

# Biological drivers of the CLM C cycle: *Peering into the Brown Box*



Will Wieder, Gordon Bonan, Steve Allison,  
C. Cleveland, S. Frey, S. Grandy, E. Hinckley,  
R. Phillips, S. Reed, A. Townsend, M. Waldrop

# Biological drivers of the CLM C cycle:



**Plant functional diversity**



**Agriculture**



**Urban**



**Soils...**

# Biological drivers of the CLM C cycle:



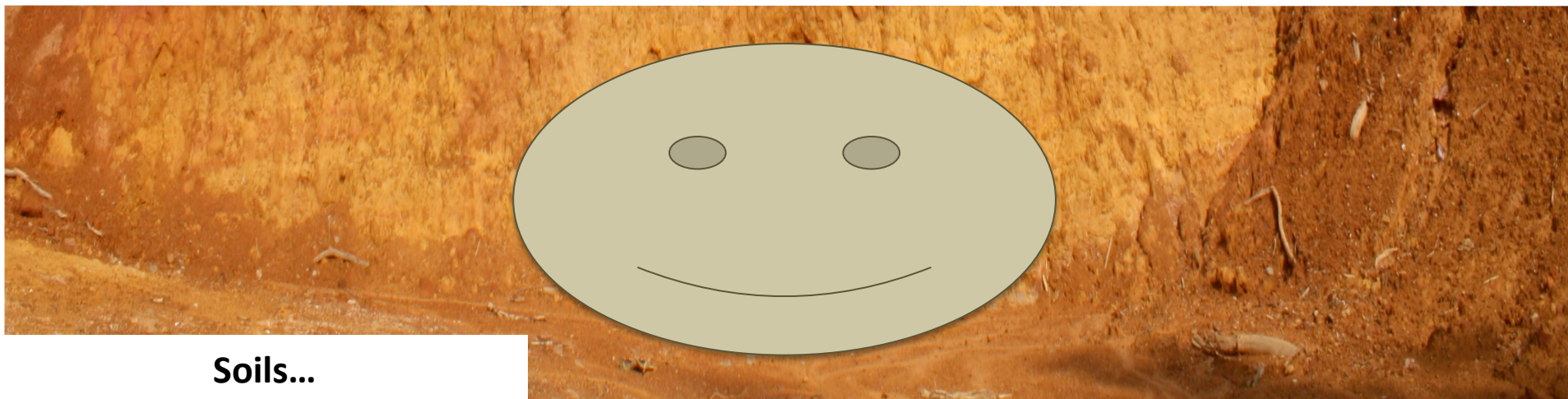
**Plant functional diversity**



**Agriculture**

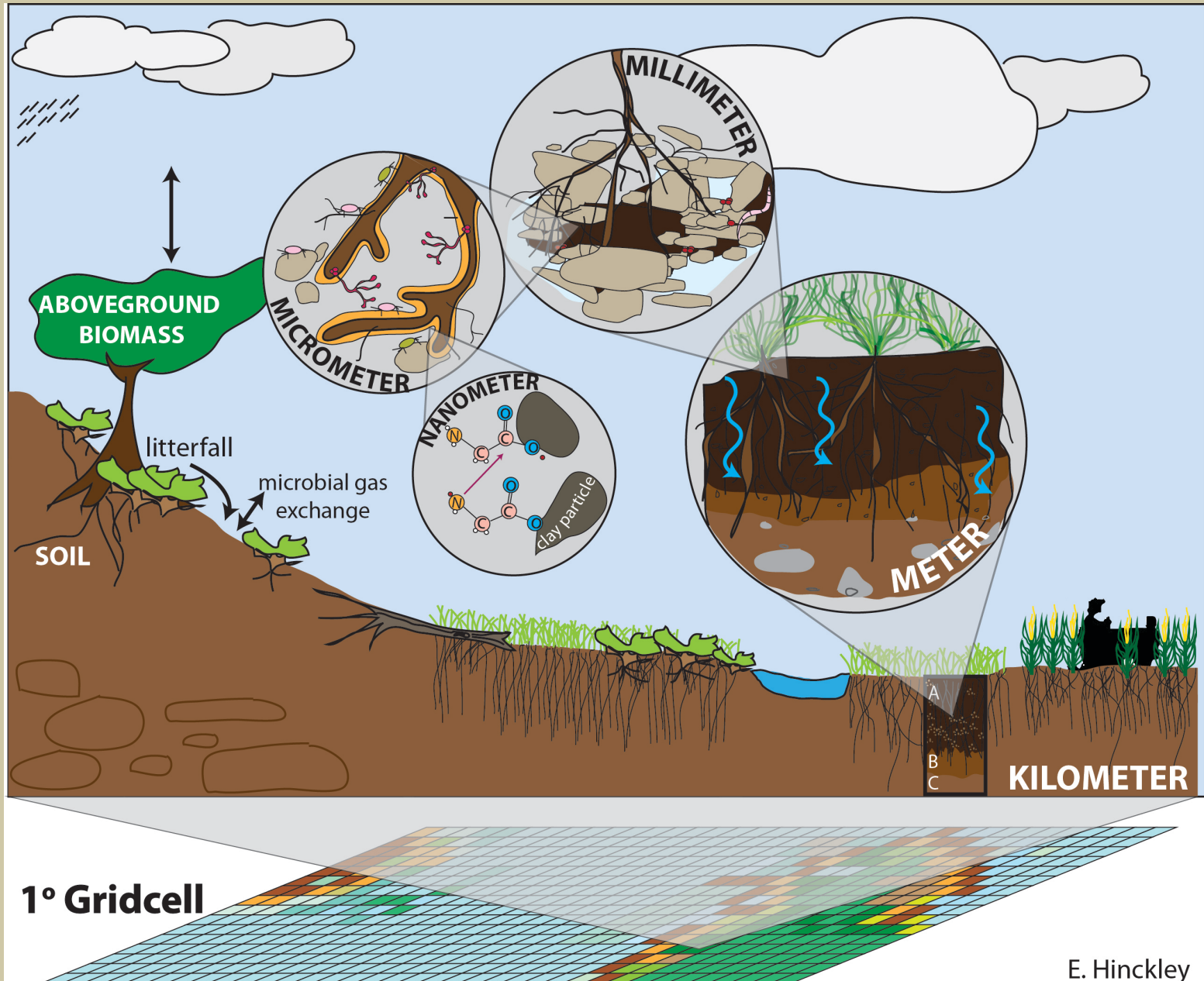


