# PhD Topic: Assessing the impact of climate change on phytoplankton in Fram Strait: 1. particle absorption properties from continuous meaurements of spectral absorption attenuation sensor meter (AC-S)


Yangyang Liu[1,2], Marta Ramirez[4], Rüdiger Röttgers[5], Astrid Bracher[1,3], Sonja Wiegmann[1]

**AWI, Climate Sciences, PHYTOOPTICS Group (Prof. Dr. Astrid Bracher) – Fachbereich Biologie, Universität Bremen**

1. Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
2. Institute of Biology, University of Bremen
3. Institute of Environmental Physics, University of Bremen
4. Spanish National Research Council
5. Helmholtz Zentrum Geesthacht Center of Materials and Coastal Research


The decline of Arctic sea ice as well as its resulting feedbacks is asserted to have great impacts on the Arctic phytoplankton, and caused large regional variations in primary production range in the Arctic Ocean and its marginal seas. Understanding and quantifying such impacts are critical to appreciate the Arctic as a system and allow diagnostic modeling of its current status and dynamics.

To assess the above impacts of reduction in sea ice and then the changes in physical properties on Arctic phytoplankton, numerical models have emerged as valuable tools. In order to generate reliable results, a high quality Arctic Chl-a dataset is essential to improve parameterizations in the coupled ice-ecosystem-ocean circulation models. With the emergency of autonomous platforms (e.g. floats (Argo), autonomous vehicles), high spatial and temporal resolution measurements of biooptical parameters are achievable. However, new challenges arise from the automated way of observing the bio-optical properties of the ocean. Indeed, conversely to what happens when the same kinds of equipment are operated from a ship, these bio-optical data are collected in environmental conditions that are out of the operator's control. Therefore, new specific data processing and management procedures have to be developed for in situ bio-optical sensors which generate high spatial and temporal resolution measurements of bio-optical data. In this study, analytical bio-optical techniques are applied to develop quality controlled high quality pan-Arctic long-term information on total biomass of phytoplankton. The quantitative distribution of phytoplankton will be determined on long time scales covering the Fram Strait in the Arctic Ocean by the integration of measurements from various platforms that enable to retrieve the total biomass of phytoplankton.

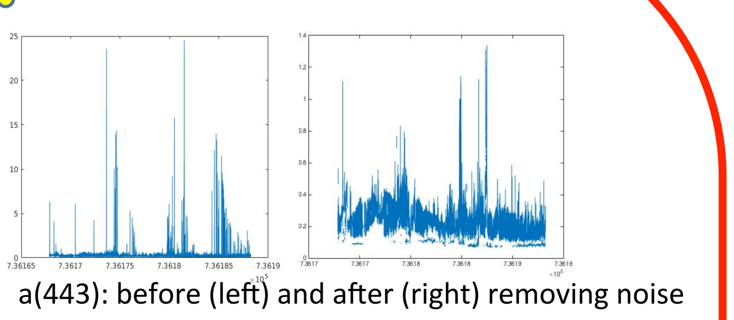
## Objective

- To develop a for the Fram Strait adapted 3-dim data set on phytoplankton biomass merged from measurements by different bio-optical sensors mounted to different platforms (AC-S, AUV, ship, satellite);
- To assess variability and trend of phytoplankton abundance in the Fram Strait and its coupling to environmental variables which are affected by climate change.

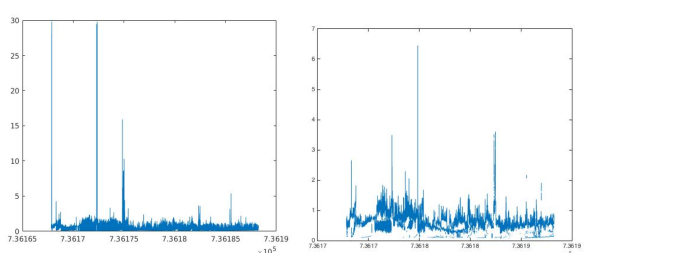
## First Results

### AC-S data processing

1. Merge raw absorption (a) & attenuation (c) data collected to one data file
2. Remove noise (spikes generated by air bubbles)
3. Bin merged raw a & c data to 1-min intervals
4. Correct temperature & salinity for pure water absorption
5. Derive particle absorption by subtracting unfiltered and filtered seawater absorption
6. Apply scattering correction for particle absorption concurrently with residual temperature correction



