

U.S. JGOFS Data Management *a retrospective*

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U.S. JGOFS Data Management Office

26 May 2005

Data Management / Data Policy Discussion

Washington, DC



Topics in today's presentation:

■ Introduction

- What is U.S. JGOFS?
- What is the DMO?

■ Lessons Learned

- U.S. JGOFS data server
 - JGOFS d-DBMS and user interface
 - Live Access Server

What is U.S. JGOFS?

U.S. Joint Global Ocean Flux Study

- part of multinational JGOFS
- U.S. Global Change Research Program (US GCRP), Scientific Committee on Oceanic Research (SCOR), and International Geosphere-Biosphere Programme (IGBP)
- long term (U.S. 1989-2005)
- multidisciplinary (bio, chem, PO, geology)
- process studies (U.S. 1989-1998), time-series, global surveys, synthesis and modeling, data management
- investigate ocean carbon flux

U.S. JGOFS

Data Management Office (DMO)

- formed in 1988 specifically to meet needs of U.S. JGOFS
- assist PIs to submit their data to DMO
- ongoing quality control of data
- develop and maintain simple, reliable interface to program data
- provide timely, easy access to project results
- collaborate with other program DMO
- publish U.S. JGOFS data reports
- plan final archive of U.S. JGOFS information



Basic Principles of Data Management

from 1988 JGOFS Working Group on Data Management

- scientists will generate data in a format useful for their needs
- oceanographic data sets are best organized in terms of metadata (temporal and geographical)
- data managers should avoid use of coded data values
- users should be able to obtain all the data they require from one source and in a consistent format
- data interchange formats should be designed for the convenience of scientific users

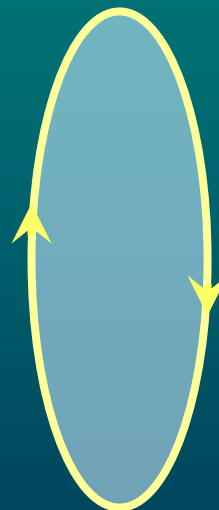
Additional Guidelines

- metadata is critical and therefore mandatory
- data managers should maintain awareness of emerging standards and strive for compliance
- whatever interface is used to provide access to the data, it's still important to provide subset and download capability
- data management systems must be dynamic - balancing tension between existing and new technologies

Basic Components of a Data Management System

first four components are active throughout the program

- data acquisition
 - from variety of sources
- quality assurance
- data publication
- synthesis and modeling



-
- archive

lesson defined . . .

1 : a passage from sacred writings read in a service of worship

2 a : a piece of instruction **b** : a reading or exercise to be studied by a pupil **c** : a division of a course of instruction

3 a : something learned by study or experience
b : an instructive example

4 : an edifying example or experience

5 : a reprimand

Lessons Learned . . .

The first lesson learned . . .

is a meta lesson . . .

All the lessons learned take on enhanced meaning when applied to science programs of increasing size and complexity.

Lessons Learned . . .

Lessons Learned . . .

- technology is good; people are more important
 - ✓ diverse range of expertise and personalities
 - ❖ designers, programmers, data managers
 - ✓ someone with authority to set overall vision
- ✓ qualified staff to make effective use of technology
- ✓ guidance from advisory committee which includes active investigators

U.S. JGOFS DMO personnel

- ❖ David Glover (director)
- ❖ Cyndy Chandler (manager)

- ❖ Previous staff members
 - Christine Hammond (manager)
 - George Heimerdinger (data specialist)
 - David Schneider (data specialist)
 - Jeff Dusenberry (data specialist)

Lessons Learned . . .

- develop a data policy, publicize and follow it
 - ✓ guidance from steering committee
 - ✓ consent from participating investigators
 - ✓ reiterate at conferences and workshops
 - ✓ encourage compliance
- ✓ agree on method of enforcement (used as last resort)

Lessons Learned . . .

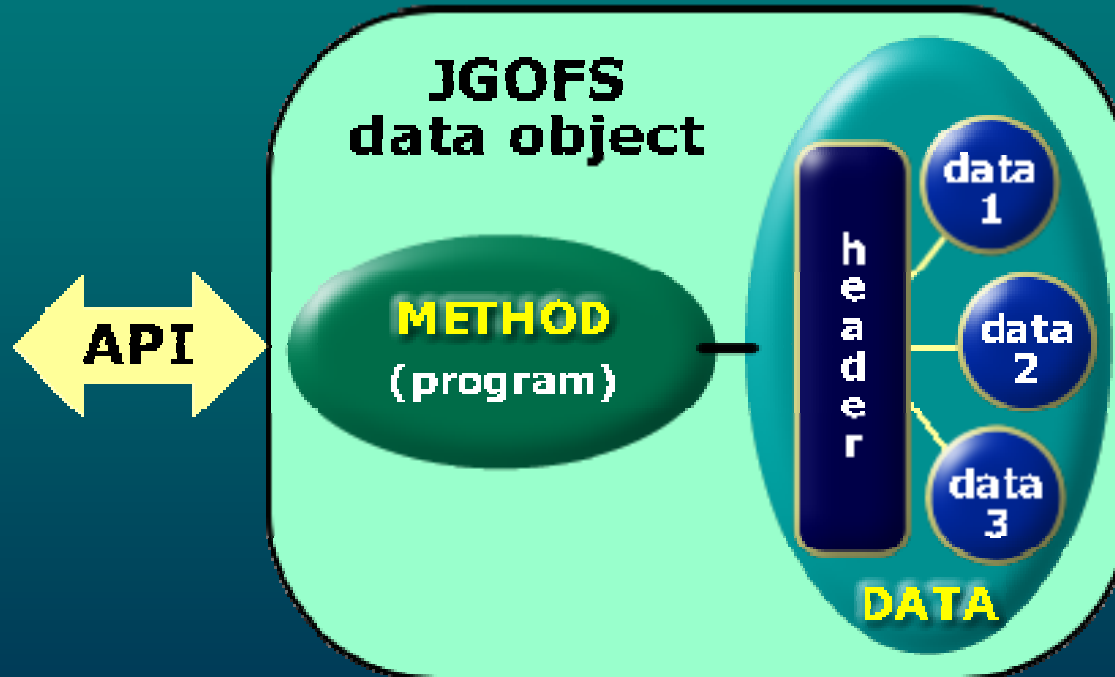
- establish protocols at program start with mechanism for adaptation when necessary
 - ✓ sampling methodologies
 - ✓ naming conventions
 - ❖ parameter dictionary, controlled vocabulary
 - ❖ XML schema, thesauri, ontologies
 - ✓ units of measurement

Lessons Learned . . .

