The Norwegian Ferrybox network after 10 years of operation

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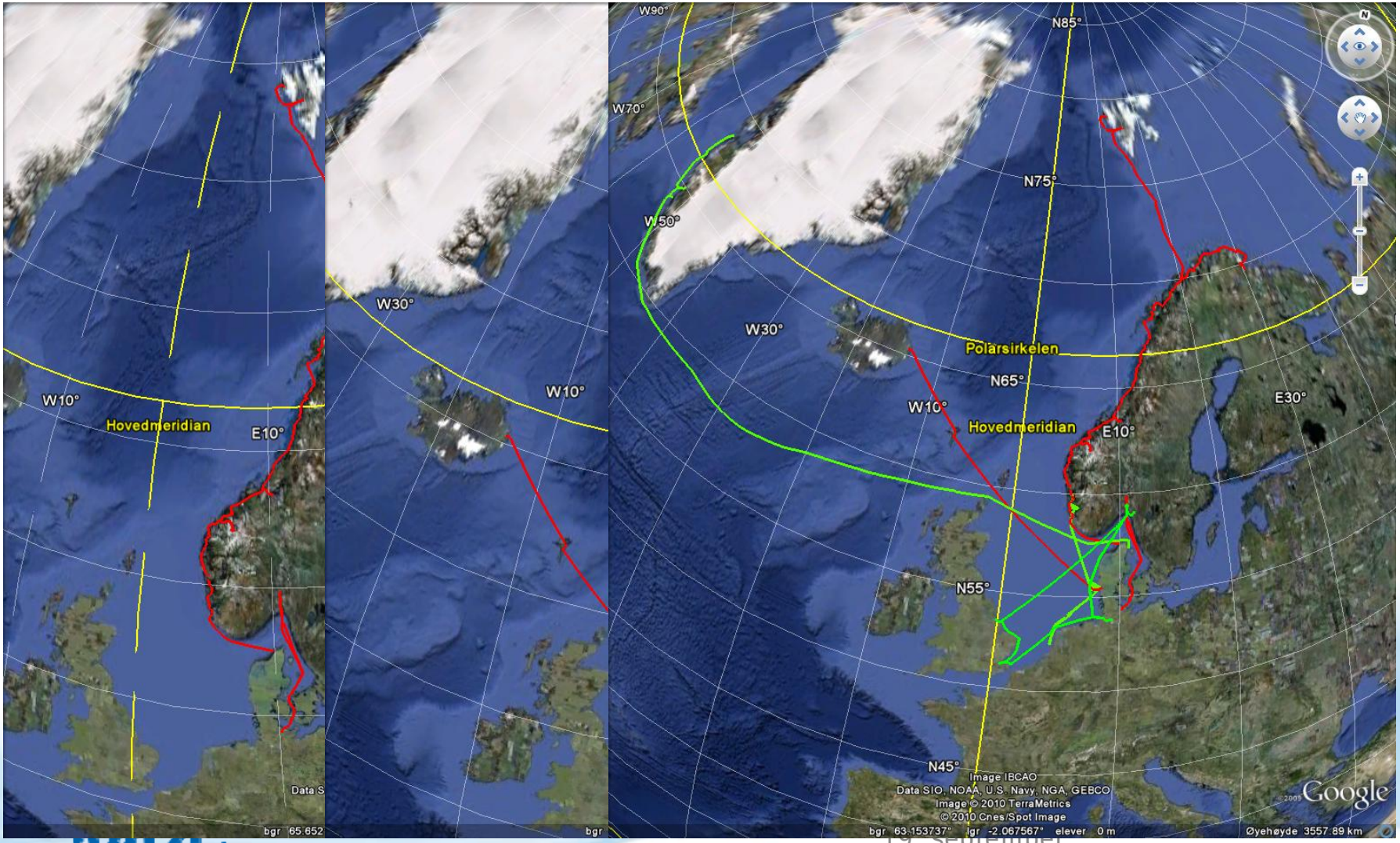
- NIVA Ferrybox system
- Calibration and maintenance
- Chl-a fluoresence vs. Chl-a
- User application

Short background

- Norwegian research project 2001-2002
  - First route: Denmark-Norway
- EU project FerryBox 2003-2005
  - Two new routes: Denmark-Norway, Norw. coast
- EU projects DISMAR/InterRisk 2004-2006
- ESA/NSC project VAMP/SatOcean 2005 -->
  - One additional ship at the Norw. coast (IMR)
- National monitoring projects 2006 -->
  - One new route in North to Svalbard
  - New installation in North Sea (MarLab)
- MyOcean I 2009 --> MyOcean II 2012 -->
- Jerico 2011 -->

