



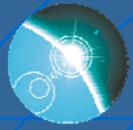
unidata



# Unidata: A Program of the Community, by the Community, and for the Community

National Weather Center Seminar  
University of Oklahoma  
Norman  
11 September 2007

Dr. Mohan Ramamurthy  
Director, Unidata  
University Corporation for Atmospheric Research  
Boulder, CO

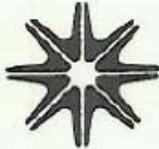


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# Unidata: Created Through A Grass-roots Effort



Conceived at a 1983 grass-roots workshop;  
Funded primarily by NSF/ATM UCAR and Lower  
Atmospheric Facilities Section;



## UCAR

University Corporation for Atmospheric Research  
P.O. Box 3000, Boulder, CO 80307  
Tel: (303) 497-1996

dent

16 July 1984

Dr. Richard E. Greenfield  
Atmospheric Sciences Division  
National Science Foundation  
1800 G Street, N.W.  
Washington, D.C. 20550

Dear Dick,

Enclosed are eight copies of our revised UNIDATA proposal,  
and also a memorandum from Stan Ruttenberg explaining how the  
reviewers' comments were used in the revision. If you think it  
would serve a useful purpose to send this explanation to your  
reviewers, feel free to do so.

Alabama  
Alaska  
Arizona  
Arkansas  
California  
Colorado  
Connecticut  
Delaware  
Florida  
Georgia  
Hawaii  
Idaho  
Illinois  
Indiana  
Iowa  
Kansas  
Kentucky  
Louisiana  
Maine  
Maryland  
Massachusetts  
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Oklahoma  
Oregon  
Pennsylvania  
Rhode Island  
South Carolina  
South Dakota  
Tennessee  
Texas  
Utah  
Vermont  
Virginia  
Washington  
West Virginia  
Wisconsin  
Wyoming



# Unidata: A Benevolent For Academia

**BASF**



- We don't do science, but we empower scientists
- We don't teach students, but we facilitate education and learning
- And so on...





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# Unidata in a Nutshell



We

*Facilitate data access*

*Provide tools for data access, management, analysis and visualization*

*Provide comprehensive support*

*Engage in community building and advocacy*

Although the principal focus of our activities is on real-time weather data provision, Unidata develops tools, middleware, and services that contribute to broader cyberinfrastructure needs of the geosciences community.

Our most widely used software, netCDF, is used in over 70 countries and it has been incorporated into 50 open source software packages and 15 commercial packages.





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# An Independent Assessment



- ❖ Earlier this year, we completed an independent Metrics and Assessment study on Unidata's impact on education and research in the community;
- ❖ The study included many components and looked at many aspects of Unidata

- Unidata has been truly transformational and is irreplaceable
- Unidata is a model facility for other communities like hydrology to develop



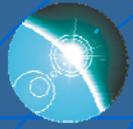
*NELSON CONSULTING, LLC*

Measure Performance and Maximize Productivity

UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

The Metrics Assessment of the Unidata Program

Final Report

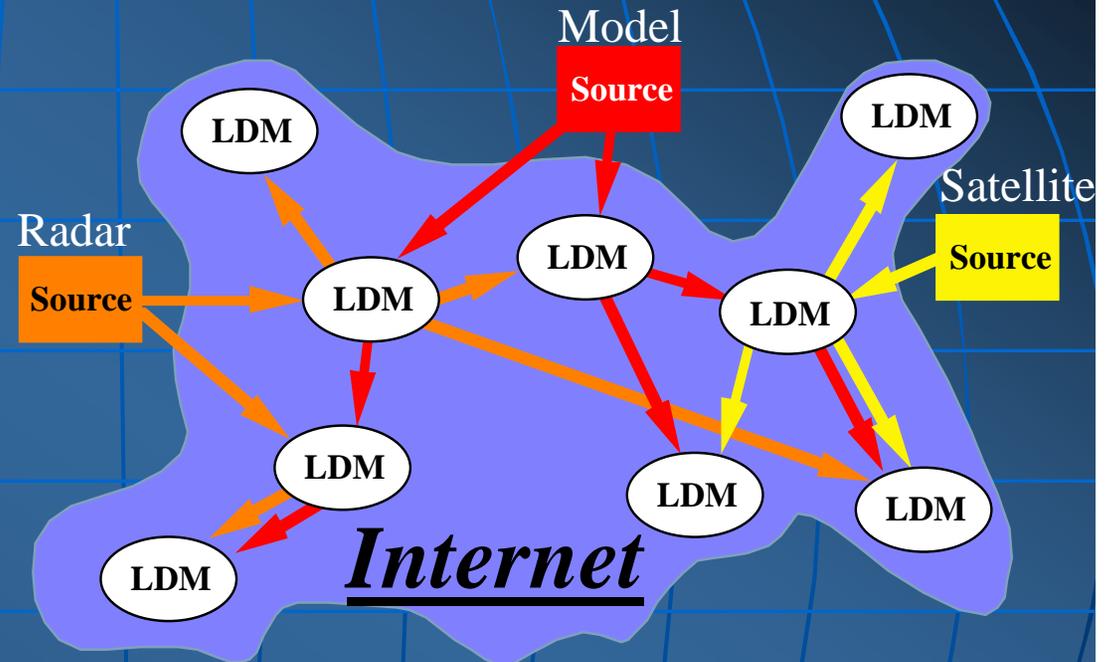


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# Internet Data Distribution



- Over 250 sites worldwide are participating in Unidata Internet Data Distribution (IDD) system
- Data ingested is about 12-13 GB/hour, but in bursts it is up to 23 GB/hour
- The LDM uses more of the Internet2 bandwidth than any other *advanced application* (18-20 TB/week)



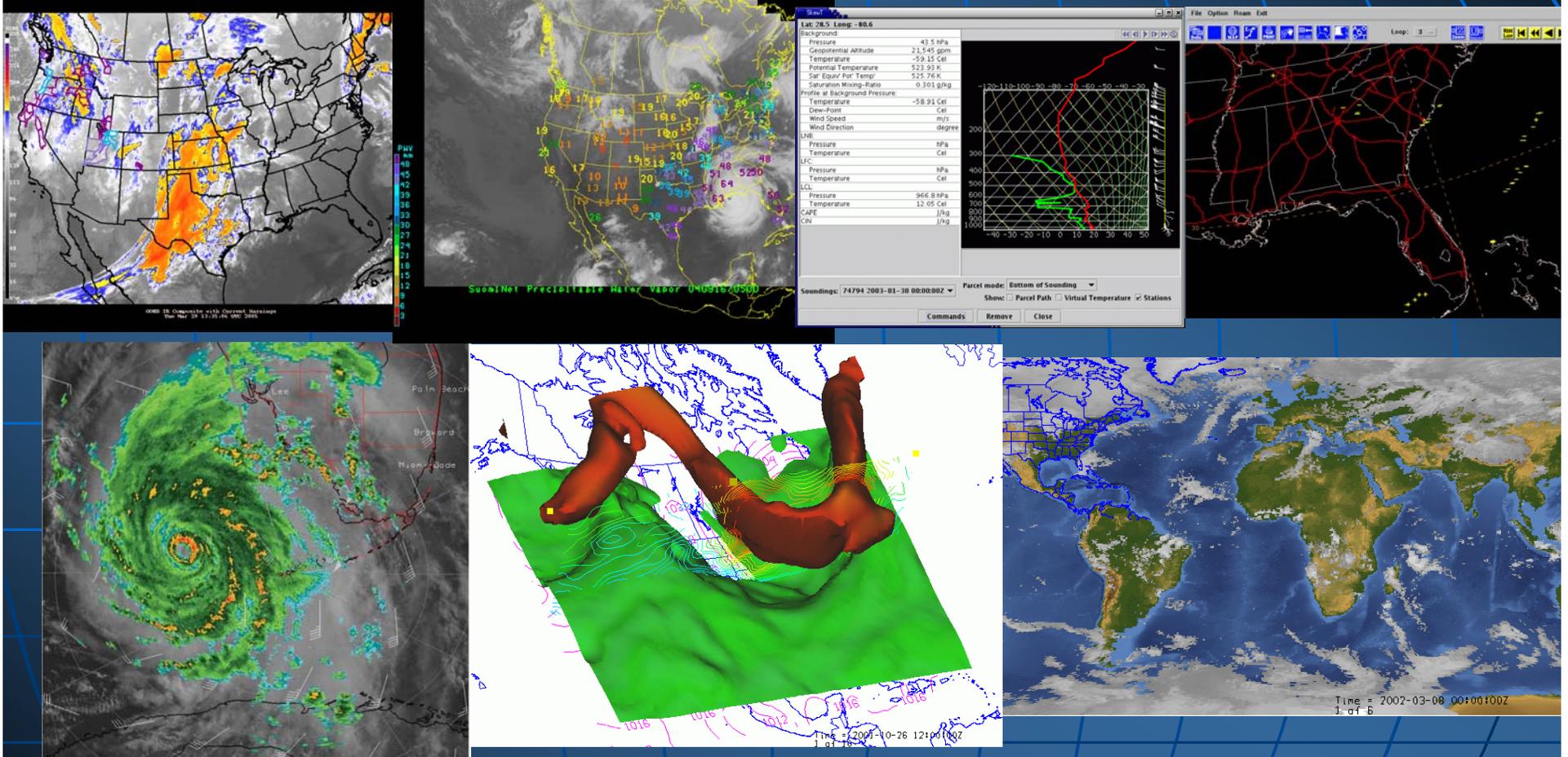
The LDM is now ranked #3 (behind HTTP and SSH) in Internet 2 usage.

