Table 1: Change equations for the carbon pools in the model. These rates are calculated for each vertical layer (subscript dropped from equations for readability). Units; $FC_{donor,reciver}$: $gCm^{-3}h^{-1}$. Details about the fluxes are found in Table A1.

Eqn	Stores	Growth rates	Sources	Sinks
(a)	Metabolic litter	$dC_{LITm}/dt =$	$FC_{Veg,LITm}$	$-FC_{LITm,SAPb} - FC_{LITm,SAPf}$
(b)	Structural litter	$dC_{LITs}/dt =$	$FC_{Veg,LITs}$	$-FC_{LITs,SAPb} - FC_{LITs,SAPf}$
(c)	Saprotrophic bacteria	$dC_{SAPb}/dt =$	$CUE_b(FC_{LITm,SAPb} + FC_{LITs,SAPb} + FC_{SOMa,SAPb})$	$-FC_{SAPb,SOMp} - FC_{SAPb,SOMa} - FC_{SAPb,SOMc}$
(d)	Saprotrophic fungi	$dC_{SAPf}/dt =$	$CUE_f(FC_{LITm,SAPf} + FC_{LITs,SAPf} + FC_{SOMa,SAPf})$	$-FC_{SAPf,SOMp} - FC_{SAPf,SOMa} - FC_{SAPf,SOMc}$
(e)	Ectomycorrhiza biomass	$dC_{EcM}/dt =$	$CUE_{EcM} \cdot FC_{Veg,EcM}$	$-FC_{EcM,SOMp} - FC_{EcM,SOMa} - FC_{EcM,SOMc}$
				$-FC_{enzEcM,SOMa}$
(f)	Arbuscular mycorrhiza biomass	$dC_{AM}/dt =$	$CUE_{AM} \cdot FC_{Veg,AM}$	$-FC_{AM,SOMp} - FC_{AM,SOMa} - FC_{AM,SOMc}$
(g)	Physically protected SOM	$dC_{SOMp}/dt =$	$FC_{Veg,SOMp} + FC_{SAPb,SOMp} + FC_{SAPf,SOMp}$	
			$+FC_{EcM,SOMp} + FC_{AM,SOMp}$	$-FC_{SOMp,SOMa} - FC_{EcMdecompSOMp}$
(h)	Chemically protected SOM	$dC_{SOMc}/dt =$	$FC_{Veg,SOMc} + FC_{SAPb,SOMc} + FC_{SAPf,SOMc}$	
			$+FC_{EcM,SOMc} + FC_{AM,SOMc}$	$-FC_{SOMc,SOMa} - FC_{EcMdecompSOMc}$
(i)	SOM available	$dC_{SOMa}/dt =$	$FC_{SAPb,SOMa} + FC_{SAPf,SOMa}$	
			$+FC_{EcM,SOMa} + FC_{AM,SOMa}$	
			$+FC_{SOMp,SOMa} + FC_{SOMc,SOMa} + FC_{enzEcM,SOMa}$	
			$+FC_{EcMdecompSOMc} + FC_{EcMdecompSOMp}$	$-FC_{SOMa,SAPb} - FC_{SOMa,SAPf}$
	Net Carbon change:	$dC/dt =$	$FC_{Veg,LITm} + FC_{Veg,LITs} + FC_{Veg,SOMp} + FC_{Veg,SOMc}$	
			$+CUE_{EcM} \cdot FC_{Veg,EcM} + CUE_{AM} \cdot FC_{Veg,AM}$	$-(1 - CUE_b)(FC_{LITm,SAPb} + FC_{LITs,SAPb} + FC_{SOMa,SAPb})$
				$-(1 - CUE_f)(FC_{LITm,SAPf} + FC_{LITs,SAPf} + FC_{SOMa,SAPf})$

0.1 Model Description

The model is based on the MIMICS framework where microbial groups, litter and soil organic matter is represented as separate pools. In its current state, the model is not coupled to a larger land model, and therefore needs prescribed litter input, soil temperature, moisture and N deposition. The model is set up to use input from CLM history files. Fig. 1 shows the model structure, Table 1 and Table 2 give the mass balance equations for each pool in the system. Rate equations for C and N, and a list of parameters are given in the Appendix, Table A1, A2. Fluxes referred to as "C*" or "N*" can be found in those tables [Better way to write?], and are illustrated as arrows in Fig. A1a and Fig. A1b. A list of parameters is given in Table A3. We represent the same number of soil layers as the active layers in the CLM-BGC simulation [rephrase!]. For each layer, the rates between the pools within the layer is calculated first, then we calculate the vertical transport. Unless otherwise stated, the equations described below [refer to sections.] is pr. layer. The vertical transport is described in Section 2.1.3.

Fig. 1 illustrate how organic C and N enters the litter and SOM pools as dead plant material. The mycorrhizal pools receive C from vegetation as payment for nutrients [phrase better?]. Atmospheric N deposition is a source of inorganic N in the model. As in MIM-

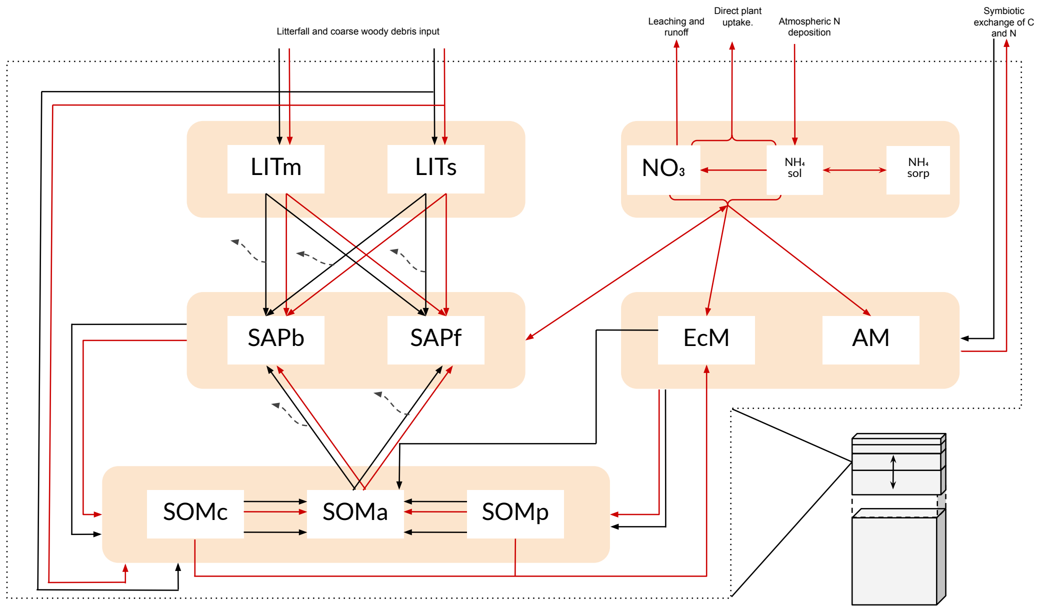


Figure 1: Schematic showing both C and N flows for each layer of the model. Black arrows indicate carbon fluxes ($gCm^{-3}h^{-1}$ while red arrows indicate nitrgen fluxes ($gNm^{-3}h^{-1}$)). LITm, LITs: Metabolic and structural litter. SAPb, SAPf: saprotrophic Bacteria and Fungi. EcM, AM: Ecto- and Arbuscular mycorrhizal fungi. SOMc,SOMa,SOMp: Chemically protected, Available and physicochemically protected soil organic matter.

Table 2: Change equations for the nitrogen pools in the model. These rates are calculated for each vertical layer (subscript dropped from equations for readability). Units; $FN_{donor,reciver}$: $gNm^{-3}h^{-1}$. Details about the fluxes are found in Table A2.

