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# ***Interactive comment on “Microbial food web dynamics in response to a Saharan dust event: results from a mesocosm study in the oligotrophic Mediterranean Sea” by E. Pulido-Villena et al.***

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Review of the manuscript “Microbial food web dynamics in response to a Saharan dust event: results from a mesocosm study in the oligotrophic Mediterranean Sea” by E. Pulido-Villena et al.

Authors’ Responses to referees We thank both referees for their relevant comments which have helped to improve our manuscript.

Anonymous Referee #1 Received and published: 3 March 2014

General considerations

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In the present study authors try to elucidate the effect of Saharan dust deposition on the different components of the microbial food webs including viruses on an oligotrophic system, using an experimental mesocosms approach. Authors are mainly centered in the plausible contribution of N and DIP transported by the Sahara dust on the activity and biomass of marine microbes in the surface of the water column (0, 5 and 10 m). The ms is well written, tables and figures almost always illustrate correctly the results, however, I found that authors need to explicitly explain that this is an experimental approach and cannot extrapolate what occurs in Nature. Authors added a determined concentration of Sahara dust that will not be as diluted as occurred in the open Sea. For this reason it is not clear to me when authors say that they added a concentration of 41 g of mineral dust mimicking a realistic flux of 10 g m<sup>-2</sup>. The question is how realistic is this addition? in nature how often during the year occurs this Saharan dust deposition?

RESPONSE: The amount of dust used to amend the mesocosms is justified in the introduction article to the DUNE Special Issue (Guieu et al. 2014). This reference has been added to the revised manuscript. Guieu, C., Dulac, F., Ridame, C., and Pondaven, P.: Introduction to project DUNE, a DUst experiment in a low Nutrient, low chlorophyll Ecosystem, *Biogeosciences*, 11, 425-442, doi:10.5194/bg-11-425-2014, 2014.

Really, authors did a quite amount of work measuring microbial biomasses, diversity and activities, although sometimes basic measurements, that would be very nice to have it in the ms as chlorophyll a and NO<sub>3</sub><sup>-</sup> concentrations are not shown because presumably are in Ridame et al. (2013), but I could not find it.

RESPONSE: There was indeed a mistake in the reference to the article showing data on NO<sub>3</sub><sup>-</sup> and chl<sub>a</sub>. These data are presented in Ridame et al (2014), this issue, currently in review at BGD. The reference has been corrected in the revised manuscript. "Phytoplanktonic response to contrasted Saharan dust deposition events during mesocosm experiments in LNL environment", by C. Ridame, J. Dekaezemacker, C. Guieu, S. Bonnet<sup>3</sup>, S. L'Helguen, and F. Malien.

## Specific questions

### Introduction

Page 340, Line 24, Boras et al. (2009, 2010), in the bibliography are referenced after Brussaard. They should go before.

RESPONSE: Done

Page 340, Line 25, Vaqué et al. (1994) is in the text but not in the reference list.

RESPONSE: We thank the referee for pointing out this omission. This paper is now included in the reference list. Vaqué, D., Gasol, J.M., and Marrasé, C. (1994) Grazing rates on bacteria: the significance of methodology and ecological factors. *Mar Ecol Prog Ser* 109: 263–274

Page 342, Line 12, "... in the form of strong pulses" What it means strong?. It is true that you add a couple of references, but it would be nice for the reader to know that, without (at this moment) to go to these references. Also as I said before authors could add how often these events occur.

RESPONSE: Please, see the response to general comment above.

### Material and Methods

Page 342, Line 9. Once you add the dust did you calculate the time that this will arrive to the whole 15 m?. Question: Why do you decide to make the second seeding after 7 days?

RESPONSE: The settling of dust in the water column after deposition is one of the key questions regarding the biogeochemical role of dust in the ocean. Various mechanisms, including ballast with organic matter or horizontal advection, will determine the distribution of particles in the water column. Thanks to the experimental design applied in the DUNE project, a convincing and accurate attempt to depict dust settling was performed. The results are shown in Bressac et al. (2013) and Desboeufs et al. (2014),

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this issue (currently under review).

Bressac, M., Guieu, C., Doxaran, D., Bourrin, F., Desboeufs, K., Leblond, N., and Ridame, C.: Quantification of the lithogenic carbon pump following a dust deposition event, *Biogeosciences Discuss.*, 10, 13639-13677, doi:10.5194/bgd-10-13639-2013, 2013.

Desboeufs, K., Leblond, N., Wagener, T., Nguyen, E. B., and Guieu, C.: Chemical fate and settling of mineral dust in surface seawater after atmospheric deposition observed from dust seeding experiments in large mesocosms, *Biogeosciences Discuss.*, 11, 4909-4947, doi:10.5194/bgd-11-4909-2014, 2014.

Concerning the second dust seeding, please see our response to the same question by Referee #2.

Page 343, Line 10. Did you take, duplicate or triplicate subsamples for bacteria, or duplicate subsamples for each mesocosms?

RESPONSE: No, we didn't. For all studied parameters, one subsample per mesocosm was collected.

Page 344, Line 11. "Two virus groups (V1 and V2) could be discriminated...." What these two groups of viruses do they represent? Are they presumably bacteriophages and viruses of other microorganisms?. In addition they are not used in results and discussion, authors use them as total VA, then it is not necessary to talk about this distinction if these two classes are not used afterwards. By the way, could you discriminate other higher classes as V3 or V4, as high or very high viruses?