For most people, Unidata is like a utility! Data flows 24x7 and students and faculty use it without knowing much about Unidata.



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# Real-time Data Examples



We provide over 30 data streams (surface & upper-air obs., radar, satellite imagery, model output, lightning data, ACARS, NWS bulletins, etc.)

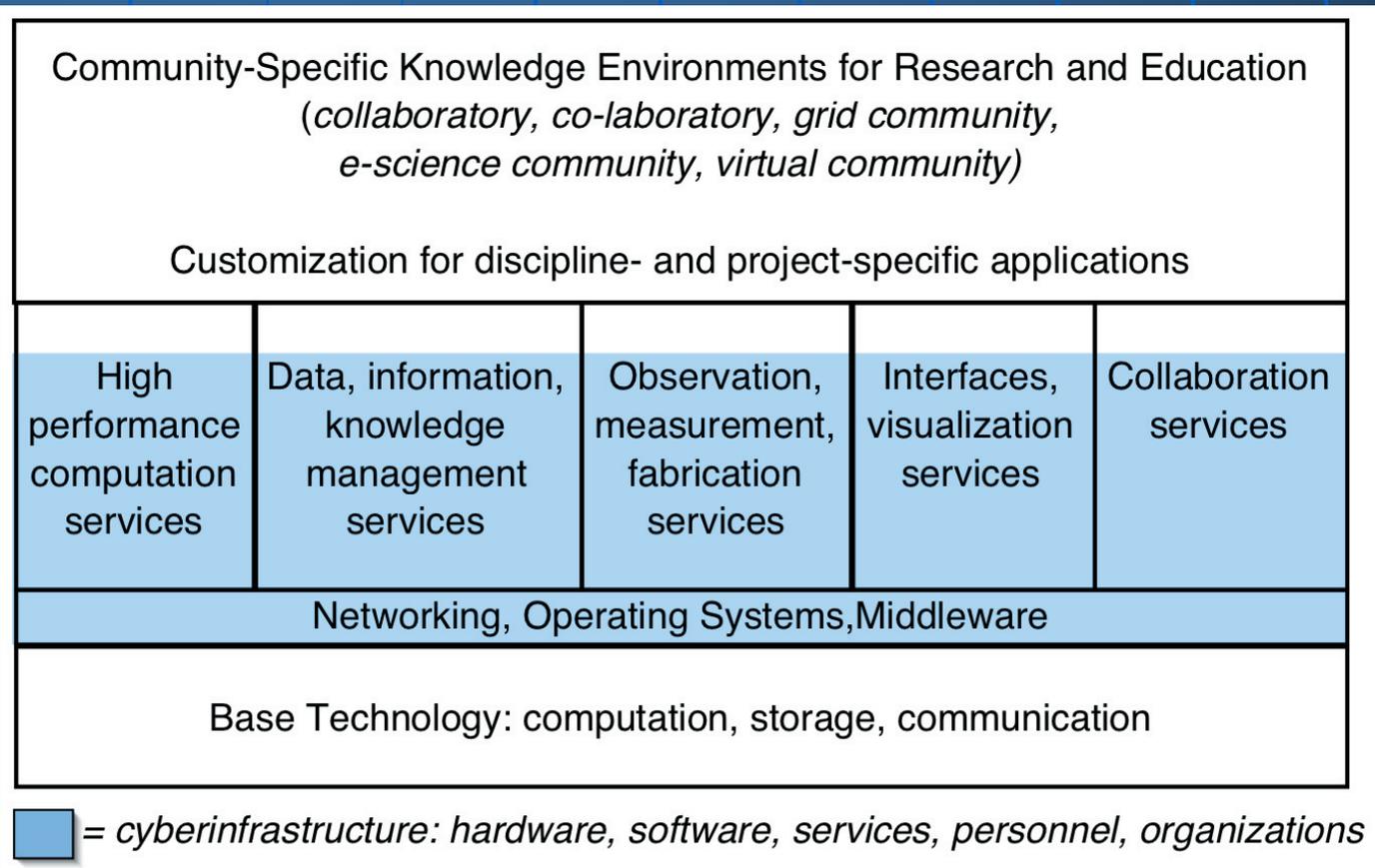


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# Cyberinfrastructure



Working definition: an integrated system of interconnected computation/communication/information elements that supports a range of applications



Cyberinfrastructure is the means; "e-Science" is the result

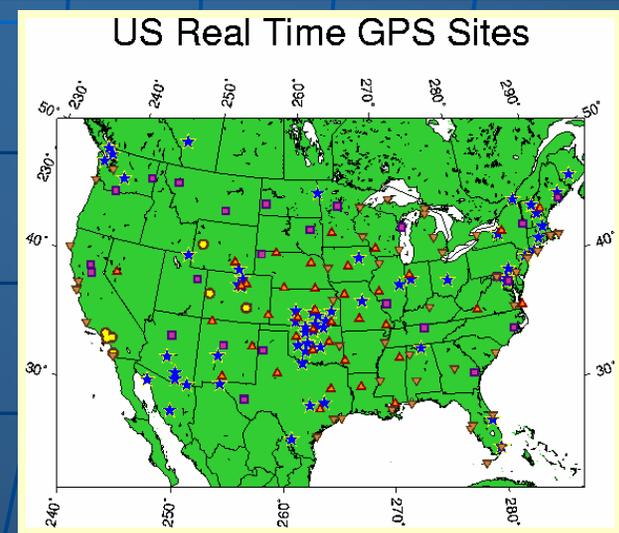
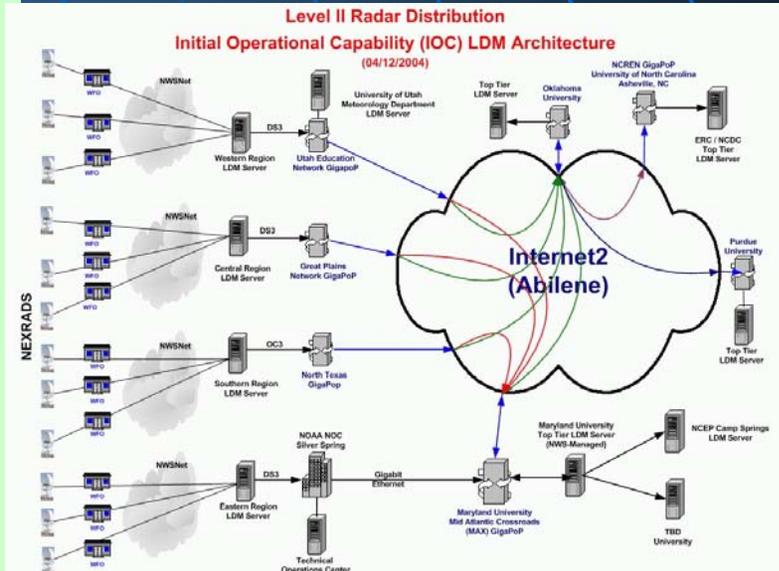


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# Unidata & Cyberinfrastructure



- Unidata's niche is in developing tools, middleware and services for data access;
- We facilitate data access and visualization on low-cost computers, lowering the barrier for entry;
- Focus is on developing hardened solutions that work;
- Core belief in the advantages of open source development;
- Software development grounded on open standards;





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# NetCDF & IPCC Assessment



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



IPCC web sites

About IPCC

Activities

Calendar of Events

## "Climate Change 2007"

The IPCC 4th Assessment Report  
Click to activate and use this control  
is coming out

A comprehensive and rigorous picture  
of the global present state of knowledge

The Physical Science Basis of Climate  
Change the first volume of the new  
IPCC assessment report, has been  
released in Paris, 2 February 2007

## Requirements for IPCC Standard Output Contributed to the PCMDI Archive

### Data format, data structure, and file composition requirements:

- Data must be written through the [netCDF](#) <sup>[4]</sup> API (application program interface) and conform to the [CF metadata standards](#) <sup>[5]</sup>.

Ray Pierrehumbert, noted climate scientist from the University of Chicago: "I think one mustn't discount a breakthrough of a technological sort in AR4 though: The number of model runs exploring more of scenario and parameter space is vastly increased, and more importantly, it is available in a coherent archive to the full research community for the first time. The amount of good science that will be done with this archive in the next several years is likely to have a significant impact on our understanding of climate. --raypierre



# Principal Drivers Shaping Unidata's Work



- Science
- Education
- Technology
- Social & Organizational Evolution



**What does the community need from Unidata?**

**What is our niche and what are our core competencies?**



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# Science Drivers



- Environmental problems like global change & water cycle transcend disciplinary as well as geographic boundaries, requiring multidisciplinary approaches and global teams for solving them;
- Rapid advances in observational technologies, especially in remote sensing;
- Increasing use of complex, coupled modeling systems;

