

## ***Interactive comment on “Biogeochemical and biological impacts of diazotroph blooms in a Low Nutrient Low Chlorophyll ecosystem: synthesis from the VAHINE mesocosm experiment (New Caledonia)” by S. Bonnet et al.***

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Dear Reviewer,

First, we would like to thank you very much for your constructive comments. We made our best to take into consideration all comments and suggestions. Comments and questions are copied with our replies below.

Referee #2

P2L11, P7L28 my experience suggests that mesocosms do disturb the ambient light

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field. Please provide evidence to the contrary or reference to the relevant paper in the special issue to support this.

We agree that the mesocosms may have produced a slight change in the light environment, albeit this was probably limited. So, we modified the text as follows in the revised version of the manuscript: “. . .to maintain a stable water-mass minimizing the disturbance of ambient light and temperature conditions. . .”. In addition, we added the Guieu et al. (2010) reference that describe extensively the mesocosms setup used during the VAHINE experiment and where the question has been more largely discussed.

P3L12 tropical LNLC ecosystems include : : .subtropical gyres? Tropical and subtropical are different environments/regimes

We agree with this comment and removed “Tropical” at the beginning of the sentence.

P3L22 need an extra ) after 2008)) P3L29 . . . . .cycles HAS been P3L32 preferentially exported directly . . . . P5L12 phytoplankton. Actual Calculations of DDN transfer were first . . . . .

All these suggested changes have been done

P5L21 : . . .poorly and challenged qualified due mainly to

Rephrased as follows: “remains poorly qualified and challenging”

P9L4 ..good replicability low variability

Rephrased as follows: “These studies also revealed a good replicability and low variability between stocks, fluxes and plankton diversity measurements among the replicate mesocosms. . . .

P9L18 within MESOCOSMS and in . . . .

The word addition has been applied in the new version of the manuscript.

P11L2 How is DIP turn-over time defined and measured. I do not see any reference to

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DIP uptake rates. This needs some detail or referencing to the appropriate paper.

DIP turn over time was measured using the radioisotope  $^{33}\text{P}$  according to Duhamel et al. (2006). Results and details on DIP turn-over time measurements during the VAHINE experiment are presented in Berthelot et al. (2015). The references for each of the parameters have been added in the caption of Figure 4.

P11 A number of rate measurements are introduced on this page which do not seem to be defined (e.g. APA, PP, BP) neither is there reference to the papers containing this data/description.

All acronyms are now defined in the text when they appear for the first time.

P12L5-8 How do your results demonstrate this? No evidence is given here neither is there any reference to the paper detailing this work.

This is detailed in the Gimenez et al paper within the special issue as cited in the text. However, we acknowledge that this part is not the main goal of the present paper and we decided to remove this paragraph. ....

P12L28-29 : : ...to determine whether : : :: : ..of particulate matter, and if so, how was this manifested.

The suggested change has been applied.

P12L34 equalled

The suggested change has been applied.

P13L27 what is nanosims and how was it used to demonstrate this?

NanoSIMS refers to nanoscale Secondary Ion Mass Spectroscopy. The sentence has been modified as follows: 'An experiment performed during the UCYN-C bloom using nanoSIMS (nanoscale Secondary Ion Mass Spectroscopy) as described in Bonnet et al., (2016) demonstrated that a significant. . .'

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P14L2 define e-ratio

The e-ratio depict the efficiency of the carbon export compared to primary production. In order to clarify, we modified the text as follows: "indicated by e-ratio calculations (e-ratio =  $\text{PP}/\text{POC}_{\text{export}}$ ), which quantify the efficiency of a system to export particulate C relative to the C fixed by PP).

P14L28-32 long sentence which needs breaking up

The sentence has been divided in two as follows: "During the maximal abundance of UCYN-C, these were responsible for  $90 \pm 29$  % of total  $\text{N}_2$  fixation rates in the mesocosms (Bonnet et al., 2015a). During this period, the DDN released to the dissolved pool (based on the direct measurement of the isotopic signature ( $^{15}\text{N}$ ) of the total dissolved N according to the denitrifying method (Knapp et al., 2005)) accounted for  $7.1 \pm 1.2$  to  $20.6 \pm 8.1$  % of gross  $\text{N}_2$  fixation (Bonnet et al., 2015a)."

P15L1 Are waters contained within a mesocosm natural?

The waters present in the mesocosms were isolated from the lagoon the first day of the experiment. The mesocosms are designed to minimize the perturbations (temperature, light. . .) and reproduce as much as possible the natural environmental conditions. Nevertheless, we agree that in the strict mean of the term, "natural" can be seen as inappropriate and we deleted it in the new version of the manuscript.

