

Greenhouse Gas Townhall Meeting

7th-8th January 2015

National Oceanography Centre
Southampton

Science Highlights

Pete Brown



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NATURAL ENVIRONMENT RESEARCH COUNCIL

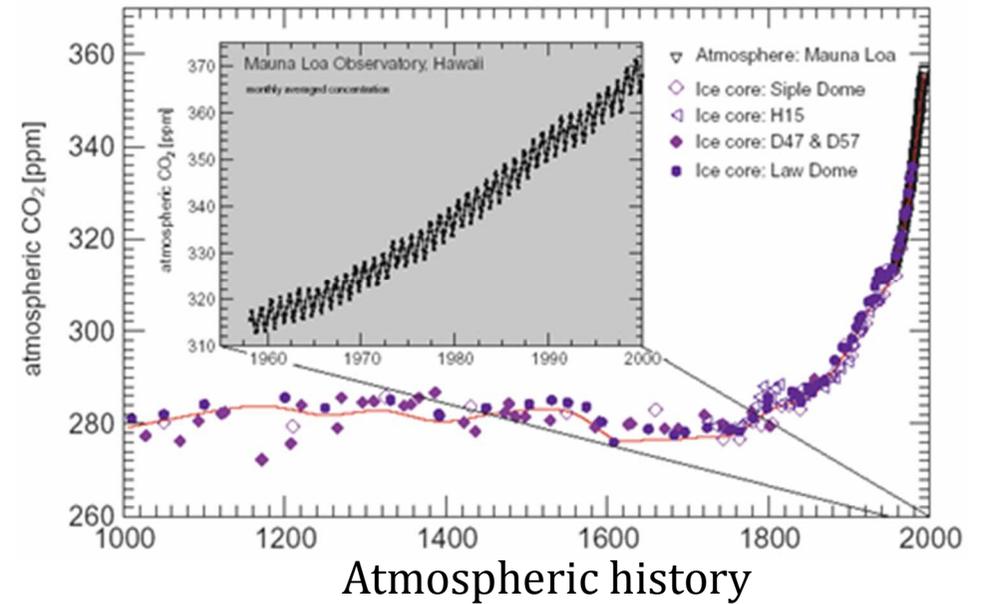
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Anthropogenic carbon (C^{anth}):

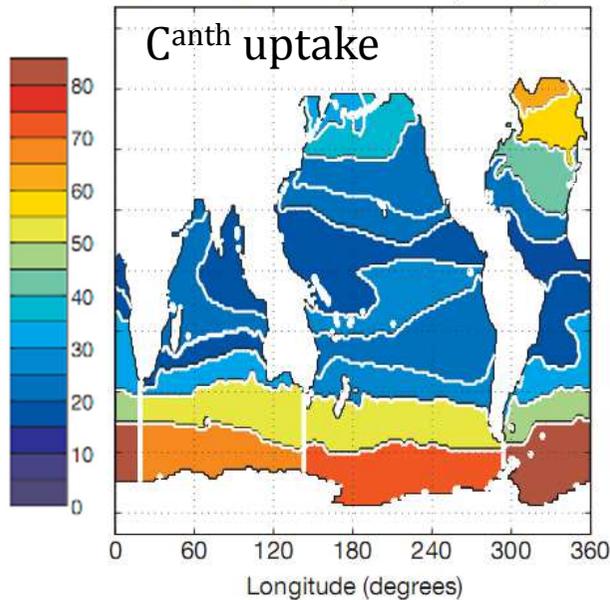
'Extra' carbon taken up by the oceans (~25-30% of total) since pre-industrial times, as a result of CO_2 emissions by human activity into the atmosphere.

In the ocean, not directly measurable, physically identical to natural CO_2 .

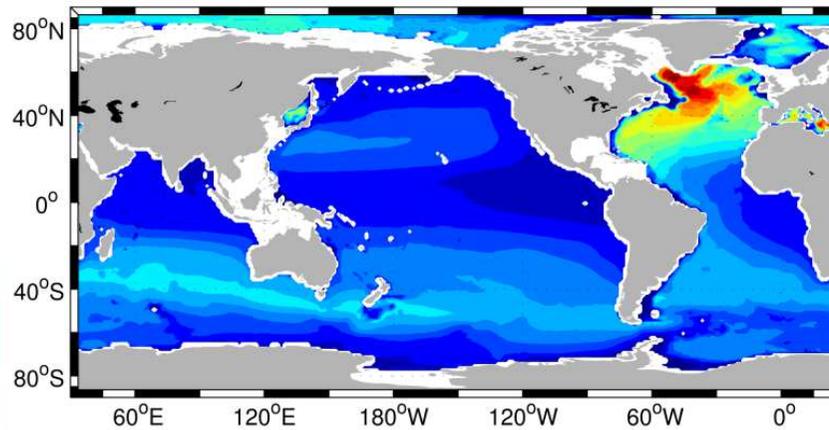
At 100% saturation, human-derived signal accounts for only a maximum 4% of bulk signal.



