Biological drivers of the CLM C cycle: 

*Peering into the Brown Box*

Biological drivers of the CLM C cycle:
Biological drivers of the CLM C cycle:

- Plant functional diversity
- Agriculture
- Urban

Soils...
A path forward: Microbial physiology & CLM Microbial model

Microbial Biomass = Inputs * efficiency (MGE) – turnover (τ)

From Allison et al. 2010 Nature Geoscience
Wieder et al. In press Nature Climate Change
A path forward: Microbial physiology & CLM Microbial model

Wieder et al. In press Nature Climate Change
CLM4.5bcg

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

CLM Microbial model

Microbial physiology
Donor & receiver pool
Temperature sensitive
Enzyme assays

Parameters:
- \(14^C\) incubations
- Enzyme assays

C pools:
- Coarse Wood
- Litter 1
- Litter n
- Soil 1
- Soil n

Diagram showing above ground and sub-surface soil layers with pathways for litter (Lit), microbes (Mic), and CO2 emissions through decomposition and respiration.
CLM4.5bcg

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)
HWSD from FAO et al. 2012
NCSCD from Hugelius et al. 2013
<table>
<thead>
<tr>
<th>Model</th>
<th>Soil C (Pg C)</th>
<th>RMSE (kgC m(^{-2}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWDS obs.</td>
<td>1260</td>
<td></td>
</tr>
<tr>
<td>CLM 4.5 bgc</td>
<td>2090</td>
<td>17.6</td>
</tr>
<tr>
<td>CLM Microbial</td>
<td>1420</td>
<td>11.0</td>
</tr>
</tbody>
</table>

HWSD from FAO et al. 2012
Model structure matters
(in global change settings)

a) Increasing Litterfall

Wieder et al. In press Nature Climate Change
Model structure matters (in global change settings)

**a)** Increasing Litterfall

**b)** Increasing temperature

*Wieder et al. In press Nature Climate Change*
CLM4.5bcg

CLM Microbial model

More Evaluation
- Warming
- eCO₂
- N enrichment

Greater Complexity / Reality
- H₂O, O₂
- Mineralogy
- C-N
New Directions

- Link observations & modeling (NEON, NGEE, university partners)
- Expand community of CLM users
- Test ecological theory across scales
Litter inputs
(Pg C y\(^{-1}\))

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