Eqn	Stores	Growth rates	Sources	Sinks	Exchange
(j)	Metabolic litter	$dN_{LITm}/dt =$	$FN_{Veg,LITm}$	$-FN_{LITm,SAPb} - FN_{LITm,SAPf}$	
(k)	Structural litter	$dN_{LITs}/dt =$	$FN_{Veg,LITs}$	$-FN_{LITs,SAPb} - FN_{LITs,SAPf}$	
(l)	Saprotrophic bacteria	$dN_{SAPb}/dt =$	$NUE(FN_{LITm,SAPb} + FN_{LITs,SAPb} + FN_{SOMa,SAPb})$	$-FN_{SAPb,SOMp} - FN_{SAPb,SOMa} - FN_{SAPb,SOMc}$	$+FN_{IN,SAPb}$
(m)	Saprotrophic fungi	$dN_{SAPf}/dt =$	$NUE(FN_{LITm,SAPf} + FN_{LITs,SAPf} + FN_{SOMa,SAPf})$	$-FN_{SAPf,SOMp} - FN_{SAPf,SOMa} - FN_{SAPf,SOMc}$	$+FN_{IN,SAPf}$
(n)	Ectomycorrhiza	$dN_{EcM}/dt =$	$FN_{IN,EcM} + FN_{SOMp,EcM} + FN_{SOMc,EcM}$	$-FN_{EcM,SOMp} - FN_{EcM,SOMa} - FN_{EcM,SOMc}$	
				$-FN_{EcM,Veg}$	
(o)	Arbuscular mycorrhiza	$dN_{AM}/dt =$	$FN_{IN,AM}$	$-FN_{AM,SOMp} - FN_{AM,SOMa} - FN_{AM,SOMc}$	
				$-FN_{AM,Veg}$	
(p)	Physically protected SOM	$dN_{SOMp}/dt =$	$FN_{SAPb,SOMp} + FN_{SAPf,SOMp}$		
			$+FN_{EcM,SOMp} + FN_{AM,SOMp} + FN_{Veg,SOMp}$	$-FN_{SOMp,SOMa} - FN_{SOMp,EcM}$	
(q)	Chemically protected SOM	$dN_{SOMc}/dt =$	$FN_{SAPb,SOMc} + FN_{SAPf,SOMc}$		
			$+FN_{EcM,SOMc} + FN_{AM,SOMc} + FN_{Veg,SOMp}$	$-FN_{SOMc,SOMa} - FN_{SOMc,EcM}$	
(r)	SOM available	$dN_{SOMa}/dt =$	$FN_{SAPb,SOMa} + FN_{SAPf,SOMa}$		
			$+FN_{SOMp,SOMa} + FN_{SOMc,SOMa}$		
			$+FN_{EcM,SOMa} + FN_{AM,SOMa}$	$-FN_{SOMa,SAPb} - FN_{SOMa,SAPf}$	
(s)	Ammonium, solved	$dN_{NH4_{sol}}/dt =$	$FN_{DEP} + (1 - NUE)(FN_{uptake,sap})$[a]	$-f_{NH4}(FN_{IN,EcM} + FN_{IN,AM} + FN_{IN,Veg})$	$-f_{NH4}(FN_{IN,SAPb} + FN_{IN,SAPf})$
				$-FN_{NH4,NO3}$	$+FN_{sol,sorp}$
(t)	Ammonium, sorbed	$dN_{NH4_{sorp}}/dt =$			$-FN_{sol,sorp}$
(u)	Nitrate	$dN_{NO3}/dt =$	$FN_{NH4,NO3}$	$-FN_{run+leach}-$	
				$(1 - f_{NH4})(FN_{IN,EcM} + FN_{IN,AM} + FN_{IN,Veg})$	$-(1 - f_{NH4})(FN_{IN,SAPb} + FN_{IN,SAPf})$
	Net Nitrogen change:	$dN/dt =$	$FN_{DEP} + FN_{Veg,LITm} + FN_{Veg,LITs}$	$-FN_{run+leach} - FN_{IN,Veg} - FN_{EcM,Veg} - FN_{AM,Veg}$	
			$FN_{Veg,SOMc} + FN_{Veg,SOMp}$		

[a] $FN_{uptake,sap} = N_{LITm,SAPb} + FN_{LITs,SAPb} + FN_{SOMa,SAPb} + FN_{LITm,SAPf} + FN_{LITs,SAPf} + FN_{SOMa,SAPf}$

ICS (Wieder et al., 2015) and ORCHIDEE-SOM (Camino-Serrano et al., 2018), we separate between metabolic (labile) litter mainly originated from leafs and fine roots, and structural litter, including coarse woody debris. For SOM we again follow the MIMICS approach with two SOM pools that are protected, physicochemically or chemically, from saprotrophic decomposition, and one pool that is available for decomposition. Desorption and oxidation moves organic matter from physicochemically and chemically protected pools,respectively, to the available pool (C11,C12,N11,N12). A portion (10% for metabolic and 30% for structural) of the incoming litter is directly transfered to the SOM pools (C3,C4,N3,N4). This, together with microbial necromass are the sources of input to the SOM pools [Removed "main" here, enzyme prod. from EcM is a minor contribution that is now not refered to..]. [Skriv mer eksplisitt at mikrobene bestemmer nedbrytingsrater..Setninger: The microbial pools in the model determines the rates of decomposition, and thereby the The SOM and litter pools are the main "storage pools" for C in the model, while the saprotropic and mycorrhizal pools, although storing some C as biomass, are mainly acting to distribute C and N around and out of the system.].

0.1.1 Microbial processes

We separate between saprotrophic fungi and bacteria (SAPb and SAPf in Fig. 1). Temperature sensitive reverse Michaelis Menten kinetics, together with a moisture modifier [refer to testbed mimics?], determines the rates at which saprotrophs decompose C from the two litter pools, and the available SOM (C5-C10). The corresponding N fluxes (N7-N10) are determined by the C:N ratio of the substrate pools. During decomposition, a fraction of the incoming C is removed as heterotrophic respiration (HR), while the rest is contributing to saprotrophic biomass. The respired fraction is determined by the Carbon Use Efficiencies CUE_b and CUE_f which have maximum values of 0.4 and 0.7, but is reduced under low nutrient conditions. Saprotrophic necromass is transferred to the SOM pools, and is partitioned between the three pools based on clay content of the soil and the metabolic fraction of incoming litter (C13-C18 and N13-N18). Only a fraction of the N released during decomposition is available to saprotrophs, determined the Nitrogen Use Efficiency (NUE = 0.7). The remaining fraction is directly converted to inorganic $NH4_{sol}$.

The C:N ratio of the saprotrophs is assumed to be constant ($CN_b = 5$ and $CN_f = 8$, Table A3). To ensure that this ratio is fulfilled in each layer and timestep, N is exchanged between the saprotrophs and the inorganic pools (N36 and N37). The exchange rates can be positive or negative, leading to either immobilization or mineralization of inorganic N, depending on how much N is available in the layer. A first calculation of the exchange rates gives the optimal rate if enough N is available in the current layer and timestep.

$$FN_{IN,SAPb} = N_{demand,b} - N_{uptake,b} \tag{1}$$

$$FN_{IN,SAPf} = N_{demand,f} - N_{uptake,f} \tag{2}$$

where, with x representing either b (bacteria) or f (fungi),

$$N_{demand,x} = \frac{CUE_x \cdot (FC_{LITm,SAPx} + FC_{LITs,SAPx} + FC_{SOMa,SAPx})}{CN_x} \tag{3}$$

$$N_{uptake,x} = NUE \cdot (FN_{LITm,SAPx} + FN_{LITs,SAPx} + FN_{SOMa,SAPx}) \tag{4}$$

This results in one of four possibilities:

1. Both Eq. 1 and 2 are positive, meaning both groups will immobilize inorganic N. In this case we check if there is enough available inorganic N to fulfill the need from both pools. If there is enough N, the two equations, 1 and 2, will be used unchanged.

