Liverpool – European Capital of Culture, 2008

Liverpool 08
EUROPEAN CAPITAL OF CULTURE


BEATLES


THE BEATLES

REDS

BLUES

UNIVERSITY OF LIVERPOOL

- A member of the Russell Group of the 20 major research-intensive institutions in the UK
- Annual turnover of £364 million including £130 million
  for research
- Largest provider of online degrees in Europe
- Only UK university with full clinical education coverage, spanning Biosciences, Clinical Medicine, Health Sciences, Dentistry, Veterinary Science and Tropical Medicine
- 22,000 students pursuing 400 programmes in 54 different subject areas
- More than 4,700 staff
- 158,000 alumni in 173 different countries

UNIVERSITY OF LIVERPOOL

Partner Institution with NOC

- Jointly supervised PhDs
- Contributions to teaching from NOC staff
- Joint research programmes (UKRC, EU, Industry) and cruises
- Shared posts
- Separate management

UNIVERSITY OF LIVERPOOL

School of Environmental Science

SoES comprises 4 research divisions:

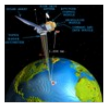
- **Oceanography and Ecology**
- **Geological Sciences**
- **Environmental Processes and Change**
- **People, Space and Place**

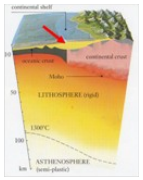
All have research interests connected to the oceans

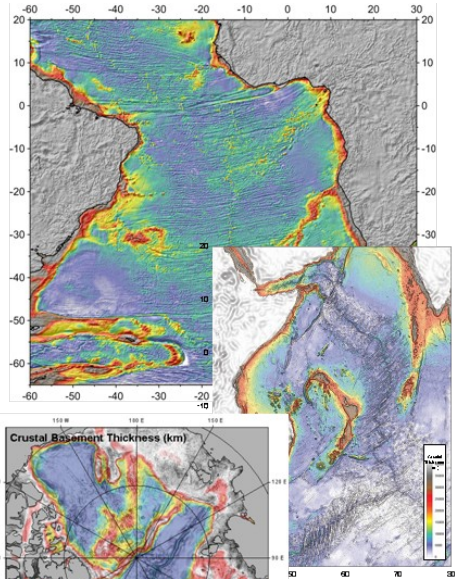
UNIVERSITY OF LIVERPOOL

Research strengt

- **Ocean and Climate Science**
- **Marine Geology**
- **Geophysics and Ocean Basins**
- Marine Biology and Environmental Change
- **Link to Sustainability and Living with Environmental Change**







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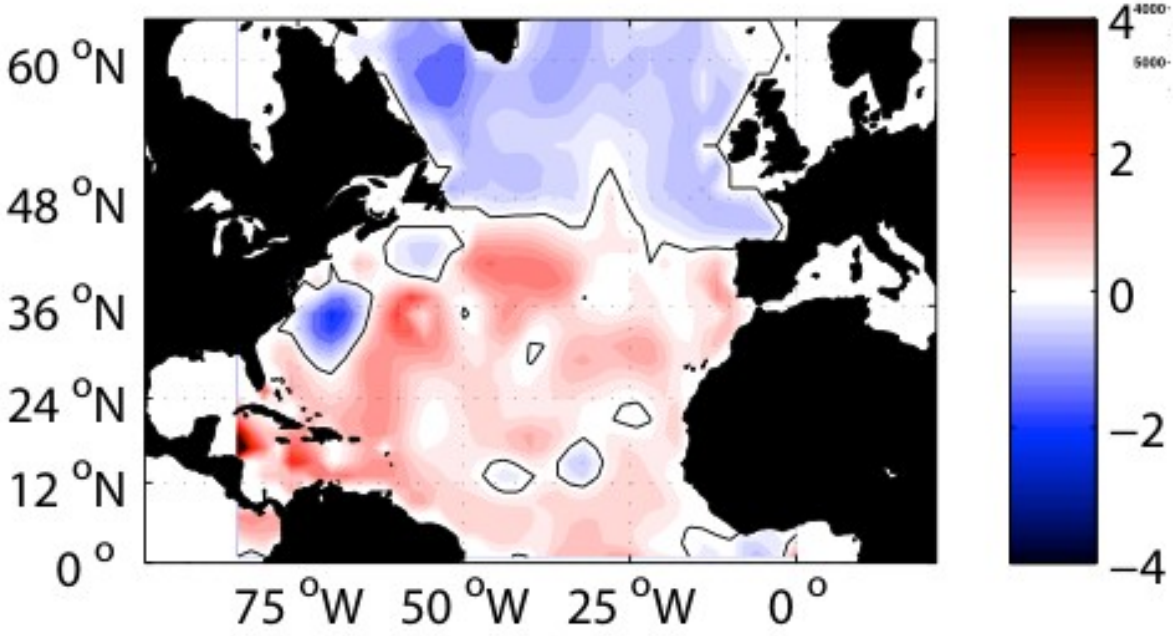
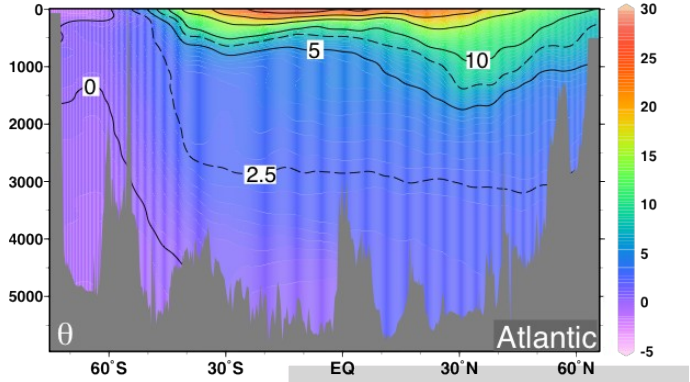
How has North Atlantic warmed over last 50 years?





Change in ocean heat content (1020J) between 1980-2000 and 1950-1970

Equivalent to surface heat flux +/– 4 Wm-2

basin change only 0.4 W m-2

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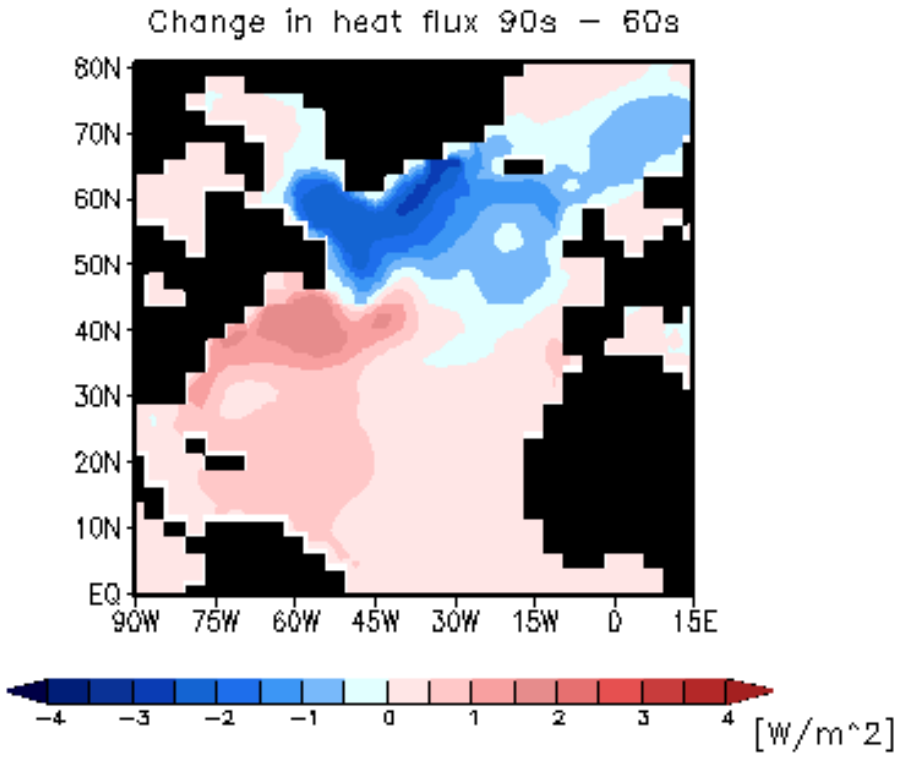
Lozier, Leadbetter, Williams, Roussenov et al. (2008) Science

Lozier, Roussenov, Reed & Williams et al. (2010) Nature Geoscience

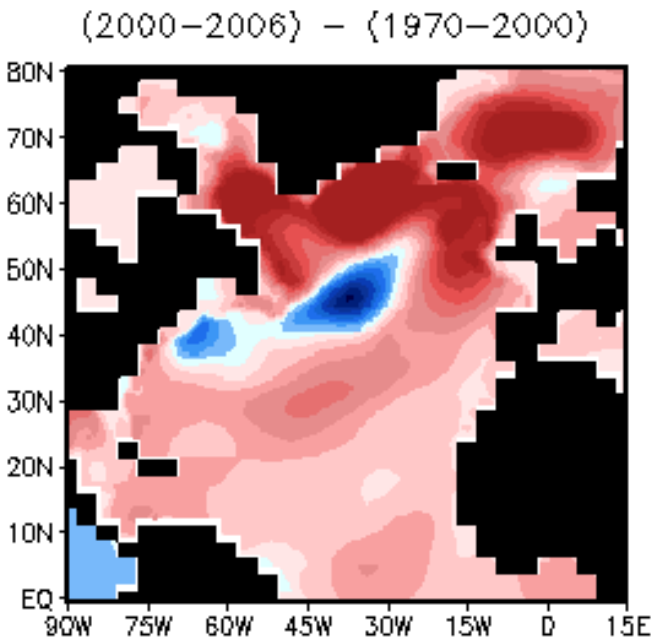
Susan Lozier, Duke

Vassil Roussenov

Ric Williams



Met office data for 2000-1980 minus 1950-1970



Met office data for 2006-2000 minus 2000-1970

Reversing gyre-scale patterns, rather than systematic trend

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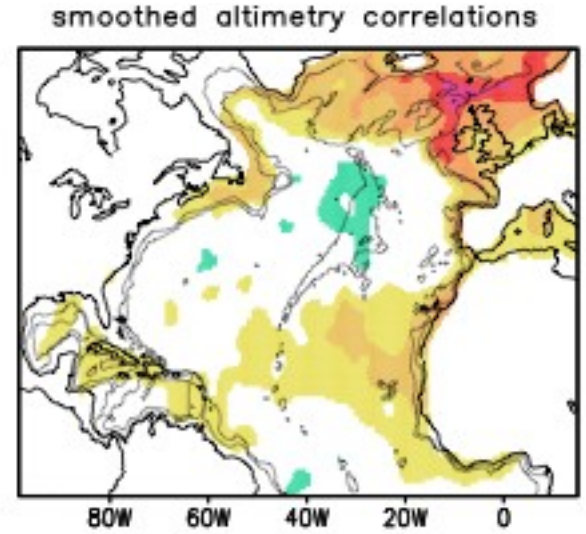
- How is sea level change at the coast connected to the open ocean?



- How is ocean warming and sea level varying over the globe?
- How is ocean mixing varying?

