

# **OPeNDAP: Accessing HYCOM (and other data) remotely**

Presented at

**The HYCOM NOPP GODAE Meeting**

By

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# Acknowledgements

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- James Gallagher - OPeNDAP, Inc
- Daniel Holloway - GSO/URI
- John Chamberlain - OPeNDAP, Inc
- In addition to HYCOM NOPP funding OPeNDAP also receives funding from:
  - NASA
  - NSF
  - NOAA

# Outline

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**Introductory Remarks**

**Current Status**

**Upgrades in Progress**

**Accessing HYCOM Data via Matlab - A Demo**

**Accessing HYCOM Data via the ODC - A Demo**

# A Historical Note

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- OPeNDAP evolved from the Distributed Oceanographic Data System (DODS).
- DODS was conceived at a workshop held at URI in 1993.
- Basic system was designed and implemented in 1993-1995.
- DAP2 (the current Data Access Protocol or DAP) was first released in 1996.
- DODS consisted of two fundamental parts:
  - A **discipline independent core infrastructure** for accessing data.
  - A **discipline specific oceanographic** portion – population, location, etc.

# Historical Note (continued)

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- To isolate the discipline independent part of the system from the discipline specific part, two entities were formed in 2000:
  - The **Open Source Project for a Network Data Access Protocol** (OPeNDAP), a 501 c(3).
  - The **National Virtual Ocean Data System** (NVODS) a distributed oceanography data system managed from the University of Rhode Island originally funded by NOPP.

# OPeNDAP Mission

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To maintain, evolve and promote a data access protocol (DAP) for the **syntactically consistent exchange of data over the network.**

The DAP should provide syntactic interoperability across disciplines and **allow for semantic interoperability within disciplines.**

# OPeNDAP Concepts

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- OPeNDAP software is open source.
  - More likely to be adopted.
  - Benefits from community software contributions.
- OPeNDAP mixes implementation with research.
  - Implementation - to encourage use.
  - Research - to keep the protocol current.
- OPeNDAP is based on a client-server architecture.

# OPeNDAP Is Defined By the DAP

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## Data Access Protocol

- Model used to describe the data;
- Request syntax and semantics; and
- Response syntax and semantics.

## Syntax

- The computer representation of a data object - the data types and structures at the computer level; e.g.,
  - T is a floating point array of 20 by 40 elements.

## Semantics

- The information about the contents of an object; e.g.,
  - T is sea surface temperature in degrees Celsius for a certain region of the Earth.



# Servers

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- Servers receive requests and provide responses via the DAP.
- Servers convert the data from the form in which they are stored to the OPeNDAP data model.
  - The OPeNDAP data model is rich - it can handle most, if not all oceanographic data types.
- Servers provide for subsetting of the data.

# Clients

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- Clients make requests and receive responses via the DAP.
- Clients convert data from the OPeNDAP data model to the form required in the client application.