a(443): before (left) and after (right) removing noise



c(443): before (left) and after (right) removing noise

Pure water absorption is dependent on T and S in the red and NIR region. (Sullivan etal., 2006)

$$a_{total}(\lambda)=a_p(\lambda)+a_g(\lambda)+a_{offset}(\lambda)+\Delta a_{sw}(\lambda,T,S)$$

$$a_{filtered}(\lambda)=a_g(\lambda)+a_{offset}(\lambda)+\Delta a_{sw}(\lambda,T,S)$$

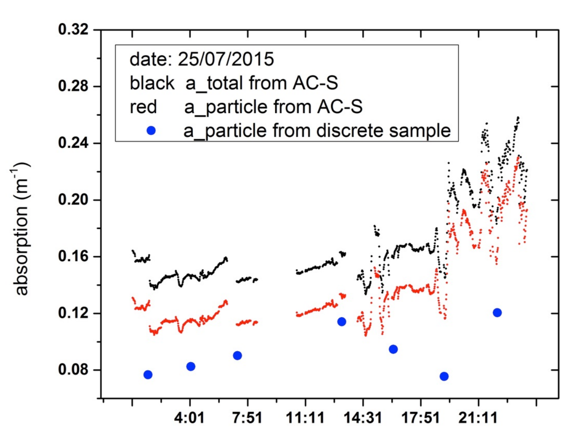
$$a_p(\lambda)=a_{total}(\lambda)-a_{filtered}(\lambda)$$

1. a-beam detector can not collect the forward scattered photons, resulting in an overestimation of a.
2. Temperature can change between unfiltered and filtered measurements.

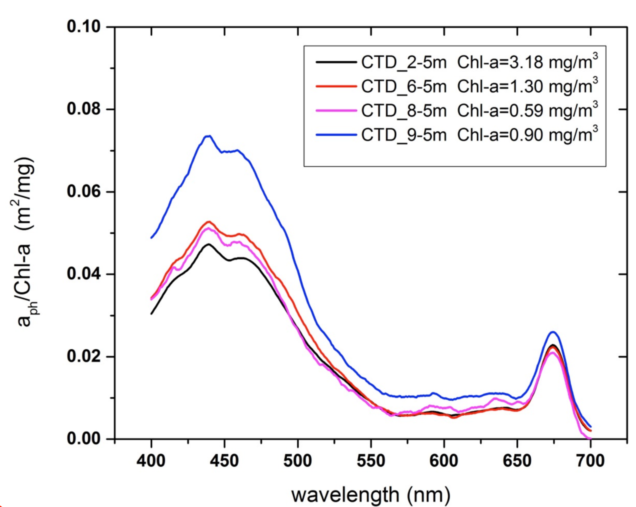
$$a_{p(\lambda)}=a_{p,meas}(\lambda)-\Psi_T(\lambda)\Delta T-\frac{a_{p,meas}(\lambda_{ref})-\Psi_T(\lambda_{ref})\Delta T}{b'_p(\lambda_{ref})}b'_p(\lambda$$

