

# Unidata Users Workshops: Past, Present, and Future

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# Unidata

- A cyberinfrastructure facility, established in 1984, for the atmospheric and related sciences.
- We are funded by the National Science Foundation.

- Acquire and distribute real-time meteorological data;
- Develop software for accessing, managing, analyzing, visualizing geoscience data;
- Provide training and support to users;
- Negotiate data & software agreements on behalf of universities;
- Facilitate advancement of standards and conventions;

# State of the Art University Meteorology Labs Before & After Unidata

unidata UCAR



# Unidata Users Workshops

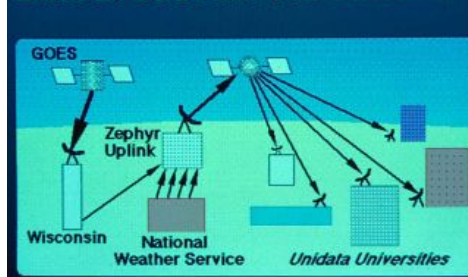
- The Unidata Program conducts Users Workshops every three years to introduce new and emerging concepts, observing systems, tools, and techniques to the Unidata community.
- Workshop themes are developed and programs planned by the Unidata Users Committee.
- These workshops are viewed as a forum for the community to come together to keep up with advances in geosciences and information technology, and exchange ideas on how best to use Unidata resources in education and research.
- The first workshop was held at the iconic Mesa Laboratory in 1988, making this the thirtieth anniversary of Unidata workshops! **I've had the privilege of attending every single workshop.**

# Data Broadcast Circa 1987

A few universities were starting to receive real-time weather data via the Satellite Broadcast.

University faculty wanted to learn how to use these data and integrate them into their teaching and student labs.

Data Broadcast Via Satellite



Service	Data Rate (Bits Per Second)
NAFAX	Analog
DIFAX	2400
Watches & Warnings	1200
U.S. Surface/Upper-Air	4800
NMC & ECMWF Grids	4800
Wisconsin Channel	9600
International (GTS) Data	1800
FAA 604	1200
Lightning Data & Others at Non-Discounted Prices	



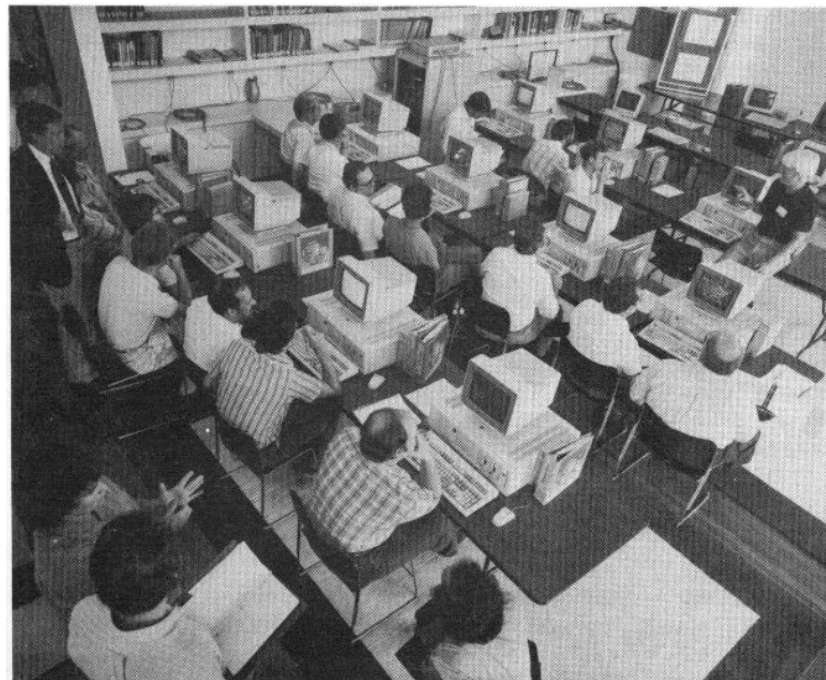
# Voila! The First Users Workshop

It was held in July 1988 at the Mesa Lab, in conjunction with a three-week NCAR Colloquium (mostly lectures on synoptic meteorology)