If not, the CUE is reduced so that the saprotrophs utilize all N that is available to them. Here, N_{for_sap} is refering to the sum of the available N pools, $N_{NH4_{sol}}$ and N_{NO3}:

$$CUE_b = \frac{(f_b \cdot N_{for\_sap} + N_{uptake,b} \cdot dt) \cdot CN_b}{(FC_{LITm,SAPb} + FC_{LITs,SAPb} + FC_{SOMa,SAPb}) \cdot dt} \tag{5}$$

$$CUE_f = \frac{((1 - f_b) \cdot N_{for\_sap} + N_{uptake,f} \cdot dt) \cdot CN_f}{(FC_{LITm,SAPf} + FC_{LITs,SAPf} + FC_{SOMa,SAPf}) \cdot dt} \tag{6}$$

where f_b determines the division of the available inorganic N between bacteria and fungi, and is calculated as: [Try to find reference]

$$f_b = FN_{IN,SAPb}/(FN_{IN,SAPb} + FN_{IN,SAPf}) \tag{7}$$

This reduces the CUE (and increase the respired fraction) enough to maintain the C:N ratios under the prevailing conditions, and the resulting exchange rates is:

$$FN_{IN,SAPb} = f_b \cdot N_{for\_sap} \tag{8}$$

$$FN_{IN,SAPf} = (1 - f_b) \cdot N_{for\_sap} \tag{9}$$

where N_{for_sap} is inorganic N in the form of $NO3$ and $NH4_{sol}$ in soil solution.

[Confusing that Eq. 1,2 and 8,9 are refering to the same fluxes?]

2. Both Eq. 1,2 are negative, meaning both groups will mineralize inorganic N:

$$N_{IN,SAPx} = N_{demand,x} - N_{uptake,x} < 0$$

The mineralized N will enter the $N_{NH4_{sol}}$ pool.

3. Eq. 1 is negative and 2 is positive. In this case bacteria can access the N mineralized by fungi if needed.

4. 1 is positive and 2 is negative. In this case fungi can access the N mineralized by bacteria if needed.

The model version used in this study represent two different mycorrhizal fungi: Ectomycorrhizal (EcM) and arbuscular mycorrhizal (AM). How the incoming carbon (Eq. C28 and C29) is partitioned between EcM and AM is determined dynamically through a Return Of Investment (ROI) function based on the method from (Sulman et al., 2019) [Modified from Brzostek et al 2014]. The partition between EcM and AM is determined by

$$f_{alloc} = \frac{ROI_i}{\Sigma_i ROI_i} \tag{10}$$

where ROI_i is the return of investment from mycorrhizal association i (EcM or AM);

$$ROI_i = \frac{N_{aquired,i} \cdot k_{myc,som} CUE_i}{C_i} \tag{11}$$

For EcM $N_{aquired,EcM} = N25 + N26 + N27$ while for AM $N_{aquired,AM} = N28$. $k_{myc,som}$ is the turnover time, while ϵ_i is the growth efficency for mycorrhizal association i. In addition to direct access to inorganic N (N27), EcM can access N from the protected organic pools, SOMp and SOMc (mining for N, (Lindahl & Tunlid, 2015)). By releasing enzymes, a fraction f_{enz}, of the incoming C directly to SOMa (C27), EcM gets N via N25 and N26, and at the same time makes some C available for the saprotrophs, C25 and C26. The arbuscular mycorrhizal fungi can only take up N from the inorganic pools (N28). Constant mortality rates determines the transport from mycorrhizal fungi to SOM pools (C19-C24 and N19-N24).

To ensure that the most efficient mining happens when the influx of C to mycorrhizal associations is largest, and to avoid that ectomycorrhiza provides "free" N to the plant during winter (when C flux is assumed to be close to zero) [write better] we use a function that modifies the mining rates;

$$r_{myc} = \frac{I_{veg,myc}(t)}{max(I_{veg,myc})} \tag{12}$$

Here, $I_{veg,myc}(t)$ $[gCm^{-2}hr^{-1}]$ is the amount of C the vegetation will use on mycorrhizal N uptake in that timestep, and $max(I_{veg,myc})$ is the maximum value of $I_{veg,myc}$ in the current year. In the current model version, $I_{veg,myc}(t)$ is prescribed (?) from the CLM input, meaning it will not respond to changes is soil N availability.

0.1.2 Inorganic N processes

Inorganic N is divided between N_{NO3} and $N_{NH4,sol}$ dissolved in soil water, and $N_{NH4,sorb}$ which is sorbed to soil particles. N from atmospheric deposition enters as $N_{NH4,sol}$ (N32) where it can undergo nitrification to N_{NO3} (N34). N_{NO3} is exposed to leaching and runoff (N31). The leaching and runoff is based on the algorithm used in CLM. Both dissolved pools, $N_{NH4,sol}$ and N_{NO3}, can be taken up by mycorrhizal fungi (N26,N27) or directly by plants (N33). Since the model is not coupled to aboveground vegetation, direct plant uptake is only a constant loss rate in the model for now. Within a time step, the different processes affecting inorganic N is calculated in a sequence: 1) Deposition, leaching and runoff 2) nitrification 3) N from decomposition 4) direct uptake by vegetation 5) uptake by mycorrhiza 6) exchange with saprotrophs (see Section 2.1.1) 7) Sorption-desorption algorithm, details below.

Before pt. 7) the total N_{NH4} value is

$$N_{NH4,tot} = N_{NH4,sorp} + N_{NH4,sol} \tag{13}$$

By solving Eq. 13 together with the Langmuir isotherm equation, we find the equilibrium partition between $N_{NH4,sol}$ and $N_{NH4,sorp}$ given the total amount $N_{NH4,tot}$. The Langmuir isotherm equation is given by

$$N_{NH4,sorp,eq} = \frac{NH4_{sorp,max} \cdot K'_L \cdot N_{NH4,sol,eq}}{1 + K'_L \cdot N_{NH4,sol,eq}} \tag{14}$$

where K'_L is a Langmuir constant related to adsorption energy, and a function of water content. [How to describe this, it cant be a constant and a function of water content at the same time..], and $NH4_{sorp,max}$ is the maximum adsorption capacity. The values for these parameters are based on Sieczka and Koda (2016). We assume that the system moves towards the equilibrium value during the timestep, via the following mechanism: [format equation better]

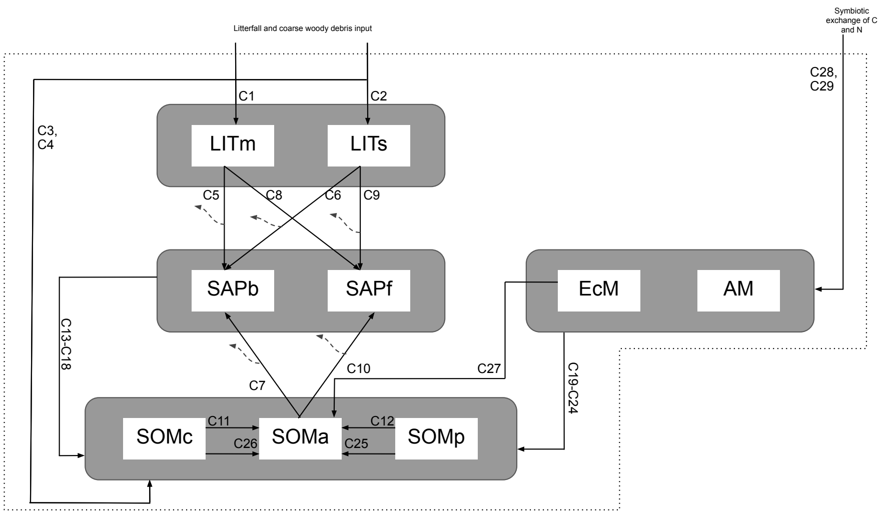
$$N_{NH4,sorp} = \begin{cases} N_{NH4,sorp,eq} - \frac{1}{\frac{1}{N_{NH4,sorp,eq} - NH4_{sorp,prev.}} + k \cdot dt} & N_{NH4,sorp,eq} > N_{NH4,sorp,prev}, \\ N_{NH4,sorp,eq} + \frac{1}{\frac{1}{N_{NH4,sorp,prev} - N_{NH4,sorp,eq}} + k \cdot dt} & N_{NH4,sorp,eq} < N_{NH4,sorp,prev}, \\ N_{NH4,sorp,prev} & N_{NH4,sorp,eq} = N_{NH4,sorp,prev} \end{cases} \tag{15}$$

Here k is a rate constant and dt is the timestep. The top option corresponds to absorption, the middle option to desorption and the third if equilibrium is already reached.

