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DALHOUSIE UNIVERSITY

# Net Primary Production (NPP) and Net Community Production (NCP) in the Center Labrador Sea

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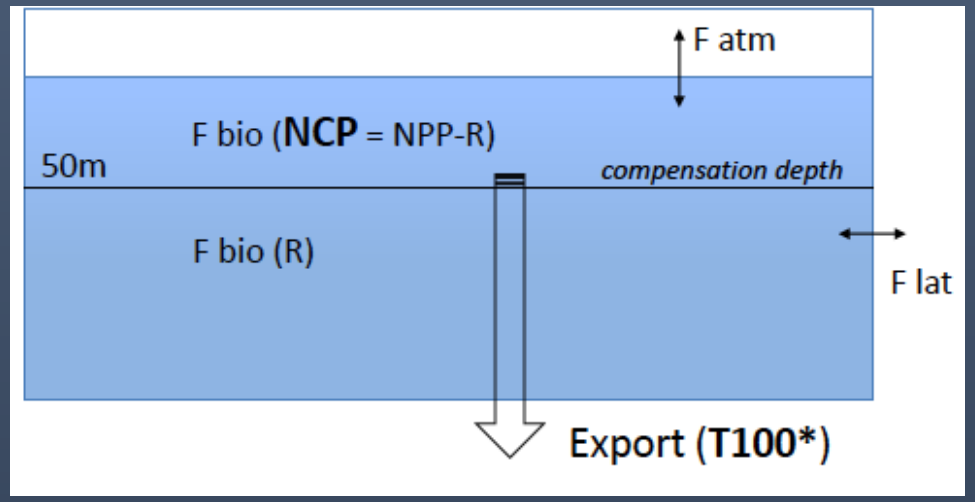
SCRIPPS INSTITUTION OF OCEANOGRAPHY

Ventilation Interactions and Transports Across the Labrador Sea

OCEAN FRONTIER INSTITUTE

# Biological Carbon Pump: NPP & NCP

- Gross Primary Production (GPP) : organic carbon produced from photosynthesis process by primary producer
- Autotrophic Respiration($R_A$): loss of organic carbon due to respiration by phytoplankton
- Heterotrophic Respiration ($R_H$): loss of organic carbon due to respiration by heterotrophs

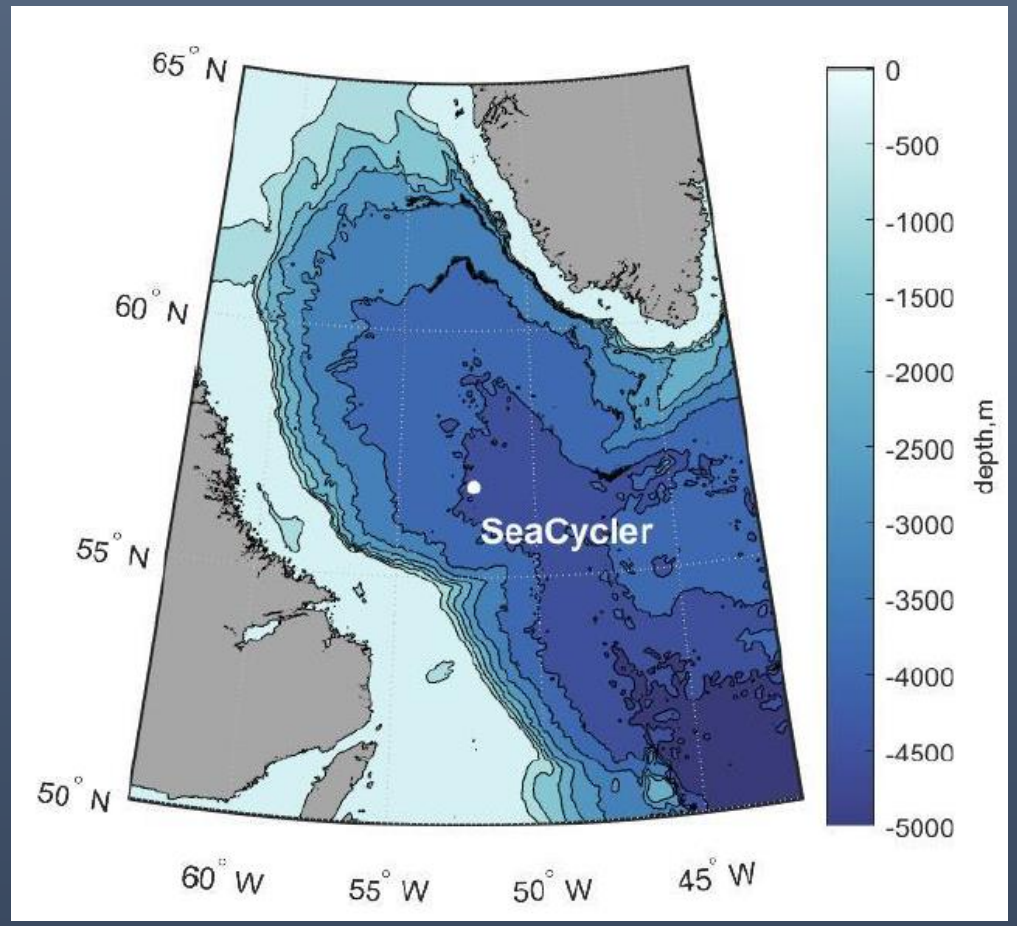



(Atamanchuk et al., 2020)

Net Primary Production (NPP) = GPP – $R_A$

Net Community Production (NCP) = GPP – ($R_A$ + $R_H$)
= NPP – $R_H$

# NPP & NCP in the Labrador Sea




(Atamanchuk et al., 2020)

