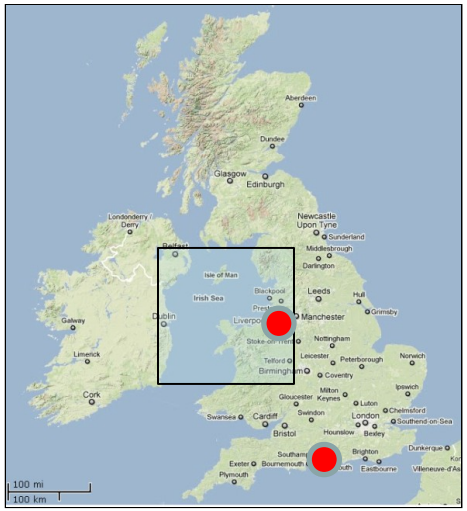
Experiences of using shallow water Slocum Gliders in the Irish Sea

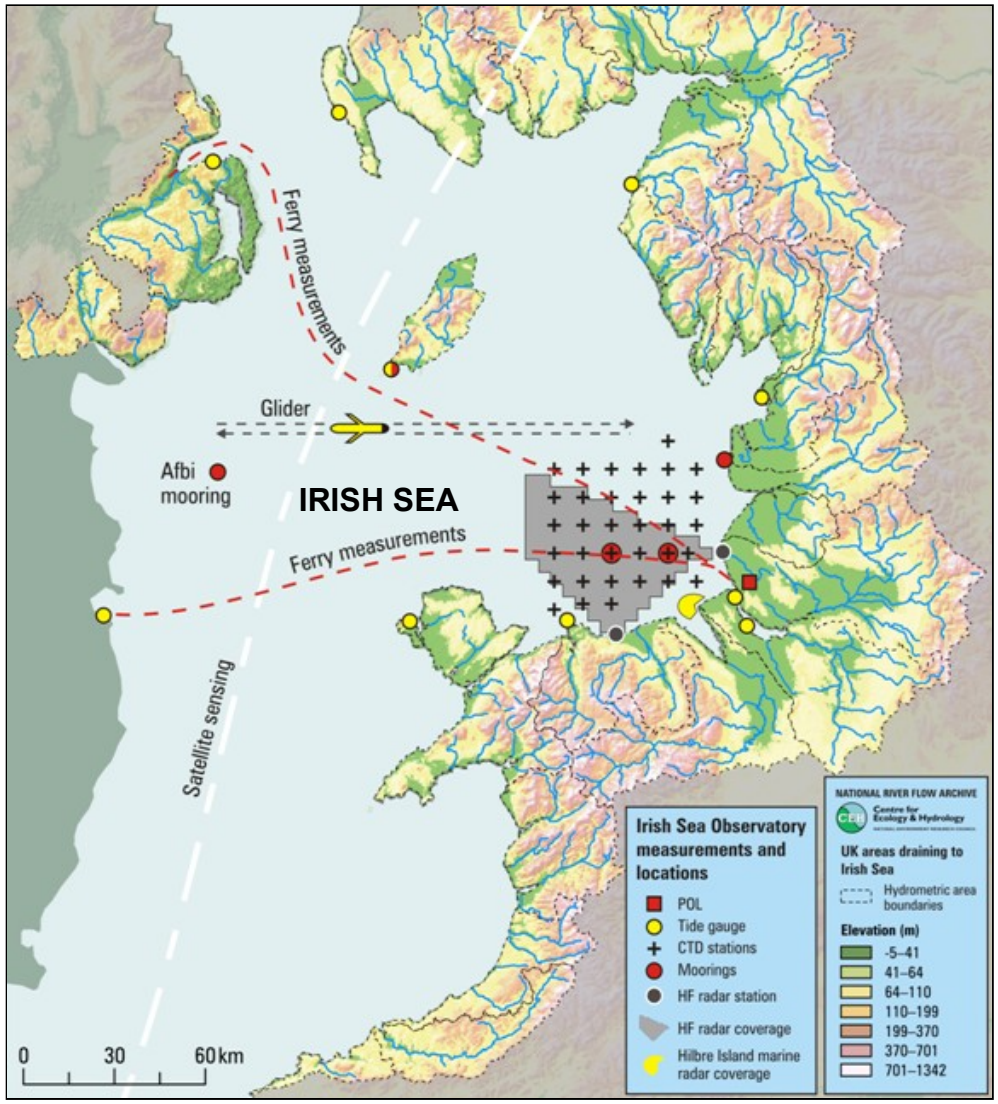
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

5th EGO Meeting & Glider School, March 14th - 18th 2011

Phil Knight, Chris Balfour, John Kenny ,
Danny McLaughlin & Matthew Palmer

- 1st scientific mission
  - Investigate Spring Bloom
- Trial of Glider fitted with Rockland turbulence probe
- 2nd scientific mission
  - Investigate the Mersey plume





NOC (based at two sites Southampton & Liverpool)

NOC-Liverpool shallow water Gliders

Gliders & Sensors

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Glider 117 G1 Zephyr - 1st Scientific mission

- Non-pumped SeaBird CTD: Temperature, Conductivity, Pressure
- Aanderaa Oxygen Optode
- Wetlabs Triplet: CDOM, Chlorophyll and Backscatter

Glider 175 G1 Rooney - Trial

- Non-pumped SeaBird CTD: Temperature, Conductivity, Pressure
- Attached: Rockland MicroRider Turbulence Probe

Glider 194 G2 (Yet to be named) - 2nd scientific mission

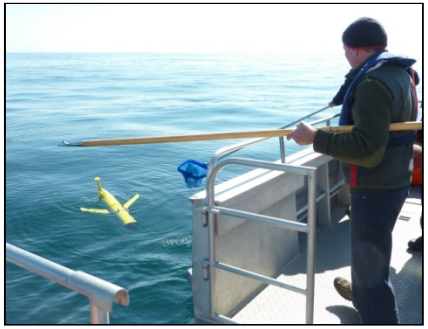
- Pumped CTD: Temperature, Conductivity, Pressure
- Aanderaa Oxygen Optode
- Wetlabs Triplet: CDOM, Chlorophyll and Backscatter

