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Pride of Bilbao FerryBox 2005
- an overview of the data obtained
and improvements in procedures

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ABSTRACT

The collection of high quality, long term data from diverse environments is required if the interplay of the complex factors affecting phytoplankton bloom development is to be investigated. With this in mind the English Channel and Bay of Biscay between Portsmouth and Bilbao has been intensively monitored starting in 2002.

In 2005 the 'FerryBox' suite of sensors measured temperature, salinity, fluorescence, oxygen and turbidity. The data are merged with position and can be viewed in real time at http://www.noc.soton.ac.uk/ops. The ferry travels between Portsmouth and Bilbao completing a round trip every 3 days; measurements in water pumped in from 5 metres depth provide data which are collected every second. In 2005 the 'FerryBox' methods were improved to reduce the affects of bio fouling on the sensors; the sensors were systematically cleaned weekly and sensor calibrations made from samples collected during monthly ferry crossings. These showed that the fluorescence and oxygen sensors were stable and a high quality dataset was produced. Calibration of the fluorescence sensor was monitored using extracted chlorophyll suspended in solid Perspex blocks. The 'FerryBox' dataset has been mapped against time and latitude to show the occurrence of phytoplankton blooms, using fluorescence, along with calculations of oxygen anomaly. Such continuous monitoring allows us to pinpoint the timings of phytoplankton bloom initiation and duration. The detailed data from the FerryBox allows the occurrence of these blooms to be correlated with other changes in the oceanic system, such as tidal energy, light and fresh water run off.

The methods used to process the data from the initial raw 1Hz ASCII files through to the quality controlled 5 minute set are documented together with the post processing resolution of system faults that caused errors in the measured salinity. The quality controlled data are archived as 5 minute averages and are held by the British Oceanographic Data Centre (BODC).

KEYWORDS

Data aquisition and processing, Bay of Biscay, English channel, Plankton Blooms, FerryBox, Monitoring, Time Series

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1.0 Aims and Objectives

The FerryBox system consists of a suite of sensors which make high frequency (1Hz) measurements of conductivity, temperature, pressure (from which salinity can be derived), fluorescence (CTDF), oxygen and turbidity. It is fitted in the engine room of a ferry that operates between Portsmouth, UK and Bilbao, Spain. The round trip is competed every 3 days. Water for the ship's refridgeration cooling system enters via a 3.5 cubic metre sea chest. It is pumped at about 40 cubic metres per minute through the system, so the refresh rate of the sea chest is of the order of 7 minutes. Water for the FerryBox system is diverted from the ferry's pump room cooling water inlet, passes through housings containing the sensors and out to the pump room cooling outlet. The pressure drop across the ship's cooling system maintains a constant flow across the sensor heads. The sensors transmit data, which are collected by a logging system. A subset of these data are sent via an Iridium Satellite link and displayed on the website http://www.noc.soton.ac.uk/ops/ferrybox_index.php The full data set is written to a flash card and this is collected periodically, it is then calibrated, quality controlled, reduced to five minute averages and these are ultimately archived at the British Oceanographic Data Centre (BODC).

There has been a FerryBox system installed onboard the Pride of Bilbao ferry (P & O Ltd) since 2002 and the experience gained in previous years has highlighted that regular cleaning of the system was essential. Hence the 2005 Pride of Bilbao dataset benefits from rigorous sensor cleaning and frequent calibration crossings. Improved monitoring of the Fluorescence sensor stability was achieved by using solid-state calibration blocks for the first time in 2005. In addition, new methods of data processing were developed. The instrumentation and measurement methodology of the FerryBox system have evolved with time, as has the use of calibration samples to control the quality of the returned data. This document sets out to provide an outline of the data collected, the procedures that were applied in processing the information-including calibration and quality control-and to highlight changes and improvements that were made during 2005. Local copies of data files are kept online at the NOC, for the file locations see the section named File descriptions and location.

2.0 List of jobs in order carried out

The following list gives a broad overview of the tasks that were employed to generate a calibrated and manageable data set from the large volume of information gathered by the Pride of Bilbao ferrybox.

2.1 Sensor Maintenance

The ferrybox system was regularly checked and cleaned nominally every 10 days, but usually more frequently. Cleaning dates and corresponding day numbers are shown in the table below. The flowchart in the section Servicing on ferry provides an overview of the proceedure followed during a cleaning visit, notes were logged to a spreadsheet, an example of which is given in the section Cleaning spreadsheet example. Cleaning dates and their corresponding day numbers are listed below.

Date	day	Date	day	Date	day	Date	day
04/02/2005	35	20/04/2005	111	16/06/2005	167	21/08/2005	233
22/02/2005	53	29/04/2005	119	25/06/2005	176	30/08/2005	242
03/03/2005	62	05/05/2005	125	04/07/2005	185	05/09/2005	248
09/03/2005	68	11/05/2005	131	07/07/2005	188	14/09/2005	257
12/03/2005	71	14/05/2005	134	16/07/2005	197	20/09/2005	263
18/03/2005	77	21/05/2005	141	19/07/2005	200	26/09/2005	269
05/04/2005	95	30/05/2005	150	28/07/2005	209	11/10/2005	284
11/04/2005	101	07/06/2005	158	03/08/2005	215		
14/04/2005	104	13/06/2005	164	12/08/2005	224		

2.2 Calibration of Sensor data

The FerryBox 1 Hz salinity and oxygen measurements were corroborated by the collection of samples (chlorophyll-a, salinity and oxygen) that were analysed in stable laboratory conditions. A total of 7 calibration crossings were made during 2005; a list of the crossing dates and corresponding day numbers is given in the following table.

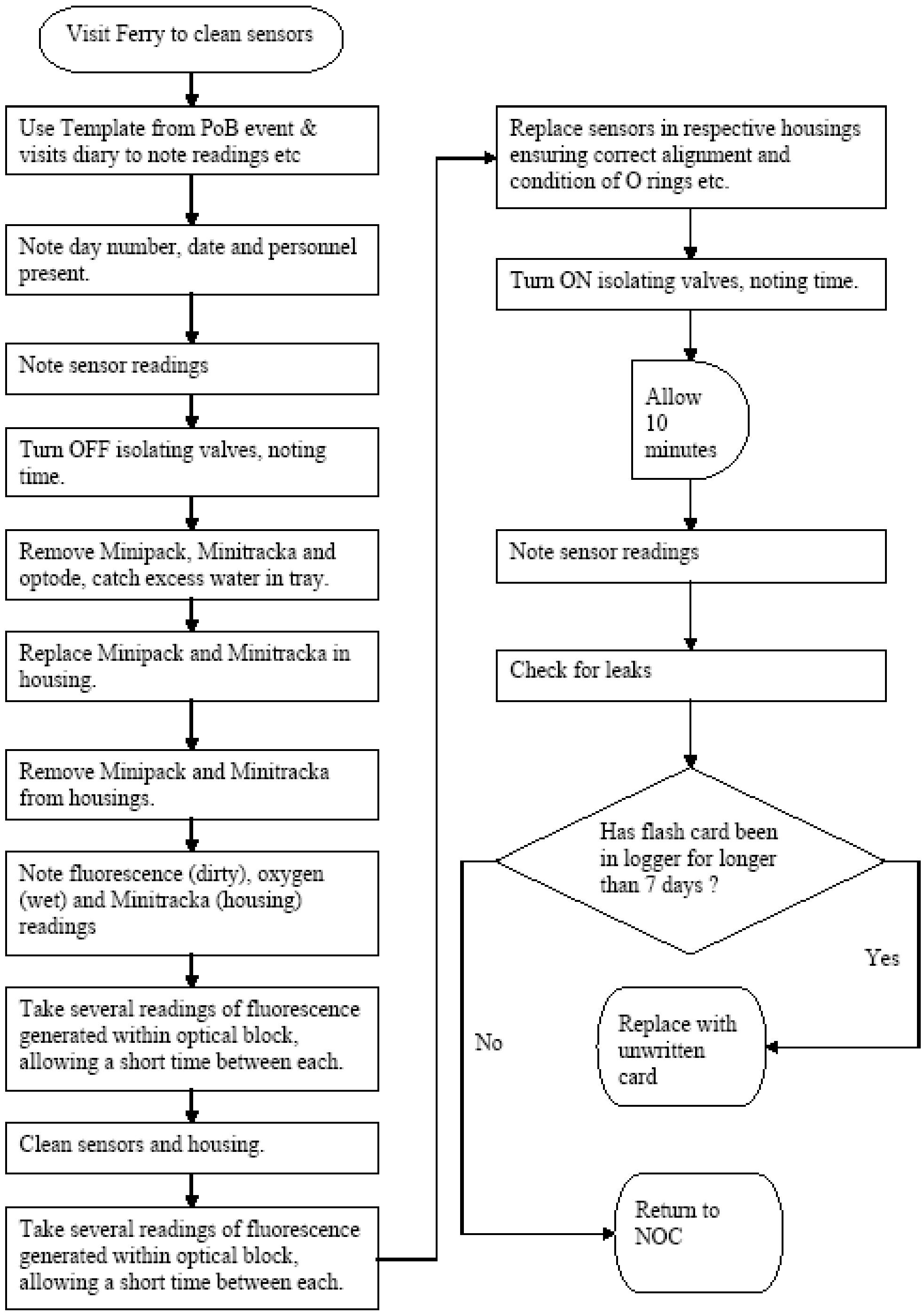
Start Date	day	End Date	day
22/02/2005	53	25/02/2005	56
09/03/2005	68	12/03/2005	71
11/04/2005	101	14/04/2005	104
11/05/2005	131	14/05/2005	134
13/06/2005	164	16/06/2005	167
26/09/2005	269	29/09/2005	272
13/12/2005	347	16/12/2005	350

2.3 Archival of processed data

The quality controlled 1Hz data were averaged to 5 minute values that were written along with their respective metadata to ASCII text files in a documented format. The archived data were ultimately lodged with the British Oceanographic Data Centre (BODC).

3.0 Servicing on ferry

3.1 Task Flowchart



3.2 Examples of forms filled in

Examples of the following documents can be found in Section 11.

CTG calibration sheets were used to maintain a record of the calibrations of the core sensors that form part of the FerryBox system. They include one page per sensor showing the regression results obtained from any comparison of the calibration samples to the 5 minute averaged values that were logged by the FerryBox system. Also included is a page showing the dates of the latest manufacturer's calibration of the instruments. An example of such a form is given in section 11.3. In practise the regressions included the salinity and fluorescence.

PoB event & visits diary section 11.4 and Pride of Bilbao Diary section 11.5 were updated regularly to keep log of what happened when.

A Cleaning Spreadsheet was completed each time that the FerryBox system was serviced; they include any checks that were made on the instruments before and after cleaning and noted the condition and cleanliness of the sensors. The location of these files is given in section 10.0.

4.0 Data collection and manipulation

4.1 "From_Mark files"

The file 'Crossing data 2005.xls' contains the values that were used for the calibration of the salinity, dissolved oxygen and fluorescence measurements. Samples collected during the 7 calibration crossings during 2005 required contemporaneous FerryBox data to be logged. The comparative sample data can then be regressed against the logged data values. For each of the water samples taken the FerryBox data are extracted on the basis of the samples' timestamp. The timestamp is noted at the time of sampling and the data from all the instruments that fall within a 2.5 minute window of this time are then averaged to a single value per parameter. The 5 minute averaged data are then assembled into a Microsoft Excel spreadsheet alongside the sample ID and an event number that is made up from the year (2005), crossing number (08) and sample number (039) for example, 200508.039. The location of the calibration crossing files can be found in the section File descriptions and location

4.2 Concatenated files – 5 minute

The 1Hz ASCII data files are too large to be handled conveniently by current desktop PC technology, thus these data are concatenated, flagged for outliers and averaged into five minute intervals so that the final file sizes are more manageable. From inspection of the two data frequencies it seems that little information is lost in this process as the magnitude of the changes in the oceanic parameters are generally smaller or of the order of the of the instrumentation resolution. The ferry speed is generally 20 knots, yielding a separation in data points of just over 3 km.

4.3 Raw data file structure.

A physical description of the logging and telemetry systems are available in the document P of B Ferry Box Manual. Instructions for the construction of the ASCII files that form the initial files for these processing stages can be found in the section Data processing from Flash card to ASCII or in the document, Pride of Bilbao Data Processing 7 March 2005. The format of these ASCII files and their corresponding variables are contained in the section ASCII data format and corresponding Matlab variables

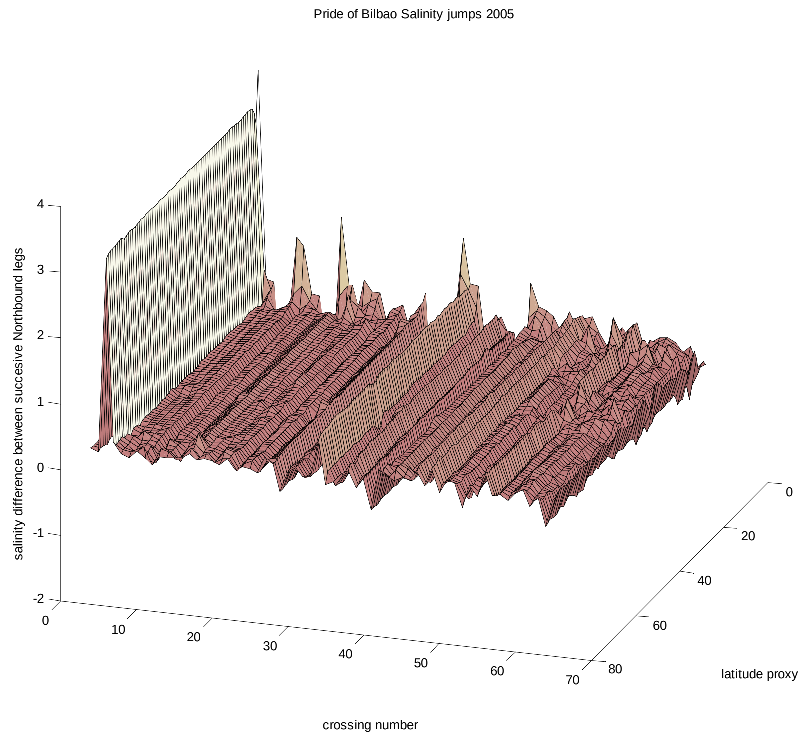
5.0 Processing and procedures developed and applied to calibrate salinity data

5.1 Introduction

In February 2005 a newly calibrated sensor was fitted into the FerryBox flow through housing. In an attempt to improve upon the accuracy of previous years' salinity measurements being made by the Minipack CTDF, a 'stand off' block was fabricated and screwed to the top of the fluorimeter sensor housing. This block was designed to ensure that when the Minipack was pushed into its housing it would remain a fixed distance from the end of the housing. In addition, orientation marks on the circumference of the Minipack and on its housing ensured that the rotational position of the sensors remained constant. Together, these two arrangements were deemed to be sufficient to maintain an invariant relative position of the instrument within its housing. However, it was discovered when comparing the bottle calibration samples against the corresponding data gathered by the instrumentation that there were substantial discrepancies between successive calibration crossings. Initially it was thought that the salinity jumps were caused by displacement of the conductivity cell within the confines of the housing. Although the stand off block restricted the depth to which the sensor pack could be pushed into the housing, the sensor pack was still able to rock about this new pivot within the flow through housing. In the latter part of the year it was discovered by replacing the Minipack with an identical unit and then later reinstalling the original that the discontinuities in the salinity were more probably being generated within the electronics of the instrument itself although there seemed to be no clear resolution to the problem of the shifts in salinity from using the calibration data alone. The decision was made to perform a graphical analysis of the salinity data in order to determine where and when any step changes or drifts may be occuring.

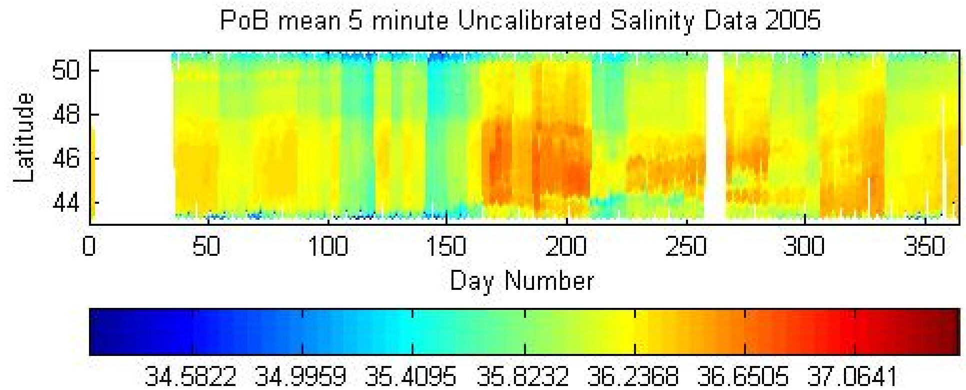
5.2 Identifying jumps in the salinity signal

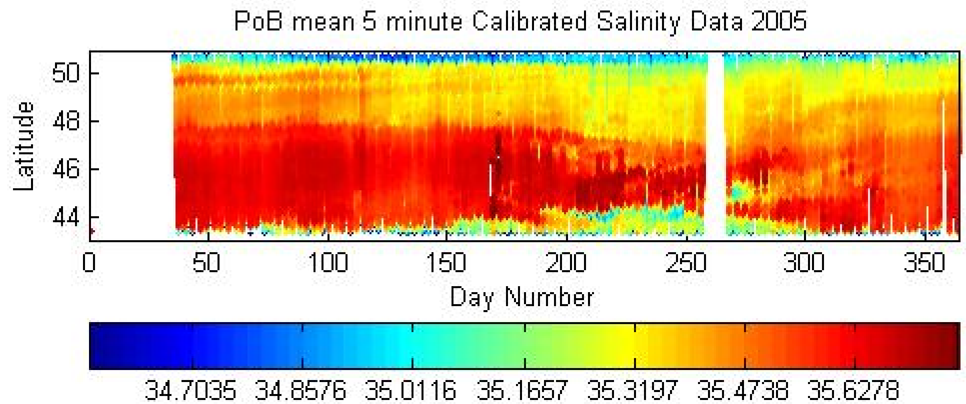
The Pride of Bilbao when bound for Portsmouth has a course that is more consistent between succesive crossings than during its Southbound leg where whale watching excursions are more common. It is for this reason that initially the salinity data from the North bound legs of the ships track were chosen for graphical comparison (although latterly both North and Southbound legs had to be analysed in order to determine where the salinity jumps actually occured). Conductivity, temperature, ship's position and derived salinity data were plotted with consistent scaling so that two consecutive North bound crossings were displayed in different colours, an example of the inter leg salinity comparison is shown in Nothbound and Southbound comparison plots. The comparisons provided evidence of offsets in the salinity data between one leg and the next over large regions (typically > 3 degrees latitude) oftentimes over the majority of the crossing. A representation of these offsets is made in the diagram below.



