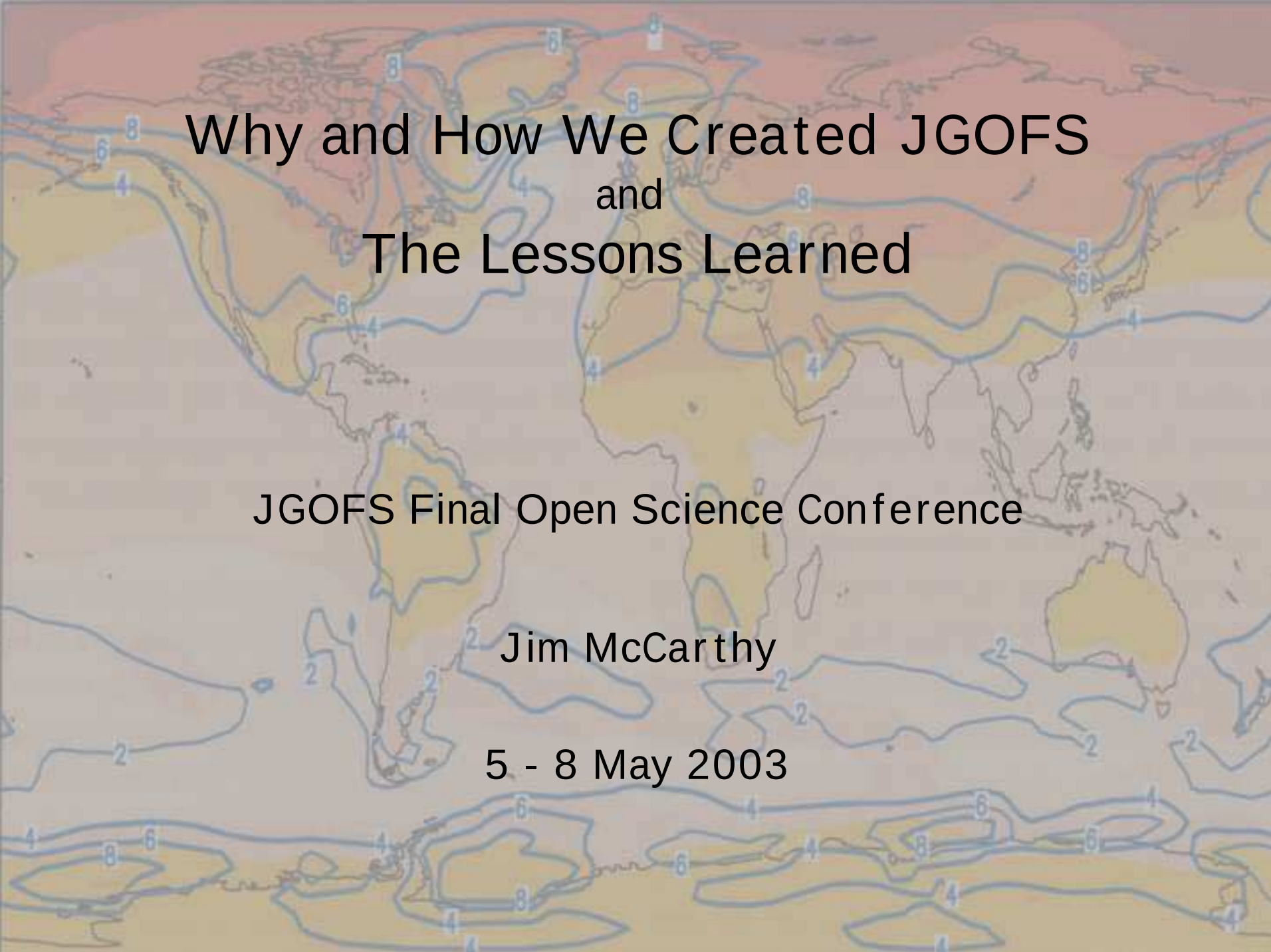


Why and How We Created JGOFS
and
The Lessons Learned

JGOFS Final Open Science Conference

Jim McCarthy

5 - 8 May 2003

Some Important Dates

October 1982 - Ocean Science Board meeting
March 1983 - Small Cambridge meeting
June 1983 - Letter from Board on Ocean Science and Policy to James Beggs, Adminsitrator of NASA
May 1984 - Boston Planning Meeting
September 1984 - The Woods Hole workshop
December 1984 - The workshop report was complete

Board on Ocean Science and Policy

ACTION ITEM

"As a result of *discussions* at the last OSB meeting, a small group consisting of Baker, Broecker, McCarthy, Steel and Wunsch met on March 22, 1983 to consider the relations between plans for larger term research on physical, chemical, and biological oceanography.

The following statement is the outcome of this meeting:"

AKA "The Truce"

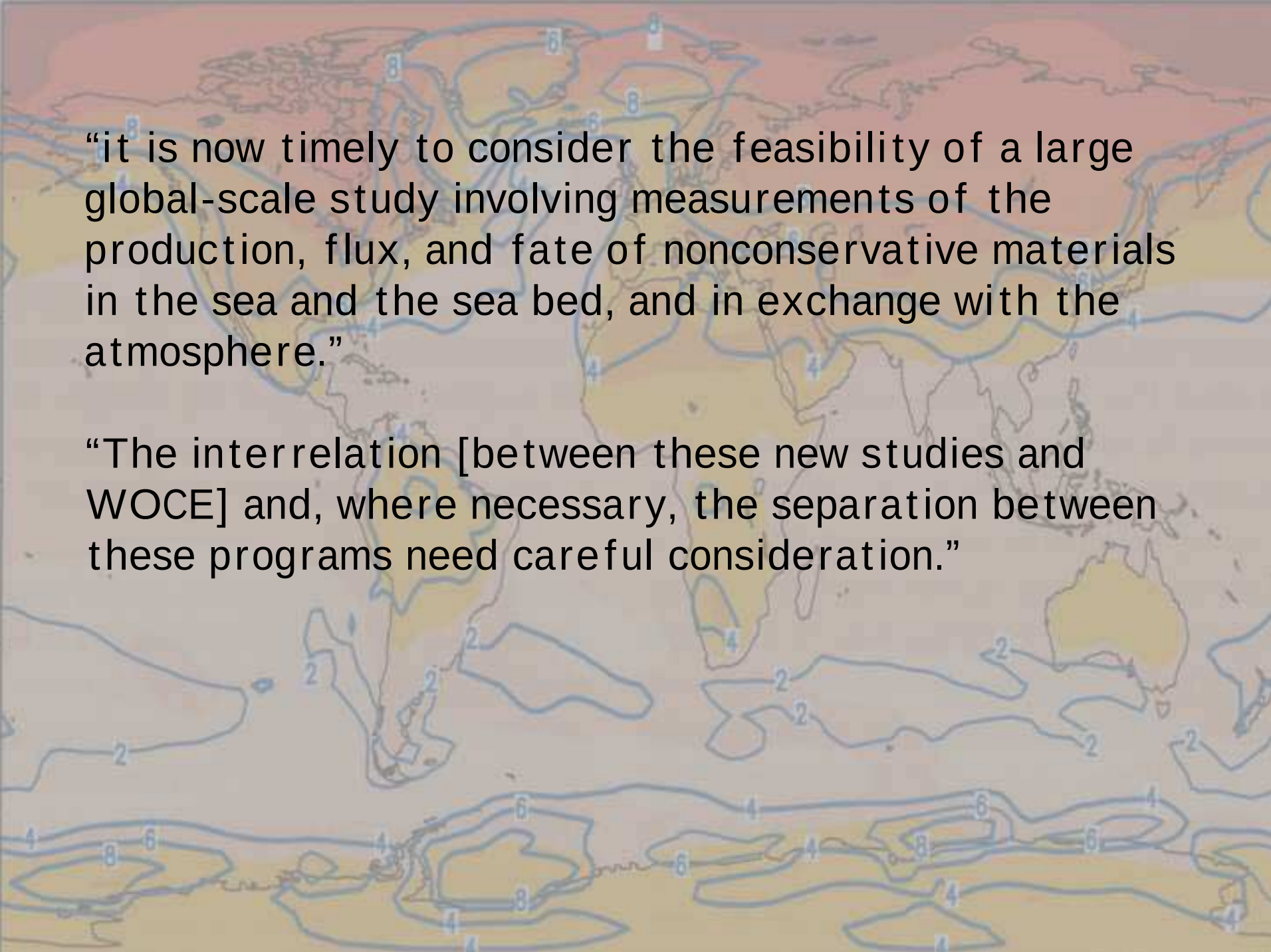
Spring 1983

Excerpts:

"the planning and implementation of WOCE have a high priority"

"At the same time, however, there should be consideration of complementary programs concerned with the distribution and fluxes of nonconservative constituents …especially those involved in critical organic pathways"

"The extrapolation to large scales can be accomplished by major expeditions such as GEOSECS & TTO, and by the use of remote sensing instruments such as the OCI"



"it is now timely to consider the feasibility of a large global-scale study involving measurements of the production, flux, and fate of nonconservative materials in the sea and the sea bed, and in exchange with the atmosphere."

"The interrelation [between these new studies and WOCE] and, where necessary, the separation between these programs need careful consideration."

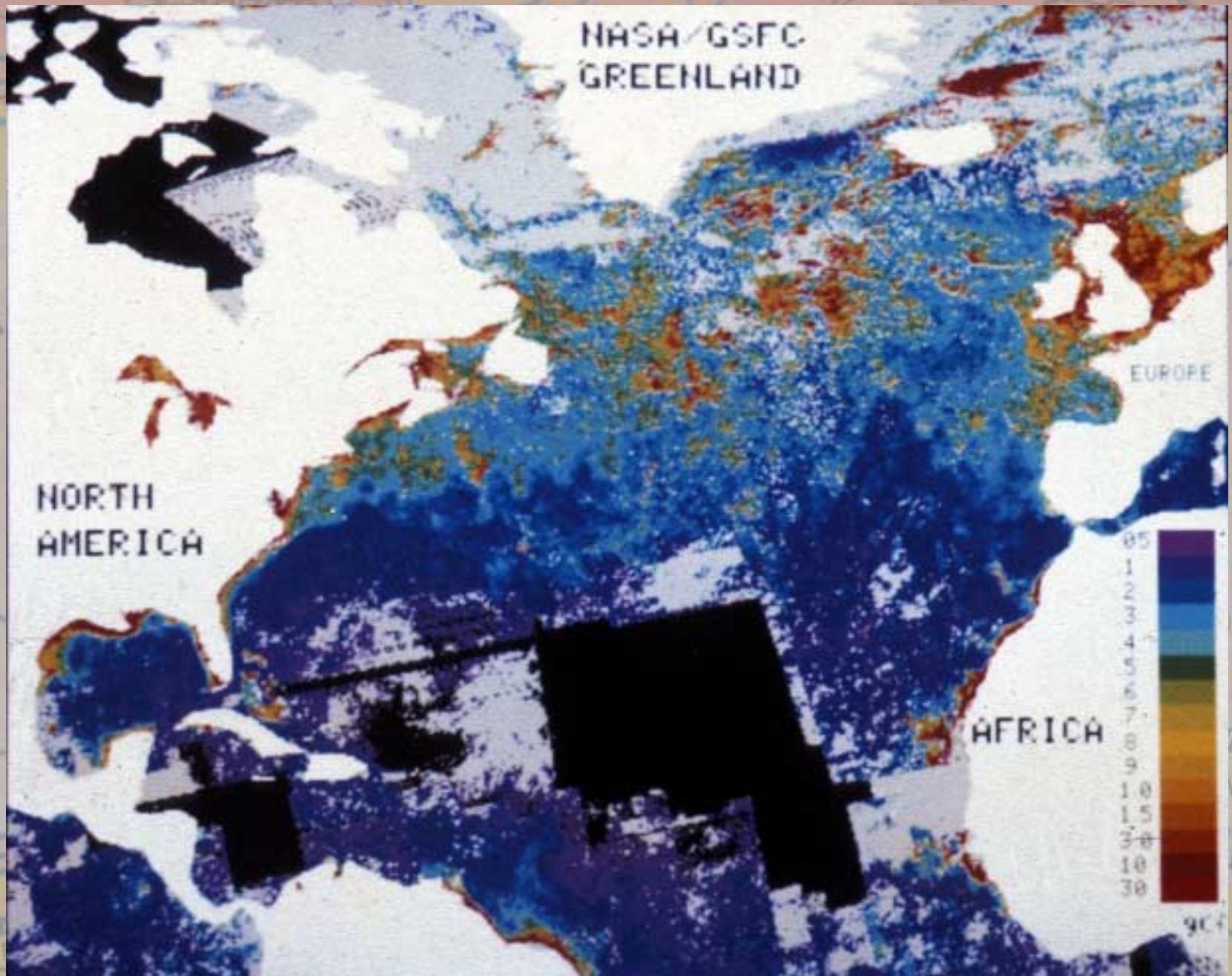
Action

"The Board should consider appointing an ad hoc group consisting of J. Baker, W. Broecker, J. McCarthy, J. Steele, and C. Wunsch to outline the scope of a scientific flux program and to request NAS program initiation funds to hold meetings to discuss the feasibility of the study and to ascertain the interest of the federal agencies."

Lesson Learned

Sort out disciplinary turf wars before wasting a lot of time on planning

“Coastal Zone Color Scanner” (CZCS) May 1979



The Ocean Science Board, having been disbanded, was replaced by The Board on Ocean Science and Policy, with John Slaughter as chair.

In June 1983 Slaughter wrote to James Beggs, Administrator of NASA to report on the planning For a global ocean flux study saying:

“remote sensing of… ocean color can potentially revolutionize our view of ocean biological processes”

“a satellite incorporating the Ocean Color Imager will be needed towards the end of this decade”

"… the Board has… established an ad hoc committee chaired by John Steele to prepare a feasibility study of global biogeochemical cycles in the ocean."

"… your assurance of continued development of the OCI is needed."

"*Our views on the altimeter and scatterometer have been the subject of previous correspondence.*"

"… the Board has… established an ad hoc committee chaired by John Steele to prepare a feasibility study of global biogeochemical cycles in the ocean."

"… your assurance of continued development of the OCI is needed."

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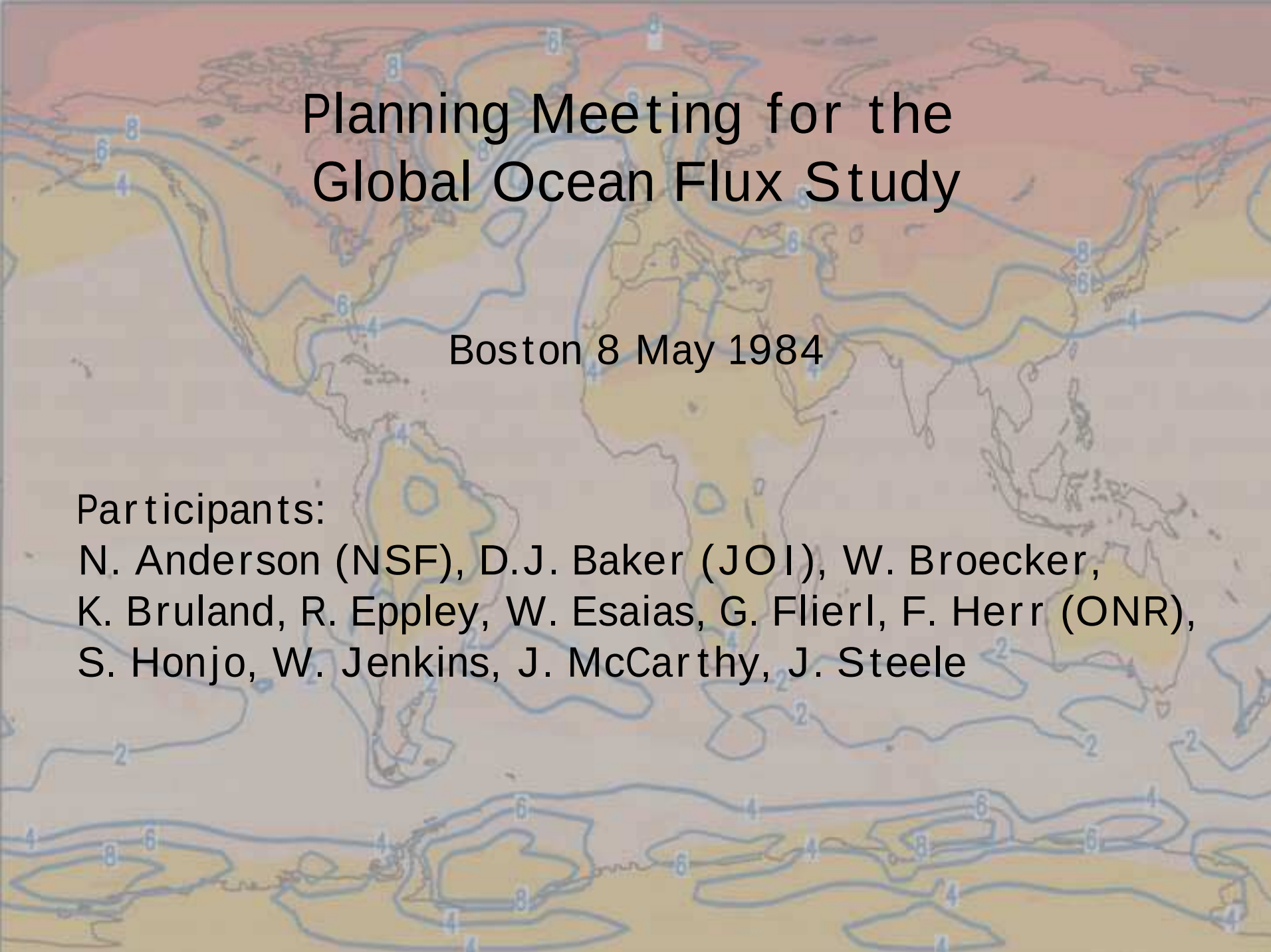


Planning Meeting for the Global Ocean Flux Study

Boston 8 May 1984

Participants:
N. Anderson (NSF), D.J. Baker (JOI), W. Broecker, K. Bruland, R. Eppley, W. Esaias, G. Flierl, F. Herr (ONR), S. Honjo, W. Jenkins, J. McCarthy, J. Steele

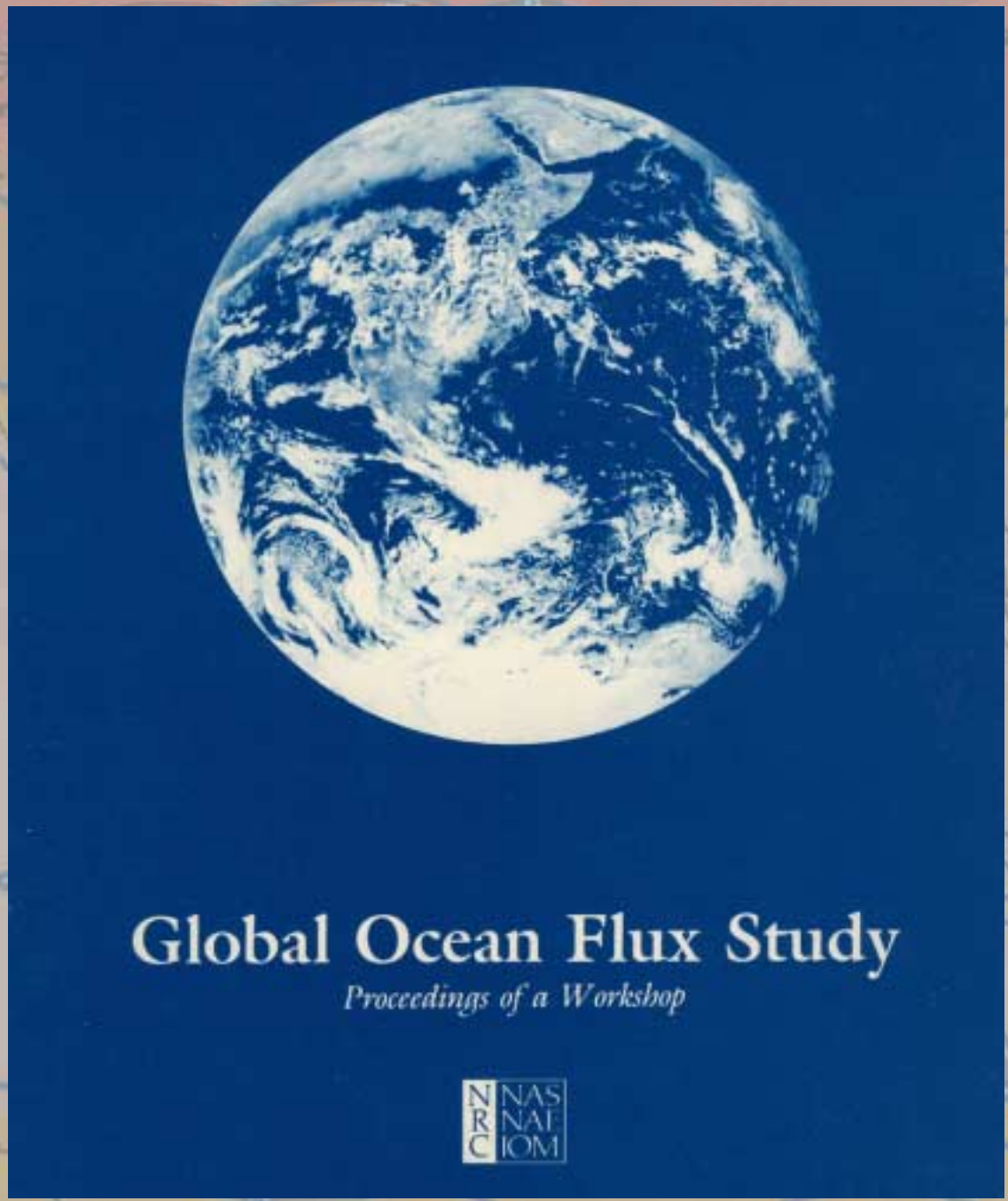
It was decided to convene a workshop in September 1984 at the Woods Hole NAS facility

Ken Bruland was asked to chair the Summer Workshop and an invitation list was drawn up including ocean Scientists from Canada, the U.K, France, and Germany

Terms of Reference were drafted for the Summer Workshop

Terms of Reference for the Summer Workshop

1) To determine whether we have the potential to obtain ocean data on a global scale that could profoundly change our understanding of the flux of critical chemical constituents.
2) To identify the immediate and long-term objectives needed to achieve the Global Ocean Flux Program
3) If the ability is achievable, to determine the U.S. role in such an international program.
4) To outline the immediate steps necessary to assure that an appropriate program can be conducted within the next decade.


