PHIDIAS

Prototype of HPC/Data Infrastructure for On-demand Services

PHIDIAS: Boosting the use of cloud services for marine data management, services and processing

SYKE

FinMARI Finnish Marine Research Infrastructure

Passport photos for plankton:
new era for marine biology research

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Webinar | June 4, 2020, 11:00 AM CEST

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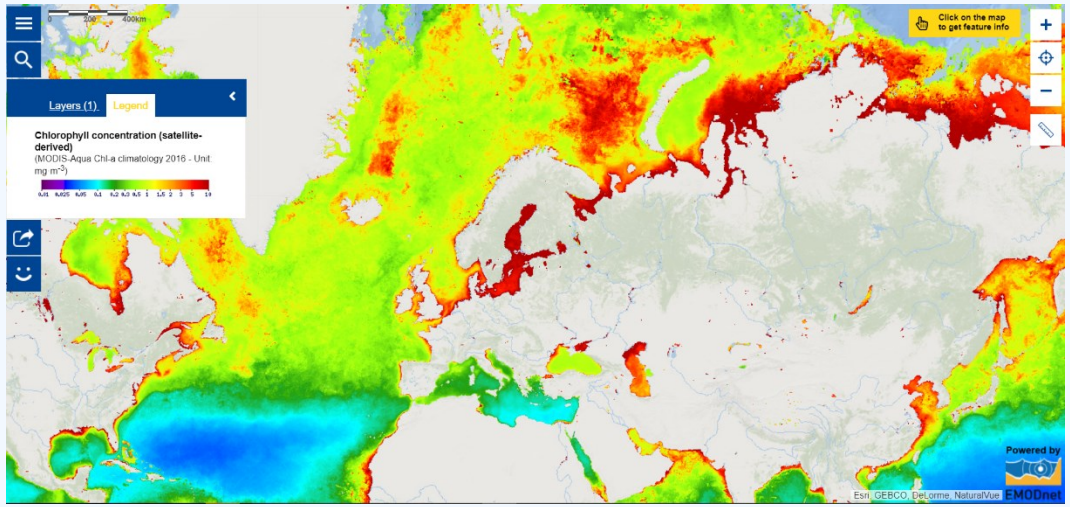
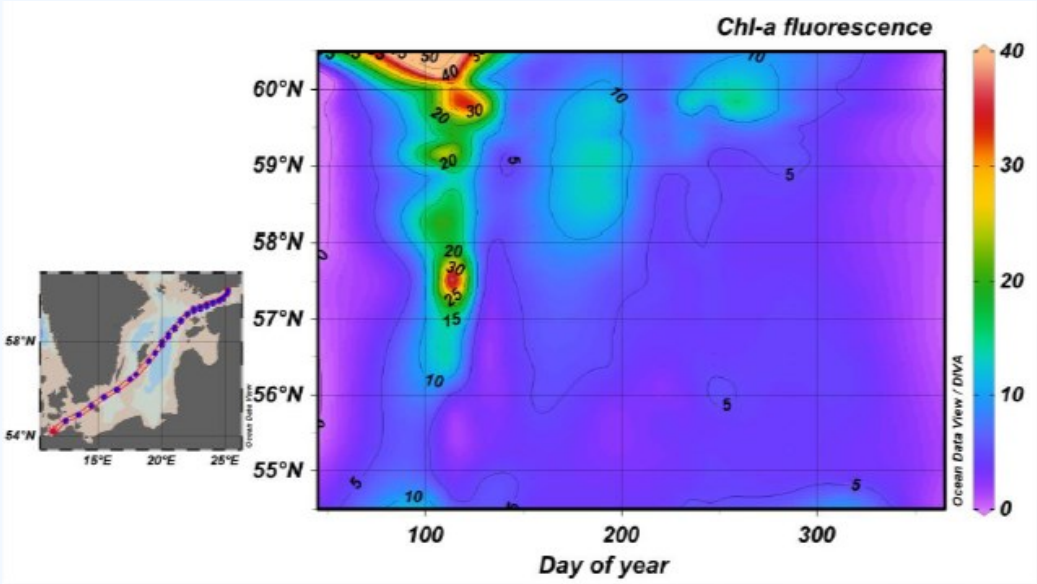
Phytoplankton abundance is typically estimated using ocean colour, in situ sensors or lab analysis

