A temporally constrained re-evaluation of temperature inferences from Boomplaas and isotope records from Cango Caves: Comments on Thackeray (2016)

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The Holocene has been characterised by rapid climatic fluctuations.[1,2] The climatic and biogeographical variations across southern Africa have presented challenges in accurately reconstructing the palaeoenvironmental and palaeoclimatic record for this period.[3] Difficulties have included the integration of palaeoclimatic reconstructions from multiple locations and the identification of contemporaneous climatic events.[4] The improvement of dating methods has facilitated temporally well-constrained comparisons and reduced the margin of errors in the ascription of ages to environmental and climatic anomalies inferred from proxy evidence.[5]

Thackeray[6] provides a comparison of his previous temperature record inferred from mammalian and insectivore records from Boomplaas[7] with Talma and Vogel's[8] speleothem isotope data from the nearby site Cango Cave. Notable are similarities in peaks and troughs demonstrated in the two records, argued to represent contemporaneous climatic events.[6] These records are not, however, presented on comparable axes, with the Cango Cave record plotted against calibrated years before present (cal yr BP), while the Boomplaas inferences are plotted against sample number. The sample numbers from Boomplaas have been demonstrated to be largely sequential, yet referring to Thackeray's Table 1[6], sample 57 is dated at 6400 years before present. If the existing radiocarbon ages, as presented by Thackeray[6,7], are to be used to argue temporally sequential samples, these ages should also be used in comparison between sites. Importantly, as the Cango Cave record presented terminates at 6000 cal yr BP, the radiocarbon date presented for sample 57 indicates that this and subsequent sample numbers plotted in Thackeray's Figure 1 precede the Cango Cave record.[6] The alignment of peaks and troughs for the two records is therefore not temporally consistent.

To facilitate direct comparison between these two records, the radiocarbon dates for Boomplaas require calibration, and it is necessary to interpolate ages for the Boomplaas samples for which there are not yet radiocarbon or other dates. The previously published radiocarbon dates[7] are therefore calibrated using ShCal13, with dates for the remaining samples interpolated by depth using Bacon, a Bayesian age-depth model using Markov Chain Monte Carlo simulation[9] (Figure 1).

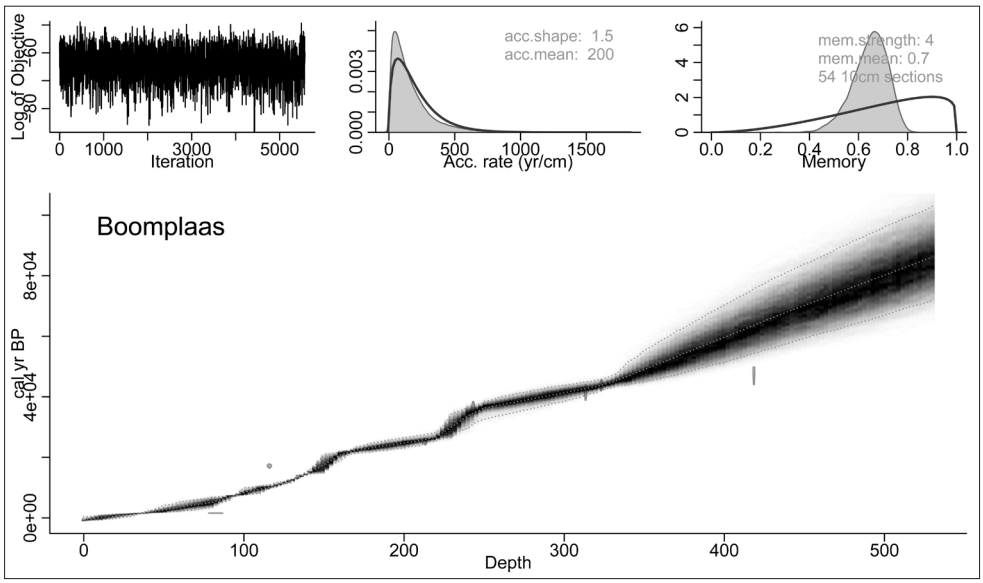

Figure 1: Bacon age-depth interpolation for Boomplaas Cave, based on the published radiocarbon ages[7].

