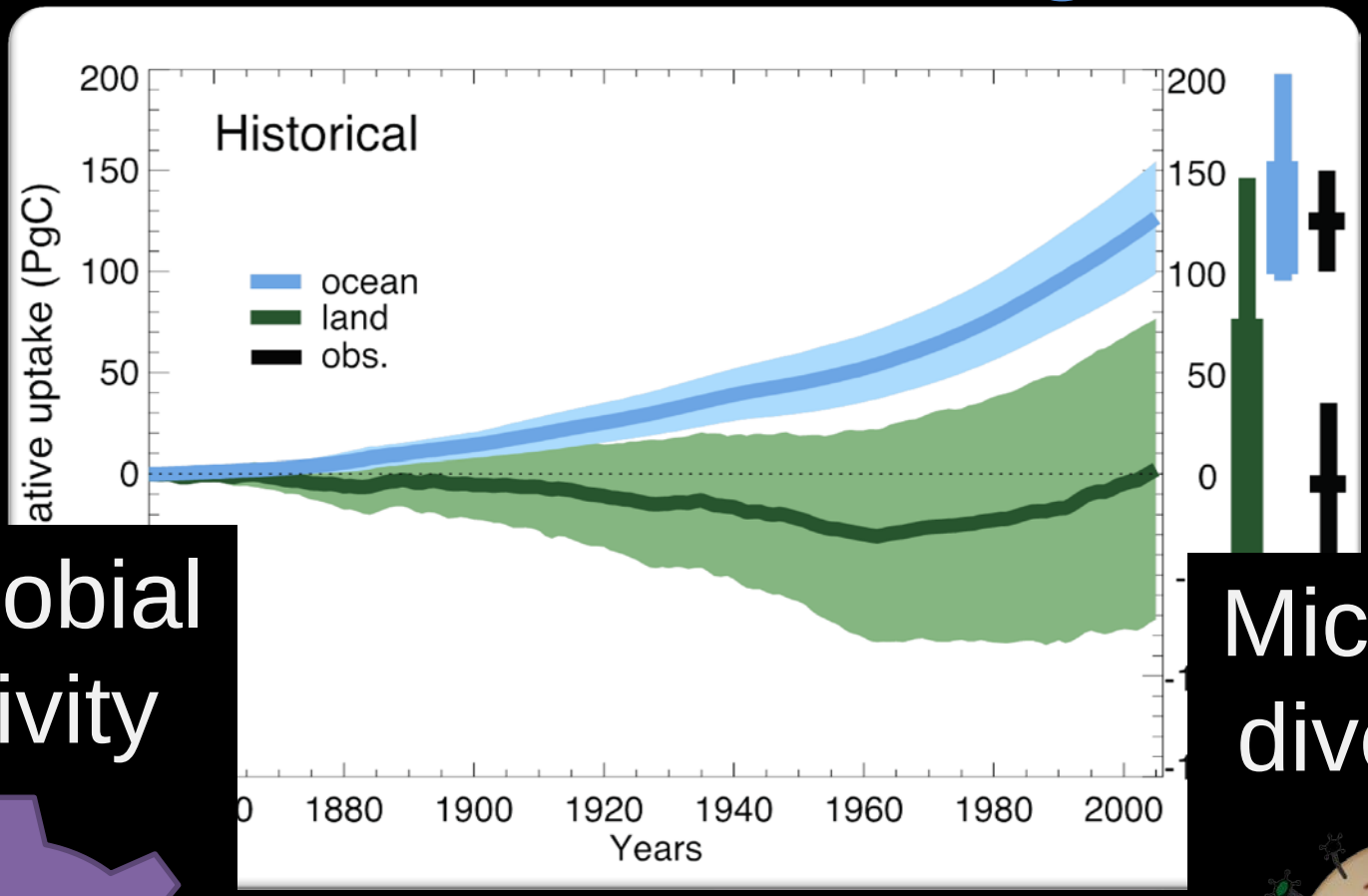


can we in **soils?**

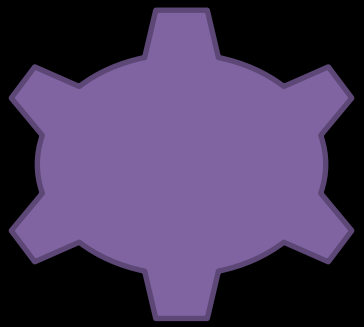
YES, and it improves simulations

Reducing uncertainty

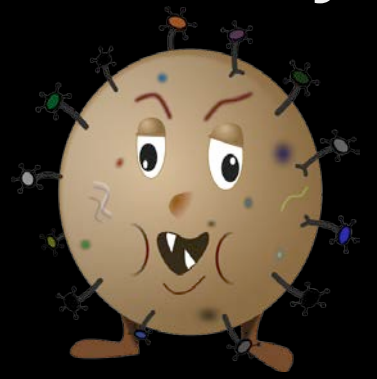
…for the **right** reasons.



