grandmaster clock PPS and the PPS generated by DK-LM3S9B96 was measured to be about 50ns [6]. This means that the external IEEE-1588 GPS can provide synchronization trigger error of 50ns.

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REFERENCES

[1] IEEE-1588 "Precision Clock Synchronization Protocol for Networked Measurement and Control Systems", IEEE standard, 2002.
[2]P. Ferrari, A. Flammini, D. Marioli, A. Taroni, "IEEE 1588-Based Synchronization System for a Displacement Sensor Network", IEEE Transactionson Instrumentation andMeasurement, Vol. 57, NO. 2, February 2008.
[3]T. Cooklev, J. C. Eidson, A. Pakdaman, "An Implementation of IEEE 1588 Over IEEE 802.11b for Synchronization of Wireless Local Area Network Nodes", IEEE Transactions onInstrumentationand Measurement, Vol. 56, NO. 5, October 2007.
[4] A. Milevsky, J.Walrod, "Development and Test of IEEE 1588 Precision Timing Protocol for Ocean Observatory Networks", Proceedings of OCEANS conference, 2008.
[5] T. Tanimoto, "The oceanic excitation hypothesis for the continuous oscillations of the Earth", Geophysical Journal Inetrnational, Vol 160, No 1, pp 276-288, January 2005.
[6]J. del Rio, D.Toma, A.Mànuel, H. Ramos, "Evaluation of IEEE1588 Appliedto Synchronized Acquisition In Marine Sensor Networks (MSN), Proceedings of IX IMEKO World Congress, 6-11 September 2009, Lisbon, Portugal.

ESTOC: NEW APPROACH WARRANTS LONG-TERM SUPPORT TO THE OCEANIC OBSERVATIONAL PROGRAM

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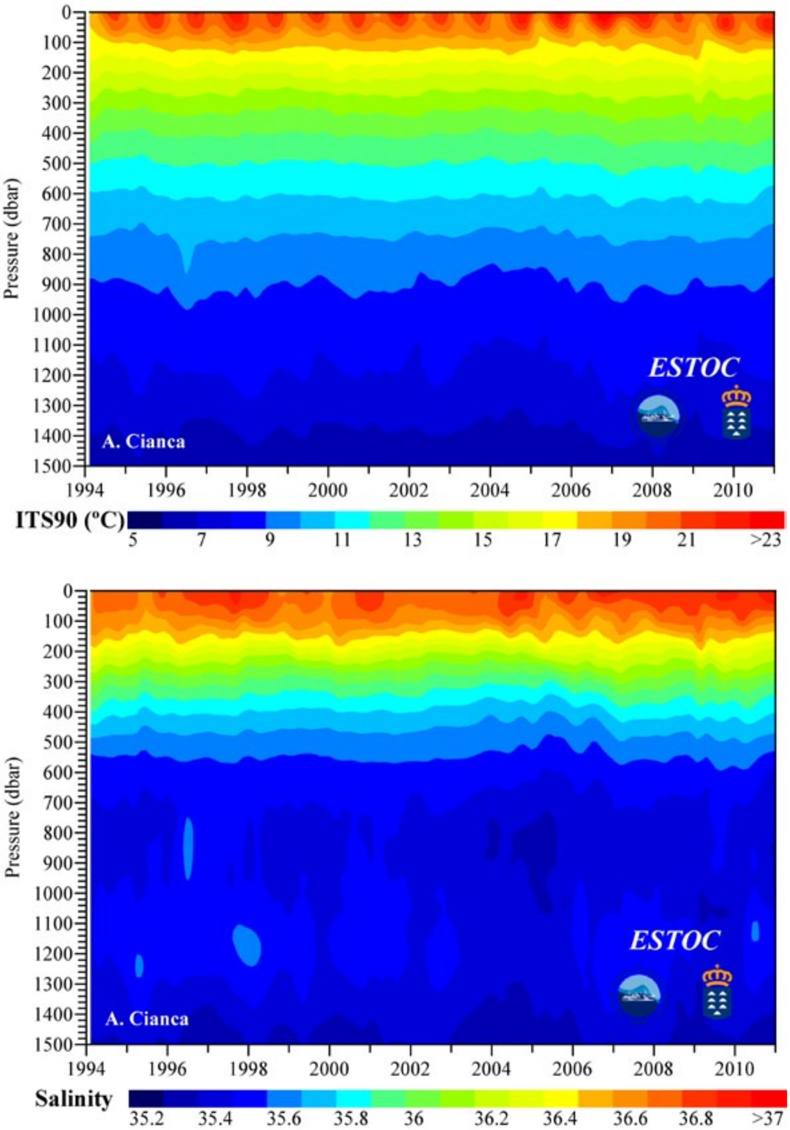
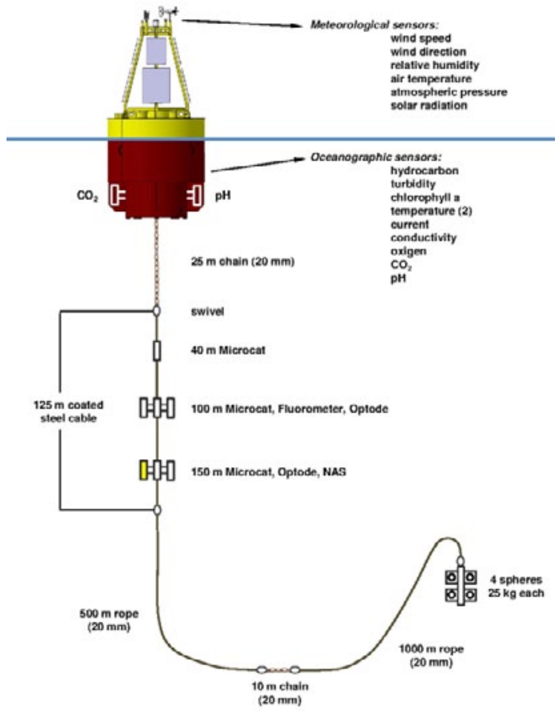
Abstract
The European Station for Time-series in the Ocean, Canary Islands "ESTOC" was initiated in 1994 about 100 km north of the Canary Islands in 3618 m water depth [1]. The University of Bremen, IFMK, IEO and ICCM created an Eulerian long time series on an inter- and multidisciplinary basis in order to monitor and help understand oceanic long-term variability in the North Atlantic subtropical gyre in conjunction with the Bermuda station BATS. ESTOC is an open ocean site in the sense that it is located well outside the highly variable eastern boundary with its strong coastal upwelling regime (although interaction with this regime exists), is deep enough to encompass the eastern subtropical North Atlantic's major water masses including the North Atlantic Deep Water (however not the AABW), is windward of the Canary Islands to avoid wake effects of both the major currents and winds (Canary Current and Northeast Trade Winds), and is far enough from coasts and islands (the Selvages 100 km northwards are very small and flat) to serve as reference for satellite images and altimetry. Thus, it was expected that long-term observations at ESTOC represent open-ocean eastern subtropical North Atlantic conditions and variability. The observation program was constituted by a monthly sampling program and some diverse arrays of physical and biogeochemical sensors[2].
The original aims of ESTOC were extended through the ANIMATE (Atlantic Network of Interdisciplinary Moorings and Time-series for Europe and MERSEA (Marine Environment and Security for the European Area) project framework. Among the principal aims we can emphasize the development of a European carbon cycle time-series infrastructure at 3 key sites in the north east Atlantic. Those sites were networked within a larger-scale ocean carbon observing system, providing critical input to studies on climate change and in particular the role of carbon dioxide (CO_2). European integration was also recently achieved with nine European deep-ocean stations through the EuroSITES project (European Ocean Observatory Network).
ESTOC has the widest time-series data of hydrography and biochemical measurements from the ship-based casts carried out in the Northeastern Atlantic Ocean (from 1994 to date). In addition, the historical ESTOC marine observational programs provide with supplementary time-series of high resolution data from moored sensors such as current meter, sediment trap, temperature, salinity and nutrient meters. Recently, the pH, CO_2 and dissolved oxygen sensors were added to the ODAS buoy, with real-time data transmission.
The ocean/atmosphere CO_2 fluxes and its influence on the biogeochemical processes is currently the main research focus[3-5]. Warming and changes in circulation and biology most likely will indeed lead to a further CO_2 increase, depletion of dissolved oxygen and ocean acidification, thus justifying the need for continuous and long-term operation of the station.