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NOC partners


Chris Hughes


Phil Woodworth


Miguel Morales Maqueda


Clare Bellingham


Simon Holgate


John Huthnance


Ruben Alvad Bustos, NOC

Harry Leach

- **Research Interests**
  - **Circulation: North Atlantic, Southern Ocean**
  - **Mesoscale Eddies**
  - **Heat and Fresh Water Budgets**
  - **Mixing**
  - **Influence of physical processes on biological productivity and export**
  - **Sea level**
  - **Sea Ice**

- **Recent Result**

Mixing in the Weddell Gyre – is low:

- Kv ~ 3 × 10-6 m2 s-1 ,
- Kh ~ 100 m2 s-1
- **Knowledge of mixing rates in the ocean interior crucial for construction of accurate climate prediction models**

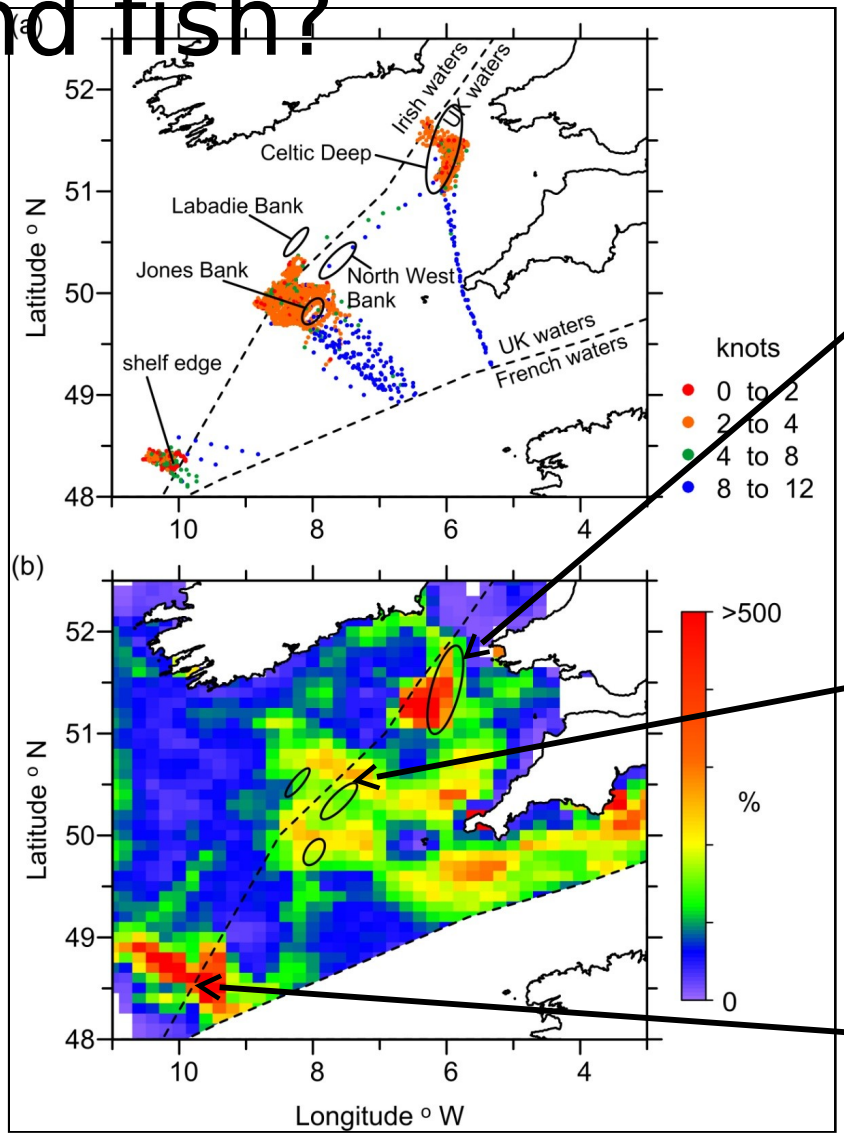
Leach, H., V.H. Strass and B. Cisewski, 2011, Modification by Lateral Mixing of the Warm Deep Water entering the Weddell Sea in the Maud Rise Region. Ocean Dynamics, 61, (1) 51-68. DOI: 10.1007/s10236-010-0342-y

Harry Leach (cont'd)

- **Current Work**
  - **Character of Eddies in the ACC**
  - **Land-Fast Ice (PhD project Nuala Carson, CASE with NOCL)**
  - **Weddell Gyre Circulation (PhD project Matt Donnelly, CASE with AWI)**
  - **Sea Level in the South Atlantic (PhD project Katie Jones with NOCL)**
- **Future Plans**
  - **Continue analysis of existing *Polarstern* datasets**
  - **Participation in *Polarstern* cruise "Eddy Pump" (2012): Export from eddies to deep ocean in ACC**
  - **Continue collaboration with NOCL on sea level variability**

Does physics affect where we find fish?

Jonathan Sharples

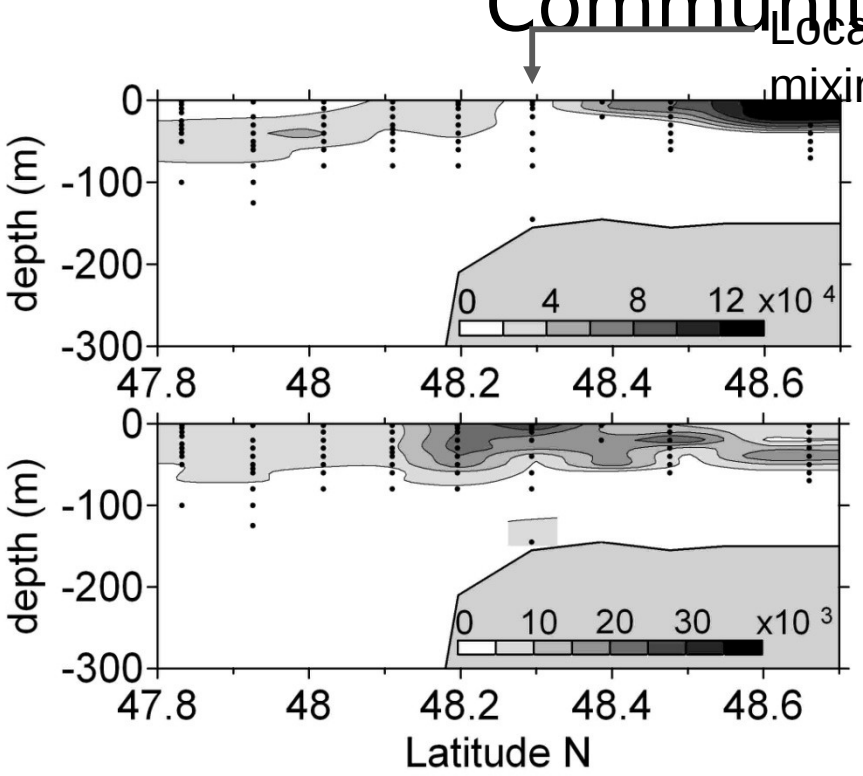


Celtic Deep:
Important *Nephrops* fishery.
Deep water, weak tides, surface frontal phytoplankton → muddy seabed with supply of organic material.

Central Celtic Sea:
Mixed fishery.
Series of seabed banks drives enhanced mixing and nutrient supply to the thermocline.
Turbulence controls predator-prey interaction.

Shelf edge:
Important mackerel, whiting, monkfish fishery.
Physics controls phytoplankton species (food for fish larvae).

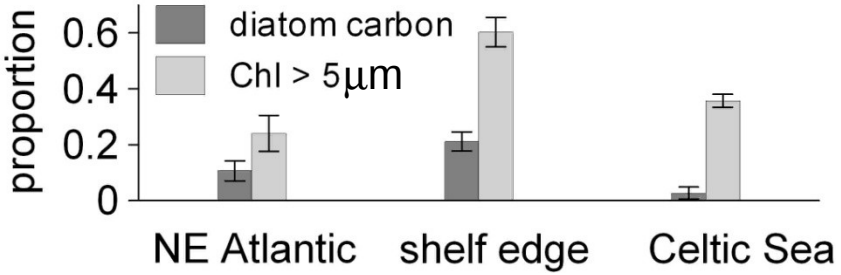
The Shelf Edge Phytoplankton Community



Cyanobacterium *Synechococcus* cells ml-1

Small eukaryotes cells ml-1

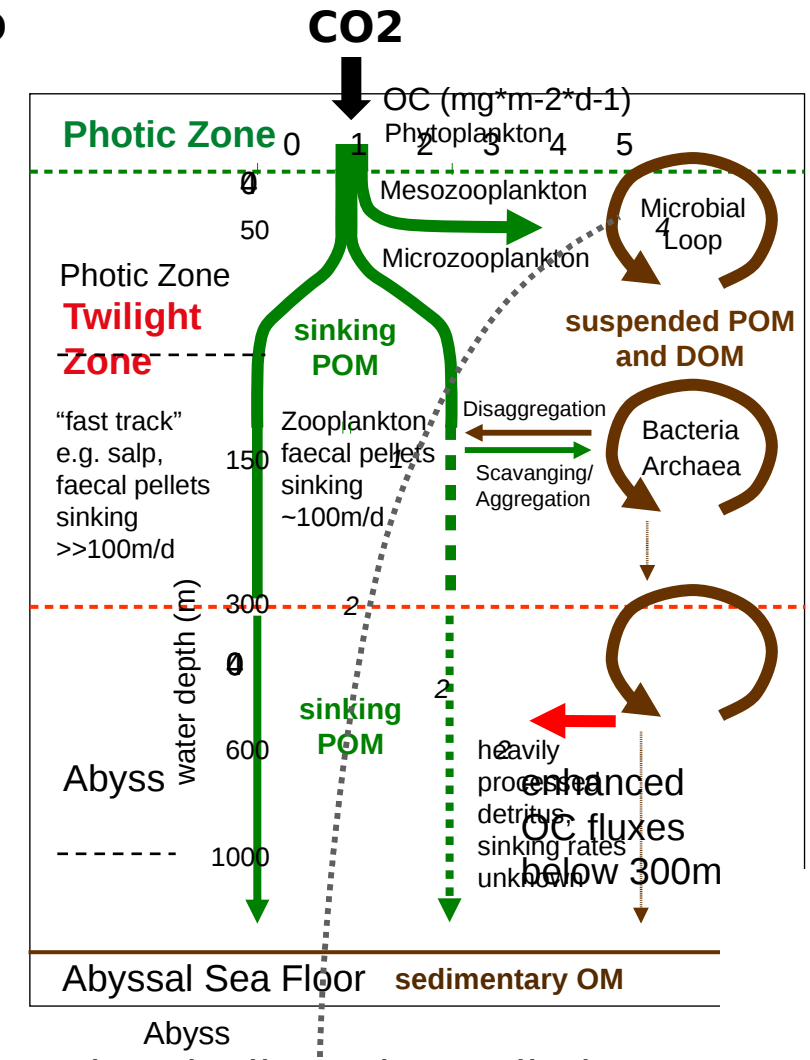
Flow cytometer



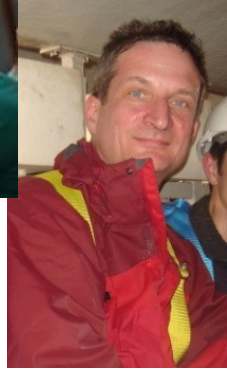
Size-fraction filtering and microscopy

The shelf edge supports a large-celled community of phytoplankton

Biological Pump

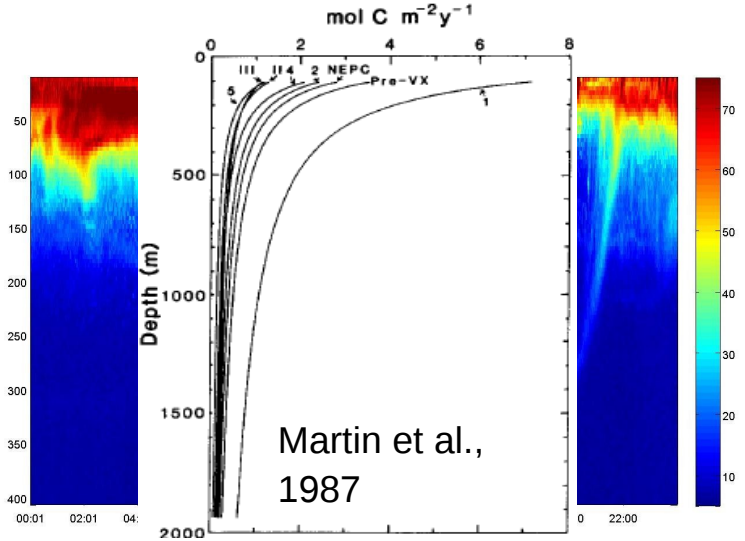


"chronically understudied"
"large variability in transfer efficiency is poorly represented biogeochemical models" (Buess et al., 2007)



efficiency of the ***biological pump***

- organic carbon burial



Future approaches?

Ability to measure δ15N and δ13C on individual amino acids and δ13C on lipids is a great step forward

Feeding experiments – understanding ecosystems and their function (rates of carbon/nutrient mineralisation)

Natural abundance – better constraints than with bulk isotopes

Journal of Experimental Marine Biology and Ecology 376 (2009) 110–121

Contents lists available at ScienceDirect

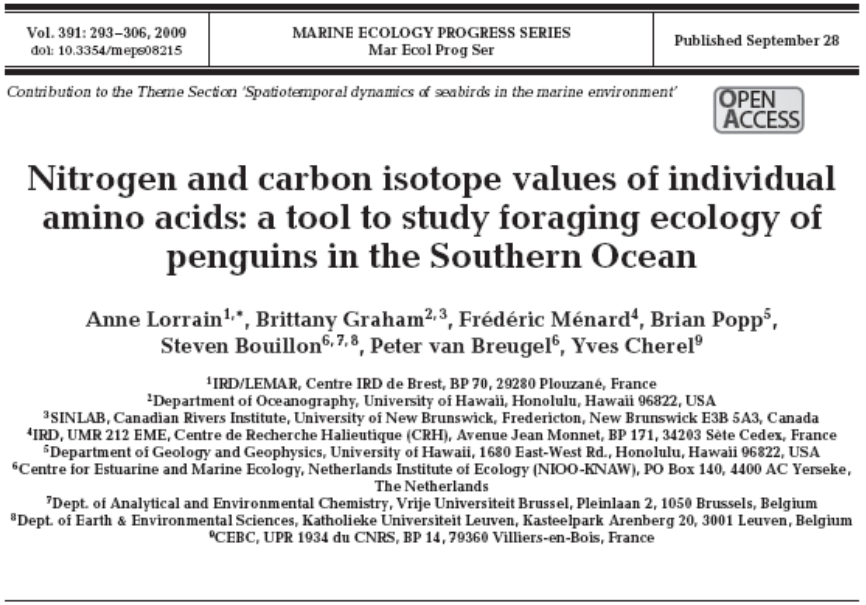
Journal of Experimental Marine Biology and Ecology

journal homepage: www.elsevier.com/locate/jembe

Different responses of two common Arctic macrobenthic species (*Macoma balthica* and *Monoporeia affinis*) to phytoplankton and ice algae: Will climate change impacts be species specific?

