



Supplement of

Influence of atmospheric deposition on biogeochemical cycles in an oligotrophic ocean system

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Figure S1: Vertical distribution of heterotrophic prokaryotic production (BP), particulate primary production (PP), and abundances of heterotrophic prokaryotes (hprok), *Synechococcus*-like cells (syn), eukaryotic picophytoplankton (pico euk) and nanophytoplankton (nano euk) at the ION site. Casts numbered the date of their sampling before (blue profiles) and after (grey profiles) the rain sampled onboard.

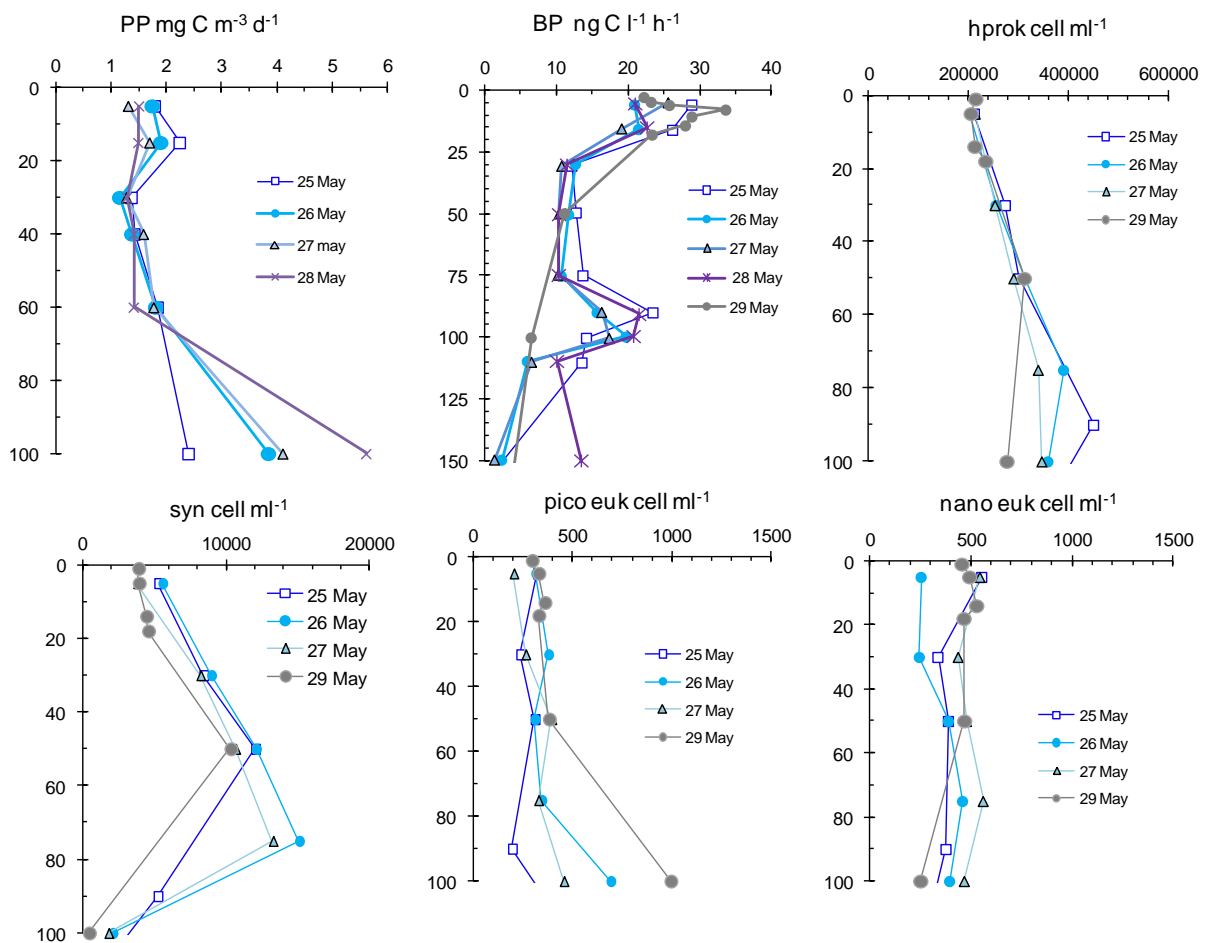


Figure S2: Vertical distribution of heterotrophic prokaryotic production (BP), particulate primary production (PP), and in vivo fluorescence profiles at the FAST site. Stations numbered in days before (blue profiles) and after (grey profiles) the rain event.

