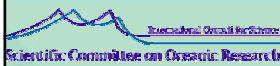


## Large-scale international research and ocean acidification – SCOR and IGBP



ESF Strategic Workshop on Ocean Acidification  
28-30 January, Gran Canaria, Spain

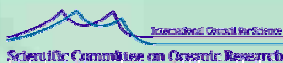


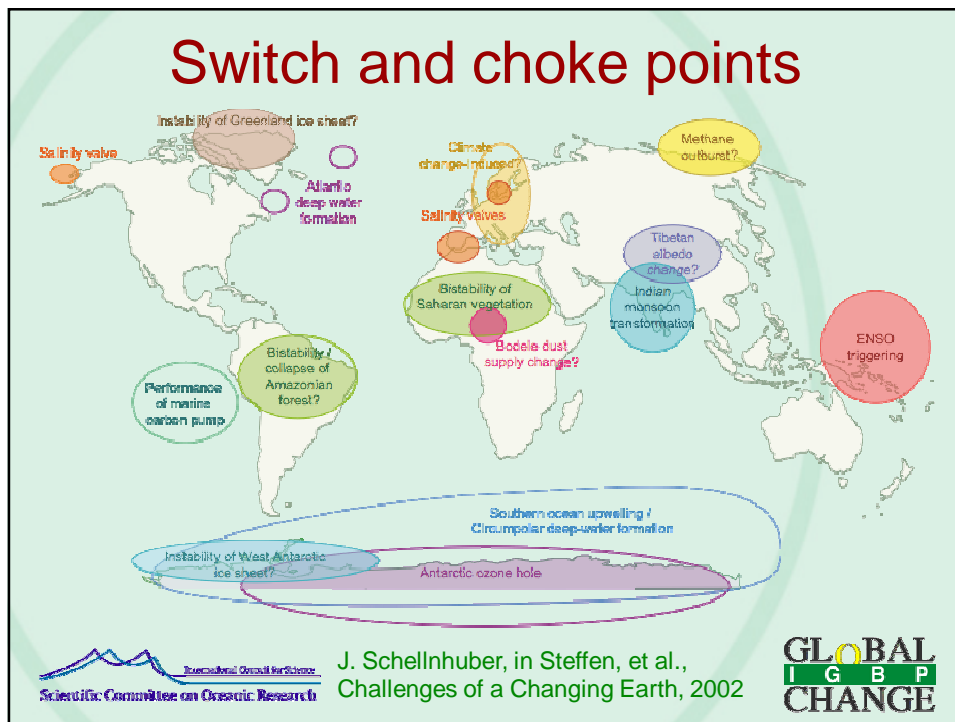
Ed Urban, (K. Noone) Manuel Barange



## It's all connected

Ocean acidification is a good example of a global-scale  
“tipping point”





## The role of SCOR and IGBP

Integrating and creating synergies among national programs, instigating international activities that provide opportunities for cooperation

The image is a composite graphic. In the center is a globe showing the Earth. To the left of the globe is a lush green landscape with trees and a river. To the right of the globe is an underwater scene with various fish and coral reefs. At the bottom left is the logo for the Scientific Committee on Oceanic Research (SCOR). At the bottom right is the logo for GLOBAL IGBP CHANGE.

## What is needed to understand OA?

- Knowledge of how the ocean carbon cycle works – JGOFS, SOLAS, IMBER, LOICZ, PAGES
- Predictions of the future trend of atmospheric CO<sub>2</sub> concentrations - IPCC
- Knowledge of present ocean circulation (how carbon is moved around) and how it might change in the future – WOCE, JGOFS, CLIVAR
- Understanding of how the cycles of other elements in the ocean—N, P, Fe, Zn, Mn—affect the carbon cycle – SOLAS, IMBER, GEOTRACES, numerous national expts.
- Specific research on the effects of ocean acidification on organisms and ecosystems – IMBER, SOLAS, GLOBEC, PAGES, ??
- Continued observations of ocean carbon system parameters, from the surface to the deep sea – CLIVAR, IOCCP, national time-series stations

National research has contributed in each of the above areas and is likely to be very important in studying specific effects of ocean acidification. International projects form a framework within which national/regional projects, with their own priorities can create synergies.



