

# Harmful Algal Bloom studies in JERICO-NEXT

The presentation takes about 5 minutes, it will repeat.

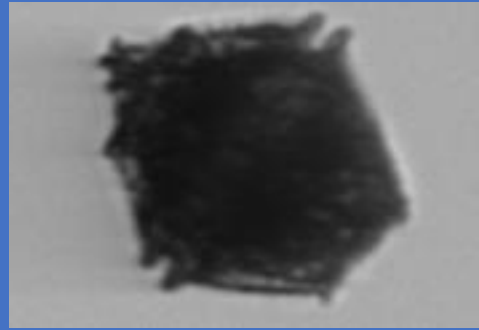
Bengt Karlson and Felipe Artigas

Contributions from: Hedy Aardema, Michael Brosnahan, Reinhoud de Blok, Pascal Claquin, Florent Colas, Veronique Créach, Klaas Deneudt, Wenche Eikrem, Gérald Grégori, Jacco Kromkamp, Soumaya Lahbib, Alain Lefebvre, Sirpa Lehtinen, Fabrice Lizon, Arnaud Louchart, Pierre Marrec, Klas Möller, Emilie Poisson-Caillault, Machteld Rijkeboer, Thomas Rutten, Suvi Rytövuori, Jukka Seppälä, Lars Stemmann, Melilotus Thyssen, Lennert Tyberghein, Guillaume Wacquet and Pasi Ylöstalo.

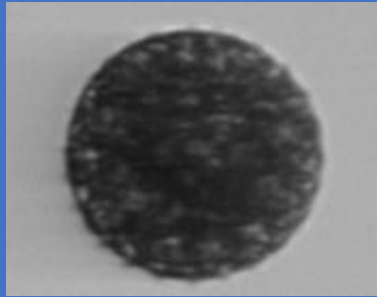
“The complexity of the coastal ocean cannot be well understood if interconnection between physics, biogeochemistry and biology is not guaranteed. Such an integration requires new technological developments allowing continuous monitoring of a larger set of parameters.”  
(The JERICO-RI consortium, 2014)

# Harmful algae in focus

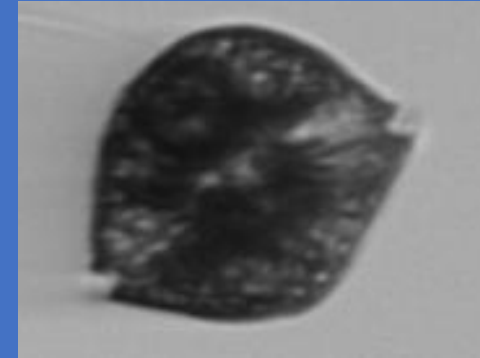
IFCB images



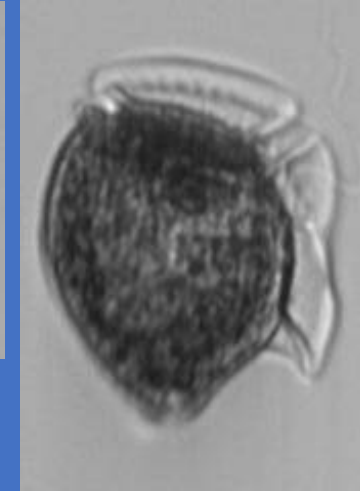
*Lingulodinium polyedra*



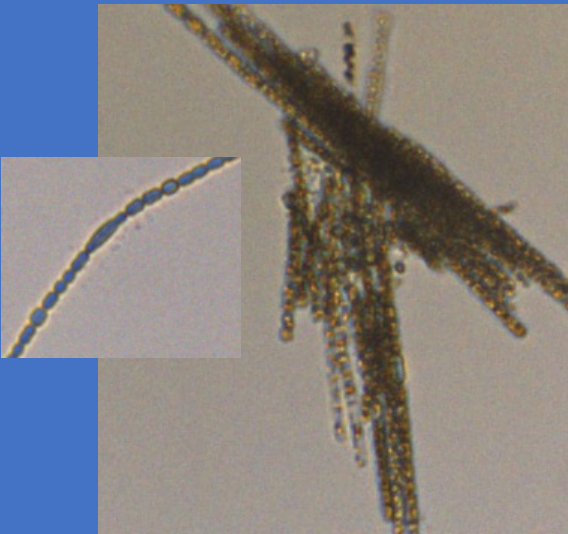
*Dictyocha speculum*



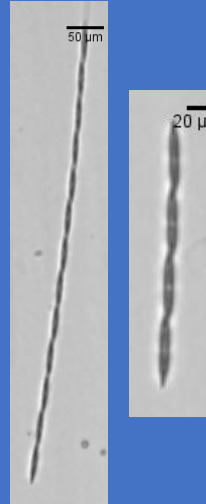
*Alexandrium  
pseudogonyaulax*



*Dinophysis* spp.



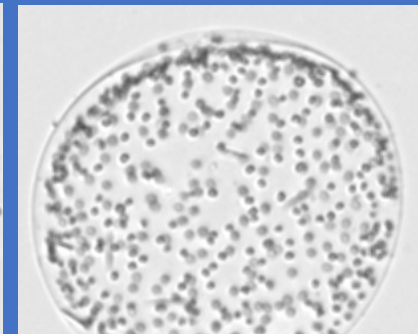
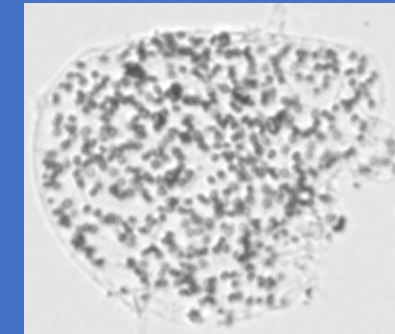
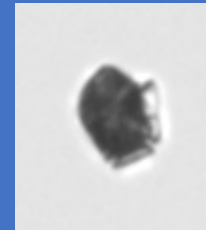
FlowCAM images  
*Cyanobacteria*



FlowCAM images  
(overall magnification: 40X)  
*Pseudo-Nitzschia* spp.



FlowCAM images  
(overall magnification: 40X)  
*Dinophysis* spp.



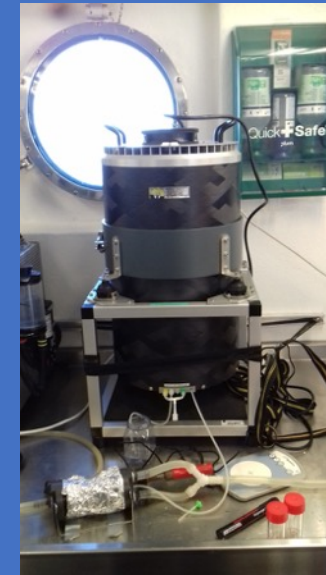
FlowCAM images  
(overall magnification: 40X)  
*Phaeocystis* spp.

# Novel methods for automated *in situ* observations of HAB, phytoplankton abundance and diversity

FlowCAM Benchtop B2 Series  
(Fluid Imaging Technologies, Inc)



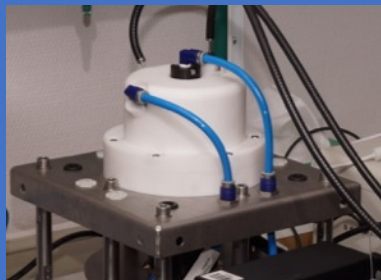
FRRF



Pulse Shape Flow  
Cytometry  
CytoSense



In flow imaging  
FlowCam



Multi wavelength  
absorbtion



Multi-wavelength  
fluorometry

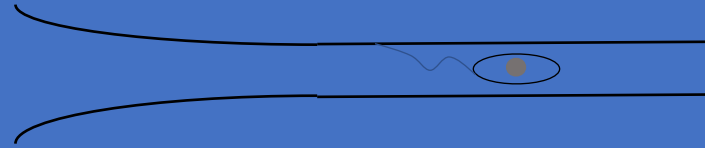
Imaging Flow Cytometry  
Imaging Flow Cytobot



