Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-1068-RC3, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Compositional changes of present-day transatlantic Saharan dust deposition" *by* Laura F. Korte et al.

Anonymous Referee #3

Received and published: 12 January 2017

Thank you for your invitation to review the manuscript submitted to the ACP journal by Laura Korte et al. This paper reports on an ambitious sediment trap experiment carried out in the Tropical North Atlantic Ocean. This experiment, which was set up in the frame of the "DUST TRAFFIC" (ERC) project, aims at documenting Saharan dust inputs to the Atlantic Ocean from the West African coast all the way to the Caribbean, along the main path for Saharan dust atmospheric transport. Korte's paper presents an impressive amount of data obtained during the first year of this experiment, including particle flux and composition temporal variability obtained from 7 sediment traps deployed at about 1100-1200m or 3400-3500m depths, at 5 mooring locations. The manuscript also includes data obtained on land in a dust source region in Mauritania. This study nicely complements earlier investigations carried out off West Africa and in the Sargasso Sea and provides, for the first time, simultaneous flux and compositional

Printer-friendly version

Discussion paper

data across the entire Atlantic ocean. This is, I find, the main originality and interest of this report. In any case, this study represents a remarkable logistical and analytical effort, which is to be commended. One of the interesting outcome of this study is that there appears to be no marked seasonal variability in the downward particle fluxes across the entire Tropical Atlantic (a moderate seasonal variability is apparent on the edges of the transect though, near western and eastern margins, especially in the terrigneous fraction and the biogenic silica, respectively). This study also demonstrates the prominent influence of Saharan dust inputs in the "residual" (i.e., non-biogenic) material along most of the E-W transect (based on a few major element ratios (Al, Fe, K) that compare well with ratios measured in the dust they collected in Mauritania). "Dust" major element composition, still, displays a marked evolution across the ocean, enabling Laura Korte et al. to track the progressive mineralogical (and grain-size) sorting during transport (with the gradual reduction of coarse quartz particles contribution from East to West, as indicated for instance by the non-biogenic Si content). Korte et al. study finally reveals the influence of an additional terrigenous source in the Western Atlantic: major compositional differences are recorded in particles collected near the Caribbean -higher K contents for instance- suggesting a possible influence of fluvial discharges (Amazon and/or Orinoco) in the area. Overall, I find that the paper presents a large number of rare, high quality sediment trap data that will be of great interest to those interested in the Saharan dust transport (including modelers) and its impact on the ocean (and Amazonian) biogeochemistry. I therefore recommend publication after the authors have addressed the minor comments listed below.

Detailed comments

page 2, line 24-25: Very few studies actually measured "fluxes" (in most cases, dust was collected by air filtration), so you may want to rephrase.

page 2, line 31: Sarthein et al. [1981] (which discusses paleo-dust records) might not be the best reference here – Chiapello et al., [1995] for example, which documents present-day seasonal Saharan dust transport in the trade wind levels, would be more

suitable.

pages 2-3, bridging paragraph: Although there is no doubt that the Bremen group has built the longest sediment trap record in this region, providing one of the most valuable trap data time series ever collected –and should be praised for this!– other groups, in the UK and France for instance, have also contributed to ample sediment flux studies in the area (both off West Africa and in the Sargasso sea) within the 90's BOFS and JGOFS programs among other frameworks. Some results obtained in these experiments are actually fully relevant to Korte's study (see below). So, I think it would be useful to provide a more exhaustive list of earlier experiments (at least provide the references).

page 3, line 12-14: I find this sentence somewhat unclear (the "other factors" have implication on grain size? on the dust deposition timing?) – please clarify.

page 3, line 24: "Composition" is a little vague (you may want to specify here what has been characterized in your study: biogenic components (CaCO3, BSiO2, OM. . .), major elements in the residual (i.e., lithogenic) fraction (Si, Al, Fe. . .) etc.).

page 6, lines 20-24: You may want to indicate that sediment traps are supposedly collecting the downward (i.e., "vertical") flux, especially since you just mentioned (line 10) that your land-based collector allows to estimate the "horizontal" dust flux.

page 7, line 34: Which "two" elements? Any? (in this case, you may want to remove "these" or rephrase).

page 8, line15: I find "daily averages" somewhat misleading (as it suggest that flux was sample with a daily or even sub-daily resolution); "daily mean" (and annual mean) might be less ambiguous; you may also simplify (e.g., ". . .each constituent, expressed both in mg.m-2.d-1 and g.m-2.a-1").

