



**Performance Report for Cooperative Agreement No: NA06OAR4810187  
For the Period from September 1, 2007 to March 30, 2007**

**North Carolina Agricultural and Technical State University**  
Interdisciplinary Scientific Environmental Technology Cooperative Science Center

**Center Director: Dr. Solomon Bililign**

North Carolina Agricultural and Technical State University (Lead Institution)

- University of Alaska Southeast (UAS)
- California State University-Fresno (CSU-Fresno)
- City University of New York (CUNY)
- Fisk University (FU)
- University of North Carolina at Pembroke (UNCP)
- North Carolina State University (NCSU)
- University of Minnesota (UM)

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## Executive Summary

The mission of the ISETCSC is to train students in NOAA scientific areas and develop technology and techniques of analysis of global data sets for an improved understanding of climate and environmental change. The focus of the ISET Cooperative Science Center (ISETCSC) is to increase the number of students from communities that are underrepresented in NOAA science and technology who complete their education and training for careers in these areas. The research goals are (1) Conduct research to develop new sensors and sensor packages that will be used for profiling atmospheric trace constituents and meteorological variables as well as for measuring water quality. (2) Conduct research using both numerical and empirical methods to characterize and specify significant factors affecting tropical storms to provide better-forecast models and predictions. (3) Develop data-fusion techniques, data mining techniques, sensor networks, and multiagent and grid computing to support implementation of the analytic techniques. This is consistent with NOAA's mission "to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social and environmental needs" and NOAA's Strategic Goal of understanding climate variability and change to enhance society's ability to plan and respond.

The ISETCSC's mission is aligned with NOAA-ESRL's strategic plan to observe and understand the Earth system, and to develop products, through a commitment to research, that will advance NOAA's environmental information and service on global-to-local scale. The goals of ISETCSC's three thrust area goals are aligned with the ESRL Division's goals. The goals of the ISETCSC thrust area I are aligned with ESRL-CSD's mission to understand the atmospheric mechanisms that drive the Earth's climate. CSD's research focuses on the chemical and radiative processes of the lower two layers of the atmosphere, known as the troposphere and stratosphere. The goals of thrust areas II and III are aligned with the goals of ESRL-PSD and GSD. ISETCSC scientists are creating collaborations with NOAA scientists both at ESRL and other relevant NOAA line offices to achieve their goals in research and teaching.

Forty-four students from all partner institutions are supported by ISET. In addition three students have been recruited at UNCP; the new students will start this summer. Four NCAT students are involved in NOAA related research but supported by other funds. The NCAT students' educational plans include participation in research and attending seminars and colloquia organized by the Center. Aggressive recruitment efforts are planned and in progress. that include scholarship offers made to 30 high school seniors who have been admitted to the departments of chemical engineering, civil and environmental engineering, computer science, chemistry, mathematics and physics at NCAT. Graduate recruitment strategies include distribution of flyers to HBCUs and attendance at graduate career fairs at different universities. Six graduate students are expected to matriculate in fall 2007. The ISETCSC website, [www.ncat.edu/~iset](http://www.ncat.edu/~iset) or [noaaiset.org](http://noaaiset.org), is live and being used as a recruitment and Center communication tool. Additional material and capabilities are being added to the site during May. A Center logo has been designed. Brochures, retractable banners, posters, and tabletop banners and DVD, will be available to all partner institutions by the end of the summer for fall recruitment purposes. REU offers for five students are given at NCAT, and some Fisk students are expected to spend the summer at the University of Minnesota.

ISET PIs have submitted proposals worth \$1.0 million and obtained \$524,000 in grants leveraging the Center. New collaborations with international agencies and countries have been created with the African Center for Meteorological Applications for Development, SURA, RENCI and CDC.

ISETCSC is instrumental in new course and program developments. A course in Remote Sensing and Surveillance is developed and taught to an advanced class in collaboration with a scientist from Northrop Grumman Electronic Systems at CUNY, and at NCAT the graduate course EES750: Chemical and Physics Processes in the Atmosphere is offered for the first time in spring 2007. The curriculum for a BS in Atmospheric Sciences and meteorology is developed at NCAT and the program is waiting for approval by the University System. A new BS degree in Environmental Science is in the final stages of approval for Fall 2007 at FRESNO. A senior scientist position is advertised and a search for climate modeling expert is completed at NCAT. NOAA scientists are visiting ISET institutions and presenting seminars and are scheduled to visit and give seminars though the year. These visits are accompanied by collaborative discussions with relevant PI's to further the research agenda.

In conjunction with the National Climatic Data Center in Asheville, NC (Carmella Watkins) and the National Weather Service Office in Raleigh, NC (Ruth Aiken) whether and climate camps for middle and high school students are planned for the 07 summer in North Carolina. Additionally, Earth System Science Institute for Educators in partnership with Incorporated Research Institutions for Seismology (IRIS) is planned for this summer in North Carolina. The UAS ISET effort is working in collaboration with the UAS EDGE (Experiential Discoveries in Geosciences Education) project, which is an initiative of UAS faculty to help Alaska's middle and high school teachers design exciting curriculum that will help students meet the state's Earth Science performance standards. At Fresno, a one-day event is planned for Earth Science Week in October 2007. The event will be targeted at K-12 teachers and students and will have two themes – urban air pollution and global warming.

ISET PI's have made several public appearances to promote NOAA sciences, organized sessions in conferences, set up booths at national conferences, and made presentations of their work at conferences. This includes (22) presentations by ISET PI's and students, (3) submitted papers, and a total of eighteen ISET supported students attended NOAA science related conferences.

### **Summary of performance**

Students supported by ISETCSC and on training in NOAA sciences in all institutions	44
Number of scholarships offered to freshmen coming in 2007 at NCAT	30
Students recruited for the summer and fall 2007 at all institutions	12
Number of publications submitted or published	3
Number of presentations made by ISET PI's	15
Number of presentations by students	7
Number of students who attended NOAA related conferences/meetings	16
Number (and dollar amount) proposals awarded leveraging ISETCSC	2(\$524,000)
Number of (and dollar amount) of proposals submitted leveraging ISETCSC	`5(\$1. M)

## SECTION I – STATUS OF AWARD ACTIVITIES

### SECTION I-1: STATUS OF GENERAL TASKS

**Goal 1:** Establish a NOAA Center that is innovative in applied science, technological research, and teaching.

Objective 1: Establish a Center and expand its administrative capacities at North Carolina A&T State University and partnering institutions to further Center's goals.

Objective 2: Build on existing academic and organizational infrastructure to develop strong academic activities related to NOAA sciences

#### *A. Establishment of the Center*

With the help of NCAT's Council of Associate and Assistant Deans and Vice Chancellor for Research and Economic Development, the NOAA-ISETCSC is now a university approved Center. The Center is housed in the College of Arts and Sciences and the Center Director reports to the Dean of the College of Arts and Sciences.

The ISETCSC Internal Advisory Committee has been formed. The members are the deans of the College of Arts and Sciences, College of Engineering, and Graduate School and the Vice Chancellor for Research and Economic Development. This committee receives monthly reports from the Center Director and helps facilitate requests by the Center to the University administration.

The Center office has been established. It is temporarily located in Room 110 of the Fort Interdisciplinary Building. An administrative secretary has been hired and the position for the Center manager has been advertised.

NCAT has designated a permanent space for the Center in Gibbs Hall. It includes office space for the Center Director, Center Manager, and a secretary. It also has space for a senior scientist, post-doctoral researchers, a meteorology lab, and a conference room. This building is currently under renovation; the move into the permanent space is expected to take place in August 2007.

The office of the PhD program in Energy and Environmental Studies will also be relocated to the same space to allow effective coordination of research and student recruitment. The Director of the Energy and Environmental Studies program is also the Director of Outreach and Educational Programs for the Center.

The Research and Technology Steering Committee has been formed. Its members are the PIs from the partner campuses and Thrust Area Leaders. The Steering Committee has been conducting monthly meetings via telephone. The ISET web page, which has been live since December 2006, is now an additional tool of communication between the partners. Job announcements, seminar announcements, and copies of seminars and colloquia are posted regularly on the web page. Resources for all PIs are available at the site. The web page is very interactive and allows PIs to post announcements, news items, etc. Other Center related materials are also archived on the web with password-protected access.

## **B. Center Related Academic Activities**

### **B.1. Course offering and new courses and programs.**

In order to encourage current PhD students on the campus of NCAT to study NOAA related science, the graduate course EES750: Chemical and Physics Processes in the Atmosphere was offered in spring 2007. One of the students in this course will continue work on a research project in collaboration with Dr. Semazzi at NCSU. A concentration in Earth System Sciences within the PhD program in Energy and Environmental Studies is being developed.

To serve as a bridge between K-12 educational efforts and the PhD program, a new BS degree program in Atmospheric Sciences and Meteorology has been proposed and a full planning request has been submitted to the NCAT Administration.

Furthermore, a complete curriculum based on the guidelines of the American Meteorological Society has been developed. This curriculum includes eighteen new courses already approved by all of the relevant university committees:

<b>Course Number</b>	<b>Course Title</b>
ASME 200	Earth System Science: Exploring the Connections
ASME 211	Computer Applications in Meteorology
ASME 251	Fundamentals of Meteorology
ASME 252	Meteorological Analysis Lab
ASME 231	Atmospheric Thermodynamics
ASME 275 Elective	Weather Systems
ASME 285 Elective	Broadcast Meteorology
ASME 422	Synoptic Meteorology
ASME 433	Atmospheric Dynamics I
ASME 434	Atmospheric Dynamics II
ASME 440 Elective	Atmospheric Chemistry
ASME 471 Elective	Weather Analysis and Forecasting
ASME 481 Elective	Atmospheric Fluid Dynamics
ASME 491 Elective	Chemical and Optical Instrumentation for Atmospheric Measurement
ASME 550	Senior Project
ASME 563	Atmospheric Remote Sensing
PHYS 411	Atmospheric Physics I
PHYS 412 Elective	Atmospheric Physics II

**CSU-Fresno:** A new BS degree in Environmental Science is in the final stages of approval for fall 2007. The degree program will parallel a joint degree currently offered with UC Riverside. Enrollment in the new degree program is expected to significantly exceed that of the older joint degree (currently enrolling twenty-two students).

**UAS:** The 2007 summer field season will support approximately six undergraduate students and will provide opportunities designed to recruit grades 7-12 students and undergraduates. Educational efforts have been coordinated with the UAS EDGE (Experiential Discoveries in Geoscience Education) project, an initiative of UAS faculty to help Alaska's middle and high

school teachers design exciting curriculum that will help students meet the state's Earth Science performance standards. The National Science Foundation funds this project. The 2006 EDGE cohort consisted of fourteen teachers and eighteen students. The students were successfully recruited to science, technology, engineering, and math programs at the colleges they plan to attend. Additionally, preliminary conversations have begun with Ms. Rosita Worl of the Sealaska Heritage Native Foundation to improve recruitment of Native Alaskan students.

**CUNY: Remote Sensing and Surveillance:** The CUNY group developed and taught an advanced class in collaboration with a scientist from Northrop Grumman Electronic Systems (Fred Moshary, CCNY and Anthony Dinardo, NGC). It was offered spring 2007 and it enrolled twenty students, both graduate and advanced undergraduates.

## B.2. Capacity building initiated by the Center

### a) Faculty hiring:

**NCAT:** A successful search recruited a new faculty member in meteorology and climate modeling. A search for a senior scientist search at the full professor level (Professor in Atmospheric Sciences and Meteorology) is ongoing.

**Fresno State** has hired three new faculty members this year who will contribute to the broad goals of the ISET center. The Department of Earth and Environmental Sciences has hired two faculty members to teach courses in the new Environmental Sciences degree program. In addition, the Department of Chemistry has hired an electrochemist with research interests in chemical sensors and fuel cells.

### b) Post doctoral research:

Two post doctoral researchers will support the research activities of Thrust areas I and III at NCAT. An additional postdoctoral research position at NCAT will support Thrust area II. One postdoctoral fellow at CUNY has been hired.