# In vivo/in situ automated approaches for observing phytoplankton

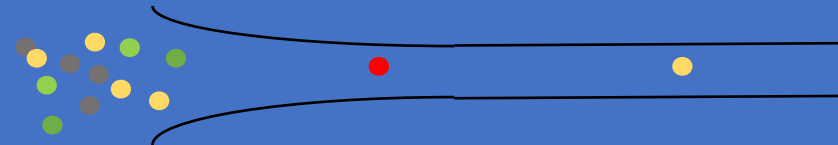
## Imaging/in flow

Single cells -  
size and  
morphology  
of organisms



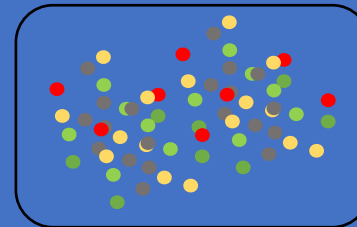
## Automated flow cytometry (pulse shape-recording)

Single cells -  
fluorescence -pigment  
content and  
scattering  
(size, shape)



## Fluorescence and absorption (multi-spectral)

Pigment based methods  
- bulk properties +  
**Variable fluorescence**  
(photosynthetic  
parameters)



## Case study areas

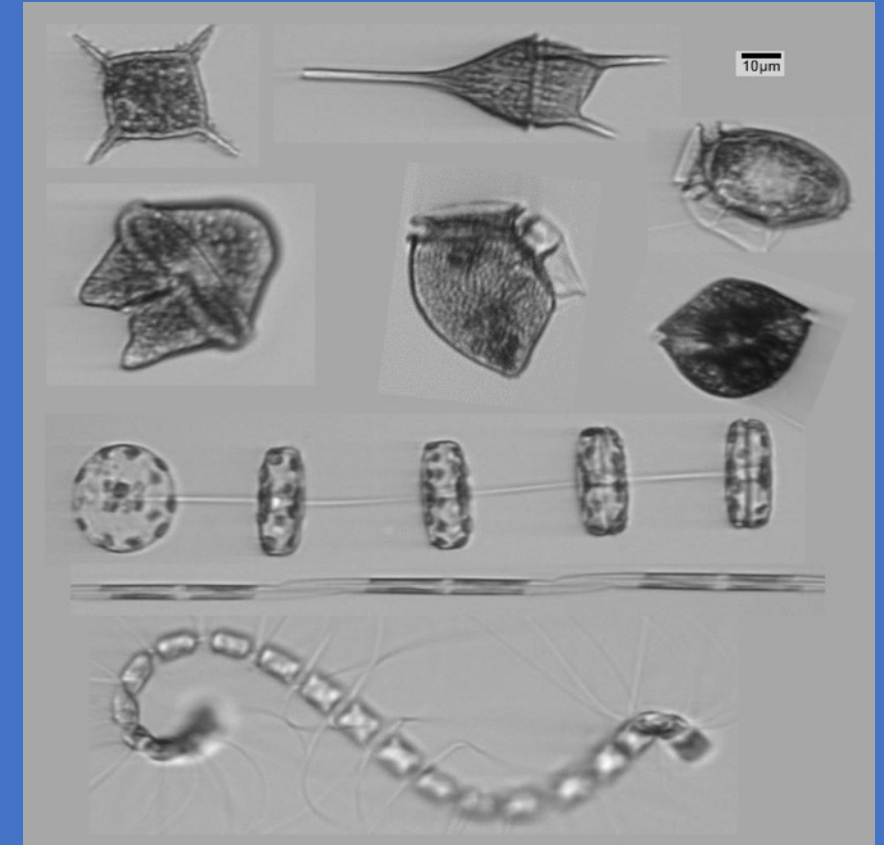
Baltic Sea

Kattegat-Skagerrak

North Sea – English Channel – British Isles

Western Mediterranean

# The Tångesund observatory

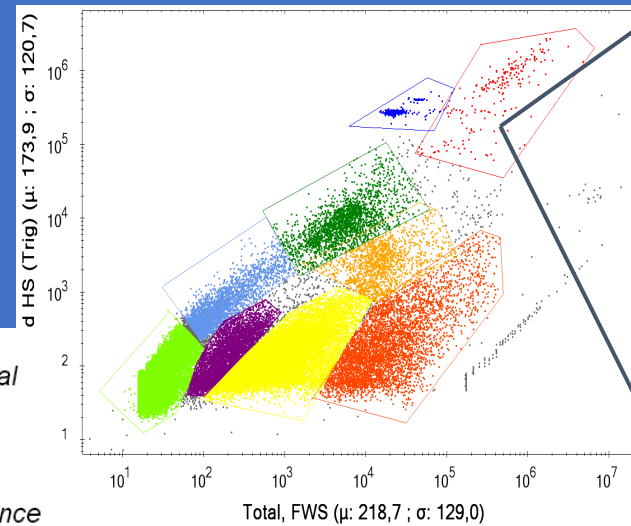
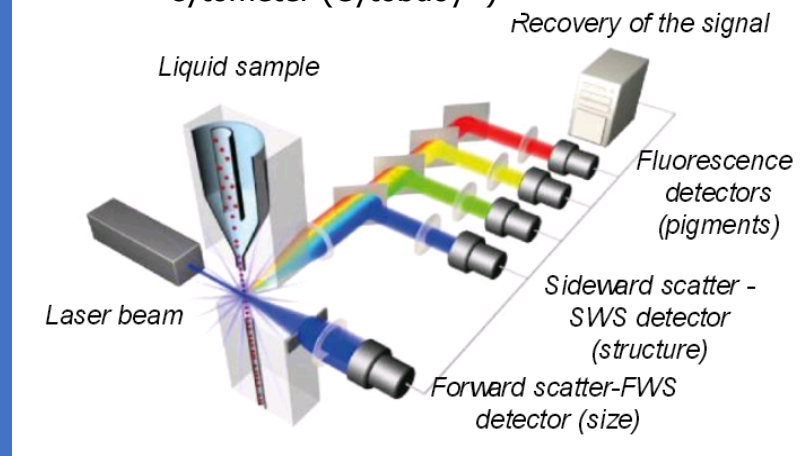


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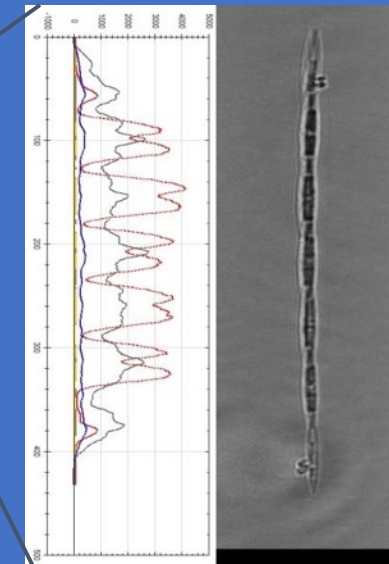
# Single-cell analysis: Pulse-shape recording flow cytometry + imaging



The CytoSense flow cytometer (Cytobuoy©)



Cytogramme :  
Multidimensional  
representation of all cells  
analysed according to their  
optical features.



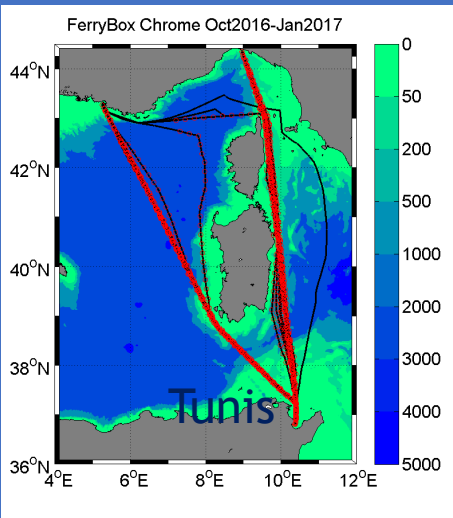
Optical profile (fluorescence,  
forward scatter and sideward  
scatter) of a particle (colony  
of *Pseudonitzchia* sp.) and  
associated image

Contact persons:  
Felipe Artigas  
Machteld Rijkeboer  
Veronique Creach  
Melilotus Thyssen  
Klaas Deneudt

