ERGOM (SED 1.0) Documentation

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Contents

1 Introduction

This is an automatically generated description of the ecosystem model ERGOM version SED 1.0 . Model formulation is provided by text files in compliance with the rules of the Code Generation Tool (CGT) by Hagen Radtke (see www.ergom.net).

The model consists of a set of state variables, the so called tracers. They are defined and described in Chapter 2.

The following Chapter 3 is the main part of this model description document, since it describes the processes which change the tracer concentrations over time. They are defined analog to chemical processes, two components describe their action:

- A process equation which describes the transformation from precursors (on the left-hand side) to products (on the right-hand side), and
- a turnover rate, describing how fast the process runs.

The rate at which a process changes a tracer can then easily be determined by multiplying the process turnover rate with the stochiometric ratio in which it consumes or produces the tracer according to the reaction equation.

We structured the documentation into different process types to keep the documentation readable. So all processes belonging to one type (e.g. phytoplankton assimilation) are listed together with their constants and auxiliary variables they depend on. This means that some constants, such as stochiometric ratios, will occur several times in this documentation, making it longer. We take this compromise for the sake of readability, keeping all information required to understand a specific process in its own section.

The classical way of describing an ecosystem model is by giving the tracer equations. We still do this in the last chapter for the sake of completeness, but rather suggest to stick to Chapter 3 to understand the model, and see Chapter 4 as a supplement only.

2 Description of model state variables (tracers)

Tracers in the water column only	
t_don	**autochthonous dissolved organic nitrogen (mol/kg)**
t_spp	**small-cell phytoplankton (mol/kg)**
opacity =	30.0 m^2/mol
t_zoo	**zooplankton (mol/kg)**
t_ipw	**suspended iron phosphate (mol/kg)**
vertical speed =	-1.0 m/day
t_lpp	**large-cell phytoplankton (mol/kg)**
vertical speed =	-0.5 m/day
opacity =	30.0 m^2/mol
t_cya	**diazotroph cyanobacteria (mol/kg)**
vertical speed =	0.1 m/day
opacity =	30.0 m^2/mol
t_det_1	**detritus fractions_1 (mol/kg)**
vertical speed =	-4.5 m/day
opacity =	45.0 m^2/mol
t_det_2	**detritus fractions_2 (mol/kg)**
vertical speed =	-4.5 m/day
opacity =	45.0 m^2/mol
t_det_3	**detritus fractions_3 (mol/kg)**
vertical speed =	-4.5 m/day
opacity =	45.0 m^2/mol
t_det_4	**detritus fractions_4 (mol/kg)**
vertical speed =	-4.5 m/day
opacity =	45.0 m^2/mol
t_det_5	**detritus fractions_5 (mol/kg)**
vertical speed =	-4.5 m/day
opacity =	45.0 m^2/mol

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Tracers in the water column only, continued from previous page	
`t_det_6`	**detritus fractions_6 (mol/kg)**
vertical speed =	-4.5 m/day
opacity =	45.0 m^2/mol
`t_ihw`	**suspended iron hydroxide (mol/kg)**
vertical speed =	-1.0 m/day
`t_mow`	**suspended manganese oxide (mol/kg)**
vertical speed =	-1.0 m/day
`t_detp_1`	**phosphate in detritus fractions_1 (mol/kg)**
vertical speed =	-4.5 m/day
`t_detp_2`	**phosphate in detritus fractions_2 (mol/kg)**
vertical speed =	-4.5 m/day
`t_detp_3`	**phosphate in detritus fractions_3 (mol/kg)**
vertical speed =	-4.5 m/day
`t_detp_4`	**phosphate in detritus fractions_4 (mol/kg)**
vertical speed =	-4.5 m/day
`t_detp_5`	**phosphate in detritus fractions_5 (mol/kg)**
vertical speed =	-4.5 m/day
`t_detp_6`	**phosphate in detritus fractions_6 (mol/kg)**
vertical speed =	-4.5 m/day
`t_poc`	**particulate organic carbon (mol/kg)**
vertical speed =	-0.5 m/day

Tracers in water and pore water	
`t_n2`	**dissolved molecular nitrogen (mol/kg)**
`t_o2`	**dissolved molecular oxygen (mol/kg)**
`t_dic`	**dissolved inorganic carbon (mol/kg)**
`t_nh4`	**ammonium (mol/kg)**
`t_no3`	**nitrate (mol/kg)**
`t_po4`	**phosphate (mol/kg)**
`t_h2s`	**hydrogen sulfide (mol/kg)**

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Tracers in water and pore water, continued from previous page	
t_sul	**sulfur (mol/kg)**
t_alk	**total alkalinity (mol/kg)**
t_so4	**sulfate (mol/kg)**
t_fe2	**ferrous iron (mol/kg)**
t_ca2	**dissolved calcium (mol/kg)**
t_mn2	**dissolved manganese-II (mol/kg)**
t_ohm_quickdiff	**OH- ions with realistically quick diffusion (mol/kg)**
t_ohm_slowdiff	**OH- ions which move unrealistically slow with alkalinity (mol/kg)**
t_sil	**silicate (mol/kg)**
Tracers in fluff and sediment	
t_ips	**iron-bound phosphate in the sediment (mol/m^2)**
t_sed_1	**sedimentary detritus fractions_1 (mol/m^2)**
t_sed_2	**sedimentary detritus fractions_2 (mol/m^2)**
t_sed_3	**sedimentary detritus fractions_3 (mol/m^2)**
t_sed_4	**sedimentary detritus fractions_4 (mol/m^2)**
t_sed_5	**sedimentary detritus fractions_5 (mol/m^2)**
t_sed_6	**sedimentary detritus fractions_6 (mol/m^2)**
t_ihs	**iron hydroxide in the sediment (mol/m^2)**
t_pyr	**pyrite (mol/m^2)**
t_ims	**iron monosulphide (mol/m^2)**
t_mos	**manganese oxide in the sediments (mol/m^2)**
t_rho	**rhodochrosite (mol/m^2)**

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Tracers in fluff and sediment, continued from previous page	
t_iim	**iron-II adsorbed to illite-montmorillonite mixed layer minerals (mol/m^2)**
t_i3i	**potentially reducible iron-III in illite-montmorillonite mixed layer minerals (mol/m^2)**
t_ihc	**iron hydroxide in the sediment - crystalline phase (mol/m^2)**
t_pim	**phosphate adsorbed to illite-montmorillonite (mol/m^2)**
t_aim	**ammonium adsorbed to illite-montmorillonite (mol/m^2)**
t_sedp_1	**phosphate in sedimentary detritus fractions_1 (mol/m^2)**
t_sedp_2	**phosphate in sedimentary detritus fractions_2 (mol/m^2)**
t_sedp_3	**phosphate in sedimentary detritus fractions_3 (mol/m^2)**
t_sedp_4	**phosphate in sedimentary detritus fractions_4 (mol/m^2)**
t_sedp_5	**phosphate in sedimentary detritus fractions_5 (mol/m^2)**
t_sedp_6	**phosphate in sedimentary detritus fractions_6 (mol/m^2)**

3 Description of model processes, ordered by process type

3.1 Process type BGC/benthic/bioresuspension

Processes	
bio resuspension of sedimentary detritus (index 1 to 6) (sediment only) [mol/m^2/day]	
`t_sed_1 -> t_det_1`	
`p_sed_1_biores_det =`	`(r_biores*t_sed_1*(1.0-cgt_in_sediment))*lim_t_o2_7* lim_t_sed_1_22`
bio resuspension of sedimentary detritus (index 1 to 6) (sediment only) [mol/m^2/day]	
`t_sedp_1 -> t_detp_1`	
`p_sedp_1_biores_detp =`	`(r_biores*t_sedp_1*(1.0-cgt_in_sediment))*lim_t_o2_7* lim_t_sedp_1_46`
bio resuspension of iron PO4 (sediment only) [mol/m^2/day]	
`t_ips -> t_ipw`	
`p_ips_biores_ipw =`	`(r_biores*t_ips*(1.0-cgt_in_sediment))*lim_t_o2_7* lim_t_ips_52`
bio resuspension of iron hydroxyde (sediment only) [mol/m^2/day]	
`t_ihs -> t_ihw`	
`p_ihs_biores_ihw =`	`(r_biores*t_ihs*(1.0-cgt_in_sediment))*lim_t_o2_7* lim_t_ihs_53`
bio resuspension of iron hydroxyde (sediment only) [mol/m^2/day]	
`t_ihc -> t_ihw`	
`p_ihc_biores_ihw =`	`(r_biores*t_ihc*(1.0-cgt_in_sediment))*lim_t_o2_7* lim_t_ihc_54`
bio resuspension of iron monosulfide (sediment only) [mol/m^2/day]	
`0.125*t_so4 + 0.25*h3oplus + 2.25*h2o + t_ims -> t_ihw + 1.125*t_h2s`	
`p_ims_biores_ihw =`	`(r_biores*t_ims*(1.0-cgt_in_sediment))*lim_t_o2_7* lim_t_so4_28*lim_t_ims_57`
bio resuspension of pyrite (sediment only) [mol/m^2/day]	
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Processes, continued from previous page

```
t_pyr + 3.75*h2o -> 0.25*h3oplus + 1.875*t_h2s + 0.125*t_so4 + t_ihw
p_pyr_biores_ihw =  (r_biores*t_pyr*(1.0-cgt_in_sediment))*lim_t_o2_7*
                    lim_t_pyr_58
```

bio resuspension of manganese oxide (sediment only) [mol/m^2/day]

```
t_mos -> t_mow
p_mos_biores_mow =  (r_biores*t_mos*(1.0-cgt_in_sediment))*lim_t_o2_7*
                    lim_t_mos_59
```

bio resuspension of rhodochrosite (sediment only) [mol/m^2/day]

```
0.25*t_so4 + 1.7*h3oplus + t_rho -> t_mow + 0.25*t_h2s + 2.3*h2o + 0.6*t_ca2 +
1.6*t_dic
p_rho_biores_mow =  (r_biores*t_rho*(1.0-cgt_in_sediment))*lim_t_o2_7*
                    lim_t_so4_28*lim_t_rho_60
```

bio resuspension of iron in clay minerals (sediment only) [mol/m^2/day]

```
0.125*t_so4 + 0.25*h2o + 0.25*h3oplus + t_iim -> t_ihw + 0.125*t_h2s
p_iim_biores_ihw =  (r_biores*t_iim*(1.0-cgt_in_sediment))*lim_t_o2_7*
                    lim_t_so4_28*lim_t_iim_61
```

Auxiliary variables

Constants

oxygen half-saturation constant for recycling of sediment detritus using oxygen [mol/kg]

```
o2_min_sed_resp =   2.0E-5
```

bio-resuspension rate [1/day]

```
r_biores =          0.03
```

Process limitation factors

```
lim_t_o2_7 =        t_o2*t_o2/(t_o2*t_o2+o2_min_sed_resp*o2_min_sed_resp)

lim_t_ips_52 =      theta(t_ips-0.0)

lim_t_so4_28 =      theta(t_so4-0.0)

lim_t_sed_1_22 =    theta(t_sed_1-0.0)

lim_t_sed_2_23 =    theta(t_sed_2-0.0)

lim_t_sed_3_24 =    theta(t_sed_3-0.0)

lim_t_sed_4_25 =    theta(t_sed_4-0.0)

lim_t_sed_5_26 =    theta(t_sed_5-0.0)
```

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Process limitation factors, continued from previous page

```
lim_t_sed_6_27 =    theta(t_sed_6-0.0)
lim_t_ihs_53 =      theta(t_ihs-0.0)
lim_t_pyr_58 =      theta(t_pyr-0.0)
lim_t_ims_57 =      theta(t_ims-0.0)
lim_t_mos_59 =      theta(t_mos-0.0)
lim_t_rho_60 =      theta(t_rho-0.0)
lim_t_iim_61 =      theta(t_iim-0.0)
lim_t_ihc_54 =      theta(t_ihc-0.0)
lim_t_sedp_1_46 =   theta(t_sedp_1-0.0)
lim_t_sedp_2_47 =   theta(t_sedp_2-0.0)
lim_t_sedp_3_48 =   theta(t_sedp_3-0.0)
lim_t_sedp_4_49 =   theta(t_sedp_4-0.0)
lim_t_sedp_5_50 =   theta(t_sedp_5-0.0)
lim_t_sedp_6_51 =   theta(t_sedp_6-0.0)
```

3.2 Process type BGC/benthic/mineralization

Processes

recycling of sedimentary detritus to ammonium using oxygen (respiration) (index 1 to 6) (sediment only) [mol/m^2/day]

```
h3oplus + rfr_pc_enrichment_det*6.625*t_o2 + t_sed_1 -> rfr_si*t_sil + (1.0+
6.625*rfr_pc_enrichment_det)*h2o + rfr_pc_enrichment_det*rfr_c*t_dic + t_nh4
```

```
p_sed_1_resp_nh4 =  (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp))*
                    lim_t_o2_12*lim_t_sed_1_22
```

recycling of sedimentary detritus to ammonium using nitrate (denitrification) (index 1 to 6) (sediment only) [mol/m^2/day]

```
t_sed_1 + (1.0+5.3*rfr_pc_enrichment_det)*h3oplus + rfr_pc_enrichment_det*5.3*
t_no3 -> rfr_pc_enrichment_det*rfr_c*t_dic + t_nh4 + rfr_pc_enrichment_det*
2.65*t_n2 + (1.0+14.575*rfr_pc_enrichment_det)*h2o + rfr_si*t_sil
```

```
p_sed_1_denit_nh4 = (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*
                    pH_inhibition_ironred)*(1.0-lim_t_o2_2)*lim_t_no3_3*
                    lim_t_sed_1_22
```

recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (index 1 to 6) (sediment only) [mol/m^2/day]

```
(1.0+rfr_pc_enrichment_det*6.625)*h3oplus + rfr_pc_enrichment_det*3.3125*t_so4
+ t_sed_1 -> (1.0+rfr_pc_enrichment_det*13.25)*h2o + rfr_pc_enrichment_det*
3.3125*t_h2s + rfr_pc_enrichment_det*rfr_c*t_dic + t_nh4 + rfr_si*t_sil
```

```
p_sed_1_sulf_nh4 =  (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*
                    max(t_so4,0.0)/(max(t_so4,0.0)+so4_min_det_sulf)*
                    pH_inhibition_ironred)*(1.0-lim_t_o2_2)*(1.0-lim_t_no3_3)*
                    (1.0-lim_t_ihs_4)*(1.0-lim_t_mos_5)*(1.0-lim_t_i3i_6)*
                    lim_t_so4_28*lim_t_sed_1_22
```

recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction) (index 1 to 6) (sediment only) [mol/m^2/day]

```
t_sed_1 + (1.0+26.5*rfr_pc_enrichment_det)*h3oplus + 13.25*
rfr_pc_enrichment_det*t_mos -> rfr_si*t_sil + (1.0+46.375*
rfr_pc_enrichment_det)*h2o + 13.25*rfr_pc_enrichment_det*t_mn2 + t_nh4 +
rfr_pc_enrichment_det*rfr_c*t_dic
```

```
p_sed_1_mnred_mn2 = (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*
                    pH_inhibition_ironred)*(1.0-lim_t_o2_2)*(1.0-lim_t_no3_3)*
                    lim_t_mos_5*lim_t_sed_1_22
```

recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (index 1 to 6) (sediment only) [mol/m^2/day]

```
26.5*rfr_pc_enrichment_det*t_h2s + 26.5*rfr_pc_enrichment_det*t_ihs + h3oplus +
t_sed_1 -> rfr_pc_enrichment_det*rfr_c*t_dic + t_nh4 + 26.5*
rfr_pc_enrichment_det*t_ims + (1.0+72.875*rfr_pc_enrichment_det)*h2o + rfr_si*
t_sil
```

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Processes, continued from previous page

```
p_sed_1_irred_ims = (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*
                    t_ihs/max(fe3_sed,epsilon)*fe2_ims_is_smallest*
                    pH_inhibition_ironred)*(1.0-lim_t_o2_2)*(1.0-lim_t_no3_3)*
                    (1.0-lim_t_mos_5)*lim_t_ihs_4*lim_t_h2s_29*lim_t_sed_1_22
```

recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (index 1 to 6) (sediment only) [mol/m^2/day]

```
26.5*rfr_pc_enrichment_det*t_ips + (1.0+159.1875*rfr_pc_enrichment_det)*h3oplus
+ 86.125*rfr_pc_enrichment_det*h2o + t_sed_1 + 26.5*rfr_pc_enrichment_det*t_h2s
-> rfr_si*t_sil + rfr_pc_enrichment_det*rfr_c*t_dic + t_nh4 + 26.5*
rfr_pc_enrichment_det*t_ims + h2o + 26.5*rfr_pc_enrichment_det*t_po4 +
238.6875*rfr_pc_enrichment_det*h3oplus
```

```
                    (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*
p_sed_1_irredips_imst_ips/max(fe3_sed,epsilon)*fe2_ims_is_smallest*
=                   pH_inhibition_ironred)*(1.0-lim_t_o2_2)*(1.0-lim_t_no3_3)*
                    (1.0-lim_t_mos_5)*lim_t_ihs_4*lim_t_ips_52*lim_t_sed_1_22*
                    lim_t_h2s_29
```

recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (index 1 to 6) (sediment only) [mol/m^2/day]

```
53.0*rfr_pc_enrichment_det*h3oplus + t_sed_1 + h3oplus + 26.5*
rfr_pc_enrichment_det*t_ihs + 53*rfr_pc_enrichment_det*ohminus -> rfr_si*t_sil
+ 125.875*rfr_pc_enrichment_det*h2o + h2o + 26.5*rfr_pc_enrichment_det*t_iim +
t_nh4 + rfr_pc_enrichment_det*rfr_c*t_dic
```

```
p_sed_1_irred_iim = (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*
                    t_ihs/max(fe3_sed,epsilon)*fe2_iim_is_smallest*
                    pH_inhibition_ironred)*(1.0-lim_t_o2_2)*(1.0-lim_t_no3_3)*
                    (1.0-lim_t_mos_5)*lim_t_ihs_4*lim_t_sed_1_22
```

recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (index 1 to 6) (sediment only) [mol/m^2/day]

```
26.5*rfr_pc_enrichment_det*t_ips + t_sed_1 + (1+53.0*rfr_pc_enrichment_det)*
h3oplus + 33.125*rfr_pc_enrichment_det*h2o + 53*rfr_pc_enrichment_det*ohminus -
> rfr_si*t_sil + rfr_pc_enrichment_det*rfr_c*t_dic + rfr_pc_enrichment_det*
26.5*t_po4 + t_nh4 + 26.5*rfr_pc_enrichment_det*t_iim + h2o + 79.5*
rfr_pc_enrichment_det*h3oplus
```

```
                    (t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*
p_sed_1_irredips_iimt_ips/max(fe3_sed,epsilon)*fe2_iim_is_smallest*
=                   pH_inhibition_ironred)*(1.0-lim_t_o2_2)*(1.0-lim_t_no3_3)*
                    (1.0-lim_t_mos_5)*lim_t_ihs_4*lim_t_ips_52*lim_t_sed_1_22
```

recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction) (index 1 to 6) (sediment only) [mol/m^2/day]

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Processes, continued from previous page	
`t_sed_1 + h3oplus + 26.5*rfr_pc_enrichment_det*t_i3i -> rfr_si*t_sil + (1.0+ 19.875*rfr_pc_enrichment_det)*h2o + 26.5*rfr_pc_enrichment_det*i2i + t_nh4 + rfr_pc_enrichment_det*rfr_c*t_dic`	
`p_i3i_1_irred_i2i =`	`(t_sed_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)* pH_inhibition_ironred)*(1.0-lim_t_o2_2)*(1.0-lim_t_no3_3)* (1.0-lim_t_mos_5)*(1.0-lim_t_ihs_4)*lim_t_i3i_6* lim_t_sed_1_22`
recycling of sediment detrital phosphate (index 1 to 6) (sediment only) [mol/m^2/day]	
`t_sedp_1 + 3*rfr_pc_enrichment_det*rfr_p*h2o -> 3*rfr_pc_enrichment_det*rfr_p* h3oplus + rfr_pc_enrichment_det*rfr_p*t_po4`	
`p_sedp_1_remin_po4 =`	`(t_sedp_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*(1.0+ (factor_pref_remin_p-1.0)*o2_min_sed_resp/(t_o2 + o2_min_sed_resp)))*lim_t_sedp_1_46`

Auxiliary variables	
absolute temperature [K]	
`temp_k =`	`cgt_temp + 273.15`
temporary value assumed for pH [1]	
`ph_temp =`	`0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)`
calculated iteratively, 10 iterations, initial value = 0.0	
self-ionization constant of Water [mol2/kg2]	
`k_water =`	`exp( -13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k) + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) * sqrt(cgt_sali) - 0.01615 * cgt_sali)`
Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]	
`k1_co2 =`	`power(10.0,( -3633.86 / temp_k + 61.2172 - 9.6777 * log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali * cgt_sali))`
Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]	
`k2_co2 =`	`power(10.0,( -471.78 / temp_k - 25.929 + 3.16967 * log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali * cgt_sali))`
Acid dissociation constant of boric acid [mol/kg]	
`k_boron =`	`exp(( -8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali + 1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) / temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142* cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474* cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k )`

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Auxiliary variables, continued from previous page

Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]

`k1_po4 =`	`exp( -4576.752/temp_k + 115.525 - 18.453*log(temp_k) + (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 + 0.65643/temp_k)*cgt_sali )`

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

`k2_po4 =`	`exp( -8814.715/temp_k + 172.0883 - 27.927*log(temp_k) + (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 - 0.37335/temp_k)*cgt_sali )`

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

`k3_po4 =`	`exp( -3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k) *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali )`

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

`k1_h2s =`	`exp( -3131.42/temp_k - 5.818 + 0.368* (power(max(0.0,cgt_sali),(1.0/3.0))))`

total concentration of boron [mol/kg]

`boron_total =`	`0.000416 * cgt_sali/35.0`

boron alkalinity [mol/kg]

`alk_boron =`	`boron_total * k_boron / (k_boron + h3o)`

calculated iteratively, 10 iterations, initial value = 0.0

hydrogen sulfide alkalinity [mol/kg]

`alk_h2s =`	`t_h2s * k1_h2s / (k1_h2s + h3o)`

calculated iteratively, 10 iterations, initial value = 0.0

water alkalinity [mol/kg]

`alk_water =`	`k_water / h3o - h3o`

calculated iteratively, 10 iterations, initial value = 0.0

denominator in phosphate alkalinity formula [mol3/kg3]

`alk_po4_denominator =`	`(h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4* k2_po4*k3_po4)`

calculated iteratively, 10 iterations, initial value = 0.0

phosphate alkalinity [mol/kg]

`alk_po4 =`	`t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o* h3o*h3o) / alk_po4_denominator`

calculated iteratively, 10 iterations, initial value = 0.0

continued on next page...

Auxiliary variables, continued from previous page	
denominator in carbonate alkalinity formula [mol2/kg2]	
`alk_co2_denominator =`	`(h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)`
calculated iteratively, 10 iterations, initial value = `0.0`	
carbonate alkalinity [mol/kg]	
`alk_co2 =`	`t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator`
calculated iteratively, 10 iterations, initial value = `0.0`	
error in total alkalinity calculation at the assumed pH [mol/kg]	
`alk_residual =`	`t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of phosphate alkalinity with respect to h3o [1]	
`dalkp_dh3o =`	`t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o*h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o-4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4*k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of carbonate alkalinity with respect to h3o [1]	
`dalkc_dh3o =`	`t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2*k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of residual_alk with respect to pH [mol/kg]	
`dalkresidual_dpH =`	`0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)`
calculated iteratively, 10 iterations, initial value = `0.0`	
newly determined pH value [1]	
`temp1 =`	`alk_residual/dalkresidual_dpH`
`ph =`	`ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1`
calculated iteratively, 10 iterations, initial value = `0.0`	
h3o ion concentration [mol/kg]	
`h3o =`	`power(10.0,0.0-max(1.0,min(13.0,ph)))`
calculated iteratively, 10 iterations, initial value = `1.0e-8`	
Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]	
`k1_h2s_sed =`	`exp( -3131.42/temp_k - 5.818 + 0.368*(power(max(0.0,cgt_sali),(1.0/3.0))))`
iron hydroxide half-saturation constant converted to [mol/m2]	
continued on next page...	

Auxiliary variables, continued from previous page

ihs_min_sed_irred_2d =	ihs_min_sed_irred*cgt_cellheight*cgt_density
manganese oxide half-saturation constant converted to [mol/m2]	
mos_min_sed_irred_2d =	mos_min_sed_irred*cgt_cellheight*cgt_density
sum of Fe-III in the sediment [mol/m2]	
fe3_sed =	t_ips+t_ihs
ionic strength of the solution [mol/kg]	
ionic_strength =	0.02*cgt_sali
dielectric constant of seawater [F/m]	
temp1 =	cgt_sali*(1.707e-2+1.205e-5*cgt_sali+4.058e-9*power(cgt_sali,2.0))
temp2 =	1.0-0.2551*temp1+5.151e-2*temp1*temp1-6.889e-3*temp1*temp1*temp1
temp3 =	87.74-0.40008*temp_k+9.398e-4*temp_k*temp_k+1.401e-6*temp_k*temp_k*temp_k
dielectric_constant =	temp2*temp3
concentration of HS- ions [mol/kg]	
hsminus =	t_h2s * k1_h2s_sed / (k1_h2s_sed + h3o)
parameter A for the Davies formula [mol0.5 l-0.5]	
davies_parameter_a =	1.82e6*power(dielectric_constant*temp_k,-1.5)
activity to concentration ratio of ions with a charge of +1/-1 [1]	
activity_coefficient_1 =	power(10.0,0.0-davies_parameter_a*1*(sqrt(ionic_strength)/(1+sqrt(ionic_strength))-0.3*ionic_strength))
activity to concentration ratio of ions with a charge of +2/-2 [1]	
activity_coefficient_2 =	power(10.0,0.0-davies_parameter_a*2*(sqrt(ionic_strength)/(1+sqrt(ionic_strength))-0.3*ionic_strength))
activity of H3O+ ions (concentration corrected by ionic strength) [mol/kg]	
activity_h3oplus =	h3o*activity_coefficient_1
Fe-II concentration in equilibrium with iron monosulfide precipitation [mol/kg]	
fe2_eq_ims =	power(10.0,-2.95)*activity_h3oplus/max(hsminus*activity_coefficient_1,1.0e-3*epsilon)/activity_coefficient_2

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Auxiliary variables, continued from previous page

Fe-II concentration in equilibrium with iron adsorbed to illite-montmorillonite mixed layer minerals [mol/kg]

```
temp1 =               2.7 * max(vol_fraction_im*(1.0-POR),epsilon)
fe2_eq_iim =          (max(t_iim,epsilon)/cgt_cellheight/cgt_density)/(100*temp1)
                      +1000*(1.0-cgt_in_sediment)
```

siderite is the favoured species for precipitation (0 or 1) [1]

```
fe2_ims_is_smallest theta(fe2_eq_iim-fe2_eq_ims)
=
```

minnesotaite is the favoured species for precipitation (0 or 1) [1]

```
fe2_iim_is_smallest theta(fe2_eq_ims-fe2_eq_iim)
=
```

factor for inhibition of iron / sulfate reduction at large pH [1]

```
                      1.0+0.0*(theta(pH_opt_ironred-pH)+theta(pH-pH_opt_ironred)*
ph_inhibition_ironremax((pH_max_ironred-pH)/(pH_max_ironred-pH_opt_ironred)
=                     ,0.0))
```

Constants

no division by 0

```
epsilon =             4.5E-17
```

iron hydroxide half-saturation concentration for detritus remineralization by iron reduction [mol/kg]

```
ihs_min_sed_irred = 0.0065
```

iron hydroxide half-saturation concentration for detritus remineralization by iron reduction [mol/kg]

```
mos_min_sed_irred = 0.0004
```

nitrate half-saturation concentration for denitrification in the water column [mol/kg]

```
no3_min_sed_denit = 4.0E-6
```

oxygen half-saturation constant for recycling of sediment detritus using oxygen [mol/kg]

```
o2_min_sed_resp =   2.0E-5
```

q10 rule factor for recycling [1/K]

```
q10_det_rec =         0.15
```

redfield ratio C/N

```
rfr_c =               6.625
```

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Constants, continued from previous page

redfield ratio P/N
rfr_p = 0.0625

enrichment factor for P and C in detritus [1]
rfr_pc_enrichment_de = 1.5

minimum sulfate concentration for sulfate reduction [mol/kg]
so4_min_det_sulf = 1.0E-6

detritus recycling rates [1/d]
r_det_1_rec = 0.0647

detritus recycling rates [1/d]
r_det_2_rec = 0.00924

detritus recycling rates [1/d]
r_det_3_rec = 0.00136

detritus recycling rates [1/d]
r_det_4_rec = 0.000108

detritus recycling rates [1/d]
r_det_5_rec = 1.62E-5

detritus recycling rates [1/d]
r_det_6_rec = 0.0

porosity
por = 0.77

optimal pH for iron reduction [1]
pH_opt_ironred = 7.2

maximum pH for iron reduction [1]
pH_max_ironred = 20.0

average ratio Si/N [1]
rfr_si = 0.9375

fraction of illite-montmorillonite mixed layer minerals on volume of all minerals [1]
vol_fraction_im = 0.5

continued on next page...

