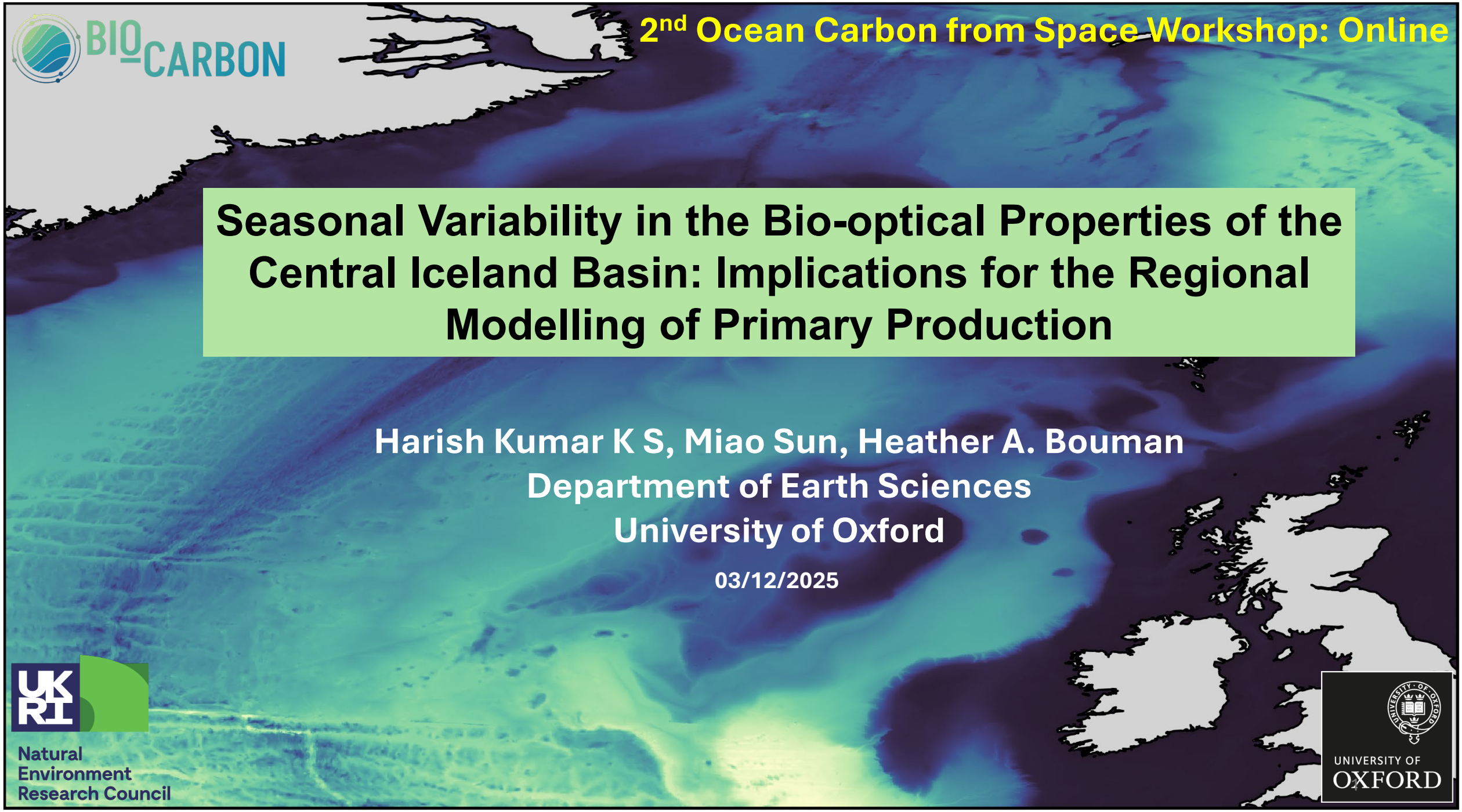
BIO CARBON
2nd Ocean Carbon from Space Workshop: Online
Seasonal Variability in the Bio-optical Properties of the Central Iceland Basin: Implications for the Regional Modelling of Primary Production
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03/12/2025
UKRI
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Greenland

Iceland

United Kingdom

Why Primary Production Matters?