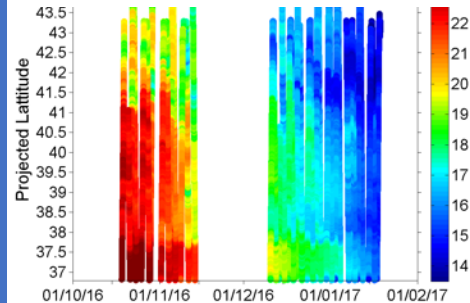


# High resolution phytoplankton community structure in the Mediterranean= MIO/INSTM

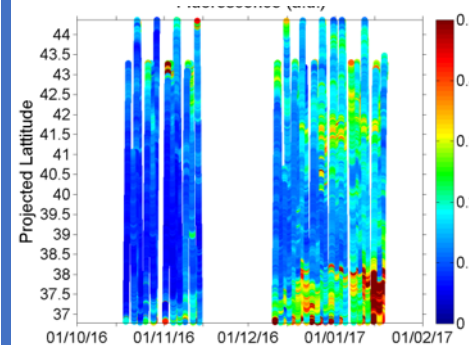
Pierre Marrec, Gérald Grégori, Soumaya Lahbib, Sana Ben Ismail, Cherif Sammari, and Melilotus Thyssen



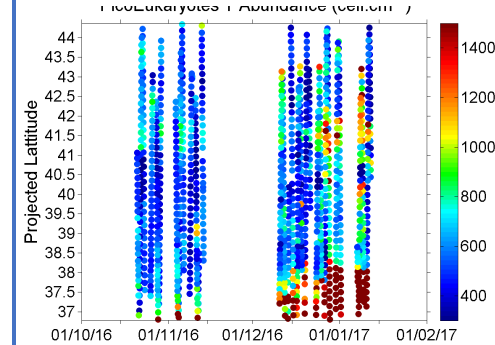
Sea Surface Temperature (°C)



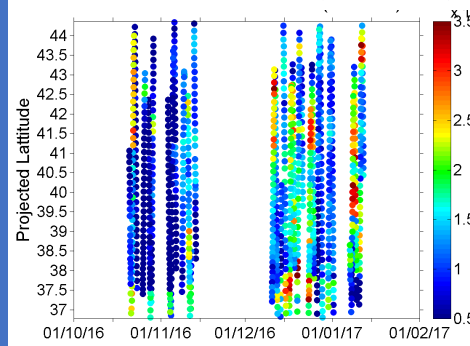
Fluorescence (r.f.u.)



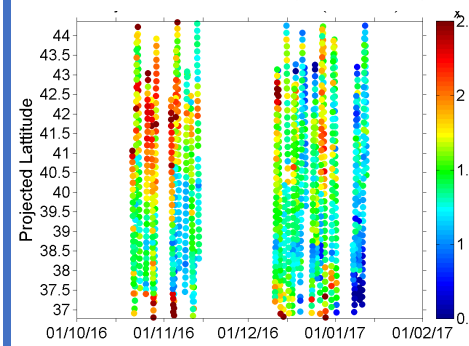
PicoEukaryotes (cell/ml)



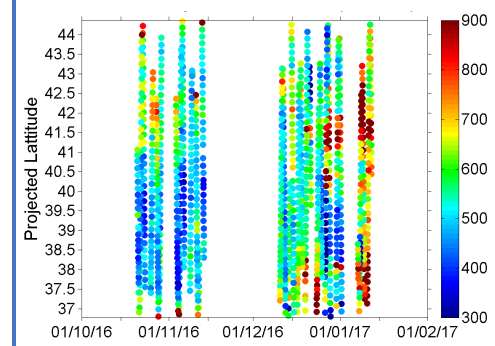
Prochlorococcus (cell/ml)



Synechococcus (cell/ml)



NanoEukaryotes (cell/ml)



32 crossings from October 2016 to January 2017 with the flow cytometer.

= 1091 analyses performed resolving up to 10 functional groups.

Continuous and High Resolution Observation of the Mediterranean Sea



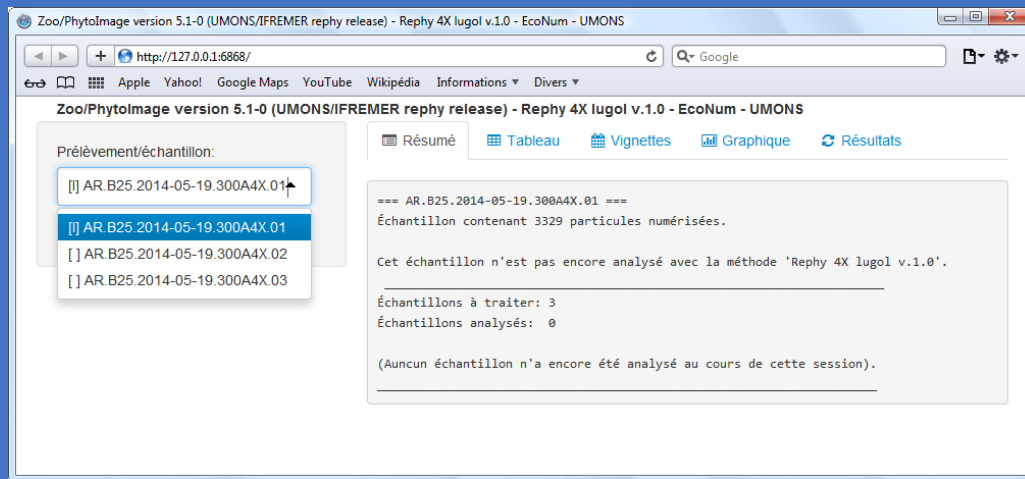
Contact person:  
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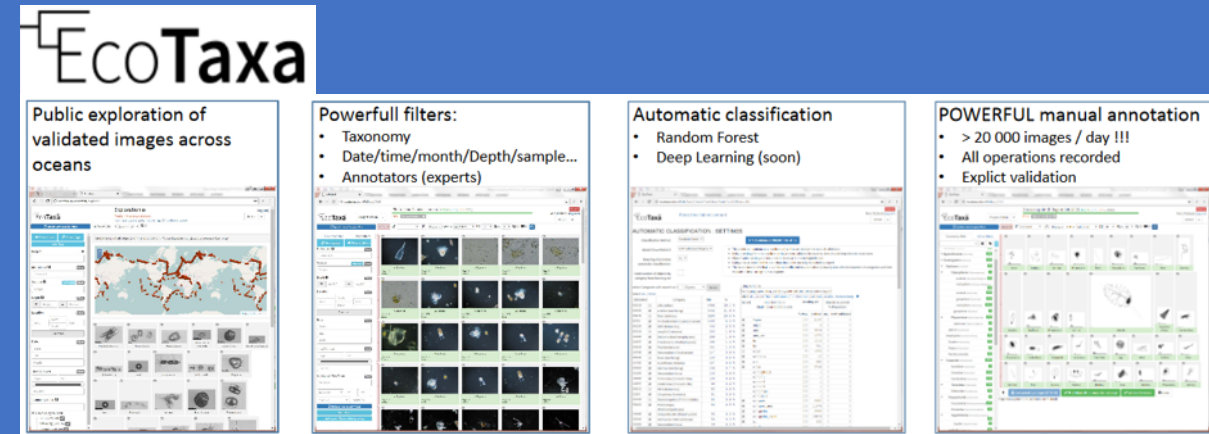
# Open source software for automated analysis of large amount of images of microalgae

ZooImage: a R-package for image analysis and classification

EcoTaxa: a web-based application for collaborating on large plankton image dataset



- ✓ Free software written in R, and specialized in classification of digital images of zoo- or phytoplankton.
- ✓ For any kinds of plankton images, i.e. from FlowCAM, ZooSCAN, micro- or macrophotography.