- Phytoplankton contribute ~50% of the global photosynthesis: CO_2 fixation and O_2 production.
- Due to measurement uncertainties and undersampling, the role of oceans – and phytoplankton – is one of the key unknowns in global carbon-budget
- We may observe the abundance of phytoplankton using Chlorophyll *a* as a proxy



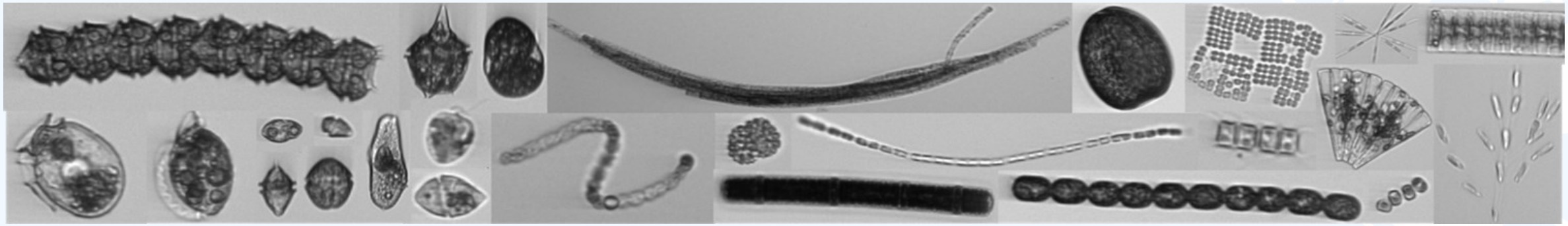
Long-term average concentration of chlorophyll at the ocean's surface in milligrams per cubic meter of water. The data in this map were provided by the Joint Research Centre (JRC). Source EMODnet.



Seasonal concentration of chlorophyll in the Baltic Sea, between Helsinki (FI) and Travemünde (DE), measured with the ferrybox. Source Alg@line project, SYKE.

Species/group –specific information is crucial to understand the biogeochemical fluxes

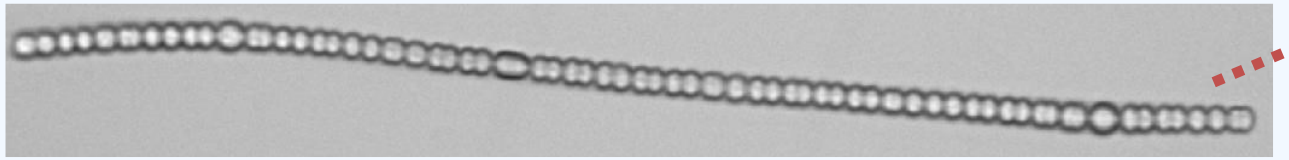
- Bulk biomass estimates by Chlorophyll *a* do not reflect the diversity of phytoplankton
- Phytoplankton community composition is largely affected by environmental and anthropogenic forcing (light, nutrients, temperature)
- Phytoplankton community composition responds very quickly to chaotic rhytms of aquatic environments
- Phytoplankton community composition (and functional types) largely affects the aquatic elemental fluxes (carbon and nutrients) and structure of the food web (up to fish)

