

Norwegian Ferrybox network for monitoring of biogeochemical variables

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Background and history I

- The Norwegian FB Network has been in operation since 2001 (15 years)
- Part of the EU FerryBox project (2003)
- Covers now with 5 NIVA and 1 IMR ship a large part of the Norwegian coast and important open sea areas
- Norwegian coastline are more than 20000 km and the use of cost-effective ships of opportunity (Ferrybox) systems is a necessity.

Background and history II

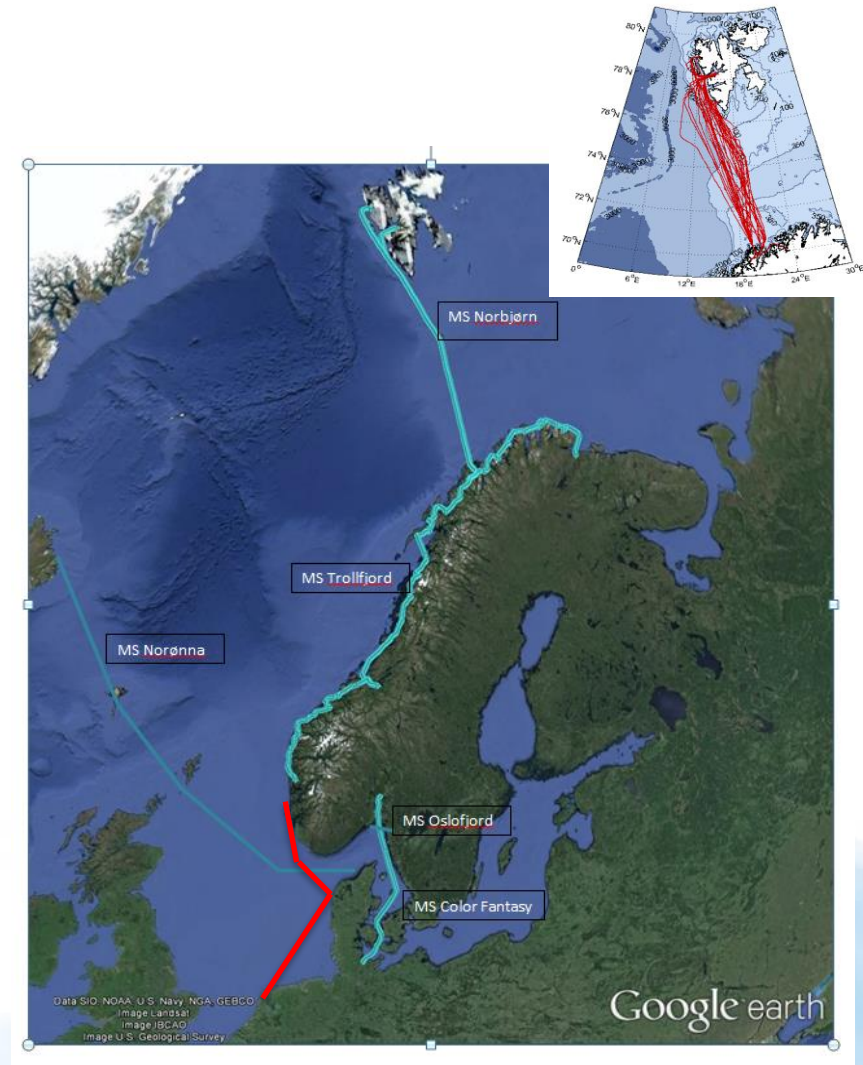
- The ships are used in different end user application:
 - marine eutrophication (WFD, national prog.)
 - harmful algal bloom warnings (Aquaculture)
 - satellite validation (ESA S3VT)
 - ocean acidification (National monitoring)
- Part of Copernicus program and we report real time data to ArcticROOS
- The network of ships are included in several EU sensor and RI programs.

Background and history III

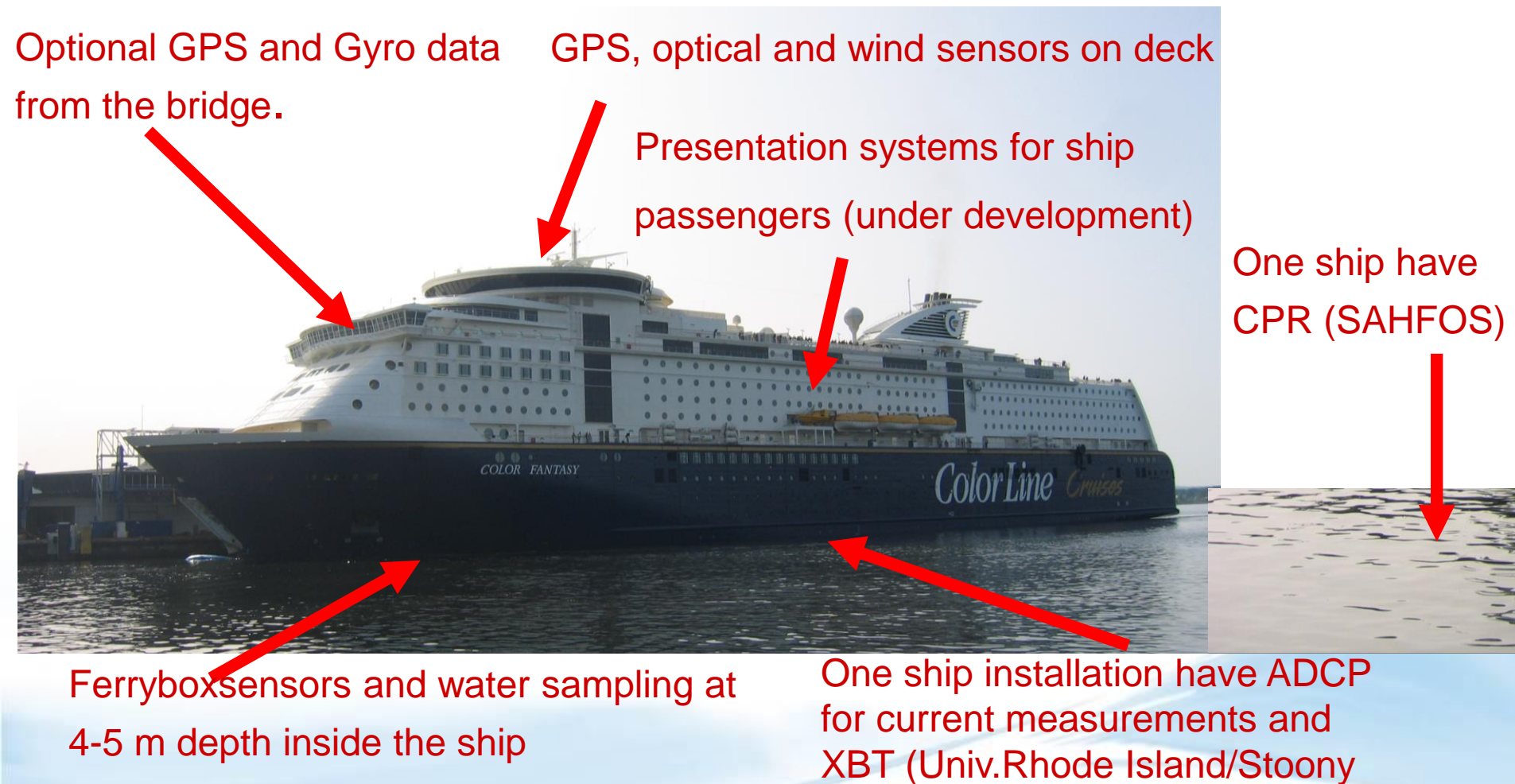
- Based on technical design developed at NIVA using different commercial sensors
 - physical and biogeochemical sensors for
 - temperature, salinity, oxygen, chlorophyll-a fluorescence, phycocyanin-, PAH and cDOM-fluorescence and turbidity.
- The network now includes advanced sensor technology and sampling for
 - carbon systems variables
 - ocean colour validation sensors
 - contaminants (passive and active sampling)