b Cumulative flux up to 2008 (mol m^{-2})



Khatiwala et al (2009) Nature



Khatiwala et al (2013) BG



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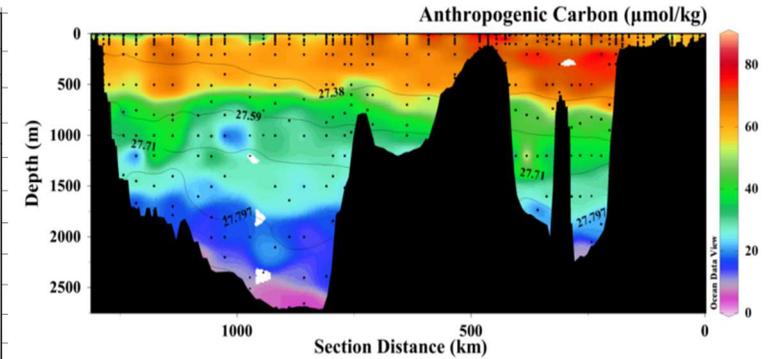
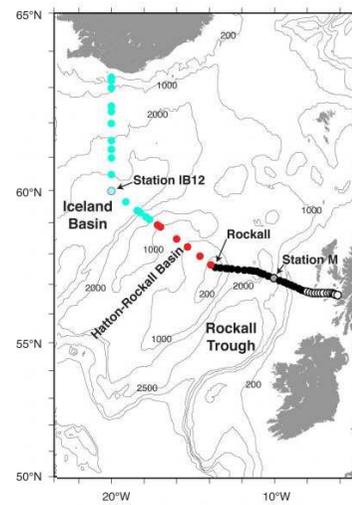
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Interior observations

Extended Ellett Line (EEL)

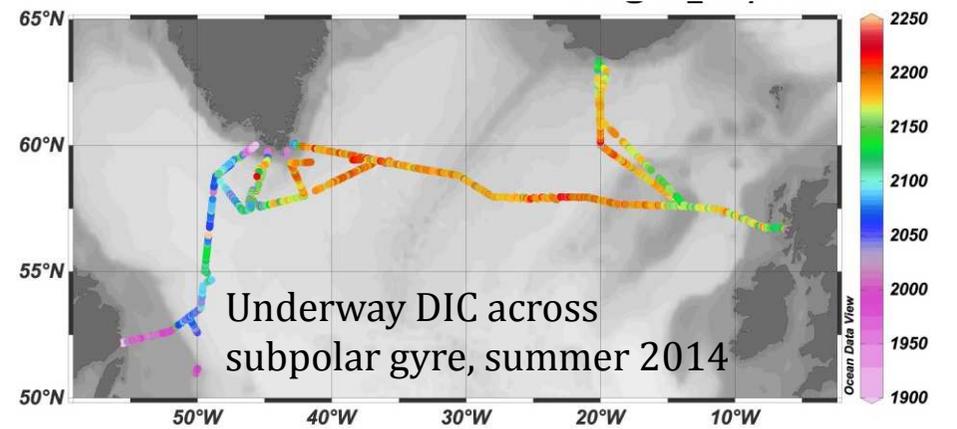
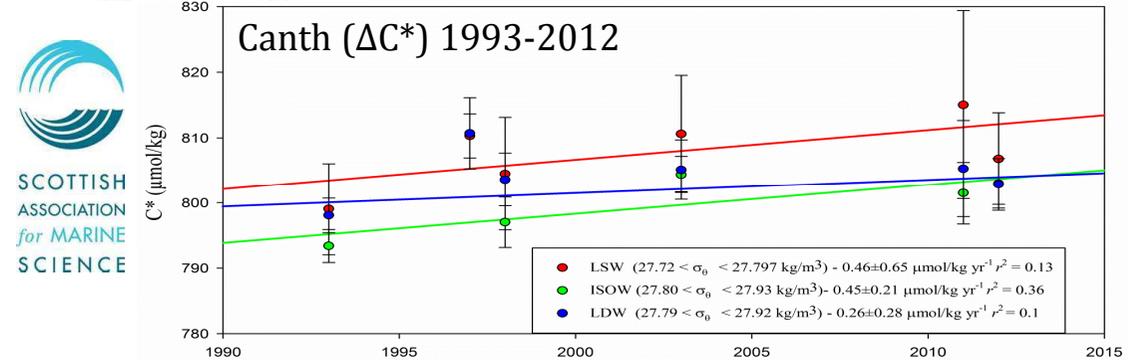
- Geographical & water mass differences Iceland Basin and Rockall Trough
- Growth of Anthropogenic Carbon is ubiquitous across northern NE Atlantic



Humphreys, et al., 2015, in prep.

