Experience from conversion («calibration») of Chl-a fluorescence data to Chl-a concentration in Ferrybox systems

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Jerico WP4 Workshop,

9th February, 2012 Helsinki

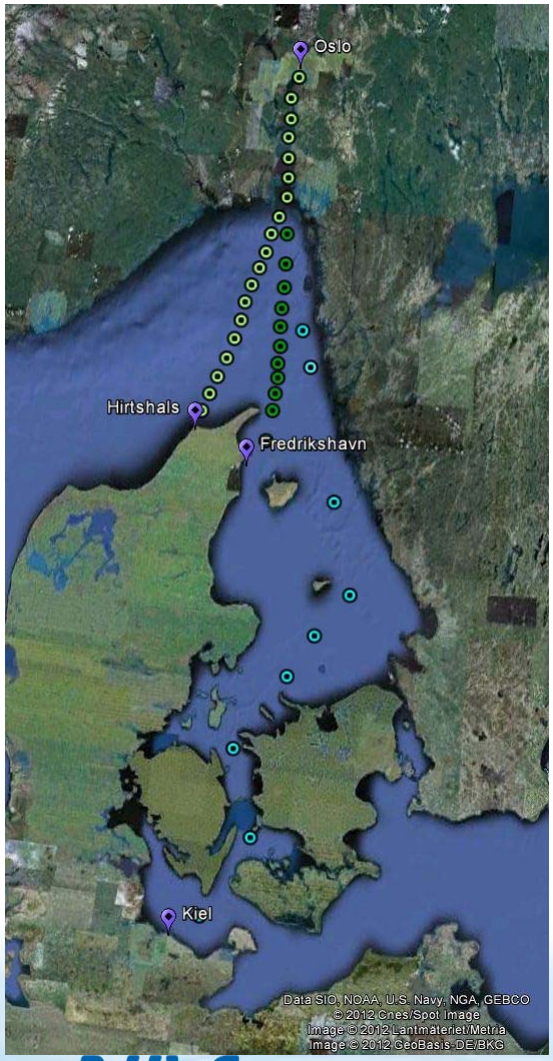
Motivation

- Conversion of *in vivo* fluorescence signal to Chl-a in a flow through Ferrybox system
- Improve the use of Chl-a_fl a “proxy” for Chl-a and phytoplankton biomass
- Using historical *in situ* and *in vivo* Chl-a-fl data from different investigations in Norway as part of project for “nature index”.

Content

- Introduction to the NIVA-Ferrybox system and sensors
- Variation in Chl-a_fl vs Chl-a_conc in Ferrybox systems
- Preliminary study of possible influence of environmental data and algal species on the Chl-a_fl signal vs Chl-a_conc.

Overview of the Norwegian Ferrybox routes and sensors



Variable/installation	Color Fantasy (Oslo-Kiel) NIVA	Bergensfjord (Hirtshals-Bergen) NIVA	Trollfjord (Bergen-Kirkenes), NIVA	Vesterålen (Bergen-Kirkenes), IMR	Norbjørn (Tromsø-Svalbard) NIVA
salinity					
water temperature					
water temperature Inlet					
oxygen					
oksygen inlet					
chlorophyll-a					
turbidity					
irradiance (PAR)					
radiance (sky)					
radiance (water)					
cyanobacteria					
cdom					
hydrocarbon					
air pressure					
true wind					
water sampler					