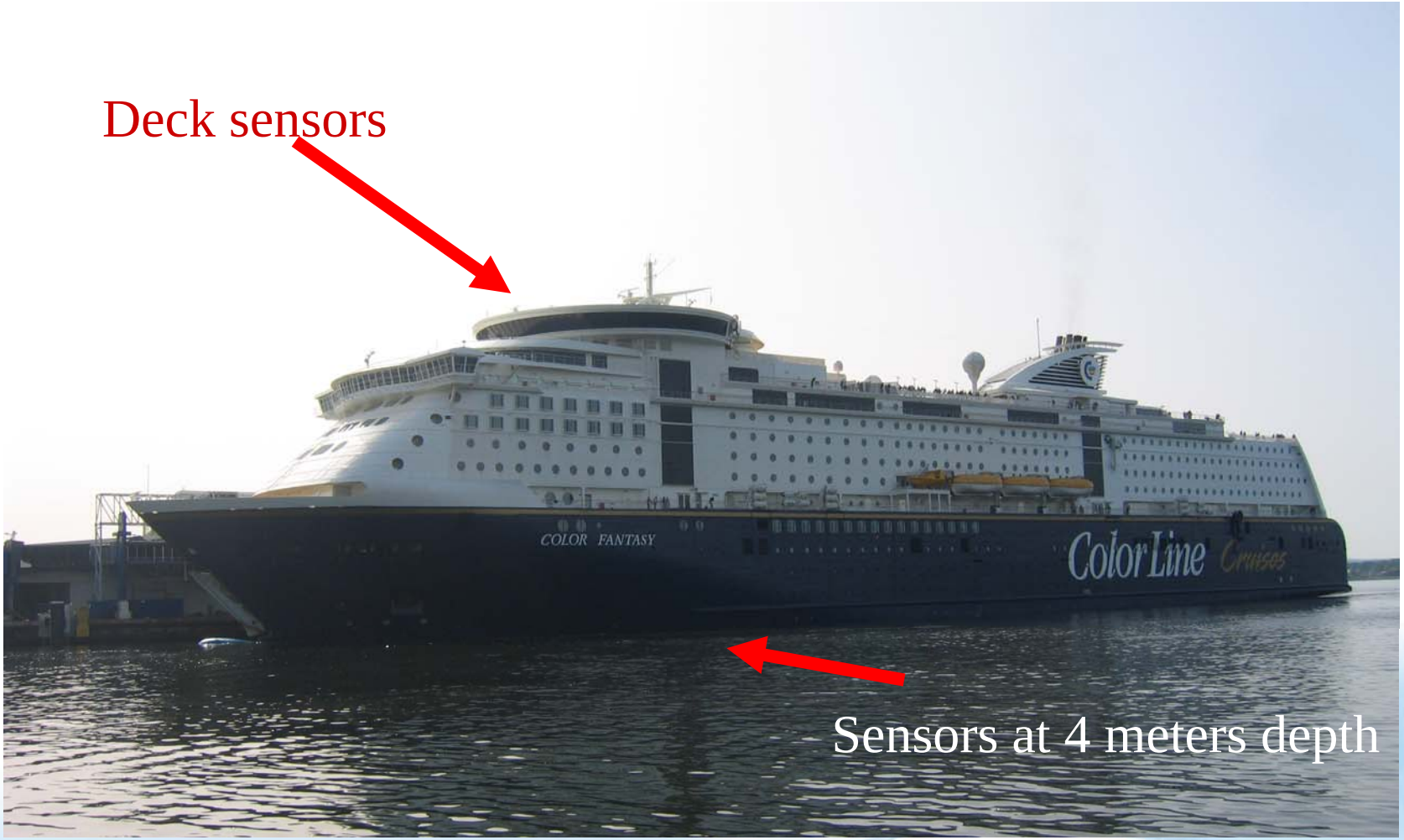
Network in Norwegian waters



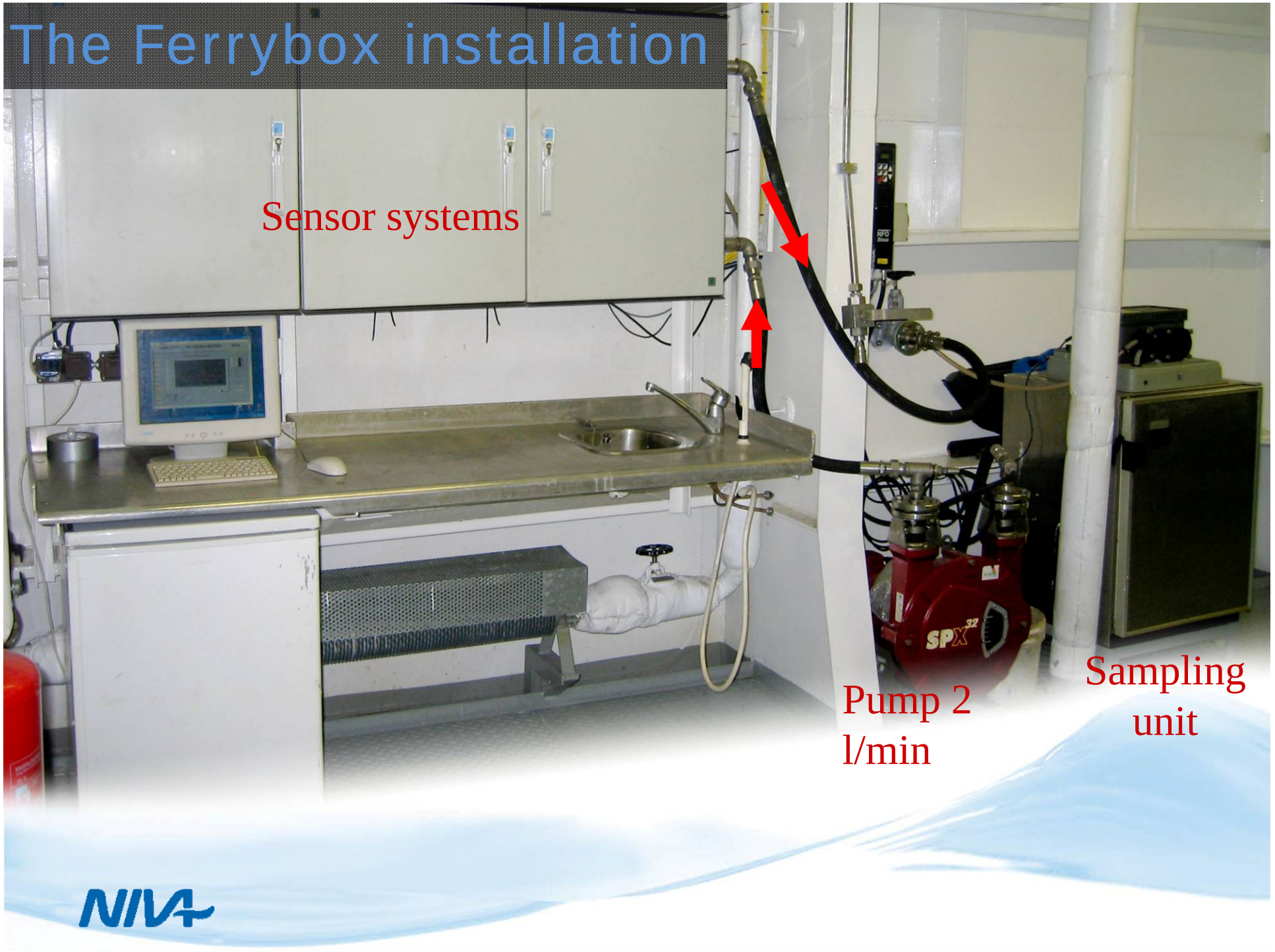
NIVAs Ferrybox system

The present design on Color Fantasy operating between Oslo and Kiel

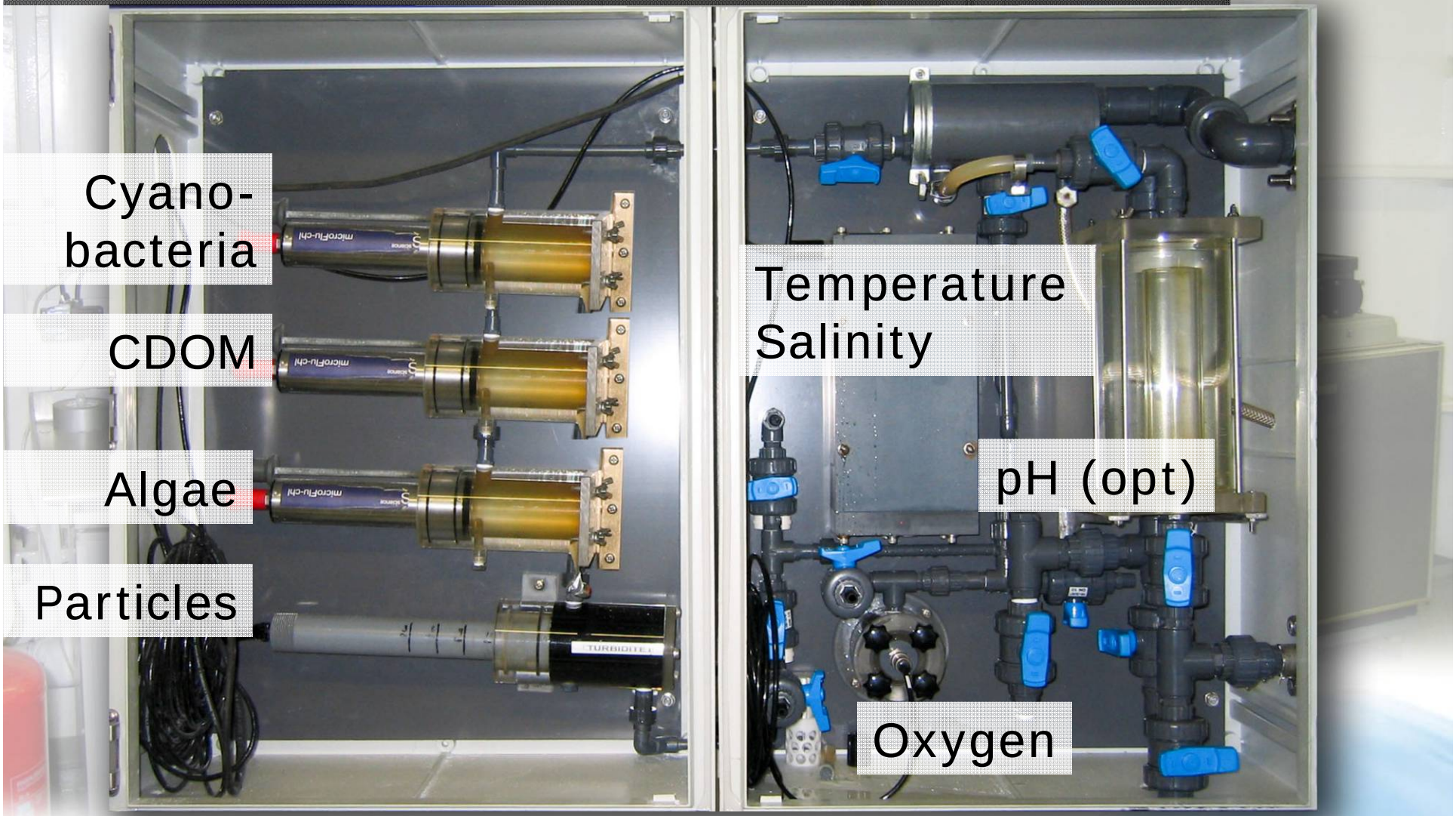
The Ferrybox systems on Color Fantasy between Oslo and Kiel



