Collaborative Research: International Digital Library of Atmospheric Visualization

An international collaboration will design and implement the International Digital Library of Atmospheric Visualization (IDLAV), providing a premier model for international digital library (IDL) structure and serving a diverse community worldwide. This IDLAV effort builds on the successful National Science Digital Library's (NSDL's) Atmospheric Visualization Collection (AVC) and focuses on all education levels. This collaborative effort includes in-kind funding from the Australian Bureau of Meteorology (BoM) and educational material from Monash University, Australia. The collaboration also involves Argonne National Laboratory, Los Alamos National Laboratory, Eastern Illinois University, Pennsylvania State University, University of Utah, and the National Center for Supercomputing Applications.

Our team of experts has NSDL experience utilizing one of the world's largest international scientific research databases developed through the U.S. Department of Energy's (DOE's) Atmospheric Radiation Measurement (ARM) Program. Through the ARM program, researchers collect atmospheric data for sites in the Tropical Western Pacific (TWP) region, with rapidly growing data collection sites in Australia, Papua New Guinea, and Nauru. ARM education and outreach programs have focused on incorporating traditional ecological knowledge with development of culturally appropriate curricula.

Argonne researchers will assemble a cutting-edge, visionary, long-term IDL with a common metadata and service tool structure that can be used far into the 21st century as a portable modular model for widespread development and use by other scientific IDL initiatives. The rapidly expanding set of international terabyte and petabyte scientific research databases, such as the ARM database, demonstrate the immediate need for such interoperable IDL features.

The research team is well positioned to accomplish the project goals by leveraging the wealth of existing tools and strategies of various digital libraries, especially the Digital Library of Earth Science Education (DLESE) and the NSDL. Our IDLAV will

(1) Improve dissemination, usability, and discoverability of atmospheric data sets through visualization and data mining capabilities;
(2) Create a user facility and user communities that contribute material to the IDLAV;
(3) Incorporate ARM and BoM educational material with interactive learning tools;
(4) Establish national and international workshops; and
(5) Implement evaluation mechanisms of research and educational efforts.

Our team has experience in working to meet each of these goals and is now in a position to expand and extend them to an international setting by collaborating with our science research and education colleagues outside of the United States. We will develop each of these items as IDL tools and deliverables that will be readily accessible to other IDL projects confronted with a host of new challenges: language differences, indigenous cultural differences, digital access and divide differences, and database and code structure differences.

This IDLAV project will allow our team to develop a fully interoperable IDL that can serve as an early precursor and model for use by many other such large-scale scientific databases, research teams, and educators. We believe the proposed project represents a unique opportunity for IDL development and growth, and we hope you share our vision, enthusiasm, and drive to develop such a resource.

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Collaborative Research: International Digital Library of Atmospheric Visualization

1 Introduction

This proposal represents technology synthesis in its most pure form — data mining and visualization techniques — applied for educators and students. We propose to develop and implement an International Digital Library of Atmospheric Visualization (IDLAV) that is not only user-friendly, but also addresses cultural, scientific, and indigenous ways of learning.

2 Background

Past Support and Related Efforts

This international collaborative proposal builds on the following National Science Foundation (NSF) awards and related efforts by the U.S. Department of Energy (DOE) and the Australia Bureau of Meteorology (BoM):

- NSF — National Science Digital Library (NSDL) Program: "Atmospheric Visualization Collection," Christopher Klaus, Principle Investigator (PI), 2000-2003, $741,660, Award # 0086225.
- NSF — Summer and In-service Institute Program: "Foundation for MS and Ed Program," Robert Waddell, Co-PI, 1964-1970. Keith Andrew and other Eastern Illinois University Department chairs expanded this program into the Master of Science in Natural Sciences program, which now has an annual budget of over $50,000.
- DOE — Atmosphere Radiation Measurement (ARM) Program, $40,000,000 per year. Christopher Klaus, ARM Engineering, $150,000 per year. Fairley Barnes, Laura Marsh, Carrie Talus, Tina Sommer, ARM Education Outreach Program, $250,000 per year. Chad Bahrmann, Scott Richardson, North Slope of Alaska site scientists, $899,000.
- Australia BoM — Darwin Regional Specialised Meteorological Centre. Dr. Peter May, Dr. Christian Jakob, and Rex Pearson will participate with in-kind support from BoM of over $76,000 Australian Dollars (AUD) per year.

The following organizations are involved in the effort:

- Argonne National Laboratory (ANL) — Christopher Klaus, PI, project and technology lead.
- Los Alamos National Laboratory (LANL) — Paul Rich, PI, lead for K-12 education.
- Eastern Illinois University (EIU) — Keith Andrew, PI, lead for technology curriculum.
- Pennsylvania State University (PSU) — Chad Bahrmann, PI, lead for higher education.
- University of Utah (UU) — Gerald Mace, PI, lead for atmospheric science direction.
- National Center for Supercomputing Applications (NCSA) — data mining experts.
- Australian Bureau of Meteorology (BoM) — Peter May, lead for Australian scientific efforts.
- Monash University (MU) — Steve Siems, lead for Australian educational efforts.

Existing Climate Data Collection and Education Programs

DOE's Atmosphere Radiation Measurement (ARM) Program: The purpose of the ARM Program[1],[2] is to collect data to test and improve General Circulation Model (GCM) characterizations of clouds and their effect on radiative energy balance. Data collection and research activities are focused in six areas: aerosols, clouds, longwave radiation, shortwave

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radiation, surface energy exchange (or flux), and atmospheric state. ARM operates field research sites in three climatically significant locations worldwide: Southern Great Plains (SGP), Tropical Western Pacific (TWP), and North Slope of Alaska (NSA) (Figure 1). As part of an international collaboration, the TWP site has instrumentation at Darwin[3], Australia; Manus, Papua New Guinea; and Nauru.

Figure 1: Location of ARM sites.

ARM's primary observational method is remote sensing and other observations at the Earth's surface. The ARM Data Management Facility employs algorithms and models (value added procedures) to produce "second generation" data sets from this observational data. The ARM External Data Center regularly collects analysis and forecast model products by the National Centers for Environmental Prediction (NCEP) and the European Center for Medium-Range Weather Forecasting (ECMWF), as well as high-quality satellite observations. These data sets are incorporated into the ARM archive for use by ARM scientists.

Australia Bureau of Meteorology (BoM)[4]: The BoM has an active research program centered on the Darwin site to collect several data sets that are not routinely available at the other ARM sites, including weather radar data from polarimetric weather radar. This radar is unique in the tropics and provides quantitative precipitation estimates that are superior to standard reflectivity-based estimates. The BoM system also provides estimates for precipitation microphysical types (e.g., rain, graupel, hail, snow, melting snow, mixtures). Diverse products generated by the radar include full three-dimensional grids of reflectivity and microphysical classification data, along with best estimates of rainfall and associated uncertainty. The uncertainty of estimates is important when using these data for validation — for example, for comparison with satellite estimates and for assimilation into model data sets. These radar data are also important for tropical observations because cloud formations are often associated with convective systems that require analysis of small-scale structure. A four-dimensional set describing the structure and evolution of convection is key to the interpretation of ARM data by the international community.

Atmospheric Visualization Collection (AVC): The AVC augments both physical science education and atmospheric visualization research with an archive of data images and educational material to facilitate better understanding of atmospheric behavior. AVC data images focus mainly on the ARM SGP site. The collection is maintained and expanded by researchers and scientists and by students and teachers through a collaborative digital library environment. Ongoing local, state, and national presentations and workshops facilitate the expansion of the AVC user community. The AVC is a collection within the National Science Digital Library (NSDL)[5,6] and in the Digital Library of Earth Science Education (DLESE)[7,8]. The AVC site[9,10,11] is used by 400-450 unique users per week and over 7,000 visitors from 65 countries in the last year.