Status	In operation	Semioperational	Test installation	Under testing

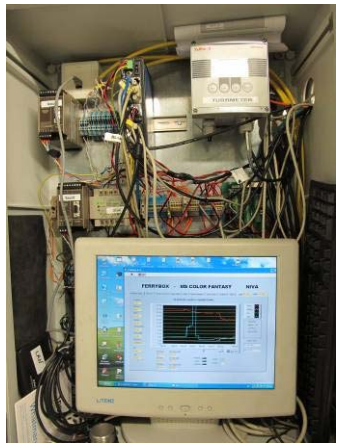
Ferrybox system on Color Fantasy

Pumpsystem, temp. and oxygen inlet

Temp., salinity, Oxygen

Algae, particles, diss. org. matr , oil

Water sampler



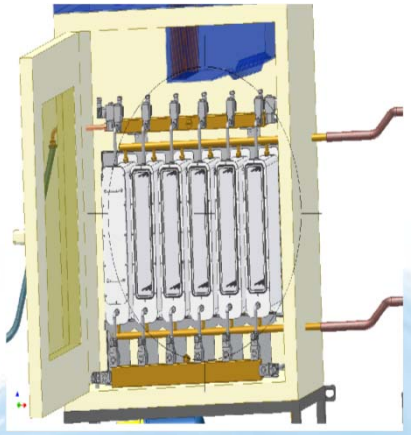
Communication, internal and to internet

Irradiance, Ed, Ld PAR, UV

Radiance, Lu, reflectance

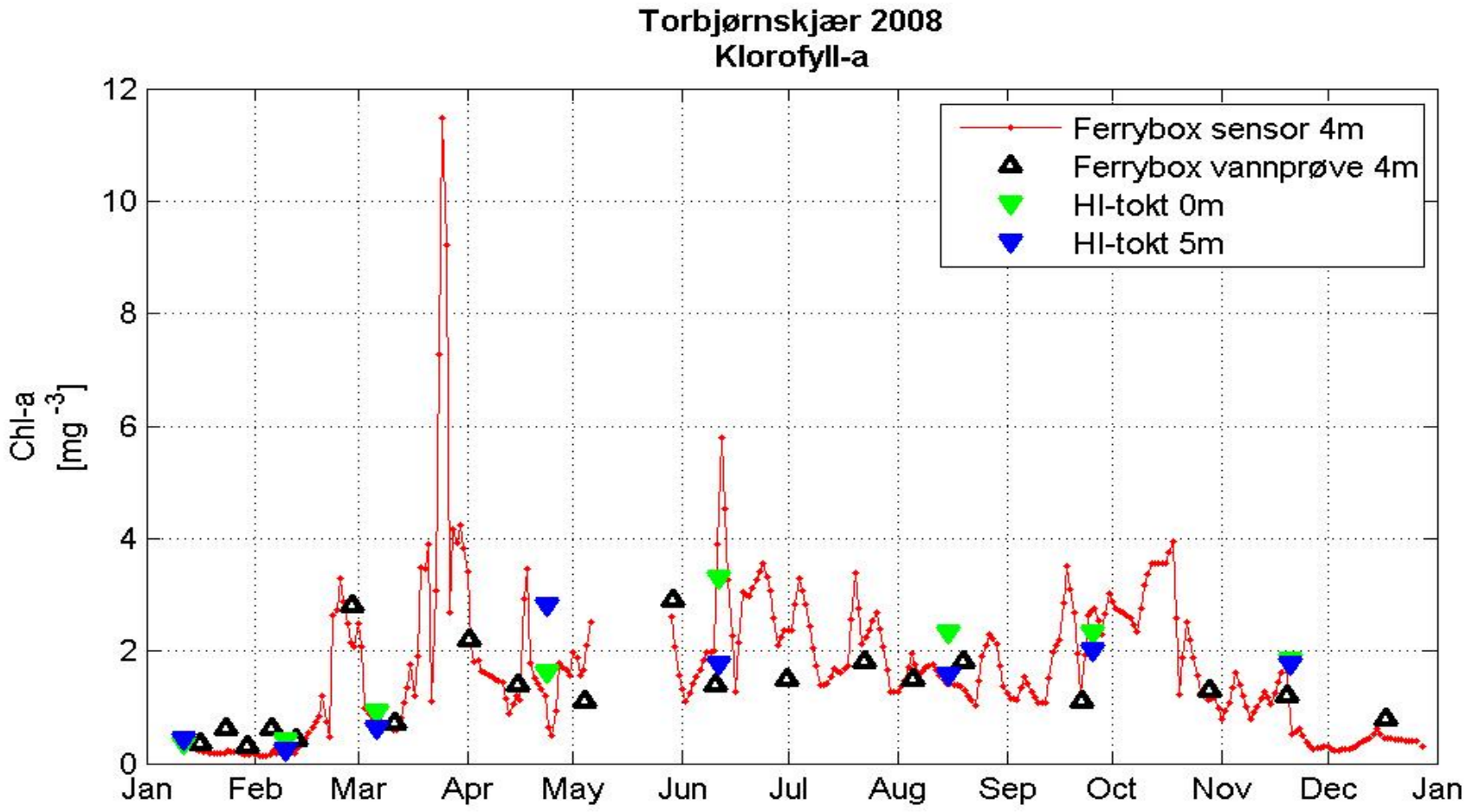
Wind, met. Obs

pCO2 , (pH under construction)



