MODEL EQUATIONS | **KEYWORDS**

1. PHYTOPLANKTON

1.1 Growth processes

The variation of the state variable P is written:

$$\frac{\partial P}{\partial t} = (\mu_P - r_P - e_P - m_P).P - \left(G_{Z2}^{P}.Z1\right) \qquad (1)$$

- μ_P - phytoplankton specific growth rate supported by nitrogen
- r_P - endogenous respiration and photorespiration
- e_P - fraction of primary production exuded as DON
- m_P - phytoplankton natural mortality rate
- G_{Z2}^{P} - loss of phytoplankton due to mesozooplankton grazing

The phytoplankton specific growth rate is:

$$\mu_P = V_P^{max}.\Psi(T)_P.\Psi(L)_P.\Psi(N)_P \qquad (2)$$

V_P^{max} - maximum specific nitrogen uptake rate at a reference temperature — **GROWMAXF**

$\Psi(T)_P$, $\Psi(L)_P$, and $\Psi(N)_P$ represents the specific growth rate dependency on temperature, light and nutrients respectively.

1.1.1 Nitrogen limiting factor

A Michaelis-Menten function is used for nitrogen limitation:

$$\Psi(N)_P = \frac{N_{inorg}}{K_N^P + N_{inorg}} \qquad (3)$$

K_N^P - half-saturation constant

N_{inorg} - useful concentration of inorganic dissolved nitrogen (ammonia + nitrate).

ÑSATCONS

1.1.2 Light limiting factor

$$\Psi(L)_P = \frac{I(z)}{I_s}.e^{\left(1-\frac{I(z)}{I_s}\right)} \qquad \text{with} \qquad I(z) = I_0.e^{(-K_d.z)} \qquad (4)$$

I_s - optimum light intensity for photosynthesis

I_0 - effective solar radiation at the water surface

z - vertical position

K_d - light extinction factor. This factor is obtained according to Parsons *et al.* (1995),

$$K_d = 0{,}04 + 0{,}0088.Ch + 0{,}54.Ch^{2/3} \qquad (5)$$

Ch - chlorophyll concentration.

1.2 Respiration Respiration is divided in dark respiration and in photorespiration. The dark respiration is defined, according to Parker *et al.*(1980), as: $$r_e = K_r^P e^{0,069T} \qquad (6)$$ K_r^P - phytoplankton endogenous respiration constant T - temperature The photorespiration, proportional to the gross photosynthetic rate, is: $$r_p = K_p^P \mu_P \qquad (7)$$ K_p^P - proportionality factor. So, the respiration rate is defined as: $$r^P = r_e + r_p \qquad (8)$$ **1.3 Excretion** $$e_P = K_e^P.\mu_P.(1-\Psi(L)) \qquad (9)$$ K_e^P - excretion constant The amount of nitrogen excreted by phytoplankton is given by: $$e_P^N = \left(e_P + r^P\right).\alpha_P \qquad (10)$$ r^P - respiration rate α_P - the phytoplankton N:C ratio	FENDREPC PHOTORES EXCRCONS FRATIONC

1.4 Natural mortality The natural mortality, following a modified Michaelis-Menten formulation proposed by Rodgers and Salisbury (1981), is: $$m_e = m_{max}^{Tref} . \frac{\frac{P}{\mu_P}}{K_m^P + \frac{P}{\mu_P}} \quad (11)$$ m_{max}^{Tref} - maximum mortality rate at a reference temperature K_m^P - mortality semi-saturation constant Dead phytoplankton concentrations are them converted into nitrogen units using the phytoplankton N:C ratio (α_P) by: $$m_P^N = m_P.\alpha_P \quad (12)$$ **2. BACTERIA** The state equation of the bacterial biomass *B* is: $$\frac{\partial B}{\partial t} = (\mu_B - e_B - m_B).B - (G_{Z1}^B.Z1) \quad (13)$$ μ_B - total bacterial uptake e_B - excretion rate m_B - natural mortality rate G_{Z1}^B - grazing rate of microzooplankton on bacteria	**FMORTMAX** **FMORTCON** **BARESPCO** **NATMORB**