- Oceanic primary producers convert CO_2 into organic matter.
- Accounts for ~50% of global net primary production.
- Regulates ocean–atmosphere carbon exchange.

Why Focus on the Central Iceland Basin?

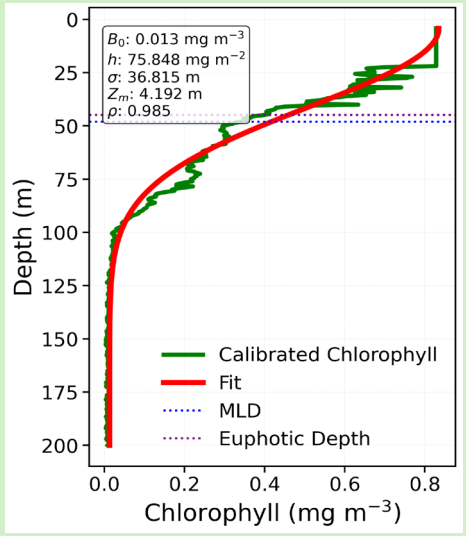
1. Biogeochemical Importance

- One of the **most productive** regions in the subpolar North Atlantic.
- Spring blooms drive intense biological carbon fixation & export (biological pump).
- Major contributor to the **North Atlantic carbon sink**.

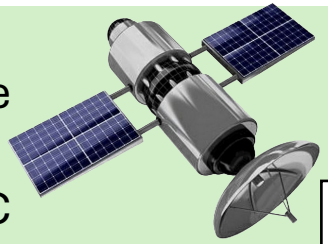
2. Dynamic Physical Environment

- Alternates between **deep winter mixing** and **shallow summer stratification**.
- Rapid seasonal shifts in **light, nutrients, and mixing depth**.
- These environmental changes drive strong variability in **bio-optical properties**.

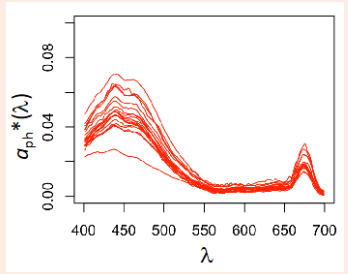
Spectrally Resolved Primary Productivity Model



Fluorescence profiles from CTD and BGC Argo

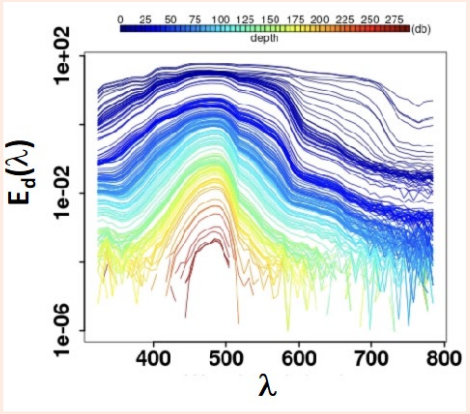


Surface Irradiance



Biomass (Chlorophyll)

