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S1. FABM-PCLake modules description

FABM-PCLake consists of 8 individual modules, and a brief description of each module is provided here.

Supplemental Table S1 Modules overview for FABM-PCLake

Module	**Nr. State variables**	**Processes**
abiotic_water.F90	14	nitrification,denitrification,mineralisation,O_2 dynamics in water column
abiotic_sediment.F90	9	diffussion,nitrification,denitrification,mineralisation,O_2 demand in sediment
phytoplankton_water.F90	9	production, nutrient uptake, respiration, excretion, mortality
phytoplankton_sediment.F90	9	respiration, excretion, mortality
macrophytes.F90	3	production, nutrient uptake, respiration, excretion, mortality, migration, seasonality forcing, germination
foodweb_water.F90	10	predation, consumption, migration, assimilation, respiration, excretion, mortality
foodweb_sediment.F90	3	predation, consumption, migration, assimilation, respiration, excretion, mortality
auxiliary.f90	0	resuspension, sedimentation, burial, conserved quantities, mass balance check

Detailed module descriptions are listed below and adhere to this general structure:

- Module description: relevant to corresponding F90 file.
- List of variables

- List of local state variables

Local State variables: local state variables are state variables that are registered within this module and changed mainly in this module's processes

- List of diagnostic variables

Diagnostic variables are additional variables that can be output and analysed, and typically these will represent key system properties and provide a more in-depth understanding of the processes occurring in the modules.

- List of external dependencies

The external dependencies are the variables that are provided by other modules, either by the hydrodynamic models (physical drivers) or by other biogeochemical modules (and models) within FABM.

Additional information on the implementation of a biogeochemical model within FABM, e.g., defining state variables, diagnostic variables and external dependencies, is provided on the FABM website (www.fabm.net/wiki) under "Developing_a_new_biogeochemical_model".

S1.1 Abiotic processes in the water column

File name: abiotic_water.F90

Module description: The abiotic_water module describes the state variables which are related to abiotic processes in the water column, including: inorganic matter (IM), organic matter (detritus), dissolved nutrients (ammonium, nitrate, phosphate and dissolved silica-dioxide), immobilized phosphorus (adsorbed phosphorus) and dissolved oxygen.

List of variables (in following tables):

Supplemental Table S2 List of local state variables in abiotic water module

State variable	Description of state variables
sDDIMW	dry weight of inorg. matter in water column, mgDW/l
sDDetW	dry weight of detritus in water column, mgDW/l
sNDetW	nitrogen in detritus in water column, mgN/l
sPDetW	phosphorus in detritus in water column,mgP/l
sSiDetW	silica in detritus in water column,mgSi/l
sPO4W	phosphate in water column,mgP/l
sPAIMW	adsorbed phosphorus in water column,mgP/l
sNH4W	ammonium in water column,mgN/l
sNO3W	nitrate in water column,mgN/l
sSiO2W	dissolved silica in water column,mgSi/l
sO2W	oxygen in water column,mgO2/l

Supplemental Table S3 List of local diagnostic variables in abiotic water module

Diagnostic variable	Description of diagnostic variable
afO2SatW	*afO2SatW =O2-concentration/saturation O2-concentration*100*,oxygen saturation percentage,%
rNDDetW	*rNDDetW = sNDetW / sDDetW*,N/D ratio of detritus in water ,gN/gD
rPDDetW	*rPDDetW = sPDetW / sDDetW*, P/D ratio of detritus in water, gP/gD
extIM	*extIM =sDIMW* cExtSpIM*, extinction factor caused by inorganic matter, -
extDet	*extDet=sDDetW*cExtSpDet*, extinction factor caused by organic matter,-
tO2Aer	oxygen reaeration rate, mg/l/day

Supplemental Table S4 List of dependencies in abiotic water column module

dependencies	Description	Linked external module	Linked external variable
uTm	temperature	physical driver	temperature
uVWind	wind speed	physical driver	wind_speed

S1.2 Abiotic processes in the sediment

File name: abiotic_sediment.F90

Module description: The abiotic_sediment module describes all the state variables which are related to abiotic processes in the sediment, including: inorganic matter (IM), organic matter (detritus), dissolved nutrients (ammonium, nitrate, and phosphate), immobilized phosphorus (adsorbed phosphorus) and humus.

List of variables (in following tables):

Supplemental Table S5 List of local state variables in abiotic sediment module

State variable	Description of state variables
sDDIMS	dry weight of inorg. matter in sediment,gDW/m**2
sDDetS	dry weight of detritus in sediment,gDW/m**2
sNDetS	nitrogen in detritus in sediment,gN/m**2
sPDetS	phosphorus in detritus in sediment,gP/m**2
sSiDetS	silica in detritus in sediment,gSi/m**2
sPO4S	phosphate in sediment,gP/m**2
sPAIMS	adsorbed phosphorus in sediment,gP/**2
sNH4S	ammonium in sediment, gN/**2
sNO3S	nitrate in sediment,gN/m**2
sDHumS	dry weight of humus in sediment, gDW/m**2
sNHumS	nitrogen of humus in sediment, gN/m**2
sPHumS	phosphorus of humus in sediment, gP/m**2

Supplemental Table S6 List of local diagnostic variables in abiotic water module

diagnostic variable	Description of diagnostic variable
afOxySed	*afOxySed = aDepthOxySed / cDepthS*,proportion aerobic sediment,-
rNDDetS	*rNDDetS = sNDetS / sDDetS*, N content of sediment detritus, gN/gDW
rPDDetS	*rPDDetS = sPDetS / sDDetS*, P content of sediment detritus, gP/gDW
aPEqIMS	*aPEqIMS = aPIsoAdsS * sDIMS*,equilibrium amount in sediment ,gP/m**2

Supplemental Table S7 List of dependencies in abiotic sediment module

dependencies	Description	Linked external module	Linked external variable
uTm	temperature	physical driver	temperature
SWNH4	ammonium_pool_in_water	abiotic_water	sNH4W
SWNO3	nitrate_pool_in_water	abiotic_water	sNO3W
SWPO4	phosphate_pool_in_water	abiotic_water	sPO4W
SWSiO2	siO2_release_to_water	abiotic_water	sSiO2W
O2Supply	oxygen_pool	abiotic_water	sO2W

S1.3 Phytoplankton in the water column

File name: phytoplankton_water.F90

Module description: The phytoplankton_water module describes the processes related to phytoplankton in the water column.Three groups of phytoplankton are described here: diatoms, green algae and cyanobacteria (blue-green algae). Each group is described in three elements, dry weight, nitrogen and phosphorus. The silica concentration in diatoms is not a state variables here but instead defined as a diagnostic variable, since the model assumes that diatoms have a fixed Si/DW ratio, i.e., 0.1.

List of variables (in following tables):

Supplemental Table S8 List of local state variables in phytoplankton water module

State variable	Description of state variables
sDDiatW	diatom concentration in dry weight,mgDW/l
sPDiatW	diatom concentration in phosphorus,mgP/l
sNDiatW	diatom concentration in nitrogen,mgN/l
sDGrenW	green algae concentration in dry weight, mgDW/l
sPGrenW	green algae concentration in phosphorus,mgP/l
sNGrenW	green algae concentration in nitrogen,mgN/l
sDBlueW	blue-green algae concentration in dry weight, mgDW/l
sPBlueW	blue-green algae concentration in phosphorus,mgP/l
sNBlueW	blue-green algae concentration in nitrogen,mgN/l

Supplemental Table S9 List of local diagnostic variables in phytoplankton water module

diagnostic variable	Description of diagnostic variable
oChlaBlue	blue-green algae chlorophyll-a concentration,ug/l
aLLimBlue	light limitation factor for blue-green algae,-
aNutLimBlue	nutrient limitation factor for blue-green algae
extBlue	*extBlue =sDBlueW* cExtSpIM*,light extinction factor caused by blue-green algae,m-1
rNDBlueW	*rNDBlueW=sNBlueW/sDBlueW*, N content in blue-green algae,gN/gD
rPDBlueW	*rPDBlueW=sPBlueW/sDBlueW*, P content in blue-green algae,gP/gD

diagnostic variable	Description of diagnostic variable
oChlaGren	green algae chlorophyll-a concentration,ug/l
aLLimGren	light limitation factor for green algae,-
aNutLimGren	nutrient limitation factor for green algae,-
extGren	*extGren =sDGrenW* cExtSpIM*,light extinction factor caused by green algae,m-1
rNDGrenW	*rNDGreenW=sNGrenW/sDGrenW*, N content in green algae, gN/gD
rPDGrenW	*rPDGreenW=sPGrenW/sDGrenW*, P content in green algae, gP/gD
oChlaDiat	diatom chlorophyll-a concentration,ug/l
aLLimDiat	light limitation factor for diatoms,-
aNutLimDiat	nutrient limitation factor for diatoms,-
extDiat	*extDiat =sDDiatW* cExtSpIM*,light extinction factor caused by diatoms,m-1
rNDDiatW	*rNDDiatW=sNDiatW/sDDiatW*, N content in diatoms, gN/gDW
rPDDiatW	*rPDDiatW=sPDiatW/sDDiatW*, P content in diatoms, gP/gDW
oSiDiatW	*oSiDiatW=sDDiatW*cSiDDiatW*, diatom silica concentration, mgSi/l
aDPhytW	*aDPhytW=sDBlueW+sDGrenW+sDDiatW*,total algae biomass in the water column,mgDW/l
rNDPhytW	*rNDPhytW=(sNBlueW+sNGrenW+sNDiatW)/aDPhytW*, N content in phytoplankton in water column, gN/gDW
rPDPhytW	*rPDPhytW=(sPBlueW+sPGrenW+sPDiatW)/aDPhytW*, P content in phytoplankton in water column, gP/gDW
ParSurf	surface photosynthetically active radiation, W/m**2
phypar	local photosynthetically active radiation (layer center par), W/m**2
phytoextinction	local extinction factor used by phytoplankton light function, m-1
wO2PrimW	oxygen production by phytoplankton, mgO2/l/d

Supplemental Table S10 List of dependencies in phytoplankton water module

dependencies	Description	Linked external module	Linked external variable
uTm	Temperature	physical driver	temperature
par	photosynthetically active radiation	physical driver	downwelling_photosynthetic_radiative_flux
Dz	cell_thickness	physical driver	cell_thickness
extc	attenuation coefficient	physical driver	attenuation_coefficient_of_photosynthetic_radiative_flux
SiO2poolW	SiO_2_source_wat	abiotic_water	sSiO2W
PO4poolW	sPO4_source_wat	abiotic_water	sPO4W
NO3poolW	sNO3_source_wat	abiotic_water	sNO3S
NH4poolW	sNH4_source_wat	abiotic_water	sNH4W
O2poolW	oxygen_pool	abiotic_water	sO2W
DDetpoolW	detritus_DW_pool_wat	abiotic_water	sDDetW
NDetpoolW	detritus_N_pool_wat	abiotic_water	sNDetW
PDetpoolW	detritus_P_pool_wat	abiotic_water	sPDetW
SiDetpoolW	detritus_Si_pool_wat	abiotic_water	sSiDetW

