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NAME OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE

University Corporation For Atmospheric Res

AWARDEE ORGANIZATION CODE (IF KNOWN)

4062600000

ADDRESS OF AWARDEE ORGANIZATION, INCLUDING 9 DIGIT ZIP CODE

BOULDER, CO 803055602
US

NAME OF PRIMARY PLACE OF PERF

University Corporation For Atmospheric Res

ADDRESS OF PRIMARY PLACE OF PERF, INCLUDING 9 DIGIT ZIP CODE

University Corporation For Atmospheric Res
1850 Table Mesa Dr
Boulder ,CO ,803055602 ,US.

IS AWARDEE ORGANIZATION (Check All That Apply) (See GPG II.C For Definitions)
☐ SMALL BUSINESS ☐ MINORITY BUSINESS ☐ FOR-PROFIT ORGANIZATION ☐ WOMAN-OWNED BUSINESS

☐ IF THIS IS A PRELIMINARY PROPOSAL THEN CHECK HERE

TITLE OF PROPOSED PROJECT **Unidata 2018: Transforming Geoscience through Innovative Data Services**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
$ **24,438,924**	**60** months	**12/01/13**	

CHECK APPROPRIATE BOX(ES) IF THIS PROPOSAL INCLUDES ANY OF THE ITEMS LISTED BELOW

☐ BEGINNING INVESTIGATOR (GPG I.G.2)
☐ DISCLOSURE OF LOBBYING ACTIVITIES (GPG II.C.1.e)
☐ PROPRIETARY & PRIVILEGED INFORMATION (GPG I.D, II.C.1.d)
☐ HISTORIC PLACES (GPG II.C.2.j)
☐ EAGER* (GPG II.D.2) ☐ RAPID** (GPG II.D.1)
☐ VERTEBRATE ANIMALS (GPG II.D.6) IACUC App. Date _____
PHS Animal Welfare Assurance Number _____

☐ HUMAN SUBJECTS (GPG II.D.7) Human Subjects Assurance Number _____
Exemption Subsection _____ or IRB App. Date _____
☐ INTERNATIONAL COOPERATIVE ACTIVITIES: COUNTRY/COUNTRIES INVOLVED (GPG II.C.2.j)
_____

PI/PD DEPARTMENT

UCAR Community Programs

PI/PD FAX NUMBER

303-497-8690

PI/PD POSTAL ADDRESS

Unidata Program Center
P.O. Box 3000
Boulder, CO 80301
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CO-PI/PD				
CO-PI/PD				

CERTIFICATION PAGE

Certification for Authorized Organizational Representative (or Equivalent) or Individual Applicant

By electronically signing and submitting this proposal, the Authorized Organizational Representative (AOR) or Individual Applicant is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding conflict of interest (when applicable), drug-free workplace, debarment and suspension, lobbying activities (see below), nondiscrimination, flood hazard insurance (when applicable), responsible conduct of research, organizational support, Federal tax obligations, unpaid Federal tax liability, and criminal convictions as set forth in the NSF Proposal & Award Policies & Procedures Guide,Part I: the Grant Proposal Guide (GPG). Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U.S. Code, Title 18, Section 1001).

Conflict of Interest Certification

When the proposing organization employs more than fifty persons, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Conflict of Interest:
By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the organization has implemented a written and enforced conflict of interest policy that is consistent with the provisions of the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Section IV.A; that to the best of his/her knowledge, all financial disclosures required by that conflict of interest policy have been made; and that all identified conflicts of interest will have been satisfactorily managed, reduced or eliminated prior to the organization's expenditure of any funds under the award, in accordance with the organization's conflict of interest policy. Conflicts which cannot be satisfactorily managed, reduced or eliminated must be disclosed to NSF.

Drug Free Work Place Certification

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent), is providing the Drug Free Work Place Certification contained in Exhibit II-3 of the Grant Proposal Guide.

Debarment and Suspension Certification

(If answer "yes", please provide explanation.)

Is the organization or its principals presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency? Yes ☐ No ☒

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant is providing the Debarment and Suspension Certification contained in Exhibit II-4 of the Grant Proposal Guide.

Certification Regarding Lobbying

This certification is required for an award of a Federal contract, grant, or cooperative agreement exceeding $100,000 and for an award of a Federal loan or a commitment providing for the United States to insure or guarantee a loan exceeding $150,000.

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:
(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, ''Disclosure of Lobbying Activities,'' in accordance with its instructions.
(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certification Regarding Nondiscrimination

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is providing the Certification Regarding Nondiscrimination contained in Exhibit II-6 of the Grant Proposal Guide.

Certification Regarding Flood Hazard Insurance

Two sections of the National Flood Insurance Act of 1968 (42 USC §4012a and §4106) bar Federal agencies from giving financial assistance for acquisition or construction purposes in any area identified by the Federal Emergency Management Agency (FEMA) as having special flood hazards unless the:
(1) community in which that area is located participates in the national flood insurance program; and
(2) building (and any related equipment) is covered by adequate flood insurance.

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) or Individual Applicant located in FEMA-designated special flood hazard areas is certifying that adequate flood insurance has been or will be obtained in the following situations:
(1) for NSF grants for the construction of a building or facility, regardless of the dollar amount of the grant; and
(2) for other NSF grants when more than $25,000 has been budgeted in the proposal for repair, alteration or improvement (construction) of a building or facility.

Certification Regarding Responsible Conduct of Research (RCR)
(This certification is not applicable to proposals for conferences, symposia, and workshops.)

By electronically signing the Certification Pages, the Authorized Organizational Representative is certifying that, in accordance with the NSF Proposal & Award Policies & Procedures Guide, Part II, Award & Administration Guide (AAG) Chapter IV.B., the institution has a plan in place to provide appropriate training and oversight in the responsible and ethical conduct of research to undergraduates, graduate students and postdoctoral researchers who will be supported by NSF to conduct research.
The AOR shall require that the language of this certification be included in any award documents for all subawards at all tiers.

CERTIFICATION PAGE - CONTINUED

Certification Regarding Organizational Support

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that there is organizational support for the proposal as required by Section 526 of the America COMPETES Reauthorization Act of 2010. This support extends to the portion of the proposal developed to satisfy the Broader Impacts Review Criterion as well as the Intellectual Merit Review Criterion, and any additional review criteria specified in the solicitation. Organizational support will be made available, as described in the proposal, in order to address the broader impacts and intellectual merit activities to be undertaken.

Certification Regarding Federal Tax Obligations

When the proposal exceeds $5,000,000, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal tax obligations. By electronically signing the Certification pages, the Authorized Organizational Representative is certifying that, to the best of their knowledge and belief, the proposing organization:
(1) has filed all Federal tax returns required during the three years preceding this certification;
(2) has not been convicted of a criminal offense under the Internal Revenue Code of 1986; and
(3) has not, more than 90 days prior to this certification, been notified of any unpaid Federal tax assessment for which the liability remains unsatisfied, unless the assessment is the subject of an installment agreement or offer in compromise that has been approved by the Internal Revenue Service and is not in default, or the assessment is the subject of a non-frivolous administrative or judicial proceeding.

Certification Regarding Unpaid Federal Tax Liability

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Federal Tax Liability:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has no unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

Certification Regarding Criminal Convictions

When the proposing organization is a corporation, the Authorized Organizational Representative (or equivalent) is required to complete the following certification regarding Criminal Convictions:

By electronically signing the Certification Pages, the Authorized Organizational Representative (or equivalent) is certifying that the corporation has not been convicted of a felony criminal violation under any Federal law within the 24 months preceding the date on which the certification is signed.

AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
NAME **Lori LaFon**	**Electronic Signature**	**May 28 2013 6:40PM**

TELEPHONE NUMBER	EMAIL ADDRESS	FAX NUMBER
303-497-2143	**loril@ucar.edu**	

* EAGER - EArly-concept Grants for Exploratory Research
** RAPID - Grants for Rapid Response Research

PROJECT SUMMARY

Overview:

Unidata is a community data facility for the atmospheric and related sciences, established in 1984 by U.S. universities with sponsorship from the National Science Foundation. While its founding mission -- making atmospheric science data available to university departments in near real time -- has remained central to Unidata's activities, Unidata's field of endeavor has grown to encompass a wide range of cyberinfrastructure technologies that make geoscience data more useful and easier for scientists and educators to access. Similarly, Unidata's member community has grown to include over 700 U.S. universities and colleges, forming a solid core of the more than 3000 educational, government, and research institutions that rely on Unidata technologies worldwide.

Intellectual Merit :

In this proposal, we have identified four strategic goals: enabling efficient access to geoscience data, developing tools for effective use of geoscience data, providing community leadership on geoscience cyberinfrastructure issues, and building and supporting a diverse geoscience community. This plan extends the work Unidata has done, addressing emerging issues related to ever-growing data volumes, complexity of data-centric scientific workflows, and IT resource constraints at our member universities.

Our approach to address these issues leverages the advantages of the robust cloud-based computing environments that have emerged in recent years. We plan to evolve and augment existing Unidata technologies with the goals of:

* Reducing the amount of data that must be transferred over computer networks,
* Reducing the complexity of the hardware and software environments our community members must maintain, while
* Increasing the flexibility of investigators to conduct science and extract knowledge from the deluge of geoscience data.

Through these efforts, Unidata will empower its users to tackle multidisciplinary grand challenge problems, develop the profession's human capacity, and transform the conduct of science.

Broader Impacts :

Although Unidata's core activities focus on serving scientists and educators in the atmospheric and related sciences, virtually every project Unidata undertakes has a broader impact on the geosciences community and society at large. Among the many examples:

* Unidata's impact on research is evidenced by references to Unidata software and services in more than 1100 scholarly articles in the past 5 years alone. Such impact is expected to continue.
* In education, Unidata has worked to encourage participation by a diverse array of academic institutions beyond its traditional constituency of universities granting degrees in the atmospheric sciences. Over 100,000 students in U.S. colleges and universities from all 31 EPSCoR states and numerous HACU and HBCU institutions are expected to use Unidata's products and services.
* Unidata-developed cyberinfrastructure will continue to be in wide use among U.S. federal agencies, private industry, and non-governmental and international organizations including NOAA, NWS, NASA, USGS, DOE, DOD, ECMWF, EUMETSAT, CMA, and CPTEC.
* Unidata undertakes a variety of activities with the goal of building a vibrant community in the geosciences and beyond, including mentoring undergraduate students at the Unidata Program Center, holding community workshops and attending scientific meetings, and participating in large-scale community projects such as OGC's GALEON and NSF's EarthCube. These collaborative efforts will be sustained during the next five years.

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For font size and page formatting specifications, see GPG section II.B.2.

*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Unidata 2018: Transforming Geoscience through Innovative Data Services

Data are the lifeblood of the geosciences. Rapid advances in computing, communications, and observational technologies — along with concomitant advances in high-resolution modeling, ensemble and coupled-systems predictions of the Earth system — are revolutionizing nearly every aspect of our field. The result is a dramatic proliferation of data from diverse sources; data that are consumed by an evolving and ever-broadening community of users and that are becoming the principal engine for driving scientific advances. Data-enabled research has emerged as a Fourth Paradigm of science, alongside experiments, theoretical studies, and computer simulations (Hey *et al.*, 2010).

For more than a quarter century, Unidata has worked in concert with the atmospheric science education and research community to develop and provide innovative data systems, tools, techniques, and resources to support data-enabled science to understand the Earth system. In doing so, Unidata has maintained a close, synergistic relationship with the universities, engaging them in collaborative efforts to exploit data and technologies, and removing roadblocks to data discovery, access, analysis, and effective use.

Unidata's long experience helping geoscientists incorporate data-centric techniques into their scientific workflows positions us perfectly to help our community take advantage of a rapidly changing scientific landscape. Science is shifting in emphasis from pure disciplinary research to a more balanced mix that advances disciplinary knowledge while looking to apply research results to interdisciplinary "grand challenge" problems touching both science and society. Unidata is in an ideal position to adapt to and capitalize on the rapid advances in information technology that will enable the community to incorporate the dramatic explosion of data volumes into their research and education programs. This will ensure that the next generation of students and young researchers in the Unidata community become leaders using state-of-the-art tools, technologies, and techniques.

Unidata's community expects it to both *lead* through innovation and *follow* the community's direction by being responsive to its changing needs. We welcome these challenges, viewing them as opportunities to enhance our community's ability to work together to create knowledge, while recognizing that our own ability to adapt and change as new technologies emerge is crucial to our continued success.

To that end, this proposal charts a course for the next five years, laying out our plans for sustaining and enhancing the Unidata program. While the goals and the action plan articulated here are consistent with and in furtherance of the National Science Foundation's vision and goals to transform the conduct of science, it provides a specific vision in which community members are empowered to tackle emerging data-related scientific and educational problems in more innovative, efficient, and productive ways. Achieving the goals in this proposal will bring our community closer to the vision of *geoscience at the speed of thought* articulated in our strategic plan, dramatically reversing today's situation in which young researchers spend 80 percent of their time performing data-related tasks and only 20 percent "doing meaningful science." Through the proposed activities and concrete steps described here, Unidata commits to work toward enabling that transformation.

Who We Are and What We Do

Unidata (http://www.unidata.ucar.edu) is a community data facility for the atmospheric and related sciences, established in 1984 by U.S. universities with sponsorship from the National Science Foundation (NSF). The Unidata Program Center (UPC), the program office for Unidata and the nexus of activities related to Unidata's mission, is managed by the University Corporation for Atmospheric Research (UCAR), a consortium of over 104 member universities and academic affiliates providing science in service to society.

Unidata exists to engage and serve researchers and educators dedicated to advancing the frontiers of Earth System science. The program's aim is to help transform the conduct of research and education in atmospheric and related sciences by providing well-integrated, end-to-end data services and tools that address many aspects of the scientific data lifecycle, from locating and retrieving useful data, through the process of analyzing and visualizing data either locally or remotely, to curating and sharing the results.

Specifically, the UPC:

- Acquires, distributes, and provides remote access to real-time meteorological data.
- Develops software for accessing, managing, analyzing, visualizing, and effectively using geoscience data.
- Provides comprehensive training and support to users of its products and services.
- In partnership with others, facilitates the advancement of tools, standards and conventions.
- Provides leadership in cyberinfrastructure and fosters adoption of new tools and techniques.
- Assesses and responds to community needs, fostering community interaction and engagement to promote sharing of data, tools, and ideas.
- Advocates on behalf of the community on data matters, negotiating data and software agreements.
- Grants equipment awards to universities to enable and enhance participation in Unidata.

Unidata is governed by its community. Representatives from universities populate standing and *ad hoc* committees that set policies for the program, provide first-hand feedback from users of program software and services, and offer guidance on individual projects. Non-voting representatives from government agencies also provide valuable information and advice. Unidata's governance structure ensures that the program stays in tune with the community it serves, and allows it to quickly adjust program priorities as the technological landscape and community needs change.

While Unidata's primary mission of serving universities engaged in atmospheric science education and research has remained unchanged through the years, the evolution and broad usefulness of its products and services have greatly enlarged its initial user base. Today, the Unidata community includes users from all sectors in over 200 countries, including nearly 2500 academic institutions and more than 80 research labs. Simultaneously, Unidata's activities and responsibilities have also grown as community needs have evolved. Despite the growth in users and enhanced scope of its activities, according to a 2010 survey conducted by the Unidata Users Committee, 97% of the respondents indicated that they were either satisfied or highly satisfied with Unidata's overall service to the community.

Last year, with community input and engagement of its governing committees, Unidata developed a strategic plan (http://bit.ly/121cdE1), creating a roadmap and a vision for the future. The overarching goal embodied in that plan is the creation of a scientific ecosystem in which "data friction" (Edwards, 2010) is reduced and data transparency and ease-of-use are increased. In such an environment, scientists will expend less effort locating, acquiring, and processing data and more time interpreting their data and sharing knowledge.

To accomplish the goals set forth in our strategic plan, Unidata will continue to build and provide infrastructure that makes it easy to discover, access, integrate and use data from disparate geoscience disciplines, allowing investigators to perceive connections that today are obscured by incompatible data formats or the mistaken impression that the data they need for their investigations do not exist. This proposal serves as an implementation plan for accomplishing those goals, moving our community toward the realization of our overarching vision.

Unidata Snapshot

The following tables provide a snapshot of the Unidata program in May 2013, with comparisons to metrics from the previous NSF proposal (where available).

Table 1: Data Services	2008	2013
Institutions Participating in the IDD network[1]	170	263
Host machines on the IDD network[1]	460 (250 unique sites)	520 (232 unique sites)
Data streams in the IDD	22	34
Approximate volume of data ingested into the IDD	100 GB/day	315 GB/day
Volume of data pushed to IDD sites	2.7 TB/day	13 TB/day
Volume of data pulled via remote access protocols	44.3 GB/day	659 GB/Day
Uptime of UPC data and support infrastructure	99.96%	

Table 2: Software Package Downloads	2008-2012
GEMPAK	11,801
IDV	43,944
Local Data Manager	11,455
McIDAS	857
netCDF-C Libraries (includes FORTRAN, C++ support)[2]	408,250
netCDF-Java Libraries (Common Data Model)	89,416
THREDDS Data Server	7,176
UDUNITS	26,265

Table 3: Workshops	2003-2007	2008-2012
Training Workshop Participants	335	475
Training Workshop Courses	38	33
Users Workshop Participants	164	183
Regional Workshop Participants	44	162

Table 4: Miscellaneous	2013
Number of community members registered with Unidata	44,231
Number of countries where Unidata software and services are used	214
Number of academic institutions participating (U.S.)	743
Number of academic institutions participating (worldwide)	2,495
Number of organizations participating worldwide	3,032
Number of community electronic mail lists	58
User support e-mail transactions, 2008-2012	21,388
Number of Community Equipment Awards, 2008-2012	30
Average staff FTEs at the UPC, 2008-2012	25

[1] These metrics are limited to sites of which Unidata is aware. Sites can use the LDM and participate in the IDD without reporting statistics to the UPC; we *suspect* the number of unreported sites is large.
[2] UPC source code downloads only. This number does not include downloads from repositories at the University of Kyoto and on the Github site, or binary distributions available via package managers on UNIX-like systems.

Unidata Focus Activities

Unidata Program Center staff are involved in a wide variety of projects in support of the Unidata community, including data distribution, software development, user support and training, and community service and leadership activities. The activities undertaken by the UPC span years or decades and affect thousands of users around the world. In a different context – without the unifying locus of the Unidata program – one could imagine many of Unidata's projects as candidates for NSF funding in their own right. As it is, our projects are able to build on and leverage each other's capabilities, advancing our community's goals more effectively as a result. The Plan of Action that follows describes how activities in these areas will address Unidata's strategic goals for the empowerment of its broad community.

Data Distribution

The UPC coordinates the Internet Data Distribution system (IDD), in which hundreds of universities cooperate to disseminate near real-time earth observations via the Internet. While the "push" data services provided by the IDD system are the backbone of Unidata's data distribution services, the UPC also provides on-demand "pull" data services via THREDDS, ADDE, and RAMADDA data servers.
The UPC's data servers are not classified as "operational" resources, but they nonetheless have a 99.96% uptime record and are used heavily by educational sites that lack the resources to store IDD-provided data locally, or to operate their own data servers (see Table 1). UPC's servers are housed in a UCAR co-location computer facility for reliability, and share UCAR's Internet2/National Lambda Rail connectivity, which provides access to ample bandwidth for Unidata's needs.

Software Development

A variety of software packages are developed, maintained, and supported by the UPC:

NetCDF

Unidata's netCDF (network Common Data Form) is a freely distributed collection of data access libraries that provide a machine-independent data format that is self-describing, portable, scalable, appendable, sharable, and archivable – all important qualities for those who wish to create, access, and share array-oriented scientific data. NetCDF permits easy access to array-based, multi-dimensional datasets, a task that can be difficult when using other common storage schemes. NetCDF has been adopted widely by the atmospheric sciences community, and is especially popular among climate and ocean modelers. For example, model output datasets for the Fifth Assessment Report of the Intergovernmental Panel on Climate Change must be submitted in netCDF format, using the associated Climate and Forecast (CF) metadata conventions. The resulting large base of netCDF users and data has led to support for the format in more than 80 open source packages and many commercial applications including MATLAB and IDL.

Common Data Model & THREDDS Data Server

Unidata's Common Data Model (CDM) provides an interface for reading and writing files in netCDF and a variety of other scientific data formats. The CDM uses metadata to provide a high-level interface to geoscience-specific features of datasets, including geolocation and data subsetting in coordinate space. Unidata's THREDDS Data Server (TDS) builds on the CDM to allow for browsing and accessing collections of scientific data via electronic networks. Data published on a TDS are accessible through a variety of remote data access protocols including OPeNDAP, OGC Web Map Service (WMS) and Web Coverage Service (WCS), NetCDF Subset Service (NCSS), and HTTP.

The CDM and TDS are widely used in the United States (by NOAA, USGS, NASA, and the Earth System Grid, for example) and internationally, and are part of the deep infrastructure on which next generation capabilities are being built by other organizations. Additionally, many other tools build on the

CDM (NOAA's ERDDAP, NASA's Panoply, and CMAS' VERDI, are examples) and on the TDS (NOAA PMEL's LAS and Ferret-TDS, for example).

Integrated Data Viewer

Unidata's Integrated Data Viewer (IDV) is a 3D geoscience visualization and analysis tool that gives users the ability to view and analyze a rich set of geoscience data in an integrated fashion. The IDV brings together the ability to display and analyze satellite imagery, gridded data (such as numerical weather prediction model output), surface observations (METARs), upper air soundings, NWS NEXRAD Level II and Level III RADAR data, NOAA National Profiler Network data, and GIS data, all within a unified interface. The IDV integrates tightly with common scientific data servers (including Unidata's TDS) to provide easy access to many real-time and archive datasets. It also provides collaborative features that enable users to easily share their own data holdings and analysis products with others.

