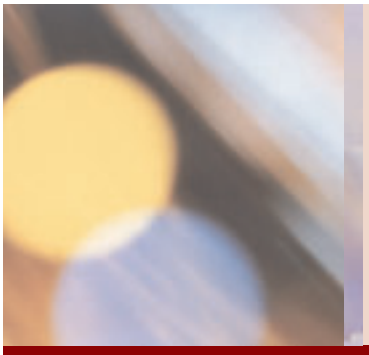


IT Solutions Focus

OCEANOGRAPHIC DATA COLLECTION ON YOUR HOLIDAY FERRY

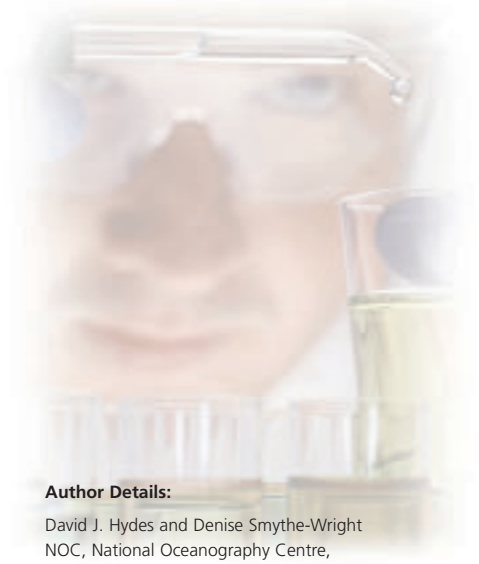
David J. Hydes and Denise Smythe-Wright, NOC National Oceanography Centre

Those of you who have started your Spanish holiday by sailing on P&O's ferry the Pride of Bilbao were probably aware of the above deck activities of the Biscay Dolphin Research Programme.

This year if you travel on the Ferry you will see for the first time a live TV display of the scientific data being collected below decks by the National Oceanography Centre, (NOC) Southampton. (www/noc.soton.ac.uk)

In the ship's engine room water is being continuously analysed to measure the concentrations of important ecosystems components to improve ourunderstanding of how the oceans function (Figures 1 and 2).

> ***"A HOLIDAY FERRY HELPS BUILD UP TO A GLOBAL OBSERVING SYSTEM"***



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There is an international desire to develop a Global Ocean Observing System (GOOS http://www.ioc-goos.org). Traditional methods of obtaining oceanographic data have high overheads in terms of staff and the use of dedicated research ships. Recently one of the oldest ideas in oceanography - the use of ships of opportunity - "piggy-backing" scientific research on merchant ships has come to the fore as reliable autonomous data collection systems can now be installed on ships. Europe has taken a lead in these activities. Our system began life as part of a major initiative part funded by the European Union to demonstrate the scientific value of well validated ship of opportunity data. The project is called "FerryBox". Details of the different systems and ships adopted by the consortium can be found on the group's web page http://www.ferrybox.org.

SCIENTIFIC DRIVERS

The oceans play a major role in reducing the rate at which the planet is "warming" (more energy is being retained in the atmosphere) due to increases in the atmospheric concentration of CO_2 and other "green-house gasses". Fossil fuel CO_2 is now a major ion in seawater, and it is accumulating in the upper ocean at a rate of 25 million tons per day. However we have a poor information base for estimates of for how long the ocean will remain an effective absorber of CO_2. This is because although the inorganic chemistry of CO_2 dissolution in seawater is well known, what happens in practice depends on:- (1) how rapidly the surface waters of the oceans are renewed from the depths with water that has not been exposed to modern days levels of CO_2, and (2) how effective the life and death cycle of plankton is at removing CO_2 by photosynthesis into material which sinks into the depths of the oceans taking carbon with it. CO_2 affects life both in the atmosphere and the ocean.

CO_2 is not the only gas that contributes to controlling the environment in which we live. For example trace amounts of organo-halides enhance chemical reactions leading to ozone loss and may lead to formation of clouds causing a net negative effect on the radiation balance and so potentially mitigate global warming. These are produced photochemically and biologically, but why phytoplankton produce these gases is unclear. Production in the sea is probably controlled by community structure and environmental conditions such as food supply.

