

RAGNARoCC

Radiatively Active Gases from the North Atlantic Region – Role of Climate Change

Stakeholder Event

Royal Society

March 12th 2014

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Southampton



National
Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

UNIVERSITY OF
Southampton



UEA University of
East Anglia



Newcastle
University

UNIVERSITY OF
EXETER

PML

Plymouth Marine
Laboratory

The ocean is a small, but non trivial source of both Methane (1-3% of total) and Nitrous Oxide (25% of total)

The ocean is a massive sink for CO₂

One-quarter of the anthropogenically mobilised CO₂



1.1±0.7 GtC y⁻¹



7.7±0.5 GtC y⁻¹

4.1±0.1 GtC y⁻¹
47%



2.4 GtC y⁻¹
27%

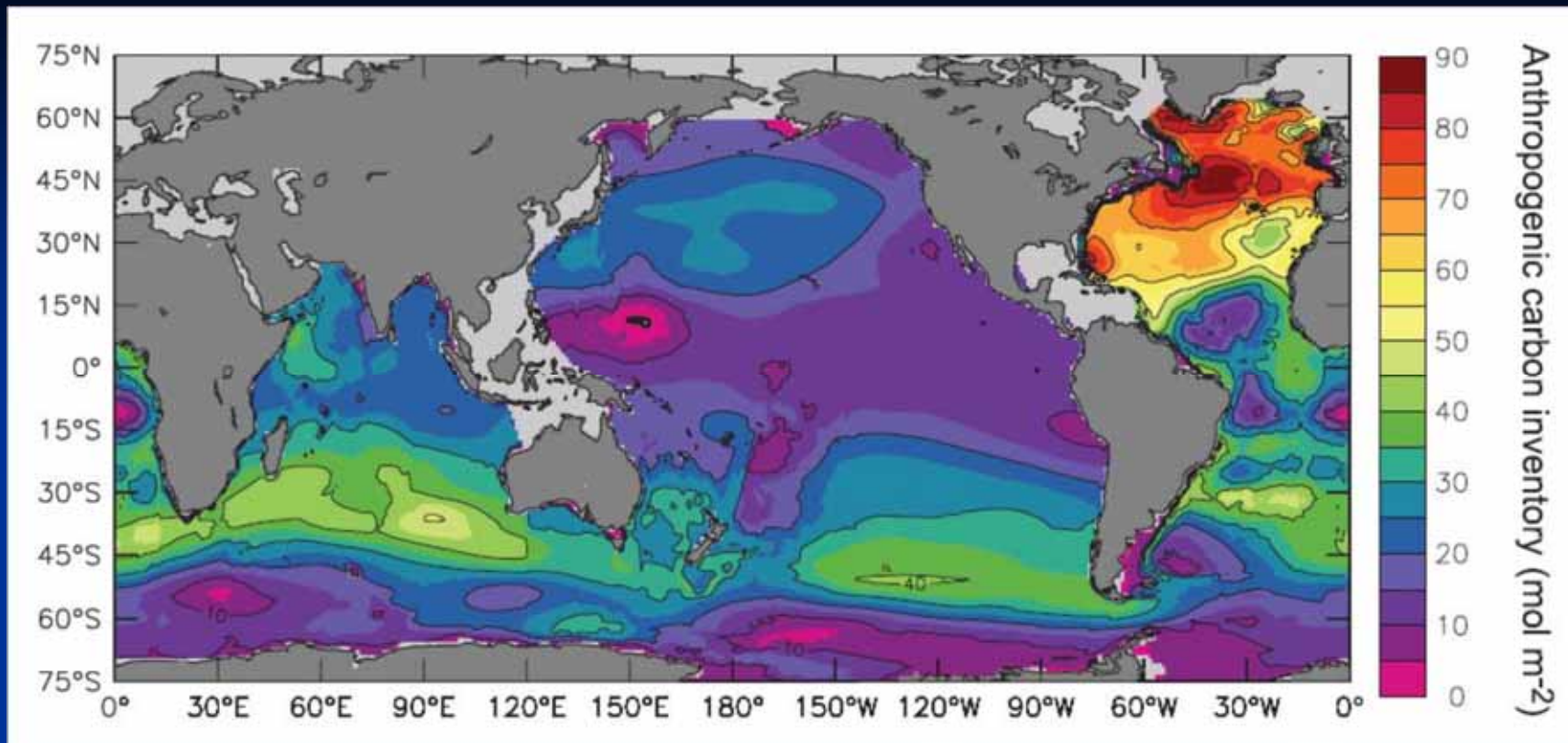


Calculated as the residual of
all other flux components

26%

2.3±0.4 GtC y⁻¹
Average of 5 models





Sabine *et al.*, 2004, *Science*

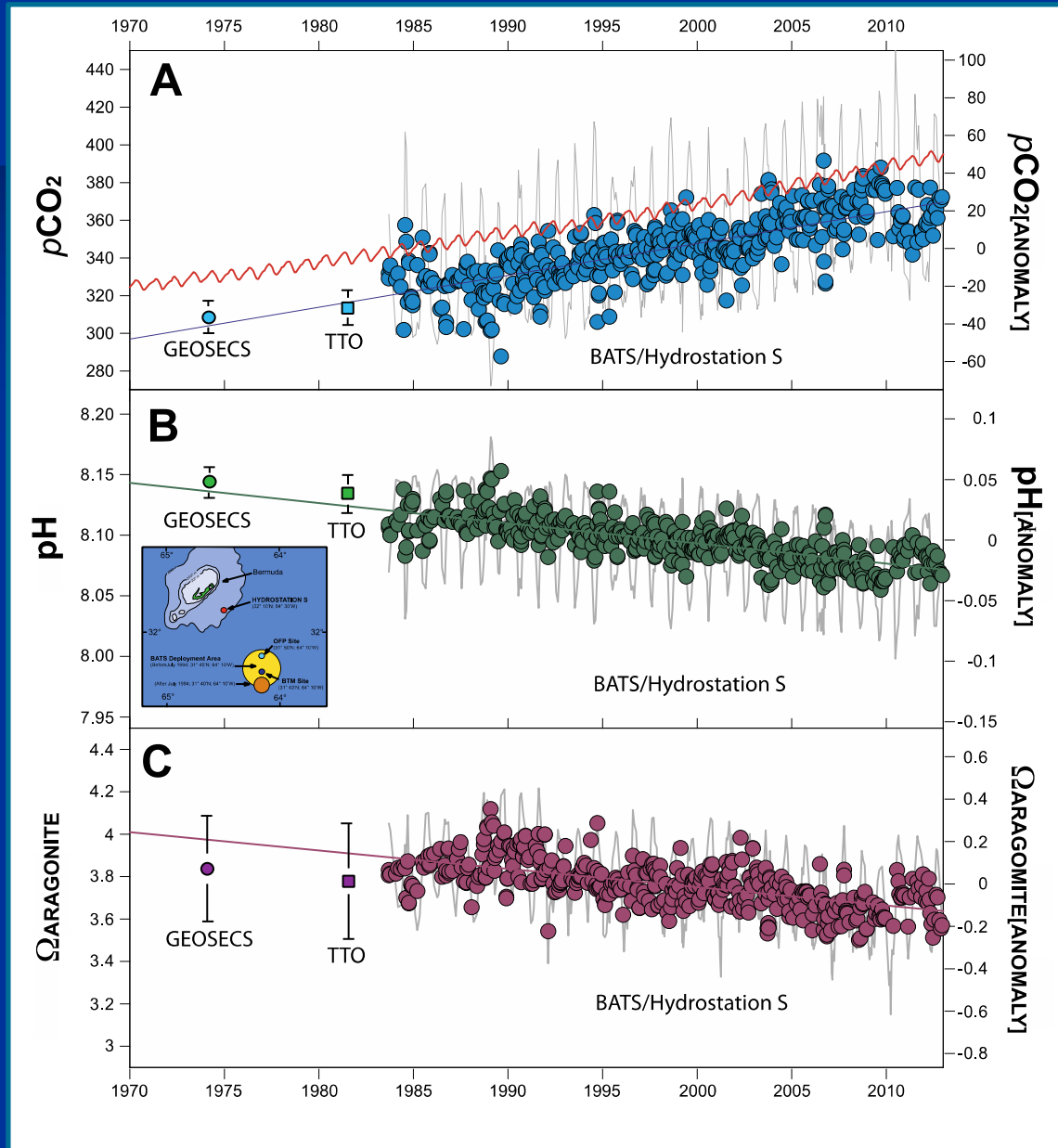
Oceanic Anthropogenic Carbon Pool

How did it get there?

How stable is it?

What will happen into the future?

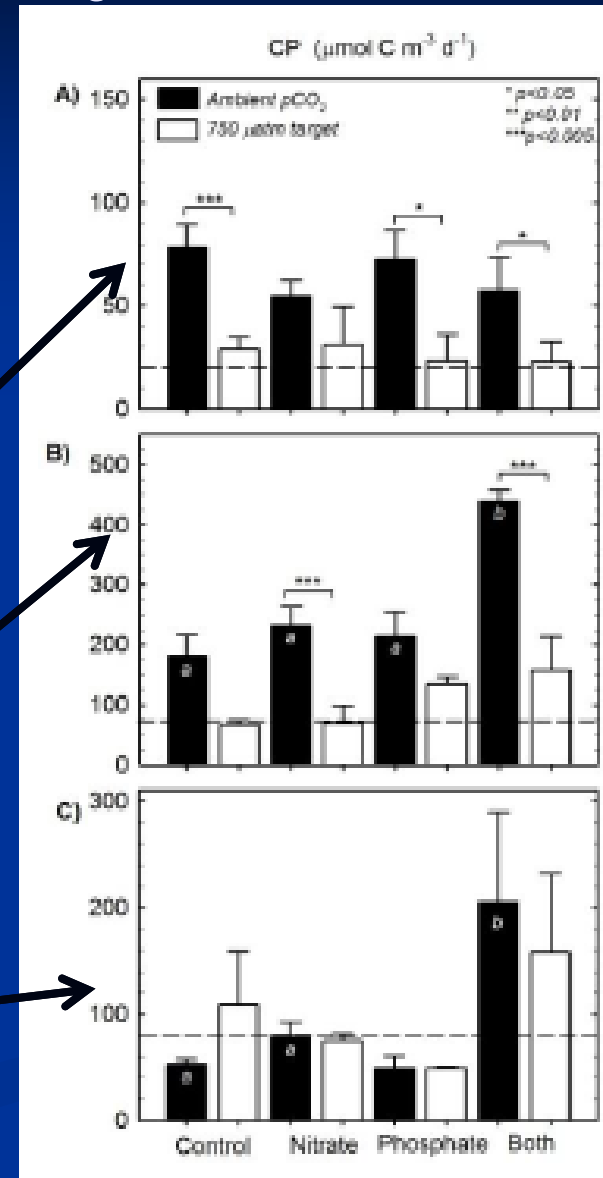
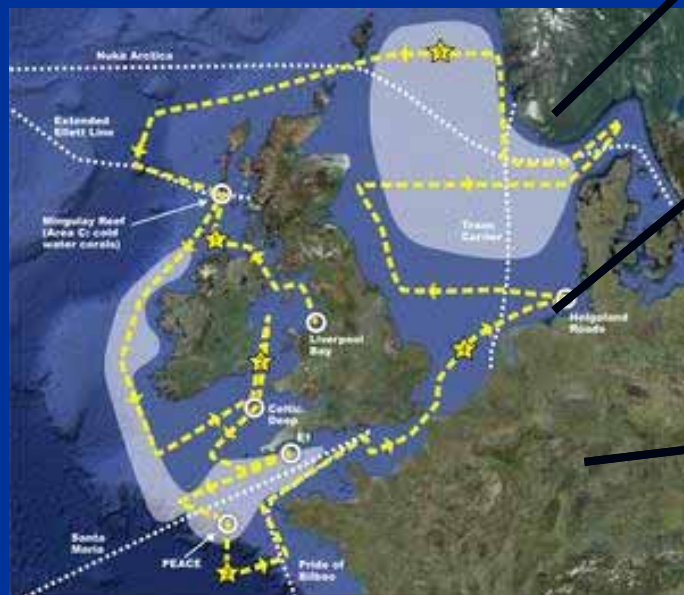
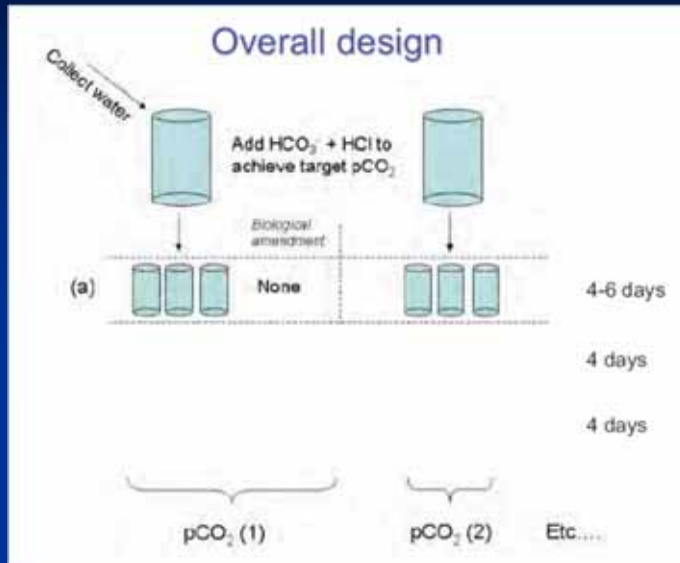
Ocean Acidification at Bermuda