It appeared that the salinity variable calculated from the Minipack CTD data could be subject to spontaneous variations that ranged in magnitude to 0.5 PSU.

The existence of large offsets throughout the 2005 salinity data set meant that a method of salvage was needed to recover meaningful information from the salinity data. From 2003 and 2004 data it was seen that the salinity around the region 45 to 45.0N remained fairly constant at 35.62 +/- 0.05. The 2005 data from this region was extracted and plotted against time and this information used in conjunction with the North and Southbound comparison plots to determine the timings of their occurence. The salinity difference between succesive north bound transects was determined directly from measurements of the comparison plots; these were based on up to 3 points per transect. These differences were tabulated against the times that they occurred. The regular calibration crossing data was used as a foundation onto which the salinity jumps could be compared. From this technique a table of saliniity corrections was constructed and subsequently applied to the data set (See section Salinity Calibration Table). An overview of the method of graphically identifying the salinity jumps is laid out in the flowchart in section 11.10. The corrected and uncorrected data are shown below for comparison.





5.3 Position change or instrument instability?

Through graphical analysis of the CTD data that were extracted from where the ship was docked in Portsmouth corroboration was found for the Minipack position change theory, that is step changes in salinity were occurring during the cleaning episodes. While the ship was docked in Portsmouth the FerryBox would routinely be serviced, requiring the CTDF unit to be removed, cleaned and replaced in its housing. Although the sensor was fitted with a positioning block that should have maintained the unit in the same relative position to its housing, in practice, when the instrument securing ring was tightened over the O-ring that seals around the Miniipack housing it a small tilt of the unit within its housing could occur. This movement may have affected the salinity measured as the conductivity measurement is sensitive to changes in the volume and shape of the water surrounding the sensor. Another possibility for the offsets may lie within the stability of the instrument itself. To check the response of the instrument with respect to its housing insertion depth, the instrument was driven in and out of the housing using a combination of water pressure in the housing and the instrument retaining nuts, noting the timestamps corresponding to the position changes. The salinity could be later calculated from the logged conductivity, temperature and pressure. A similar procedure was undertaken with another Minipack unit at NOC. More detail can be found in section 11.3. The results show that with the Minpack fully inserted into the flow-through housing a movement of 1mm away from the end of the housing will create an apparent change in the salinity of 0.1, this is equivalent to 1/3 of a rotation of the retaining bolts. Quantitative evaluation of the volume change due to the rock of the instrument was not an easy proposition but it is possible that the associated salinity errors could be as big as 0.1. This is not large enough to account for some of the greater errors of 0.5 that were noted. It is probable that instrument instability is to blame for these.

6.0 Overview of the Data Obtained in 2005

6.1 Background

The Pride of Bilbao FerryBox has been collecting data since spring 2002 across the Bay of Biscay and the English channel between Portsmouth and Bilbao. It has been particularly successful in mapping the way that the position of blooms shift in the bay. Measurements of fluorescence are used to make in-situ estimates of phytoplankton biomass. The measurements are subject to considerable uncertainties: changes in taxa, size and physiological state of the organisms as well as photo-quenching due ambient light field variation. However, once a link has been established between in-situ fluorescence measurements and water sample chlorophyll concentrations, fluorescence measurements have proven invaluable for the estimation of biomass variability.

6.2 Salinity

Salinity is calculated using the UNESCO 1983 polynomial from the FerryBox conductivity, temperature and pressure that are measured by a Minipack CTD, these values are corrected for offsets and calibrated using the bottle samples that are collected during the monthly calibration crossings. The bottle samples are measured using a Guildline Autosal salinometer located in a dedicated air conditioned laboratory at NOC.

The five minute averaged data have been plotted in Figure 1.

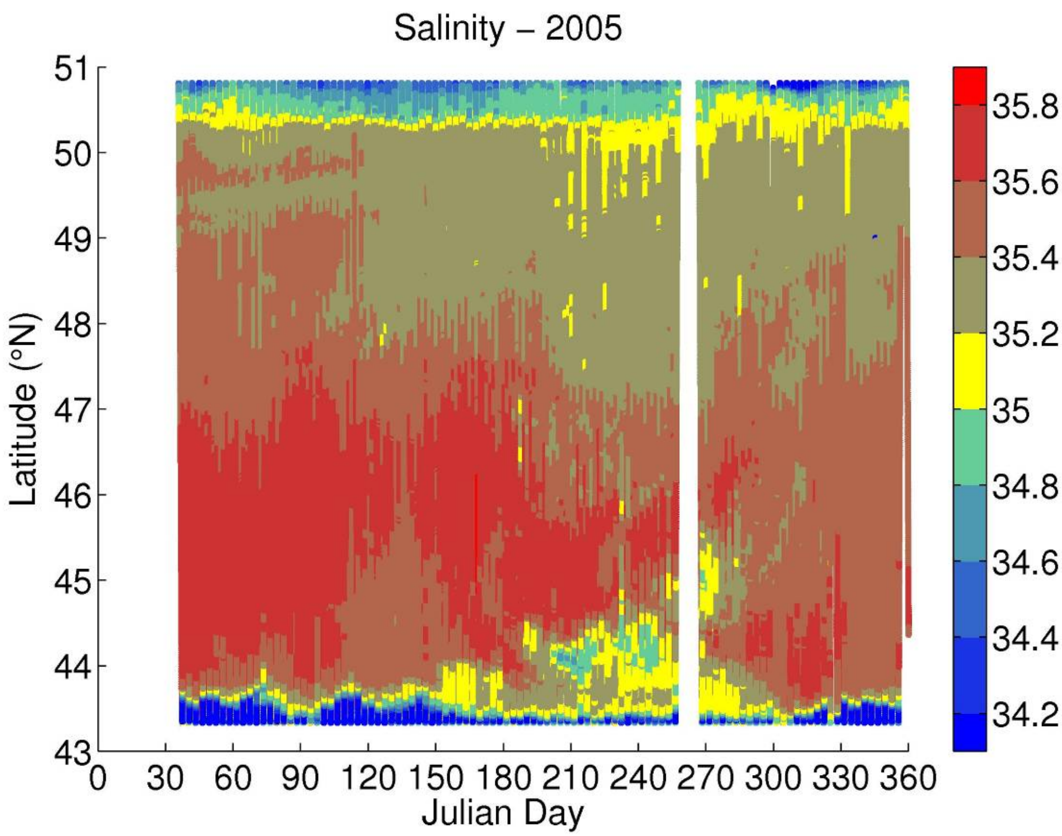


Figure 1 Salinity data

6.3 Water temperature

There are three sensors in the FerryBox system that measure temperature, they are the platinum resistance thermometer of the Minipack CTDF and the thermistors of the Seabird 48 hull temperature sensor and of the Aanderaa oxygen optode. The hull sensor provides the most accurate measurement of the in-situ water temperature whilst the ship is underway, the Minipack temperature is used in the calculation of salinity and the optode temperature is used to correct the measurement of oxygen concentration. The relationship between the temperature measurements is complicated but can be summarised as follows. The mean temperature difference between the CTD and hull sensors for the year based on five minute averaged data is 0.26 ºC with a standard deviation (n-1) of 0.35 ºC. The corresponding mean temperature difference between the optode measurement and the hull sensor is 0.44 ºC with a standard deviation (n-1) of 0.34 ºC. These differences are primarily a function of the water being warmed by the internal environment of the ship as it passes in turn by the hull, through the sea chest and pipe work, past the CTD and then past the optode within its separate housing. Based on the fortnightly averages that are shown in figure 2 the following can be noted; after day 300 the optode measurement is lower than the CTD whereas the optode-hull difference stays more or less constant, indicating that between days 270 and 315 the Minipack calibration may have altered and remained so during November and December. Figure 3 shows the 5 minute averaged FerryBox temperature data obtained from the Minipack.

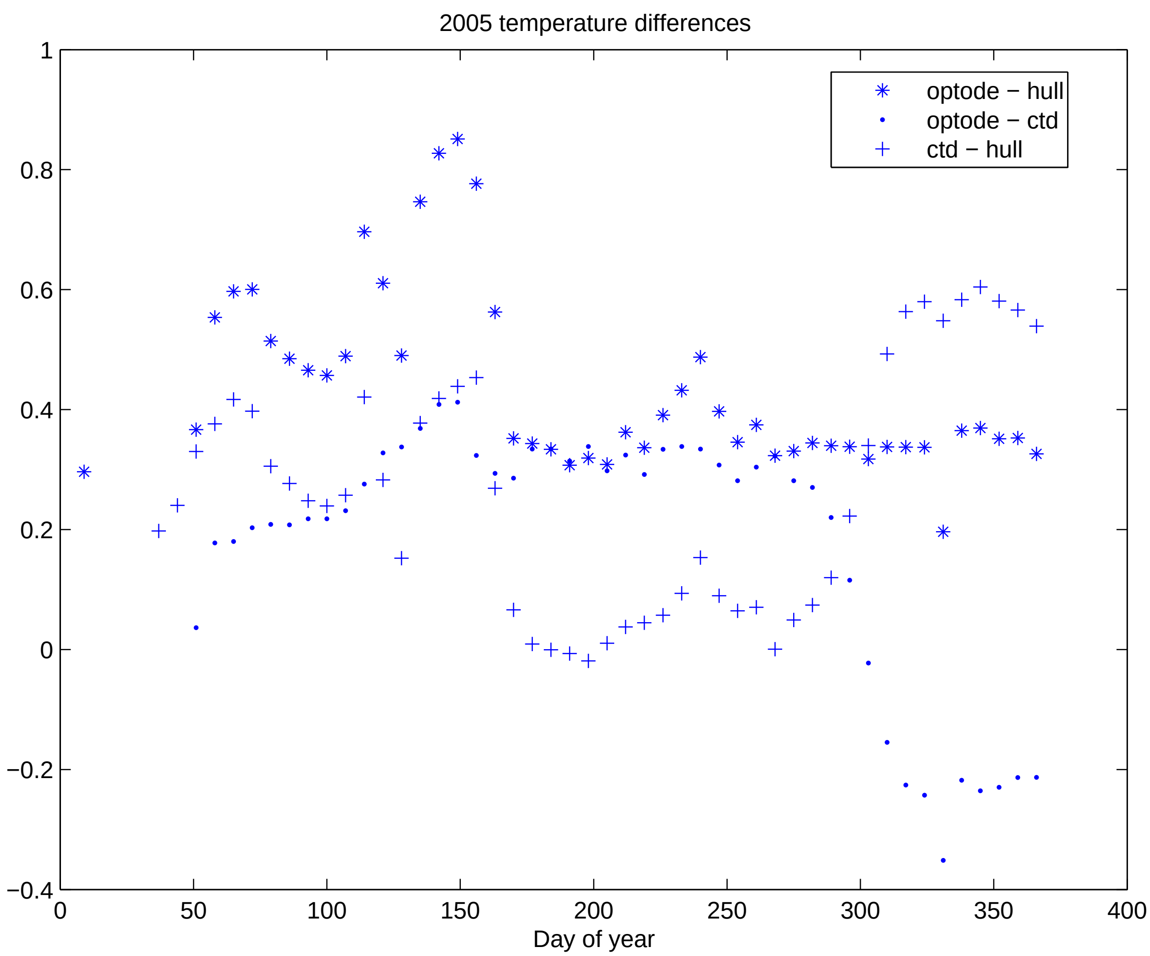


Figure 2 comparison of temperature measurements

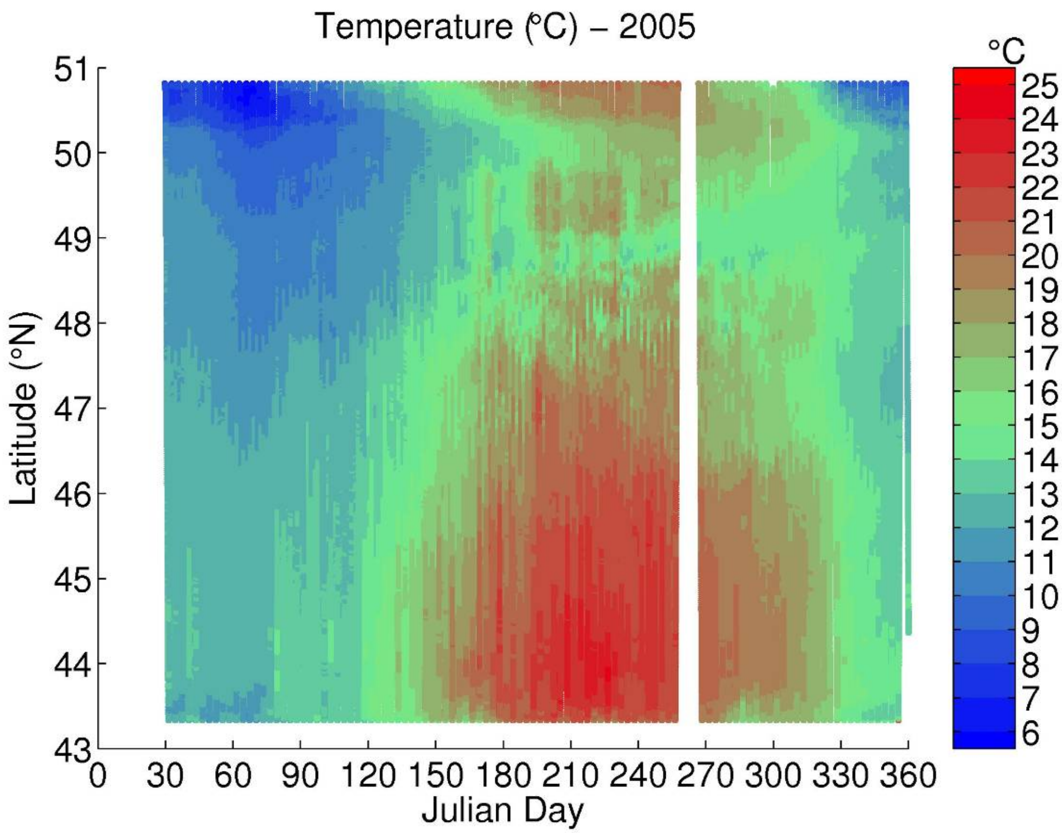


Figure 3 Minipack CTDF temperature data

6.4 Fluorescence data

Figure 4 shows the variation in the FerryBox fluorescence (Manufacturers calibration) as measured by the Chelsea Instruments Minipack fluorimeter. Those data that are within about 3 days after a cleaning event can be considered to free from the effects of biofouling; data that occur after this period and before the next clean may contain a component of fluorescence attributable to deposits of chlorophyll pigments on the sensor optics or internal housing surfaces. The minimum value of fluorescence encountered during a crossing can be seen to increase over succesive crossings when this occurs, reducing at the next clean. It is possible to apply a baseline correction to the fluorescence data by subtracting the minimum fluorescence during a crossing from all values during that crossing; this however may result in artificially low fluorescence if the entire crossing has elevated values and so has not been applied here. The section Experience with fluorescence blocks deals with this issue further.

