Progress in two-layer litter/soil model for CLM

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Current status of SOM models in LSMs

- Soil C decomposition representations have not principally changed in 30 years.
- While soil models differ in many details,
  - Several conceptual pools with separate intrinsic decomposition rates use first order “donor control” dynamics
  - C pools are interrelated
  - N, P dynamics generally follow C dynamics,
  - N, P becomes available as a result of stoichiometry constraints.
CLM4 soil model status

• The existing aboveground and belowground litter components enter and mix with the same litter and soil organic matter pools

• Differentiation is more important for ecosystems with well developed litter layers

• To make the aboveground litter enter the surface litter pool and belowground pools enter the mineral soil layer

• Direct use of the Enriched Background Isotope Study (EBIS) (the Application of an Ecosystem-scale \(^{14}\)C Tracer to Soil-Carbon-Cycle Studies)
Converging cascade model of litter and soil organic matter decomposition. The model includes three litter pools (Lit1, Lit2, and Lit3, see text) and four soil organic matter pools (SOM1, SOM2, SOM3 and SOM4).
EBIS demonstrated disconnect between origin of forest floor and soil organic matter.

Differentiation is more important for ecosystems with well developed litter layers (think SPRUCE, NGEE).
Current development status

- Model structure with C13 function is complete
- Tests with C/CN (with disturbance) for both AG and AG+BG configurations are ongoing
- Parameterization for fluxes between the above and below layers are ongoing
Subroutines with replication in CLM4

main

- clmtype.F90
- clmtypeInitMod.F90
- CNiniSpecial.F90
- CNiniTimeVar.F90
- histFldsMod.F90
- pftdynMod.F90

biogeochem

- C13SummaryMod.F90
- CNAllocationMod.F90
- CNAnnualUpdateMod.F90
- CNBalanceCheckMod.F90
- CNC13FluxMod.F90
- CNC13StateUpdate1Mod.F90
- CNC13StateUpdate2Mod.F90
- CNC13StateUpdate3Mod.F90
- CNCStateUpdate1Mod.F90
- CNCStateUpdate2Mod.F90
- CNCStateUpdate3Mod.F90
- CNDecompMod.F90
- CNEcosystemDynMod.F90
- CNFireMod.F90
- CNGapMortalityMod.F90
- CNNDynamicsMod.F90
- CNFireMod.F90
- CNNDynamicsMod.F90
- CNNStateUpdate1Mod.F90
- CNNStateUpdate2Mod.F90
- CNNStateUpdate3Mod.F90
- CNPhenologyMod.F90
- CNPrecisionControlMod.F90
- CNrestMod.F90
- CNSetValueMod.F90
- CNSummaryMod.F90

12% 62%
Fraction of root in the surface soil layer: $ag_{_\text{rootf}}$

Surface layer: $(AG)$

Mineral soil layer: $(BG)$

Fraction of root in the mineral soil layer: $1 - ag_{_\text{rootf}}$
C only test on AG plus BG
CN test on AG
CN test on AG plus BG
\textbf{CNNDynamicsMod.F90}

\begin{align*}
\text{ag\_disn\_conc} &= \frac{(sf \times ag\_sminn(c))}{\text{tot\_water}(c)} \\
\text{bg\_disn\_conc} &= \frac{(sf \times bg\_sminn(c))}{\text{tot\_water}(c)}
\end{align*}

\begin{align*}
\text{ag\_sminn\_leached}(c) &= \text{ag\_disn\_conc} \times \text{qflx\_drain}(c) \\
\text{bg\_sminn\_leached}(c) &= \text{bg\_disn\_conc} \times \text{qflx\_drain}(c)
\end{align*}

\textbf{CNNStateUpdate3Mod.F90}

\begin{align*}
\text{ag\_sminn}(c) &= \text{ag\_sminn}(c) - \text{ag\_sminn\_leached}(c) \times dt \\
\text{bg\_sminn}(c) &= \text{bg\_sminn}(c) - \text{bg\_sminn\_leached}(c) \times dt
\end{align*}

\textbf{CNAllocationMod.F90}

\begin{align*}
\text{ag\_col\_plant\_ndemandf} &= \frac{(sf \times (ag\_sminn(c) + bg\_sminn(c)))}{\text{tot\_water}(c)} \\
\text{ag\_col\_plant\_ndemand}(c) &= \text{col\_plant\_ndemand}(c) \times \text{ag\_col\_plant\_ndemandf} \\
\text{bg\_col\_plant\_ndemand}(c) &= \text{col\_plant\_ndemand}(c) \times (1.0\_r8 - \text{ag\_col\_plant\_ndemandf})
\end{align*}
Next steps

• Parameterize the fluxes between the surface and mineral layers
• C14 capability
• Model evaluation with EBIS observations
• Merge the P module at ORNL and N-layer soil model at LBNL
• Sensitivity tests, global simulations and evaluations, and feedbacks
• Optional soil BGC for CLM4.5 before Dec.
Thank you for attention!
Questions and comments?