

Interactive comment on “Dinocyst assemblage constraints oceanographic and atmospheric processes in the Eastern Equatorial Atlantic over the last 44 ka” by William Hardy et al.

William Hardy et al.

william.hardy@univ-brest.fr

Received and published: 6 July 2016

Dear reviewer,

We have corrected the manuscript taking into account the reviewer's suggestions and we have included all modifications in the revised manuscript. Below you will find our detailed responses to each of the reviewer's comments.

COMMENTS :

“Age model: I think it is critical that the authors perform a rigorous error analysis of their age model. I recommend age model uncertainty analysis for every data point using their tie-points and Bayesian statistical error analysis using softwares like “Bacon”

Printer-friendly version

Discussion paper



(Blaauw and Christen, 2011) or “B-Chron” (Parnell et al., 2008)”

We have plotted the 2-sigma range error in grayscale envelop around mean calibrated ages. The grey band plotted on the Age - Depth figure (first version) only corresponds to the 14C error (See attached figure 1)

“When discussing the onset or termination of an event, the median age of onset/termination of event and the uncertainty of the median age point should be provided.”

We have included in the text the 2-sigma range for climate events, corresponding to the maximal range we calculate from our chronology, itself mainly based on radiocarbon dates and especially for the onset of the Last Deglaciation and the Holocene.

"The authors describe changes in assemblages or species that would suggest an un “atypical” climate changes that includes warm and wet conditions during the LGM and coldest reconstructed temperature of the record during the late Holocene. In indeed, these inferences are in contradiction with several (mostly geochemical) observations. I suggest therefore, a critical discussion about the robustness and weakness of the interpretation of the assemblage changes"

Paleoecological interpretations in our study area are largely based on the modern dinocyst atlas (Zonneveld et al., 2013). In the revised manuscript, the ecology of main species discussed for the LGM atypical signature is highlighted thanks to maps highlighting the present-day distribution of taxa percentages in modern sediments: new Figure 6 inserted in the manuscript. Also, in order to be clearer, we have added a more critical discussion regarding dinocyst species and in particular for the thermophile ones that indeed lacked some present-day ecological information. (See attached Figure 2)

"The authors need also to provide a more nuanced discussion about the mechanisms that control that the Benguela advection over their core location. In Figure 7, it is suggested that the Benguela advection was severely weakened during 4-5 ka and 7-

[Printer-friendly version](#)

[Discussion paper](#)



15 ka BP. How does these interpretations compare with paleoclimate records from more southern locations relative to that of the cores described in this study."

In order to discuss the link between *Operculodinium centrocarpum* abundances and the influence of the Benguela Current over our study area, as mentioned in Zonneveld et al. (2013), a map of the actual geographical distribution of this species has been produced (cf. new Figure 6). Today, this species lives in the Benguela upwelling system and along the Angolan and Congolese margin until the equator (new Figure 6). The presence of *O. centrocarpum* north of the Angola-Benguela Front has been interpreted in the manuscript as the northward advection of cold waters during the austral winter, migrating westward around 1°S. This is illustrated below with satellite SST data of austral winter (green: 16°C, brown : above 27 °C) and the present-day abundances of *O. centrocarpum* percentages.

Present-day occurrences of this dinocyst species appear to be consistent with the winter pattern of the Eastern South Subtropical Gyre (Benguela Current, South Atlantic Current and southern South Equatorial Current), but also with the Brazilian margin through the Falkland Current (see attached Figure 3).

This species then appears to be greatly correlated with northward cold currents. We did not find any publications relative to the paleo-intensity of the Benguela Current. Modern surveys exist but are rather based on ENSO or Aguilhas Current monitoring. However, planktonic sediment traps allow discussing the actual relationship between dinocyst assemblages and current sea-surface conditions (Holzwarth et al., 2000; Zonneveld et al., 2001), showing that *O. centrocarpum* is the dominant species under the Benguela Current influence.