Plotting the Boomplaas record against the calibrated ages, the significantly coarser temporal resolution of the Boomplaas record becomes apparent; much of the detail in the Cango Cave record is not captured in the Boomplaas sequence, for which only a more smoothed trend can be produced (Figure 2). This is not uncommon when making comparisons with speleothem isotope data, for which a very high resolution of analysis is permitted.[10] Only one of Thackeray's identified peaks remains, yet notable similarities exist between the records (Figure 2). The peak in the Boomplaas sequence corresponds very closely with the largest peak in the Cango Cave records, and most likely represents the height of the Holocene Altithermal (Figure 2). There is a progressive decrease in the inferred temperatures and isotope records with time (Figure 2). This pattern is consistent with the transition from the Holocene Altithermal to the slightly cooler contemporary conditions.[4] Thackeray[6] is therefore correct in his argument that there is a notable correlation between the two records, but the coincidence of events appears to be at a coarser temporal resolution than he presents.

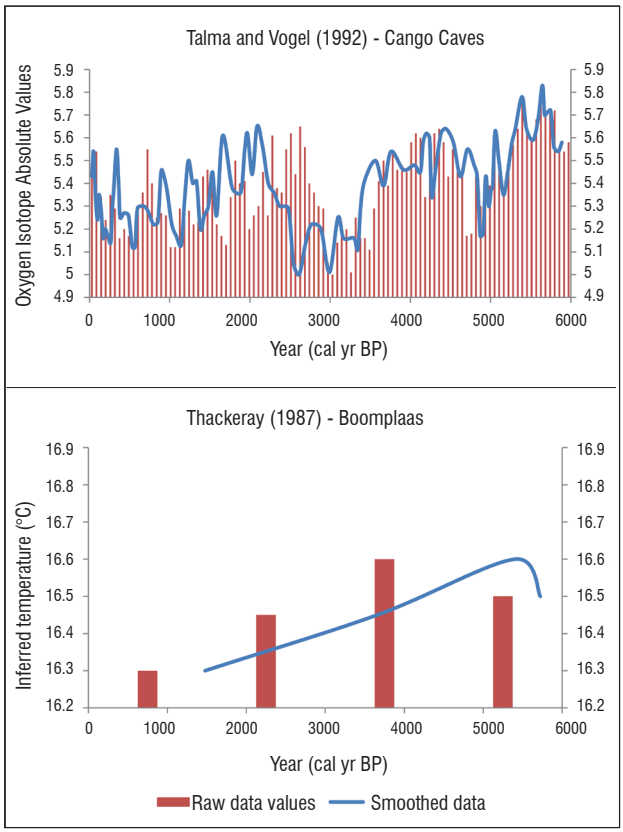

Figure 2: Comparison of the Boomplaas Cave and Cango Cave records, with the Boomplaas sequence constrained by calibrated radiocarbon ages.

With increased access to dating facilities, it is surprising for contemporary publications to plot results against sample number; an abstract measure to any reader unfamiliar with the study site in question. It would be of interest to understand the reason for the omission of existing radiocarbon dates in the plot, and for the inclusion of samples 57–59 which, by the age data presented in the paper, pre-date the Cango Cave sequence. Although methods of 'wiggle matching' are increasingly being accepted, these usually require that such adjustments occur within the error range of the measured dates, and are performed through statistical analyses of the fit of each date to the calibration curve.[11] Thackeray presents a very interesting comparison between two sites of relatively close proximity, and argues for the simplification of temperature inferences.[6] To derive the maximum benefit from these comparisons it is important to understand the temporal chronologies of the two sites, and the logic involved in making visual over statistical comparisons. Once these concerns have been resolved, Thackeray's arguments regarding the potential for reducing temperature inferences from isotope records to more simplistic regression models[6] can be explored with greater confidence.

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