Biogeosciences

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Supplement of

No nitrogen fixation in the Bay of Bengal?

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1   Model experiment

2   The model framework is based on Canfield's 5-box model (Boyle et al. 2013; Canfield 2006), using available

3   measurements for the BoB from our cruise and other literature (Tab. M1, the complete code will be released

4   on Pangaea). The model is classically based on the identification of the limiting nutrient for euphotic primary

5   production under Redfield conditions. Primary production provides the basis for determination of export

6   fluxes under consideration of respiration first using oxygen, followed by nitrate and sulfate according to the

7   following stoichiometry:

8   $$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

9   $$2.5\ C_6H_{12}O_6 + 12NO_3^- \rightarrow 6N_2 + 15CO_2 + 12OH^- + 9H_2O$$

10 $$CH_3COO^- + SO_4^{2-} + H_2O \rightarrow H_2S + 2HCO_3^- + OH^-$$
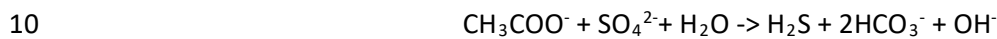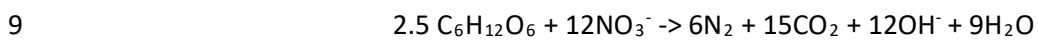
11 Export production is estimated as the sum of organic carbon respiration (R) of the three above mentioned

12 processes:

13 $$EP = R_{aerobic} + R_{denitrification} + R_{sulfate\_reduction}$$

14 For nitrate-based primary production, i.e. if nitrate is available above Redfield conditions, primary and

15 export production directly depend on upwelling of bioavailable nitrogen. Surface N_2 fixation is based on

16 Redfield stoichiometry and on Fe availability (Fe > 0). If

17 $$N_{ox} - r_{N:P}\ P < 0$$

18 is true, export production is proportional to phosphate upwelling to the euphotic zone.

19 The model was further modified to explore OMZ N_2 fixation, which we suggest adding a source of reduced N

20 (N_R) to the OMZ. This pool of N_R would upon mixing or upwelling to the oxic surface promote nitrification

21 and primary production.

22 OMZ N_2 fixation has been shown not to be limited by Redfield constraints Redfield stoichiometry as

23 suggested by Bombar, Paerl, and Riemann (2016). This leads to a modification of the previous OMZ model

24 (Boyle et al, 2013) with the Redfield control of N_2 fixation being replaced by a phosphorous only control with

25 P > 0 constantly allowing for N_2 fixation and export production scaling with phosphate and $N_{ox} + N_R$ upwelling.

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28 Tables

29 Tab M1: Concentrations used in the model experiment, data taken from Bristow et al. (2017), Grand et al.

30 (2015) and (Chinni et al. 2019)

Parameter	Description	Concentration [µM]	Reference
O_{2U}	Oxygen concentration in surface waters	220	Bristow et al., 2017
O_{2I}	Oxygen concentration in intermediate waters	0.05	Bristow et al., 2017
O_{2D}	Oxygen concentration in deep sea	50	Bristow et al., 2017
P_U	Phosphate concentration in surface	0	Bristow et al., 2017
P_I	Phosphate concentration in intermediate water depth	2.7	Bristow et al., 2017
P_D	Phosphate concentration in deep waters	2.5	Bristow et al., 2017
N_{oxU}	Nitrate concentration in surfcae	0	Bristow et al., 2017
N_{oxI}	Nitrate concentration in intermediate water depth	38	Bristow et al., 2017
N_{oxD}	Nitrate concentration in intermediate water depth	35	Bristow et al., 2017
N_{RU}	Ammonia concentration in surface	0	Bristow et al., 2017
N_{RI}	Ammonia concentration in intermediate water depth	0	Bristow et al., 2017
N_{RD}	Ammonia concentration in deep sea	0	Bristow et al., 2017
Fe_{RU}	Dissolved iron concentration in surface waters	0.0004	Chinni et al., 2019
Fe_{RI}	Dissolved iron concentration in intermediate waters	0.015	Grand et al., 2015
Fe_{RD}	Dissolved iron concentration in deep sea	0.01	Grand et al., 2015

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33 Table S1: OTU counts of primary producers from a metagenome from station #4, 84m.

