

Land Information System: *Complimentary CEOP Satellite Data Integration Activities*

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Research Scientist

Hydrological Sciences Branch, Code 974

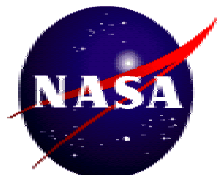
NASA Goddard Space Flight Center (GSFC), Greenbelt, MD

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Land Information System (LIS)

Dr. Christa D. Peters-Lidard





Land Information System

Global Land Modeling & Data Assimilation

<http://lis.gsfc.nasa.gov>

Co-PIs: P. Houser¹, C. Peters-Lidard¹

¹Hydrological Sciences Branch, Code 974
NASA Goddard Space Flight Center (GSFC),
Greenbelt, MD

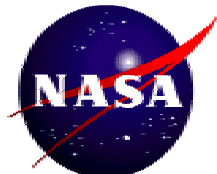
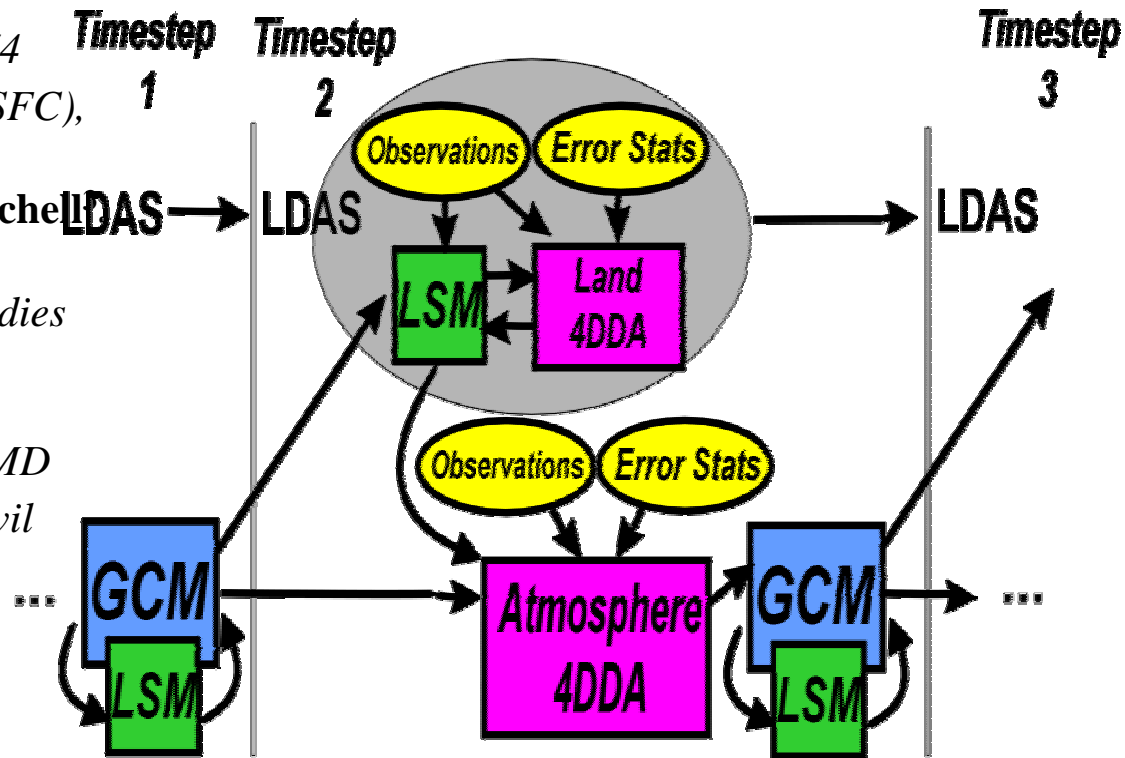
Co-Is: P. Dirmeyer², B. Doty², K. Mitchell³,
E. Wood⁴, S. Denning⁵

²Center for Ocean-Land-Atmosphere Studies
(COLA), Calverton, MD

³National Centers for Environmental
Prediction (NCEP), Camp Springs, MD

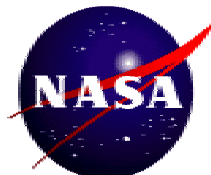
⁴Princeton University, Department of Civil
and Environmental Engineering,
Princeton, NJ

