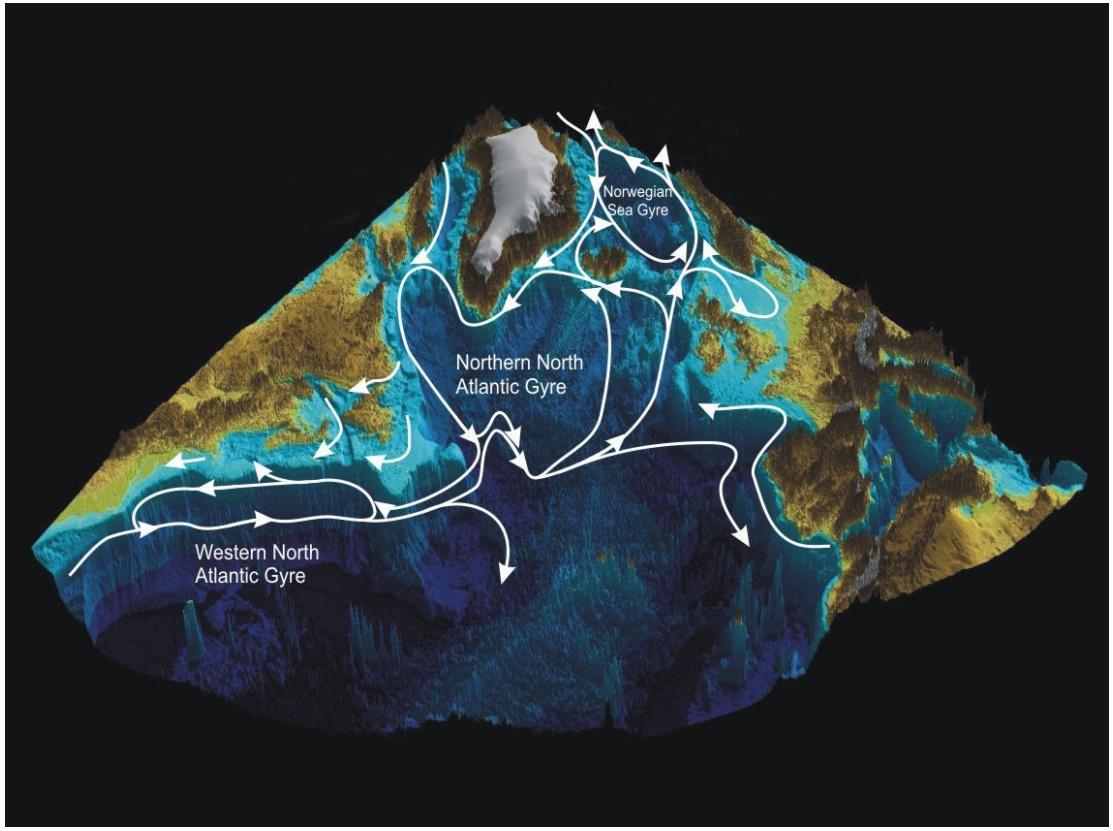
BASIN: Basin-scale Analysis, Synthesis, and INtegration.

Resolving the impact of climatic processes on ecosystems of the North Atlantic basin and shelf seas.

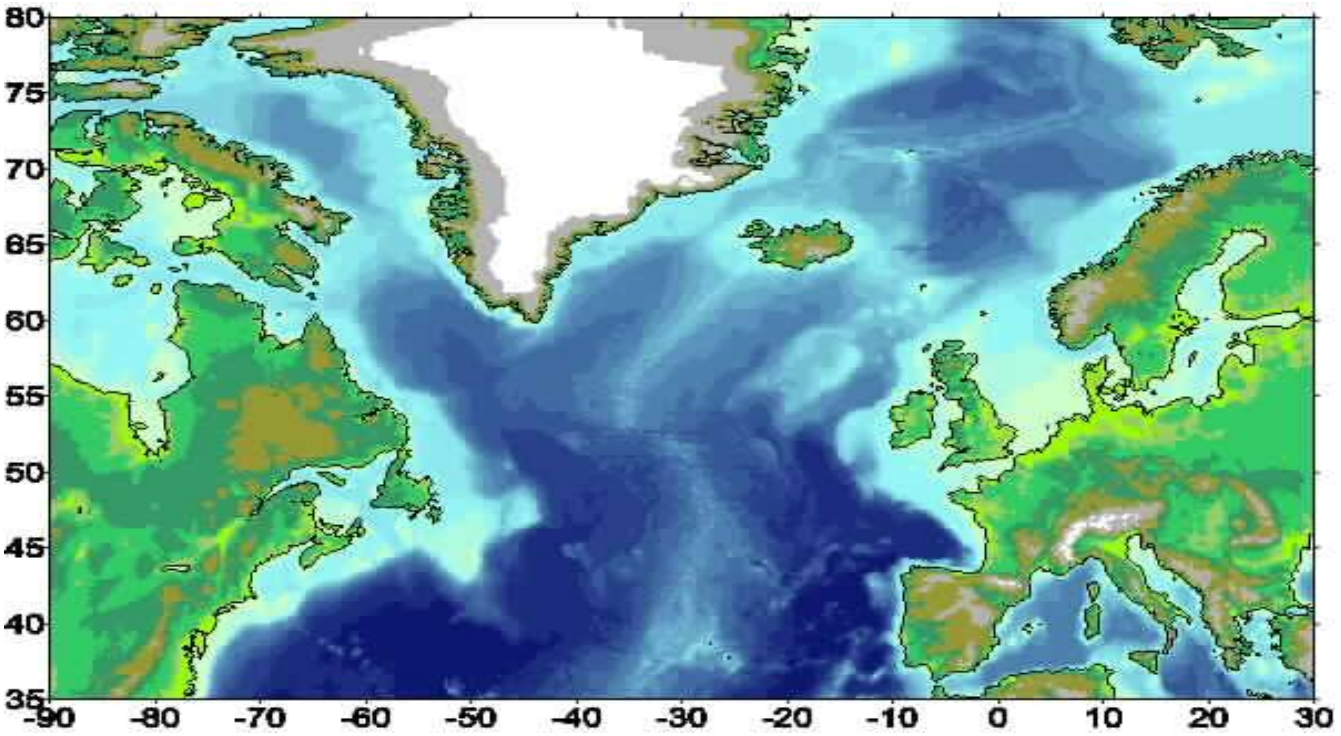
BASIN is an initiative to develop a joint EU/North American ocean ecosystem research program.

