

Response to Reviewer 1, Kasia Śliwinska, by Bijl et al.

GENERAL COMMENTS At the beginning, I would like to apologize for the delay in delivering my review. It was great to get an opportunity to comment on this paper. For some time now, I have been working on the Oligocene from the North Atlantic region. Even though our study areas are so far from each other, one cannot fully understand the paleoclimatic changes in the high northern latitudes and the global ocean circulation under the early icehouse world, without an insight into the oceanic regime in the southern high latitudes. This paper provides an important and unique record of the paleogeographical reconstruction of the Oligocene to middle Miocene of the East Antarctica based on dinoflagellate cysts. Authors apply selected dinocysts genera and taxons as proxies for sea-ice reconstruction, nutrients, and temperature. The changes in the composition of dinocysts assemblages is additionally correlated with the sedimentology and organic biomarker data. I find this manuscript interesting and very needed piece of work for our understanding of the oceanic circulation under the early icehouse world conditions. A concern however, is the way the sedimentological data are incorporated into the text. The results of the present study (i.e. changes in the dinocysts assemblages) need to be clearly presented, and other data (sedimentology, biomarkers) should be carefully included but only as a data supporting the results based on dinocysts. The part about the lithology should not be included in the section with the results but as e.g. the background information. Also, a term "Miocene deposits" (Table 2) doesn't carry any sedimentological information. Why do the authors not keep the terminology by Salabarnada et al. (submitted this volume) in this case? This expression is not used in the main text, but "Miocene sediments". The manuscript is well written, however, there is still room for improvement (see my suggestions below). Overall, the manuscript represents a substantial contribution to the scientific progress within the scope of *Climate of the Past*. I am certain that it will be of great interest for readers of the journal.

We appreciate the positive assessments by Śliwińska regarding our manuscript, and her indications as to how to improve our manuscript even further. Śliwińska posed several concerns and suggestions, which we can definitely use to improve our manuscript. We herein respond to these concerns and suggestions in detail.

SPECIFIC COMMENTS In the Supplementary material, in the sheet with the dinocysts counts I see only *Selenopemphix cf. antarctica*. Is that a typo or the specimen observed in the present study only partially resemble the holotype? If it different, then I think that this needs a bit of attention in the text.

This is indeed a typo, it does fall within the species definition of the holotype. We will amend this in our next version of the paper.

Bijl et al. (in press) have already discussed which dinocysts are *in situ* and which not, so I think that the first section of the discussion can be tightened up a bit.

The first section of our discussion aims at providing the necessary details to put forward new arguments than those proposed in Bijl et al., in press (now Bijl et al., 2018) to strengthen and support the reason why we believe that the gonyaulacoid dinocysts are *in situ*. Therefore we do not find this redundant but rather complimentary to the results of Bijl et al., 2018, as indicated in lines 366-368. This paper targets a different audience than that of *Journal of Micropaleontology*, an audience that does not necessarily want to read detailed micropaleontological contemplations, but is merely interested in the paleoceanographic reconstructions. Such reconstructions are based on detailed micropaleontological information that is now published in Bijl et al., 2018, should the reader be interested. *Journal of Micropalaeontology* is an open access journal, hence available to everyone. Because of the above, we opt for maintaining the first section of the manuscript as

is.

Also, since dinocysts play a key role in this study, I would consider to include a plate with photos of the most important taxa.

Bijl et al. (2018, Journal of Micropalaeontology) also features a large number of dinocyst plates, and the publication is open access. This paper however is targeted to present the paleoceanographic reconstructions, using the dinocysts as a tool rather than the purpose of the study. With that aim in mind, and anticipating on the audience expected, we decided that plates are irrelevant in this paper. However, we added reference to the plates as published in Bijl et al. 2018 in the methods section (3.1)

Terrestrial palynomorphs can include everything from saccate-pollen to spores or fungal hyphae, and thus suggests e.g. a different depositional setting for the site. Therefore, I think that it may be a bit risky to put them into one category without mentioning any details. One way to fix this is to give appropriate overheads in the “dinocysts counts” spreadsheet in the supplementary excel file (i.e. in situ dinocysts, reworked dinocysts, terrestrial palynomorphs, etc.) and refer to this file in the main text.

An extensive presentation of the terrestrial palynology and the vegetation and climate reconstructions derived from it, is out of the scope of this paper, and will be presented elsewhere at a later stage. For the purposes of our paper, we portray the total terrestrial organic component in our samples as a crude and qualitative proxy for terrestrial input. Since details of terrestrial palynomorphs are meant to be presented in another study, we only recorded broad categories of terrestrial palynomorphs in our counts, which we present in the figure and in the supplementary tables.