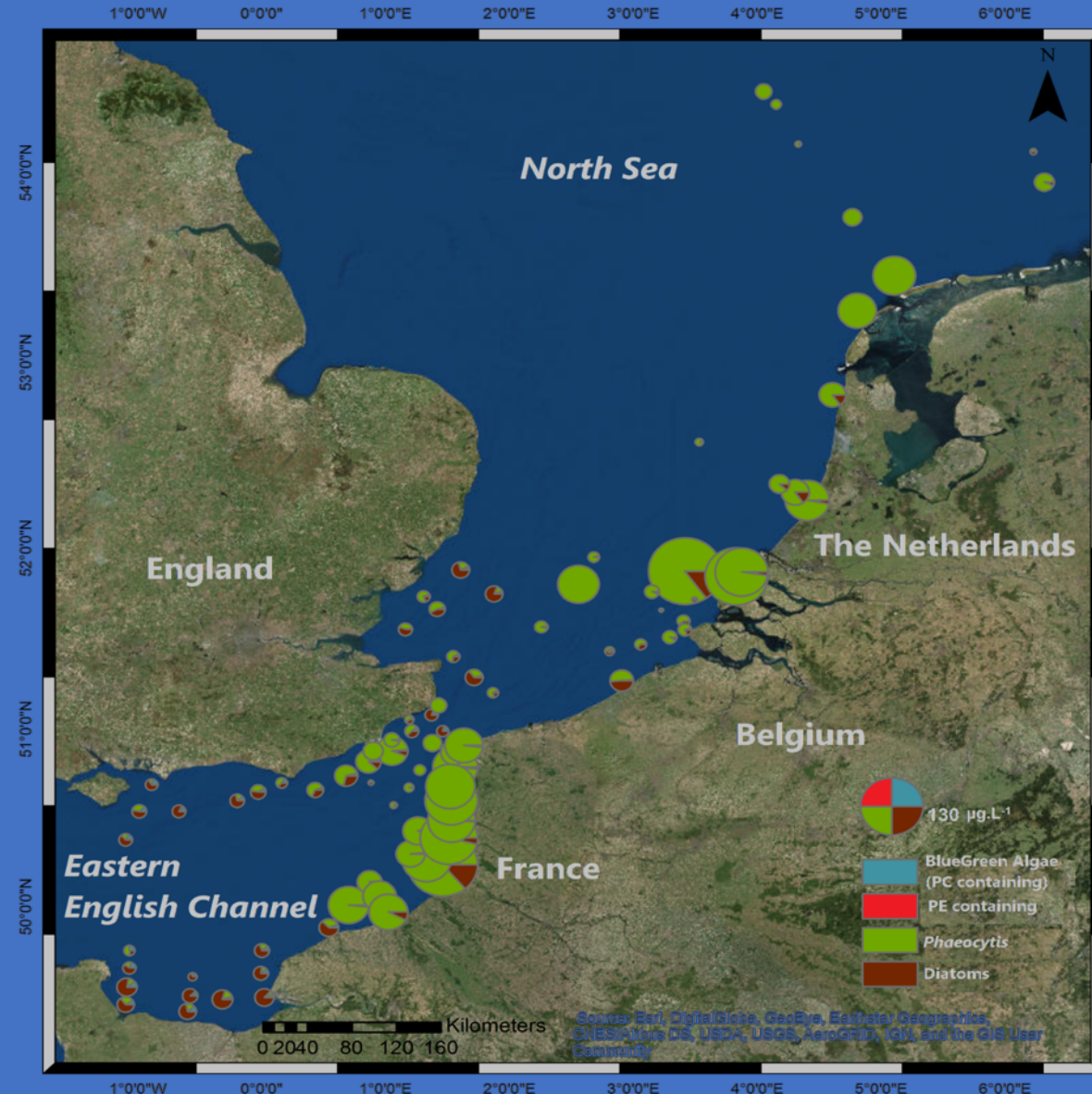
- ✓ It handles images of individual organisms and proposes identifications using « machine learning » algorithms.
- ✓ Today, it is considered as the most important worldwide dataset of annotated plankton images.

Contact persons:  
Guillaume Wacquet and Lars Stemann



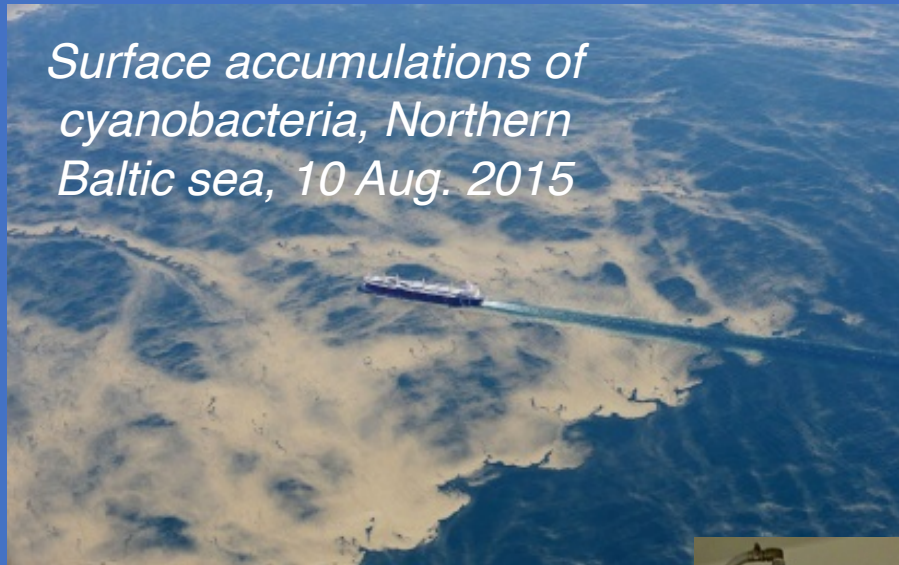
# Phytoplankton groups defined by Fluoroprobe

*Chlorophyll a equivalents (total and per group) addressed by multispectral fluorometry (Fluoroprobe bbe): discrimination of 4 pigmentary groups (Haptophytes, brown algae, phycocyanin and phytococerythrin-containing cells) during the 2017-spring blooms*



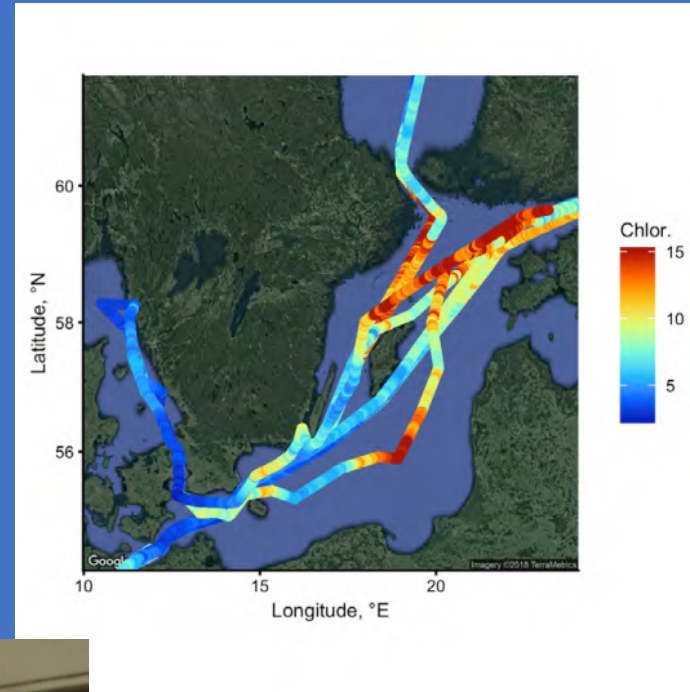
Contact persons:  
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# Chlorophyll and phycocyanin fluorescence - tools for observing HAB based on pigments



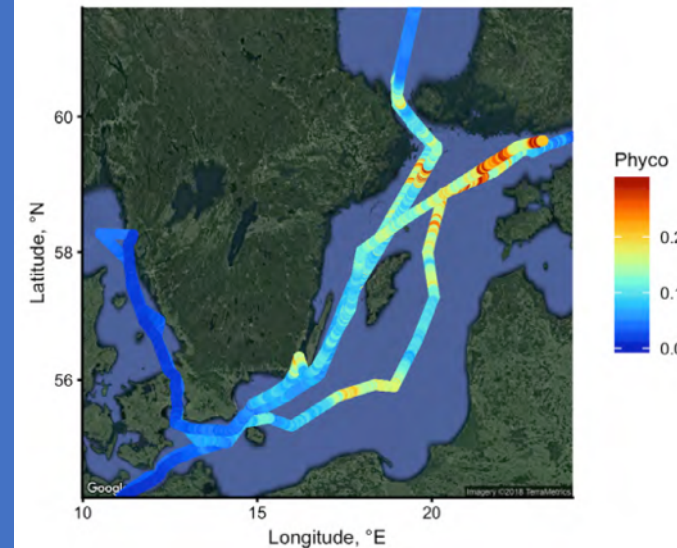
*Surface accumulations of cyanobacteria, Northern Baltic sea, 10 Aug. 2015*

