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Biogeosciences Discussions

Interactive comment on "Scaled biotic disruption during early Eocene global warming events" *by* S. J. Gibbs et al.

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We thank the referee for their well-considered review. They bring up two key points that we agree would be worth discussing further/highlighting in the manuscript –

1. Choice of relative abundance data. While this is considered a weak point by the reviewer, it is something we have to deal with constantly when looking at biotic patterns in the fossil record. The strength of this kind of data is that it provides 'biological' information, i.e. relative abundances of taxa within the populations, which is independent of modifying sedimentological effects, such as varying accumulation rate. To change these data from % abundances to a more 'absolute' abundance form, such as numbers per gram does not provide any additional information and is actually adding a level of degradation. For example, to convert to numbers per gram would mean we introduce a

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dilution signal to our data that isn't necessarily anything to do with a biotic response. If we went a step further and tried to convert to fluxes, we would degrade the integrity of the data by adding an estimated sedimentation rate that would be below the resolution of the data and therefore not meaningful. Therefore, yes, ideally it would be great to be able to directly compare abundance fluxes, but it is not possible to calculate these without adding an additional level of uncertainly that render resultant data misleading. But the point is valid - the levels of variance are do not reflect absolute flux changes but they do provide us with a first order approximation of relative changes within the assemblages based on the least degraded data, and an objective measure of variance that allows comparison between different stratigraphic levels, different sites and different fossil groups. This is something that cannot be achieved by visual assessment of abundance data alone and is a key outcome of this study.

2. Merging species data at the genus level and the potential loss of variance signal. This is a very interesting and valid point. Yes, there will be some loss of variance signal through combining species, but two points should be considered: First, combining species does not inherently mean a loss of signal as the integrated patterns at the genus level will comprise of variance from multiple species that is not automatically lost or cancelled out by their integration. Significant loss could occur if all the species co-varied in their abundance changes (but even this could still produce a relatively high level of variance), or if non-covarying abundance changes occurred at a frequency that cancelled each other out. Looking at the taxon records, the latter may in part be the case for the early Discoaster record but not for the other genera that contain multiple species. We would argue that the genus level variations can and do, to varying extents, reflect species-level variations. But it is an important point to make and will be an important consideration when applying this method to other sites and other time intervals with different genera and different levels of species-level integration. Second, of the 11 genera we used within the variance metric 7 are effectively the record of one species. Coccolithus and Zygrhablithus, are essentially monospecific here, and the genera Campylosphaera, Cruciplacolithus, Chiasmolithus, Coronocyclus, and Sphe-

nolithus, are represented by few species and dominated by one species. Therefore the variance records of these genera do, in general, reflect the variance of only one taxon. This leaves Fasciculithus, Toweius and Discoaster as multi-species signals. We agree that while much of the evolutionary turnover signal is focused in Discoaster and Fasciculithus, these signals are not necessarily what we are intending to capture and for our purposes, don't necessarily need to. Yes, there are evolutionary appearances of new species within these genera, as well as extinctions, in particular of Fasciculithus, but what we are trying to gain is a measure of abundance variations that isn't skewed by particular species richness changes in a genus. Evolutionary turnover analysis already captures these kinds of responses (e.g., Gibbs et al., 2006), but does not enable a measure of response below that of originations of extinctions. The approach set out in our paper addresses this problem. Our aim is to objectively compare how, for example, Toweius is responding (that shows little evolutionary turnover) with discoasters (which do).

Finally, we will address the other more minor points raised in the revision of the manuscript, but one point, the dissolution susceptibility of Zyghrablithus bijugatus, we will comment on here. Z. bijugatus is a holococcolith and these are typically prone to dissolution. However, Z. bijugatus, unlike most other holococcoliths, is an atypically large form and if overgrown in early diagenesis, which is its typical state as seen in electron micrograph images, it is transformed into a large robust 'grain' that is very dissolution resistant. Z. bijugatus is therefore a commonly observed holococcolith in assemblages that have no other holococcolith species and it is one of the last of all coccolith species to remain in heavily dissolved samples.

Interactive comment on Biogeosciences Discuss., 9, 1237, 2012.