Successful Model for Increasing Diversity and Capacity in Geosciences through a NOAA Cooperative Science Center

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Facts About ISET Cooperative Science Center

Partner Institutions

- North Carolina A&T State University - Lead
- North Carolina State University
- University of Minnesota
- Fisk University-Tennessee
- California State University-Fresno
- University of Alaska Southeast
- City University of New York

MISSION

Train students in NOAA scientific areas and develop technology and analysis techniques of global data sets for improved understanding of climate and environmental change

Aligned with the NOAA Office of Atmospheric Research

Thirty one scientists and engineers in seven institutions
Partnerships

GOVERNMENT
- NOAA National Severe Storm Laboratory
- Naval Research Lab, Stennis, MS
- NOAA Atlantic Oceanic and Meteorological Laboratory
- NOAA National Weather Service
- NOAA Southeast River Forecast Center
- NASA Goddard, NASA GISS, NY
- NYC Department of Health and NYC Office of Emergency Management
- National Center for Atmospheric Research (NCAR)

INDUSTRY
- Maxion Technologies
- MTECH Systems
- Vaisala
- WETLabs Inc.

ACADEMIC
- Pennsylvania State University
- Princeton University
- University of Maryland, College Park
- University of Florida
- Georgia Tech
- University of Colorado
Background on NOAA Cooperative Science Centers

Geosciences awards the fewest undergraduate degrees—less than 1 percent—of all of the science, technology, engineering and math (STEM) fields, according to the National Science Foundation’s report on *Women, Minorities and Persons with Disabilities in Science and Engineering* (January 2009).

Graduate students account for only 5.8 percent of degrees awarded in the earth, atmospheric and ocean sciences—the lowest in all STEM fields, according to NSF.

2001 Congress mandated the establishment of 4 NOAA Cooperative Science Centers (CSCs).

2006 NOAA-EPP established 5 CSCs at Minority Serving Institutions (MSIs) to advance collaborative research in the NOAA-mission sciences.

2012 Number of CSCs decreased back to 4.
Center that is *innovative* in applied science and technological *research* as well as *teaching* that will have a *national impact* on the number of *underrepresented students* earning graduate degrees, the retention of *underrepresented faculty* in NOAA disciplines, the *awareness* by underrepresented students of NOAA’s *mission*, and the *environmental literacy* of underrepresented students.

Collaborative partnerships and linkages are truly integrated and diverse and lead to the *transfer of NOAA-related research* findings to *diverse user groups* and the offering of *courses and seminars* between partner institutions and to other Minority Serving Institutions.

Cooperative with other NOAA *centers* and research facilities as well as other organizations performing climate change and *scientific environmental technology research*. 
Student Pipeline (Funnel) Strategy

Student Success in NOAA Science Careers

Sources of Students
- Targeted HS Students
- K-12 Impacted Students
- Community College Students
- ISET CSC Students
- Other CSC Students
- Other Linkages

Student Opportunities
- Summer Camps
- Classroom Presentations
- Magic Planet
- Natural Science Center
- New Curriculum
- Research Experience
- New Curriculum
- NOAA Field Experience
- NOAA Lab Experience
- AMS Student Chapter

K-12
UG
MS
PhD
ISET CSC Summer Camps

In 4 year period, ISET partners served over 200 high school teachers, over 200 high school students, and hundreds of middle and elementary students.
Geoscience Capacity Growth

Before 2006
- No degree programs in Atmospheric Sciences and Meteorology
- No courses offered in Atmospheric Sciences

Since 2006
- A BS in Atmospheric Sciences in meteorology – second in the Nation at an HBCU
- A PhD concentration in Atmospheric Sciences (EES)
- Developed 18 undergraduate and 8 graduate courses in atmospheric sciences and atmospheric technology
- Expanded MS thesis projects in atmospheric sciences in STEM departments
- Five Atmospheric Sciences Faculty Hired
- Geosciences courses as general education courses offered
1. Climate prediction
2. Pattern recognition for seasonal hurricane forecasts
Interactions Among Research Thrust I Projects

Luminescent Sensors (Assefa, NCA&T)

RC(O)O₂ + HO₂ reaction branching ratios (Hasson, FSU)

Understanding Atmospheric Composition

Monitoring Atmos. Trace Gas Constituents (Ahmed, CUNY)