**Urban**

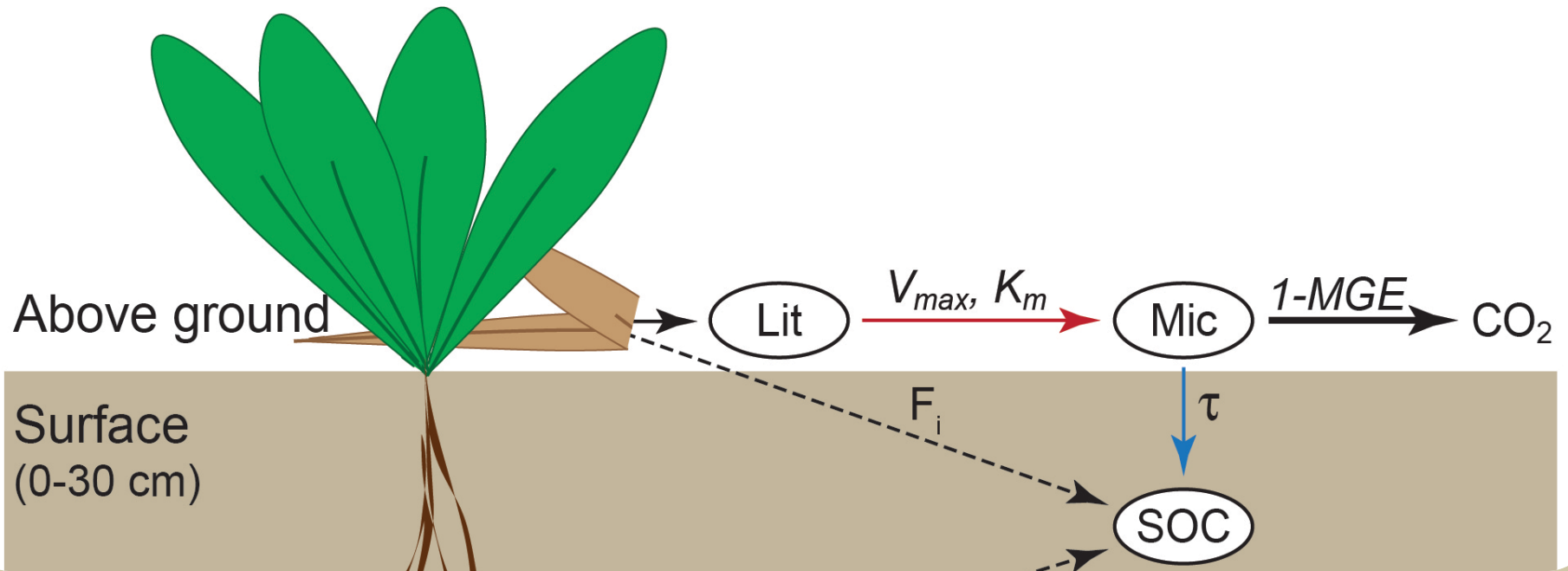


**Soils...**

# Scaling challenges

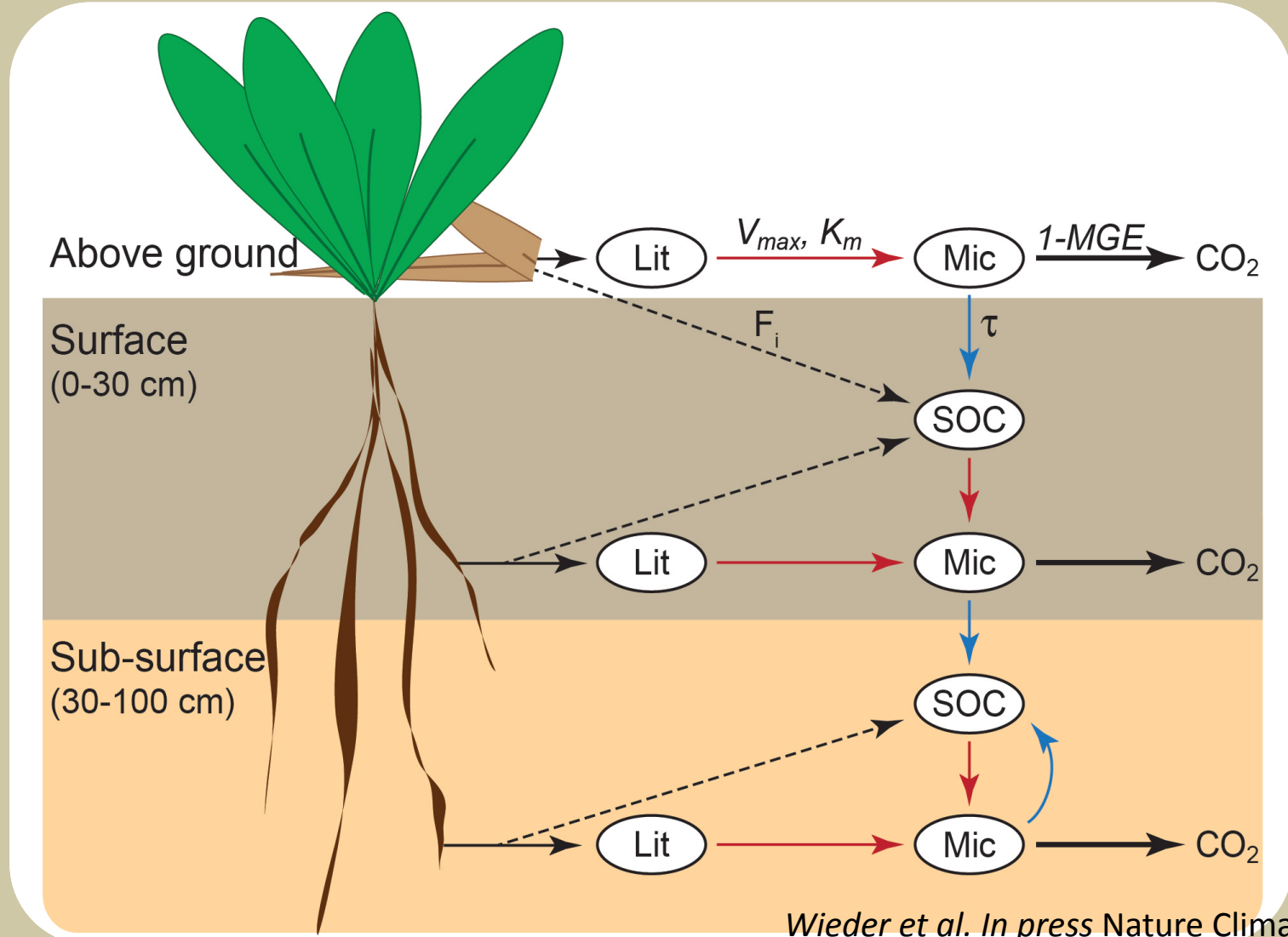


# A path forward: Microbial physiology & CLM Microbial model



$$\text{Microbial Biomass} = \text{Inputs} * \text{efficiency (MGE)} - \text{turnover } (\tau)$$

# A path forward: Microbial physiology & CLM Microbial model

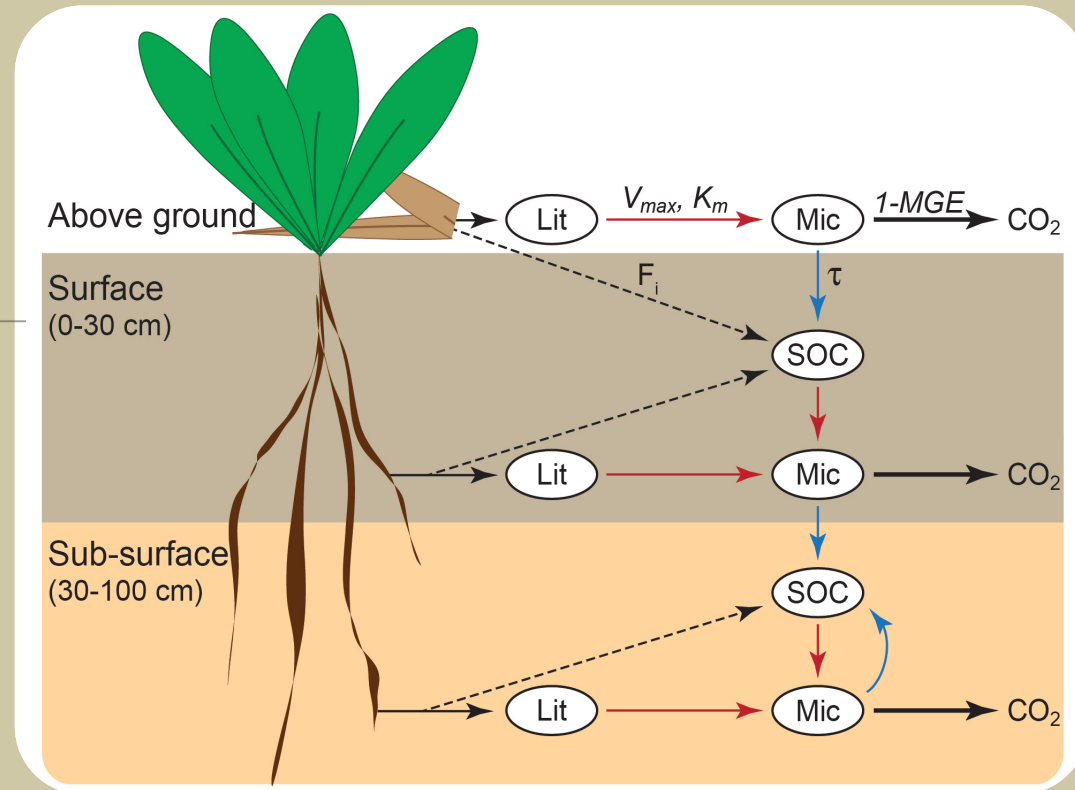
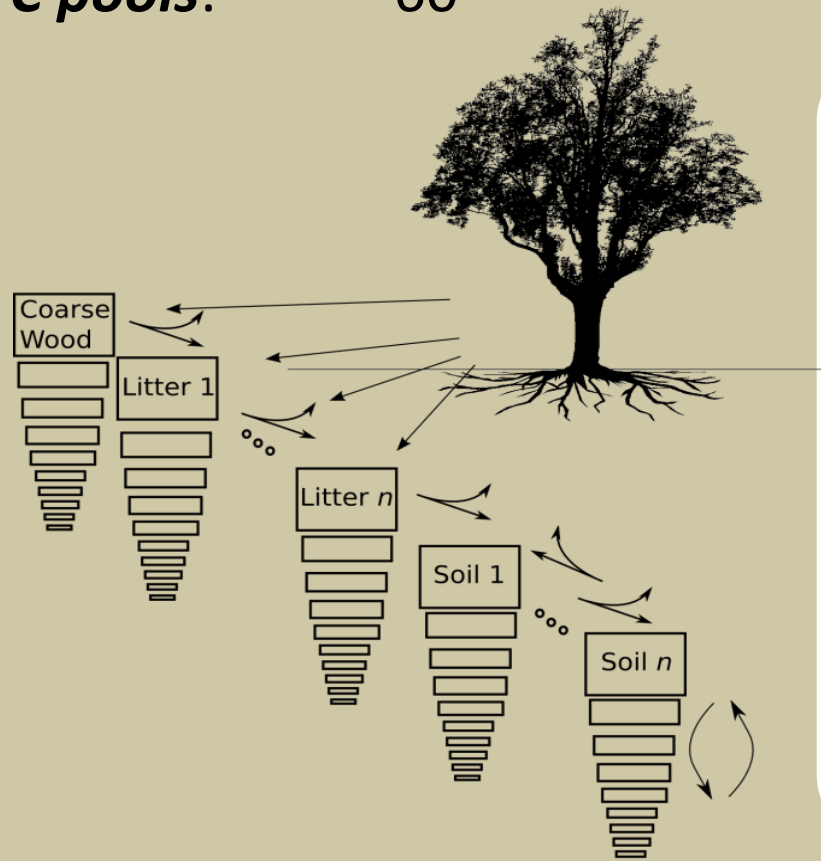


