International Activities at Unidata: A Draft White Paper

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Introduction

Increasingly, the conduct of science requires strong international scientific partnerships and sharing of knowledge, information, and other assets. This is particularly true in the geosciences where the highly coupled nature of the earth system and the need to understand global environmental processes and their regional linkages have heightened the importance of strong collaborations across national and continental boundaries. The climate system, for example, is far too complex a puzzle to be unraveled by individual nations. As science becomes increasingly global in nature, it is critical that focus is placed on full, open, and timely access to and sharing of earth system science data.

For the past two decades, the NSF-sponsored Unidata Program Center (UPC) of the University Corporation for Atmospheric Research (UCAR) has been providing data, tools, and support to enhance Earth-system education and research. In an era of increasing data complexity, accessibility, and multidisciplinary integration, Unidata provides a rich set of services and tools. Beginning as a collection of US-based, mostly atmospheric science departments, the Unidata community has grown to include government agencies and private sector entities, and today that community transcends international boundaries. The primary reason for the community broadening, which has in large part occurred organically through the free and open exchange of near real-time geo-scientific data and related software, is a recognition that most of today's formidable scientific problems in the geosciences are inherently multidisciplinary and global in character. As articulated in the draft NSF Strategic Plan: FY 2006-2011 (NSF, September 2006), "discovery increasingly requires expertise of individuals from different disciplines, with diverse perspectives, and often from different nations, working together to accommodate the extraordinary complexity of today's science and engineering challenges." The document further states, "…the ability to develop collaborations that create new value for the partners is often the limiting factor for progress in critical areas of science, engineering and technology."

The Internet and its myriad manifestations, including the World Wide Web, have amply demonstrated the compounding benefits of a global cyberinfrastructure and the power of networked communities as institutions and people exchange knowledge, ideas, and resources. The Unidata Program recognizes those benefits, and over the past several years it has developed a growing portfolio of international outreach activities, conducted in close collaboration with academic, research and operational institutions on several continents, to advance earth system science education and research. The portfolio includes provision of data, tools, support and training as well as outreach activities that bring various stakeholders together to address important issues, all toward the goals of building a community with a shared vision. The overarching goals of Unidata's international activities include:

- democratization of access-to and use-of data that describe the dynamic earth system
- building capacity and empowering geoscientists and educators worldwide
- strengthening international science partnerships for exchanging knowledge and expertise
- effectuating sustainable cultural changes that recognize the benefits of data sharing, and
- building regional and global communities around specific geoscientific themes.

To quote Prof. Gerhard Fischer, University of Colorado, "the deep and enduring changes of our ages are not technological but social and cultural." The Unidata Program continues to place high value on the transformational changes and the increasing importance of international scientific partnerships and proposes to continue fostering such collaborations and related efforts toward the building of a globally-engaged community of educators and researchers in the geosciences. The draft Unidata vision statement and the strategic plan are informed by these trends and emphasize the need for continual organic growth of the community both internationally and into other geoscience disciplines.

Data Access and Distribution

A critical component of successful scientific inquiry includes learning how to collect, process, analyze, and integrate data from myriad sources, and geo-science education is uniquely suited to making science relevant by drawing connections between the dynamic Earth system and societal impacts. In this section, we briefly describe some of Unidata's successful efforts in facilitating data access, use, and integration in the geosciences.

MeteoForum and International Data Distribution

The importance of sharing locally-held data was recognized in the earliest Unidata planning documents of the mid-1980s. Development of NSFnet and its successors provided the substrate on top of which a multi-way communications system could be built. The Unidata-developed Local Data Manager (LDM) evolved to be the vehicle that enabled the multi-way sharing of data through a project known as the Internet Data Distribution (IDD) system. Although Unidata has long fostered and maintained international interactions, an initiative starting in 2001 called MeteoForum was its first organized and natural extension into an international arena. Funded by the UCAR Office of Programs' STORM Funds, the MeteoForum pilot project, a joint effort between Unidata and COMET, had the following overarching goals:

The MeteoForum pilot project will include a small group of educational institutions (some universities and some WMO RMTCs) that are motivated to enhance the contributions of modern meteorology in their regions. Participants will be expected to have relatively fast Internet access, appropriate computers, and suitable personnel. Some of these personnel will be trained to run MeteoForum software on their computers so as to access real-time data, training materials, and other resources. Where practical, participants in the MeteoForum pilot also will *contribute* real-time data and educational resources to the effort. By integrating these elements, the pilot project will serve as a model on which to build a full-scale international MeteoForum. Initially, the

MeteoForum pilot project will build upon capabilities now offered in the U.S. by the government-sponsored COMET and Unidata programs.