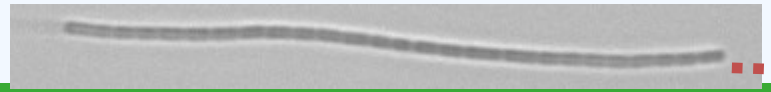


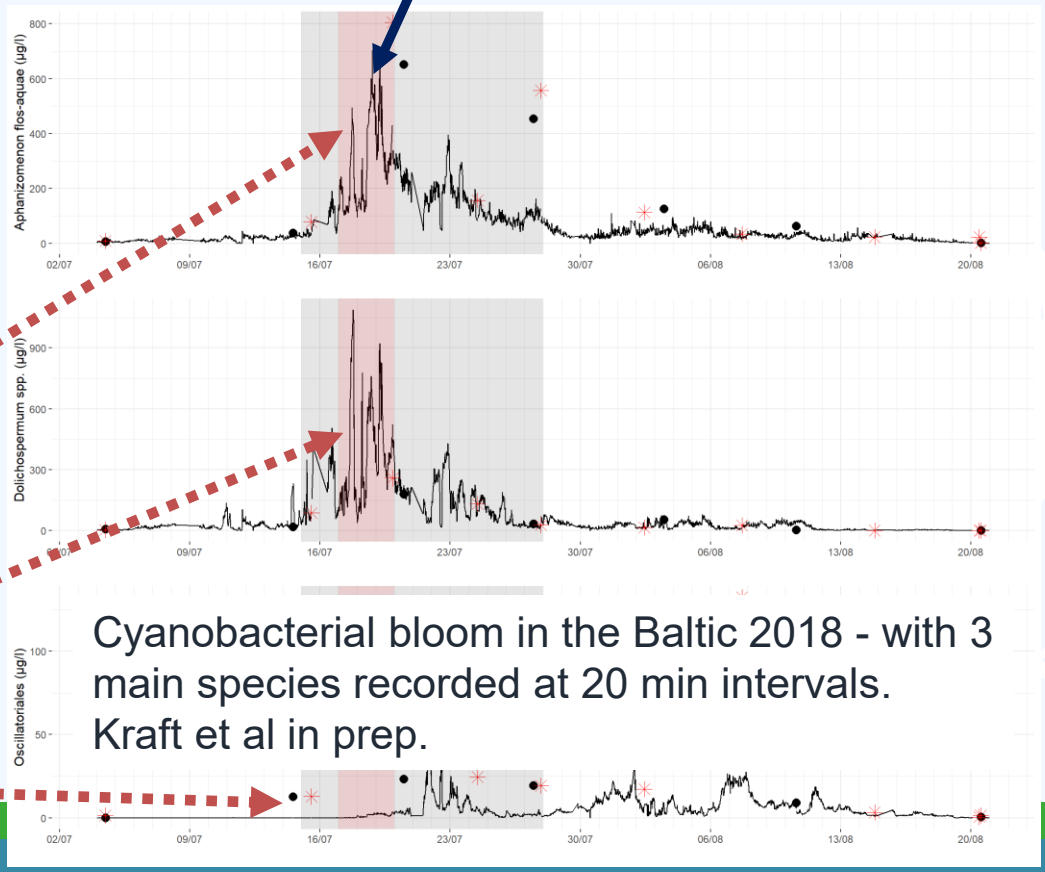
Photos of phytoplankton, taken by Imaging FlowCytobot at Utö station, Gulf of Finland

Why plankton imaging

- Trad. microscopy is slow and costly (though accurate and important reference method!)
- New technologies based on optics, fluidics and imaging offer rapid, automated, unattended, quantitative, and cost-efficient analysis of individual cells and colonies of plankton organisms
- Possibility to permanently store the digital raw data gathered, which allows re-analyses, and creation of open data archives within the international scientific community

