**Supplementary Information**

**Generalizing Microbial Parameters in Soil Biogeochemical Models: Insights from a Multi-Site Incubation Experiment**

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Supplementary Table 1. The dynamics of each soil carbon pool in MEND model.

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| --- | --- | --- |
| Carbon pool variation | Equation |  |
| Particulate organic carbon (POC) pool 1 (P1) | $$\frac{dP\_{1}}{dt}=I\_{P1}+\left(1-g\_{D}\right)∙F\_{12}-F\_{1} $$ | (S1) |
| POC pool 2 (P2) | $$\frac{dP\_{2}}{dt}=I\_{P2}-F\_{2} $$ | (S2) |
| Mineral-associated organic carbon (MOC,M) | $$\frac{dM}{dt}=\left(1-f\_{D}\right)∙\left(F\_{1}+F\_{2}\right)-F\_{3} $$ | (S3) |
| Adsorbed DOC (QOC,Q) | $$\frac{dQ}{dt}=F\_{4}-F\_{5} $$ | (S4) |
| Dissolved organic carbon (DOC,D) | $$\frac{dD}{dt}=I\_{D}+f\_{D}∙\left(F\_{1}+F\_{2}\right)+g\_{D}∙F\_{12}+F\_{3}+\left(F\_{14,EP1}+F\_{14,EP2}+F\_{14,EM}\right)-F\_{6}-\left(F\_{4}-F\_{5}\right) $$ | (S5) |
| MBA | $$\frac{dBA}{dt}=F\_{6}-\left(F\_{7}-F\_{8}\right)-\left(F\_{9}+F\_{10}\right)-F\_{12}-\left(F\_{13,EP1}+F\_{13,EP2}+F\_{13,EM}\right) $$ | (S6) |
| MBD | $$\frac{dBD}{dt}=\left(F\_{7}-F\_{8}\right)-F\_{11} $$ | (S7) |
| Enzymes for P1 (EP1) | $$\frac{dEP\_{1}}{dt}=F\_{13,EP1}-F\_{14,EP1} $$ | (S8) |
| Enzymes for P2 (EP2) | $$\frac{dEP\_{2}}{dt}=F\_{13,EP2}-F\_{14,EP2}$$ | (S9) |
| Enzymes for M (EM) | $$\frac{dEM}{dt}=F\_{13,EM}-F\_{14,EM}$$ | (S10) |
| Respiration (CO2) | $$\frac{dCO\_{2}}{dt}=\left(F\_{9}+F\_{10}\right)+F\_{11} $$ | (S11) |
| Carbon balance | $$\frac{d}{dt}\left(P\_{1}+P\_{2}+M+Q+D+BA+BD+EP\_{1}+EP\_{2}+EM\right)=I\_{P1}+I\_{P2}+I\_{D}-\left(F\_{9}+F\_{10}+F\_{11}\right)$$ | (S12) |

Supplementary Table 2. Component fluxes in the MEND model

|  |  |  |
| --- | --- | --- |
| Flux description | Equation |  |
| Particulate organic carbon (POC) pool 1 (*P*1) decomposition (*F*1) | $$F\_{1}={V\_{P1}∙EP\_{1}∙P\_{1}}/{\left(K\_{P1}+P\_{1}\right)}$$ | (S13) |
| POC pool 2 (*P*2) decomposition | $$F\_{2}={V\_{P2}∙EP\_{2}∙P\_{2}}/{\left(K\_{P2}+P\_{2}\right)}$$ | (S14) |
| Mineral-associated organic carbon (MOC, *M*) decomposition | $$F\_{3}={V\_{M}∙EM∙M}/{\left(K\_{M}+M\right)}$$ | (S15) |
| Adsorption (*F*4) and desorption (*F*5) between dissolved organic carbon (DOC, *D*) and adsorbed DOC (QOC, *Q*) | $$F\_{4}=k\_{ads}∙(1-Q/Q\_{max})∙D$$$$F\_{5}=k\_{des}∙(Q/Q\_{max})$$ | (S16)(S17) |
| DOC (*D*) uptake by microbes | $$F\_{6}=\frac{1}{Y\_{g}}∙(V\_{g}+V\_{mt})\frac{D∙BA}{K\_{D}+D}$$ | (S18) |
| Dormancy (*F*7) and reactivation (*F*8) between active (MBA) and dormant (MBD) microbial biomass (*BA* and *BD*) | $$F\_{7}=[1-D/(K\_{D}+D)]∙V\_{mt}∙BA$$$F\_{8}=D/(K\_{D}+D)∙V\_{mt}∙BD$  | (S19)(S20) |
| MBA (*BA*) growth respiration (*F*9) and maintenance respiration (*F*10) | $$F\_{9}=(\frac{1}{Y\_{g}}-1)\frac{V\_{g}∙D∙BA}{K\_{D}+D}$$$$F\_{10}=(\frac{1}{Y\_{g}}-1)\frac{V\_{mt}∙D∙BA}{K\_{D}+D}$$ | (S21)(S22) |
| MBD (*BD*) maintenance respiration | $$F\_{11}=β∙V\_{mt}∙BD$$ | (S23) |
| MBA (*BA*) mortality  | $F\_{12}=γ∙V\_{mt}$*∙BA* | (S24) |
| Synthesis of enzymes for *P*1 (*EP*1, *F*13,EP1), enzymes for *P*2 (*EP*2, *F*13,EP2), and enzymes for *M* (*EM*, , *F*13,EM) | $$F\_{13,EP1}=P\_{1}/(P\_{1}+P\_{2})∙P\_{EP}∙V\_{mt}∙BA$$$F\_{13,EP2}=P\_{2}/(P\_{1}+P\_{2})∙P\_{EP}∙V\_{mt}∙BA$ $$F\_{13,EM}=P\_{EM}∙V\_{mt}∙BA$$ | (S25) |
| Turnover of enzymes (*EP*1, *EP*2, *EM*) | $F\_{14,EP1}=r\_{E}∙EP\_{1}$ $$F\_{14,EP2}=r\_{E}∙EP\_{2}$$$$F\_{14,EM}=r\_{E}∙EM$$ | (S26) |