S1.4 Phytoplankton in the sediment

File name: phytoplankton_sediment.F90

Module description: The phytoplankton_sediment module describes the processes related to the phytoplankton which has settled to the bottom sediments. Three groups of phytoplankton are described here: diatoms, green algae and cyanobacteria (blue-green algae). Each group is described in three elements, dry weight, nitrogen and phosphorus. The silica concentration in diatom is not a state variables here but instead a diagnostic variable, since model assumes that diatoms have a fixed Si/DW ratio, i.e., 0.1

List of variables (in following tables):

Supplemental Table S11 List of local state variables in phytoplankton sediment module

State variable	Description of state variables
sDDiatS	diatom concentration in dry weight,gDW/m**2
sPDiatS	diatom concentration in phosphorus,gP/m**2
sNDiatS	diatom concentration in nitrogen,gN/m**2
sDGrenS	green algae concentration in dry weight,gDW/m**2
sPGrenS	green algae concentration in phosphorus,gP/m**2
sNGrenS	green algae concentration in nitrogen,gN/m**2
sDBlueS	blue-green algae concentration in dry weight,gDW/m**2
sPBlueS	blue-green algae concentration in phosphorus,gP/m**2
sNBlueS	blue-green algae concentration in nitrogen,gN/m**2

Supplemental Table S12 List of local diagnostic variables in phytoplankton sediment module

Diagnostic variable	Description of diagnostic variable
oSiDiatS	sediment diatom concentration in silica, gSi/m**2
rNDPhytS	*rNDPhytS=(sNBlueS+sNGrenS+sNDiatS)/aDPhytS*, N content in phytoplankton in sediment,gN/gD
rPDPhytS	*rPDPhytS=(sPBlueS+sPGrenS+sPDiatS)/aDPhytS*, P content in phytoplankton in sediment,gP/gD

Supplemental Table S13 List of dependencies in the phytoplankton sediment module

dependencies	Description	Linked external module	Linked external variable
uTm	temperature	physical driver	temperature
PO4poolS	sPO4_source_sed	abiotic_sediment	sPO4S
NO3poolS	sNO3_source_sed	abiotic_sediment	sNO3S
NH4poolS	sNH4_source_sed	abiotic_sediment	sNH4S
DDetpoolS	detritus_DW_pool_sed	abiotic_sediment	sDDetS
NDetpoolS	detritus_N_pool_sed	abiotic_sediment	sNDetS
PDetpoolS	detritus_P_pool_sed	abiotic_sediment	sPDetS
SiDetpoolS	detritus_Si_pool_sed	abiotic_sediment	sSiDetS
SiO2poolW	SiO_2_source_sed	abiotic_water	sSiO2W

S1.5 Macrophytes

File name: macrophytes.F90

Module description: This module describes the submerged macrophytes group, and is implemented as a benthic module. The state variables include: sDVeg, sNVeg, sPVeg (vegetation mass in dry weight, nitrogen and phosphorus, respectively). The related processes are: assimilation (only for sDVeg), nutrient uptake (only for sNVeg and sPVeg), respiration (only for sDVeg), excretion (only for sNVeg and sPVeg), mortality and migration.

List of variables (in following tables):

Supplemental Table S14 List of local state variables in macrophytes module

State variable	Description of state variables
sDVeg	vegetation (shoots+roots) in dry weight,gDW/m**2
sNVeg	vegetation (shoots+roots) in nitrogen,gN/m**2
sPVeg	vegetation (shoots+roots) in phosphorus,gP/m**2

Supplemental Table S15 List of local diagnostic variables in macrophytes module

diagnostic variable	Description of diagnostic variable
aCovVeg	coverage of macrophytes, %
aDSubVeg	submerged macrophytes in dry weight,gDW/m**2
aLPAR1Veg	photosynthetically active radiation at top of vegetation layer, W/m**2
aLPAR2Veg	photosynthetically active radiation at bottom of vegetation layer, W/m**2
aNutLimVeg	nutrient limitation function for macrophytes,-
aLLimVeg	light limitation function for macrophytes,-
macroextinction	local extinction factor used by macrophytes light function, m-1

Supplemental Table S16 List of dependencies in macrophytes module

dependencies	Description	Linked external module	Linked external variable
uTm	temperature	physical driver	temperature
par	photosynthetically active radiation	physical driver	downwelling_photosynthetic_radiative_flux
dz	cell_thickness	physical driver	cell_thickness
sDepthW	water depth	physical driver	bottom_depth
extc	attenuation coefficient	physical driver	attenuation_coefficient_of_photosynthetic_radiative_flux
day	number of days since start of the year	physical driver	number_of_days_since_start_of_the

dependencies	Description	Linked external module	Linked external variable
			_year
NH4poolW	uptake_target_Ammonium_water	abiotic_water	sNH4W
NO3poolW	uptake_target_Nitrate_water	abiotic_water	sNO3W
PO4poolW	uptake_target_Phosphate_water	abiotic_water	sPO4W
DDetpoolW	detritus_DW_pool_water	abiotic_water	sDDetW
NDetpoolW	detritus_N_pool_water	abiotic_water	sNDetW
PDetpoolW	detritus_P_pool_water	abiotic_water	sPDetW
O2poolW	oxygen_pool	abiotic_water	sO2W
NH4poolS	uptake_target_Ammonium_sediment	abiotic_sediment	sNH4S
NO3poolS	uptake_target_Nitrate_sediment	abiotic_sediment	sNO3S
PO4poolS	uptake_target_Phosphate_sediment	abiotic_sediment	sPO4S
DDetpoolS	detritus_DW_pool_sediment	abiotic_sediment	sDDetS
NDetpoolS	detritus_N_pool_sediment	abiotic_sediment	sNDetS
PDetpoolS	detritus_P_pool_sediment	abiotic_sediment	sPDetS
afOxySed	fraction_aerobic_sediment	abiotic_sediment	afOxySed

S1.6 Foodweb in the water column

File name: foodweb_water.F90

Module description: The foodweb_water module describes the pelagic biological state variables including zooplankton, zooplanktivorous and benthivorous fish (represented by juvenile and adults, respectively) and piscivorous fish. The local processes are:

Zooplankton: assimilation, respiration (only for sDZoo), excretion (only for sNZoo, sPZoo), mortality and consumption by juvenile fish.

Juvenile fish: migration, reproduction (fraction of adult fish biomass become juvenile fish), assimilation (predation on zooplankton), respiration (only for sDFiJv), excretion (only for PFiJv, sNFiJv), mortality, consumption by piscivorous fish and aging (part of the juvenile fish become adult fish)

Adult fish: migration, reproduction (fraction of adult fish biomass become juvenile fish), respiration (only for sDFiAd), excretion (only for sPFiAd and sNFiAd), mortality, consumption by piscivorous fish, and aging (part of juvenile fish become adult fish), (note: the assimilation of adult fish occurs in the benthic module, where adult fish predating the zoobenthos).

Piscivorous fish: migration, assimilation, respiration and mortality (piscivorous fish have fixed N/D and P/D ratio).

List of variables (in following tables):

Supplemental Table S17 List of local state variables in foodweb water module

State variable	Description of state variables
sDZoo	zooplankton in water column, dry weight,mgDW/l
sPZoo	zooplankton in water column,phosphorus,mgP/l
sNZoo	zooplankton in water column,nitrogen,mgN/l
sDFiJv	young fish in water,dry weight,mgDW/l
sPFiJv	young fish in water,phosphorus,mgP/l
sNFiJv	young fish in water,nitrogen,mgN/l
sDFiAd	adult fish in water, dry weight,mgDW/l
sPFiAd	adult fish in water, phosphorus,mgP/l
sNFiAd	adult fish in water, nitrogen,mgN/l
sDPisc	piscivorous fish in water, dry weight,mgDW/l

Supplemental Table S18 List of local diagnostic variables in foodweb water module

Diagnostic variable	Description of diagnostic variable
aNPisc	piscivorous fish in nitrogen, mgN/l
aPPisc	piscivorous fish in phosphorus, mgP/l

Supplemental Table S19 List of dependencies in foodweb water module

dependencies	Description	Linked external module	Linked external variable
uTm	temperature	physical driver	temperature
par	photosynthetically active radiation	physical driver	downwelling_photosynthetic_radiative_flux
dz	cell_thickness	physical driver	cell_thickness
day	number of days since start of the year	physical driver	number_of_days_since_start_of_the_year
DfoodDiat	diatom_as_food_DW	phytoplankton_water	sDDiatW
NfoodDiat	diatom_as_food_N	phytoplankton_water	sNDiatW
PfoodDiat	diatom_as_food_P	phytoplankton_water	sPDiatW
DfoodGren	green_as_food_DW	phytoplankton_water	sDGrenW
NfoodGren	green_as_food_N	phytoplankton_water	sNGrenW
PfoodGren	green_as_food_P	phytoplankton_water	sPGrenW
DfoodBlue	blue_as_food_DW	phytoplankton_water	sDBlueW
NfoodBlue	blue_as_food_N	phytoplankton_water	sNBlueW
PfoodBlue	blue_as_food_P	phytoplankton_water	sPBlueW
DDetpoolW	detritus_as_food_DW	abiotic_water	sDDetW
NDetpoolW	detritus_as_food_N	abiotic_water	sNDetW

dependencies	Description	Linked external module	Linked external variable
PDetpoolW	detritus_as_food_P	abiotic_water	sPDetW
SiDetpoolW	detritus_as_food_Si	abiotic_water	sSiDetW
DfoodBent	benthos_as_food_DW	phytoplankton_sediment	sDBent
NH4poolW	NH4_pool_for_web	abiotic_water	sNH4W
NO3poolW	NO3_pool_for_web	abiotic_water	sNO3W
PO4poolW	PO4_pool_for_web	abiotic_water	sPO4W
aDSubVeg	submerged_macrophytes	macrophytes	aDSubVeg
tDEnvFiAd	environmental correction	foodweb_sediment	tDEnvFiAd
aDSatFiAd	Saturation concentration of adult fish	foodweb_sediment	aDSatFiAd

S1.7 Foodweb in sediment (zoobenthos)

File name: foodweb_sediment.F90

Module description: The foodweb_sediment module describes the state variables relating to zoobenthos, thus sDBent, sPBent and sNBent. Local processes include consumption, migration, assimilation, and respiration (only for sDBent), excretion (only for sNBent and sPBent) and mortality. This module also describes the process of benthivorous fish (adult fish) predating on zoobenthos.