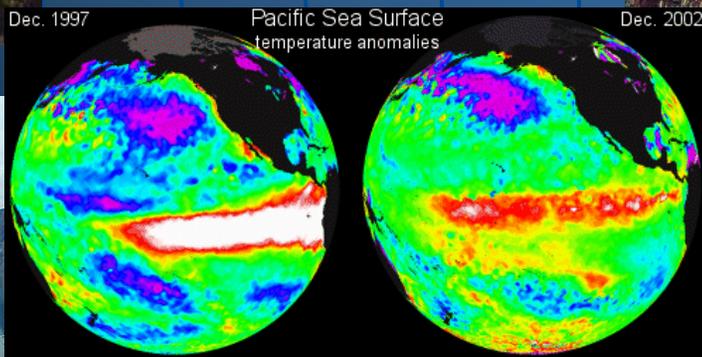
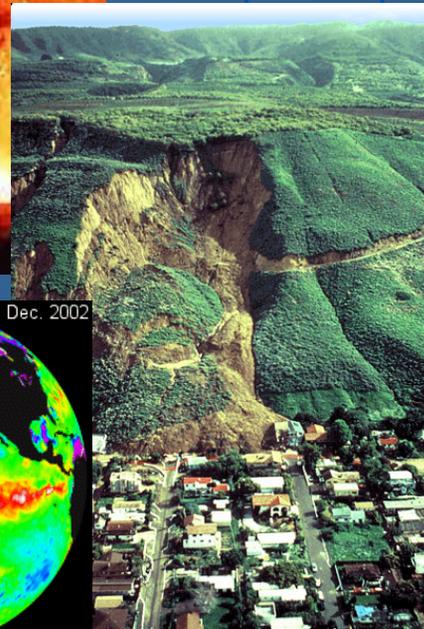
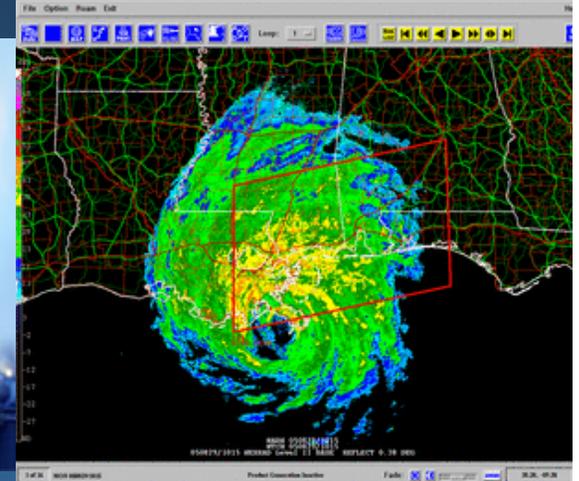


Research studies on societal impact of hurricane-related flooding involve integrating data from atmospheric sciences, oceanography, hydrology, geology, geography, and social sciences.



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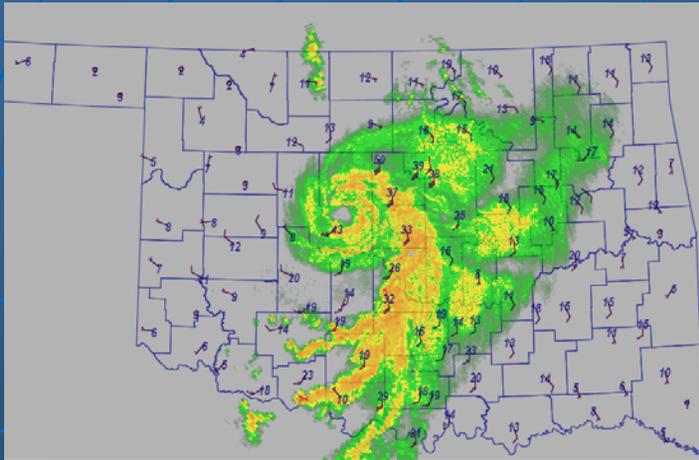
# Science Drivers: Examples





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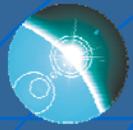
# Societal Impact



Some of the most challenging problems in the geosciences are at the interface of disciplines



**About 2/3rd of Unidata sites have users outside of the atmospheric sciences.**



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# Evolution in Academia



UNIVERSITY of WISCONSIN **MADISON**  
**Atmospheric & Oceanic Sciences**

Teaching and learning about the natural environment.

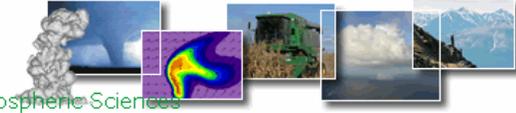
UCLA | Department of Atmospheric and Oceanic Sciences



Home Info Ugrads Grads Research People Contact

**PURDUE**  
UNIVERSITY

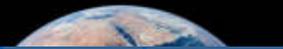
College of Science  
Department of Earth & Atmospheric Sciences



UNIVERSITY AT ALBANY

State University of New York

Welcome to the **D**EPARTMENT OF **E**ARTH  
AND **A**TMOSPHERIC **S**CIENCES



IOWA STATE UNIVERSITY

INDEX A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

E-Mail/Phones | ISU Search

College of Liberal Arts and Sciences

Department of Geological and Atmospheric Sciences

Rutgers

Department of Environmental Sciences



UNIVERSITY OF MARYLAND



DEPARTMENT OF  
ATMOSPHERIC &  
OCEANIC SCIENCE



Cornell University  
Earth and Atmospheric Sciences

These days, few traditional meteorology programs exist. **There are notable exceptions, including here at OU, FSU, and Penn State.**

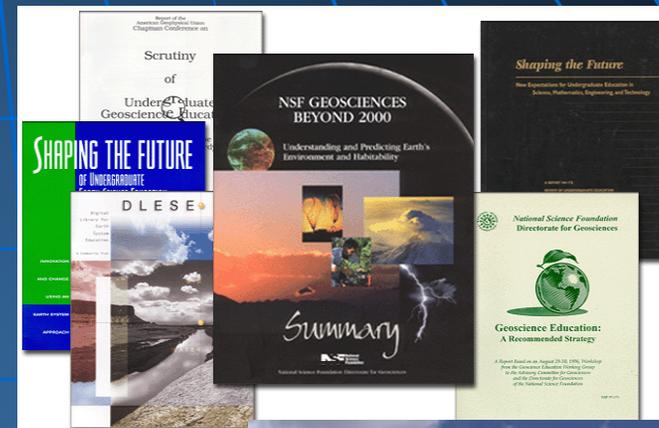


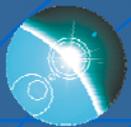
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# Education Drivers



- A “holistic” Earth-system science approach to education
- Active, student-centered learning. i.e., learning science by doing science
  - Observations
  - Tools (models, visualization)
  - Discovery



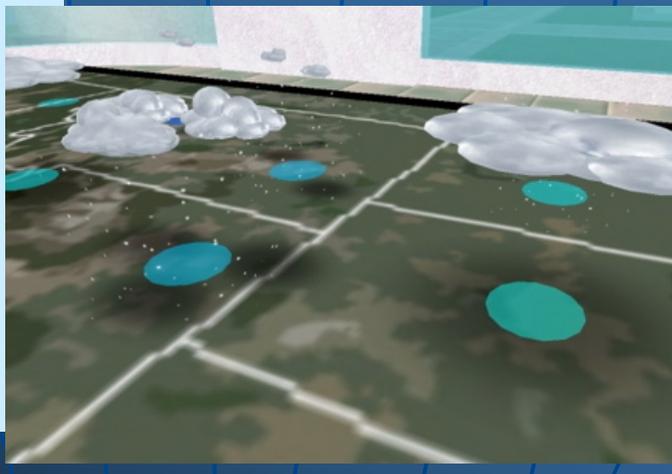
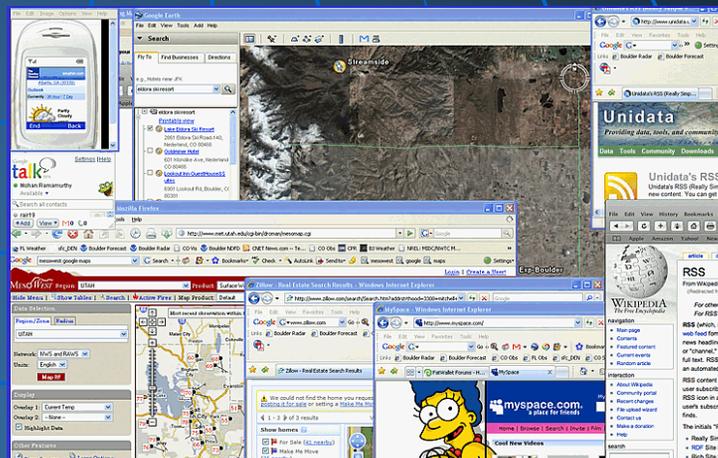


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# Technology Trends



- Internet & the World Wide Web
- Multi-core processors
- Object-oriented programming
- Open standards
- Web services and Web 2.0
- Global, high-bandwidth and wireless networks
- Digital libraries
- Virtual organizations
- Grid computing/e-Science
- Social networks
- Blogs
- Podcasts
- GIS

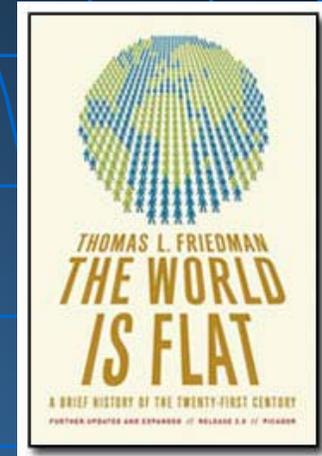




# Globalization and Networked Science



- Opportunities for individual empowerment
- Lightning swift advances in technology and communications, putting people all over the globe in touch with one another
- Distributed knowledge communities working collaboratively in virtual organizations
- Networked science tackling problems never possible before and creating new knowledge (e.g. IPCC assessments of climate change – the gold standard)