Radiatively Active Gases from the N. Atlantic Region and Climate Change (RAGNARRoCC)

- Aim to quantify CO_2 & other GHG fluxes in the North Atlantic region & processes leading to inter-annual & decadal variability



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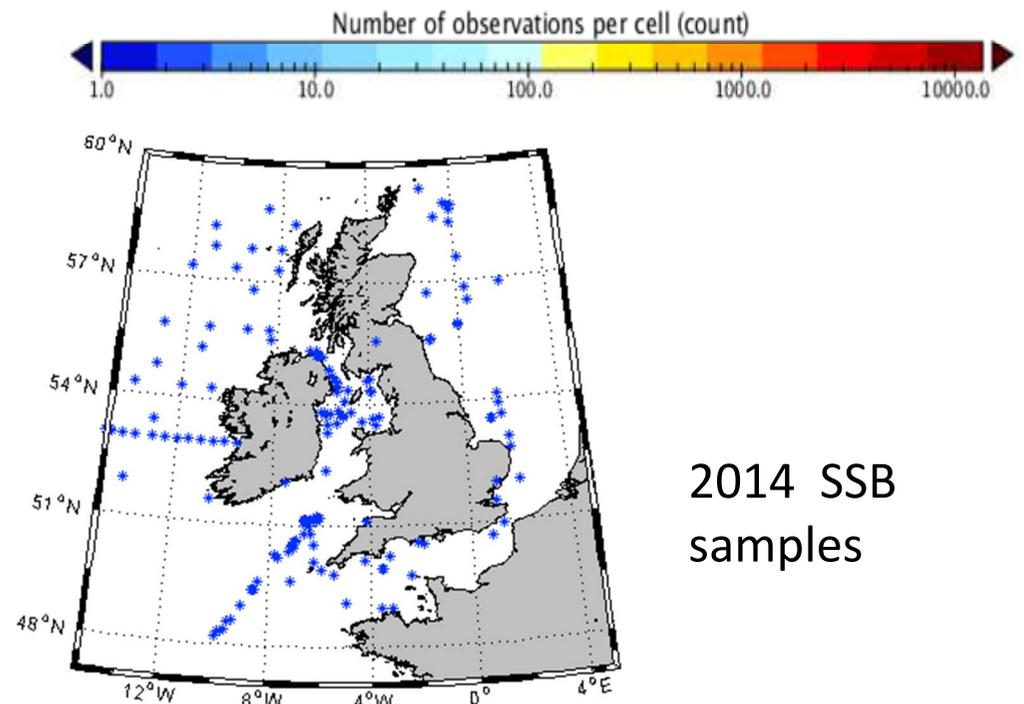
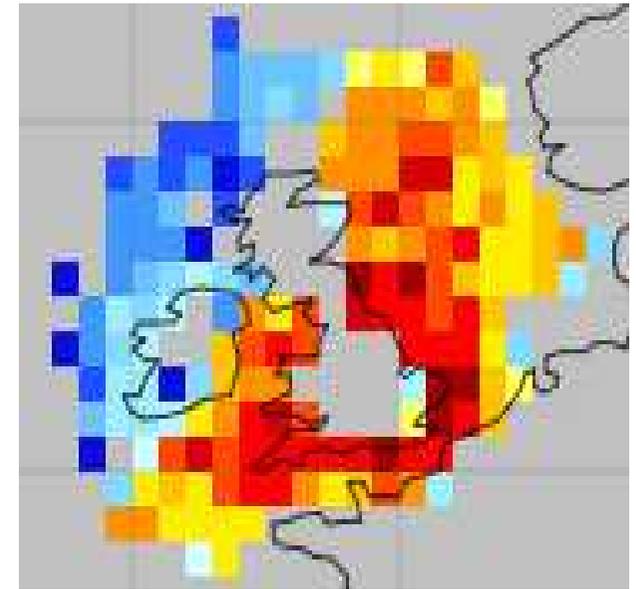
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Shelf Sea Biogeochemistry (SSB) shelf-wide carbon chemistry sampling



- Variability in ocean CO₂ assimilation: biological vs. physical & chemical control
- Surface DIC/TA sampling on SSB research cruises, Ships of opportunity & from partner vessels (AFBI, CEFAS, MI and MSS) was started in 2014 as part of the NERC SSB project 'CANDYFLOSS' (Carbon/Nutrient Dynamics and Fluxes Over Shelf Systems).
- Aim to provide Shelf Wide Seasonal and monthly surface maps of Air-sea CO₂ flux & sampling previously under-sampled regions