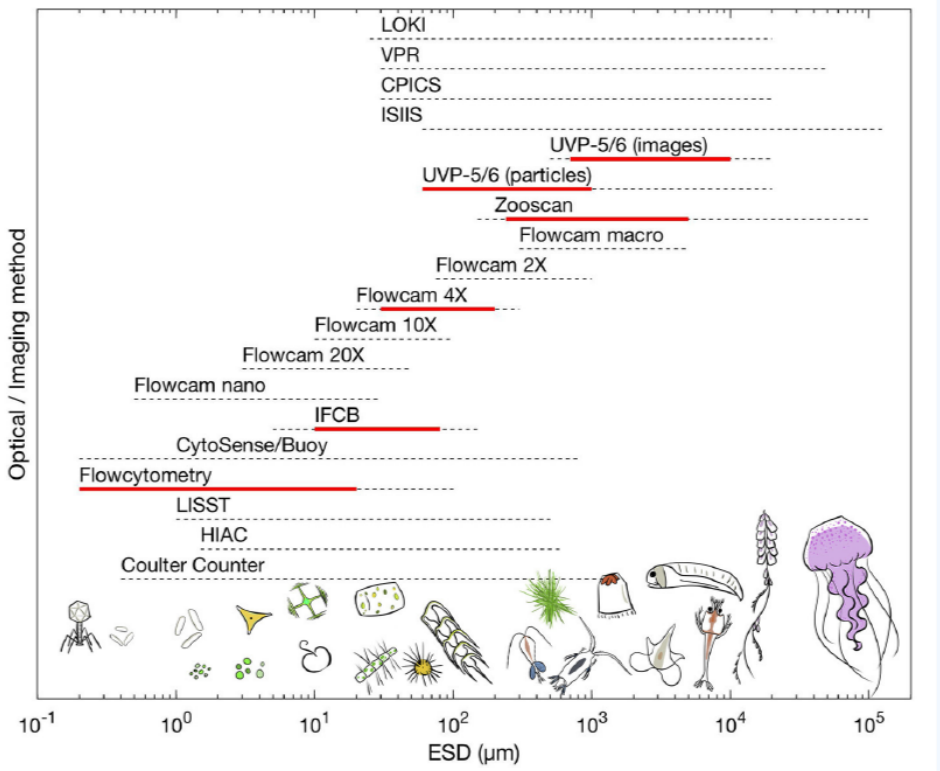






Cyanobacterial bloom in the Baltic 2018 - with 3 main species recorded at 20 min intervals. Kraft et al in prep.

Plankton imaging – state of art



frontiers in Marine Science

REVIEW
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Globally Consistent Quantitative Observations of Planktonic Ecosystems

Fabien Lombard[1,2], Emmanuel Boss[3]*, Anya M. Waite[4], Meike Vogt[5], Julia Uitz[1], Lars Stemmann[1], Heidi M. Sosik[6], Jan Schulz[7], Jean-Baptiste Romagnan[8], Marc Picheral[1], Jay Pearlman[9], Mark D. Ohman[10], Barbara Niehoff[11], Klas O. Möller[12], Patricia Miloslavich[13,14], Ana Lara-Lpez[13], Raphael Kudela[15], Rubens M. Lopes[16], Rainer Kiko[17], Lee Karp-Boss[3], Jules S. Jaffe[10], Morten H. Iversen[11,18], Jean-Olivier Irisson[1], Katja Fennel[19], Helena Hauss[17], Lionel Guidi[1], Gaby Gorsky[1], Sarah L. C. Giering[20], Peter Gaube[21], Scott Gallager[6], George Dubelaar[22], Robert K. Cowen[23], François Carlotti[24], Christian Briseño-Avena[23], Léo Berline[24], Kelly Benoit-Bird[25], Nicholas Bax[13,26], Sonia Batten[27], Sakina Dorothée Ayata[1,28], Luis Felipe Artigas[29] and Ward Appeltans[30]*

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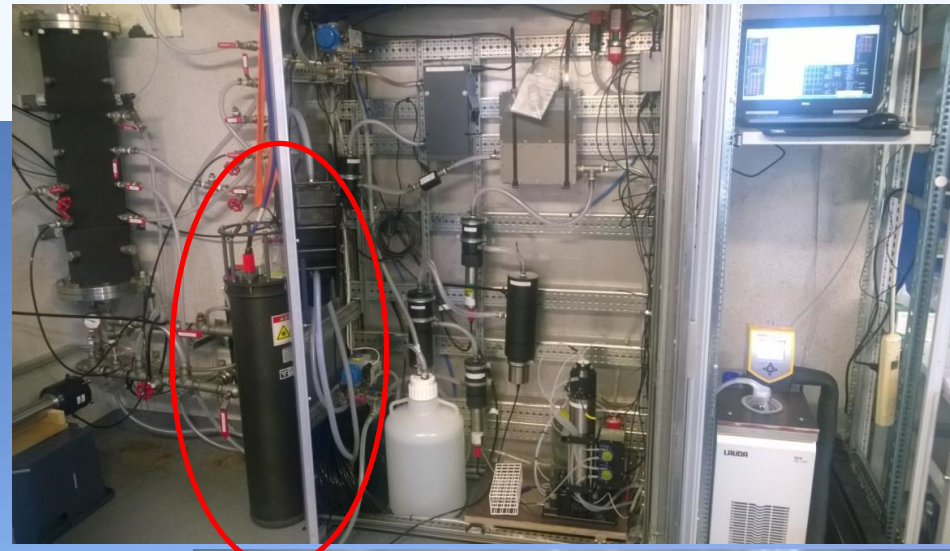
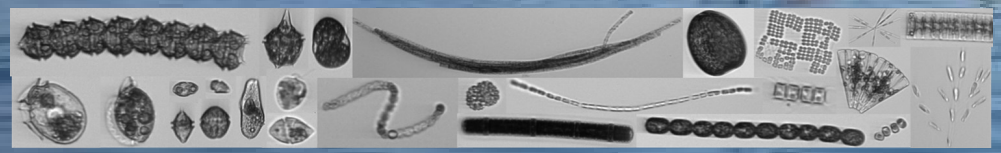
- Various technologies available, many in the beta-version/demonstration phase. Some forerunner technologies (e.g. Cytosense) have well established user communities and common vocabularies for metadata.
- Machine learning algorithms available but optimising/developments ongoing
- Central data storage not available, no agreed way to connect to data aggregators
- EcoTaxa web application an European forerunner for visual exploration and the taxonomic annotation of images. Initiated by Laboratoire d'Océanographie de Villefranche (LOV) https://ecotaxa.obs-vlfr.fr/

