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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

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Supplementary material

Symbol	Definition	Units	Value HNF	Value BAC	Value PHYS	Value UCYN	Value PHYL	Value TRI
				DOP assimilation				
K_{LDOP}	Half-saturation constant for LDOP	mol.L^{-1}	-	$6.62\ 10^{-7}$	$6.57\ 10^{-7}$	$6.57\ 10^{-7}$	$5.66\ 10^{-6}$	$5.66\ 10^{-6}$
				Intracelullar contents				
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}	$16\ Q_P^{min}$	$16\ Q_P^{min}$	-	-	-	-
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}	$3\ Q_C^{min}$	$3\ Q_C^{min}$	-	-	-	
				Nutrients assimilation				
V_{NO3}^{max}	Maximum uptake rate for NO_3	mol.cell^{-1}.s^{-1}	$\mu \cdot Q_N^{max}$	$\mu \cdot Q_N^{max}$	-	-	-	-
V_{NH3}^{max}	Maximum uptake rate for NH_4	mol.cell^{-1}.s^{-1}	$\mu \cdot Q_N^{max}$	$\mu \cdot Q_N^{max}$	-	-	-	-
V_{PO4}^{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}	$\mu \cdot Q_N^{max}$	$\mu \cdot Q_N^{max}$	-	-	-	-
V_{DOP}^{max}	Maximum uptake rate for DOP	mol.cell^{-1}.s^{-1}	$\mu \cdot Q_N^{max}$	$\mu \cdot Q_P^{max}$	-	-	-	-

			DETS-C	DETL-C	DETS-N	DETL-N	DETS-P	DETL-P
				Particulate matter hydrolysis and sink				
ω	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

Table 1. Model parameters which differ from Alekseenko et al. (2014) mentioned in Section **2.2.2**, with μ = maximum growth rate

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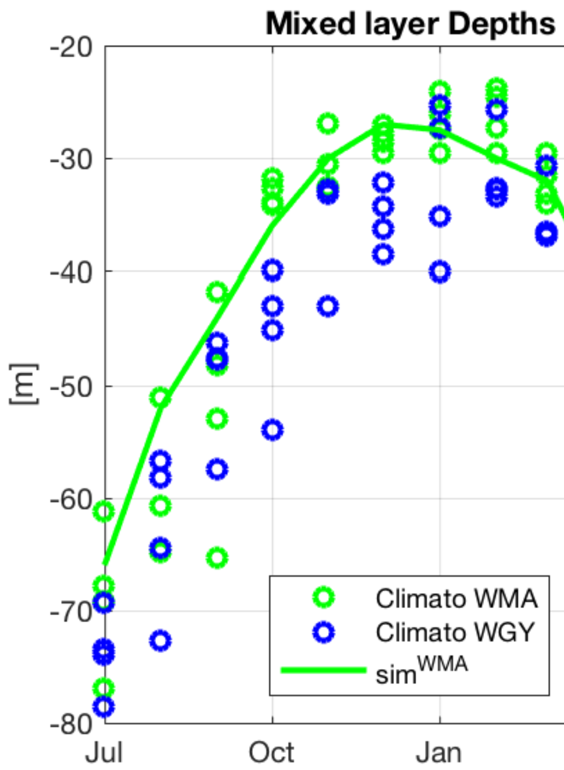
Symbol	Definition	Value TRI	Value UCYN	Units -
	Growth and Intracelullar contents			
μ_{max}	maximum growth rate	2.08 10^{-6}	3.2 10^{-5}	s^{-1}
k_m	specific natural mortality rate	1.16 10^{-6}	1.16 10^{-6}	s^{-1}
Q_C^{min}	minimum cell quota of C	2.28 10^{-10}	6.84 10^{-15}	mol.cell^{-1}
Q_C^{max}	maximum cell quota of C	6.84 10^{-15}	2.05 10^{-14}	mol.cell^{-1}
Q_N^{min}	minimum cell quota of N	3.44 10^{-11}	1.03 10^{-15}	mol.cell^{-1}