AWIPS II & GEMPAK

AWIPS II is a weather forecasting, display, and analysis package currently being developed by the NWS and NCEP. Because many university meteorology programs are eager to use the same tools used by NWS forecasters, Unidata community interest in AWIPS II is high. UPC staff have worked closely with NCEP staff during AWIPS II development in order to devise a way to make it available to the university community.

NCEP has stated that GEMPAK applications will be migrated from GEMPAK/NAWIPS into AWIPS II for the National Centers. The UPC will likewise facilitate a migration from GEMPAK/NAWIPS to AWIPS II for the university community.

Rosetta

The Rosetta project at the UPC is an effort to improve the quality and accessibility of observational data sets collected via datalogging equipment. The initial goal of Rosetta is to transform unstructured ASCII data files of the type commonly generated by datalogging equipment into the netCDF format, while minimizing disruption to existing scientific workflows.

Local Data Manager

The Unidata Local Data Manager (LDM) system includes network client and server programs designed for event-driven data distribution. It is the fundamental component of the IDD system. The LDM is used by hundreds of sites worldwide, and is integrated into the National Weather Service's AWIPS II package.

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. The older McIDAS-X system, developed by the University of Wisconsin's Space Science Engineering Center and supported by Unidata, is gradually being replaced by the IDV and by McIDAS-V (which is based on the IDV).

UDUNITS

Unidata's UDUNITS supports conversion of unit specifications between formatted and binary forms, arithmetic manipulation of units, and conversion of values between compatible scales of measurement.

RAMADDA

The Repository for Archiving, Managing and Accessing Diverse Data (RAMADDA) is a vibrant and growing technology initially developed by Unidata and now managed and developed as an open source project. Unidata integrates RAMADDA functionality into the IDV, provides training and support, and contributes code to the project. In addition, Unidata makes extensive use of RAMADDA to support

community and collaborative projects, and actively facilitates its deployment in the university community.

User Support and Training

Users of Unidata software and data rely on the UPC for comprehensive support services. UPC software developers handle user support directly, together responding to an average of more than 250 technical support questions each month. Developers also create product documentation, training materials, and provide hands-on training workshops each year. The workshops, which have been attended by more than 450 participants from the university, government, and commercial spheres in the past five years, provide UPC developers with an excellent opportunity to interact with software users face-to-face.

Cyberinfrastructure Leadership

Unidata community members look to the UPC not only for technological solutions, but for guidance on emerging trends in cyberinfrastructure and to represent their interests in collaborations with standards bodies and organizations that work across scientific disciplines. As standards-based solutions have become increasingly important to the conduct of international science, Unidata has assumed a central role in identifying and articulating standards, conventions, and data formats. Unidata's standards efforts have enabled ongoing collaboration with dozens of international organizations – especially those represented in the OGC MetOceans, Earth System Science, and Hydrology Domain Working Groups.

Community Service Activities

The UPC undertakes a wide variety of activities aimed at fostering a shared vision for and community ownership of the program and encouraging community input into its operation and direction. Bringing the community and stakeholders together to share knowledge and address problems that are important to them through meetings, workshops, conferences, and other venues is a key aspect of Unidata's community service mission, as are efforts to disseminate information of interest to community members.

Results of Prior Support Under NSF 0833450

A great majority of activities at the UPC are sponsored under the five-year core-funding award "Unidata 2013: A Transformative Community Facility for the Atmospheric and Related Sciences" (NSF 0833450). The period of performance for that award is 1 December 2008 to 30 November 2013.

The core-funding proposal identified six thematic areas as the focus of Unidata's efforts:

1. Broadening participation
2. Advancing data services
3. Developing and deploying useful tools
4. Enhancing user support services
5. Providing leadership in cyberinfrastructure
6. Promoting diversity

During the period of performance for the current award, Unidata met most of the goals described in that proposal, accomplishing many of the stated objectives.

Unidata significantly increased the reliability, volume, and variety of data provided to the community, extended the functionalities of its software, developed and deployed new tools and services, and actively engaged its growing user community. The program's contributions and accomplishments have had a demonstrable and sustained impact on the geosciences community, empowering faculty, students, and researchers to be more productive and enhancing their ability to advance science and learning.

Key Achievements 2008-2013

The following list highlights, in no particular order, Unidata's most significant accomplishments during the past five years.

- **Data Delivery.** The volume of data input to Unidata's IDD cluster has more than tripled since 2008, now averaging over 13 GB/hr; data output averages more than 540 GB/hr. Numerous new datasets were added to the IDD system, including higher resolution WSR-88D products (February 2010), Global Lightning Network (GLN) and North American Precision Lightning Network (NAPLN) (April 2011), Fire Weather products (September 2011), and Rapid Refresh (RAP) grids (replacing RUC grids April 2012).
- **OGC Standards.** In 2011, the netCDF Classic data model was accepted as an OGC core standard. The binary encoding for the classic data model was established as the first extension to the netCDF core standard, followed by the enhanced data model and the CF (Climate and Forecast) conventions extension in 2012 and 2013. These advancements encourage broader international use and greater interoperability among clients and servers interchanging data in netCDF format and will make the large collections of environmental netCDF data more readily accessible and usable.
- **NetCDF.** Unidata released netCDF-4 in late 2008, incorporating an expanded data model, compression, parallel I/O, multiple unlimited dimensions, user-defined data types, and other features supported by the HDF5 format. The NOAA GOES-R project will make all L2 and L2+ products available in netCDF-4 format. NetCDF is also used in other disciplines, including chromatography, neuro-imaging, molecular dynamics, and fusion research.
- **Integrated Data Viewer.** Among a wide variety of improvements to the IDV were support for analysis and visualization of ensemble model output, improved handling of sub-minute data and long range climate data, and addition of trajectory functionality. The IDV is now in use at more than 180 US-based, degree granting universities, colleges and technical schools, and at over 200 academic institutions abroad.
- **AWIPS II.** The UPC has been actively collaborating with NCEP and the NWS Office of Science and Technology to ensure that the AWIPS II software will be available to the academic community soon after it is operational. To that end, the UPC has been working to implement AWIPS II software on the types of computer systems that would typically be available in universities, and has partnered with universities in a beta testing program. The UPC is preparing to release the software more broadly to the university community by the end of 2013.
- **EarthCube Activities.** UPC staff have been active in NSF's EarthCube initiative, contributing several whitepapers, participating in the EarthCube charrettes and meetings, and being involved in four EAGER-award projects that generated roadmaps for EarthCube's further development. In December 2012, the UPC organized and hosted an NSF-sponsored workshop titled "Shaping the Development of EarthCube to Enable Advances in Data Assimilation and Ensemble Prediction."
- **Equipment awards.** During 2009-2013, the UPC provided 30 equipment grants to 27 universities, encouraging new members from diverse disciplinary backgrounds in the geosciences to join the Unidata community and to allow existing members to continue and enhance their active participation. The facilities developed with funding from these awards are transforming faculty instruction and student learning at those universities in a demonstrable manner.
- **Community Workshops.** In addition to its annual training workshops, the UPC organized and hosted triennial Users Workshops in 2009 and 2012, each of which brought nearly 100 community members together to share tools, techniques, and educational strategies. UPC staff also helped community universities organize and present regional workshops at California University of Pennsylvania and San Jose State University.

- **Move to Open Source Development Methods.** The UPC software team has adopted Open Source development methods including community access to source code, issue tracking, and release planning information to encourage community participation and contribution.
- **RAMADDA.** RAMADDA was originally developed by Unidata and released during the award period. RAMADDA is an information management and data repository framework for the geosciences that provides a turnkey system enabling data providers and users to upload, manage, and share data holdings.
- **GOES Data.** The UPC continues to ingest GOES-East, West, and South America imager data for injection into the IDD. GOES imagery remains one of the most-used data services in the Unidata suite, serving over 3 TB of data per month, and providing support for major field campaigns.
- **THREDDS Data Server and Common Data Model.** Unidata's TDS and its underlying CDM library have matured significantly and seen major enhancements in the last five years. As a result, the TDS is now in use in a large number of universities, organizations, and data centers; many third-party tools build on the CDM library.

Additional Highlights 2008-2013

In addition to the above-listed achievements, the following sections provide a snapshot of proposed objectives from NSF 0833450 and a brief summary of achievements in each of the six thematic areas.

Broadening Participation and Expanding Community Services

Objective	Accomplishments
Foster community ownership of the program	Moved several Unidata software projects to the Open Source environment Github. We are already seeing the fruits of this in the form of code contributions from community members.
Entrain community colleges into the Unidata community	Unidata now has 44 community college members. Provided equipment awards to Lyndon State College and Madison Area Technical College.
Bring community together through workshops, meetings, conferences, etc.	Hosted an NSF-sponsored EarthCube workshop focused on the meteorological domain in December 2012. Hosted and participated in several AccessData science education outreach workshops 2008-2010. Hosted OGC Technical Committee Meeting September 2011.
Develop global partnerships with geoscience data providers	Established working relationships with the British Atmospheric Data Center, ESSI Labs (Italy), ECMWF, EUMETSAT, and CPTEC (Brazil).

Advancing Data Services

Objective	Accomplishments
Develop and provide high-level interfaces to geoscience data	The Common Data Model (CDM) allows data servers to provide seamless access to data in a wide variety of geoscience formats (netCDF, GRIB, GEMPAK, *etc*.)
Adopt, develop, and promote open standards, conventions, and protocols	Worked closely with the OGC to establish netCDF as an international data standard. Actively participated in efforts to standardize and implement the Climate and Forecast (CF) conventions for metadata, which are used by the IPCC and many others. Implemented OPeNDAP client access.
Enable users with data holdings to contribute and share their data easily	The TDS now makes it possible to publish a wide range of scientific data for access by any client that implements the OPeNDAP protocol. RAMADDA makes it easy to publish small to medium-sized datasets. Both servers integrate tightly with the IDV.

Provide frameworks for creating dynamic case study datasets	RAMADDA facilitates the creation of dynamic case study materials by providing the ability to "federate" servers so that data from different locations appears as part of a single dataset.

Developing and Deploying Useful Tools

Objective	Accomplishments
Enhance the usefulness of the Integrated Data Viewer (IDV)	Major releases spanning versions 2.6 to 4.0. The IDV can now access and visualize every data stream provided by Unidata, including ensemble model output, sub-minute data such as lightning flash data, and long-range climate data. Collaborations with developers at other facilities have led to improved graphics capabilities.
Continue to package and support GEMPAK for the university community	Major releases spanning versions 5.11 to 6.7. Began distributing GEMPAK releases as source-code rather than binary form in 2009. GEMPAK usage has remained strong, with downloads averaging more than 200 per month in 2012.
Continue to support McIDAS-X for the university community	Unidata continues to support and release versions of McIDAS-X, which is developed at the University of Wisconsin-Madison's Space Science Engineering Center.
Build expertise with the AWIPS II system	AWIPS II has not yet been released to the Unidata community by NCEP. UPC developers are actively collaborating with NCEP to refine the AWIPS II package and prepare a version for release to universities. Five universities are participating in a beta test program.
Deploy RAMADDA	The RAMADDA scientific content management system was released to the Unidata community. Ongoing development has been transitioned to the open source community, and the UPC continues to provide support and training to the university community.
Develop new tools to make it easier to access geoscience data	Initial work on the Rosetta project began in 2011. Rosetta is a web-based service that will provide the ability to read from and write to a wide variety of scientific data formats.

Enhancing Support Services

Objective	Accomplishments
Foster effective communication among community members	In addition to traditional electronic mailing lists, the UPC has begun using blogs and social media channels communicate with community members. Ninety technical articles are now available on the Unidata developers' blog.
Harness advances in online collaboration technologies	The UPC has adopted open source community tools like Github to foster collaboration with software developers individually or in other organizations around the world.
Simplify download, installation, and maintenance of supported packages	Made major improvements to the process of building and using netCDF in the Microsoft Windows environment. Streamlining the process of installing and configuring web-based services like the TDS, RAMADDA, and Rosetta.
Document available datasets, datastreams, and services	Created a series of data flowcharts to clarify the relationship between Unidata tools and different types of data provided via the IDD.

Providing Leadership in Cyberinfrastructure

Objective	Accomplishments
Provide stewardship for standards, data formats, conventions, and protocols	UPC staff have worked closely with the OGC to recognize netCDF as an international standard and provided the C reference client for the OPeNDAP protocol standard. Staff continue to work to extend the netCDF standard.

Take a leadership role in setting future directions for geoscience cyberinfrastructure	UPC staff have been active in the NSF's EarthCube initiative, hosting a workshop in 2012. Staff have also worked with the OGC to define data encoding standards, advocated for solutions to problems with the WMO's GRIB format, and worked to advance adoption of the Climate and Forecast (CF) metadata conventions.
Help guide the evolution of international data system standards	Outreach collaborations by Unidata staff include: Marine Metadata Interoperability (MMI) Project Steering Team, IOOS DMAC Steering Team, CUAHSI Standing Committee, UCAR-wide representative to OGC Technical Committee, AGU ESSI Focus Group Board, ESIN Journal Editorial Board, Liaison to OOI Cyberinfrastructure Project, several collaborations with EarthCube teams, member of Steering Committee for international Ocean Data Interoperability Platform (ODIP), Chair of European Space Agency (ESA) Earth Observation Product Trees Project.
Serve as a testbed for deployment of emerging technologies	The UPC has worked closely with NCEP and Raytheon to test the AWIPS II system in preparation for non-operational university deployment.

Promoting Diversity by Expanding Opportunities

Objective	Accomplishments
Engage a highly diverse population of educators and researchers	Unidata's governing committees include educators and researchers from large and small institutions across the U.S. UPC staff engage with a variety of scientists worldwide through conferences, electronic communications, and organizations such as the AMS, AGU, and OGC. In order to reach out to students, the UPC has begun attending student conferences and career fairs, and continues to have a student representative on its Users committee.
Develop/promote specific opportunities to broaden participation from underrepresented communities	In partnership with UCAR's Community Development Program, Unidata staff made presentations to and worked with collaborators from Tribal College and Alaska Native communities for establishing closer ties between UCAR and those communities. Made equipment awards to HBCU and HSI institutions.
Continue participation in the UCAR-led SOARS program	UPC staff have participated actively as mentors for three SOARS protégés over four of the past five years, and will continue in 2013.

Broader Impacts

Unidata's predominant impetus is service to its community. As shown in Table 4 (page 3), Unidata's products and services are in use by over 3000 organizations including nearly 2500 academic institutions in over 200 countries (see a map online at http://www.unidata.ucar.edu/about/usage/index.html#map). Many dozens of research labs, national and international agencies, weather services around the world, and projects large and small benefit from Unidata technologies. Unidata's scientific software libraries are routinely used by scientists and service providers in most geoscience disciplines; they are embedded in more than 20 commercial and 100 open source software packages.

Although our core activities focus on serving scientists and educators in the atmospheric and related sciences, virtually every project Unidata undertakes has a broader impact on the geosciences community and society at large. This section touches on some of the ways Unidata enables research in the geosciences, enhances education in universities and colleges, provides support to our collaborators and users of our software, and strives to build a larger and more active community.

Impact on Research

The impact of Unidata's data systems, software, and services on scientific research extends far beyond our core atmospheric science community. The number and diversity of publications in peer-reviewed journals that cite Unidata or its software is one compelling measure of the growing impact of Unidata's services on research.

For example, a survey of papers published between 2008 and 2012 in journals of the American Meteorological Society shows 110 citations of Unidata software and data services. In the same period, an additional 52 papers published in journals of the American Geophysical Union cited Unidata software and data services. In both cases, papers published in the past five years account for nearly half the total number of citations recorded over more than a quarter century of Unidata history – an indicator of the growing reach of Unidata's software and services.

A review of citations reported by the Google Scholar search engine revealed similar results. Between 2008 and 2012, Unidata software and data services were cited 1150 times in the full range of scholarly literature encompassed by the search engine. Interestingly, Google Scholar returned an additional 3690 articles mentioning netCDF, but which did not include mention of its connection to Unidata. This correlates with anecdotal evidence of widespread netCDF use beyond the communities traditionally served by Unidata. Again, comparing the number of citations recorded in the past five years with a complete history indicates that roughly half of the citations have come in since 2008.

In 2012, the UPC surveyed longstanding academic community members to find what types of research Unidata software and data services are enabling today. Among the comments were:

- *We use Unidata software/facilities quite extensively from getting global model analysis/forecast fields in real time for high-resolution coupled model development and forecasting experiments, getting satellite data for analysis, and to display our model results in IDV.*
- *Several Professors are involved with field programs that have intensive observing periods that include aircraft, etc. Unidata-provided weather and model information is integral (anywhere from minor to absolutely essential) to the field program and operational decisions. In addition, software and real-time data provided by Unidata is part of the post-field program analysis.*

Looking beyond the self-reported activities of Unidata community members, a survey of some recent academic journal citations highlights the use of Unidata technologies in a wide range of contexts including:

- The Gulf of Mexico Coastal Ocean Observing System (Simoniello *et al*., 2011)
- Algorithms for Detecting and Tracking Tropical Cloud Clusters (Hennon *et al*., 2011)
- Bridging the gap between Hydrologic and Atmospheric communities (Boldrini *et al*. 2012)

Impact on Education

As mentioned earlier, Unidata software and data services are in use at nearly 750 U.S. colleges and universities and more than twice that many in other countries. Unidata reaches across geoscience disciplines to provide data and tools to researchers, educators, and students in the atmospheric sciences, hydrology, and oceanography fields, among others. From research universities to community colleges, Unidata provides timely support and service to the academic organizations that are training the next generation of geoscientists. In the process, it is estimated that more than 100,000 users are exposed to products generated using Unidata software and systems, and more than three quarters of all graduate students in the atmospheric and related sciences now use software provided by Unidata.

For example, Pennsylvania State University considers Unidata's IDD feed, along with analysis/display software packages including GEMPAK/NAWIPS and IDV, to be vital tools for research, instruction and outreach. Unidata software allows students to explore current and past weather scenarios as part of upper-

level undergraduate meteorology courses, and is also used for the generation of graphics for the popular and publicly-available Penn State electronic map wall.

Unidata strives to promote diversity in the geosciences by supporting use of its technologies in a wide array of educational institutions. Unidata software and data services are used at universities in all 31 EPSCoR jurisdictions, including many institutions that have a large number of students from underrepresented communities.

Community Equipment Awards

Each year, the UPC sets aside $100,000 to fund the Unidata Community Equipment Awards program. The program provides funds to encourage new geoscience departments to join the Unidata community and to allow existing members to continue and enhance their participation. During the past five years, 30 awards were made to a diverse group of institutions, from major U.S. research universities to community colleges to educational institutions in Europe and Central America.

Projects funded in the past five years include:

- **Madison Area Technical College** used award funding to introduce modern weather software into its meteorology curriculum, ingesting data from Unidata's IDD for display using McIDAS and IDV.
- The **Coastal Ocean Observation Lab at Rutgers University** (RU-COOL) used award funding to install Unidata and other open source technologies to collect, process, and make available a wide range of ocean data for use by students and researchers.
- **Iowa State University** used award funding to establish THREDDS and RAMADDA servers that provide access to the university's weather data archive to students and the Unidata community.

A complete list of projects funded under the Community Equipment Awards program and the many creative applications of Unidata software and systems by the recipient universities to advance education and research is available online at http://www.unidata.ucar.edu/community/equipaward/.

Impact on Other Organizations and Projects

Unidata-developed cyberinfrastructure, in addition to being used widely in universities to advance education and research, also provides a substrate for other stakeholders in federal agencies, the private sector, and many non-governmental and international organizations. For instance, many data services in NOAA, NWS, NASA, USGS, DOE, DOD, NCAR, ECMWF, EUMETSAT, CMA, and CPTEC are built on the formats, software, and data systems that Unidata has developed. Unidata systems and technologies are integral parts of numerous large-scale projects, including SuomiNet, THORPEX, GEON, EarthScope, IPY, and others.

The letters of commitment to collaborate from some of Unidata's partners, provided in Appendix A, provide a view of how Unidata's work is having a positive impact on those organizations.

