
# D7.1: Service Access Provision

Grant Agreement n° 262584

Project Acronym: JERICO

Project Title: Towards a Joint European Research Infrastructure network for Coastal Observatories

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Involved Institutions: IFREMER, BL, CNR-ISMAR, HCMR, NIVA

Version and Date: V1 – 01/04/2015

# Table of Contents

# Document description

REFERENCES
Annex 1 to the Contract Description of Work (DoW) version of the 22 Feb. 2011

| Document information | |
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| Revision | |
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| Security | |

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|---|---|---|---|
| Revision | Date | Modification | Author |
| 0.1 | 01/04/2015 | Creation of the document | IFREMER |
| 0.2 | 28/04/2015 | Inputs from involved partners | IFREMER |
| 1.0 | 30/04/2015 | First complete version | P. Farcy |

| Diffusion list | | | | |
|---|---|---|---|---|
| Consortium beneficiaries | X | | | |
| Third parties | | | | |
| Associated Partners | | | | |
| other | | | | |

# 1. Chapter 1: Facilities and data provided

The following table give an overview of the data that have been transmitted to the Myocean infrastructure. This global table will be much more detailed in version 2 of this document.

| |
|---|
| 1) MOLIT & Mesurho buoys |
| 2) RECOPESCA (158 vessels) |
| 3) Alg@line |
| 3 Ferrys : |
| - Finnmaid (call sign = OJMI) : data reaching the Coriolis/MyOcean data flow. |
| - Silja Serenade (call sign = OJCS) and Kristina Brahe (call sign = OIEC) : |
| No data. Contact taken. Data will flow through NIVA |
| 4) CRS - Coastal Research Station |
| 1 coastal station and 1 mooring |
| - Contact taken - Data integration process started |
| 5) NorFerry - Norwegian Ferrybox network |
| 3 Ferrys : |
| - Norbjorn (call sign = LAKM4) |
| - Trollfjord (call sign = LLVT) |
| - Bergensfjord (call sign = OUZI2) |
| 6) NorFerry - ColorFantasy |
| Color Fantasy (call sign = LMSD) |
| 7) IMR - Coast observatories |
| |
| Would like to identify contributor in the NetCDF files. Discussion pending |
| 8) OGS-NACObs - FVG-MMS |
| |
| D |
| 9) OGS-NACObs - MAMBO |
| |
| |
| 10) CNR - NAMS |
| |
| Data flow to Coriolis/MyOcean through HCMR |
| 11) CNR - FOS |
| |
| Data flow to Coriolis/MyOcean through HCMR |
| 12) POSEIDON Buoy Network |
| 8 stations |
| 13) POSEIDON Buoy Network |
| 3 stations |
| 1 Ferry : Olympic Champion (call sign = SYWD) |
| 14) POL - COBS |
| No answer to a mail sent by coordinator |
| 15) COSYNA |
| 3 Ferrys : |
| - Hafnia Seaways (call sign = 2AMH9) : No data |
| - FunnyGirl (call sign DFPZ) : Data reaching Coriolis/MyOcean Database |
| - LysBris (call sign = LJLN3) : Data reaching Coriolis/MyOcean Database |
| - Wadden Sea Piles : Data integration process started |
| 16) SMHI - MOS |
| |
| 17) SMHI - Laesoe |
| 18) SmartBay Galway |
| 19)Puertos del Estado Deep Water Network |

Status of the JERICO datasets regarding their integration through the NRT data stream (last update 2013-04-23)

Data set circulating in NRT

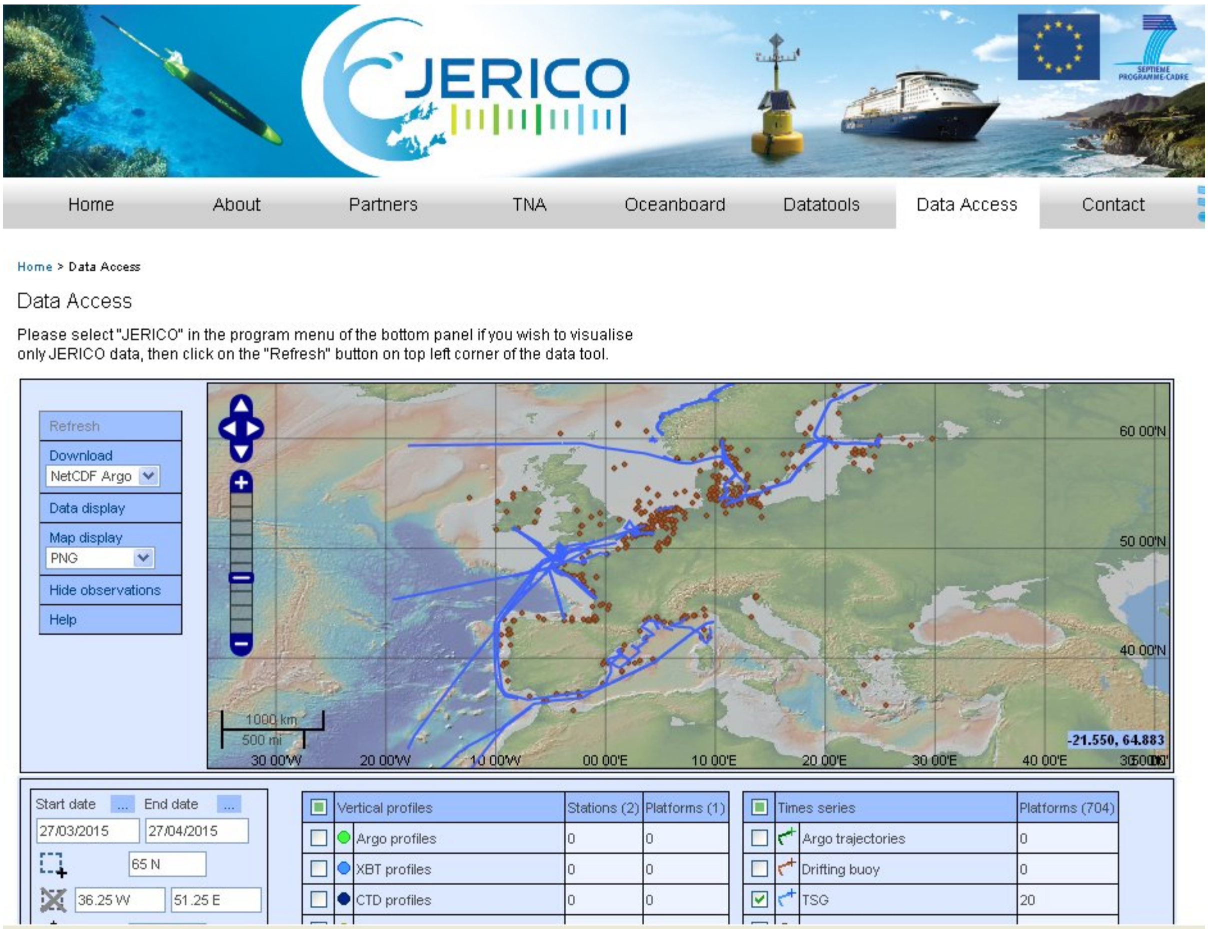
Data set not yet integrated in a NRT data stream

Contact taken with the data provider. Development for data integration is started

# Data access and visualisation

The Jerico reach the Global Myocean distribution Unit which is hosted by the French Coriolis data centre.

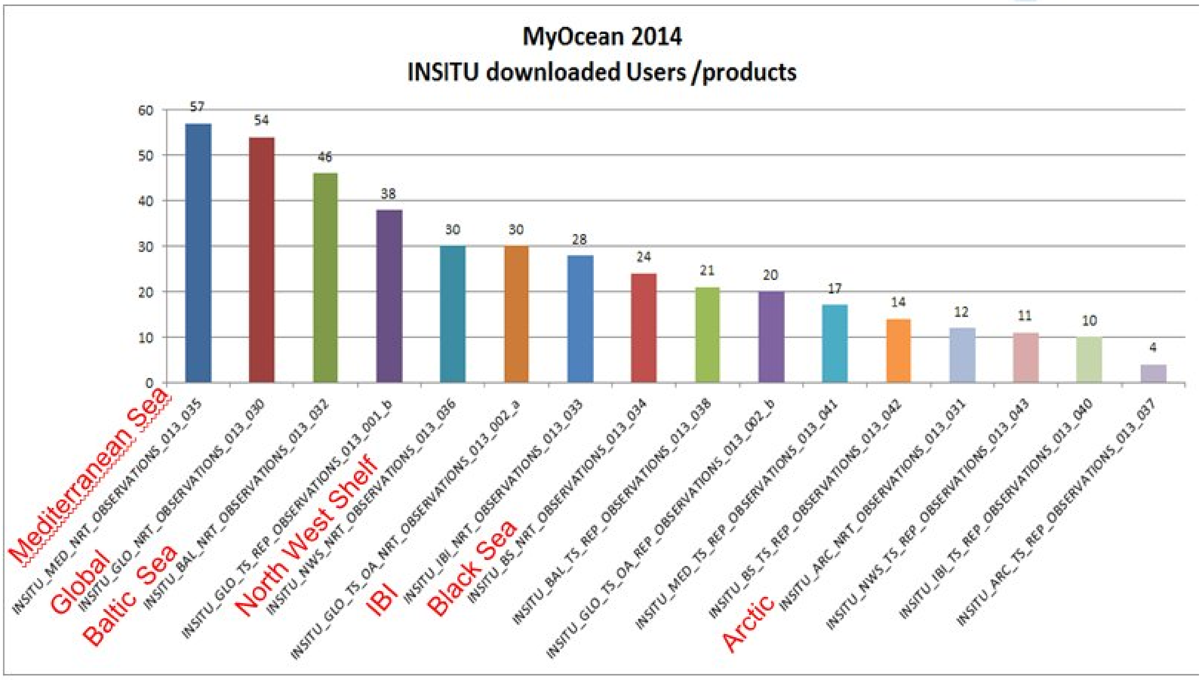
A Coriolis data selection tool has been integrated in the Jerico web Site




Through this web tool ii is possible to access the Jerico data and non Jerico data. It has been considered that Jerico observing system contributes to a wider observing system at the European level

For operational needs the Jerico data as part of this wider dataset are distributed on a daily basis through the Myocean portal and ftp site after identification or registration of the users.
As we have considered of the most importance to identify clearly what are the Jerico data amongst this wider dataset, a project dedicated index system has been developed which enables to pick up only Jerico

# Statistics of access




Courtesy of Mercator (A. Delamarche, C. Giordan, D. Obaton)

These statistics are related to the global Distribution and to the ROOS distribution.
They are not dedicated to only Jerico data because as detailed above we have considered that Jercio contributes to a wide system.

***The main difficulties make the Jerico observations data available has been to have a close relationship between the PIs and the Central data management system.***

***The second difficulty is our possibility to make the data from a dedicated project clearly visible amongst a whole system. This will be a challenge of Jerico-Next where it is planned to improve the tracability of the data through the different portals and distribution channels.***

# 2. Chapter 2: Targeted Operation Phases (TOP)

## 2.1 TOP 1: Maps from coastal observatories (JERICO Data Tool)

<u>Description of the infrastructure</u>

The European Marine Ecosystem Observatory (EMECO) is a consortium of organisations with responsibility for both monitoring and assessment of status, and also for improving understanding through research of European shelf-seas. Design and development of the EMECO Datatools began in 2007 as a suite of web based services for the regional North Sea and Irish Sea. The tools enable rapid integration and visualisation of multi-platform, multi-parameter and multi-national data.

Outputs are available in the form of maps (KML and bespoke assessment maps), data (XML and CSV) and time series charts. Since 2010, the they have been developed further to include a tool kit for producing semi-automated environmental assessments with specific assessment and reporting functionality designed to meet policy requirements at National and European levels. The purpose of the Datatools is to deliver high-level information products in a transparent and auditable manner that increases confidence, availability and uptake of *in situ* and remote sensing observational data.

<u>Description of the Service Access</u>

During the period of Service Access, Jerico data has been available on the EMECO Datatools. The data is available at a pan-European scale and include almost 40 parameters from a variety of coastal observing platforms including buoys and moorings, coastal structures, FerryBoxes, Ships of Opportunity (SOOPS) and tide gauges.  Example outputs are provided in Figures 1-4.