Class	%of OTUs in metagenome	Order	% of OTUs in class
Cyanobacteria	3,25%	Chroococcales	48%
		Prochlorales	41%
		Nostocales	5%
		Oscillatoriales	5%
		unclassified cyanobacteria	1%
Chlorophyta	0,33%	Mamiellales	75%
		Chlamydomonadales	21%
		Chlorellales	2%
		Ulvophyceae	0.4%
		unclassified chlorophta	1.6%

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Table S2: POC and PON distribution at stations 1 (17.9970°N, 88.9968°E), 4 (16.9828°N, 89.2063°E) and 5 (17.2075°N, 89.4282°E).

| station #	Incubation depth	POC [µmol L^{-1}]	SD	PON [µmol L^{-1}]	SD	POC:PON
1	67	4.956	0.195	0.531	0.027	9.331
1	106	11.057	5.038	1.411	0.773	7.838
1	112	6.730	2.493	0.700	0.182	9.613
1	128	6.709	1.015	0.818	0.048	8.198
1	169	5.946	0.830	0.586	0.125	10.151
1	253	4.720	1.774	0.262	0.105	17.998
4	60	5.854	0.734	0.688	0.051	8.505
4	112	3.833	0.336	0.395	0.030	9.714
4	145	6.674	2.634	1.022	0.645	6.527
4	176	7.884	1.713	1.247	0.255	6.321
4	213	4.858	0.112	0.676	0.048	7.186
4	265	4.166	0.667	0.475	0.074	8.773
5	60	7.844	1.094	1.253	0.256	6.259
5	111	6.461	1.462	1.013	0.080	6.376
5	122	8.783	1.263	1.488	0.143	5.902
5	157	7.409	0.241	1.325	0.067	5.590
5	195	9.337	0.404	1.433	0.203	6.514
5	280	5.232	0.659	0.674	0.017	7.766

Table S3: *nifH* qPCR quantification [copies L^{-1}], clusters which did were detectable by PCR but not quantifiable (below the detection limit of 4 copies L^{-1}) are not shown.

| station	depth [m]	filtration volume [L]	nifH [copies L^{-1}]					
			filamentous	SD	Gamma-PO	SD	Green sulfur	SD
1	10	10.2	8.2E+08	4.6E+03	1.5E+03	5.6E+02	6.4E+03	2.6E+03
1	68	10.3	1.4E+11	2.2E+06	1.2E+03	1.6E+02	1.1E+04	1.2E+03
1	80	16.2	2.4E+11	6.1E+10	5.4E+02	0.0E+00	1.8E+03	2.0E+03
1	115	12.7	0.0E+00	0.0E+00	2.2E+03	3.8E+02	3.0E+03	1.5E+03
1	130	14	0.0E+00	0.0E+00	4.3E+03	9.0E+02	1.6E+03	5.0E+02
1	140	20	0.0E+00	0.0E+00	1.7E+11	3.9E+10	4.5E+02	2.3E+02
1	160	20.2	0.0E+00	0.0E+00	5.1E+02	6.9E+01	3.4E+03	1.1E+03
1	256	21.5	0.0E+00	0.0E+00	1.7E+03	1.7E+02	3.8E+03	5.5E+02
1	500	16.3	0.0E+00	0.0E+00	7.5E+02	3.3E+01	1.6E+03	1.4E+02
2	61	14	6.7E+03	8.5E+03	1.7E+03	2.6E+02	1.9E+03	7.4E+02
2	120	10.7	8.3E+05	3.7E+05	0.0E+00	0.0E+00	1.5E+03	1.2E+03
4	60	8	0.0E+00	0.0E+00	5.1E+02	7.3E+01	1.7E+03	3.4E+01
4	84	7.6	0.0E+00	0.0E+00	4.4E+02	6.1E+01	1.6E+03	1.4E+02
4	112	9.2	0.0E+00	0.0E+00	1.0E+12	1.3E+12	2.9E+03	3.4E+02
4	154	11.7	0.0E+00	0.0E+00	1.6E+02	2.0E+01	1.5E+04	2.1E+03
4	179	19.1	0.0E+00	0.0E+00	1.8E+02	4.1E+01	3.9E+03	1.0E+03
4	211	20.1	0.0E+00	0.0E+00	1.1E+02	1.8E+01	7.7E+02	2.8E+02
4	265	22.9	5.4E+04	7.0E+04	4.7E+02	0.0E+00	2.0E+03	1.3E+03
4	321	23.2	3.0E+03	3.2E+03	0.0E+00	0.0E+00	7.3E+02	1.7E+02
5	60	7.6	5.8E+02	5.1E+02	7.5E+02	2.3E+02	1.8E+03	5.8E+02
5	80	12.6	8.9E+02	4.4E+02	0.0E+00	0.0E+00	8.1E+02	1.8E+02
5	127	14.3	0.0E+00	0.0E+00	2.4E+03	7.9E+02	2.5E+04	8.8E+03
5	156	6.4	0.0E+00	0.0E+00	0.0E+00	0.0E+00	9.8E+02	1.5E+02
5	560	15.4	8.2E+08	4.6E+03	1.5E+03	5.6E+02	6.4E+03	2.6E+03