NIVAs Ferrybox network

- MS Color Fantasy, (Daily)
 - Kiel – Oslo
- MS Norønna, (Weekly)
 - Hirtshals-Seydisfjördur
- MS Oslofjord, (Daily)
 - Sandefjord – Strømstad
- MS Trollfjord, (Biweekly)
 - Bergen-Kirkenes
- MS Norbjørn, (Weekly)
 - Tromsø – Longyearbyen
- **MS Transcarrier (Weekly)**
 - **Bergen-Esbjerg-Beverwijk**
 - **Under planning (UNI-Res/Rijkwaterstaat)**



The NIVA Ferrybox principle and the main elements in the system

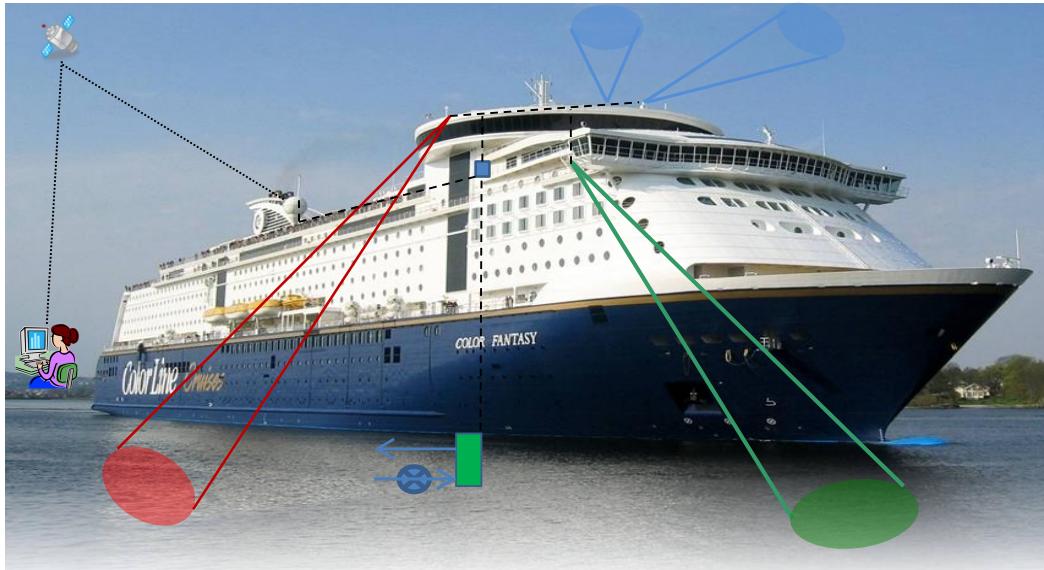


Sensor system on a Ferrybox



Water-sensors

Temperature
Salinity
Oxygen
Chlorophyll-a fluor.
Phycocyan. Fluor.
Turbidity/TSM
cDOM Fluor.
Oil-PAH
Nutrients (Planned)
pH and pCO₂



Deck-sensors

Surface temper. (Opt)
Wind and airpressure
Downwelling irradiance
Downwelling radiance
Marine Reflectance

Water sampling

Chlorophyll-a/Pigm Abs.
Turbidity/TSM
Nutrients
Alge taxonomy.

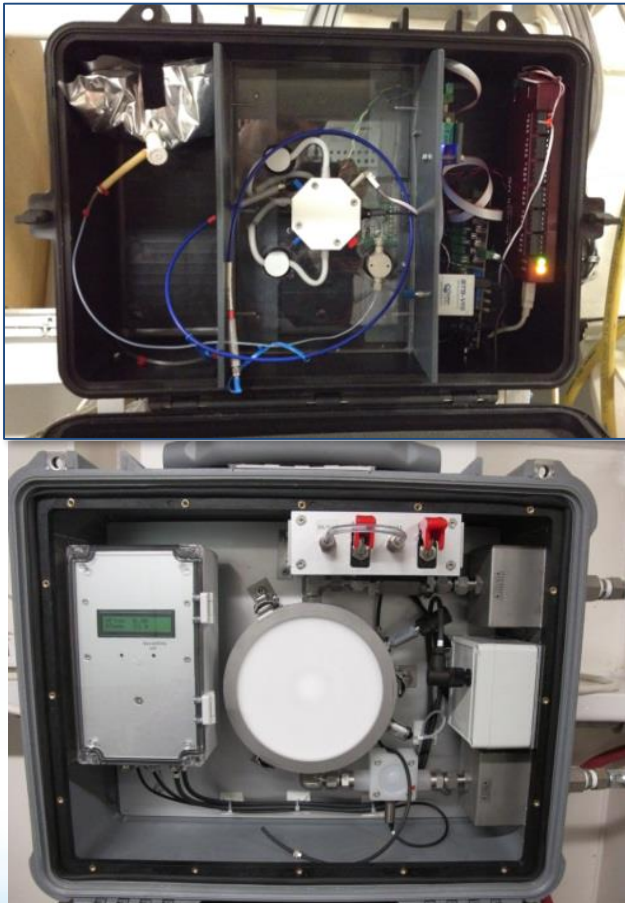
Passive sampling

Contaminants

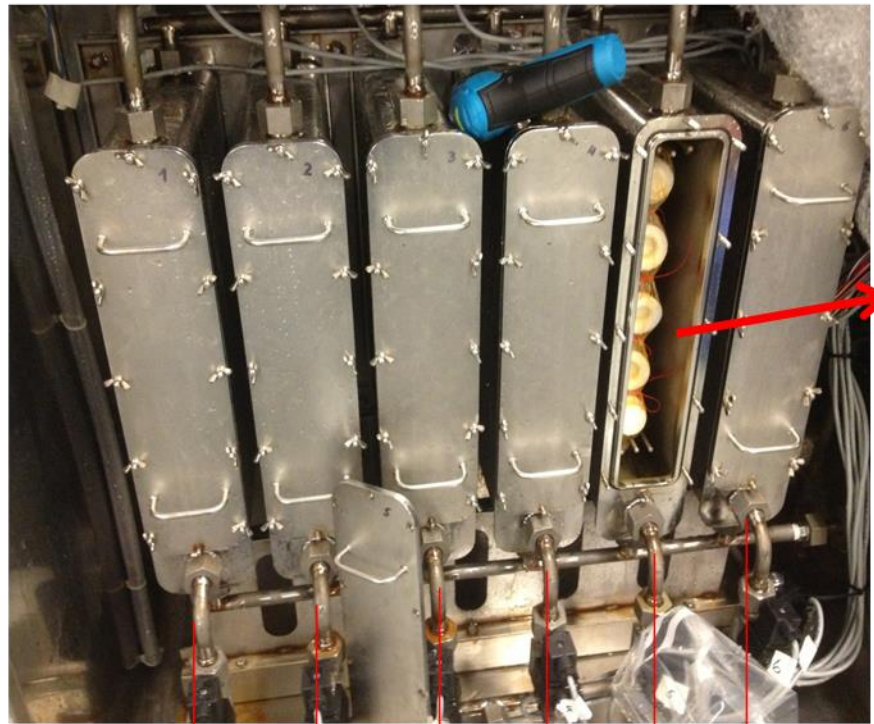
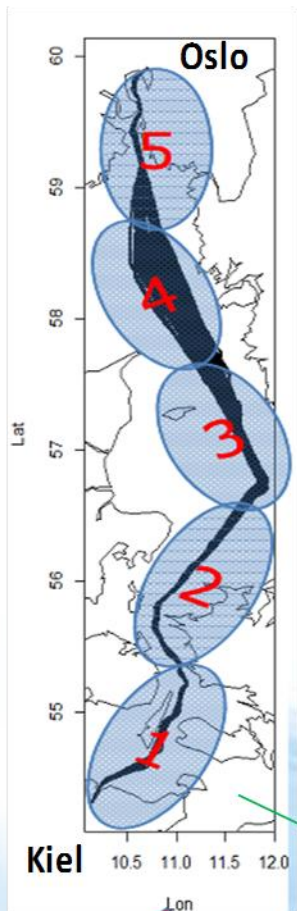
Not all ship
have the same
configuration.
Blue are the
core sensors