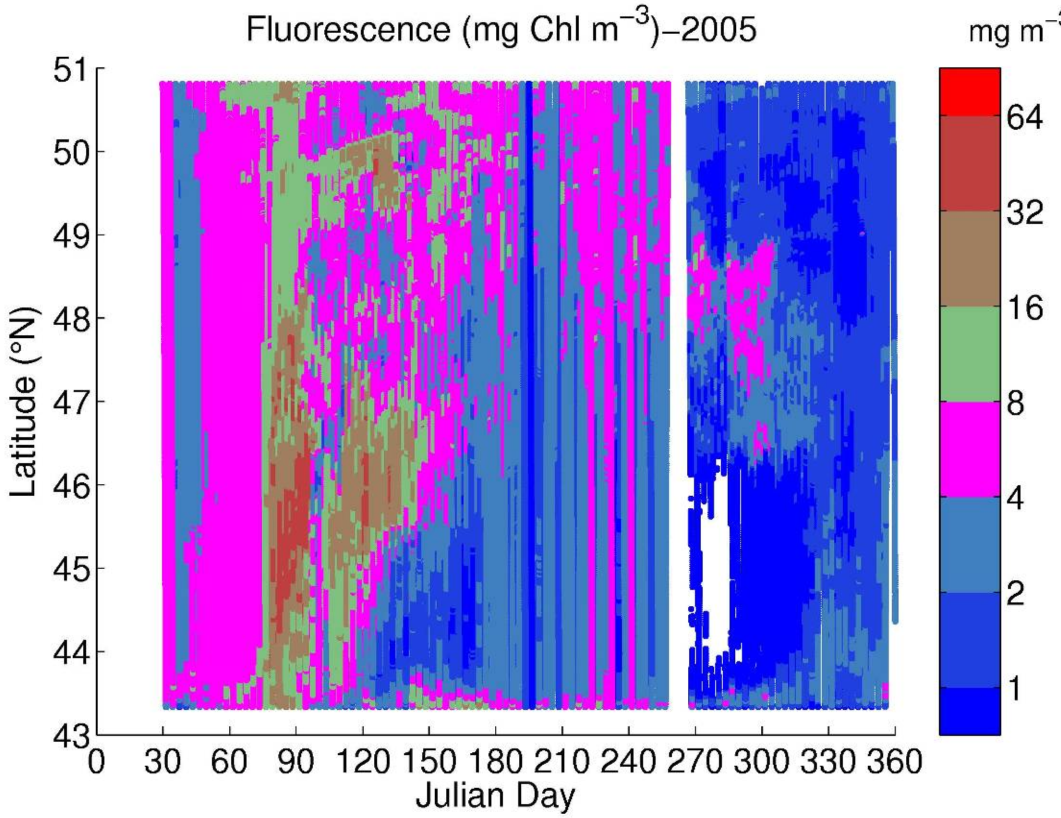


Figure 4 A map of fluorescence with location (latitude) and time with a colour bar that depicts a doubling of values (ranging from 0 to over 64 fluorescence units, each approximating to 5x the chlorophyll concentration in ug/l)

6.5 Oxygen data

An Aanderaa optode is mounted in its own flow-through housing, in series with and a short distance , (less than 1 metre) downstream of the Minipack CTD-F. It provides measurements of oxygen concentration in the sea water in which it is immersed every 30 seconds together with water temperature measurements derived from a thermistor mounted within the body of the optode. The oxygen measurement is made on the dry side of a polyester membrane and so is not sensitive to the salinity nor to the temperature of the surrounding water. The correct salinity of the water needs to be determined from the CTD and bottle calibration samples before it can be applied. This is then combined with the optode temperature measurement to generate a salinity and temperature corrected Oxygen concentration value, $O_{s,t}$. During calibration crossings oxygen samples are collected and analysed on board using the Winkler titration method. By carefully comparing the five minute averaged $O_{s,t}$ values with the contemporaneous bottle oxygen sample results a linear regression provides a correction: the correction can be applied to $O_{s,t}$ to generate a Winkler corrected oxygen concentration, $[O_2]_{obs}$ which is shown as a map against latitude and time in figure 5. Once $[O_2]_{obs}$ has been generated the oxygen saturation concentration, $[O_2]^*$ of the water is calculated. The difference between the two values yields the Oxygen anomaly, $\Delta O_2 = [O_2]_{obs} - [O_2]^*$ which is shown in figure 6.

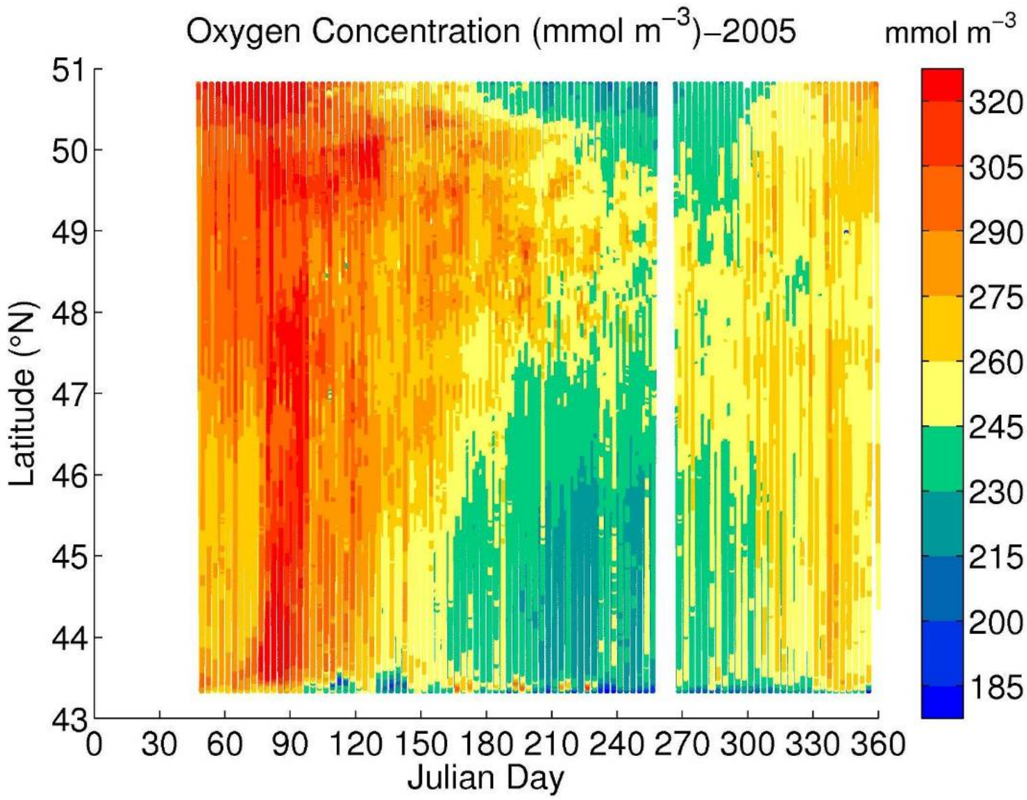


Figure 5 A map of oxygen concentration with location (latitude) and time.

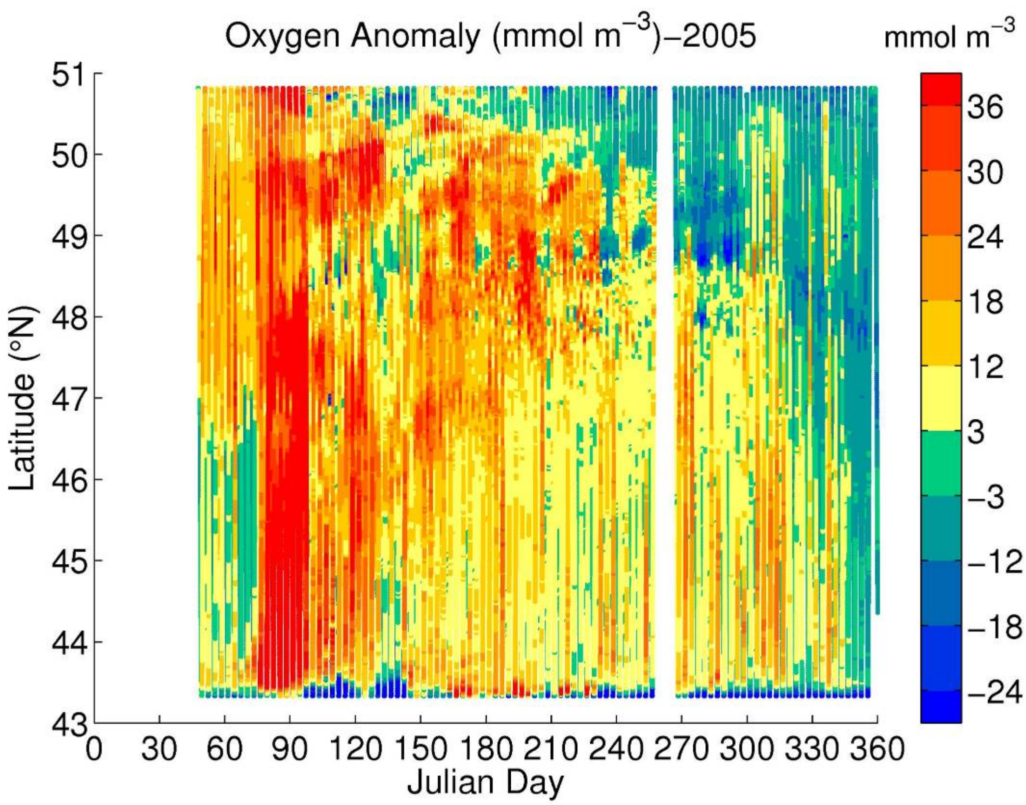


Figure 6 A map of oxygen anomaly with location (latitude) and time.

7.0 Calibration of the FerryBox System Made During 2005

A computer running bespoke logging software on a DOS based system is used to collect and to log data. Download of these data is accomplished simply by exchanging memory flash cards. A flat panel screen displays the most recently logged variables as well as the current time; this has enabled the accurate timing of the calibration samples with the logged data and has given confidence in calibration results obtained through data extraction methods.

7.1 Calibration Crossings Procedure

Calibration samples were collected from the ferry on a monthly basis where possible. Prior to each crossing the Pride of Bilbao was contacted to inform the staff of who would be travelling and on which crossing.. The complete return crossing takes 3 days; roughly equal travel time in each direction with approximately a three hour turnaround at each port. After arriving on the ferry the work required during the calibration crossing can be divided into three parts: the first part consists of cleaning the instruments, with some sensor tests; the second consists of collecting and processing samples; the third entails collecting the logged data. Samples were collected on the hour and half hour; these included Salinity, nutrients, chlorophyll and oxygen.

8.0 Experience with fluorescence blocks

Calibration of the Fluorimeter has been achieved as in previous years by comparison of the recorded instrumental values with quantities of chlorophyll extracted from water samples. However, an important addition this year has been the use of solid state transparent blocks containing chlorophyll samples. These have been used during calibration visits to track any possible drift in the measurements and hence in the stability of the instrument

8.1.1 Fluorimeter checks using plastic blocks

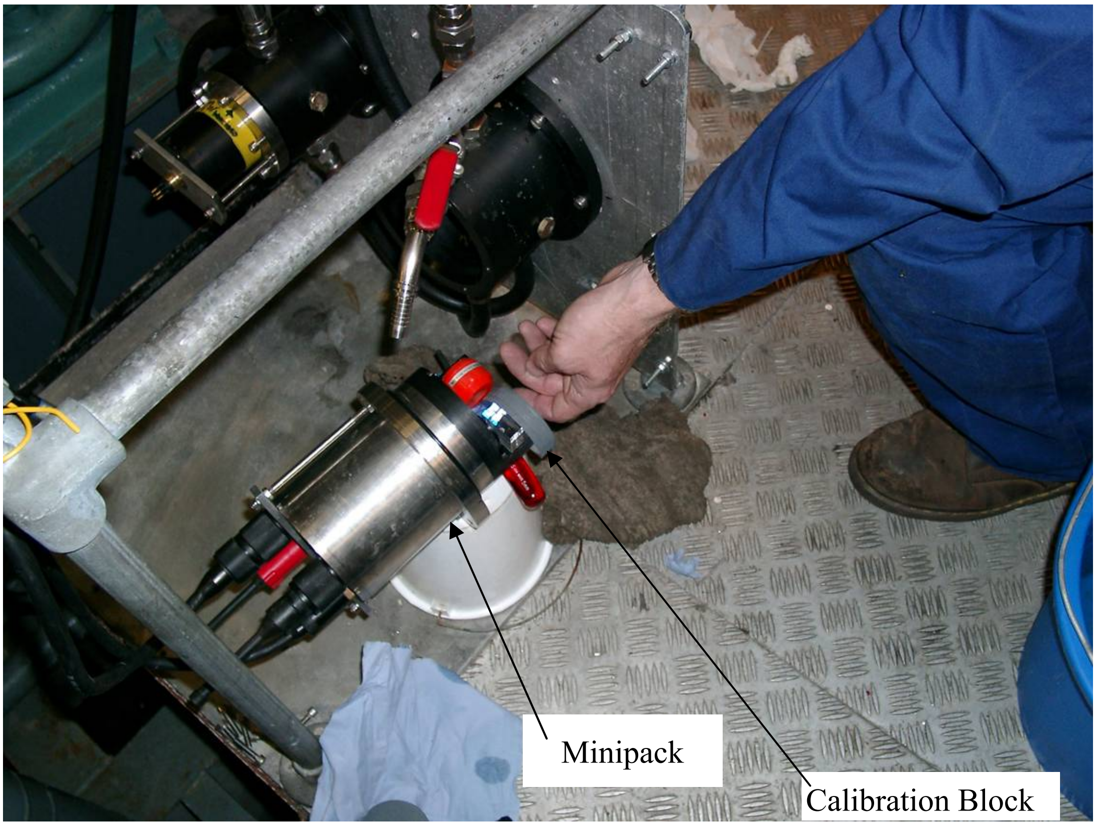


Figure 7.Performing fluorimeter checks using plastic calibration blocks

8.1.2 Method

After arriving in the pump room the Fluorimeter sensor was checked with an optical block. This is a plastic block that contains fluorescent chlorophyll particles. When using the blocks they are carefully oriented so that the blocks largest face is against the fluorimeter's sensing window with the second largest face abutting the fluorimeter's emitter. Touching the block whilst making the measurement can give up to a 10% increase in the reading. The block is wrapped in tissue to protect it from damage. Ideally the following checks are made, however in actuality the conditions within the pump room do not always lend themselves to all of the measurements being made. The same checks should be made pre and post clean.

1. Flourimeter in housing with water drained from system.
2. Fluorimeter with block L against emitter-receiver pair
3. Fluorimeter with block H against emitter-receiver pair

Figures 8 and 9 show how the output of the fluorimeter changes before and after a cleaning event. Summary statistics of the data shown in figures 8 and 9 are then given below. The clean values show no clear trend over time indicating good long term stability. Where the block is used the pre-clean (dirty) values are generally lower than the post-clean (clean) values. Conversely when the instrument is in its housing without water, the reverse is generally true: the dirty values are generally higher.