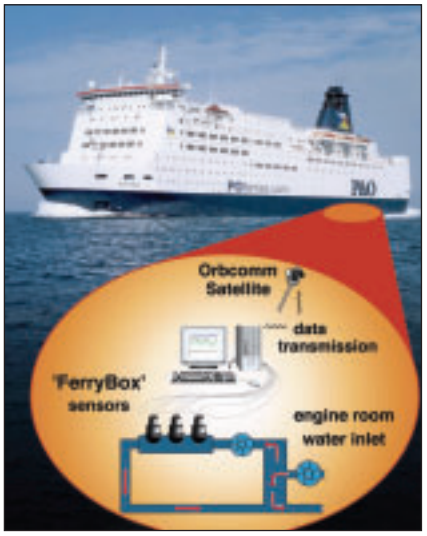

Figure 1. Pride of Bilbao with diagramatic insert showing the FerryBox equipment attached

Understanding the oceanic sources and sinks of these gases is fundamental to our ability to predict global change. Iodine compounds, are known to be produced by a small plankton called Prochlorococcus in waters warmer than 15°C. Global warming may increase their abundance and release of iodine species.

These processes can be reproduced in numerical models that are being developed to predict the future of the planet. However too few observations of the real world are available to properly calibrate them. Insufficient data exists for us to be able to identify all of the key regions of interest on the globe, for example little data exists in most shallow shelf seas and it is uncertain what role they play. The task of our work is to help redress this imbalance.

'PRIDE OF BILBAO' SYSTEM

The NOC operates a "FerryBox" between Portsmouth on the UK south coast and Bilbao on the northern coast of Spain. This route is of considerable interest because of the wide range of conditions it crosses between the Atlantic Ocean (4000m deep) and the English Channel (50m deep). The data collecting system is the culmination of recent developments in both sensor technology and system architecture. The key design criteria were:- (1) to meet the safety

Figure 2. The FerryBox flow through system - the instruments for measuring temperature conductivity, fluorescence and oxygen in their flow housing, and Fast Repetition rate fluorimeter under test on the bench in the foreground.

requirements of P&O Ferries Ltd (2) to be reliable electronically and mechanically (3) to provide data of oceanographic quality (4) to log data at 1Hz to detect small oceanographic features (5) to automatically send data ashore so that the functioning of the system could be monitored and failures detected ahead of service visits. In addition, environmental requirements dictated that the system should run reliably within any of the ships engine spaces (summer temperatures above 40 °C and 100% humidity), with no risk to disruption of the primary activity of the vessel. Also maintenance must not interfere with the ship's functions, and be able to be done by a non-expert within a maximum of 2 hours when the ship is in port.

The system has four key components: a flow through system where the sensors contact the seawater; a data logging system to collect the data from the sensors; a data transmission system to send sample data from the engine room ashore; a data logging and visualisation system on shore. In 2002 the system started with measurements salinity (conductivity), temperature, and chlorophyll-a (fluorescence) as well as time and the ship's position. In 2005 the system as expanded to include continuous measurements of dissolved oxygen and the partial pressure of CO_2 in seawater. In 2006 measurements of trace halogenated gasses have been added to the system, and later this year a robotic system for the collection and preservation of samples filtered from the water will be fitted.

INSTRUMENTATION

The key hydrographic parameters conductivity, temperature, (pressure) and chlorophyll-a fluorescence are measured using a Chelsea Technologies Group MiniPack CTD-F. A second flow through housing holds an Aanderaa oxygen