### c) Title III funding:

ISETCSC has leveraged Title III funds from NCAT to purchase equipment worth \$18,000 for the Center. The new equipment will support research activities in Thrust area I and II at NCAT.

### d) Lab infrastructure

ISETCSC has obtained support from NCAT to purchase furniture for the meteorology lab that will be established in the fall of 2007.

### e) GIS facility use

ISETCSC has negotiated the use of the GIS lab currently under direction of the Department of Political Science and Criminal Justice in the College of Arts and Sciences. The lab will be used for ISECSC research and education. ISETCSC will provide the visual display unit.

### f) Video conference facility use

The College of Arts and Sciences has provided use of the video and teleconference facility in the New Classroom Building on the campus of NCAT for ISETCSC conferences and lecture programs.

SECTION I-2: STATUS OF RESEARCH TASKS

**Goal 2:** Cooperate and collaborate with other NOAA centers and research facilities on research to develop new technologies to understand climate and environmental change.

A. Research Objective 1: Conduct research to develop new sensors, sensor technologies strategies for sensor use, and sensor packages (Thrust area I).

The research activity in Thrust area I is closely aligned to NOAA-ESRL's Chemical and Physical Sciences Division. In this reporting period, the main activity has been to identify NOAA collaborators, discuss short term and long term projects relevant to NOAA's mission, identify potential graduate and undergraduate students, and discuss plans on how best to train students. A search for a postdoctoral fellow to support the research at NCAT is on going.

**Thrust Area I: Research Objectives, Lead Researchers and Collaborators**

<b>Research objectives</b>	<b>Lead ISET researchers</b>	<b>NOAA collaborators</b>	<b>Section</b>
Eye-safe lidar. Evaluation of available techniques and technologies in both the UV and IR	Ahmed, Gross, Moshary, CUNY; Aspey, Arend	Hardesty and Tucker, NOAA ESRL	A-1
Apply multi-wavelength to measure aerosol loading and microphysical properties at cloud base.	Ahmed, Gross, Moshary, CUNY	Hardesty, NOAA ESRL; Alexandroff, NASA GISS.	A-2
Monitoring of atmospheric trace gas constituents. Evaluate, develop, and test analysis methods for multiangle passive DOAS algorithms suitable for trace gas localization	Ahmed, Gross, Moshary, CUNY.	Gmachl, Princeton, Director of NSF MIRTHE; Hardesty, NOAA ESRL.	A-3
Integrated optical sensor packages for coastal waters. Task selection of appropriate bio-optical water parameters for new measurement techniques. Evolution of technical approaches	Ahmed, Gross and Moshary, CUNY; Schalles, Creighton University, collaborator for data and instrumentation support.	Hardesty, NOAA ESRL; Brown, NOAA CICS.	A-4

& definition of system parameters for passive/active sensors & preliminary tests			
Set up of the laboratory and beginning of apparatus set up for study of the kinetic uptake and chemistry of HNO <sub>3</sub> in the atmosphere and the interactions with NO <sub>x</sub> and cloud chemistry constituents.	Adewuyi, NCAT	Talukdar, ESRL-CSD	A-5
Luminescent sensors. Development of synthetic scheme that targets new multi-dentate ligands. Set-up of vacuum lines and other essential synthetic laboratory components	Assefa, NCAT	Joost de Gouw, ESRL-CSD	A-6
Proton Transfer Mass Spectrometry in negative ion. Set up of RTOF negative ion detection	Bililign, NCAT	Roberts, ESRL-CRD	A-7
Cavity ring down spectroscopy. Get necessary components for experiment	Bililign, NCAT	Brown, ESRL-CRD	A-8
The chemistry of aerosol precursors: Configure apparatus. Recruit postdoc and students. Conduct preliminary experiments and perform calculations	Hasson, CSU-Fresno	Burkholder, ESRL-CRD	A-9
Assessment of RGA for atmospheric CO <sub>2</sub> and other trace gases measurements; Survey of CO <sub>2</sub> electrocatalysts for possible use in electrochemical	Flowers, UNCP	Tans, Dlugokencky, ESRL-CSD	A-10

sensors.			
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**Thrust Area I: Cooperative Research Activities**

A-1 Atmospheric Sensor Technologies

**A-1: Eye Safe Lidars**

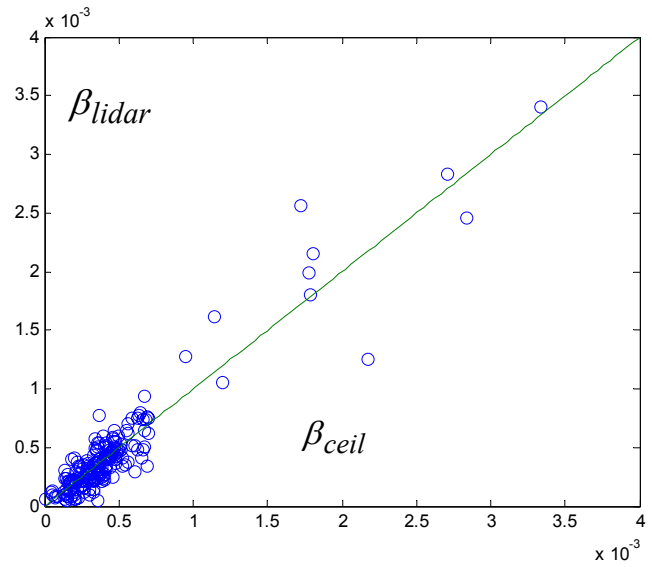
Evaluation of available techniques and technologies in both the IR and UV

**A-1: Atmospheric Sensor Technologies**

Evaluation of available techniques and technologies in both the IR

**Progress:**

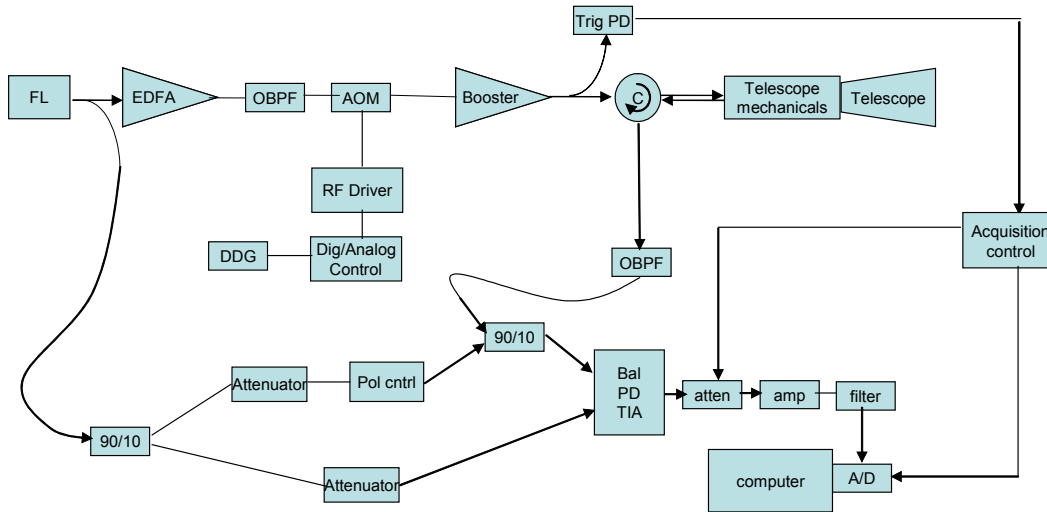
**Ceilometer instrument in NIR 900 nm, for continual observations of aerosols.** The need for continuous vertical aerosol observation is critical to aerosol transport and prediction. To this end, an eye-safe ceilometer usually used only for cloud base measurements was deployed to observe aerosols. Preliminary results show that, in direct comparisons with 1064nm lidar measurements, the ceilometer backscatter provides reasonably accurate aerosol backscatter to approximately 1 km using spatial bins of 40 meters and time averages of 15 minutes.



**Fiber-based Eye-safe Doppler Lidar.** The lidar team has established design criteria for the various components of a fiber-based 1.55 micrometer lidar system with coherent detection. By utilizing some pre-existing equipment, they have demonstrated some of the key concepts required for heterodyne coherent detection using fiber based technologies. This has helped them as they approach assorted vendors with requirements and as they begin purchasing some of the additional necessary parts. They have developed a scheme to migrate our prototype laboratory demonstration in to a working system that can be made portable and compact. This scheme will enhance their ability to test the performance of the individual parts as they are acquired, in order to insure their compatibility with their system design.

A simplified diagram of the system under construction is shown below:

### Fiber-based Eye-safe Doppler Lidar



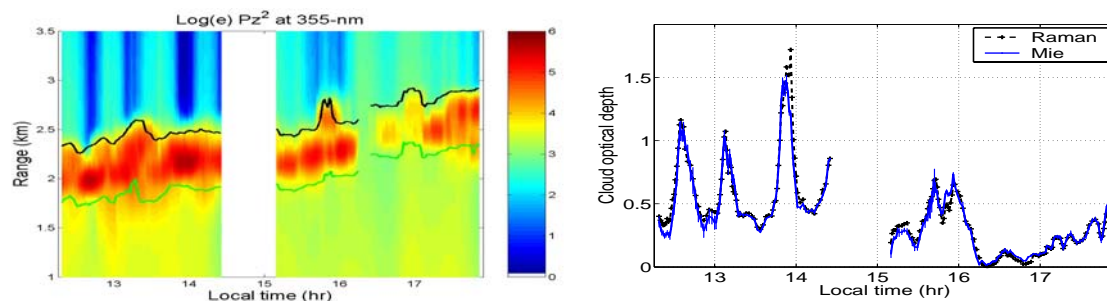
Simplified diagram of the Fiber-based Eye-safe Doppler Lidar system. FL: fiber laser for local oscillator and power amplifier seed, EDFA erbium doped fiber amplifier, OBPF: optical bandpass filter, AOM: acousto-optic modulator, C: optical circulator, DDG: digital delay generator, 90/10: optical couplers, Pol Cntrl: optical polarization controller, Bal PD TIA: balanced photodiode followed by a trans-impedance amplifier, atten: electrical attenuator.

Both aerosol concentration and wind speed can be measured simultaneously with this system by detecting the amplitude of the heterodyne detected beat signal generated by mixing (and time gating) a lidar return signal with a local oscillator reference signal.

### A-2. Aerosol–Cloud Interactions

#### Progress

The retrieval of data about low altitude, optically thin clouds and their properties is under analysis using a simple Mie scattering approach (based on the change of a linear regression slope found above and below the cloud layer) which was then compared to the results obtained using a Raman Lidar to calculate the cloud extinction directly. A representative example (March 15, 2006) for a large time interval in which the COD undergoes dramatic change is shown in Fig.1 (a~d). Range-square corrected elastic returns are plotted in Fig.1 (a), which characterize cloud heights of 1.8~3 km. Complementary radiosonde data show that temperatures vary from 255 K to 262 K in cloud zones, implying that the cloud is realistically mixed-phased.



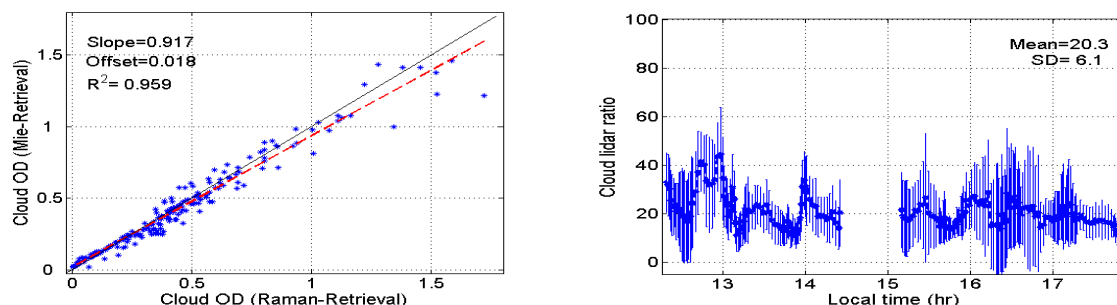


Fig.1 (a) Log range-square corrected elastic returns, (b) cloud optical depths, (c) their correlation, and (d) average lidar ratios in clouds on March 15, 2006

As Fig.1 (b) shows, after aerosol contamination is eliminated, the two retrievals are nearly coincident with each other. Cloud optical depths vary from 0.1 to 1.7 at wavelength 355-nm. A good correlation between the retrievals is seen in Fig.1 (c) with  $R^2=0.959$ . Clearly, discrepancies become larger at higher CODs. The mean and standard deviation of lidar ratios in cloud layers are shown in Fig.1 (d), and it is observed that most of them fluctuate along 20-sr line, which is indeed consistent with a water phase cloud model. From these measurements, 3D profile maps of the lidar extinction / backscatter ratio were constructed.

