

Data Visualization

Please describe the options currently available for data visualization and any new techniques/software under development. How can project PIs get access to and training on the software?

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Caveats, Apologies and Excuses

1. **UNIX** - Not widely used in the developing world and not universally loved by researchers; so my talk and my experience is strongly oriented toward PC platforms, using Windows
2. **Multi-Platform** - Platform-dependent software is widely giving way to Java-based, and similar, so multi-platform solutions are preferred and emphasized
3. **CDs and DVDs** - Giving way to online access, even in remote regions, so this presentation assumes good band-width (normal traffic on the order of 100 MB/day)
4. **Compiled Binaries** – Understandably troublesome to the publishers, but invaluable to individual researchers with little or no experience with compiling that involves (sometimes multiple) libraries and other exotica

5. **Scope:** Oceanography > Meteorology > Ancillary earth science data
6. The paragraphs used in the software descriptions pages are taken verbatim (with some minimal editing for clarity and format) from the indicated webpages. The author wants to make it very clear that he borrowed all these material from the original authors in an effort to better publicize their work, and does not want any reader to believe he could possibly write all this good stuff himself.

Some Background

To a great extent, working with earth science datasets IS visualization. Both in terms of the fundamental and complex analyses of the data AND in terms of the necessary quality control procedures that precede these analyses, the data values must be viewed graphically in order to understand their patterns and relationships. This section provides a brief introduction to some topics necessary to the understanding of the visualization process.

Digital Format Types

Inspection of the the many formats used in data files available to marine scientists indicates there are eleven basic types of formats, including several subtypes, for a total of 15. These are listed below, with brief descriptions. There is considerable overlap between several of these convenient categories, especially Gridded Data and Geo-Referenced Images.

- **Auxiliary Formats** - Information about data files; these are not really "data" files, but are included here for completeness
 - **Header Formats** - Information about the format, location or geo-referencing; usually very short - - CTL, HDR, DOC, etc. - http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/header.htm
 - **Metadata Formats** - This link takes you to Module 2 where metadata concepts and formats are discussed - - DIF, ISO, FGDC, etc. - http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/02_Meta/06_MetaStds&Form/MetadataStandards.html
- **Document** - Digital data in proprietary formats (or sometimes just simple ASCII) designed for visual inspection, but not for data processing - - DOC, PDF, TXT, etc - http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/document.htm
- **Gridded** - Rectilinear (row and column) grids of values derived from analysis of scattered measurements - - SDS, FLT, GRD, IMG, etc. http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/gridded.htm
- **Hard Copy** - Physical report volumes on paper or microfilm - http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/hard_copy.htm

- **Image**
 - **Simple** - Graphics file without earth mapping (registration) information - – TIF, JPG, BMP, PNG, etc
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/simple_image.htm
 - **Geo-Referenced** - Graphics file, with ancillary mapping information, showing 1 or more parameters of the earth's system in a rectilinear grid, usually derived by processing and decimation of very high-density information from aerial or space sensors - – TIF/TFW, JPG/JPW, PNG/PGW, etc
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/geo_image.htm
- **Mapping** - Mapping data consisting of digital representations of individual objects (points, lines, polygons, etc.)
 - **XY-** Mapping line objects, in X (usually longitude) and Y (usually latitude) coordinates only - – UNG, etc.
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/mapping_xy.htm
 - **List-** Mapping objects (points, lines, symbols, text, etc.) without topology or descriptive attributes - - HPGL, Plot10, etc.
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/mapping_list.htm
 - **Geographic Information System (GIS)** - Mapping objects (points, lines, polygons, etc.) on the earth incorporated into robust data assemblages that contain additional detailed information about the properties and topologies of the objects. [NOTE: All GIS systems can also accommodate gridded, geo-referenced image, relational and spreadsheet formats.] - – SHP , VPF
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/mappinggis.htm
- **Message** - Data in special compact form for real-time transmittal of observational data through global telecommunications systems - – JJKK, JJXX, etc. -
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/message.htm
- **Relational** - Groups of tables (spreadsheets) linked to one another through common fields, and indexed for rapid searching by (usually) proprietary software - – ODV, JOA (both internal formats) -
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/relational.htm
- **Self-Describing** - Data (of multiple format types) in complex, strictly-defined structures, with special tags and codes that identify the contents - – GRIB, NetCDF, HDF
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DataFormats/01_FormTypes/self-describing.htm
- **Spreadsheet** - Data in tabular format, consisting of columns (fields) and rows (records); each record is a complete, stand-alone datum fully describing a measurement, and all records (data rows) are identical in format. True

spreadsheets can be sorted and re-sorted many times, without losing or confusing any contained information - – XLS, TXT, CSV, XYZ , TSV

http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/spreadsheet.htm

- **Stratified** - Very similar to spreadsheet, but at least one piece of common information (such as a cruise name or a station number) is given in separate header row (or several rows) that applies to data rows that follow it. There can be multiple spreadsheets, each preceded by its own headers. The header rows have very different formats from the data rows in the spreadsheet portions of the file. Stratified files cannot be sorted with losing or confusing contained information, due to the presence of different data row formats - – WODxx, ICES, SD2
http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/stratified.htm

Relations Between Format Types and Visualization

- 1) **Little DIRECT connection to digital visualization**
 - a) Message
 - b) Auxiliary/Header Auxiliary/Metadata
 - c) Document.
- 2) **Visualization tied to one system (or very few)**
 - a) Relational
 - b) Stratified
 - c) Mapping/XY
 - d) Mapping/List
- 3) **Visualization possible with multiple systems**
 - a) Spreadsheet
 - b) Gridded
 - c) Self-Describing
- 4) **Designed for visualization; compatible with very many systems**
 - a) Simple Images.
 - b) Geo-Referenced Images
 - c) Mapping/GIS

Specific Formats to Integrate Ocean Data Resources

The following formats have been identified as "Integrated" in OceanTeacher because they link principal software programs and major published databases, or they provide bridges between software programs:

- **All ASCII and Binary Gridded Data Formats**, especially the following:
 - **GRD** - Surfer binary or ASCII
 - **ESRI ASC** - ASCII with internal header
 - **ESRI FLT+HDR** - Single-precision binary grid with external header
 - **CDL** - ASCII grid with internal header; ASCII form of NetCDF
 - **TXT** - ASCII grid/no header

- [All Spreadsheet Formats](#), (also called Tables) including
 - [TSV-O](#) - Ocean Data View Spreadsheet (TAB-Separated Variables/ODV)
 - [XYZ](#) - The simplest table
- **Geo-Images**
 - **All images with world files** (JPG+JGW, BMP+BPW, GIF+GFW, TIF+TFW, PNG+PGW)
- [HDF](#) - Hierarchical Data Format (Version 4)
- [NetCDF](#) - Network Common Data Form
- [SHP](#) - ESRI Shapefile
 - **E00** - Transmittal format for SHP files
- [WOD01](#) - World Ocean Database 2001

[In the format descriptions that follow, links are to documents in the IOC/IODE OceanTeacher training system. You can use the main link below each table to open a browser to the same page that you see each table, if you want to see the listed documents.]

Gridded Data Formats

| | |
|---------------------------|--|
| <p>Description</p> | <p>Overview: Whether the actual values are ASCII (i.e. human-readable characters) or binary (a string of digital one's and zero's), these formats are constituted by a rectangular matrix of rows and columns that can be "mapped" to ground points in the real world. In the data file, however, the values are simply a long string of numbers in a particular order. Understanding the order of the numbers, and understanding how they are read and mapped onto the real world is the challenge of using gridded formats.</p> <p>Grid Characteristics: Before any grid can be used or analyzed, 13 Questions about its format must be answered. Click HERE to learn about these questions.</p> <p>Creation of the Grid: The gridded data file is created from scattered data points in the real world, by a process called "gridding." There are many mathematical methods to create the grid, and the topic is beyond the scope of this Kit. In short, various algorithms are available to examine data points near ("in the neighborhood of") the desired fixed grid points, and to calculate the hypothetical value for the gridpoint. These algorithms often employ weighting methods to emphasize the data near the point, compared to more distant values. Most modern gridding programs provide a set of gridding algorithm choices.</p> <p>Data Values Within the Grid: The grid file can be either ASCII or BINARY, indicating the type of number values it contains. It is also common that ASCII or binary files can contain an initial header of</p> |
|---------------------------|--|

| | |
|---|--|
| | <p>ASCII text information.</p> <p>Multiple Grids: Gridded data files commonly contain more than a single grid; in fact the term Scientific Data Set (SDS) typically means large, multi-parameter files containing more than one grid. In such cases, the grid for Parameter 1 can completely precede the grid for Parameter 2, and so on. An alternate structure would be to place all the data values for Parameter 1 through Parameter N in sequence for a single XY grid location, then move on to the next grid location where the Parameter 1 through Parameter n sequence would be repeated, and so on. If separate XY grids (for any number of parameters, as shown above) are available for different Z (depth) levels, then these grids can follow one another within the file, going for example from top to bottom. This scheme can be combined with the above case for multiple parameters in many ways, using sequences of XYZ dimensions and parameter dimensions that suit the user's software and offer a logical method to analyze the data. There is no "correct" way to construct files of multiple data grids, just many options. It is extremely important to document the sequence in which the dimensions (XYZ location, time, parameters) are "read." Software programs must be directed to input these data in looping fashion, going from the fastest-changing dimension (usually, but not always, the parameters) to the slowest-changing dimension (often time).</p> <p>Vector Grids: To represent vectors (literally arrows showing the direction of flow) in ocean and meteorological datasets two methods have been devised: provide the U and V components of the vector, or provide the direction and magnitude of the arrow. Both of these methods have been adapted to grids, for vector results from gridded models for instance. The grids can be contained in separate files, or sequentially listed in the same file.</p> |
| <p>Formats Within This Group</p> | <ul style="list-style-type: none"> • ASCII <ul style="list-style-type: none"> ○ SURFER (*.GRD) - with "DSAA" header lines ○ CDL - output from ncBrowse ○ TXT - output from HDFView ○ ASC - ESRI ASCII grid (other extensions in use) • Binary <ul style="list-style-type: none"> ○ SURFER (*.GRD) ○ ESRI FLT (floating point grid) with HDR header file ○ Plain binary grids: byte, short integer, long integer, single-precision or double-precision; with or without ASCII Header Files ○ Binary grids can also be within Self-Describing Formats |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/gridded.htm]

Spreadsheet Data Formats

| | |
|----------------------------------|---|
| Description | <p>Spreadsheet formats are simply row-and-column data tables. They can easily be imported directly into several proprietary spreadsheet software programs and many public domain programs. Each row is called a "record." The separate "fields" (constituting the separate columns of the spreadsheet) may be labeled by a single "label row" at the beginning of the spreadsheet, but all other rows are exactly the same. A consequence of this is that each record constitutes a completely independent datum that does not depend on any other record for its interpretation and use. Further, the records can be sorted in any way and re-sorted back to their original sense (if you have a good spreadsheet program!), because the order of the records makes no difference for storage. The current order of the records (as determined by the most recent sort) might however be critical for some uses of the data.</p> |
| Formats Within This Group | <ul style="list-style-type: none"> • EXCEL and other proprietary binary spreadsheet formats (XLS, WK*, etc.) • Examples <ul style="list-style-type: none"> ○ TSV-O (Ocean Data View) ○ JOS (Java OceanAtlas) ○ XYZ files (only 3 columns, providing X, Y and a parameter value [Z]) ○ CSV-I - ICES Spreadsheet format |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/05_DtaMgtPrinc/01_DtaFormats/01_FormTypes/spreadsheet.htm]


Hierarchical Data Format, Version 4 (HDF4)

| | |
|----------------------|---|
| Type | Self-Describing |
| Common Usage | Satellite data, gridded climatologies |
| Documentation | <ul style="list-style-type: none"> • National Center for Supercomputing Applications HDF Home Page |
| INPUT TO: | <ul style="list-style-type: none"> • HDF Browser • HDFView • WebWinds • GRADS |

| | |
|---|--|
| | <ul style="list-style-type: none"> • HEG (see below) |
| OUTPUT FROM: | <ul style="list-style-type: none"> • HDF Browser • HDFView |
| <ul style="list-style-type: none"> • Used extensively in all the earth sciences, but especially important for satellite data. HDF, in its four version (HDF4), has been used by US NASA in the creation of an extensive system of software and database tools called HDF-EOS (or HE4). [In 1999, NCSA released a completely different form of HDF, called HDF5, and some NASA HDF-EOS functionality is slowly being converted to that format thus creating HE5. Neither HDF5 or HE5 are currently within the scope of this teaching resource; all references here to HDF mean HDF4.] • Because the HDF format is far more comprehensive than many other formats, special browsers & viewers (using libraries available at the HDF Website) are needed to view file contents, which may include labels, metadata information, vector and gridded data, images, sensor/platform identifications and measurement conditions (among others). • The advanced variant HDF-EOS, based on HDF4 contains additional navigational information. HDF-EOS is produced extensively by NASA's eponymous Earth Observing Satellites system (http://edcimswww.cr.usgs.gov/pub/imswelcome/) but there are major NASA product lines that do not use HDF-EOS: <ul style="list-style-type: none"> ○ Ocean Color Web - http://oceancolor.gsfc.nasa.gov/ ○ PO.DAAC Ocean ESIP Tool (POET) - http://poet.jpl.nasa.gov/ • HDF files can be converted to GIS-compatible TIF images through a long process described at http://ioc.unesco.org/oceanteacher/OceanTeacher2/08_Exercises/03_DtaMgtEx/Roadmaps/RoadMapist.htm > Group P • HDF-EOS files can quickly be converted to GeoTIF with the HEG software (described below in this paper) in a single step. | |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/06_OcDtaMgtProc/01_DataOps/06_OcDtaForm/02_Integration/HDF/hdf.htm]


Network Common Data Form (NC, CDF)

| | |
|----------------------|---|
| Type | Self-Describing |
| Common Usage | Climatological analyses; gridded data of all kinds; ocean profiles. |
| Documentation | <ul style="list-style-type: none"> •  NetCDF Website |
| INPUT TO: | <ul style="list-style-type: none"> • GMT • GRADS • Java OceanAtlas • WebWinds • ncBrowse |

| | |
|---|---|
| | <ul style="list-style-type: none"> • Ocean Data View <ul style="list-style-type: none"> ○ Gridded data ○ ARGO data from the Coriolis Center |
| OUTPUT FROM: | <ul style="list-style-type: none"> • GMT • WebWinds |
| <p>Used extensively by climate and ocean modelers for multidimensional earth science datasets. NetCDF is an interface for array-oriented data access, and a library that provides an implementation of the interface. The NetCDF library also defines a machine-independent format for representing scientific data. Together, the interface, library, and format support the creation, access, and sharing of scientific data. The netCDF software was developed at the Unidata Program Center in Boulder, Colorado</p> <p>NOTE: There is an ASCII "version" of this format, created by various dump or output programs, called CDL or Common Data Language.</p> | |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/06_OcDtaMgtProc/01_DataOps/06_OcDtaForm/02_Integration/NetCDF/netcdf.htm]


ESRI Shapefile (SHP, DBF, SHX; plus E00)

| | |
|----------------------|--|
| Type | Mapping GIS |
| Common Usage | Geographic Information Systems databases |
| Documentation | <ul style="list-style-type: none"> •  ESRI Shapefile Specification <ul style="list-style-type: none"> ○ ArcInfo E00 Format - Format widely used for online transmission of SHP files and other ESRI products. A converter program, Import71, is available. |
| INPUT TO: | <ul style="list-style-type: none"> • Most Geographic Information System software • ArcExplorer |
| OUTPUT FROM: | <ul style="list-style-type: none"> • ArcInfo & ArcView • MUSE |

- Although ESRI and other GIS vendors continue to push other, more elaborate formats, this one appears to be the current de facto standard. It is not, however, an easy one to create, so very few software programs have SHP export capability.
- As used in ESRI ArcView and ArcExplorer programs, the SHP file is accompanied by the following auxiliary files:
 - Shapefile database files (DBF)
 - Shapefile index files (SHX)
 - And sometimes by auxiliary files that store other information about the features (SBN, SBX and others).
- A number of other filename extensions are used by ESRI's ArcInfo software and by other GIS software programs

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/06_OcDtaMgtProc/01_DataOps/06_OcDtaForm/02_Integration/SHP/shp.htm]

World Ocean Database

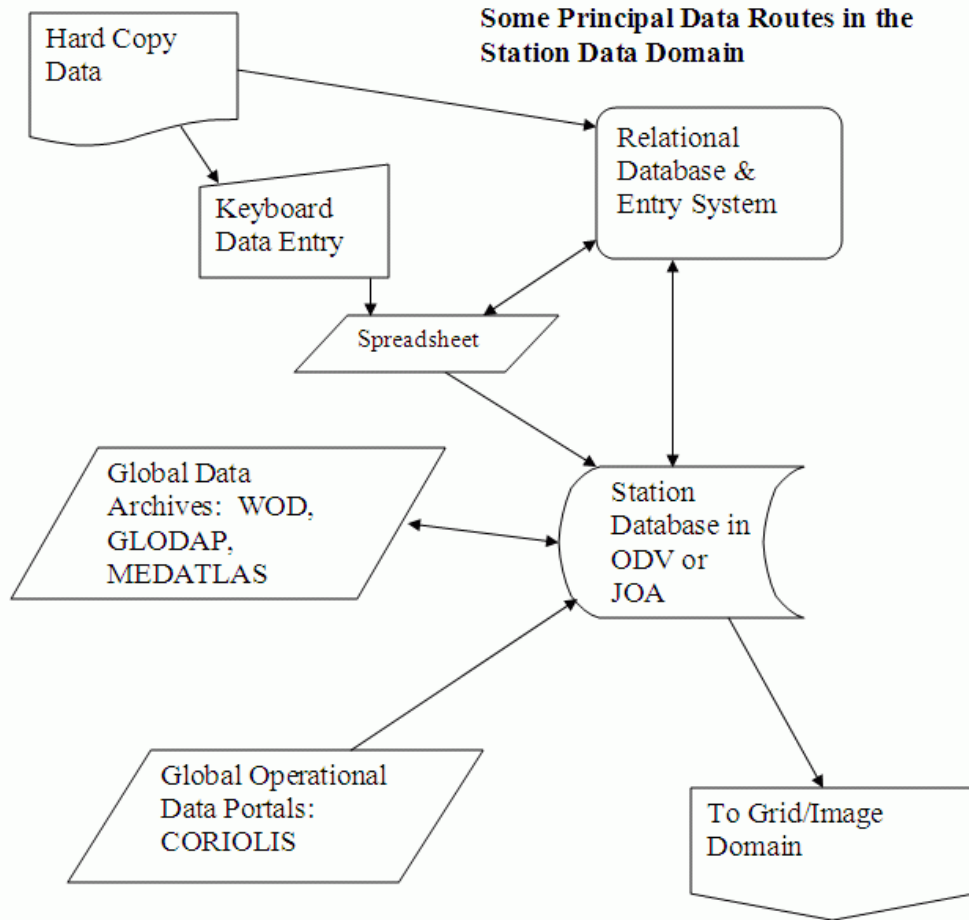
| | |
|---|---|
| Type | Stratified |
| Common Usage | Ocean station data; underway, autonomous and other types have been added |
| Documentation | <ul style="list-style-type: none"> •  Complete Database Documentation |
| INPUT TO: | <ul style="list-style-type: none"> • Ocean Data View |
| OUTPUT FROM: | |
| All data lines are "formatted" meaning that fields are allotted specific character spaces, so no separations occur between values | |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/06_OcDtaMgtProc/01_DataOps/06_OcDtaForm/02_Integration/WOD01/wod01.htm]

Relationships (Compatibilities) between Formats, Data Pools and Software

The IOC/IODE training program uses a "system," consisting of schematic diagrams of pathways between principal databases and software, based on common formats.

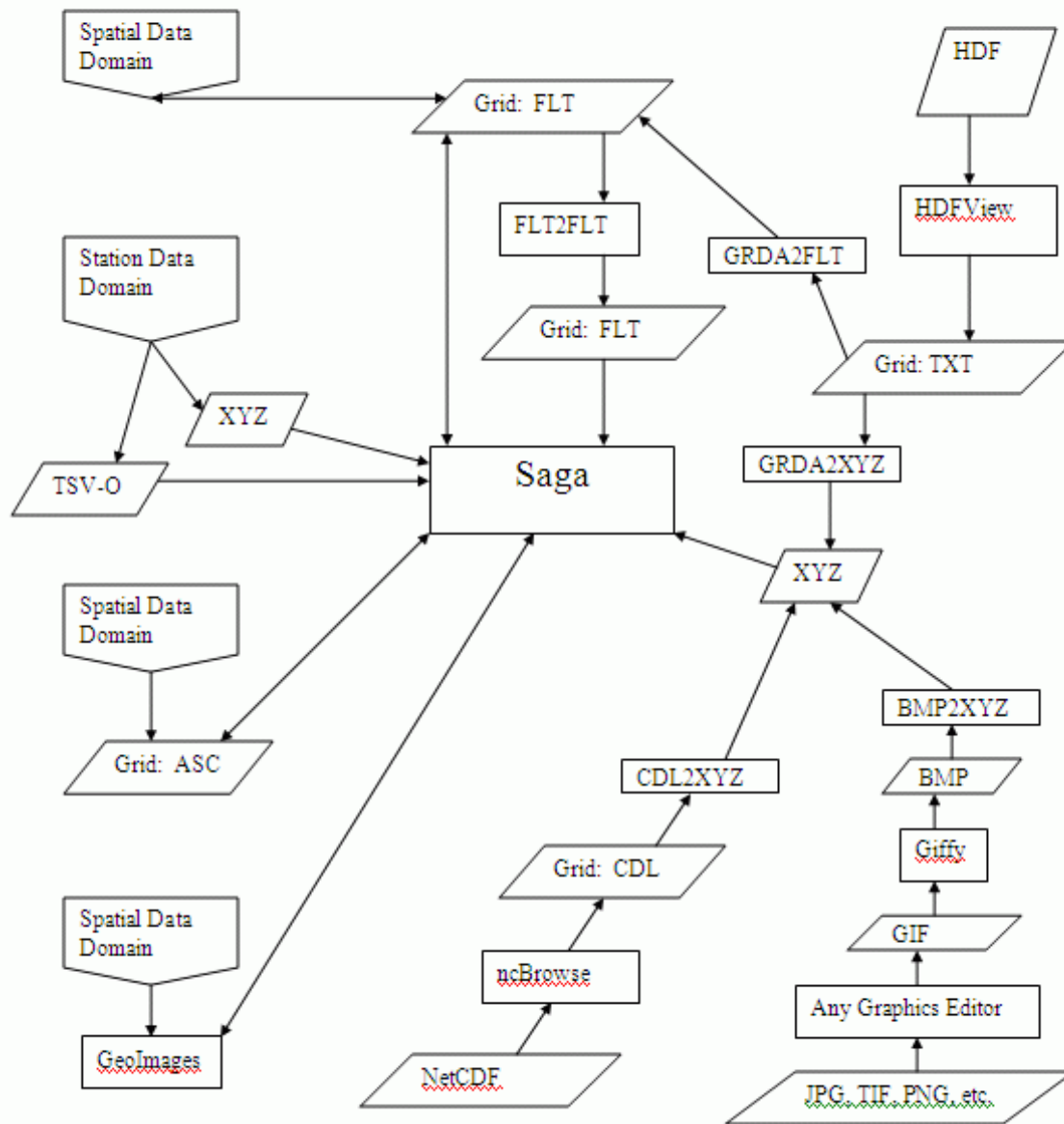
Ocean Station Data Domain



This diagram illustrates the relationships between the basic global data archives, the operational data streams, relational database systems, and the program we have selected for managing ocean data collections: Ocean Data View. Pathways between them are provided by interchange formats and by the native formats of the original data archives.

Grid & Image Data Domain

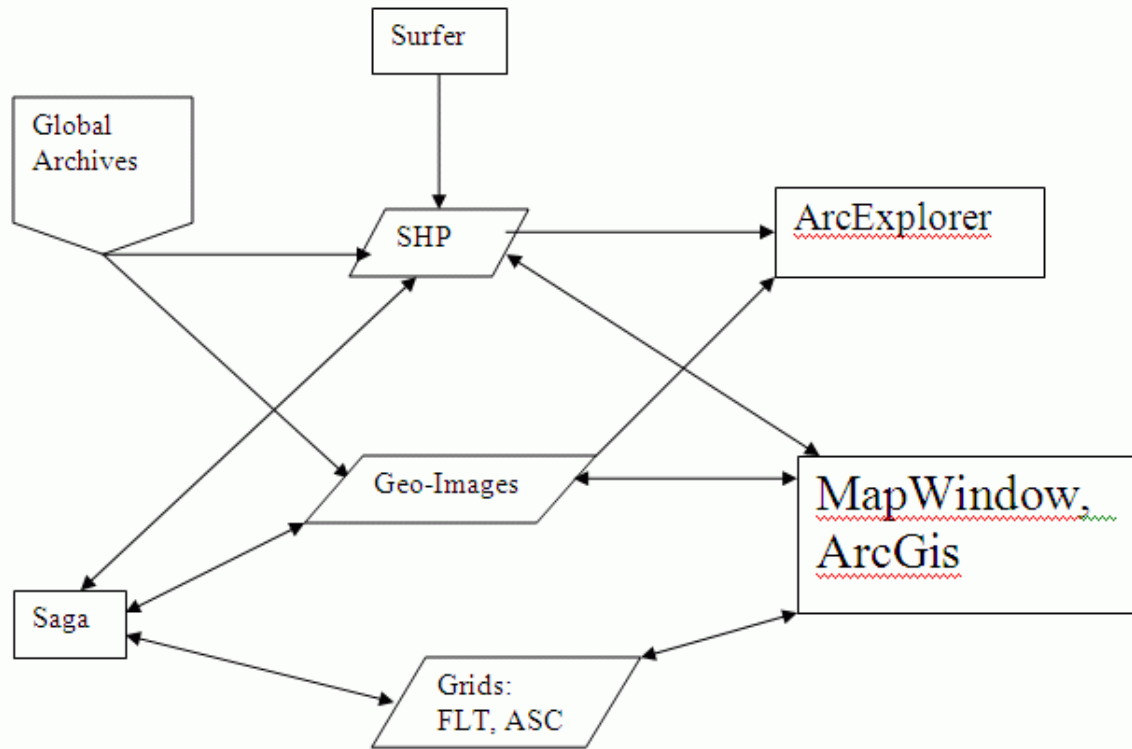
Some Principal Data Routes in the Grid/Image Data Domain



This diagram is concerned principally with data grids and images, their analysis and display. Satellite data are an important part of this work, and their availability in formats that can easily be gridded (or re-gridded) is an important new development in oceanography.

Spatial/Feature Data Domain

Some Principal Data Routes in the Spatial/Feature Data Domain



This diagram shows how different types of data from different sources can be combined in various GIS systems. The appearance here of the Saga program, which also plays a major role with grid & image data, indicates there is no clear division between this domain and the previous one.

Formats Compatibility Matrix

To catalog the various connections between software programs and the formats they recognize (or produce), a matrix has been prepared. Only the principal formats that provide necessary links within and between the diagram are included.

| YELLOW: Input to Program BLUE: Output from Program GREEN: Input & Output | | | | | | | | |
|--|-----------|-----|-------|--------|-------|--------|--------|--------|
| | GeoImages | GRD | HDF | NetCDF | SHP | TSV-O | WOD01 | XYZ |
| RDMS ¹ | | | | | | GREEN | | GREEN |
| Spreadsheet ² | | A | | | | GREEN | | GREEN |
| HDF Browser | YELLOW | A,B | GREEN | | | YELLOW | | YELLOW |
| HDFView | | TXI | GREEN | | | | | |
| ncBrowse | | CDI | | | | | | |
| Ocean Data View | | | | C | | GREEN | YELLOW | YELLOW |
| Surfer | | A,B | | | GREEN | YELLOW | | GREEN |
| ArcExplorer 9.1 | YELLOW | | | | D | | | |
| Saga | BLUE | A,B | | | GREEN | YELLOW | | YELLOW |
| MapWindow | GREEN | A,B | | | GREEN | | | |
| | GeoImages | GRD | HDF | NetCDF | SHP | TSV-O | WOD01 | XYZ |

This very simple compatibility matrix, which covers only about a fourth of the software programs described in this paper, illustrates the complex relationships between resources facing an oceanographer with multiple datasets. Essentially you can get from any format to any program, providing you can find a pathway. The original matrix is at http://ioc.unesco.org/oceanteacher/OceanTeacher2/06_OcDtaMgtProc/01_DataOps/06_OcDtaForm/03_Schematics/formats_matrix.htm.

Format Conversion

This is probably a bit off-topic here, but the IOC/IODE OceanTeacher training system includes a library of format conversion utilities at http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/01_CmpTch/05_OcSoft/03_Convert/Converters.htm.

Information Technology Programs/Projects of Importance to Visualization


1. [BioCASE](#) - Biodiversity Collection Access Service for Europe
2. [CODATA](#) - Committee on Data for Science and Technology
3. [CENDI](#) - Commerce, Energy, NASA, Defense Information Managers Group
4. [DIGR](#) - Distributed Generic Information Retrieval
5. [DMAC](#) - Data Management & Communications Steering Committee of IOOS
6. [ESIP](#) - Federation of Earth Science Information Partners
7. [GOSIC](#) - Global Observing Systems Information Center
8. [GSDI](#) - Global Spatial Data Infrastructure Association
9. [ICSTI](#) - The International Council for Scientific and Technical Information
10. [IEEE](#) - Institute of Electrical and Electronics Engineers
11. [IETF](#) - Internet Engineering Task Force
12. [ISO](#) - International Organization for Standardization
13. [Marine XML](#) - Marine Extensible Markup Language Project
14. [MMI](#) - Marine Metadata Interoperability
15. [OAI](#) - Open Archives Initiative
16. [OCLC](#) - Online Computer Library Center
17. [OGC](#) - Open Geospatial Consortium (OpenGIS)

18. [OIT](#) - Ocean Information Technology Program
19. [OPeNDAP](#) - Open Source Project for a Network Data Access Protocol
20. [OpenIOOS](#) - [Consortium of programmers working to provide open-source software solutions for the US Integrated Ocean Observing System]
21. [THREDDS](#) - Thematic Realtime Environmental Distributed Data Services Project
22. [UNICODE](#) - UNICODE Consortium
23. [W3C](#) - World Wide Web Consortium

For detailed descriptions of all these programs, go to http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/05_ProgAgen&Orgs/ProgramsAgencies.htm









[In the program/project descriptions that follow, links are to documents in the IOC/IODE OceanTeacher training system. You can use the main link below each table to open a browser to the same page that you see each table, if you want to see the listed documents.]