Some additional examples not previously mentioned:

- **ESRI** has made support for netCDF and the Climate and Forecast metadata conventions an important component of its ArcGIS software package.
- Numerous **NASA EOSDIS Data Centers** (PO.DAAC, ORNL DAAC, GES DISC *etc*.) are using the THREDDS Data Server to make geoscience datasets available to researchers and the public.
- **Weather Decision Technologies** of Norman, OK uses Unidata's LDM to retrieve weather data that is fed to its family of iMap mobile and online weather applications.
- Over the course of **NASA's Space Shuttle program**, the LDM was used to transport observational and experimental data from a variety of sources. The UPC received a commendation from the NWS's Spaceflight Meteorology Group in 2011 for providing LDM software and technical support for both the LDM and McIDAS packages. (Read more online at http://bit.ly/nl4e1o)

- Unidata, in collaboration with sister UCAR entities and external institutions, participates in the **Google Africa Initiative** Meningitis Project. Unidata technologies including LDM, IDV, RAMADDA, THREDDS, and McIDAS ADDE are used in the collection and dissemination of data relevant to the project. (Read more online at http://bit.ly/103dVls)
- The US **Integrated Ocean Observing System** (IOOS) has deployed a total of 17 THREDDS Data Servers at both academic and government institutions. At each location, NcML is used to deliver model output via OPeNDAP as CF-compliant datasets.
- Within days after the Fukushima earthquake and tsunami, the OceanNOMADS group at the **National Coastal Data Development Center** deployed a THREDDS Data Server that made it possible to deliver output from a US Navy model (predicting the transport of contaminated material in the ocean) to ships in the region. The TDS let scientists retrieve just the data in the vicinity of their ship, allowing them to predict where the water they sampled would be the following day.
- The **MyOcean project**, a part of the European Commission's Global Monitoring for Environment and Security (GMES) program, uses THREDDS Data Servers to provide WMS, OPeNDAP, and other data access and viewing capabilities for users of data collected by MyOcean provider sites. (Read more online at http://bit.ly/Yerfqz)

Building Community

Unidata undertakes a variety of activities with the goal of building a vibrant community in the geosciences and beyond. The following are a sampling of activities not previously mentioned:

- **Scientific Society Meetings**
  Unidata staff are active in convening sessions and making presentations at AGU, AMS, and EGU meetings as well as at other national and international conferences and workshops. UPC staff members helped create AGU's Earth and Space Science Informatics session in 2004; participation in the AGU ESSI program has grown to over 400 abstracts for the 2012 Fall Meeting. The EGU ESSI Division was formally launched in 2008 with the active involvement of UPC staff; it has grown significantly, receiving over 300 papers at the 2013 EGU Geosciences Meeting.
- **GALEON**
  Unidata has been a core participant in the Open Geospatial Consortium GALEON (Geo-interface for Air, Land, Earth, Oceans NetCDF) Interoperability Experiment. GALEON aims to specify and use standard interfaces to foster interoperability between data systems used by the traditional GIS community and those in the atmospheric and oceanographic science or Fluid Earth Systems (FES) communities. (Read more online at http://bit.ly/12WI75U)
- **Helping Community Members Reach the Public**
  Unidata technologies help community members reach out to their own communities, facilitating the provision of meteorological data and displays through dozens of popular web sites. For example, the College of DuPage, Iowa State University, University of Wyoming, University of Oklahoma, and University of Utah's Mesowest all make extensive use of Unidata services in their outreach. In addition, several museums (the Boston Museum of Science and San Francisco's Exploratorium among them) make use of either data or software provided by Unidata.

Synergistic Activities

For the benefit of the geoscience community, the UPC participates in projects and undertakes activities that are funded through non-core awards. These projects are always consistent with Unidata's mission, and synergistic with ongoing core-funded activities. We believe that these collaborations are essential to maintaining a healthy program, and that many benefits accrue to our community. In addition to the intrinsic merit of the projects, non-core funding brings modest additional resources to the UPC

(contributing about 10% of overall funding), relieving some of the pressure on Unidata's budget. Both the Unidata Policy Committee and NSF have encouraged Unidata to participate in synergistic opportunities as appropriate. The UPC undertakes non-core projects only after careful analysis of their merit and benefits to our core community, and endorsement by the Policy Committee.

Historically, synergistic projects have created new capabilities, provided new datasets for the community, and leveraged ongoing activities. Here are some examples of previous projects:

- The NWS provided funding for creation of COMET-Unidata case study data sets.
- Initial THREDDS development was funded by NSF/EHR under the NSDL initiative.
- The LEAD project motivated the development of uploading capabilities in RAMADDA.
- The integration of HDF5 into netCDF occurred as a result of a NASA-funded project.

Currently, Unidata is participating in the following two non-core projects:

OPULS: The OPeNDAP-Unidata Linked Servers project, funded by NOAA, reflects the intentions of the two organizations to better align, link, and eventually integrate software that they independently offer as open source. The union of the capabilities provided by the TDS and Hyrax software offerings has become increasingly important as basic infrastructure for scientific data exchange.

ACADIS: The Advanced Cooperative Arctic Data and Information Service is a collaborative effort between NSIDC, NCAR, and Unidata. It provides data management support and archival services for the Arctic Observing, Arctic System Sciences, Arctic Natural Sciences, and the Arctic Social Sciences Program. ACADIS is providing data ingest and access services to scientists, decision-makers, and other Arctic stakeholders, as well as archival services to ensure data accessibility through the coming years and decades. Unidata's Rosetta project grew out of work for the ACADIS project.

Cyberinfrastructure in Context

Facilitating and advancing research and education in Earth System sciences in general – and atmospheric sciences in particular – has been and will remain Unidata's raison d'être. While our overarching mission remains unchanged, Unidata must be cognizant of and responsive to current and future global science priorities that shape the nature and scope of research; the changing technological landscape and resource-constrained environment in which research and education are conducted; the backgrounds, skill sets, and expectations of students entering the profession; and the educational goals of all stakeholders. In proposing to both sustain and extend the Unidata Program as a cornerstone data facility for the atmospheric and related sciences, we present here a brief scan of the environment that influences not only our current activities, but also helps to shape the future direction and goals of the Program.

Science

Society is grappling with abrupt climate change and its effects, extreme weather and impacts, and water cycle changes. In response to these "grand challenge" problems, the geoscience community is shifting its emphasis from pure disciplinary research to a more balanced mix that advances disciplinary knowledge while looking to apply research results to interdisciplinary questions touching both science and society.

In 2009, UCAR surveyed more than 15,000 members of the atmospheric and related sciences community. Of the over 2000 responses, nearly 70% suggested increasing the emphasis on interdisciplinary research. The top request for additional UCAR/NCAR services was for additional datastreams and datasets, ahead of community models, educational materials, community workshops, and observing facilities.

Given the changing scientific landscape and emphasis, it is imperative that Unidata develop and support cyberinfrastructure that not only enables researchers to advance the frontiers of science, but transcends

traditional disciplinary boundaries. The main challenge we see is providing easy access to the right data, in the right format, to the right software applications.

Education

For decades, the research community has harnessed the power of data and computers to better understand Earth System problems through complex models, visualizations, and analysis techniques. Educators are increasingly integrating data-driven exploration into the learning environment, and easy access to data for student exploration is crucial to making this transformation. Professors realize that authentic learning and effective pedagogy focus on solving real-world problems that engage student interest and increase understanding of phenomena and processes. Investigation, research, analysis, and discovery of natural phenomena make the geosciences an ideal platform for integrating authentic learning activities into the curriculum, and many atmospheric science programs have successfully done so.

Data-enabled learning encourages student projects to enhance the collection and analysis of data through smart tools and sensors that automate the capture, recording, processing, and sharing of results. As an example, the Android operating system now provides support for atmospheric sensors that can monitor a variety of environmental properties. With these sensors and the geolocation facilities of their cell phones, students can engage in micro field studies and data-collection activities. Intercomparison of the crowd-sourced data gathered with such sensors is an ingenious way to advance data literacy and active learning.

It is critical to the health of our profession that future science and engineering leaders understand modern cyberinfrastructure and be trained using state-of-the-art tools, technologies, and techniques. Fluency is required not only in the geosciences and mathematical/statistical disciplines, but also in computational and information technology areas. Twenty-first century scientists must be data literate through many aspects of the data life cycle, including collection, management, analysis, and sharing of scientific data.

Data

Data-intensive science has emerged as the Fourth Paradigm of scientific discovery after empirical, theoretical, and computational methods. This is particularly true in the geosciences, where data have become increasingly important in scientific research. Modern data volumes from high-resolution ensemble prediction/projection/simulation systems and next-generation remote-sensing systems like hyper-spectral satellite sensors and phased-array radars are staggering. For example, CMIP5 alone will generate more than ten petabytes of climate projection data for use in assessments of climate change. NOAA's National Climatic Data Center projects that it will archive over 350 petabytes by 2030.

For researchers and educators, this deluge and increasing complexity of data brings challenges along with the opportunities for discovery and scientific breakthroughs. Retrieving relevant data in a usable format from an archive should not be more time consuming and arduous than the scientific analysis and investigation the data make possible. At the other end of the spectrum, the majority of agency-funded research is conducted by scientists in relatively small projects with one lead researcher, typically a faculty member with part-time commitment to the project, and one or two graduate students or part-time post-docs. While great care is frequently devoted to the collection, preservation, and reuse of data on large, multi-investigator projects, relatively little attention is paid to curating and sharing data that is being generated by these smaller projects (Heidorn, 2008), resulting in large amounts of "long tail" or "dark" data. As a result, it is difficult to discover unpublished "dark data," which might remain unshared, underutilized, or in some cases even be lost. By some estimates, only 5% of the data generated by individual PIs in the geosciences is shared with the broader community (Killeen, 2011).

Publication of research data presents unique challenges, sociological and technical, for the science community. Society has begun to demand increased scientific transparency, but researchers face a lack of incentives, inadequate resources, intellectual property issues, a culture of protectiveness, and the absence of supporting cyberinfrastructure, tools, and data repositories for sharing data. In 2011, NSF issued a new

guideline requiring that every proposal submitted include a Data Management Plan describing how the project will conform to NSF policy on the dissemination and sharing of research results. Recently, the Office of Science and Technology Policy (OSTP) directed federal agencies to develop a plan to support increased public access to the results of research funded by that agency (read online at http://1.usa.gov/VBkFJv). Among other elements, such a plan must provide a strategy for improving the public's ability to locate and access data resulting from federally funded research.

Campus Information Technology Infrastructure

Educational enterprises are in a state of rapid transformation. Since the introduction of personal computers in the 1980s and high-speed networking on college campuses in the 1990s, there has been a sea change in the IT environment in which students and faculty operate. The World Wide Web and the availability of ubiquitous wireless access, smartphones, tablets, and cloud-based services have accelerated the shift. The expectations, modalities, and skills of students have dramatically changed. As Conford (2008, http://bit.ly/18PahAH) argues, "in the past, universities and colleges were often the institutions that provided students with their first experiences of networked information technology services such as email and easy access to the web. Today, however, students arrive at universities and colleges with years of experience of these technologies. As a result, the ways in which individuals use technologies, and their expectations about how they are going to use those technologies, are already well established. Institutions no longer introduce users to information technology; instead, information technology is often the main context in which users are introduced to the institution."

Increasingly, students are not only allowed but encouraged to bring their own devices and connect them to campus networks. Students expect content and services to be delivered through their devices; they won't accept a step back in technology when they step onto campus. They expect to use interactive, intuitive, and collaborative tools to learn and communicate just as they do in their off-campus lives.

The computing environment in departments and faculty research labs is also changing. Anecdotal evidence suggests that reduced budgets mean diminished system administration and maintenance support for many departments' scientific computing infrastructure. University administrators are realizing that the traditional model, in which discrete, dedicated computer systems perform specialized tasks, cannot be sustained and that new ways of delivering information technology and data services are needed. Choices driven by budget pressures include consolidation or centralization of IT systems, increased virtualization, and the adoption of cloud computing technologies to deliver services.

EarthCube

EarthCube, a multi-year NSF CIF21 initiative that began in 2011, is described as "a collaboration between the NSF and Earth, atmosphere, ocean, computer, information, and social scientists, educators, data managers, and more." The EarthCube vision is to transform the conduct of research through the development of community-guided cyberinfrastructure to integrate information and data across the geosciences. EarthCube is aiming to build a unified, adaptive, and scalable cyberinfrastructure framework that integrates all Earth system and human dimensions data in an open, transparent, and inclusive manner.

UPC staff have been actively involved in EarthCube since its unveiling; contributing four white papers (Domenico 2011, Miller *et al.* 2011, Ramamurthy 2011, Rew 2011), attending both EarthCube charrettes, organizing a community workshop "*Shaping the Development of EarthCube to Enable Advances in Data Assimilation and Ensemble Prediction,*" participating in four EarthCube EAGER projects that developed corresponding roadmaps for Governance, Brokering, Service-based Integration, and Cross-domain Interoperability. With a quarter-century's experience providing data services to the atmospheric science community, Unidata's involvement in the EarthCube effort is both necessary and mutually beneficial.

Vision for the Future: Moving Unidata's Services and Software to "the Cloud"

We have identified some of the challenges universities are facing: shrinking budgets, rapidly evolving information technologies, growing data volumes, multidisciplinary science requirements, and high student expectations. Most faculty and researchers would prefer to focus on teaching and doing science rather than setting up computer systems. These changes are upending traditional approaches to accessing and using data and software; Unidata's products and services must also evolve to support modern approaches to research and education. In this section, we present a vision for Unidata's future that will provide a transformative community platform for collaborative development and an array of innovative data services to our users.

After years of hype and ambiguity, cloud computing technologies have matured. Their promise is now being realized in many areas of commerce, science, and education, bringing the benefits of virtualized and elastic remote services to infrastructure, software, computation, and data. Cloud environments can reduce the amount of time and money spent to procure, install, and maintain new hardware and software, reduce costs through resource pooling and shared infrastructure, and provide greater security. Cloud services aimed at providing *any resource, at any time, from any place, using any device* are increasingly being embraced by all types of organizations. NOAA, NASA, and other federal science agencies are establishing cloud computing services. Universities are no exception; the University of Washington, University of Illinois, Cornell University, and George Washington University are some of the universities that have already set up cloud services for scientific and academic computing.

Given this trend and the enormous potential of cloud-based services, we propose to gradually augment Unidata's products and services to align with the cloud-computing paradigm. Specifically, we will work to establish a community-based development environment that supports the creation and use of software services to build end-to-end data workflows. The design will encourage the creation of services that can be broken into small, independent chunks that provide simple capabilities. Chunks could be used individually to perform a task, or chained into simple or elaborate workflows. The services we envision will be loosely coupled to meet user needs rather than tightly coupled into a monolithic system. The services will be portable, allowing their use in researchers' own cloud-based computing environments.

Unidata recognizes that its community is not monolithic. Our users have diverse needs and access to a range of cloud-computing resources. Users will be able to implement these services in conjunction with their own workflows in ways they want; for example, by leveraging the capabilities of Python, R, or other workflow systems they use. This approach permits greater flexibility and interoperability. We envision users being able to invoke and use the services from an array of computing devices, including laptops, high-powered workstations, tablets, and even smartphones. The proposed vision is not about building a system, but an environment with a collection of capabilities, using a standardized approach.

Categories of Services

Here we present a list of candidate cloud-based data services that can be enabled as extensions of Unidata's current activities. In no particular order:

- Remote access to real-time data streamed via the IDD, as a cloud service (*e.g.*, Unidata's "thredds" server in a cloud)
- Data discovery, access, and extraction services (*e.g.*, subsetting services, catalog search services)
- Catalog and metadata generation services
- Data manipulation and transformation services (*e.g.*, Rosetta, decoders, Unit conversion)
- Brokering services for data and metadata (*e.g.*, ESSI labs)

- Server-side data analysis and operations (*e.g.*, netCDF+ operators, time-series generation, other mathematical calculations)
- Data-proximate display and visualization services that provide products to thin clients
- Data publishing services allowing users to publish results, analyses, and visualizations
- Subset subscription services, providing delivery of specified custom products

Community Collaboration

Unidata will *not* build all of the needed "chunks," but provide a platform for creating a range of cloud-enabled geoscience data services. Our objective is to harness the community's vast scientific and technical expertise in making this transformation. In partnership with the community and collaborators, the UPC will define the broad directions and design the general architecture/framework for composable services, provide a platform for developing services, establish a governance process for the envisioned environment, and develop and add component services to the suite incrementally and systematically.

As always, Unidata will actively engage its community, providing encouragement to community members to contribute applications and services to the collection. The UPC will provide help in "wrapping" scientists' applications into web-enabled, pluggable services. Unidata will also develop and demonstrate end-to-end prototype data services and make them available to the community.

We recognize that the governance of this process is extremely important and will pose some challenges. We have already put in place key elements to enable this transformation: by developing several web services, moving to Open Source environments like Github and Redmine for collaborative development of software, and providing remote data access for more than 15 years.

Managing Change for Our Community

Unidata and its community are at a crucial juncture in history. The IT landscape is changing dramatically even as users face rapidly shrinking budgets; our supporting community is expecting Unidata to lead by innovating and enabling new capabilities that let them do more with the resources they have. It is imperative that Unidata present a bold vision in response to these needs. In doing so, Unidata assumes the responsibility to help community members make the transition as their workflows and *modus operandi* change. To maintain the trust of our community, we firmly believe we must follow the spirit of the medical profession's Hippocratic Oath: *First, do no harm*.

We propose that the UPC align its future activities around this vision, but take a measured and disciplined approach that eases the community's evolutionary transition to newer, more powerful ways of working.

Our long-term goal is to create rich, self-sustaining scientific research ecosystems in which data, services, and tools are nurtured by an engaged geosciences community. The full realization of this vision will likely take a decade or longer, but we expect to make demonstrable progress by the end of the proposal period. We believe that the cyberinfrastructure environment that will arise from the steps we are proposing has the potential to profoundly transform the conduct of research and education in the geosciences and beyond.

Plan of Action

As described in the Results of Prior Support section, Unidata has made many continuing contributions and initiated valuable new endeavors in the past five years. We propose to maintain those critical programs while embarking on initiatives in response to the community needs described above.

A facility like Unidata, which has been providing reliable services for a quarter century, faces a healthy tension between *sustaining* support for its successful legacy products, extending and *enhancing* products

that hold promise for the future, and *innovating* via new, forward-looking endeavors that capitalize on advances in technology and respond to the evolving scientific landscape. Under tight budgets, it may be tempting to sustain only ongoing services and delay undertaking new development or initiating new endeavors. That approach risks products and services becoming obsolete or irrelevant. Allocating resources across these three areas requires not only careful consideration of the community's current needs, but an ability to anticipate emergent needs, and an appreciation of the delicate balance of priorities as the program fulfills its obligation to both lead and follow.

Unidata's strategic plan defines the program's mission, vision, and goals, and informs our decisions about how to allocate our limited resources. This section describes Unidata's strategic goals along with concrete actions planned for the near term and activities envisioned to take place over a longer time span. (You can read the Unidata strategic plan online at: http://bit.ly/121cdE1.) The descriptions below indicate whether the activity supports an ongoing service (*sustaining*), adds new features to an existing package or service (*enhancing*), or adds a new package or service to complement Unidata's existing portfolio (*innovating*).

Strategic Goal: Enable widespread, efficient access to geoscience data

Seamless access to data is essential for advancing education and research. To ensure that the geoscience research and education community gains access to the data it needs, Unidata will:

Distribute atmospheric and other geoscience data in real time

Distributing real-time meteorological data to the community is a foundational Unidata activity and remains one of its highest priorities (*sustaining*, *enhancing*, *innovating*). Planned activities include:

- Continue to operate robust IDD system top-level nodes, inserting data from NOAAPORT, CONDUIT, and GOES satellites (among others).
- Enhance the quality, quantity, and diversity of data available from UPC's remote access servers.

Develop innovative cyberinfrastructure solutions to facilitate dissemination of scientific data

Unidata's vision of future data-centric scientific workflows requires us to move beyond the current reliance on push technologies to deliver data (*enhancing*, *innovating*). Planned activities include:

- Work to make Unidata technologies function more effectively as server-side processing engines to facilitate data-proximate computations and analyses.
- Find ways to reduce the amount of data that must be transmitted over electronic networks before researchers can "do science," for example through subsetting and progressive disclosure.
- Integrate changes made by NOAA's AWIPS-II project into the Unidata LDM so that a single data-distribution system can be used in both contexts.

Work with data providers to make geoscience data freely available

Advocating for full and open access to scientific data for the university community has always been a core activity for Unidata (*enhancing*). Planned activities include:

- Work with governing committees and data providers to negotiate for access to data and model output deemed important for teaching and research.
- Provide easy mechanisms (e.g., RAMADDA and TDS) for investigators to share or publish their data for use by colleagues.

Develop and maintain the computing and networking infrastructure necessary to keep the growing volume of data flowing reliably and in a timely manner

While the UPC is not classified as an "operational" data center, we strive to provide reliable data service to the Unidata community (*sustaining*). Planned activities include:

- Continue operating UPC clusters and remote-access data servers, which have a 99.96% uptime record.
- Work with UCAR/NCAR information technology groups to ensure continued access to UCAR hardware and networking resources.

Strategic Goal: Develop and provide open-source tools for effective use of geoscience data

Faced with an abundance of scientific data, researchers and educators need well-integrated, state-of-the-art tools to access, analyze, manage, and visualize the data. Because our experience shows us that robust solutions arise from collaborative efforts, we will develop and support open-source software solutions to:

Analyze, integrate, and visualize geoscience data in two, three, and four dimensions

Unidata's scientific visualization tools are designed to make it easier for researchers, educators, and students to understand what heterogeneous geoscience data are telling them about the world (*enhancing*, *innovating*). Planned activities include:

- Integrate existing McIDAS-V functionality into the IDV to better handle data from new observation platforms such as the GOES-R satellite network. McIDAS-V excels at accessing and displaying satellite imagery; this development will bring similar capabilities to IDV users.
- Create a library of user functions for use in the statistical analysis of ensemble output.
- Collaborate with the SSEC VisAD team to update the library's 3D rendering API to incorporate a more modern, flexible, and maintainable rendering engine for the benefit of VisAD-based software including the IDV and McIDAS-V.
- Prepare for release the first publicly available version of AWIPS II, which will be bundled with the AWIPS II Development Environment for community developers who wish to create or edit plugins.
- Assist NCEP in testing GEMPAK applications within AWIPS II.

Enable visualization and effective use of very large data sets

As data volumes grow, Unidata visualization tools must take advantage of vast data holdings and new technologies that make those holdings accessible (*enhancing*, *innovating*). Planned activities include:

- Collaborate with the EarthCube community and others to enable end users to create, analyze, and visualize customized ensemble datasets from a variety of model outputs.
- Enhance the IDV's server-side functionality to make IDV capabilities available in environments that demand a "thinner" visualization client (tablets and other mobile devices, for example), expanding access to IDV display and analysis facilities to students and others who lack access to a traditional desktop scientific computing environment.
- Evaluate modifying or adding to existing AWIPS II software components to facilitate transfer of low-bandwidth graphics (images, contours, overlays, etc.) from a remote data server.