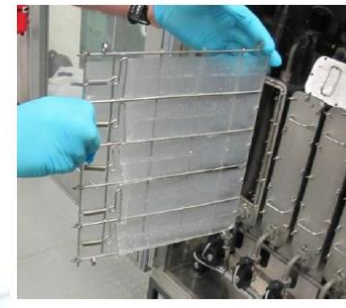
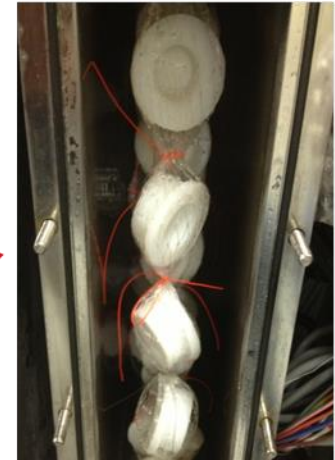
Carbon system sensor installation on Color Fantasy: pH (upper) and pCO₂ (lower) are intergrated in the FB



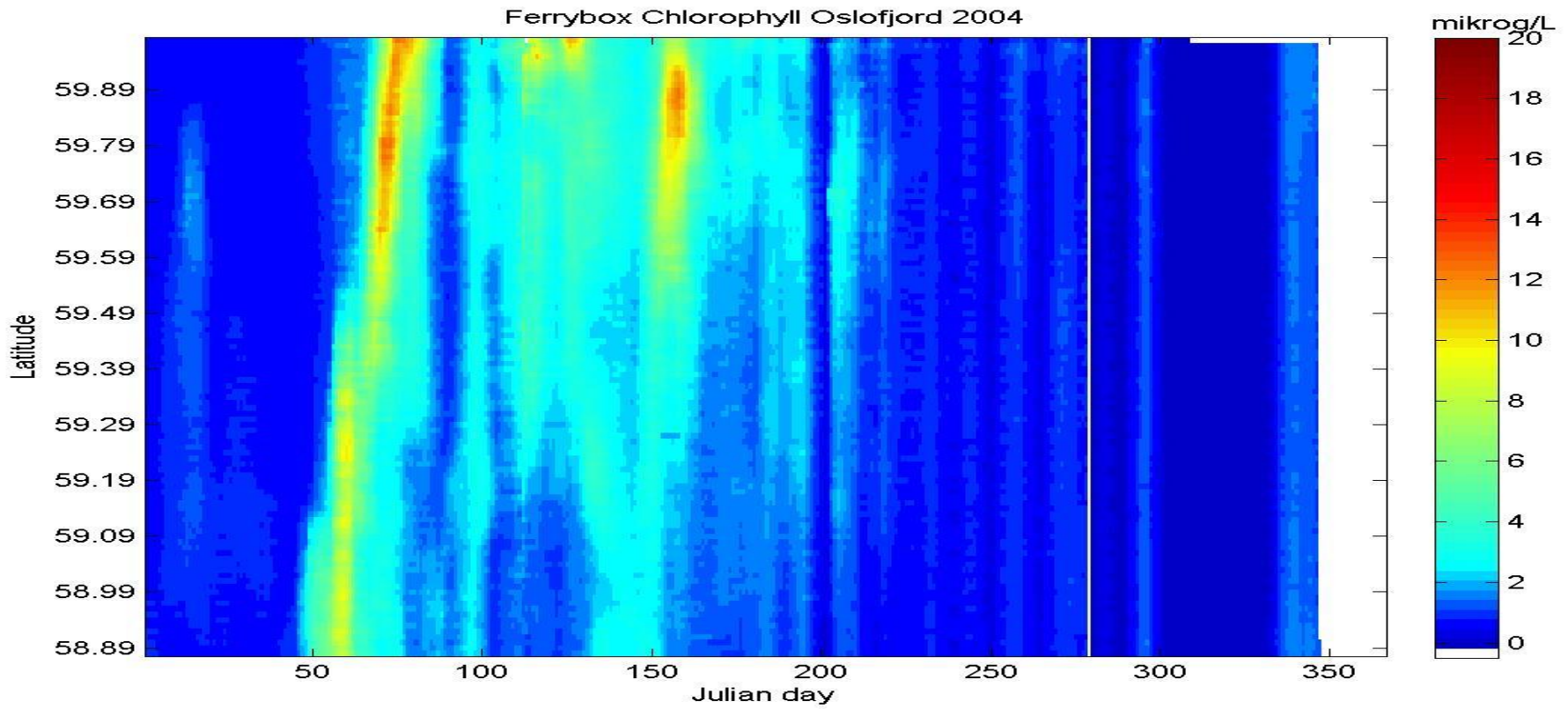
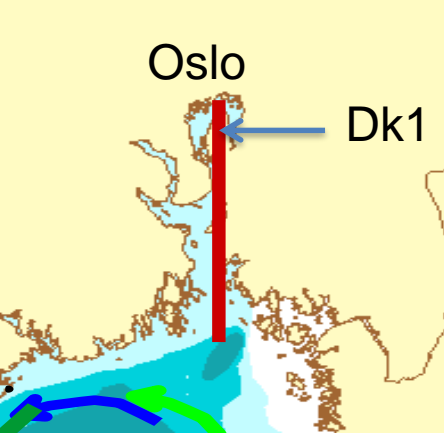
Passive sampling for SPMD or DGT using the Chem. Mariner system (Fantasy)



Area 1 2 3 4 5 6 (Ref)