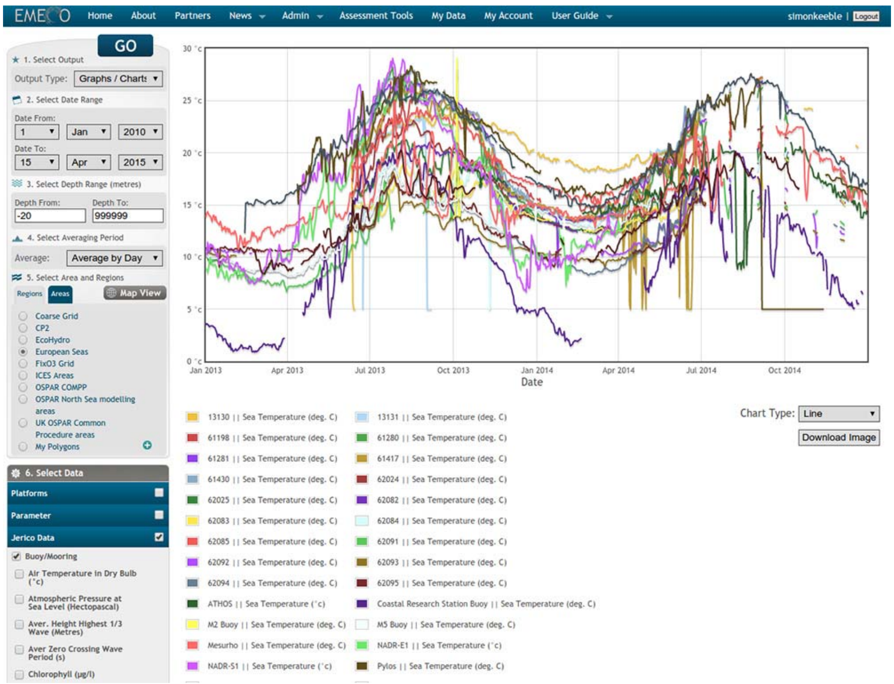



*Figure 1: Example of a time series chart generated by the EMECO Datatools. The chart shows daily averaged temperature records from 26 European Buoys and Moorings from 1st January 2013 - 28th February 2015*

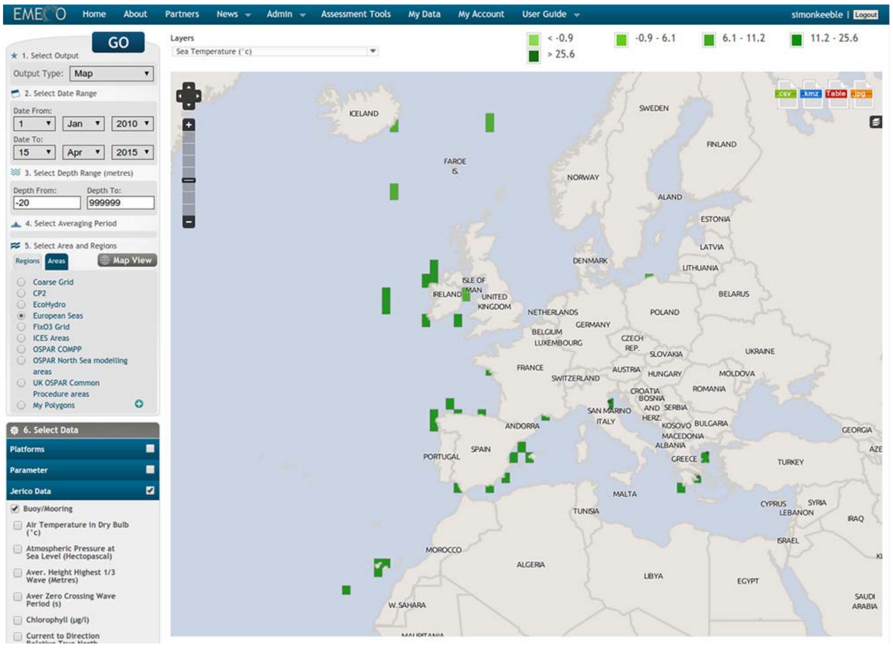



*Figure 2: Example of a data map generated by the EMECO Datatools. The map shows the average temperature and the location of the European Buoys and Moorings from 1st January 2010 - 15th April 2015*

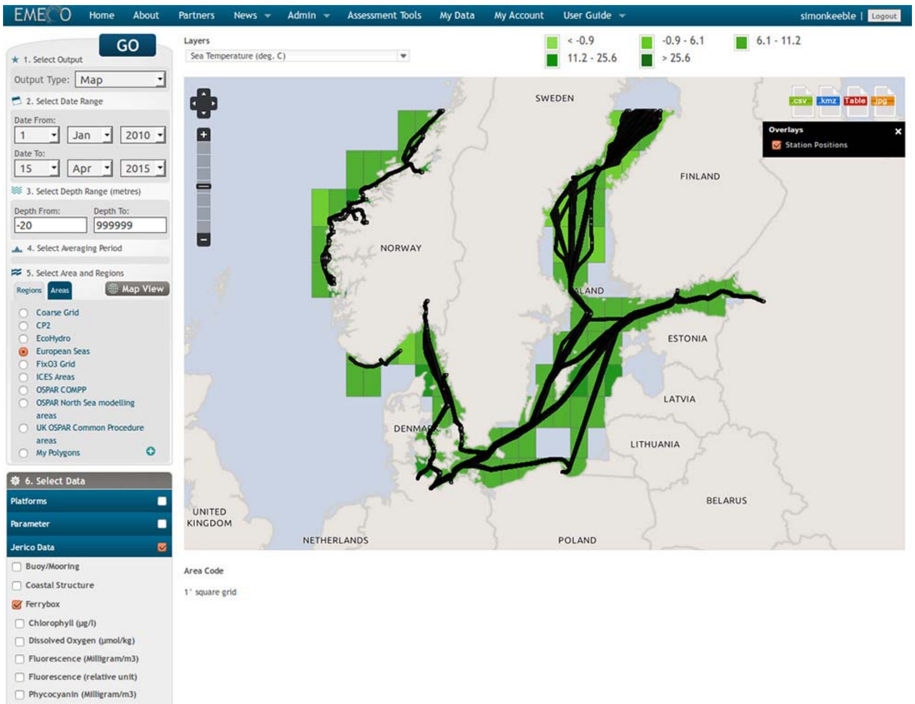



*Figure 3: Example of a data map generated by the EMECO Datatools. The map shows the average temperature and the FerryBox routes from 1st January 2010 - 15th April 2015*

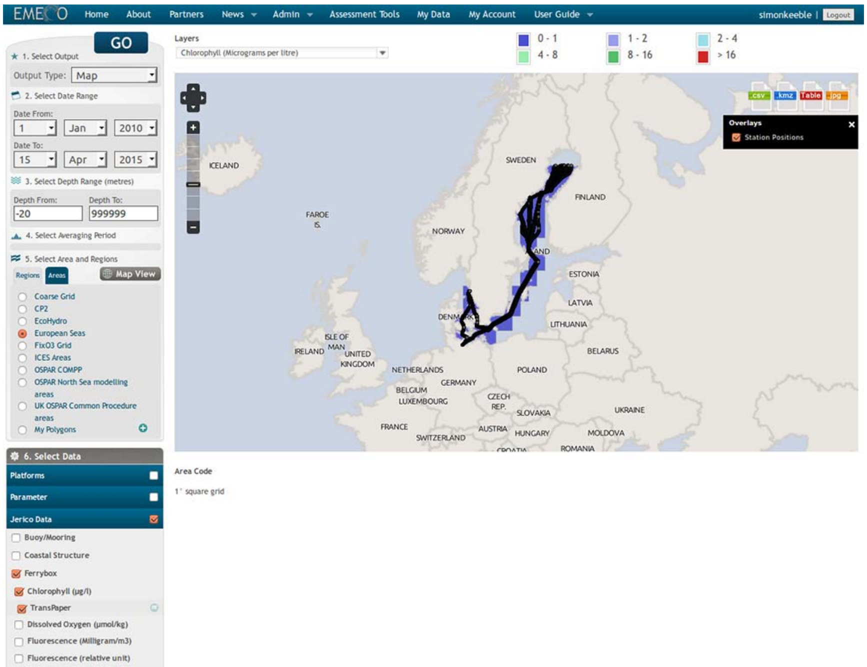



*Figure 4: Example of a data map generated by the EMECO Datatools. The map shows the average chlorophyll concentration and the FerryBox routes from 1st January 2010 - 15th April 2015*

## 2.2 TOP 2: Data and maps from sensors on board fishing vessels

Data provided from research vessels are often sporadic or specific to a particular campaign or process study. On the other hand, fishing vessels ply Europe's coastal seas at all times of year and in almost all weather conditions. In that sense, fishing vessels are under-utilized resources in terms of recovering oceanographic data.

The RECOPESCA initiative led by IFREMER in France and the Fishery and Oceanography Observing System (FOOS), developed and conducted by CNR in Italy, have led to routine recovery of such data from fishing vessels on a pilot basis.

The approach is quite novel, and further developments are still expected to enhance both for sensors (new parameters, e.g. fluorescence) and data transmission from sea to shore (from GSM to satellite). However, times are mature enough to organize the data in the JERICO server and to link them to the existing regional ocean observing system portals (MOON and IBI) so making them available to the coastal operational systems.

### 2.2.1. Adriatic Sea (Fishery and Oceanography Observing System)

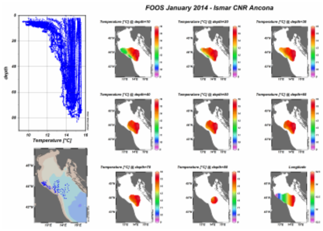
The Fishery Observing System (FOS) was a program started by CNR in 2003, in the framework of the EU-FP5 project MFSTEP; the aim was to use fishing vessels as VOOs for the collection of scientifically useful datasets. Seven commercial vessels fishing for small pelagic species in the northern and central Adriatic Sea were equipped with an integrated system for the collection of data. Until the year 2013, catches, position of the fishing operations, depth and water temperature were recorded daily during each haul.

In 2013, CNR upgraded the FOS to FOOS, the Fishery & Oceanography Observing System. New sensors for the collection of oceanographic and meteorological data allow nowadays the FOOS to collect more parameters, with higher accuracy, and to send them directly to a data center in near real time. The FOOS represents thus a multifunction system able to collect data from the fishing operation and to send them to an inland data center, but also to send back to fishermen useful information, as for instance weather and sea forecasts, etc. through an electronic logbook with an ad hoc software embedded. The FOOS implementation allowed a spatial extension of the monitored area and the installation on various kind of fishing vessels such as coupled pelagic trawlers, bottom trawlers, purse seiners etc.

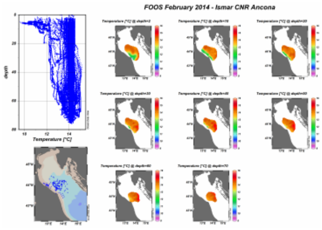
From January 2014 data from 9 vessels operating in the Adriatic Sea are monthly distributed through MyOcean - Mediterranean Sea In Situ Thematic Assembly Centre (http://www.myocean.eu/, wmo_platform_code=ADR-FOOS).

## Monthly maps & profiles

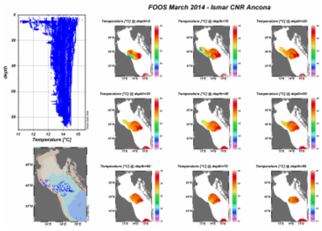
**January 2014**



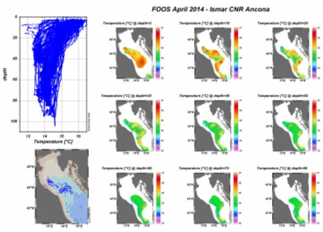
**February 2014**



**March 2014**



**April 2014**



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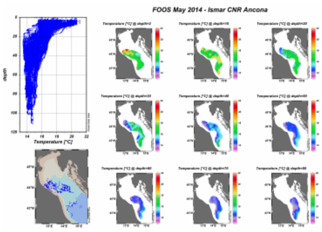

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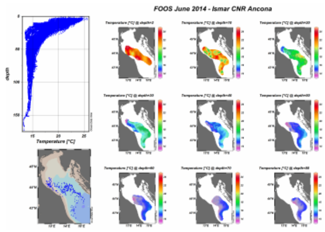

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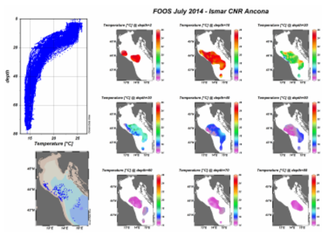

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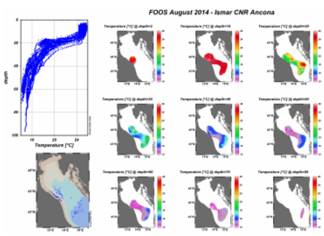

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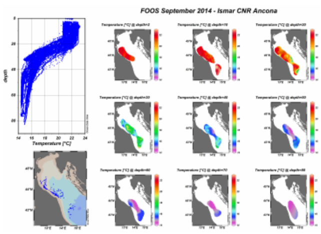
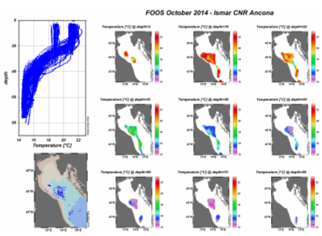


**October 2014**



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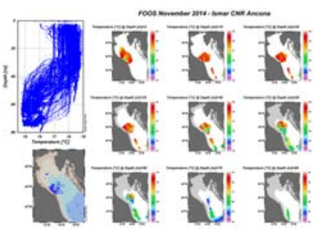

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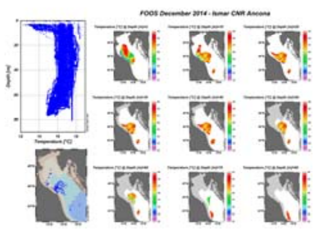
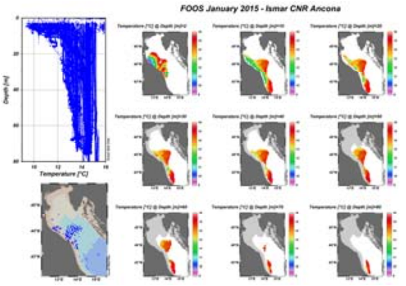


**January 2015**



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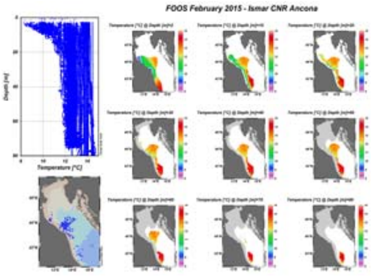

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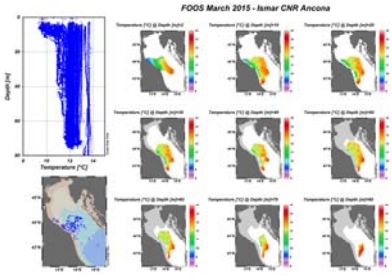

### *2.2.2. Irish Sea (RECOPESCA)*

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**Adriatic Sea (Fishery and Oceanography Observing System)**

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**Irish Sea, Bay of Biscay and English Channel (RECOPESCA)**

The aim of the RECOPESCA project (Leblond et al., 2010) is to achieve accurate spatial distribution (GPS monitoring of boat and timestamp) of catches (weight with anti-rolling weigh-scale), fishing effort (working duration of the fishing gear) and environmental (depth, temperature, salinity, turbidity) characterization of fisheries area required for an ecosystem approach to fisheries. The collected data are available for fishery scientists and physicists who dispose of continental shelf dataset from 2 to 300m depth. The physical data are stored and shared in two data centers (i) The Fisheries Information System of Ifremer and its database *Harmonie* (ii) the *Coriolis* database for operational oceanography*.* A real time quality control is applied on collected data.