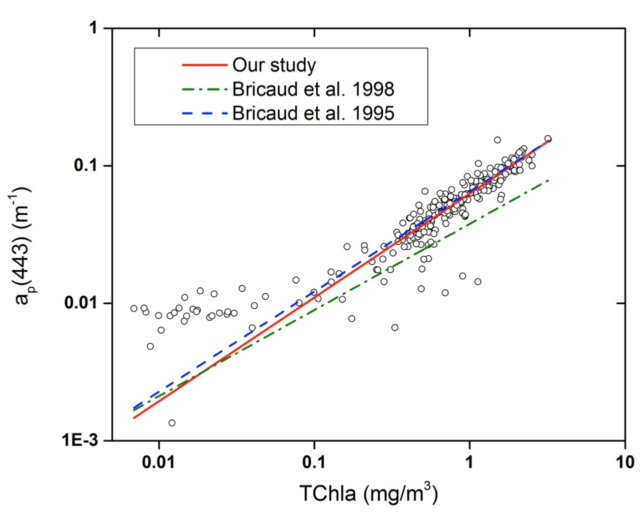
$$\chi=\sum_{\lambda_{NIR}}\left|a_{p,meas}(\lambda_{NIR})-\Psi_T(\lambda_{NIR})\Delta T-\frac{a_{p,meas}(\lambda_{ref})-\Psi_T(\lambda_{ref})\Delta T}{b'_p(\lambda_{ref})}b'_p(\lambda_{NIR})\right|,$$

### First results




Comparison of particle absorption at 443 nm obtained from AC-S and discrete sample measurements

