Mobilization of aged carbon via meltwater floods and coastal erosion in the Canadian Arctic during the last deglaciation

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It is consensus that the deglacial changes in ocean carbon storage and circulation play a role in regulating atmospheric CO₂. However, emerging evidence suggests that the rapid deglacial CO₂ rises can in part be attributed to large quantities of pre-aged carbon being released from degrading permafrost. In this study, we apply a radiocarbon approach on both terrestrial compounds (high molecular weight fatty acids; HWM-FA) and bulk organic carbon from a well-studied core ARA04C/37 from the Canadian Beaufort Sea. Based on our records, substantial amounts of ancient carbon were supplied from land to the ocean during the mid-late deglaciation (14.5-10 cal. kyr BP) by frequent high sediment flux events. Because the core location is strongly influenced by the Mackenzie River discharge, sediments only contain minor contributions from marine organic matter, allowing to consider mainly two terrestrial sources to explain the characteristics of bulk sedimentary organic matter. The terrestrial HMW-FA are taken to represent the biospheric carbon, and their age differences from the bulk organic carbon are explained by petrogenic carbon input. During the Younger Dryas, ice-sheet melting and meltwater outbursts enhanced petrogenic carbon contributions, suggesting a major source in the hinterland drainage system. During the rapid sea-level rise (meltwater pulses 1a and 1b), the very old organic carbon and comparable ages between biospheric carbon and bulk organic carbon indicate the occurrence of permafrost carbon remobilization primarily via coastal erosion while petrogenic carbon from the drainage system was found negligible. Remobilized ancient permafrost carbon is commonly regarded to be highly bioavailable, while petrogenic carbon is likely more recalcitrant to biological degradation. Our records thus suggest that the release of ancient carbon to the Beaufort Sea had the strongest impact on the atmospheric CO₂ level and contributed to its rapid increases during the B/A and Pre-Boreal when permafrost deposits along the coast were eroded.