

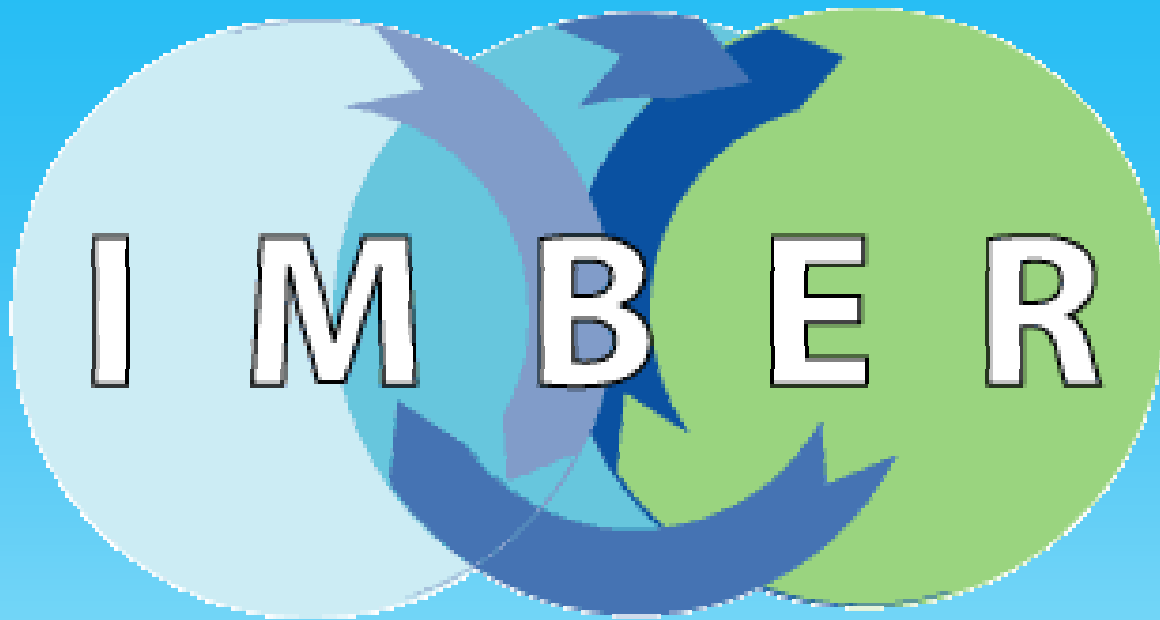
Linking Biogeochemistry, Ecosystems and the impacts of Global Change

Julie Hall



Integrated Marine Biogeochemistry and
Ecosystem Research





Integrated Marine Biogeochemistry and Ecosystem Research

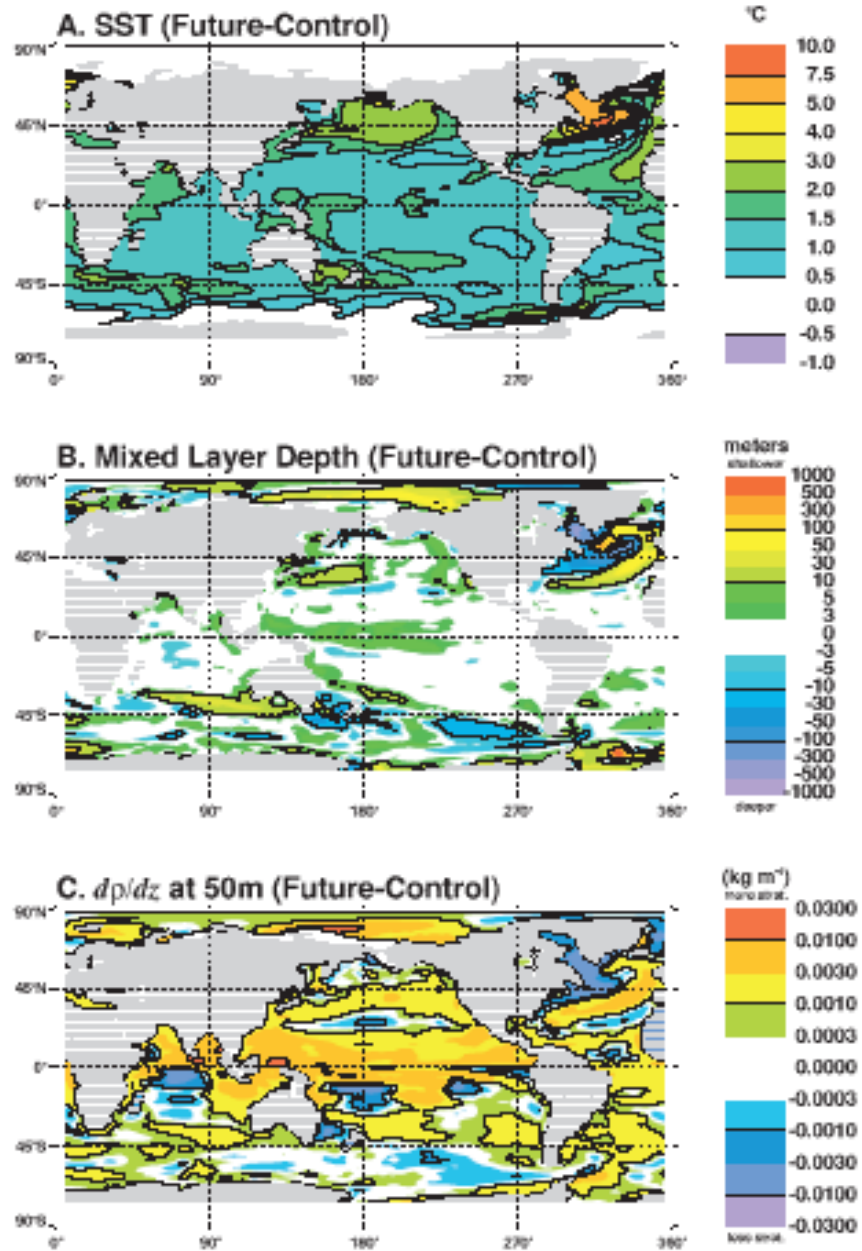
“To develop an understanding of how interactions between biogeochemical cycles and ecosystems respond to and force global change”

Global Change

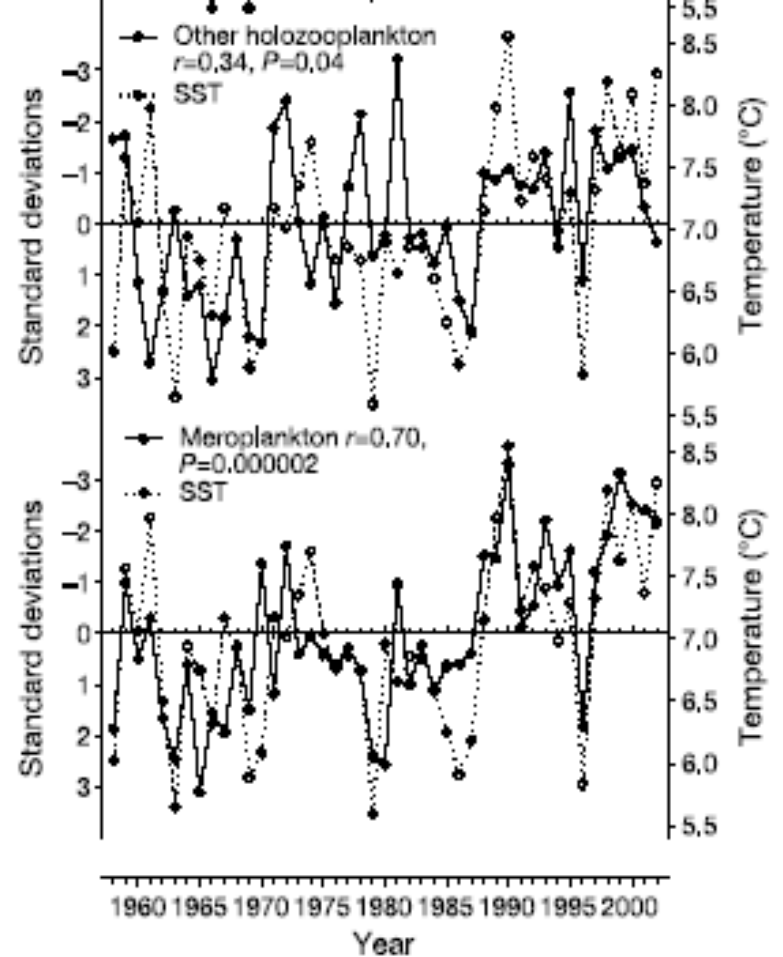
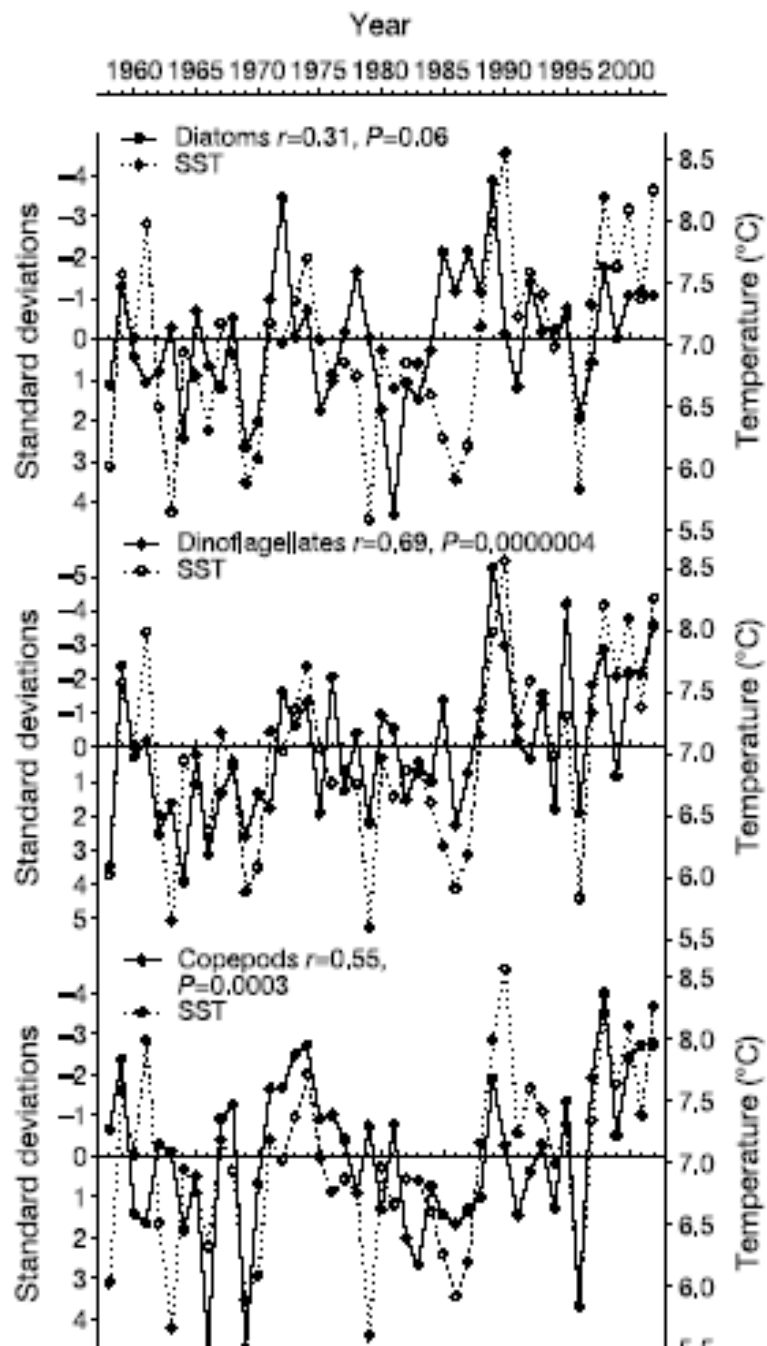
- Climate Change
- Macro/micro nutrient inputs
- Changes in CO₂ and pH
- Impacts of Harvesting