## Examples from SCOR-IGBP projects



## Contributions of the Joint Global Ocean Flux Study (JGOFS)

- JGOFS was the first large-scale ocean research program focused on the carbon cycle and the first collaboration between SCOR and IGBP.
- The legacy of JGOFS includes:
  - Process studies in the North Atlantic Ocean, equatorial Pacific Ocean, Southern Ocean, Arabian Sea and North Pacific Ocean. Each process study yielded unique insights.
  - Several time-series stations. Each of these stations has provided unique insights also, and building up a long-term record.
  - A world-wide survey of ocean carbon system parameters, done in collaboration with WOCE



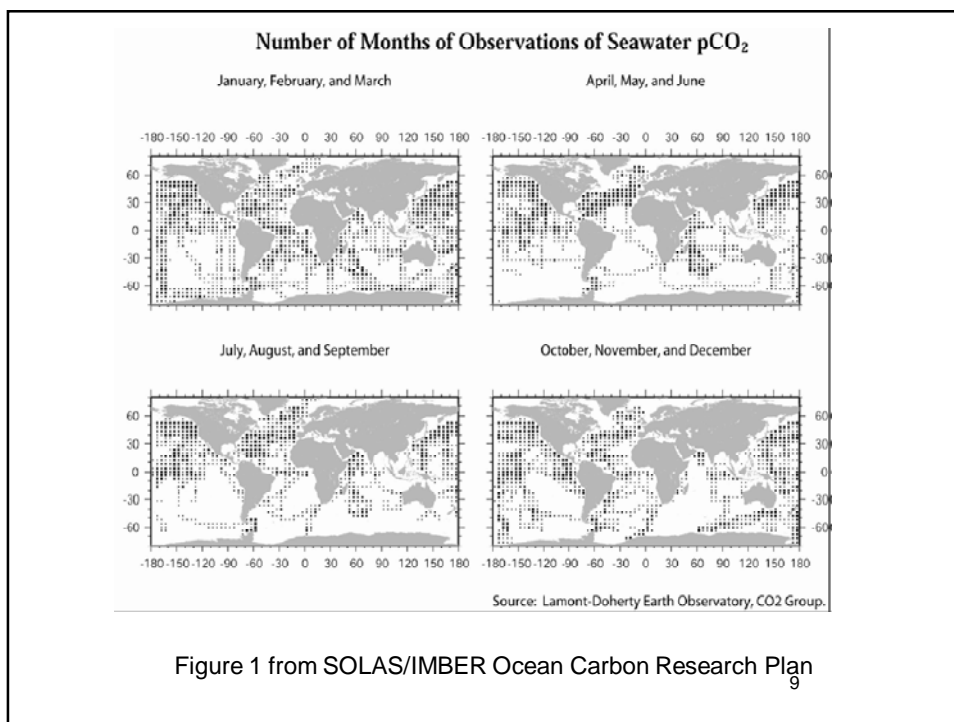
## Joint SOLAS-IMBER Ocean Carbon Research

The SOLAS and IMBER projects have a significant intersection in ocean carbon research, so the projects decided to produce a joint ocean carbon research plan (available on the project Web sites). This plan coincides more closely with national ocean carbon plans than if each project had proceeded separately.

Several of the activities discussed in the plan are relevant to future observation, research and modeling of ocean carbon:

- Continuation and enhancement of time-series stations and other sustained sampling efforts, particularly in important regions that are poorly sampled (e.g., high-latitude and coastal areas);





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Several of the activities discussed in the plan are relevant to future observation, research and modeling of ocean carbon:

- Continuation and enhancement of time-series stations and other sustained sampling efforts, particularly in important regions that are poorly sampled (e.g., high-latitude and coastal areas);
- Enhancement of capabilities to measure carbon-relevant parameters from satellites and volunteer observing ships;
- New modeling techniques to deal with sparse data and to estimate air-sea CO<sub>2</sub> fluxes, and comparing model results against data;



## Joint SOLAS-IMBER Ocean Carbon Research (continued)

- Activities to separate the increase in DIC from natural versus human-influenced processes;
- Both process studies and perturbation studies (natural and experimental manipulations);
- Studies of the mesopelagic zone; and
- Linkage of time-series sites with process studies and perturbation studies.

