Internal wave effects on photosynthesis: Experiments, theory, and modeling

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Limnol. Oceanogr., 53(1), 2008, 339-353 | DOI: 10.4319/lo.2008.53.1.0339

ABSTRACT: Using field experiments and mathematical models, we tested whether internal waves enhance photosynthesis as they move phytoplankton through a nonlinear light field in situations where photosynthesis is light limited. Phytoplankton circulated at depths mimicking isotherm displacement for moderate wind speeds had elevated photosynthetic rates compared to static incubations. Experiments and modeling revealed that surface light variation due to cloud cover interacts strongly with the effects of internal waves and may have positive or negative effects o photosynthesis depending on the relative phase of internal wave displacement and light variatio The combined effects of internal waves and fluctuations in surface irradiance ranged from a 15% reduction up to a 200% enhancement. The distribution (sine wave vs. Gaussian) of the vertical displacement of internal waves is also important in determining the internal wave effect on photosynthesis. Internal waves in a wide variety of aquatic systems and with hourly to weekly periods show a strong potential for internal wave-induced enhancement of photosynthesis. The realization of this enhancement is dependent on characteristics of the internal waves, of algal photosynthetic response, and of variable surface light.