Climate Change

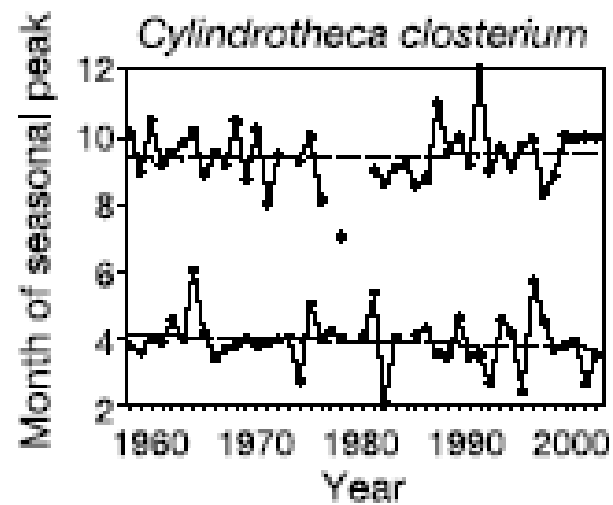
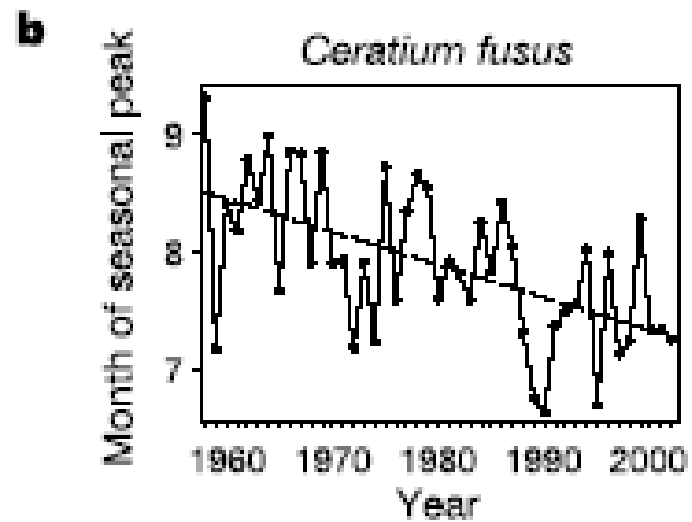
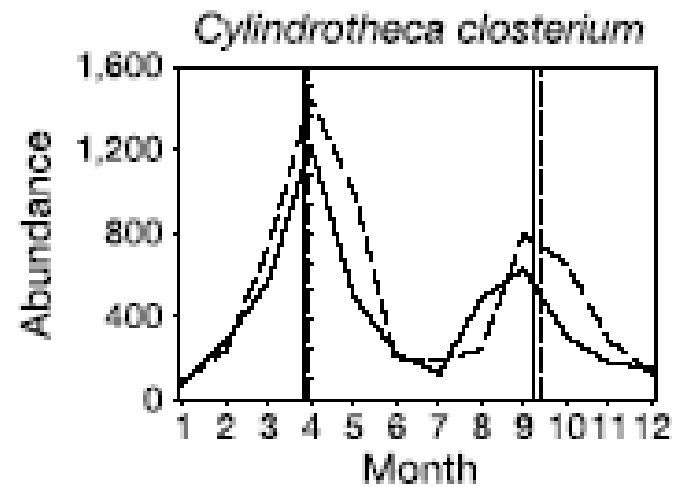
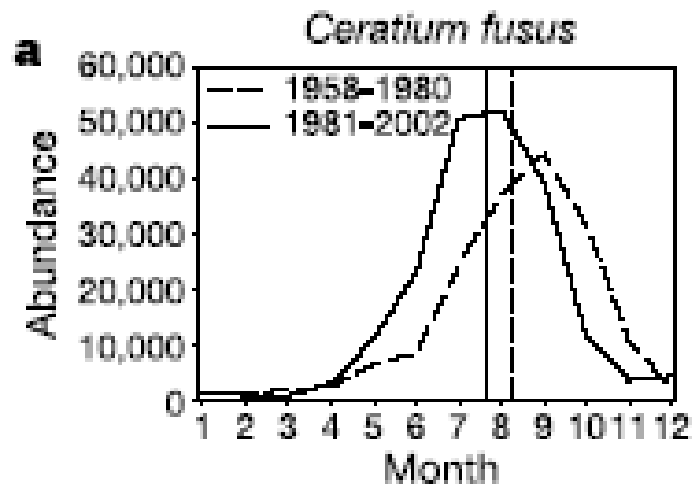
- Temperature
- Circulation and stratification
- Occurrence of extreme events



(Boyd, & Doney, 2002)



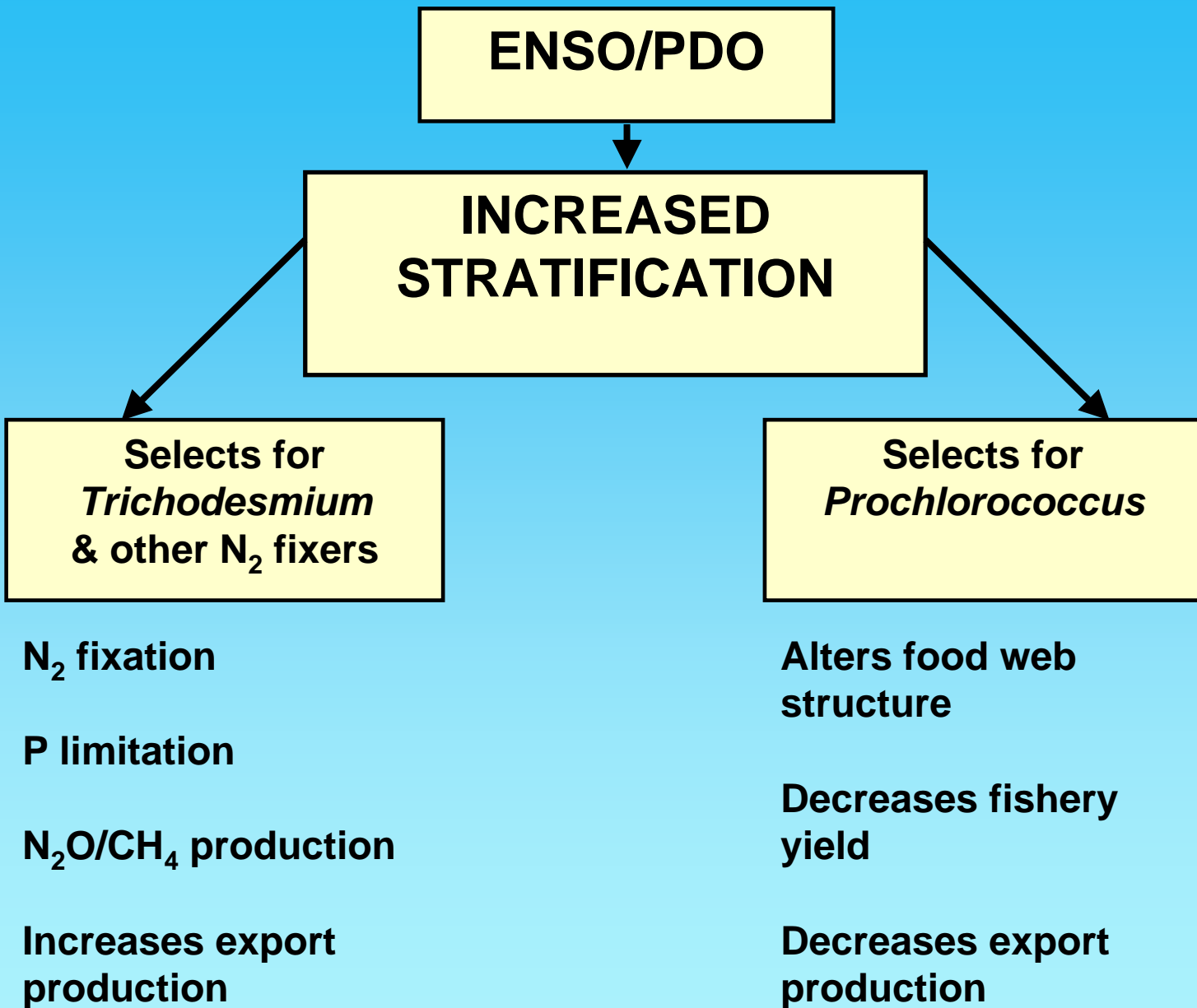
(Edwards & Richardson, 2004)



