

**Table 1: All equations and corresponding numbers used in the main text**

Equation	
1	$\frac{dC_i}{dt_{tot}} = \begin{cases} \frac{dC_i}{dt_{bgc}} + \frac{dC_i}{dt_{hyd}} & \text{if species is dissolved or suspended in water column} \\ \frac{dC_i}{dt_{bgc}} & \text{if species is attached or sedimented onto bed surface} \end{cases}$
2	$\frac{dC_i}{dt_{hyd}} = L_i - Q * [C_i]$
3	$dDIC/dt =$ $WEA_{DIC} + DOC\_MINERALIZATION + POC_{terre\_}MINERALIZATION +$ $POC_{auto\_}MINERALIZATION + SEDOC_{terre\_}MINERALIZATION +$ $SEDOC_{auto\_}MINERALIZATION + ALG\_RESPIRATION + ALG_{benth\_}RESPIRATION -$ $ALG\_PRIMARY\_PRODUCTION - ALG_{benth\_}PRIMARY\_PRODUCTION -$ $DIC\_ATMOSPHERIC\_EXCHANGE$
4	$DIC\_ATMOSPHERIC\_EXCHANGE = k_{air} * (CO_{2water} - CO_{2atmosphere})$
5	$k_{air} = k_{600} / (600/Sc_T)^{-0.5}$ $k_{air\_floodplains} = (k_{600} / (600/Sc_T)^{-0.5}) * F_{high\_veg} * F_{u10\_veg} + (k_{600} / (600/Sc_T)^{-0.5}) * (1 - F_{high\_veg})$
6	$Sc_T = 1911.1 - 118.11T + 3.4527T^2 - 0.04132T^3$
7	$k_{600} = \begin{cases} a_1 + b_1 \bar{u}_{10} & \text{if stream width} > 100 \text{ meters} \\ a_2 + b_2 * v & \text{if stream width} < 100 \text{ meters} \end{cases}$
8	$dDOC/dt =$ $SRO_{DOC} + WAS_{DOC} + ALG\_EXCRETION + ALG_{benth\_}EXCRETION -$ $DOC\_MINERALIZATION$
9	$dPOC_{terre\_}/dt =$ $LIT_{POC} + SOI_{POC} + SEDOC_{terre\_}INSTREAM\_EROSION - POC_{terre\_}SEDIMENTATION -$ $POC_{terre\_}MINERALIZATION$
10	$dPOC_{auto\_}/dt =$ $ALG\_C\_MORTALITY + ALG\_C_{benth\_}MORTALITY +$ $SEDOC_{auto\_}INSTREAM\_EROSION - POC_{auto\_}SEDIMENTATION -$ $POC_{auto\_}MINERALIZATION$
11	$dSEDOC_{terre\_}/dt =$ $POC_{terre\_}SEDIMENTATION - SEDOC_{terre\_}INSTREAM\_EROSION - SEDOC_{terre\_}$ $MINERALIZATION - SEDOC_{terre\_}BURIAL$
12	$dSEDOC_{auto\_}/dt =$

$$POC_{auto\_SEDIMENTATION} - SEDOC_{auto\_INSTREAM\_EROSION} - SEDOC_{auto\_MINERALIZATION} - SEDOC_{auto\_BURLAL}$$

$$13 \quad \Phi_{ero\_tot} = k_{ero} * (SED_{tot} / A) / (k_{sed} + SED_{tot} / A) * S * v * A$$

$$14 \quad SED_{tot} = SEDIM + SEDOM_{terre} + SEDOM_{auto}$$

$$15 \quad SEDOM_{terre} = SEDOC_{terre} / f_{C\_SEDOCterre} * MM_C$$

$$16 \quad SEDOM_{auto} = SEDOC_{auto} / f_{C\_SEDOCauto} * MM_C$$

$$17 \quad SEDOC_{terre\_INSTREAM\_EROSION} = (SEDOC_{terre} / SED_{tot}) * \Phi_{ero\_tot}$$

$$SEDOC_{auto\_INSTREAM\_EROSION} = (SEDOC_{auto} / SED_{tot}) * \Phi_{ero\_tot}$$

$$18 \quad POC_{terre\_SEDIMENTATION} = v_{sed_{POCterre}} / D * POC_{terre}$$

$$POC_{auto\_SEDIMENTATION} = v_{sed_{POCauto}} / D * POC_{auto}$$

$$19 \quad DOC\_MINERALIZATION = f_{min}(T) * k_{DOCmin} * DOC$$

$$20 \quad POC_{terre\_MINERALIZATION} = f_{min}(T) * k_{POCterre\_min} * POC_{terre}$$