P.H. Wiebe, R.P Harris, M.A. St. John, F.E. Werner, B. de Young, and, P. Pepin



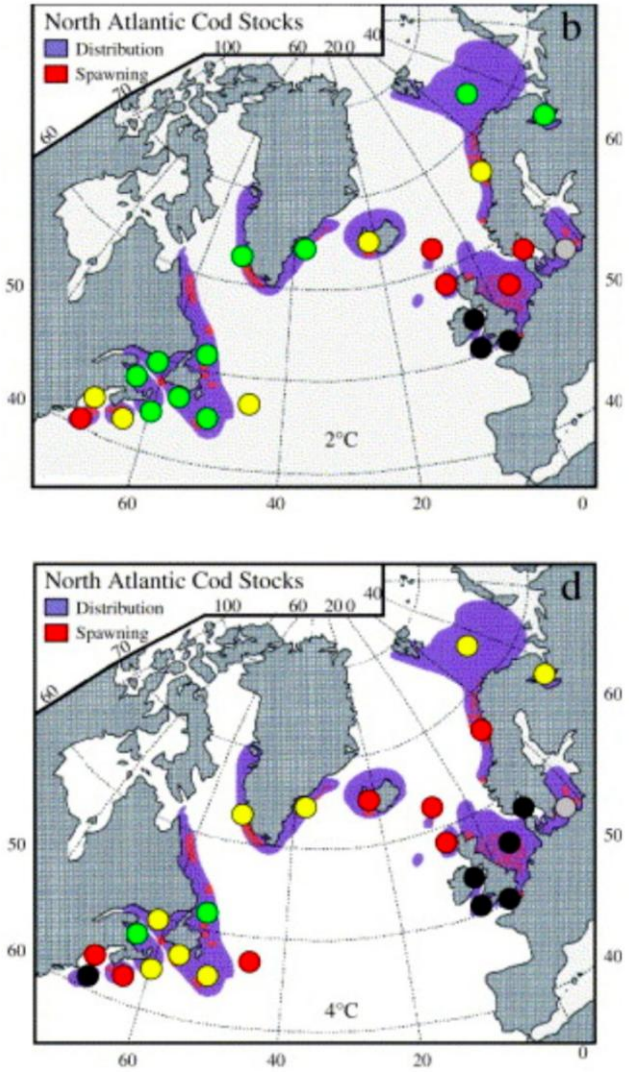
BASIN Aim

To understand and simulate the population structure and dynamics of broadly distributed and trophically important plankton and fish species in the North Atlantic ocean to resolve the impacts of climate variability on marine ecosystems, and thereby contribute to ocean management.



Need for Basin-Scale North Atlantic Studies:

- Connectivity in the North Atlantic is determined by the large-scale gyres that span the basin.
- Basin-scale forcing impacts biogeography and ecosystem structure and function both locally and across the entire region.
- The North Atlantic system is a key ocean basin globally for the sequestration of carbon.
- The ecosystem approach to management of widely distributed fish and other key species requires a basin-scale approach.



Expected changes in the abundance of the cod stocks with a temperature increase of 2C (top) and 4C (bottom) above current levels.

Dot Color:

Green = Increase;
Yellow = No change;;
Red = Decrease;
Black = Collapse;
Gray = unknown.

(Drinkwater, 2005)

BASIN Themes

- **Theme 1.** How will **climate variability and change** – for example changes in temperature, stratification, transport, acidification – influence the seasonal cycle of primary productivity, trophic interactions, and fluxes of carbon to the benthos and the deep ocean?

  - How will the ecosystem's response to these changes differ across the basin and among the shelf seas?
  - How are the populations of phytoplankton, zooplankton, and higher trophic levels influenced by large-scale ocean circulation and what is the influence of changes in atmospheric and oceanic climate on their population dynamics?

BASIN Themes

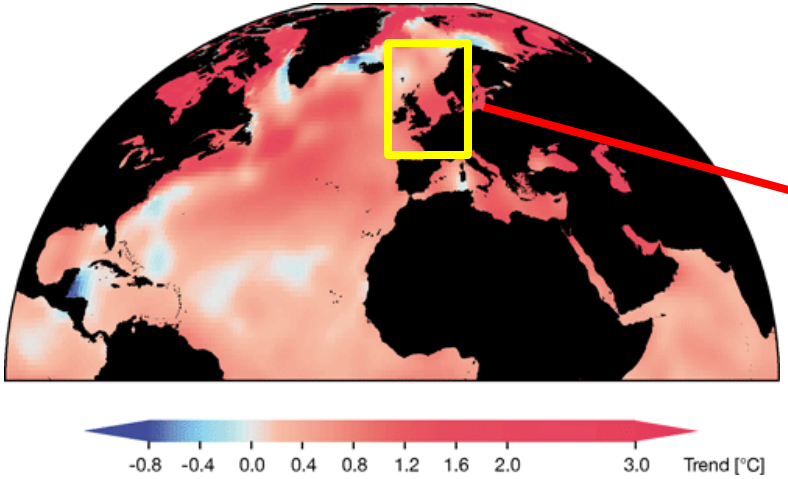
- **Theme 2.** How do **life history strategies** of target organisms, including vertical and horizontal migration, contribute to observed population dynamics, community structure, and biogeography?

  - How are life history strategies affected by climate variability
  - How will life history strategy influence the response of key species and populations to anthropogenic climate change?

BASIN Themes

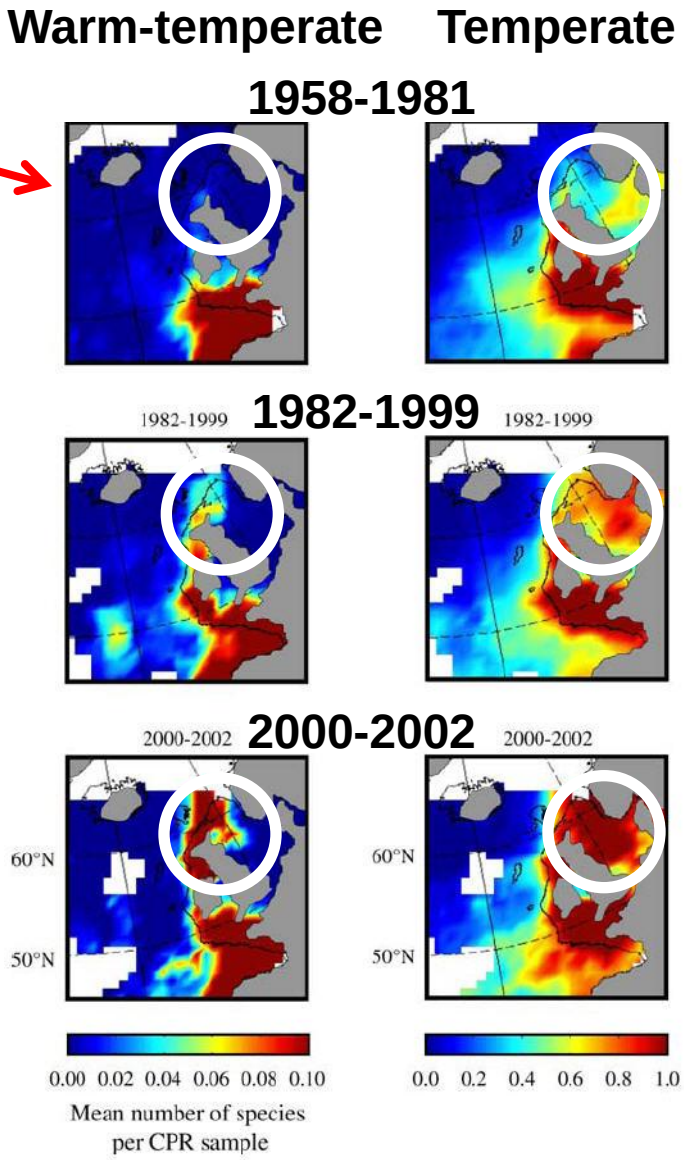
- **Theme 3.** How does the **removal of exploited species** influence marine ecosystems and sequestration of carbon?
  - Under what conditions can harvesting result in substantial restructuring of shelf or basin ecosystems, i.e., alternate stable states?
  - Do such changes extend to primary productivity and nutrient cycling?
  - How is resilience of the ecosystem affected
  - What is the potential impact on the sequestration of carbon?