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ARM Education Outreach Program: The ARM EOP was initiated by DOE in 1990. The program enriches local and regional K-12 science and public education in the communities around the ARM climate data collection sites, focusing on climate, climate change, and climate change effects relevant to the region. The program allows for development of climate lesson plans and activity curriculums[12,13]; provides sponsorship for in-service training, workshops on climate change, and field trips for teachers of all grades; and contributes significantly to the education systems in the western Pacific and Alaskan North Slope. Over 250 teachers have participated since 1998 and stay current via a newsletter and ARM web site[14].

Master of Science in Natural Sciences (MSNS) Program: The MSNS program advances the professional competency of science teachers by allowing teachers to work toward a Master of Science (MS) degree during summers while continuing to teach during the academic year. The initial 1972 MS in Education consisted of two graduate degree programs: one in biological sciences and another in physical sciences. In 1998, earth science was added, and each discipline (biology, chemistry, earth science, general science, or physics) became a concentration under a single graduate degree program for teachers: the MS in Natural Sciences[15].

Relevance to New Proposal

While the AVC focuses on the domestic ARM SGP site, our proposed IDLAV will focus on the international TWP sites in Darwin, Australia; Manus, Papua New Guinea; and the Republic of Nauru. For the IDLAV effort, we will use AVC as a template for data visualization. We will employ and use digital library tools, such as those that allow participants to modify and/or contribute material for dissemination throughout the IDLAV user community. Our Australian collaborators will replicate AVC capabilities for data from the TWP, especially from Darwin.

3 Project Goals, Themes, and Benefits

Goals

The IDLAV will integrate significant scientific observations and analysis with educational programs that use atmospheric research as a model to teach science concepts and methods. The proposed IDLAV project has three parts:

(1) Make ARM data accessible to all potential users;
(2) Build tools and applications to incorporate ARM data into educational programs for K-12, post secondary institutions, and the general public, and
(3) Ensure feedback from users to researchers so that relevant tools and applications at appropriate learning levels can be used to meet educational needs.

The specific science and technology and educational goals of the project are listed below.

Science and Technology:

(1) Provide data visualization tools and data image archives;
(2) Provide enhanced data mining capabilities for improved searching;
(3) Develop a user facility and foster research user community development; and
(4) Evaluate science and technology progress to obtain feedback to help meet development goals.

Education:

(1) Develop interactive learning tools and regionally appropriate curricula and lesson plans using IDLAV resources and data;
(2) Implement curricula through professional development workshops and teacher support;
(3) Develop a user facility and foster educational user community development; and
(4) Evaluate educational progress to obtain feedback to help meet development goals.

Themes

Three cross-cutting, multi-scale communication/education themes are at the heart of the proposed project. We will keep these themes in mind as we design tools to facilitate knowledge flow in the IDLAV.

(1) Effective Communication: IDLAV tools must be tailored to the needs of users, be appropriate to the education level of the users, and provide a convenient mechanism for feedback from users. The project team will use feedback that articulates users' needs to ensure the relevance of the tools and applications. Effective communication involves well-reasoned explanations of underlying concepts, skillful filtering to make complex data useful and accessible, and relevance to ARM, as well as other, scientific data sources. For example, communication for K-12 students requires simplified explanations of concepts that encourage exploration, whereas graduate students and scientists must be able to organize and visualize complex information efficiently and in novel ways.
(2) Local/Global Integration: This concept recognizes the relevance of local (place-based) needs and frames of reference, while employing a perspective of global processes and global concerns. For example, by understanding the context of global climate change and being aware of mitigation actions taken by those in other parts of the world, we can improve the understanding of and response to sea level rise and its effect on people who reside on low-lying Pacific islands.
(3) Traditional/Scientific Integration: When traditional knowledge is integrated with western scientific knowledge, we have the basis for a more complete and deeper understanding of natural phenomena. Traditional knowledge contributes history and time-tested understanding, sometimes unknown to science, along with unique cultural perspectives. Science contributes a systematic approach for gathering information, testing hypotheses, and developing theories.

Data collections are a cornerstone of scientific research and education. Recent advances in research and education portals highlight the need for accessible and searchable data sources and easy-to-use tools for visualizing the data, data analysis, and modeling. Visualization tools provide users with the most accessible format and basic understanding of scientific concepts or patterns that are inherent in the data.

Benefits

Scientific: The IDLAV interfaces will make atmospheric climate data available for research, education, and public outreach. The ARM sites consist of the highest-resolution and widest array of global climate modeling data tools available in the world. Applicable tools, such as

Quicklooks[16] visualization, will be tailored to enable diverse users to find and access useful data. Tools to assist with data harvesting in an environment of many terabytes coupled with efficient metadata tagging, consistent with Institute of Electrical and Electronics Engineers (IEEE) and DLESE standards, will be utilized on all data sets to allow widespread international use of the database.

Educational: The project will increase scientific literacy by integrating traditional/scientific, local/global, and collaborative approaches to education. By making current research data available, we will provide opportunities for students at all levels (K-12, undergraduate, and graduate) to move toward scientific careers. We will actively engage students in an inquiry based[17], standards focused method that follows "Data in the Classroom" principles[18]. The structure of these activities will transcend the AVC to be applicable to an extraordinarily diverse international population and across other disciplines[19].

Diversity and International Collaboration: By tailoring tools, interfaces, and curricula for diverse user communities, we will remove the barriers of culture, gender, and geographic isolation. International collaborators include expert researchers and teachers from urban and rural Australia and a diverse set of Pacific Island countries. In addition to the team's experience in dealing with this international population through the ARM EOP[20], we envision an IDLAV portal that is accessible, multilingual, and simple to use for all groups of users. Ultimately, this portal will incorporate traditional and indigenous knowledge in all regions where it is used.

4 Scope of Work

The IDLAV will make existing and future atmospheric data sets more accessible and usable to education and research communities through carefully designed IDL tools and a design that incorporates mechanisms for effective communication. We envision two cycles central to the IDLAV: a data cycle and a knowledge cycle (Figure 2).

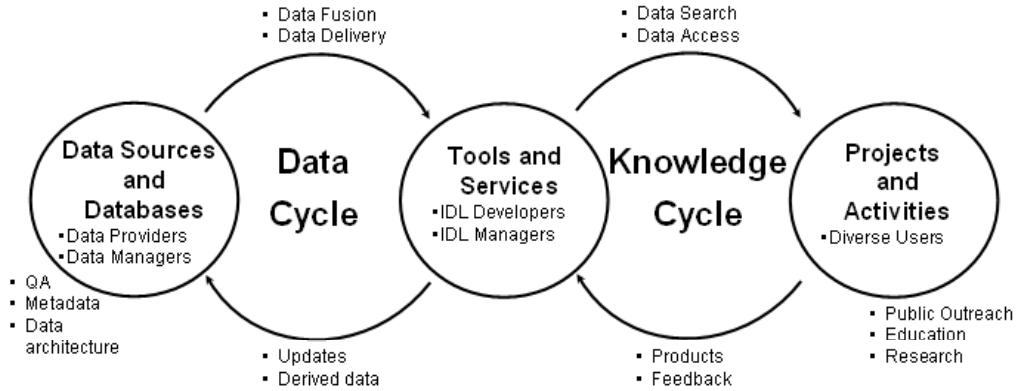

Figure 2: The IDLAV consists of coupled data and knowledge cycles.

The data cycle will involve the flow of data from sources to users via IDLAV tools. The most useful service will be the sharing of knowledge between IDLAV users such as scientists, teachers, students, the public, governmental agencies, and non-governmental organizations[21] (Figure 3). IDLAV tools will provide a means for communication of knowledge both to and from users. The flow from users includes two kinds of information: (1) value-added products, such as educational curricula, derived data and models, and synthetic interpretations; and (2) feedback

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about information needs, adequacy of tools, and recommendations for improvements of the process.

