Unidata Equipment Proposal to Upgrade the
JSU Meteorology High-Performance Computing Lab

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Principal Investigator: Loren D. White
Title: Assistant Professor
Institution: Jackson State University
Telephone Number: 601-979-3635
FAX number: 601-979-3630
Street Address: Dept. of Physics, Atmospheric Sciences, and Geoscience
P. O. Box 17660
Jackson State University
1400 J. R. Lynch St.
Jackson, MS 39217
Email Address: loren.d.white@jsums.edu

Signature of PI: _____

Name of institution official (dept. chair): Felix A. Okojie
Title: Vice-President for Research Development and Federal Relations
Telephone Number: 601-979-2931
FAX number: 601-979-3664
Email Address: faokojie@jsums.edu

Signature of University Official: _____

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PI: Loren White

I. Project Summary

The Jackson State University Meteorology Program (JSUMP) seeks to update basic components of its "High-Performance Computing Lab" to improve compatibility for use of Unidata software and data services. This lab has served as a nexus for research and training activities for several years. It is the only facility available for meteorology students to work on computer programming and data analysis exercises for their courses. Besides the two Linux clusters and SGI Origin 2100 that numerical models are run on, there are several personal computers and workstations that are used for presentations, student projects, and workshops. The lab also houses server computers for websites and data management. The JSUMP is unique within the Unidata community as the only B.S. meteorology program at a Historically Black University (since 1977) (Williams *et al.* 2007), and has a long record of working closely with the National Weather Service on operational weather research and training (Williams *et al.* 2006). In 2007 a completely revised undergraduate curriculum was submitted for approval, which is more explicitly designed to incorporate the computational and analytical resources of Unidata and UCAR. A formal internal request to develop an M.S. program in meteorology and applied meteorology is also in preparation with administrative encouragement. Jackson State University (JSU) has been an affiliate of UCAR since 1990.

Without a substantial upgrade of the basic lab facilities in the last few years, it is now necessary to acquire a variety of hardware in order to maintain the lab as a valuable resource for interaction with the Unidata community and for efficiently conducting our research and training activities. Some major goals that will be enhanced through the proposed infrastructure improvements include:

- Improved student access to Integrated Data Viewer (IDV) and related products for participation in the Linked Environments for Atmospheric Discovery (LEAD) Weather Research and Forecasting model (WRF) Weather Challenge project
- Improved Local Data Manager (LDM) data streams for operational mesoscale models
- Improved archival, processing, and sharing of data from the Mississippi Mesonet and JSU component of the NOAA Center for Atmospheric Sciences (NCAS) Aerosol and Radiation Network (AERADNET)
- Greater flexibility in training workshops (WRF, remote sensing, emergency management) for adapting datasets and visualization tools
- Incorporation of Geographic Information Systems (GIS) tools into research, courses, and special training projects
- Use of the Weather Event Simulator (WES) into training, using COMET case studies

II. Project Description

The current High-Performance Computing Lab was developed primarily through grants from the Army High Performance Computing Research Center (AHPCRC), the Navy, and NOAA. It is located in Room 259 of the research wing of Just Science Hall. It has been used for a wide variety of research, educational, and outreach activities. Its origin in particular was tied to the initial development of numerical modeling capability at JSU in the late 1990s under the leadership of Dr. Pat Fitzpatrick. Since that time, numerical modeling efforts have continued as the most intensive routine application. Models currently run operationally twice daily include the 5th generation Pennsylvania State University/NCAR Mesoscale Model (MM5), the Navy's Coupled Ocean-Atmospheric Modeling Prediction System (COAMPS), and the Weather Research and Forecasting model (WRF). For research applications, we use both the NMM (Nonhydrostatic Mesoscale Model) and ARW (Advanced Research WRF) dynamical cores of WRF, as well as various atmospheric chemistry packages. Testing with a research version of the Hurricane WRF (HWRF) is underway as well. Access to real-time data for data assimilation is available using the upstream LDM feed from the Southern Regional Climate Center at Louisiana State University. Graphical output from the operational models are served to the public through World Wide Web pages.