THE CHRONICLE OF HIGHER EDUCATION

*Information Technology*

**Cyberinfrastructure: the Second Revolution**

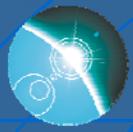
By ARDEN L. BEMENT

*The Chronicle Review*

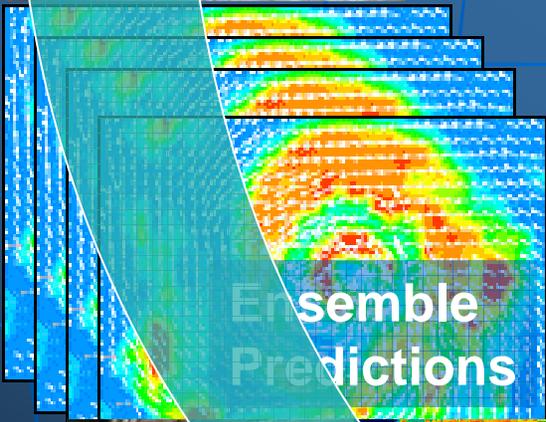
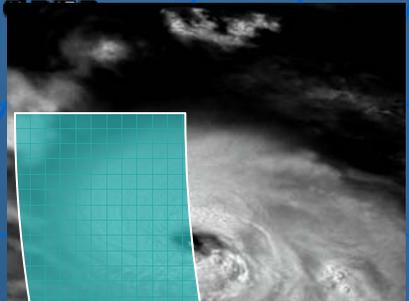
**The Dawn of Networked Science**

By DIANA RHOTEN

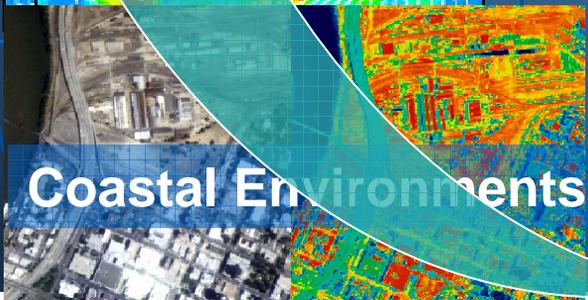




# Need for End to End Information Services

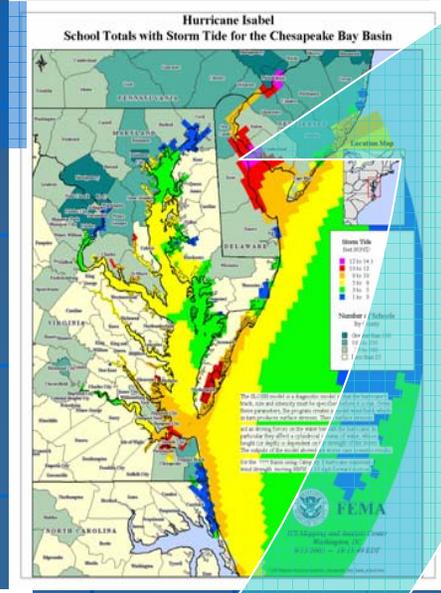


Ensemble Predictions



Coastal Environments

GIS Integration



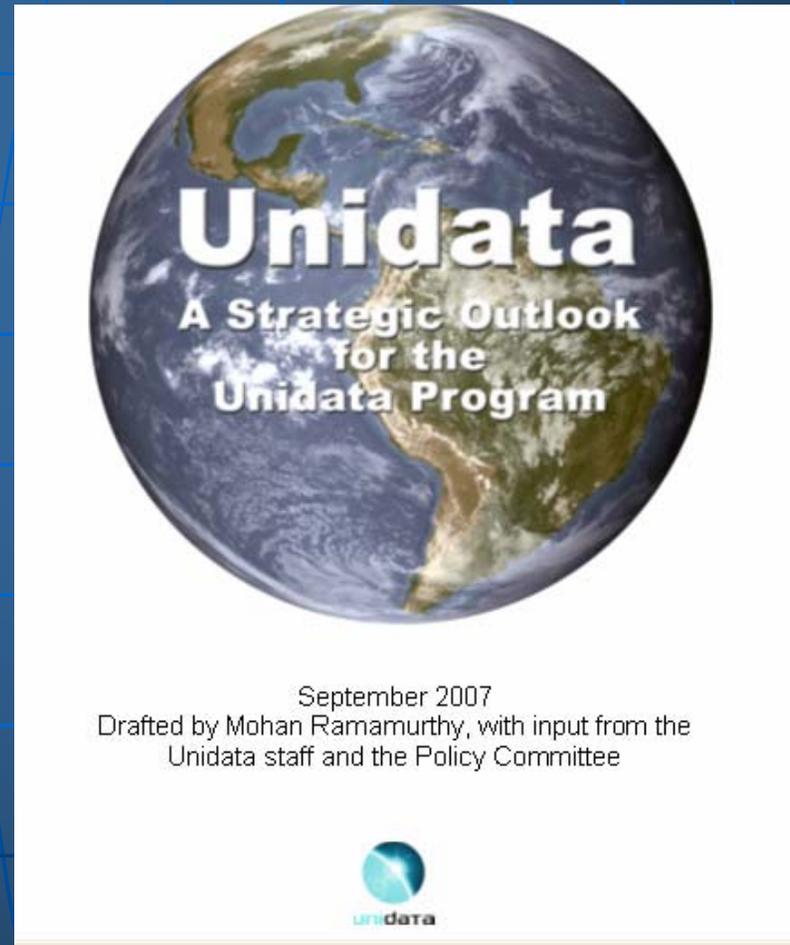
Emergency Response



Need integrated services



# Unidata Strategic Plan



We have just developed a new Strategic Plan for Unidata, to be released to the community next week.



# Mission & Vision



**Mission:** To provide the data services, tools, and cyberinfrastructure leadership that advance Earth system science, enhance educational opportunities, and broaden participation.

**Vision:** Unidata is the premier provider of seamless and comprehensive data services that help solve complex environmental problems facing science and society.

- *Implicit in this vision is recognition that Unidata will provide a broad array of end-to-end and well-integrated data services and contribute cyberinfrastructure that benefits a **broader Earth system science community**.*
- *We align our mission and goals with those of the NSF, our primary sponsor.*
- *Our goals are congruent with national and **community priorities**, and will be anchored by the evolving **community's needs** and the program's core competencies.*

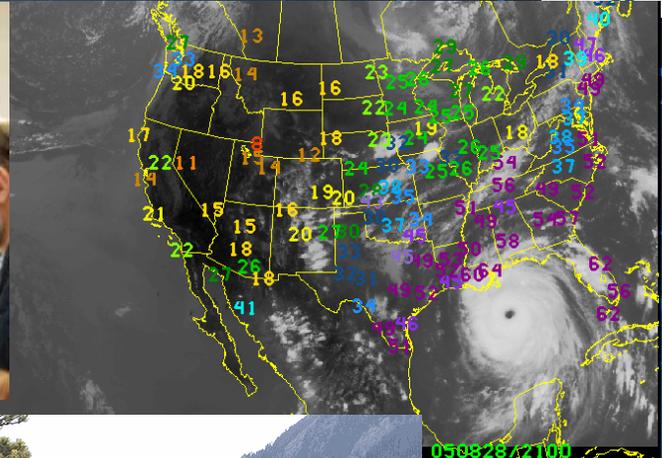


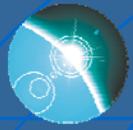
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# Strategic Focus Areas



- ◆ Community
- ◆ Data Services
- ◆ Tools
- ◆ Communication and Support
- ◆ Cyberinfrastructure Leadership
- ◆ Diversity



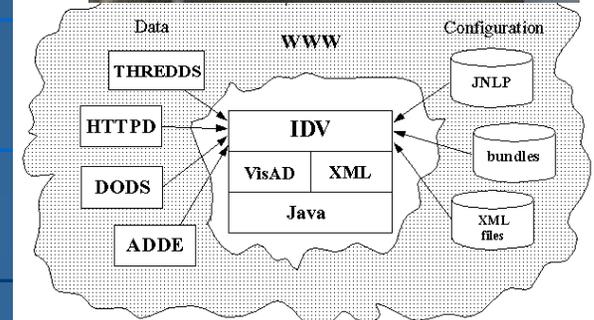
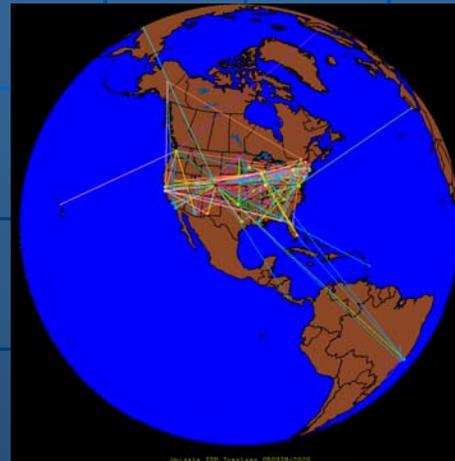


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# Data Services Will Need to Provide Multiple Access Methods