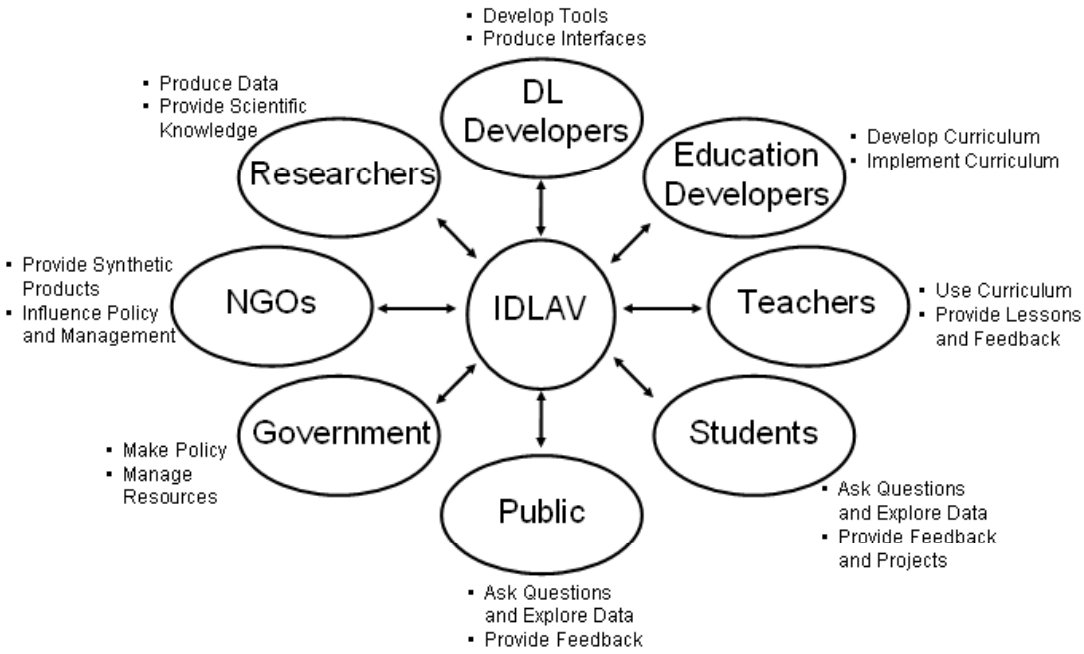

Figure 3: The IDLAV serves diverse communities of users, enabling communication and collaboration.

This section describes the science, technology, and educational development tasks that will be undertaken as part of the IDLAV project to produce the data and knowledge cycles.

Develop Data Visualization Tools

Visualization is the basis on which the AVC has improved access to atmospheric data. The IDLAV will continue collection and development of tools to interact with atmospheric data. The primary issue in dealing with the ARM data is that much of it is stored in relatively small daily files. Moving the individual full-screen graphics associated with each data stream is a slow process. The sheer number of files that must be viewed is overwhelming. Thus the use of summary data streams and data mining technology will be a key component of the proposed project. While these developments are ongoing, we will apply the existing visualization tools to the other ARM sites including the Darwin site, the three facilities at the TWP site, and the two facilities at the NSA site.

In addition to the visualization tools for individual data streams, we will implement tools that combine various data streams into "value-added products" and parameterization tools. For instance, the data from the millimeter cloud radar can be combined with other data sources in algorithms that return geophysical quantities, such as cloud particle size and water content. These derived variables often represent much more intuitive quantities than the original observables, such as radar reflectivity. Our first attempt at implementing a value-added product has resulted in a process that combines information from multiple sources to produce a

continuous optimal description of the atmospheric thermal state above the ARM sites. Another value-added product that has been implemented combines the various modes of the Millimeter Cloud Radar (MMCR) into a single rendition to which a cloud mask has been applied.

The ARM External Data Center (XDC) collects model and satellite data. This data source is available to the IDLAV and includes years of Advanced Very-High-Resolution Radiometer (AVHRR) data for all three sites, 30-m LANDSAT data for all three ARM sites, high-resolution National Weather Service (NWS) upper air data for all three sites, and numerous volumes of NWS NEXRAD data from six radars in and around the SGP site. Surface characterization data for all three ARM sites, as well as special Intensive Observation Period (IOP) data sets, are also available.

While ARM researchers have developed Quicklooks and Hovmuller diagrams for a limited subset of the data at the XDC, additional visualization tools for this model and satellite data would be invaluable to both ARM scientists and the general public. Presently the bulk of the visualization tools are based on the native files that contain the data at different temporal resolutions. While examining daily files is useful, the data can be reviewed more efficiently by examining files composed of summaries of daily data. For instance, a user interested in the occurrence of a particular cloud type may have to examine many individual daily files before finding the cloud event of interest. The same information presented as summary data on longer timescales would make browsing more efficient. A user interested in a particular cloud type could browse a file showing summary cloud occurrence data condensed into a month with graphical links in the IDLAV to specific data.

Involvement of the scientific community in the collection and production of visualization tools will continue to improve the usability of these observational data, valued-added products, model data, and satellite data sets. Feedback and reviews will drive efforts to modify and revise the visualization codes.

Incorporate Data Mining Capabilities

Research on the relationship between clouds and climate has evolved substantially in the nearly 10 years since the ARM program began. The ARM data streams can be viewed either as a nearly unlimited source of case studies or (in a statistical sense) as a probability density function of cloud property occurrence over a wide range of conditions. While both approaches have significant merit, neither has been fully utilized because of the volume of data and the challenges associated with searching the data for appropriate cases and combining multiple data sources over long periods of time to evaluate the statistics of derived geophysical quantities.

The Automated Learning Group (ALG) within National Center for Supercomputing Applications (NCSA) has developed the Data-to-Knowledge (D2K) application environment[22], which hides many of the complexities inherent in searching and analyzing data, while still providing a rich and flexible data mining system. The flexible framework of D2K integrates effective analytical data mining methods (e.g., for data preparation, prediction, discovery, and deviation detection) with data and information visualization tools. The D2K Toolkit provides a visual programming interface that allows the user to create custom knowledge-discovery applications from pre-defined modules that encapsulate the steps of the knowledge discovery process. D2K uses a data-

flow metaphor to specify the order of execution, and module parameters can be adjusted to control behavior as appropriate for the problem domain.

Data input modules will allow IDLAV data to be loaded into D2K. Application of the D2K environment to the IDLAV data will provide a mechanism for easily creating and executing data mining experiments. We will develop itineraries to estimate predictive accuracy using train-test set strategies (e.g., cross-validation) and to evaluate the effectiveness of competing and combined learning algorithms along multiple dimensions.

Design Interactive Learning Tools[23]

Models in the classroom provide an excellent tool for critical thinking and interactive learning as long as the models are easily explained and illustrated. Relationships between variables and parameters are more easily explored when teachers can deconstruct a process to illustrate phenomena to their students. Students can quickly reproduce previous research, modify the model physics, then focus on and comprehend the core of the process they are investigating.

We propose to combine software tools (applets) available from various sources with data in order to make these data more applicable and the results more meaningful for classroom use. That is the advantage of adopting them into the IDLAV: *to bring concept building models and data together for education and research*. We will generalize existing models and construct architecture for future models; the architecture will serve as a "template" for designing new tools. Any educational environment performs best when the mechanics behind the teaching aids are the same or similar, so that a student stays focused on the topic, not the mechanism with which it is introduced. Undergraduates have used idealized numerical simulations in past research to achieve a physical understanding of their observations and to guide future exploration. These same simple models can be used to illustrate class lecture concepts and promote student creativity. We will develop two simulation laboratories: a Mesoscale Simulation Laboratory and a Mobile Radar Laboratory for use in the IDLAV.

Mesoscale Simulation Laboratory. The idealized models that will be used for educational development of a Mesoscale Simulation Laboratory include a one-dimensional cloud model, a two-dimensional slab model, and an axisymmetric model. The one-dimensional cloud model will be used to explore the effects of entrainment, precipitation loading, and pressure perturbations on rising parcels of air. The two-dimensional slab model will be used by students to learn about phenomena such as squall lines and gust fronts. The model will help students understand concepts such as the importance of vertical wind shear in the development of long-lived convective storms and the role of hydrostatic pressure gradients in the propagation of thunderstorm outflow boundaries. The axisymmetric model will be used during student laboratory exercises on tornadoes and their associated dynamics. Ideally, some student experiments will uncover new areas to explore by using the existing data that the proposed IDLAV will make available.