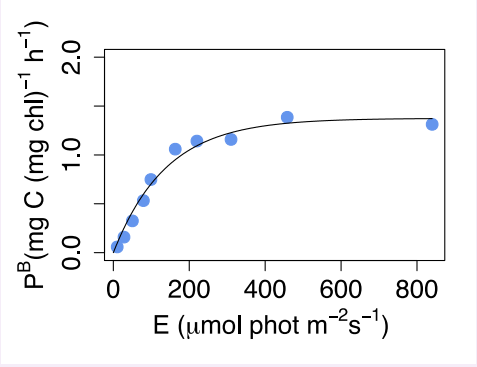
Light Penetration Model



Water-column irradiance

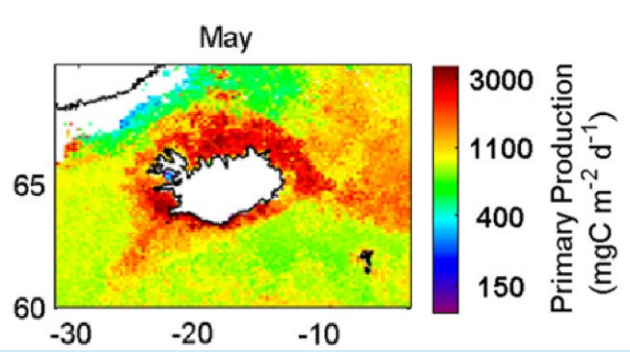
Photosynthesis-irradiance experiments conducted on both spring and autumn cruises.

