

Interactive comment on “Impacts of dust deposition on dissolved trace metal concentrations (Mn, Al and Fe) during a mesocosm experiment” by K. Wuttig et al.

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This paper introduces a new dataset of dissolved trace metal concentrations in mesocosm experiments. The results are used to estimate the solubility of Al, Fe and Mn and their scavenging over a short temporal scale (days to weeks). This is a novel and interesting study and should be published. However, the submitted manuscript needs substantial revision in order to improve the quality of the scientific English, the presentation of the data and discussion of key information. In particular, the paper contains unclear parts with respect to the interpretation of the results (biogeochemical processes and

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trace metal speciation) which should be carefully reviewed. In addition, the authors should not explain significant issues on the basis of unpublished manuscripts. Some more specific recommendations and corrections are proposed below:

RESPONSE: We thank referee #4 for the helpful comments and the recommendation for publication. We worked carefully on improving the scientific language of our manuscript and the presentation of the data and on our discussion section. By now the Chl-a data is published by Giovagnetti et al. (2012). For comparison of Al (loss rates) and biomass (as Chl-a inventory calculated after Giovagnetti et al. (2012)) we plotted these parameters (fig. 6) and added information into the discussion (please see reviewer#2 for detailed information). Also Bressac et al. (this issue) will be available for the reviewers as a confidential version together with our revised manuscript. The paper will soon be submitted and then it will be available in the same Special Issue. We carefully revised these findings and compared them to the trace metal results. Additionally some FeL data (in the first manuscript cited as Wagener et al. (in prep.)) was added to our revised manuscript for better conclusions of the behavior of Fe in the mesocosms.

P13860 Line 10: The mixing layer structure should also be considered - include a reference.

RESPONSE: As the sentence was very long, it was separated into 2 parts and information about the mixing layer structure was added including two citations (Croot et al., 2007; Moore et al., 2006).

P13861 Line 4-8: The cited experiment (Wagener et al., 2010) is a batch method and seawater was filtered. Results should not be extrapolated to the mesocosm. Why you have discussed Wagener's data?

RESPONSE: We compared our data to the only ever performed trace metal clean mesocosm experiment. The results found in Wagener et al. (2010) actually were the reason why we performed DUNE-2 with two consecutive seedings mimicking high but realistic wet depositions. We were also very interesting in finding out whether the find-

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ings performed with the batch experiments would also be found in the mesocosms. But it is true that our objectives were not clearly written and were therefore rewritten for the revised manuscript as following: "This paper presents the dissolved trace metal stocks of Fe, Mn and Al during the DUNE-2 experiment. Based on the revised experimental strategy after the DUNE-1 experiment, the specific objectives of this study are (i) to assess dissolution and loss rates of these trace metals after the addition of dust and (ii) to quantify the processes involved on different time scales."

P13861 Line 29: This needs a reference

RESPONSE: The original sentence was changed (see below). Original: "On the other hand, Mn is a bioactive metal with a complex chemistry in seawater: While Mn(II) is not thought to be organically complexed, dissolved Mn(III) and Mn(IV) organic species are possible, but have not yet been observed in oxygenated seawater."

Changed to: "On the other hand, Mn is a bioactive metal with a complex chemistry in seawater. While most of the Mn exists as the soluble Mn(II) which is not thought to be organically complexed, dissolved Mn(III) and Mn(IV) organic species are possible, but have not yet been observed in oxygenated seawater. Soluble Mn(III) is rare in natural waters because it hydrolyzes and precipitates as Mn(III) oxides or disproportionate into Mn(IV) oxides plus Mn(II) (Nealson et al., 1988; Stumm and Morgan, 1996)."

P13865 Line 7: (R1, t0, out, 5 m) These terms must be explained in the text.

RESPONSE: The R's were eliminated and the structure and nomenclature simplified in general. The codes were better explained in the result section: "The nomenclature for samples of the DUNE-2 experiment is as following dust seeded mesocosms D1, D2 and D3, unseeded control mesocosms C1, C2 and C3 and the sampling point outside the mesocosms. Samples were taken at 0.1, 2.5, 5.0, 7.5, 10.0 and 12.5 m depth. The time "tx" is expressed in hours (x) since the first dust addition and in parentheses "tx(y)" the time (in h) since the second dust addition. The samples outside the mesocosms were taken as an external reference point to the control mesocosms and the

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concentrations are not reported in the figures, but are available in the supplementary information." Therefore this is simply called "outside t0" now and explained in the text when the seawater for the standards was taken, at which depth and where.

P13868 Line 1-3: This needs to be rephrased.

RESPONSE: This sentence was changed in the revised manuscript to: "D3 was not sampled at t23 after the first addition. At t48 the same trend as in D1 and D2 was seen with a continuation of the increase in dMn which was most pronounced in the surface."

P13868 Line 10-13: This should be rewritten. Do these values differ if you take into account ___?

RESPONSE: In the revised manuscript we simplified the whole paragraph.

P13868 Line 25-28 and P13869 Line 1: You should consider discussing the observed results in the DUST-Mesos separately from those in the CONTROL mesocosm and OUT (do you think that they should respond with the same trend?)

RESPONSE: The samples taken outside the mesocosms, but close by the mesocosms, are expected to be comparable to the samples taken inside the control mesocosms at the beginning of the experiment. After a few days of experiment the water masses outside the mesocosm can be changed through oceanic circulation whereas the water mass inside the mesocosms remains. But at least this comparison is used for the elimination of the contamination of the mesocosms, for example by the plastic foil, as long as the values in the control mesocosms remained lower than outside. Also it was important that the start values for all three sampling "stations" were comparable. We changed in the revised manuscript the description. We started now with the comparison of outside and the control and then started with the dust seeded mesocosms and the processes happening with the 2 artificial dust events within.