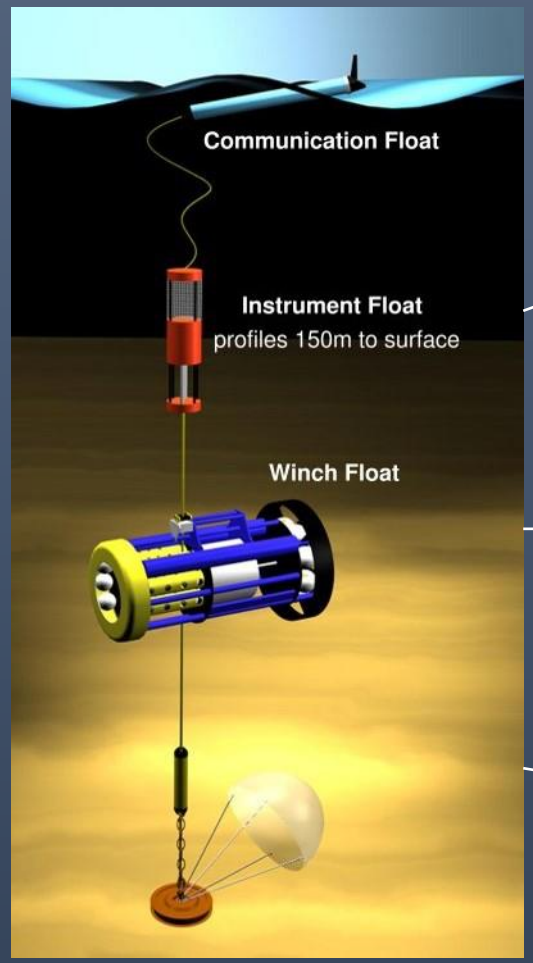
## Motivation

- Biological carbon pump (export production) is one of main carbon export to the deep ocean
- BCP is directly link to NPP and NCP
- The constraints on NPP and NCP are not well understood, especially *mixed-layer depth* and *seasonal cycle*, but essential to understand bloom development and maintenance.

- Increasing autonomous measurements but comparison between platforms is uncommon
- Lack of high resolution *in situ* data for validation (Strutton et al., 2011)
- Understand the implication of climate change to the efficiency of the biological carbon pump

# Deep Sea Moored Profiler - SeaCycler

New high-resolution continuous observations of surface and subsurface biogeochemical properties (oxygen, pCO2, nitrate, Chla, biooptics, etc) of seawater in the central Labrador using the SeaCycler platform (2016-2017).




(Atamanchuk et al., 2020)

**Sensor Float with 13 sensors (incl. redundant sensors for oxygen and pCO2)**

- **O2 and pCO2: air-sea exchange;**
- **O2, pCO2 and nitrate: biological productivity and export;**
- **FLBBCD, Ed490, transmissometer: productivity;**
- **current meter: transport and mass export;**
- **CTD: MLD, supporting data.**

**Mech Float at 150m**

- **Acoustic Doppler Current Profilers (ADCPs), O2, pCO2, CTD.**

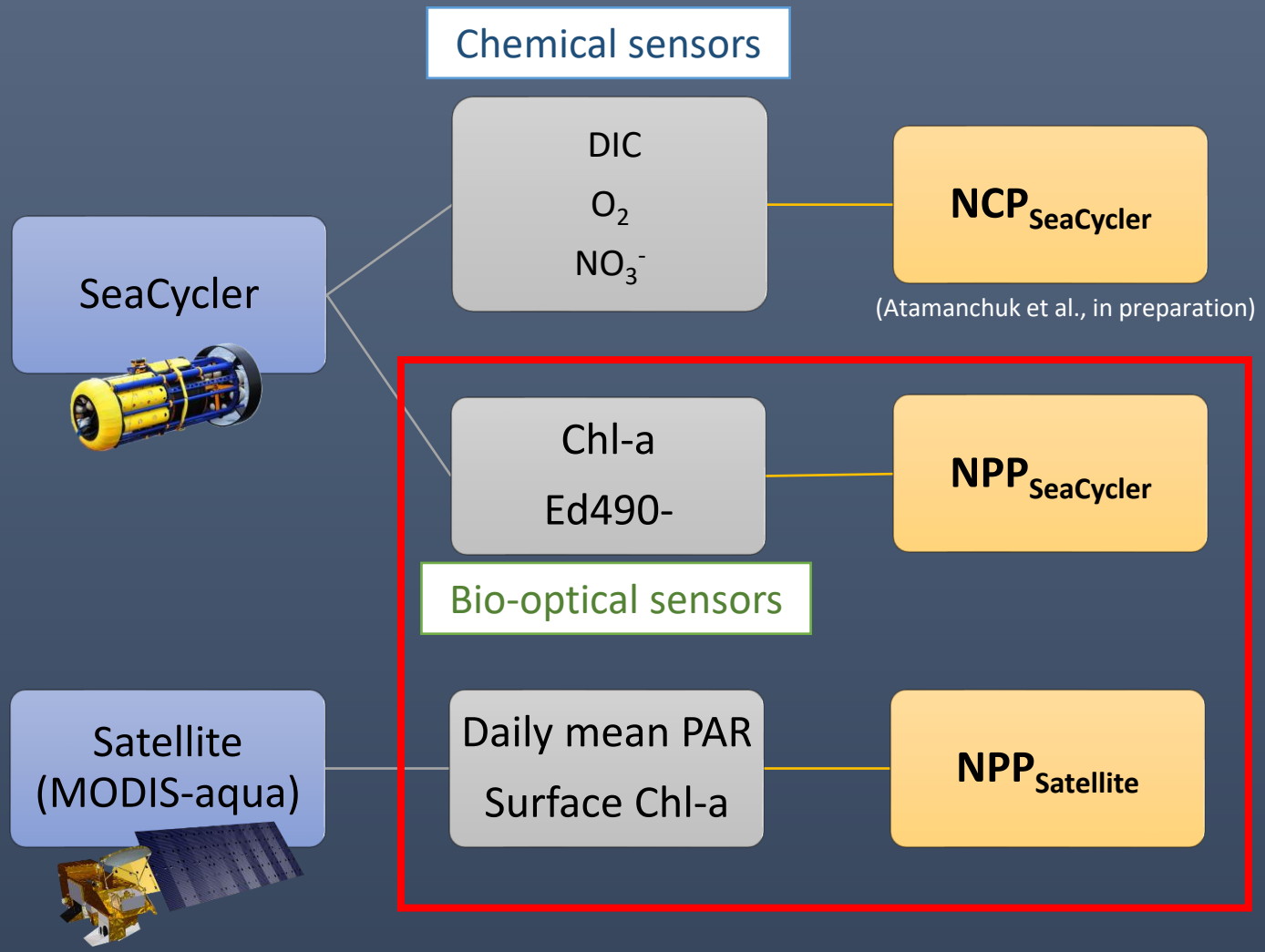
**Lower mooring:**

- **ADCPs: transport, particle export, Zbub.**
- **CTD-DO: deep convection, oxygen export, ocean respiration, stratification.**