Photosynthetic Parameters



Photosynthesis Light Model

Water-column Primary Production



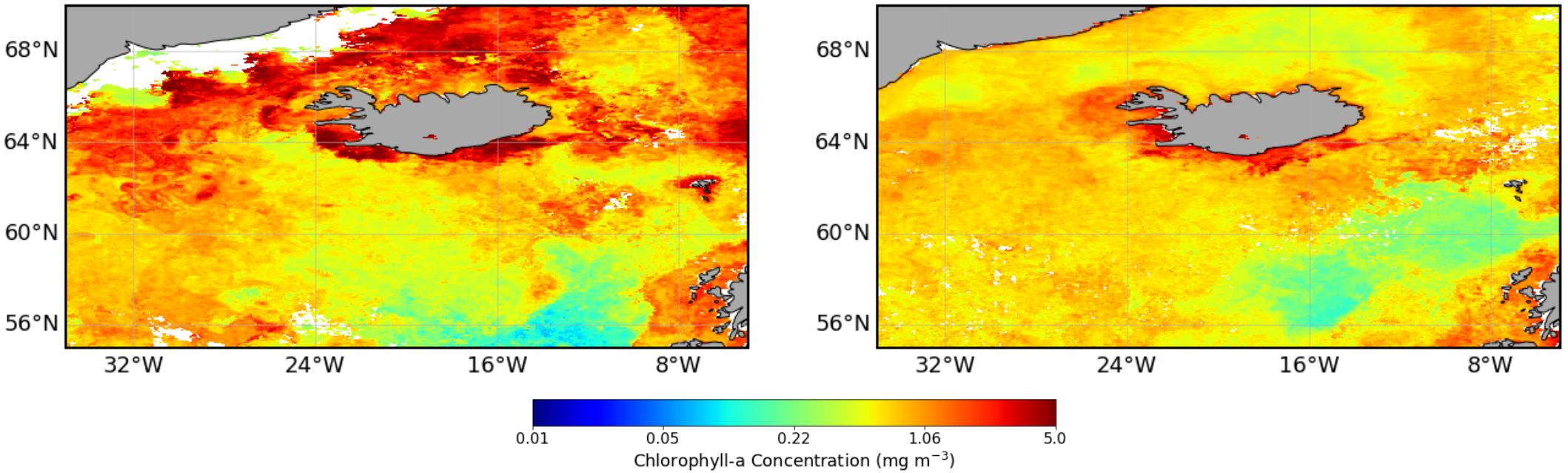
Seasonal Contrast in the Iceland Basin

Spring Cruise: DY180

OCCCI Daily Composite Products (1 km resolution): 26 May – 22 Jun 2024

Autumn Cruise: JC269

OCCCI Daily Composite Products (1 km resolution): 09 Sep – 01 Oct 2024



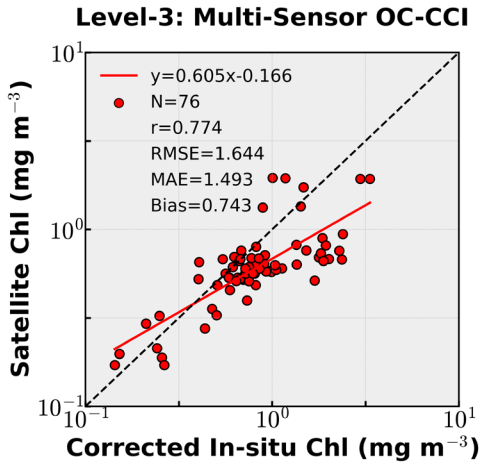
Spring Cruise:

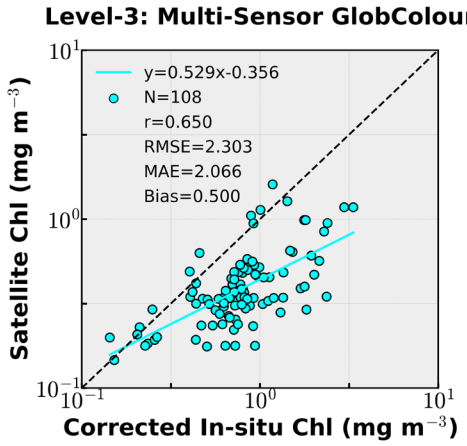
- High chlorophyll-a concentrations to the north.
- Regional blooms of coccolithophores.
- Indicates active spring bloom
- MLD is **shallow and spatially variable**, typically <~20-40 m

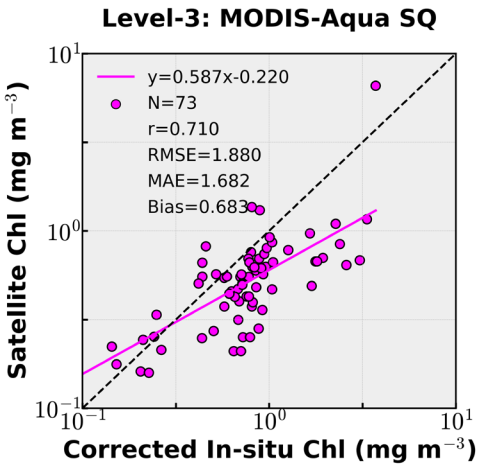
Autumn Cruise:

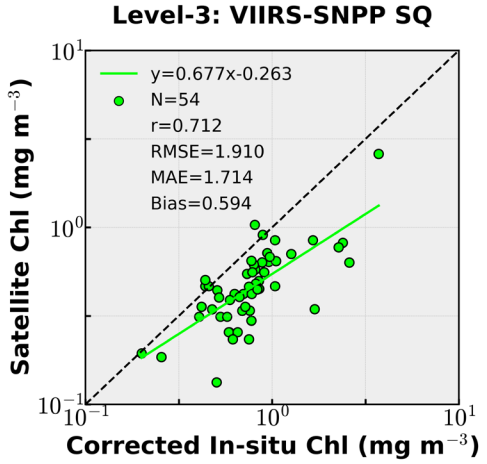
- Low chlorophyll-a concentrations in Central Iceland Basin
- Mixed assemblage
- Patchy elevated values near shelf and frontal zones
- MLD is **deeper and more stable**, ranging from ~40–60 m

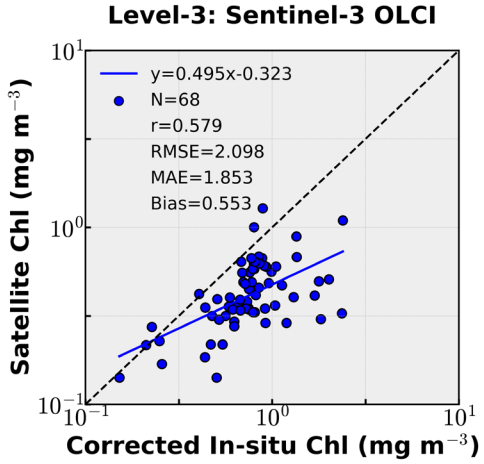
Comparison between *in-situ* Chl-*a* and Level-3 Satellite Ocean Colour Data Products