The strong upwelling occurring today around Antarctica is causing low abundances of carbonates at the sea-floor. How does the upwelling (suggested in line 363) support the presence of carbonate rich intervals during the Oligocene and Miocene (e.g. line 401)? I think that this needs to be explained a bit more clearly.

This is explained around lines 429-433, where the oceanographic reconstructions are discussed.

TECHNICAL CORRECTIONS Within the entire text “Margin” with a capital letter in “the Wilkes Land Margin”. Please correct where needed.

We will change ‘Margin’ to lower case throughout

It needs to be clearly stated when the authors talk about “dinoflagellates” and when about “dinoflagellate cysts (dinocysts)”. “sea-ice” or “sea ice”, please choose only one version

We will check throughout for consistency

Please define: “common” or “abundant”

We will rephrase throughout and specify to avoid ambiguity.

Abstract: Please avoid repetitions: “time intervals” line 25,27,44 **Done** Lines 25-29: “may bear information to resolve”? **Rephrased** please rephrase the two sentences. Lines 37-38: Consider rephrasing to “Our record shows that a sea-ice indicator, *Selenopemphix antarctica*, occurs only in the earliest Oligocene, following the full Antarctic continental glaciation, and after the Middle Miocene Climatic Optimum”. **Done** Line 39: “during the remainder of the : : :” – please rephrase Line 39: perhaps it is better to write: “the composition of the dinocyst assemblages imply” **Rephrased**

Section 1: Line 51: please rephrase: ”: : :much more ice is: : :” **Rephrased** Lines 72-84:

perhaps these two very long sentences could be made into few shorter ones. **Sentences were shortened** Lines 95-96: marine-ice? I think that “sea-ice” sounds better **We talk about marine-based ice and not sea ice in those lines, which have a rather different meaning.** Line 96: does it mean “a continent with a low topography”? If yes, then please rephrase “a lower Antarctic” **Done** Line 115: please rephrase “: : establishment of age control: : :” **Rephrased** Line 125: perhaps “recently” instead of “accurately” **Rephrased** Line 127-128: this sentence is poorly constructed **Rephrased** Line 133-134: it sounds a bit weird to compare with “detailed sedimentological descriptions”, I think that it should rather be written that the authors “correlate changes in the dinocyst assemblages with the changes in the lithology” or something like that. **Rephrased** Line 135-139: this sentence is missing something. Please rephrase. **Rephrased**

Section 2: Keep this section in the passive voice. **We used passive voice more than in the previous manuscript, but not in every case to avoid a too passive tone, which to our opinion does not read well.** Line 149: “upper Miocene” not “late Miocene” **Rephrased** Line 165-170: this sentence is poorly constructed. It is not correct to write that “the lithology lacks” something **Rephrased** Line 166-170: diatom ooze and diatom-rich clay: which one is a turbidite and or hemipelagite (see Table 2)? **We agree that our initial analyses lacked a detailed description of the Miocene facies. In the new version of the manuscript we will add the detailed Miocene lithology to the Oligocene one. We have already made this amendment in anticipation of this rebuttal and noticed, however, that this does not affect our conclusions and drawn earlier.** Line 178-179: this sentence is poorly constructed **Rephrased**

Section 3: Line 196-197. Avoid active voice. **Avoided in most cases.** Please rephrase both sentences. For me it sounds a bit weird to say “surface sample”. What about “a sample from the sea surface” instead? **We agree with the comment and will rephrase surface-samples to surface-sediment samples.** “Another important information” is used in line 227 and 231. Consider rephrasing to avoid repetition. **Rephrased** Line 235-236: What does “N” mean? I think it is better to write “north”. **Done** Please rephrase the sentence to make it more clear. Please explain all the abbreviations used in the text for the first time, e.g. GCM, STF and SAF. **Checked and done**

Section 4.1: Please describe the individual groups in the same order as they are mentioned at the beginning of the paragraph. **We will change the order.** Line 249-250: “amorphous organic matter (particles)” instead of “amorphous palynofacies”. **Done** Line 252: it should be “rare to common” not “present to common”. **Rephrased** In this section it should also be explain how authors define: “rare, “common” and “abundant”. **Rephrased to avoid ambiguity** Line 257: one can not write “dominate the assemblage during the late Oligocene”. It should be either “are the dominating group in the assemblages from the upper Oligocene” or “were dominating/most abundant during the late Oligocene”. **Rephrased**