Access, manage, and share collections of data from diverse sources

Unidata's data access technologies are integrated into its visualization software products (*enhancing*, *innovating*). Planned activities include:

- Enhance the IDV's ability to interact with local and remote datasets in ways that facilitate access to and use of very large data collections. This will entail development of improved client and server infrastructure and enhanced data access algorithms.
- Develop functionality to allow regridding of model output onto a single common grid designated by the user, and to enable the aggregation of individual datasets into ensemble collections.
- Evaluate the addition of OPeNDAP to the AWIPS II system and the possibility of using the OPeNDAP protocol to access THREDDS Data Servers, similar to remote access through the IDV.

- Foster an early-adopter group of AWIPS II data server administrators to evaluate feasibility of serving data to dozens or hundreds of remote clients at once.
- Add a WRF initialization (and boundary condition specification) service to the TDS that subsets model data, automatically selecting the parameters needed for WRF initialization and prediction.

Strategic Goal: Provide CI leadership in data discovery, access, and use

The tools and techniques of distributed scientific computing are continually evolving. In order for the Unidata community to benefit from changes in the scientific cyberinfrastructure landscape, we will:

Develop useful data models, frameworks, and protocols for geoscience data

Unidata strives to advance data science for the good of the geoscience community (*enhancing*, *innovating*). Planned activities include:

- Create a streaming protocol to allow use of netCDF in web services, reducing the need to move large datasets to local machines.
- Reduce "Big Data" performance bottlenecks by improving chunking strategies, facilitating use of parallel I/O, using new metadata access strategies, and leveraging HDF5 storage layer advances.
- Add data access abstractions like swaths and unstructured grids, based on geospatial coordinates.
- Improve Python support across the Unidata software suite.
- Speed up the THREDDS catalog parse/build and improving the associated developer API.
- Provide a TDS configuration web interface and other tools to increase ease of use, improve scalability, and support dynamic reinitialization of servers.

Advance geoscience data and metadata standards and conventions

Standards and conventions allow investigators to fit the best technology for a given task into their own scientific workflow. Unidata strives to "play nice" with existing and emerging technologies, while advancing the state of the art (*enhancing*, *innovating*). Planned activities include:

- Create netCDF APIs and web services that allow access to data by geospatial coordinates.
- Provide full client (CDM), server (TDS), and library (netCDF) support for the new DAP4 data access protocol (once it is finalized).
- Work toward furtherance of netCDF technologies as international standards.
- Advocate for improvements or alternatives to the GRIB format for weather data and model output archives.

Evaluate emerging cyberinfrastructure trends and technologies, providing information and guidance to community members

Unidata must remain fully apprised of trends in technology that will affect our community in the future (*innovating*). Planned activities include:

- Explore and implement cloud computing solutions by gradually migrating Unidata applications to become services that are available from the cloud.
- Investigate faster compression techniques that achieve better compression than zlib for netCDF.

Facilitate discovery mechanisms for quickly finding and accessing geoscience data

As data volumes increase, it is ever more important that researchers be able to find and use the data that is available (*enhancing*, *innovating*). Planned activities include:

- Support access services from emerging computing platforms, including cloud, mobile, parallel, and data-intensive architectures.
- Add support for scientific workflows involving multiple datasets and virtual machine platforms.

- Improve handling of large collections of files (feature collections) and gridded datasets.
- Promote the TDS netCDF Subset Service (NCSS) and other existing data subsetting services from semi-experimental quality to production-quality services, improving their reliability, performance, and range of response types.
- Improve automated extraction and harvesting of metadata from datasets.

Strategic Goal: Build, support, and advocate for the geoscience community

Unidata works to help community members learn from each other by providing opportunities for collaboration, discussion, and knowledge sharing. To monitor the pulse of the community, track user needs, and build community relationships, Unidata will:

Provide expertise and resources to researchers in designing and implementing effective data management plans

Unidata plans a variety of new activities aimed at supporting members in creating data management plans for proposals (*innovating*). Planned activities include:

- Provide information on data management best practices and information on NSF requirements.
- Create template data management plans for different types of projects, and provide training on their use.
- Promote the use of Unidata technologies such as TDS and RAMADDA at the PI's institution for dissemination of scientific research data.
- Serve as an information clearinghouse to help PIs publicize availability of their data.
- Investigate partnerships with potential providers of archival data storage for community members.
- Work with UCAR's Data Citation effort to help PIs issue DOIs for their data collections.

Represent the academic community in partnerships with agencies and stakeholders

Unidata works closely with agencies such as NOAA and NASA, as well as with commercial entities, to secure access to data and software of interest to the community (*sustaining*). Planned activities include:

- Collaborate with NCEP and Raytheon to make the AWIPS II package available.
- Collaborate with NOAA and NASA to make GOES-R satellite data available.
- Partner with NCEP to provide access to model data via CONDUIT.
- Collaborate with NOAA to make HRRR and FIM data more broadly available.

Conduct workshops related to current community interests and needs

Unidata assists its community to sponsor and organize workshops that bring community members and UPC staff together to learn from each other and share experiences (*sustaining*). Planned activities include:

- Work with the Unidata Users committee to organize Users workshops in 2015 and 2018.
- Increase the number of regional software training workshops arranged by the UPC, hosted by community members, and taught by UPC developers.

Offer training and support for Unidata products and services

Unidata provides training and support in a variety of modes (*enhancing*). Planned activities include:

- Create a series of short online video demonstrations of Unidata software features.
- Investigate and implement virtual training options to better serve those who cannot travel to workshops at the UPC or other locations.
- Support wider use of AWIPS II/GEMPAK by offering on-line and in-person training.
- Investigate the use of social-networking technologies to leverage knowledge within the Unidata community for solving problems.

- Facilitate and coordinate community use case contributions.
- Respond to questions not handled by our user community and conduct annual training workshops.
- Maintain comprehensive documentation, examples, FAQs, and best practices materials online.

Provide demonstration systems to allow evaluation of Unidata tools and technologies, and assist with deployment of those tools and technologies in the field

As Unidata develops new technologies, we create working installations at the UPC and make them available for the community to test and experiment (*innovating*, *enhancing*). Planned activities include:

- Make it easier to install, configure, update, and administer Unidata server technologies, allowing more member sites to operate data services for the benefit of the larger community.
- Demonstrate an increasing number of Unidata technologies that operate "in the cloud," reducing the need for local processing of large datasets or local administration of software.
- Provide easy access to new server-side technologies, building familiarity with remote processing workflows in the community and enthusiasm among community members for contributing additional server-side tools.

Foster interactions between community members through meetings and other opportunities for collaboration and communication

In addition to organizing conferences and workshops for community members, Unidata works to bring community members into contact at events organized by others (*sustaining*). Planned activities include:

- Coordinate UPC participation in scientific meetings and conferences.
- Inform community members about opportunities to meet with UPC staff and each other.
- Use the Unidata web site, electronic mailing lists, and other electronic channels to disseminate information on data streams, software releases, and program center and other community news.

Present Unidata community perspectives and experiences at scientific meetings, conferences, and other venues

UPC staff play a dual role in the geoscience community, serving both as community representatives and as scientific contributors in their own right (*sustaining*). Planned activities include:

- Participate as community representatives and scientists at annual meetings of the AMS and AGU.
- Engage actively with large-scale, long-term projects like NSF's EarthCube and the OGC's standardization efforts.

Use our community-based governance mechanisms to ensure that Unidata program efforts continue to align with the needs of community members

Unidata relies on advice and governance from representatives of member universities (*sustaining*). Planned activities include:

- Continue regular meetings of the Unidata Policy and Users committees.
- Continue efforts to ensure diverse community representation on committees and working groups.

With close cooperation between the UPC staff and the community, and continuing guidance from our governing committees, we will work toward enabling a gradual transition to the new era in cyber-enabled research and education, in ways that do not disrupt community members' current workflows.

Accomplishing these goals will require careful planning, prioritization, resource allocation, and nimble program management. As it has done throughout its history, the UPC will remain vigilant to the shifting landscape and the evolving community needs, reviewing and refining our plans on a regular basis, and making necessary course corrections along the way.

Setting Priorities

The activities outlined in the Action Plan represent our best judgment, *today*, of the actions that will bring us closer to our stated goals. The rapidly-changing technology environment we work in makes it imperative that we remain nimble and ready to adjust our course as circumstances – and the needs of our community – change. Unidata's governance structure provides a mechanism for setting priorities and brings us ongoing guidance regarding what is most important to our community, and we use this feedback as our touchstone in evaluating and re-evaluating our activities and services over time. Our agile software development methodologies are designed to accommodate, and benefit from, these reprioritizations.

Two core beliefs guide our planning and setting of priorities:

- Our community depends on Unidata to provide reliable and robust data services, tools for analysis and visualization, and user support services. These are our highest priorities.
- Transition to a remote-access "cloud" environment for geoscience data is vital to our community's ability to pursue research and education in the 21st century.

Our open-ended technical plans and interconnected products make traditional project management approaches (Gantt charts, *etc.*) less useful than the agile methods we've adopted. Still, resources are not unlimited. To free up resources for new activities, some legacy software such as the LDM, McIDAS-X, and GEMPAK will not be actively developed, but only maintained and supported, in the future. The following table attempts to delineate activities described in our plan that we deem to be critical to our community, along with those we feel could be delayed if resources are constrained.

Strategic Goal	Activities Critical to the Core Effort	Activities to Delay if Necessary
Enable widespread, efficient access to geoscience data	• Continue management of the IDD, adding new datastreams as needed. • Advance server-side processing in TDS, RAMADDA • Create easier data-sharing mechanisms	• Build new data subsetting and progressive disclosure functionality • Integrate AWIPS II data requirements into Unidata technologies
Develop and provide open-source tools for effective use of geoscience data	• Release AWIPS II to the community • Enhance IDV server-side functionality and large dataset access • Integrate McIDAS-V satellite features into IDV • Build tools for easy data file transformation (Rosetta)	• Add OPeNDAP access, low-bandwidth features to AWIPS II • Add WRF initialization services to TDS • Build tools for regridding/aggregation of model output • Enable customized ensemble analysis and visualization • Modernize IDV's rendering engine
Provide CI leadership in data discovery, access, and use	• Advocate for community standards • Develop netCDF streaming protocol, geospatial coordinate access • Begin implementing Unidata applications as "cloud" services • Improve Python support	• Provide support for DAP4 • Reduce "big data" bottlenecks • Improve TDS speed and configuration process • Build automated metadata harvesting features
Build, support, and advocate for the geoscience community	• Promote diverse participation in governing committees • Provide information on and tools for creating data management plans • Continue collaboration with agency partners to provide software and data	• Form partnerships with data archives • Enhance electronic support offerings • Create instructional materials for online virtual training

Closing Remarks

Data services, software, and committed support are critical components of geosciences cyber-infrastructure that can help scientists address problems of unprecedented complexity, scale, and scope. In this proposal we have presented innovative ideas, new paradigms, and novel techniques to complement and extend Unidata's offerings. Our goal is to empower users so that they can tackle major, heretofore difficult problems.

The goals and the action plan outlined in this proposal are in furtherance of and congruent with the National Science Foundation's strategic plans "Empowering the Nation Through Discovery and Innovation: The National Science Foundation Strategic Plan for Fiscal Years 2011-2016" (2011), "GEO vision" (2009), "Strategic Frameworks for Education & Diversity, Facilities, International Activities, and Data & Informatics in the Geosciences" (2012), and "A Vision and Strategy for Data in Science, Engineering, and Education – Cyberinfrastructure Framework for the 21st Century" (2012). We are building on the foundation Unidata has laid over the years, providing cyberinfrastructure for researchers to address frontier science questions, enabling new discoveries, and building the geoscience community's capability to educate the next generation of scientists. Our commitment goes beyond technology. By creating an environment where community members can work together, we hope not only to lower technological barriers to solving multidisciplinary grand challenge problems, but to develop the profession's human capacity and transform the conduct of science.

We acknowledge that this is an ambitious plan with many inter-related goals, but we believe bold thinking is required to address the emergent scientific, educational, and cyberinfrastructure challenges facing the community. As a cornerstone geoscience CI facility with an established record in creating ground-breaking software and services that are in use far beyond the intended audience in academia, the geoscience community expects Unidata to both *lead* users by providing innovative solutions as well as *follow* the community's direction in setting priorities and being responsive to its current and emerging needs. Yet even as we strive to engage these broad challenges, the Unidata program remains firmly committed to meeting its responsibilities to and addressing the evolving needs of its core atmospheric sciences community. Sustained and strong engagement by our community, close partnerships and collaboration with geoscience data providers, tool developers, and other stakeholders, and informed guidance from our governing committees will all be important catalysts for Unidata's success.

Our community's desire for revolutionary ways of wringing knowledge from an ever-expanding pool of Earth System science data presents Unidata with multiple, quickly moving targets. At the same time, the reality of constrained resources means we must choose the problems we will tackle with care and prudence. To succeed in dramatically improving the way data-centric geoscience is conducted will require an approach that is flexible in the face of evolving technologies and shifting priorities. As a result, the underlying theme of our long-term planning is to remain nimble. We must parlay creative, out-of-the box thinking and ongoing collaboration with the community we serve into pragmatic projects that solve today's scientific problems while setting the stage for future advancements.

Achieving these goals will help our community realize the vision of *geoscience at the speed of thought*. This simple statement asks the UPC, in partnership with the community, to work toward a transformation in the practice of data-intensive research and education in the geosciences, enabling researchers and educators to carry out their work in more innovative, efficient, and productive ways, pushing beyond the boundaries of their current knowledge and approaches. In the process, we envision a future that dramatically reverses today's situation in which a researcher may spend 80 percent of their time dealing with data discovery, access, and processing, and only 20 percent "doing science" by way of interpretation, synthesis, and knowledge creation (Michener, 2012). Unidata is firmly committed to work towards realizing this transformation.

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Appointments

Director, Unidata, University Corporation for Atmospheric Research, 2003-present
Associate Professor, Department of Atmospheric Sciences, University of Illinois, 1994 – 2003
Assistant Professor, Department of Atmospheric Sciences, University of Illinois, 1989 - 1994
Visiting Assistant Professor, Department of Atmospheric Sciences, University of Illinois, 1987 - 1989
Post-doctoral Research Assistant, Florida State University, Tallahassee, 1986 – 1987

Products

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Plale, B., D. Gannon, J. Brotzge, K. Droegemeier, J. Kurose, D. McLaughlin, R. Wilhelmson, S. Graves, M. Ramamurthy, R.D. Clark, S. Yalda, D.A. Reed, E. Joseph, V. Chandrasekar, 2006: CASA and LEAD: Adaptive Cyberinfrastructure for Real-Time Multiscale Weather Forecasting, *Computer special issue on System-Level Science*, *IEEE Computer*, **39**, No. 11, pp. 56-63.

Five other significant publications

Rauber, R. M., M. Yang, M. K. Ramamurthy, and B. F. Jewett, 2000: Origin, evolution, and fine scale structure of the St. Valentine's Day gravity wave observed during STORM-FEST. Part I: Origin and maintenance. *Mon. Wea. Rev*., **129,** 198-217.

Jewett, B. J., R. M. Ramamurthy, and R. M. Rauber, 2003: Origin, maintenance and fine scale structure of the St. Valentine's Day gravity wave observed during STORM-FEST. Part III: MM5 modeling study of gravity wave genesis and evolution. *Mon. Wea. Rev..,* **131**, 617-633.

Yang, M., R. M. Rauber and M. K. Ramamurthy 2000: Origin, evolution, and fine scale structure of the St. Valentine's Day gravity wave observed during STORM-FEST. Part II: Fine scale structure. *Mon. Wea. Rev*. **129,** 218-236.

Grim, J. A., R. M. Rauber, M. K. Ramamurthy, B. J. Jewett and M. Han, 2005: High-resolution observations of the trowal and warm frontal regions of two continental winter cyclones. Mon. Wea. Rev., 135, 1647-1670.
Han, M., R. M. Rauber, M. K. Ramamurthy, B. J. Jewett, and J. Grim, 2005: Mesoscale dynamics of the trowal and warm frontal regions of two continental winter cyclones. *Mon. Wea. Rev*., 135, 1629-1646.

Synergistic Activities

Member, NSF ATM Steering Committee for Cyberinfrastructure for Research and Education, 2002-2004
Member, THORPEX Data Policy and Management Working Group, 2005-2009
Member, NRC Committee on Archiving Environmental and Geospatial Data at NOAA, 2006-2008
Chair, AMS Ad-hoc Committee on Data Stewardship, 2008-2012
Chair, AMS Board on Data Stewardship, 2012-present

Collaborators and Other Affiliations

Recent collaborators: Dave Fulker, OPeNDAP, Mark Parson, RPI, Mark Serreze, University of Colorado, Witold Krajewski & Anton Kruger, University of Iowa, Dave Santek, University of Wisconsin, Rich Clark, Millersville University, Kelvin Droegemeir, University of Oklahoma, Beth Plale, Indiana University, Rahul Ramachandran and Sara Graves, University of Alabama-Huntsville, Tim Ahern, IRIS

Graduate students supervised or co-supervised:

Name	Degree	Status
Michael Shields	M Sc.	National Weather Service
Brian Collins	M. Sc.	Private Industry
Meng Li	M. Sc.	Private Industry
David Christensen	M. Sc.	Private Industry
Naresh Malhotra	M.Sc.	Private Industry
Liho Chen	M. Sc.	National Taiwan University
Qizhou Guo	M. Sc.	Private Industry
Taiyi Xu	Ph. D (ABD)	Climate Diagnostics Center, NOAA
Guangming Zhou	Ph.D	Private Industry
Geoffrey Manikin	M. Sc.	National Centers for Environmental Prediction/EMC
Tom Grzelak	M.Sc.	Rutgers University
Steve Hall	M.Sc.	Private Industry
Muqun Yang	Ph.D., Post Doc	NCSA, Univ. of Illinois
Jingjun Shu	M. Sc.	Private Industry
Daniel Bramer	M. Sc.	University of Illinoiis
Scott Olthoff	M.Sc.	Private Industry
Noah Nigg	M. Sc.	Private Industry
Mei Han	Ph. D.	University of Maryland, Baltimore County
Bo Cui	Ph. D.	National Centers for Environmental Prediction

Ph. D. advisor: Prof. Fred Carr, University of Oklahoma, Norman, OK

Post-doctoral supervisor: Prof. Peter S. Ray, Florida State University, Tallahassee, FL

Ethan R. Davis

University Corporation for Atmospheric Research
P. O. Box 3000, Boulder, CO 80307-3000
Tel: (303) 497-8155; e-mail: edavis@ucar.edu

Professional Preparation
University of Puget Sound Physics B.S. 1988
University of New Hampshire Mechanical Engineering M.S. 1991

Appointments
Dec 2010 – present Manager of Software Engineering, Unidata Program Center, UCAR
1996-2010 Software Engineer, Unidata Program Center, UCAR
1994-1996 Scientific Programmer, NOAA NGDC / CIRES
1992-1993 Scientific Programmer, Turbulence Prediction Systems, Boulder, CO

Most Relevant Products
Cornillon, P., J. Adams, M.B. Blumenthal, E. Chassignet, E. Davis, S. Hankin, J. Kinter, R. Mendelssohn, J.T. Potemra, A. Srinivasan, and J. Sirott, 2009. NVODS and the development of OPeNDAP, Oceanography, Vol 22, No. 2, June 2009, pages 116-127.

Domenico, B., S. Nativi,, J. Caron, L. Bigagli, E. Davis, 2005. Standards-Based, Web Services for Interoperable Geosciences Data Systems, Proc. of the Fall Meeting of the AGU, San Francisco, California, American Geophysical Union.

Domenico, B., J. Caron, E. Davis, R. Kambic, and S. Nativi, 2002. Thematic Real-time Environmental Distributed Data Services (THREDDS): Incorporating Real-time Environmental Data and Interactive Analysis Tools Into NSDL. Journal of Digital Information. http://jodi.ecs.soton.ac.uk/, Vol 2, Issue 114, May 2002.

Nativi, S., J. Caron, E. Davis, and B. Domenico, 2004. Design and implementation of netCDF Markup Language (NcML) and Its GML-based extension (NcML-GML), Computers and Geosciences, Vol 31, Issue 9, November 2005, pages 1104-1118.

Rew, R., E. Hartnett, D. Heimbigner, E. Davis, J. Caron, 2009. NASA ESDS-RFC-011: NetCDF Classic and 64-bit Offset File Formats, NASA ESDS SPG Endorsed Standard 011.

Recent Collaborators
J. Blower (U. of Reading, UK), J. Caron (Unidata Program Center (UPC)), P. Cornillon (U. of Rhode Island), B.Domenico (UPC), J. Gallagher (OpeNDAP.org), T. Habermann (NGDC), E. Hartnett (UPC), D. Heimbigner (UPC), B. Lawrence (BADC, UK), Dominic Lowe (Central Laboratory for Research Councils, Rutherford Appleton Laboratory), R. Mendelssohn (NOAA NMFS), Stefano Nativi (University of Florence), D. Neufeld (NGDC), K. O'Brien (UW/JISAO, NOAA), M. Ramamurthy (UPC), R. Rew (UPC), R. Schweitzer (Weathertop Consulting), R. Signell (USGS), J. Tandy (UK Met Office), B. Wright (UK Met Office).

