



Climate Change
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Progress in two-layer litter/soil model for CLM

Jiafu Mao^{*}, Peter E. Thornton, Xiaoying Shi, Xiaojuan
Yang and Wilfred M. Post

*Environmental Sciences Division, Oak Ridge National
Laboratory, Oak Ridge, Tennessee, USA*

(maoj@ornl.gov)

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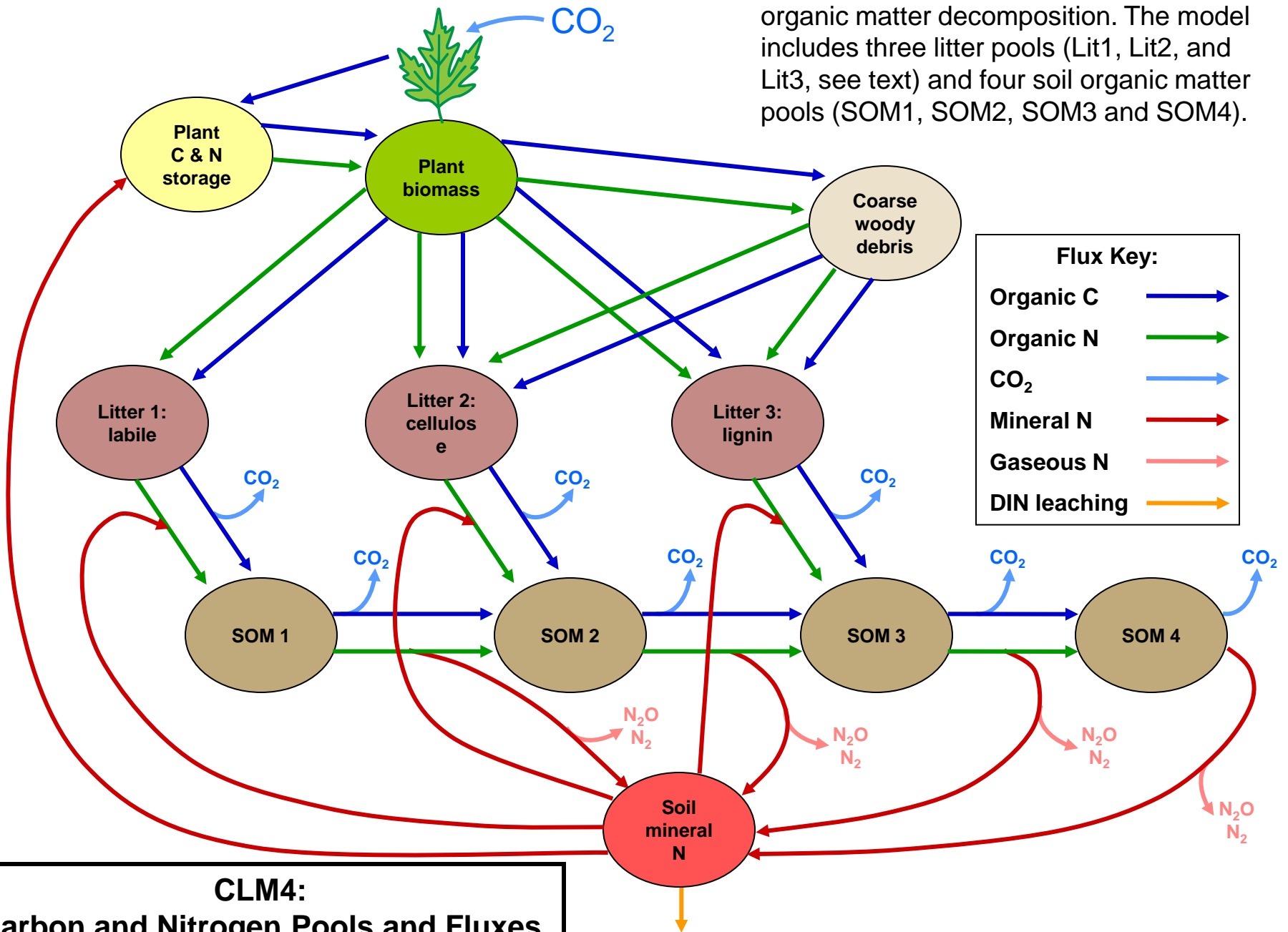
Current status of SOM models in LSMs

- 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.