Mobile Radar Laboratory. For nearly a decade, mobile Doppler radars have collected unique data near severe and tornadic thunderstorms, hurricanes, and initiating convection. These data are ideal for educational models structured to accommodate successive levels of complexity as different learning modules. These modules from a Mobile Radar Laboratory can be easily

incorporated into the IDLAV and are simple, yet interesting enough to appeal to both high school and undergraduate students. Web-interfaced case study modules will be available to educators at the undergraduate level in many different meteorology courses. Module case studies will be designed for various days of interest using the mobile radar data together with standard Mesonet meteorological data and ARM data (when appropriate). For example, a cold front intersects a dryline, creating a triple point, and convection initiates east of the triple point. Standard upper air and surface charts will be used to show the cold front and dryline locations and structure. The mobile radar data will be used to show the fine detail of the cold front and dryline, while standard NEXRAD and satellite data will be used to show the larger-scale convection. Mesoscale model *forecasts* using real data may also be incorporated to show the strengths and weaknesses of such models. Students will be presented with an exciting and unique opportunity to examine the interaction of several scales of motion. The inclusion of these data is made possible by a partnership between Pennsylvania State University and the Center for Severe Weather Research in Boulder, Colorado.

There are many other Java models of this type available for use in IDLAV. The existing models are typically written as Java applets, which only require a Java-enabled browser on the user side. The proposed work will involve collecting such existing interactive learning tools and modifying them to work with the IDLAV data. Many of the Java applet models at WeatherWise[24] assist in conceptual understanding of weather behaviors by using data such as that produced by the ARM program. These models isolate simpler principles (such as precipitation affecting convection, and, incoming solar radiation varying with latitude*)* and present them in a graphic manner that is easily understood. Some of these concept-building models are already incorporated into AVC lesson plans; we will incorporate others as appropriate. In addition, the use of the Cooperative Program for Operational Meteorology, Education and Training (COMET) Multimedia Database[25] will complement the host of visualizations developed for the IDLAV.

Develop User Facility

The IDLAV will need various user interfaces and digital library tools in order to function as an online user facility. The user facility will be a combined research and education portal, with the appropriate capabilities of each.

The user interfaces are extremely important because they provide the gateway to IDLAV content. The user interfaces will be developed for easy navigation and to provide structured documentation. Currently, the AVC has a subject-based interface, a calendar-based interface, and a location-based interface for accessing data; as well as a grade level and search interface for accessing lesson plans. Revisions of these data interfaces will enhance user capabilities for visual data mining. Furthermore, the development of standards and subject-based interfaces will allow more flexible access to lesson plans. These enhancements to the user interface will focus on tailoring functionality to the users and incorporating user feedback.

We will tailor new user interfaces to access value-added products, model data images, and satellite data images. We will design a web database interface to make data mining capabilities available and other interfaces for larger interactive learning tools such as the Mesoscale Simulation Laboratory and the Mobile Radar Laboratory.

The following digital library tools are available from the NSDL, DLESE, and AVC to assist researchers and educators in using the atmospheric data: DLESE Open Archives Initiative (OAI) harvester and server tools, the Lesson Plan Sandbox, the Presentation-Workshop Calendar, the Community Review System, the Component Repository for Assembly of Teaching Environments (CREATE), the Instructional Architect, the Data Discovery Toolkit, Multimedia Educational Resource for Learning and Online Teaching (MERLOT), Virtual Reference Desk (VRD), Thematic Real-time Environmental Distributed Data Services (THREDDS) and JESSE. These existing tools will be seamlessly integrated into the IDLAV — allowing us to build components that maximize research and educational use of the system.

Integrate Tools and Content

The collaborative developer tools available in the NSDL Communication Portal will be used to put all development efforts under version control — everything from web pages, to tools developed by our team, to educational material developed by our users.

This project will follow the path to data sharing set forth by the NSDL THREDDS[26] project with the IDLAV data sets. This task will involve implementing Open Source Project for Network Data Access Protocol (OPeNDAP) and THREDDS catalog servers. Another fundamental goal of the IDLAV is working with Unidata on using the Integrated Data Viewer (IDV)[27] as a THREDDS-enabled client for accessing the ARM data. The NSDL Data Discovery Toolkit's Earth Data Multimedia Instrument (EDMI) tool will also allow IDLAV visualization tools to become THREDDS-enabled client side tools. The result will enable use of these visualization tools on CDs and DVDs.

The DLESE OAI tools will allow metadata to be shared between the servers that make up the IDLAV. It will also allow similar data providers to become part of the IDLAV. We will share Adept DLESE NASA (ADN) metadata with the Alexandria Digital Earth Prototype (ADEPT) to enable searching this collection via their Geospatial Network[28]. Because data sets in this collection deal with geospatial data, we will collaborate with the ADEPT, DLESE, and NSDL on forming geospatial metadata extensions and improving geospatial discovery.

We will also integrate collaborative capabilities for educational material development, allowing users to contribute material to the IDLAV. Examples are the NSDL Wiki or DLESE SWiki capability, the NOAA Instructional Architect service, and CREATE. The IDLAV will use the NSDL Whiteboard Report to inform NSDL projects of success stories, workshops, and collaboration opportunities. The IDLAV will look to expand beyond the original intent through use of the NSDL Collaboration Finder to reveal new opportunities.

Develop User Community

Research Workshops and Materials

To promote awareness and use of the IDLAV tools for research purposes, we will offer Research Community Workshops at such venues as the annual ARM Science Team meeting, the American Meteorological Society annual meeting, the American Geophysical Union meeting, and the Australian Meteorological and Oceanographic Society meetings. At these workshops, we will explain how to leverage the IDLAV tools to assist in research goals and to augment existing

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research. Through presentation of these workshops, the atmospheric research community will understand:

- How to access ARM data;
- How to use and modify IDLAV visualization tools; and
- How to use the IDLAV data mining capabilities for data discovery.

Workshops aimed at scientists in this research community will explore specific applications of the IDLAV tools such as:

- Data quality uses of data images;
- Using real-time data images for tele-present activities with campaign instruments; and
- Using collaborative environments for visualization and parameterization code development.

We will produce CDs containing selected visualization tools, ARM data, and journal articles to demonstrate IDLAV uses in the research workshops. These CDs will link back to the IDLAV and act as another mechanism for disseminating the IDLAV to the research community. Frequent updates of the online user facility will demonstrate new uses of published tools and promote awareness of ongoing development efforts through examples and supportive links.

Lesson Plans and Activities: Development of curricula, classroom activities, and international school projects based on the IDLAV resources will be a major educational focus of this project. These activities will be designed to meet regional educational needs (including science standards) and incorporate regionally relevant cultural and indigenous materials. IDLAV will include new lessons on atmospheric science, earth systems, and environmental science — all with close reference to climate change science. Basic science concepts (that refer back to fundamentals in physics, chemistry, biology and mathematics) will be emphasized in the materials, and many of the lesson plans will address these concepts while also introducing more complex environmental interactions.

Initially, the lesson plans and activities will be focused on using IDLAV products and data from ARM sites, but teachers and students will be guided and encouraged to use data from other local, regional, and global sources in addition to those available from IDLAV. Lesson plans that specifically address social sciences, art, and humanities curricula enrichment areas will be included. There is a strong need for increasing scientific literacy and critical thinking skills in all areas of education, and students are typically intrigued with environmental issues that are relevant to their regions. Specific guides for teachers will be included in the IDLAV to reference the curricula and activities to educational standards and resources for all grades (K-12) and in different regions. These specific guides will be developed through consultations with regional education agencies and through interactions at the educational workshops (described below).

Traditional/Scientific Integration: A major innovative component of the proposed work is to incorporate long-term traditional indigenous knowledge of the environment**,** known as Traditional Ecological Knowledge (TEK) into the IDLAV classroom lessons. Studies have shown that in schools with indigenous students, using teaching methods and curricula that incorporate indigenous knowledge into the formal education system results in an increase in student achievement scores, a decrease in dropout rates, and an increase in university attendance. Ensuring that the IDLAV educational materials are relevant to these communities demonstrates a

degree of cultural sensitivity that scientific investigators have not typically shown. ARM has demonstrated that incorporating TEK is a very effective way to teach science in indigenous communities and is inclusive of and validates local culture, knowledge, and ways of teaching. Because the IDLAV will have users in Australia, the United States, and the Pacific regions, incorporating TEK from these areas will greatly enrich the IDLAV classroom lessons, will help the IDLAV to better serve the needs of indigenous students in these communities, and will increase the engagement of students from a broad range of ethnic and national backgrounds. Over time, validation of local knowledge and culture increases acceptance for learning about science and indirectly contributes to increased scientific literacy in a community.