But, we recognize long-term & large scale changes, such as increases in North Atlantic SST and shifts in biogeography



Change of SST in the North Atlantic and European marginal seas (between 1978 and 2002).

Based on the GISST data set of the British Hadley Centre. Source: PIK, based on Hadley Centre, 2003



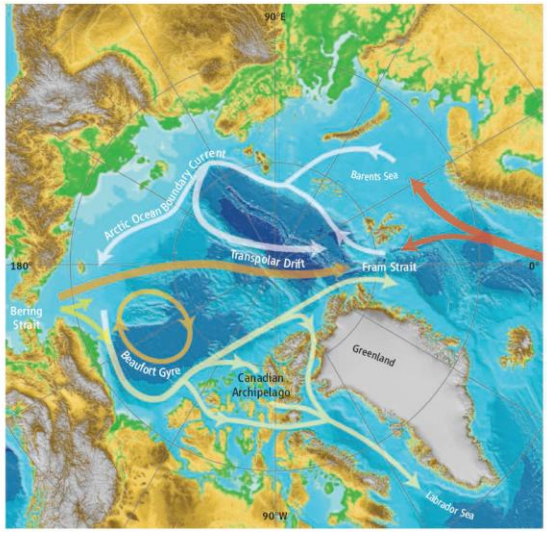
Warm-water species have extended their distribution northwards by more than 10° of latitude.

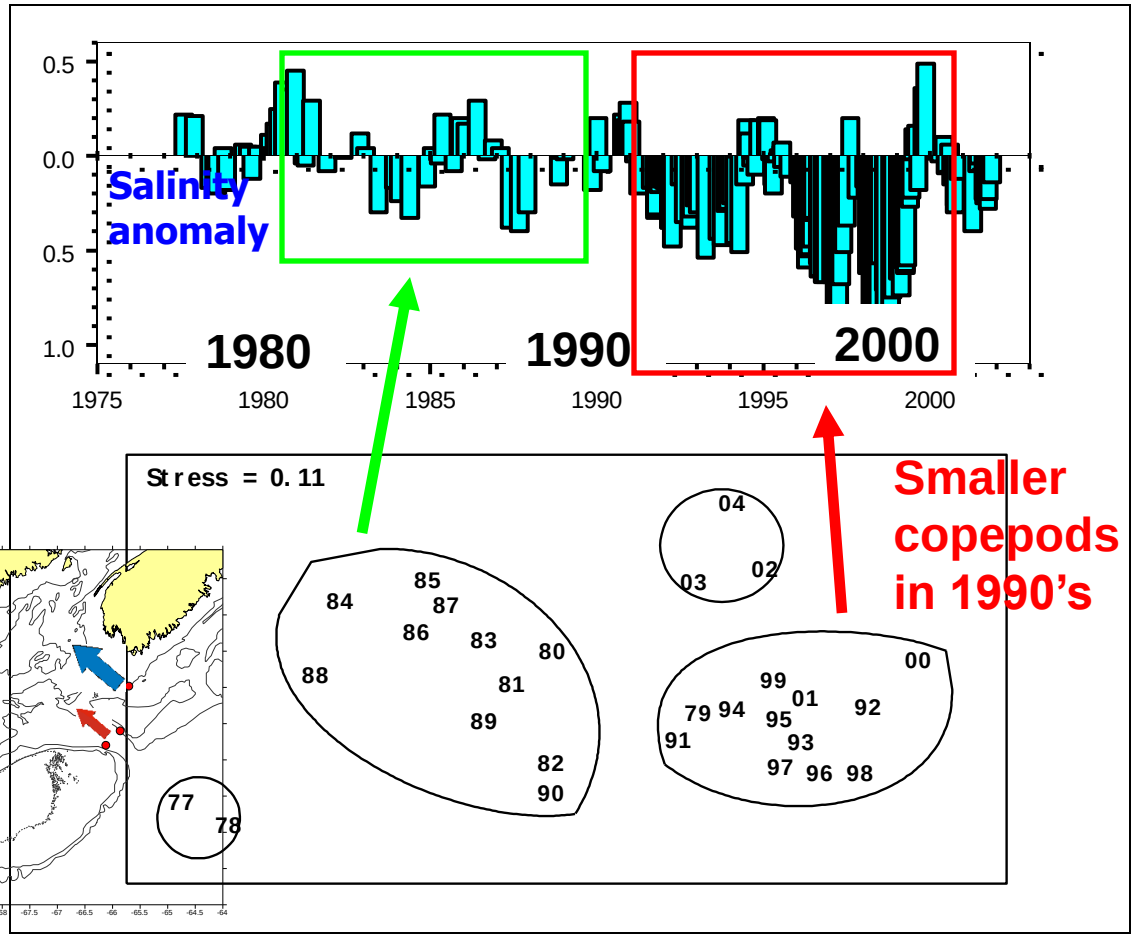
(Beaugrand, 2002)

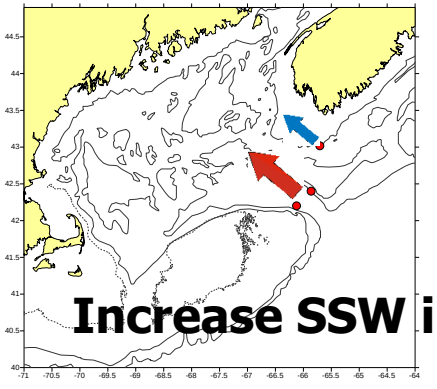
Northwest Atlantic region (advective effects):

1. **salinity change in 1990's has been large, and**
2. **change in zooplankton community structure**

