Supplemental material to “Skill assessment of the PELAGOS model over the period 1980-2000”

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Tables of parameter values and descriptions

Changes with respect to Vichi et al. (2007b,a) are highlighted in bold.

Symbol	$P^{(1)}$	$P^{(2)}$	$P^{(3)}$	**Description**	Reference
r_{0_P}	**2.00**	**2.50**	**3.00**	**Maximum specific photosynthetic rate (d^{-1})**	Baretta-Bekker et al. (1997)
Q_{10_P}	2.00	2.00	2.00	Characteristic Q10 coefficient	Baretta-Bekker et al. (1997)
$h^s_{P^{(1)}}$	1.00	-	-	Half saturation value for Si-limitation (mmolSi m^{-3})	Sarthou et al. (2005)
b_P	0.01	0.05	0.10	Basal specific respiration rate (d^{-1})	Set
γ_P	0.10	0.20	0.25	Activity respiration fraction (-)	Baretta-Bekker et al. (1997)
β_P	0.05	0.20	0.20	Excreted fraction of primary production (-)	Baretta-Bekker et al. (1997)
$h^{p,n,s}_P$	0.10	0.10	0.10	Nutrient stress threshold (-)	Baretta-Bekker et al. (1997)
d_{0_P}	0.50	0.50	0.50	Maximum specific lysis rate (d^{-1})	Baretta-Bekker et al. (1997)
a_1	2.50 10^{-2}	2.50 10^{-2}	2.50 10^{-1}	Specific affinity constant for P (m^{-3} mg C^{-1} d^{-1})	Baretta-Bekker et al. (1997)
a_3	2.50 10^{-2}	2.50 10^{-2}	0.00	Specific affinity constant for N-NO_3 (m^{-3} mg C^{-1} d^{-1})	Baretta-Bekker et al. (1997)
a_4	2.50 10^{-2}	2.50 10^{-2}	2.50 10^{-1}	Specific affinity constant for N-NH_4 (m^{-3} mg C^{-1} d^{-1})	Baretta-Bekker et al. (1997)
a_7	2.00 10^{-4}	2.00 10^{-4}	2.00 10^{-4}	Specific affinity constant for Fe (m^{-3} mg C^{-1} d^{-1})	Sunda and Huntsman (1995)
$s^{opt}_{P^{(1)}}$	0.01	-	-	Standard Si:C ratio in diatoms (mmolSi mg C^{-1})	Brzezinski (1985)
$\omega^{sink}_{P^{(1)}}$	5.00	-	-	Maximum sedimentation rate (m d^{-1})	Baretta-Bekker et al. (1997)
$l^{sink}_{P^{(1)}}$	0.10	-	-	Nutrient stress threshold for sedimentation (-)	Set
$n^{min}_P, n^{opt}_P, n^{max}_P$	**1.26 $10^{-2}\times$ (0.3, 1, 2)**	**1.26 $10^{-2}\times$ (0.3, 1, 2)**	**1.26 $10^{-2}\times$ (0.3, 1, 2)**	**Minimum, optimal and maximum nitrogen quota (mmolN mgC^{-1})**	Baretta-Bekker et al. (1997); Bertilsson et al. (2003); Timmermans et al. (2004, 2005)
$p^{min}_P, p^{opt}_P, p^{max}_P$	**7.86 $10^{-4}\times$(0.25, 1, 2)**	**7.86 $10^{-4}\times$(0.25, 1, 2)**	**7.86 $10^{-4}\times$(0.25, 1, 2)**	**Minimum, optimal and maximum phosphorus quota (mmolP mgC^{-1})**	Baretta-Bekker et al. (1997); Bertilsson et al. (2003); Timmermans et al. (2004, 2005)
$\phi^{min}_P, \phi^{opt}_P, \phi^{max}_P$	**0.30 $10^{-3}\times$ (0.3, 1, 1)**	**0.30 $10^{-3}\times$ (0.3, 1, 1)**	**0.18 $10^{-4}\times$ (~0, 1, 1)**	**Minimum, optimal and maximum iron quota (μmol Fe mgC^{-1})**	Sunda and Huntsman (1997); Timmermans et al. (2004, 2005)
α^0_{chl}	1.38 10^{-5}	0.46 10^{-5}	1.52 10^{-5}	Maximum light utilization coefficient (mgC (mg chl)$^{-1}$ μE^{-1} m^2 s)	MacIntyre et al. (2002)
θ^0_{chl}	0.025	0.015	0.020	Optimal chl:C quotum (mg chl mg C^{-1})	MacIntyre et al. (2002)
c_P	0.03	0.03	0.03	Chl-specific light absorption coefficient (m^2 (mg chl)$^{-1}$)	Set

Table 1: Symbols, standard values and description of the phytoplankton parameters. $P^{(1)}$= diatoms; $P^{(2)}$= nanoflagellates; $P^{(3)}$= picophytoplankton.

