Performance Report for Cooperative Agreement No: NA06OAR4810187
For the Period from March 1, 2008 to August 31, 2008

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)

North Carolina State University (NCSU)

University of Minnesota (UM)

EXECUTIVE SUMMARY

The ISETCSC is effectively fulfilling its mission to train students in scientific areas of interest to NOAA and develop technology and techniques for analysis of global data sets for an improved understanding of climate and environmental change. The focus of ISETCSC is to increase the number of students from underrepresented communities studying NOAA's areas of interest in science and technology and to help them complete their education and training for careers in these areas. ISETCSC's research activities are organized in three thrust areas that are, collectively, aligned to most of NOAA's strategic goals. ISETCSC interacts closely with the NOAA line office of Oceanic and Atmospheric Research (OAR) and other line offices.

Thrust Area I's foci are sensor science and sensor technology for oceanic, atmospheric and environmental applications. Its goals are to develop sensor systems intended to fill current gaps in data measurements and to conduct research on the chemical processes in the Earth's atmosphere. These research foci are aligned to the goals of NOAA's mission that include ecosystems; climate and weather; and water as well as NOAA's support mission. The research goals of Thrust Areas II and III are to perform analyses of global observation systems, including numerical and physical research and analyses of hurricanes; and to develop information technology tools for data fusion, data mining, and grid computing for real time data management in a large sensor network. This work is aligned to NOAA's mission goals that include climate, weather and water and commerce and transportation.

ISETCSC celebrated its second anniversary in the fall of 2008. In the last two years ISETCSC has led the establishment of a BS program in Atmospheric Sciences and Meteorology, (which will admit its first cohort this fall) and a concentration in Atmospheric Sciences within the Energy and Environmental Studies (EES) Ph.D. program. To support these programs ISETCSC has recruited three faculty members.

Over 100 students participated in research activities with ISET PIs, and thirteen ISETCSC graduate and undergraduate students spent time in NOAA Labs (ESRL) this summer. ISETCSC has graduated eight MS level and 15 BS level graduates and seven undergraduates. NOAA scientists are members of thesis and dissertation committees of all ISETCSC graduate students. Several NOAA scientists visited ISETCSC campuses as colloquium speakers, as members of thesis and dissertation committees, to give short lectures, and help set up labs.

ISETCSC funds have been leveraged to obtain over $4 million in new grants and over fifteen pending proposals have been submitted to NASA, NSF, DHS, etc. The research activities are generating major publications and presentations. ISETCSC has been invited to organize conferences at national physical society meetings such as the South Eastern Section of the American Physical Society.

ISETCSC is mature enough to undergo a self-assessment and a visioning process to identify flagship projects based on its core strengths. Thrust area meetings were conducted along with a retreat of the leadership team to assess weaknesses and strengths and draft future directions. Currently a strong modeling group is emerging led by the ISETCSC senior scientist. NOAA-ISETCSC recently acquired a state-of-the-art 72 processor Linux cluster from Dell Computer to support this effort.

The following are significant ISETCSC accomplishments in its two years of existence.

- Establishment of the Bachelor of Science program in atmospheric sciences and meteorology with a concentration in atmospheric sciences within the Energy and Environmental Studies PhD program
- Hiring of three NC A&T ISETCSC faculty members, one of whom is a Senior Scientist, Dr. Yuh-Lang Lin, with a strong publication record
- Financial and research support of fourteen faculty at NCAT and sixteen faculty at partnering academic institutions
- Academic and financial support for over 100 students, 50 of whom are NCAT students; with a total amount of about $300,000 for NCAT students
- Over twenty peer reviewed journal articles have been published by faculty and students and over eighty conference presentations were made in the last two years.
- Fifteen BS graduates, eight MS graduates, and one Ph.D. graduate
- Sixteen Ph.D. students in the pipeline
- Establishment of collaborative research activities between ISETCSC and NOAA's Earth System Research Laboratory in Boulder, Colorado. The research collaboration has led to student exchanges where thirteen ISETCSC students spent periods ranging from three weeks to eight weeks in NOAA laboratories on summer internships.
- Establishment of fully functional labs for atmospheric research and a computational facility for climate modeling research and a meteorology teaching lab
- Leveraging of ISETCSC funds to obtain over four million dollars in new grants resulting from the submission of over fifteen proposals
- Conducted a successful high school teacher workshop at NC A&T (with over 150 applications in 2008 and 25 slots), middle and high school summer camps both at NC A&T and partner institutions
- ISETCSC thrust areas are working towards greater collaboration and integration of the research and training effort
- ISETCSC has provided the leadership for organizing the first conference sessions in atmospheric sciences at national professional meetings of professional societies including the American Physical Society
- A new Institute for Climate Change, Oceans and the Atmosphere (ICOA) was approved at Fresno, with the major component of the educational outreach course development related to NOAA Sciences. ISETCSC PI Harmsen is involved.
- A new BS degree in Environmental science was approved at Fresno.
- A Memorandum of Agreement was signed between NCAR, NCA&T, Jackson State University, and Howard University to promote Atmospheric research. ISETCSC led this effort at NCA&T.
- ISETCSC PI Semazzi is a member of the Task force to establish a Master's of Science program in Climate Change and Society at NCSU.
- A new collaboration between ISETCSC-Alaska and the NOAA Fisheries Service and an Alaska regional group is formed.
- Adjunct faculty status for fifteen NOAA scientists is being processed so that they can serve in ISETCSC graduate theses and dissertation committees.

SUMMARY OF PERFORMANCE

Performance Matrix:	Accomplished	Performance Goals, Years I and II
Students supported (leveraged) by ISETCSC and on (were on) training in NOAA sciences in all institutions since Jan. 2007 – List and details Appendix III	126	123
Number of PhD students	16	15
Number of MS students	27	20
Number of undergraduates	83	85
Number ISETCSC supported who graduated	15 BS, 8MS,1PhD	6
Number of BS graduates exposed to NOAA Sciences (**1**)	>100	85
Research goals (milestones)-details in section 1-2	100%	Milestone goals for Year I met
Number of publications submitted/published/in manuscript by PIs (Publications and presentations list: Appendix II)	20	15
Number of presentations made by ISETCSC PIs	81	25
Number of publications by students	5	5
Number of student attending and presenting at conferences/meetings	67	13
Dollar amount of proposals awarded leveraging ISETCSC **(2)**	$3.76 Million	
Number of proposals submitted	44	6
Number of collaborative research projects with NOAA and other partners	18	20
Number of students who applied for NOAA summer opportunity	21	8
Number of students planning to spend summer research at ISETCSC partners including REU	12	11
Number of NOAA scientist to be appointed as adjunct faculty at NCA&T	15	11
Number of freshman scholarships offered **(3)**	10	15
Number of NOAA scientists visiting ISETCSC institutions	21	20
New faculty	3	3
Number of students at ESRL	13	11
Students at industrial partner sites over summer**(4)**	0	2
University Studies weather studies course attendees**(5)**	18	100

DELIVERABLES	**NOT MET**	**IN PROGRESS**	**FULLY MET**
YEAR II - ADMINISTRATIVE			
Hire a new senior scientist at NC A&T in physics/chemistry and hire three additional new faculty members in NOAA sciences.			**x**
Develop permanent location for NC A&T ISETCSC complex that includes director office, administrator office, reception area, graduate student and post-doc offices, outreach/teaching lab, analytical lab for sensor thrust group, and research lab for senior scientist during second year.			**x**

Provide a seed grant program across all partners that serve as a catalyst for generating new research ideas of interest to NOAA and bringing new faculty and new funding into ISETCSC Center research during the second and third years			**x**
Direct each ISETCSC Center project team to produce at least one proposal per year for additional funding to support their research area			**x**
YEAR 1I - EDUCATION			
Establish an undergraduate degree program in Atmospheric Sciences & Meteorology at NC A&T.			**x**
Offer an undergraduate outreach course utilizing the AMS Weather Studies curriculum at NCA&T and selected partner universities			**x**
Develop online undergraduate and graduate courses offered to all partners.		**x**	
Offer biweekly online seminar to all partners			x
Develop REU program			**x**
Offer summer camps at NC A&T and most partners for K-12			x
Sponsor undergraduate research and senior design course projects at all partner universities			x
Provide opportunities for NCA&T and partner faculty members and students to spend time at NOAA labs.			x
Invite NOAA scientists to spend time at NC A&T and partner universities			x
Hire senior scientist			x
Have all Center-related M.S. and Ph.D. committees include a NOAA scientist as a member.			x
Participate in NOAA field studies		**x**	
Utilize existing NOAA student and faculty support programs to enhance the activities of the ISETCSC Center			x
Hire lab manager at NCA&T **(6)**	x		
Hire a research associate for one of the thrust areas at NCA&T.			x
Develop permanent location for NCA&T ISETCSC analytical lab for sensor thrust group			x
Develop a concentration in Earth System Sciences within the NC A&T Energy and Environmental Systems Ph.D. program.			x

Notes: (1) These are graduates with BS degree in academic departments where there are ISET PI's. Students were either given a one class lecture on ISET research and NOAA or provided ideas for senior project on ISETCSC areas

(2) No dollar figure was put in the implementation plan, only number of proposals.