Microbial activity

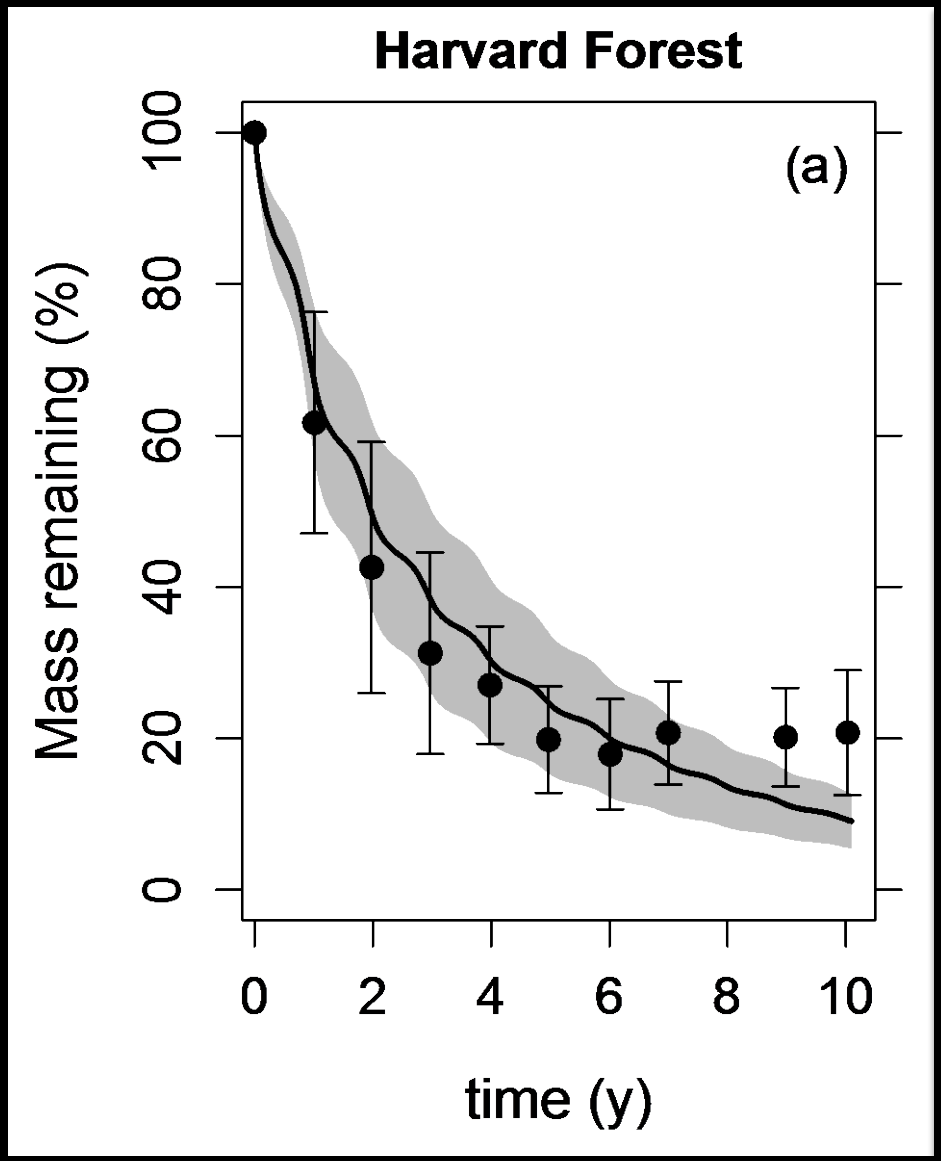


Microbial diversity



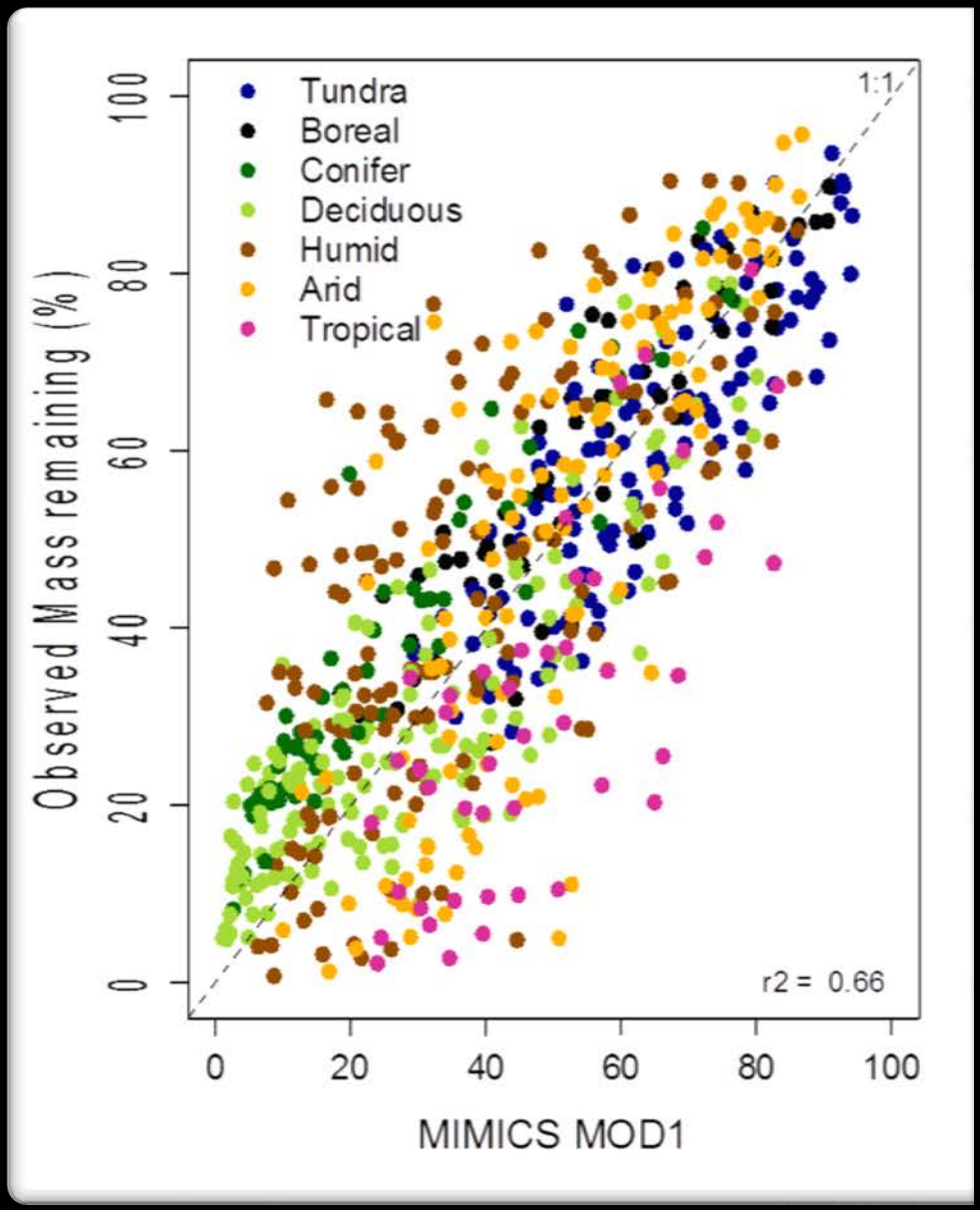
Thank you