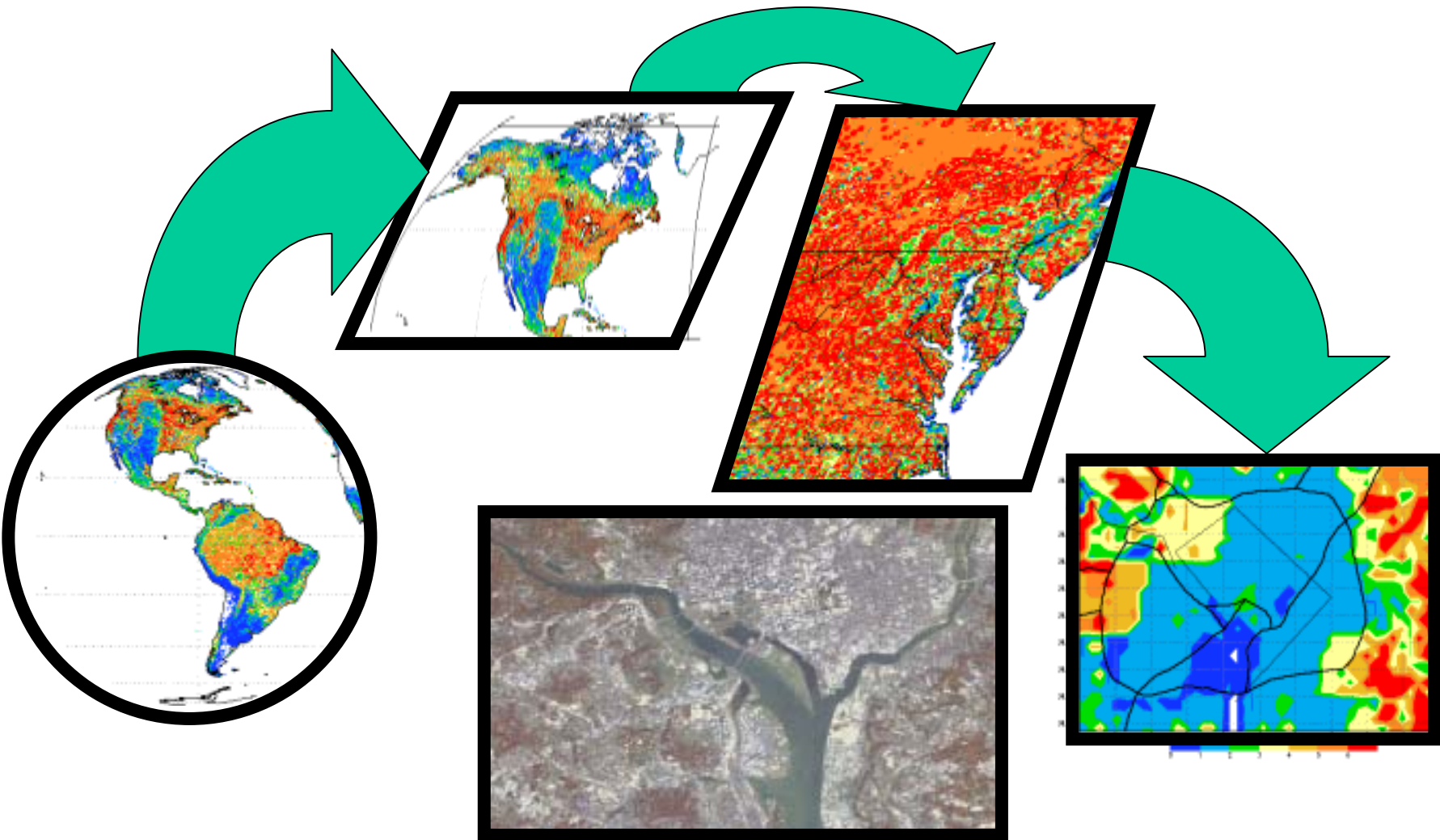
⁵Colorado State University (CSU),
Department of Atmospheric Science,
Fort Collins, CO



When complete, LIS will...

- Operate in near-real-time at a high spatial (**1km**) and temporal (**15 min**) resolution;
- Predict and assimilate global fluxes/stores of:
 - **Water,**
 - **Energy, and**
 - **Carbon**
- Build on 4DDA framework from the Land Data Assimilation System (**LDAS**);
- Exploit HPC technology to obtain high resolutions and maximize interoperability; and
- Demonstrate the developing Earth System Modeling Framework (**ESMF**) for future coupling to climate and/or weather models



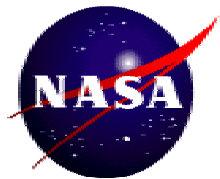


| Resolution | 1/4 deg | 5 km | 1 km |
|---------------------|----------|----------|----------|
| Land Grid Points | 2.43E+05 | 5.73E+06 | 1.44E+08 |
| Disk Space/Day (Gb) | 1 | 28 | 694 |
| Memory (Gb) | 3 | 62 | 1561 |

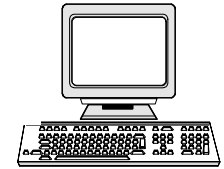


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LIS Design



LIS users

Web-based user interface

GrADS-DODS server

To atmospheric models

ALMA

ESMF

Input

Output

Output data

Data retrieving

Input data

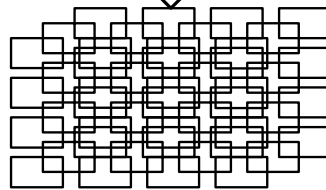
GrADS-DODS server

Parallel computing control

System management interface

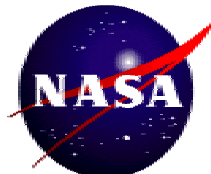
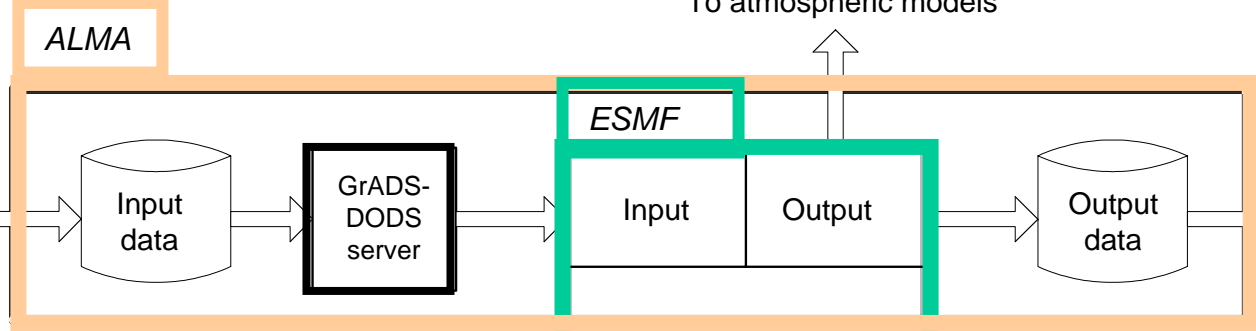
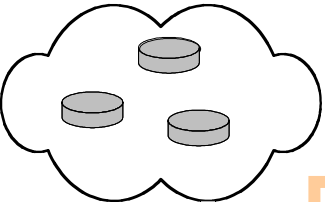
ESMF-compliant Land Surface Modeling
Parallelization scheme