- facilitate contribution of data to collection
 - ✓ compile an inventory of expected results
 - ✓ publish and maintain the inventory
 - ✓ remind investigators of opportunities to contribute data and results to the growing inventory
 - ✓ review procedure at conferences and workshops
 - ✓ accept all formats of data
 - ✓ work with investigators to complete metadata records

JGOFS distributed database management system

JGOFS object = method + data



U.S. JGOFS DMO accepted any format data from the field study investigators and used methods to locate and translate the data objects

Lessons Learned . . .

➤ metadata is of critical importance

- ❖ accurate, complete, available with data
- ❖ monitor emerging standards
- ❖ define minimal metadata requirements
- ❖ standards-compliant solutions where possible
- ❖ complete metadata record enables reuse of data

➤ metadata assembly is time consuming, but is the key to enabling secondary (reuse) of data

The screenshot shows a Netscape browser window with the address bar containing `http://usjgofs.whoi.`. The page content includes a title 'bottle', a list of metadata fields (PI, dataset, project/cruise, ship), several hyperlinks, and a table with three columns: Parameter, Description, and Units.

Directory... **Data display...**

bottle

PI: Lou Codispoti
dataset: Temp, salinity, nutrients from Niskin bottles
project/cruise: Arabian Sea/TTN045 - Process Cruise 2
ship: Thomas Thompson

[Final Recalibration changes \(10/28/96\)](#)
[PI Notes and Methodology](#)
[DMO note on calculated depth](#)

Parameter	Description	Units
event	a unique number assigned to each sampling operation consisting of month MM, day DD hour HH and minute mm	
sta	station number	
sta_std	Arabian Sea standard station identifier	
cast	CTD cast number	
date	date (YYYYMMDD) decoded as follows YYYY = year, MM = month, DD = day Date converted to UTC (GMT).	
time_begin	start time of cast in UTC (GMT)	decimal hours
time_end	end time of cast in UTC (GMT)	decimal hours
lat_begin	start latitude of cast (negative = South)	decimal degrees
lon_begin	start longitude of cast (negative = West)	decimal degrees
lat_end	end latitude of cast	decimal degrees
lon_end	end longitude of cast	decimal degrees
bot	CTD rosette bottle number	
press	sample depth reported as pressure	decibars

metadata

Lessons Learned . . .

- quality assurance is an ongoing process
 - ❖ intense QA process during initial acquisition and ingestion into data system
 - ❖ problems discovered as data are utilized by others
 - ◇ insufficient or inaccurate metadata
 - ❖ process of data product synthesis becomes a valuable diagnostic tool for improving data quality

Lessons Learned . . .

- begin synthesis early
 - ✓ do not wait until all the data has been collected
 - ✓ synthesized products greatly enhance the growing collection of data

Lessons Learned . . .

- provide timely, easy access to project results
- develop and maintain simple, reliable interface to data collection
 - ❖ single interface to entire data collection
 - ❖ balance tension between new innovative technologies and existing stable implementations
 - ❖ if an interface is broken, it doesn't matter how great the original concept was

skip data system tech details



U.S. JGOFS Data Server

- JGOFS distributed database management system (d-DBMS) used for field data
- Live Access Server (LAS) used for gridded, synthesis and model results

U.S. JGOFS

U.S. Joint Global Ocean Flux Study

General Information | What's New | Research | Publications | Data

HOME | CONTACTS | RELATED LINKS | SEARCH | SITE INDEX

US JGOFS Data System

[Help](#) | [Search...](#) | [JGOFS Data Protocols](#) | [US JGOFS Home](#)

Data Acknowledgement Policy

The data available here are intended solely for scholarly use by the academic and scientific community, with the express understanding that any such use will properly acknowledge the originating Investigator. Anyone wishing to use U.S. JGOFS data in a presentation, report, thesis or publication should contact the originating PI. It is expected that all customary courtesies and privileges attached to data use will be strictly honored. Use or reproduction of any material herein for any commercial purpose is prohibited without prior written permission from the U.S. JGOFS Data Management Office. The complete copyright information is available [here](#).

The merged data products are available via the [Live Access Server](#).

US JGOFS Data Categories

Go to the indicated category of data by clicking on its name

- [jgofs](#) ← you are here
- [SMP_results](#)
- [arabian](#)
- [ttn-039](#)
- [ttn-043](#)
- [ttn-044](#)
- [ttn-045](#)
- [ttn-049](#)
- [ttn-050](#)
- [ttn-053](#)
- [ttn-054](#)
- [bats](#)
- [espac](#)
- [tt007](#)
- [tt008](#)
- [tt011](#)
- [tt012](#)

U.S. JGOFS
 data server web interface
 to data catalog

[Data](#)

JGOFS Distributed Database Management System (d-DBMS)

- distributed, object-oriented system
- originally developed by Glenn Flierl, James Bishop, Satish Paranjpe, David Glover
- supports multidisciplinary, multi-institutional data acquisition project
- multiple data storage formats and locations
- data interpreted by ‘methods’

http://usjgofs.who.edu/jg/serv/jgofs/arabian/ttn-045/bottle

/jgofs/arabian/ttn-045/bottle ---- Level 1

Directory... Documentation Plotting and Other Operations...