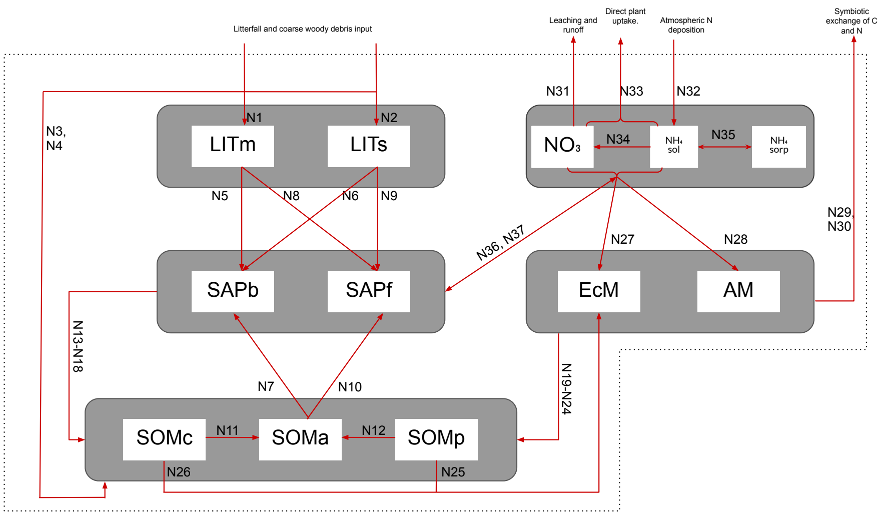
0.1.3 Vertical structure

The discretized vertical layers of the model follows the same structure as CLM [`https://escomp.github.io/ctsm-docs/versions/master/html/tech_note/Ecosystem/CLM50_Tech_Note_Ecosystem.html#vertical-discretization,referertilriktigartikkel`]. This allows incoming litter and and N deposition to be distributed following the same vertical profile as CLM. Temperature and soil moisture is also vertically resolved [Er "resolved" riktig ord her?] Each layer includes a set of the pools described above. Within each time step the fluxes between the pools (Fig. 1) are calculated and applied first, then the vertical transport is calculated and applied. This transport is calculated as a simple diffusion equation between adjacent layers (Soetaert & Herman, 2009), using a diffusion coefficient from Koven et al. (2013).

Appendix A Tables



(a) Schematic of carbon pools and flows for each layer in the model. The numbers indicated correspond to the expressions in Table A1.



(b) Schematic of nitrogen pools and flows for each layer in the model. The numbers indicated correspond to the expressions in Table A2 in the Appendix.

Figure A1: Illustration of the total system of pools and fluxes in the system, A1a shows the C flows while A1b show the N flows.

Table A1: Details about C fluxes in the model. The flux numbers corresponds to the arrows in Fig. A1a. The equation letters in the last column matches with those given in Table 1. All $FC_{donor,reciver}$ has units $gCm^{-3}h^{-1}$. Parameters are described in Table A3.

Eq.	Description	Flux Name	Rate functions	Used in eqn	Notes
C1	Metabolic litter from vegetation	$FC_{Veg,LITm} =$	$f_{met} \cdot I_C \cdot (1 - f_{met,SOM})$	(a)	
C2	Structural litter from vegetation	$FC_{Veg,LITs} =$	$((1 - f_{met}) \cdot I_C + CWD_C) \cdot (1 - f_{struct,SOM})$	(b)	
C3	Met. Lit to SOMp	$FC_{Veg,SOMp} =$	$f_{met} \cdot I_C \cdot f_{met,SOM}$	(g)	
C4	Struct. Lit to SOMc	$FC_{Veg,SOMc} =$	$((1 - f_{met}) \cdot I_C + CWD_C) \cdot f_{struct,SOM}$	(h)	
	<u>SAPb decomposition of:</u>				
C5	LITm to SAPb	$FC_{LITm,SAPb} =$	$C_{SAPb} \cdot V_{max1} \frac{C_{LITm}}{K_{m1}+C_{SAPb}}$	(a)(c)	Reverse MMK
C6	LITs to SAPb	$FC_{LITs,SAPb} =$	$C_{SAPb} \cdot V_{max2} \frac{C_{LITs}}{K_{m2}+C_{SAPb}}$	(b)(c)	Reverse MMK
C7	SOMa to SAPb	$FC_{SOMa,SAPb} =$	$C_{SAPb} \cdot V_{max3} \frac{C_{SOMa}}{K_{m3}+C_{SAPb}}$	(i)(c)	Reverse MMK
	<u>SAPf decomposition of:</u>				
C8	LITm to SAPf	$FC_{LITm,SAPf} =$	$C_{SAPf} \cdot V_{max4} \frac{C_{LITm}}{K_{m4}+C_{SAPf}}$	(a)(d)	Reverse MMK
C9	LITs to SAPf	$FC_{LITs,SAPf} =$	$C_{SAPf} \cdot V_{max5} \frac{C_{LITs}}{K_{m5}+C_{SAPf}}$	(b)(d)	Reverse MMK
C10	SOMa to SAPf	$FC_{SOMa,SAPf} =$	$C_{SAPf} \cdot V_{max6} \frac{C_{SOMa}}{K_{m6}+C_{SAPf}}$	(i)(d)	Reverse MMK
	<u>Desorption and oxidation:</u>				
C11	Oxidation from SOMc to SOMa	$FC_{SOMc,SOMa} =$	$\frac{C_{SAPf} \cdot V_{max2} \cdot C_{SOMc}}{KO \cdot K_{m2}+C_{SAPb}} + \frac{C_{SAPb} \cdot V_{max5} \cdot C_{SOMc}}{KO \cdot K_{m5}+C_{SAPf}}$	(h)(i)	As in MIMICS
C12	Desorption from SOMp to SOMa	$FC_{SOMp,SOMa} =$	$C_{SOMp} \cdot k_{desorp}$	(g)(i)	As in MIMICS

Continued on next page

Table A1 – Continued from previous page

Eq.	Description	Flux Name	Rate functions	Used in eqn	Notes
	Saprotrophic bacteria necromass to:				
C13	SOMp	$FC_{SAPb,SOMp} =$	$C_{SAPb} \cdot k_{SAPb,som} \cdot f_{SAPb,SOMp}$	(c)(g)	
C14	SOMc	$FC_{SAPb,SOMc} =$	$C_{SAPb} \cdot k_{SAPb,som} \cdot f_{SAPb,SOMc}$	(c)(h)	
C15	SOMa	$FC_{SAPb,SOMa} =$	$C_{SAPb} \cdot k_{SAPb,som} \cdot f_{SAPb,SOMa}$	(c)(i)	
	Saprotrophic fungi necromass to:				
C16	SOMp	$FC_{SAPf,SOMp} =$	$C_{SAPf} \cdot k_{SAPf,som} \cdot f_{SAPf,SOMp}$	(d)(g)	
C17	SOMc	$FC_{SAPf,SOMc} =$	$C_{SAPf} \cdot k_{SAPf,som} \cdot f_{SAPf,SOMc}$	(d)(h)	
C18	SOMa	$FC_{SAPf,SOMa} =$	$C_{SAPf} \cdot k_{SAPf,som} \cdot f_{SAPf,SOMa}$	(d)(i)	
	Ectomycorrizal necromass to:				
C19	SOMp	$FC_{EcM,SOMp} =$	$C_{EcM} \cdot k_{myc,som} \cdot f_{EcM,SOMp}$	(e)(g)	
C20	SOMc	$FC_{EcM,SOMc} =$	$C_{EcM} \cdot k_{myc,som} \cdot f_{EcM,SOMc}$	(e)(h)	
C21	SOMa	$FC_{EcM,SOMa} =$	$C_{EcM} \cdot k_{myc,som} \cdot f_{EcM,SOMa}$	(e)(i)	
	Arbuscular mycorrizal necromass to:				
C22	SOMp	$FC_{AM,SOMp} =$	$C_{AM} \cdot k_{myc,som} \cdot f_{AM,SOMp}$	(f)(g)	
C23	SOMc	$FC_{AM,SOMc} =$	$C_{AM} \cdot k_{myc,som} \cdot f_{AM,SOMc}$	(f)(h)	
C24	SOMa	$FC_{AM,SOMa} =$	$C_{AM} \cdot k_{myc,som} \cdot f_{AM,SOMa}$	(f)(i)	
	Mycorrhiza related fluxes:				