Total uptake rate of bacteria (μ_B) is the sum of the specific uptake rate for each one of the nutrient sources (DOMnr, ammonium, and POM): $$\mu_B = \mu_B^{Ndnr} + \mu_B^{N2} + \mu_B^{Np} \qquad (14)$$ The specific uptake rate of bacteria is dependent on resource availability (organic substrate), accordingly to a Michaelis-Menten function, and on temperature. It is written as: $$\mu_B^N = V_B^{max}.\frac{N_x}{K_n^B + N_x}.\Psi(T) \qquad (15)$$ V_B^{max} - maximum specific nutrient uptake rate N_x - available substrate K_n^B - half-saturation constant for nutrient uptake For ammonium uptake to take place DOMnr and POM concentration must be higher than the bacteria minimum substrate concentration. The nitrogen uptake is converted in carbon units using the N:C ratio of bacteria (α_B) assuming that the uptake of ammonia need carbon in the corresponding rate to keep a constant composition. For the transformation of DOMnr and PON the N:C ratio of dissolved organic matter (α_S) is used. $$\mu_B = \frac{\mu_B^{Npnr} + \mu_B^{Np}}{\alpha_S} + \frac{\mu_B^{N2}}{\alpha_B} \qquad (16)$$ Dead bacteria is also converted into nitrogen units according to: $$m_B^N = m_B.\alpha_B \qquad (17)$$	**BMAXUPTA** **BACNCONS** **BACMINSUB** **BRATIONC** **SRATIONC**

3. ZOOPLANKTON

3.1 Growth processes

3.1.1 Microzooplankton

The variation of the microzooplankton biomass Z_1 is written:

$$\frac{\partial Z_1}{\partial t} = (\mu_{Z1} - e_{Z1} - m_{Z1}).Z_1 - G_{Z2}^{Z1}.Z_2 \qquad (18)$$

μ_{Z1} - microzooplankton gross growth rate
G_{Z2}^{Z1} - predation rate of mesozooplankton on microzooplankton
m_{Z1} - specific mortality rate
e_{Z1} - specific excretion rate

The microzooplankton gross growth rate is defined as:

$$\mu_{Z1} = a_Z.G_{Z1}^{B} \qquad (19)$$

a_{Z1} - assimilation coefficient of microzooplankton for bacteria — **CILBACASS**
G_{Z1}^{B} - the grazing on bacteria

The parameterization of microzooplankton grazing on bacteria is

$$G_{Z1}^{B} = g_{Z1}^{max}.\Psi_{Z1}^{B}.\Psi(T) \qquad (20)$$

g_{Z1}^{max} - maximum ingestion rate — **CINGMAX**
Ψ_{Z1}^{B} - limitation by available bacteria biomass
$\Psi(T)$ - limitation by temperature

This term is dependent on food availability accordingly to a Michaelis-Menten function including accessible food concentration (prey concentration*capture efficiency) and the threshold standing stock below which predation will cease. If the available food is lower than this concentration, limitation of ingestion will reach its maximum $\left(\Psi_{pred}^{prey}=0\right)$. $$\Psi_{Z1}^{B}=\frac{c_{Z1}^{B}.B-s_{Z1}^{Bmin}}{K_{Z1}+\left(c_{Z1}^{B}.B-s_{Z1}^{Bmin}\right)},\qquad \text{if } c_{Z1}^{B}.B-s_{Z1}^{Bmin}>0 \qquad (21)$$ c_{Z1}^{B} - capture efficiency of bacteria s_{Z1}^{Bmin} - threshold standing stock of bacteria below which predation cease K_{Z1} - half saturation constant for grazing If the condition is not satisfied then $\Psi_{Z1}^{B}=0$ **3.1.2 Mesozooplankton** The time variation of the mesozooplankton biomass Z_2 is: $$\frac{\partial Z_2}{\partial t}=\left(\mu_{Z2}-e_{Z2}-m_{Z2}\right).Z_2 \qquad (22)$$ μ_{Z2} - mesozooplankton gross growth rate m_{Z2} - specific mortality e_{Z2} - excretion rate $$\mu_{Z2}=g_{Z2}^{P}.G_{Z2}^{P}+g_{Z2}^{Z1}.G_{Z2}^{Z1} \qquad (23)$$ g_{Z2}^{P} - assimilation coeficiente of phytoplankton by mesozooplankton g_{Z2}^{Z1} - assimilation coefficient of microzoopalnkton by mesozooplankton G_{Z2}^{P} - grazing of phytoplankton G_{Z2}^{Z1} - predation of microzooplankton	**EFFCAPBA** **GRAZBACMIN** **INGCONSC** **ZOPHYASS** **ZOCILASS**