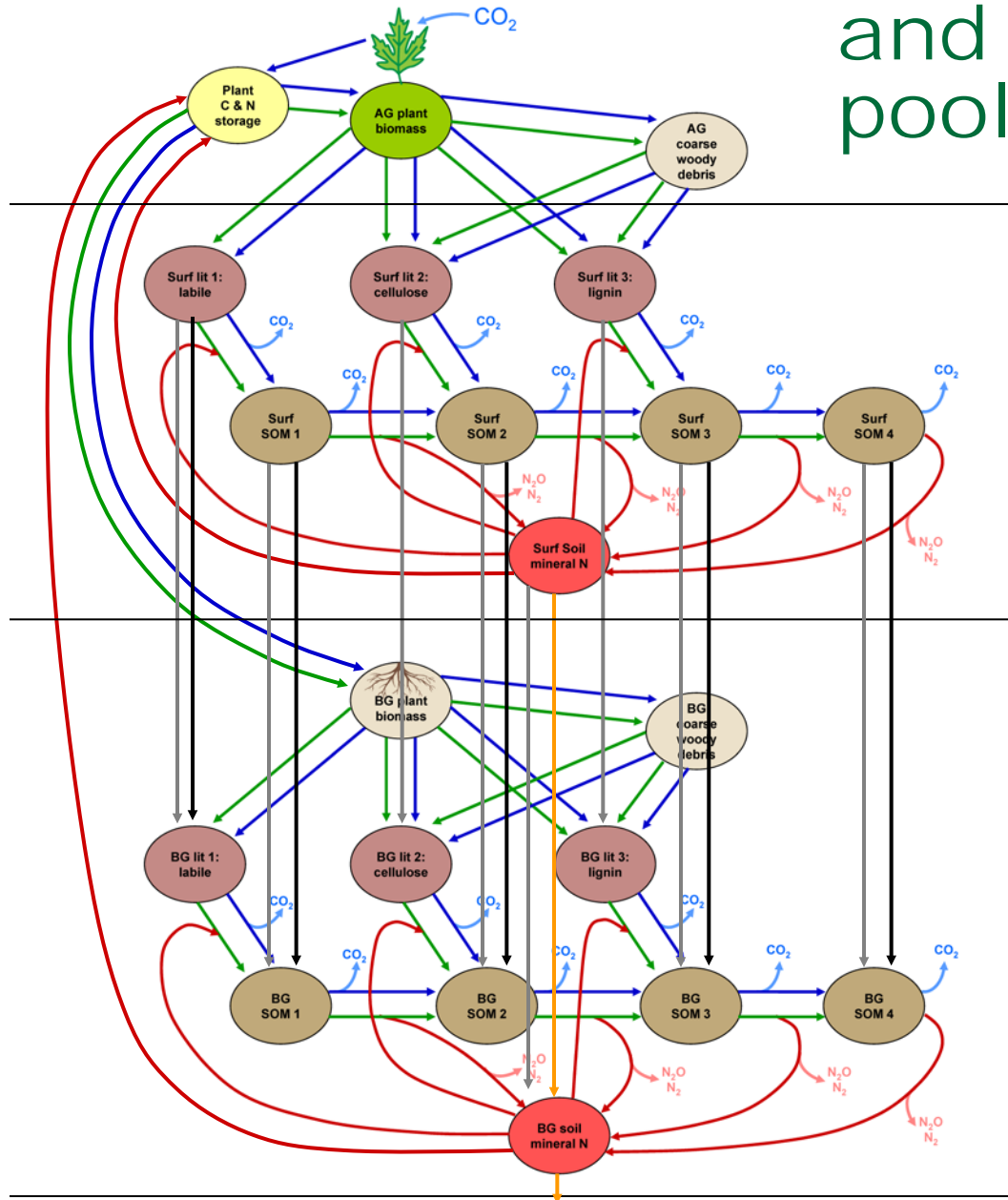
CLM4 soil model status

- 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).



Separate aboveground and belowground litter pools CLM4-EBIS



Surface layer

Mineral soil layer

- 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).

Flux Key:	
Organic C	→
Organic N	→
CO ₂	→
Mineral N	→
Gaseous N	→
Bioturbation	→
DOM leaching	→
DIN leaching	→