In order to warrant continuous and long-term operation, ESTOC is now operated by the Canary Islands Oceanic Platform "PLOCAN" Observatory, thus securing operation and maintenance until at least 2021. PLOCAN provides three gliders ready to operate around the site. The combination of the ship-based sampling, moorings, glider flights, ARGO profilers and drifters, as well as the historical time-series data, makes the ESTOC site an observational oceanic reference in the North Atlantic. In addition, PLOCAN Observatory is associated to ESONET and an accepted site infrastructure for EMSO. All Observatory components are open to science and R&D projects with third parties, including sensor connection and testing.

REFERENCES

[1] O. Llinás, A. Rodríguez de León, G. Siedler, and G. Wefer, "ESTOC Data Report 94," Informes técnicos del Instituto Canario de Ciencias Marinas, Telde 1997.
[2] S. Neuer, A. Cianca, P. Helmke, T. Freudenthal, R. Davenport, H. Meggers, M. Knoll, J. M. Santana-Casiano, M. González-Dávila, M. J. Rueda, and O. Llinás, "Biogeochemistry and hydrography in the eastern subtropical North Atlantic gyre. Results from the European time-series station ESTOC," Progress In Oceanography, vol. 72, pp. 1, 2007.
[3] A. Cianca, P. Helmke, B. Mouriño, M. J. Rueda, O. Llinás, and S. Neuer, "Decadal analysis of hydrography and in situ nutrient budgets in the western and eastern North Atlantic subtropical gyre.," Journal of Geophysical Research, vol. 112, pp. C07025, 2007.
[4] M. González-Dávila, J. M. Santana-Casiano, and E.-F. González-Dávila, "Interannual variability of the upper ocean carbon cycle in the northeast Atlantic Ocean.," Geophysical Research Letters, vol. 34, pp. L07608, 2007.
[5] J. M. Santana-Casiano, M. González-Dávila, M. J. Rueda, O. Llinás, and E.-F. González-Dávila, "The interannual variability of oceanic CO2 parameters in the Northeast Atlantic subtropical gyre at the ESTOC site.," Global Biogeochem. Cycles, vol. 21, pp. GB1015, 2007.





(above) Fig. 2 Current state of ESTOC Mooring

(left) Fig. 1. Temperature (top) and salinity (down) time-series at ESTOC site, from surface to about 1500 meter depth..

OBSEA detail. Picture by Ramon Margalef.