20 year’s of FerryBox developments at NIVA

«From a single Ferrybox line in Skagerrak to several Expedition ships in Antarctica and Great Lakes»

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A postulate that we have experienced

Niccolo Machiavelli "The Prince", (1513)

"It Must Be Remembered That There Is Nothing More Difficult To Plan, More Doubtful Of Success, Nor More Dangerous To Manage, Than The Creation Of A New System."
History

- Tried to get funding from Environment Agency mid 1990 when Alga line started
- Project funded in 2000 from the Norwegian Research Council
- Invited to the FerryBox consortium here at Hereon trying for the 3 time with a EU-proposal
- Kickoff in December 2002 on the EU-FerryBox project here at the campus
- NIVA was invited to several EU and ESA project with the FerryBox infrastructure
- Made it possible to develop the system and increase the number of FerryBox installations
- Important when we got the FerryBox into the large national and local monitoring projects
- In 2018 we got 5+5 year Research Infrastructure project NorSOOP with 4 partners NIVA, IMR, Åpn and met.no
- Status at NIVA and in NorSOOP are that we have been involved 14 FB-installation including 2 microFerrybox and on 3 Expedition ships.
- Running now 9 FB installations and 1 installation will come in 2011 and 1 in 2023.

Kai.sorensen@niva.no, 27.09.2022
The first versions of the NIVA Ferrybox from 2001/2002

- Temperature and salinity (Seabird SBE 45 Micro TSG)
- Chlorophyll-a fluorescence (Seapoint)
- Turbidity (Seapoint)
- Added the Turbidity sensor with a wiper (Polymetron)
Early results used to demonstrate the potential of the Ferrybox data.

Data from the Oslofjord with Color Festival

Monitoring station Dk1 in Inner Oslofjord

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We got the FB systems into local programs

Plankton blooms in the Outer Oslofjord in 2017

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Important that we got FerryBox into the National Monitoring programs for Eutrophication and Ocean Acidification

Coast line of 29000 km
That should be monitored by 35-40 WFD stations and about 20-25 OA stations

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Representativity of the one FB-depth for WFD of open exposed stations

Example 1: Tilreimsfjord: 5m versus 0m and 10m using Chl a water sample data

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Chl-a Fluorescence

“Chl-a_fluoresence as proxy for Chl-a”

Chl-a also a proxy for estimation of phytoplankton biomass
- Day light, length of day
- Seasonal variations
- Species composition

1400 datasets over 6 year (2003-2008) from the same ship in a transect including night and day.

«Control» of the Chl_a-Fl /Chl-a ratio we can improve the use as Chl-a_fl as proxy for Chl-a

Fluorescence low at high concentrations

Fluorescence high at small concentrations

Day-night variation larger during bloom - high production

Fluorescence high during night

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Comparision of FB Chl-a_fl and station Chl-a
Data from the Oslo-Kiel 2012-2015 on 9 stations in Kattegat

Jesper Andersen et.al, report
7167-2017 DK7 (2017)
Validation of satellite data with FerryBox deck mounted reflectance sensor data
NorSOOP: Norwegian Ships of Opportunity Program extended with Expedition ships and ships from collaborating partners

- NIVA (lead), IMR, Akvaplan-niva, Met NO
- NFR INFRASTRUKTUR (2018-2023)

Bonus installation on the Statsraad Lehmkuhl
MicroFerrybox (uFB) developed during the Covid. Used on one of the Coastal Steamers

uFB: Temp, Cond/Sal, Oxygen, Chl-a Fl, Turb, fDOM, Electronics and a microcontroller

Pump box supporting also pH and pCO2

Installed at Kong Harald with a pH box
Moved into the Expedition ships in 2019

Information to the passenger will be important

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Bringing ocean science on board

The Foyrby

An exciting year has been the ensemble of several of our Coastal Expedition ships. And as usual in the Norwegian Sea, the sound of a ship can be heard every day, both up on the podium and in the marine sciences through a small bridge.

This is the Foyrby increasing density. Through this we are using a variety of forecasting sensors that measure temperature, salinity, oxygen, chlorophyll a, organic carbon, particulate carbon, and other noise factors.

As part of a global initiative to learn more about our own, the data collected by the Foyrby is then transferred via satellite to the headquarters at the Norwegian Institute for Water Research (NIVA). Researchers there then process the signal and understand the situation in the marine environment.

The data is becoming more accurate and effective in predicting the state of the ocean in the future.