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

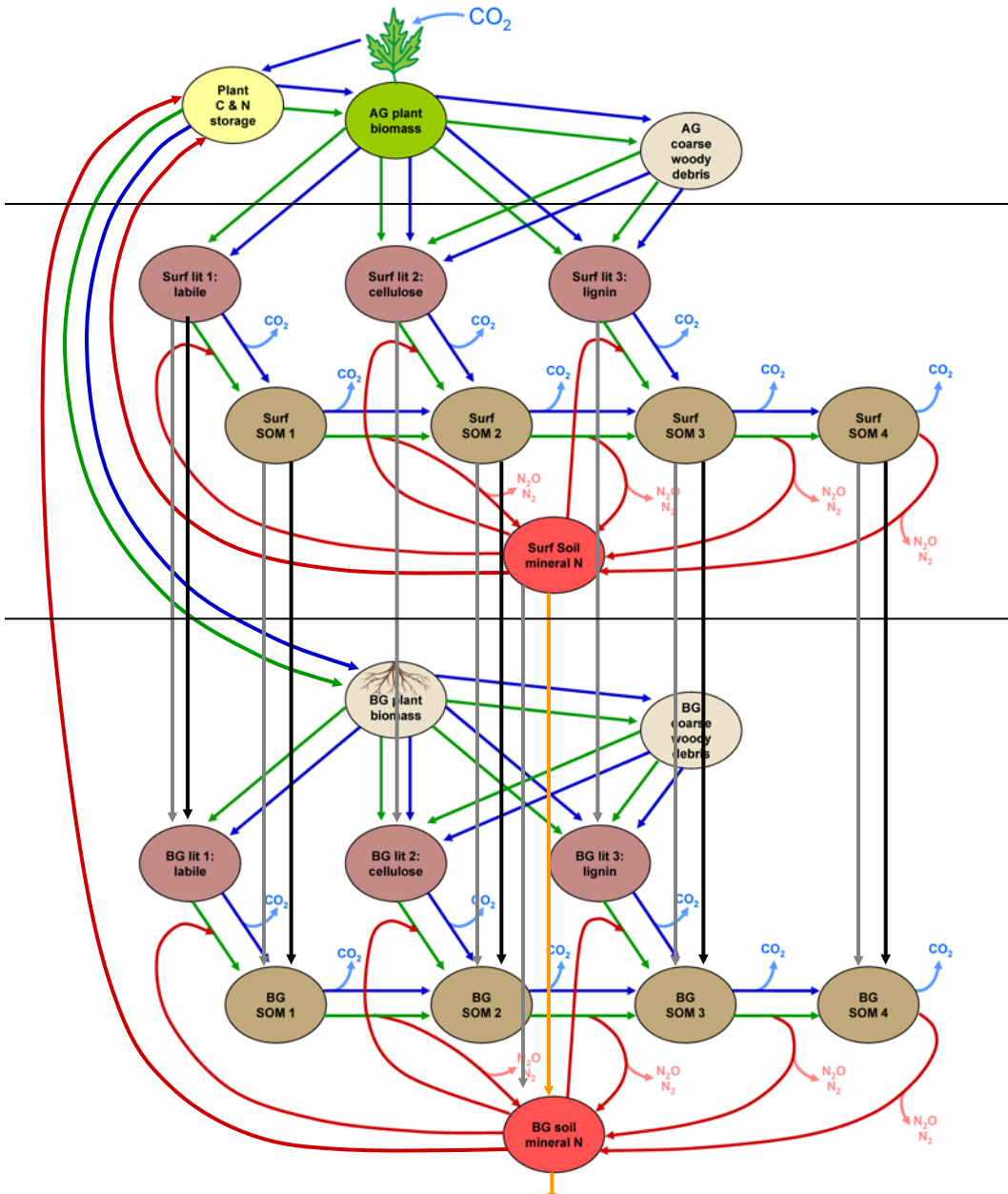
clmtype.F90
clmtypeInitMod.F90
CNiniSpecial.F90
CNiniTimeVar.F90
histFldsMod.F90
pftdynMod.F90

12%

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
CNNStateUpdate1Mod.F90
CNNStateUpdate2Mod.F90
CNNStateUpdate3Mod.F90
CNPhenologyMod.F90
CNPrecisionControlMod.F90
CNrestMod.F90
CNSetValueMod.F90
CNSummaryMod.F90

62%



ag_rootf

fraction of root in the surface soil layer

Surface layer (AG)