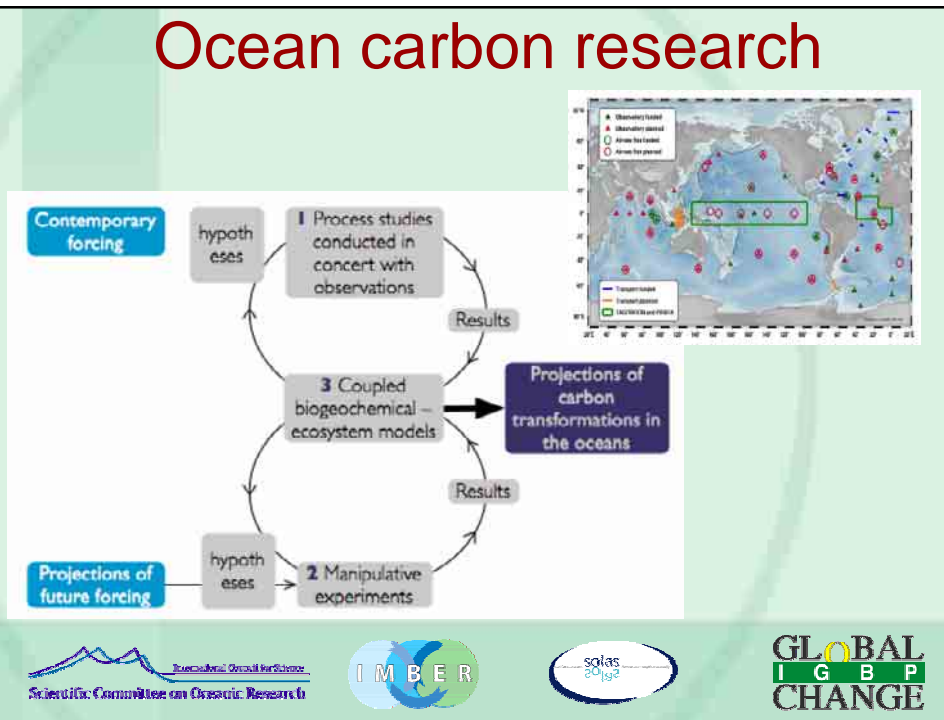


### Specific SOLAS/IMBER activities related to ocean acidification will include

- Manipulative experiments to study rising CO<sub>2</sub> (changing pH, CO<sub>2</sub> (aq), carbonate saturation state), alone and with other changing variables – Manipulative experiments include
  - Laboratory-based single species experiments in batch or chemostat cultures;
  - Mesocosm experiments with natural communities under laboratory-controlled or field conditions; and
  - In situ experiments in the open ocean or enclosed water masses.
- Planning group for mesoscale open ocean CO<sub>2</sub> enrichment experiment—“We will explore the options for mesoscale open ocean CO<sub>2</sub> enrichment experiments to allow whole-ecosystem manipulations on adequate space and times scales. Such ambitious experiments should build on the information to be gained from open ocean mesocosm experiments. They will be planned jointly by IMBER and SOLAS to make sure that the necessary expertise to trace the propagation of signals into the deeper ocean and the atmosphere is provided.”



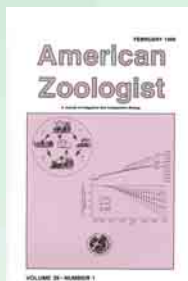
# Ocean carbon research



## Land-Ocean Interactions in the Coastal Zone (LOICZ) Project

LOICZ is working on ocean carbon inputs from the land to ocean, and has data from its past work on coastal typologies and nutrient inputs.

### SCOR/LOICZ Working Group 104 on Coral Reef Responses To Global Change: The Role of Adaptation



**Kleypas, McManus, and Meñez**—*Environmental limits to coral reef development: Where do we draw the line?*

**Gattuso, Allemand, and Frankignoulle**—*Photosynthesis and calcification at cellular, organismal and community levels in coral reefs: A review on interactions and control by carbonate chemistry*



## Past Global Changes (PAGES) Project

- Earlier presentation by Thorsten Kiefer
- **IMAGES sub-project of PAGES has numerous cores that could be examined for changes in organisms over time.**

GEOTRACES is an international study of the global marine biogeochemical cycles of trace elements and their isotopes. Its mission is to identify processes and quantify fluxes that control the distributions of key trace elements and isotopes in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions.

GEOTRACES is not focused on carbon system parameters, but one of the key parameters that will be measured on all cruises is  $^{13}\text{C}$ . GEOTRACES is planning many cruises in the Atlantic, Pacific, Indian, Arctic, and Southern oceans, and has estimated it will collect about 1 million samples.

"[w]here appropriate, measurements will be made of the inorganic carbon system, both on ocean sections and in process studies."

GEOTRACES measurements will also characterize other trace elements and isotopes that are important for better understanding of aspects of the ocean carbon cycle, such as export from the ocean surface layer.

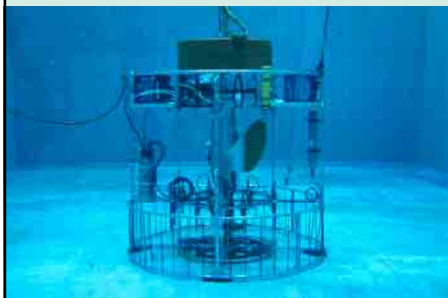


Some thoughts on research priorities and international organization of OA research...