**Theme: Synoptic Meteorology Instruction – New Trends and Techniques**

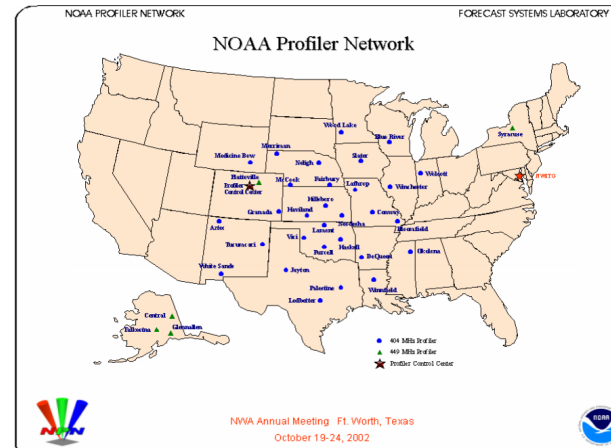
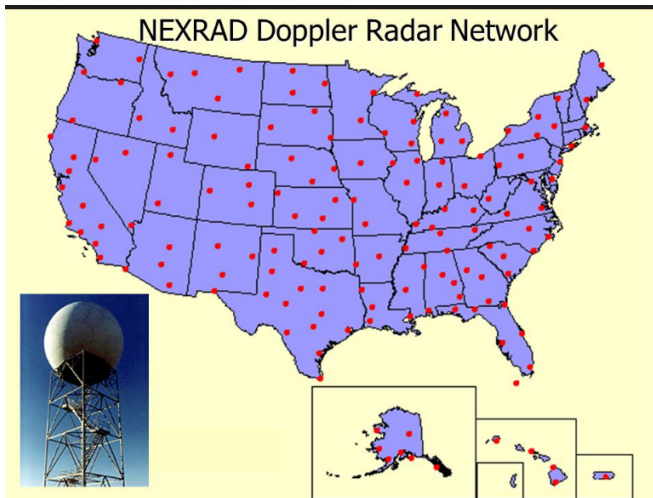
Bob Gall, one of the three organizers of this workshop:

*"There are a number of computer systems coming on line to display real-time weather data. The big question I keep hearing is how to start incorporating the new hardware and software in the synoptic meteorology classroom."*



There were ~30 participants and I was one of them. It was my first introduction to Unidata systems and staff.

# NWS Modernization ca. 1988

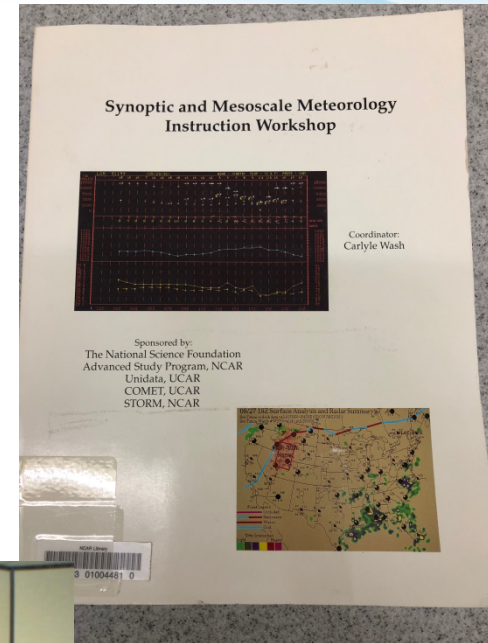


In response to the NWS Modernization, the COMET Program, a sister program within UCAR, was established in 1989 to train NWS forecasters.

Universities had a similar need to learn about the new observing systems and their use in education.

## Meteorology Instruction Workshop

- By 1991, there was a significant increase in the number of universities using Unidata systems and substantial impact of Unidata systems in instruction.
- The workshop was sponsored by Unidata, COMET, and the national STORM program. There were nearly 80 attendees.
- There were presentations, work sessions, roundtable discussions and hands-on lab sessions.
- Some called the workshop a Flea Market as there was a great deal of exchange of research methods, software, and instructional materials.
- A 241-page workshop report was published, with Prof. Wash as the editor.





# 1991 Workshop Participants



# 1994 Workshop: Teaching Mesoscale Meteorology in the Age of the Modernized National Weather Service

By this time, the NWS modernization was completed.