# CLM4.5bcg

**Theory:** C recalcitrance  
**Flux control:** Donor pool  
**Respiration:** Fixed fraction  
**Parameters:**  $^{14}\text{C}$  incubations  
**C pools:** 60

# CLM Microbial model

Microbial physiology  
Donor & receiver pool  
Temperature sensitive  
Enzyme assays  
8



# CLM4.5bcg

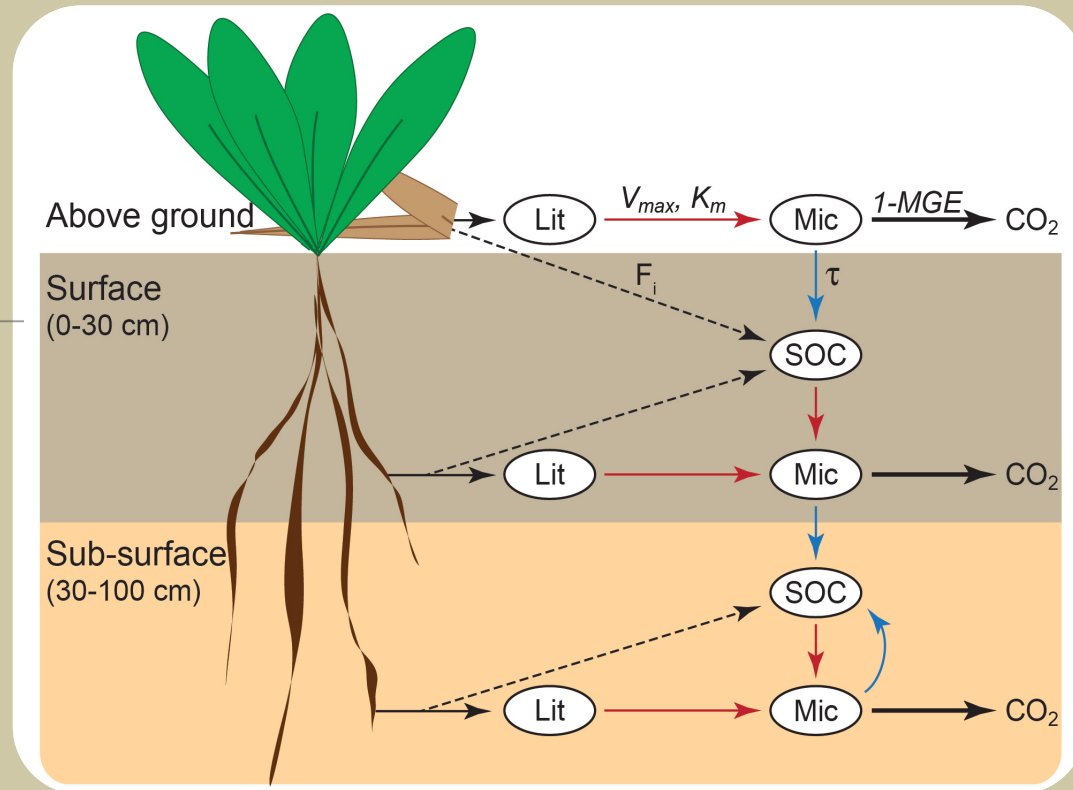
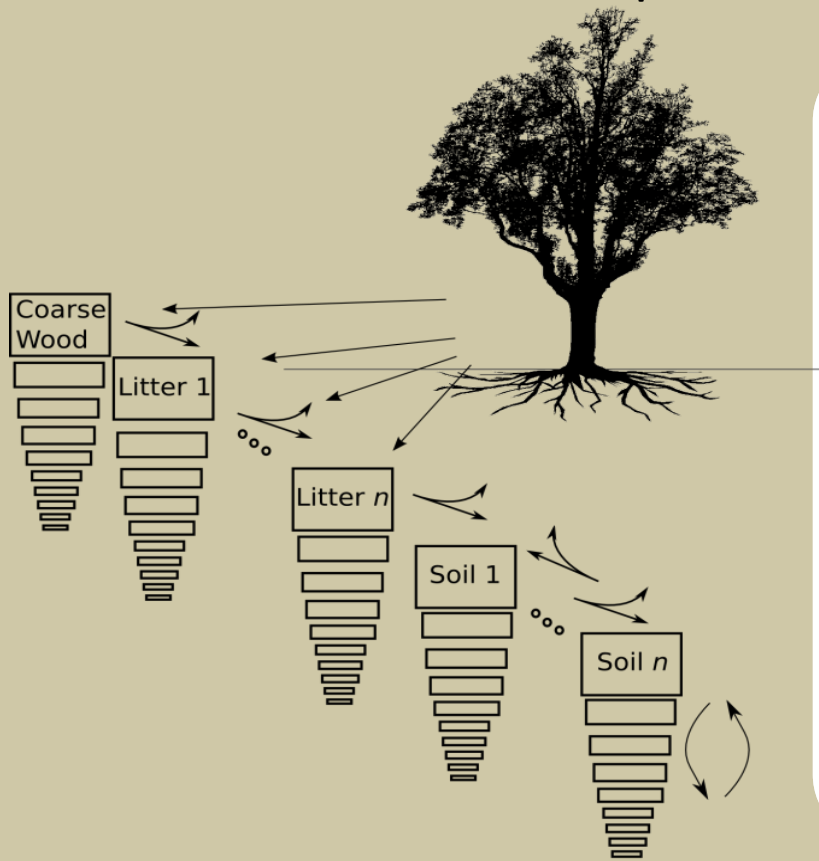
# CLM Microbial model

