

Interactive comment on “Coccolithophore fluxes in the open tropical North Atlantic: influence of the Amazon river and of Saharan dust deposition” by Catarina V. Guerreiro et al.

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The authors are most grateful to the Anonymous Referee #2 for his overall positive feedback on the manuscript, and for the helpful specific comments, the majority of which will be taken into account for the new updated version of the paper.

Reply to specific comments:

RC#2: The Abstract is at times too detailed (see comments for Page 1) with a couple of sentences being too long and thus hard to follow.

CG: Thank you for the comment. The abstract will be reduced into a more focused and

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straightforward text in the updated (revised) version of the manuscript.

BGD

RC#2: The oceanographic and meteorological conditions at the trap location during October 2012-November 2013 are results but presented in the Methods section. I suggest moving lines 5-25 to the Results section.

CG: As suggested by the reviewer, this section will be moved to the beginning of the RESULTS (section 4.1)

RC#2: Table 1 is unnecessary as most of its content has been given in the main text. It can be moved to Supplementary material along with Table 2.

CG: The authors agree that Table 2 should be moved to the Supplementary Material, but kindly disagree of the suggestion to do the same with Table 1, due to its important auxiliary function to rapidly localize the reader concerning the traps' background information. To avoid unnecessary repetition of information regarding the two traps, the respective reference in the text will be shorten.

RC#2: Authors could provide more information on the splitting of the sediment trap samples (e.g. type of splitter, splitting error).

CG: As recommended by the referee, a short paragraph will be added to the beginning of section 3.2: "Sediment trap samples from stations M4 and M2 were initially wet-sieved over a 1 mm mesh, wet-split into five aliquot subsamples using a rotary splitter (WSD-10, McLane Laboratories), washed to remove the HgCl₂ and salts, and centrifuged. Average weight differences between replicate aliquots were within 2.4 % (SD = 2.2), with 87 % of all samples differing < 5 % between splits (detailed procedure in Korte et al., 2017). Micropaleontological analysis was carried out from one 1/5 split of each original sample, after being oxidized in a low temperature ashing for approximately 4h to remove the organic matter and obtain a sample strictly composed of mineral particles (Fallet et al. 2009)."

RC#2: The authors use 1×1 box over each trap location to retrieve satellite-

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based meteorological and oceanographic data to support coccolith fluxes at M4 and M2. The authors should elaborate on their choice: is it based on the consideration of the 'statistical funnel' or particle catchment area of a moored-sediment trap (see e.g. Baker et al. 1988, Siegel et al. 1997, Waniek et al. 2000)? For example, do the authors have complementary data on current speeds above the traps to derive back-trajectories of sinking particles? This would give some idea of the distance of particle origin in support of the chosen $1^\circ \times 1^\circ$ area.

CG: Yes, each mooring was equipped with two Technicap PPS 5/2 sediment traps provided with a tilt meter at 1200 m (upper trap) and 3500 m (lower trap), two SBE MicroCat CTDs for conductivity, temperature and depth measurements, two Aanderaa RCM-11 current meters, and four floatation bodies to keep the mooring upright. The uppermost float included a downward-looking acoustic doppler current profiler (ADCP, 75Hz) for measuring current profiles (velocity and direction) and particle backscatter intensities, and a XEOS iridium beacon and flasher on top. Current-meter measurements showed that the average velocities around each mooring were $< 6 \text{ cm s}^{-1}$ in the deep and bottom ocean (at around 3500 and 4600 m water depth, respectively) and $< 10 \text{ cm s}^{-1}$ at around 1200 m water depth as measured by the ADCPs. Exception goes for only a few days when current velocities exceeded the 12 cm s^{-1} for the upper sediment traps at 1200 m at M2, and $\sim 19 \text{ cm s}^{-1}$ at 3350 m at M4, in early August 2013. All other sensors showed that the sediment traps at sites M2 and M4 remained well within 5° from the vertical and at constant depths during the entire sampling period. For the detailed description of the moorings and respective oceanographic instruments, the referee is referred to Korte et al. (2007). The $2^\circ \times 2^\circ$ box, corresponding to $\sim 200 \text{ km} \times 200 \text{ km}$ ($1^\circ = \sim 110 \text{ km}$), was assumed to be representative of the catchment area of a trap deployed at 1200 m depth, taking into account the sinking speed for marine phytoplankton and algal aggregates (as indicated, for example, in Table 1 of Waniek et al., 2000) and based on temperature-pressure measurements indicating that M2 and M4 were equally and effectively vertical during the deployment period. As recommended by the referee, the criteria for the selected box will be

