Modeling carbon to nitrogen and carbon to chlorophyll a ratios in the ocean at low latitudes: Evaluation of the role of physiological plasticity

Lefèvre, Nathalie, Arnold H. Taylor, Francis J. Gilbert, Richard J. Geider

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ABSTRACT: Simulation modeling provides a means for testing the limits of our quantitative understanding of the factors that control phytoplankton biomass, growth rate, and primary productivity in the sea. We simulated the annual cycles of chlorophyll *a* (Chl *a*) concentration, primary productivity, nitrogen export, phytoplankton carbon to nitrogen (C :N) and carbon to Chl *a* ratios (C : Chl *a*) using a physiological model of phytoplankton carbon, nitrogen, and Chl *a* dynamics. The model was embedded within a one-dimensional physical model of vertical exchanges that included simple mortality and recycling terms. A sensitivity analysis allowed evaluation of the relative effects of changes in phytoplankton physiology, physical forcing, mortality, and nutrient cycling on Chl *a* distributions and phytoplankton C: N. Critical to the success of the model was the treatment of mortality, which included seasonal (temperature) and depth-related components, and the treatment of recycling efficiency, which was considered to be a function of the inorganic nitrogen concentration. The subtropical simulation compared favorably with data obtained at the Bermuda Atlantic Time-series Study (BATS) station. Our results illustrate the utility of physiological data in validation of biogeochemical models. In particular, model predictions of phytoplankton C: Chl *a*, which ranged from 30 to 170 g C (g Chl *a*)$^{-1}$, compared well with direct estimates based on ^{14}C labeling of Chl *a*. However, predictions of phytoplankton C: N, which ranged from ~5-9 g C (g N)$^{-1}$, could not be verified because of lack of data. This range of C:N suggests a slight limitation of phytoplankton growth rates by nutrients in surface waters.

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