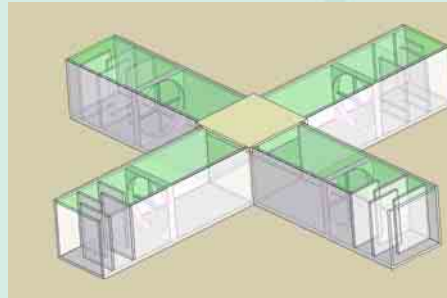
1. There is some urgency in research on calcareous larvae.
2. Examination of long time series (e.g., CPR, CalCOFI, Bermuda) that contain calcareous organisms might show that trends are already detectable.
3. Free Ocean CO<sub>2</sub> Enrichment (FOCE) Experiment

17

## Free Ocean CO<sub>2</sub> Enrichment Experiment (FOCE)



Acid system



Proposed experimental flume

From Peter Brewer (MBARI)

18

Some thoughts on research priorities and international organization of OA research...

1. There is some urgency in research on calcareous larvae.
2. Examination of long time series (e.g., CPR, CalCOFI, Bermuda) that contain calcareous organisms might show that trends are already detectable.
3. Free Ocean CO<sub>2</sub> Enrichment Experiment (FOCE)
4. Should there be international coordination and planning for OA research?
  - Probably, as there are a lot of advantages to international cooperation in marine research.
  - The OA research community needs to decide how to proceed. There could be advantages to partnering with SOLAS and IMBER because they already include this topic area and have IPOs, but new funding would be needed. But, there are several other coordination models that could be used.

19

## SCOR Working Groups

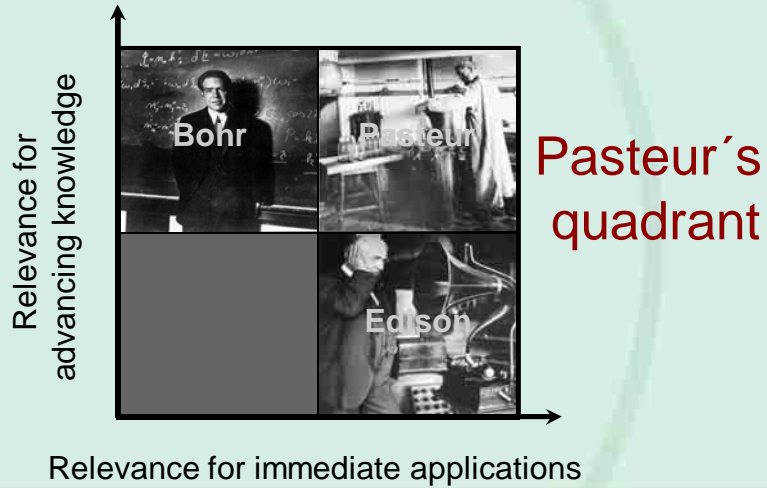
The purpose of a group may be to

- synthesize the state of an area of science,
- make recommendations about research priorities,
- conduct method development, and/or
- conduct intercalibration exercises.

Proposals for new WGs will be accepted starting 1 March

20

## IGBP – Applied Earth System Science

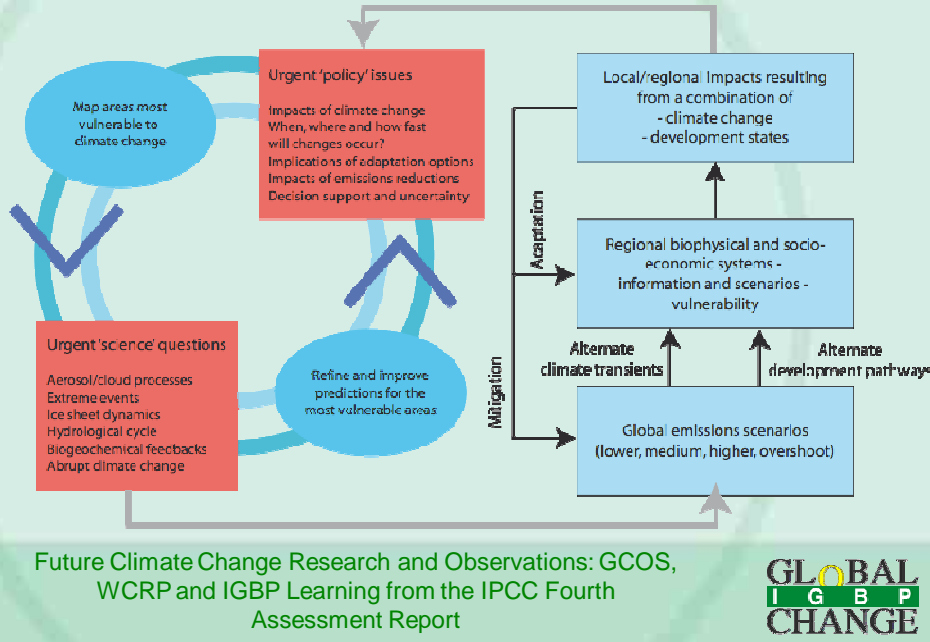


Scientific Committee on Oceanic Research  
 International Geosphere and Biosphere Programme