(3) 16% budget reduction in 08-09

(4) Offers are made by one industrial partner for summer 09

(5) Course was approved in 2007 and offered in fall 2008

(6) Positions is partially used to support hire of senior scientist.

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

NCAT has assigned a permanent space in Gibbs Hall for the Center. The Center is increasing its visibility in the community and the University system, and providing leadership in joint proposals both within and outside the university.

B. Center Related Academic Activities

B-1: Course offering and new courses and programs

NC A&T:

Dr. S. Bae is co-teaching EES 750, Chemical and Physical Processes in the Atmosphere, with Dr. Rastigeyev. Courses in climatology and dynamic meteorology are offered at the graduate level

The new BS degree program in Atmospheric Sciences and Meteorology accepted its first group of four students this fall. A concentration in Atmospheric Sciences has been developed within the PhD program in Energy and Environmental Studies. (Details in Appendix IV) A University Studies course on climate has been offered for the first time during fall 2008 under the existing UNST 211. (Details in Appendix IV)

Dr. Esterline and Dr. Li, along with Dr. Kenneth Williams of the Computer Science Department at NCAT are team-teaching a course on wireless sensor networks this fall. Dr. Esterline is also teaching a data fusion class this fall.

ALASKA:

A new member of the engineering faculty was hired at UAS. Part of the workload includes recruiting at Juneau area high schools. This will have direct benefit to the UAS NOAA ISET projects.

B-2. Capacity building initiated by the Center

B-2a: Faculty hiring:

NCAT:

Dr. Sunyoung Bae started work on July 1, 2008 as assistant professor at NC A&T. Her work includes studying international dust migrations such as the Asian and African dust events that have blown to the U.S. She will serve as a bridge between Thrust Area I and II.

NCSU:

Fredrick Semazzi is member of a task force to develop a joint all-North Carolina state supported universities Master of Science Degree in Climate Change & Society. This program is complimentary to ISET's objectives. (Appendix III)

Fredrick Semazzi has started a three-year term to serve on the World Climate Research Programme(WCRP) sponsored by the World Meteorological Organization(WMO) and the Intergovernmental Oceanographic Commission (IOC) http://wcrp.wmo.int/wcrp-index.html), 2009-2012.

Lian Xie served as chief forecasting meteorologist for the Beijing sailing competition event for the 2008 summer Olympics. His model was used to support decision-making for scheduling the Olympics sailing competition event. The model predicts the occurrence of a threshold minimum wind which is critical for having/delaying/canceling the Olympics sailing competition event.

FRESNO:

A new institute, the Institute for Climate Change, Oceans and Atmosphere (ICOA), was approved by President Welty of Fresno State in May 2008. A center director, Dr. Don Hunsaker, was hired in August 2008. A major component of ICOA is educational outreach, course development in the NOAA sciences, and climate research. The Institute has just completed a 111 page report on "Mitigation and Adaption Strategies for Climate Change in Fresno, California" by Harmsen et al., 2008.

A new BS degree in Environmental Science was approved and offered for the first time in fall 2007. Currently, three new options are being developed under this degree. Twenty-three students are currently enrolled in this degree program.

B-2b: Postdoctoral research

A search for a climate modeling postdoc is underway at NC A&T.

B-2c: Title III funding

The NOAA-ISETCSC recently acquired a state-of-the-art 72 processor Linux cluster from Dell Computer. This was possible due to the Title III funding of $10K to supplement ISETCSC funds.

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 I

Conduct research to develop new sensors, new strategies for using sensor technologies, and sensor packages**.** Conduct research on the chemical processes in the Earth's atmosphere.

Relevance to NOAA [A1-A4]: The work of this group will be relevant to a number of NOAA's mission goals, including **Climate**, **Ecosystems**, and **Weather and Water**. The proposed Center will develop a number of sensor systems intended to fill current gaps in data measurements. This group will work closely with NOAA's ESRL Aeronomy Lab and NOAA-ETL optical remote sensing group.

Relevance to NOAA [A5-A9]: Understanding atmospheric processes is an important part of modeling predictions of changes in climate, regional air quality, and the stratospheric ozone layer. This research serves the mission of NOAA-ESRL-CSD**:** to discover and understand the processes that govern the chemical reactions of Earth's atmosphere, and to improve NOAA's capability to predict its behavior.

Thrust Area I: Research Goals, Lead Researchers, and Outcome

Section	Research objectives and deliverables for year II from the IP	Lead ISETCSC researchers	Comments: Met milestone goals?
A-1: Eye Safe Lidar	Eye-safe lidar. Evaluation of available techniques and technologies in both the UV and IR	Moshary, Gross, Ahmed, and Arend (CUNY)	Met year II goals
A-2: Aerosol–Cloud Interactions	Apply multi-wavelengths to measure aerosol loading and microphysical properties at cloud base. Estimation of MFRSR cloud optical depth	Ahmed, Gross, Moshary, and Yonghua Wu (CUNY)	Met year II goals
A-3: Monitoring of Atmospheric Trace Gas Constituents	Evaluation, development, and testing of analysis methods for multiangle passive DOAS algorithms suitable for trace gas localization	Ahmed, Gross, Moshary, and Paul Corrigan. Senior Scientist (CUNY)	Met year II goals
A-4: Integrated Optical Sensor Packages for Coastal Waters	Integrated optical sensor packages for coastal waters. Task selection of appropriate bio-optical water parameters for new measurement techniques. Evolution of technical approaches & definition of system parameters for passive/active sensors & preliminary tests. Implementation of selected sensor packages, e.g. time gated detector systems and active illumination systems	Alex Gilerson, Sam Ahmed, Barry Gross, Fred Moshary (CUNY)	Met year II goals
New: **Meteorological Sensor Network (MetNet) Instrumentation in NYC**	Transitions existing equipment and infrastructure for Urban Dispersion Program to CCNY. Begin Preliminary SODAR processing.	Barry Gross, Fred Moshary, Sam Ahmed, and Mark Arend (CUNY)	Met preliminary goals
A-5: Atmospheric Chemistry of Mercury	This project is discontinued for lack of progress since 9/07	Adewuyi (NC A&T) Initiate	NONE reported
A-6: Luminescent Sensors	Synthesis of multidentate ligands with different active sites capable of accommodating bimetallic system and VOCs. Perfection of the synthetic scheme for the multidentate ligands	Assefa (NC A&T)	Met Year II goals
A-7a: Proton Transfer Mass Spectrometry in Negative Ion A-7b: Cavity Ring Down Spectroscopy	Testing of different ion sources under different conditions (temperature, pressure, water vapor concentration). Set up CRDS experiments.	Bililign (NC A&T)	Met year II goals
A-8: Chemistry of Aerosol Precursors:	Measurement and calculation for linear C2 – C5 peroxy radicals	Hasson, (CSU-Fresno)	Met year II goals
A-9: Methodology for Batch and Continuous CO2 and Other Trace Gases	UNCP withdrew from ISET as of 4/08, no replacement has been found.	Flowers, UNCP	None reported

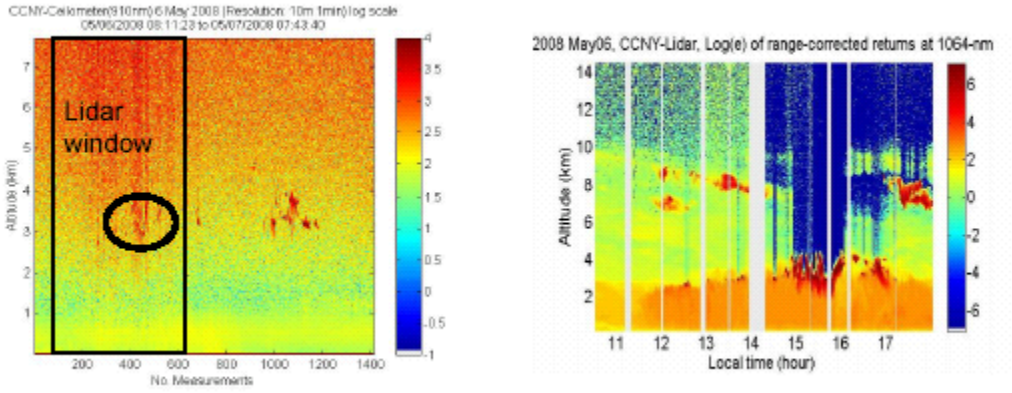
Note: 1 and 2: Implementation plan revised on 9/08 will reflect these changes

