



Promoting STEM Literacy and Diversity through the Center for Applied Atmospheric Research and Education (CAARE)

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1. Abstract

The Center for Applied Atmospheric Research and Education (CAARE) is funded by the NASA Minority University and Education Project (MUREP) Institutional Research Opportunity (MIRO) Program and led by San Jose State University (SJSU). CAARE is a collaborative effort between SJSU, Universities Space Research Association (USRA) at NASA Marshall Space Flight Center (NASA/MSFC), Bay Area Environmental Research Institute (BAERI) at NASA Ames Research Center (NASA/ARC), University of Alabama in Huntsville (UAH), and Fond du Lac Tribal and Community College (FDLTC). The motivation for the establishment of CAARE is to promote Science, Technology, Engineering and Mathematics (STEM) literacy and to enhance and sustain the capability at these partner institutions to support NASA's Science Mission Directorate (SMD). CAARE's goals are to: a) Contribute to NASA Centers' atmospheric and environmental research programs through the use of in situ and remotely-sensed observations, geospatial technologies and models; and b) Train underrepresented STEM students with emphasis on understanding atmospheric processes through the use of state-of-the-art atmospheric observing instruments, modeling techniques, analytical approaches and remotely-sensed data. To that end, student interns from underrepresented institutions spend ten weeks in the summer of each year at NASA/MSFC and NASA/ARC working with NASA-affiliated researchers on hands-on applied atmospheric and environmental research projects related to subject areas such as air quality, hydrology, water quality, climate variations, urban heat islands, agricultural productivity, wildfires and ecological forecasting. The student interns also receive fundamental remote sensing, geographic information systems (GIS), geospatial analysis and programming trainings that allow them to more efficiently perform their research. In addition to technical trainings, these projects also help the students improve their technical writing, presentation and critical thinking skills. In this conference presentation, we will give an overview of CAARE's recent research and educational activities and share our lessons learned.

2. Project Goals/Objectives

- Contribute to NASA Centers' research programs in urban heat islands, air quality, public health, hydrology and climate variations through the use of in situ and remotely-sensed observations, geospatial technologies and models.
- Train underrepresented STEM students with emphasis on understanding atmospheric processes through the use of state-of-the-art atmospheric observing instruments, modeling techniques, analytical approaches and remotely-sensed data.
- Inspire and engage community college students through outreach, expanded degree opportunities and summer internship experiences.
- Engage in basic research with faculty members and students at Minority Serving Institutions with the view that the resulting knowledge will advance weather, climate and air quality prediction through intensive and long-term field atmospheric observations and measurements.

3. Project Operations

To achieve our project goals and to address NASA SMD science questions, we promote research and education in four areas: 1) urban heat island and climate variability, 2) aerosol and its impacts on air quality, weather and regional climate, 3) wildfire impacts on air quality, and 4) public health linkages to air quality, weather, and climate. Figure 1 illustrates how the four primary CAARE research and education thrusts are organized. The research component of CAARE will encompass urban and regional-scale atmospheric processes and their linkages to air quality, weather, public health and climate change. The education includes workshops, short courses, hands-on field experiments and summer internships for undergraduate and graduate students at NASA Centers.

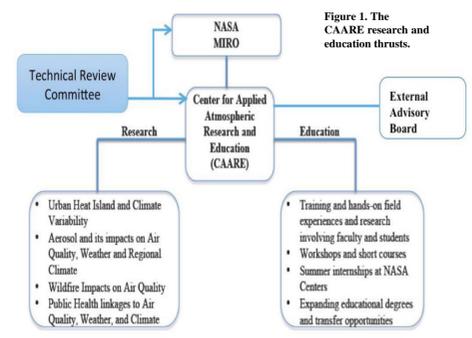


Figure 1. The CAARE research and education thrusts.



