N2PZDQ

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Contents

Symbols

Symbols used in formulas, respective model parameters, and their descriptions

α	affin_par : initial slope of the P-I curve

Chapter 1

N2PZDQ: 2-Nutrients, Quota resolving NPZD model

1.1 General Overview

Description

State variables

N2PZDQ model resolves:

- 2 nutrients, nitrogen and phosphorus in dissolved and detrital form
- Phytoplankton with flexible C:N:P stoichiometry
- Zooplankton with fixed stoichiometry

Fluxes

The NPZD (nutrient-phytoplankton-zooplankton-detritus) model described here consists of $I=4$ state variables. Nutrient uptake (phytoplankton growth) is limited by light and nutrient availability, the latter of which is modelled by means of Michaelis-Menten kinetics, see eq. (dnp}). The half-saturation nutrient concentration $$ used in this formulation has typically a value between 0.2 and 1.5 mmol N\, m^{-3}. Zooplankton grazing which is limited by the phytoplankton standing stock is modelled by means of an Ivlev formulation, see eq. (dpz}). All other processes are based on linear first-order kinematics, see eqs. (dpn}) - (dzd}).

For all details of the NPZD model implemented here, see**[Burchardetal2005b]**}.

Here is a diagram of fluxes:

Conventions

For the sake of readibility of the formulas, conventional symbols (e.g., Greek letters, sub and superscripts, etc) are used. For the correspondance between the symbols and parameters in the model code, see the Nomenclature section at the end of this report.

```
maybe some script here
```

1.2 References

-?

Chapter 2

Todo List

Subprogram fabm_hzg_n2pzdq::initialize (self, configunit)
here a more detailed description can be provided

Chapter 3

Data Type Index

3.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 4

Data Type Index

4.1 Data Types List

Here are the data types with brief descriptions:

Chapter 5

File Index

5.1 File List

Here is a list of all documented files with brief descriptions:

Chapter 6

Data Type Documentation

6.1 fabm_hzg_n2pzdq Module Reference

This modeule describes an NPZD model extended with 2 nutrients and variable stoichiometry of phyto.

Data Types

- type type_hzg_n2pzdq

  This is the derived model type.

Public Member Functions

- subroutine initialize (self, configunit)

  here the n2pzdq namelist is read,variables exported by the model are registered in FABM and variables imported from FABM are made available

Private Member Functions

- subroutine do (self, _ARGUMENTS_DO_)

  This is the main routine where right-hand-sides are calculated.
- subroutine get_light_extinction (self, _ARGUMENTS_GET_EXTINCTION_)

  to calculate light extinction when kc chnages with depth
- subroutine fprod (self, par, temp_fact, qnc, qpc, primprod, Nlim, Plim, Llim)

  subroutine: primary production
- pure real(rk) function fupn (self, DIN, qnc)

  nitrogen uptake function
- pure real(rk) function fupp (self, DIP, qpc)

  phosphorus uptake function

6.1.1 Detailed Description

This modeule describes an NPZD model extended with 2 nutrients and variable stoichiometry of phyto.

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HZG

See Section 1 for a general overview to see what the model is about.

Definition at line 11 of file n2pzdq.F90.

6.1.2 Member Function/Subroutine Documentation

6.1.2.1 subroutine fabm_hzg_n2pzdq::initialize (class (type_hzg_n2pzdq), intent(inout), target *self,* integer, intent(in) *configunit*)

here the n2pzdq namelist is read,variables exported by the model are registered in FABM and variables imported from FABM are made available

Todo here a more detailed description can be provided

Definition at line 60 of file n2pzdq.F90.

6.1.2.2 fabm_hzg_n2pzdq::do (class (type_hzg_n2pzdq), intent(in) *self,* *_ARGUMENTS_DO_*) [private]

This is the main routine where right-hand-sides are calculated.

Calculate rhs:

Zooplankton processes: $G = d_{zd} = r_{zd} c_z$.

Remineralisation of detritus into nutrients: n {equation}{ddn}.

Phytoplankton processes:

Phyto quatas are calculated as: $Q_N = P_N / P_C$, $Q_P = P_P / P_C$

Production: $phy_{prod}, Nlim, Plim$ is obtained by calling fprod

Mortality: $phy_{mort} = phy_{mort} 0 * e^{(-mort\,par_p hy * Nlim, Plim)} * det_N$

N-uptake: fupN function is called

P-uptake: fupP function is called.

Here details about specific processes are provided.

Definition at line 283 of file n2pzdq.F90.

References fprod(), fupn(), and fupp().

6.1.2.3 subroutine fabm_hzg_n2pzdq::get_light_extinction (class (type_hzg_n2pzdq), intent(in) *self,* *_ARGUMENTS_GET_EXTINCTION_*) [private]

to calculate light extinction when kc chnages with depth

get_light: some more description here?

Definition at line 437 of file n2pzdq.F90.

6.1.2.4 subroutine fabm_hzg_n2pzdq::fprod (type (type_hzg_n2pzdq), intent(in) *self,* real(rk), intent(in) *par,* real(rk), intent(in) *temp_fact,* real(rk), intent(in) *qnc,* real(rk), intent(in) *qpc,* real(rk), intent(out) *primprod,* real(rk), intent(out) *Nlim,* real(rk), intent(out) *Plim,* real(rk), intent(out) *Llim*) [private]

subroutine: primary production

Light limitation, $Llim = (-\alpha * par)/\sqrt{grow_max^2 + \alpha^2}$

N-limitation, $Nlim = 1 - qmin_N/qnc$

N-limitation, $Plim = 1 - qmin_P/qpc$

primary production, $primprod = rmax * min(Nlim, Plim) * Llim * temp_fact$

P=affin_par $*$ X

Definition at line 476 of file n2pzdq.F90.

