

# FerryBox Systems:

## *State of the art and incorporation in European Observation Networks*

W. Petersen et al.



### Outline:

- Short history of FerryBox
- FerryBox Community
- FBs within Coastal Observatories (JERICO)
- FB Data Management & QA
- FB Data and Models
- New Sensors
- Summary

# History of FerryBox Systems

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- Use of S-T thermosalinographs on the Hurtigruten in Norway, since 30ies
- since 1993 first application of FerryBoxes for monitoring in the Baltic Sea (Alg@line, SYKE (former Finnish Marine Institute )
- EU Project “FerryBox” 2003-2005 (after 2 refusals)  
→ FerryBox consortium
- Continuous operation by most of the partners since that time (individual funding mostly by research money)
- Setup of new lines
- Commercially FerryBox systems on the market

# **FerryBox Community in Europe**

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**After finishing of the EU funded project meetings took place to exchange ideas and further develop new techniques:**

- 1. Meeting in October 2006 in Oslo, ca. 25 participants**
- 2. Meeting in September 2008 in Southampton, ca. 60 participants**
- 3. Meeting in March 2010 in Göteborg, ca. 55 participants**
- 4. Meeting in September 2011, in Hamburg, ca 80 participants**

**Activities related to FB are incorporated in e.g. EU-JERICO**

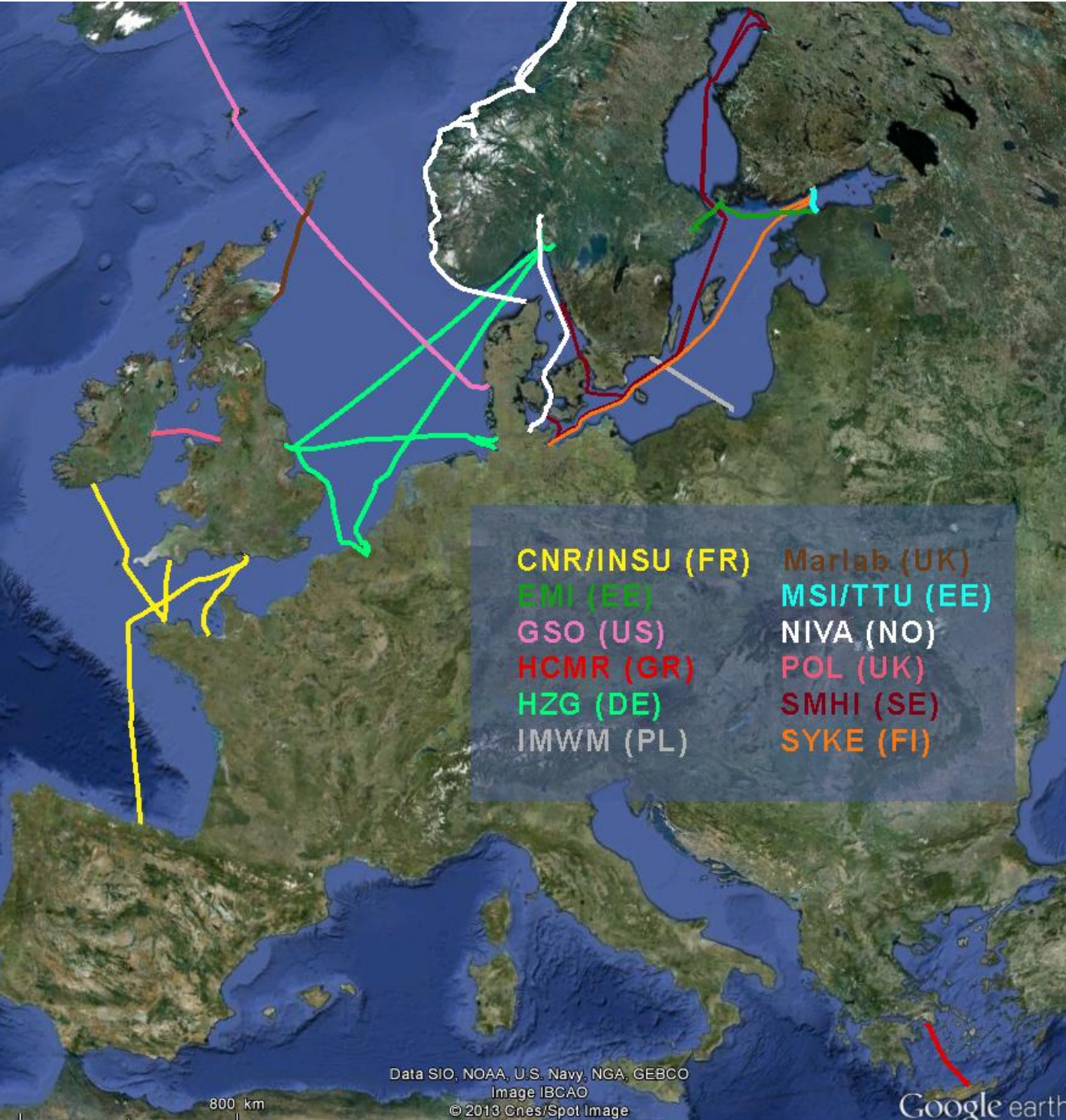


# 4th FerryBox Workshop September 2011





# FerryBox Lines within Europe



CNR/INSU (FR) Marlab (UK)  
EMI (EE) MSI/TTU (EE)  
GSO (US) NIVA (NO)  
HCMR (GR) POL (UK)  
HZG (DE) SMHI (SE)  
IMWM (PL) SYKE (FI)

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image IBCAO  
© 2013 Cnes/Spot Image  
Image © 2013 TerraMetrics

Google earth

800 km



# FerryBox Community in Europe:

## FerryBox Community



### Why a FerryBox (FB)?

#### Objectives

#### FB Principle

#### → FB Ship Routes

North Sea & Atlantic

Baltic Sea

Northern Atlantic

Mediterranean Sea

Table of Routes

#### FB Institutions

#### FB Online Data

#### FB Future Perspectives

#### FB Links

#### FB Workshops

#### Publications

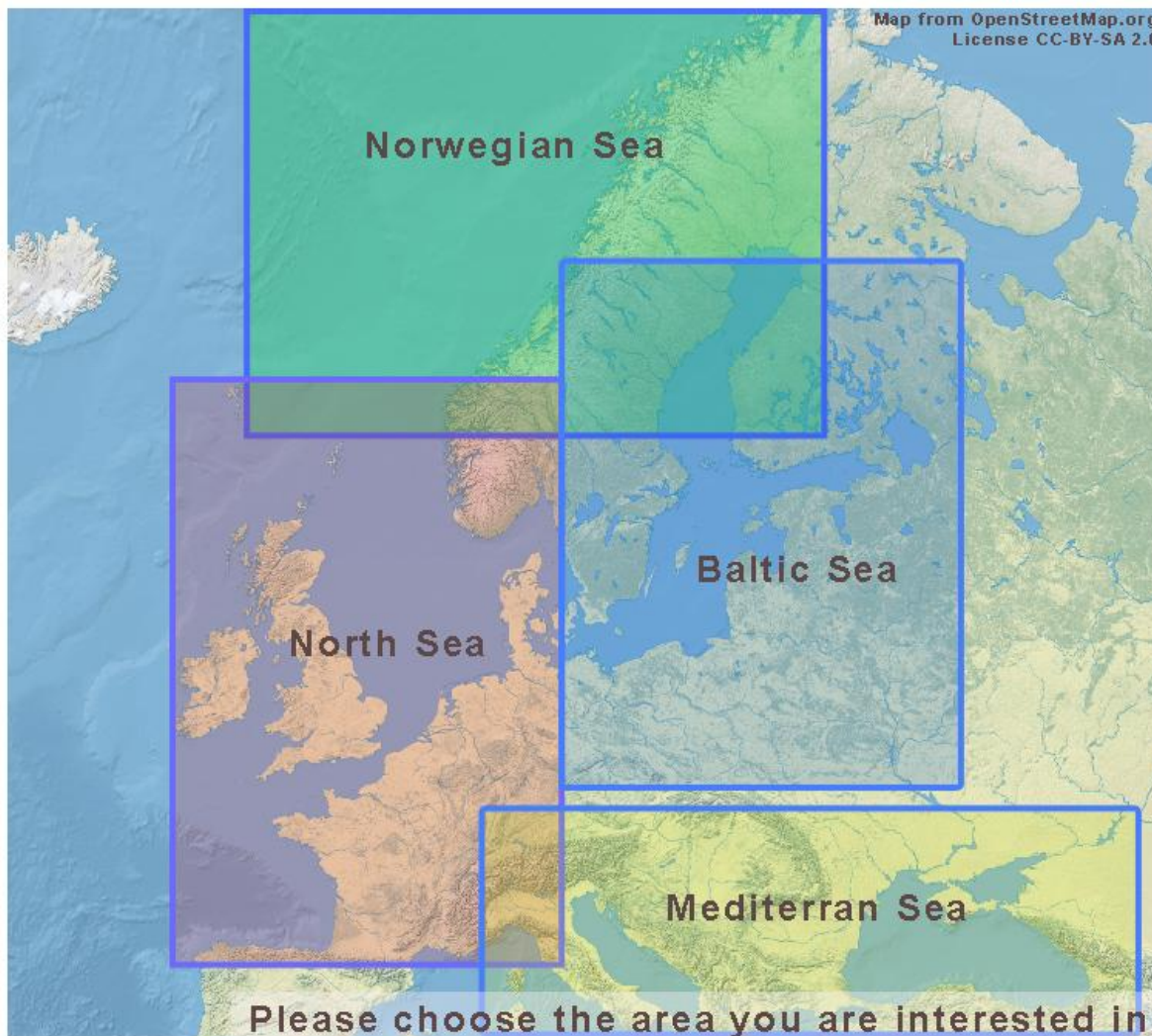
#### Companies

#### EU-Project "FerryBox"

#### Internals

> Home > FB Ship Routes

### FerryBox Routes in Europe



### Website hosted by:



Centre for Materials and Coastal Research

[>] <http://www.hzg.de>



[>] [5th FerryBox Workshop 2013 \(SYKE\)](#)

[>] [Oceanology International 2014](#)

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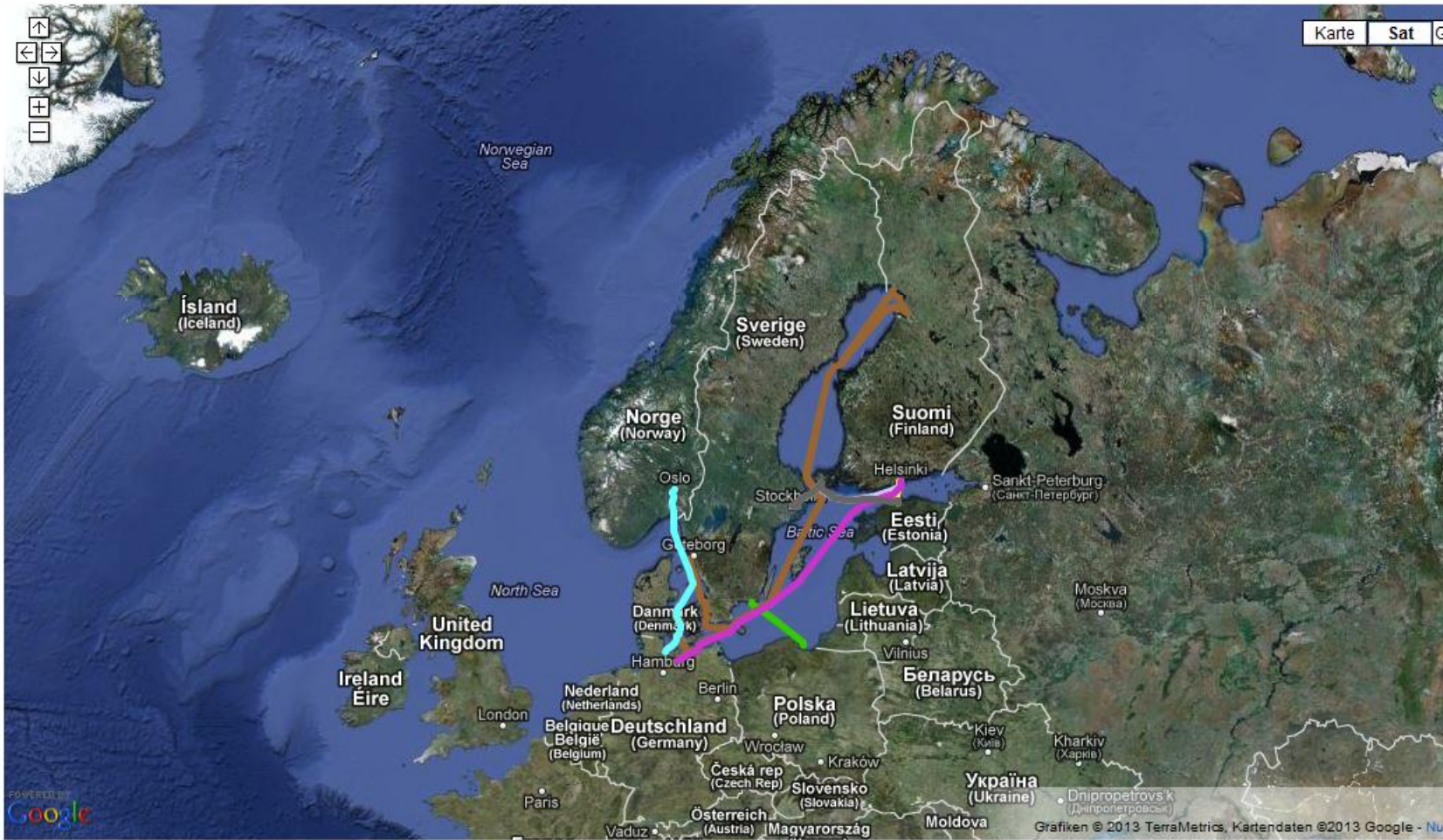


- Why a FerryBox (FB)?
- Objectives
- FB Principle
- FB Ship Routes
  - North Sea & Atlantic
  - Northern Atlantic
  - Mediterranean Sea
  - Table of Routes
  - **Baltic Sea**
  - Northern Atlantic
  - Mediterranean Sea
  - Table of Routes
- FB Institutions
- FB Online Data
- FB Future Perspectives
- FB Links
- FB Workshops
- Publications
- Companies
- EU-Project "FerryBox"
- Internals

> Home > FB Ship Routes > Baltic Sea

## FerryBox Routes in the Baltic Sea

Choose a ship line by clicking on the route in order to get the link of the website of the operating institution.