b) Process representation: LIDET



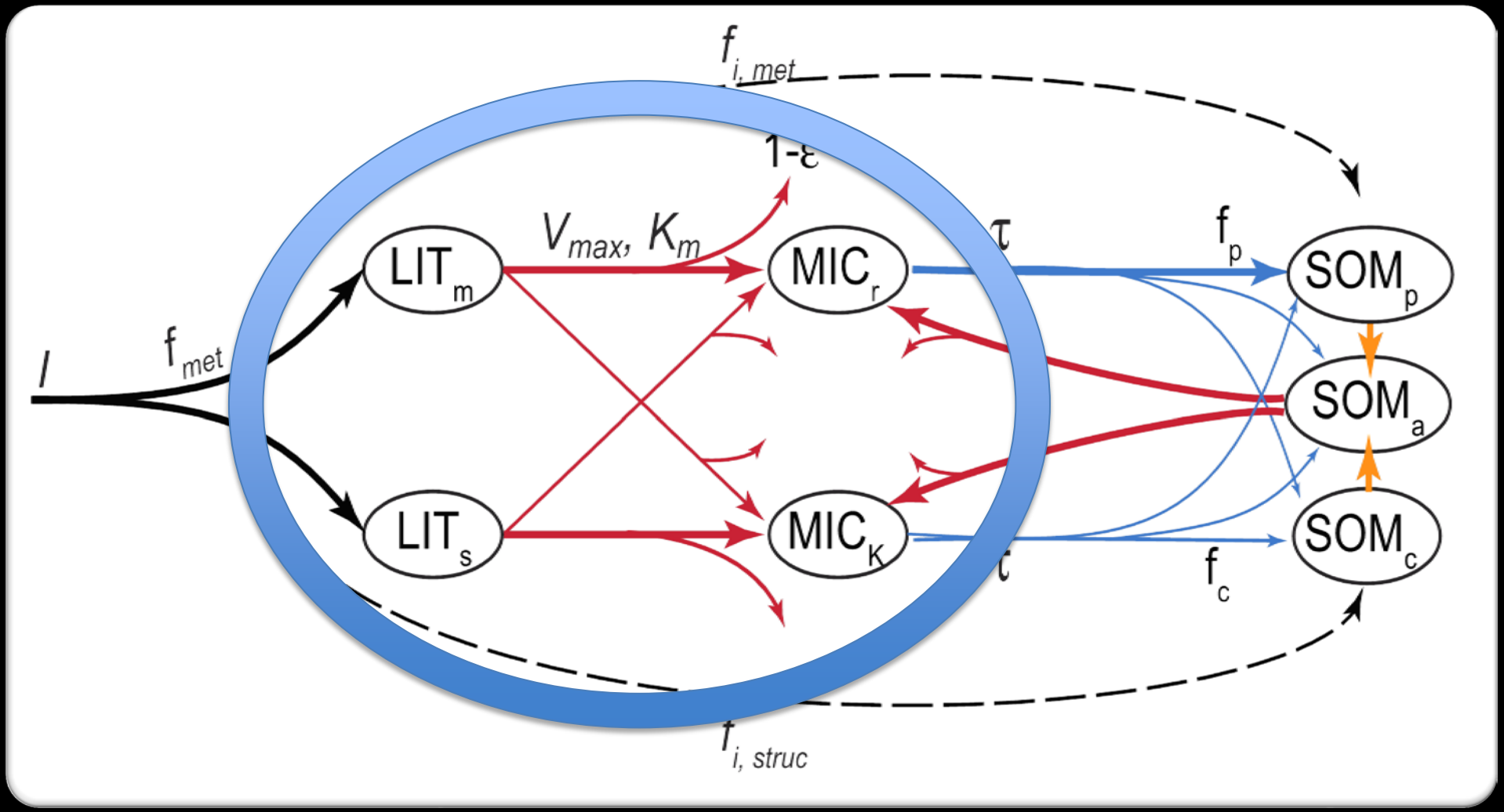
Wieder et al. *BGD* 2014; see also Bonan et al. GCB 2013