RECOPESCA is a mean based on a participative approach, where the voluntary fishermen team up with fishery scientists. This successful collaboration is possible because we used equipment, which doesn't need interventions of the fisherman team during several months. For this, we developed rugged probes who can be directly fixed on fishing gears (trawl, net, fishing trap,…), self-powered, autonomous, with accurate and fast response time sensors for profiling function during way down.

Onboard basic equipment is comprised with:

- A probe with depth (3% full scale precision) and temperature sensor (precision less than 0.05°C in the range 0°C to 20°C) without or with an additional sensor such as conductivity sensor (precision ± 0,05 mS/cm in the range 10 to 60 mS/cm) or turbidity sensor (precision less than 2%). The probe records only during immersion stage and the data are timestamp. The record time frequency is configurable. Typically we use two frequencies. The first is set to 1 second during the way down period (profiling period) and the second set to 2-10 minutes during the fishing gear bottom working period. The probe is equipped with a radio device for transmitting automatically its data to the *concentrator.*
- A receiver on-board hub called *concentrator*, placed outside on the vessel bridge. The *concentrator* is equipped with a GPS 3D patch, a GPRS modem for transferring all the data to the Ifremer data center in Brest, a radio device for bi-directional communication with the probes. The probes are set to time at each data transfer with the *concentrator*. The *concentrator* has 6 months memory capacity.
-

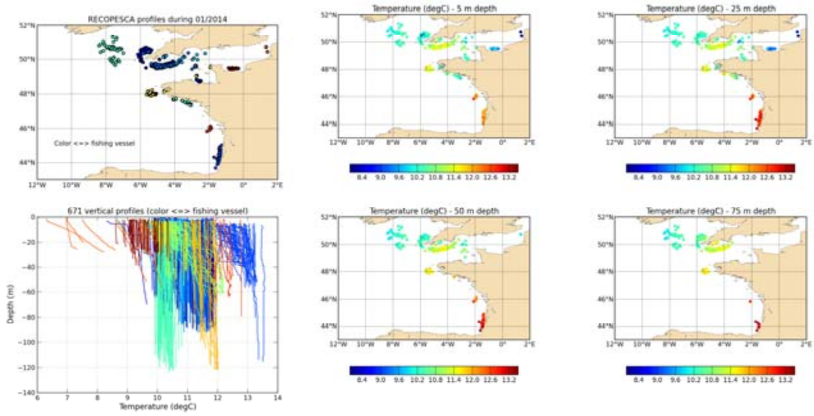
In addition, specific equipment can be added:

- A turn-counter placed on the gear hauler in order to measure the length of passive gears hauled at each fishing operation. A radio device is present for data transfer to the concentrator.
- An anti-rolling weight-scale recording the catches per species and fishing operation. A radio device is present for data transfer to the concentrator.

At the end of 2014, 49 vessels are equipped and 33276 profiles have been collected in the Irish Sea, the Bay of Biscay and the English Channel Channel. The deployment plan, at the national scale, is in accordance with the diversity and representativeness of the fishing fleets (fishing area, vessel length and work experience).

**Monthly maps & profiles**

**January 2014**

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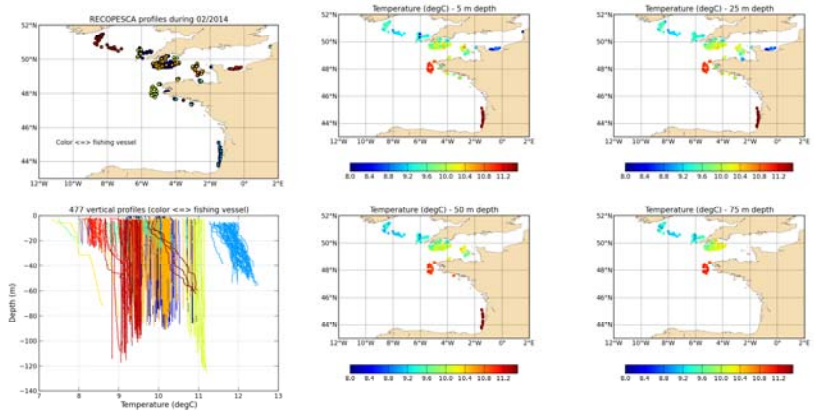


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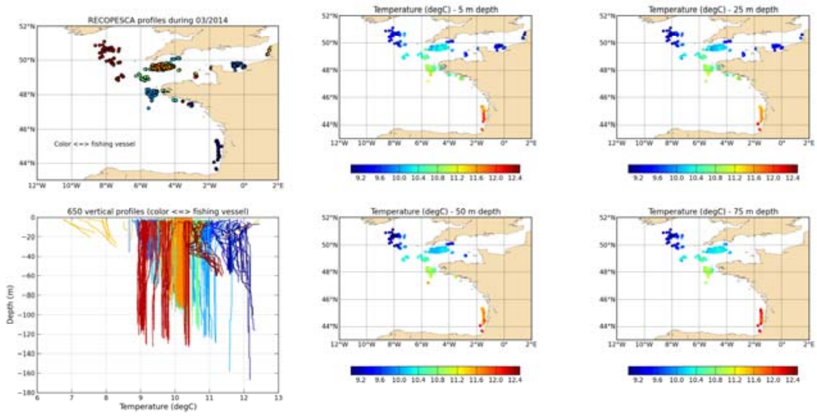

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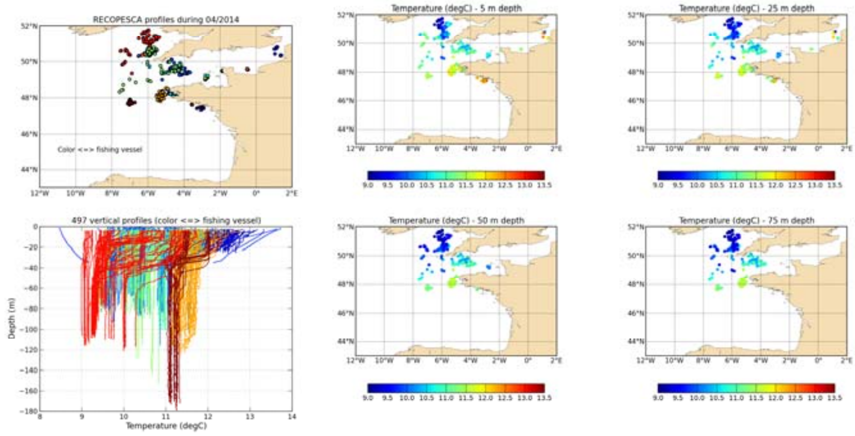


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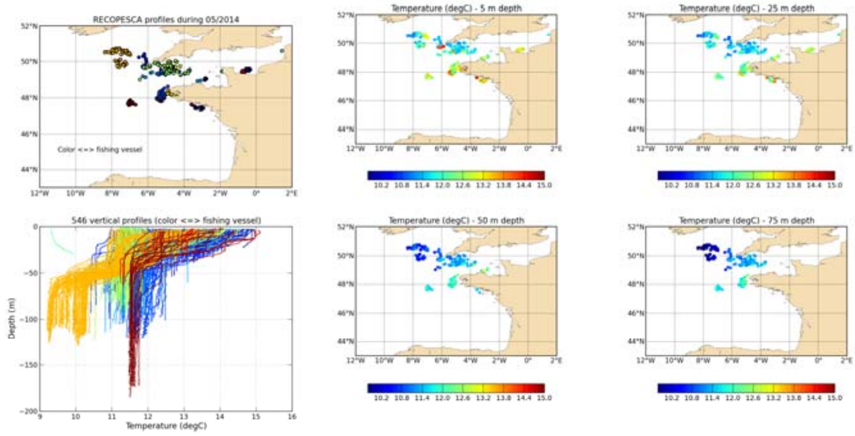


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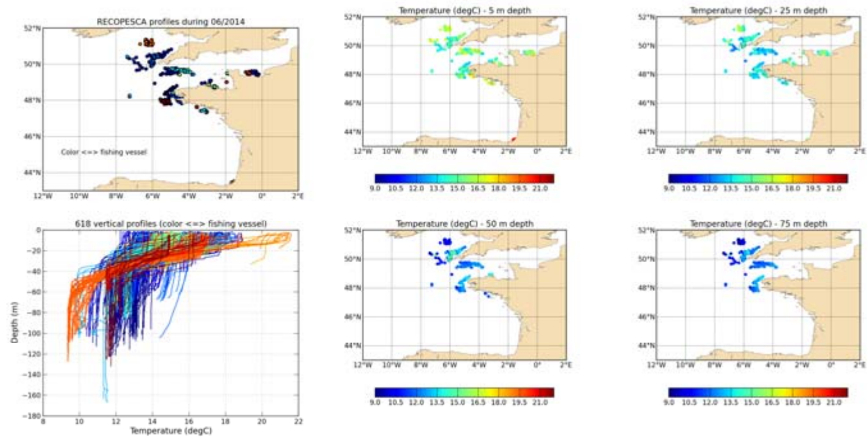

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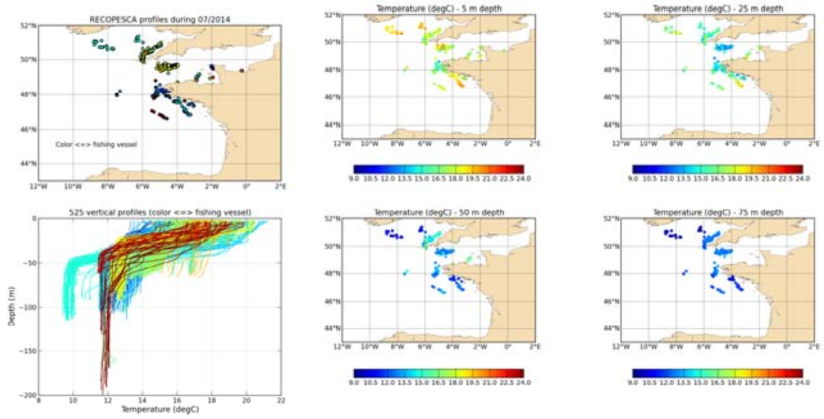


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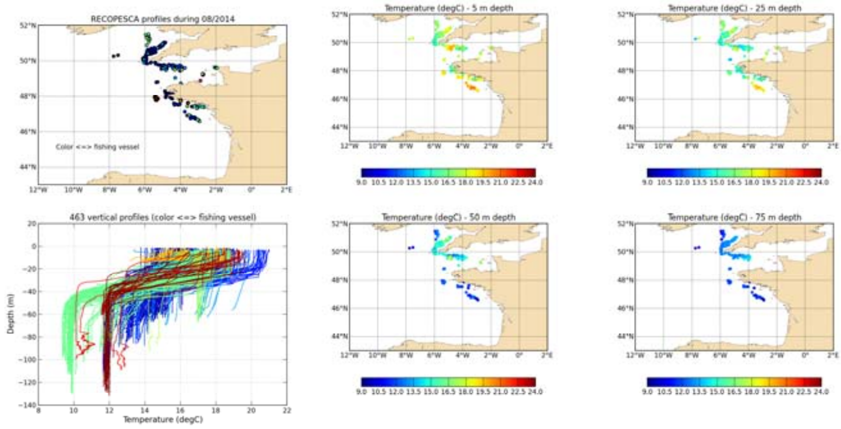