Imaging technology

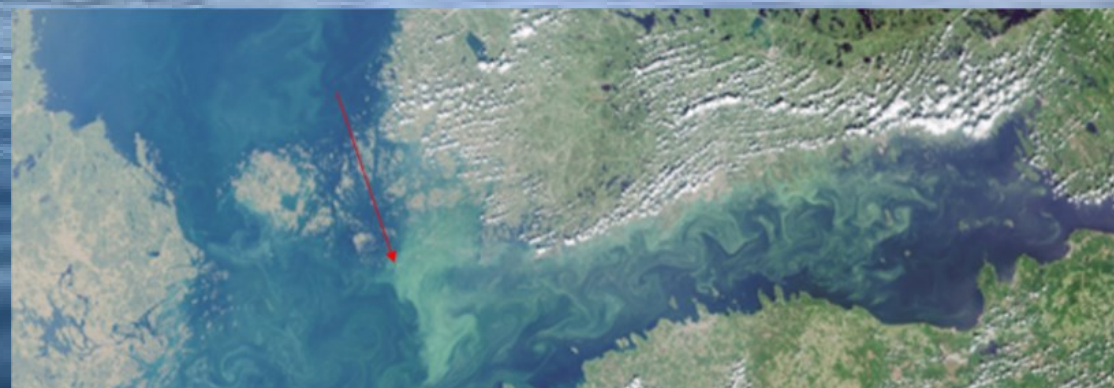
IMAGING FLOWCYTOBOT at SYKE

- Images of phytoplankton cells (range 10-150µm)
- Operate remotely on Utö island flow through system
- Samples of 5ml with approx. 20 min interval
- Camera triggered by chlorophyll-a fluorescence
- Up to 30 000 high resolution images / hour





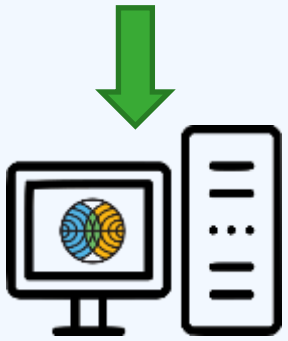
- Random Forest algorithm for image regocnition – moving towards Convolutional Neural Networks



Plankton imaging – PHIDIAS

Demonstration: from image to information

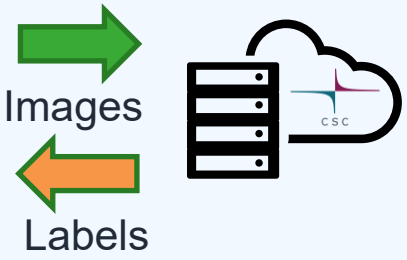
Imaging FlowCytobot (Finnish Environment Institute, Utö)



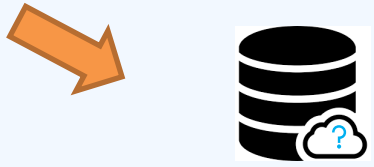
Finnish Meteorological Institute's server

