Gif sur Yvette, February 3rd, 2021

Dear Editor,

Please, find enclosed the revised version of manuscript bg-2020-247 “Contrasted release of insoluble elements (Fe, Al, REE, Th, Pa)after dust deposition in seawater: a tank experiment approach” by Matthieu Roy-Barman, Lorna Folio, Eric Douville, Nathalie Leblond, Fréderic Gazeau, Matthieu Bressac, Thibaut Wagener, Céline Ridame, Karine Desboeufs, and Cécile Guieu.

We greatly appreciated detailed review and copy editing of MS by C. Klaas. We have followed it as closely as a possible. A detailed response to the main questions raised by Christin Klaas is given below.

Yours faithfully,

Matthieu Roy-Barman

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[CK] Dear author,

The experiments and results presented in this manuscript are novel and of great interest. I do have some issues that I believe should be addressed before publication.

The text needs improvements (English). Suggestions are given in the annotated manuscript.

[MRB] All the suggested text improvement have been included in the ms.

[CK] The authors often report approximate (~) values for quantities, even though data is available. Please in these cases refer to the exact values and their uncertainties.

[MRB] All the ~ symbols have been removed and changed for exact values and uncertainties or for the value range.

[CK] I failed to understand how the solubility of tracers (section 4.1) was estimated for several reasons:

1) the terms in the equations, in particular Eq.1, are not defined in the text, and the explanations in the text are unclear (see also comments in the annotated manuscript).

[MRB] All the terms used in equation 1 are now defined. Below I group and answer to the main questions reported in the annoted ms on section 4.1:

Page 8 line 16 :

[CK] *Unclear. Do you mean you use the the difference between initial and maximum dissolved concentration from the treatment that gave maximum dissolution? or do you take the difference bewteen treatment with maximum dissolution and the control tank?*

[MRB] We use the data obtained at t = 1 h and we calculate the difference between the element concentration in the D or G experiment averaged over tank replicates 1 and 2 and the concentration in the C tanks also averaged over tank replicates 1 and 2.

Page 8 line 21 // line 25 // line 26

[CK] *why not use the mass of dust added minus the amount that sedimented? // this is not a robust explanation since the % dissolution also depend on the differences in concentration (nominator) in Eq. 1. Again, why not use the input-trap material? // How is this estimated? If you can estimate this, why not use the mass of dust added (or for REE, 232Th and Pa the particulate amount) minus the amount that sedimented in the denominator of Eq.1? Where are the analysis of particulate suspended material and sedimented material that would allow you to close the budgets?*

[MRB] We calculate the dissolved fraction relative to the total mass of dust added to the tank (m) rather than to the mass of dust remaining in the tank at the end of the experiment (= dust added minus the amount that settled in the trap) for several reasons:

- First, we are interested in relating amount of element released to the total flux of dust deposited at the sea surface, whether the dust particles sink rapidly or not. We are interested in the bulk effect of dust deposition.

- the rationale for using the mass of dust remaining in suspension at the end of the experiment is that particles remaining in suspension are more likely to release dissolved elements in seawater. However, as elements are released very rapidly (at least for Th and REE) and as we do not know if dust sinks in the trap at the beginning of the experiment, at the end of the experiment or more or less continuously, it is unclear if particles remaining in suspension had a chance to release more elements than particles setting in the trap.

- To test the effect of particle dynamics within the tanks (settling or remaining in suspension), we compare the results obtained for ION D1 and ION D2 for which the fraction of particles remaining in suspension (= input to the tank – output in the trap) varies almost by a factor of 3 (25% of m for ION D1 and 68% of m for ION D2). Despite different dust fractions remaining is suspension, the quantity of element released in solution evolves similarly during the ION D1 and ION D2 experiments (dissolved Al, REE, Th concentrations identical within analytical uncertainties).

Page 8 line 22 // line 25:

[CK] *How so? You assume that their concentration in plankton and other suspended particles is the same than in sedimenting material? I have difficulties in believing this assumption. // Again as for REE and Th, this applies only if Pa in plankton and other suspended material in the tank is the same as in the trap. That seems like a big IF no?*

[MRB] We assume that :

- the concentrations of insoluble elements of the suspended dusts are identical to the concentrations in the trapped particles.

- the quantity of insoluble elements newly produced biogenic particles or plankton are negligible compared to the quantity of insoluble elements of the dusts. This is both because we expect low concentrations in the biogenic particles and because the mass of biogenic particles is much lower than the mass of dust given the mass of dust (3.6 g used in each tank).

Page 8 line 23 :

[CK] *of what? Mass flux?*

[MRB] concentration

[CK] *Since carbonates are part of the natural dust input, what is your point in correcting for that?*

We have removed the correction of the concentrations for carbonate dissolution

[MRB] We have removed the correction of the concentrations for carbonate dissolution.

Page 8 line 31:

[CK] *Why do you discuss THE outlier here and not the other treatments? What is the point of this paragraph?*

[MRB] Unfortunately, there is not only one outlayer and it is difficult and risky to draw any trend on Fe dissolution from these tank experiments. Therefore, we limit the discussion/interpretation to the calculation of an upper limit for Fe dissolution.

[CK] 2) For the elements that were not measured in the original dust, the authors use the values from the sedimented material. Here the methods and assumptions are also poorly described.

[MRB] The assumptions for using the REE, Th and Pa concentrations in the trapped material as an analog for the original dust are:

- REE, Th and Pa concentrations were identical in the sedimented material and in the suspended particles;

- for REE, Th and Pa, the contribution of plankton and other biogenic material produced during the experiment was negligible in the sedimented material given the high dust load recovered in the trap

- carbonate dissolution (see section 3.6) add negligible effect.

These hypotheses have been added to the main text.

[CK] In short: section 4.1 needs some clarifications, and the assumptions should be clear and also discussed.

[MRB] Done above

[CK] Further minor aspects that need clarification are commented in the combined annotated manuscript and supplement.

[MRB] Answer to these questions have been included in the text of the ms and of the supplement.

[MRB] The only point for which we did not follow CK suggestion concerns TEP (page 11, line 18): we agree that other particles or colloids mat scavenge Th. However, many studies highlight the putative role of TEP. Therefore, we think it is worth mentioning that during the present experiments that TEP do not seem to be the main Th scavenger.