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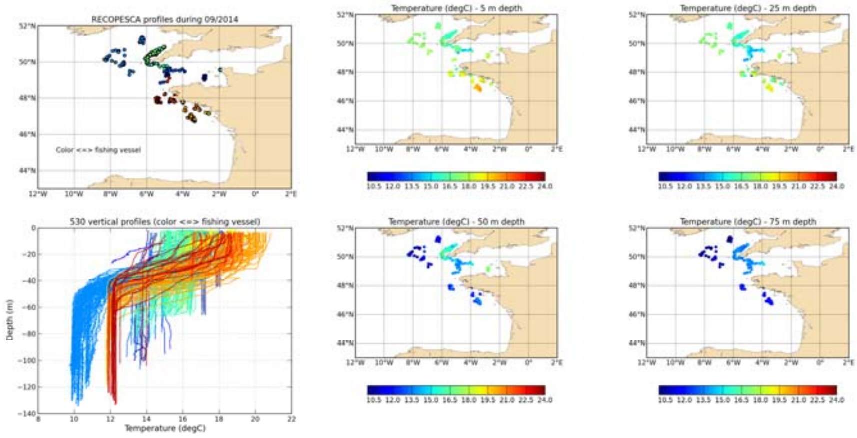
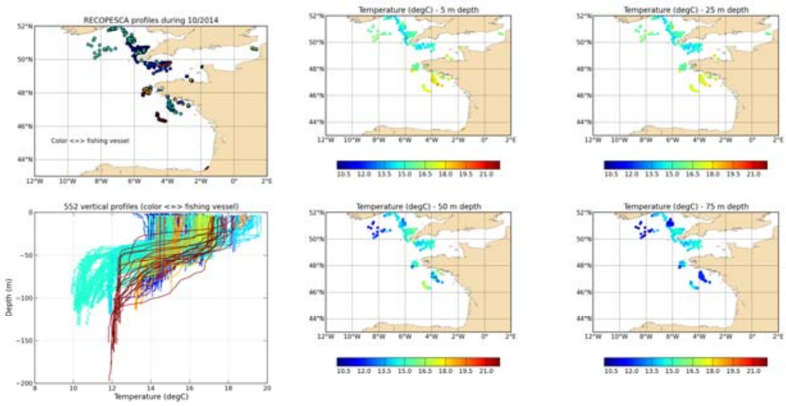


**October 2014**

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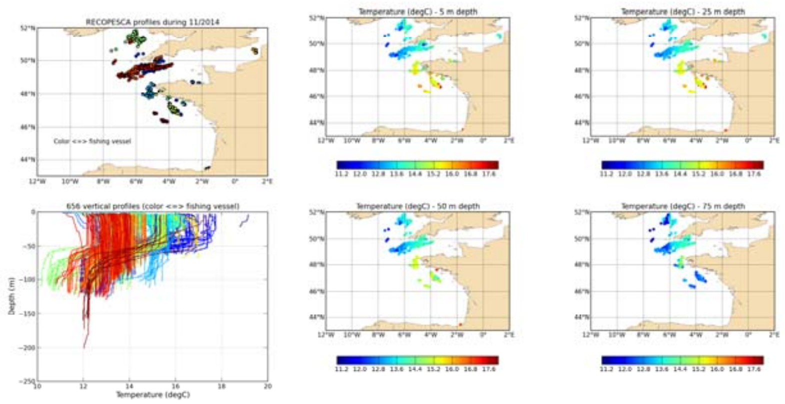


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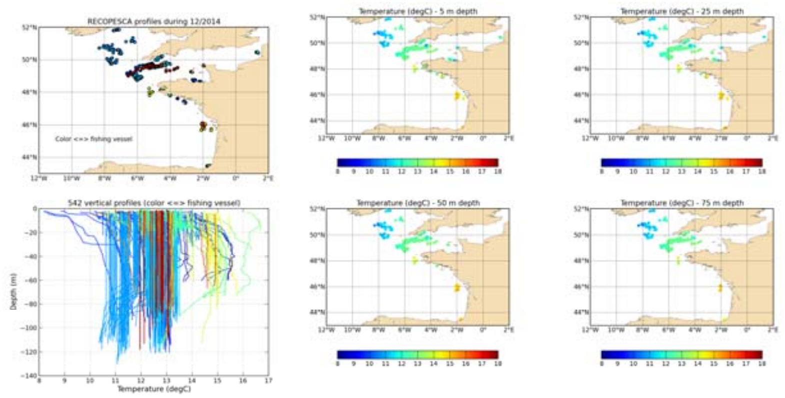

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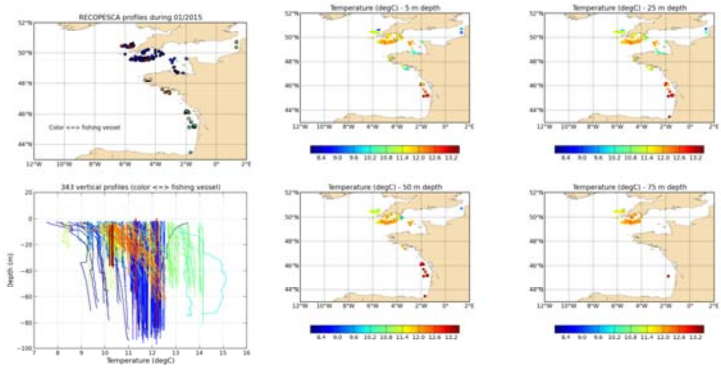


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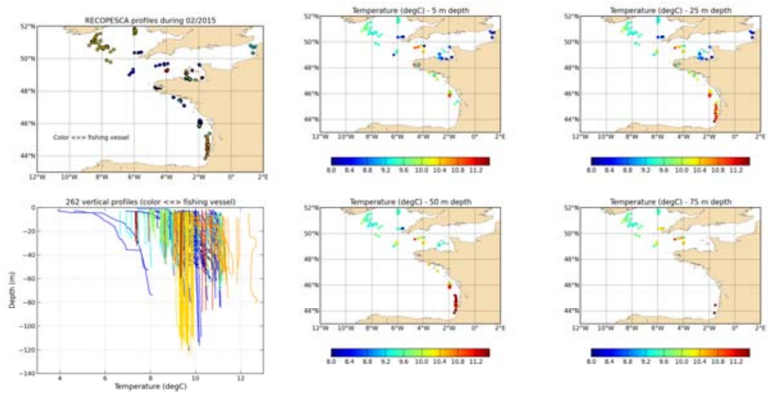


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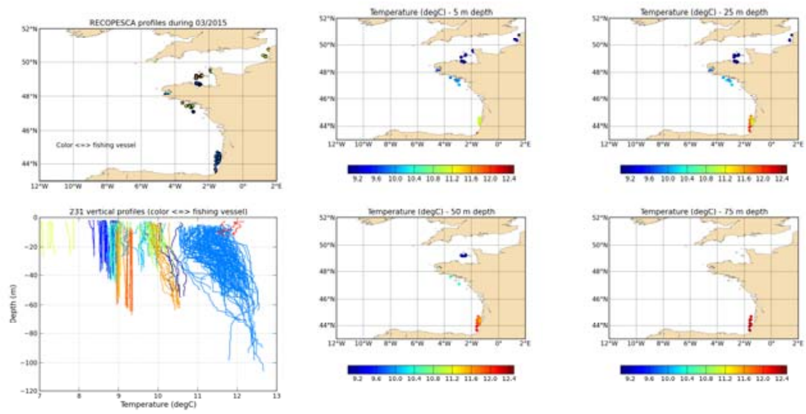


## *2.3 TOP 3: Data from buoys and co-located Ferry Bow line, in the south Aegean Sea and in the Kattegat*

### *1.1.1 2.3.1 Observing oceanographic conditions in the Skagerrak using an FerryBox-system and an oceanographic buoy (HCMR)*

In the framework of JERICO FP7 project and in particular in the supporting actions, HCMR participated at WP7 (Service and Data Access) and proposed within TOP SA one year of data from the POSEIDON SOUTH AEGEAN BUOYS (E1-M3A & Saronikos) and the FERRYBOX SYSTEM.

The three platforms are part of the POSEIDON buoy network namely E1-M3A and Saronicos together with the FerryBox system the only one in the Eastern MEditerranean. The network is the backbone of the POSEIDON integrated operational system (Nittis et al, 2007; Nittis et al, 2003; Nittis et al, 2001; Petihakis et al, 2007) which is linked with the monitoring, forecasting and study of the Eastern Mediterranean basin during the last 15 years. Funded by EEA and Greek national funds, POSEIDON infrastructure is an innovative operational system that HCMR has developed. All these years the system has been providing a series of products used for policy making and decision systems but also supporting several activities related to the marine environment. Moreover, these products are widely used by the public through POSEIDON's website (www.poseidon.hcmr.gr). This major upgrade of its operational capacities has created the solid ground for HCMR to participate in all the major European projects in the Operational Oceanography field the last fifteen years (MFS, MERSEA, ECOOP, MyOcean I&II, JERICO, FixO3 , etc.) and also to represent Greece in major European infrastructures such as EMSO (ESFRI) and EuroARGO (ERIC).

**The Observing Systems**

#### Ferry Box

Initially the Aegean Sea FB system (I-4H- JENA engineering GmbH) was installed in 2003 under the European network for Ferry Box measurements ((http://www.ferrybox.org), on board "Kriti II", an 192 m ferry performing daily the route between Piraeus – Heraklion. The first generation system was equipped with temperature, conductivity, fluorescence and turbidity sensors, operated for 1 year and as mentioned above the data were used for assimilation experiments (Korres et al. 2009; Kores et al. 2015).

In 2012 the system was moved from the laid-up "Kriti II" to the new High-Speed ferry "Olympic Champion" travelling daily on the same route. The new installation included the renewal of the supporting equipment and a major upgrade of the system (replacement of malfunctioning sensors and addition of new ones), in order to ensure the smooth operation in respect to the ship's safety regulations. Previous experience suggests that the main challenges for the system to retain its long-term efficient operation are the relative isolation of the measuring equipment from the ship's engine room, the small distance of inlet pipes and the continuous seawater flow to ensure the quality of the measurements. Thus the new FB system is hosted in a customized rack in the tight bow-thruster department, 2 meters below the waterline. Water is sampled from the ship's main bow inlet (1.5m long) without the interference of the ship's equipment such as filters and electro-chlorination systems. The FB sampling cycle during each trip is controlled by a coordinate switch and is pre-set to operate at a specific distance away from the coast in order to avoid interference from the operation of the thruster engines, used inside the port during docking manoeuvres.

The updated system (Fig. 1) is equipped, apart from the initial sensors, with dissolved oxygen and pH sensors and can be remotely controlled during the transect as long as there is mobile phone network coverage. These sensors are operating continuously in a closed measuring circuit with seawater passing at a rate of 25 liters per minute, while a debubbling unit removes air bubbles, which may enter the system during heavy seas. Biofouling is prevented by automated cleaning of the sensors with tap water and acidified water rinsing after each cruise. The system is controlled through a computer, and is equipped with internal pressure and flow control sensors, which can shut it down in case of severe errors and malfunctions. The data are transmitted daily, when the ship reaches the destination harbor.

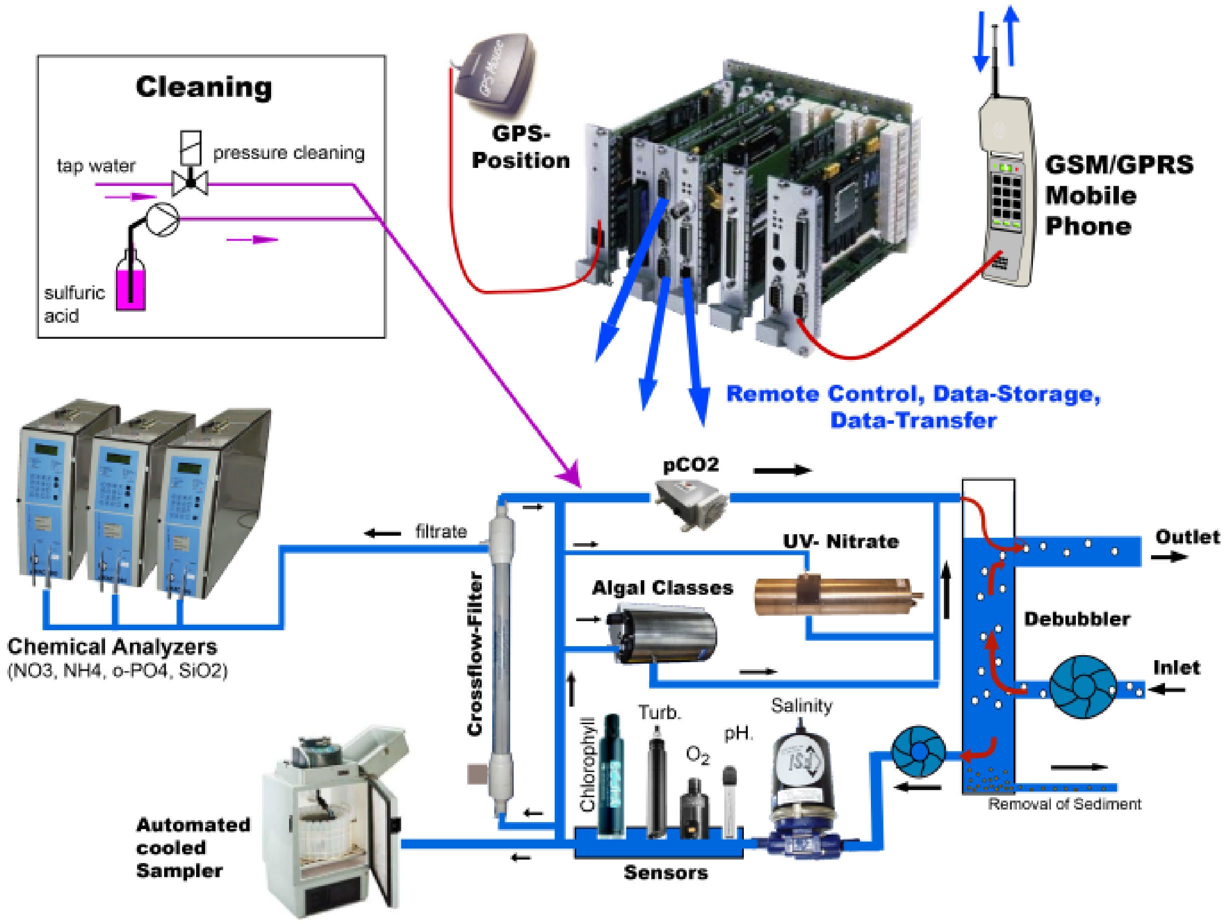



Figure 1. Ferry Box trajectories and POSEIDON Saronicos and E1M3A locations (2012-2014)