To achieve the above goals, Unidata carried out the following MeteoForum activities:

- Facilitate data access to a broad spectrum of observations and forecasts
- Coordinate a data-relay network that collects and distributes data in real-time at no cost to educators and researchers
- Build a community where data, tools, and best practices in education and research are shared
- Support faculty at research and educational institutions in the use of Unidata systems

MeteoForum is a success story of organizations that leveraged their expertise in a collaboration that resulted in the creation of a data distribution system for South America, the *IDD-Brasil*. This success was built collaboratively among the UPC and several Brazilian institutions including the Universidade Federal do Rio de Janeiro, the Universidade de São Paulo, the Universidade Federal do Pará, and the Centro de Previsão de Tempo e Estudos Climáticos (CPTEC, a division of INPE). The data relay infrastructure established in Brazil coupled with the North American *IDD* represents the beginnings of a hemisphere-wide network that acts as conduit for multi-way sharing of international, national, and locally-held environmental datasets. For the first time, previously unavailable observational data and high resolution model output for Brazil are now being made available to both Latin American *IDD-Brazil* and North American *IDD* participants in near real-time. Real-time atmospheric science data delivered to Latin America by the *IDD*/*IDD-Brasil* has helped initiate teaching innovations in multiple geo-science disciplines in Argentina, Brazil, and Chile.

Currently, over 160 institutions of higher education in North, Central and South America, the Caribbean, Asia, and Europe are participating in the IDD. Profound and transformative impacts have already been noticed since the distribution system expanded beyond North American borders some three years ago. For example, data delivery to Central and South America has initiated teaching innovations at many universities in those regions, including the University of Costa Rica, the University of Buenos Aires, and Universities of Rio de Janeiro and São Paolo. Integration of real-world data has provided opportunities for active, student-centered and inquiry-based learning, infusing the excitement of discovery into geo-science courses at these institutions.

The *IDD* can be an invaluable tool for learning more about differences in atmospheric phenomena and processes in different geographical regions. For example, every tropical meteorology textbook states that hurricanes do not occur in the South Atlantic Ocean. Imagine the befuddlement of the meteorological community when forecasters followed the development of the first ever recorded hurricane off the coast of Brazil in March, 2004. Hurricane Catarina was significant for two reasons: a) it is forcing the reevaluation of conventional wisdom; and b) it could potentially be a climate change signal. Researchers believe that the South Atlantic region

is one of the areas to watch for increased tropical cyclone activity in a warmer global climate. Looking to the future, the *IDD* will provide an important resource to scientists across the two hemispheres who can investigate, among other things, geographic differences in atmospheric and oceanic processes and circulations.

The democratizing and transformative effects of free and open access to data on atmospheric science research and education cannot be overstated. For example, the *IDD* system is providing important benefits to the Antarctic meteorological community. Because of communication and logistical difficulties, the provision of data to Antarctic researchers, educators and forecasters has been a significant challenge, and these challenges are being overcome by the *Antarctic-IDD*, which carries surface and upper air observations, satellite imagery, and forecast model output to an increasing number of participating nodes, including one at the US McMurdo Station. The availability of observations from polar areas is especially crucial for documenting the nature and extent of climate change, for those are the very regions that are projected to experience the most significant warming in climate simulations and as such most vulnerable from an Earth system science perspective.

Most recently, THORPEX (THe Observing system Research and Predictability EXperiment) Interactive Grand Global Ensemble (TIGGE) adopted use of the LDM/IDD for data collection at three archive sites: the National Center for Atmospheric Research (NCAR), the European Center for Medium range Weather Forecasting (ECMWF), and the Chinese Meteorological Agency (CMA). WMO's THORPEX, a ten-year Global Atmospheric Research Program, was conceived and initiated to respond to 21st century challenges of accelerating the accuracy of one-day to two-week weather forecasts to achieve social, economic, and environmental benefits. A specific goal of THORPEX is to advance the knowledge of global-to-regional influences on the initiation, evolution, and predictability of weather systems.