+

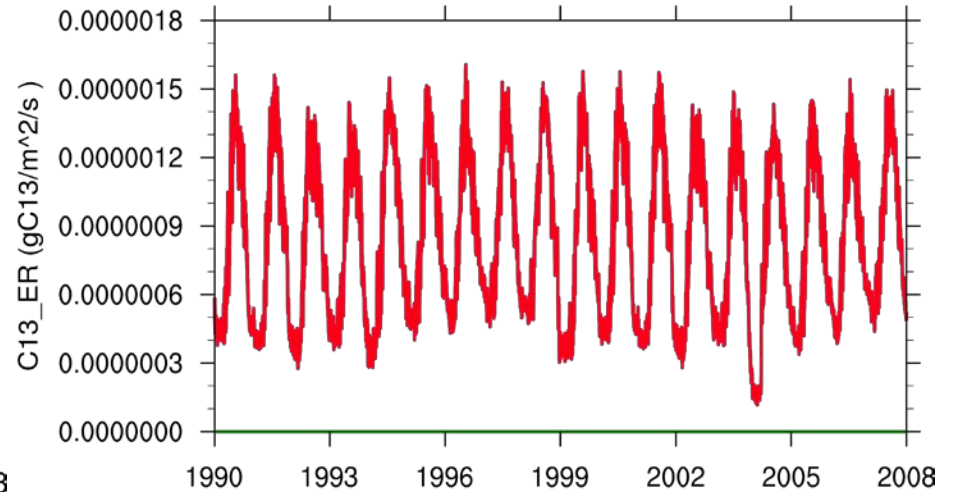
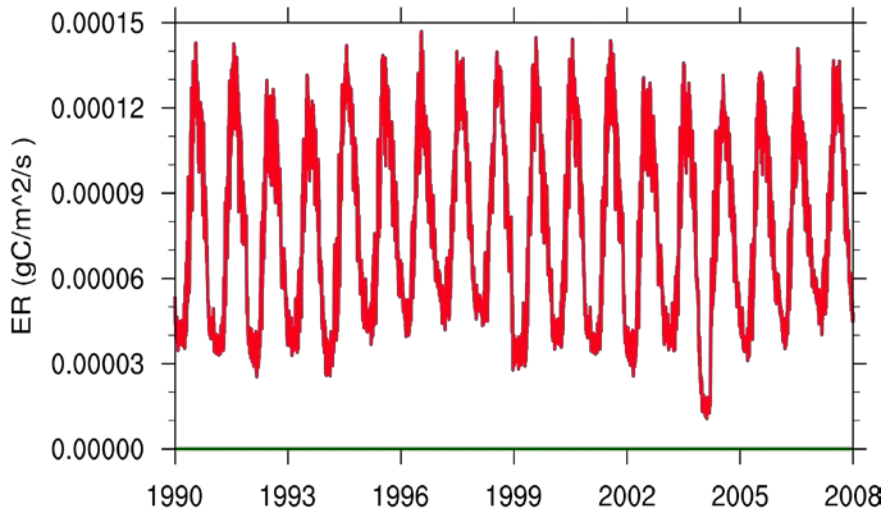
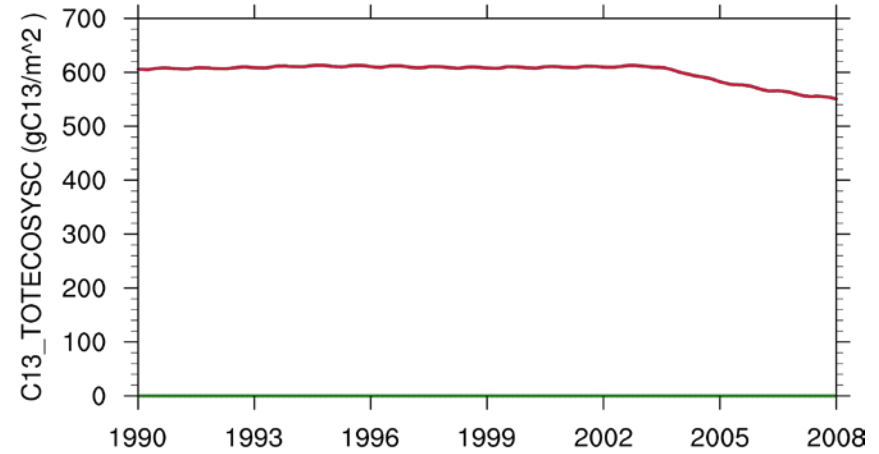
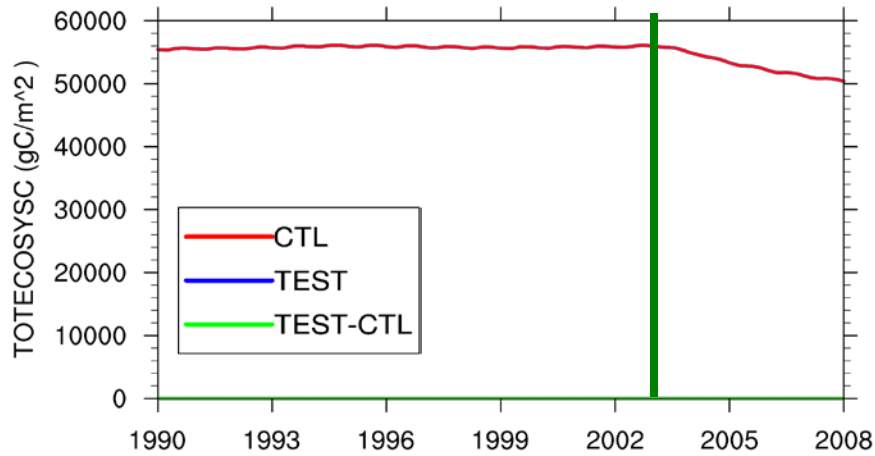
(CTL)

Mineral soil layer (BG)

