Underway observations of inherent optical properties for the estimation of near-surface chlorophyll-a in the Fram Strait

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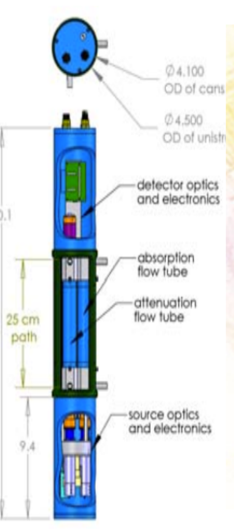
Introduction

The inherent optical properties (IOPs) of seawater are proved to have good linkage to biogeochemical variables. With the emergency of in situ optical sensors, high spatial and temporal resolution measurements of bio-optical properties are achievable, making it possible to understand ocean biogeochemical processes on a broader scale. However, data quality control of the optical sensors remains challenging because of biofouling and the instrumental instability. In this study, we established a ship-based flow-through system of Absorption Attenuation Spectra Meter (AC-s) .

Objectives:

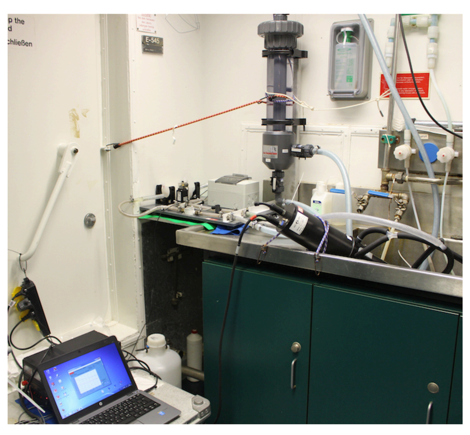
1. Develop a method to correct light absorption and attenuation of seawater from flow-through AC-S system;
2. Retrieve surface phytoplankton Chl-a concentration from quality controlled hyperspectral particulate absorption (a_p).

Instrument Setup



Description of AC-S (Wetlabs Inc.)

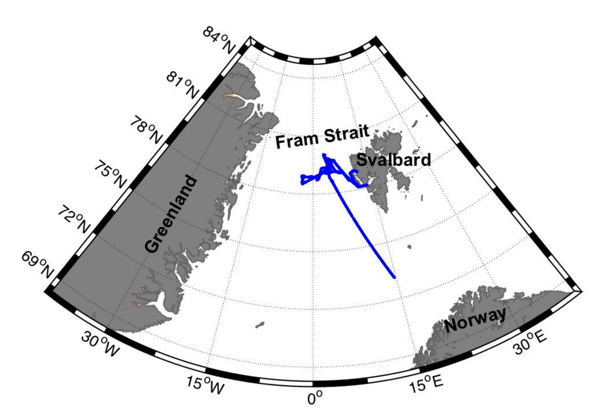
- a: light absorption coefficient; c: light attenuation coefficient.
- a-beam reflective flow tube with a large area diffuser/receiver
- c-beam non-reflective flow tube with a collimated receiver
- 400-735 nm with 83 wavelengths output with a step length of ~4nm



AC-S flow-through system

- An AC-S was installed on R/V Polarstern's flow-through seawater system, measuring both a and c.
- The flow-through seawater was supplied by a vacuum pump plumbed to the keel intake (~11 m below surface). This water was passed through a debubbler and then through the AC-S.
- The AC-S sensor was operated constantly except when in port or once per day or every 2 days for instrument cleaning and filter cartridge replacement.
- Periodic switching of a custom valve passed 0.2 µm filtered seawater through the sensor for 10 min of every hour, allowing for the calculation of a and c for particulate.

Study Area

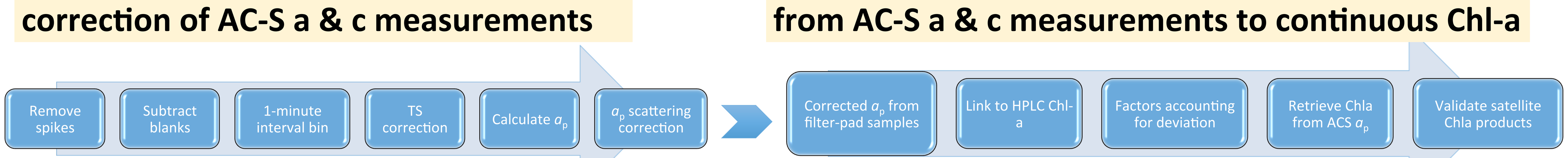


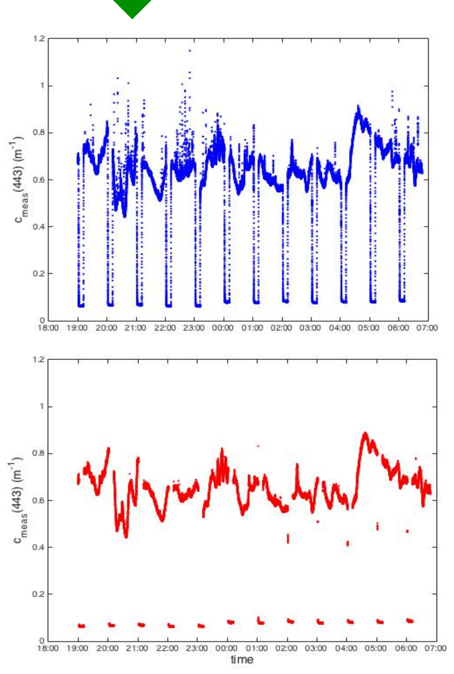
We conducted continuous underway measurements of hyperspectral IOPs during the PS93.2 expedition to the Fram Strait.