43 **Figures**


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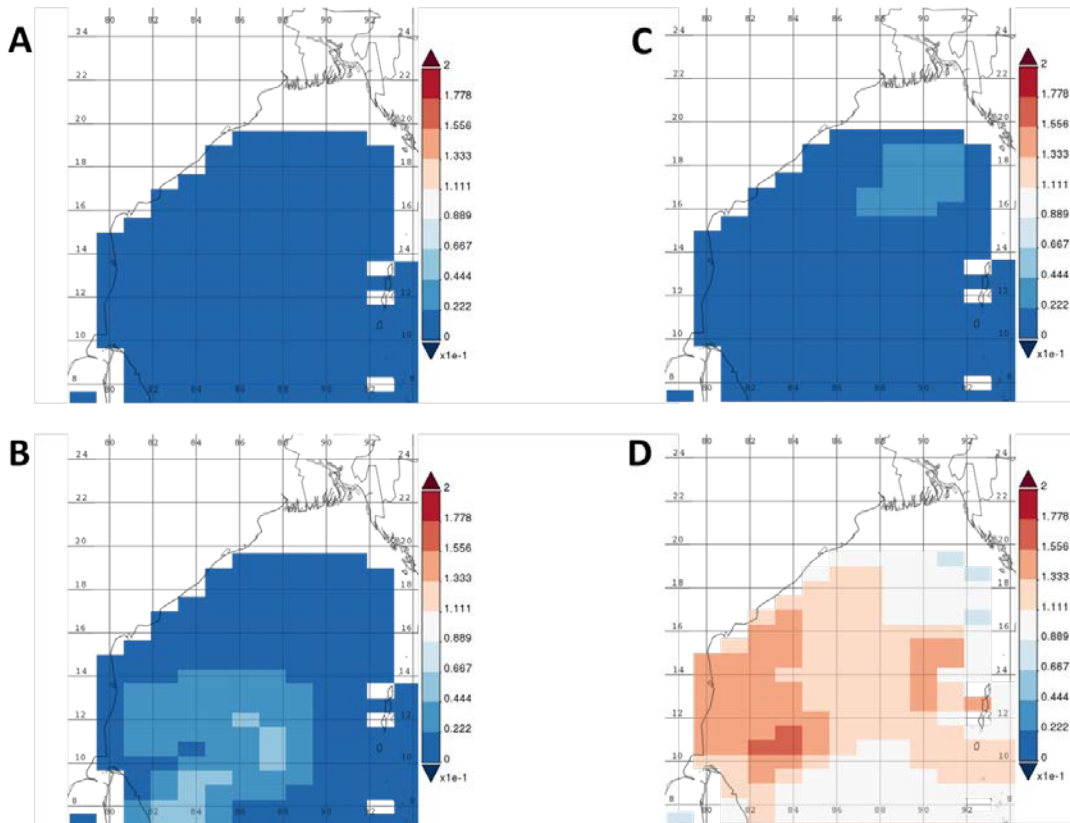
Figure S1: Phytoplankton distribution in the BoB during the time of the cruise: (A) diatoms, (B) chlorophytes, (C) coccolithophores, and (D) cyanobacteria in mg m^{-3}. Data obtained from a combination of the Sea-viewing Wide Field of view Sensor (SeaWiFS), the Moderate Resolution Imaging Spectroradiometer (MODIS-Aqua), and the Visible Infrared Imaging Radiometer Suite (VIIRS) satellite product as available from https://giovanni.gsfc.nasa.gov have been averaged from 15 Jan to 15 Feb, 2019. The combination of those sensors allows for covering a range of different wavelengths useful to identify different phytoplankton clades. The maps have been generated using the NASA Ocean Biogeochemical Model (NOBM, Gregg and Casey (2007)) using the most recent version of NASA ocean color data product (R2014), which represents circulation/biogeochemical/radiative processes in a 2/3° latitude spatial resolution as described in Gregg, Rousseaux, and Franz (2017). NOBM is designed to represent open ocean areas, with water depths greater than 200 m. It contains four phytoplankton groups, diatoms, chlorophytes, cyanobacteria, and coccolithophores, to represent diversity in the global oceans. Total chlorophyll is the sum of the phytoplankton groups.
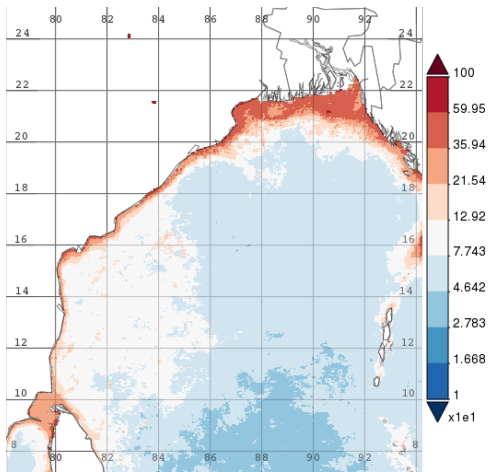
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59 Figure S2: Time-averaged (15 Jan to 15 Feb, 2019) POC distribution as monitored via MODIS-Aqua