The Ferrybox installation



Ferrybox sensors on Oslo-Kiel



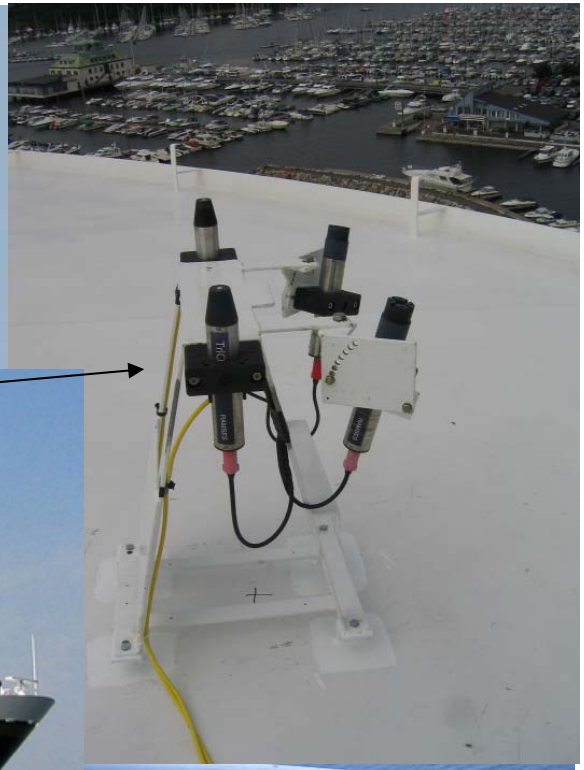
Overview of variables and routes

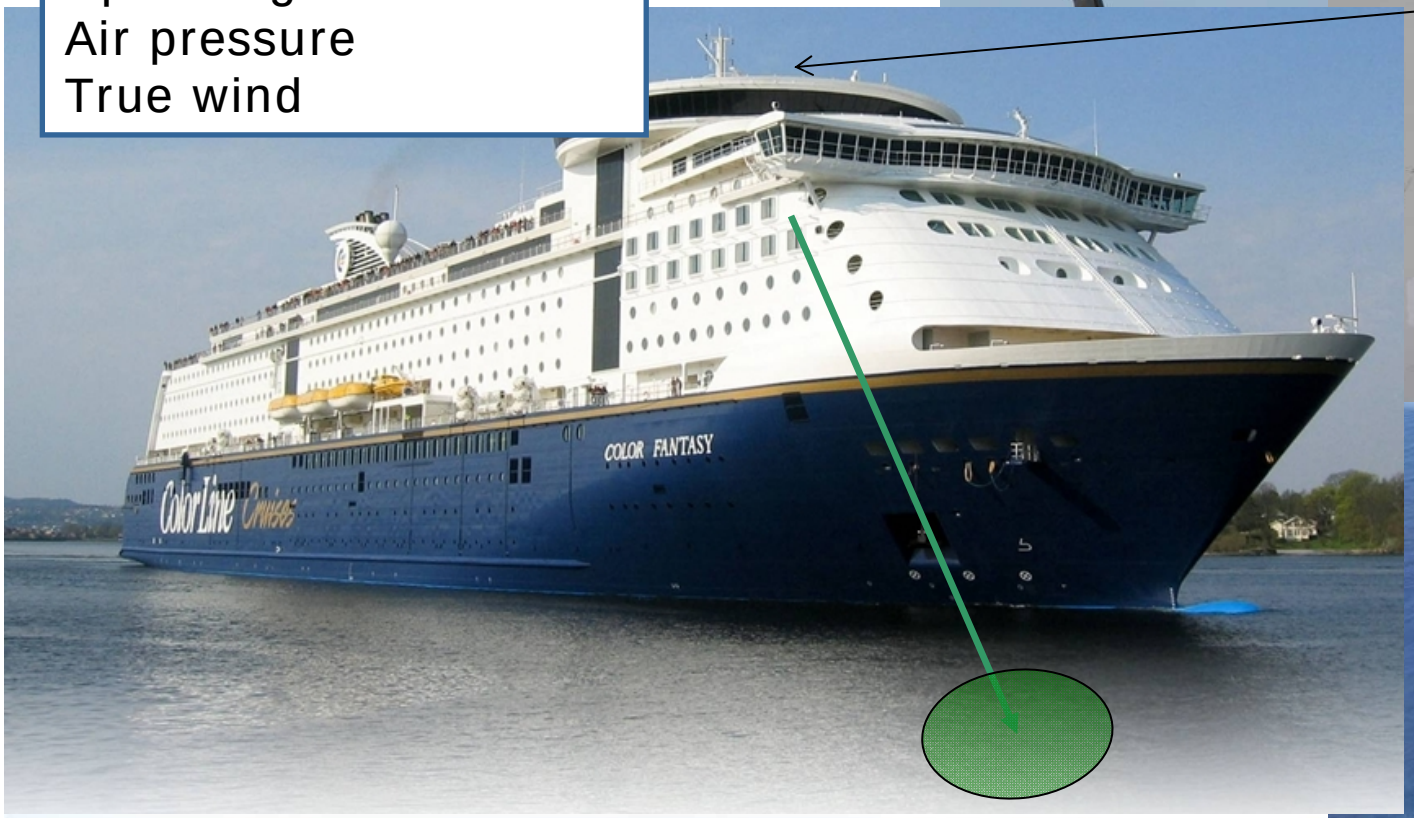
Variable/installation	Color Fantasy (Oslo-Kiel) NIVA	Bergensfjord (Hirtshals-Bergen) NIVA	Trollfjord (Bergen-Kirkenes), NIVA	Vesterålen (Bergen-Kirkenes), IMR	Norbjørn (Tromsø-Svalbard) NIVA
salinity					
water temperature					
water temperature Inlet					
oxygen					
oksygen inlet					
chlorophyll-a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

Status	In operation	Semioperational	Test installation	Under testing

Deck sensors and installations

Downwelling irradiance
Upwelling radiance
Air pressure
True wind

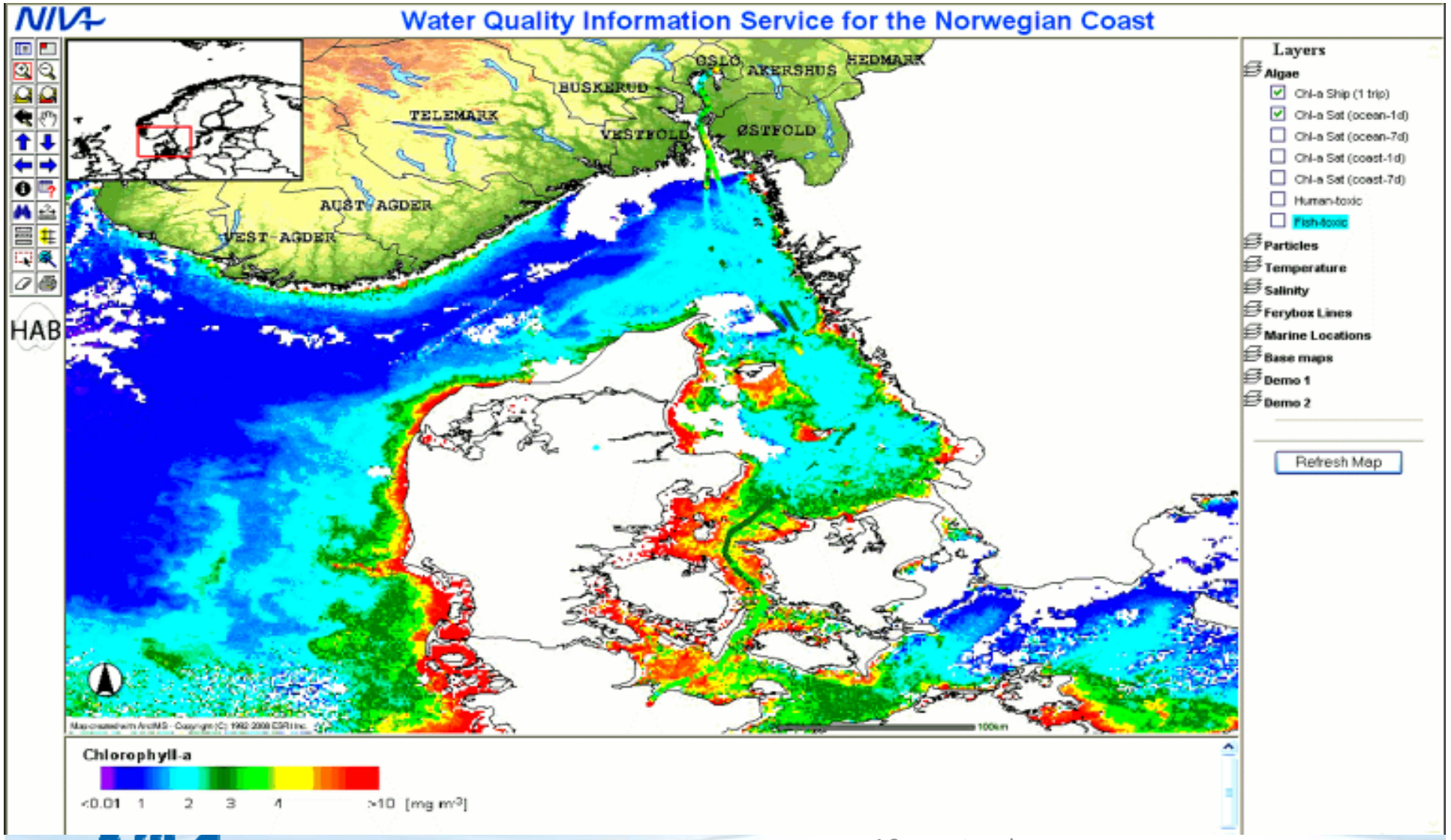




Data transmission

- Internally on ship: Between sensor and PC or between deck sensors and PC
  - RS232
  - Modem from deck to PC
  - Analog signal (turbidity)
  - (W)LAN (internal internet)
- Externally to database at NIVA
  - GPRS
  - Internet

