Controls on pCO_2 variation at a sustained observatory (PAP-SO) in the northeast Atlantic Ocean

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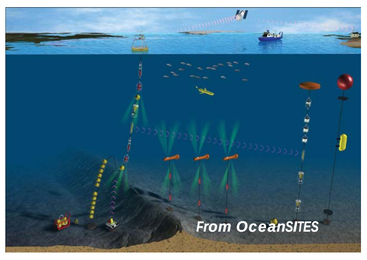
EuroSITES

PAP Porcupine Abyssal Plain Observatory

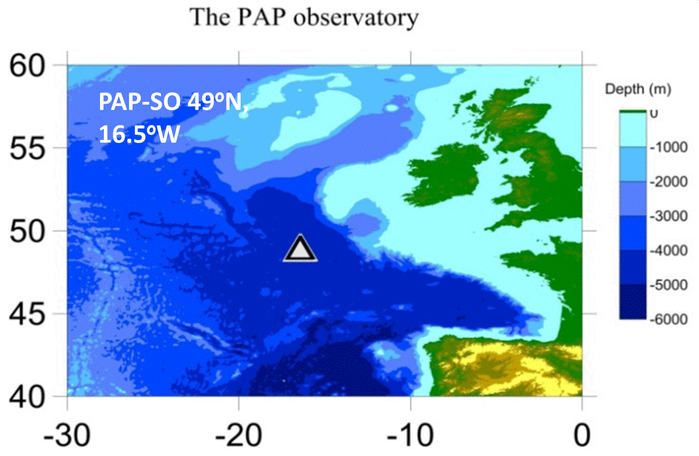
Introduction

The northeast Atlantic is a significant oceanic CO_2 sink region. However the sink has been shown to vary from year to year (1-3 mol C m^{-2} yr^{-1}). This variability has been attributed to changes in wintertime mixing and stratification (Schuster & Watson, 2007). To understand both the physical and biological causes for this variability we require a wide range of measurements as offered by time series studies.

Time series

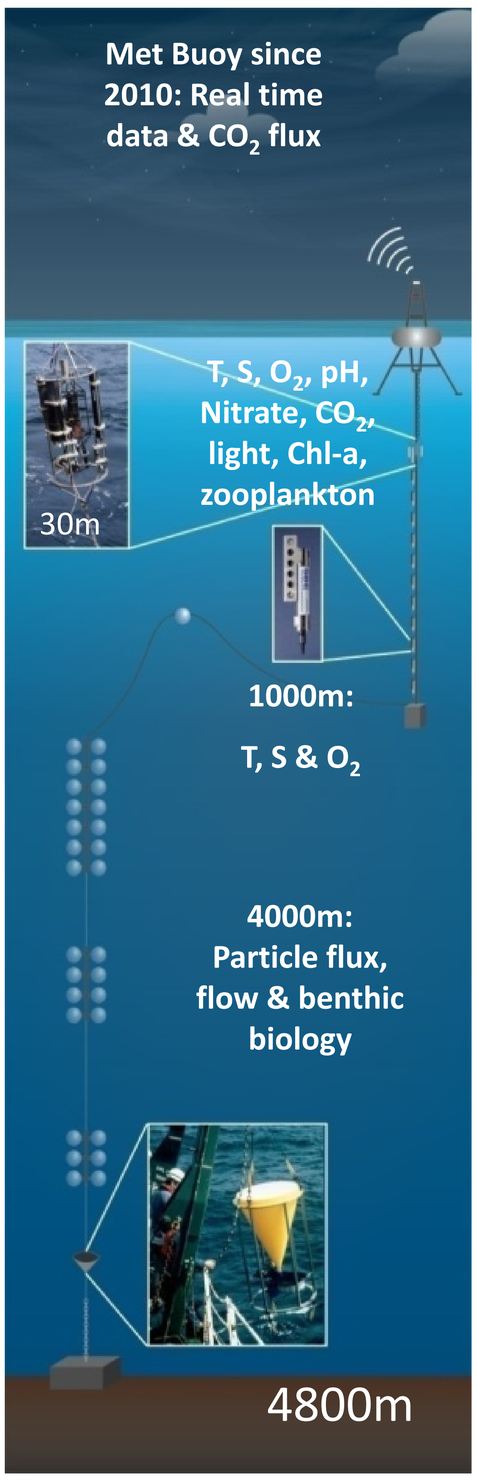


Fixed-point deep ocean observatories are an integral part of monitoring the marine environment, producing **high resolution**, **long-term time-series** data sets of **climatically and ecologically relevant variables**.