4.2.1 to 4.2.5 Mean annual fluxes ("annual averages") for each component of the settling particulate matter (CaCO3, BSiO2, OM, and for the residual fraction) are of great

interest too, and should also be provided for each trap (either in the text or in a table). I find such data are clearly missing in the manuscript. These would also allow discussing how they compare with results obtained at nearby locations in earlier studies (e.g., Bory and Newton, 2000; Bory et al., 2001), which may provide useful clues on the spatial (and/or interannual) variability in the Saharan dust deposition in the tropical Atlantic off West Africa.

4.4 Shouldn't the M5L (and M4L) compositional difference (K for instance) mentioned in this section?

section 5, page 5, lines 14-16: It seems as if you assume that dust collected at Iwik derives exclusively from local sources (during emission processes); couldn't distal sources also contribute (during deposition processes)? This should be discussed I think, especially as Iwik might be on the path of large outbreaks involving numerous source regions in West Africa.

Page, line 19: The fact there is a downwind decrease in the residual mass flux (and marine biogenic matter fluxes) is interesting but these data are not given in the text or in the table (unless I missed them), as I already pointed out above (4.2.1 to 4.2.5); so please provide numbers (for residual mass fluxes especially, but for the other components as well), especially as such decreases are clearly not obvious from the plots! (cf. fig. 4)

page 16, line 3: suggests

page 16, 5.1, line 17: Is it realistic that the event shown on fig. 10 (i.e., from 31 July) could be sampled in the 18 July- 3 August cups, considering the fact that it takes at least a week for the dust to reach the upper traps (as indicated page 18, lines 1-2)? Especially as dust travels at higher atmospheric levels at that time of the year, as you rightly point it out, and so that it may take longer for the dust to settle through the atmospheric column in the first place.

Section 5.1: Overall (for the reason just stated) I find this section should come after section 5.2, since indications on the settling speed in the water column is obviously essential to make the connection between satellite data and water column measurements (as this is actually acknowledged lines 32-33).

page 16, 5.1, lines 22-24: The point you want to make in this sentence (starting by "The diffuse. . .") is unclear to me. Please clarify and a reference should be provided.

page 17, section 5.2, lines 7-8: This is an important point: as you rightly indicate, a significant part of the dust deposited in the ocean needs indeed to be incorporated with biogenic matter (OM in particular) in order to settle in the water column; for this reason, it would have been interesting to plot the residual flux vs the OM flux for all traps as this may provide useful clues on the interplay between the two in the particle settling processes in the different sectors of the Atlantic ocean (see for instance Deuser et al., 1983; Jickells et al., 1990; Bory et Newton, 2000. . . etc.).

page 18, section 5.3, first paragraph: As above, the discussion would benefit from the comparison with all existing data (comments on 4.2.1 to 4.2.5).

page 18, section 5.3, lines 15-17: Additional data on ocean productivity (and its seasonal patterns) in the two regions should be provided in order to support such a statement; I would develop the discussion in order to strengthen this hypothesis, or remove this statement, which is too speculative as such.

page 18, section 5.3, lines 28-31: I am not sure I follow the reasoning here: the contribution of an additional "fluvial" (and therefore fine) component on the western side of the transect seems perfectly consistent to me with westward decreasing trend in the grain size. A major fluvial contribution would also be fully consistent with the negative correlation between M1 and M5. So the statement that your grain size data implies that the residual fraction is dominated at all stations by Saharan dust seems to be at odd with the above (and with the last paragraph of page 18 actually).

page 19, conclusions, line 4: “same” source may be little too affirmative and restrictive (replace with “. . .are similar to the dust collected on the African coast”?).

page 19, conclusions, line 10-11: As above, I see no contradiction here.

page 19, conclusions, lines 13-14: This is surprising, and therefore interesting, but the apparent correspondence should be considered with caution (see my comments on page 16, 5.1, line 17).

page 19, conclusions, lines 15-17: It is unclear what [changing] “fluxes” [of Saharan mineral dust] you are referring to (and how it would be calculated). Also, is this under-estimation discussed in the text?

Finally, I think the paper does not really document dust “deposition” as indicated in the title (this will surely be best documented by the buoys deployed within the DUST-TRAFFIC project). So you may want to reformulate (I would suggest something in the line of “Compositional changes of Saharan across the Atlantic as recorded in the water column downward particle flux”).

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-1068, 2016.

Printer-friendly version

Discussion paper