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Developing a global context for alteration of amino acid-specific stable isotope patterns in oceanic particulate matter

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As ubiquitous biological products, the absolute and relative abundances of amino acids have long been used as indicators of the degradative status of natural organic matter in ocean water columns (e.g., [1]). Across the world's oceans, both the concentrations and downward fluxes of particulate organic matter are attenuated rapidly with increasing depth below the euphotic zone; better characterization of the processes responsible for loss of fixed carbon in this depth range is therefore critical for improving our predictions for oceanic carbon fluxes in the future. Recently, the naturally occurring stable isotope ratios of individual amino acids have shown promise for distinguishing microbial and metazoan mechanisms that transform organic particles in upper- to mid-water regions of the water column (e.g., [2], [3]). Using the nitrogen isotopic composition of individual amino acids, we introduced a classification framework and mixing model to estimate the broad organic composition of oceanic particles as a mixture of recent surface production (phytoplankton/phytodetritus), metazoan feces, and microbially degraded material [3], [4]. Here, we assess – and aim to refine – the universality of this model, and other amino acid-based degradative indicators, by examining variation in the nitrogen isotopic patterns of amino acids across surface to mesopelagic depths, multiple size fractions of particles, and a range of oceanic sites. We examine additional in situ and climatological data to further characterize factors that can influence the interpretation of amino acid isotopic data, such as varying phytoplankton communities, productivity, and the concentrations and nitrogen isotope ratios of inorganic nitrogen. Within this context, we will discuss how additional results from the nitrogen and carbon isotopic analysis of amino acids can be normalized to local conditions and therefore contribute to a more refined comparison of organic matter composition and degradative pathways across the global ocean.

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