CLM 4.5 bgc litter fluxes

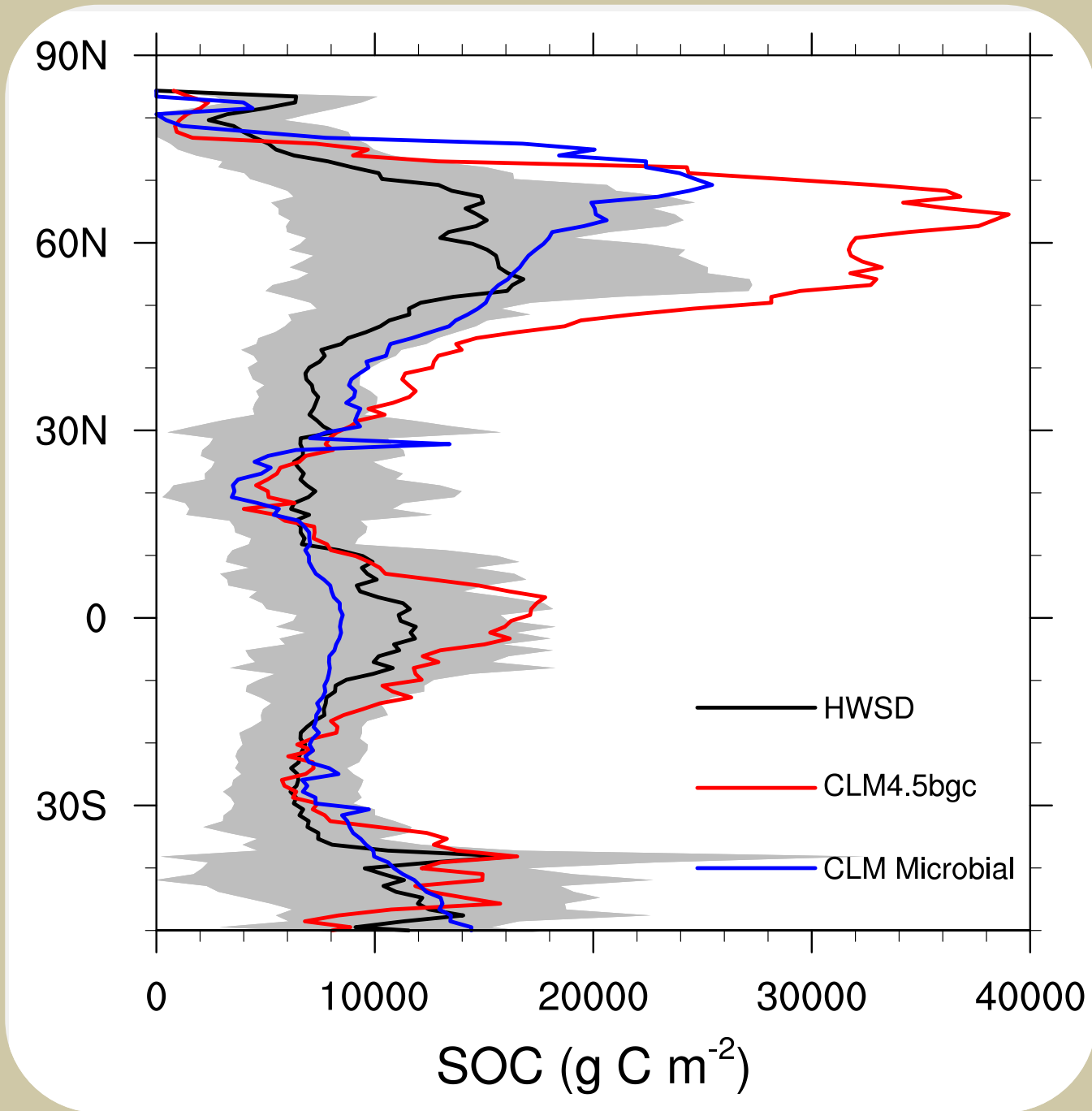
CLM 4.5 soil temperature

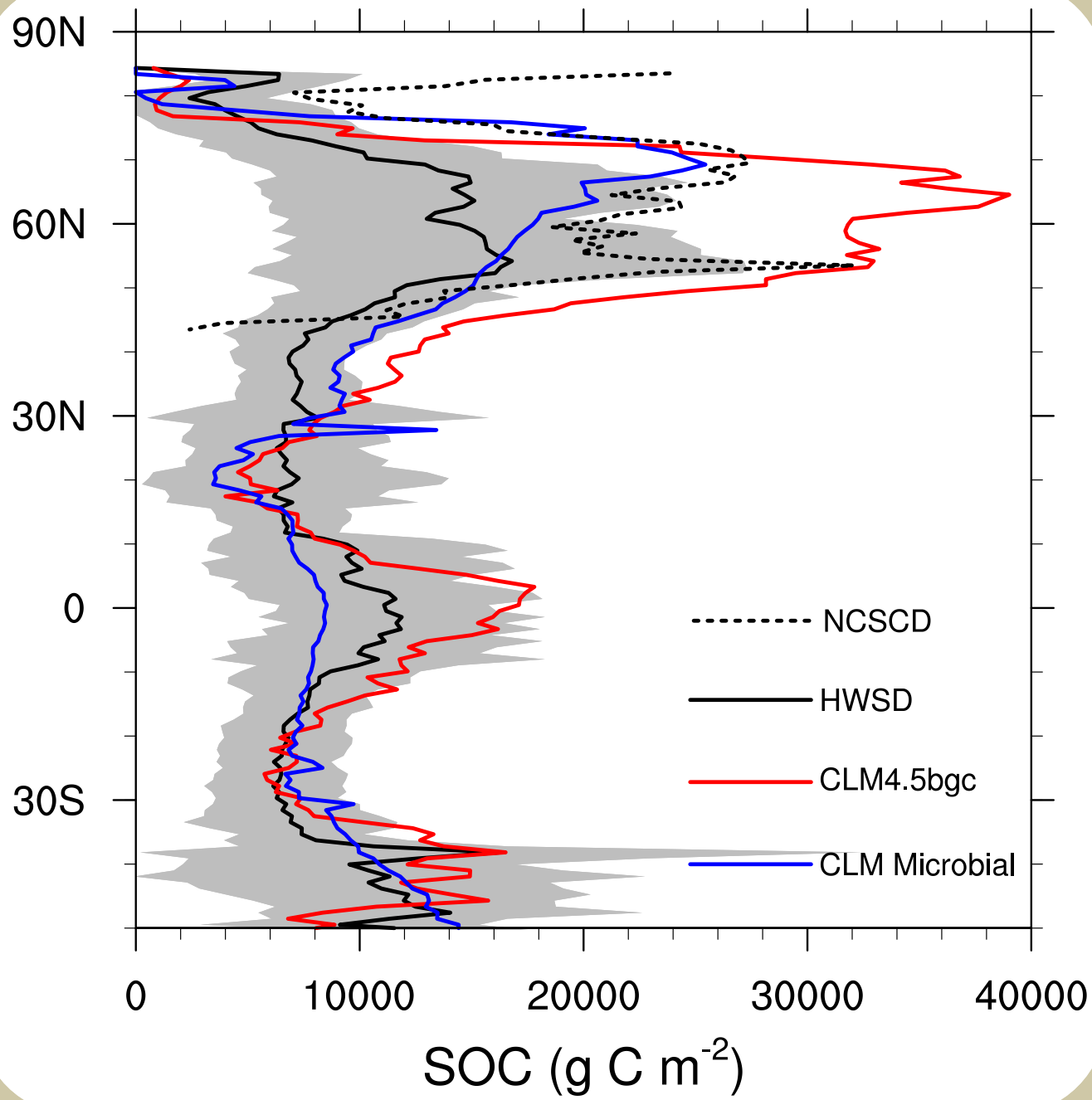
Compare to observations (0-100 cm):

- Harmonized world soils database (HWSD)
- Northern Circumpolar Soil Carbon Database (NCSCD)