Graduate Advisor
John P. McHugh, University of New Hampshire

BENEDICT A. DOMENICO

Unidata Program Center
University Corporation for Atmospheric Research (UCAR)
Post Office Box 3000; Boulder, Colorado 80307-3000
(303) 497-8631
ben@unidata.ucar.edu

Professional Preparation

University of Colorado	Astrophysics	Ph.D., 1971
Yale University	Physics	M.S., 1966
Georgetown University	Physics	B. S., 1965

Professional Appointments

Outreach Coordinator, Unidata Program Center, June 2007 to present
Deputy Director, Unidata Program Center, January 2003 to June 2007
Acting Director, Unidata Program Center, 2001 to 2003
Deputy Director, Unidata Program Center, 1987 to 2001
Deputy Director Program for the Advancement of Geosciences Education (PAGE), 1998 to 2000
Manager, Data Display Division, Science Horizons, Inc., 1986
Manager, Software and Libraries Group SCD/National Center for Atmospheric Research (NCAR), 1981 to 1986

Closely-related Publications

Nativi, S. and B. Domenico, 2013, The OGC CF-netCDF specification: towards a common data model for feature, coverage and specimen data, *Proceedings of the European Geophysical Union Annual Meeting*, Vienna, Austria.

Nativi, S., J. Caron, B. Domenico, L. Bigagli, 2008, Unidata's Common Data Model Mapping to the ISO 19123 Data Model, Earth Science Informatics, Volume 1, Number 2, September, 2008, pp. 58-78, ISSN 1865-0473, Springer Berlin / Heidelberg.

Domenico, B., Evolving standards for interdisciplinaary data integration, January 2007, *Proc. of the 22nd International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology* Oceanography, and Hydrology. American Meteorological Society, San Antonio, Texas.

Domenico, B., S. Nativi,, A. Woolf, T. Whittaker, R. Husar, L. Bigagli, December 2006: GALEON Phase 2: Testing Gateways Between Formal Standard Interfaces and Existing Community Standard Client/server Implementations, *Proc. of the Fall Meeting of the AGU*, San Francisco, California, American Geophysical Union.

Domenico, B., Data Interoperability: Standard Interfaces Connect Complex Systems, Earth Imaging Journal, Volume 3, Number 5, September/October 2006, Pages 22-26.

Other Significant Publications

Domenico, B and S. Nativi, editors, 2011, OGC Network Common Data Form (NetCDF) Core Encoding Standard version 1.0, OpenGeospatial Consortium, http://www.opengeospatial.org/standards/netcdf

S. Chiswell, B. Domenico and J. Weber, Real-time steering of mesoscale forecast models using objective techniques, 2006, *Proc. of the 21st International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology,* American Meteorological Society, Oceanography, and Hydrology, Atlanta, Georgia.

Nativi, S., M. Blumenthal, J. Caron, B. Domenico, T. Habermann, D. Hertzmann, Y. Ho, R. Raskin, and J. Weber, 2004: Differences Among the Data Models Used by the Geographic Information Systems and Atmospheric Science

Communities. *Proc. of the 20th International Conference on Interactive Information and Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology,* Seattle, Washington, American Meteorological Society, [Available online at http://ams.confex.com/ams/84Annual/techprogram/paper_73229.htm.]

Domenico, B., J. Caron, E. Davis, D. Edelson, R. Kambic, R. Pandya, and S. Nativi, 2003: THREDDS Second Generation (THematic Real-time Environmental Distributed Data Services): Engaging the GIS Community and Tools. *Proc. of the Fall Meeting of the AGU*, San Francisco, California, American Geophysical Union.

Davis, E., S. Nativi, J. Caron, and B. Domenico, 2003: Cataloging and Describing Scientific Data: Simplifying Data Discovery and Use for Researchers and Educators. *Proc. of the Annual Meeting of the GSA*, Seattle, Washington, Geological Society of America.

Synergistic Activities

- Participant in first two EarthCube charrettes, Brokering and Domain Interoperability concept award projects
- Editor of all OGC NetCDF-related standards
- PI for THREDDS (THematic Real-time Environmental Distributed Data Services (THREDDS)
- Co-PI for DLESE Data Services and follow on Enhanced Data in Education Project
- Initiator and Manager of the GALEON (Geo-interface for Land, Air, Earth, Ocean NetCDF) interoperability experiment of the OGC (Open Geospatial Consortium)
- Initiator of and Participant in the Ocean Sciences interoperability experiment of the OGC
- Member of the Steering Committee for the Marine Metadata Initiative (MMI)
- Member of the Steering Committee for Data Management and Communications for the Integrated Ocean Observing System (IOOS)
- Secretary of the American Geophysical Union focus group on Earth and Space Science Informatics
- Editorial Board Member for the Journal of Earth Science Informatics

Recent Collaborators

Peter Baumann (Jacobs University of Bremen, Germany), Lorenzo Bigaglia (Italian National Research Council Institute of Methodologies for Environmental Analysis), Mike Botts (University of Alabama Huntsville), Richard Clark (Millersville University), Martin Daly (CadCorp, UK), Liping Di (George Mason University), David Dimitriou (Fleet Numerical Meteorology and Oceanography Center), Kelvin Droegemeier (University of Oklahoma), Sarah Graves (University of Alabama Huntsville), Ted Habermann (NGDC), Steve Hankin (PMEL), Steve Kopp (ESRI), Everette Joseph (Howard University), Tamara Shapiro Ledley (TERC), Dominic Lowe (Central Laboratory for Research Councils, Rutherford Appleton Laboratory), Don Middleton (NCAR/SCD), Stefano Nativi (University of Florence), Beth Plale (Indiana University), Rahul Ramachandran (University of Alabama Huntsville), Clemens Portel (Interactive Instruments, UK Glenn Rutledge (NCDC), Phil Sharfstein (FNMOC), Michael R. Taber (Northern Colorado University), Tom Whittaker (University of Wisconsin-Madison Andrew Woolf (Natural Environment Research Council, Rutherford Appleton Laboratory

Graduate Advisor

Andrew Skumanich, University of Colorado (Presently NCAR/HAO [ret])

Professional Societies

American Geophysical Union

Biographical Sketch
Russell K. Rew

Unidata Program
University Corp. for Atmospheric Research
Boulder, CO 80307-3000

russ@unidata.ucar.edu
http://www.unidata.ucar.edu/staff/russ
Voice: (303) 497-8645

i. PROFESSIONAL PREPARATION

University of Colorado at Boulder	Mathematics	B.A.	1972
University of Colorado at Boulder	Mathematics	M.A.	1977
University of Colorado at Boulder	Computer Science	Ph.D.	1987

ii. APPOINTMENTS

2010-present	NetCDF Project Lead
1987-2010	Head, Data Services Group, Unidata
1986-1987	Systems Software Specialist, Unidata
1982-1986	Programmer, Advanced Methods Group, Sci. Comp. Division, NCAR
1978-1981	Group Head, Software and Libraries Group, Sci. Comp. Division, NCAR
1975-1977	Programmer, Univ. Liaison and Inf. Serv., Computing Facility, NCAR
1973-1974	Group Head, High Altitude Observatory Programming Group, NCAR
1970-1972	Programmer, Computing Facility, NCAR

iii. (a) PUBLICATIONS RELATED TO PROPOSED TOPIC

Rew, R.: CF Metadata Conventions, April 2010, NASA ESDS-RFC-021v0.02. http://www.esdswg.org/spg/rfc/esds-rfc-021/ESDS-RFC-021-v0.01.pdf

Hankin, S., J. Blower, T. Carval, K. Casey, C. Donlon, O. Lauret, T.Loubrieu, A. Srinivasan, J. Trinanes, Ø. Godøy, R. Mendelssohn, R. Signell, J. de La Beaujardiere, P. Cornillon, F. Blanc, **R. Rew**, J. Harlan (2009), NetCDF-CF-OPeNDAP: Standards for Ocean Data Interoperability and Object Lessons for Community Data Standards Processes, *OceanObs'09*

Rew, R., E. Hartnett, and J. Caron.: NetCDF-4: software implementing an enhanced data model for the geosciences. *22nd IIPS.*, Amer. Met. Soc., 2006. http://ams.confex.com/ams/pdfpapers/104931.pdf

Rew, R. and E. Hartnett: Merging NetCDF and HDF5. *Proceedings, 20th IIPS.,* Amer. Met. Soc., 2004. http://ams.confex.com/ams/pdfpapers/73771.pdf

Brown, S., M. Folk, G. Goucher, and **R. Rew**, Software for Portable Scientific Data Management, *Computers in Physics, American Institute of Physics, Vol. 7, No. 3, 1993.*

(b) FIVE ADDITIONAL PUBLICATIONS

Rew, R.: Fishing for Data, Pier to Pier. *Proceedings, 20th IIPS.,* American Meteorology Society, 2004. http://ams.confex.com/ams/pdfpapers/73785.pdf

Wilson, A. and **R. Rew**: Exploring an Alternative Architecture for Unidata's Internet Data Distribution. *Proceedings, 18th IIPS.,* American Meteorology Society, 2002. http://ams.confex.com/ams/pdfpapers/27648.pdf

Rew, R. and A. Wilson: The Unidata LDM System: Recent Improvements for Scalability. *Proceedings, 17th IIPS,* American Meteorological Society, 2001.

Rew, R., J. Caron, S. Emmerson, and D.. Murray: Future Directions for Unidata Applications *Proceedings, 16th IIPS*, American Meteorological Society, 2000.

Rew, R., 1998: Georeferencing with Java: An Example of Executable Metadata. *Proceedings, 14th IIPS*, American Meteorological Society, January, Phoenix, Arizona.

iv. SYNERGISTIC ACTIVITIES

1. Member of Climate and Forecast Conventions Committee
2. Author of NASA ESDS standards for netCDF classic and 64-bit offset formats and of standard for CF Conventions
3. External member, NOAA Data Management Integration Team
4. Invited lecturer, International Centre for Theoretical Physics (Trieste, Italy), Advanced School on High Performance and Grid Computing, 11-15 April 2011.
5. Invited member, Research Institute for Sustainable Humanosphere Database Advisory Committee, Kyoto University

v. (a) COLLABORATORS

F. Blanc (CLS Space Oceanography, France), J. Blower (U. of Reading, UK), J. Caron (Unidata Program Center (UPC)), T. Carval (Ifremer, France), K. Casey (NOAA NODC), E. Davis (UPC), J. de La Beaujardiere (NOAA IOOS), P. Cornillon (U. of Rhode Island), B. Domenico (UPC), C. Donlon (European Space Agency), M. Folk (The HDF Group, Inc.), J. Gallagher (OpeNDAP.org), Ø. Godøy (Nowegian Met. Inst.), J. Gregory (NCAS, UK), S. Hankin (NOAA PMEL), J. Harlan (NOAA IOOS), E. Hartnett (UPC), D. Heimbigner (UPC), A. Kruger (U. of Iowa), O. Lauret (CLS Space Oceanography), B. Lawrence (BADC, UK), T.Loubrieu (Ifremer), R. Mendelssohn (NOAA NMFS), L. Miller (UPC), D. Murray (UPC), M. Ramamurthy (UPC), R. Signell (USGS), A. Srinivasan (Florida State Univ.), K. Taylor (LLNL), J. Trinanes, T. Whittaker (U. of Wisconsin), T. Yoksas (UPC)

(b) GRADUATE AND POSTDOCTORAL ADVISORS

L. Osterweil (U. of Massachusetts), R. Schnabel (Indiana U.)

(c)THESIS ADVISOR: none

SUMMARY PROPOSAL BUDGET

YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University Corporation For Atmospheric Res

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Mohan K Ramamurthy

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mohan K Ramamurthy - Unidata Director**	9.12	0.00	0.00	**111,457**	
2. **Ethan R Davis - Software Engineer IV**	10.80	0.00	0.00	**88,057**	
3. **Benedict A Domenico - Unidata Outreach Manager**	2.40	0.00	0.00	**25,531**	
4. **Russell K Rew - Software Engineer IV**	6.00	0.00	0.00	**105,900**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	28.32	0.00	0.00	**330,945**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**19**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	228.00	0.00	0.00	**1,542,795**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**2**) UNDERGRADUATE STUDENTS				**14,000**	
5. (**2**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**70,825**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**1,958,565**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,047,521**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**3,006,086**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Development and Porting Platforms $ **25,000**					
SSEC - IDD Cluster **10,000**					
SSEC - Satellite Data Ingest Platforms **25,000**					
TOTAL EQUIPMENT				**60,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**100,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **33,000**					
3. SUBSISTENCE **4,000**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**19**) TOTAL PARTICIPANT COSTS				**37,000**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**26,500**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**200,000**	
6. OTHER				**81,713**	
TOTAL OTHER DIRECT COSTS				**308,213**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,511,299**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
UCP Indirect Rate (Rate: 34.1000, Base: 3339299)					
TOTAL INDIRECT COSTS (F&A)				**1,138,701**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**4,650,000**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**4,650,000**	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Mohan K Ramamurthy

ORG. REP. NAME*
Lori Iafon

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 2

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University Corporation For Atmospheric Res

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Mohan K Ramamurthy

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mohan K Ramamurthy - Unidata Director**	9.12	0.00	0.00	**114,801**	
2. **Ethan R Davis - Software Engineer IV**	10.80	0.00	0.00	**90,699**	
3. **Benedict A Domenico - Unidata Outreach Manager**	2.40	0.00	0.00	**26,297**	
4. **Russell K Rew - Software Engineer IV**	6.00	0.00	0.00	**62,476**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	28.32	0.00	0.00	**294,273**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**19**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	228.00	0.00	0.00	**1,635,680**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**2**) UNDERGRADUATE STUDENTS				**14,420**	
5. (**2**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**72,949**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**2,017,322**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,078,946**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**3,096,268**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
Development and Porting Platforms $ **25,000**					
GOES-R Satellite Equipment **20,000**					
TOTAL EQUIPMENT				**45,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**103,000**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **33,990**					
3. SUBSISTENCE **4,120**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**19**) TOTAL PARTICIPANT COSTS				**38,110**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**27,296**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**200,000**	
6. OTHER				**84,163**	
TOTAL OTHER DIRECT COSTS				**311,459**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,593,837**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
UCP Indirect Rate (Rate: 34.1000, Base: 3435727)					
TOTAL INDIRECT COSTS (F&A)				**1,171,583**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**4,765,420**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**4,765,420**	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Mohan K Ramamurthy

ORG. REP. NAME*
Lori Iafon

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INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 3

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University Corporation For Atmospheric Res

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Mohan K Ramamurthy

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mohan K Ramamurthy - Unidata Director**	9.12	0.00	0.00	**118,245**	
2. **Ethan R Davis - Software Engineer IV**	10.80	0.00	0.00	**93,420**	
3. **Benedict A Domenico - Unidata Outreach Manager**	2.40	0.00	0.00	**27,086**	
4. **Russell K Rew - Software Engineer IV**	6.00	0.00	0.00	**64,350**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	28.32	0.00	0.00	**303,101**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**19**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	228.00	0.00	0.00	**1,684,750**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**2**) UNDERGRADUATE STUDENTS				**14,853**	
5. (**2**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**75,138**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**2,077,842**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,111,314**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**3,189,156**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
File Server Upgrades **$ 40,000**					
TOTAL EQUIPMENT				**40,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**106,090**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **35,010**					
3. SUBSISTENCE **4,244**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**19**) TOTAL PARTICIPANT COSTS				**39,254**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**28,114**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**200,000**	
6. OTHER				**86,688**	
TOTAL OTHER DIRECT COSTS				**314,802**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,689,302**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
UCP Indirect Rate (Rate: 34.1000, Base: 3535048)					
TOTAL INDIRECT COSTS (F&A)				**1,205,451**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**4,894,753**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**4,894,753**	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Mohan K Ramamurthy

ORG. REP. NAME*
Lori Iafon

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 4

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University Corporation For Atmospheric Res

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Mohan K Ramamurthy

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mohan K Ramamurthy - Unidata Director**	9.12	0.00	0.00	**121,792**	
2. **Ethan R Davis - Software Engineer IV**	10.80	0.00	0.00	**96,223**	
3. **Benedict A Domenico - Unidata Outreach Manager**	2.40	0.00	0.00	**27,899**	
4. **Russell K Rew - Software Engineer IV**	6.00	0.00	0.00	**66,281**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	28.32	0.00	0.00	**312,195**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**19**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	228.00	0.00	0.00	**1,735,292**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**2**) UNDERGRADUATE STUDENTS				**15,298**	
5. (**2**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**77,392**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**2,140,177**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,144,654**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**3,284,831**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**109,273**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **36,060**					
3. SUBSISTENCE **4,371**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**19**) TOTAL PARTICIPANT COSTS				**40,431**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**28,957**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**200,000**	
6. OTHER				**89,289**	
TOTAL OTHER DIRECT COSTS				**318,246**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,752,781**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **UCP Indirect Rate (Rate: 34.1000, Base: 3637351)**					
TOTAL INDIRECT COSTS (F&A)				**1,240,337**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**4,993,118**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**4,993,118**	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Mohan K Ramamurthy

ORG. REP. NAME*
Lori Iafon

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

YEAR 5

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University Corporation For Atmospheric Res

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Mohan K Ramamurthy

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mohan K Ramamurthy - Unidata Director**	9.12	0.00	0.00	**125,446**	
2. **Ethan R Davis - Software Engineer IV**	10.80	0.00	0.00	**99,109**	
3. **Benedict A Domenico - Unidata Outreach Manager**	2.40	0.00	0.00	**28,736**	
4. **Russell K Rew - Software Engineer IV**	6.00	0.00	0.00	**68,269**	
5.					
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	28.32	0.00	0.00	**321,560**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**19**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	228.00	0.00	0.00	**1,787,352**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**2**) UNDERGRADUATE STUDENTS				**15,757**	
5. (**2**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**79,714**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**2,204,383**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**1,178,994**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**3,383,377**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.)					
TOTAL EQUIPMENT				**0**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**112,551**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **37,142**					
3. SUBSISTENCE **4,502**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**19**) TOTAL PARTICIPANT COSTS				**41,644**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**29,825**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**200,000**	
6. OTHER				**91,968**	
TOTAL OTHER DIRECT COSTS				**321,793**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**3,859,365**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **UCP Indirect Rate (Rate: 34.1000, Base: 3742721)**					
TOTAL INDIRECT COSTS (F&A)				**1,276,268**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**5,135,633**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**5,135,633**	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Mohan K Ramamurthy

ORG. REP. NAME*
Lori Iafon

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 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University Corporation For Atmospheric Res

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Mohan K Ramamurthy

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-months CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Mohan K Ramamurthy - Unidata Director**	45.60	0.00	0.00	**591,741**	
2. **Ethan R Davis - Software Engineer IV**	54.00	0.00	0.00	**467,508**	
3. **Benedict A Domenico - Unidata Outreach Manager**	12.00	0.00	0.00	**135,549**	
4. **Russell K Rew - Software Engineer IV**	30.00	0.00	0.00	**367,276**	
5.					
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	0.00	0.00	0.00	**0**	
7. (**4**) TOTAL SENIOR PERSONNEL (1 - 6)	141.60	0.00	0.00	**1,562,074**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL SCHOLARS	0.00	0.00	0.00	**0**	
2. (**95**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	1140.00	0.00	0.00	**8,385,869**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**10**) UNDERGRADUATE STUDENTS				**74,328**	
5. (**10**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**376,018**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**10,398,289**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**5,561,429**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**15,959,718**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **$ 145,000**					
TOTAL EQUIPMENT				**145,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**530,914**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **175,202**					
3. SUBSISTENCE **21,237**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**95**) TOTAL PARTICIPANT COSTS				**196,439**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**140,692**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**1,000,000**	
6. OTHER				**433,821**	
TOTAL OTHER DIRECT COSTS				**1,574,513**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**18,406,584**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**6,032,340**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**24,438,924**	
K. RESIDUAL FUNDS				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				**24,438,924**	

M. COST SHARING PROPOSED LEVEL $ **Not Shown** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Mohan K Ramamurthy

ORG. REP. NAME*
Lori Iafon

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C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget Justification

Unidata 2018: Transforming Geosciences Through Innovative Data Services

To advance the program in congruence with the submitted plan, we are requesting a total of $24,438,924 for operating the Unidata Program Center (UPC) for a period of five years from 1 December, 2013 to 30 November, 2018. This amount includes salaries, benefits, travel, equipment, materials and supplies, participant support costs, and awards to subcontractors, who provide necessary data and software which are broadly used by the community, and funds for continuing the Community Equipment Awards to universities.

We are requesting four additional staff at the UPC, which requires an explanation. As described in the Project Description of the proposal, we propose to gradually transition Unidata's products and services to align them with the cloud-computing paradigm and provide remote access to an array of data services from a "cloud" environment that facilitates end-to-end workflows. Additional resources are requested in this proposal in the IDV and THREDDS (Data Services) areas for two Software Engineers so that Unidata can begin taking steps to enhance and advance those applications so that they can be "cloud enabled." In addition, we are also requesting a System Administrator to manage Unidata's cloud-computing platform for developing and providing a range of new cloud-based data services. Furthermore, in today's challenging budget environment with diminishing resources for travel, Unidata's users are looking to the UPC to provide online, virtual training on Unidata software. To address that need, we are also requesting a new instructional designer to begin developing online training materials that can support virtual software training workshops, along with an additional student summer intern position.

Personnel, Salaries, Program Management and Work Effort:

During the proposal period, the UPC will employ 23.87 employees (excluding 0.89 FTEs covered by the UCAR indirect cost pool, and 3.84 FTEs funded by other direct grants), including technical and support staff, managerial and administrative personnel, community liaisons, and students. We request support for Dr. Mohan Ramamurthy, Director (PI), at .76 FTE. Additionally, we request funding for Dr. Benedict Domenico, Unidata Outreach Manager, who is currently working at 0.60 FTE and who is expected to reduce to 0.20 FTE in FY14. Dr. Russell Rew, Software Engineer IV, is budgeted at 0.95 FTE for midway through the third quarter of FY14, at which time he is expected to reduce to 0.50 FTE. Ethan Davis, Software Engineer IV and Data Services Manager, is budgeted at 0.90 FTE. As some of our senior staff members transition to retirement/reduced FTEs throughout the award period, we will be budgeting accordingly, and in alignment with the goals and priorities set forth in the proposal.