Level 0 Next level Flat listing

```

# version May 8, 2000
# Lou Codispoti
# Hydrographic data (temp, salinity and nutrients)
# Thomas Thompson TTN-045, Process Cruise 2 to Arabian Sea
#
=====
event      sta  sta_std  cast  date      time_begin  time_end  lat_begin  lon_begin  lat_end  lon_end
-----
03142214  1    N1       1     19950314  22.2461    22.9030  22.38423  59.88413  23.38506  58.87938
=====
bot  press  depth  temp  sal_ctd  sal_bot  O2_ml_L  O2_umol_kg  O2_umol_L  NO3  P04  Si04  NO2
-----
24  1.9    1.9    23.792  36.594  36.593  nd      nd          nd          5.07  0.79  3.4   0.49
23  1.8    1.8    23.788  36.594  36.589  4.254  185.33     189.98     5.12  0.81  3.4   0.49
22  12.0   11.9   23.793  36.594  36.590  nd      nd          nd          5.25  0.81  3.4   0.51
21  12.0   11.9   23.792  36.594  36.589  4.214  183.58     188.19     5.30  0.81  3.4   0.52
20  22.0   21.9   23.791  36.594  nd      nd      nd          nd      nd      nd      nd      nd
19  22.3   22.2   23.766  36.594  36.593  4.084  177.92     182.39     6.12  0.85  3.3   0.64
18  32.1   31.9   23.755  36.606  36.602  nd      nd          nd          5.89  0.84  3.2   0.66
17  32.0   31.8   23.755  36.606  36.601  4.157  181.10     185.65     5.89  0.84  3.2   0.65
16  42.1   41.8   23.659  36.592  36.588  4.078  177.66     182.12     6.69  0.88  3.3   0.38
15  42.2   41.9   23.660  36.592  36.595  4.083  177.88     182.34     6.76  0.89  3.3   0.36
14  52.1   51.8   23.203  36.500  36.544  nd      nd          nd          9.81  1.08  4.8   0.14
13  52.3   52.0   23.302  36.522  36.545  3.421  149.04     152.78     9.92  1.08  4.8   0.14
12  62.4   62.0   22.733  36.460  36.463  2.660  115.88     118.79     13.05  1.35  7.8   0.10
11  62.4   62.0   22.738  36.460  36.464  2.639  114.96     117.86     13.15  1.36  7.8   0.11
10  72.3   71.8   21.868  36.336  36.332  nd      nd          nd          18.49  1.77  11.4  0.09
9   72.1   71.6   21.867  36.336  36.328  1.435  62.51     64.09     18.64  1.79  11.4  0.10
8   102.4  101.7  20.761  36.186  36.185  0.531  23.13     23.71     22.43  2.15  15.4  0.06
7   102.3  101.6  20.760  36.186  36.185  0.525  22.87     23.45     22.47  2.23  15.6  0.06
6   132.4  131.5  19.937  36.142  36.134  0.220  9.58      9.83      23.40  2.38  18.3  0.04
5   132.4  131.5  19.934  36.136  nd      nd      nd          nd      nd      nd      nd      nd
4   162.5  161.4  18.967  36.220  36.223  0.127  5.53     5.67     22.93  2.39  21.1  0.03
3   162.4  161.3  18.965  36.218  36.222  0.130  5.66     5.81     22.92  2.29  20.9  0.03
2   202.8  201.4  18.193  36.356  nd      nd      nd          nd      nd      nd      nd      nd
1   253.2  251.5  17.428  36.404  36.414  0.170  7.40     7.59     22.32  2.35  24.8  0.05

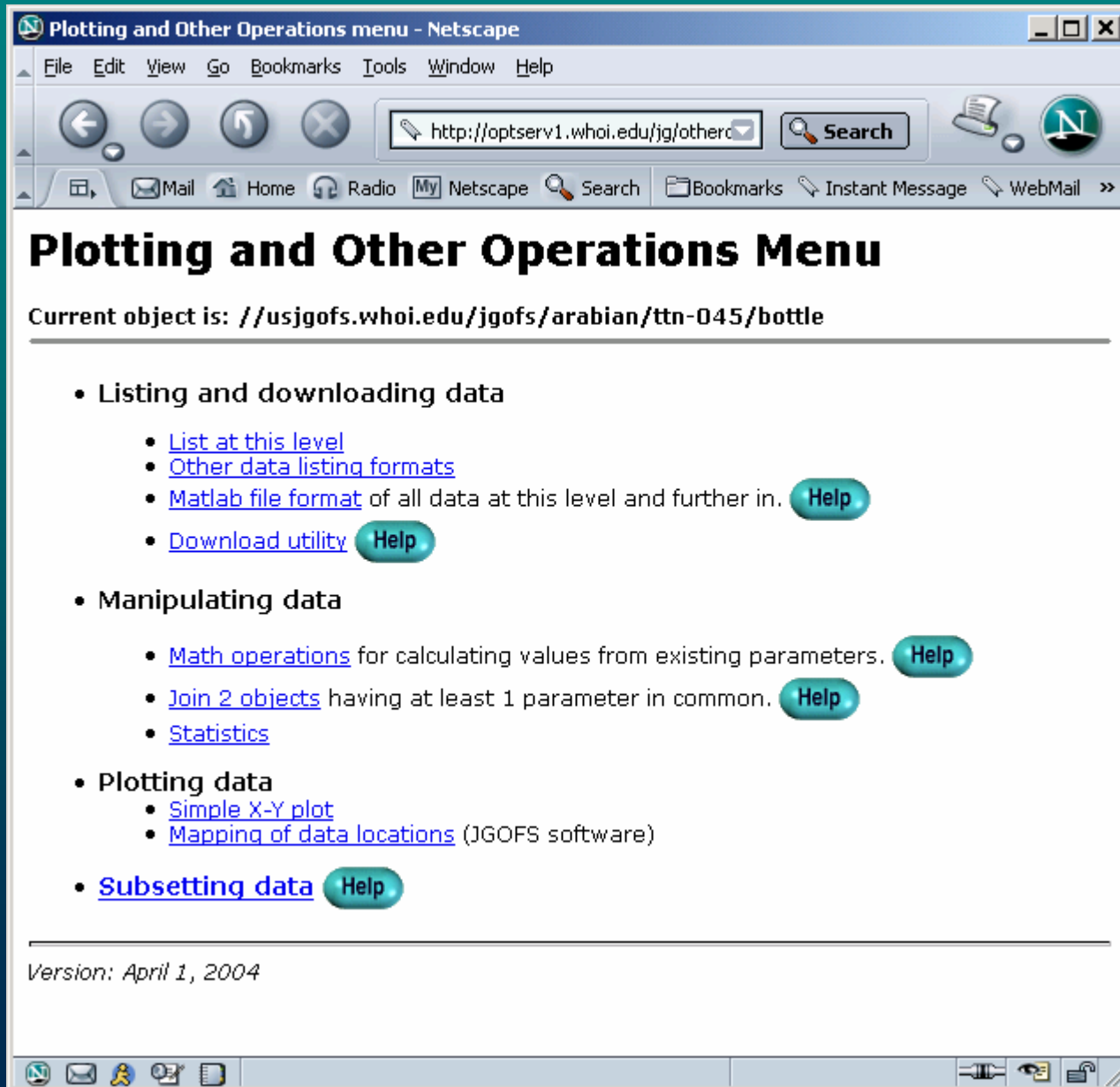
```