RESPONSE: We agree with this comment and we have removed the sentence "Two virus groups ...". For information to the referee, we typically assume that V1 and V2 comprise mostly bacteriophages. During this study, virus populations with high green fluorescence signature (putative algal viruses) were not detected.

Results

Page 347, Lines 20-24. Authors talk about the nitrate evolution after the first and the second seeding and are referred in Ridame et al. (2013, this issue). First, if I am not wrong looking at Ridame et al, (2013), I could not find the dynamics of Nitrate, It would be nice whether authors would add it in their study. Second, this reference it is not in the bibliography of the present ms.

RESPONSE: Please, see response to the general comment above. The reference to the article showing nitrate data has been corrected in the revised manuscript.

Page 348, Line 10. DIP concentration after the second seeding (Fig. 1). Authors have any hint for this high variability of DIP among D-mesocosms? It is true that DIP concentration averages for D-mesocosms are higher than for C-mesocosms, however the very large errors bars at least for the surface waters prevent for making reliable interpretations.

RESPONSE: High variability among mesocosms after the second seeding was observed for most studied parameters. The exact reasons for such divergence were not identified. However, despite the large error bars, the higher average DIP concentration in D-mesocosms is evident enough to reflect the input of new P from the added dust.

Page 349, Figs 4a and 4b. These two figures are difficult to follow. I tried to understand looking at the figures when you say: After 4 days, the relative abundance of 4 OTUs was significantly higher in D-than in the C-mesocosms, and the relative abundance of 8 OTUs was significantly lower in the D- than in the C-mesocosms. I did not succeed. Neither, the legend of both figures help very much

RESPONSE: Changes in bacterial community composition were one of the several parameters determined in the present study. We therefore aimed to present the results in a synthetic manner. The main message from this Figure is that dust addition had both positive and negative effects on different OTUs, and that the extent of change varies over time. We have changed the text in the Material and Methods Section, and we hope that this description renders the graph more accessible.

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"We followed dust-induced changes in the composition of the total and active bacterial community using the following approach. Our fingerprinting approach provided the relative abundances of OTUs, based on their contributions to the total peak area, in three D-mesocosms and three C-mesocosms for each time point. We first tested for each OTU whether its relative abundance was significantly different between treatments at a given time point (Students t-test,  $p < 0.05$ ). For any OTU that was significantly different between treatments, we calculated its mean relative abundance in the D- and C-mesocosms, and then the difference in the relative abundance as  $D_{\text{mean}} - C_{\text{mean}}$ . This difference could be positive, that is the relative abundance of a given OTU is higher in the D-treatment compared to the C-treatment, or negative, that is the relative abundance of a given OTU is lower in the D-treatment compared to the C-treatment. To weigh these relative changes, we expressed them as percent of the total peak area of the control community. Summing all positive or negative changes allowed us to illustrate the overall extent of change induced by dust addition".

#### Discussion

Page 351, Line 1: Ridame et al (2013b) is not in the reference list. This is the same reference than the one before in page 347, Line 23? The other one does not have any indication if is a or b or the same.

RESPONSE: There was indeed a mistake in this reference. There is only one Ridame et al. article cited in this paper (Phytoplanktonic response to contrasted Saharan dust deposition events during mesocosm experiments in LNLC environment, by C. Ridame, J. Dekaezemacker, C. Guieu, S. Bonnet<sup>3</sup>, S. L'Helguen, and F. Malien, 2014, currently under review at BGD).

Page 353, Lines 4-8. Authors say that a plausible explanation why bacteria are not utilizing DIP in the second seeding is due to the release of DOM from phytoplankton. I think that probably bacterial lyses or phytoplankton lyses could contribute to the pool of these nutrients plus dissolved organic carbon, and maintain the high respiration. By

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the way it would have been nice to have also BP for having a more complete picture of bacterial activity.

RESPONSE: We agree that the lack of bacterial uptake of dust-derived DIP after the second seeding might be linked to phytoplankton and/or bacterial lyses contributing to the pool of nutrients plus dissolved organic carbon, and maintaining the high respiration rates observed. We have clarified this explanation in the revised version of the manuscript. Unfortunately, as the DUNE experiment was conducted inside a strictly protected marine area we were not allowed to use radioactive techniques allowing measuring BP. We totally agree that it would have been beneficial to have this data.

Page 354. Comment: The reasoning of the authors when referring to the impact of viruses and HNF on BA is logical. However, although seems that viruses activity are enhanced in the second seeding, the decline of bacteria could also be caused together by lyses and bacterivory, although authors did not found a clear evidence of that because they (HNF) do not increase, and it is not different in both C and D-mesocosms. The heterotrophic nanoflagellate abundance observed is the result of their growth and the predation on them by other microorganisms as ciliates or other heterotrophic nanoflagellate larger than them (cascade effect, Sher and Sher 2002). I love the discussion part about the hypothetical different reasons as bacterial lyses as well as lysogeny, why bacterial abundance declined in the second seeding, it was a pity that authors did not have measurements of that, because you would had a good scenario to test this hypothesis.

RESPONSE: We totally agree with this comment. Unfortunately, it was not possible to measure the proportion of lysogens vs rates of virus production during this experiment. However, our results indicate that these parameters should be accurately assessed in future studies.

Finally, I did not go trough all references, just I detected few that were not in the list or were in the wrong place. Just check all of them to make sure that are OK

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RESPONSE: We have now checked all the cited references.

Interactive comment on Biogeosciences Discuss., 11, 337, 2014.

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