Kai Sorensen, Senior Researcher at NIVA, was one of the first people to introduce the Foyrby to Norway twenty years ago. According to him, without the cooperation of the Hurtigruten Coastal Express, this important research would not be much further to achieve.

"The ship was able to collect data at a useful rate, which makes the results more accurate and specific," he says. "The alternative would have been a much larger vessel, which would have been too expensive." As says.

Observing changes

The data collected has revealed some significant discoveries. One of the latest focuses is on seawater density. "If the surface, you might think it's better looking, or a more balanced ecosystem or something," Sorensen says. "But actually, what's happening is that as winter temperatures get higher due to climate change, nutrients from the land are washed into the sea, bringing more and more organic material with it, which is captured in the water.

"As the nutrients from the land flow into the sea, it forms a bottom layer of larger algae blooms which deplete the sea. These algae blooms are both toxic and pose a threat to our sea. We've already had cases with this connected to problems in Northern Norway," Sorensen warns.

But there are some positive outcomes. "Thankfully, we've got consistent, valuable data from Foyrby on the Coastal Expedition ship. This allows scientists like me to check on the marine life and long-term climate warming and the timing and duration of algae blooms.

Sorensen continues, "The Foyrby is equipped with cameras that observe the Foyrby, which can be used to study algae blooms. It can also take images of the ocean, which not only indicate the extent of land-based emissions and carbon dioxide in the ocean, but also carbon sequestration and feedback.

"We've also testing one of the latest features by Foyrby's citizen scientists, which collects underwater samples along the Coastal Express. These samples can be further analysed in NIVA's laboratory," he adds.

At your fingertips

As part of a board visit, you will have the opportunity to learn about the investigations being done in real-time. Data from the Foyrby is displayed directly on an interactive map so that everyone can see it, thanks to the interactive and exciting selection of ships, raising awareness about pressing environmental issues.

Sorensen is very happy about the engagement from you. "We invite everyone to be interested in seeing how the surrounding sea is evolving, but we don't expect people to be an environmentalist. We just need information about our research into the waves and the great ocean's journey taking their time to learn more," he says sincerely.

"New technology has made a big difference in our ability to understand the ocean. The data gathered from Foyrby on the Hurtigruten Coastal Express has played an important role in how we are working, and it will continue to do so in the future," concludes Sorensen.

"If you have any questions, feel free to ask. We are all interested in solving the challenges of climate change and finding a way to navigate towards a sustainable future."
Ships of opportunity at Expedition ship

- Console for Ocean Literacy
- Laboratory for Citizen Science
- FerryBox sensor system
- Advanced water samplers
- Meteorological observations
- Deck sensors for satellite validation

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Science Center on board Roald Amundsen

Phytoplankton from November 12, 2019
The community was dominated by diatoms and Chlorella species were the most abundant. Chlorophyll-a concentration 4.65 mg/mg.
Temperature 13.5°C, salinity 34.65‰.

The naked dinoflagellate Gonyaulax lucifer was present.
Massive plankton bloom when we passed the «Antarctic convergence zone» 16. February-22

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Trained the Expedition Team in preservation of Chl-a, phytoplankton and Microplastic samples and maintenance and controls of the FerryBox.
The Ferrybox installation on Viking Octantis with Laminar flow cabinet for Microplastic sample preservation

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Present and near future

- The Ferrybox systems is an excellent costs effective system for water quality monitoring of surface water.
- One depth data are representative for the surface (0-10m) water masses (WFD) in open exposed areas along the FerryBox route in Norwegian waters/Kattegat.
- The Norwegian ships used in WFD and Ocean Acidification monitoring can replace/supplement traditional stations monitoring.
- The core sensor like Temp., Sal., O2, Chl_a_Fl, PC_Fl, PE_Fl, cDOM_Fl and turbidity works well with proper maintenance, biofouling handling e.g. the SOP.
- Water sampling for phytoplankton, nutrients and BGC-parameters are possible.
- The FerryBox systems can be used for some atmospheric research and satellite validation (SST, reflectance, water quality products).
- The ships can host several advanced sensor systems like ADCP, CPR, XBT.
- Advanced carbon systems sensors (pH, pCO2, Alkalinity) are used.
- New sensors like PSICAM, FRRF, flowcytometry and nutrients to be tested/implemented.
- Advanced sampling for microplastic are possible. Advanced sensors in the future?
- The passenger should have visualization system of data and environmental info.

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Norsk institutt for vannforskning