# Outline

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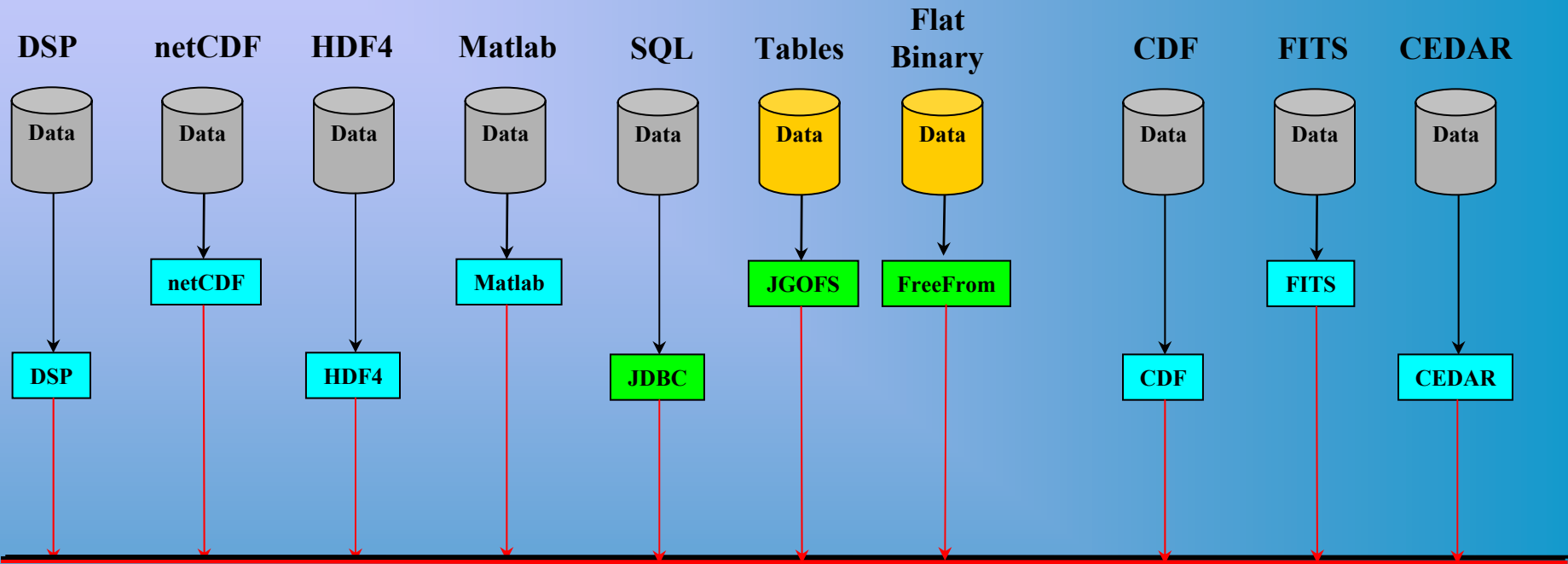
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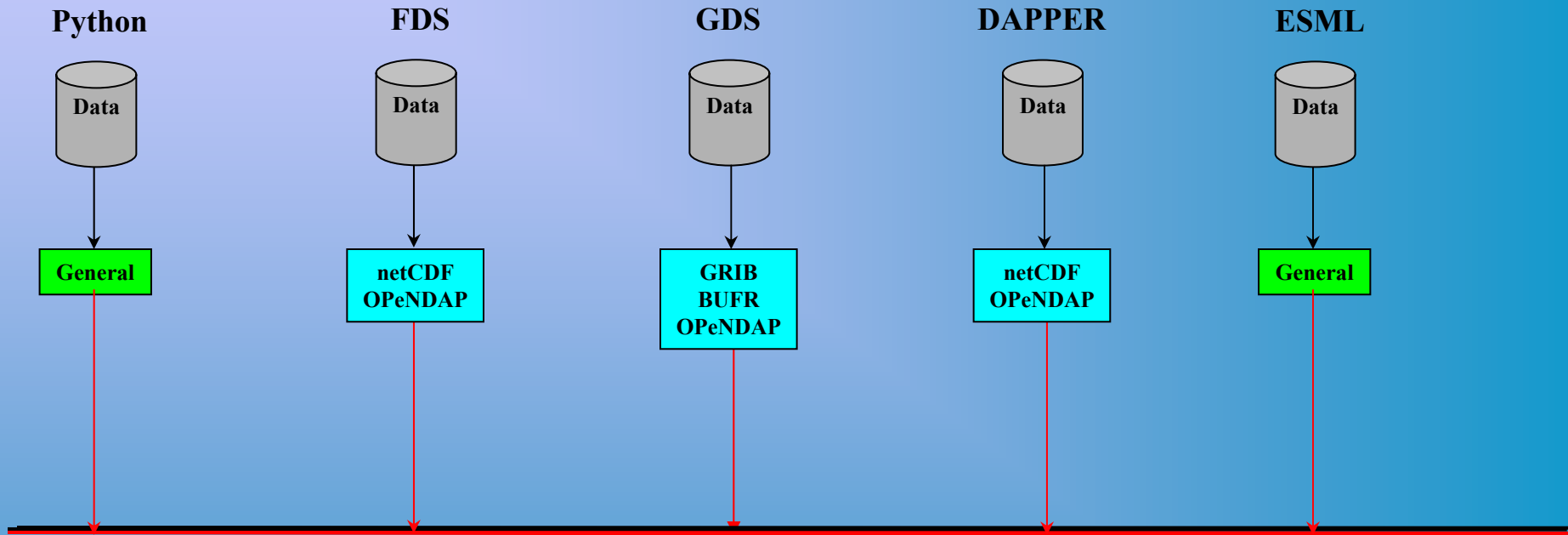
# OPeNDAP Servers

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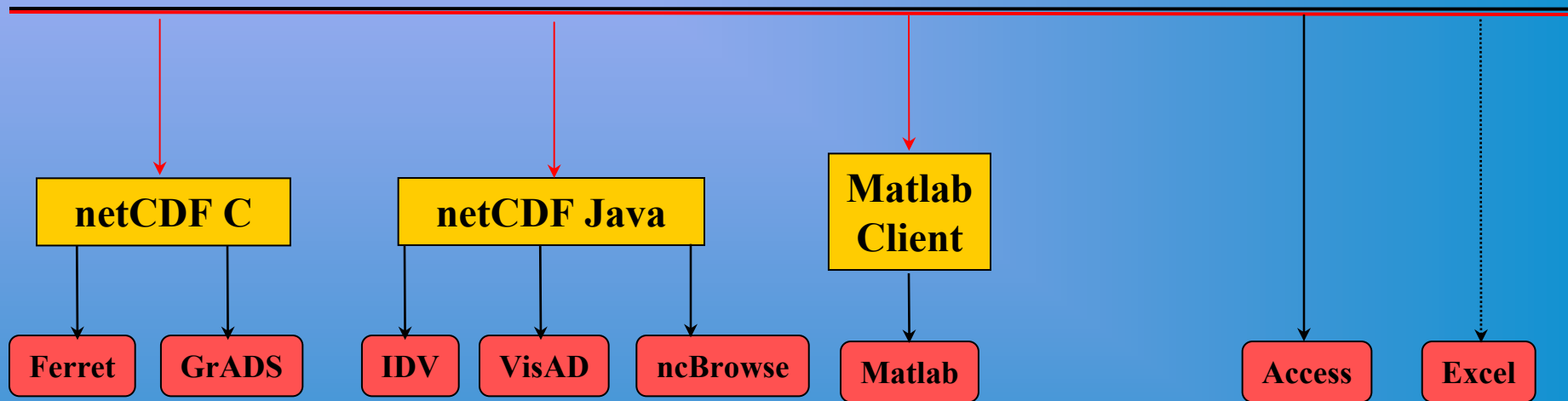
# OPeNDAP Servers (continued)

