

SUSTAINED OBSERVATIONS IN THE ATLANTIC AND SOUTHERN OCEANS

Denise Smythe-Wright, Stuart A. Cunningham, Richard A. Lampitt, Elizabeth C. Kent,
Brian A. King, Graham D. Quartly, Jane F. Read, Mikhail V. Zubkov.
National Oceanography Centre, Southampton, UK

The marine environment is large in scale, highly dynamic and relatively inaccessible. It requires sustained observations to obtain meaningful information on environmental changes and their causes. To this end, the National Oceanography Centre, Southampton, supports a number of marine time-series and monitoring studies in the Atlantic and Southern Oceans (Fig 1). Some of these are in conjunction with other UK marine laboratories.

The primary aims are to provide data and knowledge on a wide range of oceanic processes, from ocean circulation to biodiversity. They have been developed not just to provide long-term datasets but also to capture extreme or episodic events and play a key role in the initialisation and validation of models.

The Atlantic Meridional Transect (AMT) aims to understand ocean plankton communities and improve our ability to predict the role of the open ocean in the global carbon cycle. It is an open ocean in-situ observing system, which began in 1995 and utilises the passage of the RRS James Clarke Ross between the UK and the Falkland Islands southwards in September and northwards in April each year.

Recent results show that the abundance of the smallest algae, which are responsible for a major part of CO₂ fixation, were about twice as high across the Atlantic Ocean from 30°N to 30°S in autumn 2008 compared to autumn 2005. The observed differences are more likely related to large-scale changes of wind forcing rather than to seasonality, taking into account a corresponding ~50% increase in the mean wind speed in autumn 2008 compared to autumn 2005. This suggests that climate-change induced increases in wind stirring could elevate phytoplankton growth and sequestration of CO₂ in the open ocean.

The Porcupine Abyssal Plain fixed point observatory (PAP) sited at 49°N, 16.5°W in the Northeast Atlantic is the longest running deep ocean time-series observatory in Europe. The aim is to collect high-resolution in-situ multidisciplinary time-series data of climatically and environmentally relevant parameters from the euphotic

zone to the benthic boundary layer. These include sub-surface measurements of temperature, salinity, chlorophyll-a fluorescence, nitrate, pCO₂ and deep ocean particle flux. Data are sent in near real-time from the upper 1000m through Iridium telemetry to shore stations.

Trends from 2003 to 2005 [1] indicate a higher temperature and salinity signal in surface waters with increased stratification, decreased nitrate concentration and consequent decline in productivity and delay in the spring bloom. In addition, there is evidence that the levels of pCO₂ being absorbed in this persistently under-saturated region are reducing which has implications for the future global carbon cycle and importance of the oceans as a carbon sink.

The Atlantic Meridional Overturning Circulation (AMOC) East-West mooring array at 26°N aims to observe on a daily basis the strength and structure of the AMOC and deliver a decade-long time-series of calibrated and quality controlled measurements.

The AMOC at 26.5°N, carries a northward heat flux of 1.3 PW and as it moves north much of this heat is transferred to the atmosphere and subsequently is responsible for maintaining the UK climate at about 5°C warmer than the zonal average at this latitude. However, due to sparse data, it is unclear whether the AMOC is slowing in response to global warming as suggested by recent model results.

The data from the arrays and elsewhere will be used to determine and interpret recent changes in the AMOC, assess the risk of rapid climate change, and investigate the potential for predictions of the AMOC and its impacts on climate. So far, results demonstrate that the AMOC, has dramatic and unexpected variability with a mean strength in the first year of 18.7 ± 5.6 Sv. [2]

The extended Ellett Line is an annually occupied, full depth hydrographic section between Scotland, Rockall, 60° N 20° W and Iceland that is designed to sample the warm saline inflow into the sub-polar gyre and the Nordic Seas, and the path of the deep returning flow in

the lower branch of the Meridional Overturning Circulation.

The aim is to create a time-series that can be used as a measure of climate change in the Northeast Atlantic and against which numerical models can be assessed. In addition, there is an ADCP mooring monitoring the Wyville-Thomson Ridge overflow. The line from Scotland to Rockall has been occupied since 1975 and the extension to Iceland since 1996.

Results show a steady increase in both temperature and salinity in the upper ocean over the last 30 years, with variability of up to 1.5° C and 0.1 in salinity. Both temperature and salinity have remained at an all-series high over the last 5 years. More details are available at <http://www.noc.soton.ac.uk/obe/PROJECTS/EEL.index.php>

The international Argo programme aims to populate the world's oceans with autonomous profiling floats, contributing to long-range weather forecasts and climate change research. The UK has been a strong supporter of Argo since the program began, and is fully committed to the Argo goal of maintaining a global array. So far the UK has deployed nearly 300 floats in the North and South Atlantic, Indian and Southern Oceans since the start of the program in 2000 and has collaborate with other countries including Ireland and Mauritius on deployments and data handling.