2014 SSB samples



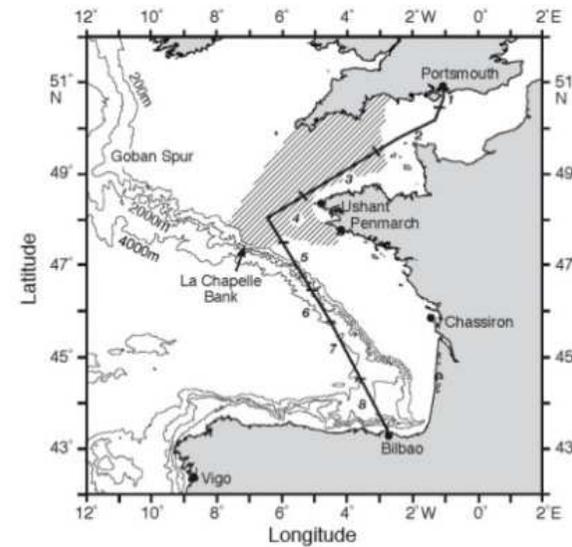
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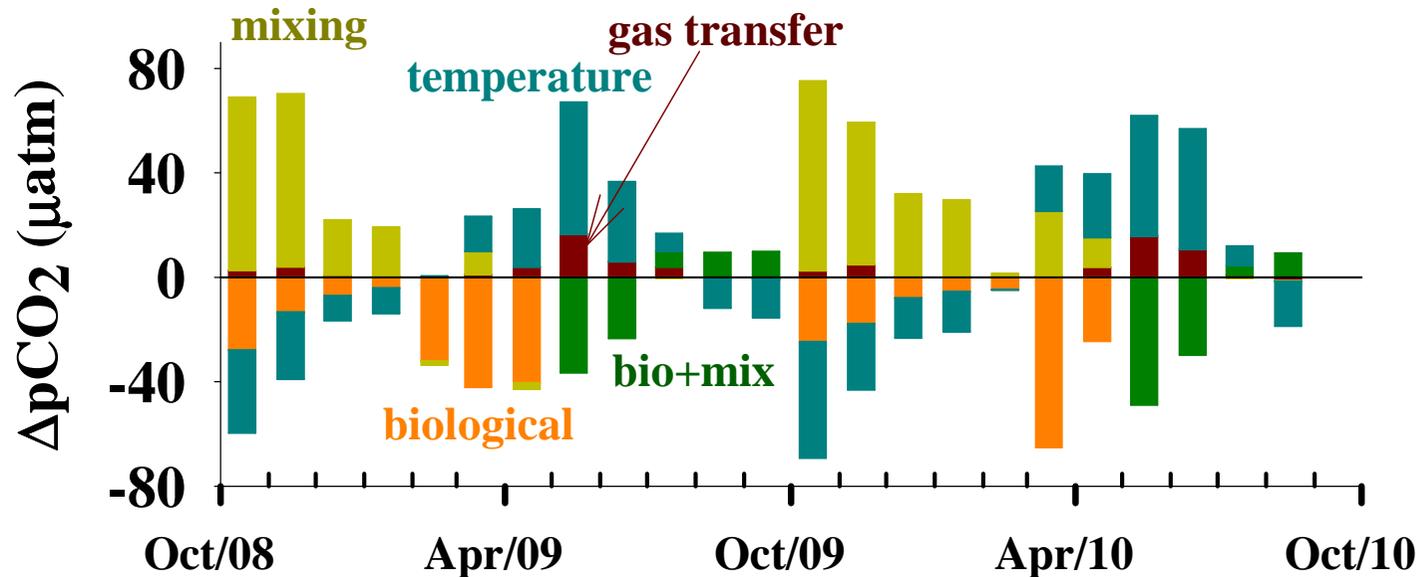
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Surface CO₂ fluxes from Ships of Opportunity

- Variability in ocean CO₂ assimilation: biological vs. physical & chemical control



$$\Delta p\text{CO}_{2, \text{obs}} = \Delta p\text{CO}_{2, \text{gas}} + \Delta p\text{CO}_{2, \text{bio}} + \Delta p\text{CO}_{2, \text{mix}} + \Delta p\text{CO}_{2, \text{temp}}$$