Ming-Yi Sun [a,*], Lisa M. Clough [b], Michael L. Carroll [c], Jihong Dai [a], William G. Ambrose Jr. [c,d], Glenn R. Lopez [e]

[a] Department of Marine Sciences, University of Georgia, Athens, Georgia 30602, USA
[b] Department of Biology, East Carolina University, Greenville, North Carolina 27858, USA
[c] Ringpion-senter, Polar Environmental Centre, N-9296 Tromsø, Norway
[d] Department of Biology, Bates College, Lewiston, Maine 04240, USA
[e] School of Marine & Atmospheric Sciences, Stony Brook University, Stony Brook, New York 11794, USA



Vol. 391: 293–306, 2009
doi: 10.3354/meps08215

MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

Published September 28

Contribution to the Theme Section 'Spatiotemporal dynamics of seabirds in the marine environment'

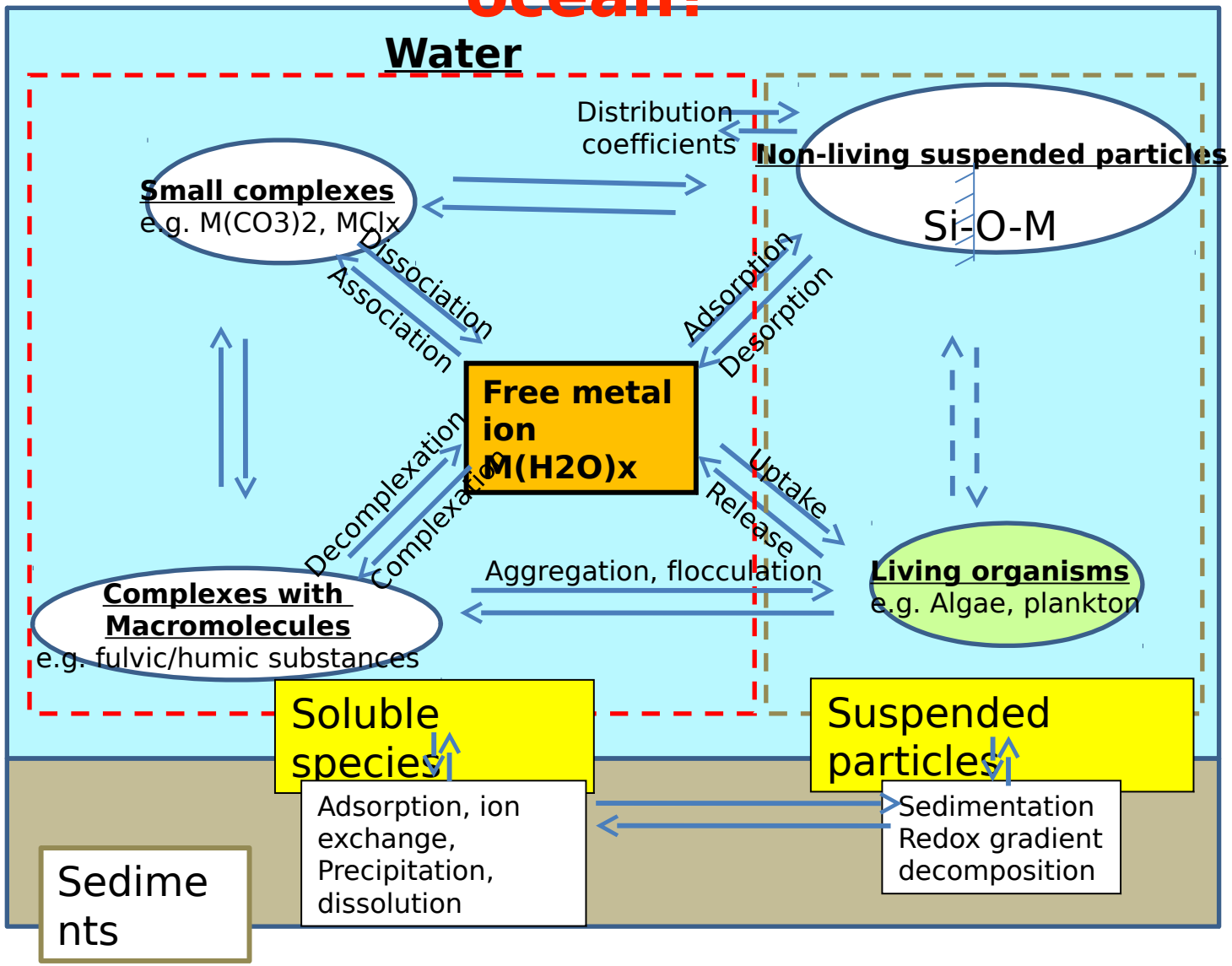
OPEN ACCESS

Nitrogen and carbon isotope values of individual amino acids: a tool to study foraging ecology of penguins in the Southern Ocean

Anne Lorrain[1,*], Brittany Graham[2,3], Frédéric Ménard[4], Brian Popp[5], Steven Bouillon[6,7,8], Peter van Breugel[6], Yves Cherel[9]

[1]IRD/LEMAR, Centre IRD de Brest, BP 70, 29280 Plouzané, France
[2]Department of Oceanography, University of Hawaii, Honolulu, Hawaii 96822, USA
[3]SINLAB, Canadian Rivers Institute, University of New Brunswick, Fredericton, New Brunswick E3B 5A3, Canada
[4]IRD, UMR 212 EME, Centre de Recherche Halieutique (CRH), Avenue Jean Monnet, BP 171, 34203 Sète Cedex, France
[5]Department of Geology and Geophysics, University of Hawaii, 1680 East-West Rd., Honolulu, Hawaii 96822, USA
[6]Centre for Estuarine and Marine Ecology, Netherlands Institute of Ecology (NIOO-KNAW), PO Box 140, 4400 AC Yerseke, The Netherlands
[7]Dept. of Analytical and Environmental Chemistry, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium
[8]Dept. of Earth & Environmental Sciences, Katholieke Universiteit Leuven, Kasteelpark Arenberg 20, 3001 Leuven, Belgium
[9]CEBC, UPR 1934 du CNRS, BP 14, 79360 Villiers-en-Bois, France

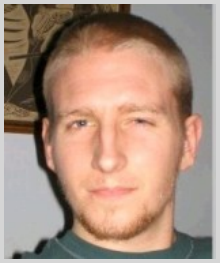
Trace metals are toxic and vital to ecosystem functioning. How can we measure/speciate tiny amounts in the ocean?



Marine Electrochemistry Group


Stan van den Berg


Pascal Salaün

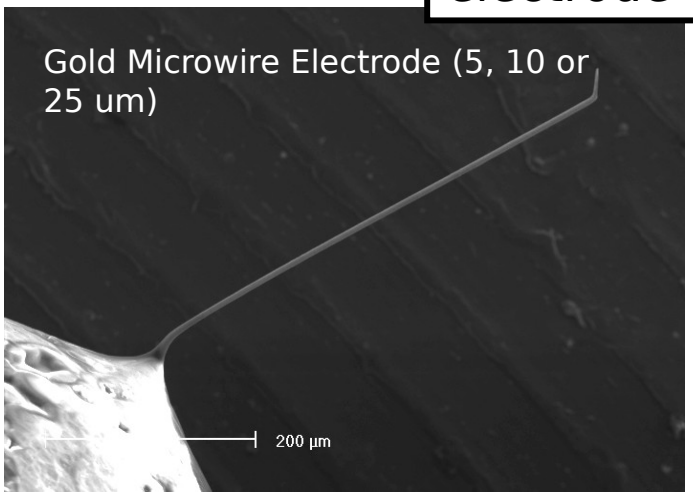

Kris Gibbon-Walsh

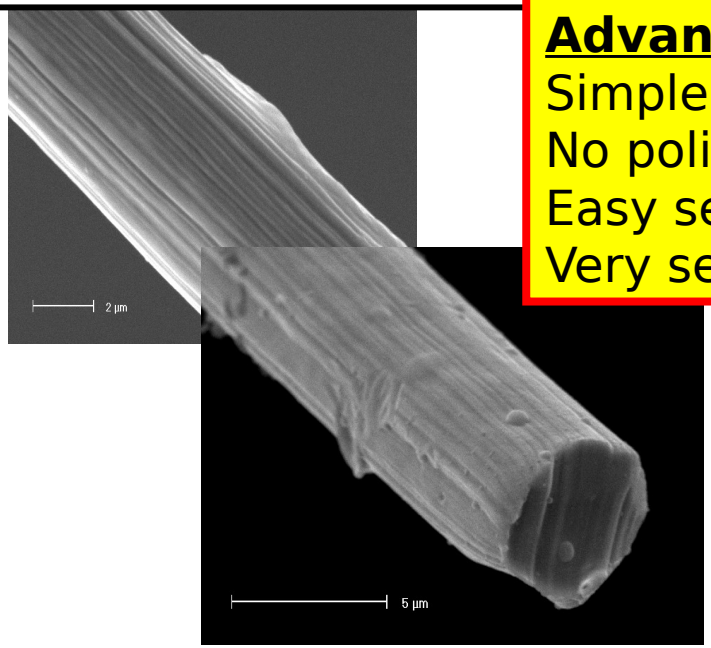

Zhaoshun Bi

Specialised in the development of voltammetric sensors and voltammetric techniques:

- for trace metal speciation (knowledge about the chemical distribution of the element):
  - Sensitive and unique methods for 20 elements: As, Hg, Cu, Sb, Zn, Mn, etc...
  - Detection limits usually in the ppt range (< nM levels) – Amongst the most sensitive techniques for specific elements.
  - Applicable in marine systems, freshwater/groundwaters , biological fluids and other applications (e.g current project looking at Sb in meglumine antimoniate for Leishmaniasis treatment)
  -
- for *in-situ*/on-site analysis;

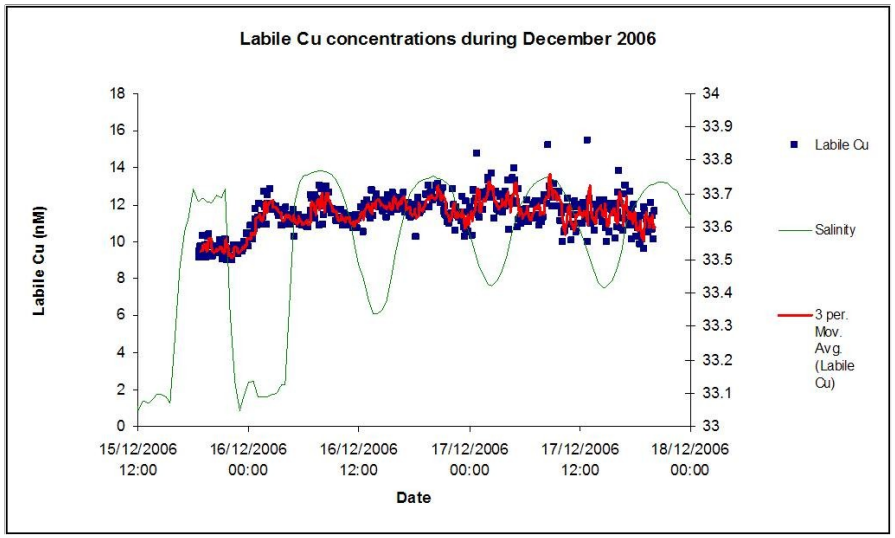
Example of sensor: Gold microwire electrode