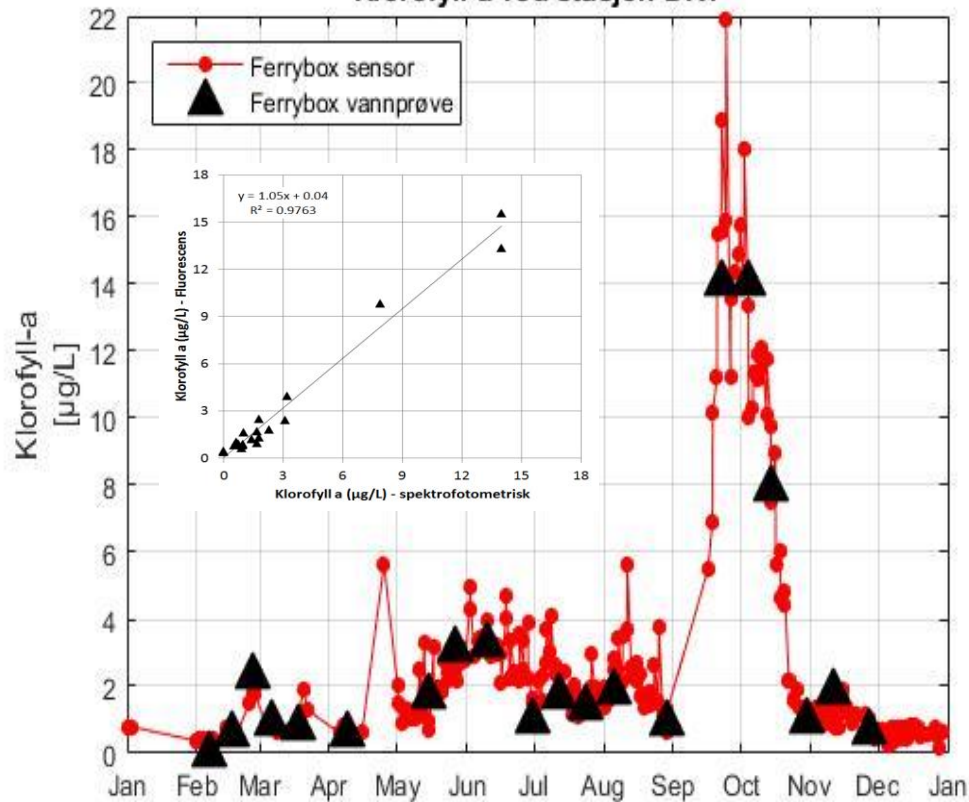


Example of chlorophyll-a fluorescence transect plot in the Oslofjord in 2004

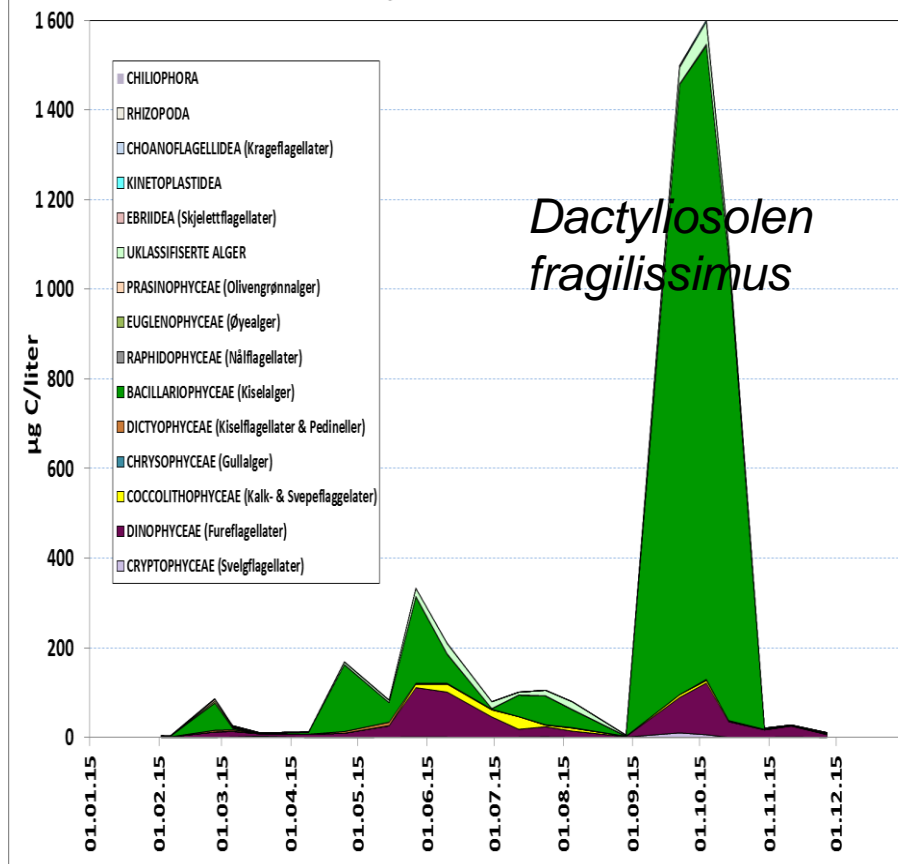


Chl-a_fl, Chl.a and phytoplankton as cell carbon on a monitoring station (Dk1)

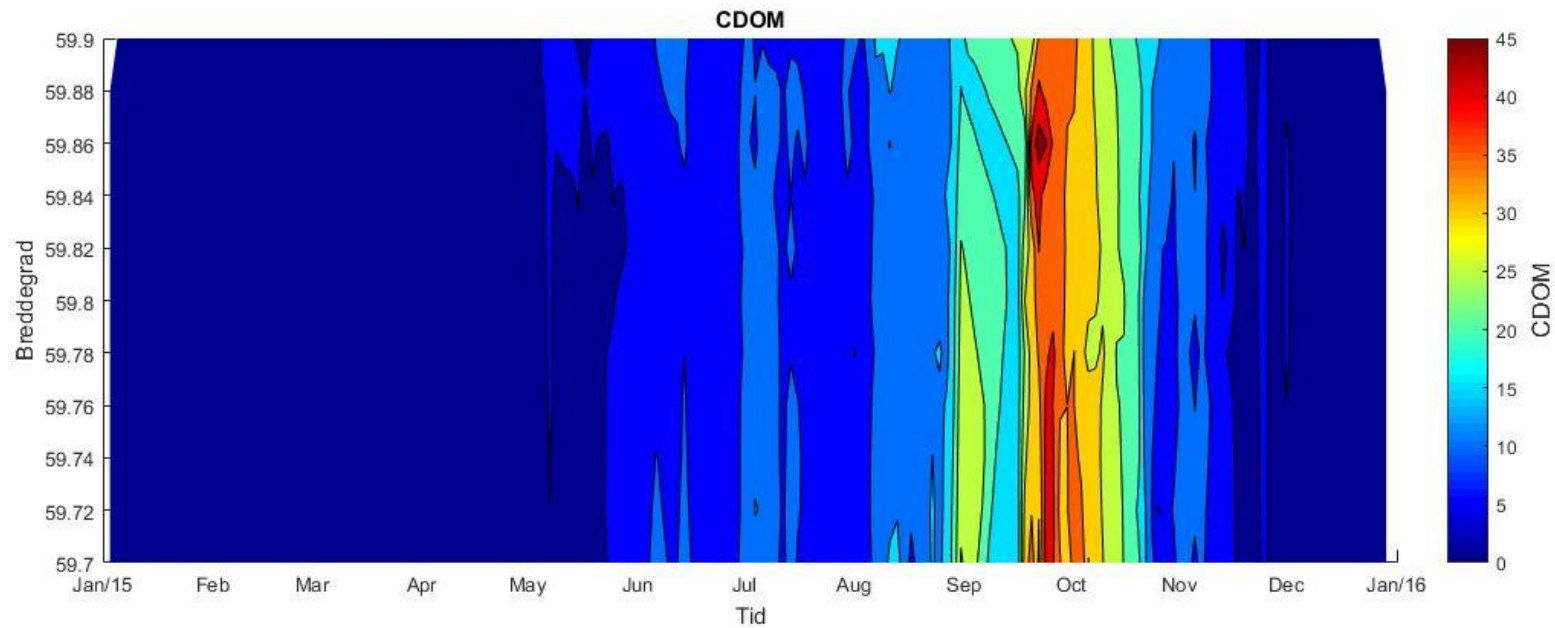
FA2015
Klorofyll a ved stasjon DK1



Indre Oslofjord 2015 - cellekarbon



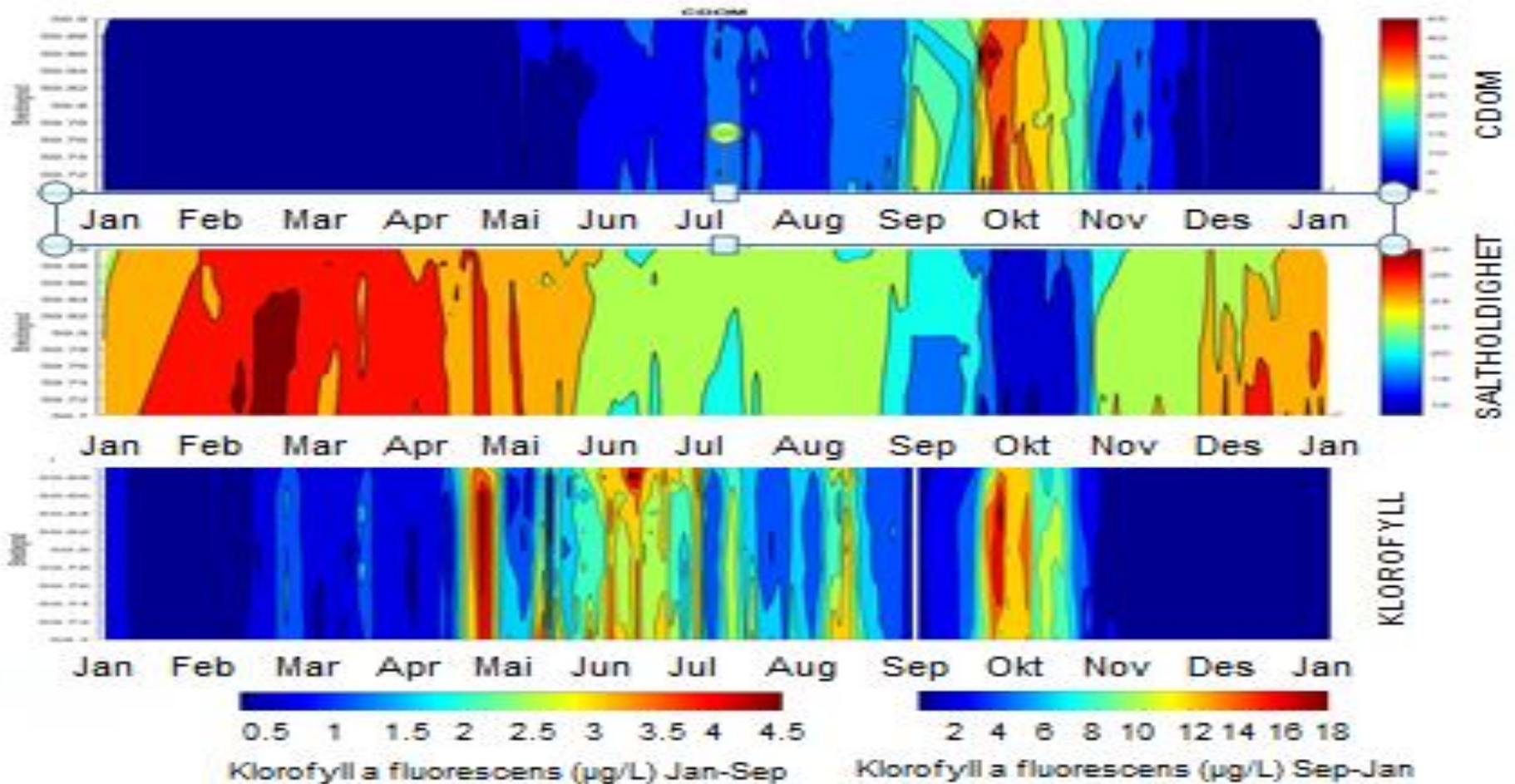
cDOM fluorescence using TriOS Micro_FLU sensor