Many other significant developments were taking place – The first web browser, Mosaic, was released by NCSA and the World Wide Web was starting to take off; GOES-8, a new generation of geostationary satellites was launched, and AWIPS was installed in NWS forecast offices to integrate all of the new observations.

There were 72 participants



## Resolution

1. encourage and financially support faculty attendance at such workshops;
2. be aware of benefits to faculty and students from attending such workshops;
3. allow the tenure and promotion system to reward efforts in teaching and related activities (e.g., laboratory development, development of instructional resources);
4. realize need for equipment in the classroom and labs;

## Appendix A: Synoptic meteorology course outline

- Equations of motion
- Surface and upper-air plotting
- Principles of scalar (subjective) analysis
- Surface and upper-air analysis
- Isobaric and isentropic analyses
- Cross-sectional analysis
- Sounding analysis
- Objective analysis
- Introduction to GEMPAK/WXP/McIDAS/PC-GRIDDs analysis
- Cyclogenesis: Structure and evolution of cyclones
- Cyclone climatology
- Quasigeostrophic theory
- Baroclinic instability
- Synoptic forecasting methods
- Kinematics and dynamics of fronts
- Jets and jet streaks
- NWP and NMC models
- Statistical forecasting techniques (MOS, Perfect Prog)
- Satellite interpretation
- Introduction to radar meteorology
- Severe weather forecasting

## Appendix B: Mesoscale meteorology course outline

- Definition of mesoscale and overview of mesoscale meteorology
- Mesoscale observing systems, radar, and satellite interpretation
- Mesoscale analysis
- Mesoscale structure of cyclones
- Mesoscale frontogenesis
- Dry lines, coastal fronts, barrier jets, low-level jets, jet streaks, density currents, and cold-air damming
- Mesoscale precipitation systems, banded precipitation

# 1997: Using Instructional Technologies and Satellite Data for College-level Education in the Atmospheric and Earth Sciences

For the first time, the Users workshop had speakers from an “Education” departments.

Prof. Tom Reeves, University of Georgia, delivered the keynote speech on education and spoke on the importance of “mental models” and challenges in science literacy.



HARVARD COMMENCEMENT

# 1997 Workshop Highlights

Participants learned how to create HTML documents and publish content on websites. Faculty were very excited about delivering course material to their students using the World Wide Web.

The sentiments of the participants was best summarized by this comment: *"I applaud this effort in bringing research, teaching and technology into one workshop. We need much more of this. It forced me to reevaluate my teaching."*

# 2000: Shaping the Future: Unidata Users as Leaders

By this time, Unidata was beginning to move beyond meteorology and into Earth System Science



Tim Killeen, who had just been appointed as NCAR Director, argued that interdisciplinary Earth System Science courses could revolutionize undergraduate general education

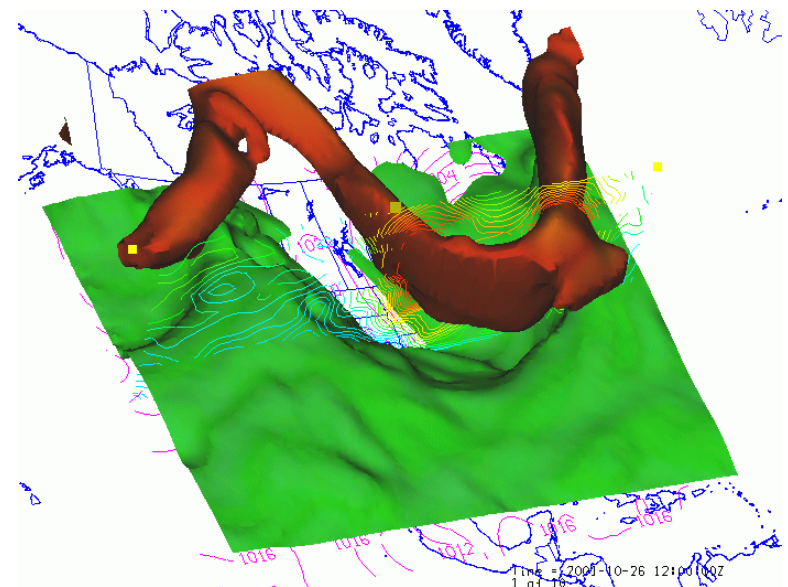
There was some concern about Unidata's expansion into ESS, which could result in possible decrease in focus on the core meteorology community amongst the 70 participants.