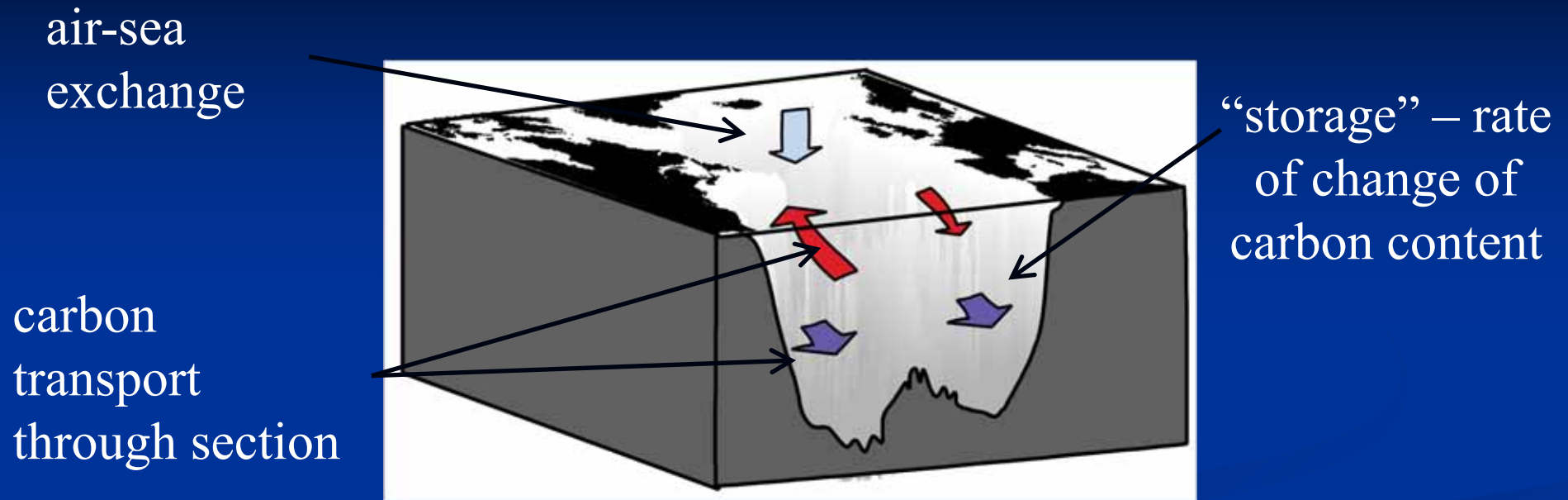
pH changes =
 $-0.0017 \text{ year}^{-1}$