# My Project: NPP & NCP comparison

**Goals:**

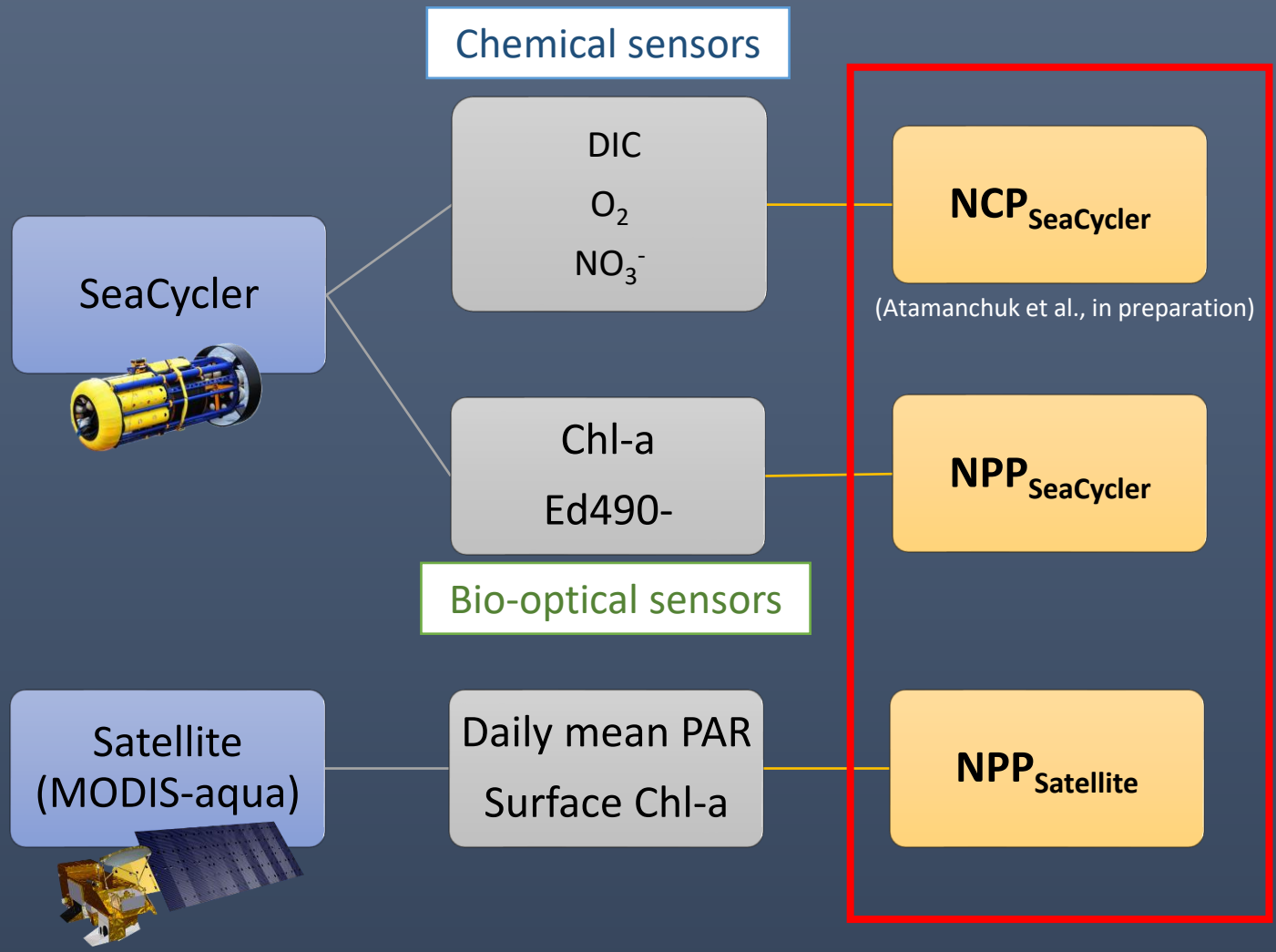
1. **Estimate two sets of NPPs from *in situ* and remotely sensed bio-optical parameters using a 1-dimensional primary production model**