Constants, continued from previous page
acceleration factor for preferential mineralization of P compared to N under hypoxic conditions [1]
`factor_pref_remin_p 10.0 =`

Process limitation factors	
`lim_t_o2_2 =`	`1.0-exp(-t_o2/o2_min_sed_resp)`
`lim_t_o2_12 =`	`theta(t_o2-0.0)`
`lim_t_no3_3 =`	`1.0-exp(-t_no3/no3_min_sed_denit)`
`lim_t_h2s_29 =`	`theta(t_h2s-0.0)`
`lim_t_ips_52 =`	`theta(t_ips-0.0)`
`lim_t_so4_28 =`	`theta(t_so4-0.0)`
`lim_t_sed_1_22 =`	`theta(t_sed_1-0.0)`
`lim_t_sed_2_23 =`	`theta(t_sed_2-0.0)`
`lim_t_sed_3_24 =`	`theta(t_sed_3-0.0)`
`lim_t_sed_4_25 =`	`theta(t_sed_4-0.0)`
`lim_t_sed_5_26 =`	`theta(t_sed_5-0.0)`
`lim_t_sed_6_27 =`	`theta(t_sed_6-0.0)`
`lim_t_ihs_4 =`	`1.0-exp(-t_ihs/ihs_min_sed_irred_2d)`
`lim_t_mos_5 =`	`1.0-exp(-t_mos/mos_min_sed_irred_2d)`
`lim_t_i3i_6 =`	`1.0-exp(-t_i3i/ihs_min_sed_irred_2d)`
`lim_t_sedp_1_46 =`	`theta(t_sedp_1-0.0)`
`lim_t_sedp_2_47 =`	`theta(t_sedp_2-0.0)`
`lim_t_sedp_3_48 =`	`theta(t_sedp_3-0.0)`
`lim_t_sedp_4_49 =`	`theta(t_sedp_4-0.0)`

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Process limitation factors, continued from previous page	
lim_t_sedp_5_50 =	theta(t_sedp_5-0.0)
lim_t_sedp_6_51 =	theta(t_sedp_6-0.0)

3.3 Process type BGC/benthic/precipitation

Processes	
transformation of amorphous iron oxyhydroxides to crystalline phase (sediment only) [mol/m²/day]	
`t_ihs -> t_ihc`	
`p_ihs_trans_ihc =`	`(r_ihs_trans_ihc*t_ihs)*lim_t_ihs_53`
manganese-II precipitation to rhodochrosite (sediment only) [mol/m²/day]	
`4.8*h2o + 0.6*t_ca2 + t_mn2 + 1.6*t_dic -> t_rho + 3.2*h3oplus`	
`p_mn2_prec_rho =`	`(0.1*t_mn2*theta(saturation_rhodochrosite-1.0)* cgt_in_sediment*cgt_cellheight*cgt_density)*lim_t_ca2_56* lim_t_mn2_62*lim_t_dic_13`

Auxiliary variables	
absolute temperature [K]	
`temp_k =`	`cgt_temp + 273.15`
temporary value assumed for pH [1]	
`ph_temp =`	`0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)`
calculated iteratively, 10 iterations, initial value = 0.0	
self-ionization constant of Water [mol2/kg2]	
`k_water =`	`exp( -13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k) + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) * sqrt(cgt_sali) - 0.01615 * cgt_sali)`
Solubility of CO2 [mol/kg/Pa]	
`k0_co2 =`	`exp(9345.17 / temp_k - 60.2409 + 23.3585 * (log(temp_k) - 4.605170186) + cgt_sali*(0.023517 - 0.00023656 * temp_k + 0.00000047036 *temp_k*temp_k))/101325.0`
Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]	
`k1_co2 =`	`power(10.0,( -3633.86 / temp_k + 61.2172 - 9.6777 * log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali * cgt_sali))`
Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]	
`k2_co2 =`	`power(10.0,( -471.78 / temp_k - 25.929 + 3.16967 * log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali * cgt_sali))`
Acid dissociation constant of boric acid [mol/kg]	
`k_boron =`	`exp(( -8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali + 1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) / temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142* cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474* cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k )`

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Auxiliary variables, continued from previous page

Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]

```
k1_po4 =            exp( -4576.752/temp_k + 115.525 - 18.453*log(temp_k) +
                    (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 +
                    0.65643/temp_k)*cgt_sali )
```

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

```
k2_po4 =            exp( -8814.715/temp_k + 172.0883 - 27.927*log(temp_k) +
                    (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 -
                    0.37335/temp_k)*cgt_sali )
```

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

```
k3_po4 =            exp( -3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k)
                    *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali )
```

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

```
k1_h2s =            exp( -3131.42/temp_k - 5.818 + 0.368*
                    (power(max(0.0,cgt_sali),(1.0/3.0))))
```

total concentration of boron [mol/kg]

```
boron_total =       0.000416 * cgt_sali/35.0
```

boron alkalinity [mol/kg]

```
alk_boron =         boron_total * k_boron / (k_boron + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

hydrogen sulfide alkalinity [mol/kg]

```
alk_h2s =           t_h2s * k1_h2s / (k1_h2s + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

water alkalinity [mol/kg]

```
alk_water =         k_water / h3o - h3o
```

calculated iteratively, 10 iterations, initial value = 0.0

denominator in phosphate alkalinity formula [mol3/kg3]

```
alk_po4_denominator (h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4*
=                   k2_po4*k3_po4)
```

calculated iteratively, 10 iterations, initial value = 0.0

phosphate alkalinity [mol/kg]

```
alk_po4 =           t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o*
                    h3o*h3o) / alk_po4_denominator
```

calculated iteratively, 10 iterations, initial value = 0.0

continued on next page...

Auxiliary variables, continued from previous page

denominator in carbonate alkalinity formula [mol2/kg2]
```
alk_co2_denominator (h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)
=
```
calculated iteratively, 10 iterations, initial value = `0.0`

carbonate alkalinity [mol/kg]
```
alk_co2 =           t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator
```
calculated iteratively, 10 iterations, initial value = `0.0`

error in total alkalinity calculation at the assumed pH [mol/kg]
```
alk_residual =      t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water
```
calculated iteratively, 10 iterations, initial value = `0.0`

derivative of phosphate alkalinity with respect to h3o [1]
```
dalkp_dh3o =        t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o*
                    h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o-
                    4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4*
                    k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)
```
calculated iteratively, 10 iterations, initial value = `0.0`

derivative of carbonate alkalinity with respect to h3o [1]
```
dalkc_dh3o =        t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2*
                    k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)
```
calculated iteratively, 10 iterations, initial value = `0.0`

derivative of residual_alk with respect to pH [mol/kg]
```
dalkresidual_dpH =  0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+
                    h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)
```
calculated iteratively, 10 iterations, initial value = `0.0`

newly determined pH value [1]
```
temp1 =             alk_residual/dalkresidual_dpH
ph =                ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1
```
calculated iteratively, 10 iterations, initial value = `0.0`

h3o ion concentration [mol/kg]
```
h3o =               power(10.0,0.0-max(1.0,min(13.0,ph)))
```
calculated iteratively, 10 iterations, initial value = `1.0e-8`

co2 partial pressure [Pa]
```
pco2 =              t_dic / k0_co2 / (1 + k1_co2/h3o + k1_co2*k2_co2/h3o/h3o)
```

ionic strength of the solution [mol/kg]
```
ionic_strength =    0.02*cgt_sali
```

continued on next page...

Auxiliary variables, continued from previous page

dielectric constant of seawater [F/m]

temp1 =	cgt_sali*(1.707e-2+1.205e-5*cgt_sali+4.058e-9*power(cgt_sali,2.0))
temp2 =	1.0-0.2551*temp1+5.151e-2*temp1*temp1-6.889e-3*temp1*temp1*temp1
temp3 =	87.74-0.40008*temp_k+9.398e-4*temp_k*temp_k+1.401e-6*temp_k*temp_k*temp_k
dielectric_constant =	temp2*temp3

CO2 concentration in the surface layer [mol/kg]

co2 =	pco2*k0_co2

parameter A for the Davies formula [mol0.5 l-0.5]

davies_parameter_a =	1.82e6*power(dielectric_constant*temp_k,-1.5)

concentration of HCO3- ions

hco3minus =	co2*k1_co2/h3o

activity to concentration ratio of ions with a charge of +2/-2 [1]

activity_coefficient =	power(10.0,0.0-davies_parameter_a*2*(sqrt(ionic_strength)/(1+sqrt(ionic_strength))-0.3*ionic_strength))

concentration of CO3-- ions

co32minus =	hco3minus*k2_co2/h3o

activity of CO3-- ions (concentration corrected by ionic strength) [mol/kg]

activity_co32minus =	co32minus*activity_coefficient_2

relative saturation of rhodochrosite [1]

saturation_rhodochro =	t_mn2*activity_coefficient_2*activity_co32minus/power(10.0,-9.5)

Constants

transformation rate from amorphous to crystalline iron hydroxide [1/d]

r_ihs_trans_ihc =	0.00164

Process limitation factors

lim_t_dic_13 =	theta(t_dic-0.0)
lim_t_ihs_53 =	theta(t_ihs-0.0)

continued on next page...

Process limitation factors, continued from previous page	
`lim_t_ca2_56 =`	`theta(t_ca2-0.0)`
`lim_t_mn2_62 =`	`theta(t_mn2-0.0)`

3.4 Process type BGC/benthic/reoxidation

Processes

nitrification in the sediment [mol/kg/day]

```
t_nh4 + 2*t_o2 + h2o -> t_no3 + 2*h3oplus
p_nh4_nit_no3_sed = (t_nh4*t_o2*k_nh4_o2*exp(q10_nit*cgt_temp)*cgt_in_sediment)
                    *lim_t_o2_1*lim_t_nh4_16
```

oxidation of hydrogen sulfide with oxygen [mol/kg/day]

```
t_h2s + 0.5*t_o2 -> t_sul + h2o
p_h2s_oxo2_sul =    (t_h2s*t_o2*k_h2s_o2*exp(q10_h2s*cgt_temp))*lim_t_h2s_29*
                    lim_t_o2_12
```

oxidation of hydrogen sulfide with nitrate [mol/kg/day]

```
0.4*h3oplus + 0.4*t_no3 + t_h2s -> 0.2*t_n2 + 1.6*h2o + t_sul
p_h2s_oxno3_sul =   (t_h2s*t_no3*k_h2s_no3*exp(q10_h2s*cgt_temp))*lim_t_no3_14*
                    lim_t_h2s_29
```

oxidation of elemental sulfur with oxygen [mol/kg/day]

```
3*h2o + 1.5*t_o2 + t_sul -> 2*h3oplus + t_so4
p_sul_oxo2_so4 =    (t_sul*t_o2*k_sul_o2*exp(q10_h2s*cgt_temp))*lim_t_o2_12*
                    lim_t_sul_30
```

oxidation of elemental sulfur with nitrate [mol/kg/day]

```
1.2*h2o + 1.2*t_no3 + t_sul -> 0.6*t_n2 + 0.8*h3oplus + t_so4
p_sul_oxno3_so4 =   (t_sul*t_no3*k_sul_no3*exp(q10_h2s*cgt_temp))*lim_t_no3_14*
                    lim_t_sul_30
```

oxidation of Fe2+ to iron hydroxide in the sediment (sediment only) [mol/m^2/day]

```
t_fe2 + 4.5*h2o + 0.25*t_o2 -> 2*h3oplus + t_ihs
p_fe2_ox_ihs =      (k_feo2*t_fe2*t_o2*oh*oh*cgt_in_sediment*cgt_cellheight*
                    cgt_density)*lim_t_fe2_55*lim_t_o2_12
```

reduction of sedimentary iron hydroxide to iron-II (sediment only) [mol/m^2/day]

```
t_h2s + 8.0*t_ihs -> 8.0*t_iim + 2*h2o + t_so4 + 2.0*h3oplus
p_ihs_red_iim =     (k_h2s_ihs*t_h2s*ihs_conc_pw*fe2_iim_is_smallest)*
                    lim_t_ihs_4*lim_t_h2s_29
```

reduction of sedimentary iron hydroxide to iron-II (sediment only) [mol/m^2/day]

```
9.0*t_h2s + 8.0*t_ihs -> 8.0*t_ims + 18*h2o + t_so4 + 2.0*h3oplus
p_ihs_red_ims =     (k_h2s_ihs*t_h2s*ihs_conc_pw*fe2_ims_is_smallest)*
                    lim_t_ihs_4*lim_t_h2s_29
```

oxidation of Mn2+ to manganese oxide in the sediment (sediment only) [mol/m^2/day]

continued on next page...

Processes, continued from previous page	
t_mn2 + 0.5*t_o2 + 3*h2o -> 2*h3oplus + t_mos	
p_mn2_ox_mos =	(k_mno2*t_mn2*t_o2*cgt_in_sediment*cgt_cellheight*cgt_density)*lim_t_mn2_62*lim_t_o2_12
oxidation of pyrite by manganese oxide to iron oxyhydroxide (sediment only) [mol/m^2/day]	
t_mos + t_pyr + 1.25*h3oplus + 1.25*h2o -> 0.375*t_so4 + 1.625*t_h2s + t_ihs + t_mn2	
p_pyr_oxmos_ihs =	(cgt_in_sediment*max(r_max_lib_mn2_pyrox/cgt_cellheight/cgt_density,r_max_ox_pyr*t_pyr))*lim_t_mos_59*lim_t_pyr_58
oxidation of pyrite by manganese oxide to iron oxyhydroxide (sediment only) [mol/m^2/day]	
0.25*t_o2 + t_pyr + 4*h2o -> 1.75*t_h2s + 0.25*t_so4 + 0.5*h3oplus + t_ihs	
p_pyr_oxo2_ihs =	(cgt_in_sediment*t_o2*pyr_conc_pw*k_o2_pyr*cgt_cellheight*cgt_density)*lim_t_o2_12*lim_t_pyr_58
oxidation of minnesotaite by oxygen to iron oxyhydroxide (sediment only) [mol/m^2/day]	
0.25*t_o2 + t_iim + 0.5*h2o -> t_ihs	
p_imm_oxo2_ihs =	(cgt_in_sediment*t_o2*iim_conc_pw*k_o2_pyr*cgt_cellheight*cgt_density)*lim_t_o2_12*lim_t_iim_61
oxidation of iron-II in illite-montmorillonite mixed layer minerals to iron-III (sediment only) [mol/m^2/day]	
0.5*h2o + 0.25*t_o2 + i2i -> t_i3i	
p_i2i_oxo2_i3i =	(cgt_in_sediment*max(i3i_max-t_i3i,0.0)*r_i2i_ox)*lim_t_o2_2
reduction of iron-III in clay minerals to iron-II consuming h2s (sediment only) [mol/m^2/day]	
8*t_i3i + t_h2s -> t_so4 + 2*h3oplus + 2*h2o + 8*i2i	
p_i3i_redh2s_i2i =	(r_h2s_ox_i3i*t_h2s)*lim_t_i3i_6*lim_t_h2s_29
reduction of sedimentary iron hydroxide to iron-II (sediment only) [mol/m^2/day]	
t_h2s + 8.0*t_ihc -> 8.0*t_iim + 2*h2o + t_so4 + 2.0*h3oplus	
p_ihc_red_iim =	(k_h2s_ihs*t_h2s*ihc_conc_pw*fe2_iim_is_smallest)*lim_t_ihc_10*lim_t_h2s_29
reduction of sedimentary iron hydroxide to iron-II (sediment only) [mol/m^2/day]	
9.0*t_h2s + 8.0*t_ihc -> 8.0*t_ims + 18*h2o + t_so4 + 2.0*h3oplus	
p_ihc_red_ims =	(k_h2s_ihs*t_h2s*ihc_conc_pw*fe2_ims_is_smallest)*lim_t_ihc_10*lim_t_h2s_29

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Processes, continued from previous page	
oxidation of Fe2+ by reduction of MnO2 (sediment only) [mol/m^2/day]	
t_mos + 2.0*t_fe2 + 6.0*h2o -> 2.0*h3oplus + t_mn2 + 2.0*t_ihs	
p_fe2_mnox_ihs =	(t_fe2*mos_conc_pw*k_mno2_fe2*cgt_cellheight*cgt_density)* lim_t_mos_59*lim_t_fe2_55
oxidation of h2s by reduction of MnO2 (sediment only) [mol/m^2/day]	
0.25*t_h2s + 1.5*h3oplus + t_mos -> t_mn2 + 2.5*h2o + 0.25*t_so4	
p_h2s_mnox_so4 =	(t_h2s*mos_conc_pw*k_mno2_h2s*cgt_cellheight*cgt_density)* lim_t_h2s_29*lim_t_mos_59
iron monosulfide oxidation to iron oxihydroxides (sediment only) [mol/m^2/day]	
t_ims + 2.25*t_o2 + 4.5*h2o -> t_so4 + t_ihs + 2*h3oplus	
p_ims_oxo2_ihs =	(k_ims_o2*ims_conc_pw*t_o2*cgt_cellheight*cgt_density)* lim_t_ims_57*lim_t_o2_12

Auxiliary variables	
absolute temperature [K]	
temp_k =	cgt_temp + 273.15
temporary value assumed for pH [1]	
ph_temp =	0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)
calculated iteratively, 10 iterations, initial value = 0.0	
self-ionization constant of Water [mol2/kg2]	
k_water =	exp(-13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k) + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) * sqrt(cgt_sali) - 0.01615 * cgt_sali)
Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]	
k1_co2 =	power(10.0,(-3633.86 / temp_k + 61.2172 - 9.6777 * log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali * cgt_sali))
Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]	
k2_co2 =	power(10.0,(-471.78 / temp_k - 25.929 + 3.16967 * log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali * cgt_sali))
Acid dissociation constant of boric acid [mol/kg]	
k_boron =	exp((-8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali + 1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) / temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142* cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474* cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k)

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Auxiliary variables, continued from previous page

Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]

```
k1_po4 =            exp( -4576.752/temp_k + 115.525 - 18.453*log(temp_k) +
                    (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 +
                    0.65643/temp_k)*cgt_sali )
```

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

```
k2_po4 =            exp( -8814.715/temp_k + 172.0883 - 27.927*log(temp_k) +
                    (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 -
                    0.37335/temp_k)*cgt_sali )
```

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

```
k3_po4 =            exp( -3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k)
                    *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali )
```

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

```
k1_h2s =            exp( -3131.42/temp_k - 5.818 + 0.368*
                    (power(max(0.0,cgt_sali),(1.0/3.0))))
```

total concentration of boron [mol/kg]

```
boron_total =       0.000416 * cgt_sali/35.0
```

boron alkalinity [mol/kg]

```
alk_boron =         boron_total * k_boron / (k_boron + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

hydrogen sulfide alkalinity [mol/kg]

```
alk_h2s =           t_h2s * k1_h2s / (k1_h2s + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

water alkalinity [mol/kg]

```
alk_water =         k_water / h3o - h3o
```

calculated iteratively, 10 iterations, initial value = 0.0

denominator in phosphate alkalinity formula [mol3/kg3]

```
alk_po4_denominator (h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4*
=                   k2_po4*k3_po4)
```

calculated iteratively, 10 iterations, initial value = 0.0

phosphate alkalinity [mol/kg]

```
alk_po4 =           t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o*
                    h3o*h3o) / alk_po4_denominator
```

calculated iteratively, 10 iterations, initial value = 0.0

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Auxiliary variables, continued from previous page	
denominator in carbonate alkalinity formula [mol2/kg2]	
alk_co2_denominator =	(h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)
calculated iteratively, 10 iterations, initial value = 0.0	
carbonate alkalinity [mol/kg]	
alk_co2 =	t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator
calculated iteratively, 10 iterations, initial value = 0.0	
error in total alkalinity calculation at the assumed pH [mol/kg]	
alk_residual =	t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of phosphate alkalinity with respect to h3o [1]	
dalkp_dh3o =	t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o* h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o- 4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4* k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of carbonate alkalinity with respect to h3o [1]	
dalkc_dh3o =	t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2* k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of residual_alk with respect to pH [mol/kg]	
dalkresidual_dpH =	0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+ h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)
calculated iteratively, 10 iterations, initial value = 0.0	
newly determined pH value [1]	
temp1 =	alk_residual/dalkresidual_dpH
ph =	ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1
calculated iteratively, 10 iterations, initial value = 0.0	
h3o ion concentration [mol/kg]	
h3o =	power(10.0,0.0-max(1.0,min(13.0,ph)))
calculated iteratively, 10 iterations, initial value = 1.0e-8	
h3o ion concentration [mol/kg]	
oh =	power(10.0,log(k_water)/log(10.0)+max(1.0,min(13.0,ph)))
Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]	
k1_h2s_sed =	exp(-3131.42/temp_k - 5.818 + 0.368* (power(max(0.0,cgt_sali),(1.0/3.0))))

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Auxiliary variables, continued from previous page	
iron hydroxide half-saturation constant converted to [mol/m2]	
ihs_min_sed_irred_2d =	ihs_min_sed_irred*cgt_cellheight*cgt_density
ionic strength of the solution [mol/kg]	
ionic_strength =	0.02*cgt_sali
dielectric constant of seawater [F/m]	
temp1 =	cgt_sali*(1.707e-2+1.205e-5*cgt_sali+4.058e-9*power(cgt_sali,2.0))
temp2 =	1.0-0.2551*temp1+5.151e-2*temp1*temp1-6.889e-3*temp1*temp1*temp1
temp3 =	87.74-0.40008*temp_k+9.398e-4*temp_k*temp_k+1.401e-6*temp_k*temp_k*temp_k
dielectric_constant =	temp2*temp3
concentration of HS- ions [mol/kg]	
hsminus =	t_h2s * k1_h2s_sed / (k1_h2s_sed + h3o)
rate constant iron-II oxidation by o2 [kg3/mol3/d]	
k_feo2 =	power(10.0,21.56-1545.0/temp_k-3.29*power(ionic_strength,0.5)+1.52*ionic_strength)
parameter A for the Davies formula [mol0.5 l-0.5]	
davies_parameter_a =	1.82e6*power(dielectric_constant*temp_k,-1.5)
activity to concentration ratio of ions with a charge of +1/-1 [1]	
activity_coefficient =	power(10.0,0.0-davies_parameter_a*1*(sqrt(ionic_strength)/(1+sqrt(ionic_strength))-0.3*ionic_strength))
activity to concentration ratio of ions with a charge of +2/-2 [1]	
activity_coefficient =	power(10.0,0.0-davies_parameter_a*2*(sqrt(ionic_strength)/(1+sqrt(ionic_strength))-0.3*ionic_strength))
activity of H3O+ ions (concentration corrected by ionic strength) [mol/kg]	
activity_h3oplus =	h3o*activity_coefficient_1
amount of structural iron in illite-montmorillonite mixed-layer minerals that can be oxidized or reduced [mol/m2]	
temp1 =	2.7 * max(vol_fraction_im*(1.0-POR),epsilon)

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Auxiliary variables, continued from previous page	
temp2 =	temp1*fe_content_im
temp3 =	temp2/55.0
i3i_max =	temp3 * 1000 * cgt_cellheight*cgt_density
Fe-II concentration in equilibrium with iron monosulfide precipitation [mol/kg]	
fe2_eq_ims =	power(10.0,-2.95)*activity_h3oplus/max(hsminus* activity_coefficient_1,1.0e-3*epsilon) /activity_coefficient_2
Fe-II concentration in equilibrium with iron adsorbed to illite-montmorillonite mixed layer minerals [mol/kg]	
temp1 =	2.7 * max(vol_fraction_im*(1.0-POR),epsilon)
fe2_eq_iim =	(max(t_iim,epsilon)/cgt_cellheight/cgt_density)/(100*temp1) +1000*(1.0-cgt_in_sediment)
siderite is the favoured species for precipitation (0 or 1) [1]	
fe2_ims_is_smallest =	theta(fe2_eq_iim-fe2_eq_ims)
minnesotaite is the favoured species for precipitation (0 or 1) [1]	
fe2_iim_is_smallest =	theta(fe2_eq_ims-fe2_eq_iim)
pyrite concentration if all was dissolved in the pore water [mol/kg]	
pyr_conc_pw =	t_pyr/cgt_cellheight/cgt_density/max(POR,epsilon)
potential iron-II adsorbed to illite-montmorillonite mixed-layer minerals concentration if all was dissolved in the pore water [mol/kg]	
iim_conc_pw =	t_iim/cgt_cellheight/cgt_density/max(POR,epsilon)
potential amorphous iron hydroxide concentration if all was dissolved in the pore water [mol/kg]	
ihs_conc_pw =	t_ihs/cgt_cellheight/cgt_density/max(POR,epsilon)
potential crystalline iron hydroxide concentration if all was dissolved in the pore water [mol/kg]	
ihc_conc_pw =	t_ihc/cgt_cellheight/cgt_density/max(POR,epsilon)
potential manganese oxide concentration if all was dissolved in the pore water [mol/kg]	
mos_conc_pw =	t_mos/cgt_cellheight/cgt_density/max(POR,epsilon)
potential iron monosulfide concentration if all was dissolved in the pore water [mol/kg]	
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Auxiliary variables, continued from previous page	
ims_conc_pw =	t_ims/cgt_cellheight/cgt_density/max(POR,epsilon)

Constants	
no division by 0	
epsilon =	4.5E-17
iron hydroxide half-saturation concentration for detritus remineralization by iron reduction [mol/kg]	
ihs_min_sed_irred =	0.0065
reaction constant h2s oxidation with no3 [kg/mol/day]	
k_h2s_no3 =	438.0
reaction constant h2s oxidation with o2 [kg/mol/day]	
k_h2s_o2 =	438.0
reaction constant sul oxidation with no3 [kg/mol/day]	
k_sul_no3 =	20000.0
reaction constant sul oxidation with o2 [kg/mol/day]	
k_sul_o2 =	20000.0
oxygen half-saturation constant for nitrification [mol/kg]	
o2_min_nit =	1.0E-6
oxygen half-saturation constant for recycling of sediment detritus using oxygen [mol/kg]	
o2_min_sed_resp =	2.0E-5
q10 rule factor for oxidation of h2s and sul [1/K]	
q10_h2s =	0.0693
q10 rule factor for nitrification [1/K]	
q10_nit =	0.11
nitrification rate for ammonium in the sediment at 0°C [1/d]	
k_nh4_o2 =	274000.0
porosity	
por =	0.77
rate constant for hydrogen sulfide oxidation in presence of iron-III minerals [1/d]	
k_h2s_ihs =	21.9

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Constants, continued from previous page	
oxidation constant for manganese-II [kg3/mol3/d]	
`k_mno2 =`	`548000.0`
fraction of illite-montmorillonite mixed layer minerals on volume of all minerals [1]	
`vol_fraction_im =`	`0.5`
potentially reducible iron content of illite-montmorillonite mixed layer minerals [g/g]	
`fe_content_im =`	`0.001`
maximum rate of mn2 liberation due to pyrite reduction [mol/kg/d]	
`r_max_lib_mn2_pyrox =`	`1.0E-5`
maximum oxidation rate of pyrite [1/d]	
`r_max_ox_pyr =`	`0.1`
rate coefficient for oxygen consumption by pyrite oxidation [kg/mol/d]	
`k_o2_pyr =`	`2.73`
rate of oxidation of iron-II in illite-montmorillonite mixed-layer minerals [1/d]	
`r_i2i_ox =`	`0.1`
rate of h2s reduction by i3i oxidation [1/d]	
`r_h2s_ox_i3i =`	`0.1`
rate constant for MnO2 reduction by Fe2+ [kg/mol/d]	
`k_mno2_fe2 =`	`5.48`
rate constant for ims oxidation by O2 [kg/mol/d]	
`k_ims_o2 =`	`822.0`
rate constant for manganese oxide reduction by h2s [kg/mol/d]	
`k_mno2_h2s =`	`58.4`

Process limitation factors	
`lim_t_o2_1 =`	`t_o2/(t_o2+o2_min_nit)`
`lim_t_o2_2 =`	`1.0-exp(-t_o2/o2_min_sed_resp)`
`lim_t_o2_12 =`	`theta(t_o2-0.0)`
`lim_t_nh4_16 =`	`theta(t_nh4-0.0)`
`lim_t_no3_14 =`	`theta(t_no3-0.0)`

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Process limitation factors, continued from previous page	
lim_t_h2s_29 =	theta(t_h2s-0.0)
lim_t_sul_30 =	theta(t_sul-0.0)
lim_t_ihs_4 =	1.0-exp(-t_ihs/ihs_min_sed_irred_2d)
lim_t_fe2_55 =	theta(t_fe2-0.0)
lim_t_pyr_58 =	theta(t_pyr-0.0)
lim_t_ims_57 =	theta(t_ims-0.0)
lim_t_mos_59 =	theta(t_mos-0.0)
lim_t_mn2_62 =	theta(t_mn2-0.0)
lim_t_iim_61 =	theta(t_iim-0.0)
lim_t_i3i_6 =	1.0-exp(-t_i3i/ihs_min_sed_irred_2d)
lim_t_ihc_10 =	1.0-exp(-t_ihc/ihs_min_sed_irred_2d)

3.5 Process type BGC/pelagic/mineralization

Processes	
mineralization of DON [mol/kg/day]	
t_don -> t_nh4	
p_don_rec_nh4 =	(t_don*r_don_rec)*lim_t_don_21
recycling of detritus to ammonium using oxygen (respiration) (index 1 to 6) [mol/kg/day]	
h3oplus + rfr_pc_enrichment_det*6.625*t_o2 + t_det_1 -> (1.0+6.625*rfr_pc_enrichment_det)*h2o + rfr_pc_enrichment_det*rfr_c*t_dic + t_nh4 + 0*h3oplus + 0*h2o	
p_det_1_resp_nh4 =	(t_det_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*(1.0-cgt_in_sediment))*lim_t_o2_8*lim_t_det_1_31
recycling of detritus to ammonium using nitrate (denitrification) (index 1 to 6) [mol/kg/day]	
rfr_pc_enrichment_det*5.3*t_no3 + (1.0+5.3*rfr_pc_enrichment_det)*h3oplus + t_det_1 -> (1.0+14.575*rfr_pc_enrichment_det)*h2o + rfr_pc_enrichment_det*2.65*t_n2 + t_nh4 + rfr_pc_enrichment_det*rfr_c*t_dic	
p_det_1_denit_nh4 =	(t_det_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*(1.0-cgt_in_sediment))*(1.0-lim_t_o2_8)*lim_t_no3_9*lim_t_det_1_31
recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (index 1 to 6) [mol/kg/day]	
(1.0+rfr_pc_enrichment_det*6.625)*h3oplus + rfr_pc_enrichment_det*3.3125*t_so4 + t_det_1 -> (1.0+rfr_pc_enrichment_det*13.25)*h2o + rfr_pc_enrichment_det*3.3125*t_h2s + rfr_pc_enrichment_det*rfr_c*t_dic + t_nh4	
p_det_1_sulf_nh4 =	(t_det_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*max(t_so4,0.0)/(max(t_so4,0.0)+so4_min_det_sulf)*(1.0-cgt_in_sediment))*(1.0-lim_t_o2_8)*(1.0-lim_t_no3_9)*lim_t_so4_28*lim_t_det_1_31
recycling of detritus to ammonium using oxygen (respiration) (index 1 to 6) [mol/kg/day]	
t_detp_1 + 3*rfr_pc_enrichment_det*rfr_p*h2o -> 3*rfr_pc_enrichment_det*rfr_p*h3oplus + rfr_pc_enrichment_det*rfr_p*t_po4	
p_detp_1_remin_po4 =	(t_detp_1*r_det_1_rec*exp(q10_det_rec*cgt_temp)*(1.0-cgt_in_sediment)*(1.0+(factor_pref_remin_p-1.0)*o2_min_sed_resp/(t_o2 + o2_min_sed_resp)))*lim_t_detp_1_37
respiration of POC [mol/kg/day]	
t_o2 + t_poc -> h2o + t_dic	
p_poc_resp =	(t_poc * r_poc_rec * exp(q10_det_rec * cgt_temp))*lim_t_o2_8*lim_t_poc_68

continued on next page...

