Temperature and salinity variability between Bilbao (ES) & Portsmouth (UK) from 2003 through 2010

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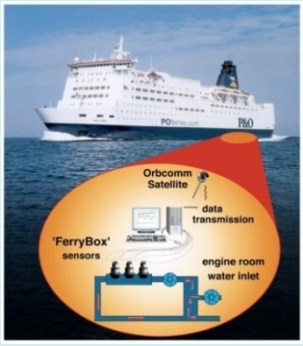
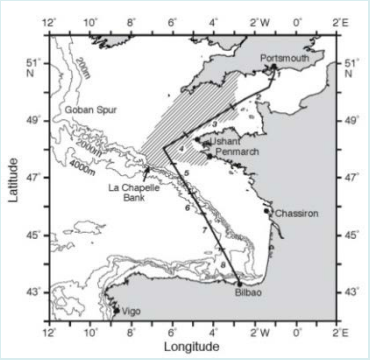


The FerryBox advantage
Oceanic changes occur over a broad range of spatial and temporal scales. Ships of Opportunity (SOO) incorporating FerryBox systems can and do fill a vital niche between other measurement methods including Eulerian, Lagrangian and Remote sensing. The high repeat rate (hours to a few days) of a ferry route allows the effects of short period processes such as storms to be identified as well as providing information on the spatial distribution of these changes and identifying where features are either transient or persistent.

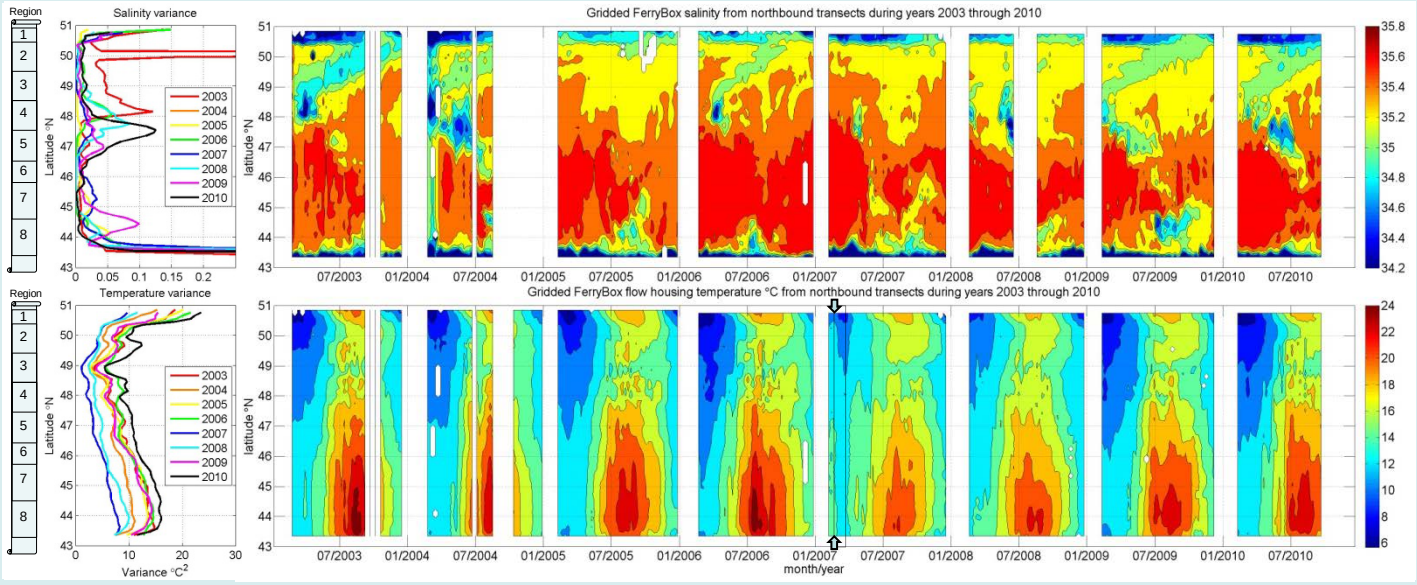
Data management Development of robust physical systems and data processing methodologies are necessary to deal with these demanding and harsh environments. Pride of Bilbao FerryBox data are logged at a rate of up to one sample per second, outliers are flagged on a latitudinal basis and then five minute averages are generated from these. The Northbound transects (Bilbao to Portsmouth) are chosen as their routes are consistent. The data shown here are gridded into cells representing one week in time and 1/10° latitude. The gridding process enables data from successive years to be compared.



Eight years of data The figures below show how salinity and temperature from 5 metres below the ocean surface vary over an eight year period that covers 0.8x10^{6}km of ship's track. From left to right; 1) The regions from which the data were collected derived from the map at top right. 2) The variance of the gridded data with latitude within 0.1º latitude bins over each year. 3) Contour plots of salinity and flow housing temperature against time and latitude. Gaps in the data at the year ends are due to the ship being in refit. In summer 2008 a faulty conductivity sensor led to an salinity data absence.

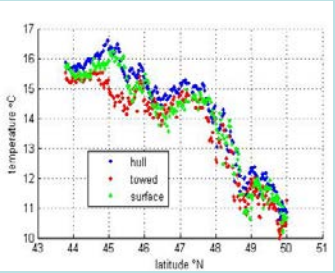
Data quality The data density increases with time as does the confidence in the accuracy of the data returned. The salinity has been calibrated by discrete samples that were analysed using a Guildline Autosalinometer and can be expected to be within 0.5 units up of the true values up to 2006 thereafter, improving by an order of magnitude to 0.05 by 2010. Improvements in salinity and temperature accuracy have been key for determination of a number of parameters including Total Alkalinity, density and correcting oxygen optode measurements.

Persistent regional features Strong tides off Ushant in region 4 mix heat well into the 100m water column. This reduces the mean surface temperature and it's variance; whereas in waters shallower than 60m of regions 1 and 2 at latitudes above 50ºN the variance is seen to increase. At the steep Iberian shelf break in region 8 a decrease in the temperature variance is associated with an increase in salinity variance. There is stability across the years at 46.25ºN in region 6 where the ship crosses the continental shelf break; which incidentally is also a region frequented by a variety of cetaceans.



Ongoing analysis Sensors employing differing measurement principles and at different positions around the ship yield different results for the same parameter. Understanding the relationship between these results forms part of ongoing work. Characterisation of the temperature differences between a bridge mounted Infra-red sensor (ISAR) measuring sea **Surface** temperature, an internally mounted SBE48 **hull** thermistor at a depth of 5 metres and an (RBR) temperature sensor mounted on a Continuous plankton recorder (CPR) **towed** at a depth of 5 metres will enable a better grasp of the relationships between these measurements. Results from one CPR tow shown below.

Transient temporal features During March 2007 Gale Force winds precede cooling of the surface layers throughout the 1000km transect lasting for at least a month in regions 5 through 8. Arrows on temperature plot indicate time of the storm and the box highlights the duration of the perturbation. Bifurcation of the temperature maxima in regions 6, 7 and 8 can also be distinguished during most summers. These events have an important impact on processes such as the air-sea transfer of gases. The high salinity variance in regions 4 and 5 particularly in 2003, 2008 & 2010 is associated with freshwater input from the Loire and Gironde river systems; an example of a transient regional feature.



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