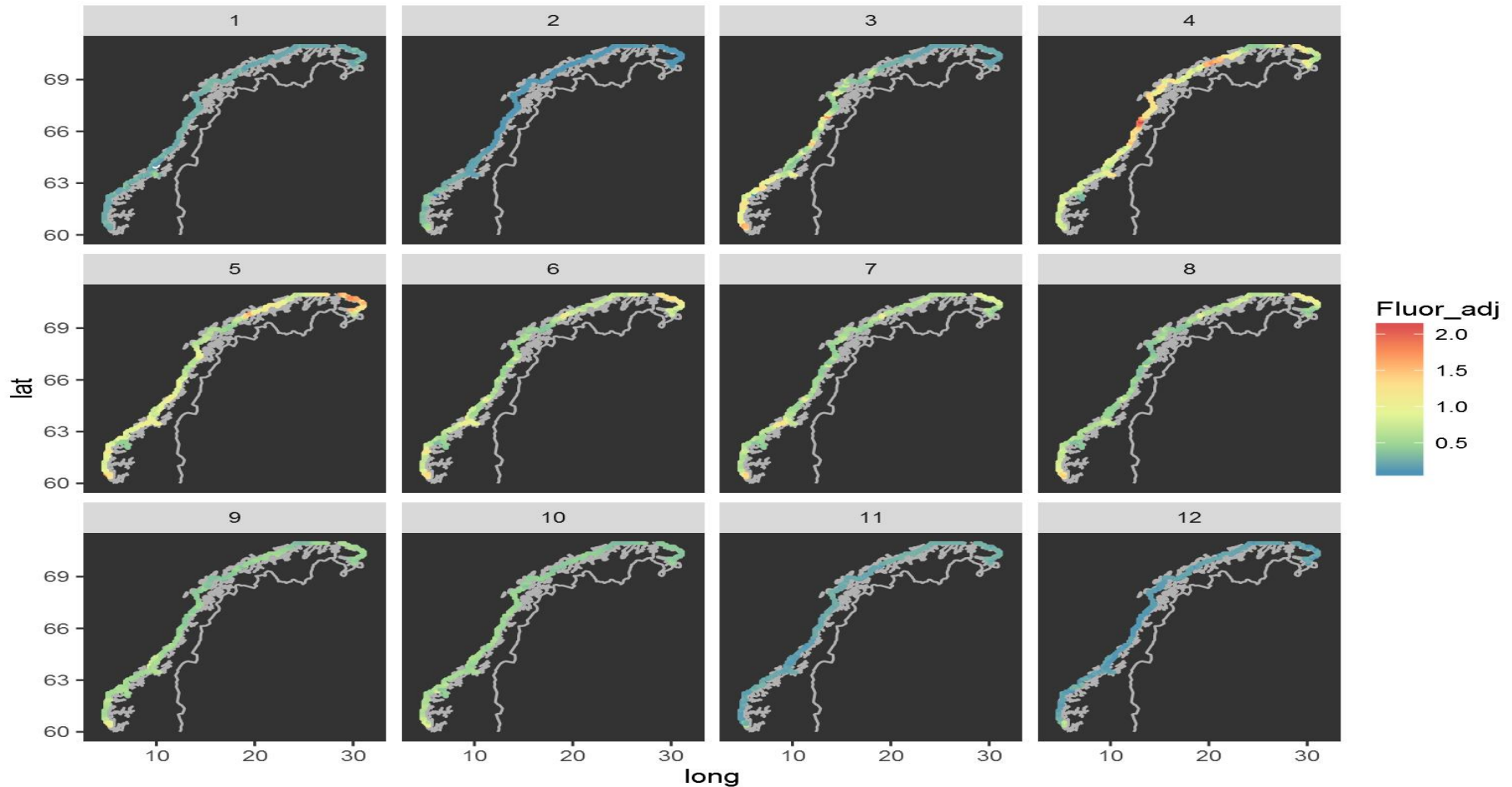
- cDOM=Coloured dissolved organic material measured by TriOS Micro_FLU cDOM sensor picked up a strong signal in october. Micro_flu are factory calibrated (rel unit).
- Same time as the autumn bloom

cDOM, salinity and Chl-a_fl at the monitoring station (Dk1) in 2015

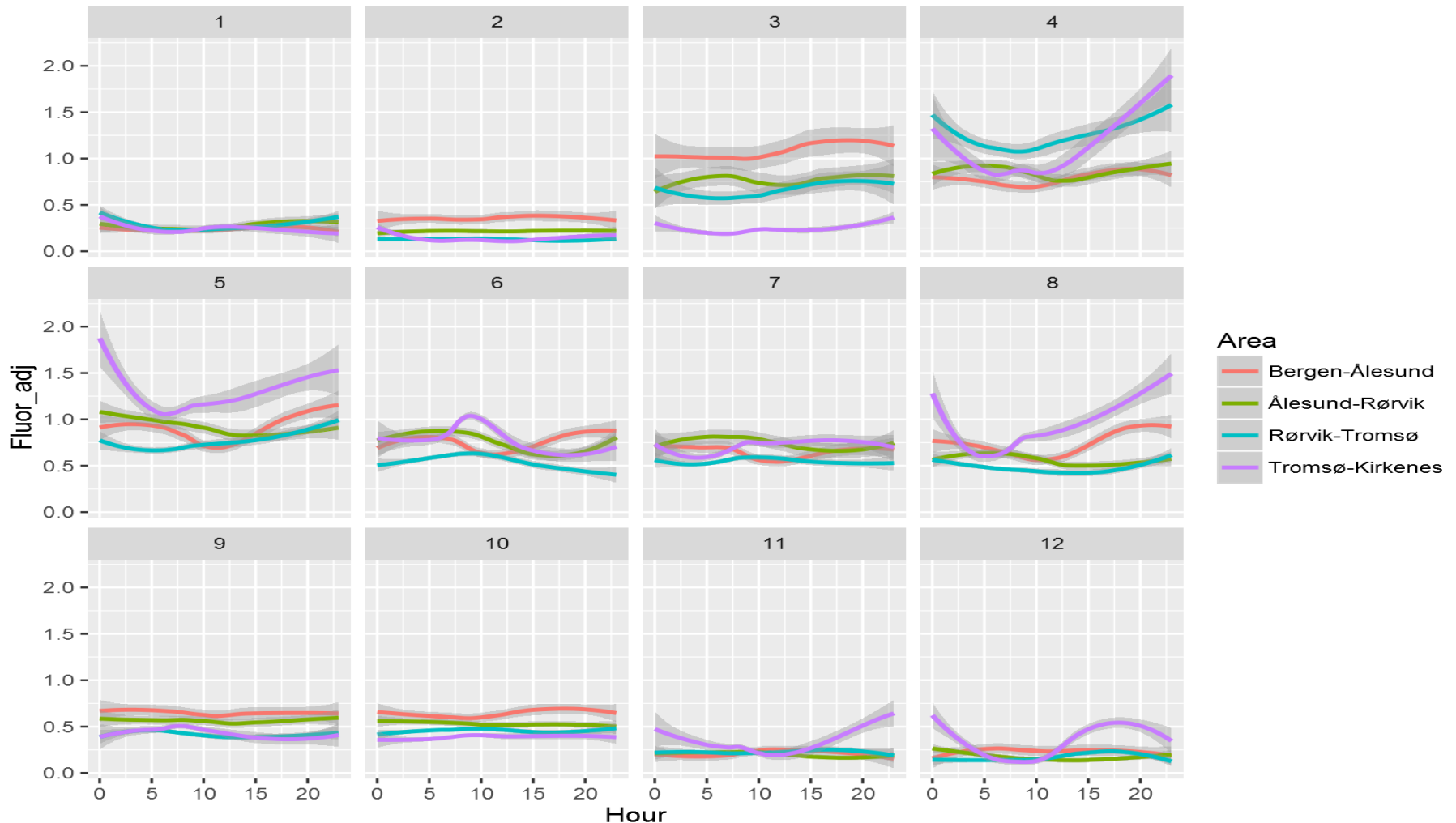
cDOM in factory calibration (rel unit)