Global Ocean Flux Study
Proceedings of a Workshop
NRC
NAS
NAE
IOM

1984

About 60 scientists (from 7 nations) participated and a broad overall goal was formulated

Chapter I
Statement of Goals and Objectives

An overall goal of a Global Ocean Flux Study (GOFS) was defined to be:

> To identify and quantify the physical, chemical, and biological processes controlling biogeochemical cycling in the ocean, and their interaction with the global atmosphere. The goal is to understand the processes governing the production and fate of biogenic materials in the sea well enough to predict their influences on, and responses to, global scale perturbations.

After 4 days of presentations of prepared papers and working group discussion/drafting sessions, thoughts turned to next steps, and an editing team consisting of Bruland, Brewer, Jumars, and McCarthy was elected to complete the report.

Global Ocean Flux Study

Proceedings of a Workshop
September 10–14, 1984
National Academy of Sciences
Woods Hole Study Center
Woods Hole, Massachusetts

Global Ocean Flux Study Committee
Board on Ocean Science and Policy
Commission on Physical Sciences,
Mathematics, and Resources
National Research Council

National Academy Press
Washington, D.C. 1984

Lesson Learned

Academy Boards etc. can be useful.

But do they have similar relevance today?

To some degree this vetting role for science like JGOFS occurs today as part of the IGBP and WCRP programatic function.

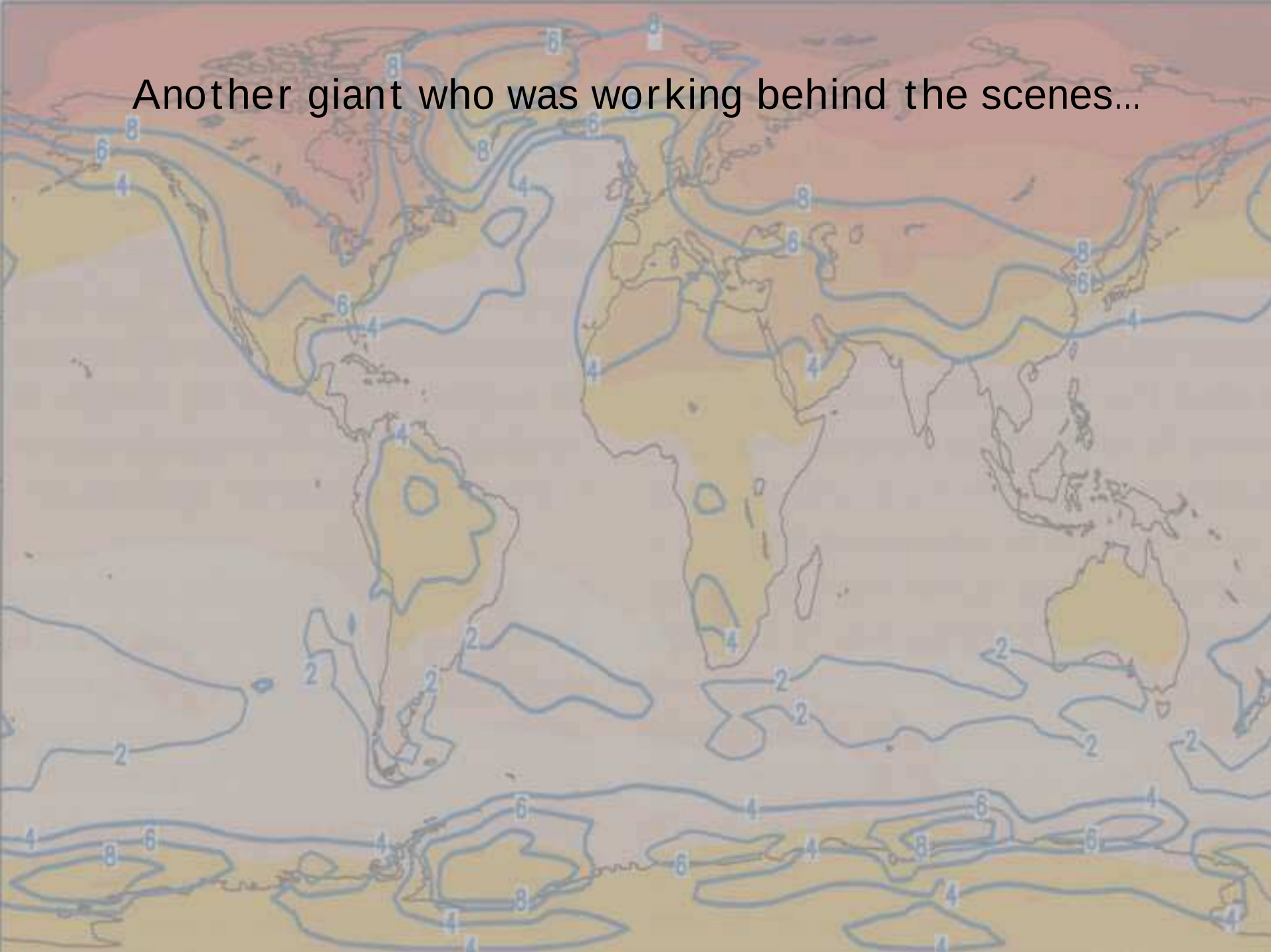
Some Important Dates

November 1982 - Ocean Science Board meeting
March 1983 - Small Cambridge meeting
June 1983 - Letter from Board on Ocean Science and Policy to James Beggs, Adminsitrator of NASA
May 1984 - Boston Planning Meeting
September 1984 - The Woods Hole workshop
December 1984 - The workshop report was complete

One critical constant in all of this

John Steele

Another giant who was working behind the scenes…



Roger Revelle

Coined the phrase “biological pump”

November 1984 - Roger proposed to the now defunct Committee on Climate and the Ocean (CCCO) that a Program be launched to improve understanding of the Carbon Dioxide Cycle in the Ocean with 2 objectives

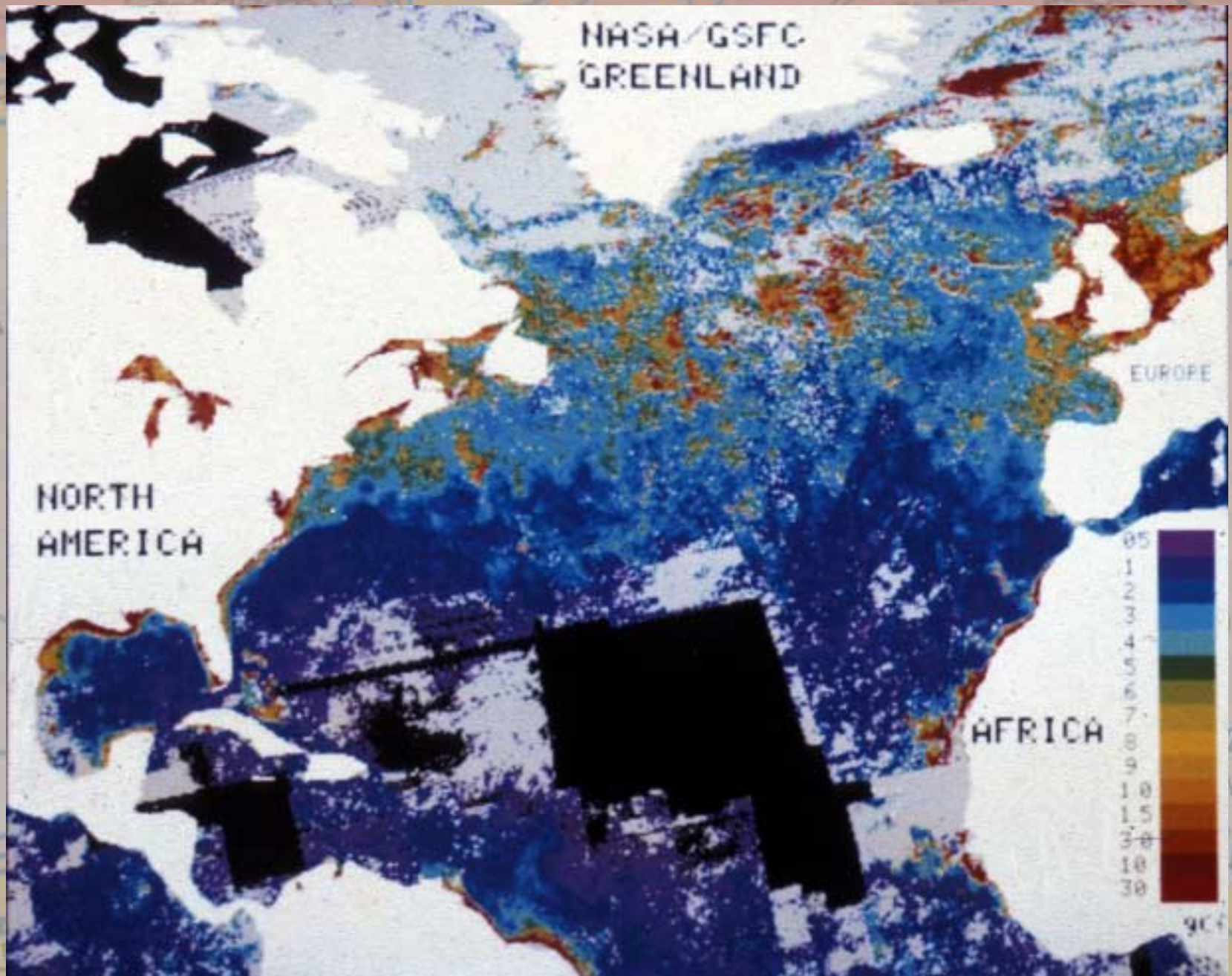
1) Measurements of the constituents of the CO_2 system in surface and subsurface waters…

2) Studies of the interaction between biological activity and atmospheric and oceanic carbon dioxide…

Lesson Learned

Old guys and gals can be helpful, but at some point those who are going to do the science for the next 10 - 20 years have to take charge

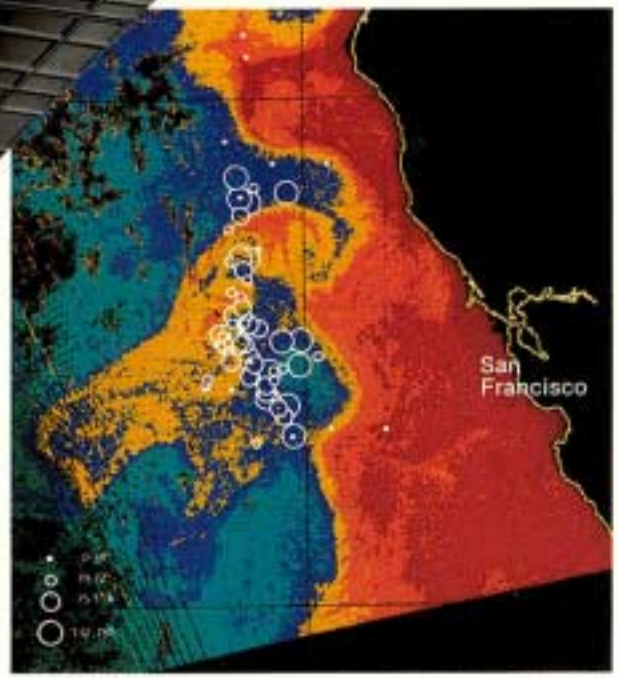
“Coastal Zone Color Scanner” (CZCS) May 1979




Oceanography from Space
OCI
Ocean Color Imager
Ocean color observations:
a new environmental
perspective

Ready For Implementation

Both the research and operational communities are prepared to exploit the capability offered by an OCI.



Week-long albacore tuna catch (circles) correlated with outer edge of upwelled water on 21 September 1981, demonstrating the utility of ocean color for fishery forecasts

International Programs on Climate and Global Change

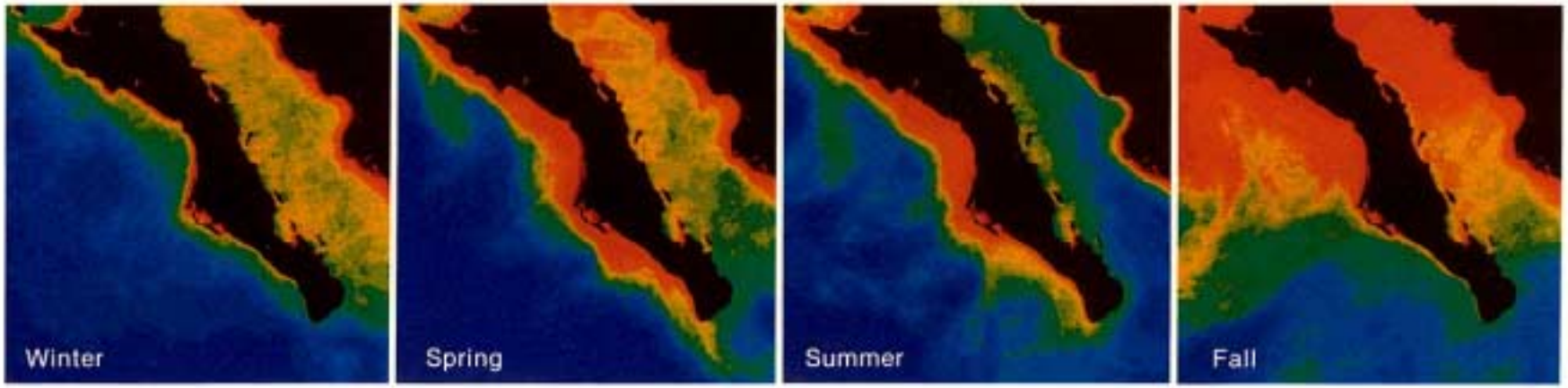
- The World Climate Research Program (WCRP) has two major oceanographic efforts — World Ocean Circulation Experiment (WOCE) and Tropical Ocean and Global Atmosphere (TOGA).
- WOCE and TOGA will study surface-wind forcing, ocean-current response, and air-sea heat exchange.
- The Global Ocean Flux Study (GOFS) will investigate global chemical and biological fluxes in the ocean, ranging from phytoplankton production at the surface to formation of the sedimentary record on the sea floor.
- Together with WOCE and TOGA, GOFS will provide the basis for an improved understanding of global biogeochemical processes.

Simultaneous Satellite Observations Required

- Simultaneous satellite observations of winds, currents, surface temperature, and ocean color are required to support these international programs.
- These requirements can be met by the scatterometer aboard NROSS for winds, TOPEX for currents, and the infrared radiometer and OCI aboard a NOAA satellite for temperature and color.

Ocean Forecasting

- On regional and global scales, these simultaneous observations will lead to a new understanding of the dependence of phytoplankton productivity on winds, currents, and temperature.
- Together with numerical models, the data will enable improved marine forecasting for operational applications.