Processes, continued from previous page

recycling of POC using nitrate (denitrification) [mol/kg/day]

```
0.8*h3oplus + 0.8*t_no3 + t_poc -> 0.4*t_n2 + 2.2*h2o + t_dic
p_poc_denit =       (t_poc*r_poc_rec*exp(q10_det_rec*cgt_temp))*(1.0-
                    lim_t_o2_8)*lim_t_no3_9*lim_t_poc_68
```

Mineralization of POC, e-acceptor sulfate (sulfate reduction) [mol/kg/day]

```
h3oplus + 0.5*t_so4 + t_poc -> 2*h2o + 0.5*t_h2s + t_dic
p_poc_sulf =        (t_poc*r_poc_rec*exp(q10_det_rec*cgt_temp))*(1.0-
                    lim_t_o2_8)*(1.0-lim_t_no3_9)*lim_t_so4_28*lim_t_poc_68
```

Auxiliary variables

Constants

minimum no3 concentration for recycling of detritus using nitrate (denitrification)

`no3_min_det_denit = 1.0E-9`

oxygen half-saturation constant for detritus recycling [mol/kg]

`o2_min_det_resp =   1.0E-5`

oxygen half-saturation constant for recycling of sediment detritus using oxygen [mol/kg]

`o2_min_sed_resp =   2.0E-5`

q10 rule factor for recycling [1/K]

`q10_det_rec =       0.15`

redfield ratio C/N

`rfr_c =             6.625`

redfield ratio P/N

`rfr_p =             0.0625`

enrichment factor for P and C in detritus [1]

```
                    1.5
rfr_pc_enrichment_de
=
```

rate constant mineralizing DON into NH4 [1/d]

`r_don_rec =         0.01`

minimum sulfate concentration for sulfate reduction [mol/kg]

`so4_min_det_sulf =  1.0E-6`

detritus recycling rates [1/d]

continued on next page...

Constants, continued from previous page	
r_det_1_rec =	0.0647
detritus recycling rates [1/d]	
r_det_2_rec =	0.00924
detritus recycling rates [1/d]	
r_det_3_rec =	0.00136
detritus recycling rates [1/d]	
r_det_4_rec =	0.000108
detritus recycling rates [1/d]	
r_det_5_rec =	1.62E-5
detritus recycling rates [1/d]	
r_det_6_rec =	0.0
acceleration factor for preferential mineralization of P compared to N under hypoxic conditions [1]	
factor_pref_remin_p =	10.0
recycling rate of particulate organic carbon (TEP) at 0 degC [1/day]	
r_poc_rec =	0.003

Process limitation factors	
lim_t_don_21 =	theta(t_don-0.0)
lim_t_o2_8 =	1.0-exp(-t_o2/o2_min_det_resp)
lim_t_no3_9 =	1.0-exp(-t_no3/no3_min_det_denit)
lim_t_so4_28 =	theta(t_so4-0.0)
lim_t_det_1_31 =	theta(t_det_1-0.0)
lim_t_det_2_32 =	theta(t_det_2-0.0)
lim_t_det_3_33 =	theta(t_det_3-0.0)
lim_t_det_4_34 =	theta(t_det_4-0.0)
lim_t_det_5_35 =	theta(t_det_5-0.0)
lim_t_det_6_36 =	theta(t_det_6-0.0)

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Process limitation factors, continued from previous page	
lim_t_detp_1_37 =	theta(t_detp_1-0.0)
lim_t_detp_2_38 =	theta(t_detp_2-0.0)
lim_t_detp_3_39 =	theta(t_detp_3-0.0)
lim_t_detp_4_40 =	theta(t_detp_4-0.0)
lim_t_detp_5_41 =	theta(t_detp_5-0.0)
lim_t_detp_6_42 =	theta(t_detp_6-0.0)
lim_t_poc_68 =	theta(t_poc-0.0)

3.6 Process type BGC/pelagic/phytoplankton

Processes	
assimilation of nitrate by large-cell phytoplankton [mol/kg/day]	
t_no3 + rfr_p*t_po4 + rfr_c*t_dic + 6.4375*h2o + 1.1875*h3oplus -> t_lpp + 8.625*t_o2	
p_no3_assim_lpp =	(lpp_plus_lpp0*lr_assim_lpp*t_no3/(din+epsilon))* lim_t_no3_14*lim_t_po4_15*lim_t_dic_13
assimilation of ammonium by large-cell phytoplankton [mol/kg/day]	
7.4375*h2o + rfr_c*t_dic + rfr_p*t_po4 + t_nh4 -> 0.8125*h3oplus + 6.625*t_o2 + t_lpp	
p_nh4_assim_lpp =	(lpp_plus_lpp0*lr_assim_lpp*t_nh4/(din+epsilon))* lim_t_dic_13*lim_t_po4_15*lim_t_nh4_16
assimilation of nitrate by small-cell phytoplankton [mol/kg/day]	
t_no3 + rfr_p*t_po4 + rfr_c*t_dic + 6.4375*h2o + 1.1875*h3oplus -> t_spp + 8.625*t_o2	
p_no3_assim_spp =	(spp_plus_spp0*lr_assim_spp*t_no3/(din+epsilon))* lim_t_no3_14*lim_t_po4_15*lim_t_dic_13
assimilation of ammonium by small-cell phytoplankton [mol/kg/day]	
t_nh4 + rfr_p*t_po4 + rfr_c*t_dic + 0*h2o + 7.4375*h2o -> t_spp + 6.625*t_o2 + 0.8125*h3oplus	
p_nh4_assim_spp =	(spp_plus_spp0*lr_assim_spp*t_nh4/(din+epsilon))* lim_t_nh4_16*lim_t_po4_15*lim_t_dic_13
fixation of dinitrogen by diazotroph cyanobacteria [mol/kg/day]	
0.1875*h3oplus + 0.5*t_n2 + rfr_p*t_po4 + rfr_c*t_dic + 7.9375*h2o -> t_cya + 7.375*t_o2	
p_n2_assim_cya =	(cya_plus_cya0*lr_assim_cya)*lim_t_n2_11*lim_t_po4_15* lim_t_dic_13
respiration of large-cell phytoplankton [mol/kg/day]	
t_lpp + 6.625*t_o2 + 0.8125*h3oplus -> don_fraction*t_don + (1-don_fraction)* t_nh4 + rfr_p*t_po4 + rfr_c*t_dic + 7.4375*h2o	
p_lpp_resp_nh4 =	(t_lpp*r_lpp_resp*(1.0-cgt_in_sediment))*lim_t_lpp_17* lim_t_o2_12
respiration of small-cell phytoplankton [mol/kg/day]	
0.8125*h3oplus + 6.625*t_o2 + t_spp -> 7.4375*h2o + rfr_c*t_dic + rfr_p*t_po4 + (1-don_fraction)*t_nh4 + don_fraction*t_don	
p_spp_resp_nh4 =	(t_spp*r_spp_resp*(1.0-cgt_in_sediment))*lim_t_o2_12* lim_t_spp_18

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Processes, continued from previous page

respiration of diazotroph cyanobacteria [mol/kg/day]

```
0.8125*h3oplus + 6.625*t_o2 + t_cya -> 7.4375*h2o + rfr_c*t_dic + rfr_p*t_po4 +
don_fraction*t_don + (1-don_fraction)*t_nh4
p_cya_resp_nh4 =    (t_cya*r_cya_resp*(1.0-cgt_in_sediment))*lim_t_o2_12*
                    lim_t_cya_19
```

mortality of large-cell phytoplankton (index 1 to 6) [mol/kg/day]

```
(1.0-(1.0/rfr_pc_enrichment_det))*h3oplus + t_lpp -> (1.0-
(1.0/rfr_pc_enrichment_det))*h2o + (1.0-(1.0/rfr_pc_enrichment_det))*t_nh4 +
(1.0/rfr_pc_enrichment_det)*t_det_1 + (1.0/rfr_pc_enrichment_det)*t_detp_1
p_lpp_mort_det_1 =  (frac_det_1*t_lpp*r_pp_mort*(1+9*theta(5.0e-6-t_o2)))*
                    lim_t_lpp_17
```

mortality of small-scale phytoplankton (index 1 to 6) [mol/kg/day]

```
(1.0-(1.0/rfr_pc_enrichment_det))*h3oplus + t_spp -> (1.0-
(1.0/rfr_pc_enrichment_det))*h2o + (1.0-(1.0/rfr_pc_enrichment_det))*t_nh4 +
(1.0/rfr_pc_enrichment_det)*t_det_1 + (1.0/rfr_pc_enrichment_det)*t_detp_1
p_spp_mort_det_1 =  (frac_det_1*t_spp*r_pp_mort*(1+9*theta(5.0e-6-t_o2)))*
                    lim_t_spp_18
```

mortality of diazotroph cyanobacteria (index 1 to 6) [mol/kg/day]

```
t_cya + (1.0-(1.0/rfr_pc_enrichment_det))*h3oplus ->
(1.0/rfr_pc_enrichment_det)*t_detp_1 + (1.0/rfr_pc_enrichment_det)*t_det_1 +
(1.0-(1.0/rfr_pc_enrichment_det))*t_nh4 + (1.0-(1.0/rfr_pc_enrichment_det))*h2o
p_cya_mort_det_1 =  (frac_det_1*t_cya*r_pp_mort*(1+9*theta(5.0e-6-t_o2)))*
                    lim_t_cya_19
```

Production of POC by LPP [mol/kg/day]

```
h2o + t_dic -> t_o2 + t_poc
p_assim_lpp_poc =   (rfr_c * lpp_plus_lpp0 * lr_assim_lpp_poc)*lim_t_dic_13
```

Production of POC by SPP [mol/kg/day]

```
h2o + t_dic -> t_o2 + t_poc
p_assim_spp_poc =   (rfr_c * spp_plus_spp0 * lr_assim_spp_poc)*lim_t_dic_13
```

Production of POC by CYA [mol/kg/day]

```
t_dic + h2o -> t_poc + t_o2
p_assim_cya_poc =   (rfr_c * cya_plus_cya0 * lr_assim_cya_poc)*lim_t_dic_13
```

Auxiliary variables

square of positive temperature [°C * °C]

```
temp_sq =           max(0.0,cgt_temp)*max(0.0,cgt_temp)
```

dissolved inorganic nitrogen [mol/kg]

```
din =               t_no3+t_nh4
```

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Auxiliary variables, continued from previous page	
squared phosphate [mol2/kg**2]**	
`po4_sq =`	`t_po4*t_po4`
large-cell phytoplankton plus seed concentration [mol/kg]	
`lpp_plus_lpp0 =`	`t_lpp+lpp0`
small-cell phytoplankton plus seed concentration [mol/kg]	
`spp_plus_spp0 =`	`t_spp+spp0`
diazotroph cyanobacteria plus seed concentration [mol/kg]	
`cya_plus_cya0 =`	`t_cya+cya0`
light limitation factor for large-cell phytoplankton growth [1]	
`lim_light_lpp =`	`cgt_light/max(cgt_light/2.0,light_opt_lpp)*exp(1-cgt_light/max(cgt_light/2.0,light_opt_lpp))`
light limitation factor for small-cell phytoplankton growth [1]	
`temp1 =`	`max(cgt_light/2.0,light_opt_spp)`
`lim_light_spp =`	`cgt_light/temp1*exp(1-cgt_light/temp1)`
squared DIN [mol2/kg2]	
`din_sq =`	`din*din`
growth rate of diazotroph cyanobacteria, limited by DIP, light, oxygen, temperature and salinity [1/day]	
`lr_assim_cya =`	`r_cya_assim*theta(t_o2-2*t_h2s)*min(po4_sq/(po4_sq+dip_min_cya*dip_min_cya),lim_light_spp)*(1/(1+exp(temp_min_cya-cgt_temp)))*(1/(1+exp(cgt_sali-sali_max_cya)))*(1/(1+exp(sali_min_cya-cgt_sali)))`
growth rate of large-cell phytoplankton, limited by DIN, DIP, light and oxygen [1/day]	
`lr_assim_lpp =`	`r_lpp_assim*theta(t_o2-2*t_h2s)*min(din_sq/(din_sq+din_min_lpp*din_min_lpp),min(po4_sq/(po4_sq+din_min_lpp*din_min_lpp*rfr_p*rfr_p),lim_light_lpp))`
growth rate of small-cell phytoplankton, limited by DIN, DIP, light, oxygen and temperature [1/day]	
`lr_assim_spp =`	`r_spp_assim*theta(t_o2-2*t_h2s)*min(din_sq/(din_sq+din_min_spp*din_min_spp),min(po4_sq/(po4_sq+din_min_spp*din_min_spp*rfr_p*rfr_p),lim_light_spp))*(1+temp_sq/(temp_sq+temp_min_spp*temp_min_spp))`

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Auxiliary variables, continued from previous page

production rate of POC by LPP

```
lr_assim_lpp_poc =  fac_poc_assim * r_lpp_assim * theta(t_o2-2*t_h2s) *
                    min(max(1 - din_sq/(din_sq+din_min_lpp*din_min_lpp),1 -
                    po4_sq/(din_min_lpp*din_min_lpp*rfr_p*rfr_p + po4_sq)),
                    lim_light_lpp)
```

production rate of POC by LPP

```
lr_assim_spp_poc =  fac_poc_assim * r_lpp_assim * theta(t_o2-2*t_h2s) *
                    min(max(1 - din_sq/(din_sq+din_min_lpp*din_min_lpp),1 -
                    po4_sq/(din_min_lpp*din_min_lpp*rfr_p*rfr_p + po4_sq)),
                    lim_light_lpp)
```

production rate of POC by CYA

```
lr_assim_cya_poc =  fac_poc_assim * r_cya_assim*theta(t_o2-2*t_h2s)*min(1 -
                    po4_sq/(po4_sq+dip_min_cya*dip_min_cya),lim_light_spp)*
                    (1/(1+exp(temp_min_cya-cgt_temp)))*(1/(1+exp(cgt_sali-
                    sali_max_cya)))*(1/(1+exp(sali_min_cya-cgt_sali)))
```

Constants

seed concentration for diazotroph cyanobacteria [mol/kg]

```
cya0 =              4.5E-9
```

DIN half saturation constant for large-cell phytoplankton growth [mol/kg]

```
din_min_lpp =       1.125E-6
```

DIN half saturation constant for small-cell phytoplankton growth [mol/kg]

```
din_min_spp =       4.5E-7
```

DIP half saturation constant for diazotroph cyanobacteria growth [mol/kg]

```
dip_min_cya =       1.125E-7
```

no division by 0

```
epsilon =           4.5E-17
```

optimal light for large-cell phytoplankton growth [W/m2]**

```
light_opt_lpp =     35.0
```

optimal light for small-cell phytoplankton growth [W/m2]**

```
light_opt_spp =     50.0
```

seed concentration for large-cell phytoplankton [mol/kg]

```
lpp0 =              4.5E-9
```

maximum rate for nutrient uptake of diazotroph cyanobacteria [1/day]

continued on next page...

Constants, continued from previous page	
`r_cya_assim =`	`0.75`
respiration rate of cyanobacteria to ammonium [1/day]	
`r_cya_resp =`	`0.01`
maximum rate for nutrient uptake of large-cell phytoplankton [1/day]	
`r_lpp_assim =`	`1.4`
respiration rate of large phytoplankton to ammonium [1/day]	
`r_lpp_resp =`	`0.06`
mortality rate of phytoplankton [1/day]	
`r_pp_mort =`	`0.02`
maximum rate for nutrient uptake of small-cell phytoplankton [1/day]	
`r_spp_assim =`	`0.46`
respiration rate of small phytoplankton to ammonium [1/day]	
`r_spp_resp =`	`0.015`
redfield ratio C/N	
`rfr_c =`	`6.625`
redfield ratio P/N	
`rfr_p =`	`0.0625`
enrichment factor for P and C in detritus [1]	
`rfr_pc_enrichment_de =`	`1.5`
upper salinity limit - diazotroph cyanobacteria [psu]	
`sali_max_cya =`	`10.0`
lower salinity limit - diazotroph cyanobacteria [psu]	
`sali_min_cya =`	`1.0`
seed concentration for small-cell phytoplankton [mol/kg]	
`spp0 =`	`4.5E-9`
lower temperature limit - diazotroph cyanobacteria [°C]	
`temp_min_cya =`	`13.5`
lower temperature limit - small-cell phytoplankton [°C]	
`temp_min_spp =`	`10.0`

continued on next page...

Constants, continued from previous page

fraction of DON in respiration products
`don_fraction = 0.1`

fraction of this detritus class in total detritus production [1]
`frac_det_1 = 0.26`

fraction of this detritus class in total detritus production [1]
`frac_det_2 = 0.16`

fraction of this detritus class in total detritus production [1]
`frac_det_3 = 0.16`

fraction of this detritus class in total detritus production [1]
`frac_det_4 = 0.16`

fraction of this detritus class in total detritus production [1]
`frac_det_5 = 0.08`

fraction of this detritus class in total detritus production [1]
`frac_det_6 = 0.18`

which fraction of DIC assimilation continues and causes POC production if nutrients are depleted [1]
`fac_poc_assim = 1.0`

Process limitation factors

```
lim_t_n2_11 =      theta(t_n2-0.0)

lim_t_o2_12 =      theta(t_o2-0.0)

lim_t_dic_13 =     theta(t_dic-0.0)

lim_t_nh4_16 =     theta(t_nh4-0.0)

lim_t_no3_14 =     theta(t_no3-0.0)

lim_t_po4_15 =     theta(t_po4-0.0)

lim_t_spp_18 =     theta(t_spp-0.0)

lim_t_lpp_17 =     theta(t_lpp-0.0)

lim_t_cya_19 =     theta(t_cya-0.0)
```

continued on next page...

Process limitation factors, continued from previous page

3.7 Process type BGC/pelagic/reoxidation

Processes

nitrification [mol/kg/day]

```
h2o + 2*t_o2 + t_nh4 -> 2*h3oplus + t_no3
p_nh4_nit_no3 =     (t_nh4*r_nh4_nitrif*exp(q10_nit*cgt_temp)*(1.0-
                    cgt_in_sediment))*lim_t_o2_0*lim_t_nh4_16
```

oxidation of Fe2+ to iron hydroxide in the sediment [mol/kg/day]

```
0.25*t_o2 + 4.5*h2o + t_fe2 -> t_ihw + 2*h3oplus
p_fe2_ox_ihw =      (k_feo2*t_fe2*t_o2*oh*oh*(1.0-cgt_in_sediment))*
                    lim_t_o2_12*lim_t_fe2_55
```

nitrification in the sediment (sediment only) [mol/m^2/day]

```
2*t_o2 + t_aim -> h3oplus + t_no3
p_aim_nit_no3_sed = (t_aim*t_o2*k_nh4_o2*exp(q10_nit*cgt_temp)*cgt_in_sediment)
                    *lim_t_o2_1*lim_t_aim_67
```

Auxiliary variables

absolute temperature [K]

```
temp_k =            cgt_temp + 273.15
```

temporary value assumed for pH [1]

```
ph_temp =           0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)
```

calculated iteratively, 10 iterations, initial value = 0.0

self-ionization constant of Water [mol2/kg2]

```
k_water =           exp( -13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k)
                    + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) *
                    sqrt(cgt_sali) - 0.01615 * cgt_sali)
```

Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]

```
k1_co2 =            power(10.0,( -3633.86 / temp_k + 61.2172 - 9.6777 *
                    log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali *
                    cgt_sali))
```

Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]

```
k2_co2 =            power(10.0,( -471.78 / temp_k - 25.929 + 3.16967 *
                    log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali *
                    cgt_sali))
```

Acid dissociation constant of boric acid [mol/kg]

```
k_boron =           exp(( -8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali +
                    1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) /
                    temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142*
                    cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474*
                    cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k )
```

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Auxiliary variables, continued from previous page

Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]

```
k1_po4 =            exp( -4576.752/temp_k + 115.525 - 18.453*log(temp_k) +
                    (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 +
                    0.65643/temp_k)*cgt_sali )
```

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

```
k2_po4 =            exp( -8814.715/temp_k + 172.0883 - 27.927*log(temp_k) +
                    (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 -
                    0.37335/temp_k)*cgt_sali )
```

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

```
k3_po4 =            exp( -3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k)
                    *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali )
```

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

```
k1_h2s =            exp( -3131.42/temp_k - 5.818 + 0.368*
                    (power(max(0.0,cgt_sali),(1.0/3.0))))
```

total concentration of boron [mol/kg]

```
boron_total =       0.000416 * cgt_sali/35.0
```

boron alkalinity [mol/kg]

```
alk_boron =         boron_total * k_boron / (k_boron + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

hydrogen sulfide alkalinity [mol/kg]

```
alk_h2s =           t_h2s * k1_h2s / (k1_h2s + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

water alkalinity [mol/kg]

```
alk_water =         k_water / h3o - h3o
```

calculated iteratively, 10 iterations, initial value = 0.0

denominator in phosphate alkalinity formula [mol3/kg3]

```
alk_po4_denominator (h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4*
=                   k2_po4*k3_po4)
```

calculated iteratively, 10 iterations, initial value = 0.0

phosphate alkalinity [mol/kg]

```
alk_po4 =           t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o*
                    h3o*h3o) / alk_po4_denominator
```

calculated iteratively, 10 iterations, initial value = 0.0

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Auxiliary variables, continued from previous page	
denominator in carbonate alkalinity formula [mol2/kg2]	
`alk_co2_denominator =`	`(h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)`
calculated iteratively, 10 iterations, initial value = `0.0`	
carbonate alkalinity [mol/kg]	
`alk_co2 =`	`t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator`
calculated iteratively, 10 iterations, initial value = `0.0`	
error in total alkalinity calculation at the assumed pH [mol/kg]	
`alk_residual =`	`t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of phosphate alkalinity with respect to h3o [1]	
`dalkp_dh3o =`	`t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o*h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o-4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4*k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of carbonate alkalinity with respect to h3o [1]	
`dalkc_dh3o =`	`t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2*k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of residual_alk with respect to pH [mol/kg]	
`dalkresidual_dpH =`	`0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)`
calculated iteratively, 10 iterations, initial value = `0.0`	
newly determined pH value [1]	
`temp1 =`	`alk_residual/dalkresidual_dpH`
`ph =`	`ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1`
calculated iteratively, 10 iterations, initial value = `0.0`	
h3o ion concentration [mol/kg]	
`h3o =`	`power(10.0,0.0-max(1.0,min(13.0,ph)))`
calculated iteratively, 10 iterations, initial value = `1.0e-8`	
h3o ion concentration [mol/kg]	
`oh =`	`power(10.0,log(k_water)/log(10.0)+max(1.0,min(13.0,ph)))`
ionic strength of the solution [mol/kg]	
`ionic_strength =`	`0.02*cgt_sali`

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Auxiliary variables, continued from previous page

rate constant iron-II oxidation by o2 [kg3/mol3/d]

```
k_feo2 =          power(10.0,21.56-1545.0/temp_k-3.29*
                  power(ionic_strength,0.5)+1.52*ionic_strength)
```

Constants

oxygen half-saturation constant for nitrification [mol/kg]

```
o2_min_nit =      1.0E-6
```

q10 rule factor for nitrification [1/K]

```
q10_nit =         0.11
```

nitrification rate at 0°C [1/day]

```
r_nh4_nitrif =    0.1
```

nitrification rate for ammonium in the sediment at 0°C [1/d]

```
k_nh4_o2 =        274000.0
```

Process limitation factors

```
lim_t_o2_0 =      1.0-exp(-t_o2/o2_min_nit)

lim_t_o2_1 =      t_o2/(t_o2+o2_min_nit)

lim_t_o2_12 =     theta(t_o2-0.0)

lim_t_nh4_16 =    theta(t_nh4-0.0)

lim_t_fe2_55 =    theta(t_fe2-0.0)

lim_t_aim_67 =    theta(t_aim-0.0)
```

3.8 Process type BGC/pelagic/zooplankton

Processes

grazing of zooplankton eating large-cell phytoplankton [mol/kg/day]

```
t_lpp -> t_zoo
p_lpp_graz_zoo =    ((t_zoo+zoo0)*lr_graz_zoo*t_lpp/max(food_zoo,epsilon))*
                    lim_t_lpp_17
```

grazing of zooplankton eating small-cell phytoplankton [mol/kg/day]

```
t_spp -> t_zoo
p_spp_graz_zoo =    ((t_zoo+zoo0)*lr_graz_zoo*t_spp/max(food_zoo,epsilon))*
                    lim_t_spp_18
```

grazing of zooplankton eating diazotroph cyanobacteria [mol/kg/day]

```
t_cya -> t_zoo
p_cya_graz_zoo =    ((t_zoo+zoo0)*lr_graz_zoo*(0.5*t_cya)/max(food_zoo,epsilon)
                    )*lim_t_cya_19
```

respiration of zooplankton [mol/kg/day]

```
0.8125*h3oplus + 6.625*t_o2 + t_zoo -> 7.4375*h2o + rfr_c*t_dic + rfr_p*t_po4 +
(1-don_fraction)*t_nh4 + don_fraction*t_don
p_zoo_resp_nh4 =    (zoo_eff*r_zoo_resp*(1.0-cgt_in_sediment))*lim_t_o2_12*
                    lim_t_zoo_20
```

mortality of zooplankton (index 1 to 6) [mol/kg/day]

```
(1.0-(1.0/rfr_pc_enrichment_det))*h3oplus + t_zoo -> (1.0-
(1.0/rfr_pc_enrichment_det))*h2o + (1.0-(1.0/rfr_pc_enrichment_det))*t_nh4 +
(1.0/rfr_pc_enrichment_det)*t_det_1 + (1.0/rfr_pc_enrichment_det)*t_detp_1
p_zoo_mort_det_1 =  (frac_det_1*zoo_eff*r_zoo_mort*(1+9*theta(5.0e-6-t_o2)))*
                    lim_t_zoo_20
```

Auxiliary variables

square of positive temperature [°C * °C]

```
temp_sq =           max(0.0,cgt_temp)*max(0.0,cgt_temp)
```

effectice zooplankton concentration assumed for mortality and respiration process [mol/kg]

```
zoo_eff =           t_zoo*t_zoo/zoo_cl
```

suitable food for zooplankton (weighted with food preferences) [mol/kg]

```
food_zoo =          t_lpp+t_spp+0.5*t_cya
```

growth rate of zooplankton, limited by food, oxygen and temperature [1/day]

```
lr_graz_zoo =       r_zoo_graz*(1-exp(-food_zoo*food_zoo/(food_min_zoo*
                    food_min_zoo)))*theta(t_o2-2*t_h2s)*(1.0+
                    temp_sq/(temp_opt_zoo*temp_opt_zoo)*exp(2.0-cgt_temp*
                    2.0/temp_opt_zoo))
```

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Auxiliary variables, continued from previous page

Constants	
no division by 0	
epsilon =	4.5E-17
Ivlev phytoplankton concentration for zooplankton grazing [mol/kg]	
food_min_zoo =	4.108E-6
maximum zooplankton grazing rate [1/day]	
r_zoo_graz =	0.5
mortality rate of zooplankton [1/day]	
r_zoo_mort =	0.03
respiration rate of zooplankton [1/day]	
r_zoo_resp =	0.01
redfield ratio C/N	
rfr_c =	6.625
redfield ratio P/N	
rfr_p =	0.0625
enrichment factor for P and C in detritus [1]	
rfr_pc_enrichment_de =	1.5
optimal temperature for zooplankton grazing [°C]	
temp_opt_zoo =	20.0
seed concentration for zooplankton [mol/kg]	
zoo0 =	4.5E-9
zooplankton closure parameter [mol/kg]	
zoo_cl =	9.0E-8
fraction of DON in respiration products	
don_fraction =	0.1
fraction of this detritus class in total detritus production [1]	
frac_det_1 =	0.26
fraction of this detritus class in total detritus production [1]	

continued on next page...