b) Process representation: LIDET



Wieder et al. in prep; see also Bonan et al. GCB 2013

b) Process representation: LIDET



Wieder et al. *Biogeosciences Discussions* 2014

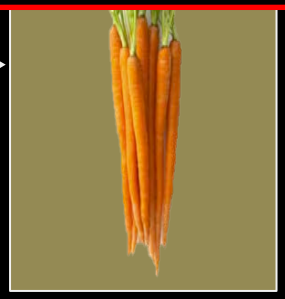
Microbial implicit

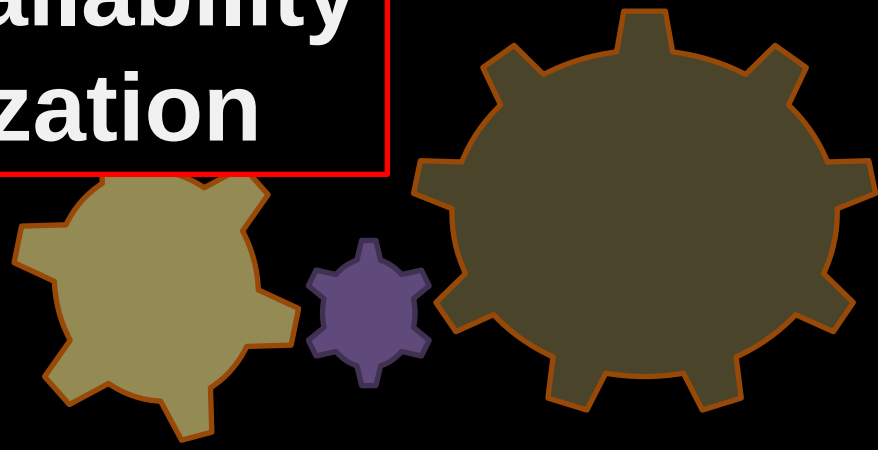
Microbial Explicit

Substrate quality

Microbial activity

Substrate availability
Soil C Stabilization





DAYCENT
CLM 4.5
CLM 4.0