$$G_{Z2}^{P} = \rho_P . I_{max} . \Psi_{Z2}^{P} . \Psi(T) \quad (24)$$

$$G_{Z2}^{Z1} = (1-\rho_P).(I_{max} - G_{Z2}^{P}).\Psi_{Z2}^{Z1}.\Psi(T) \quad (25)$$

ρ_P - proportion of phytoplankton in mesozooplankton ingestion	**PHYRATING**
I_{max} - maximum ingestion rate	**ZINGMAX**
Ψ_{Z2}^{P} - limitation by phytoplankton concentration	
Ψ_{Z2}^{Z1} - limitation by microzooplankton concentration	

These limitation are defined as:

$$\Psi_{Z2}^{P} = \frac{c_{Z2}^{P}.P - s_{Z2}^{Pmin}}{K_{Z2}^{P} + \left(c_{Z2}^{P}.P - s_{Z2}^{Pmin}\right)} \quad (26)$$

$$\Psi_{Z2}^{Z1} = \frac{c_{Z2}^{Z1}.P - s_{Z2}^{Z1min}}{K_{Z2}^{Z1} + \left(c_{Z2}^{Z1}.P - s_{Z2}^{Z1min}\right)} \quad (27)$$

c_{Z2}^{P} - capture efficiency of phytoplankton	**EFFCAPHI**
s_{Z2}^{Pmin} - threshold standing stock of phytoplankton below which grazing cease	**GRAZFITOMIN**
K_{Z2}^{P} - half saturation constant for ingestion phytoplankton	**INGCONSZ**
c_{Z2}^{Z1} - capture efficiency of microzooplankton	**EFFCAPCIL**
s_{Z2}^{Z1min} - threshold standing stock of microzooplankton below which predation cease	**GRAZCILMIN**
K_{Z2}^{Z1} - half saturation constant for microzooplankton ingestion	**INGCONSZ**

3.2 Natural mortality Zooplankton specific mortality rate m_X is directly related to the concentration of prey F_X. Bellow a threshold concentration of prey (F_X^{min}), the mortality is high and constant m_X^{max}, given that it is assumed that zooplankton mortality is related to starvation. So, mortality is written as: $$m_X = \frac{a_X^m}{F_X} + m_X^0, \quad \text{if} \quad F_X > F_X^{min}, \qquad (28)$$ or $$m_X = m_X^{max}, \quad \text{if} \quad F_X \leq F_X^{min} \qquad (29)$$ a_X^m - shape factor for the mortality curve m_{0X} - minimum mortality rate Each group of zooplankton has its own F_X, F_X^{min}, m_X^{max}, and m_X^0 values. F_X for microzooplankton corresponds to bacteria concentration and for mesozooplankton to phytoplankton and microzooplankton concentrations. Carbon released in this process is converted in nitrogen using the N:C ratio (α_X) for microzooplankton and mesozooplankton. $$m_X^N = m_X.\alpha_X \qquad (30)$$ **3.3 Excretion** The excretion rate e_X is given by Andersen and Nival (1989) as a temperature function: $$e_X = (a_x.b_X)^T \qquad (31)$$ a_X - excretion rate at 0ºc b_X - shape factor for the excretion curve T - temperature	**GRAZBACMIN** **MAXMORTCI ; MAXMORTZ** **MORTCICOEF ; MORTZCOEF** **MINMORTCI ; MINMORTZ** **CRATIONC ; ZRATIONC** **CEXCFAC ; ZEXCFAC** **CEXCCONS ; ZEXCCONS**