Constants, continued from previous page	
frac_det_2 =	0.16
fraction of this detritus class in total detritus production [1]	
frac_det_3 =	0.16
fraction of this detritus class in total detritus production [1]	
frac_det_4 =	0.16
fraction of this detritus class in total detritus production [1]	
frac_det_5 =	0.08
fraction of this detritus class in total detritus production [1]	
frac_det_6 =	0.18

Process limitation factors	
lim_t_o2_12 =	theta(t_o2-0.0)
lim_t_spp_18 =	theta(t_spp-0.0)
lim_t_zoo_20 =	theta(t_zoo-0.0)
lim_t_lpp_17 =	theta(t_lpp-0.0)
lim_t_cya_19 =	theta(t_cya-0.0)

3.9 Process type gas_exchange

Processes	
downward nitrogen flux through the surface (surface only) [mol/m²/day]	
-> t_n2	
p_n2_stf_down =	w_n2_stf*(n2_sat-t_n2)*theta(n2_sat-t_n2)*cgt_density
upward nitrogen flux through the surface (surface only) [mol/m²/day]	
t_n2 ->	
p_n2_stf_up =	(w_n2_stf*(t_n2-n2_sat)*theta(t_n2-n2_sat)*cgt_density)* lim_t_n2_11
downward oxygen flux through the surface (surface only) [mol/m²/day]	
-> t_o2	
p_o2_stf_down =	w_o2_stf*(o2_sat-t_o2)*theta(o2_sat-t_o2)*cgt_density
upward oxygen flux through the surface (surface only) [mol/m²/day]	
t_o2 ->	
p_o2_stf_up =	(w_o2_stf*(t_o2-o2_sat)*theta(t_o2-o2_sat)*cgt_density)* lim_t_o2_12
downward co2 flux through the surface (surface only) [mol/m²/day]	
-> t_dic	
p_co2_stf_down =	w_co2_stf*(patm_co2-pco2)*k0_co2*theta(patm_co2-pco2)* cgt_density
upward co2 flux through the surface (surface only) [mol/m²/day]	
t_dic ->	
p_co2_stf_up =	(w_co2_stf*(pco2-patm_co2)*k0_co2*theta(pco2-patm_co2)* cgt_density)*lim_t_dic_13

Auxiliary variables	
absolute temperature [K]	
temp_k =	cgt_temp + 273.15
temporary value assumed for pH [1]	
ph_temp =	0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)
calculated iteratively, 10 iterations, initial value = 0.0	
self-ionization constant of Water [mol2/kg2]	
k_water =	exp(-13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k) + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) * sqrt(cgt_sali) - 0.01615 * cgt_sali)
Solubility of CO2 [mol/kg/Pa]	
k0_co2 =	exp(9345.17 / temp_k - 60.2409 + 23.3585 * (log(temp_k) - 4.605170186) + cgt_sali*(0.023517 - 0.00023656 * temp_k + 0.00000047036 *temp_k*temp_k))/101325.0

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Auxiliary variables, continued from previous page

Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]

k1_co2 = power(10.0,(-3633.86 / temp_k + 61.2172 - 9.6777 * log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali * cgt_sali))

Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]

k2_co2 = power(10.0,(-471.78 / temp_k - 25.929 + 3.16967 * log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali * cgt_sali))

Acid dissociation constant of boric acid [mol/kg]

k_boron = exp((-8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali + 1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) / temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142* cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474* cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k)

Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]

k1_po4 = exp(-4576.752/temp_k + 115.525 - 18.453*log(temp_k) + (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 + 0.65643/temp_k)*cgt_sali)

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

k2_po4 = exp(-8814.715/temp_k + 172.0883 - 27.927*log(temp_k) + (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 - 0.37335/temp_k)*cgt_sali)

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

k3_po4 = exp(-3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k) *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali)

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

k1_h2s = exp(-3131.42/temp_k - 5.818 + 0.368* (power(max(0.0,cgt_sali),(1.0/3.0))))

total concentration of boron [mol/kg]

boron_total = 0.000416 * cgt_sali/35.0

boron alkalinity [mol/kg]

alk_boron = boron_total * k_boron / (k_boron + h3o)

calculated iteratively, 10 iterations, initial value = 0.0

hydrogen sulfide alkalinity [mol/kg]

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Auxiliary variables, continued from previous page	
`alk_h2s =`	`t_h2s * k1_h2s / (k1_h2s + h3o)`
calculated iteratively, 10 iterations, initial value = 0.0	
water alkalinity [mol/kg]	
`alk_water =`	`k_water / h3o - h3o`
calculated iteratively, 10 iterations, initial value = 0.0	
denominator in phosphate alkalinity formula [mol3/kg3]	
`alk_po4_denominator =`	`(h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4*k2_po4*k3_po4)`
calculated iteratively, 10 iterations, initial value = 0.0	
phosphate alkalinity [mol/kg]	
`alk_po4 =`	`t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o*h3o*h3o) / alk_po4_denominator`
calculated iteratively, 10 iterations, initial value = 0.0	
denominator in carbonate alkalinity formula [mol2/kg2]	
`alk_co2_denominator =`	`(h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)`
calculated iteratively, 10 iterations, initial value = 0.0	
carbonate alkalinity [mol/kg]	
`alk_co2 =`	`t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator`
calculated iteratively, 10 iterations, initial value = 0.0	
error in total alkalinity calculation at the assumed pH [mol/kg]	
`alk_residual =`	`t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water`
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of phosphate alkalinity with respect to h3o [1]	
`dalkp_dh3o =`	`t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o*h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o-4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4*k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)`
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of carbonate alkalinity with respect to h3o [1]	
`dalkc_dh3o =`	`t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2*k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)`
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of residual_alk with respect to pH [mol/kg]	
`dalkresidual_dpH =`	`0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)`

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Auxiliary variables, continued from previous page	
calculated iteratively, 10 iterations, initial value = 0.0	
newly determined pH value [1]	
temp1 =	alk_residual/dalkresidual_dpH
ph =	ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1
calculated iteratively, 10 iterations, initial value = 0.0	
h3o ion concentration [mol/kg]	
h3o =	power(10.0,0.0-max(1.0,min(13.0,ph)))
calculated iteratively, 10 iterations, initial value = 1.0e-8	
co2 partial pressure [Pa]	
pco2 =	t_dic / k0_co2 / (1 + k1_co2/h3o + k1_co2*k2_co2/h3o/h3o)
oxygen saturation concentration [mol/kg]	
o2_sat =	(10.18e0+((5.306e-3-4.8725e-5*cgt_temp)*cgt_temp-0.2785e0)* cgt_temp+cgt_sali*((2.2258e-3+(4.39e-7*cgt_temp-4.645e-5)* cgt_temp)*cgt_temp-6.33e-2))*44.66e0*1e-6
dissolved molecular nitrogen saturation concentration [mol/kg]	
temp1 =	log((298.15-cgt_temp)/(273.15+cgt_temp))
temp2 =	temp1*temp1
temp3 =	temp2*temp1
n2_sat =	1e-6*exp(6.42931 + 2.92704*temp1 + 4.32531*temp2 + 4.69149* temp3 + cgt_sali*(0.0 -7.44129e-3 - 8.02566e-3*temp1 - 1.46775e-2*temp2))

Constants	
atmospheric partial pressure of CO2 [Pa]	
patm_co2 =	35.8
piston velocity for co2 surface flux [m/d]	
w_co2_stf =	0.5
piston velocity for n2 surface flux [m/d]	
w_n2_stf =	5.0
piston velocity for oxygen surface flux [m/d]	
w_o2_stf =	5.0

Process limitation factors	
lim_t_n2_11 =	theta(t_n2-0.0)
lim_t_o2_12 =	theta(t_o2-0.0)
lim_t_dic_13 =	theta(t_dic-0.0)

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Process limitation factors, continued from previous page

3.10 Process type only1d

Processes	
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_ihs ->	
p_ihs_removal =	(r_fluffy_moveaway*t_ihs*(1.0-cgt_in_sediment))* lim_t_ihs_53
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_ips ->	
p_ips_removal =	(r_fluffy_moveaway*t_ips*(1.0-cgt_in_sediment))* lim_t_ips_52
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_ims ->	
p_ims_removal =	(r_fluffy_moveaway*t_ims*(1.0-cgt_in_sediment))* lim_t_ims_57
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_pyr ->	
p_pyr_removal =	(r_fluffy_moveaway*t_pyr*(1.0-cgt_in_sediment))* lim_t_pyr_58
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_mos ->	
p_mos_removal =	(r_fluffy_moveaway*t_mos*(1.0-cgt_in_sediment))* lim_t_mos_59
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_rho ->	
t_rho_removal =	(r_fluffy_moveaway*t_rho*(1.0-cgt_in_sediment))* lim_t_rho_60
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_iim ->	
p_iim_removal =	(r_fluffy_moveaway*t_iim*(1.0-cgt_in_sediment))* lim_t_iim_61
transport from fluffy layer to deep basins (sediment only) [mol/m^2/day]	
t_ihc ->	
p_ihc_removal =	(r_fluffy_moveaway*t_ihc*(1.0-cgt_in_sediment))* lim_t_ihc_54
transport from fluffy layer to deep basins (index 1 to 6) (sediment only) [mol/m^2/day]	

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Processes, continued from previous page	
t_sed_1 ->	
p_sed_1_removal =	(r_fluffy_moveaway*t_sed_1*(1.0-cgt_in_sediment))* lim_t_sed_1_22

transport from fluffy layer to deep basins (index 1 to 6) (sediment only) [mol/m^2/day]

t_sedp_1 ->	
p_sedp_1_removal =	(r_fluffy_moveaway*t_sedp_1*(1.0-cgt_in_sediment))* lim_t_sedp_1_46

relax alkalinity to default value to compensate for detritus removal [mol/kg/day]

-> ohminus	
p_stf_alk =	theta(0.0024-t_alk)*0.01*(0.0024-t_alk)*(1.0-cgt_in_sediment)*theta(20.0-cgt_bottomdepth)

relax alkalinity to default value to compensate for detritus removal [mol/kg/day]

ohminus ->	
p_stf_alk_up =	theta(t_alk-0.0024)*0.01*(t_alk-0.0024)*(1.0-cgt_in_sediment)*theta(20.0-cgt_bottomdepth)

Auxiliary variables

Constants

rate with which fluffy layer is transported to deeper areas [1/d]

r_fluffy_moveaway = 0.0

Process limitation factors

lim_t_ips_52 =	theta(t_ips-0.0)
lim_t_sed_1_22 =	theta(t_sed_1-0.0)
lim_t_sed_2_23 =	theta(t_sed_2-0.0)
lim_t_sed_3_24 =	theta(t_sed_3-0.0)
lim_t_sed_4_25 =	theta(t_sed_4-0.0)
lim_t_sed_5_26 =	theta(t_sed_5-0.0)
lim_t_sed_6_27 =	theta(t_sed_6-0.0)
lim_t_ihs_53 =	theta(t_ihs-0.0)
lim_t_pyr_58 =	theta(t_pyr-0.0)

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Process limitation factors, continued from previous page	
lim_t_ims_57 =	theta(t_ims-0.0)
lim_t_mos_59 =	theta(t_mos-0.0)
lim_t_rho_60 =	theta(t_rho-0.0)
lim_t_iim_61 =	theta(t_iim-0.0)
lim_t_ihc_54 =	theta(t_ihc-0.0)
lim_t_sedp_1_46 =	theta(t_sedp_1-0.0)
lim_t_sedp_2_47 =	theta(t_sedp_2-0.0)
lim_t_sedp_3_48 =	theta(t_sedp_3-0.0)
lim_t_sedp_4_49 =	theta(t_sedp_4-0.0)
lim_t_sedp_5_50 =	theta(t_sedp_5-0.0)
lim_t_sedp_6_51 =	theta(t_sedp_6-0.0)

3.11 Process type physics/adsorption

Processes	
adsorption of phosphate to iron hydroxide particles (sediment only) [mol/m^2/day]	
t_po4 + t_ihs -> 3*ohminus + t_ips	
p_po4_ads_ips =	(k_ips_dissolution * (t_po4 - po4_eq_ips) * theta(t_po4 - po4_eq_ips) *cgt_cellheight*cgt_density)*lim_t_po4_15* lim_t_ihs_53
dissolution of iron phosphate (sediment only) [mol/m^2/day]	
3*ohminus + t_ips -> t_po4 + t_ihs	
p_ips_diss_po4 =	(k_ips_dissolution * (po4_eq_ips-t_po4) * theta(po4_eq_ips-t_po4) *cgt_cellheight*cgt_density)*lim_t_ips_52
adsorption of phosphate to iron hydroxide particles [mol/kg/day]	
t_ihw + t_po4 -> t_ipw + 3*ohminus	
p_po4_ads_ipw =	(k_ips_dissolution * (t_po4 - po4_eq_ipw) * theta(t_po4 - po4_eq_ipw)*(1.0-cgt_in_sediment))*lim_t_ihw_44* lim_t_po4_15
dissolution of iron phosphate [mol/kg/day]	
3*ohminus + t_ipw -> t_po4 + t_ihw	
p_ipw_diss_po4 =	(k_ips_dissolution * (po4_eq_ipw-t_po4) * theta(po4_eq_ipw-t_po4)*(1.0-cgt_in_sediment))*lim_t_ipw_43
phosphate adsorption to illite-montmorillonite mixed layer minerals (sediment only) [mol/m^2/day]	
t_po4 + 3*h3oplus -> t_pim + 3*h2o	
p_po4_ads_pim =	(cgt_in_sediment*min(t_po4*cgt_cellheight* cgt_density,max(0.0,pim_eq-t_pim))*r_po4_ads_pim)* lim_t_po4_15
phosphate liberation from illite-montmorillonite mixed layer minerals (sediment only) [mol/m^2/day]	
t_pim + 3*h2o -> t_po4 + 3*h3oplus	
p_pim_lib_po4 =	(cgt_in_sediment*min(po4_ads_pim*cgt_cellheight* cgt_density,max(0.0,t_pim-pim_eq))*r_po4_ads_pim+(1.0-cgt_in_sediment)*t_pim*r_po4_ads_pim)*lim_t_pim_66
ammonium adsorption to illite-montmorillonite mixed layer minerals (sediment only) [mol/m^2/day]	
ohminus + t_nh4 -> h2o + t_aim	
p_nh4_ads_aim =	(cgt_in_sediment*min(t_nh4*cgt_cellheight* cgt_density,max(0.0,aim_eq-t_aim))*r_nh4_ads_aim)* lim_t_nh4_16

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Processes, continued from previous page

ammonium liberation from illite-montmorillonite mixed layer minerals (sediment only) [mol/m^2/day]

`h2o + t_aim -> ohminus + t_nh4`

p_aim_lib_nh4 =	(cgt_in_sediment*min(nh4_ads_aim*cgt_cellheight* cgt_density,max(0.0,t_aim-aim_eq))*r_nh4_ads_aim+(1.0- cgt_in_sediment)*t_aim*r_nh4_ads_aim)*lim_t_aim_67

Auxiliary variables

absolute temperature [K]

temp_k =	cgt_temp + 273.15

temporary value assumed for pH [1]

ph_temp =	0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)

calculated iteratively, 10 iterations, initial value = 0.0

self-ionization constant of Water [mol2/kg2]

k_water =	exp(-13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k) + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) * sqrt(cgt_sali) - 0.01615 * cgt_sali)

Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]

k1_co2 =	power(10.0,(-3633.86 / temp_k + 61.2172 - 9.6777 * log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali * cgt_sali))

Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]

k2_co2 =	power(10.0,(-471.78 / temp_k - 25.929 + 3.16967 * log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali * cgt_sali))

Acid dissociation constant of boric acid [mol/kg]

k_boron =	exp((-8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali + 1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) / temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142* cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474* cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k)

Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]

k1_po4 =	exp(-4576.752/temp_k + 115.525 - 18.453*log(temp_k) + (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 + 0.65643/temp_k)*cgt_sali)

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Auxiliary variables, continued from previous page

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

`k2_po4 =` `exp( -8814.715/temp_k + 172.0883 - 27.927*log(temp_k) + (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 - 0.37335/temp_k)*cgt_sali )`

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

`k3_po4 =` `exp( -3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k) *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali )`

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

`k1_h2s =` `exp( -3131.42/temp_k - 5.818 + 0.368* (power(max(0.0,cgt_sali),(1.0/3.0))))`

total concentration of boron [mol/kg]

`boron_total =` `0.000416 * cgt_sali/35.0`

boron alkalinity [mol/kg]

`alk_boron =` `boron_total * k_boron / (k_boron + h3o)`

calculated iteratively, 10 iterations, initial value = 0.0

hydrogen sulfide alkalinity [mol/kg]

`alk_h2s =` `t_h2s * k1_h2s / (k1_h2s + h3o)`

calculated iteratively, 10 iterations, initial value = 0.0

water alkalinity [mol/kg]

`alk_water =` `k_water / h3o - h3o`

calculated iteratively, 10 iterations, initial value = 0.0

denominator in phosphate alkalinity formula [mol3/kg3]

`alk_po4_denominator =` `(h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4* k2_po4*k3_po4)`

calculated iteratively, 10 iterations, initial value = 0.0

phosphate alkalinity [mol/kg]

`alk_po4 =` `t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o* h3o*h3o) / alk_po4_denominator`

calculated iteratively, 10 iterations, initial value = 0.0

denominator in carbonate alkalinity formula [mol2/kg2]

`alk_co2_denominator =` `(h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)`

calculated iteratively, 10 iterations, initial value = 0.0

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Auxiliary variables, continued from previous page	
carbonate alkalinity [mol/kg]	
`alk_co2 =`	`t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator`
calculated iteratively, 10 iterations, initial value = `0.0`	
error in total alkalinity calculation at the assumed pH [mol/kg]	
`alk_residual =`	`t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of phosphate alkalinity with respect to h3o [1]	
`dalkp_dh3o =`	`t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o*h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o-4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4*k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of carbonate alkalinity with respect to h3o [1]	
`dalkc_dh3o =`	`t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2*k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)`
calculated iteratively, 10 iterations, initial value = `0.0`	
derivative of residual_alk with respect to pH [mol/kg]	
`dalkresidual_dpH =`	`0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)`
calculated iteratively, 10 iterations, initial value = `0.0`	
newly determined pH value [1]	
`temp1 =`	`alk_residual/dalkresidual_dpH`
`ph =`	`ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1`
calculated iteratively, 10 iterations, initial value = `0.0`	
h3o ion concentration [mol/kg]	
`h3o =`	`power(10.0,0.0-max(1.0,min(13.0,ph)))`
calculated iteratively, 10 iterations, initial value = `1.0e-8`	
theoretical phosphate concentration in equilibrium with iron phosphate in the sediments [mol/kg]	
`po4_eq_ips =`	`power(max(t_ips/max(t_ips+t_ihs,epsilon)/0.201 - 1.483 + 0.157*pH,0.0),2.0)/1000.0`
theoretical phosphate concentration in equilibrium with iron phosphate in the water [mol/kg]	
`po4_eq_ipw =`	`power(max(t_ipw/max(t_ipw+t_ihw,epsilon)/0.201 - 1.483 + 0.157*pH,0.0),2.0)/1000.0`

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Auxiliary variables, continued from previous page	
amount of phosphate that can be maximally adsorbed to illite-montmorillonite mixed-layer minerals [mol/m2]	
`temp1 =`	`2.7 * max(vol_fraction_im*(1.0-POR),epsilon)`
`temp2 =`	`temp1*p_content_im`
`temp3 =`	`temp2/55.0`
`pim_max =`	`temp3 * 1000 * cgt_cellheight*cgt_density`
pim in equilibrium with po4 concentration	
`pim_eq =`	`pim_max*min(1.0,t_po4/max(po4_ads_pim,epsilon))`
amount of phosphate that can be maximally adsorbed to illite-montmorillonite mixed-layer minerals [mol/m2]	
`temp1 =`	`2.7 * max(vol_fraction_im*(1.0-POR),epsilon)`
`temp2 =`	`temp1*n_content_im`
`temp3 =`	`temp2/18.0`
`aim_max =`	`temp3 * 1000 * cgt_cellheight*cgt_density`
aim in equilibrium with po4 concentration	
`aim_eq =`	`aim_max*min(1.0,t_nh4/max(nh4_ads_aim,epsilon))`

Constants	
no division by 0	
`epsilon =`	`4.5E-17`
inverse timescale for dissolution of iron phosphate [1/d]	
`k_ips_dissolution =`	`0.1`
porosity	
`por =`	`0.77`
fraction of illite-montmorillonite mixed layer minerals on volume of all minerals [1]	
`vol_fraction_im =`	`0.5`
mass fraction of phosphate that can be adsorbed/desorbed to illite-montmorillonite mixed layer minerals [1]	
`p_content_im =`	`0.0002`
mass fraction of ammonium that can be adsorbed/desorbed to illite-montmorillonite mixed layer minerals [1]	
`n_content_im =`	`0.0`
phosphate concentration when phosphate in illite-montmorillonite mixed layer minerals is fully adsorbed [mol/kg]	
`po4_ads_pim =`	`3.0E-5`

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Constants, continued from previous page	
ammonium concentration when ammonium in illite-montmorillonite mixed layer minerals is fully adsorbed [mol/kg]	
nh4_ads_aim =	4.0E-5
rate of phosphate adsorption/desorption to illite-montmorillonite [1/d]	
r_po4_ads_pim =	0.1
rate of ammonium adsorption/desorption to illite-montmorillonite mixed-layer minerals [1/d]	
r_nh4_ads_aim =	0.1

Process limitation factors	
lim_t_nh4_16 =	theta(t_nh4-0.0)
lim_t_po4_15 =	theta(t_po4-0.0)
lim_t_ips_52 =	theta(t_ips-0.0)
lim_t_ipw_43 =	theta(t_ipw-0.0)
lim_t_ihs_53 =	theta(t_ihs-0.0)
lim_t_ihw_44 =	theta(t_ihw-0.0)
lim_t_pim_66 =	theta(t_pim-0.0)
lim_t_aim_67 =	theta(t_aim-0.0)

3.12 Process type physics/erosion

Processes	
sedimentary detritus erosion (index 1 to 6) (sediment only) [mol/m^2/day]	
t_sed_1 -> t_det_1	
p_sed_1_ero_det =	(erosion_is_active*r_sed_ero*t_sed_1*(1.0-cgt_in_sediment)) *lim_t_sed_1_22
sedimentary detritus erosion (index 1 to 6) (sediment only) [mol/m^2/day]	
t_sedp_1 -> t_detp_1	
p_sedp_1_ero_detp =	(erosion_is_active*r_sed_ero*t_sedp_1*(1.0-cgt_in_sediment))*lim_t_sedp_1_46
erosion of iron PO4 (sediment only) [mol/m^2/day]	
t_ips -> t_ipw	
p_ips_ero_ipw =	(erosion_is_active*r_ips_ero*t_ips*(1.0-cgt_in_sediment))* lim_t_ips_52
erosion of iron PO4 (sediment only) [mol/m^2/day]	
t_ihs -> t_ihw	
p_ihs_ero_ihw =	(erosion_is_active*r_ips_ero*t_ihs*(1.0-cgt_in_sediment))* lim_t_ihs_53
erosion of larger-crystalline iron PO4 (sediment only) [mol/m^2/day]	
t_ihc -> t_ihw	
p_ihc_ero_ihw =	(erosion_is_active*r_ips_ero*t_ihc*(1.0-cgt_in_sediment))* lim_t_ihc_54
resuspension of iron monusulfide (sediment only) [mol/m^2/day]	
t_ims + 2.25*h2o + 0.25*h3oplus + 0.125*t_so4 -> 1.125*t_h2s + t_ihw	
p_ims_ero_ihw =	(erosion_is_active*r_ips_ero*t_ihw*(1.0-cgt_in_sediment))* lim_t_ims_57*lim_t_so4_28
resuspension of pyrite (sediment only) [mol/m^2/day]	
t_pyr + 3.75*h2o -> 0.25*h3oplus + 1.875*t_h2s + 0.125*t_so4 + t_ihw	
p_pyr_ero_ihw =	(erosion_is_active*r_ips_ero*t_pyr*(1.0-cgt_in_sediment))* lim_t_pyr_58
bio resuspension of manganese oxide (sediment only) [mol/m^2/day]	
t_mos -> t_mow	
p_mos_ero_mow =	(erosion_is_active*r_ips_ero*t_mos*(1.0-cgt_in_sediment))* lim_t_mos_59
bio resuspension of rhodochrosite (sediment only) [mol/m^2/day]	
0.25*t_so4 + 1.7*h3oplus + t_rho -> t_mow + 0.25*t_h2s + 2.3*h2o + 0.6*t_ca2 + 1.6*t_dic	

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Processes, continued from previous page	
p_rho_ero_mow =	(erosion_is_active*r_ips_ero*t_rho*(1.0-cgt_in_sediment))* lim_t_so4_28*lim_t_rho_60

bio resuspension of iron in clay minerals (sediment only) [mol/m^2/day]

0.125*t_so4 + 0.25*h2o + 0.25*h3oplus + t_iim -> t_ihw + 0.125*t_h2s

p_iim_ero_ihw =	(erosion_is_active*r_ips_ero*t_iim*(1.0-cgt_in_sediment))* lim_t_so4_28*lim_t_iim_61

Auxiliary variables

switch (1=erosion, 0=no erosion) which depends on the combined bottom stress of currents and waves

erosion_is_active = theta(cgt_current_wave_stress - critical_stress)

Constants

critical shear stress for sediment erosion [N/m2]

critical_stress = 0.016

erosion rate for iron PO4 [1/day]

r_ips_ero = 6.0

maximum sediment detritus erosion rate [1/day]

r_sed_ero = 6.0

Process limitation factors

lim_t_ips_52 =	theta(t_ips-0.0)
lim_t_so4_28 =	theta(t_so4-0.0)
lim_t_sed_1_22 =	theta(t_sed_1-0.0)
lim_t_sed_2_23 =	theta(t_sed_2-0.0)
lim_t_sed_3_24 =	theta(t_sed_3-0.0)
lim_t_sed_4_25 =	theta(t_sed_4-0.0)
lim_t_sed_5_26 =	theta(t_sed_5-0.0)
lim_t_sed_6_27 =	theta(t_sed_6-0.0)
lim_t_ihs_53 =	theta(t_ihs-0.0)
lim_t_pyr_58 =	theta(t_pyr-0.0)

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Process limitation factors, continued from previous page	
lim_t_ims_57 =	theta(t_ims-0.0)
lim_t_mos_59 =	theta(t_mos-0.0)
lim_t_rho_60 =	theta(t_rho-0.0)
lim_t_iim_61 =	theta(t_iim-0.0)
lim_t_ihc_54 =	theta(t_ihc-0.0)
lim_t_sedp_1_46 =	theta(t_sedp_1-0.0)
lim_t_sedp_2_47 =	theta(t_sedp_2-0.0)
lim_t_sedp_3_48 =	theta(t_sedp_3-0.0)
lim_t_sedp_4_49 =	theta(t_sedp_4-0.0)
lim_t_sedp_5_50 =	theta(t_sedp_5-0.0)
lim_t_sedp_6_51 =	theta(t_sedp_6-0.0)

3.13 Process type physics/parameterization_deep_burial

Processes

parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (index 1 to 6) (sediment only) [mol/m^2/day]

```
t_sed_1 + rfr_pc_enrichment_det*3.3125*t_so4 + (1.0+rfr_pc_enrichment_det*
6.625)*h3oplus -> rfr_si*t_sil + t_nh4 + rfr_pc_enrichment_det*rfr_c*t_dic +
rfr_pc_enrichment_det*3.3125*t_h2s + (1.0+rfr_pc_enrichment_det*13.25)*h2o
                    (t_sed_1*vel_remin_deep*24.0*3600.0/0.02*theta(k-21.0))*
p_sed_1_sulfdeep_nh4lim_t_sed_1_22*lim_t_so4_28
=
```

parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (index 1 to 6) (sediment only) [mol/m^2/day]

```
t_sedp_1 + 3*rfr_pc_enrichment_det*rfr_p*h2o -> 3*rfr_pc_enrichment_det*rfr_p*
h3oplus + rfr_pc_enrichment_det*rfr_p*t_po4
                    (t_sedp_1*vel_remin_deep*24.0*3600.0/0.02*theta(k-21.0))*
p_sedp_1_sulfdeep_polim_t_sedp_1_46
=
```

Auxiliary variables

Constants

redfield ratio C/N

```
rfr_c =             6.625
```

redfield ratio P/N

```
rfr_p =             0.0625
```

enrichment factor for P and C in detritus [1]

```
                    1.5
rfr_pc_enrichment_de
=
```

average ratio Si/N [1]

```
rfr_si =            0.9375
```

effective velocity of detritus mineralization in the deepest layer [m/s]

```
vel_remin_deep =    0.0
```

Process limitation factors

```
lim_t_so4_28 =      theta(t_so4-0.0)

lim_t_sed_1_22 =    theta(t_sed_1-0.0)
```

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Process limitation factors, continued from previous page	
lim_t_sed_2_23 =	theta(t_sed_2-0.0)
lim_t_sed_3_24 =	theta(t_sed_3-0.0)
lim_t_sed_4_25 =	theta(t_sed_4-0.0)
lim_t_sed_5_26 =	theta(t_sed_5-0.0)
lim_t_sed_6_27 =	theta(t_sed_6-0.0)
lim_t_sedp_1_46 =	theta(t_sedp_1-0.0)
lim_t_sedp_2_47 =	theta(t_sedp_2-0.0)
lim_t_sedp_3_48 =	theta(t_sedp_3-0.0)
lim_t_sedp_4_49 =	theta(t_sedp_4-0.0)
lim_t_sedp_5_50 =	theta(t_sedp_5-0.0)
lim_t_sedp_6_51 =	theta(t_sedp_6-0.0)

3.14 Process type physics/parameterization_diffusion

Processes	
relax ohm_quickdiff tracer against actual OH- concentration [mol/kg/day]	
-> t_ohm_quickdiff	
relax_ohm_quickdiff_ =	theta(oh-t_ohm_quickdiff)*(oh-t_ohm_quickdiff)/cgt_timestep
relax ohm_quickdiff tracer against actual OH- concentration [mol/kg/day]	
t_ohm_quickdiff ->	
relax_ohm_quickdiff_/cgt_timestep)*lim_t_ohm_quickdiff_63 =	(theta(t_ohm_quickdiff-oh)*(t_ohm_quickdiff-oh)
relax ohm_slowdiff tracer against actual OH- concentration [mol/kg/day]	
-> t_ohm_slowdiff	
relax_ohm_slowdiff_u =	theta(oh-t_ohm_slowdiff)*(oh-t_ohm_slowdiff)/cgt_timestep
relax ohm_slowdiff tracer against actual OH- concentration [mol/kg/day]	
t_ohm_slowdiff ->	
relax_ohm_slowdiff_d*lim_t_ohm_slowdiff_64 =	(theta(t_ohm_slowdiff-oh)*(t_ohm_slowdiff-oh)/cgt_timestep)
rise of total alkalinity by quicker-than-assumed diffusion of OH- [mol/kg/day]	
-> ohminus	
p_alk_rise_ohmdiff =	theta(t_ohm_quickdiff-t_ohm_slowdiff)*(t_ohm_quickdiff-t_ohm_slowdiff)/cgt_timestep
falling of total alkalinity by quicker-than-assumed diffusion of OH- [mol/kg/day]	
-> h3oplus	
p_alk_fall_ohmdiff =	theta(t_ohm_slowdiff-t_ohm_quickdiff)*(t_ohm_slowdiff-t_ohm_quickdiff)/cgt_timestep

Auxiliary variables	
absolute temperature [K]	
`temp_k =`	`cgt_temp + 273.15`
temporary value assumed for pH [1]	
`ph_temp =`	`0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)`
calculated iteratively, 10 iterations, initial value = `0.0`	
self-ionization constant of Water [mol2/kg2]	
`k_water =`	`exp( -13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k) + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) * sqrt(cgt_sali) - 0.01615 * cgt_sali)`

continued on next page...