The FB system average data sampling rate is set to 1 min, along Piraeus (37° 58′N 23° 38′E) to Heraklion (35° 20′N 25° 10′E) route. “Olympic Champion” travels the 165 miles distance at a speed of 20 knots/h collecting 430 samples on average. The trip duration is ~9h and the FB is geographically initiated to log over the 200m isobath, 6 miles north of Heraklion and stops 4 miles south of Piraeus at a depth of 100m. Along the FB route, two buoys of the POSEIDON network are located; the Saronikos Gulf (37° 36′N 23° 33′E) equipped with surface sensors and the E1-M3A (35° 47′N 24° 55′E) that hosts, apart from surface instruments, a variety of sensors for physical observations in the upper 1000 m of the ocean, bio-optical observations in the euphotic zone as well as air-sea interaction ones. Scheduled routes are performed once a day, during night, with the exception of July and August, the peak tourism season months, when daily cruises are also added on the program. Although the ship’s track is rather stable, currents, winds and traffic can affect it. Particularly in Saronikos Gulf two distinct tracks exist due to ship traffic regulations. To date, bad weather conditions and FB computer malfunction are the major reasons for missing data.

## E1-M3A Station

E1-M3A observing system started in its current configuration in May 2007 and is located approximately 24 nm Northwest of Heraklion port of Crete at a depth of 1400m. It consists of a “Wavescan” type buoy manufactured in Norway and provided by Fugro OCEANOR (www.oceanor.com). These types of buoys are multi-parametric instrumentation platforms that are built to be deployed in deep offshore locations. The platform, which has been upgraded through the POSEIDON II project, hosts a variety of different sensors measuring meteorological, physical and biochemical parameters (detailed configuration of the station is shown on Table 1). It also integrates an inductive mooring cable so that instruments that support the data transfer through this cable to be adjusted on the mooring line providing in real-time salinity, temperature, biochemical parameters and pressure data down to 1000m depth. The site has been deployed in the Cretan Sea in a transitional area with complex hydrology where water masses formed in the Levantine, the Aegean Sea and the Adriatic Seas meet and interact with the water masses of the Western Mediterranean Sea that enter through the Sicily straits. Repeated cruises are conducted by the HCMR to visit the E1-M3A mooring location to measure optical and physical (T, S) properties down to 150m depth and biochemical parameters (D.O, chl-a, PO4, Si, NO2, NO3, NH4) down to 100m depth.

## Saronicos Station

Saronicos buoy is located approximately 12 nm from Piraeus port in the Gulf of Saronicos at a depth of 250m. It consists of a “Seawatch” type buoy manufactured in Norway and provided by Fugro OCEANOR (www.oceanor.com). Such platforms are deployed in areas where the water depth does not exceed 300m and are equipped with sensors monitoring the basic met-ocean parameters. By now several sensors are attached on the buoy shell measuring sea surface parameters such as salinity, temperature, current speed and direction and a variety of wave parameters (table 1). On the top of the platform meteorological parameters are measured such as air pressure, air temperature as well as wind speed and direction. The transmission is near real time with a three hours cycle where the data is collected and transmitted through a dual GSM/GPRS and INMARSAT-C satellite system. Currently, additional sensors have been attached to this mooring such as a subsurface pH sensor and a Passive Aquatic Listener (PAL) sensor focused on measuring anthropogenic noise in the sea since Saronicos gulf that surrounds the Athens metropolitan area is characterized by high level of ship traffic. Additional multi-parameter measurements are ongoing with a R/V on a monthly basis. It is a part of POSEIDON buoy network since 2007.

Table 1. Sensors integrated in E1M3A and Saronicos observatories

| | **E1-M3A** | **Saronicos** | **E1-M3A** | **Saronicos** |
|---|---|---|---|---|
| **Parameter** | **Depths measured (m)** | **Depths measured (m)** | **Sensor(s) used** | **Depths measured (m)** |
| Wind speed/dir., | Surface | Surface | Young x | Young x |
| Air Pressure, | Surface | Surface | Vaisala PTB 220A | Vaisala PTB 220A |
| Air temperature, | Surface | Surface | Omega | Omega |
| Wave Height | Surface | Surface | Fugro OCEANOR Wavesense | Seatex MRU |
| Pyranometer PSP, | Surface | | Eppley | |
| Radiometer PIR, | Surface | | Epply | |
| Relative humidity, | Surface | | Vaisala HMP 45A | |
| Precipitation sensor, | Surface | | Young 50203 | |
| Radiance | Surface | | Satlantic ocr-507-r10w | |

| | | | | |
|---|---|---|---|---|
| Irradiance | Surface | | Satlantic ocr-507-ricsw | |
| SST, SSS surface, | Surface (1m) | Surface (3m) | SBE 37 SIP | Aanderaa 3919A |
| $CO_2$ | Surface (1m) | | CONTROS | |
| Currents | 5-50, 10 bins of 5m | 3 m | Nortek Aquadopp 400 kHz | Nortek Aquadopp 400 kHz |
| Temperature | 20, 50, 75, 100, 250, 400, 600, 1000m | | Seabird 16plus-IMP C-T Seabird 37-IM C-T | |
| Salinity | 20, 50, 75, 100, 250, 400, 600, 1000m | | Seabird 16plus-IMP C-T Seabird 37-IM C-T | |
| Pressure | 250m | | Seabird 37-IM C-T-P | |
| Turbidity | 20, 50, 75, 100m | | Wetlabs flntus-rt | |
| Dissolved Oxygen | 20, 50, 75, 100m | | SBE43 | |
| Chl-a | 20, 50, 75, 100m | | Wetlabs flntus-rt | |
| PAR | 20, 50, 75, 100m | | Licor LI-193 | |
| Sound | | 40m | | PAL |

**Data acquired during 2012-2014**

The Ferry Box operation period at the Piraeus-Crete line started on 19th of June 2012 and ended on 10th of October 2014. During this lifetime, more of 450 transects were performed and 138413 samples were recorded at an approximately 400 days of operation (fig. 2). The sampling rate was set to 60 seconds and most of the data were acquired during 2013 (64.700 records) while due to maintenance of the sensors during 2014 only 20.000 samples were recorded (fig. 3). During the same period the E1-M3A station recorded approximately 3100 3-hourly valid measures. This was due to technical problems and the cut off of the mooring line. For the Saronicos case the data gathered were almost 5000 after a continuous operation between February 2013 and October 2014.

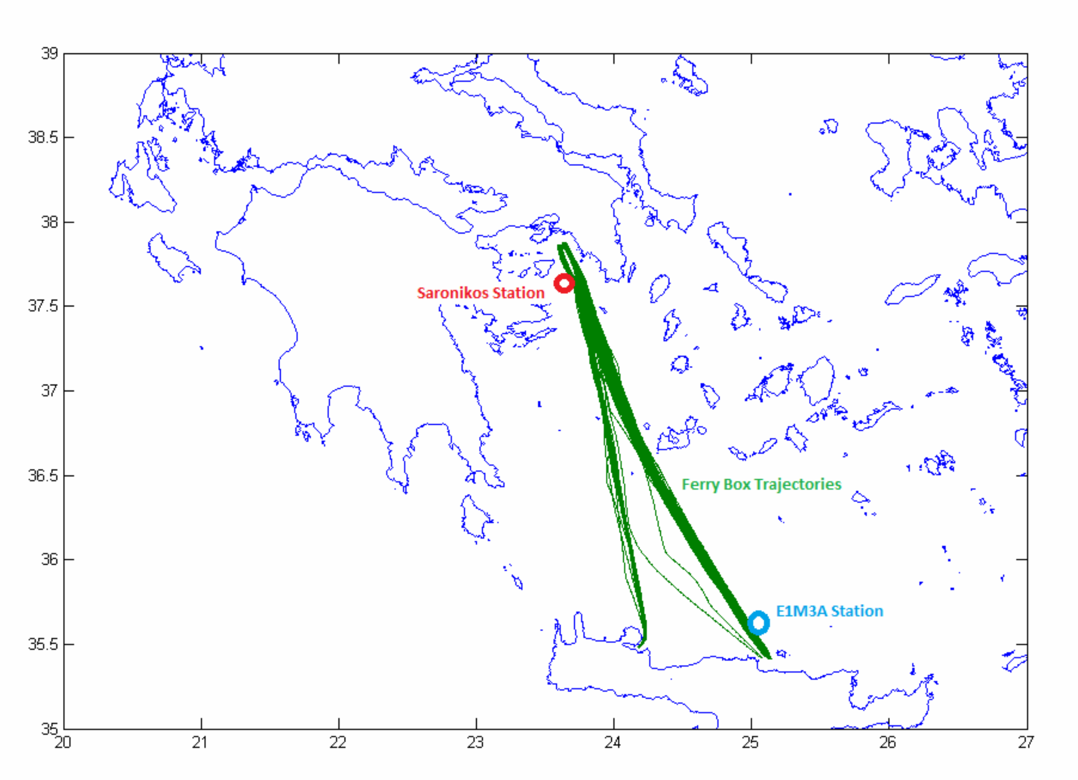



Figure 2. Ferry Box trajectories and POSEIDON Saronicos and E1M3A locations (2012-2014)

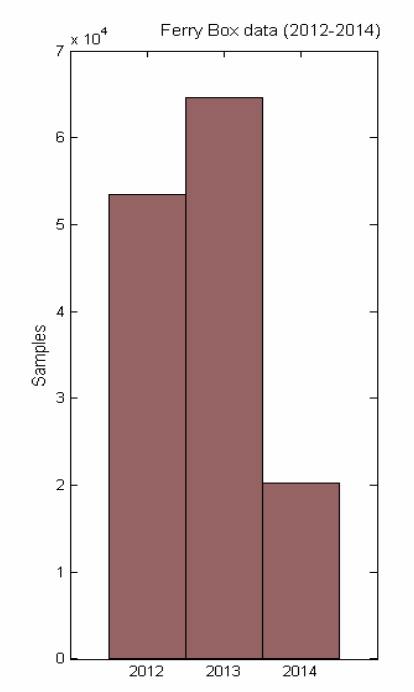
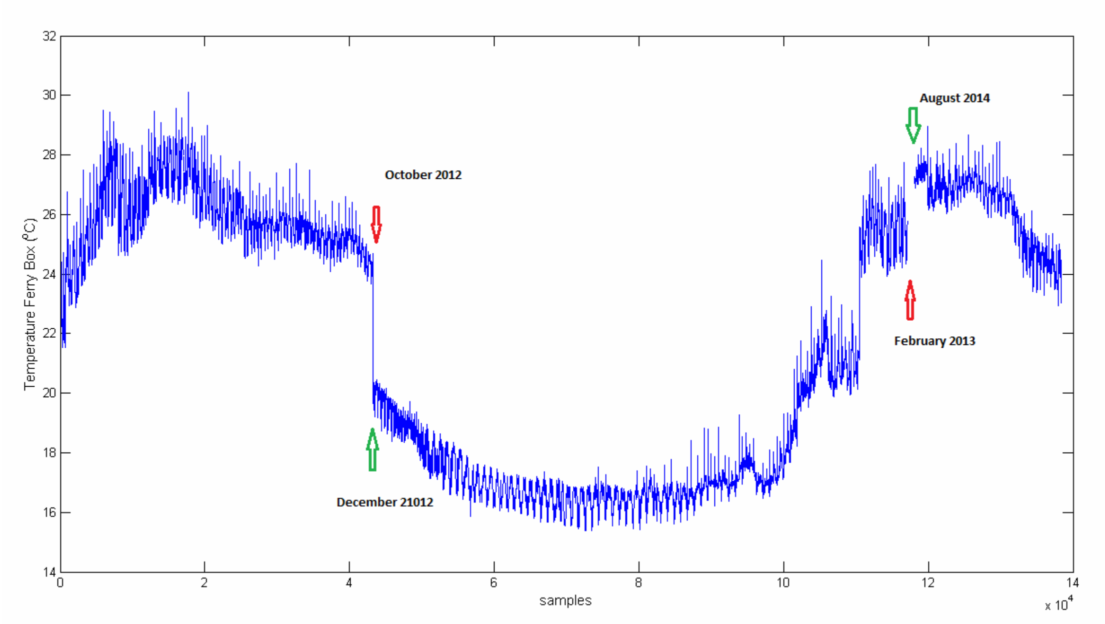



Figure 3. Recorded samples from Ferry Box for the period 2012-2014

Ferry box data present high variability in both temperature and salinity along each transect. Regarding temperature the differences along a single transect reaches 2 $^{o}$C during the warm periods while this span is reduced to less than 1 °C during winter. A maximum temperature of 30.04 °C was recorded in August 2012 and a minimum of 15.4 °C in February 2013. Regarding salinity, the performance of the conductivity sensor seemed to vary while a significant drift of approximately 0.003 psu/transect depicts the biofouling effects on the sensor (fig. 4).