Jiang et al., JGR, 2013; Hartman et al., 2014 DSRII & JMS



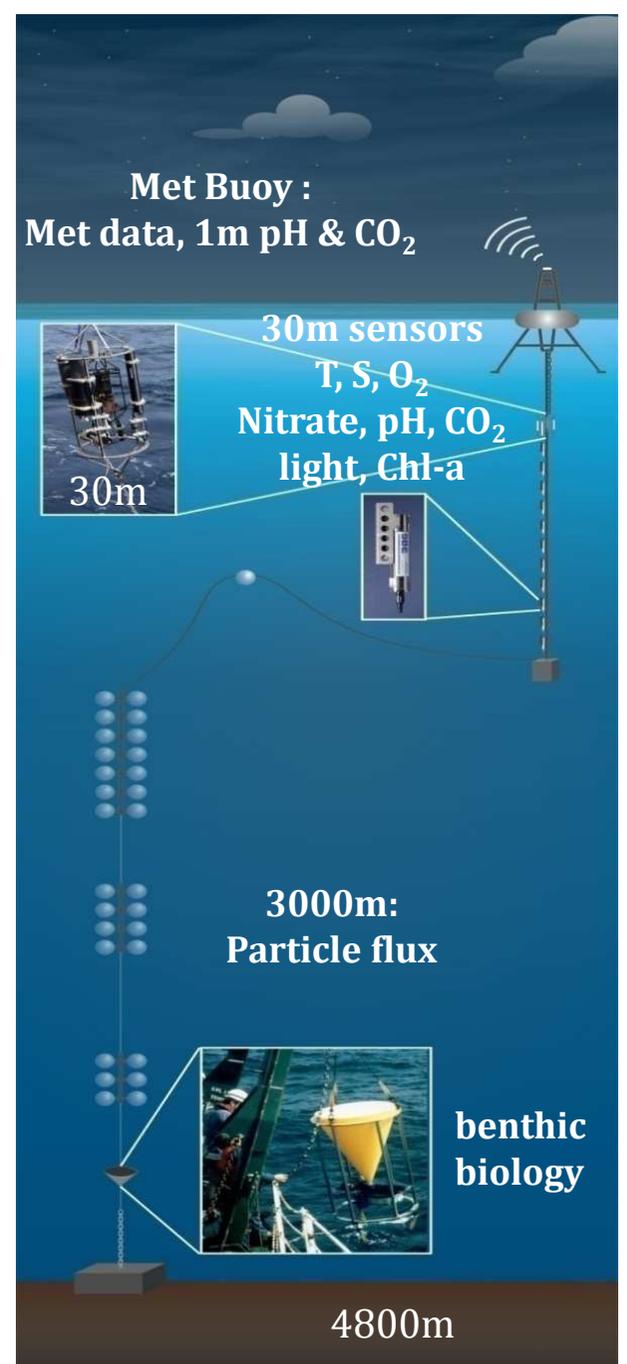
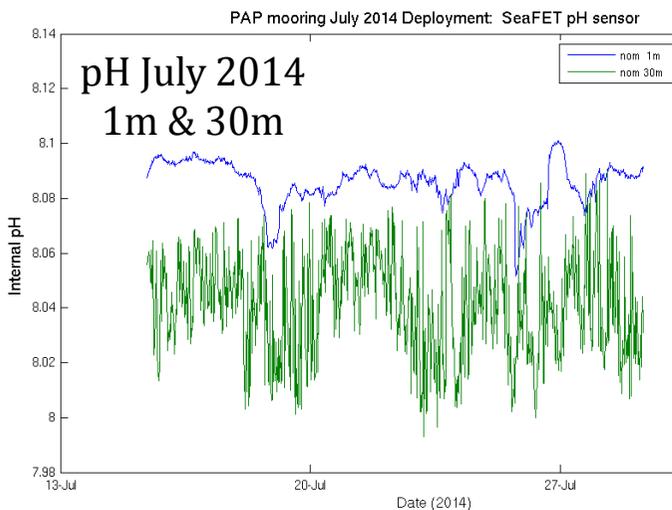
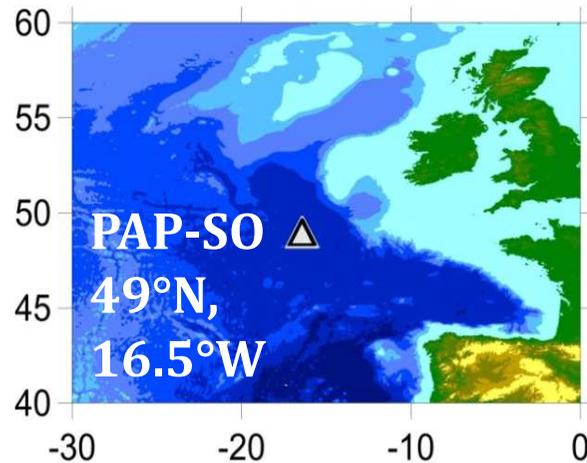
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Automated Time Series Porcupine Abyssal Plain Sustained Observatory (PAP-SO)