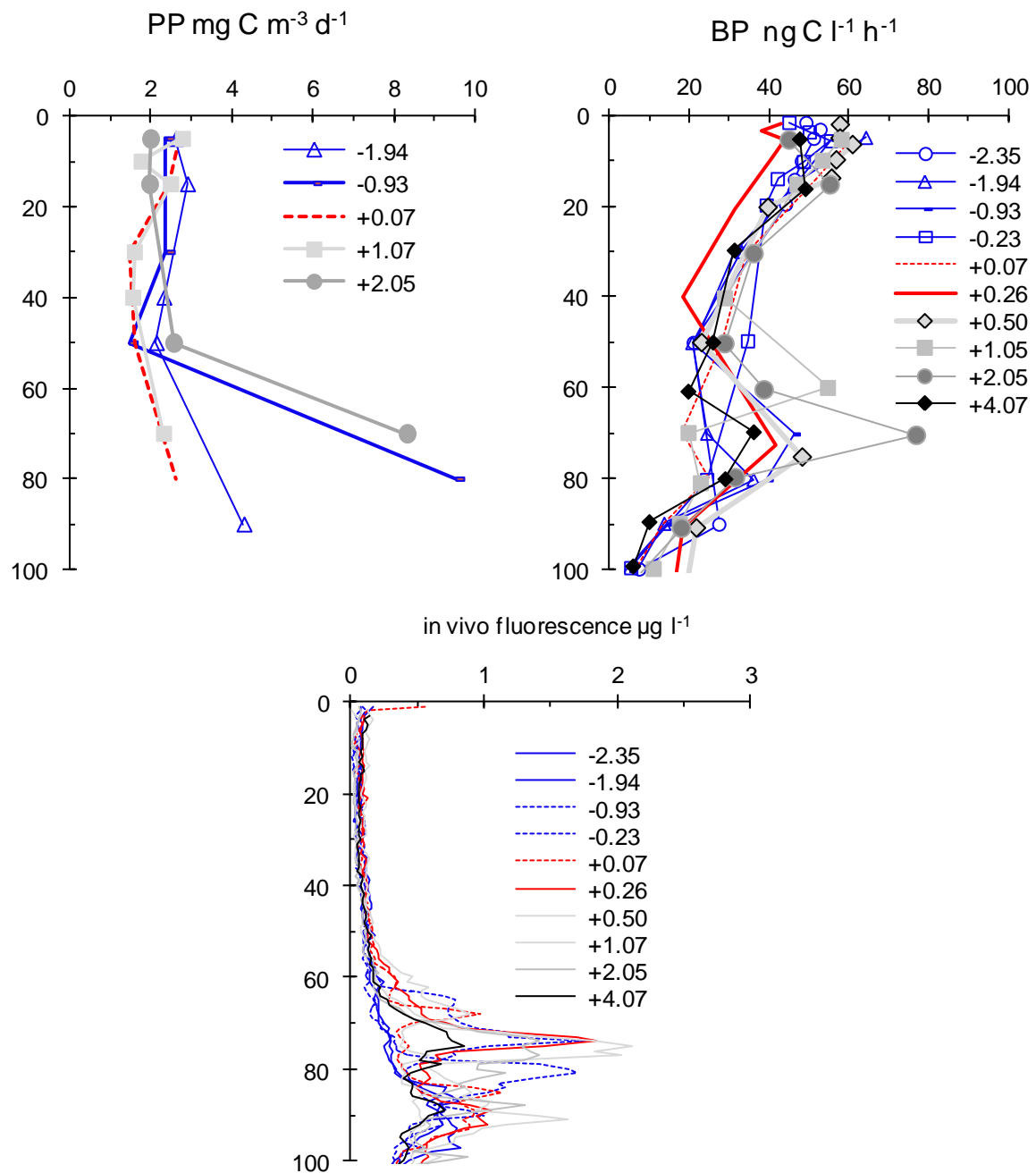
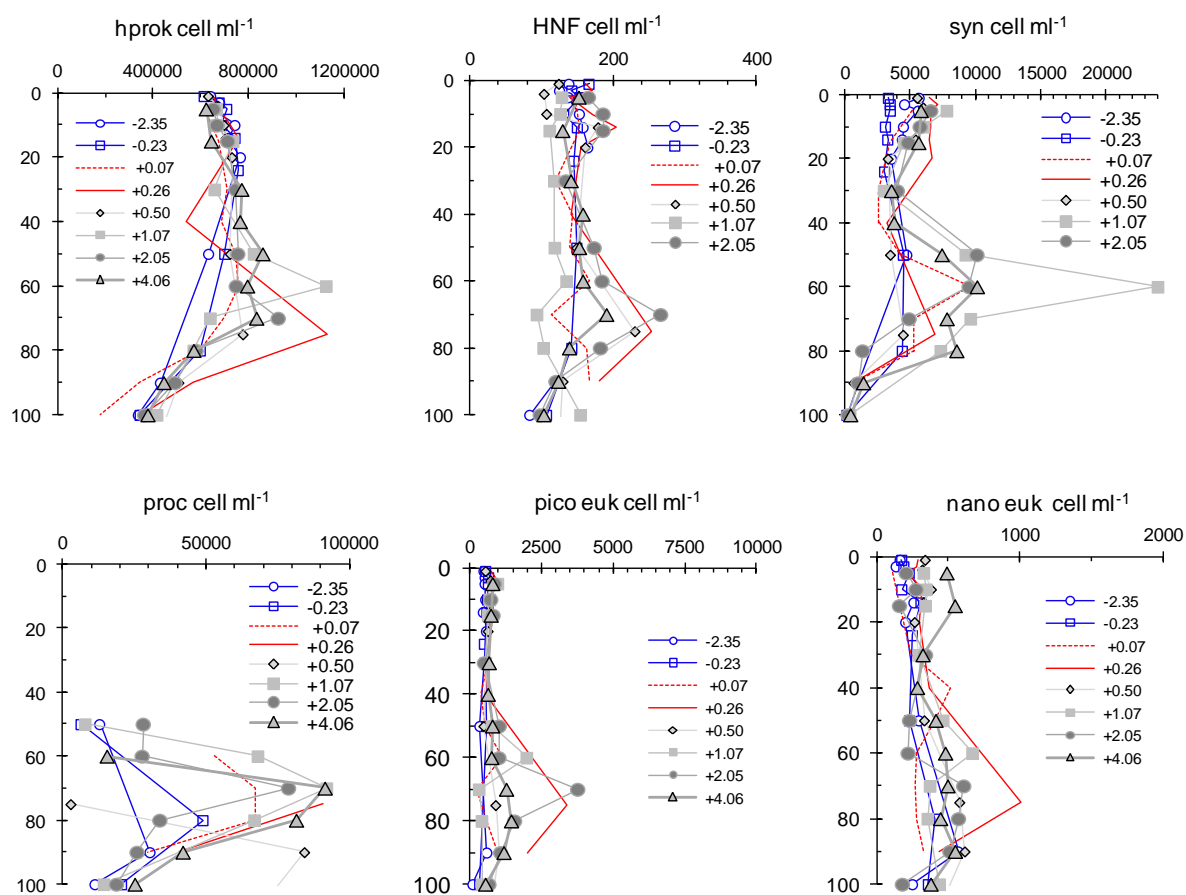