System monitor



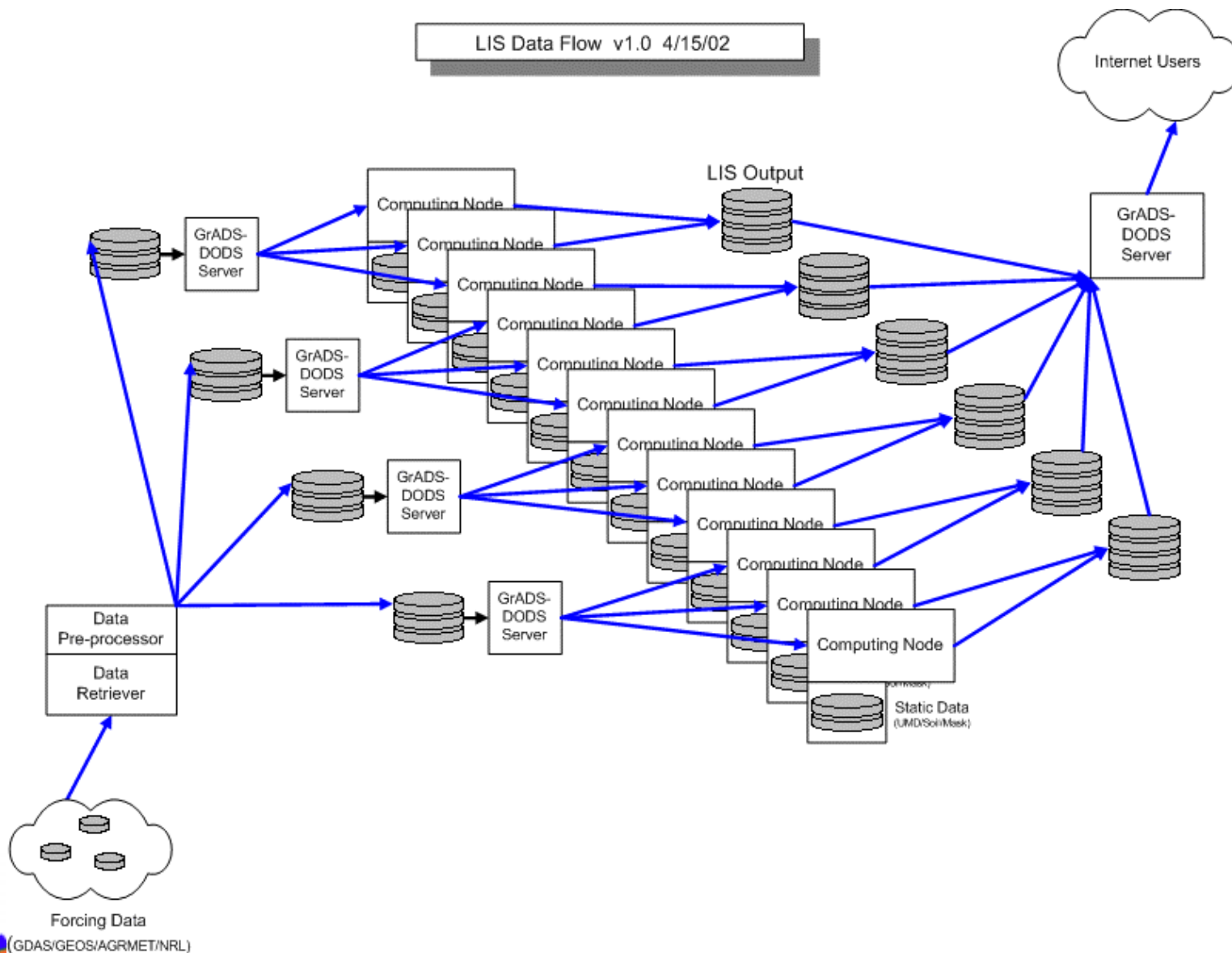
Parallel computing hardware platform
(SGI Origin 3000 or Linux cluster)

Raw data on the Internet



LIS Beowulf Cluster

LIS Data Flow v1.0 4/15/02



Grid Analysis and Display
System (GrADS)

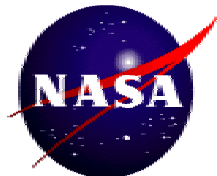
+

Distributed Oceanographic Data
System (DODS)

=

GrADS-DODS Server (GDS)

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



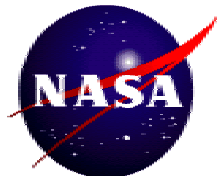
GrADS and DODS

Data Interoperability
Distributed Data
Distributed Analysis



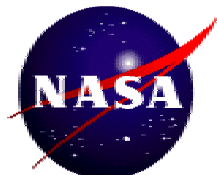
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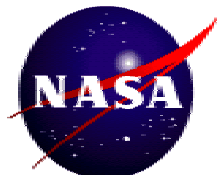
Distributed Oceanographic Data System (DODS)

- **Conceived in 1993 at a workshop held at U. Rhode Island, USA.**
- **Objective was to facilitate access to network-based oceanographic data by making it easier to:**
 - **serve distributed data, and**
 - **analyze distributed data.**



DODS = OPeNDAP + NVODS

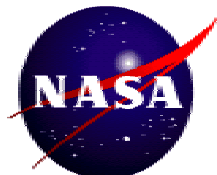
- To isolate the discipline independent part of the system from the discipline specific part, two entities have been formed
 - **Open Source Project for a Network Data Access Protocol (OPeNDAP)**. This the **discipline independent core infrastructure** for data distribution, and
 - **National Virtual Ocean Data System (NVODS)** This is the **discipline specific** portion related to **data** – data population, data location, specialized clients, etc.



DODS and Data Organization

Example: Consider the different ways of organizing a multi-year data set consisting of one global sea surface temperature (SST) field per day:

- **one 2-d file per day $sst(lat,lon)$ - URI**
- **one 3-d file $sst(lon,lat,time)$ - PMEL**
- **one file per year with one variable per day $\Rightarrow 365$ variables per file, n files for n year - GSFC**



GrADS-DODS Server (GDS)