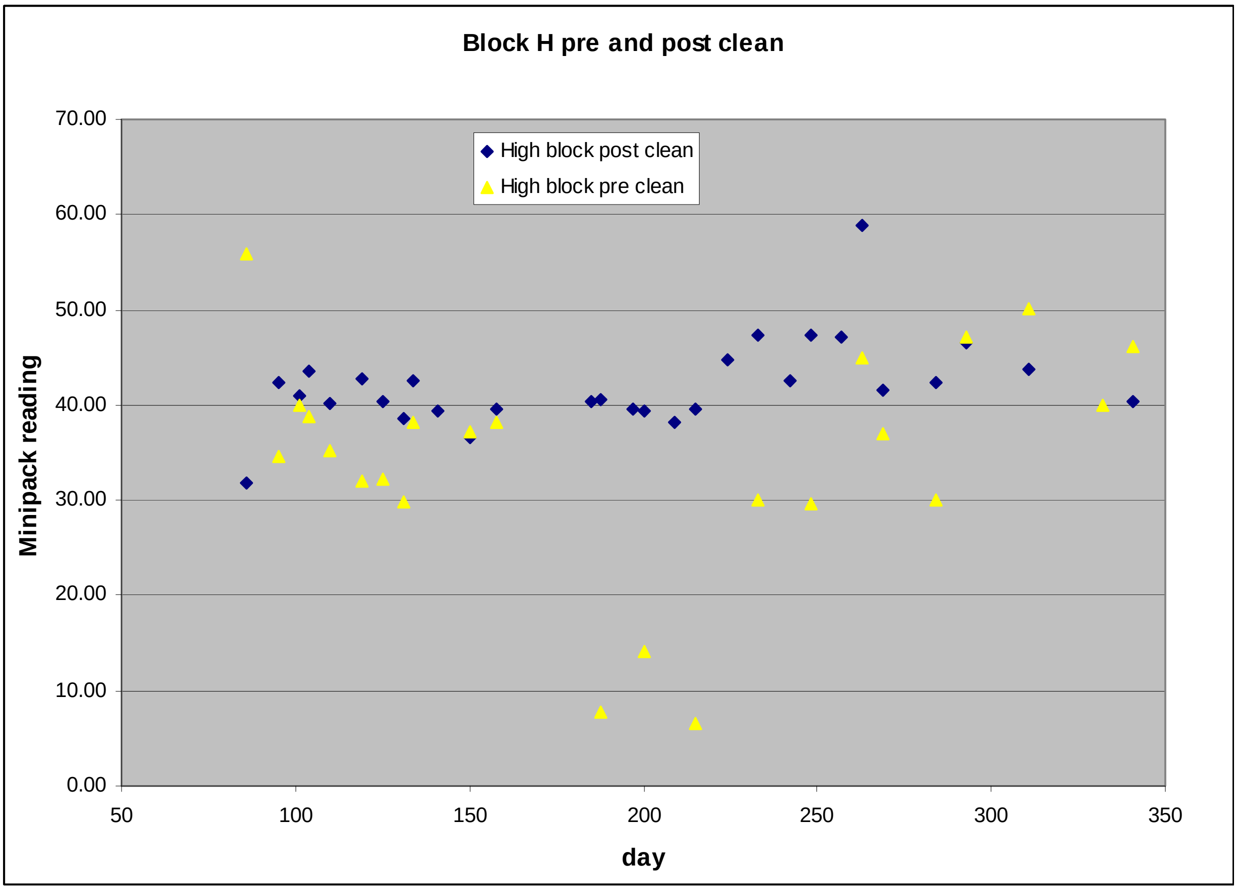


Figure 8.Fluorimeter checks using plastic calibration block H

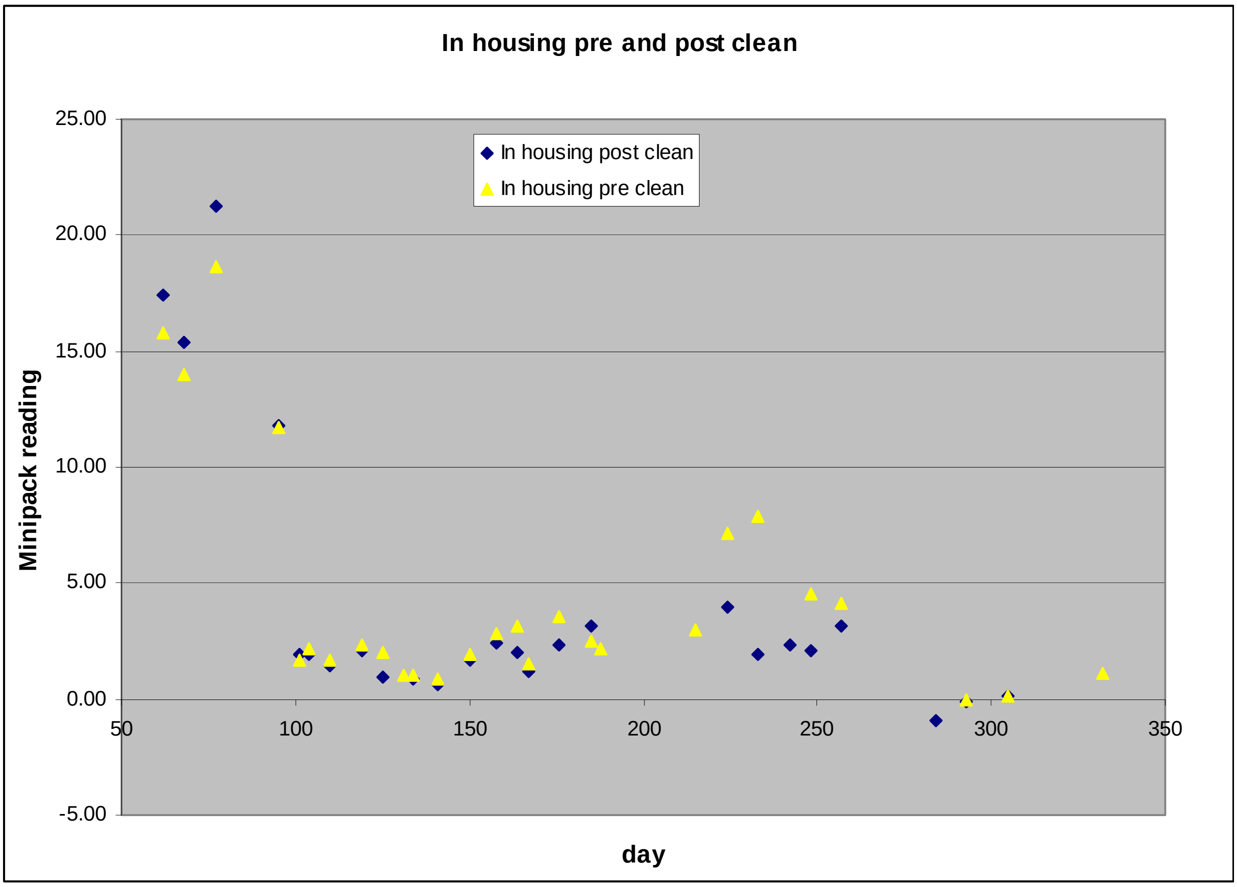


Figure 9.Fluorimeter checks-sensor in flow through housing

Block H	*clean*	*dirty*	*In Housing*	*clean*	*dirty*
Mean	42.4	34.3	Mean	4.0	4.4
Standard Error	0.8	2.4	Standard Error	1.2	1.0
Median	41.2	36.1	Median	2.0	2.4
Standard Deviation	4.3	11.9	Standard Deviation	5.8	5.0
Sample Variance	18.6	142.5	Sample Variance	33.6	24.7
Range	22.3	49.4	Range	22.2	18.7
Minimum	36.6	6.5	Minimum	-0.9	0.0
Maximum	58.9	55.9	Maximum	21.3	18.7
Sum	1186.3	823.3	Sum	101.1	118.5
Count	28.0	24.0	Count	25.0	27.0
Confidence Level(95.0%)	1.7	5.0	Confidence Level(95.0%)	2.4	2.0

The times of cleaning events are superimposed onto the five minute averaged fluorescence output of the Minipack displayed against time in figure 11. From the outset of data collection to the clean on day 86 it appears that the minimum signal from the crossings was higher than ambient and increased with time, the minimum signal then reduces to day 95. Throughout this period and similarly for the period 167 through 185 the cleaning events had little effect on the lowest signal values. This can be interpreted as the minimisation of the interim effects of biofouling through regular cleaning. The same cannot be said for the period of cleans 209 through 250 where there is a marked reduction in fluorescence output subsequent to cleaning events. It can also be noted that the period of `rusty` biofouling coincides with larger cleaning effects (post clean output less pre clean output).

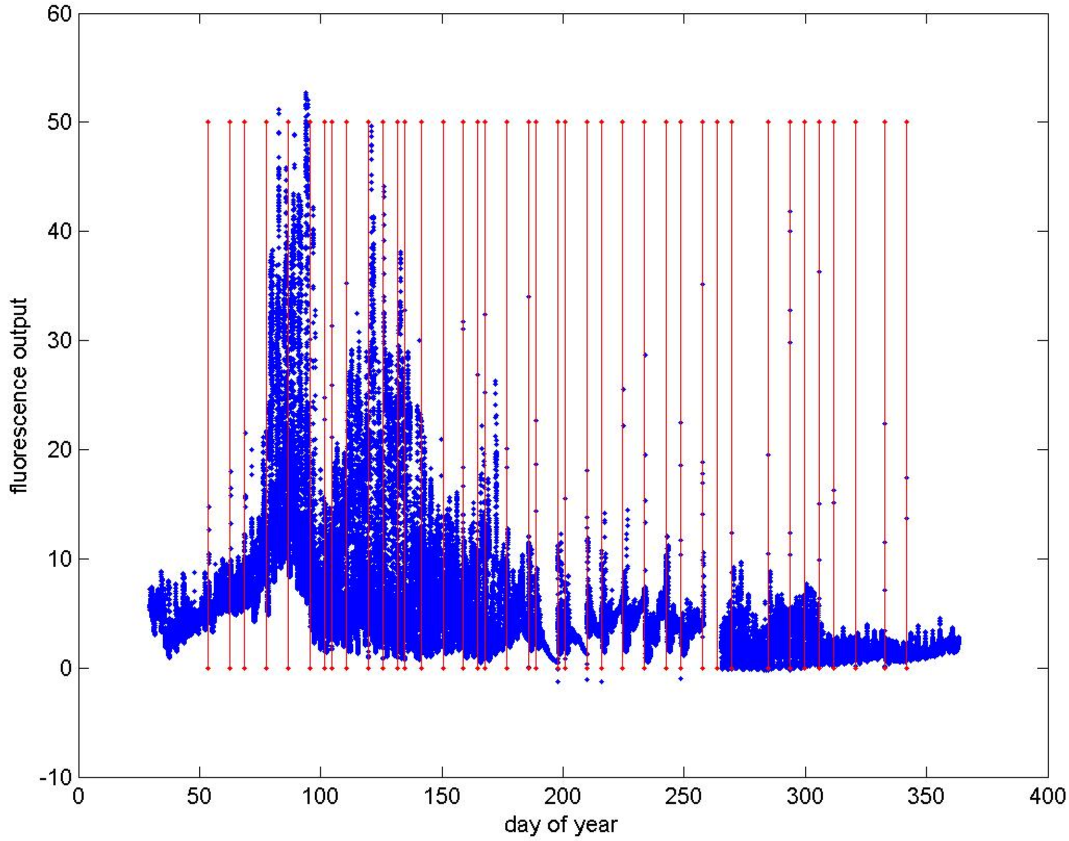


Figure 11. Minipack fluorescence with time annotated with cleaning events shown in red

9.0 Anomalous long term fouling event

9.1.3 Abstract

Regular cleaning of the Ferry Box system aboard the Pride of Bilbao during 2005 gives the operator an indication of the level of fouling present on the sensor heads. During the period between days 176 and 248 the normal biological fouling of the FerryBox sensors was accompanied by contamination of what appeared to be rust coloured deposits on all of the instrumentation and internal housing surfaces; brown fouling of the sensors was first noted when cleaning on day 176 and persisted until day 242 it was not noted on day 248. Figure 10 shows an image of the Aanderaa Optode oxygen sensor, Minitracka turbidity sensor and Minipack CTD-F that is typical of the period taken during a cleaning event on day 233. It appeared that there was corrosion being developed somewhere in the shipside system but that this was being held within a thin layer of biological substrate (biofilm).

Figure 10.Optode, Minitracka and Minipack showing rusty deposits typical of the period between days 176 and 248

9.1.4 Sample

Water from the Minipack housing was collected in a clean bucket as the Minipack was withdrawn for cleaning, this contained lots of rust coloured sediment, it was mixed with clear seawater (water flushed through the pipes until it ran clear). The total was mixed and a sample collected using an Oxygen sample bottle. The sample was pulled by vacuum through a 47mm glass fibre filter and deionised water was then passed through the filter to wash out any salt content. A portion of the filter was cut away mounted on a base and gold coated prior to analysis using a Scanning Electron Microscope (SEM).

9.1.5 SEM images

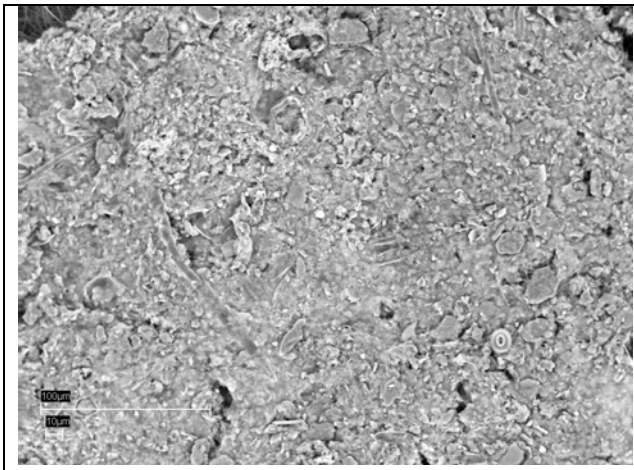
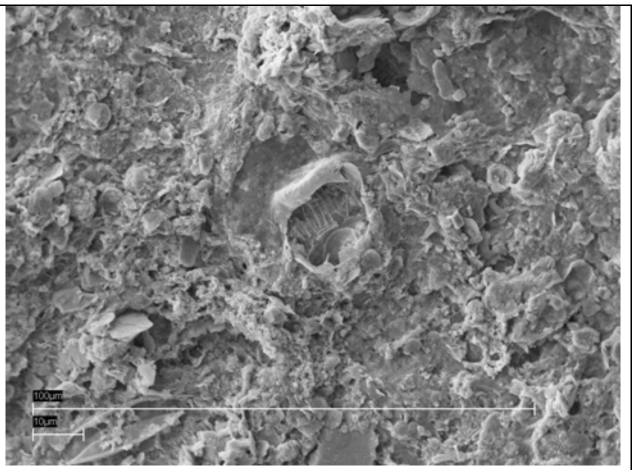
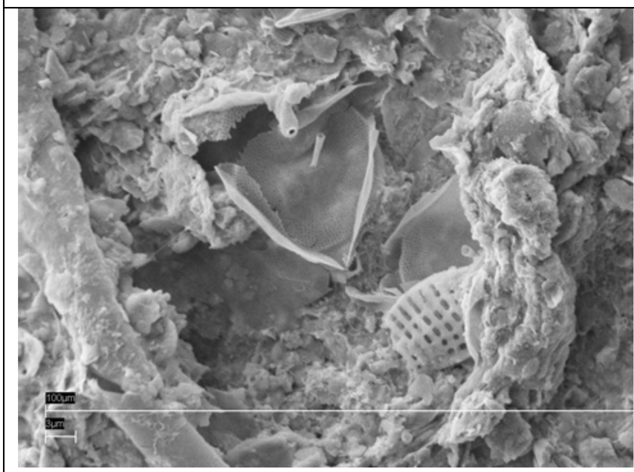
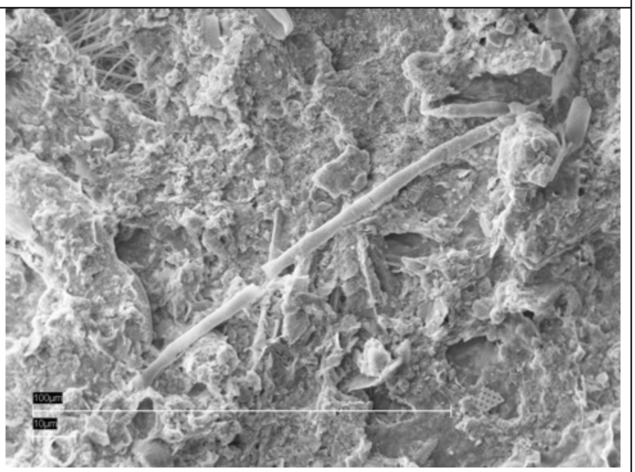
Backscatter images highlight the differences in chemical composition whereas the secondary beam gives more topographical detail; lighter indicates higher, darker indicates lower. Owing to the nature of the sample using the secondary tended to generate higher Voltages where there was a poor connection to the sample holder.

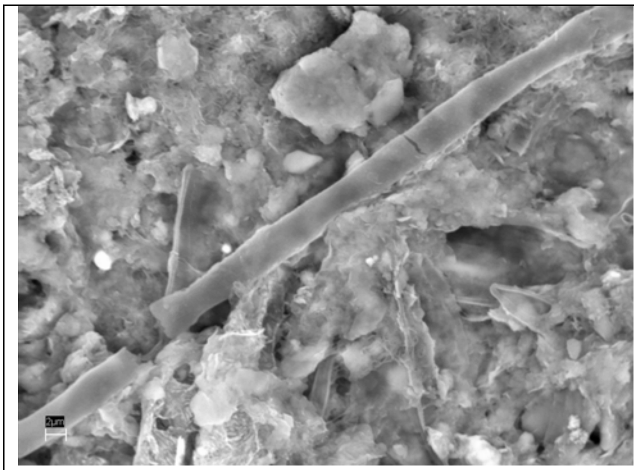
Filter_03	backscatter this shows the area over which the elemental X-ray analysis was performed. The number of pixels is 1024 by 768 and each pixel is 354.3 nm on a side.
Filter_04	Secondary Expands what appears to be an almost skeletal interior of perhaps a biological enclosure found towards the top-middle of ‘Filter_03’.
Filter_05	Higher magnification again. This shows what appear to be broken centric and pennate frustules.
Filter_06	Similar magnification to Filter_04. One of numerous linear filament like or possibly tubular structures.

Filter_07	Increased magnification of the structure in Filter_06. The two PRG analyses Filter_04_linear and Filter_05_debris were made towards the centre of the image as indicated by the annotations.
Filter_08	backscatter 3 more biological entities – a plate (lith) from a coccolithophore bottom right and a diatom top right (Thalasioema Nitzschoides) on typical background material.
Filter_09	Shows the deposited material that has cracked and shrunk under desiccation revealing the Filaments of the glass filter beneath.
Filter_10	Lower magnification showing the general pattern of the dried, cracked membrane.
Filter_11	Higher magnification showing where a portion of the membrane has lifted from the Filter.
Filter_12	Higher magnification still showing where a portion of the membrane has lifted from the Filter giving an indication of the local deposition thickness.

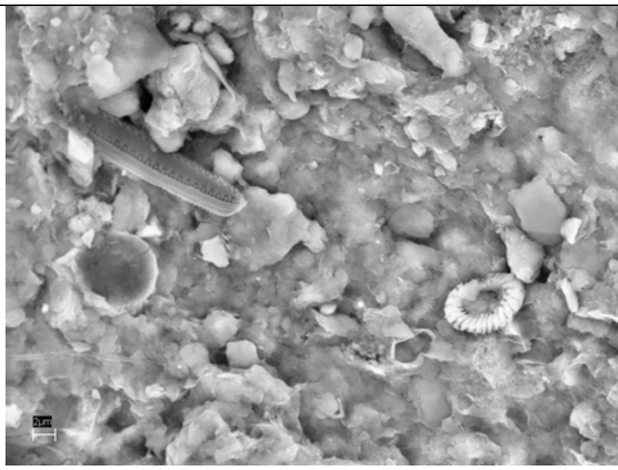
X-ray analyses were made on the following samples the expectation was that there may higher than normal iron levels due to the rust colouration but the levels were no higher than normal, silicon levels were elevated- this may be down to the glass fibre backing filter.

Filter_03_overview-targeted on the area shown in Filter_03_Overwiew1000X. Filter_04_linear-targeted on the linear filament like structure of Filter_07a. Filter_05_debris-targeted about 7um to the right of the filament.

