ESTIMATING CHLOROPHYLL-A FROM CHLOROPHYLL FLUORESCENCE

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Baltic Data Flows

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Empiric conversion/Field calibration of chlorophyll fluorescence

- Aim:

  Provide an estimate of chlorophyll-a from chlorophyll fluorescence measured by a FerryBox system.
- Motivation:

  Comparability of data from different sources for use in assessments (for example Helcom HOLAS and OSPAR assessment)
- Method:

  Linear regression between chlorophyll fluorescence data and water samples analysed for chlorophyll-a using fluorometric method.
  - Sea area, the difference between the Baltic Sea and the Kattegat-Skagerrak related to phytoplankton composition.
  - Differences due to season

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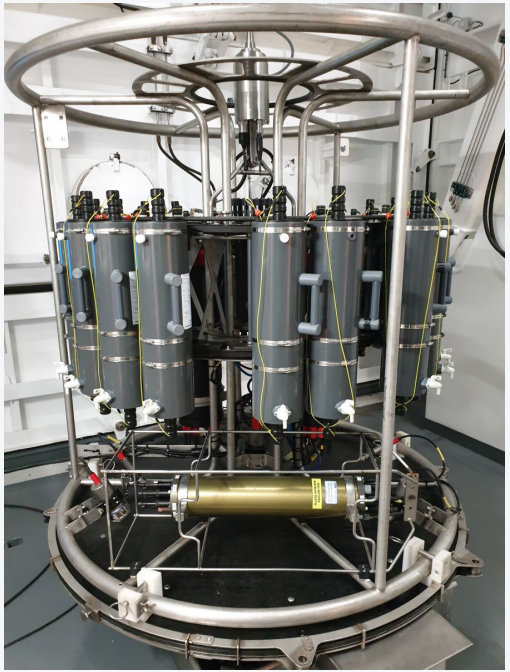
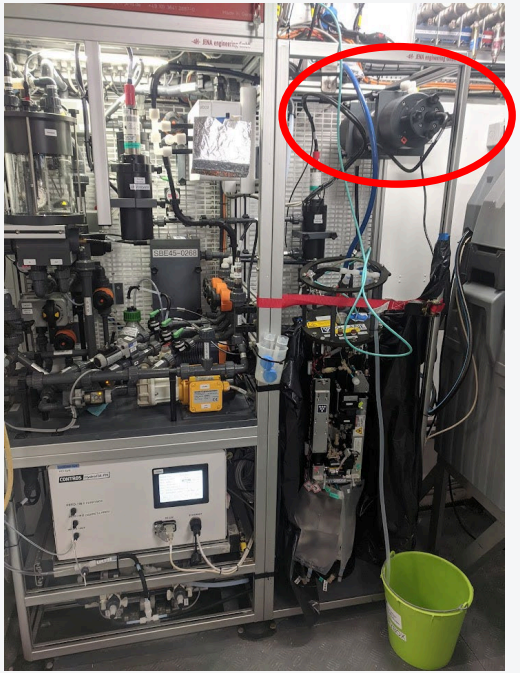
Questions

- Can 5 years fluorescence data and bottle data be used to provide empirical conversion/field calibration of future data (from the same sensor and calibration) or is it necessary to make one field calibration for each cruise?
- How do we need to split data by time of year? There may be effects of phytoplankton composition
- What documentation should be included with the corrected fluorescence data when data is shared to data portals? (ICES, Emodnet etc.)?

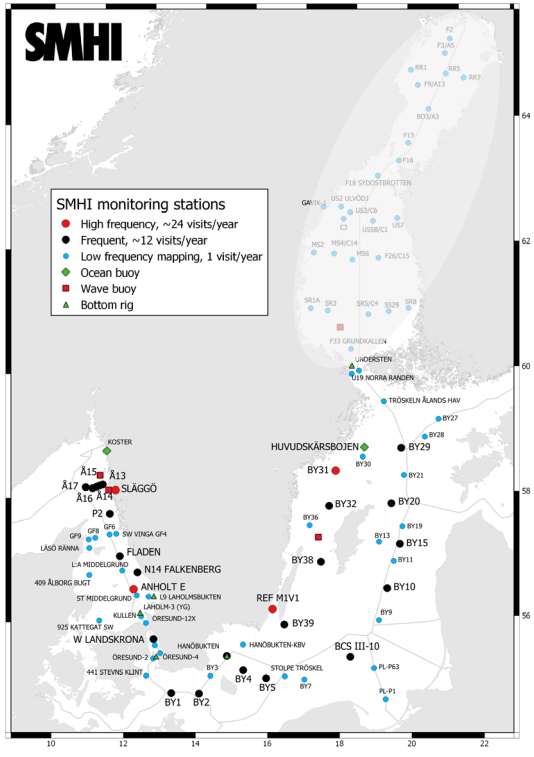
Sampling equipment

- 24 water sampling bottles, 5L each
- Fiberoptical telemetry and laser detection for near bottom deployment
- SBE 9+ with pressure, temperatur, salinity and oxygen
- PAR
- Wetlabs: turbidity and chlorophyll fluoresence, ECO-FLNTURT
- Wetlabs: phycocyanin fluoresence
- Phytoplankton: Tube sampling 0-10 m





Area and data description



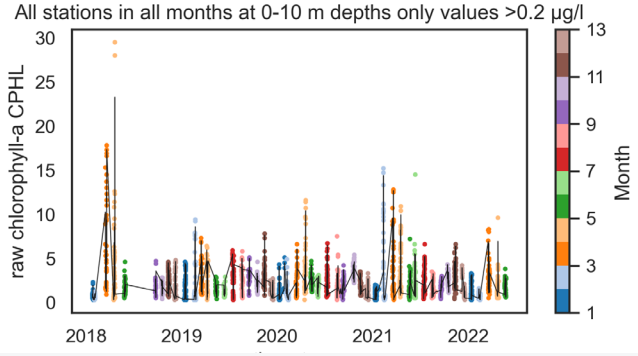
All data presented is from SMHIs marine monitoring in the Baltic Proper and the Skagerrak-Kattegat.

Chlorophyll-a in water samples is collected from 0-50 m on frequent and high frequency stations.