### **MFRSR cloud optical depth estimations**

The Investigators in this area are looking at integrating an improved algorithm into the standard MFRSR processing for aerosols and to make any algorithm of clouds to be consistent with it.

### ***A-3. Monitoring of Atmospheric trace gas constituents***

#### **Progress:**

A 2AP azimuth over elevation positioner was acquired from Kipp-Zonen. The device will serve as the scanning platform for both passive and active DOAS system as it can be operated both with a sun-tracker as well as under computer control. Jerome Richardson (Electrical Engineering, Undergraduate) is working on writing Labview software for operation of the platform.

This work is leveraged by another effort in collaboration with Princeton University, funded by NSF Engineering Research Center (ERC) program. The NSF Center at Princeton focuses on Mid-Infrared Technologies. Princeton is in the process of delivering a Quantum Cascade Laser to CCNY; it will operate in the 9.7-10.3 micron mid-ir range. The group is designing an open path active system that will integrate this laser with a receiver for ambient measurements.

### ***A-1 to A-3***

#### **Scholarly Productivity: Publications**

Barry Gross, Viviana Vladutescu, Fred Moshary, Sam Ahmed. "Assessment of a QCL Laser approach for the simultaneous measurement of ambient ammonia and ozone." Infrared, Mid-IR, and THz Technologies for Health and the Environment II – Submitted to SPIE Optics East, July 2007.

### **Presentations/meetings attended**

S. Ahmed, "Development Challenges of Systems and Technologies for Atmospheric and Coastal Water Quality Monitoring." Fourth NOAA Education and Science Forum Science, Stewardship and Sustainability October 30, 31 and November 1, 2006, Florida A&M University, NOAA Environmental Cooperative Science Center, Tallahassee, Florida.

David Santoro. "Continuous Wave Frequency Modulated Aerosol Lidar." Fourth NOAA Education and Science Forum Science, Stewardship and Sustainability, October 30, 31 and November 1, 2006. Florida A&M University, NOAA Environmental Cooperative Science Center, Tallahassee, Florida.

### **Students working on Project**

Jerome Richardson (African American, US Citizen): BS Student, Electrical Engineering Department, Scanning DOAS project

David Santoro (White, US Citizen, Student with Disabilities): Ph. D. Student, Electrical Engineering Department, CCNY. Eye Safe Lidar Project

Viuviana Vladutescu (Electrical Engineering-PhD-Leveraged Student),

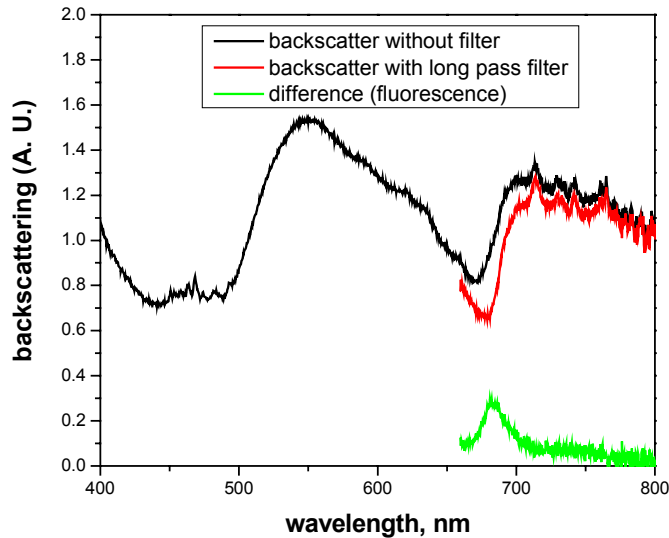
Chuen Meei Gan: Leveraged Student, MS Electrical Engineering - Cloud Lidar Project

### ***A-4. Integrated Optical Sensor Packages for Coastal Waters***

The highly structured nature of the phytoplankton backscatter spectrum is due to anomalous dispersion. It must be taken into account in remote sensing retrievals where phytoplankton (algal) scattering is significant, e.g. algal blooms. Initial efforts in instrumentation development have focused on more effective means of in-situ backscatter measurements. Backscatter information is also becoming recognized as particularly relevant for discriminating between different particle types because it is very sensitive to the shape, size and the refractive index of the particles. Although backscatter sensors are available at discrete, but widely spaced, multiple wavelengths, they miss many essential features. Thus, there is little knowledge about continuous spectral dependence of different particulate backscattering in sea water, particularly in coastal Case 2 waters where both mineral and phytoplankton scattering is important.

To address this issue, schemes with white light illumination coupled to optical fibers for both delivery of illumination and collection of backscatter that is directed to a miniature spectroradiometer are being developed. Laboratory experiments were performed to measure the backscattering spectrum of algae samples at various angles. To eliminate fluorescence interference in the backscatter spectrum, the illumination was carried out using a combination of long and short pass filters, which were combined to remove the chlorophyll fluorescence signal. This successfully extended the acquisition of continuous backscattering spectrum across the critical near infrared band that is so important in retrieval algorithms (see Fig. below). To simulate possibilities for time gated field measurements the laboratory measurements were carried out with background light, which was captured then subtracted.

The preliminary results indicate that the comparison of backscattered signal recorded in a simple geometric arrangement at two different locations along the incident light path can probably be processed to provide inherent optical properties of the samples, including absorption, extinctions and scattering. This information also permits assessment of the influence of attenuation on the



backscattered signal, which will lead to its more accurate retrieval. More detailed knowledge about the morphology and refractive index including real and imaginary part of the various types of algae cells are needed for simulations and to confirm the experimental results. This includes calibration using standard particle sizes to obtain absolute backscattering values. The approach will also be extended to explore the use of polarization discrimination measurement techniques developed by the team, in the same types of geometries, in order to obviate the need for illumination through filter sets, as well as for obtaining more inherently accurate results. Results of this work have been submitted for presentation to SPIE Boston, 2007.

#### A-4

##### **Scholarly Productivity: publications**

Samir Ahmed, Alexander Gilerson, Jing Zhou, Soe Hlaing, Ioannis Ioannou, William Jerez, Barry Gross, Fred Moshary. "Impact of Backscattering Spectra and Fluorescence on NIR Retrieval Algorithms for Coastal Waters." Accepted for AGU meeting, Mexico, May 2007.

J. Zhou, A. Gilerson, I. Ioannou, B. Gross, F. Moshary and S. Ahmed. "Continuous Spectral Measurement of Backscattering in Sea Water." Submitted to SPIE Optics East 2007

##### **Presentations/meetings attended**

S. Ahmed. "Development Challenges of Systems and Technologies for Atmospheric and Coastal Water Quality Monitoring." Fourth NOAA Education and Science Forum Science, Stewardship and Sustainability October 30, 31 and November 1, 2006. Florida A&M University NOAA Environmental Cooperative Science Center, Tallahassee, Florida.

SPIE Optics East October 2006, Boston – Dr. J. Zhou attended this meeting to study state of the art presentations in optical sensor technology.

### **Students working on Project**

William Jerez (Hispanic, US citizen): MS Student Electrical Engineering Department - Water Quality Instrumentation Project

Ioannis Ioannou: Leveraged Student PhD Electrical Engineering Department - Water Instrumentation Project

### ***A-5. Uptake Studies of HNO<sub>3</sub> on Carbonaceous Soot***

**Progress:** Preliminary laboratory developments for the study of the kinetic uptake and chemistry of HNO<sub>3</sub> in the atmosphere and the interactions with NO<sub>x</sub> and cloud chemistry constituents using IR procedures have been initiated. Purchases of necessary analytical equipment and supplies are underway. A Bruker FT-IR purchased from Title III funds has been setup and purchase of Parker Balston Purge Gas Generator for the FT-IR instrument has been initiated. Hiring of a postdoctoral fellow for Group 1c and recruitment of graduate and undergraduate students are also in progress.

Dr. Adewuyi has identified two undergraduate students (Korey Craig and Dajuan Horton) interested in working on the NOAA project this summer and/or fall. Active recruitment of graduate students is underway for this fall. Dr. Adewuyi will co-advise several students with Dr. Assefa of the Chemistry Department and Dr. Bililign in the Physics Department. Dr. Ranajit K. Talukdar of the Chemical Sciences Division, NOAA Earth System Research Laboratory, is the potential collaborator in this endeavor; he visited NCAT on April 19.

### **Presentations:**

Adewuyi, Y. G. “Combinative Sonophotocatalytic and Sonophotocatalytic Oxidation Processes for the Treatment of Pollutants in Water: an Overview and Future Research Needs.” Paper 572b. AIChE Annual Meeting, San Francisco, CA, November 12 – 17, 2006.

Adewuyi, Y. G. “Sonochemical Removal of Nitric Oxide from Flue Gases.” Paper No. 557b. AIChE Annual Meeting, San Francisco, CA, November 12 – 17, 2006.

Adewuyi, Y.G. “Ultrasonic Irradiation as an Advanced Oxidation Technology for Water Treatment: Investigation of Process Parameters using a Novel Reactor. TiO<sub>2</sub> Photocatalysis (TiO<sub>2</sub> -12) and Advanced Oxidation Technologies (AOTs).” International Conference, Pittsburgh, Pennsylvania, USA, September 25-28, 2006.

### ***A-6. Luminescent sensors***

**Progress:** Preliminary work has targeted the perturbation of the intensely luminescent metal-metal interaction in group eleven complexes. The perturbation of the metal-metal interaction is the key strategy being pursued to develop complexes with VOC detection capabilities. The synthesis and characterization of some triphosphine adducts of gold(I) and other heavy metal complexes has been started. A graduate student, Ms. Darkus Jenkins, is pursuing this part of the research activity. A collaborative effort with Dr. Richard Sykora (University of South Alabama)

has been established. He will provide most of the structural x-rays. Ms. Jenkins has presented her work at the ACS- national meeting in Chicago in March 2007.

Two undergraduate students are also actively participating in the photochemistry of the columnar square planar tetracyano platinates. These systems are interesting in that their square planar units stack one unit on top of the other forming a one dimensional columnar arrangement with nominal metal-metal interaction. As the materials are strongly luminescent, it was thought that perturbation of the metals interactions should change the metal-metal distance and subsequently shift the emission energy in a predictable direction. Preliminary data by undergraduate researchers appears to confirm that. This line of research will be thoroughly pursued. This part of the research was developed solely to entice undergraduate researchers. They will learn the synthetic schemes, spectroscopic instruments, data analysis and reporting, while at the same time contributing meaningful information in the area of VOC detection methodologies.

The NOAA collaborator is Joost de Gouw of the Chemical Sciences Division, NOAA Earth System Research Laboratory. The current collaboration has mainly concentrated on establishing general understanding of the research project. The common theme is VOC detection. While Joost's expertise is in the direct mass spec. analysis of the targeted VOC, the ISET team's approach is aimed at developing luminescent-based materials that can show a change in their luminescent characteristics when they absorb a VOC. The staff of the chemical division has taught us about NOAA's crucial needs in this area, an important part of this effort to develop the new materials.

Instrumentation purchase is in progress and hopefully the lab will be fully functional at the beginning of the summer. Lab improvements include i) an upgrade of the photoluminescence spectrophotometer; ii) *in-situ* vibrational capability, and iii) vacuum line set-up.

### **Student projects**

Mr. David Pollard has joined the group at the beginning of the spring semester to pursue PhD in the Environmental Science program. He will be assigned to develop the multidentate gold(I)-gold(I) complexes for luminescent VOC sensor applications.