Section 4.2: Line 266: if it is not an observation made by the authors, I would suggest to add a reference here. **Done** Line 267-269: I suggest to rephrase the sentence: “is common to abundant between 33.6 to 32.1 Ma (earliest Oligocene) and after 14.2 Ma (i.e. during and after the mid-Miocene climatic transition)” **Done** Line 270: please remove “generally”. **Done** Line 270-281: please consider to rephrase this part, so it will be clear what was the assemblage composition in the Oligocene-Miocene and what is today. **Rephrased** Line 289: please remove “noted” **Done** Line 291: Instead of “Of these taxa” it should be “Of the gonyaulacoid taxa” and add “spp.” after Nematosphaeropsis. **Changed to N. labyrinthus.** Line 294: it should be Section 4.3 not 4.5. Please correct in the following headings accordingly, i.e. 4.3.1 and 4.3.2. **Done** Lines 296-306: I am not certain if the part describing the lithology fits in the result section. This is not a result of the current study, but rather a summary of the (already interpreted) lithological observations by

Salabarnada et al. However, I see that this is an important part for the manuscript, I suggest to keep it, but incorporate it into the earlier part of the manuscript. **Indeed, lithological details can be avoided and we now refer to Salabarnada et al., for details.** Section 4.5.1: Line 314: perhaps it should be: “: : occur in the reworked glauconitic sandstones of the lower Oligocene age.”? **Done** Line 315: Keep sentences short: “: : sandstones. This is in line: : :” **Done** Line 316: Great, that what one can expect! Section 4.5.2 Please, avoid expressions as “we compare”, “we note”, etc. Please change it into the passive voice. **Done** Lines 327-328: repetition of “interval” **Rephrased** Line 330: “restricted to” or “limited to” instead of “connected to” **Rephrased** Line 333: “in the Eocene sediments” **done** Line 334-336: I suggest to rewrite like this: “Within the Oligocene strata *Lejeunecysta* spp. (: :) lower abundance in the interglacial deposits and pelagic clays. The taxon is also less abundant in the Miocene.” **Rephrased**

Section 5. Discussion Line 353: why upwelling? Is that the only possibility? **We believe that, given the geographic setting, upwelling is the only possibility. We now indicate that more clearly in the text** Lines 354- 356: circular argumentation, that abundant oligotrophic cyst taxa support oligotrophic dinoflagellate assemblage **Rephrased to avoid circular argumentation** Line 357: which taxa? It may be a good idea to list them here as a reminder for readers **We really want the reader to focus on the paleoceanographic inferences. As we have elaborately described the species in the results section, we do not repeat the species names here.** Line 359-362: “we interpret that these taxa are part of the in situ pelagic assemblage and reflect warming of surface waters rather than them being reworked” – I think that this needs rephrasing. **Done** What is more, which taxa are considered as indicators of warming? Is this based on the present study or the literature? If on the literature, then please provide proper references here. **Done** Line 366-367: this sentence is poorly constructed **Rephrased** Lines 368-369: active voice should be avoided here **Avoided** Lines 370-372: grammatically something is missing in this sentence. **Rephrased** Line 381: what does “the average assemblage” means? **Rephrased** Lines 387, 391: add “Site” before U1356 **Done** Line 391: please add “succession at Site U1356”. **Done** Lines 393-394: repetition of lines 381-382 **Repetition avoided** Line 395-396: it sounds weird to compare “Oligocene-Miocene surface waters” with “the same Oligocene-Miocene sediments”. Please consider rewriting **Agreed. Rephrased** Line 407: “i.e.” instead of “e.g.” **Done** Line 420: “more oligotrophic character of the dinocyst assemblages” – please rephrase **Rephrased** Line 430: “an evidence” **Done** Lines 449-450: this sentence is poorly constructed **Rephrased** Line 451: modern dinocysts assemblages? **Rephrased** Line 455: “: : ACC. This is in line with numerical: : :” **Done** Line 460: please explain what does abbreviation MMCO means, perhaps even earlier in the text **Spelled out** Line 465: consider different order, like: “weaker throughout the Oligocene and the Miocene, than at present” **Done** Line 467: please remove “to us” **Done** Line 476: please explain what does abbreviation MMCT means, perhaps earlier in the text **Done** Line 533: “records have recorded”- please rephrase **Done**