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

Joe Wielgosz, Brian Doty,
James Gallagher, Daniel Halloway

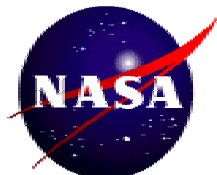
GrADS

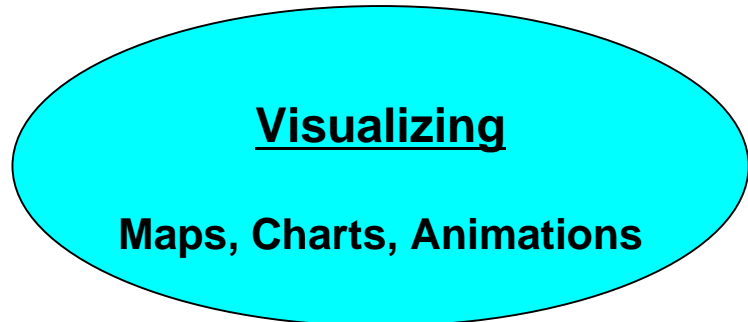
Jennifer Adams, Reinhard Budich, Luigi Calori, Brian Doty,
Wesley Ebisuzaki, Mike Fiorino, Tom Holt, Don Hooper, Jim Kinter,
Steve Lord, Gary Love, Karin Meier, Matt Munnich,
Uwe Schulzweida, Arlindo da Silva, Michael Timlin,
Pedro Tsai, Brian Wilkinson, Katja Winger



Land Information System (LIS)

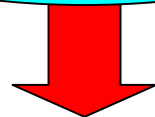
Dr. Christa D. Peters-Lidard



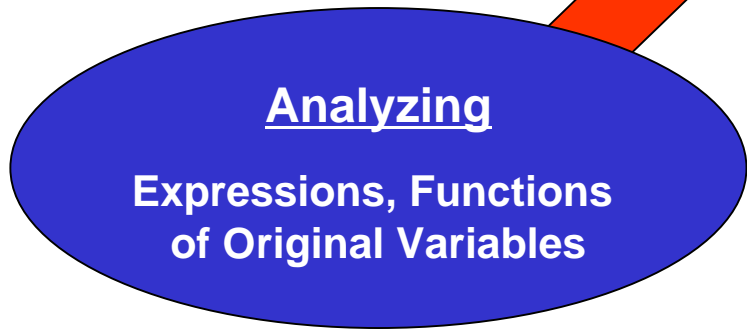


Interactive

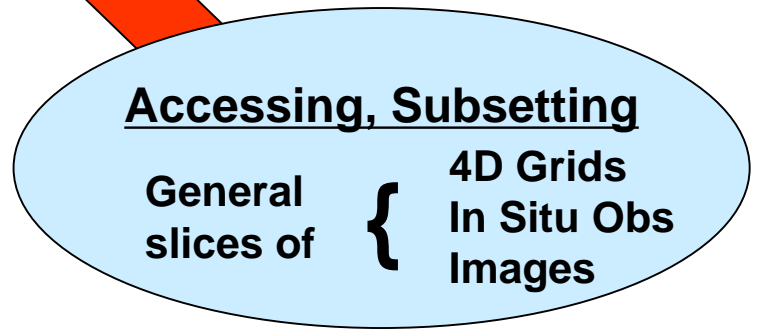
Quantitative



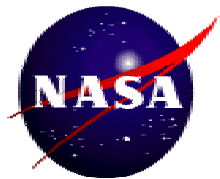
**INTEGRATED
USER INTERFACE**



User Definable,
Extensible

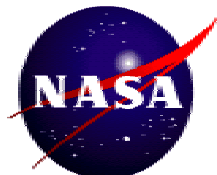


Arbitrary Domains
Optimized for Typical Queries



GrADS Usage

- **“Natural” user interface for scientific computations, and graphical production**
 - Used at over 100 laboratories worldwide
 - Used by over 1000 scientists worldwide
 - E.g., J. Climate - Over ½ of all figures (and computations?) produced using GrADS
- **Handles GRIB, binary (model output) formats in “native” mode**
 - Widely used for analysis and display of data from the National Weather Service, other WMO sources



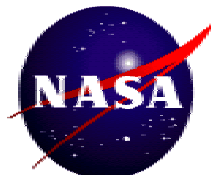
GrADS Analysis Model

**ENABLES VERY SOPHISTICATED ANALYSIS TASKS
IN A HIGHLY ENCAPSULATED WAY**

Scientists only need to specify:

- dimension constraint
- list of data sets
- GrADS expression

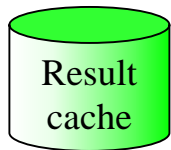
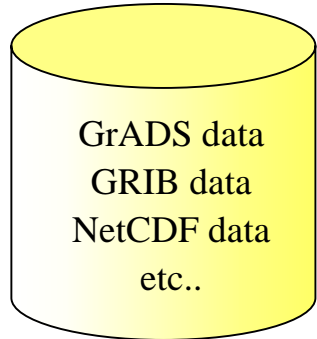
This unique, innovative approach to geophysical data analysis is the major reason for GrADS' popularity.