Timeseries of Chl-a_fl data from Norwegian coast 2005-2014

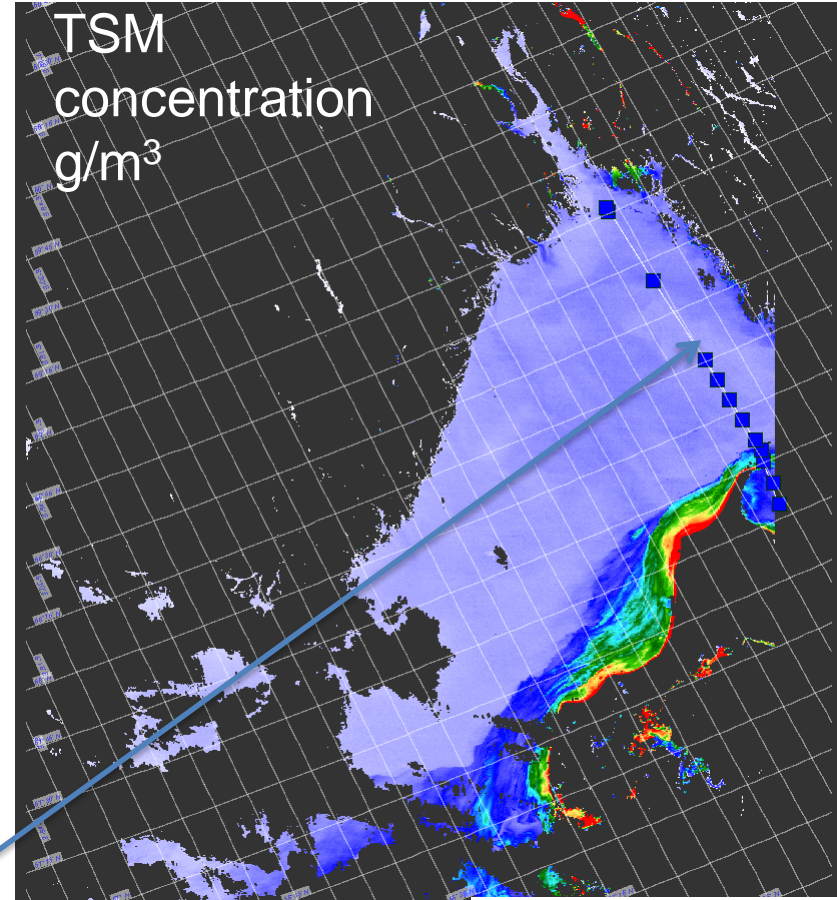
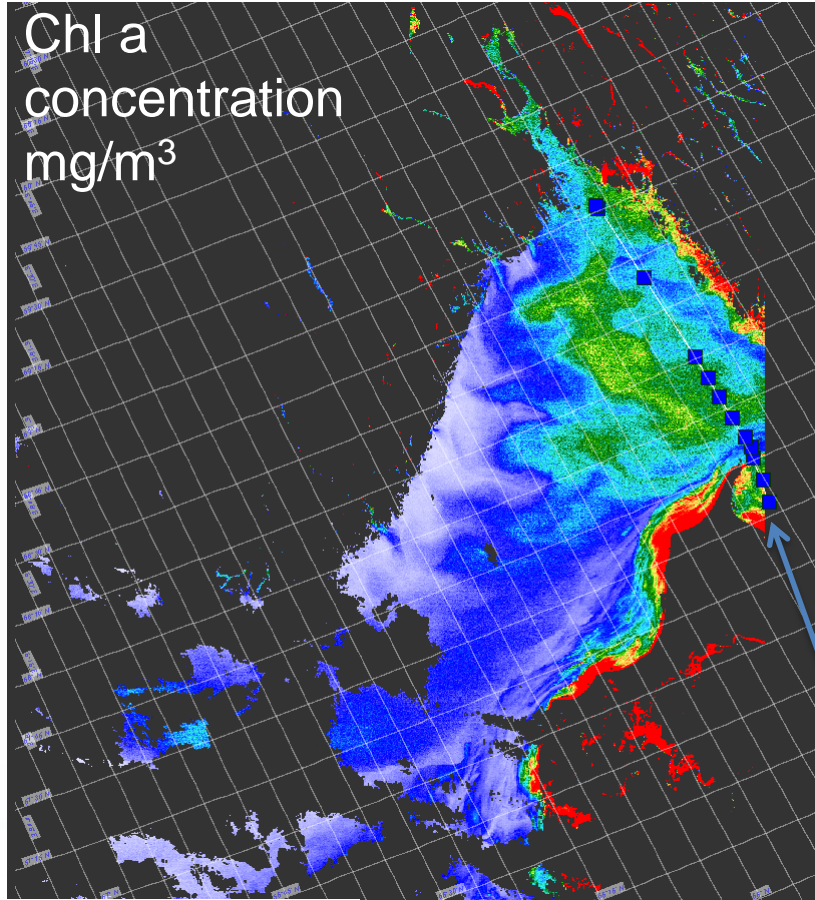


10 years monthly average of Chl-a_fl (mg/m³) in section

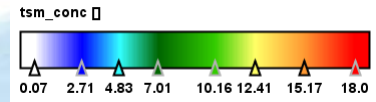
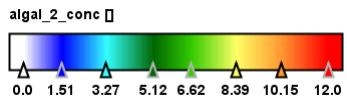