*Photo by the Swedish Coast Guard*



Chlorophyll fluorescence

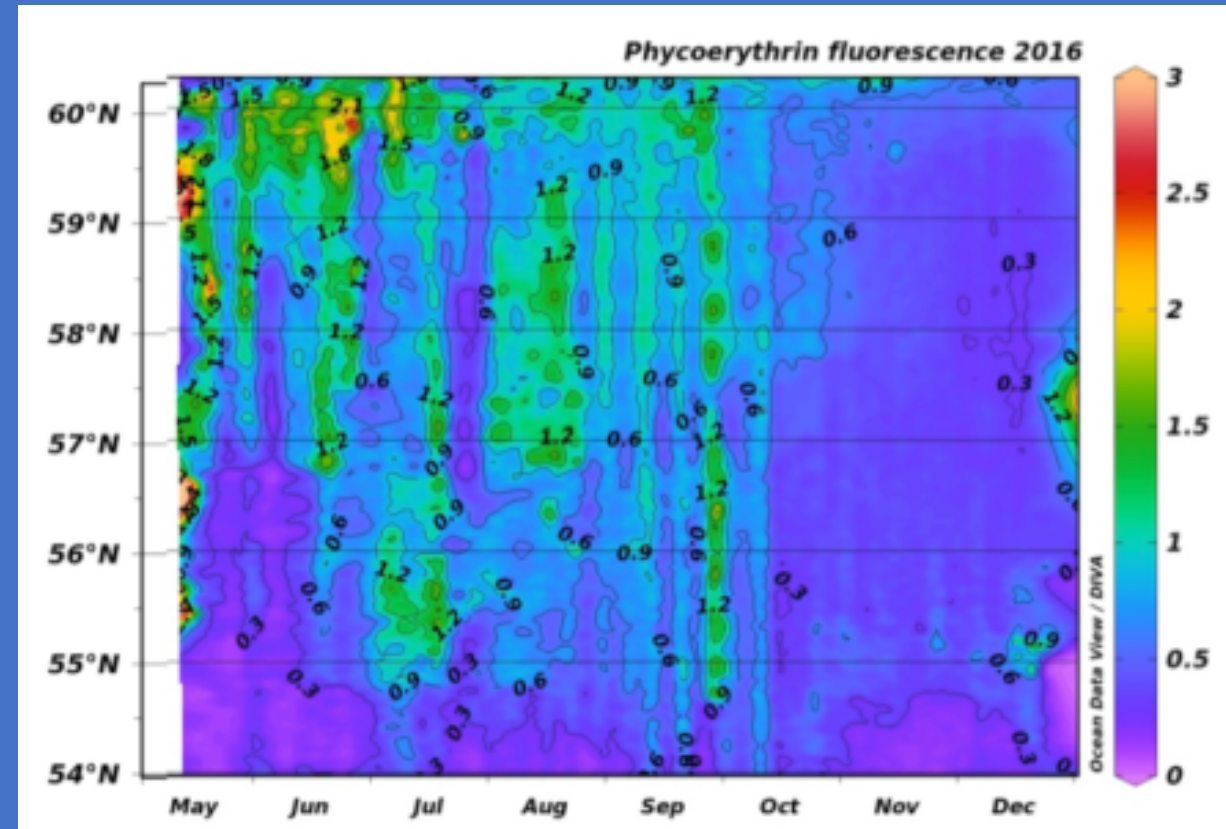
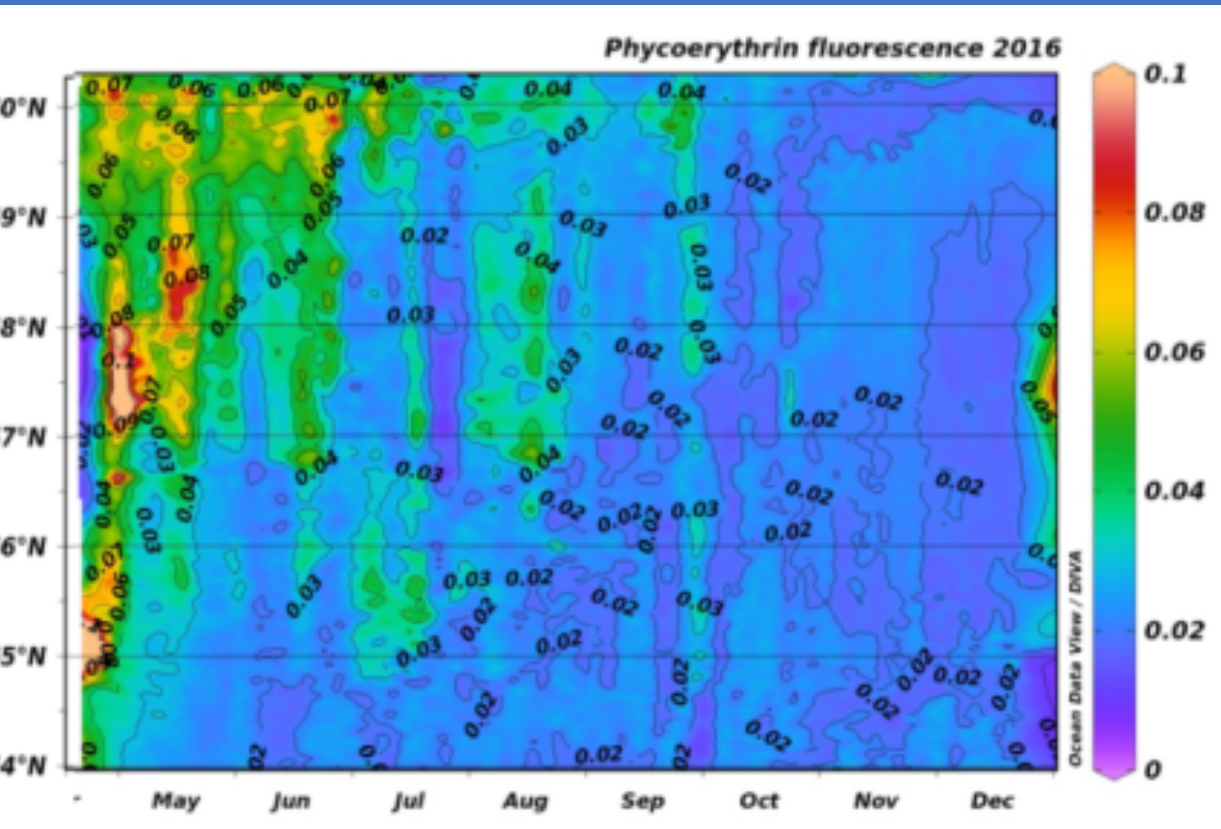
Phycocyanin fluorescence