Auxiliary variables, continued from previous page

Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]

k1_co2 = `power(10.0,( -3633.86 / temp_k + 61.2172 - 9.6777 * log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali * cgt_sali))`

Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]

k2_co2 = `power(10.0,( -471.78 / temp_k - 25.929 + 3.16967 * log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali * cgt_sali))`

Acid dissociation constant of boric acid [mol/kg]

k_boron = `exp(( -8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali + 1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) / temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142* cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474* cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k )`

Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]

k1_po4 = `exp( -4576.752/temp_k + 115.525 - 18.453*log(temp_k) + (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 + 0.65643/temp_k)*cgt_sali )`

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

k2_po4 = `exp( -8814.715/temp_k + 172.0883 - 27.927*log(temp_k) + (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 - 0.37335/temp_k)*cgt_sali )`

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

k3_po4 = `exp( -3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k) *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali )`

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

k1_h2s = `exp( -3131.42/temp_k - 5.818 + 0.368* (power(max(0.0,cgt_sali),(1.0/3.0))))`

total concentration of boron [mol/kg]

boron_total = `0.000416 * cgt_sali/35.0`

boron alkalinity [mol/kg]

alk_boron = `boron_total * k_boron / (k_boron + h3o)`

calculated iteratively, 10 iterations, initial value = `0.0`

hydrogen sulfide alkalinity [mol/kg]

continued on next page...

Auxiliary variables, continued from previous page	
`alk_h2s =`	`t_h2s * k1_h2s / (k1_h2s + h3o)`
calculated iteratively, 10 iterations, initial value = 0.0	
water alkalinity [mol/kg]	
`alk_water =`	`k_water / h3o - h3o`
calculated iteratively, 10 iterations, initial value = 0.0	
denominator in phosphate alkalinity formula [mol3/kg3]	
`alk_po4_denominator =`	`(h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4*k2_po4*k3_po4)`
calculated iteratively, 10 iterations, initial value = 0.0	
phosphate alkalinity [mol/kg]	
`alk_po4 =`	`t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o*h3o*h3o) / alk_po4_denominator`
calculated iteratively, 10 iterations, initial value = 0.0	
denominator in carbonate alkalinity formula [mol2/kg2]	
`alk_co2_denominator =`	`(h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)`
calculated iteratively, 10 iterations, initial value = 0.0	
carbonate alkalinity [mol/kg]	
`alk_co2 =`	`t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator`
calculated iteratively, 10 iterations, initial value = 0.0	
error in total alkalinity calculation at the assumed pH [mol/kg]	
`alk_residual =`	`t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water`
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of phosphate alkalinity with respect to h3o [1]	
`dalkp_dh3o =`	`t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o*h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o-4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4*k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)`
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of carbonate alkalinity with respect to h3o [1]	
`dalkc_dh3o =`	`t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2*k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)`
calculated iteratively, 10 iterations, initial value = 0.0	
derivative of residual_alk with respect to pH [mol/kg]	
`dalkresidual_dpH =`	`0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)`

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Auxiliary variables, continued from previous page	
calculated iteratively, 10 iterations, initial value = `0.0`	
newly determined pH value [1]	
`temp1 =`	`alk_residual/dalkresidual_dpH`
`ph =`	`ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1`
calculated iteratively, 10 iterations, initial value = `0.0`	
h3o ion concentration [mol/kg]	
`h3o =`	`power(10.0,0.0-max(1.0,min(13.0,ph)))`
calculated iteratively, 10 iterations, initial value = `1.0e-8`	
h3o ion concentration [mol/kg]	
`oh =`	`power(10.0,log(k_water)/log(10.0)+max(1.0,min(13.0,ph)))`

Constants	
Process limitation factors	
`lim_t_ohm_quickdiff_ =`	`theta(t_ohm_quickdiff-0.0)`
`lim_t_ohm_slowdiff_6 =`	`theta(t_ohm_slowdiff-0.0)`

3.15 Process type physics/parameterization_lateral

Processes	
surface flux of detritus (index 1 to 6) (sediment only) [mol/m^2/day]	
-> t_detp_1 + t_det_1	
p_stf_det_1 =	frac_det_1*accrate_det_1*2.47e-4*(1.0-cgt_in_sediment)
raise SO4 concentration in the water column to salinity-determined default value [mol/kg/day]	
-> t_so4	
p_so4_relax_upwards =	(0.077*sal_for_so4/(32+4*16)-t_so4)*theta(0.077*sal_for_so4/(32+4*16)-t_so4)*(1.0-cgt_in_sediment)
lower SO4 concentration in the water column to salinity-determined default value [mol/kg/day]	
t_so4 ->	
p_so4_relax_downward =	((t_so4-0.077*sal_for_so4/(32+4*16))*theta(t_so4-0.077*sal_for_so4/(32+4*16))*(1.0-cgt_in_sediment))*lim_t_so4_28
raise Ca2+ concentration in the water column to salinity-determined default value [mol/kg/day]	
-> t_ca2	
p_ca2_relax_upwards =	(0.0118*sal_for_so4/(40.1)-t_ca2)*theta(0.0118*sal_for_so4/(40.0)-t_ca2)*(1.0-cgt_in_sediment)
lower Ca2+ concentration in the water column to salinity-determined default value [mol/kg/day]	
t_ca2 ->	
p_ca2_relax_downward =	((t_ca2-0.0118*sal_for_so4/(40.1))*theta(t_ca2-0.0118*sal_for_so4/(40.0))*(1.0-cgt_in_sediment))*lim_t_ca2_56
remove silicate in water column as it gets too much [mol/kg/day]	
t_sil ->	
p_remove_silicate =	((t_sil-1.0e-5)*0.1*(1.0-cgt_in_sediment)*(20.0-cgt_bottomdepth))*lim_t_sil_65
iron hydroxide generation by internal sources (surface only) [mol/m^2/day]	
-> t_ihw	
p_stf_ihw_3d =	9.42e-5

Auxiliary variables	
salinity used for so4 calculation	
sal_for_so4 =	cgt_sali
accumulation ratio of detritus [1]	

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Auxiliary variables, continued from previous page	
accrate_det_1 =	0.0
accumulation ratio of detritus [1]	
accrate_det_2 =	0.0
accumulation ratio of detritus [1]	
accrate_det_3 =	accratedet
accumulation ratio of detritus [1]	
accrate_det_4 =	accratedet
accumulation ratio of detritus [1]	
accrate_det_5 =	accratedet
accumulation ratio of detritus [1]	
accrate_det_6 =	accratedet

Constants	
fraction of this detritus class in total detritus production [1]	
frac_det_1 =	0.26
fraction of this detritus class in total detritus production [1]	
frac_det_2 =	0.16
fraction of this detritus class in total detritus production [1]	
frac_det_3 =	0.16
fraction of this detritus class in total detritus production [1]	
frac_det_4 =	0.16
fraction of this detritus class in total detritus production [1]	
frac_det_5 =	0.08
fraction of this detritus class in total detritus production [1]	
frac_det_6 =	0.18
accumulation ratio of detritus (import vs. local production) [1]	
accratedet =	0.0

Process limitation factors	
lim_t_so4_28 =	theta(t_so4-0.0)
lim_t_ca2_56 =	theta(t_ca2-0.0)
lim_t_sil_65 =	theta(t_sil-0.0)

continued on next page...

Process limitation factors, continued from previous page

3.16 Process type physics/precipitation

Processes	
precipitation of iron II as siderite (sediment only) [mol/m^2/day]	
t_fe2 + t_h2s + 2.0*ohminus -> t_ims + 2.0*h2o	
p_fe2_prec_ims =	(fe2_ims_is_smallest*cgt_in_sediment*theta(t_fe2-fe2_smooth)*(t_fe2-fe2_smooth)/cgt_timestep*cgt_cellheight*cgt_density)*lim_t_fe2_55*lim_t_h2s_29
dissolution of magnetite to iron II (precipitating iron hydroxides) (sediment only) [mol/m^2/day]	
2.0*h3oplus + t_ims -> 2.0*h2o + t_h2s + t_fe2	
p_ims_diss_fe2 =	(fe2_ims_is_smallest*cgt_in_sediment*theta(fe2_smooth-t_fe2)*(fe2_smooth-t_fe2)/cgt_timestep*cgt_cellheight*cgt_density)*lim_t_ims_57
precipitation of iron II as minnesotaite (sediment only) [mol/m^2/day]	
2*ohminus + t_fe2 -> t_iim	
p_fe2_prec_iim =	(fe2_iim_is_smallest*cgt_in_sediment*theta(t_fe2-fe2_smooth)*(t_fe2-fe2_smooth)/cgt_timestep*cgt_cellheight*cgt_density)*lim_t_fe2_55
dissolution minnesotaite to of iron-II (sediment only) [mol/m^2/day]	
t_iim -> t_fe2 + 2*ohminus	
p_iim_diss_fe2 =	(fe2_iim_is_smallest*cgt_in_sediment*theta(fe2_smooth-t_fe2)*(fe2_smooth-t_fe2)/cgt_timestep*cgt_cellheight*cgt_density)*lim_t_iim_61
iron monosulfide transformation to minnesotaite (sediment only) [mol/m^2/day]	
t_ims + 2*h2o -> t_iim + t_h2s	
p_ims_trans_iim =	(fe2_iim_is_smallest*theta(ims_dissolution_rate)*ims_dissolution_rate)*lim_t_ims_57
minnesotaite transformation to iron monosulfide (sediment only) [mol/m^2/day]	
t_iim + t_h2s -> t_ims + 2*h2o	
p_iim_trans_ims =	(fe2_ims_is_smallest*theta(iim_dissolution_rate)*iim_dissolution_rate)*lim_t_iim_61*lim_t_h2s_29
rhodochrosite dissolution to manganese-II (sediment only) [mol/m^2/day]	
t_rho + 3.2*h3oplus -> 4.8*h2o + 0.6*t_ca2 + t_mn2 + 1.6*t_dic	
p_rho_diss_mn2 =	(0.1*1.0e-5*theta(1.0-saturation_rhodochrosite)*cgt_in_sediment*cgt_cellheight*cgt_density)*lim_t_rho_60
pyrite formation from iron monosulfide (sediment only) [mol/m^2/day]	
0.5*h3oplus + 0.25*t_so4 + 0.75*t_h2s + t_ims -> t_pyr + 1.5*h2o	

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Processes, continued from previous page	
p_ims_form2_pyr =	(t_ims*t_h2s*k_pyrite)*lim_t_so4_28*lim_t_h2s_29* lim_t_ims_57

Auxiliary variables	
absolute temperature [K]	
temp_k =	cgt_temp + 273.15
temporary value assumed for pH [1]	
ph_temp =	0.0-log(min(max(h3o,1.0e-12),1.0e-2))/log(10.0)
calculated iteratively, 10 iterations, initial value = 0.0	
self-ionization constant of Water [mol2/kg2]	
k_water =	exp(-13847.26 / temp_k + 148.96502 - 23.6521 * log(temp_k) + (118.67/temp_k - 5.977 + 1.0495 * log(temp_k)) * sqrt(cgt_sali) - 0.01615 * cgt_sali)
Solubility of CO2 [mol/kg/Pa]	
k0_co2 =	exp(9345.17 / temp_k - 60.2409 + 23.3585 * (log(temp_k) - 4.605170186) + cgt_sali*(0.023517 - 0.00023656 * temp_k + 0.00000047036 *temp_k*temp_k))/101325.0
Acid dissociation constant CO2 + 2 H2O <-> HCO3- + H3O+ [mol/kg]	
k1_co2 =	power(10.0,(-3633.86 / temp_k + 61.2172 - 9.6777 * log(temp_k) + 0.011555 * cgt_sali - 0.0001152 * cgt_sali * cgt_sali))
Acid dissociation constant HCO3- + H2O <-> [CO3 2-] + H3O+ [mol/kg]	
k2_co2 =	power(10.0,(-471.78 / temp_k - 25.929 + 3.16967 * log(temp_k) + 0.01781 * cgt_sali - 0.0001122 * cgt_sali * cgt_sali))
Acid dissociation constant of boric acid [mol/kg]	
k_boron =	exp((-8966.9 - 2890.53*sqrt(cgt_sali) - 77.942*cgt_sali + 1.728*cgt_sali*sqrt(cgt_sali) - 0.0996*cgt_sali*cgt_sali) / temp_k + 148.0248 + 137.1942*sqrt(cgt_sali) + 1.62142* cgt_sali + (-24.4344 - 25.085*sqrt(cgt_sali) - 0.2474* cgt_sali)*log(temp_k) + 0.053105*sqrt(cgt_sali)*temp_k)
Acid dissociation constant H3PO4 + H2O <-> [H2PO4 -] + H3O+ [mol/kg]	
k1_po4 =	exp(-4576.752/temp_k + 115.525 - 18.453*log(temp_k) + (0.69171 - 106.736/temp_k)*sqrt(cgt_sali) - (0.01844 + 0.65643/temp_k)*cgt_sali)

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Auxiliary variables, continued from previous page

Acid dissociation constant [H2PO4 -] + H2O+ <-> [HPO4 2-] + H3O+ [mol/kg]

```
k2_po4 =            exp( -8814.715/temp_k + 172.0883 - 27.927*log(temp_k) +
                    (1.35660 - 160.340/temp_k)*sqrt(cgt_sali) - (0.05778 -
                    0.37335/temp_k)*cgt_sali )
```

Acid dissociation constant [HPO4 2-] + H2O <-> [PO4 3-] + H3O+ [mol/kg]

```
k3_po4 =            exp( -3070.75/temp_k - 18.141 + (2.81197 + 17.27039/temp_k)
                    *sqrt(cgt_sali) - (0.09984 + 44.99486/temp_k)*cgt_sali )
```

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

```
k1_h2s =            exp( -3131.42/temp_k - 5.818 + 0.368*
                    (power(max(0.0,cgt_sali),(1.0/3.0))))
```

total concentration of boron [mol/kg]

```
boron_total =       0.000416 * cgt_sali/35.0
```

boron alkalinity [mol/kg]

```
alk_boron =         boron_total * k_boron / (k_boron + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

hydrogen sulfide alkalinity [mol/kg]

```
alk_h2s =           t_h2s * k1_h2s / (k1_h2s + h3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

water alkalinity [mol/kg]

```
alk_water =         k_water / h3o - h3o
```

calculated iteratively, 10 iterations, initial value = 0.0

denominator in phosphate alkalinity formula [mol3/kg3]

```
alk_po4_denominator (h3o*h3o*h3o + k1_po4*h3o*h3o + k1_po4*k2_po4*h3o + k1_po4*
=                   k2_po4*k3_po4)
```

calculated iteratively, 10 iterations, initial value = 0.0

phosphate alkalinity [mol/kg]

```
alk_po4 =           t_po4*(k1_po4*k2_po4*h3o + 2.0*k1_po4*k2_po4*k3_po4 - h3o*
                    h3o*h3o) / alk_po4_denominator
```

calculated iteratively, 10 iterations, initial value = 0.0

denominator in carbonate alkalinity formula [mol2/kg2]

```
alk_co2_denominator (h3o*h3o + k1_co2*h3o + k1_co2*k2_co2)
=
```

calculated iteratively, 10 iterations, initial value = 0.0

continued on next page. . .

Auxiliary variables, continued from previous page

carbonate alkalinity [mol/kg]

```
alk_co2 =             t_dic*k1_co2*(h3o+2*k2_co2)/alk_co2_denominator
```

calculated iteratively, 10 iterations, initial value = 0.0

error in total alkalinity calculation at the assumed pH [mol/kg]

```
alk_residual =        t_alk - alk_co2 - alk_po4 - alk_boron - alk_h2s - alk_water
```

calculated iteratively, 10 iterations, initial value = 0.0

derivative of phosphate alkalinity with respect to h3o [1]

```
dalkp_dh3o =          t_po4*(0.0-k1_po4*h3o*h3o*h3o*h3o-4*k1_po4*k2_po4*h3o*h3o*
                      h3o-(k1_po4*k1_po4*k2_po4+9*k1_po4*k2_po4*k3_po4)*h3o*h3o-
                      4*k1_po4*k1_po4*k2_po4*k3_po4*h3o-k1_po4*k1_po4*k2_po4*
                      k2_po4*k3_po4)/(alk_po4_denominator*alk_po4_denominator)
```

calculated iteratively, 10 iterations, initial value = 0.0

derivative of carbonate alkalinity with respect to h3o [1]

```
dalkc_dh3o =          t_dic*(0.0-k1_co2*h3o*h3o-k1_co2*k1_co2*k2_co2-4*k1_co2*
                      k2_co2*h3o)/(alk_co2_denominator*alk_co2_denominator)
```

calculated iteratively, 10 iterations, initial value = 0.0

derivative of residual_alk with respect to pH [mol/kg]

```
dalkresidual_dpH =    0.0-log(10.0)*h3o*(alk_boron/(k_boron+h3o)+alk_h2s/(k1_h2s+
                      h3o)+k_water/(h3o*h3o)+1-dalkp_dh3o-dalkc_dh3o)
```

calculated iteratively, 10 iterations, initial value = 0.0

newly determined pH value [1]

```
temp1 =               alk_residual/dalkresidual_dpH
ph =                  ph_temp - temp1 + theta(abs(temp1) - 1)*0.5*temp1
```

calculated iteratively, 10 iterations, initial value = 0.0

h3o ion concentration [mol/kg]

```
h3o =                 power(10.0,0.0-max(1.0,min(13.0,ph)))
```

calculated iteratively, 10 iterations, initial value = 1.0e-8

co2 partial pressure [Pa]

```
pco2 =                t_dic / k0_co2 / (1 + k1_co2/h3o + k1_co2*k2_co2/h3o/h3o)
```

Acid dissociation constant H2S + H2O <-> HS- + H3O+ [mol/kg]

```
k1_h2s_sed =          exp( -3131.42/temp_k - 5.818 + 0.368*
                      (power(max(0.0,cgt_sali),(1.0/3.0))))
```

ionic strength of the solution [mol/kg]

```
ionic_strength =      0.02*cgt_sali
```

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Auxiliary variables, continued from previous page	
dielectric constant of seawater [F/m]	
temp1 =	cgt_sali*(1.707e-2+1.205e-5*cgt_sali+4.058e-9*power(cgt_sali,2.0))
temp2 =	1.0-0.2551*temp1+5.151e-2*temp1*temp1-6.889e-3*temp1*temp1*temp1
temp3 =	87.74-0.40008*temp_k+9.398e-4*temp_k*temp_k+1.401e-6*temp_k*temp_k*temp_k
dielectric_constant =	temp2*temp3
CO2 concentration in the surface layer [mol/kg]	
co2 =	pco2*k0_co2
concentration of HS- ions [mol/kg]	
hsminus =	t_h2s * k1_h2s_sed / (k1_h2s_sed + h3o)
parameter A for the Davies formula [mol0.5 l-0.5]	
davies_parameter_a =	1.82e6*power(dielectric_constant*temp_k,-1.5)
concentration of HCO3- ions	
hco3minus =	co2*k1_co2/h3o
activity to concentration ratio of ions with a charge of +1/-1 [1]	
activity_coefficient/ =	power(10.0,0.0-davies_parameter_a*1*(sqrt(ionic_strength)/(1+sqrt(ionic_strength))-0.3*ionic_strength))
activity to concentration ratio of ions with a charge of +2/-2 [1]	
activity_coefficient/ =	power(10.0,0.0-davies_parameter_a*2*(sqrt(ionic_strength)/(1+sqrt(ionic_strength))-0.3*ionic_strength))
concentration of CO3-- ions	
co32minus =	hco3minus*k2_co2/h3o
activity of H3O+ ions (concentration corrected by ionic strength) [mol/kg]	
activity_h3oplus =	h3o*activity_coefficient_1
activity of CO3-- ions (concentration corrected by ionic strength) [mol/kg]	
activity_co32minus =	co32minus*activity_coefficient_2
relative saturation of iron monosulfide [1]	
saturation_ims =	t_fe2*activity_coefficient_2*hsminus*activity_coefficient_1/activity_h3oplus/power(10.0,-2.95)

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Auxiliary variables, continued from previous page

relative saturation of rhodochrosite [1]

```
                    t_mn2*activity_coefficient_2*
saturation_rhodochroactivity_co32minus/power(10.0,-9.5)
=
```

relative saturation of iron-II to be adsorbed on illite-montmorillonite mixed-layer minerals [1]

```
temp1 =             2.7 * max(vol_fraction_im*(1.0-POR),epsilon)
saturation_iim =    t_fe2/((max(t_iim,epsilon)/cgt_cellheight/cgt_density)
                    /(100*temp1))
```

dissolution rate of iron monosulfide [mol/m2/d]

```
                    r_ims_diss*theta(1.0-saturation_ims)*(1.0-saturation_ims)*
ims_dissolution_ratecgt_cellheight*cgt_density
=
```

desorption rate of iron adsorbed to illite-minnesotaite mixed-layer minerals [mol/m2/d]

```
                    r_iim_diss*theta(1.0-saturation_iim)*(1.0-saturation_iim)*
iim_dissolution_ratecgt_cellheight*cgt_density
=
```

Fe-II concentration in equilibrium with iron monosulfide precipitation [mol/kg]

```
fe2_eq_ims =        power(10.0,-2.95)*activity_h3oplus/max(hsminus*
                    activity_coefficient_1,1.0e-3*epsilon)
                    /activity_coefficient_2
```

Fe-II concentration in equilibrium with iron adsorbed to illite-montmorillonite mixed layer minerals [mol/kg]

```
temp1 =             2.7 * max(vol_fraction_im*(1.0-POR),epsilon)
fe2_eq_iim =        (max(t_iim,epsilon)/cgt_cellheight/cgt_density)/(100*temp1)
                    +1000*(1.0-cgt_in_sediment)
```

siderite is the favoured species for precipitation (0 or 1) [1]

```
fe2_ims_is_smallest theta(fe2_eq_iim-fe2_eq_ims)
=
```

minnesotaite is the favoured species for precipitation (0 or 1) [1]

```
fe2_iim_is_smallest theta(fe2_eq_ims-fe2_eq_iim)
=
```

Fe-II concentration in equilibrium with the fastest precipitating Fe species

```
fe2_eq =            fe2_ims_is_smallest*fe2_eq_ims+fe2_iim_is_smallest*
                    fe2_eq_iim
```

continued on next page...

Auxiliary variables, continued from previous page	
smoother value for fe2__eq [mol/kg]	
`temp1 =`	`3.0e-6`
`fe2_smooth =`	`fe2_eq`

Constants	
no division by 0	
`epsilon =`	`4.5E-17`
rate constant for formation of pyrite [kg/mol/d]	
`k_pyrite =`	`8.9`
porosity	
`por =`	`0.77`
fraction of illite-montmorillonite mixed layer minerals on volume of all minerals [1]	
`vol_fraction_im =`	`0.5`
rate of iron monosulfide dissolution [1/d]	
`r_ims_diss =`	`0.001`
dissilution rate of iron adsorbed to illite-montmorillonite mixed-layer minerals [1/d]	
`r_iim_diss =`	`0.001`

Process limitation factors	
`lim_t_h2s_29 =`	`theta(t_h2s-0.0)`
`lim_t_so4_28 =`	`theta(t_so4-0.0)`
`lim_t_fe2_55 =`	`theta(t_fe2-0.0)`
`lim_t_ims_57 =`	`theta(t_ims-0.0)`
`lim_t_rho_60 =`	`theta(t_rho-0.0)`
`lim_t_iim_61 =`	`theta(t_iim-0.0)`

3.17 Process type physics/sedimentation

Processes

detritus sedimentation (index 1 to 6) (sediment only) [mol/m^2/day]

```
t_det_1 -> t_sed_1
p_det_1_sedi_sed =  ((1.0-erosion_is_active)*(0.0-w_det_sedi)*t_det_1*
                    cgt_density*(1.0-cgt_in_sediment) + cgt_in_sediment*
                    (t_det_1*cgt_density*cgt_cellheight*0.1))*lim_t_det_1_31
```

detritus sedimentation (index 1 to 6) (sediment only) [mol/m^2/day]

```
t_detp_1 -> t_sedp_1
p_detp_1_sedi_sedp  ((1.0-erosion_is_active)*(0.0-w_det_sedi)*t_detp_1*
=                   cgt_density*(1.0-cgt_in_sediment) + cgt_in_sediment*
                    (t_detp_1*cgt_density*cgt_cellheight*0.1))*lim_t_detp_1_37
```

sedimentation of iron PO4 (sediment only) [mol/m^2/day]

```
t_ipw -> t_ips
p_ipw_sedi_ips =    ((1.0-erosion_is_active)*(0.0-w_ipw_sedi)*t_ipw*
                    cgt_density*(1.0-cgt_in_sediment))*lim_t_ipw_43
```

sedimentation of iron hydroxide (sediment only) [mol/m^2/day]

```
t_ihw -> t_ihs
p_ihw_sedi_ihs =    ((1.0-erosion_is_active)*(0.0-w_ipw_sedi)*t_ihw*
                    cgt_density*(1.0-cgt_in_sediment))*lim_t_ihw_44
```

sedimentation of iron hydroxide (sediment only) [mol/m^2/day]

```
t_mow -> t_mos
p_mow_sedi_mos =    ((1.0-erosion_is_active)*(0.0-w_ipw_sedi)*t_mow*
                    cgt_density*(1.0-cgt_in_sediment))*lim_t_mow_45
```

Auxiliary variables

switch (1=erosion, 0=no erosion) which depends on the combined bottom stress of currents and waves

```
erosion_is_active = theta(cgt_current_wave_stress - critical_stress)
```

Constants

critical shear stress for sediment erosion [N/m2]

```
critical_stress =   0.016
```

sedimentation velocity (negative for downward) [m/day]

```
w_det_sedi =        -0.5
```

sedimentation velocity for iron PO4 [m/day]

```
w_ipw_sedi =        -0.5
```

Process limitation factors	
lim_t_ipw_43 =	theta(t_ipw-0.0)
lim_t_det_1_31 =	theta(t_det_1-0.0)
lim_t_det_2_32 =	theta(t_det_2-0.0)
lim_t_det_3_33 =	theta(t_det_3-0.0)
lim_t_det_4_34 =	theta(t_det_4-0.0)
lim_t_det_5_35 =	theta(t_det_5-0.0)
lim_t_det_6_36 =	theta(t_det_6-0.0)
lim_t_ihw_44 =	theta(t_ihw-0.0)
lim_t_mow_45 =	theta(t_mow-0.0)
lim_t_detp_1_37 =	theta(t_detp_1-0.0)
lim_t_detp_2_38 =	theta(t_detp_2-0.0)
lim_t_detp_3_39 =	theta(t_detp_3-0.0)
lim_t_detp_4_40 =	theta(t_detp_4-0.0)
lim_t_detp_5_41 =	theta(t_detp_5-0.0)
lim_t_detp_6_42 =	theta(t_detp_6-0.0)

3.18 Process type standard

Processes

Auxiliary variables

Constants

Process limitation factors

4 Tracer equations

Tracer equations	
Change of: autochthonous dissolved organic nitrogen	
$\frac{d}{dt}$ t_don =	
+ (p_lpp_resp_nh4)* (don_fraction)	respiration of large-cell phytoplankton
+ (p_spp_resp_nh4)* (don_fraction)	respiration of small-cell phytoplankton
+ (p_cya_resp_nh4)* (don_fraction)	respiration of diazotroph cyanobacteria
+ (p_zoo_resp_nh4)* (don_fraction)	respiration of zooplankton
- p_don_rec_nh4	mineralization of DON
Change of: dissolved molecular nitrogen	
$\frac{d}{dt}$ t_n2 =	
+ p_n2_stf_down/(cgt_cellheight* cgt_density)	downward nitrogen flux through the surface
+ (p_sed_1_denit_nh4)* (rfr_pc_enrichment_det*2.65) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_2_denit_nh4)* (rfr_pc_enrichment_det*2.65) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_3_denit_nh4)* (rfr_pc_enrichment_det*2.65) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_4_denit_nh4)* (rfr_pc_enrichment_det*2.65) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)

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Tracer equations, continued from previous page	
+ (p_sed_5_denit_nh4)* (rfr_pc_enrichment_det*2.65) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_6_denit_nh4)* (rfr_pc_enrichment_det*2.65) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_h2s_oxno3_sul)*(0.2)	oxidation of hydrogen sulfide with nitrate
+ (p_sul_oxno3_so4)*(0.6)	oxidation of elemental sulfur with nitrate
+ (p_det_1_denit_nh4)* (rfr_pc_enrichment_det*2.65)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_2_denit_nh4)* (rfr_pc_enrichment_det*2.65)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_3_denit_nh4)* (rfr_pc_enrichment_det*2.65)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_4_denit_nh4)* (rfr_pc_enrichment_det*2.65)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_5_denit_nh4)* (rfr_pc_enrichment_det*2.65)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_6_denit_nh4)* (rfr_pc_enrichment_det*2.65)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_poc_denit)*(0.4)	recycling of POC using nitrate (denitrification)
- p_n2_stf_up/(cgt_cellheight* cgt_density)	upward nitrogen flux through the surface
- (p_n2_assim_cya)*(0.5)	fixation of dinitrogen by diazotroph cyanobacteria

Change of: dissolved molecular oxygen

$\frac{d}{dt}$ t_o2 =

+ p_o2_stf_down/(cgt_cellheight* cgt_density)	downward oxygen flux through the surface

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Tracer equations, continued from previous page	
+ (p_no3_assim_lpp)*(8.625)	assimilation of nitrate by large-cell phytoplankton
+ (p_nh4_assim_lpp)*(6.625)	assimilation of ammonium by large-cell phytoplankton
+ (p_no3_assim_spp)*(8.625)	assimilation of nitrate by small-cell phytoplankton
+ (p_nh4_assim_spp)*(6.625)	assimilation of ammonium by small-cell phytoplankton
+ (p_n2_assim_cya)*(7.375)	fixation of dinitrogen by diazotroph cyanobacteria
+ p_assim_lpp_poc	Production of POC by LPP
+ p_assim_spp_poc	Production of POC by SPP
+ p_assim_cya_poc	Production of POC by CYA
- p_o2_stf_up/(cgt_cellheight* cgt_density)	upward oxygen flux through the surface
- (p_lpp_resp_nh4)*(6.625)	respiration of large-cell phytoplankton
- (p_spp_resp_nh4)*(6.625)	respiration of small-cell phytoplankton
- (p_cya_resp_nh4)*(6.625)	respiration of diazotroph cyanobacteria
- (p_zoo_resp_nh4)*(6.625)	respiration of zooplankton
- (p_nh4_nit_no3)*(2)	nitrification
- (p_nh4_nit_no3_sed)*(2)	nitrification in the sediment
- (p_sed_1_resp_nh4)* (rfr_pc_enrichment_det*6.625) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
- (p_sed_2_resp_nh4)* (rfr_pc_enrichment_det*6.625) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)