or about **25%**
increase in
acidity (H^+) in
the
last forty years

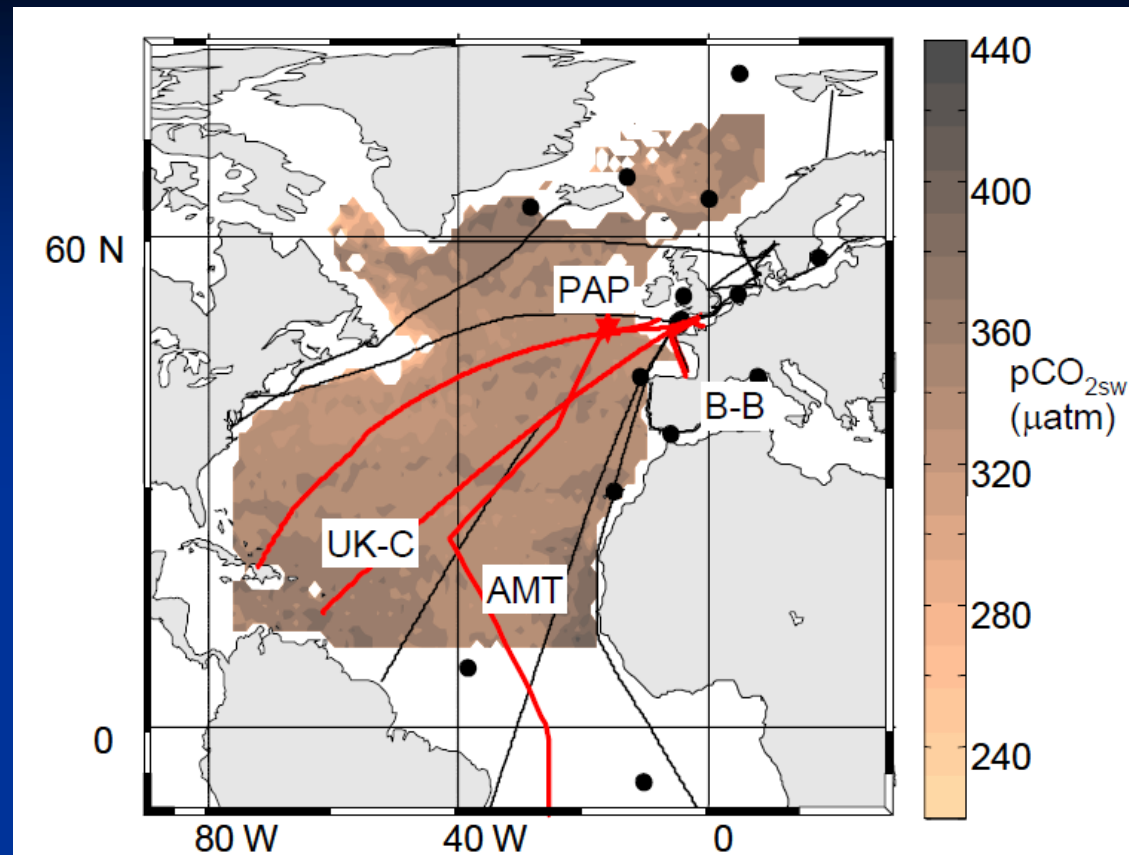
Bioassays



RAGNARoCC Structure

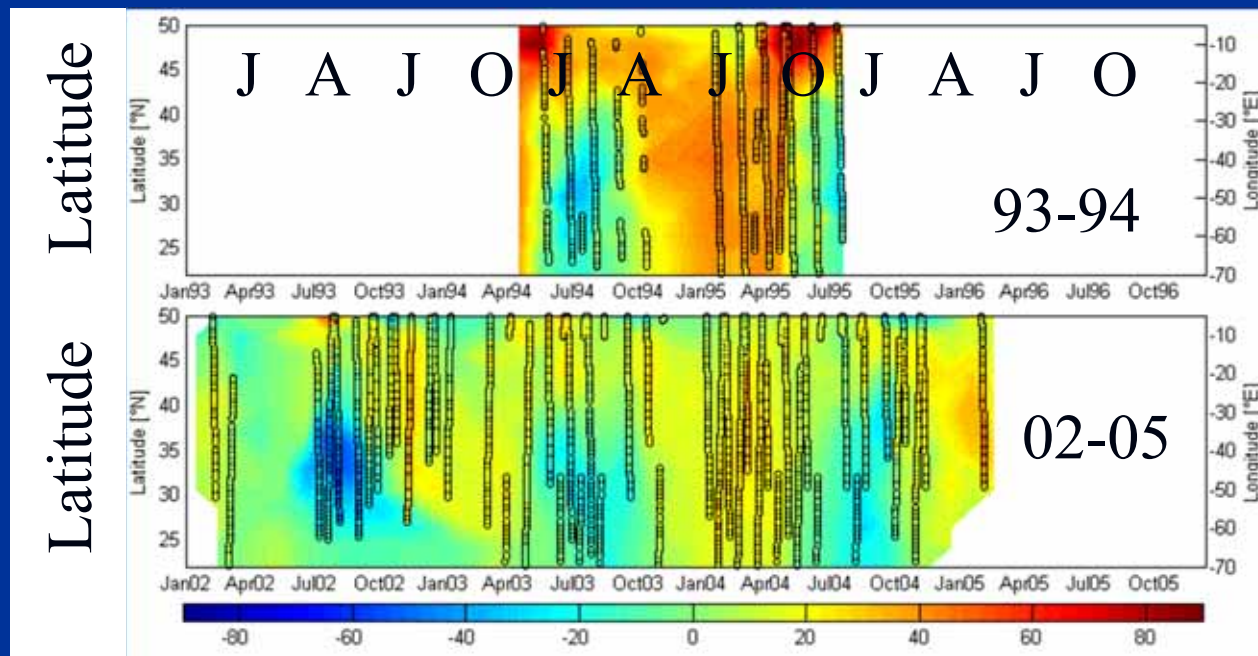
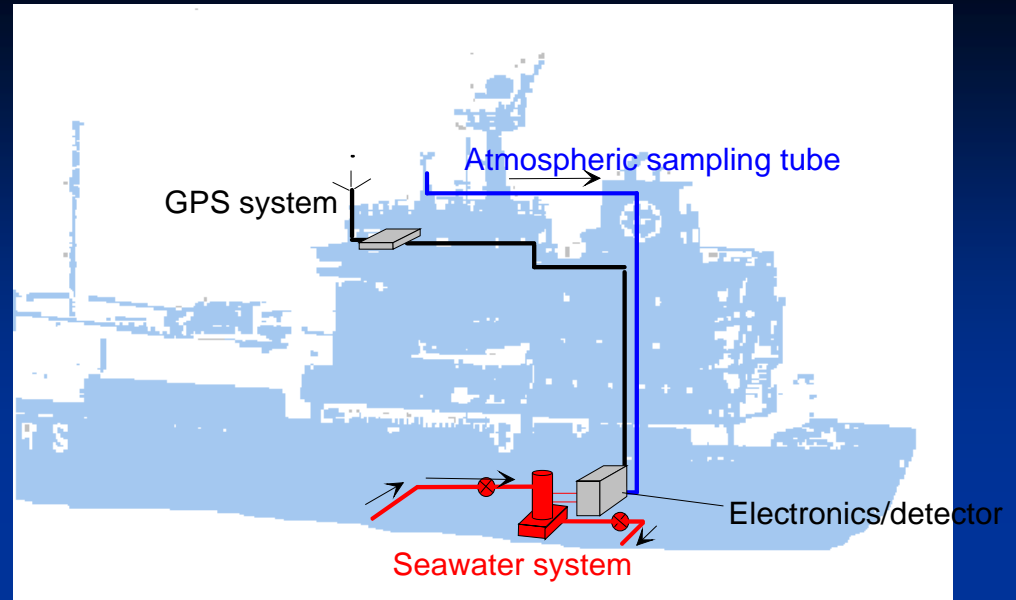


- WP 1 Surface observations
- WP 2 Interior observations
- WP 3 Data synthesis
- WP 4 Numerical modelling



- Contribution to surface CO₂ flux observations VOS, PAP
 - NOC, Exeter, PML
- N₂O and CH₄ observations +technology development
 - Exeter, PML
- Improved gas transfer velocities – data analysis and experiments
 - (NOC, Newcastle, PML)

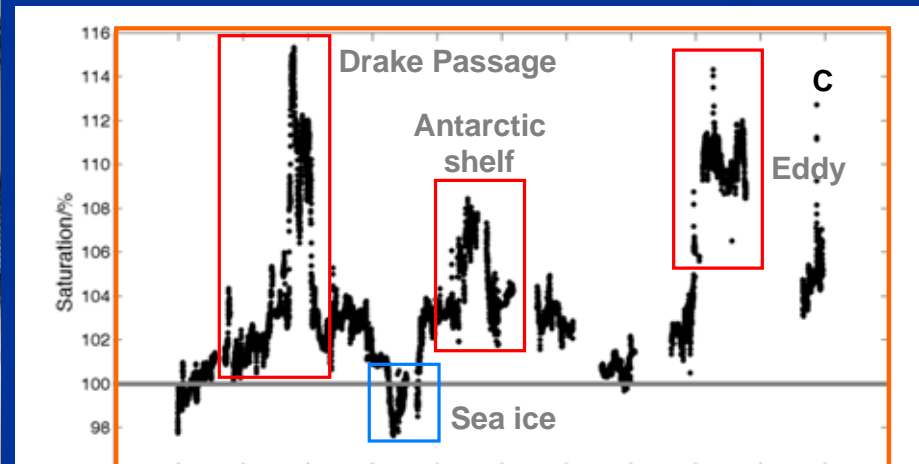
- Continuous measurements in N. Atlantic since 2002
- GHG funds ongoing network for 1 year,
- Other contributions from EU and NERC OA



$\Delta p\text{CO}_2$

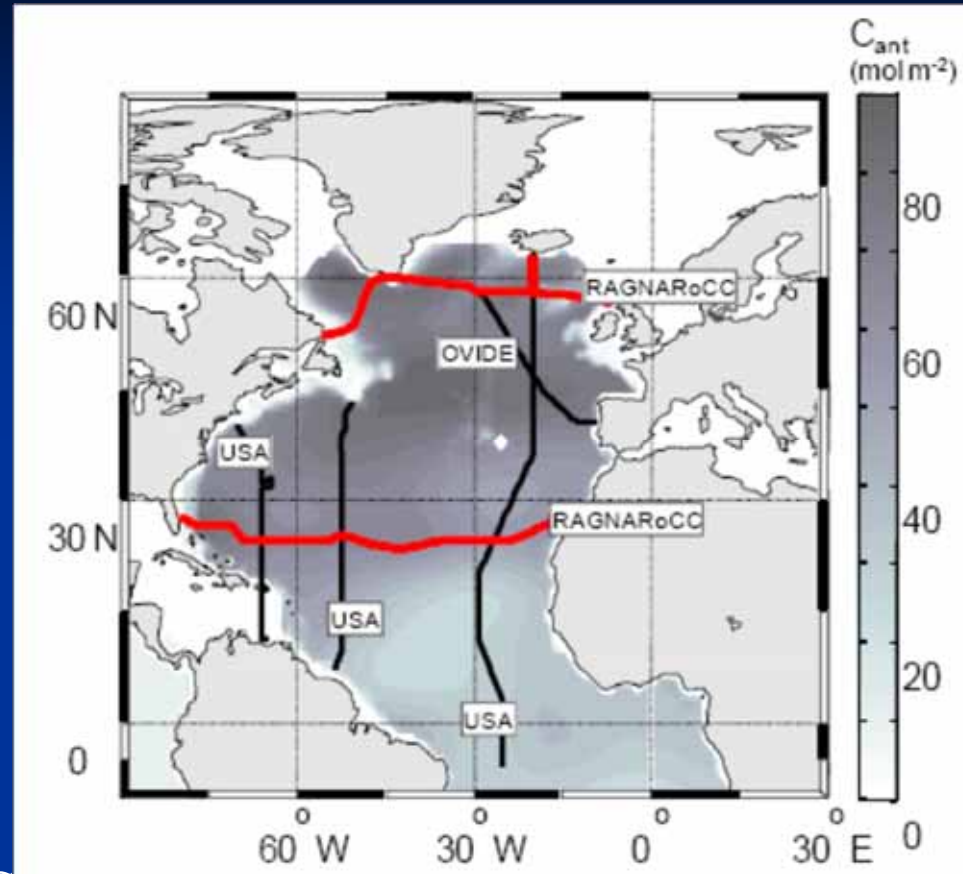
CH₄ and N₂O (PML, Exeter)