Here you can download all files with the coordinates of each route on the Map above. Please click the right mouse button and save the files on your computer.

- [>] FIMR: Helsinki-marienhamn-stockholm.kml
- [>] FIMR: Helsinki-marienhamn-stockholm.kml





## Why a FerryBox (FB)?

### Objectives

### FB Principle

### ➤ FB Ship Routes

North Sea & Atlantic

### ➤ Baltic Sea

Northern Atlantic

Mediterranean Sea

Table of Routes

### FB Institutions

### FB Online Data

### FB Future Perspectives

### FB Links

### FB Workshops

### Publications

### Companies

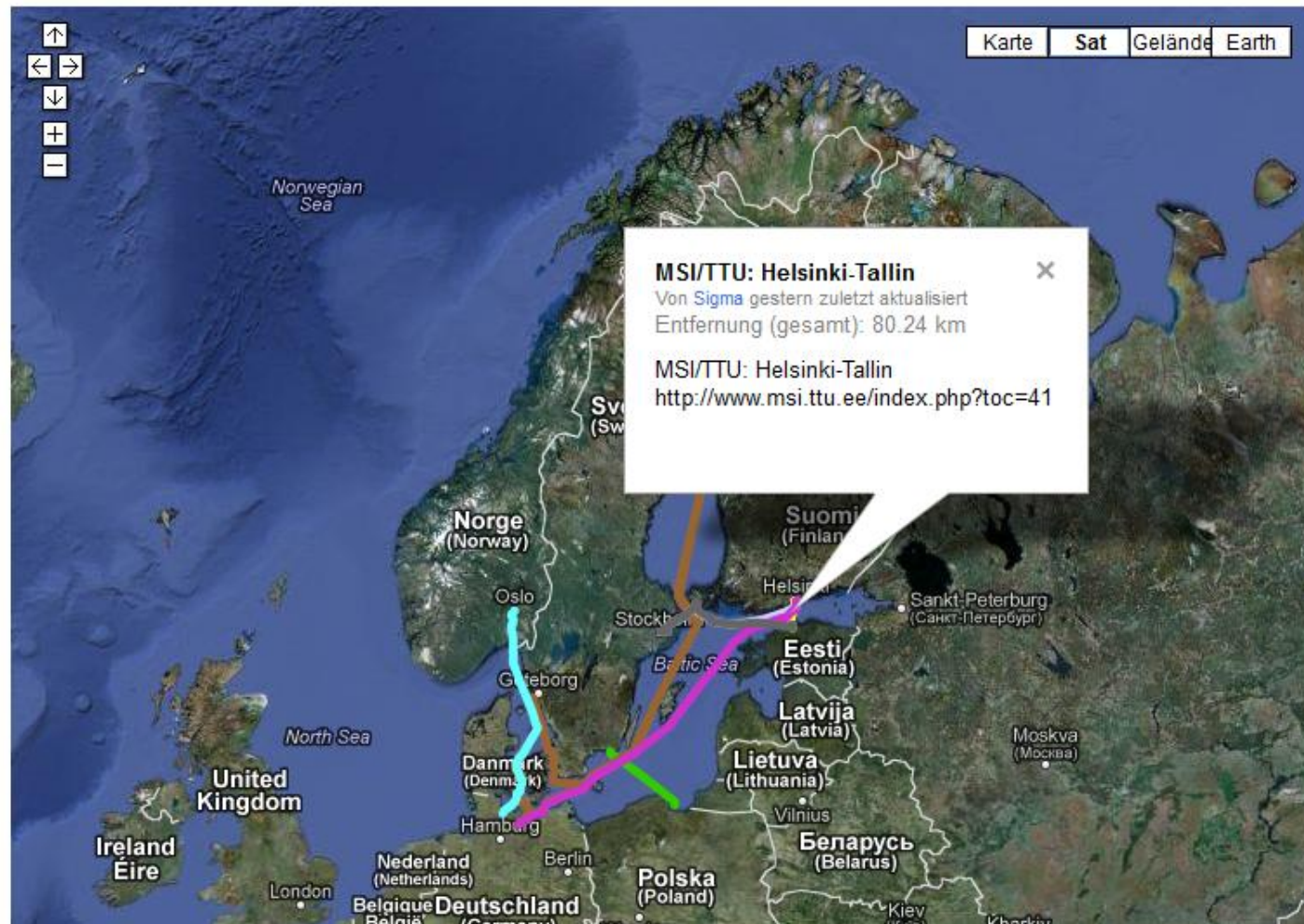
### EU-Project "FerryBox"

### Internals

> Home > FB Ship Routes > Baltic Sea

## FerryBox Routes in the Baltic Sea

Choose a ship line by clicking on the route in order to get the link of the website of the operating institution.







## Why a FerryBox (FB)?

**Objectives**

**FB Principle**

### ↳ FB Ship Routes

North Sea & Atlantic

Baltic Sea

Northern Atlantic

Mediterranean Sea

### → Table of Routes

**FB Institutions**

**FB Online Data**

**FB Future Perspectives**

**FB Links**

**FB Workshops**

**Publications**

**Companies**

**EU-Project "FerryBox"**

**Internals**

> Home > FB Ship Routes > Table of Routes

## Table of FerryBox Routes in Europe

FerryBox.org\_Table\_of\_Routes von ferrybox.org - 433 Ansichten

[Tabellenansicht](#) [Druckversion](#)

Institution	Destination harbours	Name of platform	Observed parameters	Ship type	Shipping Company & website	
BCCR, UIB	Amsterdam - Bergen	M/S Trans Carrier	pCO <sub>2</sub> , T, S, Trb, Chl-a, pH	cargo ship	Sea Cargo	<a href="http://www.sea-cargo.no">http://www.sea-cargo.no</a>
EMI	Tallinn - Mariehamn - Stockholm	Victoria I	T, S, Trb, Chl-a	car/passenger ferry	Tallink	<a href="http://www.tallinksilja.ee">http://www.tallinksilja.ee</a>
HCMR	Piraeus-Heraklion	Olympic Champion	T, S, Trb, Chl-a, DO, pH	car/passenger ferry	Anek Lines	
HZG	Cuxhaven - Harwich	Duchess of Scandinavia	T, S, DO, Chl-a, pH, Trb, nutrients	car/passenger ferry	DFDS A/S	<a href="http://www.dfdsseaway.com">http://www.dfdsseaway.com</a>
HZG	Cuxhaven - Immingham	TorDania	T, S, DO, Chl-a, pH, Trb, nutrients	Ro/Ro-ship	DFDS TorLine	<a href="http://www.dfdstorline.com">http://www.dfdstorline.com</a>
HZG	Moss-Halden-Zeebrugge-Immingham	LysBris	T, S, DO, Chl-a, pH, Trb, nutrients	cargo ship	DFDS Lys Line	<a href="http://www.lysline.com">http://www.lysline.com</a>
HZG	Büsum - Helgoland	MS Funny Girl	T, S, DO, Chl-a, pH, Trb	passenger ship	Reederei Cassen Eils	<a href="http://www.Helgolandre.com">http://www.Helgolandre.com</a>
HZG	Cuxhaven - Helgoland	MS FunnyGirl	T, S, DO, Chl-a, pH, Trb	passenger ship	Reederei Cassen Eils	<a href="http://www.Helgolandre.com">http://www.Helgolandre.com</a>
Ifremer	Portsmouth-Santander-Plymouth	Pont-Aven	T, S, DO, chl-a, Trb, CDOM	car/passenger ferry	Brittany Ferries	<a href="http://www.brittany-ferries.co.uk">http://www.brittany-ferries.co.uk</a>

FB\_Route Europe

## List of the equipment on the FerryBoxes

FerryBox.org\_instruments von ferrybox.org - 379 Ansichten

[Tabellenansicht](#) [Druckversion](#)

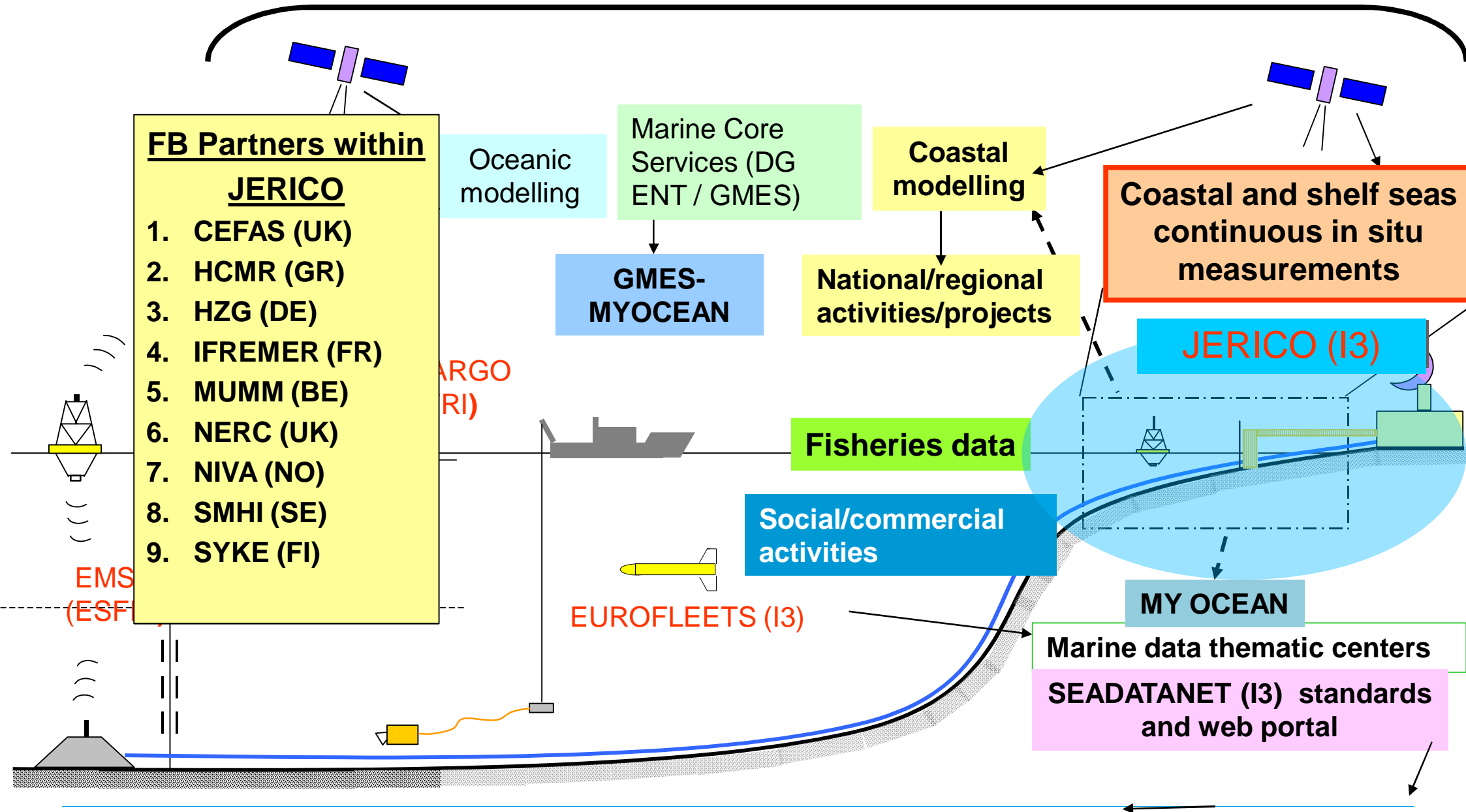
Ship & route	Parameter	Measurement principle	Sensor	Manufacturer	Use
<b>Helsinki - Travemünde</b>					
Finnmaid	Water temperature	Pt 2000	SBE Temp sensor 38	Sea-Bird Electronics	SYKE
	conductivity	inductively	SBE TSG 45	Sea-Bird Electronics	SYKE
	turbidity	light scattering (blue)	FLNTURT	WETLabs	SYKE
	chlorophyll-a	fluorescence	FLNTURT	WETLabs	SYKE
	Phycocyanin	fluorescence	microFlu-blue	TriOS	SYKE
	CDOM	fluorescence	microFlu-cdom	TriOS	SYKE
	automatic water sampler	phytoplankton nutrients chl-a-analysis		ISCO (USA)	SYKE
<b>Gothenburg - Kemi</b>					
TransPaper	Water temperature	Pt 2000	SBE Temp sensor 38	Sea-Bird Electronics	SMHI
	conductivity	inductively	SBE TSG 45	Sea-Bird Electronics	SMHI
	turbidity	light scattering (blue)	FLNTURT	WETLabs	SMHI
	chlorophyll-a	fluorescence	FLNTURT	WETLabs	SMHI
	Phycocyanin	fluorescence	microFlu-blue	TriOS	SMHI