(Edwards & Richardson, 2004)

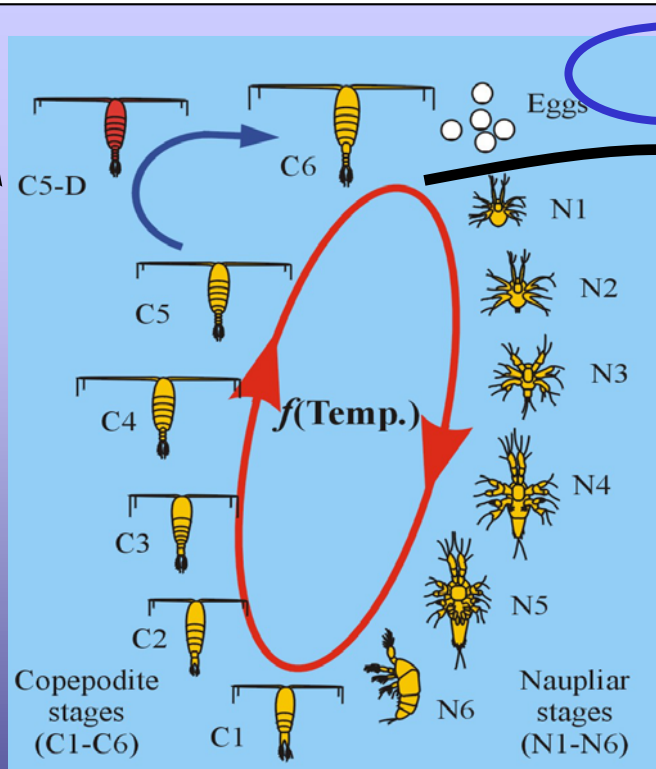
Climate Change

- Circulation and stratification



NORTH ATLANTIC OCEAN

SHELF SEAS



Variability in the populations of the ocean basin is impressed upon shelf regions.

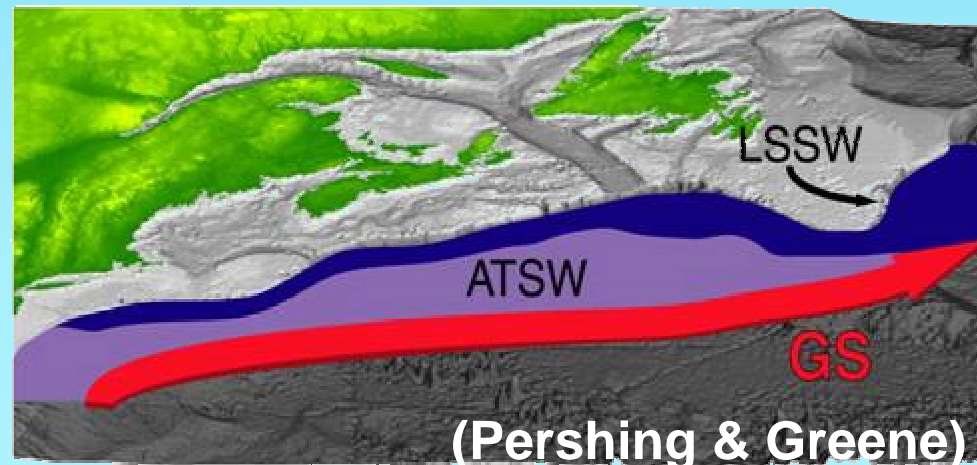
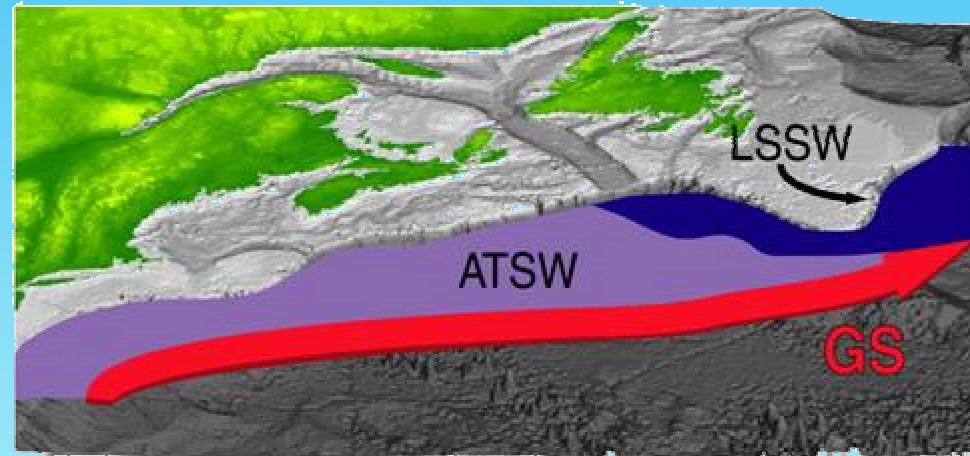
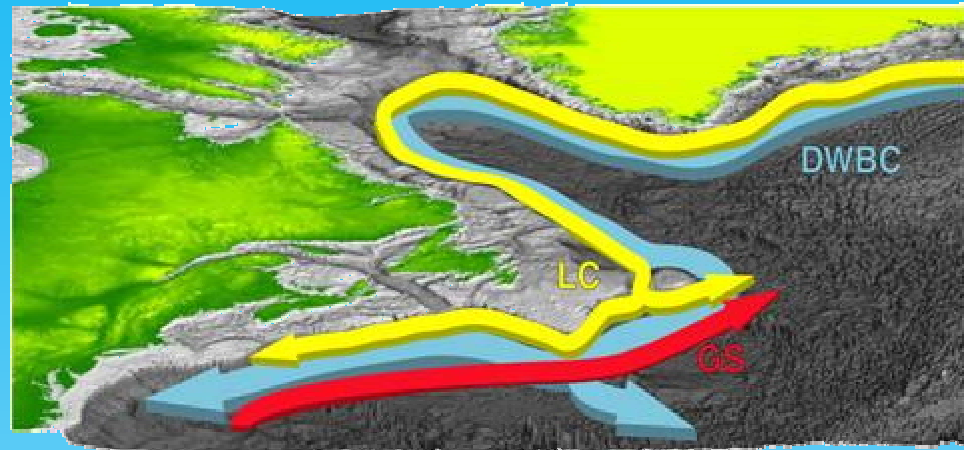
Climate forcing of ocean circulation

(from M. Heath)

NW Atlantic's Coupled Slope Water System

- Associated with **NAO +**

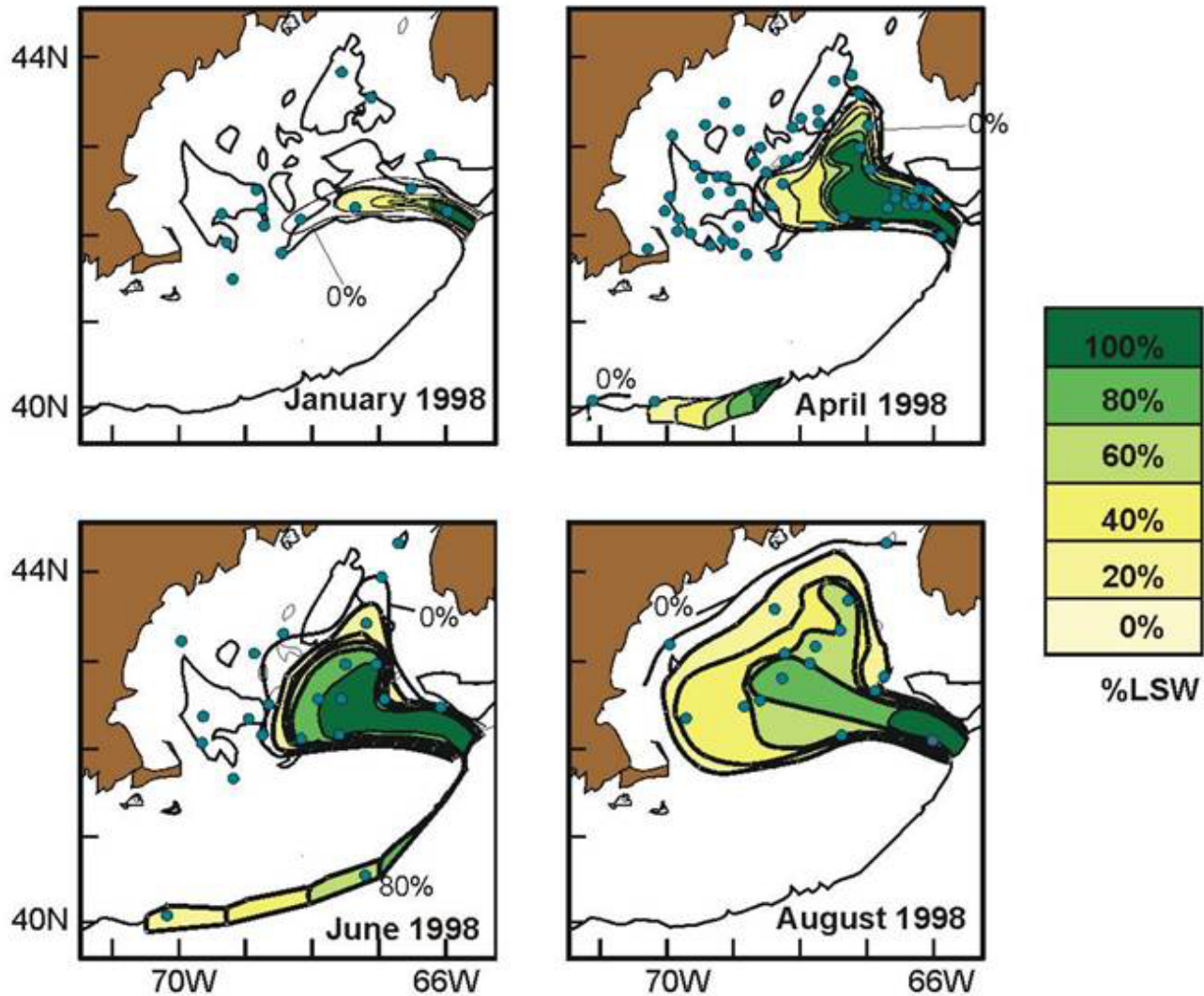
- Associated with **NAO -**



(Pershing & Greene)