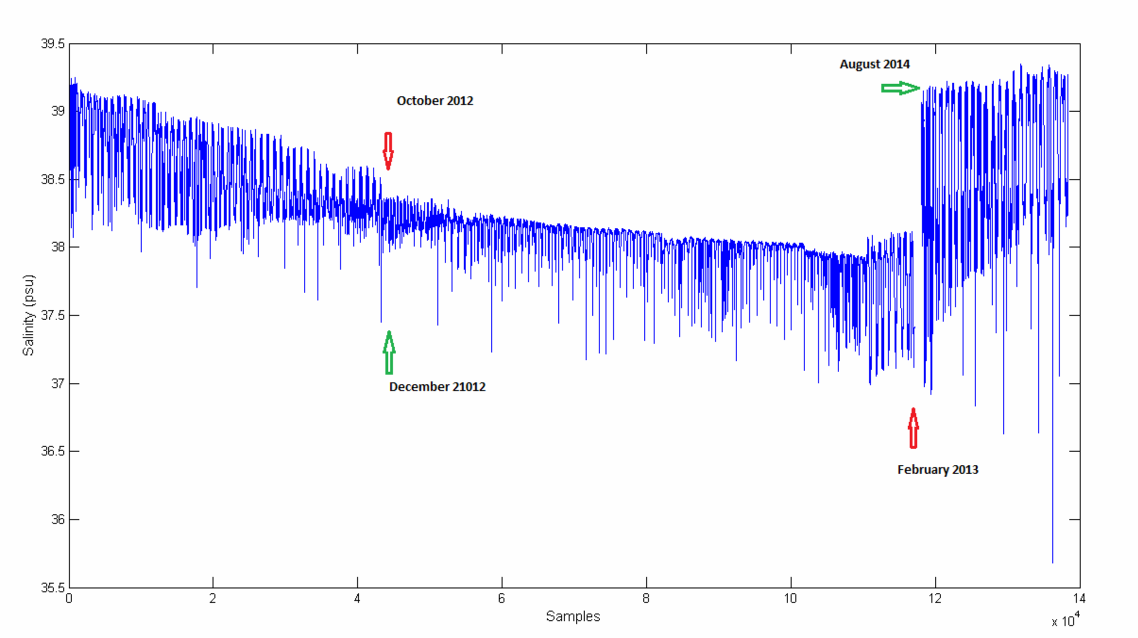




Figure 4. Ferry Box records for temperature (up) and salinity (down) for the period 2/2012- 10/2014.

A data comparison of Ferry Box and the two POSEIDON buoys unfortunately presented a small subset of data for the same time period and geographical position. Records from Ferry Box inside the two geographical areas of 0.2 X 0.2 degrees around the moorings location were extracted and plotted against buoy's timeseries (fig. 5 & 6).

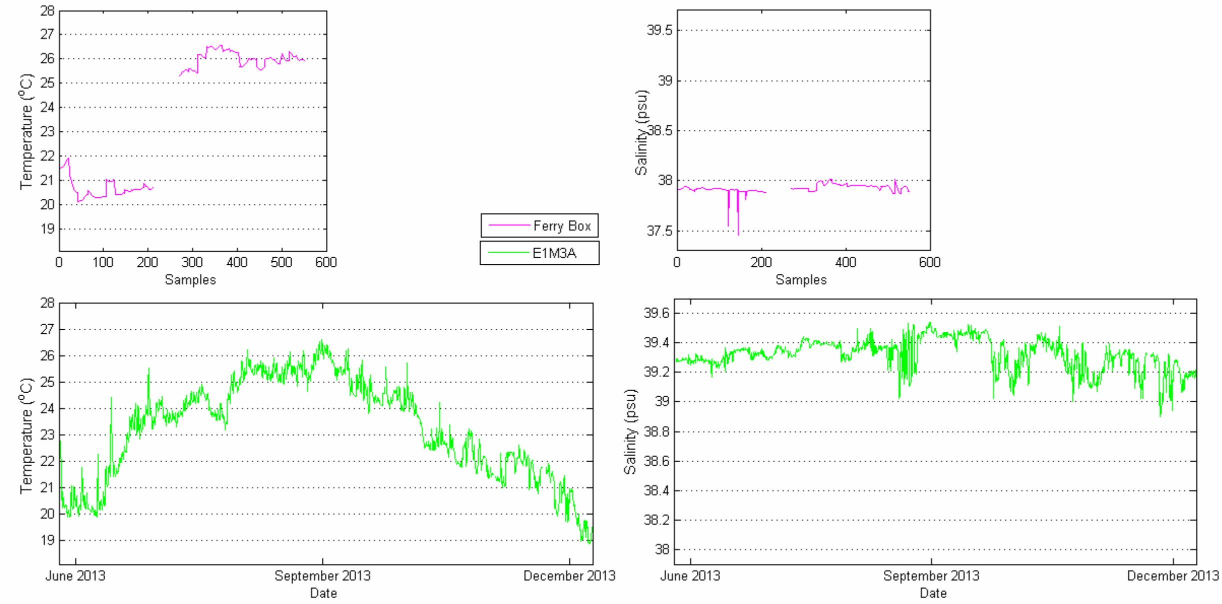



Figure 5. Temperature (left) and Salinity (right) from Ferry Box near E1-M3A site (up) and E1-M3A station (down) for 2013.

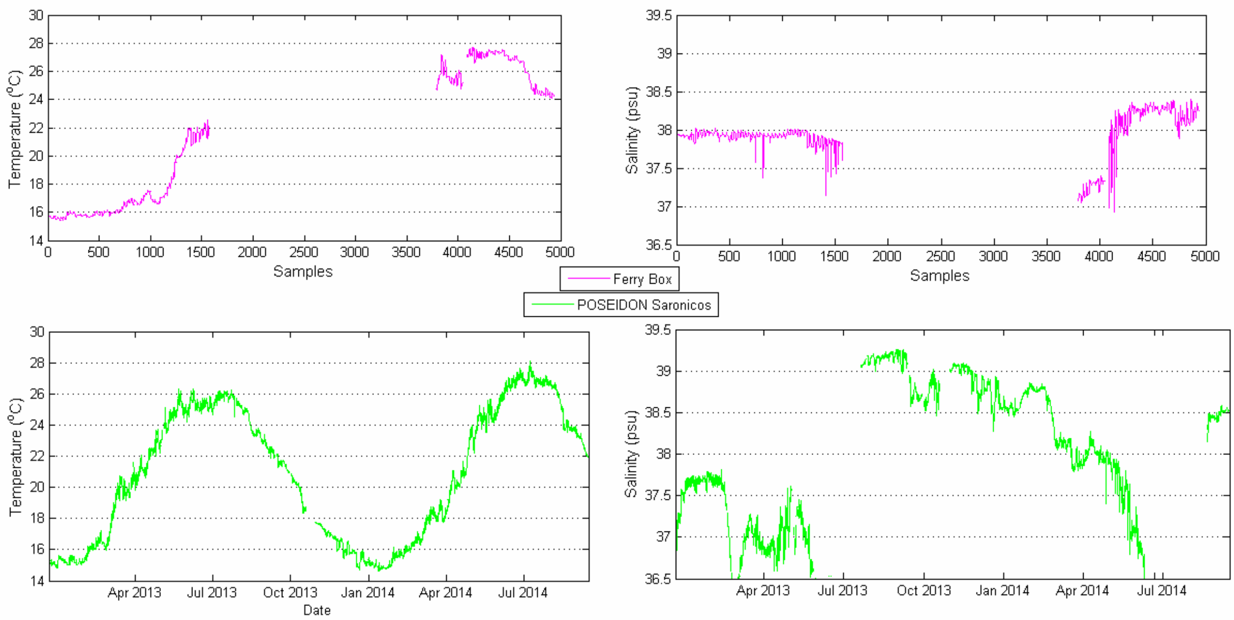



Figure 6. Temperature (left) and Salinity (right) from Ferry Box near Saronicos site (up) and Saronicos station (down) for the period February 2013 – October 2014.

At E1-M3A site, Ferry Box temperature presented a range between 20.14 - 21.93 $^{o}$C during May 2013 and 25.43 - 26.58 $^{o}$C during July – August of the same year while the mooring recorded 19.89 -22.75 $^{o}$C and 24.85 – 26.22 $^{o}$C respectively. Regarding salinity, Ferry Box data show an underestimation of approximately 1.4 psu (<38 psu) compared to buoy data (39.2 – 34.5 psu) possibly due to biofouling on the sensor.

At Saronicos site temperature data from both buoy and Ferry Box depict the surface warming during the spring of 2013 and the warm summer period of 2014 with temperatures ranging from 24.71 - 27.68 °C (Ferry Box) and 24.4 – 28.11 °C (buoy). Regarding salinity the mooring's CT sensor presented extreme low values due to fouling during spring of 2013 and 2014. The only comparable period for the two platforms is at the end of the Ferry Box's operation during the first days of October 2014 when the buoy sensor was changed (Ferry Box 38.04 - 38.4 psu, Saronicos 38.14 - 38.58 psu).

The TS diagrams from both sides present a large density distribution due to the extensive misrepresentation of the salinity field in all cases apart from E1-M3A records (fig 7).

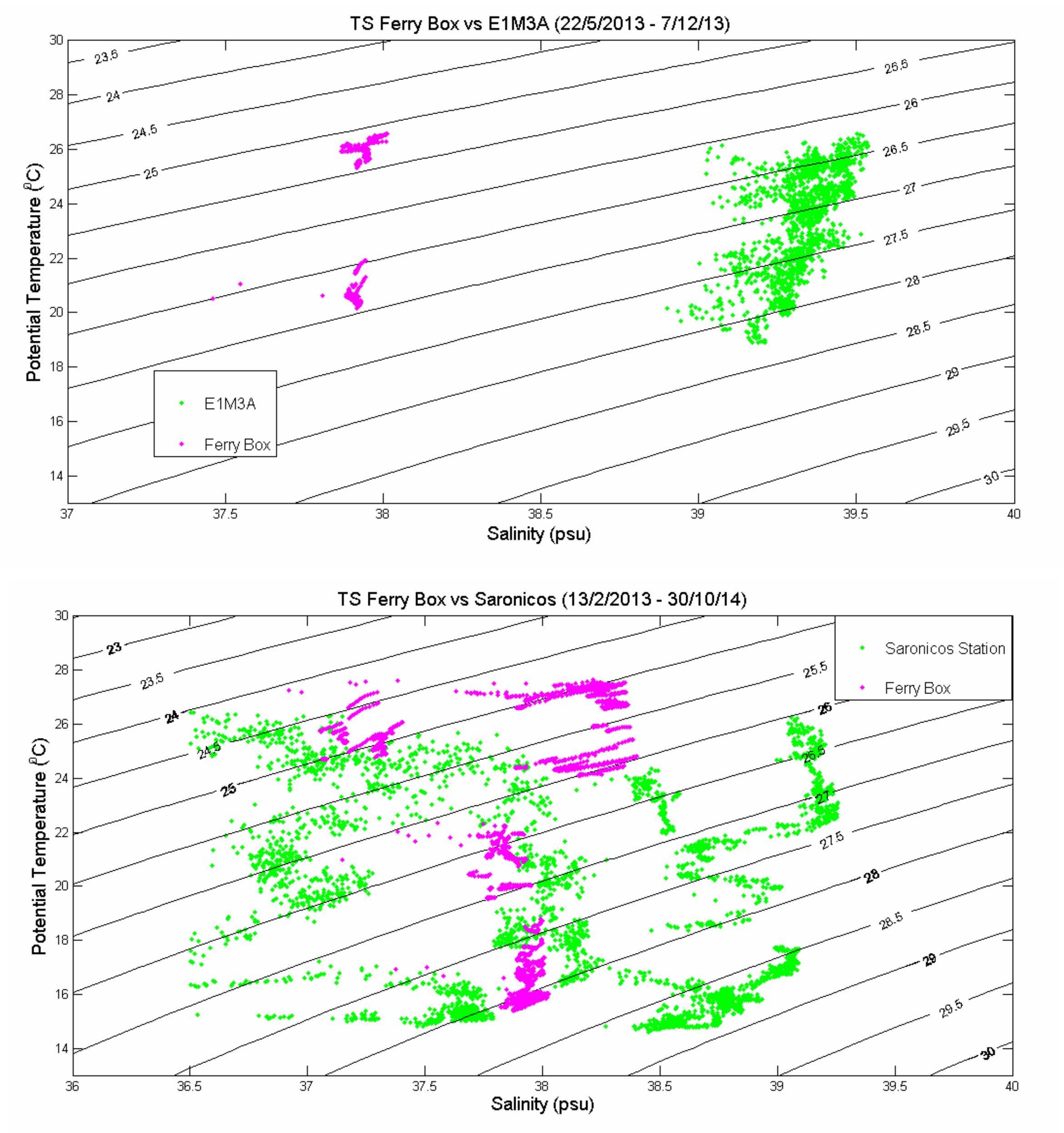



Figure 7. TS diagrams of Ferry Box data at E1-M3A site and E1-M3A timeseries (up) and of Ferry Box data at Saronicos site and Saronicos timeseries (down) for overlapping periods.