Federation of Earth Science Information Partners (ESIP)

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|  | <p>The Federation of Earth Science Information Partners brings together government agencies, universities, non-profit organizations, and businesses in an effort to make Earth Science information available to a broader community. The technological advances and political atmosphere leading to the formation of the Federation were fueled by scientific discoveries that showed potential adverse impacts upon the environment due to human activity. The objective of the Federation is to evolve methods that make Earth science data easy to preserve, locate, access and use for all beneficial applications. The scientific information must be of high quality, easily accessible and low in cost.</p> <p>[The editors of OceanTeacher consider ESIP to be the principal guild of data and information providers in the United States; due to the enormous amount of material available from this group, they also constitute a major global resource. Pioneering work in data delivery infrastructure is taking place within partner sites listed here.]</p> |
| <p>Important Data-Related Documents</p> | <p>List of Earth Science Information Partners Data from The Federation's Earth Science Centers Data from The Federation's Businesses and Groups GIS Products & Services</p> |
| <p>Web Links</p> | <p>Program Homepage Federation Data and Services Catalog</p> |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/05_progagen&orgs/ESIP/ESIP.htm]

Global Spatial Data Infrastructure Association (GSDI)






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|  | <p>The GSDI Association is an inclusive organization of organizations, agencies, firms, and individuals from around the world. The purpose of the organization is to promote international cooperation and collaboration in support of local, national and international spatial data infrastructure developments that will allow nations to better address social, economic, and environmental issues of pressing importance.</p> <p>The mission of the GSDI Association is to</p> <ul style="list-style-type: none"> • serve as a point of contact and effective voice for those in the global community involved in developing, implementing and advancing spatial data infrastructure concepts, • foster spatial data infrastructures that support sustainable social, economic, and environmental systems integrated from local to global scales, and • promote the informed and responsible use of geographic information and spatial technologies for the benefit of society. <p>[See also Open Geospatial Consortium]</p> |
| <p>Important Data-Related Documents</p> | <p> GSDI Brochure</p> <p> Global Spatial Data Infrastructure Cookbook v2.0</p> |
| <p>Web Links</p> | <p> GSDI Geographic Gateway - provides access to catalogs of data and online map services around the world</p> <p> Spatial Data Infrastructure Web Links</p> <p> SDI Africa: An Implementation Guide - to assist African countries to improve the management of their geo-spatial data resources</p> <p> Open Geospatial Network</p> <p> OGC WMS (Web Map Server) Viewer</p> |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/05_progagen&orgs/GSDI/GSDI.htm]

Marine XML









The development of a Marine XML (also called MML) will support the tracking through to the generation of of integrated global and regional datasets. MML describes the data collection, quality control and subsequent processing. The MML at the instrument level would provide the ability to automate such processing descriptions. A number of international initiatives are currently in progress with development of the MML framework. These include:

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| | <p>ICES/IOC SG-XML. IOC and ICES have jointly established the Study Group on Marine Data Exchange Systems Using XML (SG-XML). The Group is investigating how XML might best be used in an oceanographic context. From an IOC/IODE perspective, the group will design a framework for an XML structure that data centres can use.</p> <p>XML Brick concept. The XML brick concept, developed by R. Keeley of MBL, is a small number of generally defined structures that can be assembled in different ways to represent a variety of data collected over a broad spectrum of disciplines. This brick is a building block for packaging data and metadata.</p> <p>EU Marine XML Project. The aim of the EU Marine XML project is to demonstrate how XML can be used to improve the interoperability of data, specifically in support of marine data. The project will develop an XML-based Marine Mark-Up Language (MML) to show how MML and data supported by other established standards. It will specifically demonstrate how this approach supports data interoperability, widens data re-use and improves end-user access to marine observing systems.</p> |
| <p>Important Data-Related Documents</p> | <p> XML Bricks Paper</p> <p> Developing an eXtensible Markup Language (XML) Application for DFO and the Web</p> <p> Development and Use of Marine XML within the Australian Oceanographic Data Management System</p> <p> An XML-Based Marine Data Management System</p> |
| <p>Web Links</p> | <p> Marine XML Home Page</p> |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/05_progagen&orgs/MarineXML/MarineXml.html]


Open Geospatial Consortium (OGC)











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|  | <p>The Open Geospatial Consortium, Inc. (OGC) is a non-profit, international, voluntary organization that is leading the development of standards for geospatial and location-based information. Through member-driven consensus programs, OGC works with government, private industry, and academia to develop open and extensible software application programming interfaces for geographic information systems and other mainstream technologies.</p> <p>Our Approach:</p> <ul style="list-style-type: none"> • Formalize OpenGIS Specifications Through Consensus: Through OGC's standardization and consensus process, OGC members develop, review, and release OpenGIS specifications. • Organize Interoperability Projects: OGC employs testbeds, pilot projects, pilots, and efficiently test, validate, and document vendor-neutral specifications based on real-world use cases. • Develop Strategic Business Opportunities: We identify user communities and their needs, develop spatial interfaces and engage those communities in development and adoption of standards. |
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| | <p>Specifications.</p> <ul style="list-style-type: none"> • Develop Strategic Standards Partnerships: OGC harmonizes its geoprocess standards through partnerships with international standards efforts. • Promote Demand for Interoperable Products: Through our marketing and p work with our members and the public to increase users' awareness and acc Specifications. <p>[See also Global Spatial Data Infrastructure Association]</p> |
| <p>Important Data-Related Documents</p> | <p>OpenGIS Reference Model (ORM) - The OpenGIS Reference Model (ORM) p OGC Technical Baseline. The OGC Technical Baseline consists of the currentl Specifications as well as for a number of candidate specifications that are curre contains a foundation for coordination and understanding (both internal and ext</p> <p> OGC activities and the Technical Baseline. It contains updates of segments of t describes both the OGC requirements baseline for geospatial interoperability an framework. The latter is accomplished through a series of non-overlapping vie and future elements.</p> <p> Adopted Documents List - Includes specifications and ancillary planning docum</p> |
| <p>Web Links</p> | <p> Program Homepage</p> <p> Catalog of OpenGIS-Compliant or OpenGIS-Implementing Software</p> <p> GML - the Geography Markup Language</p> |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/05_progagen&or gs/OpenGIS/OpenGIS.htm]

Open Source Project for a Network Data Access Protocol (OPeNDAP)





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|  | <p>"OPeNDAP" stands for "Open-source Project for a Network Data Access Protocol". OPeNDAP is both the name of a non-profit organization and the name of the protocol which the OPeNDAP organization has developed.</p> <p>The OPeNDAP protocol provides a discipline-neutral means of requesting and providing data across the World Wide Web. The goal is to allow end users, whoever they may be, to access immediately whatever data they require in a form they can use, all while using applications they already possess and are familiar with. In the field of oceanography, OPeNDAP has already helped the research community make significant progress towards this end. Ultimately, it is hoped, OPeNDAP will be a fundamental component of systems which provide machine-to-machine interoperability with semantic meaning in a highly distributed environment of heterogeneous datasets.</p> <p>The OPeNDAP organization exists to develop, implement, and</p> |
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| | promulgate the OPeNDAP protocol. It presents the results of its work freely to the public with the hope that it will be of service in many disciplines and facilitate sharing of and access to their datastreams. |
| Important Data-Related Documents | <ul style="list-style-type: none">  A DODS Quick Start Guide Version 1.5  DODS User Guide Version 1.1.1  OPeNDAP Reference Manual 1.2.14  Data Access Protocol (DAP) Version 2 |
| Web Links | <ul style="list-style-type: none">  Program Homepage  OPeNDAP-Accessible Datasets  DODS/OPeNDAP Datasets Cataloged in the Global Change Master Directory (GCMD)  US National Virtual Ocean Data System (NVODS) - Currently the largest OPeNDAP portal, covering mainly US NOAA datasets (National Virtual Ocean Data System)  List of OPeNDAP Client Programs  List of OPeNDAP Server Programs |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/05_progagen&orgs/OPeNDAP/OPeNDAP.htm]






OpenIOOS

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| Description | <p><i>Q: What is OpenIOOS?</i></p> <p>A: OpenIOOS is a grass-roots partnership effort to support integration of the various activities involved in collection of observations and making predictions of the coastal environment, including contributions from federal agencies and research institutions.</p> <p><i>Q: What's an IOOS?</i></p> <p>A: IOOS stands for "Integrated Ocean Observing System" and designates a national initiative to create a new system for collecting and disseminating information about the oceans. The system will support a variety of practical applications, along with enabling research. The myriad needs and benefits of the IOOS have been articulated by the U. S. Commission on Ocean Policy (www.oceancommission.gov). For more information on the IOOS, check out the Ocean.US web site (www.ocean.us).</p> <p>[This extremely ambitious project is not documented in the usual sense. Its amazing prototype products (see links below) speak for themselves, because they combine, within a GIS framework, various operational oceanographic and meteorological data products. The results are almost</p> |
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| | startling, in that they present -- at once and with great ease -- synthesis products that most users have only dreamed about. This work represents the pinnacle of operational data delivery in global oceanography today.] |
| Important Data-Related Documents | |
| Web Links | <ul style="list-style-type: none">  Program Homepage with prototype wind, SST and hurricane observation products  Southeastern Universities Research Consortium (SURA) Coastal Ocean Observing and Prediction (SCOOP) Program - programming team behind the project  SEACOOS - Southeast Atlantic Coastal Ocean Observing System prototype IOOS demonstration  OpenIOOS Project WIKI |

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/02_InfTchSciCmm/05_progagen&orgs/OpenIOOS/OpenIOOS.htm]

Thematic Realtime Environmental Distributed Data Services (THREDDS)

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|  | <p>The THREDDS (Thematic Realtime Environmental Distributed Data Services) project is developing middleware to bridge the gap between data providers and data users. The goal is to simplify the discovery and use of scientific data and to allow scientific publications and educational materials to reference scientific data.</p> <p>The mission of THREDDS is for students, educators and researchers to publish, contribute, find, and interact with data relating to the Earth system in a convenient, effective, and integrated fashion. Just as the World Wide Web and digital-library technologies have simplified the process of publishing and accessing multimedia documents, THREDDS is building infrastructure needed for publishing and accessing scientific data in a similarly convenient fashion.</p> |
| Important Data-Related Documents | <ul style="list-style-type: none"> THREDDS Overview THREDDS Technical Status Summary  THREDDS Presentation  Abstract Data Distribution Environment (ADDE) - Satellite image access software using THREDDS technology  OPeNDAP (formerly DODS) Data Servers Project - Technology now using THREDDS cataloging |
| Web Links | <ul style="list-style-type: none">  Program Homepage |

Selected Online Data Sources for Visualization

1. **OceanPortal** – 5000 categorized sites, including extensive collection of direct data download servers - <http://oceanportal.org>
 - a. **Online Data Source in OceanPortal (600 sites)** - <http://www.iode.org/oceanportal/browse.php?cat=4>
2. **IOC Selected Data Analyses & Products** - http://ioc.unesco.org/oceanteacher/OceanTeacher2/06_OcDtaMgtProc/05_DtaAnal&Prods/08_SelectProds/SelAnalProds.htm
3. **OPeNDAP Data Catalog** - <http://www.opendap.org/data/datasets.cgi?xmlfilename=datasets.xml&exfunction=none>
4. **National Virtual Oceanographic Data System (NVODS)** - <http://ferret.pmel.noaa.gov/NVODS/servlets/dataset>
5. **US GODAE Live Access Server** - <http://usgodae2.usgodae.org/las/servlets/dataset>
6. **OceanTeacher** – <http://oceanteacher.org>
7. **Earth Observing System Data Gateway (EDG)** - <http://edcimswww.cr.usgs.gov/pub/imswelcome/>

Software for Ocean Data Visualization

This collection of visualization software strongly reflects the IOC/IODE marine data management training program's structured lessons and the programs it employs. To these have been added a number of very useful other programs that are intended to be included in the program in the near future (or their equivalents). It is, of course, NOT an exhaustive catalog of the hundreds of available programs, and probably no reader will feel satisfied that his/her favorite programs are included. Using the data and format integration schema described in this paper (above) the IOC/IODE program has managed to achieve a quasi-system of integrated resources, such that you can go "from any format to any program." This criterion is more important, we think, than elaborate and complex software that might perform marvelous tricks, but at the expense of special personal, extensive training or high cost.

The groupings, comparisons, advantages and disadvantages, and connections between these programs will be discussed in the oral presentation.

ArcExplorer

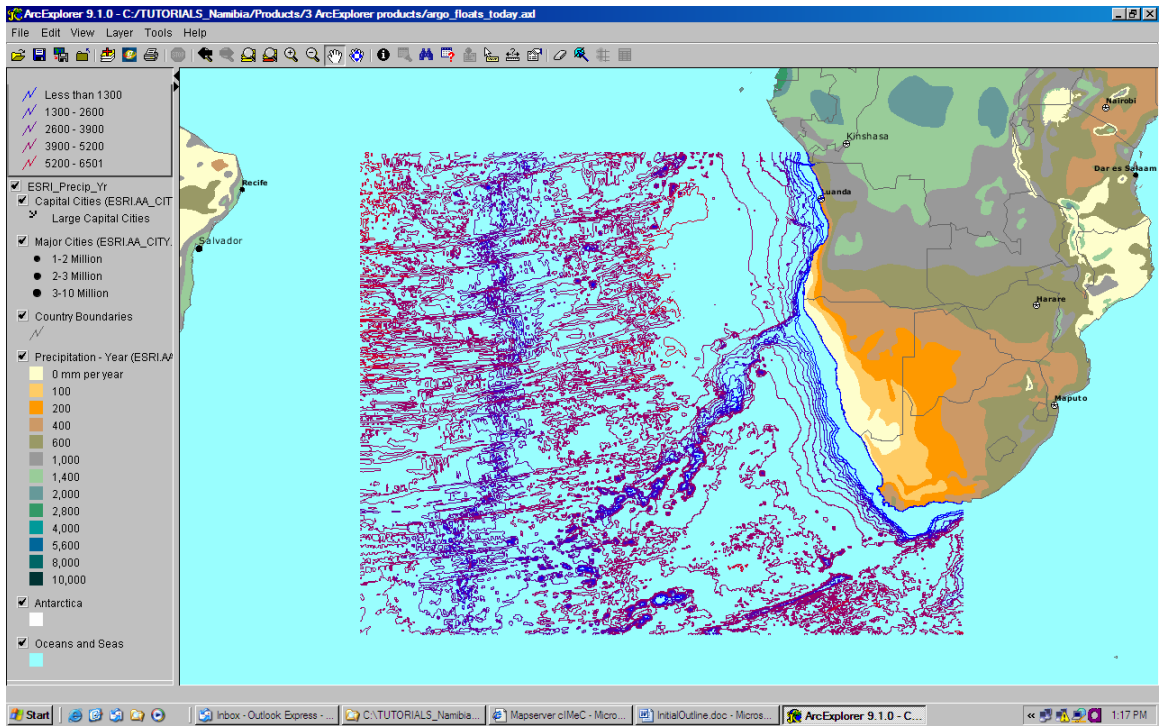
<http://www.esri.com/software/arcexplorer/index.html>

- **Windows, UNIX, Solaris, AIX, HP-UX, Linux,**
- **Version 2.0 [pre-java version with more format compatibilities than succeeding Java versions]; Version 9.1 [Java version with online capability for combining local datasets with IMS-served datasets]; Java Edition for Education, Version 2. [capable of importing tabular data to create “event themes,” the only known case of actual data manipulation with an ESRI browser]**
- **Good documentation at**
<http://support.esri.com/index.cfm?fa=knowledgebase.documentation.listDocs&PID=28>

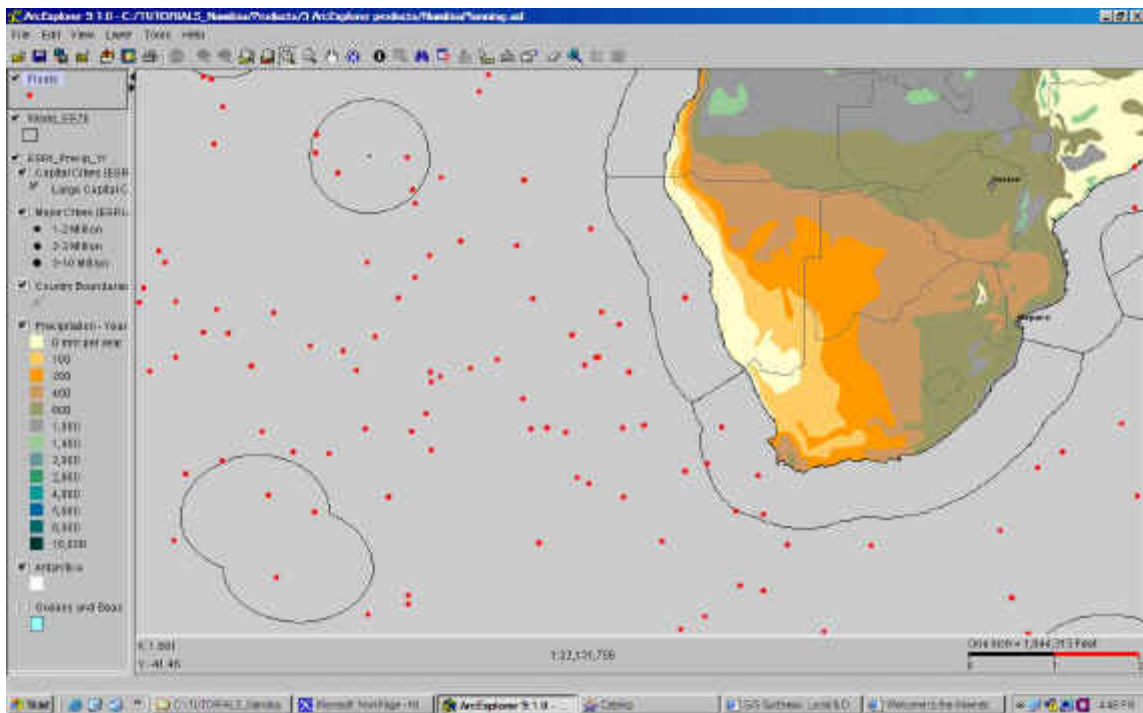
ArcExplorer is a lightweight GIS data viewer developed by ESRI. This freely available software offers an easy way to perform a variety of basic GIS functions, including display, query, and data retrieval applications. It can be used on its own with local data sets or as a client to Internet data and map servers.

With ArcExplorer you can

- Freely distribute the ArcExplorer installation and your data CDs so recipients can view your data effectively.
- Display and query a variety of standard data sources including:
 - ESRI shapefiles
 - ArcInfo coverages
 - ArcSDE layers
 - Images
 - ArcIMS Services (i.e., Geography Network sources)
- Pan and zoom through multiple map layers and identify, locate, and query geographic and attribute data.
- Symbolize your data based on attributes contained in your data layers to create thematic maps.
- Perform basic spatial analysis tasks on the geographic data, such as selecting and buffering features.
- Dynamically, view your data in different coordinate systems (with ArcExplorer-Java Edition for Education).



Typical view of multiple datasets with ArcExplorer 9.1. The depth contours are a local dataset derived from GEBCO, but the African precipitation data are actually online data from an IMS installation.



In this similar figure, the locations of Argo floats are shown. They are also served online by a JCOMMOPS IMS installation, and represent the latest locations.

ArcIMS

www.esri.com

- **Virtually all platforms are supported**
- **Training catalog at**
<http://training.esri.com/gateway/index.cfm?fa=catalog.gateway>

ArcIMS is a server-based product that provides a scalable framework for distributing GIS services and data over the Web. ArcIMS provides Web publishing of GIS maps, data, and metadata for access by many users both inside the organization and outside on the World Wide Web. ArcIMS enables Web sites to serve GIS data, interactive maps, metadata catalogs, and focused GIS applications. ArcIMS users access these services through their Web browsers using HTML or Java applications that are included with ArcIMS. In addition, ArcIMS services can be accessed using many different clients including ArcGIS Desktop, custom applications created using ArcGIS Engine, ArcReader, ArcPad, ArcGIS Server, MapObjects—Java Edition, and a wide variety of mobile and wireless devices.

Why Use ArcIMS?

With ArcIMS you can

- Publish high-quality interactive maps that can be accessed by thousands of people simultaneously over the Internet.
- Integrate data from multiple sources (Internet or local) and serve it on the Web.
- Make your maps, data, and metadata accessible using a variety of clients (mobile, desktop, browser).
- Use the highly scalable server architecture to accommodate growing demand for your services without having to rebuild applications.
- Create a central repository for publishing and browsing metadata.
- Make your GIS content more accessible by publishing metadata about your services.

How Is ArcIMS Used?

ArcIMS is used for GIS Web publishing. Its primary focus is Web delivery of geographic data, maps, and metadata. The following examples illustrate the main application functions of ArcIMS.

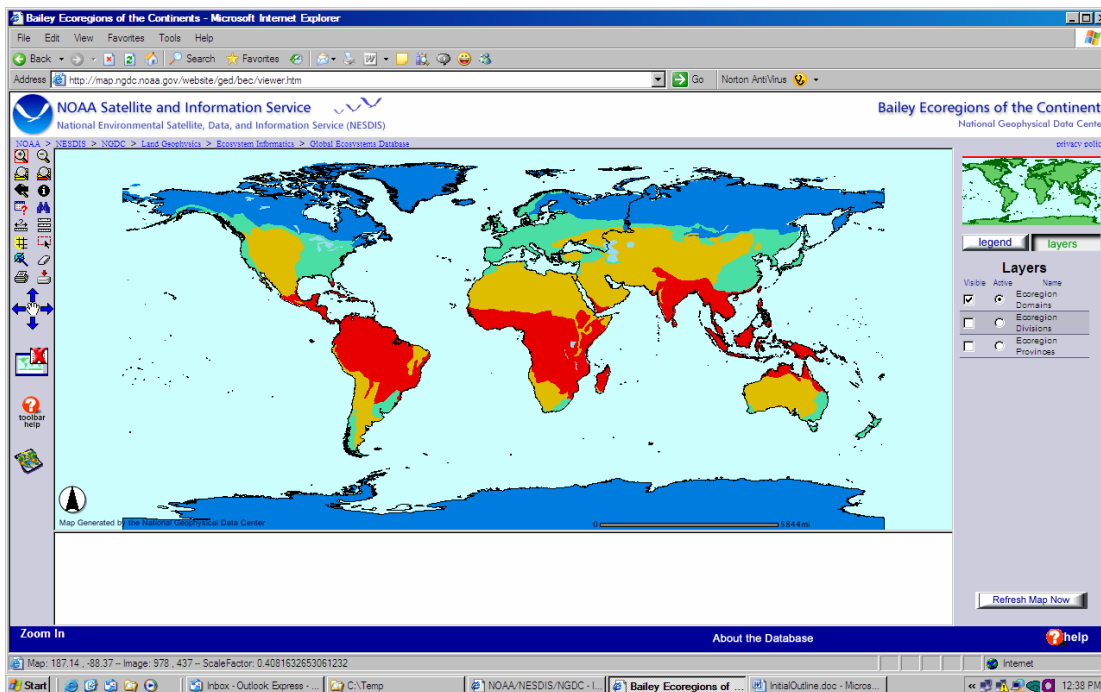
- **Focused application delivery**—ArcIMS can be used to deliver GIS to numerous internal users or to external users on the Internet. ArcIMS provides data access and simple, focused applications to users through a Web browser.
- **Publishing for professional GIS users**—Many organizations publish GIS data for GIS professionals both within and outside their organization. Such ArcIMS applications are focused on data sharing between GIS professionals. The intended

uses of the data are not necessarily well known ahead of time and can vary from user to user. GIS professionals use the data in their GIS along with other information to accomplish many tasks.

- Technology for GIS networks—GIS Web publishing with ArcIMS is often the initial step in the implementation of enterprise GIS. GIS organizations publish and deliver GIS data and services to a broad audience, often across several departments. ArcIMS is important for building all the parts of a GIS network. ArcIMS includes tools for building a GIS portal with a metadata catalog such as search and discovery, data and metadata harvesting, gazetteer functions, and Web mapping applications.

Who Uses ArcIMS?

The geopublishing capabilities of ArcIMS appeal to governments, businesses, and organizations that need to provide geographic-based data and services on the Web both publicly over the Internet and within the organization over an Intranet. ArcIMS is used to provide city and county land use information, real-time traffic information, store location maps, business relocation and home buyer services, and countless other services.



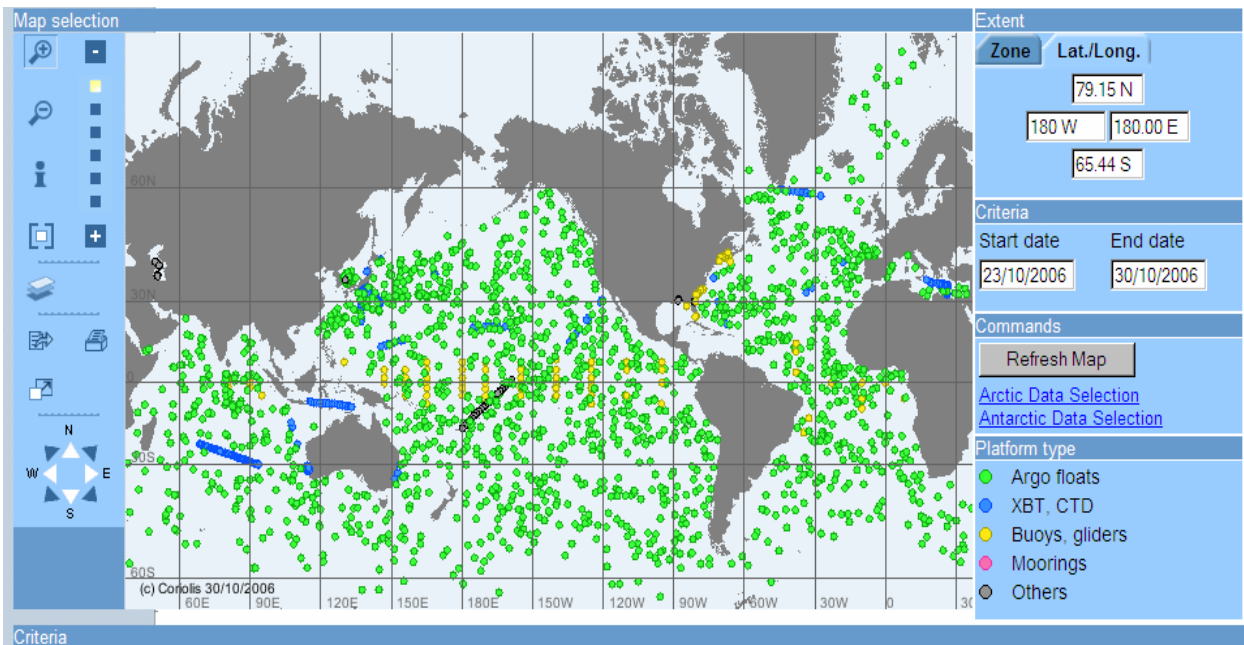
Typical IMS installation webpage, in this case delivering ecosystems data from the US National Geophysical Data Center. Notice that the “data extract” control is provided.

Coriolis

http://www.coriolis.eu.org/cdc/data_selection.htm

- Online visualization of operational oceanographic units
- IOC/IODE Tutorial at http://ioc.unesco.org/oceanteacher/OceanTeacher2/08_Exercises/03_DtaMgt/Ex/Roadmaps/K_OpOcDta/1_OpOcData/Argo&GtsppDta.htm

The data selection pages allow you to visualize and download in-situ data. Vertical profile and trajectory data are available. Vertical profile data mainly come from XBT, XCTD from research vessels or ships of opportunity; Argo profiling floats; anchored buoys or moorings; drifting buoys. Trajectory data come mainly from drifting buoys; argo floats; vessels equipped with a thermosalinograph. Data selection criteria are geographic, temporal and selection of meta-data (such as platform name, cruise or experience name, principal investigator's name).



Typical display of global data locations of various Global Ocean Observing System component program sensors and units.

DChart

<http://dapper.pmel.noaa.gov/dchart/>

- **Online visualization of operational oceanographic units**

What is DChart?

The Dapper Data Viewer (aka DChart) allows you to visualize and download in-situ oceanographic or atmospheric data from a [Dapper OpenDap](#) server. Features include an interactive map that is draggable, an in-situ station *layer* that allows you to select data stations, and a plot window that allows you to plot data from one or more stations. Three plot types are supported (profile, property-property, and time series) and users can interact directly with the plot to pan or zoom in and out. Click here to [try DChart](#).