Passive sampler for contaminants under implementation

Validation of the chlorophyll-a fluorescence with monitoring data

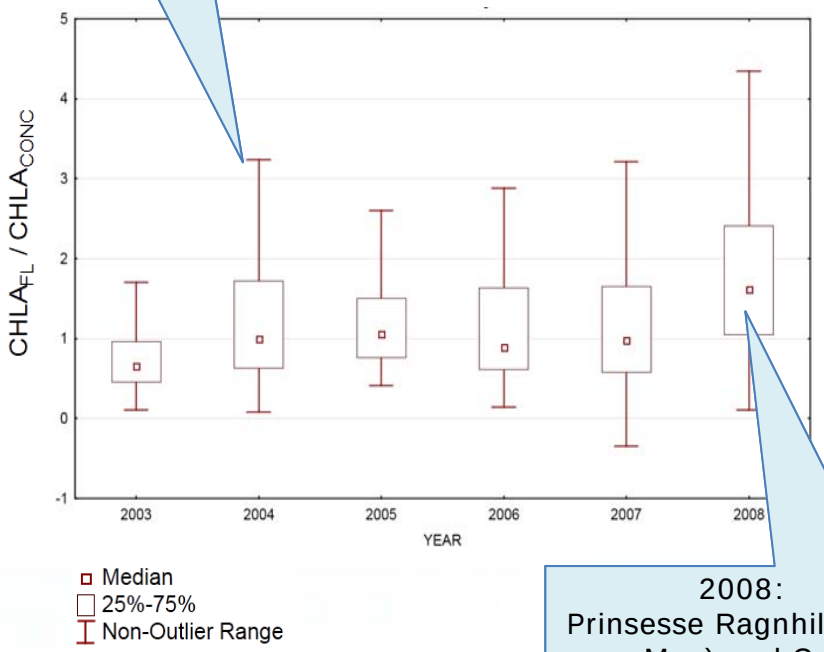


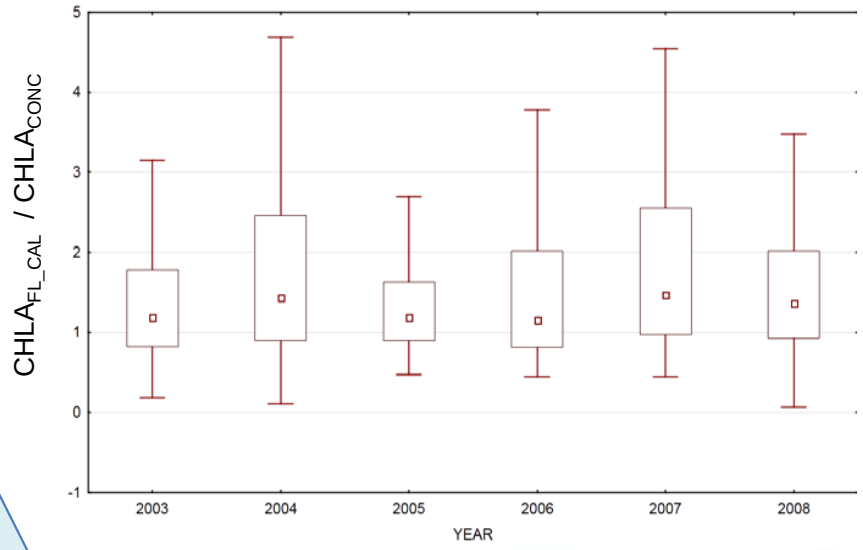
Yearly ratio of $CHLA_{FL}$ to $CHLA_{CONC}$

Sensor factory calibration + correction with from yearly linear regression using water samples

Color Festival (2003-2007) Seapoint sensor

$$CHLA_{FL\_CAL} = a_{CHL} \cdot CHLA_{FL} + b_{CHL}$$



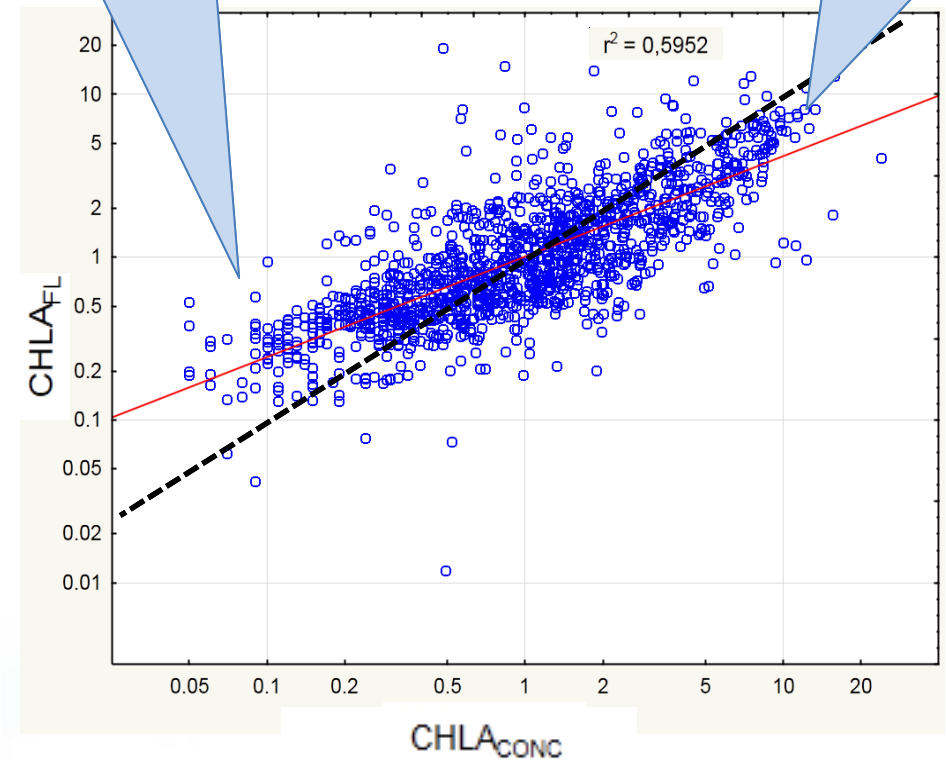


2008: Prinsesse Ragnhild (Jan – May) and Color Fantasy (May- Dec) Few data with TriOS in this dataset