Monitor pollutant dispersal

Dairy Emissions (Hasson, FSU)

Cavity Ring Down Spectroscopy (Bililign, NC A&T)

Measurement of peroxides

Proton Transfer Mass Spectrometry (Bililign, NC A&T)

Measurement of acids

Monitor pollutant dispersal

Understanding air quality and climate

Alternative technique for measurement of peroxides in lab

Alternative technique for emissions measurements

Alternative instrumentation for lab and field measurements
Cavity Ring Down Spectroscopy

Goals

• Develop and calibrate a cavity ring down spectroscopy setup for trace gas detection.
• Investigate vibrational overtone initiated photodissociation processes that are significant sources of atmospheric radicals for glyoxal, carboxylic acids and methyl hydroperoxide.
• Measure the absorption cross-section for the fourth OH overtone of organic acids.

We now have a CRD instrument that has a sensitivity to measure absorption as low as $10^{-9}$ cm$^{-1}$Hz$^{1/2}$.
Field Measurements - CUNY

Brooklyn Marina

NJ cruise, R/V Connecticut
Research Thrust I: Sensor Science and Technology

NC A&T Atmospheric Physics

NC A&T Sensor Science group

CUNY Sensor Technology group

CUNY Sensor Technology group

Fresno Atmospheric Chemistry group
Research Thrust II:
Global Observing Systems

NC A&T, NCSU, CUNY

NC A&T Modeling group

Atmospheric Sciences and Meteorology Majors
Instrumentation - Alaska

- Pressure Transducer
- Met Station
- GPS
- Pan-Tilt-Zoom Camera
- Temp, DO, pH, Turbidity, Conductivity
Research Thrust III: Data Mining, Fusion, Distributed Architecture

- Distributed Architecture - NC A&T
- Data Mining-Minnesota
- Boulder, CO
- Data Fusion-NC A&T
- Distributed Architecture - Alaska
- Data Mining-Fisk
Two ISETCSC undergraduates Malcolm Blow and Martin Blow are NOAA EPP Undergraduate Scholarship Program scholars.


Keren Cepero (graduate student, NCSU) (Paul Liu, advisor) worked on watershed modeling and has been intensively involved in the collaborations with NOAA, the National Weather Service (NWS), and the Office of Hydrologic Development (OHD) in Silver Springs, MD, in 2009 and 2010.

National Marine Fisheries Service (NMFS): Fisk student Wilsharo Scott contacts Carlos Rivero (NMFS) almost every week. He also visited Carlos during the spring break and has an NMFS internship in Miami.
NCAR scientists providing lectures and course modules though webinar or web. A course in Atmospheric Chemistry will be offered for graduate students at NC A&T and Fresno.

NCAR provided support for speakers to come to NCA&T, give seminars, spend time with students and faculty, and to provide training on some areas of common interest.
# Summary of Center-wide Accomplishments 2006-2011

<table>
<thead>
<tr>
<th>Educational and Research Metrics</th>
<th>Accomplishments</th>
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<tbody>
<tr>
<td>Number of students supported by ISET CSC across all institutions 93% MIs at NCAT, 74% MIs overall, 36% female</td>
<td>342 (All students who received some form of support)</td>
</tr>
<tr>
<td></td>
<td>69 MS, 36 PhD</td>
</tr>
<tr>
<td>Number of graduates</td>
<td>38 MS, 12 PhD, 385 BS</td>
</tr>
<tr>
<td>Number of students who participated in summer research at NOAA labs</td>
<td>60</td>
</tr>
<tr>
<td>Refereed publications by faculty published and under review</td>
<td>92</td>
</tr>
<tr>
<td>Student and faculty conference presentations</td>
<td>475</td>
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<tr>
<td>NOAA relevant seminars and colloquium</td>
<td>8-15/year</td>
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<tr>
<td>Leveraged funding (171 proposals)</td>
<td>$35,583,900</td>
</tr>
<tr>
<td>New faculty</td>
<td>6</td>
</tr>
<tr>
<td>Number of collaborative projects with NOAA scientists</td>
<td>45</td>
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</table>
Student and Instructor Surveys and Student Interviews