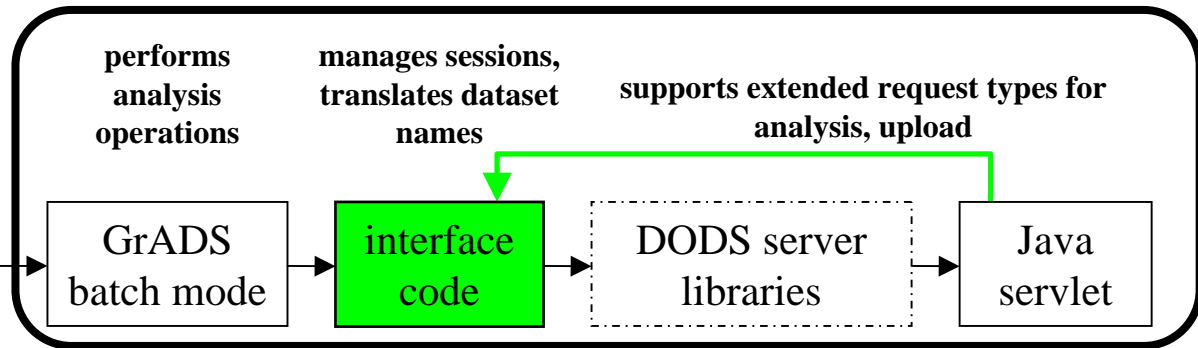
GrADS-DODS Analysis Server

Server

datasets in any format supported by GrADS



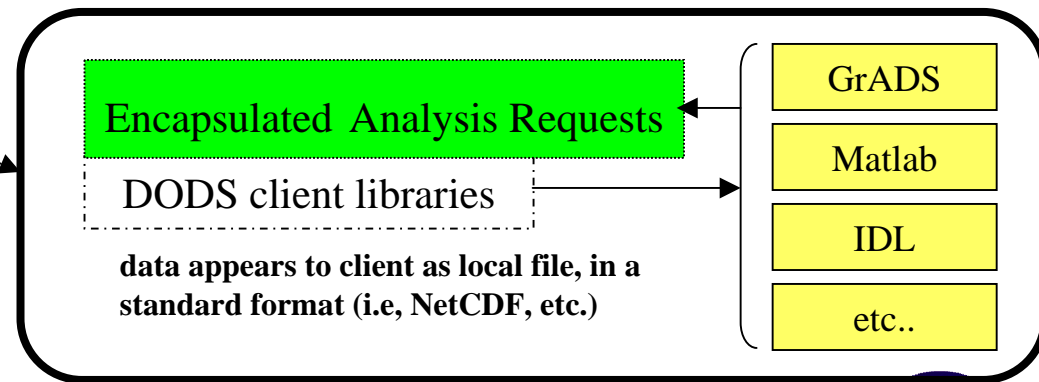
holds temporary data (uploaded, generated by a previous operation, or transferred directly from another server) for use in remote analysis



internet

DODS data and requests

Client



Joe Wielgosz: 5/25/00

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Data Access/Interoperability/Analysis

- **Level 0:** FTP & basic Web capability.
- **Level 1:** DODS server concept: general data subsetting; metadata. Client can support **data interoperability**.
- **Level 2:** Analysis server. Uses GrADS unique encapsulated analysis capability.

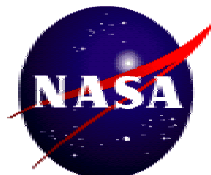
Example:

Calculate – at the server! – sea level pressure anomaly over N. America when tropical Pacific SSTA > 1.0. Return the result – as data ! – to the desktop.

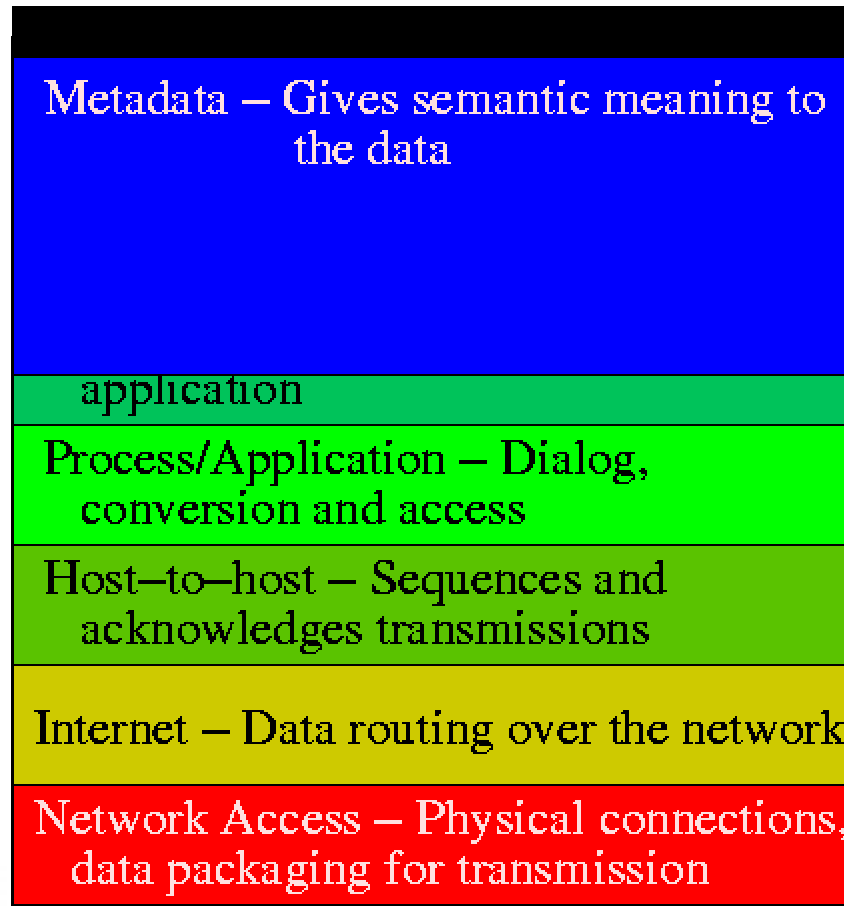
Size of data sets: 3GB (Level 0)

Data processed at server: 5 MB (Level 1)

Returned to client: 10KB (Level 2)