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# OPeNDAP Clients

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# Data Available via OPeNDAP Servers

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- There are more than 1000 data sets served via OPeNDAP.
  - Meteorological
  - Oceanographic
  - Land Cover
  - ...
- A partial list of serving institutions/projects is available at the OPeNDAP web site

# Data Providers **Please Register Your Data**

OPeNDAP-Accessible Datasets

home download support developers about us

search OPeNDAP:  go

Sources of data

OPeNDAP Datasets

**Register your server**

Search the GCMD

## OPeNDAP-Accessible Datasets

Search for:

(keywords)

Show All Datasets

Hide All Datasets

Key:

- GCMD - NASA's Global Change Master Database
- HTML - an HTML form to query the data
- DDS - shows data structure
- DIR - shown if the entry points to a directory
- CAT - the entry is a catalog
- LAS - NOAA's Live Access Server
- INFO - site information page

To get dataset info click on `dds` and then change `dds` at the end of the URL to `das` or to `info` in the resulting browser window."

Provider:

- ▶ Archiving, Validation and Interpretation of Satellite Oceanographic data (AVISO) / CNES (Centre National d'etudes Spatiales)
- ▶ Antarctic Cooperative Research Centre, Tasmanian Partnership for Advanced Computing (TPAC)
- ▶ Carolinas Coastal Ocean Observing and Prediction System (Caro-COOPS)
- ▶ Center for Ocean Land Atmosphere Studies (COLA)
- ▶ Columbia University/LDEO - International Research Institute (IRI/LDEO)
- ▶ Florida State University - Center for Ocean-Atmospheric Prediction Studies (COAPS)
- ▶ George Mason University - Seasonal to Interannual Earth Science Information Partner (SIESIP)
- ▶ Gulf of Maine Ocean Observing System (GoMOOS)
- ▶ Maine - Department of Marine Resources (Maine DMR)
- ▶ Monterey Bay Aquarium Research Institute (MBARI)
- ▶ Naval Oceanographic Office (NAVOCEANO)
- ▶ NASA/GSFC - Goddard Distributed Active Archive Center (GDAAC)
- ▶ NASA/IPL - Physical Oceanography Distributed Active Archive Center (PODAAC)



# Data Providers **Please Register Your Data**

The screenshot shows a web browser window with the address bar displaying `http://www.opendap.org/data/addtolist.html`. The page title is "Add a server to the DODS Dataset list". The OPeNDAP logo is in the top left, and navigation links for "home", "download", "support", "developers", and "about us" are in the top right. A search bar is also present. On the left side, there is a sidebar menu with links for "Support", "Sources of data", "DODS Datasets", "Register your server", and "Search the GCMD". The main content area is titled "Add a Dataset to the list" and contains a form with the following fields and instructions:

**All fields are Required.**  
Please refrain from using the following characters: " ' & % \$

Dataset Name:

URL:

Provider:

Your Email Address:

**Contact Us**  
Questions? Comments? [webmaster@OPeNDAP.org](mailto:webmaster@OPeNDAP.org)  
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This file last modified 4 November 2005

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# Server4 - Early 2006

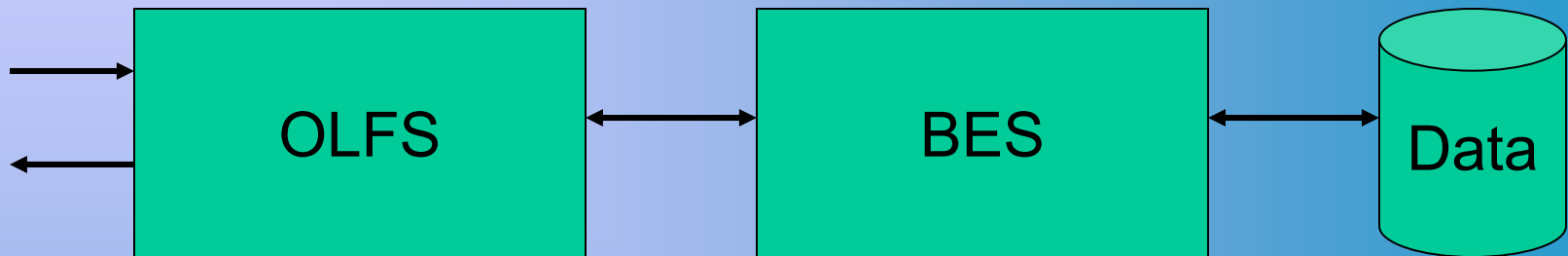
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A major server rearchitecture from: cgi-based to servlet based.