Ms Darkus Jenkins is currently working for her MS. Her program is in the area of synthesis and luminescent dynamics of group 11 metal complexes with phosphines and aminophosphine ligands. Ms. Jenkins is currently writing her thesis, and she is expected to graduate over the summer of 2007.

### **Research Plan for undergraduate students**

Ms. Amber Strothe and Ms. Kendra Whitehead have been awarded the NOAA scholarship grants. These undergraduates are studying photoluminescence study of stacked tetracyano platinates of lanthanum and europium and other lanthanide complexes. Ms. Kendra Whitehead has agreed to continue this aspect of the research during the summer. She will analyze various types of VOC interactions with the tetracyanoplatintes and develop fundamental understanding of the system.

### ***A-7. Proton Transfer Mass Spectrometry in Negative Ion***

**Progress:** The implementation of the PTRMS-NI requires a clean, relatively intense source of the appropriate negative ion, for example  $^{13}\text{C}$ -labelled acetate ions  $\{^{13}\text{CH}_3^{13}\text{C}(\text{O})^-\}$ . This phase of the research will involve the development and testing of different ion sources under conditions (temperature, pressure, and water vapor concentration) required for ambient measurements. The second phase of the research will involve the laboratory determination of the relative gas-phase acidities of the simple carboxylic acids, propionic, butyric and others, and some stopovers of acetate. The measurements will allow the prediction of which measurements are possible and to help define the conditions (temperature, pressure, and water vapor concentration). The Reflectron time of flight spectrometer has been upgraded for the proposed work, and a training session by the manufacturer of the instrument is planned for the summer of 2007. Jim Roberts from NOAA-ESRL visited in February to discuss projects.

Student Prospect: PhD student expected to join fall 2007.

### ***A-8. Cavity Ring Down Spectroscopy***

**Progress:** Important aspects of the chemistry of the atmosphere take place at very small concentration scales. In developing a chemical picture of the atmosphere, characterizing the abundance of trace compounds is of interest to NOAA. Due to the availability of the necessary hardware (lasers etc), at NCAT, a cavity ring down spectroscopy set up is being developed; this system is known to be the most sensitive trace gas detection method. Initial studies will focus on near infrared absorbers and infrared absorbers near 1.4 micron.

**Activities to date:** All lasers have been serviced and tuned and their parts changed. Discussions on needed parts to set up the experiments are going on, and a potential loan of parts from NOAA-ESRL was discussed with Steve Brown when he visited in March. A potential graduate and undergraduate student have been recruited to start in summer 2007. Two undergraduates will work in the laser lab this summer. Their initial phase work will be reproducing the results of the NOAA-CSD results.

**Expected students:** Chris Jessemy (Physics Graduate Student), Chris Ware (Current Physics Undergraduate).

### ***A-9. Chemistry of Aerosol Precursors***

**Progress:** The Center is well on course to meet its first-year objectives. Work has been carried out to validate HPLC and GC/MS sample collection and analysis protocols. The GC/MS method developed to quantify carboxylic acid yields has also been used in field experiments to measure emission fluxes of C<sub>2</sub> – C<sub>6</sub> acids. This work has been presented at a regional meeting. The gas cell, multipass optics and photolysis source have been tested, and preliminary calibrations for acetic and peracetic acid have been performed. Mirror mounts for the FTIR transfer optics are almost ready for use, which will enable the first experiments to be carried out shortly. Due to the success in student recruitment, a second reaction chamber is under construction that will allow to parallel experiments using GC/MS, GC/FID and HPLC to be done.

**Presentations:**

Mark Sorenson, Dale Sullivan\*, Phillip Alanis, Brian Shamp, Koua Cha and Alam Hasson.  
“Quantification of Volatile Organic Compound Emissions from California Dairy Facilities.” 28<sup>th</sup> Annual Central California Research Symposium, California State University Fresno, April 12, 2007.

\* ISET student.

***A-10. Methodology for Batch and Continuous CO<sub>2</sub> and Other Trace Gases***

**Progress:** The researchers in this area met with NOAA scientists Peter Tans and Ed Dlugokencky of the ESRL during the ISET meeting in fall 2006 and discussed several research projects that would be of relevance and potential benefit to NOAA’s mission, resulting in the revision of the original research project. They met with Jim Roberts of the CSD and discussed possible applications of portable electrochemical sensors for certain field applications that may be an area of future pursuit by this group. At this time he has been ordering supplies and equipment necessary to conduct the research as described in the Implementation Plan. One undergraduate student has been conducting some preliminary research related to the GC method development project for academic credit.

**B. Research Objective II.**

Conduct research, using both numerical and empirical methods, on the analysis of observation systems (Thrust area II)

For Thrust area II, collaborations with NOAA scientists are in the formative stage. A request for computational resources at NOAA-ESRL has been submitted.

**Thrust Area II: Research Objectives, Lead Researchers, and Collaborators**

<b>Research objectives</b>	<b>Lead ISET researchers</b>	<b>NOAA collaborators: proposed, created</b>	<b>Section</b>
Collection, processing, and transformation into gridded forms of data derived from multiple sensors constituents.	Semazzi, Xie; NCSU.	JinLee, Fairall, Koch, NOAA/ESRL; Marks, Friedman, NOAA/AOML.	B-1
(i) CC Compilation and preliminary analysis of data from multiple sensors for aerosol & hydrological-related data; processing & transformation into gridded data; & (ii) customization of WRF-CHEM to investigate the relationships between aerosols, microphysics, hydrological variables, and climate.	Mahani, Khanbilvardi, CCNY, CUNY.	Fairall, Grell, NOAA/ESRL (Collaboration in development stage)	B-2
Compilation of observational and model data; perform preliminary empirical analyses to investigate the modulation of hurricane activity by climate change. Study the influence of geomagnetic pole drift on the global warming and hurricane genesis.	Ahmidouch, Danagouliau, NCAT.	Knutson; Geophysical Fluid Dynamics Lab / P.O. Box 308 Princeton, New Jersey; Jin-Luen Lee, NOAA/ESRL	B-3
Customization of the RegCM3 model and its application to study the climate anomaly	Semazzi, Xie, NCSU	Lee, Fairall, Koch, NOAA-ESRL; Marks, Friedman, NOAA/AOML,	B-4

conditions over West Africa during the 2005 extreme hurricane season		(Proposed collaborators)	
Begin initial WRF numerical experiments to quantify the relationships between prescribed exit region coastal SST anomalies associated with upwelling/downwelling.	Semazzi, Xie, NCSU	Lee, Fairall, Koch, NOAA-ESRL; Marks, Friedman, NOAA/AOML (Proposed collaborators)	B-5
Optimization of lateral boundary conditions; formulation, resolution, and the tuning of physical parameters for the WRF-NMM regional climate model for the bifurcation region	Tang, Kyei, NCAT; Semazzi, Xie, NCSU	Lee (Planned collaboration; contacted)	B-6
Collection, processing & transformation into gridded forms, of data derived from multiple sensors to support the modeling of inland flooding in years 2-5.	Liu, Semazzi, Xie, NCSU	Palmer, NOAA/South East Forecast Center; Mark, Rogers, AOML/HRD.	B-7

**Thrust area II Cooperative Research Activities**

***B-1. Analysis of Storms and Hurricanes-1***

**Progress:** Several datasets derived from multiple sensors have been processed to support year 1 research on the linkages among hurricane developmental phases. These data include MODIS, TRMM, CMAP, CRU, and GPCP. These datasets have been used to customize the RegCM3 and WRF regional climate models as described below. Future activity will involve compilation and analysis of additional sensor data.

Students working on the project, current, planned (to be recruited)  
 Current: Jared Bowden (PhD), Matthew Norman (MS), Neil Davis (MS)  
 Planned (Fall 2007): Michael Diaz (MS)

***B-2. Analysis of Storms and Hurricanes-2***

The proposed approach uses satellite imagery to explore the effects of air particles and land-based pollutants on cloud properties and hydro-climatological variables (e.g. precipitation) to

better understand their impacts on climate system. Aerosol data from NASA-AERONET ground stations and weather station data have been downloaded for a study site located at the north-eastern United States, and processed to be utilized for starting the analysis to track relationships between aerosol optical depths and hydro-climate variables. The areal-based aerosols from remotely sensed sources (e.g. MODIS, POLDER) will be used in this study as well. Station-based AERONET data will be used to evaluate the quality of the satellite data, and if needed will serve as a calibration metric to improve satellite retrievals over surfaces similar to the AERONET stations. Characteristic profiles of tropospheric aerosol content have been observed and related to the concurrent and antecedent weather situations. This project will study the United States first and then progress to the global scale. An updated WRF mesoscale model has been customized (WRF-CHEM) to investigate the relationship between aerosols, microphysics and hydro-climatological variables for predicting climate variability.

**Research accomplishments:** The most of the literature review and downloading and processing of ground station-based data has been completed. A predictive understanding of the global climate system, observations and analysis, climate forcing, and weather and water are important to NOAA as are better, quicker, and more valuable weather information to support improved decisions for climate change study.

### ***B-3. Analysis of Storms and Hurricanes-3***

**Progress:** To determine whether the changes in Atlantic hurricane in recent decades are part of a cycle, a long-term trend, or some combination of cycle and trend is a crucial question for the future outlook of hurricane activity in the Atlantic basin.

The research undertaken is to perform a statistical analysis on past tropical storm counts (going back to 1870s) to try to distinguish between alternative hypotheses about the dominant controlling factors. Adding error bars - which are often neglected in most studies - to the observed or inferred data is key to this study and can change the outcome of the analysis. To get further insight, predictions of a regional model downscale for hurricanes, developed by Tom Knutson et al. to simulate full seasons of tropical cyclone (TC) activity in the Atlantic, will be compared to observed Atlantic hurricane statistics for the period 1980-2006.

One of the studies to be performed is to look into the Earth's magnetic field to determine its influence, if any. The trend of geomagnetic North Pole drift has been studied and it was found that during the last 150 years the North Pole drifted by more than 685 miles north. It is predicted that, during the next fifty years, the pole would move toward Russian Siberia if the drift continues at the present rate (about forty km/day). The drift of the magnetic North Pole redistributes the solar particle impact to the atmosphere, changing the properties of the ionosphere. It has also been observed that the field strength has decreased by ten per cent since nineteenth century. The correlation between these changes in the Earth's magnetic field and changes in hurricane activity in the Atlantic region during recent decades will be studied. The geomagnetic North Pole drift will be inserted in the Flow-following Finite-volume Icosahedral Model (FIM), a weather prediction model that is under development at the NOAA Earth System Research Laboratory (Jin-luen Lee et. al.).



The movement of Earth's north magnetic pole across the Canadian arctic, 1831--2001. Credit: Geological Survey of Canada.

**Student:** Patrick McCarter (Undergraduate)

#### ***B-4. Analysis of Storms and Hurricanes-4***

The 2005 Atlantic hurricane season was the most active since records began in 1851 with a total of twenty-eight tropical storms, fifteen of which developed into hurricanes. In contrast, the average was only about thirteen tropical storms during the past six years, excluding the 2005 season. Virtually all the seasonal predictions fell far short of the observed level of hurricane activity. The relationship between Atlantic hurricane activity and climatic conditions across West Africa has been a subject of intense research over the past thirty years. These investigations have shown that there is a direct relationship between African tropical easterly disturbances and hurricane activity. However, it is unclear if the same relationships would hold under the extreme conditions observed in 2005 hurricane season. In this study, the RegCM3 regional climate model is used to investigate the relative role of tropical easterly wave disturbances activity and climate of West Africa in modulating the unprecedented 2005 Atlantic hurricane season.