Gulf of Maine / Georges Bank





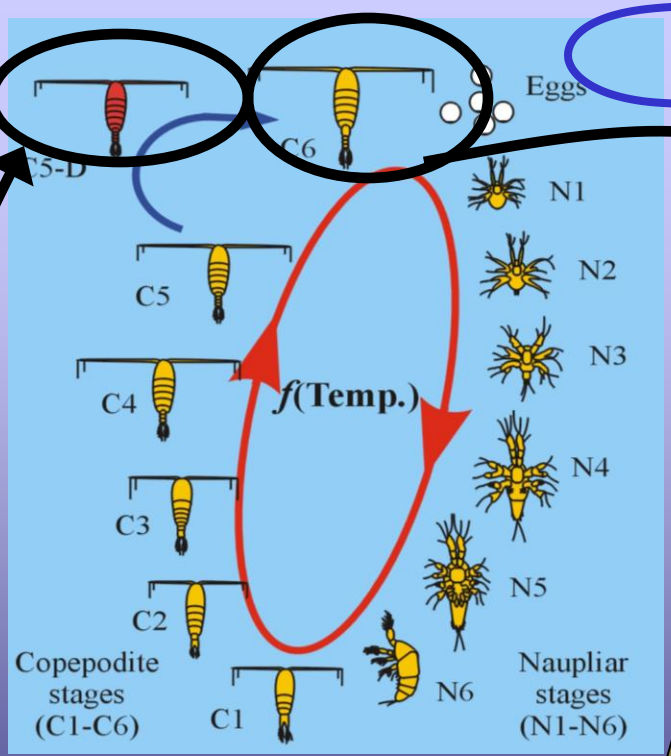


Increase SSW inflow

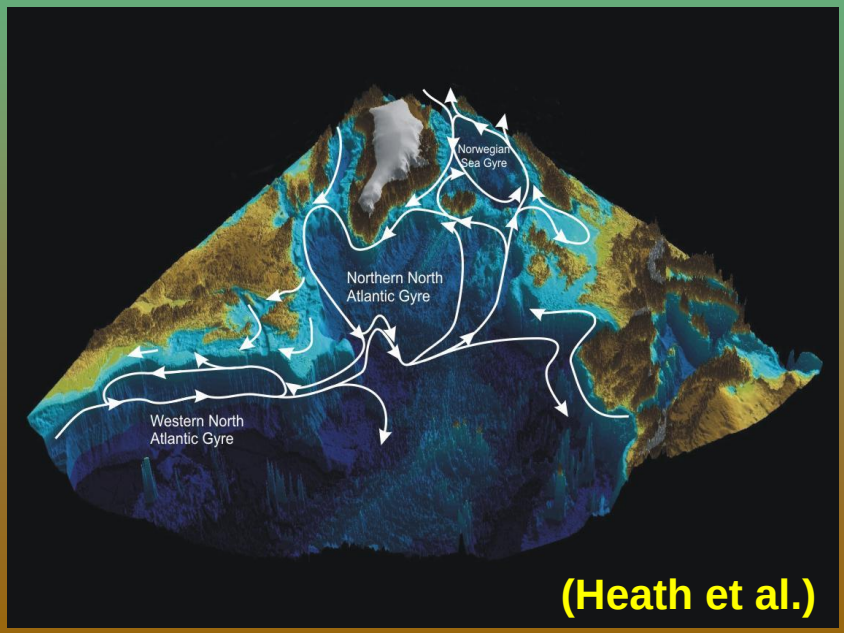
(Mountain, 2003)

NORTH ATLANTIC OCEAN

SHELF SEAS



Climate forcing of ocean circulation



(Heath et al.)

Research Goals

- Integrate and synthesize existing basin-wide data sets from previous programs in Europe and North America,
- Improve the current state of the art in bio-physical modelling,
- Develop hindcast modelling studies to understand the observed historical variability of the North Atlantic ecosystem,
- Construct scenarios of possible ecosystem changes in response to future climate variability,
- Identify data gaps that limit process understanding and contribute to uncertainty in model results,
- Specify new data needed to assess the performance of forecasts,
- Provide relevant information to resource managers and decision makers.

Program Elements

Phase I

Data
- Assembly
- Integration
- Analysis
- Synthesis

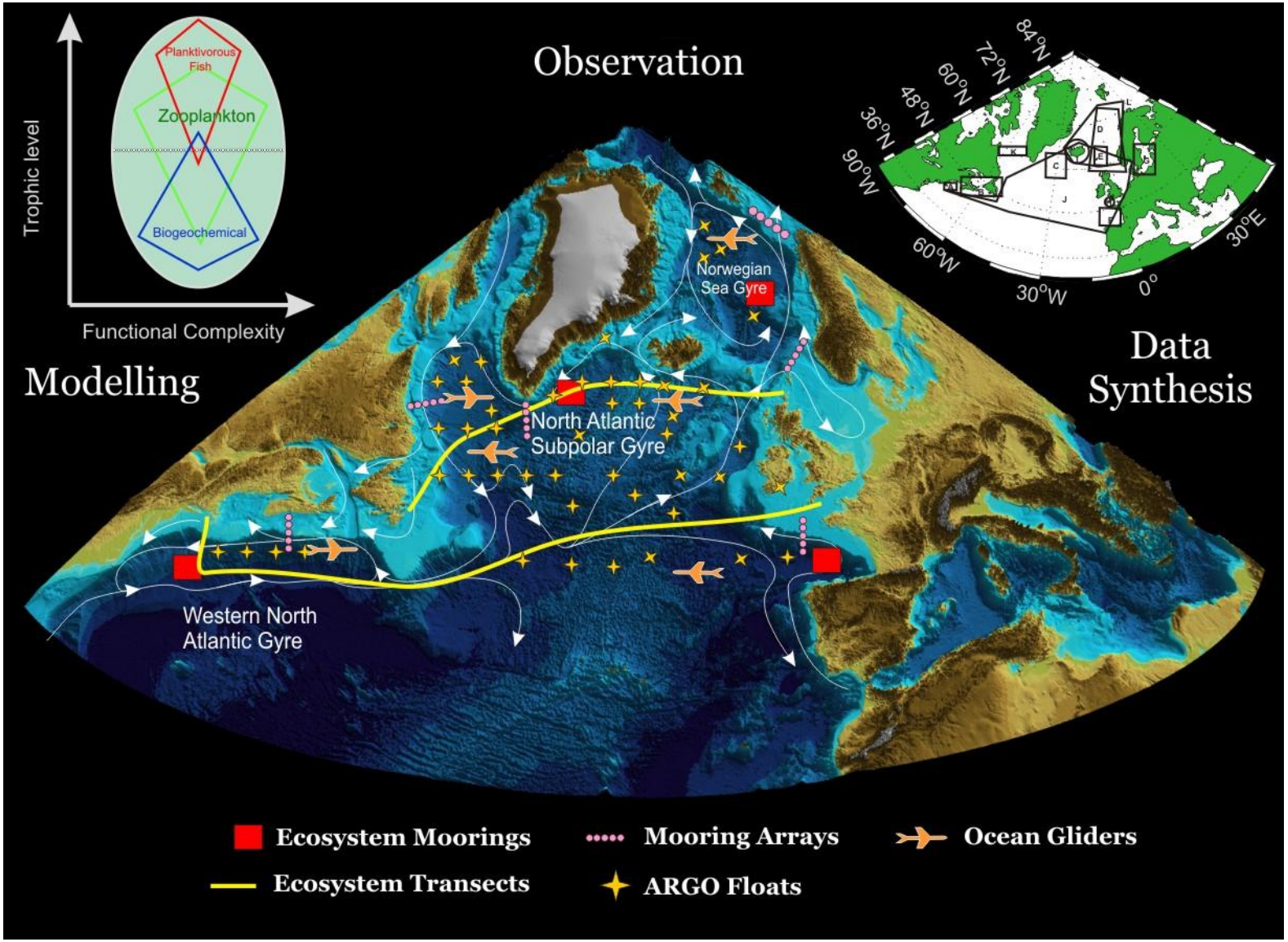
Modeling
- Coupled phys/bio
- Hindcasts
- Forecasts
- OSSEs*