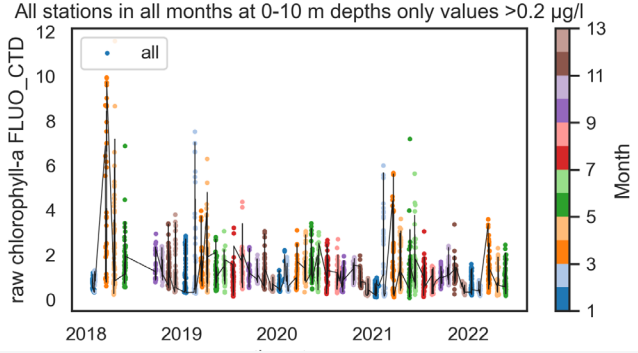
In addition we will show some data from our bouy at Huvudskär in the Northern Baltic Proper.

The data is collected with R/V Svea where we have a ferrybox system from 4HJena.

Chlorophyll a - discrete samples

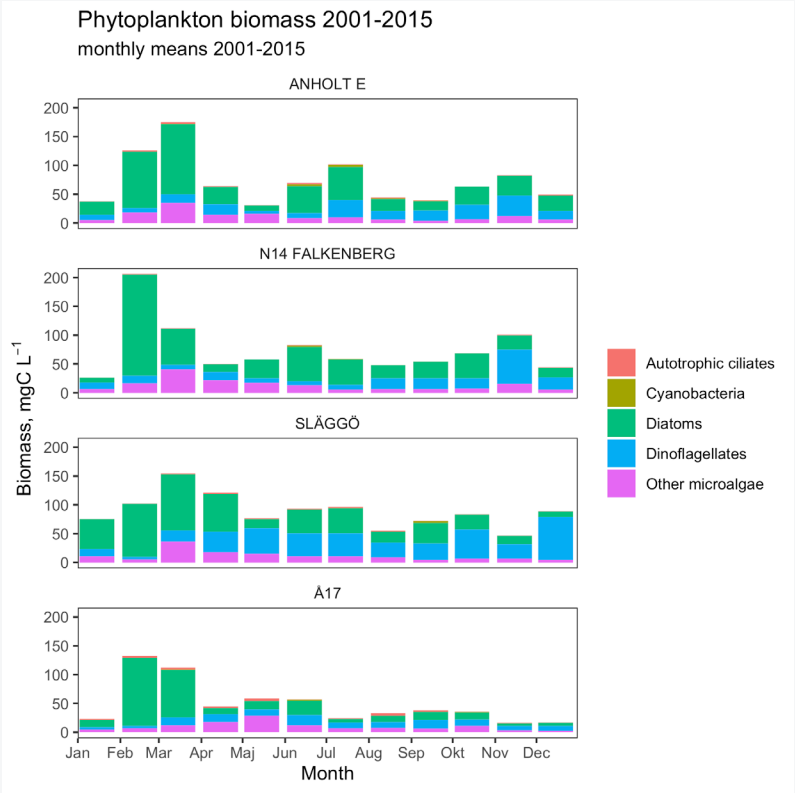


Chlorophyll-a fluorescence



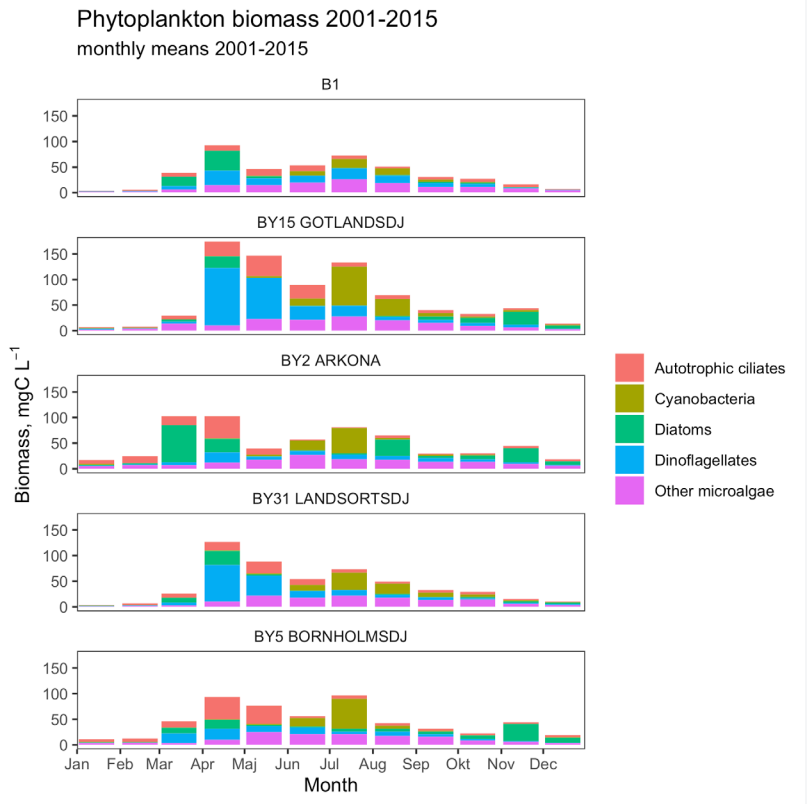
Biomass of phytoplankton communities Skagerrak-Kattegat

- Biomass estimates based on microscopy and cell volumes
- Carbon conversion according to Menden-Deuer and Lessard 2000
- Diatoms and dinoflagellates dominate biomass