**Research accomplishments:** (Detailed description at [climlab.meas.ncsu.edu](http://climlab.meas.ncsu.edu)): Several runs over the domain for 2005 have been completed to customize the model. In the process of customizing the model the investigators have examined the performance of two convective schemes: the Grell with Fritsch-Chappell forcing and the Emanuel scheme. The output from the RegCM3 model was compared with the observational data (TRMM, CMAP and GPCC) to determine the best convective scheme. Additional model verification included comparing the reanalysis surface winds with model output. The results show that the surface flow is generally consistent between the model with southwest winds occurring near the exit region near Dakar and south southwest winds occurring in the Gulf of Guinea. Not only is the wind direction verified by the reanalysis data, the magnitude over these critical regions is also very similar. Using Hovmöller diagrams at 10N they observe the propagation of tropical waves in the U-V winds at 700 mb and 850 mb. There is reduced but still discernable movement of the precipitation along 10N during the active

August-September period. There appears to be a diurnal cycle of precipitation over the African continent (between 15W and 20E). Within this diurnal pattern, amplified precipitation that appears to be associated with the tropical waves can be noted. These 'waves' become more defined as they propagate off the exit region (~15W) as the diurnal cycle relaxes. The Hovmöeller diagrams show the model is producing tropical waves of realistic strength and waves are also propagating at speeds that are consistent with the observed three to five day African wave period (e.g. Diedhiou et al, 1999). Carlson (1969a) found that the maximum of rainfall and thunderstorm activity occurs approximately 600 km ahead of the trough axis, with a minimum immediately behind. This observation is also discernible in the model output. Monthly precipitation totals have also been studied. The monthly model precipitation totals have been compared to available GPCP and TRMM data. The model produces a realistic distribution of rainfall with maximum precipitation totals over Nigeria/Cameroon and the aforementioned exit region relatively much less precipitation over Ghana. Preliminary results indicate that the RegCM3 is suitable for the proposed study described in the ISET project implementation plan.

#### **Students working on the project**

Current: Jared Bowden (PhD), Matthew Norman (MS), Neil Davis (MS)

Planned (Fall/2007): Michael Diaz (MS)

#### ***B-5. Analysis of Storms and Hurricanes-5***

**Research accomplishments:** A three level nesting domain for this modeling project has been designed. The outmost domain includes the Ethiopian highlands and the Darfur highlands. Recent studies indicate that the Africa Easterly Waves (AEWs) originate in the vicinity of these highlands (e.g. Berry and Thorncroft, 2005; Lin et al., 2005; Mekonnen et al., 2006). The innermost domain is centered over the region where the AEWs exits the African continent and is associated with significant upwelling/downwelling Atlantic Ocean region.

The Weather Research and Forecasting Model (WRF) version 2.2 has been adopted in this research. The NOAA National Center for Environmental Prediction (NCEP) Environmental Modeling Center (EMC) Final Global Data Assimilation System (FNL) six hourly analyses on  $1.0^{\circ} \times 1.0^{\circ}$  grids (<http://www.emc.ncep.noaa.gov/modelinfo/index.html>) provides the initial conditions and lateral boundary conditions of the outmost domain. The model is initialized at 00Z 10 August 2004 for 96-hour simulations forced by the FNL analyses. The inner domains (domain 2 and domain 3) start at 03Z 10 August 2004 and are terminated at same time as the outmost domain. Comparison of the numerical simulations and observations show that the WRF has been successfully customized to undertake the proposed study as described in the implementation plan.

#### **Students working on the project**

Current: Jared Bowden (PhD), Matthew Norman (MS), Neil Davis (MS)

Planned (Fall/2007): Michael Diaz (MS)

### ***B-6. Analysis of Storms and Hurricanes-6***

**Research accomplishments:** One of the team members, Guoqing Tang, participated in the 2007 Winter WRF-NMM Tutorial on February 27-March 2 in Boulder, CO. The team has successfully installed and tested WRF-NMM in a 64-bit Linux workstation. WRF-NMM will be used as a regional climate model for optimization of lateral boundary conditions formulation, horizontal and vertical resolution, and tuning of physical parameters for the hurricane bifurcation region. The team is currently examining the existing lateral boundary condition formulation in the WRF-NMM model, and investigating its flexibility for modification. They will next consider implementing the "well-posed approach" in the WRF-NMM model through appropriate normal fluxes at the boundary (as opposed to the prescription of state values), and apply the relaxation method to the WRF-NMM model regarding mass conservation, long time behavior and buffer zone dependency on model problems. The aim is to make optimal choices of the adjustable model parameters for the specification of the lateral boundary schemes. The ultimate goal is to use the upgraded treatment of lateral boundary condition to conduct experimental forecasts for hindcasts for previous hurricane seasons. The study of optimization of LBC formulation deserves special attention because it accounts for a significant portion of RCM forecasting uncertainty due to unphysical treatment of LBCs.

#### **Scholarly Productivity: publications**

Y. Kyei, K. Edoh, G. Tang and J. P. Roop. "Higher-Order Compact Finite-Difference Schemes Designed through Minimization of *a priori* Error." submitted to Numerical Methods for Partial Differential Equations.

#### **Students working on the project, current**

Danny Fritz, a graduate student in the Applied Mathematics graduate program has been recruited into the project. He has been going through training in using WRF-NMM model for weather forecasts.

A graduate of the Applied Math M.S. program has been targeted for recruitment into Energy and Environmental Studies Ph.D. program and the project team.

An undergraduate physics major from NCSU who worked the previous summer with project personnel on another project is currently being considered for a summer research internship working on the project.

### ***B.7. Analysis of Storms and Hurricanes-7***

**Research accomplishments:** The watershed model of WMS7.1 has been set up, configured, and tested; some initial parameters (e.g. DEM, Land use, and gauge stations data) have been collected.

#### **Students working on the project, current, planned**

Current: Yiyi Wong

Planned: Keren Cepero

C. Research Objective III

Conduct information technology research on data fusion and mining for climate studies. (Thrust area III)

**Thrust Area III: Research Objectives, Lead Researchers, and Collaborators**

<b>Research objectives</b>	<b>Lead ISET researchers</b>	<b>NOAA collaborators: proposed, created</b>	<b>Section</b>
Development of linear algebraic and information theoretic techniques for characterizing dependence and independence in multi-modal data.	Grossberg, CUNY	DeMaria, RAMMB; Menzel, NOAA/NESDIS	C-1
Characterization of fuzzy integrals in relation to the domain. (Classical and Non-classical techniques.)	Homaifar, Samanlioglu, NCAT	Contacts made with Stankov, Kihn, Lee, Hansen, Schultz, Hamer, NOAA/ESRL	C-2
Determination of the trend in the frequency and intensity of climate disturbances. Detection of disturbance events; Trend analysis of results	Kumar, Steinbach, University of Minnesota	Weatherhead, NOAA-ESRL	C-3
Characterization of images of certain weather events. Exploration of possible pattern recognition algorithms.	Qian, Caulfield, Fisk University	Lee, NOAA-ESRL; Kihn, NOAA-NGDC	C-4
Development of general sensor grid services. Development of sensor grid service definition language. Development of a sensor grid infrastructure with sensor data integration.	Li, NCAT	Govett, NOAA/ESRL	C-5
Development of prototype multi-agent data-fusion system for restricted data sets	Esterline, NCAT	Govett, NOAA/ESRL	C-6
Deployment of SEAMONSTER network in Lemo Creek	Heavner, UAS	Weatherhead, Schultz, Hansen, and Hamer, NOAA-ESRL	C-7

Watershed; development of data framework.			
Conduct research projects on LIDAR-derived elevation models and BMPs, floodplain mapping and related topographic LiDAR research	Nzewi, NCAT	Identified but not contacted: Golden, NOAA Forecast Systems Lab; McGinley, NOAA Global Systems Division	C-8

**Thrust Area III Cooperative Research Activities:**

***C-1. Data Fusion-1***

**Progress:** The data fusion group has begun studies on heterogeneous hurricane data (for fusion) to predict storm intensification. They have begun studies clustering MODIS image for automatic identification of cloud type. They are porting from Matlab to C/C++ our entropy and mutual information estimation programs purely in order to handle the large size and volume of imager and sounder granules. They have integrated hdf libraries into their code so we can work directly with NOAA/NASA data in native form. They have ordered a 3TB network and in the processes of setting up a 3TB Network Attached Storage system to host data from GOES imager, AVHR, MODIS, and AIRS imagers for data fusion work.

Collaboration with other ISET Members:

Yaohang Li (NCAT): Grid computing and Monte-Carlo Sampling for estimation of Mutual Information in imager and sounder data to identify candidates for data fusion.

Abbie Homaifar (NCAT): Application of Baysian Network and Fuzzy Logic frame work for PDF estimation on MODIS imager data.

Vipin Kumar (UMN): Using mutual information measures for Data Mining in climate data.

**Students:**

Jamal Goddard, BS (Potential MS) (CS) CCNY

***C-2. Data Fusion-2***

**Progress:** Several data fusion techniques have been investigated. Each type of data fusion has its own advantages and disadvantages, but the data fusion team is investigating further only three of the methods at this point. Fuzzy integrals are being investigated because they can address the non-homogenous and homogenous interactions between the different sensors. The Sequential Quadratic Programming (SQP) algorithm along with the use of a hybrid neural network is being explored as a way to construct a feasible set of fuzzy measures for the integrals. They are looking into the use of Bayesian networks because they are easy to construct and to modify and can provide a good and quick approximation of the desired value. Neural networks are being researched because they can handle non-linear problems and provide a fairly accurate approximation of the desired value; they can also apparently define good sets of fuzzy measures

in a system with a moderate to high level of noise. After they have concluded an in-depth examination of the fuzzy integral, Bayesian networks, and neural networks, they may decide to reinvestigate the integration of some of the state space and statistical methods.

### **Presentations/publications**

Submitted: “Sensor Fusion Analysis Using Fuzzy Integral and Bayesian Network Techniques,” to 10th International Conference on Information Fusion, 2007 Conference.

### **Students:**

Jamie Walls, PhD Candidate, (Fellowship from NAVY, ECE), NCAT; S. Hudson, MS (CS), NCAT

### ***C-3. Data Mining***

**Progress:** The group’s research efforts have been devoted to collaboration with Betsy Weatherhead. Although a number of potential projects have been identified, they are currently focusing their efforts on just one. Specifically, they are working on a project to analyze the change in the character of the weather. In particular, many people have a feeling that the weather is changing or has changed over time, but studies of weather data often don’t confirm that feeling or capture the way in which people think the weather has changed. However, these studies often look at simple statistics, like changes in the mean, which may not be the most appropriate. Weatherhead’s goal is to quantify the persistence of weather and see how persistence has changed with time. The current approach looks at the trend in autocorrelation and various other statistics. To perform this analysis, they are using daily temperature data from the NCDC data center (<ftp://ftp.ncdc.noaa.gov/pub/data/ghcn/daily>). Most efforts have centered on porting the current analysis code from S-plus to R and addressing efficiency issues. Work is currently in progress to address quality issues with data in order to ensure the trustworthiness of the data.

### **Students:**

Blayne Field (Spring 2007), UM; Robert Olabode (started April 5, 2007), UM. Recruited new PhD student for fall 2007.

### ***C-4. Image Data Mining***

**Progress:** The data mining team is exploring the image recognition algorithms for weather events. They have explored kernel methods like SVM (support vector machine), LDA (Linear Discrimination Analysis) and PCA (Principal Components Analysis). Furthermore, they are also exploring neural network and wavelet methods. With the help of Dr. Kihn, they downloaded fairly large amount of DMSP images (over 50GB) from the CLASS web site and have built a 400 image training/testing set.

### **Students:**

Deidre Johnson and Nautica Crower began to participate in the project from November of 2006. They attended the NOAA Education & Science Forum in Florida A&M University. They met NOAA-ISET investigators in Fisk regularly and were taught skills in data mining and image

processing that are required for the research activities. Joylika Adams, Wilsharo Scott and Matthew Richardson joined the program from January of 2007. They were mentored by investigators in Fisk to perform the research in image data mining. They collected satellite images from NOAA web sites, preprocessed them and classified them to create training/testing images sets.

