Comment on esd-2021-48
Anonymous Referee #2

Referee comment on "Sedimentary microplankton distributions are shaped by oceanographically connected areas" by Peter Nooteboom et al., Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2021-48-RC2, 2021

Review of
“Sedimentary microplankton distributions are shaped by oceanographically connected areas” by Peter D. Nooteboom et al.,

Summary:
Nooteboom et al., use a strongly eddying global ocean model simulation to investigate the influence of particle advection by ocean currents on sedimentary microplankton distributions.

They show that the effect of clustering by the advection that leads to regions that originate from ‘clusters’ and regions that are more noisy (originate from various source positions) can be detected in the microplankton distributions of dinocyst and foraminifera assemblages.

This is a very interesting study, contributing a better understanding of sedimentary microplankton distributions that are routinely used to reconstruct past climate conditions. However, in its present form, the manuscript is quite challenging to read (for a person from a (paleo)climate background) and while I agree with the conclusions that an effect of the advection can be detected in the assemblages; even after reading it several times, it is unclear to me how strong this effect is.

As the metrics used are rather complex and unfamiliar to me (e.g. Partial Mantel correlation of the reachability distance D, reachability estimated with the OPTICS algorithm, with the taxonomy with spatial distance held constant) it is challenging to judge the robustness of the results.

Overall, I recommend publication after clarifications are made according to the comments below.

Oceanographically disconnected clusters and ANOSIM results.
Figure 2 shows that the sedimentary microplankton composition are more similar within than between clusters. However, as the authors note themselves, this could also be explained with the fact that sediment sites within clusters are closer to each other. Thus, to the reader, it is unclear whether this result indicates any effect of the advection ‘connections’ on the assemblages. Would it be possible to create a proper null hypothesis for this experiment e.g. by creating random clusters with the same size as the true clusters and test if the similarity in the true clusters is higher than in the surrogate clusters?

Oceanographically isolated clusters

According to the authors, Figure 3c demonstrates the effect of the reachability / isolation on the assemblage. However, despite the explanations, I find it challenging to understand and interpret this diagnostic. If I understand it right, it compares reachability distance (which is only defined in the Appendix) to the distance in SST and distance in taxonomy while removing the effect of the geometrical/spatial distance. Maybe the authors can explain in a simple way what this means.

Why is the distance in reachability important for the distance in assemblages... and not the reachability itself...? I would have expected a strong reachability (thus a connection to many sites and thus many environmental conditions) to lead to a diverse taxonomy... but it is less clear why the distances in these parameters should be related.

If one looks at the distances for some reason, intuitively I would have thought that the distance in taxonomy would have to be compared to the distance in SST ... and then compared to the distance in reachability?

In Figure 3c, there is a strong correlation of reachability distance to SST for foram’s for small smin; is this discussed in the text? I might have missed it.

Finally, when I try to visualize what is going on, I look at the reachability in Figure 3a... but unfortunately, just at the parameter smin=300 used in Figure 3a the correlation in Figure 3c is nearly zero.

Line 192 writes that the reachability distance is independent of the spatial distance between sites, but isn’t the effect of the spatial distance removed/ controlled for in the partial Mantel correlation that is used here?

Likely these are all quite ignorant and stupid comments, but they might show the challenge in understanding this part of the paper.

In Figure 4, a dimension reduced version of the species composition is compared to the OPTICS clusters and it is argued that spatially closed clusters (e.g. red and yellow) show a well separated taxonomy, arguing for an influence of the current-shaped clusters. But aren’t the surface conditions as SST also very different for the regions of the red and yellow clusters... the clusters are separated by the Antarctic Polar Front and thus even in a classical interpretation of the taxonomy only driven by e.g. temperature, we would expect a separated taxonomy?

Figure 5 shows the relation between microplankton species variability and environmental variables in clustered and ‘noisy’ sites. This demonstration is easy to follow and shows an increase in the explained variance of 5-15% when excluding the noisy sites.

Again, I’m not yet fully convinced that this must be related to the 3D advection /
clustering. If we expect that there is a correlation of the spatial distance and the taxonomy (e.g., due to some secondary spatially varying variable...); wouldn't we expect that picking some spatial patches/subsets from the full field would remove noise and increase the explained variance? One possibility to disprove this hypothesis would be to repeat the same analysis with similar sized randomly spaced clusters.

(Line 231 ff) Finally, it is argued that the clustered samples are less taxonomically mixed; Maybe I missed it, but can it be excluded that the surface conditions (as SST, Nitrate) are not just less variable inside the clusters than outside (1. Because of the spatial distance inside and outside of the clusters; 2. As the clusters avoid the fronts?).

Line 265ff: Implications

These are important results for the paleoclimate community and maybe some clarifications could help to increase the impact of the study for this field.

Do I understand it right that the recommendation would be to only train the transfer function inside a cluster (or pick the analogues) inside a cluster?

Line 285: How could the provinces be used to correct for ocean connectivity in assimilation approaches? By using the modern clusters?

Line 287: Why should the disconnected provinces provide the spatial structure for proxy calibration parameters? Variations in the proxy calibration parameters could be either due to secondary variables not considered in the calibration, or due to different species/variants of the organisms ‘recording’ the climate signal. Why would either of these options follow the disconnected provinces instead of following the climatic/oceanographic conditions?

In summary, I recommend strengthen and clarifying the argumentation for a strong effect of the 3D advection/clustering on the assemblages. Depending on the outcome, I suggest formulating the statements of the advection effect a bit more moderate.

This applies especially to the title “Sedimentary microplankton distributions are shaped by oceanographically connected areas”... A weaker version would be e.g., “microplankton distributions are influenced...”

And line 8 “These provinces explain the microplankton composition, together with e.g. ocean surface environment...”...e.g. to “in addition to the ocean surface environment, the provinces contribute to the microplankton composition.”

Minor comments:

- In some parts, only sites in the SH are considered... (L50 “in order to limit the total diversity of microplankton species”). Why is a high diversity an issue?

- The figure captions are difficult to read, and I see room for improvement here. I would
suggest starting the caption with an overview sentence; than describe the panels and then potentially draw some conclusions.

- Figure 3a. (a) Scatter plot of the site reachability in space; I wouldn’t call this a scatter plot.

Figure 3 and 4: Sediment location... this is a scalar number of a 2D location; I guess nearby records have a similar location index but it’s unclear how this is defined