Layers of Interoperability

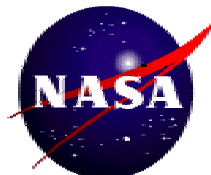


← { **Machine-to-machine Interoperability with semantic meaning.**

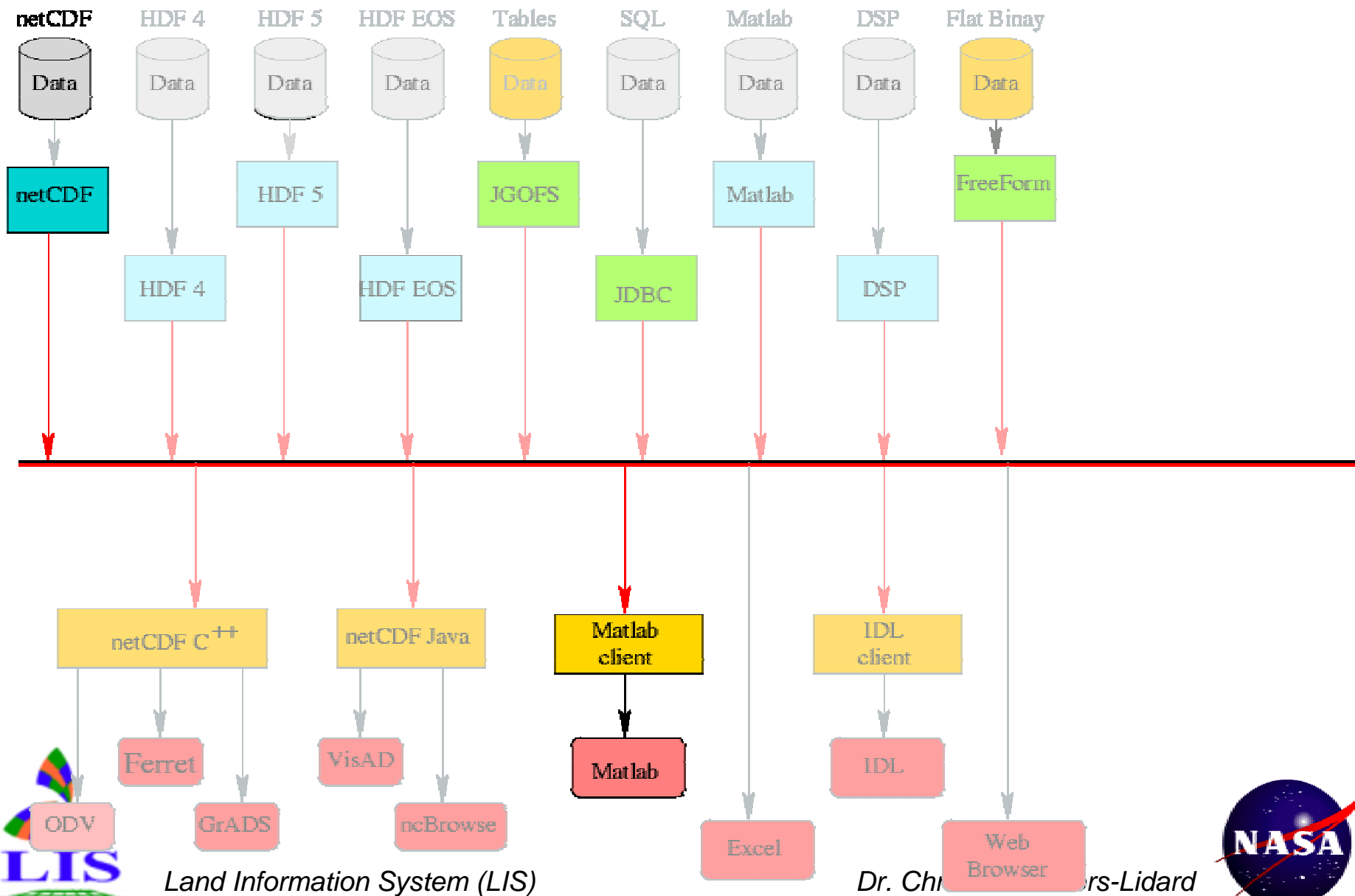
Aggregation

OPeNDAP2

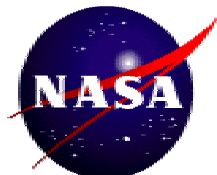
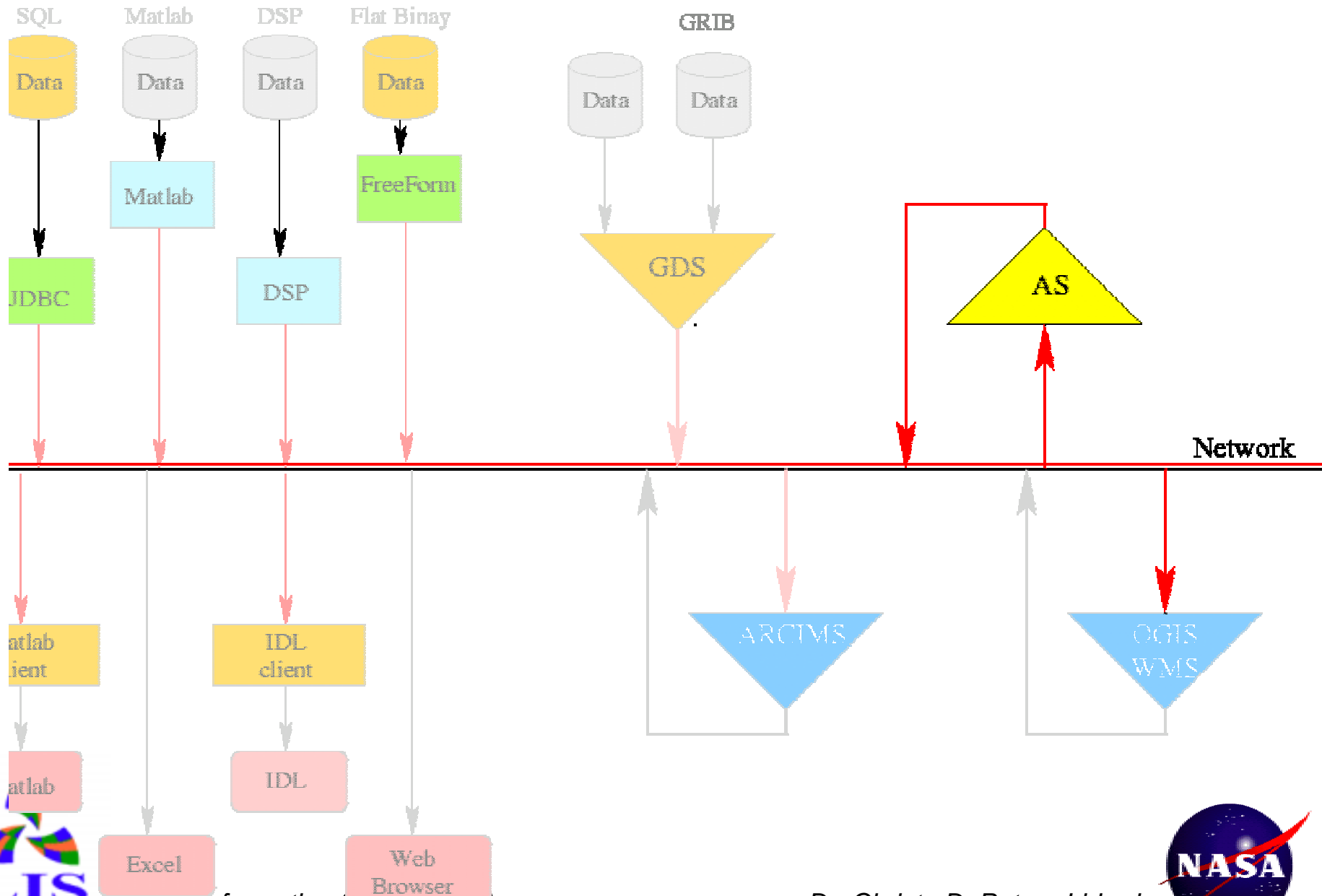
TCP/IP