Ferrybox Chl_a time-series 2002-2008

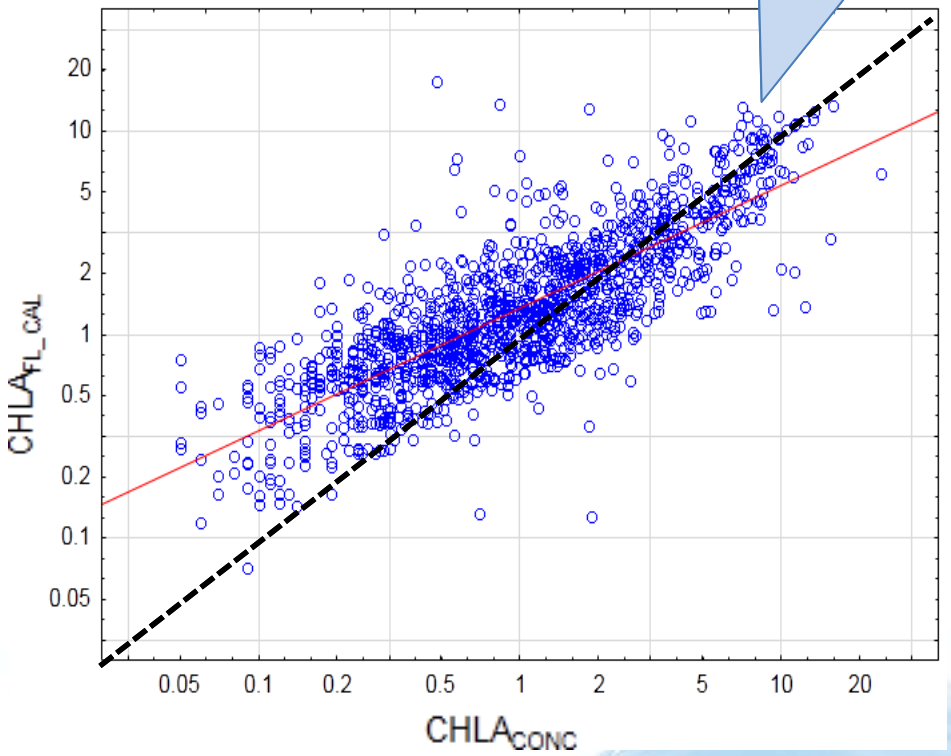
Fluorescence high at small concentrations

Fluorescence low at high concentrations



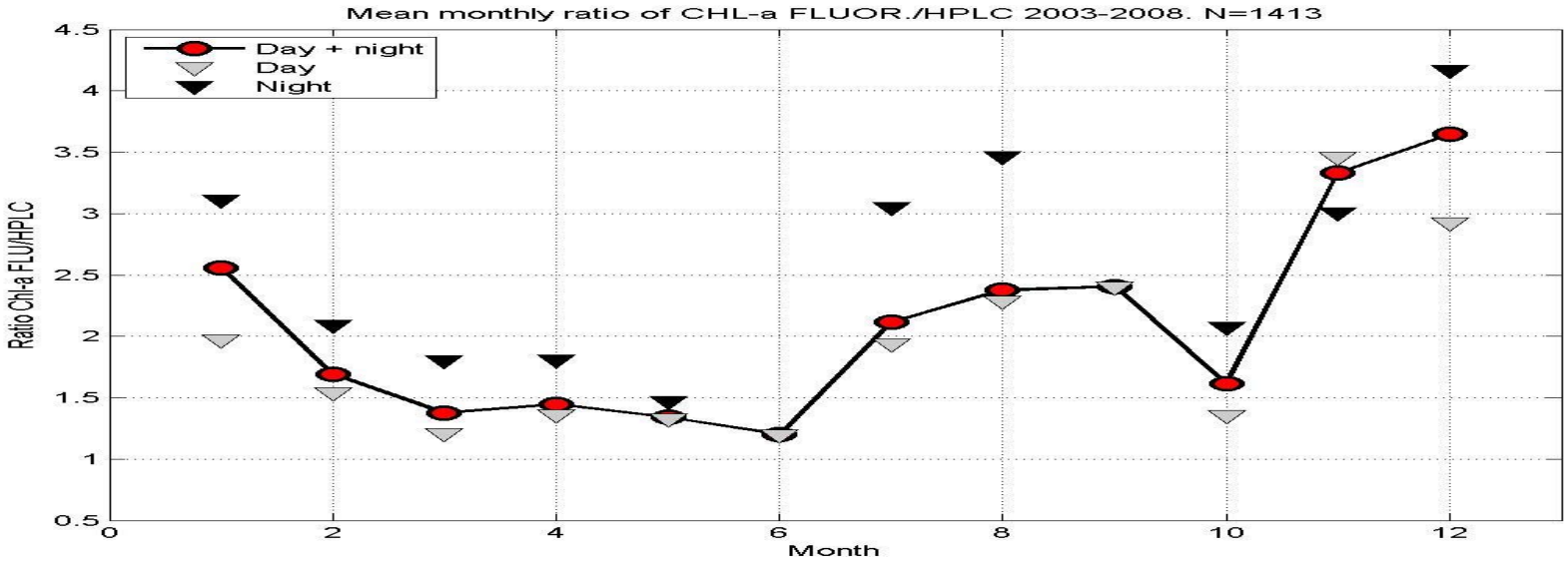
No yearly calibration of the fluorescence