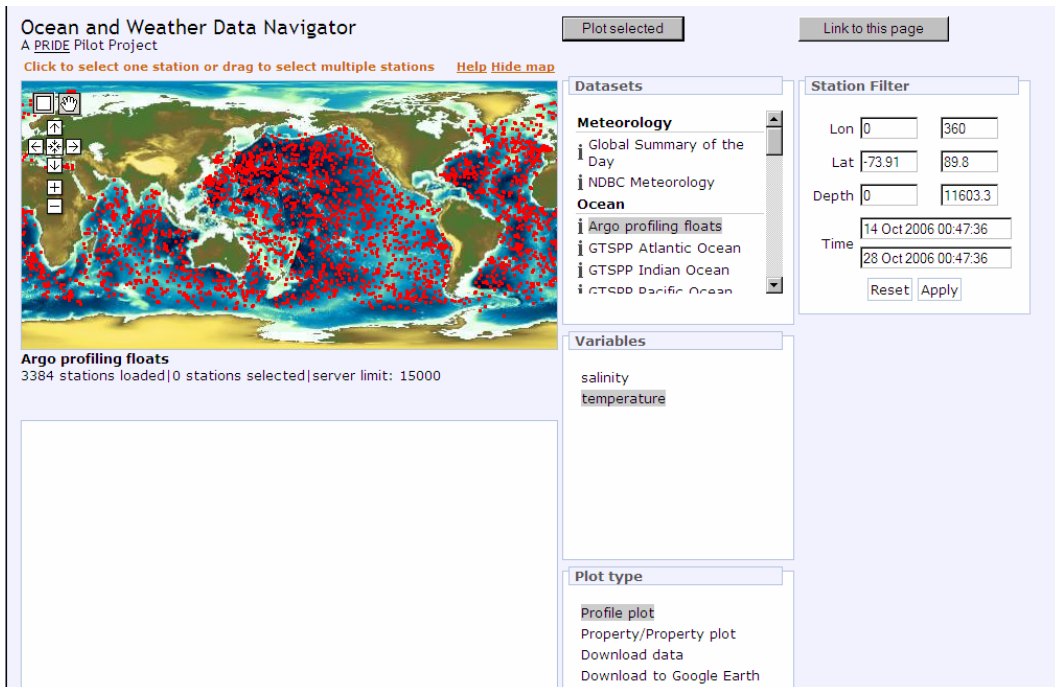
What problem does DChart address?

Millions of in-situ ocean observations are now available to scientists through the OPeNDAP network protocol. However, access to this data is limited because there are few Web applications that support the in-situ OPeNDAP protocol.

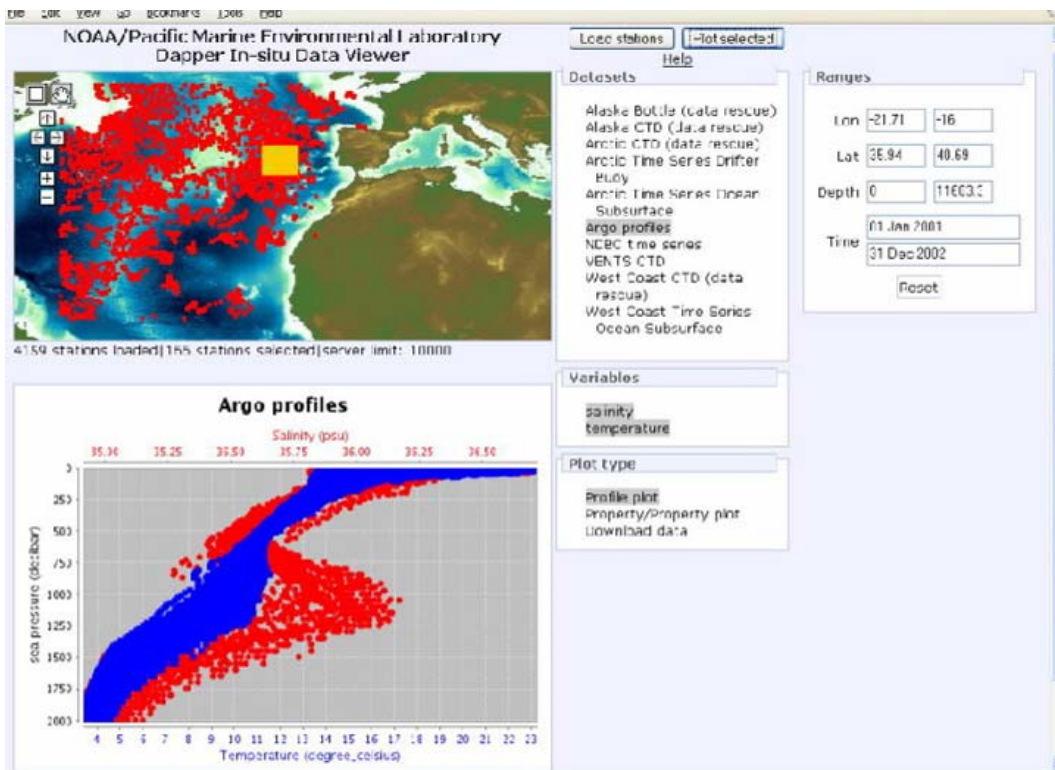
What is the solution?

Several Web browser based technologies (XHTML/CSS/DOM/XML/XSLT and JavaScript) have matured over the last few years to the point where it is now possible to design OPeNDAP compatible Web applications with richer user interfaces than are possible with traditional Web technologies.

[DChart](#) is a Web application that takes advantage of this technology to allow interactive selection, browsing, plotting and downloading of in-situ observations from [Dapper](#), an in-situ OPeNDAP server. Users have access to the functionality of a desktop application in a Web browser without having to download any plugins or applets.



Opening screen from DChart, showing the marked similarity to the parallel Coriolis operational data server. Notice the Dowload to Google Earth control at the bottom.



Additional figure indicating the data analysis capability of DChart.

Ferret

<http://ferret.wrc.noaa.gov/Ferret/>

- **Sun, Linux, Unix, Windows (with X Windows); & others**
- **Extensive training and tutorial materials (“tours”) at**
http://ferret.wrc.noaa.gov/Ferret/Documentation/ferret_documentation.html

Ferret is an interactive computer visualization and analysis environment designed to meet the needs of oceanographers and meteorologists analyzing large and complex gridded data sets. It runs on most Unix systems, and on Windows XP/NT/9x using X windows for display. It can transparently access extensive remote Internet data bases using OPeNDAP (formerly known as DODS); see <http://www.unidata.ucar.edu/packages/dods/>.

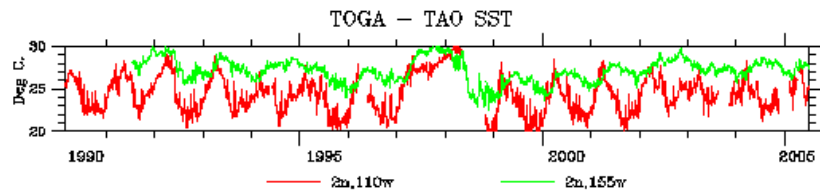
Ferret was developed by the Thermal Modeling and Analysis Project (TMAP) at PMEL in Seattle to analyze the outputs of its numerical ocean models and compare them with gridded, observational data. The model data sets are generally multi- gigabyte in size with mixed 3 and 4-dimensional variables defined on staggered grids. Ferret offers a Mathematica-like approach to analysis; new variables may be defined interactively as mathematical expressions involving data set variables. Calculations may be applied over arbitrarily shaped regions. Fully documented graphics are produced with a single command.

Many excellent software packages have been developed recently for scientific visualization. The features that make Ferret distinctive among these packages are Mathematica-like flexibility, geophysical formatting, "intelligent" connection to its data base, memory management for very large calculations, and symmetrical processing in 4 dimensions.

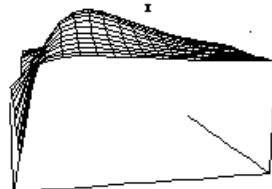
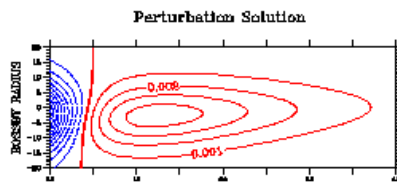
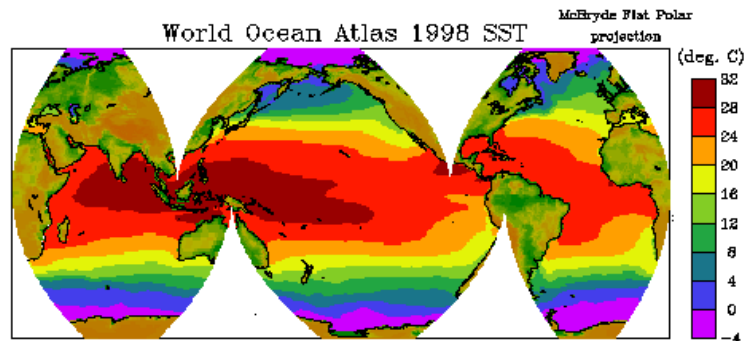
Ferret is widely used in the oceanographic community to analyze data and create publication quality graphics. [It is the graphics engine seen during the use of Live Access Servers (LAS) within the OPeNDAP system of data communication protocols. It is arguably the best documented visualization package available today, with online demonstrations of all the following topics:]

- Remote data access (with OPeNDAP)
- External functions
- Binary stream file capability
- Constant array syntax
- COADS ocean-atmosphere data set
- Levitus data set: Climatologic Atlas of the World Ocean
- Color palettes
- Map projections
- Track plotting
- Continuous colorbar

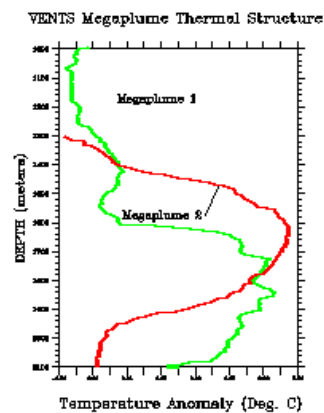
- Color-filled vectors
- Graticules
- Detailed land outlines
- Data sets
- Files and data manipulations
- Math & statistics
- Contouring & 2-D plots
- Plot symbols, lines, patterns
- Track plotting
- Other topics



NOAA / PMEL
F E R R E T
 An Analysis Tool for Gridded and Non-Gridded Data



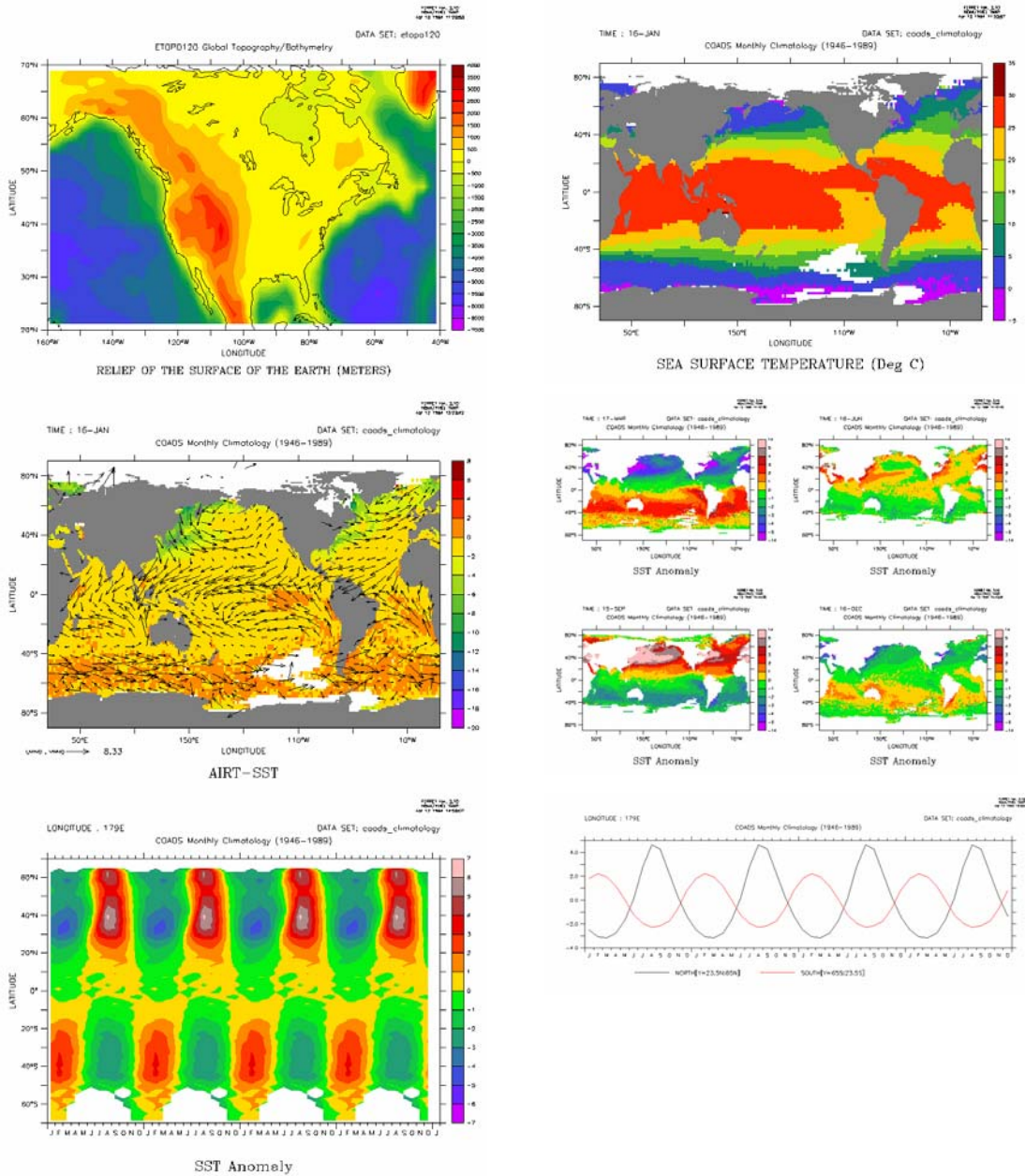
$$-(B+1/2)*D_r * e^B / D^2$$



The cover of this User's Guide was produced by Ferret. From the top down the plots are: "TOGA-TAO SST," time series from the Tropical Pacific TAO array; "Levitus

Climatological SST," an equal area projection of level one of the annual Climatological Atlas of the World Oceans by Sydney Levitus of NOAA/NODC; "Perturbation Solution," a visualization of abstract functions by Dr. Ping Chang; "Vents Megaplume Thermal Structure," vertical temperature profiles of undersea thermal vents from the NOAA Vents program.

The following small gallery of images from the Ferret Tour indicates the scope of possible data visualization options:



About Live Access Servers - The Live Access Server (LAS) is a highly configurable Web server designed to provide flexible access to geo-referenced scientific data. It can

present distributed data sets as a unified virtual data base through the use of the OPeNDAP protocols. Ferret is the default visualization application used by LAS, though other applications (Matlab, IDL, GrADS, ...) can also be used. The following table (known to be only partially updated, unfortunately) gives the locations of many LAS servers:

| LAS Sites Hosted by NOAA/PMEL/TMAP | | | |
|---|----------------|---|---|
| Server Name | Version | URL | Server Description |
| NVODS | 6.4 | http://ferret.pmel.noaa.gov/nvods | National Virtual Ocean Data System -- data available via OPeNDAP (DODS) |
| WODB | 6.4.1 | http://ferret.pmel.noaa.gov/wodb | in-situ data server providing access to NODC's World Ocean Data Base |
| GODAE Modelers | 6.1 | http://ferret.pmel.noaa.gov/godae | Cooperative modeling umbrella site linking distributed Live Access Servers |
| TMAP | 6.1 | http://ferret.pmel.noaa.gov/tmap | PMEL's Thermal Modeling and Analysis Project: model results, gridded data products, and research-quality reference fields |
| NGDC (coastal bathymetry) | 3.0 prototype | http://ferret.pmel.noaa.gov/coastal_bathymetry | NOAA/National Geophysical Data Center: 3-arc second blended coastal bathymetry/topography (funded by NOAA/ESDIM) |
| Alternative Interfaces to LAS | | | |
| Office of Climate Observation | | http://osmc.noaa.gov/OSMC/adopt_a_drifter.html | Adopt-a-Drifter tracking page |
| | | | |
| LAS Sites at Other Institutions | | | |
| Institution Name (Project Name) | Version | URL | Server Description |
| NOAA (National Oceanic and Atmospheric Administration) | | | |
| Pacific | 5.1 | http://las.pfeg.noaa.gov/las | Ocean/climate fields for |

| | | | |
|--|-----|---|---|
| Fisheries Environmental Lab | | | fisheries research |
| | 6.0 | http://las.pfeg.noaa.gov:8080/las_fish1/servlets/dataset | California fish landings |
| | 5.1 | http://las.pfeg.noaa.gov/las_TOPP | Tagging Of Pacific Pelagics (TOPP) |
| | 6.5 | http://oceanwatch.pfel.noaa.gov/ | OceanWatch |
| | 5.1 | http://las.pfeg.noaa.gov/las_oscurs | OSCURS drift model |
| Geophysical Fluid Dynamics Lab | 4 | http://data1.gfdl.noaa.gov/las4/ | Ocean data from the IRI/ARCS. |
| National Geophysical Data Center | 6.3 | http://las.ngdc.noaa.gov/las/servlets/dataset | NOAA Observing Systems Architecture (GIS back end) |
| FACTS | 5.0 | http://ferret.pmel.noaa.gov/FACTS | Facility for the Analysis and Comparison of Tsunami Simulations (FACTS) (funded by NOAA/HPCC) |

NASA (National Aeronautics and Space Administration)

| | | | |
|---|-----|---|--|
| NASA Seasonal-to-Interannual Prediction Project | 6.1 | http://nsipp.gsfc.nasa.gov:8080/las/servlets/dataset | Climate model output |
| Goddard Space Flight Center | 5.0 | http://daac.gsfc.nasa.gov/las/ | MODIS and SeaWifs data |
| Goddard Space Flight Center | 6.0 | http://aquarius1.gsfc.nasa.gov:8080/las/servlets/dataset | Aquarius/SAC-D |
| My NASA Data | 6.4 | http://mynasadata.larc.nasa.gov/las/servlets/dataset | NASA data for students and amateur scientists. |

Navy

| | | | |
|---|-----|---|--|
| Naval Oceanographic Offices | 5.0 | http://pdas.navo.navy.mil/las/ | real-time WAMS, SWAFS, MCSST model output |
| USGODAE | 6.0 | http://usgodae1.usgodae.org/las/servlets/dataset | US component of the Global Ocean Data Assimilation Experiment -- providing data streams needed for operational modeling research |

DOE (Department of Energy)

| | | | |
|---|-----|---|---|
| Lawrence Livermore National Lab | 6 | http://esg.llnl.gov:8080/las/servlets/dataset/ | Program for Climate Model Diagnosis and Intercomparison (PCMDI) |
| Oak Ridge National Lab | 6.4 | http://cdiac3.ornl.gov/las/servlets/dataset | Carbon Dioxide Information Analysis |

| | | | |
|---|--------|---|--|
| | | | Center (CDIAC) -- Ocean CO2 |
| Oak Ridge National Lab | 6.4 | http://cdiac3.ornl.gov/underway/servlets/dataset | CDIAC Underway carbon measurements |
| Multi-Agency Programs | | | |
| National Center for Atmospheric Research (NCAR) | 4.0 | http://dataserver.ucar.edu/arcas | ARCAS (ACACIA Regional Climate Data Access System) |
| | 5.0 | http://dataserver.ucar.edu/vemap | VEMAP (The Vegetation/Ecosystem Modeling and Analysis Project) |
| International Pacific Research Center | 6.0 | http://apdrc.soest.hawaii.edu:9090/las/servlets/dataset | Asia-Pacific Data Research Center |
| US JGOFS | 6.3 | http://usjgofs.whoi.edu/las/servlets/dataset | Joint Global Ocean Flux Study -- system for model result intercomparison |
| Estimating the Circulation and Climate of the Ocean (ECCO) | 6.3 | http://www.ecco-group.org:8080/lasxml-org/servlets/dataset | ocean model output |
| | 6.3 | http://ecco.jpl.nasa.gov/las/servlets/dataset | ECCO JPL |
| | 6.4.2 | http://mit.ecco-group.org:8080/las/servlets/dataset | ECCO MIT |
| | 6.3 | http://ecco-las.ucsd.edu:8080/lasxml/servlets/dataset | ECCO SIO |
| IGES/COLA | 6.0 | http://monsoondata.org:8080/las/servlets/dataset | Indian Monsoon data |
| HYCOM | 5.1 | http://hycom.rsmas.miami.edu/dataserver/ | HYCOM/MICOM model data |
| US .EDU and .ORG | | | |
| NYU/CAOS | 6 | http://maud.cims.nyu.edu:8080/las/servlets/dataset | Arctic Ocean Model Intercomparison Project (AOMIP) |
| | 5.2 | http://hamish.cims.nyu.edu/las | |
| Monterey Bay Aquarium Research Institute (MBARI) | 4.0 | http://dods.mbari.org/lasOASIS/ | mooring and observatory data |
| Joint Institute for the Study of Atmosphere and Ocean (JISAO) | 6.2 | http://margaret.atmos.washington.edu:8180/las/servlets/dataset | atmospheric reanalysis data |
| Canada | | | |
| Gulf of Main | custom | http://palapa.ocean.dal.ca/las_mooring/las_mooring.html | Halifax harbor moorings |

| | | | |
|--|-----|---|---|
| GoMOOS | | | |
| England | | | |
| National Environmental Research Council | 5.0 | http://www.nerc-essc.ac.uk/las/ | Environmental Systems Science Centre -- Met office model data |
| France | | | |
| Centre National de la Recherche Scientifique | 6.4 | http://climserv.lmd.polytechnique.fr/las-pub/servlets/dataset | Laboratoire de Météorologie Dynamique - NCEP reanalysis |
| AVISO | 6 | http://las.aviso.oceanobs.com/las/servlets/dataset | satellite altimetry |
| MERCATOR | | http://las.mercator-ocean.fr (access on request to products@mercator-ocean.fr) | serving MERCATOR model outputs (for more information see http://www.mercator-ocean.fr) |
| MERSEA | | http://las.Mersea.eu.org (access on request to webmaster@mersea.eu.org) | serving european model outputs + AVISO satellite altimeter data + Coriolis in situ data (for more information see http://www.mersea.eu.org) |
| IPSL | 6 | http://las.ipsl.jussieu.fr:8080/las/servlets/dataset | model output |
| IFREMER | 6.3 | http://www.ifremer.fr/las/servlets/dataset | near real time satellite products |
| Germany | | | |
| Alfred Wegener Institute for Polar and Marine Research | 5.0 | http://mmm.awi-bremerhaven.de/las | sea surface elevation |
| India | | | |
| Center for Modeling and Simulation | 2? | http://www.cmmacs.ernet.in/cgi-bin/climate_server | Indian Ocean model runs |
| Australia | | | |
| CSIRO | 6.3 | http://www.marine.csiro.au/las/servlets/dataset | Australasian SST |

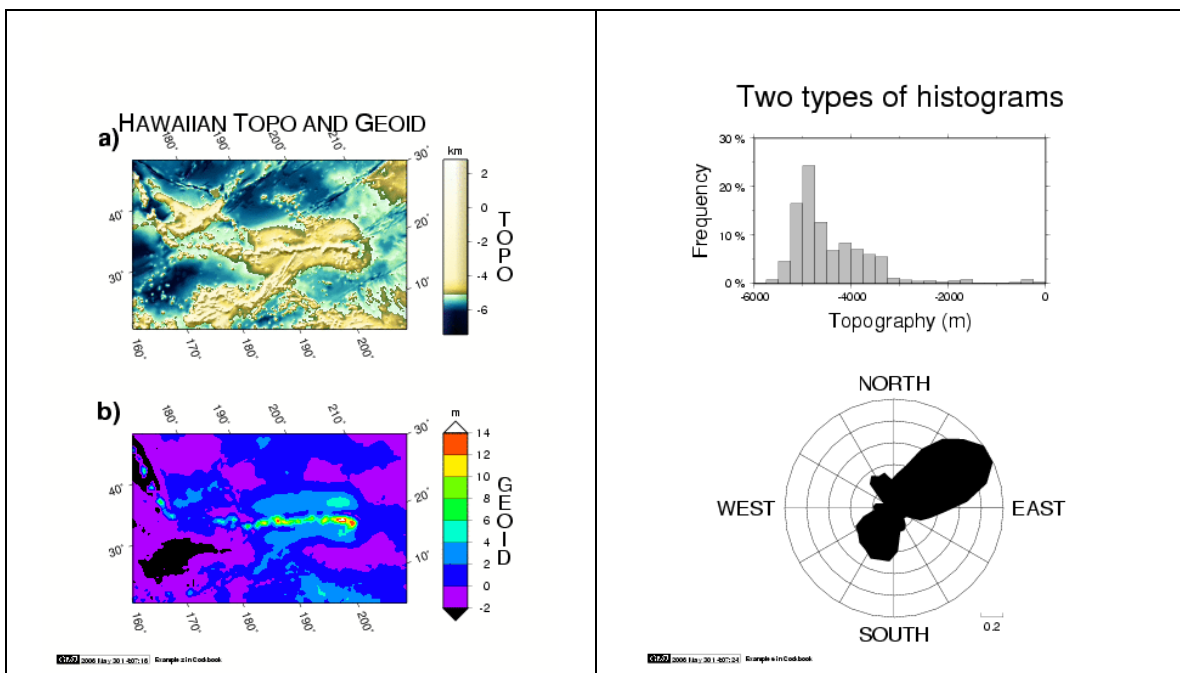
GMT (General Mapping Tools)

<http://gmt.soest.hawaii.edu>

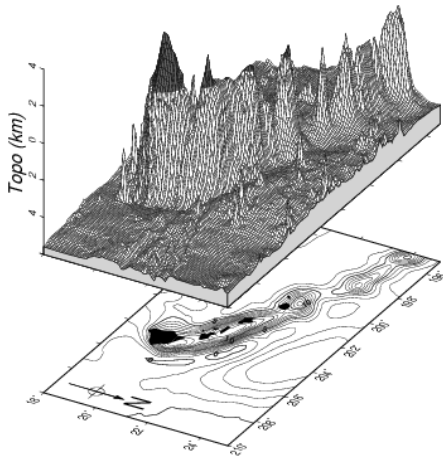
- Windows, Linux, Unix, MacOS X, OS2
- Extensive documentation and examples at

GMT is an open source collection of ~60 tools for manipulating geographic and Cartesian data sets (including filtering, trend fitting, gridding, projecting, etc.) and producing Encapsulated PostScript File (EPS) illustrations ranging from simple x-y plots via contour maps to artificially illuminated surfaces and 3-D perspective views. GMT supports ~30 map projections and transformations and comes with support data such as coastlines, rivers, and political boundaries. GMT is developed and maintained by Paul Wessel and Walter H. F. Smith with help from a global set of volunteers, and is supported by the National Science Foundation. It is released under the GNU General Public License.

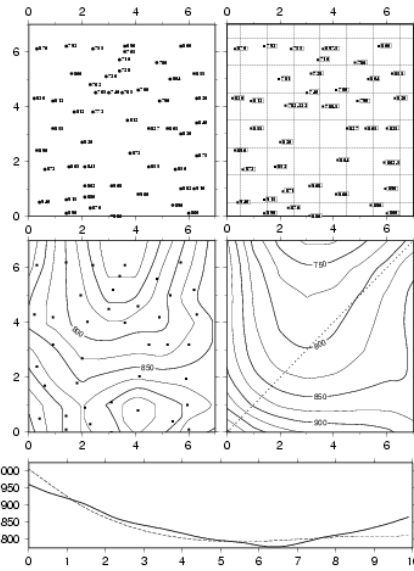
[GMT is compatible with NetCDF and its own “native” data formats for linear or gridded data. The program is enormously powerful, but has a notoriously steep learning curve.]



HAWAIIAN RIDGE

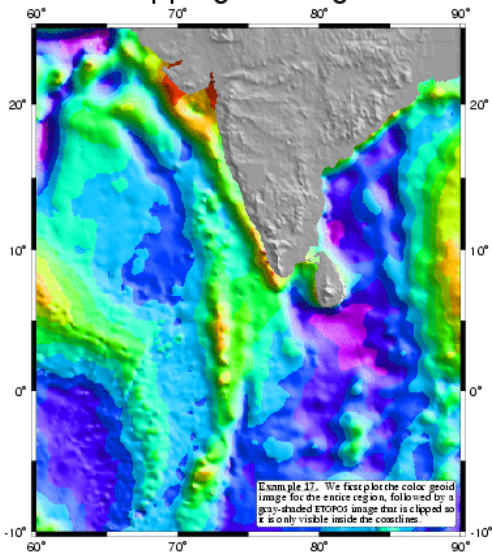


Example 11 in Cookbook



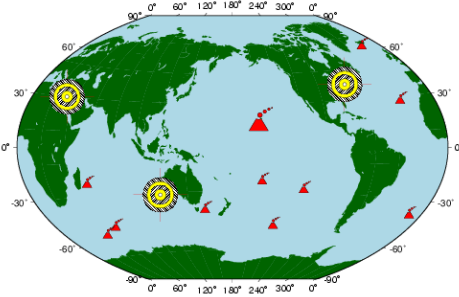
Example 14 in Cookbook

Clipping of Images



Example 17 in Cookbook

Hotspot Islands and Cities



Example 20 in Cookbook

Google Earth

<http://earth.google.com/>

- **Windows, Mac, Linux**
- **This program is the lowest level in a hierarchy of software solutions that is not free at the higher levels**
- **No online documentation or tutorials, but there is a huge and growing international users community**

The idea is simple. It's a globe that sits inside your PC. You point and zoom to anyplace on the planet that you want to explore. Satellite images and local facts zoom into view. Tap into Google search to show local points of interest and facts. Zoom to a specific address to check out an apartment or hotel. View driving directions and even fly along your route. We invite you to try it now.

Google Earth is free for personal use. No registration is required. This program is the lowest level in a hierarchy of software solutions that is not free at the higher levels

Features:

- Free for personal use.
- Sophisticated streaming technology delivers the data to you as you need it.
- Imagery and 3D data depict the entire earth - Terabytes of aerial and satellite imagery depict cities around the world in high-resolution detail.
- Local search lets you search for restaurants, hotels, and even driving directions. Results show in your 3D earth view. Easy to layer multiple searches, save results to folders, and share with others.
- Layers show parks, schools, hospitals, airports, shopping, and more.
- KML – data exchange format lets you share useful annotations and view thousands of data points created by Google Earth users - http://earth.google.com/kml/kml_tut.html

Use it for:

- Planning a trip
- Getting driving directions
- Finding a house or apartment
- Finding a local business
- Exploring the world

GOOGLE Ocean:

- A parallel initiative developed by a private firm at <http://www.justmagic.com/GM-GE.html>

- Data objects include many maps and images that have been manually georeferenced, as well as vector datasets
- Presently includes:
 - **Submarine cables**
 - **Shipwrecks (French coasts)**
 - **Coastal orthophoto**
 - **Aerial photos**
 - **Marine raster chart**
 - **World tide predictions**
 - **Bathymetry**
 - **Weather**
 - **Magnetic declination**



A typical Google Earth image of a peninsula in the Bahamas. Notice the extreme difference in sea conditions from south to north.