60 (https://giovanni.gsfc.nasa.gov) on an 8-daily basis, with a 4km resolution, POC concentrations in mg m^{-3},

61 concentrations in the cruise area were between 7.7 and 12.9 mg m^{-3} and are consistent with our in-situ

62 measurements.

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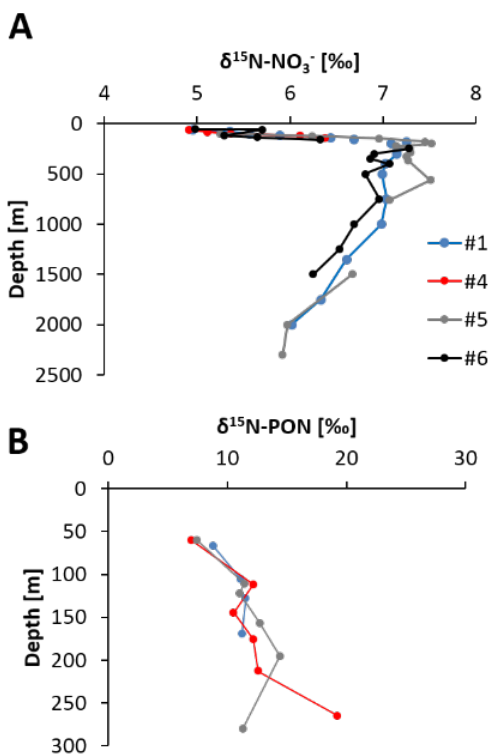
64 Fig. S3: Both, (A) δ^{15}N-NO$_3^-$ (data from Bristow et al., 2017) and (B) δ^{15}N-PON show slightly lighter isotope

65 signatures in the upper 100 m of the water column (samples were collected between 3 and 2300 m water

66 depth), however, this signal does not clearly indicate N$_2$ fixation.

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