NIVA web portal for Ferrybox and satellite data (www.ferrybox.no)



The coverage through 10 years of operation - NIVA ships

Water bodies/areas	Port start	Port end	Freq.	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Eastern Skagerrak, Oslofjord	Oslo	Hirtshals	Daily	*CF*	*CF*	*CF*	*CF*	*CF*	*CF*		*PR*		
Eastern Skagerrak, Oslofjord	Oslo	Fredrikshavn	Daily						*CF*	*CF*			
Eastern Skagerrak, Oslofjord, Kattegat, Kiel Bight	Oslo	Kiel	Sec								*FA*	*FA*	*FA*
North Sea (central)	Bergen	Newcastle	3/week					*FN*	*FN*				
Western Skagerrak, Norwegian coast/fjords (North Sea)	Bergen	Hanstholm	3/week							*PR*	*BF*		
Western Skagerrak, Norwegian coast/fjords (North Sea)	Bergen	Hirtshals	3/week									*BF*	*BF*
North Sea, Norwegian Sea, Atlantic Ocean	Bergen	Iceland	Weekly								*NO*		
North Sea, Norwegian Sea, Atlantic Ocean	Esbjerg	Iceland	Weekly									*NO*	*NO*
Barents Sea/ Arctic Ocean	Tromsø	Longyearbyen	1/week								*NB*	*NB*	*NB*
Norwegian coast/fjords (North Sea, Norw. Sea, Barents Sea)	Bergen	Kirkenes	Weekly				*TF*	*TF*	*TF*	*TF*	*TF*	*TF*	*TF*

PR = Prinsesse Ragnhild	*CF = Color Festival*	*NB = Norbjørn*
BF = Bergensfjord	*FA = Color Fantasy*	*FN = Fjord Norway*
NO = Norrøna	*TF = Trollfjord*	

Maintenance and calibration of the core sensors and system

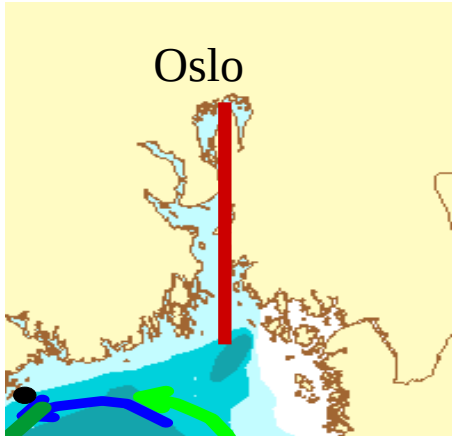
Maintenance

- Airjet cleaning of all optical sensor
  - In harbours (1x/day)
- Manual cleaning of all sensors
  - Biweekly/weekly wash with tap water
    - Backflushing with tap water of inlet valve
  - Min 2-3x/year cleaning of inlet/outlet valves
  - Acid cleaning when needed
- Irradiance/radiance sensors
  - Cleaning and control 3-4x/year

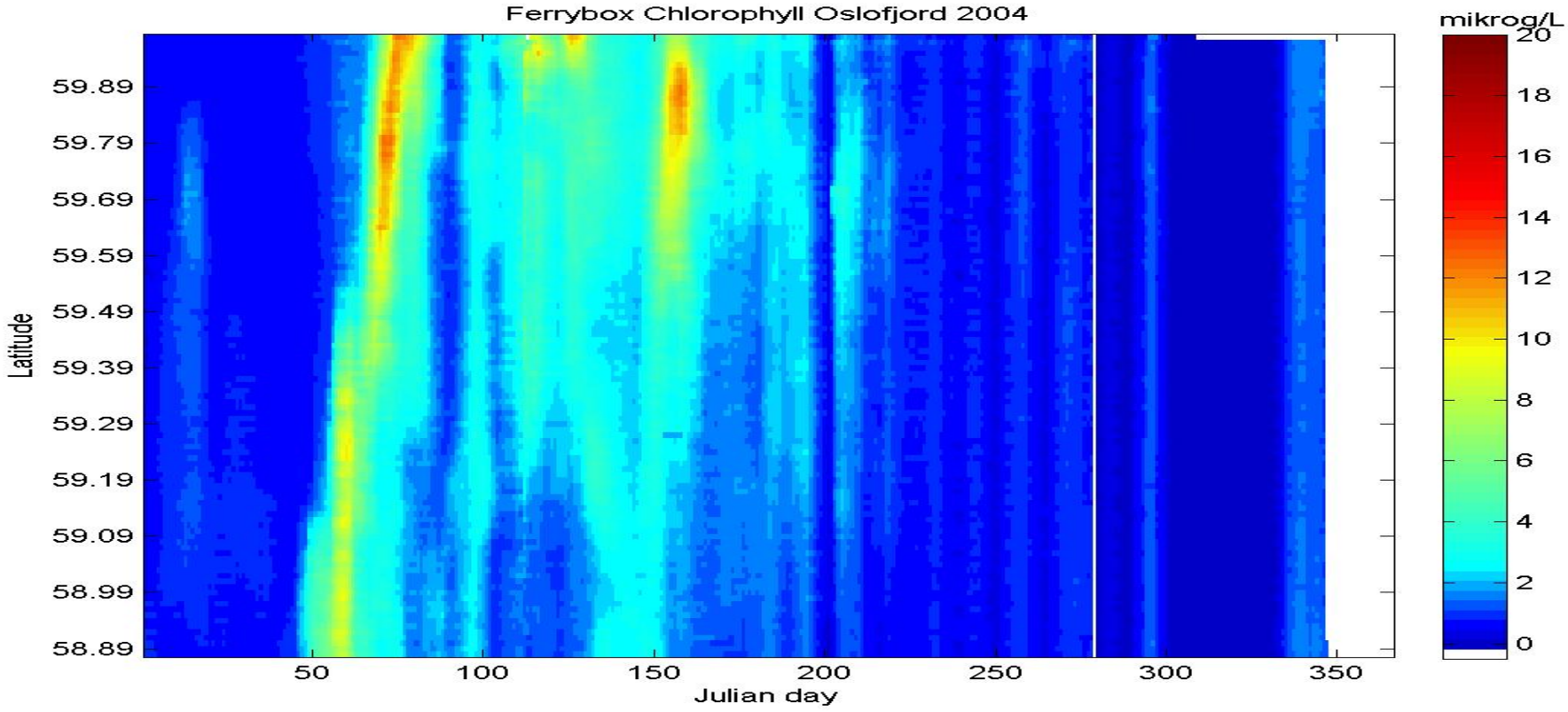
Calibration and controls

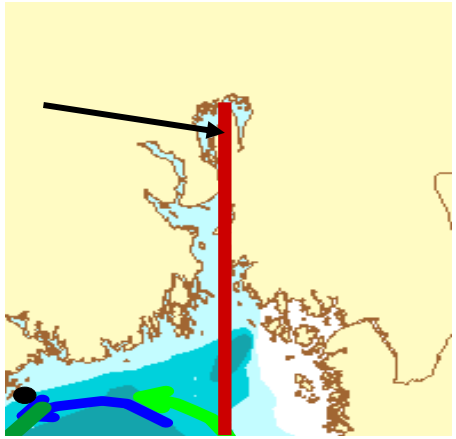
- Salinity/temperature
  - Controll samples minimum 2-4x/year
  - Factory calibration when needed (every 2 years)
- Oxygen
  - Winkler (in harbour/at sea) 4-6x/year ?
- Turbidity
  - Formazin turbidity standards 1-2x/year
- Chlorophyll-a fluorescence
  - Algal culture yealy
  - Water samples montly/weekly
- Irradiance/radiance sensor
  - FieldCal lamp 3-4x/year
  - Yearly control at NIVA - NIST reference lamp
  - Factory or external calibration when needed