CAARE Director, Mentors and Students at the NASA/MSFC/NSSTC in 2017 (left photo) and 2018 (right photo)

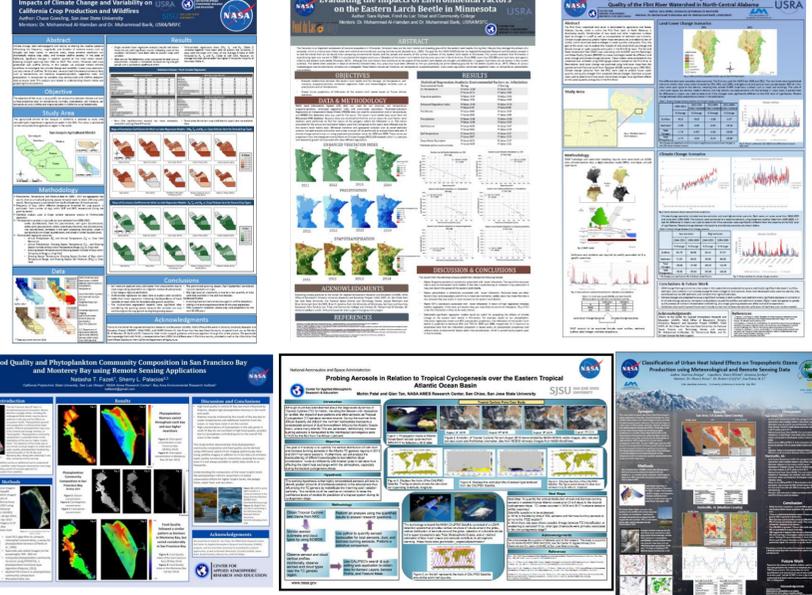


4. Students' Research and Educational Activities

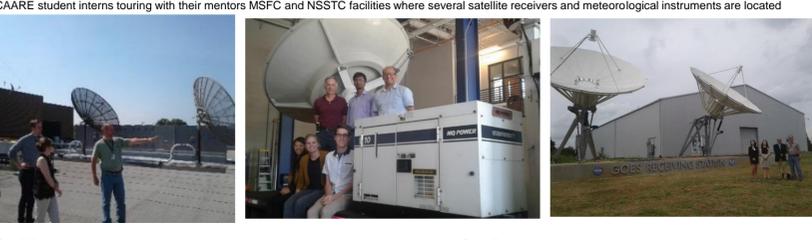
Recent research projects include:

1. Impacts of Land Cover and Climate Changes on Water Quantity and Quality of the Flint River Watershed in North-Central Alabama
2. Evaluating the Impacts of Climate Change and Environmental Factors on the Eastern Larch Beetle in Minnesota
3. Impacts of Climate Change and Variability on California Crop Production and Wildfires
4. Evaluation of Different NASA/MODIS Aerosol Optical Depth (AOD) Retrieval Algorithms for Fine Particulate Matter (PM2.5) Estimation in the Western, Midwestern and Southeastern United States with Implications for Public Health
5. Effects of Land-use/Land-cover and Climate Changes on Water Quantity and Quality in Sub-basins near Major US Cities in the Great Lakes Region
6. Satellite remote sensing for modeling and monitoring of water quality in the Great Lakes
7. Assessment of the urban heat-island effect in Madison County using NASA's Remotely Sensed Data
8. Analyzing the Relationship Between Influenza Like Illnesses, Temperature, Humidity, and Precipitation in Alabama from 2013-2018 using NASA's Remotely Sensed Data
9. Assessing Riparian Buffer Zone Health of Pinhook Creek, Madison County, AL, using NASA's Remotely Sensed Data to Understand Impacts of Water Quality and Quantity
10. Water Quality Influence on Southwest Puerto Rican Coral Species Distribution
11. Monitoring Snow Cover Extent in the Navajo Nation
12. The Breathing Ocean: Is the California Current System a Source or Sink of CO2?
13. Long-range Aerosol Transport via Rossby Wave Breaking During Atmospheric River Events on the Western U.S.
14. Bloom Modeling and Prediction of the Harmful Algae Alexandrium in Bellingham Bay, WA
15. Emulating Radiative Transfer Through Vegetation Canopies Using Physically Based Rendering
16. Probing Aerosols in Relation to Tropical Cyclogenesis over the Eastern Tropical Atlantic Ocean Basin