Paleo reconstructions mainly concern latitudinal shifts of the Angola-Benguela Front (Jansen et al., 1996; Uliana et al., 2002). We thus have added the Jansen et al. (1996) reconstructions in new Figure 8.

Concerning dinocyst-based studies in southern locations, there is GeoB 1016 core

[Printer-friendly version](#)[Discussion paper](#)

published by Dupont and Behling (2006), but the resolution is low regarding our chronological interval. There is finally the GeoB1023 core (Shi et al., 1998), a high resolution study carried out in the Benguela Upwelling System. Shi et al. (1998) did not discuss the Benguela Current activity (neither *O. centrocarpum* abundances).

We can however extract *O. centrocarpum* abundances from this study and add this data in new Figure 8 to make regional comparisons.

"A significant part of the Congo Basin is located north of the equator and, therefore, it is a part of the West African monsoon system. I highly encourage the authors to graphically compare their time-series of thermophile and low salinity assemblage/species with the highly resolved runoff and SST records from the Gulf of Guinea (Weldeab et al, 2007a-b, Weldeab et al., 2012a, Weldeab et al., 2012b). It is important that G2 BGD Interactive comment Printer-friendly version Discussion paper the authors' micro-paleontological approach is compared with and tested against the geochemical proxy records from the same region (see above reference)"

We totally agree and we have added the Ba/Ca signal in Figure 6 (now named Figure 7)

There are several references cited in the main text but no listed in the reference list. It mismatch can avoided by using one of the several citation software and a careful checking.

We fixed it.

Wordings: there are several wordings (admitted, thanks to, climateuring, mitigation, tierce) that the authors need to replace with more appropriated words/phrases. Please change: "Weldeab et al" instead "Syee Weldeab et al.. "biogenic opal" instead "Biogenic Silica (BiSiO_2)"

We fixed it.

Sincerely yours,

REFERENCES OF PAPERS CITED IN THIS LETTER

Dupont, L. and Behling, H.: Land–sea linkages during deglaciation: High-resolution records from the eastern Atlantic off the coast of Namibia and Angola (ODP site 1078), *Quaternary International*, 148(1), 19–28, doi:10.1016/j.quaint.2005.11.004, 2006.

Holzwarth, U., Esper, O. and Zonneveld, K.: Distribution of organic-walled dinoflagellate cysts in shelf surface sediments of the Benguela upwelling system in relationship to environmental conditions, *Marine Micropaleontology*, 64(1–2), 91–119, doi:10.1016/j.marmicro.2007.04.001, 2007.

Jansen, J. H. F., Ufkes, E. and Schneider, R. R.: Late Quaternary Movements of the Angola-Benguela Front, SE Atlantic, and Implications for Advection in the Equatorial Ocean, in *The South Atlantic*, pp. 553–575, Springer Berlin Heidelberg. [online] Available from: http://scdproxy.univ-brest.fr:2068/chapter/10.1007/978-3-642-80353-6_28 (Accessed 28 October 2014), 1996.

Shi, N., Dupont, L. M., Beug, H.-J. and Schneider, R.: Vegetation and climate changes during the last 21 000 years in S.W. Africa based on a marine pollen record, *Veget Hist Archaeobot*, 7(3), 127–140, doi:10.1007/BF01374001, 1998.

Weldeab, S.: Bipolar modulation of millennial-scale West African monsoon variability during the last glacial (75,000–25,000 years ago), *Quaternary Science Reviews*, 40, 21–29, doi:10.1016/j.quascirev.2012.02.014, 2012.

Zonneveld, K.A.F., Hoek, R.P., Brinkhuis, H., Willems, H., Geographical distributions of organic-walled dinoflagellate cysts in surficial sediments of the Benguela upwelling region and their relationship to upper ocean conditions, *Progress in Oceanography*, 48, 25-72, 2001.

