A. Cover Page

Unidata Community Equipment Awards Cover Sheet

"Advancing Weather Visualization at Mississippi State University through a Dedicated AWIPS Server"

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B. Project Summary

The equipment requested by this proposal enables student and faculty access to essential meteorology tools and visualizations at Mississippi State University (MSU). This access will be accomplished through the purchase of a Linux workstation and the subsequent installation of Unidata's Advanced Weather Interactive Processing System (AWIPS), MetPy, and other Unidata tools such as netCDF. The widespread use of AWIPS by meteorologists and the software's ability to overlay multiple fields, including the latest generation satellite imagery from the Advanced Baseline Imager, will support student learning of atmospheric behavior as well as develop computing skills beneficial long after graduation. Dedicated equipment would also provide the department with a Jupyter notebook server to expose students to Python and MetPy tools.

The PI currently provides Linux access in the classroom through a workstation intended for the PI's existing research projects, thus the requested equipment would ensure dedicated teaching resources and create avenues for undergraduate research. The equipment requested in this proposal will directly support "GR 4783/6783 Satellite Meteorology," a lecture and laboratory course for upper-division meteorology undergraduate students and graduate students. Outcomes from successful incorporation of AWIPS and Python visualization in Satellite Meteorology will subsequently support both face-to-face and online teaching across the meteorology curriculum. Tutorials and code examples developed for classroom use will be incorporated into the PI's existing outreach program and shared with the Unidata and broader meteorological communities.

C. Project Description

C.1. MSU's meteorology program

MSU is a public, Carnegie R1, land-grant institution adjacent to Starkville, Mississippi, a town of approximately 25,000 (2017 estimate). Established in 1878 as the Agricultural and Mechanical College of the State of Mississippi, MSU's enrollment exceeded 22,000 in Fall 2019 (Laird 2019). Housed in the Department of Geosciences within the College of Arts & Sciences, MSU's meteorology program strongly contributes to the education of active broadcast meteorologists, providing the most degrees of any institution (Green et al. 2019). Such distinction motivates us to develop ever-improving resources to better serve our students in their future careers, particularly with respect to freely available data and open-source software tools.

The Department of Geosciences meteorology team is comprised of nine tenure-track and clinical professors who deliver face-to-face and online courses in meteorology and climatology. Our on-campus curriculum requires all undergraduate students in the broadcast and the professional meteorology concentrations to take a meteorology-focused remote sensing course, either Satellite Meteorology or Radar Meteorology. However, we recommend each of our students take both courses given the increasing application of satellite and radar information in many meteorology careers. Beyond day-to-day analysis and forecasting, the ability to visualize these observations can be a powerful communication tool to share weather information with colleagues and the general public we and our graduates serve. For example, the PI has developed storm-centered animations over a fixed domain to demonstrate the evolution of tropical cyclones as observed by

the ABI (Fig. 1), which have been widely shared within and outside the tropical meteorology community.

