Acquiring a Dedicated Workstation to Support Advanced MetPy-Based Synoptic Weather Visualization and Analysis as Part of The University of South Alabama Meteorology Program's Capstone Course

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A. Project Summary

This project aims to support undergraduate education at the University of South Alabama (USA) in basic and advanced synoptic meteorology by enhancing student access to modern, reproducible weather analysis tools built on Unidata software. During their senior-level synoptic capstone course sequence, students complete 8–10 rigorous current weather briefings each academic year, analyzing synoptic-scale conditions across the United States using 40–50 weather graphics per briefing. These briefings emphasize real-time diagnosis of atmospheric structure, dynamics and evolution, mirroring professional forecasting workflows.

In recent years, the PIs have transitioned from providing students with static, pre-generated graphics produced by other institutions to custom user-generated analyses created using Python, with a particular emphasis on MetPy and Unidata-supported data access to complete their briefings. The Python charts are generated by remotely accessing numerical weather prediction (NWP) model data directly from the Unidata THREDDS server. Specifically, we use the NetCDF Subset Service (NCSS) to remotely access GRIB2 files of the 12-km North American Mesoscale (NAM) and 0.5-degree Global Forecast System (GFS) models from the server. In addition, the Siphon package allows us to remotely download upper-air observations from rawinsonde stations across the continental United States and portions of Canada and Mexico. Custom Python scripts are used to generate tailored synoptic charts that improve interpretability and reduce noise relative to traditional operational products available online. These scripts are currently executed on a single faculty laptop computer, which limits reliability, scalability, and student engagement.

The PIs request a dedicated workstation to serve as a centralized, stable computing platform for running Python- and MetPy-based synoptic analysis workflows. The system will be housed in a faculty office and used to generate real-time and archived analysis products for classroom briefings, demonstrations, and student-led investigations. By investing in modest but targeted computing infrastructure, this project advances Unidata's mission to support education, improve access to Earth system data, and prepare the next generation of atmospheric scientists with practical, community-supported tools.

B. Project Description

B1. USA's Meteorology Program and Capstone Course

USA is a Carnegie R2 public research university located in Mobile, AL, with an enrollment of approximately 13,992 students (2026 estimate). USA established its Meteorology Program in 1991 as a concentration within the Geography discipline, graduating its first student in 1995. In 1999, the Alabama Commission on Higher Education officially approved the Bachelor of Science in Meteorology degree. Housed in the Department of Earth Sciences within the College of Arts and Sciences, USA's Meteorology Program emphasizes operational meteorology and forecasting, preparing students for careers in the National Weather Service, private sector, military services, broadcast meteorology, and graduate school/academia. The curriculum offers three specialty tracks: professional meteorology, broadcast meteorology, and a graduate school track for those pursuing advanced studies. The program is supported by three full-time faculty and one full-time instructor, with several required courses—including all broadcast meteorology offerings—taught by highly experienced adjunct faculty. Several recent developments position the program for continued growth and increased impact. The department is preparing to relocate from the Earth and Life Sciences Building to the Science Laboratory Building,

where the Coastal Weather Research Center (CWRC) is housed. The CWRC is an on-campus, fully self-supporting operational facility that provides real-time weather information to businesses, industries, and municipal governments across the Gulf Coast region. This center offers students hands-on forecasting experience, enhancing their practical skills as well as simulating the workplace environment of an operational meteorologist in the private sector. This move will reunite faculty, instructional staff, and CWRC personnel in the same physical space for the first time in over 10 years. The co-location will significantly strengthen interactions among students, faculty, and professional weather staff, reducing a long-standing disconnect and providing students with more equitable access to the program's unique operational and research resources. Of particular relevance to the proposed project, the CWRC recently installed a high-resolution 120-inch display (Fig. 1). This facility will be directly incorporated into the synoptic meteorology curriculum, with students conducting real-time weather briefings in an environment that closely mirrors professional forecast operations.