Zonneveld, K. A. F., Marret, F., Versteegh, G. J. M., Bogus, K., Bonnet, S., Bouimetarhan, I., Crouch, E., de Vernal, A., Elshanawany, R., Edwards, L., Esper, O.,

Forke, S., Grøsfjeld, K., Henry, M., Holzwarth, U., Kieft, J.-F., Kim, S.-Y., Ladouceur, S., Ledu, D., Chen, L., Limoges, A., Londeix, L., Lu, S.-H., Mahmoud, M. S., Marino, G., Matsouka, K., Matthiessen, J., Mildenthal, D. C., Mudie, P., Neil, H. L., Pospelova, V., Qi, Y., Radi, T., Richerol, T., Rochon, A., Sangiorgi, F., Solignac, S., Turon, J.-L., Verleye, T., Wang, Y., Wang, Z. and Young, M.: Atlas of modern dinoflagellate cyst distribution based on 2405 data points, *Review of Palaeobotany and Palynology*, 191, 1–197, doi:10.1016/j.revpalbo.2012.08.003, 2013.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/bg-2016-148/bg-2016-148-AC2-supplement.pdf>

Interactive comment on *Biogeosciences Discuss.*, doi:10.5194/bg-2016-148, 2016.

Printer-friendly version

Discussion paper



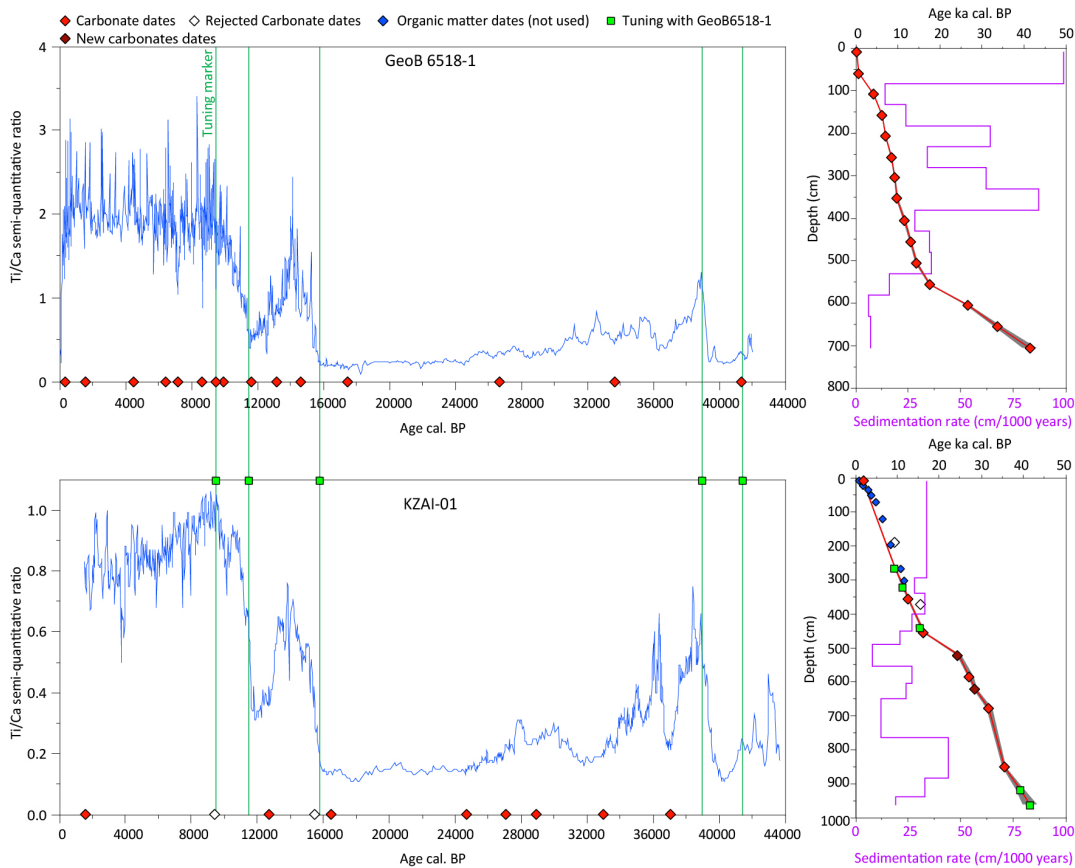


Fig. 1. Figure 1 : fixed Figure 2 of the submitted paper. The grey band correspond now to the 2-sigma range error.