Clearly, there was some risk.

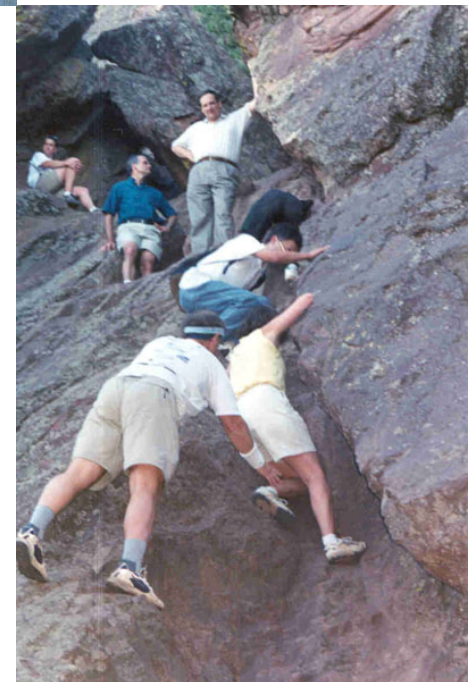
The precursor to the Integrated Data Viewer, MetApps toolkit, was demonstrated for the first time;

Bill Hibbard presented the VisAD architecture, upon which the IDV is built;

Users now had the ability to visualize the atmosphere in three dimensions using real-time weather data;



# 2000 Workshop Collage





# 2003: Expanding Horizons: Using Environmental Data and Model Output for Education, Prediction, and Decision Making

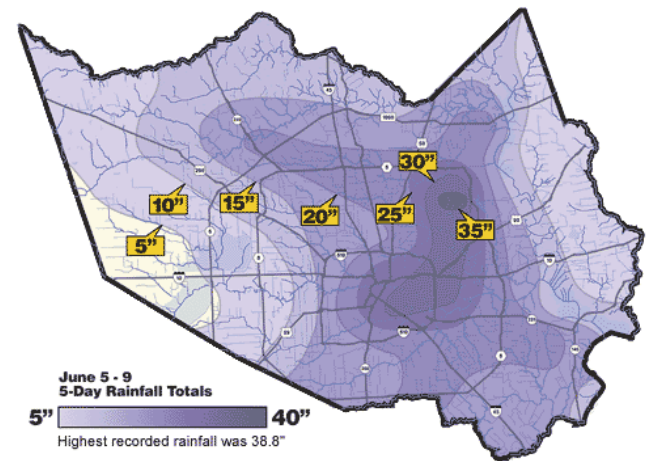
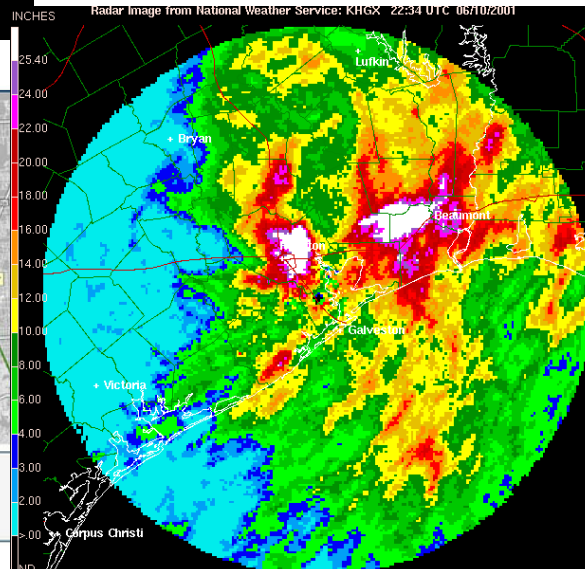
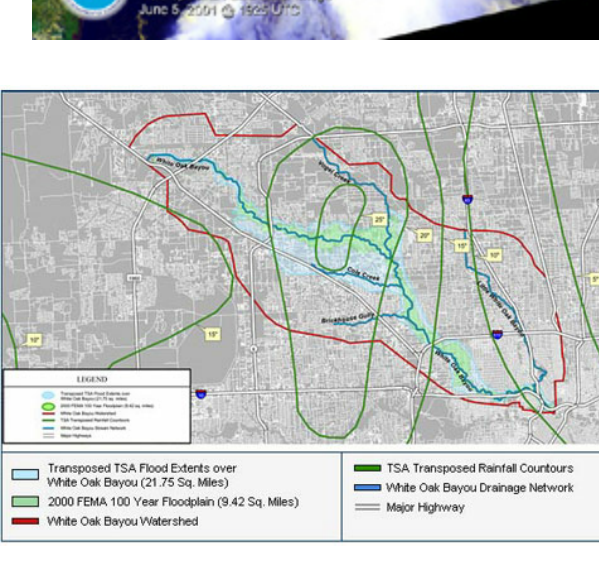
The workshop coincided with the 20<sup>th</sup> anniversary of Unidata, infusing a celebratory tone to the week's activities.