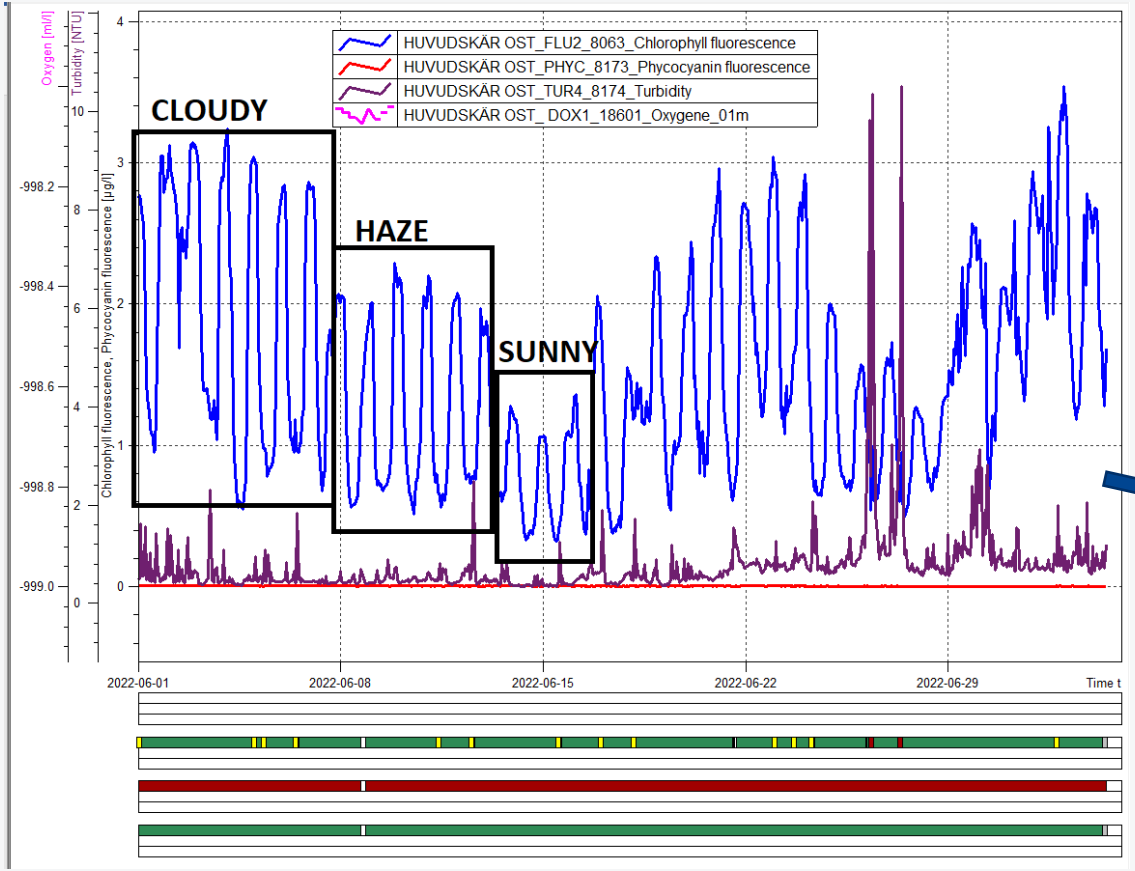


Biomass of phytoplankton communities in the Baltic Proper

- Diatoms and dinoflagellates dominate biomass
- Dinoflagellates more important compared to the Skagerrak-Kattegat
- Cyanobacteria important in summer
- Phototrophic ciliates (*Mesodinium rubrum*) important



Chlorophyll fluorescence high resolution



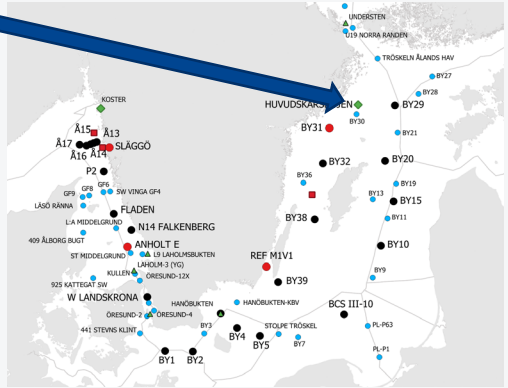
Example of photo quenching effect

Chlorophyll fluorescens observed at ~1 m depth in the Baltic proper

Note diurnal variability

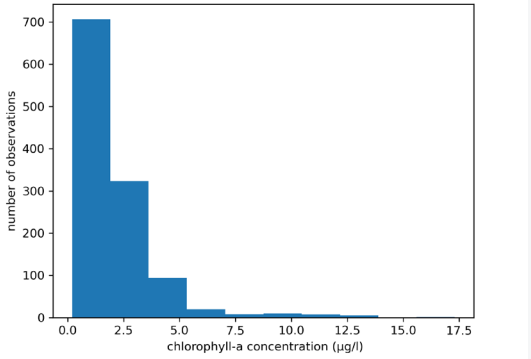
Chlorophyll fluorescence around midnight is ~3 times higher compared to at noon

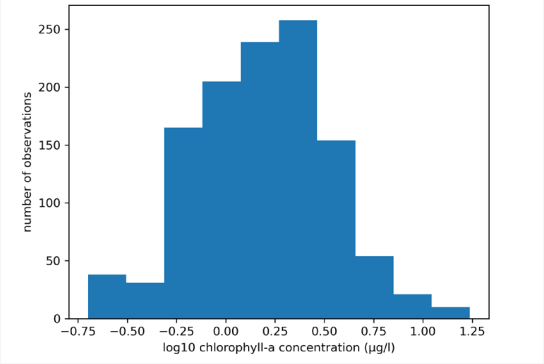
Vertical migration of phytoplankton possible, but unlikely