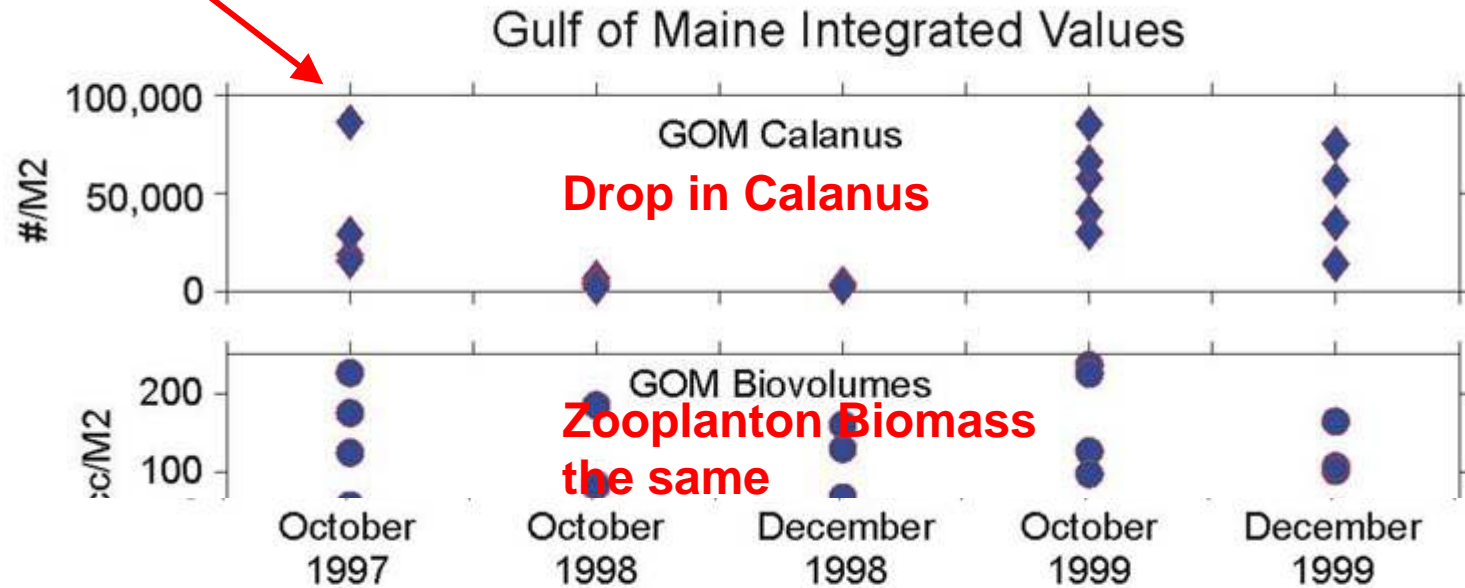


Labrador Seawater Incursion into the Gulf of Maine after the negative NAO event in 1996



(Wiebe & Mountain)

These $\#/m^2$ are as high as found in North Atlantic or Norwegian Sea.



Is the drop in Calanus a result of their lower concentration in the water mass?

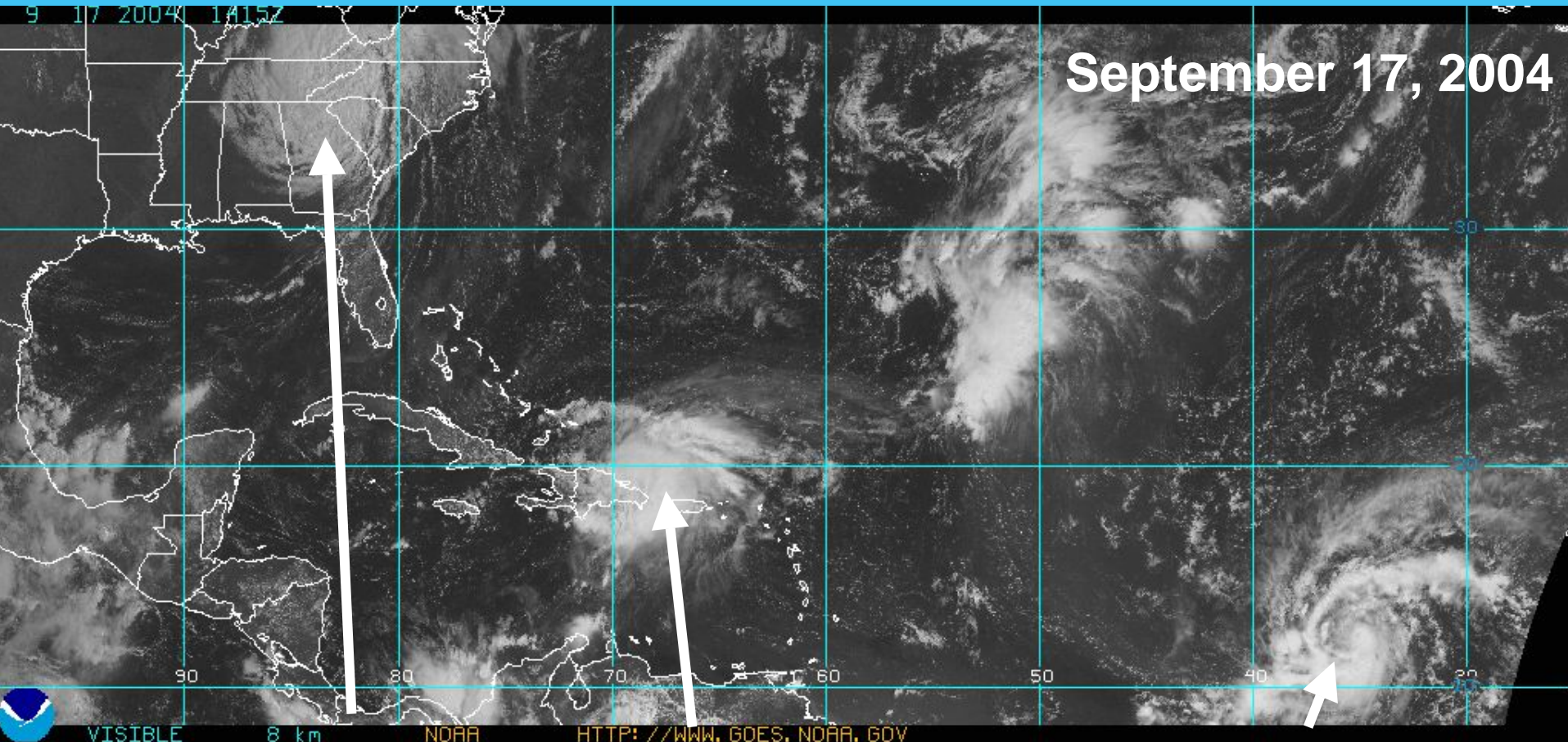
Is it a result of increased mortality from predation by decapods, euphausiids, medusae and pteropods?

(Wiebe)

Climate Change

- Occurrence of extreme events

What is the full effect of these systems each year on marine biogeochemistry and ecosystems?