- Current methods rely on human intervention
- Move from GC to Optical methods - semiautomated systems
- Aim to produce standalone systems by end of programme

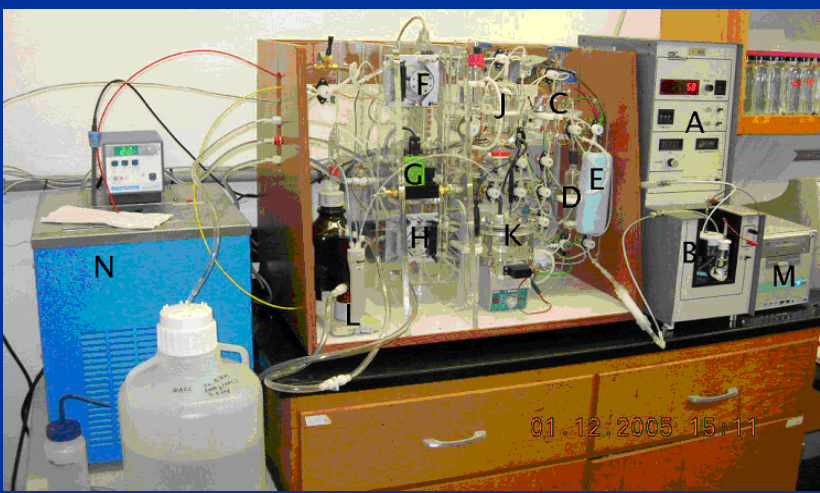
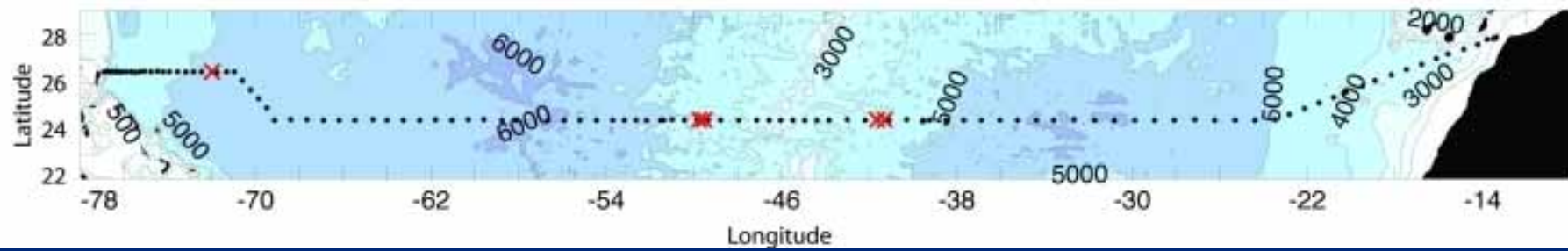