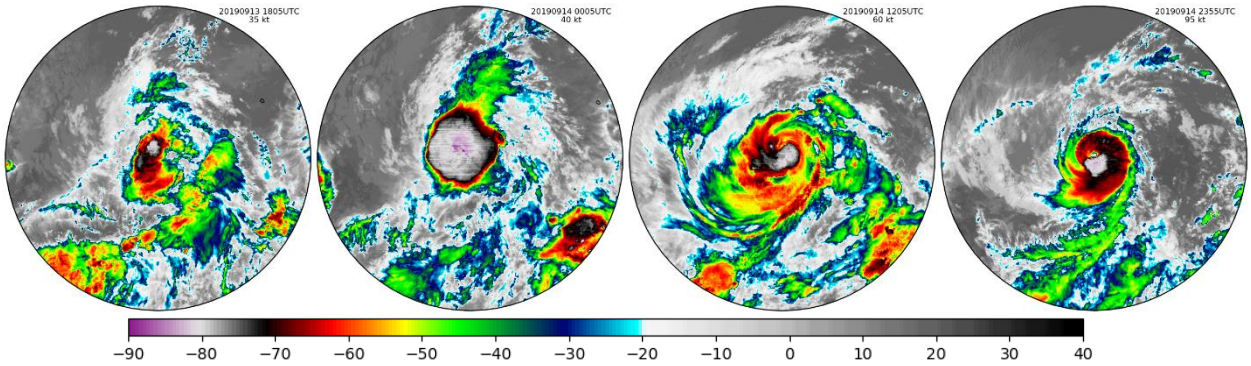


Figure 1*. Storm-centered snapshots of ABI Band 13 cloud-top temperature (°C) from an animation of Hurricane Kiko (2019) rapidly intensifying in the eastern North Pacific. Each image covers a domain of radius 600 km from the interpolated operational best-track center provided by the National Hurricane Center. These images are generated in Python using packages that include MetPy and Cartopy.*

Many of our on-campus faculty also teach online, and we strive for the same rigor in our distance courses as we apply in our on-campus offerings (efforts that have been accelerated by the ongoing coronavirus pandemic). Tutorials developed for in-class use are being transitioned online, and additional computing and web-based resources would support continued teaching excellence regardless of the course's platform.

C.2. Motivation for the proposed equipment

With the launch of the Advanced Baseline Imager (ABI; Schmit et al. 2017), the capabilities of routine geostationary observations grew exponentially as did associated applications in satellite meteorology. The PI created a course focused on satellite meteorology to better serve our program and equip our graduates with cutting-edge skills for use in their careers. This course, first delivered in Spring 2017, includes a laboratory component to provide hands-on learning opportunities. Most laboratory assignments rely on the Satellite Information Visualization Tool (SIFT; https://sift.ssec.wisc.edu/), a freely available, Python-based software package that can interrogate ABI imagery and generate RGB products from multiple bands.

However, not all students' devices are capable of running SIFT in a meaningful manner. The program is memory-intensive and can cause laptops to grind to a halt, limiting its usefulness for high-resolution visible imagery and full-disk files. Alternatives have been offered, ranging from limited access to the PI's own Windows laptop to remote access through the PI's existing research Linux workstation. These alternatives come with drawbacks as the PI also needs to use the laptop for teaching and research and SIFT tends to lag when students attempt to access it over the network or when that workstation is in use for research (e.g., idealized tropical cyclone simulations).

The Advanced Weather Interactive Processing System (AWIPS) software is advertised as "the cornerstone of NWS Forecast Offices" (GSD 2020). Through its capability to display a suite of

meteorological products, including surface data and model output, on top of radar and satellite imagery, students would gain a more complete picture of the state of the atmosphere at the temporal resolution of these data than by examining any one product alone. They would also learn how to use a software package that is widely accepted across meteorology careers. It is a major goal of the PI to facilitate access to AWIPS for students prior to graduation to further enhance their skill set and their overall understanding of meteorology.

The PI frequently relies on externally-generated AWIPS images and animations that are posted online through social media and other outlets, including the Cooperative Institute for Meteorological Satellite Studies (CIMSS) satellite blog (https://cimss.ssec.wisc.edu/satellite-blog/) and Bill Line's Satellite Liaison Blog (https://satelliteliaisonblog.com/). These are deeply appreciated, helpful resources. But the PI is restricted to the available images and animations which may not always tie into current class content or learning goals. With equipment dedicated to course-related content, the PI can free students of the burden of variable software performance on their personal devices (e.g., SIFT). The PI can also ensure in-class examples and laboratory exercises are targeted to that week's learning outcomes. The students will subsequently interact with imagery and animations produced by software they are likely to use in their careers.

Finally, the Department of Geosciences does not currently have a Jupyter Notebook server. The proposed equipment will provide this essential resource to expose students to the capabilities of Python and meteorology-specific tools such as MetPy. The PI has extensive experience with MetPy and strongly advocates for students to learn Python in part due to MetPy's existence. However, many students find programming to be intimidating, so the use of Jupyter notebooks will demonstrate the range of mapped products and time-saving calculations in a guided, user-friendly environment. The PI will incorporate Python examples into Satellite Meteorology and other courses through a Jupyter Notebook server hosted on the proposed equipment.