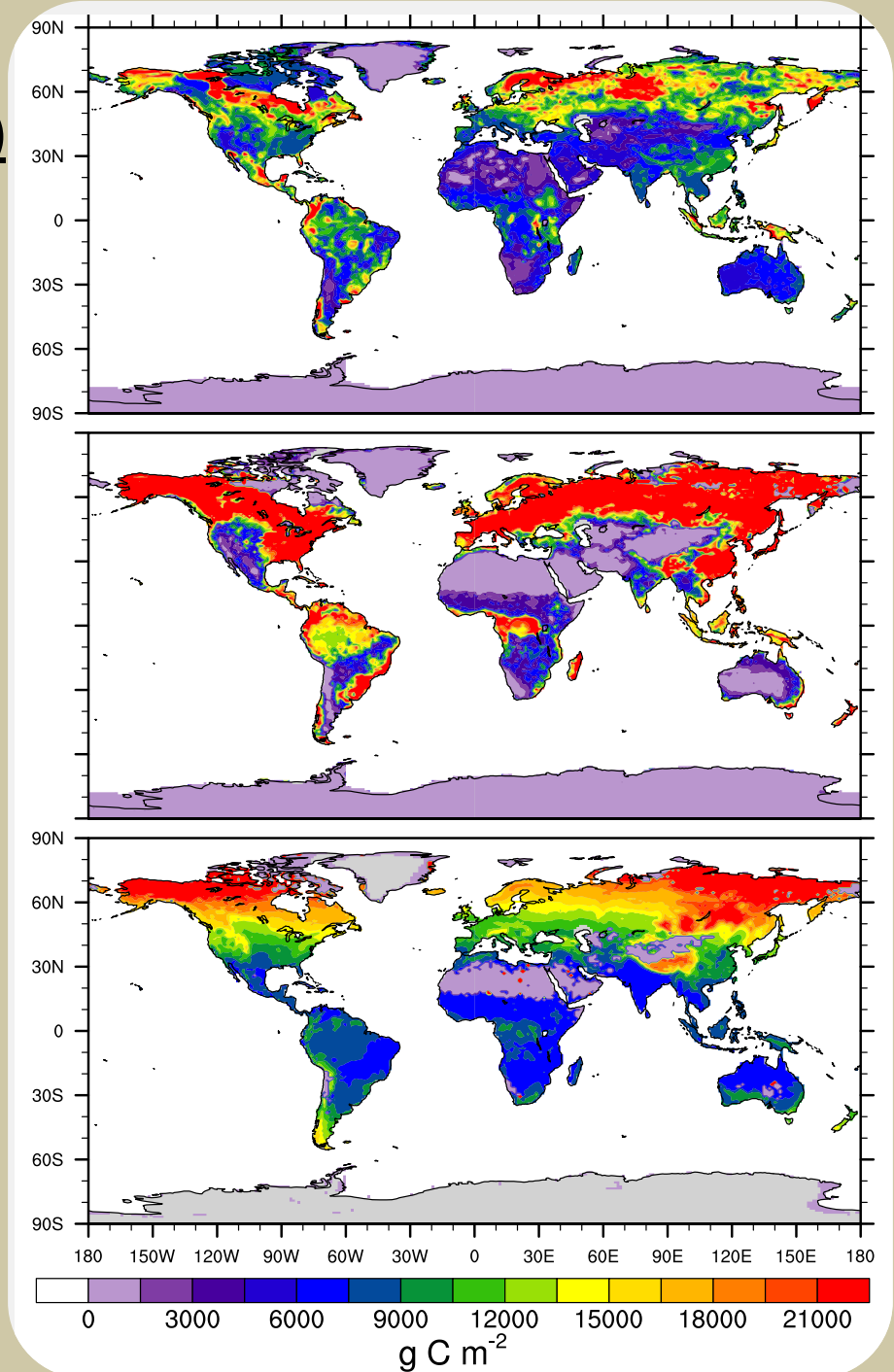


Model	Soil C (Pg C)	RMSE (kgC m <sup>-2</sup> )
-------	------------------	--------------------------------

HWDS obs.	1260	
-----------	------	--

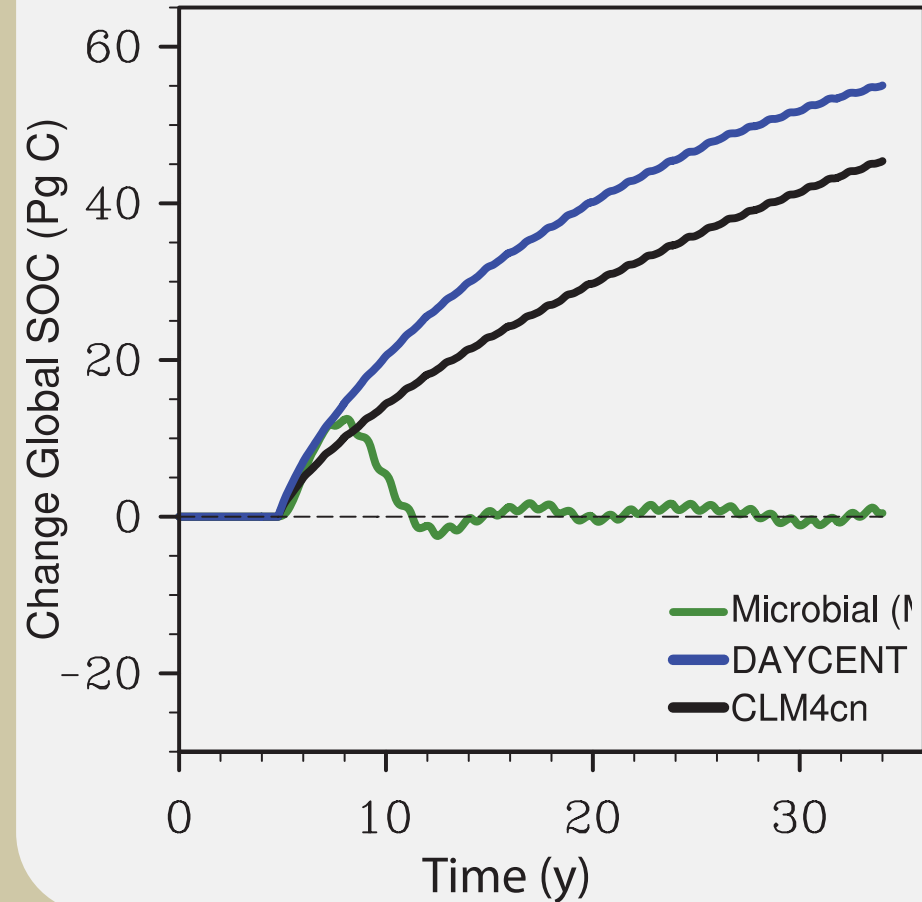
CLM 4.5 bgc	2090	17.6
-------------	------	------

CLM Microbial	1420	11.0
---------------	------	------



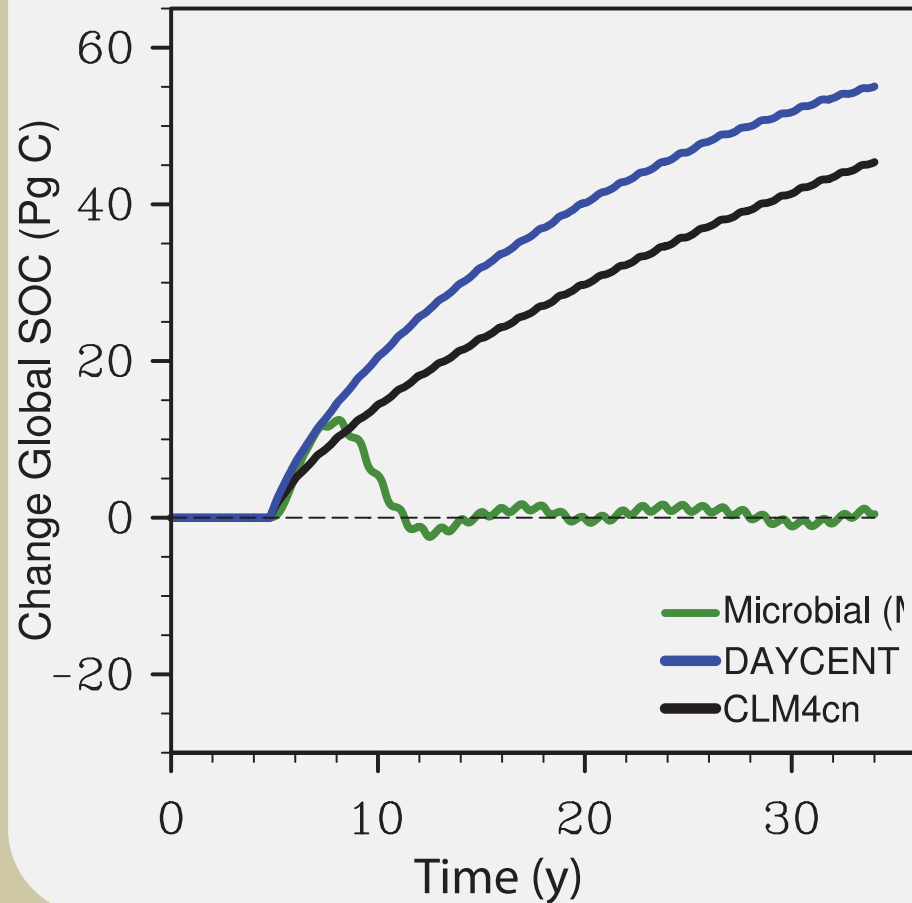
# Model structure matters (in global change settings)