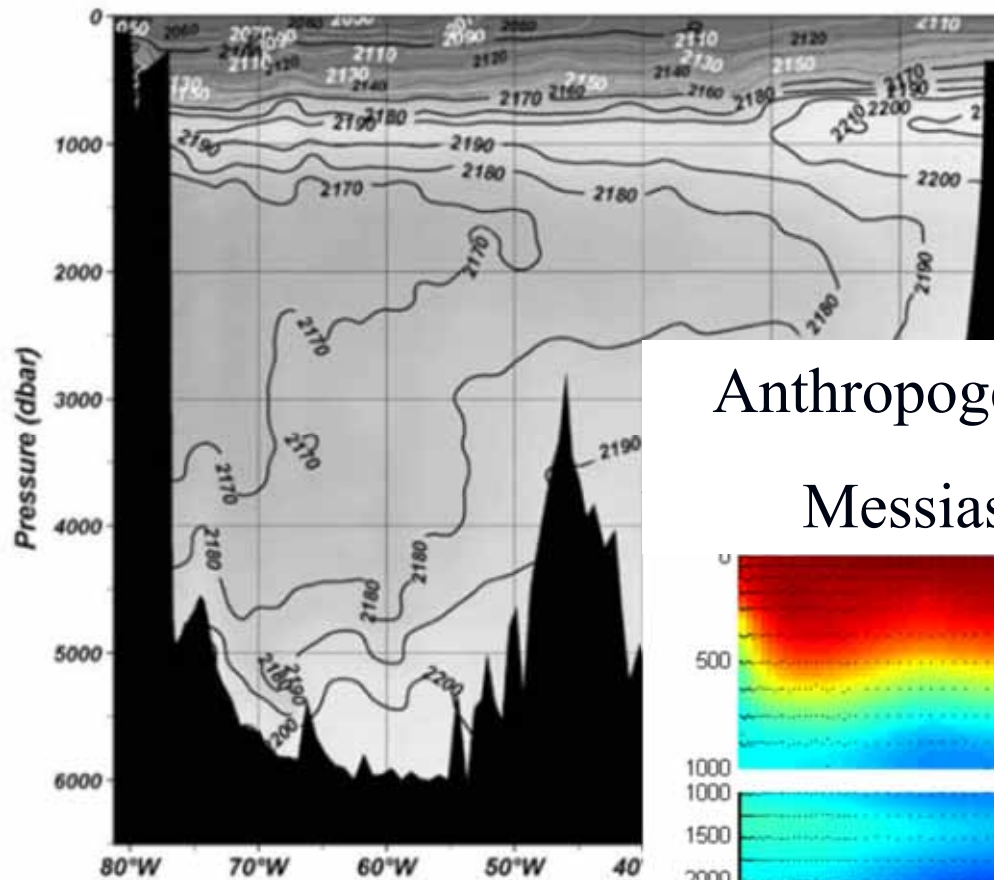
N₂O Saturation

WP2: Interior - lead King NOC



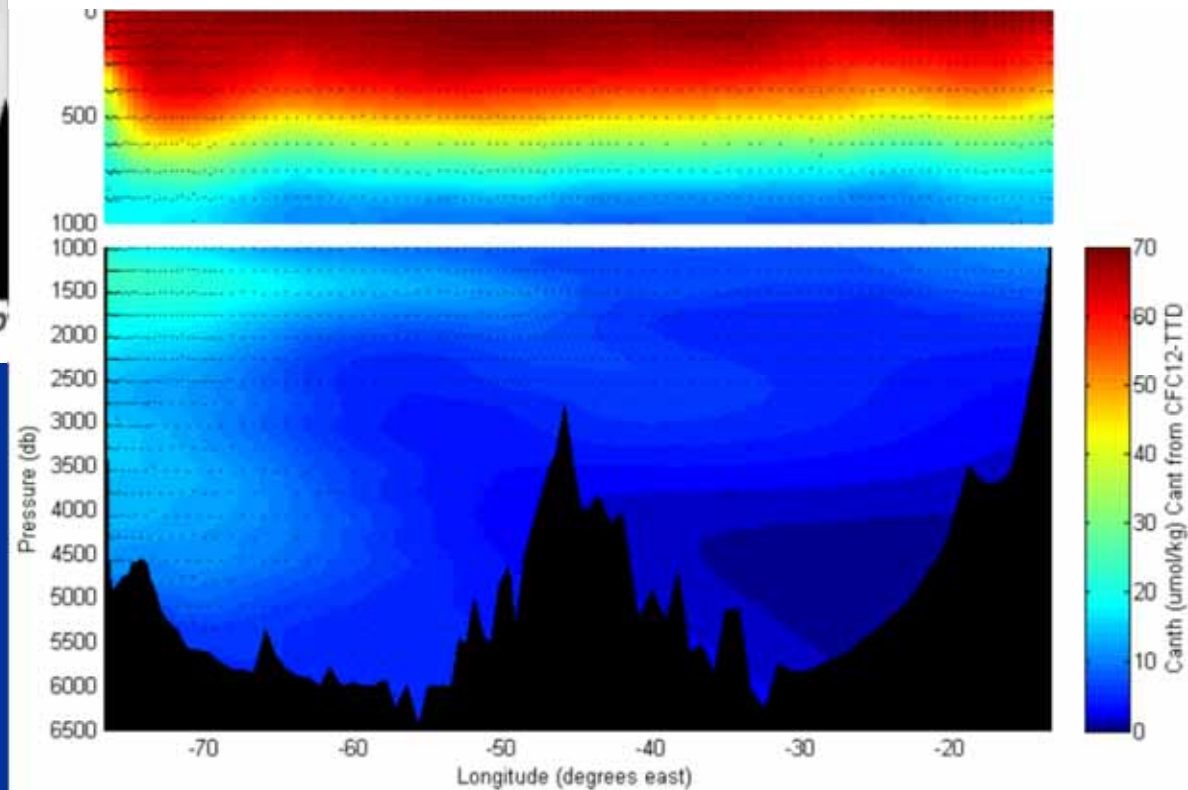
- Long Sections
 - Inorganic carbon (Exeter, USoton, NOC)
 - CFCs (Exeter)
- 60N 2014
- 24N 2015





Anthropogenic Carbon from TTD at 24N

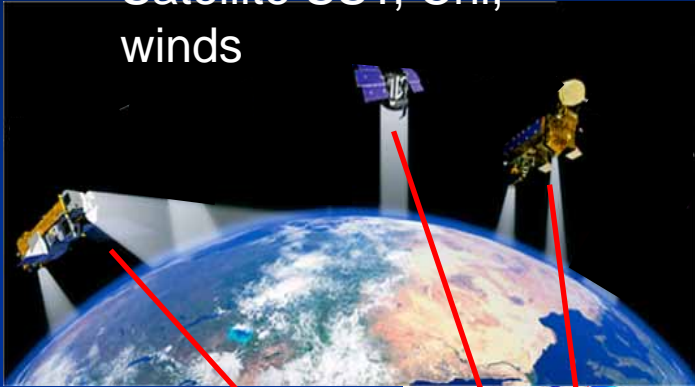
Messias, Watson, Schuster, Exeter



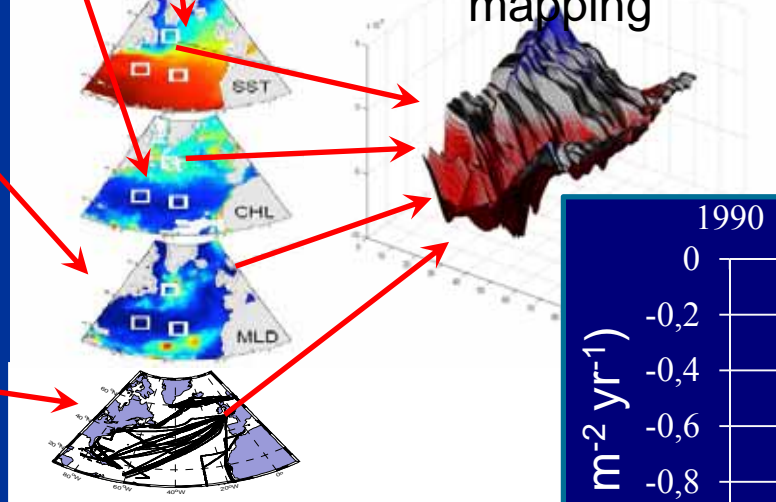
- CO₂ at 24°N
- Schuster, Brown, Watson, Messias, Exeter.