Referenced by do().

6.1.2.5 pure real(rk) function fabm_hzg_n2pzdq::fupn (type (type_hzg_n2pzdq), intent(in) *self,* real(rk), intent(in) *DIN,* real(rk), intent(in) *qnc*) [private]

nitrogen uptake function

Process description:quota-dependent regulation of uptake rate (forced to stay above 0) times the limitation dependent on external concentration

$fupN = max(0, upmax_N(1 - (Q_N - Q_{min})/(Qmax_N - Qmin_N)) * DIN/(DIN + K_N)$

Definition at line 501 of file n2pzdq.F90.

Referenced by do().

6.1.2.6 pure real(rk) function fabm_hzg_n2pzdq::fupp (type (type_hzg_n2pzdq), intent(in) *self,* real(rk), intent(in) *DIP,* real(rk), intent(in) *qpc*) [private]

phosphorus uptake function

Calculated as: $fupP = max(x, y)$

Definition at line 517 of file n2pzdq.F90.

Referenced by do().

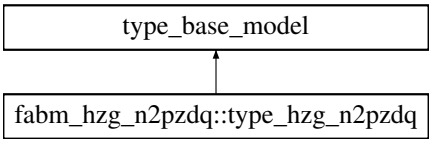
The documentation for this module was generated from the following file:

- n2pzdq.F90

6.2 fabm_hzg_n2pzdq::type_hzg_n2pzdq Type Reference

This is the derived model type.

Inheritance diagram for fabm_hzg_n2pzdq::type_hzg_n2pzdq:



Public Member Functions

- procedure **initialize**
- procedure **do**
- procedure **get_light_extinction**

Public Attributes

- type(type_state_variable_id) **id_din**
- type(type_state_variable_id) **id_dip**
- type(type_state_variable_id) **id_phyc**
- type(type_state_variable_id) **id_phyn**
- type(type_state_variable_id) **id_phyp**
- type(type_state_variable_id) **id_detn**
- type(type_state_variable_id) **id_detp**
- type(type_state_variable_id) **id_zooc**
- type(type_state_variable_id) **id_dic**
- type(type_dependency_id) **id_par**
- type(type_dependency_id) **id_temp**
- type(type_horizontal_dependency_id) **id_i_0**
- type(type_diagnostic_variable_id) **id_gpp**
- type(type_diagnostic_variable_id) **id_ncp**
- type(type_diagnostic_variable_id) **id_ppr**
- type(type_diagnostic_variable_id) **id_npr**
- type(type_diagnostic_variable_id) **id_dpar**
- type(type_diagnostic_variable_id) **id_dmort**
- type(type_diagnostic_variable_id) **id_dllim**
- type(type_diagnostic_variable_id) **id_dnlim**
- type(type_diagnostic_variable_id) **id_dplim**
- type(type_diagnostic_variable_id) **id_dqnc**
- type(type_diagnostic_variable_id) **id_dqpc**
- type(type_diagnostic_variable_id) **id_den**
- type(type_diagnostic_variable_id) **id_dep**
- type(type_diagnostic_variable_id) **id_dec**
- type(type_diagnostic_variable_id) **id_dgraz**
- type(type_diagnostic_variable_id) **id_dmortz**
- type(type_conserved_quantity_id) **id_totn**
- type(type_conserved_quantity_id) **id_totp**
- real(rk) **p0**
- real(rk) **upmax_n**
- real(rk) **upmax_p**
- real(rk) **grow_max**
- real(rk) **iv**
- real(rk) **halfsatn**
- real(rk) **halfsatp**
- real(rk) **rem_n**
- real(rk) **rem_p**
- real(rk) **mort0_phy**
- real(rk) **mortpar_phy**
- real(rk) **qmax_n**
- real(rk) **qmax_p**
- real(rk) **qmin_n**
- real(rk) **qmin_p**
- real(rk) **kc**
- real(rk) **w_p**
- real(rk) **w_d**
- real(rk) **rpn**
- real(rk) **grazmax**
- real(rk) **mort_zoo**
- real(rk) **n**
- real(rk) **qzn**

- real(rk) **qzp**
- real(rk) **eff**
- real(rk) **e_c**
- real(rk) **k_detn**
- real(rk) **k_detp**
- real(rk) **mort_zoo2**
- real(rk) **n2**
- real(rk) **zexcdetfr**
- real(rk) **affin_par**
- real(rk) **dic_per_n**
- logical **use_dic**

6.2.1 Detailed Description

This is the derived model type.

Parameters

affin_par	α : initial slope of the P-I curve

Definition at line 27 of file n2pzdq.F90.

The documentation for this type was generated from the following file:

- n2pzdq.F90

Chapter 7

File Documentation

7.1 n2pzdq.F90 File Reference

This file contains the fabm_hzg_n2pzdq module.

```
#include "fabm_driver.h"
```

Data Types

- module fabm_hzg_n2pzdq

  This modeule describes an NPZD model extended with 2 nutrients and variable stoichiometry of phyto.
- type fabm_hzg_n2pzdq::type_hzg_n2pzdq

  This is the derived model type.

7.1.1 Detailed Description

This file contains the fabm_hzg_n2pzdq module.

Definition in file n2pzdq.F90.

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