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Photoadaptation in a convective layer

David Farmer*, Craig McNeil

Institute Of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada, V8L 4B2

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Abstract

Measurements of Lagrangian trajectories acquired with neutrally buoyant floats in an upper ocean mixing layer during a five-day period of nearly cloudless and calm conditions, provide an opportunity for investigating the implications of photo-adaptation of phytoplankton exposed to varying light intensities as they traverse the water column in convective plumes. The predominant convective motions develop over night and persist through the morning until giving way to thermal restratification. Despite the paucity of observed trajectories, their essential characteristics are extracted and used to generate a large number of pseudo-tracks having characteristics similar to those measured at any given depth and time of day. A Monte Carlo simulation is run for a sample set of biological variables to identify predominant features of the production. For each pseudo-trajectory the production is calculated from a photo-adaptive model in order to identify primary features of the instantaneous and accumulated production. The simulation illustrates the way in which photo-inhibition can reduce production near the surface during the morning, developing a subsurface layer of increased production that progressively deepens to approximately 12 m at noon. The surface production is suppressed during the afternoon, but subsequently recovers as light levels drop below the photo-inhibition threshold. © 1999 Elsevier Science Ltd. All rights reserved.

1. Introduction

Photosynthesis in the ocean is a subtle and only partially understood function of available light. Over some range of illumination, photosynthesis can be expected to increase with light intensity. It is well known, however, that photo-inhibition constrains this process at higher light levels. Moreover, with sufficient light exposure, the

* Corresponding author. Fax: + 1-250-363-6798.
E-mail address: farmerd@dfo-mpo.gc.ca (D. Farmer)

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