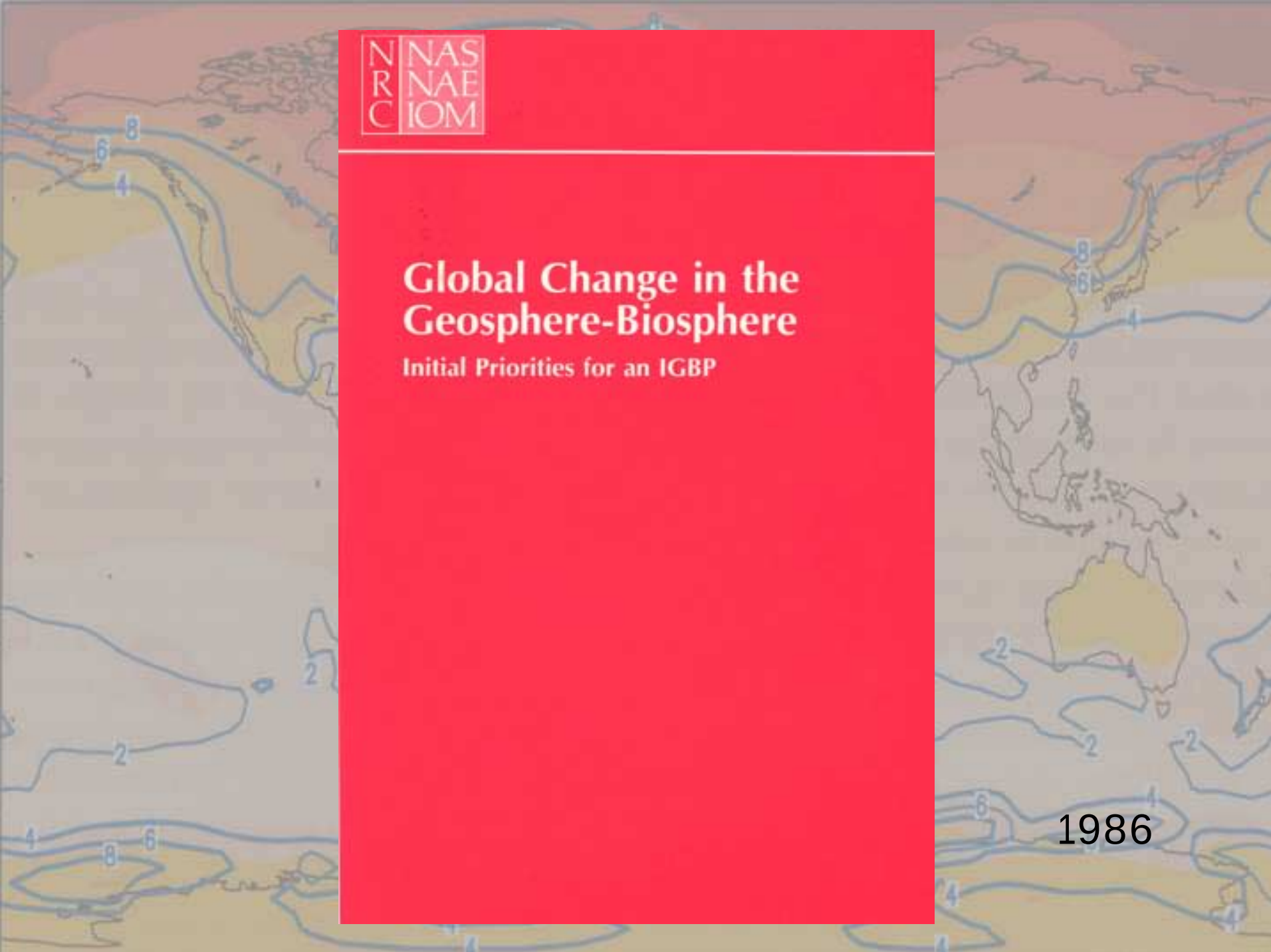


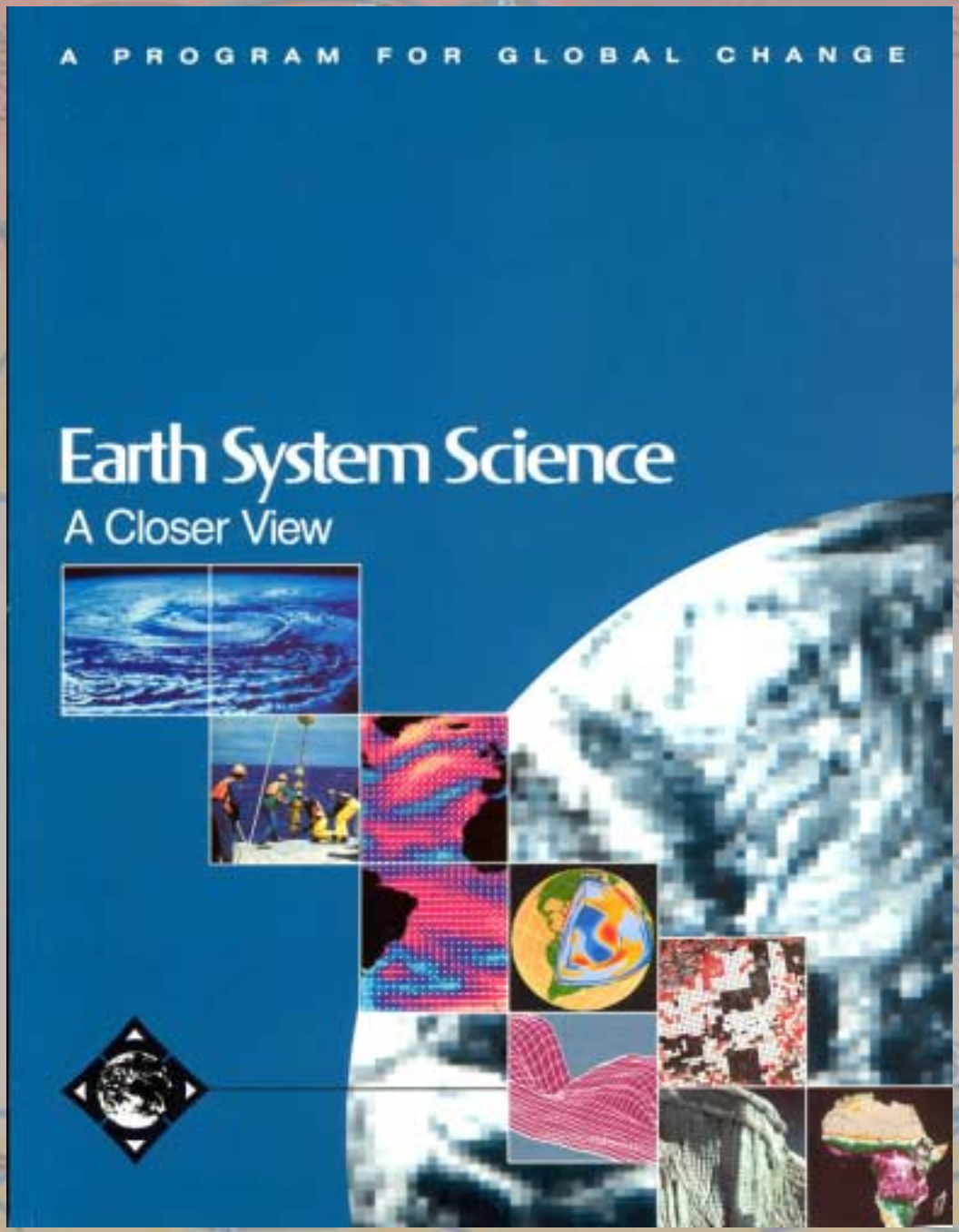
Shown are seasonally averaged phytoplankton-abundance images (off Baja California, 1979) indicating a dramatic increase in the fall. This is an example of a new observational basis to relate biological and physical processes over seasonal and longer scales.

Ready For Implementation

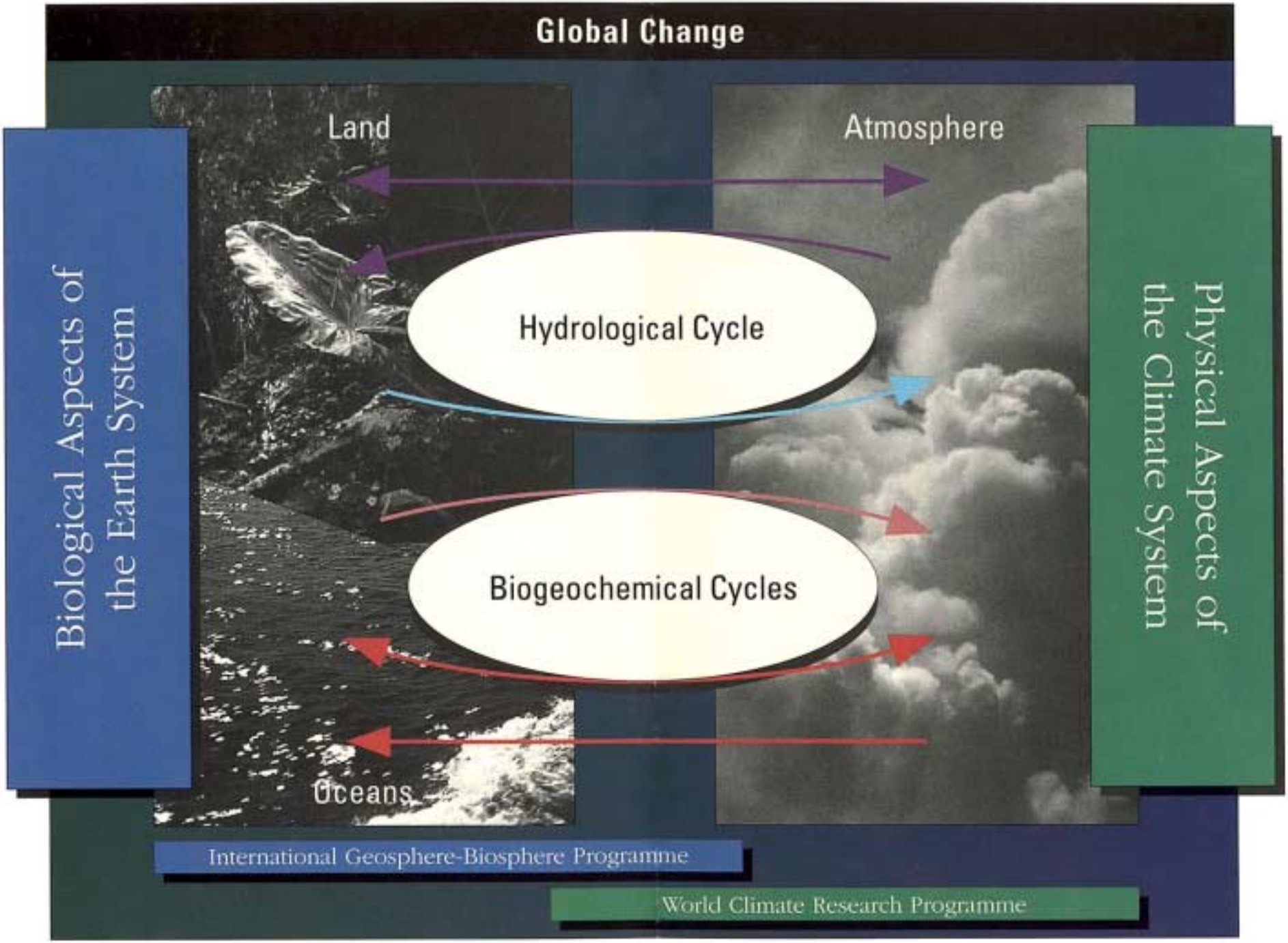
Both the research and operational communities are prepared to exploit the capability offered by an OCI.

June 1985


NRC
NAS
NAE
IOM
Global Change in the Geosphere-Biosphere
Initial Priorities for an IGBP
1986


A PROGRAM FOR GLOBAL CHANGE
Earth System Science
A Closer View

1985-8

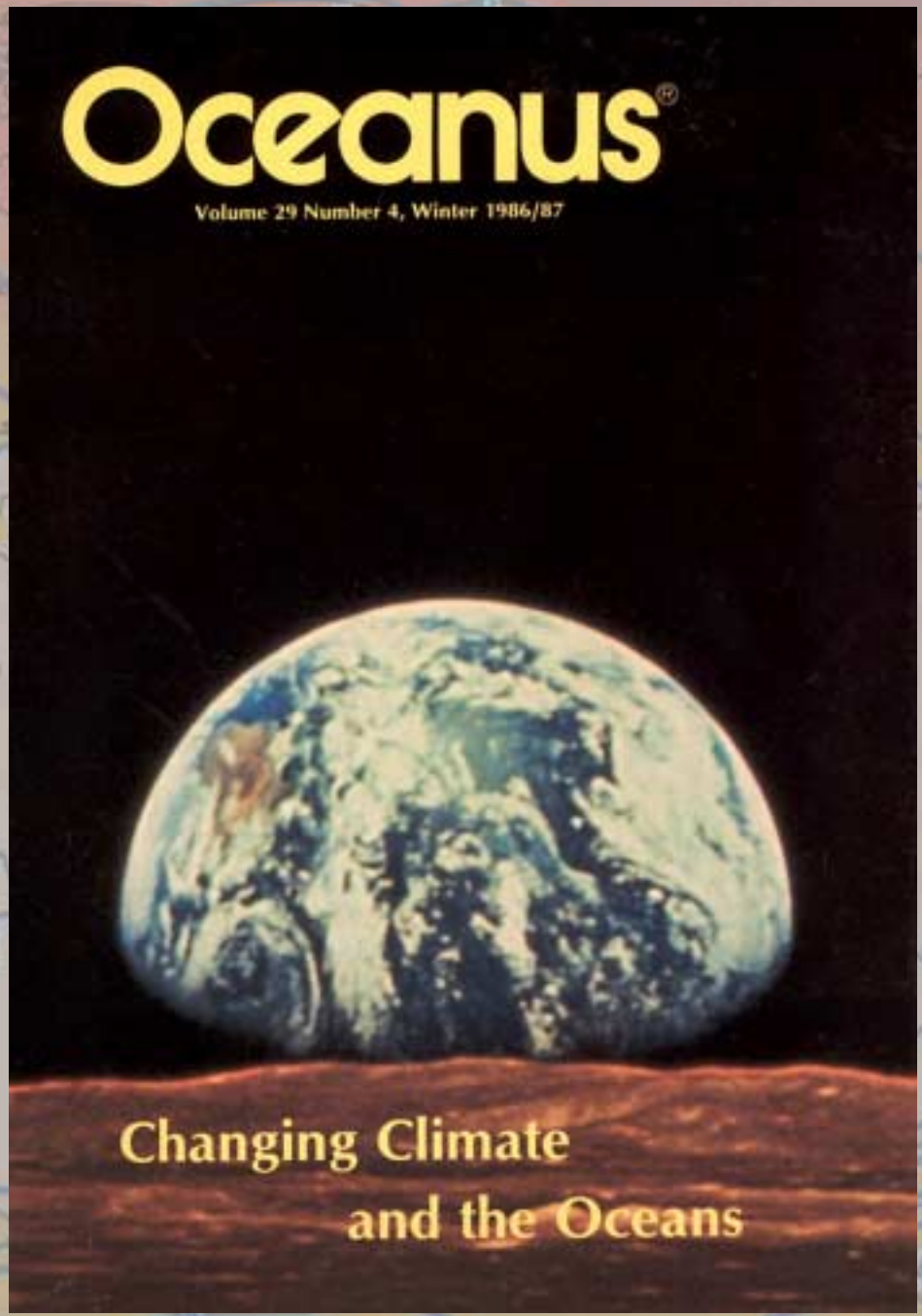

Global Change
Land
Atmosphere
Biological Aspects of the Earth System
Physical Aspects of the Climate System
Hydrological Cycle
Biogeochemical Cycles
Oceans
International Geosphere-Biosphere Programme
World Climate Research Programme

Lesson Learned

Support from multiple bodies can be helpful, especially when going international

Lesson Learned

Support from multiple bodies can be helpful, especially when going international, and most especially when their ranks have been infiltrated


Oceanus®
Volume 29 Number 4, Winter 1986/87
Changing Climate
and the Oceans

1986

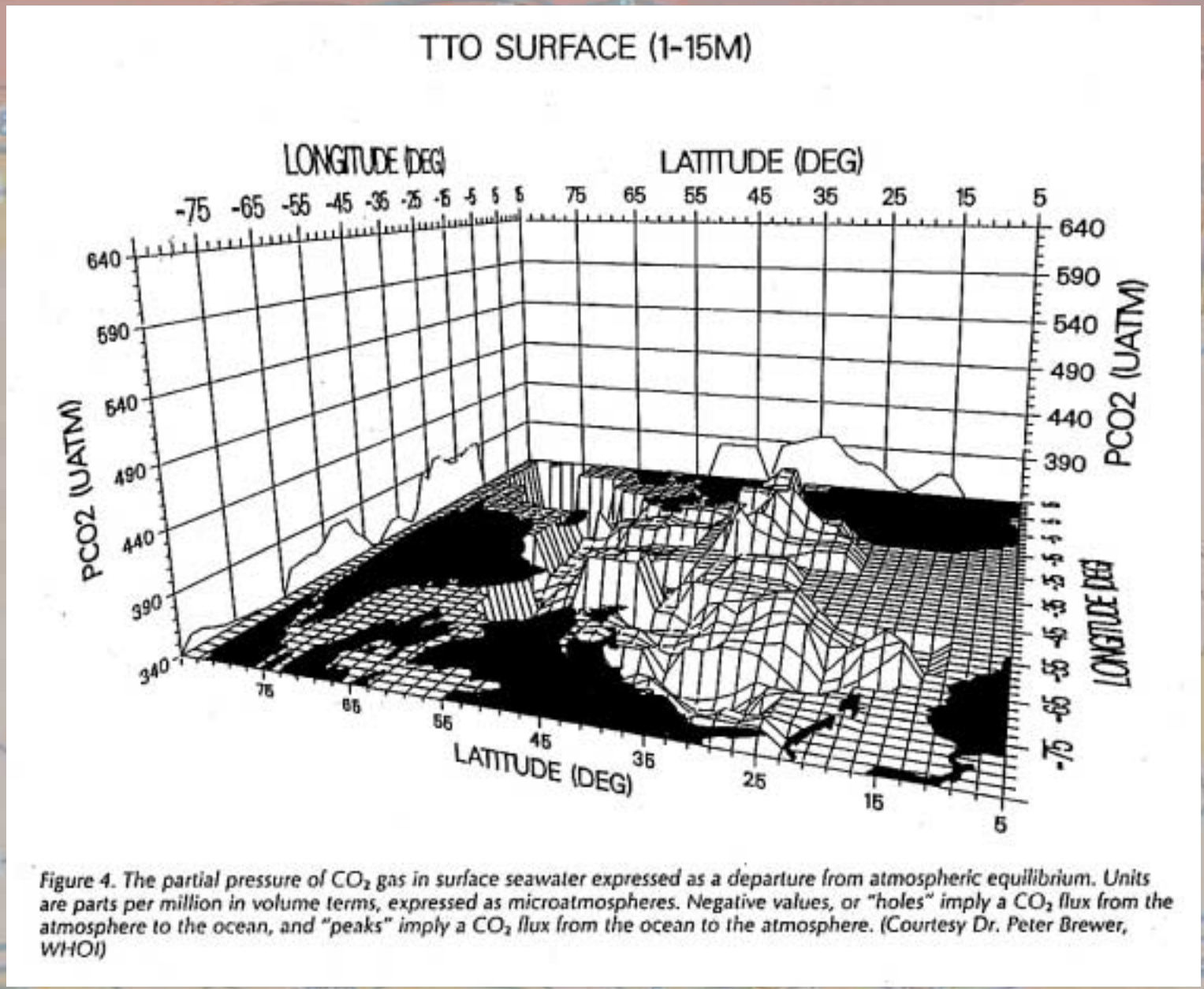
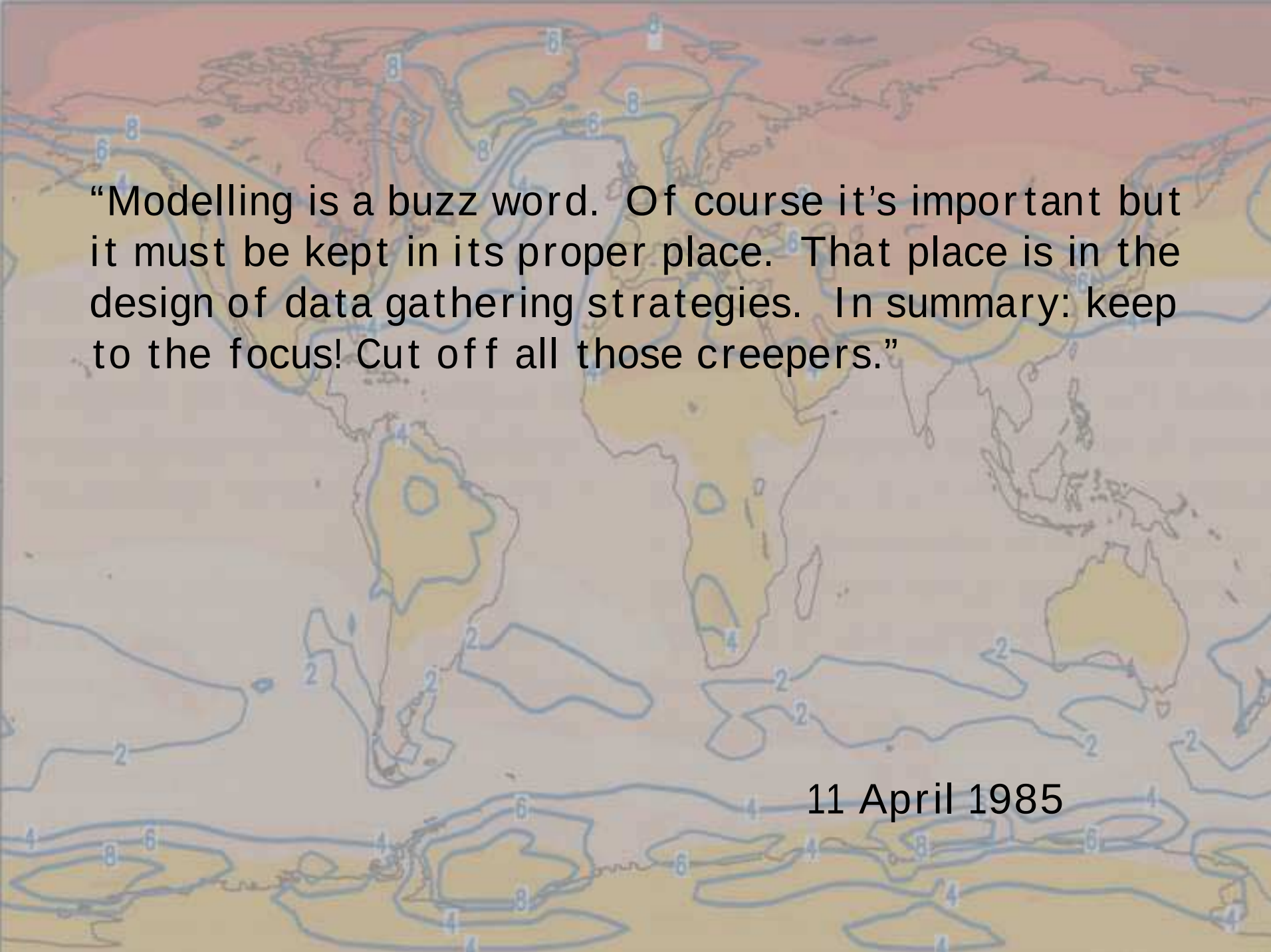