P13869 Line 12-16: It should be explained in the text why spatial and temporal scales for Al were not similar to those for Fe and Mn. In addition, the distribution of Al mea-

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surements at D1, D2 and D3 are not the same.

RESPONSE: All three trace metals were sampled in their own specially cleaned bottles and it was not always possible to get a sample for every metal for every time point sadly. A sentence will be added in the revised manuscript in order to justify the differences in sampling resolutions between the parameters.

P13870 Line 8-12: the variations observed for the dCo concentration seem uncertain after taking into account the control concentrations and considering that the three DUST-Mesos experiments did not behave in the same way. Are the variations significantly different (___)?

RESPONSE: the paragraph 3.4 was eliminated from the revised manuscript as it is of no relevance for the other three dissolved trace metals. Therefore also 2.2.5 was shrunk down to only the Mn measurement for the validation of the Mn-FIA data (which was then moved to section 2.2.2). Also section 4.1 was therefore shortened to make the discussion have more of a leitmotif. But as the data is important as baseline data and for comparison reasons, the values are still given as supplementary information to the paper.

P13871 Line 13-15: The reference is not appropriate. Why is the Fe biogeochemistry in the Mediterranean being compared with the Pacific?

RESPONSE: This sentence was changed in the revised manuscript to: "However, the dFe start values in the mesocosms were clearly increased compared to other dFe values measured in the surface Mediterranean (Bonnet and Guieu, 2004)."

P13871 Line 15-17: Too speculative; in this case the authors should have also found higher Al concentrations.

RESPONSE: We agree with the reviewer that this part of the discussion is highly speculative. The dissolved Al concentrations are not particularly high for the Mediterranean sea, whereas the dissolved Fe concentrations are high. We have rephrased this sen-

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tence in order to mention that we are unable to clearly define the reasons of these high Fe concentrations. However, as mentioned in the lines before these concentrations still remain within the range of Fe values reported in the western Mediterranean sea.

P13872 Line 7-9: Rephrase.

RESPONSE: The sentence was rephrased in the revised manuscript to: "The inventories which were calculated for each 2.5 m increments were then added up as the inventory. This inventory was calculated for each mesocosm at the corresponding time point "tx"."

P13873 Line 3-5: The authors are questioning the relevance of their values.

RESPONSE: This sentence was erased from the revised manuscript.

P13873 Line 7: In Methodology the first depth was 0.2 m.

RESPONSE: In methodology the depth was corrected to 0.1 m.

P13873 Line 24-25: Remove "The major observed trends were:"

RESPONSE: This part was erased from the revised manuscript.

P13873 Line 27-28: Resolution for dAl graph is lower compared with dMn graph. I recommend not using the phrase "with similar trends observed", the described trend applies more to dMn than dAl.

RESPONSE: We agree with this comment of the reviewer. The phrase "with similar trends observed" has been removed.

P13874 Line 26-27: It is not clear using values in Table 2 that average values are used to compare. Also, when the author compares the inventories with the estimated dissolved metal, it is not very well explained whether the estimate is for the whole water column and over what period.

RESPONSE: We agree with the reviewer and this has been changed in the revised

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manuscript. The explanation has been clarified and Table 2 has been changed and in the revised manuscript the δ is shown.

P13874 Line 28: Better: "percentage of each element in the dust"

RESPONSE: This sentence was changed in the revised manuscript to: "This elemental stock is divided by the percentage of each element in the dust in order to evaluate the percentage of dissolution."

P13876 Line 5: It is not realistic for Mn or Al either, because according to the values given, the fractional solubility changed between the 1st and 2nd dust addition.

RESPONSE: In the revised manuscript, error estimates on fractional solubilities are provided in the text and in a table. For Mn and Al, the fractional solubility is within the error of the estimates.

P13876 Line 22: Rephrase "over much more of the water column"

RESPONSE: This was changed in the revised manuscript to: "In contrast to this finding, Fig. 1 clearly shows that the increase in dMn concentrations was occurring throughout the whole water column for the first compared to the second seeding, in which the increase was concentrated in the first few meters of the mesocosms."

P13878 Line 17: Figure 5A?

RESPONSE: This was corrected in the revised manuscript.

P13878 Line 24: Is it Saharan dust? It has not been mentioned before, the author just called it dust.

RESPONSE: The origin of the artificial dust has been added to the introduction.

P13879 Line 1-4: contradicts what has been said on page 13876 Line 24-26.

RESPONSE: In the revised manuscript this apparent contradiction has been corrected.

P18879 Line 14: Where are the optical data? No relation between dust and bacterial
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and phytoplankton production has been presented.

RESPONSE: To the submitted revised manuscript we add a confidential version of Bressac et al. (this issue) in which the optical data of the DUNE-2 mesocosm project is shown. This paper will soon be submitted to the Special Issue. Also Giovagnetti et al. (2012) is available now with HPLC data, information about phytoplankton and chl-a. The latter was used for inventory calculations which are compared in a new fig. 6 to Al loss rates. We found a correlation for these parameters and added some more information and discussion to these informations.

P13893, P13894, P13895: Figure 1, 2, 3 do not have the depth units of measurement.

RESPONSE: This was corrected in the figures for the revised manuscript.

P13897: Figure 5 does not have the dAl, dFe, dMn and Temperature units of measurement.

RESPONSE: This was added in the figures for the revised manuscript.

REFERENCES: Bonnet, S., and Guieu, C.: Dissolution of atmospheric iron in seawater, *Geophys. Res. Lett.*, 31, L03303, Doi 10.1029/2003gl018423, 2004.

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Interactive comment on *Biogeosciences Discuss.*, 9, 13857, 2012.