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Table A1 – Continued from previous page

Eq.	Description	Flux Name	Rate functions	Used in eqn	Notes
C25	C made available by mining	$FC_{EcMdecompSOMp} =$	$K_{MO} \cdot H \cdot C_{EcM} \cdot C_{SOMp} \cdot r_{myc}$	(g)(i)	Baskaran + mining term
C26	C made available by mining	$FC_{EcMdecompSOMc} =$	$K_{MO} \cdot H \cdot C_{EcM} \cdot C_{SOMc} \cdot r_{myc}$	(h)(i)	Baskaran + mining term
C27	EcM enzyme production	$FC_{enzEcM,SOMa} =$	$f_{enz} \cdot CUE_m \cdot FC_{Veg,EcM}$	(e)(i)	Fraction of input goes directly to enzyme prod.
C28	EcM	$FC_{Veg,EcM} =$	$f_{alloc,EcM} \cdot I_{veg,Myc}$	(e)	
C29	AM	$FC_{Veg,AM} =$	$f_{alloc,AM} \cdot I_{veg,Myc}$	(f)	

Table A2: Details about N fluxes in the model. The flux numbers corresponds to the arrows in Fig. A1b. The equations in the last column matches with those given in Table 2. Parameters are described in Table A3.

Eq.	Description	Flux Name	Rate functions	Used in eqn	Notes
	Litter input				
N1	Metabolic litter from vegetation	$FN_{Veg,LITm} =$	$f_{met} \cdot I_N \cdot (1 - f_{met,SOM})$	(a)	
N2	Structural litter from vegetation	$FN_{Veg,LITs} =$	$((1 - f_{met}) \cdot I_N + CWD_N) \cdot (1 - f_{struct,SOM})$	(b)	
N3	Met. Lit to SOMp	$FN_{Veg,SOMp} =$	$f_{met} \cdot I_C \cdot f_{met,SOM}$	(g)	
N4	Struct. Lit to SOMc	$FN_{Veg,SOMc} =$	$((1 - f_{met}) \cdot I_N + CWD_N) \cdot f_{struct,SOM}$	(h)	
	SAPb decomposition of:				
N5	LITm	$FN_{LITm,SAPb} =$	$FC_{LITm,SAPb} \cdot \left(\frac{N_{LITm}}{C_{LITm}}\right)$	(j)(l)	as in MIMICS
N6	LITs	$FN_{LITs,SAPb} =$	$FC_{LITs,SAPb} \cdot \left(\frac{N_{LITs}}{C_{LITs}}\right)$	(k)(l)	as in MIMICS
N7	SOMa	$FN_{SOMa,SAPb} =$	$FC_{SOMa,SAPb} \cdot \left(\frac{N_{SOMa}}{C_{SOMa}}\right)$	(r)(l)	as in MIMICS
	SAPf decomposition of:				
N8	LITm	$FN_{LITm,SAPf} =$	$FC_{LITm,SAPf} \cdot \left(\frac{N_{LITm}}{C_{LITm}}\right)$	(j)(m)	as in MIMICS
N9	LITs	$FN_{LITs,SAPf} =$	$FC_{LITs,SAPf} \cdot \left(\frac{N_{LITs}}{C_{LITs}}\right)$	(k)(m)	as in MIMICS
N10	SOMa	$FN_{SOMa,SAPf} =$	$FC_{SOMa,SAPf} \cdot \left(\frac{N_{SOMa}}{C_{SOMa}}\right)$	(r)(m)	as in MIMICS
	Desorption and oxidation:				

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Table A2 – Continued from previous page

Eq.	Description	Flux Name	Rate functions	Used in eqn	Notes
N11	Oxidation	$FN_{SOMc,SOMa} =$	$FC_{SOMc,SOMa} \cdot \left(\frac{N_{SOMc}}{C_{SOMc}}\right)$	(q)(r)	
N12	Desorption	$FN_{SOMp,SOMa} =$	$FC_{SOMp,SOMa} \cdot \left(\frac{N_{SOMp}}{C_{SOMp}}\right)$	(p)(r)	
	Saprotrophic bacteria necromass to:				
N13	SOMp	$FN_{SAPb,SOMp} =$	$FC_{SAPb,SOMp} \cdot \left(\frac{N_{SAPb}}{C_{SAPb}}\right)$	(l)(p)	
N14	SOMc	$FN_{SAPb,SOMc} =$	$FC_{SAPb,SOMc} \cdot \left(\frac{N_{SAPb}}{C_{SAPb}}\right)$	(l)(q)	
N15	SOMa	$FN_{SAPb,SOMa} =$	$FC_{SAPb,SOMa} \cdot \left(\frac{N_{SAPb}}{C_{SAPb}}\right)$	(l)(r)	
	Saprotrophic fungi necromass to:				
N16	SOMp	$FN_{SAPf,SOMp} =$	$FC_{SAPf,SOMp} \cdot \left(\frac{N_{SAPf}}{C_{SAPf}}\right)$	(m)(p)	
N17	SOMc	$FN_{SAPf,SOMc} =$	$FC_{SAPf,SOMc} \cdot \left(\frac{N_{SAPf}}{C_{SAPf}}\right)$	(m)(q)	
N18	SOMa	$FN_{SAPf,SOMa} =$	$FC_{SAPf,SOMa} \cdot \left(\frac{N_{SAPf}}{C_{SAPf}}\right)$	(m)(r)	
	Ectomycorrhizal necromass to:				
N19	SOMp	$FN_{EcM,SOMp} =$	$FC_{EcM,SOMp} \cdot \left(\frac{N_{EcM}}{C_{EcM}}\right)$	(n)(p)	
N20	SOMc	$FN_{EcM,SOMc} =$	$FC_{EcM,SOMc} \cdot \left(\frac{N_{EcM}}{C_{EcM}}\right)$	(n)(q)	
N21	SOMa	$FN_{EcM,SOMa} =$	$FC_{EcM,SOMa} \cdot \left(\frac{N_{EcM}}{C_{EcM}}\right)$	(n)(r)	
	Arbuscular mycorrhizal necromass to:				
N22	SOMp	$FN_{AM,SOMp} =$	$FC_{AM,SOMp} \cdot \left(\frac{N_{AM}}{C_{AM}}\right)$	(o)(p)	
N23	SOMc	$FN_{AM,SOMc} =$	$FC_{AM,SOMc} \cdot \left(\frac{N_{AM}}{C_{AM}}\right)$	(o)(q)	

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Table A2 – Continued from previous page