Facilities at NOC Liverpool

Lab space / deployment recovery options

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

RV Marisa



RV Prince Madog

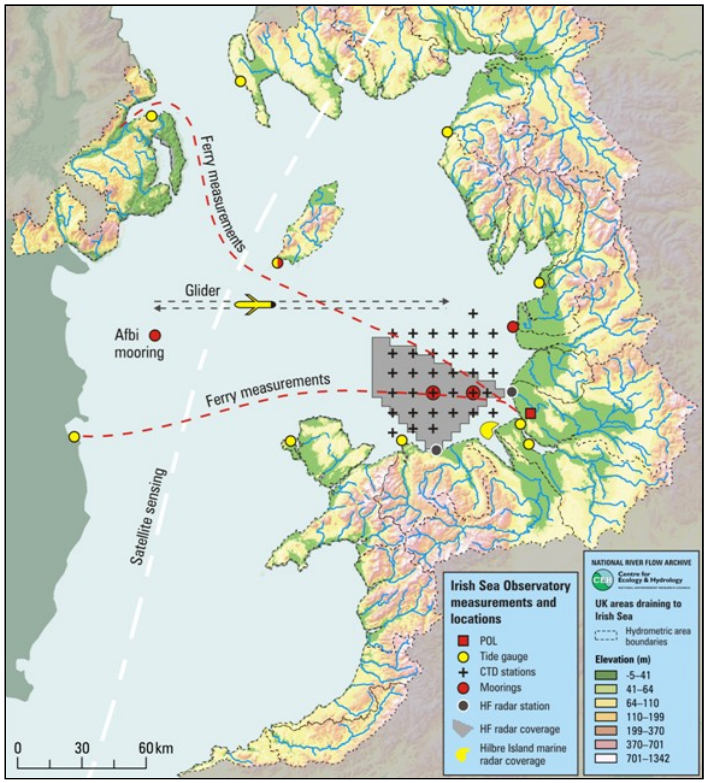
First scientific mission

24 Mar – 12 Apr 2010

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Aims

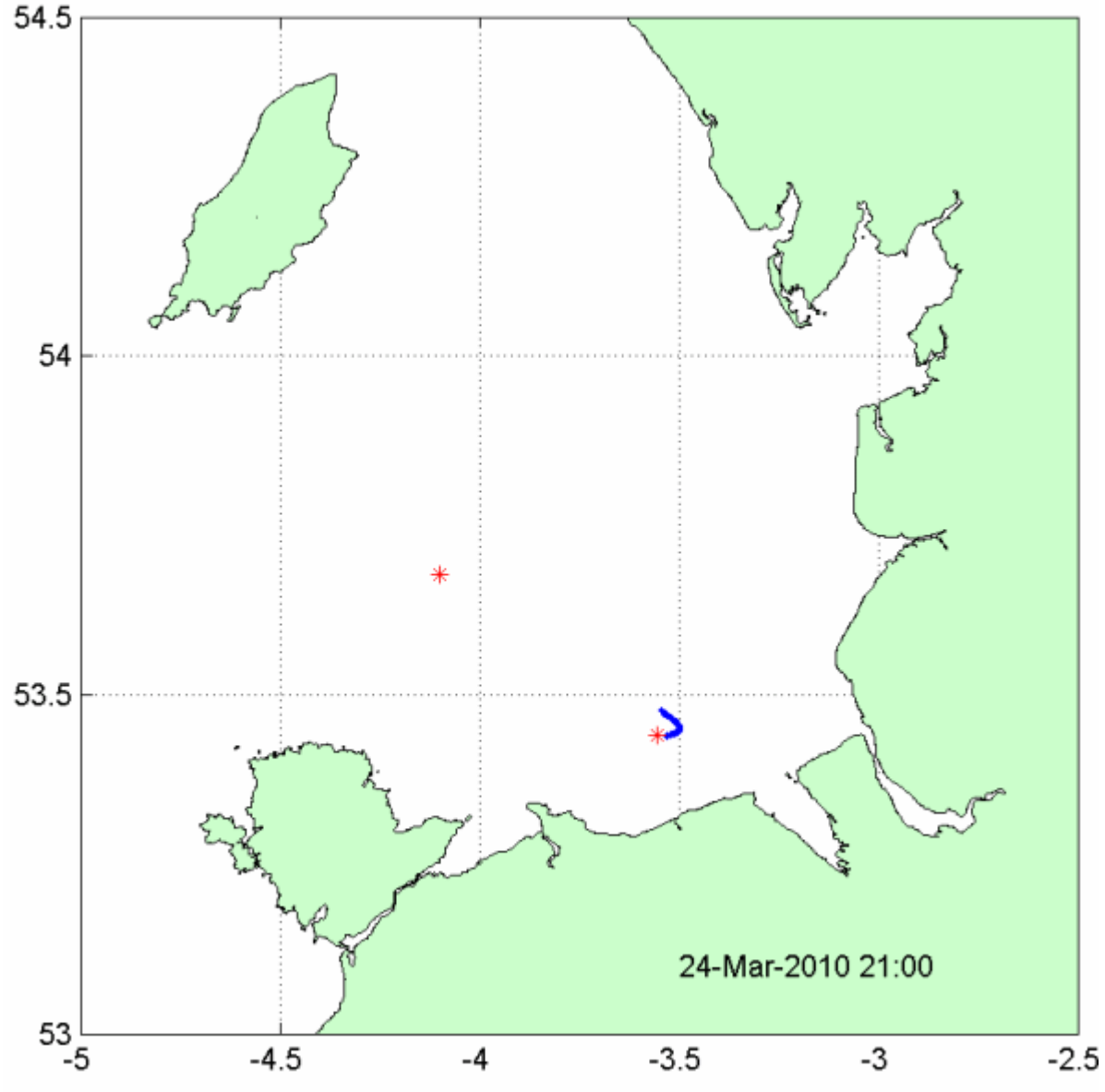
- Be deployed during the Spring Bloom
- Cover a Spring/Neap cycle
- Perfect control and flying (24/7)
- Avoid shipping and fixed installations
- Experiment with moving to areas of interest
  - Variability of algal bloom (patchiness)
  - Use satellite images/ferry box data to direct track
- Keep the Glider on position
- Move in and out of survey area
- Provide data to validate modelling



First scientific mission

24 Mar – 12 Apr 2010

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

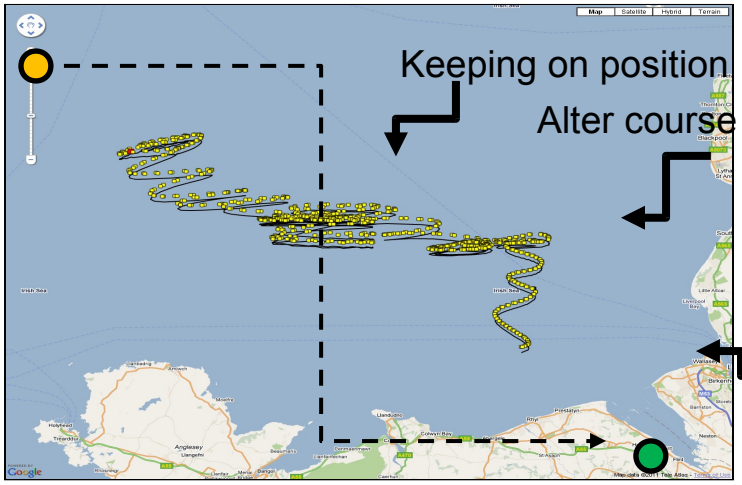


First scientific mission

24 Mar – 12 Apr 2010

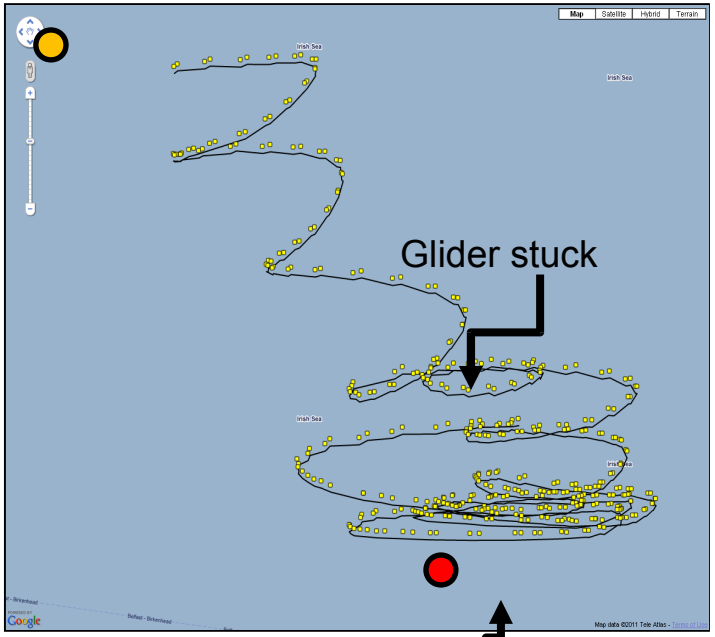
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