The carbon release is converted into nitrogen units using the N:C ratio (α_X). $$e_X^N = e_X^r.\alpha_X \qquad (32)$$ **3.4 Respiration** The respiration rate r_X is used for the oxygen simulation. It is assumed that oxygen consumption of heterotrophs is a constant (ρ_X), and that the whole process is temperature dependent. So, the respiration rate used in oxygen differential equations is given by: $$r_X = \rho_X.\Psi(T) \qquad (33)$$	**CRATIONC ; ZRATIONC** **CREFRESP ; ZREFRESP**

4. NITROGEN DYNAMICS

The simulation of nitrogen dynamics in the WQ model assumes 6 different forms of this nutrient. The dynamics of each one of this forms is therefore addressed. Starting with common rates for most of the forms we have,

Nitrification rate:

$$K_{nit} = K_{nit}^{ref} . T_{nit}^{(T-20.0)} . \frac{[O_2]}{K_{nit}^{sat} + [O_2]} \qquad (34)$$

K_{nit}^{ref}	- reference nitrification rate	**NITRIREF**
T_{nit}	- nitrification temperature coefficient	**TNITCOEF**
T	- temperature	
K_{nit}^{sat}	- nitrification semi-saturation constant	**NITSATCO**

Denitrification rate:

$$K_{dnit} = K_{dnit}^{ref} . T_{dnit}^{(T-20.0)} . \frac{K_{dnit}^{sat}}{K_{dnit}^{sat} + [O_2]} \qquad (35)$$

K_{dnit}^{ref}	- reference denitrification rate	**DENITREF**
T_{dnit}	- denitrification temperature coefficient	**TDENCOEF**
K_{dnit}^{sat}	- denitrification semi-saturation constant	**DENSATCO**

Particulate organic nitrogen decomposition rate:

$$K_{dec}^{Np} = K_{dec}^{ref} . T_{dec}^{(T-20.0)} . \frac{P}{Kr^{P} + P} \qquad (36)$$

K_{dec}^{ref}	- PON decomposition reference rate	**NOPREF**
T_{dec}	- PON decomposition temperature coefficient	**NOPCOEF**

Refractory dissolved organic nitrogen mineralization rate:	
$$K_{min}^{Ndr} = K_{min}^{ref}.T_{min}^{(T-20.0)} \cdot \frac{P}{Kr^P + P} \quad (37)$$	
K_{min}^{ref} - reference mineralization rate of DONr	**NMINR**
T_{min} - DONr mineralization temperature coefficient	**TMINR**
Kr^P - phytoplankton nutrient regeneration half-saturation rate	**FREGSATC**
4.1 Nitrate (NO_3^-)	
$$\frac{\partial N_1}{\partial t} = \underbrace{-[(1-\Phi_{N2}).\alpha_P.\mu_P].P}_{Phytoplankton} + \underbrace{K_{nit}.N_{1-2}}_{Nitrite} - K_{dnit}.N_1 \quad (38)$$	
The ammonia preference factor ΦN_2 used in the model is described by the formula:	
$$\Phi_{N2} = \frac{[N_1].[N_2]}{(K_N^P + [N_1]).(K_N^P + [N_2])} + \frac{K_N^P.[N_2]}{([N_1]+[N_2]).(K_N^P + [N_1])} \quad (39)$$	
K_N^P - half-saturation constant	**NSATCONS**
4.2 Nitrite (NO_2^-)	
$$\frac{\partial N_{1-2}}{\partial t} = \underbrace{K_{nit}.N_2}_{Ammonia} - K_{nit}.N_{1-2} \quad (40)$$	