Ferrybox timeseries and important datasets

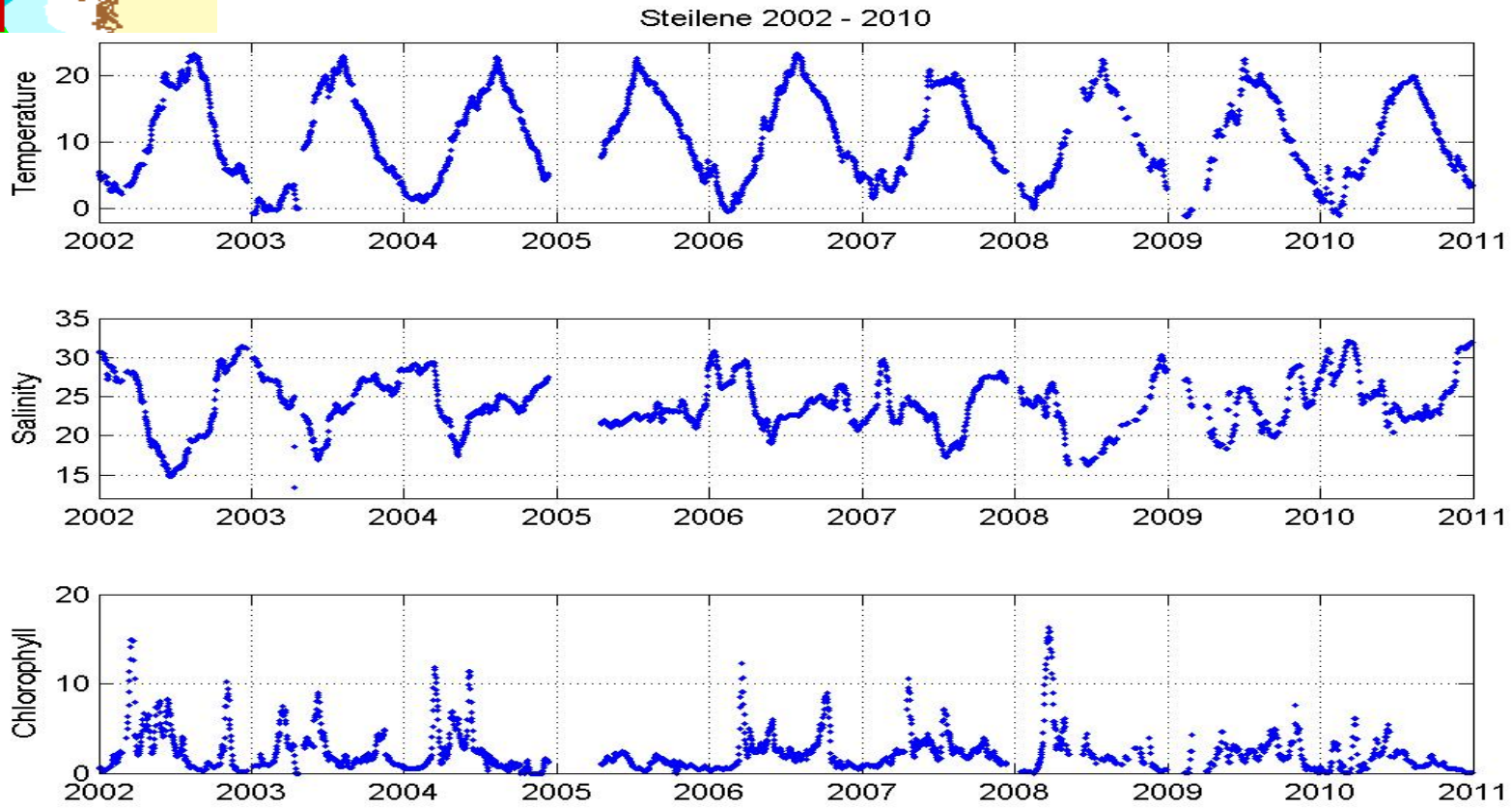


Chlorophyll-a fluoresence in the Oslofjord in 2004

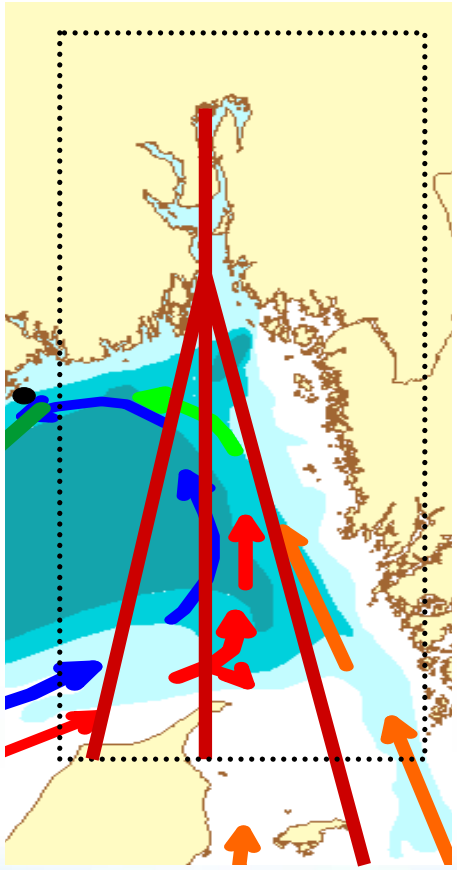


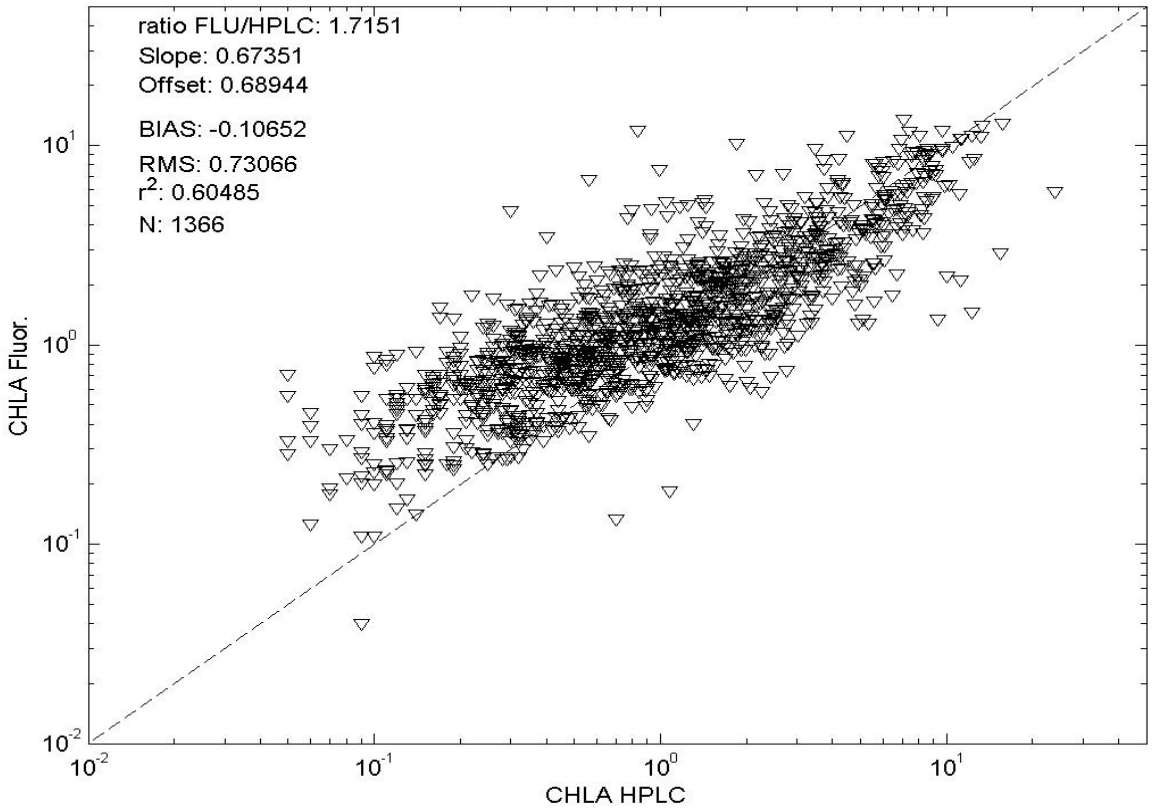


Inner Oslofjord for 2002-2010

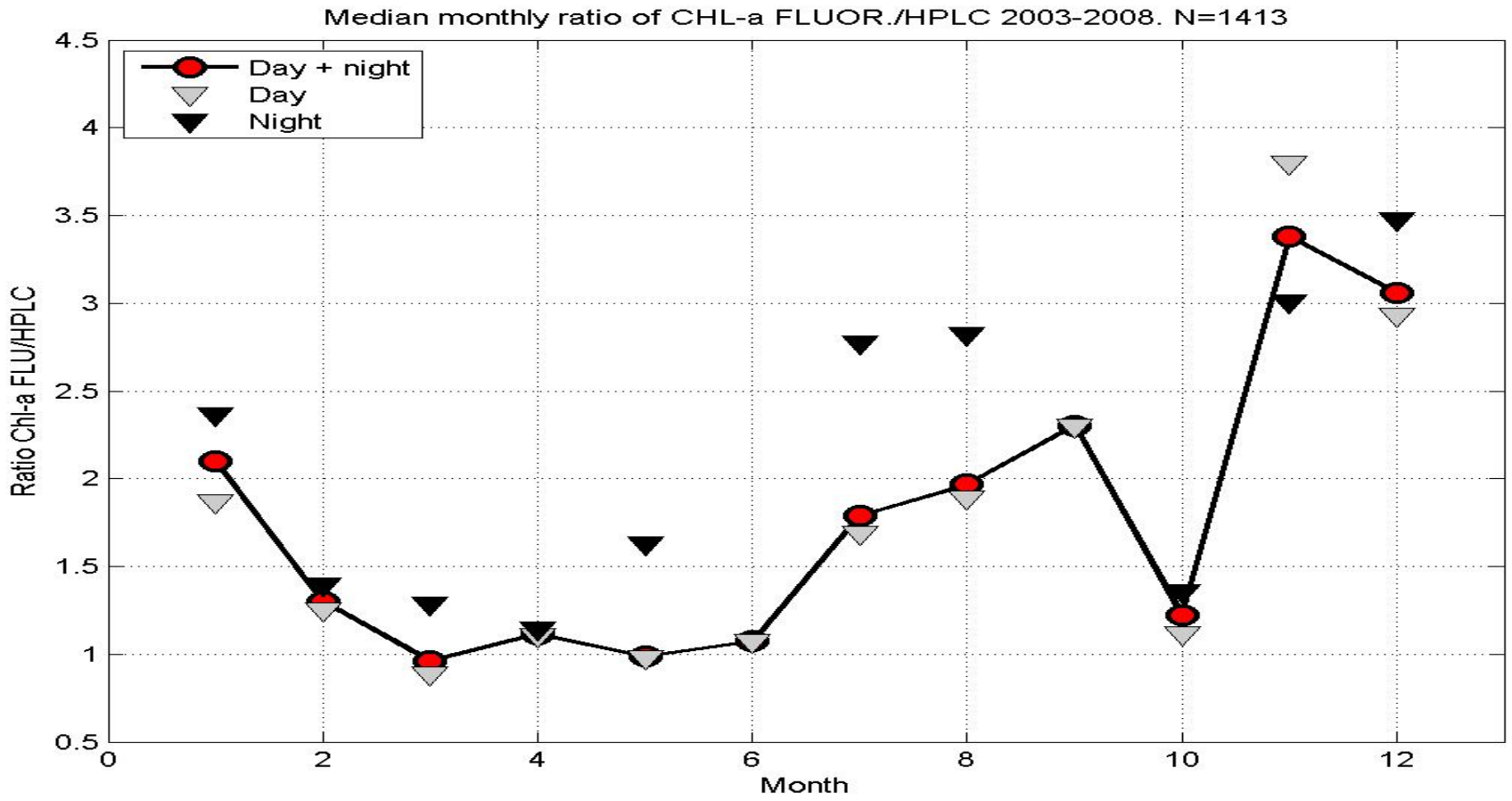


Chl-a_fl vs Chl-a_hplc for 6 years of data in the Skagerrak