24th March to 6th April



Start
End
Return way-point added

6th April to 12th April

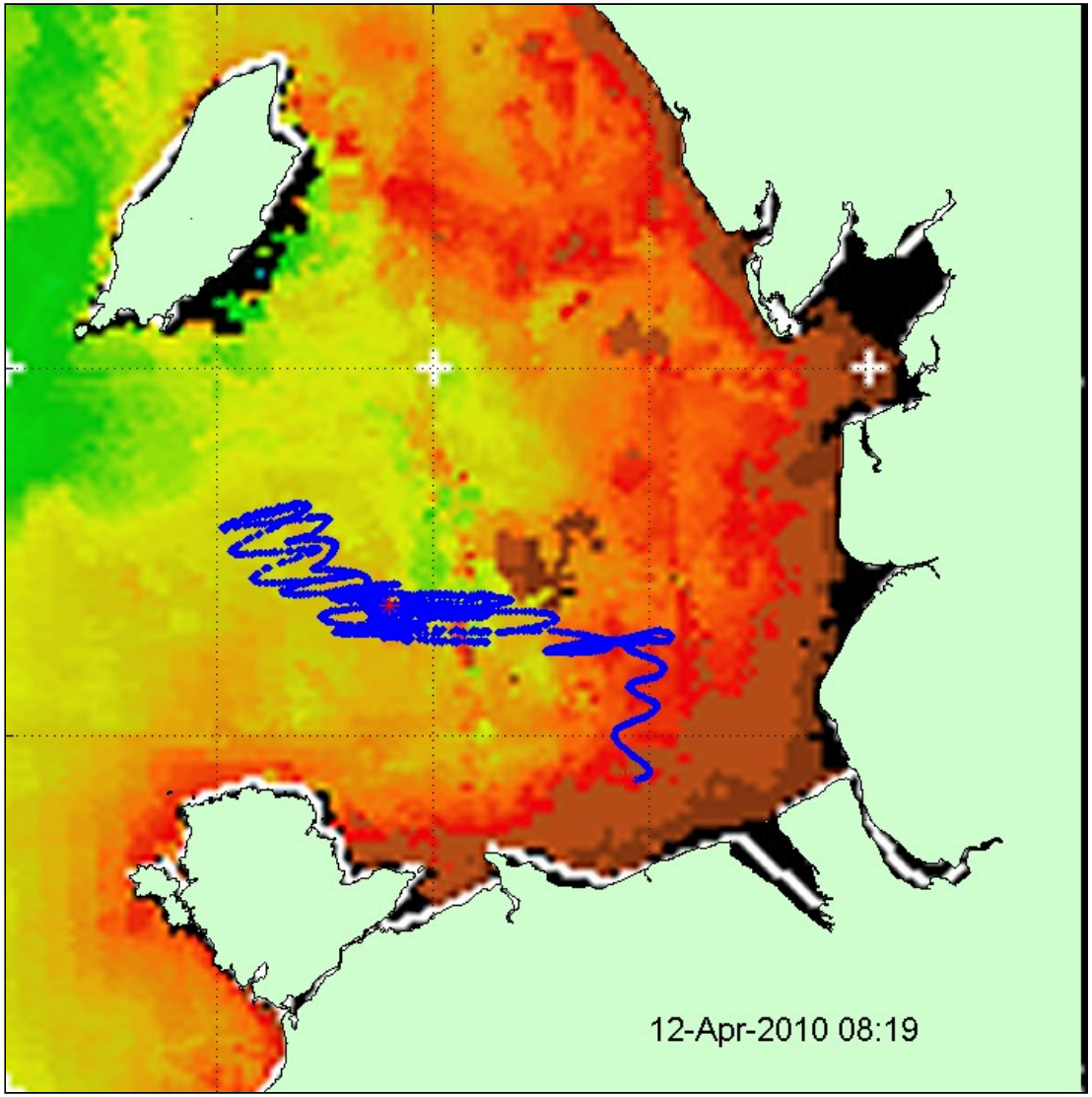


Glider stuck again

First scientific mission

24 Mar – 12 Apr 2010

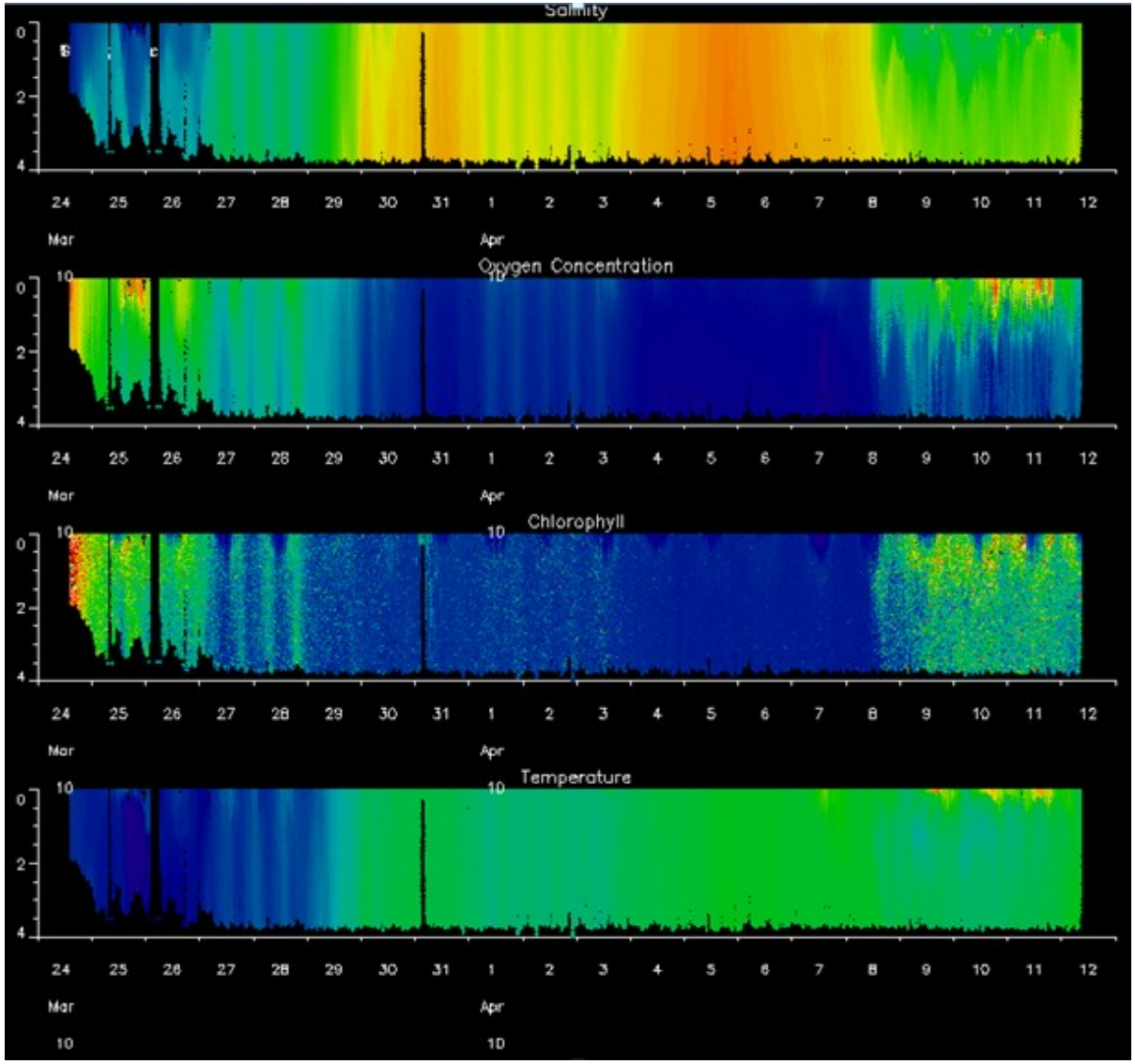
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

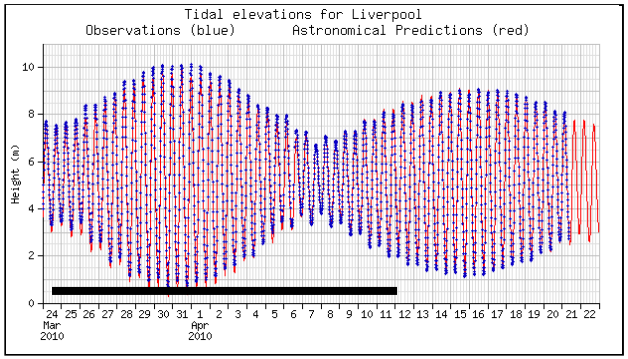


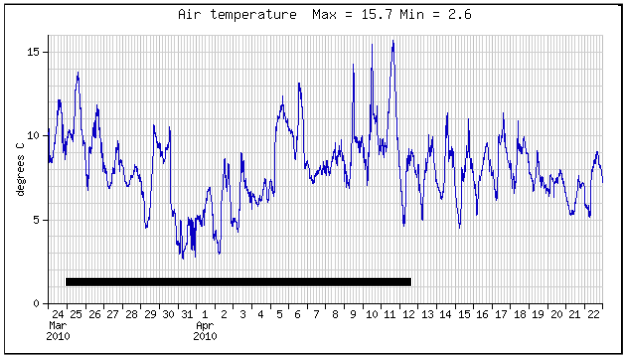
First scientific mission

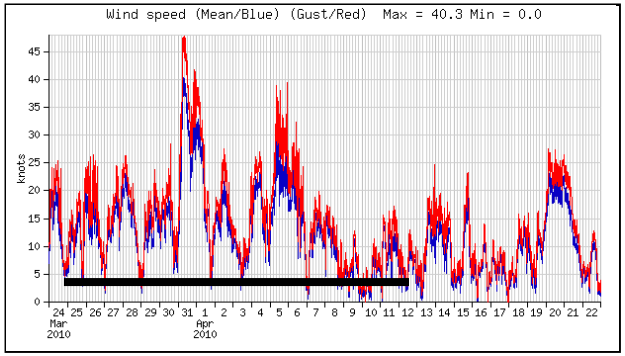
24 Mar – 12 Apr 2010

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL









First scientific mission

24 Mar – 12 Apr 2010

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Lessons learnt

- Minimise time at surface when in shallow water
- Minimise time at surface during flood ~(1m/s)
  if you don't want to go that way
- Use knowledge of tide to move around obstacles
- Satellite costs (only send back the SBD TBD data that you really need)

- We were able to direct the Glider based on other observations

Turbulence trial

13 Oct – 14 Oct 2010

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Why use a turbulence probe on a Glider instead of traditional methods

Advantages
- Able to make longer measurements
- Can sample closer to the surface
- Able to sample during storm events

Drawbacks
- Noise (mechanical/electrical)
- Glider profile (not vertical)