Data Listing

- ✓ select dataset
- ✓ select variable (columns)
- ✓ select range (rows)
- ✓ view metadata



subset, plot, download data



Plotting and Other Operations menu - Netscape

File Edit View Go Bookmarks Tools Window Help

http://optserv1.whoi.edu/jg/otherc Search

Mail Home Radio My Netscape Search Bookmarks Instant Message WebMail >>

Plotting and Other Operations Menu

Current object is: [//usjgofs.whoi.edu/jgofs/arabian/ttn-045/bottle](http://usjgofs.whoi.edu/jgofs/arabian/ttn-045/bottle)

- Listing and downloading data
 - [List at this level](#)
 - [Other data listing formats](#)
 - [Matlab file format](#) of all data at this level and further in. [Help](#)
 - [Download utility](#) [Help](#)
- Manipulating data
 - [Math operations](#) for calculating values from existing parameters. [Help](#)
 - [Join 2 objects](#) having at least 1 parameter in common. [Help](#)
 - [Statistics](#)
- Plotting data
 - [Simple X-Y plot](#)
 - [Mapping of data locations](#) (JGOFS software)
- [Subsetting data](#) [Help](#)

Version: April 1, 2004

Live Access Server Interface

provides
access to
synthesis
and model
results

The screenshot shows a Netscape browser window titled "Live Access to U.S. JGOFS Data - Netscape". The address bar contains the URL "http://usjgofs.whoi.edu:8089/las/servlets/dataset". The browser's toolbar includes navigation buttons (back, forward, home, stop), a search box, and various utility icons (mail, home, radio, my netscape, search, bookmarks, instant message, webmail, calendar, radio, people). The main content area features a header with a globe icon and the text "U.S. JGOFS U.S. Joint Global Ocean Flux Study". Below the header is a navigation menu with links for "General Information", "What's New", "Research", "Publications", and "Data". A search bar is located below the menu, with the text "Live Access to U.S. JGOFS Data" and a "Go" button. The main content area is titled "Datasets" and contains a search box with the text "Click on a dataset to continue or an i for information about a dataset." and a "Help" link. Below the search box is a "Select dataset:" section with a list of links: "Climatology", "In situ Data Synthesis", "Model Results", "Ocean Color", and "Synthesis Projects". On the left side of the main content area, there is a vertical navigation menu with links for "single data set", "compare two", "Datasets", "Variables", "Constraints", "Output", "Output Options", "Previous Output", "Define variable", and "About". At the bottom left of the browser window, the text "LAS UI Version 6.2.1" is visible.

Live Access Server ~ LAS

- LAS Development Team (original)
 - Steve Hankin
 - Jon Callahan
 - Joe Sirott

- located at UW JISAO/NOAA-PMEL
University of Washington's Joint Institute for the Study of the Atmosphere and Ocean and NOAA Pacific Marine Environmental Laboratory

Live Access Server Interface

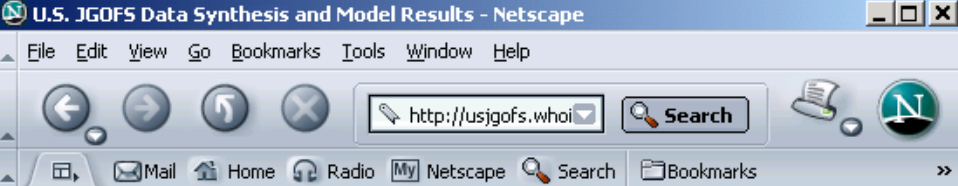
- configurable Web server
- data and metadata interface
- provides access to geo-referenced scientific data
- presents distributed data sets as a unified virtual data base (DODS/OPeNDAP)
- uses Ferret as the default visualization application
- visualize data with on-the-fly graphics
- request custom subsets of variables in a variety of file formats
- access background reference material (metadata)
- compare variables from distributed sources

LAS enables a data server to ...

- unify access to multiple types of data in a single interface
- create thematic data collections from distributed data sources
- offer derived products on the fly
- offer variety of visualization styles
 - customized for the data

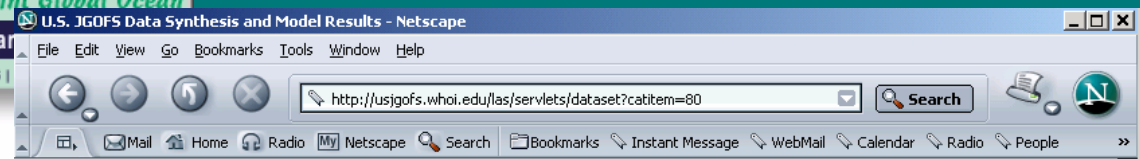
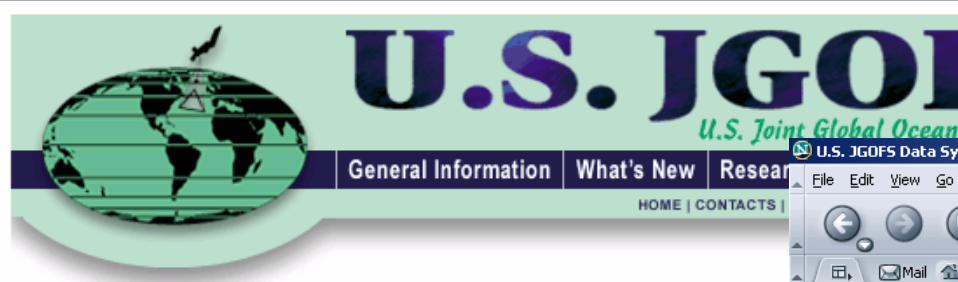
U.S. JGOFS LAS

- MySQL database of netCDF and JGOFS format data objects
- interface to project data and metadata
- data sub-selection (selections, projections)
- multi-variable support
- gridded vs. in-situ data differencing
- multiple views
 - (property-property, depth horizon, cruise tracks, overplots)
- multiple products (ps, gif, text, NetCDF)



LAS v6

select dataset and variables



U.S. JGOFS Data Synthesis and Model Results



- single data set
- compare two
- Datasets
- Variables
- Constraints
- Output
- Output Options
- Previous Output
- Define variable
- About
- LAS UI Version 6.3

Datasets > In situ Data Synthesis

Click on a dataset to continue c

Select dataset:

- [U.S. JGOFS Arabian Sea CTD Data](#)
- [U.S. JGOFS Arabian Sea Niskin Bottle Data](#)
- [U.S. JGOFS Arabian Sea TM Bottle Data](#)
- [U.S. JGOFS Equatorial Pacific CTD Data](#)
- [U.S. JGOFS Equatorial Pacific Niskin Bottle D](#)
- [U.S. JGOFS North Atlantic CTD Data](#)
- [U.S. JGOFS North Atlantic GoFlo Bottle Data](#)
- [U.S. JGOFS North Atlantic Niskin and GoFlo E](#)
- [U.S. JGOFS North Atlantic Niskin Bottle Data](#)
- [U.S. JGOFS Southern Ocean CTD Data](#)
- [U.S. JGOFS Southern Ocean Niskin Bottle Da](#)
- [U.S. JGOFS Southern Ocean TM Bottle Data](#)

U.S. JGOFS Data Synthesis and Model Results

Search:

Datasets > In situ Data Synthesis > U.S. JGOFS Arabian Sea Niskin Bottle Data

Select a variable and then click **Next >** to proceed to the Constraints page. [Help](#)

Merged Data Product compiled from *in situ* U.S. JGOFS Arabian Sea Niskin Bottle Data

[Merged Product Metadata](#)

Dataset variable(s): [Reset](#) | [Select all](#) | [Unselect all](#)

PHYSICAL PROPERTIES

- salinity, water bottle sample, PSS-78 scale **Next >**
- salinity, from CTD unit when water bottle tripped
- temperature, from CTD, IPTS-68
- depth of mixed layer, calculated based on a .1 deg. C change in temperature
- depth of mixed layer, calculated based on a .5 deg. C change in temperature
- depth of mixed layer, calculated based on a .03kg/meter³ change in density from the surface, reported in decibars
- depth of mixed layer, based on a .05kg/meter³ change in density from the surface, reported in decibars
- depth of mixed layer, calculated based on a .125kg/meter³ change in density from the surface, reported in decibars
- depth of mixed layer, calculated based on a .25kg/meter³ change in density from the surface, reported in decibars

LAS v6 constraints

- ✓ select dataset
- ✓ select variable
- set constraints
- select view (XYZT)
- select output type
- selections:
 - lat/lon
 - time
 - depth range

26 May 2005

Live Access to U.S. JGOFS Data - Netscape

File Edit View Go Bookmarks Tools Window Help

http://usjgofs.whoi.edu:8089/las/servlets/constrain?var=85 Search

U.S. JGOFS
U.S. Joint Global Ocean Flux Study

General Information What's New Research Publications Data

HOME | CONTACTS | RELATED LINKS | SEARCH | SITE INDEX

Live Access to U.S. JGOFS Data Search: [] Go

single data set compare two

Datasets Variables Constraints Output Output Options Previous Output Define variable About

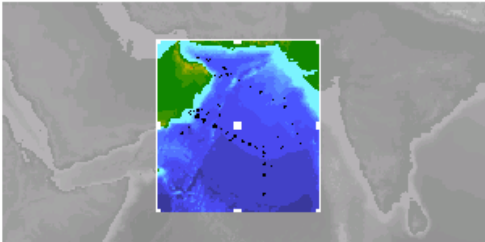
LAS UI Version 6.2.1

Datasets > In situ Data Synthesis > U.S. JGOFS Arabian Sea Niskin Bottle Data
Variable(s): Ammonium

Select your desired view (geometry of output) and output (type of product). Then set the 4-D region (lon-lat-depth-time) and any additional constraints. [Help](#)

Select view: Longitude-Latitude
Select output: Pie plot (GIF)
Select region: Arabian Sea Study Area Go

[Don't use map applet](#)