# FerryBoxes within Coastal Observatories

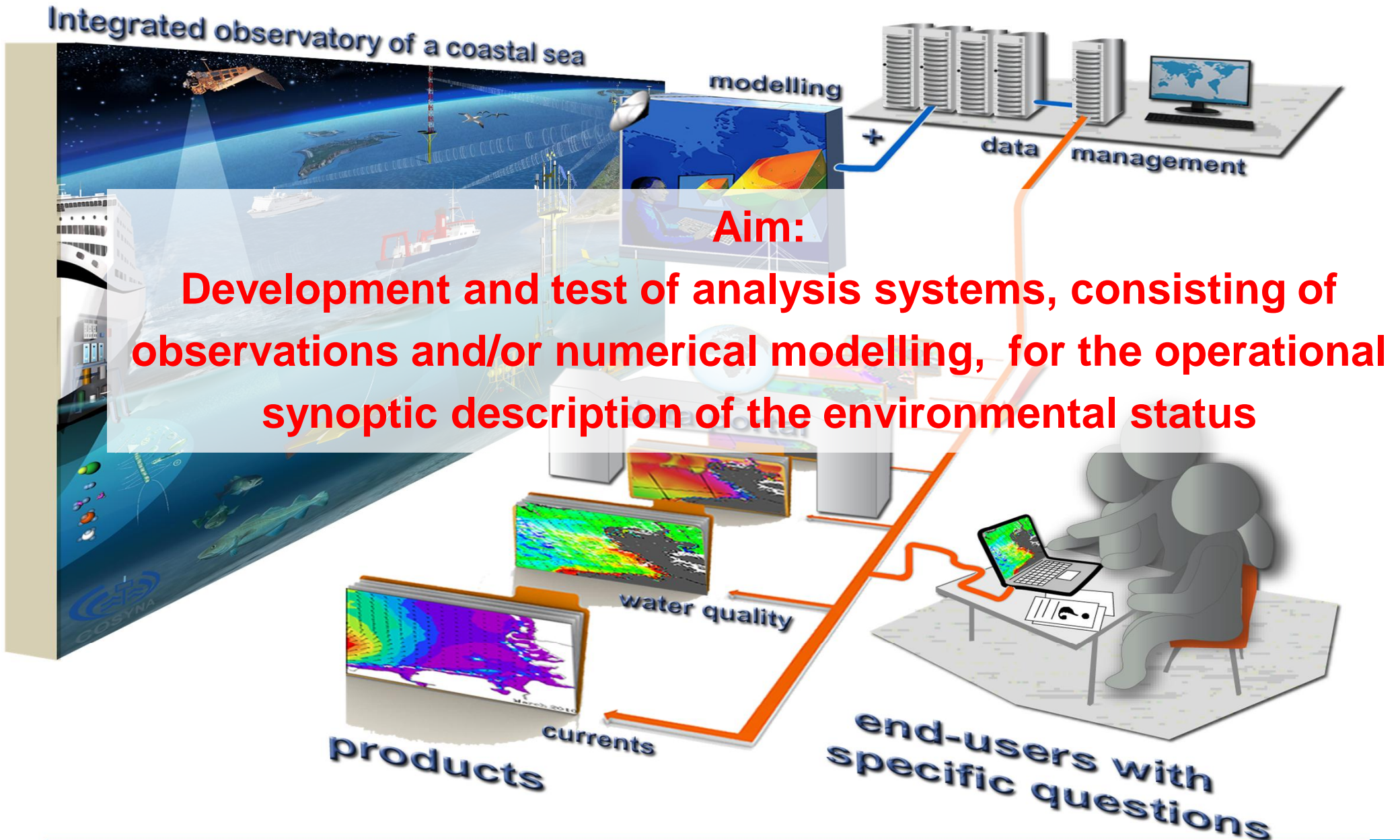


# JERICO: Towards a long-term and sustained European network of coastal observatories

EC umbrella (directives, policies, communications)

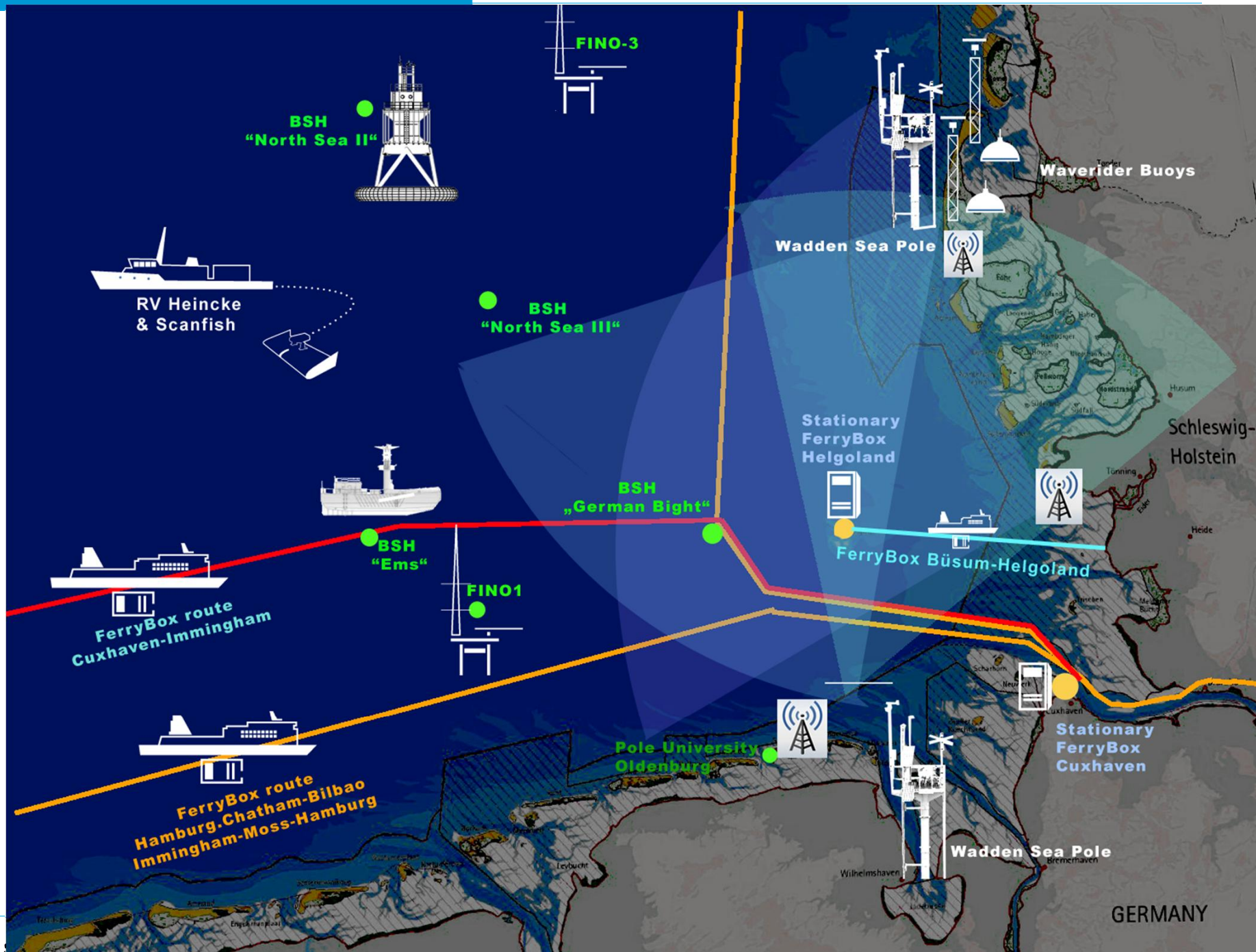


# Integrated Approach of COSYNA: Coastal Observing System for Northern and Arctic Seas:





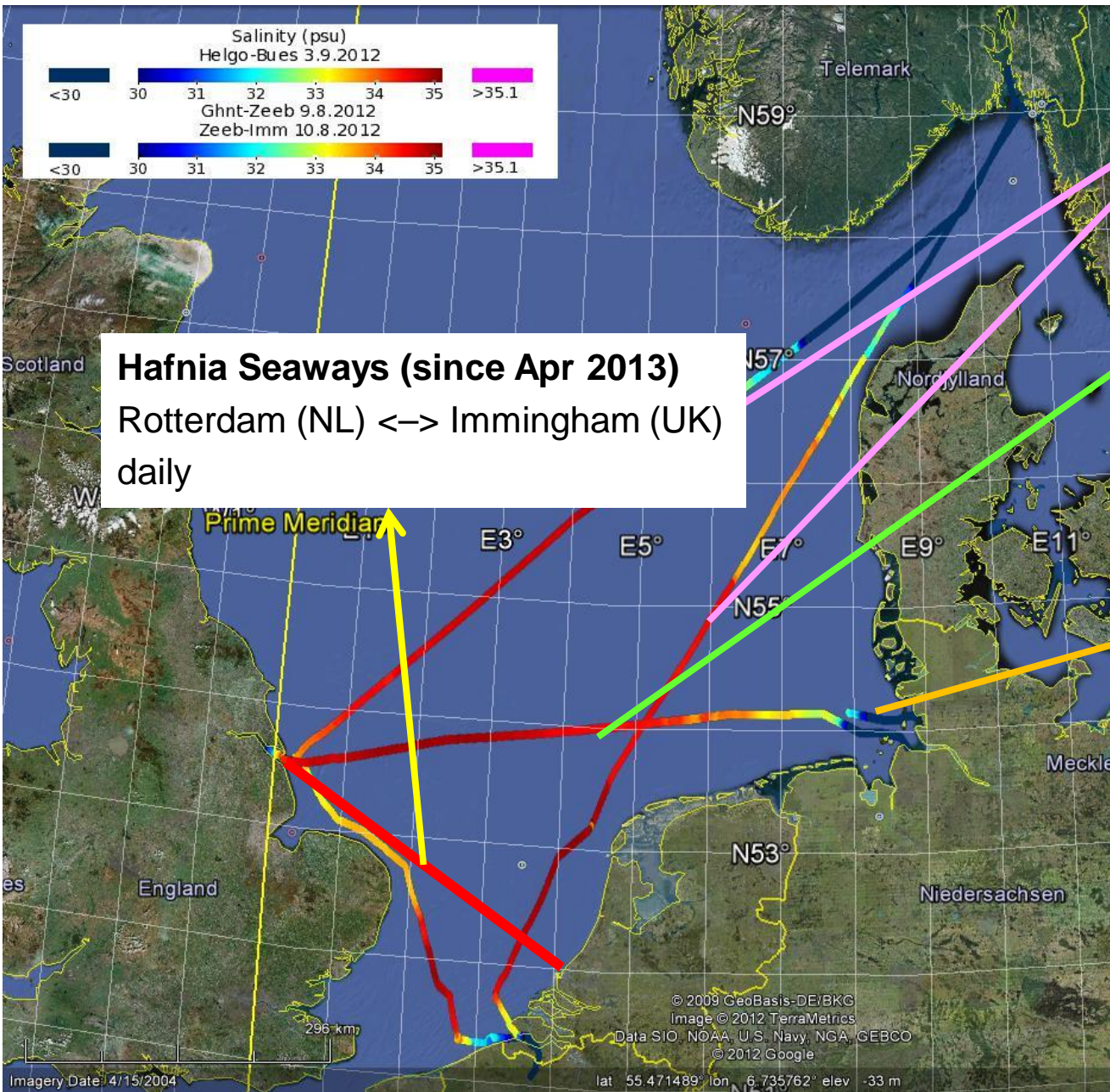
# Integration of FerryBox Lines in the Coastal Observeratory COSYNA (German Bight)





# FerryBox Lines operated by Helmholtz-Centre Geesthacht (HZG)

## FerryBox Routes (HZG)



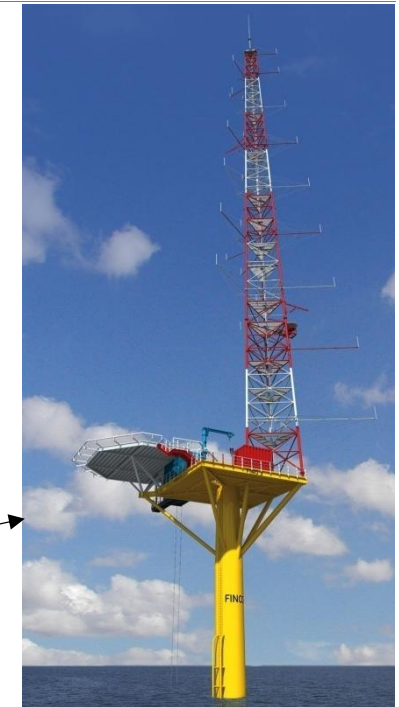
## Measured Variables

- temperature
- salinity
- turbidity
- chlorophyll
- oxygen,
- pH
- (algal groups)
- (nutrients)
- (pCO<sub>2</sub>)





FB-Station  
at FINO 3  
Installation:  
July 2011



FB-Station  
Cuxhaven  
since Okt'10:



# FerryBoxes aboard Research Vessels

- **RV Ludwig Prandtl** (temporarily)
- **RV Heincke** (temporarily, all COSYNA campaigns since 2009)
- **RV Pelagia** (temporarily, entire North Sea BSH 2008-2010)
- **RV Polarstern** (permanent installation, operation by AWI, technical support HZG)
- **RV Uthörn** (feste Installation, AWI)