Figure 4. The partial pressure of CO_2 gas in surface seawater expressed as a departure from atmospheric equilibrium. Units are parts per million in volume terms, expressed as microatmospheres. Negative values, or "holes" imply a CO_2 flux from the atmosphere to the ocean, and "peaks" imply a CO_2 flux from the ocean to the atmosphere. (Courtesy Dr. Peter Brewer, WHOI)

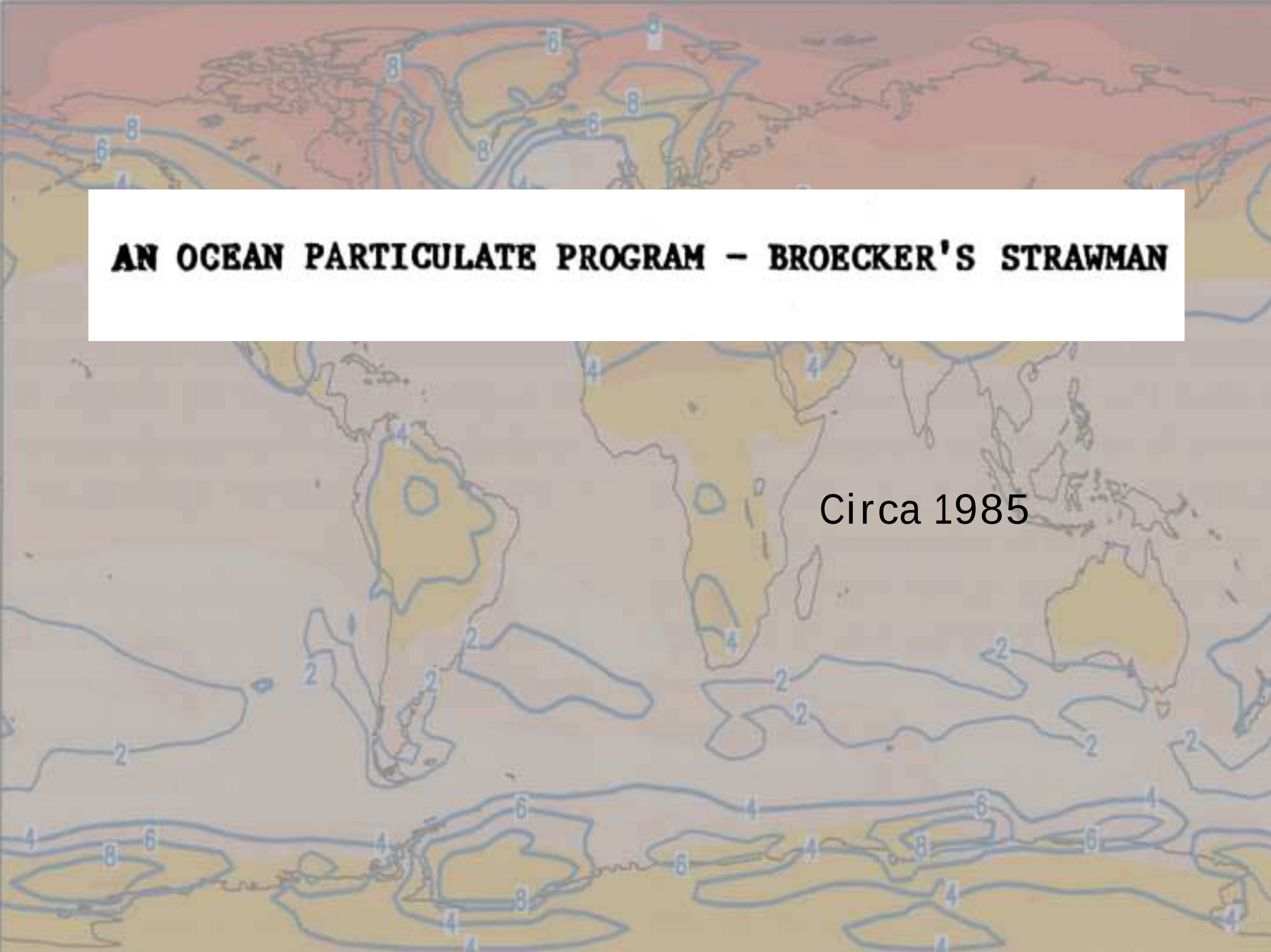
McCarthy, Brewer, and Feldman 1986


…and the role of yet another Giant, Wally



"Modelling is a buzz word. Of course it's important but it must be kept in its proper place. That place is in the design of data gathering strategies. In summary: keep to the focus! Cut off all those creepers."

11 April 1985



AN OCEAN PARTICULATE PROGRAM - BROECKER'S STRAWMAN

Circa 1985

OBJECTIVES

1) To define the rate of production of organic matter* as a function of geographic location and season.

2) To define the rain rate of organic particulate matter from the photic zone into the upper thermocline as a function of geographic location and season.

3) To define the destruction rate (by respiration and dissolution) of particulate matter as a function of geographic location and depth in the sea.

TECHNIQUES

1) Color scanning satellite to determine spacial pattern of ocean chlorophyll concentration.

2) ^{14}C, ^{18}O, O_2, ΣCO_2 measurements for sea truth of the relationship between color as measured by satellite and rate of water column photosynthesis.

3) Measurements of the ratio of calcite and of opal production to the rate of photosynthesis as a function of geographic location and season.

4) Floating sediment traps (and perhaps <u>in situ</u> filtration) to measure the rain rate of organic particulates from the photic zone (i.e., to establish the relationship between the rate of water column photosynthesis and the rain rate of organic particulates).

5) Moored sediment traps to measure the rain rate of organic debris to various depths in the water column (ideally these measurements would yield information regarding the depth dependence of particulate destruction).

6) Quantitative means of estimating the complications introduced by marine "snow".

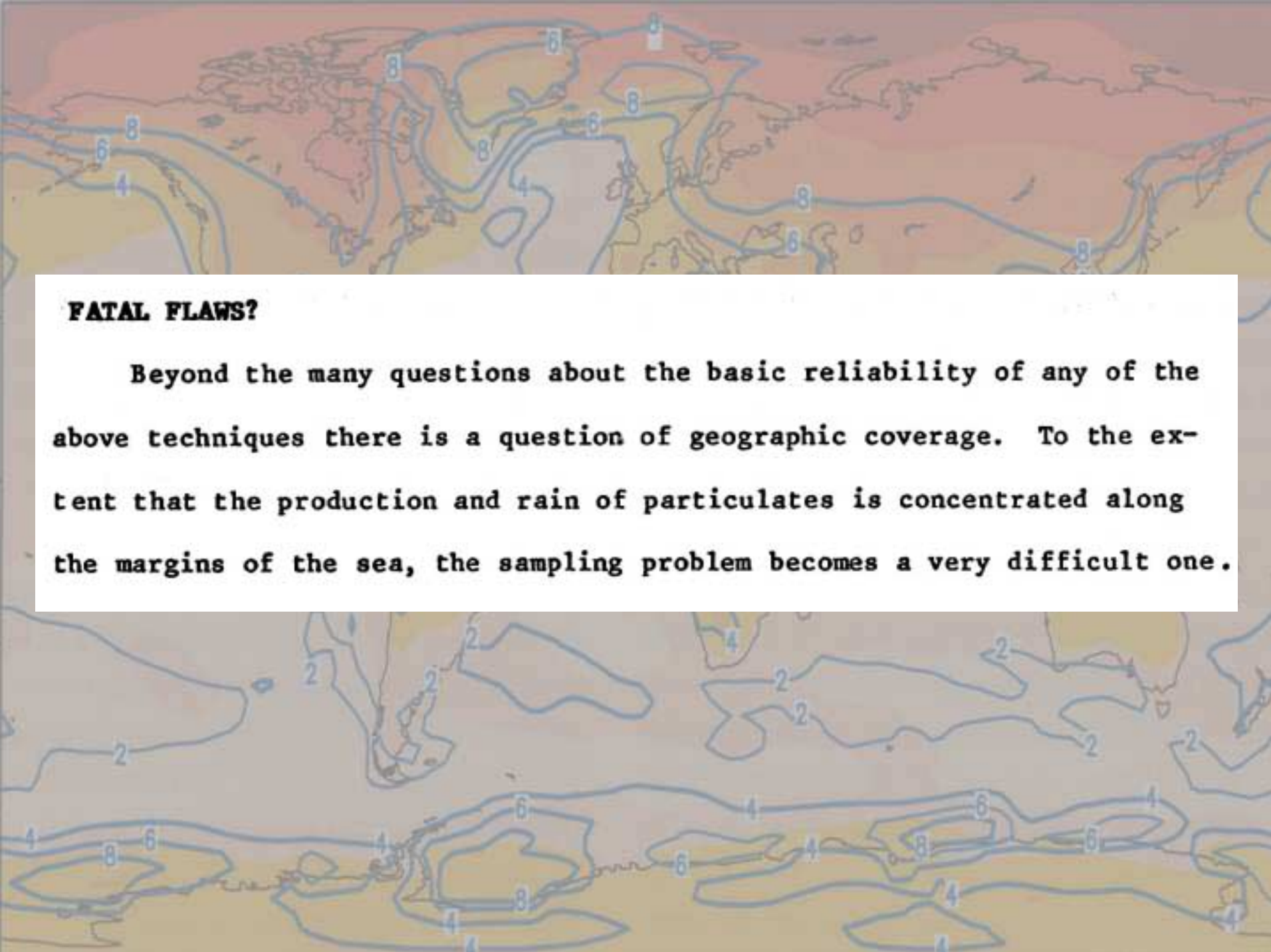
7) Benthic flux devices to measure the rate of destruction of particulate matter on the sea floor (these results, after correction for the accumulation flux would be compared to fluxes obtained using near bottom sediment traps).

SCIENTIFIC APPLICATION

1) A knowledge of the rates of photosynthesis and respiration as a function of space and time in the sea is fundamental to any understanding of the "ecology" of marine organisms.

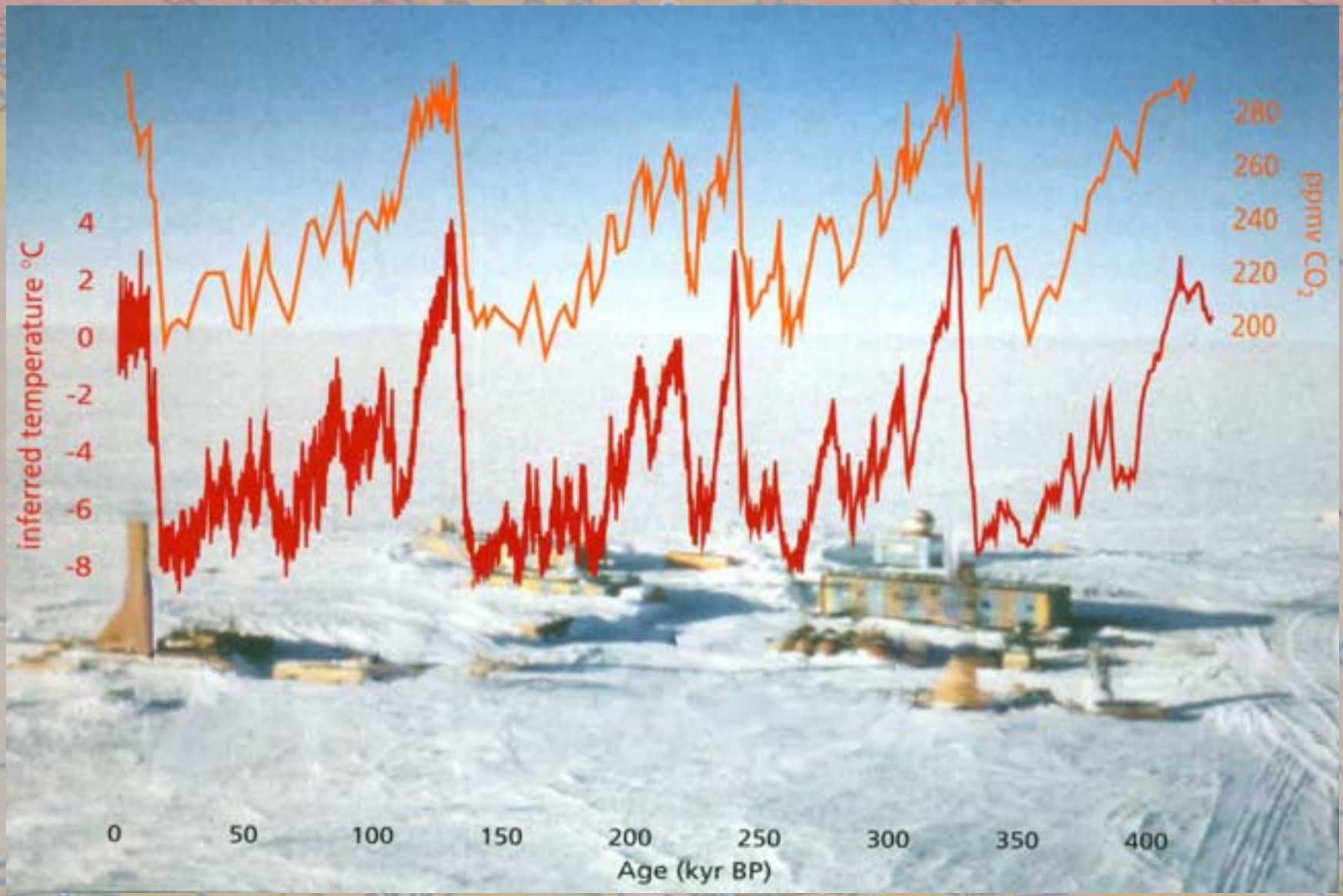
2) A knowledge of the production and dissolution patterns of opal and calcite hard parts is fundamental to those wishing to read the record of paleo environments preserved in marine sediments.

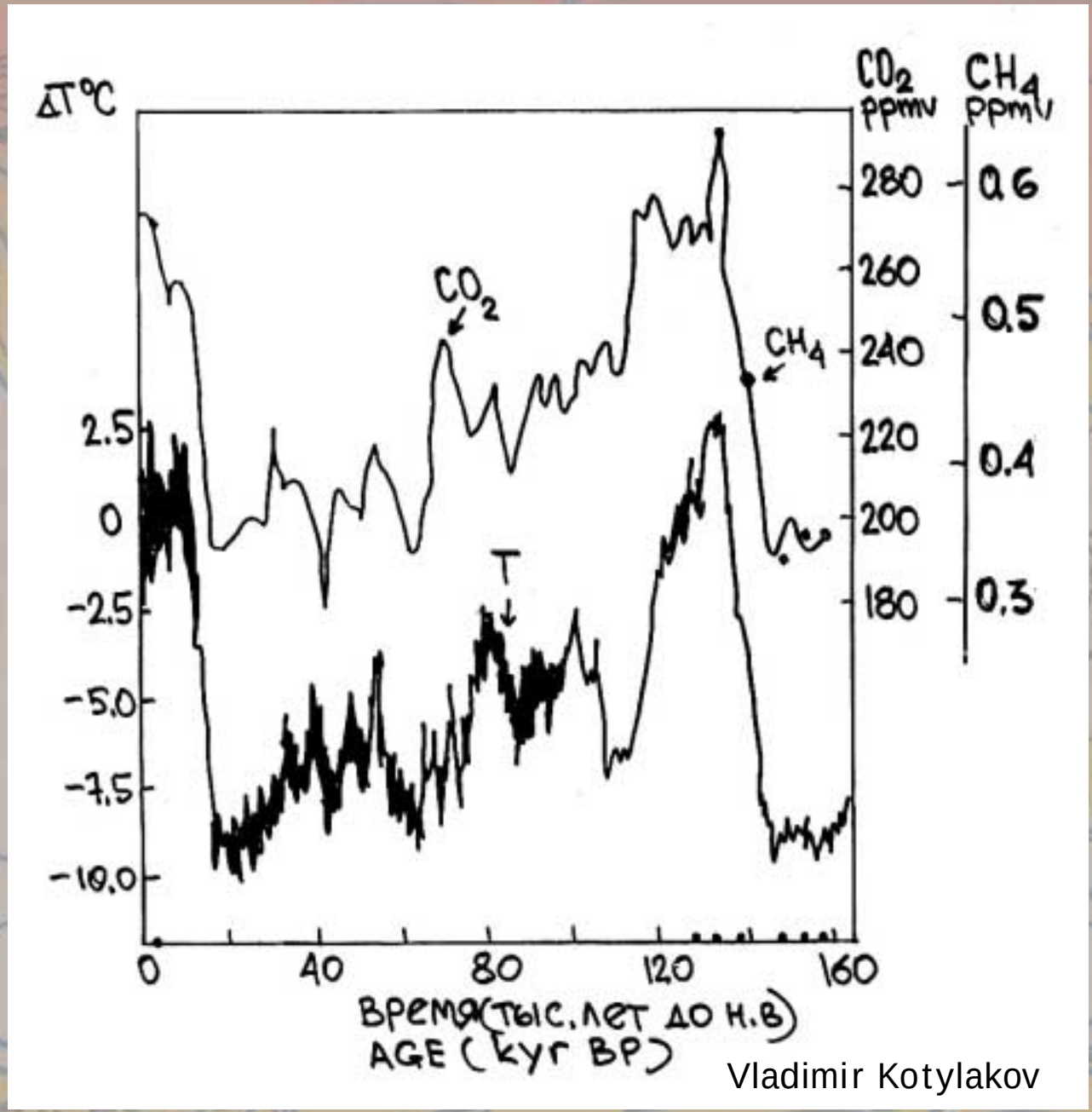
3) A knowledge of the pattern of nutrient transport to the ocean's surface and of the pattern of nutrient regeneration in the sea's interior will provide powerful constraints on models of water flow through the sea.



FATAL FLAWS?