CSC (Center for Scientific Computing, FI) Allas object storage
- Data storage and sharing during the project's duration

cPouta (Cloud computing)
- Development of CNN-models
- GPU flavor is needed

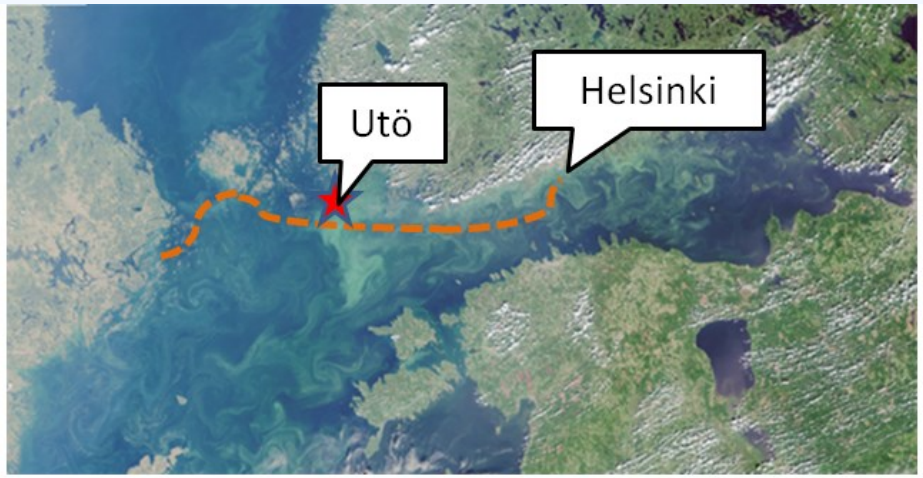


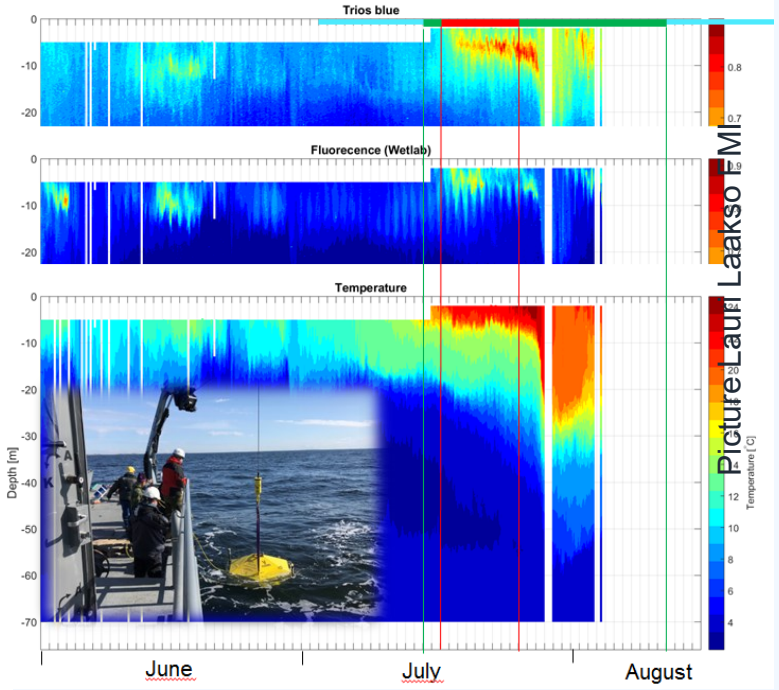
Puhti (high performance computing)
- CNN in production mode (classification of new images)
- GPU or CPU flavor
- Potential realtime usage