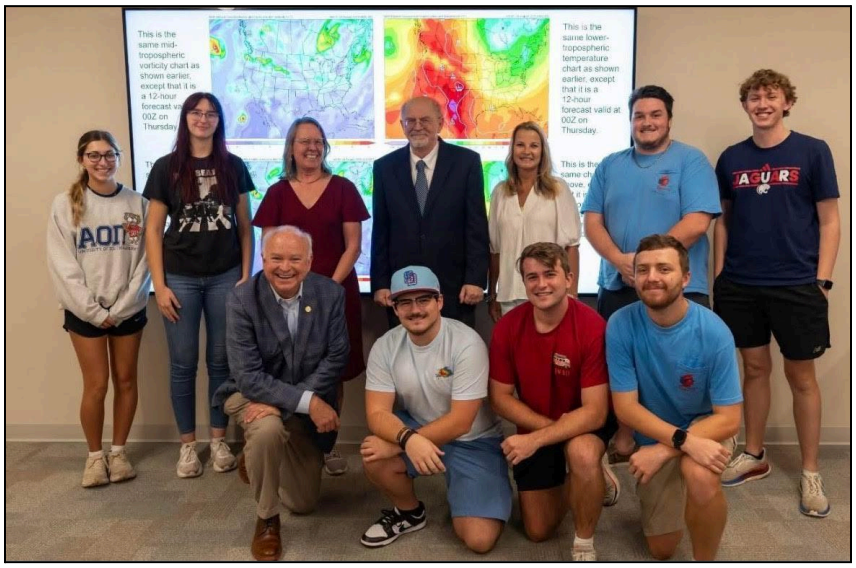


Figure 1. *High-resolution 120-inch display in the Coastal Weather Research Center at the University of South Alabama used during a condensed demonstration of the Synoptic II current weather discussion format. The briefing was conducted by course instructors for the Dean of the College (top middle) and the President of the University (bottom left).*

USA's Meteorology Program culminates in a rigorous 12-credit senior capstone sequence in Synoptic-Dynamic Meteorology, which spans the entire academic year. The course is divided into two semesters: Synoptic Meteorology I in the fall and Synoptic Meteorology II in the spring. While the curriculum includes topics covered in traditional synoptic meteorology courses, such as quasi-geostrophic (QG) theory, numerical weather prediction (NWP), the vorticity equation and thermal wind, USA's synoptic meteorology sequence distinguishes itself by incorporating a strong emphasis on operational forecasting and hands-on application that allows theory to be applied in real-time conditions. This capstone course integrates two primary components to provide students with practical forecasting experience. The first component is a year-long forecasting contest (Lanicci et al. 2026), in which students submit forecasts for various atmospheric variables at specific cities chosen by the instructors. The contest challenges students to predict different variables, such as geopotential height, wind speed and direction,

temperature, etc., with forecast lead times from 24 to 48h. The second component involves 8–10 extensive synoptic weather briefings conducted throughout the academic year. Each briefing requires students to analyze a wide array of weather maps and graphics, including surface and upper-air charts, satellite imagery, and NWP model output (Fig. 2). During the briefings, students identify and highlight specific atmospheric features and processes, such as frontal boundaries, jet streaks, and areas of thermal and vorticity advection, while explaining their implications for current and future weather patterns. The objective is to apply theory learned in lecture for developing a deep understanding of the current state of the atmosphere and its evolution based on observational data and model guidance.