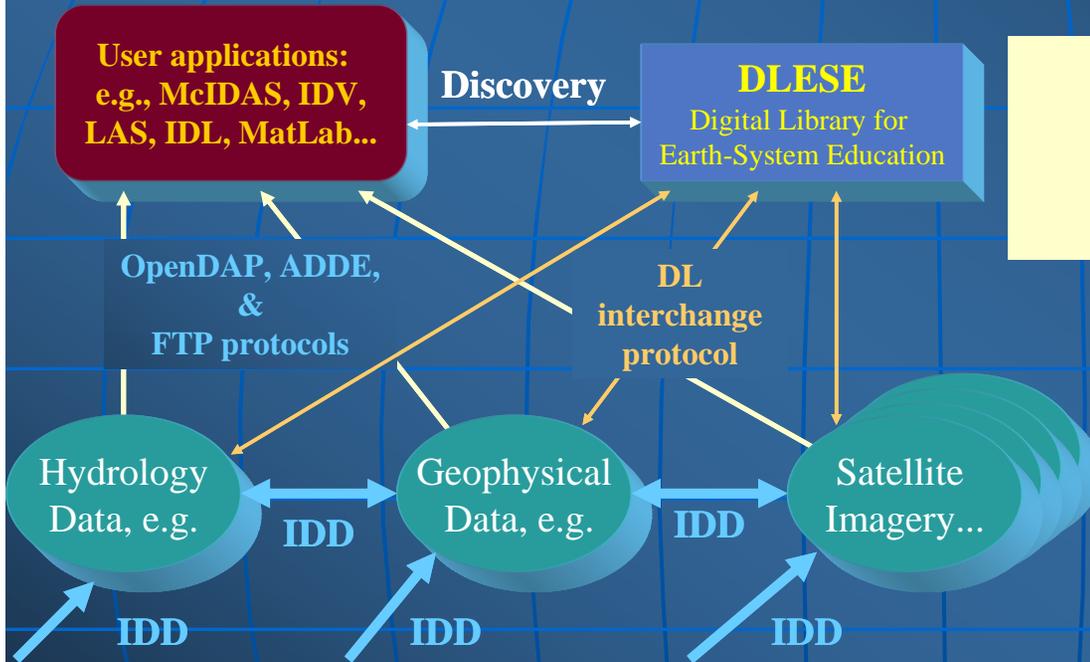


- Given the very high data rates from each GOES-R satellite, the university community will need a hybrid solution that couples a satellite-based reception system with a terrestrial, Internet-based data access system
- Both local and remote data access mechanisms will be required



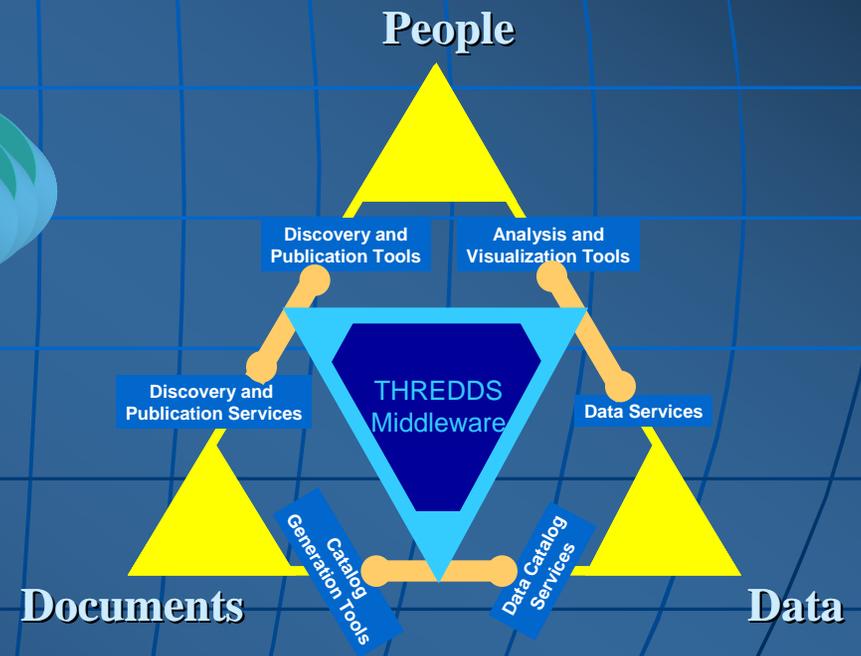


# Thematic Real-time Environmental Distributed Data Servers (THREDDS)



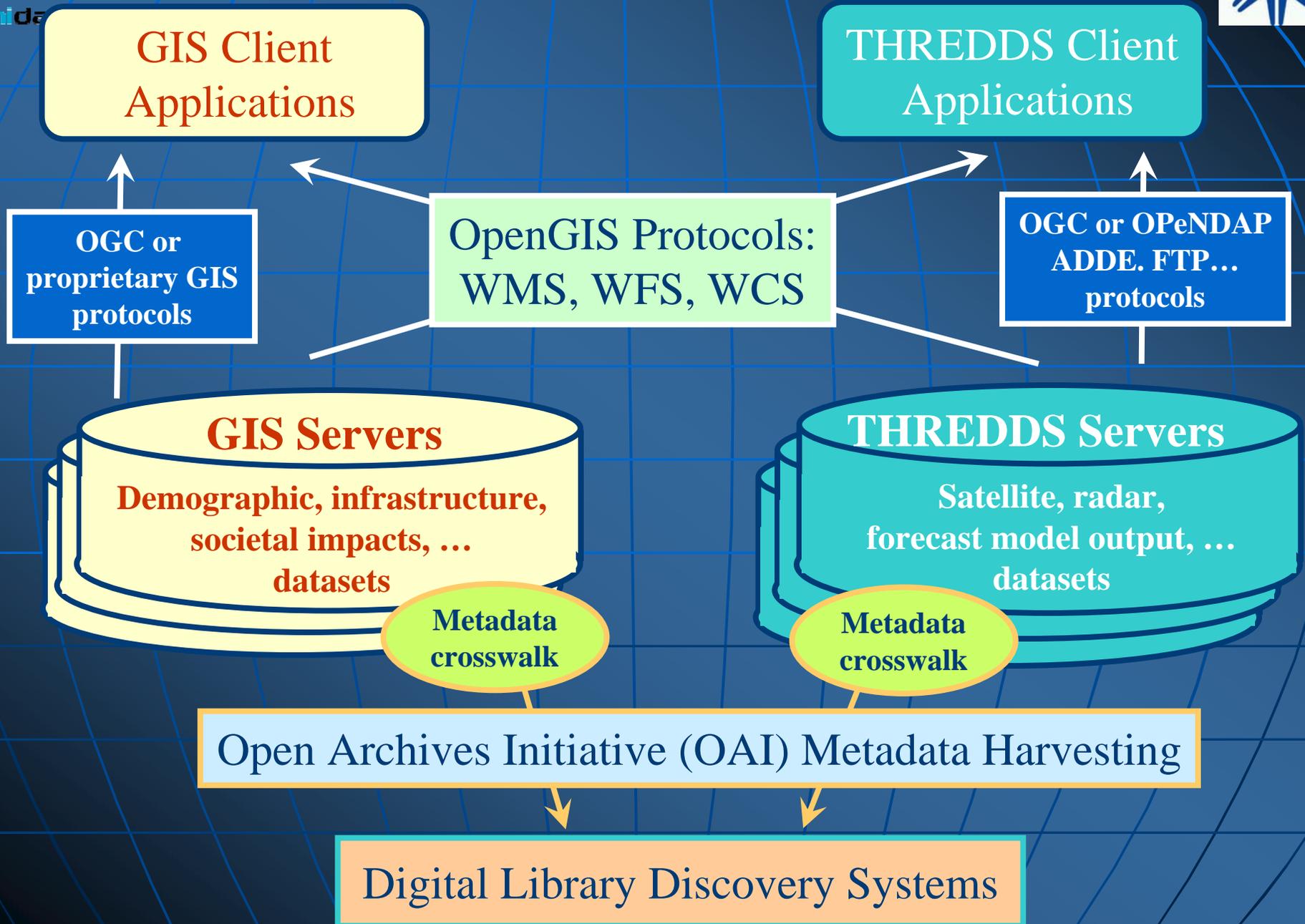
To make it possible to publish, locate, analyze, visualize, and integrate a variety of environmental data

- Combines IDD "push" with several forms of "pull" and DL discovery
- About 25 data providers are partners in THREDDS



Connecting People with Documents and Data

# THREDDS Interoperability



# Common Data Model – TDS



Primary  
Interfaces

TDS

OGC WCS (Web Coverage Server)

(THREDDS Data Server Interface)