Symbol	$Z^{(4)}$	$Z^{(5)}$	$Z^{(6)}$	**Description**	Reference
Q_{10_Z}	3.00	2.00	2.00	Characteristic Q10 coefficient (-)	Baretta-Bekker et al. (1995)
h_Z^F	$r_{0_Z} \setminus v_Z$	**20.0**	**20**	**Michaelis constant for total food ingestion (mg C m^{-3})**	Set
μ_Z	0.00	**20.0**	**20.0**	**Feeding threshold (mg C m^{-3})**	Set
r_{0_Z}	2.00	2.00	10.0	Potential specific growth rate (d^{-1})	Broekhuizen et al. (1995); Baretta-Bekker et al. (1995)
v_Z	**0.025**	-	-	**Specific search volume (m^3 mg C $^{-1}$)**	Broekhuizen et al. (1995)
b_Z	0.02	0.02	0.02	Basal specific respiration rate (d^{-1})	Broekhuizen et al. (1995); Baretta-Bekker et al. (1995)
η_Z	0.60	0.60	0.50	Assimilation efficency (-)	Broekhuizen et al. (1995); Baretta-Bekker et al. (1995)
β_Z	0.55	0.40	0.30	Excreted fraction of uptake (-)	Broekhuizen et al. (1995); Baretta-Bekker et al. (1995)
ε_Z^c	0.00	**0.50**	1.00	**Partition between dissolved and particulate excretion of C (-)**	Set
ε_Z^n	0.00	0.84	1.00	Partition between dissolved and particulate excretion of N (-)	Set
ε_Z^p	0.00	0.96	1.00	Partition between dissolved and particulate excretion of P (-)	Set
n_Z^{opt}, p_Z^{opt}	0.015, 0.00167	0.0167, 0.00185	0.0167, 0.00185	Maximum nutrient quota (mmolN mgC^{-1}, mmolP mgC^{-1})	Broekhuizen et al. (1995); Baretta-Bekker et al. (1995)
ν_Z	1.00	1.00	1.00	Specific rate of nutrients and carbon excretion (d^{-1})	Set
d_{0_Z}	0.02	0.05	0.05	Specific mortality rate (d^{-1})	Broekhuizen et al. (1995); Baretta-Bekker et al. (1995)
d_Z^{dns}	0.02	0.00	0.00	Density-dependent specific mortality rate (m^3 mgC^{-1} d^{-1})	Broekhuizen et al. (1995)
γ_Z	2.50	-	-	Exponent for density dependent mortality (-)	Broekhuizen et al. (1995)

Table 2: Symbols, standard values and description of the zooplankton parameters. $Z^{(4)}$= mesozooplankton; $Z^{(5)}$= microzooplankton; $Z^{(6)}$= heterotrophic nanoflagellates.

Symbol	*Value*	**Description**
Q_{10_B}	2.95	Characteristic Q10 coefficient
h_B^o	30.0	Half saturation value for oxygen limitation (mmolO_2 m^{-3})
r_{0_B}	8.38	Potential specific growth rate (d^{-1})
b_B	0.01	Basal specific respiration rate (d^{-1})
η_B	0.40	Assimilation efficiency (-)
η_B^o	0.20	Decrease in assimilation efficiency under anoxic conditions (-)
d_{0_B}	0.00	Specific mortality rate (d^{-1})
v_B^1	0.30	Specific potential $R^{(1)}$ uptake (d^{-1})
v_B^6	0.01	Specific potential $R^{(6)}$ uptake (d^{-1})
$v_B^n = v_B^p$	1.00	Specific rate of uptake or remineralization (d^{-1})
n_B^{opt}, p_B^{opt}	0.0167, 0.00185	Optimal nutrient quota (mmolN mgC^{-1}, mmolP mgC^{-1})
h_B^n, h_B^p	5.00, 1.00	Half saturation for nutrient uptake (mmolN mgC^{-1}, mmolP mgC^{-1})

Table 3: Symbols, standard values and description of the bacterioplankton parameters.