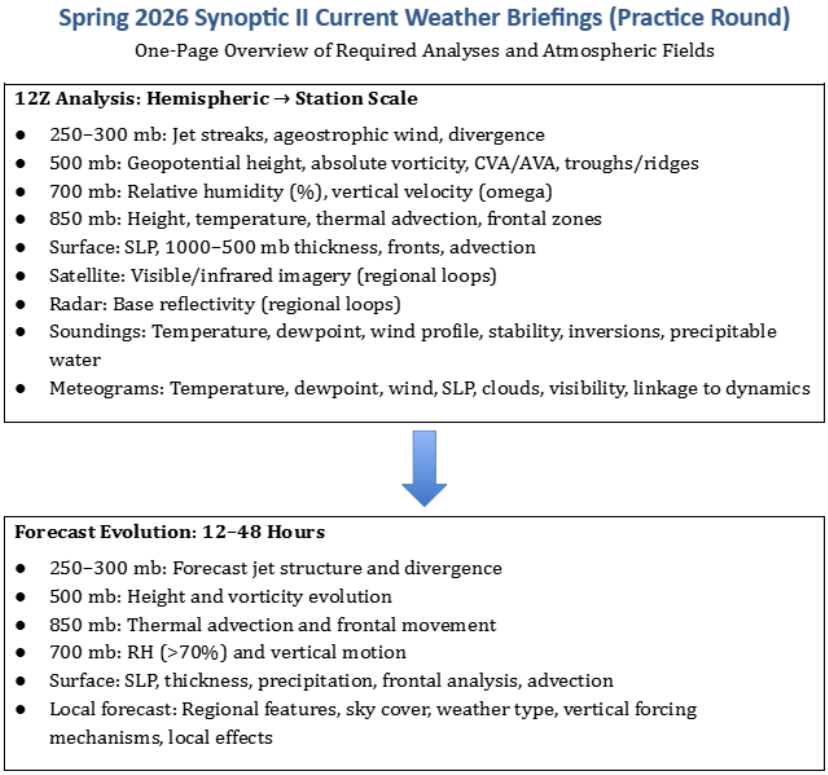


Figure 2*. Condensed overview of Spring 2026 Current Weather Discussion rubric (practice round).*

B2. Project Motivation

A central motivation for this project is to reduce instructional reliance on third-party weather graphics and web-based map servers, which present recurring challenges for both instructional continuity and student learning. Like many undergraduate synoptic courses conducted in smaller, undergraduate-only programs, our curriculum has historically depended on externally generated graphics for real-time analysis of model and observational data. While these products are convenient, they introduce vulnerabilities that are increasingly misaligned with modern, data-centric meteorology education.

One challenge is operational reliability. Third-party websites may fail to update or become temporarily unavailable due to maintenance, power outages, or data ingestion issues. The PIs have experienced multiple instances in which commonly used resources—such as the University of Wisconsin model visualization pages (https://www.aos.wisc.edu/) for NAM-derived fields (e.g., 500-mb heights/vorticity,

850-mb heights/temperature)—did not update as expected. In these situations, students are forced to rapidly locate alternative sources during time-limited briefing preparation, increasing cognitive load and detracting from meaningful atmospheric analysis.

A second, equally important limitation is the lack of control over data representation. When using externally generated graphics, instructors and students are constrained by the plotting choices made by others, including smoothing, contouring, color scales, and map projections. These choices directly influence interpretation. For example, vorticity fields are inherently noisy due to their derivative-based formulation (Fig. 3). When insufficiently smoothed or overly detailed, these fields can obscure synoptic-scale structures and instead emphasize numerous mesoscale extrema. Students often focus on these small-scale features at the expense of identifying synoptic patterns and processes. Given that students typically have only a few hours to prepare a full synoptic briefing, this misallocation of effort can significantly reduce the educational value of the exercise.

By generating our own synoptic analysis products using Python and MetPy, we are able to tailor visualizations to instructional goals, applying appropriate smoothing, scaling, and filtering to emphasize physically meaningful synoptic patterns for student use as part of their Current Weather Discussions and the City Forecast contest. However, reliably producing these graphics in real time requires stable, dedicated computing infrastructure. The proposed workstation directly addresses this need by enabling consistent, instructor-guided, and pedagogically intentional map generation, while simultaneously reducing dependence on external services. For example, we maximize smoothing of 500-mb vorticity fields during the fall semester of Synoptic I for several key reasons. First, the students are just beginning to learn how to diagnose synoptic-scale areas of vorticity advection, so enhanced smoothing eases them into this learning process. Secondly, the atmosphere is still not very baroclinic during much of the late summer into early fall, which allows us to smooth out the smaller-scale, more convectively driven areas of vorticity.

