Building a new database of photosynthesis parameters

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Introduction

There have been several efforts to collect primary production measurements from various oceans and seas under one umbrella. Noticeable recent effort was conducted by Mattei & Scardi (2021) in which the authors collected over 6000 in-situ measured primary production profiles from over the globe. Prior global dataset of photosynthesis parameters was published by Bouman et al. (2018). Historically, the pioneering, and arguably the best known effort was by Trevor Platt and his associates, which resulted in numerous photosynthesis versus depth and photosynthesis versus irradiance measurements. These experiments have historically formed the backbone for the formulation of mathematical models of primary production and to this day remain an invaluable resource for model development. Other well known sources are time series of primary production measurements at fixed stations, such as: Hawaii Ocean Time Series, Bermuda Atlantic Time Series, Cariaco Ocean Time Series and others. These time series stations are useful as model testing grounds and for detection of long term changes in primary production. Here we present ongoing work on data collection for model testing and development. Please visit www.photoclim.org for more information on theses activities and the PHOTOCLIM project.

Photosynthesis irradiance functions

We have accessed the historical archive from Trevor Platt and collaborators which consists of over 50 000 photosynthesis irradiance measurements. At present we are working on digitizing the entire dataset. Below is an example of a model data comparison for Bedford Basin 1975 dataset, which has 2500 experiments carried out.

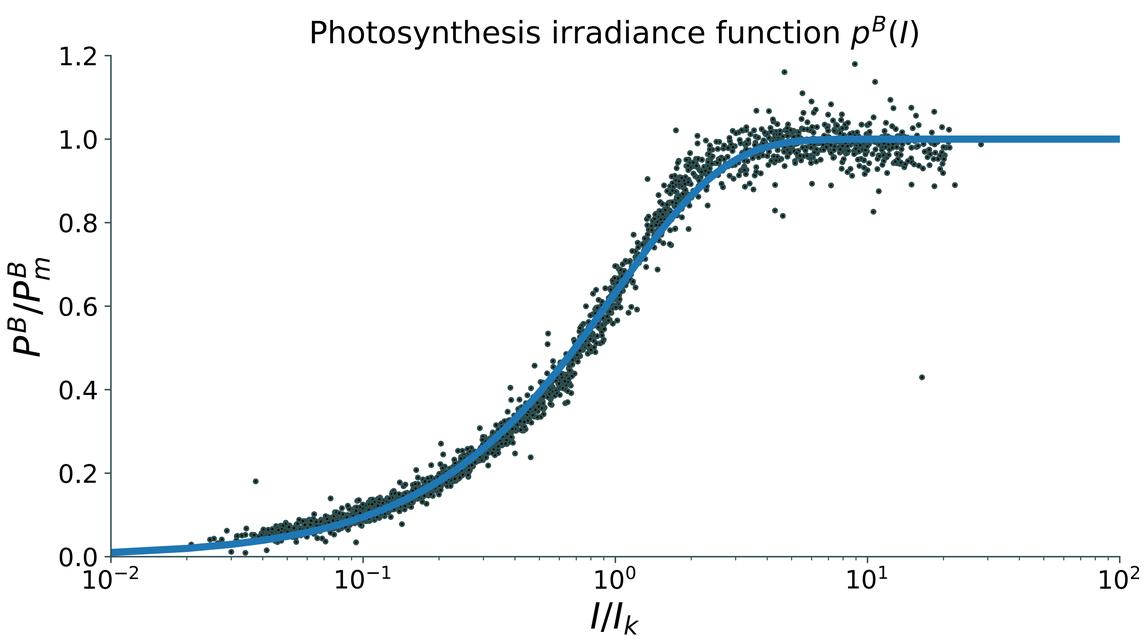

Figure 1: Normalized primary production measurements (black dots) compared to a photosynthesis irradiance function (blue curve). The plot is in log space to highlight the model versus data match at low and high irradiance equally.