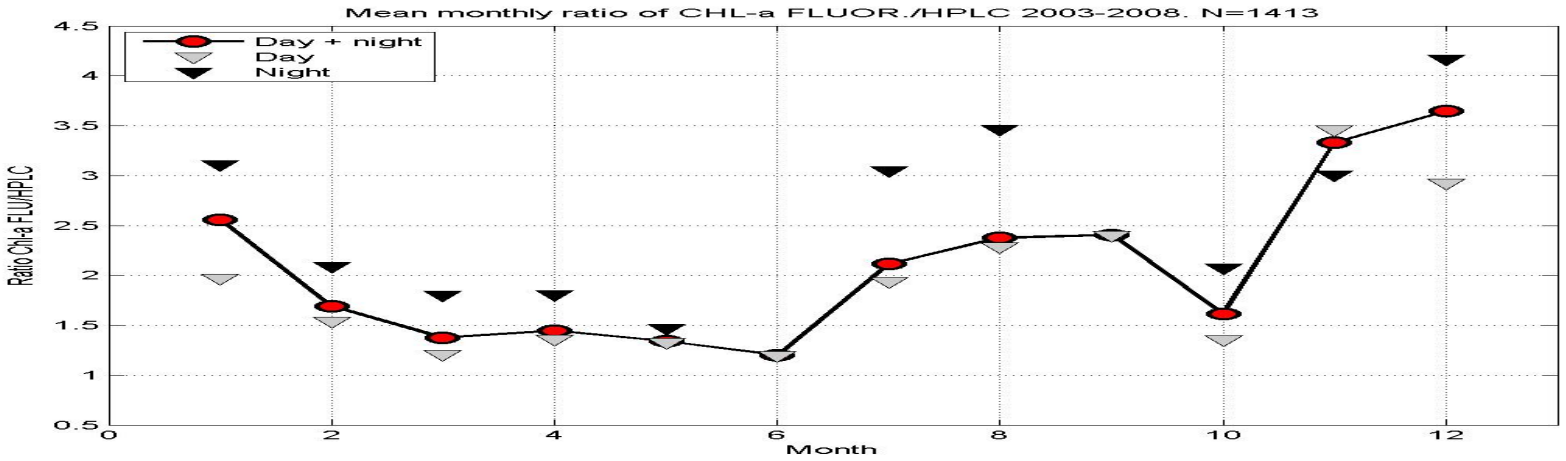


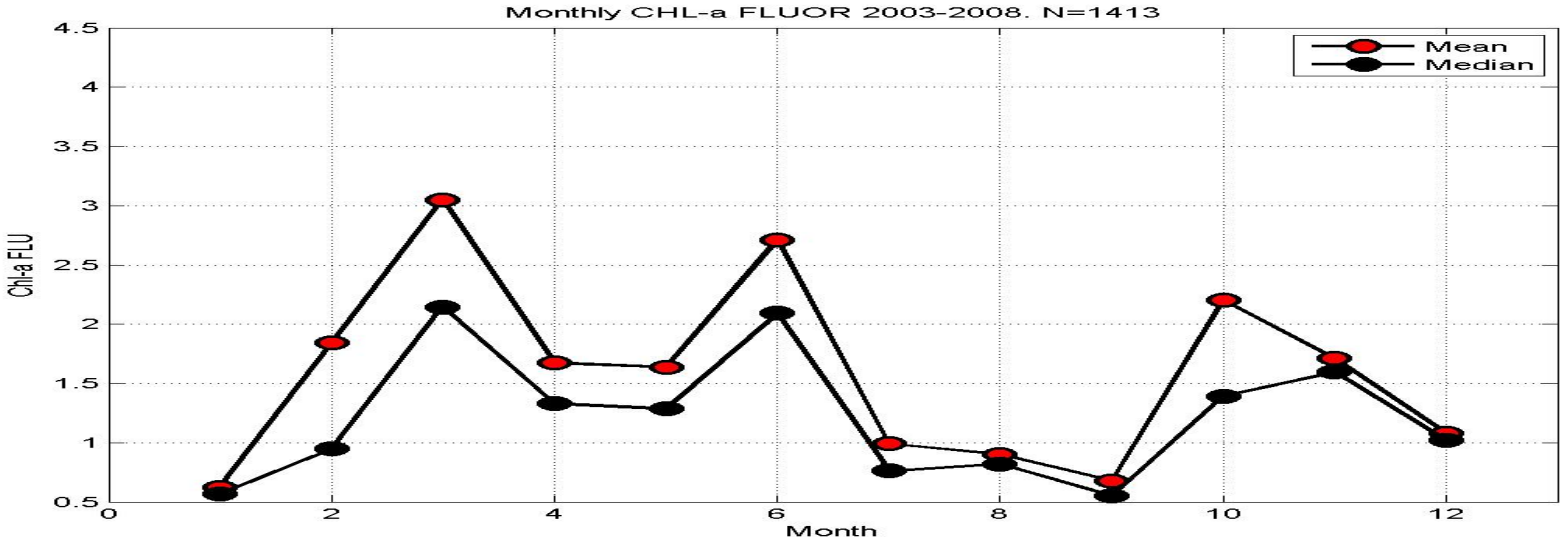


Chl-a_Fl/Chl-a ratio for 6 years of data in the Skagerrak



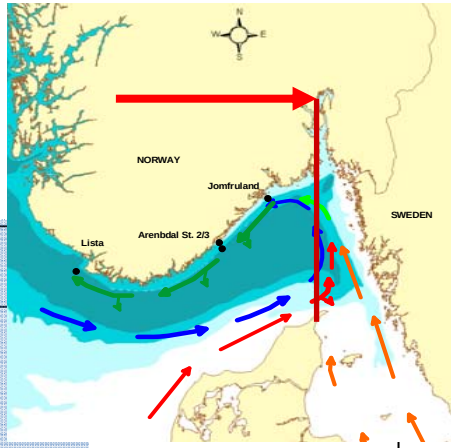
Chl-a_fl/Chl-a and Chl-a





User application

High frequent measurements compared to routine sampling



Chl-a (mg/m3)