Phase II

New Data Acquisition
- Biota
  - Distribution
  - Abundance
  - Process
- Biogeochemistry

Management Applications
- Focus on science for ecosystem approaches to fisheries

***Observation System Simulation Experiments**


Observation
Modelling
Data Synthesis
Trophic level
Functional Complexity
Planktivorous Fish
Zooplankton
Biogeochemical
84°N
72°N
60°N
48°N
36°N
90°W
60°W
30°W
0°
30°E
Norwegian Sea Gyre
North Atlantic Subpolar Gyre
Western North Atlantic Gyre
Ecosystem Moorings
Mooring Arrays
Ocean Gliders
Ecosystem Transects
ARGO Floats

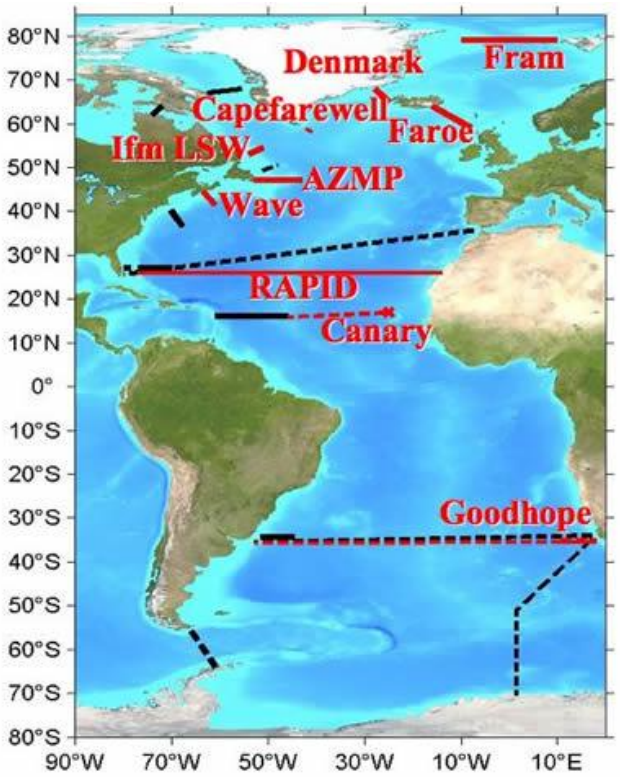
Related programs

Parallel basin-scale programs

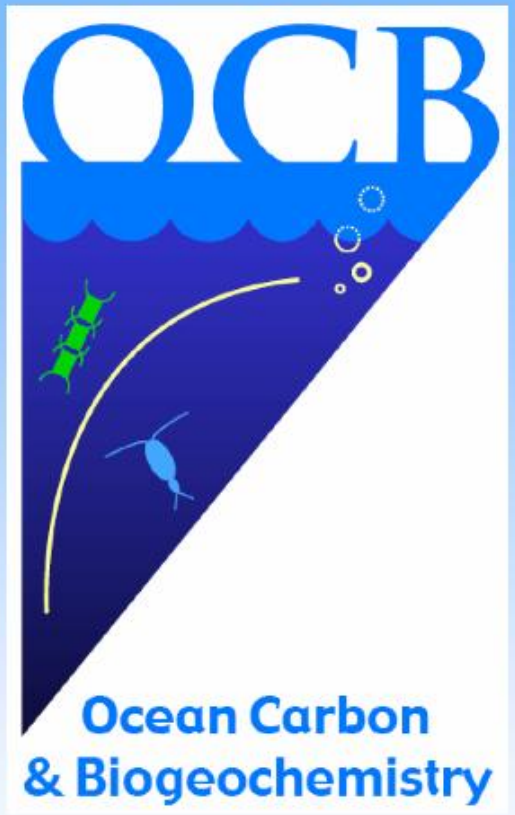
- AMOC (http://www.atlanticmoc.org/)

Potential Impacts of AMOC Variability:

1. **Climate and Extreme Weather Events**
2. **Marine Ecosystems**
3. **Carbon Budget and Sequestration**
4. **Sea Level Change**
5. **Sea Ice**



Parallel basin-scale programs



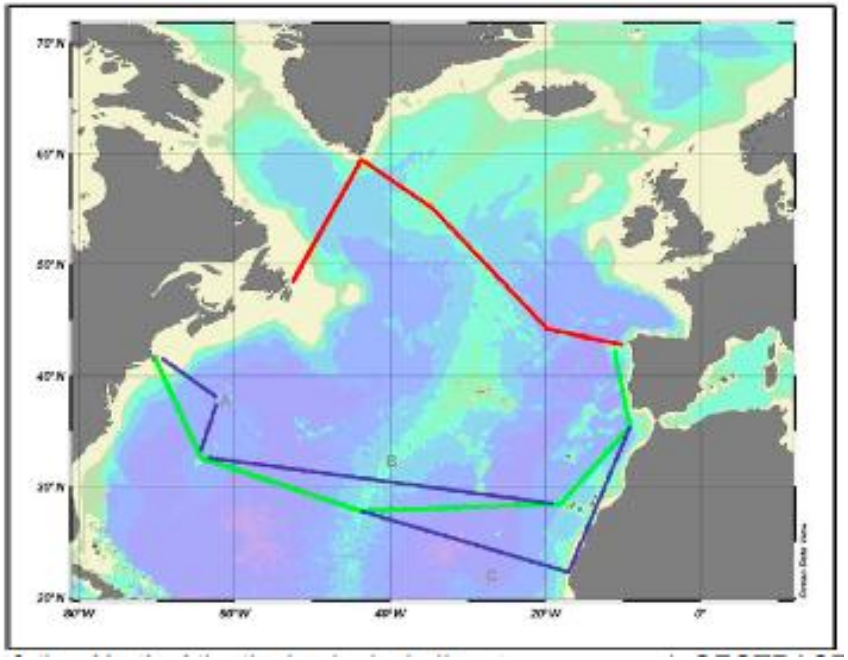
OCB: Ocean Carbon and Biogeochemistry Program