Symbol	**Value**	**Description**
Ω_c^o	$\frac{1}{12}$	Unit conversion factor and stoichiometric coefficient ($mmolO_2$ mgC^{-1})
Ω_n^o	2.00	Stoichiometric coefficient nitrification reaction ($mmolO_2$ $mmolN^{-1}$)
$\widetilde{\Omega}_n^o$	1.25	Stoichiometric coefficient denitrification reaction ($mmolO_2$ $mmolN^{-1}$)
Ω_o^r	0.5	Stoichiometric coefficient ($mmolHS^-$ $mmolO_2{}^{-1}$)
Ω_n^r	0.625	Stoichiometric coefficient ($mmolHS^-$ $mmolN^{-1}$)
Λ_{N4}^{nit}	**0.00**	**Specific nitrification rate (d^{-1})**
$Q10_{N4}$	2.37	Q10 factor for nitrification reaction.
$Q10_{N3}$	2.37	Q10 factor for denitrification reaction.
h_{N4}^o, h_{N6}^o	10.0	Half saturation oxygen concentration for chemical processes ($mmolO_2$ m^{-3})
Λ_{N3}^{denit}	0.35	Specific denitrification rate (d^{-1})
$\mathscr{M}_o^*$	1.00	Reference anoxic mineralization rate (mmol O_2 m^{-3} d^{-1})
Λ_{N6}^{reox}	0.05	Specific reoxidation rate of reduction equivalents (d^{-1})
$Q10_{N5}$	1.49	Q10 factor for dissolution of biogenic silica
Λ_s^{rmn}	0.001	Specific dissolution rate of biogenic silica (d^{-1})
Λ_f^{rmn}	0.001	Specific remineralization rate of biogenic iron (d^{-1})
Λ_f^{dep}	**0.005**	**Specific dissolution fraction of dust iron (-)**
Λ_f^{scv}	$0.7\ 10^{-4}$	Specific scavenging rate for iron (d^{-1})
ε_{PAR}	**0.4**	**Fraction of Photosynthetically Available Radiation (-)**
λ_w	0.041	Optical extinction coefficient for pure water (m^{-1})
$c_{R^{(6)}}$		C-specific extinction coefficient of particulate detritus (m^2 mg C^{-1})
v_{R6}^{sed}	**10.00**	**Settling velocity of particulate detritus (m d^{-1})**

Table 4: Chemical stoichiometric coefficients and general parameters involving pelagic components.

		Preys						
		$P_i^{(1)}$	$P_i^{(2)}$	$P_i^{(3)}$	$Z_i^{(4)}$	$Z_i^{(5)}$	$Z_i^{(6)}$	B_i
Predators	$Z_i^{(3)}$	0	0	0	1.0	0	0	0
	$Z_i^{(4)}$	1.0	0	0	1.0	1.0	0	0
	$Z_i^{(5)}$	0.2	1.0	0.1	0	1.0	0.8	0.1
	$Z_i^{(6)}$	0	0	0.9	0	0	0.2	0.9

Table 5: Availability $\delta_{Z,X}$ (non-dimensional) of prey X_i to predator Z_i

References

Baretta-Bekker, J., Baretta, J., Ebenhoeh, W., 1997. Microbial dynamics in the marine ecosystem model ERSEM II with decoupled carbon assimilation and nutrient uptake. J. Sea Res. 38 (3/4), 195–212.

Baretta-Bekker, J., Baretta, J., Rasmussen, E., 1995. The microbial food web in the European Regional Seas Ecosystem Model. J. Sea Res. 33 (3-4), 363–379.

Bertilsson, S., Berglund, O., Karl, D. M., Chisholm, S. W., 2003. Elemental composition of marine Prochlorococcus and Synechococcus: Implications for the ecological stoichiometry of the sea. Limnol. Oceanogr. 48, 1721–1731.

Broekhuizen, N., Heath, M., Hay, S., Gurney, W., 1995. Modelling the dynamics of the North Sea's mesozooplankton. J. Sea Res. 33 (3-4), 381–406.

Brzezinski, M. A., 1985. The Si-C-N ratio of marine diatoms - interspecific variability and the effect of some environmental variables. J. Phycol. 21, 347–357.

MacIntyre, H., Kana, T., Anning, T., Geider, R., 2002. Photoacclimation of photosynthesis irradiance response curves and photosynthetic pigments in microalgae and cyanobacteria. J. Phycol. 38, 17–38.

Sarthou, G., Timmermans, K. R., Blain, S., Treguer, P., 2005. Growth physiology and fate of diatoms in the ocean: a review. J. Sea Res. 53, 25–42.

Sunda, W. G., Huntsman, S. A., 1995. Iron uptake and growth limitation in oceanic and coastal phytoplankton. Mar. Chem. 50, 189–206.

Sunda, W. G., Huntsman, S. A., 1997. Interrelated influence of iron, light and cell size on marine phytoplankton growth. Nature 390, 389–392.

Timmermans, K. R., van der Wagt, B., de Baar, H. J. W., 2004. Growth rates, half-saturation constants, and silicate, nitrate, and phosphate depletion in relation to iron availability of four large, open-ocean diatoms from the Southern ocean. Limnol. Oceanogr. 49, 2141–2151.

Timmermans, K. R., van der Wagt, B., Veldhuis, M. J. W., Maatman, A., de Baar, H. J. W., 2005. Physiological responses of three species of marine pico-phytoplankton to ammonium, phosphate, iron and light limitation. J. Sea Res. 53, 109–120.

Vichi, M., Masina, S., Navarra, A., 2007a. A generalized model of pelagic biogeochemistry for the global ocean ecosystem. Part II: numerical simulations. J. Mar. Sys. 64, 110–134.

Vichi, M., Pinardi, N., Masina, S., 2007b. A generalized model of pelagic biogeochemistry for the global ocean ecosystem. Part I: theory. J. Mar. Sys. 64, 89–109.