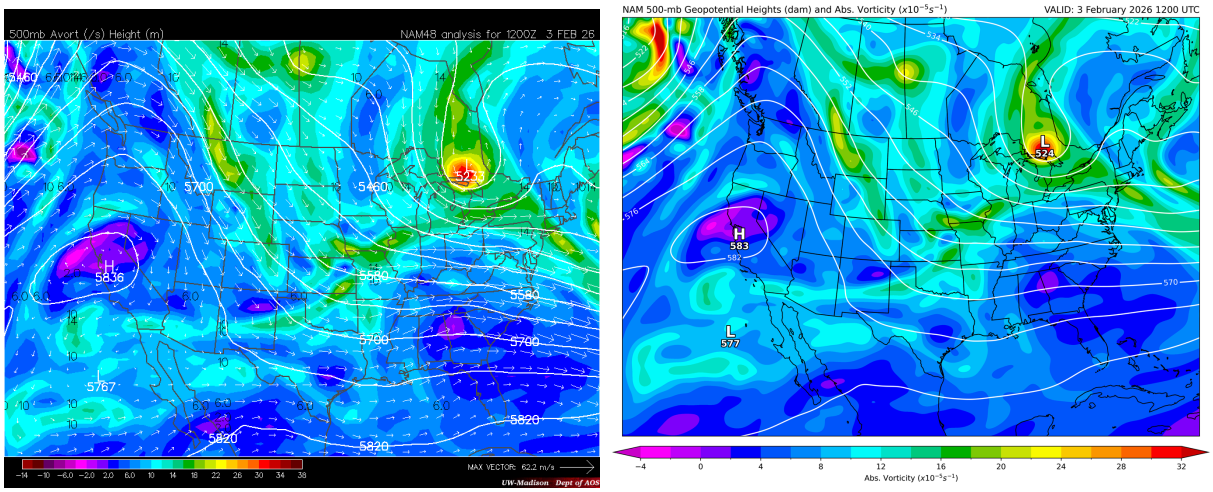


Figure 3. *Example of a University of Wisconsin (UW) NAM 500-mb vorticity field (left) versus our custom MetPy-based version of the same field (right). Notice how our vorticity fields appear slightly smoother compared to the UW fields, which makes identifying synoptic patterns easier for the students. Additionally, we purposefully do not plot wind vectors since we make students conform to QG theory,*

where the geostrophic advection of vorticity is assessed solely via the geopotential height fields. We are also able to customize our color table and apply a MetPy-based function to automatically stamp the centers of high and low geopotential height anomalies.

B3. Goals and Benefits of Project

The primary goal of this project is to establish a stable computing platform to support real-time, Python-based synoptic weather analysis featured in our capstone course and in two unique applied exercises to simulate operational forecasting. At present, the extensive Python and MetPy scripts used to generate custom synoptic charts are executed on a single instructor's personal laptop computer. While this approach has enabled initial innovation and established a proof of concept, it is not a sustainable or appropriate long-term solution for a core instructional activity that serves multiple students each semester. Running computationally intensive, time-sensitive scripts on personal equipment introduces limitations related to performance, reliability, software maintenance, and data storage. It also creates unnecessary risk associated with hardware failure, operating system updates, and availability during critical instructional periods. From an institutional perspective, reliance on personal devices for essential teaching infrastructure is misaligned with best practices for continuity, equity, and data stewardship.