GRADS

<http://www.iges.org/grads/>

- **Good User's Guide** at <http://www.iges.org/grads/gadoc/users.html>
- **Modest Tutorial** at <http://www.iges.org/grads/gadoc/tutorial.html>
- **Syntax and Usage Index** at <http://www.iges.org/grads/gadoc/gadocindex.html>

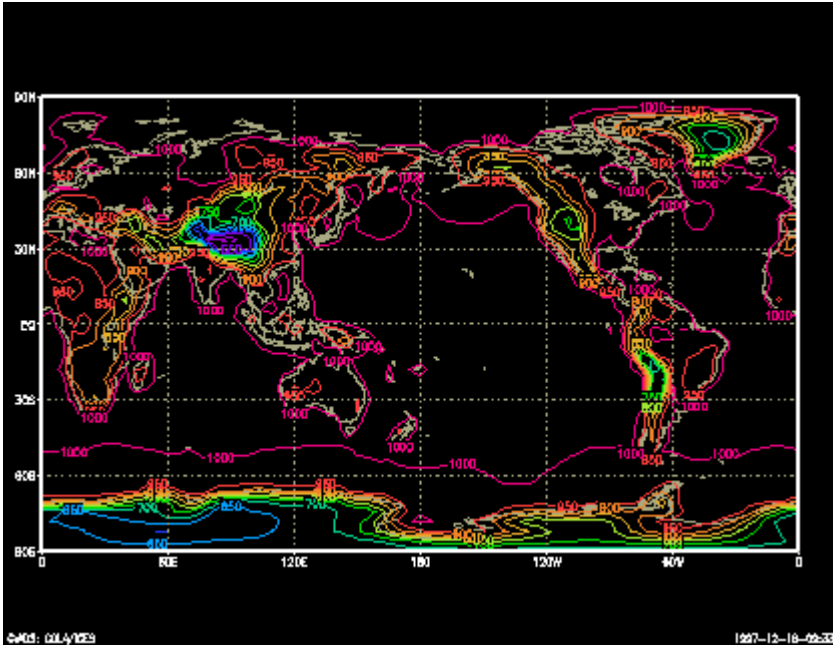
The Grid Analysis and Display System (GrADS) is an interactive desktop tool that is used for easy access, manipulation, and visualization of earth science data. The format of the data may be either binary, GRIB, NetCDF, or HDF-SDS (Scientific Data Sets). GrADS has been implemented worldwide on a variety of commonly used operating systems and is freely distributed over the Internet.

GrADS uses a 4-Dimensional data environment: longitude, latitude, vertical level, and time. Data sets are placed within the 4-D space by use of a data descriptor file. GrADS interprets station data as well as gridded data, and the grids may be regular, non-linearly spaced, gaussian, or of variable resolution. Data from different data sets may be graphically overlaid, with correct spatial and time registration. Operations are executed interactively by entering FORTRAN-like expressions at the command line. A rich set of built-in functions are provided, but users may also add their own functions as external routines written in any programming language.

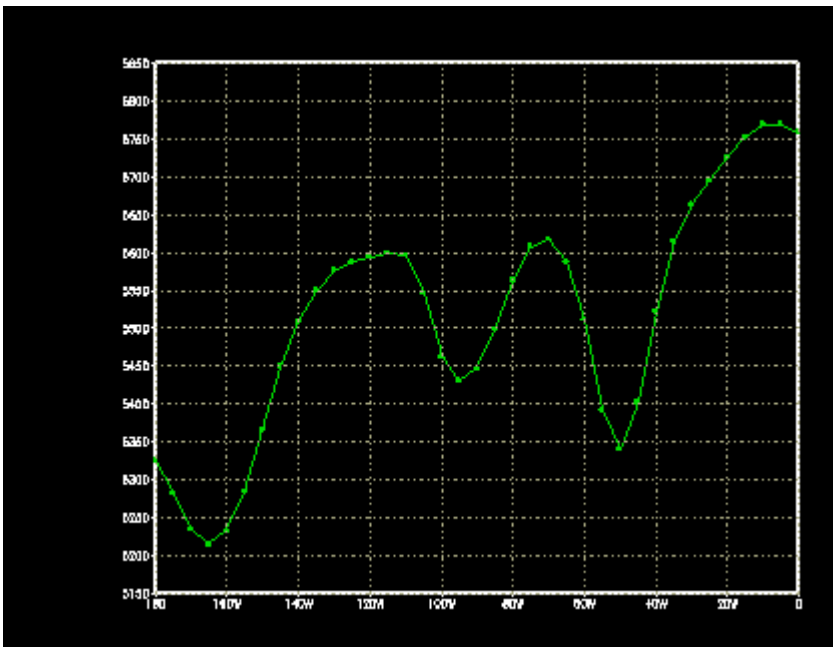
Data may be displayed using a variety of graphical techniques: line and bar graphs, scatter plots, smoothed contours, shaded contours, streamlines, wind vectors, grid boxes, shaded grid boxes, and station model plots. Graphics may be output in PostScript or image formats. GrADS provides geophysically intuitive defaults, but the user has the option to control all aspects of graphics output.

GrADS has a programmable interface (scripting language) that allows for sophisticated analysis and display applications. Use scripts to display buttons and dropmenus as well as graphics, and then take action based on user point-and-clicks. GrADS can be run in batch mode, and the scripting language facilitates using GrADS to do long overnight batch jobs.

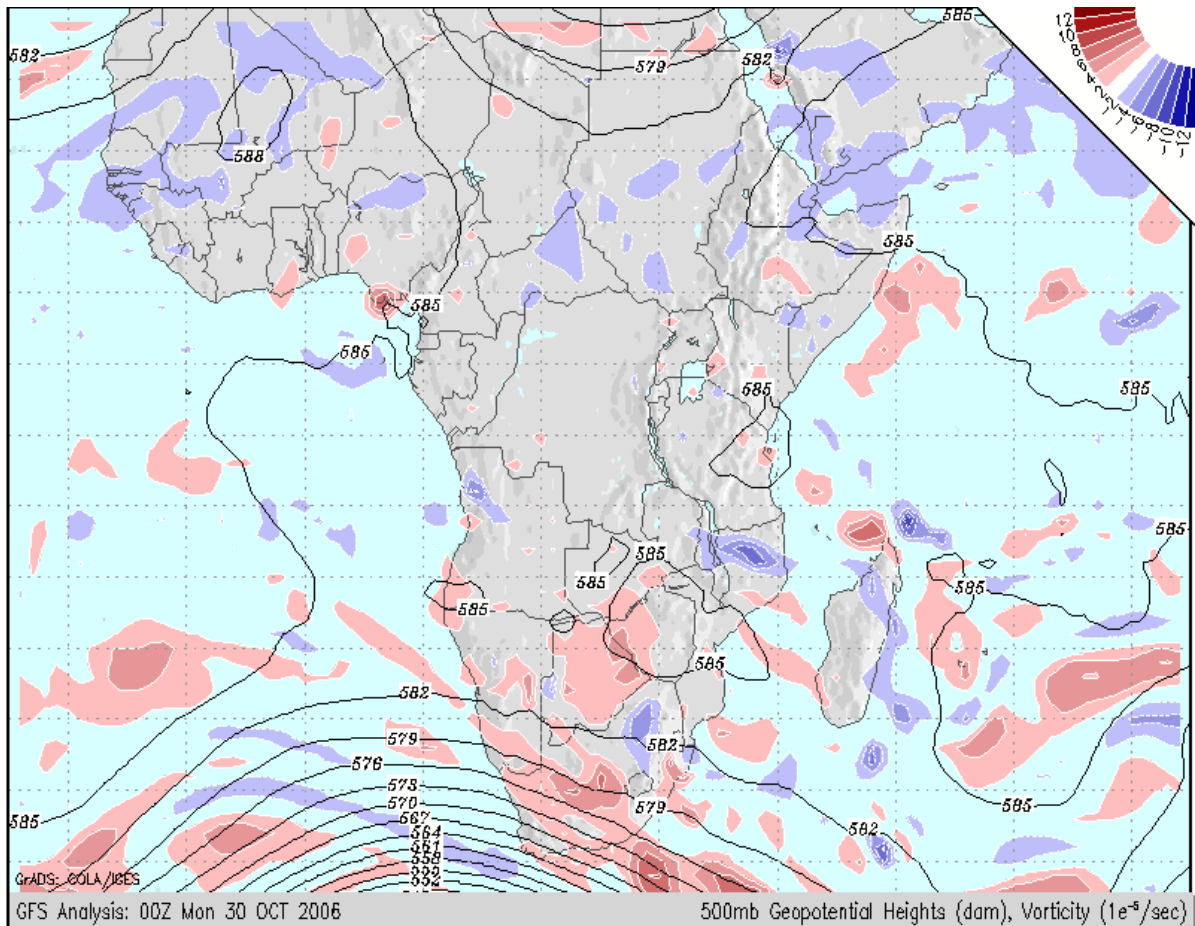
Online documentation has become the new standard for GrADS. The [documentation page](#) has links to the User's Guide, a Tutorial, and a useful Index for quick reference. You can also get a tar file containing all the documentation web pages to install locally. Outdated hardcopy is also available. A list of publications about GrADS can be found [here](#).



The most basic GRADS plot, and the first one illustrated in the Tutorial. This figure is of surfaced pressure in a sample, 4-dimensional data file that is used extensively in the Tutorial.



Users can “slice and dice” the 4-dimensional data any way they wish, as shown by this time plot of pressure at a single location, from the same data set.



GRADS is arguably the most widely used visualization package in the earth sciences, due to the fact that it is the graphics engine for meteorologists worldwide. Daily, thousands of images – at all scales—are generated, using analysis feeds from the World Meteorological Organization’s distributions systems. There is even a guide to interpreting typical images at <http://wxmaps.org/pix/fcstkey.html> .

HDF-EOS to GeoTIFF Conversion Tool (HEG)

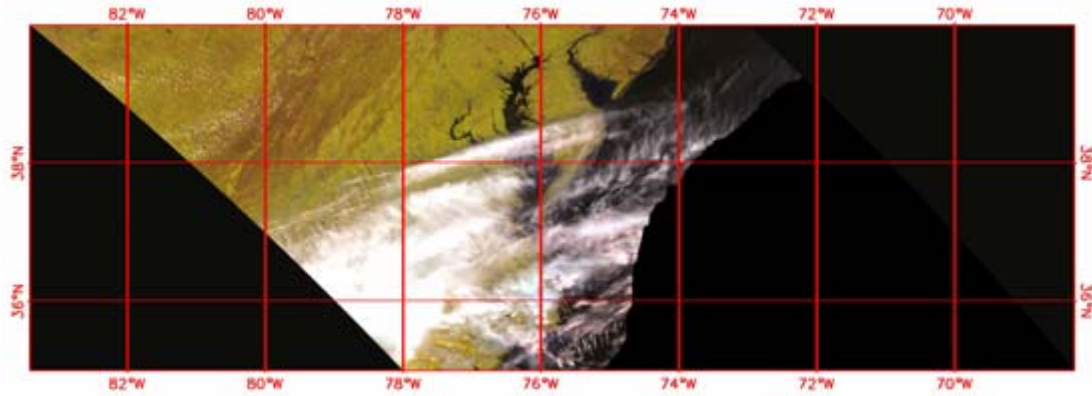
<http://newsroom.gsfc.nasa.gov/sdptoolkit/HEG/HEGHome.html>

- **LINUX, Windows, SUN, SGI , and MAC OSX**
- **Good User's Guide at**
<http://newsroom.gsfc.nasa.gov/sdptoolkit/HEG/HEGDownload.html>

The HDF-EOS To GeoTIFF Conversion Tool (HEG) is a tool developed to allow a user to reformat, re-project and perform stitching/mosaicing and subsetting operations on HDF-EOS objects. The output GeoTIFF file is ingestible into commonly used GIS applications. HEG will also write to HDF-EOS Grid & SWATH formats (i.e for Subsetting purposes) and native (or raw) binary. HEG presently works with MODIS (AQUA and TERRA), ASTER, MISR, AIRS, and AMSR-E HDF-EOS data sets.

Brief Summary of Features include:

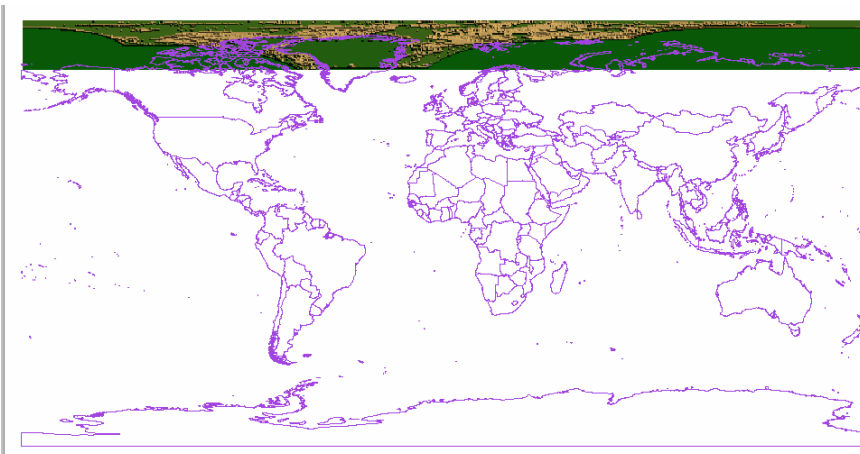
- **Reprojection**
- **Spatial** (geolocation) **Subsetting**
- **Band** and **Parameter** (aka Field) **Subsetting** of HDF-EOS datasets
- Support for **MODIS, ASTER, MISR, AIRS, and AMSR-E**
- **Format Conversion** of various output Format types: GeoTIFF, HDF-EOS GRID & SWATH, MultiBand GeoTIFF, Multi-Band HDF-EOS GRID & SWATH, and native binary.
- Format Conversions without reprojection or manipulation of input data. Allows data to remain in original unaltered state.
- **Stitching** (or **mosaicing**) HDF-EOS SWATH and GRID datasets
- Stitching with combinations of Reformatting/Reprojection/Subsetting Operations
- Data subsampling
- Control of various parameters including output pixel resolution and output projection parameters
- Metadata preservation and creation
- **Java GUI**
- **Command-line interface** (Useful for running batch jobs. This is usually seen in automated production environments where large quantities of granules are processed.)
- Supported Platforms: **LINUX, WINDOWS, SUN, SGI , and MAC OSX** (built on Darwin Kernel Version 7.5.0)



An obvious swath image of post-tornado weather conditions over Maryland in 2005. The Level 2 product has been converted to a GeoTIF image with geographic coordinates (projection unknown, or unprojected).



A raw, uncolored Level 2 swath image of sea ice properties from MODIS. After conversion to a regular grid (below) with HEG, the data fit neatly onto a GIS base map (in MapWindow)



HDFView

<http://www.hdfgroup.com/hdf-java-html/hdfview/>

- **Windows, Solaris, Linux, AIX, Irix, MacOSX, OSF1**
- **Good User's Guide at <http://www.hdfgroup.com/hdf-java-html/hdfview/UsersGuide/index.html>**
- **Module Guide at <http://www.hdfgroup.com/hdf-java-html/hdfview/ModularGuide/index.html>**

What It Is

The HDFView is a Java-based tool for browsing and editing NCSA HDF4 and HDF5 files. HDFView allows users to browse through any HDF4 and HDF5 file; starting with a tree view of all top-level objects in an HDF file's hierarchy. HDFView allows a user to descend through the hierarchy and navigate among the file's data objects. The content of a data object is loaded only when the object is selected, providing interactive and efficient access to HDF4 and HDF5 files. HDFView editing features allow a user to create, delete, and modify the value of HDF objects and attributes.

The HDFView user interface is designed to be easy to use and intuitive. HDFView was implemented by using Java™ 2 Platform that is designed to be machine-independent. The interface and features of the HDFView are the same for all platforms. HDFView displays the structure of the HDF file in a tree with data groups and data objects represented as conventional folders and icons. Users can easily expand or collapse folders to navigate the hierarchical structure of an HDF file.

About This Release

This release includes bug fixes and a few new features. The following is a list of major changes.

- Fix bugs
- Support for HDF-SRB (Windows and Linux)
- Update HDF5 library to release 1.6.5
- Support for compound datatypes containing 2D arrays (or greater)
- Create/display named datatypes in HDF5
- Create link in hdf5
- Improve ability to manipulate palette
- Select row/column data as X axis for xy plot in the table view

The **HDF-SRB model** is a client-server model that provides interactive and efficient access to remote HDF5 files. Like most client/server model, the HDF-SRB model is implemented on a set of client and server APIs and message passing scheme. Unlike other client/server model, the HDF-SRB model is object oriented. The client can access datasets or subsets of datasets in large files without bringing entire files into local

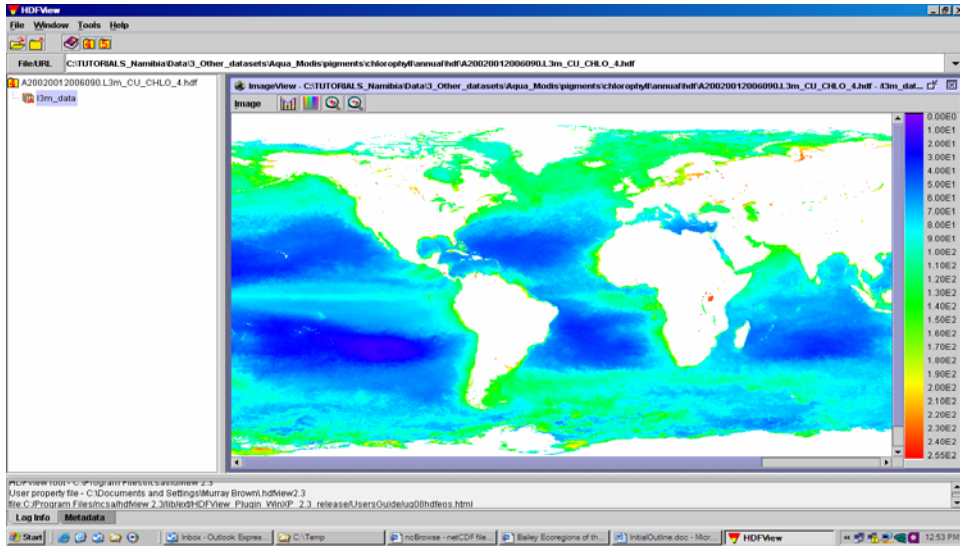
machines. For more details, please read the HDF-SRB User's Guide. HDFView version 2.0 is the first release of the modular HDFView. It includes bug fixes and new features. The main difference between version 2.0 and its previous releases is that this version is built on replaceable I/O and GUI modules. For more information about HDFView modules, please read "A User's Guide on How to Implement HDFView Modules" at <http://hdf.ncsa.uiuc.edu/hdf-java-html/hdfview/ModularGuide/>

Early versions of HDFView (version 1.3 or earlier) are implemented with standard GUI components such as tree view, table, and image view. These components cannot be replaced. There is no optional tree view, table view, and etc for users to display the data the way they want. version or modular HDFView is built on modules of I/O and GUI components.

Modular HDFView is an improved HDFView where I/O and GUI components are replaceable modules. It consists of several interfaces that enable users to write and use alternative implementations to replace default modules. The current replaceable modules include:

- File I/O (already implemented)
- Image view
- Table view (a spreadsheet-like layout)
- Text view
- Metadata (metadata and attributes) view
- Tree view
- Palette view

HDFView 2.3 is build on the common object package or the abstract I/O layer, *ncsa.hdf.object*, which provides classes that reflect fundamental design of object-oriented data objects. Objects of file elements such as groups and dataset are presented as Java classes. The package includes abstract classes for users to build their implementation subclasses. Two default implementations for HDF4 and HDF5, *ncsa.hdf.object.h4* and *ncsa.hdf.object.h5*, are included in the distribution.



Typical colored view of a MODIS chlorophyll image. Palette manipulation is allowed.

Page 1 of 30 TableView - E:\hdf-files\hdf5_test.h5 - /arrays/5D int array

| | 1 | 2 | 3 | 4 | 5 | 6 |
|-------------|------|------|------|------|------|------|
| 3, 2 = 1201 | | | | | | |
| 1 | 1000 | 1001 | 1002 | 1003 | 1004 | 1005 |
| 2 | 1100 | 1101 | 1102 | 1103 | 1104 | 1105 |
| 3 | 1200 | 1201 | 1202 | 1203 | 1204 | 1205 |
| 4 | 1300 | 1301 | 1302 | 1303 | 1304 | 1305 |
| 5 | 1400 | 1401 | 1402 | 1403 | 1404 | 1405 |
| 6 | 1500 | 1501 | 1502 | 1503 | 1504 | 1505 |
| 7 | 1600 | 1601 | 1602 | 1603 | 1604 | 1605 |
| 8 | 1700 | 1701 | 1702 | 1703 | 1704 | 1705 |
| 9 | 1800 | 1801 | 1802 | 1803 | 1804 | 1805 |
| 10 | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 |

Dataset Selection - /arrays/5D int array

Display As: Spreadsheet Show As Char Image Select palette

TableView: ncsa.hdf.view.DefaultTableView ImageView: ncsa.hdf.view.DefaultImageView

Dimension and Subset Selection

Swap Only

| | Start: | End: | Stride: | Max Size |
|--------------|--------|------|---------|----------|
| Height dim 0 | 1 | 100 | 1 | 100 |
| Width dim 1 | 1 | 50 | 1 | 50 |
| Depth dim 2 | 1 | 1 | 1 | 30 |

Input: Select slice location for dimension(s): "dim 3 [1 .. 20]" x "dim 4 [1 .. 10]"

2 x 3

Spreadsheet view of matrix data allows easy export of ASCII text files for further manipulation.

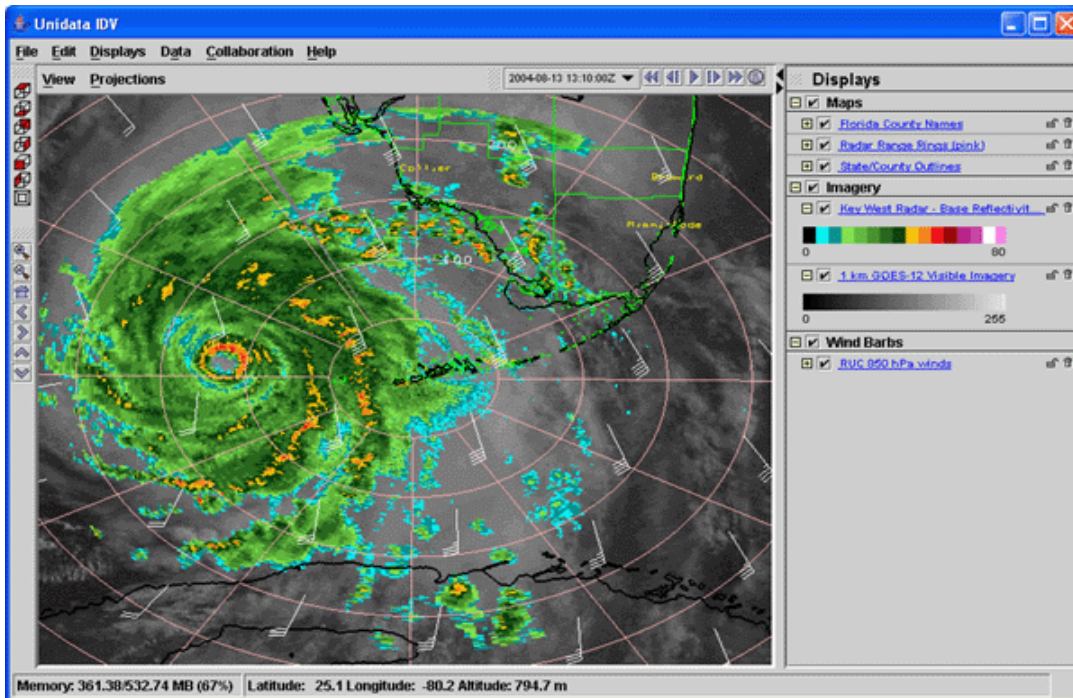
IDV

<http://www.unidata.ucar.edu/software/idv/>

- **Windows, Linux, Solaris/SPARC, Mac OS-X; AIX and IRIX** in certain configurations.
- **Extremely complete User's Guide** at <http://www.unidata.ucar.edu/software/idv/docs/userguide/toc.html#index.html>
- **Extensive online training** at <http://www.unidata.ucar.edu/software/idv/docs/workshop/>
- **UNIDATA training workshops in IDV**, see <http://www.unidata.ucar.edu/events/>

The Integrated Data Viewer (IDV) from Unidata is a Java™-based software framework for analyzing and visualizing geoscience data. This IDV release includes a software library and a reference application made from that software. It uses the [VisAD](http://www.ssec.wisc.edu/~billh/visad.html) library (<http://www.ssec.wisc.edu/~billh/visad.html>) and other Java-based utility packages. The IDV is developed at the Unidata Program Center (UPC), part of the University Corporation for Atmospheric Research, Boulder, Colorado, which is funded by the National Science Foundation. The software is freely available under the terms of the GNU Lesser General Public License.

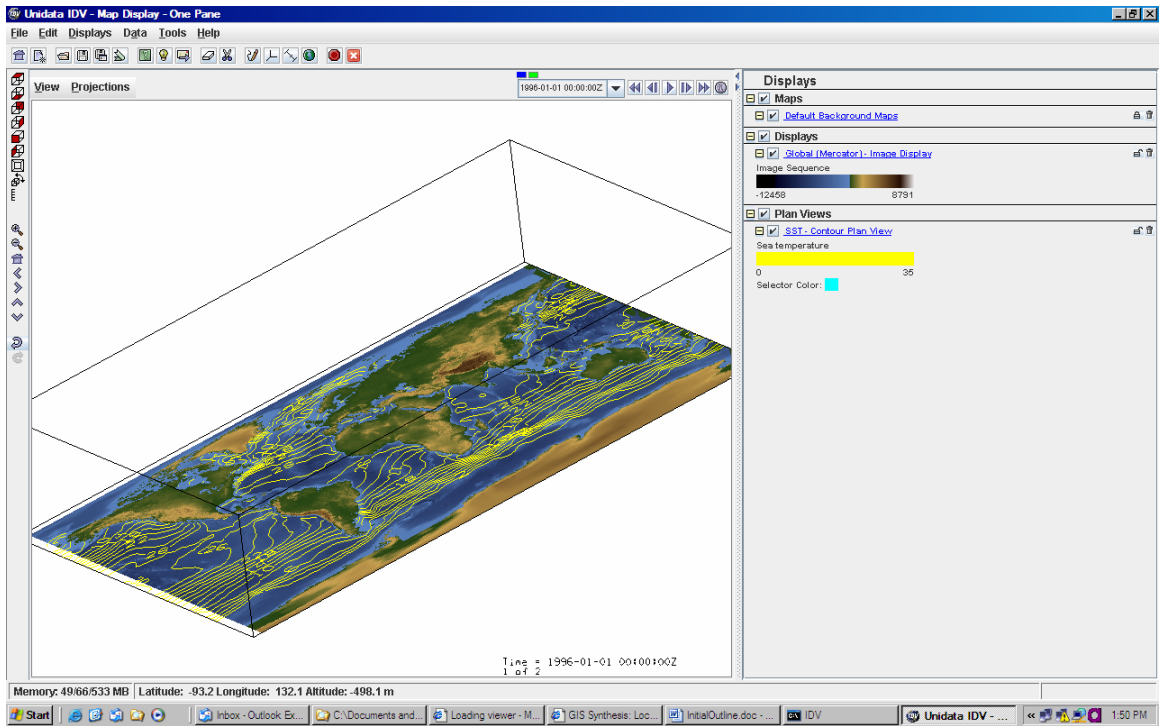
The IDV "reference application" is a geoscience display and analysis software system with many of the standard data displays that other Unidata software (e.g. GEMPAK and McIDAS) provide. It brings together the ability to display and work with satellite imagery, gridded data (for example, numerical weather prediction model output), surface observations, balloon soundings, NWS WSR-88D Level II and Level III RADAR data, and NOAA National Profiler Network data, all within a unified interface. It also provides 3-D views of the earth system and allows users to interactively slice, dice, and probe the data, creating cross-sections, profiles, animations and value read-outs of multi-dimensional data sets. The IDV can display any Earth-located data if it is provided in a known format .