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Tracer equations, continued from previous page	
`- (p_sed_3_resp_nh4)* (rfr_pc_enrichment_det*6.625) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`- (p_sed_4_resp_nh4)* (rfr_pc_enrichment_det*6.625) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`- (p_sed_5_resp_nh4)* (rfr_pc_enrichment_det*6.625) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`- (p_sed_6_resp_nh4)* (rfr_pc_enrichment_det*6.625) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`- (p_h2s_oxo2_sul)*(0.5)`	oxidation of hydrogen sulfide with oxygen
`- (p_sul_oxo2_so4)*(1.5)`	oxidation of elemental sulfur with oxygen
`- (p_det_1_resp_nh4)* (rfr_pc_enrichment_det*6.625)`	recycling of detritus to ammonium using oxygen (respiration)
`- (p_det_2_resp_nh4)* (rfr_pc_enrichment_det*6.625)`	recycling of detritus to ammonium using oxygen (respiration)
`- (p_det_3_resp_nh4)* (rfr_pc_enrichment_det*6.625)`	recycling of detritus to ammonium using oxygen (respiration)
`- (p_det_4_resp_nh4)* (rfr_pc_enrichment_det*6.625)`	recycling of detritus to ammonium using oxygen (respiration)
`- (p_det_5_resp_nh4)* (rfr_pc_enrichment_det*6.625)`	recycling of detritus to ammonium using oxygen (respiration)
`- (p_det_6_resp_nh4)* (rfr_pc_enrichment_det*6.625)`	recycling of detritus to ammonium using oxygen (respiration)
`- (p_fe2_ox_ihs)*(0.25) /(cgt_cellheight*cgt_density)`	oxidation of Fe2+ to iron hydroxide in the sediment
`- (p_fe2_ox_ihw)*(0.25)`	oxidation of Fe2+ to iron hydroxide in the sediment

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Tracer equations, continued from previous page

`- (p_mn2_ox_mos)*(0.5) /(cgt_cellheight*cgt_density)`	oxidation of Mn2+ to manganese oxide in the sediment
`- (p_pyr_oxo2_ihs)*(0.25) /(cgt_cellheight*cgt_density)`	oxidation of pyrite by manganese oxide to iron oxyhydroxide
`- (p_imm_oxo2_ihs)*(0.25) /(cgt_cellheight*cgt_density)`	oxidation of minnesotaite by oxygen to iron oxyhydroxide
`- (p_i2i_oxo2_i3i)*(0.25) /(cgt_cellheight*cgt_density)`	oxidation of iron-II in illite-montmorillonite mixed layer minerals to iron-III
`- (p_aim_nit_no3_sed)*(2) /(cgt_cellheight*cgt_density)`	nitrification in the sediment
`- (p_ims_oxo2_ihs)*(2.25) /(cgt_cellheight*cgt_density)`	iron monosulfide oxidation to iron oxihydroxides
`- p_poc_resp`	respiration of POC

Change of: dissolved inorganic carbon

$\frac{d}{dt}$ `t_dic` =

`+ p_co2_stf_down/(cgt_cellheight cgt_density)`	downward co2 flux through the surface
`+ (p_lpp_resp_nh4)*(rfr_c)`	respiration of large-cell phytoplankton
`+ (p_spp_resp_nh4)*(rfr_c)`	respiration of small-cell phytoplankton
`+ (p_cya_resp_nh4)*(rfr_c)`	respiration of diazotroph cyanobacteria
`+ (p_zoo_resp_nh4)*(rfr_c)`	respiration of zooplankton
`+ (p_sed_1_resp_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ (p_sed_2_resp_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)

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Tracer equations, continued from previous page	
`+ (p_sed_3_resp_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ (p_sed_4_resp_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ (p_sed_5_resp_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ (p_sed_6_resp_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ (p_sed_1_denit_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
`+ (p_sed_2_denit_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
`+ (p_sed_3_denit_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
`+ (p_sed_4_denit_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
`+ (p_sed_5_denit_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
`+ (p_sed_6_denit_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
`+ (p_sed_1_sulf_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

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Tracer equations, continued from previous page	
+ (p_sed_2_sulf_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_3_sulf_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_4_sulf_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_5_sulf_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_6_sulf_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_1_resp_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_det_2_resp_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_det_3_resp_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_det_4_resp_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_det_5_resp_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_det_6_resp_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_det_1_denit_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_2_denit_nh4)* (rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using nitrate (denitrification)

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Tracer equations, continued from previous page	
+ (p_det_3_denit_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_4_denit_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_5_denit_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_6_denit_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of detritus to ammonium using nitrate (denitrification)
+ (p_det_1_sulf_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_2_sulf_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_3_sulf_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_4_sulf_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_5_sulf_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_6_sulf_nh4)*(rfr_pc_enrichment_det*rfr_c)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_1_mnred_mn2)*(rfr_pc_enrichment_det*rfr_c)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_2_mnred_mn2)*(rfr_pc_enrichment_det*rfr_c)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_3_mnred_mn2)*(rfr_pc_enrichment_det*rfr_c)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_4_mnred_mn2)*(rfr_pc_enrichment_det*rfr_c)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)

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Tracer equations, continued from previous page	
+ (p_sed_5_mnred_mn2)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_6_mnred_mn2)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_1_irred_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_2_irred_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_3_irred_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irred_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irred_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irred_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_1_irredips_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_2_irredips_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_3_irredips_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)

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Tracer equations, continued from previous page	
+ (p_sed_4_irredips_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_5_irredips_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_6_irredips_ims)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_1_irred_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_2_irred_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_3_irred_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irred_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irred_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irred_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_1_irredips_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_2_irredips_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page	
+ (p_sed_3_irredips_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irredips_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irredips_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irredips_iim)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_i3i_1_irred_i2i)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ (p_i3i_2_irred_i2i)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ (p_i3i_3_irred_i2i)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ (p_i3i_4_irred_i2i)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ (p_i3i_5_irred_i2i)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ (p_i3i_6_irred_i2i)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ (p_rho_diss_mn2)*(1.6) /(cgt_cellheight*cgt_density)	rhodochrosite dissolution to manganese-II

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Tracer equations, continued from previous page		
	+ (p_sed_1_sulfdeep_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
	+ (p_sed_2_sulfdeep_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
	+ (p_sed_3_sulfdeep_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
	+ (p_sed_4_sulfdeep_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
	+ (p_sed_5_sulfdeep_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
	+ (p_sed_6_sulfdeep_nh4)* (rfr_pc_enrichment_det*rfr_c) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
	+ (p_rho_biores_mow)*(1.6) /(cgt_cellheight*cgt_density)	bio resuspension of rhodochrosite
	+ (p_rho_ero_mow)*(1.6) /(cgt_cellheight*cgt_density)	bio resuspension of rhodochrosite
	+ p_poc_resp	respiration of POC
	+ p_poc_denit	recycling of POC using nitrate (denitrification)
	+ p_poc_sulf	Mineralization of POC, e-acceptor sulfate (sulfate reduction)
	- p_co2_stf_up/(cgt_cellheight* cgt_density)	upward co2 flux through the surface

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Tracer equations, continued from previous page

- (p_no3_assim_lpp)*(rfr_c)	assimilation of nitrate by large-cell phytoplankton
- (p_nh4_assim_lpp)*(rfr_c)	assimilation of ammonium by large-cell phytoplankton
- (p_no3_assim_spp)*(rfr_c)	assimilation of nitrate by small-cell phytoplankton
- (p_nh4_assim_spp)*(rfr_c)	assimilation of ammonium by small-cell phytoplankton
- (p_n2_assim_cya)*(rfr_c)	fixation of dinitrogen by diazotroph cyanobacteria
- (p_mn2_prec_rho)*(1.6) /(cgt_cellheight*cgt_density)	manganese-II precipitation to rhodochrosite
- p_assim_lpp_poc	Production of POC by LPP
- p_assim_spp_poc	Production of POC by SPP
- p_assim_cya_poc	Production of POC by CYA

Change of: ammonium

$\frac{d}{dt}$ t_nh4 =

+ (p_lpp_resp_nh4)*((1-don_fraction))	respiration of large-cell phytoplankton
+ (p_spp_resp_nh4)*((1-don_fraction))	respiration of small-cell phytoplankton
+ (p_cya_resp_nh4)*((1-don_fraction))	respiration of diazotroph cyanobacteria
+ (p_zoo_resp_nh4)*((1-don_fraction))	respiration of zooplankton
+ p_don_rec_nh4	mineralization of DON
+ (p_lpp_mort_det_1)*((1.0-(1.0/rfr_pc_enrichment_det)))	mortality of large-cell phytoplankton

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Tracer equations, continued from previous page	
`+ (p_lpp_mort_det_2)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton
`+ (p_lpp_mort_det_3)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton
`+ (p_lpp_mort_det_4)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton
`+ (p_lpp_mort_det_5)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton
`+ (p_lpp_mort_det_6)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton
`+ (p_spp_mort_det_1)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of small-scale phytoplankton
`+ (p_spp_mort_det_2)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of small-scale phytoplankton
`+ (p_spp_mort_det_3)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of small-scale phytoplankton
`+ (p_spp_mort_det_4)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of small-scale phytoplankton
`+ (p_spp_mort_det_5)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of small-scale phytoplankton
`+ (p_spp_mort_det_6)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of small-scale phytoplankton
`+ (p_cya_mort_det_1)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of diazotroph cyanobacteria
`+ (p_cya_mort_det_2)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of diazotroph cyanobacteria
`+ (p_cya_mort_det_3)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of diazotroph cyanobacteria
`+ (p_cya_mort_det_4)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of diazotroph cyanobacteria

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Tracer equations, continued from previous page	
`+ (p_cya_mort_det_5)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of diazotroph cyanobacteria
`+ (p_cya_mort_det_6)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of diazotroph cyanobacteria
`+ (p_zoo_mort_det_1)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of zooplankton
`+ (p_zoo_mort_det_2)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of zooplankton
`+ (p_zoo_mort_det_3)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of zooplankton
`+ (p_zoo_mort_det_4)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of zooplankton
`+ (p_zoo_mort_det_5)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of zooplankton
`+ (p_zoo_mort_det_6)*((1.0-(1.0/rfr_pc_enrichment_det)))`	mortality of zooplankton
`+ p_sed_1_resp_nh4/(cgt_cellheig cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ p_sed_2_resp_nh4/(cgt_cellheig cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ p_sed_3_resp_nh4/(cgt_cellheig cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ p_sed_4_resp_nh4/(cgt_cellheig cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
`+ p_sed_5_resp_nh4/(cgt_cellheig cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration)

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Tracer equations, continued from previous page	
+ p_sed_6_resp_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
+ p_sed_1_denit_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ p_sed_2_denit_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ p_sed_3_denit_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ p_sed_4_denit_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ p_sed_5_denit_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ p_sed_6_denit_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ p_sed_1_sulf_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_sed_2_sulf_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_sed_3_sulf_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_sed_4_sulf_nh4/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

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Tracer equations, continued from previous page	
+ p_sed_5_sulf_nh4/(cgt_cellheig cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_sed_6_sulf_nh4/(cgt_cellheig cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_det_1_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
+ p_det_2_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
+ p_det_3_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
+ p_det_4_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
+ p_det_5_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
+ p_det_6_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
+ p_det_1_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
+ p_det_2_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
+ p_det_3_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
+ p_det_4_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
+ p_det_5_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
+ p_det_6_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)

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Tracer equations, continued from previous page	
+ p_det_1_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_det_2_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_det_3_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_det_4_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_det_5_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_det_6_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_sed_1_mnred_mn2/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ p_sed_2_mnred_mn2/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ p_sed_3_mnred_mn2/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ p_sed_4_mnred_mn2/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ p_sed_5_mnred_mn2/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ p_sed_6_mnred_mn2/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ p_sed_1_irred_ims/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page	
+ p_sed_2_irred_ims/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_3_irred_ims/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_4_irred_ims/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_5_irred_ims/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_6_irred_ims/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_1_irredips_ims/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ p_sed_2_irredips_ims/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ p_sed_3_irredips_ims/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ p_sed_4_irredips_ims/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ p_sed_5_irredips_ims/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ p_sed_6_irredips_ims/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)

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Tracer equations, continued from previous page	
+ p_sed_1_irred_iim/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_2_irred_iim/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_3_irred_iim/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_4_irred_iim/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_5_irred_iim/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_6_irred_iim/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_1_irredips_iim/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_2_irredips_iim/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_3_irredips_iim/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_4_irredips_iim/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_sed_5_irredips_iim/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page

+ p_sed_6_irredips_iim/(cgt_cell cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_i3i_1_irred_i2i/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ p_i3i_2_irred_i2i/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ p_i3i_3_irred_i2i/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ p_i3i_4_irred_i2i/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ p_i3i_5_irred_i2i/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ p_i3i_6_irred_i2i/(cgt_cellhei cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ p_aim_lib_nh4/(cgt_cellheight* cgt_density)	ammonium liberation from illite-montmorillonite mixed layer minerals
+ p_sed_1_sulfdeep_nh4/(cgt_cell cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ p_sed_2_sulfdeep_nh4/(cgt_cell cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ p_sed_3_sulfdeep_nh4/(cgt_cell cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

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Tracer equations, continued from previous page	
+ p_sed_4_sulfdeep_nh4/(cgt_cell cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ p_sed_5_sulfdeep_nh4/(cgt_cell cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ p_sed_6_sulfdeep_nh4/(cgt_cell cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
- p_nh4_assim_lpp	assimilation of ammonium by large-cell phytoplankton
- p_nh4_assim_spp	assimilation of ammonium by small-cell phytoplankton
- p_nh4_nit_no3	nitrification
- p_nh4_nit_no3_sed	nitrification in the sediment
- p_nh4_ads_aim/(cgt_cellheight* cgt_density)	ammonium adsorption to illite-montmorillonite mixed layer minerals

Change of: nitrate

$\frac{d}{dt}$ t_no3 =

+ p_nh4_nit_no3	nitrification
+ p_nh4_nit_no3_sed	nitrification in the sediment
+ p_aim_nit_no3_sed/(cgt_cellhei cgt_density)	nitrification in the sediment
- p_no3_assim_lpp	assimilation of nitrate by large-cell phytoplankton
- p_no3_assim_spp	assimilation of nitrate by small-cell phytoplankton

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Tracer equations, continued from previous page	
- (p_sed_1_denit_nh4)* (rfr_pc_enrichment_det*5.3) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- (p_sed_2_denit_nh4)* (rfr_pc_enrichment_det*5.3) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- (p_sed_3_denit_nh4)* (rfr_pc_enrichment_det*5.3) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- (p_sed_4_denit_nh4)* (rfr_pc_enrichment_det*5.3) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- (p_sed_5_denit_nh4)* (rfr_pc_enrichment_det*5.3) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- (p_sed_6_denit_nh4)* (rfr_pc_enrichment_det*5.3) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- (p_h2s_oxno3_sul)*(0.4)	oxidation of hydrogen sulfide with nitrate
- (p_sul_oxno3_so4)*(1.2)	oxidation of elemental sulfur with nitrate
- (p_det_1_denit_nh4)* (rfr_pc_enrichment_det*5.3)	recycling of detritus to ammonium using nitrate (denitrification)
- (p_det_2_denit_nh4)* (rfr_pc_enrichment_det*5.3)	recycling of detritus to ammonium using nitrate (denitrification)
- (p_det_3_denit_nh4)* (rfr_pc_enrichment_det*5.3)	recycling of detritus to ammonium using nitrate (denitrification)
- (p_det_4_denit_nh4)* (rfr_pc_enrichment_det*5.3)	recycling of detritus to ammonium using nitrate (denitrification)
- (p_det_5_denit_nh4)* (rfr_pc_enrichment_det*5.3)	recycling of detritus to ammonium using nitrate (denitrification)

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Tracer equations, continued from previous page

`- (p_det_6_denit_nh4)*(rfr_pc_enrichment_det*5.3)`	recycling of detritus to ammonium using nitrate (denitrification)
`- (p_poc_denit)*(0.8)`	recycling of POC using nitrate (denitrification)

Change of: phosphate

$\frac{d}{dt}$ `t_po4` =

`+ (p_lpp_resp_nh4)*(rfr_p)`	respiration of large-cell phytoplankton
`+ (p_spp_resp_nh4)*(rfr_p)`	respiration of small-cell phytoplankton
`+ (p_cya_resp_nh4)*(rfr_p)`	respiration of diazotroph cyanobacteria
`+ (p_zoo_resp_nh4)*(rfr_p)`	respiration of zooplankton
`+ (p_sed_1_irredips_ims)*(26.5*rfr_pc_enrichment_det)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_2_irredips_ims)*(26.5*rfr_pc_enrichment_det)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_3_irredips_ims)*(26.5*rfr_pc_enrichment_det)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_4_irredips_ims)*(26.5*rfr_pc_enrichment_det)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_5_irredips_ims)*(26.5*rfr_pc_enrichment_det)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_6_irredips_ims)*(26.5*rfr_pc_enrichment_det)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_1_irredips_iim)*(rfr_pc_enrichment_det*26.5)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page	
+ (p_sed_2_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_3_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ p_ips_diss_po4/(cgt_cellheight cgt_density)	dissolution of iron phosphate
+ p_ipw_diss_po4	dissolution of iron phosphate
+ p_pim_lib_po4/(cgt_cellheight* cgt_density)	phosphate liberation from illite-montmorillonite mixed layer minerals
+ (p_detp_1_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_detp_2_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_detp_3_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_detp_4_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_detp_5_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration)

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Tracer equations, continued from previous page	
+ (p_detp_6_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration)
+ (p_sedp_1_remin_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate
+ (p_sedp_2_remin_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate
+ (p_sedp_3_remin_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate
+ (p_sedp_4_remin_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate
+ (p_sedp_5_remin_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate
+ (p_sedp_6_remin_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate
+ (p_sedp_1_sulfdeep_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sedp_2_sulfdeep_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sedp_3_sulfdeep_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

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Tracer equations, continued from previous page	
+ (p_sedp_4_sulfdeep_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sedp_5_sulfdeep_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sedp_6_sulfdeep_po4)* (rfr_pc_enrichment_det*rfr_p) /(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
- (p_no3_assim_lpp)*(rfr_p)	assimilation of nitrate by large-cell phytoplankton
- (p_nh4_assim_lpp)*(rfr_p)	assimilation of ammonium by large-cell phytoplankton
- (p_no3_assim_spp)*(rfr_p)	assimilation of nitrate by small-cell phytoplankton
- (p_nh4_assim_spp)*(rfr_p)	assimilation of ammonium by small-cell phytoplankton
- (p_n2_assim_cya)*(rfr_p)	fixation of dinitrogen by diazotroph cyanobacteria
- p_po4_ads_ips/(cgt_cellheight* cgt_density)	adsorption of phosphate to iron hydroxide particles
- p_po4_ads_ipw	adsorption of phosphate to iron hydroxide particles
- p_po4_ads_pim/(cgt_cellheight* cgt_density)	phosphate adsorption to illite-montmorillonite mixed layer minerals

Change of: small-cell phytoplankton

$\frac{d}{dt}$ t_spp =

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Tracer equations, continued from previous page

+ p_no3_assim_spp	assimilation of nitrate by small-cell phytoplankton
+ p_nh4_assim_spp	assimilation of ammonium by small-cell phytoplankton
- p_spp_graz_zoo	grazing of zooplankton eating small-cell phytoplankton
- p_spp_resp_nh4	respiration of small-cell phytoplankton
- p_spp_mort_det_1	mortality of small-scale phytoplankton
- p_spp_mort_det_2	mortality of small-scale phytoplankton
- p_spp_mort_det_3	mortality of small-scale phytoplankton
- p_spp_mort_det_4	mortality of small-scale phytoplankton
- p_spp_mort_det_5	mortality of small-scale phytoplankton
- p_spp_mort_det_6	mortality of small-scale phytoplankton

Change of: zooplankton

$\frac{d}{dt}$ t_zoo =

+ p_lpp_graz_zoo	grazing of zooplankton eating large-cell phytoplankton
+ p_spp_graz_zoo	grazing of zooplankton eating small-cell phytoplankton
+ p_cya_graz_zoo	grazing of zooplankton eating diazotroph cyanobacteria
- p_zoo_resp_nh4	respiration of zooplankton
- p_zoo_mort_det_1	mortality of zooplankton
- p_zoo_mort_det_2	mortality of zooplankton
- p_zoo_mort_det_3	mortality of zooplankton
- p_zoo_mort_det_4	mortality of zooplankton

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Tracer equations, continued from previous page

- p_zoo_mort_det_5	mortality of zooplankton
- p_zoo_mort_det_6	mortality of zooplankton

Change of: hydrogen sulfide

$\frac{d}{dt}$ t_h2s =

+ (p_sed_1_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_2_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_3_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_4_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_5_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_6_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_1_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_2_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

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Tracer equations, continued from previous page	
+ (p_det_3_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_4_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_5_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_det_6_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ p_ims_diss_fe2/(cgt_cellheight cgt_density)	dissolution of magnetite to iron II (precipitating iron hydroxides)
+ p_ims_trans_iim/(cgt_cellheight cgt_density)	iron monosulfide transformation to minnesotaite
+ (p_pyr_oxmos_ihs)*(1.625) /(cgt_cellheight*cgt_density)	oxidation of pyrite by manganese oxide to iron oxyhydroxide
+ (p_pyr_oxo2_ihs)*(1.75) /(cgt_cellheight*cgt_density)	oxidation of pyrite by manganese oxide to iron oxyhydroxide
+ (p_sed_1_sulfdeep_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sed_2_sulfdeep_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sed_3_sulfdeep_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

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Tracer equations, continued from previous page	
`+ (p_sed_4_sulfdeep_nh4)*(rfr_pc_enrichment_det*3.3125)/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
`+ (p_sed_5_sulfdeep_nh4)*(rfr_pc_enrichment_det*3.3125)/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
`+ (p_sed_6_sulfdeep_nh4)*(rfr_pc_enrichment_det*3.3125)/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
`+ (p_ims_biores_ihw)*(1.125)/(cgt_cellheight*cgt_density)`	bio resuspension of iron monosulfide
`+ (p_pyr_biores_ihw)*(1.875)/(cgt_cellheight*cgt_density)`	bio resuspension of pyrite
`+ (p_rho_biores_mow)*(0.25)/(cgt_cellheight*cgt_density)`	bio resuspension of rhodochrosite
`+ (p_iim_biores_ihw)*(0.125)/(cgt_cellheight*cgt_density)`	bio resuspension of iron in clay minerals
`+ (p_ims_ero_ihw)*(1.125)/(cgt_cellheight*cgt_density)`	resuspension of iron monusulfide
`+ (p_pyr_ero_ihw)*(1.875)/(cgt_cellheight*cgt_density)`	resuspension of pyrite
`+ (p_rho_ero_mow)*(0.25)/(cgt_cellheight*cgt_density)`	bio resuspension of rhodochrosite
`+ (p_iim_ero_ihw)*(0.125)/(cgt_cellheight*cgt_density)`	bio resuspension of iron in clay minerals
`+ (p_poc_sulf)*(0.5)`	Mineralization of POC, e-acceptor sulfate (sulfate reduction)
`- p_h2s_oxo2_sul`	oxidation of hydrogen sulfide with oxygen

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Tracer equations, continued from previous page	
`- p_h2s_oxno3_sul`	oxidation of hydrogen sulfide with nitrate
`- (p_sed_1_irred_ims)*(26.5* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`- (p_sed_2_irred_ims)*(26.5* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`- (p_sed_3_irred_ims)*(26.5* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`- (p_sed_4_irred_ims)*(26.5* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`- (p_sed_5_irred_ims)*(26.5* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`- (p_sed_6_irred_ims)*(26.5* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`- (p_sed_1_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`- (p_sed_2_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`- (p_sed_3_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`- (p_sed_4_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`- (p_sed_5_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)

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Tracer equations, continued from previous page

- (p_sed_6_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- p_ihs_red_iim/(cgt_cellheight* cgt_density)	reduction of sedimentary iron hydroxide to iron-II
- (p_ihs_red_ims)*(9.0) /(cgt_cellheight*cgt_density)	reduction of sedimentary iron hydroxide to iron-II
- p_fe2_prec_ims/(cgt_cellheight cgt_density)	precipitation of iron II as siderite
- p_iim_trans_ims/(cgt_cellheigh cgt_density)	minnesotaite transformation to iron monosulfide
- (p_ims_form2_pyr)*(0.75) /(cgt_cellheight*cgt_density)	pyrite formation from iron monosulfide
- p_i3i_redh2s_i2i/(cgt_cellheig cgt_density)	reduction of iron-III in clay minerals to iron-II consuming h2s
- p_ihc_red_iim/(cgt_cellheight* cgt_density)	reduction of sedimentary iron hydroxide to iron-II
- (p_ihc_red_ims)*(9.0) /(cgt_cellheight*cgt_density)	reduction of sedimentary iron hydroxide to iron-II
- (p_h2s_mnox_so4)*(0.25) /(cgt_cellheight*cgt_density)	oxidation of h2s by reduction of MnO2

Change of: sulfur

$\frac{d}{dt}$ t_sul =

+ p_h2s_oxo2_sul	oxidation of hydrogen sulfide with oxygen
+ p_h2s_oxno3_sul	oxidation of hydrogen sulfide with nitrate
- p_sul_oxo2_so4	oxidation of elemental sulfur with oxygen

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Tracer equations, continued from previous page	
- p_sul_oxno3_so4	oxidation of elemental sulfur with nitrate

Change of: total alkalinity

$\frac{d}{dt}$ t_alk =

+ (1)*(p_po4_ads_ips)*(3) /(cgt_cellheight*cgt_density)	adsorption of phosphate to iron hydroxide particles (produces ohminus)
+ (1)*(p_po4_ads_ipw)*(3)	adsorption of phosphate to iron hydroxide particles (produces ohminus)
+ (1)*(p_iim_diss_fe2)*(2) /(cgt_cellheight*cgt_density)	dissolution minnesotaite to of iron-II (produces ohminus)
+ (1)*(p_stf_alk)	relax alkalinity to default value to compensate for detritus removal (produces ohminus)
+ (1)*(p_alk_rise_ohmdiff)	rise of total alkalinity by quicker-than-assumed diffusion of OH- (produces ohminus)
+ (1)*(p_aim_lib_nh4) /(cgt_cellheight*cgt_density)	ammonium liberation from illite-montmorillonite mixed layer minerals (produces ohminus)
- (1)*(p_sed_1_irred_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_2_irred_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_3_irred_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_4_irred_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_5_irred_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)

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Tracer equations, continued from previous page	
- (1)*(p_sed_6_irred_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_1_irredips_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_2_irredips_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_3_irredips_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_4_irredips_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_5_irredips_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_sed_6_irredips_iim)* (53*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes ohminus)
- (1)*(p_ips_diss_po4)*(3) /(cgt_cellheight*cgt_density)	dissolution of iron phosphate (consumes ohminus)
- (1)*(p_ipw_diss_po4)*(3)	dissolution of iron phosphate (consumes ohminus)
- (1)*(p_fe2_prec_ims)*(2.0) /(cgt_cellheight*cgt_density)	precipitation of iron II as siderite (consumes ohminus)
- (1)*(p_fe2_prec_iim)*(2) /(cgt_cellheight*cgt_density)	precipitation of iron II as minnesotaite (consumes ohminus)
- (1)*(p_stf_alk_up)	relax alkalinity to default value to compensate for detritus removal (consumes ohminus)

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Tracer equations, continued from previous page	
- (1)*(p_nh4_ads_aim) /(cgt_cellheight*cgt_density)	ammonium adsorption to illite-montmorillonite mixed layer minerals (consumes ohminus)
+ (-1)*(p_nh4_assim_lpp)* (0.8125)	assimilation of ammonium by large-cell phytoplankton (produces h3oplus)
+ (-1)*(p_nh4_assim_spp)* (0.8125)	assimilation of ammonium by small-cell phytoplankton (produces h3oplus)
+ (-1)*(p_nh4_nit_no3)*(2)	nitrification (produces h3oplus)
+ (-1)*(p_nh4_nit_no3_sed)* (2)	nitrification in the sediment (produces h3oplus)
+ (-1)*(p_sul_oxo2_so4)*(2)	oxidation of elemental sulfur with oxygen (produces h3oplus)
+ (-1)*(p_sul_oxno3_so4)* (0.8)	oxidation of elemental sulfur with nitrate (produces h3oplus)
+ (-1)*(p_det_1_resp_nh4)*(0)	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
+ (-1)*(p_det_2_resp_nh4)*(0)	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
+ (-1)*(p_det_3_resp_nh4)*(0)	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
+ (-1)*(p_det_4_resp_nh4)*(0)	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
+ (-1)*(p_det_5_resp_nh4)*(0)	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
+ (-1)*(p_det_6_resp_nh4)*(0)	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
+ (-1)*(p_fe2_ox_ihs)*(2) /(cgt_cellheight*cgt_density)	oxidation of Fe2+ to iron hydroxide in the sediment (produces h3oplus)
+ (-1)*(p_fe2_ox_ihw)*(2)	oxidation of Fe2+ to iron hydroxide in the sediment (produces h3oplus)
+ (-1)*(p_sed_1_irredips_ims) *(238.6875* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces h3oplus)

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+ (-1)*(p_sed_2_irredips_ims) *(238.6875* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_3_irredips_ims) *(238.6875* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_4_irredips_ims) *(238.6875* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_5_irredips_ims) *(238.6875* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_6_irredips_ims) *(238.6875* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_1_irredips_iim) *(79.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_2_irredips_iim) *(79.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_3_irredips_iim) *(79.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_4_irredips_iim) *(79.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces h3oplus)
+ (-1)*(p_sed_5_irredips_iim) *(79.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces h3oplus)