A-1: Eye-Safe Lidar
Faculty: Gross, Moshary, and Ahmed; Staff: Mark Arend
Relevance to NOAA: This project is directly relevant to two of NOAA's strategic goals: the **Weather and Water Goal** and the **Climate Goal**. Through development of effective lidar technologies for routine and ongoing measurements of vertical profiles of the atmosphere, this project contributes to NOAA's Air Quality, Environmental Modeling, and Climate Forcing programs. This follows OAR's strategies to "develop and infuse research results and new technologies more efficiently to improve products and services, to streamline dissemination, and to communicate vital information more effectively," and to "improve the quantification and understanding of the forces bringing about climate change by examining relevant human-induced increases in atmospheric constituents," and finally to "employ scientific and emerging technological capabilities to advance decision support services and to educate stakeholders."
PROGRESS: In this period the team worked on the following two areas:

- • Assessment of Ceilometer Cloud Base data and calibration of Elastic 1064 Lidar
- • 1.55um Doppler-backscatter wind lidar development

Vaisala Ceilometer

The utility of the 24/7 eye safe lidar is driving the group's investigation of the performance of the Vaisala CL31 Ceilometer. The SNR (for the aerosol backscatter from the ceilometer) is too small to measure the magnitudes of the aerosol backscatter accurately. The ceilometer performance within clouds was examined as a way to



calibrate the CCNY lidar and to explore realistic limits of the ceilometer in probing the aerosol. In Figure 1, the cloud feature has been seen for calibration.

Figure 1.a) Lidar signal at 1064 nm (b) Ceilometer signal

The ceilometer noise is quite significant on the aerosol layers. A direct matchup of time slices through the cloud has much better agreement. This is shown in Figure 2 for 10 minute averaging and 30 meter resolution. A very good agreement is observed not only at the base of the cloud but through the cloud. However, while a position is being ironed to measure the geometric thickness of the cloud, the optical depth of the cloud can not be obtained due to very strong noise of the ceilometer profile. As long as the data

near the base of the cloud is compared, calibration of the two datasets can be attempted. The data sets seem to give decent agreement for the magnitude of the aerosol layer below

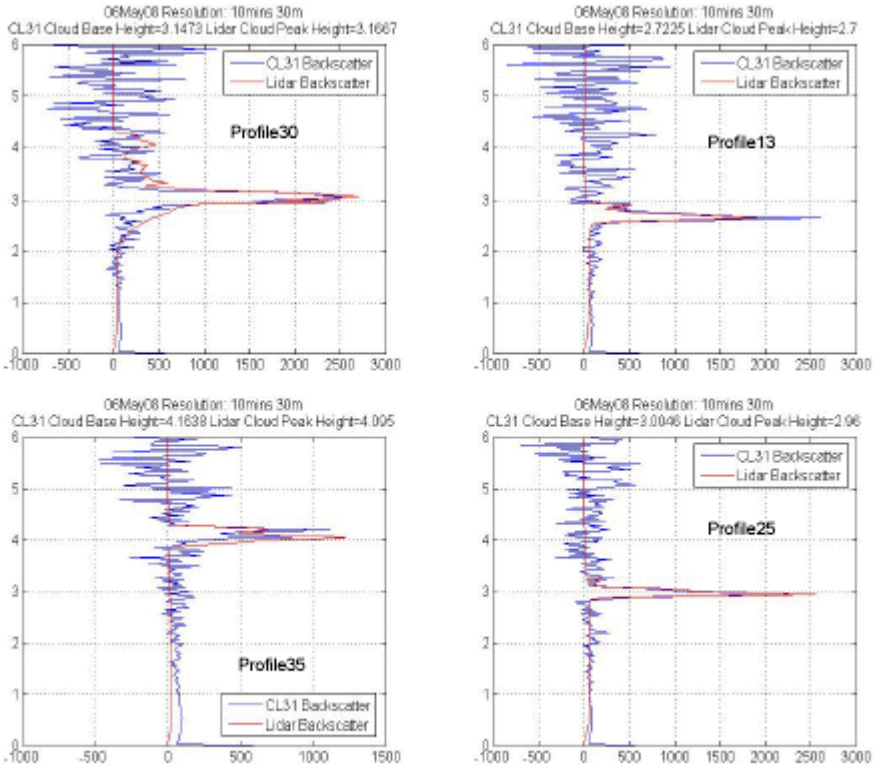


Figure 2 Comparison traces for 10 minute averaging and 30 meter resolution

the cloud. In particular, a good agreement is seen in the magnitude of the backscatter from 1-2.5 km (in most cases). The lidar signal below 1km drops significantly due to reduction in the overlap of the lidar system at low altitudes, however.

The results of the calibration exercise between the ceilometer and the lidar are illustrated in Figure 3. A good linear behavior is observed between the ceilometer and the lidar. The resultant slope fixes the calibration at 3 x 10^4. This result can be compared against independent measurements of calibration. In particular, the very fact that the cloud is probably dominated by water phase clouds allows the team to form an independent calibration.

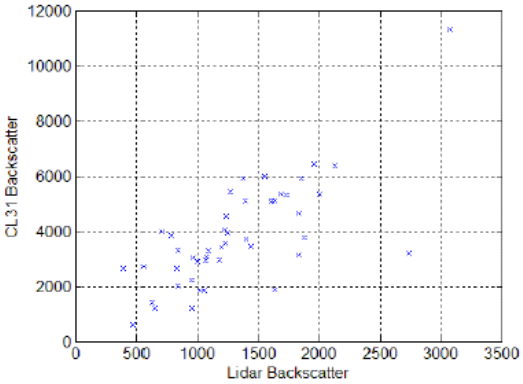


Figure 3 Inter comparison of Range corrected lidar signal and precalibrated ceilometer

The results of the independent calibration give 2.2 x 10^4 with a STD of 0.7 x 10^{-4}. In other words, a 40% overestimate of the calibration is observed based on the assumption that the ceilometer is a calibration standard. However, degradation in sensor efficiency may have occurred. Any degradation of the sensor efficiency will manifest in the calibration linearly so a 40% overestimate in calibration that would be explained as a 40% drop in detection efficiency which is quite reasonable.

Some spatial-temporal features are seen within the PBL height even if it seems that the ceilometer is not sensitive enough to pull the spatial and temporal dynamics of the aerosol. An example is given in Figure 4. The left column is the lidar imagery at 30 meter resolution (1 minute averaging) compared to the ceilometer results at 240 meter running average and 20 minute resolution. An agreement with the coherent structures is found.

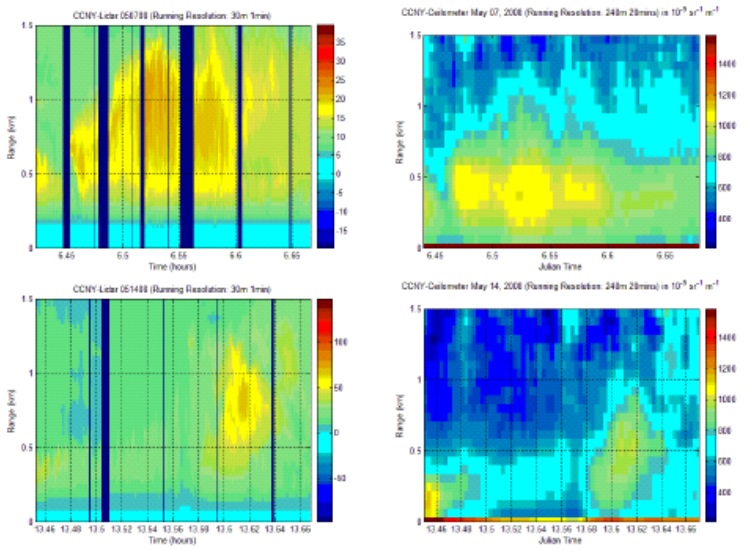


Figure. 4 Left column CCNY Lidar, (1min 30m) Right Column Ceilometer

However, there seems to be an anomalous mismatch of ~ 300 meters. This mismatch is clearly due to the running averaging scheme. Comparisons based on the Vaisala industrial software results are presented in Figure 5; a similar underestimation is seen in the ceilometer processing.