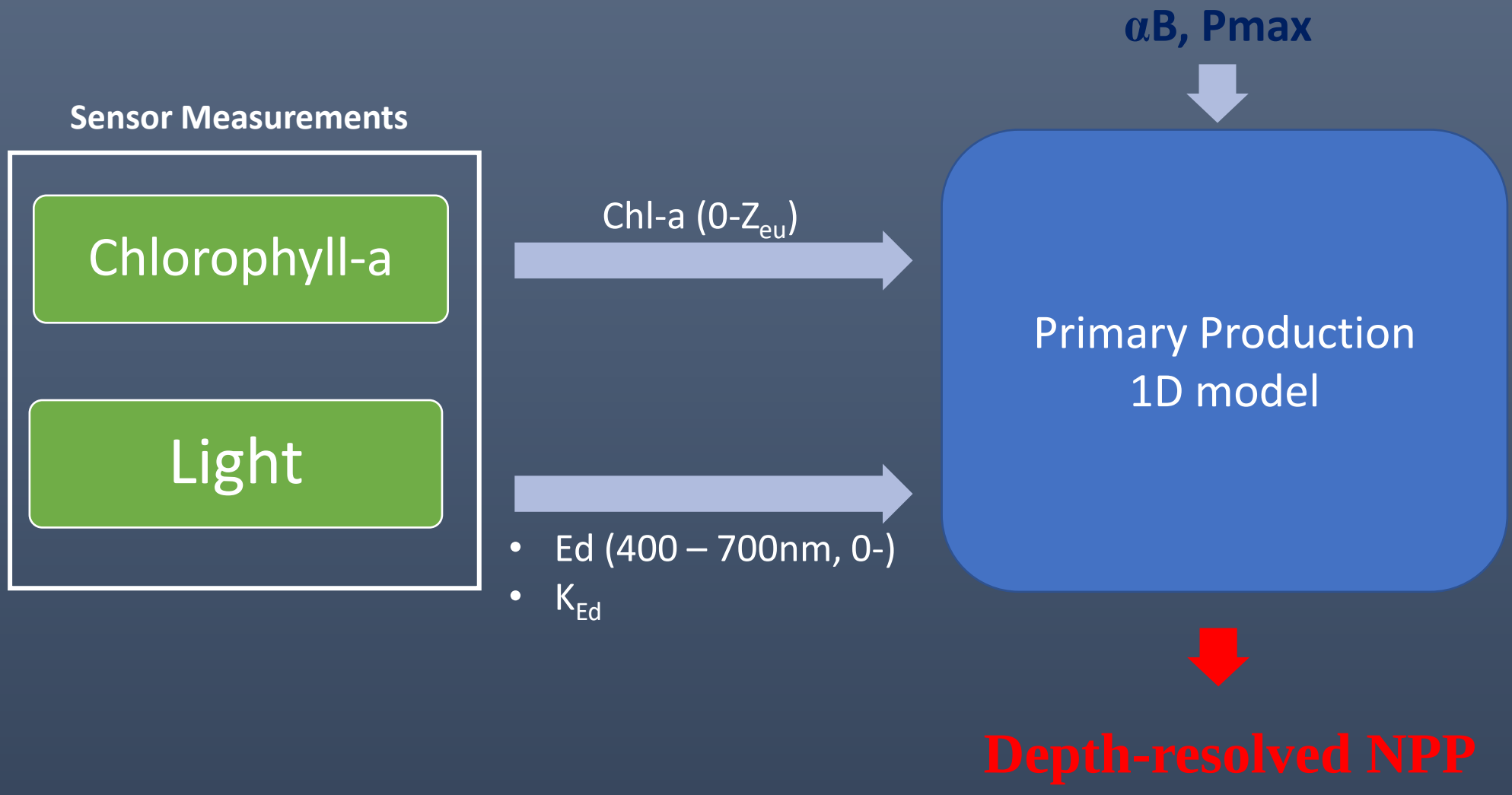
# My Project: NPP & NCP comparison

**Goals:**

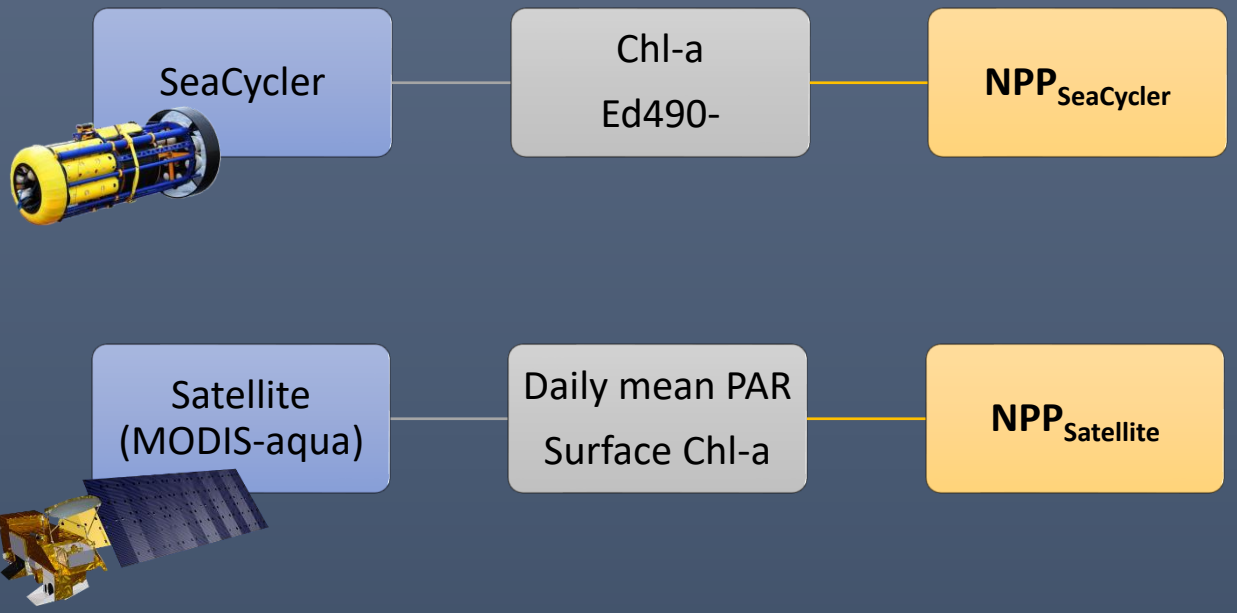
1. **Estimate two sets of NPPs from *in situ* and remotely sensed bio-optical parameters using a 1-dimensional primary production model**
2. **Compare NCP and NPPs**
   a) Magnitude
   b) Seasonal Cycles
   c) Dependency on controlling factors (e.g. Mixed-Layer Depth)