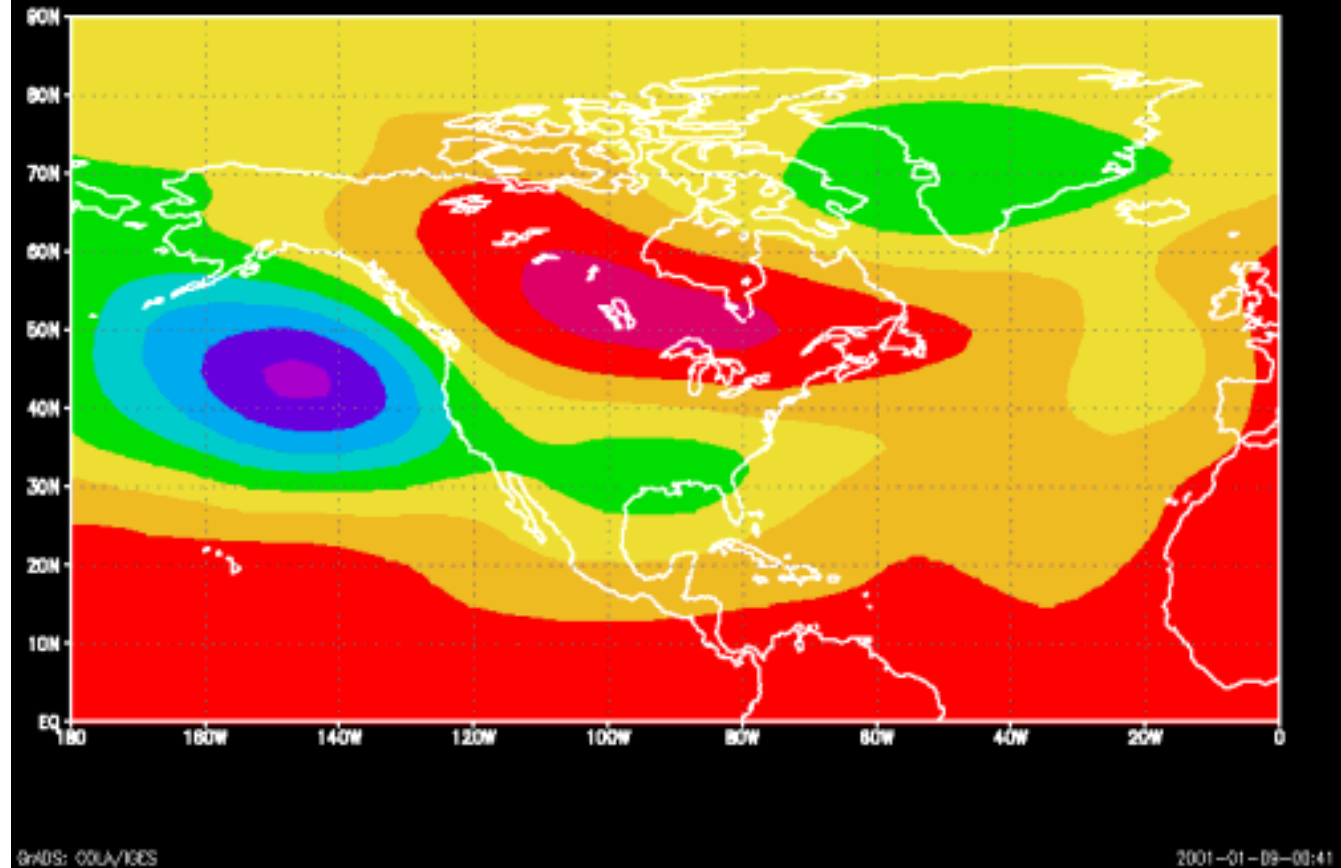
DODS Client and Server Status



Special Servers



Example: Analysis at the Server



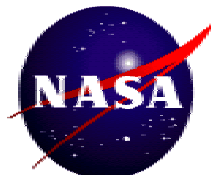
`sdfopen`

```
http://cola8.iges.org:9090/dods/_expr_{ssta,z5a}  
  {tmave(maskout(aave(...  ){-180:0,0:90,500:500,  
    jan1950,dec1990})
```

```
set gxout shaded  
display result
```