This was the first workshop I oversaw as Unidata Director.

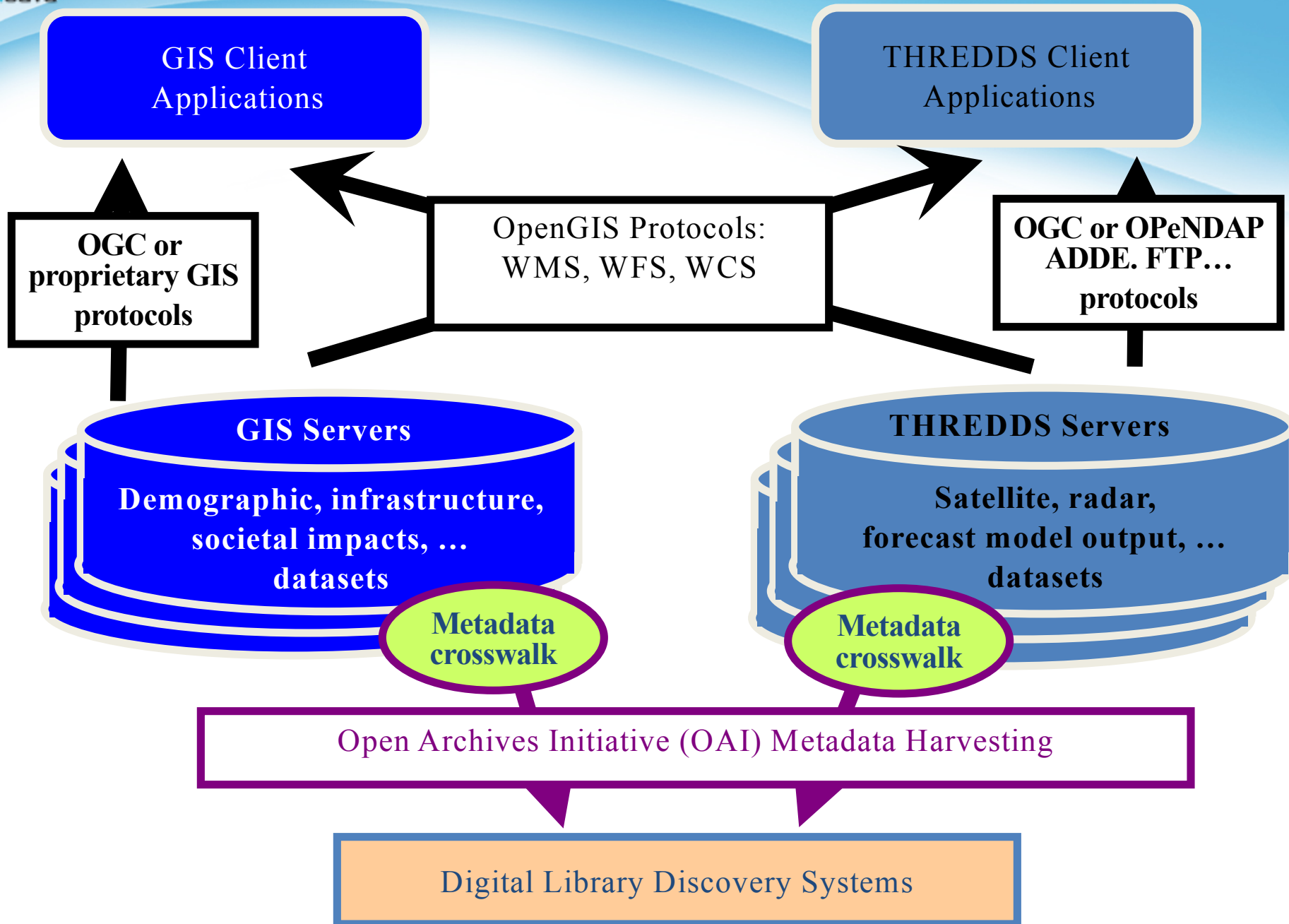
This workshop laid out a vision of Unidata's future in the broader geosciences, presenting a bridge between traditional Unidata users in the atmospheric sciences and GIS users.