OCB Mission:
to establish the evolving role of the ocean in the global carbon cycle, in the face of environmental change, through studies of marine biogeochemical cycles and associated ecosystems

Parallel basin-scale programs

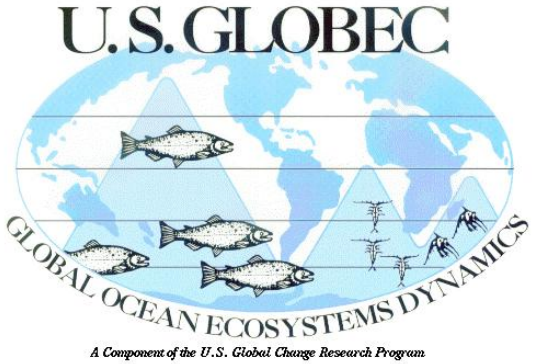
GEOTRACES

International study of the global marine biogeochemical cycles of trace elements and their isotop



(http://www.ldeo.columbia.edu/res/pi/geotraces/)

U.S. GLOBEC: Pan-synthesis



Projects focusing on:

(1)synthetic activities, including conceptual and analytical modeling

(2) broad-scale studies including comparisons across system types; and/or

(3) development of management strategies at pop'n, community, and ecosystem levels.

CAMEO

Comparative Analysis of Marine Ecosystem Organization

The program supports fundamental research to understand complex dynamics controlling ecosystem structure, productivity, behavior, resilience, and population connectivity, as well as effects of climate variability and anthropogenic pressures on living marine resources and critical habitats.

CAMEO encourages the development of multiple approaches, such as ecosystem models and comparative analyses of managed and unmanaged areas (e.g., marine protected areas) that can ultimately form a basis for forecasting and decision support.

Central to the program is the emphasis on collaborations between academic and private researchers and federal agency scientists with mission responsibilities to inform ecosystem management activities.

US National Science Foundation (NSF): COOPERATIVE RESEARCH ...TH THE EUROPEAN COMMISSION AND EUROPEAN SCIENTISTS

http://www.nsf.gov/geo/oce/programs/biores.jsp#Cooperative

- In October of 2001 the EC and the NSF signed an Implementing Arrangement to foster cooperative activities in environmental research between EU and US Scientists.

- An EC-NSF agreement was established to give particular attention to research on climate change, marine science and technology, ...

US National Science Foundation (NSF): COOPERATIVE RESEARCH WITH THE EUROPEAN COMMISSION AND EUROPEAN SCIENTISTS

http://www.nsf.gov/geo/oce/programs/biores.jsp#Cooperative

- The NSF Division of Ocean Sciences supports US researchers in collaborative efforts either through submissions to targeted announcements or by providing support for proposals with collaborative efforts submitted to our regular target dates.

- EC-NSF discussions have focused on climate change, ocean acidification, and marine ecosystems of the North Atlantic (see the following series of reports available using International GLOBEC's website).

US National Science Foundation (NSF): COOPERATIVE RESEARCH WITH THE EUROPEAN COMMISSION AND EUROPEAN SCIENTISTS

http://www.nsf.gov/geo/oce/programs/biores.jsp#Cooperative

- In FY2010 and beyond we are anticipating supporting U.S. scientists engaged in collaborative environmental research with European scientists via EC Programs, particularly in the areas of climate effects on ocean ecosystem dynamics, carbon and geochemical cycles, ocean acidification.
- There may be opportunities and resources for targeted announcements in these areas (e.g., to link specifically with EC calls for proposals in their Framework Program), but we also expect that many of the successful collaborations will develop as investigator-initiated proposals submitted to our regular 15 August and February target dates.

