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Comment on bg-2021-67

Anonymous Referee #2

Referee comment on "Test-Size Evolution of the planktonic foraminifer Globorotalia menardii in the Eastern Tropical Atlantic since the Late Miocene" by Thore Friesenhagen, Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-67-RC2, 2021

General comments

The manuscript 'Test-size evolution of the planktonic foraminifera *Globorotalia menardii* in the Eastern Tropical Atlantic since the Late Miocene' present a size record of *M. menardii* over the last 8 million years. Most notably, it shows an increase in size to a 'giant' *G. menardii* type in the last 2 million years. The manuscript explains this size change by investigating three possible hypotheses: influx of giant specimens from the Indian Ocean by Agulhas Leakage, a local evolutionary event or a response to oceanographic conditions.

I have several major concerns regarding the methods and data interpretations. The dataset is not suitable to test the first two hypotheses (Agulhas Leakage and Local Evolution), and evidence for the third hypothesis is inconclusive. Additionally, the characteristics used for species identification (number of chambers in final whorl) are not sufficient to tell Menardiform species apart. There is a possibility that the size record presented here consists of multiple Menardiform species and any changes in size could therefore be the result of a change in species composition, rather than a species-specific evolutionary event.

Specific comments

Interpretation

- The link between AMOC strength and size, which is presented as the best explanation for size increase at 2.0 Ma in *G. menardii*, is weak. The covariation between εNd and size is not significant at Site 925 and explains very little variation in the size record of Site 667 (Figure A8). If Atlantic water column restructuring had a strong influence on size through accumulation of nutrients we would expect this effect to be visible everywhere in the Tropical Atlantic. Additionally, if size increased due to nutrient accumulation in the thermocline we would expect to see a size increase in all thermocline dwelling species at the same time. For as far as I know, no such increases are known for any other species. Finally, if εNd and *G. menardii* size are linked we

would also expect an increase in size in the interval 3.5-5.5 Ma, when εNd values were comparable to those of the interval with giant specimens. As *G. menardii* reached minimum size values in this interval, I am not convinced there was a strong link between εNd and size.

- In the Agulhas Leakage hypothesis giant *G. menardii* are transported from the Indian Ocean, around South Africa into the tropical Atlantic Ocean. Although a giant form existed in the Pacific, no existing or new data is presented to suggest that giant forms also evolved in, or migrated to the Indian Ocean. A record of Indian Ocean *G. menardii* size is needed before the Agulhas Leakage hypothesis can be tested.
- The Local Evolution hypothesis discusses whether the giant *G. menardii* evolved locally through punctuated evolution. The resolution of the record presented here, with a sample resolution of 0.1-0.2 million years, is too low to test for sudden evolutionary events taking place in as little as 50,000 years (line 397). A much higher resolution record of the interval around (suspected) speciation is necessary to test for sudden punctuated evolution. A higher-resolution record could also help distinguish between the Agulhas Leakage and local evolution hypotheses: local evolution is likely a single interval with increasing maximum size, whereas leakage of eddies could have resulted in the sudden appearance of fully formed giant *G. menardii* several times. A higher resolution record with sample spacing of 5-10 kyr might be able to detect these differences.

Methods

- The Methods describe species identification based on the number of chambers in the final whorl. However, chamber number alone is not enough to distinguish Menardiform species. The species descriptions in the Neogene planktonic foram atlas (Kennett & Srinivasan, 1983) state that *G. menardii* has 5-6 chambers in the final whorl, *G. limbata* has 6-8 and *G. multicamerata* has 8 or more. Additionally, *G. exilis* and *G. pertenuis* have 5-7 and 6-8 chambers in the final whorl, respectively. Therefore, specimens with 6 or fewer chambers, which the manuscript calls *G. menardii*, could be either *G. menardii*, *G. limbata*, *G. exilis* or *G. pertenuis*. The *G. menardii* size record presented in the manuscript could thus be a composite of several species, and any changes in size could reflect changes in relative species abundance rather than an evolutionary event.
- *G. exilis* and *G. pertenuis*, which evolved from *G. limbata* are not mentioned in the manuscript, even though both were present in the tropical Atlantic at the time of the study interval (Chaisson & Pearson, 1997). These two species became extinct around 2.0 million years ago, around the time that *G. menardii* size increased. I wonder if this size change could in part be explained by a removal of smaller Menardiform species in the assemblage.