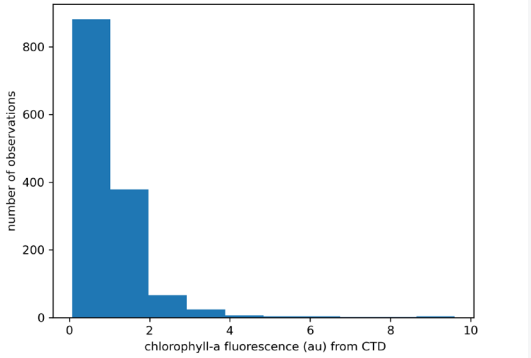
All areas, 2018-2021, 0-10 m average

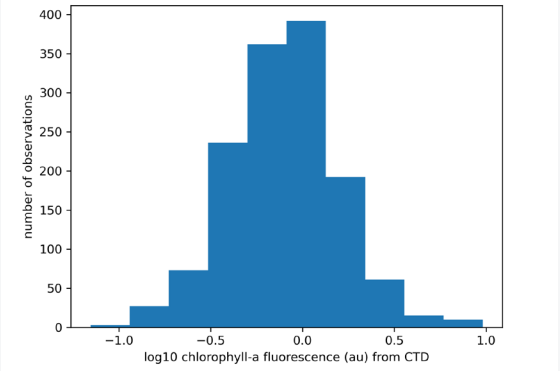
Chlorophyll a





Chlorophyll fluorescence

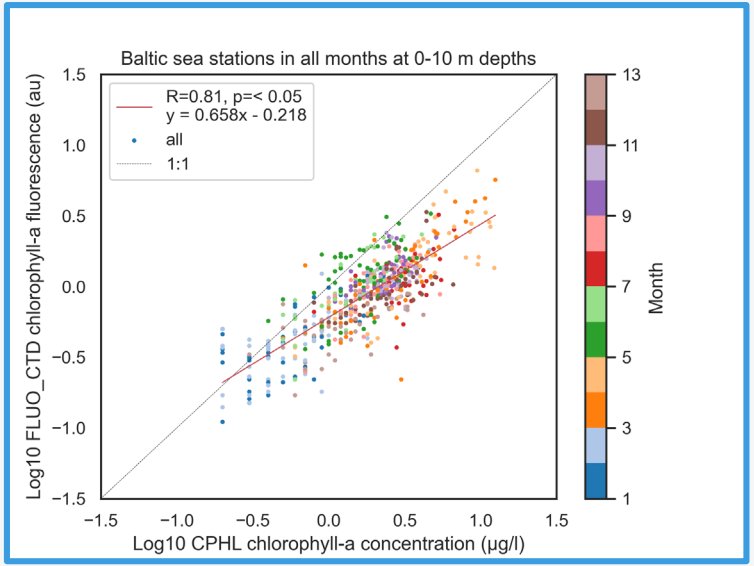


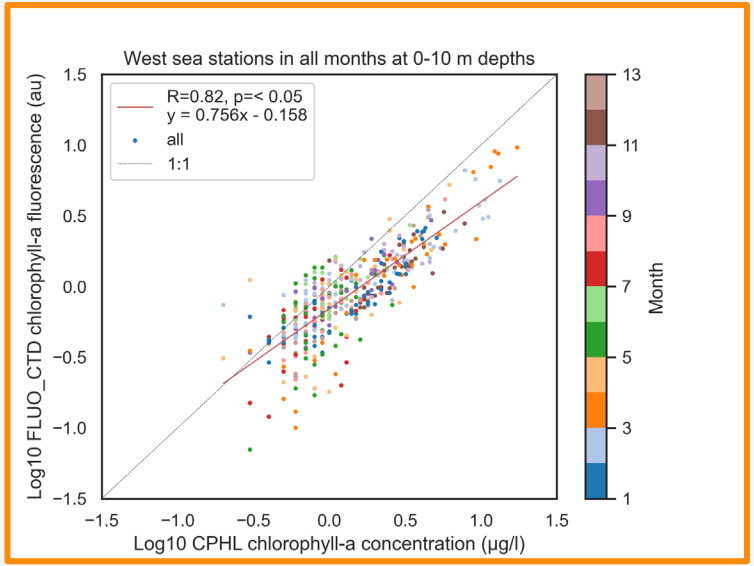


The data does not have normal distribution, therefore data was $\log_{10}$ - transformed before the regression analysis

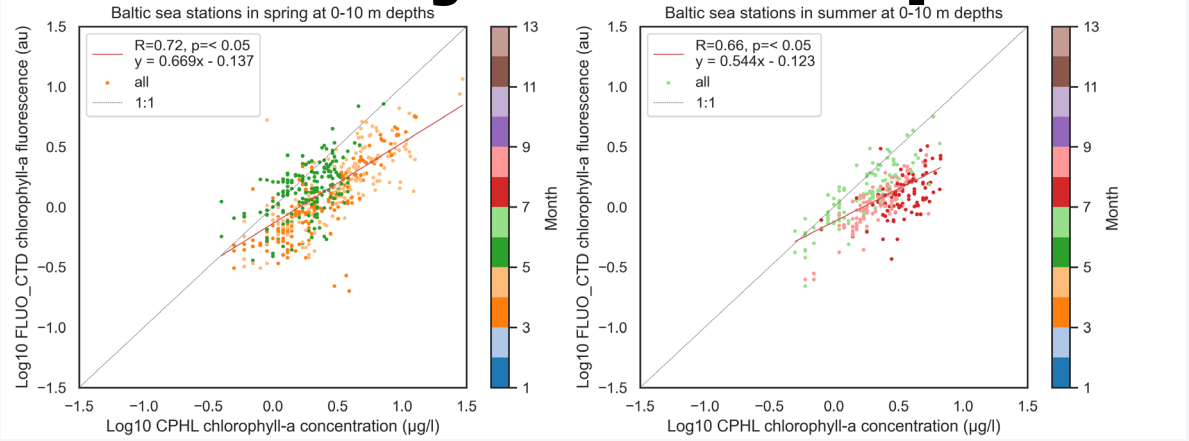
Both sea areas show higher concentration compared to fluorescence in the surface water