- Fall 2010 Report
- Amy Germuth, PhD
  President, EvalWorks, LLC; Durham, NC
- 43 students (22 graduate and 21 undergraduate) responded to Student Surveys
- 21 instructors responded to Instructor Surveys
- 21 NC A&T students (undergraduates and graduates) participated in student interviews
## Engagement in Strategies Designed to Improve Research-related Skills/Competencies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>%</th>
<th>n</th>
<th>Undergraduate</th>
<th>Graduate</th>
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<tr>
<td>Research experiences on campus</td>
<td>88.4%</td>
<td>38</td>
<td>19</td>
<td>19</td>
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<tr>
<td>Attending seminars and/or conferences</td>
<td>81.4%</td>
<td>35</td>
<td>15</td>
<td>20</td>
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<tr>
<td>Presenting at seminars and/or conferences</td>
<td>62.8%</td>
<td>27</td>
<td>11</td>
<td>16</td>
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<tr>
<td>Mentoring (by a NOAA ISET professor)</td>
<td>58.1%</td>
<td>25</td>
<td>11</td>
<td>14</td>
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<tr>
<td>Research experiences at NOAA labs</td>
<td>39.5%</td>
<td>17</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Web-based tutorials</td>
<td>18.6%</td>
<td>8</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>NOAA ISET Courses</td>
<td>18.6%</td>
<td>8</td>
<td>1</td>
<td>7</td>
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<tr>
<td>Field study experiences</td>
<td>14.0%</td>
<td>6</td>
<td>5</td>
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<tr>
<td>Industrial internship experiences</td>
<td>7.0%</td>
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# Overview of Skills/Competencies Students Gained by Strategy

<table>
<thead>
<tr>
<th></th>
<th>Research experiences</th>
<th>Mentoring</th>
<th>Attending seminars and/or conferences</th>
<th>Research experiences at NOAA labs</th>
<th>Presenting at seminars and/or conferences</th>
<th>Field study experiences</th>
<th>Web-based tutorials</th>
<th>Industrial internship experiences</th>
<th>NOAA ISET Courses</th>
<th>Total</th>
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<td>Networking</td>
<td>19</td>
<td>24</td>
<td>36</td>
<td>21</td>
<td>24</td>
<td>14</td>
<td>5</td>
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<td>164</td>
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<td>25</td>
<td>25</td>
<td>18</td>
<td>16</td>
<td>16</td>
<td>7</td>
<td>10</td>
<td>10</td>
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<td>Technical presentation</td>
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<td>16</td>
<td>26</td>
<td>14</td>
<td>32</td>
<td>7</td>
<td>10</td>
<td>7</td>
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<td>21</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>8</td>
<td>10</td>
<td>8</td>
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<td>Scientific method</td>
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<td>13</td>
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<td>17</td>
<td>14</td>
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<td>10</td>
<td>5</td>
<td>9</td>
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<td>Creativity</td>
<td>20</td>
<td>15</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>11</td>
<td>8</td>
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<td>16</td>
<td>11</td>
<td>9</td>
<td>17</td>
<td>9</td>
<td>10</td>
<td>4</td>
<td>9</td>
<td>101</td>
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<tr>
<td>Independence</td>
<td>25</td>
<td>14</td>
<td>5</td>
<td>15</td>
<td>11</td>
<td>11</td>
<td>3</td>
<td>10</td>
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<td>96</td>
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<td>Computer software</td>
<td>27</td>
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<td>9</td>
<td>16</td>
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<td>7</td>
<td>7</td>
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<tr>
<td>Leadership / Mentoring</td>
<td>18</td>
<td>22</td>
<td>5</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>14</td>
<td>9</td>
<td>4</td>
<td>10</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>65</td>
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<td>Hardware troubleshooting</td>
<td>17</td>
<td>11</td>
<td>1</td>
<td>12</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>57</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>349</td>
<td>289</td>
<td>242</td>
<td>219</td>
<td>201</td>
<td>147</td>
<td>111</td>
<td>110</td>
<td>104</td>
<td>1772</td>
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</table>
## Instructor Ratings of Student Competencies

