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Interactive comment on "An astronomical correspondence to the 1470 year cycle of abrupt climate change" *by* A. M. Kelsey et al.

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This paper presents an interesting investigation of astronomical factors that could produce a 1,470-year cycle. However, similar to previous comments, I think that the relevance of a 1,470-year cycle to millennial-scale variability must be better explained. The authors are focused on a body of work that is primarily 10-20 years old. The field has greatly evolved since that time, with the current consensus being that there is little evidence for an intrinsic "1,500-year cycle" in climate. Furthermore, the authors' response to Professor Wolff's comment leaves the impression that they would benefit from a more detailed explanation on the historical background of the 1,470-year cycle and the current state of research, which motivates me to comment.

In the early 1990s, both the North Atlantic sediment and the Greenland ice archives were shown to vary coherently (Bond et al., 1993). A sharp 1,470-year spectral peak was later detected in the GISP2 ice core water isotope record (Grootes and Stuvier, 1997). Coincidentally, an enigmatic ice-rafting proxy, the percentage of hematite-stained quartz and fledspar (HSG), was reported to exhibit an average 1,470-year cycle length (Bond et al., 1997). As the authors are aware this resulted in tremendous interest. However, as I will explain below, work from the last decade indicates it is unlikely that either Greenland water isotopes or HSG contain evidence for a 1,470-year climate cycle.

Of the manuscripts discussing a 1,470-year climate cycle cited in the authors' response to Professor Wolff (1), all but one predate the publication of the Greenland Ice Core Chronology 2005 (GICC05) (Andersen et al., 2006; Svensson et al., 2008). [Regarding the Bond chapter in the AGU Monograph, please note that the publisher's "how to cite" section (2) indicates the correct citation is Bond et al. (1999).] GICC05 and the North GRIP (NGRIP) ice core strongly suggest that the GISP2 chronology contains significant inaccuracies, and thus NGRIP superseded GISP2 as the key last-glacial reference series. GISP2 on it's original chronology (Meese-Sowers) exhibited an inconsistent climate/annual layer thickness relationship; Svensson et al. (2006) note that: *"the existence of the proposed 1,470yr cycle depends on the exact timing and phasing of the onset of D–O events, and ... this is exactly where we believe that the GISP2 time scale is inaccurate."* Furthermore, the GISP2 age scale places the Toba Eruption about 4,000 years too early (e.g., Svensson et al., 2013).

The GICC05 chronology has been transferred to GISP2 though high-precision volcanic synchronization with NGRIP (Seierstad et al., 2014). This largely corrects the inconsistent climate-layer thickness relationship of GISP2 (Obrochta et al., 2014a) and drastically changes the characteristics of the time series. The sharp 1,470-year peak that dominated the millennial band is removed, with power redistributed to a larger number of low-amplitude peaks (see figure on last page). While one of these is near 1,500 years, I personally see no *a priori* reason to focus attention on this one frequency when it is of no higher significance than the others.

Regarding HSG, it has been pointed out that 1,470 $\pm$ 532 years is obtained by averaging 1374 $\pm$ 502 and 1536 $\pm$ 563 years. At keystone North Atlantic Site DSDP 609, HSG cyclicity was reported to be 1476 $\pm$ 585 years (Bond et al., 1999). After updating the radiocarbon calibration, correcting errors in the event stratigraphy correlation, and importing GICC05, this becomes 1573 $\pm$ 669 years. More importantly, within the GICC05-dated interval of Site 609, HSG is bimodally distributed with rare occurance of 1,500 years cycles. Modes at 1,000-years and 2,000-years simply average to 1500 $\pm$ 500. That is the 1,500-year cycle in HSG – the nonexistent mean in a bimodal population. Thus, I interpet that HSG provides little support for 1,500-year intervals of climate change (Obrochta et al., 2012).

Finally, there is a growing number of records from the North Atlantic region that extend beyond 200 ka and contain Greenland-like variability during the last glaciation (MIS 4-2) but exhibit a drastically different pattern during the penultimate glaciation (MIS 6; fewer, longer, and less abrupt "events") (e.g., Kandiano et al., 2004; Martrat et al., 2004; Martrat et al., 2007; Margari et al., 2010; Margari et al., 2014; Obrochta et al., 2014b). That is, the nature of millennial variability is inconsistent between individual glaciations. This suggests that internal processes are more important to the actual expression of sub-orbital climate change than external forcing.

In the absence of Greenland ice, one may consider HSG variability over the previous two glaciations from the same location, DSDP 609/IODP U1308 (Obrochta et al., 2014b). The MIS 8 record is similar to the MIS 4-2 record, with no clustering of cycles at a 1,500-year period. Cycle lengths are more uniformly distributed, but there are two modes around 1,000 and 2,000. (It should be noted that suborbital age control is much less precise for MIS 8.) MIS 6 on the other hand is quite dissimilar to the records from the surrounding glaciations. high amplitude events are spaced 4-8 ky apart, with no indication of 1,500-year periodicity.

Therefore I reiterate that, while I find this work to be an interesting investigation of astronomical factors that could produce a 1,470-year cycle, I question the relavence to the paleoclimate community as the primary archives previously interpreted to exihibit this cycle are now interpreted much differently in the light of improved chronology.

Notes

(1) http://www.clim-past-discuss.net/11/C2098/2015/cpd-11-C2098-2015.pdf (2) http://onlinelibrary.wiley.com/doi/10.1029/GM112p0035/summary

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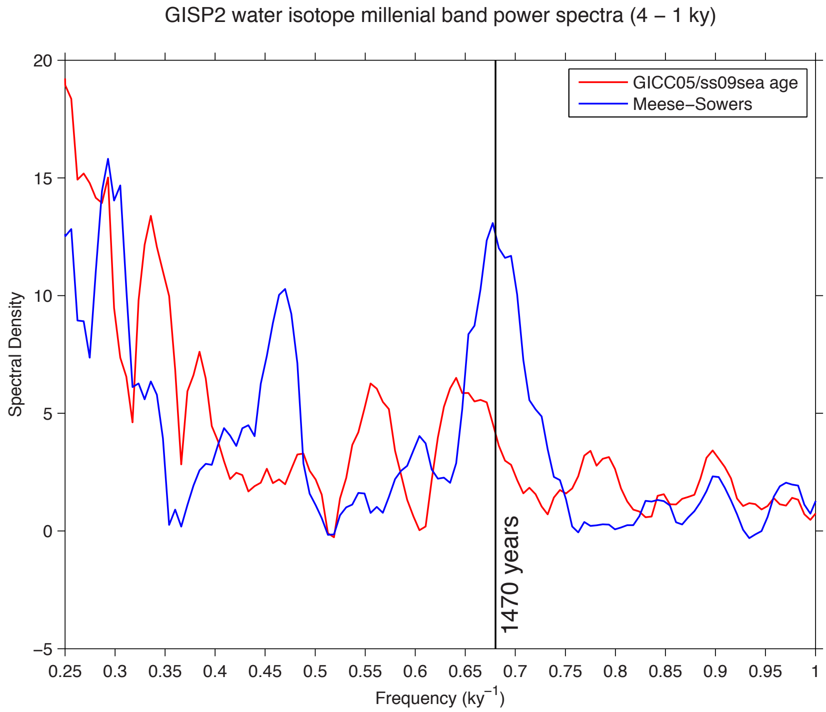

Multitaper method spectral analysis of GISP2 δ^{18}Ousing originalchronology (blue) and GICC05 (red).

Fig. 1.