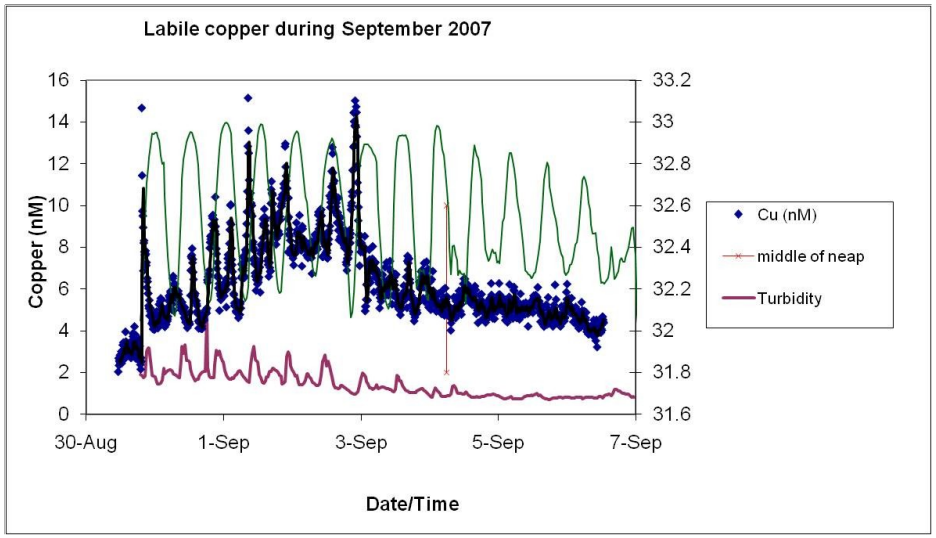




Advantage:
Simple to produce
No polishing require
Easy sealing
Very sensitive

Advantage:
In-situ analysis for real time monitoring


Labile Cu concentrations during December 2006
Labile Cu (nM)
Date
15/12/2006 12:00
16/12/2006 00:00
16/12/2006 12:00
17/12/2006 00:00
17/12/2006 12:00
18/12/2006 00:00
Labile Cu
Salinity
3 per. Mov. Avg. (Labile Cu)


Labile copper during September 2007
Copper (nM)
Date/Time
30-Aug
1-Sep
3-Sep
5-Sep
7-Sep
Cu (nM)
middle of neap
Turbidity

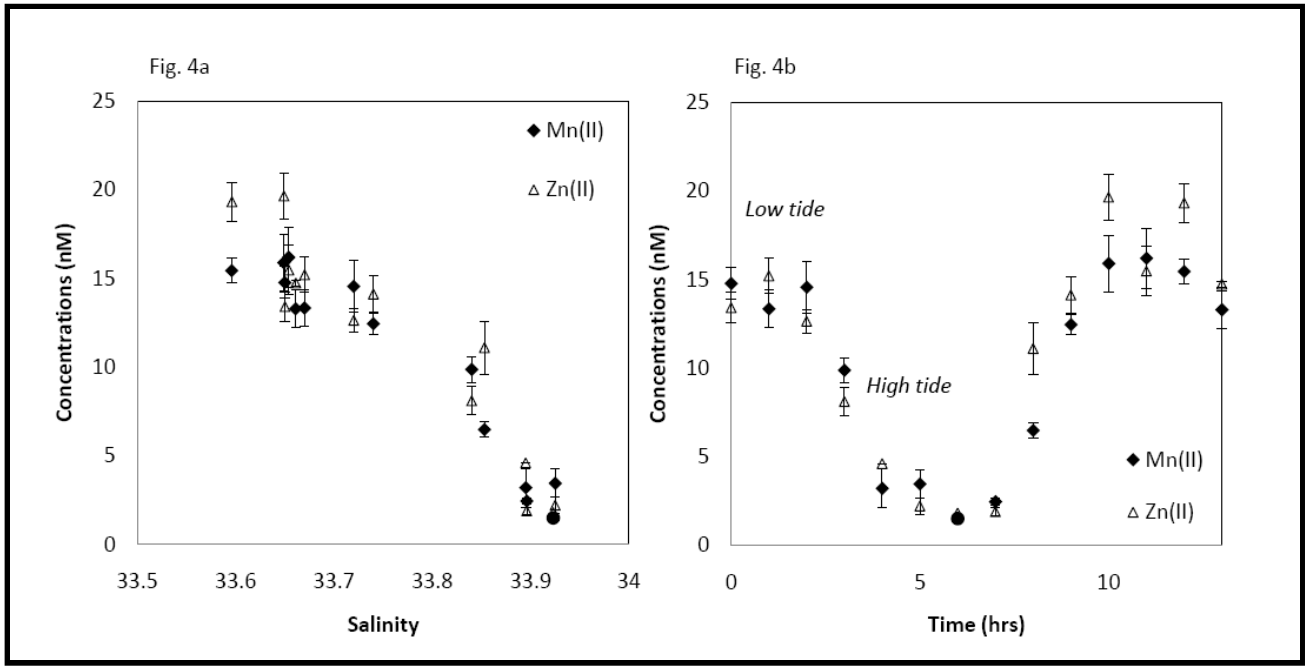
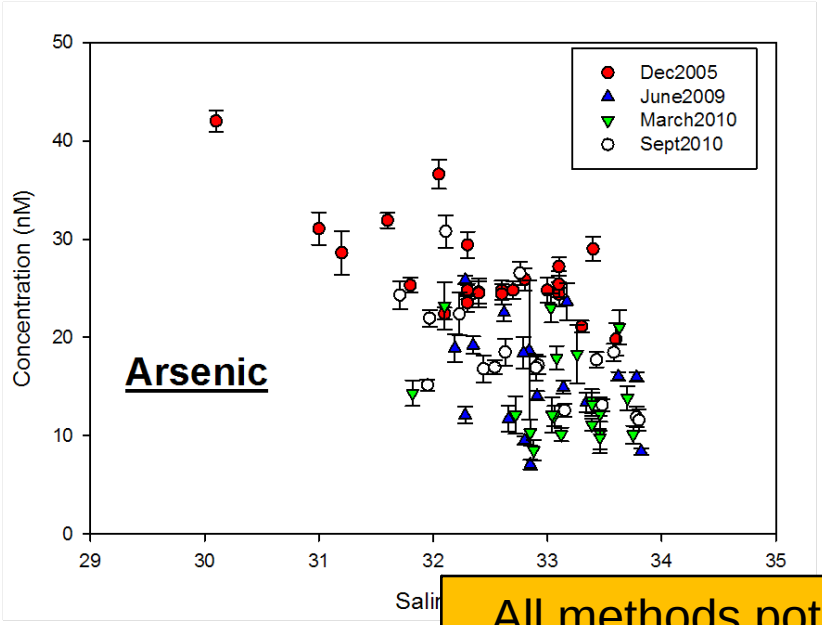
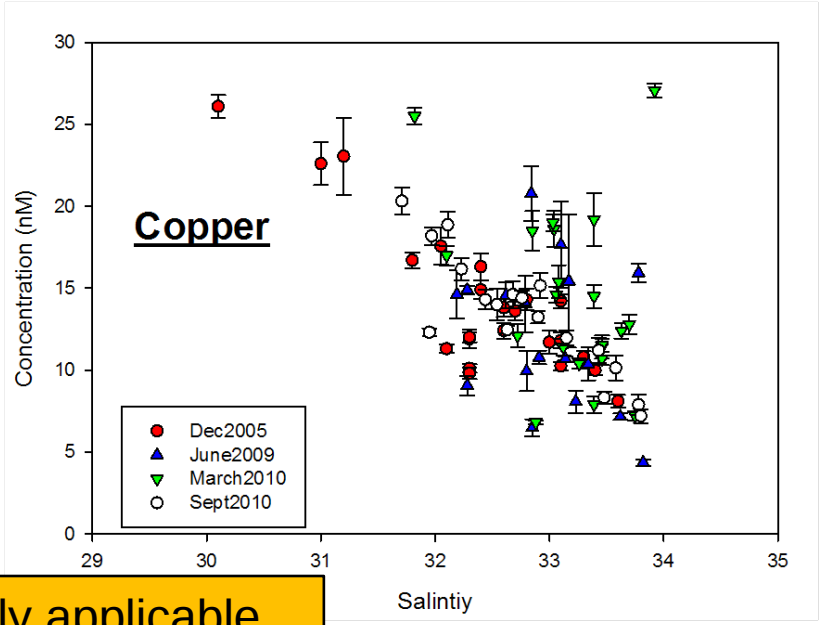


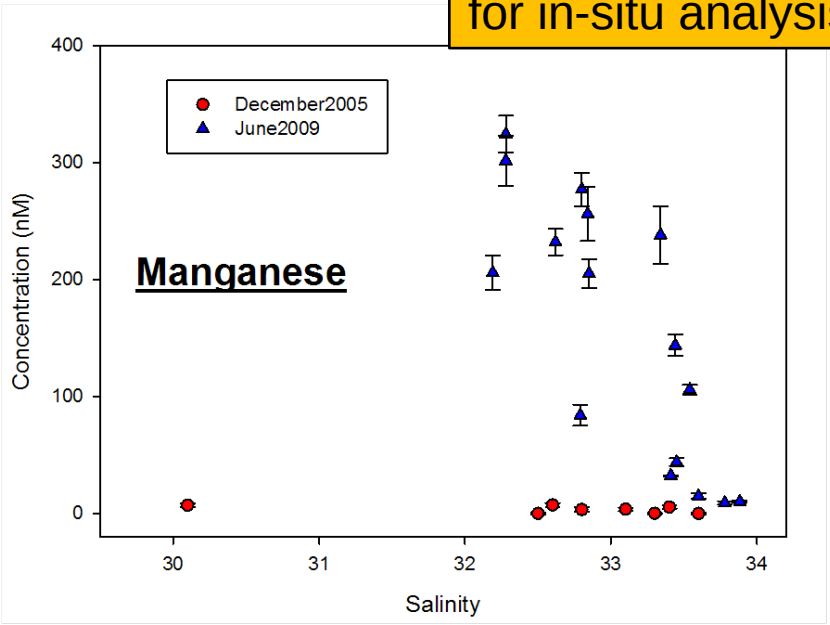
Fig. 4a
Concentrations (nM)
Salinity
Mn(II)
Zn(II)
Fig. 4b
Low tide
High tide
Time (hrs)

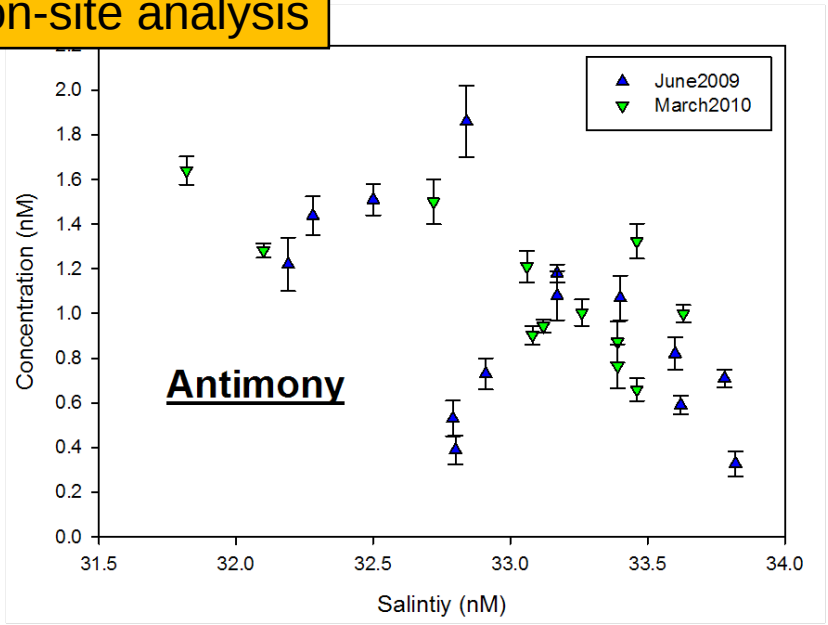
Total Dissolved concentrations in Liverpool Bay





All methods potentially applicable
for in-situ analysis or on-site analysis





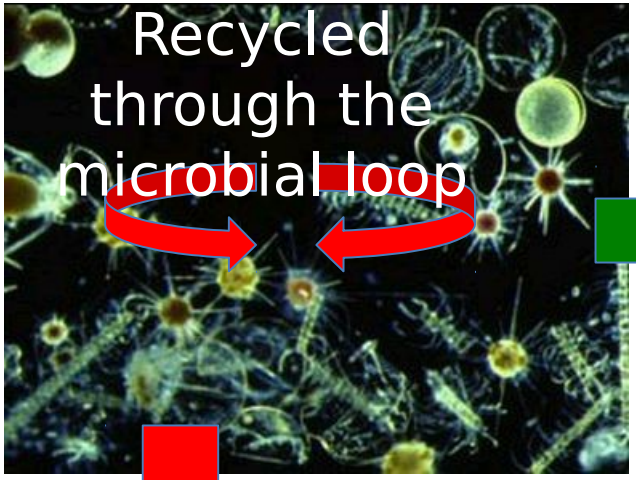
Nutrient biogeochemistry

Claire Mahaffey

Nutrient : a substance that provides nourishment essential for growth and the maintenance of life