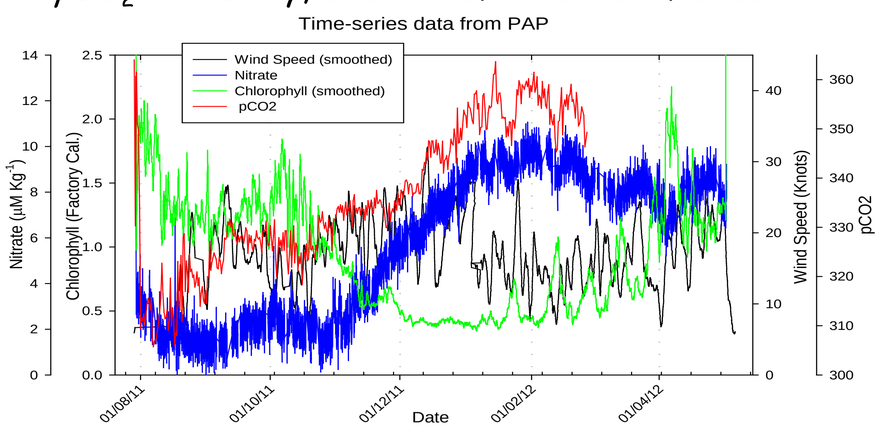
Location of the PAP-SO EuroSITES, FixO3 and OceanSITES deep-ocean observatory

The **Porcupine Abyssal Plain Sustained Observatory (PAP-SO)** in the Northeast Atlantic (49°N, 16.5°W; water depth ~ 4800 m) has produced *in situ* time-series datasets from the euphotic zone to the seafloor for the past 20 years. A mooring with autonomous sensors has been in place since 2002 producing high-resolution, year-round **physical and biogeochemical measurements**. The main objectives are to understand the system & to monitor changes in key variables.

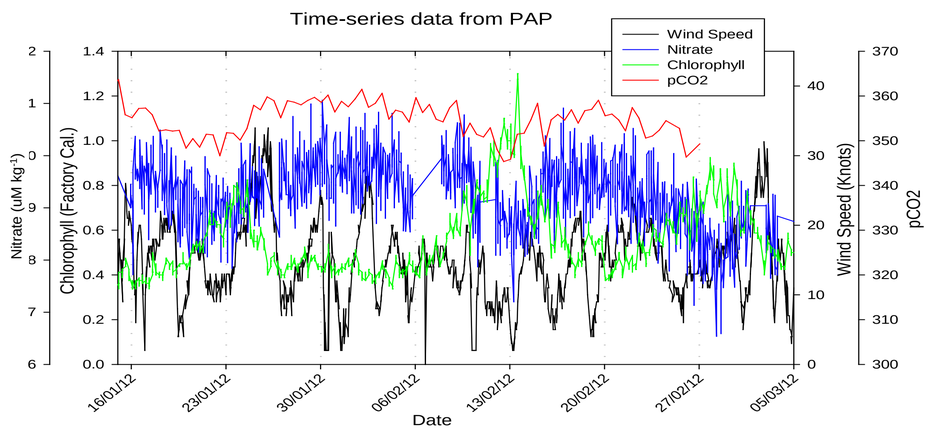


PAP-SO data

The PAP-SO is in a region where surface **'mixed' layer** depth changes from 25m in the summer to > 400m in winter. Inter-annual changes in the winter mixing depth can result in large (x2) changes in surface concentrations of nutrients (Hartman *et al.*, 2010). PAP-SO data details processes and time scales (from **diurnal to inter annual**) and related variations in pCO_2. Physical and biological processes control seasonal pCO_2 variability, and therefore annual fluxes.



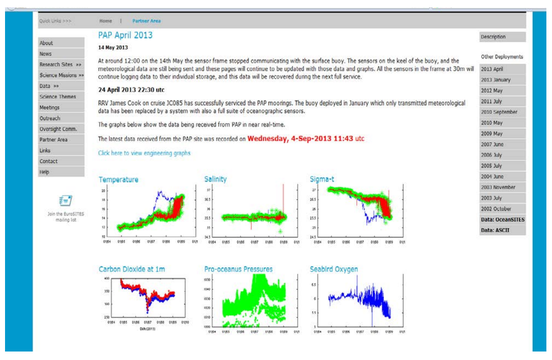
30m data from a recent deployment of the PAP-SO: nitrate & pCO_2 increases with convective mixing in the winter months as chlorophyll-fluorescence decreases.



Periods of calm when an increase in chlorophyll-fluorescence indicates phytoplankton growth even in February, accompanied by a decrease in nitrate and pCO_2 at the PAP-SO (30m depth).