Source: Stokes, D. E. (1997). *Pasteur's Quadrant: Basic Science and Technological Innovation.*

GLOBAL  
 I G B P  
 CHANGE

## A different approach



**GLOBAL  
I G B P  
CHANGE**



1 – From description to prediction  
2 – From blue skies research to societal applications  
3 – From biogeochemical research to multidisciplinary science

23



To advance our understanding of the **structure and functioning of the global ocean ecosystem**, its major subsystems, and its **response to physical forcing** so that a capability can be developed to **forecast the responses of the marine ecosystem to global change.**

**Global sponsors**



**Regional sponsors**



# Message #1

From single driver  
research to multiple  
driver impacts

25

## Marine Ecosystem Evolution in a Changing Environment

**MEECE**

**MEECE**

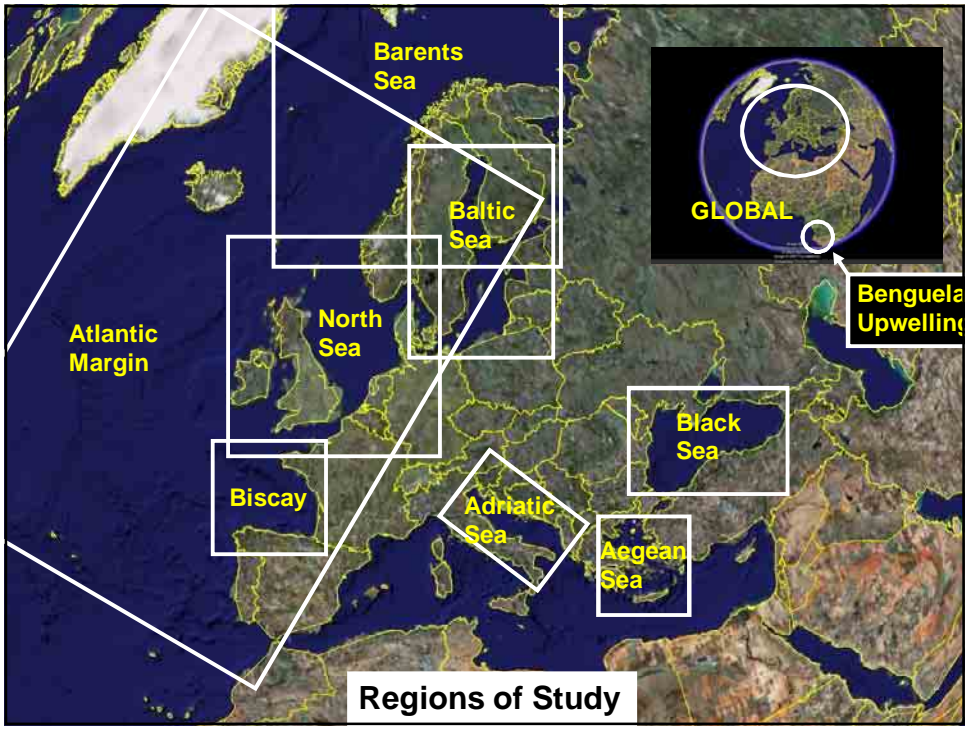
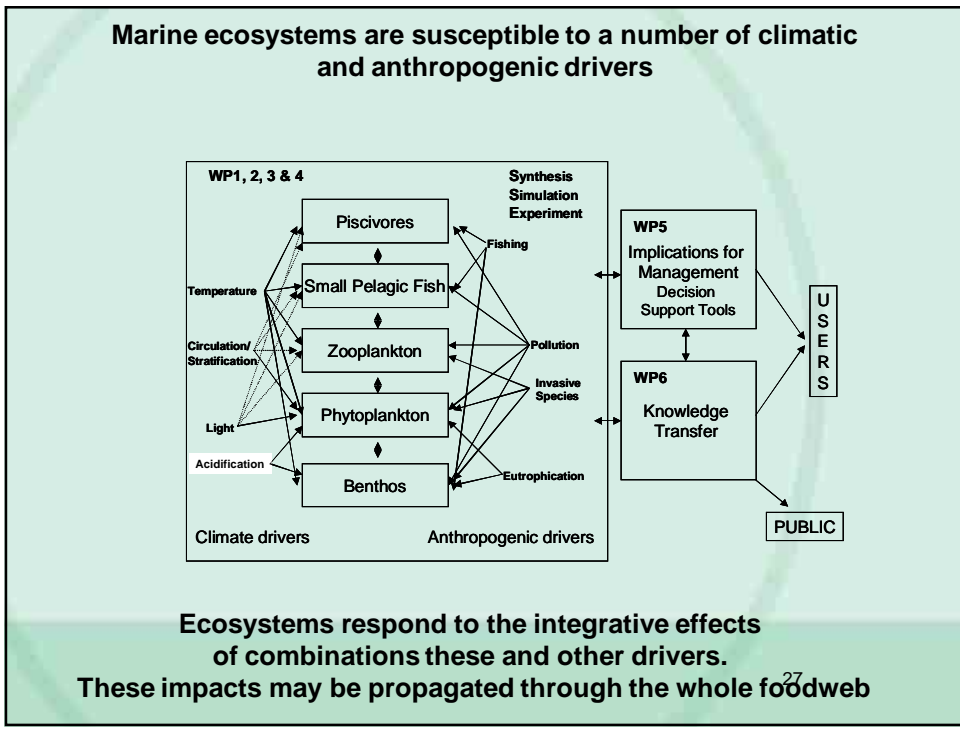
<http://www.meece.eu/>