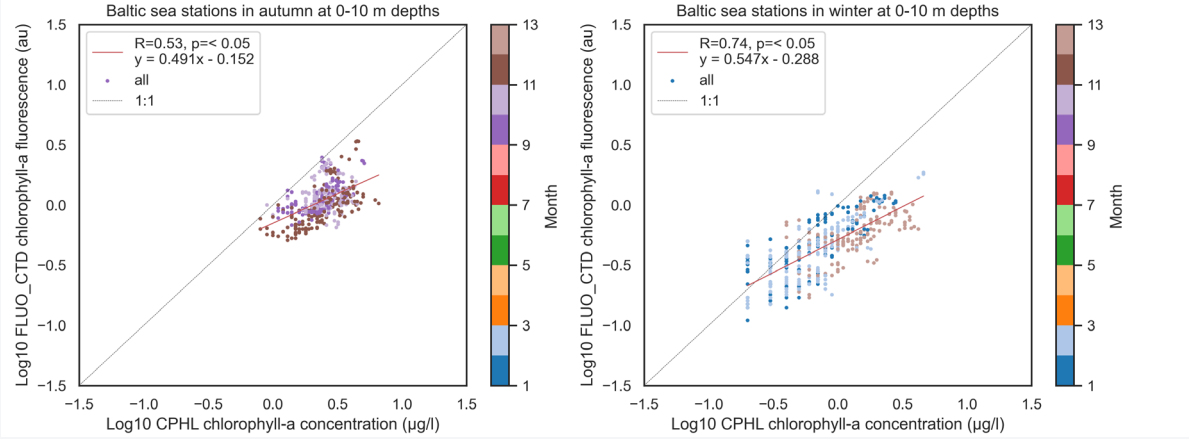
0-10 m



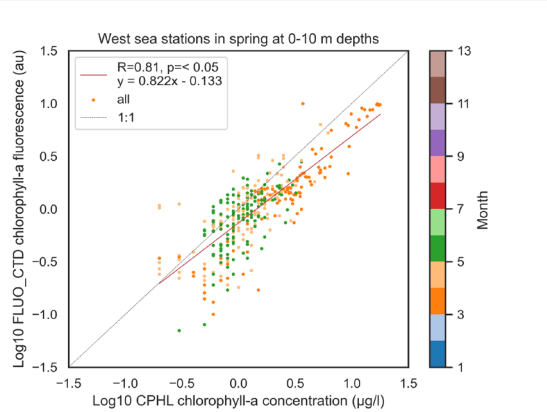


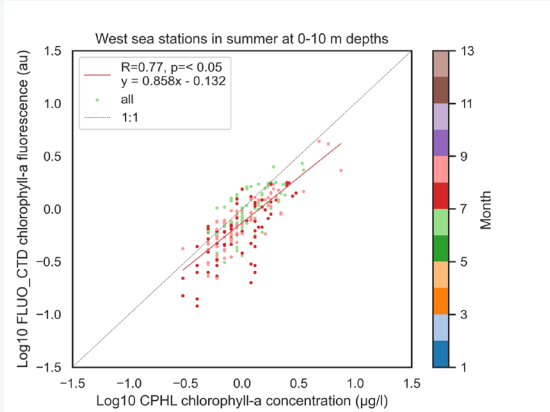
Seasonality Baltic Proper 0-10 m

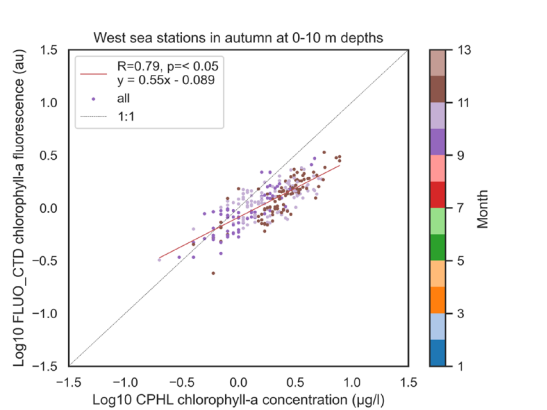


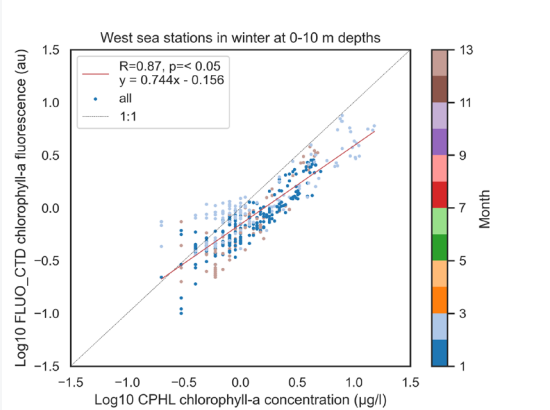


Seasonality Skagerrak/Kattegat 0-10

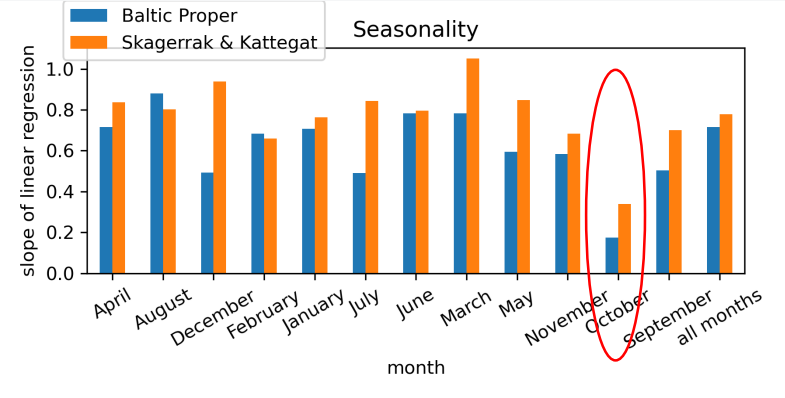








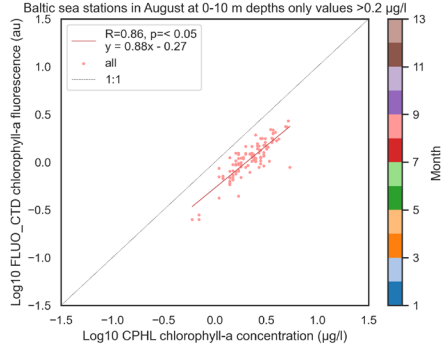
Overview of resulting slopes and R-values



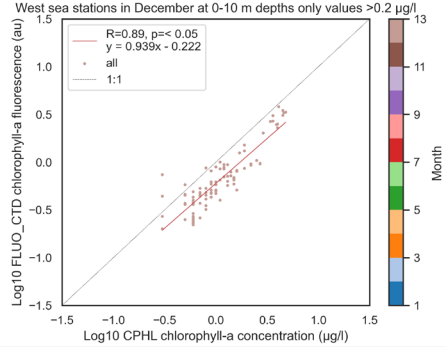
R-values:
Spring 0.67
Summer 0.66
Autumn 0.49
Winter 0.55

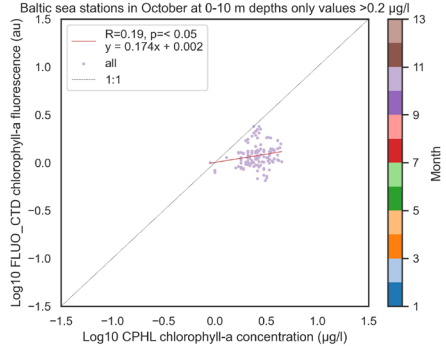
R-values:
Spring 0.81
Summer 0.77
Autumn 0.55
Winter 0.87