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Data Interoperability

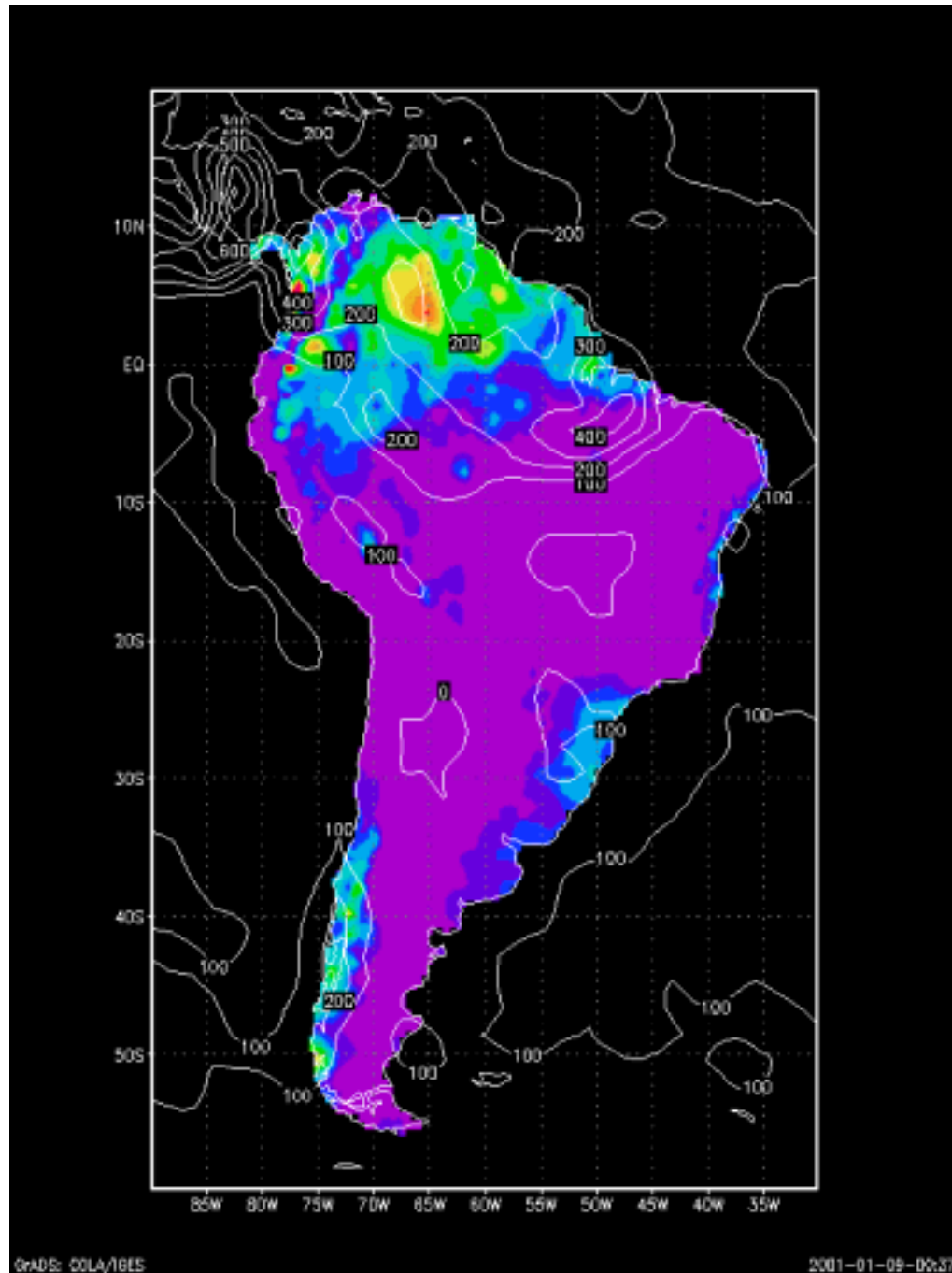
Example:

Data from two Servers

```
sdfopen http://cola8...  
set gxout shaded  
set time jul1980  
d p  
sdfopen http://cdc...  
set gxout contour  
d prate.2*86400*31
```

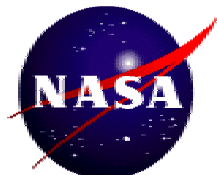


Land Information System (LIS)



Summary: GrADS-DODS Server

- **Share data:** Enterprise-wide; Internet-wide --- data-format independent
- **Data interoperability:** Consistent metadata for many data types
- **Distributed analysis:** Reduces network load; improves interactivity
- **Automation of analysis techniques:** Analysis techniques can be captured in the form of scripts and provided on server and/or client



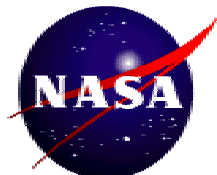
DODS Status



- **Current DODS Sites**
- **Future NOPP-DODS Sites**

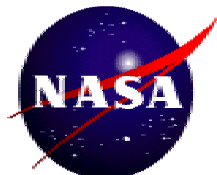
Some DODS Servers

- **ARCAS (ACACIA Regional Climate Data Access System)**
 - <http://dataserver.ucar.edu/cgi-bin/dods/nph-nc/dods/acacia/>
- **VEMAP (The Vegetation/Ecosystem Modeling and Analysis Project)**
 - <http://dataserver.ucar.edu/cgi-bin/dods/nph-nc/dods/vemap/>
- **TIME-GCM (Thermosphere/Ionosphere/Mesosphere Electrodynamic General Circulation Model)**
 - <http://dataserver.ucar.edu/cgi-bin/dods/nph-nc/dods/time-gcm/>



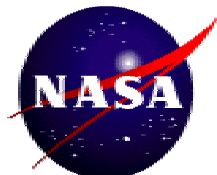
Some DODS Servers

- **NASA Goddard Space Flight Center
Distributed Active Archive Center (DAAC)**
➤ <http://daac.gsfc.nasa.gov/dods/>
- **NOMADS (NOAA Operational Model Archive and
Distribution System)**
➤ <http://nomads.gfdl.noaa.gov>



NOMADS

- **NOMADS (NOAA Operational Model Archive and Distribution System)**
 - <http://nomads.gfdl.noaa.gov>
- **NOMADS Software Infrastructure**
 - **Distributed Oceanographic Data System (DODS) package from Unidata/ UCAR**
 - **Grid Analysis and Display System - DODS Server (GDS) package from COLA/ IGES**
 - **Live Access Server (LAS) package from PMEL/ NOAA**



DODS and NOMADS Demo

- **NASA LIS GrADS/DODS Server**
 - <http://lis.gsfc.nasa.gov>
- **NASA LIS GrADS/DODS Server Interface**
 - http://lshp.gsfc.nasa.gov/lis/test_runs/demo/test.html
- **NASA Goddard Space Flight Center
Distributed Active Archive Center (DAAC)**
 - <http://daac.gsfc.nasa.gov/dods/>
 - <http://daac.gsfc.nasa.gov/las/>
- **NOMADS (NOAA Operational Model Archive and
Distribution System)**
 - <http://nomads.gfdl.noaa.gov>