- **MEECE is a FP7 Integrated Project which aims to push forward the state-of-the-art of our understanding of impacts of global climate change and direct anthropogenic drivers on marine ecosystems end to end.**

For further details on MEECE and its future activities please contact the  
Project Coordinator, Icarus Allen (JIA@pml.ac.uk)

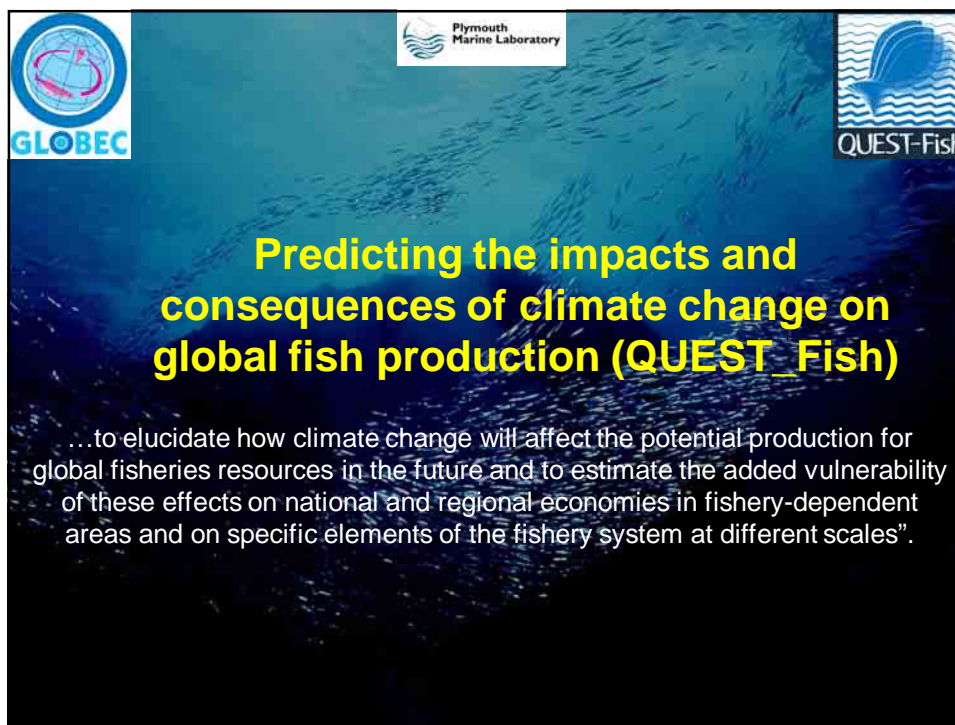
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# Message #2