Not consistently better in summer compared to winter, Baltic Proper



Best fit (R-value) and highest slope in the Baltic Proper, August





Worst fit (R-value) and lowest slope in the Baltic Proper, October

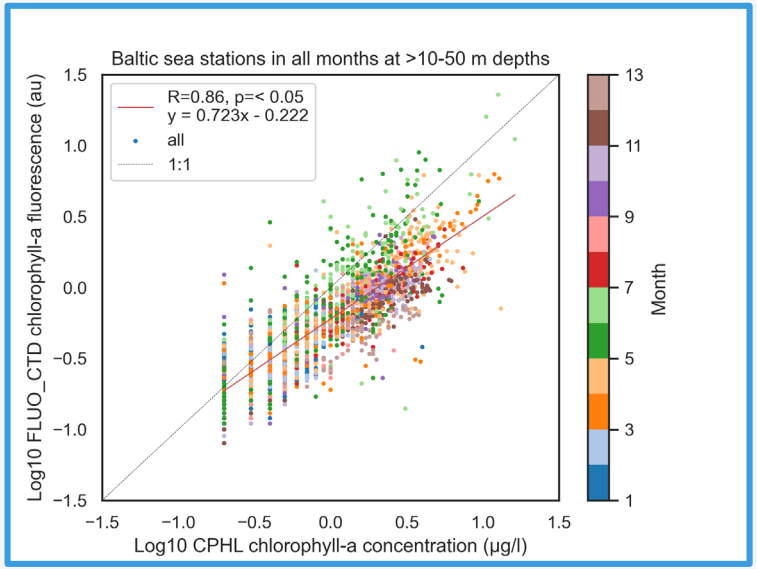
Difference due to species composition

Calibrated against chlorophyll from waters with other phytoplankton communities than in the Baltic Sea, without cyanobacteria and the phytoplankton populations in the Baltic Sea.

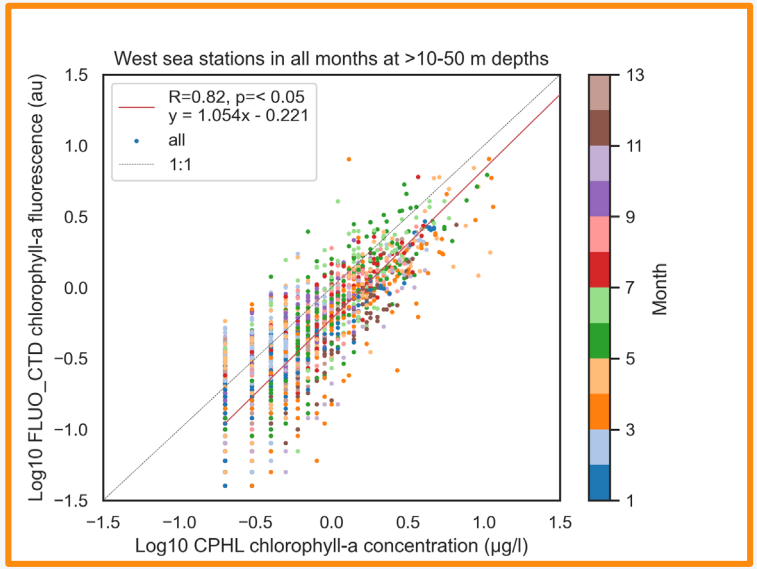
In the Baltic Sea the seasons might be more important than in the Skagerrak and Kattegat

10-50 m

- Baltic Proper, chlorophyll-a is larger than chlorophyll-fluorescence at depth >10 m

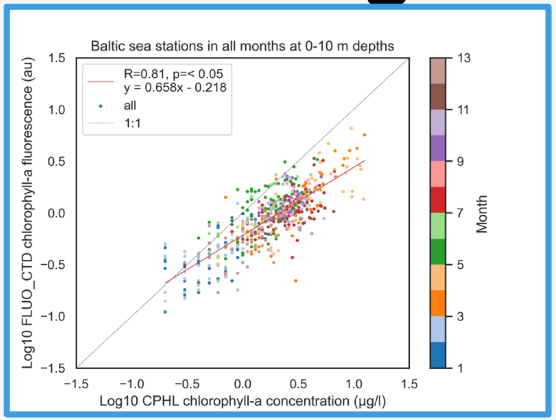


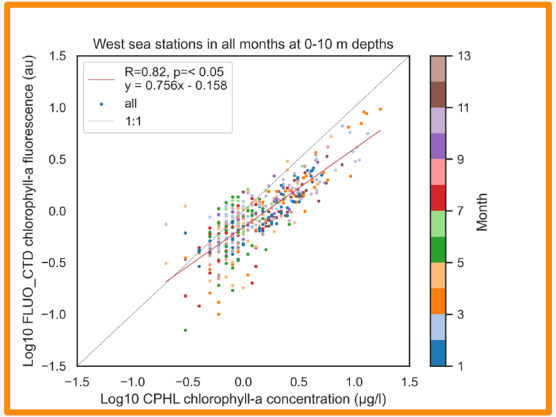
- In the Skagerrak/Kattegat chlorophyll-a and fluorescence match well at depth > 10 m



Difference between the Baltic and the Skagerrak/Kattegat

0-10 m

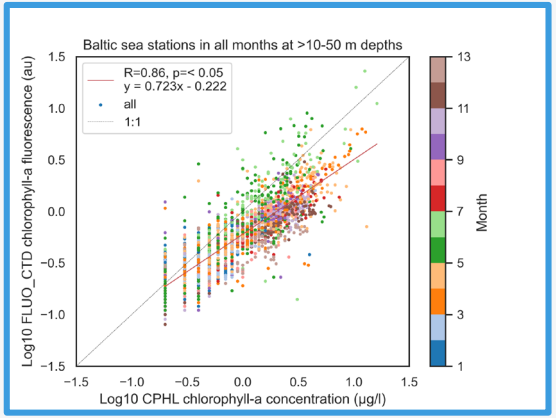


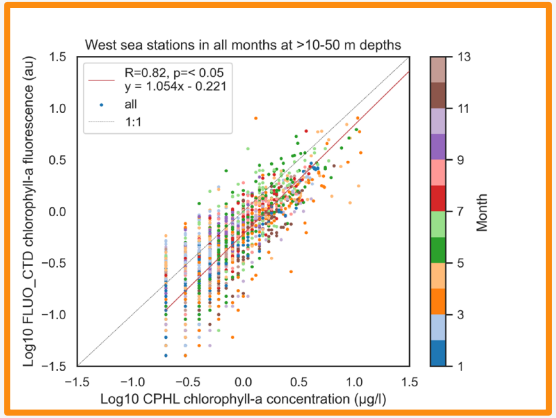


In the Baltic chlorophyll-a is lower than chlorophyll-a fluorescence both in shallow and deep waters.