Several undergraduate Meteorology classes make use of the lab on at least an occasional basis for instruction, student presentations, weather briefings, guest speakers, programming, or literature searches. Access to current weather data sources and multimedia training tools such as the modules developed by COMET particularly enhances the educational experience. During the summer, the lab facilities are used for workshops sponsored by the NOAA Center for Atmospheric Sciences (NCAS), which typically include a high school Weather Camp and a WRF Modeling Workshop (Morris *et al.* 2007). Visiting researchers and faculty from other departments have occasionally made use of the lab to develop collaborative research efforts.

The ability to serve our 30+ undergraduate majors, develop a new M.S. program in meteorology, and to provide hands-on training workshops is beginning to suffer as the core computing infrastructure of the lab ages. There have recently been plans to add a new more powerful Linux cluster to the lab, to help keep our most demanding numerical modeling efforts current. However the more basic and mid-level resources still require upgrading or replacement. In particular, we have been impacted by frequent failures of the server that hosts the primary website that defines the JSUMP's internet presence to the public (http://weather.jsums.edu). As we have been requested to participate in the LEAD WRF testing for the Weather Challenge forecasting contest, outdated computers have become a bottleneck and a hindrance. In 2006 a new server was launched to manage the data of the Mississippi Mesonet and to share it publicly (White and Matlack 2007). Once the other computing facilities are upgraded we would like to share mesonet data more efficiently through Unidata and through contribution to NOAA's Meteorological Assimilation Data Ingest System (MADIS). Over the next several months, technical assistance with improving the public use of Mississippi Mesonet data is expected from

recently initiated partnerships with the Mississippi Department of Marine Resources and with WeatherBug Professional. We would also like to begin serving as a centralized source for meteorological data (surface, upper air, satellite, radar) relevant to Mississippi and surrounding states once sufficient archival space is available.

II.A Details of Equipment Request

The JSUMP proposes to use the requested resources to upgrade the existing computational facilities so that we can better (1) provide instruction and training to traditionally underserved minority students, (2) contribute toward significant collaborative research efforts, and (3) participate in the sharing of data within the Unidata community as well as with the general public. These upgrades will make it much more practical for Unidata software and data to be routinely incorporated in our instruction and research activities.

1) The Dell PowerEdge 840 server is the centerpiece of the proposed upgrade. This system will replace the trouble-prone "weather" and "twister" web and email servers for the program, alleviating communications and publicity problems for the meteorology program. It will also serve as the computational workhorse for Unidata software and other numerical analysis tools (such as MATLAB, IDL, and ArcView). This server will interface seamlessly with the personal computers and archive storage resources.

2) There will be eight OptiPlex 320 Minitower P4 personal computers added, which will be linked into the server. This will provide capacity for no more than two students to have to share a computer during classes or workshops. Unidata software is expected to become more fully integrated into instructional activities as the proposed new undergraduate and graduate curricula go into effect.

3) Acquisition of 6 TB of archival space will facilitate data sharing activities. It will improve our ability to routinely archive data streams from LDM, satellite and radar data, model output, and case studies. Besides providing a local clearinghouse of atmospheric data, this will improve instruction in synoptic meteorology classes, provide capability for graduate students to conduct thesis research, and facilitate incorporation of case study scenarios (such as with WES) in various training efforts.

4) The Sharp XR-30X DLP Projector system will replace an aging projector which is used for class lectures, student presentations, daily weather briefings, workshops, and seminars. Ensuring the continued capability for such presentations is important for instructional development, improvement of student presentation skills, and smooth interaction with visiting researchers. Unfortunately there is no available allocation within the departmental operating budget that can fund such resources.

Other than operating systems and related bundled software, there should not be a need for software purchases. Once appropriate computing resources are available, the required graphics, data management, and GIS software will either be obtained at no charge from the Unidata program or installed through existing campus-wide site licenses.

The existing network configuration at Jackson State University offers Internet-2 capability to facilitate transfer of large data files to and from remote facilities.