From single disciplinary  
research to multi-  
disciplinary assessments

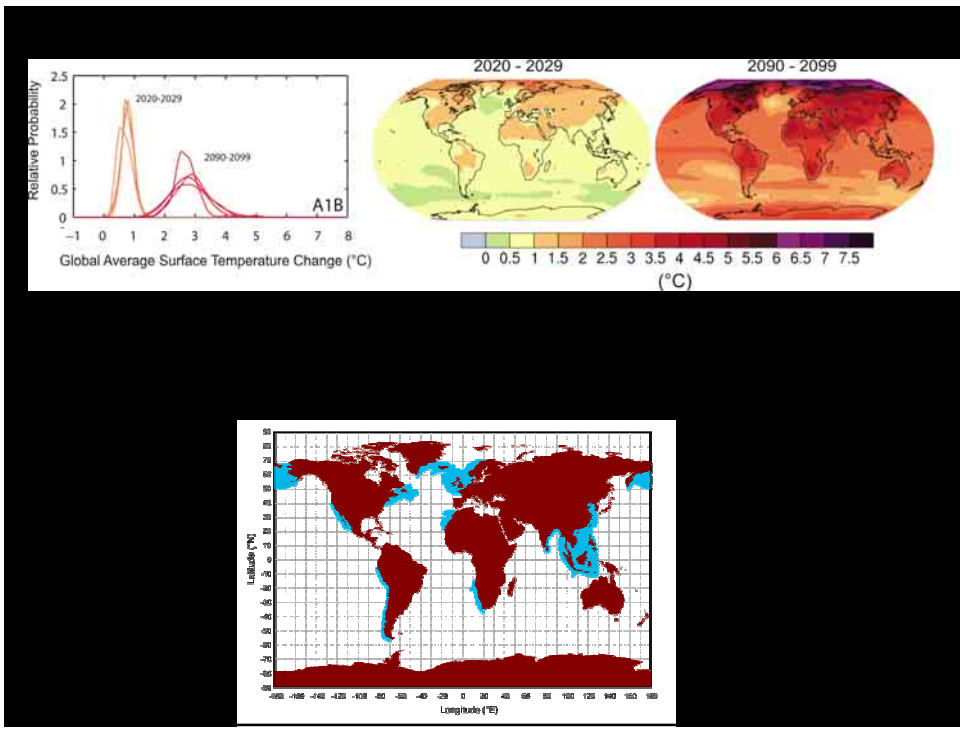
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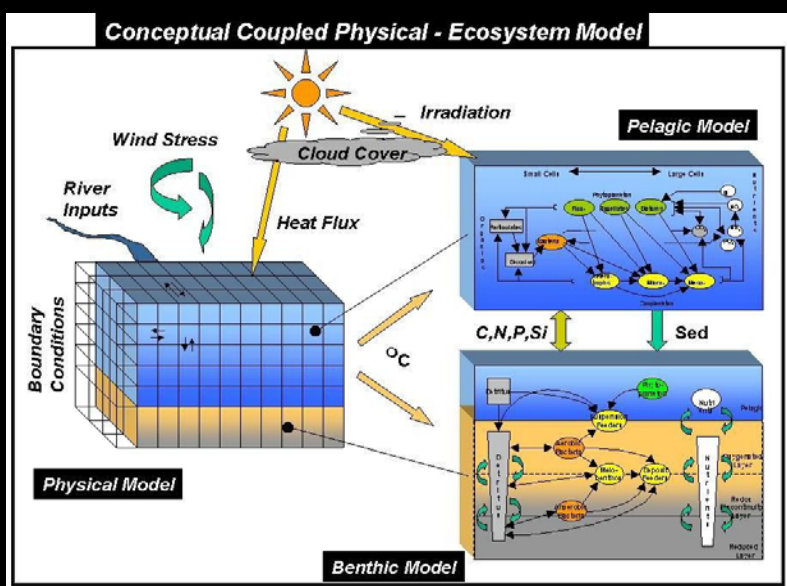
  

**Predicting the impacts and  
consequences of climate change on  
global fish production (QUEST\_Fish)**

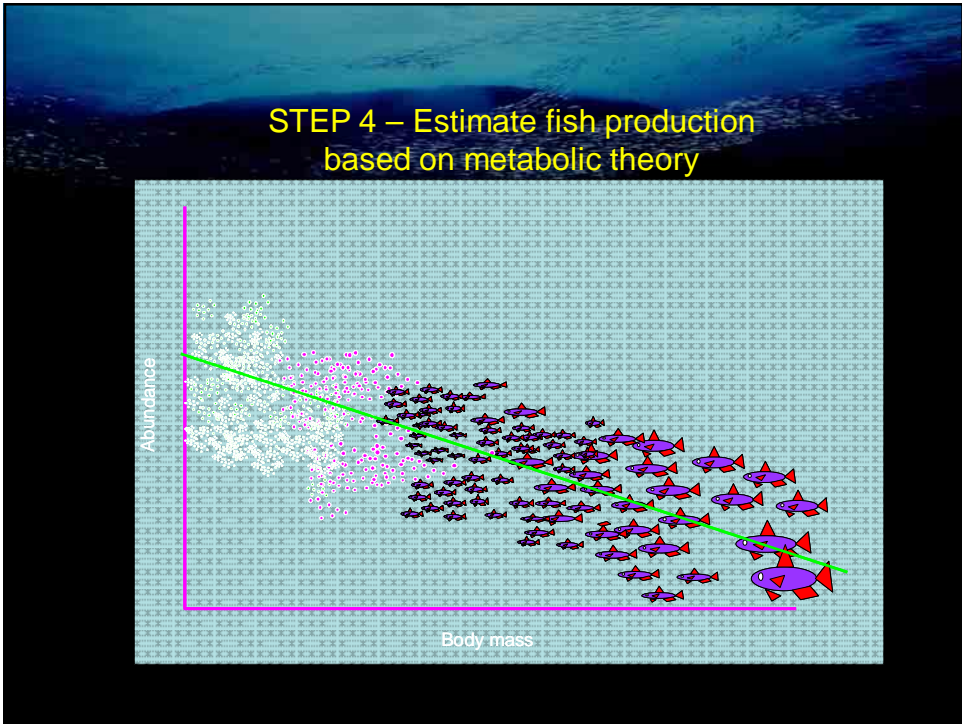
...to elucidate how climate change will affect the potential production for global fisheries resources in the future and to estimate the added vulnerability of these effects on national and regional economies in fishery-dependent areas and on specific elements of the fishery system at different scales”.