4.3 Ammonia (NH_4^+) $$\frac{\partial N_2}{\partial t} = \underbrace{\left[\left(e_P^N.\varepsilon_P^{Sol\,In}\right)-\left(\Phi_{N_2}.\mu_P.\alpha_P\right)\right].P}_{Phytoplankton}+\underbrace{\left[\left(e_B.\alpha_B\right)-\mu_B^{N_2}\right].B}_{Bacteria}+\underbrace{\left(e_{Z1}^N.\varepsilon_Z^{Sol\,In}\right).Z_1}_{Microzooplankton}+\underbrace{\left(e_{Z2}^N.\varepsilon_Z^{Sol\,In}\right).Z_2}_{Mesozooplankton}$$ (41) $$+\underbrace{K_{min}^{Ndr}.N_{dr}}_{DONr}+\underbrace{\left(K_{dec}^{Np}.\phi_P\right).N_p}_{PON}-K_{nit}.N_2$$ Φ_{N_2} - phytoplankton ammonia preference factor $\varepsilon_P^{Sol\,In}$ - phytoplankton soluble inorganic excretion fraction $\varepsilon_Z^{Sol\,In}$ - zooplankton soluble inorganic excretion fraction ϕ_P - available PON for transformation into ammonia **4.4 Non-refractory dissolved organic nitrogen (**DONnr**)** $$\frac{\partial N_{dnr}}{\partial t} = \underbrace{\left[\left(1-\varepsilon_P^{Sol\,In}\right).e_P^N.\varepsilon_P^{Dis\,Or}\right].P}_{Phytoplankton}-\underbrace{\left(\mu_B^{Ndnr}\right).B}_{Bacteria}+\underbrace{\left[e_{Z1}^N.\left(1-\varepsilon_Z^{Sol\,In}\right).\varepsilon_Z^{Diss\,Or}\right].Z_1}_{Microzooplankton}+\underbrace{\left[e_{Z2}^N.\left(1-\varepsilon_Z^{Sol\,In}\right).\varepsilon_Z^{Diss\,Or}\right].Z_2}_{Mesozooplankton}$$ (42) $\varepsilon_P^{Dis\,Or}$ - phytoplankton dissolved organic excretion fraction $\varepsilon_Z^{Diss\,Or}$ - zooplankton dissolved organic excretion fraction **4.5 Refractory dissolved organic nitrogen (**DONr**)** $$\frac{\partial N_{dr}}{\partial t} = \underbrace{K_{dec}^{Np}.\left(1-\phi_P\right).N_P}_{PON}-K_{min}^{Ndr}.N_{dr}$$ (43)	**FSOLEXCR** **ZSOLEXCR** **PHDECOMP** **FDISSDON** **ZDISSDON**

4.6 Particulate organic nitrogen (PON)

$$\frac{\partial N_P}{\partial t} = \underbrace{\left[e_P^N.\left(1-\varepsilon_P^{Sol\,In}\right).\left(1-\varepsilon_P^{Dis\,Or}\right)+m_P^N\right].P}_{Phytoplankton} - \underbrace{\left(\mu_B^{Np}+m_B^N\right).B}_{Bacteria} + \underbrace{\left[m_{Z1}^N+\left(1-a_{Z1}\right).G_{Z1}^B.\alpha_B+e_{Z1}^N.\left(1-\varepsilon_Z^{Sol\,In}\right).\left(1-\varepsilon_Z^{Diss\,Or}\right)\right].Z_1}_{Microzooplankton}$$

$$\underbrace{\left[e_{Z2}^N.\left(1-\varepsilon_Z^{Sol\,In}\right).\left(1-\varepsilon_Z^{Diss\,Or}\right)+m_{Z2}^N\right].Z_2}_{Mesozooplankton} + \delta_P + \varphi_N - \underbrace{K_{dec}^{Np}.\left(1-\phi_P\right).N_P}_{DONr} - \underbrace{K_{dec}^{Np}.\left(\phi_P\right).N_P}_{Ammonia}$$

δ_P - stoichiometric food web losses, defined by

$$\delta_P = \left(1-g_{Z2}^P\right).G_{Z2}^P.\alpha_{Z2} + \left(1-g_{Z2}^{Z1}\right).G_{Z2}^{Z1}.\alpha_{Z1} \qquad (45)$$