RV Polarstern



RV L. Prandtl



RV Heincke



RV Pelagia



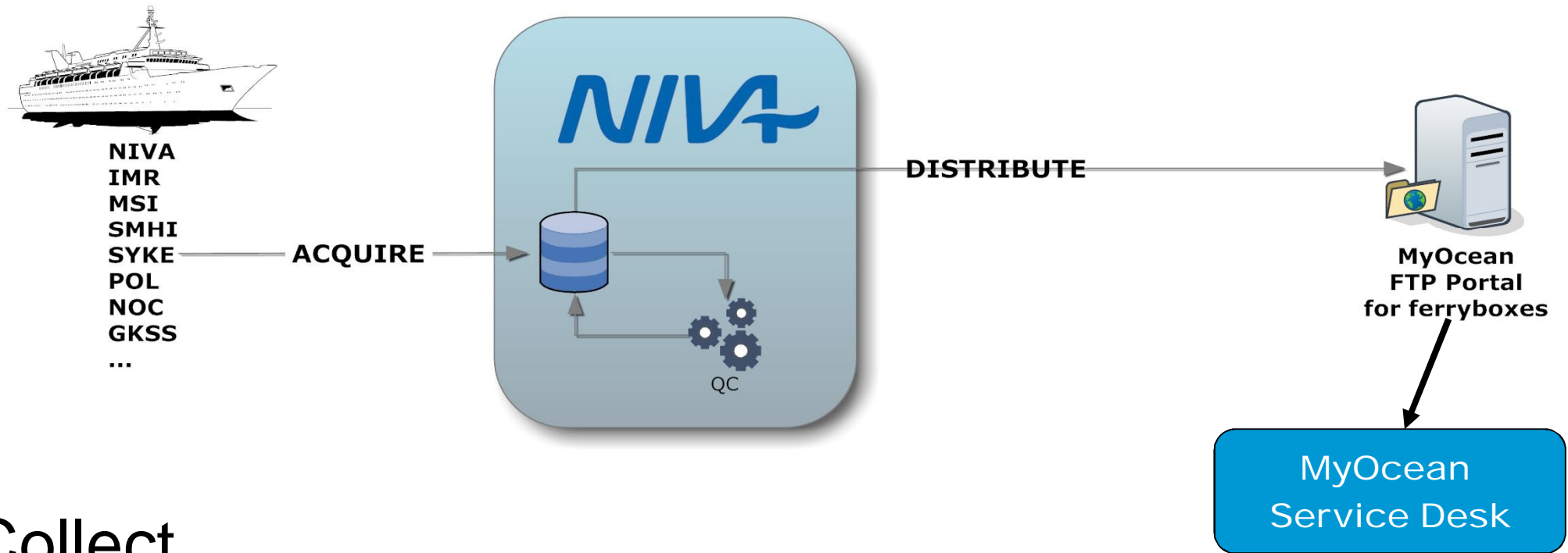
RV Uthörn



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# Data Management

# Ferrybox in MyOcean



Collect

Process QC

Export

Manage the MyOcean ferrybox FTP Portal

INS-VESSEL-GLO\_TS\_NRT-OBS



# Realtime Data Quality Control at HZG

## Real-Time Mode

### → Post Processing

All parameters filtered/flagged by housekeeping parameters

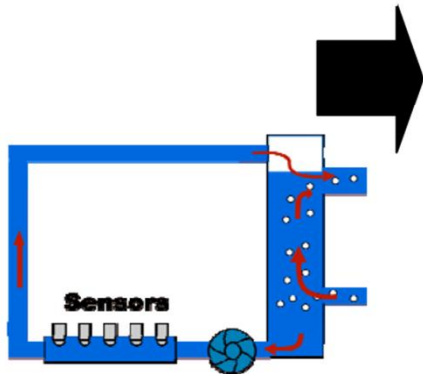
- status of the FB
- flowrate
- speed of the vessel

Single parameters flagged<sup>1)</sup> by

- range-check (reasonable regional and seasonal limits)
- frozen values
- variance (noise)
- spikes

<sup>1)</sup> MyOcean/SeaDataNet flagging scheme

All data stored aboard on FerryBox computer



## HZG FerryBox Database

Transfer to HZG and import into the FerryBox database

Stored information in the Database per data point:

- date/time
- longitude/latitude
- physical value
- quality flag
- minimum
- maximum
- variance
- counts

automatic processing

Web-based visualization tools on [ferrydata.hzg.de](http://ferrydata.hzg.de)

MyOcean ftp site  
(NIVA)

# Delayed Mode Data Quality Control at HZG

## Delayed Mode

- Quality Assessment
- Data Management

### Flagging<sup>1)</sup> of:

- frozen values
- after departure problems
- noisy values
- spikes
- visual control
- comparison with bottle samples analyzed in the lab

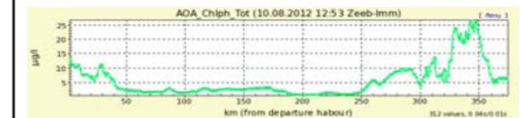
<sup>1)</sup> MyOcean/SeaDataNet flagging scheme

## HZG FerryBox database

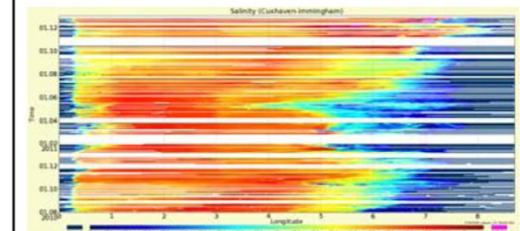
- quality checked values
- plot and export of the quality checked data from all FerryBoxes from HZG on [ferrydata.hzg.de](http://ferrydata.hzg.de)

manual processing

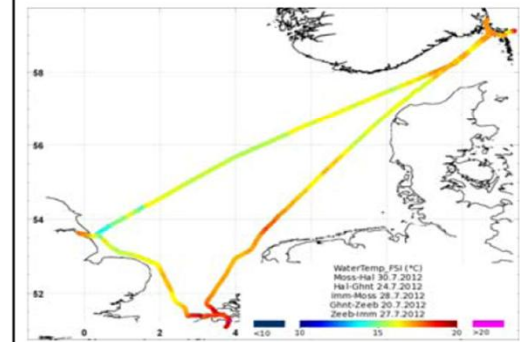
### Transect Plot:



### Scatter Plot:

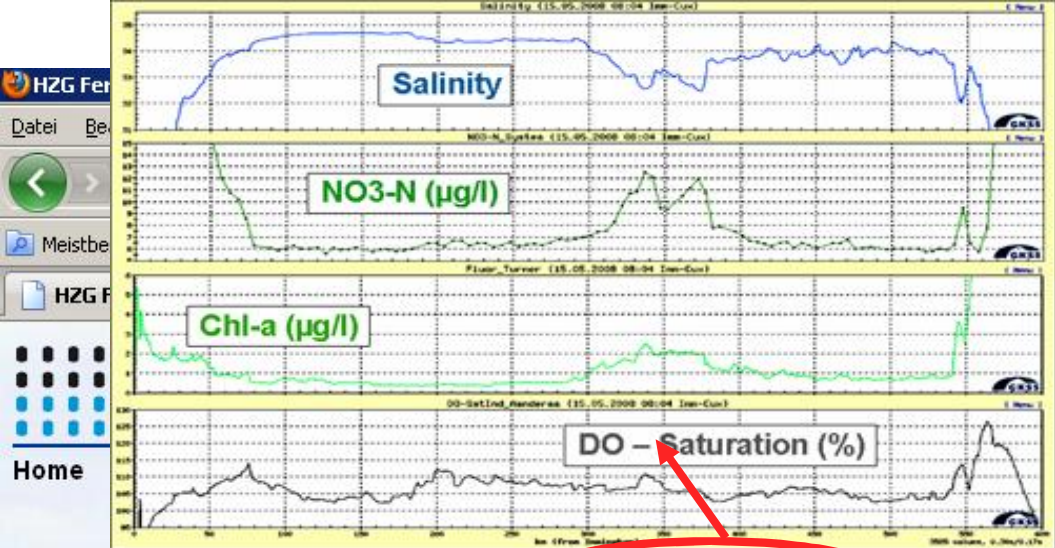


### Map Plot:

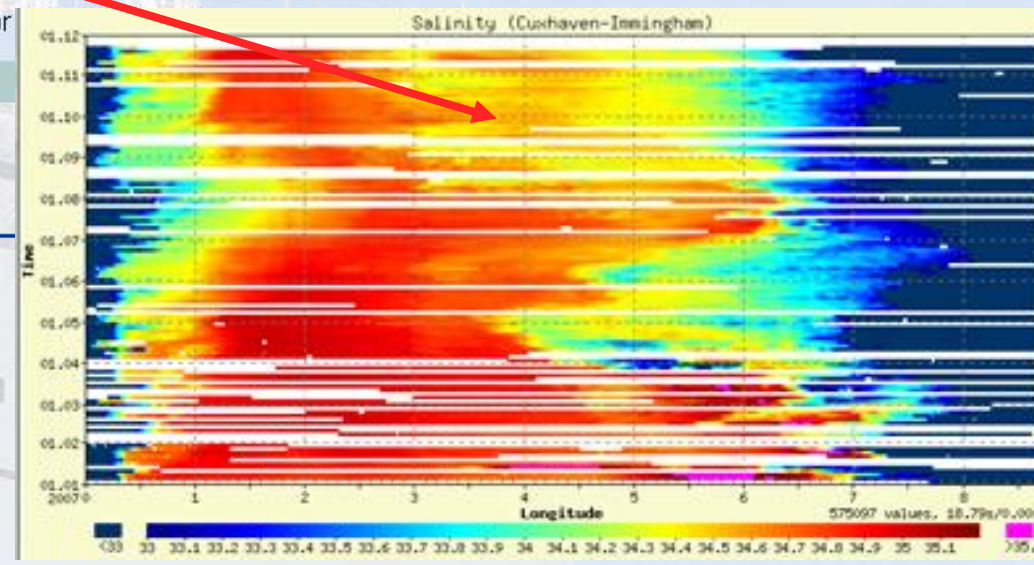
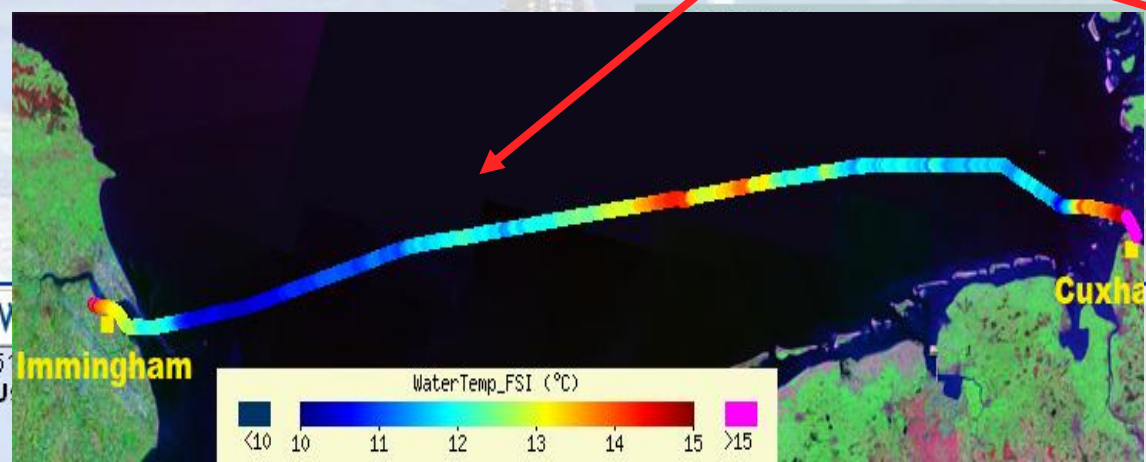




# Data Visualization and Handling



- [Transect Plot I](#) Plot of one select variables/parame
- [Transect Plot II](#) Plot of one or mo variable/parametr
- [Time-Series Plot](#) Plot at a selected position of the route: One or more variables/parameters vs. time
- [Scatter Plot](#) Scatter Plot
- [Map Plot](#) Map Plot





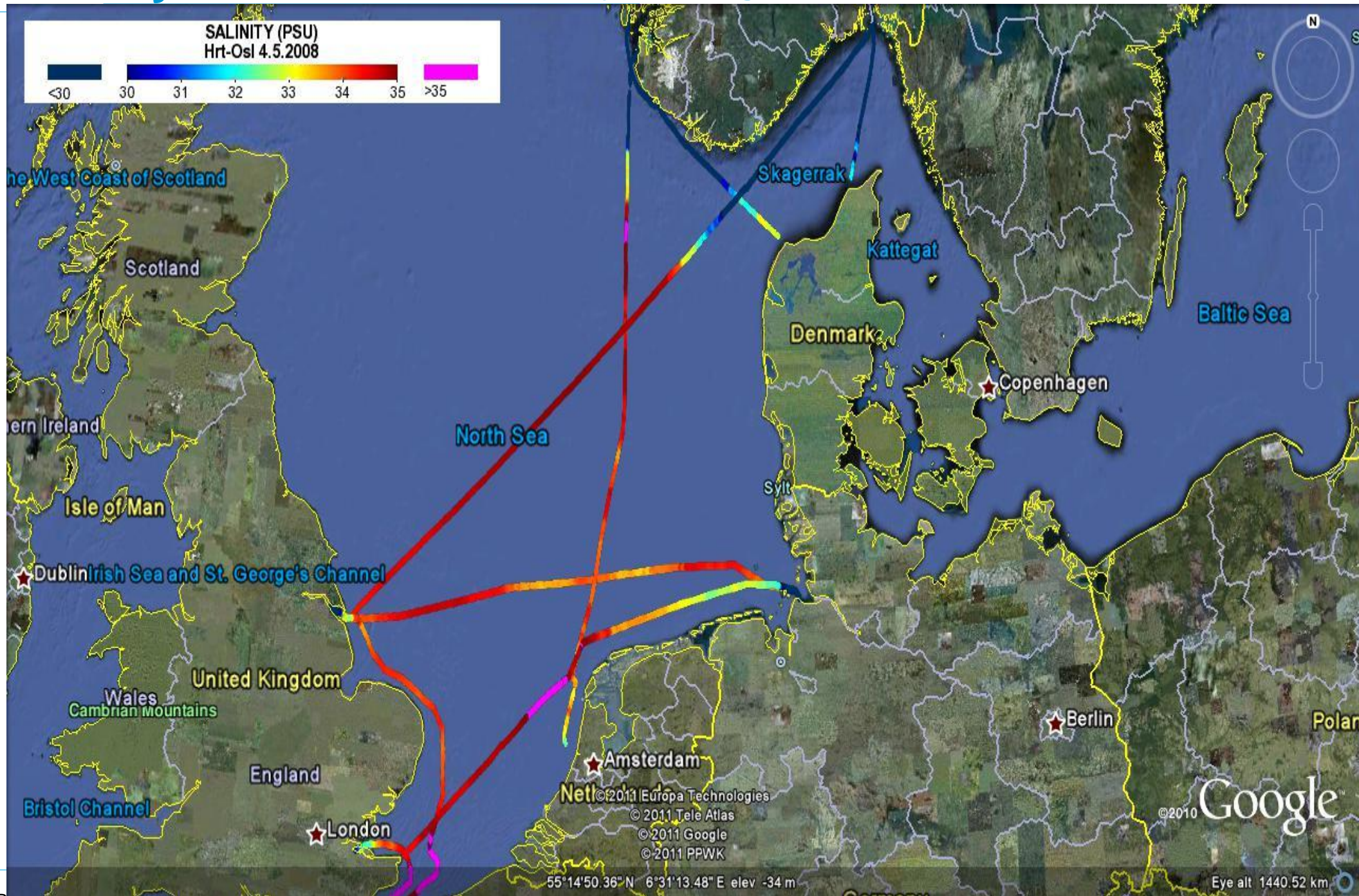
# FerryBox Routes in HZG Database

Route	Vessel	Institution
Amsterdam-Bergen (RIKZ, NL)	TransCarrier	RIKZ
Bergen-Hansholm (NIVA, NO)	Bergenfjord	NIVA
Buesum-Helgoland	FunnyGirl	HZG
Cuxhaven-Harwich	Duchess of Scandinavia	HZG
Cuxhaven-Helgoland	FunnyGirl	HZG
Cuxhaven-Immingham	Tor Dania	HZG
Germany-England-Norway	LysBris	HZG
Gothenb-Kemi-Travem (SMHI, SE)	Transpaper	SMHI
Helsinki-Tallinn (MSI, FI)	Baltic Princess	MSI
Helsinki-Travemuende (SYKE, FI)	Finmaid	SYKE
Norw-Holl_Belg-Engl	LysBris	HZG
Oslo-Hirtshals (NIVA, NO)	Color Fantasy	NIVA
Oslo-Kiel (NIVA, NO)	Color Fantasy	NIVA
Peraues-Irakleion (HCMR, GR)	Olympic Champion	HCMR
Roscoff-Plymouth (CNRS/INSU, FR)	Armorique	CNRS/INSU
Ros-Cor-Ply-Por-San (CNRS, FR)	Pont Aven	CNRS/INSU
Rotterdam-Immingham	Hafnia Seaways	HZG