$$POC_{auto\_MINERALIZATION} = f_{min}(T) * k_{POCauto\_min} * POC_{auto}$$

$$21 \quad SEDOC_{terre\_MINERALIZATION} = f_{min}(T) * k_{SEDOCterre\_min} * SEDOC_{terre}$$

$$SEDOC_{auto\_MINERALIZATION} = f_{min}(T) * k_{SEDOCauto\_min} * SEDOC_{auto}$$

$$22 \quad f_{min}(T) = \exp\left(\frac{T - T_{ref}}{10}\right) \ln(Q10)$$

$$f(T) = e^{\frac{(T_{opt} - T)^2}{\sigma^2}}$$

$$23 \quad SEDOC_{terre\_BURLAL} = k_{burial} * SEDOC_{terre}$$

$$SEDOC_{auto\_BURLAL} = k_{burial} * SEDOC_{auto}$$

$$24 \quad dALG/dt = ALG\_PRIMARY\_PRODUCTION - ALG\_RESPIRATION - ALG\_MORTALITY - ALG\_EXCRETION$$

$$25 \quad dALG_{benth}/dt = ALG_{benth\_PRIMARY\_PRODUCTION} - ALG_{benth\_RESPIRATION} - ALG_{benth\_MORTALITY} - ALG_{benth\_EXCRETION}$$

$$26 \quad ALG\_PRIMARY\_PRODUCTION = f_{ALG\_pp}(T) * ALG_{I\_lim} * ALG_{DIC\_lim} * k_{ALG\_pp} * ALG$$

$$27 \quad ALG_{benth\_PRIMARY\_PRODUCTION} = f_{ALG_{benth\_pp}}(T) * ALG_{benth\_I\_lim} * ALG_{benth\_DIC\_lim} * k_{ALG_{benth\_pp}} * ALG_{benth}$$

$$28 \quad ALG\_RESPIRATION = f_{ALG\_resp}(T) * k_{ALG\_resp} * ALG\_C$$

$$29 \quad ALG_{benth\_RESPIRATION} = f_{ALG_{benth\_resp}}(T) * k_{ALG_{benth\_resp}} * ALG_{benth}$$

$$30 \quad ALG\_EXCRETION = f_{ALG\_excr}(T) * k_{ALG\_excr} * ALG$$

$$31 \quad ALG_{benth\_EXCRETION} = f_{ALG_{benth\_excr}}(T) * k_{ALG_{benth\_excr}} * ALG_{benth}$$

$$32 \quad ALG\_MORTALITY = (f_{ALG\_mort}(T) * k_{ALG\_mort}) + (f_{ALG\_mort}(T) * k_{ALG\_mort}) * (1 + \nu f) * ALG$$

$$33 \quad ALG_{benth\_MORTALITY} = (f_{ALG_{benth\_mort}}(T) * k_{ALG_{benth\_mort}}) + (f_{ALG_{benth\_mort}}(T) * k_{ALG_{benth\_mort}}) * (1 + \nu f) * ALG_{benth}$$

$$34 \quad ALG_{DIC\_lim} = \frac{[DIC]}{k_{DIC} + [DIC]}$$

$$35 \quad I_0(MOY, lat) = \frac{\int_0^t I_0(t, lat) dt}{HPM}$$

$$36 \quad I\_lim(MOY, lat) = \begin{cases} \frac{I_z}{(I_z + k_{I_{ALG_{benth}}})} & \text{for } ALG_{benth} \\ \frac{\int_0^z I_0(MOY, lat)}{(\int_0^z I_0(MOY, lat) + k_{I_{ALG_C}})} & \text{for } ALG \end{cases}$$

$$37 \quad I_z = I_0(MOY, lat) * e^{-\eta_{tot} * z}$$

$$38 \quad \eta_{tot} = \eta_{water} + \eta_{POC_{terre}} * [POC_{terre}] + \eta_{POC_{auto}} * [POC_{auto}] + \eta_{ALG} * [ALG] + \eta_{DOC} * [DOC] + \eta_{PIM} * [PIM]$$

$$39 \quad I_0(t, lat) = \theta_s(t, lat) * t * I_{solar\_constant}$$

$$40 \quad \theta_s(t, lat) = \arccos((\sin(lat) * \sin(\delta(t)) + \cos(lat) * \cos(\delta(t)) * \cos(h(t, lat)))$$

$$41 \quad \delta(t) = 23.45 * \pi / 180 * \sin(2\pi * (284 + DOY(t)) / 362.5)$$

$$42 \quad Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 \dots + \beta_n X_n + e$$

$$43 \quad SRC_i = \beta_i \frac{\sigma_{X_i}}{\sigma_Y}$$