P15L23 Surely the evidence to date indicates that the bubble method underestimates rates? (Mohr et al, Grosskopf et al, etc)

Indeed, Mohr et al. 2010 reference appears to be more suitable in the context of the sentence and replace the Montoya et al. 1996 reference in the new version of the manuscript.

P16L22-27 long sentence

The sentence has been divided in two in the new version of the manuscript: "The re-

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relationships between BP and N<sub>2</sub> fixation rates were weak (during P2) or absent (during P1) but tightly coupled between BP and Chl a concentrations, and between BP and PP. This suggests that N<sub>2</sub> fixation stimulated autotrophic communities and these subsequently stimulated heterotrophic prokaryotes through the production and release of dissolved organic matter including C (DOC) (Van Wambeke et al., 2015)."

P17L10-15 long sentence

The sentence has been modified as follows: "These results indicate that the extensive oceanic blooms of *Trichodesmium* spp. can contribute to a large indirect downward flux of organic matter by promoting large cells (e.g., diatoms and dinoflagellates) characterized by efficient export rates (Nelson et al., 1995, Bonnet et al., Accepted; Devassy et al., 1979; Lenes et al., 2001)."

P19L5 deconvolute???? No idea what is meant by this

The term "deconvolute" has been changed by "separate".

P19L15-16 .. during the first 10 days .... P19L31-32 (nearly up to 40% of the DDN .....experiment is found .....) P20L12 DDN was mainly transferred through .....

The suggested change has been applied in the new version of the manuscript.

Figs 6,7,8 Labelling of REF and NOFIX in figure legends is the wrong way round

The captions of Figs. 6,7 and 8 have been corrected in order to fix this problem.

P22L9-10 aggregation processes mediated diazotrophs-derived TEP release – this needs re-phrasing somehow

The sentence has been rephrased and the paragraph has been reorganized to improve the clarity of the text : "It is likely that during the experiment, TEP release favored aggregation and accumulation of particles and subsequently enhanced vertical flux from the different compartments in the water column. To represent the latter phenomenon, we considered in the model that 10 % of the living and non-living compartments were

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allowed to sink after day 10 (see Gimenez et al. (2016) for more details). Since this extra aggregation is mainly attributable to diazotrophs, it was not represented in the NOFIX simulation. However, we ran a third simulation (not shown) to further analyze the excess of C export in the REF simulation as compared to the NOFIX one (Fig. 8). This third simulation is intermediate between the REF and the NOFIX simulations in that sense that only the N<sub>2</sub> fixation capability by diazotrophs is removed (but aggregation processes are still represented). This simulation indicated that C export is nearly equal to that of the REF simulation after 25 days (they differ by only 2.9 %), thereby suggesting that during the 25 first days, the suppression of N<sub>2</sub> fixation does not significantly impact carbon export fluxes. This further suggests that the higher C export in the REF simulation during P2 (Fig.8) is mainly due to aggregation processes mediated by diazotrophs-derived TEP release and the subsequent export of diazotrophs (Berman-Frank et al., 2016; Bonnet et al., 2015a). However, beyond day 25, the difference in carbon export between the REF and the third simulation increases up to 25% on day 35. In other words, the N<sub>2</sub> fixation process per se (by supporting PP and BP fluxes) contributes more and more to the enhanced C export as N<sub>2</sub> fixation fluxes increase. Hence, on day 30, N<sub>2</sub> fixation supports ~50 % of the excess C export observed between the REF and the NOFIX simulations, the remaining still being attributed to aggregation processes".

P23L26 what is PCD?

PCD means "Programmed Cell Death" and is defined in the new version of the manuscript.

References cited:

Duhamel, S., Zeman, F., and Moutin, T.: A dual labelling method for the simultaneous measurement of dissolved inorganic carbon and phosphate uptake by marine planktonic species, *Limnol. Oceanogr.-Meth.*, 4, 416–425, doi:10.4319/lom.2006.4.416, 2006.

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Berthelot, H., Moutin, T., L'Helguen, S., Leblanc, K., Hélias, S., Grosso, O., Leblond, N., Charrière, B., and Bonnet, S.: Dinitrogen fixation and dissolved organic nitrogen fueled primary production and particulate export during the VAHINE mesocosm experiment (New Caledonia lagoon), *Biogeosciences*, 12, 4099-4112, 2015.

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Interactive comment on *Biogeosciences Discuss.*, doi:10.5194/bg-2015-668, 2016.