Eq.	Description	Flux Name	Rate functions	Used in eqn	Notes
N24	SOMa	$FN_{AM,SOMa} =$	$FC_{AM,SOMa} \cdot \left(\frac{N_{AM}}{C_{AM}}\right)$	(o)(r)	
	Mycorrhiza related fluxes:				
N25	N aquired from SOMp	$FN_{SOMp,EcM} =$	$FC_{EcMdecompSOMp} \cdot \left(\frac{N_{SOMp}}{C_{SOMp}}\right)$	(g)(e)	
N26	N aquired from SOMc	$FN_{SOMc,EcM} =$	$FC_{EcMdecompSOMc} \cdot \left(\frac{N_{SOMc}}{C_{SOMc}}\right)$	(h)(e)	
N27	N from inorganic to EcM	$FN_{IN,EcM} =$	$V_{max,myc} \cdot N_{IN} \cdot \left(\frac{C_{EcM}}{(C_{EcM}+K_{m,myc}/H)}\right) \cdot r_{myc}$	(s)(u)(n)	Baskaran et al. (2017)
N28	N from inorganic to AM	$FN_{IN,AM} =$	$V_{max,myc} \cdot N_{IN} \cdot \left(\frac{C_{AM}}{(C_{AM}+K_{m,myc}/H)}\right) \cdot r_{myc}$	(s)(u)(o)	
	N from myc. fungi to plant:				See main text for details
N29	EcM	$FN_{EcM,Veg} =$	$(FN_{IN,EcM} + FN_{SOMc,EcM} + FN_{SOMp,EcM})$	(n)	
			$-CUE_{EcM} \cdot FC_{Veg,EcM} \cdot (1 - f_{enz})/CN_{EcM}$		
			or lower, if N limited (reduced CUE)		
N30	AM	$FN_{AM,Veg} =$	$FN_{IN,AM} - CUE_{AM} \cdot FC_{Veg,AM}/CN_{EcM}$	(o)	
			or lower, if N limited (reduced CUE)		
	Inorganic N related:				
N31	Leaching	$FN_{run+leach} =$	$N_{NO3} \cdot \left(\frac{QDRAI}{H_2O_{tot}} + \frac{QRUNOFF}{H2O_{top5cm}}\right)$	(u)	See CTSM doc. 2.22.6
N32	Deposition	$FN_{DEP} =$	$NDEP\_TO\_SMINN \cdot NDEP\_PROF_j$	(s)	
N33	Direct plant uptake	$FN_{Inorg,Veg} =$	$(N_{NH4} + N_{NO3}) \cdot k_{uptake}$	(s)(u)	

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Table A2 – Continued from previous page

Eq.	Description	Flux Name	Rate functions	Used in eqn	Notes
N34	Nitrification	$FN_{NH4,NO3} =$	$NH4 \cdot k_{nitr}$ or	(s)(u)	based on CTSM doc.
			zero if temp. is below freezing		chapter 2.22.5
N35	Equil. kinetics NH4	$FN_{sol,sorp} =$			
<u>Exchange of N between saprotrophic pools and inorg. N:</u>					See main text for details
	Here $U_{S*} = FC_{LITm,SAP*} + FC_{LITs,SAP*} + FC_{SOMa,SAP*}$, * is B or F.				
N36	SAPb	$FN_{IN,SAPb} =$	$(1 - NUE) \cdot (FN_{LITm,SAPb} + FN_{LITs,SAPb}+$		
			$FN_{SOMa,SAPb}) - CUE_b \cdot U_{SB}/CN_b$	(l)(u)(s)	
		or =	$f_b \cdot N_{for\_sap}$ if limited N		
N37	SAPf	$FN_{IN,SAPf} =$	$(1 - NUE) \cdot (FN_{LITm,SAPf} + FN_{LITs,SAPf}+$		
			$FN_{SOMa,SAPf}) - CUE_f \cdot U_{SF}/CN_f$	(m)(u)(s)	
		or =	$(1 - f_b) \cdot N_{for\_sap}$ if limited N		

[for mycorrizal turnover rates, Baskaran refers to Edblad 2013, which gives 0.1/year?]

Table A3: Description of parameters and other relevant sizes used in the model.

Parameter	Description	Value	Units	Notes
f_{met}	Met. frac. of plant litter	0.0-1.0	-	(Wieder et al., 2015)
f_{clay}	Clay fraction in soil	0.0-1.0	-	
T	Soil temperature	-	$^{\circ}C$	Vary with season and depth
Michaelis Menten kinetics param. for SAP: Wieder et al. (2015), German et al. (2012)				
V_{max}	Max reaction velocity	$exp(V_{slope} \cdot T + V_{int}) \cdot a_V \cdot V_{mod} \cdot r_{moist}$	$mg(mg)^{-1}h^{-1}$	
K_m	Half saturation constant	$exp(K_{slope} \cdot T + K_{int}) \cdot a_K \cdot K_{mod}$	$mgCcm^{-3}$	
K_{slope}	Regression coefficient	lit: 0.017, SOMa: 0.027	$ln(mgCcm^{-3})^{\circ}C^{-1}$	For all 6 fluxes
V_{slope}	Regression coefficient	0.063	$ln(mg(mg)^{-1}h^{-1})^{\circ}C^{-1}$	For all 6 fluxes
K_{int}	Regression intercept	3.19	$ln(mgCcm^{-3})$	Directly (Wieder et al., 2015)
V_{int}	Regression intercept	5.47	$ln(mg(mg)^{-1}h^{-1})$	Directly (Wieder et al., 2015)
a_V	Tuning coefficient	$1.25 \cdot 10^{-8}$	-	
P	Physical protection scalar used in K_{mod}	$1/(2.0 \cdot exp(-2\sqrt{f_{CLAY}}))$	-	range: 0.5-3.7

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Parameter	Description	Value	Units	Notes
$a_K \cdot K_{mod}$	Tuning coefficients	$1.953125, 7.81250, 3.90625 \cdot P,$		As in MIMICS CLM version
		$7.8125, 3.90625, 2.604167 \cdot P$		for LITm, LITs, SOMa
V_{mod}	Modifies V_{max}	$10.0, 3.0, 10.0, 3.0, 5.0, 2.0$	-	for LITm, LITs, SOMa
				entering SAPb, SAPf
KO	Increase Km in eq. C11	6	-	(Kyker-Snowman et al., 2020)
$k_{myc,som}$	Turnover rate	$1.14 \cdot 10^{-4}$	h^{-1}	1/year as Sulman et al. (2019)
				and Baskaran et al. (2017)
$k_{SAPb,som}$	Turnover rate of SAPb	$5.2 \cdot 10^{-4} \cdot exp(0.3 \cdot f_{met}) \cdot$		
		$max(p_{mod}, m_{mod})$	h^{-1}	
$k_{SAPf,som}$	Turnover rate of SAPf	$2.4 \cdot 10^{-4} \cdot exp(0.1 \cdot f_{met}) \cdot$		
		$max(p_{mod}, m_{mod})$	h^{-1}	
	p_{mod} scales with root profile, $m_{mod} = 0.1$ is the minimum value of the modifier. m_{mod} is used when $T < 0$			
k_{desorp}	desorption rate	$1.5 \cdot 10^{-5} \cdot exp(-1.5 \cdot f_{clay})$	h^{-1}	Wieder et al. (2015)
K_{MO}	Mycorrhizal decay rate constant for oxidizable store	$3.42 \cdot 10^{-7}$	$m^2/(gC \cdot hr)$	Baskaran et al. (2017)

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Parameter	Description	Value	Units	Notes
$V_{max,myc}$	Max. mycorrhizal uptake of inorg N	$2.05 \cdot 10^{-4}$	$g/(g \cdot hr)$	Baskaran et al. (2017) for EcM, we also use it for AM
$K_{m,myc}$	Half saturation constant of ectomycorrhizal uptake of inorg N	0.08	gN/m^2	(Baskaran et al., 2017) for EcM we also use it for AM
CUE_{EcM}	Growth efficiency of mycorrhiza	0 - 0.5	-	Baskaran et al. (2017)
CUE_{AM}	Growth efficiency of mycorrhiza	0 - 0.5	-	Baskaran et al. (2017)
CUE_b	Growth efficiency of sap. bacteria	0 -0.4	-	Determined by N availability
CUE_f	Growth efficiency of sap. fungi	0 -0.7	-	Determined by N availability
NUE	Nitrogen use efficiency of saprotrophs	0.7	-	Assumed
r_{moist}	Moisture function	0.05-1	-	
r_{myc}	Mycorrhizal modifier	0-1	-	
$f_{SAPb,SOMp}$	Frac. necromass into SOMp	$0.3 \cdot exp(1.3 \cdot f_{clay})$	-	
$f_{SAPb,SOMc}$	Frac. necromass into SOMc	$0.1 \cdot exp(-3 \cdot f_{met})$	-	
$f_{SAPb,SOMa}$	Frac. necromass into SOMa	$1 - (f_{SAPb,SOMp} + f_{SAPb,SOMc})$	-	
$f_{SAPf,SOMp}$	Frac. necromass into SOMp	$0.2 \cdot exp(0.8 \cdot f_{clay})$	-	
$f_{SAPf,SOMc}$	Frac. necromass into SOMc	$0.3 \cdot exp(-3 \cdot f_{met})$	-	
$f_{SAPf,SOMa}$	Frac. necromass into SOMa	$1 - (f_{SAPf,SOMp} + f_{SAPf,SOMc})$	-	