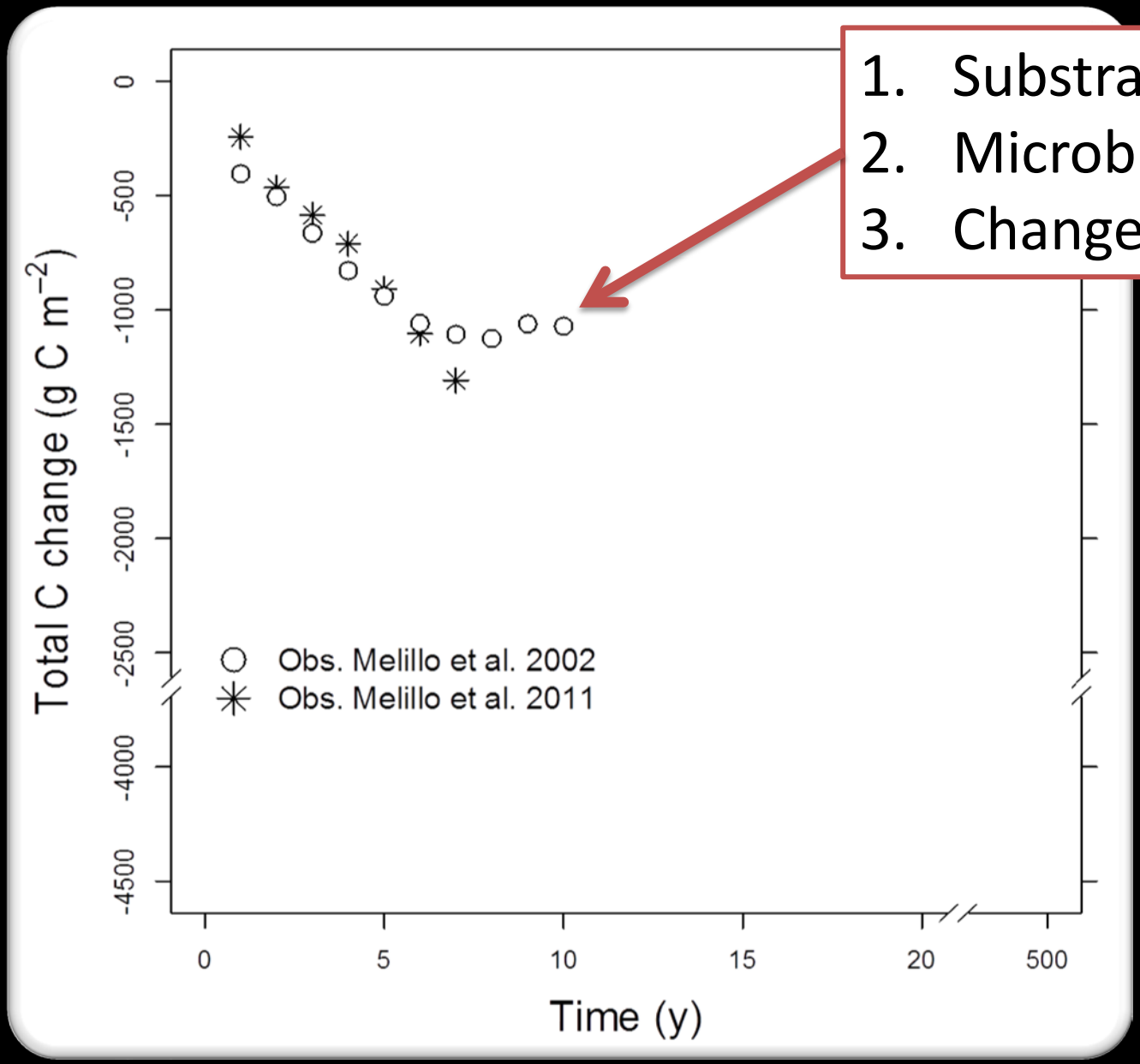
CLM^3

c) Response Perturbations

- Soil Warming
- N Enrichment

http://www.umass.edu/newsoffice

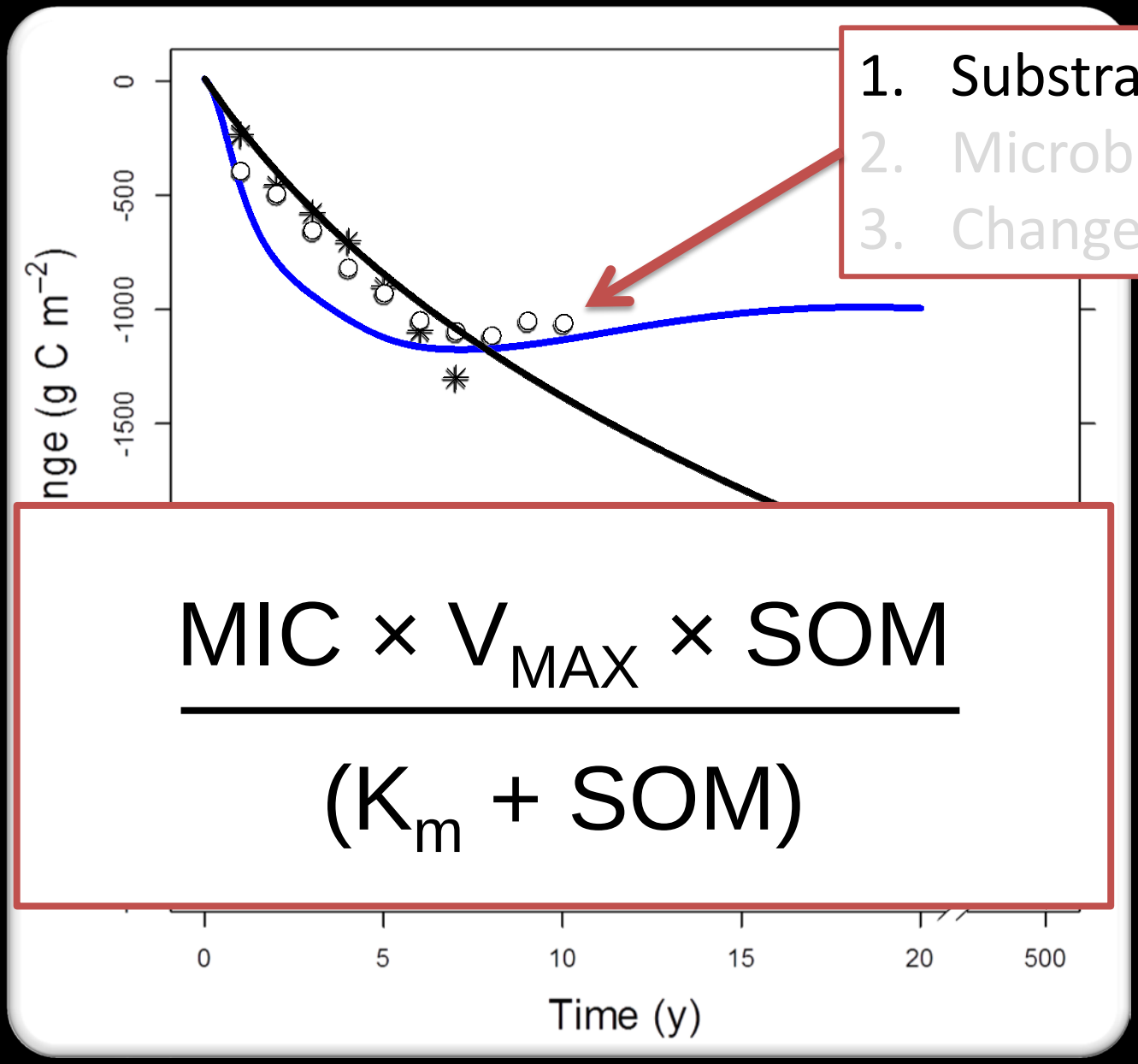
c) Response to Soil Warming, HFR



1. Substrate limitation
2. Microbial acclimation
3. Change C inputs

Wieder et al. In prep

c) Response to Soil Warming, HFR



1. Substrate limitation
2. Microbial acclimation
3. Change C inputs

$$\frac{MIC \times V_{MAX} \times SOM}{(K_m + SOM)}$$