### ***C-5. Distributed Architecture-1***

**Progress:** Currently, the distributed architecture group is working on a pilot project of setting up a local sensor network at NCAT and then building a grid portal on it. They are also trying to develop a grid portal based on the SEAMONSTER sensor network at Alaska. Their NOAA collaborator is Mark Govett. Two students are currently working on this project: Allen Graham is working on setting up the sensor network and building a grid service on it; Michael Burns is working on the Grid Portal on the sensor network. Dr. Li is collaborating with Mark Govett to set up a pilot project of building a sensor grid based on the sensor network at NCAT and SEAMONSTER at Alaska. The collaboration has just begun. Other collaborators are Dr. Albert Esterline at NCAT and Dr. Matt Heavner at the University of Alaska Southeast (UAS).

#### **Students:**

Allen Graham, MS, NCAT; Michael Burns, MS, NCAT.

### ***C-6. Distributed Architecture-2***

**Progress:** The group is using the JADE agent framework to develop prototype monitoring systems. They are also investigating integration of Web services with JADE-based multiagent systems; this is in collaboration with Yaohang Li of NCA&T and Mark Govett of NOAA/ESRL. This is related to their work (with Li) on combining multiagent and grid functionality. Finally, they are developing specifications with Matt Heavner of UAS to be used with the SPIN model checker so that designs for concurrent sensor systems (particularly, those running as a multiagent system) may be verified against formal specifications.

#### **Students:**

MS student Larry Brown will finish his project relating Web and multiagent functionality at the end of this semester. Yusef Pogue, also an MS student, will finish next December. He is modeling checking designs for distributed sensor systems. Undergraduate Sentel Allen has been working with Brown. Finally, undergraduate Quintin Ash, who will graduate at the end of this semester, has been prototyping monitoring systems using the JADE agent framework.

### ***C-7. Distributed Architecture-3***

**Progress:** The University of Alaska Southeast ISET research activities in distributed architectures has focused on preparing for the implementation of a sensor web in southeast Alaska. By involving five undergraduate students, they have assembled and integrated data streams from four weather stations and are streaming those through various data analysis and database programs. They have assembled hardware to support the deployment of these and other instrumentation in the Lemon Creek Watershed in summer 2007. Distributed sensing and

processing is a feature of the sensor web under construction. They have explored technologies for sensing, data collection and transmission, data storage, data analysis, and data distribution. One of the weather stations has been stationed at the local ski area and has generated tremendous public outreach by including a measurement of snow depth. The specific integration of the real-time data streams into ArcView GIS analysis software has been started by students and is directly relevant to the NOAA ESRL Earth Information System (EIS) efforts.

Dr. Heavner has initiated preliminary collaboration with Mary Sue Schultz, Tracey Lee Hansen, and Paul Hamer to understand how UAS students can begin local projects that contribute to the development of the Earth Information System (EIS) at the NOAA ESRL. Jamie Turner is one UAS student working on this effort.

**Students:**

Jamie Turner, undergraduate, white, female, UAS; Logan Berner, undergraduate, white, male, UAS; Micaela Ponce, undergraduate, Native American, female, UAS; Matthew Nelson, undergraduate, white, male, UAS; Suzie Teerlink, undergraduate, white, female, UAS; Nick Korzen, undergraduate, white, male, UAS; Dave Sauer, undergraduate, white, male, UAS.

**Presentations/Meetings**

Several presentations by Dr. Heavner and UAS students reported on activities in support of NOAA ISET efforts and student projects aligned with NOAA interests in the Juneau area. At the NOAA EPP meeting Oct 29-Nov 1, 2006 in Tallahassee, Florida, Dr. Heavner presented a poster to describe research and educational opportunities at UAS. Four UAS students participated in the meeting by presenting posters of their research: Logan Berner, Micaela Ponce, Suzie Teerlink, and Matthew Nelson. Dr. Heavner presented two posters describing ISET related work at the American Geophysical Union meeting in San Francisco, CA Dec 11-15, 2006. One poster focused on the sensor web scientific goals and the second poster focused on integrating the sensor web into both UAS undergraduate education and Juneau area K-12 student opportunities

***C-8. Geospatial Information Systems***

**Progress:** Because the project is in its startup phases, most of the activities presented here are in their initial stages. The setup of the geospatial information systems lab was discussed. Space has been identified for the teaching lab and it is currently under renovation. The research lab is under development as well. At a minimum, a five-seat lab, devoted primarily to research, is planned. Data acquisition for the LiDAR (Light Detection and Ranging) research has been initiated with the NC Geodetic Survey. The initial LiDAR dataset is about one terabyte and covers the entire state of NC. A proposal for a PhD thesis by Charla Gaskins studying weather-based intelligent transportation systems was developed. A number of NOAA researchers who might collaborate in these projects were identified.

**Students:**

Charla Gaskins, PhD, African American, female, NCAT; Crystol Stewart, MS, African American, female, NCAT; Desiree Gordon, MS, African American, female, NCAT.

#### D. Research Objective IV

Strengthen Existing Collaborative Programs that Interact with a Wide Range of Stakeholders.

##### ***D-1. Grants and proposals: submitted, planned, and awarded.***

##### **Proposals**

Nzewi: A proposal entitled, "Development of a Geospatial Informatics Lab for Education, Research and Outreach," was submitted to the Department of Defense, March 26, 2007 for \$140,000 for two years

Dr. Adewuyi submitted two new competitive NSF proposals on NO<sub>x</sub> and mercury (Hg) removal to complement and leverage his ISET projects, and one of the proposals has already been awarded funding and the other is pending.

Adewuyi, Y.G. Mercury Removal from Simulated Flue Gases by Absorption into Aqueous Strong Oxidants (NSF-CBET 04-23), \$476,862 for three years (10/01/07 – 09/30/10).  
Pending

Adewuyi, Y.G. Development of an Advance Aqueous Scrubbing Process for the Simultaneous Removal of Nitrogen Oxides and Sulfur Oxides from Flue Gases by a Sonochemical Method (NSF-CBET 04-23), \$375,000 for three years (05/01/07 – 04/30/10). **Funded**

Drs. Schimmel and Bililign will lead the Education sub Center for the Home Land Security Center of Excellence DHS-COE proposed by the UNC system.

Drs. Esterline, Li, Homaifar, and Samanlioglu are also submitting proposals for the research thrust areas in the DHS COE.

Drs. Bililign and Danagoulian: NSF award \$149,000: International Experience for Undergraduates in Atmospheric Sciences and Geosciences

##### **NCSU**

High-Resolution Modeling to Assess Tropical Cyclone Activity in Future Climate Regimes (North Carolina State University Department of Marine, Earth, and Atmospheric Sciences); Submitted to the United States Department of Energy, Funding Opportunity Number: DE-PS02-07ER07-06. Principal Investigators: Gary Lackmann, Fredrick Semazzi (ISET PI), Anantha Aiyyer, and Lian Xie (ISET PI); Total Proposed Cost: \$450,000; Budget Period: three Years

##### **UAS**

Dr. Heavner has initiated discussions with local NOAA scientists about possible ISET collaborations. Specifically, Dr. Heavner has met with Dr. Phil Mundy, director of NOAA Auke Bay Labs, Dr. John Moran, at NOAA Auke Bay Labs, and Tom Ainsworth, the meteorologist-in-Charge at the Juneau National Weather Service Office. These discussions have resulted in an internal NOAA Auke Bay Labs funding request to provide support for ISET related work on technological developments for ocean monitoring by Dr. John Moran. Mr. Ainsworth has presented a guest lecture in Dr. Heavner's Climate Change class and used the opportunity to better inform the students about NOAA activities and interests in the Juneau area.

***D-2 New collaborations that leverage the Center's resources***

**Semazzi, NCSU:** With the African Center for Meteorological Applications for Development (ACMAD, Niamey, Niger)

**Li and Esterline, NCAT:** Plan to collaborate with the SURA grid organization to take advantage of the SURA grid resources in this project. Moreover, they intend to collaborate with RENCI to integrate with their grid portal or workflow.

**Nzewi, NCAT:** plans to actively collaborate with NOAA's NCDC, Asheville through Carmella Davis-Watkins [Carmella.davis.watkins@noaa.gov]; North Carolina Geodetic Survey; North Carolina Floodplain Mapping Program (NCFMP); North Carolina Center for Geographic Information and Analysis.

## SECTION II: EDUCATION & OUTREACH EFFORTS

**Goal 3:** Increase the number of underrepresented minorities trained and educated in NOAA sciences; education and training provided by the Center's staff and by NOAA collaborators at all levels from K-12 to undergraduate and graduate students.

A. Education Objective I: Establish NOAA-ISETCSC graduate and undergraduate scholarships at all partner universities and develop and implement a coordinated student recruitment plan involving all university partners.

### ***A-1: ISETCSC Supported Students***

#### **FISK**

Five students participated in the NOAA-ISET program in Fisk University. They are: Deidre Johnson, female, CS major sophomore; Joylika Adams, female, CS major sophomore; Wilsharo Scott, male, CS major freshman; Matthew Richardson, male, CS and Physics major junior; Nautica Crower, female, CS and Psychology major senior.

#### **ALASKA**

Jamie Turner, undergraduate; Logan Berner, undergraduate, presented poster at EPP Tallahassee; Micaela Ponce, undergraduate, Native American, presented poster at EPP Tallahassee; Matthew Nelson, undergraduate, presented poster at EPP Tallahassee; Suzie Teerlink, undergraduate, presented poster at EPP Tallahassee; Nick Korzen, undergraduate; Dave Sauer, undergraduate.

#### **MINNESOTA**

Blayne Field, Spring 2007; Robert Olabode, April 5, 2007, African American; Fernando Torre, PhD. Student to start fall 2007, Hispanic.

#### **Fresno**

Undergraduate students are Dale Sullivan, Geology, senior; Sukhdip Singh, chemistry, junior; Yesenia Ibarra, geology, junior. Dale Sullivan will graduate in May 2007, but will enter the MS program in the fall and will continue his involvement with the project. One additional student is currently being sought for the research program. The position is being advertised internally and at sister CSU campuses. Fresno State ISET faculty will also continue to publicize the position at conferences such as AGU and ACS meetings until the position is filled.

#### **UNCP**

Applications were solicited from UNCP undergraduates to work as research assistants with NOAA support during the coming summer 2007 period. The three available student assistantships have been awarded to Emily Kuhlbars, biology major, Caucasian female; Joshua Locklear, chemistry major, Native American male; Shane Gutierrez, chemistry/applied physics major, Hispanic male.

#### **CUNY**

William Jerez, Hispanic, US citizen, MS, Electrical Engineering, Water Quality Instrumentation Project; David Santoro, white, US citizen, student with disabilities, PhD, Electrical Engineering, CCNY, Eye Safe Lidar Project; Jerome Richardson, African American, US Citizen, BS,

Electrical Engineering, Scanning DOAS project; Viuviana Vladutescu, Electrical Engineering, PhD, leveraged student; Chun Mei Gan, leveraged student, MS, Electrical Engineering, Cloud Lidar Project; Ioannis Ioannou, leveraged student, PhD, Electrical Engineering, Water Instrumentation Project; Maria Irizary, Hispanic, US Citizen, MS, starting Sept. 2007, CE, Summer Intern 2007, Aerosol Climate Interaction; Brian Vant-Hull, Post Doc, Aerosol and Climate Interaction Project.

#### NCSU

Ahmed Tawfik, undergraduate, AEW genesis region; Kristin Raisanen, undergraduate, soil moisture/hurricane relationship; Michael Diaz, undergraduate, WRF customization; Jared Bowden, graduate student, 2005 hurricane season; Matthew Norman, Grad, African continental climate modes; Neil Davis, Grad, Customization of RegCM3; Yiyi Wong, Grad, hurricane flooding modeling.

#### **Students expected next fall:**

Michael Diaz, graduate student, hurricane development; Keren Cepero, graduate student, hurricane flooding modeling; Shenek Heyward, graduate student, hurricane climatology.

#### **Spring application pool:**

Graduate student, hurricane developmental phases.