- **Integral THREDDS catalog support.**
- *http and GridFTP* capable.
- Provides a way to reuse server software developed by other groups
- Improved performance.
- Improved security.

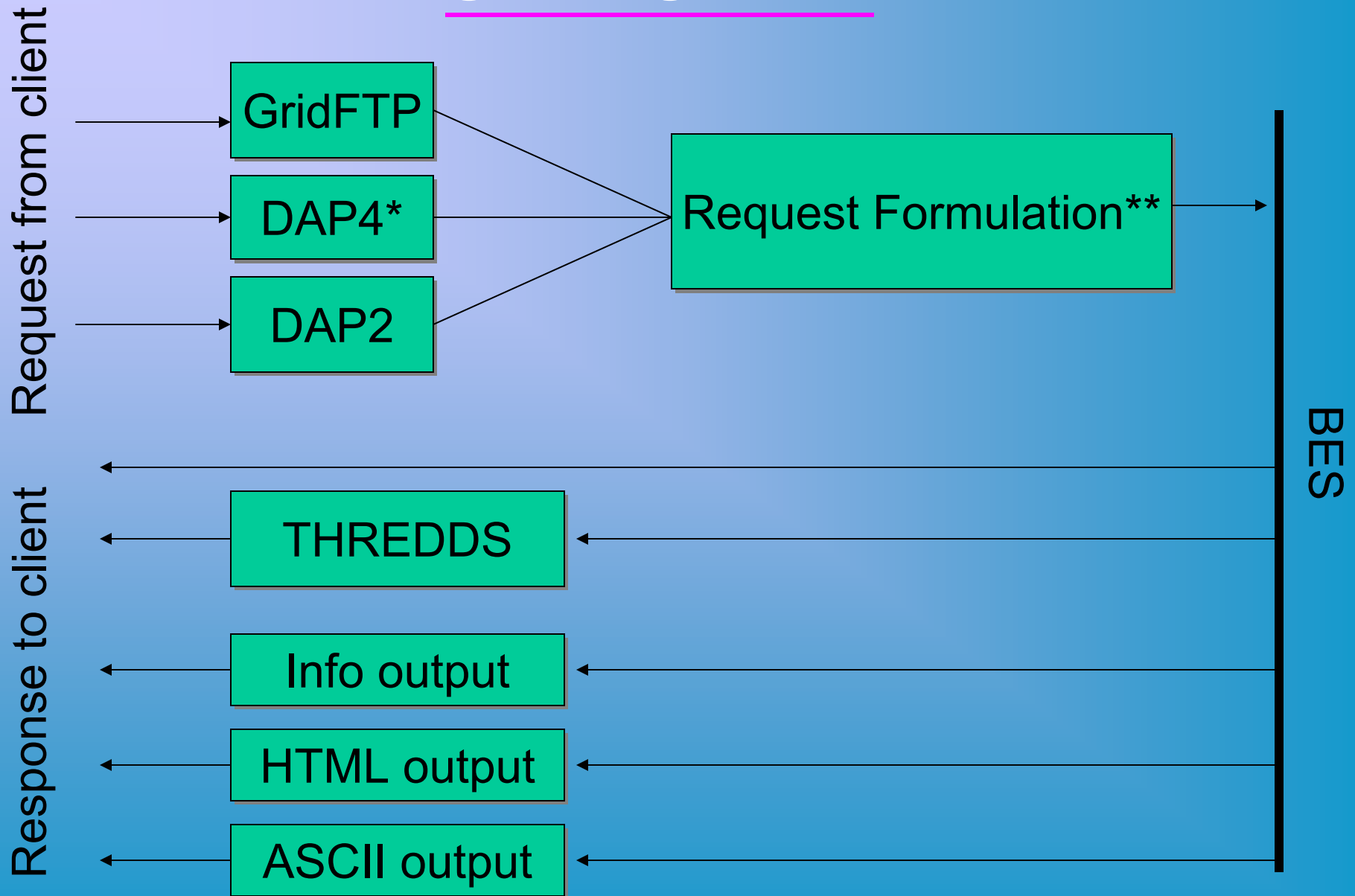
# Server4

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- OPeNDAP Lightweight Front end Server (OLFS)
  - Receives requests and asks the BES to fill them
  - Uses Java Servlets
  - Does not directly 'touch' data
- Back End Server (BES)
  - Reads data files, Databases, et c., returns info
  - May return DAP objects or other data

# OPeNDAP Lightweight Front end Server



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# The HYCOM Matlab GUI

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- A Matlab GUI has been developed for the:  
**1/12° North Atlantic Ocean Prediction System**

Version: HYCOM 2.1

Horizontal Grid: **1/12°** (1678 x 1609 grid points, 6.5 km spacing on average)