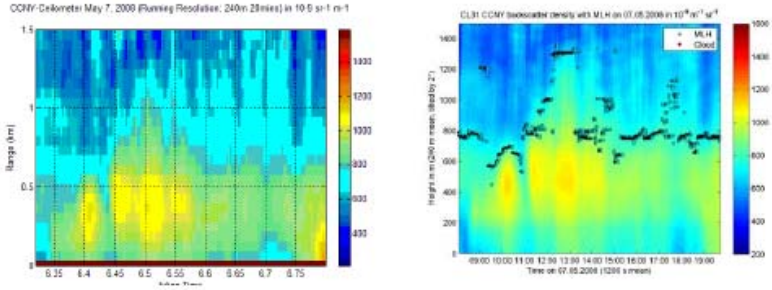


Figure.5 a) Ceilometer processed without higher smoothing b) Vaisala software product Ceilometer (20min 240m)

1.55um Doppler-Backscatter Wind Lidar Development

CCNY has completed some analysis of the basic system design. This analysis was necessary to guide the choice of capital equipment purchases related to the coherent detection Doppler wind lidar project. The fundamental theory of heterodyne detection indicates that, with sufficiently high local oscillator power P_L, shot noise from the local oscillator can dominate over both thermal noise due to the load impedance R_L at temperature T as well as any other downstream electrical noise (often given in terms of noise figure F_N). However, if the local oscillator has a significant degree of relative intensity noise, R_{in}, then the noise power density due to R_{in} will eventually dominate the shot noise density as the local oscillator power is increased. A certain amount of R_{in} can be rejected by using balanced detection, effectively improving the ratio R_{in} by a factor R_B. Using the carrier to noise power as a reference (when shot noise dominates and when there is no R_{in}) the reduction can be expressed in optimum carrier to noise power as a function of local oscillator power for various degrees of R_{in} using the following equation:

$$\eta_{pp} = \left(1 + \frac{2kTF_N h\upsilon}{\eta_q e^2 P_L R_L} + \frac{\eta_q P_L R_{in} R_B}{2h\upsilon} \right)^{-1}$$ where η_{pp} is called the efficiency on power penalty, k, h, and e are Boltzmann's constant, Plank's constant and the charge on the electron, T is the temperature in degrees Kelvin and η_q is the quantum efficiency of the detector. Assuming 25 dB balanced detection R_{in} rejection, room temperature operation and a 70 Ohm load resistor and 0.8 Quantum efficiency, the efficiency on power penalty can be plotted as a function of local oscillator power for R_{in} values of between -140 dB/Hz and -160 dB/Hz as shown in Figure 6.

A power level of at least 80 mW was requested from the vendor of the narrow band fiber laser and they were asked to make specific R_{in} measurements in the region of interest. As R_{in} is frequency dependent, R_{in} to be measured vs. frequency in the band of interest to (50 to 110 MHz) was requested. Figure 7 shows that the measured R_{in} is less than -152 dBm/Hz in band. Therefore, operating with about 12 dBm of LO power on each detector of the balanced detector units should be optimum and provide a few dB of margin in available power.

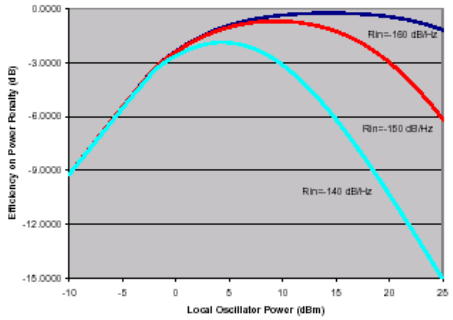


Figure. 6 Efficiency on Power Penalty vs. local oscillator power for different Rin levels

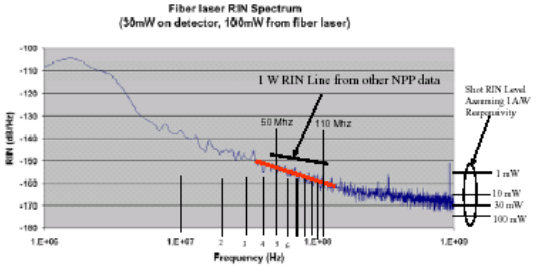


Figure. 7 Rin of the fiber laser (local oscillator) vs. frequency

Discussion of the results / conclusion:

According to the plots shown in Figure 6, the signal to noise performance of the lidar receiver is degraded by no more than 1 dB, compared to shot noise limited performance in the absence of R_{in}, assuming that the R_{in} level is less than -150 dBm and assuming that local oscillator power entering each detector of the balanced receiver is around 12 dBm. Although such a low level of R_{in} performance is quite challenging, we believe it to be attainable according to Figure 7 which shows that the R_{in} is well below -150 dBm over the 50 to 110 MHz region of interest. With this level of signal to noise performance and assuming that the pulse energy is on the order of 15 micro-joules (a level we expect to obtain with 200 nsec, 75 W peak power pulses), we expect that the range limits under typical backscatter conditions will be sufficient for us to span the planetary boundary layer.

A-2: Aerosol-Cloud Interactions
Faculty: Gross, Moshary, Ahmed Staff: Wu
Relevance to NOAA: This project is directly relevant to NOAA's **Climate goal**. A multi-sensor approach to the study of aerosol-cloud interactions will shed light on the indirect impact of atmospheric aerosols. This project contributes to NOAA's **Climate Forcing** and **Climate Observations and Analysis** programs, and is in line with OAR's strategies to "improve the quantification and understanding of the forces bringing about climate change by examining relevant human-induced increases in atmospheric constituents."
PROGRESS: In the last reporting period, the potential of measuring low altitude optically thin clouds with a Raman-elastic lidar in the daytime was analyzed. In particular, optical depths of low clouds were derived by two separate methods from nitrogen-Raman and elastic scattering returns. By correcting the aerosol influences with the combined Raman-elastic returns, Mie-retrievals of low cloud optical depth can be dramatically improved. Ultimately, excellent agreements were obtained from these two retrievals. In this period, based on this agreement, it is possible to map the lidar ratio profile in these clouds using the Raman lidar and explore the aerosol structure below cloud base.

An example of the cloud interactions with aerosols may be explored by separating cloud and background by means of a threshold statistics. In particular a threshold of $1.5e^{-3}$ backscatter is seen sufficient to separate cloud from aerosol. The results of the aerosol can be seen in Figure 8 for the backscatter and Figure 9b for the cloud interior (S ratio). In particular, there is a significant increase in the aerosol at the front edge of the cloud which is probably the cause for the increased amount of high s-ratio values in the front cloud edge.

A-3: Monitoring of atmospheric trace gas constituents
Faculty: Gross, Moshary, Ahmed Staff: Corrigan
Relevance to NOAA: This project is directly relevant to NOAA's strategic **Weather and Water goal,** through the development of effective technologies for instruments that measure open-path trace gas. This project contributes to NOAA's **Air Quality** and **Environmental Modeling** programs in line with OAR's strategies to "develop and infuse research results and new technologies more efficiently to improve products and services,

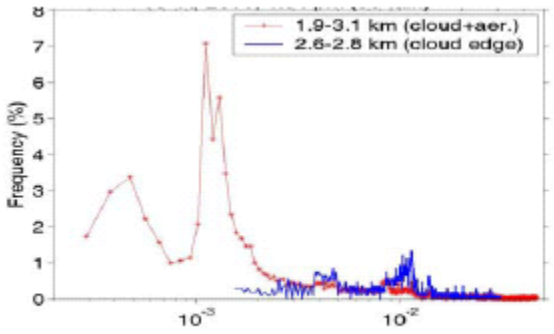


Figure 8 Histogram for aerosol /cloud separation

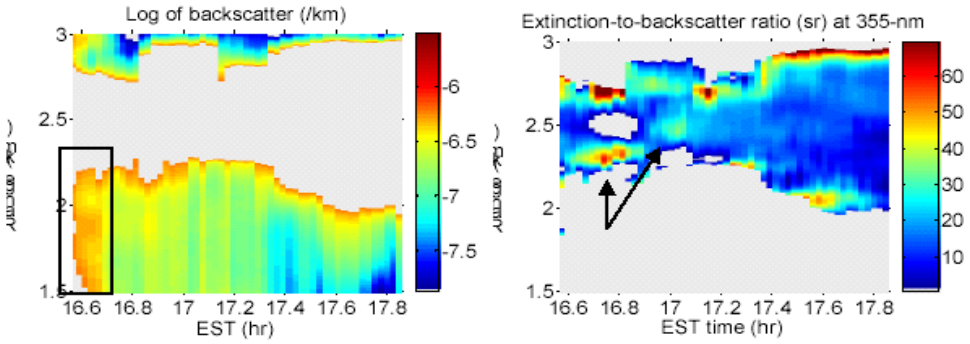


Figure. 9 a) Aerosol Backscatter below cloud base b) S ratio in cloud showing small droplets

to streamline dissemination, and to communicate vital information more effectively" and to "employ scientific and emerging technological capabilities to advance decision support services and to educate stakeholders."