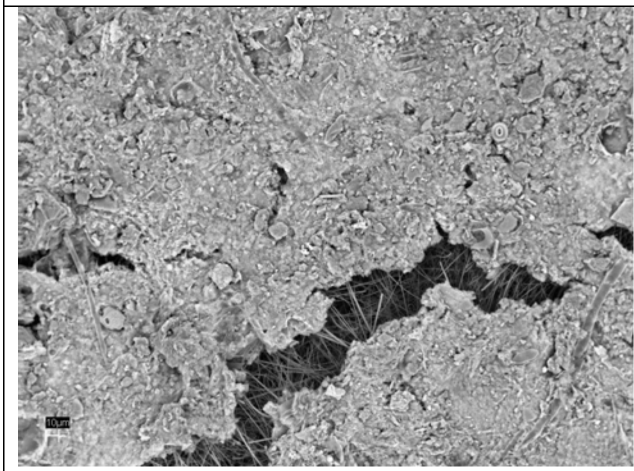
	
Filter_03_Overview1000X	Filter_04
	
Filter_05	Filter_06



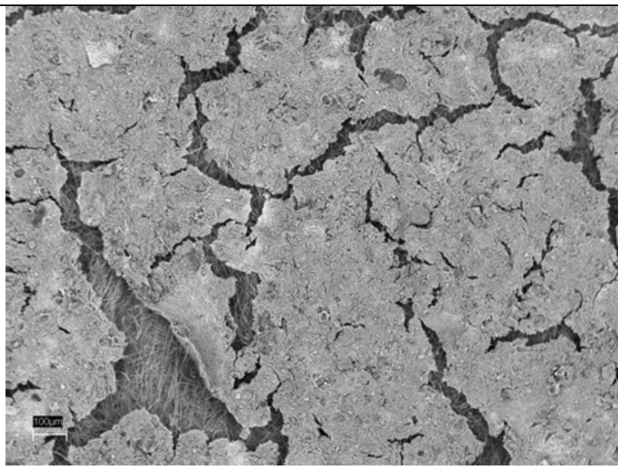
Filter_07



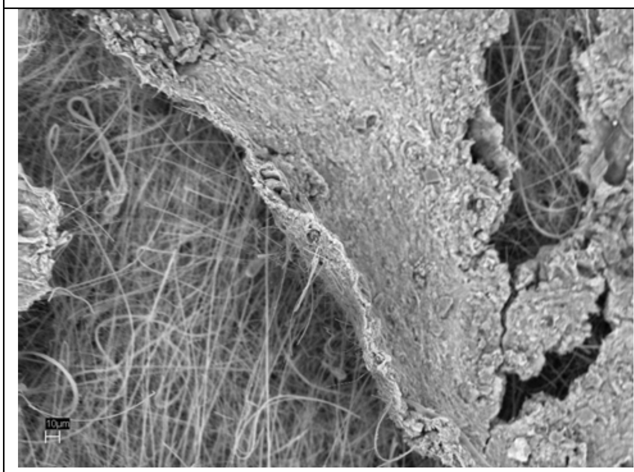
Filter_08



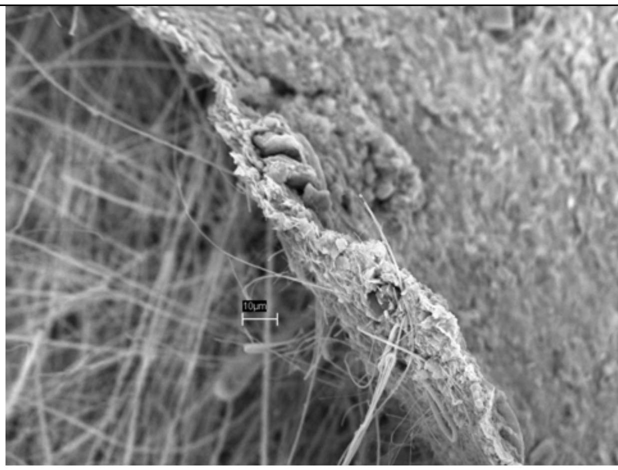
Filter_09



Filter_10



Filter_11



Filter_12

10.0File descriptions and location

Files relating to the processing of the FerryBox data are stored at the National Oceanography Centre, Southampton. The top level directory of the online storage is denoted by S: where the address is \\Polaris\SHARED1\OBEPRIV\Ferrybox.

File Type	Directory	File name
Chelsea Spreadsheets	S:\Pride of Bilbao\2005 calibration sheets	PoBcal0205.xls through PoBcal0209.xls
Sensor maintenance / cleaning	S: \2005\Documents\DIARY	PoB event & visits diary Jan to June.xls
Sensor maintenance / cleaning	S:\2005\Documents\DIARY	PoB event & visits diary July to Dec.xls
Salinity leg plots	S:\Pride of Bilbao\Comparison plots	CTD and Salinity Southbound344a.xls
2003 to 2005 graphical salinity calibration sample comparison	S:\2005\Documents	PoB Salinity Calibration 03-05
Salinity correction table	S:\2005\From_Mark	for_archive
Archival Format	S:\bag mch BODC_Data	FBox_D-3-data_management_guides_for_testing.pdf
Calibration spreadsheets	S:\2005\From_Mark	Crossing data 2005.xls
Raw data file	S:\OBEPRIV\Ferrybox\Pride of Bilbao\2005	Day_monthYY\Mdddhhmm.XNG
1Hz Matlab data	S:\ARCHIVE_MCH\matlab_data_files\2005\1Hz_data	
5 minute averaged matlab	S:\ARCHIVE_MCH\matlab_data_files\2005\5 minute mean data	5mindata.mat (combined) or individual 5min(varname).mat & min(varname)nan.mat where flagged data are set absent.
Archive data (5 minute)	S:\ARCHIVE_MCH\Archival\bag mch BODC_Data\2005	variou
gridded	S:\ARCHIVE_MCH\matlab_data_files\Analysis\working\Ngrid	grid0308

11.0 Appendix

The following processing route is constructed as follows; **Matlab script name** – Description of script function. The archival of 2005 data has followed the procedure developed in previous years with some minor modifications. These were primarily due to the size of files generated exceeding the 1GB memory capacity of the computer being used to process it. A new editor was written '**data_grab.m**' allowing suspect data to be selected graphically. **loadit.m -** 1Hz Matlab files were put in the following directory on the local disk of the PC (this substantially increased the processing speed) ; C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\allMAT\raw matlab\all1Hz

arch_ctrl.m - archive control file. Runs the following: **read_varlist.m** - creates empty variables in their eponymous files of the form *2005.m using the data in the file 2005varlist.txt. **yearly1Hz_a.m** – creates the variable xarray that contains all the filenames M*.mat. **missing_file_check.m** - Preliminary check of Ferrybox matlab 1Hz data files prior to concatenating. **yearly1Hz_b.m** - This m-file loads the first of the year's files and from the variables therein it creates additional yearly variables with a postscript '05' so that the data from subsequent files can be appended to it. It saves these yearly 1Hz variables in files of the same name eg file COND05.mat contains variable COND05. As the data files contain nearly 29 million data points the following procedure was modified from previous years in order to enable processing within the constraints of computer memory. To this end the variables were split into two parts the first 15 million Cycles long the second part the remainder. **splityear05.m** – cleaves each yearly 1Hz vector in two. Both parts stored in files with names like COND05new. **findgoodCONDoneHzdata2005a.m** – and its kin **findgoodCONDoneHzdata2005b.m** (a and b correspond to the first and second parts of each vector) locate the data cycle numbers that occur within the specified latitude limits and assigns them to the variable, f. The latitude limits and the variable name are edited within the file to the values that are required, Ctrl+H and then vara05 varb05. replace all. It plots suspect data in a different colour on top of the entire data for that particular latitude range. NB in actuality it is only about half the data within that latitude band as the vector has been split in two. **data_grab.m** – uses a graphical drag and drop box method to add data that is suspect to the variable, suspcdat. The command save suspcdat5051a suspcdat then saves the suspect data cycles to a filename that corresponds to the lower and upper latitude limits and the part a or b of the vector. Once suspect data has been generated for each of the latitude bands and for both 'halves' of the vector; **compile_suspdata2005.m** – compiles all the suspect data from these files into one file. These are kept along with associated files in subdirectories of the following directory. C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\archive. The process is repeated for all relevant variables. **calcsalinityuncal.m** Generate salinity data for 1st half. Saves to oneHzALLsaluncal2005 **calcsalinityuncalb.m** Generate salinity data for 2nd half. Saves to oneHzALLsaluncal2005. load oneHzALLsaluncal2005. saluncal = [saluncala ; saluncalb]; append all salinity data. save oneHzALLsaluncal2005. **Check_sus.m** - check that suspect data are where they should be and produces a postscript file that overlays the suspect data upon the entire data for that particular latitude range. Run **findgoodSALoneHzdata2005.m** and **data_grab.**m on the newly created salinity data to flag suspect data. **Fiveminavg_o2_2005.m** - calculates five-minute averages from the 1 hertz data and saves two files per variable: one in which flags are ignored and one in which flags = NaN. Each file contains the variable explicit in its name and corresponding timestamp. So for conductivity, the output file **5minconds2005nan.mat** contains the variables; days and cond. **Collateaveragedata.m** – combines all separate 5 minute variable files into a single matlab file **5mindata2005.mat** that is then used as input to create the final quality checked file that is sent to BODC. Also generates excel files containing the same five minute averages. **FBsetparamflags.m** - This program sets the flags for each of the ferrybox parameters. The flags are determined by looking at time series plots over one degree latitude sections along the ferry route.(Does not seem to be needed) **FBwriteformatteddata.m -** creates the Ferrybox data management files, then writes the appropriate data **FBwritemetadata.m –** writes metadata in ASCII file according to specifications in FBox_D-3-data_management_guides_for_testing.pdf.

11.1 Matlab and UNIX Scripts

Directory	C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\allMAT\raw matlab\all1Hz
loadit.m	Sequentially loads FerryBox data from all the files in the current directory with the extension .XNG (ASCII), calculates salinity and saves as Matlab files of the same name but with .mat extension.
decimator.m	This m-file loads sequentially the FerryBox data from all the matlab files in the current directory and reduces the sampling rate to once every 5 minutes.
	C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\m_files
whichway.m	Sequentially loads FerryBox data from all the files in the current directory with the extension .XNG decides which way the ferry is going by comparing first+100 and last-100 latitudes from the file. If the last latitude is the greater then it appends the filename to a list file called Northlist.txt.
	Archival Procedure
Directory	C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\allMAT\raw matlab\all1Hz
loadit.m	Sequentially loads FerryBox data from all the files in the current directory with the extension .XNG (ASCII), calculates salinity and saves as Matlab files of the same name but with .mat extension.
Directory	C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\allMAT\raw matlab\all1Hz
yearly1Hz_a.m	Creates two arrays from a directory listing; an input array of type 'M*.mat' and an output array of type '*2005.mat' and checks with the user if they are what is required.
missing_file_check.m	Preliminary continuity check of Ferrybox matlab 1Hz data files prior to concatenating
yearly1Hz_b.m	Loads the first of the year's files and from the variables therein creates yearly variables that can be appended to.
splityear05.m	split yearly 1Hz data into 2 parts as files are too large to be handled with current PC memory.
Directory	C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\archive\m_files
findgoodCONDoneHzdata2005a.m	Plots time series of the 1Hz data indicated in the program name within a selected one degree latitude band. Sets absent data North of 50.811032 and South of 43.335. Overlays suspect data in red.
data_grab.m	uses a graphical drag and drop box method to add suspect data to the variable, suspcdat.
compile_suspdata2005.m	compiles the suspect data from each latitude band into one filewith a name of the type oneHzALL'*variable*'2005. These are kept along with associated files in subdirectories of the following directory. C:\Documents and Settings\mch\My Documents\Backup (E)\Ferrybox\PoB2005\archive
calcsalinityuncal.m	Generate salinity data for 1st half. Saves to oneHzALLsaluncal2005
calcsalinityuncalb.m	Generate salinity data for 2nd half. Saves to oneHzALLsaluncal2005
findgoodSALoneHzdata2005.m	As per '*findgoodCONDoneHzdata2005a*' but produces variable '*suspcdat*' by combining suspect data from variables pressure temperature and conductivity.
Check_sus.m	Plots data from latitude band overlayed by suspect data as a visual check.

Fiveminavg_o2_2005.m	calculates five-minute averages from the 1 hertz data and saves two files per variable: one in which flags are ignored and one in which flags = NaN. Each file contains the variable explicit in its name and corresponding timestamp. So for conductivity, the output file 5minconds2005nan.mat contains the variables; days and cond.
Collateaveragedata.m	combines all separate 5 minute variable files into a single matlab file 5mindata2005.mat that is then used as input to create the final quality checked file that is sent to BODC. Also generates excel files containing the same five minute averages.
FBwriteformatteddata.m	This file creates the Ferrybox data management files , and then writes the appropriate data to them.
Fbwritemetadata.m	creates the Ferrybox metadata management files
	Plotting routines
binlat2.m	Extracts and plots data from specified latitudes
northsth.m	determine direction of travel N/S

11.2 Minipack: change in apparent conductivity with positional variation

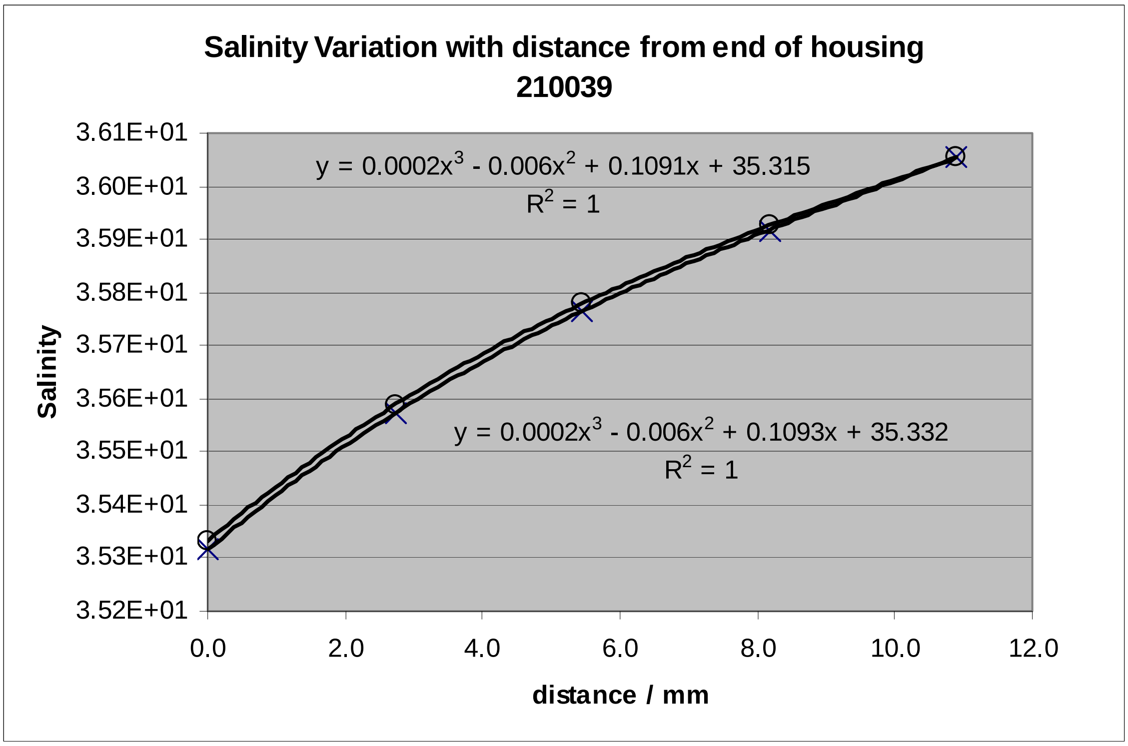
The salinity variations were initially attributed to positional change of the CTD sensor within its housing during cleaning events; the proximity of the inductive conductivity cell to the flat end of the housing being targetted as contributing the majority effect. To asses the magnitude of this effect two sets of measurements were made; the first set used the system Minipack serial number 210039 in its housing aboard the Pride of Bilbao, the second another Minipack serial number 04-4350-003 within an identical housing in the calibration lab at NOC.

Method

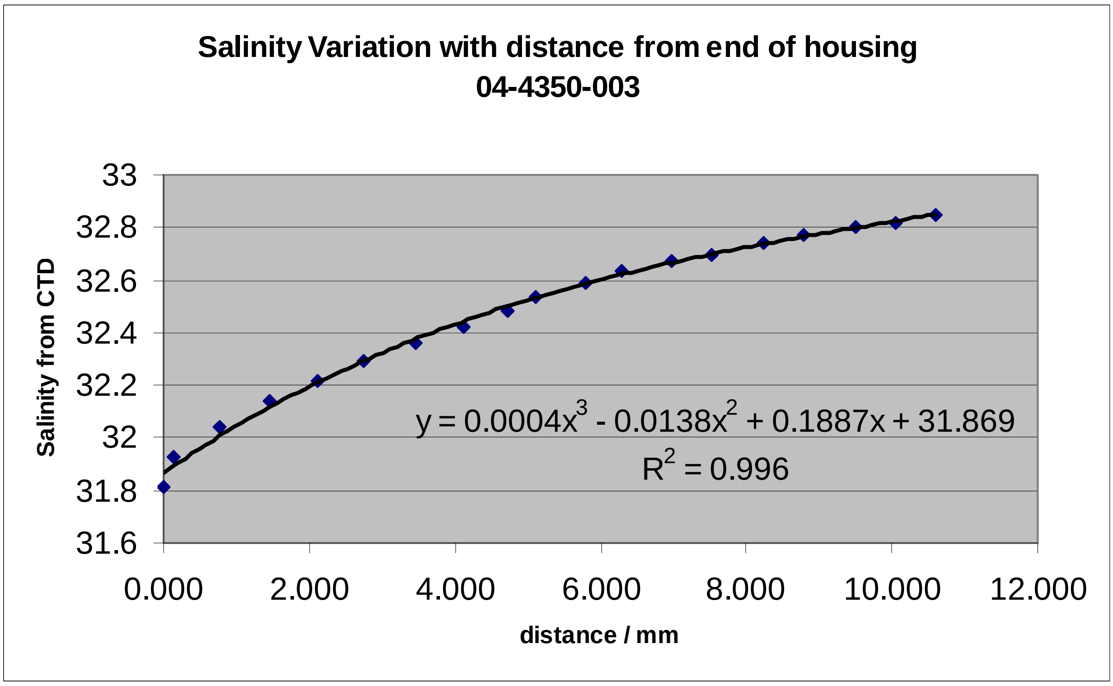
This positional sensitivity of Minipack 210039 was assessed by allowing the system pressure to move the unit outwards from its fully home position whilst logging the CTD data (see 051101 Salinity check). This was accomplished by incrementally unscrewing the Minipack retaining nuts and letting the system pressure drive the unit out from its housing and then incrementally tightening the nuts to return the unit to its original position (10.9 cm protrusion). The assumption was that there was no change in the salinity during the 10 minutes taken to perform the test; the start and end conductivities were identical.

A comparable arrangement was made using Minipack 04-4350-003 (see cal_lab). It was suspended above a constant salinity bath from which water was pumped upward under low pressure through the housing, returning to the bath from the upper hose. The system had no internal pressure to drive the minipack out so this time the minipack could only be driven into the housing with its retaining nuts.

