A Nitrogen-, Phosphorous- and Silicon-based Model of Primary Production and Export Applied to Station ALOHA: Can we get the model to agree with the data for primary production, DOM concentrations and POM flux?

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We have developed a one dimensional coupled biological-physical model, consisting of a marine ecosystem model based on the NEMURO formulation developed by the PICES program coupled to a Mellor-Yamada level-2 mixed-layer model. We plan to incorporate this model into global three dimensional simulations in the near future. But first, using this one dimensional implementation we aim to address some of the challenges of simulating the production and export of organic matter at several time series sites. This study simulates the Hawaii Ocean Time-series (HOT) Station ALOHA.

Because of the importance of N_2 fixation for supplying nitrogenous nutrients at this location (and in much of the ocean) we have modified the NEMURO formulation to include this process. To simulate the dynamics of diazotrophs (N_2-fixing organisms) and to account for the phosphorous limitation that is expected to result from the supply of nitrogen by N_2 fixation, we have added phosphorous and phosphorous-limitation to the model. We have also added a formulation for the cycling of Dissolved Organic Matter (DOM) via the microbial food web, which is particularly important at this location and others where most production is recycled.

To allow for the varying composition of organic matter, we simulate the concentrations of C, N, P, Si and $CaCO_3$ separately in each compartment (e.g., DOM) except for plankton, for which we apply constant (but distinct) stoichiometries. Using high frequency data for wind speed and solar radiation collected by the HALE-ALOHA buoy (University of Hawaii at Manoa), and data from the Station ALOHA time series (Hawaii Ocean Time series, HOT), we drive this model for 1997 and 1998. We compare the simulations to time series data for nutrients and organic matter from the HOT program.

In short simulations (a few years), the model is able to simulate the export of Particulate Organic Matter (POM) reasonably well (the annual average and some features of the seasonal cycle) and variations in its stoichiometry with depth (e.g., N:P ratio). Tuning the model to do this, however, produces primary production and DOM concentrations that are far too low (by roughly a factor of two). Furthermore, in longer simulations (10 to 100 years) nutrient trap-ping becomes a major problem and the simulated concentrations of nutrients below the euphotic zone are unrealistically high. Similar to what others have found in previous studies, tuning the model (especially the ratio of sinking rate to degradation rate of POM, termed the Remineralization Length Scale) to avoid the nutrient trapping problem results in erroneous simulations of export flux. We will discuss some of the challenges of consistently simulating primary production, DOM concentrations and POM export at Station ALOHA.