#### NCAT

Darkus Jenkins, graduate student, Chemistry; David Pollard, graduate student, Chemistry; Kendra Whitehead, undergraduate, Chemistry; Amber Strother, undergraduate, Chemistry; Danny Fritz, graduate student, Mathematics; Yusef Pogue, graduate student, Computer Science; Larry Brown, graduate student, Computer Science; Sentel Allen, undergraduate, Computer Science; Quintin Ash, undergraduate, Computer Science; Michael Burns, graduate student, Computer science; Christopher Ware, undergraduate, Physics; Patrick McCarter, undergraduate, Physics; Desiree Gordon, graduate student, Civil Engineering; Crystol Stewart, graduate student, Civil Engineering; Stephan A Hudson, graduate student, Electrical Engineering.

#### **Not supported by ISET but involved in ISET research and education**

Terrel Dial, graduate student, physics; Glen Smith, graduate student, physics; Katif Peay graduate student, Energy and Environmental Studies; Charla Gaskins, graduate student, Energy and Environmental Studies.

#### ***A-2: Student Conference Attendance***

At the NOAA EPP meeting Oct 29-Nov 1, 2006 in Tallahassee, Florida, Dr. Heavner presented a poster to describe research and educational opportunities at UAS. Four UAS students participated in the meeting by presenting posters of their research: Logan Berner, Micaela Ponce, Suzie Teerlink, and Matthew Nelson. Dr. Heavner presented two posters describing ISET related work at the American Geophysical Union meeting in San Francisco, CA Dec 11-15, 2006. One poster focused on the sensor web scientific goals and the second poster focused on integrating the sensor web into both UAS undergraduate education and Juneau area K-12 student opportunities.

The presentations are:

Undergraduate Earth System Science Education Methods used for Undergraduate Education at the University of Alaska Southeast Environmental Sciences Program: Matt Heavner, Eran Hood, Cathy Connor

Dissolved Oxygen Levels in Urban Streams: Matt Nelson, Jon Bower, Lisa Hoferkamp, Eran Hood

The Influence of Changing Glacier Coverage on the Physical Hydrology and Hydrochemistry of Coastal Watersheds in Southeastern Alaska: Logan Berner and Eran Hood

Distribution of Pacific Sleeper Shark (*Somniosus Pacificus*) Bycatch in Yakutat Bay from Interviews with Longline Fishermen: Suzie Teerlink

Breeding Site Fidelity and Philopatry in Ringed Seals (*Phoca hispida*): Micaela E. Ponce and Brendan P. Kelly

Seamonster Education: A Sensor Network Project in Southeast Alaska: Rob Fatland, Sonia Nagorski, Cathy Connor, Matt Heavner, and Eran Hood; Fall American Geophysical Union Meeting, San Francisco; 2006.

Seamonster: A Smart Sensor Web in Southeast Alaska: Rob Fatland, Matt Heavner, Eran Hood, Cathy Connor, and Sonia Nagorski; Fall American Geophysical Union Meeting, San Francisco; 2006.

Angela Edwards, Bradnon Davis, Eldon Threadwell, Chris Ware (NC A&T) attended the National Society of Black Physicists Conference in Boston, Feb 2007.

All ISET supported students and a large number of NCAT faculty attended the ISET colloquium. Talks on ISET activities were given to students in regular classes and to faculty members at meetings in different colleges.

Deidre Johnson and Nautica Crower began to participate in the project in November of 2006. They attended the NOAA Education & Science Forum at Florida A&M University. They met with NOAA-ISET investigators at Fisk regularly and were taught skills in data mining and image processing that are required for the research activities.

Three NCAT Students (Charla Gaskins, EES PhD; Katif Peay, EES PhD; Daryl Fields, MS Computational Science and Engineering) attended the NOAA Education and Science Forum at Florida A&M University with ISET support. Charla was awarded a NOAA-EPP Science and Education Forum Travel Award. She presented a graduate student poster on her research entitled “Weather-Based Intelligent Transportation Systems” that received honorable mention.

David Santoro: “Continuous Wave Frequency Modulated Aerosol Liar” Fourth NOAA Education and Science Forum Science, Stewardship and Sustainability October 30, 31 and November 1, 2006 Florida A&M University NOAA Environmental Cooperative Science Center, Tallahassee, Florida.

### ***A-3: Recruitment Plans/and activities***

Conference Recruitment Booths: ISETCSC set up displays at the NOAA Education & Science Forum at Florida A&M University, Tallahassee, FL, October 29-November 1, 2006; the AMS Annual Meeting, San Antonio, TX, January 14-16, 2007; the Twenty-First Annual Ronald E. McNair Commemorative Celebration and Sixth National Research Symposium, Greensboro, NC,

January 26 - 28, 2007; National Society of Black Physicists, Boston, MA, February 23-24, 2007; and the 64<sup>th</sup> Joint Meeting of Beta Kappa Chi (BKX) and the National Institute of Science (NIS), Greensboro, NC, March 14-18, 2007.

New incoming freshman scholarship: Offers of the following scholarship have been made to thirty high school seniors who have been admitted to the Departments of Chemical Engineering, Civil and Environmental Engineering, Computer Science, and Physics, Chemistry, and Mathematics at NCAT. The scholarship provides

- \$2,000 (\$1,000/semester) during freshman year
  - Five hours/week working with graduate students and faculty on a NOAA ISETCSC research project of your choice
- \$3,000 (\$1,500/semester) during sophomore year
- \$4,000 (\$2,000/semester) during junior year
- \$5,000 (\$2,500/semester) during senior year
  - Ten hours/week working with graduate students and faculty on a NOAA ISETCSC research project of their choice
- Participation in professional development activities each year
- Opportunity for national and international summer research experiences in academic, industrial, and government settings

In return for the scholarship funds and to maintain the scholarship, they are required to satisfy the following conditions:

- U.S. Citizen
- Maintain 3.0 or higher GPA in a NOAA science program (physics, chemistry, computer science, chemical engineering, electrical and computer engineering, civil and environmental engineering, or industrial engineering)
- Present oral and written progress reports on their research each semester
- Participate in professional development activities

Graduate recruitment through bulk e-mail to HBCU Chairs

The ISETCSC website, [www.ncat.edu/~iset](http://www.ncat.edu/~iset) or [noaaaset.org](http://noaaaset.org), is live and being used as a recruitment tool. Additional material and capabilities are being added to the site during May to complete the site.

Production of a NCAT energy and environmental research recruitment DVD will be completed in May in cooperation with the NCAT television studio. ISETCSC relevant parts will be included on the website and production of a specific ISETCSC DVD will begin.

Logo, brochures, retractable banners, posters, and tabletop banners have been contracted out to Set Communicate. These items can be used by all ISETCSC academic partners. The logo will be completed in May. All other items will be ready for use by all partners during the fall.

#### B. Education Objective II

Organize and develop colloquium seminar series in NOAA Sciences at all partner institutions, and organize sponsor and develop conferences to address NOAA Sciences. Encourage Student presentations.

**B-1. Center Sponsored Seminars, Colloquia, Conferences Workshops**

One of the goals of the Center is to educate the University community about NOAA, its mission and NOAA research activities, and the Interdisciplinary nature of NOAA Sciences. To facilitate this effort the Center created the ISET Colloquium Series and used available opportunities to deliver talks, workshops, and organize or sponsor conference sessions, and use the web page to communicate its activities.

**B-1-ii: ISET Colloquium Series**

The following talks were given and planned for the rest of the academic year. Planning of the 2007-2008 academic year colloquium series is underway, and a videoconference facility at NCA&T has been secured to allow live broadcast of seminars and colloquia to and from partner institutions and NOAA labs. The talks are posted on ISETCSC web page.

<b>Date/location</b>	<b>Speaker</b>	<b>Title</b>
January 1, 2007 NCAT	Watkins, NOAA NCDC	NOAA Educational Opportunities
February 20, 2007 NCAT	Brown, Chemical Sciences Division, NOAA -ESRL	Moonlighting: Atmospheric Chemistry After Dark
March 1, 2007 NCAT. February 28, 2007 UNCP	Roberts, Chemical Sciences Division, NOAA -ESRL	Peroxy-carboxylic Nitric Anhydrides (PANs) in the Atmosphere
March 19, 2007 UAS	Weatherhead, NOAA-ESRL	Climate Change and the Arctic
April 4, 2007 UAS	Ainsworth, Juneau Meteorologist in Charge, National Weather Service, Juneau Forecast Office	Guest Lecture, Environmental Science 293 Climate Change
March 29, 2007	Koch, NOAA-ISET Technical Monitor Chief, Global Systems Division, NOAA-ESRL	The Structure and Dynamics of Atmospheric Bores and Solitons

Other scheduled seminars are:

April 10, 2007, NCAT, Mining Patterns in Climate Data, Dr. Vipin Kumar, William Norris Professor and Head, Department of Computer Science and Engineering, University of Minnesota

April 19, 2007, NCAT and UNCP, Application of Pulsed Photolysis and Flow Tube Techniques to Studies of Atmospheric Chemical Processes, Dr. Ranajit K Talukdar, Chemical Sciences Division, NOAA, Earth System Research Laboratory; Boulder CO

April 26, 2007, NCAT, Modeling of the African Climate: Opportunities for Research Collaboration & Applications, Professor Fredrick Semazzi, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University; Raleigh, NC

**Fresno State**

Dr. James Burkholder reports his group will visit NCAR in Boulder for several weeks during the summer to work with Geoff Tyndall and John Orlando on a closely related project. During this

period, they plan to meet with Dr. Burkholder to discuss collaboration and student exchange in Year 2.

Dr. Steven Brown (NOAA-ESRL) will visit Fresno State in September, 2007.

B-2-ii. Conference sessions and workshops

Creating public awareness about NOAA sciences and NOAA activities is not limited to ISET partner institutions. Other activities undertaken during this reporting period include the creation, for the first time, of two sessions on Earth System Science at the Annual Conference of the National Society of Black Physicists and National Society of Hispanic Physicists. February 21-24.

ESS: Sessions I and II: Chair Bililign

<b>SESSION I</b>	<b>Title</b>
EES-1.1 –J. Jones	National Oceanic and Atmospheric Administration, Educational Partnership Program, Student Opportunities. (Invited)
EES-1.2- G. Duane	Synchronized Chaos in Geophysical Fluid Dynamics and the Predictive Modeling of Natural Systems
EES-1.3- V. Morris	The NOAA Center for Atmospheric Sciences (NCAS): Recent Research Achievements (Invited)
EES-1.4-Khanbilvardi	Multi-Spectral Remotely Sensed Precipitation Estimation. (Invited)
<b>SESSION II</b>	
EES-II-2 Ahmed	Polarization Techniques Applied to LIDAR Atmospheric Remote Sensing and Chl Fluorescence Retrieval from Seawater (Invited)
ESS-II-3 Lopez	Modeling the Magnetosphere for Space Weather Prediction
ESS-II-4 Hernandez	Assess of NewModis Land Albedo Model Over Urban Scenes Using Hyperion
ESS-II-5 Charles	Application of CCNY Lidar and Ceilometers to the Study of Aerosol Transport and PM2.5 Monitoring

The first joint recruiting event between two EPP centers, CREST and ISET took place at the February 21-23, 2007 Joint conference of the National Society of Black Physicists and the National Society of Hispanic Physicists (NSBP NSHP) held at the Hynes Convention Center, Boston, Mass. Approximately 800 attendees including students, faculty and industry representatives attended the conference. ISET and CREST shared a joint recruiting table. With the help of the office of Chantell Haskins, several dozen students were directed to the joint booth. A number of well-qualified students showed interest our programs. This is being followed up. This is the first of many intended joint recruiting efforts of the two centers.

Workshop presented by Center director at the 64<sup>th</sup> Joint Annual Meeting of BKX/NIS: Solving the Challenges of Life through Interdisciplinary Science. Title of Workshop: Understanding Climate Change-Capstone Interdisciplinary Problem of the Century, March 17, 2007, North Carolina A&T State University.

The Twenty-First Annual Ronald E. McNair Commemorative Celebration and Sixth National Research Symposium.

NOAA Educational Partnership Program Scientific Environmental Technology Cooperative Science Center NOAA-ISET.