List of variables (in following tables):

Supplemental Table S20 List of local state variables in foodweb sediment module

State variable	Description of state variables
sDBent	zoobenthos, in dry weight,gDW/m**2
sPBent	zoobenthos, in phosphorus,gP/m**2
sNBent	zoobenthos, in nitrogen,gN/m**2

Supplemental Table S21 List of local diagnostic variables in foodweb sediment module

diagnostic variable	Description of diagnostic variable
None	

Supplemental Table S22 List of dependencies in foodweb sediment module

dependencies	Description	Linked external module	Linked external variable
uTm	temperature	physical driver	temperature
sDepthW	water depth	physical driver	bottom_depth
DDetpoolS	detritus_as_food_DW	abiotic_sediment	sDDetS
PDetpoolS	detritus_as_food_P	abiotic_sediment	sPDetS
NDetpoolS	detritus_as_food_N	abiotic_sediment	sNDetS
SiDetpoolS	detritus_as_food_Si	abiotic_sediment	sSiDetS
PO4poolS	PO4_pool_ web_sed	abiotic_sediment	sPO4S
NH4poolS	NH4_pool_ web_sed	abiotic_sediment	sNH4S
NO3poolS	NO3_pool_web_sed	abiotic_sediment	sNO3S
DfoodDiatS	diatom_as_food_DW	phytoplankton_sediment	sDDiatS
PfoodDiatS	diatom_as_food_P	phytoplankton_sediment	sPDiatS
NfoodDiatS	diatom_as_food_N	phytoplankton_sediment	sNDiatS
DfoodGrenS	green_as_food_DW	phytoplankton_sediment	sDGrenS
PfoodGrenS	green_as_food_P	phytoplankton_sediment	sPGrenS
NfoodGrenS	green_as_food_N	phytoplankton_sediment	sNGrenS
DfoodBlueS	blue_as_food_DW	phytoplankton_sediment	sDBlueS
PfoodBlueS	blue_as_food_P	phytoplankton_sediment	sPBlueS
NfoodBlueS	blue_as_food_N	phytoplankton_sediment	sNBlueS
DAdFish	adult_fish_DW	foodweb_water	sDFiAd

dependencies	Description	Linked external module	Linked external variable
NAdFish	adult_fish_N	foodweb_water	sNFiAd
PAdFish	adult_fish_P	foodweb_water	sPFiJv
DJvFish	young_fish_DW	foodweb_water	sDFiJv
aCovVeg	macrophytes_coverage	macrophytes	aCovVeg

S1.8 Auxiliary module

File name: auxiliary.F90

Module description: The auxilary module is created for the purpose of computing resuspension and sedimentation, erosion and sediment burial processes (that influence several other modules).

List of variables (in following tables):

Supplemental Table S23 List of dependencies in auxiliary module

dependencies	Description	Linked external module	Linked external variable
uTm	temperature	physical driver	temperature
sDepthW	water depth	physical driver	bottom_depth
SWNH4	ammonium pool in water column	abiotic_water	sNH4W
SWNO3	nitrate_pool_in_water	abiotic_water	sNO3W
SWPO4	phosphate_pool_in_water	abiotic_water	sPO4W
SWPAIM	adsorbed_phosphorus_in_water	abiotic_water	sPAIMW
SWDIM	inorg_pool_in_water	abiotic_water	sIMW
SWSiO2	SiO2_release_to_water	abiotic_water	sSiO2W
SWO2	oxygen_pool	abiotic_water	sO2W

dependencies	Description	Linked external module	Linked external variable
SWDDet	detritus_DW_in_water	abiotic_water	sDDetW
SWNDet	detritus_N_in_water	abiotic_water	sNDetW
SWPDet	detritus_P_in_water	abiotic_water	sPDetW
SWSiDet	detritus_Si_in_water	abiotic_water	sSiDetW
SWDDiat	diatom_DW_in_water	phytoplankton_water	sDDiatW
SWNDiat	diatom_N_in_water	phytoplankton_water	sNDiatW
SWPDiat	diatom_P_in_water	phytoplankton_water	sPDiatW
SWDGren	green_DW_in_water	phytoplankton_water	sDGrenW
SWNGren	green_N_in_water	phytoplankton_water	sNGrenW
SWPGren	green_P_in_water	phytoplankton_water	sPGrenW
SWDBlue	blue_DW_in_water	phytoplankton_water	sDBlueW
SWNBlue	blue_N_in_water	phytoplankton_water	sNBlueW
SWPBlue	blue_P_in_water	phytoplankton_water	sPBlueW
WSDDiatS	diatom_DW_in_sediment	phytoplankton_sediment	sDDiatS
WSNDiatS	diatom_N_in_sediment	phytoplankton_sediment	sNDiatS
WSPDiatS	diatom_P_in_sediment	phytoplankton_sediment	sPDiatS
WSDGrenS	green_DW_in_sediment	phytoplankton_sediment	sDGrenS
WSNGrenS	green_N_in_sediment	phytoplankton_sediment	sNGrenS
WSPGrenS	green_P_in_sediment	phytoplankton_sediment	sPGrenS
WSDBlueS	blue_DW_in_sediment	phytoplankton_sediment	sDBlueS
WSNBlueS	blue_N_in_sediment	phytoplankton_sediment	sNBlueS
WSPBlueS	blue_P_in_sediment	phytoplankton_sediment	sPBlueS
DragVeg	vegetation_biomass	macrophytes	sDVeg
TurbFish	adult_fish_biomass	foodweb_water	aDFish
tDAbioDetS	detritus_abiotic_update	abiotic_sedimentiment	tDAbioDetS

dependencies	Description	Linked external module	Linked external variable
tDAbioHumS	humus_abiotic_update	abiotic_sedimentiment	
tDPrimDetS	detritus_from_algae	phytoplankton_sediment	tDPrimDetS
tDWebDetS	detritus_from_vegetation	foodweb_sediment	tDWebDetS
tDBedDetS	detritus_from_foodweb	macrophytes	tDBedDetS

S2. List of FABM-PCLake biogeochemical sink and source terms

This section provides a full list of the derivatives (and the processes in these) for the state variables implemented in FABM-PCLake. In order to distinguish the processes' modular location, different symbols are introduced to mark the processes (adopted from(Janse 2005)), see table 2 for the symbols representing the various modules.

Supplemental Table S24 Symbols of different FABM-PCLake module processes

Modules	Module mark	Example
abiotic water	( )	(-wDMinDetW)
abiotic sediment	(__)	(-tDMinDetS)
phytoplankton water	[ ]	[+ wDMortPhytW]
phytoplankton sediment	[__]	[+ tPMortPhytDetS]
macrophytes	< >	<+ tDMortVegW>
food web water column	{ }	{-wDConsDetZoo}
food web sediment	{__}	{- tDConsDetBent}
auxiliary module	simp	- tDSetIM + tDResusIM

S 2.1 Abiotic water column module

1) inorg. matter in water [mgD/l/s]

dDIMW = - tDSetIM + tDResusIM+uDErosIMW

=– settling + resuspension+erosion

2) detritus in water [mgD/l/s]

dDDetW = - tDSetDet + tDResusDet (-wDMinDetW) [+ wDMortPhytW] <+ tDMortVegW> {-wDConsDetZoo + wDEgesZoo + wDMortZoo + tDEgesFish + tDMortFishDet +tDEgesPisc + tDMortPiscDet}

3) detritus in water [mgP/l/s]

dPDetW = - tPSetDet + tPResusDet (-wPMinDetW) [+ wPMortPhytDetW] <+ tPMortVegDetW> {-wPConsDetZoo + wPEgesZooDet + wPMortZooDet + tPEgesFishDet + tPMortFishDet +tPEgesPiscDet + tPMortPiscDet}

4) detritus in water [mgN/l/s]

dNDetW = - tNSetDet + tNResusDet (-wNMinDetW) [+ wNMortPhytDetW] <+ tNMortVegDetW> {-wNConsDetZoo + wNEgesZooDet + wNMortZooDet + tNEgesFishDet + tNMortFishDet+ tNEgesPiscDet + tNMortPiscDet}

= - settling + resuspension (- mineralisation) [+ algal mortality] <+ part of macrophyte mortality in water> {– zooplankton detritus consumption +zooplankton egestion and mortality + whitefish egestion and mortality + pred.fish egestion and mortality}

5) detritus [mgSi/ l/s]

dSiDetW = - tSiSetDet + tSiResusDet (- wSiMinDetW) [+ wSiMortDiatW] {+ wSiConsDiatZoo}

= - settling + resuspension (– mineralisation) [+ diatoms mortality] {+zooplankton diatoms consumption}

6) PO4 in water [mgP/l/s]

dPO4W = (wPMinDetW - wPSorpIMW + tPDifPO4) + tPResusPO4 [- wPUptPhyt + wPExcrPhytW +wPMortPhytPO4W] < - tPUptVegW + tPExcrVegW + tPMortVegPO4W> {+

wPExcrZoo + wPEgesZooPO4 + wPMortZooPO4 +tPExcrFiJv + tPExcrFiAd + tPEgesFishPO4 + tPMortFishPO4 + tPExcrPisc +tPEgesPiscPO4 + tPMortPiscPO4}

= (mineralisation – sorption + diffusion from sediment) + resuspension [- algal uptake + algal excretion + part of algal mortality] <- macrophyte uptake from water + macrophyte excretion in water + part of macrophyte mortality> {+ zooplankton excretion and part of egestion and mortality + whitefish excretion and part of egestion and mortality + pred.fish excretion and part of egestion and mortality }

7) adsorbed P in water [mgP/l/s]

dPAIMW = tPResusAIM – tPSetAIM (+wPSorpIMW)

= resuspension - settling (+ sorption)

8) ammonium in water [mgN/l/s]

dNH4W = (wNMinDetW - wNNitrW - tNDifNH4) + tNResusNH4 [- wNUptNH4Phyt + wNExcrPhytW + wNMortPhytNH4W] <– tNUptNH4VegW + tNExcrVegW + tNMortVegNH4W> {+ wNExcrZoo + wNEgesZooNH4 +wNMortZooNH4 + tNExcrFiJv + tNExcrFiAd + tNEgesFishNH4 + tNMortFishNH4 + tNExcrPisc + tNEgesPiscNH4 + tNMortPiscNH4}

= (mineralisation – nitrification in water - diffusion from sediment) + resuspension [- algal uptake + algal excretion + part of algal mortality - macrophyte uptake from water] <+ macrophyte excretion in water + part of macrophyte mortality> {+ zooplankton excretion and part of egestion and mortality + whitefish excretion and part of egestion and mortality + pred.fish excretion and part of egestion and mortality}

9) nitrate in water [mgN/l/s]

dNO3W = (wNNitrW - wNDenitW + tNDifNO3) +tNResusNO3 [- wNUptNO3Phyt] <- tNUptNO3VegW>

= (nitrification in water – denitrif. in water + diffusion from sediment) + resuspension [- algal uptake] <- macrophyte uptake>.

10) oxygen in water [mgO2/l/s]

dO2W = (tO2Aer - wO2MinDetW - wO2NitrW) (- tO2MinDetS + tO2NitrS) [+ wO2ProdPhyt - wO2RespPhytW +wO2UptNO3Phyt] <+ tO2ProdVegW - tO2RespVegW + tO2UptNO3VegW>

=(reaeration - mineralisation – nitrification) (- sediment oxygen demand) [+algal production - algal respiration + nitrate uptake by algae] <+ macrophyte production - macrophyte respiration + nitrate uptake by macrophytes>

11) dissolved silicon dioxide in water [mgSi/ l/ s]

dSiO2W = (wSiMinDetW) (+ (1.0 - fRefrDetS) * tSiMinDetS) [- wSiUptDiat + wSiExcrDiatW] [+ tSiExcrDiatS]

= (mineralisation in water) (+ mineralisation in sediment) [– diatoms uptake + diatoms excretion in water] [+ diatoms excretion in sed.]