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Tracer equations, continued from previous page	
+ (-1)*(p_sed_6_irredips_iim) *(79.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces h3oplus)
+ (-1)*(p_ihs_red_iim)*(2.0) /(cgt_cellheight*cgt_density)	reduction of sedimentary iron hydroxide to iron-II (produces h3oplus)
+ (-1)*(p_ihs_red_ims)*(2.0) /(cgt_cellheight*cgt_density)	reduction of sedimentary iron hydroxide to iron-II (produces h3oplus)
+ (-1)*(p_mn2_ox_mos)*(2) /(cgt_cellheight*cgt_density)	oxidation of Mn2+ to manganese oxide in the sediment (produces h3oplus)
+ (-1)*(p_alk_fall_ohmdiff)	falling of total alkalinity by quicker-than-assumed diffusion of OH- (produces h3oplus)
+ (-1)*(p_pyr_oxo2_ihs)*(0.5) /(cgt_cellheight*cgt_density)	oxidation of pyrite by manganese oxide to iron oxyhydroxide (produces h3oplus)
+ (-1)*(p_i3i_redh2s_i2i)*(2) /(cgt_cellheight*cgt_density)	reduction of iron-III in clay minerals to iron-II consuming h2s (produces h3oplus)
+ (-1)*(p_ihc_red_iim)*(2.0) /(cgt_cellheight*cgt_density)	reduction of sedimentary iron hydroxide to iron-II (produces h3oplus)
+ (-1)*(p_ihc_red_ims)*(2.0) /(cgt_cellheight*cgt_density)	reduction of sedimentary iron hydroxide to iron-II (produces h3oplus)
+ (-1)*(p_pim_lib_po4)*(3) /(cgt_cellheight*cgt_density)	phosphate liberation from illite-montmorillonite mixed layer minerals (produces h3oplus)
+ (-1)*(p_aim_nit_no3_sed) /(cgt_cellheight*cgt_density)	nitrification in the sediment (produces h3oplus)
+ (-1)*(p_fe2_mnox_ihs)*(2.0) /(cgt_cellheight*cgt_density)	oxidation of Fe2+ by reduction of MnO2 (produces h3oplus)
+ (-1)*(p_ims_oxo2_ihs)*(2) /(cgt_cellheight*cgt_density)	iron monosulfide oxidation to iron oxihydroxides (produces h3oplus)
+ (-1)*(p_detp_1_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)

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Tracer equations, continued from previous page	
`+ (-1)*(p_detp_2_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)`	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
`+ (-1)*(p_detp_3_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)`	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
`+ (-1)*(p_detp_4_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)`	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
`+ (-1)*(p_detp_5_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)`	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
`+ (-1)*(p_detp_6_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)`	recycling of detritus to ammonium using oxygen (respiration) (produces h3oplus)
`+ (-1)*(p_sedp_1_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)`	recycling of sediment detrital phosphate (produces h3oplus)
`+ (-1)*(p_sedp_2_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)`	recycling of sediment detrital phosphate (produces h3oplus)
`+ (-1)*(p_sedp_3_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)`	recycling of sediment detrital phosphate (produces h3oplus)
`+ (-1)*(p_sedp_4_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)`	recycling of sediment detrital phosphate (produces h3oplus)
`+ (-1)*(p_sedp_5_remin_po4)* (3*rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)`	recycling of sediment detrital phosphate (produces h3oplus)

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Tracer equations, continued from previous page	
+ (-1)*(p_sedp_6_remin_po4)*(3*rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate (produces h3oplus)
+ (-1)*(p_mn2_prec_rho)*(3.2)/(cgt_cellheight*cgt_density)	manganese-II precipitation to rhodochrosite (produces h3oplus)
+ (-1)*(p_sedp_1_sulfdeep_po4)*(3*rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces h3oplus)
+ (-1)*(p_sedp_2_sulfdeep_po4)*(3*rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces h3oplus)
+ (-1)*(p_sedp_3_sulfdeep_po4)*(3*rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces h3oplus)
+ (-1)*(p_sedp_4_sulfdeep_po4)*(3*rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces h3oplus)
+ (-1)*(p_sedp_5_sulfdeep_po4)*(3*rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces h3oplus)
+ (-1)*(p_sedp_6_sulfdeep_po4)*(3*rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces h3oplus)
+ (-1)*(p_pyr_biores_ihw)*(0.25)/(cgt_cellheight*cgt_density)	bio resuspension of pyrite (produces h3oplus)

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Tracer equations, continued from previous page	
`+ (-1)*(p_pyr_ero_ihw)*(0.25) /(cgt_cellheight*cgt_density)`	resuspension of pyrite (produces h3oplus)
`- (-1)*(p_no3_assim_lpp)* (1.1875)`	assimilation of nitrate by large-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_no3_assim_spp)* (1.1875)`	assimilation of nitrate by small-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_n2_assim_cya)* (0.1875)`	fixation of dinitrogen by diazotroph cyanobacteria (consumes h3oplus)
`- (-1)*(p_lpp_resp_nh4)* (0.8125)`	respiration of large-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_spp_resp_nh4)* (0.8125)`	respiration of small-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_cya_resp_nh4)* (0.8125)`	respiration of diazotroph cyanobacteria (consumes h3oplus)
`- (-1)*(p_zoo_resp_nh4)* (0.8125)`	respiration of zooplankton (consumes h3oplus)
`- (-1)*(p_lpp_mort_det_1)* ((1.0- (1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_lpp_mort_det_2)* ((1.0- (1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_lpp_mort_det_3)* ((1.0- (1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_lpp_mort_det_4)* ((1.0- (1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton (consumes h3oplus)
`- (-1)*(p_lpp_mort_det_5)* ((1.0- (1.0/rfr_pc_enrichment_det)))`	mortality of large-cell phytoplankton (consumes h3oplus)

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Tracer equations, continued from previous page	
- (-1)*(p_lpp_mort_det_6)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of large-cell phytoplankton (consumes h3oplus)
- (-1)*(p_spp_mort_det_1)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of small-scale phytoplankton (consumes h3oplus)
- (-1)*(p_spp_mort_det_2)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of small-scale phytoplankton (consumes h3oplus)
- (-1)*(p_spp_mort_det_3)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of small-scale phytoplankton (consumes h3oplus)
- (-1)*(p_spp_mort_det_4)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of small-scale phytoplankton (consumes h3oplus)
- (-1)*(p_spp_mort_det_5)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of small-scale phytoplankton (consumes h3oplus)
- (-1)*(p_spp_mort_det_6)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of small-scale phytoplankton (consumes h3oplus)
- (-1)*(p_cya_mort_det_1)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of diazotroph cyanobacteria (consumes h3oplus)
- (-1)*(p_cya_mort_det_2)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of diazotroph cyanobacteria (consumes h3oplus)
- (-1)*(p_cya_mort_det_3)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of diazotroph cyanobacteria (consumes h3oplus)
- (-1)*(p_cya_mort_det_4)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of diazotroph cyanobacteria (consumes h3oplus)

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Tracer equations, continued from previous page	
- (-1)*(p_cya_mort_det_5)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of diazotroph cyanobacteria (consumes h3oplus)
- (-1)*(p_cya_mort_det_6)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of diazotroph cyanobacteria (consumes h3oplus)
- (-1)*(p_zoo_mort_det_1)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of zooplankton (consumes h3oplus)
- (-1)*(p_zoo_mort_det_2)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of zooplankton (consumes h3oplus)
- (-1)*(p_zoo_mort_det_3)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of zooplankton (consumes h3oplus)
- (-1)*(p_zoo_mort_det_4)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of zooplankton (consumes h3oplus)
- (-1)*(p_zoo_mort_det_5)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of zooplankton (consumes h3oplus)
- (-1)*(p_zoo_mort_det_6)* ((1.0- (1.0/rfr_pc_enrichment_det)))	mortality of zooplankton (consumes h3oplus)
- (-1)*(p_sed_1_resp_nh4) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration) (consumes h3oplus)
- (-1)*(p_sed_2_resp_nh4) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration) (consumes h3oplus)
- (-1)*(p_sed_3_resp_nh4) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration) (consumes h3oplus)
- (-1)*(p_sed_4_resp_nh4) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration) (consumes h3oplus)

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Tracer equations, continued from previous page	
`- (-1)*(p_sed_5_resp_nh4) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_sed_6_resp_nh4) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_sed_1_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
`- (-1)*(p_sed_2_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
`- (-1)*(p_sed_3_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
`- (-1)*(p_sed_4_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
`- (-1)*(p_sed_5_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
`- (-1)*(p_sed_6_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
`- (-1)*(p_sed_1_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
`- (-1)*(p_sed_2_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)

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Tracer equations, continued from previous page	
`- (-1)*(p_sed_3_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
`- (-1)*(p_sed_4_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
`- (-1)*(p_sed_5_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
`- (-1)*(p_sed_6_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
`- (-1)*(p_h2s_oxno3_sul)* (0.4)`	oxidation of hydrogen sulfide with nitrate (consumes h3oplus)
`- (-1)*(p_det_1_resp_nh4)`	recycling of detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_det_2_resp_nh4)`	recycling of detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_det_3_resp_nh4)`	recycling of detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_det_4_resp_nh4)`	recycling of detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_det_5_resp_nh4)`	recycling of detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_det_6_resp_nh4)`	recycling of detritus to ammonium using oxygen (respiration) (consumes h3oplus)
`- (-1)*(p_det_1_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det))`	recycling of detritus to ammonium using nitrate (denitrification) (consumes h3oplus)

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Tracer equations, continued from previous page	
- (-1)*(p_det_2_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det))	recycling of detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
- (-1)*(p_det_3_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det))	recycling of detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
- (-1)*(p_det_4_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det))	recycling of detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
- (-1)*(p_det_5_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det))	recycling of detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
- (-1)*(p_det_6_denit_nh4)* ((1.0+5.3* rfr_pc_enrichment_det))	recycling of detritus to ammonium using nitrate (denitrification) (consumes h3oplus)
- (-1)*(p_det_1_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
- (-1)*(p_det_2_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
- (-1)*(p_det_3_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
- (-1)*(p_det_4_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
- (-1)*(p_det_5_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)
- (-1)*(p_det_6_sulf_nh4)* ((1.0+rfr_pc_enrichment_det* 6.625))	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction) (consumes h3oplus)

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Tracer equations, continued from previous page	
- (-1)*(p_sed_1_mnred_mn2)* ((1.0+26.5* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction) (consumes h3oplus)
- (-1)*(p_sed_2_mnred_mn2)* ((1.0+26.5* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction) (consumes h3oplus)
- (-1)*(p_sed_3_mnred_mn2)* ((1.0+26.5* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction) (consumes h3oplus)
- (-1)*(p_sed_4_mnred_mn2)* ((1.0+26.5* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction) (consumes h3oplus)
- (-1)*(p_sed_5_mnred_mn2)* ((1.0+26.5* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction) (consumes h3oplus)
- (-1)*(p_sed_6_mnred_mn2)* ((1.0+26.5* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction) (consumes h3oplus)
- (-1)*(p_sed_1_irred_ims) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_2_irred_ims) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_3_irred_ims) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)

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Tracer equations, continued from previous page	
- (-1)*(p_sed_4_irred_ims) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_5_irred_ims) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_6_irred_ims) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_1_irredips_ims) *((1.0+159.1875* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_2_irredips_ims) *((1.0+159.1875* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_3_irredips_ims) *((1.0+159.1875* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_4_irredips_ims) *((1.0+159.1875* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_5_irredips_ims) *((1.0+159.1875* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_6_irredips_ims) *((1.0+159.1875* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (consumes h3oplus)

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Tracer equations, continued from previous page	
- (-1)*(p_sed_1_irred_iim)* (53.0*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_1_irred_iim) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_2_irred_iim)* (53.0*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_2_irred_iim) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_3_irred_iim)* (53.0*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_3_irred_iim) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_4_irred_iim)* (53.0*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_4_irred_iim) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_5_irred_iim)* (53.0*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_5_irred_iim) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
- (-1)*(p_sed_6_irred_iim)* (53.0*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)

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Tracer equations, continued from previous page	
`- (-1)*(p_sed_6_irred_iim) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
`- (-1)*(p_sed_1_irredips_iim) *((1+53.0* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
`- (-1)*(p_sed_2_irredips_iim) *((1+53.0* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
`- (-1)*(p_sed_3_irredips_iim) *((1+53.0* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
`- (-1)*(p_sed_4_irredips_iim) *((1+53.0* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
`- (-1)*(p_sed_5_irredips_iim) *((1+53.0* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
`- (-1)*(p_sed_6_irredips_iim) *((1+53.0* rfr_pc_enrichment_det)) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (consumes h3oplus)
`- (-1)*(p_i3i_1_irred_i2i) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction) (consumes h3oplus)
`- (-1)*(p_i3i_2_irred_i2i) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction) (consumes h3oplus)

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Tracer equations, continued from previous page	
`- (-1)*(p_i3i_3_irred_i2i) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction) (consumes h3oplus)
`- (-1)*(p_i3i_4_irred_i2i) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction) (consumes h3oplus)
`- (-1)*(p_i3i_5_irred_i2i) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction) (consumes h3oplus)
`- (-1)*(p_i3i_6_irred_i2i) /(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction) (consumes h3oplus)
`- (-1)*(p_ims_diss_fe2)*(2.0) /(cgt_cellheight*cgt_density)`	dissolution of magnetite to iron II (precipitating iron hydroxides) (consumes h3oplus)
`- (-1)*(p_rho_diss_mn2)*(3.2) /(cgt_cellheight*cgt_density)`	rhodochrosite dissolution to manganese-II (consumes h3oplus)
`- (-1)*(p_ims_form2_pyr)* (0.5)/(cgt_cellheight* cgt_density)`	pyrite formation from iron monosulfide (consumes h3oplus)
`- (-1)*(p_pyr_oxmos_ihs)* (1.25)/(cgt_cellheight* cgt_density)`	oxidation of pyrite by manganese oxide to iron oxyhydroxide (consumes h3oplus)
`- (-1)*(p_po4_ads_pim)*(3) /(cgt_cellheight*cgt_density)`	phosphate adsorption to illite-montmorillonite mixed layer minerals (consumes h3oplus)
`- (-1)*(p_h2s_mnox_so4)*(1.5) /(cgt_cellheight*cgt_density)`	oxidation of h2s by reduction of MnO2 (consumes h3oplus)
`- (-1)*(p_sed_1_sulfdeep_nh4) *((1.0+rfr_pc_enrichment_det* 6.625))/(cgt_cellheight* cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (consumes h3oplus)

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Tracer equations, continued from previous page	
`- (-1)*(p_sed_2_sulfdeep_nh4)*((1.0+rfr_pc_enrichment_det*6.625))/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (consumes h3oplus)
`- (-1)*(p_sed_3_sulfdeep_nh4)*((1.0+rfr_pc_enrichment_det*6.625))/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (consumes h3oplus)
`- (-1)*(p_sed_4_sulfdeep_nh4)*((1.0+rfr_pc_enrichment_det*6.625))/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (consumes h3oplus)
`- (-1)*(p_sed_5_sulfdeep_nh4)*((1.0+rfr_pc_enrichment_det*6.625))/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (consumes h3oplus)
`- (-1)*(p_sed_6_sulfdeep_nh4)*((1.0+rfr_pc_enrichment_det*6.625))/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (consumes h3oplus)
`- (-1)*(p_ims_biores_ihw)*(0.25)/(cgt_cellheight*cgt_density)`	bio resuspension of iron monosulfide (consumes h3oplus)
`- (-1)*(p_rho_biores_mow)*(1.7)/(cgt_cellheight*cgt_density)`	bio resuspension of rhodochrosite (consumes h3oplus)
`- (-1)*(p_iim_biores_ihw)*(0.25)/(cgt_cellheight*cgt_density)`	bio resuspension of iron in clay minerals (consumes h3oplus)
`- (-1)*(p_ims_ero_ihw)*(0.25)/(cgt_cellheight*cgt_density)`	resuspension of iron monusulfide (consumes h3oplus)
`- (-1)*(p_rho_ero_mow)*(1.7)/(cgt_cellheight*cgt_density)`	bio resuspension of rhodochrosite (consumes h3oplus)

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Tracer equations, continued from previous page	
- (-1)*(p_iim_ero_ihw)*(0.25) /(cgt_cellheight*cgt_density)	bio resuspension of iron in clay minerals (consumes h3oplus)
- (-1)*(p_poc_denit)*(0.8)	recycling of POC using nitrate (denitrification) (consumes h3oplus)
- (-1)*(p_poc_sulf)	Mineralization of POC, e-acceptor sulfate (sulfate reduction) (consumes h3oplus)
+ (2)*(p_lpp_resp_nh4)* (rfr_p)	respiration of large-cell phytoplankton (produces t_po4)
+ (2)*(p_spp_resp_nh4)* (rfr_p)	respiration of small-cell phytoplankton (produces t_po4)
+ (2)*(p_cya_resp_nh4)* (rfr_p)	respiration of diazotroph cyanobacteria (produces t_po4)
+ (2)*(p_zoo_resp_nh4)* (rfr_p)	respiration of zooplankton (produces t_po4)
+ (2)*(p_sed_1_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces t_po4)
+ (2)*(p_sed_2_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces t_po4)
+ (2)*(p_sed_3_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces t_po4)
+ (2)*(p_sed_4_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces t_po4)
+ (2)*(p_sed_5_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces t_po4)
+ (2)*(p_sed_6_irredips_ims)* (26.5*rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction) (produces t_po4)

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Tracer equations, continued from previous page	
+ (2)*(p_sed_1_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces t_po4)
+ (2)*(p_sed_2_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces t_po4)
+ (2)*(p_sed_3_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces t_po4)
+ (2)*(p_sed_4_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces t_po4)
+ (2)*(p_sed_5_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces t_po4)
+ (2)*(p_sed_6_irredips_iim)* (rfr_pc_enrichment_det*26.5) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction) (produces t_po4)
+ (2)*(p_ips_diss_po4) /(cgt_cellheight*cgt_density)	dissolution of iron phosphate (produces t_po4)
+ (2)*(p_ipw_diss_po4)	dissolution of iron phosphate (produces t_po4)
+ (2)*(p_pim_lib_po4) /(cgt_cellheight*cgt_density)	phosphate liberation from illite-montmorillonite mixed layer minerals (produces t_po4)
+ (2)*(p_detp_1_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration) (produces t_po4)
+ (2)*(p_detp_2_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration) (produces t_po4)
+ (2)*(p_detp_3_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration) (produces t_po4)
+ (2)*(p_detp_4_remin_po4)* (rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration) (produces t_po4)

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Tracer equations, continued from previous page	
+ (2)*(p_detp_5_remin_po4)*(rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration) (produces t_po4)
+ (2)*(p_detp_6_remin_po4)*(rfr_pc_enrichment_det*rfr_p)	recycling of detritus to ammonium using oxygen (respiration) (produces t_po4)
+ (2)*(p_sedp_1_remin_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate (produces t_po4)
+ (2)*(p_sedp_2_remin_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate (produces t_po4)
+ (2)*(p_sedp_3_remin_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate (produces t_po4)
+ (2)*(p_sedp_4_remin_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate (produces t_po4)
+ (2)*(p_sedp_5_remin_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate (produces t_po4)
+ (2)*(p_sedp_6_remin_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	recycling of sediment detrital phosphate (produces t_po4)
+ (2)*(p_sedp_1_sulfdeep_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces t_po4)
+ (2)*(p_sedp_2_sulfdeep_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces t_po4)
+ (2)*(p_sedp_3_sulfdeep_po4)*(rfr_pc_enrichment_det*rfr_p)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces t_po4)

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Tracer equations, continued from previous page	
+ (2)*(p_sedp_4_sulfdeep_po4) *(rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces t__po4)
+ (2)*(p_sedp_5_sulfdeep_po4) *(rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces t__po4)
+ (2)*(p_sedp_6_sulfdeep_po4) *(rfr_pc_enrichment_det* rfr_p)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation) (produces t__po4)
- (2)*(p_no3_assim_lpp)* (rfr_p)	assimilation of nitrate by large-cell phytoplankton (consumes t__po4)
- (2)*(p_nh4_assim_lpp)* (rfr_p)	assimilation of ammonium by large-cell phytoplankton (consumes t__po4)
- (2)*(p_no3_assim_spp)* (rfr_p)	assimilation of nitrate by small-cell phytoplankton (consumes t__po4)
- (2)*(p_nh4_assim_spp)* (rfr_p)	assimilation of ammonium by small-cell phytoplankton (consumes t__po4)
- (2)*(p_n2_assim_cya)* (rfr_p)	fixation of dinitrogen by diazotroph cyanobacteria (consumes t__po4)
- (2)*(p_po4_ads_ips) /(cgt_cellheight*cgt_density)	adsorption of phosphate to iron hydroxide particles (consumes t__po4)
- (2)*(p_po4_ads_ipw)	adsorption of phosphate to iron hydroxide particles (consumes t__po4)
- (2)*(p_po4_ads_pim) /(cgt_cellheight*cgt_density)	phosphate adsorption to illite-montmorillonite mixed layer minerals (consumes t__po4)

Change of: iron-bound phosphate in the sediment

$\frac{d}{dt}$ t_ips =

+ p_ipw_sedi_ips	sedimentation of iron PO4

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Tracer equations, continued from previous page	
+ p_po4_ads_ips	adsorption of phosphate to iron hydroxide particles
- p_ips_ero_ipw	erosion of iron PO4
- p_ips_biores_ipw	bio resuspension of iron PO4
- (p_sed_1_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- (p_sed_2_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- (p_sed_3_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- (p_sed_4_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- (p_sed_5_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- (p_sed_6_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- (p_sed_1_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_2_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_3_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_4_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_5_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_6_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_ips_diss_po4	dissolution of iron phosphate

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Tracer equations, continued from previous page	
- p_ips_removal	transport from fluffy layer to deep basins

Change of: sulfate

$\frac{d}{dt}$ t_so4 =

+ p_sul_oxo2_so4	oxidation of elemental sulfur with oxygen
+ p_sul_oxno3_so4	oxidation of elemental sulfur with nitrate
+ p_ihs_red_iim/(cgt_cellheight* cgt_density)	reduction of sedimentary iron hydroxide to iron-II
+ p_ihs_red_ims/(cgt_cellheight* cgt_density)	reduction of sedimentary iron hydroxide to iron-II
+ p_so4_relax_upwards	raise SO4 concentration in the water column to salinity-determined default value
+ (p_pyr_oxmos_ihs)*(0.375) /(cgt_cellheight*cgt_density)	oxidation of pyrite by manganese oxide to iron oxyhydroxide
+ (p_pyr_oxo2_ihs)*(0.25) /(cgt_cellheight*cgt_density)	oxidation of pyrite by manganese oxide to iron oxyhydroxide
+ p_i3i_redh2s_i2i/(cgt_cellheig cgt_density)	reduction of iron-III in clay minerals to iron-II consuming h2s
+ p_ihc_red_iim/(cgt_cellheight* cgt_density)	reduction of sedimentary iron hydroxide to iron-II
+ p_ihc_red_ims/(cgt_cellheight* cgt_density)	reduction of sedimentary iron hydroxide to iron-II
+ (p_h2s_mnox_so4)*(0.25) /(cgt_cellheight*cgt_density)	oxidation of h2s by reduction of MnO2
+ p_ims_oxo2_ihs/(cgt_cellheight cgt_density)	iron monosulfide oxidation to iron oxihydroxides

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Tracer equations, continued from previous page	
`+ (p_pyr_biores_ihw)*(0.125) /(cgt_cellheight*cgt_density)`	bio resuspension of pyrite
`+ (p_pyr_ero_ihw)*(0.125) /(cgt_cellheight*cgt_density)`	resuspension of pyrite
`- (p_sed_1_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
`- (p_sed_2_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
`- (p_sed_3_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
`- (p_sed_4_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
`- (p_sed_5_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
`- (p_sed_6_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
`- (p_det_1_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
`- (p_det_2_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

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Tracer equations, continued from previous page	
- (p_det_3_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- (p_det_4_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- (p_det_5_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- (p_det_6_sulf_nh4)* (rfr_pc_enrichment_det* 3.3125)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- p_so4_relax_downwards	lower SO4 concentration in the water column to salinity-determined default value
- (p_ims_form2_pyr)*(0.25) /(cgt_cellheight*cgt_density)	pyrite formation from iron monosulfide
- (p_sed_1_sulfdeep_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
- (p_sed_2_sulfdeep_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
- (p_sed_3_sulfdeep_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
- (p_sed_4_sulfdeep_nh4)* (rfr_pc_enrichment_det* 3.3125)/(cgt_cellheight* cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

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Tracer equations, continued from previous page	
`- (p_sed_5_sulfdeep_nh4)*(rfr_pc_enrichment_det*3.3125)/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
`- (p_sed_6_sulfdeep_nh4)*(rfr_pc_enrichment_det*3.3125)/(cgt_cellheight*cgt_density)`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
`- (p_ims_biores_ihw)*(0.125)/(cgt_cellheight*cgt_density)`	bio resuspension of iron monosulfide
`- (p_rho_biores_mow)*(0.25)/(cgt_cellheight*cgt_density)`	bio resuspension of rhodochrosite
`- (p_iim_biores_ihw)*(0.125)/(cgt_cellheight*cgt_density)`	bio resuspension of iron in clay minerals
`- (p_ims_ero_ihw)*(0.125)/(cgt_cellheight*cgt_density)`	resuspension of iron monusulfide
`- (p_rho_ero_mow)*(0.25)/(cgt_cellheight*cgt_density)`	bio resuspension of rhodochrosite
`- (p_iim_ero_ihw)*(0.125)/(cgt_cellheight*cgt_density)`	bio resuspension of iron in clay minerals
`- (p_poc_sulf)*(0.5)`	Mineralization of POC, e-acceptor sulfate (sulfate reduction)

Change of: suspended iron phosphate

$\frac{d}{dt}$ `t_ipw` =

`+ p_ips_ero_ipw/(cgt_cellheight*cgt_density)`	erosion of iron PO4
`+ p_ips_biores_ipw/(cgt_cellheig` `cgt_density)`	bio resuspension of iron PO4
`+ p_po4_ads_ipw`	adsorption of phosphate to iron hydroxide particles

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Tracer equations, continued from previous page

- p_ipw_sedi_ips/(cgt_cellheight cgt_density)	sedimentation of iron PO4
- p_ipw_diss_po4	dissolution of iron phosphate

Change of: large-cell phytoplankton

$\frac{d}{dt}$ t_lpp =

+ p_no3_assim_lpp	assimilation of nitrate by large-cell phytoplankton
+ p_nh4_assim_lpp	assimilation of ammonium by large-cell phytoplankton
- p_lpp_graz_zoo	grazing of zooplankton eating large-cell phytoplankton
- p_lpp_resp_nh4	respiration of large-cell phytoplankton
- p_lpp_mort_det_1	mortality of large-cell phytoplankton
- p_lpp_mort_det_2	mortality of large-cell phytoplankton
- p_lpp_mort_det_3	mortality of large-cell phytoplankton
- p_lpp_mort_det_4	mortality of large-cell phytoplankton
- p_lpp_mort_det_5	mortality of large-cell phytoplankton
- p_lpp_mort_det_6	mortality of large-cell phytoplankton

Change of: diazotroph cyanobacteria

$\frac{d}{dt}$ t_cya =

+ p_n2_assim_cya	fixation of dinitrogen by diazotroph cyanobacteria
- p_cya_graz_zoo	grazing of zooplankton eating diazotroph cyanobacteria
- p_cya_resp_nh4	respiration of diazotroph cyanobacteria
- p_cya_mort_det_1	mortality of diazotroph cyanobacteria

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Tracer equations, continued from previous page	
- p_cya_mort_det_2	mortality of diazotroph cyanobacteria
- p_cya_mort_det_3	mortality of diazotroph cyanobacteria
- p_cya_mort_det_4	mortality of diazotroph cyanobacteria
- p_cya_mort_det_5	mortality of diazotroph cyanobacteria
- p_cya_mort_det_6	mortality of diazotroph cyanobacteria

Change of: detritus fractions_1

$\frac{d}{dt}$ t_det_1 =

+ (p_lpp_mort_det_1)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_1)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_1)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_1)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sed_1_ero_det/(cgt_cellheigh cgt_density)	sedimentary detritus erosion
+ p_sed_1_biores_det/(cgt_cellhe cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_1/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_det_1_sedi_sed/(cgt_cellheig cgt_density)	detritus sedimentation
- p_det_1_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)

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Tracer equations, continued from previous page

- p_det_1_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
- p_det_1_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

Change of: detritus fractions_2

$\frac{d}{dt}$ t_det_2 =

+ (p_lpp_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sed_2_ero_det/(cgt_cellheigh cgt_density)	sedimentary detritus erosion
+ p_sed_2_biores_det/(cgt_cellhe cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_2/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_det_2_sedi_sed/(cgt_cellheig cgt_density)	detritus sedimentation
- p_det_2_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
- p_det_2_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
- p_det_2_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

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Tracer equations, continued from previous page	

Change of: detritus fractions_3

$\frac{d}{dt}$ t_det_3 =

+ (p_lpp_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sed_3_ero_det/(cgt_cellheigh cgt_density)	sedimentary detritus erosion
+ p_sed_3_biores_det/(cgt_cellhe cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_3/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_det_3_sedi_sed/(cgt_cellheig cgt_density)	detritus sedimentation
- p_det_3_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
- p_det_3_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
- p_det_3_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

Change of: detritus fractions_4

$\frac{d}{dt}$ t_det_4 =

+ (p_lpp_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton

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Tracer equations, continued from previous page	
+ (p_spp_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sed_4_ero_det/(cgt_cellheigh cgt_density)	sedimentary detritus erosion
+ p_sed_4_biores_det/(cgt_cellhe cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_4/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_det_4_sedi_sed/(cgt_cellheig cgt_density)	detritus sedimentation
- p_det_4_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
- p_det_4_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
- p_det_4_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

