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Here we report a comprehensive analysis of small, polar metabolites in particulate organic matter from the North Pacific Subtropical Gyre across two sets of mesoscale eddies of opposing polarity at multiple depths. Given the importance of these features in altering the biogeochemistry of the open ocean and the associated planktonic community we expected to find changes in the molecular composition of the particulate organic matter produced, with implications for the fate of carbon exported to depth. We use both targeted and untargeted metabolomics to document how the enrichment of eukaryotic phytoplankton at the deep chlorophyll maximum of the cyclone is reflected in the composition of the organic matter produced and show that water contained in anticyclonic eddies has a biochemical signature similar to seawater collected from deeper in the water column. The compounds measured here mediate organism interactions that have consequences for community function and carbon export. We demonstrate the importance of using untargeted methodologies alongside searches for known compounds given that the signals most different across the eddy dipoles detected in this dataset were largely uncharacterized and place an emphasis on reproducibility by collecting an entirely separate set of data from a new location a year later for comparison. We believe that the novel and interdisciplinary nature of this work makes it a suitable candidate for publication in Frontiers in Marine Science alongside other marine microbial metabolomics manuscripts published here previously. (232 words)

Open ocean environments undergo significant variability in the form of mesoscale eddies. These circular ocean dipoles alter the biogeochemistry of the upper ocean by moving water both horizontally and vertically. This altered biogeochemistry results in an altered planktonic community composition and function by changing elemental stoichiometry and size structure of planktonic communities, with potential implications for carbon exported to depth. These changes also likely influence the composition of small molecules, or metabolites, produced within these communities.

Here we report a comprehensive analysis of small, polar metabolites in particulate organic matter from the North Pacific Subtropical Gyre across two sets of eddies of opposing polarity at multiple depths. We use both targeted and untargeted metabolomics to document how the enrichment of eukaryotic phytoplankton at the deep chlorophyll maximum of the cyclone is reflected in the composition of the organic matter produced and show that water contained in anticyclonic eddies has a biochemical signature similar to seawater collected from deeper in the water column. We also report the putative identification of several metabolites that have not been previously reported in the marine environment, specifically taurine betaine (N-trimethyl taurine) and threonine betaine (N-trimethyl threonine) and their relationship to common marine organisms. The compounds measured here mediate organism interactions that have consequences for community function and carbon export. We demonstrate the importance of using untargeted methodologies alongside searches for known compounds given that the signals most different across the eddy dipoles detected in this dataset were largely uncharacterized and place an emphasis on reproducibility by collecting an entirely separate set of data from a new location a year later for comparison.

Given our systems-level approach of linking metabolites to the taxonomy and biogeochemical shifts in the environment resulting from common oceanographic features, we believe this manuscript will appeal to the diverse readership of mSystems. This submission consists of a manuscript containing 5,500 words in the main text and 6 main text figures as well as 2 supplementary tables and 4 supplementary figures. All biogeochemical and metabolite data presented in the manuscript is available online and the manuscript itself has been implemented as a reproducible markdown document with code and scripts included available on GitHub.