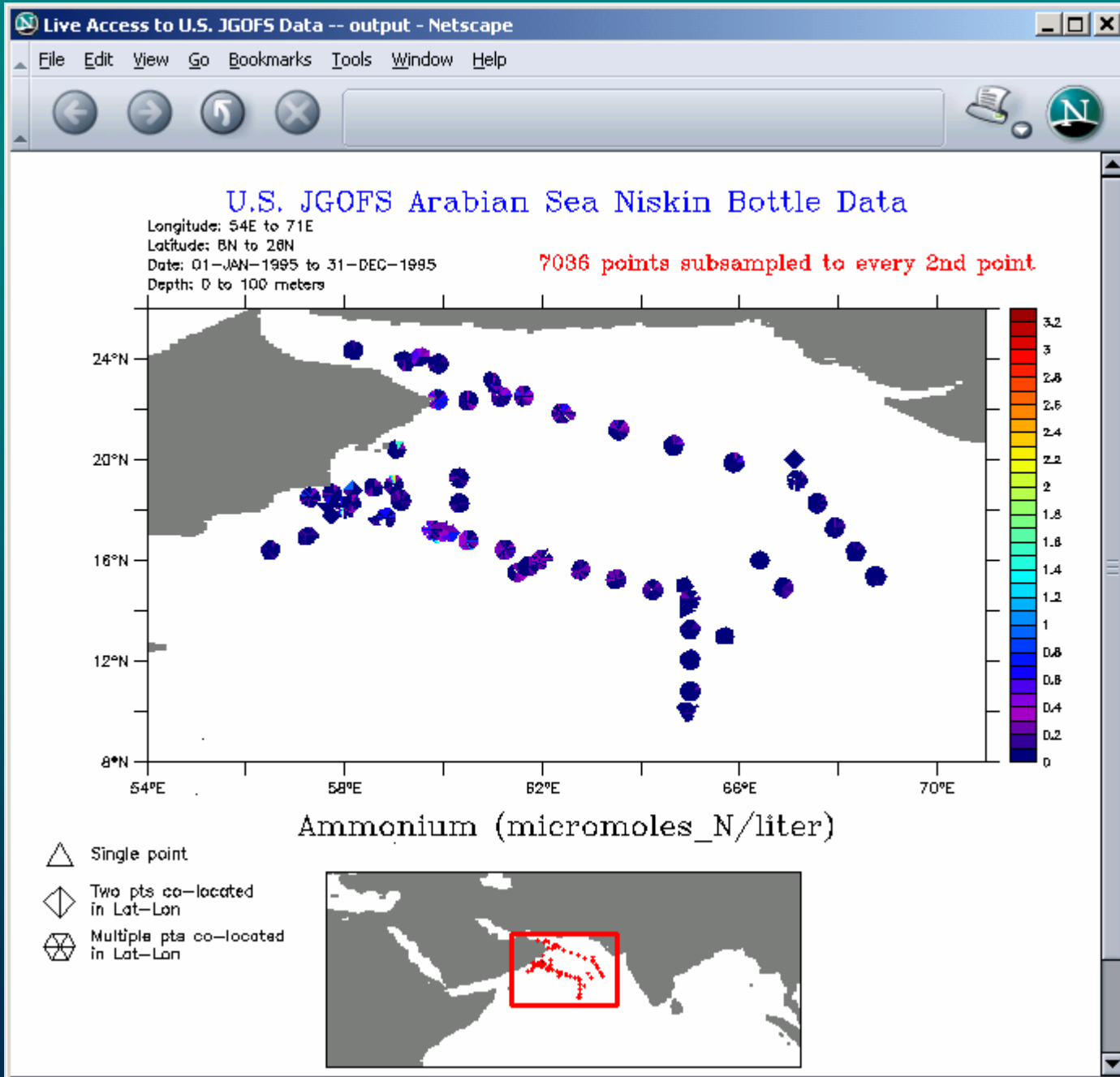


26.0 N
54.0 E 71.0 E
8.0 N
Zoom In Zoom Out

Select time range: 01 Jan 1995 to 31 Dec 1995
Select depth range: 0 to 4900
Select Constraints:

Apply: 19-prime-butanoyloxyfucoxanthin < []
Apply: Standard Station = [] A
Apply: Cruise ID = [] PC1 TTN-043 (Jan-08:Feb-05)

Applet map started



- ✓ select dataset
- ✓ select variable
- ✓ set constraints
- output

LAS

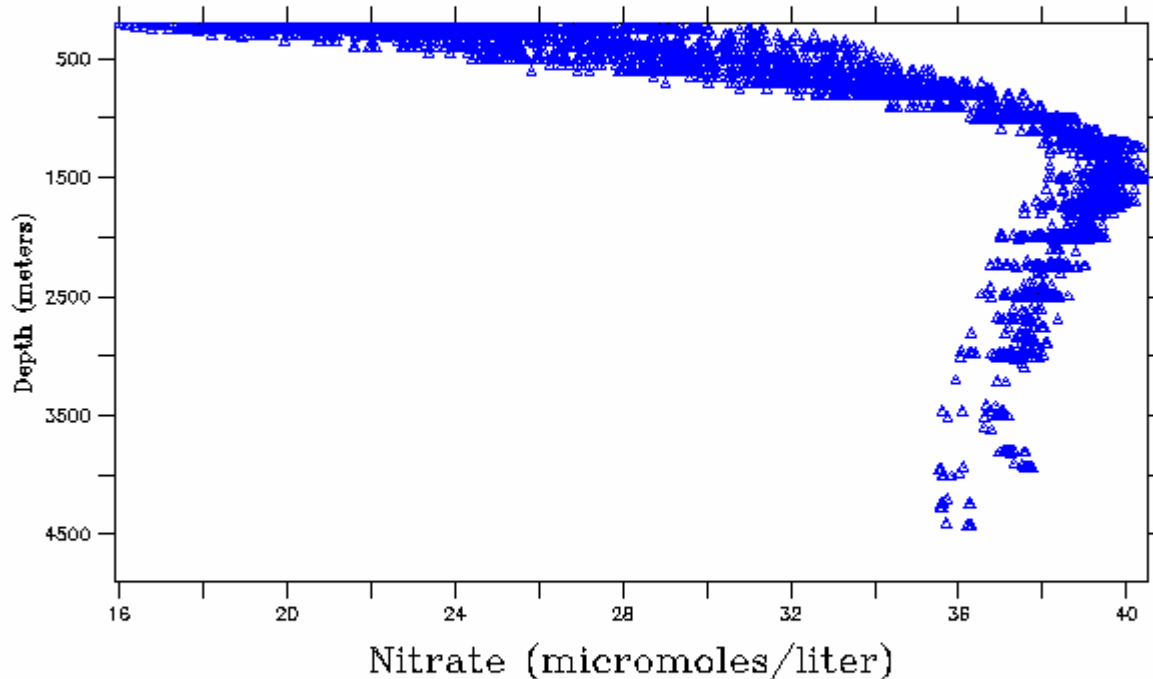
26 May 2005



U.S. JGOFS Arabian Sea Niskin Bottle Data

Longitude: 54E to 71E
Latitude: 6N to 28N
Date: 01-JAN-1995 to 31-DEC-1995

4492 points



LAS v6

Property-
Depth

Arabian Sea
Nitrate

from merged
product
generated by
DMO from *in situ*
Niskin bottle data

Comparison Overlay Plot

Live Access to U.S. JGOFS SMP Data (Test Server) - Netscape

File Edit View Go Bookmarks Tools Window Help

Live Access to U.S. JGOFS SMP Data (Test Server) Search: Go

single data set **compare two**

Dataset 1
Variable 1
Dataset 2
Variable 2
Constraints
Output
Output Options
Previous Output

1: Datasets > Global SeaWiFS chlorophyll 1998-2002
1: Variable(s): **Chlorophyll**

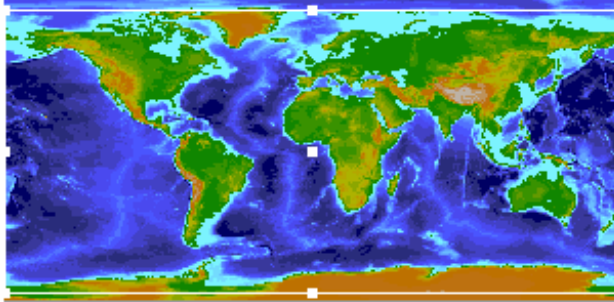
2: Datasets > Najjar monthly nutrients
2: Variable(s): **nitrate**

Select your desired view (geometry of output) and output (type of product). Then set the 4-D region (lon-lat-depth-time) and any additional constraints. [Help](#)

Select view: **Next >**

Select output:

Select region: [Don't use map applet](#)