TIGGE, (THORPEX Interactive Grand Global Ensemble) is a key component of THORPEX--a framework for central access for the complete set of forecast ensembles that will be combined into a single ensemble system. NCAR, in collaboration with ECMWF and the Chinese Meteorological Agency (CMA), is seeking to establish identical international data repositories for the TIGGE data which will be output from THORPEX. Data from the project needs to be received and archived and accessible to ensemble forecasts from several international numerical weather prediction centers. The data have to be quickly available through a portal and secure long-term archives and services need to be implemented. NCAR's CISL/SCD will be one of the long-term archives. TIGGE will use the LDM to enable the global data receipts to build the TIGGE archives and probably will be used to fulfill subscription data requests.

The key objectives of TIGGE are:

- Enhanced international collaboration between operational centers and universities on the development of ensemble prediction

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- Development of new methods of combining ensembles of predictions from different sources and of correcting for systematic errors (biases, spread over-/under-estimation)
- Increased understanding of the contribution of observation, initial and model uncertainties to forecast error
- Increased understanding of the feasibility of employing, operationally, an interactive ensemble system which responds dynamically to changing uncertainty (including the use of adaptive observing, variable ensemble size, on -demand regional ensembles) and which exploits new technology for grid computing and high-speed data transfer
- Evaluation of the elements required of a TIGGE Prediction Center to produce ensemble-based predictions of high-impact weather, wherever it occurs, on all predictable time ranges
- Development of a prototype future Global Interactive Forecasting System

When fully implemented, the TIGGE archive will provide researchers and educators access to global model output from ten different operational numerical weather prediction centers. Continued collaborations resulting from the availability of these data will result in greater understanding of a range of geo-scientific problems that include advances in climate change science, weather and ENSO predictions, and hydrologic processes. This will provide richer global analyses of the state of the planet. Notably, what once was the province of a few in elite US universities is now available to many, thanks to innovations made possible by Unidata's sustained cyberinfrastructure, development and deployment, and support for international outreach.

THREDDS

It has long been realized that the **push** data delivery method employed in the *IDD* is not applicable when the volume of data to be moved exceeds the capacity of a site's network capacity, or when each site desires different subsets of data from a large distributed data collection. Since the volume of geo-scientific data slated to become available in the near future will be several orders of magnitude greater than what is available today, Unidata embarked on a project aimed at providing programmatic remote access to collections of data. 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.

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.

THREDDS is truly international in scope. Contributors to THREDDS development and/or deployment include the UK's British Atmospheric Data Center (BADC), and organizations in France, Greece, Japan, Italy, and Australia. Users of the prototype THREDDS server hosted by the UPC at UCAR include Brazil and China as well as those contributing to development and deployment.

Tools

In addition to data provision, Unidata develops, maintains, and supports a variety of software packages. Most of these packages are developed at the UPC, while a few others originated externally, but are modified, maintained, and supported at the UPC. Software provided by Unidata is available at no charge to users worldwide. A list of UPC-supported software packages is provided in Appendix A. As shown in Table 1[1], all of these tools are downloaded and possibly used broadly by the international community[2], although their use varies markedly from application to application and country to country. While netCDF, Unidata's most widely used software, is used in 78 countries, even a relatively new application like the Integrated Data Viewer has been downloaded by users in over 60 countries.

Table 1:

	Total	International	% Intl	# of Countries	Top 3
Registrations	11805	1563	22	117	DE,CA,IT
Support (2003-06)	19948	2123	11	44	CA, BR, AU
Downloads: (2005-2006)					
LDM	2504	276	11	38	BR, CA, FR
GEMPAK	4276	1128	26	54	FR, BR, SG
McIDAS	911	224	25	15	CA, IN, BR
IDV	2836	511	18	65	FR, CN, RU
netCDF (from Unidata)	187556	63134	34	78	JP, DE, FR
Java	14357	4126	29	67	DE,FR, RU
Perl	1366	350	26	45	JP, DE, EU
UDUNITS	3305	1223	37	57	JP, CA, DE
THREDDS	4813	901	19	38	ES, CA, FR
Decoders	3489	1042	43	37	FR, DE, CA

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[1] The Table was generated using raw data in the Unidata database and results should be regarded as being preliminary. At this point, many IP addresses could not mapped to a specific location. Further processing and refinement is needed before drawing conclusions.