Supplementary Table 3. Default parameter values adopted by the MEND model.

|  |  |  |  |  |  |
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| ID | Parameter | Description | Prior range | Predetermined value | Unit |
| 1 | *LF0* | Initial fraction of POC1 in POC  | (0.1, 1.0) | 0.3 | ― |
| 2 | *r*0 | Initial active fraction of microbes | (0.01, 1) | 0.1 | ― |
| 3 | *VP*1 | Max specific decomposition rate for POC1  | (0.1, 100) | 20 | mg C∙mg-1 C∙h-1 |
| 4 | *VP*2 | Max specific decomposition rate for POC2 | (0.1, 100) | 20 | mg C∙mg-1 C∙h-1 |
| 5 | *VM* | Max specific decomposition rate for MOC | (0.1, 100) | 20 | mg C∙mg-1 C∙h-1 |
| 6 | *KP*1 | Half-saturation constant (*K*) for POC1 decomposition | (40, 100) | 60 | mg C∙g-1 soil |
| 7 | *KP*2 | *K* for POC2 decomposition | (1, 40) | 6 | mg C∙g-1 soil |
| 8 | *KM* | *K* for MOC decomposition | (100, 1000) | 600 | mg C∙g-1 soil |
| 9 | *Q*max | Max sorption capacity | (0.5, 5) | 1.7 | mg C∙g-1 soil |
| 10 | *K*ba | Binding affinity | (1, 16) | 6 | *(*mg C∙g-1 soil)-1 |
| 11 | *k*des | Desorption rate | (0.0001, 0.01) | 0.006 | mg C∙g-1 soil∙h-1 |
| 12 | *rE* | Turnover rate of enzymes | (0.0001, 0.01) | 0.003/calibrated | mg C∙mg-1 C∙h-1 |
| 13 | *pEP* | [*Vm*×*pEP*] is the production rate of *EP* (*EP*1+ *EP*2), *Vm* is the specific maintenance rate for active microbes | (0.0001, 0.05) | 0.1/calibrated | ― |
| 14 | *fpEM* | *fpEM*  = *pEM*/*pEP* , [*Vmt*×*pEM*] is the production rate of *EM* | (0.5, 3.0) | 1/calibrated | ― |
| 15 | *fD* | Fraction of decomposed POC allocated to DOC | (0.05, 1) | 0.5/calibrated | ― |
| 16 | *gD* | Fraction of dead microbes allocated to DOC | (0.01, 1) | 0.38 | ― |
| 17 | *V*g | Max specific growth rate  | (0.001, 0.1) | Calibrated | mg C∙mg-1 C∙h-1 |
| 18 | *α* | *= V*mt / (*V*g + *V*mt) | (0.01, 0.5) | Calibrated | ― |
| 19 | *KD* | *K* for microbial uptake  | (0.01, 0.5) | Calibrated | mg C∙g-1 soil |
| 20 | *Y*g | True growth yield at reference temperature (*T*ref) | (0.2, 0.6) | Calibrated | ― |
| 21 | *kYg* | Temperature slope for *Yg*  | (0.001,0.016) | 0.01 | (°C)-1 |
| 22 | *γ* | Max microbial mortality rate = *Vm*× *γ* | (0.1, 20) | 1 | ― |
| 23 | *β* | Ratio of dormant maintenance rate to *Vm* | (0.0005,0.05) | 0.001 | ― |
| 24 | *ψ*A2D | Soil water potential (SWP) threshold for microbial dormancy | (−0.6, −0.2) | −0.4 | MPa |
| 25 | *τ* | *ψ*D2A = *ψ*A2D × *τ*, *ψD2A* is the SWP threshold for microbial resuscitation | (0.1, 0.95) | 0.25 | ― |
| 26 | *ω* | Exponential in SWP function for microbial dormancy or resuscitation  | (1, 6) | 4 | ― |