Printer-friendly version

Discussion paper



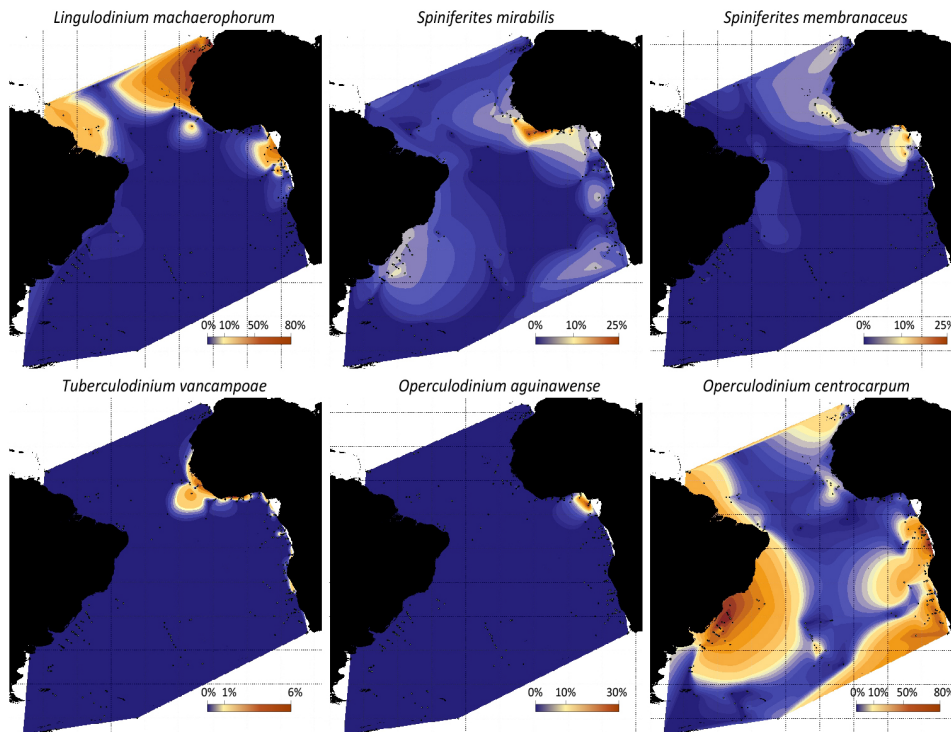


Fig. 2. Figure 2 : Modern-day dinocyst location according modern Atlas (Zonneveld et al., 2013)