Beyond the many questions about the basic reliability of any of the above techniques there is a question of geographic coverage. To the extent that the production and rain of particulates is concentrated along the margins of the sea, the sampling problem becomes a very difficult one.


inferred temperature °C
4
2
0
-2
-4
-6
-8
ppmv CO2
280
260
240
220
200
0
50
100
150
200
250
300
350
400
Age (kyr BP)



1986

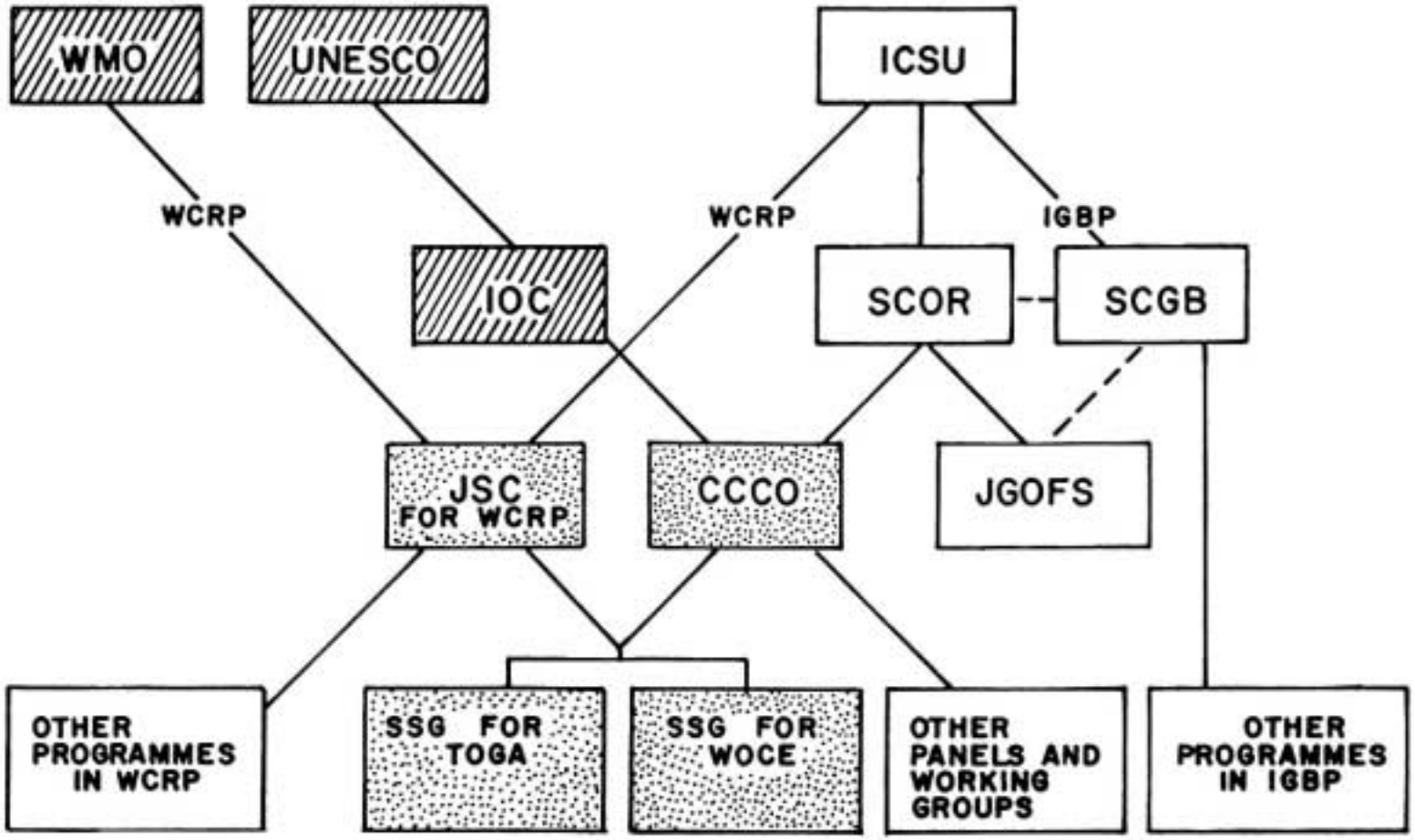
Vladimir Kotylakov

THE JOINT GLOBAL OCEAN FLUX STUDY

BACKGROUND, GOALS, ORGANIZATION, AND NEXT STEPS

1987

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH
INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS



LEGEND:

——— FORMAL SPONSORSHIP

– – – – INFORMAL RELATIONSHIP

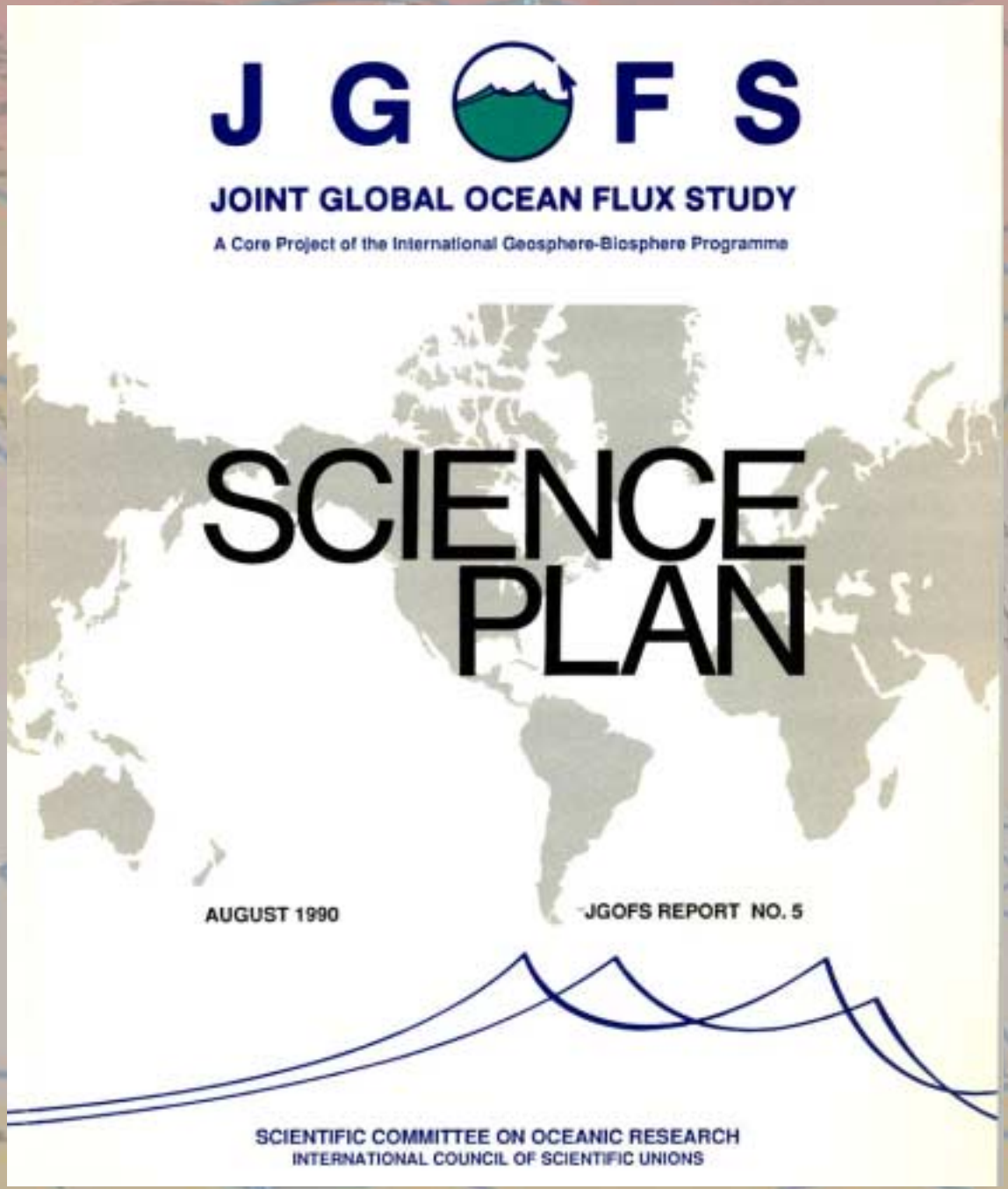
NON-GOVERNMENTAL ORGANIZATION

INTERGOVERNMENTAL ORGANIZATION

COSPONSORED BODY

Lesson Learned

Don’t underestimate needs for programmatic infrastructure, and endeavor to ensure rapid and full access to all data generated by the program’s scientists.


J G F S
JOINT GLOBAL OCEAN FLUX STUDY
A Core Project of the International Geosphere-Biosphere Programme
SCIENCE PLAN
AUGUST 1990
JGOFS REPORT NO. 5
SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH
INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

1990

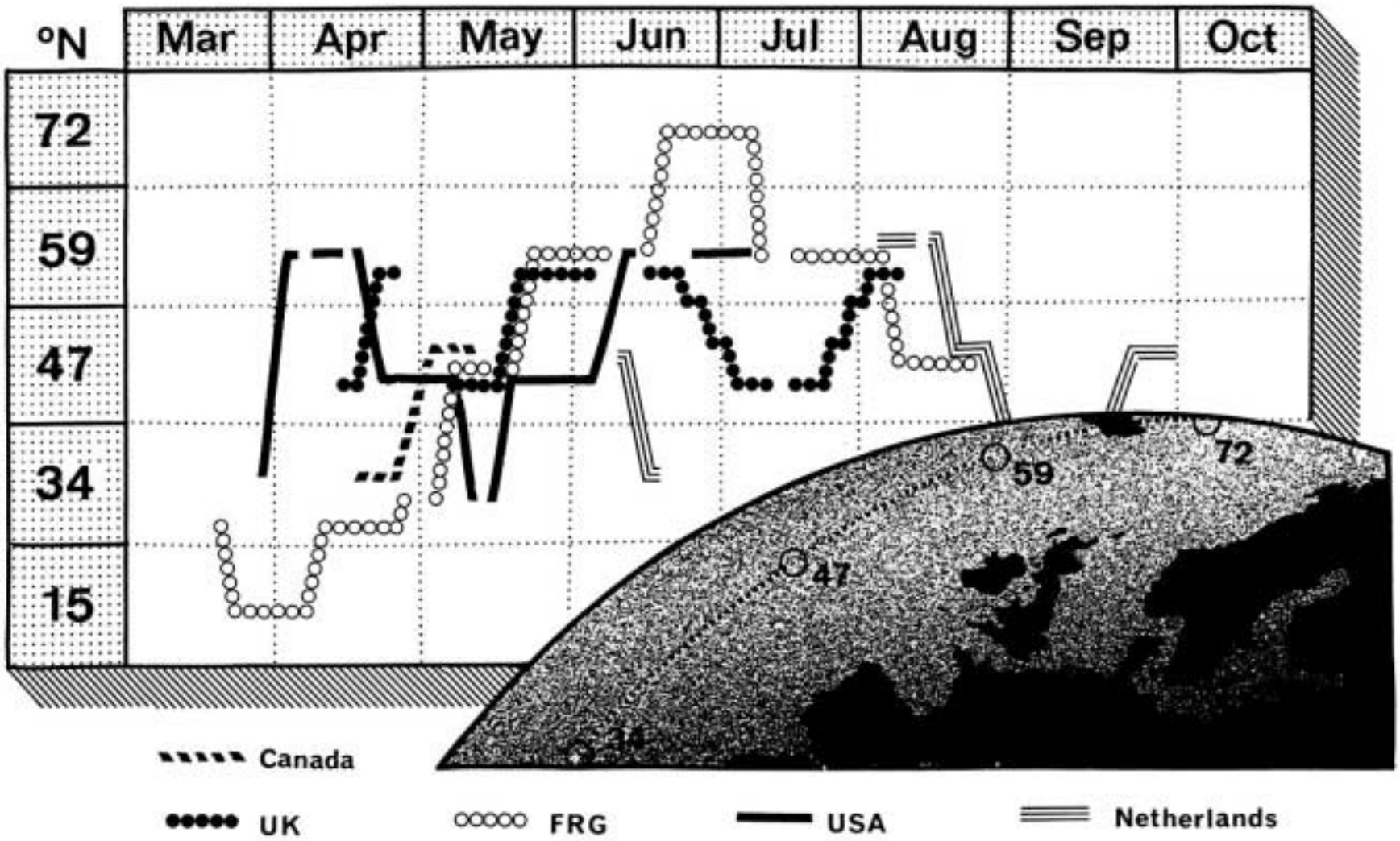
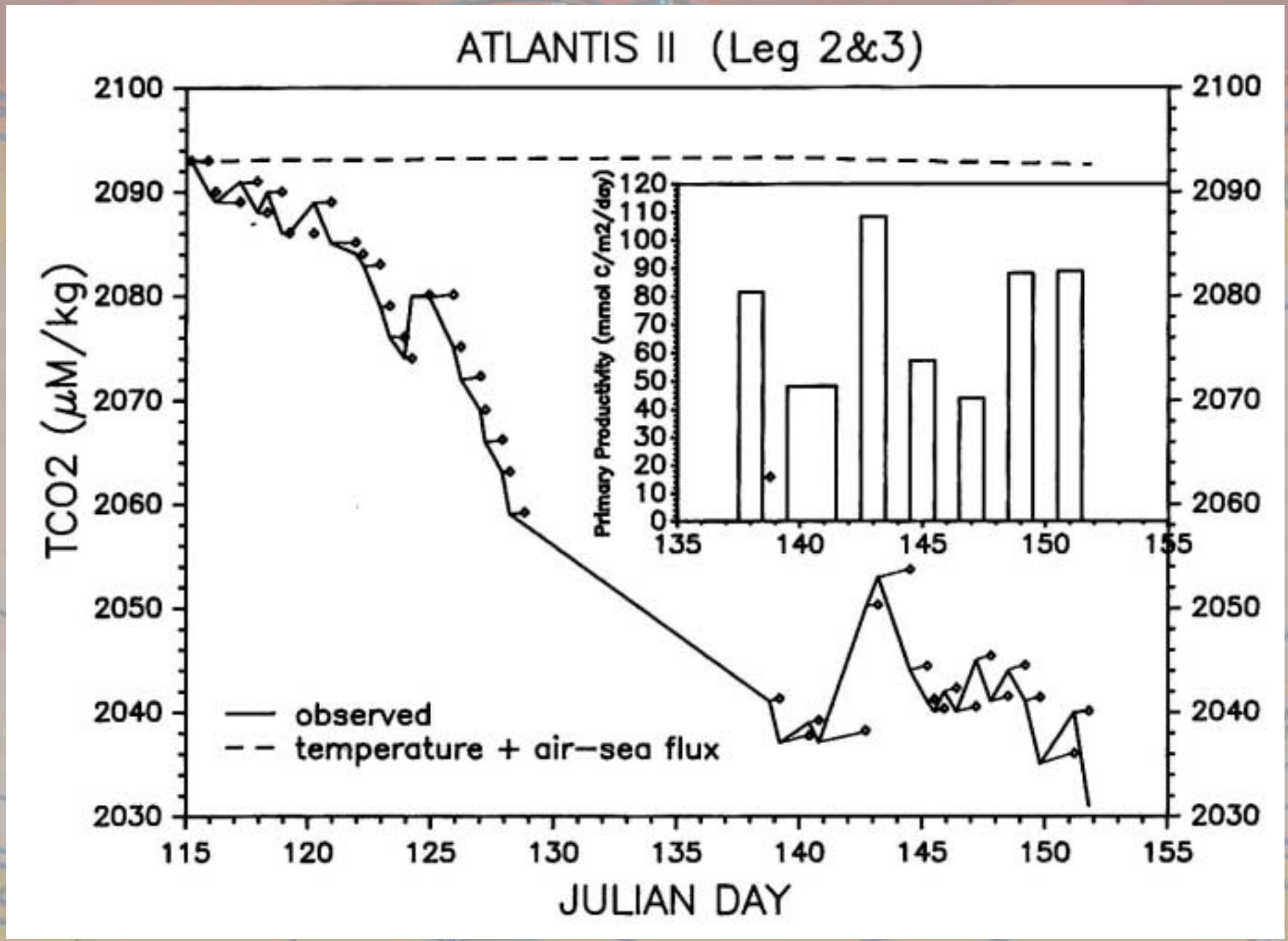
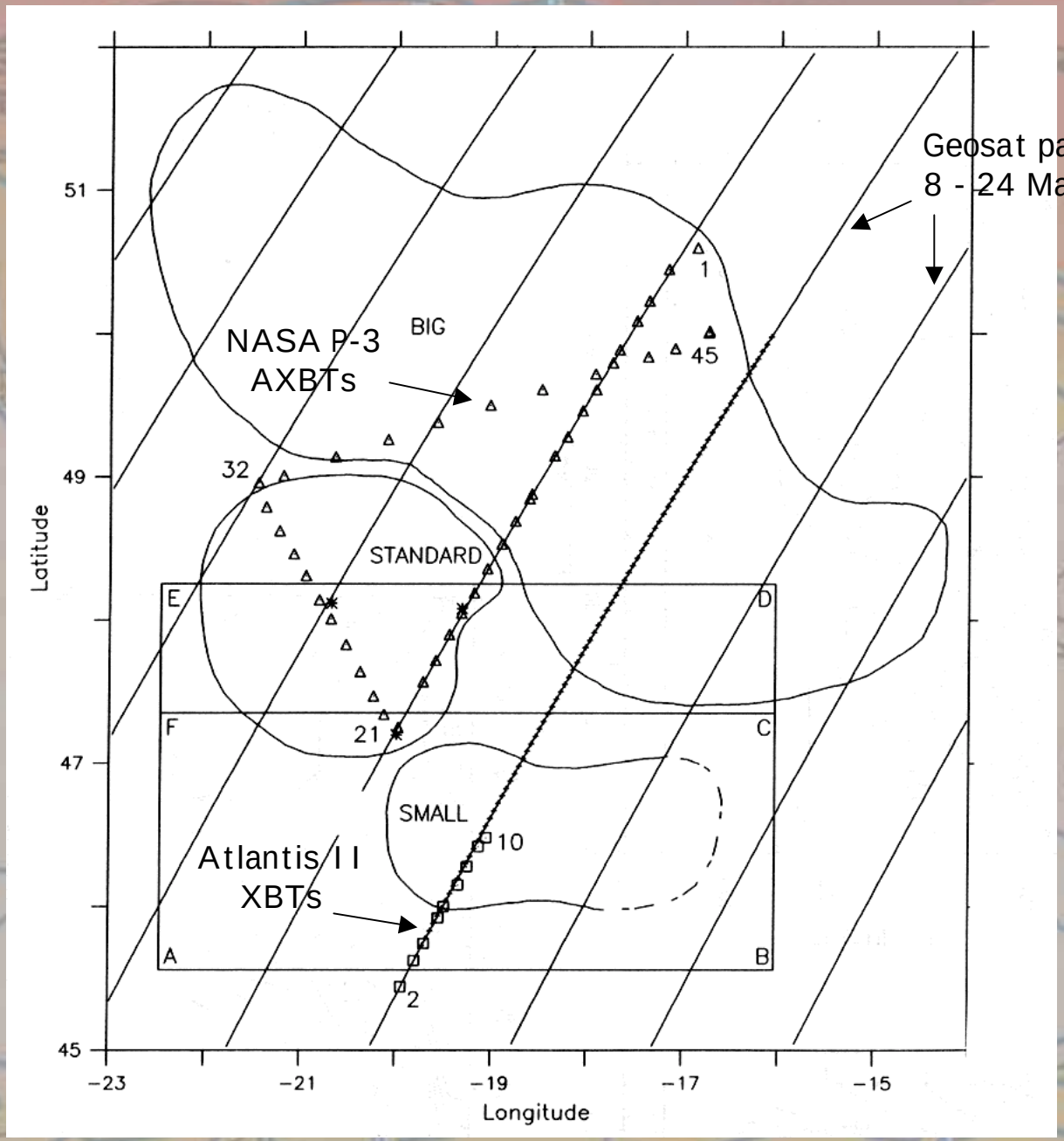
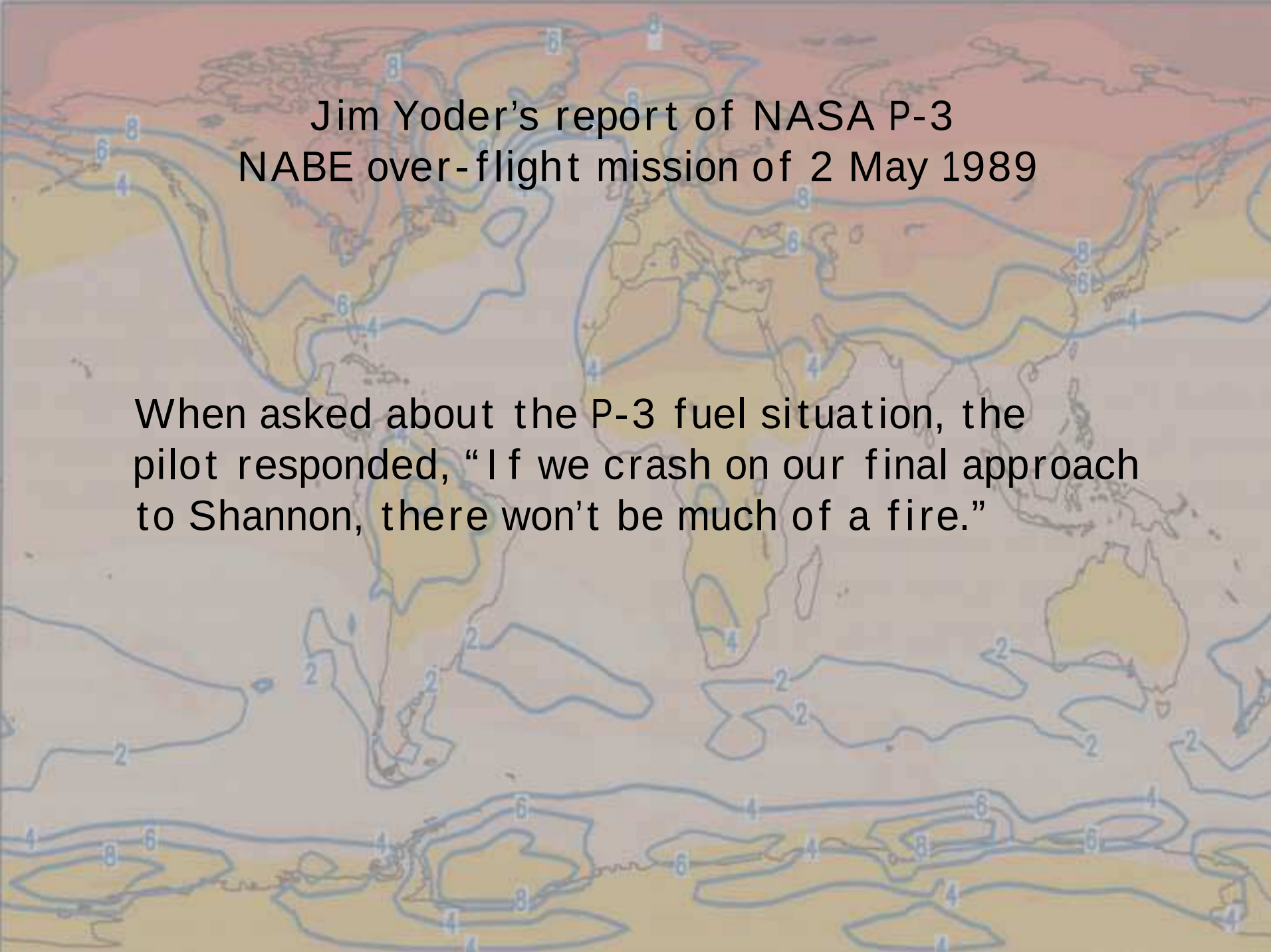