Method flow and Results

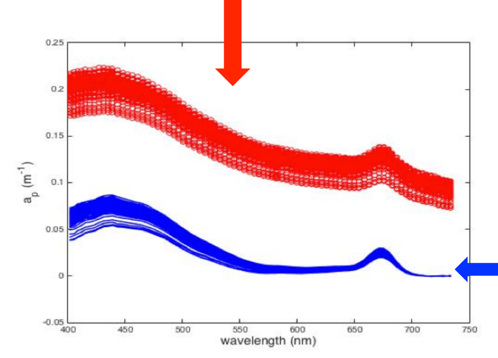
correction of AC-S a & c measurements

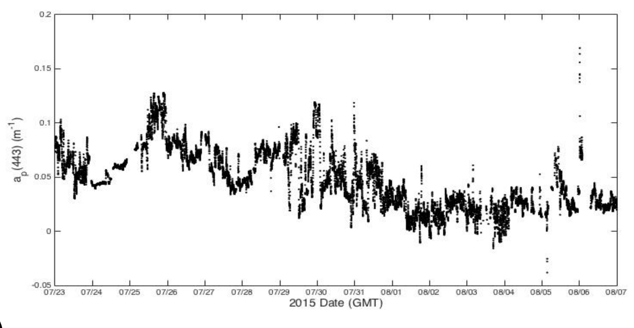
from AC-S a & c measurements to continuous Chl-a



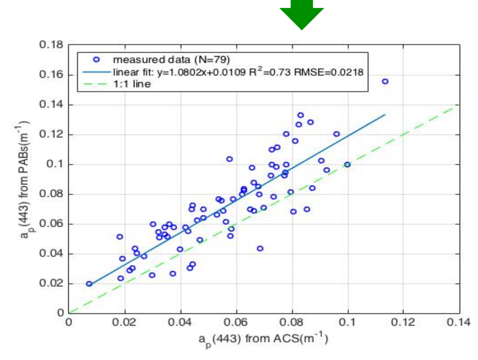


Before (blue) and after (red) spikes removal of raw AC-S data collected from 23/07/2015 18:59 to 24/07/2015 6:47.

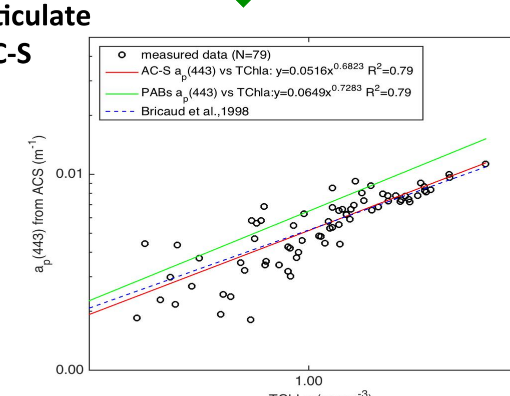




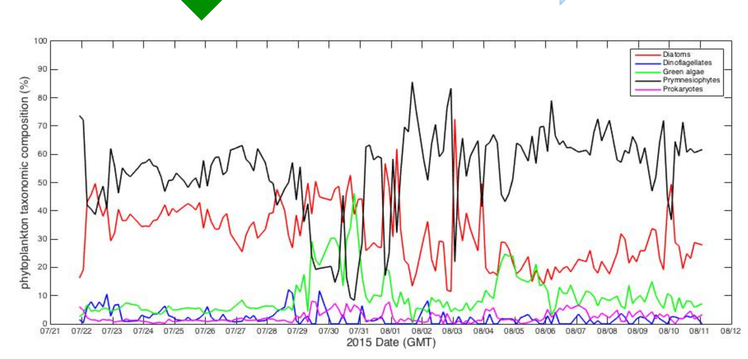
Time series of the corrected particulate absorption at 443 nm.



Comparison of particulate absorption from AC-S versus filter-pad.



Comparison of particulate absorption from AC-S & filter-pad versus Chl-a



Contribution of phytoplankton taxonomic composition to surface water.

Conclusion

- The AC-S data are reliable after applying our correction scheme.
- AC-S a_p has a good agreement with filter-pad data.
- AC-S a_p has a robust relationship with Chl-a.

Outlook

- Adjust beta factor of filter-pad data, and further correct AC-S a_p.
- Apply scattering correction method from Röttgers et al., 2013, and see if better relationship can be found between AC-S a_p and filter-pad data.
- Clustering analysis of how packaging and phytoplankton composition determined by Chemtax) affects a_p within the cruise.
- Validate satellite data with Chla retrieved from AC-S.

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