Supplement of Biogeosciences, 15, 6573–6589, 2018
https://doi.org/10.5194/bg-15-6573-2018-supplement
© Author(s) 2018. This work is distributed under the Creative Commons Attribution 4.0 License.

Supplement of

Diazotrophy as the main driver of the oligotrophy gradient in the western tropical South Pacific Ocean: results from a one-dimensional biogeochemical–physical coupled model

Audrey Gimenez et al.

Correspondence to: Audrey Gimenez (audrey.gimenez@mio.osupytheas.fr) and Melika Baklouti (melika.baklouti@mio.osupytheas.fr)

The copyright of individual parts of the supplement might differ from the CC BY 4.0 License.
### Supplementary material

| Symbol | Definition | Units | Value HNF | Value BAC | Value PHYS | Value UCYN | Value PHYL | Value TRI |
|--------|------------|-------|-----------|-----------|------------|------------|------------|-----------|
| $K_{LDOP}$ | Half-saturation constant for LDOP | mol.L$^{-1}$ | - | 6.62 $10^{-7}$ | 6.57 $10^{-7}$ | 6.57 $10^{-7}$ | 5.66 $10^{-6}$ | 5.66 $10^{-6}$ |
| $Q_P^{min}$ | minimum phosphate content | mol.cell$^{-1}$ | 1.27 $10^{-12}$ | 1.15 $10^{-15}$ | - | - | - | - |
| $Q_P^{max}$ | maximum phosphate content | mol.cell$^{-1}$ | 3 $Q_P^{min}$ | 3 $Q_P^{min}$ | - | - | - | - |
| $Q_N^{min}$ | minimum nitrogen content | mol.cell$^{-1}$ | 16 $Q_N^{min}$ | 16 $Q_N^{min}$ | - | - | - | - |
| $Q_N^{max}$ | maximum nitrogen content | mol.cell$^{-1}$ | 3 $Q_N^{min}$ | 3 $Q_N^{min}$ | - | - | - | - |
| $Q_C^{min}$ | minimum carbon content | mol.cell$^{-1}$ | 106 $Q_P^{min}$ | 106 $Q_P^{min}$ | - | - | - | - |
| $Q_C^{max}$ | maximum carbon content | mol.cell$^{-1}$ | 3 $Q_C^{min}$ | 3 $Q_C^{min}$ | - | - | - | - |

**DOP assimilation**

**Intracellular contents**

| $V_{NO_3}^{max}$ | Maximum uptake rate for NO$_3$ | mol.cell$^{-1}$.s$^{-1}$ | $\mu \cdot Q_N^{max}$ | $\mu \cdot Q_N^{max}$ | - | - | - | - |
| $V_{NH_3}^{max}$ | Maximum uptake rate for NH$_4$ | mol.cell$^{-1}$.s$^{-1}$ | $\mu \cdot Q_N^{max}$ | $\mu \cdot Q_N^{max}$ | - | - | - | - |
| $V_{PO_4}^{max}$ | Maximum uptake rate for PO$_4$ | mol.cell$^{-1}$.s$^{-1}$ | $\mu \cdot Q_P^{max}$ | $\mu \cdot Q_P^{max}$ | - | - | - | - |
| $V_{DON}^{max}$ | Maximum uptake rate for DON | mol.cell$^{-1}$.s$^{-1}$ | $\mu \cdot Q_P^{max}$ | $\mu \cdot Q_P^{max}$ | - | - | - | - |
| $V_{DOP}^{max}$ | Maximum uptake rate for DOP | mol.cell$^{-1}$.s$^{-1}$ | $\mu \cdot Q_P^{max}$ | $\mu \cdot Q_P^{max}$ | - | - | - | - |

**Nutrients assimilation**

| $\omega$ | sinking rate | m.d$^{-1}$ | 1.0 | 25.0 | 1.0 | 25.0 | 1.0 | 25.0 |
| $TT_{DET_P}$ | Turnover time for DET-P | d$^{-1}$ | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

**Particulate matter hydrolysis and sink**

| DETS-C | DETL-C | DETS-N | DETL-N | DETS-P | DETL-P |
|--------|--------|--------|--------|--------|--------|
| 1.0 | 25.0 | 1.0 | 25.0 | 1.0 | 25.0 |

