Unidata Community Equipment Awards

Installation of RAMADDA, THREDDS, and LDM at UWM

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A. Project Summary

The University of Wisconsin at Milwaukee (UWM), Atmospheric Science Program, in the Department of Mathematical Sciences, has heretofore been unable to be an active participant in Unidata. This proposal seeks to obtain funds to support installation of RAMADDA, THREDDS, and LDM at UWM. This support will allow UWM to become an active participant in the sharing of locally-generated and Unidata meteorological data streams. The addition of this capability will contribute to the extensive and growing research and educational efforts at UWM (including experiential learning through the Innovative Weather Program, as described below), and further allow UWM to contribute to the Unidata community by sharing locally generated research and other datasets widely.

B. Project Description

1. Overview and current configuration

The Atmospheric Science Program at the University of Wisconsin at Milwaukee (UWM), part of the Department of Mathematical Sciences, offers undergraduate and graduate (master of science and doctoral) degrees in atmospheric sciences. In existence since the mid-1970's, the program has grown to 7 faculty, with approximately 15 graduate and 30 undergraduate students. The program prepares students for career pursuits by stressing breadth of knowledge in course studies in the various sub-fields of atmospheric science and the development of quantitative thinking through a unique emphasis on the mathematical and computational aspects of the discipline. In addition, the program offers students real operational experience through the Innovative Weather Program (Roebber et al. 2010), where students provide weather-based decision support for paying community clients (energy companies, sewage treatment, lake ferries, cable, etc.). Through Innovative Weather and other initiatives, the program maintains strong ties with regional employers in both the private sector and the National Weather Service, where many of our recent graduates have been placed. Because of the high faculty-to-student ratio, there is close contact between students and faculty.

Computational resources in the UWM Atmospheric Science Program includes a weather lab for scientific visualization, modeling and forecasting with 10 Macintosh Intel 3.06 GHz core duo desktop computers, with 4 GB RAM and a 500 GB hard drive on each machine, along with projection and color laser printing capability. Additionally, there is a campus High Performance Computing (HPC) Service for large jobs [such as running high resolution and ensemble versions of the Weather Research and Forecasting (WRF) model in real-time and research modes], with 142 compute nodes (1136 cores). Each node contains two quad-core 2.67 GHz Intel Xeon X5550 processors and 24 GB of system memory. The HPC service also provides 80 TB of RAID 60 and RAID 10 storage available through NFS. Full details can be found at

http://www4.uwm.edu/hpc/about/specifications.cfm. For weather forecasting, additional resources are available at the off-campus facility of UWM's Innovative Weather Program, including several late generation PCs with multiple monitors, a printer, and a 4 channel Behringer mixer for audio. All of the Atmospheric Science Program computers are equipped with software appropriate for research and weather data analysis, including, for example, a full Matlab implementation (mapping, statistics, signal processing, optimization, filter design, wavelet, symbolic math, and PDE toolboxes), IDV, GEMPAK, and standard tools such as MS Office, web browsers, and so on.

To date, however, real-time data streams have been obtained through the web rather than directly through the Unidata LDM/IDD feed. In addition, computational resources have not been sufficient so as to permit locally-generated or locally-obtained meteorological data to be shared with the Unidata and larger meteorological communities. The program has grown sufficiently now, including 2 faculty with expertise in the area of synoptic and mesoscale dynamics, that UWM is well-positioned to become an active participant in the sharing of locally-generated and Unidata meteorological data streams. Without the requested funds, given the declining resources available to state universities in Wisconsin, it will not be possible for UWM to participate in the IDD.

2. Proposed equipment acquisition and implementation

2.1 Description of equipment

To support installation of RAMADDA, THREDDS, and LDM, funds to support the purchase of one server are requested. This server must be capable of handling requests from multiple local and remote users at any given time. Furthermore, it must also be capable of storing up to 10 TB of meteorological data in a redundant RAID 5 or RAID 6 configuration.