φ_N - non assimilated phytoplankton and microzooplankton

$$\varphi_N = \mu_{Z2}.\left(\alpha_P - \alpha_{Z2}\right) \qquad (46)$$

APPENDIX

A1. TEMPERATURE EFFECT

The temperature effect, $\Psi(T)$, on the various biological processes addressed by the model follows the concept of Thornton & Lessen (1978):

$$\Psi(T) = k_A{}^{(T)} * k_B{}^{(T)} \qquad \text{(A1)}$$

where,

$$k_A{}^{(T)} = \frac{k_1.e^{\gamma_1.(T-T_{min})}}{1+k_1.(e^{\gamma_1.(T-T_{min})}-1)} \qquad \text{(A2)}$$

$$k_B{}^{(T)} = \frac{k_4.e^{\lambda_2.(T_{max}-T)}}{1+k_4.(e^{\gamma_2.(T_{max}-T)}-1)} \qquad \text{(A3)}$$

with,

$$\gamma_1 = \frac{\ln\dfrac{k_2(1-k_1)}{k_1(1-k_2)}}{T_{min}^{opt}-T_{min}} \qquad \text{(A4)}$$

$$\gamma_2 = \frac{\ln\dfrac{k_3(1-k_4)}{k_4(1-k_3)}}{T_{max}-T_{max}^{opt}} \qquad \text{(A5)}$$

T_{min}^{opt} - minimum temperature for the optimal growth interval T_{max}^{opt} - maximum temperature for the optimal growth interval T_{min} - minimum tolerable temperature T_{max} - maximum tolerable temperature The remaining constants k_1, k_2, k_3, and k_4, are used to control the shape of the temperature effect response curve. Given the lack of knowledge on the temperature effects on the various organisms considered in this study, theses values are assumed to be equal for all kinds of organisms in the model.	**TOPTFMIN ; TOPTZMIN; TOPTBMIN** **TOPTFMAX; TOPTZMAX; TOPTBMAX** **TFMIN; TZMIN; TBMIN** **TFMAX; TZMAX; TBMAX**

A2. State variables in the model

Variable	Definition	Unit
P	Phytoplankton	
B	Bacteria	
Z1	Microzooplankton	
Z2	Mesozooplankton	
N1	Nitrate	
N2	Ammonium	
N1-2	Nitrite	
Ndnr	Dissolved organic matter - labile	
Ndr	Dissolved organic matter - refractory	
Np	Particulate organic matter	

A3. KEYWORDS

A3.1 Non specific rates & constants

NSATCONS	NSatConst	Nitrogen half-saturation constant, mgN/l
FREGSATC	PhytoNutRegenerationSatConst	Phytoplankton nutrient regeneration half saturation rate, mgC/l
FRATIONC	AlfaPhytoNC	Phytoplankton ratio between Nitrogen and Carbon, mgN/mgC Redfield ratio

A3.2 Rates & constants to the PHOSPHORUS simulation

PMINEREF	KPhosphorusMineralizationRate	Reference Phosphorus mineralization rate, 1/T
PMINCOEF	TPhosphorusMineralization	Phosphorus mineralization temperature coefficient
FRATIOPC	AlfaPhytoPC	Redfield ratio phytoplankton ratio between Phosphorus and Carbon, mgP/mgC
ZRATIOPC	AlfaZooPC	Zooplankton ratio between Phosphorus and Carbon, mgP/mgC

A3.3 Rates & constants to the OXYGEN simulation

PHOTOSOC	PhotosynthesisOxygenCarbonRatio	Photosynthesis Oxygen:Carbon ratio, (M/L^3)/(M/L^3) mgO2 / mgC
ZOCRATIO	RatioOxygenCarbonZooRespiration	Zooplankton respiration Oxygen:Carbon ratio, mgO2 / mgC
NITONRAT	NConsOxyNitRatio	Secondary Oxygen production due to Nitrate consumption, (M/L^3)/(M/L^3)

A3.4 Rates & constants to the BOD simulation

BODCOEF	BODOxidationCoefficient	BOD oxidation coefficient
BODREF	BODOxidationReferenceRate	Reference BOD oxidation, 1/T
ODOSSAT	BODOxygenSSatConstant	Oxygen limitation half-saturation constant, 1/T
DENITRON	DenitConvOxyNitMass	During the Denitrification the organic material is decomposed, we need to convert Oxygen mass to Nitrogen mass, (M/L^3)/(M/L^3)