Challenge is can we overcome some of the problems

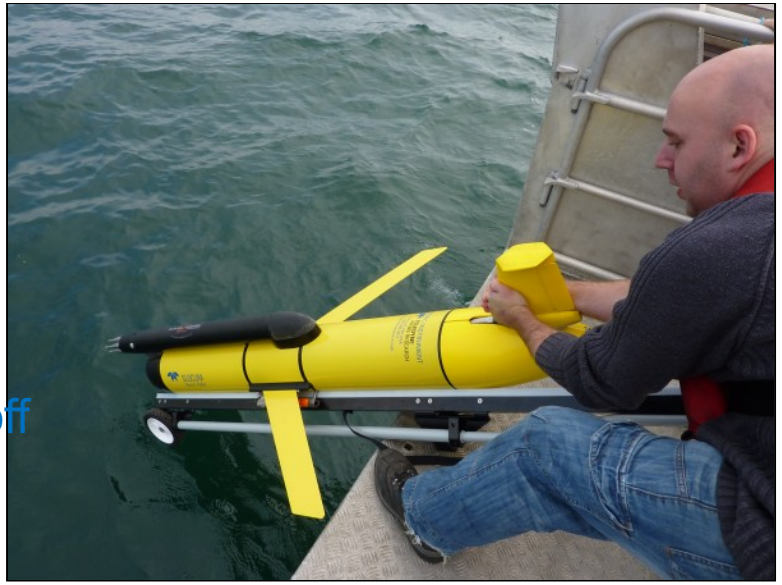
Turbulence trial

13 Oct – 14 Oct 2010

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

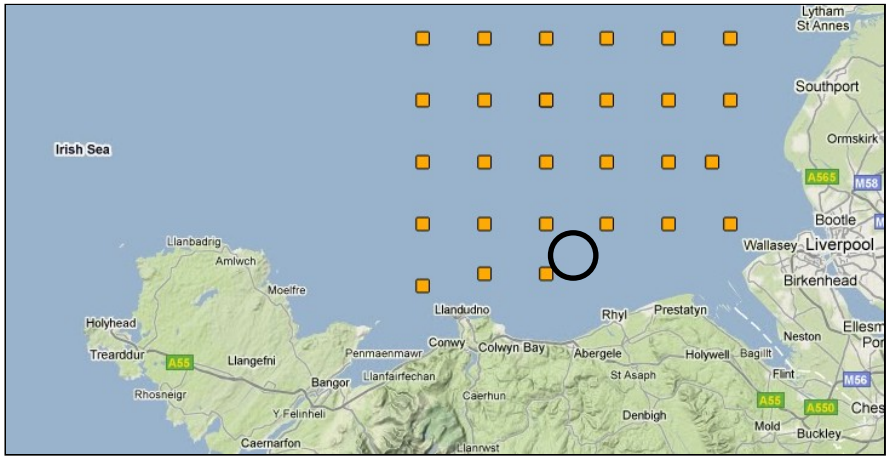
Aims (short deployment)

- Test performance
- Sampling
  - all the time
  - on upcast
  - on upcast – servo motors off
- Compare with MSS 90



Background

- Water depth <30m
- Tidal currents in excess of 0.8 m/s

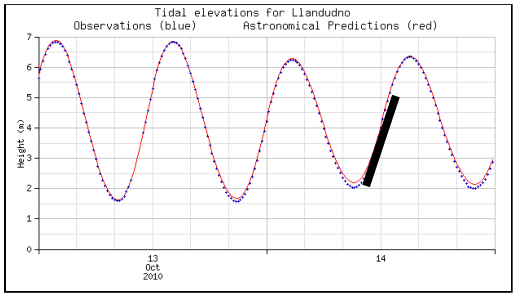


Turbulence trial

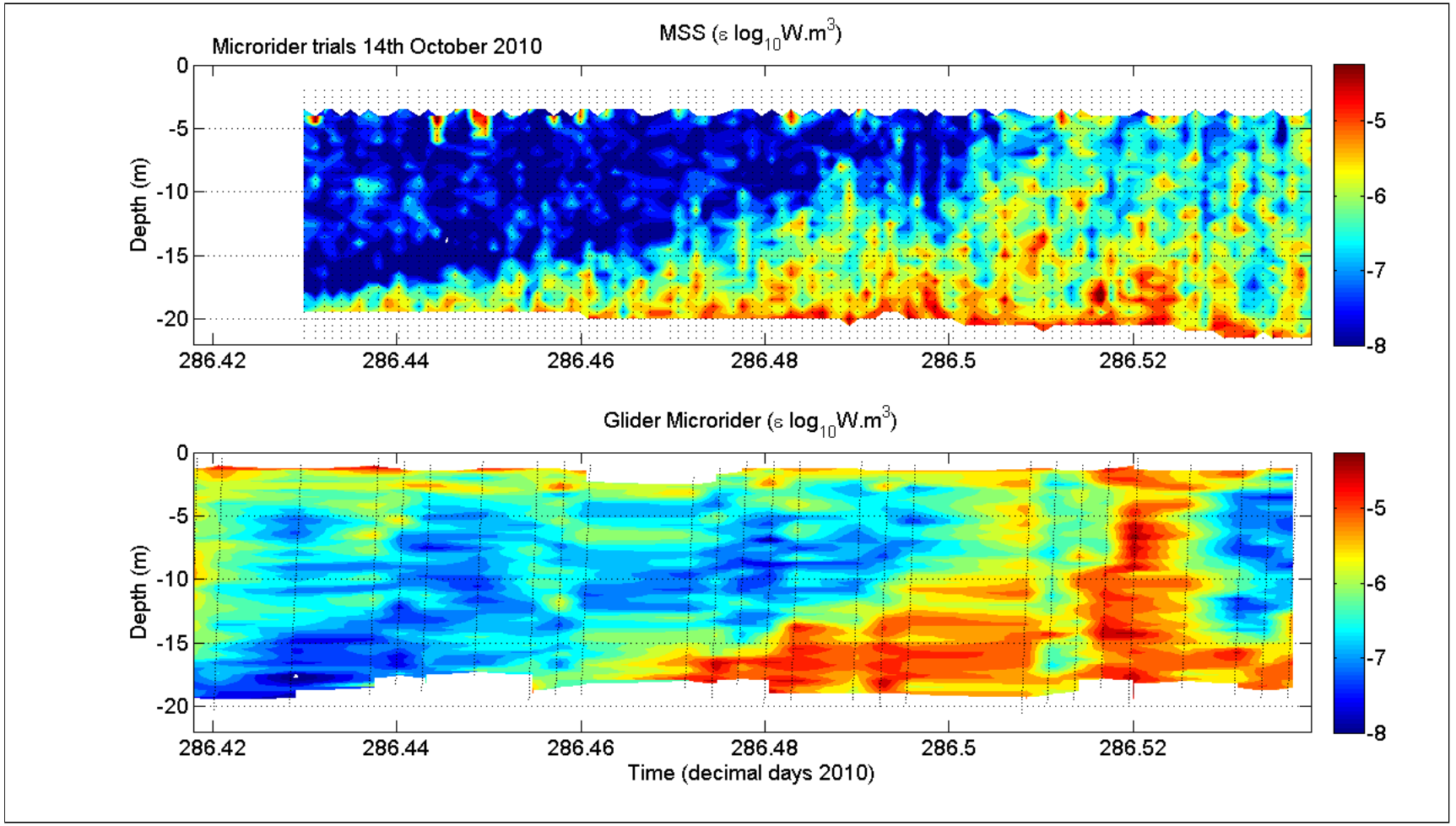
13 Oct – 14 Oct 2010

Matthew Palmer

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL



Results from comparison with MSS



Turbulence trial

13 Oct – 14 Oct 2010

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

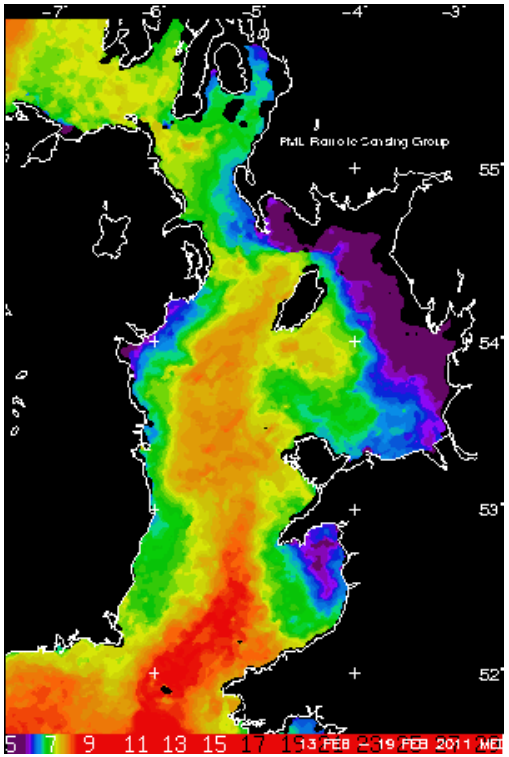
Lessons learnt

- Pump noise limits range.
- Require the servo off for sampling
- Measurements made within 50cm of the surface (on climb)
- Pitch typically within 30-34o during ascent.
- Roll typically within ±2o but extremes can be double.
- Some uncertainty with angle of attack
- Recovery is DIFFICULT