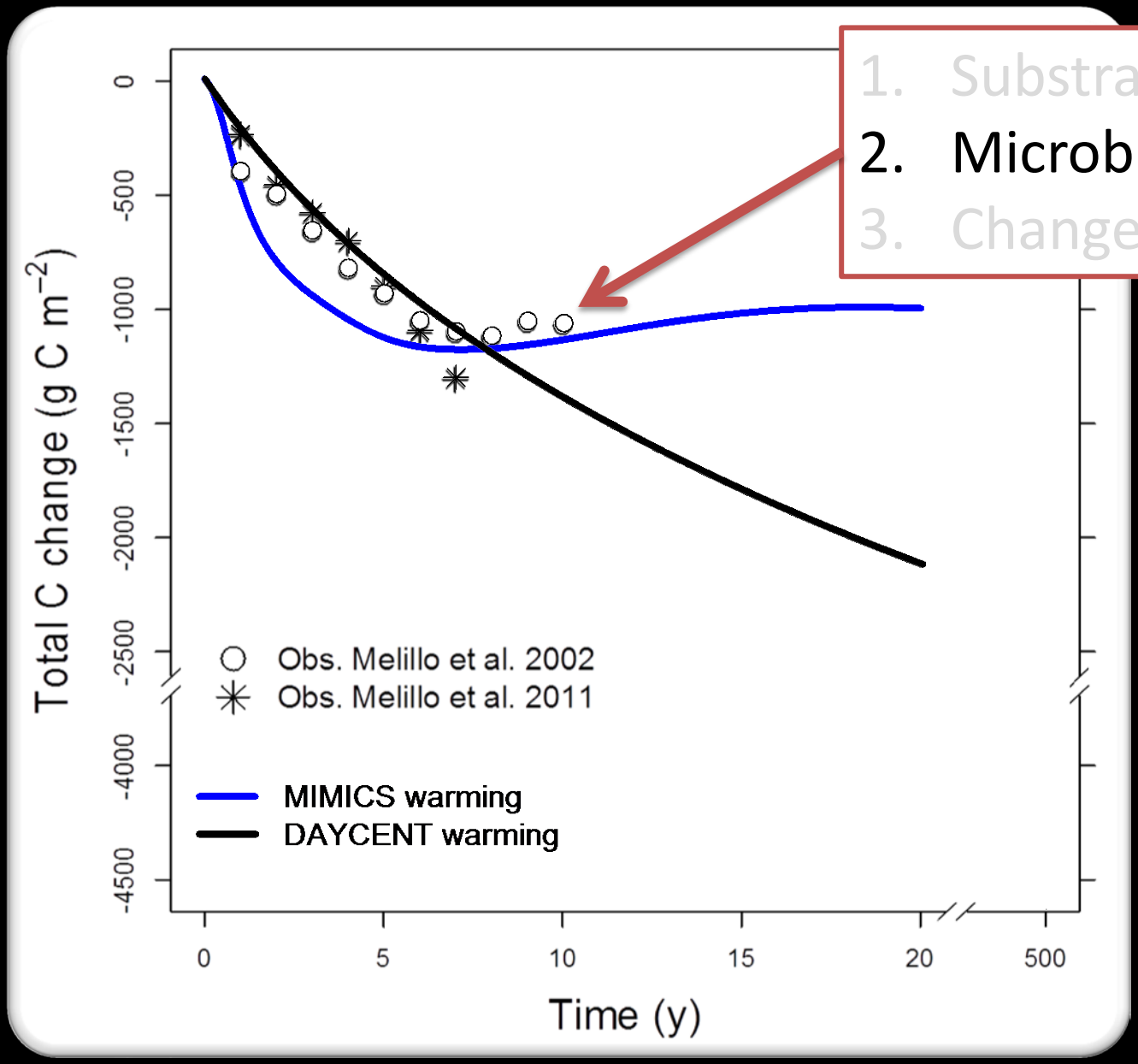
Wieder et al. In prep

c) Response to Soil Warming, HFR

1. Substrate limitation
2. Microbial acclimation
3. Change C inputs

Wieder et al. In prep

c) Response to Soil Warming, HFR



1. Substrate limitation
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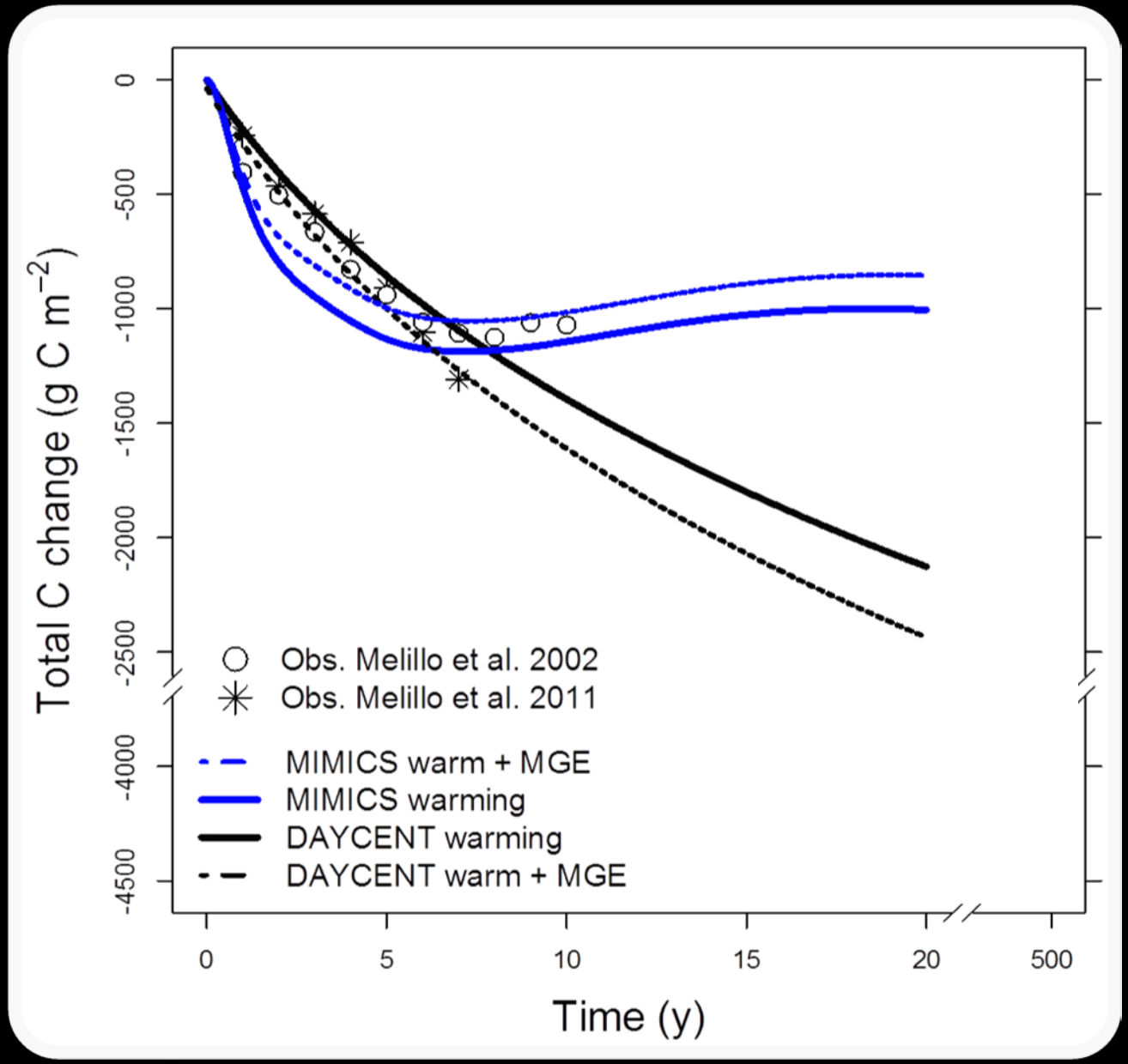
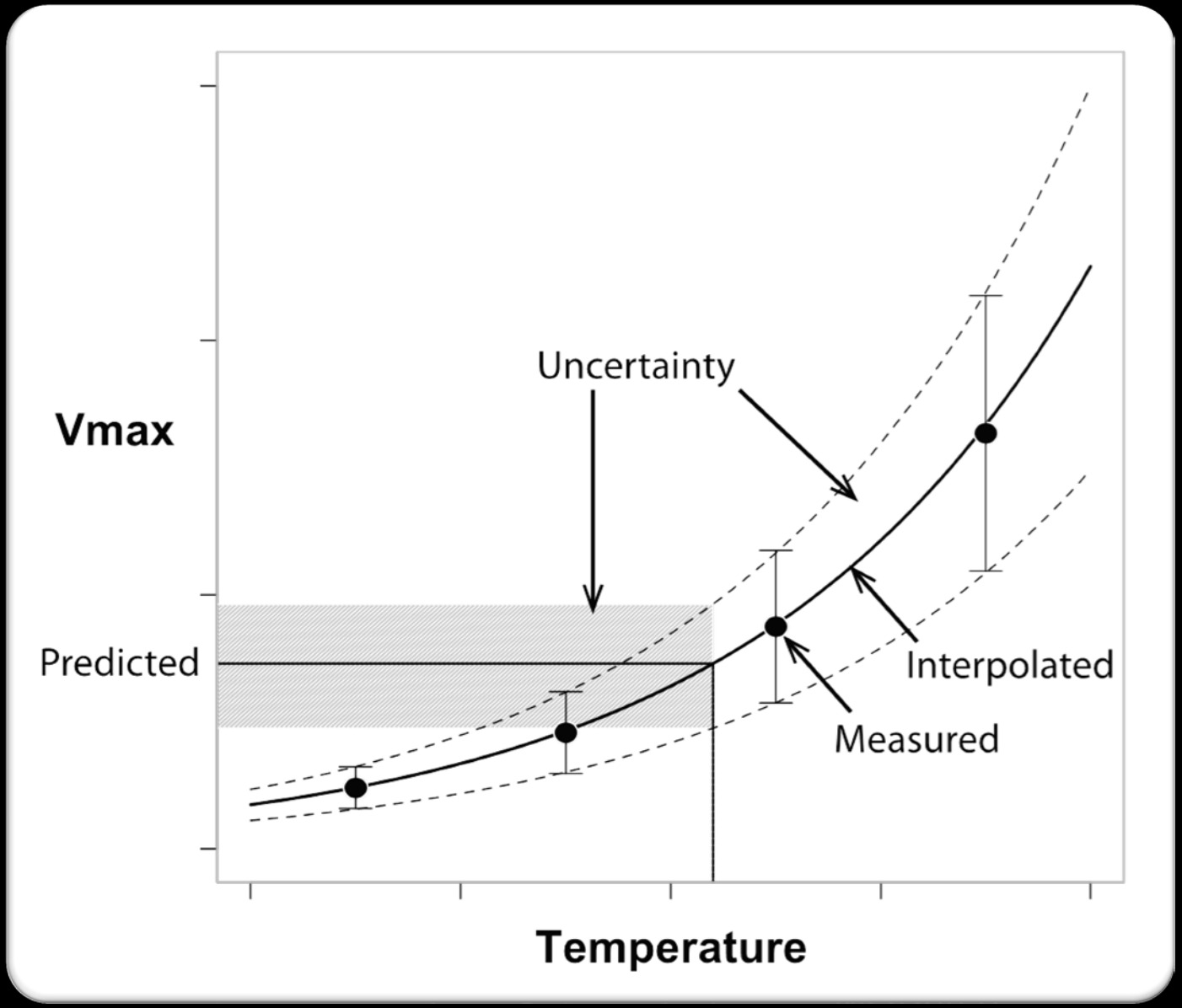
Wieder et al. In prep

