

Discussion contribution Climate of the Past.

['Comment on cp-2021-173'](#), by Edouard Bard and Timothy J. Heaton.

**<sup>14</sup>C plateau tuning – A misleading approach for marine paleoclimate studies.**

First reply and invitation for further clarification by Pieter M. Grootes

We (Sarnthein and Grootes) welcome the discussion contribution of Bard and Heaton (B&H) to ‘<sup>14</sup>C Plateau Tuning – A misleading approach or a trendsetting tool for marine paleoclimate studies?’. This continues the evaluation, started with Sarnthein et al 2020, of Plateau Tuning (PT) as a paleoceanographic research tool to evaluate small <sup>14</sup>C signals in a patchy, noisy record where traditional methods fail.

We submitted to Climate of the Past (CP) to provide a summary of our PT results for 19 cores and to invite community discussion of the new PT technique and its, for some, sometimes controversial results. After considerable discussion, the paper was published late 2020. B&H submitted comments with serious objections in late January 2020 - yet listed as received by CP on 23 December 2020 - after Sarnthein et al 2020 had been published (Bard and Heaton, CP 2021, p.1701-1725). B&H raised 17 objections spread over two chapters. As pointed out in our 2021 CP comments, it seems ‘Its aim is to demonstrate that Plateau Tuning (PT) is fraught with problems and should not be used’. The present B&H comment appears to follow this line.

B&H start by referring to objections in their long 2021 CP-paper and the detailed discussion of those objections in our comments and their answers. We answered in 2021 in detail B&H objections related to the difficulty of identifying plateaus and to the lack of statistical robustness (in 2.3, 3.2, 3.4, 3.7, and 3.8). B&H selectively grouped comments and ignored several, both in their rebuttal and in the final paper.

Our present paper is the promised update of Sarnthein et al., 2020 that brings together all our data sets using the new Suigetsu time scale of Bronk Ramsey et al 2020, showing the information that may be obtained from ‘difficult’ sediment records by using Plateau tuning. To answer the question in its title we need to consider, in addition to the present B&H comments, some earlier discussion points that B&H failed to address in CP 2021. For a meaningful discussion I invite B&H’s further response to the points listed below.

#### **The difference between PT and IntCal20:**

**PT** aims to extract new information regarding variations in internal ocean dynamics and ocean-atmosphere exchange over last glacial-deglacial-Holocene times from ocean sites that lack clear chronostratigraphic markers for detailed age control, e.g., as listed in ‘Outlook’ of B&H 2021. PT hunts for small <sup>14</sup>C signals in a patchy, noisy record that will generally fail statistical tests for robustness. This is even true for the fine structure of the Suigetsu atmospheric <sup>14</sup>C record.

**IntCal20**, by contrast, is a statistically robust tool to translate <sup>14</sup>C ages into calendar ages. To achieve robustness, decadal to centennial information has been smoothed, which makes it less suitable for PT, as illustrated by Fig. 2 of the present B&H comment, comparing the Bayesian splines of Suigetsu and IntCal20.

### **PT robustness.**

As pointed out earlier: Absence of statistical proof is not proof of absence. The lack of statistical robustness of a single PT  $^{14}\text{C}$  record, emphasized in the statistical perspective of B&H 2021, is compensated in PT by much work, that documents consistency of the derived  $^{14}\text{C}$  plateau sequence with local sedimentology, stratigraphy, and the multi-parameter sediment record, and with similar plateau sequences developed elsewhere. The probability that a specific  $^{14}\text{C}$  fluctuation is caused by noise decreases with each new record in which this fluctuation is found, thus building robustness. The set of 19 records provides a base to check the global consistency.

### **Incorrect PT assumptions B&H 2021 used in formulating their objections.**

Bard is an experienced paleoceanographer and his list of potential problems of sediment records is realistic. Yet, contrary to his writing, these problems have been recognized by Sarinthein and coworkers in developing PT. In our comments 2021 and in the manuscript presently submitted, we pointed out that B&H's objections were based on their misunderstanding of PT and that several of their supposed 'assumptions made in PT' were incorrect.

### **Physical impossibility of PT plateau schedule**

B&H discussed (in 2.3) in great detail the timing of  $^{14}\text{C}$  fluctuations in the PT-tuned Suigetsu record. They objected that PT tuning resulted in a highly irregular behaviour of the  $^{14}\text{C}$  clock and, when moved from  $^{14}\text{C}$  age to  $^{14}\text{C}$  concentration  $\Delta^{14}\text{C}$ , in physically unrealistic jumps in atmospheric  $^{14}\text{C}$  concentration. B&H repeat this objection in the present comment. They ignore our comments to 2.3 that the jumps were the result of our use of constant-age plateaus that was dictated by the lack of data sufficient to define a plateau slope. An irregular  $^{14}\text{C}$  clock, moreover, is the logical consequence of fluctuating atmospheric  $^{14}\text{C}$  concentrations.

### **Bayesian spline and age plateaus.**

B&H made the Bayesian spline plot of Suigetsu  $\Delta^{14}\text{C}$  values to demonstrate the physically unreasonable consequences of PT. Despite our comments, B&H so far do not acknowledge the surprising agreement between their Bayesian spline and the PT record of atmospheric plateaus and jumps, especially after the recent time scale update. Figure 2 of their present comment - unfortunately including a typo in our Table 1; thanks to B&H for finding it – again demonstrates this. Fig. 2 also shows the loss of fine structure in IntCal20.