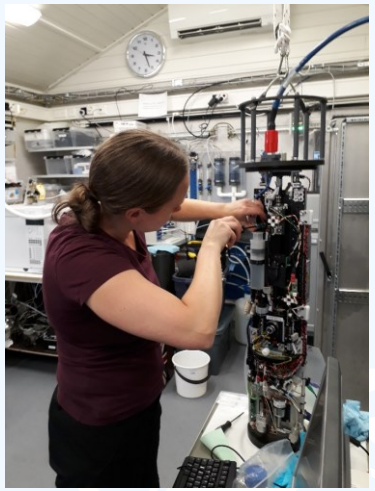


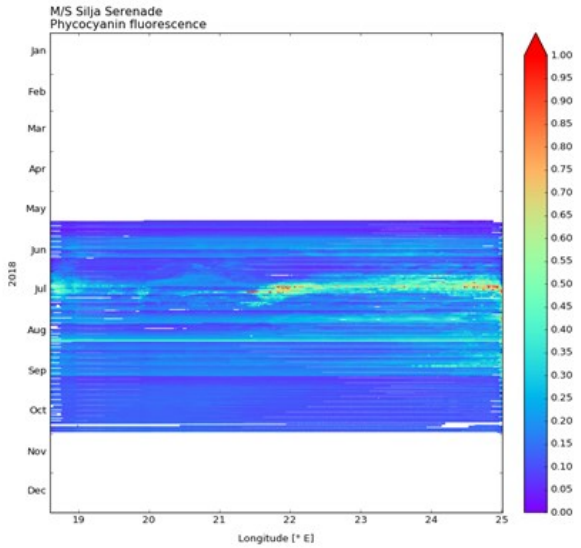
Data aggregators / other users
- EcoTaxa
- Long time data storage

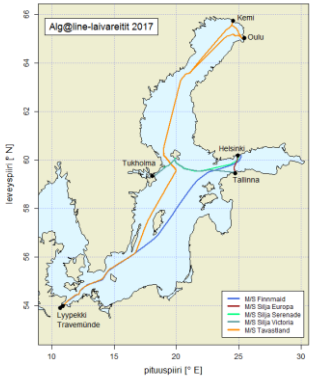
PHIDIAS, at the focal point for multiplatform detection of phytoplankton: EO algorithms – sensor validation – ML, CNN – DIVA

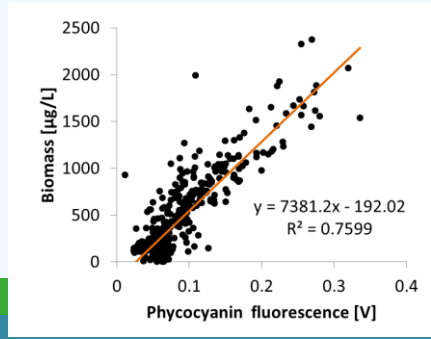


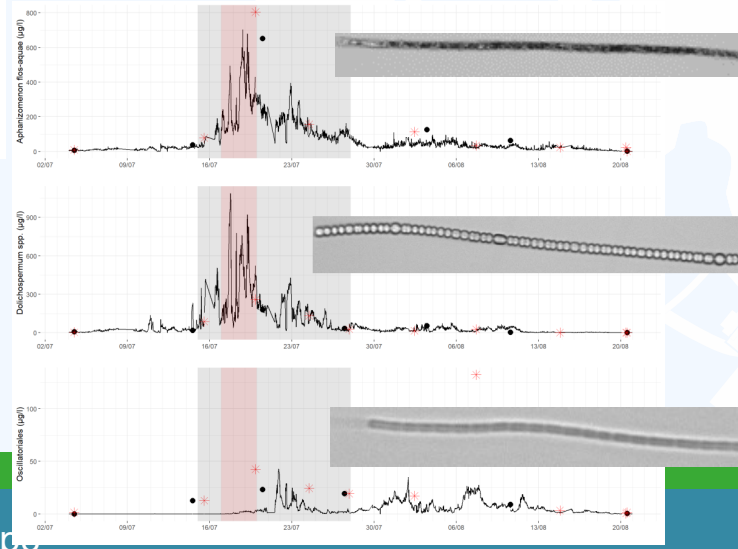




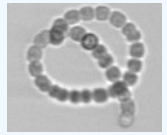








Thank-you, stay tuned, and see you again!



Special Thanks to SYKE, FMI, LUT and CSC staff supporting the various steps of plankton imaging!!!

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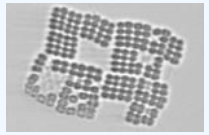

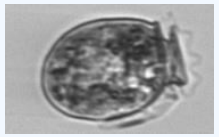

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