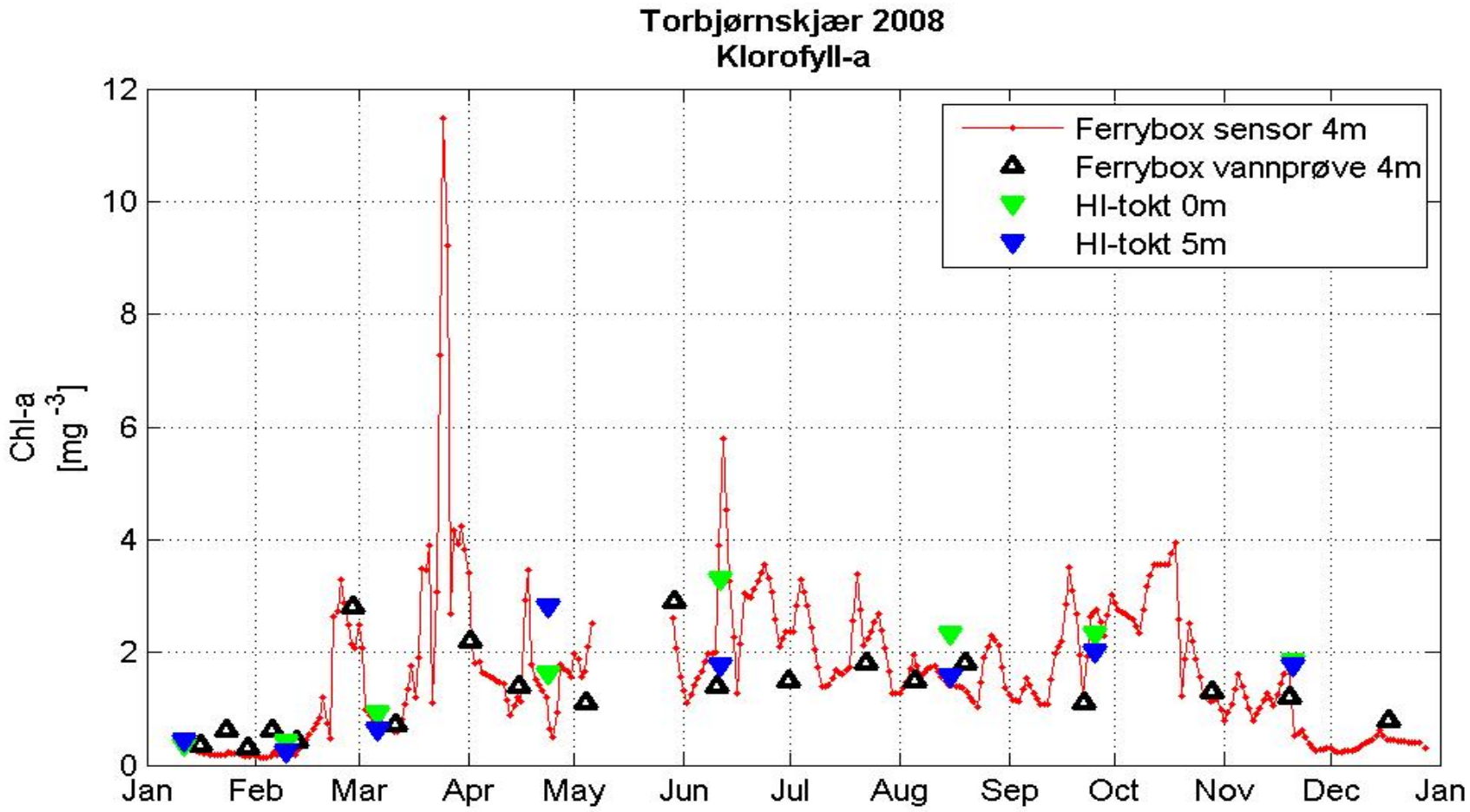
20
15
10
5
0

Sampling from Ferrybox

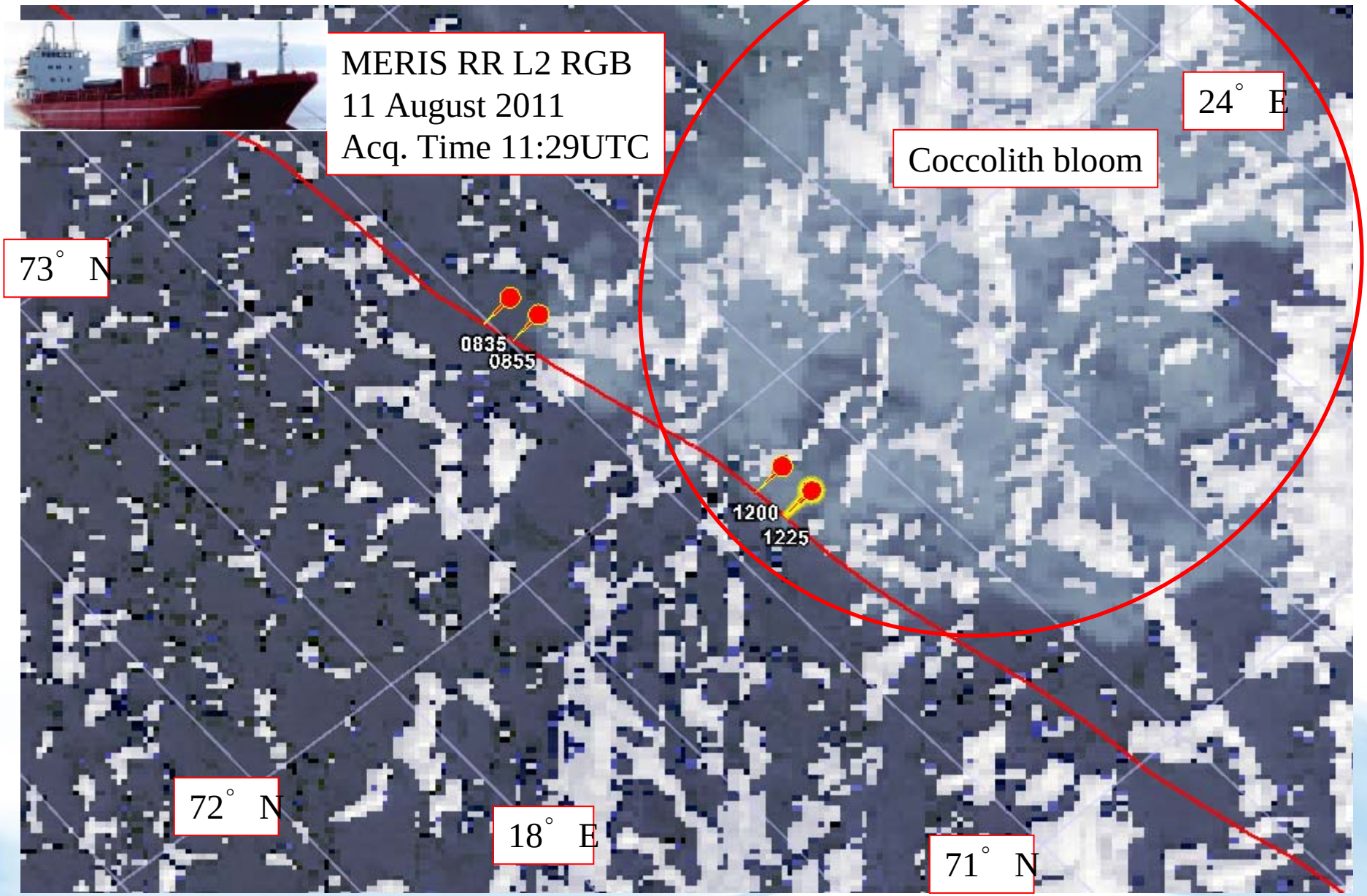
Sampling from traditional research cruises/monitoring program