Fig. 6. *Ship coverage during the JGOFS 1989 North Atlantic Pilot Study.*


ATLANTIS II (Leg 2&3)
TCO2 (μM/kg)
JULIAN DAY
observed
temperature + air–sea flux
Primary Productivity (mmol C/m2/day)
2100
2090
2080
2070
2060
2050
2040
2030
115
120
125
130
135
140
145
150
155
0
10
20
30
40
50
60
70
80
90
100
110
120


Geosat passes
8 - 24 May 1989
NASA P-3
AXBTs
Atlantis II
XBTs
BIG
STANDARD
SMALL
A
B
C
D
E
F
1
45
32
21
10
2
51
49
47
45
−23
−21
−19
−17
−15
Latitude
Longitude



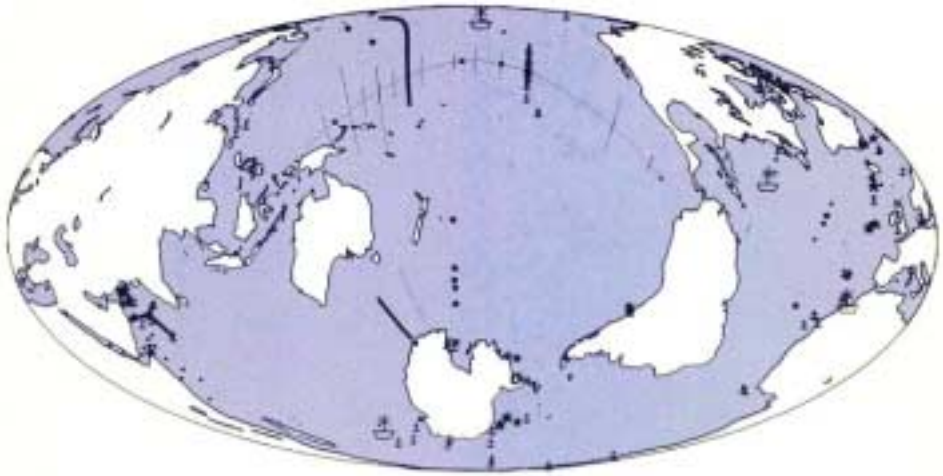
Jim Yoder's report of NASA P-3 NABE over-flight mission of 2 May 1989

When asked about the P-3 fuel situation, the pilot responded, "If we crash on our final approach to Shannon, there won't be much of a fire."

GLOBAL CHANGE

IGBP

IGBP REPORT No. 23



Joint Global Ocean Flux Study
Implementation Plan

J G O F S REPORT NO. 9

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH
INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

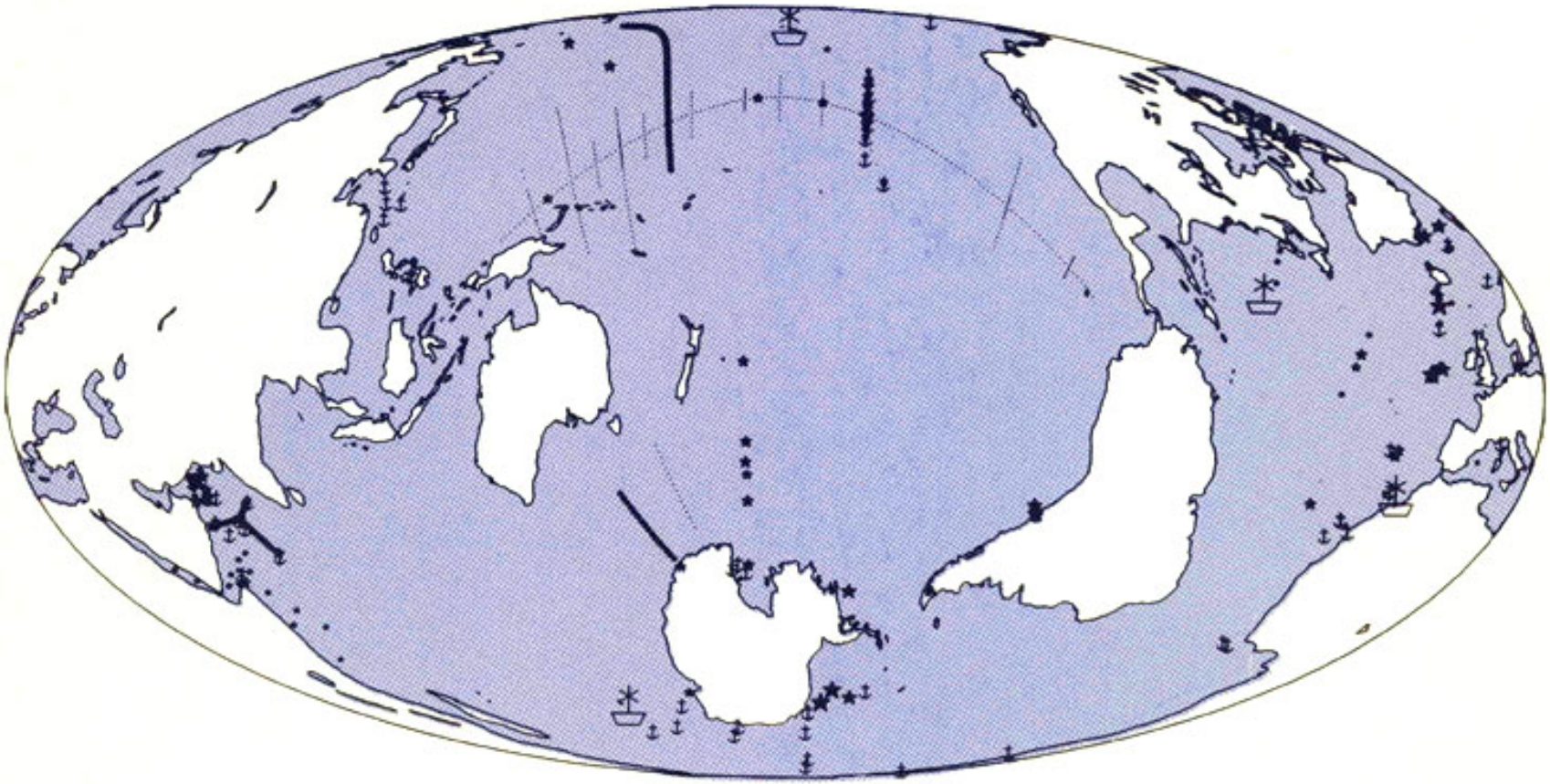
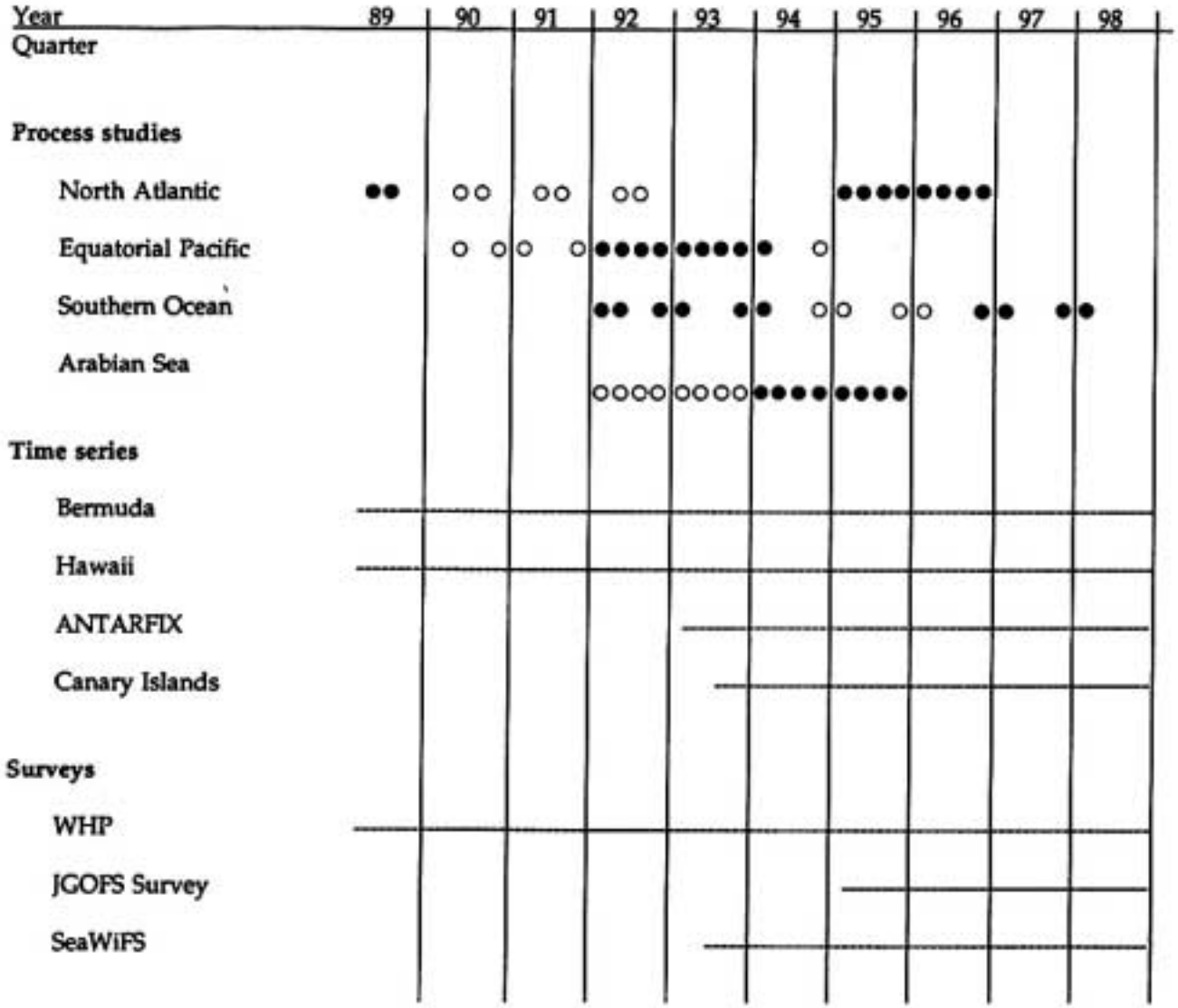


Table 1. Provisional schedule of main JGOFS field activities 1989 - 1998.

● denotes times of intensive, internationally coordinated activity
○ denotes times of extra, national contributions



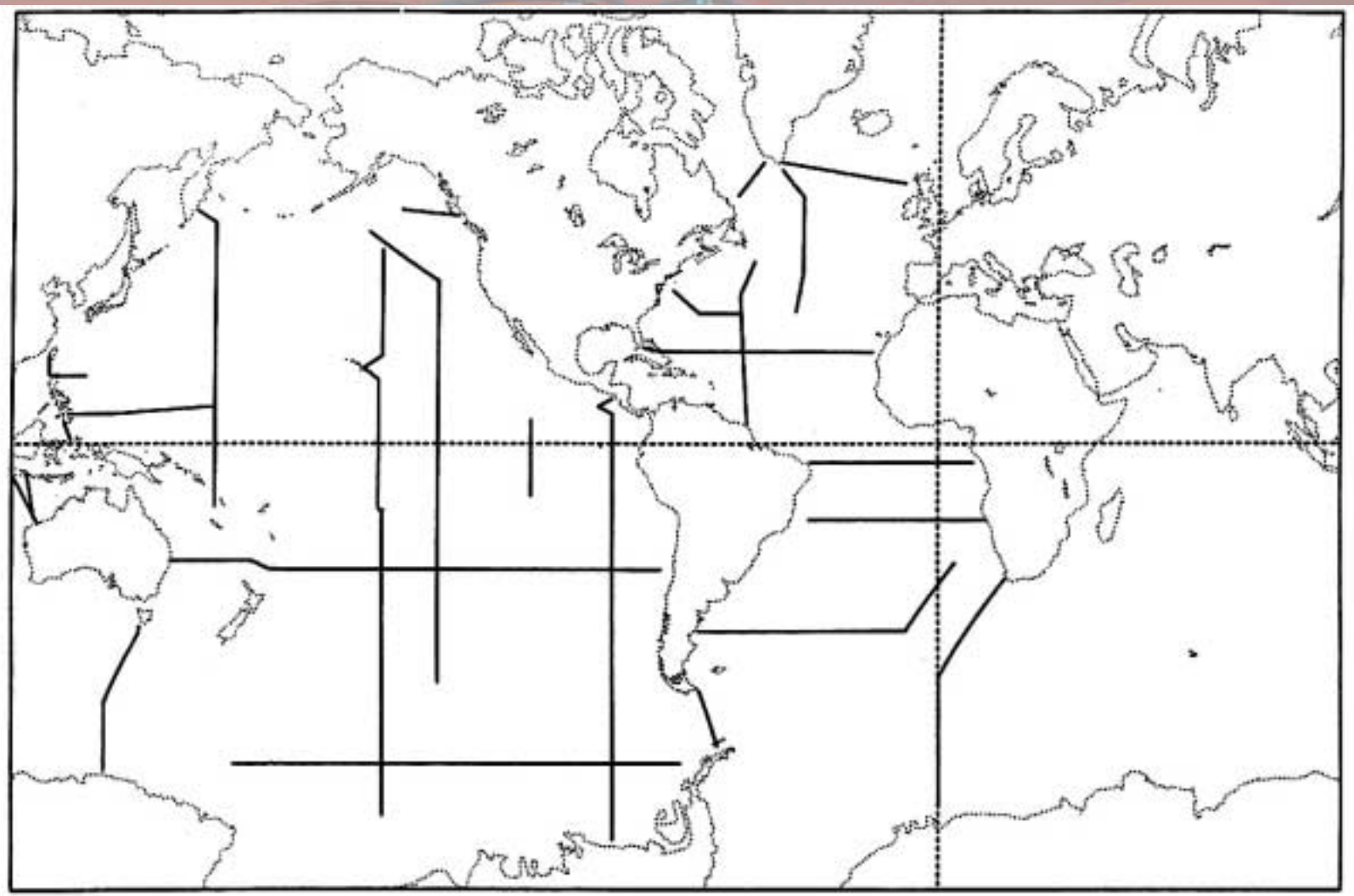


Figure 2. The carbon dioxide survey.

Transects along which CO_2 has already been measured (either in JGOFS cruises or on cruises of the WOCE Hydrographic Programme) or will be measured by the end of 1992. WHP transects in subsequent years will cover at least as much again.

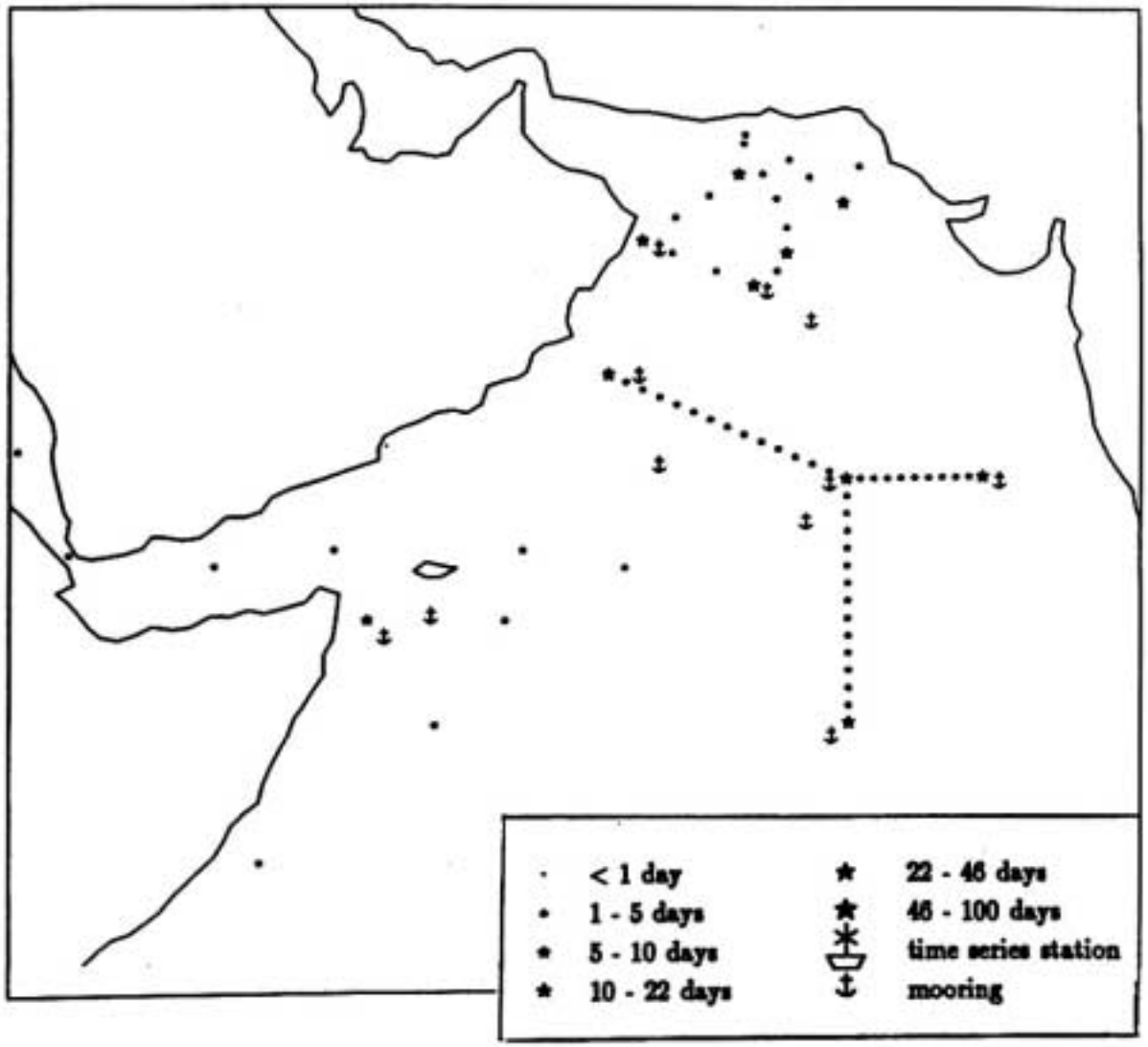


Figure 6. Arabian Sea process study.

