

## ***Interactive comment on “Planktonic dinitrogen fixation in the Mediterranean Sea: a major biogeochemical process during the stratified period?” by S. Bonnet et al.***

**Anonymous Referee #1**

Received and published: 12 March 2011

### General comments

In this study, Sophie Bonnet and co-authors present a nice dataset on diazotroph N-inputs to the Mediterranean Sea. Based on extensive rate measurements carried out during a cruise across the whole basin, the authors show that N<sub>2</sub> fixation can be substantial during summer stratification. The observed spatial pattern in N<sub>2</sub> fixation rates (rates decreasing from west to east) contrasts earlier studies, which identified the eastern basin as the hot spot of N<sub>2</sub> fixation. Thus, this manuscript provides important new insights on N<sub>2</sub> fixation in a system that has been puzzling to investigators studying diazotrophy. However, there are quite a few issues that would need to be resolved

C212

before this manuscript can be published in Biogeosciences. I find that the presentation of the data can be somewhat improved, especially regarding which data are presented to complement the measured rates of N<sub>2</sub> fixation. The discussion is too long and its structuring makes some topics appear torn apart. Unfortunately, there are also numerous typographic errors, as well as grammar- and phrasing issues. A few very obvious errors appear in the captions of tables and figures. Figure 3 presents chlorophyll data but there is no information on how chlorophyll concentrations were measured or from which paper they are cited. I was therefore overall left with the impression as if the manuscript was written in a rush. I can see that this is partly due to the fact that the manuscript is supposed to become part of a special issue, and will thus try to link the results to other papers. But still, care should be taken to present a paper that stands on its own with rigorous conclusions as much as possible.

### Specific comments

Abstract Page 1198, line 2: I would use inputs or rates instead of “fluxes”. line3: “representing a variety of trophic conditions” contains no important information and can be deleted. Instead, this variety of trophic conditions, which is partly mentioned in line 6 (“less oligotrophic”), should explained a bit more in order to enable the reader to better understand in which settings low/high rates were found. It would be also easier for the reader if information on the spatial patterns (east/west) is combined with information on the trophic setting (at present, it's up to the reader to collect these informations from 2 sentences). Line 6: I'd write “are found within” instead of “are performed within”. Line 7: clarify here whether the estimate of 45-75% of N<sub>2</sub> fixation happening in the <3 size fraction refers to the whole transect or just to the western basin Line 9: new production is defined as primary production based on external N-sources. Thus, it is a bit confusing to read that 35% of new production is based on N<sub>2</sub> fixation, while the same process accounts for only 25% of the external N sources. I know that these numbers represent different estimates and that it would be hard to actually reconcile measured rates of primary production and potential primary production based

C213

on estimates of different N-inputs, but it's obviously a bit unlucky to combine these two numbers in one sentence here. Line 14: the final sentence of the abstract basically says "we need more sampling". This is true, but maybe a bit dry for an abstract. It could be explained that the interplay between diazotrophs and the seasonally changing biogeochemical settings is obviously not fully understood for this region, and that the presented data shed more light on these dynamics.

Introduction The title of this paper points to the importance of N<sub>2</sub> fixation during the stratification period. Yet the introduction gives only little information on the seasonality of the hydrography in the Mediterranean, and about how the biogeochemistry responds to these changes. This should be shortly explained so that the reader can better grasp how different the conditions really are between seasons, and how the system differs from e.g. the oligotrophic open Atlantic where most studies on diazotrophy have been carried out. Page 1198, line 23: "some biological processes" is a bit too general; you could shortly explain that non-Redfieldian elevated ratios of NO<sub>3</sub><sup>-</sup> to PO<sub>4</sub><sup>3-</sup> produced from regenerated particulate material are indicative of N<sub>2</sub> fixation inputs, since this becomes the focus in the next paragraph.