MERIS in Skagerrak

17.March 2007

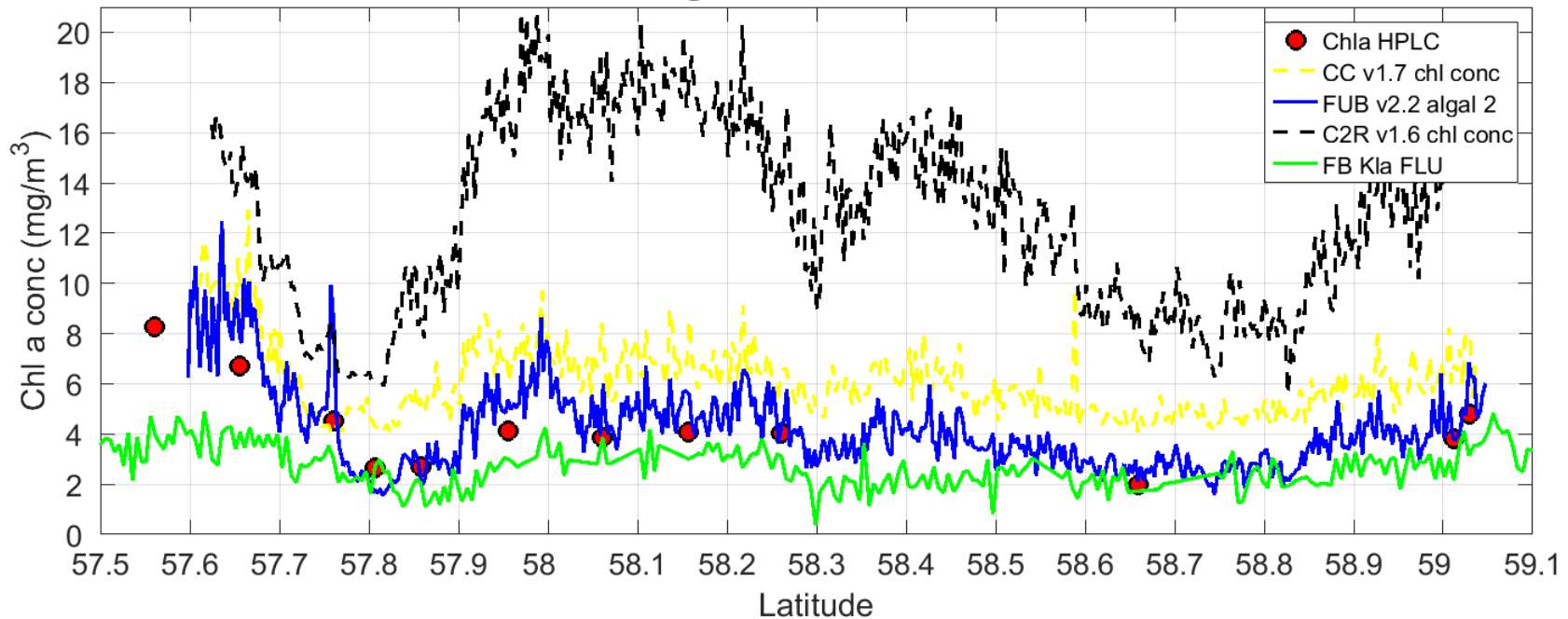


Ferrybox transect, Color Festival



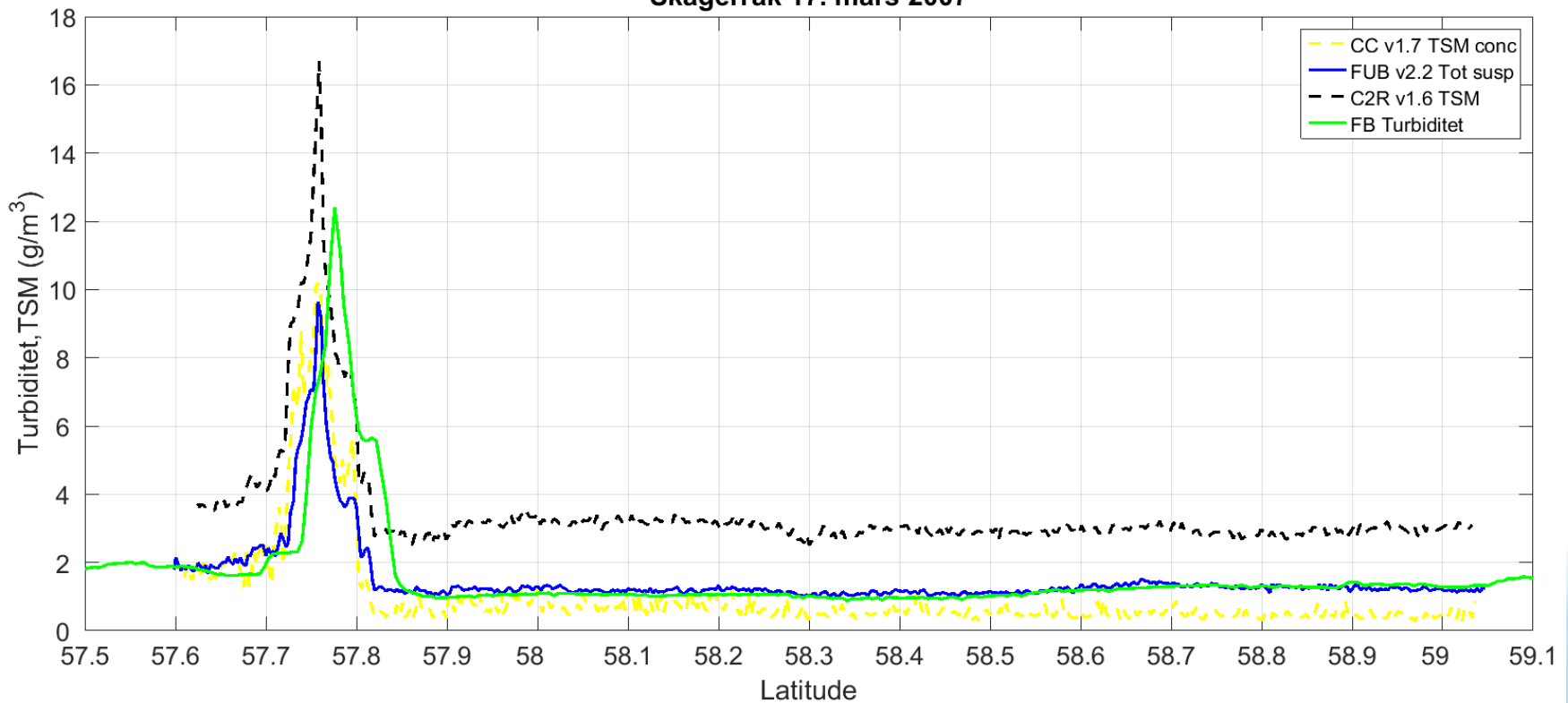
Satellite algorithm validation Chlorophyll-a