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Parameter	Description	Value	Units	Notes
$f_{EcM,SOMp}$	Frac. necromass into SOMp	0.4	-	Assumed
$f_{EcM,SOMc}$	Frac. necromass into SOMc	0.2	-	Assumed
$f_{EcM,SOMa}$	Frac. necromass into SOMa	0.4	-	Assumed
$f_{AM,SOMp}$	Frac. necromass into SOMp	0.3	-	Assumed
$f_{AM,SOMc}$	Frac. necromass into SOMc	0.4	-	Assumed
$f_{AM,SOMa}$	Frac. necromass into SOMa	0.3	-	Assumed
f_{enz}	Frac. of EcM C uptake used for enzyme prod.	0.10	-	Assumed
f_{use}	Frac. C released by mining taken up by EcM.	0.10	-	Assumed
$f_{alloc,i}$	Frac. of C from plant alloc. to myc. i	0-1	-	See Sec. 2.1.1
$f_{met,SOM}$	Frac. of metabolic litter prod.	0.1	-	
	going directly to SOMp			
$f_{struct,SOM}$	Frac. of structural litter prod.	0.3	-	
	going directly to SOMc			
H	Soil depth (column height)		m	Depth of active layers in CLM
I_C, I_N	Litter and fine root C and N input	$FROOT*\_TO\_LIT \cdot FROOT\_PROF$		
		$+LEAF*\_TO\_LIT \cdot LEAF\_PROF$	$g*/m3h$	*: C or N
CWD_C,	Coarse woody debris C and N input	CWD*_TO_LITR2,	$g*/m3h$	*: C or N

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Parameter	Description	Value	Units	Notes
		CWD*_TO_LITR3		
CWD_N				
D	Diffusion coefficient	$1.14 \cdot 10^{-8}$	$m2/h$	1cm2/yr, Koven et al. (2013)
CN_b	Optimal CN ratio for bacteria	5	-	F. H. Tang et al. (2019)
CN_f	Optimal CN ratio for sap. fungi	8	-	F. H. Tang et al. (2019)
CN_m	Optimal CN ratio for myc. fungi	20	-	Baskaran et al. (2017)
BD_{soil}	Soil Bulk density	$1.6 \cdot 10^6$	g/m^3	Sieczka and Koda (2016)
$NH4_{sorp,max}$	Max. adsorption capacity	$0.09 \cdot BD_{soil}/(10^3 mg/g)$=144	$mgNH4/gsoil$	Sieczka and Koda (2016)
$K_L^{'}$	Modified Lagmuir constant	$0.4/soil\_water\_frac$	$m3/g$	
k_{pseudo}	Rate constant		$m^3/(g \cdot hr)$	

Table A4

CLM-BGC variable	Units	Long name	Notes
LEAFC_TO_LITTER	$gCm^{-2}s^{-1}$	leaf C litterfall	Partitioned between the two litter pools based on f_{MET}.
FROOTC_TO_LITTER	$gCm^{-2}s^{-1}$	fine root C litterfall	Partitioned between the two litter pools based on f_{MET}
CWDC_TO_LITR2C_vr	$gCm^{-3}s^{-1}$	decomp. of coarse woody debris C to litter 2 C	Input to structural litter (LITs)
CWDC_TO_LITR3C_vr	$gCm^{-3}s^{-1}$	decomp. of coarse woody debris C to litter 3 C	Input to structural litter (LITs)
LEAFN_TO_LITTER	$gNm^{-2}s^{-1}$	leaf N litterfall	Partitioned between the two litter pools based on f_{MET}
FROOTN_TO_LITTER	$gNm^{-2}s^{-1}$	fine root N litterfall	Partitioned between the two litter pools based on f_{MET}
CWDN_TO_LITR2N_vr	$gNm^{-3}s^{-1}$	decomp. of coarse woody debris N to litter 2 N	Input to structural litter (LITs)
CWDN_TO_LITR3N_vr	$gNm^{-3}s^{-1}$	decomp. of coarse woody debris N to litter 3 N	Input to structural litter (LITs)
NPP_NACTIVE	$gCm^{-2}s^{-1}$	Mycorrhizal N uptake used C (WRONG??)	First subtract NPP_NNONMYC, then partition between EcM and AM based on $f_{alloc,i}$
NPP_NNONMYC	$gCm^{-2}s^{-1}$	Non-mycorrhizal N uptake used C	Subtracted from NPP_NACTIVE
NDEP_TO_SMINN	$gNm^{-2}s^{-1}$	atmospheric N deposition to soil mineral N	N deposition to NH4 pool
LEAF_PROF	m^{-1}	profile for litter C and N inputs from leaves	Multiplied with LEAF_TO_LITTER to get rates for each depth layer, $gm^{-3}s^{-1}$
FROOT_PROF	m^{-1}	profile for litter C and N inputs from fine roots	Multiplied with FROOT_TO_LITTER to get rates for each depth layer, $gm^{-3}s^{-1}$
NDEP_PROF	m^{-1}	profile for atmospheric N deposition	Multiplied with NDEP_TO_SMINN to get

			deposition for each depth layer, $gNm^{-3}s^{-1}$
Environmental variables:			
TSOI	K	soil temperature	Converted to $^{\circ}C$
WATSAT	mm^3mm^{-3}	saturated soil water content (porosity)	Used for calculating r_{moist}
SOILLIQ	kgm^{-2}	soil liquid water	Used for calculating r_{moist}
SOILICE	kgm^{-2}	soil ice water	Used for calculating r_{moist}
W_SCALAR	-	Moisture (dryness) inhibition of decomposition	Used in nitrification algorithm
T_SCALAR	-	temperature inhibition of decomposition	Used in nitrification algorithm
QDRAI	mms^{-1}	sub-surface drainage	Used for calculating leaching
QOVER	mms^{-1}	surface runoff	Used for calculating Runoff
nbedrock	mm^3mm^{-3}	index of shallowest bedrock layer	for determining how many layers to use in the simulations
Read from surface data file:			
PCT_CLAY	-	percent CLAY	
PCT_NAT_PFT	-	percent plant functional type on the natural veg landunit	

References

Arora, V. K., Katavouta, A., Williams, R. G., Jones, C. D., Brovkin, V., Friedlingstein, P., … Ziehn, T. (2020, 8). Carbon-concentration and carbon-climate feedbacks in cmip6 models and their comparison to cmip5 models. *Biogeosciences*, *17*, 4173-4222. doi: 10.5194/BG-17-4173-2020

Bardgett, R. (2005). *The biology of soil: A community and ecosystem approach.* Oxford University Press. (p. 58: Source for dividing into bacteria and fungi) doi: 10.1093/ACPROF:OSO/9780198525035.001.0001

Baskaran, P., Hyvönen, R., Berglund, S. L., Clemmensen, K. E., Ågren, G. I., Lindahl, B. D., & Manzoni, S. (2017, 2). Modelling the influence of ectomycorrhizal decomposition on plant nutrition and soil carbon sequestration in boreal forest ecosystems. *New Phytologist*, *213*, 1452-1465. Retrieved from `https://onlinelibrary.wiley.com/doi/10.1111/nph.14213` doi: 10.1111/nph.14213

Bonan, G. (2015). Soil biogeochemistry. In *Ecological climatology* (p. 358-375). doi: 10.1017/cbo9781107339200.022

Camino-Serrano, M., Guenet, B., Luyssaert, S., Ciais, P., Bastrikov, V., Vos, B. D., … Janssens, I. A. (2018). Orchidee-som: modeling soil organic carbon (soc) and dissolved organic carbon (doc) dynamics along vertical soil profiles in europe. *Geosci. Model Dev*, *11*, 937-957. Retrieved from `https://doi.org/10.5194/gmd-11-937-2018` doi: 10.5194/gmd-11-937-2018

