UNIDATA COMMUNITY EQUIPMENT AWARD PROPOSAL

Submitted to

Unidata Program Center,
FL4-1240, 3090 Center Green Drive
Boulder, CO 80301

TITLE: **Enhancing Education in Atmospheric Sciences using AWIPS II and CAVE at the University of Hawaii at Manoa**

EFFECTIVE DATES: 6/1/2020-5/31/2021
REQUESTED AMOUNT: $19,400

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1. Project Summary

The Department of Atmospheric Sciences (AMTO) at the University of Hawaii at Manoa (UHM) has offered a Bachelor of Science in Meteorology/Atmospheric Sciences for over nearly 65 years. UHM is a minority and indigenous serving institution and is the only school in the state of Hawaii to offer a degree in Atmospheric Science. Our well-established and respected program attracts students of diverse backgrounds from Hawaii, the mainland and abroad. Our mission is to provide rigorous training in the atmospheric sciences through student oriented experiential learning and research opportunities. We prepare students for successful careers with government agencies, academia, and private institutions. One foundational aspect of our program is training students to work in operational meteorology at the National Weather Service (NWS).

This proposal seeks resources to expand the UHM VisionLab by bringing state-of-the-art workstations capable of running CAVE (Common AWIPS Visualization Environment) a Visualization Client for AWIPS (Advanced Weather Interactive Processing System) II to the Department of Atmospheric Sciences in the School of Ocean and Earth, Science and Technology (SOEST) of which it is part. VisionLab utilizes operational data streams from Unidata and NOAA NWS, and custom data from UHM research programs to bring real-time and archived weather observations and products to UHM students and staff. In addition VisionLab weather servers provide access to a broad range of operational and custom products via the Internet. Staff responsible for installation, configuration and maintenance of VisionLab will interact with Unidata's support environment to develop new software capabilities and data resources for the central North Pacific Region. The new workstations will link to a data server housed at NSF that will allow us to reproduce the visual environment used by the NWS. Our current hardware is insufficient to provide students with an experience comparable to working with CAVE as it is intended at the NWS. The new more capable workstations will allow us to reproduce the NWS environment for students in our classes. This capability is critical to our efforts to recruit future classes of students and train them in the science and art of forecasting tropical weather systems, which is our specialty of UHM.

The goals of this proposal are to acquire necessary hardware resources to:

i) Allow the seamless use of the modified non-operational version of AWIPS at UHM using the CAVE visualization framework (an Eclipse-built Java application which runs on Linux, Mac, and Windows);
ii) Provide a realistic, more responsive work-environment for CAVE and IDV;
iii) Increase speed of calculations on large matrices in MATLAB and Python, which are both used in courses and research;
iv) Facilitate the exploration of data science and deep learning as they pertain to geophysical science;
v) Enhance research and teaching with deep learning capabilities

Receiving funding to upgrade the VisionLab at UHM will ensure students are kept up to date with the latest meteorological data sets and visualization methods. This will be a vast improvement over our current capabilities and will allow students, faculty and researchers alike to be able to analyze and plot meteorological data for educational and research purposes.

2. Project Description

SOEST is a multidisciplinary world-class environmental science and technology institution offering degrees in atmospheric science (B.S., M.S., PhD), earth and environmental science (B.S, B.A., M.S., Phd), oceanography (M.S., PhD), ocean resource engineering (M.S., PhD) and global environmental change (B.S.). Collaborative and integrated research conducted at SOEST informs solutions to some of the most important global issues through an integrated, comprehensive, and sustained system of Earth and planetary observations, research, education, service, and extension. In ATMO, we focus on the physics of tropical storms, monsoons, and decadal processes such as El Niño, particularly in the Aust-Asia/Pacific area, and their impact on winds, rainfall, droughts, and floods as well as physical meteorology with a focus on cloud microphysics, aerosol-cloud interactions, orographic precipitation and convection. ATMO Faculty develop and maintain a wide range of climate, weather, and atmospheric forecast models to advance understanding of climate variability; assist the NWS with providing accurate extended range weather forecasts; and assist emergency managers with assessing brush/forest fire risk, health impacts of volcanic gas, and the hazard potential (winds & floods) from monsoons and storms. In climate research, we manage large spatial data sets and run robust numerical models that capture the interplay between the world's oceans, atmosphere, polar-regions, ecosystems, and landmasses. ATMO Faculty participate in large national and international field campaigns to explore global and regional weather and climate phenomena. Our skill in measuring and modeling climate variability has led to greater understanding of trade wind and rainfall trends, and the occurrence of extreme events such as monsoons, tropical cyclones, storms, droughts and floods.