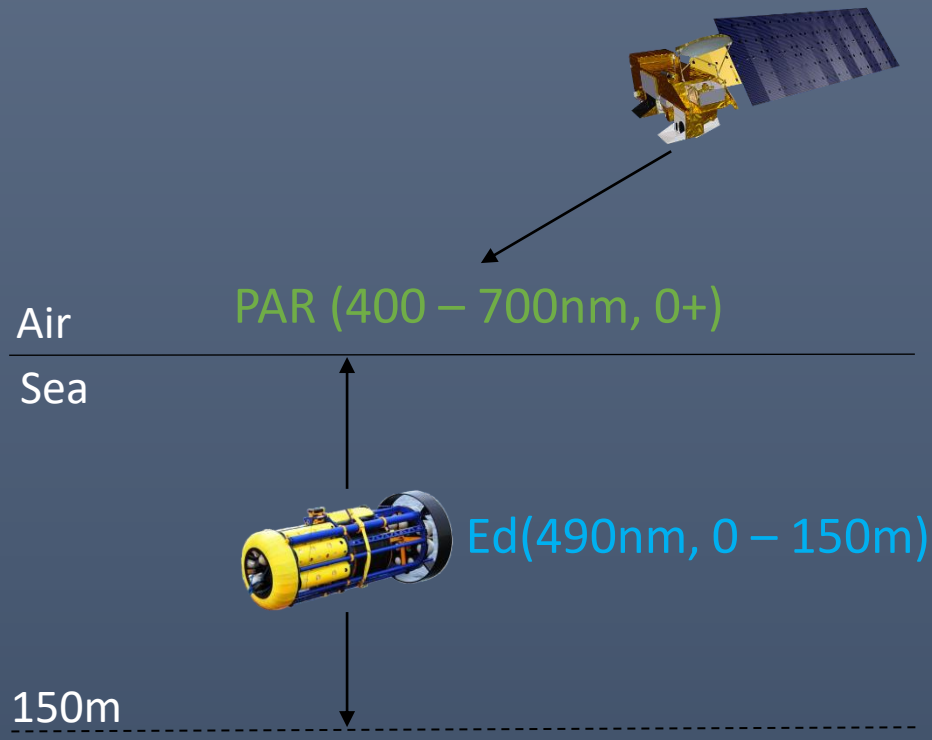


# Workflow – NPP estimation



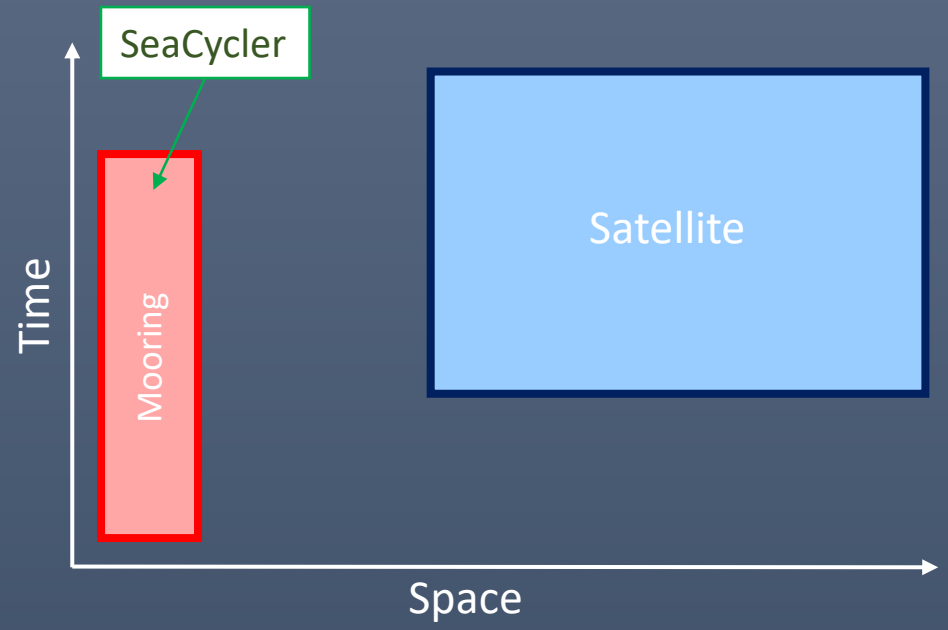
# Problems for comparison and NPP estimation

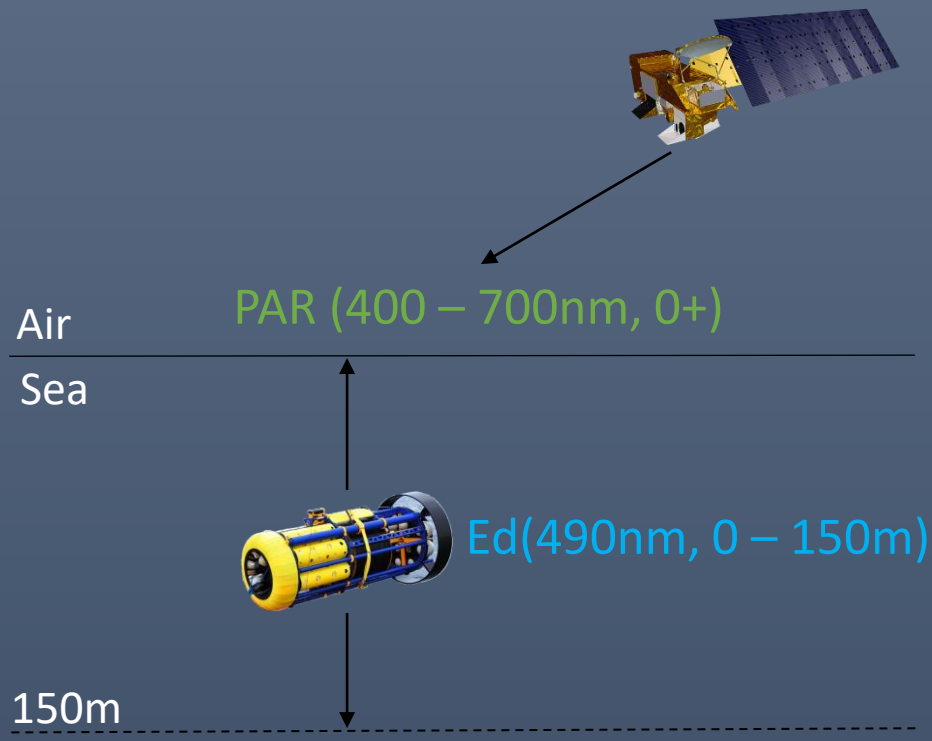



- Different light parameters between SeaCycler and MODIS-aqua satellite
  - SeaCycler : downward irradiance at 490 nm measured from below the water surface