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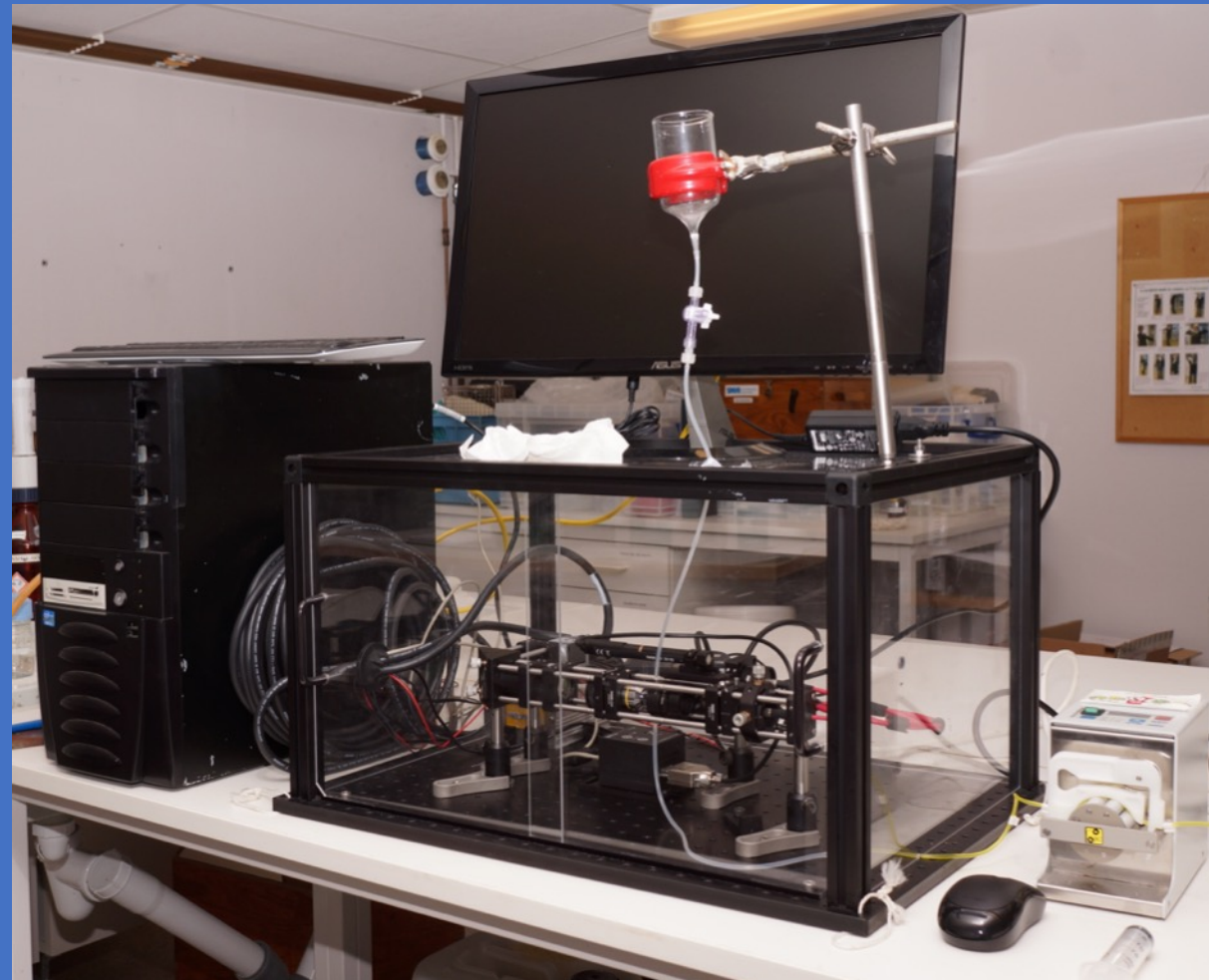
# Phycoerythrin fluorescence - a tool for observing HAB with distinct pigments



Variability of phycoerythrin fluorescence measured with microFlu Red (left) and unilux (right fluorimeters). Limits of quantification (LoQ) for instruments were 0.025 V and 0.5 fluorescence units, respectively. The values below these LoQ threshold are to be considered as background noise. Higher values indicate abundance of PE containing species.

Contact person:  
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# FastCam



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# Utö observatory, Baltic Sea



## Utö Atmospheric and Marine Research Station

<http://en.ilmatieteenlaitos.fi/uto>

- ▼ CO<sub>2</sub>-flux
- ▼ SO<sub>2</sub>
- ▼ pCH<sub>4</sub>, pN<sub>2</sub>O (?)
- ▼ Chlorophyll
- ▼ Nutrients
- ▼ Bottle sampler
- ▼ CH<sub>4</sub>- ja N<sub>2</sub>O-fluxes (?)
- ▼ Flow cytometer (?)
- ▼ pVOC (?)
- ▼ Underwater camera

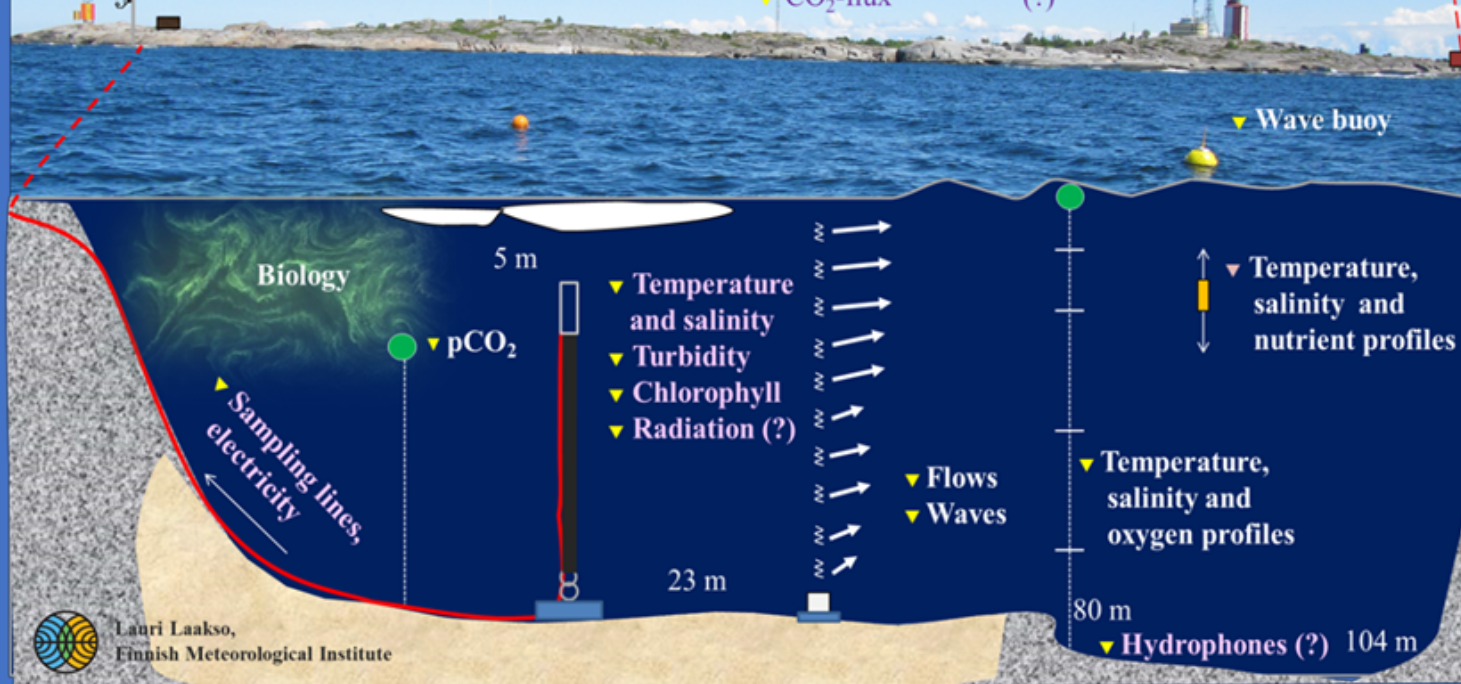
- ▼ Continuous
- ▼ Sampling
- AA Operational
- AA Starting in summer/autumn 2014
- (?) Considered (long-term)

- ▼ Meteorology
- ▼ Atmospheric optics and cloud cover
- ▼ Solar radiation (global, PAR, UV etc)
- ▼ Trace gases (SO<sub>2</sub>, NO<sub>x</sub>, O<sub>3</sub> etc)
- ▼ Aerosol particles (sizes, chemical composition etc)
- ▼ 3D-boundary layer wind profiles (lidar)
- ▼ Deposition (phosphorus)
- ▼ Radioactivity



- ▼ CO<sub>2</sub>- ja CH<sub>4</sub>- concentrations
- ▼ N<sub>2</sub>O- concentration (?)
- ▼ CO<sub>2</sub>-flux (?)

- ▼ Ice cover radar
- ▼ Weather camera

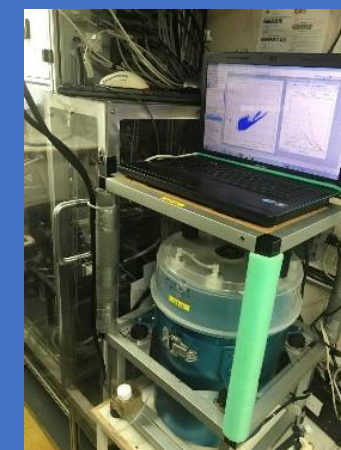
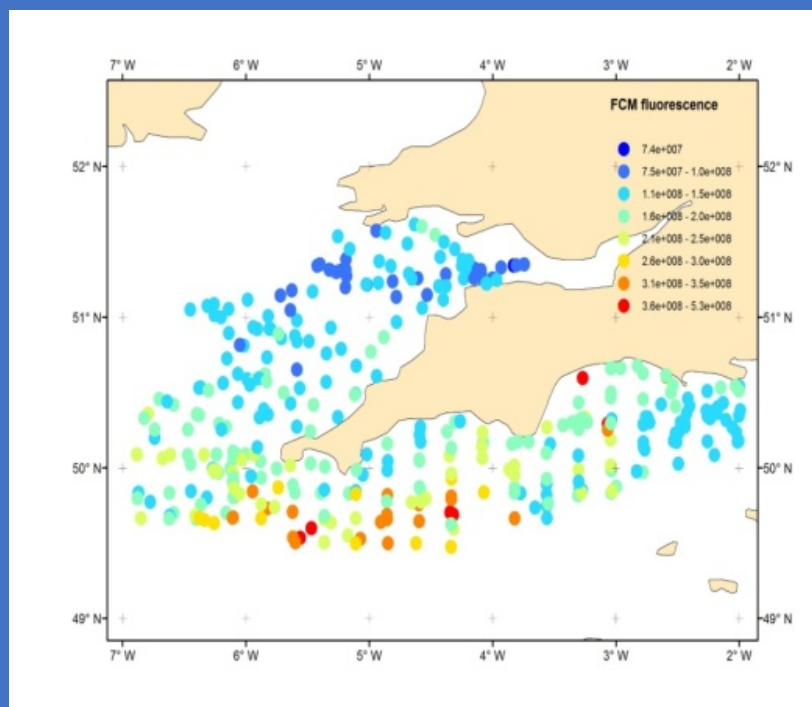