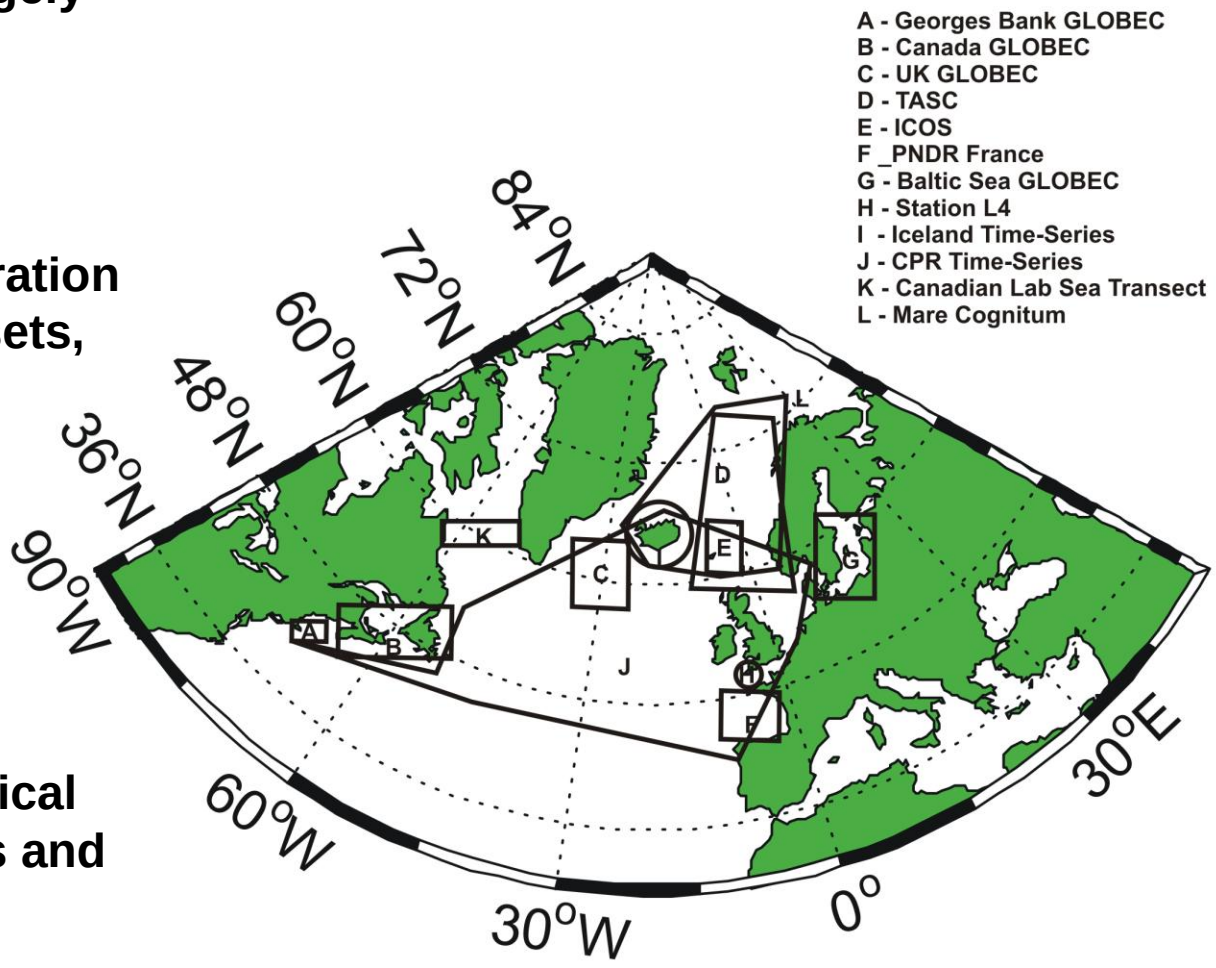
Data Sets

There are many existing data sets, but they are mostly in isolated repositories or largely not available.

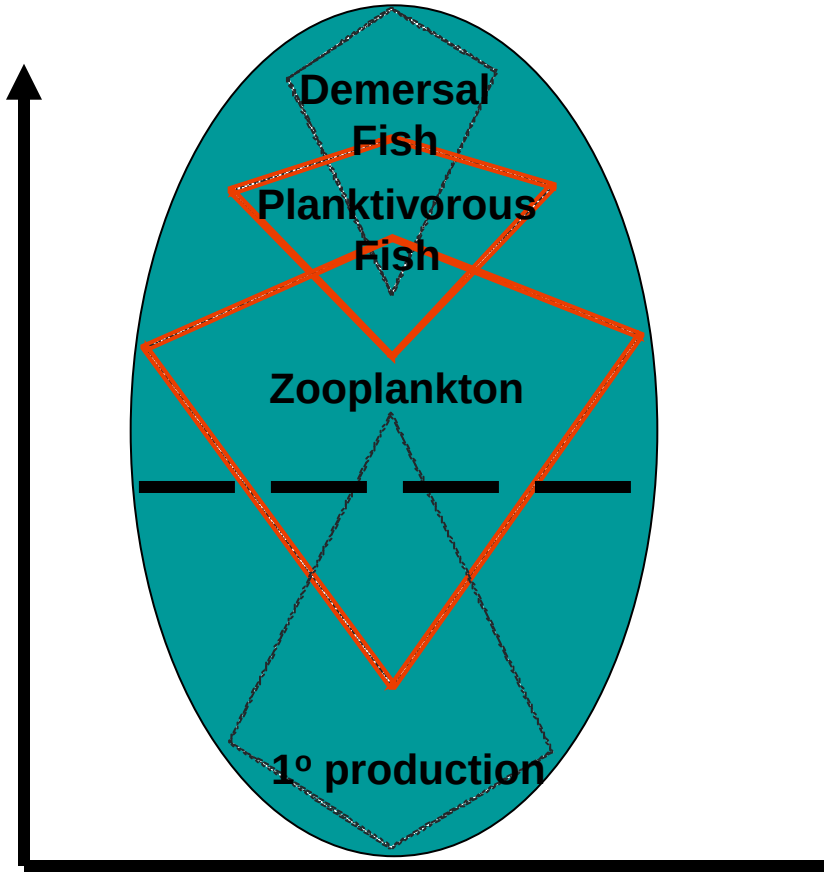
Badly needed are:

1) The assembly and integration of the current digital data sets, especially those for key species:
- **Distribution & Abundance**
- **Rates of growth, reproduction, & mortality.**

2) Recovery of other historical data sets that are in papers and reports etc.



Modeling



Rhomboid Approach

The rhomboids indicate the conceptual characteristics for models with different species and differing areas of primary focus.

Rhomboid is broadest where model has its greatest functional complexity i.e., at the level of the target organism.

deYoung et al, 2004

The emphasis of the program will be determined by the ecological requirements to achieve the understanding required to simulate the population dynamics of the selected targeted organisms.

Modeling: Basic Objectives

- Hindcast modeling studies to understand the observed variability of the North Atlantic ecosystem over (at least) the last 50 years
- Construction of scenarios of possible ecosystem changes in response to future climate variability

The focus is on four major trophic components

- Primary production and biogeochemical cycles
- Zooplankton
- Planktivorous fish
- Demersal fish

Modeling: Selection of targeted species

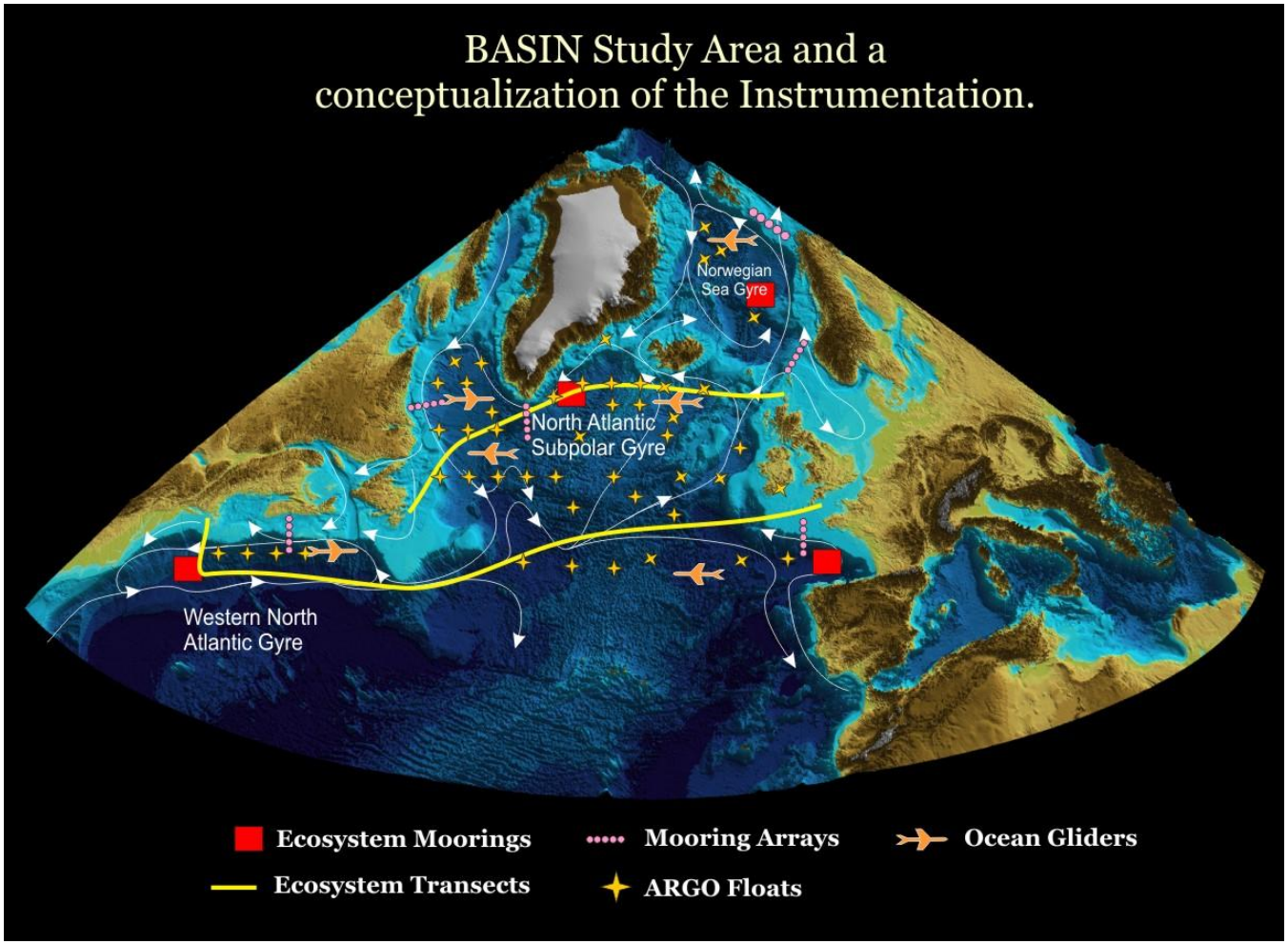
Integrating across trophic levels will require some selective analysis of organisms to target. How should we best do this?