*2.3.2 Observing oceanographic conditions in the Skagerrak using an FerryBox-system and an oceanographic buoy (NIVA - SMHI)*

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## Introduction

As part of work package 7 in JERICO a TOP-activity has been carried out in the Skagerrak, eastern part of the North Sea. TOP is an acronym for Targeted Operation Phase. The aim of the activity was to use data from a Ferrybox-system and a co-located oceanographic buoy to give a detailed view of the oceanographic conditions and to compare the data from the two platforms. The study was carried out in year 2014 by SMHI and NIVA.

The physical oceanographic conditions in the Skagerrak area are complex (Fig. 1). In general the water column is strongly stratified with surface conditions influenced by water from the Baltic Sea which is mixed with Atlantic water. Surface salinity may vary from about 20 psu up to 33 psu. The deep water is more stable with salinities at about 33-34 psu. A pycnocline at about 15-20 m depth is found during a large part of the year. A strong seasonal signal is seen in temperature data. There is also a signal in salinity due to riverine input of fresh water. Some years ice is formed. Summer surface temperatures may reach 20 degrees.

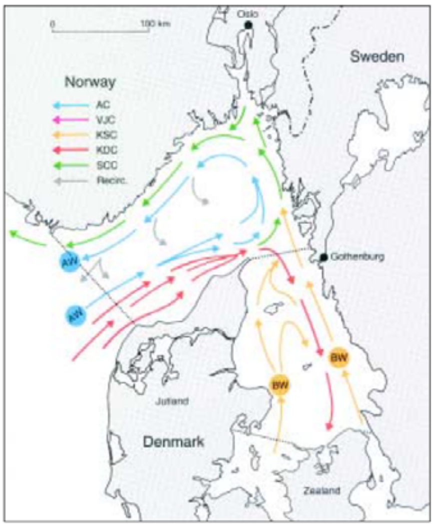


Fig. 1. The map illustrates the main current systems in the Kattegat-Skagerrak. The Väderö buoy is located in the northern part of the Baltic current along the coast of Sweden. Here water from the Jutland current has been mixed with the Baltic current. (Source of map: Anon. 1993).

## The Observing Systems

Between Oslo and Kiel the ferry Color Fantasy crosses the Kattegat, the Skagerrak and the Oslofjord with high repetition. In the eastern Skagerrak the ship passes close to the SMHI operated Väderö buoy every night (northbound) and every evening on the way back from Oslo (southbound). The closest passing to the buoy are on the northbound transects (Fig.2). The Ferrybox system has been in operation for many years in this area. The Ferrybox are equipped with the core sensor for temperature, salinity, Chl. *a* fluorescence and turbidity as well as a water sampling system. The water intake is located at a depth of approximately 4- 5 m. Also more advance carbon system sensors are in operation as well as above water optical sensors. Data are sent to NIVA using internet communication.

The oceanographic buoy was deployed by SMHI at location N 58.4833 E 10.9333. Water depth is approximately 73 m. The buoy has instruments for measuring in water temperature, conductivity, chl. *a* fluorescence and turbidity. ADCP:s are used for measuring currents. Sensors are located at a depth of approximately 1 m. In addition wave parameters are measured, e.g. wave height and direction. In air temperature is also measured. Data is collected continuously and sent to SMHI every hour using satellite communication.

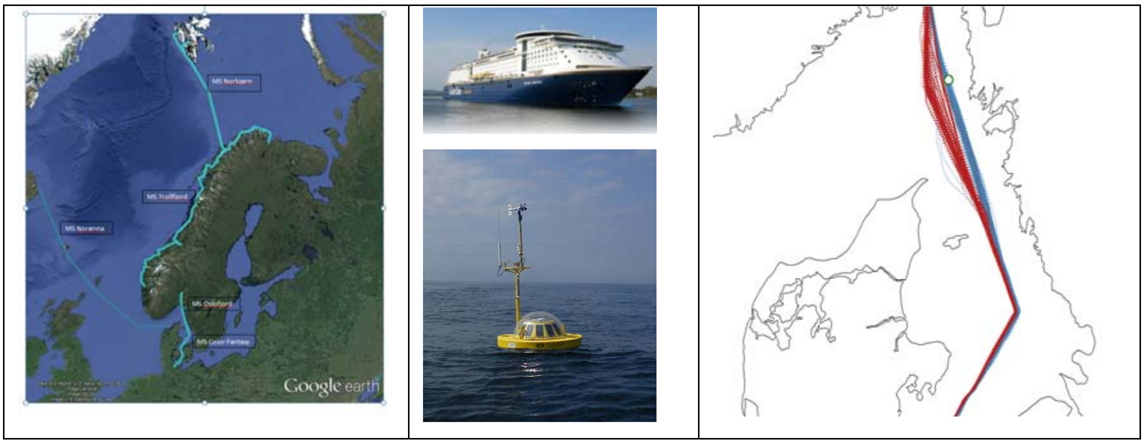


Fig. 2. The NIVA Ferrybox network (left), the Color Fantasy and the SMHI buoy (mid) and the position of the transects (red=southbound, blue=northbound) and the position of the SMHI buoy.

Data acquired during 2014

Figures 3-6) show the Ferrybox data close to the buoy position for both southbound and northbound transects. The ship passes close to the buoy on the northbound transects and further way on the South bound transects. The distance between the two routes are on average 0.25 degrees, approximately 3-4 nautical miles. The time the ship passes the buoy on the southbound track around 17:00 UTC and on the northbound track around 03:00 UTC.

In Fig. 3 the differences in the temperature are illustrated and the differences are as expected small. Unfortunately there was a stop in the operation of the Ferrybox in July due to a pump failure so we were not able to record the summer maximum from the Ferrybox data. The winter minimum occurs in February close to 1 °C.

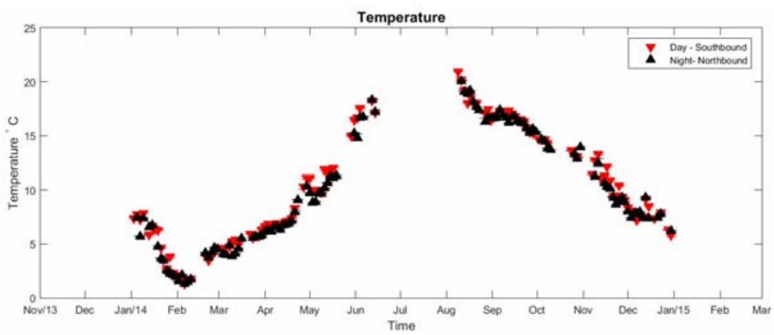


Fig. 3. Ferrybox data showing the difference of south and North bound data of temperature for 2014.

The salinity data illustrated in Fig. 4 show a higher variability between the two position than the temperature. From the data there is an indication that the southbound position has situation with lower saline Baltic water indication another water masses.

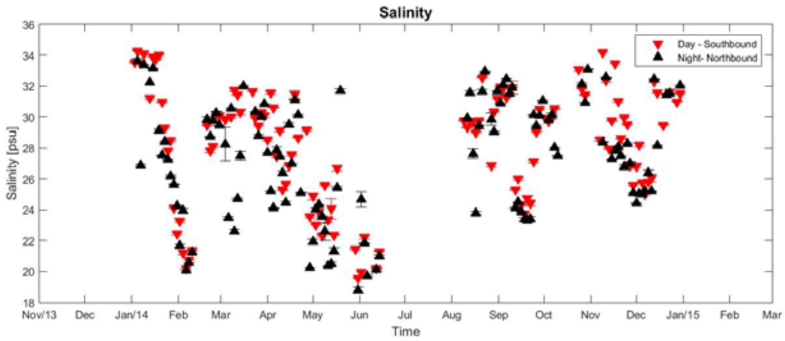


Fig. 4 Ferrybox data showing the difference of south- and northbound data on salinity for 2014.

The difference in Chl. *a* fluorescence (Fig. 5) may be an effect of the night and day variations due to sun induced photoquenching since the night data and specially during the spring bloom show higher value This has been seen that a factor 2-3 can be present due to photosynthetic activity.

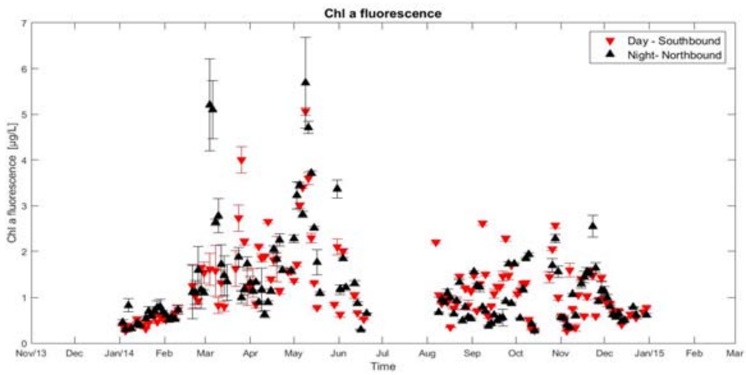


Fig. 5. Ferrybox data showing the difference of south- and north-bound data of Chl. *a* fluorescence in 2014.

To compare the Ferrybox and the buoy data the northbound Ferrybox data are used to remove some of the effects of local patchiness and diurnal variation.

It is also important to note that the sensor on the Ferrybox measures at 4-5 meters depth and that the sensors on the buoy measures at 1 m. Since the water column is strongly stratified during a large part of the year a difference in data is to be expected.

The buoy data presented are night time data, i.e. 2200-0200 Swedish winter time, that is 2100 to 0100 UTC. The night time data is used to minimize the effects of photoquenching on chl. *a* fluorescence.

Temperature and salinity data from the buoy and the Ferrybox are illustrated in Fig.6 and Fig 7. The differences in temperature are very low. Salinity differences are somewhat higher, probably reflecting differences in the surface water or differences between 1 and 4-5 meters depth.

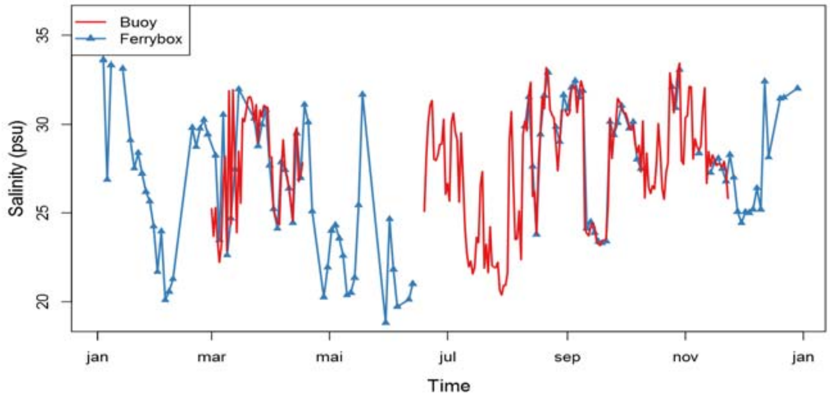


Fig. 6. Time series of salinity from the buoy and Ferrybox-data in 2014.

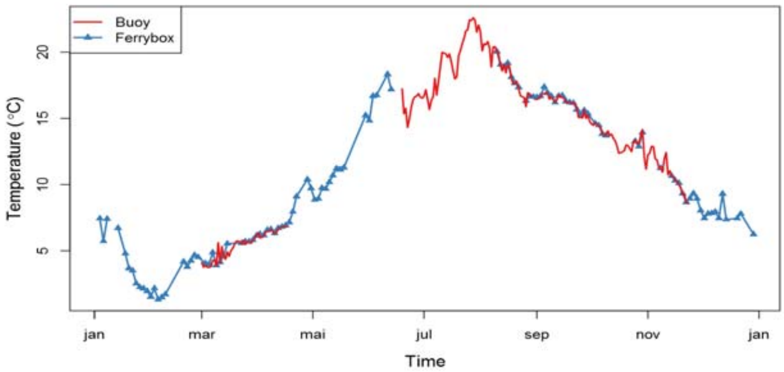


Fig. 7. Time series of water temperature from the buoy and Ferrybox-data in 2014.

The data on Chl. *a* fluorescence show a significant difference (Fig. 8), the data from the buoy showing lower values. The calibrations of the two sensors were not performed in the same manner. The buoy sensor was calibrated at the factory while the Ferrybox sensor was field calibrated using water samples taken onboard the Ferrybox during the year of 2014.