Domain: North Atlantic- 98°W to 36.5°E and 28°S to 70°N

Vertical: 26 vertical coordinates (sigma theta reference)

Period Covered: **June 2003 to present**

Bathymetry: quality controlled ETOPO 2.5

Surface Forcing: FNMOC wind stress, wind speed, heat flux, E-P+ relaxation to climatological SSS

River runoff

Buffer Zones: 3° north and south with relaxation to monthly climatological T and S (MODAS)

Data **Assimilation**: satellite altimeter data from MODAS operational system, mean SSH from 1/12°

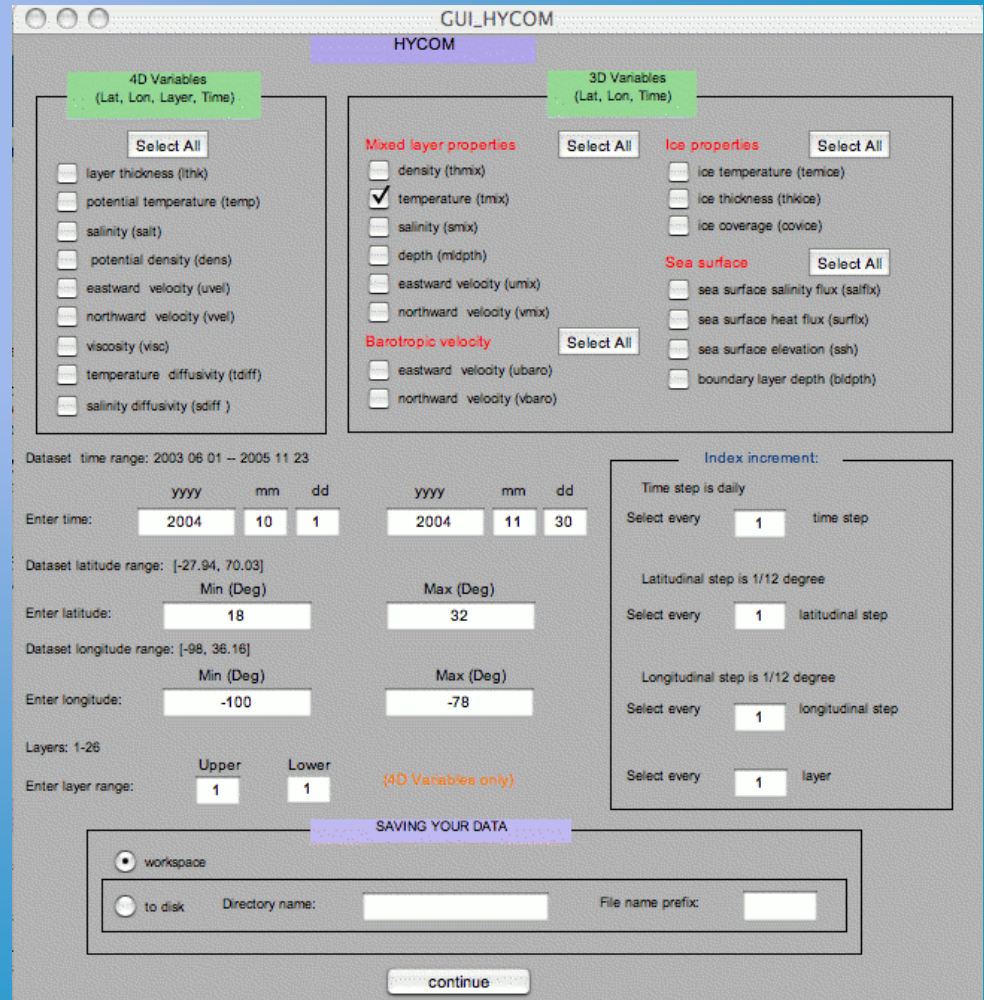
MICOM (ECMWF)

Vertical projection via the Cooper and Haines tech.

Available via the GUI: **daily time series of the best estimates.**

# The HYCOM Matlab GUI

- In addition to a GUI, the associated programs may be called as a function in Matlab.





# SST Fronts as a Metric

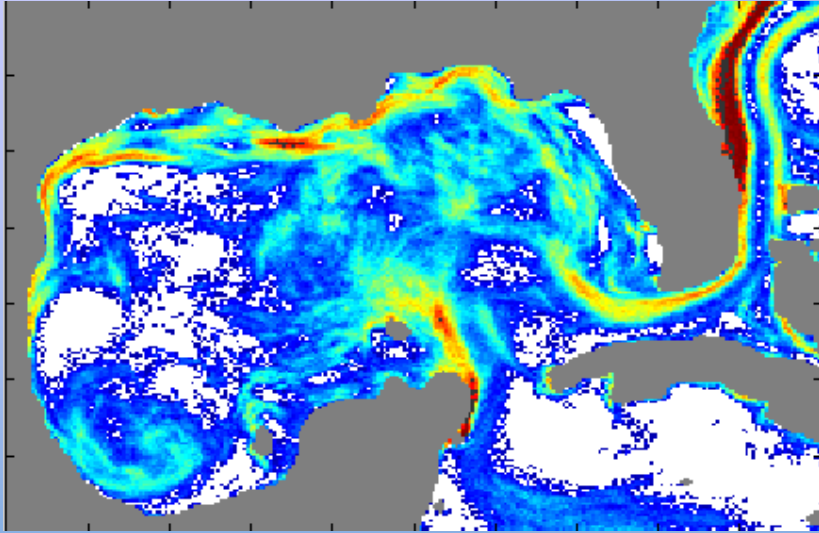
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SST fronts may present a very sensitive measure of the performance of a model. I did an experiment last night. I