- Aim to understand system structure and function, & track changes in key variables
- pCO₂ & CO₂ flux at PAP-SO
Hartman et al., 2014, Biogeosciences, 11
- Observe variability in CO₂ fluxes. 1m & 30m CO₂ & pH sensors added July 2014.



www.noc.ac.uk/pap

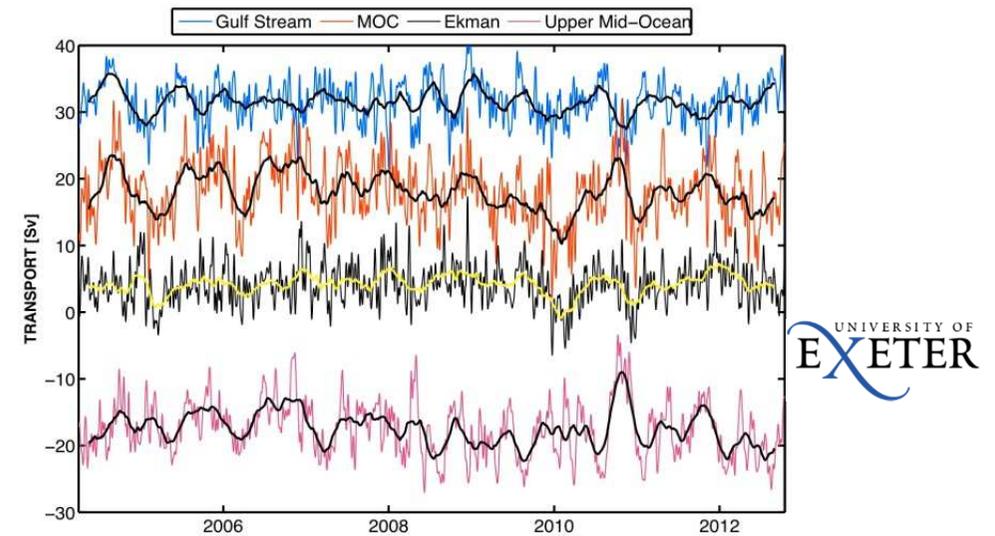
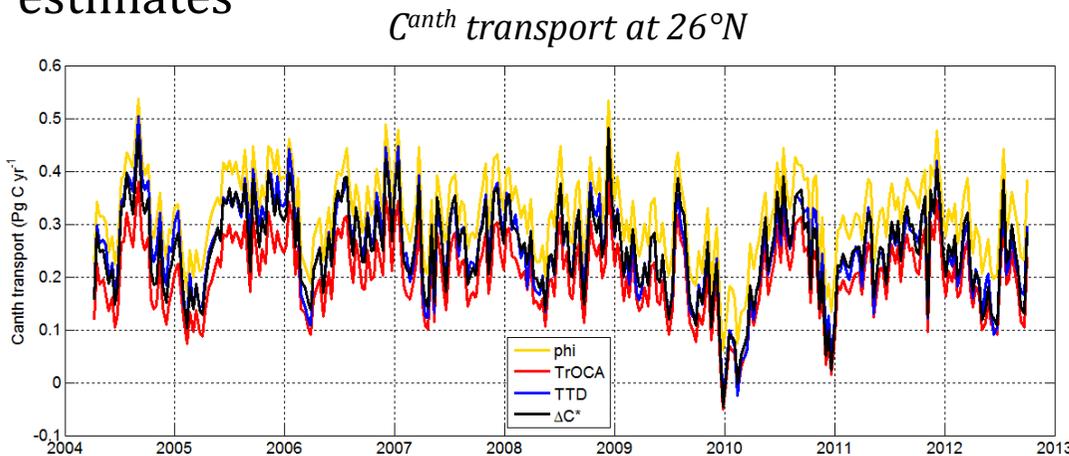
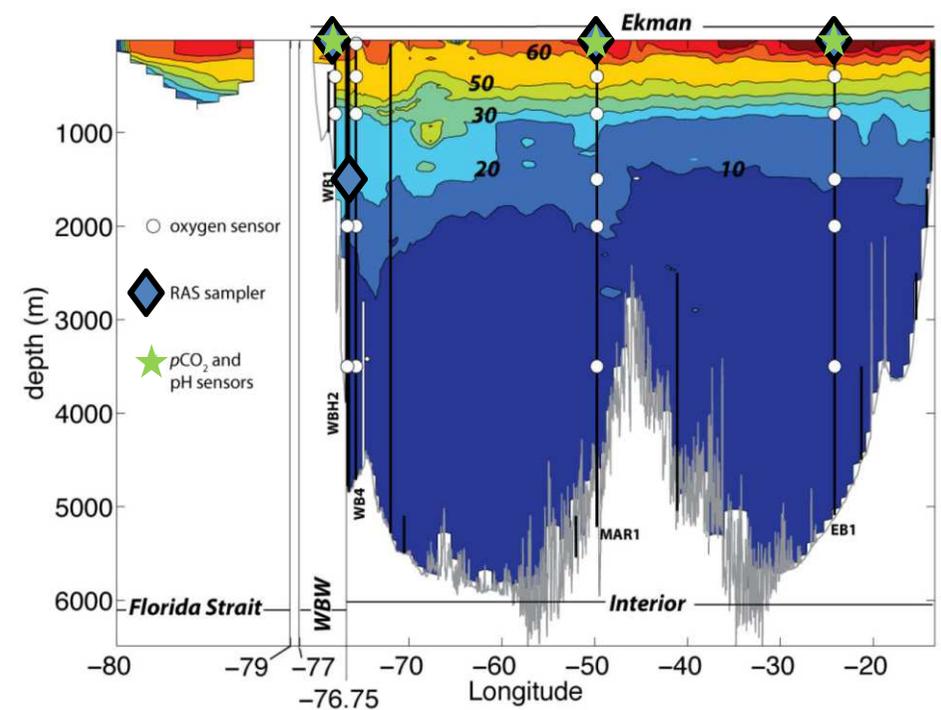


