*Appendix: DAMM-MCNiP model default parameters, initial values, and equations.*

**Table A1.** Initial pool values for spin up and default runs.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Abbreviation | Units | Spin Up | Default |
| SOC pool | initSOC | mg cm-3 | 100 | 53.8846 |
| SON pool | initSON | mg cm-3 | 3.6232 | 1.7936 |
| DOC pool | initDOC | mg cm-3 | 0.5 | 0.0021 |
| DON pool | initDON | mg cm-3 | 0.0333 | 0.0011 |
| microbial biomass C | initBiomassC | mg cm-3 | 0.5 | 1.8699 |
| microbial biomass N | initBiomassN | mg cm-3 | 0.05 | 0.1870 |
| enzyme pool | initEnz | mg cm-3 | 0.01 | 0.0341 |

**A1 Parameterization**

Most parameters listed in Table 1 are from Davidson et al. (2012) or Allison et al. (2010) unless otherwise stated. Activation energy (Ea) and pre-exponential constant (A) for depolymerization and uptake were parameterized using enzyme assays of beta-glucoside using organic and mineral soil from the autochamber site (Davidson et al., 2012). The C:N of soil was taken from Schimel and Weintraub (2003). Default initial pool sizes were determined after model spin up for 2000 years using spin up parameters from Allison et al. (2010) for the C pool. The N pool was parameterized using the following principles, SON = SOC/27.6 [C:N ratio of soil], DON = DOC/15 [mid-range of DOC:DON from Hopkinson et al. (1997) and Neff & Hooper (2002)], microbial biomass N = microbial biomass C/10 [C:N ratio of microbes]. For the default model, we assume that litter and root inputs have C:N of 50 and 27.6, respectively.

**A2 Model equations**

Soluble C & N Pool

Change in the soluble C & N pool depends on inputs to the pool, depolymerization of SOM, turnover of microbial biomass and enzymes, and microbial uptake [1,2]. Litter DOM is added to the bulk [1] and rhizosphere [2] soil at each timestep, but root inputs (rootDOC\_N) are only added to rhizosphere [2] soil. Depolymerization depends on (1) amount of available SOC that can diffuse through soil pores to the reaction site [3], (2) Equilibrium Chemistry Approximation dynamics [4,5] and (3) temperature according to Arrhenius dynamics [6].

*dDOC/dt = DOCmult\*inputDOC + DEPOLYC + DEATH \* (1 – MICC toSOMC ) + (CNe/(1+CNe)) + ELOSSC – UPTC [1a]*

*dDON/dt = DOCmult\*inputDON + DEPOLYN + DEATH \* (1 – MICN toSOMN ) + (1/CNe) + ELOSSN – UPTN  [1b]*

*dDOC/dt = DOCmult\*(inputDOC + rootDOC) + DEPOLYC + DEATH \* (1 – MICCtoSOMC) + (CNe/(1+CNe)) + ELOSSC – UPTC [2a]*

*dDON/dt = DOCmult\*(inputDON + rootDON) + DEPOLYN + DEATH \* (1 – MICNtoSOMN) + (1/CNe) + ELOSSN – UPTN [2b]*

*avail\_SOM=SOM\*frac\*Dliq\*soilM^3 [3]*

*DEPOLYC* = *VmaxC \* a\*Enz \*avail\_ SOC/(KmC +avail\_ SOC+Enz) [4]*

*DEPOLYN* = *VmaxN \* (1-a)\*Enz \* avail\_SON/(KmN +avail\_ SON+Enz) [5]*

*VmaxC\_N = AC\_N* \* exp (*-EaC\_N / RT*)  *[6]*

Microbial Biomass

Change in microbial biomass is determined by uptake of C and N, C and N use efficiency, growth and death of microbes, and production of extracellular enzymes [7,8]. Uptake is limited by oxygen availability in soil pore spaces [9,10]. Uptake of C and N depend on Michaelis-Menton and Arrhenius equations [11,12]. Maintenance respiration [13] depends on the carbon use efficiency. Enzyme production can be C or N limited, depending on the stoichiometry of the C and N after allocation to maintenance respiration [14,15]. Growth occurs after allocation to both maintenance respiration and enzyme production. Like enzyme production, either C or N can be limiting [16,17]. After enzyme production and growth, excess C and N are mineralized [18,19]. Death is a first order processes with a pre-defined rate constant [20].

***dMICC/ dt =CNm\*GROWTH – DEATHC*** *[7]*

***dMICN/ dt =GROWTH – DEATHN*** *[8]*

*porosity = 1 – BD/PD [9]*

*O2 = Dgas\*O2airfrac\*[(porosity –soilM)4/3] [10]*

*UPTC\_N = MicC\_N \* VmaxuptC\_N \* DOC\_N / (KmuptC\_N + DOC\_N)\*O2/(KmO2 + O2)[11]*

*VmaxuptC\_N = AuptC\_N* \* exp (*-EauptC\_N / RT*) *[12]*

*CMIN = UPTc \* (1 – CUE) [13]*

*EPROD = q\*UPTN [N-limited] [14]*

*EPROD = p\*(CUE\*UPTC)/CNe [C-limited] [15]*

*GROWTH= ((1-p)\*UPTC\*CUE + EnzC – CNe\*EPROD) /CNm [C-limited] [16]*

*GROWTH = (1-q)\*UPTN\*EnzN – EPROD [N-limited] [17]*

*OverflowC = GrowthC – CNm\*Growth [18]*

*NMIN = GrowthN - Growth [19]*

*DEATH = rdeath \* MicC\_N [20]*

Enzyme Pool & Turnover

The enzyme pool is a balance between production and turnover, defined as a first order process [21,22].

***dEnz/dt = EPROD – ELOSS*** *[21]*

*ELOSS = renzloss\*Enz[22]*

SOM Dynamics

The SOM pool is fed by litter inputs and turnover of microbial biomass. Depolymerization transfers SOC and SON to the DOC and DON pools, respectively [23].

***dSOMC\_N/dt = LitterC\_N + DEATH\*MICC\_NtoSOMC\_N – DEPOLYC\_N*** *[23]*