A Dell PowerEdge T710 server, featuring a six-core Intel Xeon E5645 2.4GHz processor, 48 GB RAM, eight 2 TB 7,200 RPM hard drives in a RAID 5 configuration would fulfill this requirement. Utilizing two hard drives as spares in the RAID 5 configuration, this enables approximately 11 TB (after operating system installation) to be dedicated to (1) sharing current and archived data obtained via LDM; (2) local model output from both deterministic and ensemble model systems; (3) case study analyses; and (4) data obtained as part of students' thesis and dissertation research (see section 3 below for further details).

2.2 Management and maintenance/University commitment

The PI (Paul Roebber) and co-PI (Clark Evans) are currently generating research and real-time WRF datasets as part of their regular research and teaching activities as well as through the supervision of several graduate students. These activities will continue and will be enhanced with the new Unidata configuration.

The PI and co-PI will both supervise the new data facilities as part of their regular duties. In addition, campus IT expertise will be provided by Mr. Dan Siercks, who is a member of the IT staff of UWM's College of Letters and Science, and is an expert in Unix/Linux hardware and software installations. Mr. Siercks will assist in the installation and maintenance of the computers obtained through this grant.

3. Benefits to the university and Unidata

3.1 Contributions to the research and educational programs at UWM

Professor Clark Evans runs a once-daily, sixteen member ensemble of 10 km numerical forecasts obtained using version 3.3.1 of the WRF numerical model. Output from this ensemble is available in static form at http://derecho.math.uwm.edu/wrf/. As such model efforts are largely unfunded, current computational capabilities only permit the storage of approximately one week of model simulations (at approximately 38 GB per model cycle) without significantly impacting the conduct of grant-supported research. We anticipate that the purchase of the equipment proposed herein would enable us to archive gridded data from approximately 45 ensemble cycles at a time. These data will be made available to others at UWM, local partners, and the community as a whole through RAMADDA for case study analyses, model climatology and bias development, and other uses. Additionally, Professor Roebber runs a 4 times daily realtime WRF forecast at 3 km grid spacing for a domain covering the upper Midwest. These deterministic forecasts likewise would be shared through RAMADDA.

Increasing emphasis is being placed by funding agencies such as the National Science Foundation upon the ability for others to be able to access data produced as a part of the normal conduct of grant-supported research. To this point, however, it is difficult at best to access research data generated by faculty and their advised undergraduate and graduate students at UWM and elsewhere. This is despite the significant quantity of data produced from numerical simulations and observational data analyses, among other research tasks, that may not just be beneficial to the research project for which they were obtained but also to those in the community who wish to duplicate their results or use such data to study related phenomena. The purchase of the equipment proposed herein would enable us to share (via RAMADDA and THREDDS) such research data with the community as a whole. We anticipate that between 5-8 TB of such data would be able to be shared at any given time as a result of this request.

3.2 Outreach

Not only would the proposed equipment enable us to establish an LDM/IDD feed to support educational and research objectives at UWM, it would also enable us to share data obtained via IDD with the community as a whole. We thereby propose to utilize the data-sharing capabilities of RAMADDA to share these data with the community at-large. We anticipate that this would benefit any schools that currently do not have the LDM/IDD feed (e.g., like UWM currently), plus provide much needed redundancy in

data sharing across the LDM/IDD system to protect against the inevitable outages that occur. Furthermore, a developing STEM education initiative utilizing the outreach of Innovative Weather and other campus entities, currently in the planning stages at UWM, would lead to further benefits to future K-12 partners. Finally, the core mission of the UWM Innovative Weather Program is student education and training through interactions with community clients in a professional setting. Thus, the LDM/IDD feed and data-sharing capabilities of RAMADDA will extend the capabilities of this community outreach program.

