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Introduction to our on-going development of an adaptive model for plankton communities in the North Pacific

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This presentation will introduce our on-going efforts, as part of a CREST project funded by JST, to develop a new prototype model to represent the biodiversity and adaptive capacity of lower-trophic ecosystems in the North Pacific. The ultimate goal is to develop a computationally efficient representation of the community-level interactions of the producers (phytoplankton) and consumers (zooplankton) with each other and with the marine environment. This of course includes the adaptive response of plankton communities to changing environmental conditions, and later potential feedbacks, including for example the impact of plankton communities on controlling nutrient concentrations. We will present the size-based model of phytoplankton communities that is already under development and one scientific result already obtained, regarding the size-scaling of growth parameters, as commonly applied in large-scale models, in terms of the more commonly measured parameters for nutrient uptake kinetics. This scaling relationship provides a basis for consistently incorporating observed allometries into models based on Monod growth kinetics. This new simplified model of phytoplankton communities accounts for biodiversity via size-scaling of phytoplankton traits and for flexibility of the C:N ratio of biomass.

Fig. 1. Traits, which define how organisms respond to environmental conditions, have evolved subject to inescapable biophysical constraints. Thus have arisen trade-offs in competitive ability under different conditions, here illustrated for typical small phytoplankton adapted to low-nutrient, high-light conditions, which have high affinity (α), low maximum uptake rates (V_{max}) and relatively less allocation to chlorophyll/light harvesting ability, vs. large phytoplankton adapted to high-nutrient, low-light conditions, which have low α, high V_{max}, and relatively more allocation to chlorophyll/light harvesting ability. Maximum growth rate (μ_{max}) is constrained by the opportunity cost of allocating resources to the various processes necessary to support growth.

Keywords: plankton, ecosystem, model, traits, trade-offs, adaptive