c) Response to Soil Warming, HFR

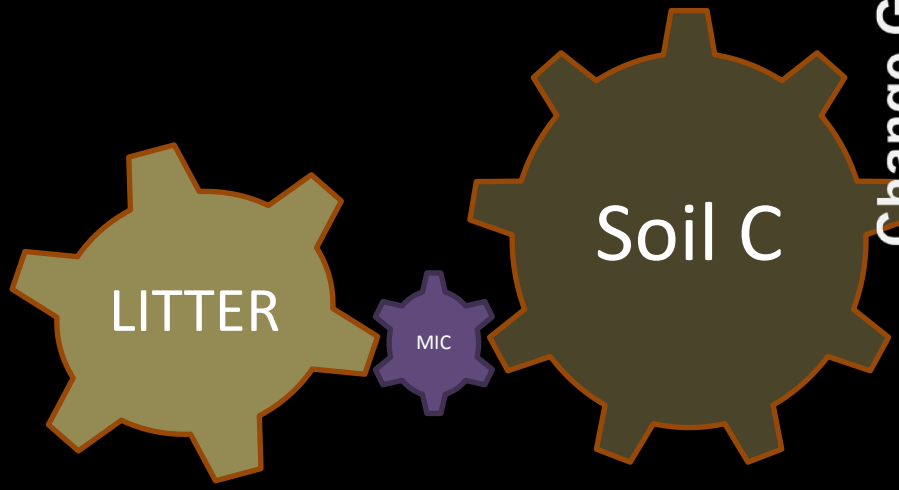


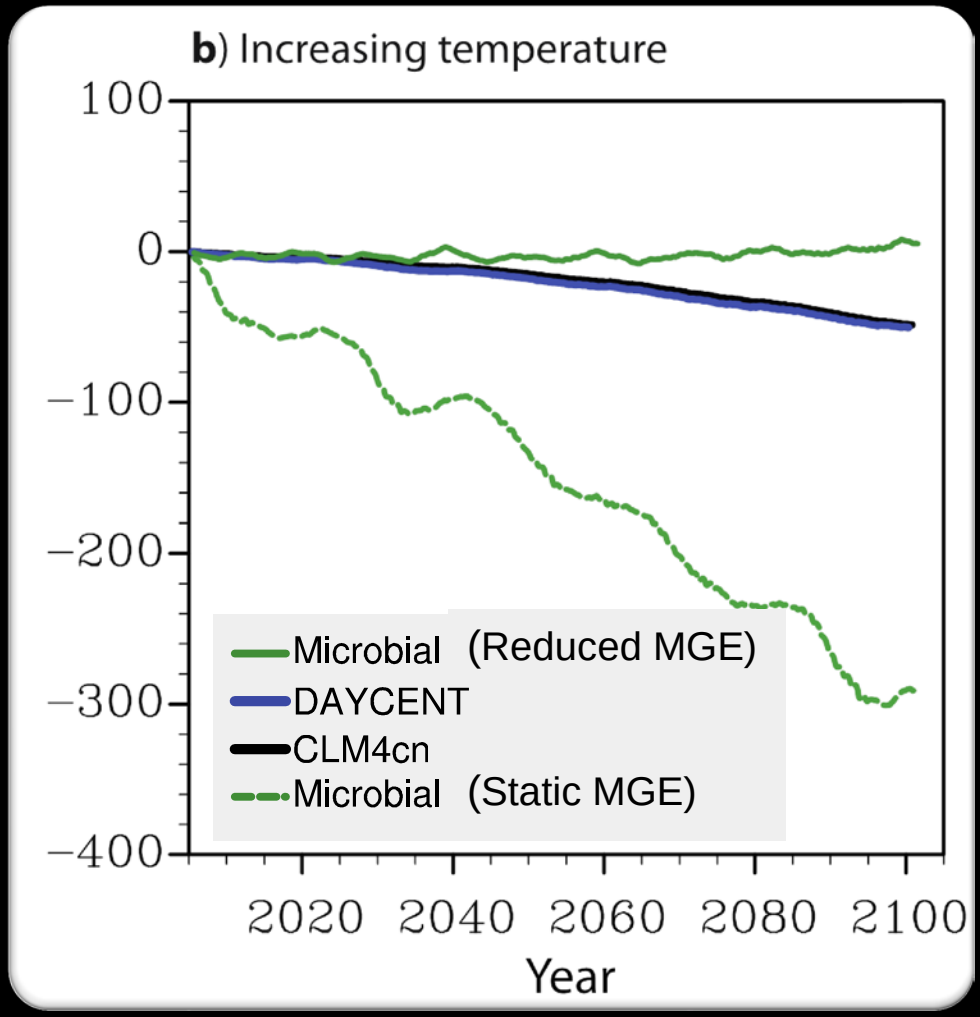
Wieder et al. In prep

Scaling microbial traits



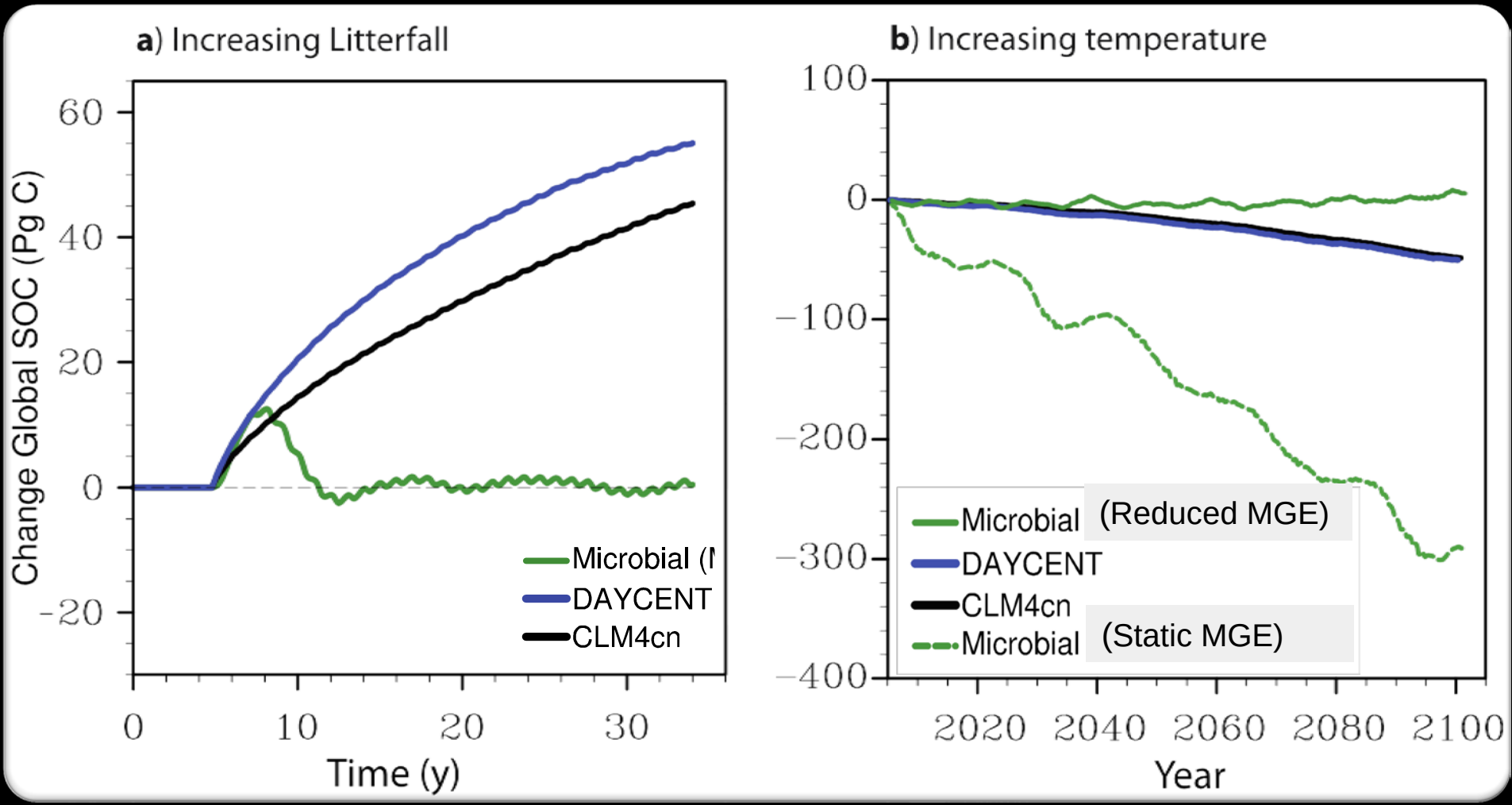
Global change response





Wieder *et al.* Nature Climate Change 2013

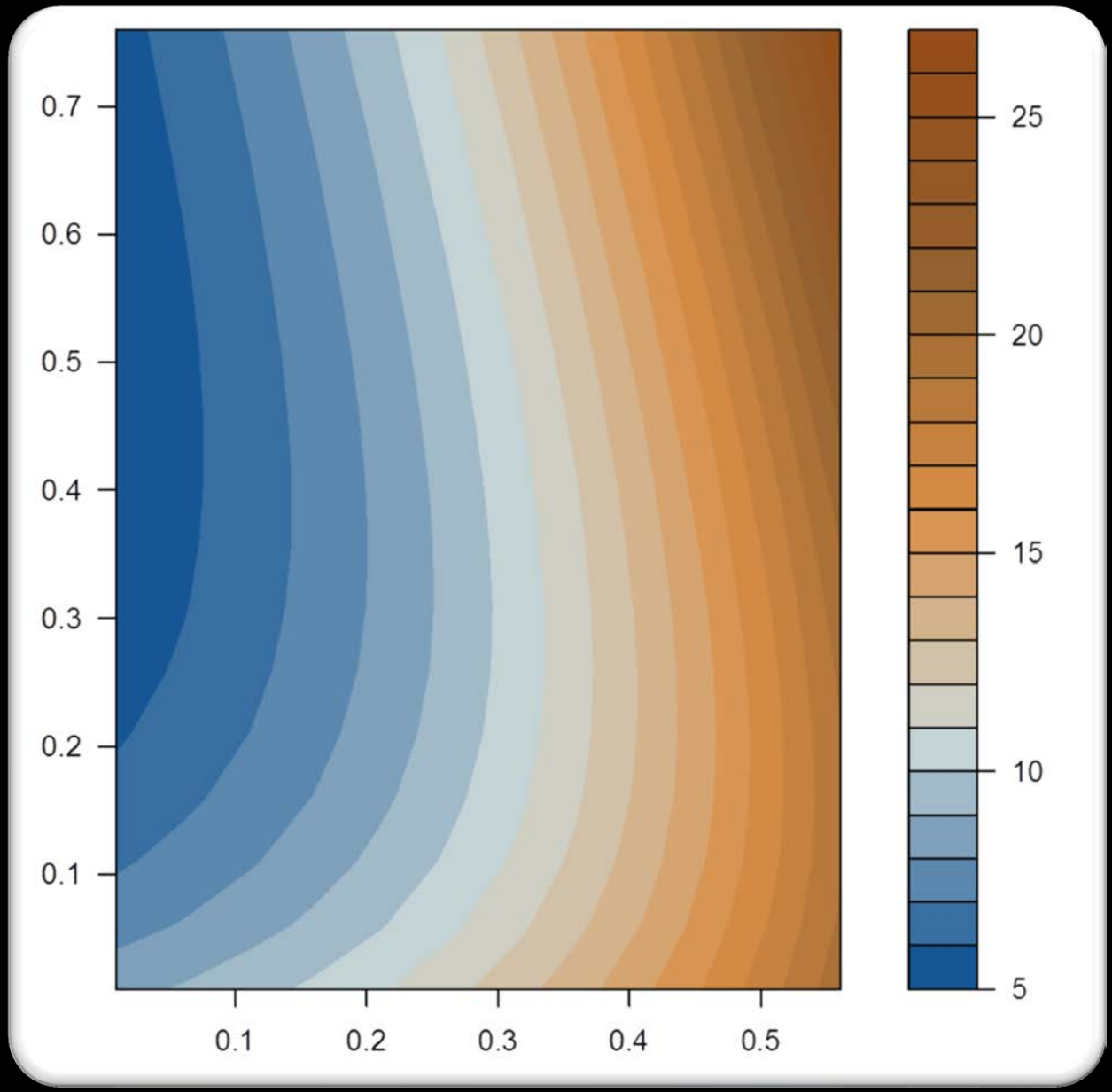
Model structure matters