Figure S3. Vertical distribution of abundances for heterotrophic prokaryotes (hprok), heterotrophic nanoflagellates (HNF), *Synechococcus*-like cells (syn), *Prochlorococcus* (proc), eukaryotic picophytoplankton (pico euk) and nanophytoplankton (nano euk) at the FAST site. Stations numbered in days before (blue profiles) and after (grey profiles) the rain event sampled on board.



Enrichment experiments

At the three sites, enrichment experiments were performed using seawater from 5 m depth to assess factors limiting BP in the surface mixed layer. The sampling of seawater for these experiments [FAST (June 2, 22:00), TYR (May 16, 20:00) and ION (May 25, 20:00)] was done before the rain events occurring at the FAST and ION sites. Eight series of triplicate 60 mL polycarbonate bottles were filled with unfiltered seawater and amended as follows: C : no enrichment, N: +1 μM NO_3 + 1 μM NH_4 ; P: + 0.2 μM DIP; G: + 10 μM C-glucose; NP: N + P; NG : N + G; PG : P + G; NPG: N + P + G. After 48 h incubation in the dark at *in situ* temperature, BP was determined in the 24 bottles (as described in M&M section).

At the TYR site, BP was significantly stimulated only after addition of 2 major elements, with a greater response with PN and NPG combinations (Fig. S4). At the ION site, BP was primarily limited by P availability, as only combinations with P (single or in combination with other elements), stimulated BP whereas all other combinations of enrichment did not stimulate BP significantly compared to the control. At the FAST site, BP was primarily limited by N availability, as all combinations with N, single or in combination with other elements, stimulated BP. However at this site it is likely that BP was also co-limited by 2 elements, as G addition alone also stimulated BP. Note that the PN combination has induced a higher stimulation of BP than other double combinations (NG or PG).