ISETCSC sponsored conferences:

Chemical Sciences Symposium, Feb. 23, 2005, 3<sup>rd</sup> National Conference on Environmental science and Technology, to be held September 12-14, 2007

ISETCSC Recruitment Booth/Brochure distribution:

Annual Conference of the National Society of Black Physicists and National Society of Hispanic Physicists, February 21-25, Boston, MS

American Meteorological Society's 87th Annual Meeting; 14-18 January 2007 in San Antonio, Texas

Twenty-First Annual Ronald E. McNair Commemorative Celebration & Sixth National Research Symposium, Greensboro, NC

64<sup>th</sup> Joint Annual Meeting of BKX/NIS

Organized a Grid Computing Symposium and High Performance Computing Workshop at North Carolina A&T State University on April 13 and 14, 2007 in Greensboro, North Carolina.

Michael Burns and Allen Graham presented a student presentation entitled "Building a pilot sensor grid portal at NCAT" in the Grid Computing Workshop. Center researchers also attended the meeting of Thrust Area III PIs held at NCAT on April 10 and made a short presentation on the status of our projects

#### **NCSU**

Dr. Lian Xie attended the World Meteorological Organization (WMO) training workshop on tropical cyclone disaster reduction in Guangzhou, China, March 26-31, 2007.

Dr. Fredrick Semazzi was featured in the Technician Newspaper (Wednesday March, 14<sup>th</sup>, 2007) (Appendix 1-1)

#### **UNCP**

Dr. Flowers appeared on news paper and local radio (Appendix 1-2)

#### **NCAT**

Dr. Bililign in the local news (Appendix 1-3)

### ***B.2. Outreach***

#### **NCAT**

Offer summer camps at NCAT and most partners for K-12. Offer workshops in Earth System Science to K-12 teachers at NCAT

The following outreach activities have been accomplished:

March 17 – Dr. Bililign presented a seminar on the ISETCSC at NCAT for attendees of the Beta Kappa Chi (BKX) meeting in Greensboro.

March 23 – Dr. Schimmel presented lesson on the Greenhouse Effect using NOAA SAM II data to three middle school math classes (75 students) at Lincoln Academy as part of the NSF Content Mentoring project in which he is participating.

April 23-24 – Dr. Schimmel presented information on the NOAA ISETCSC to the middle school and high school student forums at Caldwell Academy.

The following outreach activities have been scheduled and planned for this summer on the NCAT campus in conjunction with the National Climatic Data Center in Asheville, NC (Carmella Watkins) and the National Weather Service Office in Raleigh, NC (Ruth Aiken): (Appendix 1-4 and 1-5)

June 25-29: Earth System Science Institute for Educators, Incorporated Research Institutions for Seismology (IRIS) is a partner in the offering of this workshop.

June 28-29: GEAR-UP North Carolina Summer Program for High School students

July 9-13: NOAA ISETCSC Middle School Weather and Climate Camp

July 16-20: NOAA ISETCSC High School Weather and Climate Camp

### **Alaska**

The UAS ISET effort is working in collaboration with the UAS EDGE (Experiential Discoveries in Geosciences Education) project, which is an initiative of UAS faculty to help Alaska's middle and high school teachers design exciting curriculum that will help students meet the state's Earth Science performance standards.

Dr. Heavener presented a public lecture that highlighted NOAA's support of the sensor web technology efforts at the U.S. Forest Service Mendenhall Glacier Visitor's Center. Approximately seventy-five members of the public attended the lecture.

### **Fresno**

A one-day event is planned for Earth Science Week in October 2007. The event will be targeted at K-12 teachers and students, and will have two themes – urban air pollution and global warming. The event will include short talks and hands-on activities.

APPENDIX  
I-1: NCSU



## NASA to contribute to climate seminar

*The Millennium Seminar today will host NASA speaker and panelists on global warming, climate change*

**Saja Hindi**  
*Deputy News Editor*

The University is hosting the Millennium Seminar series today at 2 p.m., a discussion and presentations on areas of increasing interest to the public, climate change and global warming.

The theme of this year's series is "innovation, leadership and higher education."

NASA's Waleed Abdalati, director of its cyrospheric sciences branch at the Goddard Space Flight Center, will speak as a part of the series about global warming regarding the research NASA

funded on the issue.

According to Mary Easley, first lady of North Carolina and executive in residence in the provost's office, long-term data show there are significant changes in climate.

Easley, who coordinated the event, said climate change will occur in North Carolina 50 to 70 years from now, and the seminar will cover up-to-date research on the issue.

"Because I want the seminar to be timely and topical, I don't book [the speakers] way ahead," Easley said. "I look for people on the cusp of a hot issue, such as Abdalati. I'm catching him before he gets all over everywhere."

Easley said the University is not paying for most of the speakers at the seminar.

"NASA pays for Abdalati to come because it is time well spent here," she said.

**"The series provides students the opportunity to interact with world leaders in diverse backgrounds. The presentations are world issues from the speaker's perspective."**

Fred Semazzi, marine, earth and atmospheric sciences professor

Fred Semazzi, a marine, earth and atmospheric sciences professor, is one of the panelists at the seminar who will contribute to the discussion.

"The series provides students the opportunity to interact with world leaders in diverse backgrounds. The presentations are world issues from the speaker's perspective," he said. "We are trying to place local and national events in a global context."

Easley said Semazzi will help localize the issue of global cli-

mate change on which Abdalati is an expert. She said paleontologists will also be available to discuss what is happening "on the ground." She said the speakers will not hold back.

"When [speakers and politicians] come to this seminar, they seem to be very unguarded about their opinions and what needs to happen," Easley said. "For some reason, the Millennium Seminar is always very unfiltered."

According to Semazzi, the seminar's goal is to engage and

encourage students to "reach behind borders and think more globally about land and where we will all be in the future" with an emphasis on higher education.

"My focus is going to be to challenge of North Carolina in science education," he said.

Semazzi said he will express the need for the state to invest in its institutions of higher education for the benefit of its citizens.

According to Easley, the organizers want student participation and don't want the faculty or administration to "squeeze out the student aspect."

Easley said global climate change is becoming a bigger issue for everyone, and

**SEMINAR** continued page 4

## 1-2. UNCP

NEWS ITEM at UNCP  
stategovernmentradio.com

<http://www.uncp.edu/home/paul/122106uncpgrant.mp3>

Thursday, December 14, 2006

UNCP wins grant to study carbon dioxide in earth's atmosphere

The National Oceanic and Atmospheric Administration (NOAA) has funded a research project to be conducted at The University of North Carolina at Pembroke that aims to develop new techniques for measuring carbon dioxide levels in the atmosphere.

The project was awarded \$263,880 over five years and is led by Dr. Paul Flowers, chair of UNCP's Chemistry and Physics Department.



*Paul Flowers*

The University's grant is part of a larger \$12.5 million program, directed by Dr. Solomon Bililign, Chair of the Physics Department at North Carolina A&T University, and involves a consortium of universities and other institutions across the country including North Carolina State University, the University of Minnesota, the City University of New York, the University of Alaska-Southeast, California State University-Fresno, Fisk University, and several industrial, state, and federal government partners.

UNCP and the partnering institutions will pursue various research programs that promise to yield new technologies for monitoring and predicting global climate change, Dr. Flowers said.

"I am an analytical chemist, which means I develop tools to measure things," Dr. Flowers said.

"We will seek new methods for measuring carbon dioxide in the atmosphere.

"Scientists must track CO<sub>2</sub> levels in order to understand the earth's carbon cycle, which many theorize is driving global climate change," he said. "I'm excited about this opportunity, both for our students and myself, to conduct research in such an important area of science."

Dr. Flowers returned recently from a meeting with the grant team and NOAA scientists in Boulder, Co., and he is currently preparing a final project description and beginning the process of recruiting three students to receive paid research assistantships for the coming summer.

1-3. NCAT

## NOAA Funds \$12.5M Interdisciplinary Center at North Carolina A&T

Researchers at North Carolina Agricultural and Technical State University have received a \$12.5 million grant from the National Oceanographic & Atmospheric Administration (NOAA) to fund an Interdisciplinary Scientific Environmental Technology (ISET) Cooperative Research and Education Center on the campus.

According to Solomon Bililign, chair of the department of physics and principal investigator on the grant, "The ISET Center will cooperate with NOAA's Earth Science Research Laboratory in Boulder, Colo., and is aligned with NOAA's mission to provide the data needed to address specific climate and weather related concerns,

such as hurricanes, droughts, tornadoes, global warming, and ecosystem degradation. The ISET Center will provide opportunities for minority students to study in NOAA related sciences."

The center will perform research in areas including sensor science and sensor technology for oceanographic and atmospheric applications, analysis of global observing systems that includes numerical and physical research and analysis of hurricanes, and information technology tools for data fusion, data mining, and geospatial modeling and analysis.

Said N. Radhakrishnan, vice chancellor for research and



*Bililign*

economic development, "We are very excited about this grant, which gives us the opportunity to partner with NOAA. A&T has internationally known researchers whose work is

capable of impacting the world. This grant is evidence of that fact."

Bililign's team includes a diverse network of scientists, engineers and students from A&T, North Carolina State University, University of Minnesota, University of North Carolina at Pembroke, City University of New York, University of Alaska Southeast, California State University-Fresno and Fisk University as well as industrial, state and federal government partners. Cooperating units at North Carolina Agricultural and Technical State University include the College of Arts and Sciences, the College of Engineering and the School of Graduate Studies. ■

**1-4. Summer Camp**



# NOAA ISET WEATHER AND CLIMATE CAMPS



**Date: July 9-13 (Middle School)  
July 16-20 (High School)**

**Time: 8:00 AM—5:00 PM, Monday-Friday**

**Location: North Carolina A&T State University**

**Registration Fee: \$60.00**

**For Further Information, Contact:**

**Dr. Keith A. Schimmel, [schimmel@ncat.edu](mailto:schimmel@ncat.edu)**

**(336) 256-2341 x 2495**

**Requirements: Interest In Math, Science & Computers**

**Participation: First 30 students to apply**

**Deadline for Registration: June 15, 2007**

**To Register go to: [www.ncat.edu/~iset](http://www.ncat.edu/~iset)**

*National Oceanic & Atmospheric Administration/Interdisciplinary Scientific  
Environmental Technology Cooperative Science Center (NOAA/ISETCSC)*

1-5. Summer workshop



**North Carolina A&T State University**  
**Interdisciplinary Scientific Environmental Technology**  
**Cooperative Science Center**  
*presents*  
**Earth System Science Institute for Educators**  
**June 25-29, 2007**

**Purpose of the Workshop**

To learn about earth systems, participate in hands-on activities that can be used in the classroom, and obtain FREE materials, maps, curriculum guides, and books correlated to the National Science Education Standards. The program is open only to high school science teachers. Preference will be given to those teaching at least one section of Earth Science.

Participants will be encouraged to become engaged with the content and inquiry based materials and design classroom experiences that relate to Earth Systems Science

- as an active participant, learning through demonstrations, computer modeling, and hands-on activities;
- as an educator, aware of how your students will interact with the materials and activities; and
- as a peer, providing feedback and suggestions to the presenters and other participants.

Topics covered include: causes of earthquakes, plate tectonics, propagation of seismic waves, seismographs, earthquake locations in Africa, statistics and seismology data, Earth's interior structure beneath Africa, earthquake hazards and local seismicity in Africa, climatological processes from the global scale down to the microscale, understanding the nature of climate and the role that it plays, and the development of lesson plans from the vast NOAA data archives.

**There will be a trip to a NOAA facility!**

To learn more about AfricaArray, visit:  
<http://www.africaarray.psu.edu>

To learn more about NOAA, visit:  
<http://www.noaa.gov>

To learn more about IRIS, visit:  
<http://www.iris.edu>

**To be held at:**  
North Carolina A&T  
State University  
Workshop participants are eligible to receive up to 4 Continuing Education Unit (CEU) credits.

**To register, contact:**  
Dr. Keith Schimmel  
E-mail: [schimmel@ncat.edu](mailto:schimmel@ncat.edu)  
or visit:  
<http://www.ncat.edu/~iset>  
Transportation subsidy will be provided up to 200 miles.

**Registration deadline:**  
April 30, 2007  
Space will be limited!  
Register early.  
Stipend: \$100/day  
(Meals and refreshments will be provided.)