Modeling Algal-Bacterial Mutualism in a Global Ocean: The Impact of Non-Trophic Interactions D. Rao[1] and M. J. Follows[2], [1] Massachusetts Institute of Technology and Woods Hole Oceanographic Institution (drao@mit.edu), [2] Massachusetts Institute of Technology (mick@ocean.mit.edu).

Introduction: Our search for life elsewhere in the universe begins at home, with our investigations to better understand the origin and evolution of life on Earth. It is well known that natural microbial communities are composed of a network of interactions that determines community composition and function. However, models of microbial communities often represent two modes of interactions: trophic and resource competition. Given that microbial consortia are the primary drivers of biogeochemical cycles in the ocean, it is crucial to develop representative models including a range of non-trophic interactions (NTIs) to understand their role in global elemental cycling. An important class of NTIs is the mutualistic exchange of organic resources that influence growth, for example vitamins. A unique case of such exchange is that of vitamin B12 and organic carbon. Only prokaryotes — bacteria and archaea — can produce vitamin B12, but it is an essential micronutrient for many eukaryotic phytoplankton, which exude organic carbon that the heterotrophic prokaryotes consume. In this study, we improve the representation of NTIs in the MIT Darwin Model to create a more comprehensive microbial ecosystem in a model ocean. The model includes phytoplankton competition for inorganic resources, zooplankton consuming phytoplankton, and mutualistic interactions between phytoplankton as an analog to vitamin exchange (i.e. B1, B6, B7 among phytoplankton). We examine the consequences of including NTIs jointly with trophic interactions in a multi-species phytoplankton consortia on community structure and biogeochemical function. This model is a starting point to studying the potential ways that vitamin (or any organic resource) exchange impacts microbial community connectedness, biogeography, and primary production. This new framework helps us explore the role of NTIs, which have largely been ignored in ecological, let alone, biogeochemical ocean models. Developing model frameworks that encompass the full range of ecological interactions can help us resolve the importance of NTIs (i.e. expanding the habitable range of the symbiotic pair) and their impact larger biogeochemical processes.

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