S2.2 Abiotic sediment module

12) sediment inorg. matter [gD/m2/s]

dDIMS = tDSetIM - tDResusIM – tDBurIM+uDErosIMS

= settling – resuspension – burial+erosion

13) sediment detritus [gD/m2/s]

dDDetS = tDSetDet – tDResusDet - tDBurDet (- tDMinDetS) [+ tDMortPhytS] <+tDMortVegS> {- tDConsDetBent + tDEgesBent + tDMortBent}

14) sediment detritus P [gP/m2/s]

dPDetS = tPSetDet - tPResusDet - tPBurDet (- tPMinDetS) [+ tPMortPhytDetS] <+ tPMortVegDetS> {- tPConsDetBent + tPEgesBent + tPMortBent}

15) sediment detritus N [gN/m2/s]

dNDetS = tNSetDet - tNResusDet - tNBurDet (- tNMinDetS) [+ tNMortPhytDetS] <+ tNMortVegDetS> {- tNConsDetBent + tNEgesBent + tNMortBent}

= settling – resuspension - burial (- mineralisation) [+ sed. algal mortality] <+macrophyte mortality in sed> {– zoobenthos detritus consumption + zoobenthos egestion and mortality}

16) sediment detritus Si [gSi/m2/s]

dSiDetS = tSiSetDet - tSiResusDet - tSiBurDet (- tSiMinDetS) [+ tSiMortDiatS] {+tSiConsDiatBent}

= settling – resuspension - burial (- mineralisation) [+ sed.diatoms mortality] {– zoobenthos diatoms consumption}

17) phosphate in pore water [gP/m2/s]

dPO4S = (tPMinDetS* (1.0-fRefrDetS) – tPSorpIMS - tPDifPO4 - tPChemPO4) - tPResusPO4 - tPBurPO4 [+ tPExcrPhytS + tPMortPhytPO4S] <- tPUptVegS + tPExcrVegS + tPMortVegPO4S> {+ tPExcrBent +tPEgesBentPO4 + tPMortBentPO4 }

=(detritus and humus mineralisation – sorption - diffusion to/from water - immobilisation) – resuspension - burial [+excretion and part of mortality of sed. algae]<- macrophyte uptake from sediment +macrophyte excretion in sediment + part of macrophyte mortality> {+ excretion and part of egestion and mortality of zoobenthos}

18) adsorbed P in sediment [gP/m2/s]

dPAIMS = tPSetAIM - tPResusAIM - tPBurAIM (+ tPSorpIMS)

= (sorption) +settling – resuspension – burial

19) pore water ammonium [gN/m2/s]

dNH4S =(tNMinDetS *(1.0-fRefrDetS) - tNDifNH4- tNNitrS) -tNResusNH4- tNBurNH4 [+ tNExcrPhytS +tNMortPhytNH4S - tNUptNH4VegS] <+ tNExcrVegS + tNMortVegNH4S> {+ tNExcrBent +tNEgesBentNH4 + tNMortBentNH4}

= (detritus and humus mineralisation - diffusion to/from water-nitrification in sediment) – resuspension - burial [+excretion and part of mortality of sed. algae] <- macrophyte uptake from sediment + macrophyte excretion in sediment + part of macrophyte mortality> {+ excretion and part of egestion and mortality of zoobenthos}

20) pore water nitrate [gN/m2/s]

dNO3S =(tNNitrS - tNDenitS - tNDifNO3) - tNResusNO3 - tNBurNO3 <- tNUptNO3VegS>

= (nitrification in sed. - denitrification in sed. - diffusion to/from water) – resuspension - burial <- macrophyte uptake from sediment>

21) Sediment humus [gD /m2 /s]

dDHumS =uDErosOM - tDBurHum (+ fRefrDetS * tDMinDetS – tDMinHumS)

22) Sediment humus [gN /m2 /s]

dNHumS = uNErosOM - tNBurHum + (fRefrDetS * NDMinDetS – tNMinHumS)

23) Sediment humus [gP /m2 /s]

dPHumS = uPErosOM - tPBurHum (+ fRefrDetS * tPMinDetS – tPMinHumS)

= erosion – burial (+ humification– mineralisation)

S2.3 Phytoplankton water column module

24) diatom dry weight in water column [mgD/l/s]

dDDiatW = [wDAssDiat - wDRespDiatW – wDMortDiatW] - tDSetDiat + tDResusDiat {- wDConsDiatZoo}

25) green algae dry weight in water column [mgD/l /s]

dDGrenW = [wDAssGren - wDRespGrenW – wDMortGrenW] - tDSetGren + tDResusGren {- wDConsGrenZoo

26) cyanobacteria (blue-green algae) dry weight in water column [mgD/l /s]

dDBlueW = [wDAssBlue - wDRespBlueW – wDMortBlueW] - tDSetBlue + tDResusBlue {- wDConsBlueZoo}

= [production - respiration – mortality] – settling + resuspension {– grazing}

27) diatom P in water column [mgP/l /s]

dPDiatW = [wPUptDiat - wPExcrDiatW – wPMortDiatW] - tPSetDiat + tPResusDiat – wPConsDiatZoo}

28) green algae P in water column [mgP/l /s]

dPGrenW = [wPUptGren - wPExcrGrenW – wPMortGrenW] - tPSetGren + tPResusGren {- wPConsGrenZoo}

29) cyanobacteria (blue-green algae) P in water column [mgP/l /s]

dPBlueW = [wPUptBlue - wPExcrBlueW – wPMortBlueW] - tPSetBlue + tPResusBlue {- wPConsBlueZoo}

= [uptake – excretion – mortality] – settling + resuspension {– grazing }

30) diatom N in water column [mgN/l /s]

dNDiatW = [wNUptDiat - wNExcrDiatW – wNMortDiatW] - tNSetDiat + tNResusDiat {- wNConsDiatZoo}

31) green algae N in water column [mgN/l /s]

dNGrenW = [wNUptGren - wNExcrGrenW – wNMortGrenW] - tNSetGren + tNResusGren {- wNConsGrenZoo}

32) cyanobacteria (blue-green algae) N in water column [mgN/l /s]

dNBlueW = [wNUptBlue - wNExcrBlueW – wNMortBlueW] - tNSetBlue + tNResusBlue {- wNConsBlueZoo}

= [uptake – excretion – mortality] – settling + resuspension {– grazing}

S2.4 Phytoplankton sediment module

33) sediment diatom dry weight [gD/m2/s]

dDDiatS =tDSetDiat - tDResusDiat [– tDMortDiatS – tDRespDiatS] {- tDConsDiatBent}

34) sediment green algae dry weight [gD/m2/s]

dDGrenS = tDSetGren - tDResusGren [– tDMortGrenS – tDRespGrenS] {– tDConsGrenBent}

35) sediment cyanobacteria (blue-green algae) dry weight [gD/m2/s]

dDBlueS = tDSetBlue - tDResusBlue [– tDMortBlueS – tDRespBlueS] {– tDConsBlueBent}

= settling – resuspension [– mortality – respiration] {– zoobenthos consumption}

36) sediment diatom phosphorus [gP/m2/s]

dPDiatS = tPSetDiat - tPResusDiat [– tPMortDiatS – tPExcrDiatS] {- tPConsDiatBent}

37) sediment green algae phosphorus [gP/m2/s]

dPGrenS = tPSetGren - tPResusGren [– tPMortGrenS – tPExcrGrenS] {- tPConsGrenBent}

38) sediment cyanobacteria (blue-green algae) phosphorus [gP/m2/s]

dPBlueS = tPSetBlue - tPResusBlue [– tPMortBlueS – tPExcrBlueS] {– tPConsBlueBent}

= settling – resuspension [– mortality – excretion] {– zoobenthos consumption}

39) sediment diatom nitrogen [gN/m2/s]

dNDiatS = tNSetDiat - tNResusDiat [– tNMortDiatS – tNExcrDiatS] {- tNConsDiatBent}

40) sediment green algae nitrogen [gN/m2/s]

dNGrenS = tNSetGren - tNResusGren [– tNMortGrenS – tNExcrGrenS] {- tNConsGrenBent}

41) sediment cyanobacteria (blue-green algae) nitrogen [gN/m2/s]

dNBlueS = tNSetBlue - tNResusBlue – tNMortBlueS - tNExcrBlueS – tNConsBlueBent

= settling – resuspension [– mortality –excretion] {– zoobenthos consumption}

S2.5 Macrophytes module

42) macrophytes dry weight [gD/m2/s]

dDVeg = <tDProdVeg - tDRespVeg - tDMortVeg + tDMigrVeg>

= <production - respiration - mortality + migrationz>

43) macrophytes phosphorus [gP/m2/s]

dPVeg = <tPUptVeg - tPExcrVeg - tPMortVeg + tPMigrVeg>

= <uptake – excretion - mortality + migration>

44) macrophytes nitrogen [gN/m2/s]

dNVeg = <tNUptVeg - tNExcrVeg - tNMortVeg + tNMigrVeg>

= <uptake – excretion - mortality + migration>

S2.6 Foodweb module in water column

45) zooplankton dry weight [mgD/l/s]

dDZoo ={wDAssZoo - wDRespZoo - wDMortZoo – tDConsFiJv}

= {assimilation - respiration – mortality – fish predation}

46) zooplankton phosphorus [mgP/l/s]

dPZoo = {wPAssZoo - wPExcrZoo - wPMortZoo – tPConsFiJv}

= {assimilation - excretion – mortality – fish predation}

47) zooplankton phosphorus [mgN/l/s]

dNZoo = {wNAssZoo - wNExcrZoo - wNMortZoo – tNConsFiJv}

= {assimilation - excretion – mortality – fish predation}

48) juvenile whitefish dry weight[mgD/l/s]

dDFiJv = {tDMigrFiJv + tDReprFish - tDAgeFish + tDAssFiJv - tDRespFiJv - tDMortFiJv - tDConsFiJvPisc}

49) juvenile whitefish phosphorus [mgP/l/s]

dPFiJv = {tPMigrFiJv + tPReprFish - tPAgeFish + tPAssFiJv - tPRespFiJv - tPMortFiJv - tPConsFiJvPisc}

50) juvenile whitefish nitrogen [mgN/l/s]

dDFiJv = {tDMigrFiJv + tDReprFish - tDAgeFish + tDAssFiJv - tDRespFiJv - tDMortFiJv - tDConsFiJvPisc}

= {migration + reproduction – ageing + assimilation - respiration – mortality –predation}

51) adult whitefish dry weight[mgD/l/s]

dDFiAd = {tDMigrFiAd - tDReprFish + tDAgeFish - tDRespFiAd – tDMortFiAd - tDConsFiAdPisc – tDHarvFish} <u>{+ tDAssFiAd}</u>

52) adult whitefish phosphorus [mgP/l/s]

dPFiAd = {tPMigrFiAd - tPReprFish + tPAgeFish - tPRespFiAd – tPMortFiAd - tPConsFiAdPisc} <u>{+ tPAssFiAd}</u>

53) adult whitefish nitrogen [mgN/l/s]

dNFiAd = {tNMigrFiAd - tNReprFish + tNAgeFish - tNRespFiAd – tNMortFiAd - tNConsFiAdPisc} <u>{+ tNAssFiAd}</u>

= {migration - reproduction + ageing - respiration – mortality – predation } <u>{+ assimilation}</u>

54) piscivorous fish dry weight[mgD/l/s]

dDPisc = {tDMigrPisc + tDAssPisc - tDRespPisc - tDMortPisc}

= migration + assimilation - respiration – mortality }

S2.7 Foodweb module in the sediment

55) zoobenthos dry weight[gD/m2/s]

dDBent = {tDMigrBent + tDAssBent - tDRespBent – tDMortBent - tDConsFiAd}

56) zoobenthos phosphorus[gP/m2/s]

dPBent = {tPMigrBent + tPAssBent - tPRespBent – tPMortBent - tPConsFiAd}

57) zoobenthos nitrogen[gN/m2/s]

dNBent = {tNMigrBent + tNAssBent - tNRespBent – tNMortBent - tNConsFiAd}

= {migration + assimilation - respiration – mortality – fish predation}

S3. FABM-PCLake parameter list (input file in .yaml format) in modular structure

The input file can be downloaded from www.fabm.net and use of the template provided here is recommended as a basis for parameter adaptation, as the yaml file format includes a strict indentation standard.