  - Satellite: daily averaged PAR measured from above the water surface

# Problems for comparison and NPP estimation

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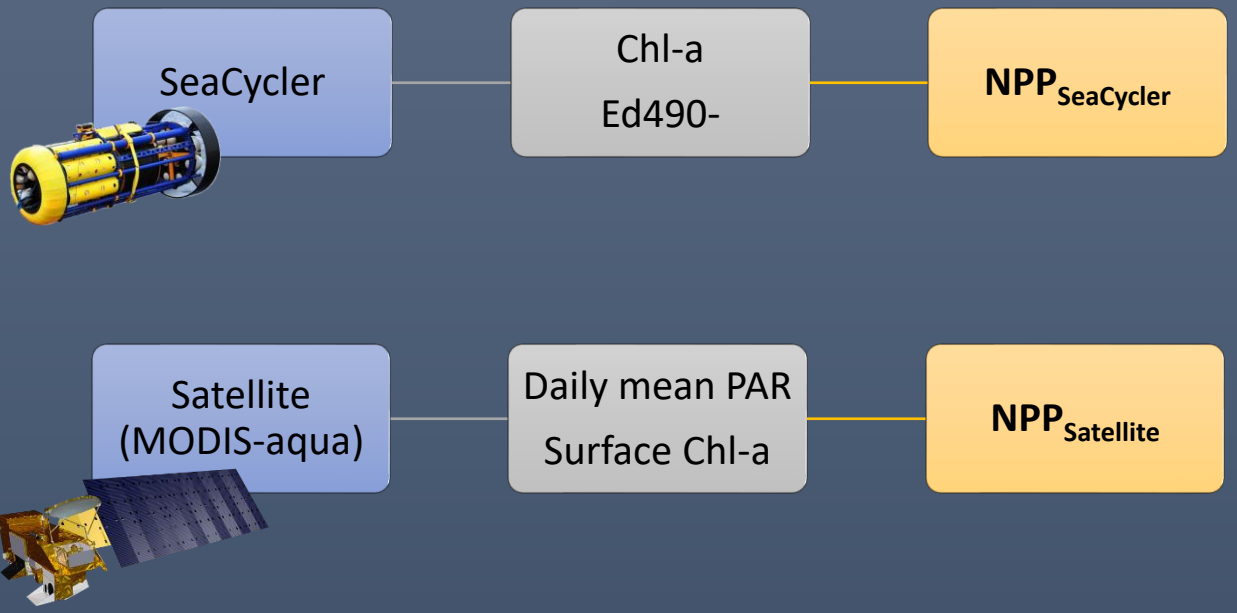
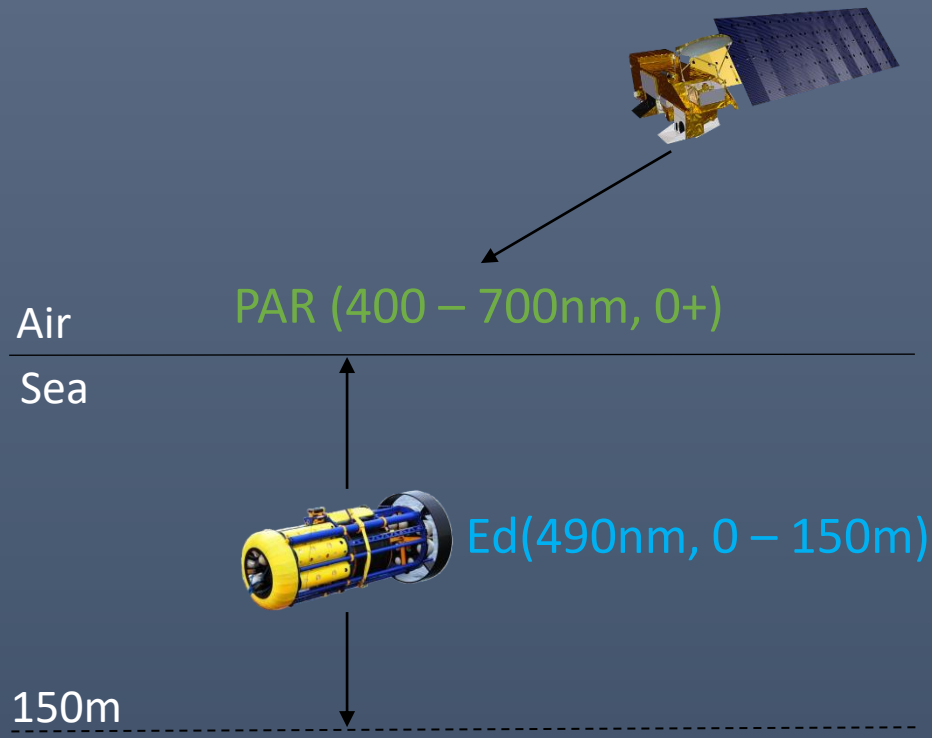
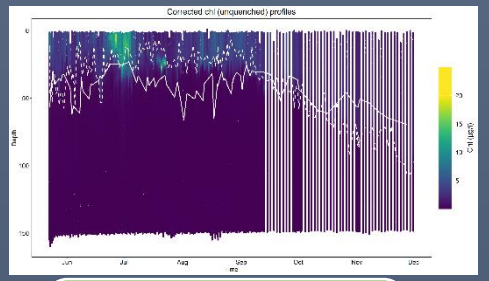