Hurricane Ivan

Hurricane Jeanne

Tropical Storm Karl

Hurricane Gert September 21-24 1999

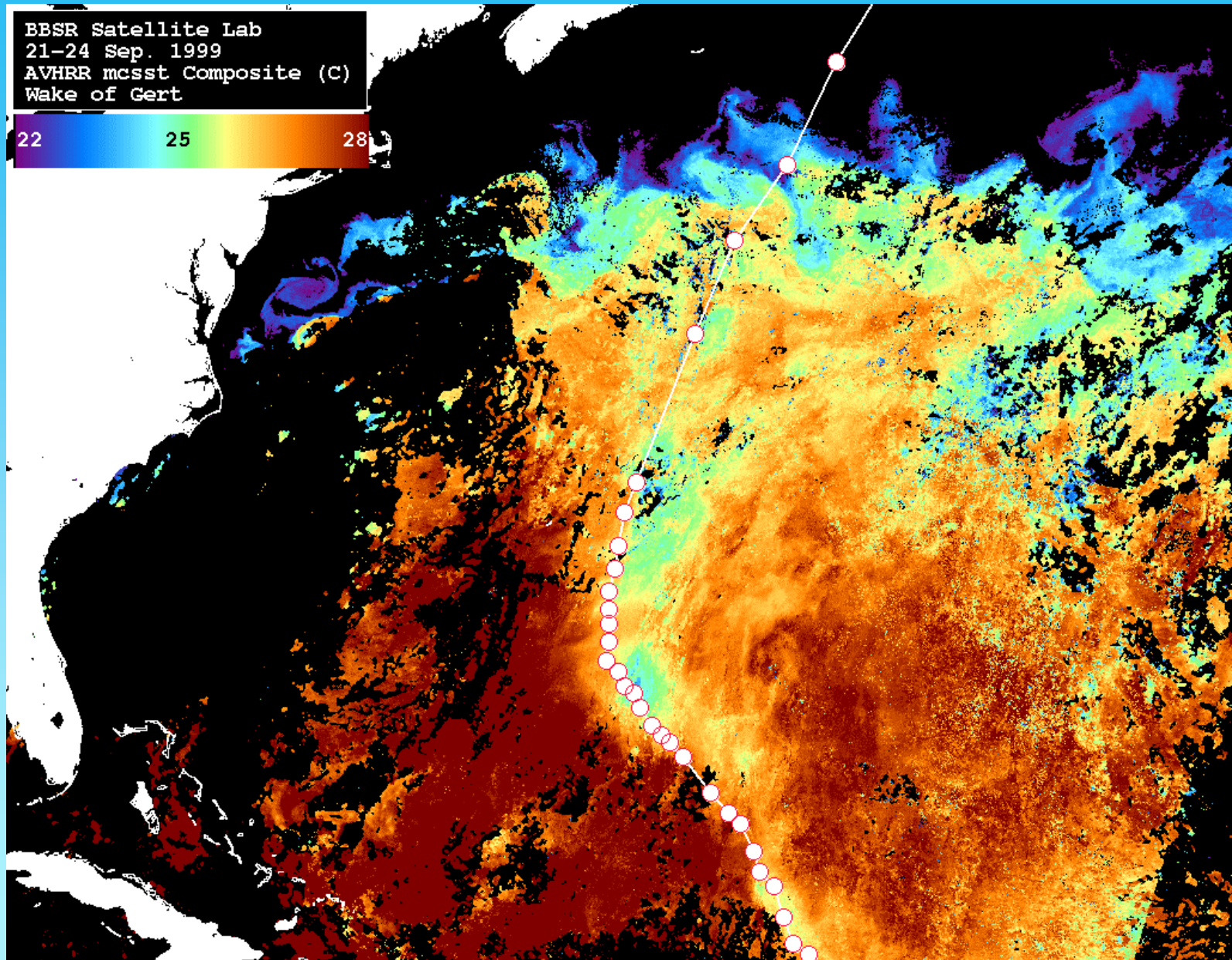
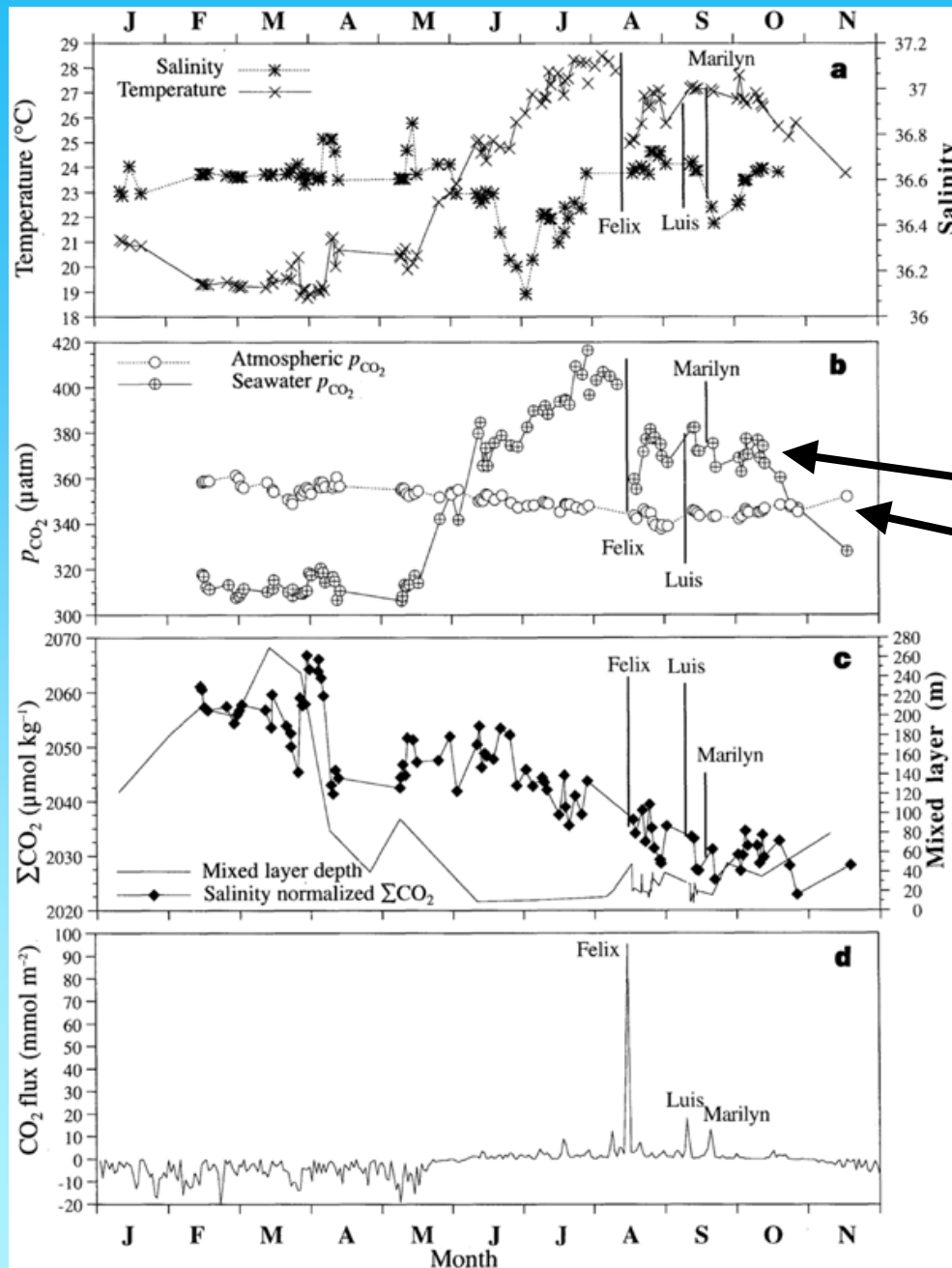


Image supplied by Norm Nelson

Passage of Hurricanes Felix, Luis, Marilyn in Sargasso Sea –

Impact on CO₂ flux



Salinity & SST

pCO₂
Water
Air

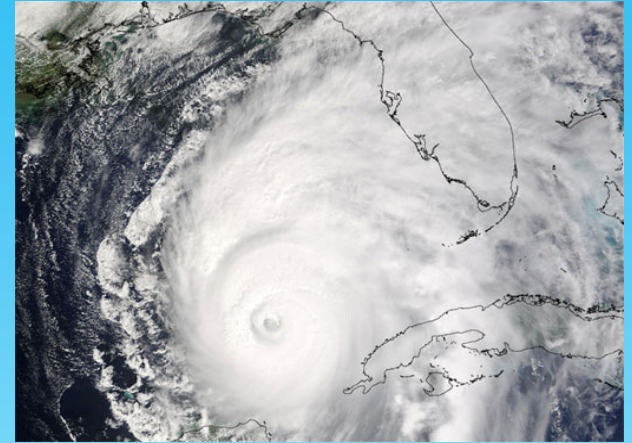
CO₂ flux

(Bates *et al.*, 1998)

Extreme Events

- **Extreme wind events (e.g. hurricanes) – SST/stratification, nutrients, food webs**
- **Coastal flooding/droughts – anoxic zones, nutrient delivery, salinity/stratification**