The current equipment request will facilitate both real-time data delivery and access, while greatly expanding our ability to visualize, store and serve large geosciences data sets. The requested hardware resources will allow UHM to more fully contribute to and participate in Unidata activities.

VisionLab is managed and housed by the Department of Atmospheric Science and takes advantage of the Unidata program's data stream and other data resources from NOAA and NASA via the Internet and NOAAport to bring real-time weather data using state-of-the art visualization tools to UH. VisionLab was developed and upgraded in four phases with support from NSF equipment grants (ATM-9419433 in 1995, ATM-9815959 in 1998, and ATM-0562842 in 2005), and in 2012 SOEST invested in 17 Dell OptiPlex 790 Workstations with monitors. The Dell OptiPlex workstations are no longer state-of-the art and cannot provide a realistic work-environment experience.

During the course of the VisionLab project, ongoing interaction has taken place with Unidata's support environment to develop new software capabilities directed at training the next generation of atmospheric scientists and monitoring and researching the tropical Pacific Region. Mr. Michael Gonsalves is the full-time IT specialist in our department and oversees VisionLab, with the help of three of ATMO faculty Dr. Jennifer Small Griswold, Dr. Steven Busing and Dr. Giuseppe Torri. The VisionLab project represents a core resource for the Atmospheric Sciences Program at UHM. It is utilized to varying degrees in most academic courses offered. The greatest academic impact of VisionLab has been upper-division synoptic lab classes and introductory level classes. In introductory courses access to real time data and imagery and high

resolution digital video projection systems has formed an engaging combination to bring the visual power of science to the lecture hall. In the upper division courses visualization tools such as CAVE will provide the ability to manipulate real time data sets, as part of a sophisticated hands-on learning environment.

Following hardware and software installation, we will stage a local workshop at UHM to expose current faculty, students and staff to AWIPS II and CAVE to train researchers and students on use of both. Dr. Small Griswold will host an invited Unidata staff at her home to reduce travel costs to the cost of an airline ticket only.

2.1 Details of the Equipment Request

To achieve the goals outlined in the previous section and to remain a vibrant contributor to the Unidata community, we propose to upgrade our existing facilities with new workstations. The requested equipment will replace outdated workstations and be integrated with other existing equipment serving many purposes that benefit UHM and the broader community. The following specifications are based on the recommendation of Unidata staff.

1) Dell G5 Gaming Desktops
    a. 9th Gen Intel Core i9 9900 8-Core, 16 MB Cache, Up to 5 GHz with Intel Turbo Boost Technology
    b. NVIDA GeForce RTX 2070 8GB GDDR6
    c. 32 GB Dual Channel DDR4 at 2666MHz
    d. 1TB M.2 PCI NVMe SSD
    e. Qualcomm DW1810, 1x1, 802.11ac, Bluetooth 4.2

SOEST's computer network provides high-speed connections and data transfer capabilities. It connects to the UHM Manoa campus FDDI campus backbone network, and through that to PACOM wide-area network services, which link Hawaii directly with the Far East and the US mainland. Network switches in the Hawaii Institute for Geophysics Building (HIG) that houses VisionLab have recently been upgraded to one GB capacity. The proposed hardware will allow us to take advantage of the enhanced SOEST network bandwidth.

VisionLab comprises ~1200 square feet of space, which contains five Ethernet outlets and 27 electrical outlets. Sufficient space is available in VisionLab for the proposed computing resources. Once the hardware arrives, SOEST research computing facility (RCF) staff and Mike Gonsalves will work with the PI to integrate and maintain the VisionLab. Appropriate software for the project is currently available for transfer through a limited area network to the workstations. Existing full-time technical personnel that are currently employed in SOEST will maintain hardware purchased for VisionLab. Ongoing network support for data delivery from Unidata via Internet will be provided through departmental resources. The previous generation of lab computers will be transitioned for use by our graduate students for other uses or relocated to other classrooms for student needs that require less computing power. With this repurposing of the older machines, the overall life cycle for each computer will be another two to three years, maximizing our technology investment made in summer 2012.

2.2 Benefits to Education, Research and Unidata Community at Large

This Unidata Community Equipment Award will benefit and support research, education and the Unidata community at large.

