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Atmospheric radiocarbon variation between 44 and 28 ka based on a U-series dated speleothem

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Radiocarbon is an important tool in geochronology as well as a parameter for the study of past environmental change of the last 50 ka. For radiocarbon dating a major scientific object is to extend the radiocarbon calibration curve beyond the current IntCal04 limit of 26 ka using marine and terrestrial archives such as foraminifera, corals or speleothems (Hughen et al., 2004; Bard et al., 1998; Fairbanks et al., 2005; Beck et al., 2001). However, past atmospheric Δ^{14}C reconstruction based on these different records do not agree, leading to the conclusion that there are problems with the calendar age timescale, variable amounts of post-depositional alteration or complications resulting from indeterminate reservoir or dead carbon effects.

Previously, we presented a high resolution record of Δ^{14}C from 45 to 11 ka based on TIMS U, Th and Pa measurements and AMS ^{14}C ages of a stalagmite (GB-89-24-1) from a cave on Grand Bahama (Beck et al., 2001). This record revealed elevated Δ^{14}C for the duration of growth, particularly so at $\sim$ 44 ka. Here, we focus on efforts to explore the millennial and sub-millennial Δ^{14}C variations observed in the Bahamas speleothem record, using another sample from the same cave (GB89-25-3). A robust chronology for this stalagmite has been obtained using MC-ICPMS U and Th measurements with precisions comparable to AMS ^{14}C analyses for similar sample sizes. We present a new radiocarbon record for GB89-25-3 from 44 to 28 ka. The new record does not display the extremely large radiocarbon excursions during the time 44 – 40 ka

B.P. previously reported from GB89-24-1. However, we still see a large $\Delta^{14}C$ shift of nearly 600 per mil during that time and other rapid excursions of 200 permil between 40 and 28 ka.

The Cariaco Basin $\Delta^{14}C$ dataset tuned to the GISP2 chronology is highly correlated with our new U-Th dated stalagmite record, except between 40-42 ka BP, where the Cariaco record shows more elevated $\Delta^{14}C$. This is also true for Cariaco tuned to the NGRIP (GICC05) timescale, though the discrepancies are slightly larger between 40-42 kaBP. In contrast, the Cariaco dataset using the Hulu cave speleothem chronology (Hughen et al., 2006) is better correlated to ours between 40-42 ka BP than the record either using the NGRIP or GISP2 chronologies, but shows significant differences to our data between 30 – 32 ka. This suggests that there may be errors in the Hulu age correlations. The new speleothem record also reveals that past atmospheric $\Delta^{14}C$ variation is concordant with predictions by model results incorporating the variation of the ocean circulation and variation of the Earth's magnetic field strength, suggesting that this is the major first order control on atmospheric $\Delta^{14}C$ during this interval.

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