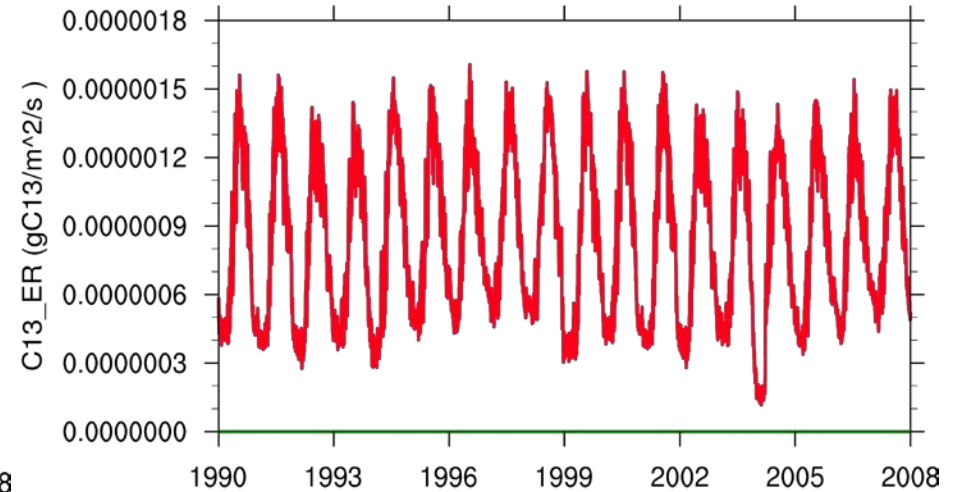
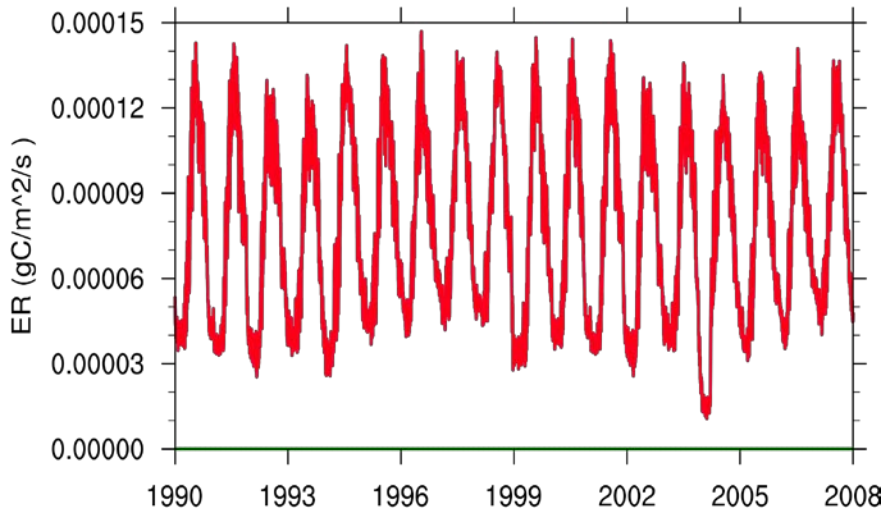
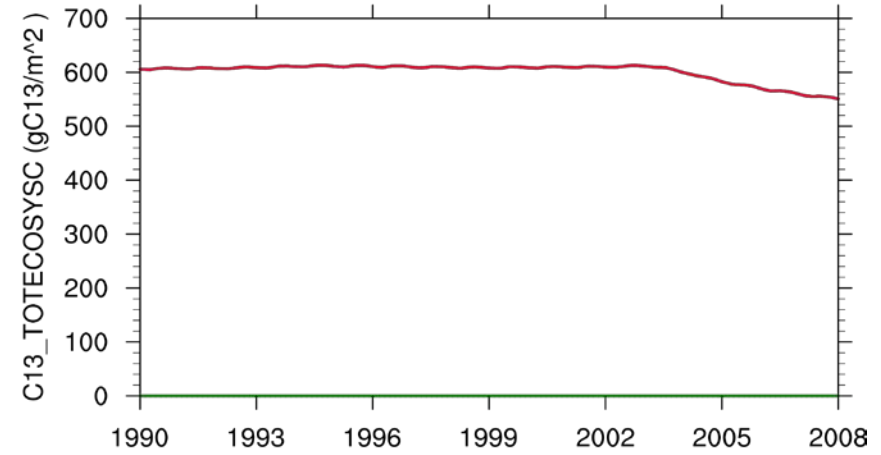
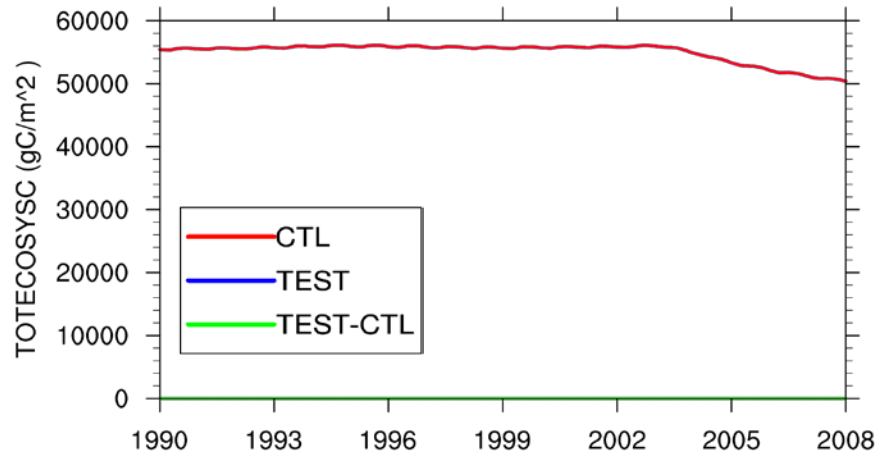
1 - ag_rootf