**a) Increasing Litterfall**

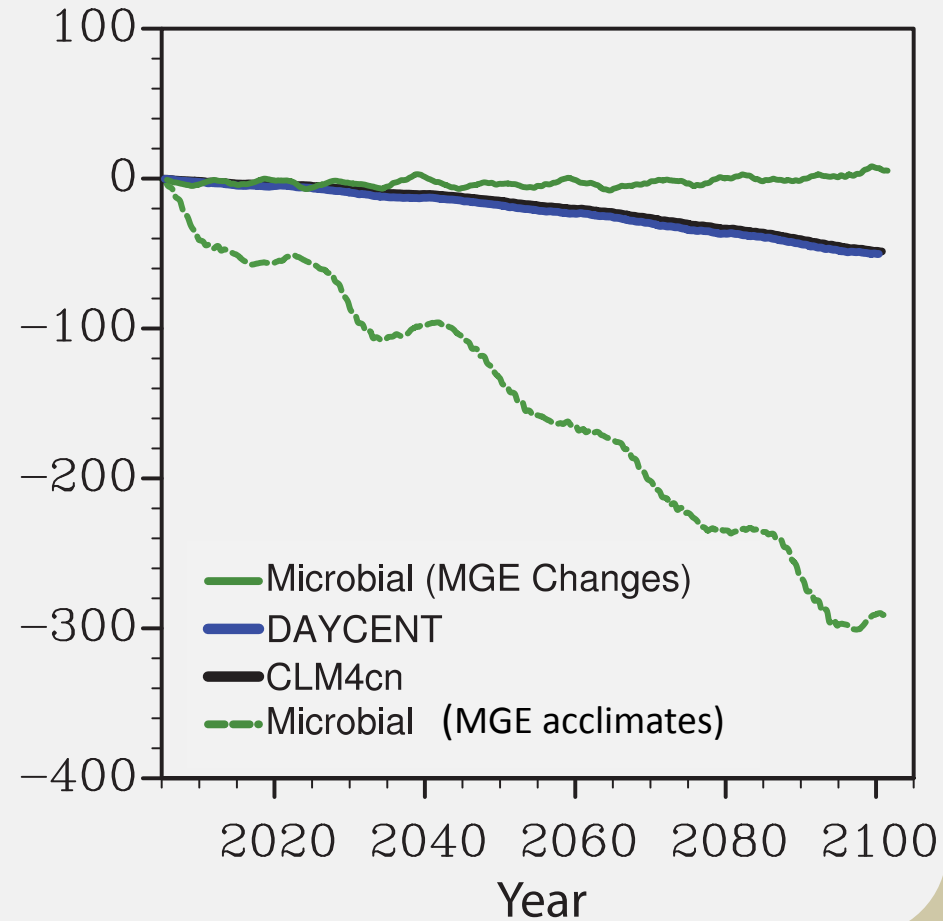


# Model structure matters (in global change settings)

**a) Increasing Litterfall**



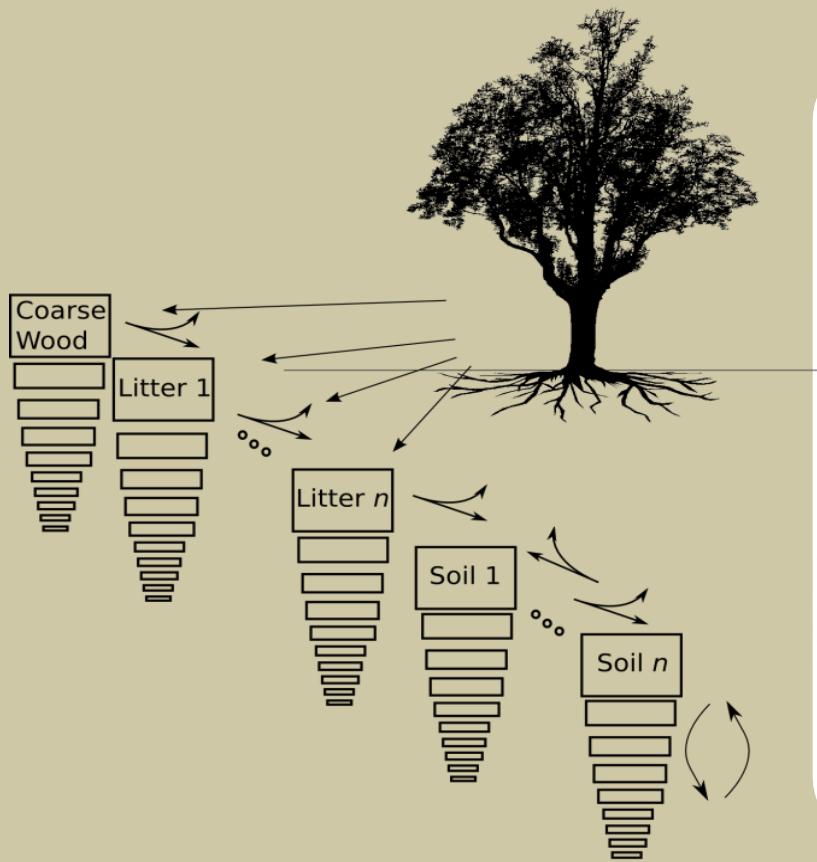
**b) Increasing temperature**



# CLM4.5bcg

## More Evaluation

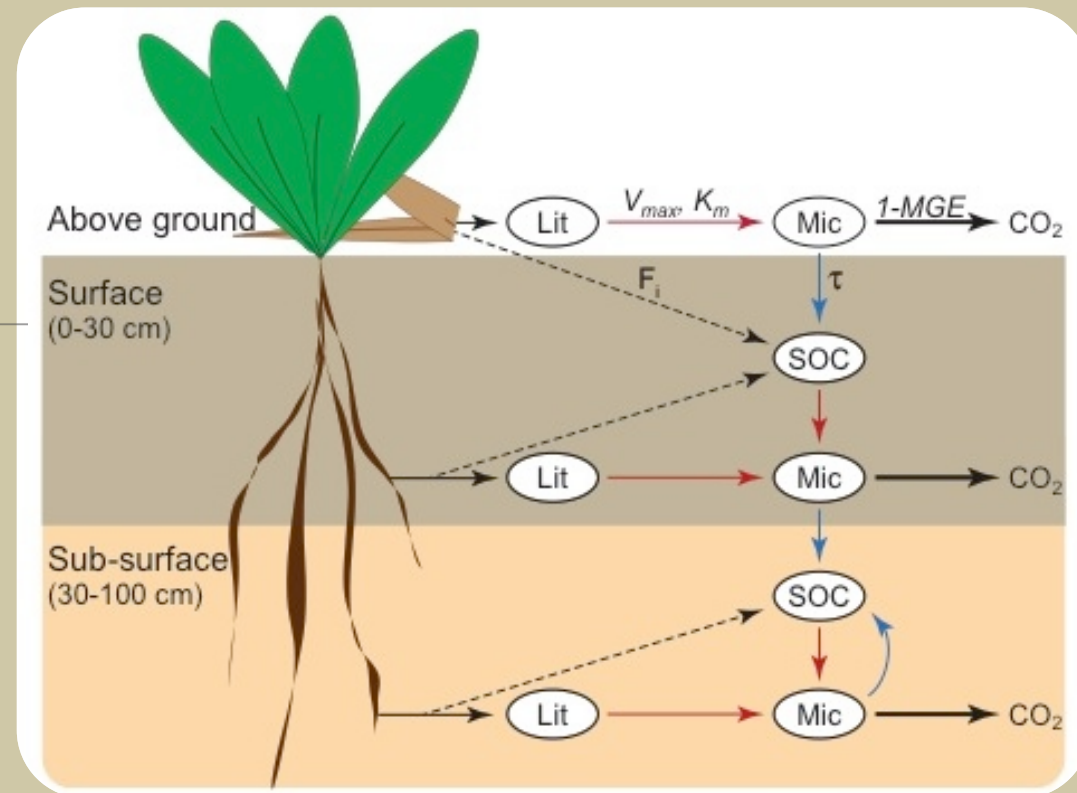
- Warming
- eCO<sub>2</sub>
- N enrichment