Local/Global Integration: The third crosscutting theme of the IDLAV is to develop projects that engage students and teachers from widely different regions, and with widely different environmental conditions. An example: a joint project to analyze basic meteorological data between Australian, mid-Pacific and Arctic schools. We propose bringing in other data sets to the IDLAV by demand of the user community. Data on drought, precipitation, and vegetation can be a powerful way to teach climate change science. For example, comparing U.S. data on drought with Australian drought data will be an interesting issue for educators to explore with their students. The project will facilitate matching schools and teachers as interest is expressed, particularly after the first year of operation.

Educational Workshops: We will hold one large international workshop annually that will link teachers in the United States with Australian and Pacific teachers through videoconferencing, teleconferencing, sharing of data, and cultural exchange. We also propose to hold one annual domestic workshop to bring in more interested teachers in the United States and a similar international workshop to bring in interested Pacific teachers. Teachers who attend these workshops will become familiar with the IDLAV and will learn how to teach the IDLAV classroom lessons using near-real time data from IDLAV data sources.

The teacher workshops will include an annual master teacher training program for further development of professional skills, including learning how to actively develop lesson plans for posting to the IDLAV portal. Graduates of this program will assist and teach in future workshops at schools within their own regions or as part of the IDLAV program. IDLAV participants will work to obtain continuing education or professional credit hours as appropriate. During the first year, AVC/IDLAV teachers in the United States will share the material from our current workshops on using the IDLAV in the classroom with participants at an Australian IDLAV workshop. In the following years, U.S. and Australian teachers will exchange best practices for using the ARM data in the classroom. We will also pursue digital mechanisms for sharing workshop materials.

Support Networks: A variety of support tools will be used for teachers who have attended the educational workshops. Web-based communications will be the main means of interaction for teachers with appropriate computer resources. The IDLAV web site will allow teachers to send feedback, ask questions, submit new lessons and activities, or collaborate with teachers from other schools for joint projects. Evaluations of post-workshop value will be conducted yearly and the results will be used to improve the workshops.

Rural Education Support: For teachers from schools with limited or no internet access, the project will develop support networks through newsletters, packaged data CDs, pen pal projects, mailed lesson plans, and national and regional support for school projects. The ARM EOP works routinely with rural populations and has the capacity for continued development.

Undergraduate Studies: A series of courses routinely taught at PSU requires students to use computers along with the analysis of a variety of data sets. The IDLAV would like to use these courses in a synergistic way to educate undergraduate meteorology students and potentially provide tools for the IDLAV to be used by university educators worldwide. We envision a process in which students in any university could develop web-based tools, but with two aims instead of one: first, to gain computer and meteorological knowledge, and second, to develop a tool with a specific educational aim proposed by the IDLAV. A typical third-year course (at PSU), "Applications of Computers to Meteorology," requires undergraduate students to learn to develop web-based tools "on-the-fly." Students work in teams to promote teaming and leadership skills. Student teams are given a large stream of meteorological data and a rough vision of the kinds of products that could be developed from the data. Usually, the students quickly learn particular analysis tools and/or languages along with various graphics packages that allow for visualization of the data[29]. The final product the students develop is required to be useful to some segment of the community. One example, 2003 students at PSU developed a final product of sufficient quality that it is in the process of being implemented by a member of our team (Harrington) as the operational weather page for the ARM NSA Site Scientist Team.

Evaluate Project Success

Scientific Review: One of the keys to the success of any program is the usefulness and validity of its contents. The meteorological expertise available at PSU and University of Utah will play an integral role in the scientific content review of the IDLAV. This continuous process will ensure the scientific content and validity of the products being collected/produced for this library. Through the use of existing tools (e.g., sourceforge, wiki), we plan to provide feedback to the IDLAV developers on the review findings

Educational Review: Educational reviewers will use the DLESE Community Review System (CRS)[30,31] as the tool for reviewing educational material within the IDLAV. Workshops will introduce educators to the DLESE CRS to review IDLAV material. Workshops to train teachers in the use of IDLAV material and methods will be evaluated by participants. This feedback will be used to assess the relevance and quality of the material presented to teachers, improve the workshop techniques, and assess utility and effectiveness of the lesson plans and activities in the post-workshop period.

5 Deliverables and Milestones

Deliverables:

- Review panels for technical and educational materials: year 1
- Movement of existing AVC tools to IDLAV environment: year 1
- Research community workshop and user notebook: year 2
- Peer review and publication of material submitted to the Journal of Earth System Science Education (JESSE)[32]: years 3 and 5

- Peer review and publication of material to the Bulletin of the American Meteorological Society (BAMS): year 3 and 5
- Fully operational IDLAV User Facility: year 4.
- K-12 Curriculum User Notebook: year 3 (revision: year 5).
- Professional Development Workshop accreditation for K-12 teachers: year 4

Table 1: Table of Milestones.

Component	Year 1	Year 2	Year 3	Year 4	Year 5
Develop Data Visualization Tools	Migration of NSDL Tools to other sites	Test/Release first parameterizations	Test/Release Models and Satellites	Feedback and Revisions	Sustain efforts
Incorporate Data Mining Capabilities	Migration of Existing Tools	Development & refine D2K	Initial D2K integration	Application of D2K to external data sets	Feedback and Revisions
Design Interactive Learning Tools	Inventory existing tools	Implement Java Tools	Implement Laboratories	Full integration in User Facility	Sustain growth plan & revisions
Develop User Facility	TWP/Darwin user interface Migrate NSDL Tools Data mining tools interface	Build interface for parameterization and Java tools	Models/Satellites/D2K labs interfaces	Feedback and revisions	Sustain efforts
Integrate Tools & Content	Initialize metadata integration Implement OAI sources and harvester Migrate WIKI and Source Forge	Implement metadata DLESE Integration & collaboration EDMI tools (CD/DVD)	Metadata THREDDS enabled Share metadata with ADEPT	Collaborate with other Digital Libraries (international, etc.)	Sustain Efforts
Develop User Community	Curriculum/Science Standards workshop Existing Lesson Plans On-line tutorial	Workshop to develop new lesson plans Research community workshop Language translation (ongoing)	Grad/Undergrad education workshop Professional Development Credits for workshops K-12 curriculum development	Continue previous workshops First on-line workshop	Sustain efforts
Evaluate Project Success	All years: Science and Education review panels (ongoing)	Yr. 2 through Yr 5: DLESE CRS use (ongoing)			

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6 Conclusions

We have assembled a talented team of experts to establish the premier model for a long-term IDL structure that will serve as a model for IDL development far into the 21st century. This project will bring new tools and insights to digital library development by (1) extending the current flow diagram structure methodology; (2) applying a novel D2K learning environment; (3) bringing metadata development and standards to an international population, thereby helping to address a worldwide digital library bottleneck; and (4) adding newly developed atmospheric databases from outside the United States. We will leverage existing tools and digital library structures to set a new standard in IDL development. Our foundational AVC collection comprises one of the world's largest scientific databases (over 25 terabytes), which already serves 64 countries with over 7,000 different users and 400 unique users per week. Our outreach plans are to extend this capability to over a million within the next three years through NSDL and IDL development.

We have international data collection sites and outreach programs in the TWP region with rapidly growing data collection sites in Darwin, Australia; Papua, New Guinea; and the island nation of Nauru. Our team includes experienced specialists who are sensitive to the traditional and indigenous knowledge within local populations. Our ability to share, document, disseminate, and model diverse experiences is applicable to language difficulties, scientific representation and intrusion issues, and significant cultural barriers is of great value to the IDL movement — especially in the non-First World arena. The IDLAV promises to become the cutting edge IDL portal in Australia, with visibility and usage that greatly exceeds the capacity of current structures.