Printer-friendly version

Discussion paper



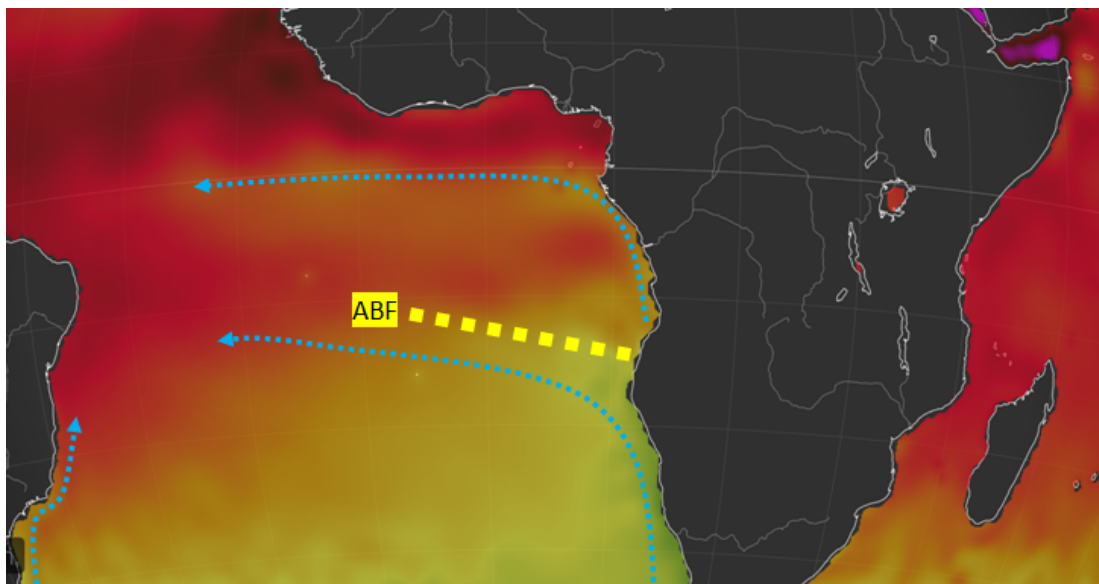


Fig. 3. Figure 3 : Map of mean July SST in South Atlantic Ocean. Blue arrows display the major northward cold currents and yellow dashed line represents the Angola-Benguela Front. Green : 16°C, brown : 27°C

[Printer-friendly version](#)[Discussion paper](#)

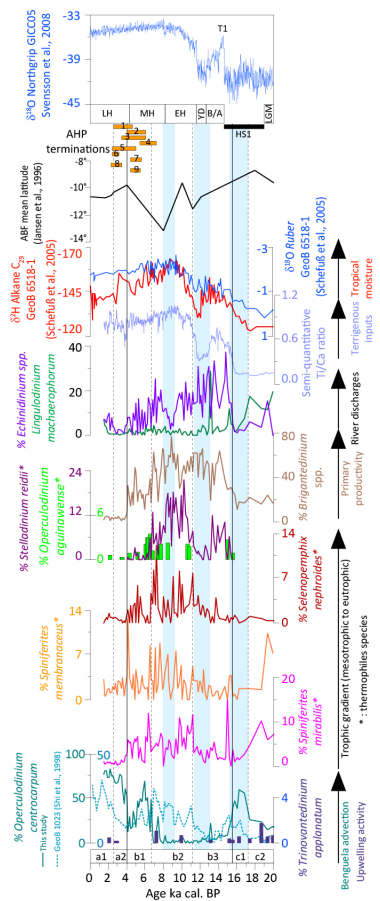


Fig. 4. Figure 4 : Fixed Figure 8 according reviewer comments.

Printer-friendly version

Discussion paper



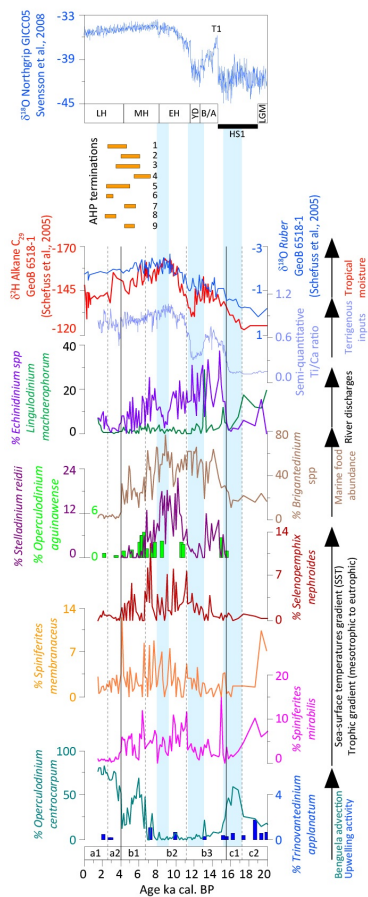


Fig. 5. Figure 5 : Firstly submitted version of Figure 8