# CLM Microbial model

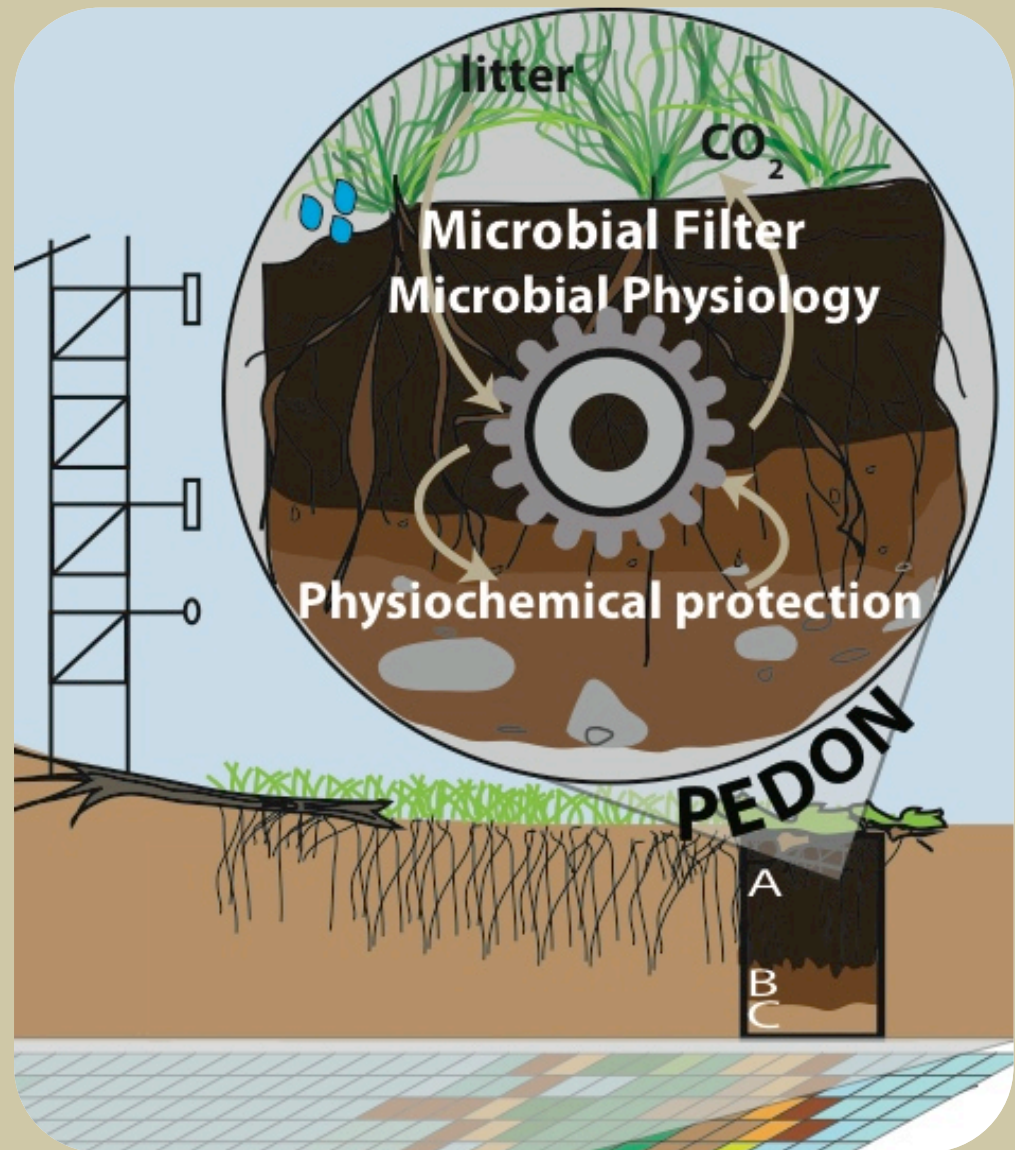
## Greater Complexity / Reality

- H<sub>2</sub>O, O<sub>2</sub>
- Mineralogy
- C-N



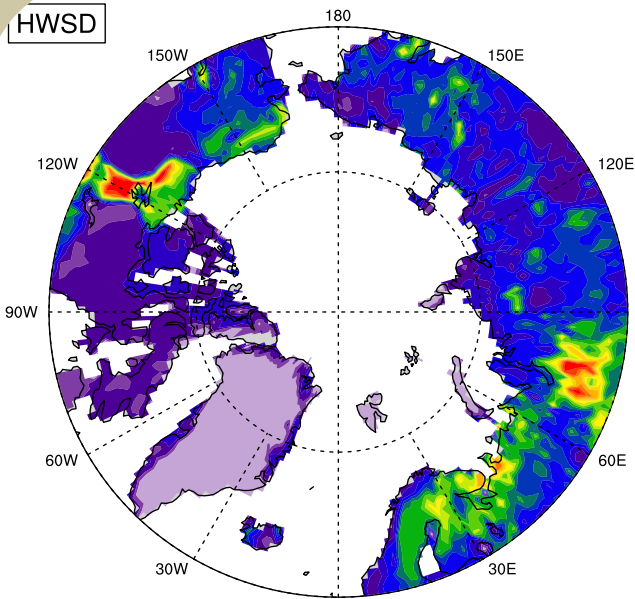
# New Directions

- Link observations & modeling (NEON, NGEE, university partners)
- Expand community of CLM users
- Test ecological theory across scales

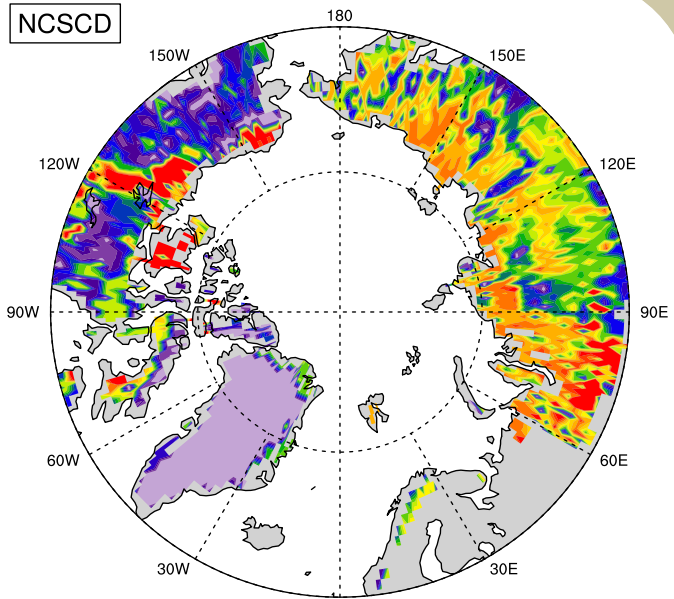


# Arctic SOC

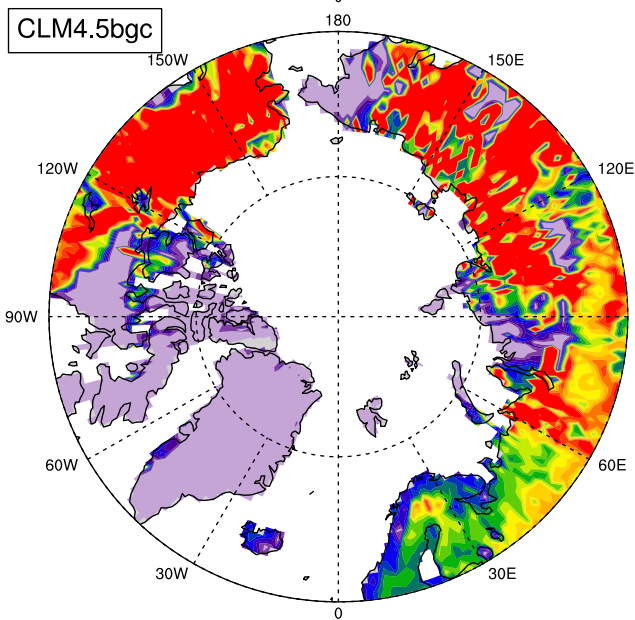
HWSD



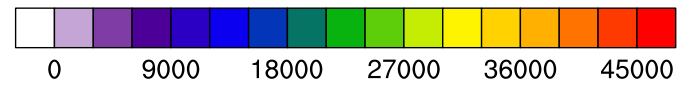
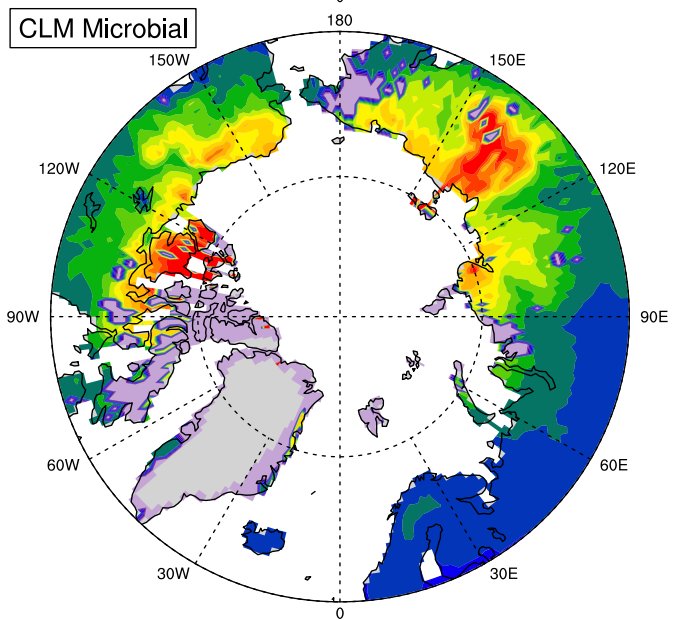
NCSCD