[2] Downloads may not equate to usage.

(netCDF, LDM-McIDAS)					
IDD Hosts	342	32	11	8	BR, CA, AR
IDD Domains	169	18	9	8	BR, CA, AR
Workshop Attendees (2005-2006)	165	15	9	8	BR, CA, FR
Equipment Awards (2003-06)					
Proposals	57	4	7	1	BR
Funded	30	3	10	1	BR

Projects

Unidata is also directly involved in or its offerings are used by a variety of projects that have international scope. Below we highlight some of these activities.

Advocacy

Dating back to the early 1990's, the UPC became involved in international data exchange issues (*e.g*.., ramifications of WMO Resolution 40) by participation in the Forum on International Data Exchange meetings with multi-national representatives at AMS Annual Meetings. The UPC has long advocated free data exchange through its contacts in NOAA, NWS, NSF, and WMO. In the early 1990s, the UPC became somewhat of a "broker" by creating partnerships between US universities and international entities that wanted to participate in the Unidata Program by receipt of real-time data delivered through the ***IDD***. The UPC supplied the tools to access and analyze data while the US universities shouldered the responsibility for supporting the international users.

GALEON

The Geo-interface to Atmosphere, Land, Earth, Ocean, NetCDF (GALEON) WCS Interoperability Experiment (IE) was set up to implement a geo-interface to netCDF datasets via the WCS 1.0 protocol specification. One specific approach implemented the WCS as a layer above a set of client/server and catalog protocols already widely in use in the atmospheric and oceanographic sciences communities. In particular, it leverages the widespread base of OPeNDAP servers that provide access to netCDF datasets and accompanying THREDDS servers providing ancillary information about the datasets. The IE investigated the feasibility of adapting data and metadata originating from OPeNDAP/THREDDS servers to the WCS specifications, thus bridging the gap between the atmospheric, oceanographic and GIS communities, by alleviating data interoperability issues. The IE can be viewed as a step in the direction of

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interoperability with data systems already in existence in the oceanographic and atmospheric sciences. These technologies include netCDF, OPeNDAP, ADDE, and THREDDS.

GALEON is an active international initiative that includes participants from the US, Europe, China, Japan, and Australia.

A related activity is the GEOSS Services Network (GSN), a spin-off of the international GALEON project. The GALEON team members are among the most active GSN participants.

European Geophysical Union / American Geophysical Union Sessions

The UPC has also been active in organizing meetings to bring communities together to address important cyberinfrastructure challenges and opportunities. For instance, the UPC staff proposed, organized, and held special sessions at recent European Geophysical Union (EGU) and American Geophysical Union (AGU) meetings:

"Earth System Science Data Access, Distribution and Use for Education and Research"

This AGU session emphasized Earth System Science Data (ESSD) discovery, collection, storage, analysis, visualization and dissemination requirements for enabling distributed and scalable solutions in the Education and Research sectors. It included technologies and services that enable effective, secure and reliable access and sharing of ESSD over well-accepted distributed computing platforms (e.g. the Internet, the World Wide Web, open Grid platforms, etc.).

It should be added that there is a serious push to make the Earth and Space Sciences Informatics (ESSI) session international by promoting active Latin American and European participation.

"Earth and space science Cyberinfrastructures: Data, Tools, Distribution and Forecast Systems for International Collaboration"

The underlying idea of this session, organized with NSF sponsorship and collaboration with members of the community, was to help build a stronger and broader space and Earth science cyberinfrastructure community through international collaboration. The session encouraged papers on bio-geophysical, meteorological, ecological, remote sensing, and related intelligent and adaptive systems for data collection, processing, and knowledge discovery and classroom dissemination. Of special interest were presentations on data, tools and forecast systems that foster collaborations among the research and education communities in the Western Hemisphere.