2.2.1 Education

Our goal is to further professionalize the learning experience at UHM by providing workstations capable of running Unidata AWIPS II Standalone EDEX Data Server and the CAVE client and incorporating their use in required and elective undergraduate and graduate courses. These classes include, but are not limited to, Meteorological Analysis Lab, Tropical Analysis Lab, Introduction to Weather and Climate, Programming for Meteorologists, Satellite Meteorology, Satellite Data Analysis and for Undergraduate and Graduate Thesis projects. These courses are designed with laboratory and computing contact hours allowing the use of AWIPS II data and the CAVE client to become an integral part of our academic program. This modern approach will enhance learning by providing students with hands-on experience using the same software that is currently used in all NWS offices. Experience with the current NWS software will allow our student to be competitive if they pursue employment with the NWS. Students will be able to visualize and comprehend advanced topics in meteorology in a way that has been unavailable at UHM in the past. This opportunity will not only benefit current students, but will increase our ability to attract students who aspire to work for the NWS to our undergraduate and graduate degree programs. Faculty are eager to integrate AWIPS II and CAVE into their curriculum as we modernize our program and incorporate real-world applications, issues and solutions into the classroom. We also anticipate an increase in use across SOEST allowing for interdisciplinary use of the workstations and bringing together students and faculty from departments such as Oceanography and Earth and Environmental Sciences.

2.2.1 Research

All members of the Atmospheric Sciences community at UHM will benefit from new research opportunities with the installation of the proposed workstations and software. Students will be able to use the workstations for scholarly work related undergraduate thesis research and graduate thesis. Faculty, researchers and postdocs will also have the opportunity to learn how to use AWIPS II and the CAVE client and will have access to the workstations for academic and scholarly pursuits. In addition, new deep learning capabilities will enhance research in areas such as the improvement of long-range optical turbulence and seeing. Previous iterations of the VisionLab has facilitated a number cross-disciplinary research efforts including exciting research in renewable energy such as wind power (Argueso and Businger, 2018) and an analysis of solar radiation resources on Oahu (Williamson and Businger, 2018). Researchers using the VisionLab have led us to better understand vertical motion in the lowest part of the atmosphere (Robinson and Businger, 2019) and how hurricane force winds impact the North Pacific Ocean environment (Businger et al., 2015). The staff of the Mauna Kea Weather Center (MKWC), which provides custom forecast support for the astronomical observatories at Mauna Kea (Businger et al., 2001) undertakes research in data assimilation and modeling of turbulence and seeing above the summit of Mauna Kea. Recent research has result in the development of a regional retrieval processor for high-spectral-resolution infrared data that provides the forecasting community with products suitable for nowcasting applications and optimal data assimilation. An effort to model

the dispersion of volcanic smog (vog) emanating from the Kilauea volcano complex (Businger et al., 2015, Businger et al. 2016) has led to the development of an operational vog dispersion forecast system The ensemble dispersion model helps mitigate the adverse impacts of vog on general aviation and health. This system was integral in public air quality warnings during the May 2018 major Kilauea eruption. By improving our visualization and analysis capabilities will increase interest in interdisciplinary research activities.

2.2.1 Unidata Community

The Atmospheric Science program will make our data and trainings available to any student or other programs in SOEST or the broader UHM community. The ATMO department plans to continue to interacted with and participate in Unidata programs via our VisionLab project. We are particularly interested in developing new software capabilities, and improving our online archival facility. We also plan to continue supporting and promoting other sites in the Pacific, and participating in testing of future data diagnostic, transfer, and archiving technologies (e.g., EarthCube building blocks). Finally, we have already shared our data Vog dispersion model forecasts via the ingestor in LDM and would continue to so in the future. ATMO has also previously expanded the Visionlab to include the state-of-the-art THREDDS Data Server (TDS) which enhanced the Internet Data Delivery (IDD) system at UHM and the NOAAport data exchange with the Honolulu NWS Forecast Office. This allowed us to become a relay node in the IDD for additional users in the Pacific Region and expanded our ability to archive historical data and facilitate automated remote access to custom and operational Pacific data sets for research and education. The UH THREDDS server provides a number of data sets that are unique to the Pacific and are now available to the Unidata community and beyond.