Figure S4. Results of the enrichment experiment. BP reached after 36 h of enrichment in the dark. C: control unamended, P: +DIP, N:+ NO_3 + NH_4 , G: +glucose, and combinations of these elements in PN, NG, PG and NPG. Stars show significantly different BP compared to the unamended control .

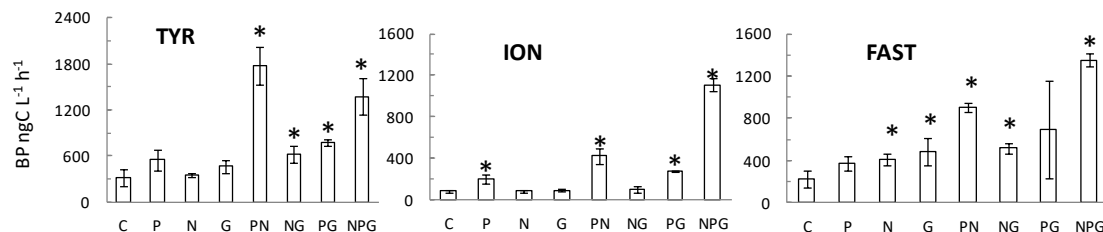


Table S1: NO₃ ranges within the surface mixed layer (ML) and the base of the nitrate depleted layer below (NDLb) and advective fluxes when measurable. CTDs at the FAST sit are chronologically indexed in days before (negative index) and after (positive index) the occurrence of the rain event collected on board. no lwcc: no data because at these stations concentrations were determined only by classical analysis and were under its detection limits (50 nM), na : not available. From comparison of concentrations, we identified four groups of stations: group 1: poor nitrates in ML and NDLb (< 50 nM); weak differences (< 15 nM); group 2: moderate nitrates in ML and NDLb (50 nM < NO₃ < 80 nM); weak differences (< 20 nM); group 3: high nitrate in ML and NDLb (NO₃ > 80 nM); weak positive differences (< 20 nM) and group 4: high nitrate in ML and moderate to high in NDLb, large positive differences (> 20 nM). MLD: mixed layer depth. sd of fluxes were estimated using propagation of errors on NO₃_{ML}, NO₃_{NDLb} and dMLD/dt.

	Date, local time	MLD m	base NDLb m	NO ₃ in ML			NO ₃ in NDLb			difference nM	Flux SML to NDLb μmol N m ⁻² d ⁻¹		Station group
				Mean nM	sd nM	n	Mean nM	sd nM	n		Mean	sd	
ST 1	12/05/2017 12:26	21	52	no lwcc			no lwcc				na		na
ST2	13/05/2017 07:40	21	60	no lwcc			no lwcc				na		na
ST3	14/05/2017 12:05	11	73	no lwcc			no lwcc				na		na
ST4	15/05/2017 07:09	15	55	no lwcc			no lwcc				na		na
ST5	16/05/2017 04:04	9	66	29	na	1	17	8	2	13	na		1
ST TYR 17 May	17/05/2017 09:36	9	69	14	0	2	19	6	4	-5	na		1
ST6	22/05/2017 05:48	18	71	9	na	1	9	0	2	0	na		1
ST7	23/05/2017 21:11	18	79	9	na	1	9	0	2	0	na		1
ST ION 25 May	25/05/2017 05:28	14	86	14	5	2	14	6	6	0	na		1
ST ION 27 May	27/05/2017 08:24	18	93	127	31	6	103	12	2	24	45	52	4
ST ION 29 May	29/05/2017 09:19	16	88	92	17	6	67	na	1	25	-25	21	4
ST8	30/05/2017 04:48	14	79	60	na	1	68	12	3	-8	na		2
ST9	01/06/2017 21:15	7	72	117	na	1	106	15	2	11	na		3
ST FAST -2.3	02/06/2017 19:16	9	80	79	4	3	74	15	3	6	0	0	2
ST FAST -1.5	03/06/2017 15:30	13	78	59	3	2	46	5	5	13	62	34	2
ST FAST -0.25	04/06/2017 20:57	12	77	56	4	3	54	14	3	2	-2	9	2
ST FAST +024	05/06/2017 08:54	16	77	93	15	5	51	7	3	42	337	173	4
ST FAST +0.53	05/06/2017 15:50	16	82	70	5	4	50	na	1	20	0	69	4
ST FAST +1.05	06/06/2017 04:23	19	85	39	3	4	45	9	2	-6	-34	46	1
ST FAST +2.11	07/06/2017 05:38	15	59	9	0	3	19	3	2	-10	38	15	1
ST10	08/06/2017 06:55	19	62	120	na	1	58	15	3	62	na		4
ST FAST +3.8	08/06/2017 22:09	17	73	135	7	3	116	22	3	20	22	28	4