A3.5 Rates & constants to the NITROGEN simulation

ZRATIONC	AlfaZooNC	Zooplankton ratio between Nitrogen and Carbon, mgN/mgC
NMINR	KRefrAmmoniaMinRate	Reference ammonia mineralization rate of the refractory DON, 1/T
NOPREF	KPartDecompRate	Reference particulate organic Nitrogen decomposition rate, 1/T
PHDECOMP	PhytoAvaibleDecomp	
DENITREF	KDenitrificationRate	Reference denitirfication rate, 1/T
NITRIREF	KNitrificationRate	Reference nitirfication rate, 1/T
TMINR	TRefrAmmoniaMin	Nitrogen mineralization temperature coefficient of the refractory DON
NOPCOEF	TPartDecomposition	Particulate organic Nitrogen decomposition temperature coefficient
TDENCOEF	TDenitrification	Denitirfication temperature coefficient
TNITCOEF	TNitrification	Nitrification temperature coefficient
NITSATCO	NitrificationSatConst	Nitrification semi-saturation constant, mgO2/l
DENSATCO	DenitrificationSatConst	Denitrification semi-saturation constant, mgO2/l
FSOLEXCR	PhytoSolublInorgExcreFraction	Soluble inorganic fraction of the phytoplankton excretions
FDISSDON	PhytoExcreDissOrgFraction	Dissolved organic fraction of the phytoplankton excretions

If (PropCalc%Bacteria) then

PLANK_OC_RAT	PlanktonOxygenCarbonRatio	
ZSOLEXCR	ZooSolublInorgExcreFraction	Soluble inorganic fraction of the zooplankton excretions
ZDISSDON	ZooExcreDissOrgFraction	Dissolved organic fraction of the zooplankton excretions

else

NMINENR	KNonRefrAmmoniaMinRate	Reference ammonia mineralization rate of the non refractory DON, 1/T
TMINNR	TNonRefrAmmoniaMin	Nitrogen mineralization temperature coefficient of the non refractory DON

end if

A3.6 Rates & constants to the PHYTOPLANKTON simulation

PSATCONS	PSatConst	Phosphorus half-saturation constant, phosphorus, M/L^3
GROWMAXF	GrowMaxPhytoRate	Maximum phytoplankton growth rate, 1/T
FMORTMAX	PhytoMortMaxRate	Phytoplankton maximum mortality, carbon, M/(L^3.T)
TOPTFMIN	TOptPhytoMin	Minimum temperature of the optimal interval for the phytoplankton growth, oC
TOPTFMAX	TOptPhytoMax	Maximum temperature of the optimal interval for the phytoplankton growth, oC
TFMIN	TPhytoMin	Minimum tolerable temperature of the interval for the phytoplankton growth, oC
TFMAX	TPhytoMax	Maximum tolerable temperature of the interval for the phytoplankton growth, oC
TFCONST1	FK1	Constant to control temperature response curve shape
TFCONST2	FK2	Constant to control temperature response curve shape
TFCONST3	FK3	Constant to control temperature response curve shape
TFCONST4	FK4	Constant to control temperature response curve shape
FMORTCON	FMortSatConst	Mortality half saturation rate, M/(L^3.T)
PHOTORES	PhotorespFactor	Fraction of actual photosynthesis which is oxidised by photorespiration
FENDREPC	PhytoEndogRepConst	Phytoplankton endogenous respiration constant 1 / T
EXCRCONS	PhytoExcretionConstant	Phyto excretion constant