Esser, J., & Åge Nyborg. (1992). *Jordsmonn i barskog : en oversikt for norge.* Norsk institutt for jord-og skogkartlegging. Retrieved from `https://urn.nb.no/URN:NBN:no-nb_digibok_2010030504019`

Fatichi, S., Manzoni, S., Or, D., & Paschalis, A. (2019, 6). A mechanistic model of microbially mediated soil biogeochemical processes: A reality check. *Global Biogeochemical Cycles*, 2018GB006077. Retrieved from `https://onlinelibrary.wiley.com/doi/abs/10.1029/2018GB006077` doi: 10.1029/2018GB006077

German, D. P., Marcelo, K. R. B., Stone, M. M., & Allison, S. D. (2012, 4). The michaelis-menten kinetics of soil extracellular enzymes in response to temperature: A cross-latitudinal study. *Global Change Biology*, *18*, 1468-1479. Retrieved from `http://doi.wiley.com/10.1111/j.1365-2486.2011.02615.x` doi: 10.1111/j.1365-2486.2011.02615.x

Hansson, A., Dargusch, P., & Shulmeister, J. (2021, 2). A review of modern treeline migration, the factors controlling it and the implications for carbon storage. *Journal of Mountain Science 2021 18:2*, *18*, 291-306. Retrieved from `https://link-springer-com.ezproxy.uio.no/article/10.1007/s11629-020-6221-1` doi: 10.1007/S11629-020-6221-1

Hararuk, O., Smith, M. J., & Luo, Y. (2015, 6). Microbial models with data-driven parameters predict stronger soil carbon responses to climate change. *Global Change Biology*, *21*, 2439-2453. doi: 10.1111/GCB.12827

Haugland, H., Backer, E. B., Løbersli, E. M., Selboe, O.-K., Gunnarsdottir, H., Granhus, A., ... Sørlie, H. A. (2014, 5). Målrettet gjødsling av skog som klimatiltak - egnede arealer og miljøkriterier.

Jonard, M., Fürst, A., Verstraeten, A., Thimonier, A., Timmermann, V., Potoi, N., ... Rautio, P. (2015, 1). Tree mineral nutrition is deteriorating in europe. *Global Change Biology*, *21*, 418-430. Retrieved from `https://onlinelibrary-wiley-com.ezproxy.uio.no/doi/full/10.1111/gcb.12657` doi: 10.1111/GCB.12657

Koven, C. D., Riley, W. J., Subin, Z. M., Tang, J. Y., Torn, M. S., Collins, W. D., ... Swenson, S. C. (2013, 4). The effect of vertically-resolved soil biogeochemistry and alternate soil c and n models on c dynamics of clm4. *Biogeosciences Discussions*, *10*, 7201-7256. Retrieved from `http://www.biogeosciences-discuss.net/10/7201/2013/` doi: 10.5194/bgd-10-7201-2013

Kyker-Snowman, E., Wieder, W. R., Frey, S. D., & Grandy, A. S. (2020, 9). Stoichiometrically coupled carbon and nitrogen cycling in the microbial-mineral carbon stabilization model version 1.0 (mimics-cn v1.0). *Geoscientific Model Development*, *13*, 4413-4434. doi: 10.5194/GMD-13-4413-2020

Lindahl, B. D., & Tunlid, A. (2015, 3). Ectomycorrhizal fungi potential organic matter decomposers, yet not saprotrophs. *New Phytologist*, *205*, 1443-1447. Retrieved from `https://onlinelibrary.wiley.com/doi/10.1111/nph.13201` (Referenced in Baskaran article) doi: 10.1111/nph.13201

Lorenz, M. (1995). International co-operative programme on assessment and monitoring of air pollution effects on forests -icp forests-. *Water, Air and Soil Pollution*, *85*, 1221-1226.

Parton, W. J., Stewart, J. W. B., & Cole, C. V. (1988, 2). Dynamics of c, n, p and s in grassland soils: a model. *Biogeochemistry*, *5*, 109-131. Retrieved from http://link.springer.com/10.1007/BF02180320 doi: 10.1007/BF02180320

Sieczka, A., & Koda, E. (2016, 9). Kinetic and equilibrium studies of sorption of ammonium in the soil-water environment in agricultural areas of central poland. *Applied Sciences (Switzerland)*, *6*. (Fra Helge etter møte om uorganisk N tilgjengelig for saprotrofer.) doi: 10.3390/APP6100269

Soetaert, K., & Herman, P. M. (2009). *A practical guide to ecological modelling: using r as a simulation platform.* doi: 10.1007/978-1-4020-8624-3

Strand, L. T., Callesen, I., Dalsgaard, L., & de Wit, H. A. (2016). Carbon and nitrogen stocks in norwegian forest soils the importance of soil formation, climate, and vegetation type for organic matter accumulation. *Canadian Journal of Forest Research*, *46*, 1459-1473. Retrieved from http://www.nrcresearchpress.com/doi/10.1139/cjfr-2015-0467 doi: 10.1139/cjfr-2015-0467

Sulman, B. N., Moore, J. A. M., Abramoff, R., Averill, C., Kivlin, S., Georgiou, K., ... Classen, A. T. (2018, 11). Multiple models and experiments underscore large uncertainty in soil carbon dynamics. *Biogeochemistry*, *141*, 109-123. Retrieved from http://link.springer.com/10.1007/s10533-018-0509-z doi: 10.1007/s10533-018-0509-z

Sulman, B. N., Shevliakova, E., Brzostek, E. R., Kivlin, S. N., Malyshev, S., Menge, D. N., & Zhang, X. (2019, 4). Diverse mycorrhizal associations enhance terrestrial c storage in a global model. *Global Biogeochemical Cycles*, *33*, 501-523. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1029/2018GB005973 (Earth System Model: GFDL ESM 2.1.
Land model: LM3) doi: 10.1029/2018GB005973

Sveistrup, T. E. (1984). Retningslinjer for beskrivelse av jordprofil. *Jord og Myr*. Retrieved from http://hdl.handle.net/11250/2489357

Tang, F. H., Riley, W. J., & Maggi, F. (2019). Hourly and daily rainfall intensification causes opposing effects on c and n emissions, storage, and leaching in dry and wet grasslands. *Biogeochemistry*, *144*, 197-214. doi: 10.1007/s10533-019-00580-7

Tang, J., & Riley, W. J. (2014, 11). Weaker soil carbonclimate feedbacks resulting from microbial and abiotic interactions. *Nature Climate Change 2014 5:1*, *5*, 56-60. Retrieved from `https://www-nature-com.ezproxy.uio.no/articles/nclimate2438` doi: 10.1038/NCLIMATE2438

Taylor, M. K., Lankau, R. A., & Wurzburger, N. (2016, 11). Mycorrhizal associations of trees have different indirect effects on organic matter decomposition. *Journal of Ecology*, *104*, 1576-1584. Retrieved from `https://besjournals-onlinelibrary-wiley-com.ezproxy.uio.no/doi/10.1111/1365-2745.12629https://onlinelibrary.wiley.com/doi/full/10.1111/1365-2745.12629` doi: 10.1111/1365-2745.12629

Todd-Brown, K. E. O., Hopkins, F. M., Kivlin, S. N., Talbot, J. M., & Allison, S. D. (2012, 7). A framework for representing microbial decomposition in coupled climate models. *Biogeochemistry*, *109*, 19-33. Retrieved from `http://link.springer.com/10.1007/s10533-011-9635-6` doi: 10.1007/s10533-011-9635-6

Wieder, W. R., Grandy, A. S., Kallenbach, C. M., Taylor, P. G., & Bonan, G. B. (2015). Representing life in the earth system with soil microbial functional traits in the mimics model. *Geosci. Model Dev*, *8*, 1789-1808. Retrieved from `www.geosci-model-dev.net/8/1789/2015/` doi: 10.5194/gmd-8-1789-2015

Yu, L., Ahrens, B., Wutzler, T., Schrumpf, M., & Zaehle, S. (2020, 2). Jena soil model (jsm v1.0; revision 1934): A microbial soil organic carbon model integrated with nitrogen and phosphorus processes. *Geoscientific Model Development*, *13*, 783-803. doi: 10.5194/GMD-13-783-2020