CLM4.5bgc



CLM Microbial



g C m<sup>-2</sup> *NCSCD from Hugelius et al. 2013*

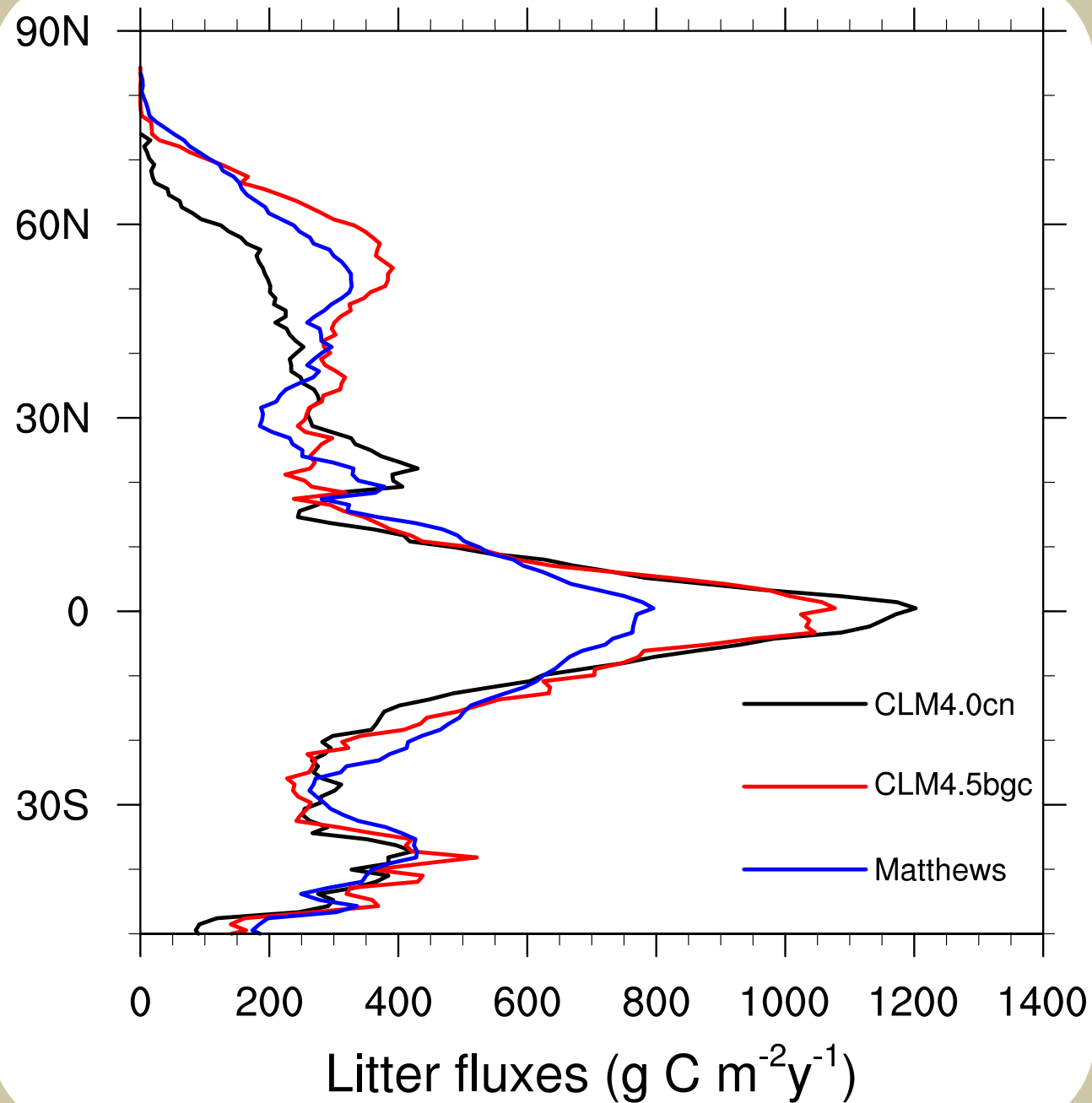


# Litter inputs (Pg C y<sup>-1</sup>)

CLM4.0 = 43

CLM4.5 = 49

Matthews = 45



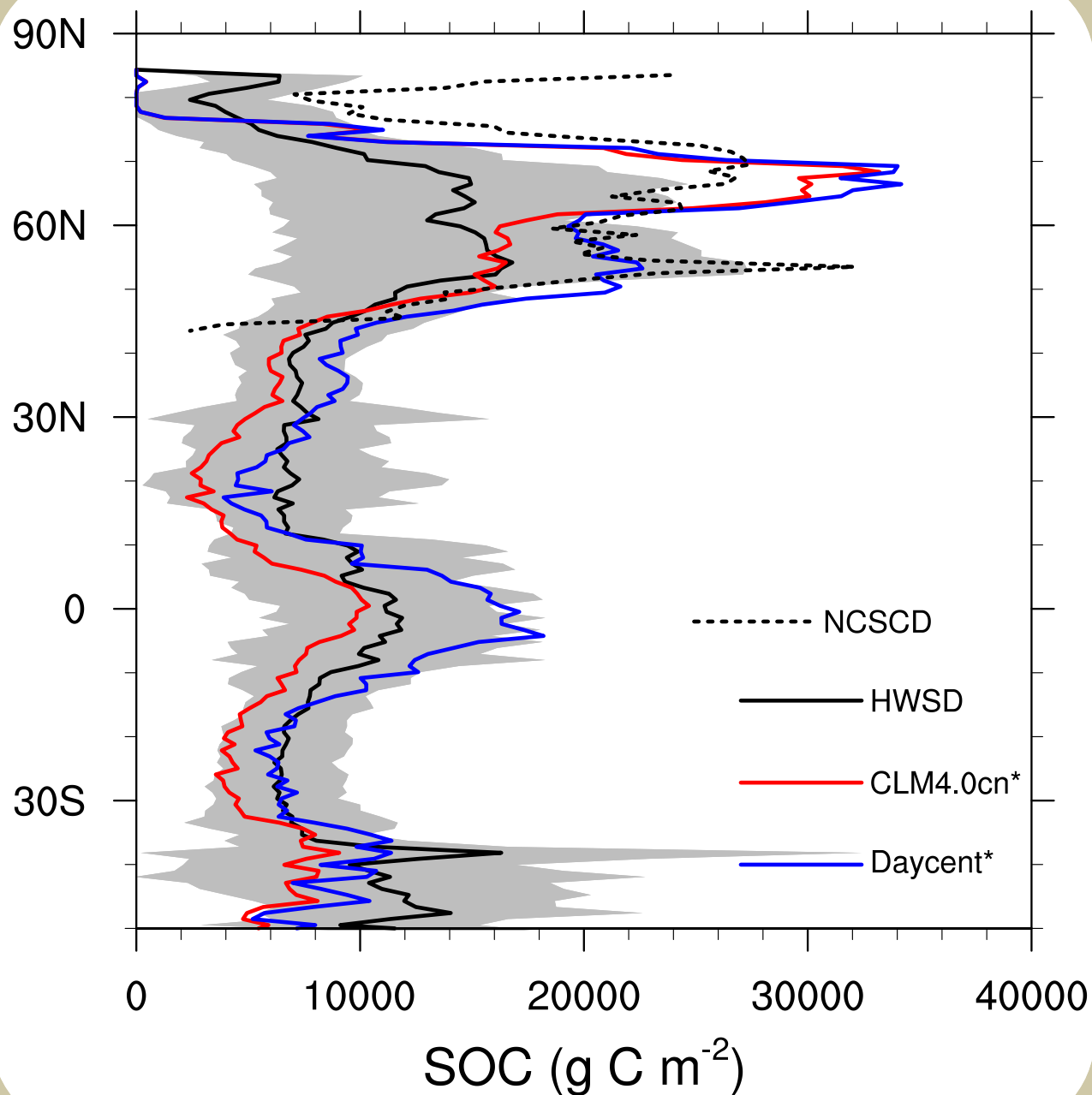
# “Old” SOC (Pg C)

HWSD = 1260

CLM4.0 = 1280

DAYCENT = 1710

\*CLM4.5 litter fluxes



# “New” SOC (Pg C)

HWSD = 1260

CLM4.5 = 2090

Microbial = 1420

\*CLM4.5 litter fluxes