Second scientific mission

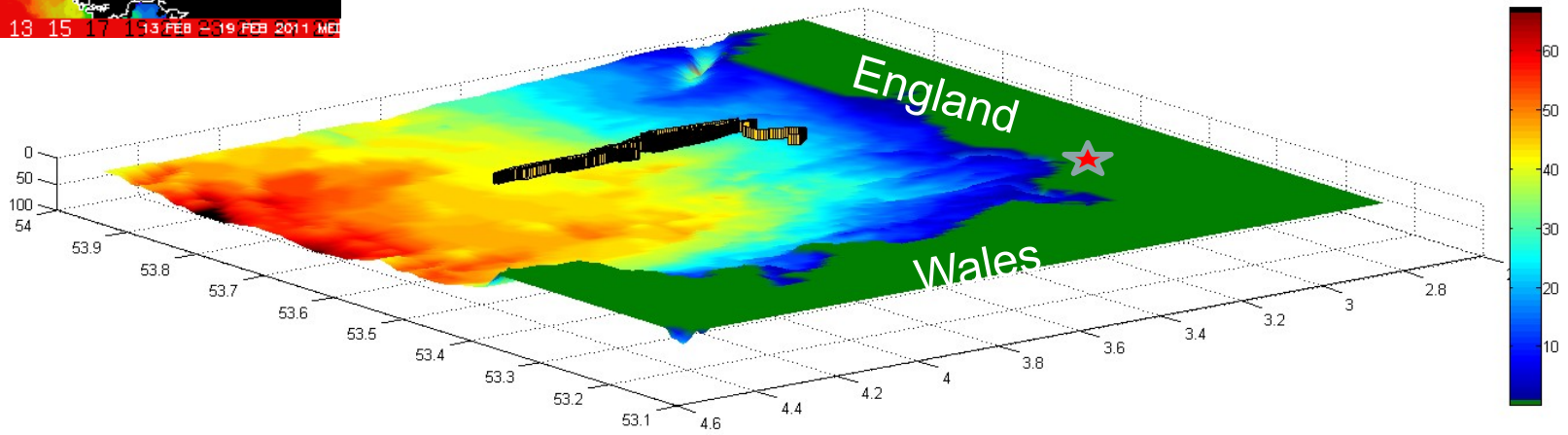
10 Feb – 1 Mar 2011

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL



Aims

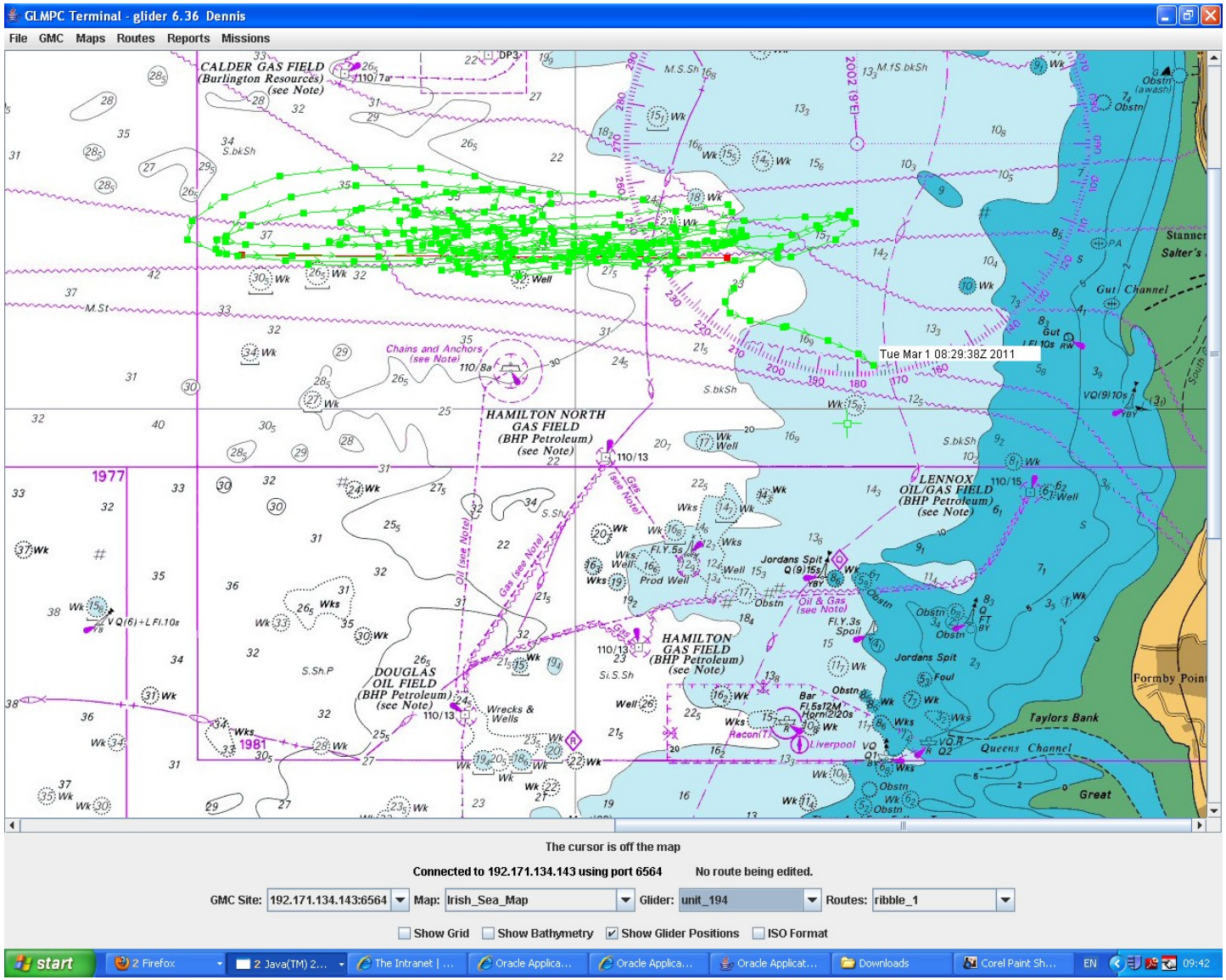
- Investigate the evolution of the Mersey plume.
- Push the limits of an ocean glider
  - Spring tides 1.2m/s
  - Shallow water 15-40m
  - Tidal range 10m



Second scientific mission

10 Feb – 1 Mar 2011

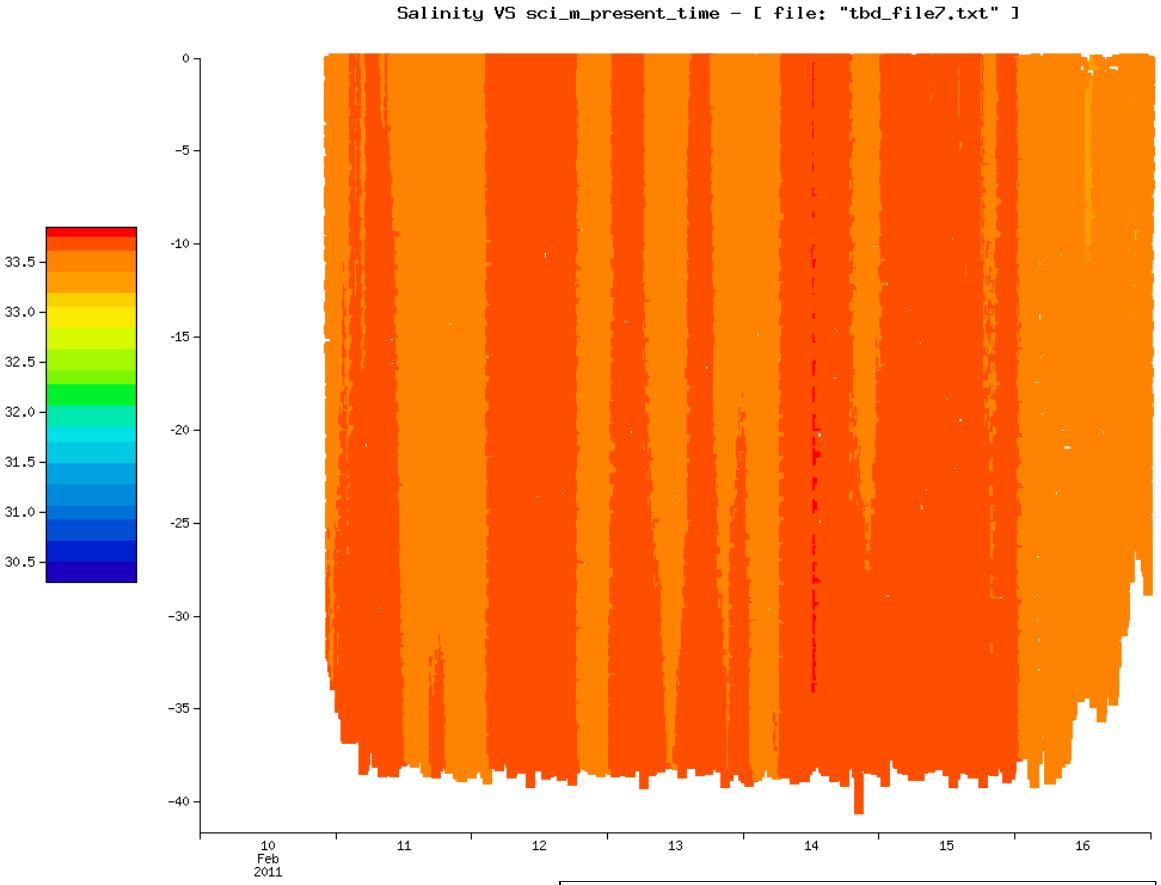
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