explained with more detail in the new version of the manuscript, and referring to the suggested references. Furthermore, we will rectify in the text that the box used in the manuscript was actually of $2^\circ \times 2^\circ$ and not $1^\circ \times 1^\circ$ as mistakenly indicated in the submitted version of the manuscript."

My other comments related (mostly of technical/language nature) are outlined below:
Page 1 Line 18: remove 'in successive 16-day intervals'

CG: Ok

Line 19: correct to 'showed'.

CG: Ok

Lines 24-25: provide coccolith fluxes as average \pm stdev.

CG: Ok

Line 27-30: split into two sentences.

CG: Ok

Line 26: correct to 'contributed to higher fluxes'.

CG: Ok

Line 36: replace 'an open-ocean tropical setting' with 'the tropical open ocean'

CG: Ok

Lines 35-38: split into two sentences.

CG: Ok

Page 2 Line 13: replace 'from' to 'in'.

CG: Ok

Line 14: remove 'next to'.

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CG: This will be replaced by “In addition to”

Lines 14-15: replace ‘diazotrophic fixation by cyanobacteria’ to simply ‘N2 fixation by marine diazotrophs’.

CG: Ok

Line 18: replace ‘despite low per unit area’ to ‘despite relatively low primary production rates’.

CG: Ok

Line 27-29: this sentence needs rephrasing, and possibly split into two sentences.

CG: this will be rephrased to: “Coccolithophores, being at the same time photosynthetic and calcifying, are major contributors to the organic and inorganic oceanic carbon pumps (e.g. Rost and Riebesell, 2004). Due to their ability to cover their cells with tiny calcite plates (the coccoliths), coccolithophores can be studied in time-series samples collected by deep-ocean sediment traps (e.g. Broerse et al., 2000; Sprengel et al., 2002; Ziveri et al., 1995; Koebrich et al., 2015), thus providing insight into the seasonal to inter-annual dynamics of open-ocean phytoplankton.”

Line 30-31: I do not see the reason for the contrast with opportunistic coccolithophores in this sentence. I suggest splitting the sentence into two for clarity.

CG: This will be rephrased to: Coccolithophores are amongst the most important phytoplankton groups within open-ocean, stratified-oligotrophic waters (e.g. Winter et al., 1994), hence displaying features more typical of K-selected taxa (Margalef, 1978). These so called “K-selected species” are better adapted to compete successfully for limited nutrient availability in more stable environments, such as tropical regions and subtropical gyres, presenting low maximum growth rates and fairly constant populations that are in equilibrium with the environmental resources (see Margalef, 1978). Still, coccolithophores also include more opportunistic (r- selected) taxa that quickly respond to short-term changes associated with nutrient input (e.g. Guerreiro et al.,

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2013). These so-called “r-selected species” are recognized for their ability to reproduce quickly in unstable conditions, being often characterized for higher maximum growth rates and well adapted to survive and flourish within nutrient-rich and turbulent coastal environments.

Lines 37: ‘whereas... coccolithophores studies using sediment traps’ is confusing. Consider replacing to ‘Although a significant amount of sediment trap data on coccolithophores fluxes exists for the open ocean. . .’.

CG: Ok

Page 3 Lines 8: replace ‘to 75 m depth’ with ‘in the top 75 m’.

CG: Ok

Lines 9-15: please itemise the depth floral groups defined by Poulton et al. 2017, otherwise the sentence appears to long and hard to follow.

CG: Ok

Line 15: More insight into what?

CG: The sentence will be rephrased to: “Therefore, more insight into the ecological preferences and environmental needs required by coccolithophores can be expected from a clear distinction between the distribution and abundance of UPZ and LPZ taxa.”