S3.1 FABM-PCLake_abiotic_water

model: pclake_abiotic_water

long_name: abiotic_process_in_water

initialization:

sNH4W: 0.1 # mgN/l, ammonium in water

sNO3W: 0.1 # mgN/l, nitrite in water

sPO4W: 0.01 #mgP/l, phosphate in water

sPAIMW: 0.0 # mgP/l, adsorbed phosphorus on inorg. matter in water

sSiO2W: 3.0 # mgSi/l, dissolved silicon dioxide in water

sO2W: 10.0 # mgO2/l, oxygen in water

sDIMW: 5.0 # mgDW/l, inorg.matter in water

sDDetW: 2.0 # mgDW/l, water detritus in dry weight

sPDetW: 0.005 # mgP/l, water detritus in phosphorus

sNDetW: 0.05 # mgN/l, water detritus in nitrogen

sSiDetW: 0.02 # mgSi/l, water detritus in silica

parameters:

cCPerDW: 0.4 # gC/gDW, C content of organic matter

cExtSpDet: 0.15 # m2/gDW,specific_extinction_detritus

cExtSpIM: 0.05 # 0.05m2/gDW specific_extinction_inert_matter

cExtWat: 0.5 # background_extinction"

cKPAdsOx: 0.6 # m3/gP, P adsorption affinity at oxidized conditions

cRelPAdsAl: 0.134 # gP/gAl, max. P adsorption per g Al

cRelPAdsD: 0.00003 # gP/gD, max. P adsorption per g DW cRelPAdsFe: 0.065 # gP/gFe, max. P adsorption per g Fe

cThetaAer: 1.024 # 1/e^oC, temperature coeff. for reaeration

cThetaMinW: 1.07 # exponantional temperature constant of mineralisation in water

cThetaNitr: 1.08 # temperature coefficient for nitrification

fAlDIM: 0.01 # gAl/gD, Al content of inorg. matter

fFeDIM: 0.01 # gFe/gD, Fe content of inorg. matter

fRedMax: 0.9 # max. reduction factor of P adsorption affinity

hNO3Denit: 2 # mgN/l, quadratic half-sat. NO3 conc. for denitrification

hO2BOD: 1 # mgO2/l, half-sat. oxygen conc. for BOD

hO2Nitr: 2 # mgO2/l ,half-sat_O2_conc_for_nitrification_in_water

kDMinDetW: 0.01 # day-1, decomposition constant of detritus

kNitrW: 0.1 # day-1, nitrification rate constant in water

kPSorp: 0.05 # day-1, P sorption rate constant not too high -> model speed day

NO3PerC: 0.8 # mol NO3 denitrified per mol C mineralised

O2PerNH4: 2 # mol O2 used per mol NH4+ nitrified

 # Sinking

cVSetIM: -1.0 # m/day, max. sedimentation velocity of inert org. matter

cVSetDet: -0.25 # m/day, max. sedimentation velocity of detritus

S3.2 FABM-PCLake_abiotic_sediment

model: pclake_abiotic_sediment

long_name: abiotic_process_in_sediment

initialization:

sNH4S: 0.02 # gN/m2, dissolved N-NH4 in interstitial water

sNO3S: 0.002 # gN/m2, dissolved N-NO3 in interstitial water

sPO4S: 0.181703 # gP/m2, dissolved P-PO4 in interstitial water

sPAIMS: 17.9886 # gP/m2, adsorbed P in sediment

sDIMS: 32706.5 # gDW/m2; Inorg matter in sediment sDDetS: 181.703 # gDW/m2, detritus in sediment

sNDetS: 4.54258 # gN/m2, detritus in sediment

sPDetS: 0.454258 # gP/m2, detritus in sediment

sSiDetS: 1.81703 # gSi/m2, detritus in sediment

sDHumS: 3452.36 # gDW/m2, humus in sediment,

sNHumS: 172.618 # gN/m2, humus in sediment,initial N fraction in humus

sPHumS: 17.2618 # gP/m2, humus in sediment, initial P fraction in humus

parameters:

bPorS: 0.847947 # porosity [m3 water m-3 sediment

bPorCorS: 0.737275 # sediment porosity, corrected for tortuosity

cCPerDW: 0.4 # gC/gDW, C content of organic matter

cDepthS: 0.1 # sediment depth [m]

cKPAdsOx: 0.6 # m3/gP, P adsorption affinity at oxidized conditions

coPO4Max: 1.0 # mgP/l, max. PO4 conc. in pore water

cRelPAdsAl: 0.134 # gP/gAl, max. P adsorption per g Al

cRelPAdsD: 0.00003 # gP/gD, max. P adsorption per g DW

cRelPAdsFe: 0.065 # gP/gFe, max. P adsorption per g Fe

cThetaDif: 1.02 # Temperature coefficient for diffusion

cThetaMinS: 1.07 # -, exponantial Temperature constant of sediment mineralisation

cThetaNitr: 1.08 # Temperature coefficient for nitrification

cTurbDifNut: 5.0 # bioturbation factor for diffusion

cTurbDifO2: 5.0 # -, bioturbation factor for diffusion

fAlDIM: 0.01 # gAl/gD, Al content of inorg. matter

fDepthDifS: 0.5 # utrient diffusion distance as fraction of sediment depth

fFeDIM: 0.01 # gFe/gD, Fe content of inorg. matter

fRedMax: 0.9 # max. reduction factor of P adsorption affinity

fRefrDetS: 0.15 # -, refractory fraction of sed. detritus

hNO3Denit: 2.0 # mgN/l, quadratic half-sat. NO3 conc. for denitrification kDMinDetS: 0.002   # "day-1, decomposition constant of sediment detritus

kNDifNH4: 0.000112 # m2/day, mol. NH4 diffusion constant

kNDifNO3: 0.000086 # m2/day, mol. NO3 diffusion constant

kNitrS: 1.0   # day-1,nitrification rate constant in sediment

kO2Dif: 0.000026   # m2/day, mol. O2 diffusion constant

kPChemPO4: 0.03   # day-1, chem. PO4 loss rate

kPDifPO4: 0.000072 # m2/day, mol. PO4 diffusion constant

kPSorp: 0.05   # day-1, P sorption rate constant not too high -> model speed

NO3PerC: 0.8   # mol NO3 denitrified per mol C mineralised

O2PerNH4: 2.0   # mol O2 used per mol NH4+ nitrified

kDMinHum: 0.00001 # day-1 ,maximum_decomposition_constant_of_humic_material_(1D-5)

coupling:

oxygen_pool_water: abiotic_water/sO2W

SiO2_generated_by_mineralisation: abiotic_water/sSiO2W

NH4_diffusion_flux: abiotic_water/sNH4W

NO3_diffusion_flux: abiotic_water/sNO3W

PO4_diffusion_flux: abiotic_water/sPO4W

S3.3 FABM-PCLake_phytoplankton_water

model: pclake_phytoplankton_water

long_name: phytoplankton_in_water

initialization:

sDDiatW: 0.5   # diatoms_DW_in_lake_water

sPDiatW: 0.005 # diatoms_P_in_lake_water

sNDiatW: 0.05   # diatoms_N_in_lake_water

sDGrenW: 0.5   # green_algae_DW_in_lake_water

sPGrenW: 0.005 # green_algae_P_in_lake_water sNGrenW: 0.05 # green_algae_N_in_lake_water

sDBlueW: 3.0 # blue-greens_DW_in_lake_water

sPBlueW: 0.03 # blue-greens_P_in_lake_water

sNBlueW: 0.3 # blue-greens_N_in_lake_water

parameters:

cAffNUptBlue: 0.2 # l/mgDW/day, initial N uptake affinity bluegreens

cAffNUptDiat: 0.2 # l/mgDW/day, initial N uptake affinity diatoms

cAffNUptGren: 0.2 # l/mgDW/day, initial N uptake affinity greens:

cAffPUptBlue: 0.8 # l/mgDW/day, initial P uptake affinity bluegreens

cAffPUptDiat: 0.2 # l/mgDW/day, initial P uptake affinity diatoms

cAffPUptGren: 0.2 # l/mgDW/day, initial P uptake affinity greens

cChDBlueMax: 0.015 # mgChl/mgDW,max._chlorophyll/C_ratio_bluegreens

cChDBlueMin: 0.005 # mgChl/mgDW,min._chlorophyll/C_ratio_bluegreens

cChDDiatMax: 0.012 # mgChl/mgDW, max._chlorophyll/C_ratio_diatoms

cChDDiatMin: 0.004 # mgChl/mgDW ,min._chlorophyll/C_ratio_diatoms

cChDGrenMax: 0.02 # mgChl/mgDW,max._chlorophyll/C_ratio_greens

cChDGrenMin: 0.01 # mgChl/mgDW, min._chlorophyll/C_ratio_greens

cCPerDW: 0.4 # gC/gDW, C content of organic

cExtSpBlue : 0.35 #0.35m2/gDW,specific_extinction_bluegreens

cExtSpDiat : 0.25 # 0.25m2/gDW,specific_extinction_diatoms

cExtSpGren : 0.25 # 0.25m2/gDW,specific_extinction_greens

cLOptRefBlue: 13.6 # W/m2, optimum PAR for blue-greens at 20 ^{o}C (Steele function)

cLOptRefDiat: 54.0 # W/m2, optimum PAR for diatoms at 20 ^{o}C (Steele function)

cMuMaxBlue: 0.6 # day-1,maximum_growth_rate_bluegreens'

cMuMaxDiat: 2.0 # day-1,maximum_growth_rate_diatoms

cMuMaxGren: 1.5 # day-1,maximum_growth_rate_greens

cNDBlueMax: 0.15 # mgN/mgDW, max. N/day ratio bluegreens

cNDBlueMin: 0.03 # mgN/mgDW, minimum N/day ratio bluegreens cNDDiatMax: 0.05 # mgN/mgDW, max. N/day ratio diatoms

cNDDiatMin: 0.01 # mgN/mgDW, minimum N/day ratio diatoms

cNDGrenMax: 0.1 # mgN/mgDW, max. N/day ratio greens

cNDGrenMin: 0.02 # mgN/mgDW, minimum N/day ratio greens

cPDBlueMax: 0.025 # mgP/mgDW, max. P/day ratio blue-greens

cPDBlueMin: 0.0025 # mgP/mgDW, minimum P/day ratio bluegreens

cPDDiatMax: 0.005 # mgP/mgDW, max. P/day ratio diatoms

cPDDiatMin: 0.0005 # mgP/mgDW, minimum P/day ratio diatoms

cPDGrenMax: 0.015 # mgP/mgDW, max. P/day ratio greens

cPDGrenMin: 0.0015 # mgP/mgDW, minimum P/day ratio greens

cSiDDiat: 0.15 # mgSi/mgDW, Si/D ratio of diatoms

cSigTmBlue: 12.0 # ^{o}C, temperature constant bluegreens (sigma in Gaussian curve)