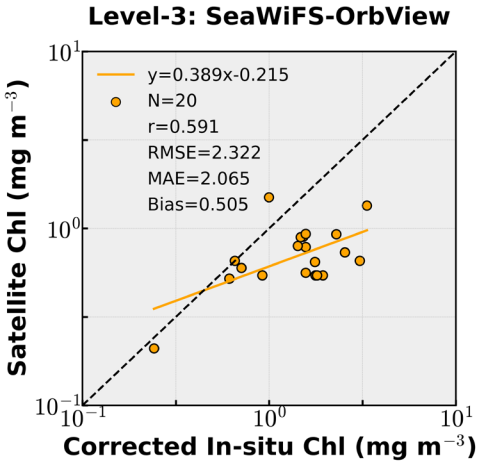








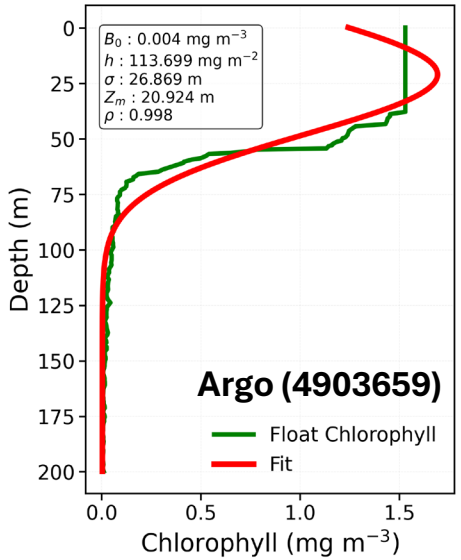




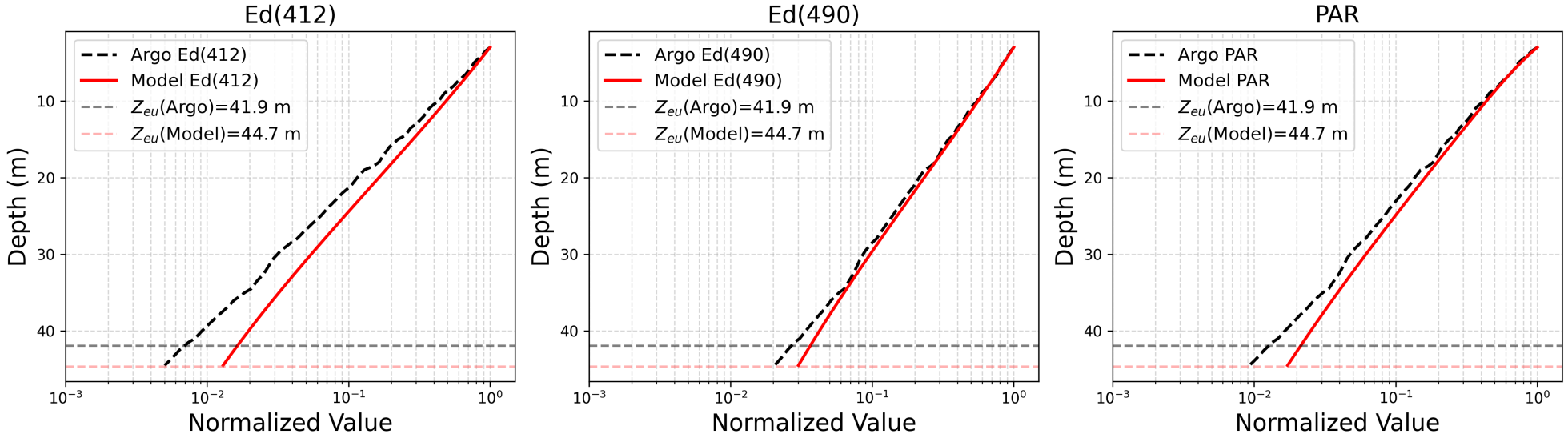
- ***In-situ* fluorometric chlorophyll-a** measurements have been **calibrated against HPLC chlorophyll-a** concentrations.
- All sensors show consistent underestimation of in-situ Chl-a.