PROGRESS: The optimization of the QCL system which is intensity (thermal) chirped simultaneously retrieve ammonia and ozone requires that the effective SNR for both species be minimized for a given tolerance of retrieval. Because of turning limit in DFB-QCL that is only few to 10's cm^{-1}, the specific micro-window that may have the strong absorption spectra for O_3 and NH_3 is needed to design sensitive system. HITRAN data base and Genspect tool box are used to calculate the best micro-windows. Figure 10 shows that required signal to noise ratio (SNR) to obtain 1% accuracy measurement is

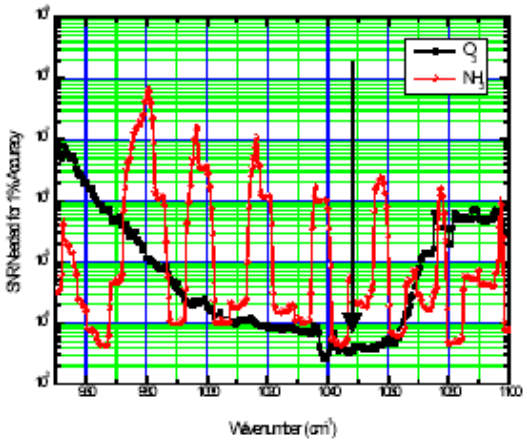


Figure 10. Theoretical result of optimum micro-window that requires minimum SNR for O_3 and NH_3 to obtain 1% accuracy

minimal for O_3 and NH_3 at 1045-1050 cm^{-1} micro-window.

In addition, in the first preliminary experiments, an ambient target of opportunity (laboratory walls) was used and current available components were demonstrations of the possibility of detecting NH_3 with an EC-QCL. An EC-QCL and laser controller (Daylight Solutions system TL001) with a characteristic emission wavelength between 950 and 1017 cm^{-1} with 1cm^{-1} interval at each measurement was employed as a laser source. Current pulses with fixed repetition rate of 500 kHz (5% duty cycle for 100 ns pulses) and driving current of 1.5A were used in the measurement. 2.3 mV of output power was detected and a (gain 20) pre-amplifier was used. A photovoltaic IR detector (PVM-10.6) was installed 26 cm away from the laser. Two ZnSe lenses were used to

focus the laser beam onto the detector and the sample (high NH_3 substance contained liquid) was placed between these two lenses. The signal was processes by a computer after it passed through a pre-amplifier. During measurements, 256 pulses were averaged this averaging made the spectra in Figure 11 more stable and much smoother. Further averaging is clearly important for future analysis. The above spectrum was processed to calculate absorbance spectrum of NH3 and that is shown in Figure 11(a and b). The theoretical spectrum of NH3 was also generated at standard temperature and pressure condition using HITRAN database and GENSPECT codes. Due to the temperature chirp, the trailing edge of the pulse is redshifted to shorter wave numbers. Unfortunately, to characterize the chirp requires sensitive etalon measurements which will take time to carry out accurately. Therefore, only qualitative comparison has been considered. As shown in Figure 12 (a, b, and c), the measurement spectrum approximately matches with theoretical spectrum features based on line spectra calculations using 150 ppmv NH3

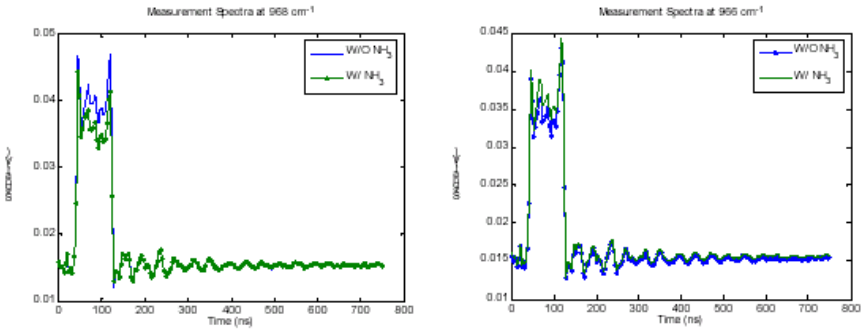


Figure 11 Spectra collected from EC-QCL with and without NH_3 present. The QCL has 968 cm^{-1} and 966 cm^{-1} emissions with 100 ns pulse width at (a) and (b) respectively.

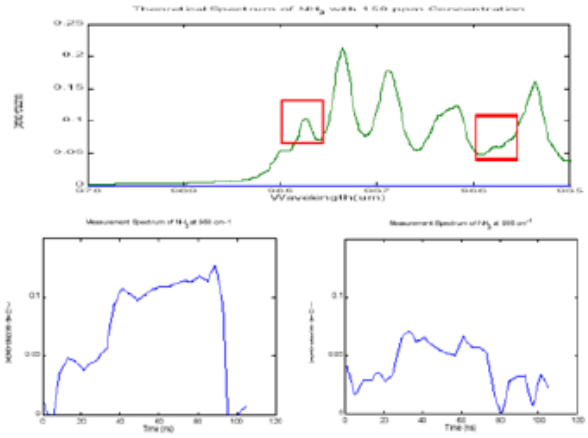


Figure 12: a) Theoretical spectrum of NH_3 with 150 ppm concentration, b) measurement spectrum of NH_3 at 968 cm^{-1} and c) measurement spectrum of NH_3 at 966 cm^{-1}

concentrations. Clearly these experiments are only preliminary because of problems with the QCL laser quality, optical setup, and IR detector.

A-4: Coastal Sensor Technologies
Faculty: Gilerson, Ahmed, Gross and Moshary

Relevance to NOAA: This project is directly relevant to NOAA's strategic Weather and Water goal through the development of integrated optical sensor packages for coastal water monitoring. This project contributes to NOAA's Coasts Estuaries and Oceans program and is in line with OAR's strategies to "employ scientific and emerging technological capabilities to advance decision support services and to educate stakeholders."

PROGRESS: A new Stokes vector spectroradiometer was developed by the Optical Remote Sensing Laboratory at the City College of New York. The instrument consists of three Satlantic Hyperspectral radiance sensors (recording intensity at the wavelengths 350-800nm, 8.5º field of view in water, 3º in air) mounted on a scanning system controlled by an underwater electric stepper motor as shown in Figure 13. The motor rotates the sensors in a vertical plane in a specific angular range which can be adjusted according to the solar altitude angle in order to cover the full 0-180º range of scattering angles. Linear polarizers are attached in front of the sensors; the polarizers are oriented at 0º (vertical), 90º (horizontal) and 45º. By rotating the sensors relative to the nadir direction, the instrument scanned the angular features of the underwater degree of polarization (DOP) in a vertical plane defined by its azimuth angle relative to the sun. The azimuth angular orientation of the instrument could be easily controlled by hand using two poles connected to a perpendicular frame with a compass as shown in Figure 14. The instrument was kept afloat by the buoys on four arms attached to it. That makes the instrument position very stable against the water surface and independent of the supporting devices on the boat. Axis of sensors' rotation was chosen close to the front of the sensors, so recorded signals come mainly from the same immediate volume near the instrument. Original depth of the measurements was chosen at 1 m below the water surface but it can be changed easily with the simple installation of additional square tubing. This instrument can be also positioned on the rope of the winch for above water measurements. A Forth Satlantic hyperspectral sensor which measures downwelling irradiance was installed on the deck of the boat. Special interface was created in LabView software (National Instruments) to combine sensor positioning with a stepper motor and data acquisition by spectroradiometric sensors. The instrument was successfully tested in the Marina of the Kingsborough College of CUNY in the southern part of Brooklyn, NY with the chlorophyll concentration about 30 mg/m^3 and mineral concentration about 4 mg/l at different depths, above and below water surface position and various azimuth angles.

Figure.13 Stokes vector

Figure. 14 Measurements with a new instrument

The instrument was also used to measure water polarization characteristics in the cruise on R/V "Connecticut" on July 21-23, 2008 in the area of Sandy Hook, NJ. Measured degree of polarization and radiance as a function of the scattering angle match the results of a vector radiative transfer model (that uses the Monte Carlo method to determine the complete Stokes vector as shown in Figure 15) extremely well. In addition, spectral dependence of degree of polarization was accurately measured for various scattering angles as shown in Figure 16. Overall, results show very high instrument reliability and accuracy and its high potential for measurements of polarization characteristics in various water conditions.