This includes accomplished or planned work by Pakistan, the Netherlands, Germany, USA and India. Work by other countries bordering the region, and by the UK, is being planned.

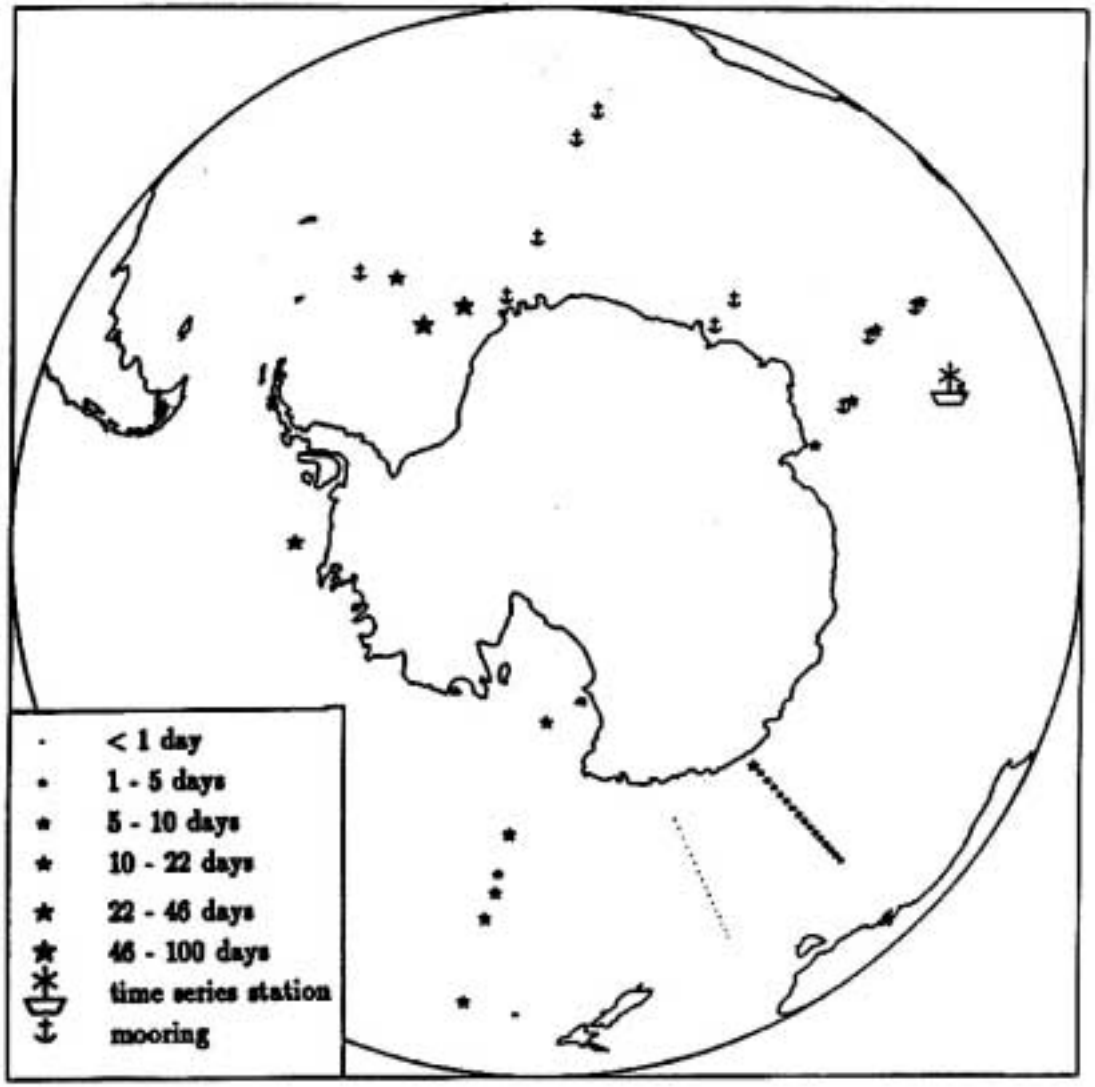


Figure 5. Southern Ocean process study.

This include planned work by the USA, UK, France, Germany, Japan and Australia. Positions are approximate: they will depend on the positions of the ice edge and polar front at the time of the cruises.

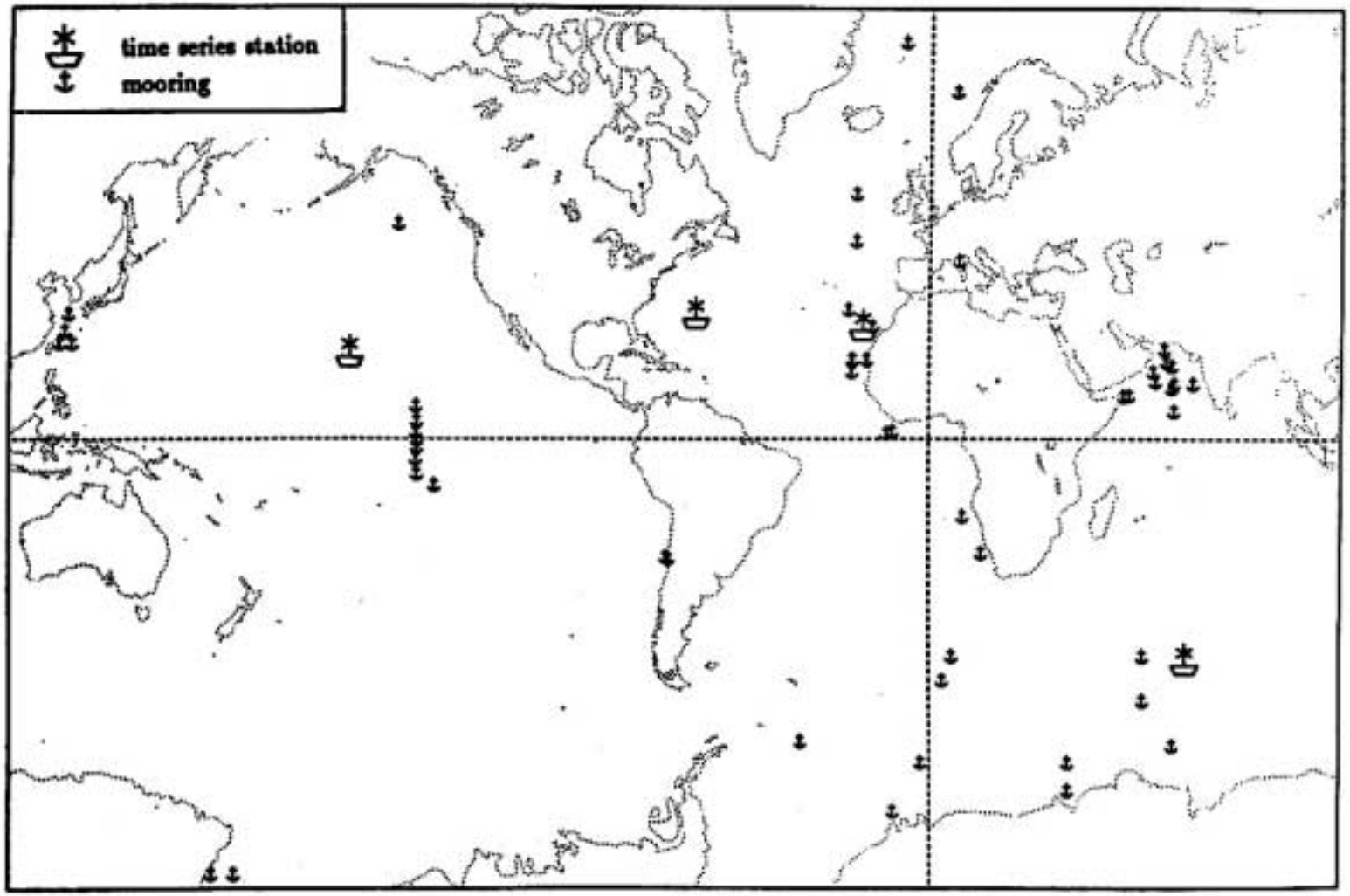


Figure 7.

Time series and long-term sediment trap moorings. The list of moorings comprises those that have been reported to the JGOFS Project Office.

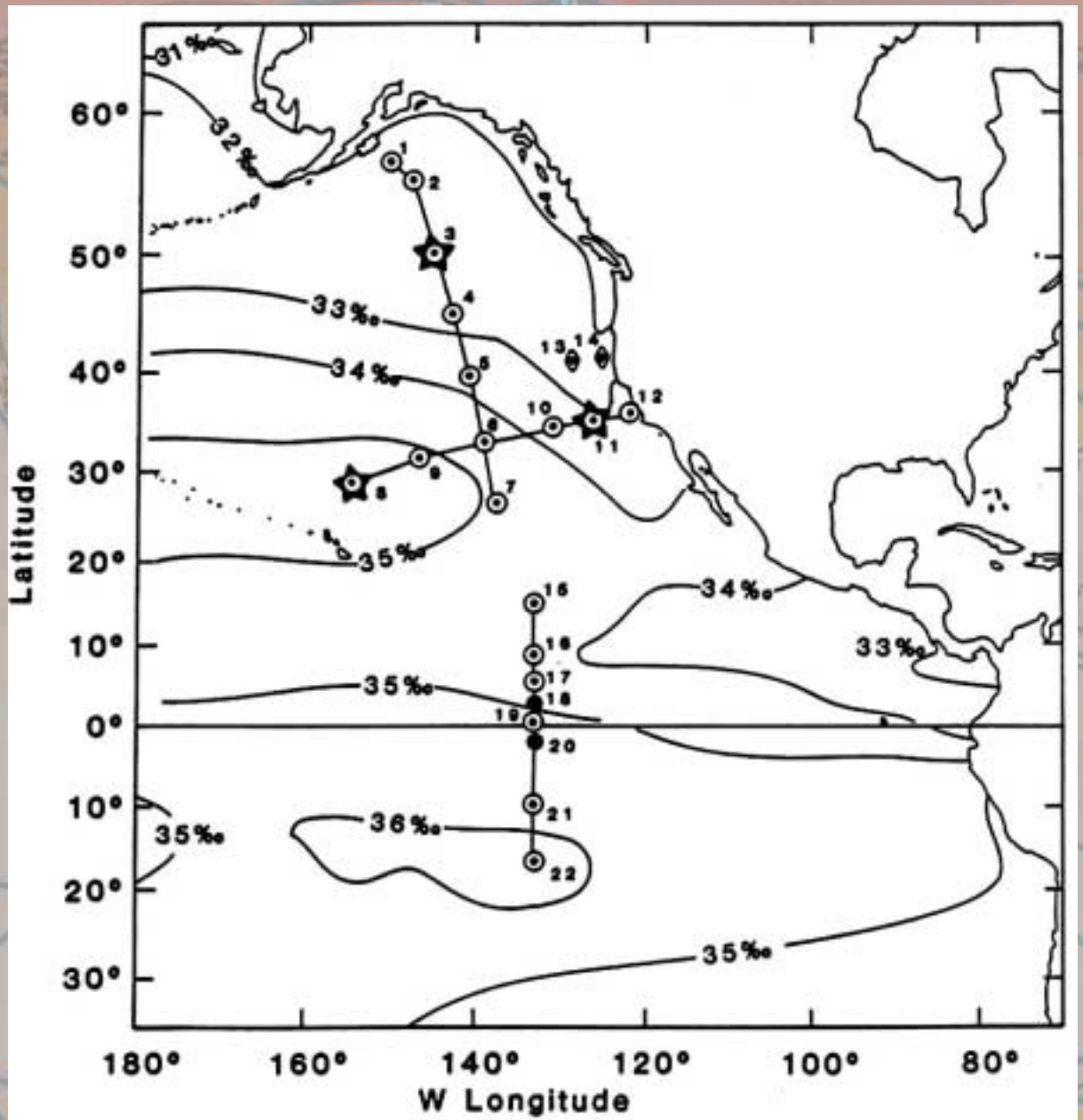
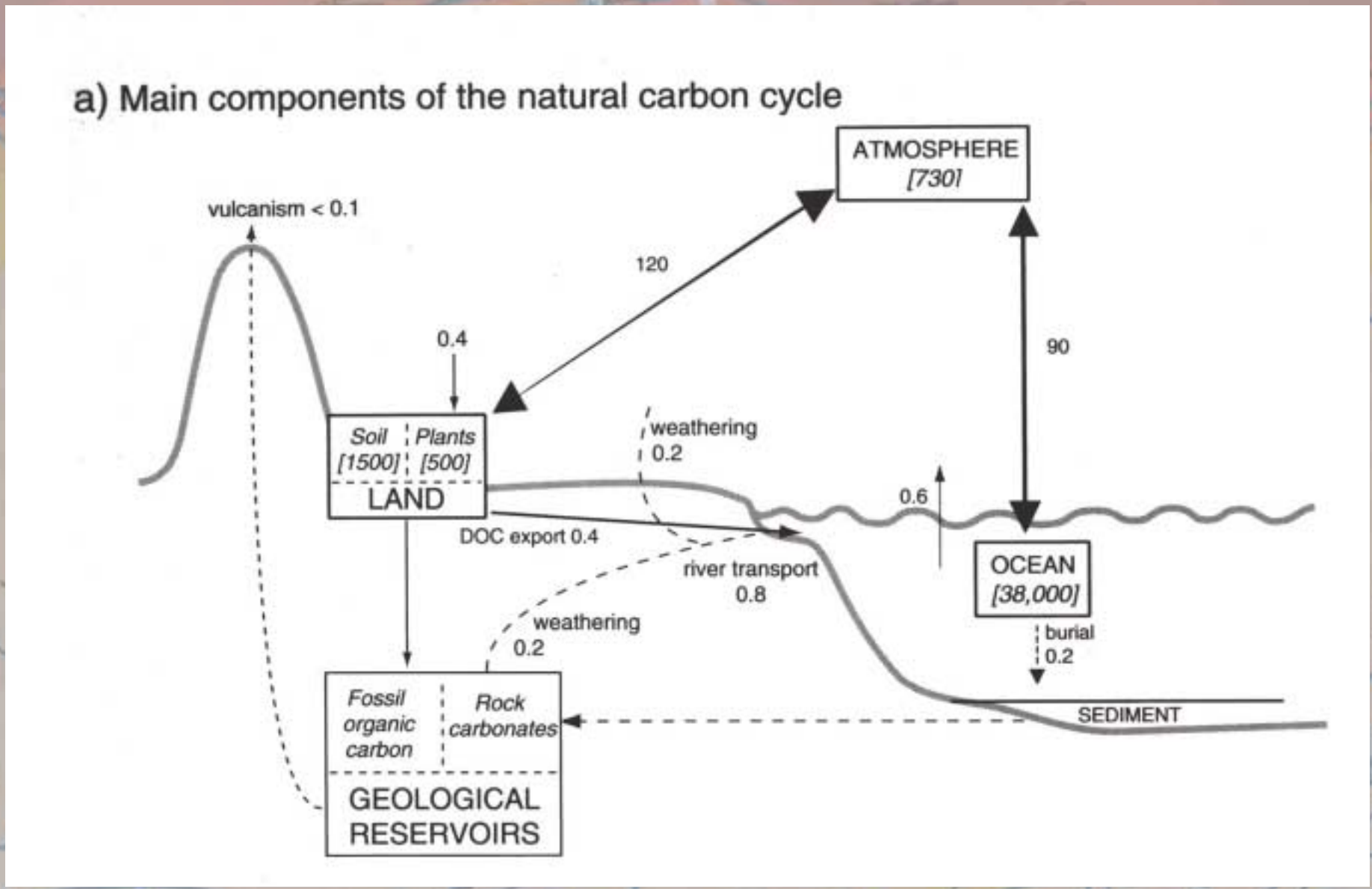


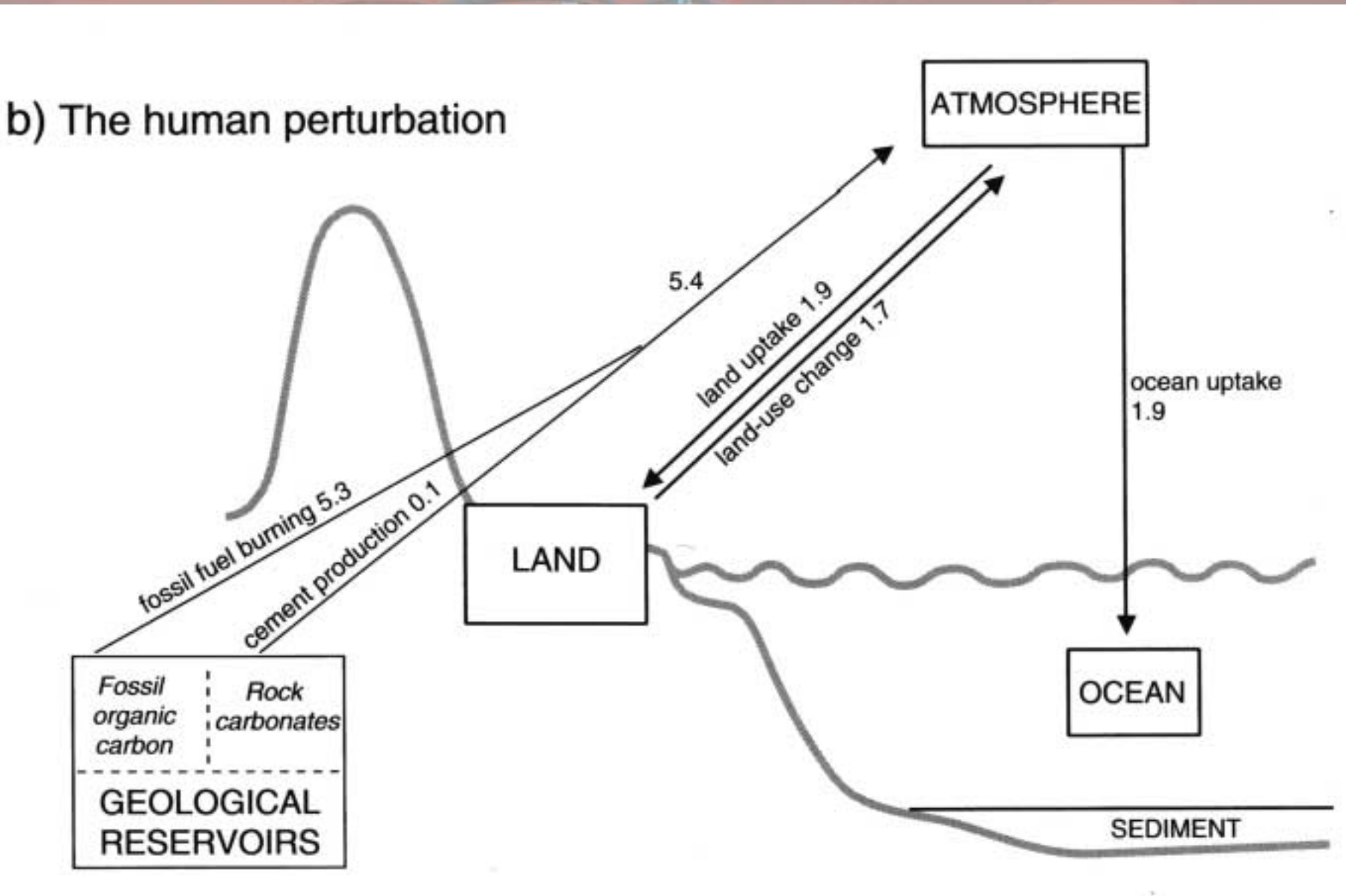
Fig. 3. GOFS North Pacific cruise track and equatorial transect (U.S. GOFS Pacific Working Group; J. Martin, Moss Landing Marine Laboratory, chair).