Results



During the test of Minipack 04-4350-003 the actual bath salinity increased linearly by 0.01.



With the minipack pushed fully into its housing and loosening the retaining nuts by one turn Minipack 210039 gave a salinity increaseof 0.26 for a 2.7mm increase in the axial distance from the housing bottom. Minipack 04-4350-003 in the lab test gave a salinity increase of 0.369 for a 2.6 mm increase. This does not include the closest point at 11.284 cm protrusion, from 11.284+/-0.002cm to 11.298+/-0.002cm which yields a salinity change of 0.12+/-0.03 in the first 0.014 cm alone; equivalent to 0.8psu / mm. The table below shows the increase in salinity, ΔS as the Minipack is moved further out from its housing, ie. .Δd increases.

Distance, d / mm	0	2	10
Minipack Number	Salinity change per mm assuming cubic regression, ΔS/Δd (psu / mm)		
210039	0.103	0.083	0.049
04-4350-003	0.175	0.127	0.031

Conclusions

There is an increase in measured salinity as the axial length and hence volume of water within the housing are increased. ΔS/Δd reduces the further the Minipack is moved out from its housing;.this implies that salinity changes resulting from movement of the Minipack within its housing can be mitigated by increasing the distance of the conductivity cell from the flat end of the housing.

11.3 Example of CTG calibration form

FERRYBOX

CALIBRATION FORMS
FOR CORE SENSORS

2005-006-PQ

Issue B

Approved:		John Attridge
Checked:		Bill Neal
Originated:		Elliott
Issue	ECO	Date
A	Original Issue	06/08/2004

CALIBRATION REPORT FORM

Route 7 NERC-NOCS Portsmouth - Bilbao

DATE	12/03/2005
Name of Member Organisation	National Environment Research Council National Oceanography Centre Southampton
Contact name	Dr David Hydes
Email address	djh@soc.soton.ac.uk
Telephone number	+44 2380 596 547
Address	National Oceanography Centre Southampton Waterfront Campus Empress Docks SO14 3ZH Great Britain
Name of Ferry ship deployed	Pride of Bilbao
Ferry operator	P&O
Travel time	
Frequency of sailings	every 3 days
Depth of water intake	5 metres

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Index	1
Instructions	2
Temperature	3
Salinity Calibration using bottle samples	4
Salinity Calibration with cleaning	5
Turbidity Calibration by Formazine	6
Turbidity Calibration using bottle samples	7
Fluorimeter Calibration using plastic blocks	8
Fluorimeter Calibration using bottle samples	9
Manufacturer/laboratory calibration log	10

Instructions for using the Calibration Form Page 2

At the end of each month complete this Excel form and email to;
jelliott@chelsea.co.uk

1) The completed forms must be sent to CTG at the end of each month. Sections relating to instruments calibrated less frequently are to be left blank as appropriate.

2) Check the details on page 1. These should generally stay the same and can be copied into future forms.

3) Add the date for this months submission on page 1

4) Turbidity and Chlorophyll Sensors
Enter date of testing at the top of each page completed
Use page 6 for turbidity calibration with formazine
Use page 7 for turbidity calibration using bottle samples
Use page 8 for fluorimeter calibration using plastic block
Use page 9 for fluorimeter calibration with bottle samples
The standard and blank are measured before and after cleaning the sensor in manually cleaned systems
If there is a significant difference, it means that the previous data was degraded by the fouling and may not be valid.
If the system is automatically cleaned, only provide the after-cleaning data
The blank and standard readings should be taken at 10 second intervals to check drift and stability.
The mean and standard deviation are calculated automatically by the spreadsheet after values are entered
Until values are entered, #DIV/0! shows.

5) Temperature Sensor
Enter date of testing at top of page
For the annual temperature probe calibration, the probe reading should be compared with a calibrated standard temperature probe at several different temperatures. This can be achieved with a temperature controlled water bath.

6) Salinity measurements
Enter date of testing at top of page
Salinity is derived from conductivity, temperature and depth, so errors will be in combination.
Note Values may be different inside Ferrybox container than on bench due to metal proximity and plastic walls.
Use page 4 for bottle sample data
Use page 5 for data with cleaning
Calibration should be conducted inside flow cell to check for these effects.
10 consecutive readings are made at 10 second intervals to check for drift and stability.

7) Manufacturer/ laboratory calibration log
Use page 10 to keep track of manufacturer/laboratory instrument calibrations and when they are due.

Route 7 NERC-NOCS Portsmouth - Bilbao

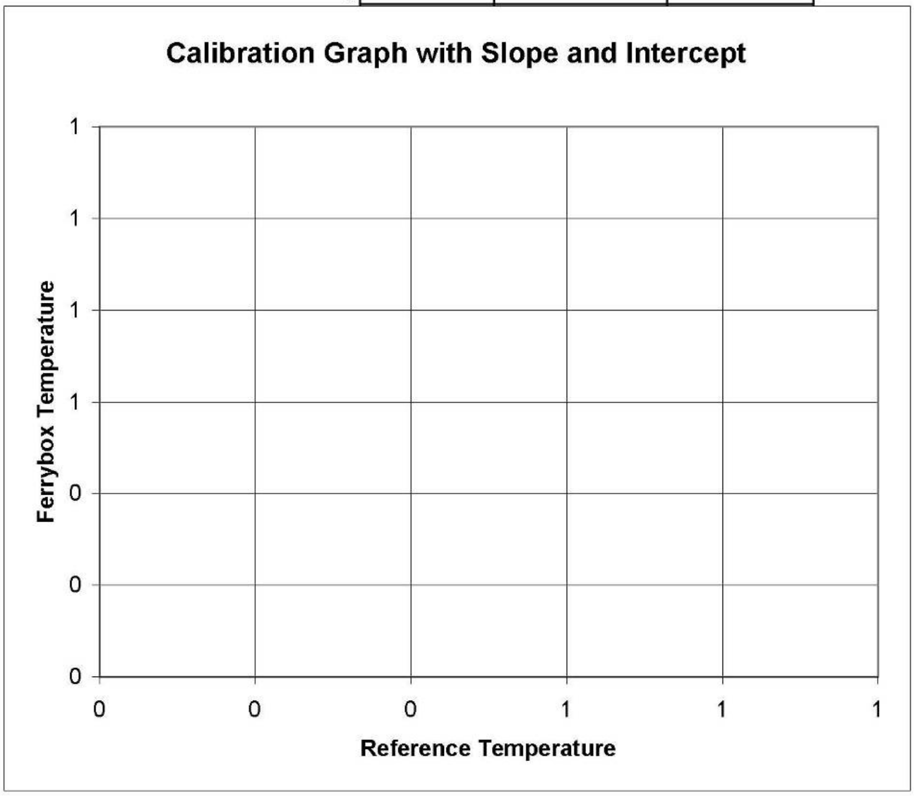
Page 3

Temperature Calibration

Date form completed	12/03/2005
Manufacturer	CTG
Model	Minipack
Serial number	210039
Date last calibrated by manufacturer	02/02/2005
Calibration life remaining (months)	24
Frequency of user calibration check	
Units of measurement	Centigrade
Date last calibrated by user(if applicable)	

Checked today by	
Model of reference thermometer	standard PRT
Date of last manufacturer calibration of reference thermometer	ref CTG

	Reference temperature	Ferrybox temperature	Difference
1			
2			
3			
4			
5			



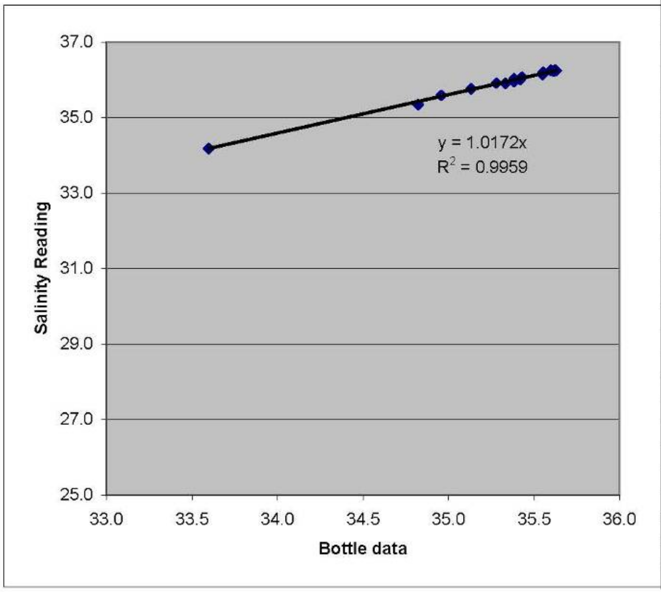
Route 7 NERC-NOCS Portsmouth - Bilbao

Page 4

Salinity Calibration using bottle samples

Date form completed	12/03/2005
Manufacturer	CTG
Model	Minipack
Serial number	210039
Date last calibrated by manufacturer	02/02/2005
Calibration life remaining (months)	23
Frequency of user calibration check	monthly
Units of measurement	PSU
Date last calibrated by user(if applicable)	25/02/2005
Checked today by	mch
Calibrated against	Guildline Salinometer
Type of standard	OSI 33 psu
Slope from previous calibration	1.0149 5minute mean salinity / bottle

	Bottle Readings	Salinometer Readings	Bottle Readings	Salinometer Readings
1	34.8213	35.3358		36.2464
2			35.5970	36.2470
3			35.6273	36.2430
4	35.3820	35.9438	35.6170	36.2344
5	35.3330	35.9053	35.1307	35.7532
6	35.4180	35.9995	33.5990	34.1737
7		35.9969		36.2029
8		35.9993		36.2404
9	35.5487	36.1399		36.2549
10	35.6170	36.2191		36.2483
11	35.6150	36.2286		36.1979
12	35.6213	36.2394	35.5527	36.1857
			35.4267	36.0559
			35.4297	36.0636
			35.3820	36.0267
				35.9512
				35.9673
			35.2800	35.9102
			34.9577	35.5823
			34.3334	



Route 7 NERC-NOCS Portsmouth - Bilbao

Page 5

Salinity Calibration with cleaning

Date form completed	12/03/2005
Manufacturer	CTG
Model	Minipack
Serial number	210039
Date last calibrated by manufacturer	02/02/2005
Calibration life remaining (months)	23
Frequency of user calibration check	
Units of measurement	PSU
Date last calibrated by user(if applicable)	
Checked today by	mch

Description of calibration Standard	See page 4
Description of calibration Blank	See page 4

Mean from previous calibration	
Std Dev from previous calibration	
Slope mV/ unit from previous calibration	

Before cleaning	Blank (fresh) Readings	**Before cleaning**	Standard (sea water) Readings
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
Mean	0	Mean	0
Std Dev	#DIV/0!	Std Dev	#DIV/0!

After cleaning	Blank Readings	**After cleaning**	Standard Readings
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
Mean	0	Mean	0
Std dev	#DIV/0!	Std dev	#DIV/0!

Difference before & after cleaning	n/a		
Mean Blank	0	Mean standard	0
Slope mV/ unit			

Route 7 NERC-NOCS Portsmouth - Bilbao

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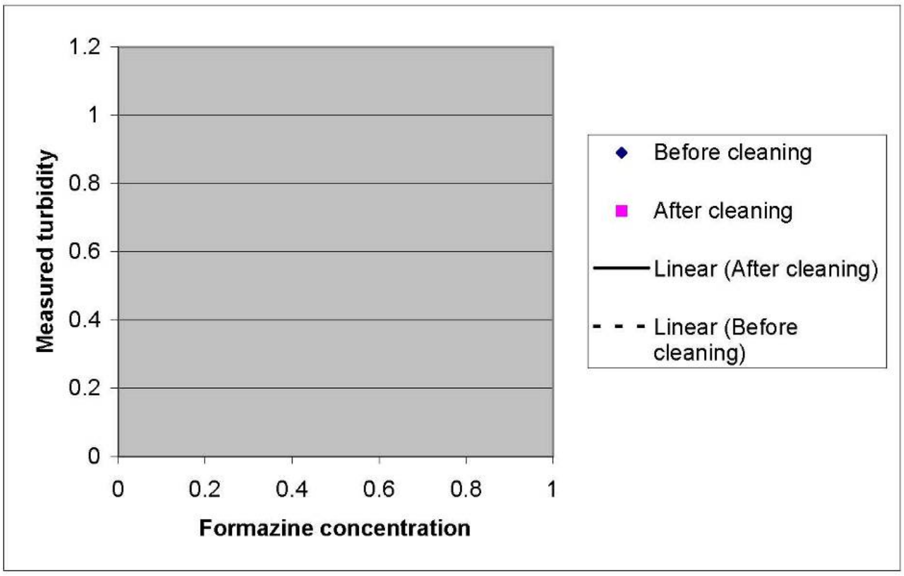
Turbidity Calibration by Formazine

Date form completed	12/03/2005
Manufacturer	CTG
Model	Minitracka
Serial number	175250
Date last calibrated by manufacturer	13/05/2003
Calibration life remaining (months)	10
Frequency of user calibration check	
Units of measurement	FTU
Date last calibrated by user	
Checked today by (Name)	mch

Description of calibration Standard	In situ Formazine
Description of calibration Blank	Formazine 1014 FTU dilutions

Mean from previous calibration	
Std Dev from previous calibration	R-Squared
Slope mV/ unit from previous calibration	

		Before cleaning	After cleaning
	Formazine concentration	Measured turbidity	Measured turbidity
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

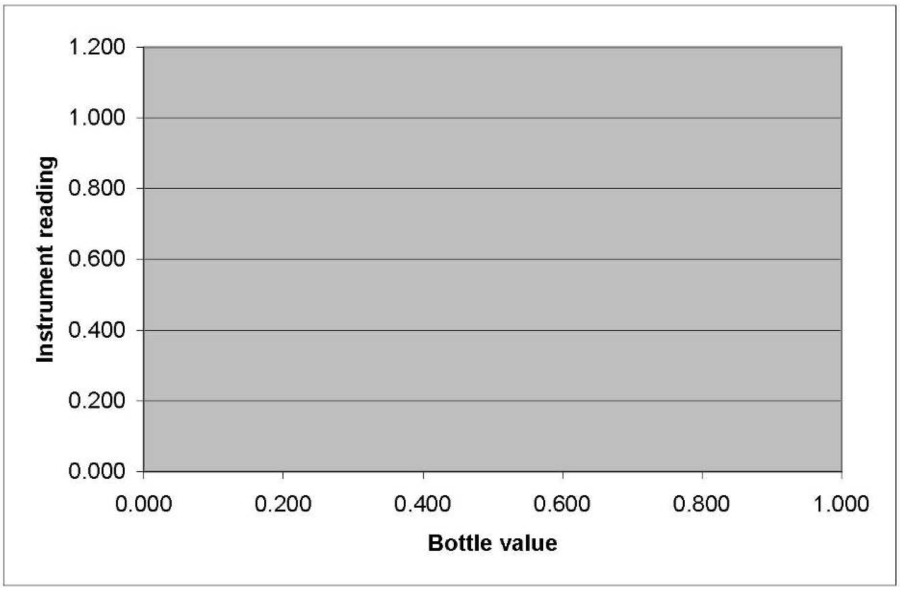


Route 7 NERC-NOCS Portsmouth - Bilbao

Turbidity Calibration using bottle samples

Date form completed	12/03/2005	
Manufacturer	CTG	
Model	Minitracka	
Serial number	175250	
Date last calibrated by manufacturer	13/05/2003	
Calibration life remaining (months)	10	
Frequency of user calibration check		
Units of measurement	mgl^{-1}	
Date last calibrated by user		
Checked today by (Name)	mch	
Description of calibration Standard	Gravimetric	
Description of calibration Blank	Suspended	Solids
Mean from previous calibration		
Std Dev from previous calibration		R-squared
Slope mV/ unit from previous calibration		

	Bottle Readings	Minipack Readings
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		



Route 7 NERC-NOCS Portsmouth - Bilbao

Fluorimeter Calibration using plastic blocks Page 8

Date form completed	09/03/2005
Manufacturer	CTG
Model	Minipack
Serial number	210039
Date last calibrated by manufacturer	02/02/2005
Calibration life remaining (months)	23
Date last calibrated by user	03/03/2005
Frequency of user calibration check	weekly
Checked today by (Name)	mch
Units of measurement	µg Chlorophyll-a /litre
Specification accuracy	not known
Concentration of calibration Standard	0, Low & High solid state chlorophyll blocks
Description of calibration Blank	in housing, no water

	High Standard
Mean from previous calibration	
Std Dev from previous calibration	
Slope mV/ unit from previous calibration	

	Before cleaning Blank Readings	Before cleaning Low Standard Readings	Before cleaning High Standard Readings
1	14.0		
2			
3			
4			
5			
6			
7			
8			
9			
10			
Mean	14	0	0
Std Dev	#DIV/0!	#DIV/0!	#DIV/0!