The UPC's system administration staff currently includes two employees at 1.80 FTEs (a System Administrator II & III) who maintain and support Unidata's computer infrastructure and network system. We have budgeted for another system administrator at 1.0 FTE, as our proposed cloud computing administrator. The administrative staff includes the Unidata Director, Dr. Ramamurthy, a Program Administrator at 0.82 FTE, and two Administrative Assistants at 0.90 FTE, who are all critical in the daily administration, operation, and support of the program. The UCAR Community Programs (UCP) charge costs in accordance with the cost principles established in OMB Circular A-122. The circular defines direct costs as those that can be identified specifically with a particular final cost objective, such as a particular award or project. Administrative support services that can be specifically identified with a particular award are charged as direct costs.

PI and Senior Personnel

Dr. Mohan Ramamurthy, Unidata Director, PI
Ethan Davis*, MS, Software Engineer IV, Data Services Manager
Dr. Benedict Domenico*, Unidata Development and Outreach Manager
Dr. Russell Rew, Software Engineer IV, Project Lead for netCDF

Unidata Management Team (in addition to the PI and Senior Personnel)

Linda Miller*, Community Liaison, Responsibility: Community Services
Terrence Mitchell*, MBA, Program Administrator II, Responsibility: Management/Administration
Michael Schmidt*, MS, Systems Administrator III, Responsibility: System/Network Administration

* Reports directly to Dr. Ramamurthy.

As Unidata Director, Dr. Ramamurthy's responsibilities are to:

- Direct the Unidata Program Center, setting, in consultation with the Unidata Policy and Users committees, goals and priorities for the program and developing strategies for advancement.
- Responsible for the overall productivity, creativity, and excellence of the program, including the formulation and execution of both long and short-range plans.
- Develop program plans, position papers, and budgets, including successful proposals for funding the UPC and community activities.
- Manage—directly or by delegation—all UPC activities, meeting obligations to sponsors, governing committees, collaborators, community, and other stakeholders.
- Supervise the above managers.
- Lead the Unidata Program—nationally and at UCAR—to be of increasing value to the current community and potential users.

- Provide oversight for governing committees, including timely appointment of new members, organization of periodic meetings, selection and awarding of the Russell L. DeSouza award, and leveraging the collective expertise of committee members to fulfill Unidata mission.
- Align the UPC with the current and future needs of the community.
- Enhance the quality of the program through superior management and direction of technical and administrative staff, balancing research, development, and support.
- Engage staff so as to maximize the collective strengths and creativities they apply toward Unidata goals and objectives.
- Employ advances in information technology, including hardware, software engineering, and cyberinfrastructure, to keep Unidata systems current and effective.
- Provide leadership in cyberinfrastructure through innovation, outreach, and other activities.
- Assess the effectiveness of the program and transformative impacts on the community on a regular basis, and make programmatic adjustments as needed.
- Keep in touch with the pulse of the community, establishing effective relations and communications with the university community and other stakeholders.
- Help universities to be aware of and benefit from Unidata progress and plans.
- Engage community as active "owners" of the Unidata Program.
- Establish and foster strategic partnerships and alliances, and create a culture of collaboration among all stakeholders.

As Data Services Manager, Ethan Davis' responsibilities are to:

- Lead Unidata's Data Services section, which creates and supports all systems-level software for the Unidata community.
- Meet Unidata software development goals directly, by delegation and/or through collaboration, for portability, software reuse, and adherence to industry standards.
- Provide technical support for all Unidata program users directly and by delegation to ensure that the users are properly supported.
- Serve on the Unidata Management Team and Unidata Technical Team by participating in the highest level of Unidata decision-making, solving problems and contributing ideas.
- Establish and foster strategic partnerships and alliances, and create a culture of collaboration among all stakeholders.

As Unidata Outreach and Development Manager, Dr. Domenico's responsibilities are to:

- Establish and maintain key Unidata relationships with external organizations, especially those in international standards, earth science and education communities.

- Act as Senior Advisor to the Director by providing advice and support to the Director on policy, plans and activities pertaining to Unidata's mission and by serving on the Unidata Management and Technical Teams.
- Establish productive and collaborative relationships for Unidata with the hydrology, oceanography, air quality, and human impacts communities.
- Coordinate Data Systems Development with organizations working on data system development that complements Unidata.
- Lead and manage educational and professional outreach efforts by acting as data provider liaison to various projects.
- Lead Project Development by identifying opportunities for collaboration with the scientific and data community, both national and international.

As Senior Software Engineer IV, Dr. Rew's responsibilities are to:

- Provide technical support for netCDF users directly and by delegation to ensure that netCDF users are properly supported.
- Serve on the Unidata Management Team and Unidata Technical Team by participating in the highest level of Unidata decision-making, solving problems and contributing ideas.
- Establish and foster strategic partnerships and alliances, and create a culture of collaboration among all stakeholders.

Unidata Management Team: The UMT is the senior management body of the UPC and it serves in an advisory capacity to the Director. The UMT is responsible for strategic management of the UPC and for providing high-level direction and advice on programmatic issues. Specifically, the UMT:

- Provides guidance and leadership in support of Unidata's strategic direction and priorities.
- Discusses and makes recommendations on programmatic matters to ensure that UPC activities support Unidata's mission, facilitate cross-cutting activities, and sustain Unidata as a healthy organization.
- Helps develop strategic plans and core-funding proposals, reviews potential opportunities for additional, non-core funding, and makes recommendation on allocation of resources across the whole program.
- Makes sure that appropriate internal policies and procedures are in place to address issues important to staff, keeping the program productive and healthy.

The following table provides an approximate allocation of the UPC's current and proposed FTEs, by proposed focus areas and augmented by related management, administration and system admin personnel.

Approximate Resource Allocations by Focus Area Averaged Over the Proposal Period			
Area	Current FTEs	Proposed FTEs	
Community Services Lead: Ramamurthy, Domenico, and Miller	2.10	2.10	No change
Data Services, including tools Lead: Davis, Domenico, and Rew Program Areas include: AWIPS II/GEMPAK – Lead: Michael James IDV – Lead: Yuan Ho LDM, UDUNITS – Lead: Steve Emmerson McIDAS – Lead: Tom Yoksas NetCDF – Lead: Russell Rew THREDDS – Lead: John Caron	7.59 (1 student*)	9.78 (2 students*)	2 new positions
User Support Services Lead: Davis, Miller, and Rew All staff provide user support.	3.18	4.18	1 new position
Cyberinfrastructure Leadership Lead: Ramamurthy, Domenico and Rew	1.10	1.10	No change
System/Network Administration Lead: Schmidt	1.80	2.80	1 new position
Management/Administration Lead: Ramamurthy and Mitchell	3.91	3.91	No change
Total FTEs funded in the core program	19.68** (1 student*)	23.87** (2 students*)	

* Students are calculated at .19 FTE
** Excludes .89 FTEs covered by the indirect cost pool in the System/Network Admin and Management/Admin areas

In addition to the above FTEs funded by the NSF/AGS 5-year award, approximately 4 additional FTEs are funded by non-core awards from other sources.

UCAR salaries are based on estimated salaries at the start date. The salary budgets include direct labor charges for time worked only. Unidata's total salary request is $10,398,290 for the five-year proposal.

Waiver Request to Section II.C.2.g.i.a of the GPG 13-1: Project Personnel Salaries & Wages Policy
UCAR, as a non-academic institution, limits the total salary compensation to no more

than 100% on all funded projects. The UCAR Community Programs (UCP), of which Unidata is a part of, do not receive base funding, therefore the funds requested in this proposal, if awarded, will be directly used to support the personnel in fulfilling their obligations as described in this proposal.

Fringe Benefits:

The provisional employee benefit rate of 53.8% for FY2014 includes direct charges for non-work time such as paid-time-off, holidays and other paid leave, as well as standard staff benefits. The reduced benefit rate of 9.6% applies to casual employees (students and visitors) who do not receive the full benefit package.

Unidata's total benefits request is $5,561,429 for the five-year proposal.

Materials and Supplies:

Funds are requested for office supplies and furnishings, publication and journal page charges, office equipment, meeting and workshop support materials, and general supplies for existing staff and new hires over the five-year period. This line item also includes infrastructure maintenance and improvement (desktop computing and laptop systems under $5k, and parts and upgrades to existing equipment). We are requesting $119,456 for the five-year award period.

Purchased Services:

1) General:

Funds are requested for software purchases, hardware maintenance, meeting and workshop services, professional development classes, telephone and facsimile charges, and other general office services. As part of our annual Training Workshop, funds are also requested for equipment rental. To be more proactive in our outreach and community broadening efforts, we request funds to participate as an exhibitor in at least one conference per year. As part of our effort to move to cloud-based computing, we request funds to establish a cloud-based server along with the associated bandwidth subscription cost.

2) Subcontracts/awards:

Space Science and Engineering Center, University of Wisconsin
The University of Wisconsin, SSEC has a long-standing record of being a major data provider to the Unidata community. The SSEC incurs substantial costs which they must recover in order to make data available to the Unidata community in proper format.

Additionally, SSEC allows Unidata to redistribute McIDAS software to the community at no cost. $100,000 per year is requested to maintain this contract. The Subcontractor agrees to provide services and support to the Unidata Program Center (UPC), including:

1) GOES East and GOES West Satellite imagery and products for broadcast to the Unidata community. In addition, an archive of satellite images and products broadcast to the Unidata community will be maintained and made available upon request by Unidata community members to the SSEC Datacenter. $65,000
2) Support for and documentation updates to all McIDAS and related software packages, and multisite licensing for Unidata universities. $22,000
3) Support for and documentation updates to all GOES SDI software packages. $8,000
4) Modifications and enhancements to the SSEC-developed McIDAS-X, McIDAS-XCD, OpenADDE, and VisAD packages for Unidata Community use. $5,000

In addition, SSEC provides at no cost:

1) Continued hosting of the Unidata Satellite Data Receiver/Server and top tier IDD injection node in the SSEC Datacenter with no bandwidth restrictions.
2) Continued collaboration with UPC staff to deploy full resolution GOES East and GOES West imagery through ADDE on the Unidata Satellite Data Receiver/Server that is hosted in the SSEC Datacenter.

Other Subcontracts
We are requesting $500,000 for our Equipment Award subcontracts. The Unidata Equipment Awards program has been an important component of the Unidata Program for over twenty years, during which time hundreds of institutions, both large and small, have obtained much needed funding in order to be productive members of the Unidata community. This program was formerly administered directly by NSF, but for reasons of cost efficiency, the equipment award has been managed by the UPC since 2003.

For the five-year proposal we are requesting $1,080,057 for Purchased Services plus an additional $375,000 for subcontracts/awards in this category which is not subject to overhead.

Travel:

To support the distributed nature of our community and governance structure, engage community members, interface with collaborators, participate in professional conferences (primarily, AGU and AMS), and to continually assess evolving community needs, the UPC requests $530,914 for the five-year proposal to fund staff travel. This includes travel required for professional development activities and for staff to conduct Unidata Regional Workshops. Travel is budgeted, approved and monitored based on relevant off-site events for each participating staff member. Again, these requests are consistent with previous travel expenses.

Equipment:

We request a budget of $145,000 for equipment to provide data infrastructure support and porting capabilities to our community. This budget is in line with previous equipment expenditures, with the anticipation of maintaining a three year replacement/upgrade schedule.

Development and Porting Platforms - (4 @ $10,000 = $40k total budget) - includes desktop and server grade equipment for the porting and development of Unidata software to platforms commonly found in the community as specified by the Policy Committee. A subset of these currently includes AIX, Linux, MacOS, and Solaris. Acquisition dates are contingent upon staff rotation and new technologies for porting. We will request title transfer/disposal of obsolete equipment.

Server Upgrades - (2 @ $25,000 = $50k total budget) - includes mid-range multi-core computation, multi-terabyte storage, and high speed (gigabit) network hardware from vendors such as Dell, Sun, IBM and HP. These will primarily serve Unidata end-user visible functions, making services and data available directly to our community. These purchases are anticipated near the end of the vendor's fiscal years to take advantage of favorable cyclical pricing. We will request title transfer/disposal of obsolete equipment.

Satellite Data Ingest Platforms - (1 @ $25,000) and the associated Data Distribution cluster (1 @ $10,000) - For access to real-time GOES (East, West, and South) data via ADDE ingested from GOES and NOAAport off of SSEC Satellite Data Ingesters (SDIs) and DVBS streams, creating and archival of the Unidata-Wisconsin stream data content for IDD distribution to the community.

GOES-R Satellite Equipment (4 @ $10,000 = $40k total budget) -- Associated equipment for access to real-time GOES (East, West, and South) data via ADDE off of SSEC Satellite Data Ingesters (SDIs).

Participant Support Costs (PSC):

The UPC will support travel and associated costs to committee meetings for 8 Policy Committee members and 10 Users Committee members as well as some interdisciplinary liaisons and experts. Typically, there are 2 Policy Committee and 2 Users Committee meetings every year. During proposal years, we hold an extra Policy Committee meeting to develop the core-funding proposal. We also have 3 Users Committee members participate in the Equipment Awards Review Panel (facilitated by the Director and Program Administrator), which meets once a year to award those funds. These costs include round-trip airfare, typically two nights lodging per committee member per meeting, (mostly committee shared) rental car and/or other ground transportation expenses, per diem, and miscellaneous travel expenses. PSCs also include food and beverages for working lunches and working dinners for the duration of the day and a half

long meetings as part of the meetings. Any alcohol beverages served during the dinners are paid for out of Unidata's discretionary account, not direct NSF core funds. Based on previous year's expenditures, we have calculated these costs at $196,438 for the five-year award period.

Consultant Services:

No consulting services are anticipated for this award period.

Indirect Costs:

FY2014 provisional benefit and indirect rates were used to calculate this budget and are subject to review and approval of NSF, our cognizant audit agency. The UCP Indirect Rate for FY2014 is 34.1%. Indirect costs are applied to all Modified Total Direct Costs (MTDC), which currently exclude equipment and participant support costs. The rate is charged on the first $25,000 of each subcontract per fiscal year. Out year rates are estimated based on current provisional rates and are subject to change. For this proposal, the total Indirect Costs are budgeted at $6,032,340 on a total MTDC of $17,690,146.

Escalation:

Salaries are projected to increase by 3.0% per year. Non-salary items are also budgeted with an annual 3% inflationary rate.

Monitoring and Reporting:

All subawards are administered through UCAR's Contracts office and are closely monitored for compliance with both NSF and UCAR guidelines and regulations. Reports on project progress are required at the time of partial and full awarding of funds. Awardees are also required to submit a final follow up report one year after their subaward is granted, specifically outlining how the award has met the goals of their proposal and how it has contributed to the advancement of the Unidata community and mission.

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Mohan Ramamurthy**

Other agencies (including NSF) to which this proposal has

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Unidata 2013: A Transformative Community Facility for the Atmospheric and Related Sciences Support Atmospheric Science and Engineering Research

Source of Support: NSF

Award Amount (or Annual Rate): $ $20,296,000 Period Covered: 12/01/08 - 11/30/13

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 12.0 Acad: Summ:

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Collaborative Research: An Integrated Arctic Data Management System (IADS) to Support Arctic Research

Source of Support: NSF

Award Amount (or Annual Rate): $ 576,482 Period Covered: 07/15/11-06/30/15

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.5 Acad: Summ:

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: 2012 Unidata Users Workshop: “Navigating Earth System Science Data”

Source of Support: NSF

Award Amount (or Annual Rate): $ $97,583.00 Period Covered: 07/01/2012-06/30/2013

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.0 Acad: Summ:

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: EarthCube Workshop: “Shaping the Development of EarthCube to Enable Advances in Data Assimilation and Ensemble Prediction”

Source of Support: NSF

Award Amount (or Annual Rate): $ $41,225 Period Covered: 12/15/2012 - 11/30/2013

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.0 Acad: Summ:

Support: [ ] Current [X] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: EarthCube Building Blocks: Specifying and Implementing ODSIP, A Data-Service Invocation Protocol

Source of Support: NSF

Award Amount (or Annual Rate): $ $600,000 Period Covered: 12/01/2013 - 11/30/2015

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.0 Acad: Summ:

Support: [ ] Current [X] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: EarthCube Building Blocks: Deploying Web Services Across Multiple Geoscience Domains

Source of Support: NSF

Award Amount (or Annual Rate): $ $179,375 Period Covered: 12/01/2013 - 11/30/2015

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.0 Acad: Summ:

Support: [ ] Current [X] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: EarthCube Building Blocks: Specifying and Implementing ODSIP, A Data-Service Invocation Protocol

Source of Support: NSF

Current and Pending Support

Award Amount (or Annual Rate): $ $322,576 Period Covered: 7/15/2013 - 7/14/2015

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.0 Acad: Summ:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ * Transfer of Support

Project/Proposal Title: EarthCube Building Blocks: Specifying and Implementing ODSIP, A Data-Service Invocation Protocol

Source of Support: NSF

Award Amount (or Annual Rate): $ $313,402 Period Covered: 12/01/2013 - 11/30/2015

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.0 Acad: Summ:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ * Transfer of Support

Project/Proposal Title: Unidata 2018: Transforming Geosciences Through Innovative Data Services

Source of Support: NSF

Award Amount (or Annual Rate): $ $24,438,924 Period Covered: 12/01/2013 - 11/30/2018

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 12.0 Acad: Summ:

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Ethan R. Davis**

Other agencies (including NSF) to which this proposal has

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Unidata 2013: A Transformative Community Facility for the Atmospheric and Related Sciences Support Atmospheric Science and Engineering Research

Source of Support: NSF

Award Amount (or Annual Rate): $ $20,296,000 Period Covered: 12/01/08 - 11/30/13

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 10.8 Acad: Summ:

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: OPeNDAP Unidata Linked Servers (OPULS)

Source of Support: NOAA (subaward from OPeNDAP)

Award Amount (or Annual Rate): $ $163,245 Period Covered: 08/29/2011 – 08/28/2014

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 1.2 Acad: Summ:

Support: [ ] Current [X] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: EarthCube Building Blocks: Integrating Discrete and Continuous Data

Source of Support: NSF

Award Amount (or Annual Rate): $ $211,491 Period Covered: 12/01/2013 - 11/30/2015

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 0.0 Acad: Summ:

Support: [ ] Current [X] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Unidata 2018: Transforming Geosciences Through Innovative Data Services

Source of Support: NSF

Award Amount (or Annual Rate): $ $24,242,149 Period Covered: 12/01/2013 - 11/30/2018

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 10.8 Acad: Summ:

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Ben Domenico**	Other agencies (including NSF) to which this proposal has

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Unidata 2013: A Transformative Community Facility for the Atmospheric and Related Sciences Support Atmospheric Science and Engineering Research

Source of Support: NSF

Award Amount (or Annual Rate): $ $20,296,000 Period Covered: 12/01/08 - 11/30/13

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 7.2 Acad: Summ:

Support: [ ] Current [X] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Unidata 2018: Transforming Geosciences Through Innovative Data Services

Source of Support: NSF

Award Amount (or Annual Rate): $ $24,242,149 Period Covered: 12/01/2013 - 11/30/2018

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 2.4 Acad: Summ:

Current and Pending Support

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Russ Rew**

Other agencies (including NSF) to which this proposal has

Support: [X] Current [ ] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Unidata 2013: A Transformative Community Facility for the Atmospheric and Related Sciences Support Atmospheric Science and Engineering Research

Source of Support: NSF

Award Amount (or Annual Rate): $ $20,296,000 Period Covered: 12/01/08 - 11/30/13

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 11.4 Acad: Summ:

Support: [ ] Current [X] Pending [ ] Submission Planned in Near Future [ ] * Transfer of Support

Project/Proposal Title: Unidata 2018: Transforming Geosciences Through Innovative Data Services

Source of Support: NSF

Award Amount (or Annual Rate): $ $24,242,149 Period Covered: 12/01/2013 - 11/30/2018

Location of Project: UCAR, Boulder, Colorado

Person-Months Committed to the Project Cal.: 6.0 Acad: Summ:

Facilities, Equipment, and Other Resources

The Unidata Program Center (UPC) has full access to the high-bandwidth research and education network and commodity Internet network connections available through the Front Range GigaPop (FRGP). Connections include Internet2 and National LambdaRail connections at 10 gigabit per second and multiple commodity Internet connections at a minimum of 1 gigabit per second. The FRGP is managed and operated by staff primarily housed within UCAR/NCAR and has a record of very high uptime and excellent service to the community.

The UPC has full use of the supercomputing, mass storage, and network resources available to UCAR, including the 1.5 petaFLOPS Yellowstone supercomputer, 11 petabyte GLADE storage system at the NCAR Wyoming Supercomputing Center, and 10 gigabits per second networking to all computer facilities and many desktop environments including Unidata offices. In addition, Unidata hosts about a dozen publicly available servers and services for the community, making data available on a nearly 24x7x365 basis. These systems serve data via ADDE, HTTP, FTP, and other popular network protocols from current and retrospective data archives totaling in excess of 120 terabytes of raw capacity with a data archive window going back as far as 180 days.

The UPC has access to all of the UCAR computer co-location spaces, which afford centrally managed infrastructure management, power management, cooling, UPS, and in some cases, emergency generator backup power. Some of the facilities can operate with very high uptime potential, including the facility Unidata uses as its primary facility, which has been available 100% over the past year. UCAR co-location facilities have geographic diversity to avoid issues with single points of failure. Unidata also maintains offsite systems at the University of Wisconsin (Madison), providing additional geographic diversity, sharing the network traffic load, and providing redundancy in the event of failure.