Within the UK, the main customers for float data are the data assimilation activities at the Met Office, either for short-term ocean forecasting or seasonal combined ocean-atmosphere forecasts, and nearly 50 individual projects or researchers in Universities and Government laboratories.

Antarctic Circumpolar Current monitoring in the Drake Passage provides measurements from a choke point in the global ocean circulation which impacts on the North Atlantic and the MOC. This annual full-depth repeat hydrographic section in the eastern Drake Passage was first occupied in 1993, and only two years have been missed since then. The measurements are mainly physical: CTD and shipboard ADCP, with Lowered ADCP added in 1996, at a maximum station spacing of 35 km.

This coast-to-coast transect across the Antarctic Circumpolar Current enables the baroclinic transport of the current to be measured, and this is found to have an average of 137 Sv, with an inter-annual variability of

about 6%. The variability means that 20 years of measurements would be needed to be sure of detecting a change of 10%, and an even longer time-series would be needed to detect smaller changes.

Climate quality surface marine observations and products. The aim of this programme is to take historical and operational data collected by international meteorological programmes and satellite agencies and develop datasets and data products that can be used in ocean circulation and climate research.

In-situ marine meteorological datasets contain well-known variations in sampling density with good data coverage in the main shipping lanes and in Northern mid-latitudes, but are sparse in other areas of the world; there are also issues of quality control. Using state of the art flux parameterisations, improved bias corrections, data homogenization and uncertainty estimates, a 36-year (1973-2008) global monthly mean surface meteorological and flux dataset has been produced [3] The dataset includes global marine monthly fields of air temperature, SST, humidity, wind speed, pressure, sensible and latent heat fluxes and shortwave and long-wave radiation. The next steps for the flux dataset are to extend the record back to the late 1950s and to include selected satellite parameters.

Improved satellite datasets are also being constructed: a global wave height and period dataset from satellite altimeters is under development and research is working toward new methods to derive wind and wave parameters from GPS satellite "signals of opportunity" [4]

The Portsmouth-Bilbao Transect (PoB) is traversed twice weekly throughout the year by the commercially operated P&O ferry MV Pride of Bilbao. The ship is fitted with a dedicated seawater intake for scientific work and has been instrumented by NOCS with a standard 'Ferrybox' system that logs temperature, salinity, oxygen, fluorescence and occasionally pCO₂. There is also a radiometer above the bridge for sea surface temperature measurements. Data is received at NOCS via satellite link and the novelty of the project is the long time-series of integrated simultaneous high density measurements that began in 2001. Since the ferry crosses a number of oceanic and biological provenances, it provides data over a variety of temporal and spatial conditions.

The information from these activities has been integrated into the UK Marine Monitoring Assessment Strategy and has contributed to the UK DEFRA (Department for Environment, Food and Rural Affairs) Charting Progress

II initiative. The observations also contribute to International GOOS (Global Ocean Observing System) and GMES (Global Monitoring for the Environment and Security)

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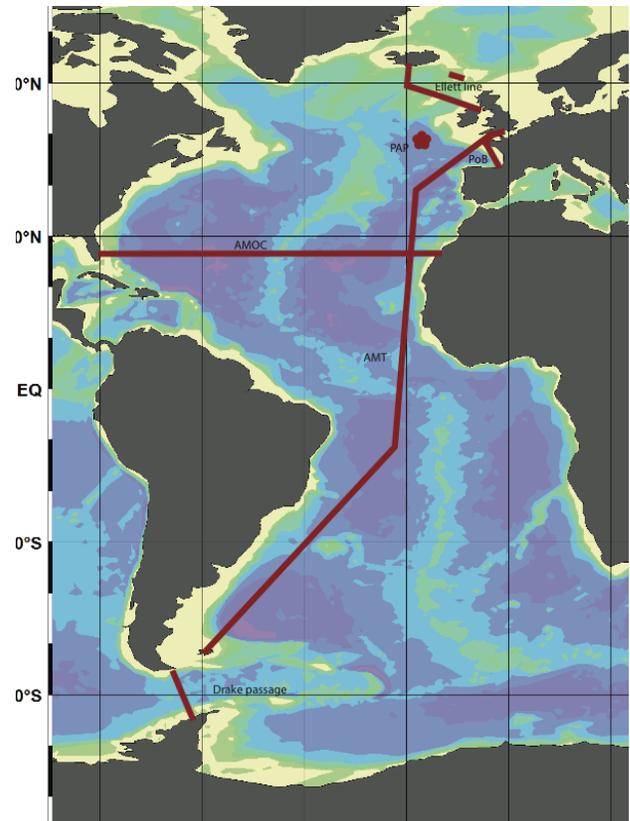


Figure 1 Location of the sites