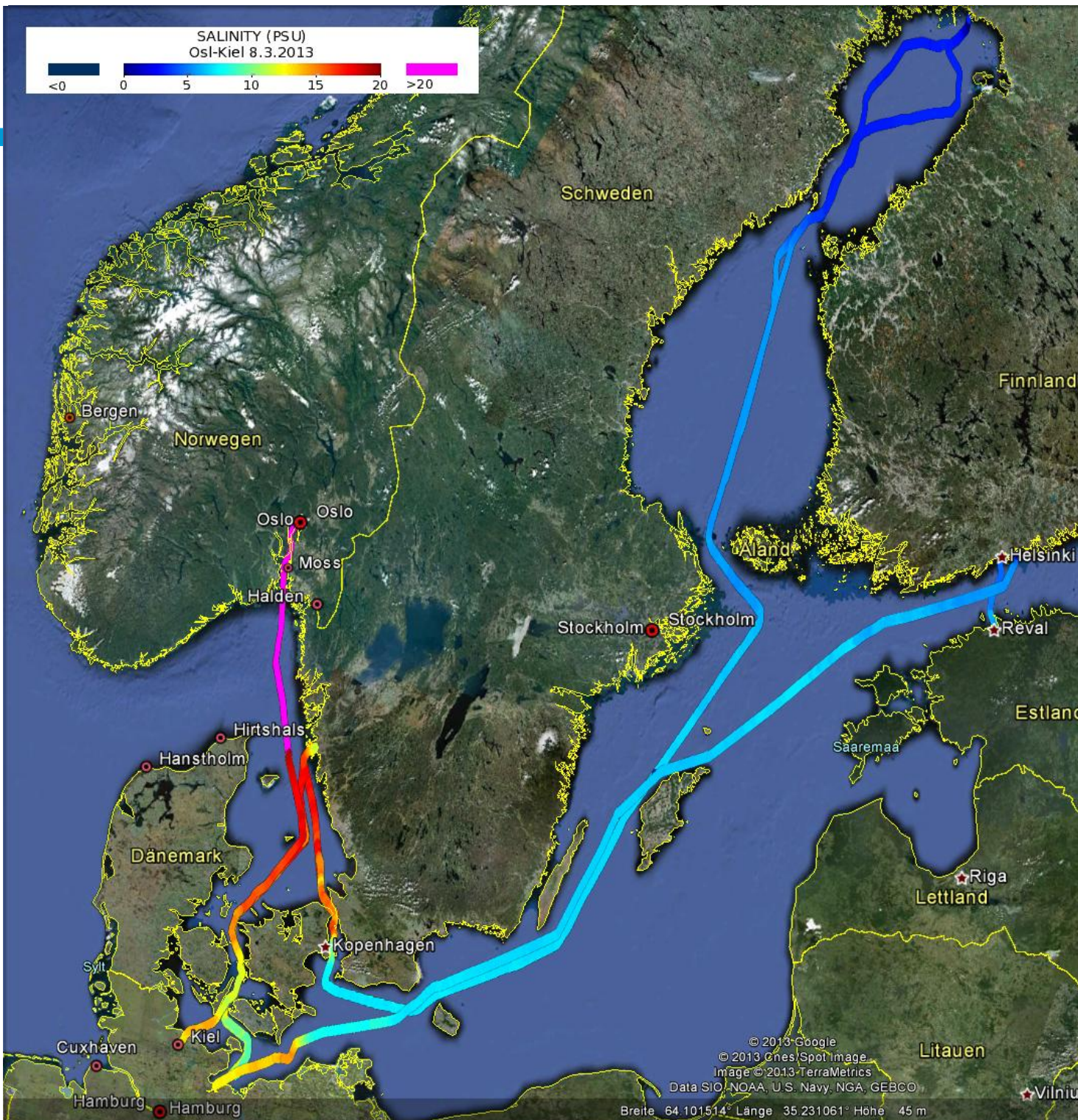


# Example of Integration of multiple FB Lines

## Salinity June 2008 (<http://ferrydata.hzg.de>)

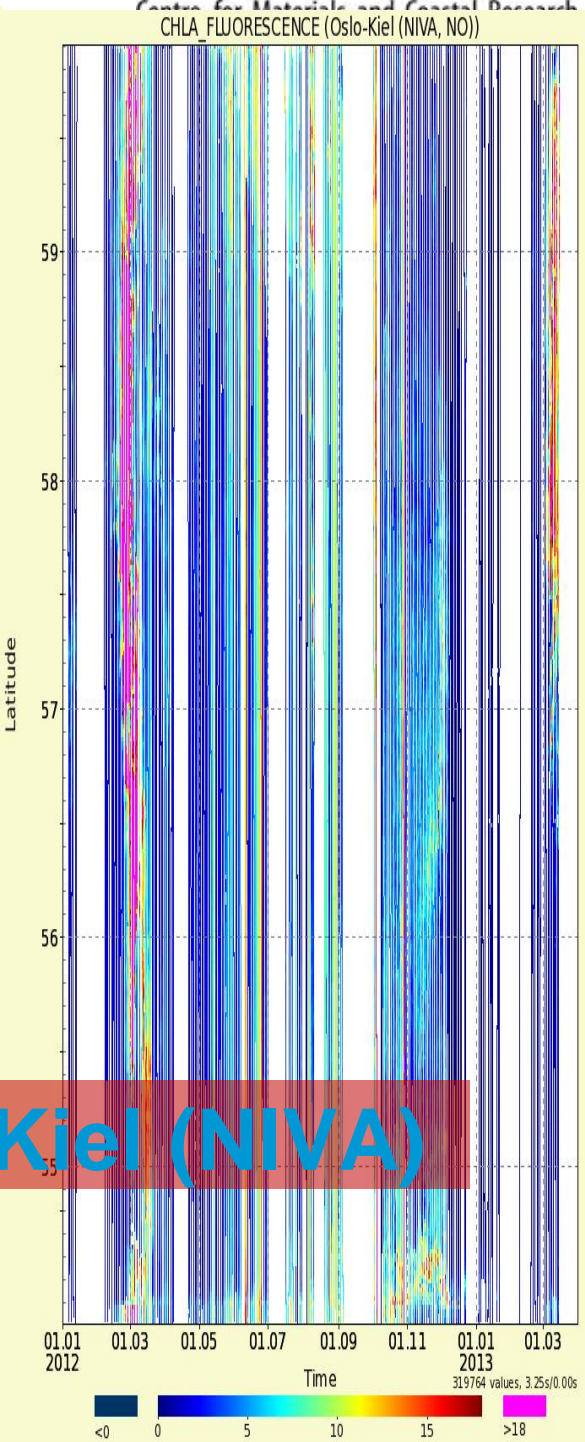
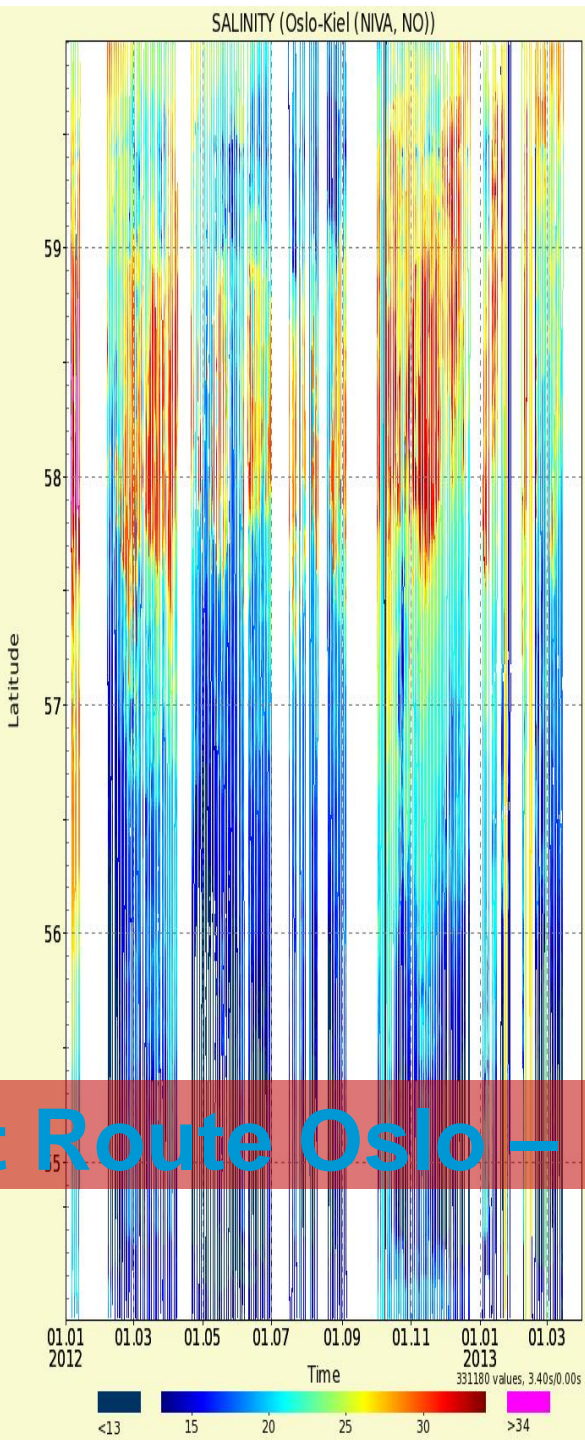
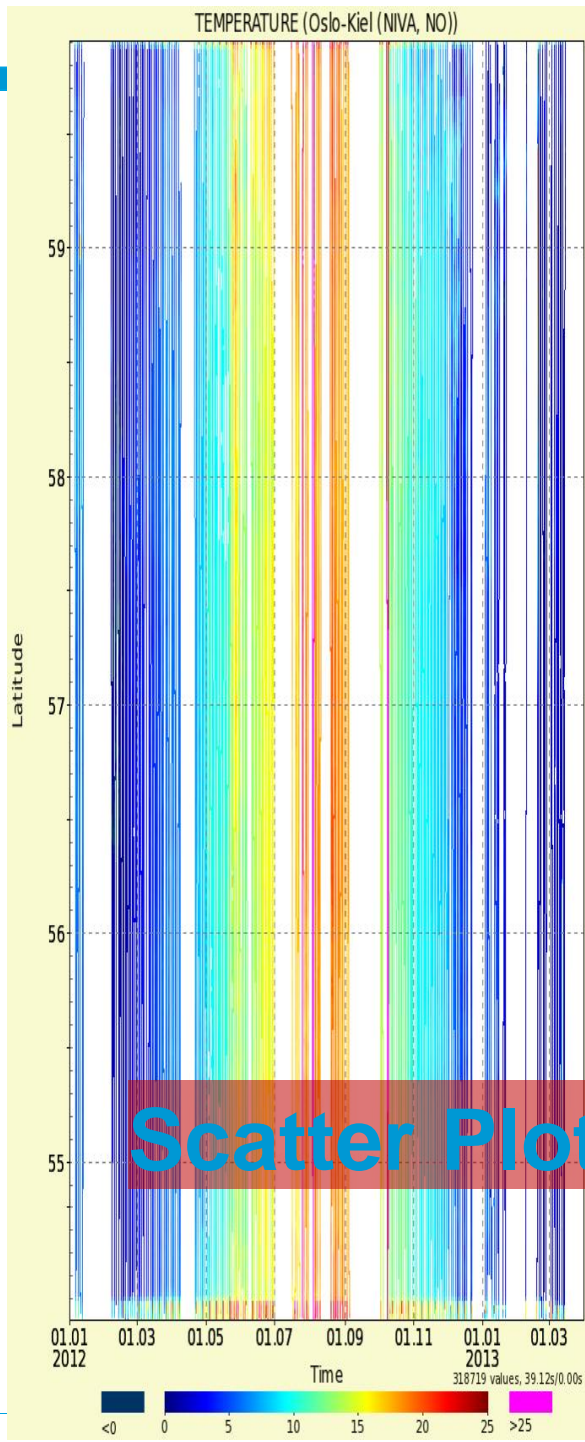
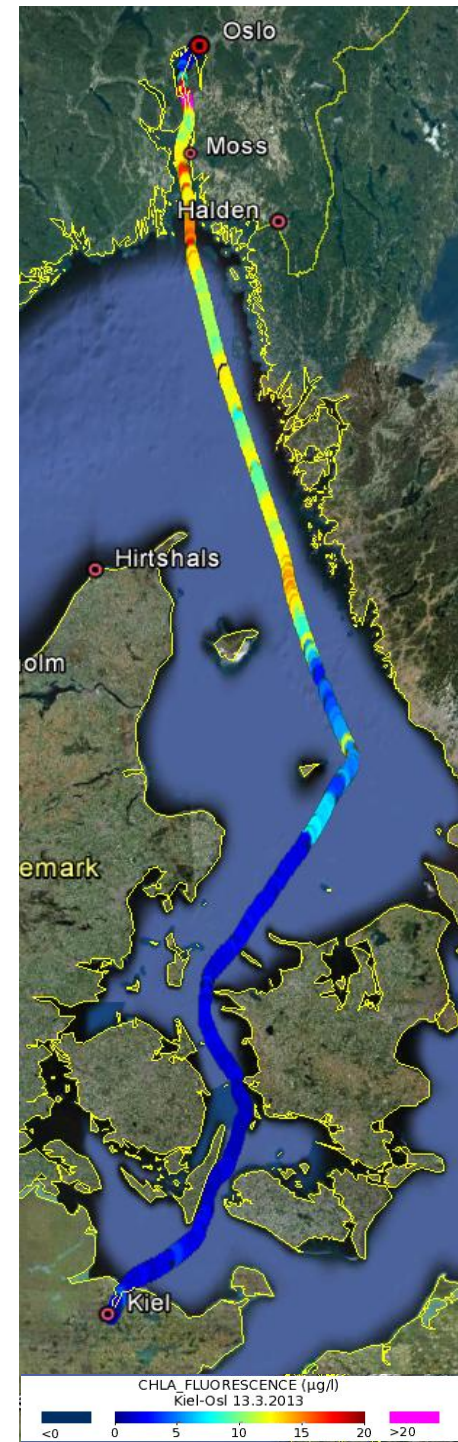