## Tropical Storm Allison



Research studies and emergency management of hurricane-induced flooding involve integrating data from atmospheric sciences, oceanography, hydrology, geology, geography, and social sciences.



# 2003 Workshop: GIS Emphasis

Subsequent to this workshop, native support for netCDF was provided within ArcGIS, as a result of Unidata's Collaboration with Esri.

The addition of GIS capabilities have enabled Unidata to serve a broader, more diverse community.





## Models in the Atmospheric and Related Sciences

The theme was motivated by the increasing prominence of numerical as tools for geoscience education.

The 80 participants had an opportunity to test the use of web-based applets, simple models like STELLA and edGCM, and state-of-the-art WRF model, using the LEAD system.

For the first time, the workshop set aside funds for student participation, who helped to energize the workshop.



To increase awareness of Unidata activities amongst students, they suggested that a graduate student representative be appointed to the Unidata Users Committee.

# 2006 Workshop Collage



# 2009: Using Operational and Experimental Observations in Geoscience Education

Goal: Expand the use of instrumentation and observations in geoscience education

The 81 participants leveraged the then new Unidata tool, RAMADDA, for sharing and archiving digital content.



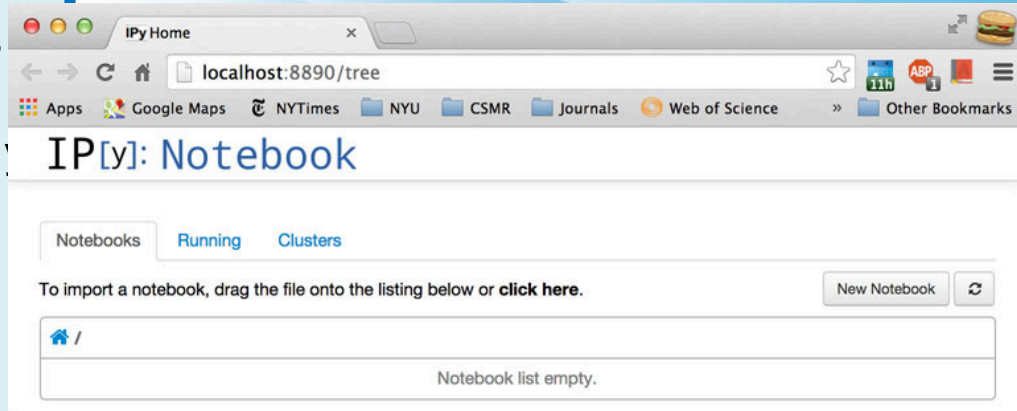
# 2009 Workshop Highlights





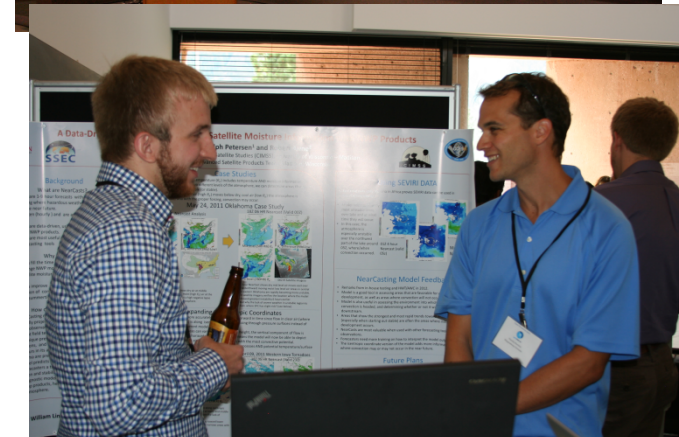
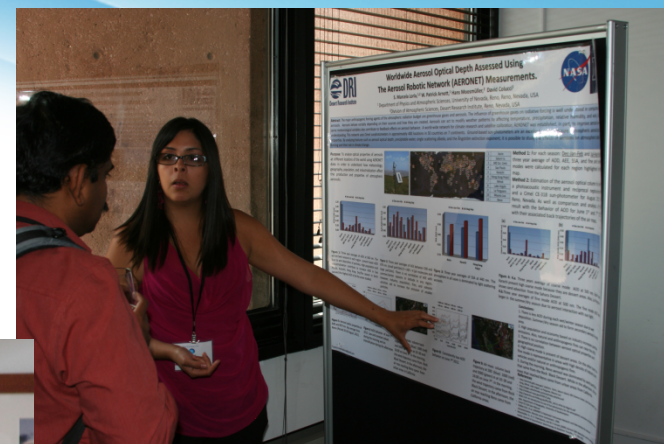
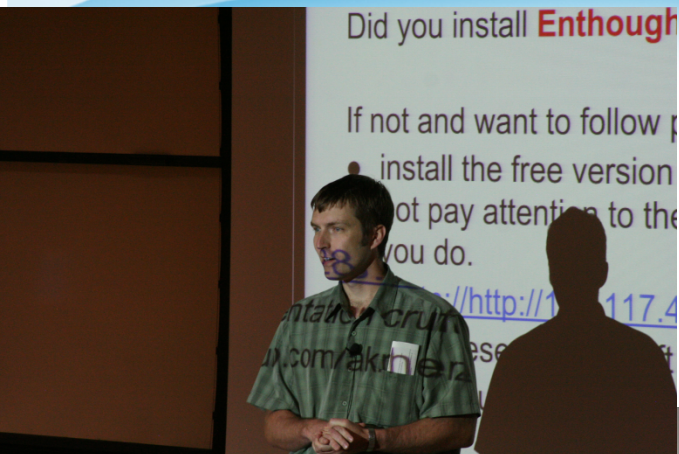
# 2012: Navigating Earth System Science Data

- The workshop had a record attendance of 102 participants. The demographics of attendees reflected a broad community, with participants from many federal agencies, private sector, international institutions, and many geoscience and computer science domains.
- Participants were wowed by the revolutionary interactive Python tool, iPython notebook, which was relatively new to the community.
- The emergent EarthCube initiative was introduced to the Unidata community by NSF.
- Reducing data friction, geoscience at the speed of thought, and tools for fulfilling NSF's data management plan requirement were some of the foci.