Better match at high concentrations



With yearly calibration of the fluorescence

FerryBox seasonal and night and day variation



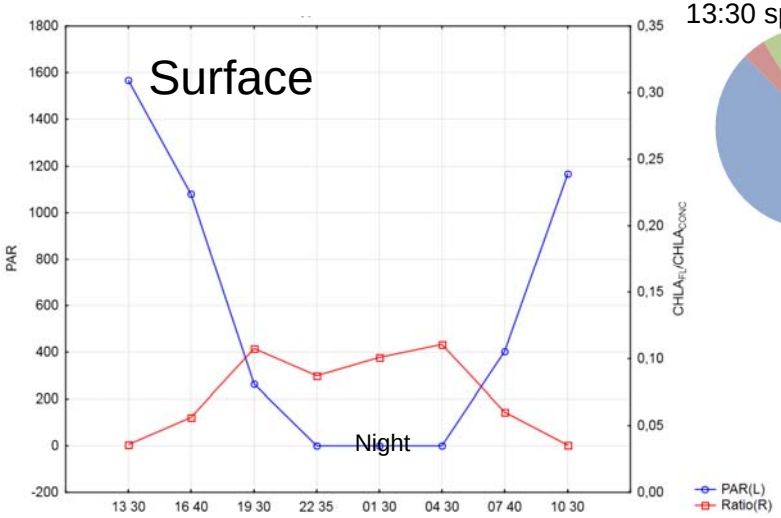
Yearly calibration of the Chl-a fluorescense using all the Chl-a_hplc water samples

- Most months show the same trend:
  - High ratio at night
  - Lower ratio at daytime

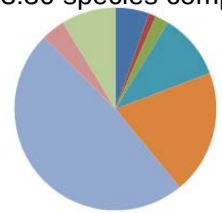
Fluctuations in $CHLA_{FL}$ / $CHLA_{CONC}$

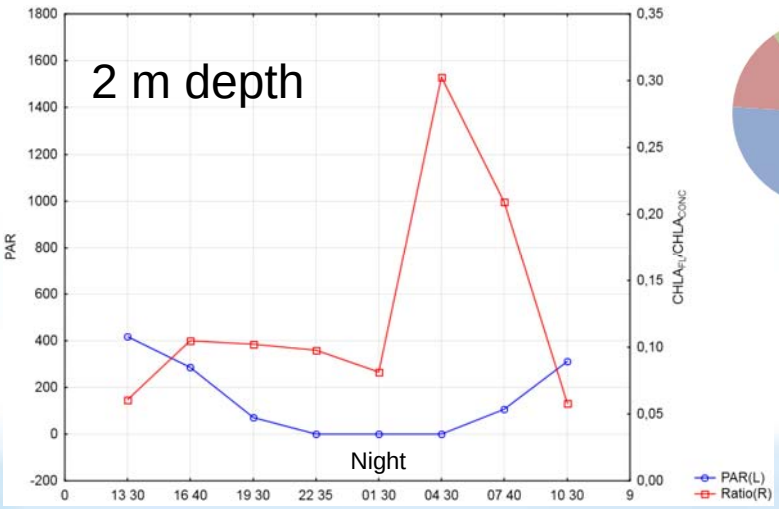
- Problem for using Chla_fl as phytoplankton biomass estimation
- Search for “solutions” in Ferrybox data series and other dataset/time-series from other investigations using data on:
  - PAR
  - Day length
  - Temperature
  - Species composition
  - Nutrients (not in this study)
  - Prim. production (not in this study)

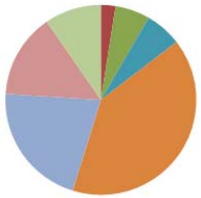
Diel variation in Chl-a fluorescence (Oslofjord, Bomannsvikstation April 1984)



13:30 species comp:



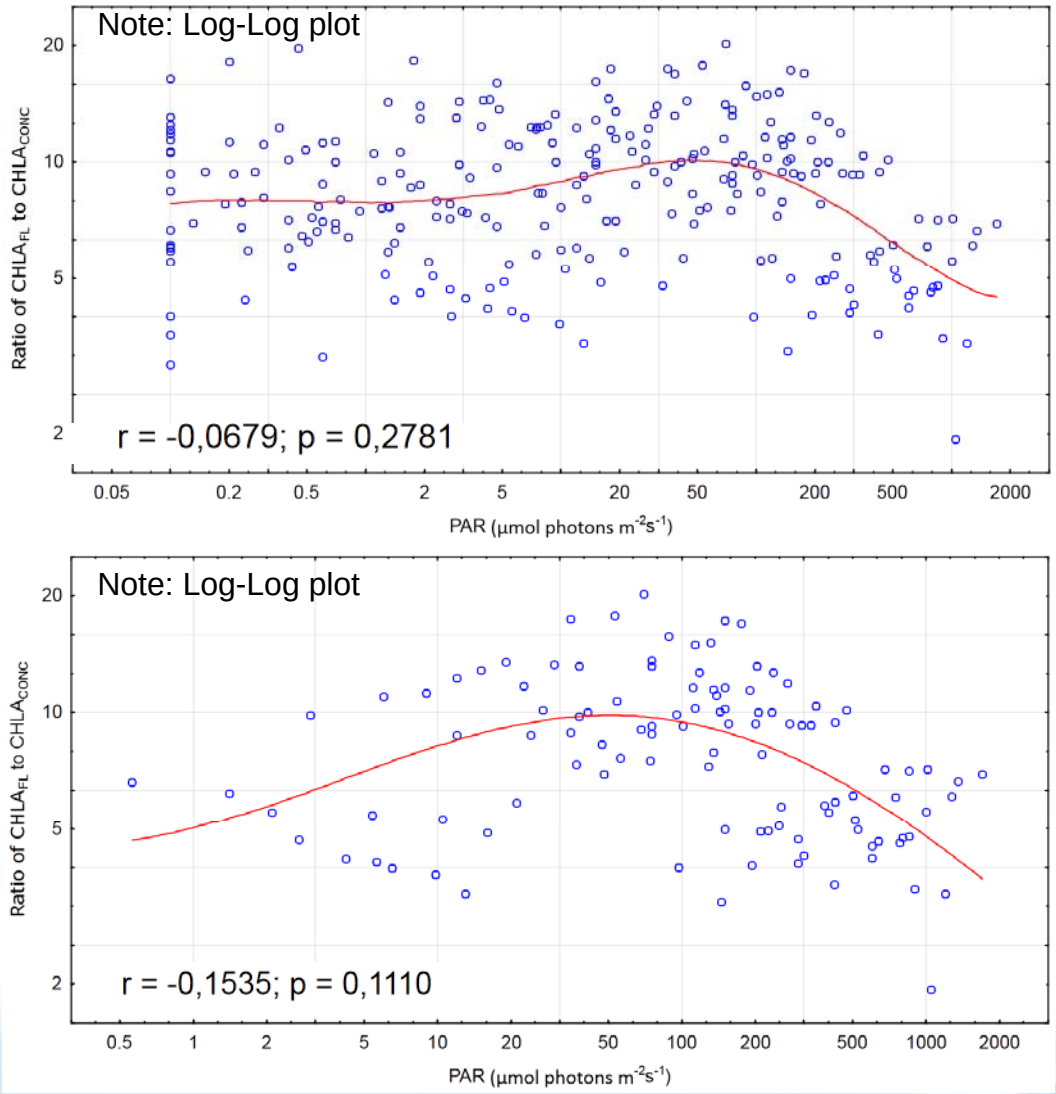




- Thalassiosira nordenskioldii
- Thalassiosira spp. (dom antarctica)
- Chaetoceros decipiens → 4-10 chloroplasts/cell
- Chaetoceros mitra → 4-10 chloroplasts/cell
- Chaetoceros debilis → 1 chloroplast/cell
- Chaetoceros laciniosus → 2 chloroplasts/cell
- Chaetoceros sp. dom socialis → 1 chloroplast/cell
- Skeletonema costatum
- Detonula pumila

Source: Carmelo R. Tomás
Identifying marine diatoms and dinoflagellates

One year of variation in Chl-a fluorescence (Norwegian fjord, Kårstø 1981)



Variation in $CHLA_{FL}$ / $CHLA_{CONC}$ according to light

Monthly depth profiles at 3 stations (Surf to 0,1% light depth).

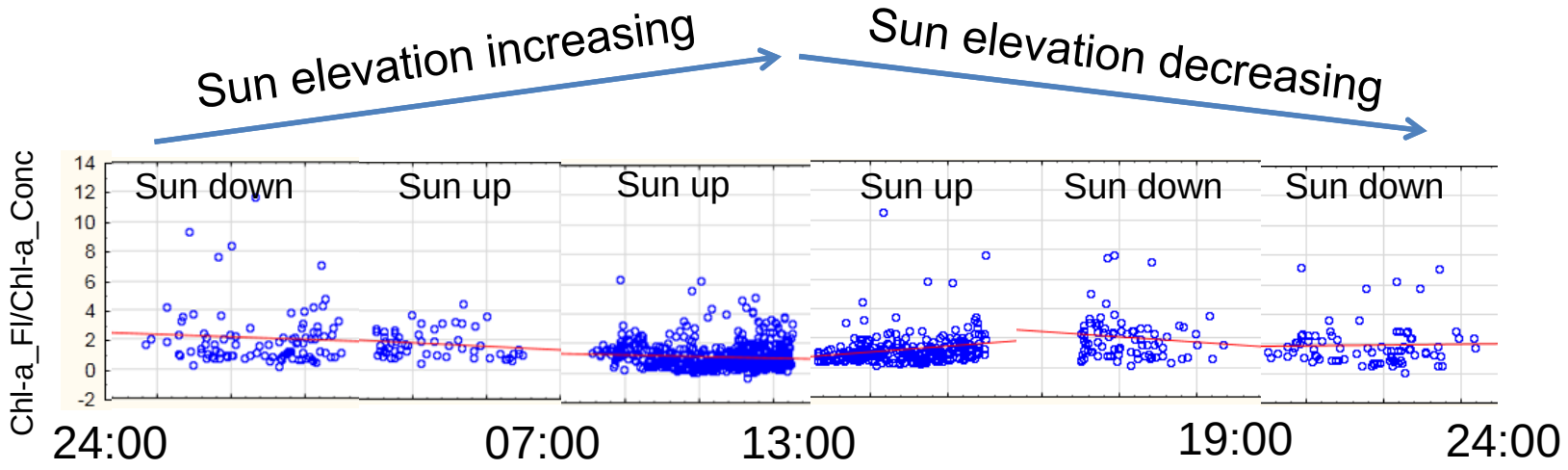
In vitro fluorometric determination of $CHLA_{CONC}$