Lauri Laakso,  
Finnish Meteorological Institute



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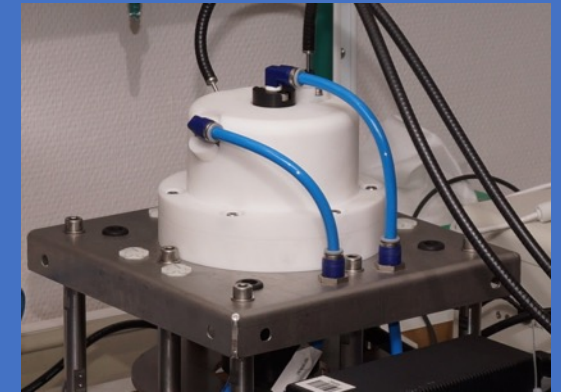
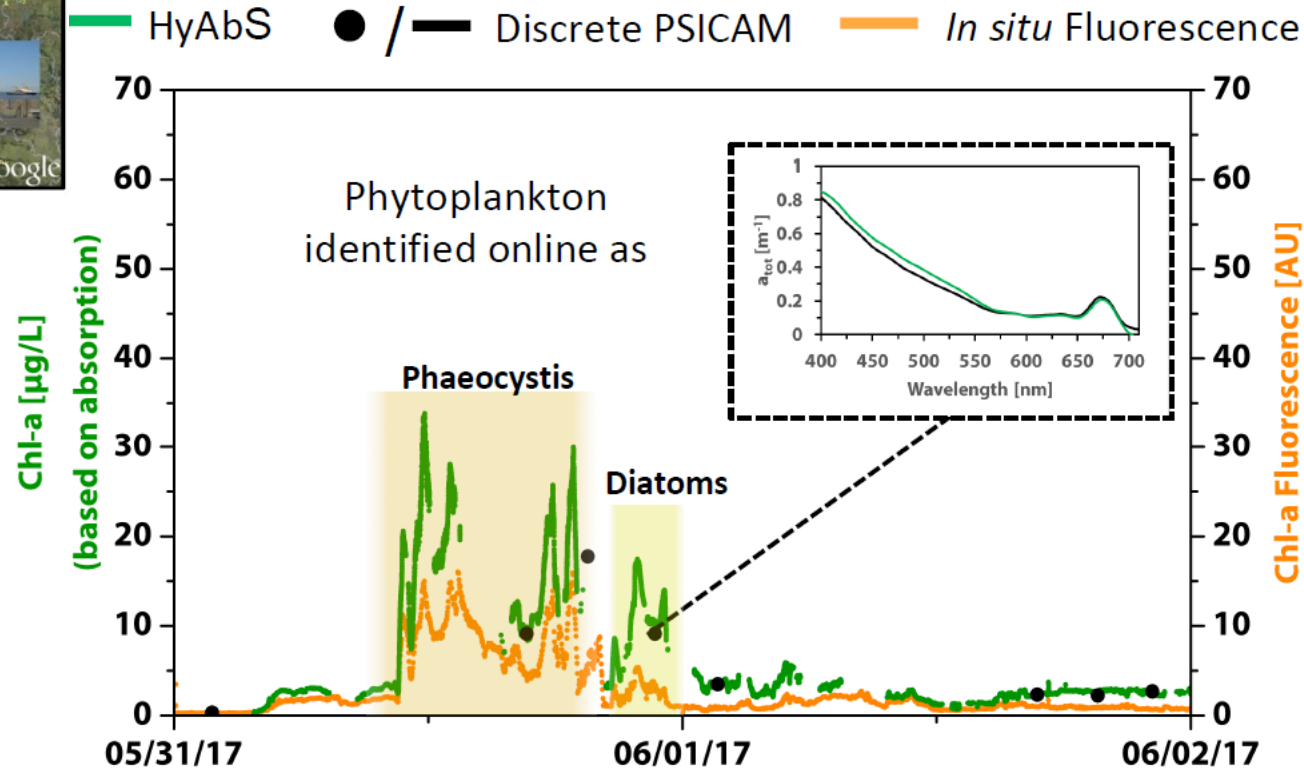
# On board of the RV Cefas Endeavour as a platform



Contact person:  
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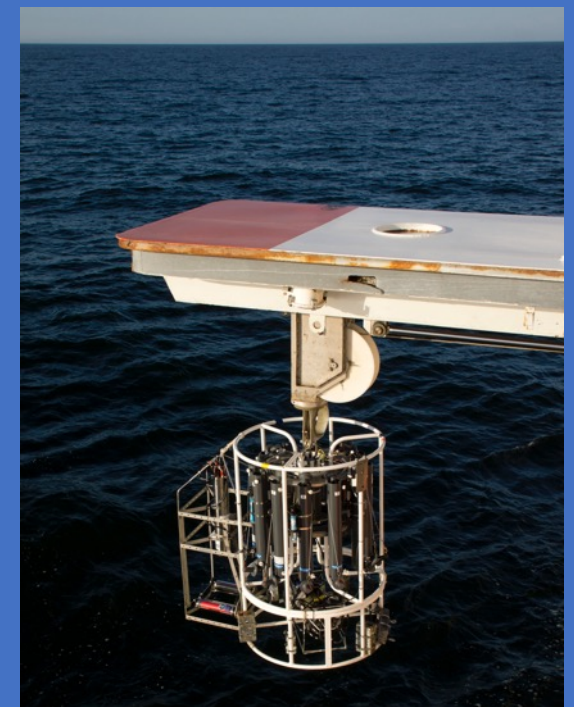
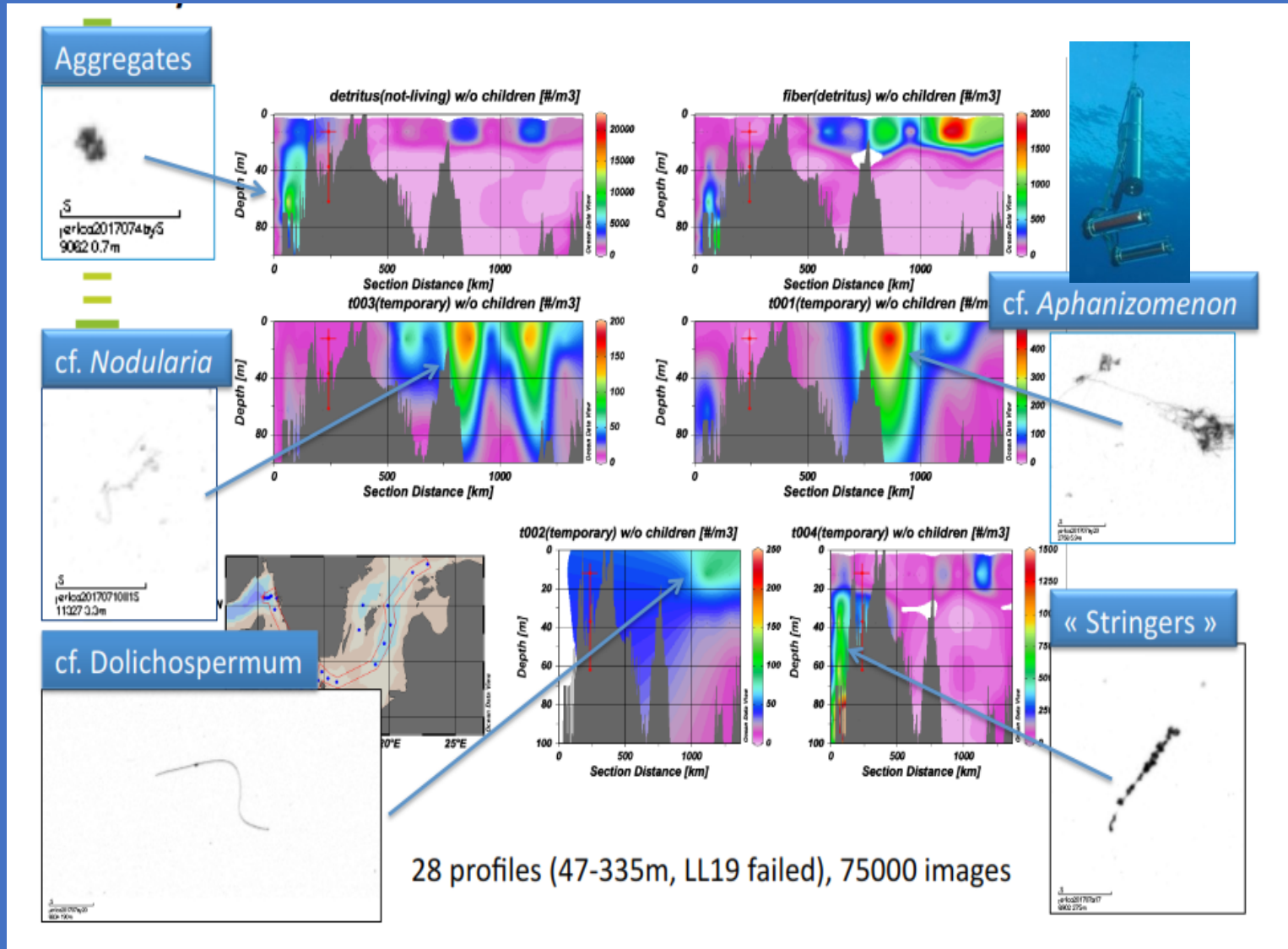
# Multi wavelength absorption



