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Globally resolved marine carbon isotope data spanning the last 25ka: what do they tell us about the drivers of atmospheric radiocarbon and CO2 on millennial and deglacial timescales?

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Be10 in ice cores provides a uniquely well resolved indication of past radionuclide production rates, with a direct bearing on past radiocarbon production. In the absence of past carbon cycle perturbations (e.g. involving ocean-atmosphere carbon exchange), Be10-based radiocarbon production rate anomalies should correlate directly with atmospheric radiocarbon anomalies, as confirmed by models. Over the past ~30ka, Be10-inferred radiocarbon production rates and atmospheric radiocarbon (i.e. Intcal20) both exhibit recurrent millennial anomalies, typically of ~5ka duration. A correlation between these anomalies breaks down during the deglaciation. This is intriguing and suggests a mix of millennial carbon cycle and radionuclide production influences. Here, global compilations of marine carbon isotope data (radiocarbon and $\delta^{13}C$) are used to assess the potential contribution of ocean circulation and air-sea gas exchange to the apparent millennial component of variability in Intcal20, and atmospheric CO_2. We find that existing marine $\delta^{13}C$ data provide strong support for a marine influence on atmospheric radiocarbon. Support from marine radiocarbon data is more complex, due to the influence of 'attenuation biases' (arising from radiocarbon production changes), and due to a distinct regionalism in the ocean's impact on atmospheric radiocarbon, versus atmospheric CO_2, with air-sea gas-exchange playing a significant role. Major differences in the long-term evolution of radiocarbon and $\delta^{13}C$ across the last deglaciation further point to distinct and independent controls on these isotopes systems, providing clues as to the nature and timing of different carbon cycle processes during deglaciation.