WP3: Synthesis

Satellite SST, Chl,
winds

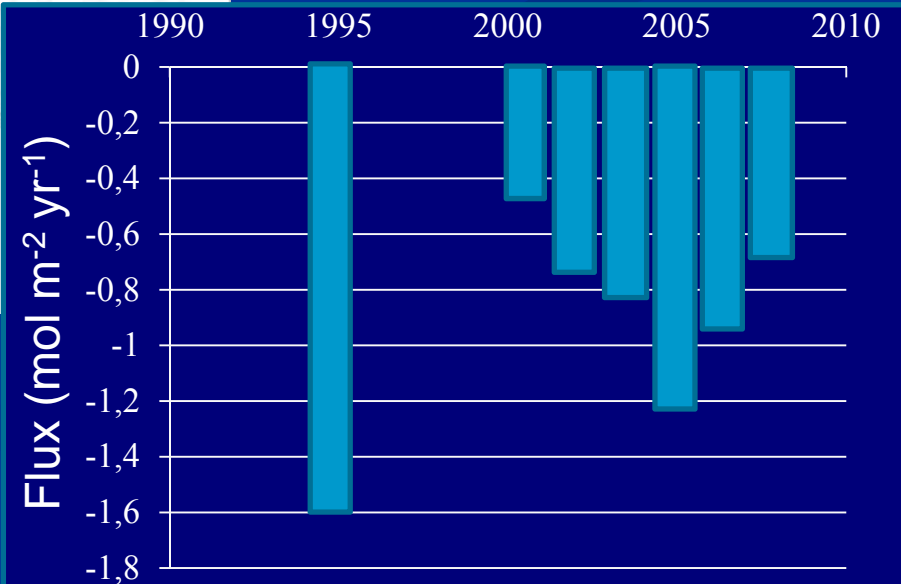


CO₂
mapping

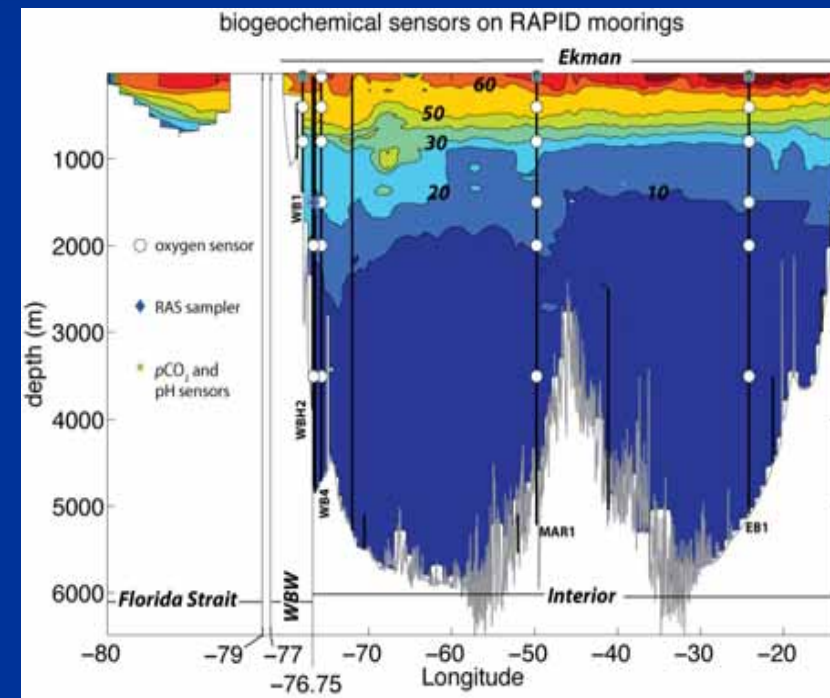
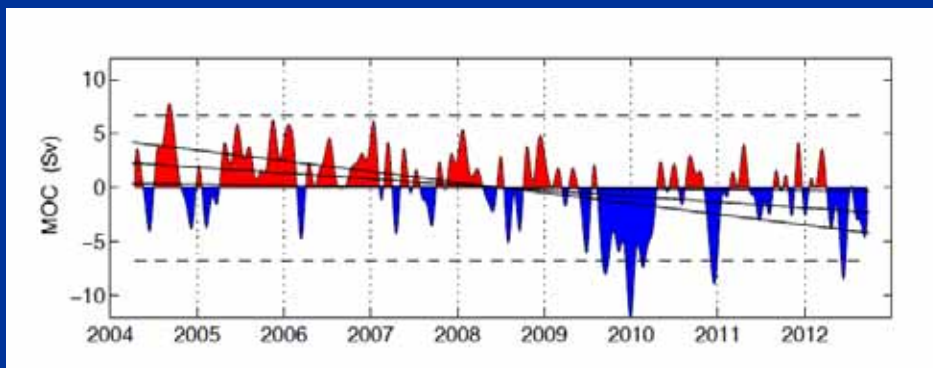
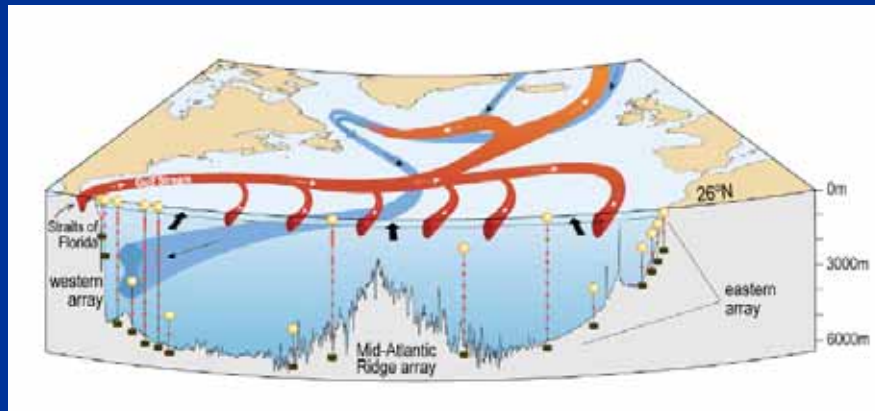