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Atlantic BiogeoChemical (ABC) Fluxes

- Fluxes and controls of carbon uptake in the North Atlantic
- Deployment of remote access samplers and $p\text{CO}_2$ & pH sensors across RAPID array at 26°N of NA in 2015 to investigate sub-seasonal variability in carbon system across subtropics
- Combination of hydrographic carbon data with RAPID & Argo-derived volume transport time-series to give high resolution carbon flux estimates



26°N Volume transports - McCarthy et al (2012) GRL



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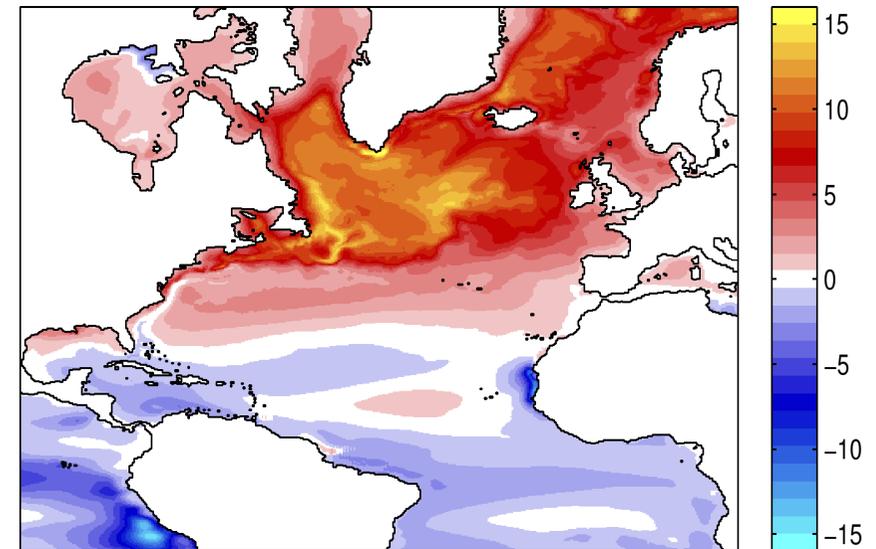




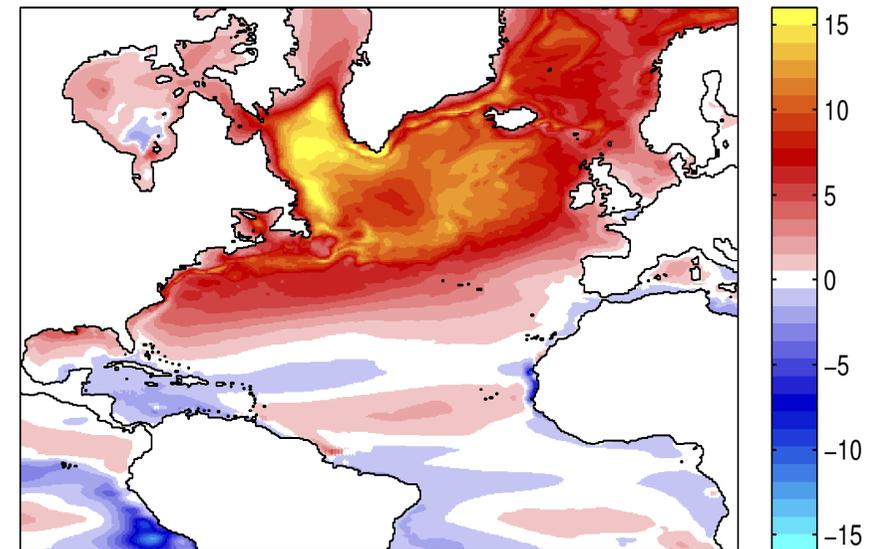
Marine carbon cycle modelling

- Uses state-of-the-art NEMO ocean general circulation model
- Global-scale resolutions from low (1°) to high ($1/4^\circ$) with ultra-high ($1/12^\circ$) spinning up
- Biogeochemical cycles of carbon, oxygen and nutrients resolved
- BGC model is a component of the UKESM model to be used in IPCC AR6