cSigTmDiat: 20.0 # ^{o}C, temperature constant diatoms (sigma in Gaussian curve)

cSigTmGren: 15.0 # ^{o}C, temperature constant greens (sigma in Gaussian curve)

cTmOptBlue: 25.0 # ^{o}C, optimum temperature bluegreens

cTmOptDiat: 18.0 # ^{o}C, optimum temperature diatoms

cTmOptGren: 25.0 # ^{o}C, optimum temperature of greens

cVNUptMaxBlue: 0.07 # mgN/mgDW/day, maximum N uptake capacity of bluegreens

cVNUptMaxDiat: 0.07 # mgN/mgDW/day, maximum N uptake capacity of diatoms

cVNUptMaxGren: 0.07 # mgN/mgDW/day, maximum N uptake capacity of greens

cVPUptMaxBlue: 0.04 # mgP/mgDW/day, maximum P uptake capacity of bluegreens

cVPUptMaxDiat: 0.01 # mgP/mgDW/day, maximum P uptake capacity of diatoms

cVPUptMaxGren: 0.01 # mgP/mgDW/day, maximum P uptake capacity of greens

fDissMortPhyt: 0.2 # [-], soluble_nutrient_fraction_of_died_

hLRefGren: 17.0 # W/m2, half-sat. PAR for greens at 20 ^{o}C (Lehmann function)

hO2BOD: 1.0 # mgO2/l, half-sat. oxygen conc. for BOD

hSiAssBlue: 0.0 # mgSi/l, half-sat. Si conc. for growth of bluegreens: 0

hSiAssDiat: 0.09 # mgSi/l, half-sat. Si for diatoms hSiAssGren: 0.0 # mgSi/l, half-sat. Si conc. for growth of green algae: 0

kDRespBlue: 0.03 # day-1, maintenance respiration constant bluegreens (: 0.05 * MuMax)

kDRespDiat: 0.1 # day-1, maintenance respiration constant diatoms (: 0.05 * MuMax)

kDRespGren: 0.075 # day-1, maintenance respiration constant greens (: 0.05 * MuMax)

kMortBlueW: 0.01 # day-1, mortality constant of bluegreens in water

kMortDiatW: 0.01 # day-1, mortality constant of diatoms in water

kMortGrenW: 0.01 # day-1, mortality constant of diatoms in water

 # sinking

cVSetDiat: -0.5 # m/day, sedimentation velocity diatoms

cVSetGren: -0.2 # m/day, sedimentation velocity of greens

cVSetBlue: -0.06 # m/day, sedimentation velocity bluegreens

coupling:

SiO2_pool_water: abiotic_water/sSiO2W

sPO4_pool_water: abiotic_water/sPO4W

sNH4_pool_water: abiotic_water/sNH4W

sNO3_pool_water: abiotic_water/sNO3W

oxygen_pool_water: abiotic_water/sO2W

detritus_DW_pool_water: abiotic_water/sDDetW

detritus_N_pool_water: abiotic_water/sNDetW

detritus_P_pool_water: abiotic_water/sPDetW

detritus_Si_pool_water: abiotic_water/sSiDetW

surface_vegetation_coverage: macrophytes/afCovSurfVeg

S3.4 FABM-PCLake_phytoplankton_sediment

model: pclake_phytoplankton_sediment

long_name: phytoplankton_in_sediment

initialization:

sDDiatS: 0.001 # diatoms_DW_on_lake_sediment sPDiatS: 0.00001   # diatoms_P_on_lake_sediment

sNDiatS: 0.0001   # diatoms_N_on_lake_sediment

sDGrenS: 0.001   # green_algae_DW_on_lake_sediment

sPGrenS: 0.00001   # green_algae_P_on_lake_sediment

sNGrenS: 0.0001   # green_algae_N_on_lake_sediment

sDBlueS: 0.001   # bluegreens_DW_on_lake_sediment

sPBlueS: 0.00001   # bluegreens_P_on_lake_sediment

sNBlueS: 0.0001   # bluegreens_N_on_lake_sediment

parameters:

cNDBlueMax: 0.15   # mgN/mgDW, max. N/day ratio bluegreens

cNDBlueMin: 0.03   # mgN/mgDW, minimum N/day ratio bluegreens

cNDDiatMax: 0.05   # mgN/mgDW, max. N/day ratio diatoms

cNDDiatMin: 0.01   # mgN/mgDW, minimum N/day ratio diatoms

cNDGrenMax: 0.1   # mgN/mgDW, max. N/day ratio greens

cNDGrenMin: 0.02   # mgN/mgDW, minimum N/day ratio greens

cPDBlueMax: 0.025   # mgP/mgDW, max. P/day ratio bluegreens

cPDBlueMin: 0.0025   # mgP/mgDW, minimum P/day ratio bluegreens

cPDDiatMax: 0.005   # mgP/mgDW, max. P/day ratio diatoms

cPDDiatMin: 0.0005   # mgP/mgDW, minimum P/day ratio diatoms

cPDGrenMax: 0.015   # mgP/mgDW, max. P/day ratio greens

cPDGrenMin: 0.0015   # mgP/mgDW, minimum P/day ratio greens

cSiDDiat: 0.15   # mgSi/mgDW, Si/D ratio of diatoms

cSigTmBlue: 12.0   # ^{o}C, temperature constant bluegreens (sigma in Gaussian curve)

cSigTmDiat: 20.0   # ^{o}C, temperature constant diatoms (sigma in Gaussian curve)

cSigTmGren: 15.0   # ^{o}C, temperature constant greens (sigma in Gaussian curve)

cTmOptBlue: 25.0   # ^{o}C, optimum temperature bluegreens

cTmOptDiat: 18.0   # ^{o}C, optimum temperature diatoms

cTmOptGren: 25.0   # ^{o}C, optimum temperature of greens fDissMortPhyt: 0.2 # -, soluble nutrient fraction of dead algae

kDRespBlue: 0.03 # day-1, maintenance respiration constant gluegreens (: 0.05 * MuMax)

kDRespDiat: 0.10 # day-1, maintenance respiration constant diatoms (: 0.05 * MuMax)

kDRespGren: 0.075 # day-1, maintenance respiration constant greens (: 0.05 * MuMax)

kMortBlueS: 0.2 # day-1, mortality constant bluegreens

kMortDiatS: 0.05 # day-1, mortality constant of sed. diatoms

kMortGrenS: 0.05 # day-1, mortality constant greens

coupling:

sPO4_pool_sediment: abiotic_sediment/sPO4S

sNH4_pool_sediment: abiotic_sediment/sNH4S

sNO3_pool_sediment: abiotic_sediment/sNO3S

detritus_DW_pool_sediment: abiotic_sediment/sDDetS

detritus_N_pool_sediment: abiotic_sediment/sNDetS

detritus_P_pool_sediment: abiotic_sediment/sPDetS

detritus_Si_pool_sediment: abiotic_sediment/sSiDetS

SiO2_pool_water: abiotic_water/sSiO2W

S3.5 FABM-PCLake_macrophytes

model: pclake_macrophytes

long_name: macrophytes

initialization:

sDVeg: 1.0 # vegetation_DW_in_lake_water

sNVeg: 0.02 # vegetation_N_in_lake_water

sPVeg: 0.002 # vegetation_P_in_lake_water

parameters:

bPorS: 0.847947 # porosity [m3 water m-3 sediment]

cAffNUptVeg: 0.2 # l/mgDW/day,initial_N_uptake_affinity_vegetation

cAffPUptVeg: 0.2 # l/mgDW/day,initial_P_uptake_affinity_vegetation cCovSpVeg: 0.5 # %_cover/gDW/m2 specific_cover

cCPerDW: 0.4 # gC/gDW, C content of organic matte

cDayWinVeg: 259.0 # day, end of growing season: 16 Sep

cDCarrVeg: 400.0 # gDW/m2, max. vegetation standing crop

cDepthS: 0.1 # sediment depth [m]

cDLayerVeg: 0.0 # gD/m2, biomass of a single layer floating leaves

cDVegIn: 1.0 # gD/m2, external vegetation density

cExtSpVeg : 0.01 # 0.01 m2/gDW,specific_extinction

cLengAllo: 15.0 # day, duration of allocation and reallocation phase

cLengMort: 15.0 # day, length of shoot mortality period

cMuMaxVeg: 0.2 # g/g shoot/day, maximum growth rate of vegetation at 20°C

cNDVeg0: 0.02 # gN/gD, initial N fraction in vegetation

cNDVegMax: 0.035 # mgN/mgD, maximum N/day ratio vegetation

cNDVegMin: 0.01 # mgN/mgD, minimum N/day ratio vegetation

cPDVeg0: 0.002 # gP/gD, initial P fraction in vegetation

cPDVegMax: 0.0035 # mgP/mgD, maximum P/day ratio vegetation

cPDVegMin: 0.0008 # mgP/mg, minimum P/day ratio vegetation

cQ10ProdVeg: 1.2 # temperature quotient of production

cQ10RespVeg: 2.0 # temperature quotient of respiration

cTmInitVeg: 9.0 # oC, temperature for initial growth

cVNUptMaxVeg: 0.1 # mgN/mgDW/day, maximum_N_uptake_capacity_of_vegetation

cVPUptMaxVeg: 0.01 # mgP/mgDW/day ,maximum_P_uptake_capacity_of_vegetation

fDepth1Veg: 0.5

#max._upper_depth_of_submerged_veget._layer,_as_fraction_of_water_depth

fDepth2Veg: 1.0 #

max._lower_depth_of_submerged_veget._layer,_as_fraction_of_water_depth

fDetWMortVeg: 0.1 # fraction_of_shoot_mortality_becoming_water_detritus

fDissMortVeg: 0.25 # fraction_dissolved_nutrients_from_died_plants fEmergVeg: 0.0 # g floating / g shoot, emergent fraction of shoot

fFloatVeg: 0.0 # g floating / g shoot, floating fraction of shoot

fRootVegSum: 0.1 # g root / g veg, root fraction outside growing season

fRootVegWin: 0.6 # g root / g veg, root fraction outside growing season

fSedUptVegCoef: 2.66 # sigm._regr._coeff._for_sediment_fraction_of_nutrient_uptake

fSedUptVegExp : -0.83 #

exponent_in_sigm._regr._for_sediment_fraction_of_nutrient_uptake

fSedUptVegMax: 0.998 # maximum_sediment_fraction_of_nutrient_uptake

fWinVeg: 0.3 # fraction surviving in winter

hLRefVeg: 17.0 # W/m2 PAR, half-sat. light at 20°C

hO2BOD: 1.0 # mgO2/l, half-sat. oxygen conc. for BOD

kDRespVeg: 0.02 # day-1, dark respiration rate of vegetation

kMigrVeg: 0.001 # day-1, vegetation migration rate

kMortVegSum: 0.005 # day-1, vegetation mortality rate in Spring and Summer

UseEmpUpt: 0 # 0=do_not_use_this_empirical_relation

coupling:

ammonium_pool_water: abiotic_water/sNH4W

nitrate_pool_water: abiotic_water/sNO3W

phosphate_pool_water: abiotic_water/sPO4W

ammonium_pool_sediment: abiotic_sediment/sNH4S

nitrate_pool_sediment: abiotic_sediment/sNO3S

phosphate_pool_sediment: abiotic_sediment/sPO4S

oxygen_pool_water: abiotic_water/sO2W

detritus_DW_pool_water: abiotic_water/sDDetW

detritus_N_pool_water: abiotic_water/sPDetW

detritus_P_pool_water: abiotic_water/sNDetW

detritus_DW_pool_sediment: abiotic_sediment/sDDetS

detritus_N_pool_sediment: abiotic_sediment/sNDetS detritus_P_pool_sediment: abiotic_sediment/sPDetS