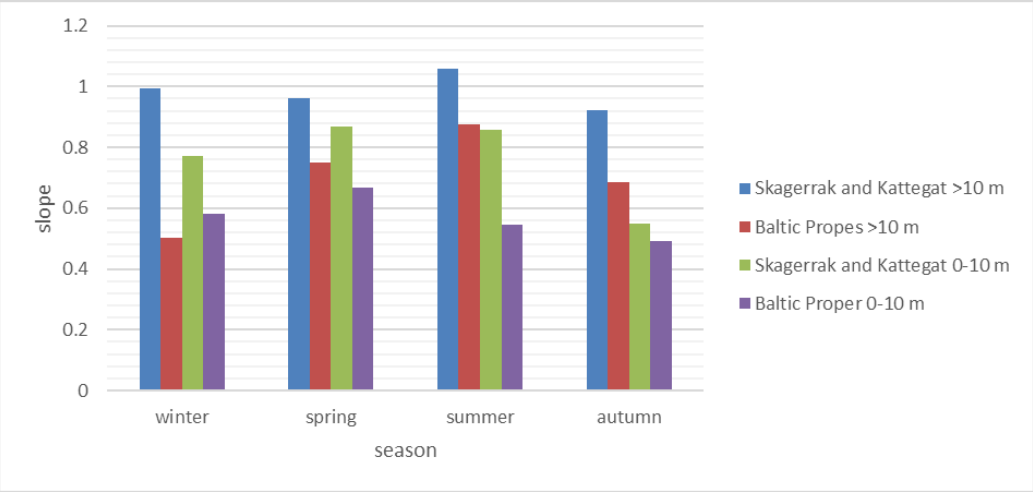
In the Skagerrak/Kattegat chlorophyll-a is lower than chlorophyll-a fluorescence only in shallow waters.

10-50 m

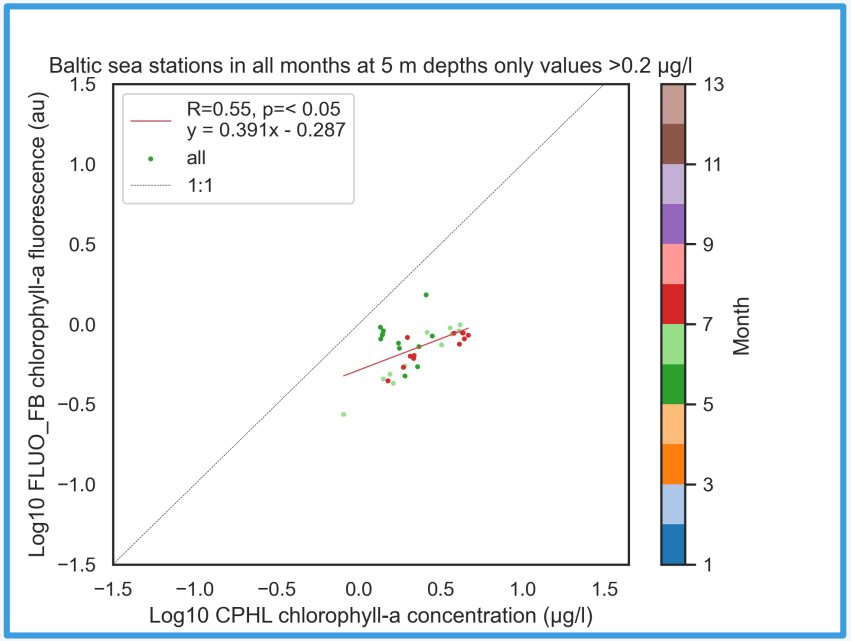


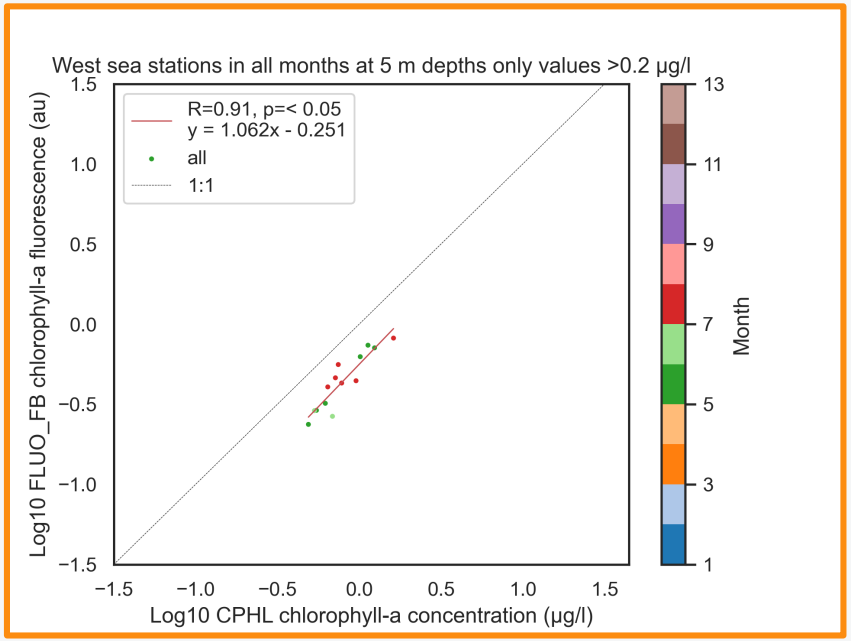


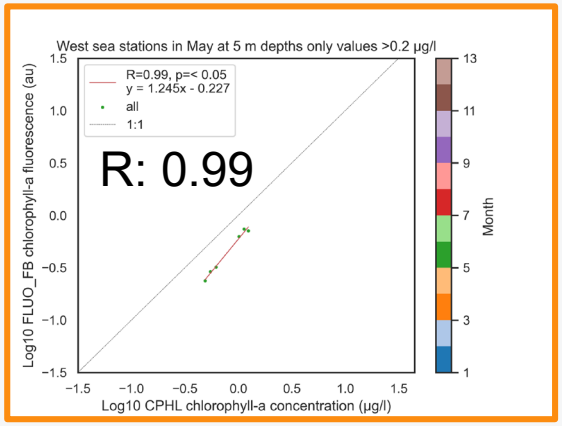
Overview of slopes in different depth ranges.

