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

- 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)
  \( \rightarrow \) 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

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
FerryBox
Lines within Europe
FerryBox Community in Europe:

FerryBox Community in Europe:

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

Norwegian Sea
Baltic Sea
North Sea
Mediterranean Sea

Please choose the area you are interested in.

Website hosted by:
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research
http://www.hzg.de

Conferences
- 5th FerryBox Workshop 2013 (SYKE)
- Oceanology International 2014

Contact
Wilhelm Petersen
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research
Institute for Coastal Research
Max Planck Str. 1
D-21502 Geesthacht
Germany
Phone: +49 4152 67 2368
Fax: +49 4152 67 2366
wilhelm.petersen@hzg.de

Susanne Reinke
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research
Institute for Coastal Research
Max Planck Str. 1
D-21502 Geesthacht
Germany
Phone: +49 4152 67 2337
Fax: +49 4152 67 2366
susanne.reinke@hzg.de
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.
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.
### Table of FerryBox Routes in Europe

<table>
<thead>
<tr>
<th>Institution</th>
<th>Destination harbours</th>
<th>Name of platform</th>
<th>Observed parameters</th>
<th>Ship type</th>
<th>Shipping Company &amp; website</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCCR, UIB</td>
<td>Amsterdam - Bergen</td>
<td>M/S Trans Carrier</td>
<td>pCO2, T, S, Trb, Chl-a, pH</td>
<td>cargo ship</td>
<td>Sea Cargo [<a href="http://www.seacargo.no">http://www.seacargo.no</a>]</td>
</tr>
<tr>
<td>HCMR</td>
<td>Piraeus-Heraklion</td>
<td>Olympic Champion</td>
<td>T, S, Trb, Chl-a, DO, pH</td>
<td>car/passenger ferry</td>
<td>Anek Lines</td>
</tr>
<tr>
<td>HZG</td>
<td>Cuxhaven - Harwich</td>
<td>Duchess of Scandinavia</td>
<td>T, S, DO, Chl-a, pH, Trb, nutrients</td>
<td>car/passenger ferry</td>
<td>DFDS A/S [<a href="http://www.dfdsseaways.com">http://www.dfdsseaways.com</a>]</td>
</tr>
<tr>
<td>HZG</td>
<td>Cuxhaven - Immingham</td>
<td>TerDania</td>
<td>T, S, DO, Chl-a, pH, Trb, nutrients</td>
<td>car/passenger ferry</td>
<td>DFDS TotLine [<a href="http://www.dfdstotline.co.uk">http://www.dfdstotline.co.uk</a>]</td>
</tr>
<tr>
<td>HZG</td>
<td>Bissum - Helgoland</td>
<td>MS Funny Girl</td>
<td>T, S, DO, Chl-a, pH, Trb</td>
<td>passenger ship</td>
<td>Reederei Cassen Eils [<a href="http://www.helgoland.de">http://www.helgoland.de</a>]</td>
</tr>
<tr>
<td>HZG</td>
<td>Cuxhaven - Helgoland</td>
<td>MS FunnyGirl</td>
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<td>Reederei Cassen Eils [<a href="http://www.helgoland.de">http://www.helgoland.de</a>]</td>
</tr>
<tr>
<td>Hermon</td>
<td>Portsmouth - Santander - Plymouth - Plymouth</td>
<td>Post-Aven</td>
<td>T, S, DO, chl-a, Trb, CDOM</td>
<td>car/passenger ferry</td>
<td>Brittany Ferries [<a href="http://www.brittany-ferries.co.uk">http://www.brittany-ferries.co.uk</a>]</td>
</tr>
</tbody>
</table>

### List of the equipment on the FerryBoxes

<table>
<thead>
<tr>
<th>Ship &amp; route</th>
<th>Parameter</th>
<th>Measurement principle</th>
<th>Sensor</th>
<th>Manufacturer</th>
<th>Use</th>
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</thead>
<tbody>
<tr>
<td>Finnmark</td>
<td>Water temperature</td>
<td>Pt 2000</td>
<td>SBE Temp sensor 38</td>
<td>See Bird Electronics</td>
<td>SYK2</td>
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<tr>
<td></td>
<td>conductivity</td>
<td>inductively</td>
<td>SBE TSG 45</td>
<td>See Bird Electronics</td>
<td>SYK2</td>
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<tr>
<td></td>
<td>turbidity</td>
<td>light scattering (blue)</td>
<td>FLINTUR</td>
<td>WETlabs</td>
<td>SYK2</td>
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<td>chlorophyll-a</td>
<td>fluorescence</td>
<td>FLINTUR</td>
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<tr>
<td></td>
<td>Phycocyanin</td>
<td>fluorescence</td>
<td>microFlu-blue</td>
<td>ThoOS</td>
<td>SYK2</td>
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<tr>
<td></td>
<td>CDOM</td>
<td>fluorescence</td>
<td>microFlu-codom</td>
<td>ThoOS</td>
<td>SYK2</td>
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<tr>
<td></td>
<td>automatic water sampler</td>
<td>phosphat transport nutrients chl-a-analysis</td>
<td>SED (USA)</td>
<td>SYK2</td>
<td></td>
</tr>
<tr>
<td>Gotland-Berg-Kemn</td>
<td>Water temperature</td>
<td>Pt 2000</td>
<td>SBE Temp sensor 38</td>
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W. Petersen
FerryBoxes within Coastal Observatories
JERICO: Towards a long-term and sustained European network of coastal observatories