Variosens-Fluorometer used for in situ determination of $CHLA_{FL}$

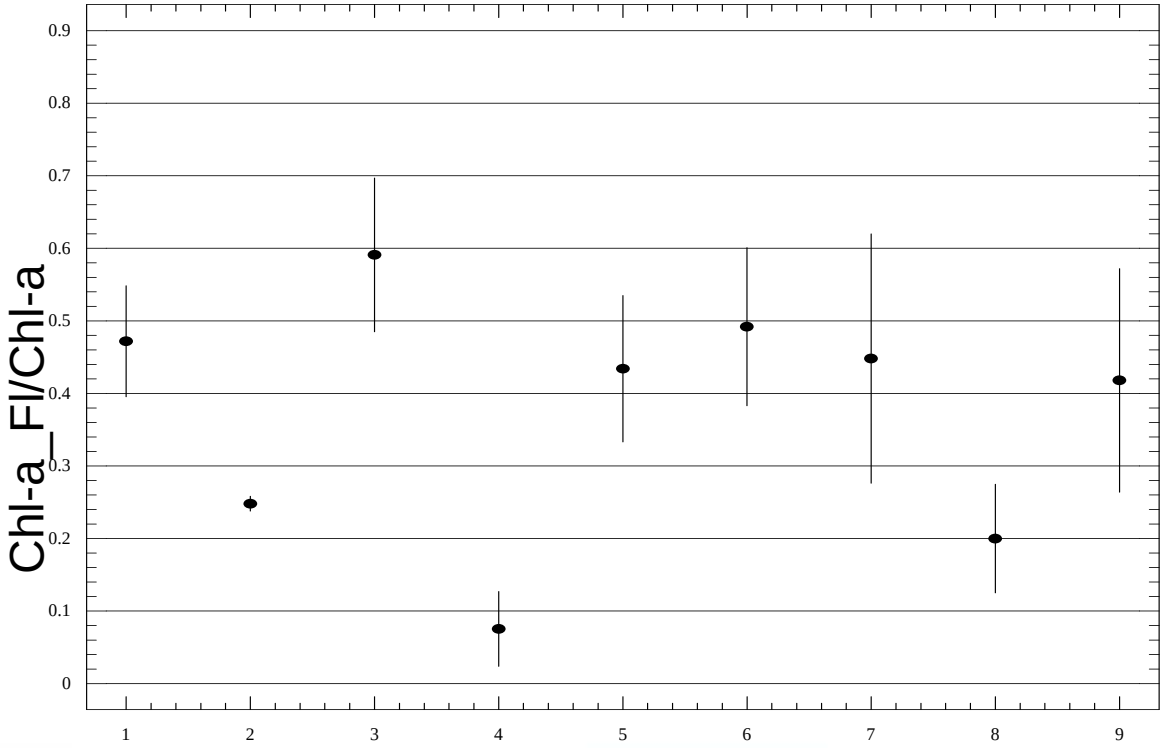
On top: No trend when looking at the data from all depths