Supply of inorganic and organic nutrients

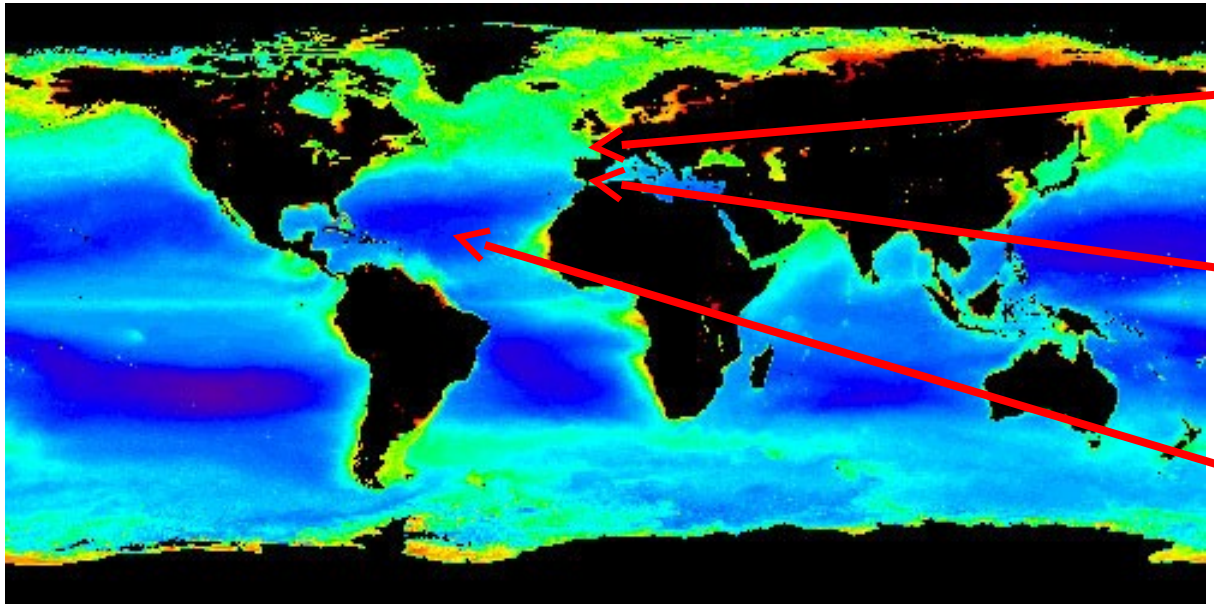
SOURCE: physical or biological
RATE: mol X m-2 d-1



Export production

Interaction with the marine ecosystem

Rates of supply, assimilation and fate?



Permanently mixed coastal ocean

Seasonally stratified shelf sea (NOC)

Permanently stratified oligotrophic open ocean

Measurements and tools:

Quantify **concentration** of inorganic and organic nutrients

- colorimetric, UV and high temperature oxidation

Quantify **rate** of supply and rate of assimilation of nutrients (inorganic and organic)

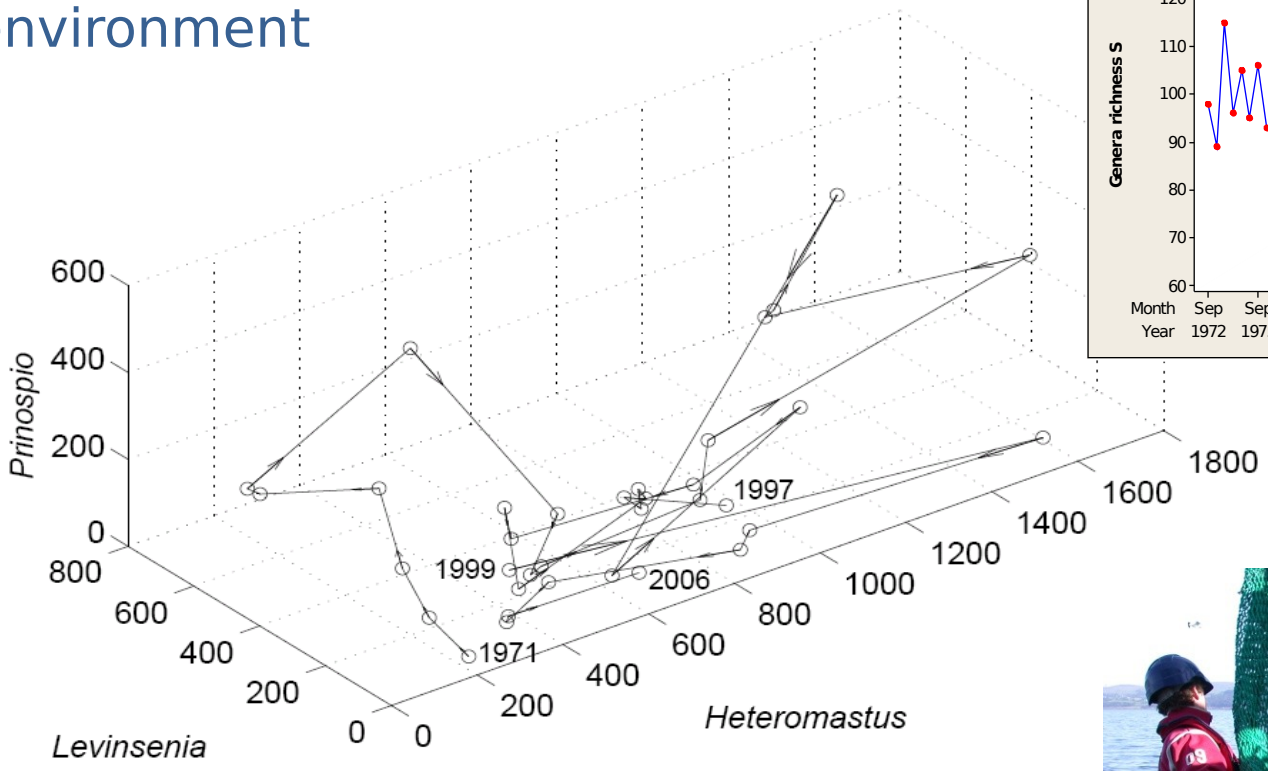
- nutrient concentrations and physical measurements, radionuclide and stable isotope techniques, measurement of enzyme activity)

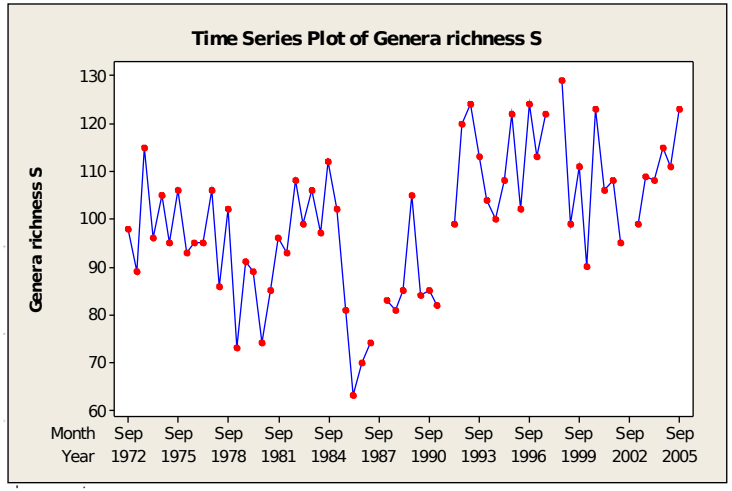
Determine the source and fate of nitrogen in the marine environment

- stable nitrogen isotope composition of dissolved and particulate

What are the consequences of environmental change on large-scale ecosystem dynamics?

e.g. Spatial patterns and temporal change in marine environment





Matt Spencer

Jon Green

Chris Frid

Leonie Robinson

e.g. ‘Conservation Physiology’ predicting effects of climate change on species and populations (Green)

e.g. Developing tools to predict effects of fishery activity on benthic habitats (Robinson, Frid)

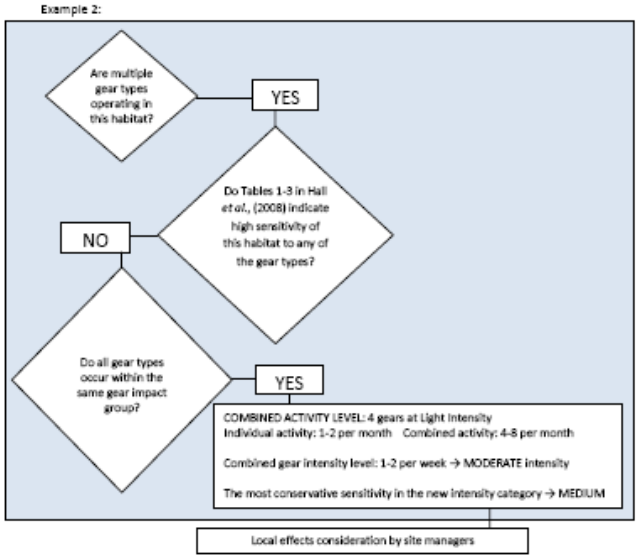


Figure 3. Combining gear types 1, 3, 4 and 5 from gear impact group I at Habitat 18. All gear types are at LIGHT intensity. CGE is MEDIUM.

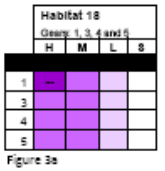


Figure 3a

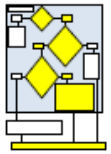
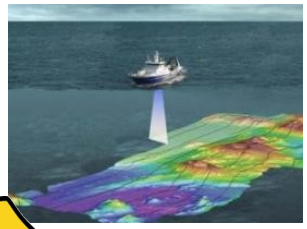


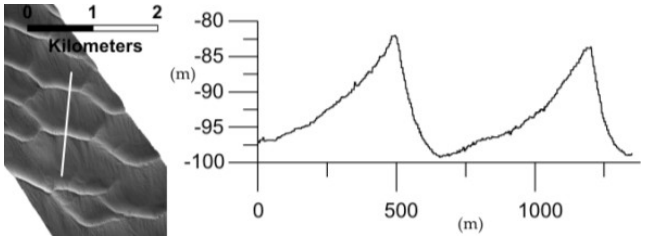
Figure 3b

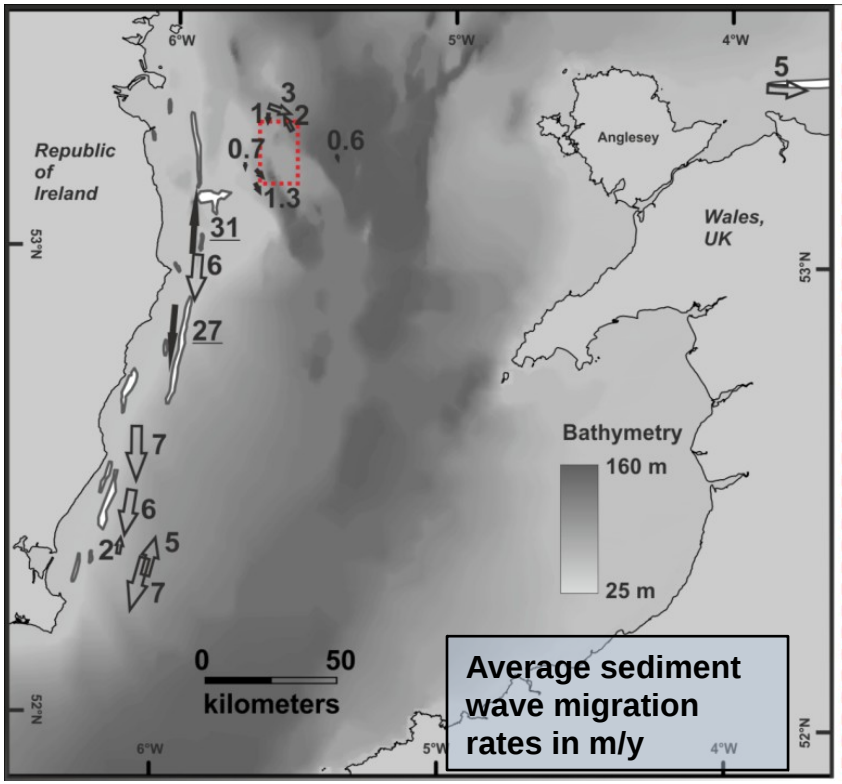
Figure 3a shows the sensitivity of H18 to fishing gears used in this CGE example. Figure 3b shows a schematic diagram of this example; it shows how this example can be used with GIS.