Underlying  
Interfaces

OPeNDAP

THREDDS  
catalog

NetCDF interface

Local/Remote  
Services

OpenDAP

ADDE

netCDF via HTTP

IOsp

File  
Formats

NetCDF

Jgoffs

DMSP

AREA

GRID

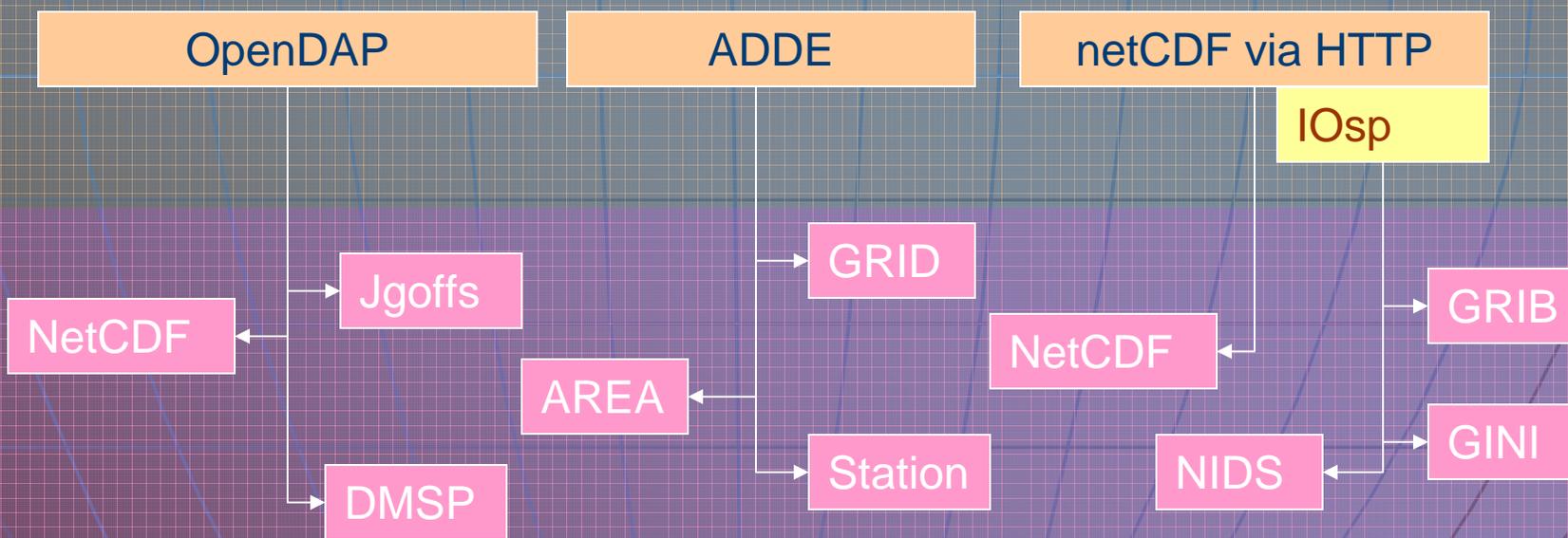
Station

NetCDF

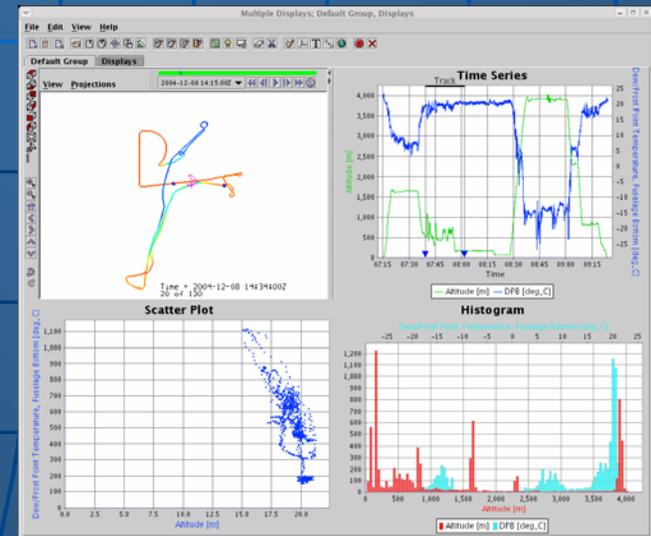
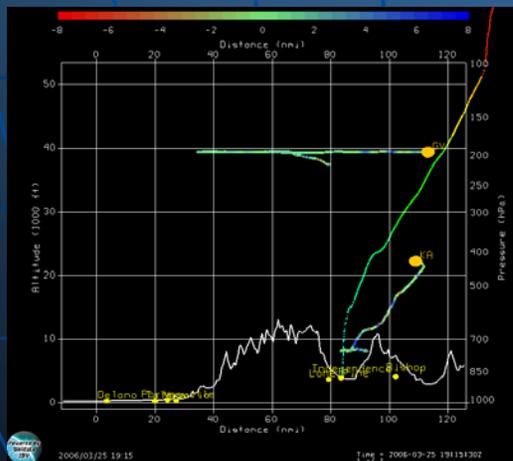
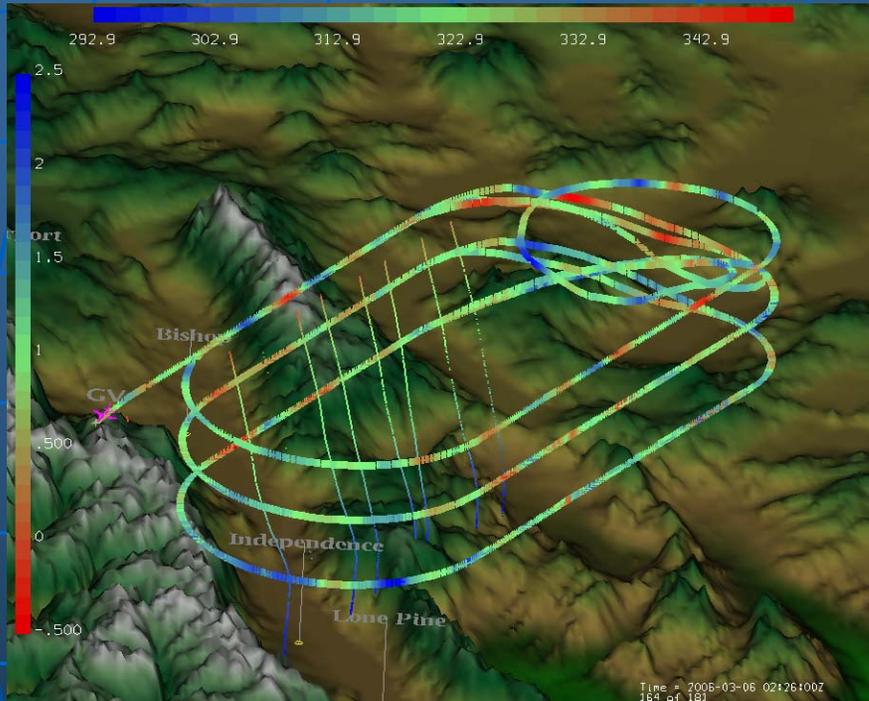
NIDS

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# IDV in Field Projects



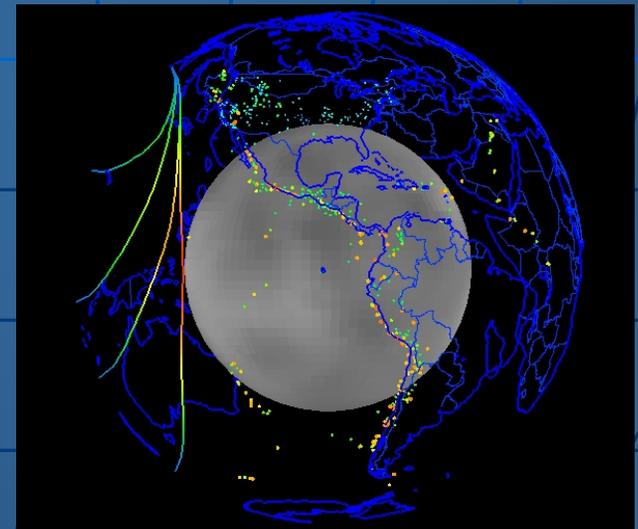
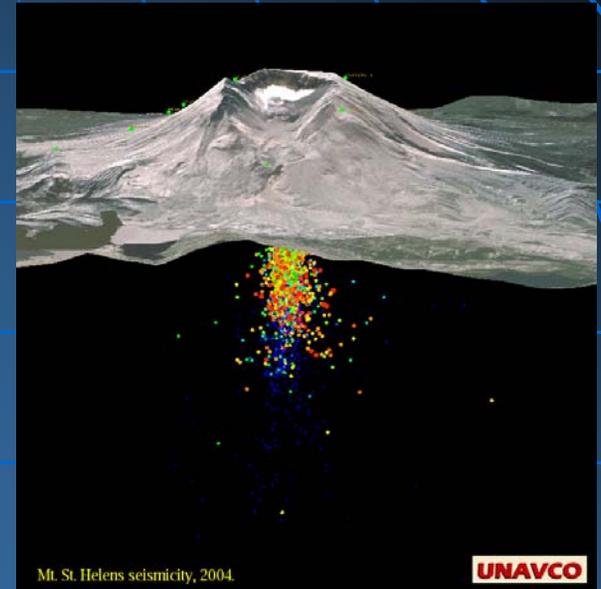


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# GEON-IDV



- ❖ GEON, a large NSF ITR project in solid Earth Sciences, is leveraging the IDV (and THREDDS) in a major way
- ❖ GEON-IDV, their visualization tool developed by Unavco, is an extension of the Unidata IDV for that community.
- ❖ The GEON-IDV visualizations are providing unique insights into processes associated with mantle convection, tomography and seismology and have led to new discoveries
- ❖ This is a great example of the broader impact of Unidata-developed cyberinfrastructure on the geosciences