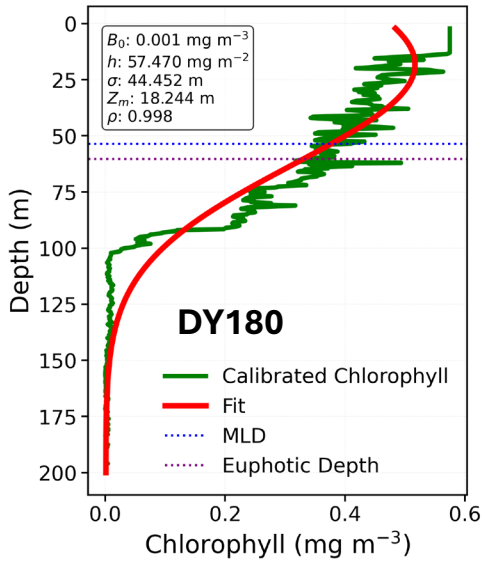
Vertical Biomass Distribution & Spectral Light Model

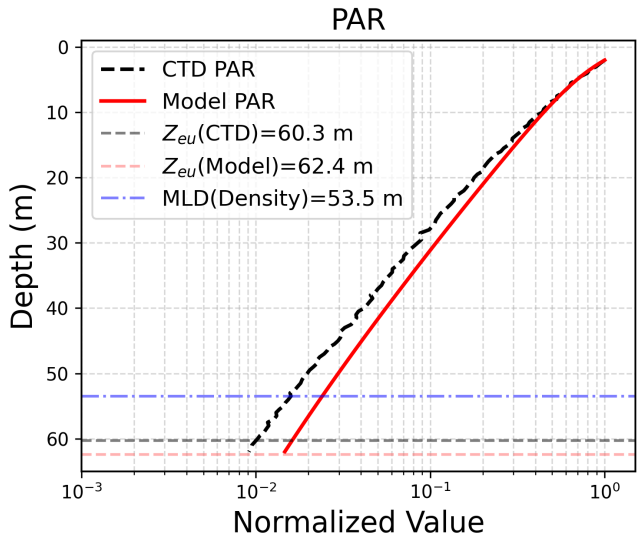
Biomass Profile



Spectral irradiance & PAR profile normalised to surface (max) values

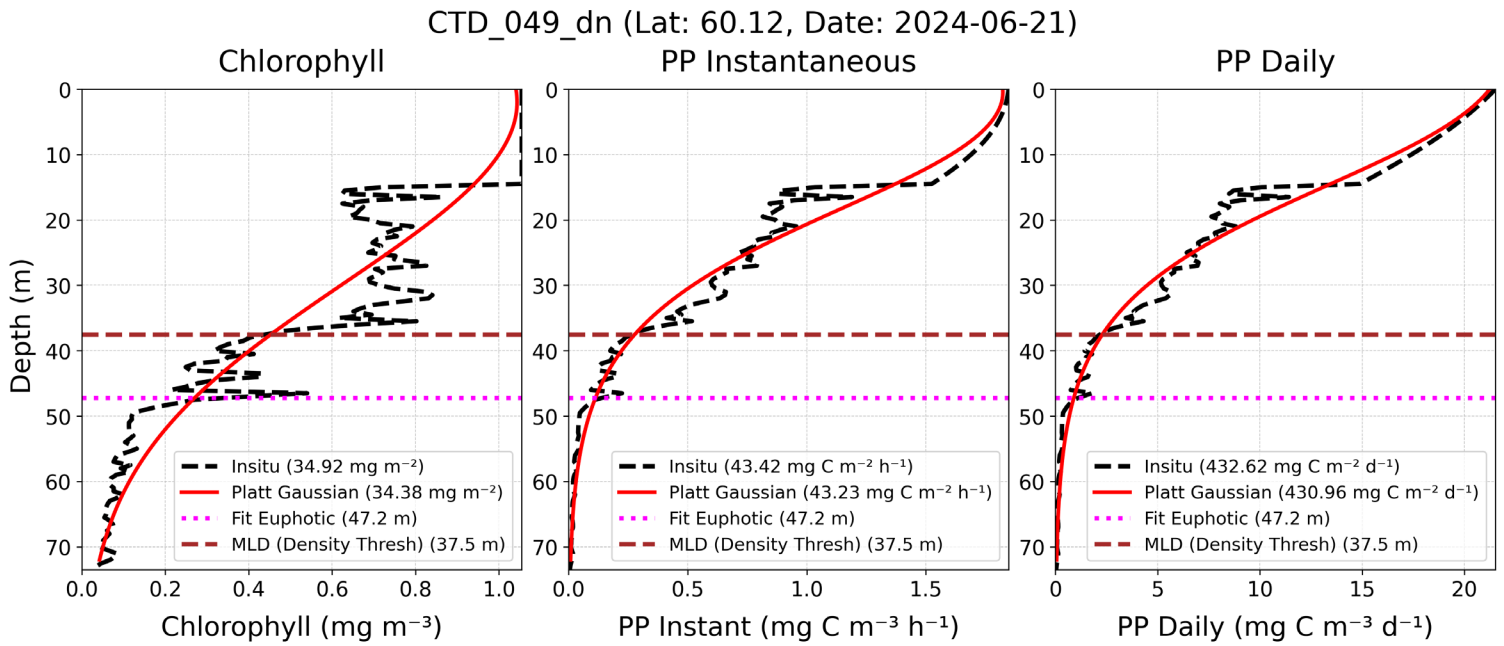






- Observed irradiance (Ed, PAR) **attenuates faster than model.**
- Exploring the role that CDOM, detrital absorption and coccolithophore **backscattering** may play in this divergence.

Implications for Regional PP Modelling



Satellite Chlorophyll

- OC-CCI underestimates in-situ Chl-a in the Iceland Basin.
- Bias present in both cruise periods → not strictly seasonal.

Vertical Biomass Structure

- The shifted gaussian profile captured the vertical distribution of chlorophyll reasonably well.
- Estimates of euphotic depth and primary production similar to that using high resolution in situ data.

Spectral Light Field

- Observed $E_d(412)$, $E_d(490)$ and PAR attenuated faster than model predictions.
- Regional tuning of model for CDOM, NAP and coccolith scattering may be necessary.

Knowledge Gaps

- Vertical Chl-a structure shows strong spatial and seasonal variability. BGC Argo data to be used to assign vertical profile parameters on a pixel-by-pixel basis.
- Sparse winter optical and primary production (α, P_{max}) data in the Central Iceland Basin.
- Uncertain contributions of CDOM, NAP, and coccolithophore backscattering to light attenuation.

Short-Term Priorities

- Quantify how satellite Chl-a underestimation propagates into PP bias.
- Improve vertical Chl-a profile parameterisation using ship-based and BGC-Argo data.
- Examine changes in IOPs (CDOM, NAP, phytoplankton) to improve light propagation model.
- Build a multi-season matchup dataset (in-situ, satellite, BGC-Argo) to get a robust picture of seasonal cycle.
- Use above information to test and refine a **regionally tuned spectral PP model** for the Iceland Basin.

Medium/Long-Term Priorities

- Implement **operational assignment of biomass and photosynthesis-irradiance parameters to PP models**.