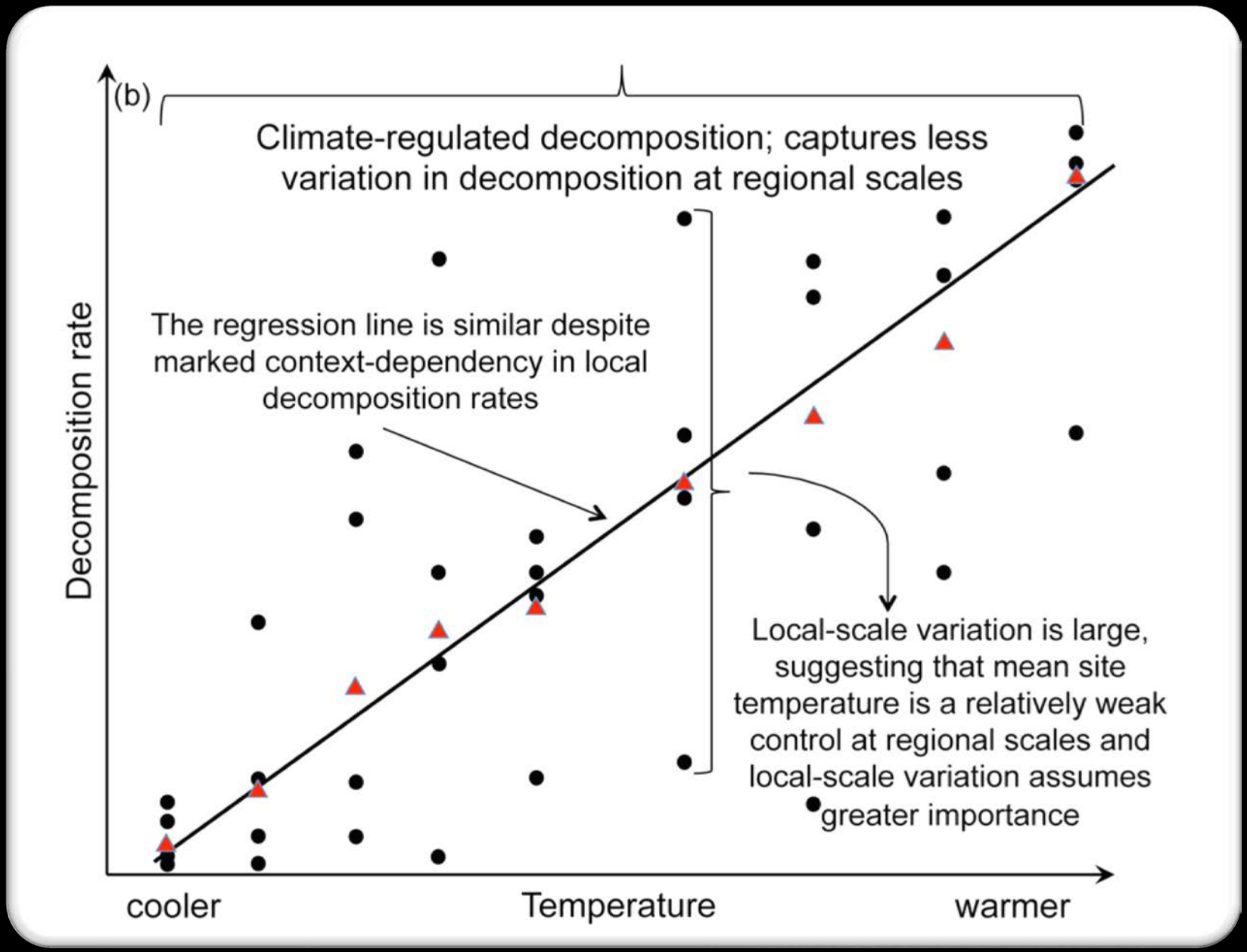


Wieder *et al.* Nature Climate Change 2013

Microbial *theory* at global scales

MIMICS SOC (mg C cm^{-3})





Bradford et al. *Nature Climate Change* In Press

MIcrobial-**MI**neral **C**arbon **S**tabilization **MIMICS** model

$$\text{Decomposition} = MIC_r \times V_{max} \times SOM_a / (K_m + SOM_a)$$

(mg cm^{-3})