<table>
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<tr>
<th>Competency</th>
<th>n</th>
<th>Min.</th>
<th>Max</th>
<th>Mean</th>
<th>sd</th>
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<td>5</td>
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<td>0.768</td>
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<td>3.70</td>
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<td>5</td>
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<td>2</td>
<td>5</td>
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<td>5</td>
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<td>5</td>
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<td>0.826</td>
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<td>5</td>
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<td>5</td>
<td>3.37</td>
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<td>2</td>
<td>5</td>
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<td>4</td>
<td>3.30</td>
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<td>0.895</td>
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<td>3.26</td>
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<td>Hardware troubleshooting</td>
<td>19</td>
<td>1</td>
<td>5</td>
<td>2.79</td>
<td>1.134</td>
</tr>
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</table>
Freshmen noted that their experiences with the NOAA ISET program were minimal and they were not always clear what the benefits of the program were beyond receiving financial support.
Objectives for ReGenesis Game Design

1. Increase NOAA ISETCSC undergraduate and graduate student knowledge of NOAA, particularly OAR Line Office
2. Motivate students to pursue careers with NOAA and NOAA contractors
3. Determine if 3D Gaming is an effective tool for accomplishing “1” and “2”
4. Determine the development challenges
Productivity Since the End of NOAA Funding 2011-Present

<table>
<thead>
<tr>
<th>Number of Proposals Submitted</th>
<th>45 by 6 Core ISET Faculty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Proposals Funded</td>
<td>16</td>
</tr>
<tr>
<td>Number of Published Articles</td>
<td>37</td>
</tr>
<tr>
<td>Number of Presentations</td>
<td>140</td>
</tr>
<tr>
<td>Number of PhD Students</td>
<td>13 New PhD Atm. Sci. students enrolled since 2011; 9 PhD Atm. Sci. graduates; 27 PhD Atm. Sci. students enrolled during part of the time period</td>
</tr>
<tr>
<td>MS students</td>
<td>13 (Physics and Math majors)</td>
</tr>
</tbody>
</table>
Active Collaborations

- WINTER - an atmospheric chemistry campaign that focuses on wintertime emissions and chemical processes in the Northeastern US. AGU special session in Dec 2015

- The Front Range Air Pollution and Photochemistry Éxperiment (FRAPPÉ) field campaign took place from 7/16 to 8/16, 2014.

- Fire Influence on Regional and Global Environments Experiment (FIREX)-The Impact of Biomass Burning on Climate and Air Quality: NOAA Field and Laboratory Studies during 2015-2019.
I first came across Samuel Hernandez in an upper division chemistry class in Spring 2007. I noticed that this student had aced the first midterm, but I had no idea who he was. I quickly realized that he was the student who sneaked into the back of the room just as I started lecturing and who disappeared through the door as soon as the class ended. He never spoke in class, or asked a question, or came to office hours for the entire semester, but continued to set the curve.
At the end of the semester, I approached him and talked to him about the ISET Center. Up to that point, his goal had been to get through the degree program, get out, and get a job. He was the first member of his family to attend college and the idea that a student could get paid to do research, let alone make a career doing this, was beyond his comprehension. Sam was interested in the program, but his GPA was just below 3.0. (I later learned that he has a learning disability and has struggled to overcome a stammer).
We realized that Sam would be able to raise his GPA above 3.0 if he got straight A’s the following semester. During Fall 2007 we met regularly through the semester to check on his progress. Over the winter break, he proudly showed me his transcript, and we were able to accept him into the ISET program. His research the following semester led to a journal article and several conference presentations. He applied to our graduate program and began his MS in Chemistry last Fall. Since his involvement in ISET he has a GPA of 4.0. This Fall, he will apply to PhD programs in Chemistry, with UCLA being his likely first choice. In his own words, “Two years ago, I didn’t know if I would finish my BS degree. Now I want to push myself and see how far I am able to go.”
Lessons Learned

- MSI/Government Lab/Industry partnership can be an effective model for leveraging resources to provide best practices for increasing diversity:
  - Student research and field study experiences
  - Clear paths to student job/career opportunities
  - Hands-on course work
  - Community building/networking/mentoring
  - Faculty Development
Recommendations

- NOAA CSC type partnerships should be a high priority for MSI funding due to demonstrated success in building sustainable capacity for increasing geoscience diversity.
- Development of academic rewards for departments and faculty involvement in interdisciplinary geoscience programs is critical to closing the geosciences diversity gap.
- Increased accountability of universities to funding agencies needed in terms of sustainability plan.