Spot CO₂ values

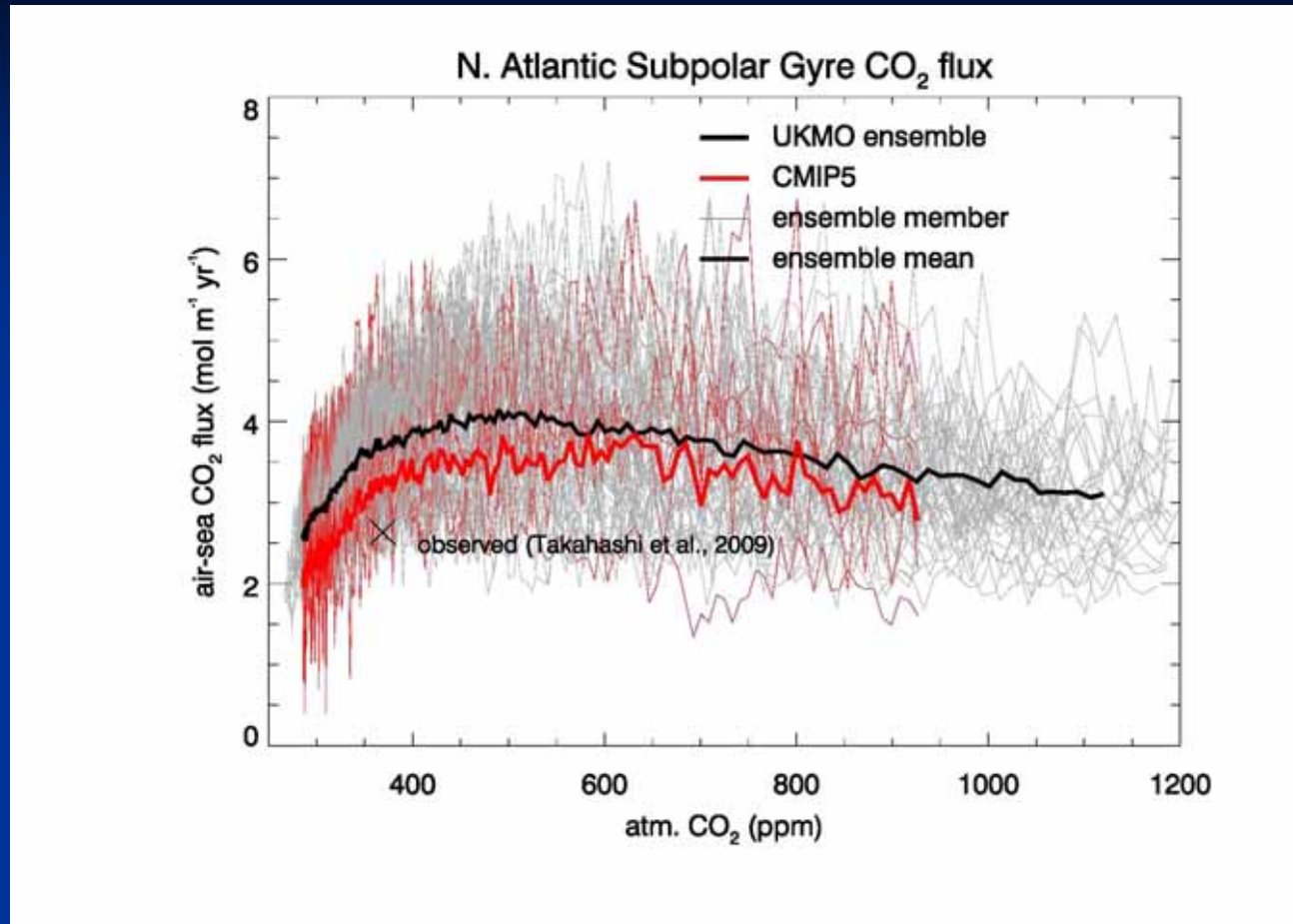
Reason for reduction
unclear



Hypothesis that Ocean Physics causes reduction in uptake



Smeed et al., Ocean Sciences,
McDonagh., proposal to NERC



- Reduced uptake seen in models
- Top Down (box model, large ensemble)
- Bottom up (detailed GCM analysis).

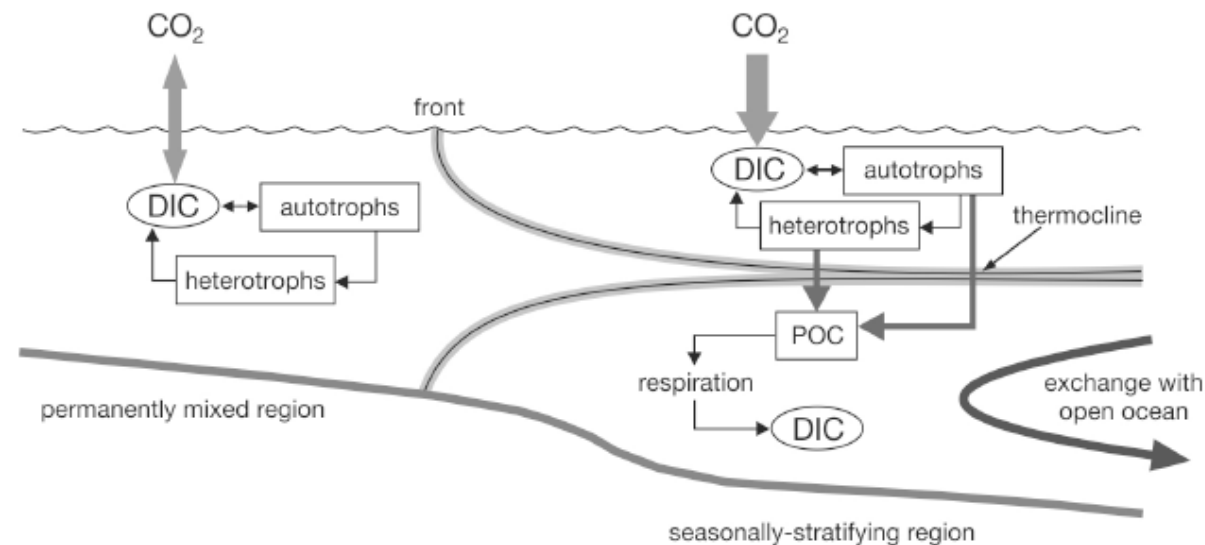
Shelf Seas Research Programme 2013-2017

The Shelf Seas Carbon Pump

It is *broadly accepted* that shelf seas provide a net sink for atmospheric CO₂:

$\Delta p\text{CO}_2$ data \Rightarrow 0.35 GT C a⁻¹, or 29% of global sink (Chen & Borges, 2009)

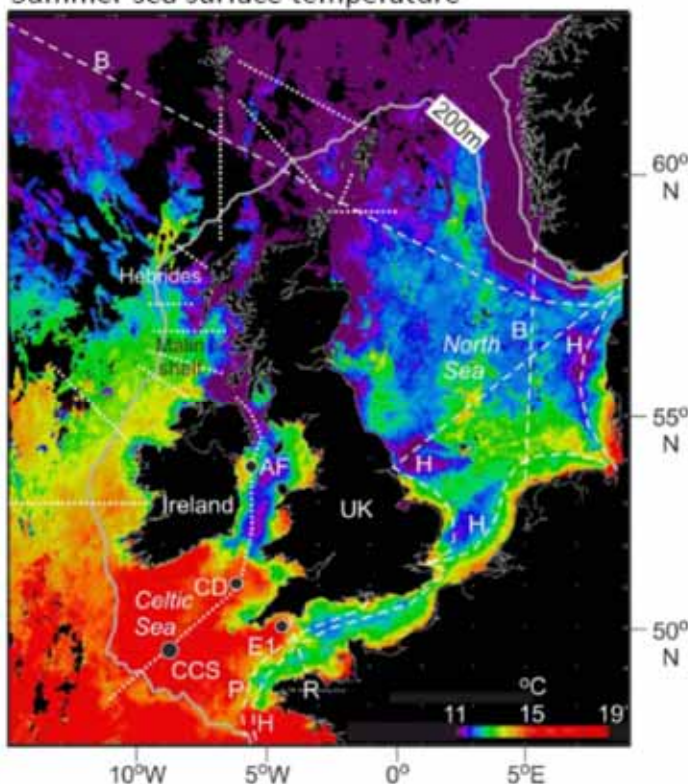
Also thought to drive >40% of global particulate carbon sequestration (Muller-Karger et al., 2005)



Objective 1 : Quantify role of entire NW European Shelf in Global C Cycle

Objective 2: Understand how this functions to allow prediction of future

Summer sea surface temperature



12 months of nutrient and carbonate chemistry sampling

Daily surface sampling, key transects, moorings (Marine Scotland, CEFAS, AFBI, Irish Marine Institute). Collaboration with 5 groups running ferry box routes (Roscoff, HZG, Universities of Bergen, Vigo, Las Palmas)

Earth-Observation and statistical techniques to interpolate across patchy data fields.

Utilise existing databases on riverine and atmospheric inputs.

A highly cost-effective NW European research programme

Highly ambitious – only achievable because of linkages and goodwill achieved via UK-IMON

Deliverable, Impact and Legacy

- Data - N Atlantic fluxes and storage
- Information on ongoing ocean acidification
- Projection of future sink strength
- Operational estimates to ECMWF
- To be implemented under ICOS?

Integrated Carbon Observing System

- EU Infrastructure project linking Greenhouse Gas observations around Europe
- Thematic centres to support observations
- Ocean Thematic Centre supported by UK and Norway
- UK GHG community needs to maximise benefits
- Propose that UK ICOS committee established

