Surface peaks of primary production during summer in the oligotrophic open ocean: a modeling study

*Bingzhang Chen[1], Sherwood Lan Smith[1]

1. Japan Agency for Marine-Earth Science and Technology

Classic understanding on the phytoplankton dynamics in the oligotrophic open ocean such as the central North Pacific gyre is that phytoplankton growth rate is limited by the upward supply of inorganic nutrients delivered largely by diffusion. Since nutrient supply mostly comes from below and light attenuates from surface to the depth, phytoplankton growth rate should peak at some intermediate depth, coinciding with the deep chlorophyll maximum (DCM) layer. However, examination on the data of net primary production (NPP) measured at two stations (ALOHA and S1) in the subtropical North Pacific reveals that NPP peaks within the surface mixed layer in spite of the negligible nutrient concentration at surface and a pronounced deep chlorophyll maximum (DCM) around 100 m. While the formation of DCM might be largely accounted for by phytoplankton photoacclimation (changes of chlorophyll-to-carbon ratios), the surface peak of phytoplankton growth rates suggests that the phytoplankton growth rate is not really limited by nutrient availability but could be light-limited. We developed a 1D model that couples ocean physics with two different kinds of ecosystem models (one species vs. two species of phytoplankton) built upon nutrient-phytoplankton-zooplankton-detritus (NPZD) plankton models. Model parameters were optimized by a Delayed Rejection Adaptive Monte-Carlo (DRAM) algorithm. Results suggest that the two-species model can better reproduce the vertical patterns of NPP. The implications are: 1) phytoplankton nutrient limitation may not be as severe as previously expected and light could play a more important role in controlling NPP in the oligotrophic open ocean; 2) phytoplankton diversity seems critical in faithfully reproducing NPP patterns.

Keywords: Primary production, Phytoplankton, community structure

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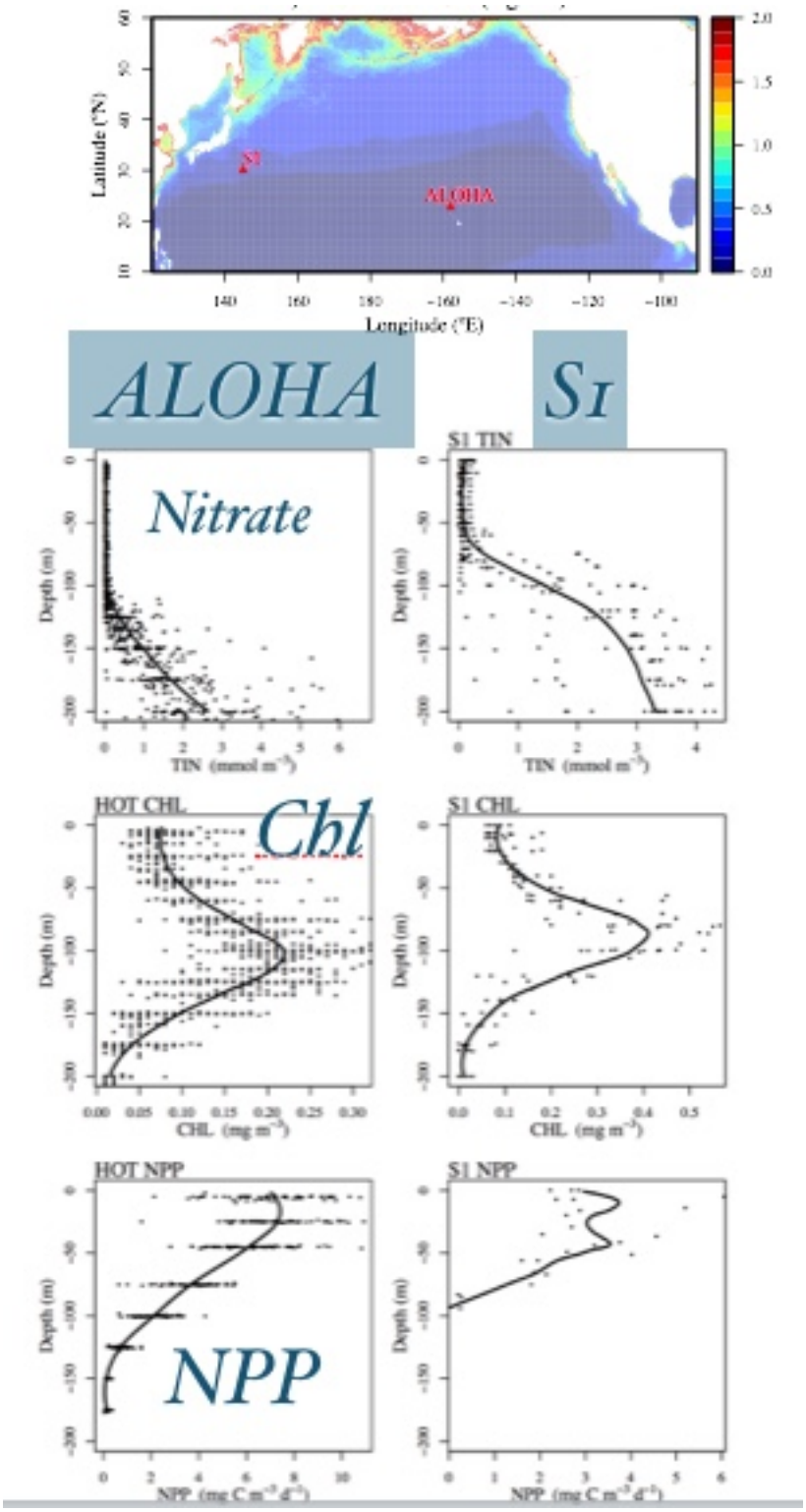

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