Lesson Learned

Don’t be afraid to jettison some plans

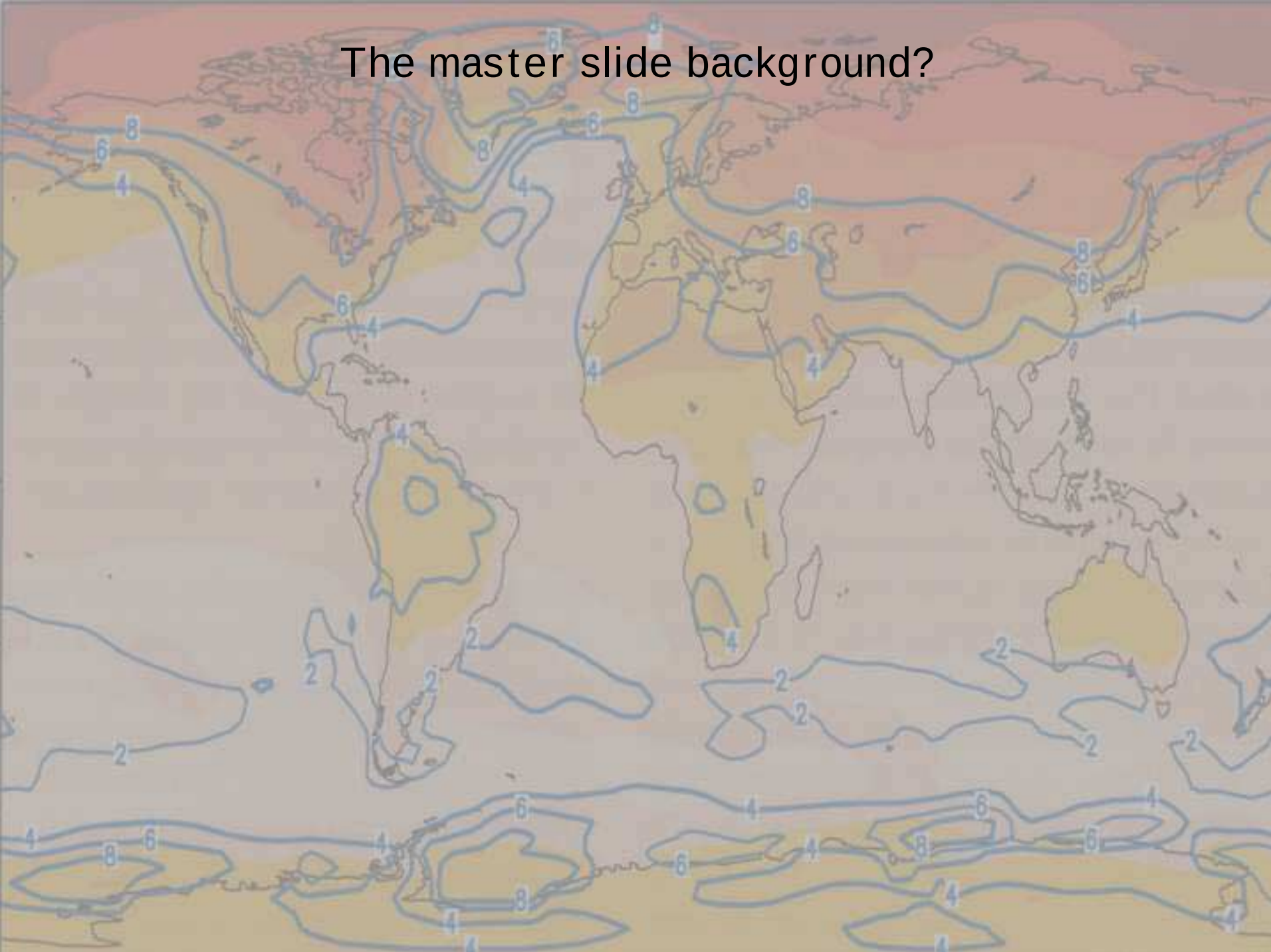


Carbon reservoirs (PgC) and fluxes (PgC/yr) (IPCC 2001)

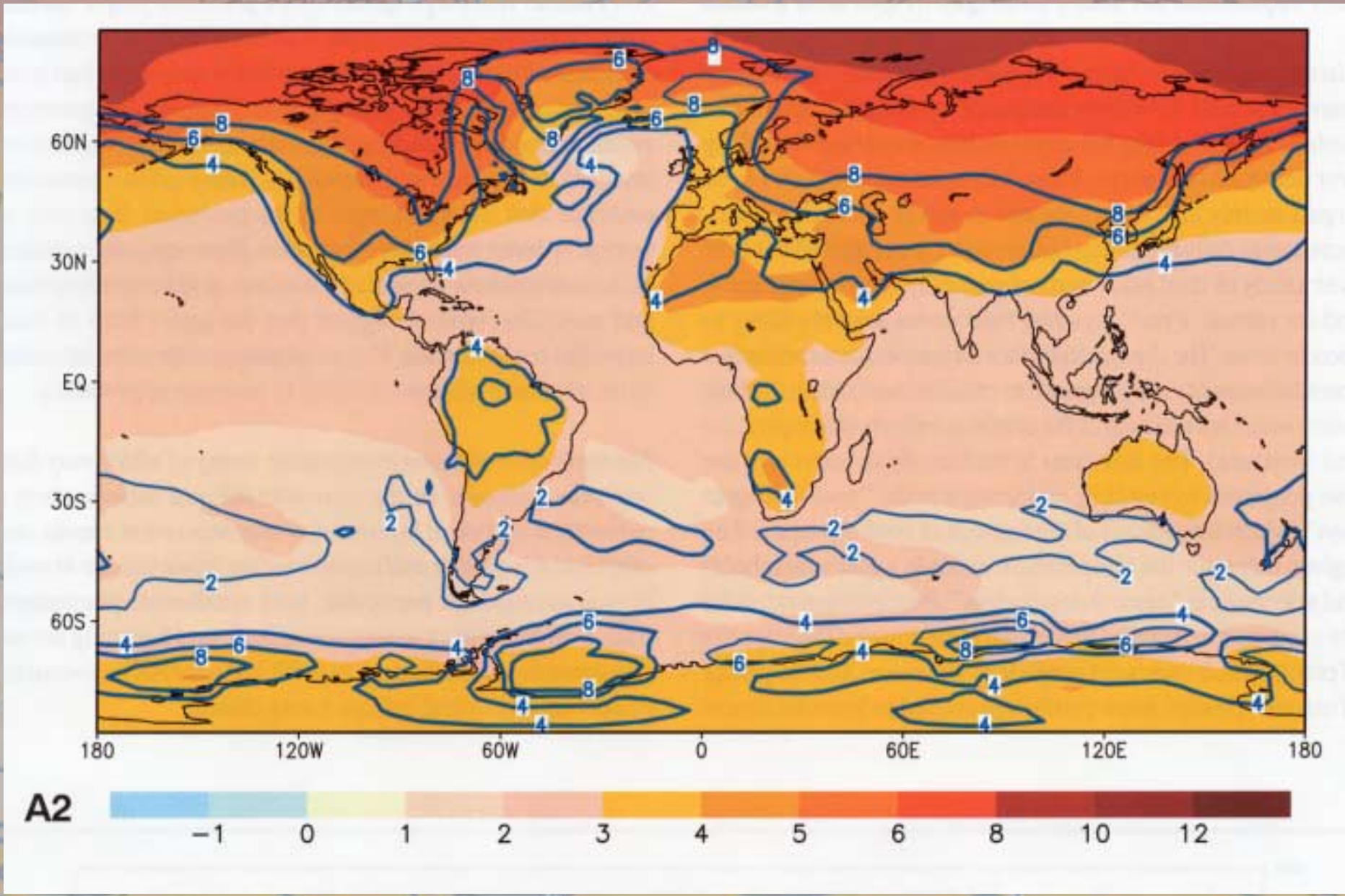


Carbon reservoirs (PgC) and fluxes (PgC/yr) (IPCC 2001)

The master slide background?

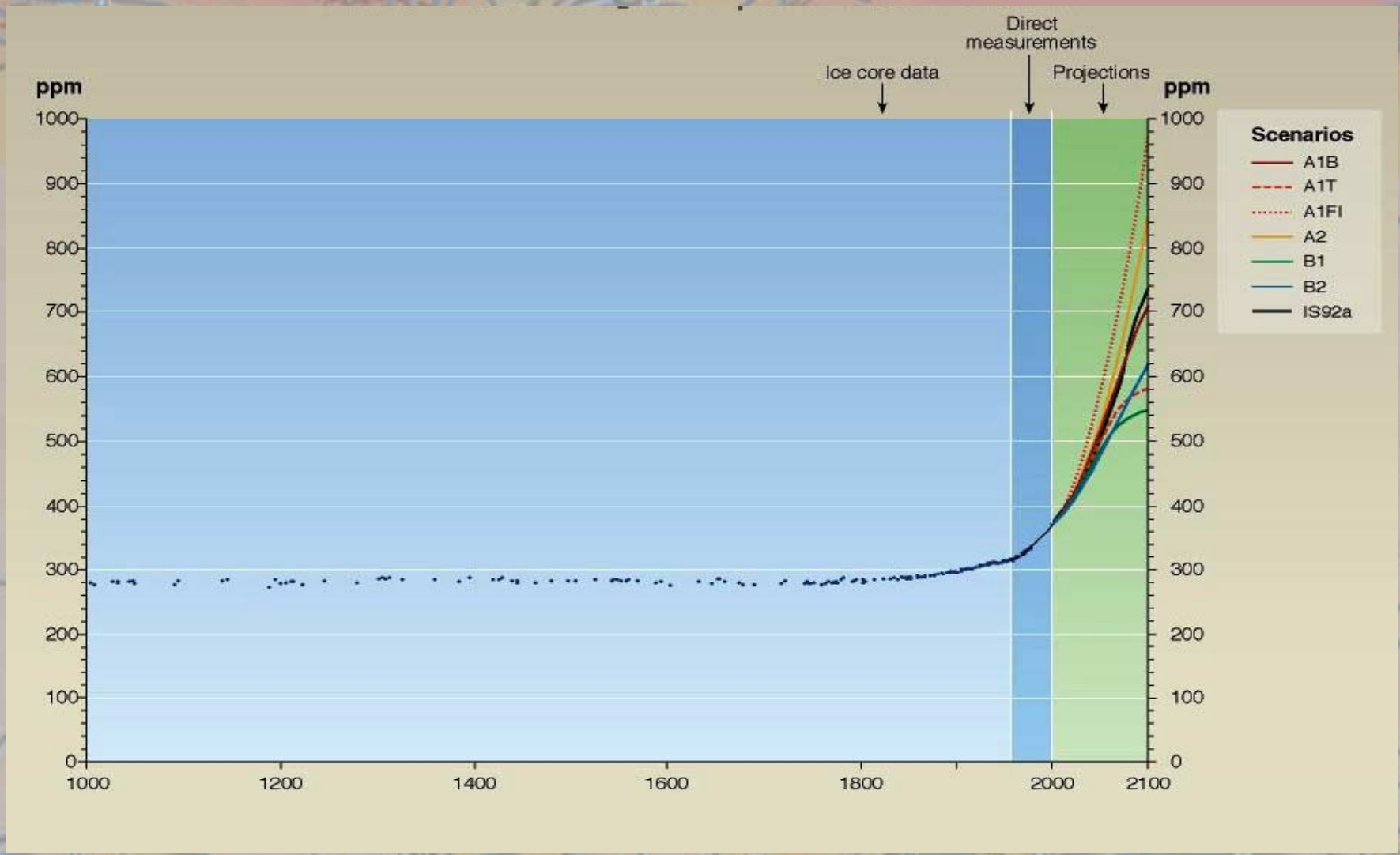


Projected for 2100, IPCC Scenario A2



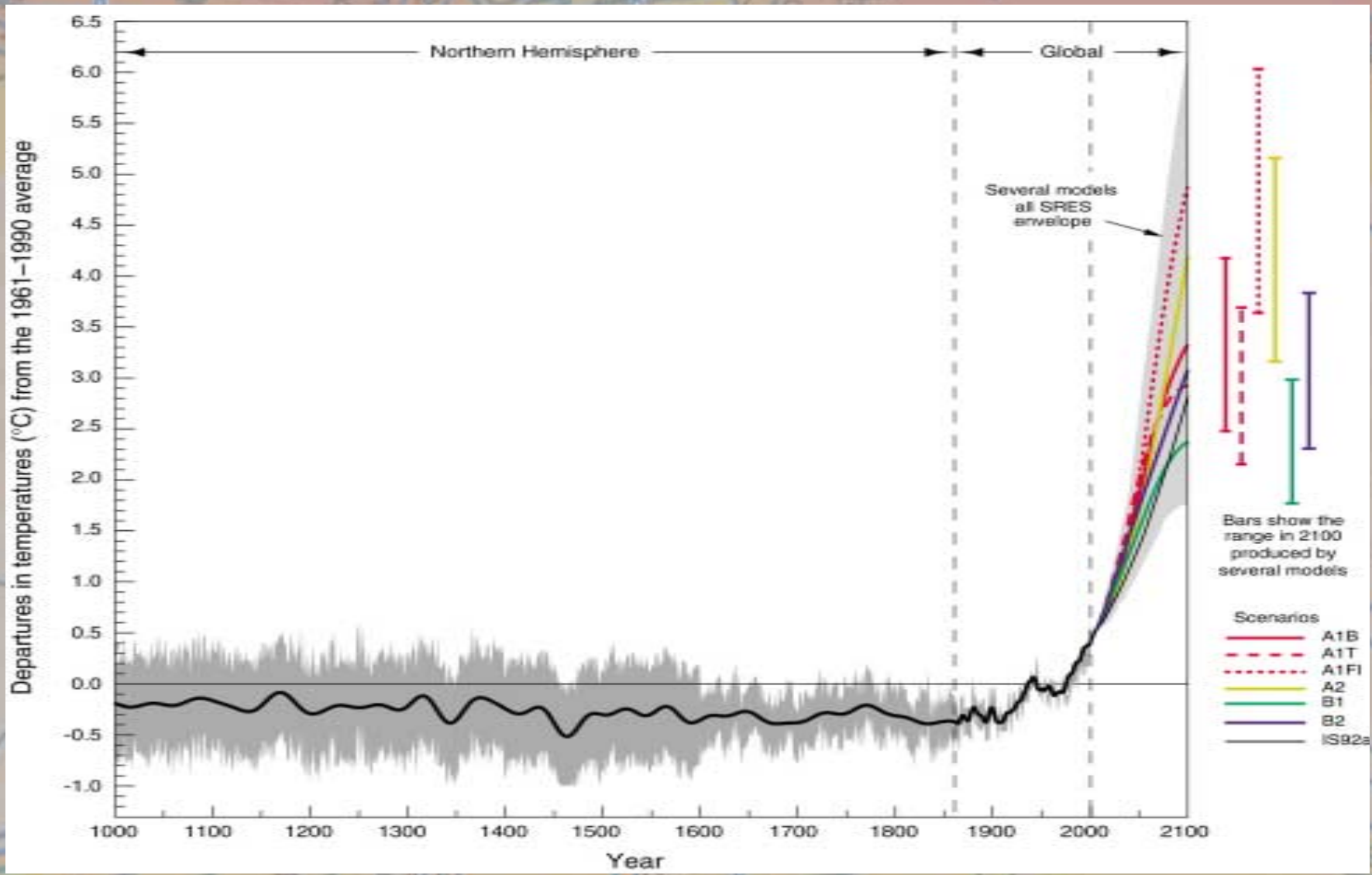
IPCC

Past and future carbon dioxide concentrations



IPCC

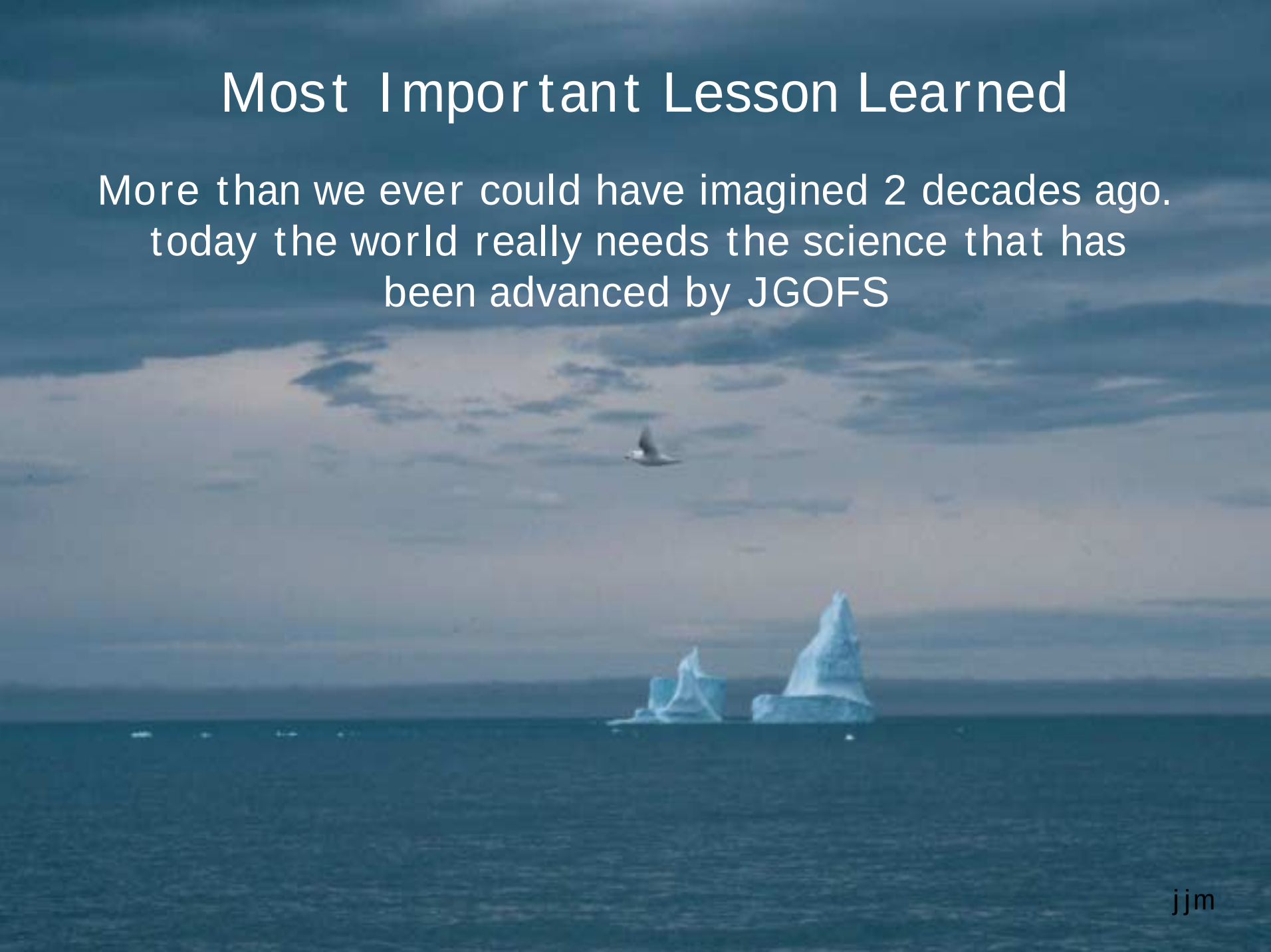
Earth's temperature 1000 - 2100



IPCC

Most Important Lesson Learned

More than we ever could have imagined 2 decades ago. today the world really needs the science that has been advanced by JGOFS



jjm