

Supplementary Information:

Radiocarbon Analysis:

Corals were run for Fraction modern (Fm) where 'modern' is defined as 95% of the 1950 AD radiocarbon concentration of NBS Oxalic Acid I (NIST-SRM-4990) normalized to a $\delta^{13}\text{C} = -19\text{‰}$. Samples were run at the National Ocean Sciences Accelerator Mass Spectrometry Facility at Woods Hole Oceanographic Institute. Coral standards were run using the traditional hydrolysis method and the reconnaissance dating method (1) to ensure that there was no bias to the reconnaissance dating method (SI Figure 1). Coral standards were also run at regular intervals during sample processing (SI Figure 2). Corals were blank corrected using the IAEA C-1 calcite standard. Results of ^{14}C analysis are reported in Tables 1-2.

SI Figure Captions:

SI Figure 1: Comparison of Reconnaissance Dating Method versus Hydrolysis Dating.

SI Figure 2: Standard data associated with coral measurements. (A) Comparison of different radiocarbon dead standards in run order in 2008 and 2009. Errors represent 1 sigma standard deviation. (B) Variability of different coral standards ($\sigma=1$ sigma standard deviation, $\text{SE}=1$ sigma standard error). (C) A comparison of TIRI-I (in run order) in 2008 and 2009. Errors represent 1 sigma standard deviation and the accepted age of TIRI-I is 11059 yrs.

Table 1: Radiocarbon data for the North Atlantic deep-sea corals with their unique sample name, seamount, depth and age.

Table 2: Radiocarbon data for the Southern Ocean deep-sea corals with their unique sample name, seamount, depth and age.

Table 3: Wilcoxon and Brown-Forsythe test results for comparing depth distributions during different time periods in this study. North Atlantic depth distributions are indicated by (NA) and Southern Ocean distributions are indicated by (SO).

Table 4: All Southern Ocean corals analyzed for U/Th ages including their corresponding Reconnaissance ^{14}C Ages. Four corals (highlighted in red) were selected from the ACR mode and these U/Th ages confirm that the mode seen in the Southern Ocean dataset is the ACR and not the YD or H1. These same four corals are outlined in red on Figure 5.

Paper Cited:

1. Burke A, *et al.* (2010) Reconnaissance dating: A new radiocarbon method applied to assessing the temporal distribution of Southern Ocean deep-sea corals. *Deep Sea Research Part I: Oceanographic Research Papers* 57(11):1510-1520.