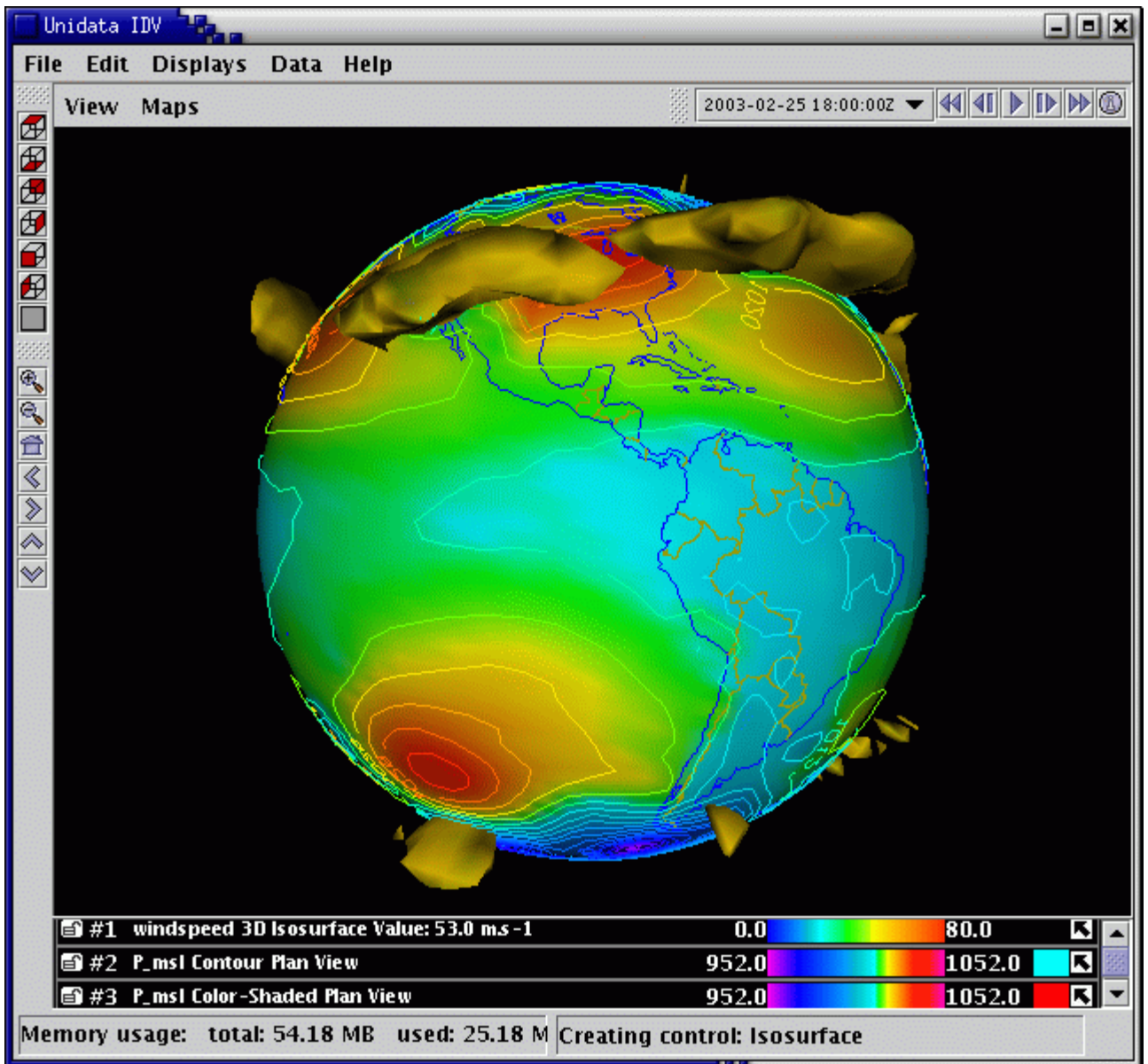
IDV view of Hurricane Charlie, August 13, 2004, integrating satellite, radar, model and geopolitical data

This IDV User's Guide describes using the features available in the IDV reference application. The Unidata IDV Training Workshop serves as a tutorial.

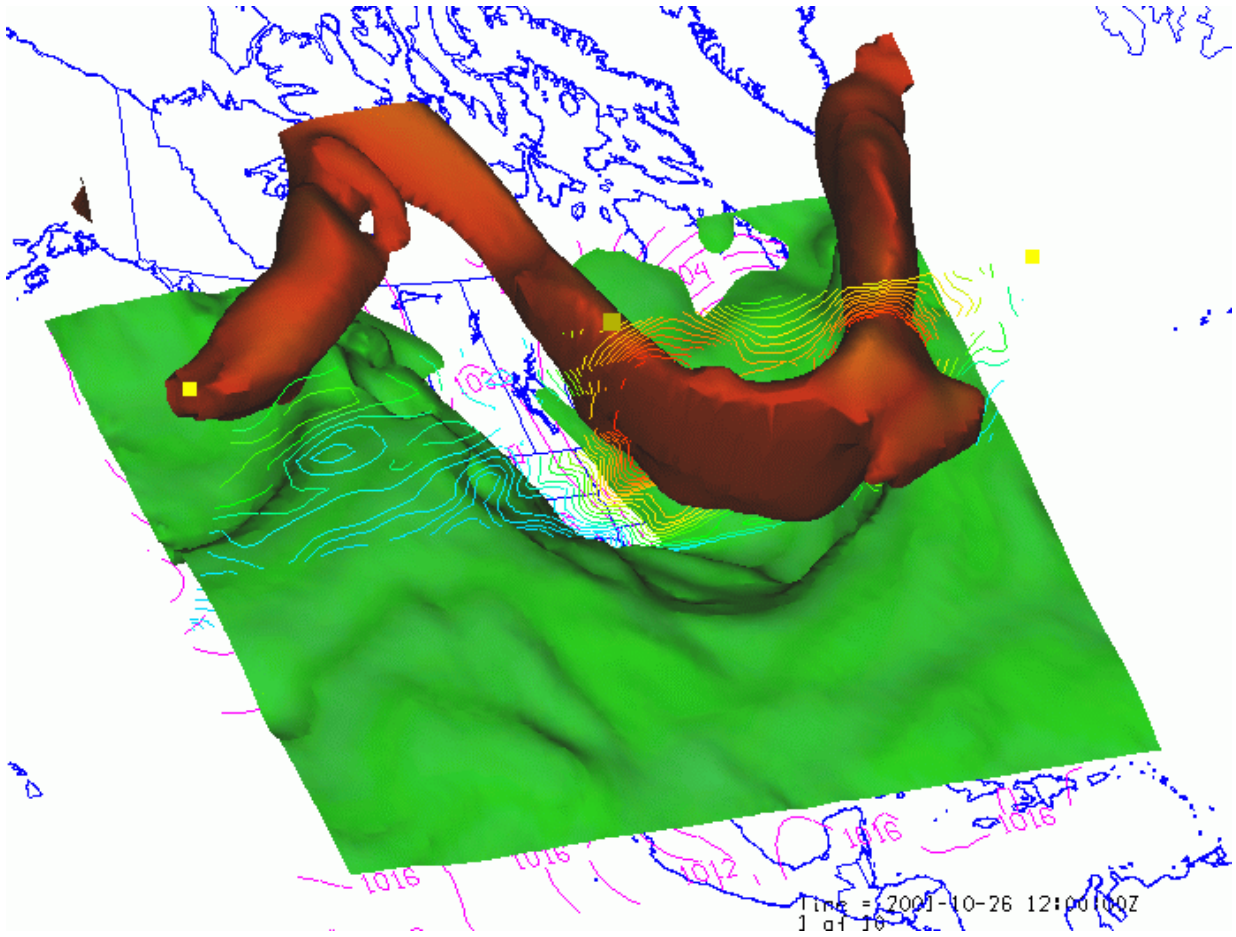
The IDV software library can be easily be used and extended to create custom geoscience applications beyond the atmospheric science realm. This customization allows new applications to be tailored to specific datasets and provide customized user interfaces for different tasks. Development of the IDV is ongoing at the Unidata Program Center. The development is driven by the needs of the community of users. Suggestions, comments, and collaboration are welcomed and encouraged. The goal is to provide new and innovative ways of displaying and analyzing Earth science data, as well as provide common displays that many users have come to expect.



Gridded data in IDV can be displayed and manipulated in 3-dimensions, and time-series of these displays can be created (in effect, 4-D displays).



Globe display of jet stream winds and surface pressure . Specific iso-surfaces can be identified and viewed in 3-dimensions and over time (as animations). This method is extensively for atmospheric data already, but apparently has not yet been exploited by the ocean modelers.



View this animation of the jet stream and 0-degree temperature surface at <http://www.unidata.ucar.edu/software/idv/gallery/jetStream.gif>

IrfanView

<http://www.irfanview.com/>

- **Windows 9x/ME/NT/2000/XP/2003**
- **Very modest User's Guide included with the download**

[Author's Note: After years of working with various "free" graphics editors, we at IODE find this one to be the very best. It offers no unique capabilities, but it is easy to use.]

IrfanView is trying to create new and/or interesting features in its own way, unlike some other graphic viewers, which whole "creativity" is based on feature cloning, stealing of ideas and whole dialogs from ACDSee and/or IrfanView! (for example: XnView is stealing/cloning features and whole dialogs from IrfanView, since 5+ years). IrfanView was the first Windows graphic viewer WORLDWIDE with Multiple (animated) GIF support. One of the first graphic viewers WORLDWIDE with Multipage TIF support. The first graphic viewer WORLDWIDE with Multiple ICO support.

Some IrfanView features:

- Many supported file formats
- Multi language support
- Thumbnail/preview option
- Slideshow (save slideshow as EXE/SCR or burn it to CD)
- Show EXIF/IPTC/Comment text in Slideshow/Fullscreen etc.
- Support for Adobe Photoshop Filters
- Fast directory view (moving through directory)
- Batch conversion (with image processing)
- Multipage TIF editing
- Email option
- Multimedia player
- Print option
- Change color depth
- Scan (batch scan) support
- Cut/crop
- IPTC editing
- Effects (Sharpen, Blur, Adobe 8BF, Filter Factory, Filters Unlimited, etc.)
- Capturing
- Extract icons from EXE/DLL/ICLs
- Lossless JPG rotation
- Many hotkeys
- Many command line options
- Many PlugIns
- Only one EXE-File, no DLLs, no Shareware messages like "I Agree" or "Evaluation expired"

Java OceanAtlas

<http://odf.ucsd.edu/joa/>

- **Mac, Windows, Linux**
- **Extended User Guide at <http://odf.ucsd.edu/joa/userguide/index.html>**

Introduction

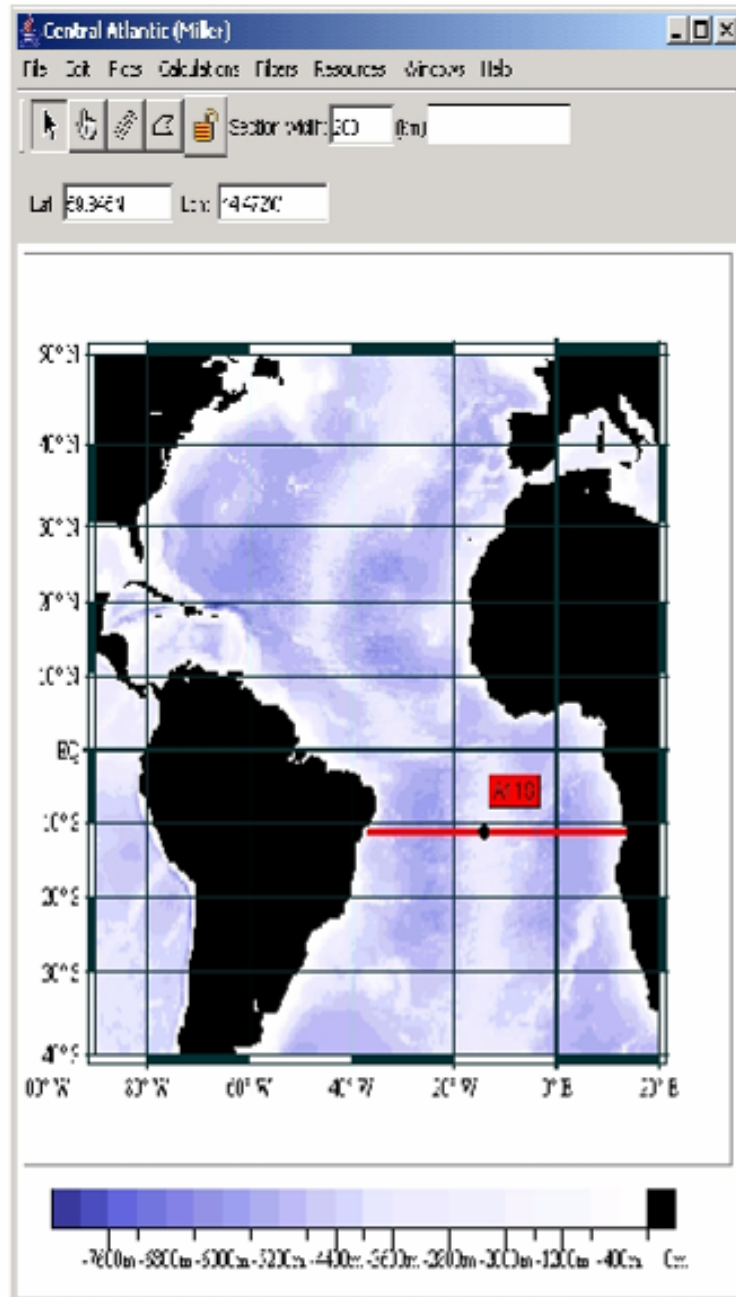
Java OceanAtlas is a Java application which provides a graphic exploration environment to examine and plot oceanographic vertical profile data. The original root of the application is the program *Atlant* developed by Peter Rhines (1989), and the MacOS applications *OceanAtlas* (1990) and *Power OceanAtlas* (1996). Java OceanAtlas brings many new and improved features, and it will run on any computer operating system which supports the appropriate level of Java, for example MacOS, Windows, and UNIX.

Java OceanAtlas can function as a stand-alone living atlas of oceanographic sections: the data sets supplied include pre-1990s data for pressure, temperature, salinity, dissolved oxygen, and the 'nutrients' nitrate, phosphate, and silicate from more than 2000 ocean sections (including the major pre-WOCE trans-oceanic sections), data extracted from the mean property fields in the Levitus WOA98 compilation, and many multi-parameter basin-scale sections from the 1990-1998 WOCE Hydrographic Program. Additional profiles - as individual profiles, sections, or other collections of profile data - of arbitrary parameter composition can be imported at any time in several standard community formats including spreadsheets, WOCE 'WHP-Exchange', NODC 'SD2', and EPIC netCDF. Java OceanAtlas will work with any type of pressure-indexed data.

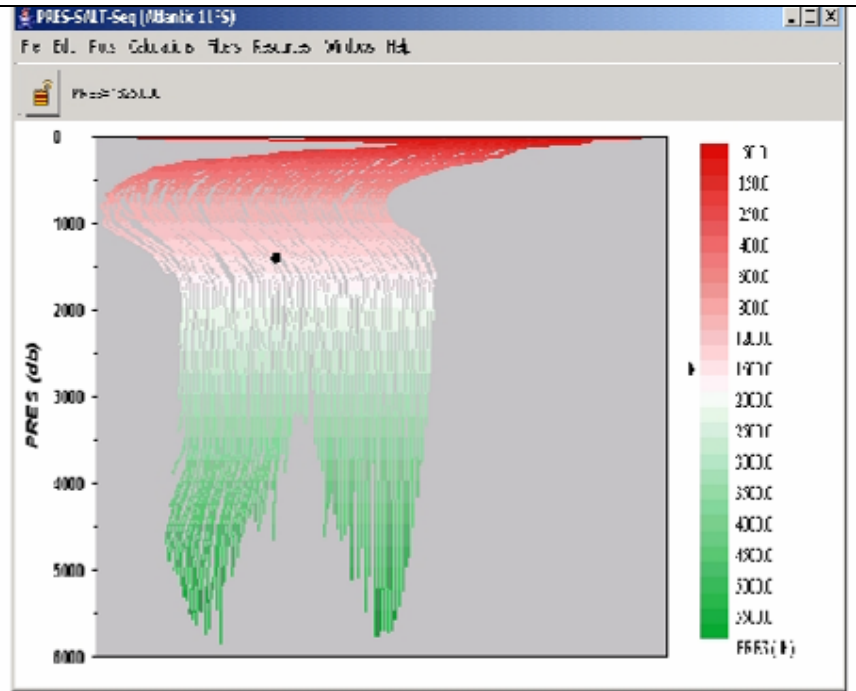
Java OceanAtlas plots include property-property plots, offset profiles, contour plots, and maps, using color as a plotted variable to aid interpretation. There is a comprehensive data display window. All Java OceanAtlas plots are linked and may be 'browsed' by sample and/or by station. Plots can be re-scaled, resized or have their colored variable changed. Selected areas of most plots can be made into new plots. Standard levels, scales, contours, and colors can be changed via user interfaces similar to those used in commercial applications. Java OceanAtlas provides data filtering and exporting. Many different types of calculations can be performed, including custom parameter calculations.

The growing 'Atlas of Ocean Sections' electronic atlas of oceanographic sections provides a unique reference and teaching environment. Java OceanAtlas is also a powerful data examination tool, and as such is useful for initial exploration and data quality examination of new expedition data.

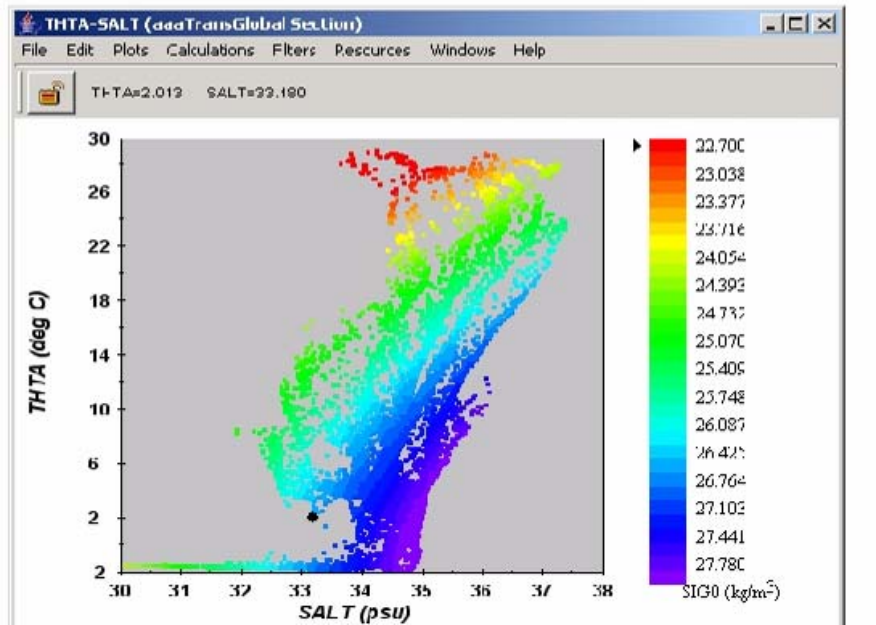
Station Plots



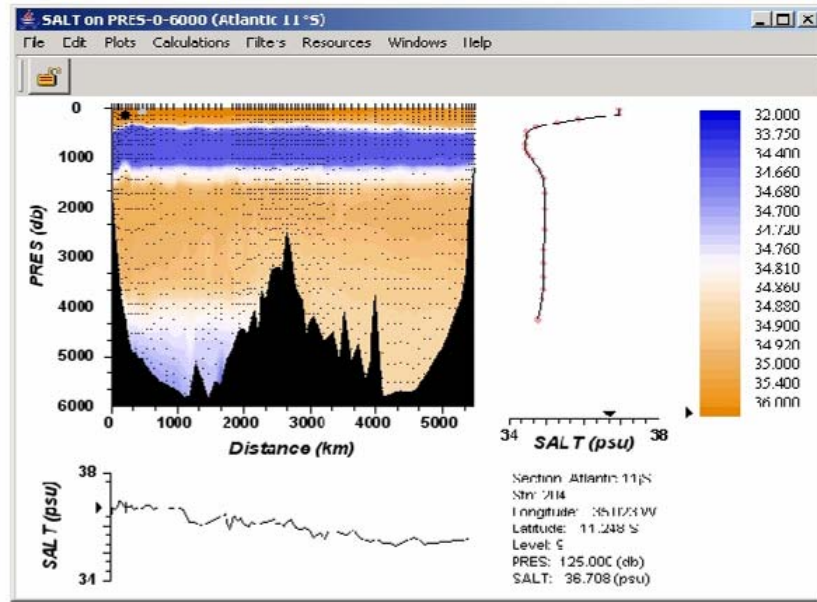
Profile Plots



Property-Property Plots



Contour Plots



What Java OceanAtlas Does Best

Java OceanAtlas (JOA) is great at property-property plots, allowing any original or calculated parameter to be plotted against any other. There is full control over axis ranges, plot point size, etc., plus the plotted points can be colored by any other parameter for which there are values and a color/contour bar. And by selecting "Connect Observations" during plot set-up or modification, on each property-property plot a line will be drawn connecting the values in sequence.

Profile (waterfall) plots, again allowing any original or calculated parameter to be plotted against any other, are colored by the current color/contour bar. Amplitude, line width, and spacing are adjustable.

Java OceanAtlas produces Contour plots without the visually-appealing but occasionally data-obscuring effects of objective analysis, using simple linear interpolation to prepare gridded data and contours. Coloring/contouring can be specified from JOA-supplied, autoscaled, or user-generated colors and intervals.

Station maps can easily be customized to show the regions or underlying bathymetric features of interest. Station dots can optionally be colored in accord with water property values; along with the vertical data browsing tool this provides an effective substitute for contoured lateral data maps.

JOA is an excellent data exploration tool: click the mouse pointer on a data point on one plot and it gets highlighted there, on all other open plots (including Maps and Contour plots), and the actual data are displayed in the Data Window. By using Filters and appropriate plot scales to focus on the data of greatest interest one can get drawn into the

data.

Any number of data sets can be combined, or subsets made and re-combined, or multiple data sets can be opened without combining them.

The default plot set-ups will provide a useable plot without further input from the user, but a great range of customization is feasible for every plot.

Limitations of Java OceanAtlas

Java OceanAtlas works with vertical profile data, and is optimized for working with vertical sections. Mainly Java OceanAtlas does not support contoured horizontal mapping. There are good reasons for this, mostly having to do with data density, data noise, and the limits of gridding algorithms. We have experimented with an OceanAtlas version which made contoured data maps, but while it worked fine with carefully prepared pre-gridded data, it left much to be desired for the mixed data which goes into most basin-scale maps such as those made by Professor Joseph Reid of the Scripps Institution of Oceanography.

Java OceanAtlas was not made as a publication plot tool. Other applications are better at that, although some interesting presentation-quality graphics are possible by using a screen capture utility, the 'Save' function, or the clipboard to grab JOA plots and copy them into a graphics program for enhancement and printing.

The present version of Java OceanAtlas does not generate velocity, flux, and transport calculations and related plots.

Java OceanAtlas is a Java application and suffers from the limitations of that environment. In particular memory usage can be high by present day standards (using >100 MB of RAM in a JOA session is not unusual) and some JOA functions are on the slow side. Also, although JOA updates keep pace with Java updates, for the most part this is only with the current lowest common Java version across MacOS, Windows, and Unix.

MapServer – WMS

<http://mapserver.gis.umn.edu/>

- **Windows, Linux, Mac**
- **Modest online documentation at <http://mapserver.gis.umn.edu/docs>**
- **New User tutorials at http://mapserver.gis.umn.edu/new_users**

MapServer is an Open Source development environment for building spatially-enabled internet applications. MapServer is not a full-featured [GIS](#) system, nor does it aspire to be. Instead, MapServer excels at rendering spatial data (maps, images, and vector data) for the web.

Beyond browsing GIS data, MapServer allows you create "geographic image maps", that is, maps that can direct users to content. For example, the Minnesota DNR Recreation Compass provides users with more than 10,000 web pages, reports and maps via a single application. The same application serves as a "map engine" for other portions of the site, providing spatial context where needed.

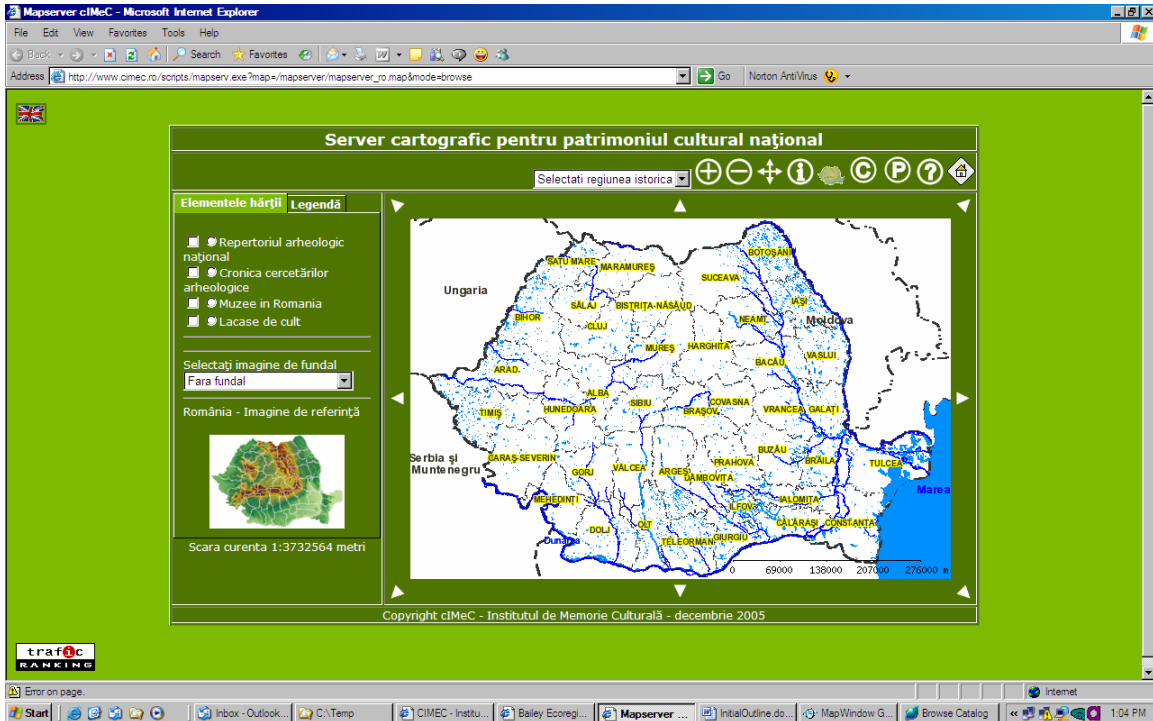
MapServer was originally developed by the University of Minnesota (UMN) ForNet project in cooperation with NASA and the Minnesota Department of Natural Resources (MNDNR). Presently, the MapServer project is hosted by the TerraSIP project, a NASA sponsored project between the UMN and consortium of land management interests.

The software is maintained by a growing number of developers (nearing 20) from around the world and is supported by a diverse group of organizations that fund enhancements and maintenance.

Features

- **Advanced cartographic output**
 - Scale dependent feature drawing and application execution
 - Feature labeling including label collision mediation
 - Fully customizable, template driven output
 - TrueType fonts
 - Map element automation (scalebar, reference map, and legend)
 - Thematic mapping using logical- or regular expression-based classes
- **Support for popular scripting and development environments**
- **PHP, Python, Perl, Ruby, Java, and C#**
- **Cross-platform support**
 - Linux, Windows, Mac OS X, Solaris, and more
- **A multitude of raster and vector data formats**
 - TIFF/GeoTIFF, EPPL7, and many others via GDAL
 - ESRI shapfiles, PostGIS, ESRI ArcSDE, Oracle Spatial, MySQL and many others via OGR
 - Open Geospatial Consortium (OGC) web specifications

- WMS (client/server), non-transactional WFS (client/server), WMC, WCS, Filter Encoding, SLD, GML, SOS
- Map projection support
 - On-the-fly map projection with 1000s of projections through the Proj.4 library



One of the few WMS sites currently available. This one covers cultural sites in Romania.

MapWindow

<http://www.mapwindow.com/>

- **Windows**
- **Extremely short documentation at**
http://www.mapwindow.org/wiki/index.php/Main_Page
- **Training:** <http://www.coaps.fsu.edu/gis/index.php>

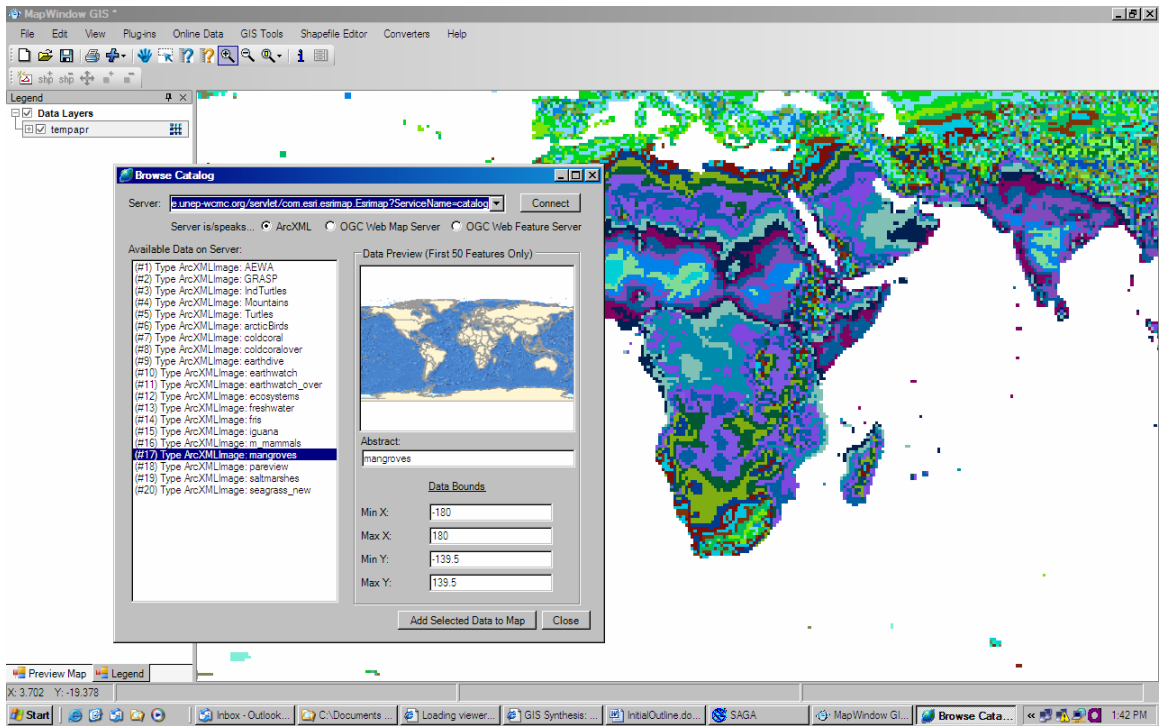
MapWindow is an open source "Programmable Geographic Information System" that supports manipulation, analysis, and viewing of geospatial data and associated attribute data in several standard GIS data formats. MapWindow is a mapping tool, a GIS modeling system, and a GIS application programming interface (API) all in one convenient redistributable open source form.