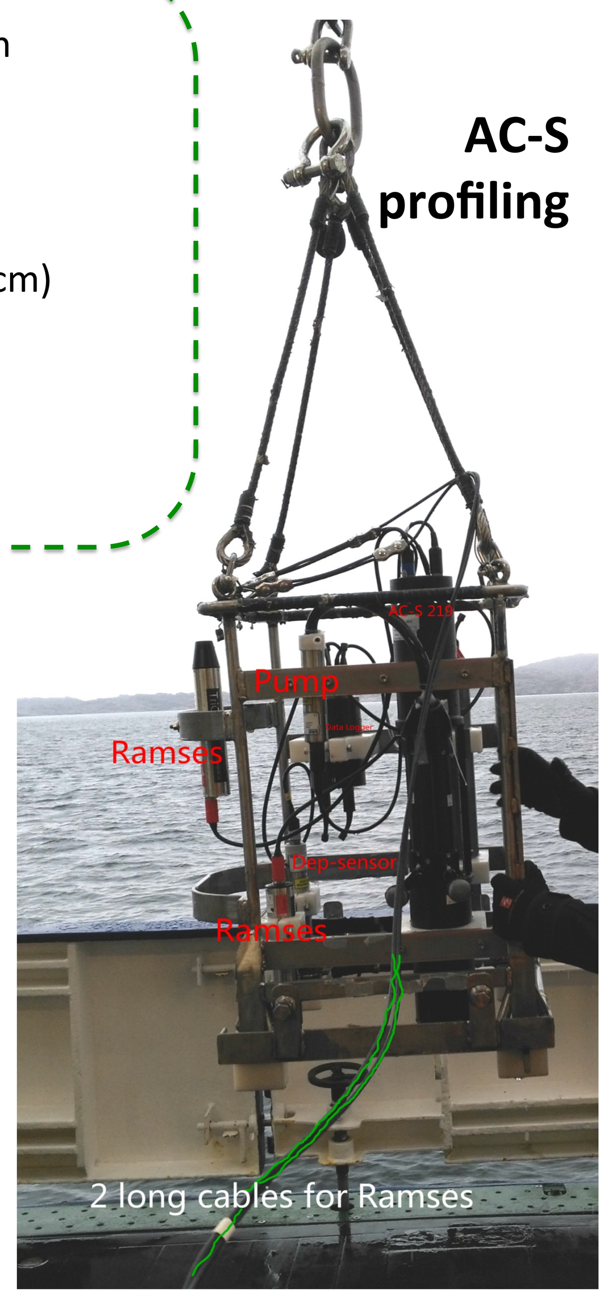


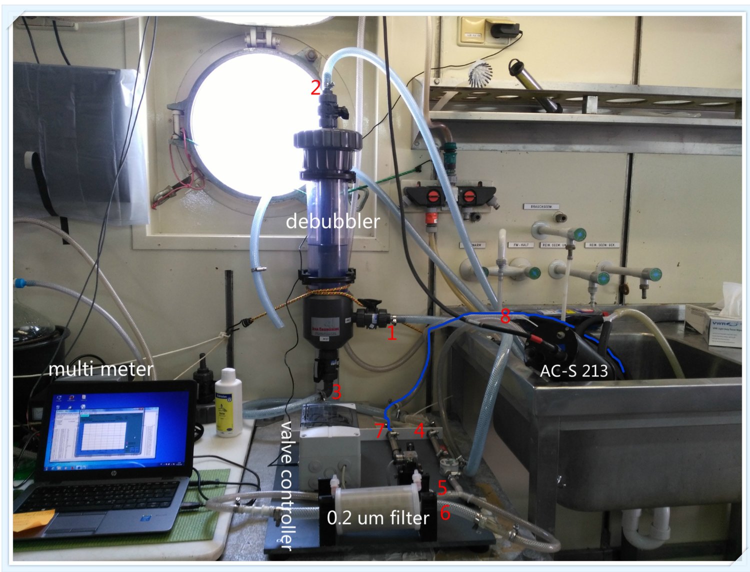

Discrete sample (N=242): $a_p(443)=0.0625*Chla^{0.755}$

## In situ sensor: Absorption Attenuation Spectra Meter (AC-S)

- a: light absorption coefficient; c: light attenuation coefficient.
- a-beam reflective flow tube (pathlength: 25cm)
- a-beam large area diffuser/receiver
- c-beam non-reflective flow tube (pathlength: 25cm)
- c-beam collimated receiver
- 400-735 nm with 83 wavelengths output
- Step length: ~4nm
- No. averages: 60

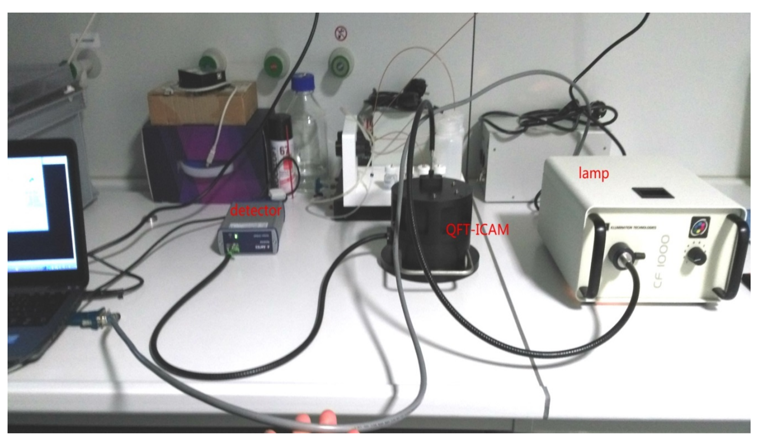



AC-S profiling

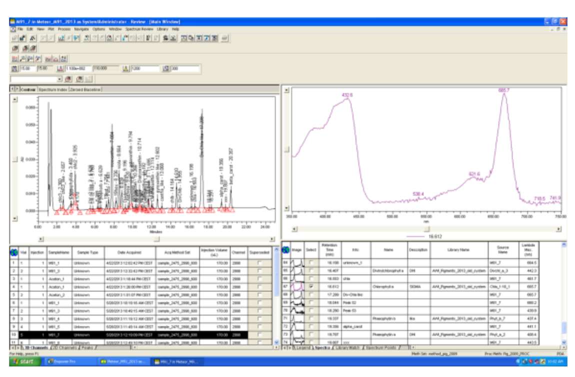



AC-S flow through system

## Validation data: discrete measurements on water samples



On board: **particle and phytoplankton absorption** with Quantitative Filter Technique-Integrative Cavity Measurements (QFT-ICAM)



Separation, identification and quantification of **phytoplankton pigments:** High Pressure Liquid Chromatography (HPLC) analysis at AWI.


## Acknowledgements:

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## References


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