- Functional importance - trophic or biogeochemical
- Size of data sets (spatial and temporal)
- Concurrence with other relevant data sets
- Understanding of life history and physiology
- Well resolved taxonomy
- Widely distributed and covering the basin
- Economic and social importance

New Data Acquisition

Deep Ocean Work Integrated with on-going national programs.

Basin-scale Analysis BASIN Synthesis, and INtegration



New Technologies

Physical

Satellite Salinity

Chemical

In situ nutrient sensors

Biological

Optical imaging

Molecular genetic

New P/B Platforms

Drifters

Gliders

Advanced moorings

Shipboard

Observations

Process studies

What's Next?

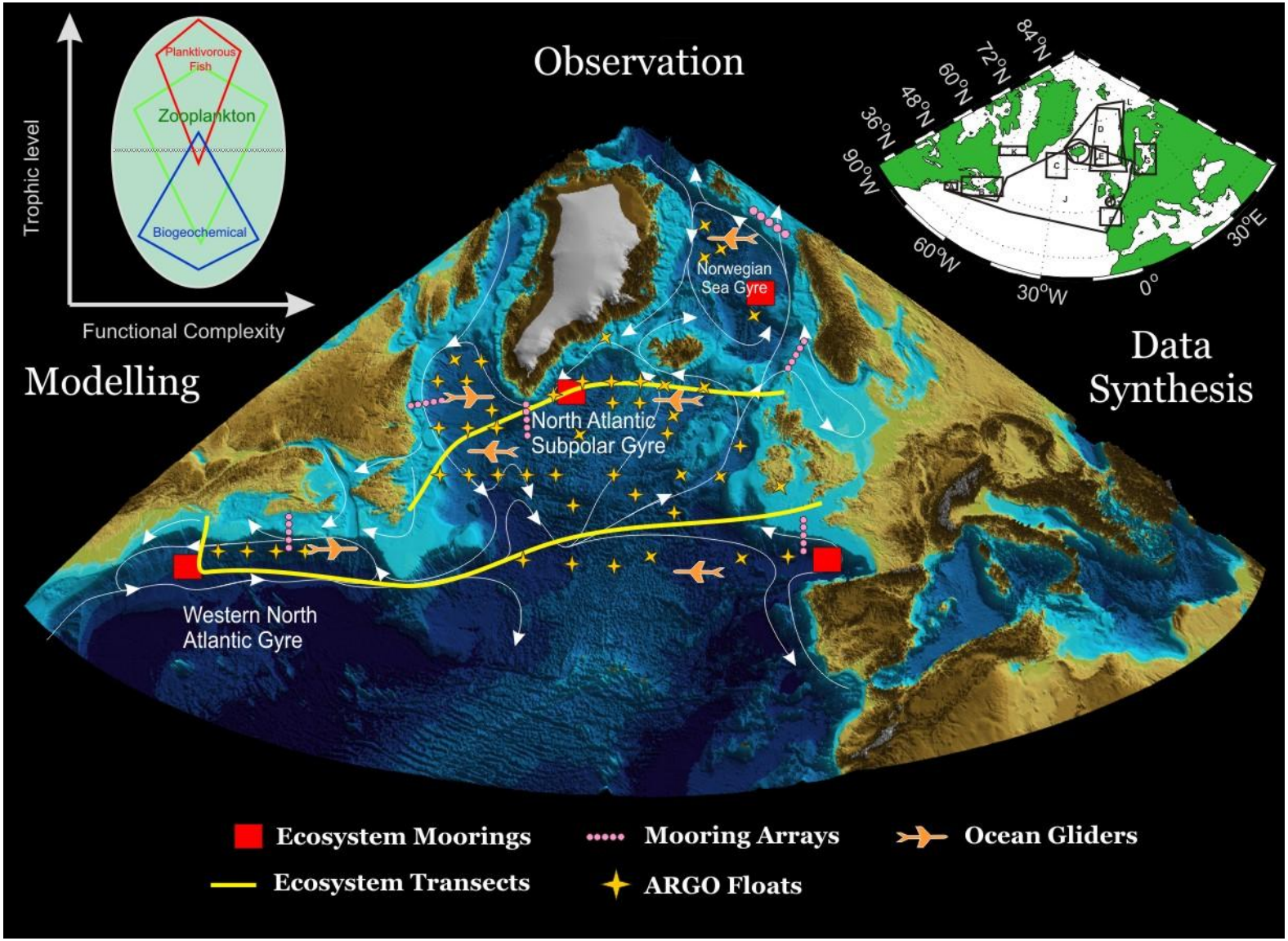
There are opportunities for writing joint proposals that enable the kind of collaboration articulated in the BASIN Science and Implementation Plan.

1) **Through the EU Framework 7: proposal submitted in Jan 2010 and positive reviews received. Formal announcement of award perhaps in summer 2010. Collaborative activities with US & Canada encouraged/expected.**

2) **Implementation Plan targeted for early summer 2010**

3) **Submittals to**
   - **NSF (15 Aug 2010)**
   - **CAMEO – cross-Atlantic comparative analyses**

The End


Observation
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