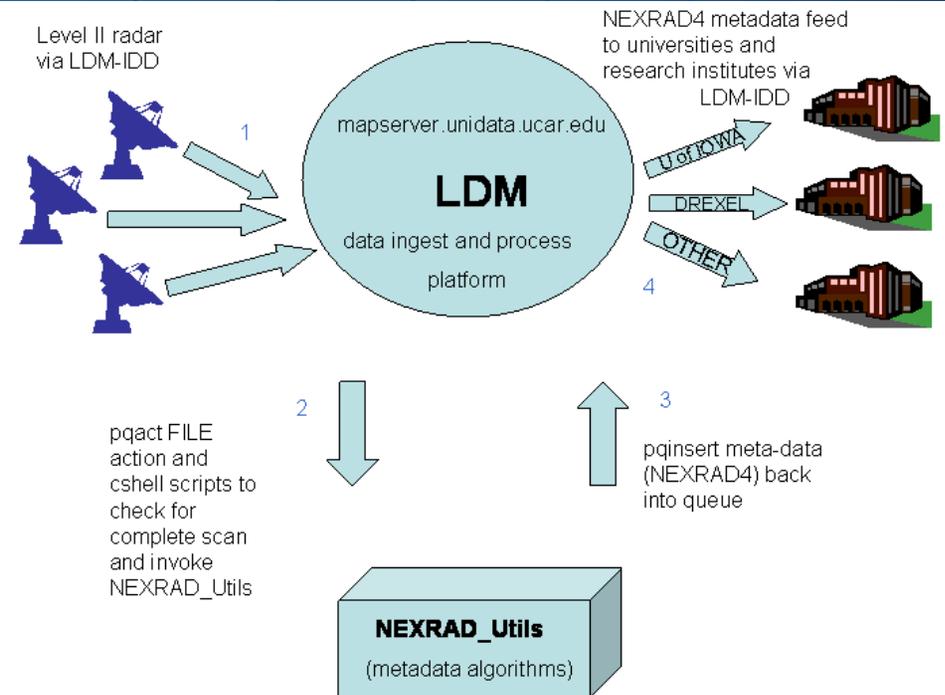
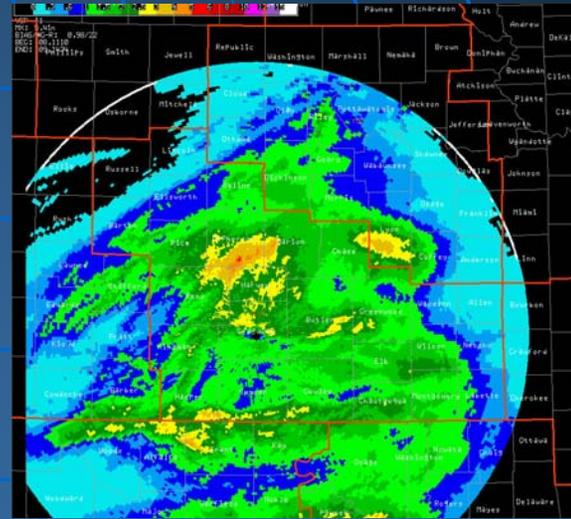


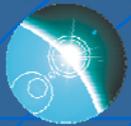
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# Unidata and Hydrology

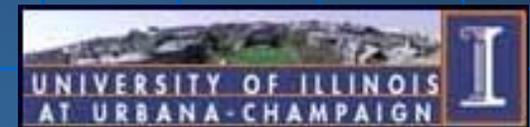


- The CRAFT Project opened new opportunities for collaboration with the hydrology community
- We are working closely with the hydrology community (CUAHSI) to bring Unidata systems and tools to that community
- HYDRO Feed – An Innovative, Value-added Data Stream that provides not just radar data, but value added metadata (e.g., #of pixels over 50 dbZ, precipitation rate in excess of 1"/hour, etc.)

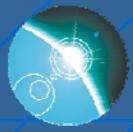




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LEAD is connecting the traditional Unidata community (small computers) to the High-performance computing world (TeraGrid)



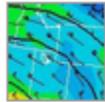
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# Integrating Data with Educational Materials



## LEAD-TO-LEARN MODULES

(Modules created by Millersville LEAD undergraduate students)



### Exploring The Polar Jet Stream

Students interact with numerical model output from the North American Mesoscale (NAM) model to explore the components of the polar jet stream.



### Exploring Lake Effect Snow

Students interact with numerical model output to explore the ingredients for generating lake effect snow. Students use a case study that covers the event that occurred in the Oswego, NY area on January 28-30, 2004.



### From Observations to Models

Students learn about the different data sources used to initialize numerical weather prediction (NWP) models as well as complexity of the data assimilation process used in most models.

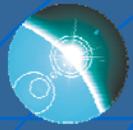


### Exploring Land/Sea Breeze Circulations

Students interact with numerical model output from the Global Forecast System (GFS) to explore the land/sea breeze circulation. Students use a case study that covers the event that occurred in Florida on September 1, 2005.

Future journal publications will not only have the article, but the associated data, animations, and links to community blogs where people are discussing the paper.

Our IDV and THREDDS work is facilitating this approach to data-publication integration.



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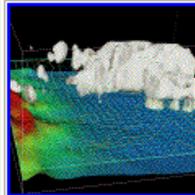
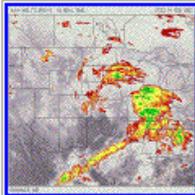
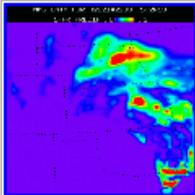
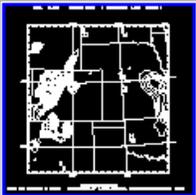
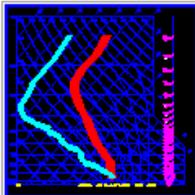
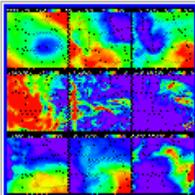
# THREDDS Data Server & Data Repository: A Legal File Sharing Service



- Let us look at how faculty at a typical university share information with their students and colleagues
- Now let's ask ourselves how we can integrate THREDDS & IDV to extend this concept
- Voila! Next Generation Case Studies!!!!

**Gravity wave studies with MM5**

Other cases: [KS snowband](#) | [hurricanes](#) | [Chicago flood](#) | [April 19](#) | [May 15](#)  
(access restricted)

 <a href="#">3d views</a>	 <a href="#">Observations</a>	 <a href="#">Rain evolution</a>	 <a href="#">Contoured fields</a>
 <a href="#">Run details</a>	 <a href="#">Soundings/X-sections</a>	 <a href="#">Panels/Time Series</a>	 <a href="#">FDDA experiments</a>

Click on any image to see that topic page.



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# Next Generation Case Studies



- **Vision: To leverage and bring together the strengths of Unidata and COMET programs to develop a new generation of case studies that are dynamic, integrated, and interactive.**
  - These case studies will include not only datasets of weather events, but they will, where appropriate, integrate relevant educational modules.
  - These new case studies will be “living” or dynamic, allowing for the community to augment and add value to existing case studies by contributing related observations, analyses, educational, curricular and multimedia materials, and other views on the case.
- An important element of that vision is to build an easy to use framework in which community members can develop and build on future case studies.

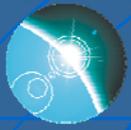


# Cooperative Arctic Data and Information Service



- ❖ An IPY effort to support Arctic science studies, funded by NSF/OPP
- ❖ **Goal: To provide data services for the Arctic Observatories and other IPY-related projects**
- ❖ A collaborative project involving Unidata, NCAR/EOL, NCAR/CISL and NSIDC
- ❖ Several Unidata technologies will be applied, including the LDM, THREDDS Data Server, and the IDV





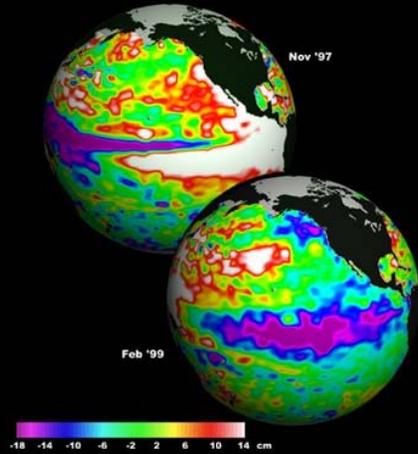
uni data

# Importance of International Partnerships

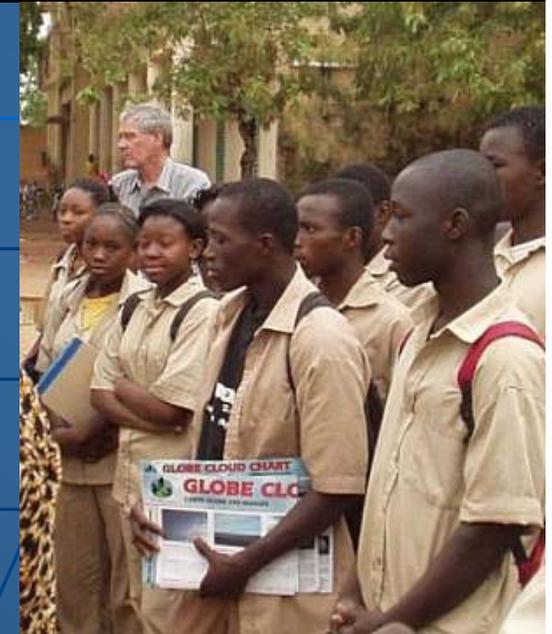
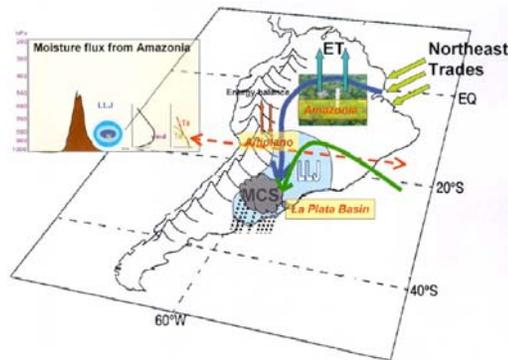