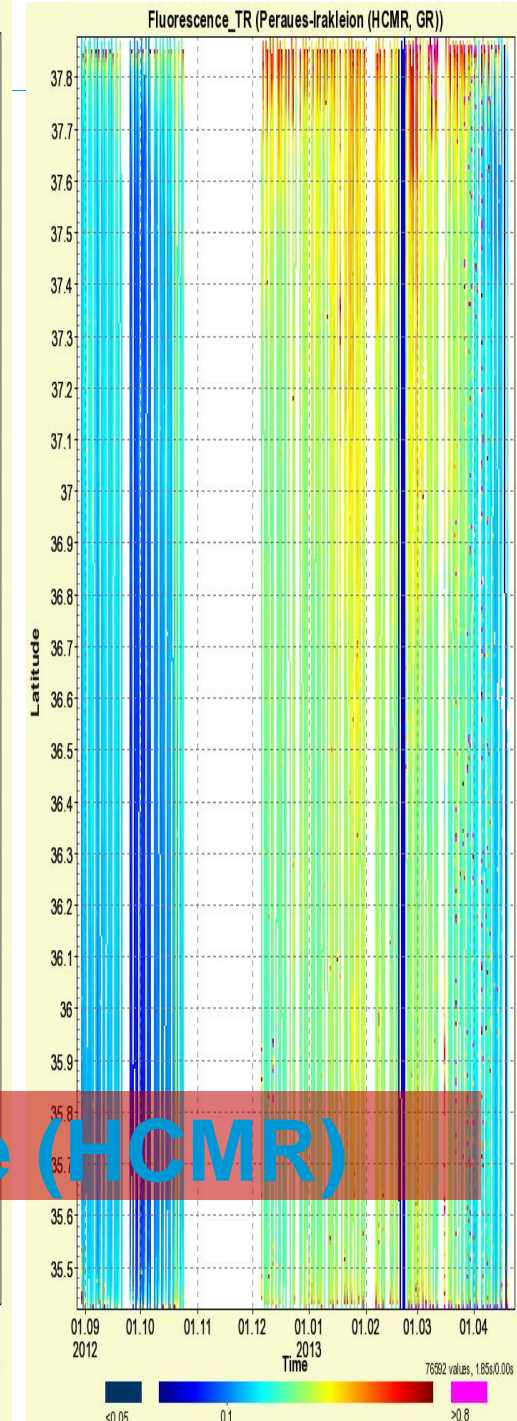
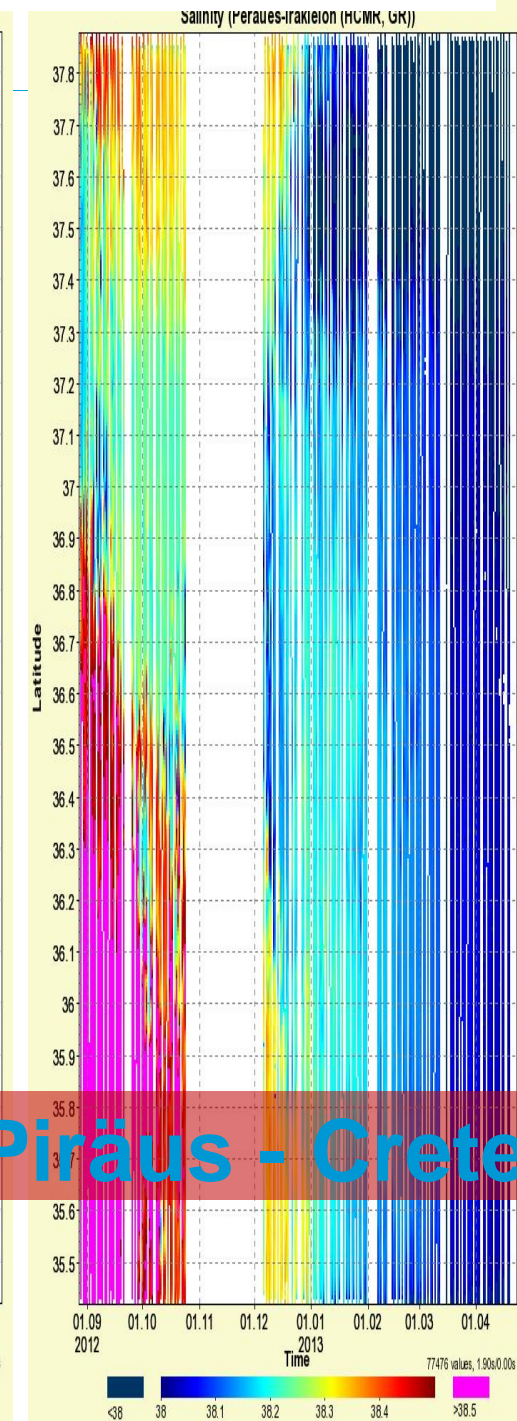
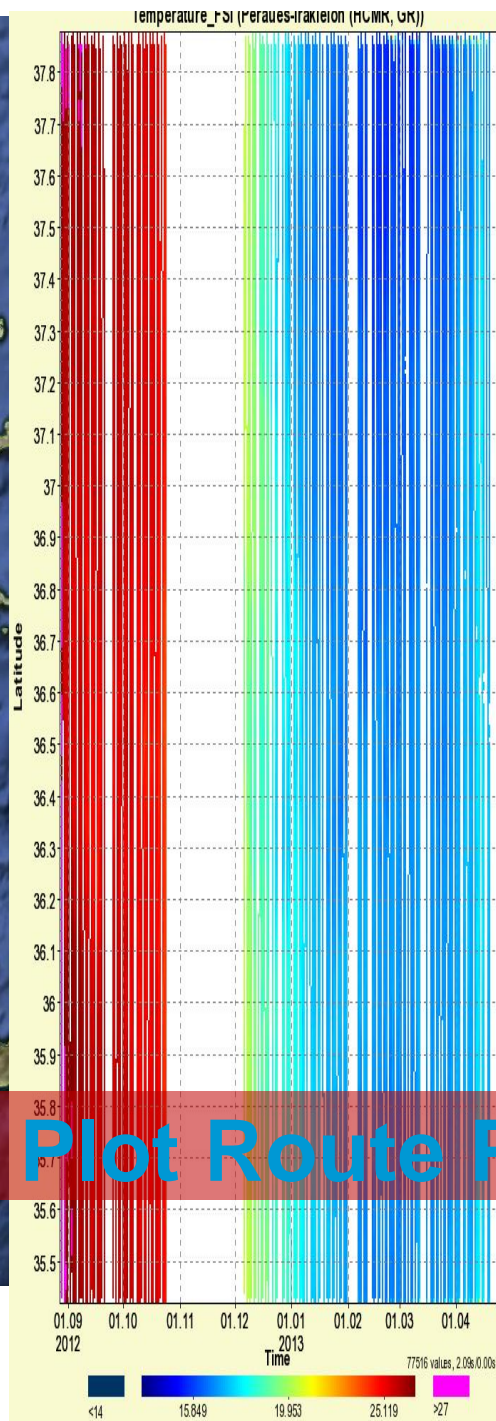
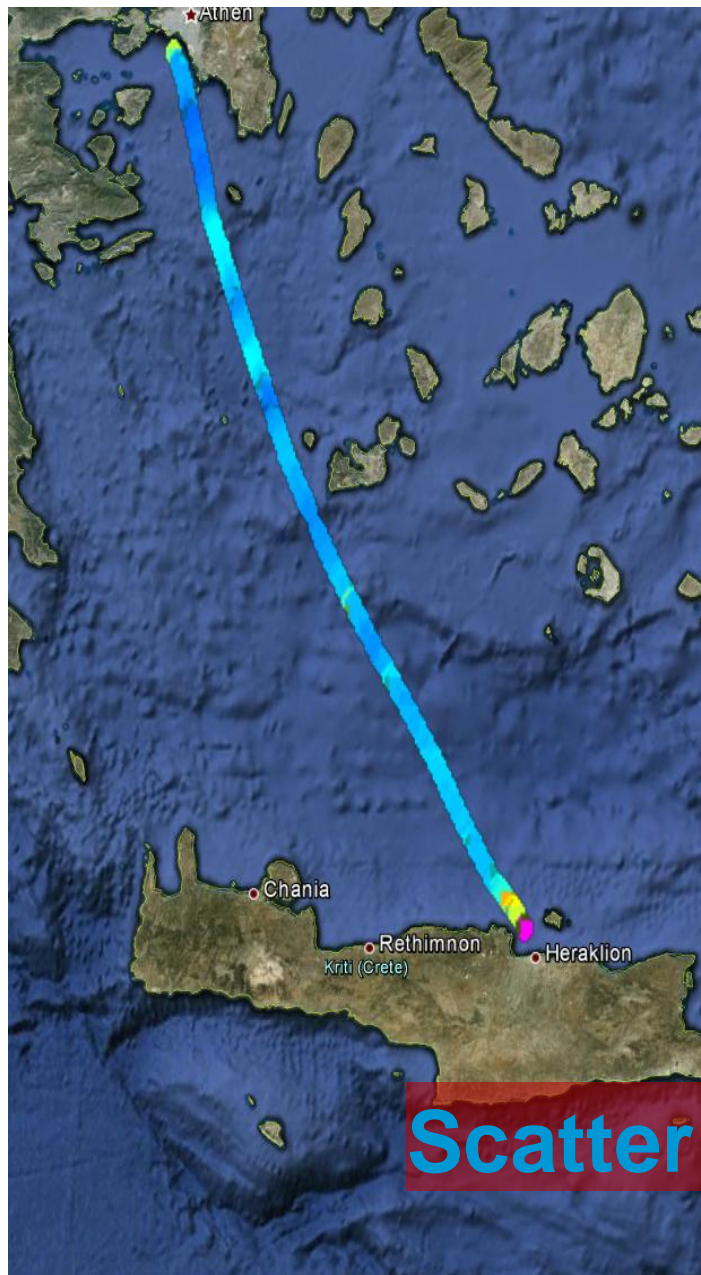
# Example of Data Visualization from HZG Database



Scatter Plot Route Oslo – Kiel (NIVA)