Page 1199, line 8: it should read "nutrient budgets for the Mediterranean sea" Lines 10-16: these sentences are a bit complex while giving ambiguous information. After all, the topic is nutrient inputs, so it appears unnecessary to first talk about "Aeolian material deposition" and "anthropogenic aerosols", and then to make the point in line 16 by reporting on N and P inputs. Thus, lines 10-18 could be distilled into 2 concise sentences. I assume that in line 15 it's supposed to read "that represent a background of available N in the Mediterranean"? Definitely check phrasing here. Line 22: how about "found" instead of "generally preferred"? Or, "an alternative explanation for elevated N:P ratios"?

Page 1200, Line 8: this is confusing: "(7-40% according to the hypothesis considered)". Which hypotheses do you mean? Does this refer to the reference that follows at the end of the sentence? Lines 15-19: how about "related to" instead of affiliated? Reading

C214

about *Richelia* "in low abundances" seems to contrast what is cited from Crombet et al. 2010 later in the manuscript. Lines 19-25: this sentence is too long and the phrasing is a bit confusing; what is meant with "high and controversial", is that supposed to mean "high but variable"?

Methods Page 1201, line 17: Here and in a few other cases: Do you mean "these latter stations"? (instead of "these latest"). Page 1202, lines 5-8: this is interesting- were the two methods, i.e. in situ- and on-deck incubations, ever done simultaneously and the results compared? Line 26: constant response to what?

Results Page 1203, line 16: Here, in line 25, and on page 1204 line 7, the authors use "global" or "globally" when talking about the overall range of rates measured within the Mediterranean, which is the wrong choice in parts and can also be a bit misleading since the paper also includes comparisons to rates measured in other basins around the "globe" (Table 2). Please use "overall" instead. Lines 16- 24: Figures 2 and 3 essentially show the same kind of data, i.e. the vertical distribution of volumetric N<sub>2</sub> fixation rates. The calculation of contours in Figure 2 is in most cases based on only 2 or 3 measurements within the water column (SD stations), and thus, vertical patterns of N<sub>2</sub> fixation are "invented" for large parts of the transect. Blanking out all areas not supported by data would be necessary here, but would make the plot look very awkward, I assume. Further issues with Figure 2 are that a) the SD stations are not clearly marked on the x-axis, b) rates at station B appear to differ from rates shown in Figure 3 for station B (is this due to averaging?) and c) the caption of Figure 2 includes confusing information (unit is written as nmol l<sup>-1</sup> d<sup>-1</sup> ; and what does "distance 11 from station 27" mean?). I therefore think it would be best to delete Figure 1. The spatial patterns would appear much clearer if measurements from all stations were shown as rate profiles (as shown in Fig. 3), with rates from SD stations as single data points and data from the LD stations drawn as profiles, as already done in Figure 3. Sentence starting in Line 25: This sentence is very hard to read and understand. The authors should stick to providing one message per sentence- this one has at least

C215

2, it seems. Were there any measureable differences in salinity, temperature, nutrients between stations within and outside of these gyres? Shortly commenting on these differences would provide a nice context to the rate measurements. At present the paper completely lacks information on hydrography, I assume since these are supposed to be presented in other papers within the special issue? Still, it would be nice to have a basic set of such data in the paper, e.g. marking mixed layer depths in plots that show vertical distributions.

Page 1204, line 4: "over the vertical" should be replaced by "throughout the water column". Lines 6-11: it is difficult to clearly see these vertical differences in N<sub>2</sub> fixation rates at the SD stations, especially since SD stations are not marked in Fig. 2. This is another reason for rather providing the rates as simple 2D graphs instead of a contour plot, as requested above. Line 13: Using "confirmed" here appears inappropriate to me. Of course both the profiles of rate measurements as well as areal rates show the decrease towards the east, since areal rates are calculated by depth-integrating the rate profiles. The areal rates are simply the better choice when comparing diazotrophs inputs between different areas, as done in Table 2, but apart from that, they provide no further information regarding spatial patterns. The authors should delete this sentence; it is enough to discuss areal rates as done on pages 1207 and 1209. Line 19: "same trend" refers to what?