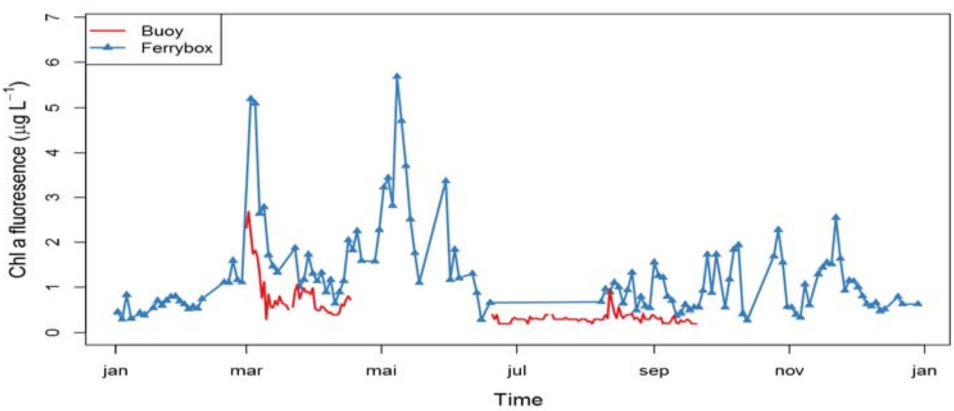

Fig. 8. Timeseries of Chl. *a* fluorescence from the buoy (open circle, 1 m) and Ferrybox data (closed circle, 4m) from 2014.

In the following figures the correlation between the buoy data and the Ferrybox data are plotted. For salinity and temperature buoy data is from the same time as the passage of the ship with the Ferrybox while for chl. *a* fluorescence data from around midnight is used to minimize effects of photoquenching.

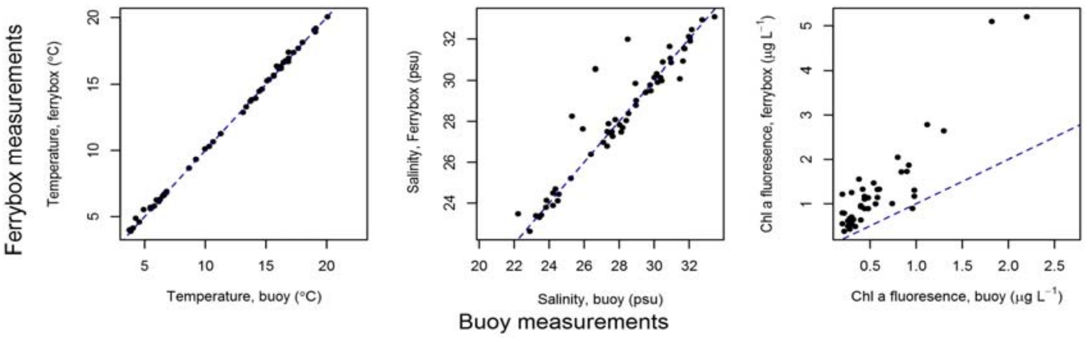


Fig. 9 Scatterplots of temperature, salinity and chl. *a* fluorescence from the Ferrybox Color Fantasy and the SMHI buoy.

In the following graphs we have extracted Ferrybox data from the northbound track- from +/- 5 nm North and South of the buoy position to investigate at the spatial variability over during five days in March 2014. These data are compared to buoy data from the time of the passing of the ferry (from 1 hr before to 1 hr after), except in the case of chl. *a* fluorescence where we used buoy data from midnight (21:00 to 01:00 UTC).

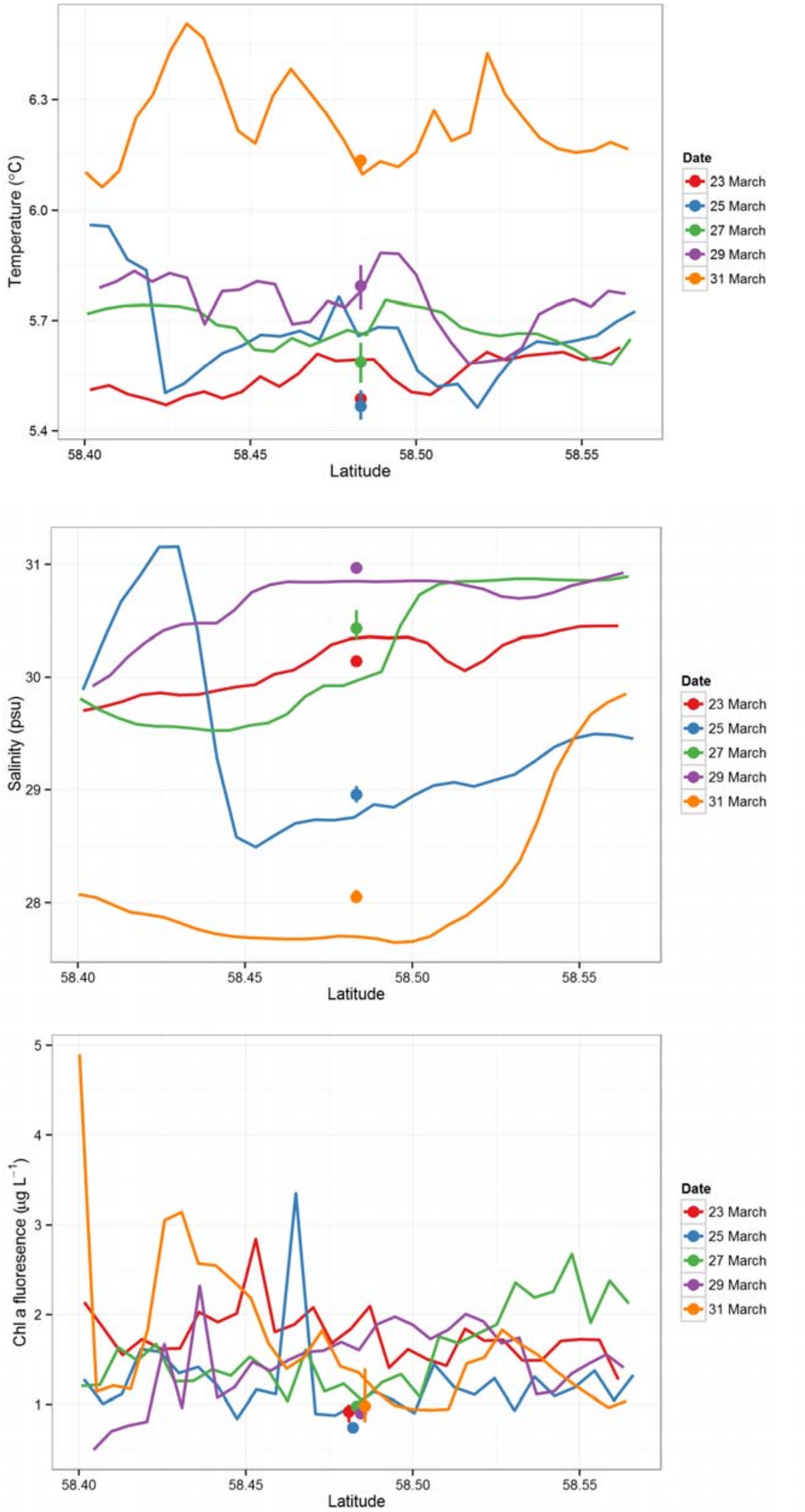


Fig. 10. Spatial variability in the Ferrybox data. The lines show temperature (upper), Salinity (mid) and Chl. *a* fluorescence (lower) data for a 10 nm stretch from Color Fantasy (5 nm N and S of the buoy) for each of 5

days. Buoy data from the time of passage +/- one hour are shown as dots (mean) with a line range (min-max). For chl. *a* fluorescence, the buoy symbols are slightly shifted horizontally to separate the days.

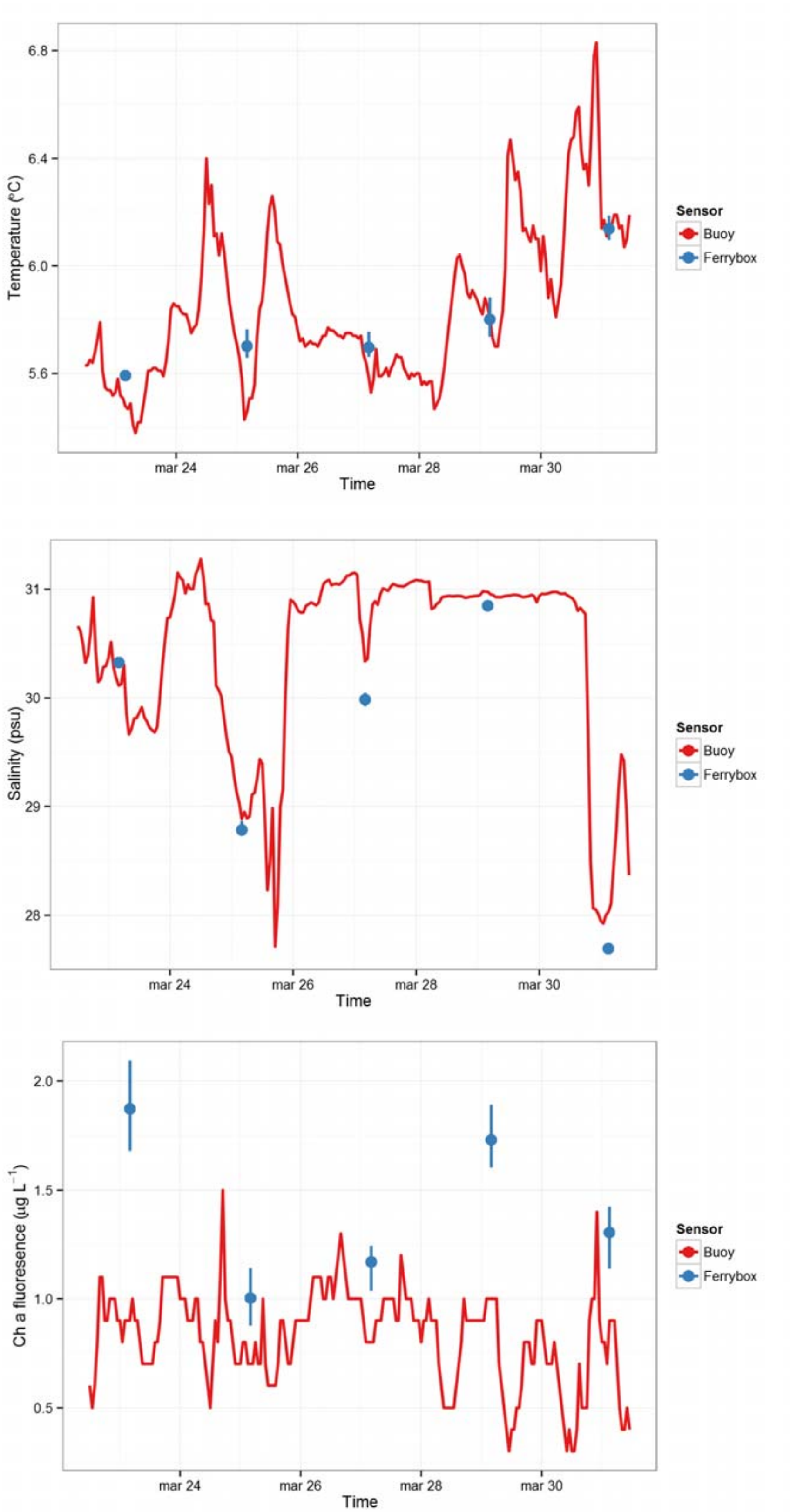

Fig. 11. Temporal variability in the buoy data. Data are shown for 10 days (5 passings of the Ferrybox). The Ferrybox data shows the mean (dots) and range (lines) for a 1 nm stretch centered on the latitude of the buoy.

## Discussion and conclusions

The Ferrybox data include most of year 2014 with a gap from late June to early August. The spring bloom in March is evident in the dataset and a second algal bloom in early May was also detected. The buoy was deployed at the end of the spring bloom and removed before the May bloom. It was re-deployed in late May and provided data until the mid November, however the data from the sensor for chl. *a* fluorescence was not usable from 20 Sep. onwards due to biofouling.

The buoy data and the Ferrybox data are very similar for temperature. Salinity show larger differences, probably reflecting variability in the sea due to the distance between the buoy and the route of the ship and the different depths (1 and 4-5 m) where data was collected. Data on chlorophyll *a* fluorescence show a larger difference. The main reason is that the instruments used were calibrated in different ways. Another reason is the patchy distribution of phytoplankton in the sea and the different depth that can effect the Chl *a* fluorescence more that the temperature and salinity.

The small scale (10 nautical miles) horizontal variability was investigated in March using the Ferrybox data. For salinity the maximum variability was 2-3 psu within 10 nm, for temperature it was approximately 0.5 °C reflecting variability in the surface water. Chlorophyll a fluorescence showed a larger variability reflecting patchiness in phytoplankton distribution.

Buoy data and Ferrybox data was used to investigate small scale temporal variability during a 10 day period in March. The buoy data and the Ferrybox data were well correlated for temperature and salinity. Maximum variability in temperature in 24 hours was approximately 1 °C, for salinity it was approximately 3 psu. Chlorophyll *a* fluorescence from the buoy showed a diurnal variability, night time data is roughly 2 times higher than day time data.

In conclusion the Ferrybox and the buoy produce complimentary data. The Ferrybox system provide high frequency data from a large sea area while the buoy provide even higher frequency data from a single point. Buoys may collect data from several depths may be collected. The importance of consistent calibration of instrument was highlighted and also the importance of a regular service program for buoys. The data from bio-optical sensors on the buoy was useless after a 3 month deployment although an anti-fouling device (copper shutter) was mounted.