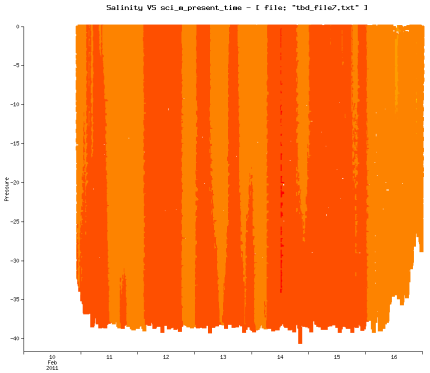


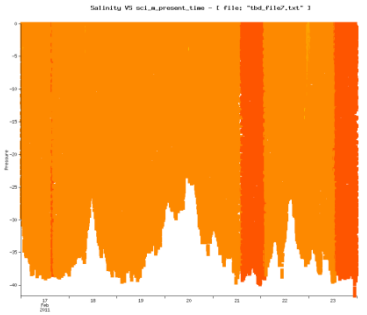
Second scientific mission

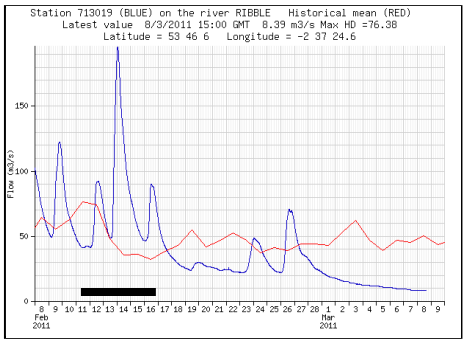
10 Feb – 1 Mar 2011

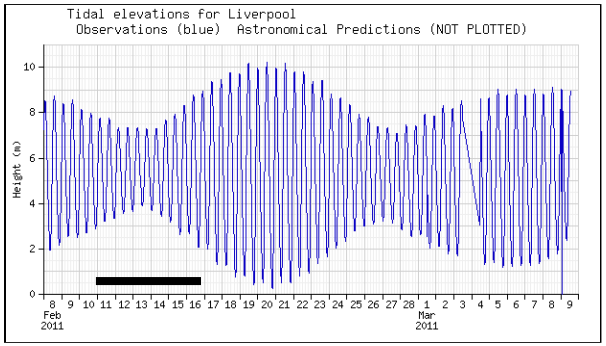
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

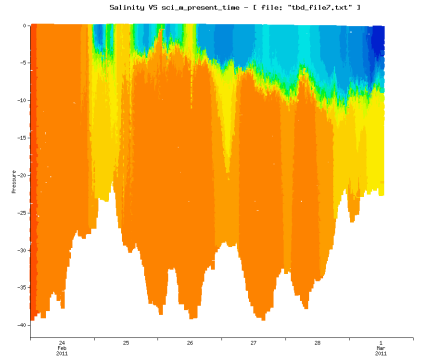








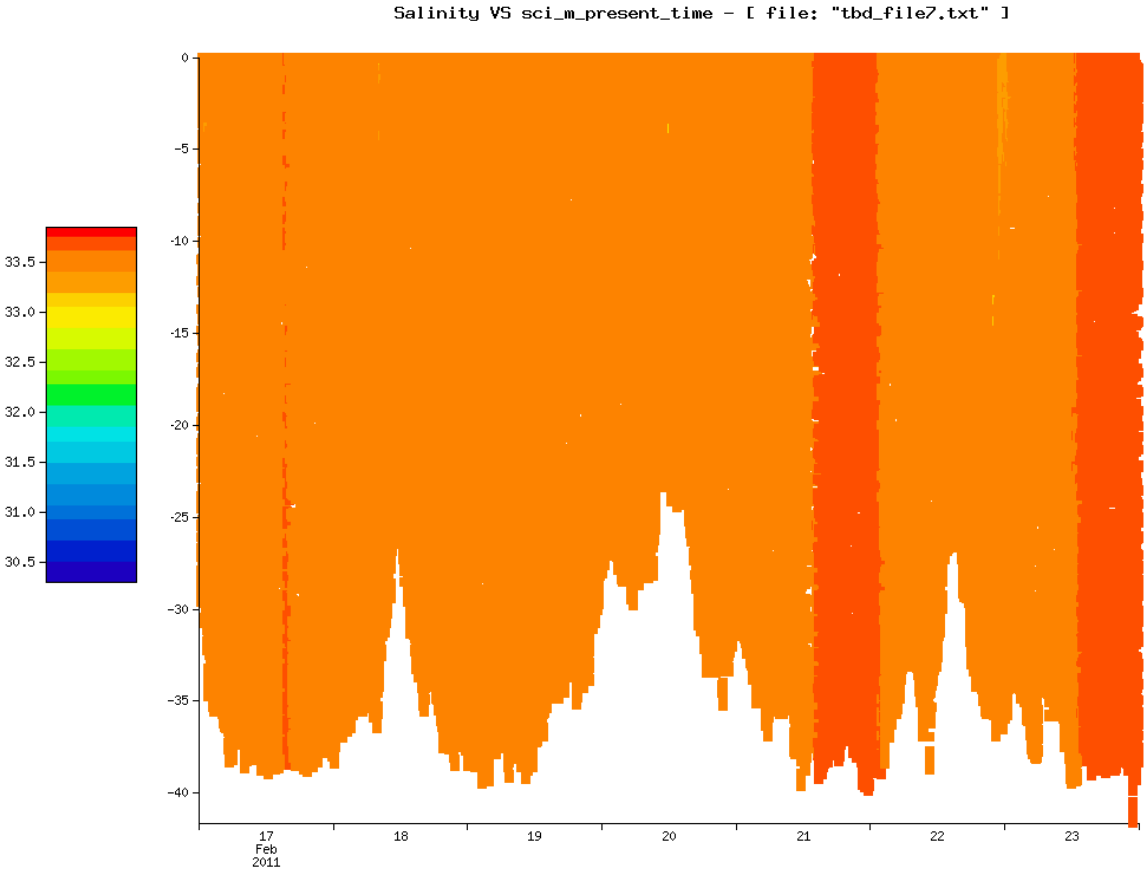


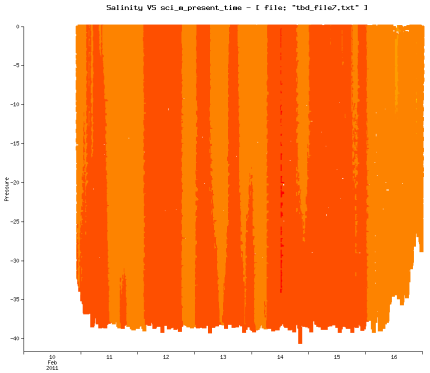


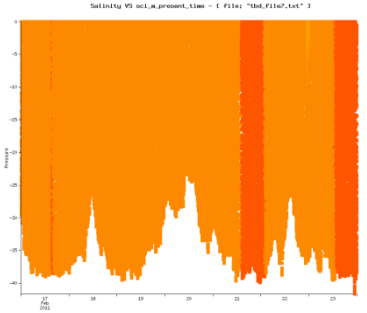
Second scientific mission

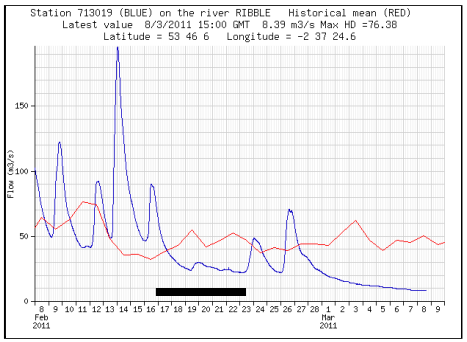
10 Feb – 1 Mar 2011

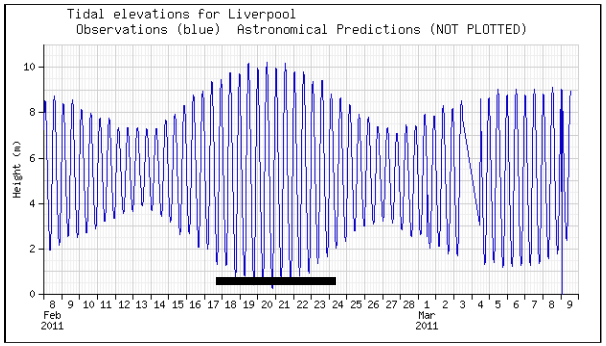
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

