

Assessing the use of natural abundance carbon isotopes towards quantifying cyanobacterial carbohydrate exudation

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Marine phytoplankton exude between 2 and 50% of initially fixed carbon, primarily as mono- and poly-saccharides. Exuded carbohydrates likely represent quantitatively important fractions of marine dissolved organic carbon, but their rapid recycling makes it difficult to quantify the contributions of this fraction towards marine carbon cycling. Here, we hypothesize that the stable carbon isotopic composition of individual monosaccharide sugars can be used to constrain the flux of carbon towards precursors of exuded mono- and poly-saccharides. We test this hypothesis by culturing cyanobacteria under irradiance and CO₂ concentrations promoting variable carbohydrate exudation, quantifying the $\delta^{13}\text{C}$ compositions of extracellular monosaccharides, and comparing these compositions to those predicted by models over a range of metabolic fluxes built with Quantifying Isotopologue Reaction Networks (QIRN). Exudates are increasingly recognized as key components of the marine carbon cycle, underscoring the need for tools to study their production dynamics under changing environmental conditions.