## Hurricane Catarina, 2004

### El Niño / La Niña



### SALLJEX, 2003





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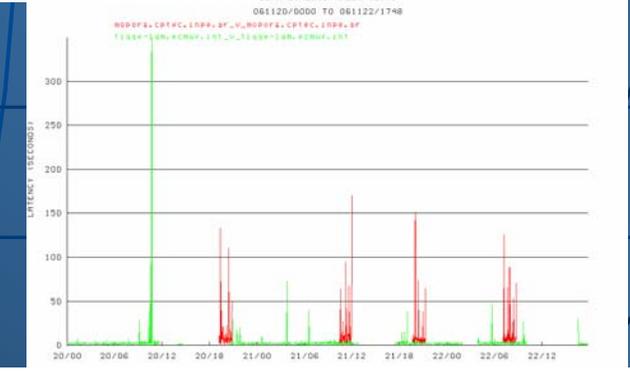
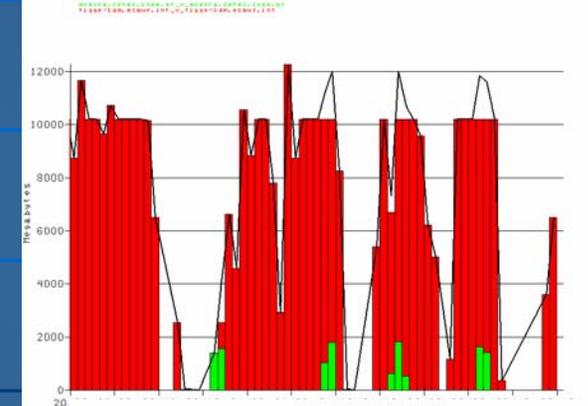
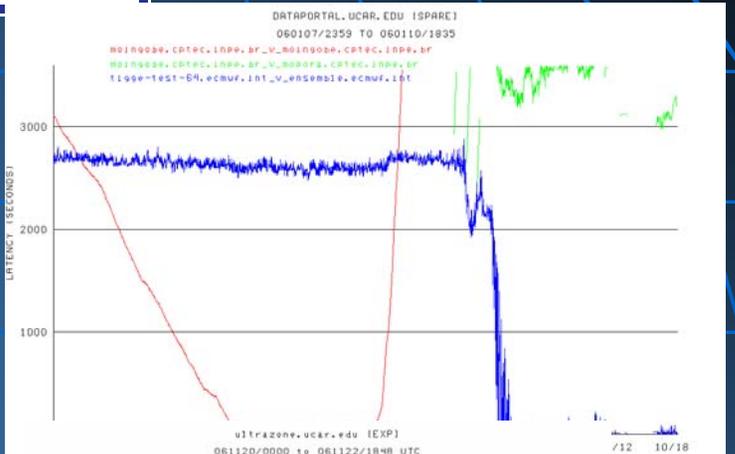
# THORPEX

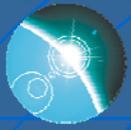
A Global Atmospheric Research Programme

# TIGGE



- Unidata technology is being used in the THORPEX Interactive Grand Global Ensemble (TIGGE) project
- There are three TIGGE Archive Centers (NCAR, ECMWF, and CMA, Beijing)
- Each center hosts data from operational global models at NCEP, FNMOC, ECMWF, UKMO, BMRC, JMA, CMA, MS Canada, CPTEC, Meteo-France, and KMA in GRIB2 Format on native grids.
- TIGGE is regarded as a WMO Information System pilot project;





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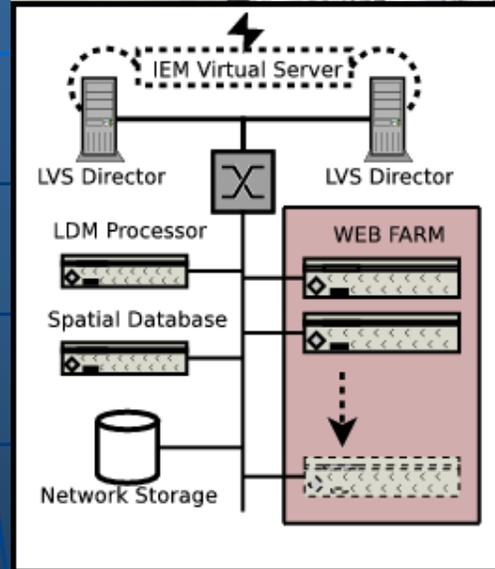
# Community Equipment Awards



- ❖ The primary purpose is to encourage new academic members from diverse disciplinary backgrounds in the geosciences to join the Unidata community, and for existing members to continue their active participation
- ❖ A total of \$100K is allocated for this program each year, targeting one or two themes
- ❖ Over the past 5 years, we have made 36 awards totaling \$560,000, ranging from \$5K to \$25K.
- ❖ The review process actively engages the Users Committee and community members



Modis image of the Georgia Bugaboo Scrub Fire





# Training Workshops



- ❖ Each year, we hold training workshops on our software.
- ❖ This year, 75 people attended our workshops.
- ❖ Each year, we get several international participants.



Register Online	
netCDF for developers	July 20
GEMPAK	July 23-25
LDM	July 26-27
THREDDS Data Server Administration	July 30-31
Introductory IDV	August 1-2
Advanced IDV	August 3-4
netCDF JAVA	August 6
McIDAS	August 7-10

[Event Details](#)





# New Users Committee Student Member



- ❖ Sean Arms, Graduate Student
  - School of Meteorology
  - University of Oklahoma
- ❖ Sean's two-year appointment as the student representative to the Users Committee is a historic moment in Unidata's nearly 25-year history.
- ❖ Sean's selection came after a competitive process that saw the nomination of six highly-qualified students.
- ❖ Sean uses several Unidata software packages in his daily life as a grad student that include GEMPAK, IDV, and netCDF.





# Goal: Seamless Access to and Sharing of Data

- From a device anywhere on the Internet to local and institutional libraries anywhere on the Internet





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# Web Services and E-Commerce



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**MORE BUYING CHOICES**

**antonline\_com**  
Price: **\$48.49**  
Availability: Usually ships in 1-2 business days

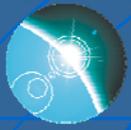
**J&R Music and Computer World**  
Price: **\$49.99**  
Availability: Usually ships in 1-2 business days

**TigerDirect**  
Price: **\$49.99**  
Availability: Usually ships in 1-2 business days

**22 used & new** from \$32.99

Have one to sell?

Tremendous strides have been made in the commercial arena by companies like Amazon, EBay, Yahoo & Google

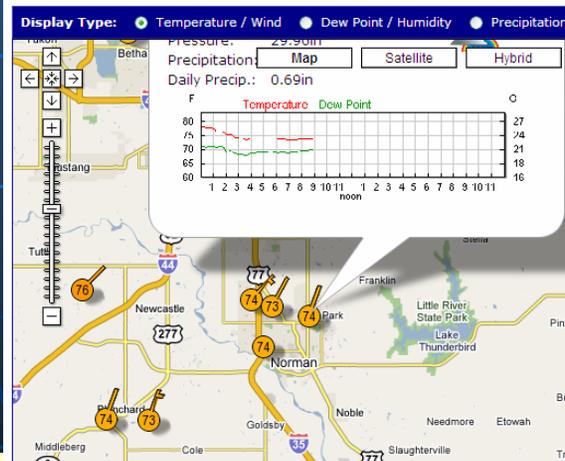


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# Light-weight GIS and Hands-on Learning



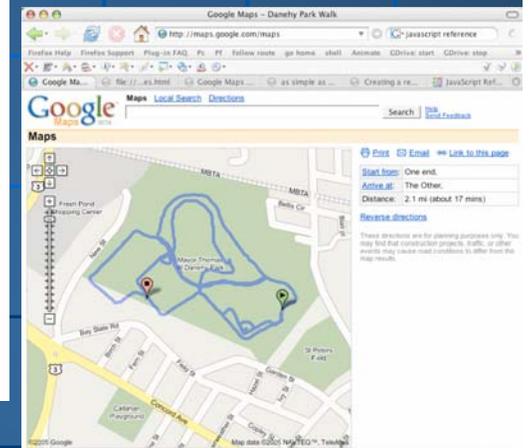
Personal Weather Stations Google Map



Select a Location

Search:  Go

Place	Station	Temp
1m W Blanchard	KOKBLANC3	73.5° F
2 E of Blanchard	KOKBLANC1	73.3° F
Northeast Norman	KOKNORMA6	74.5° F
Norman	KOUN	73.4° F
Terrace Place	KOKNORMA9	74.1° F
Northwest Norman	KOKNORMA5	73.5° F
Midwest City	KOKMIDWE1	72.1° F
Sooner Rd. @ SE 44th	KOKKLAH21	74.5° F
Tinker AFB	KTIK	72.7° F
KingsRidge	KOKKLAH29	75.0° F



Google Earth and Google Maps have unleashed a revolution in light-weight GIS integration. They have immense potential for enhancing geoscience education and spatial awareness, but they lack capabilities for conducting detailed analysis.



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# New Data Distribution Software



- ❖ Project still in the design stage
- ❖ Features will include:
  - Support for multiple operating-systems via Java
  - Support for adaptive and redundant connection topology
  - Download initiation via a web browser
  - Support for both static and dynamic datasets (e.g., case-studies, streaming data)
  - Infinitely-extensible product-namespace
  - Built-in security and cryptographic validation of data requests
  - Highly Scalable

# Concluding Remarks

- We live in an exciting era in which the confluence of science, technology and societal behavior is reshaping the conduct of research and education.
- A new generation of data and information services are enabling new discoveries and the use of innovative education strategies.
- Global scientific partnerships and data sharing activities are crucial for this transformation.



# Thank You!

- Questions?
- Contact information: [mohan@ucar.edu](mailto:mohan@ucar.edu)
- <http://www.unidata.ucar.edu/>