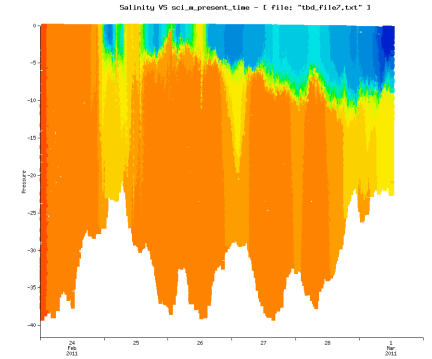








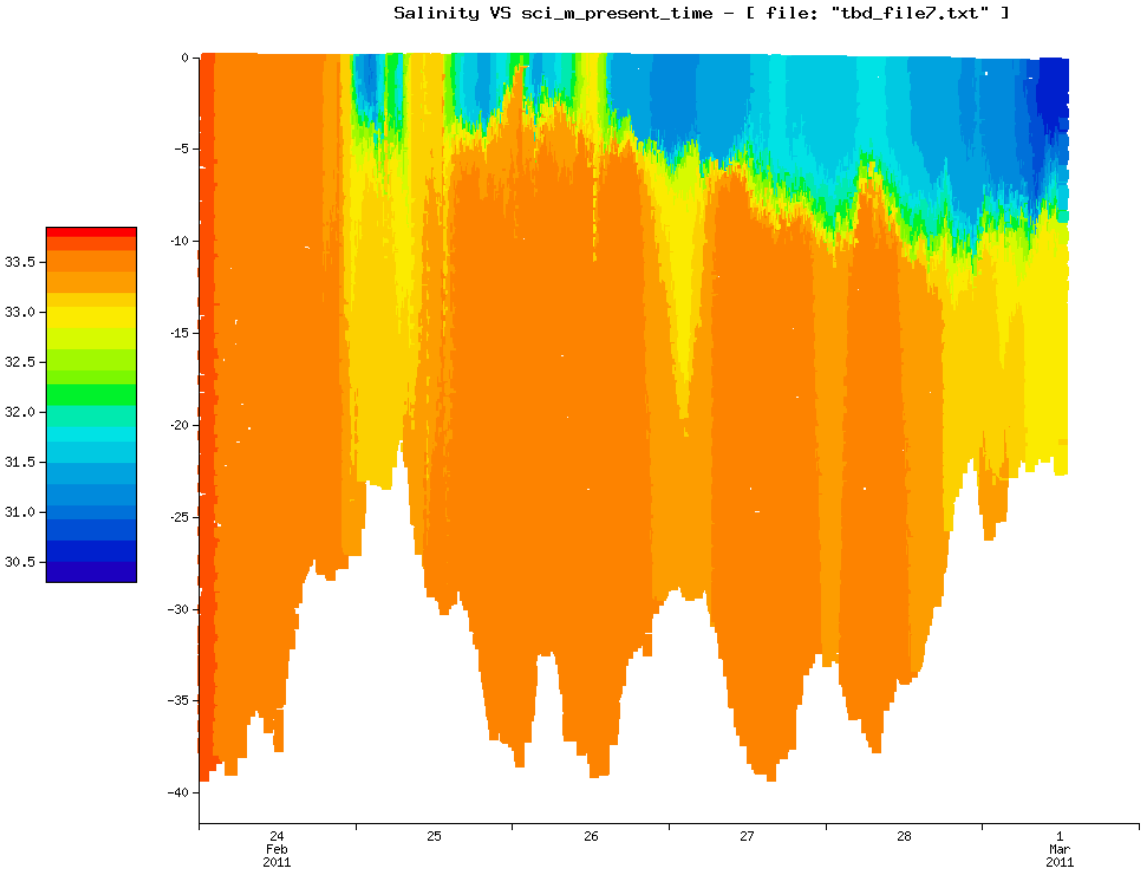


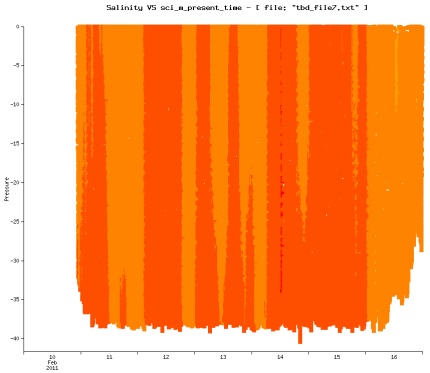


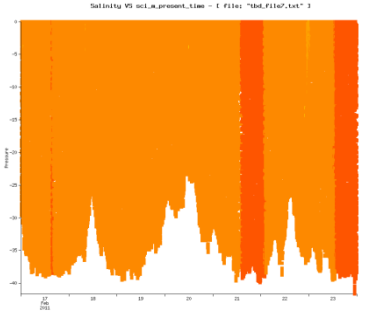
Second scientific mission

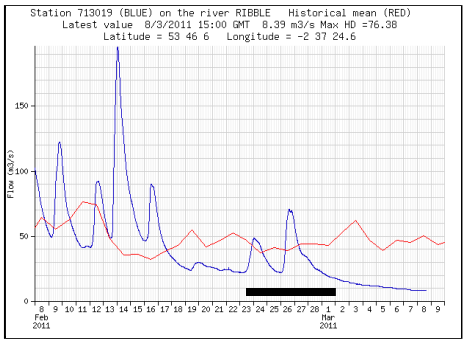
10 Feb – 1 Mar 2011

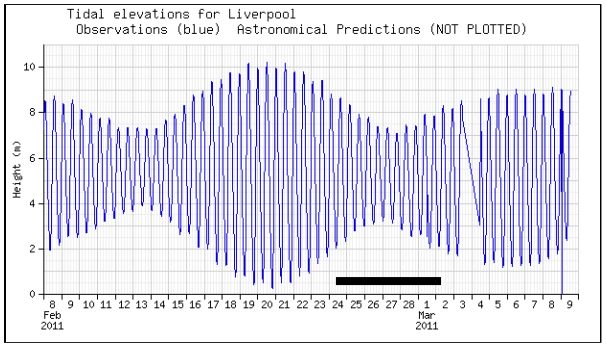
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