The UPC strongly encouraged participation of Latin American scientific and higher education organizations in this session.

International Academic Partnerships

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In June, 2006, Dr. Melanie Wetzel, Unidata Policy Committee Chair and professor at the Desert Research Institute of the University of Nevada-Reno, asked the Unidata community to assist in fostering more international teamwork by providing information on:

- international universities or research groups that they currently interact with
- how using Unidata software and *IDD* data acquisition promotes international partnerships for advancement of atmospheric research and education
- how using Unidata could contribute to the development of international academic partnerships (international workshops; interaction with UCAR International Affiliates; demonstration of software for meteorological analysis for international regions; etc).

This is a new initiative and the UPC is still in the process of gathering community input. The community feedback, coupled with Policy Committee discussions from this draft white paper, will inform our next steps.

Other Related Activities

In the past, Unidata has participated in WMO meetings as invited experts on data access and information systems. Unidata is also centrally involved in the development of the Climate and Forecast (CF) Conventions, an international standard for model and observational metadata. The UPC has hosted long-term visitors from Australia and Italy as well as many short term visitors. For example, five developers from Japan visited the UPC in 2005 to discuss Unidata developments and the use of Ruby (a scripting language from Japan) as software "glue."

Unidata has been contributing to international field projects related to special data, services, and tool needs for several years. These activities escalated as word spread and people shared their stories of using the data and adopting tools for teaching and research activities. The most recent activity is the WMO THORPEX Interactive Grand Global Ensemble project.

Unidata is also collaborating in the International Polar Year (IPY) in data management activities and will be involved in several international data sharing efforts in the polar community.

Recently, UCAR has been in discussions with Shirley Malcome, American Association for the Advancement of Science (AAAS), on a joint AAAS-UCAR Africa Initiative. The purpose is to design a sustainable partnership between AAAS and UCAR for the benefit of the African people. The initiative envisioned will:

- Involve genuine collaboration between UCAR-AAAS and African institutions
- Focus on institutional capacity building and research support
- Explore science research themes that are critical to Africa and important for the world
- Leverage the research infrastructure in the US to add value

The guiding principles of the Africa initiative will be

- **Build on existing efforts:** Focus on leveraging existing activities and coordinating pre-existing networks, not on creating anything new.
- **Develop research capacity while integrating research and education:** Efforts in Africa must integrate research and education, and will not be successful if they don't contribute to developing local research capacity.
- **African Solutions for African Problems:** The issues addressed should arise from an needs defined by local institutions, and focus on developing and enabling long-term strategies led by those institutions.

There is considerable interest in Unidata providing real-time meteorological data to African institutions via the *IDD* and possibly augmenting it through satellite broadcast services in order to work around spotty network availability in many parts of that continent.

Some Thoughts on Future Activities

An increasing number of US and international institutions rely on the UPC's expertise in providing access-to and use-of a wide variety of data; provision of tools to analyze and visualize those data; provision of support in the use-of data; and in community leadership and advocacy. The UPC has furthered its reputation for excellence through successful efforts in a variety of domestic and international projects. Most of the international activities that have been undertaken to date have been *ad-hoc*; they have been undertaken on a low priority basis in addition-to fulltime support and advocacy for the US education and research community. As opportunities continued to grow, it has become apparent that the UPC has a role to play in building international scientific partnerships and as such it needs to actively plan and seek appropriate resources for increased international collaborations.

The UPC proposes to continue playing an active role in extending its outreach internationally by aiding the ongoing deployment of the *IDD-Brazil* throughout South America and extending *IDD-Caribe* to serve Central American and Caribbean research and educational institutions; promoting the use of its data sharing technologies in Europe and Asia; and investigating ways to extend its services to Africa. The UPC seeks to assist leading international universities with connections to existing data sharing networks by:

- informing institutions of the existence of the data sharing through expanded outreach and advocacy activities at international conferences
- assisting in the installation and configuration of application servers akin to ones installed at the Universidad de Costa Rica and the Caribbean Institute for Meteorology and Hydrology as part of the MeteoForum project