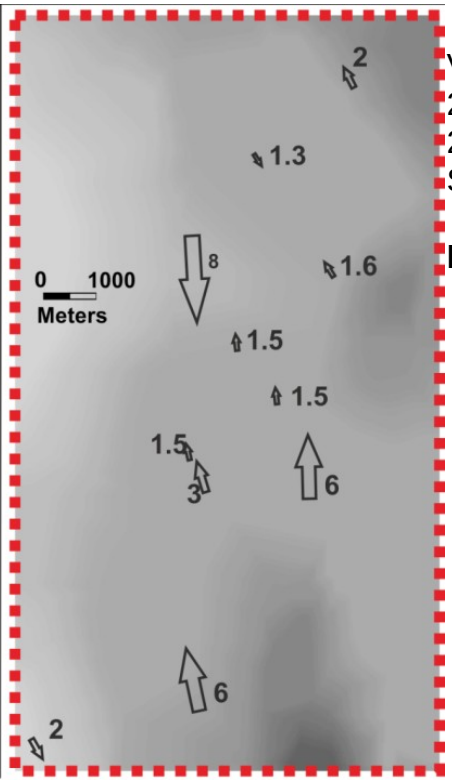
Coastal sedimentary processes - depositional history and preservation into the geological record – Linking the present to the past

Large sediment waves migrating in the Irish Sea



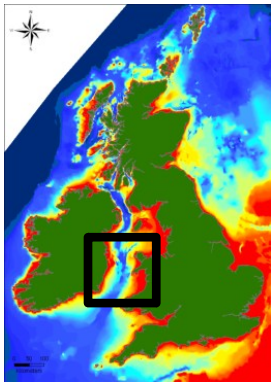




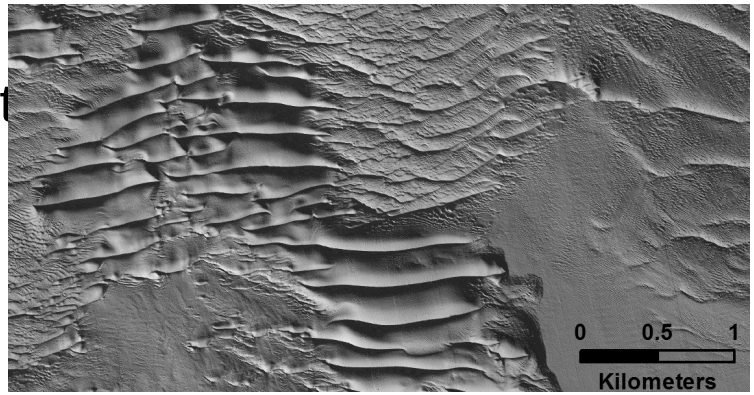


Van Landeghem et al., 2009 (Cont. Shelf Res.)
2009 (Mar .Geol.)
Subm. (Mar. Geol.)

kjjvl@liv.ac.uk

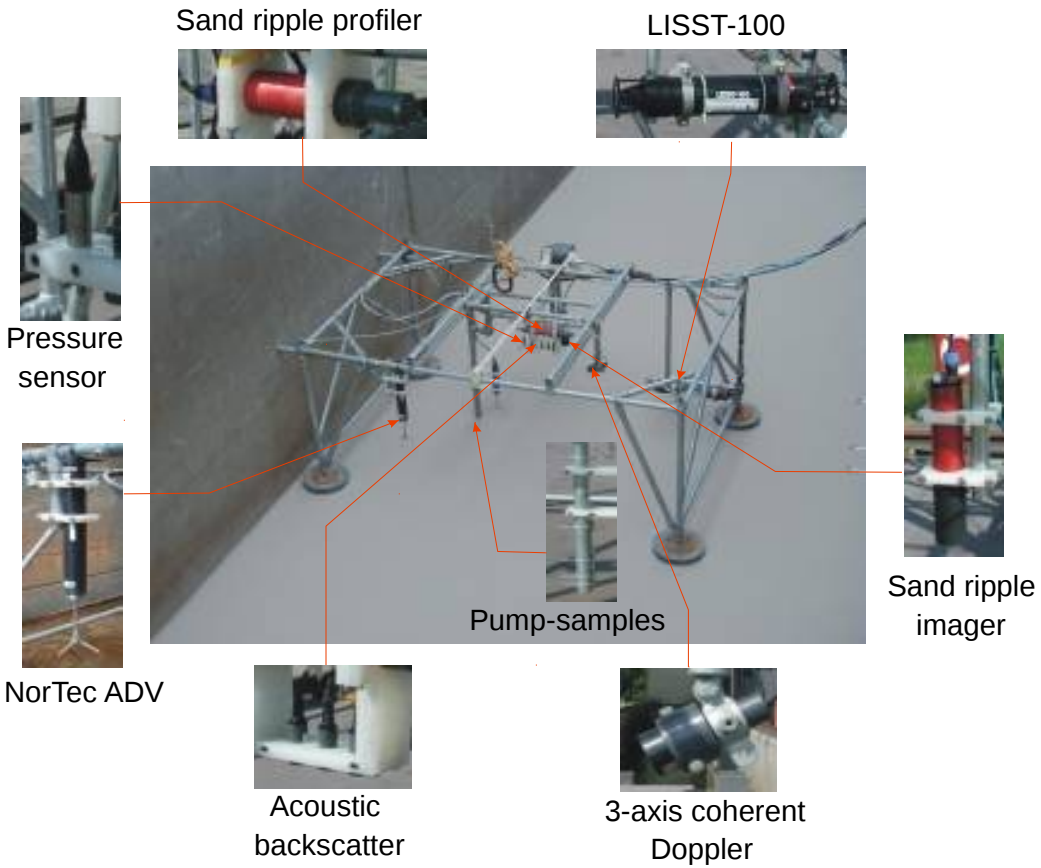


1. **Sediment wave size**: **up to 36m high!** Existing knowledge insufficient:
   - Flow data: high resolution and peak events: interaction with sediment waves
   - Detailed grain size variations within sediment waves: feedback with growth
   - Gas seepage: inducing extreme growt
   - Post-LGM sea-level rise:
   - Revised sea-level rise models might reveal peaks in bed stresses
   - **Update morphodynamic models (with NOC and Univ. of Genoa)**



2. **Sediment wave migration**: size and asymmetry correlate **very poorly** with migration rates: **we need to disregard simple geometry-based sediment wave migration predictors...**
   - **Incorrect predictions are hazardous for offshore developments: infrastructure, plough performance, seabed recovery, navigation**
   -

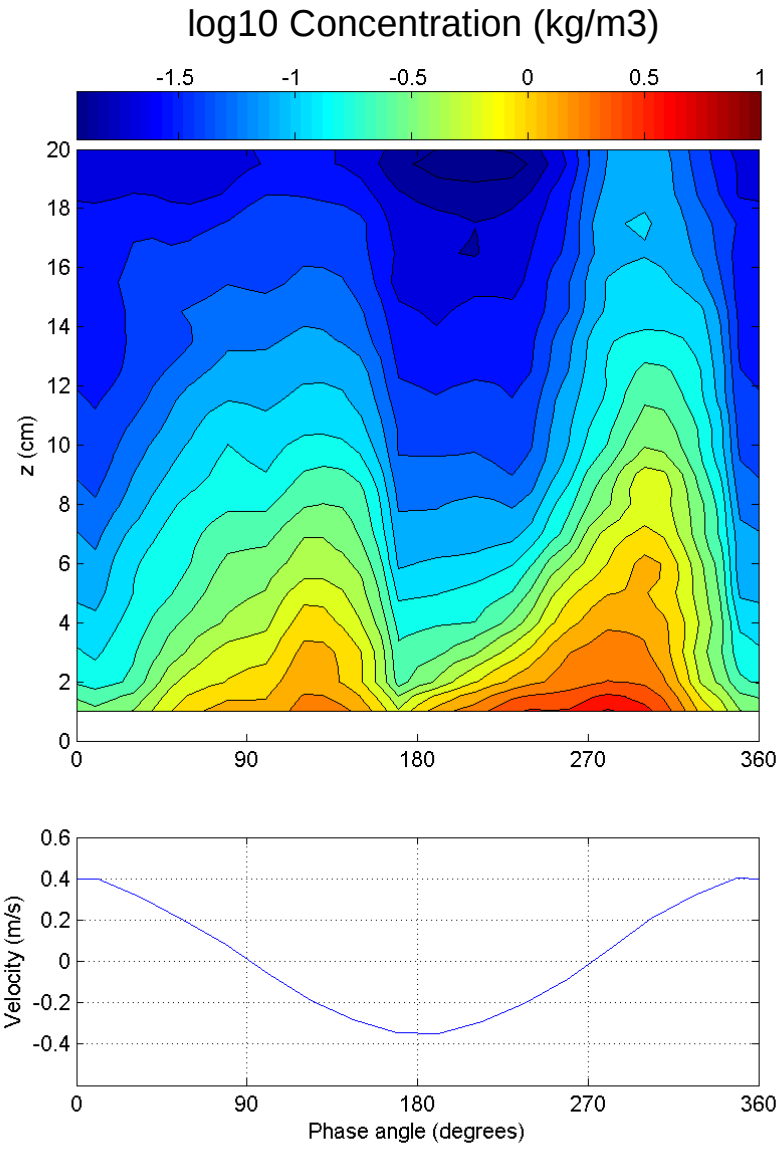
Sediment suspension in the diffusive and vortex regimes under irregular waves