MapWindow was developed to address the need for a GIS programming tool that could be used in engineering research and project software, without requiring end users to purchase a complete GIS system, or become GIS experts.

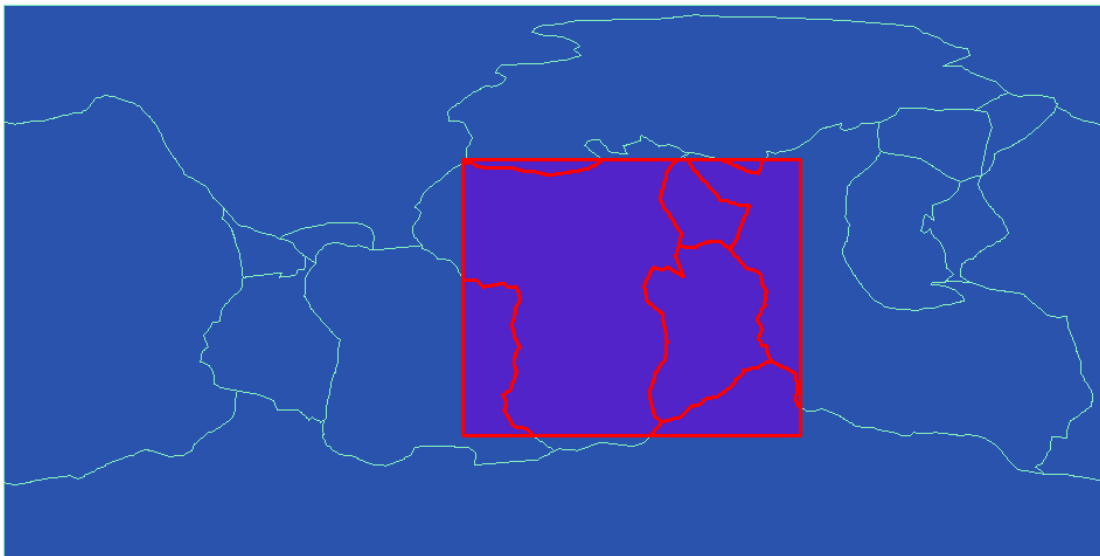
For example, a researcher or company may want to deploy a tool that lets users build and interact with maps of GPS data overlaid on USGS quad maps. One approach is to build the tool as an extension to a popular GIS software, and then require users to purchase that software to run the extension. Alternatively, the company could use MapWindow as a platform and build a specialized application that does the needed function and then give it or sell it directly to end user with no need for third party software purchases.

What makes this GIS tool different than the others?

- MapWindow is free to use and redistribute to your clients and other end users.
- Unlike other free tools, MapWindow is more than just a data viewer, it is an extensible geographic information system. This means that you can [write plug-ins](#) to add additional functionality (models, special viewers, hot-link handlers, data editors, etc.) and pass these along to any number of your clients and end users.
- MapWindow includes standard GIS data visualization features as well as DBF attribute table editing, shapefile editing, and grid importing and conversion.
- MapWinGIS ActiveX includes a GIS API for shapefile and grid data with many built in GIS functions.
- MapWinGIS ActiveX can be redistributed royalty-free.



In this view of MapWindow, a local dataset of temperature data (already mapped) is about to be combined with online mangrove data from a UN Environment Program IMS installation. MapWindow is the only known free GIS software with online (IMS and WMS) data capability.



MapWindow has moderately powerful shapefile management capabilities, allowing subsetting, reprojection, etc., as indicated here by the clipping of global geologic plate polygons to the area of the African continent.

ncBrowse

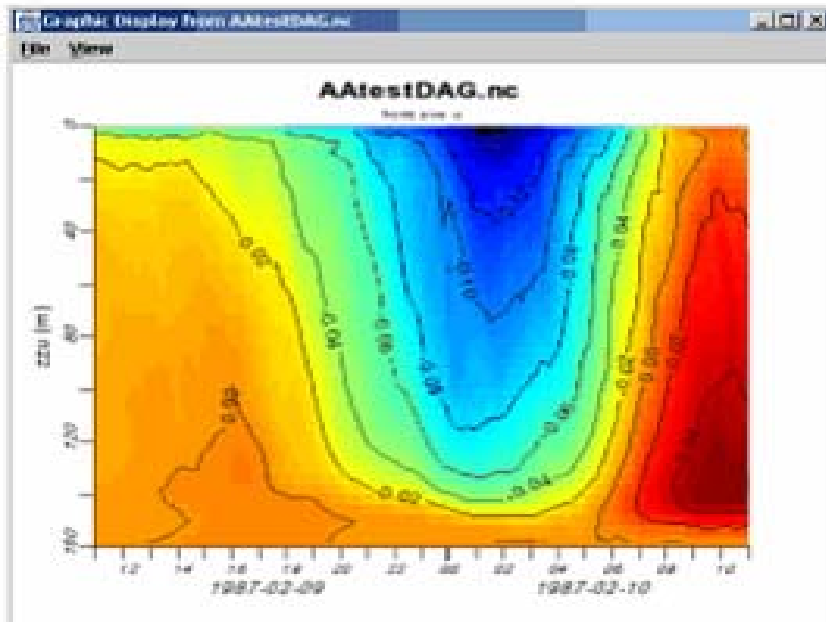
<http://www.epic.noaa.gov/java/ncBrowse/>

- **Windows, Unix (any), Mac, Solaris**
- **Very modest documentation at**
<http://www.epic.noaa.gov/java/ncBrowse/help.htm>

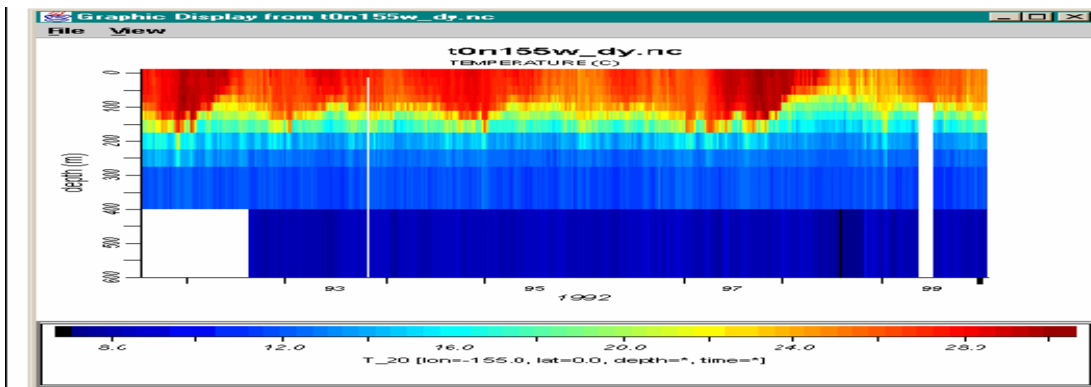
ncBrowse is a Java application that provides flexible, interactive graphical displays of data and attributes from a wide range of netCDF data file conventions.

Features

- Version 1.6.3 released. Fixes Dapper connection problem.
- Version 1.6.2 released. Fixes epic_code missing error.
- Version 1.6.0 released. Cleans up Dapper data access and fixes numerous bugs.
- Color lines by another variable.
- 3D visualizations and LAS data access now available.
- New OPeNDAP (formerly known as DODS) support with test version.
- New MacOS X support with test version.
- Contains support for variable mapping and animation. (Warning: this is test version, please report any problems.)
- Directly access remote netCDF files from the Web. Uses the HTTPClient library for connectivity.
- Designed to work with arbitrary netCDF files.
- Browses file using the EPIC and COARDS conventions.
- Provides a "tree" view of the netCDF file.
- Handles character variables.
- Handles dimensions without an associated variable.
- Uses sgt graphics to perform 1 and 2 dimensional cuts through data.
- Save to file a complete or the subset of a single variable as a "cdl" text file.
- Save to file time-depth slice in UNH format.
- InstallAnywhere scripts for UNIX, Win32, and MacOS.
- Currently uses Java 2 and Swing.
- Jdk1.1 version available for Mac Users.



Plot of velocity as a function of depth and time.



Typical plot of temperatures from an Argo float

NIMA Muse & VPFView

http://www.mapability.com/index1.html?http&&www.mapability.com/info/vmap0_soft.html

- **Windows**

[Author's Note: These packages are included here only because they offer the only public domain methods to use VPF (Vector Product Format) files, and/or to convert VPF to shapefiles. The relatively modest visualization capability of VPFView is noted, but it certainly is not capable of publication-ready images. The importance of VPF cannot be overemphasized, because it is being used by the US and NATO military for vector GIS global mapping.]

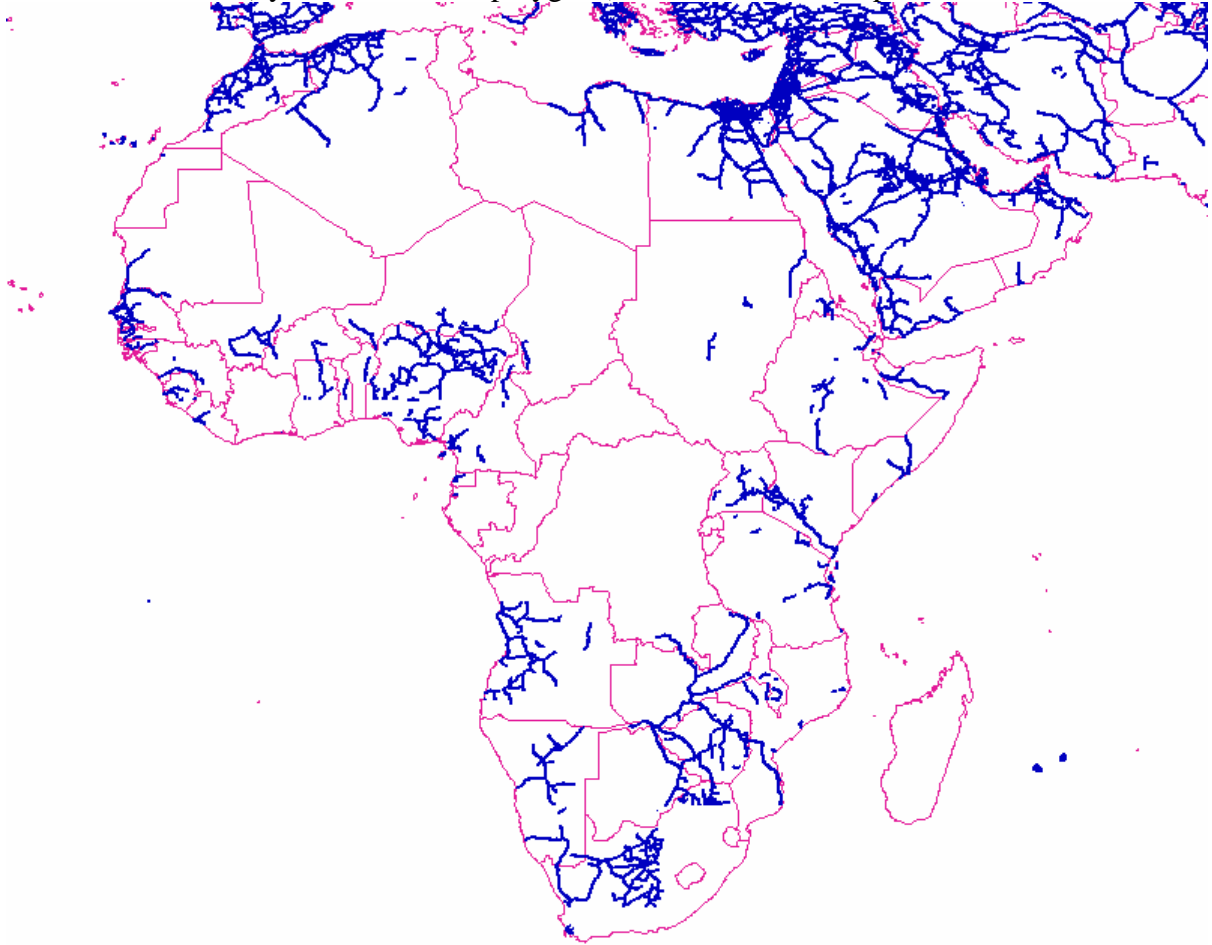
Application software, called VPFVIEW V2.1, has been developed by NIMA and allows users the ability to access and view VMap Level 0 data. The software, available separately from NIMA or USGS within the DMAMUSE software package, has been developed to operate on a PC.

The VPFView software is designed to access any database implemented in the Vector Product Format (VPF) and allows data to be selected for display from one or more databases by geographic region and by data type. For example, you can zoom into a geographic area of interest and request a single type of feature, such as dual-lane highways to be displayed. Or, you can display a group of related features (e.g., all road types), combinations of feature types (e.g., dual-lane highways and international airports), or all features existing in the database. The software also allows you to display and evaluate the database directly from CD-ROM, hard drive, or other media without loading or converting the data (although you will pay a speed penalty when reading the data from CD-ROM or an equivalent media).

The VPFView software is not a geographic information system (GIS). The software is designed to enable you to view and perform spatial queries on data contained in any VPF database, but its analytical capability is limited to constructing views and themes.

Once you have generated a display, you can save the results of a data request as a graphic display (.bmp) or the text of a report. You can also save the data request itself, in the form of a 'feature selection list'. Selected libraries and coverages can be saved in a user-defined database.

[NIMAMUSE is especially valuable for the VPF Import module it contains, which extracts VPF data (by area of interest polygons) and converts to shapefile format.]



Major highways on the African continent from the Vmap Level 0 global dataset.
(Successive levels of VMap [e.g. VMap1] are being produced at increased resolution.)

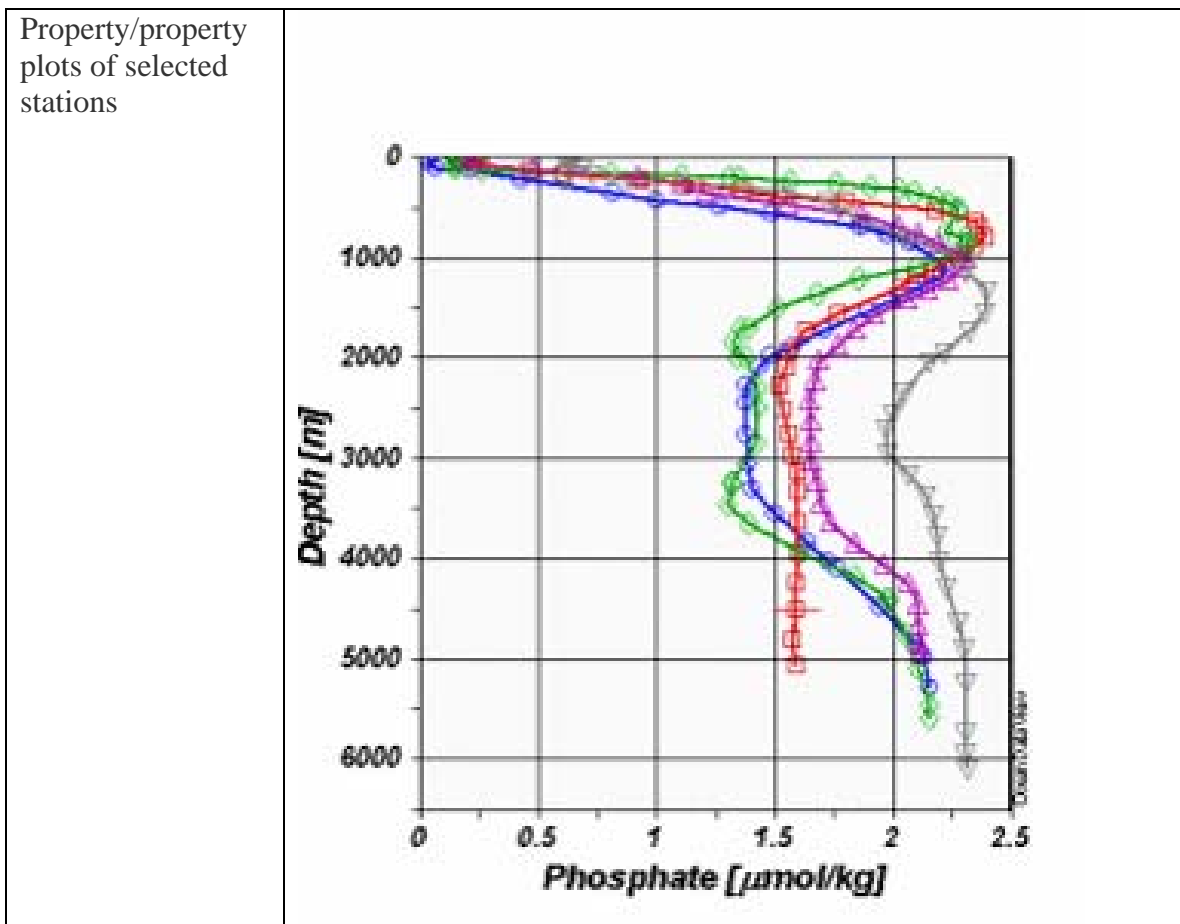
Ocean Data View

<http://odv.awi-bremerhaven.de/>

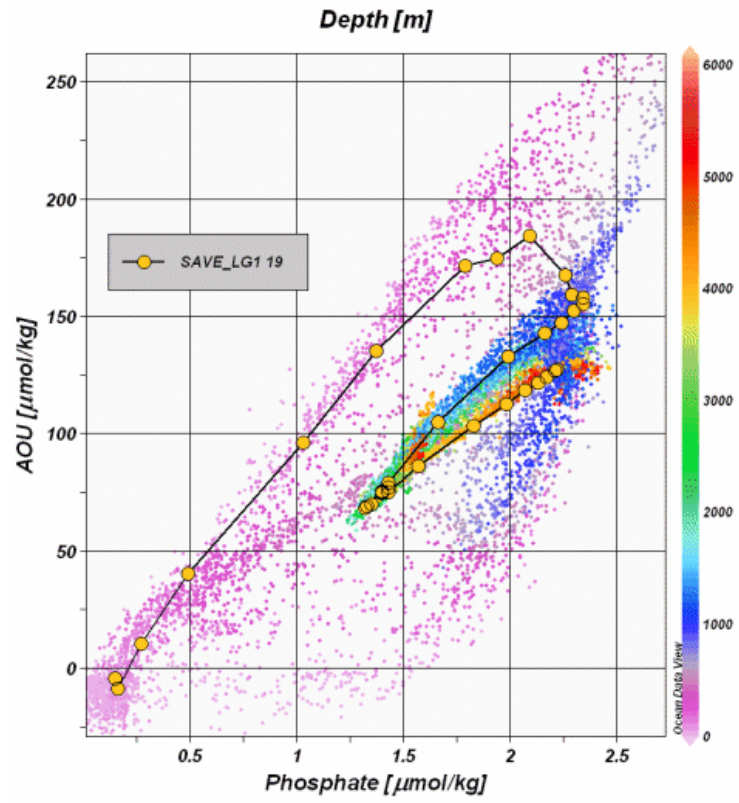
- Windows, Mac, Linux. Unix
- Extended User Guide at http://odv.awi-bremerhaven.de/fileadmin/user_upload/odv/misc/odvGuide.pdf
- Online tutorials at http://ioc.unesco.org/oceanteacher/OceanTeacher2/08_Exercises/03_DtaMgtEx/Roadmaps/RoadMapList.htm (within IOC/IODE OceanTeacher Roadmap lessons)

Ocean Data View (ODV) is a software package for the interactive exploration, analysis and visualization of oceanographic and other geo-referenced profile or sequence data. ODV runs on Windows (9x, Me, NT, 2000, XP), Mac OS X, Linux, and UNIX (Solaris, Irix, AIX) systems. ODV data and configuration files are platform-independent and can be exchanged between different systems.

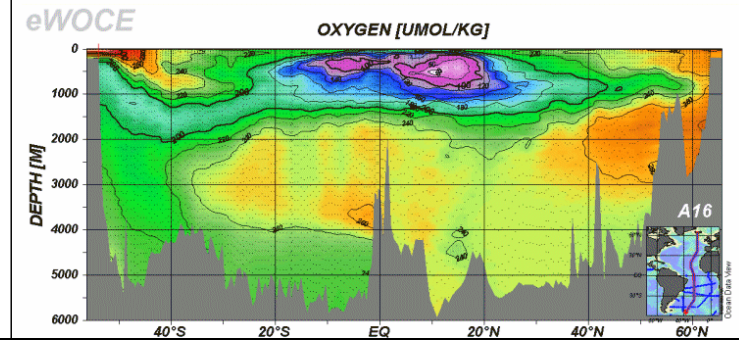
Use ODV to produce:



Scatter plots for sets of stations

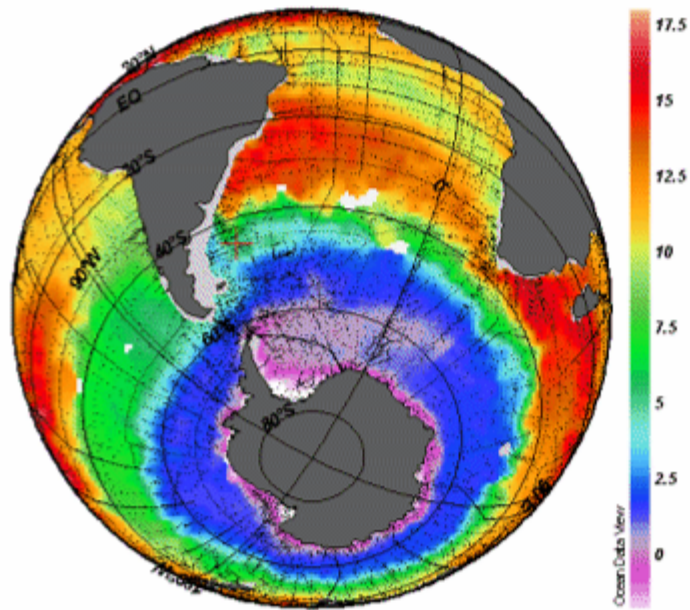


Color sections along arbitrary cruise tracks

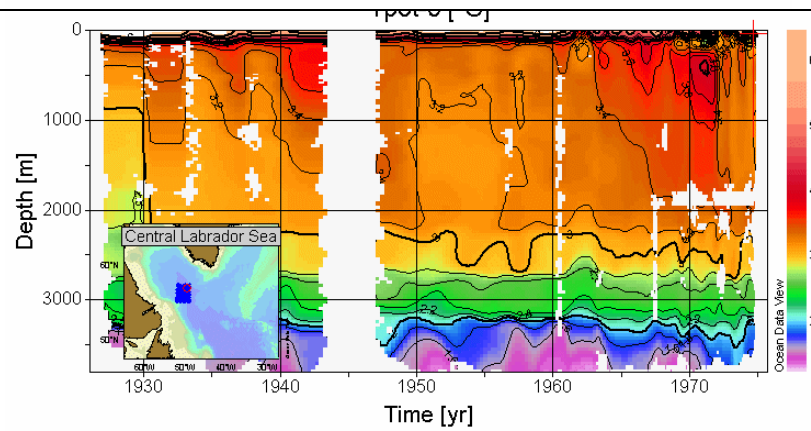


Color distributions on general iso-surfaces

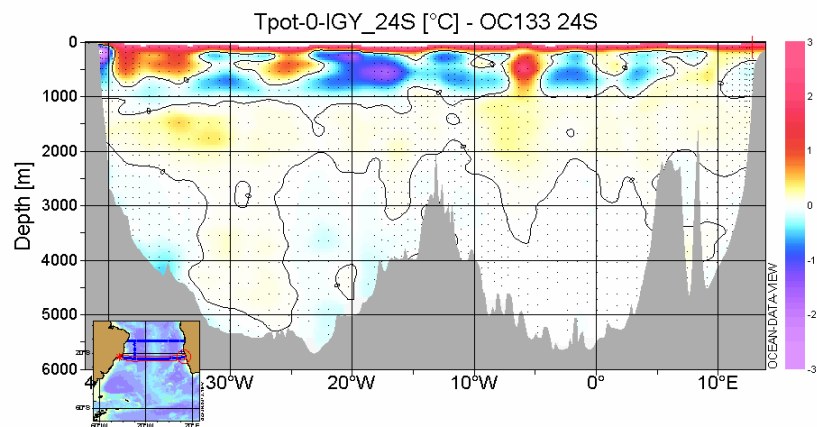
Temperature [C] on Depth [m]=300

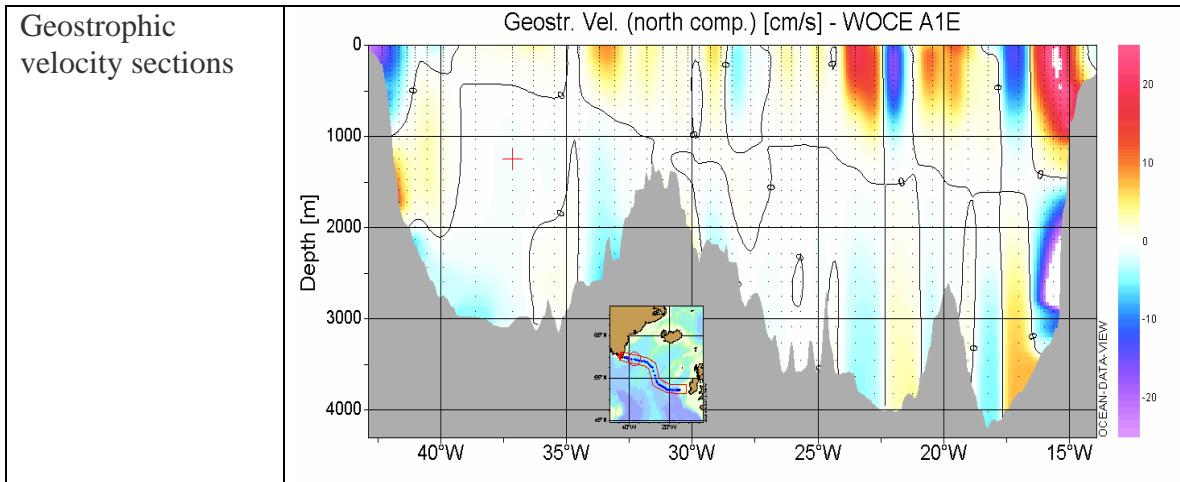


Temporal evolution plots of tracer fields



Differences of tracer fields between repeats





ODV can display original data points or gridded fields based on the original data. Gridded fields can be color-shaded and/or contoured. ODV supports five different map projections and can be used to produce high quality cruise maps. ODV graphics output can be sent directly to printers or may be exported to PostScript, gif, png, or jpg files. The resolution of exported graphics files is specified by the user and not limited by the pixel resolution of the screen.

The ODV data format allows dense storage and very fast data access. Even large data collections containing thousands of stations can easily be maintained and explored on inexpensive desktop and notebook computers. Data from the World Ocean Circulation Experiment (WOCE), the World Ocean Database, and the World Ocean Atlas 1994 can be directly imported into ODV. Ready-to-use versions of the WOCE data, the gridded World Ocean Atlas 2001 as well as many other important geo-science datasets are available for download.

ODV also supports the netCDF format and lets you explore and visualize CF, COARDS, GDT and CDC compliant netCDF datasets. Climate data in netCDF format are available at http://www.cdc.noaa.gov/cgi-bin/db_search/SearchMenus.pl

Optional high-resolution coastline, bathymetry and topography sets for special regions of interest can be produced on request. Note that there is a charge for this extra service.

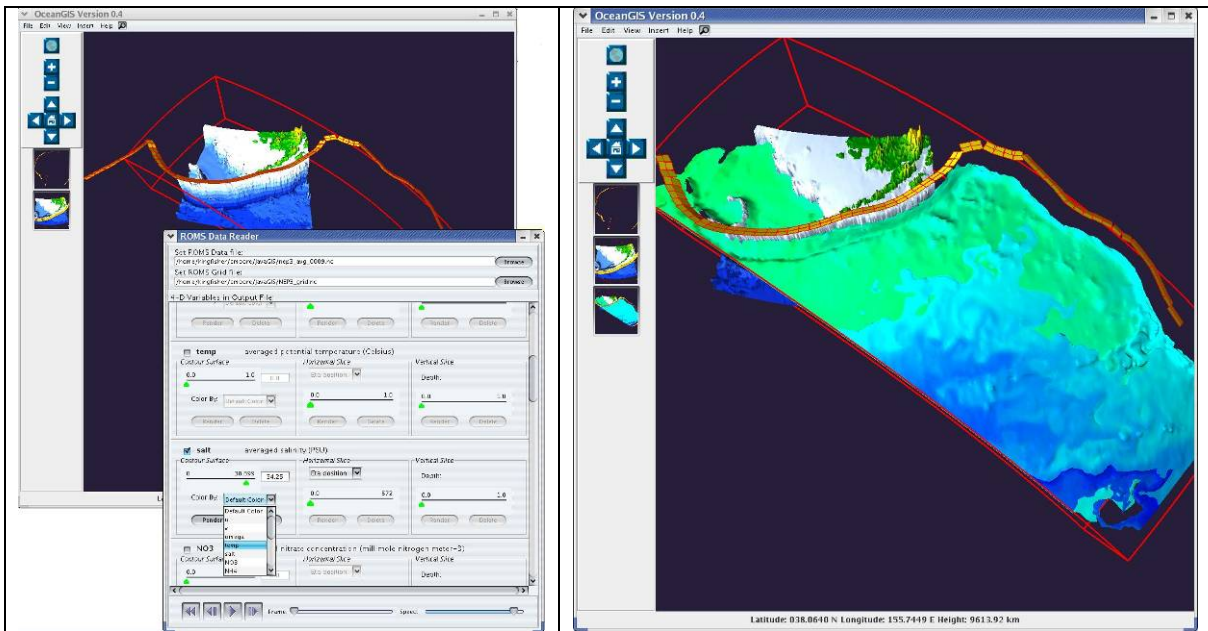
ODV is used by more than 3000 scientists at leading research institutes world wide. The UNESCO Ocean Teacher project employs ODV as one of its main analysis and display tools. In addition, ODV is used as visualization tool for the Pangaea information system. Pangaea data sets can be easily converted into ODV collections using the Pan2Applic application. Data in TGM-3M format can be converted using the TGM2ODV Windows application. Data in Medatlas/Medar format may be converted to ODV generic format using the MedODV Windows application.