oxic_layer_value: abiotic_sediment/afOxySed

S3.6 FABM-PCLake_foodweb_water

model: pclake_foodweb_water

long_name: foodweb_components_in_water

initialization:

sDZoo: 0.05 # zooplankton_DW_in_lake_water

sPZoo: 0.0005 # zooplankton_P_in_lake_water

sNZoo: 0.0035 # zooplankton_N_in_lake_water

sDFiJv: 0.25 # young_fish_DW_in_lake_water

sPFiJv: 0.0055 # young_fish_P_in_lake_water

sNFiJv: 0.025 # young_fish_N_in_lake_water

sDFiAd: 1.0 # adult_fish_DW_in_lake_water

sPFiAd: 0.022 # adult_fish_P_in_lake_water

sNFiAd: 0.1 # adult_fish_N_in_lake_water

sDPisc: 0.005 # Predatory_fish_DW_in_lake_water

parameters:

cCovVegMin: 40 # %,min._subm.veg._coverage_for__Pi_sc

cDayReprFish: 120 # -, reproduction_date_of_fish_: _1_May

cDCarrFish: 15 # gDW/m2,carrying_capacity_of_fish(: _100_gFW/m2,Grimm_1983)

cDCarrPiscBare: 0.1 #

gDW/m2,carrying_capacity_of__Pi_sc_for_lake_without_marsh_zone

cDCarrPiscMax: 1.2 # gDW/m2,maximum_carrying_capacity_of__Pi_sc(: 75_kg/ha)

cDCarrPiscMin: 0.1 # gDW/m2,minimum_carrying_capacity_of__Pi_sc(: 6_kg/ha)

cDCarrZoo: 25 # mg/l , carrying_capacity_of_zooplankton

cDFiAdIn: 0.005 # gDW/m2,external_fish_density

cDFiJvIn: 0.005 # gDW/m2,external_fish_density cDPhraMinPisc: 50 # gDW/m2,min._reed_biomass_for__Pi_sc

cDPiscIn: 0.001 # gDW/m2,external__Pi_sc_density

cFiltMax: 4.5 # ltr/mgDW/day,maximum_filtering_rate(when_DOMW: 0)

cNDFishRef: 0.1 # mgN/mgDW,reference_N/C_ratio_of_Fish

cNDPisc: 0.1 # mgN/mgDW ,reference_N/C_ratio_of__Pi_sc ing

cNDZooRef: 0.07 # mgN/mgDW,reference_N/C-ratio_herb._zooplankton

cPDFishRef: 0.022 # mgP/mgDW , reference_P/C_ratio_of_Fish

cPDPisc: 0.022 # mgP/mgDW, reference_P/C_ratio_of__Pi_sc

cPDZooRef: 0.01 # mgP/mgDW,reference_P/C-ratio_herb._zooplankton

cPrefBlue: 0.125 # -,selection_factor_for_bluegreens_Cal.

cPrefDet: 0.25 # -,selection_factor_for_detritus

cPrefDiat: 0.75 # -,selection_factor_for_diatoms

cPrefGren: 0.75 # -,selection_factor_for_greens

cRelPhraPisc: 0.075 # gDW/m2/%,rel.__Pi_sc_density_per_%_reed_if_subm.veg.

cRelVegPisc: 0.03 #

gDW/m2/% ,extra_rel.__Pi_sc_density_per_%_reed_if__aCovVeg__>__cCovVegMiN

cSiDDiat: 0.15 # mgSi/mgDW Si/DW_ratio_of_daitoms

cSigTmFish: 10 # ^{O}C,temperature_constant_of_fish(sigma_in_Gaussian_curve)

cSigTmPisc: 10 # ^{o}C,temperature_constant_of__Pi_sc(sigma_in_Gaussian_curve)

cSigTmZoo: 13 # ^{o}C,temperature_constant_zooplankton(sigma_in_Gaussian_curve)

cTmOptFish: 25 # ^{o}C,optimum_temp._of_fish

cTmOptPisc: 25 # ^{o}C,optimum_temp._of__Pi_sc

cTmOptZoo: 25 # ^{o}C,optimum_temp._zooplankton

fAgeFish: 0.5 # -,yearly_ageing_fraction_of_young_fish

fDAssFiJv: 0.4 # -,C_assimilation_efficiency_of_young_fish

fDAssPisc: 0.4 # -, C_ass._efficiency_of__Pi_sc

fDAssZoo: 0.35 # -,DW-assimilation_efficiency_of_herb._zooplankton

fDBone: 0.35 # -,fraction_of_fish_C_fixed_in_bones_and_scales fDissEgesFish: 0.25 # -, soluble_nutrient_fraction_of_by_fish_egested_food

fDissEgesPisc: 0.25 # -, soluble_P_fraction_of_by_fish_egested_food

fDissEgesZoo: 0.25 # -,soluble_nutrient_fraction_of_by_herb.zoopl._egested_food

cVSetDiat: -0.5 # m/day, sedimentation velocity diatoms

fDissMortFish: 0.1 # -,soluble_nutrient_fraction_of_died_fish(excl._bones_and_scales

fDissMortPisc: 0.1 # -,

soluble_nutrient_fraction_of_died__Pi_sc(excl._bones_and_scales

fDissMortZoo : 0.1 # -, soluble_nutrient_fraction_of_died_zooplankton

fPBone: 0.5 # -, fraction_of_fish_P_fixed_in_bones_and_scales

fReprFish: 0.02 # -,yearly_reproduction_fraction_of_adult_fish, divided by 86400 here

hDFishPisc: 1 # g/m2,half-saturating_DFish_for__Pi_sc_predation

hDVegPisc: 5 # g/m2,half-sat._vegetation_biomass_for__Pi_sc_growth

hDZooFiJv: 1.25 # g/m2, half-

saturating_zooplankton_biomass_for_young_fish_predation

hFilt: 1.0 # mgDW/l,half-sat._food_conc._for_filtering

kDAssFiJv: 0.12 # day-1,maximum_assimilation_rate_of_young_fish

kDAssPisc: 0.025 # day-1, maximum_assimilation_rate

kDRespFiAd: 0.004 # day-1, maintenance_respiration_constant_of_adult_fish

kDRespFiJv: 0.01 # day-1,maintenance_respiration_constant_of_young_fish

kDRespPisc: 0.005 # day-1 , maint._respiration_constant_of__Pi_sc

kDRespZoo: 0.15 # day-1,maintenance_respiration_constant_herb.zooplankton

kMigrFish: 0.001 # day-1,fish_migration_rate

kMigrPisc: 0.001 # day-1,_Pi_sc_migration_rate

kMortFiAd: 0.00027 # day-1 , specific_mortality_of_adult_fish(: _0.1_y-1)

kMortFiJv: 0.00137 # day-1 ,specific_mortality_of_young_fish(: _0.1_y-1)

kMortPisc: 0.00027 # day-1,specific_mortality_of__Pi_sc_: _0.1_y-1

kMortZoo: 0.04 # day-1,mortality_constant_herb.zooplankton

cNDBlueMax: 0.15 # mgN/mgDW, max. N/day ratio bluegreens cNDBlueMin: 0.03   # mgN/mgDW, minimum N/day ratio bluegreens

cNDDiatMax: 0.05   # mgN/mgDW, max. N/day ratio diatoms

cNDDiatMin: 0.01   # mgN/mgDW, minimum N/day ratio diatoms

cNDGrenMax: 0.1   # mgN/mgDW, max. N/day ratio greens

cNDGrenMin: 0.02   # mgN/mgDW, minimum N/day ratio greens

cPDBlueMax: 0.025   # mgP/mgDW, max. P/day ratio blue-greens

cPDBlueMin: 0.0025   # mgP/mgDW, minimum P/day ratio bluegreens

cPDDiatMax: 0.005   # mgP/mgDW, max. P/day ratio diatoms

cPDDiatMin: 0.0005   # mgP/mgDW, minimum P/day ratio diatoms

cPDGrenMax: 0.015   # mgP/mgDW, max. P/day ratio greens

cPDGrenMin: 0.0015   # mgP/mgDW, minimum P/day ratio greens

coupling:

diatom_as_food_DW: phytoplankton_water/sDDiatW

green_as_food_DW: phytoplankton_water/sDGrenW

blue_as_food_DW: phytoplankton_water/sDBlueW

detritus_DW_pool_water: abiotic_water/sDDetW

diatom_as_food_N: phytoplankton_water/sNDiatW

green_as_food_N: phytoplankton_water/sNGrenW

blue_as_food_N: phytoplankton_water/sNBlueW

detritus_N_pool_water: abiotic_water/sNDetW

diatom_as_food_P: phytoplankton_water/sPDiatW

green_as_food_P: phytoplankton_water/sPGrenW

blue_as_food_P: phytoplankton_water/sPBlueW

detritus_P_pool_water: abiotic_water/sPDetW

detritus_Si_pool_water: abiotic_water/sSiDetW

NH4_pool_water: abiotic_water/sNH4W

NO3_pool_water: abiotic_water/sNO3W

PO4_pool_water: abiotic_water/sPO4W

submerged_vegetation: macrophytes/aDSubVeg

env_correction_adfish: foodweb_sediment/tDEnvFiAd

food_limit_function_adfish: foodweb_sediment/aDSatFiAd

S3.7 FABM-PCLake_foodweb_sediment

model: pclake_foodweb_sediment

long_name: foodweb_components_in_sediment

initialization:

sDBent: 1.0 # zoobenthos_DW_in_lake_sediment

sPBent: 0.01 # zoobenthos_P_in_lake_sediment

sNBent: 0.07 # zoobenthos_N_in_lake_sediment

parameters:

cDBentIn: 0.01 # gDW/m2,external_zoobenthos_density

cDCarrBent: 10.0 # gDW/m2,carrying_capacity_of_zoobenthos

cDCarrFish: 15 # gDW/m2,carrying_capacity_of_fish(: _100_gFW/m2,Grimm_1983)

cNDBentRef: 0.07 # mgN/mgDW, reference_N/C_ratio_of_zoobenthos

cNDFishRef: 0.1 # mgN/mgDW,reference_N/C_ratio_of_Fish

cPDBentRef: 0.01 # mgP/mgDW,reference_P/C_ratio_of_zoobenthos

cPDFishRef: 0.022 # mgP/mgDW,reference_P/C_ratio_of_Fish

cRelVegFish: 0.009 # - ,decrease_of_fish_feeding_per_%_vegetation_cover(max._0.01)

cSiDDiat: 0.15 # mgSi/mgDW, Si/DW_ratio_of_daitoms

cSigTmBent: 16.0 #

^{o}C,temperature_constant_of_zoobenthos(sigma_in_Gaussian_curve)

cSigTmFish: 10 # ^{o}C,temperature_constant_of_fish(sigma_in_Gaussian_curve)

cTmOptBent: 25.0 # ^{o}C, optimum_temp._of_zoobenthos

cTmOptFish: 25 # ^{o}C , optimum_temp._of_fish

fDAssBent: 0.3 # -,C_ass._efficiency_of_zoobenthos fDAssFiAd: 0.4 # -,C_assimilation_efficiency_of_adult_fish