Variable characteristics: location, duration, strength, frequency



NASA

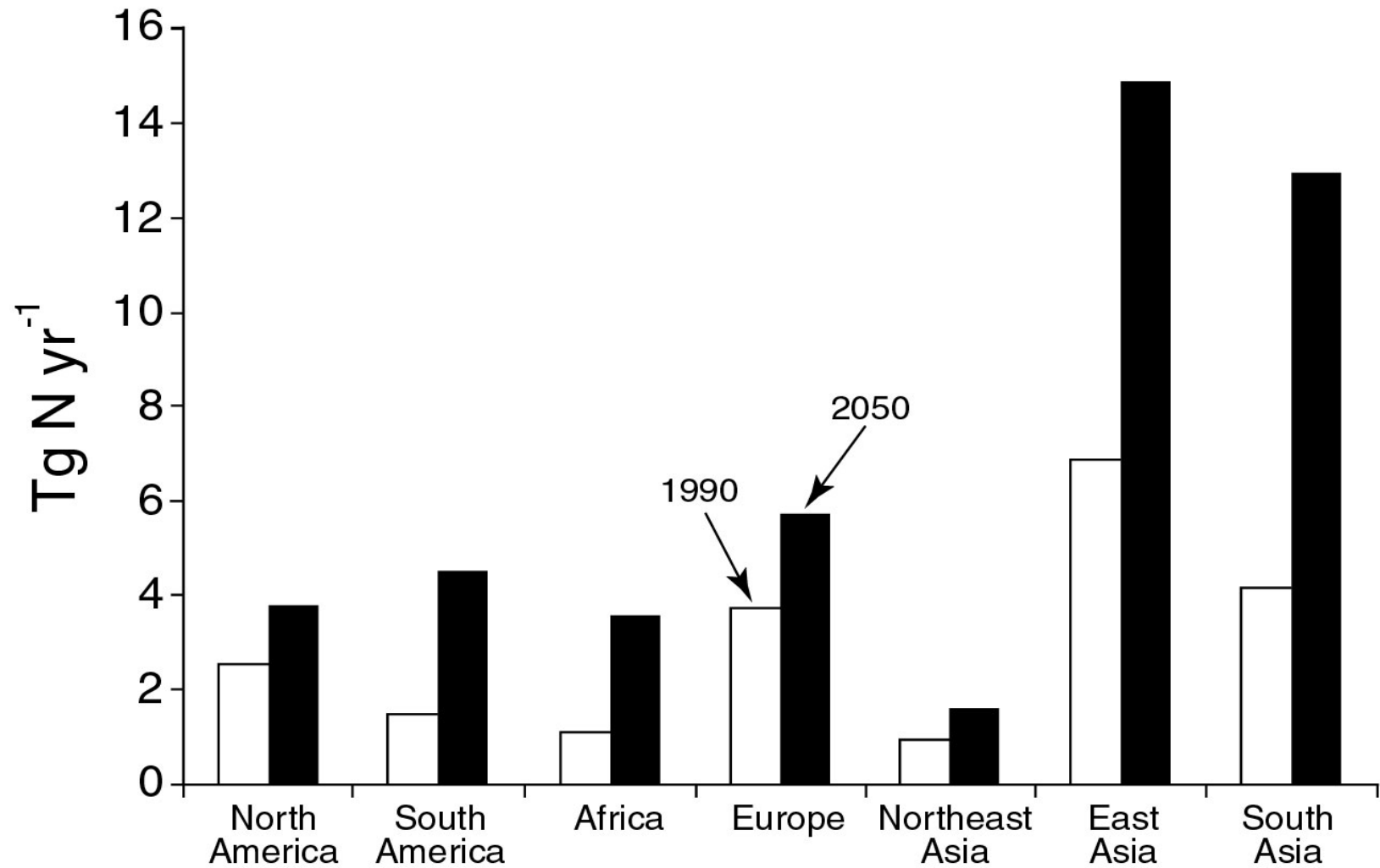


Liam Gumley, Univ. of Wisconsin-Madison, & the MODIS science team

Input of macro and micro nutrients to surface waters

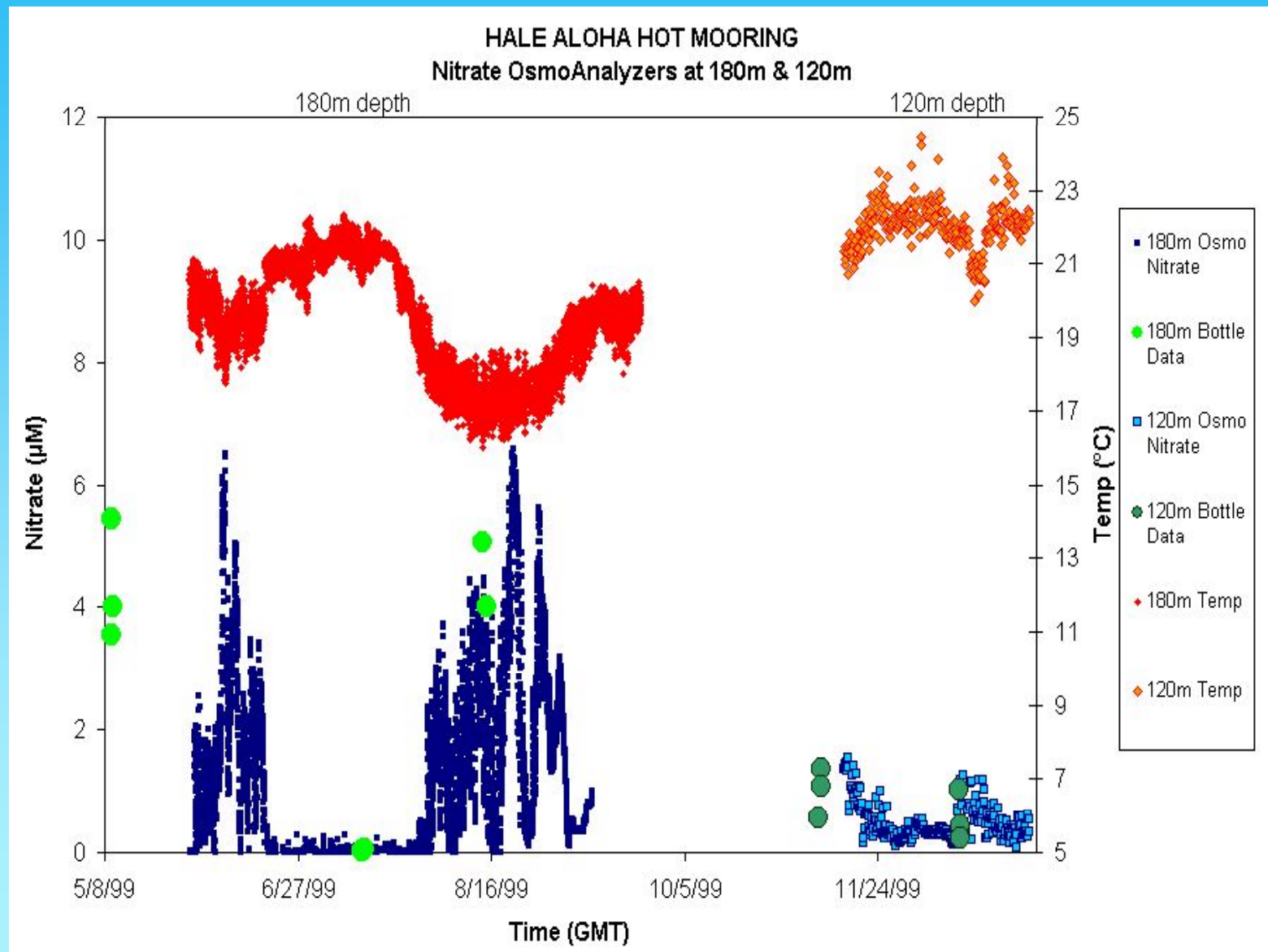
- Macro nutrients
- Micro nutrients

DIN Export by Rivers for World Regions 1990 and 2050 BAU Scenario



(Seitzinger *et al.*, 2002)

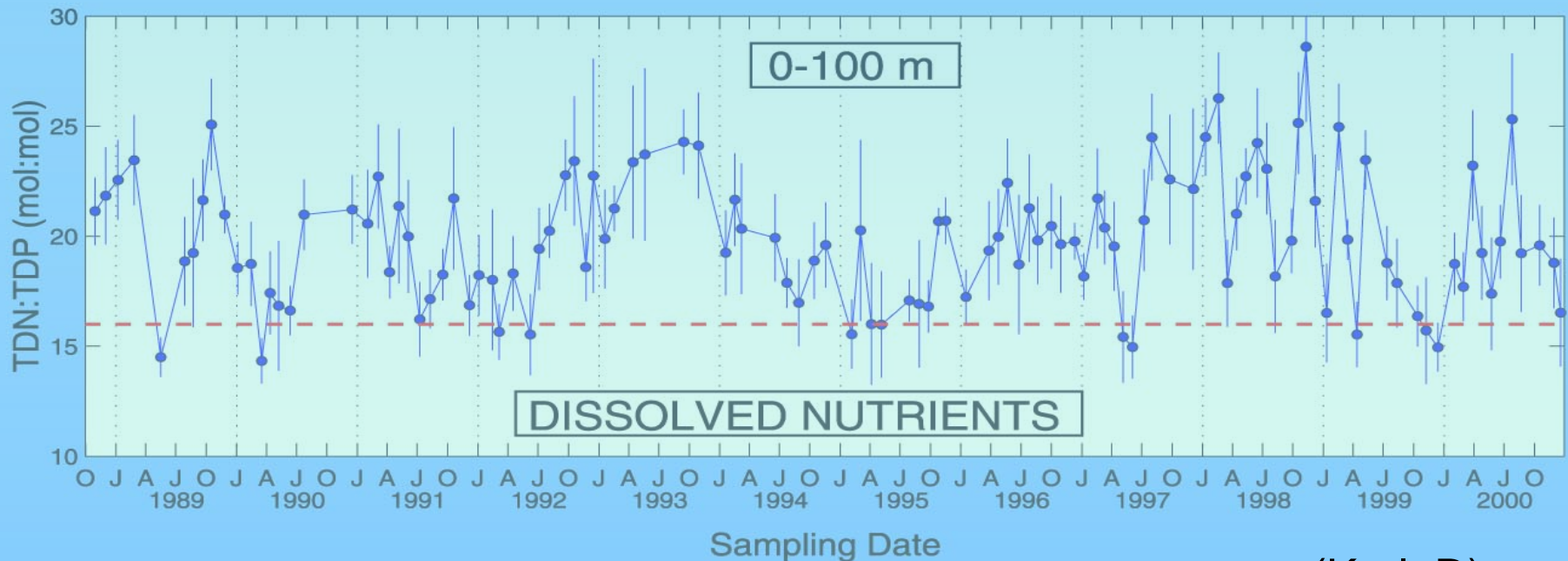
Nitrate Injections at JGOFS H-A/HOT Site



(Letelier, 2000)

Periodic “return to Redfield”

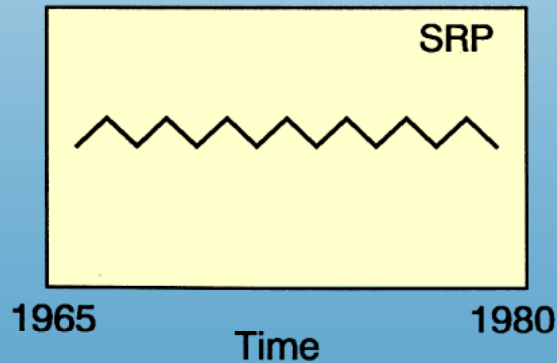
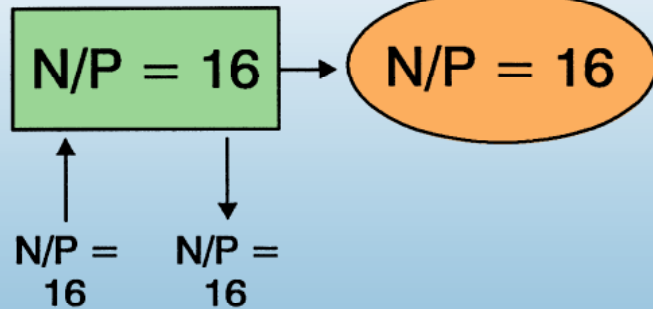
- Shifts in community structure
- Selective metabolism/export



(Karl, D)