# Example of Data Visualization from HZG Database



## Scatter Plot Route Piräus - Crete (HCMR)

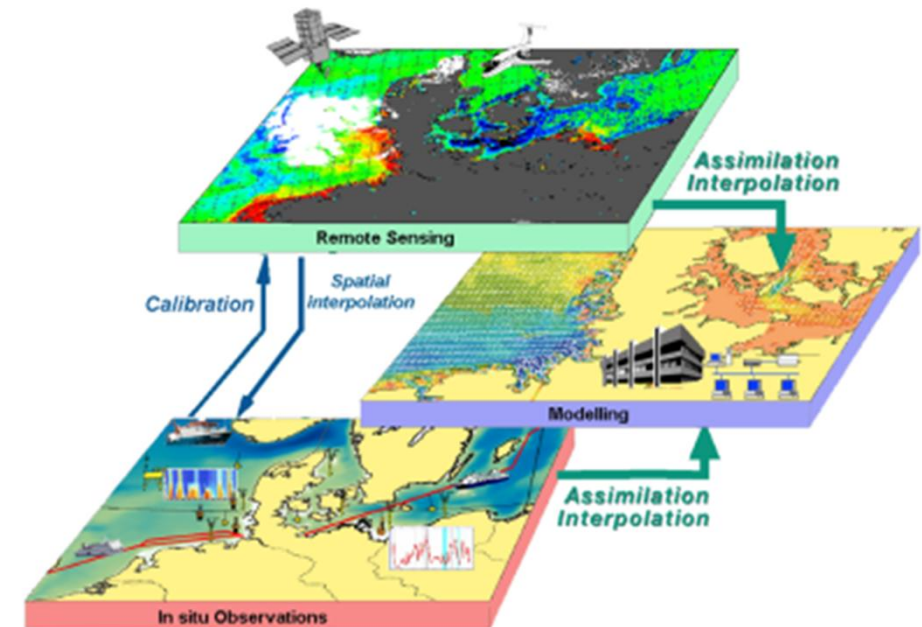
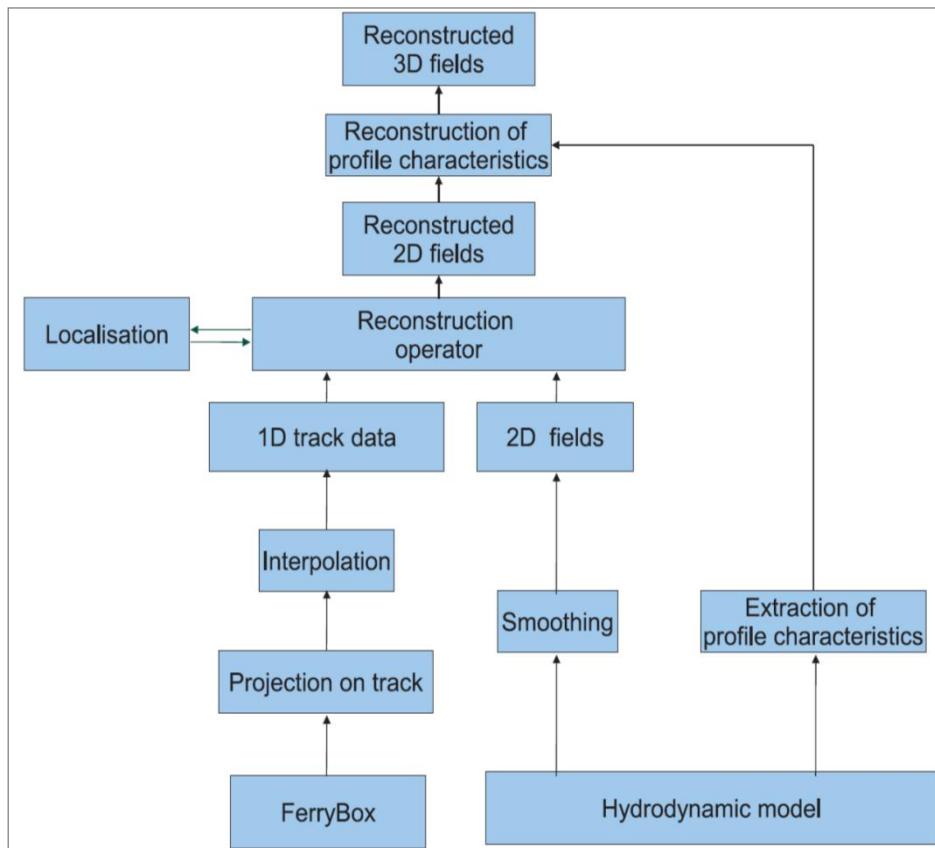
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# FerryBox Data Assimilation



# FB-Data Assimilation

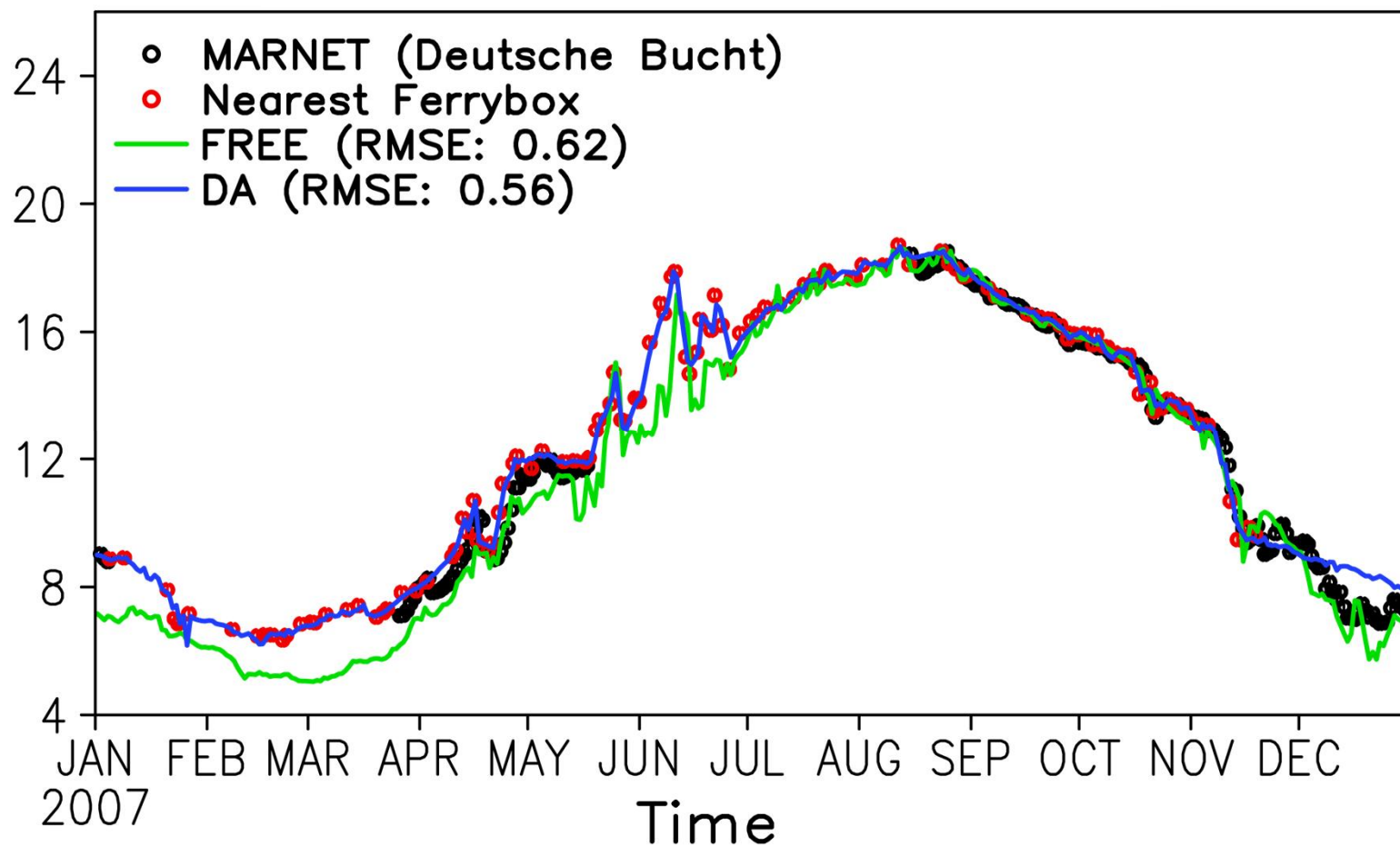
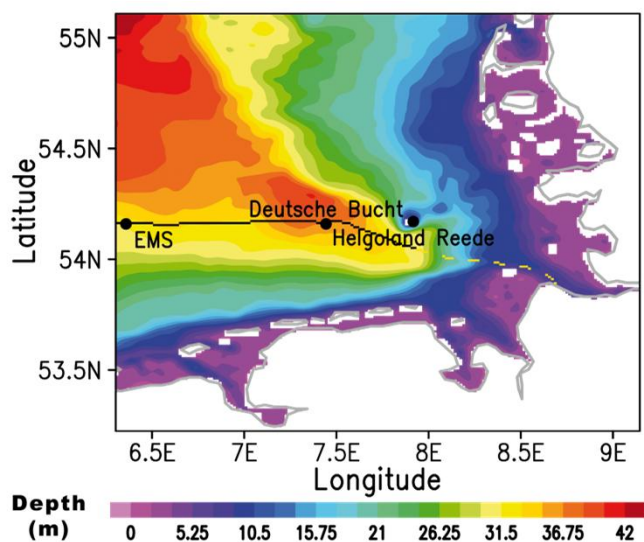
- Singular evolutive extended *Kalman filter* (SEEK)
- Temporal resolution and OSTIA data is 24h (reference time =12 o'clock UTC)
- Assimilation every 24 hours at 12 o'clock UTC.



Data flow diagram for assimilation of FerryBox Data

# SST Validation of Data Assimilation (DA) vs. MARNET Station “German Bight”

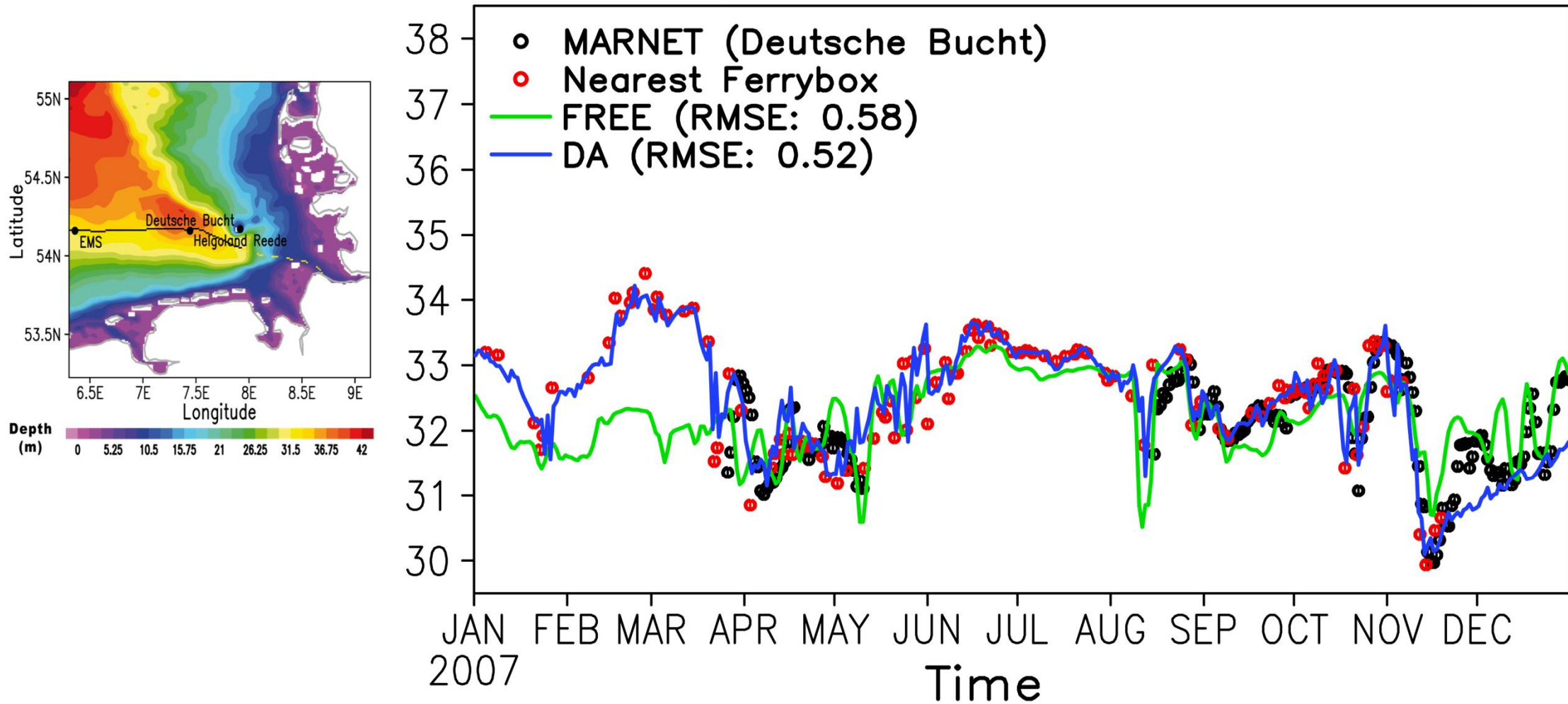
## SST Station ‘German Bight’ (°C)





# SSS Validation of Data Assimilation (DA) vs. MARNET Station “German Bight”

## SSS Station ‘German Bight’ (psu)



# Conclusion

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## Strength:

- SSS and SST data of FerryBox are reliable and have the potential for operational use in data assimilation schemes
- Assimilation of FB data enhances quality of the state estimates with respect to both SST and SSS in the German Bight
- Validation with other SST data (OSTIA) shows a good skill in the vicinity of FB transect

## Weakness:

- Limitation to the vicinity of the transect (+/- 40 km apart from the track)
- Currently only surface data are assimilated

## Next steps:

- Including other data sources
- Making FB data available in real-time (satellite communication)
- Making system pre-operational
- Including 3D data (glider, Scanfish...)