In partnership with multiple UCAR entities (COMET, RAL, EOL), the UPC receives and ingests multiple different satellite data streams, including NOAAPort satellite broadcast network (SBN), from two heated groundstations in Boulder, CO. The UPC also ingests all three geosynchronous operational environmental satellite (GOES) feeds from the current east, west, and south satellites, including a tracking receiver configuration for GOES South. All three groundstations (and a backup groundstation available in the event of failure) are located in Boulder. CO. These systems serve data directly to the Unidata community on a nearly 24x7x365 basis.

Data Management Plan

The Unidata Program Center (UPC) is a community service facility that focuses on making data collected or generated by government agencies, commercial organizations, and university researchers available to the wider university and geosciences community, and on creating technologies that foster the wide dissemination and use of geoscience data. The UPC does not, in its own right, create new geoscience data to be shared with the community.

In an abstract sense, our entire proposal can be viewed as a "data management plan," since our goal is to make it easier for community members to gain access to, use, and share geoscience data. The UPC does, however, handle large amounts of data prior to making it available to others via our technologies. This document briefly describes the data that passes through our care, and the policies we put in place surrounding that data.

Types of Data Managed at the UPC

The UPC collects a wide variety of observation data and model output from numerous data providers and distributes it to our community in near real time. Data types include:

- Radar data and products in Level 2 and Level 3 formats
- Satellite data and products in AREA and GINI formats
- Point data including METAR, Profiler, GPS, ACARS, and Lightning strike
- Text data in ASCII and other formats
- Model output in GRIB1, GRIB2, and netCDF formats

Data are either automatically "pushed" by servers at the UPC to users' sites or "pulled" from UPC servers by user request. Most data "pushed" to the community are provided in the format used by the data provider, although some are "decoded" first in order to make them more widely useful. Data "pulled" from remote access servers at the UPC are available in a variety of standard formats of the user's choosing, predominantly netCDF.

Data and Metadata Standards Used

Because the UPC serves primarily as a relay for data collected or generated by others, control over data standards, quality control, and metadata is left largely to the original data providers. The UPC does provide software for decoding raw data and translating them into standard formats that are compatible with the tools it provides or other tools the community members may use. In addition, the UPC provides access to data using community or international standards in the atmospheric sciences (e.g., GRIB1, GRIB2, BUFR, netCDF-CF, WCS, and WMS).

Mechanisms for Access and Sharing

The UPC makes data available to its community in two main ways:

Push

"Push" access involves data being copied automatically between computers connected to the Internet Data Distribution (IDD) network. Computers running Unidata's Local Data Manager (LDM) software "subscribe" to specific data feeds, which are automatically copied from a nearby IDD network node when they become available. Some, but not all, IDD sites also choose to serve as relays to other downstream sites. Any site can install the LDM and join the IDD network at its own discretion; the UPC does not control access to the network.

Pull

"Pull" access involves a computer at a remote site connecting to a Remote Access Server at the UPC and requesting data. The UPC supports two primary types of remote access server: The THREDDS Data Server (TDS) and RAMADDA. Remote access servers operating at the UPC are not access-controlled; any site or individual can connect and retrieve data.

Policies for Re-use and Distribution

In most cases, data available either via the IDD or via remote access servers at the UPC is free of re-use or distribution restrictions. The following data sets, however, are made available subject to restrictions as specified by the data provider:

- National Lightning Data Network data (Vaisala)
- North American Precision Lightning Network and Global Lightning Network (WSI)
- ACARS data from aircraft

Policies for Archiving and Preservation

The UPC is not an archive center, and does not archive the real-time data we make available for long periods of time. (Note that all data available from UPC servers becomes available from NOAA's National Climatic Data Center (NCDC) archives after 30 days.) We do, however, provide a short term archive for some data, for the convenience of our community. Archive times fluctuate, depending on data volumes and resource constraints. The table below shows some representative archive times for different data types:

In addition to native-format data, the UPC also provides decoded data in GEMPAK and McIDAS formats. These decoded versions are provided as a service to our community, and can be recreated at any time from native-format data. The UPC provides a rolling archive of decoded McIDAS-format data for two days, decoded GEMPAK-format model data for two days, and decoded GEMPAK-format surface observation data for seven days.

Data Type	Archive (days)
Model Output	138
Satellite Imagery	138
Radar (Level 2 and 3)	120
Surface Observations	60
Upper Air Observations	40

Appendix A: Letters of Collaboration

Unidata has received letters of collaboration supporting this proposal from the following:

- NOAA Earth System Research Laboratory
- NOAA National Centers for Environmental Prediction
- NOAA National Climatic Data Center
- NASA Earth Science Division
- NCAR Earth Observing Laboratory
- NCAR Computational Information Systems Laboratory
- U.S. Geological Survey
- Earth and Space Science Informatics Laboratory (Italy)
- Open Geospatial Consortium
- The HDF Group
- Consortium of Universities for the Advancement of Hydrologic Science, Inc.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of Oceanic and Atmospheric Research
Earth System Research Laboratory
325 Broadway – David Skaggs Research Center
Boulder, Colorado 80305-3337

April 23, 2013

UCAR/Unidata
Dr. Mohan Ramamurthy
P.O. Box 3000
Boulder, CO 80307-3000

RE: Unidata 2018: Transforming Geoscience through Innovative Data Services NSF Proposal

Dear Dr. Ramamurthy,

I gladly write this letter in support of your NSF proposal titled "Transforming Geoscience through Innovative Data Services." ESRL's Global Systems Division (GSD), formerly the Forecast Systems Laboratory (FSL), continues to collaborate with Unidata to communicate many of its technological achievements and release them to its user community. The following examples illustrate our productive relationship, both past and future, as many of them are longer-term projects.

FSL developed the Advanced Weather Interactive Processing System (AWIPS), which is a technologically advanced information processing, display, and telecommunications system used by every Forecast Office in the National Weather Service (NWS). AWIPS heavily relies on netCDF for data storage. Information exchanges between GSD and Unidata pertaining to netCDF have occurred, regarding the extension and merging of netCDF and HDF data formats. However, the complexity of the original AWIPS system and access to AWIPS-I data streams made it difficult for Unidata to collaborate with FSL. By contrast, in the current and future AWIPS-II era, it is quite possible for Unidata to develop a system outside the security firewall using web services and data discovery capabilities. The payoff could be substantial if universities could be more directly involved in developing plug-ins that could eventually make it into the AWIPS-II operational systems. GSD could possibly provide the bridge between capabilities developed by universities and the operational AWIPS-II. In fact, Unidata personnel are coordinating with GSD staff on the next-generation AWIPS-II development, which is being led by Raytheon. Unidata is following the development with NWS and Raytheon contractors. Although no decision has been made yet whether Unidata will adopt AWIPS-II to include in its suite of tools for the community, they are very interested in learning more about it, and

AWIPS-II developers are interested in learning about Unidata technologies. If Unidata could help familiarize students with this NWS operational system, then students would be provided a smoother transition into the NWS workforce; a clear benefit of such activities.

The Meteorological Assimilation Data Ingest System (MADIS) developed by GSD leverages partnerships with international agencies; federal, state, and local agencies (e.g. state Departments of Transportation); universities; volunteer networks; and the private sector (e.g. airlines, railroads) to integrate observations from their stations with those of NOAA to provide a finer density, higher frequency, and higher quality observational database for use by the greater meteorological community. MADIS uses the Unidata Local Data Manager to ingest and distribute the observations and the Network Common Data Format (NetCDF) for data storage. There are university suppliers of data to MADIS and universities using MADIS data in their research efforts. Unidata has advocated support of the MADIS project and it's team in the past and close collaboration will continue into the future.

Researchers and service providers from the academic and private communities have a strong need for a portable, computationally efficient, user-friendly data assimilation scheme to assess the state of the atmosphere on very fine scales in support of situational awareness and for initializing numerical weather prediction models for very short-range, Warn-On-Forecast and other applications. NOAA/ESRL/GSD's Local Analysis and Prediction System (LAPS) has been developed with and used by national and international partners. To make LAPS more accessible to the customer base of Unidata, GSD contributed with a presentation on the use of the LAPS system at the 2012 Unidata Users Workshop: Navigating Earth System Science Data, 9-13 July 2012, Boulder, Colorado.

The use of LAPS by the weather community was discussed at length at the Second LAPS User Workshop held at ESRL, Oct 23-25, 2012. Workshop participants expressed a strong interest in using LAPS installed on AWIPS-II, and one of the recommendations of the workshop was for GSD to partner with UCAR to explore whether the LAPS software could be distributed by Unidata to the community, either as part of AWIPS-II, and or via other means. Our experts at the Forecast Applications Branch (FAB) of GSD are ready to collaborate with colleagues at Unidata to assess the feasibility of this project.

GSD receives WSR-88D Level-II data from Unidata's Internet Data Distribution (IDD) LDM distribution system. These data are assimilated by the Local Analysis and Prediction System (LAPS) and the Space and Time Multiscale Analysis System (STMAS) within GSD. GSD’s Central Facility system relies on LDM as its middleware for data transport and event-driven processing and supplies, e.g. NOAA Profiler Network (NPN) Wind and RASS data to the Unidata community via its LDM distribution farm. Data are also distributed to numerous external clients via LDM services.

GSD participates in the CONDUIT program that distributes large gridded data sets to the Unidata community via LDM. By agreement, we have served as a fan-out point for NOAA users within the DSRC, and so feed the data researchers in ESRL’s Chemical Sciences Division, in addition to serving GSD Systems such as FX-Net. We also provide Unidata HRRR output on

constant pressure levels through an LDM feed at Unidata's request. Reportedly, these grids are being used in some cases to initialize smaller-domain, finer mesh runs of the Weather Research and Forecasting model for teaching purposes. Unidata is successful in the in the teaching of synoptic meteorology by providing of gridded model output such as we supply with the HRRR distribution.

GSD has developed software based on the java McIDAS libraries to acquire a variety of satellite data sets from the NESDIS using the Unidata McIDAS Abstract Data Distribution Environment (ADDE) services. ADDE is a remote data access protocol originally developed for geolocated data that communicates requests from client applications to servers, which then return data objects back to the client. Certainly, the training and support for McIDAS offered by Unidata have been and will continue to be instrumental in enabling GSD to use these systems.

The AMDAR (Aircraft Meteorological Data and Reporting) program encourages commercial airlines to provide real-time meteorological data to weather services worldwide. Collaborative AMDAR activity has been ongoing for several years with GSD providing AMDAR data to the university community for use in research and education. Unidata wanted to distribute these data to universities themselves several years ago, but because the data are restricted (a policy developed between GSD and the U. S. airline industry), GSD asked Unidata to put the universities in direct touch with us, and we distribute the data directly to the universities who have made the request. Unidata has been helpful in making universities aware that this data can be useful in research.

There are many other examples of collaboration between Unidata and GSD. To briefly name just a couple more: 1) THREDDS is an infrastructure built by Unidata for publishing and conveniently accessing scientific data. GSD has configured a THREDDS Catalog server to facilitate distribution of GSD's model data to NWS and other clients. 2) GSD extensively uses the netCDF libraries (C, C++, Fortran, and Java) in creating and processing numerous data sets. These packages are utilized with NextGen and CSS-Wx as the standard format for gridded data distribution from NOAA to the FAA for aviation.

As described, the ESRL relationship with Unidata is long-term and comprehensive. We have the full intention of continuing and developing it as opportunities arise. Our mutual efforts to transform the geosciences community, research, and education by providing innovative data services and tools are enhanced by our collaborative activities.

Best Regards,

Dr. Alexander E. MacDonald
Director, Earth System Research Laboratory
NOAA/OAR Chief Science Advisor

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
National Centers for Environmental Prediction
5830 University Research Court, Suite 4600, W/NP
College Park, MD 20740

APR 16 2013

Dr. Mohan Ramamurthy
Director, Unidata Program Center
University Corporation for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307-3000

Dear Dr. Ramamurthy,

Over 15 years ago, the U.S. Weather Research Program supported the National Centers for Environmental Prediction (NCEP) and the National Weather Service (NWS) by providing funds to enable distribution of NCEP's high resolution model grids, not available via NOAAPORT, to the research community through Unidata. This collaboration was significantly enhanced over the past five years. CONDUIT has expanded allowing for a more robust distribution of data. In addition, the data content has expanded tremendously with new model products and higher resolution from existing models. Currently152 sites are receiving the model grids using the same Local Data Manager (LDM) push technology that is used for distribution of other data facilitated by Unidata.

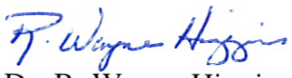
NCEP's use of the LDM is critical for our operational transfer and ingest of data. Unidata has created and supported LDM over the years including training, documentation, software upgrades, and NCEP customer support. Without Unidata's continued support of the LDM, our enterprise tool for obtaining data for NCEP Centers would be at risk.

The N-AWIPS/GEMPAK analysis and display software continues to be an extremely successful collaboration between NCEP and Unidata. Unidata is our portal to the University community for software. Unidata has provided valuable feedback on our software, suggested improvements, as well as providing us with new tools and algorithms that we have integrated into our baseline. During the last three years,

NCEP has worked closely with Unidata to make a gradual transition from N-AWIPS to the Java-based AWIPS II. Even though the AWIPS II software has not been fully implemented across NWS offices and centers, Unidata has been able to implement a baseline version at their facility, conduct beta tests at several universities, and is planning to conduct an initial AWIPS II training course this summer.

We look forward to continued collaboration, and wish you success with your NSF proposal.

Sincerely,



Dr. R. Wayne Higgins
Acting Director

April, 26 2013

Mohan Ramamurthy
Unidata Program Center
University Corporation for Atmospheric Research
P.O. Box 3000
Boulder, Colorado 80307

Dear Dr. Ramamurthy:

I am pleased to provide you with this letter of support for outstanding service to the scientific community. I know that Federal agencies and organizations that work with Unidata benefit greatly from their leadership and cross agency integration of standards. This statement results from my observations from two perspectives: serving as Director of the National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC); and Chair of the United States Sub-Committee on Global Change Research.

At NCDC, the Unidata cooperation has had very positive results. Several key data access projects use Unidata developed and supported technologies including the NOAA Operational Model Archive and Distribution System (NOMADS); access to the National Weather Service (NWS) NEXRAD radar holdings; and direct support to the NOAA-wide 'Climate.gov' portal activity. These and other efforts at NCDC depend heavily on Unidata accomplishments. The management and delivery of those data are only possible because Unidata developed and supported software and technologies for interoperable access to data across the geo-sciences. A primary technology used across our Center include: the THematic Real-time Environmental Distributed Data Services (THREDDS); the Local Data Manager; and the Common Data Model for format neutral access to various data sets. All of these capabilities have allowed us to greatly improve our service to customers.

It is with great pleasure that I support the mission and efforts of Unidata, and look forward to continued collaborations.

Sincerely,

Thomas R. Karl

Thomas R. Karl, L.D.H.
Director, National Climatic Data Center
Chair, Subcommittee on Global Change Research

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

April 8, 2013

Reply to Attn of: SMD/Earth Science Division

Dr. Mohan Ramamurthy
Unidata Program Center
UCAR Office of Programs
P.O. Box 3000
Boulder, CO 80307-3000

Dear Dr. Ramamurthy:

This letter is in reference to your proposal entitled "Unidata 2018", to be submitted to the National Science Foundation (NSF). The National Aeronautics and Space Administration (NASA) anticipates continuing a collaboration with Unidata to the mutual benefit of NASA, Unidata, NSF, and Earth observation data users in the following areas.

The NetCDF data format is a community standard format and data model utilized by multiple NASA Earth science communities. NASA, through the Earth Observation System Data and Information System (EOSDIS), is interested in continuing its collaboration with Unidata to improve NetCDF usability, compatibility with common tools used by our communities, and data interoperability with other standard data formats.

EOSDIS data centers have deployed a number of Unidata tools (e.g. THREDDS data servers) to improve data services for users. NASA is interested in collaborating with Unidata to improve the usability, capability, and performance of these tools.

NASA is interested in continuing technical information exchanges through the Earth Science Data Systems Working Groups (ESDSWG), the Federation of Earth Science Information Partners, and other fora. These exchanges in the past have proved to be informative and useful.

NASA fully supports the continuation of Unidata and its objectives of enabling ease of Earth observation data access and usability across interagency stovepipes and advocacy of standards. The collaborative spirit between NSF/Unidata and NASA has benefited the understanding and prediction of Earth system science.

Sincerely,

Martha E. Maiden
Program Executive Earth Science Data Systems

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

National Center for
Atmospheric Research

VANDA GRUBIŠIĆ
NCAR Associate Director for
Earth Observing Laboratory (EOL)

PO Box 3000, Boulder, CO 80307-3000
Phone: 303.497.2040

Dr. Mohan Ramamurthy, Director
Unidata, UCAR/UCP
P.O. Box 3000
Boulder, CO 80307

April 26, 2013

Dear Mohan,

It is my understanding that you are currently assembling the next 5-year proposal, "Unidata 2018: Transforming Geoscience through Innovative Data Services", to support the core activities of Unidata. I wish to state my strong support for your efforts and emphasize the future close and mutually beneficial partnership that will continue between Unidata and EOL. Our relationship is synergistic and I expect a number of important joint projects to emerge in the near future that will greatly benefit the community. The following are ongoing projects which have a high priority within EOL:

1. EOL routinely relies on Unidata tools and services in our service to the scientific community. We receive satellite data in near real-time by way of the LDM and process the data through McIDAS during field experiments. Unidata's netCDF has become the Gold Standard for data formats in the EOL, facilitating easy access and sharing of data during field experiments and in the scientific analysis phase. THREDDS catalogs are used to link our data holdings to other portals and search tools such as NCAR's Community Data Portal.

2. Unidata and EOL will continue to collaborate in making further enhancements to the IDV and supporting tools for analysis of data from our field experiments. A long term goal is to work together to promote the use of the IDV as a key tool for accessing, analyzing and visualizing data from our projects, with special focus on classroom applications.

3. A recent collaboration between Unidata, EOL and RAL has been the design and proposal of the CfRadial data format to serve as a comprehensive format for radar, lidar and profiler data. This new format adheres to the Climate Forecasting conventions for gridded data, making our remote sensing data more usable and compatible with globally adopted standards within the scientific modeling community.

4. Unidata and EOL are collaborating with CISL and NSIDC to further develop and deploy a comprehensive suite of data services for the arctic community through the Advanced Cooperative Arctic Data Information Service (ACADIS).

Good luck and please let me know if I can assist you in any way.

Sincerely,

Vanda Grubišić
NCAR Associate Director for Earth Observing Laboratory

Computational & Information Systems Laboratory

P.O. Box 3000 ~ Boulder, CO 80307-3000 ~ www.cisl.ucar.edu

From the Office of the Director

Memorandum

To: Mohan Ramamurthy

From: Al Kellie

Date: 4/26/2013

Re: Unidata 2018: Transforming Geosciences through Innovative Data Services

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I would like to indicate my strong and continuing commitment, as Director of the Computational and Information Systems Laboratory (CISL) of the National Center for Atmospheric Research (NCAR), to the goals Unidata is proposing for the next five years in the proposal "*Unidata 2018: Transforming Geosciences through Innovative Data Services*". Data-centric science is a mutual challenge for CISL and Unidata. This challenge has many aspects and Unidata is a critical solutions provider in the areas of data management tools, systems of integrated cyberinfrastructure, and support for atmospheric and related geoscience education and research across the US and internationally.

There are numerous places where CISL data services rely on developments from Unidata. We have especially appreciated how responsive Unidata has been when technical problems have arisen in applications that push the limits of the current tools sets. Based on this and other collaborative experiences, we see a future of continuing and new collaborations in a suite of activities that will be beneficial to both parties, and are strategic for a number of reasons.

First, our parallel strategies will promote advancement of science and education through the exploitation of CI, and Unidata's broad community reach will assist CISL with a portion of its educational goals. Secondly, Unidata and CISL have the experience, expertise, and organizational structure to make rapid CI progress in a world where data and distributed systems are evolving. By joining forces and sharing requirements we are both better equipped to keep pace with the challenge and meet the expectations of our user communities. Finally, in my judgment, Unidata has a track record for long-term dependability, which is crucial in a CI environment where complex systems are built from various components, and if each is properly supported, the potential for stable and efficient operations is enhanced.

These factors make Unidata a logical and attractive partner in CISL's pursuit of a more collaborator focused infrastructure devoted to research. We look forward to working with Unidata to build on current successes.

NCAR The National Center for Atmospheric Research is operated by the University Corporation for Atmospheric Research under sponsorship of the National Science Foundation. NSF

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
12201 Sunrise Valley Drive
Reston, Virginia 20192-0002

Mail Stop 108

April 30, 2013

To: Dr. Mohan Ramamurthy
Director, Unidata Program Center, Boulder, Colorado

From: Kevin Gallagher,
Associate Director, Core Science Systems, U.S. Geological Survey

Subject: Letter of support and collaboration for the Unidata facility

Dear Dr. Ramamurthy,

The U.S. Geological Survey (USGS) expresses our strong support for your upcoming National Science Foundation (NSF) renewal. For nearly 30 years the USGS has been used and contributed to key infrastructure technologies developed by Unidata to improve our ability to conduct scientific research and deliver high-quality, unbiased data to the public.

Unidata's NetCDF-Java Common Data Model (CDM) has allowed USGS science to break new ground in the integration of data from various scientific domains. The USGS Center for Integrated Data Analytics (CIDA) and the USGS ScienceBase platform have adopted THREDDS data server, which is built on the CDM, for serving large and discrete gridded time series data sets with great success. The CIDA's collaboration with Unidata, NOAA, and the open-source scientific community focused around the CDM has brought significant value to the USGS and it is expected that the CDM will continue to be an instrumental component of our data integration strategies.