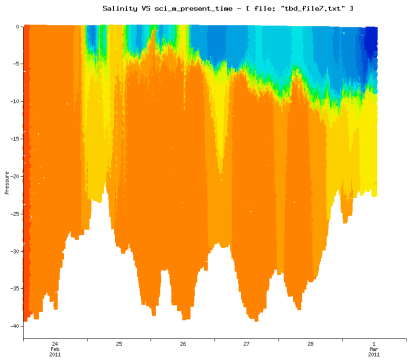








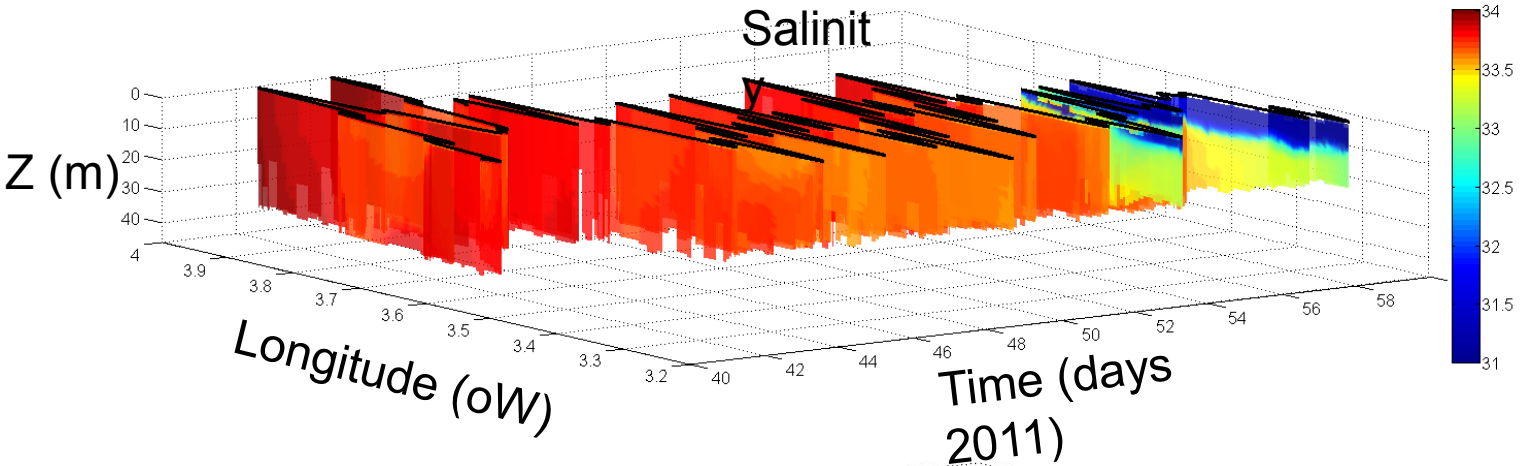


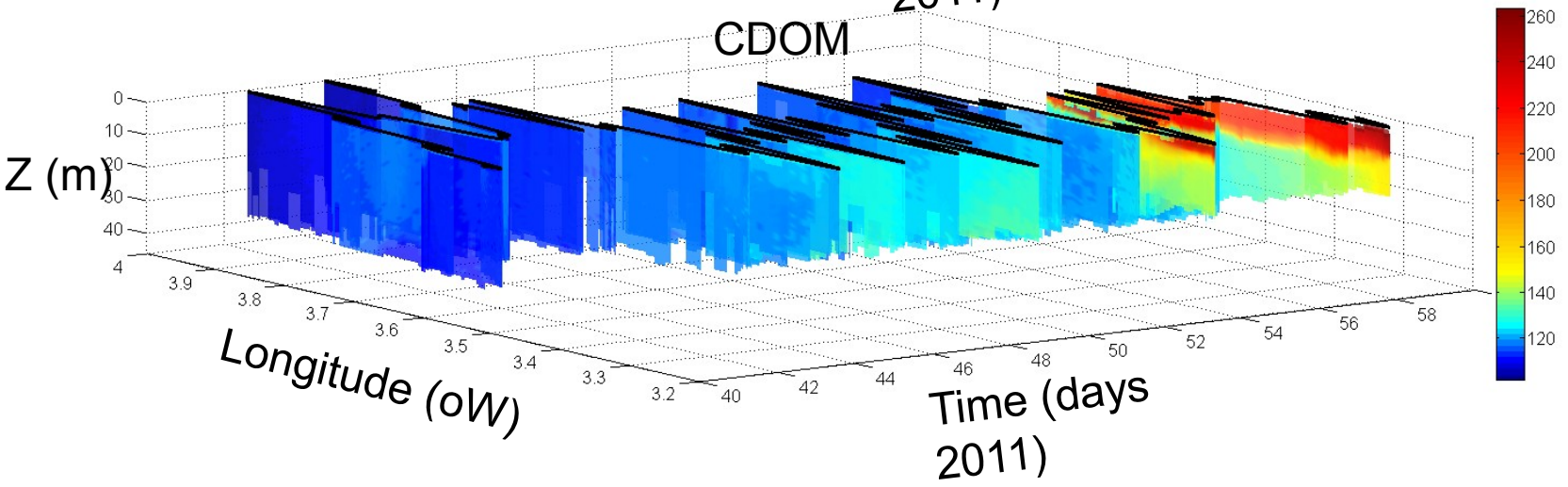


Second scientific mission

10 Feb – 1 Mar 2011

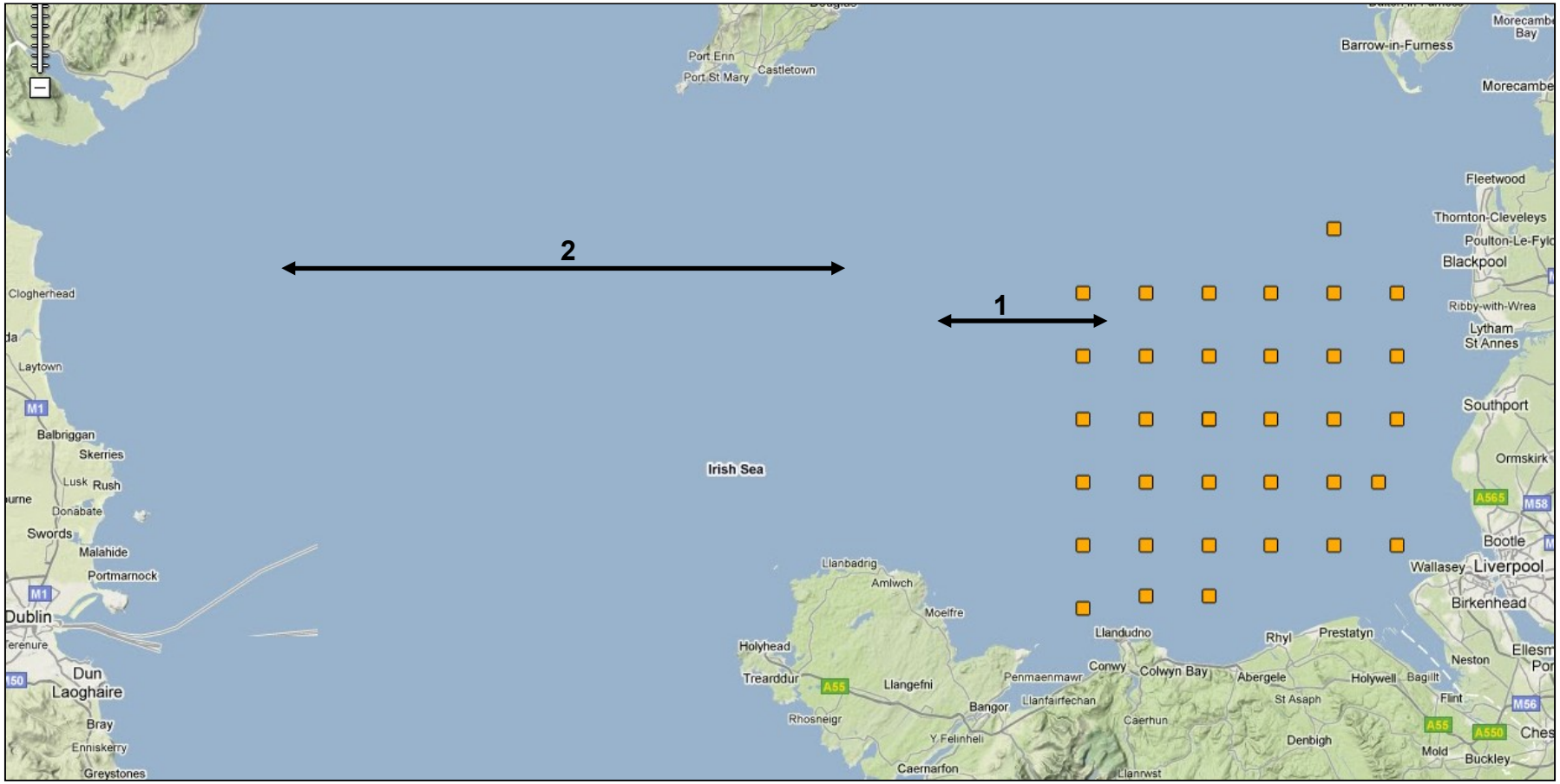
National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL





Further planned deployments 2011

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL



1. May – Turbulence study, comparisons with 5 beam ADCP & MSS in an area clear of river water influences

2. July – Transect across the Irish Sea, across the frontal region into deeper stratified waters

Turbulence trial

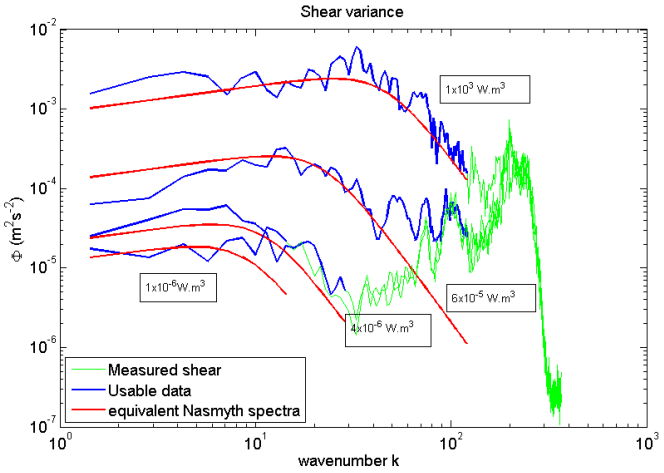
13 Oct – 14 Oct 2010

Matthew Palmer

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Measuring turbulence and ocean mixing

Typical results from non-glider methods of deployment



The dissipation rate of TKE per unit volume, □, can be derived from the variance of the shear-

$$\varepsilon = 7.5\mu \left(\frac{\partial u}{\partial z} \right)^2 \quad \text{W.kg}$$

From which a mixing rate can be inferred-

$$K_z = \frac{R_f}{1 - R_f} \cdot \frac{\varepsilon}{N^2} = \Gamma \cdot \frac{\varepsilon}{N^2} \quad \text{m2/s}$$

Turbulence trial

13 Oct – 14 Oct 2010

Matthew Palmer

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Glider (Rockland): Turbulent spectra

- Range of energy levels detected.
- Good agreement with Nasmyth spectral shape.
- Instrument noise is variable.