Our unique collaboration with the Australian BoM and Monash University allows for significant development and the final establishment of a long-term sustainable IDL program. Once the NSF and BoM establish the essential infrastructure of this portion of the IDL, the long-term maintenance and continual growth of data will become a normal part of the DOE ARM program and the BoM, reflecting the current long-term sustainability features of the AVC and the ARM EOP. User communities extending far beyond the scientific research community and far into the pre-service and in-service teacher populations will allow for ongoing opportunities for student use, contributions through authorship and peer review, and opportunities for special program development required for different cultural needs.

As many countries are striving to better understand the global nature of atmospheric science[33], the time is ripe to develop an ambitious, worldwide initiative using ARM data. This NSF IDL program will allow our team to develop a fully interoperable IDL that can serve as a model for use by many other such large-scale scientific databases, research teams, and educators. The proposed model is designed to highlight the power of strong international collaboration across scientific, teaching, learning, and cultural barriers. Wide dissemination efforts will help establish and further develop this IDL model into the world's finest and most useful digital portals for learners. We believe our team comprises ideal group of ambassadors for such a visionary program and that the IDL format is the perfect vehicle for worldwide learning and sharing of knowledge.

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BUREAU OF METEOROLOGY RESEARCH CENTRE
GPO Box 1289K, Melbourne VIC 3001, Australia

15 April 2003

Mr Christopher Klaus
Bldg 900 Rm L21
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
USA

Dear Mr Klaus,

I am writing in support of your NSF proposal, "International Digital Library of Atmospheric Visualization (IDLAV)".

As collaborators in your project, the Bureau of Meteorology Research Centre (BMRC) will be making several contributions, including 20% of the salary of Dr Peter May and Mr Rex Pearson and the provision of a host work-station for the digital library. We will also use our extensive meeting facilities to host workshops on the use of the digital library. In collaboration with Monash University and other IDLAV participants, we are seeking additional funds within Australia of approximately $US20,000 to support these workshops.

The Bureau of Meteorology operates a joint research facility with the US DOE ARM (Department of Energy Atmospheric Radiation Measurement) Program in Darwin, Northern Australia. The data from this facility will form the basis of much of the development and data within the IDLAV. This includes state-of-the-art radar data as well as sounding, radiation and satellite data provided by the Bureau.

Yours sincerely,

(M.J. Manton)
Chief of Division

Pacific Northwest National Laboratory

P. O. Box 999
Richland, WA, 99352
(509) 372-6032

April 15, 2003

Dr. Steven M Griffin
Program Manager, CISE/IIS
Division of Information and Intelligent Systems
4201 Wilson Boulevard, Suite 1115
Arlington, Virginia 22230, USA

Dear Dr. Griffin:

It is a pleasure to write a letter in support of the proposal entitled *Collaborative Research: International Digital Library of Atmospheric Visualization* submitted by Christopher Klaus and his colleagues.

The Atmospheric Radiation Measurement (ARM) Program, which is sponsored by the Department of Energy, is a major component of the federal Climate Change Science Program. We are heavily engaged in the acquisition and use of ground-based remote sensing data of the atmosphere. Our archive contains terabytes of data, collected from a wide range of instruments, and more data are added every day. While experienced research scientists involved in our program have learned their way around our archive, new users often find it difficult to deal with the breadth and complexity of our data holdings. Not surprisingly, one of the very best ways to introduce new users to the system is through visualization software and quick-look data products. These tools are also very helpful to educators at a variety of levels from elementary school to college because it allows students to experience the data with only a small investment of effort.

We have struggled during the lifetime of this program to develop a single visualization system that served all of our users. We gradually came to the conclusion that we needed more than one system, but we also realized that we did not have the resources for multiple development activities. Although we do maintain a small education project and view it as a very important part of our overall program, our primary mandate is the support of research activities. Consequently, our principal visualization activities have been and continue to be directed towards the needs of the experience users, which makes them less usable to the novice research community and the educational community. Fortunately, Chris was able to obtain support through the National Science Foundation that allowed him and his colleagues to develop visualization tools aimed specifically at the novice users, particularly in the educational arena. The web site supported by this activity has been one of our most successful means to reach out to the broader community, particularly in education. Not surprisingly, many of our researchers also access the site to help locate specific types of events or simply to look at the data to hone their understanding and scientific intuition. I often do so myself. We are very anxious to see that site develop and grow. The idea of including visualization of our value-added products, which combine multiple data streams into a single data product, is very exciting because these products are what the broader community is most often interested in.

The ARM program began an expansion into the tropics in the early ‘90’s and opened its first continuously operating site in Manus Island, Papua New Guinea in 1996. We currently operate three sites: Manus, Nauru, and Darwin, Australia. These sites represent not only a national, but an international resource. From the very beginning in New Guinea, we have sought to engage the local populace in our research and allow them access to the data. We have found the latter to be difficult in the tropical countries because many of the schools are underfunded and underequipped. We have purchased and installed computer systems in these schools but the usefulness of the systems is limited by a lack of access to data and display software. This new project being proposed by Chris and his

colleagues is a major effort to change this situation. The Australian community has a long and commendable relationship with the Pacific island nations. Thus, linking up with the Australians and working with them on visualization of our tropical data is an excellent idea. Since internet access is gradually making its way through the island nations, the time is ripe to create tools and internet access for these data. A few years ago, I was invited to address a Pacific Islands Conference on Climate, Climate Change, and Sea Level Rise to talk about our data and our program. One of the primary messages that I received in response to my talk was a plea for data access. These island nations are deeply concerned about their future in a world with a warmer climate and higher sea levels. I had no answer for them at the time. This effort could provide some very concrete steps in that direction.

In summary, I view this effort as a very important complement to our existing program. I wish that we had funds available to support it. However, it falls largely outside the boundaries of our principal objectives, which are tied to the national research community. I strongly encourage you to fund it. If funded, I am sure of its success because of the success of the previous project and the quality of the proposing team, most of whom I know well. Its success will certainly pay large dividends in Australia and in the Pacific Island nations, as well as here in the United States. If I can be of any further help to you in this matter, please feel free to contact me.

Sincerely,

Thomas Ackerman
Chief Scientist
Atmospheric Radiation Measurement Program

Los Alamos

Earth and Environmental Sciences Division
Atmospheric, Climate, and Environmental Dynamics (EES-2)
Mail Stop J495
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Ph.# (505) 667-3331 Fax #: (505) 665-3866
Email: fyb@lanl.gov

Date: April 10, 2003
Re: EES-2-03-030

Mr. Christopher Klaus
Bldg. 900 Rm. L21
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

Dear Mr. Klaus:

The Atmospheric Radiation Measurement (ARM) Education Outreach Program (EOP) is pleased to submit a letter of support and statement of collaboration for the proposed development of the International Digital Library for Atmospheric Visualization under the auspices of the US National Science Foundation. We are eager to support this venture and its application to Pacific Island Countries, Pacific region nations, and we strongly support the interface between the IDLAV effort and existing programs in the USA.

ARM EOP is an integral part of the DOE Atmospheric Radiation Measurement Program. Our budget is of the order of $250,000 per year. We develop education curricula and lesson plans (K-12) as well as conduct public outreach activities that are relevant to the three locales surrounding the ARM sites: the Tropical Western Pacific, the North Slope of Alaska, and the Southern Great Plains. We also contribute to regional workshops and conferences.

From the initial work of ARM EOP in 1992, we have concentrated on providing culturally sensitive and place-relevant materials. We have held teacher training workshops in Papua New Guinea (Port Moresby and Manus), Nauru, and in villages on the North Slope of Alaska. In the Pacific, we typically address teaching basic scientific concepts using climate, meteorology, and climate change effects as the vehicle in extremely poor school districts. We have also developed a climate change and sea –level rise enrichment curriculum that contains activities with minimal equipment needs. In the last 3 years, we have used the NSDL AVC lesson plans and contributed lessons to the AVC in order to start to bring computer and internet skills to the Pacific Island schools. In the North Slope of Alaska schools, internet access is typically very available, and the NSDL AVC lessons are already in use. Climate-related knowledge and activities are extremely relevant to all communities, but particularly to rural and indigenous groups that depend on knowledge of the weather and climate for survival and economic

success. In addition, we have found that including traditional and indigenous ways of knowledge in scientific presentations and lessons increases interest, and promotes utilization of lessons and activities.