fraction of root in the mineral soil layer

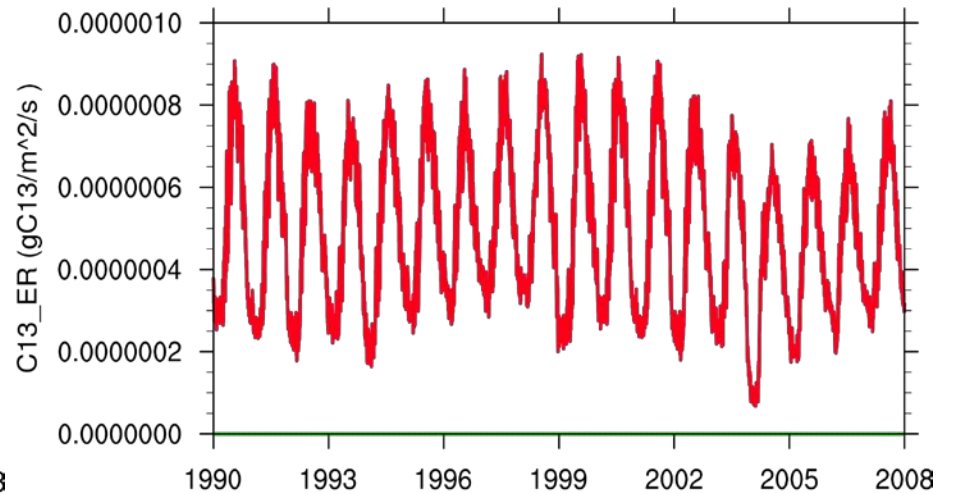
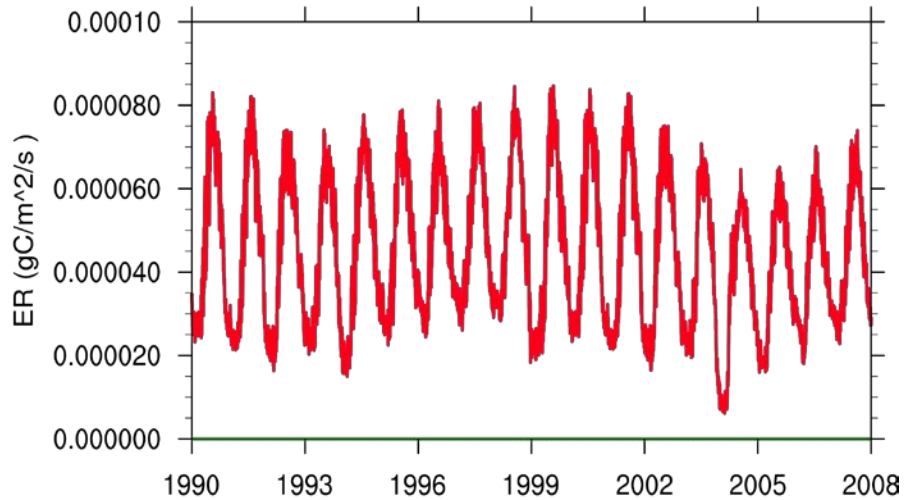
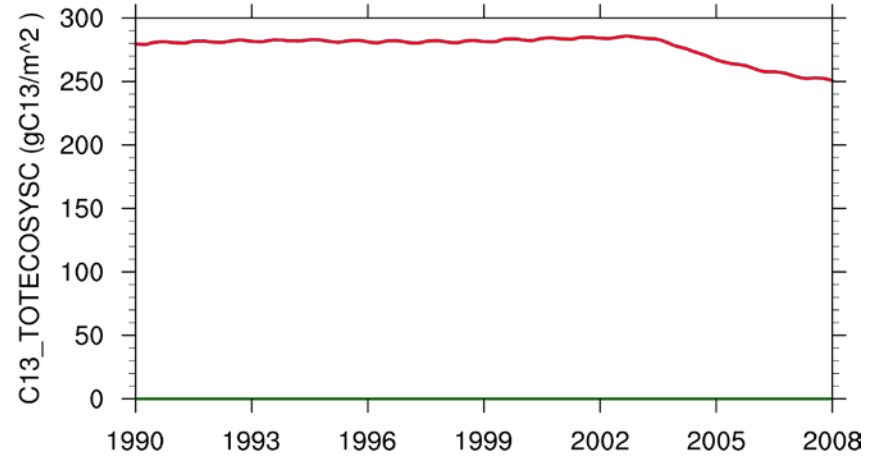
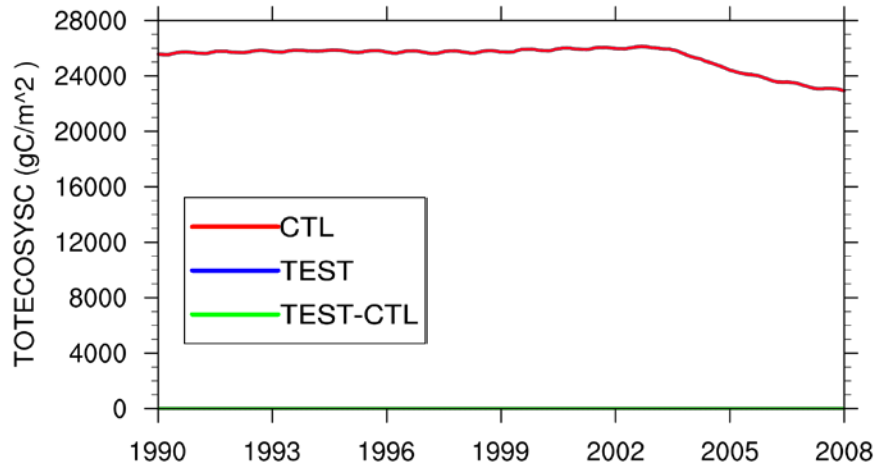
C only test on AG (*Niwot Ridge*)