**EARTHCUBE**  
TRANSFORMING GEOSCIENCES RESEARCH

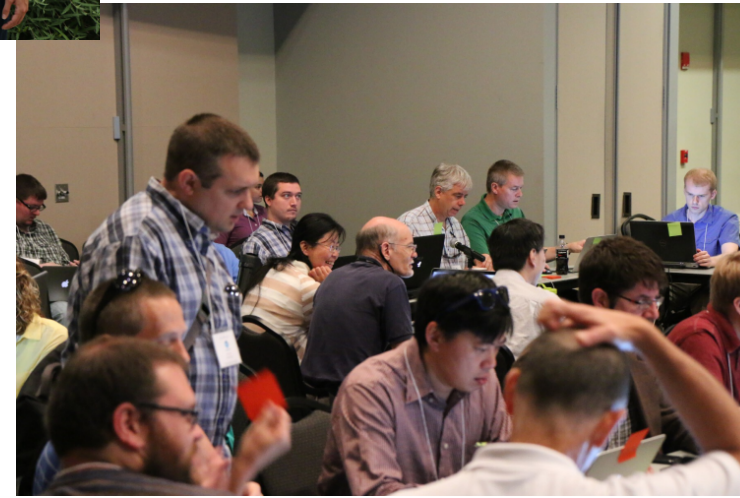
# 2012 Workshop Collage



# 2015: Data-driven Geoscience: Applications, Opportunities, Trends, and Challenges

- The workshop had an ambitious goal of discussing the rapidly-changing landscape of managing and analyzing geoscience data: Python, cloud computing, big data, and long-tail data management.
- About 75 participants attended the workshop, including 10 students.
- A recommendation to consider using Python as a primary programming language appeared as a common theme from the workshop presenters.
- GitHub was used as the repository for software developed during and for the workshop.
- Another recommendation by the participants asked Unidata to adopt virtualization/container technologies (e.g., Docker) for cloud computing to assist with the reproducibility of research. **Unidata has since addressed this by developing Docker containers for almost all of our applications.**

# 2015 Workshop Collage



- **Theme: Reducing Time to Science: Evolving Workflows for Geoscience Research and Education**
- **Topics:**
  - Techniques for data-proximate analysis and working with remotely-hosted datasets;
  - Machine learning and incorporating it into geoscience workflows;
  - Explore modern workflows for dealing with very large datasets, using data from GOES-R series satellites (e.g. GOES-16) and ensemble numerical weather prediction models;
  - Highlight how Unidata's products and services can be integrated to complement and expand the capacity of highlighted techniques.

# What is next for Unidata?

- Unidata is in the midst of developing its next 5-year proposal to NSF, to be submitted in a few months.
- As always, the proposal will continue to address the evolving and newly emerging needs of the education and research community.
- While the focus on data-proximate analysis in the cloud will continue and expand, our goals will include:
  - scalability and efficiency of Unidata data systems and tools in the cloud
  - significant leveraging of JupyterHub and the Python ecosystem
  - expansion of activities in collaborative open source development
  - exploration of workspaces and modern workflows, implemented on a cloud-hosted Unidata Science Gateway
  - enabling modeling research in the cloud and contributing to the goals of Harnessing the Data Revolution, one of NSF's Ten Big Ideas
  - Facilitating the conduct of Open Science and reproducibility, via sharing of data, software, and knowledge.

# Future: NSF's 10 Big Ideas

**NSF 10 Big Ideas for Future NSF Investments**



**Navigating the New Arctic**

STATISTICAL COMPUTATIONAL FOUNDATIONS OPEN EDUCATION WORKFORCE

**DATA SCIENCE**

Harnessing Data for 21st Century Science and Engineering



**Work at the Human-Technology Frontier: Shaping the Future**

**RESEARCH IDEAS**



**Understanding the Rules of Life: Predicting Phenotype**

**The Quantum Leap: Leading the Next Quantum Revolution**





**Windows on the Universe: The Era of Multi-messenger Astrophysics**

**PROCESS IDEAS**



**Growing Convergent Research at NSF**



**NSF-Includes: Enhancing Science and Engineering through Diversity**



**Mid-scale Research Infrastructure**



**NSF 2050: Seeding Innovation**

**HARNESSING THE DATA REVOLUTION**

MATHEMATICAL, STATISTICAL, COMPUTATIONAL FOUNDATIONS  
 ANALYTICS  
 DATA SCIENCE  
 RESEARCH DATA CYBERINFRASTRUCTURE  
 MODELING  
 DATA MINING  
 HUMAN-DATA INTERFACE

# Concluding Remarks

In addition to providing forums for addressing contemporary issues to enhance teaching in the atmospheric and related sciences, Users workshops have facilitated sharing of ideas and materials, in-depth discussions on curricular matters, and offered real-world solutions to improve student learning.

- The close collaboration between the Unidata Users Committee and the Unidata Program Center has been key to the success of these workshops.
- Evolution in topics reflect the evolving landscape, science drivers, and trends and techniques in information and computer technologies and has permitted the Unidata community to stay abreast of and benefit from these trends.
- Demographics of participants has evolved in concert with the above – in the early days, it was mostly synoptic and mesoscale meteorology faculty. Nowadays, the audience is much more diverse in every sense – domain, types of organizations represented, geography, etc.
- Every workshop has succeeded in establishing a lasting discussion and a close network to improve the sharing of both materials and pedagogical techniques for advancing geoscience education.
- Post-workshop surveys consistently point to the overwhelmingly positive impact of these workshops on faculty, students, and researchers in their professional development.



# Acknowledgement

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