- Different light parameters between SeaCycler and MODIS-aqua satellite
  - SeaCycler : downward irradiance at 490 nm measured from below the water surface
  - Satellite: daily averaged PAR measured from above the water surface
- Both platforms have different *temporal* and *spatial* resolutions
- Conversion are needed before direct comparison and NPP estimation

# Workflow - SeaCycler




Chl-a (z)

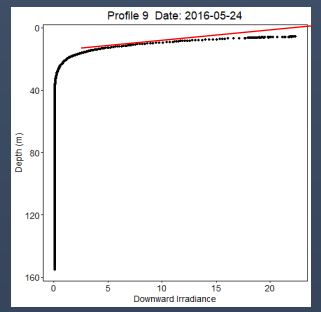
Quenching correction

Unquenched Chl-a (0-Zeu)

αB, Pmax

Ed (z,490)

Extrapolate
1. **Ed(0-,490)**
2. **$K_{Ed}$**



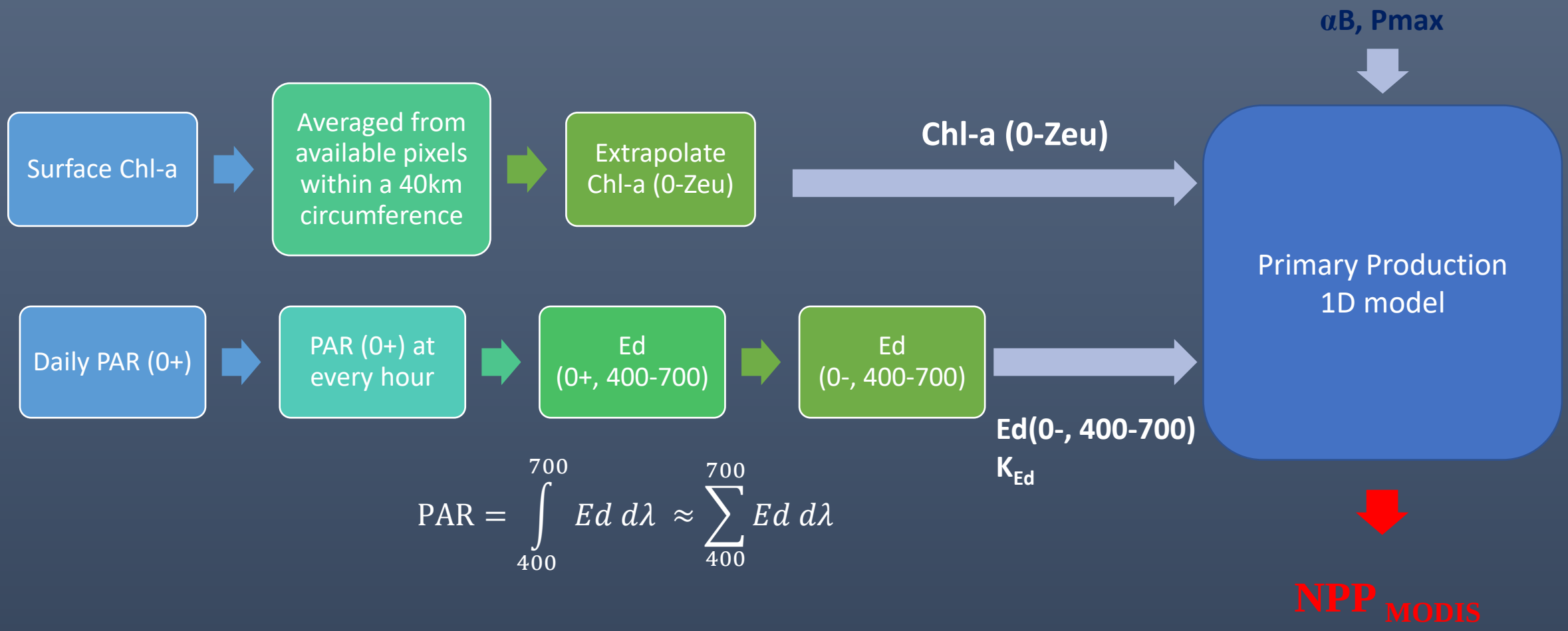

Extract the full photosynthetic light spectrum:
**Ed(0-, 400-700)**

**Ed(0-, 400-700)**
**$K_{Ed}$**

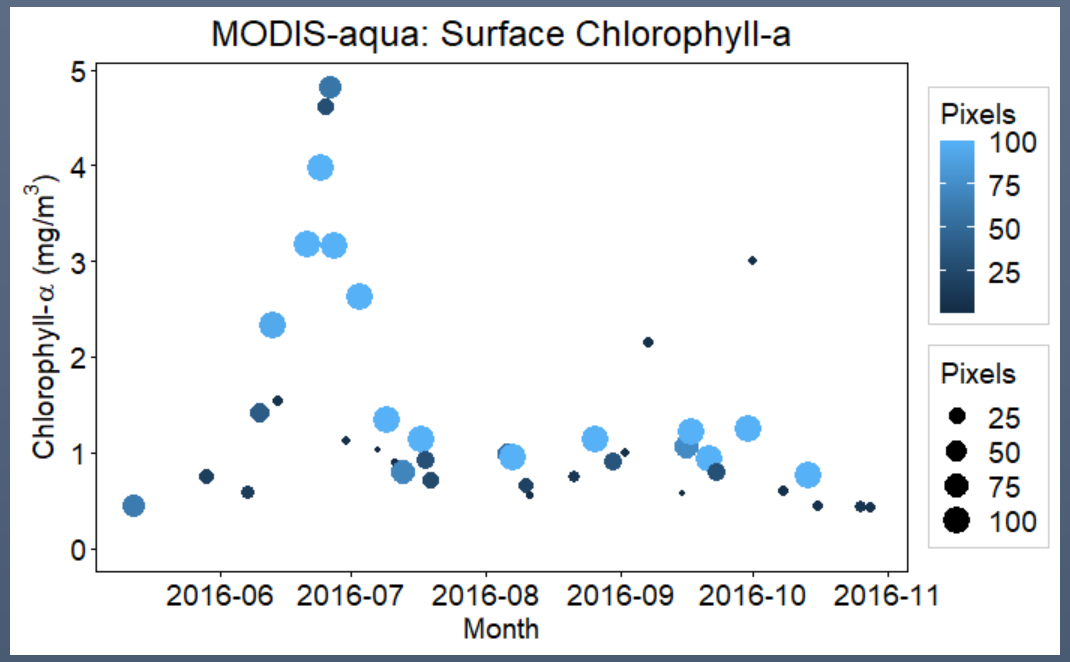
Primary Production 1D model

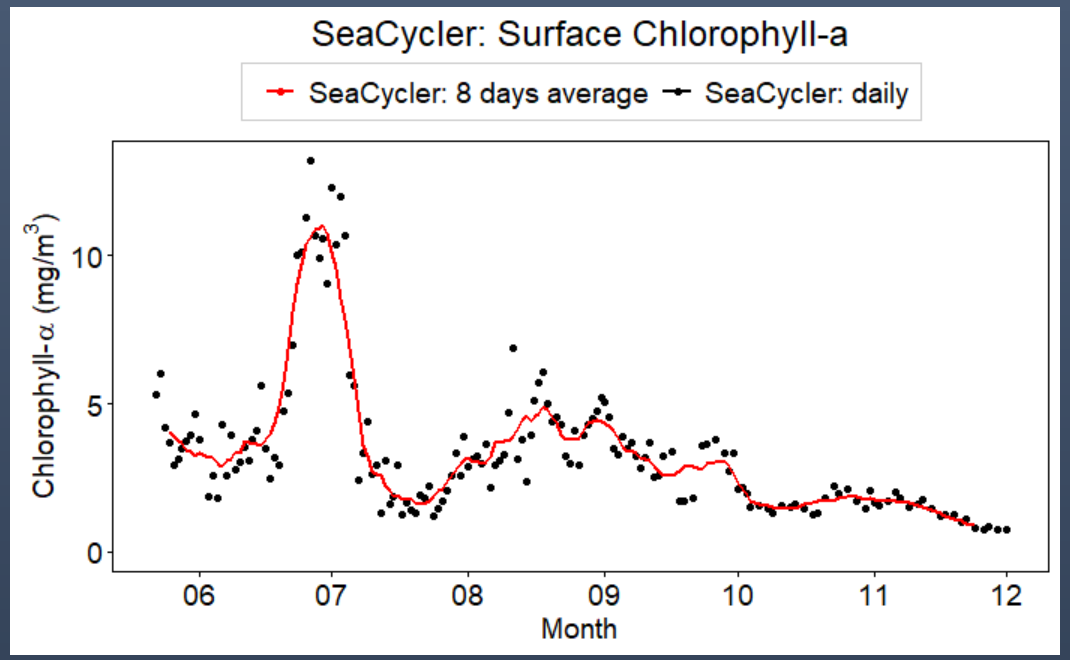
**NPP SeaCycler**

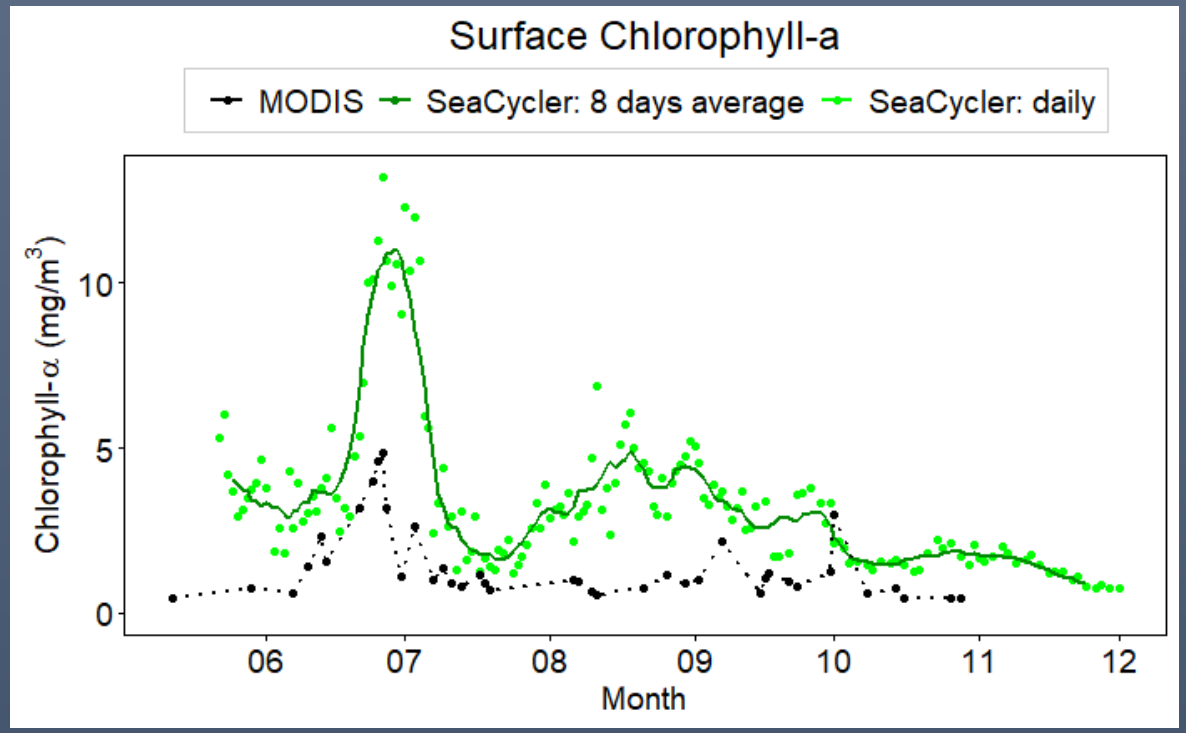
# Workflow – MODIS satellite




$$\mathrm{PAR} = \int_{400}^{700} Ed\, d\lambda \approx \sum_{400}^{700} Ed\, d\lambda$$



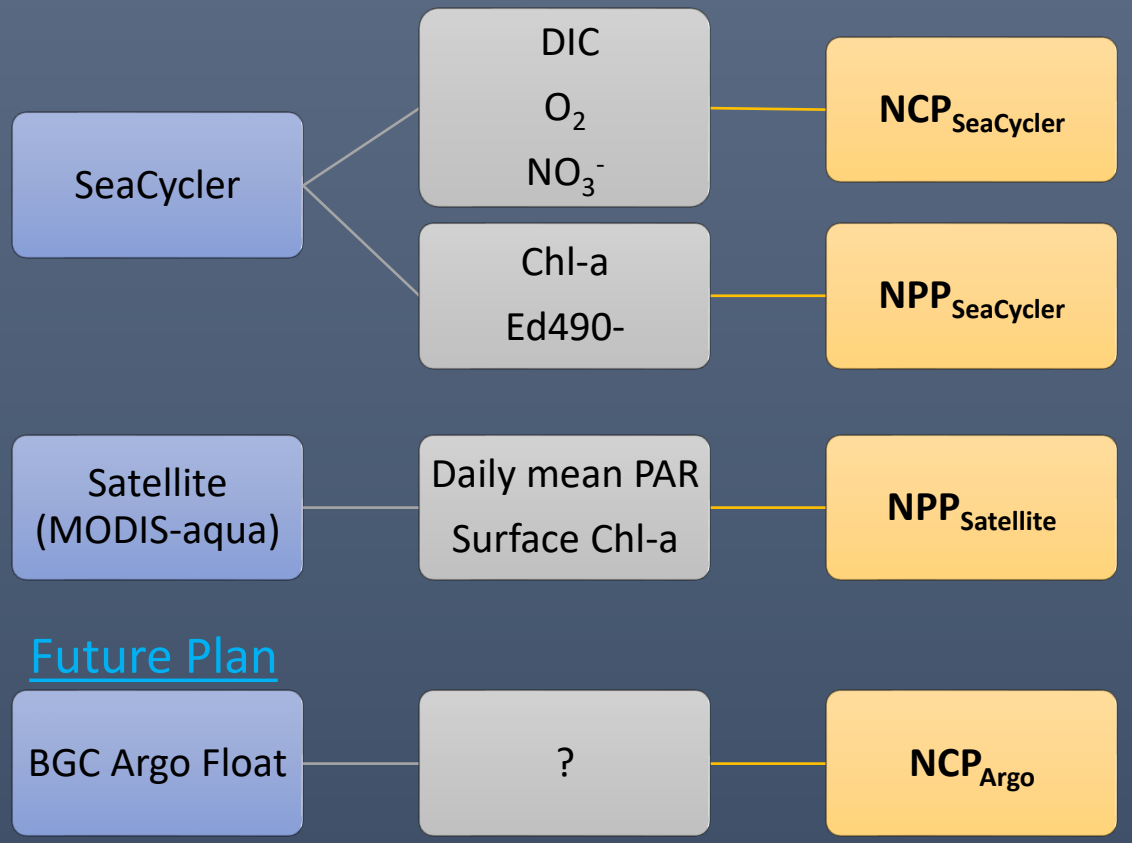




- Early summer bloom in June/July dominated by Atlantic diatoms (Fragoso et al., 2016)
- Discrepancy between in situ and satellite measurements
- In situ chl-a is higher than satellite chl-a by a factor of 2 during the bloom, also observed in Strutton et al. (2011)
- Important to have sufficient in situ validation data for regional remote-sensing algorithm.

# Summary

## Goals

1. **Compare NCP and NPP estimates of SeaCycler and Satellite in the Labrador Sea**