- Good agreement of discrete and continuous absorption spectra
- Good qualitative agreement of absorption-based biomass estimates with fluorescence
- Online phytoplankton identification is in accordance with on-board microscopy

Contact person:  
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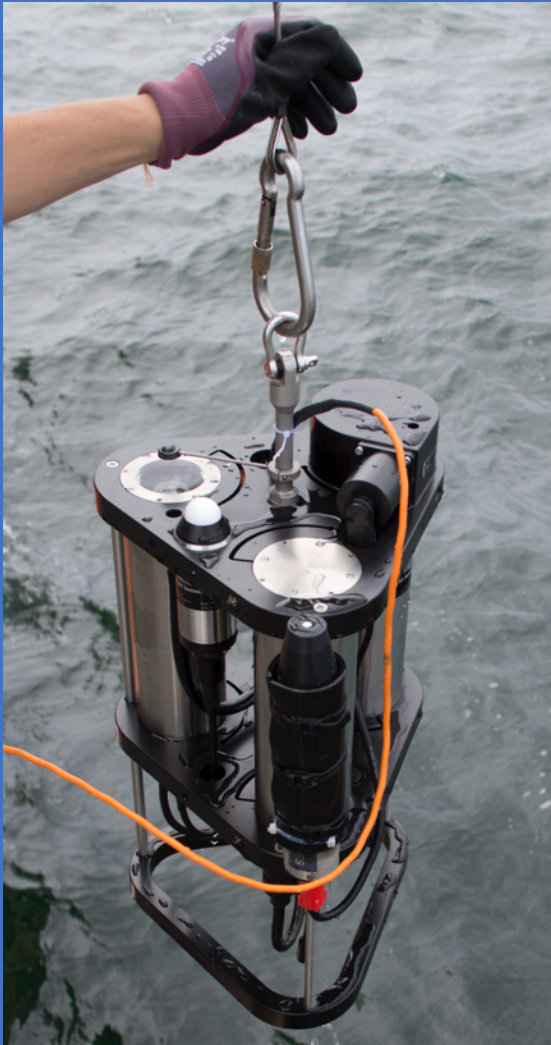
# Underwater Vision Profiler UVP 5



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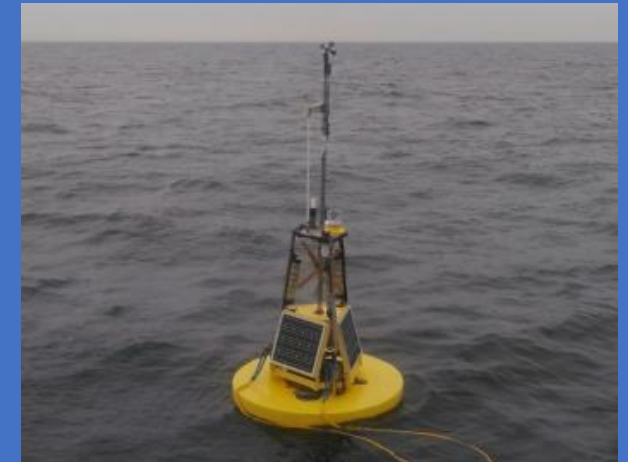


# Fast Repetition Rate Fluorometry



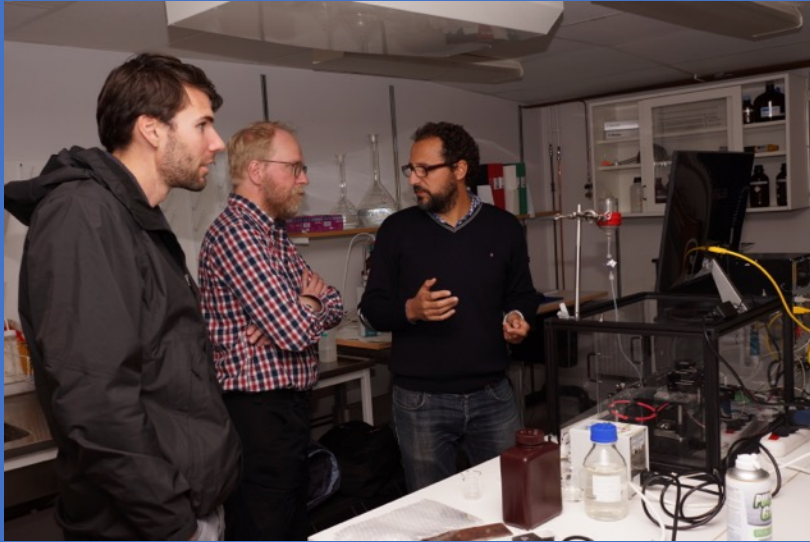
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# Other instrument platforms



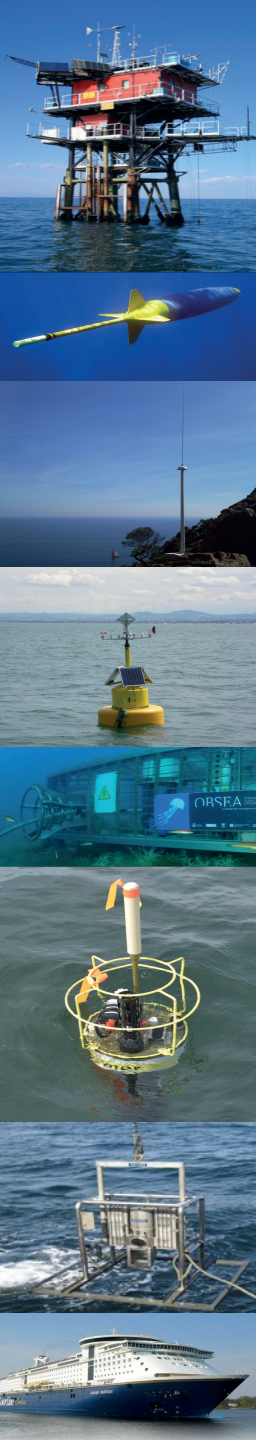


# Some persons involved



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is EU-funded through the Horizon 2020  
program  
see <http://jerico-ri.eu> for more information





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654410.