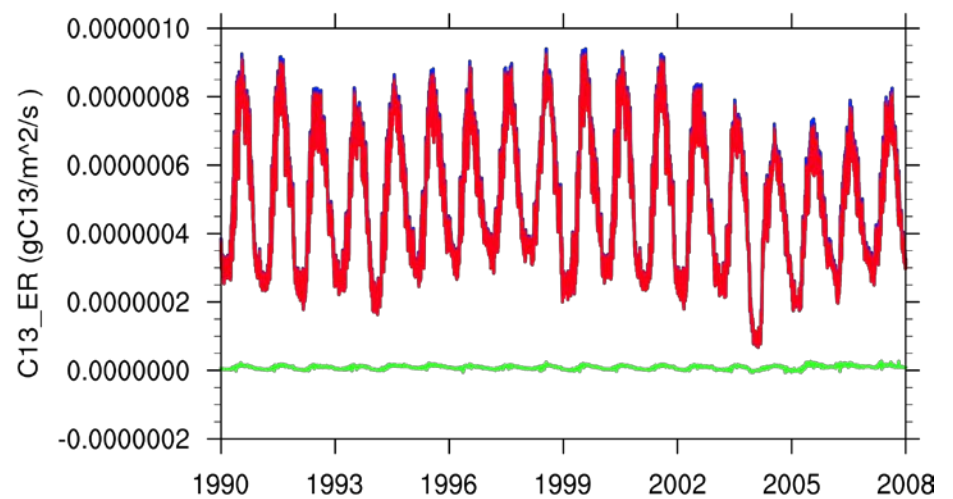
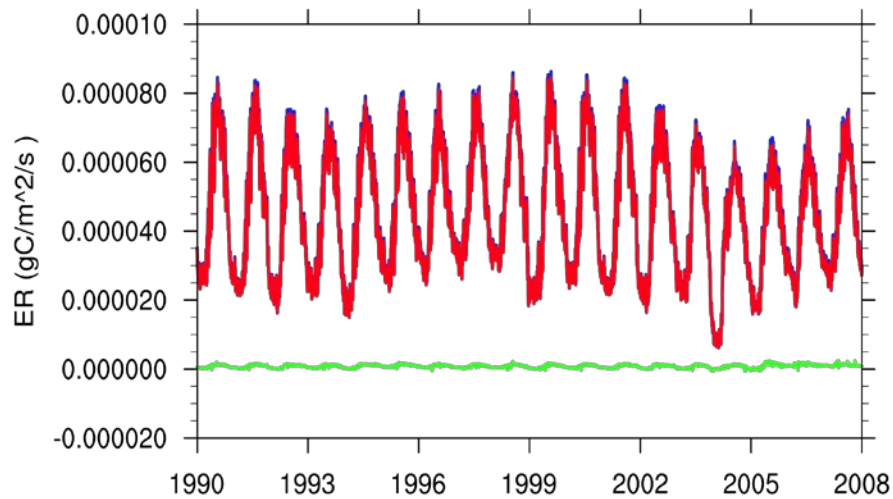
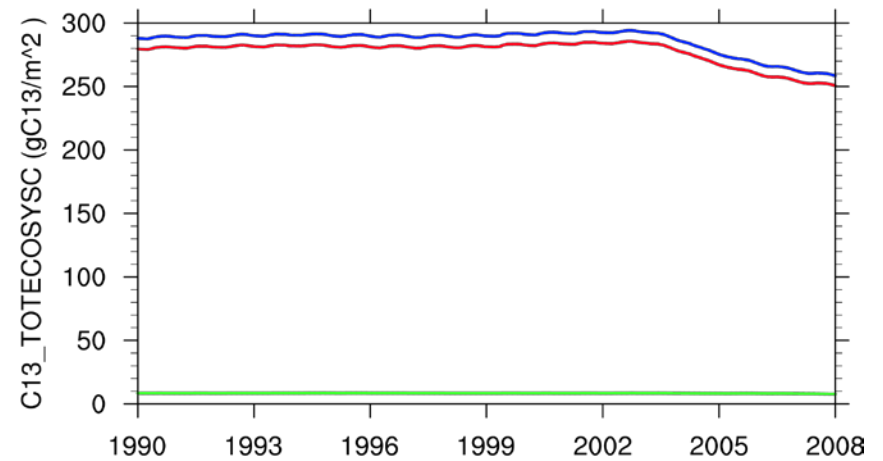
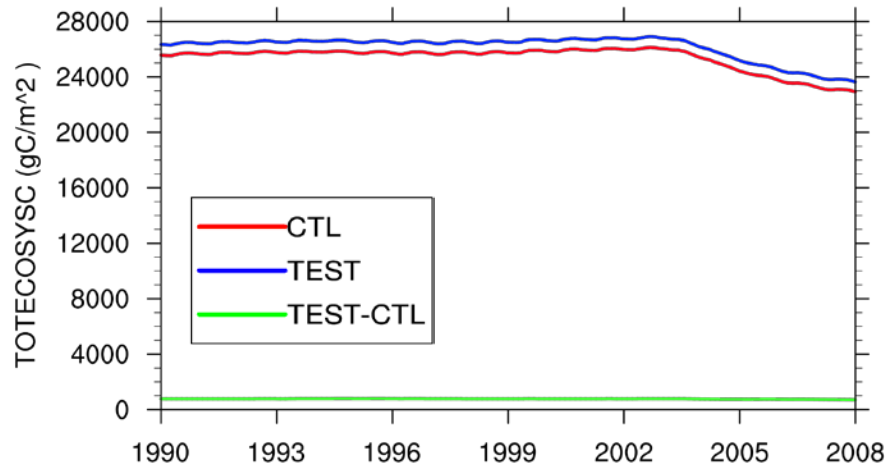
C only test on AG plus BG