Examples of Students' Posters



Examples of Field Trips



NASA/MSFC and ARC Poster Expositions



5. What STEM Students Have Learned

- Remote sensing fundamentals and applications
- GIS fundamentals and applications (mapping and analysis)
- Programming and data processing
- Statistical analysis
- Conducting scientific research and literature review, oral and poster presentations, and technical papers for journal publication
- Through MSFC/ARC bi-weekly tag-up web conferences, the interns shared their experiences, updated each other on their progress, and created a sense of CAARE community
- Familiarization of MSFC and ARC facilities and current and future opportunities through NASA tours
- Analytical, critical thinking, technical writing
- Presentation/communication skills developed through the NASA/MSFC and ARC Academic Affairs Office Poster Exposition and scientific conference presentations
- Exposure to a diverse community of professional scientists and engineers, providing role models for the students' professional careers and a pathway for future internship opportunities, graduate research assistantships and/or full time positions

6. Evaluation Metrics/Highlights

As of Year 3 of this 5-year Project:

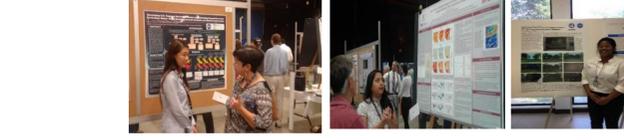
- Number of Interns from STEM Minority Serving Institutions (MSIs) **Twenty three STEM students from MSIs (Out of Forty)**
- Number of publications, posters, presentations with faculty/students' involvement **- Twelve conference poster presentations - Forty poster presentations at MSFC and ARC Poster Expositions - Three journal papers submitted/published**
- Number of research proposals with MSIs faculty/students' involvement **- Two student applications for NSF Graduate Research Fellowships (one awarded) - Two grant proposals submitted (both awarded) (Amounts: \$374K and \$334K)**
- Number of students (i.e., CAARE cohorts) that are now in graduate schools **- Seven students (most with full graduate scholarships in Atmospheric and Earth System Sciences)**
- Number of interns from community colleges (CC) **- Six students from CC**
- Number of students (i.e., CAARE cohorts) from CC to 4-yr colleges **- Four CAARE CC interns decided to attend 4-yr colleges**

7. Summary

CAARE is a collaborative effort between SJSU, USRA at NASA/MSFC, BAERI at NASA/ARC, UAH, and FDLTC. The motivation for the establishment of CAARE is to promote STEM literacy and to enhance and sustain the capability at these partner institutions to support NASA's scientific research activities. Diverse student interns from several underrepresented institutions spend ten weeks in the summer of each year at NASA/MSFC and NASA/ARC working with NASA-affiliated researchers on hands-on applied atmospheric and environmental research projects related to subject areas such as air quality, hydrology, water quality, climate variations, urban heat islands, agricultural productivity, wildfires and ecological forecasting. The student interns also receive fundamental remote sensing, geographic information systems (GIS), geospatial analysis and programming trainings that allow them to more efficiently perform their research. In addition to technical trainings, these projects also help the students improve their technical writing, presentation and critical thinking skills. Furthermore, exposure to a diverse community of professional scientists and engineers helps provide role models for the students' professional careers and a pathway for future internship opportunities, graduate research assistantships and/or full time positions.

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Presenting at MSFC and ARC Poster Expos



Presenting at Scientific Conferences (AGU, AMS, AWRC)



Sharing experiences and Creating a sense of CAARE Community



MSFC/ARC CAARE Bi-weekly Tag-up Web Conferences



CAARE Reunion at the 2018 AGU Fall Meeting