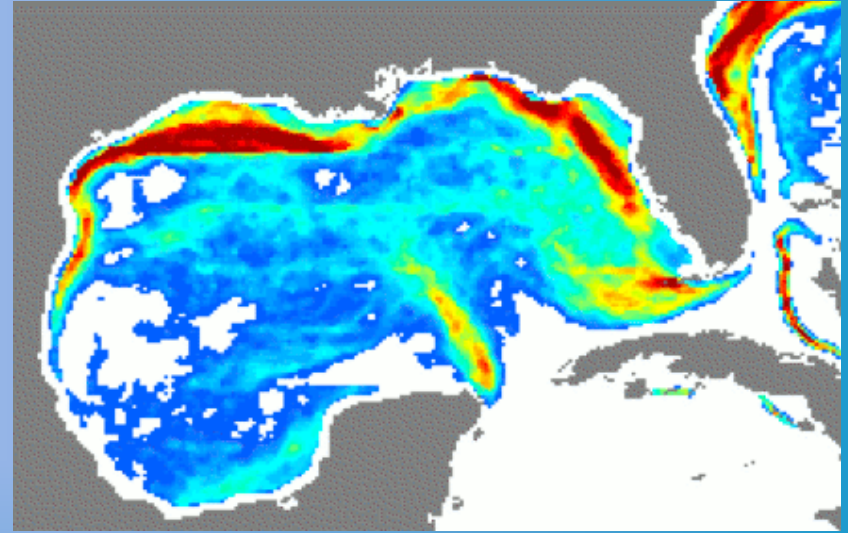
- Downloaded all SST fields for the Gulf of Mexico winter months 10/03-12/03, 10/04-12/04, 10/05-11/05 with the GUI
- Took the gradient of the fields (Matlab function).
- Thresholded the gradient magnitudes - 0 if  $|\nabla T| < T_c$ ; 1 if  $|\nabla T| > T_c$
- Summed thresholded fields.
- Compared with AVHRR SST fronts for winters 1985-1995

# Winter SST Fronts

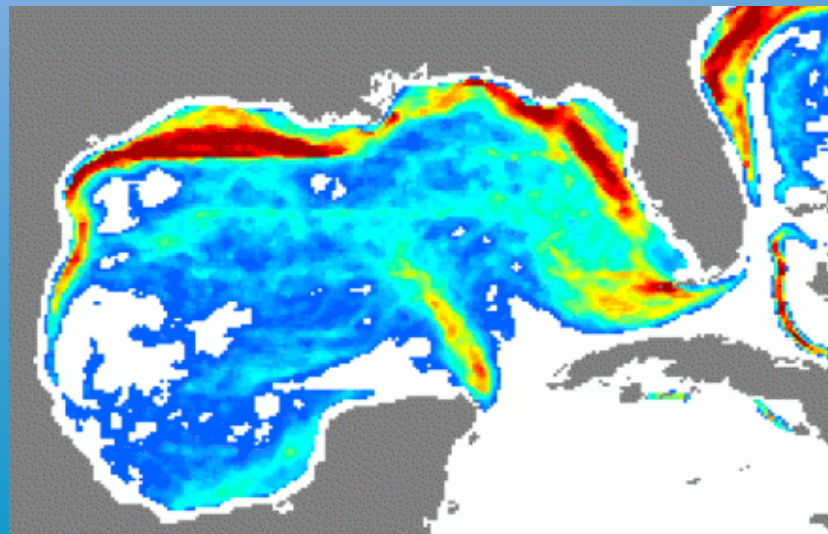
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HYCOM Fronts