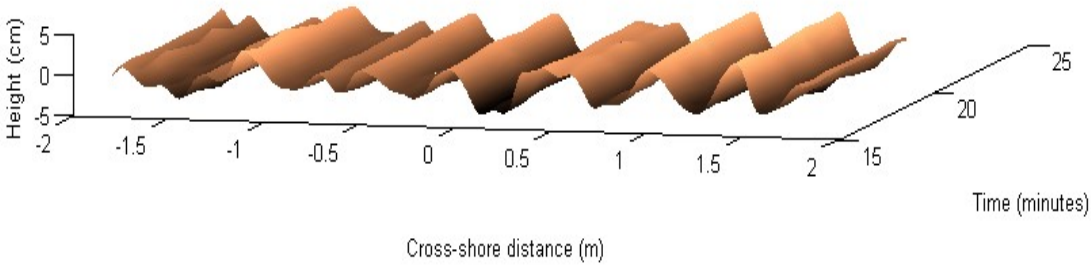
Peter Thorne - NOC

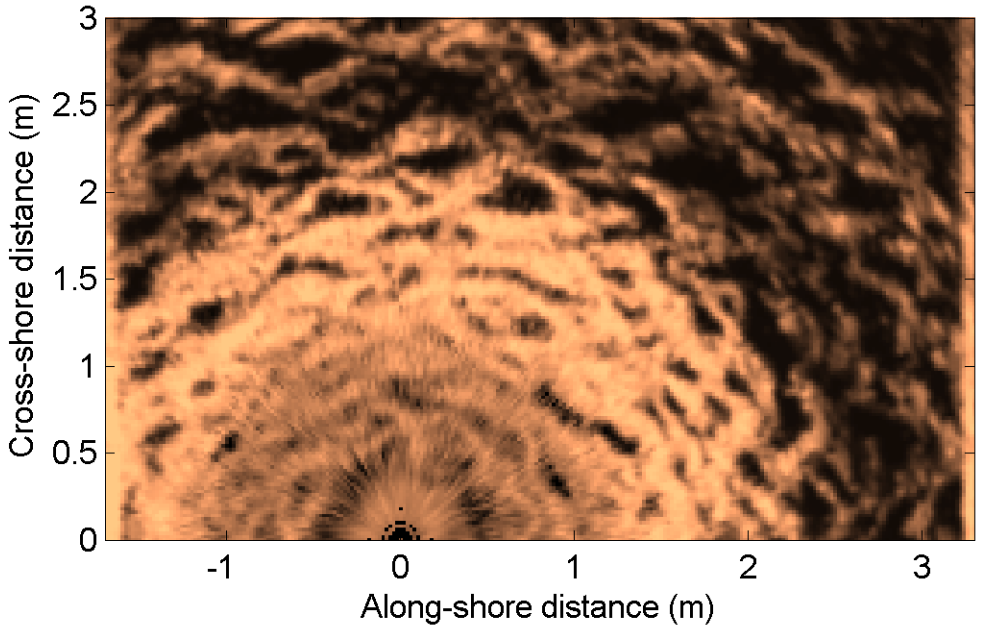
Dave Hodgson

ABS results: Rippled bed Hs=0.83m medium-grained-sand

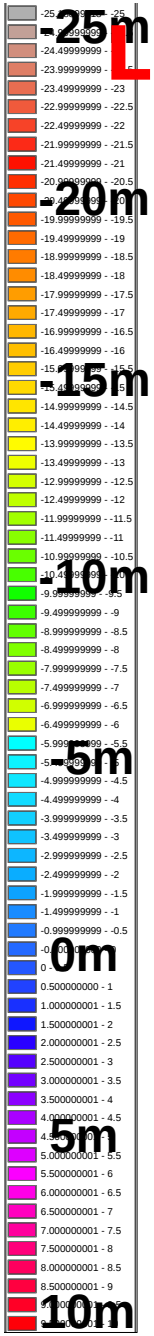


η/λ>0.1

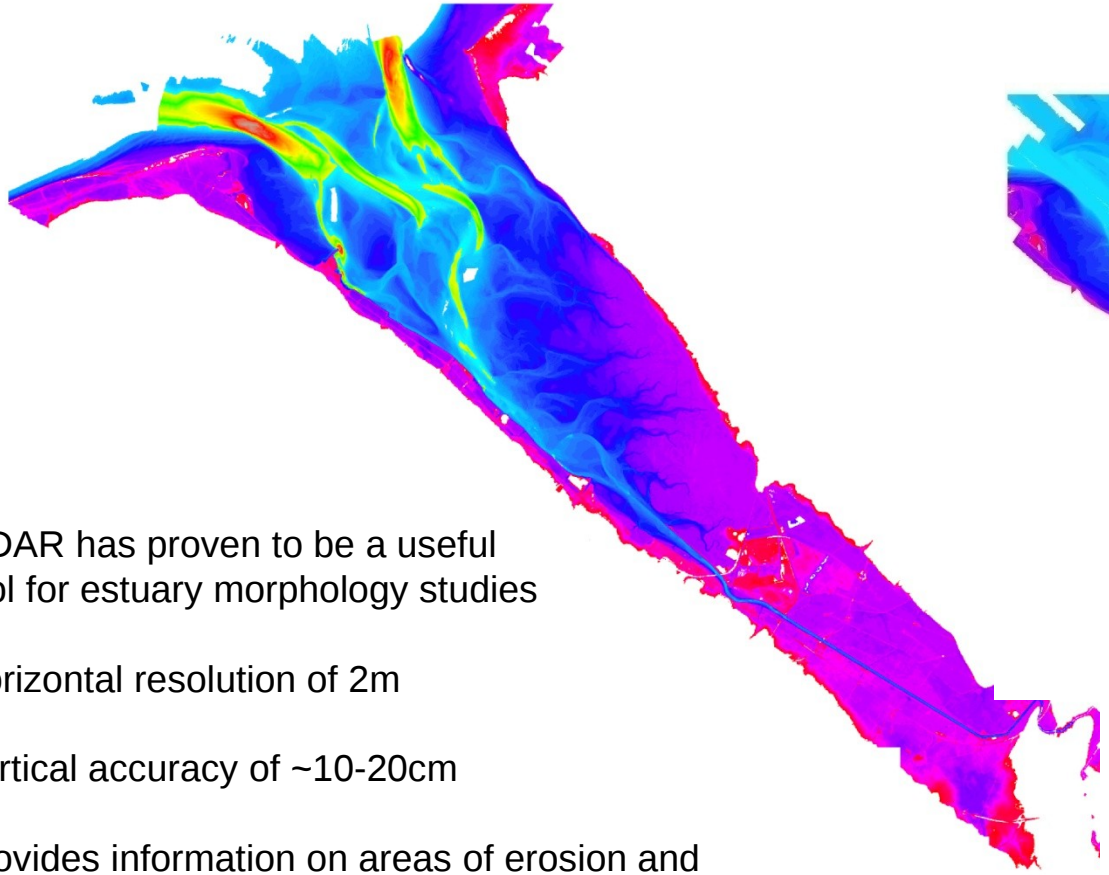




LIDAR surveys reveal high resolution bathymetry of the Dee



2003



200

LIDAR has proven to be a useful tool for estuary morphology studies

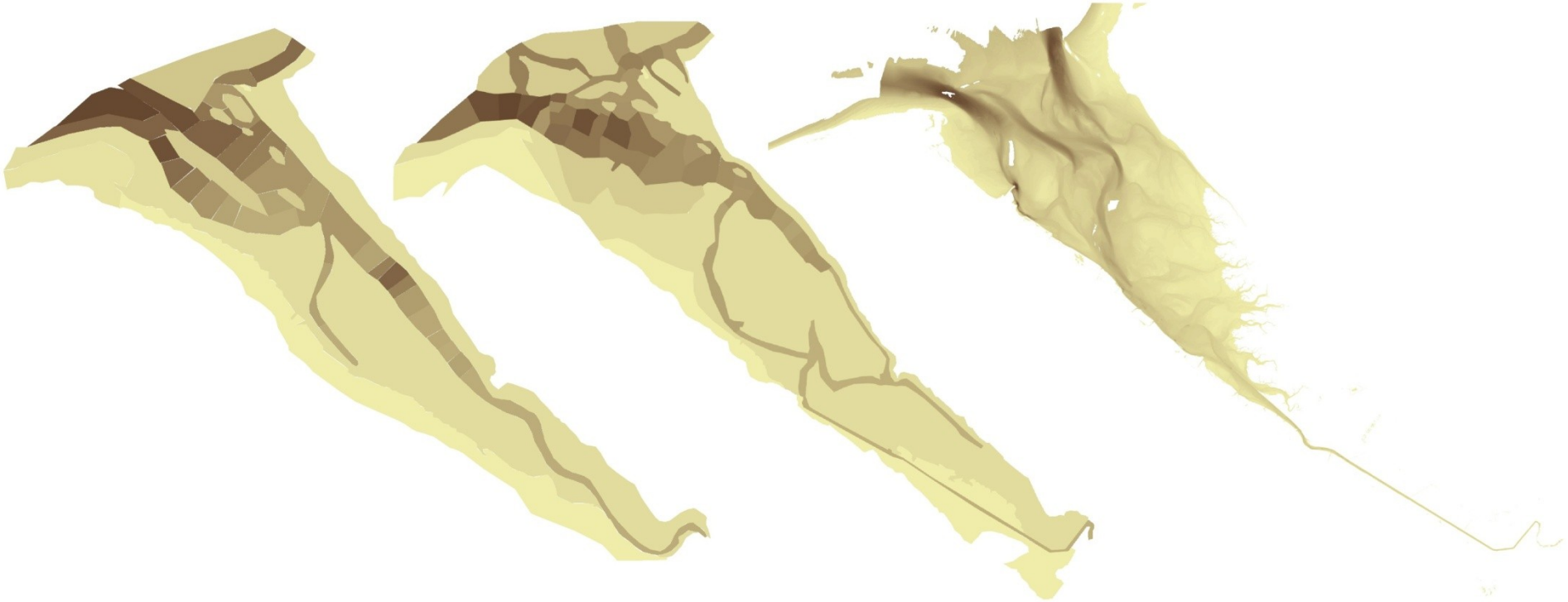
Horizontal resolution of 2m

Vertical accuracy of ~10-20cm

Provides information on areas of erosion and deposition

Provides bathymetric input for numerical modelling

Historically, large amounts of sediment infill, saltmarsh colonisation and changes of channel configuration

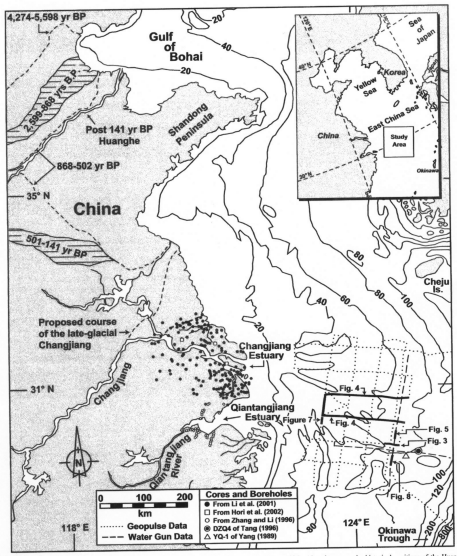


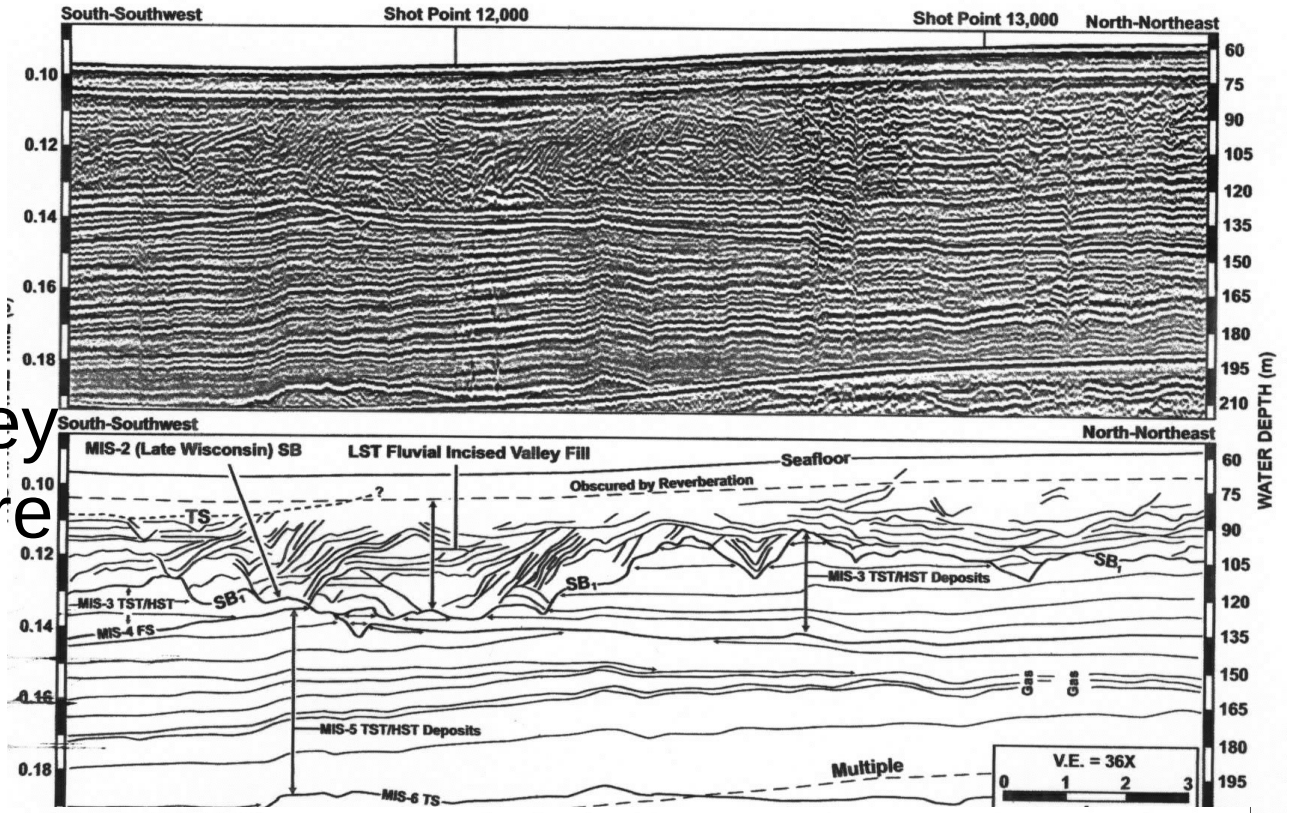
- Canalisation caused channel switch from eastern shore to western shore
- Reduction in estuary area and volume
- Estuary and channels are very mobile and dynamic

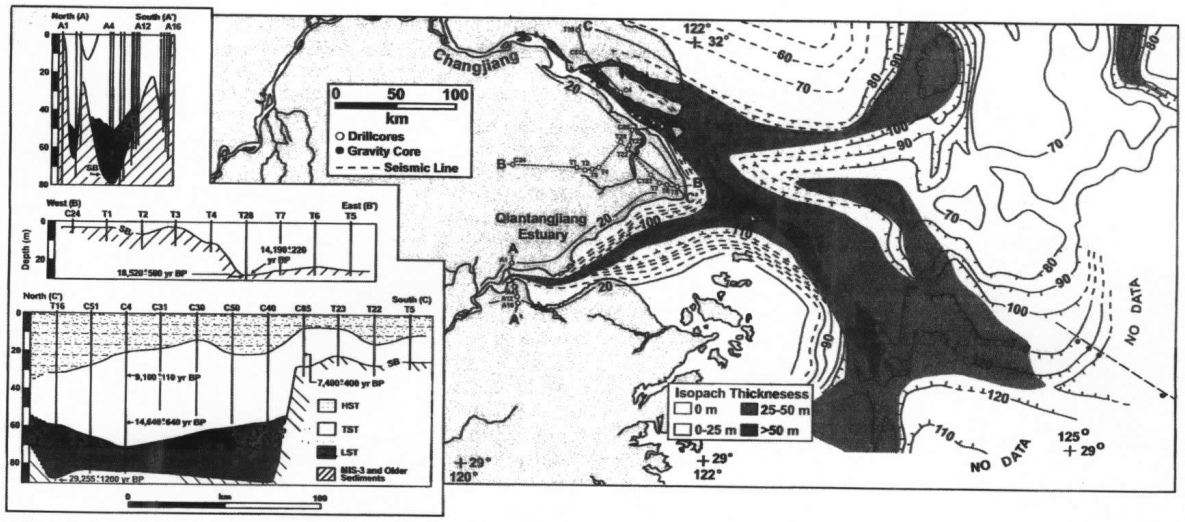
Applications to older systems

e.g. Holocene valley complexes, offshore China

(Wellner and Bartek, 2003)