Section 6 Avoid repeating “fundamentally different” so close to each other (Lines 534 and 542), or “that of today” (line 542 and 543), “compared to today” (lines 548, 550) **Done** Lines 545-547: please consider rephrasing this sentence. **Done** Line 608: it should be “data compiled from Site” **Rephrased** Line 611: please use passive voice **Done** Line 613: perhaps it should be “or calibrating our data against age-scale” **Rephrased** Line 622: “sandstones” – please correct in the entire text **Done**

Figure captions and references:

“Bijl et al. in press” not in the reference list “Salabarnada et al. submitted this volume” not in the reference list. **We added these references**

Fig. 2 – Why does the colour lines reflecting various lithology have different length? **This was done to improve clarity** What does (o) and (y) mean? **Now explained in the caption** Please align overheads “Miocene” and “Oligocene”. **Done** Please explain what the grey colour in the palmag column implies. **Now explained in the caption**“(from Tauxe et al.,2012, but recalibrated to GTS2012 of Gradstein et al., 2012; see Table 1 and modified based on Crampton et al., 2016)” - this sentence is poorly constructed

Rephrased

Fig. 4 and 5 – what is determining the order of the dinocysts? Shouldn't Spiniferites cpx be moved to the right? **Agreed, done** And actually, is Spiniferites cpx needed on the figure if it is not even mentioned in the main text? **Yes it is, as it is one of the most common dinocyst genera in many places.** The same with Corrudinium, Cerebrocysta – these are not mentioned in the text. If they are merged in a complex with Pyxidiniopsis spp. then please clearly state it in the text or supplementary. **Now mentioned in the text.**

Fig. 4 – I think that it is necessary to mark the position of unconformities in e.g. the column with “epoch and stage”. Otherwise, Chattian followed immediately by Burdigalian looks a bit odd. **Done** The intervals which look like barren in the column with “ Total palynomorphs/ dinocysts”, are not marked as such in the following plots in the figure, therefore the figure looks a bit chaotic. **Many barren samples are positioned close to productive samples. The plot is meant to provide the reader with a comprehensive image of the palynological assemblages, similarly to the way they were presented and discussed in the text.** The overheads for “total palynomorphs/dinocysts” and “Palynomorph relative abundance” should be aligned with the overheads to the right (i.e. dinocysts taxa and genera). **Done** Also, I would suggest to add a column with sample position on this and the following figure. **The sample intervals are already plotted in Figure 2. We believe that this information is no longer needed when interpreting the data in figures 4 and 5.** Are all other dinocysts recorded in the assemblages “oligotrophic/outside oceanic fronts” as suggested by the color/filling in the plot? **We clarified this in the results section in the text.** It is not clear to me why “oligotrophic/outside oceanic fronts” has two colors (red and dotted orange). **We choose to give Operculodinium spp. another color because it is such a well-known and paleoceanographically significant genus both in this region and in the northern hemisphere.** Why are absolute abundances not shown in the same way as the relative abundances? **Absolute abundances of the different dinocyst groups are not mentioned or discussed in the text, nor they do have a readily interpretable paleoceanographic signal.**

Fig. 5 – While in Fig.2 Oligocene and Miocene are divided into “late”, “middle” and “early” , on figs 4 and 5 they are divided into stages. Adding a subdivision of the Oligocene and Miocene into “late”, “middle” and “early” on figures 4 and 5 will help readers to directly correlate it with figure 2. **Agreed. Done** This may be a good place to mark a position of the climatic events mentioned in the main text, such as the Oi-1 glaciation and MMCO. **Agreed. Done** Please add that the figure shows the distribution of the “in situ dinocyst”, like in figure 4. **Done in the caption**

Fig. 6-7: According to table 2 “Miocene deposits” consist partially of turbidites. Isn't that a bit odd that turbidite deposits yield so many in situ dinocysts? **We agree and thought about this. Possibly, turbidites in the Miocene transport very young sediments from the shelf. This causes reworking in these turbidites to be overlooked as there is no age gap between the species encountered in the turbidites from those encountered in the pelagic sediments. We will add this to the main text of the paper, and in any case we now separate turbidite deposits from pelagic sediments.** However, Fig.7 – I would write something like that: “The distribution of eco-groups within various lithologies encountered in Site: :” in the figure caption. **Done**

With my best regards

Kasia K. Sliwinska

Please also note the supplement to this comment:

<https://www.clim-past-discuss.net/cp-2017-148/cp-2017-148-RC1-supplement.pdf>