Table 1. Model parameters which differ from Alekseenko et al. (2014) mentioned in Section 2.2.2, with $\mu$ = maximum growth rate.
| Symbol          | Definition                                                                 | Value TRI     | Value UCYN    | Units          |
|-----------------|---------------------------------------------------------------------------|---------------|---------------|----------------|
| $\mu_{max}$     | maximum growth rate                                                       | $2.08 \times 10^{-6}$ | $3.2 \times 10^{-5}$ | s$^{-1}$       |
| $k_m$           | specific natural mortality rate                                            | $1.16 \times 10^{-6}$ | $1.16 \times 10^{-6}$ | s$^{-1}$       |
| $Q_{C_{min}}$   | minimum cell quota of C                                                   | $2.28 \times 10^{-10}$ | $6.84 \times 10^{-15}$ | mol.cell$^{-1}$ |
| $Q_{C_{max}}$   | maximum cell quota of C                                                   | $6.84 \times 10^{-15}$ | $2.05 \times 10^{-14}$ | mol.cell$^{-1}$ |
| $Q_{N_{min}}$   | minimum cell quota of N                                                   | $3.44 \times 10^{-11}$ | $1.03 \times 10^{-15}$ | mol.cell$^{-1}$ |
| $Q_{N_{max}}$   | maximum cell quota of N                                                   | $1.03 \times 10^{-10}$ | $3.09 \times 10^{-15}$ | mol.cell$^{-1}$ |
| $Q_{P_{min}}$   | minimum cell quota of P                                                   | $3.44 \times 10^{-11}$ | $1.03 \times 10^{-15}$ | mol.cell$^{-1}$ |
| $Q_{P_{max}}$   | maximum cell quota of P                                                   | $1.03 \times 10^{-10}$ | $3.09 \times 10^{-15}$ | mol.cell$^{-1}$ |
| $Q_{C_{CN}}$    | minimum cell C:N ratio                                                    | 5.0           | 5.0           | mol.mol$^{-1}$ |
| $Q_{C_{CP}}$    | maximum cell C:N ratio                                                    | 19.8          | 19.8          | mol.mol$^{-1}$ |
| $Q_{C_{XP}}$    | minimum cell C:P ratio                                                    | 35.33         | 35.33         | mol.mol$^{-1}$ |
| $Q_{C_{XP}}$    | maximum cell C:P ratio                                                    | 318.0         | 318.0         | mol.mol$^{-1}$ |

### Growth and Intracellular contents

- $\mu_{max}$: maximum growth rate
- $k_m$: specific natural mortality rate
- $Q_{C_{min}}$: minimum cell quota of C
- $Q_{C_{max}}$: maximum cell quota of C
- $Q_{N_{min}}$: minimum cell quota of N
- $Q_{N_{max}}$: maximum cell quota of N
- $Q_{P_{min}}$: minimum cell quota of P
- $Q_{P_{max}}$: maximum cell quota of P
- $Q_{C_{CN}}$: minimum cell C:N ratio
- $Q_{C_{CP}}$: maximum cell C:P ratio

### Nutrients assimilation

- $K_{NO^3-}$: Half-saturation constant for $NO^3-$
- $V_{NO^3-}^{max}$: Maximum uptake rate for $NO^3-$
- $K_{NH^4+}$: Half-saturation constant for $NH^4+$
- $V_{NH^4+}^{max}$: Maximum uptake rate for $NH^4+$
- $K_{PO^4-}$: Half-saturation constant for $PO^4-$
- $V_{PO^4-}^{max}$: Maximum uptake rate for $PO^4-$
- $K_{DON}$: Half-saturation constant for $DON$
- $V_{DON}^{max}$: Maximum uptake rate for $DON$
- $K_{DOP}$: Half-saturation constant for $DOP$
- $V_{DOP}^{max}$: Maximum uptake rate for $DOP$

### Diazotrophy process

- $Nase_{prod}^{max}$: Maximum rate of increase of nitrogenase activity
- $Nase_{decr}^{max}$: Maximum rate of decay of nitrogenase activity
- $K_{Nase}$: Coefficient of nitrogenase degradation
- $COST_{DIAZO}$: Respiration cost for nitrogen fixation
- $EXUD_{DON}$: Exudation part of N$_2$ fixed towards $DON$
- $EXUD_{NH_4}$: Exudation part of N$_2$ fixed towards $NH_4$

Table 2. Model Parameters relative to diazotroph organisms TRI and UCYN
Figure SM 1 Temporal dynamics of the *in situ* mixed layer depths estimated using a climatology (de Boyer Montégut et al., 2004) at WMA (green circles) and WGY (blue circles), and simulated by the model (green line).
Figure SM 2 Atmospheric forcings provided by the Weather Research Forecast model and extracted at the WMA (green) and WGY (blue) locations from September 2014 to September 2015
Figure SM 3 Evolution of monthly averaged (a) sea surface temperature (SST), (b) surface density and (c) mixed layer depths (MLD) from September 2014 to August 2015 predicted by the model (green line) and calculated with climatologies (WOA13 for SST and Surface density, and de Boyer Montegut et al., 2004 for MLD)