Q_N^{max}	maximum cell quota of N	1.03 10^{-10}	3.09 10^{-15}	mol.cell^{-1}
Q_P^{min}	minimum cell quota of P	3.44 10^{-11}	1.03 10^{-15}	mol.cell^{-1}
Q_P^{max}	maximum cell quota of P	1.03 10^{-10}	3.09 10^{-15}	mol.cell^{-1}
Q_{CN}^{min}	minimum cell C:N ratio	5.0	5.0	mol.mol^{-1}
Q_{CN}^{max}	maximum cell C:N ratio	19.8	19.8	mol.mol^{-1}
Q_{CP}^{min}	minimum cell C:P ratio	35.33	35.33	mol.mol^{-1}
Q_{CP}^{max}	maximum cell C:P ratio	318.0	318.0	mol.mol^{-1}
	Nutrients assimilation			
$K_{NO^{3-}}$	Half-saturation constant for $_{NO^{3-}}$	1.85 10^{-6}	7.6 10^{-6}	mol.L^{-1}
$V_{NO^{3-}}^{max}$	Maximum uptake rate for $_{NO^{3-}}$	3.16 10^{-15}	9.91 10^{-20}	mol.cell^{-1}.s^{-1}
$K_{NH^{4+}}$	Half-saturation constant for $_{NH^{4+}}$	7.0 10^{-6}	1.69 10^{-6}	mol.L^{-1}
$V_{NH^{4+}}^{max}$	Maximum uptake rate for $_{NH^{4+}}$	3.16 10^{-15}	9.91 10^{-20}	mol.cell^{-1}.s^{-1}
$K_{PO_4^{3-}}$	Half-saturation constant for $_{PO_4^{3-}}$	1.4 10^{-6}	2.62 10^{-7}	mol.L^{-1}
$V_{PO_4^{3-}}^{max}$	Maximum uptake rate for $_{PO_4^{3-}}$	1.98 10^{-16}	6.19 10^{-21}	mol.cell^{-1}.s^{-1}
K_{DON}	Half-saturation constant for $_{DON}$	4.32 10^{-5}	1.05 10^{-5}	mol.L^{-1}
V_{DON}^{max}	Maximum uptake rate for $_{DON}$	3.16 10^{-15}	9.91 10^{-20}	mol.cell^{-1}.s^{-1}
K_{DOP}	Half-saturation constant for $_{DOP}$	3.4 10^{-6}	6.57 10^{-7}	mol.L^{-1}
V_{DOP}^{max}	Maximum uptake rate for $_{DOP}$	3.16 10^{-15}	6.19 10^{-21}	mol.cell^{-1}.s^{-1}
	Diazotrophy process			
$Nase_{prod}^{max}$	Maximum rate of increase of nitrogenase activity	1.17 10^{-21}	3.51 10^{-26}	mol.cell^{-1}.s^{-2}
$Nase_{decr}^{max}$	Maximum rate of decay of nitrogenase activity	9.36 10^{-22}	2.83 10^{-26}	mol.cell^{-1}.s^{-2}
K_{Nase}	Coefficient of nitrogenase degradation	9.44 10^{-16}	1.92 10^{-20}	mol.cell^{-1}.s^{-1}
$COST_{DIAZO}$	Respiration cost for nitrogen fixation	1.5	1.5	mol.mol^{-1}
$EXUD_{DON}$	Exudation part of N_2 fixed towards $_{DON}$	0.5	0.5	-
$EXUD_{NH_4}$	Exudation part of N_2 fixed towards $_{NH_4}$	0.5	0.5	-