Change of: detritus fractions_5

$\frac{d}{dt}$ t_det_5 =

+ (p_lpp_mort_det_5)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_5)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_5)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria

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Tracer equations, continued from previous page	
+ (p_zoo_mort_det_5)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sed_5_ero_det/(cgt_cellheigh cgt_density)	sedimentary detritus erosion
+ p_sed_5_biores_det/(cgt_cellhe cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_5/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_det_5_sedi_sed/(cgt_cellheig cgt_density)	detritus sedimentation
- p_det_5_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
- p_det_5_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
- p_det_5_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

Change of: detritus fractions_6

$\frac{d}{dt}$ t_det_6 =

+ (p_lpp_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sed_6_ero_det/(cgt_cellheigh cgt_density)	sedimentary detritus erosion

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Tracer equations, continued from previous page	
+ p_sed_6_biores_det/(cgt_cellhe cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_6/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_det_6_sedi_sed/(cgt_cellheig cgt_density)	detritus sedimentation
- p_det_6_resp_nh4	recycling of detritus to ammonium using oxygen (respiration)
- p_det_6_denit_nh4	recycling of detritus to ammonium using nitrate (denitrification)
- p_det_6_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)

Change of: sedimentary detritus fractions_1

$\frac{d}{dt}$ t_sed_1 =

+ p_det_1_sedi_sed	detritus sedimentation
- p_sed_1_resp_nh4	recycling of sedimentary detritus to ammonium using oxygen (respiration)
- p_sed_1_denit_nh4	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- p_sed_1_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- p_sed_1_ero_det	sedimentary detritus erosion
- p_sed_1_biores_det	bio resuspension of sedimentary detritus
- p_sed_1_mnred_mn2	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- p_sed_1_irred_ims	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page

- p_sed_1_irredips_ims	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- p_sed_1_irred_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_sed_1_irredips_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_i3i_1_irred_i2i	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- p_sed_1_removal	transport from fluffy layer to deep basins
- p_sed_1_sulfdeep_nh4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: sedimentary detritus fractions_2

$\frac{d}{dt}$ t_sed_2 =

+ p_det_2_sedi_sed	detritus sedimentation
- p_sed_2_resp_nh4	recycling of sedimentary detritus to ammonium using oxygen (respiration)
- p_sed_2_denit_nh4	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- p_sed_2_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- p_sed_2_ero_det	sedimentary detritus erosion
- p_sed_2_biores_det	bio resuspension of sedimentary detritus
- p_sed_2_mnred_mn2	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- p_sed_2_irred_ims	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page

- p_sed_2_irredips_ims	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- p_sed_2_irred_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_sed_2_irredips_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_i3i_2_irred_i2i	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- p_sed_2_removal	transport from fluffy layer to deep basins
- p_sed_2_sulfdeep_nh4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: sedimentary detritus fractions_3

$\frac{d}{dt}$ t_sed_3 =

+ p_det_3_sedi_sed	detritus sedimentation
- p_sed_3_resp_nh4	recycling of sedimentary detritus to ammonium using oxygen (respiration)
- p_sed_3_denit_nh4	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- p_sed_3_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- p_sed_3_ero_det	sedimentary detritus erosion
- p_sed_3_biores_det	bio resuspension of sedimentary detritus
- p_sed_3_mnred_mn2	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- p_sed_3_irred_ims	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_sed_3_irredips_ims	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)

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Tracer equations, continued from previous page

- `p_sed_3_irred_iim`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- `p_sed_3_irredips_iim`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- `p_i3i_3_irred_i2i`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- `p_sed_3_removal`	transport from fluffy layer to deep basins
- `p_sed_3_sulfdeep_nh4`	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: sedimentary detritus fractions_4

$\frac{d}{dt}$ `t_sed_4` =

+ `p_det_4_sedi_sed`	detritus sedimentation
- `p_sed_4_resp_nh4`	recycling of sedimentary detritus to ammonium using oxygen (respiration)
- `p_sed_4_denit_nh4`	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- `p_sed_4_sulf_nh4`	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- `p_sed_4_ero_det`	sedimentary detritus erosion
- `p_sed_4_biores_det`	bio resuspension of sedimentary detritus
- `p_sed_4_mnred_mn2`	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- `p_sed_4_irred_ims`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- `p_sed_4_irredips_ims`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)

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Tracer equations, continued from previous page	
- p_sed_4_irred_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_sed_4_irredips_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_i3i_4_irred_i2i	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- p_sed_4_removal	transport from fluffy layer to deep basins
- p_sed_4_sulfdeep_nh4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: sedimentary detritus fractions_5

$\frac{d}{dt}$ t_sed_5 =

+ p_det_5_sedi_sed	detritus sedimentation
- p_sed_5_resp_nh4	recycling of sedimentary detritus to ammonium using oxygen (respiration)
- p_sed_5_denit_nh4	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- p_sed_5_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- p_sed_5_ero_det	sedimentary detritus erosion
- p_sed_5_biores_det	bio resuspension of sedimentary detritus
- p_sed_5_mnred_mn2	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- p_sed_5_irred_ims	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_sed_5_irredips_ims	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- p_sed_5_irred_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page

- p_sed_5_irredips_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_i3i_5_irred_i2i	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- p_sed_5_removal	transport from fluffy layer to deep basins
- p_sed_5_sulfdeep_nh4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: sedimentary detritus fractions_6

$\frac{d}{dt}$ t_sed_6 =

+ p_det_6_sedi_sed	detritus sedimentation
- p_sed_6_resp_nh4	recycling of sedimentary detritus to ammonium using oxygen (respiration)
- p_sed_6_denit_nh4	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
- p_sed_6_sulf_nh4	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
- p_sed_6_ero_det	sedimentary detritus erosion
- p_sed_6_biores_det	bio resuspension of sedimentary detritus
- p_sed_6_mnred_mn2	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- p_sed_6_irred_ims	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_sed_6_irredips_ims	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
- p_sed_6_irred_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page

- p_sed_6_irredips_iim	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- p_i3i_6_irred_i2i	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- p_sed_6_removal	transport from fluffy layer to deep basins
- p_sed_6_sulfdeep_nh4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: iron hydroxide in the sediment

$\frac{d}{dt}$ t_ihs =

+ p_ihw_sedi_ihs	sedimentation of iron hydroxide
+ p_fe2_ox_ihs	oxidation of Fe2+ to iron hydroxide in the sediment
+ p_ips_diss_po4	dissolution of iron phosphate
+ p_pyr_oxmos_ihs	oxidation of pyrite by manganese oxide to iron oxyhydroxide
+ p_pyr_oxo2_ihs	oxidation of pyrite by manganese oxide to iron oxyhydroxide
+ p_imm_oxo2_ihs	oxidation of minnesotaite by oxygen to iron oxyhydroxide
+ (p_fe2_mnox_ihs)*(2.0)	oxidation of Fe2+ by reduction of MnO2
+ p_ims_oxo2_ihs	iron monosulfide oxidation to iron oxihydroxides
- p_ihs_ero_ihw	erosion of iron PO4
- p_ihs_biores_ihw	bio resuspension of iron hydroxyde
- (p_sed_1_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page	
- (p_sed_2_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_3_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_4_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_5_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_6_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_1_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_2_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_3_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_4_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_5_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_sed_6_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
- (p_ihs_red_iim)*(8.0)	reduction of sedimentary iron hydroxide to iron-II
- (p_ihs_red_ims)*(8.0)	reduction of sedimentary iron hydroxide to iron-II
- p_po4_ads_ips	adsorption of phosphate to iron hydroxide particles
- p_ihs_removal	transport from fluffy layer to deep basins
- p_ihs_trans_ihc	transformation of amorphous iron oxyhydroxides to crystalline phase

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Tracer equations, continued from previous page

Change of: suspended iron hydroxide

$\frac{d}{dt}$ t_ihw =

+ p_ihs_ero_ihw/(cgt_cellheight* cgt_density)	erosion of iron PO4
+ p_ihc_ero_ihw/(cgt_cellheight* cgt_density)	erosion of larger-crystalline iron PO4
+ p_ihs_biores_ihw/(cgt_cellheig cgt_density)	bio resuspension of iron hydroxyde
+ p_ihc_biores_ihw/(cgt_cellheig cgt_density)	bio resuspension of iron hydroxyde
+ p_fe2_ox_ihw	oxidation of Fe2+ to iron hydroxide in the sediment
+ p_ipw_diss_po4	dissolution of iron phosphate
+ p_ims_biores_ihw/(cgt_cellheig cgt_density)	bio resuspension of iron monosulfide
+ p_pyr_biores_ihw/(cgt_cellheig cgt_density)	bio resuspension of pyrite
+ p_iim_biores_ihw/(cgt_cellheig cgt_density)	bio resuspension of iron in clay minerals
+ p_ims_ero_ihw/(cgt_cellheight* cgt_density)	resuspension of iron monusulfide
+ p_pyr_ero_ihw/(cgt_cellheight* cgt_density)	resuspension of pyrite

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Tracer equations, continued from previous page	
+ p_iim_ero_ihw/(cgt_cellheight* cgt_density)	bio resuspension of iron in clay minerals
+ p_stf_ihw_3d/(cgt_cellheight* cgt_density)	iron hydroxide generation by internal sources
- p_ihw_sedi_ihs/(cgt_cellheight cgt_density)	sedimentation of iron hydroxide
- p_po4_ads_ipw	adsorption of phosphate to iron hydroxide particles

Change of: ferrous iron

$\frac{d}{dt}$ t_fe2 =

+ p_ims_diss_fe2/(cgt_cellheight cgt_density)	dissolution of magnetite to iron II (precipitating iron hydroxides)
+ p_iim_diss_fe2/(cgt_cellheight cgt_density)	dissolution minnesotaite to of iron-II
- p_fe2_ox_ihs/(cgt_cellheight* cgt_density)	oxidation of Fe2+ to iron hydroxide in the sediment
- p_fe2_ox_ihw	oxidation of Fe2+ to iron hydroxide in the sediment
- p_fe2_prec_ims/(cgt_cellheight cgt_density)	precipitation of iron II as siderite
- p_fe2_prec_iim/(cgt_cellheight cgt_density)	precipitation of iron II as minnesotaite
- (p_fe2_mnox_ihs)*(2.0) /(cgt_cellheight*cgt_density)	oxidation of Fe2+ by reduction of MnO2

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Tracer equations, continued from previous page

Change of: pyrite

$\frac{d}{dt}$ t_pyr =

+ p_ims_form2_pyr	pyrite formation from iron monosulfide
- p_pyr_removal	transport from fluffy layer to deep basins
- p_pyr_oxmos_ihs	oxidation of pyrite by manganese oxide to iron oxyhydroxide
- p_pyr_oxo2_ihs	oxidation of pyrite by manganese oxide to iron oxyhydroxide
- p_pyr_biores_ihw	bio resuspension of pyrite
- p_pyr_ero_ihw	resuspension of pyrite

Change of: iron monosulphide

$\frac{d}{dt}$ t_ims =

+ (p_sed_1_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_2_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_3_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irred_ims)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_1_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_2_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_3_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)

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Tracer equations, continued from previous page	
+ (p_sed_4_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_5_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_sed_6_irredips_ims)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
+ (p_ihs_red_ims)*(8.0)	reduction of sedimentary iron hydroxide to iron-II
+ p_fe2_prec_ims	precipitation of iron II as siderite
+ p_iim_trans_ims	minnesotaite transformation to iron monosulfide
+ (p_ihc_red_ims)*(8.0)	reduction of sedimentary iron hydroxide to iron-II
- p_ims_removal	transport from fluffy layer to deep basins
- p_ims_diss_fe2	dissolution of magnetite to iron II (precipitating iron hydroxides)
- p_ims_trans_iim	iron monosulfide transformation to minnesotaite
- p_ims_form2_pyr	pyrite formation from iron monosulfide
- p_ims_oxo2_ihs	iron monosulfide oxidation to iron oxihydroxides
- p_ims_biores_ihw	bio resuspension of iron monosulfide
- p_ims_ero_ihw	resuspension of iron monusulfide

Change of: dissolved calcium

$\frac{d}{dt}$ t_ca2 =

+ p_ca2_relax_upwards	raise Ca2+ concentration in the water column to salinity-determined default value
+ (p_rho_diss_mn2)*(0.6) /(cgt_cellheight*cgt_density)	rhodochrosite dissolution to manganese-II

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Tracer equations, continued from previous page

+ (p_rho_biores_mow)*(0.6) /(cgt_cellheight*cgt_density)	bio resuspension of rhodochrosite
+ (p_rho_ero_mow)*(0.6) /(cgt_cellheight*cgt_density)	bio resuspension of rhodochrosite
- p_ca2_relax_downwards	lower Ca2+ concentration in the water column to salinity-determined default value
- (p_mn2_prec_rho)*(0.6) /(cgt_cellheight*cgt_density)	manganese-II precipitation to rhodochrosite

Change of: manganese oxide in the sediments

$\frac{d}{dt}$ t_mos =

+ p_mow_sedi_mos	sedimentation of iron hydroxide
+ p_mn2_ox_mos	oxidation of Mn2+ to manganese oxide in the sediment
- (p_sed_1_mnred_mn2)*(13.25* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- (p_sed_2_mnred_mn2)*(13.25* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- (p_sed_3_mnred_mn2)*(13.25* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- (p_sed_4_mnred_mn2)*(13.25* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- (p_sed_5_mnred_mn2)*(13.25* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- (p_sed_6_mnred_mn2)*(13.25* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
- p_mos_removal	transport from fluffy layer to deep basins
- p_pyr_oxmos_ihs	oxidation of pyrite by manganese oxide to iron oxyhydroxide
- p_fe2_mnox_ihs	oxidation of Fe2+ by reduction of MnO2

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Tracer equations, continued from previous page	
- p_h2s_mnox_so4	oxidation of h2s by reduction of MnO2
- p_mos_biores_mow	bio resuspension of manganese oxide
- p_mos_ero_mow	bio resuspension of manganese oxide

Change of: suspended manganese oxide

$\frac{d}{dt}$ t_mow =

+ p_mos_biores_mow/(cgt_cellheig cgt_density)	bio resuspension of manganese oxide
+ p_rho_biores_mow/(cgt_cellheig cgt_density)	bio resuspension of rhodochrosite
+ p_mos_ero_mow/(cgt_cellheight* cgt_density)	bio resuspension of manganese oxide
+ p_rho_ero_mow/(cgt_cellheight* cgt_density)	bio resuspension of rhodochrosite
- p_mow_sedi_mos/(cgt_cellheight cgt_density)	sedimentation of iron hydroxide

Change of: dissolved manganese-II

$\frac{d}{dt}$ t_mn2 =

+ (p_sed_1_mnred_mn2)*(13.25* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_2_mnred_mn2)*(13.25* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_3_mnred_mn2)*(13.25* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)

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Tracer equations, continued from previous page	
+ (p_sed_4_mnred_mn2)*(13.25* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_5_mnred_mn2)*(13.25* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_6_mnred_mn2)*(13.25* rfr_pc_enrichment_det) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ p_rho_diss_mn2/(cgt_cellheight cgt_density)	rhodochrosite dissolution to manganese-II
+ p_pyr_oxmos_ihs/(cgt_cellheight cgt_density)	oxidation of pyrite by manganese oxide to iron oxyhydroxide
+ p_fe2_mnox_ihs/(cgt_cellheight cgt_density)	oxidation of Fe2+ by reduction of MnO2
+ p_h2s_mnox_so4/(cgt_cellheight cgt_density)	oxidation of h2s by reduction of MnO2
- p_mn2_ox_mos/(cgt_cellheight* cgt_density)	oxidation of Mn2+ to manganese oxide in the sediment
- p_mn2_prec_rho/(cgt_cellheight cgt_density)	manganese-II precipitation to rhodochrosite

Change of: rhodochrosite

$\frac{d}{dt}$ t_rho =

+ p_mn2_prec_rho	manganese-II precipitation to rhodochrosite
- t_rho_removal	transport from fluffy layer to deep basins
- p_rho_diss_mn2	rhodochrosite dissolution to manganese-II

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Tracer equations, continued from previous page

- p_rho_biores_mow	bio resuspension of rhodochrosite
- p_rho_ero_mow	bio resuspension of rhodochrosite

Change of: OH- ions with realistically quick diffusion

$\frac{d}{dt}$ t_ohm_quickdiff =

+ relax_ohm_quickdiff_up	relax ohm_quickdiff tracer against actual OH- concentration
- relax_ohm_quickdiff_down	relax ohm_quickdiff tracer against actual OH- concentration

Change of: OH- ions which move unrealistically slow with alkalinity

$\frac{d}{dt}$ t_ohm_slowdiff =

+ relax_ohm_slowdiff_up	relax ohm_slowdiff tracer against actual OH- concentration
- relax_ohm_slowdiff_down	relax ohm_slowdiff tracer against actual OH- concentration

Change of: silicate

$\frac{d}{dt}$ t_sil =

+ (p_sed_1_resp_nh4)*(rfr_si) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
+ (p_sed_2_resp_nh4)*(rfr_si) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
+ (p_sed_3_resp_nh4)*(rfr_si) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
+ (p_sed_4_resp_nh4)*(rfr_si) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
+ (p_sed_5_resp_nh4)*(rfr_si) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
+ (p_sed_6_resp_nh4)*(rfr_si) /(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using oxygen (respiration)
+ (p_sed_1_denit_nh4)* (rfr_si)/(cgt_cellheight* cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)

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Tracer equations, continued from previous page	
+ (p_sed_2_denit_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_3_denit_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_4_denit_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_5_denit_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_6_denit_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using nitrate (denitrification)
+ (p_sed_1_sulf_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_2_sulf_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_3_sulf_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_4_sulf_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_5_sulf_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_6_sulf_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using sulfate (sulfate reduction)
+ (p_sed_1_mnred_mn2)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_2_mnred_mn2)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)

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Tracer equations, continued from previous page	
+ (p_sed_3_mnred_mn2)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_4_mnred_mn2)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_5_mnred_mn2)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_6_mnred_mn2)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using manganese oxide (manganese reduction)
+ (p_sed_1_irred_ims)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_2_irred_ims)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_3_irred_ims)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irred_ims)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irred_ims)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irred_ims)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_1_irredips_ims)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)

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Tracer equations, continued from previous page	
`+ (p_sed_2_irredips_ims)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_3_irredips_ims)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_4_irredips_ims)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_5_irredips_ims)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_6_irredips_ims)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron phosphate (iron reduction)
`+ (p_sed_1_irred_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_2_irred_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_3_irred_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_4_irred_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_5_irred_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_6_irred_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page	
`+ (p_sed_1_irredips_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_2_irredips_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_3_irredips_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_4_irredips_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_5_irredips_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_sed_6_irredips_iim)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
`+ (p_i3i_1_irred_i2i)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
`+ (p_i3i_2_irred_i2i)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
`+ (p_i3i_3_irred_i2i)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
`+ (p_i3i_4_irred_i2i)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
`+ (p_i3i_5_irred_i2i)*(rfr_si)/(cgt_cellheight*cgt_density)`	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)

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Tracer equations, continued from previous page

+ (p_i3i_6_irred_i2i)*(rfr_si)/(cgt_cellheight*cgt_density)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
+ (p_sed_1_sulfdeep_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sed_2_sulfdeep_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sed_3_sulfdeep_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sed_4_sulfdeep_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sed_5_sulfdeep_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
+ (p_sed_6_sulfdeep_nh4)*(rfr_si)/(cgt_cellheight*cgt_density)	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)
- p_remove_silicate	remove silicate in water column as it gets too much

Change of: iron-II adsorbed to illite-montmorillonite mixed layer minerals

$\frac{d}{dt}$ t_iim =

+ (p_sed_1_irred_iim)*(26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)

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Tracer equations, continued from previous page	
+ (p_sed_2_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_3_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irred_iim)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_1_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_2_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_3_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_4_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_5_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_sed_6_irredips_iim)* (26.5*rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron hydroxide (iron reduction)
+ (p_ihs_red_iim)*(8.0)	reduction of sedimentary iron hydroxide to iron-II
+ p_fe2_prec_iim	precipitation of iron II as minnesotaite
+ p_ims_trans_iim	iron monosulfide transformation to minnesotaite
+ (p_ihc_red_iim)*(8.0)	reduction of sedimentary iron hydroxide to iron-II

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Tracer equations, continued from previous page

- p_iim_removal	transport from fluffy layer to deep basins
- p_iim_diss_fe2	dissolution minnesotaite to of iron-II
- p_iim_trans_ims	minnesotaite transformation to iron monosulfide
- p_imm_oxo2_ihs	oxidation of minnesotaite by oxygen to iron oxyhydroxide
- p_iim_biores_ihw	bio resuspension of iron in clay minerals
- p_iim_ero_ihw	bio resuspension of iron in clay minerals

Change of: potentially reducible iron-III in illite-montmorillonite mixed layer minerals

$\frac{d}{dt}$ t_i3i =

+ p_i2i_oxo2_i3i	oxidation of iron-II in illite-montmorillonite mixed layer minerals to iron-III
- (p_i3i_1_irred_i2i)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- (p_i3i_2_irred_i2i)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- (p_i3i_3_irred_i2i)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- (p_i3i_4_irred_i2i)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- (p_i3i_5_irred_i2i)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- (p_i3i_6_irred_i2i)*(26.5* rfr_pc_enrichment_det)	recycling of sedimentary detritus to ammonium using iron-III in clay minerals (iron reduction)
- (p_i3i_redh2s_i2i)*(8)	reduction of iron-III in clay minerals to iron-II consuming h2s

Change of: iron hydroxide in the sediment - crystalline phase

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Tracer equations, continued from previous page

$\frac{d}{dt}$ `t_ihc` =

`+ p_ihs_trans_ihc`	transformation of amorphous iron oxyhydroxides to crystalline phase
`- p_ihc_ero_ihw`	erosion of larger-crystalline iron PO4
`- p_ihc_biores_ihw`	bio resuspension of iron hydroxyde
`- p_ihc_removal`	transport from fluffy layer to deep basins
`- (p_ihc_red_iim)*(8.0)`	reduction of sedimentary iron hydroxide to iron-II
`- (p_ihc_red_ims)*(8.0)`	reduction of sedimentary iron hydroxide to iron-II

Change of: phosphate adsorbed to illite-montmorillonite

$\frac{d}{dt}$ `t_pim` =

`+ p_po4_ads_pim`	phosphate adsorption to illite-montmorillonite mixed layer minerals
`- p_pim_lib_po4`	phosphate liberation from illite-montmorillonite mixed layer minerals

Change of: ammonium adsorbed to illite-montmorillonite

$\frac{d}{dt}$ `t_aim` =

`+ p_nh4_ads_aim`	ammonium adsorption to illite-montmorillonite mixed layer minerals
`- p_aim_lib_nh4`	ammonium liberation from illite-montmorillonite mixed layer minerals
`- p_aim_nit_no3_sed`	nitrification in the sediment

Change of: phosphate in detritus fractions_1

$\frac{d}{dt}$ `t_detp_1` =

`+ (p_lpp_mort_det_1)* ((1.0/rfr_pc_enrichment_det))`	mortality of large-cell phytoplankton
`+ (p_spp_mort_det_1)* ((1.0/rfr_pc_enrichment_det))`	mortality of small-scale phytoplankton

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Tracer equations, continued from previous page	
+ (p_cya_mort_det_1)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_1)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sedp_1_ero_detp/(cgt_cellhei cgt_density)	sedimentary detritus erosion
+ p_sedp_1_biores_detp/(cgt_cell cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_1/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_detp_1_sedi_sedp/(cgt_cellhe cgt_density)	detritus sedimentation
- p_detp_1_remin_po4	recycling of detritus to ammonium using oxygen (respiration)

Change of: phosphate in detritus fractions_2

$\frac{d}{dt}$ t_detp_2 =

+ (p_lpp_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_2)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sedp_2_ero_detp/(cgt_cellhei cgt_density)	sedimentary detritus erosion

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Tracer equations, continued from previous page	
+ p_sedp_2_biores_detp/(cgt_cell cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_2/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_detp_2_sedi_sedp/(cgt_cellhe cgt_density)	detritus sedimentation
- p_detp_2_remin_po4	recycling of detritus to ammonium using oxygen (respiration)

Change of: phosphate in detritus fractions_3

$\frac{d}{dt}$ t_detp_3 =

+ (p_lpp_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_3)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sedp_3_ero_detp/(cgt_cellhei cgt_density)	sedimentary detritus erosion
+ p_sedp_3_biores_detp/(cgt_cell cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_3/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_detp_3_sedi_sedp/(cgt_cellhe cgt_density)	detritus sedimentation

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Tracer equations, continued from previous page	
- p_detp_3_remin_po4	recycling of detritus to ammonium using oxygen (respiration)

Change of: phosphate in detritus fractions_4

$\frac{d}{dt}$ t_detp_4 =

+ (p_lpp_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_4)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sedp_4_ero_detp/(cgt_cellhei cgt_density)	sedimentary detritus erosion
+ p_sedp_4_biores_detp/(cgt_cell cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_4/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_detp_4_sedi_sedp/(cgt_cellhe cgt_density)	detritus sedimentation
- p_detp_4_remin_po4	recycling of detritus to ammonium using oxygen (respiration)

Change of: phosphate in detritus fractions_5

$\frac{d}{dt}$ t_detp_5 =

+ (p_lpp_mort_det_5)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_5)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton

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Tracer equations, continued from previous page	
+ (p_cya_mort_det_5)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ p_sedp_5_ero_detp/(cgt_cellhei cgt_density)	sedimentary detritus erosion
+ p_sedp_5_biores_detp/(cgt_cell cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_5/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_detp_5_sedi_sedp/(cgt_cellhe cgt_density)	detritus sedimentation
- p_detp_5_remin_po4	recycling of detritus to ammonium using oxygen (respiration)

Change of: phosphate in detritus fractions_6

$\frac{d}{dt}$ t_detp_6 =

+ (p_lpp_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of large-cell phytoplankton
+ (p_spp_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of small-scale phytoplankton
+ (p_cya_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of diazotroph cyanobacteria
+ (p_zoo_mort_det_6)* ((1.0/rfr_pc_enrichment_det))	mortality of zooplankton
+ p_sedp_6_ero_detp/(cgt_cellhei cgt_density)	sedimentary detritus erosion

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Tracer equations, continued from previous page	
+ p_sedp_6_biores_detp/(cgt_cell cgt_density)	bio resuspension of sedimentary detritus
+ p_stf_det_6/(cgt_cellheight* cgt_density)	surface flux of detritus
- p_detp_6_sedi_sedp/(cgt_cellhe cgt_density)	detritus sedimentation
- p_detp_6_remin_po4	recycling of detritus to ammonium using oxygen (respiration)

Change of: phosphate in sedimentary detritus fractions_1

$\frac{d}{dt}$ t_sedp_1 =

+ p_detp_1_sedi_sedp	detritus sedimentation
- p_sedp_1_ero_detp	sedimentary detritus erosion
- p_sedp_1_biores_detp	bio resuspension of sedimentary detritus
- p_sedp_1_removal	transport from fluffy layer to deep basins
- p_sedp_1_remin_po4	recycling of sediment detrital phosphate
- p_sedp_1_sulfdeep_po4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: phosphate in sedimentary detritus fractions_2

$\frac{d}{dt}$ t_sedp_2 =

+ p_detp_2_sedi_sedp	detritus sedimentation
- p_sedp_2_ero_detp	sedimentary detritus erosion
- p_sedp_2_biores_detp	bio resuspension of sedimentary detritus
- p_sedp_2_removal	transport from fluffy layer to deep basins

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Tracer equations, continued from previous page

- p_sedp_2_remin_po4	recycling of sediment detrital phosphate
- p_sedp_2_sulfdeep_po4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: phosphate in sedimentary detritus fractions_3

$\frac{d}{dt}$ t_sedp_3 =

+ p_detp_3_sedi_sedp	detritus sedimentation
- p_sedp_3_ero_detp	sedimentary detritus erosion
- p_sedp_3_biores_detp	bio resuspension of sedimentary detritus
- p_sedp_3_removal	transport from fluffy layer to deep basins
- p_sedp_3_remin_po4	recycling of sediment detrital phosphate
- p_sedp_3_sulfdeep_po4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: phosphate in sedimentary detritus fractions_4

$\frac{d}{dt}$ t_sedp_4 =

+ p_detp_4_sedi_sedp	detritus sedimentation
- p_sedp_4_ero_detp	sedimentary detritus erosion
- p_sedp_4_biores_detp	bio resuspension of sedimentary detritus
- p_sedp_4_removal	transport from fluffy layer to deep basins
- p_sedp_4_remin_po4	recycling of sediment detrital phosphate
- p_sedp_4_sulfdeep_po4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

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Tracer equations, continued from previous page

Change of: phosphate in sedimentary detritus fractions_5

$\frac{d}{dt}$ t_sedp_5 =

+ p_detp_5_sedi_sedp	detritus sedimentation
- p_sedp_5_ero_detp	sedimentary detritus erosion
- p_sedp_5_biores_detp	bio resuspension of sedimentary detritus
- p_sedp_5_removal	transport from fluffy layer to deep basins
- p_sedp_5_remin_po4	recycling of sediment detrital phosphate
- p_sedp_5_sulfdeep_po4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: phosphate in sedimentary detritus fractions_6

$\frac{d}{dt}$ t_sedp_6 =

+ p_detp_6_sedi_sedp	detritus sedimentation
- p_sedp_6_ero_detp	sedimentary detritus erosion
- p_sedp_6_biores_detp	bio resuspension of sedimentary detritus
- p_sedp_6_removal	transport from fluffy layer to deep basins
- p_sedp_6_remin_po4	recycling of sediment detrital phosphate
- p_sedp_6_sulfdeep_po4	parameterization for recycling of sedimentary detritus to ammonium below the deepest sediment layer (sulfate reduction / methane formation)

Change of: particulate organic carbon

$\frac{d}{dt}$ t_poc =

+ p_assim_lpp_poc	Production of POC by LPP
+ p_assim_spp_poc	Production of POC by SPP

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Tracer equations, continued from previous page	
+ `p_assim_cya_poc`	Production of POC by CYA
- `p_poc_resp`	respiration of POC
- `p_poc_denit`	recycling of POC using nitrate (denitrification)
- `p_poc_sulf`	Mineralization of POC, e-acceptor sulfate (sulfate reduction)