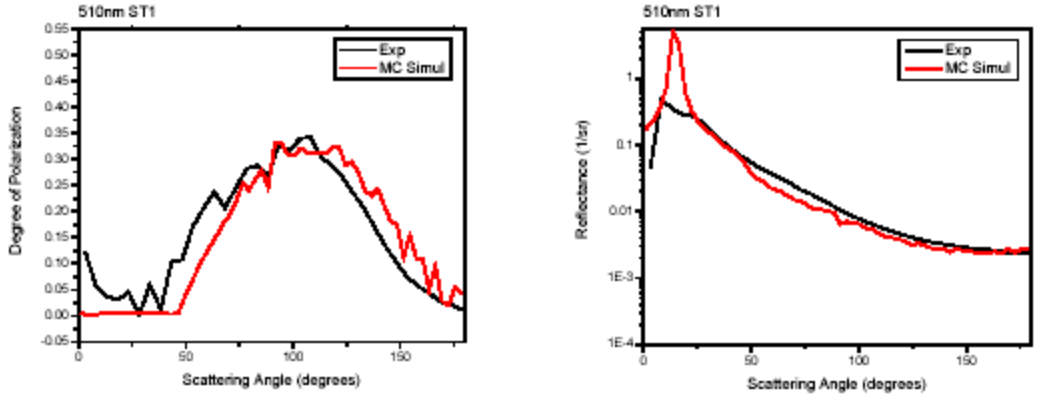


Figure 15. Comparison of modeled and measured data for 510 nm, Stations 1 of NJ cruise: a) DOP, b) total normalized radiance.

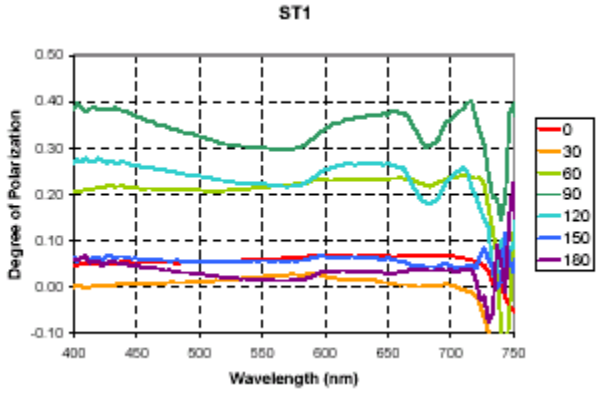


Figure 16 DOP spectral dependence for ST 1 (NJ cruises) and different scattering angles.

CUNY New Project: Meteorological sensor network (MetNet) instrumentation in NYC

Faculty: Gross, Moshary, Ahmed Staff: Arend

Much of the equipment and installations used for the Department of Homeland Security sponsored Urban Dispersion Program (UDP) managed by PNNL have been transitioned. The equipment consists of weather instrumentation placed on some of the tallest buildings in NYC and at select points around the city and is aimed at investigating air flow and atmospheric dispersion through heavily urbanized New York City (NYC) and to explore the performance of a variety of air dispersion modeling strategies at both street level and urban level. Measurements provide wind, temperature, pressure, humidity, and

rainfall rate. The usefulness of these measurements in assessing emergency management capabilities was established at the outcome of the UDP. The ability to continue making these measurements was noted. This permanent meteorological network in NYC (NYC MetNet) will provide a means to obtain baseline comparisons and a platform to continuously validate dispersion modeling algorithms that have to date only been validated during individual field campaigns. This will also enhance the development of the eye safe fiber lidar.

An example of the systems being deployed is the Radar Wind Profiler shown in Figure 18 on top of the Liberty Science Center. Data processing of this data showing a frontal passage is illustrated in Figure 19

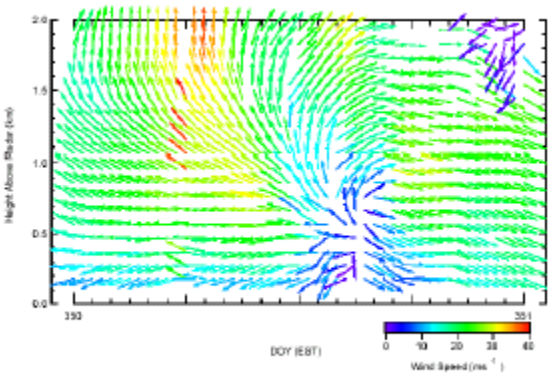


Figure 18 View of the radar wind profiler from the LSC observation tower

Figure 19 Radar wind profiler sample case study, December 16th, 2007. Here, the arrows indicate horizontal, two-dimensional winds (vector pointing upward indicates a southerly wind). The exhibited behavior is consistent with approaching warm front as observed based on MODIS satellite imagery observing a cloud line. (Vertical line indicates time of the plots [0700 EST]). Low-altitude winds measured are northeasterly, while the winds aloft between 1.5 and 2.0 km above ground are southerly.Other instrumentation included within MetNet are two Doppler Sodar wind profilers and a number of building top weather stations. One Sodar is installed at Steven's Institute of Technology for the purpose of retrieving primarily upwind conditions in lower Manhattan. The other Sodar is installed on a high rise in mid-town Manhattan. All of the instruments are networked together via a central command at CCNY where archiving, assimilation and data serving are implemented.

Students: (CUNY for projects A-1-A-4)
David Santoro (White, US citizen, Student with Disabilities): Ph. D. Student, EE Dept, CCNY, Eye Safe Lidar Project
Rushane Dyer (African American) Undergraduate, EE Dept., Water Quality Instrumentation Project
Viviana Vladutescu (White) Leveraged Student, PhD, EE Dept., Study of Aerosol Hygroscopic Properties using Raman LIDAR; Ozone and Ammonia Detection in the Atmosphere Using Quantum-Cascade Laser (QCL)
Chun Mei Gan: (Asian) Leveraged Student, PhD, EE, Ceilometer Project
Ioannis Ioannou: (White) Leveraged Student, PhD, EE Dept., Water Instrumentation Project Aerosol Climate Interaction

Erika Garofalo (Hispanic, US citizen,) Undergraduate, EE Dept., Aerosol-Cloud Interactions.
Lin Lin (Asian, US citizen,), Leveraged Undergraduate Student, EE Dept., Summer Intern, Eye Safe Lidar
Sameh Abdelazim (White, US citizen,) Leveraged Student, PhD, EE Dept., Eye Safe Lidar Project
Alberto Tonizzo (White, Permanent Res) Leveraged Student, PhD, EE Dept., Water Quality Instrumentation Project
Fausto Hernandez (Hispanic, US citizen,) Undergraduate, EE Dept., Eye Safe MetNet
Lian Niu (Asian) Undergraduate, MetNet
Rupert Wilmer-Dunbar (African American, US citizen,) Undergraduate, EE Dept., MetNet
Reuvan Huntley (White, US citizen) Leveraged (NSF-REU) Undergraduate, EE Dept., Trace Gas Detection
Amandeep Chhabra (Asian, Permanent Res) Leveraged (NSF-REU) Undergraduate, EE Dept., Trace Gas Detection
Rita Barely (African American, US Citizen) MS Student EE Dept, Aerosol-Cloud Interactions
Jonathan Tien-(Asian, US citizen) HS Senior, Water Quality Instrumentation
Emauel Arnaud-(Hispanic, US citizen) HS Junior, MetNet
NOAA- Collaborators: Sara Tucker and Mike Hardesty: On going collaboration and frequent visits and lectures by NOAA scientists; Chris Brown (NOAA NESDIS)
***Other Collaborations*:** Prof. James Smith (Environmental Engineering Department, Princeton); Prof. Claire Gmach, (Electrical Engineering Department, Princeton); Dr. Robert Arnon, Branch Head, (Ocean Sciences, Naval Research Lab, Stennis Research Center)

A-5. Atmospheric Chemistry
None reported; project discontinued.