EC umbrella (directives, policies, communications)

**FB Partners within JERICO**
1. CEFAS (UK)
2. HCMR (GR)
3. HZG (DE)
4. IFREMER (FR)
5. MUMM (BE)
6. NERC (UK)
7. NIVA (NO)
8. SMHI (SE)
9. SYKE (FI)

- Oceanic modelling
- Marine Core Services (DG ENT / GMES)
- Coastal modelling
- Coastal and shelf seas continuous in situ measurements
- Fisheries data
- Social/commercial activities
- Marine data thematic centers
- SEADATANET (I3) standards and web portal

**EC umbrella**
- Fisheries data
- Coastal and shelf seas continuous in situ measurements
- Marine data thematic centers
- SEADATANET (I3) standards and web portal
Integrated Approach of COSYNA:
Coastal Observing System for Northern and Arctic Seas:

Aim:
Development and test of analysis systems, consisting of observations and/or numerical modelling, for the operational synoptic description of the environmental status.
Integration of FerryBox Lines in the Coastal Observeratory COSYNA (German Bight)
FerryBox Routes (HZG)

1. Lysbris (cargo ship, round trip)
   Halden (NO) → Ghent (BE) → Immingham (UK) → Moss (NO) →
   ~ weekly

2. TorDania (RoRo ship) replaced by
   Hafnia Seaways (Dec 2012)
   replaced by Selandia Seaways (Sep’13)
   Immingham (UK) <-> Cuxhaven (DE)
   ~ 6 transects/week

3. FunnyGirl (passenger ferry)
   Helgoland (DE) <-> Büsum (DE)
   ~ 2 transects/day
   Helgoland (DE) <-> Cuxhaven (DE)

Measured Variables

- temperature
- salinity
- turbidity
- chlorophyll
- oxygen,
- pH
- (algal groups)
- (nutrients)
- (pCO2)
Stationary FerryBoxes operated by HZG

FB-Station Cuxhaven since Okt‘10:

FB-Station at FINO 3
Installation: July 2011
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)
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 data stored aboard on FerryBox computer

All parameters filtered/flagged by housekeeping parameters

→ status of the FB
→ flowrate
→ speed of the vessel

Single parameters flagged\(^1\) by

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

\(^1\) MyOcean/SeaDataNet flagging scheme

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

Web-based visualization tools on ferrydata.hzg.de

MyOcean ftp site (NIVA)
Delayed Mode Data Quality Control at HZG

**Flagging**¹ of:
- frozen values
- after departure problems
- noisy values
- spikes
- visual control
- comparison with bottle samples analyzed in the lab

¹ MyOcean/SeaDataNet flagging scheme

**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
# FerryBox Routes in HZG Database

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

- MARNET (Deutsche Bucht)
- Nearest Ferrybox
- FREE (RMSE: 0.62)
- DA (RMSE: 0.56)
SSS Validation of Data Assimilation (DA) vs. MARNET Station “German Bight”
Conclusion

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
- pCO2
- pH (high precision) new
- alkalinity \( (A_T) \) new

*suitable for long-term unattended operation
From physical towards biogeochemical data: Algae dynamics and impact on carbon budget (pH and pCO2)

- Chlorophyll-a fluorescence
- Oxygen Saturation
- pH
- pCO2

Pooled data of pCO2 (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 for quantifying carbon budget

→ p-CO2 Sensors (installed in two Ferryboxes)

→ PSICam (point-source integrating-cavity absorption meter) for better quantification of chlorophyll-a and detection of algal species

→ Automated Gen Probe System (under development) (e.g. for detection of harmful algal blooms)

see talk Steffen Aßmann and others about new sensor 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

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)
Summary cont

**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

• 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
JERICO:
www.jerico-fp7.eu/
Costal observatories:
www.cosyna.de
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