A Bio-optical Modelling Study of Inland Waterbodies of the Western Cape, South Africa

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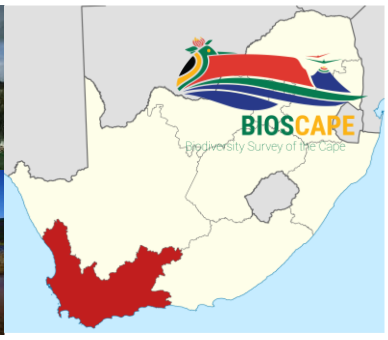
Introduction



Rationale: Globally, high-quality in situ bio-optical measurements of optically complex aquatic environments remain limited, yet they are crucial for the parameterization and calibration of optical models and datasets essential for remote sensing applications in these contexts. During November 2023, the BioSCape campaign in the Western Cape, South Africa, facilitated the acquisition of a comprehensive array of synchronized biogeochemical data, inherent optical properties (IOP), and hyperspectral radiometric measurements across four biologically and optically diverse inland water sites.

Study Aim: Evaluate different Hydrolight radiative transfer models, using a variety of input combinations that include both pre-existing IOP models and in situ measurements, to determine the most effective approach and model combinations for characterizing and replicating the environmental conditions of our study sites.

Methods

Measured and modelled IOPs (absorption and scatter) were input into Hydrolight with the measured constituent concentrations. The output modelled reflectances was compared to in situ measurements to determine the accuracy of the modelling methods. The uncertainties between different measuring techniques were exposed through these optical closure experiments.

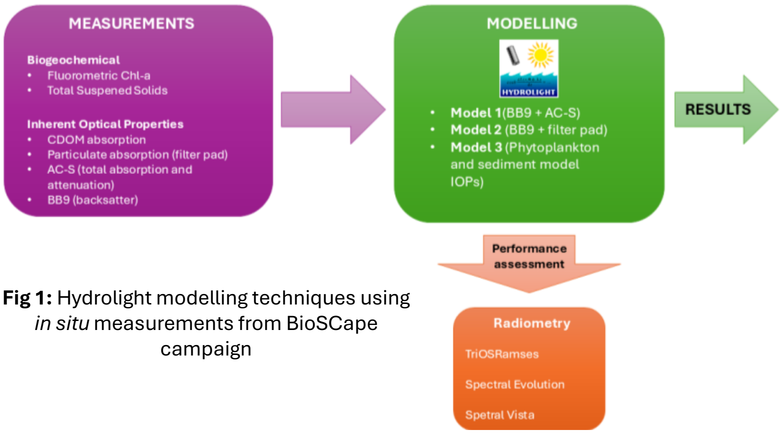


Fig 1: Hydrolight modelling techniques using *in situ* measurements from BioSCape campaign

Model 1: The BB9 chi-factor adjustments were required for highly scattering waters.
Model 2: Filter pad absorption was combined with CDOM measurements to capture the total absorption.
Model 3: In Zeekoevlei the equivalent algal population model for *A. Microcystis* IOPs was combined with mineral models from Hydrolight scaled to their respective Chl-a and a portion of the suspended matter concentration. However, the mixed phytoplankton assemblage IOPs performed better with scaling the mineral IOPs with the whole suspended matter for Theewaterskloof.

Results

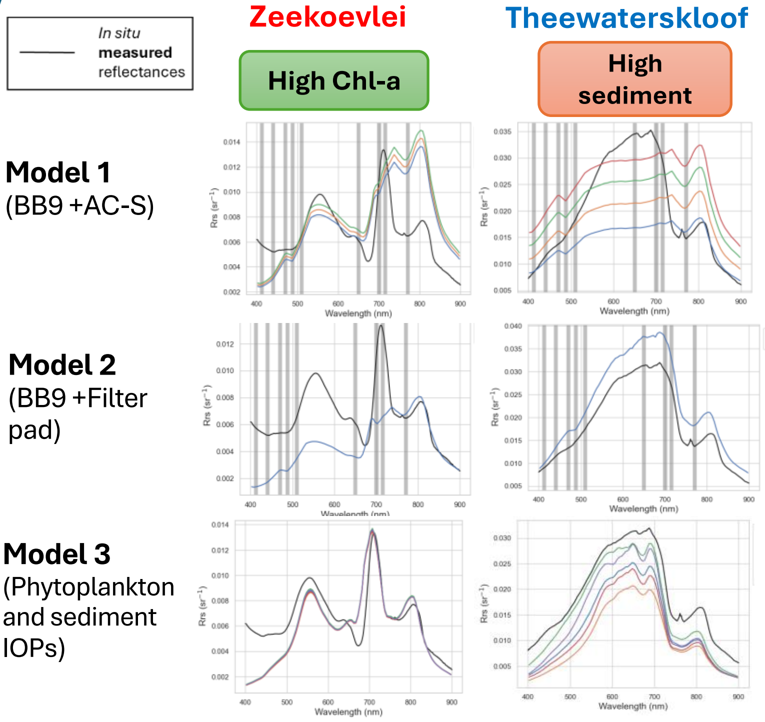


Fig 2: Performance assessment results from different models.

Findings: For most sites, filter pad and modelled IOPs were able to model the water-leaving refelctances for high sediment and Chl-a Inland waterbodies. We can use pre-existing models to represent the outcoming reflectances in this region.

Future work

Extract airborne and satellite match-up data → Model the atmosphere → Develop **a synthetic dataset** of the natural inland water-leaving reflectances → **Train deep learning models** with a dataset where the uncertainties are characterised

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References: 1) Robertson Lain, L., Bernard, S., & Evers-King, H. (2014). Biophysical modelling of phytoplankton communities from first principles using two-layered spheres: Equivalent Algal Populations (EAP) model. *Optics express*, *22*(14), 16745-16758.
2) Lain, L.R., Kravitz, J., Matthews, M. and Bernard, S., 2023. Simulated inherent optical properties of aquatic particles using the equivalent algal populations (EAP) model. *Scientific Data*, *10*(1), p.412