A-6: Luminescent sensors
Faculty: Assefa; Staff: Basova
Relevance to NOAA*:* This project is directly relevant to two NOAA strategic goals in **Climate** and **Weather and Water**: "understanding the processes that govern the chemical reactions of the Earth's atmosphere," and "conduct research on the chemical processes in the Earth's atmosphere." Detection of several VOCs is of interest to NOAA's mission. These include CH_3CN (as a forest fire marker), the environmental pollutant and toxicant VOC isoprene, and several other volatile organic gases. This work contributes to NOAA's effort to "study better understand the atmospheric factors that are responsible for poor air quality, and detecting them."
Background: Synthesis of new materials with "vapoluminescent" properties is the target of this research. The first phase of the research activity focuses on the development and synthesis of new multidentate ligands that can ligate metal centers in close proximity; this phase is progressing. The targeted ligands designed for these studies possess sites that can accept VOCs of interest. Benziimidazole based ligands are the primary targets that could be tailored for this application. The goal of the first part of the project is to

establish correlation between the M-M interaction and VOC inclusion in the lattice. Significant progress has been made in the synthesis of these ligands. New schemes and methodologies are being modified and refined. Some of the targeted ligands have been successfully synthesized; the team is currently proceeding in coordinating these ligands to metal centers. The ultimate goal is to develop a metal centered emission whose emission energy and/or intensity depend on the M-M interaction, attaining luminescence-sensing capability.

PROGRESS: All of the milestones charted out for this period have been met. As indicated in the March, 2008 report, instrument purchases and installations have been finalized, including upgrading the photoluminescence spectrophotometer system. This upgrade allows the performance of both steady state and time resolved studies in the pico-second to seconds range. *In-situ* vibrational capability has also been achieved through the purchase of a miniaturized Raman setup. The vacuum line set-up, which is essential for the synthetic work, is now complete.

Three major activities have been performed since the last report.

1) Development of ligand syntheses was mainly assigned to the post-doc Yulia Basova. Several students have been assigned to continue this project. The team is trying to refine and simplify the methodology. The graduate students and several undergraduates will be involved directly in the synthesis work. An already established collaboration with Dr. Richard Sykora (University of South Alabama) has been complementing the structural studies in this area.

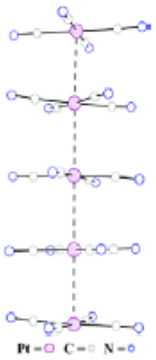


Figure 20: Columnar structure showing Pt-Pt

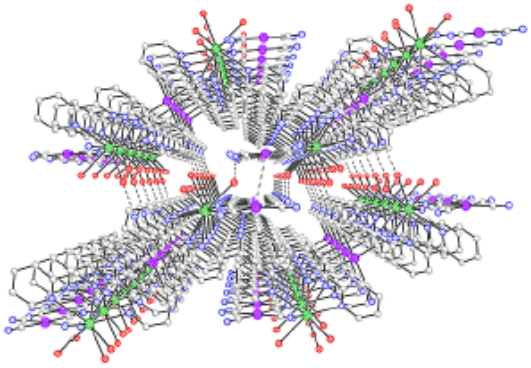


Figure 21: Packing diagram showing channel feature Interaction

2) Darkus Jenkins, a graduate student in the group was sent to the University of North Texas for the entire summer to enrich her synthetic skills and to develop theoretical interests and skills. This trip appears to have been very successful; she is now developing the theoretical component of the group's research endeavor.

3) Undergraduate Mr. Mohammoud Abas gained research experience. He was assigned to develop a new synthetic scheme in our laboratory. He worked on the synthetic scheme of hydrothermal and solvothermal synthesis on lanthanide containing tetracyanoplatinates system.

In addition, a graduate student, Nuquie Beedoe, has been studying the photochemistry of columnar square planar tetracyano platinates. Undergraduate students

are also actively participating in the photochemistry of the columnar square planar tetracyano platinates. These systems are interesting because their square planar units stack one unit on top of the other forming a one dimensional columnar arrangement with nominal metal-metal interaction (Figure 20). As the materials are strongly luminescent, it is expected that perturbation of the metals interactions should change the metal-metal distance and subsequently shift the emission energy in a predictable direction. Preliminary data appears to confirm that. The significant progress in this area also indicates that the channel feature exhibited in the structure (Figure 21) accommodates various volatile organic compounds that can be probed with a concomitant change in the emission behavior of the system (both in intensity and position). Therefore such materials are very promising candidates for use in the detection of VOCs. The work has already resulted in the publication of a peer-reviewed article co-authored by an undergraduate student. Another manuscript will also be submitted shortly.

Highlights of Student Progress:

1) Darkus Jenkins (PhD student in Energy and Environmental Science since January, 2008), conducted synthetic and theoretical work on gold complexes at the University of North Texas. Currently, she is working on -methyl-2-imidazolyldiphenylphosphine and several adducts of the ligand. She is also pursuing complexation studies of the ligand with gold and silver metal atoms.

2) Kendra Whitehead (MS graduate student since August 2008). As an undergraduate Kendra studied luminescence and optical properties of a class of lanthanide platinum tetracyano complexes that allowed the discovery of highly efficient intra-molecular energy transfer properties in Europium system.

Collaboration with NOAA Scientists:

At the moment, the level of collaboration with Joost is at the consulting level. On-going discussions and agreements are expected to enhance the level of collaboration. The initial plan of sending Kendra Whitehead to Boulder this summer didn't happen because of personal complications; the visit is now planned for next year. Joost has agreed to serve as a member of the thesis committee for Darkus Jenkins.

Students: (working on the project, current and planned)

Graduate students 1) Darkus Jenkins, PhD; 2) Nuquie Beedoe, MS student; and 3) Kendra Whitehead, MS student. *Undergraduate Students*: 4) Carlos Crawford, sophomore; 5) Debra Ragland, sophomore; and 6) Ashley Bradley, sophomore

A-7a: Proton Transfer Mass Spectrometry in Negative Ion

Faculty: Bililign

Relevance to NOAA: This project is directly relevant to NOAA strategic goal **Climate**. The relative gas-phase acidities of the simple carboxylic acids (propionic, butyric and others) and some isotopomers of acetate play a central role in VOC chemistry and in an understanding of climate forcing. This work contributes to NOAA's effort to "better understanding the atmospheric factors that are responsible for poor air quality."

PROGRESS: Negative Ion Proton Transfer Mass Spectrometry (NI-PTRMS) represents a conceptually new approach to the gas-phase measurement of acidic gases. This method has the potential to provide a rapid, sensitive measurement of environmentally important chemical species. This project is being done by Anthony Cochran, a PhD student in Energy and Environmental Studies/Physics. He has been working on building the system

at NCA&T; this involved several modifications to the existing time of flight mass spectrometer and the ion source for negative ion detection. In order to obtain training, he successfully completed the NOAA-ESRL internship in Boulder, CO during May-June 2008. He assisted with their CIMS system characterization by collecting calibration data with formic acid. This provided independent verification of previously work as well as collecting new signal and background data at various pressures (see data and plots Figure 22). The new data will be useful for optimizing the signal to noise ratio (S/N) versus flow tube pressure and identifying any dependencies. His S/N results and the non-linear signal response (signal increased with pressure) indicated that the configuration was not suitable and that the acid needed to be injected at a different location.

Point	signal	sigmaS	noise	sigmaN	ratio	pessure
0	32961.9	367.716	2278.59	141.281	14.4659	17
1	53310.6	549.154	3434.63	118.527	15.5216	19
2	82571.5	871.226	4941.47	224.907	16.7099	21
3	117146	1506.39	6450.9	254.406	18.1599	23
4	172026	2732.07	8774.31	218.812	19.6056	25
5						

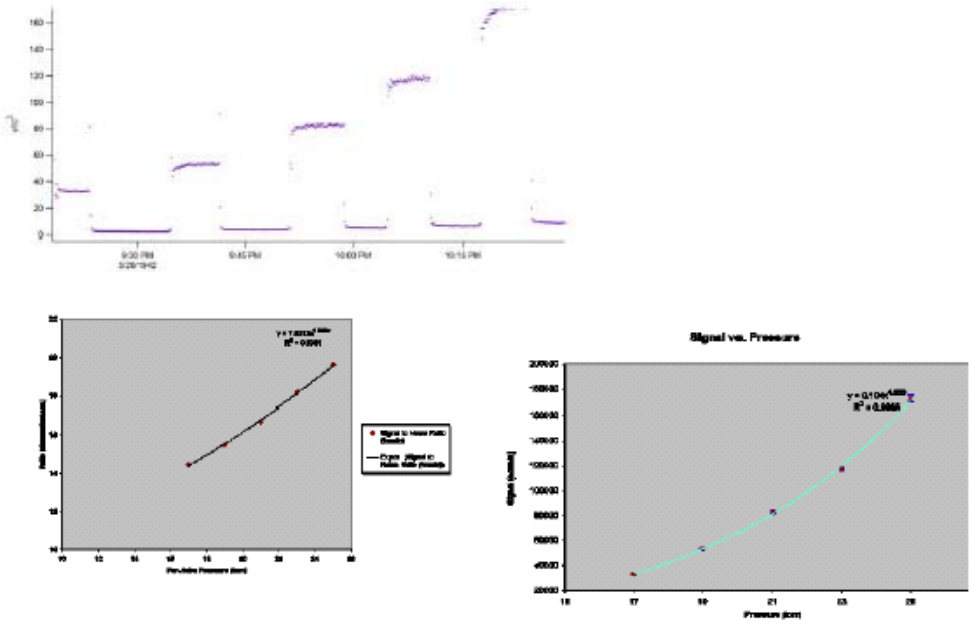


Figure 22.a) Formate ion signal behavior as a function of flow tube pressure; (b) Ratio of formate ion signal to background as a function of flow tube pressure.