OceanGIS: 3-D GIS for Ocean Data

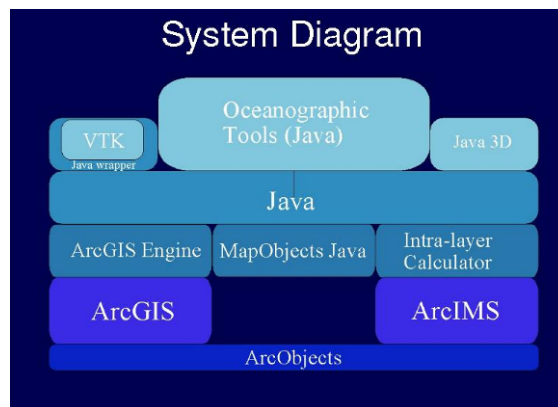
<http://nctr-people.pmel.noaa.gov/cmoore/OceanGIS/>

- Windows, Linux
- Early prototype; no regular documentation at present

OceanGIS is meant to be a Proof-of-Concept only! Please don't expect too much!
OceanGIS is an oceanography-specific 3D data viewer based on GIS technology (using [GeoTools](#)), and 3D-support using the Visualization Toolkit ([VTK](#)).



This pair of sample figures indicates the general direction they might go with this program: 3-D display of earth data surfaces within a formal GIS framework.



This slide from one of the developers' presentations indicates a high reliance on standard commercial (i.e. ESRI) components, essentially a prototype of the MarineGIS project.

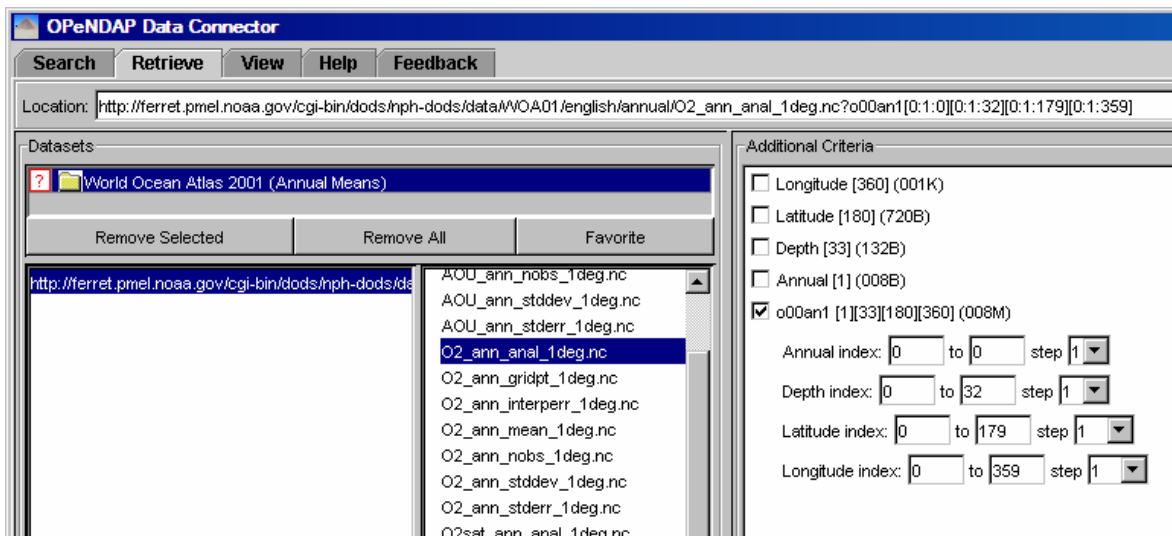
OPeNDAP Data Connector

<http://www.opendap.org/ODC/download.html>

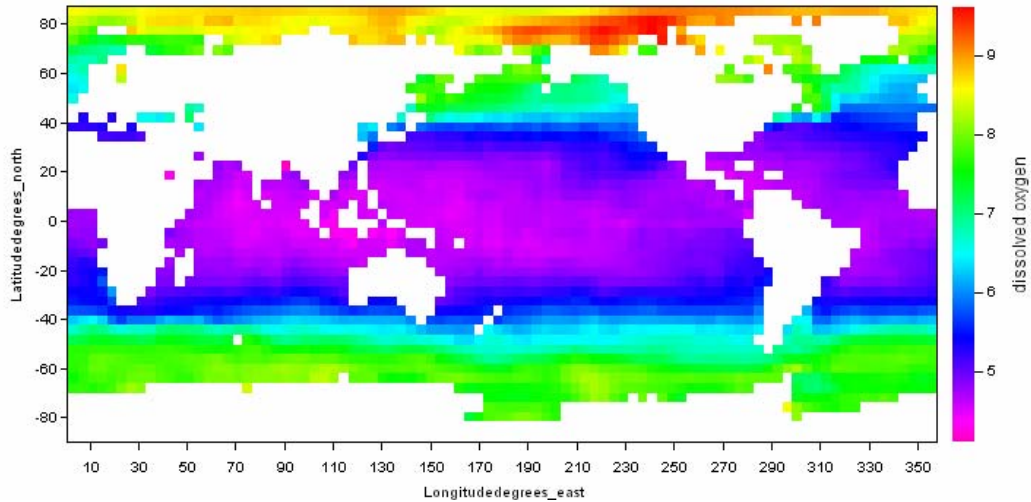
- **Out-of-date guide and tutorial at <http://www.opendap.org/ODC/index.html>**

[Author's Note: ODC is possibly the best "failed initiative" in the current era of data visualization. Originally envisioned as a general tool to identify, examine and extract any datasets cataloged within the OPeNDAP (formerly DODS) system, without the need to set up a Live Access Server-type installation, the project was apparently terminated in approximately 2004, while some serious bugs remained in the code. Although the data visualization capability was rather simple (i.e. essentially equivalent to ncBrowse) its ability to decimate and subset large grids gave it extreme power, at least from the viewpoint of PC users. Currently the data catalog used by ODC, the XML catalog sometimes updated by the OPeNDAP organization at the above URL, is growing out of data and frequently does not work with ODCs search capability. Unless re-invigorated and authorized again, this worthy project will soon die of neglect.]

The OPeNDAP Data Connector (ODC) is a program which allows you to search for and retrieve datasets published by OPeNDAP data servers. OPeNDAP servers (also known as DODS servers) located at major institutions around the world serve a wide variety of data including: climatic data, satellite imagery, and ocean sensor results. The ODC allows you to find these datasets, download them to your machine, save them, and import them into client applications like IDL, Matlab, SPSS, Excel, or into databases such as Access and Oracle, and plot them with advanced graphics capabilities. The ODC is your gateway to terabytes of scientific data and imagery.



This view of a typical data access operation (in this case the oxygen data from the World Ocean Atlas 2001) the user can select data by any combination of longitudes, latitudes, depths, etc. including setting the increments so the data can be decimated.



This figure shows the result of decimating the surface data by a factor of 4 (in each axis) and viewing only the first level (the surface). Although this same graphic is available from many Live Access Servers – due to the huge popularity of the WOA datasets – the fact that it could also be produced for many hundreds of lesser-known OPeNDAP datasets that are not currently configured for LAS access makes ODC a very attractive and powerful tool.

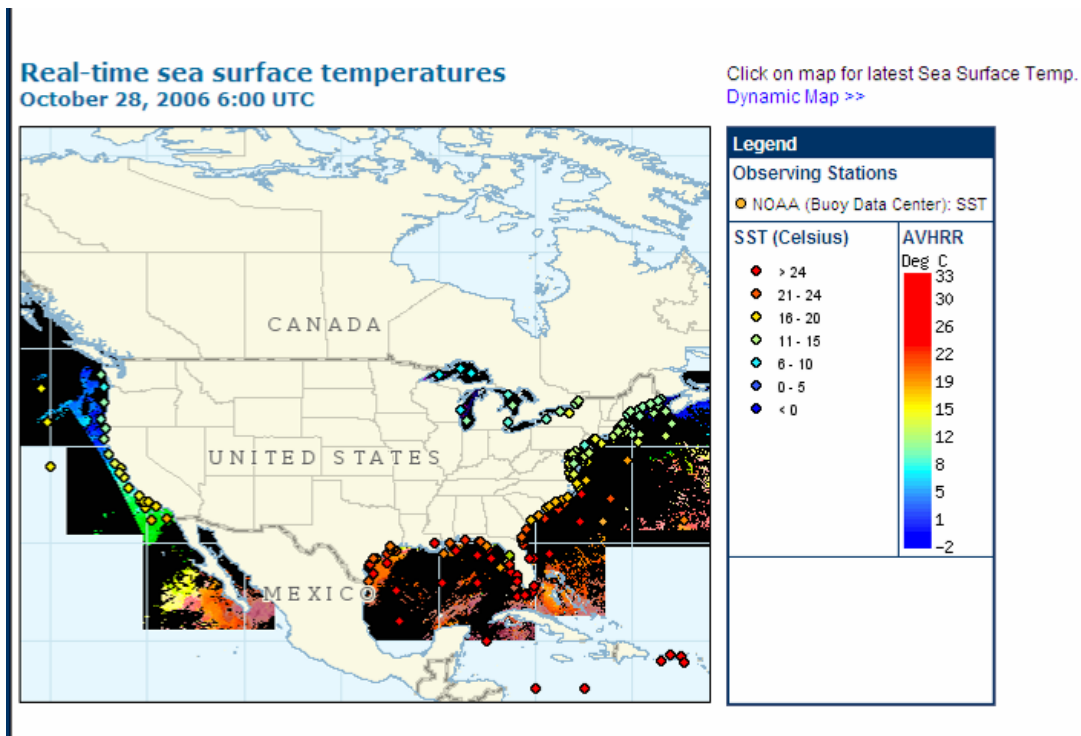
OpenIOOS.org

<http://openioos.org/>

- Not a software program, per se, but a project to develop OGC-compliant tools for displaying operational oceanographic data

This interoperability demonstration represents a coastal sciences community effort. Our partners include several federal agencies and dozens of the top research universities in the country. We rely heavily on Open Geospatial Consortium (OGC)

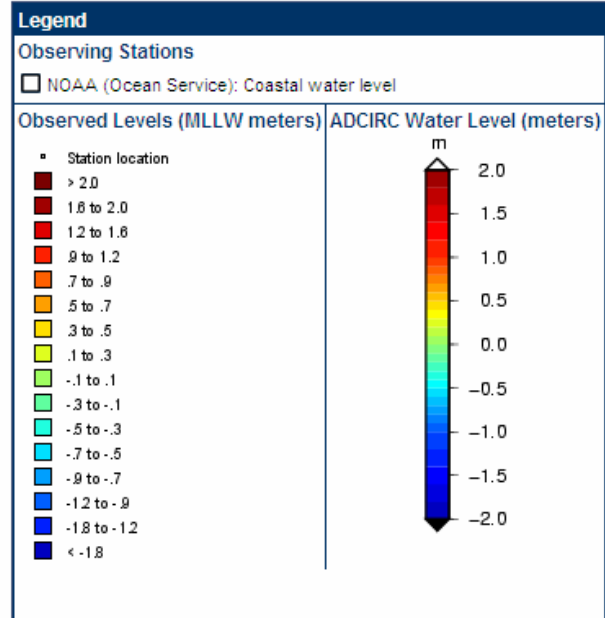
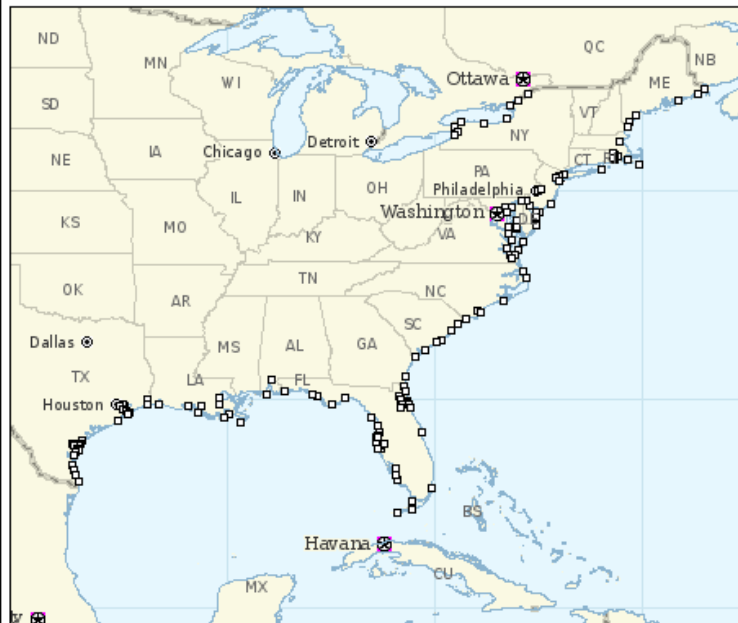
(<http://www.opengeospatial.org/>) standards. IOOS stands for "Integrated Ocean Observing System" and designates a national initiative to create a new system for collecting and disseminating information about the oceans. The system will support a variety of practical applications, along with enabling research. The myriad needs and benefits of the IOOS have been articulated by the U. S. Commission on Ocean Policy (www.oceancommission.gov). For more information on the IOOS, check out the Ocean.US web site (www.ocean.us).



Real-time water-level observations and models

October 28, 2006 18:00 UTC

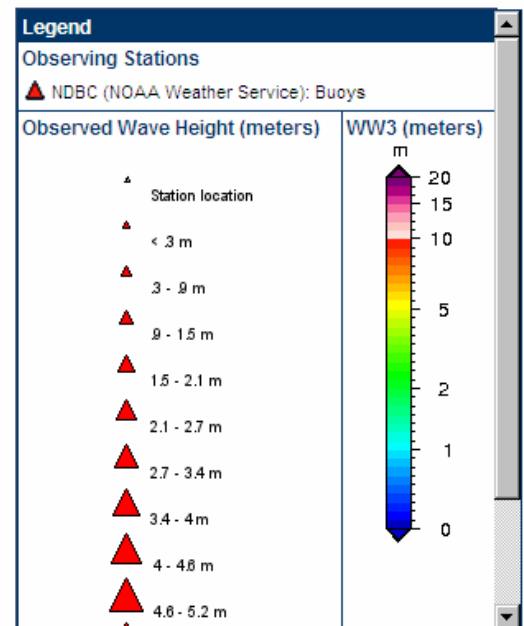
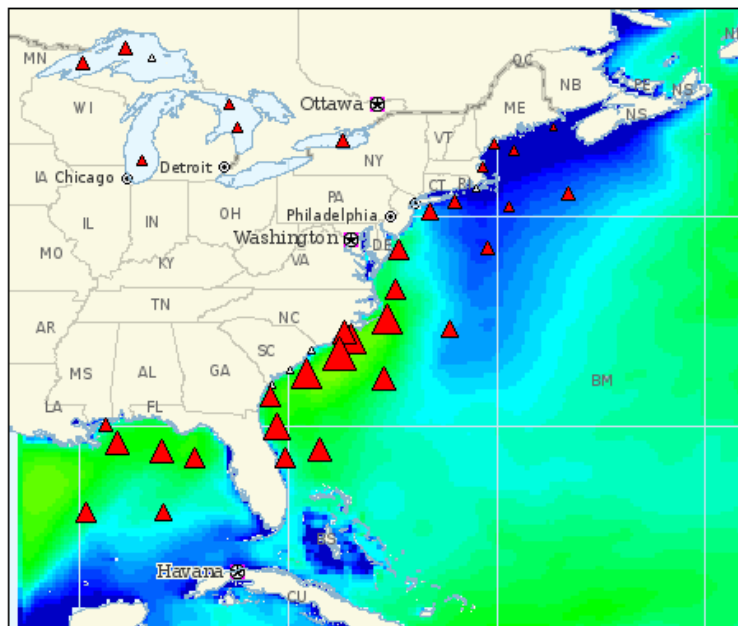
Click on map for time series
[Dynamic Map >>](#)



Real-time wave observations and models

October 28, 2006 18:00 UTC

Click on map for time series
[Dynamic Map >>](#)



Latest Salinity from SOS servers



PMEL/EPIC OPeNDAP Software Suite

<http://www.pmel.noaa.gov/home/software.shtml>

[Any discussion of visualization software could easily be overwhelmed by the number and high quality of the PMEL programs. This short paper will not even attempt to describe them all, although a couple of them (DChart, Ferret, ncBrowse, Java OceanAtlas, OceanGIS) have been singled out for individual treatment. All the below links can be found at the URL above.]

Desktop, Web, Internet & OPeNDAP

- [Dapper](#) - *OPeNDAP Server for in-situ data (EPIC)*
- [DChart](#) - *Web viewer for OPeNDAP in-situ data (EPIC)*
- [EPIC and TAO Web Utilities](#) - *Making in situ data available on the Web*
- [EPIC Java tools](#) - *Interactive Java netCDF data file browser, Interactive Java graphics, Java collaborative tools, etc.*
- [EPIC](#) - *Data management, display and analysis of observational in situ data*
- [FERRET](#) - *Visualization and analysis of large gridded data sets*
- [Ferret Data Server](#) - *Sharing and processing data over the Internet (OPeNDAP)*
- [Java OceanAtlas](#) - *Java application for viewing/manipulation oceanographic profile data (OPeNDAP)*
- [Live Access Server \(LAS\)](#) - *Gridded data access from the web (OPeNDAP Client)*
- [ncBrowse](#) - *Java utility for browsing netCDF files - supports a wide range of netCDF file conventions (OPeNDAP)*
- [OceanGIS](#) - *3D GIS for Ocean Data (OPeNDAP)*
- [OceanShare](#) - *Collaborative Tool for Integrated Browse of Data from Multiple Archives (OPeNDAP)*
- [VENTS GIS](#) - *Geographic Information System for geophysical data*

Toolkits

- [Any URL](#) - *Used to create web pages with FORMS*
- [cdfsync](#) - *networked netCDF synchronization*
- [Cover CGI forms utility](#) - *Used for dynamic generation of graphs and listings*
- [Email contact form](#) - *A program which can be used for a webpage contact, comment, or feedback form. The user of the web page enters their email address, a subject line, and text comments into a form on the web page. The utility sends the comment/feedback email to a list of recipients. Quick Start instructions help a web developer install the form into a web page in minutes. - PMEL local access only.*
- [Live Map](#) - *Map display software*
- [PMEL Virtual Reality tools and resources](#) and [visualization](#)
- [Scientific Graphics Toolkit \(SGT\)](#) - *Java graphics developers toolkit*

Saga

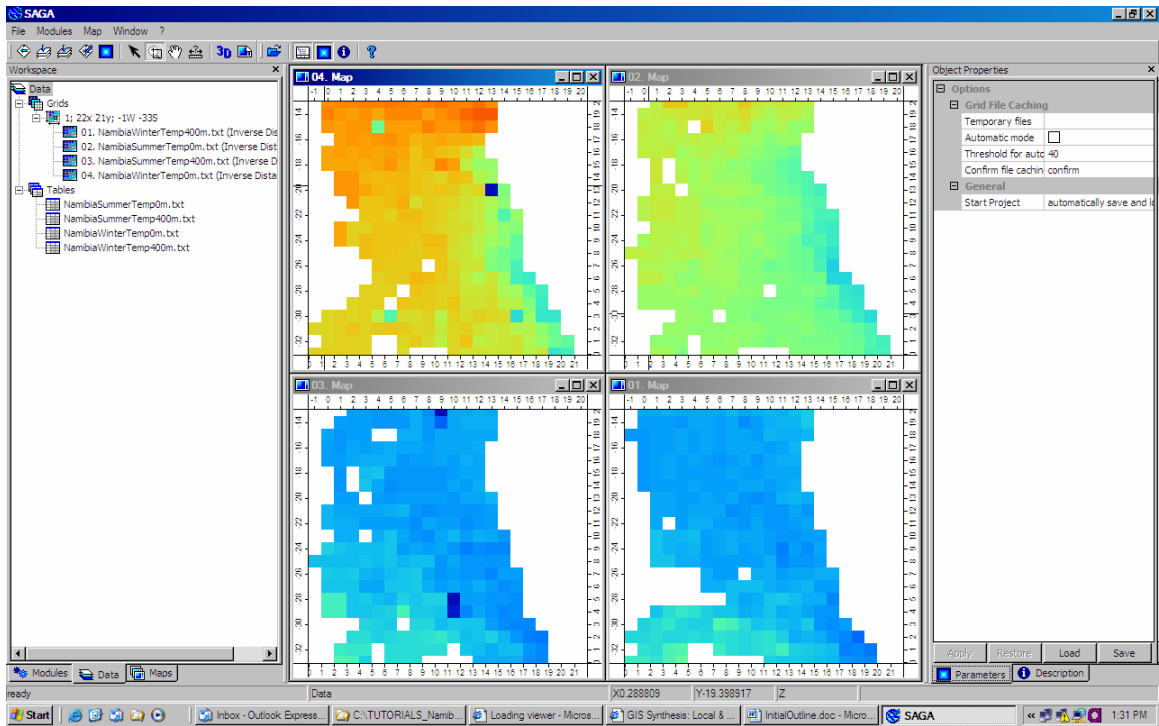
<http://www.saga-gis.uni-goettingen.de/html/index.php>

- Windows, Linux
- Extremely poor documentation at <http://www.saga-gis.uni-goettingen.de/html/modules.php?op=modload&name=Sections&file=index&req=listarticles&secid=1> [Almost useless - badly out of date]

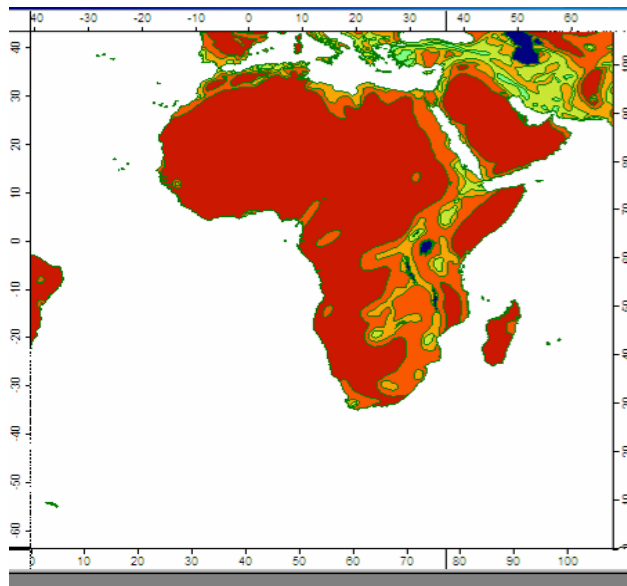
SAGA – System for Automated Geoscientific Analyses- is a hybrid GIS software. The first objective of SAGA is to give (geo-)scientists an effective but easy learnable platform for the implementation of geoscientific methods, which is achieved by SAGA's unique **Application Programming Interface** (API). The second is to make these methods accessible in a user friendly way. This is mainly done by the **Graphical User Interface** (GUI). Together this results in SAGA's true strength: a fast growing set of geoscientific methods, bundled in exchangeable **Module Libraries**. SAGA is written in the widespread and powerful C++ programming language and follows an **object oriented** approach. Moreover it relies on the **GNU Public License**, which means it is an open source project. All this designates SAGA to be a first choice tool for everybody who works in the field of geosciences, in particular for those who want transparent state of the art methods.

Currently there are about 120 modules available in SAGA's standard edition. This list gives an overview of the variety of implemented methods.

- **File access:** interfaces to various table, vector, image and grid file formats.
- **Filter for grids:** gaussian, laplacian, multi direction lee filter...
- **Gridding:** interpolation from vector data using triangulation, nearest neighbour, inverse distance...
- **Geostatistics:** residual analysis, ordinary and universal kriging, single and multiple regression analysis, variance analysis...
- **Grid calculator:** combine grids through user defined functions...
- **Grid discretisation:** skeletonisation, segmentation...
- **Grid tools:** merging, resampling, gaps filling...
- **Image classification:** cluster analysis, box classification, maximum likelihood, pattern recognition, region growing...
- **Projections:** various coordinate transformations for vector and grid data (using Proj4 and GeoTrans libraries), georeferencing of grids.
- **Simulation of dynamic processes:** TOPMODEL, nitrogen distributions, erosion, landscape development...
- **Terrain analysis:** slope, aspect, curvatures, curvature classification, analytical hillshading, sink elimination, flow path analysis, catchment delineation, solar radiation, channel lines, relative altitudes...
- **Vector tools:** polygon intersection, contour lines from grid...
- And more...



Saga is very well suited to image and grid management, due to its origin within the hydrologic modeling community. It includes a large number of “modules” for importing, exporting and converting numerical grids, such as these temperature grids offshore Namibia.



As this shapefile of earthquake potential shows, Saga is also good for displaying existing shapefiles. It is not a particularly good shapefile management tool, however.

SeaCOOS

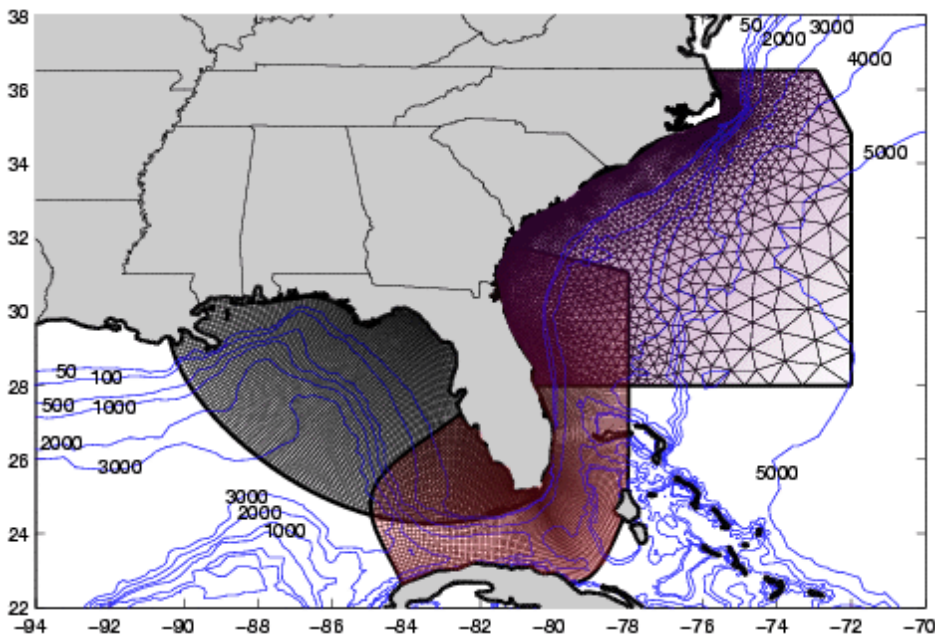
<http://www.seacoos.org/>

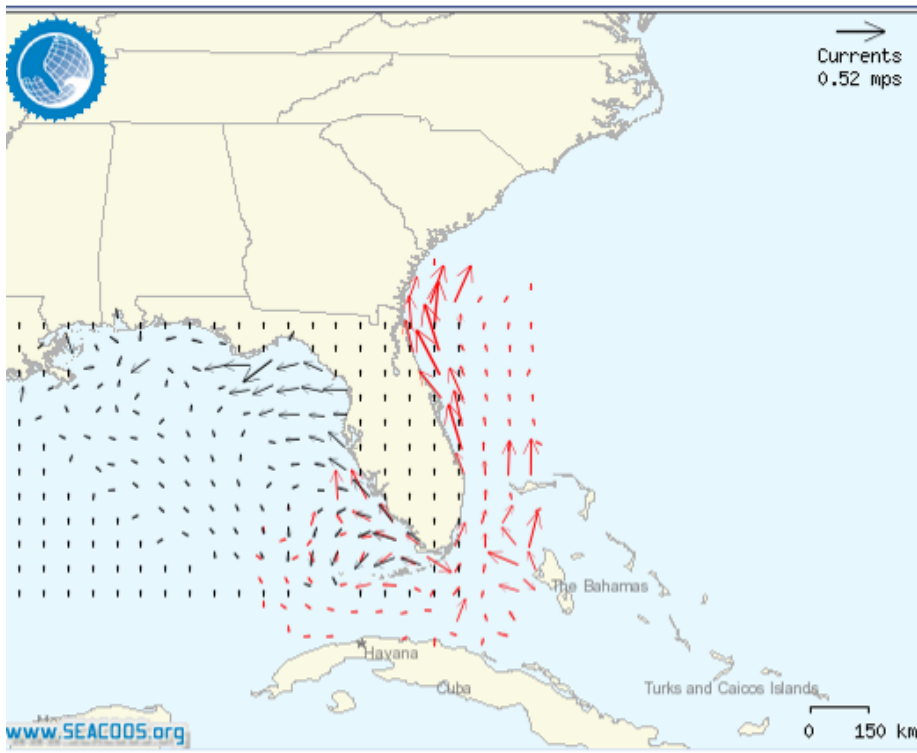
- **Online delivery of active images, developed as part of the OpenIOOS project**

The SEACOOS observing system is to be one of the regional systems ringing the U.S. to form the coastal component of the Integrated Ocean Observing System (IOOS). In May of 2000, the Chief of Naval Research, the Administrator of NOAA, and the President of the Consortium for Ocean Research and Education announced the formation of OCEAN.US, an organization dedicated to the formation of an integrated and sustainable ocean observation system.

The vision for this ocean observation system requires that observing systems scattered across the country cooperate to “collect and disseminate data and data products to serve the critical and expanding needs of environmental protection, public health, industry, education, research, and recreation (from the September 30, 2003, draft of the IOOS Executive Summary). The SouthEast Atlantic Coastal Ocean Observing System (SEACOOS) is to be a part of this larger IOOS system.