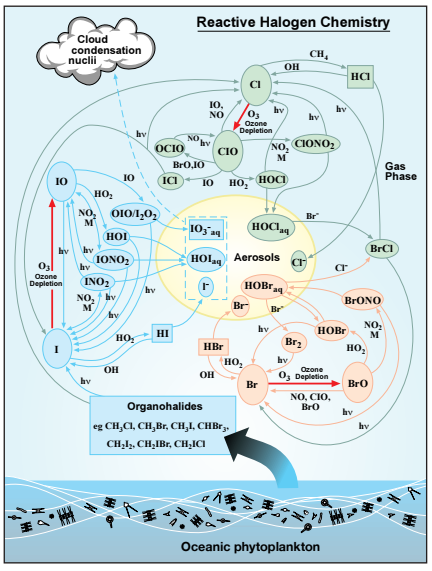

Figure 3. The complex web ot reactions in the atmosphere following the release of organohlaide gasses from plankton

Optode. The Aanderaa Instruments Optode is one of several instruments that have revolutionised the quality of data being collected for oxygen in recent years. Comparison of the data from the Optode with measurements made on board the ship using the classic Winkler titration showed that the output from the Optode did not drift over a year of continuous operation. It gave a reading every 30 seconds and the precision remained similar that achievable with the titration. (*Figure 2* shows how these are mounted in the ship)

The partial pressure of CO_2 is measured by equilibrating a steam of air with seawater flowing down a cascade chamber. The CO_2 content of the air stream is measured using a Li-Cor Biosciences, Licor 7000 CO_2 analyser. The pCO_2 in the seawater is then calculated knowing the in-situ temperature and salinity of the seawater the water temperature in the equilibriator and the air pressure. The GC-MSD is a Hewlett Packard HP 5890/5971, fitted with a 60 m CB Sil-5, 0.32 mm id column

The other gases measured include small organo-halides. GPS information is used to automatically switch off the system close to port areas which are heavily contaminated. The instrumentation consists of an autonomous membrane-inlet purge and trap system, which pumps water from our intake manifold (*Figure 4*) . This is coupled to a combined Gas Chromatograph Mass Spectrometer system (GC MS). The carrier gas is helium throughout. The inlet comprises co-axial stainless steel/silicone tubes that act as a membrane for the gas transfer from the sea water, and a carboxen trap. The GC-MS is a Hewlett Packard HP 6890/5973 MSD, fitted with a 30 m CB Sil-5, 0.32 mm id column. We are developing an unmanned robotic system for the collection of samples for biological analysis. The robotic arm has two claws, one is fitted with a seawater injection system, and the other is for moving samples into appropriate cryogenic storage containers.

DATA ACQUISITION AND TRANSMISSION

A major part of the growing success of the work on the Pride of Bilbao has been the high degree of reliability of the data acquisition and transfer system developed by NOC's engineers. Sampled data is sent to an Orbcomm satellite communications unit on the bridge and received at NOC from the Orbcomm ground station in Italy as an e-mail message. The message is automatically processed and the information is written to a MYSQL data base. This un-calibrated data is then available via a public access web page so that operation of the system can be checked from anywhere in the world with web access. In addition the data in the MYSQL data base can be downloaded from the webpage* to a text or directly to an EXCEL file.

**www.soc.soton.ac.uk/ops/ferrybox_index.php*

Figure 4. The autonomous membrane-inlet purge and trap system being fitted in the Pride of Bilbao engine room.

INTO SPACE

Instrumented satellites orbiting the earth are able to provide an integrated picture of how the earth's temperature is changing as the climate changes. These remote observations need to be calibrated against ground truth. NOC, working with Brookhaven National Laboratory (USA), the European Joint Research Centre (JRC), and the UK Met Office, has built an autonomous instrument to measure sea surface temperature (SST) from ships validate the skin SST measured by satellites. This has been fitted on the bridge of the Pride of Bilbao and provides measurement SST with an accuracy of ± 0.1K. This data and other data provided by satellites are important is enabling us to extrapolate the one dimensional data from the line of the ferry into more dimensions.

Acknowledgements

We are very grateful to P&O Ferries Ltd for the access they have provided to their ship and their helpfulness to us in setting up and maintaining the system. NOC's Portsmouth-Bilbao FerryBox system would not exist or be the success that it has been without the input of large number of people. Particularly C. Bargeron, S. Boswell, J. Campbell, M. Edwards, J. Gonzalas-Rodriques, B . Kelly-Gerreyn, M. Hartman & W. Wimmer.