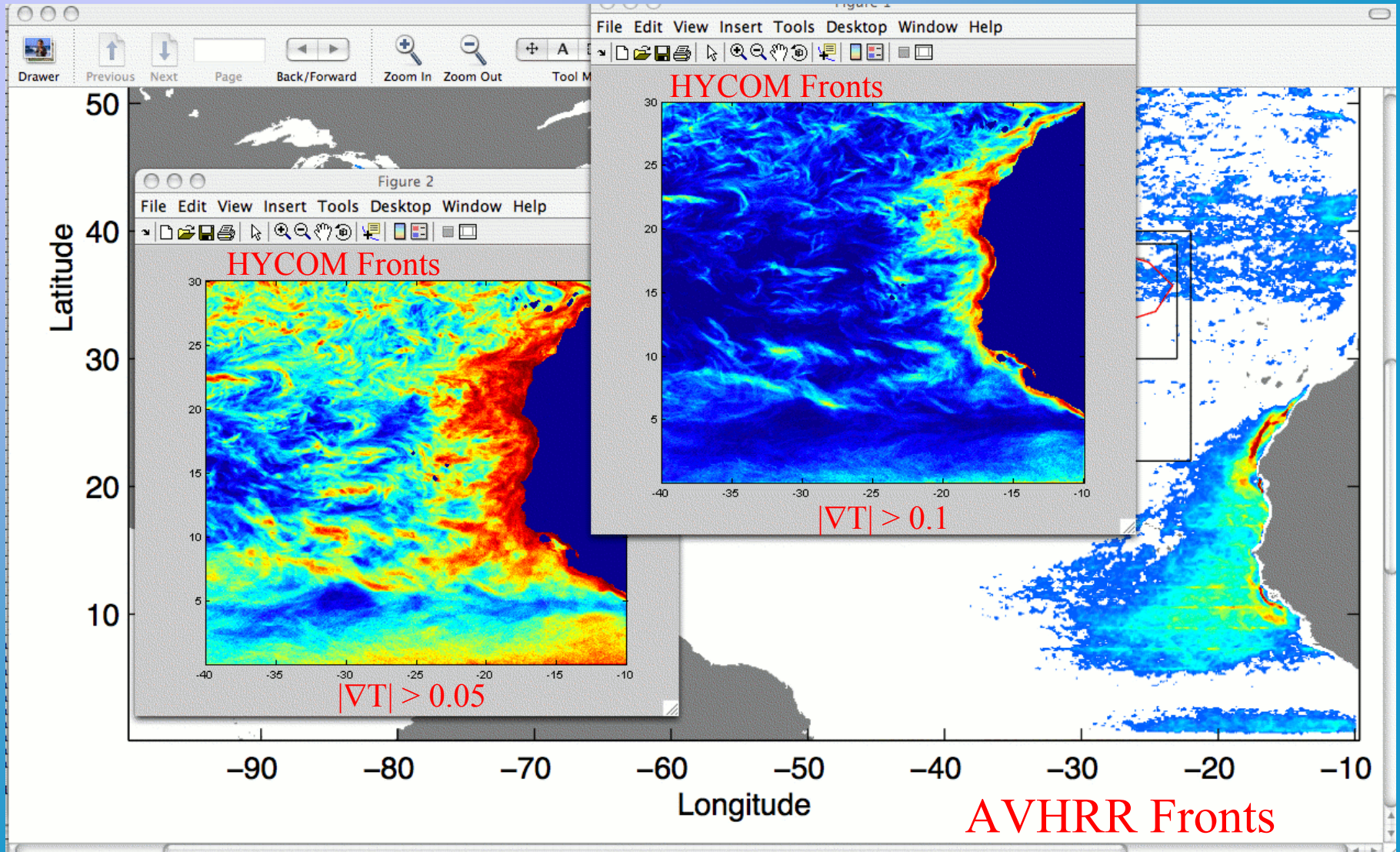


AVHRR Fronts





# Spring SST Fronts



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# The Data System Integrator

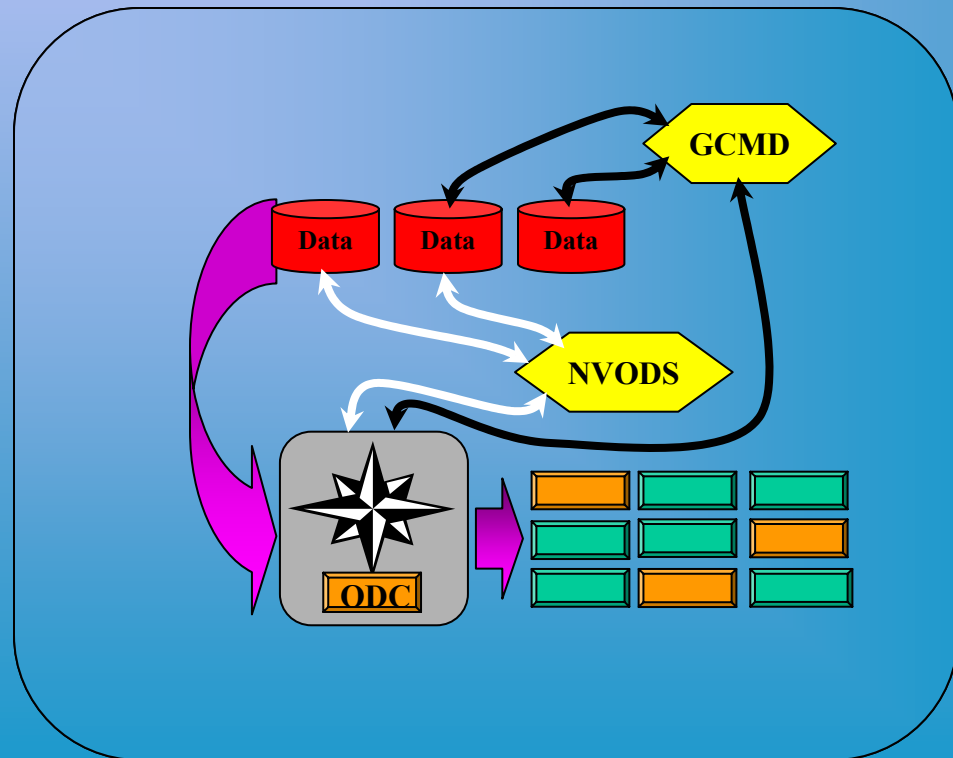
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- The *data system integrator* is an element which assembles a suite of data system elements that together provide seamless access to the data from discovery to use.
- The data system integrator *defines* the data system.
- The data system integrator generally ‘speaks’ several different protocols.

