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The Pre-bomb, Holocene and Deglacial Radiocarbon Content of the Deep Atlantic Ocean

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Much of our current understanding of past deep ocean circulation has come from passive nutrient tracers. Chief among these circulation indicators are the proxies $\delta^{13}C$ and Cd/Ca ratios in benthic foraminifera. Data from these two have shown that changes in the relative distribution of northern and southern source deep waters in the Atlantic are correlated with glacial to interglacial fluctuations. Maps of the volumes and distributions of Atlantic water masses since the Last Glacial Maximum (LGM) are becoming much more complete. In this study, we present data from an ongoing project to monitor the past radiocarbon content of deep waters in the Atlantic and to therefore add circulation rate information to our understanding derived from the passive nutrient tracers. Coupled radiocarbon and thorium dates from uranium rich deep-sea corals allow for the direct determination of past $\Delta^{14}C$. In the modern ocean, this value provides our strongest constraints on deep-ocean turnover times and circulation rates. One complication to these calculations is the fact that North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW) have very different initial values of $\Delta^{14}C$. Mixing of water masses, as opposed to ventilation age, is therefore a large component of the modern Atlantic $\Delta^{14}C$ distribution. One complication to using the modern data is that the value for the NADW $\Delta^{14}C$ end member has been overwritten by the oceanic invasion of bomb produced radiocarbon. From extrapolations of other GEOSECS tracer data, Broecker et al have estimated the pre-bomb value of NADW to be -67‰. We have measured four pre-bomb deep-sea corals from the mid-ocean ridge south of Iceland for their coupled U-Th and ^{14}C ages. These data from two different locations (60 2.5'N, 29 40'W, 1125 meters and 62 21.3'N, 25 46.8'W, 640-675 meters) have an average $\Delta^{14}C$ value of -64±5‰. This direct measurement of the NADW end member is in close agreement with the previous estimations. We also have over a dozen new data points from the Holocene and deglaciation. This data set includes two corals of Younger Dryas age, from 37 N, 25 W, 1069-1235 meters and from 25 W, 2475-2820 meters on the equator. However, radiocarbon data for these samples is still being collected.