Bottom: Sorted for 0-5 m data seems to give a clearer trend

FerryBox – Light vs Chl-a_fl/Chl-a_conc



Variation of Chl-a_Fl/Chl-a for algal culture



Algal culture

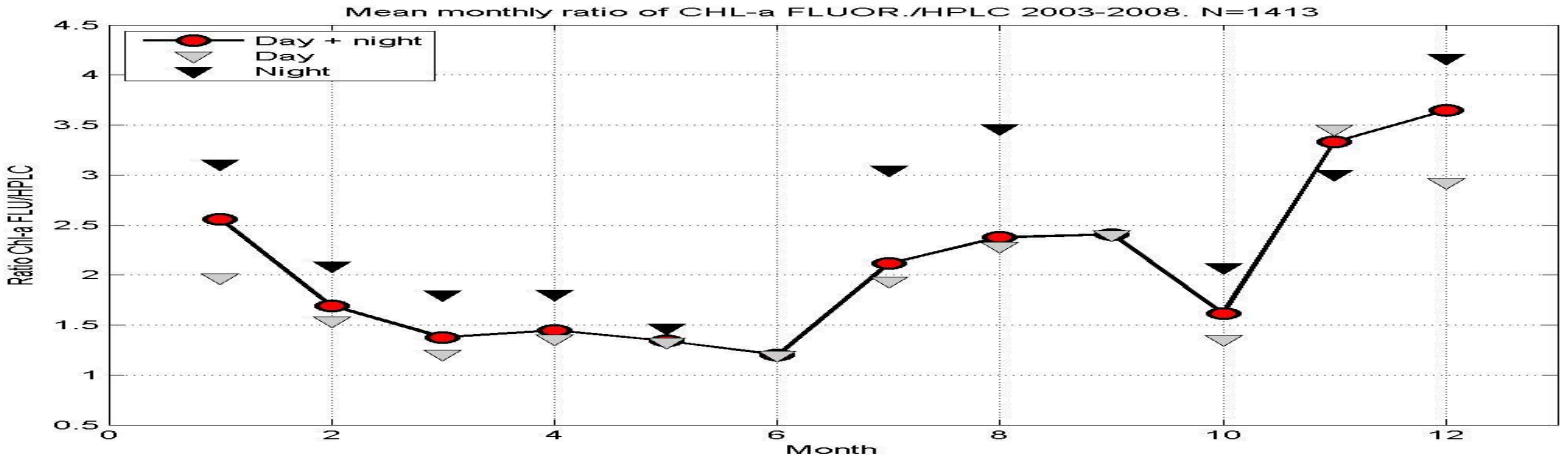
Determined during dark adapted algal from a exponetial growing algal culture

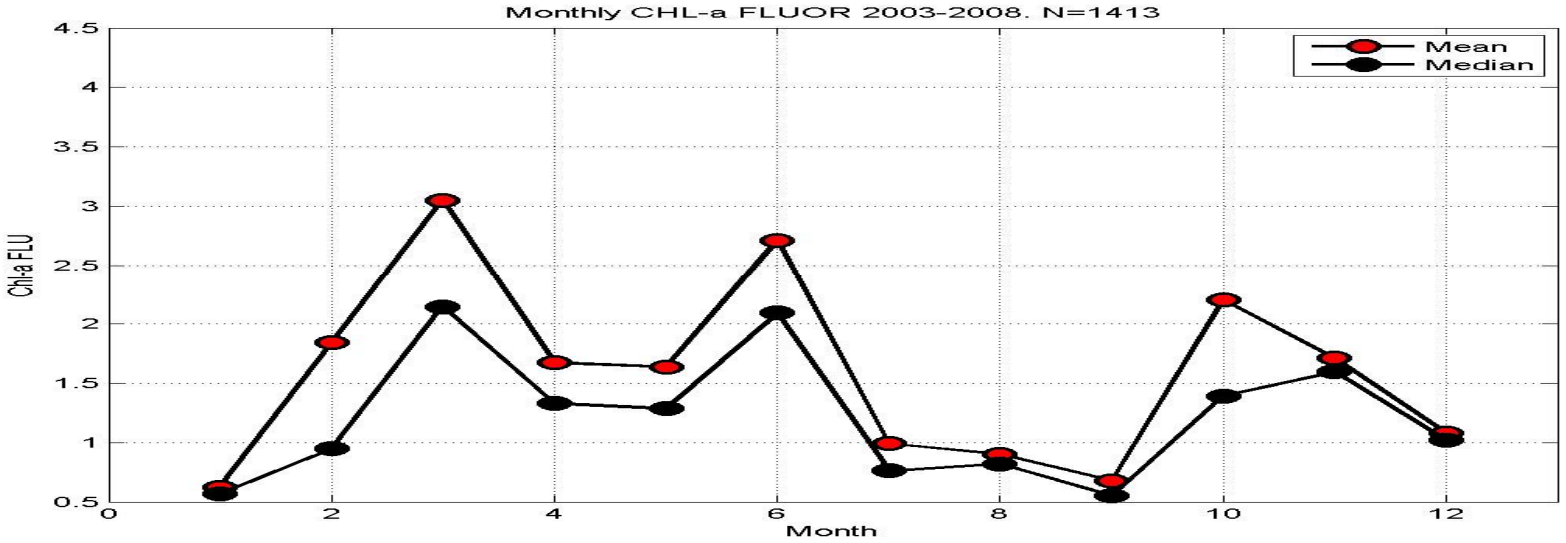
Factor 6 all species tested

Factor 2.5- 3 for Norw. waters

Nr.	Algekulturer
1	Chrysochromulina polylepis
2	Dunaliella tertiolecta
3	Emiliania huxleyi
4	Oscilatoria agardii
5	Prorocentrum minimum
6	Prymnesium parvum
7	Phaeodactylum tricornutum
8	Selenastrum capricornutum
9	Skeletonema costatum

Chl-a_fl/Chl-a and Chl-a





Summary

- Trends in Ferrybox timeseries show variation in Chl-a_Fl/Chl-a_conc in the order of 3-3.5.
- Variation vs PAR show lower ratio with higher PAR (above ~100).
- Sun Zenit indicate lower ratio at daytime vs night
- Algal culture show variation up to 6 (3 for dominating marine plankton in Norw. Waters)
- Increasing domiance of nano- og picoflagellates indicate increased ratio.
- Dinoflagellates indicate lower ratio
- Temp effect difficult to see any trends in the data