	After cleaning Blank Readings	After cleaning Low Standard Readings	After cleaning High Standard Readings
1	15.4		
2			
3			
4			
5			
6			
7			
8			
9			
10			
Mean	15.4	0	0
Std Dev	#DIV/0!	#DIV/0!	#DIV/0!
Difference before & after cleaning	Mean Blank	Mean low standard	Mean high standard
	-1.4	0	0
Slope mV/ unit			

Route 7 NERC-NOCS Portsmouth - Bilbao

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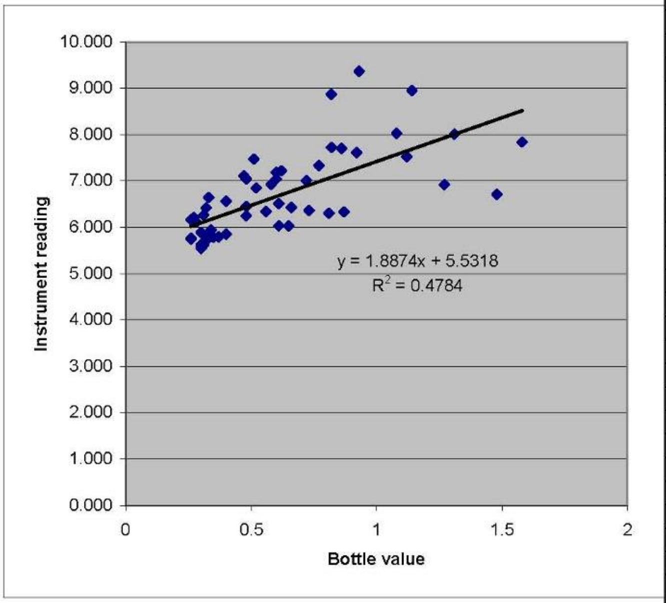
Fluorimeter Calibration using bottle samples

Date form completed	12/03/2005	
Manufacturer	CTG	
Model	Minipack	
Serial number	210039	
Date last calibrated by manufacturer	02/02/2005	
Calibration life remaining (months)	23	
Frequency of user calibration check	monthly	
Units of measurement	µg Chlorophyll-a /litre	
Date last calibrated by user		
Checked today by (Name)	mch	
Description of calibration Standard	Chl-a in acetone	
Description of calibration Blank		
Mean from previous calibration		
Std Dev from previous calibration	0.6071	R-squared
Slope mV/ unit from previous calibration	2.4983	

	Bottle Readings	Minipack Readings
1	1.58	7.840
2	1.27	6.920
3	1.48	6.710
4	0.81	6.300
5	1.12	7.520
6	0.87	6.330
7	0.73	6.360
8	0.65	6.030
9	0.61	6.030
10	0.66	6.430



Bottle Readings	Minipack Readings
0.56	6.340
0.61	6.510
0.48	6.250
0.48	6.450
0.37	5.790
0.3	5.600
0.26	5.770
0.26	5.750
0.32	5.760
0.3	5.890
0.34	5.940
0.31	5.620
0.3	5.540
0.3	5.570
0.3	5.620
0.35	5.790
0.4	6.560
0.93	9.370
0.82	8.870
0.72	7.010
0.4	5.850
0.33	5.770
0.31	6.260
0.33	6.640
0.28	6.110
0.26	6.170
0.27	6.210
0.32	6.420
0.48	7.040
0.51	7.470
0.47	7.110
0.62	7.220
0.52	6.850
0.6	7.040
0.58	6.930
0.6	7.180
0.77	7.330
0.86	7.700
1.14	8.950
0.82	7.720
0.92	7.610
1.08	8.030
1.31	8.010

CALIBRATION REPORT FOR FERRYBOX ROUTE 7 Page 10

DATE FORM COMPLETED:	12/03/2005

Temperature Sensor	
Type	Minipack
Serial Number	210039
Date of last calibration	02/02/2005
Calibration life remaining	23
Date calibration last checked	25/02/2005
Standard used for calibration check	bottle salinity

Conductivity (Salinity) Sensor	
Type	Minipack 2994
Serial Number	210039
Date of last calibration	02/02/2005
Calibration life remaining	23
Date calibration last checked	25/02/2005
Standard used for calibration check	bottle salinity

Turbidity Sensor	
Type	Minitracka II
Serial Number	175250
Date of last calibration	13/05/2003
Emission Wavelength	470nm
Excitation Wavelength	470nm
Calibration life remaining	10
Date windows last cleaned	09/03/2005
Date calibration last checked	

Chlorophyll *a* Sensor	
Type	Minipack
Serial Number	210039
Emission Wavelength	685nm
Excitation Wavelength	430nm
Date of last calibration	02/02/2005
Calibration life remaining	23
Date calibration last checked	25/02/2005
Standard used for calibration check	Chl-a in acetone
Date windows last cleaned	09/03/2005

Flow Through System	
Frequency of flushing	
Date last flushed	

Inspected by	

Signed	

11.4 PoB Events & visits diary

date	dayno.	time	entry by	comment
29/01/2005	29		djh	minitracka fitted
04/02/2005	35		mch	mch+je fitted newly calibrated minipack
22/02/2005	53	20:21	mch	Sensors cleaned. Start of Calibration crossing.
03/03/2005	62	19:30	mch	Sensors cleaned.
09/03/2005	68	20:10	mch	Sensors cleaned. Start of Calibration crossing.
12/03/2005	71	16:44	mch	Sensors cleaned. End of Calibration crossing
18/03/2005	77	17:56	mch	Sensors cleaned mch, djh.
05/04/2005	95		mch	Sensors cleaned.
11/04/2005	101		mch	Sensors cleaned.Start of Calibration crossing,
14/04/2005	104		mch	Sensors cleaned.End of Calibration crossing
20/04/2005	111		djh	Sensors cleaned.
29/04/2005	119		mch	Sensors cleaned.
05/05/2005	125		mch	Sensors cleaned.
11/05/2005	131		djh	Sensors cleaned.Start of Calibration crossing,
14/05/2005	134		mch	Sensors cleaned.End of Calibration crossing.
21/05/2005	141		djh	Sensors cleaned.
30/05/2005	150		djh	Sensors cleaned.
07/06/2005	158		mch	Sensors cleaned.
13/06/2005	164		mch	Sensors cleaned.Start of Calibration crossing,
16/06/2005	167		mch	Sensors cleaned.End of Calibration crossing.
25/06/2005	176		djh	sensors cleaned. FRRF removed from ship.
04/07/2005	185		djh	Sensors cleaned. rusty
07/07/2005	188		djh	Sensors cleaned.
16/07/2005	197		djh	Sensors cleaned. Very rusty lens nerly completely obscured. Bozo trap mted
19/07/2005	200		djh	Sensors cleaned. Rusty pipes flushed out. Bozo air pump turned back on
28/07/2005	209	18:00	djh	Sensors cleaned. Very rusty lens nearly completely obscured. Bozo trap checked OK. Hose replaced to minipack reust removed in take off point fittings
03/08/2005	215	17:00	djh	all surfaces rusty may be lighter than last week but only 6 days since last clean - changing hose has made no difference - photos taken.
12/08/2005	224	20:00	mch	Sensor heads were very dirty orange covering over most surfaces including and obscuring optics - sample obtained for SEM analysis
21/08/2005	233	20:00	mch	Sensor heads were very dirty orange covering over most surfaces including and obscuring optics. Oxygen sensor membrane lightly covered. Flushed out lower feed to minipack;
30/08/2005	242	18:00	djh	Fouling perhaps less heavy but still bad see pics
05/09/2005	248	17:00	mch	Tried new CTD S/N 04-4350-003, bad output, returned.
14/09/2005	257	16:25	mch	Minipack housing and minipack replaced with new units (210039 replaced with 04-4350-003), only functions for a few hours.
20/09/2005	263	16:25	djh	cable and old minipack - cable OK
26/09/2005	269	19:25	djh	September crossing
11/10/2005	284	17:10	djh	FerryBox senors - relatively clean -photos taken : Getting consistent readings with flourescent block seemed difficult when MiniPack cleaned

11.5 Pride of Bilbao Diary

date	entry by	
02/04/2005	djh	Pride of Bilbao Back in service
	djh	
24/05/2005	djh	Cal Xing
07/05/2005	djh	Cal Xing nutrients taken
	djh	
02/06/2005	djh	09:00 Xing Unit in engine room had stopped logging about 16:00 on 1/6/04. Got flash card from SOC fitted on 12:00 system then ran OK. NO samples taken. All time went in refitting system. System left flowing at 4LPM.
02/06/2005	djh	12:00 Xing fit flow meter and adjust flow. Problem was alignment of minitracka. Flow left at 4LPM. Higher rate flow meter ordered.
		e-mail from Malcolm to say flow turned off and he would turn it on again
10/06/2005	djh	calibration Xing with Mark Hartman
16/06/2005	djh	cal Xing djh & mch
23/06/2005	djh	Day of storms and rain. Cal Xing djh & mch. 13 Nut & chl samples. System cleaned fouling looked like last week but data shows very high positive fouling particularly of fluorimeter. Fluorimeter and minitracka readings remained high in air before windows were cleaned. Very windy (35-40 kts?) from South high turbidity measurements as ferry took a detour over shallower waters.
30/06/2005	mch	No calibrations possible as Logging had stopped day 181 04:19:59 and would not restart. Fault traced to occur when cable plugged into Minipack. Replacement unit brought out to ferry upon return, fitted in place. Logging commenced as per usual. Fault deemed to lie in Minipack. Flow meter reading 20 lpm even when no flow problem caused by vegetation buildup within flow meter, unit removed.
07/0704	mch	Wind strong 5 ish from the East so some swell in English channel. First crossing with replacement Minipack. 1100am sailing. Delayed Bilbao (link span failure). Updated logging software installed whilst at Bilbao, should now show unexpected signals from Minipack. 15 calibration samples made 5.01 to 5.15. Chl 5.05 and 5.06 filters very evenly covered brown rather than green. Nut 5.11 only had 1 cursory rinse.
14/07/2005	mch	Cal Xing mch & saw With djh onboard at outset. Wind Southerly steady breeze, second crossing with replacement minipack. 0900 sailing (0800 GMT). Little apparent fouling. No high variations in any recorded values. Data downloaded from Bridge and engine room loggers
21/07/2005	mch	Cal Xing mch, saw. Third crossing with replacement minipack. Little apparent overall variation. Temperatures from alcohol, IR and logger compared.
28/07/2005	mch	Cal Xing mch, saw. fourth crossing with replacement minipack. Slimy transparent coating over lenses. One lugol sample taken.
04/08/2005	mch	Cal Xing mch, saw. fifth crossing with replacement minipack. Slimy transparent coating over lenses slight increase in greenness of filters this week over the last few. One lugol sample taken 9.12. More filters required. Weather warm, some breeze from SW.
11/08/2005	mch	mch Fluorimeter check, cleaned sensors. Heavyish build up of muddy sediment over sensor head. Downloaded engine room data.
18/08/2005	mch	mch, djh cleaned sensors, downloaded all data. Chopped minitracka cable spliced as per PoB, refitted 19/8/04.

25/08/2005	mch	Cal Xing mch, djh. First crossing with new minitracka cable. Heavy deposits of grey/green substance. Wind from North.
02/09/2005	mch	Cal Xing mch. First leg attempt to asses minitracka output. 2nd leg calibration samples
16/09/2005	mch	cal Xing djh & mch. Clean sensors. Fluor check. Minitracka check using new blocks, no data download. Little fouling of optics.
23/09/2005	mch	cal Xing mch & mqurban. Formazine standard used with turbidity sensor in housing, acrylic blocks and photo stops. Cal check of fluorimeter, samples taken on Bilbao - Soton leg, strong wind from W, high turbidity generally.
30/09/2005	mch	suh + djh. Clean Sensors. Fluor + minitracka check.
13/10/2005	mch	cal Xing djh & mch Sensors cleaned. Formazine standard used with turbidity sensor in housing, acrylic blocks and photo stops. Cal check of fluorimeter, Wind from South some white horses.
27/10/2005	mch	djh & mch data download. Removed sensors to SOC. Last data 10:40

11.6 Salinity Calibration table

Period	From	To	A	B
1	35.73450	53.85120	0	-0.157
2	53.85120	62.81500	0.157	0.000
3	62.81500	68.78400	0.046	0.046
4	68.78400	71.69850	-0.093	-0.046
5	71.69850	77.72800	-0.046	-0.093
6	77.72800	86.70900	0.037	-0.056
7	86.70900	95.72900	0.148	0.093
8	95.72900	101.75400	0.065	0.157
9	101.75400	104.64480	-0.111	0.046
10	104.64480	110.77100	0.318	0.364
11	110.77100	113.70000	-0.028	0.337
12	113.70000	116.60000	0.1395	0.476
13	116.60000	119.69800	0.1008	0.577
14	119.69800	125.72600	-0.573	0.004
15	125.72600	131.72800	0.204	0.208
16	131.72800	134.65520	-0.176	0.032
17	134.65520	140.72900	0.085	0.117
18	140.72900	146.70000	0.496	0.613
19	146.70000	149.69400	-0.039	0.574
20	149.69400	158.70000	-0.163	0.411
21	158.70000	164.74000	-0.231	0.179
22	164.74000	167.66200	-0.278	-0.098
23	167.66200	170.70000	0.000	-0.098
24	170.70000	176.68000	-0.066	-0.164
25	176.68000	185.76000	0.157	-0.007
26	185.76000	188.74440	-0.231	-0.238

Period	From	To	A	B
27	188.74440	197.69000	0.101	-0.137
28	197.69000	200.75000	-0.054	-0.192
29	200.75000	203.60000	-0.037	-0.229
30	203.60000	206.90000	0.06	-0.169
31	206.90000	209.76000	0.07	-0.099
32	209.76000	215.71000	0.398	0.300
33	215.71000	224.81000	0.093	0.393
34	224.81000	233.87000	-0.316	0.077
35	233.87000	242.74000	0.000	0.077
36	242.74000	248.72000	0.039	0.116
37	248.72000	257.68540	-0.052	0.064
38	257.68540	269.71000	-0.116	-0.052
39	269.71000	284.72000	0.104	0.052
40	284.72000	293.68000	0.207	0.259
41	293.68000	299.90000	0.021	0.280
42	299.90000	305.86000	0.078	0.357
43	305.86000	311.77500	-0.254	0.103
44	311.77500	320.80340	0.066	0.169
45	320.80340	323.71000	-0.066	0.103
46	323.71000	326.72000	-0.054	0.048
47	326.72000	332.79200	-0.016	0.033
48	332.79200	335.81060	0.287	0.320
49	335.81060	338.91950	-0.035	0.285
50	338.91950	341.73540	-0.031	0.254
51	341.73540	347.92890	-0.019	0.234
52	347.92890	365.00000	-0.016	0.219

Period	Identifier
From	Start of period of correction (day number)
To	End of period of correction (day number)
Column A	Corrective offset from previous period
Column B	Corrective offset from period 2

How to correct the data

1/ Calculate the salinity from the FerryBox conductivity, temperature and pressure variables.

2/ Add the correction in column B to data spanned by the 'From' and 'To' columns.
This corrects for jumps in the salinity created by flow cell conductivity changes

3/ Apply the following equation y = 1E-07x2 - 8E-05x + 0.9895
where x is the day number (12:00 January 1st = day 1.5)
This applies a calibration based on the bottle samples throughout the year
with a fit of R^2 = 0.9747

Table 2 Timing and corrections applied to salinity data during 2005

11.7 Data processing from Flash card to ASCII

Pride of Bilbao Ferry Box System Data Processing

January 2005 Overview

The new engine room logger that began recording on 8th October 2004 underwent various modifications and additions during the autumn of 2004 and was reinstalled after the ship's annual refit on 29th January 2005.
Data are logged on to CompactFlash cards, which can hold up to 2 months of data, but are usually swapped after a week or two. The current data rate for this "raw" data (much of which is in binary format) is just under 10 MB per day.

The processing regime has gradually evolved over the past 4 months and will continue to do so as new sensors are added to the system.

Processing Stages

1. Copy entire flash card to hard disk and to optical storage archive.
2. Use "PofBprc2.c" program to produce 1 text file of combined MiniPack and GPS data at 1Hz.
3. Use fmergeXP.c to concatenate daily hull temperature or PIC temperature files.
4. Use oxy_proc.c to combine all the daily, binary oxygen files into a single text file.
5. Use MATLAB to plot the results and check all is OK.
6. Use oxy_prc2.c to combine the oxygen, MiniPack and GPS data and produce individual crossings files. Sampling rate is determined by the oxygen sampling rate.
7. Use TCM2proc.c to combine daily, binary pitch/roll files into a single text file.
8. Copy processed data to shared network drive.

Data Processing Programs

PofBprc2.c
This program begins by converting the binary GPS files to text files, and interpolating across any gaps in the 1 Hz data. This is done because the Garmin 128 GPS receiver currently used is unable to maintain a 1 Hz output rate, only managing around 3 position fixes every 4 seconds.
The program then converts and combines the binary MiniPack files into a single text file and for each sample, locates the closest GPS fix and adds this data to the output string. If there are no GPS records available for a given MiniPack record, all the relevant fields are set to zero.
The output text file is given the same name as the first MiniPack file to be processed, but with an extension ".prc". This file contains 16, space-delimited fields. Working from left to right these are:-

1. The year as 2 digits
2. The Julian Day to 8 decimal places
3. The corresponding time expressed as hh:mm:ss.ss (This is superfluous, but can be useful)
4. The MiniPack conductivity reading in mmhos/cm
5. The MiniPack temperature reading in degrees centigrade
6. The MiniPack pressure reading in dbar
7. The MiniPack fluorimeter reading (units?)
8. The MiniTraka reading in Volts
9. The MiniPack power supply voltage in Volts
10. The MiniPack power supply current in mA
11. The GPS latitude
12. The GPS longitude
13. The distance in km from a "reference" position, in this case Portsmouth (50.811062 °N, 1.093519 °W)

pride of bilbao data processing *1* *4-Feb-05*

Pride of Bilbao Ferry Box System
Processing of Flash card data

Key points

1. Unadulterated flash card contents to be archived by Jon for engineering purposes and as a last resort data backup.
2. MiniPack and GPS data to be combined at 1Hz and divided into separate files for each crossing. A crossing is deemed to start/end when the ship has been stationary for 1 hour.
3. Hull temperature and Oxygen data to be merged into these files, with missing values assigned a vale of "NaN".
4. Format of these files is described below.