CN test on AG



CN test on AG plus BG



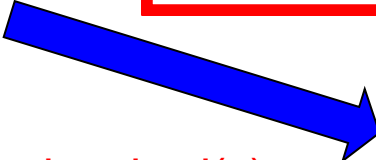
CNNDynamicsMod.F90

$$\text{ag_disn_conc} = (\text{sf} * \text{ag_sminn}(c)) / \text{tot_water}(c)$$
$$\text{bg_disn_conc} = (\text{sf} * \text{bg_sminn}(c)) / \text{tot_water}(c)$$



9.8338529178336649E-008
9.8338529178336663E-008

$$\text{sf} * (\text{ag_sminn}(c) + \text{bg_sminn}(c)) / \text{tot_water}(c)$$



A blue arrow points from the equations in the first block to the equations in this block.

$$\text{ag_sminn_leached}(c) = \text{ag_disn_conc} * \text{qflx_drain}(c)$$
$$\text{bg_sminn_leached}(c) = \text{bg_disn_conc} * \text{qflx_drain}(c)$$



A red arrow points from the equations in the second block to the equations in this block.

CNNStateUpdate3Mod.F90

$$\text{ag_sminn}(c) = \text{ag_sminn}(c) - \text{ag_sminn_leached}(c) * \text{dt}$$
$$\text{bg_sminn}(c) = \text{bg_sminn}(c) - \text{bg_sminn_leached}(c) * \text{dt}$$



A green arrow points from the equations in the third block to the equations in this block.

CNAAllocationMod.F90

$$\text{ag_col_plant_ndemandf} = \text{ag_sminn}(c) / (\text{ag_sminn}(c) + \text{bg_sminn}(c))$$
$$\text{ag_col_plant_ndemand}(c) = \text{col_plant_ndemand}(c) * \text{ag_col_plant_ndemandf}$$
$$\text{bg_col_plant_ndemand}(c) = \text{col_plant_ndemand}(c) * (1.0_r8 - \text{ag_col_plant_ndemandf})$$

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?