The PI has extensive experience with Python and Linux administration, currently maintaining two Fedora workstations that run the Weather Research and Forecasting (WRF) model and Cloud Model 1 (CM1). The PI's public server, arashi.geosci.msstate.edu (hereafter "arashi"), currently hosts course material and student user accounts as needed for both classroom and research purposes. However, arashi was purchased with the intent to run numerical experiments and support graduate student research. The proposed equipment will replace arashi as the main computing resource for course-related applications as well as enable the use of AWIPS and MetPy within and beyond the classroom, such as small-scale research experiences for undergraduate students.

Beyond the Department of Geosciences, the PI will share animations and code examples produced by the requested equipment with the broader community. If this proposal is awarded, the PI will capitalize on the investment made by this program to host numerous resources and tutorials, both directly on the Linux workstation and through GitHub. Python scripts developed for teaching purposes that incorporate MetPy will be offered for potential inclusion in the Unidata Python Gallery (https://unidata.github.io/python-gallery/examples/index.html). Though no personnel time is budgeted in this proposal (Section D), the PI is committed to not only maintaining the requested equipment but training graduate students to use the tools installed on it for research and outreach. Graduate students will learn how to use Jupyter notebooks and be

challenged to post their developed code on GitHub to ensure their achievements—made possible through the requested equipment—are shared with the world.

C.3. Description of MSU IT support

The Department of Geosciences maintains a Geographic Information Systems (GIS) laboratory with 30 workstations through the efforts of experienced staff. These staff and MSU's Information Technology Services (ITS) will support the PI by activating an ethernet port in the PI's office for the proposed equipment and subsequently enabling the URL for public access.

If the proposed equipment cannot be accessed outside of MSU's virtual private network (VPN) for any reason, all enrolled students will have VPN access and thus machine access. In that scenario, the PI's existing public-facing workstation (arashi) will serve as a portal to graphics and analyses produced by students using the proposed equipment.

D. Budget

The PI proposes the acquisition of a Thinkmate workstation with 64 GB of memory (see attached quote). The quoted specifications are based on the PI's experience with the arashi server purchased in 2016 which continues to perform well nearly four years later. The Thinkmate workstation is poised to handle not only AWIPS and a Jupyter Notebook server but computationally expensive MetPy calculations of gridded fields not always available from real-time model output or reanalysis datasets, such as mixed-layer convective available potential energy.

The machine will run the latest version of Fedora Linux upon the expected April release of Fedora 32. The PI's campus office has sufficient space and connections to accommodate the proposed equipment, ensuring direct physical access as needed. The total estimated cost of the system is $4,016.38 before shipping. Shipping is not included in the attached quote, which is estimated at $100 based on shipping costs from the PI's previous Thinkmate orders. The total requested amount for the equipment purchase is $4,116.38. In addition to the equipment cost, MSU will charge indirect cost at a federally negotiated rate for other sponsored activities on-campus at a rate of 27.2% ($1,120 total). **The total requested amount is thus $5,236.38.**

Itemized budget request:

- 1 Corsair RM750x 750W Modular Power Supply, Gold Certified
- 1 Intel Core i9-9960X X-series 16-core processor
- 4x 16 GB Crucial 2666MHz DDR4 (64 GB total)
- 1 512 GB Samsung 970 PRO M.2 SSD
- 1 4.0 TB Seagate Barracuda Pro SATA
- 1 NVIDIA GeForce GTX 1660 6GB GDDR5 (1xHDMI, 1xDP, 1xDVI-D)
- 1 Intel Gigabit CT Desktop Adapter
- 1 keyboard
- 1 mouse
- 1 monitor
- Freight shipping costs

Total Direct Cost: $4,116
Total Indirect Cost: $1,120
Total Project Cost: $5,236

E. Project Milestones

Assuming no delays due to mitigation measures for the novel coronavirus in 2020, the PI can place the purchase order according to the attached quote upon receipt of funds (e.g., June 2020) and subsequently install the equipment and software during the summer when on-campus student activity is minimized. If funds are received in early June 2020, the following project timeline is expected:

Time frame	***Tasks***
June 2020	Purchase and delivery of equipment
July 2020	Installation of hardware and software Test remote access and perform troubleshooting as needed
August 2020	Machine ready for student use

References

Green, T.A., C.J. Schreck, N.S. Johnson, and S.S. Heath, 2019: Education Backgrounds of TV Weathercasters. *Bull. Amer. Meteor. Soc.*, **100**, 581–588, https://doi.org/10.1175/BAMS-D-17-0047.1.