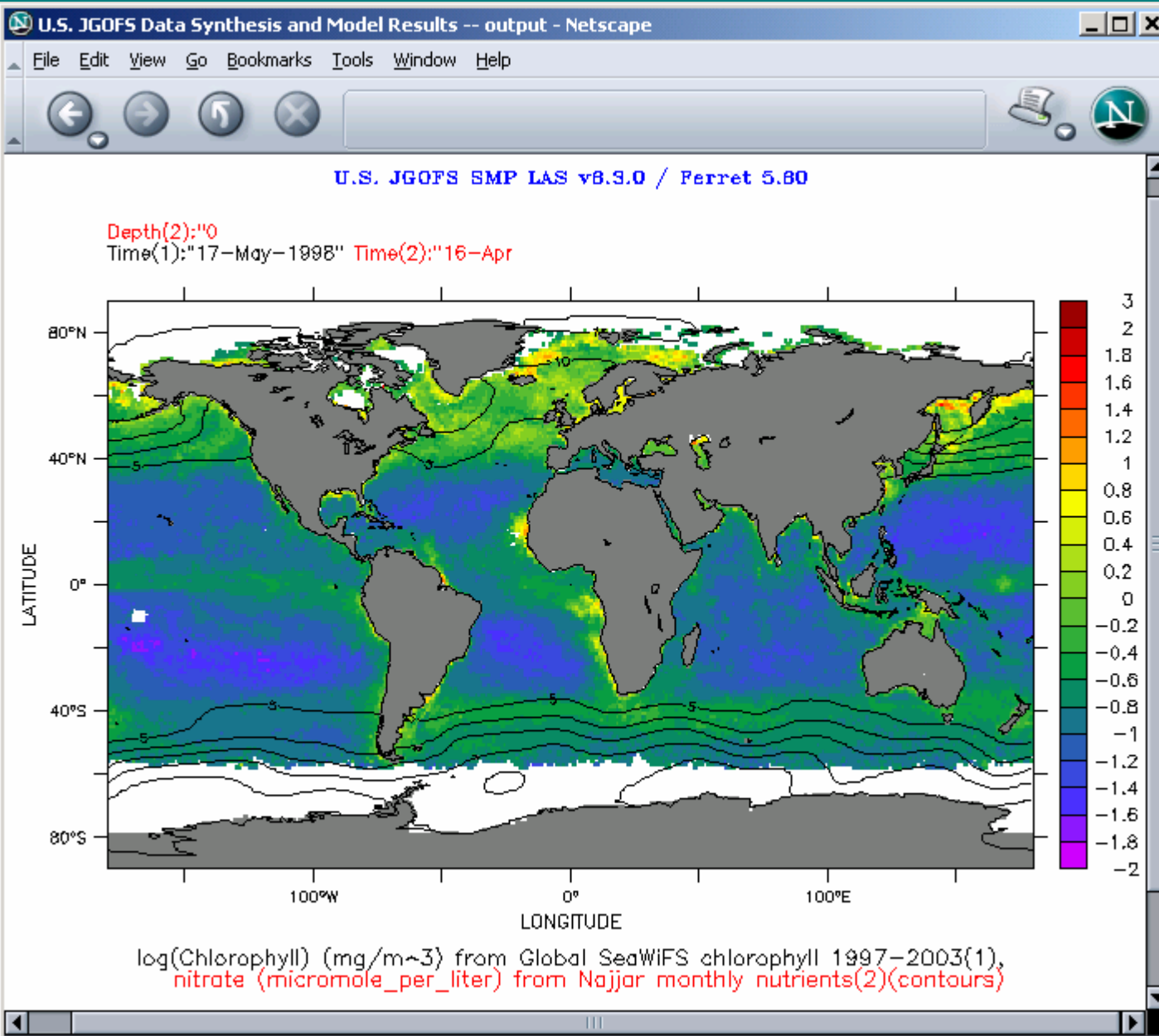


84.0 N
180.0 E 180.0 E
84.0 S
Zoom In Zoom Out

Select time for first variable:

Select time for second variable:

Select depth for second variable:



chlorophyll
(May)
shaded

SeaWiFS data
contributed by:
Yoder and
Kennelly

surface
nitrate (April)
contours

Nutrient
Climatologies
contributed by:
Ray Najjar

U.S. JGOFS Data System Summary

- supports a variety of data formats
- OPeNDAP used to access data collection
- coupled metadata and data
- supports data subselection
- offers variety of products for download

Lessons Learned . . .

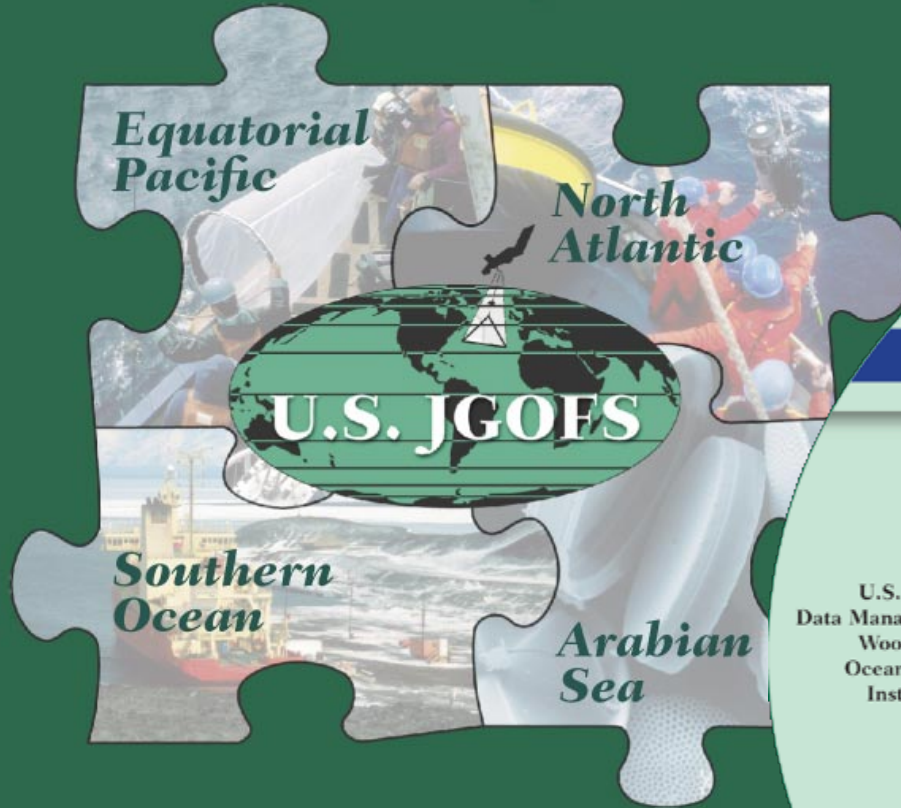
- encourage data managers to collaborate
 - ✓ other data managers within program
 - ❖ JGOFS DMTT
 - ✓ data managers from other programs
 - ❖ GLOBEC, LTER
 - ✓ program investigators and participants
 - ❖ attend conferences and workshops
 - ❖ offer data system tutorials

Lessons Learned . . .