Jan Feb Mar Apr Mai Juni Juli Aug Sep Okt Nov Des

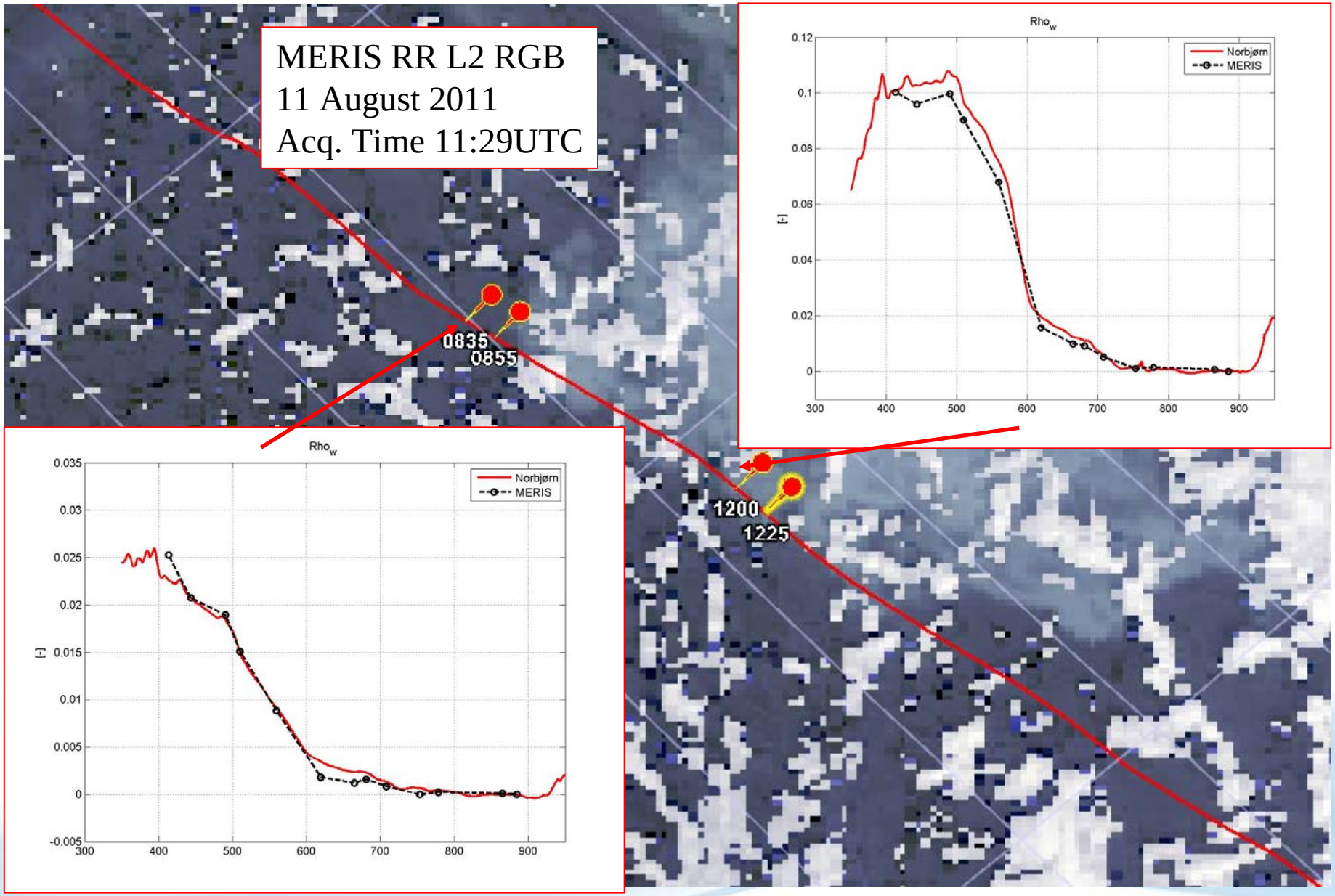
Validation of the chlorophyll-a fluorescence with monitoring data



Satellite validation in the Barents Sea

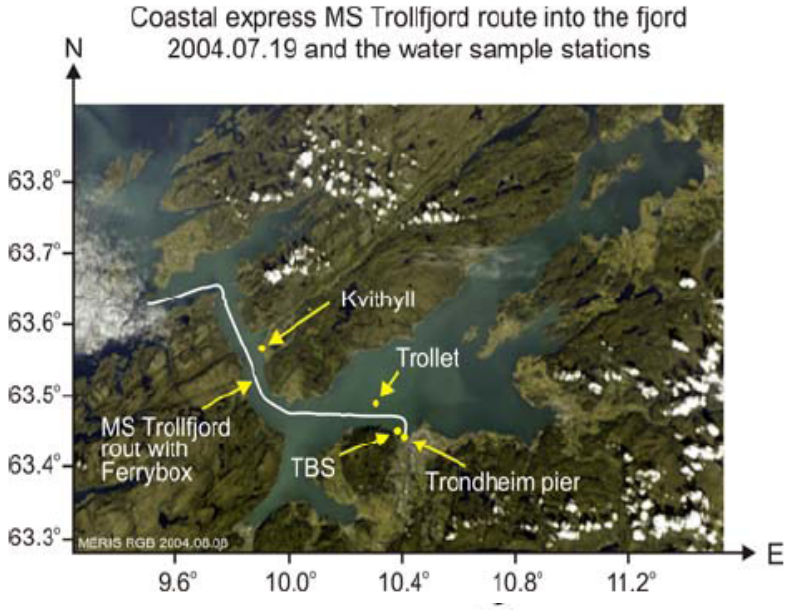


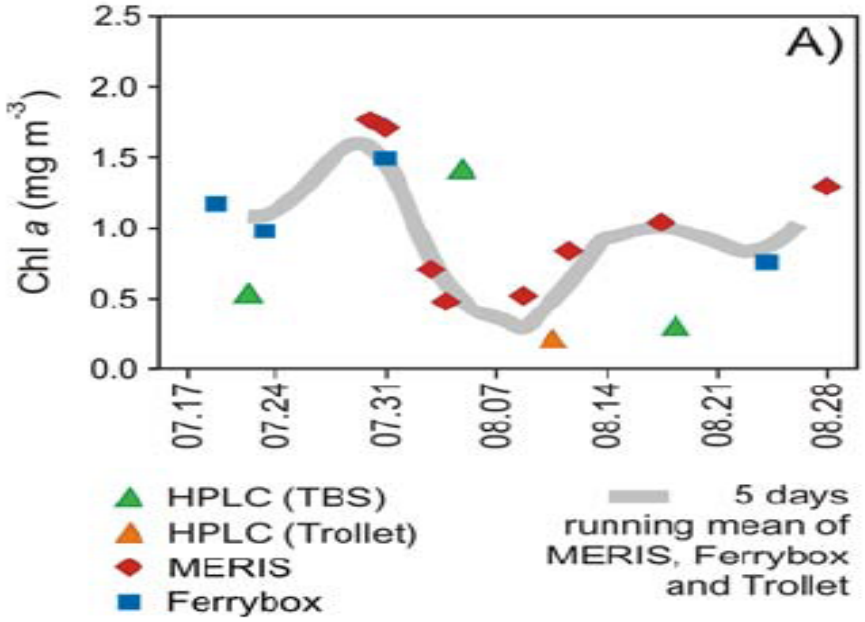
Satellite and ship measured reflectance

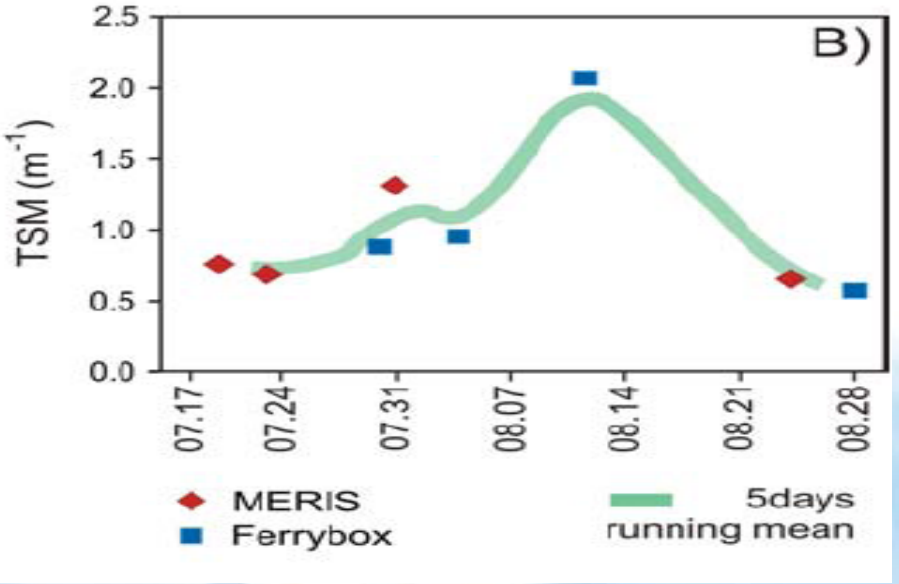


WRD in the Trondheimsfjord

Combining data from Ferrybox with local monitoring data and satellite data. Zolt et.al. In press







Summary

- 10 years of developments of the systems has given a high quality operational oceanographic observing system for e.g. GMES
- The Ferrybox system has proven to be a cost-effective observing system
- Ferrybox data set has and will give insight in topics of high scientific value
- User application are developed and are under implementation within national monitoring, WFD and satellite validation.