# The Data System Integrator

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The data system integrator brings order to a disordered array of system elements.



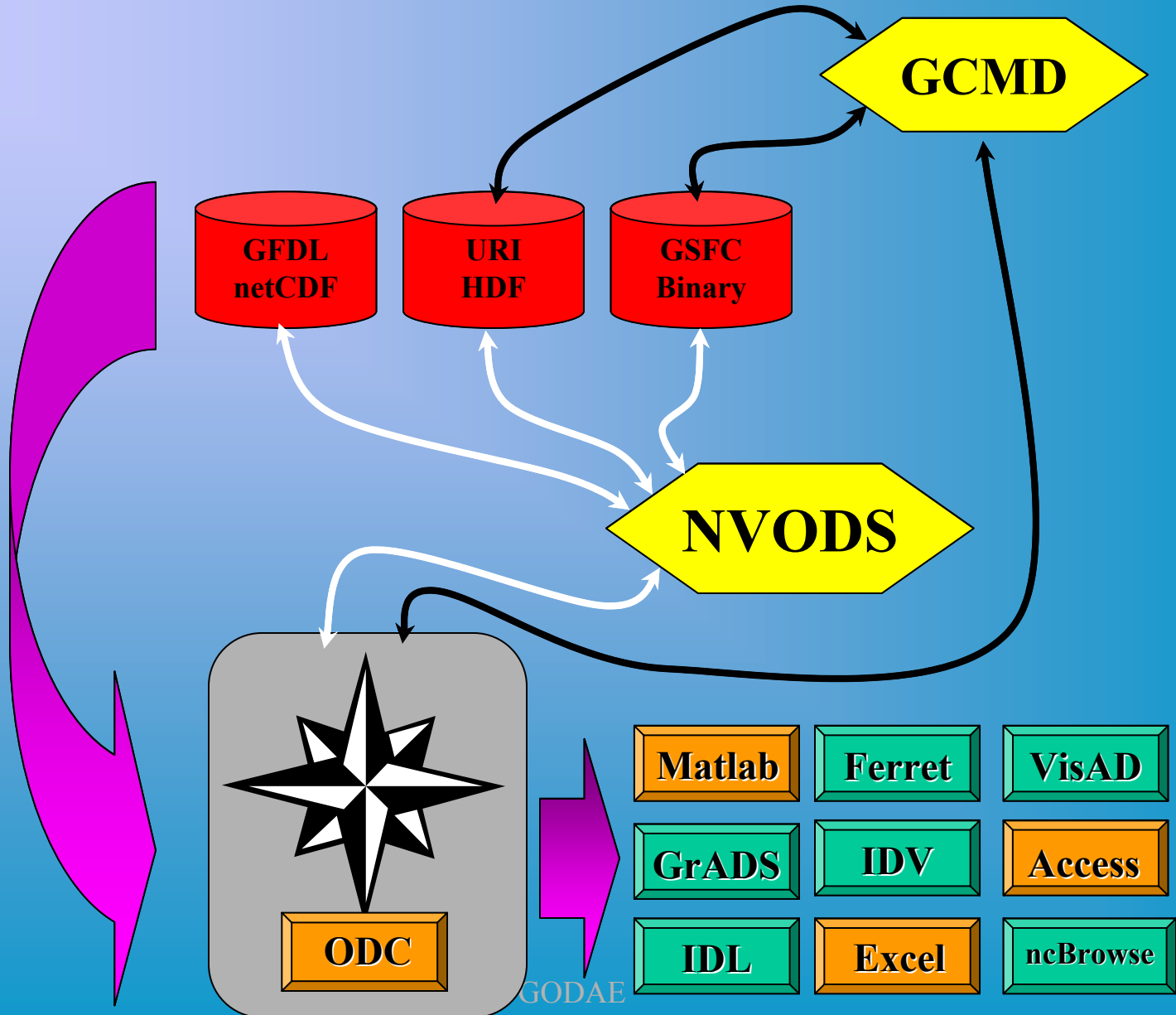
# The OPeNDAP Data Connector

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# A Data System Integrator

OPeNDAP





<http://opendap.org>