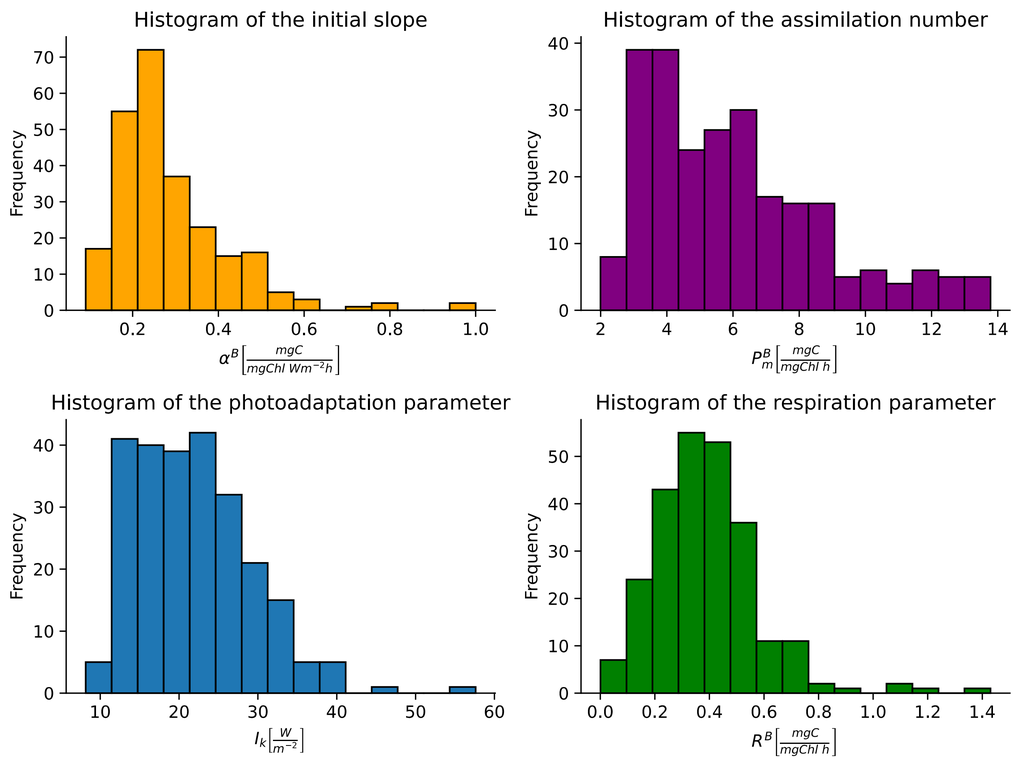

Figure 2: Histograms of the initial slope α^B, assimilation number P^B_m, photoadaptation parameter I_k and the respiration parameter R^B, obtained from the Bedford Basin 1975 dataset using the exponential photosynthesis irradiance function.

Time series of photosynthesis parameters

At present we are working on constructing time series of photosynthesis parameters estimated by inverse modelling from in situ time series of primary production. Here we show an example from the Hawaii Ocean Time Series. The time series is 34 years long and is arguably the longest time series of photosynthesis parameters available globally. We are currently working on applying the same methodology to Bermuda Atlantic Time Series and Cariaco Ocean Time Series stations.

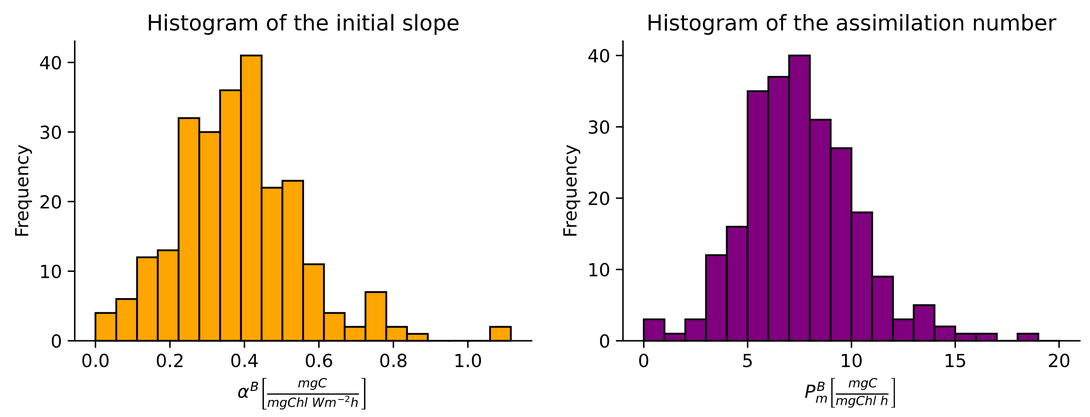

Figure 3: Histograms of the photosynthesis parameters, the initial slope α^B and the assimilation number P^B_m, estimated from measured daily primary production profiles and chlorophyll profiles at the Hawaii Ocean Time Series.

