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## Comment on cp-2020-164

Anonymous Referee #2

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Referee comment on "On the tuning of plateaus in atmospheric and oceanic  $^{14}\text{C}$  records to derive calendar chronologies of deep-sea cores and records of  $^{14}\text{C}$  marine reservoir age changes" by Edouard Bard and Timothy J. Heaton, *Clim. Past Discuss.*,  
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The review of the submission of Bard and Heaton actually required as well a close look the Sarnthein et al. (2020) paper, below Sant2020) about a synthesis of the plateau technique (PT). The outcome is strikingly clear: Bard & Heaton (1) clearly identify errors and limitations of PT as applied so far, almost exclusively, by Sarnthein and co-authors, (2) discuss basic obstacles to obtain calendar ages of marine sediment cores by  $^{14}\text{C}$ , and (3) provide statistical procedures to evaluate the limits imposed by scarce and noisy  $^{14}\text{C}$  dates to link marine sediments to the atmospheric  $^{14}\text{C}$  calibration data.

- errors and limitations of PT as applied so far: Already in the figures of Sant2020 it is obvious that the  $^{14}\text{C}$  plateaus as chosen are much too long, as it requires extremely strong  $^{14}\text{C}$  production/emission changes at transitions between the plateaus as selected, for which no mechanisms are known; and these are not observed during the past 14k years of high-resolution atmospheric  $^{14}\text{C}$  data; and ocean-induced  $^{14}\text{C}$  changes occur on century scale, not in less than a decade. These aspects are presented well in Bard&Heaton in figs. 1 and 2
- basic obstacles: Compared to matching of  $^{14}\text{C}$  ages floating dendro sections (known years of gap between dates) to the  $^{14}\text{C}$  calibration curve, matching of  $^{14}\text{C}$  dates of marine sediment cores is complicated by an unknown depth-to-age scale,  $^{14}\text{C}$  variability by changes in foraminifera assembly and potentially varying marine reservoir age (MRA). Effects of fluctuation in these parameters on marine  $^{14}\text{C}$  plateaus, not considered in Sant2020, are discussed well in Bard&Heaton.
- Statistical procedures: Bard&Heaton demonstrate the effect of  $^{14}\text{C}$  errors in marine cores, which hamper firm identification of plateaus for ages >14k. The simulation exercises, under best case assumptions, exhibit the severe limitations imposed by sampling rate and errors. They also demonstrate that selection of just one of the  $^{14}\text{C}$  archives of IntCal20 (here Suigetsu) does not result in a more accurate representation of the atmospheric  $^{14}\text{C}$  variability. Instead, the creation of IntCal20 by Bayesian splines attempts to best preserve centennial scale signals (which are shown to be present in the production of cosmogenic isotopes back to 22.5k by Adolphi et al., *Nature Geoscience* 2014). Here figure 7 of Bard&Heaton is particularly striking.

The authors list in the abstract the main conclusions ('The main problems are linked to:---'). However that authors might consider to add a 'conclusion and outlook' paragraph at the end of the paper, pointing again to the complexity of the link of atmospheric and marine 14C variability in these points:

- 14C changes in marine sediment cores do not mirror 1:1 atmospheric variability, due to attenuation, phase shift of atmospheric signals, variability in sedimentation rate, MRA and foraminifera assembly. Hence alternatives in age-depth modeling of marine core 14C age sequences and alternative age link proxies are required, as used extensively (and on some of the cores in Sant2020) by Waelbroeck et al. 2019. Consistently dated Atlantic sediment cores over the last 40 thousand years. *Scientific Data*. 6(1):165,
- Scarcely resolved and noisy 14C data sets, hard to avoid especially in marine sediment cores, severely limit the reconstruction of calendar ages of sediment cores by 14C.
- IntCal20, compared to earlier versions, profited from a multitude of improvements in all 14C archives beyond 14k, e.g. new, high resolution data of Hulu cave, reanalysis of the Lake Suigetsu calendar scale, updates in calendar scale and 14C dates of the Cariaco basin 14C data set, and from the new concept of Bayesian technique to best combine the data of these archives. Still, as admitted by the authors of IntCal20, sampling resolution and error ranges may still hamper to employ centennial signals of 14C in linking of floating archives to IntCal20. Here the approach of floating glacial tree-ring chronologies, linked via 10Be to the ice-core time scale, as cited by Bard&Heaton, could be promising in the future.