Discussion: In all, based on the presented dataset, the discussion appears a bit over-ambitious and should be shortened. Points 4.2 and 4.3 could be combined to a discussion about "Biogeochemical significance and potential controlling factors of N<sub>2</sub> fixation in the Mediterranean Sea"

Page 1205, line 6: I am unaware of the term "UCYN2-fix". It is not defined here nor in the LeMoal manuscript- the original papers by Zehr et al. differentiate between the different types (UCYN-A, -B etc), but never use "UCYN2-fix". Why not use "diazotrophic cyanobacteria" throughout?

C216

Page 1206, line 9: write: (Gomez et al., unpublished data) Line 25-26: the choice of words is suboptimal here; to what do the authors refer when talking about "behaviour"? I assume the sentence is about the different biogeochemical/nutrient forcing on diazotrophs within the different basins.

Page 1207, line 10: more precise information on the possible temperature effects would be nice here (too low I assume? How do temperatures differ between seasons?) Lines 15-20: this sentence is too long, confusing, and the brackets are not closed.

Pages 1207-1208: Comparison of N<sub>2</sub> fixation and diffusive fluxes: Unfortunately, neither Moutin et al. 2010 nor Cuypers et al. 2010, both supposed to be found as open discussion papers in the same special issue, are (yet?) accessible on the Biogeosciences website at the time of this writing. This makes me assume that they have either not been submitted yet, or have been initially rejected. It would be necessary to know about the contents, the status, and the outcome of these manuscripts, otherwise the present paper would reference to a lot of "unpublished data". In table 3, I think the truly interesting data are the Nitrate fluxes; but these are presented in Table 1 already and are just listed here in more detail- if Cuypers et al. is published in the same special issue, presenting the data in 2 separate tables would be unnecessary/excessive here.

Page 1209, line 12: "confirmed since ever": what does that mean? Line 14: I assume it should read "subject to" instead of "submitted to"? Line 17: stating that rates of N<sub>2</sub> fixation were higher in the western part has been said many times before; I would suggest starting right with the comparison of rates with results from the other oceanic areas.

Page 1210, line 21: again the same information at the beginning of a paragraph (N<sub>2</sub> fix higher in the west). I would rather start right away with discussing possible explanations for the spatial patterns (phosphate availability is the topic of this paragraph).

Page 1211, line 5-7: it is unclear how "despite stimulation was higher with Saharan dust" relates to the first part of the sentence. Please explain. Lines 13-29: this para-

C217

graph discusses the interesting finding of elevated N<sub>2</sub> fixation in waters having detectable N concentrations, and suggests that a low N:P ratio, i.e. a surplus of P relative to N, is important in promoting the growth of certain diazotrophs. These findings can be backed up further by some other recent studies which report on the same scenario, i.e. elevated N<sub>2</sub> fixation by planktonic diazotrophs in estuarine/coastal waters having high N concentrations but low N:P ratios (Grosse et al. 2010, L&O, Bombar et al. 2011, MEPS); these papers should be cited here as well, in addition to Short and Zehr 2007.

Technical corrections

Abstract, Line 13: it should read “which indicate” instead of “who suspected” if sentence refers to data instead of authors

Page 1200, Lines 13/14 “never reaches”! Line 23: “across the basin”

Page 1209 line 13: change “atmosphé” to “atmosphere”

Table 3: Please note that there are some errors and inconsistencies in this table and its caption: The sentence “K<sub>z</sub> values given for stations 15, 19, and 24. . .” appears twice (second and last line of the caption). NO<sub>3</sub>- gradients/Fluxes should always be noted the same way; in the present version one can find NO<sub>3</sub>- flux in the caption but “N flux” in the table.

Table 4: write the “9” as exponent in the caption

Fig. 3: explain in the methods section how chlorophyll concentrations were measured, or provide a reference.

End of review.

---

Interactive comment on Biogeosciences Discuss., 8, 1197, 2011.