II.B Benefits to Research, Education, and Unidata Community

The JSUMP has a strong collaborative research relationship with NOAA and provides a growing resource of observed and model datasets for use by researchers, educators, and the public. We would like for the proposed equipment to be used not only for internal improvement of teaching and research but also to develop a comprehensive "clearinghouse" or repository of data, software, and outreach materials. The aforementioned workshops provide opportunities for intensive sharing of our expertise. In particular, underserved minorities and stakeholders in the local region depend heavily on the capabilities of the JSUMP for research, training, and outreach (Shoemake *et al.* 2007; Williams *et al.* 2007).

Primary research areas within the JSUMP currently include mesoscale model validation (especially convective parameterizations) (Lu *et al.* 2006; Zhang and Liu 2007); air quality modeling; surface fluxes and climate interactions (Liu and Randerson, 2008; Oncley *et al.* 2007; Randerson *et al.* 2006); hurricane development and landfall (Lu *et al.* 2007); observing networks (Mississippi Mesonet, AERADNET, etc.) (White 2008; Mauder *et al.* 2007); and aerosol-radiative interactions. All would benefit from the upgraded facilities. The facilities will also be more amenable to GIS applications of meteorological data.

Fully functional use of the Unidata graphical display and data analysis tools such as GEMPAK, MCIDAS, and IDV will benefit several undergraduate and graduate classes, in particular several courses with enhanced laboratory components in the new undergraduate curriculum. This will include participation in efforts such as the current LEAD WRF Weather Challenge pilot. The data access capabilities of netCDF, LDM, THREDDS, and OPeNDAP/DODS also offer expanding educational opportunities by sharing more interactively with the Unidata community. The combination of data and software tools will encourage classroom use of case studies such as the COMET WES cases.

II.C Relationship to Existing Resources

The current workhorses of the numerical modeling efforts are: (1) an SGI Origin 2100 with four 350 MHz processors ("lightning") that runs the operational models; (2) a Linux cluster with eight nodes of dual 866 MHz processors ("master") that is used only for research; (3) a second Linux cluster ("ncas") that has eight nodes of four 2.8 GHz processors and 2 GB of RAM each. The "ncas" cluster has been used both for research integrations and operational modeling support for the AMMA field operations. The two server computers ("twister" and "weather") that have been used for email and web hosting run Red Hat Linux with single 800 MHz processors and 512 MB of RAM. Both have become unreliable recently. The other currently operating server is "jsumesonet",

which runs Campbell Scientific Loggernet software and provides World Wide Web access to live and archived data from the Mississippi Mesonet and other data sources.

Several older Linux workstations and personal computers have traditionally been available in the lab to researchers, students, and faculty, although no more than five are currently deemed to be functional. Personal computers are also available in the adjacent "Weather Lab" for use by students doing daily weather observing duties and for basic staff needs. About half of the computers were upgraded to flat screen monitors during 2007 using research grant funds. A small portable projection system in the High Performance Lab is used for presentations, but is quite old and not in good condition.

The new Linux cluster which will be purchased (subject to release of funding) is planned to have five nodes of dual core 2 GHz processors, 8 GB of RAM each, and 7.5 TB of storage.

The major computing resources (e.g. Linux clusters) were purchased through funding by the High Performance Computing Visualization Initiative (HPCVI; Navy and Army) and NCAS projects over the last several years. Other systems and resources have been acquired through a variety of grants and university expenditures over approximately the last ten years.

Additional supercomputing resources are remotely available to faculty and staff through the JSU College of Science, Engineering, and Technology, the Mississippi Center for Supercomputing Research at the University of Mississippi, the National Center for Atmospheric Research (NCAR), and other partner research institutions.

III. Budget

The budget request covers equipment only, per Unidata guidelines. Although there is no formal matching (not required), JSU provides in-kind contributions through maintenance of Internet-2 capability and access to various supercomputing facilities.