GSD, 2020: "AWIPS (2019)." https://www.esrl.noaa.gov/gsd/eds/awips/ [Accessed 1 Mar 2020]

Laird, H., 2019: "Numbers show fifth consecutive year of enrollment growth at Mississippi State." https://www.msstate.edu/newsroom/article/2019/11/numbers-show-fifth-consecutive-year-enrollment-growth-mississippi-state-0 [Accessed 17 Mar 2020]

Schmit, T.J., P. Griffith, M.M. Gunshor, J.M. Daniels, S.J. Goodman, and W.J. Lebair, 2017: A Closer Look at the ABI on the GOES-R Series. *Bull. Amer. Meteor. Soc.*, **98**, 681–698, https://doi.org/10.1175/BAMS-D-15-00230.1.

THINKMATE
159 Overland Road, Waltham, MA 02451
Phone: 800-371-1212 Fax: 781-762-6014

QUOTATION

Quote # **200320-8A**
Date **03/20/2020**
Expires 04/04/2020

Billing Information	Shipping Information	Account Manager
Mississippi State University	Mississippi State University	Amir Golparvar
Kimberly Wood	108 Hilbun Hall	Amirg@thinkmate.com
108 Hilbun Hall	355 Lee Blvd	800-371-1212 x4205
355 Lee Blvd	Mississippi State, MS 39762	
Mississippi State, MS 39762	Ship Via: TO BE DETERMINED	
kimberly.wood@msstate.edu		
6623250602		

SKU	Description	Unit Price	Qty	Ext. Price
VSX R5 540X1		$4,016.38	1	$4,016.38

This system will be used to run Unidata AWIPS II for student use, classroom demonstrations, and potential research applications. The expected purchase time frame is June 2020.

RAID Configuration
M.2 Sockets M Key [NVMe Only, 2 ports]
No RAID (*OS) -> 1 x 512GB Samsung 970 PRO M.2 PCIe 3.0 x4 NVMe Solid State Drive

- Intel X299 Chipset - 8x SATA - 3x M.2 NVMe - Intel 1-Gigabit Ethernet (RJ-45)
- Intel Core i9-9960X X-series Processor 16-core 3.10GHz 22.00MB Cache (165W)
- Thinkmate VSX Hydro Series High Performance Liquid Heatsink & Cooler (LGA115x / 20xx / AM4)
- 4 x Crucial 16GB PC4-21300 2666MHz DDR4 Non-ECC UDIMM
- Thinkmate VSX-R6 Series Mid Tower Chassis - ATX - Thinkmate Black
- Corsair RM750x - Gold Certified - 750W Modular Power Supply
- 512GB Samsung 970 PRO M.2 PCIe 3.0 x4 NVMe Solid State Drive
- 4.0TB SATA 6.0Gb/s 7200RPM - 3.5" - Seagate Barracuda Pro
- LG 24x Super Multi DVD+/-RW with M-DISC (SATA)
- PNY NVIDIA GeForce GTX 1660 Blower Edition 6GB GDDR5 (1xHDMI, 1xDP, 1xDVI-D)
- Intel Gigabit CT Desktop Adapter (1x RJ-45)
- 22" LED-Backlit LCD - 1920x1080 (FHD) - ASUS VE228H (VGA, DVI, HDMI)
- Logitech Desktop MK120 Keyboard and Mouse
- No Operating System
- Thinkmate Three Year Warranty with Advanced Parts Replacement and RSL

Sub Total:	$4,016.38
Freight:	TBD
Quote Total:	**$4,016.38**