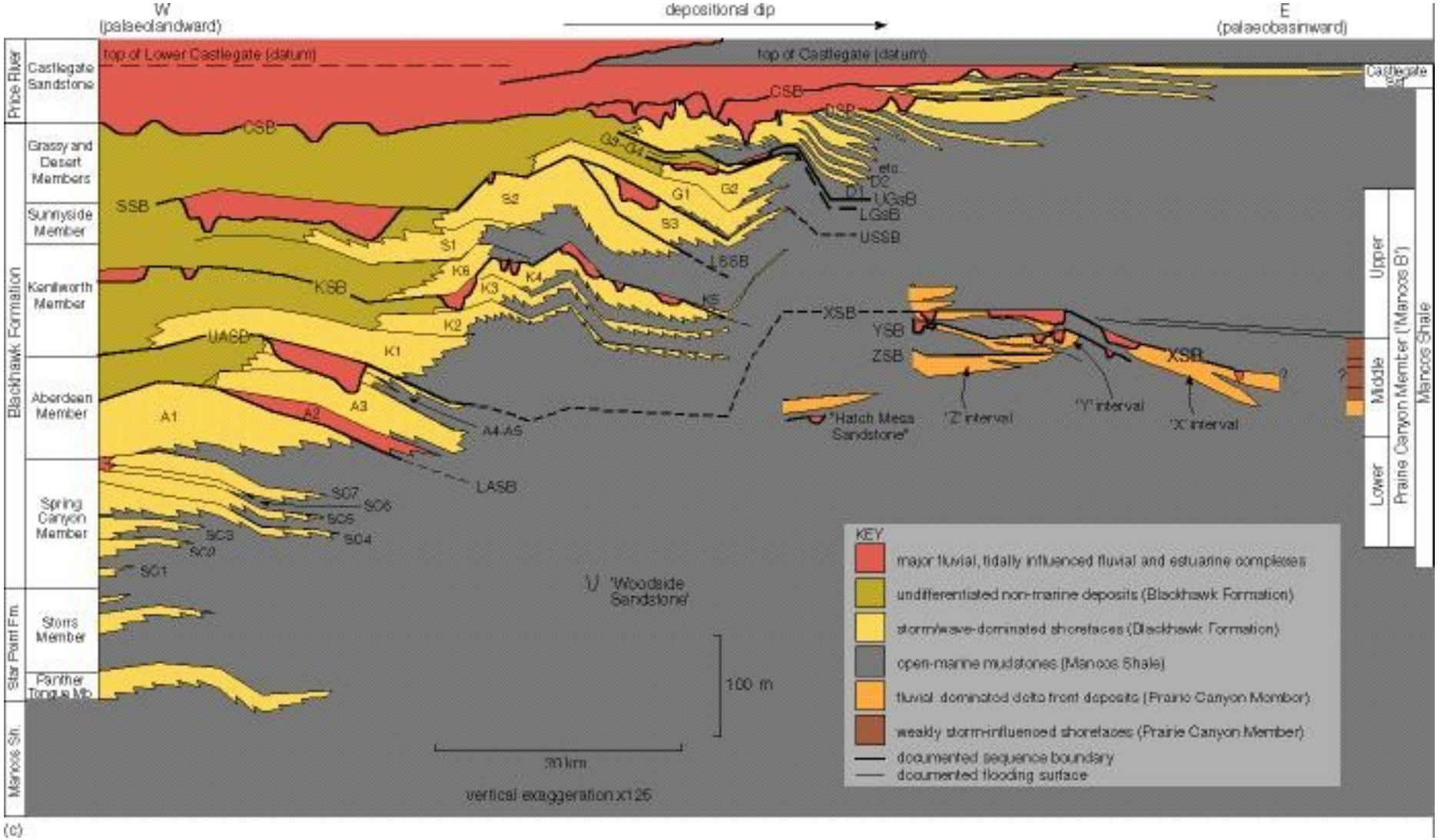






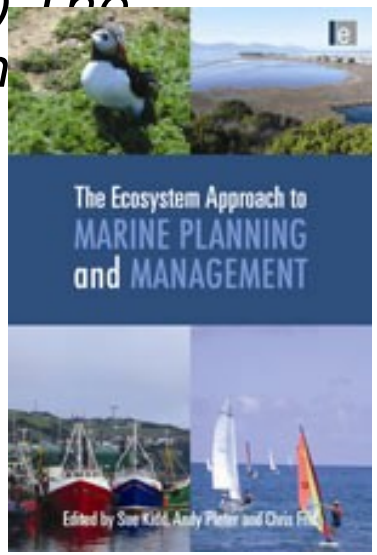
Contour map of sequence boundary/valley complex

Applications to much older systems: Cretaceous Blackhawk Formation, Book Cliffs, Utah



Sustainable/environmental marine and coastal management research projects

- New Approaches to Managing Ecosystem Services in the Marine Environment (ESRC/NERC, PI (Sue Kidd), 2008-2010)
  - forum for discussion between natural scientists, social scientists and users and managers of the marine environment with the objective of improving understanding of some of the key dimensions of marine management that are being developed at the present time.
  - *Kidd, S., Plater, A. and Frid, C. (eds.) (2011) The Ecosystem Approach to Marine Planning and Management, Earthscan, London*
- European Seas in Territorial Development' (EC ESPON project with seven other European universities, 11/2010 – 10/2012 – P dd and Dave Shaw)

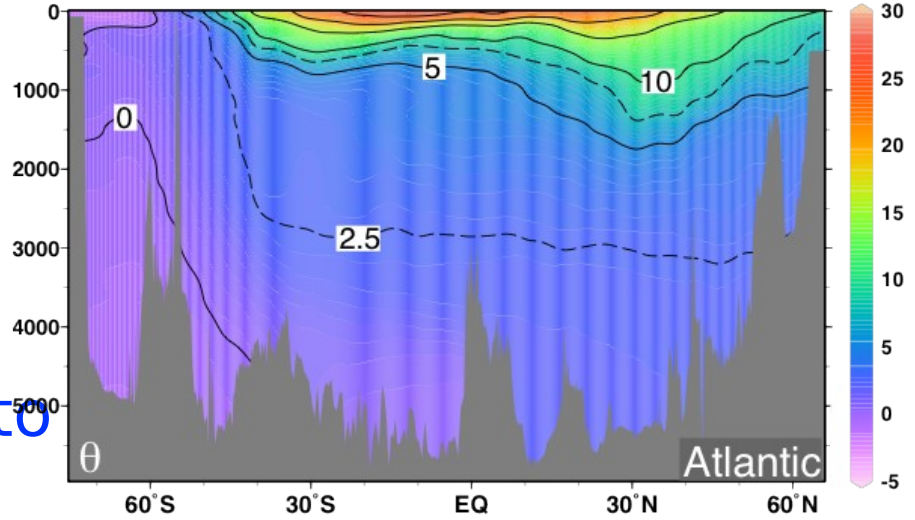


Sustainable/environmental marine and coastal management research projects

- Work on sustainability appraisal/strategic environmental assessment (considering shoreline and offshore planning/technologies):
  - Fischer, T. B. und Phylip-Jones, J. 2007. *Strategic Environmental Assessment (SEA) of the Fife Supplementary Planning Guidance for Renewable Energies*, in: SEA – materials for China's 'International Conference on Strategic Environmental Assessment (SEA)', SEPA.

Why care about the ocean?

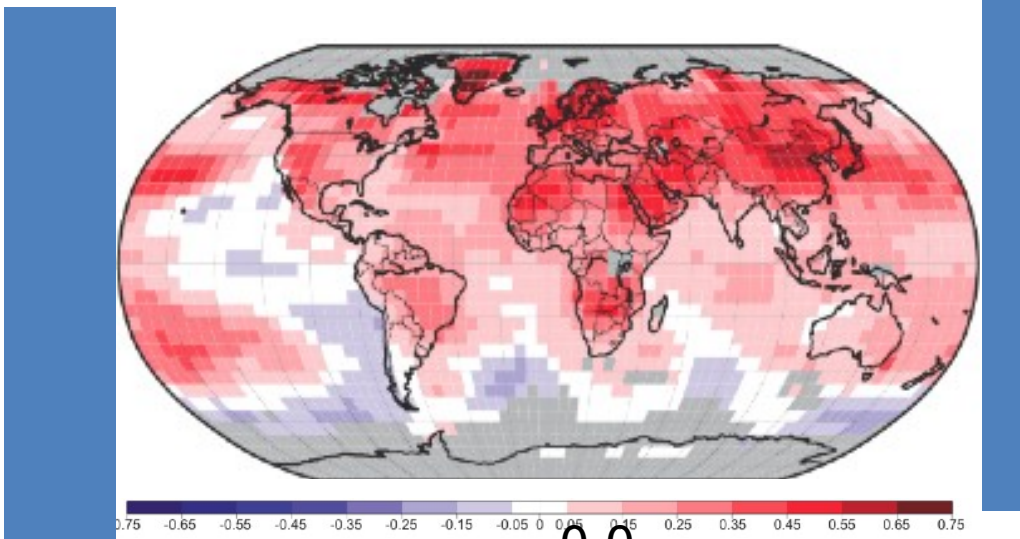
- upper 2.5 m of ocean holds as much heat as overlying atmosphere



- oceans have absorbed more than 80% of the heat added to the climate system (IPCC, 2007)

surface warming 1979-2005:

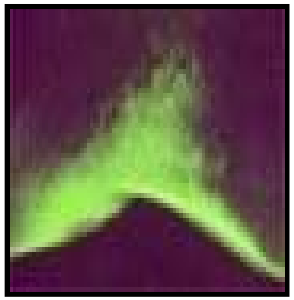
- warming over most of globe
- land warming faster than ocean



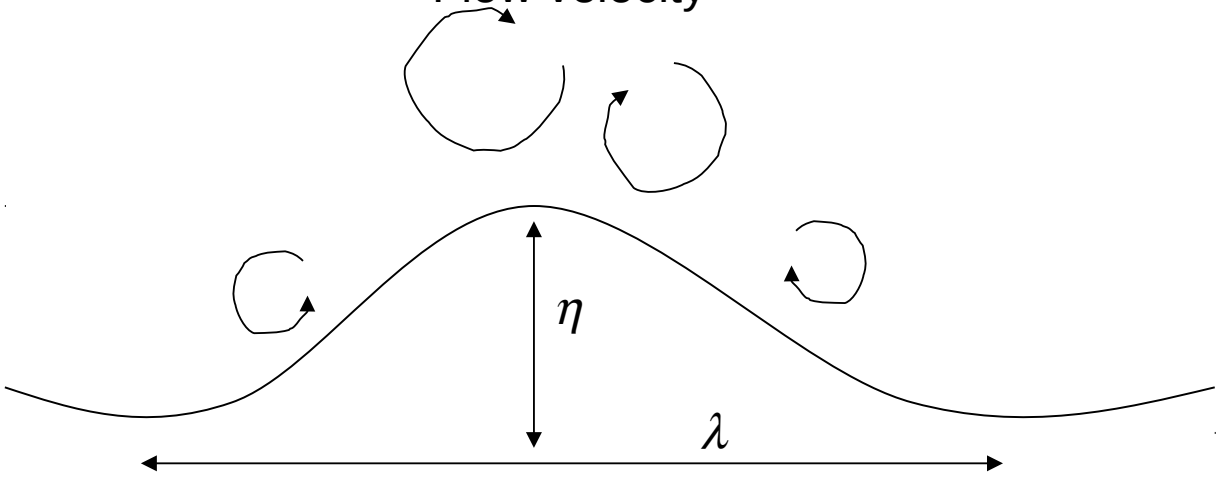
UNIVERSITY OF LIVERPOOL

Vortex ripples…..with irregular waves

- Common features in coastal areas
- Near bed hydrodynamics are dominated by vortex shedding
- Can entrain sediment to far greater heights than over flat beds
- Great amount of sediment can be transported over vortex ripples
- Asymmetry in waves can results in net onshore or offshore transport



A schematic…



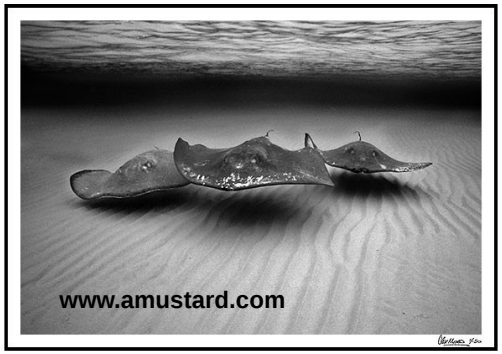
Near shore sediment transport

Currents and Storms

Waves and tides

Dunes and
Sediment in the water

Ripples and offshore bars



3. **Ocean University of China, Qingdao:**
   - Expertise in ocean remote sensing and physical oceanography
   - Research Vessel Dong Fang Hong 2

5. **The Continental Shelf where you are:**
   - Migrating, large sediment waves in the Yellow Sea reflect depositional processes and sediment dispersal systems during the Holocene transgression and high-stand
   - Deep-water migrating sediment waves in the South China Sea reflects the power of the world's largest internal solitary waves

7. **How could UoL, NOC and OUC collaborate?**
   - Sharing expertise and equipment: sampling sediment waves in detail
   - Sediment wave research in different environments: generate a non-site-specific architectural model on sediment wave formation, growth and migration (potentially high impact research