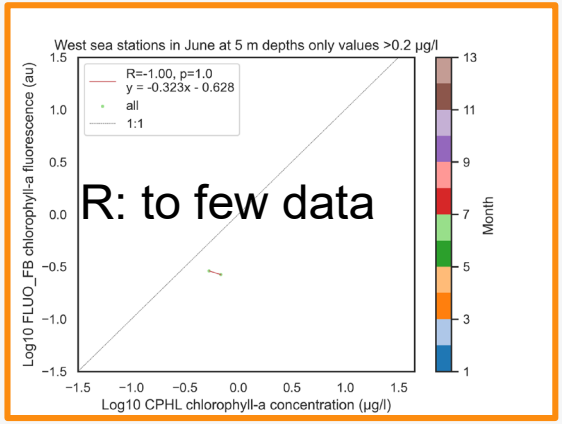


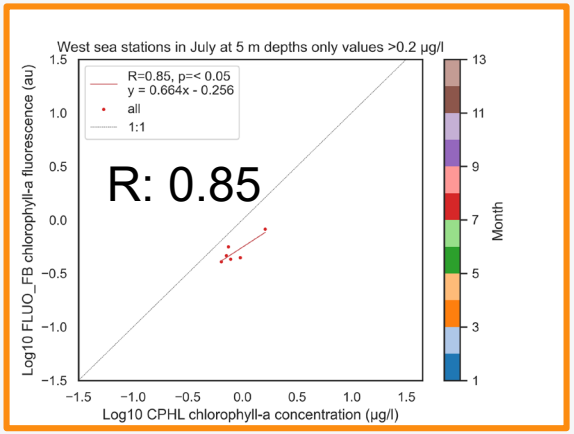
Ferrybox field calibration 2022

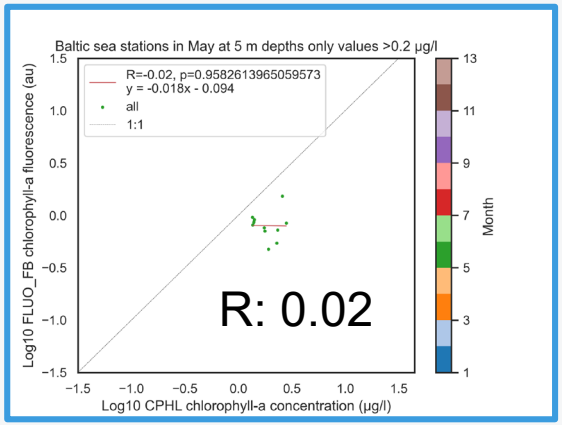


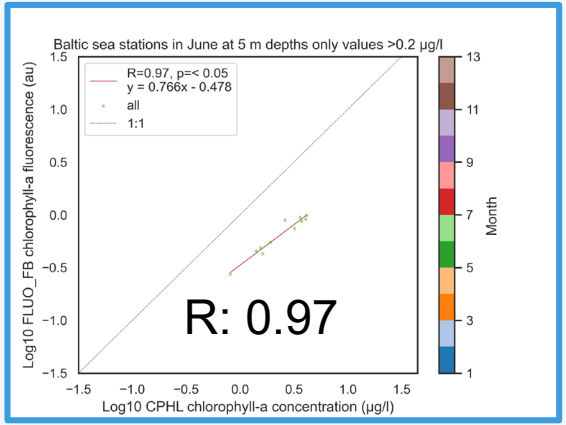


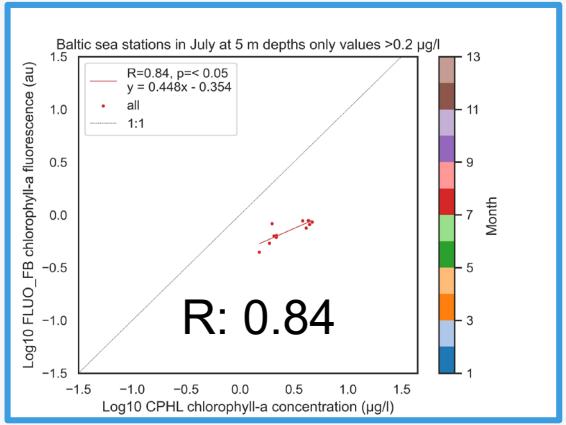

West sea stations in May at 5 m depths only values >0.2 µg/l
R=0.99, p=< 0.05
y = 1.245x - 0.227
all
1:1
R: 0.99
Log10 FLUO_FB chlorophyll-a fluorescence (au)
Log10 CPHL chlorophyll-a concentration (µg/l)
Month


West sea stations in June at 5 m depths only values >0.2 µg/l
R=-1.00, p=1.0
y = -0.323x - 0.628
all
1:1
R: to few data
Log10 FLUO_FB chlorophyll-a fluorescence (au)
Log10 CPHL chlorophyll-a concentration (µg/l)
Month


West sea stations in July at 5 m depths only values >0.2 µg/l
R=0.85, p=< 0.05
y = 0.664x - 0.256
all
1:1
R: 0.85
Log10 FLUO_FB chlorophyll-a fluorescence (au)
Log10 CPHL chlorophyll-a concentration (µg/l)
Month


Baltic sea stations in May at 5 m depths only values >0.2 µg/l
R=-0.02, p=0.9582613965059573
y = -0.018x - 0.094
all
1:1
R: 0.02
Log10 FLUO_FB chlorophyll-a fluorescence (au)
Log10 CPHL chlorophyll-a concentration (µg/l)
Month


Baltic sea stations in June at 5 m depths only values >0.2 µg/l
R=0.97, p=< 0.05
y = 0.766x - 0.478
all
1:1
R: 0.97
Log10 FLUO_FB chlorophyll-a fluorescence (au)
Log10 CPHL chlorophyll-a concentration (µg/l)
Month


Baltic sea stations in July at 5 m depths only values >0.2 µg/l
R=0.84, p=< 0.05
y = 0.448x - 0.354
all
1:1
R: 0.84
Log10 FLUO_FB chlorophyll-a fluorescence (au)
Log10 CPHL chlorophyll-a concentration (µg/l)
Month

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Conclusions

- The fit (R-value) between chlorophyll-a and chlorophyll fluorescence is better in the Skagerrak and Kattegat compared to the Baltic Proper.
- In the Baltic Proper the species composition leads to lower slope (higher chlorophyll-a compared to chlorophyll fluorescence) than in the Skagerrak and the Kattegat.
- A field calibration from a single cruise does not necessarily give a better fit than combining data from the same season/month from multiple years.

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Next steps

- For CTD-data calculate chlorophyll-a from chlorophyll fluorescence using the linear regression for each month using data from 2018-2022.
- For R/V Svea ferrybox, continue collecting water samples to make a similar field calibration for the ferrybox fluorescence sensor.
- Quality control the data from our phycocyanin and phycoerythrin sensors from Trios mounted on the R/V Svea Ferrybox to see if they can be used to give a better estimate of chlorophyll-a.