2.3 Relationship of Requested to Current Computer Resources

The proposed update to VisionLab hardware satisfies the projected need in the area of data visualization, data access, synoptic instruction, and geosciences data display for the next 5 years. The UHM SOEST and the Department of Atmospheric Sciences are committed to strengthening such mutually beneficial activities. Our commitment to maintaining a state-of-the-art research and instructional facility is readily documented. Excluding salaries for support staff, the UHM and SOEST have collectively contributed more than $100K in real dollars over the past fifteen years through grant-matching funds, software, maintenance, and hardware upgrades. Given the growth in the data streams available through research, Unidata and the NWSFO, and the visualization capabilities required state-of-the art graphics and memory the hardware requested in this proposal will allow the UH/SOEST to contribute to and participate fully in Unidata's future efforts.

a) Current VisionLab Computing Resource

In addition to the 18 VisionLab workstations, the Atmospheric Sciences Department "computing commons" consists of two home directory servers, 2 PC workstations, and two printers with specifications given in Table 2. Individual faculty now tend to buy into the UHM Information Technology Services condominium super computer on campus, which has ~3000 nodes. In addition, faculty utilize computer resources off campus, including supercomputer facilities at the Subaru center in Hilo, the Maui High-Performance Computing Center, NCAR (Yellowstone),

and the Earth Simulator in Japan. We also plan to continue to utilize Unidata's cloud-based server.

Table 2 The Atmospheric Sciences Department "computing commons" consists of two home directory servers, 18 PC workstations, and two printers with specifications as follows:

Host Name	Description	Role	CPUs	Memory	Storage	Qty
uila	Dell PowerEdge 2950 acquired October 2008	Home directory server.	Quad Core Xeon 3.1GHz	16GB	5TB	1
kahi	Advanced HPC Mercury RM206 acquired December 2011	Home directory server.	Quad Core Opteron, 1.15GHz	8GB	19TB	1
vision01 to vision15,	Dell OptiPlex 790 acquired in May 2012	Computer lab workstation.	Quad Core i7	8GB	250GB	16
m1	Lenovo ThinkStation S20	Open computing workstation, dual-boot Windows and linux	Quad Core Xeon 2.66GHz	10GB	380GB	1
AltaLink	Xerox AltaLink 8030	Departmental printer				1
hpmetlab	HP Color LaserJet CP2025	Lab printer				1

3. Description of the Budget

Please refer to Section 2.1 for a detailed justification of the hardware listed in this section.

Description	Number	Price Per Unit
Dell G5 Gaming Desktop Workstation • 9th Gen Intel Core i9 9900 (8-Core, 16MB Cache, up to 5GHz with Intel Turbo Boost Technology) • NVIDIA GeForce RTX 20170 8 GB GDDR6 • 32GB Dual Channel DDR4 at 2666MHz • 1TB M.2 PCIe NVMe SSD • Qualcomm DW1810, 1x1, 802.11ac, Bluetooth 4.2	17	$2,300*
		$ 39,100
Expected cost savings from "bulk purchase," bidding process negotiations and general downward trend of hardware pricing		$10,000

50% Cost Match from SOEST		$9,700
Total Request to Unidata Community Equipment Program		$19,400

**The quoted price is for a single workstation and we expect that when we go out for official bid for multiple we will see a drop in price that will allow us to purchase additional workstations over the 12 requested above.*

3.1 Cost-Sharing and Bulk Price Decrease

It is anticipated that UH will provide 50% matching funds on the requested hardware, along with providing all software, installation, warranty and maintenance services needed to operate the equipment. The Dr. Small Griswold and Dr. Businger will make a request for the matching funds to the University Research Council of UH and SOEST.

The per-workstation price is expected to decrease when purchased in bulk. We also expect a combination of decreased prices in the future (when the bidding process and purchasing would be complete) due to the general downward trend for computer hardware. We also expect a negotiation in the bidding process to result in a decreased price per workstation.

4. Project Milestones

Since the physical space and networking for VisionLab and the personnel involved with maintaining VisionLab are already in place, we foresee no contingency to delay the timetable below.

Timetable for new hardware installation and CAVE

Semester	Activity
Summer 2020	Equipment will be purchased and installed so that the updated VisionLab facility will be fully functional for Fall 2020 classes that start at the end of August.
Fall 2020	CAVE and all other relevant AWIPS II related software will be installed onto the new workstations. Invited Unidata workshop to train current faculty, staff and students to use CAVE.
Winter-Spring 2021	Integration of AWIPS II and CAVE into lower and upper division Atmospheric Science courses.
Summer 2021-Onward	A fully implemented AWIPS II and CAVE and integration and use in departmental courses and research activities

5. References

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