CO₂ flux, 2000s



CO₂ flux, 2050s

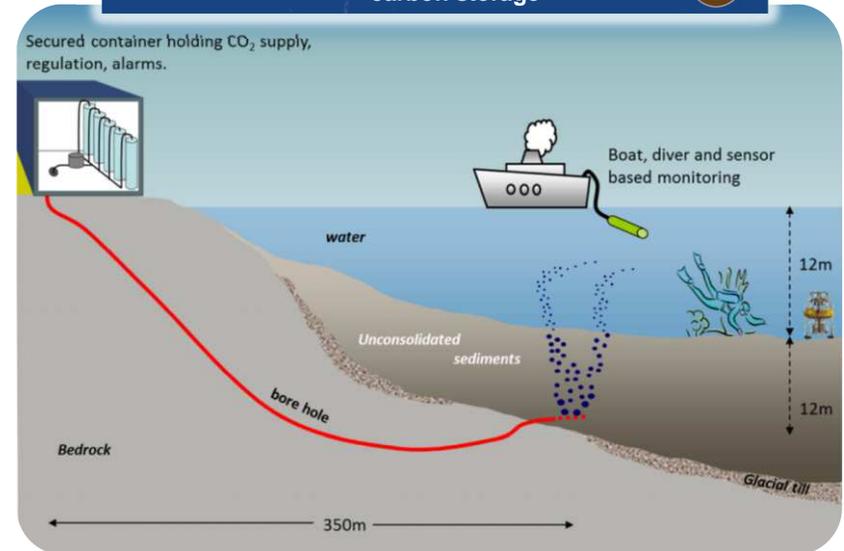
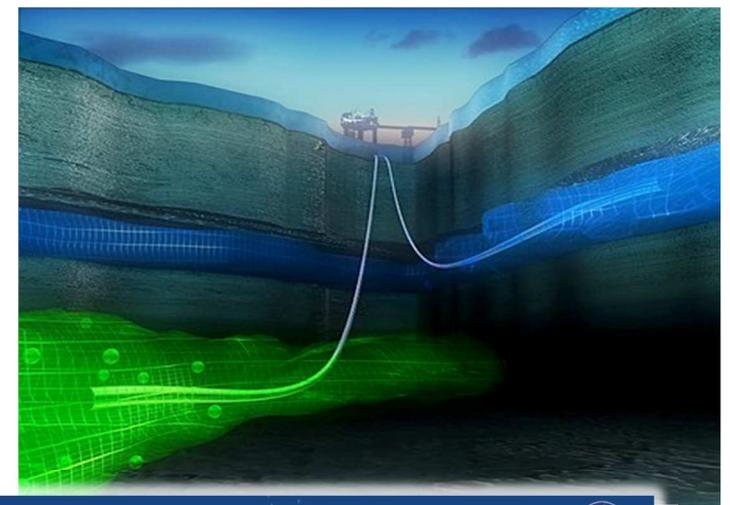


Carbon Capture & Storage (CCS)

- QICS: test release of CO₂ to investigate potential impacts of leakage. 4.2 t of CO₂ was injected over 37 days.
- Measurement, Modelling and Verification of CO₂ Storage (MMV) funded by the ETI. Partnering with Sonarydyne, Fugro, and others, the project will develop new AUV and sensor technology for future commercial CCS operations



- Diagnostic Seismic Toolbox for the Efficient Control of CO₂ Storage (DiSECCS): interdisciplinary collaborative project focusing on developing monitoring tools and methodologies to identify and characterise storage reservoirs stability and performance



(Blackford et al. Nature Climate Change 2014; Special issue IJGHG, 2014; Dewar et al, Mar. Poll. Bull 2013; Blackford et al, Energy Procedia 2012)



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Principal investigators:

- Interior Observations: Penny Holliday, Sue Hartman
- Shelf sea biogeochemistry: Richard Sanders
- Ships of opportunity: Sue Hartman
- PAP-SO: Richard Lampitt
- ABC Fluxes: Elaine McDonagh
- Carbon cycle modelling: Andrew Yool
- CCS: Douglas Connelly
- Satellites: Stephanie Henson



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