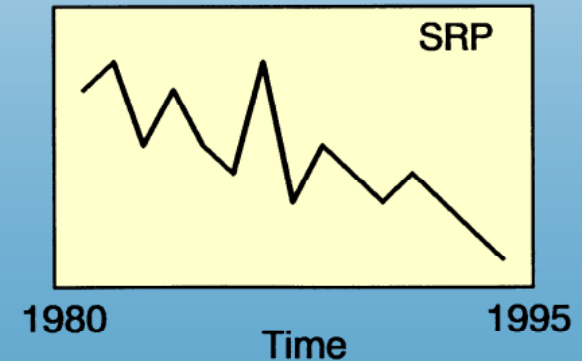
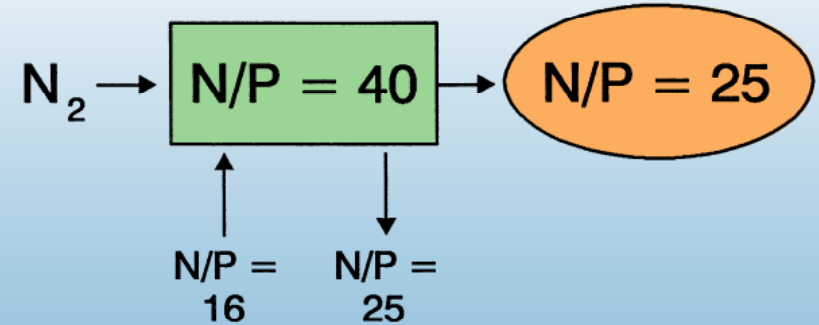
ALTERNATING ECOSYSTEM STATES OF THE NORTH PACIFIC GYRE

1970's



N-limited
Trichodesmium absent

ENSO favorable and
Warm phase PDO (post-1980)

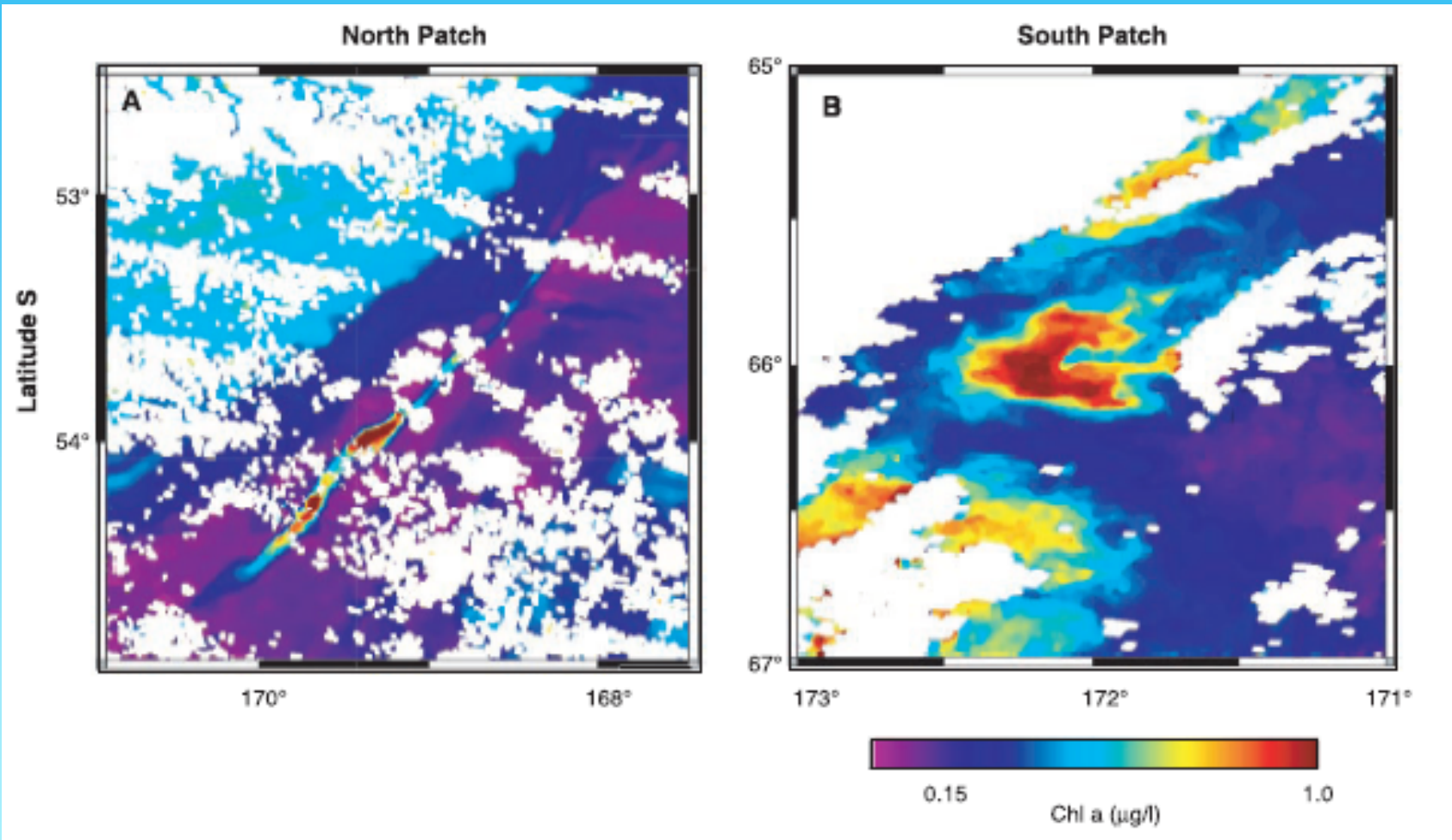


P-limited
Trichodesmium present

(Karl, D)