- working with EUMETSAT in the deployment of satellite-based data distribution in Africa
- assisting sites in the use of real-time data by providing the same display and analysis applications used throughout the existing North American Unidata community at no cost
- assisting in connecting to the networks during site visits and conducting short training sessions that will allow sites to effectively operate their data ingest/relay nodes
- providing remote troubleshooting if and when problems arise
- assisting in the development of regional training workshops for use of Unidata systems in research and education
- assisting institutions in expanding their data distribution roles within their country and to other countries
- entraining users into the greater Unidata community through their active participation in email discussion groups and workshops
- promoting the sharing of locally held datasets of interest with the entire Unidata community
- working with sites to develop THREDDS data cataloging and remote data access services
- in collaboration with the community, convening and organizing regional workshops and meetings to bring communities together to address important issues
- promoting strategic partnerships centered around cyberinfrastructure and data sharing efforts
- deploying LEAD technologies for on-demand weather prediction to academic institutions outside the U. S.

Clearly, the extent to which Unidata can engage in the above activities will depend on the availability of resources and other considerations.

Appendix A: Unidata Tools

NetCDF

NetCDF (network Common Data Form) 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. NetCDF is by far the most widely distributed of all software packages provided by Unidata.

GEMPAK

The GEneral Meteorology PAcKage (GEMPAK) is an analysis, display, and product generation package for meteorological data. It is used at US National Centers for producing operational forecast and analysis products. A comprehensive set of decoders enables integration of real-time and archive data, products, and bulletins. GEMPAK is the most actively used Unidata display and analysis package. It is in use in the US and Central and South America.

McIDAS

The Man computer Interactive Data Access System (McIDAS) is a large, research quality suite of applications used for decoding, analyzing, and displaying meteorological data for research and education. The software can be used with conventional observational, satellite, and grid-point data. McIDAS is the oldest continuously supported and developed analysis package in the world. It is used on every continent to display, manipulate, and analyze a wide variety of satellite imagery. Unidata's license with McIDAS' developer, the Space Science and Engineering Center (SSEC) at the University of Wisconsin-Madison, allows distribution to educational institutions worldwide.

Integrated Data Viewer (IDV)

The Integrated Data Viewer (IDV) is a Java(TM)-based software framework for analyzing and visualizing geo-science data. The IDV brings together the ability to display and work with satellite imagery, numerical 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. The IDV's use is broadening beyond Unidata's core atmospheric science community. For instance, the Geosciences Network (GEON) project has adopted the IDV for its data analysis and visualization needs. The IDV is Unidata's fastest growing data analysis and visualization tool. It is currently being evaluated by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) for use in its international training activities. The IDV has been downloaded by users in North, Central, and South America, Europe, Russia, Korea, Japan, China, and Australia.

LDM

The Local Data Manager (LDM) is a collection of cooperating programs that select, capture, manage, and distribute arbitrary data products. The system is designed for event-driven data distribution, and is currently used in the Unidata Internet Data Distribution (IDD) project. The LDM system includes network client and server programs and their shared protocols. An important characteristic of the LDM is its support for flexible, site-specific configuration.

OPeNDAP/DODS

Originally developed at the University of Rhode Island and MIT and supported by Unidata, OPeNDAP/DODS servers make remote scientific data accessible to data analysis and visualization packages that link to OPeNDAP/DODS client interfaces. OPeNDAP is used to serve data in a wide variety of disciplines including agriculture, atmospheric science, oceanography, the biosphere, the cryosphere, the hydrosphere, solid earth sciences, paleo-climatology, land-surface disciplines, spectral engineering, and Sun-Earth interactions. OPeNDAP servers are maintained by academic institutions, commercial entities, US and foreign government agencies, multinational organizations, US Federal agencies, US state/regional agencies, and a variety of consortia.

UDUNITS

The Unidata units library, UDUNITS, supports conversion of unit specifications between formatted and binary forms, arithmetic manipulation of unit specifications, and conversion of values between compatible scales of measurement. UDUNITS is in use in a large fraction of the institutions where netCDF is used.

NetCDF and GRIB Decoders

The netCDF and GRIB decoder packages are used to manage GRIB and text data by either decoding the data into netCDF files or by decoding the data on the fly. This package of decoders is being used widely throughout the Unidata community.