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Marine reservoir age variability and its link to the bipolar seesaw over the last deglaciation

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Marine radiocarbon dates, corrected for ocean-atmosphere reservoir age offsets (i.e. 'reservoir ages') are widely used to constrain marine chronologies. Reservoir ages also represent the surface boundary condition that links the ocean interior radiocarbon distribution (i.e. 'radiocarbon ventilation ages') to the ocean's large scale overturning circulation. Understanding how reservoir ages have varied over time is therefore equally essential for accurate dating and for investigations into past ocean circulation/carbon cycle interactions. A number or recent studies have shed light on the surface reservoir age changes over the last deglaciation; however a clear picture of global/regional spatiotemporal patterns of variability has yet to emerge. Such a picture is likely to be regionally heterogeneous. Here we combine new and existing reservoir age estimates to show coherent but distinct regional reservoir age trends in the sub-polar North Atlantic and Southern Ocean. Within the North Atlantic region, it can be further shown that similar, but lower amplitude changes occurred at mid-latitudes (i.e. on the Iberian Margin) as compared to higher latitudes. Regionally coherent patterns are also apparent in the southern hemisphere, with similar but lower amplitude variability seen in the sub-tropical south Atlantic (on the Brazil Margin), as compared to the sub-Antarctic.

An apparent link between regional patterns of reservoir age variability and regional climate changes, including in particular the 'thermal bipolar seesaw', suggests a causal link with perturbations to the ocean circulation and/or changes in mixed layer or sea ice dynamics (as well as associated marine carbon cycle changes). This proposal is supported by new and existing ocean interior radiocarbon ventilation records from the North Atlantic that implicate large-scale ocean circulation changes in deglacial North Atlantic climate anomalies. The existence of distinct regional patterns of reservoir age variability over the deglaciation emphasizes the fact that local deviations from a global mean reservoir age (i.e. delta-R values) have not been constant over time, posing a problem for marine radiocarbon age calibrations. However the apparent regional consistency also raises the prospect of developing region-specific marine calibration curves for radiocarbon-dating purposes.