Phytoplankton primary production products

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BACKGROUND

Primary production by phytoplankton is a fundamental process underlying lake metabolism. The uptake, transformation and respiration of carbon (C) by phytoplankton in lakes contributes significantly to carbon transfer across the air-water interface and is thus an integral processes in regional and global carbon cycling.

There are several published models for the estimation of phytoplankton production from satellite-derived data, but these have been almost exclusively developed and validated using data from marine waters. In the INFORM project, we have tested and, where appropriate, adapted a number of satellite-based primary production models using data from a number of case study lakes.

METHODOLOGY

The efficacy of the vertical generalised production model (VGPM) first published by Behrenfeld and Falkowski (1997) for the estimation of gross primary production (PP) in Lake Balaton was assessed using model paramterisations based on *in situ* and satellite-derived inputs.

VGPM was modified according to Zhang et al. (2007; mVGPM) for application to shallow, turbid waters. Inputs to the model comprised surface chlorophyll concentration [mg m^{-3}], euphotic depth (Z_{eu} [m]), daily surface photosynthetically active radiation (PAR [µmols m^{-2} s^{-1}]) and an estimate of P^B_{opt} based on lake surface water temperature fields.

The full formulation of mVGPM is provided in Eq.1.

$$PP_{\,\mathrm{mVGPM}} = 0.66125 \times P^B_{\mathrm{opt}} \left[\frac{E_0}{(E_0+4.1)}\right] Z_{\mathrm{eu}} C_{\mathrm{opt}} D_{\mathrm{irr}} \quad [1]$$

DATA

The *in situ* data used to parameterise and validate the mVGPM model was obtained during a sampling campaign at Lake Balaton in 2010. Primary production was measured at 23 stations across the lake via photosynthesis-irradiance incubations in a photosynthetron. Satellite inputs to mVGPM were derived from MERIS FRS and AATSR data concurrent to the lake sampling campaign (Fig 1.).

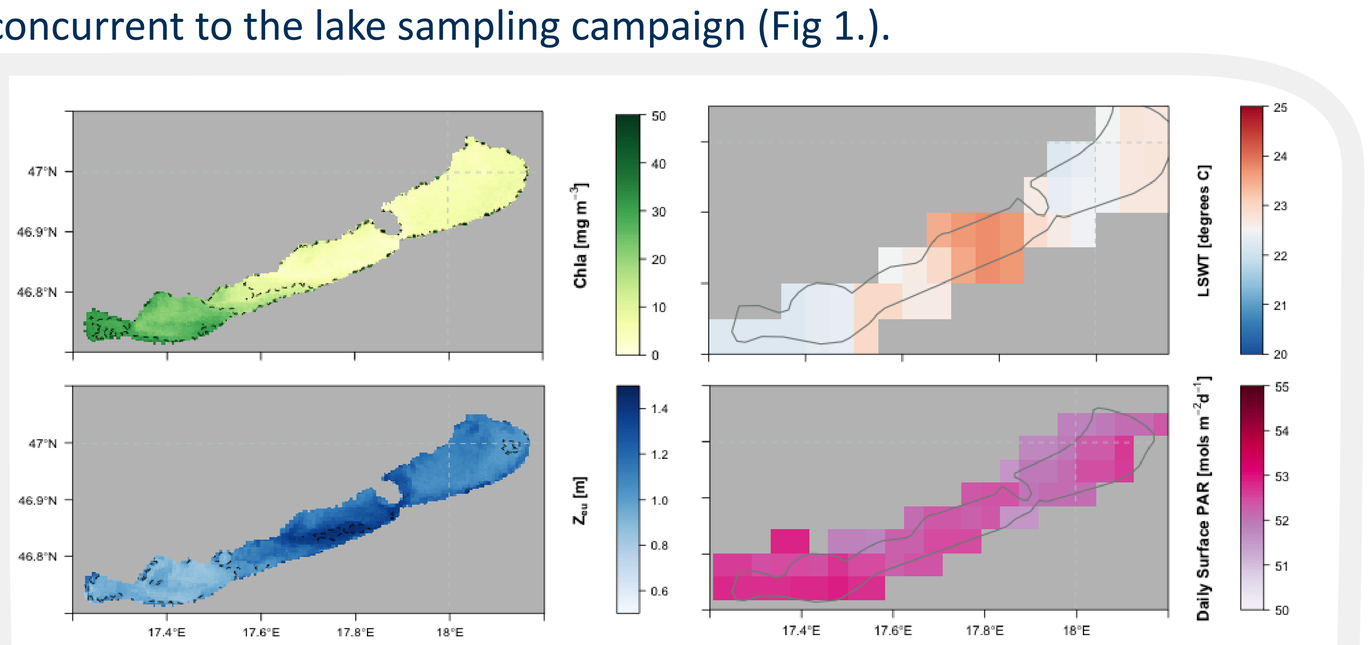


Fig.1. Examples of the satellite data inputs to the mVGPM primary production model for 22 Aug 2010. Top-left to bottom-right: surface chlorophyll-*a*; lake surface water temperature; euphotic depth; daily surface PAR.