# Extension to more biogeochemical Parameters

## Advantages of mobile FerryBoxes for observation of biogeochemical processes:

- cost-effective
- high resolution in space and time
- long-term and seasonally resolved records

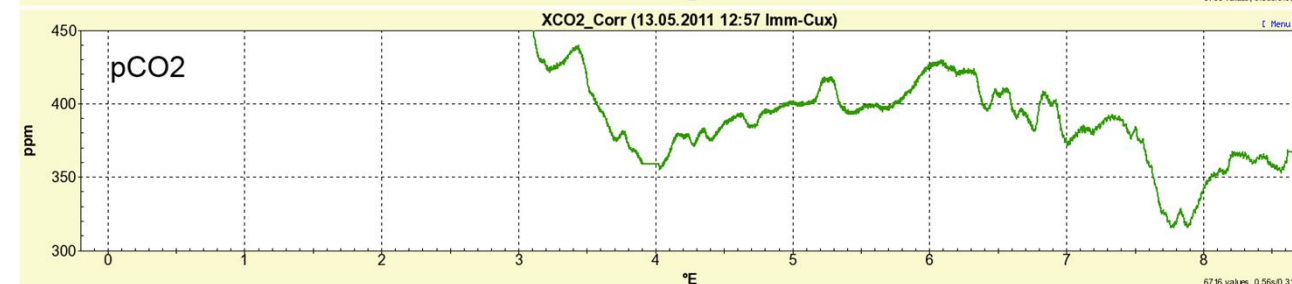
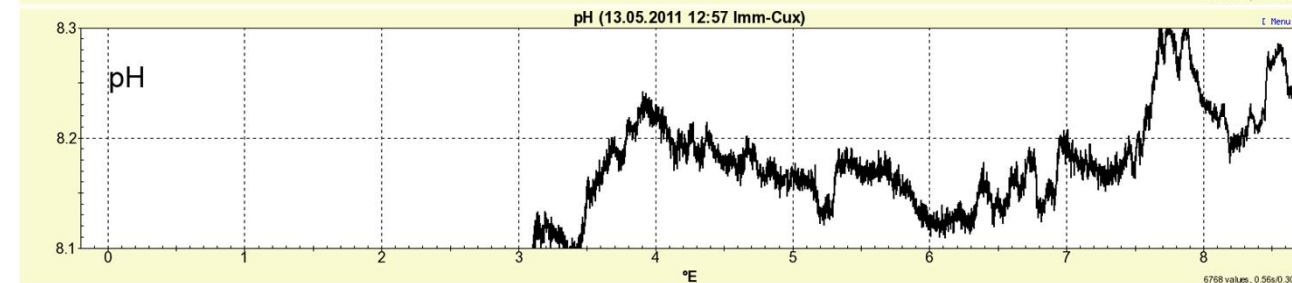
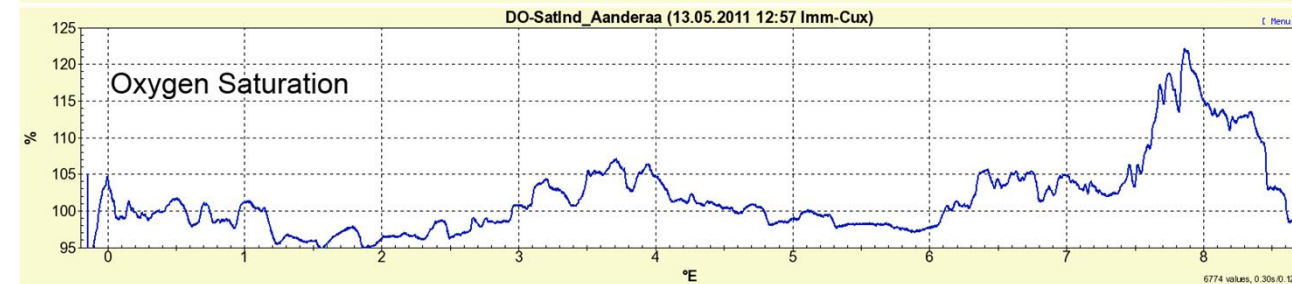
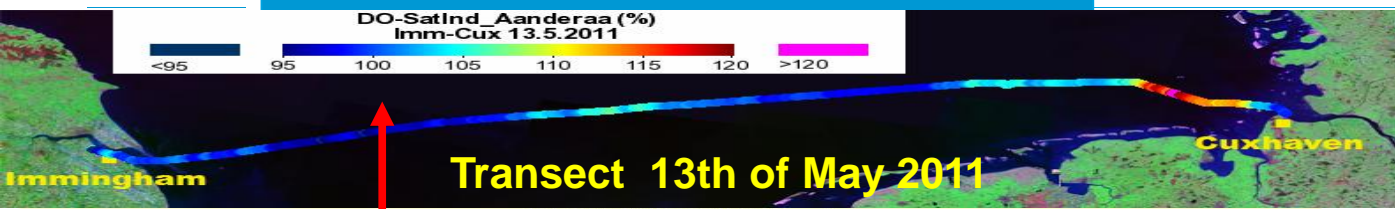
## Available autonomous\* sensors for biogeochemical variables:

- chlorophyll-a fluorescence
- chlorophyll-a absorption **new**
- dissolved oxygen
- nutrients
- pCO<sub>2</sub>
- pH (high precision) **new**
- alkalinity (A<sub>T</sub>) **new**

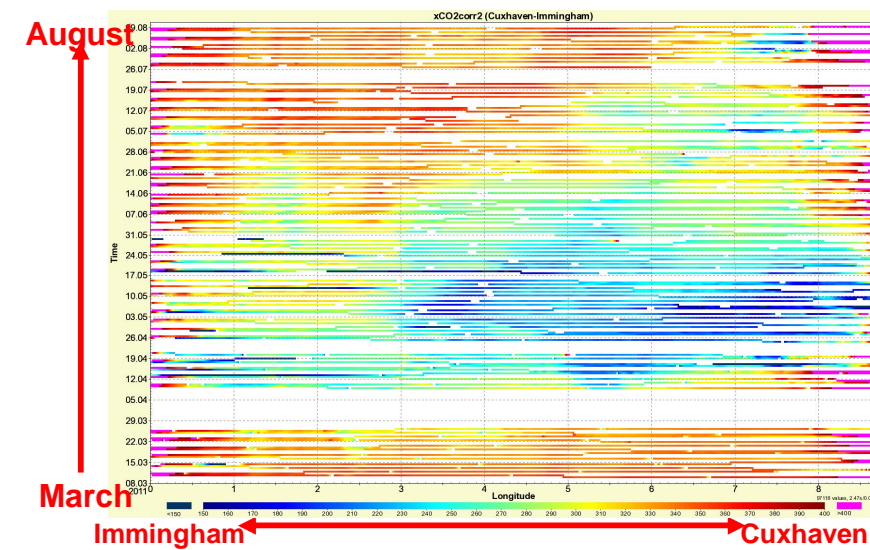
\*suitable for long-term unattended operation



# From physical towards biogeochemical data: Algae dynamics and impact on carbon budget (pH and pCO<sub>2</sub>)



Pooled data of pCO<sub>2</sub>  
(March – August 2011)



# Extension of FB systems to more biogeochemical parameters

**FerryBoxes are an ideal platform for new (even not so robust) sensors/instruments**

## Developments at HZG FerryBoxes:

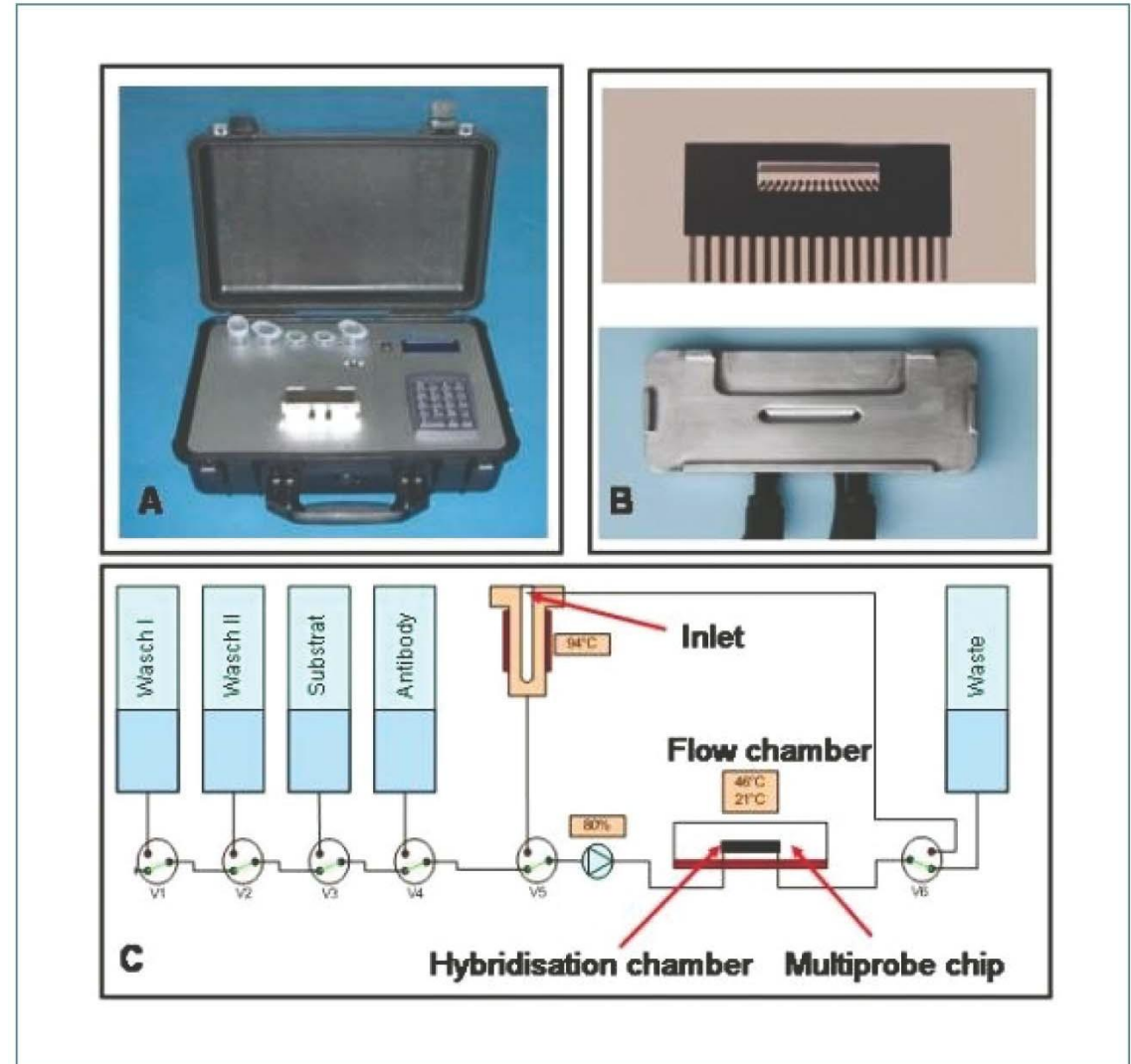
- new sensor (under development) for automatic **more precise pH + alkalinity** measurements **see talk Steffen** for quantifying carbon budget
- **p-CO<sub>2</sub> Sensors** (installed in two FerryBoxes) **Aßmann and others**
- **PSICam** (point-source integrating-cavity absorption meter) for better quantification of chlorophyll-a and detection of algal species **about new sensor**
- Automated **GenProbe System** (under development) (e.g. for detection of harmful algal blooms) **developments**



# Further developments:

Nucleic Acid Biosensor (AWI & HZG)  
for automatic detection of algae taxa and algal groups (e.g. HABs)

Automatic Sampler (AutoFIM) for the Biosensor



# Summary

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## FerryBox Systems:

- are “trans-boundary systems”
- have reached a status of maturity
- are a very cost effective monitoring system
- have a high recovery of reliable highfrequent data
- have a high potential of evolution  
(easy implementation and operation of new sensors for more and better biogeochemical data)



## Operability:

- platforms are available on a voluntary basis (“ships are coming and going”)
- Most FB activities are on a voluntary basis driven by research activities
  - High demand on sustained funding for long-term operation
- **EURO-FerryBox??**
- Cooperation with JCOMM-Ship Observation Team (SOT)
- enhancement of the partnership between the ocean observing community and the shipping industry
  - SCOR working group “OceanScope”, WOC workshop in Paris in Dec 2011
  - new built ships should be already prepared for installation of a FB (water inlet & outlet, communication cables ...)
  - development of “plug&play” FerryBox systems

# Summary cont

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- Harmonization of existing FerryBox activities (data flow, QA....)
  - JERICO
- Extension of FB systems to more biological/chemical parameters (WP10 JERICO)
- Data management:
  - Free and open access to all data
  - Common vocabulary and quality flags (WP4+5 JERICO)
  - Common database:
    - RT&NRT data → MyOcean ftp site
    - Delayed mode distributed databases assessable via EMODNET?
- Aim:  
**Integrated Monitoring by combination of Ferry Boxes with “conventional” monitoring (research ships, fixed stations) and with remote sensing and numerical models**



# Thanks for your attention!

Further information:

FerryBox community:

[www.ferrybox.org](http://www.ferrybox.org)

JERICO:

[www.jerico-fp7.eu/](http://www.jerico-fp7.eu/)

Costal observatories:

[www.cosyna.de](http://www.cosyna.de)

[www.previmer.org](http://www.previmer.org)

HZG FerryBox Database:

<http://ferrydata.hzg.de>



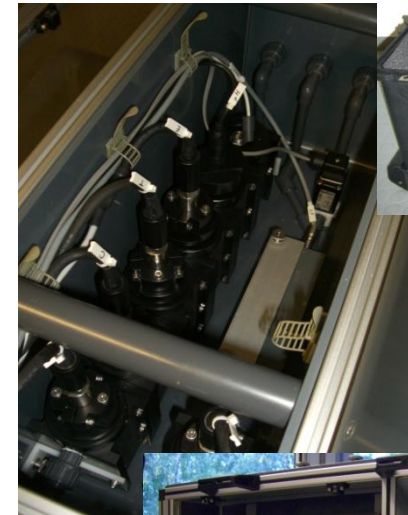
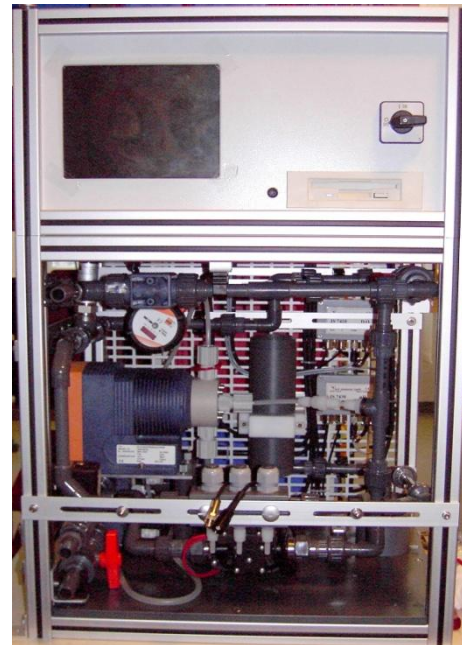
# Industrial version of FerryBoxes

(company 4H-Jena, Germany)

Standard FerryBox  
incl. debubbler



Pressure resistant  
FerryBox II  
(closed system)



Transportable „Pocket FerryBox“  
For field campaigns  
aboard small boats