The recently-funded SEACOOS initiative is an eleven-institution collaboration to begin development of a regional coastal ocean observing system for the southeast (NC, SC, GA, FL) United States. A three-pronged program of observing, modeling, and data management will be established while simultaneously conducting outreach studies of user needs and exploring governance models for the program in future years. Details of the program specifics are given.





<http://seacoos.org/Model%20Output%20and%20Mapping/InteractiveModel>

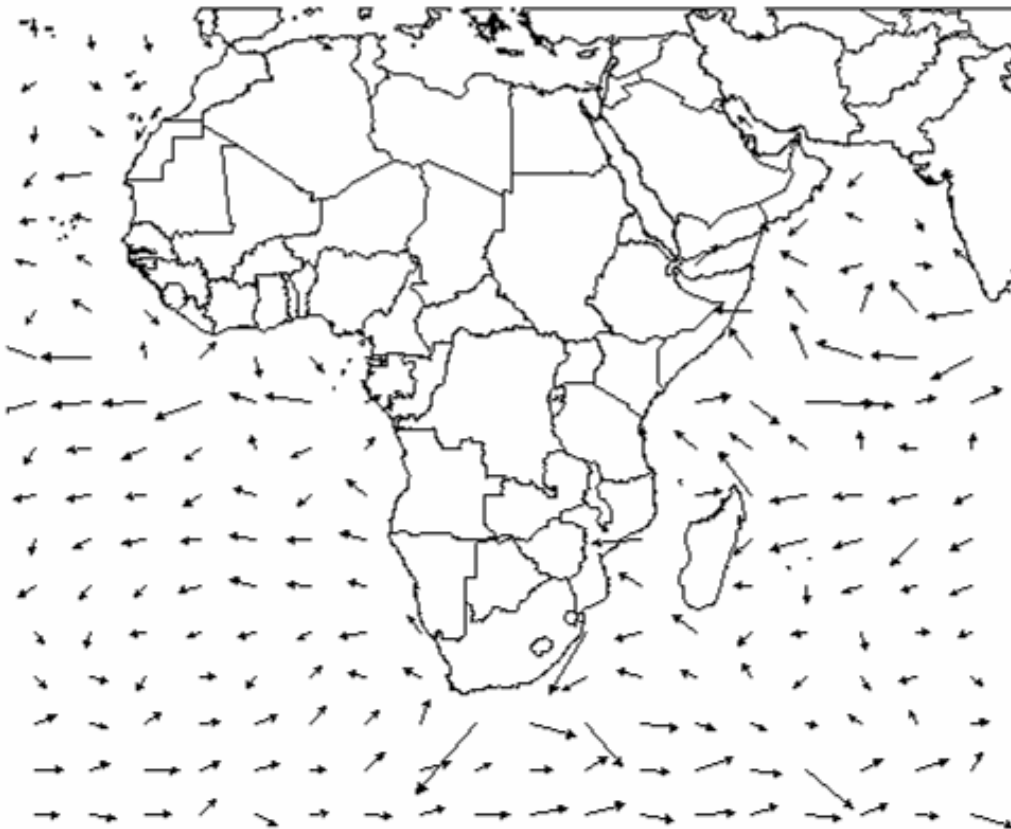
Surfer

<http://golden.com/>

- **The usual customer services and documentation are available at the above site**

Surfer is a contouring and 3D surface mapping program that runs under Microsoft Windows. It quickly and easily converts your data into outstanding contour, surface, wireframe, vector, image, shaded relief, and post maps. Virtually all aspects of your maps can be customized to produce exactly the presentation you want. Producing publication quality maps has never been quicker or easier.

[Author's Note: Surfer is included here only because it is the only easy-to-use program we can find that creates vector plots as shapefiles. Surfer is so widely used that no in-depth description seems necessary here.]



Average surface current vectors for January from the Global Drifter Program's climatology data at http://www.aoml.noaa.gov/phod/dac/drifter_climatology.html.

WebWinds

<http://www.openchannelsoftware.com/projects/WebWinds/>

- **Windows, Linux, Mac, Unix**
- **Modest, but adequate documentation and skimpy tutorial at <http://www.openchannelsoftware.com/projects/WebWinds/>**

[Author's Note: WebWinds is another orphan program, that seems to have lost favor at NASA and been relegated to the archives. It's quirky interface, which seems to have been unique, was probably one reason for its fate. It is included here because of the wide range of format compatibility and its 3-D display capabilities (i.e. spherical globe option), and an amazing Tool Suite. The bottom line with Web Winds is that it could do just about anything with earth- and space-science grids, but the visual displays were so miniscule and blurry as to be useless.)

WebWinds is an interactive science data visualization system, written in Java and available for all major computer platforms. Its use does not require any user programming experience since sessions are created by assembling components on the screen via 'point and click'. WebWinds is modular, allowing flexibility in tool construction and application. This version allows internet-based distributed processing for the first time so that it can fulfill the needs of data providers as well as data consumers.

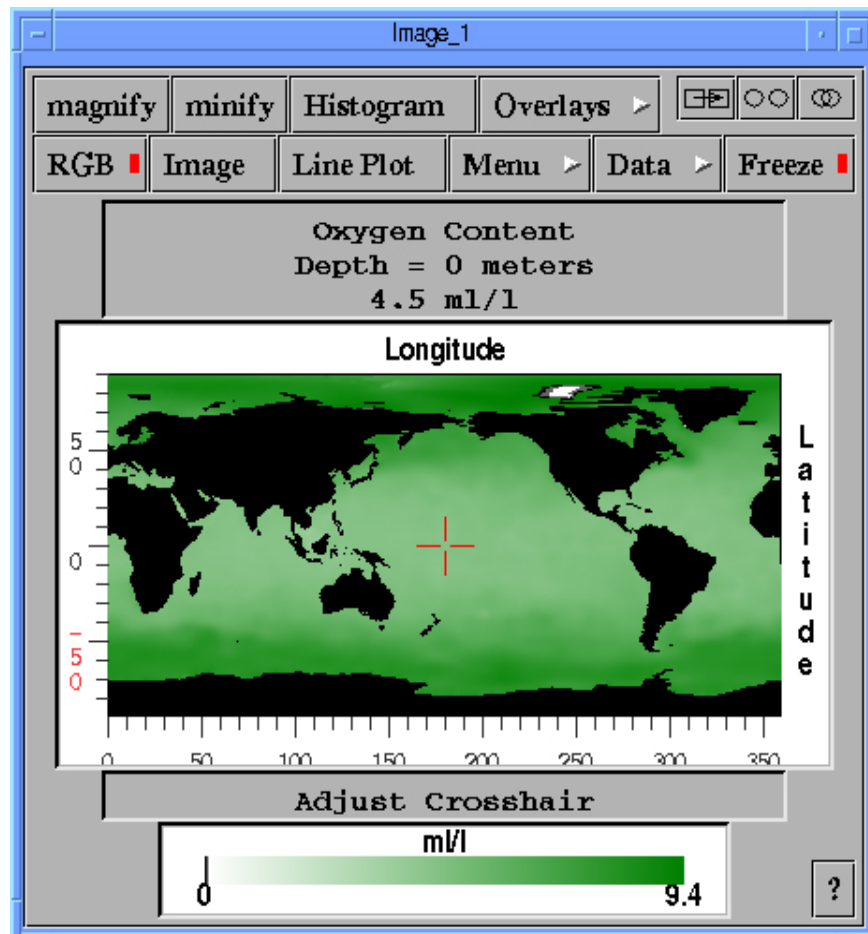
The WebWinds user interface uses a direct manipulation approach in that it employs continuous representation of displays and controls requiring physical actions rather than complex syntax. The benefits of this approach are that it allows rapid response to operations with immediately visible effects.

Webwinds now does distributed processing allowing direct data access via a [data server](#).

Currently, the main features of WebWinds are:

- The ability to present and manipulate 2 and 3 dimensional data in a variety of 1 and 2 dimensional display tools
- The ability to subset and sub-sample data on input or display output, making it possible to handle very large data sets.
- The ability to concatenate or combine data sets to create a higher order data set.
- The ability to overlay tabular data on top of images.
- The ability to display several types of coordinate projections for some types of data.
- Simultaneous display and analysis of multiple data sets which may be totally unrelated.
- Interactive color manipulation.
- The ability to act as a Web browser helper application, making it possible to survey scientific data archives in interactive mode.
- Ability to save sub-setted or sub-sampled data.

- A scripting language which allows session configuration, re-run, macros, network collaboration and distributed processing.
- A context sensitive help system.
- The ability to save images from the screen to a file, including animated movies.
- Complete, free installation programs (including Java) for most platforms.
- A [server](#) software package which allows remote data access, sub-setting and sub-sampling.
- 3D rendered displays capable of depicting an image in perspective using lighting and shading



This image is approximately the same size as typical WebWinds images, indicating how poorly suited the system is for visualization. The underlying data management and analysis modules, however, are probably peerless.

World Wind

<http://worldwind.arc.nasa.gov/index.html>

- **Windows (with .NET and DirectX)**
- **All user help included with the download package**

World Wind lets you zoom from satellite altitude into any place on Earth. Leveraging Landsat satellite imagery and Shuttle Radar Topography Mission data, World Wind lets you experience Earth terrain in visually rich 3D, just as if you were really there.

Virtually visit any place in the world. Look across the Andes, into the Grand Canyon, over the Alps, or along the African Sahara.

3D Engine

World Wind allows any user to zoom from satellite altitude into any place on Earth, leveraging high resolution LandSat imagery and SRTM elevation data to experience Earth in visually rich 3D, just as if they were really there.

Particular focus was put into the ease of usability so people of all ages can enjoy World Wind. All one needs to control World Wind is a two button mouse. Additional guides and features can be accessed through a simplified menu. Navigation is automated with single clicks of a mouse as well as the ability to type in any location and automatically zoom into it.

World Wind was designed to run on recent PC hardware with 3D acceleration. Please refer to the [download section](#) for more information on system requirements.

Blue Marble

World Wind has a full copy of the Blue Marble, a spectacular true-color image of the entire Earth as seen on [NASA's Earth Observatory: the Blue Marble](#).

Put together from data of a variety of satellites such as MODIS and Terra, the Blue Marble can be seen in all its glory at 1 km per pixel resolution.

Landsat 7

Using World Wind, you can continue to zoom past Blue Marble and reveal the extremely detailed seamless mosaic of [LandSat 7](#) data.

LandSat 7 is a collection of images from 1999-2003 at an impressive 15 m per pixel resolution. It includes other color bands such as the infrared spectrum. Users will be able to browse these different sets as they become available. Any changes and updates are automatically inherited by World Wind.

LandSat 7's resolution makes it possible to see your own city, neighborhood, or landmarks in your vicinity. Seeing the whole globe like this puts the world in context with scientifically accurate data.

The complete LandSat 7 data set is too large to fit on a single machine so World Wind only downloads what you see and stores a compressed copy on your computer for later viewing.

SRTM

Combining LandSat 7 imagery with Shuttle Radar Topography Mission (SRTM) Data, World Wind can display a dramatic view of the Earth at eye level. Users will literally be able to fly across the world in any direction.

In addition, World Wind can exaggerate these views so a user can easily pick out the details.

NASA SVS

Goddard Space Flight Center (GSFC) has produced a set of visually intense animations that demonstrate a variety of subjects such as hurricane dynamics and seasonal changes across the globe.

World Wind can take these animations and play them directly on the world. Anyone can immediately grasp where the event is taking place as World Wind rotates automatically into view.

MODIS

Moderate Resolution Imaging Spectroradiometer or MODIS produces a set of time relevant data that's updated every day. MODIS catalogs fires, floods, dust, smoke, storms and even volcanic activity.

World Wind produces an easily customized view of this information and marks them directly on the globe. When one of these color coded markers are clicked, it downloads the full image and displays them.

MODIS images can download publication quality material at a resolution of 250 m per pixel. A new fresh set of images can be downloaded every day.

World Wind also has a "tour mode" to automatically skim through any number of samples.

GLOBE

World Wind is capable of browsing through and displaying GLOBE data based on any time the user wants. For example, a user can download today's (or any previous day's) temperature across the world.

You can view rainfall, barometric pressure, cloud cover, or even the student GLOBE samples themselves. Each sample comes with a temperature scale

Country & (USA) State Borders

World Wind has a complete set of borders that traces every country and state. As you zoom into the world, the boundaries become more precise

You can observe where mountain ridges and rivers have formed the political boundaries of today.

Place names

World Wind has a full catalog of countries, capitals, counties, cities, towns, and even historical references. The names update dynamically, by increasing in number as the user zooms in. This prevents too many names from cluttering up the screen.

It's likely that you'll find your own town no matter how big or small it is in World Wind.

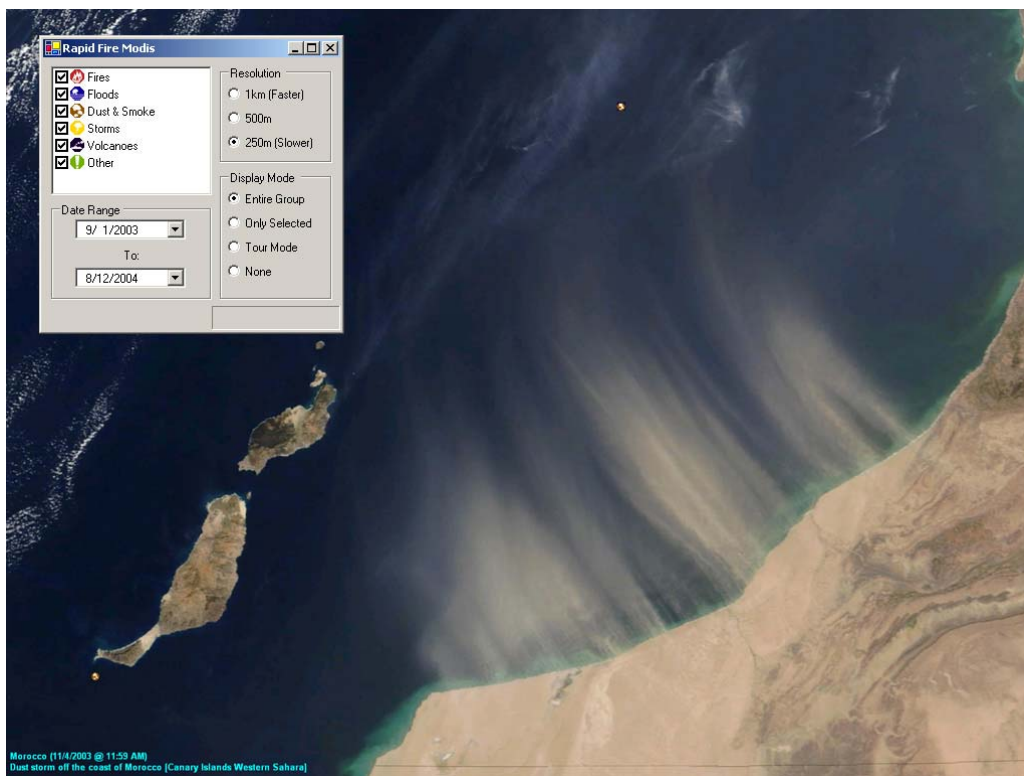
Visual Tools

World Wind comes with a variety of visual guides that help the user's experience such as latitude and longitude lines, as well as extremely precise coordinate data.

These helpers can be toggled on or off any time and are viewable with any of World Wind's other features turned on.

Landmark Set

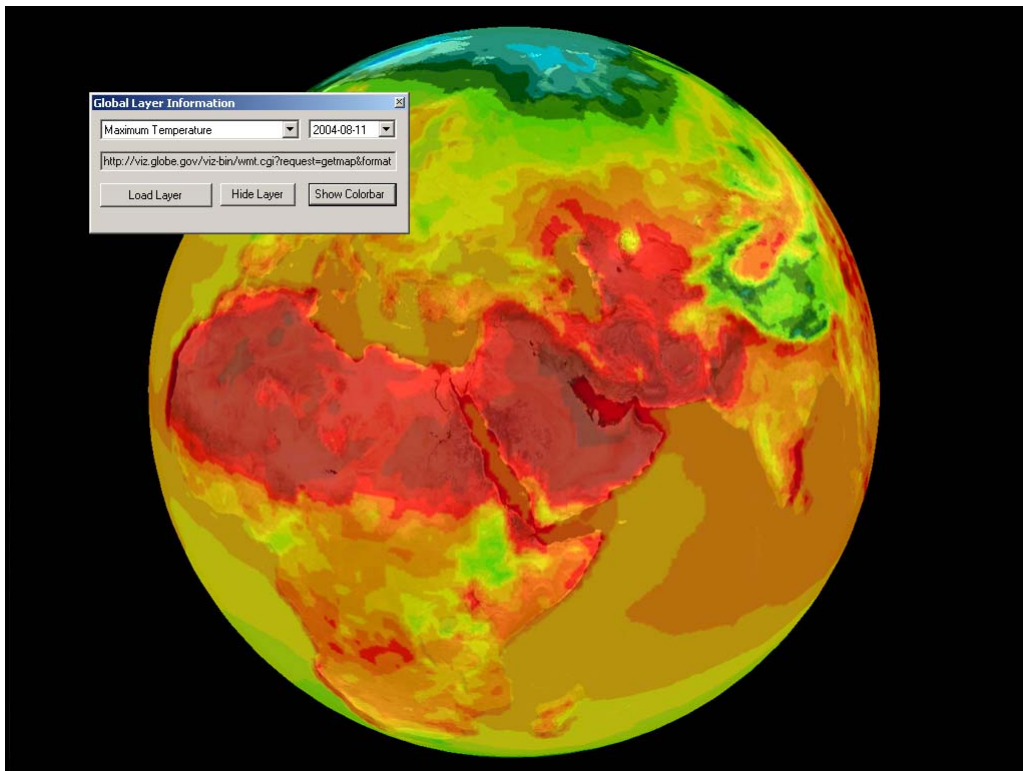
World Wind has the capability to display actual 3d models of landmarks on the earth. This helps to see the world in context to places a user may have been to. Those landmarks that do not have 3D models for it yet have place markers similar to how MODIS displays places of interest.



MODIS image of dust storms off the coast of Morocco.



MODIS image of Hurricane Kate, 2003.



Land surface maximum temperature, projected onto a global surface.

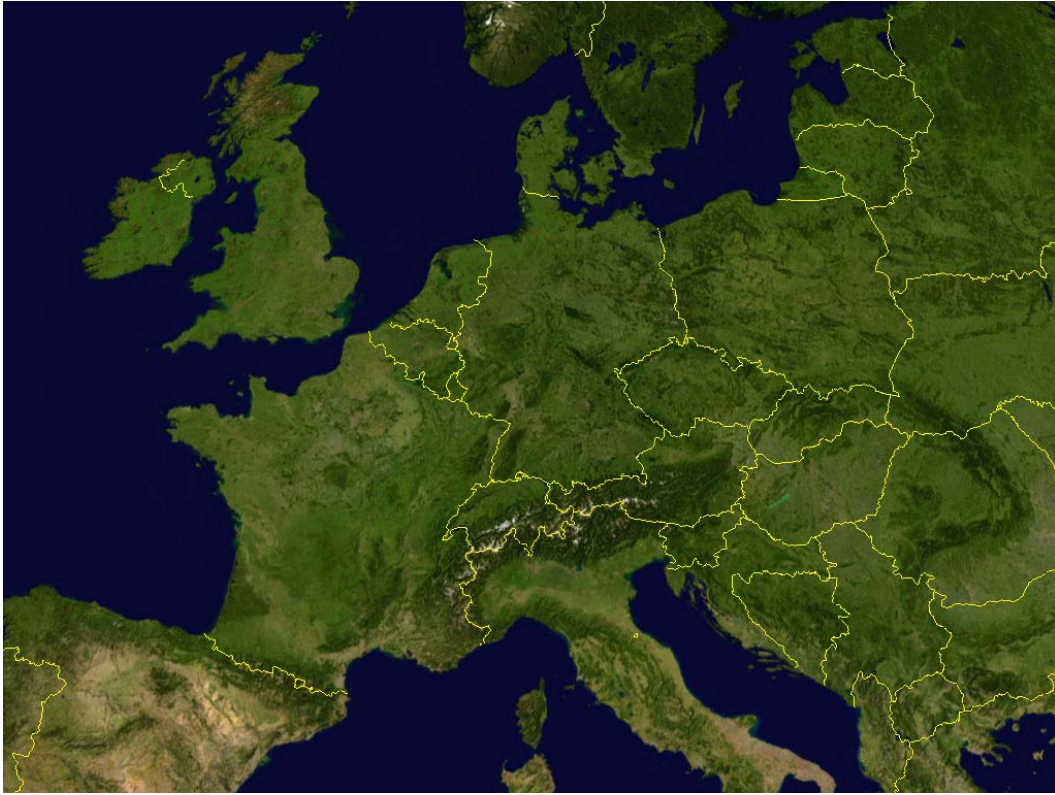


Image of Europe with country boundary feature enabled.

Appendix A – IOC/IODE Roadmap Tutorials List

[http://ioc.unesco.org/oceanteacher/OceanTeacher2/08_Exercises/03_DtaMgtEx/Roadmaps/RoadMapList.htm]

These are the Roadmap Exercises, a detailed, step-by-step, set of tutorials that develops a complete national data archive for a selected country, and demonstrates basic analysis methods for many data types. Although a few of them do not address visualization issues, the main thrust of the data management training program is the quality control, preparation, and analysis of national data collections through graphic processes.

- A. [Preliminaries](#) - How to work through these exercises.
- B. [Folder Structure](#) - Create a complete folder structure for the many datafiles and products that will be used or created.
- C. **General Mapping/Area of Interest (AOI)**
 1. [*ArcExplorer: First Guess](#) - Making a simple world map with ArcExplorer to make a "first guess" AOI
 2. [*GEBCO Depth Contours](#) - Obtaining vector contours from the GEBCO Digital Atlas.
 3. [**Marine Geology Data](#) - Obtaining a sediment thickness map (in image format)
 4. [**VMap0 Digital Chart of the World](#) - Obtaining an entire library of geospatial data, and converting contained layers to shapefiles
 5. [*ArcExplorer: Project Map](#) - Create a project synthesis map and use it to define the AOI
 6. [**AOI Polygon & Graticule](#) - Creating shapefiles to outline the AOI and to display a lat/lon grid
- D. **Mapping & AOI Determination with ArcGIS**
 1. [**Introduction to ArcGIS](#)
 2. [**Map Projections in ArcGIS](#)
 3. [**ArcGIS Data Acquisition](#)
 4. [**View Data in ArcMap](#)
 5. [**Create AOI and Landmask Polygon In ArcMap](#)
 6. [**Create Publication-Quality Map in ArcMap](#) - Under construction
- E. **Beginning a Data Collection**
 1. [*World Ocean Database on WODSelect](#) - Instructions for downloading World Ocean Database datasets directly from the US NODCs WODSelect server
 2. [**Obtaining Cruise & Station Metadata](#) - Instructions for downloading and understanding metadata that describe the specific contents of the data collection [Under construction]
 3. [*Data Inventory](#) - How to locate and interpret the data inventory file in the data collection
- F. **Basic Data Analyses**
 1. [*Station Plots/Scatter Plots](#) - Constructing standard station plots and scatter plots of National Collection data

2. [*Ocean Section Plots](#) - Constructing ocean section plots
3. [Improving Graphics](#) - Methods to improve Ocean Data View graphics to make them acceptable for publication

G. Exporting ODV Products

1. [*Export Data Product](#) - How to export a subset of a National Collection from Ocean Data View
2. [*Export Analysis Graphic](#) - How to export any graphics figure from Ocean Data View

H. Adding Other Bottle Data

1. [Create a Standard ODV Spreadsheet Template](#) - Export a data spreadsheet from the National Collection to use as a template
2. [Analyze the Project Dataset](#) - Examine an historical, hard-copy dataset to see what parameters were measured, what units were used, and how this compares to the data spreadsheet template
3. [Create a Project Spreadsheet Template](#) - Edit the standard template to add desired parameters (and their units) and to delete unnecessary ones
4. [Spreadsheet Data Input](#) - Manually enter the historical data into the spreadsheet
5. [Import the Spreadsheet to ODV](#) - Add the historical data spreadsheet to the National Collection using ODV's import procedures

I. Adding Other CTD Data

1. [Convert CNV to Spreadsheet](#) - Method to convert the ASCII data files from Seabird CTD systems to a usable, ODV-compatible spreadsheet
2. [Import CTD Data Spreadsheet](#) - Method to import the spreadsheet of CTD data into ODV

J. Special-Purpose Collections and Quality Control

1. [*Special World Ocean Atlas 2001 Collection](#) - Create a collection of hypothetical "stations" synthesized from gridded analyses of the World Ocean Database 2001
2. [*Special GLODAP Collection](#) - Create a collection consisting only of very accurate ocean station datasets (1972-1999), carefully merged and quality-controlled
3. [*Comparison System with Special Collections](#) - Preparing a system of side-by-side graphics to compare the national collection and special collections
4. [**QC with Special Collections](#) - Flagging bad or suspect data values, on the basis of these comparisons

K. Methods for Operational Data

1. [*Accessing Argo and GTSPP Data Online](#) - Use a graphical interface to select and request files of quality-controlled Argo and GTSPP data in NetCDF format
2. [NetCDF Station Data and ncBrowse](#) - Viewing Argo and GTSPP files in a special browser program
3. [*NetCDF Station Data and Ocean Data View](#) - Adding Argo and GTSPP NetCDF data to an ODV data collection

L. Gridding and Contouring Data in Surfer

1. [Basic Gridding](#) - Examination of various gridding methods (algorithms; grid resolutions)
2. [Basic Contouring](#) - Using Surfer to draw isopleths (contours) through ocean data grids
3. [Basic Blanking](#) - How to eliminate data contours from map areas where there are no data
4. [Basic Grid Math](#) - How to perform mathematical operations on grids
5. [Exporting Contours](#) - How to export contour lines from Surfer in a GIS-compatible format
6. [Adding Objects to Maps](#) - Methods to improve Surfer graphics for publication
7. ****[Post Map](#)** - How to make a map of data stations

M. Gridding and Grid Products in Saga

1. ****[Spreadsheet to Table](#)** - Basic procedure for importing a data table into Saga; creates an "event theme"
2. ****[Table to Points Shape](#)** - Convert the "event theme" to a shapefile
3. ****[Grid a Points Shape](#)** - Grid a selected data column in the "event theme" table
4. ****[Grid Products](#)** - Creating and saving statistical, other-format, and image products from Saga grids
5. ****[Land-Masking a Grid](#)** - Creating and applying a special grid that masks land areas on ocean data grids

N. Rasterizing Data in ArcGIS

1. ****[Add Spreadsheet Data to ArcMap](#)**
2. ****[Edit Data in ArcMap](#)**
3. ****[Interpolate to Raster](#)**
4. ****[Raster Calculations in ArcMap with Spatial Analyst](#)**
5. ****[Methods of Surface Display in ArcMap](#)**

O. Vector Charts in Surfer

1. ***[Vector Chart from Speed & Direction](#)** - Using speed and direction grids data to create vector charts
2. ****[Vector Chart from U & V Components](#)** - Using zonal and meridional component grids to create vector charts

P. Managing HDF Files

1. ***[Download an HDF Image](#)** - Downloading HDF files from a typical online server
2. ***[Extract an ASCII Grid](#)** - How to extract an ASCII data grid from an HDF file
3. ***[Convert a Grid to XYZ](#)** - How to convert the ASCII grid to XYZ format (to use in gridding)
4. ***[XYZ Value Conversion](#)** - How to convert color palette values in the XYZ file to oceanographic units
5. ****[Convert a Grid to FLT](#)** - How to convert the ASCII grid to the ESRI binary ArcGrid format
6. ****[FLT Value Conversion](#)** - How to convert color palette values in the FLT grid to oceanographic units

Q. Special Methods for Land/Ocean Relief Data

1. [Grid & Contour Relief Data](#) - How to obtain, grid and contour high-resolution relief data, and to construct maps of specific depth or height contours
2. ******[Extract Relief Grids from Existing Grids](#) - How to obtain a relief grid for a specific area from global grids
3. *****[Contours on Basemaps](#) - Combining selected depth/height contours with a basemap (in this case a geo-referenced satellite image) to assess flooding potential due to a hypothetical storm or tsunami surge
4. [Blanking Files](#) - How to make a special blanking file (for Surfer) corresponding to a physical coastline, a political boundary, or a particular ocean depth/land height
5. [Combining Contours with XYZ Topography Data](#) - Under construction

R. Managing GeoTIF Images

1. *****[Image Manipulation](#) - Changing the size and format of images
2. *****[Convert to GeoTIF](#) - Converting simple images to geo-referenced images for use in GIS systems

S. Advanced GIS Methods

1. ******[Local & Online Data Synthesis in ArcExplorer](#)
2. ******Vector Operations with MapWindow
3. ******Local & Online Data Synthesis in MapWindow

T. ODV and MS Access

1. [Import an ODV spreadsheet into ACCESS](#) - Basic movement of an entire collection into Access
2. [Parsing the Data in ACCESS](#) - How to break up the collection into linked tables in Access
3. [Access Queries](#) - How to write queries to produce data subsets in Access

U. Managing NetCDF Gridded Data

1. *****[OPeNDAP Data from Live Access Servers](#) - How to obtain netCDF data grids from OPeNDAP servers with the Live Access Server client interface
2. *****[Browsing NetCDF Gridded Data in ncBrowse](#) - Examining the contents of NetCDF grids with ncBrowse
3. *****[Extracting CDL ASCII Grids from NetCDF](#) - Converting NetCDF grids to simple ASCII CDL grids
4. *****[Converting CDL to XYZ](#) - Converting simple ASCII CDL grids to XYZ format
5. [OPeNDAP Data from ODC Client](#) - Using OPeNDAP Data Connector to browse/visualize NetCDF grids from any OPeNDAP server

*Revised

**New