Input of macro and micro nutrients to surface waters

- **Micro nutrients**

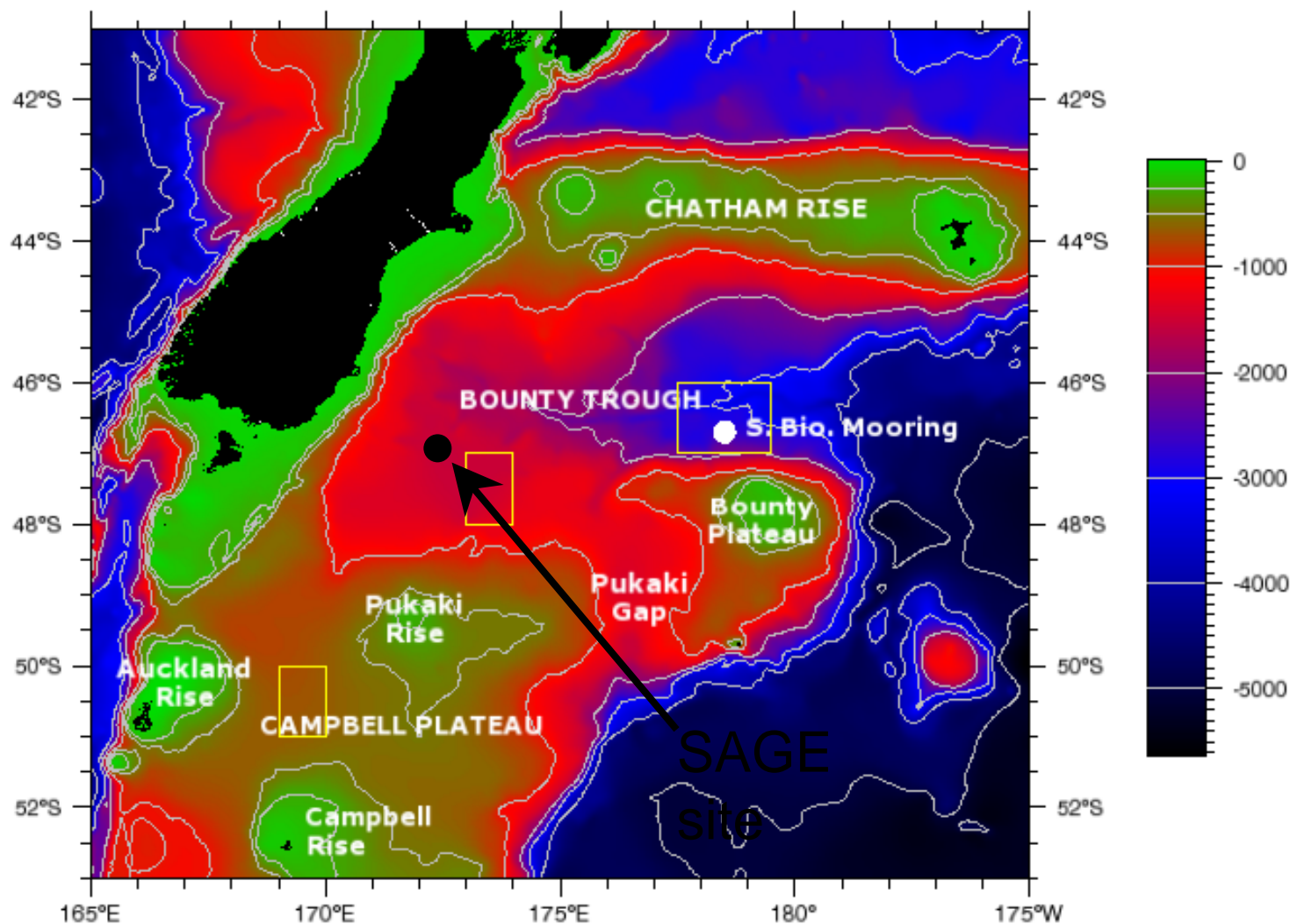


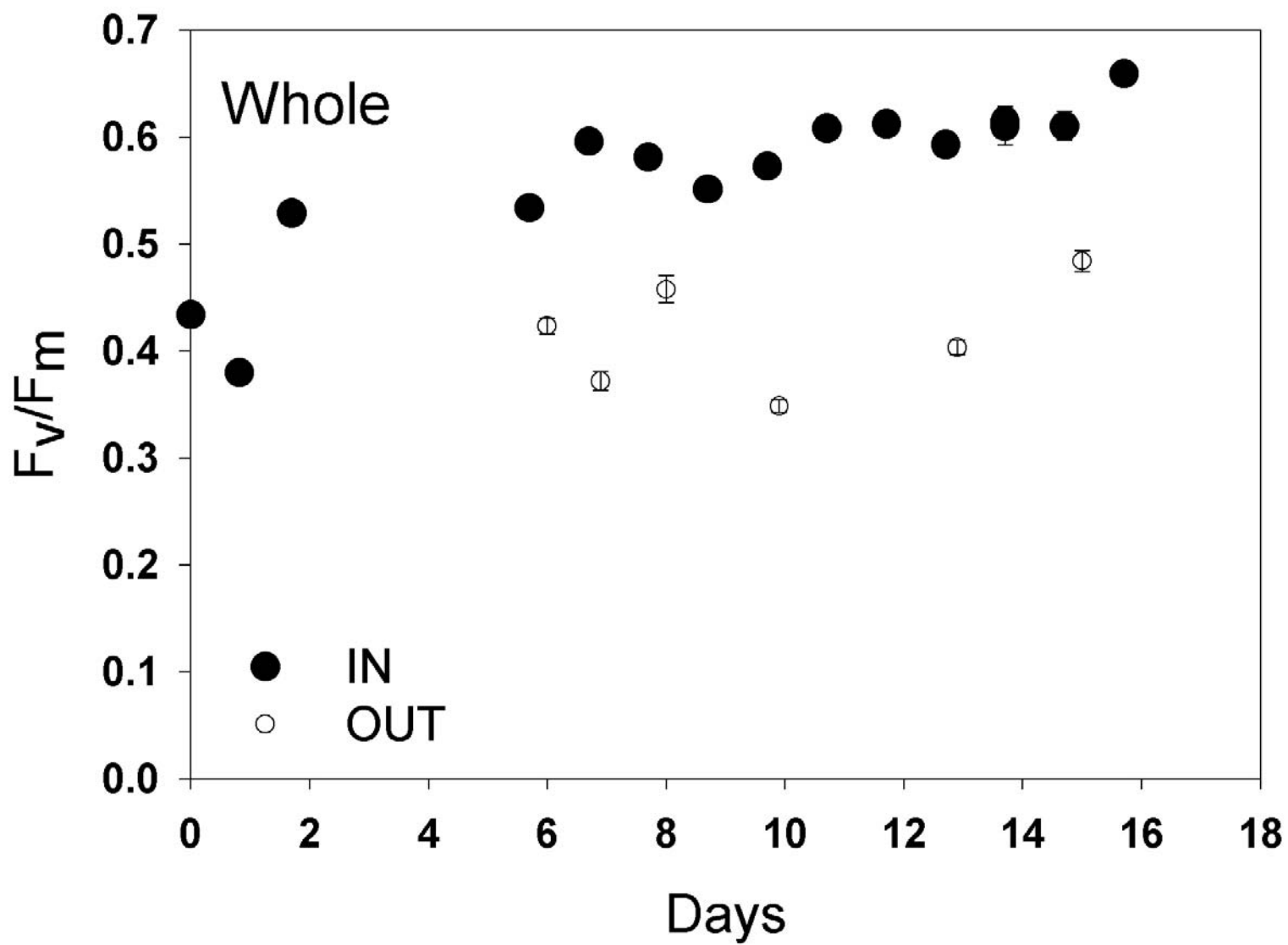
(Coale *et al.*, 2003)

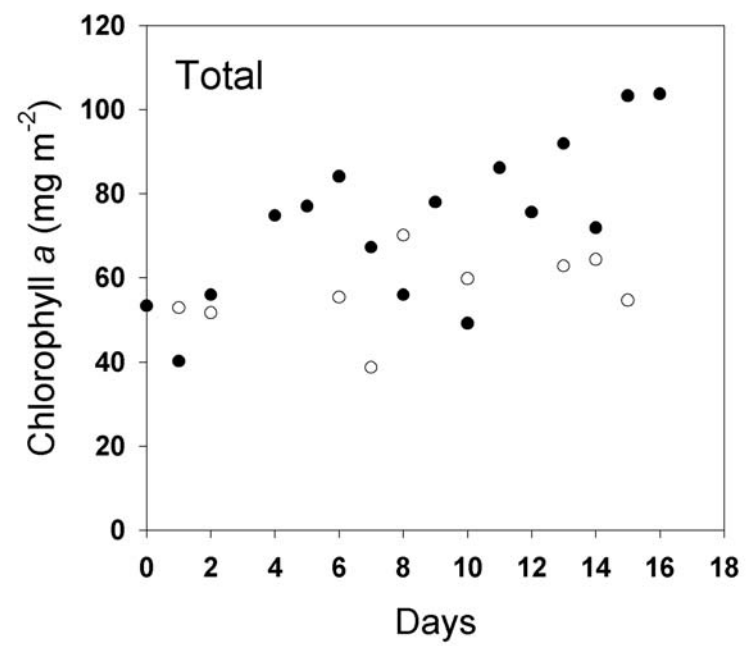


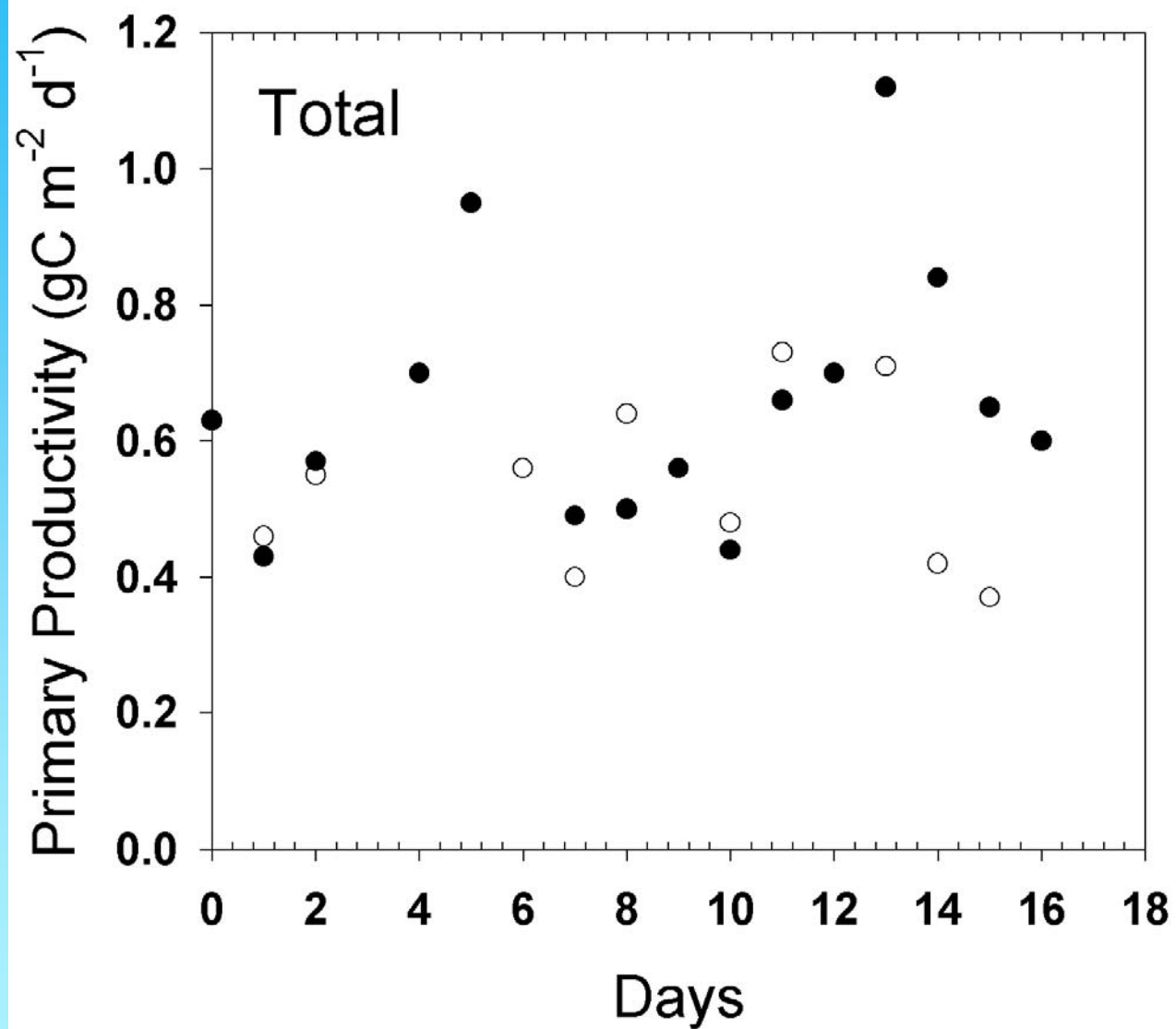
Mar/Apr 2004

Site



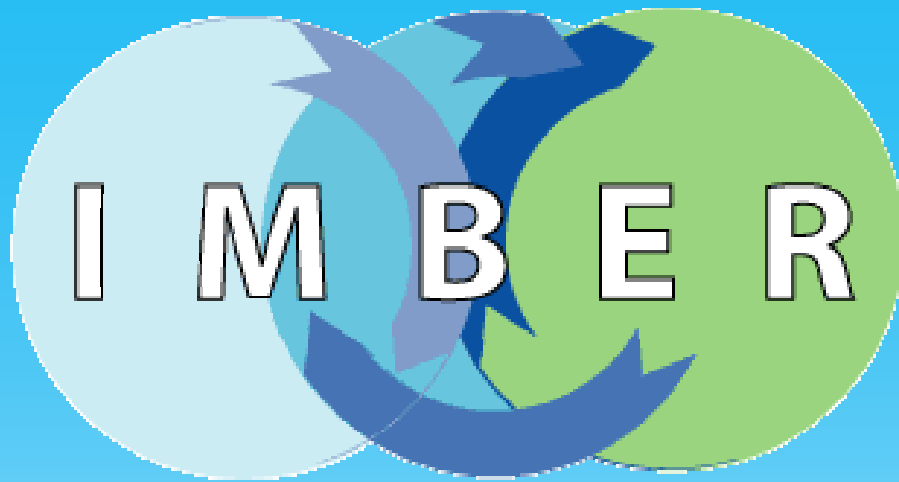






What is the explanation for the lack of phytoplankton response

- Seed population
- Macronutrient limitation
- Dilution and mixing of the patch
- Light limitation
- ????



Integrated Marine Biogeochemistry and
Ecosystem Research

“To develop an understanding of how interactions between biogeochemical cycles and ecosystems respond to and force global change”

Acknowledgements

- Ann Bucklin
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