3.3 Responsiveness to proposal review criteria

(i) Intellectual or technical merit of the proposed work

Research on ensemble forecasting and the limits of forecast capability (probability and possibility) are ongoing at UWM, in the pure academic setting of our classrooms and laboratories, but also in the real-world framework in which weather forecast decision support is being provided through Innovative Weather. There is a developing synergy between these two efforts and the Unidata technology will greatly facilitate this capability.

(ii) Contribution to Unidata community capabilities

One important outgrowth from the efforts listed in (i) above will occur as we learn how to better "frame" probability and possibility. The modeling efforts of Professors Evans and Roebber help our forecasters to delineate both of these forecast aspects, and applying this knowledge in a real-world decision support context through Innovative Weather allows for a direct examination of these capabilities in a cost-loss framework.

(iii) Broadens the Unidata community scope and capabilities

The sharing of UWM-generated data, particularly in the areas of ensemble and deterministic modeling in a decision support framework, and the research analyses and dataset that results therein, will broaden the scope and capability of the larger Unidata community.

(iv) Enhanced participation in the Internet Data Distribution (IDD)

By allowing UWM to take part in the IDD, we will become an active Unidata participant.

(v) Contributes to the advancement of technology

As noted above, technological advances related to ensemble modeling and the use of such information in a decision support context with real-world cost-loss scenarios will lead to insights into better use of forecast uncertainty information.

(vi) Contribution to education

Participation in Unidata will expand the scope of our current educational activities, both in the classroom, and in developing the operational experience of our students through Innovative Weather.

(vii) Contribution to research

The addition of the Unidata capabilities contributes to the research efforts at UWM in the areas of ensemble and deterministic modeling across a variety of forecast contexts, and provides an important means of disseminating research data across the larger community.

C. Project Budget

The proposed equipment will fulfill the requirements needed by the UWM Atmospheric Science Program to become an active participant in Unidata data-sharing initiatives. The costs below are for hardware only; all system maintenance will be provided by the PI (Roebber), the co-PI (Evans), and the IT support specialist (Siercks).

A Dell PowerEdge T710 server, featuring a six-core Intel Xeon E5645 2.4GHz processor, 48 GB RAM, eight 2 TB 7,200 RPM hard drives in a RAID 5 configuration, five years of hardware support, and an uninterruptible power supply, has been quoted at $7,177 through Dell Premier. Utilizing two hard drives as spares in the RAID 5 configuration, this enables approximately 11 TB (after operating system installation) to be dedicated to (1) sharing current and archived data obtained via LDM; (2) local model output from both deterministic and ensemble model systems; (3) case study analyses; and (4) data obtained as part of students' thesis and dissertation research (see section 3 above).

DIRECT COSTS	6/1/2012 – 5/31/2013	TOTAL
Salaries – Senior Personnel		
PI Paul J. Roebber	$0	$0
Co-PI Allen C. Evans	$0	$0
Subtotal	$0	$0
Total Salaries and Wages	$0	$0
Modified Total Direct Costs	$0	$0
Capital Equipment 1 Dell PowerEdge T710 server (6 core Intel Xeon E5645 2.4 GHz processor, 48 GB RAM, eight 2 TB hard drives, UPS, 5 years hardware support)	$7,177	$7,177
Total Equipment Costs	$7,177	$7,177
Total Direct Costs	$7,177	$7,177
Facilities and Administrative Costs	$0	$0
TOTAL REQUESTED FROM SPONSOR	$7,177	$7,177

D. Project Milestones

June 2012:	Order equipment.
July-August 2012:	Install equipment and LDM/IDD and THREDDS/RAMADDA data systems.
September 2012 and ongoing:	Begin integration of local data streams into the THREDDS/RAMADDA servers.

E. References

Roebber, P.J. M. Westendorf and G.R. Meadows, 2010: Innovative Weather: A new strategy for student, university and community relationships. *Bull. Amer. Meteorol. Soc.*, **91**, 877-888.