Skagerrak 17. mars 2007

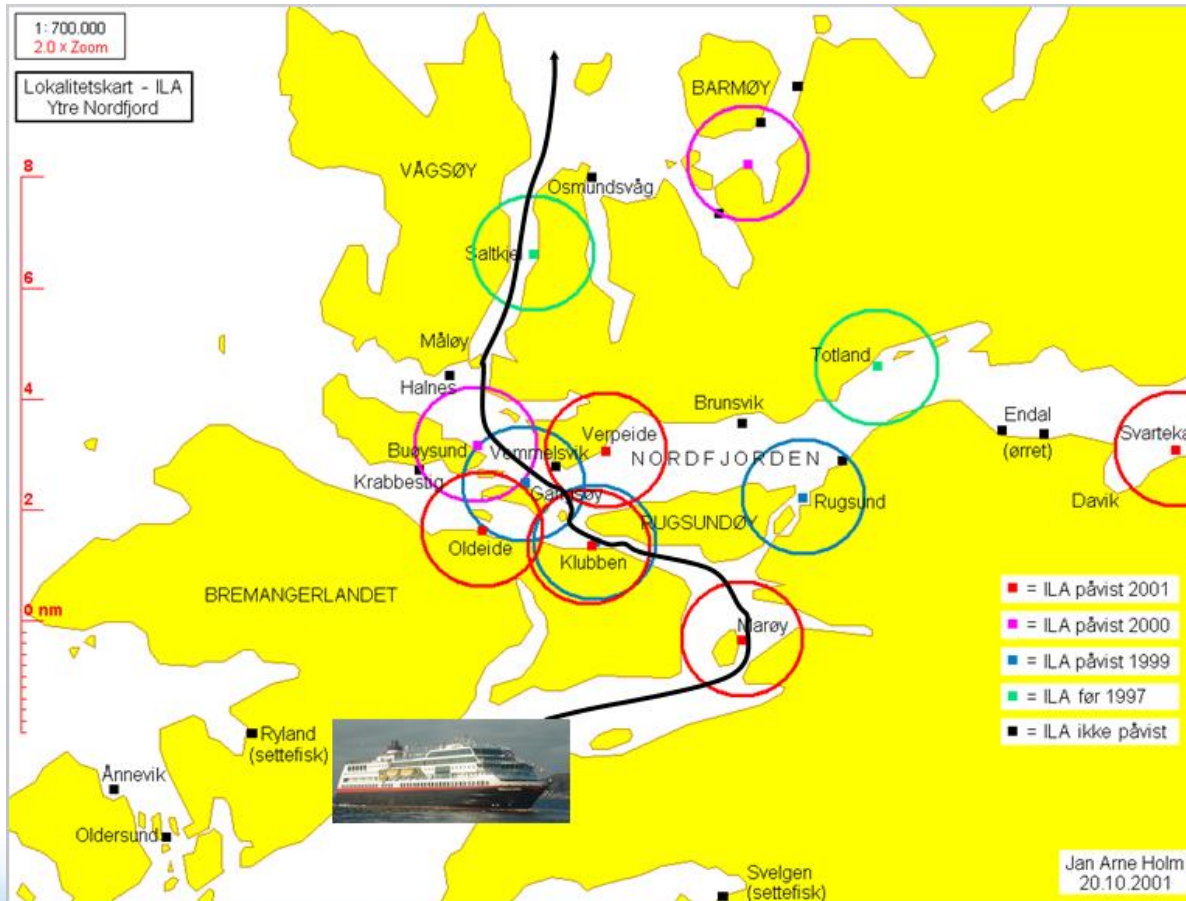


Satellite algorithm validation Turbidity and TSM

Skagerrak 17. mars 2007



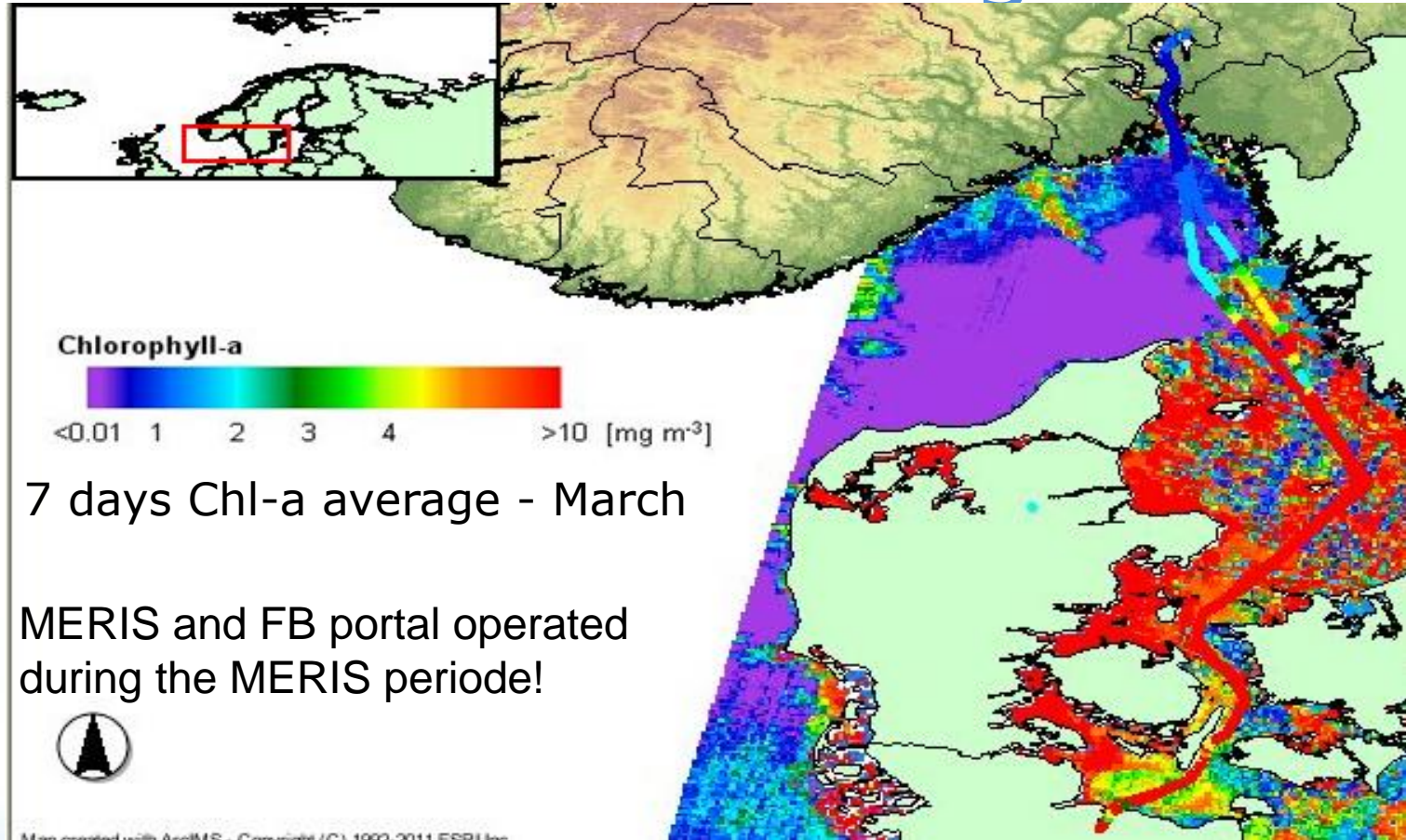
Monitoring Aquaculture areas



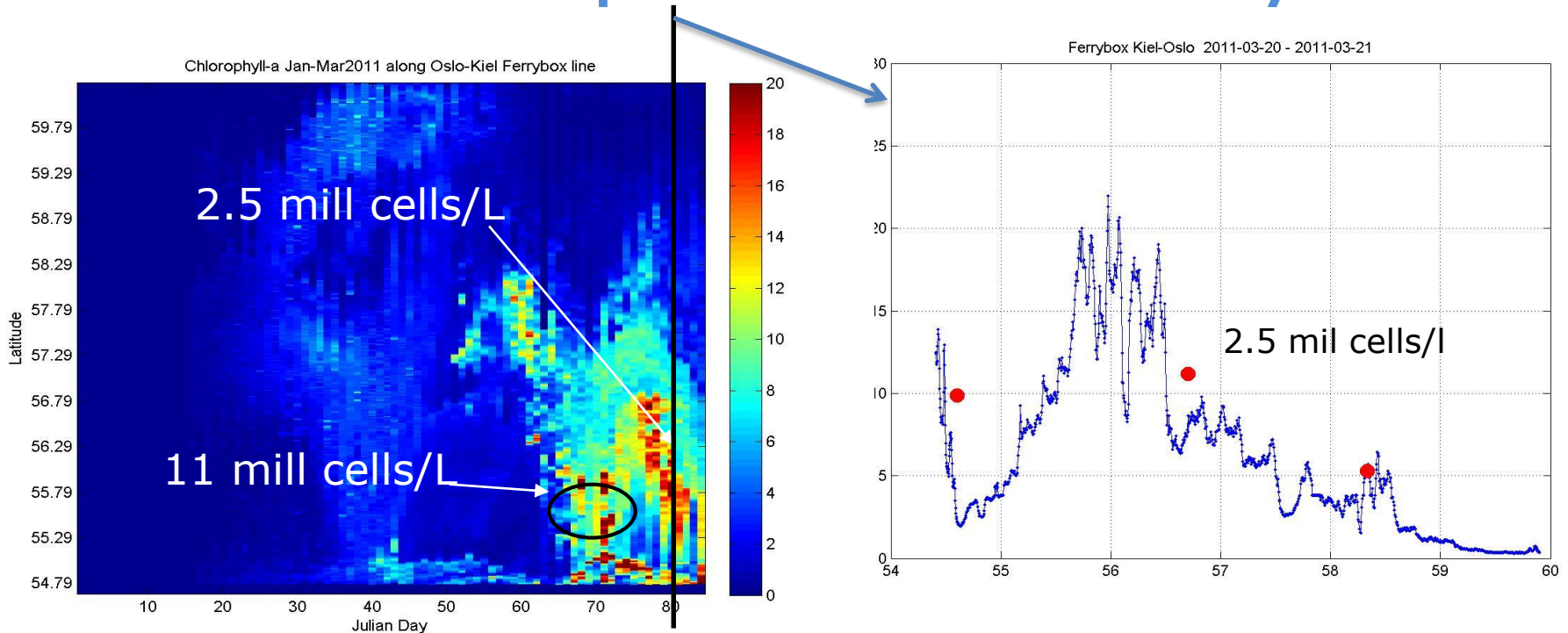
- Well boat corridors
- Area with restricted transport with open wells
- HAB monitoring
- Contamination between plants
- Verification of models for spreading of diseases

Monitoring of HAB events

Pseudochatonella bloom in March 2011 in Kattegat



The bloom was validated by water samples from Ferrybox



Pseudochatonella; Critical limit for fish are 0.5 mill cells/l
Earlier blooms in 1998, 2000 and 2001;
1998: 350 ton fish killed,
2001: 1100 ton fish killed

The logo for NIVA, consisting of the letters 'NIVA' in a bold, blue, sans-serif font. The letter 'A' is stylized with a horizontal bar that curves upwards and to the right, resembling a wave or a stylized '4'.

Norsk institutt for vannforskning