PRIMARY PRODUCTION VALIDATION

The preliminary primary production product from mVGPM demonstrated good quantitative agreement with the primary production rates measured during the photosynthesis-irradiance incubations (R^2=0.75, logRMSE=0.30; MAPE=42%; see Fig. 2).

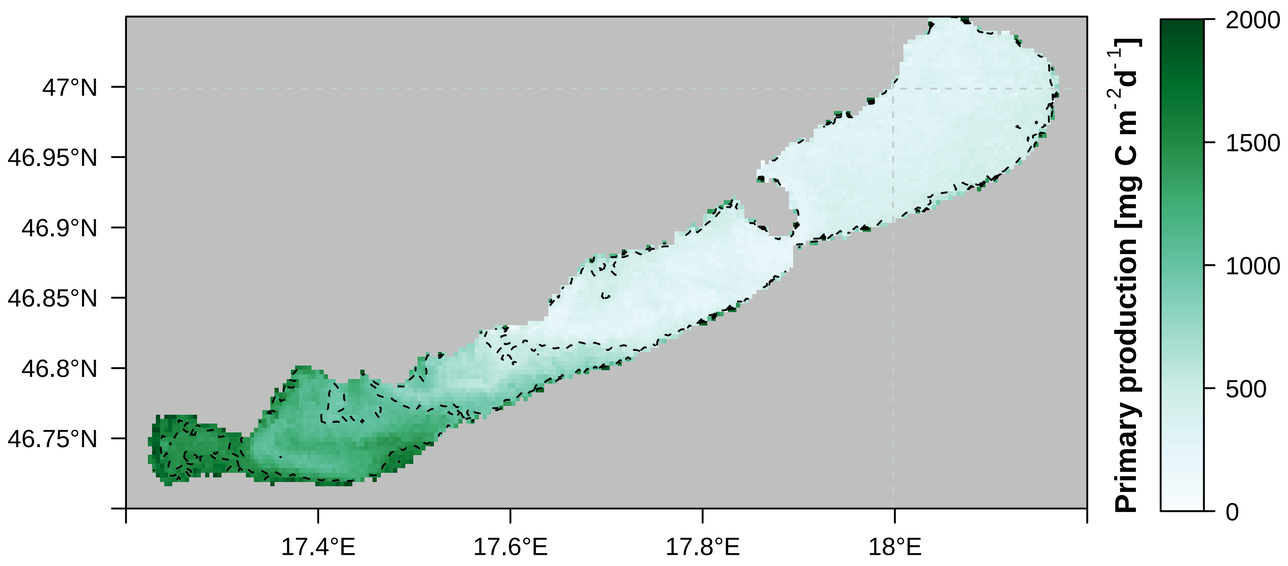
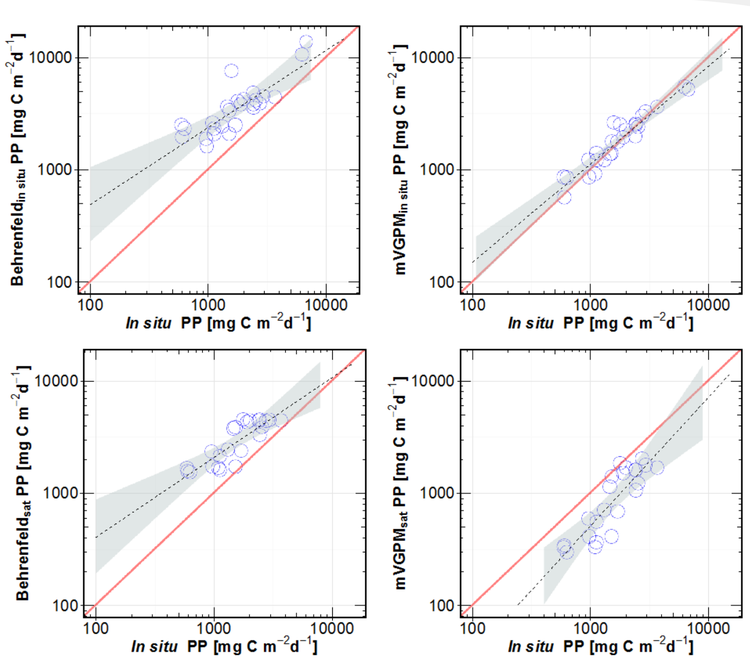


Fig.2. (Above) Example of satellite-derived primary production for Lake Balaton on 22 Aug 2010 from the mVGPM showing productivity declining along a trophic gradient from west to east. (Right) Comparison between measured and satellite derived primary production in Lake Balaton for the 2010 sampling campaign.



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