The requested dedicated workstation will directly enhance teaching, learning, and applied research in meteorology at the University of South Alabama by providing reliable, university-owned infrastructure for Python- and MetPy-based synoptic analysis. For students, the workstation ensures consistent access to locally generated, instructor-curated weather graphics used in time-limited current weather briefings. This reliability allows students to focus on physical interpretation and pattern recognition rather than troubleshooting unavailable or poorly displayed third-party products. For educators, the workstation replaces an unsustainable reliance on personal hardware with a stable, reproducible platform for core instructional workflows. Centralized computing supports consistent software environments, improved instructional continuity, and the long-term sustainability of custom visualization tools integrated into the synoptic curriculum.

B4. Project Activities

If funded by Unidata, the requested dedicated workstation will be used to support a coordinated set of instructional, scientific, and dissemination activities centered on data-driven synoptic meteorology education using Unidata-supported tools and services.

Instructional Activities and Current Workflow

The primary use of the workstation will be to support the Synoptic capstone sequence, where students conduct daily current weather briefings and short-range forecasts throughout each semester. The workstation will serve as the centralized platform for executing Python- and MetPy-based scripts that generate custom synoptic analysis graphics in real time. The workstation will enable instructors to tailor visualization parameters—such as smoothing, contouring, and map domains—to emphasize synoptic-scale processes and align graphics with specific learning objectives. The scripts and example outputs will continue to be disseminated to students via GitHub, reinforcing reproducible workflows and transparent analysis practices.

The following serves as a summary of the current workflow used to generate the Python-based synoptic meteorology charts that would be integrated on the requested workstation. Two separate code scripts were developed for Synoptic I and II because the student-run weather briefings for each course require a different set of charts. Between these two scripts, over 13,000 lines of code were constructed by one of the USA faculty members and Co-PIs, resulting in the current production of 14 different types of charts. These charts cover a wide variety of surface and mandatory pressure levels, including 500-mb heights and absolute vorticity (useful for identifying geostrophic vorticity advection), MSLP and 1000–500 mb thickness (useful for detecting surface fronts and areas of thickness advection), and 700-mb heights, temperature, and relative humidity (useful for diagnosing areas of mid-level moisture supportive of cloud formation). In addition, we are able to create replicas of the traditional black-and-white DIFAX charts (that are no longer produced by NOAA) by using a series of MetPy functions, including the remote access of rawinsonde station data through the Siphon package.

After importing all required Python packages (e.g., NumPy, Matplotlib, Cartopy, MetPy, and Pandas), the date and time information needed to generate each chart is manually updated at the beginning of the script. This is the only section of code that requires updating at the start of each run. From there, each chart is individually created, and very little oversight is needed. One exception is the DIFAX charts, which require some quality control of the remotely accessed rawinsonde data. We use the Siphon function to acquire upper-air station data from the University of Wyoming's rawinsonde archive. Each station across the continental United States and portions of Canada and Mexico is queried individually so that we can compute height changes from 0000 UTC to 1200 UTC. Unfortunately, the sequential querying of over 80 rawinsonde stations can often produce processing timeout errors, requiring the user to restart the loop. We would eventually like to secure an in-house server in the USA Meteorology Program to store observed sounding data like the University of Wyoming, but that is beyond the scope of this proposal.

Finally, all charts are uploaded to a GitHub repository that is shared among the instructors and students. The students are then able to download these charts and import them into PowerPoint presentations for their weather briefings.

Scientific and Applied Activities

In addition to direct classroom use, the requested workstation will support formal scholarly documentation of the Synoptic I and II current weather discussion model and the development and dissemination of instructional workflows built entirely on Unidata-supported software and data services, including MetPy, GRIB2, NetCDF, and Unidata's cloud-based THREDDS data server. The structure, rigor, and scale of these current weather briefings are highly rare at the undergraduate level, and the project team intends to formally describe and evaluate this instructional framework through established professional venues, including presentations at the AMS Annual Meeting's Conference on Education, as well as a planned manuscript(s) submitted to an education-focused journal such as the Journal of Geoscience Education.

Through these activities, the project contributes a scalable model for integrating open-source, Unidata-supported technologies into undergraduate forecasting education, extending the impact of the requested resources beyond South Alabama to the broader Unidata community.