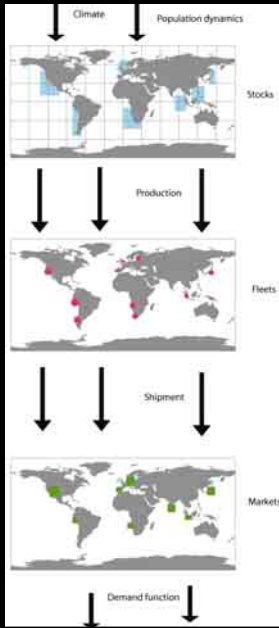
**STEP 3 – Develop coupled Ecosystem models to predict production**



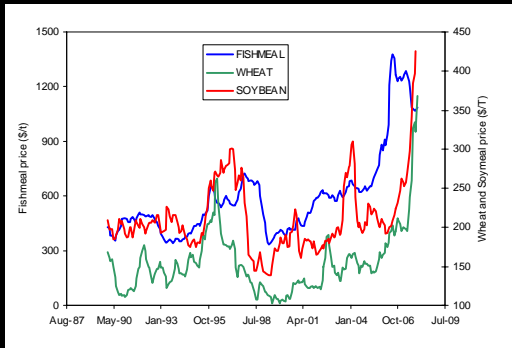


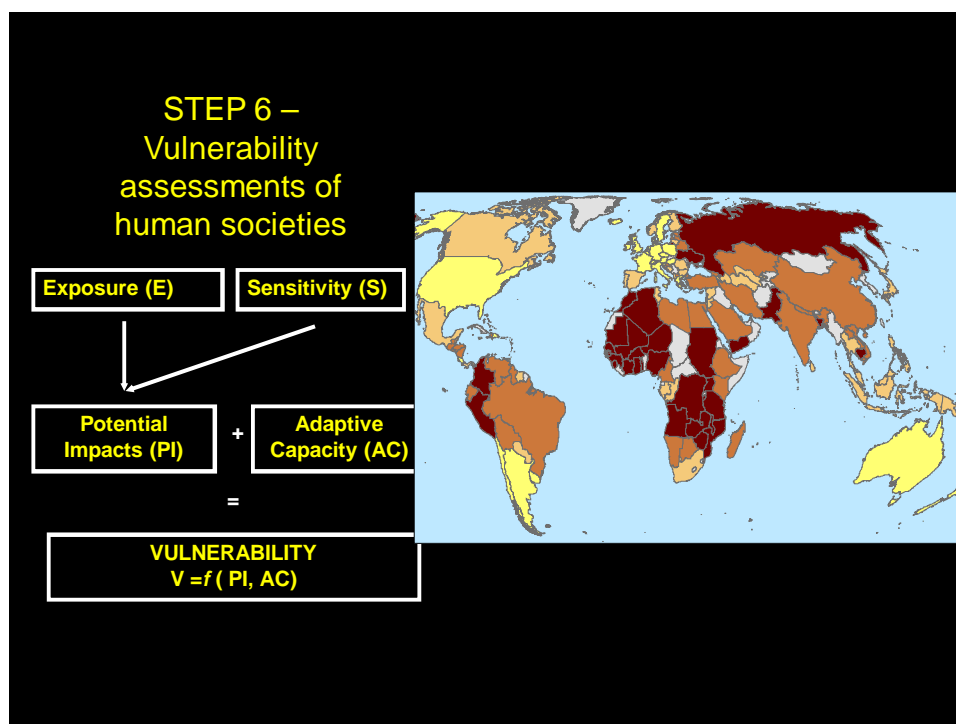


### WSSPF (Worldwide System of Small Pelagic Fisheries)



### STEP 5 – Bioeconomic modelling of Marine-based commodities in a globalised world





## Closing remarks

- Ocean acidification is a huge issue for IGBP and SCOR
- It offers us the opportunity to link basic, process-oriented research to stakeholder concerns *at the outset of the process of designing international research programs*
- *It should be investigated in the context of a GEC Multiple drivers approach*
- *An ideal example for academic/applied, multi-disciplinary science that responds to current policy requirements.*
- SCOR and IGBP are committed to advancing both process-level research and producing information relevant to stakeholders
- We look forward to working together and with all of you!