We are very interested in the success of this project. We anticipate leveraging our existing activities to support the IDLAV workshops and will be willing to try and schedule ARM EOP activities so as to contribute expertise and advice as needed. We will continue to develop lesson plans for remote rural areas and will contribute these to the IDLAV. We also look forward to using all the lessons in the IDLAV and will actively present the IDLAV structure, concepts, sand box and lesson plans to teachers and educators. We will also collaborate on developing science standards and curricula, and will promote use of IDLAV resources as appropriate within ARM locales.

I am pleased to offer our expertise and support in this endeavor.

Sincerely,

Fairley J. Barnes, Ph.D.
ARM EOP Director
Los Alamos National Laboratory, EES-2

FJB/hb

Cy: BUS-4, MS-A190
EES-2 File

DLESE: Digital Library for Earth System Education
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University Corporation for Atmospheric Research
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April 15, 2003

Christopher Klaus
Bldg. 900 Rm. L21
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9700 South Cass Avenue
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Dear Chris:

I am pleased to offer this letter in support of your proposal *Collaborative Research: International Digital Library of Atmospheric Visualization*, in response to NSF 02-085, International Digital Libraries Collaborative Research and Applications Testbeds. Your plans to collaborate with the Australian Bureau of Meteorology and their research and education outreach efforts, combined with the DOE Atmospheric Radiation Measurement (ARM) program, to improve access to atmospheric data through visualization tools, tailored user interfaces, and data mining capabilities will be a significant contribution to the DLESE and NSDL collections.

DLESE encourages the development and integration of specialized collections and services that support Earth system education. In support of this goal, the DLESE Program Center (DPC) offers a suite of collaborative services to all community members. This suite includes tools and training to support collection development and management; help in addressing the technology and policy requirements of collections accessioning; and through inclusion in DLESE, seamless integration with NSDL.

The success of DLESE and NSDL rides on the active participation of an engaged community of users, builders, and contributors. The work you propose has the potential to make a substantial contribution to these two libraries and to Earth system education. We look forward to working with you to integrate your resources and services with DLESE and with NSDL tools such as THREDDS and the DLESE Community Review System, providing even greater value to the collections, and fulfilling the visions of both libraries to provide integrated resource development and delivery.

Sincerely,

Mary R. Marlino

Mary R. Marlino
Director, DLESE Program Center

MRM/em

SPREP **PROE**

South Pacific Regional Environment Programme **Programme régional océanien de l'environnement**

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AP 3/3/1/7

14 April 2003

Mr. Christopher Klaus
Bldg. 900 Rm. L21
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

Dear Mr. Klaus

SUBJECT: Integrated Digital Library of Atmospheric Visualisation

The South Pacific Regional Environment Programme (SPREP) is pleased to submit a letter of support and statement of collaboration for the proposed development of the International Digital Library for Atmospheric Visualization under the auspices of the US National Science Foundation. We are eager to support this venture and its application to Pacific Island Countries.

SPREP contracts with the DOE Atmospheric Radiation Measurement Program (ARM) to provide advice and oversight of international collaborative efforts in the Pacific region. In this capacity, we ensure that ARM meets regional needs for environmental research and environmental educational support in appropriate ways. We have worked with ARM for over 10 years, and have consistently found that our collaborations are pertinent to regional needs. ARM Education Outreach has made significant contributions to scientific curriculum enrichment in Papua New Guinea and Nauru. They have also contributed to regional workshops and conferences.

I am convinced that important advances in environmental education in the Pacific region can be focused through the NSF International Digital Library program to add value to the ongoing ARM efforts. These advances include (1) expanding the curricula to include computer and internet access skills, (2) usage of current research data, including ARM data from the Pacific region, in classroom activities for students, (3) bringing a stronger place-based and regional focus to the proposed classroom activities through the integration of western science with traditional and indigenous knowledge systems. In addition, we are eager to see the educational efforts expanded into undergraduate and graduate university levels.

The high calibre of research and development that has resulted in the existing National Science Digital Library, and the commitment and innovation of existing educational activities by the participants in the current proposal provide a strong foundation for success. I am pleased to offer our expertise and support in this endeavour. SPREP will continue to review and oversee certain ARM activities as per the existing contract. We will be pleased to review educational materials for

the Pacific region, and as ARM as indicated, we will be happy to facilitate workshops and follow up activities as permitted by the ARM contractual agreements. We will also offer oversight on science standards issues and curriculum development as they pertain to Pacific Island Countries.

Sincerely

Asterio Takesy
Director

Cc: SPREP PDM, BSM, CCC, ARM PC

The New Media Studio

Forging Digital Learning Tools
for the Human Environment

Data Discovery Toolkit and Foundry
http://www.newmediastudio.org/DataDiscovery

April 16, 2003

Dr. Steven M Griffin
Program Manager, CISE/IIS
Division of Information and Intelligent Systems
4201 Wilson Boulevard, Suite 1115
Arlington, Virginia 22230, USA
Dear Dr. Griffin:

I am writing in support of Dr. Christopher Klaus, and his team's proposed work for the International Digital Libraries Collaborative Research and Applications Testbeds effort. First let me congratulate them on the work their team has accomplished already through the Atmospheric Visualization Collection (AVC) at the NSDL. Their plans for the International Digital Library of Atmospheric Visualization (IDLAV) are an exciting next step. In my estimation, the IDLAV will provide a useful model for international digital library (IDL) structure and serve a diverse community worldwide.

The New Media Studio and our Data Discovery Toolkit and Foundry NSDL project have been watching as the AVC data resources have developed. We are looking forward to working together with Dr. Klaus to build robust user-side visualization tools for these data. As a programmer in the Foundry, he has access to all of our tools and content. The AVC collection will continue to provide a wealth of value for students of the atmosphere. And now, through the proposed IDVAC they can cover a much larger area of the planet.

As a result of our very positive interactions with the AVC project and our extremely high opinion of their capabilities, we strongly encourage your consideration of their request for funding. Please feel free to contact me for additional information about our project or our collaborations with the AVC.

Regards,

Bruce Caron
Executive Director
exdir@newmediastudio.org

Management Plan

Coordination and Cooperation

In addition to frequent electronic meetings, e-mail exchanges, and conference calls we will explore using technologies like the Access Grid and online workshop environments to reduce the need for travel.

It is important to periodically gather the entire team together for discussions. Thus, we will schedule at least one team meeting per year, ideally co-located with other meetings to reduce travel costs. These meetings will be used to identify problems, coordinate approaches for problem solving, and to discuss new development ideas.

Collaborative Code Development

Use of the NSDL Communication Portal means access to a collaborative code development environment that includes:

- Bug tracking system
- Feature requests tracking system
- Support request tracking system
- Patch tracking system
- Web accessible Concurrent Versions System (CVS) for tracking code revisions
- Repository for public releases of source code

Such tools increase the quality and speed of collaborative code development efforts.

Partitioning of Research Activities / Participant Roles

Argonne National Laboratory (ANL):

- ***PI:*** Christopher Klaus, DLESE Collections Committee Member and AVC program manager;
- ***Co-PIs:*** Michael Vogt, Portal and GUI design specialist;
- ***Student:*** graduate research assistant in computer science.
- ***Role:*** Project and technical lead; lead on portal development, user interfaces, visualization tools design; direct metadata development, and implementation of NSDL and DLESE tools; contribute to research and teacher workshops.

Bureau of Meteorology (BoM):

- ***PI:*** Peter May, BoM and ARM Scientist;
- ***Co-PI:*** Christian Jacob, BoM and ARM Scientist;
- ***Senior Personnel:*** Rex Pearson, system administrator;
- ***Role:*** Lead for Australian scientific efforts; lead for applying tools to Darwin and TWP data; host for Australian workshops; maintain Australian IDLAV server.