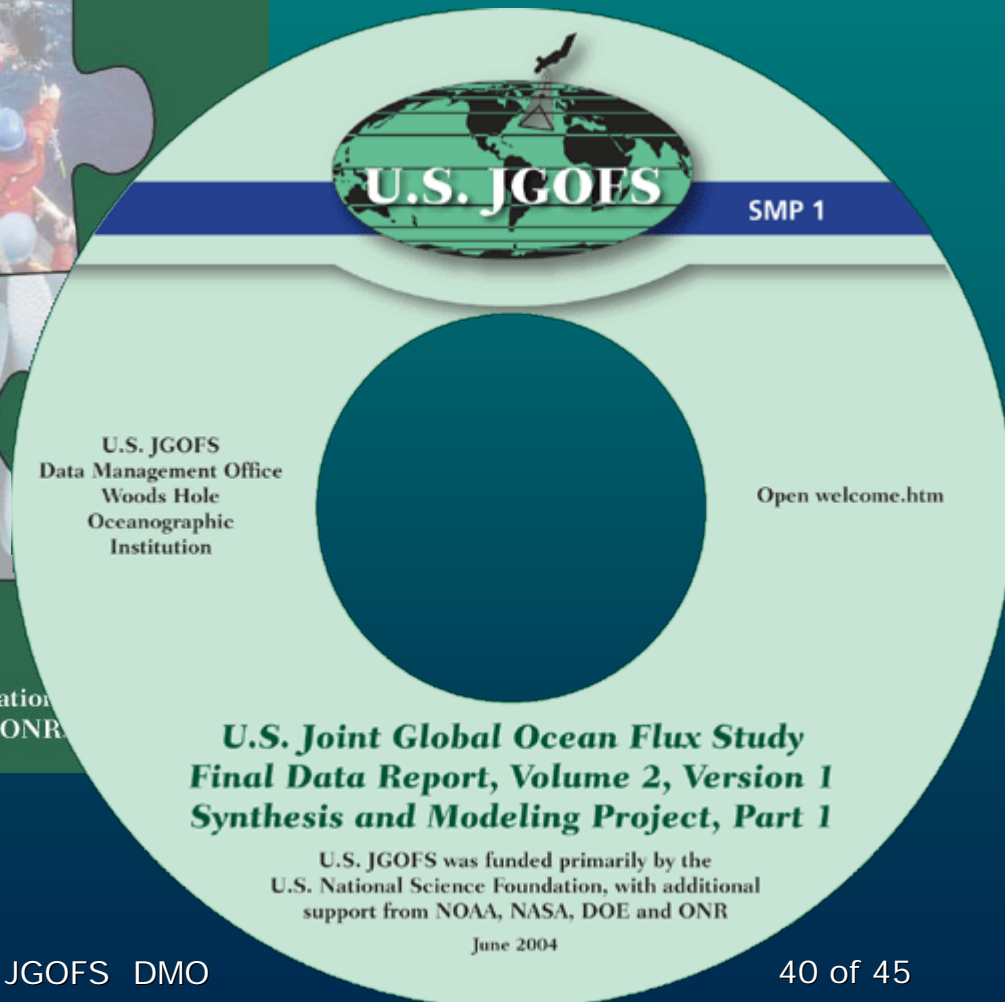
- publish data reports
 - ✓ archive data in one place
 - ✓ easy access to project results
 - ✓ most complete and accurate form of database

**United States Joint Global Ocean Flux Study
Final Data Report, Volume 1
Process Study Data**

data reports published on
CD-ROM



Funded primarily by the U.S. National Science Foundation
with additional support from NOAA, NASA, DOE and ONR



Lessons Learned . . .

- plan early for final archive of program results
 - ✓ digital records
 - ✓ don't forget the boxes of stuff !



Lessons Learned . . .

- develop a data policy, publicize and follow it
- establish protocols at program start with mechanism for adaptation when necessary
- facilitate contribution of data to collection
- **metadata is of critical importance**
 - ❖ **accurate, complete, available with data**
- quality assurance is an ongoing process
- begin synthesis early

Lessons Learned . . .

- provide timely, easy access to project results
- develop and maintain simple, reliable interface to data collection
- encourage data managers to collaborate
- publish data reports
- plan early for final archive of program results

Challenges

➤ functioning amid the chaos

- ❖ maintaining a healthy data management system amid the chaos of rapidly changing information technology
- ❖ distinguishing between enabling and disruptive technologies

➤ data and results – what to preserve?

- ❖ raw and processed data, synthesized products, model code, inputs, results

➤ increasing volume and diversity

➤ long-term preservation of data

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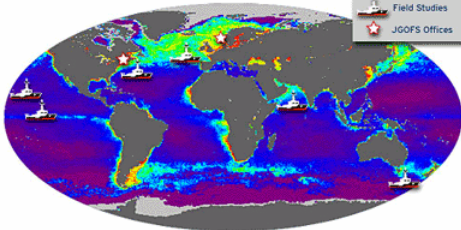
U.S. Joint Global Ocean Flux Study

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The United States Joint Global Ocean Flux Study is a national component of international JGOFS and an integral part of global climate change research.

A Sea of Change: JGOFS Accomplishments and the Future of Ocean Biogeochemistry
 Final Open Science Conference • 5-8 May 2003 • Washington, DC USA
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Field Studies
JGOFS Offices

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The U.S. launched the Joint Global Ocean Flux Study (JGOFS) in the late 1980s to study the ocean carbon cycle. An ambitious goal was set to understand the controls on the concentrations and fluxes of carbon and associated nutrients in the ocean. A new field of ocean biogeochemistry emerged with an emphasis on quality measurements of carbon system parameters and interdisciplinary field studies of the biological, chemical and physical process which control the ocean carbon cycle. As we studied ocean biogeochemistry, we learned that our simple views of carbon uptake and transport were severely limited, and a new "wave" of ocean science was born. U.S. JGOFS has been supported primarily by the U.S. National Science Foundation in collaboration with the National Oceanic and Atmospheric Administration, the National Aeronautics and Space Administration, the Department of Energy and the Office of Naval Research. The current and final phase of U.S. JGOFS is the [Synthesis and Modeling Project \(SMP\)](#). Additional information about the [history and mission](#) of U.S. JGOFS is available.

[Contact](#) the U.S. JGOFS Project Office

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