B5. Information Technology Support Available

The University of South Alabama's Department of Earth Sciences is supported by two dedicated Management Systems Specialists within the College of Arts and Sciences who will assist with the initial setup and configuration of the workstation. This support includes installation of required security software, firewall configuration, and virus protection to ensure the system meets university IT and data security standards.

In addition, the University of South Alabama's Computer Services Center (CSC) provides comprehensive campus-wide computing and networking support, including wired and wireless network connectivity, internet and email services, networked storage solutions, and related infrastructure. Together, these resources ensure that the requested workstation will be securely deployed, properly maintained, and fully integrated into the university's computing environment.

C. Budget and Justification

The amount requested is *$5,437.41* to support the purchase and deployment of a dedicated forecasting workstation and associated peripherals that will serve as the computational backbone of our custom meteorological graphics system. The primary component is a Lenovo ThinkStation P2 Tower Gen 2 AI Workstation (Core Ultra 9 configuration) at a cost of $4,875.52. This workstation will provide the high-performance multi-core processing and memory capacity necessary to efficiently parse, analyze, and visualize large NetCDF datasets using Python-based workflows built with MetPy and related scientific libraries.

An HP E27k G5 27-inch 4K UHD monitor ($502.46) is included to ensure high-resolution visualization of meteorological fields. Accurate interpretation of vorticity, geopotential height, temperature gradients, and wind structure depends strongly on graphical clarity and contour detail. A 15-foot 4K-compatible HDMI cable ($12.37) will enable reliable high-bandwidth connectivity between the workstation and both the dedicated monitor and the 120-inch display in the Coastal Weather Research Center, supporting classroom demonstrations and formal presentations. A Logitech MK270 wireless keyboard and mouse ($22.95) will provide flexible control during live briefings, improving instructional flow and mobility within the presentation space.

Finally, a six-month Lenovo onsite extended service agreement ($24.11) is included to ensure rapid technical support during initial deployment and early operational use. Because this workstation will support recurring, time-sensitive forecasting exercises, minimizing downtime is essential. Shipping is not included in the attached quote, which is estimated at $100. Collectively, these modest but essential resources will establish a stable, institutionally supported computational infrastructure that enhances student learning, ensures operational reliability, and supports the continued development and scholarly dissemination of custom weather graphics built using Unidata-supported technologies. In addition to the equipment cost, USA will charge indirect cost at a federally negotiated rate for other sponsored activities on campus at a rate of 37% ($2,011.84 total). **The total requested amount is thus $7,449.25.**

Itemized Budget Request:

- Lenovo ThinkStation P2 Tower Gen 2 - tower - AI Workstation - Core Ultra 9
- C2G Core Series 15ft High Speed HDMI Cable with Ethernet - 4K HDMI 2.0
- HP E27k G5 27" Class 4K UHD LCD Monitor - 16 9 - Black

- Logitech MK270 Wireless Keyboard and Mouse Combo for Windows, 2.4 GHz Wireless
- Lenovo Onsite - extended service agreement - 6 months - on-site

Total Direct Cost: *$5,437.41*
Total Indirect Cost: *$2,011.84*
Total Project Cost: *$7,449.25*

D. Project Milestones

Assuming no delays due to USA's Meteorology team migrating to the Science Lab Building/CWRC over the summer, upon receipt of the Unidata Equipment Award, the requested workstation will be purchased promptly to ensure deployment prior to the start of the Fall 2026 semester. The workstation will be purchased in June 2026 in accordance with university procurement procedures. Installation and configuration will occur in late July to early August 2026, allowing sufficient time before the semester begins. During this phase, the operating system will be fully updated, Python will be installed, and all required scientific packages—including MetPy and supporting libraries for GRIB2 and NetCDF data access—will be configured. The faculty will also migrate existing synoptic analysis scripts to the new system and conduct multiple test runs to verify performance, reliability, and correct graphic generation. In September 2026, the workstation will be incorporated into the practice round of the Synoptic I Current Weather Discussions and City Forecasting contest. This phase will allow instructors to refine visualization choices and ensure smooth operation under real-time, time-limited conditions. Full operational use will continue throughout the remainder of the semester as part of the regular synoptic briefing cycle. A table outlining this timeline can be found here:

Timeframe	Activity
June 2026	Purchase of dedicated workstation following award notification
Late July – Early August 2026	Physical installation; OS updates; Python environment setup; installation of MetPy and required packages
August 2026	Migration of existing synoptic scripts; multiple test runs to verify graphic generation and performance
September 2026	Deployment during Practice Round of Current Weather Discussions and City Forecasting contest in Synoptic I
Fall 2026 Semester	Full instructional use during recurring synoptic briefings and forecasting contest for Synoptic I

E. References

Lanicci, J; McLeod, J.; Wiley, J. Performance of NCEP Operational Model Products as "Contestants" in a University Weather Forecasting Contest. Journal of Operational Meteorology. 2026, 14.

F. Equipment Quotes

Thank you for choosing CDW. We have received your quote.

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QUOTE CONFIRMATION

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For all other customers, click below to convert your quote to an order.

Convert Quote to Order

QUOTE #	QUOTE DATE	QUOTE REFERENCE	CUSTOMER #	GRAND TOTAL
1CJV3CP	2/23/2026	ASEARTHWILEY	442913	$5,437.41

QUOTE DETAILS

ITEM	QTY	CDW#	UNIT PRICE	EXT. PRICE
Lenovo ThinkStation P2 Tower Gen 2 - tower - AI Workstation - Core Ultra 9 Mfg. Part#: 30JQ008VUS Contract: E&I CNR01439 Catalog SMA (CNR01439)	1	9059572	$4,875.52	$4,875.52
Lenovo Onsite - extended service agreement - 6 months - on-site Mfg. Part#: 5WS1P80320 Electronic distribution - NO MEDIA Contract: E&I CNR01439 Catalog SMA (CNR01439)	1	9023671	$24.11	$24.11
C2G Core Series 15ft High Speed HDMI Cable with Ethernet - 4K HDMI 2.0 Mfg. Part#: 50612 UNSPSC: 26121628 Contract: E&I CNR01439 Catalog SMA (CNR01439)	1	3587438	$12.37	$12.37
HP E27k G5 27" Class 4K UHD LCD Monitor - 16 9 - Black Mfg. Part#: 6N4C4AA#ABA Contract: E&I CNR01439 Catalog SMA (CNR01439)	1	7350298	$502.46	$502.46
Logitech MK270 Wireless Keyboard and Mouse Combo for Windows, 2.4 GHz Wirel Mfg. Part#: 920-004536 UNSPSC: 43211706 Contract: E&I CNR01439 Catalog SMA (CNR01439)	1	3006282	$22.95	$22.95

SUBTOTAL	$5,437.41

SHIPPING	$0.00
SALES TAX	$0.00
GRAND TOTAL	**$5,437.41**

PURCHASER BILLING INFO	DELIVER TO
Billing Address: UNIVERSITY OF SOUTH ALABAMA ACCTS PAYABLE 650 CLINIC DRIVE MOBILE, AL 36688-3053 **Phone:** (251) 460-6191 **Payment Terms:**	**Shipping Address:** UNIVERSITY OF SOUTH ALABAMA ATTN:JILL SHOWERS 5991 USA DRIVE NORTH ROOM 118 MOBILE, AL 36688 **Phone:** (251) 460-6191 **Shipping Method:** UPS Ground (2- 3 Day)
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G. IT Statement

Jill Showers Chow, Management Specialist II for the College of Arts and Sciences at the University of South Alabama, will assist and support this project to the best of her ability. Support will include the implementation and maintenance of a dedicated workstation to support advanced MetPy-based weather visualization and analysis.