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Los Alamos National Laboratory (LANL):

- ***PI:*** Paul Rich, environmental education and higher education;
- ***Co-PIs:*** Fairley Barnes, ARM education program director and K-12; Michael Ebinger, scientific integration; Laura Marsh, ARM science program specialist;
- ***Student:*** ARM graduate research assistant.
- ***Role:*** Lead for K-12 education; assist with undergraduate and graduate education; focus feedback towards tailoring tools and user interfaces; responsible for curriculum development, teacher workshops, and design of feedback tools.

Monash University (MU):

- ***PI:*** Steven Siems, School of Mathematics, Atmospheric Science Program Faculty;
- ***Role:*** Lead for Australian educational workshops; organize Australian efforts to contribute to IDLAV curriculum development.

Eastern Illinois University (EIU):

- ***PI:*** Keith Andrew, physics education and in-service/pre-service teacher preparation;
- ***Co-PIs:*** Timothy McCollum, 8th grade science teacher; Michael Hoadley, Assistant Vice President for Academic Affairs for Technology,
- ***Senior Personnel:*** Troy Gobble, Brookfield Riverside High School, teacher and Science Department Chair.
- ***Role:*** Lead for implementation of cutting edge technology based teaching and curriculum methods, leaders in mentoring in-service and pre-service science teachers through student teaching, using data in the classroom, translations, workshops and NSTA Teaching Standards rubric development.

Penn State University (PSU):

- ***PI:*** Chad Bahrmann, Research Assistant;
- ***Co-PI:*** Scott Richardson, Research Assistant;
- ***Senior Personnel:*** Yvette Richardson, Assistant Professor; Paul Markowski, Assistant Professor;
- ***Facilities Assistant:*** Chuck Pavloski, Director of Meteorological Computing;
- ***No-Cost Contributor:*** Jerry Harrington, Assistant Professor.
- ***Role:*** Lead for the graduate and undergraduate educational development. Lead on the development of meteorological simulation labs. Contribute to the development of user interfaces and visualizations. Contribute to curriculum development and teacher workshops.

University of Utah (UU):

- ***PI:*** Gerald Mace, ARM Scientist and ARM Cloud Working Group Co-chair;
- ***Senior Personnel:*** Chris Galli
- ***Role:*** Lead for the atmospheric science direction and research workshops. Contribute to data mining and visualization development.

National Center for Supercomputing Applications (NCSA):

- ***PI:*** David Tcheng, Applied Learning Group, Data Mining Specialist;
- ***Role:*** Lead for data mining efforts, and for use of the Access Grid.

Evaluation of Progress

Status and assessment reports will be issued every four months summarizing how the project is meeting milestones and deliverables, incorporating feedback and reviews for the period.

A science panel will be formed from ARM and BoM scientists to evaluate the scientific quality of the IDLAV. In addition ARM has an engineering change review process, which will be used to announce major changes to the IDLAV and request input from ARM scientists for how these changes would impact their use of the IDLAV as a research tool.

An educational panel will be formed from US, Australian, Nauru, Papua New Guinea, Samoa, and any other country interested in using the IDLAV. The educational panel will review the pedagogical quality of the IDLAV. In addition, user evaluation will take place using the DLESE Community Review System (CRS). The CRS is basically an online rubric that allows input on specific items, such as a lesson plan, within a collection or digital library from the educational community at large.

LANL will review K-12 feedback. PSU will review undergraduate and graduate feedback. They will refine feedback into potential directions for development efforts.

Cost Sharing from International Collaborators

The Bureau of Meteorology (BoM) will be supplying several data sets that are not routinely available at the other ARM sites. Since BoM makes this data publicly available we have not included an estimate of the effort involved in collecting this data, yet it is significant in making this collaboration possible.

Peter May and Christian Jakob, researchers at BoM, will work with Christopher Klaus and Chad Bahrmann on producing *quicklook* products that aid in the interpretation of the Darwin and TWP data sets. Peter and Christian will also be investigating the provision of model guidance and model output to the quicklook suite of data along with appropriate analysis tools. This will involve 20% of Peter May's time and of Christian Jakob's time. The BoM has already purchased a work station with appropriate disk storage arrays to be used as the Australian IDLAV server. This server will host all the IDLAV tools and apply them to the Darwin data. The server will involve 20% of Rex Pearson's time for maintenance and system administration. The server with related software cost **$21,000 Australian Dollar (AUD)**. The BoM effort contribution is estimated at over **$60,000 AUD** annually.

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The BoM has K-12 educational links to class notes, lesson plans, and experiments that deal with atmospheric science. These will be incorporated into the IDLAV.

The BoM will be supporting workshops held in Australia through the provision of full workshop facilities. This includes classrooms with fully networked computers for all workshop participants. These will include workshops aimed at upper primary and secondary teachers, as well as workshops aimed at faculty, and undergraduate and graduate students. Renting a similar conference facility would cost **$2,000 AUD** per day. There will be 2-4 workshops of 2 days planned each year with attendance from US collaborators, and 2 workshops without US collaborators attending. We expect there will be 4-6 Australian workshops annually, giving this contribution a value of **$16,000** to **$24,000 AUD** annually. The Australian Meteorological and Oceanographic Society (AOS) awarded BoM **$1,500 AUD** to host an IDLAV workshop for 2003-2004. BoM will apply for similar funding in the future.

Peter May at BoM in collaboration with Steve Siems at Monash University (MU) and Christopher Klaus at Argonne National Laboratory have submitted a proposal to the Australian Academy of Technological Sciences and Engineering (ASTE) requesting an additional **$34,000 AUD** for 2003-2004. If funded this would support 2 additional workshops for the technical transfer of IDLAV to Australian collaborators by covering travel for presenters from the US. BoM and MU will continue to submit ASTE proposals each year to allow additional workshops to the already proposed efforts.

MU plans to submit a Teacher Release to Industry Program (TRIP) proposal, which would allow an Australian secondary teacher 40 weeks to work at MU and / or BoM in order to learn how to use the IDLAV and to develop lesson plans which would be contributed to the IDLAV. If awarded MU would still be expected to cover **$27,750 AUD** for costs related to releasing this teacher for that school year. MU will continue to make TRIP proposals each year to allow more secondary teachers to become deeply involved in the IDLAV.

Table 2: Minimum Australian Contribution in AUDs. ($1.5 AUD ~ $1 USD)

Organization	Year 1	Year 2	Year 3	Year 4	Year 5
BoM	$97,000	$76,000	$76,000	$76,000	$76,000
AOS	$1,500	0	0	0	0
Total	$98,500	$76,000	$76,000	$76,000	$76,000

Table 3: Expected Australian Contribution in AUDs. ($1.5 AUD ~ $1 USD)

Organization	Year 1	Year 2	Year 3	Year 4	Year 5
BoM	$97,000	$76,000	$76,000	$76,000	$76,000
AOS	$1,500	$1,500	$1,500	$1,500	$1,500
ASTE	$34,000	$34,000	$34,000	$34,000	$34,000
MU	$27,750	$27,750	$27,750	$27,750	$27,750
Total	$159,250	$139,250	$139,250	$139,250	$139,250

Sustainability

The significant educational focus and variety of data sources makes the IDLAV an unlikely candidate for *development funding* from sources other than the NSF.

However, once the IDLAV is built, DOE ARM funding will sustain the US side for use with the ARM Educational Outreach program and use by the ARM scientists. This has already been demonstrated by DOE ARM funding to maintain the NSF developed AVC.

The Bureau of Meteorology (BoM) will be directly funding this effort at over $76,000 AUD annually, which will continue after the NSF funding is completed.

The IDLAV server at Darwin and the IDLAV servers in the US will retain the latest copies of all IDLAV tools. This mirrored redundancy is common practice to ensure availability and access is more robust to infrastructure problems or support funding interruptions at either site.

Both the US and Australian collaborators plan to continue applying for further funding in the future to develop more IDLAV capabilities and to add further atmospheric data sets.

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