Table 2. Model Parameters relative to diazotroph organisms TRI and UCYN



<u>Figure SM 1</u> **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)**

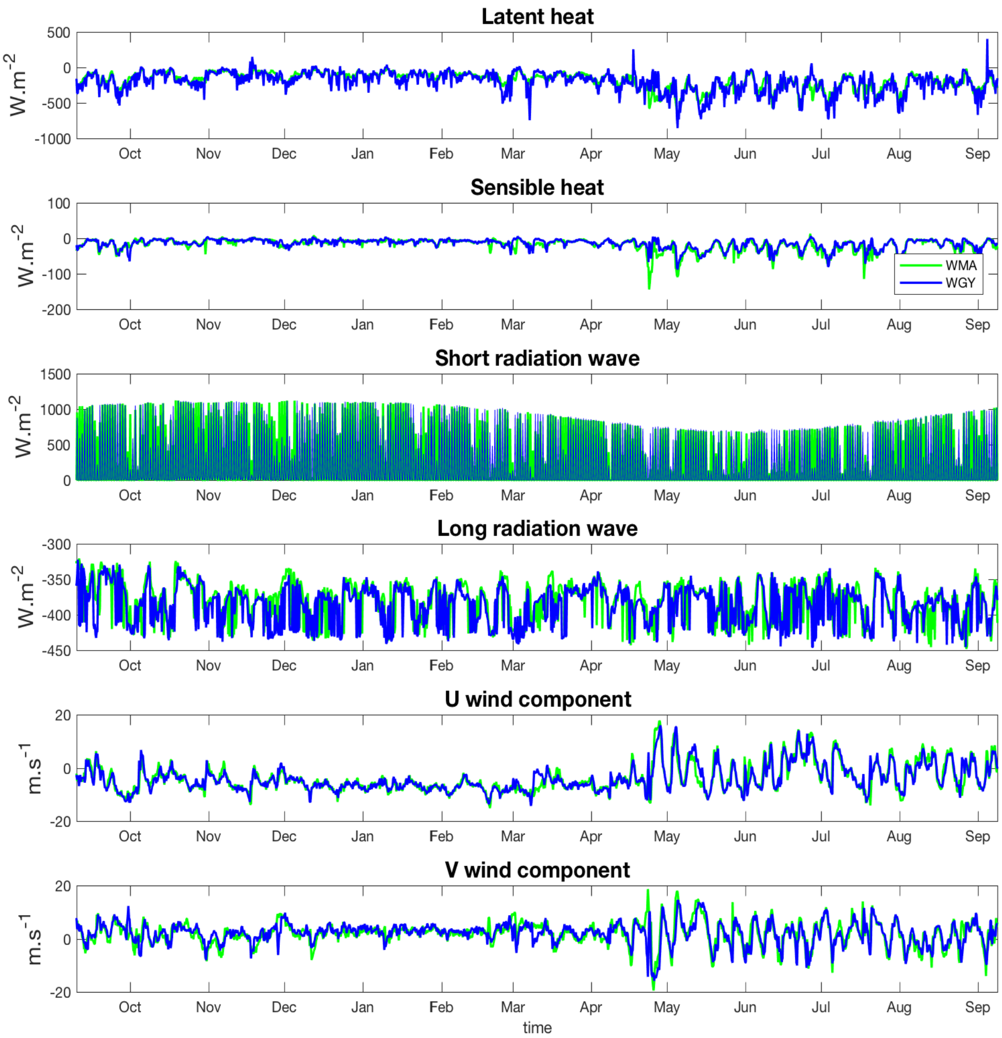


Figure SM 2 **Atmospheric forcings provided by the Weather Research Forecast model and extracted at the WMA (green) and WGY (blue) locations from September 2014 to September 2015**

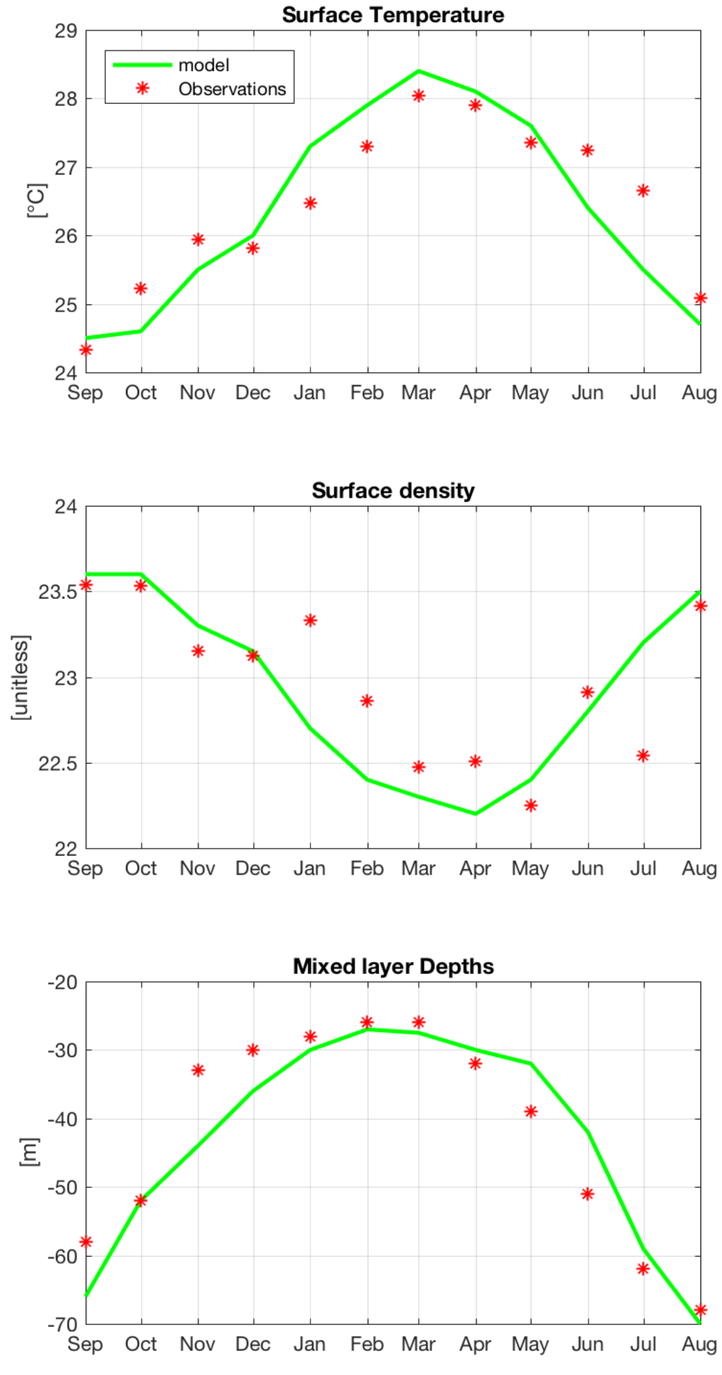


Figure SM 3 Evolution of monthly averaged (a) sea surface temperature (SST), (b) surface density and (c) mixed layer depths (MLD) from September 2014 to August 2015 predicted by the model (green line) and calculated with climatologies (WOA13 for SST and Surface density, and de Boyer Montegut et al., 2004 for MLD)