In the USGS Coastal and Marine Program, coastal ocean modelers retrieve atmospheric data to force their models using Unidata's LDM, store model results in Unidata's NetCDF format, and utilize Unidata's THREDDS Data Server to deliver the results via standard web services. Our scientists and collaborators then access data via these web services using analysis and visualization packages for Matlab, Python and ArcGIS. Even these commercial and open source packages rely on Unidata technologies behind the scenes: the Matlab package relies on the Unidata NetCDF-Java library, and the Python and ArcGIS packages utilize the Unidata NetCDF C library. The success of this standards-based approach for ocean model data within USGS has allowed USGS scientists to benefit broader cross-institutional and interagency programs such as

the US Integated Ocean Observing System, where THREDDS Data Servers were deployed at 17 locations across the 11 regions that span all US coastal waters.

As a facility operation, Unidata provides valuable leadership in the geoscience community and has set the bar for how a scientific research and development facility should operate. By conducting software development and standards setting projects in an open and collaborative way across communities of use, Unidata has achieved broad participation and support amongst working scientists in many disciplines. By maintaining close ties to the community through workshops, conferences, and other venues and also through direct user support services, Unidata continues to produce strong, relevant products. The efficacy of this approach is becoming evident in how concepts and methods that trace their roots back to Unidata are being propagated in other NSF activities such as the Integrated Earth Data Applications facility and the continuing evolution of EarthCube.

Recently Unidata has adopted community open-source practices such as continuous integration and GitHub, encouraged and aided by USGS. These practices are essential for continued productive collaboration with external developers in the geoscience community. With this improved collaboration framework, USGS developers regularly now contributing patches and extensions back to Unidata that not only deliver key functionality to accomplish the USGS mission, but improve the reliability and functionality of Unidata products.

Unidata technologies are critical to our operation, and we fully support continued funding by NSF to build tools that are making science and delivery of data better and more efficient for USGS and the entire international geoscience community.

Sincerely,

Kevin T. Gallagher
Associate Director
Core Science Systems
kgallagher@usgs.gov

April 03, 2013

Dear Mohan,

This letter of support and collaboration serves to confirm the ESSI Lab willingness to continue the fruitful collaboration with UNIDATA and support the Unidata 2018 funding proposal: *Transforming Geoscience through Innovative Data Services.*

(Open) Data Services are playing an important role to advance Geoscience and address the many challenges recently posed by Global Changes. Innovative interoperability solutions, like brokering services, promise to significantly change the way Scientists collaborate and share information. In such a context, UNIDATA and ESSI-lab can strengthen their successful collaboration pursuing multi(cross)-disciplinary solutions and services.

Sincerely,

Stefano Nativi
Head
Earth and Space Science Informatics (ESSI) Laboratory of CNR-IIA

Open Geospatial Consortium, Inc.
35 Main Street, Suite 5
Wayland, MA 01778-5037, USA
tel: +1 508-655-5858
fax: +1 508-655-2237
www.opengeospatial.org

April 17, 2013

Dr. Mohan Ramamurthy
Director, Unidata Program Center
University Corporation for Atmospheric Research
P_O. Box 3000
Boulder, CO 80307

RE: Commitment of Support for NSF Proposal "Unidata 2018:
Transforming Geoscience through Innovative Data Services"

Dear Dr. Ramamurthy:

As you know, the Open Geospatial Consortium, Inc. (OGC) is an international industry consortium of 475+ companies, government agencies, non-profit organizations, research institutions and universities participating in a consensus process to develop publicly available data interface and encoding standards. OGC standards enable the design and deployment of interoperable solutions that "geo-enable" the Web, wireless and location-based services, enterprise applications, and mainstream IT. These standards empower technology developers to make geospatial information and services accessible and usable with a wide variety of applications.

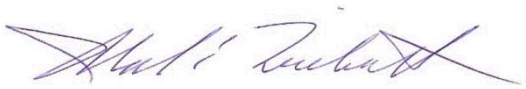
Over the past several years, the OGC has established a very productive relationship with the Earth sciences research and education community. Several key activities have greatly enhanced the highly productive relationship with the Geosciences. Led by the Unidata Program Center, UCAR has been actively involved in the establishment of the Unidata netCDF and the related CF conventions as OGC encoding standards. In addition, Unidata has been an active participant in the OGC MetOceans and Earth System Science domain working groups as well as the Web Coverage Service (WCS) standards working group. In the last 6 years, UCAR has hosted two OGC Technical Committee meetings in Boulder -- setting a record for attendance at the September 2011 meeting.

We are pleased that the auspices of the OGC have played an integral role in fostering interoperable data systems among the geosciences and the traditional GIS communities. We are committed to supporting this valuable and productive collaborative relationship into the future. We view this collaboration as critical to many Members of the OGC who

have an interest and stake in ready access to atmospheric, oceanographic, hydrologic, and other environmental data. Hence we strongly endorse and support the Unidata "Unidata 2018: Transforming Geoscience through Innovative Data Services" to continue their innovative data systems work in support of the research and education community. It is clear that the establishment of these standards makes it possible for international partners as well as those in other academic disciplines, in industry, and in government to find, access, and use atmospheric and related environmental data with a minimum of impact on Unidata support of its core community. Moreover, the adoption of the standards increases the likelihood that data from other sources and disciplines will be made available in a format familiar to the Unidata community.

The OGC looks forward to continued work with Unidata that will benefit all the focus areas of the proposal but especially these: “Advancing Data Services (by increasing interoperability), Community Services (through outreach and broadening), and Cyberinfrastructure Leadership (via establishing and promoting community standards).” As an active member of the OGC, the UCAR Unidata program has successfully leveraged OGC’s global industry membership programs to advance open standards useful to key science and research objectives. These open standards in turn position important research work to be transferred more rapidly to broader community application. We look forward to working with Unidata to make open, freely available standards accessible to and useful for the research and education community, and to assure that future program activities continue receive supporting resources from OGC programs for the substantial follow on initiatives that are planned for netCDF and related standards..

Sincerely yours,



Mark Reichardt
OGC President and CEO

Open Geospatial Consortium, Inc. • 35 Main Street, Suite 5, Wayland, MA 01778
Tel: 508 655 5858 • Fax: 508 655 2237

The HDF Group

May 2, 2013

Dr. Mohan Ramamurthy
Director, Unidata Program Center
UCAR Office of Programs
P.O. Box 3000
Boulder, CO 80307-3000

Dear Mohan,

I am excited to hear about the Unidata proposal to NSF and agree that the Geosciences are ready for transformation using innovative web services. I presented a vision for the HDF Earth Science Group last week and it included several slides featuring innovation at Unidata over the years. There is a strong foundation to build on.

As you know, the HDF Earth Science Group now has an office in Boulder. An important goal of that office is to focus attention on our relationship with Unidata. We are in the process of improving access to HDF data using the netCDF libraries and include those libraries in our on going testing and maintenance. As this work solidifies the connection, we look forward to extending into the service layer. We are also interested in building on the metadata services now available through ncISO and understanding how HDF's grouping capabilities can be used to improve organization, access, and understanding. Developing these ideas will definitely require a strong partnership with Unidata.

In addition, there is significant synergy around many of the new ideas you are proposing. Improved server-side capabilities, big data on the cloud, improved access and strengthening the community of data providers and users are all goals we share. The HDF Group is excited and looking forward to strong collaborations with Unidata as we lead through these changing times.

Sincerely,

Dr. Ted Habermann
Director of Earth Science
(217) 531-4202
thabermann@hdfgroup.org

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David G. Tarboton, Sc.D., P.E.
Professor
Telephone: 435 797 3172
Email: dtarb@usu.edu
http://www.engineering.usu.edu/dtarb/

April 24, 2013

Dr Mohan Ramamurthy
UCAR Office of Programs
Unidata Program Center
P.O. Box 3000
Boulder, CO 80307-3000

Dear Mohan:

Letter of Commitment for Unidata Renewal Proposal

I am delighted to write this letter committing to ongoing collaboration with Unidata in the development of Cyberinfrastructure for the Earth Sciences. Unidata provides key Cyberinfrastructure that is relied upon across the Earth Sciences and it is important that this Cyberinfrastructure be sustained.

I am lead of the Consortium of Universities for the Advancement of Hydrologic Science, Inc (CUAHSI) HydroShare project (http://www.cuahsi.org/hydroshare.aspx). CUAHSI's Informatics activities in general and HydroShare specifically are working to enhance access to hydrologic data and models. In HydroShare we are developing a web based system to support data and model sharing in hydrology to address critical issues related to water quantity, quality, accessibility, and management. HydroShare will expand the data sharing capability of the CUAHSI Hydrologic Information System by broadening the classes of data accommodated, expanding capability to include the sharing of models and model components, and taking advantage of emerging social media functionality to enhance information about and collaboration around hydrologic data and models.

HydroShare has identified space-time gridded data as a key data type where the CUAHSI Hydrologic Information System will be extended and we plan to rely on Unidata technology in this area, specifically using NetCDF and THREDDS technologies. We anticipate collaborating with Unidata in the following areas:

(1) NetCDF. Ongoing evolution of NetCDF and the libraries that support cross-platform use of NetCDF. Much hydrologic modeling uses PCs, and sometimes legacy languages such as Fortran. These libraries support data interoperability and sharing and sustained support for these libraries is important.
(2) THREDDS. THREDDS provides important functionality for publishing space time gridded data (including NetCDF) using web services. We are plan to incorporate elements from THREDDS into the HydroShare software stack and to collaborate with Unidata on information exchange to enhance the interoperability between Unidata and HydroShare systems.

Unidata has lead the way in cyberinfrastructure for the Earth Sciences for many years. I appreciate that Unidata has reached out beyond the Atmospheric Science community to serve and collaborate with other domains, such as Hydrology. This has had a tremendous impact on broader Earth Sciences cyberinfrastructure development and I appreciate the opportunity to continue this collaboration and to forge a tighter integration between the closely related fields of Atmospheric Science and Hydrology.

Yours sincerely,

David Tarboton
Professor

Appendix C: Partnerships and Collaborations

Unidata participates in partnerships and collaborations with a wide range of organizations around the world. The following is a list of some our ongoing collaborations.

Organization	Description
BADC (British Atmospheric Data Center)	THREDDS, netCDF and GALEON
BASC (UK)	THREDDS and netCDF collaboration
Climate and Forecast (CF) Metadata Conventions Committee	International standards group with Unidata staff on governance and conventions panels
CMA (PRC)	TIGGE archive and modeling center. Using IDV for visualization. Development of Tropical Cyclone IDV for Shanghai Tropical Institute.
CUAHSI	Hydrological coordination, adopted NetCDF for GIS systems, metadata collaboration
EUMETSAT (Germany)	Evaluation of the IDV for EUMETSAT training activities. Investigating use of THREDDS for data access. Strategic partner in Africa Initiative. Offering popular archived datasets in netCDF format.
GALEON/OGC	OGC GALEON Interoperability Experiment and UCAR representation on the OGC technical committee.
Google Africa Initiative	UCAR/NCAR initiative recommended by AAAS for enhancing atmospheric science infrastructure in West Africa. Unidata has been instrumental in data distribution, provision of visualization via IDV. Workshop in Mali and Burkina Faso.
Harris Corp.	Prime contractor for development of the GOES-R ground segment system, collaborate to use netCDF best practices in representing GOES-R data products
IDD-Brazil	5 out of 15 Brazilian states participating. Unidata community receives data from some sites.
INPE/CPTEC (Brazil)	Distribution of mesonet and local model output to partners in U.S., Portugal, Brazilian Navy and Air Force. Operational use of GEMPAK.
IOOS	Participation on the Data Management and Communications Steering Committee and Expert Teams
Italian National Research Council and/or U of Florence	THREDDS and GALEON
ITC (The Netherlands)	Strategic partner in African outreach.
Japan's Research Institute for Sustainable Humanosphere (RISH)	Reciprocal visits to review technologies

LEAD (UNC-RENCI, UAH and IU)	Grid technology to study the evolving weather-IDV, WRF
Meteorological Services of Canada	GEM model output made available to the university community
Millersville University	LEAD, IDV, IDD
NCAR/CISL	Virtual Operations Center, TIGGE, THREDDS, netCDF
NCAR/EOL Field Project Support	Use of IDV in field projects, RICO and T-REX, participation on steering committee and NSF Facilities workshop
NCAR/EOL/RAL	GOES10-use of existing satellite dish at Mesa with some equipment to receive GOES10 and GOES East/West imagery with satellite dish at FL2. Through leveraging, the data is broadly available using ADDE and THREDDS technologies.
NCAR/ISSE	GIS-related activities
NCSA, The HDF Group, and LEAD	NetCDF-4 and HDF5 integration, and Grid technology to study the weather, including WRF modeling
NOAA/ESRL/GSD	Uses LDM, netCDF, THREDDS for data sharing
NOAA/NCDC	NEXRAD Level II data access, THREDDS
NOAA/NMFS/SWFSC's Environmental Research Division	Collaboration on THREDDS, netCDF, and GALEON
NOAA/NSIDC	Advanced Cooperative Arctic Data and Information Service (ACADIS)
NOAA/NSSL	3D Reflectivity Mosaic (QPE (NMQ)
NOAA/NWS	LDM for Level II data access and distribution
NOAA/PMEL	Actively engaged in netCD, THREDDS, and LAS
NOAA/ROC	Level II data access & distribution coordination
NWS/NCEP	CONDUIT high resolution model data AWIPS II development and support
OPeNDAP.org	Support provision of OPeNDAP servers and coordinates with THREDDS, netCDF, CDM
SuomiNet	Network of GPS met instruments connected via LDM; Also, contributed analysis and display capabilities
THG (The HDF Group)	Non-profit corporation that develops and supports HDF5 software, uses netCDF-4 for testing new releases, makes available early releases for testing with netCDF-4.
TIGGE	Collaboration with ECMWF, CMA, INPE/CPTEC, Australia, NCAR data centers. Use of LDM technology
U. S. Navy/FNMOC	Made available NOGAPS and COAMPS data to community

UCAR/UOP/COSMIC	Use of Unidata technologies (LDM for data distribution and GEMPAK and IDV for visualization)
UCAR/UOP/NSDL & DLESE	Workshop coordination and participation to broaden educational
UK Met Office	THREDDS and GALEON
UNAVCO-GEON	IDV
UNC-Charlotte, COMET	Case Studies-Leveraging COMET multimedia educational materials with Unidata's IDV and THREDDS Data Repository to facilitate case studies for the community.
University at Albany, SUNY	Provision of data from National Lightning Detection Network to the university community
University of Iowa	Provision of NEXRAD Level II data and metadata via the newly created HYDRO feed to hydrology and atmospheric science community
University of Oklahoma	CRAFT leading to NEXRAD Level II data access & distribution and LEAD
University of Virginia	Investigation of Internet data-distribution using multicast over virtual circuits
University of Wisconsin-Space Science Engineering Center	Many areas since the inception of Unidata, include McIDAS, VisAD, IDV, Unidata-Wisconsin data stream, decoder technology, ADDE satellite data archives. Is top level IDD site
USGS Woods Hole Field Center	Collaborate on use of THREDDS and netCDF-Java in recording and serving observations and ocean model output

Appendix D: Glossary

The following is a list of acronyms related to this proposal. You can find a more complete list of acronyms related to Unidata activities in general at http://www.unidata.ucar.edu/publications/acronyms/glossary.html.

ACADIS	Advanced Cooperative Arctic Data and Information Service
ACARS	Aircraft Communications Addressing and Reporting System.
ADDE	Abstract Data Distribution Environment. A McIDAS remote data access system.
AGU	American Geophysical Union
AMS	American Meteorological Society
ATM	Division of Atmospheric Sciences, a division of the NSF
AWIPS	Advanced Weather Interactive Processing System
AWIPS II	Next generation of the Advanced Weather Interactive Processing System software.
BADC	The British Atmospheric Data Centre
BUFR	Binary Universal Form for the Representation of Meteorological Data
CADIS	Cooperative Arctic Data and Information Service
CAVE	Common AWIPS Visualization Environment
CDC	Climate Diagnostics Center
CDF	Common Data Form
CDM	Common Data Model
CF	NetCDF Climate and Forecast (CF) Metadata Convention
CI	Cyberinfrastructure
CISL	Computation and Information Systems Laboratory at NCAR
CIMSS	Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison
CMIP3/4/5	Multi-model dataset used for the IPCC Assessments
CNR	Italian National Research Council
CONDUIT	Cooperative Opportunity for NCEP Data Using IDD Technology
CUAHSI	Consortium of Universities for the Advancement of Hydrological Science, Inc.
DAP	Data Access Protocol
DODS	Distributed Oceanographic Data System, former name for the discipline-specific National Virtual Oceanographic Data System and the discipline-independent access protocols now known as OPeNDAP .
EarthCube	EarthCube is a National Science Foundation initiative to create a data and knowledge management system for the 21st century.
ECMWF	European Center for Medium range Weather Forecasting
EGU	European Geosciences Union
EHR	Education and Human Resources, a division of the NSF
EMC	Environmental Modeling Center
EOL	Earth Observing Laboratory
EOS	Earth Observing System
EPSCoR	Experimental Program to Stimulate Competitive Research

ESIP	Earth System Information Partners Federation
ESRI	Environmental Systems Research Institute
ESRL	Earth System Research Laboratory (formerly FSL)
ESS	Earth System Science
ESSI	Earth and Space Science Informatics
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FES	Fluid Earth Systems
FFRDC	Federally Funded Research and Development Center
FNMOC	Fleet Numerical Meteorology and Oceanography Center
GALEON	Gateway or Geo-interface for Air Land Earth Ocean netCDF
GEMPAK	General Meteorological Package
GEON	The GEOsciences Network
GEON IDV	The GEON Integrated Data Viewer is an extension of the Unidata IDV for exploration of complex three-dimensional data in geophysics.
GOES	Geostationary Operational Environmental Satellite, Environmental Satellite
GOES 10	Geostationary Operational Environmental Satellite, South
GPS	Global Positioning System
GRIB	Gridded Binary (Editions 1 and 2)
GRIDSPEC	A proposed CF extension for the annotation of complex Earth system grids.
GrADS	Grid Analysis and Display System
HBCU	Historically Black Colleges and Universities
HDF	Hierarchical Data Format
HDF4	Hierarchical Data Format, version 4
HDF5	Hierarchical Data Format, version 5
HPCC	High Performance Computing & Communications
HRRR	High Resoluton Rapid Refresh
HYDRO-NEXRAD	A system that allows access to the vast archives and real time information collected by the national network of NEXRAD radars.
HYRAX	OPeNDAP Data Server
IDD	Internet Data Distribution System
IDV	Integrated Data Viewer
IIPS	International Conference on Interactive Information Processing Systems for Meteorology, Oceanography, and Hydrology
IOOS	Integrated Ocean Observing System
IPCC	Intergovernmental Panel on Climate Change
ISO TC211	International Standards Organization TC211 , a spatial data standard
IT	Information Technology
LDM	Local Data Manager
LEAD	Linked Environments for Atmospheric Discovery
LEVEL II	NWS WSR-88D Level II Radar Data
LEVEL III	NWS WSR-88D Level III Radar Data
MADIS	Meteorological Assimilation Data Ingest System

McIDAS	Man-computer Interactive Data Access System
McIDAS-V	A Java-based version of McIDAS based on the SSEC-developed VisAD software and the Unidata Integrated Data Viewer (IDV) reference application and library.
METAR	Meteorological Aviation Reports
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NAWIPS	National Centers Advanced Weather Interactive Processing Systems
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction (NOAA)
NcML	The netCDF Markup Language
NCO	NCEP Central Operations
NetCDF	Network Common Data Forma
NESDIS	National Environmental Satellite, Data, and Information Service
NEXRAD	Next Generation Weather Radar
NGDC	National Geophysical Data Center
NLDN	National Lightning Detection Network
NMAP	An integrated display and product generation GUI environment
NOAA	National Oceanic and Atmospheric Administration
NOAAport	NOAA's broadcast data dissemination system
NOMADS	The NOAA Operational Model Arvhive and Distribution System
NSF	National Science Foundation
OGC	Open Geospatial Consortium
OPeNDAP	Open Source Project for a Network Data Access Protocol (formerly DODS)
Python	Programming language created by Guido van Rossum in 1990.
RAL	Research Applications Laboratory
RAMADDA	Repository for Archiving, Managing, and Accessing Diverse DAta
RO	Radio Occultation
Rosetta	A web-based service to transform ASCII output into Climate and Forecast (CF) compliant netCDF files
SOARS	Significant Opportunities in Atmospheric Research and Science
SSEC	Space Science and Engineering Center of the University of Wisconsin at Madison
STEM	Science, Technology, Engineering, and Mathematics
SuomiNet	An international network of GPS receivers, configured and managed to generate near real-time estimates of precipitable water vapor in the atmosphere, total electron content in the ionosphere, and other meteorological and geodetic information.
TDS	THREDDS Data Server
THORPEX	THe Observing system Research and Predictability EXperiment
THREDDS	Thematic Real-time Environmental Distributed Data Services
TIGGE	THORPEX Interactive Grand Global Ensemble
UCAR	University Corporation for Atmospheric Research
UCP	UCAR Community Programs (formerly the UCAR Office of Programs)

UCSB	University of California, Santa Barbara
UDUNITS	The Unidata units library supports conversion of unit specifications between formatted and binary forms, arithmetic manipulation of unit specifications, and conversion of values between compatible scales of measurement.
UNAVCO	University NAVSTAR [not an acronym] Consortium
UPC	Unidata Program Center
USGS	U.S. Geological Survey
USPLN	United States Precision Lightning Network
VisAD	Visualization for Algorithm Development. VisAD is a Java component library for interactive and collaborative visualization and analysis of numerical data.
WFS	Web Feature Service
WMO	World Meteorological Organization, Geneva, Switzerland
WMS	Web Mapping Service
WRF	Weather Research and Forecasting Model
WSI	WSI Corporation
zlib	A software library used for data compression.