fDissEgesBent: 0.25 # -,soluble_nutrient_fraction_of_by_zoobenthos_egested_food

fDissEgesFish: 0.25 # -,soluble_nutrient_fraction_of_by_fish_egested_food

fDissMortBent: 0.1 # -,soluble_P_fraction_of_died_zoobenthos_P

hDBentFiAd: 2.5 # g/m2,half-saturating_zoobenthos_biomass_for_adult_fish_predation

hDFoodBent: 200.0 # g/m2,half-saturating_food_for_zoobenthos

kDAssBent: 0.1 # day-1, maximum_assimilation_rate

kDAssFiAd: 0.06 # day-1 ,maximum_assimilation_rate_of_adult_fish

kDRespBent: 0.005 # day-1,maint._respiration_constant_of_zoobenthos

kDRespFiAd: 0.004 # day-1 ,maintenance_respiration_constant_of_adult_fish

kMigrBent: 0.001 # day-1,zoobenthos_migration_rate

kMortBent: 0.005 # day-1 ,mortality_constant_of_zoobenthos

kMortFiAd: 0.00027 # day-1,specific_mortality_of_adult_fish(: _0.1_y-1)

cNDBlueMax: 0.15 # mgN/mgDW, max. N/day ratio bluegreens

cNDBlueMin: 0.03 # mgN/mgDW, minimum N/day ratio bluegreens

cNDDiatMax: 0.05 # mgN/mgDW, max. N/day ratio diatoms

cNDDiatMin: 0.01 # mgN/mgDW, minimum N/day ratio diatoms

cNDGrenMax: 0.1 # mgN/mgDW, max. N/day ratio greens

cNDGrenMin: 0.02 # mgN/mgDW, minimum N/day ratio greens

cPDBlueMax: 0.025 # mgP/mgDW, max. P/day ratio bluegreens

cPDBlueMin: 0.0025 # mgP/mgDW, minimum P/day ratio bluegreens

cPDDiatMax: 0.05 # mgP/mgDW, max. P/day ratio diatoms

cPDDiatMin: 0.005 # mgP/mgDW, minimum P/day ratio diatoms

cPDGrenMax: 0.015 # mgP/mgDW, max. P/day ratio greens

cPDGrenMin: 0.0015 # mgP/mgDW, minimum P/day ratio greens

coupling:

diatom_as_food_DW: phytoplankton_sediment/sDDiatS green_as_food_DW: phytoplankton_sediment/sDGrenS

blue_as_food_DW: phytoplankton_sediment/sDBlueS

diatom_as_food_N: phytoplankton_sediment/sNDiatS

green_as_food_N: phytoplankton_sediment/sNGrenS

blue_as_food_N: phytoplankton_sediment/sNBlueS

diatom_as_food_P: phytoplankton_sediment/sPDiatS

green_as_food_P: phytoplankton_sediment/sPGrenS

blue_as_food_P: phytoplankton_sediment/sPBlueS

detritus_DW_pool_sediment: abiotic_sediment/sDDetS

detritus_P_pool_sediment: abiotic_sediment/sPDetS

detritus_N_pool_sediment: abiotic_sediment/sNDetS

detritus_Si_pool_sediment: abiotic_sediment/sSiDetS

NH4_pool_sediment: abiotic_sediment/sNH4S

NO3_pool_sediment: abiotic_sediment/sNO3S

PO4_pool_sediment: abiotic_sediment/sPO4S

adult_fish_biomass: foodweb_water/sDFiAd

adult_fish_nitrogen: foodweb_water/sNFiAd

adult_fish_phosphrus: foodweb_water/sPFiAd

NH4_pool_water: abiotic_water/sNH4W

PO4_pool_water: abiotic_water/sPO4W

DDet_pool_water: abiotic_water/sDDetW

NDet_pool_water: abiotic_water/sNDetW

PDet_pool_water: abiotic_water/sPDetW

vegetation_coverage: macrophytes/aCovVeg

young_fish_biomass: foodweb_water/sDFiJv

S3.8 FABM-PCLake_auxilary

model: pclake_auxilary

long_name: extra_processes

parameters:

cDepthS: 0.1 # sediment depth [m]

cThetaSet: 1.01 # 1/e^^{o}C, temp. parameter of sedimentation

kVegResus: 0.01 # m2/gDW, rel. resuspension reduction per g vegetation

kTurbFish: 1.0 # g/g fish/day, relative resuspension by adult fish browsing

cSuspRef: 0.5 # reference suspended matter function [-]

cSuspMin: 6.1 # minimum value of logistic function

cSuspMax: 25.2 # maximum value of logistic function

cSuspSlope: 2.1 # slope of logistic function

hDepthSusp: 2.0 # half-sat. value of depth in logistic function

cFetchRef: 1000.0 # reference fetch [m]

cFetch: 1000.0 # fetch [m],the length of the lake in the prevailing wind direction

fLutum: 0.1 # lutum content of inorg. matter

fLutumRef: 0.2 # reference lutum fraction

bPorS: 0.847947 # porosity [m3 water m-3 sediment]

kResusPhytMax: 0.25 # day-1,max._phytopl._resuspension

cResusPhytExp: -0.379 # (gDW/m2/day)-1 ,exp._par._for_phytopl._resuspension

cVSetIM: 1.0 # m/day, max. sedimentation velocity of inert org. matter

cVSetDet: 0.25 # m/day, max. sedimentation velocity of detritus

cVSetDiat: 0.5 # m/day, sedimentation velocity diatoms

cVSetGren: 0.2 # m/day, sedimentation velocity of greens

cVSetBlue: 0.06 # m/day, sedimentation velocity blue-greens

cRhoIM: 2500000.0 # g/m3 solid, density of sediment IM

cRhoOM: 1400000.0 # g/m3, density of sediment detritus

fDOrgSoil: 0.1 # fraction soil organic matter

cPO4Ground: 0.1 # mgP/l, PO4 cone in groundwater cNH4Ground: 1.0 # mgN/l, NH4 cone in groundwater

cNO3Ground: 0.1 # mgN/l, NO3 cone in groundwater

cTmOptFish: 25 # °C,optimum_temp._of_fish

cSigTmFish: 10 # °C,temperature_constant_of_fish(sigma_in_Gaussian_curve)

cLoadPO4: 0.005 # gP/m2/day, constant, different from cLoadIM

cLoadNO3: 0.05 # gN/m2/day, constant

uQIn: 20.0 # mm/day, net water load rate, constant

cDErosTot: 0.1 # g/m2/day,Erosion_input_(tentative)

fSedErosIM: 0.95 # instantly_sedimentating_fraction_of_IM

cNDBlueMax: 0.15 # mgN/mgDW, max. N/day ratio bluegreens

cNDBlueMin: 0.03 # mgN/mgDW, minimum N/day ratio bluegreens

cNDDiatMax: 0.05 # mgN/mgDW, max. N/day ratio diatoms

cNDDiatMin: 0.01 # mgN/mgDW, minimum N/day ratio diatoms

cNDGrenMax: 0.1 # mgN/mgDW, max. N/day ratio greens

cNDGrenMin: 0.02 # mgN/mgDW, minimum N/day ratio greens

cPDBlueMax: 0.025 # mgP/mgDW, max. P/day ratio bluegreens

cPDBlueMin: 0.0025 # mgP/mgDW, minimum P/day ratio bluegreens

cPDDiatMax: 0.005 # mgP/mgDW, max. P/day ratio diatoms

cPDDiatMin: 0.0005 # mgP/mgDW, minimum P/day ratio diatoms

cPDGrenMax: 0.015 # mgP/mgDW, max. P/day ratio greens

cPDGrenMin: 0.0015 # mgP/mgDW, minimum P/day ratio greens

coupling:

Amonia_pool_in_water: abiotic_water/sNH4W

Nitrates_pool_in_water: abiotic_water/sNO3W

Phosphate_pool_in_water: abiotic_water/sPO4W

Adsorbed_phosphrus_in_water: abiotic_water/sPAIMW

Oxygen_pool_in_water: abiotic_water/sO2W

Inorg_pool_in_water: abiotic_water/sDIMW

Detritus_DW_in_water: abiotic_water/sDDetW

Detritus_N_in_water: abiotic_water/sNDetW

Detritus_P_in_water: abiotic_water/sPDetW

Detritus_Si_in_water: abiotic_water/sSiDetW

Diatom_DW_in_water: phytoplankton_water/sDDiatW

Green_DW_in_water: phytoplankton_water/sDGrenW

Blue_DW_in_water: phytoplankton_water/sDBlueW

Diatom_N_in_water: phytoplankton_water/sNDiatW

Green_N_in_water: phytoplankton_water/sNGrenW

Blue_N_in_water: phytoplankton_water/sNBlueW

Diatom_P_in_water: phytoplankton_water/sPDiatW

Green_P_in_water: phytoplankton_water/sPGrenW

Blue_P_in_water: phytoplankton_water/sPBlueW

Amonia_pool_in_sediment: abiotic_sediment/sNH4S

Nitrates_pool_in_sediment: abiotic_sediment/sNO3S

Phosphate_pool_in_sediment: abiotic_sediment/sPO4S

Adsorbed_phosphrus_in_sediment: abiotic_sediment/sPAIMS

Inorg_pool_in_sediment: abiotic_sediment/sDIMS

Detritus_DW_in_sediment: abiotic_sediment/sDDetS

Detritus_N_in_sediment: abiotic_sediment/sNDetS

Detritus_P_in_sediment: abiotic_sediment/sPDetS

Detritus_Si_in_sediment: abiotic_sediment/sSiDetS

Diatom_DW_in_sediment: phytoplankton_sediment/sDDiatS

Green_DW_in_sediment: phytoplankton_sediment/sDGrenS

Blue_DW_in_sediment: phytoplankton_sediment/sDBlueS

Diatom_N_in_sediment: phytoplankton_sediment/sNDiatS

Green_N_in_sediment: phytoplankton_sediment/sNGrenS

Blue_N_in_sediment: phytoplankton_sediment/sNBlueS

Diatom_P_in_sediment: phytoplankton_sediment/sPDiatS

Green_P_in_sediment: phytoplankton_sediment/sPGrenS

Blue_P_in_sediment: phytoplankton_sediment/sPBlueS

vegetation_DW: macrophytes/sDVeg

adult_fish_DW: foodweb_water/sDFiAd

Detritus_abiotic_update: abiotic_sediment/tDAbioDetS

Detritus_from_algae: phytoplankton_sediment/tDPrimDetS

Detritus_from_vegetation: macrophytes/tDBedDetS

Detritus_from_foodweb: foodweb_sediment/tDWebDetS

Humus_DW_in_sediment: abiotic_sediment/sDHumS

Humus_N_in_sediment: abiotic_sediment/sNHumS

Humus_P_in_sediment: abiotic_sediment/sPHumS

Humus_abiotic_update: abiotic_sediment/tDAbioHumS

Zooplankton_DW: foodweb_water/sDZoo

Zooplankton_P: foodweb_water/sPZoo

Zooplankton_N: foodweb_water/sNZoo

SiO2_pool_water: abiotic_water/sSiO2W

S4. References

Janse, J. H. 2005. Model studies on the eutrophication of shallow lakes and ditches, publisher not identified.