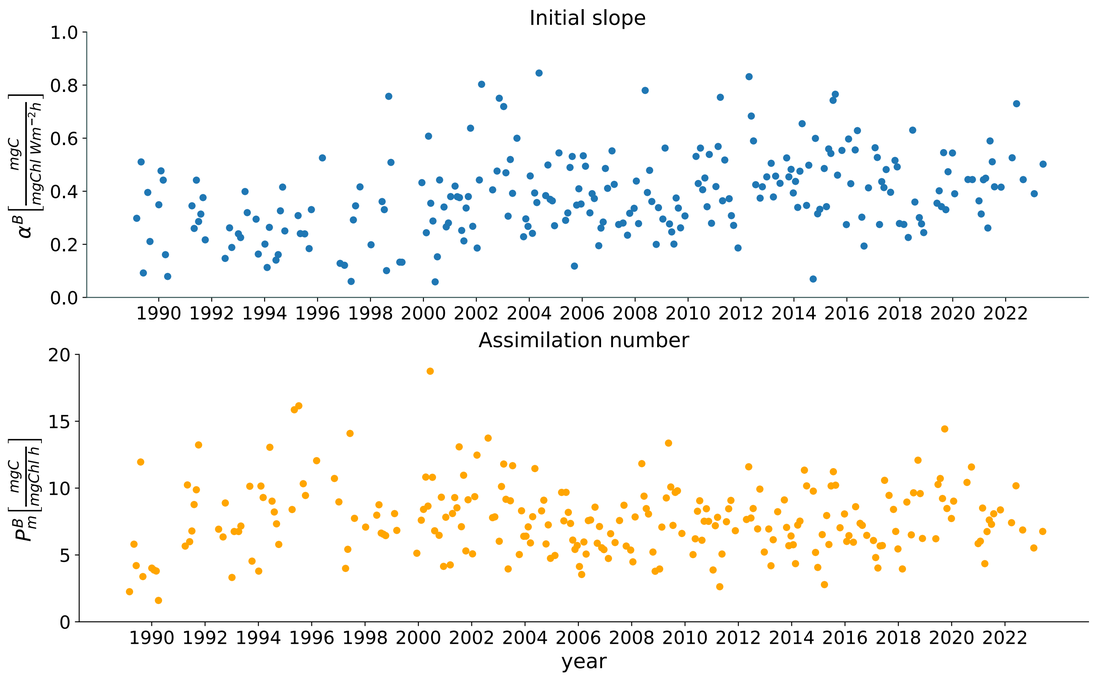

Figure 4: Time series of photosynthesis parameters, the initial slope α^B and the assimilation number P^B_m, estimated by inverse modelling from in situ primary production data at Hawaii Ocean Time Series.

New global dataset of photosynthesis parameters

We are also currently working on estimating photosynthesis parameters from a global dataset by Mattei & Scardi (2021). Below is a preliminary result on the global distribution of photosynthesis parameters. Please see the poster by Marija Bačeković Koloper et al. for more technical details.

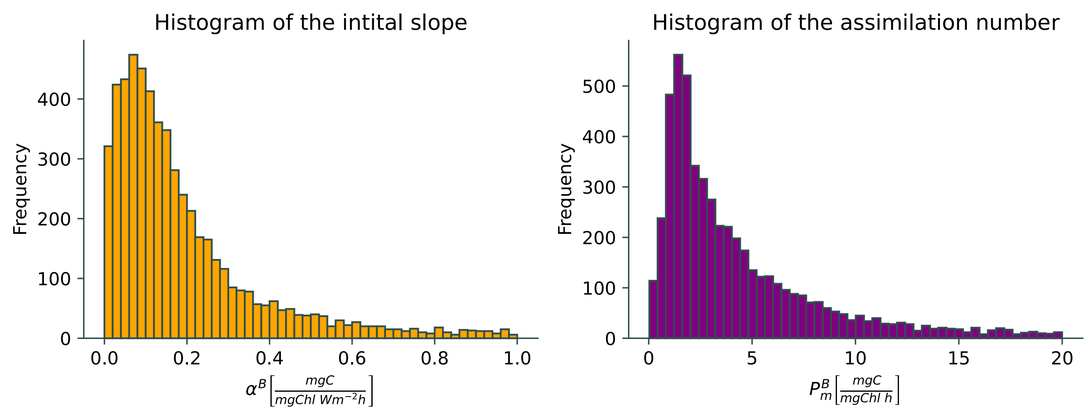

Figure 5: Histograms of the global photosynthesis parameters estimated from in situ production profiles from Mattei & Scardi (2021) dataset. The parameters were estimated using the exponential photosynthesis irradiance function.

References

Mattei, F., Scardi. M. (2021). Collection and analysis of a global marine phytoplankton primary-production dataset. *Earth System Science Data*, 13, 4967-4985. doi: 10.5194/essd-13-4967-2021

Bouman, H. A., Platt, T., Doblin, M., Figueiras, F. G., Gudmundsson, K., Gudfinnsson, H. G., Huang, B., Hickman, A., Hiscock, M., Jackson, T., Lutz, V. A., Melin, F., Rey, F., Pepin, P., Segura, V., Tilstone, G. H., van Dongen-Vogels, V., Sathyendranath, S. (2018). Photosynthesis–irradiance parameters of marine phytoplankton: synthesis of a global data set. *Earth System Science Data*, 10, 251-266. doi: 10.1594/PANGAEA.874087.