If (.NOT. PropCalc%Bacteria) then

ASS_EFIC	E	Assimilation efficiency of the phytoplankton by the zooplankton

end if

A3.7 Rates & constants to the ZOOPLANKTON simulation

TOPTZMIN	TOptZooMin	Minimum temperature of the optimal interval for the zooplankton growth oC
TOPTZMAX	TOptZooMax	Maximum temperature of the optimal interval for the zooplankton growth oC
TZMIN	TZooMin	Minimum tolerable temperature of the interval for the zooplankton growth oC
TZMAX	TZooMax	Maximum tolerable temperature of the interval for the zooplankton growth oC
TZCONST1	ZK1	Constant to control temperature response curve shape
TZCONST2	ZK2	Constant to control temperature response curve shape
TZCONST3	ZK3	Constant to control temperature response curve shape
TZCONST4	ZK4	Constant to control temperature response curve shape
ZREFRESP	ZooReferenceRespirationRate	Rate of consumption of Carbon by respiration and non-predatory mortality at the reference temperature, 1/T
GRAZFITOMIN	GrazPhytoMin	Minimum phytoplankton concentration for the existence of grazing, mgC/l

If (PropCalc%Bacteria) then

GRAZCILMIN	GrazCiliateMin	Minimum phytoplankton concentration for the existence of grazing, mgC/l
ZEXCFAC	ZooExcretionFactor	
ZEXCCONS	ZooExcretionConst	Zoo excretion constant
MORTZCOEF	ZooMortalityCoef	
MINMORTZ	ZooMinMortalityRate	
MAXMORTZ	ZooMaxMortalityRate	1/day
INGCONSZ	ZooIngestionConst	1/2 sat
EFFCAPHI	ZooEfficiencyCapturePhyto	
EFFCAPCIL	ZooEfficiencyCaptureCiliate	
ZINGMAX	ZooIngestionMax	
ZOPHYASS	ZooAssimilationPhytoRate	
ZOCILASS	ZooAssimilationCiliateRate	

PHYRATING	PhytoRatioIngestionZoo	

else

GROWMAXZ	GrowMaxZooRate	Maximum zooplankton growth rate, 1/T
IVLEVCON	IvlevGrazConst	Ivlev grazing constant
PREDMOR	ZPredMortalityRate	Predatory mortality rate, 1/T

A3.8 Rates & constants to the CILIATE simulation

GRAZBACMIN	GrazBactMin	Minimum phytoplankton concentration for the existence of grazing, mgC/l
CREFRESP	CiliateReferenceRespirationRate	Rate of consumption of Carbon by respiration and
CEXCFAC	CiliateExcretionFactor	Excretion constant
CEXCCONS	CiliateExcretionConst	Excretion constant
MORTCICOEF	CiliateMortalityCoef	
MINMORTCI	CiliateMinMortalityRate	
MAXMORTCI	CiliateMaxMortalityRate	
INGCONSC	CiliateIngestionConst	1/2 sat
EFFCAPBA	CiliateEfficiencyCaptureBacteria	
CINGMAX	CiliateIngestionMax	
CILBACASS	CiliateAssimilationBacteriaRate	

A3.9 Rates & constants to the BACTERIA simulation

CRATIONC	AlfaCilNC	Ciliate ratio between Nitrogen and Carbon, mgN/mgC
BRATIONC	AlfaBacteriaNC	Bacteria ratio between Nitrogen and Carbon, mgN/mgC
SRATIONC	AlfaSubstratNC	Organic dissolved substrat ratio between Nitrogen and Carbon, mgN/mgC
NATMORB	BacteriaNonGrazingMortalityRate	!1/day
BARESPCO	BacteriaExcretionRate	
BMAXUPTA	BacteriaMaxUptake	day-1 /24
BMINUPTA	BacteriaMinUptake	
BACMINSUB	BacteriaMinSubstrate	
BACNCONS	NitrogenSaturationConstBacteria	mgN/l
TOPTBMIN	TOptBacteriaMin	Minimum temperature of the optimal interval for the Bacteria growth, oC
TOPTBMAX	TOptBacteriaMax	Maximum temperature of the optimal interval for the Bacteria growth, oC
TBMIN	TBacteriaMin	Minimum tolerable temperature of the interval for the Bacteria growth, oC
TBMAX	TBacteriaMax	Maximum tolerable temperature of the interval for the Bacteria growth, oC
TBCONST1	BK1	Constant to control temperature response curve shape
TBCONST2	BK2	Constant to control temperature response curve shape
TBCONST3	BK3	Constant to control temperature response curve shape
TBCONST4	BK4	Constant to control temperature response curve shape