Table S2. Biological stocks and fluxes integrated over the mixed layer (a), the euphotic zone (b) and 200 m (c), along with atmospheric dry deposition during the occupation of the ION and FAST sites. Time CTD cast is the local time at the beginning of the CTD cast. For atmospheric dry deposition, start and end shows the period during which PILS data were averaged to compute daily DIN (NO₃+NH₄) depositions fluxes. PP: Primary production, BP: heterotrophic prokaryotic production, LAP: *In situ* leucine aminopeptidase hydrolysis rates, N₂fix: N₂ fixations rates.

	time CTD cast	biological flux						stocks		dry deposition		
		PP ^b mg C m ⁻² d ⁻¹	BP ^c mg C m ⁻² d ⁻¹	PP ML ^a mg C m ⁻² d ⁻¹	BP ML ^a mg C m ⁻² d ⁻¹	LAP ML ^a μmol N m ⁻² d ⁻¹	N ₂ fix ML ^a μmol N m ⁻² d ⁻¹	NO ₃ stocks ML ^a μmol N m ⁻²	DIP stocks ML ^a μmol P m ⁻²	start	end	DIN μmole N m ⁻² d ⁻¹
TYR 17 May	17/5/17 4:58		5.6	13.7	5.6	17.2	3.9	127	64	17/5/17 2:54	17/5/17 4:58	23.2
TYR 18 May	18/5/17 4:57		6.0	12.0	6.0					17/5/17 4:58	18/5/17 4:57	25.1
TYR 19 May	19/5/17 4:53		6.1	13.9	6.1					18/5/17 4:57	19/5/17 4:53	26.9
TYR 20 May	20/5/17 4:45		14.5	46.1	14.5					19/5/17 4:53	20/5/17 4:45	37.9
ION 25 May	25/5/17 4:34	188	56.1	19.7	7.5	27.8	6.1	195	142	24/5/17 18:02	25/5/17 4:34	24.1
ION 26 May	26/5/17 4:25	207	44.7	26.9	8.0					25/5/17 4:34	26/5/17 4:25	27.8
ION 27 May	27/5/17 4:26	210	43.9	19.9	8.0		5.1	2113	109	26/5/17 4:25	27/5/17 4:26	32.6
ION 28 May	28/5/17 4:21	226		31.3	10.7					27/5/17 4:26	28/5/17 4:21	33.8
ION 29 May	29/5/17 9:19		45.2		10.3		6.3	1477	167	28/5/17 4:21	29/5/17 9:19	29.2
FAST-2.32	2/6/17 18:37		87.8		13.2	31.1		715	99	2/6/17 20:24	2/6/17 18:37	
FAST-1,48	3/6/17 4:32	257	81.2	37.8	19.9		5.9	751	162	2/6/17 18:37	3/6/17 4:32	42.5
FAST-0,93	4/6/17 4:40	274	87.9	28.5	15.6		7.1			3/6/17 4:32	4/6/17 4:40	38.3
FAST-0,25	4/6/17 21:27		88.9		12.4			665	137	4/6/17 4:40	4/6/17 21:27	61.2
FAST 0.07	5/6/17 4:44	164	80.8	29.3	15.6		6.4			4/6/17 21:27	5/6/17 4:44	39.6
FAST 0,24	5/6/17 9:24		92.7		14.6	47.2		1520	136	5/6/17 4:44	5/6/17 9:24	
FAST 0,53	5/6/17 14:59		113.3		19.4	52.8		1113	210	5/6/17 9:24	5/6/17 14:59	12.9
FAST 1,05	6/6/17 4:51	140	99.2	33.4	18.6	54.8	8.3	752	281	5/6/17 14:59	6/6/17 4:51	
FAST 2.11	7/6/17 4:17	218	104.1	31.8	18.7	35.1	8.1	177	194	6/6/17 4:51	7/6/17 4:17	19.8
FAST 3.8	9/6/17 4:40		82.9		21.9	34.5		2314	125	8/6/17 21:06	9/6/17 0:16	23.9