1) Dell PowerEdge 840 Server $5,200
Quad core Intel Xeon 2.4GHz 1066 MHz FSB
4GB DDR2, 667MHz 4x1GB Dual DIMMs
Windows Server 2003 R2 SE Incl. 5CALs
4 1TB 7.2K RPM SATA 3Gbps Cabled Hard Drive
Broadcom Gigabit Ethernet NIC
48x CDRW/DVD Combo Drive
Symantic Antivirus 5 Users
Onsite Installation, 3-yr 5x10 Onsite Tech Support

2) Buffalo TeraStation Pro II 3TB NAS 2 x $1600 = $3200
2 USB ports, 4 750GB 7.2K SATA Hard Drives
10/100/1000 Gb Ethernet

3) Dell OptiPlex 755 Minitower 8 x $1300 = $10400
Intel Core 2 Duo 2.66GHz 4M Cache, 2x250GB SATA 3Gb/s and 8MB Cache
Windows XP Pro SP2, 2GB DDR2 667MHz RAM, 256MB ATI Radeon 2400XT, Dual Monitor VGA Video Card
Dell 19" Flat Panel Monitor, 16x DVD+/- RW SATA
3-Yr Warranty

4) Sharp XR-30X DLP Meeting Room Projector $750
DTV/HDTV Compatability
2300 Lumens, 2000:1 Contrast Ratio

Total $19,550

IV. Project Milestones

Summer 2008:
Initiate purchasing of all equipment

Fall 2008:
Complete the installation/configuration of equipment
Install software from Unidata and other vendors

Spring 2009:
Expanded routine use of lab and Unidata tools by classes and researchers
Increased sharing of data with Unidata community and public

Summer 2009:
Improved capabilities will be used in summer workshops

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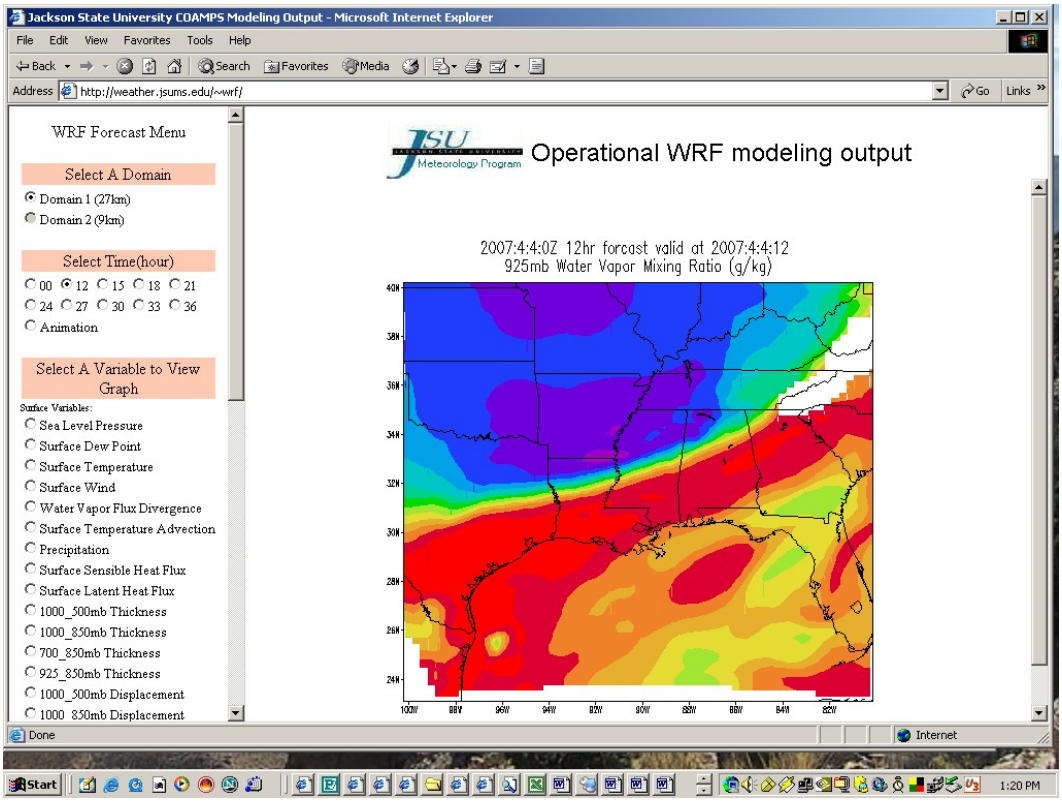

Fig. 1: Example of operational WRF model output provided through http://weather.jsums.edu website.

Fig. 2: View of part of the High-Performance Computing Lab being used in a workshop (before purchase of new monitors).