   a) Magnitude
   b) Seasonal Cycles
   c) Dependency on controlling factors (e.g. Mixed-Layer Depth)
2. **Compare with NCP estimate of BGC Argo float**




## Take-home message:

- SeaCycler gives a long-term, fixed-location and high-frequency carbon-based estimate
- Quite rare for having such a high resolution dataset to compare with satellite data
- Validation for regional models and remote sensing algorithm

## Reference:


Atamanchuk, D., Koelling, J., Send, U., & Wallace, D. (2020). *Constraining Net Community Production (NCP) and Export of Carbon (T100*) From Daily In Situ Sensor Measurements of Carbon, Nitrate and Oxygen in the Central Labrador Sea*. Ocean Science Meeting.

Fragoso, G. M., Poulton, A. J., Yashayaev, I. M., Head, E. J. H., Stinchcombe, M. C., & Purdie, D. A. (2016). Biogeographical patterns and environmental controls of phytoplankton communities from contrasting hydrographical zones of the Labrador Sea. *Progress in Oceanography*, *141*, 212–226. https://doi.org/10/f8tdgg

Strutton, P. G., Martz, T. R., DeGrandpre, M. D., McGillis, W. R., Drennan, W. M., & Boss, E. (2011). Bio-optical observations of the 2004 Labrador Sea phytoplankton bloom. *Journal of Geophysical Research: Oceans*, *116*(C11). https://doi.org/10/cb4g68


# Thank you!
# Question?


Acknowledgement: Dr. Doug Wallace, Dr. Dariia Atamanchuk, Dr. Emmanuel Devred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