Page 4 Lines 1-3: this sentence needs rephrasing with respect to ‘the world’s largest river. . . for discharging large volumes’. I suggest ‘the world’s largest river with respect to fresh water discharge into the open ocean’.

CG: Ok

Lines 22-24: This sentence does not read well. Please rephrase. I suggest ‘Two sediment traps at sites (M2 14° N, 37° W) and M4 (12° N, 49° W) collected sinking particles at 1200 m depth in synchronous intervals of 16 days from October 19,

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2012 to November 7, 2013'.

BGD

CG: Ok, and thank you!

Lines 24-26: this sentence is more suitable for the Supplementary Information.

CG: We agree.

Page 5 Lines 19-20: Does it mean that the larger the ratio the deeper nutricline is?
Please, be a bit more specific in here.

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CG: No, it is precisely the opposite: the larger the ratio (i.e. higher abundance of UPZ taxa), the shallower is the nutricline. This part of the text will be rephrased into a clearer manner.

Page 6 Please move Table 2 to Supplementary information

CG: Ok

Lines 5-25: This is result, please move to the appropriate section.

CG: Ok

Line 15: Do you need these many significant figures for the PAR values? Please be consistent with the number of significant digits when reporting values in the main text.

CG: The reason why PAR is referred to in higher number of digits compared to the other parameters/proxies is due to the fact that the range of values for PAR is comparably lower, in spite of its clear seasonal variation at both stations.

Page 7 Line 11: replace 'commonest' to the 'most abundant'

CG: Ok

Line 14: replace 'factors' temporal variability...' to 'assess temporal variability of the factors'.

CG: Ok

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Lines 18-20: I suggest to use mean \pm stdev when reporting fluxes at the study sites. We can see the range from Figure 3 and Table 3.

BGD

CG: Ok

Page 8 Figure 3 – dashed line for the Shannon-Weaver Diversity Index cannot be seen or appears as a solid line.

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CG: The reviewer is correct: the line should be (and will) referred as solid.

Line 14: remove 'fairly'.

CG: Ok

Page 9 Line 4: this sentence is confusing, please rephrase.

CG: This sentence will be rephrased to: "Most of the taxa produced much higher coccolith fluxes at the western station M4".

Figure 5 will benefit from segregating the coccolithophore taxa into LPZ and UPZ species (in the legend).

CG: OK

Lines 11 and 34: add subsection numbers for clarity.

CG: Ok

Page 10 Line 3: replace 'further west' to M4.

CG: Ok

Page 11 Table 3: identify LPZ and UPZ species; also, in table caption, consider replacing 'max- imum' with 'range' as given in the table.

CG: Ok

Page 13 Figure 8: be consistent how you report units in the legend. I suggest removing

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word 'units' for precipitation rates. Also, in figure axes, consider using Latitude (°N) and Longitude (°W).

BGD

CG: Ok

Line 5: replace 'drastically' to 'considerably' or 'significantly'.

CG: Ok

Line 18: replace 'by contrast' to 'in contrast'.

CG: Ok

Page 15 Line 14: elaborate on the meaning of Factor 1 – what variables does it represent?

CG: Factor 1 is the most important result from factor analysis, since it explains the highest percentage of the variability within the taxa and environmental parameters (i.e. 30%, compared to only 16%, 10% and 9% for F2, F3 and F4, respectively). That F1 is clearly characterized by the opposition between the central station M2 from the western station M4, it highlights the much higher abundances of *G. flabellatus* further west as the most important feature/difference between the two sites. This result indicates the presence of spatial variability shown by the LPZ flora as being the statistically more relevant factor explaining our flux records. For clarification, a brief explanation will be included in this part of the discussion.

Line 17-19: this sentence does not read well, please consider rephrasing.

CG: This sentence will be rephrased to: "Highest coccolith fluxes recorded under these conditions suggest that higher stability of the photic layer has favored the development and/or the settling of coccolithophores during these periods."

Page 18 Line 8: remove 'quite'.

CG: Ok

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Line 34: correct 'Falkowsky' to 'Falkowski'.

BGD

CG: Ok

Line 41: replace '...seem to fit quite nicely' with 'this fits well'.

CG: Ok

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