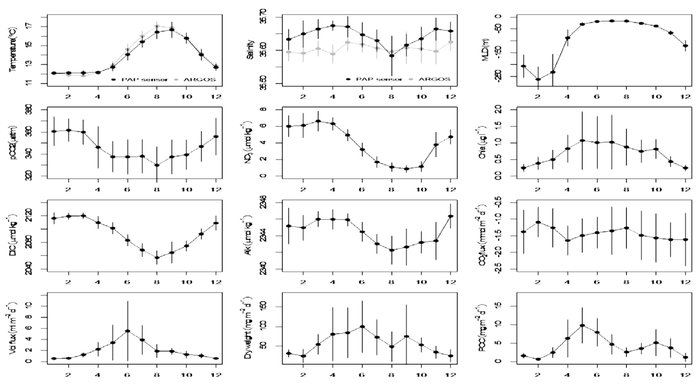
Through collaboration with the **UK Met Office** since 2010 (Hartman *et al.*, 2012) we have contemporaneous atmospheric and ocean datasets from PAP so we can investigate the effect of the relatively high wind measurements on pCO_2 data in the region.

The latest PAP-SO data can be viewed at **www.eurosites.info/pap**

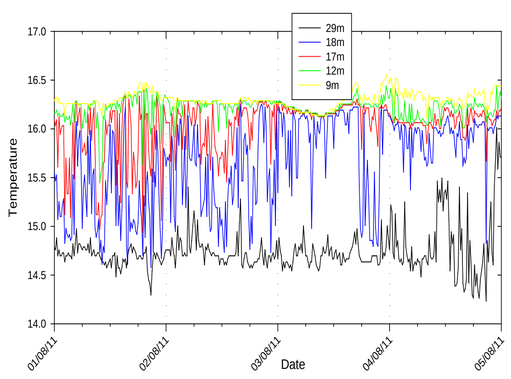


Data comparison

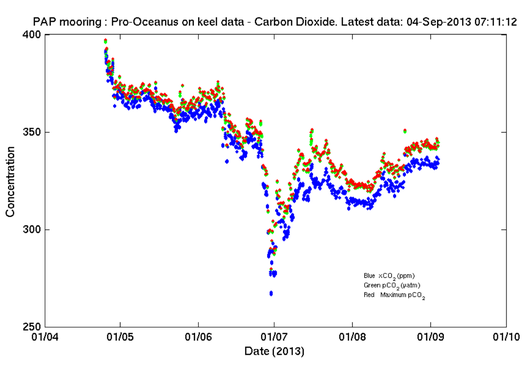
PAP-SO pCO_2 data (measured at 30m) shows a persistent under-saturation throughout the year. The region is an oceanic **CO_2 sink** (-1.0 mol CO_2 m^{-2} yr^{-1}). This figure is lower than previously calculated by Kortzinger et al., 2008 (average of -3.2 mol CO_2 m^{-2} yr^{-1} in +ve NAO years 2003-2005). This is a significant sink compared with subtropical time series sites such as ESTOC (near the Canary Islands, 29.17°N, 15.5°W), which is an overall annual CO_2 source region (0.05 mol CO_2 m^{-2} yr^{-1}, Gonzalez-Davila *et al.*, 2003).



Monthly PAP & ARGO data 2003-2012 (+/- 1SD) shows the seasonal cycle in measured and calculated variables



Variation in sea surface temperature (over the top 30m) at the PAP-SO



Recent surface pCO_2 measurements for comparison with SOO data

We are currently looking at how pCO_2 varies in the **upper mixed layer**, where large changes in temperature occur. pH and pCO_2 sensors have been deployed at 5m depth as part of a **Greenhouse Gas** Theme Action Plan. This will allow us to compare 5m depth PAP-SO data with surface (~5m) ships of opportunity (SOO) data from the UEA *MV Benguela Stream* route and research vessels that visit a few times a year. Variations between datasets need to be addressed before we can investigate inter-annual variability in pCO_2

References

Gonzalez-Davila, M., Santana-Casiano, J. M., Rueda, M. J., Llinas, O., Gonzalez-Davila, E. F., 2003. *Global Biogeochemical Cycles, 17*(3)

Hartman, S.E, Larkin. K. E., Lampitt, R. S, Lankhorst, M, Hydes, D.J., 2010. *Deep-Sea Research II* 57 (15): 1267-1428

Hartman, S.E., Lampitt, R.S., Larkin, K.E., Pagnani, M., Campbell, J., Gkritzalis, A., Jiang, Z., Pebody, C.A., Ruhl, H. A. , Gooday, A. J., Bett, B. J. , Billett, D. S. M. , Provost, P. , McLachlan, R. , Turton, J. , Lankester, S., 2012. ICES Journal of Marine Science, ICESJMS-2011-214.R1

Prytherch, J., Yelland, M. J., Pascal, R. W., Moat, B. I., Skjelvan, I., Srokosz, M. A., 2010. *Geophys. Res. Lett., 37, L23607, doi:10.1029/2010GL045597*

Schuster, U., Watson, A., 2007. JGR, 112, C11006. doi:10.1029/2006JC003941

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