First stage processed file – proposed format

1. The year as 2 digits
2. The Julian Day fraction to 8 decimal places
3. The corresponding time expressed as hh:mm:ss.ss
4. The GPS latitude
5. The GPS longitude
6. The time difference in seconds between the GPS time stamp and the MiniPack time stamp (MPK – GPS)
7. The MiniPack conductivity reading in mmhos/cm
8. The MiniPack temperature °C
9. The MiniPack pressure reading in dbar
10. The MiniPack fluorescence reading (units?)
11. The MiniTraka reading in Volts
12. Seabird hull temperature °C
13. Optode oxygen in µmol/l for s=0
14. Optode oxygen saturation (%)
15. Optode temperature °C
16. Optode Dphase
17. Optode Bphase
18. Optode Rphase
19. Optode Bamp
20. Optode Bpot
21. Optode Ramp
22. Optode RawTem.
23. The time difference in seconds since last Optode sample
24. The time difference in seconds since last MiniPack sample (should be 1 second)

NOTE that all of these values will be as received from the various sensors. No calibrations or corrections are applied at this stage.

11.8 ASCII data format and corresponding Matlab variables

tdiff - time difference in seconds

No.	Description	Variable name
1	The year as 2 digits	YR
2	The Julian Day fraction to 8 decimal places	jd
3	The corresponding time expressed as hh:mm:ss.ss	HH, MM, SS
4	The GPS latitude	LAT
5	The GPS longitude	LON
6	tdiff between the GPS time stamp and the MiniPack time stamp (MPK – GPS)	TDIFF
7	The MiniPack conductivity reading in mmhos/cm	COND
8	The MiniPack temperature °C	TEMP
9	The MiniPack pressure reading in dbar	PRESS
10	The MiniPack fluorescence reading (units?)	FLUOR
11	The MiniTraka reading in Volts	MTRK
12	Seabird hull temperature °C	THULL
13	Optode oxygen in µmol/l for s=0	OXY
14	Optode oxygen saturation (%)	OSAT
15	Optode temperature °C	OTEMP
16	Optode Dphase	ODPHS
17	Optode Bphase	OBPHS
18	Optode Rphase	ORPHS
19	Optode Bamp	OBAMP
20	Optode Bpot	OBPOT
21	Optode Ramp	ORAMP
22	Optode RawTem.	ORTMP
23	tdiff since last Optode sample	OTDIFF
24	tdiff since last MiniPack sample(should be 1 second)	LAST

11.9 Cleaning spreadsheet example

Platform	Pride of Bilbao
Instrument suite	Ferrybox
Personnel	mch, joc
Date	19/10/01
Day number	293

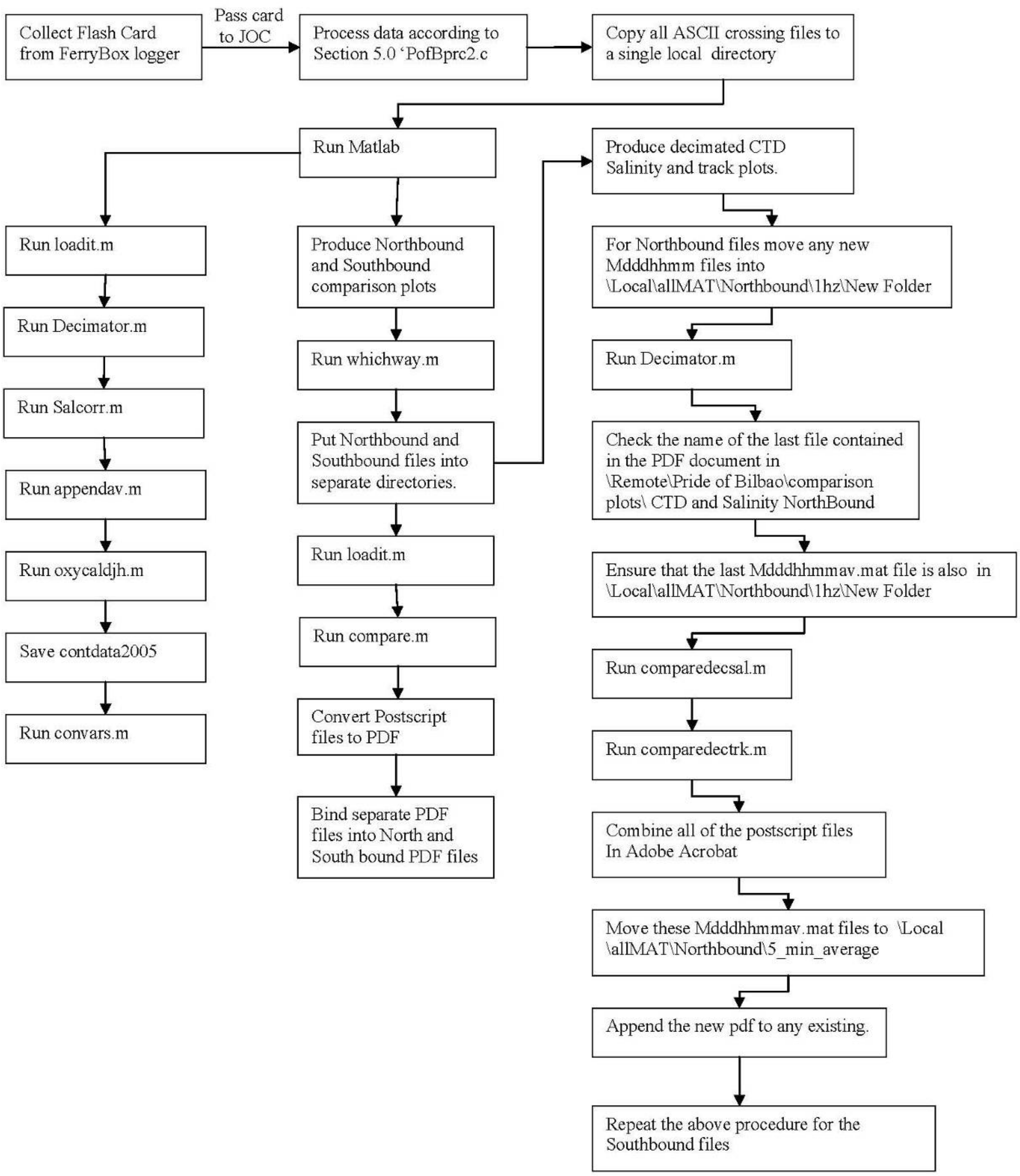
	Before	After	Diff
taps ON		17:21:00	
time	16:04		0.05
conductivity	44.26	43.95	-0.31
water temperature	16.00	15.91	-0.10
hull temperature	16.11	16.46	0.35
fluorescence	1.46	1.42	-0.04
pressure	19.62	18.67	-0.95
minitracka	0.21	nan	
oxygen	289.70	283.11	-6.59
saturation	94.37	92.04	-2.33
optode temperature	16.14	16.06	-0.08
box temperature	30.80	31.20	0.40
power temperature	43.00	43.20	0.20
FerryBox flowrate	11.23	12.20	0.97
taps OFF	16:13:30		

Sensor	Fluor	Orientation			Minit			Oxygen sensor in air	
Reading	housing	flat	wide	tall	housing	Low	High	dry	wet
time	16:26:00				16:28:00				
dirty 1	0	48.8			0.353				271.7
2		48							
3		47							
4		48.4							
5		45.6							
6		46.5							
7		47.2							
8		47.8							
9		46.9							
10		45.2							
time	16:45	16:52			16:45				
clear 1	-0.1	47.5			0.581			254.87	202.97
2	-0.1	48.1			0.575				250.62
3		46							
4		46.7							251.6
5		45.3							251.8
6		46.1							
7		41.9	not held with fingers						
8		41.6	not held with fingers						
9		41.5	not held with fingers						
10		41.5	not held with fingers						
Diff	-0.10	-2.52			0.23				

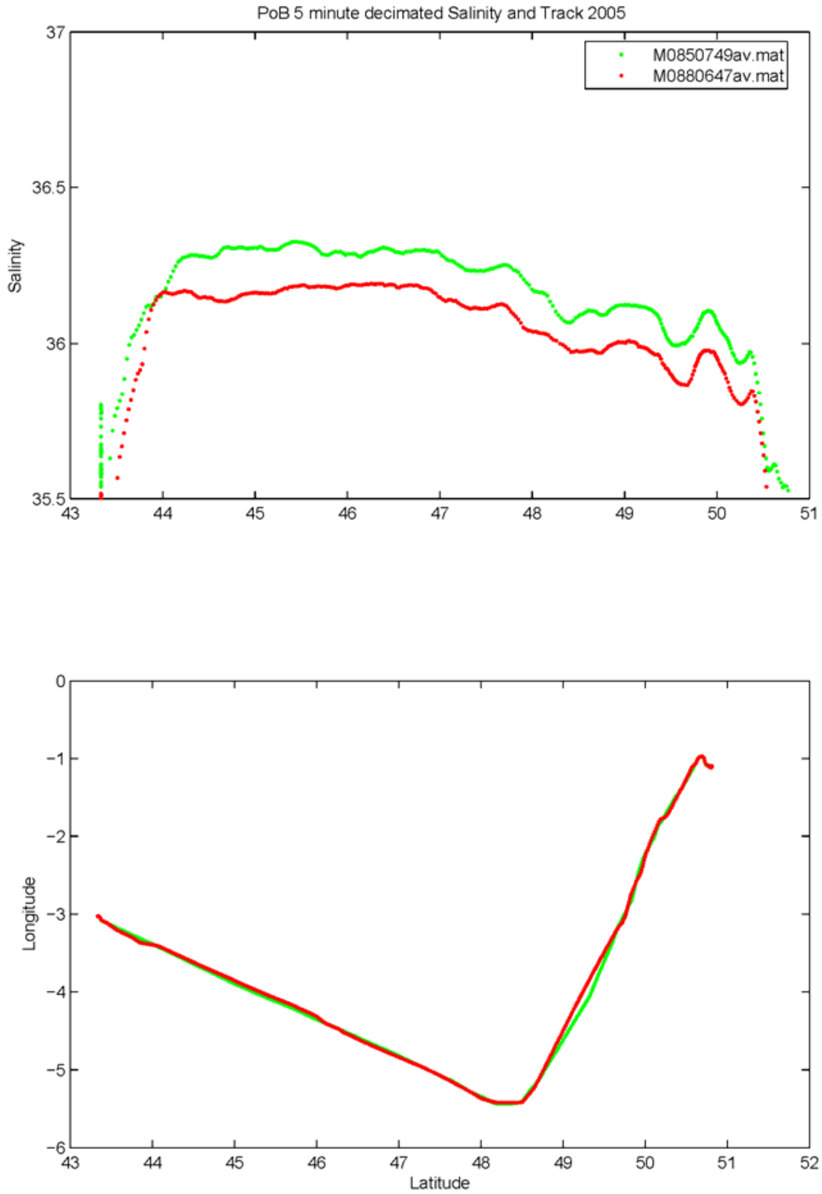
comments :	Some growth in drainage hole to RHS of minipack housing: long stems ~3 to 5 cm with
	bulbous heads.
	Holding the fluorescence block in place with one finger increases the fluorescence rea
	in the cleaned situation from 42 to around 48 FTU
	17:11 Minitracka housing cracked along line of allen bolt shortly after water
	was turned on. Temperature effect?

Day num.	Pre and post clean Salinity Samples	
293	Before	After
Bottle	66 yellow	67 yellow
Time	16:11:09	17:37:00
C	44.233	43.944
T	15.9936	15.911
D	19.69	18.58
Salinity Minipack Bottle	35.295	35.110

11.10 Salinity jump graphical analysis method



11.11 Northbound and Southbound comparison plots



11.12 Processing notes

Copy files from the sub-directories in \Remote\Pride of Bilbao\2005

To \Local\allASCII

Move files (<10MB) to the sub-directory \Local\allASCII \short files

\Scripts\ **whichway.m**-this selects files where the ferry was traveling North by comparing first and last latitudes from the file; if the last latitude is the greater then it appends the filename to a list file called Northlist.txt and creates an m-file called nlist.

Move files to their respective Northbound and Southbound subdirectories.

\Scripts**loadit.m**-this reads in the files sequentially, calculates salinity and then saves the data in matlab files with the same name but extension .mat.

\Scripts**compare.m**-this loads sequentially in pairs Ferrybox data from all the files in the current directory of the type M*.mat. In this case all the files are either Northbound or all Southbound. It renames vars var1 from file 1 and vars2 from file 2. It calculates axes limits to highlight the differences between successive legs and plots the variables SAL FLUOR MTRK OXY in a stack on the page. It also creates Postscript files of the same. The Postscript files are converted to PDF format and bound into two files \Local\ NorthboundPoB.pdf and \Local\ SouthboundPoB.pdf. In order to compare salinity more effectively the y-axis limits were set to 35.5 to 36.5 and the last routine reran to produce files Northboundfix and Southboundfix, these were put in the directory \Remote\Pride of Bilbao\Comparison plots together with the last versions.

To produce decimated CTD Salinity and track plots.

For Northbound files move any new Mdddhhmm files into
\Local\ \allMAT\Northbound\1hz\New Folder
Run **Decimator.m** in this directory to generate 5-minute files
Check to see what the last file contained in the pdf document in
\Remote\Pride of Bilbao\comparison plots\ CTD and Salinity NorthBound
Ensure that the last Mdddhhmmav.mat file is also in
\Local\allMAT\Northbound\1hz\New Folder
Run **comparedecsal.m** to produce CTD postscript files
Run **comparedectrk.m** to produce Sal and track postscript files
Combine all of the postscript files In Adobe Acrobat
Move these Mdddhhmmav.mat files to \Local \allMAT\Northbound\5_min_average
Append the new pdf to any existing.
Repeat the above procedure for the Southbound files

NB file M2040640 is Northbound but has a Southbound part around 45N. ie LAT is NOT monotonic
M1671649 occurred in both North and South directories but should have been in South only hence will appear incorrectly in the compound comparison pdf files.

C:\Documents and Settings\mch\Desktop\PoB2005 processing\2005\all\decimated contains files that have been reduced in sampling rate by 300 to 5 minute samples. These have all been appended into a file called 'alldec.mat' using the file '**appendav.m**'

Discrepancies in the salinity between successive Northbound legs could indicate a problem either in the processing route or the underlying programs. In order to rule out the processing aspect the original files will be compared rather than using the decimated files. The same effect ie offset in salinity was seen in the 1 Hz files M0520750 and M0550746 they do however span a cleaning event.

Salinity anomaly

In order to check that the Salinity values calculated within Matlab the variation between variables from the crossing files M0520750 and M0550746 at Latitude 45N were checked using a separate salinity calculator http://ioc.unesco.org/oceanteacher/resourcekit/M3/Converters/SeaWaterEquationOfState/Sea%20Water%20Equation%20of%20State%20Calculator.htm

Conuctivity	**Pressure**	**Temperature**	**Salinity**
41.818	16.7	12.67	36.12655
41.818	16.7	12.3	36.48472
42.727	16.7	12.67	37.00678
42.727	16.7	12.3	37.37387

The Salinities thus calculated bounded those displayed in the Matlab plots. As a rule of thumb at 12.7 degrees an increase in Salinity of 1psu can be caused by a Conductivity increase of 1mmho/cm (0.1S/m) or a drop in Temperature of about 1 degree.

Latitude Bins

When the ASCII files have been read into Matlab the m-file

C:\Documents and Settings\mch\My Documents\Ferrybox\PoB2005\m_files**bin_it.m**

Is used to average all of the variables from the North bound legs (less longitude variation) into 70 latitude bins. These files were moved to the directory;

C:\Documents and Settings\mch\My Documents\Ferrybox\PoB2005\North\lat_bin

Where they were appended into a single file called allbin.mat using the script

C:\Documents and Settings\mch\My Documents\Ferrybox\PoB2005\m_files**appendbin.m**

As there are large offsets throughout the salinity data set a method of salvage was needed to recover meaningful information from the salinity data. From 2003 and 2004 data it was seen that the salinity around the region 45 to 45.0N remained fairly constant at 35.62 +/- 0.05. Doubts over the quality of the bottle salinity data have also been raised.

Power Supply

1Hz Voltage and Current supply data were analysed alongside 1Hz salinity data from day 215 to 242. See

C:\Documents and Settings\mch\My Documents\Ferrybox\PoB2005\Power

PwrSal.m and **PwrSalav.m** were created to this end.

The difference between successive salinity measurements does not generally exceed 0.005 psu. This difference was calculated before the data were filtered using a moving average filter.

Dot plots

C:\Documents and Settings\mch\My Documents\Ferrybox\PoB2005\decimated\PoB 2002 to 2005

This directory has decimated variables plotted as dot plots against Latitude and Day number. This highlights the salinity offsets and how they occur with cleaning events.

Overview

copy ASCII crossing files to local directory

C:\Documents and Settings\mch\My Documents\Ferrybox\PoB2005\monthly

Extract from folders so all files are in the same folder

loadit.m - loads sequentially Ferrybox data from all the files in the current directory with the extension .XNG (ASCII) calculates salinity and saves as matlab files of the same name but with .mat extension. The program PFE was used to remove lines from files that did not load due to NaN's for the majority of the data. **decimator.m** - loads sequentially the Ferrybox data from all the matlab files in the current directory and reduces the sampling rate to once every 5 minutes. **salcorr.m**-calculates a salinity correction assuming a constant salinity of 35.62 between 45 and 45.5 degrees North on PoB track. It takes allbin.mat as input **salcorr1.m**-applies salinity correction to PoB decimated data using a constant value of 35.62 at latitude 42.25. Input-Mdddhhmm.av, output-Mdddhhmm.sav. Load alldec.mat – the file containing the currently concatenated data processed to this stage. Run **appendav.m** to concatenate 'avs' files. Run **oxycaldjh.m** to calculate oxygen anomaly. Save file as contdata2005 in directory
C:\Documents and Settings\mch\My Documents\Ferrybox\PoB2005\2003_2005. Run **convars.m** to convert varnames to be coincident with Boris' execs. Produce plots with Boris' programs.