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# *Interactive comment on* "Detecting the onset and effects of major northern hemisphere glaciation in the abyssal tropical Atlantic Ocean" *by* Brent Wilson and Lee-Ann C. Hayek

**Brent Wilson and Lee-Ann C. Hayek**

Brent.Wilson@sta.uwi.edu

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Dear Editor

The advent of new statistical techniques presents opportunities for palaeoecologists to obtain new insights from older data when they are re-analysed statistically. This allows more detailed and inferential or informative interpretations to be based upon the quantitative results. Such was the case in the present study, where we applied the Assemblage Turnover Index (ATI) of Hayek and Wilson (2013) to a dataset published by Yasuda (1997, table 1).

We will in our revised text comply with the reviewers' many recommendations regard-



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Discussion paper

ing our text and diagrams, but will decline to add a diagram showing the limits of all the abundance biozones detected with SHE analysis. This paper instead focusses on the ATI at a single boundary, coincident with the onset of Northern Hemisphere continental glaciations early in Pleistocene times, and insights that can be gained from our application of ATI.

Reviewer 1 suggested that we develop new datasets for the Quaternary in order to assess regional change. This we have already done for the Upper Quaternary in the western tropical Atlantic Ocean – see Wilson (2008, 2011, 2013, 2014); Wilson and Costelloe (2011), Hayek and Wilson (2013), and Wilson and Hayek (2014b, 2015). The reviewer seems to have been unaware of these many high quality datasets and of the insights they have provided, although they were all included in our bibliography. In a revised manuscript we will include a summary of the results from these studies.

The present work is an expansion of our many applications of ATI, which has previously been applied to high-resolution datasets from Upper Quaternary sections. In this manuscript it was applied to a lower-resolution dataset from abyssal depths from the central tropical Atlantic Ocean (ODP Hole 926A, Ceara Rise, (3°43.146'N, 43°44.884'W, water depth 3598.4 m). We showed how the ATI applied to benthic foraminifera in this Hole detects the onset of northern hemisphere glaciations near the beginning of the Pleistocene, at ∼2.54 Ma. In this sense, the reviewers are correct in stating that this was noted by Yasuda (1997). However, the mean values of ATI provide insights not available from that author. The higher value of mean ATI following the onset of glaciations shows that the benthic foraminiferal assemblage was less stable than that prior to the onset. That is, we showed that, despite ODP Site 926As being in an oligotrophic area, the community after the onset of glaciations was less stable at this site than on the nutrient-rich Demerara Rise (ODP Site 1261A). Application of the Conditioned-on-Boundary Index (CoBI) to the 2.54 Ma boundary, following the method presented by Wilson and Hayek (2014a), provided new insights, highlighting differences in the niches of Alabaminella weddellensis and Epistominella exigua,

and allowing the detection of previously unrecognised enhancement of bottom current strength on the basis of the relative abundance of Cibicidoides wuellerstorfi.

Reviewer 1 expressed concern that we had applied ATI to only one dataset in our original manuscript. In this, they were quite prudent, as application to other sites is ideally needed to confirm the signal we detected. To verify the validity of our observation, we have since our original submission, and in response to reviewer 1, further applied our technique to ODP Hole 929A ((5°58.573'N, 43°44.396'W, 4357.6 m) from Yasuda (1997, table 3). Use of data from the same author avoids taxonomic complications that might arise were we to use data from different authors. Our results concerning ODP Hole 929A confirm those from nearby Hole 926A. The section in Hole 929A comprises two subsections, one each above and below the 2.54 Ma boundary (i.e., coincident with the onset of major Northern Hemisphere glaciation). The mean ATIs of 0.739 after 2.54 Ma significantly exceeds that of 0.579 prior to 2.54 Ma ($t = 3.83$, $p = 0.0001$, $df = 83$). Student's t-test shows that the mean value of ATIs in the lower (Miocene-Pliocene) subsection at 929A does not differ significantly from that of 0.526 in the lower subsection at 926A ($t = 1.795$, $p = 0.075$m $df = 112$). Likewise, the mean ATIs in the upper subsection at 929A does not differ significantly from that of 0.669 in the upper subsection at 926A ($t = 1.513$, $p = 0.134$, $df = 82$).

There was thus a regional onset of enhanced assemblage turnover in the abyssal, tropical Atlantic Ocean following the 2.54 Ma commencement of Northern Hemisphere continental glaciation. SHE analysis also detected the change in community structure at an abundance biozone boundary at 2.54 Ma in ODP Hole 929A. We will include a description of this confirmation in Hole 929A, obtained using the same techniques as at 926A, in our future manuscript.

Reviewer 2 suggested that we "generate new valuable data of (our) own, from ocean drilling cores in areas of the ocean where we do not yet have data, to increase our knowledge of deep sea environmental changes during the time of NHG." Like for reviewer 1, this overlooks our previous work in this regard, references for which were

provided in our original manuscript.

Reviewer 1 suggested that we create “a transect of sites spanning the equator to 30N to investigate changes in the ITCZ or using an Atlantic-wide transect to investigate changes in thermohaline circulation.” As shown in the references cited, we have already made much progress towards this in our previous work. The difference between that work and the present paper, however, is that we in our previous work used much higher resolution datasets than that provided by Yasuda (1997). Obtaining the data for such a revision as the one requested and at high resolution would be a monumental, extremely time consuming and costly task. Might the reviewer perhaps have access to such high-resolution datasets not yet published that would allow them to contribute to such work? If so, we would encourage them to publish these and so add to the corpus of work on the Pleistocene of the tropical Atlantic. We would ask the reviewer to note, however, that such low-resolution datasets as Yasuda’s are unable to detect individual glacial terminations, although they can be used to detect coarser resolution features such as the onset of northern hemisphere glaciation. Thus, the contributing of high resolution datasets would be much appreciated.

Both reviewers state that we cite ourselves frequently. We have no alternative but to do so. As mentioned above, the topical work in this area is ours. In addition, it is well known that it takes time for any new technique to be accepted and used by other authors, and ATI is a very new technique (October 2013). We do know, however, of some students and researchers who are beginning to use ATI in their work. We look forward to the time when sufficient other authors have employed and developed ATI for us to be able to cite them.

Sincerely

Brent Wilson and Lee-Ann Hayek

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