This data collection enabled him to identify the parts and procedures necessary for commissioning the experiment at NC A&T simultaneously. He subsequently identified much of the equipment for the first stages of work including calibrations and background characterization.

During the rest of the summer two major tasks were (1) to identify all parts and materials necessary to construct a system capable of NI-PTRMS and (2) to characterize the present configuration's ability to measure negative ions. There were two major setbacks in achieving the latter. The first was testing the system in negative ion mode. The system arced at high voltages. The systems code (Lab View) had a polarity glitch that needed to be tracked down by the manufacturer. The arcs also damaged some of the circuitry and they had to be removed and rebuilt.

The other major setback was in the installation of the flow tube. The new proton transfer flow tube would not fit as designed and a 2.5 inch spacer flange was needed.

A-7b: Cavity Ring Down Spectroscopy
Faculty: Bililign
Relevance to NOAA: This project is directly relevant to the NOAA strategic goal **Climate**. NOAA's interests in this area include developing a chemical picture of the atmosphere and characterizing the abundance of trace compounds.
PROGRESS: The experimental set up for CRD work is now complete. Two graduate students in physics have been involved in this project since January 2008. The students are Israel Begashaw (International student, leveraged) and Chris Jessamy (African American) –currently supported by NSF funds. In the last six months:

1. The students attended the Bililign research group meeting, conducted an intensive literature review on the technique, and made presentations on the literature review.
2. They attended a physics graduate course, Spectroscopic Techniques, in the spring of 2008.
3. Dr. Steve Brown visited twice this summer. The first weeklong visit involved delivering a lecture in the course on CRD, and training students in cavity alignment and the general CRD technique. The second visit was a follow up to check the progress and test the system.
4. The students were given two days' training by a representative of the CONTINUUM lasers on the laser system; they are now able to align, trouble shoot, and operate the lasers effectively.
5. The lab view program for data acquisition was installed and modified by the students to run the system. The students are now able to fully set up, run, and operate the system.

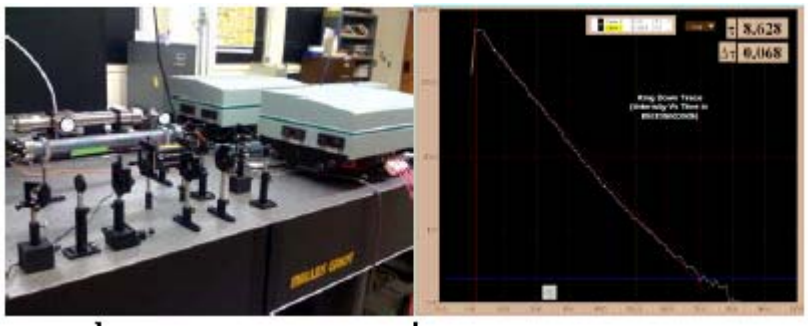


Figure 23 CRD set up and the cavity ring down signal measuring the time constant

6. Initial ring down data was taken in August (Figure 23).

Students: *(All students are African Americans)*
Three undergraduate members of the Bililign research group participated in all group meetings and were required to present their literature review. They worked with the graduate students. During the summer, Chris Ware (Physics, junior) and Jonathan Jefferies (Chemical Engineering, sophomore) spent this summer at NOAA offices and Charles Melvin (Chemical Engineering, senior) spent the summer at EXXON Mobil.

The systems to be studied have been identified. Initial work will focus on overtone spectroscopy of H_2O at 760 nm and 660 nm to calibrate the system and

reproduce results. The following systems will be studies using CRD, and compare results obtained using other techniques.

1. Hydroperoxidess such as methyl hyroperoxide (MeOOH) are sources of hydroxyl radicals (OH) in the atmosphere via photodissociation. The inability to account for the quantity of OH observed in the atmosphere has recently prompted an investigation into absorption of visible and near infrared wavelengths that leads to direct overtone photolysis. While there has been laser induced fluorescence (LIF) studies, the overtone spectroscopy has not been studied using CRD. The team will collaborate with the Assefa group here on campus to synthesize MeOOH, conduct OH-vibrational overtone studies using CRD, and compare results. This will form the basis of the MS thesis for Israel Begashaw.
2. Due to the importance and significant impact of halogen compounds on the chemistry of the boundary layer, HOBr will also be considered. Models suggest that HOBr molecules are generally more important than H_2O_2 or O_3 in the oxidation of S in sea salt aerosols in the cloud free Marine Boundary Layer (MBR). This system has never been studied using CRD.

Because both a second Yag laser and a dye laser are available, a two laser CRD experiment involving the gas phase reactions of NO_3 radicals with isoprene will be carried out. Isoprene is one of the most abundant naturally emitted hydrocarbons in the troposphere; the determination of the rate constants of the reactions of NO_3 radicals towards isoprene was investigated using different methods. CRD was not used for these studies.

***NOAA Collaborators*: ESRL-CSD: Jim Roberts, Ranajit Talukdar, Steve Brown**

1. Roberts and Talukdar helped design equipment for the upgrade of RTOF.
2. Steve Brown provided the Lab view program and set up CRD at NCA&T. He visited twice in May and August, to deliver lecture for a class and help set up experiments and train students. Steve Brown has been appointed as adjunct faculty.
3. Roberts and Talukdar worked on a joint proposal, "Kinetics and Thermochemistry Studies of Carboxylic and Other Acids Using Negative Ion Proton Transfer Mass Spectrometry (NI-PTMS)." They requested $313,000 for three years.
4. Roberts hosted Anthony Cochran for three weeks in the summer of 2008. He has been appointed as an adjunct faculty at NCA&T and will serve on Anthony's dissertation committee.

A-8: Chemistry of Aerosol Precursors

Faculty: Hasson

Relevance to NOAA: This project is directly relevant to two NOAA strategic goals, **Climate** and **Weather and Water**. The measurements will improve our understanding of the atmospheric chemistry of organic acids and peroxy radicals. This in turn will improve our understanding of air pollution and climate change, and thus contribute to the NOAA's mission "to understand and predict changes in Earth's environment…"

PROGRESS: The principal goal of this project is to measure branching ratios for the reaction between acylperoxy radicals and hydroperoxy radicals.

RC (O) O2 + HO_2	→ RC (O) O2H + O_2	R1a
	→ RC (O) OH + O_3	R1b
	→ RC (O) O + OH + O_2	R1c

Prior work done in the lab showed for the first time that acetylperoxy radicals ($CH_3C(O)O_2$) generate substantial quantities of OH radicals via R1c. This result has attracted substantial interest from the atmospheric chemistry community as it may explain anomalously high radical concentrations measured in various field campaigns and because the reaction also contributes to the atmospheric budget of carboxylic acids via reaction R1b. However, there are no measurements in the literature for larger acylperoxy radicals. This study will therefore establish whether or not the chemistry is unique to acetylperoxy radicals or whether it is a more general phenomenon.

The project goal for Year 2 is to measure R1a-c branching ratios for C_2-C_5 acetyl peroxy radicals. Work on the C_2 and C_3 radicals was completed during the last reporting period. Measurements for the C_4 and C_5 radicals have proved to be more difficult both because the chemistry is more complex than originally anticipated and because some of the instruments have not been able to measure the reaction products quantitatively. Consequently, alternative instruments and additional experiments (i and ii) have been carried out. These experiments will lead to publications that were not originally anticipated; one manuscript has already been accepted. Despite these obstacles, the project is on course to reach its Year 2 milestones by the end of September. The measurements show substantial yields of both radicals and acids from C_2, C_3 and C_4 acylperoxy radicals, and preliminary data for the C_5 radical indicate that reactions R1b and R1c are also important for this species. Collectively, the measurements provide strong evidence that these reactions are important radical and acid sources for all straight-chain acylperoxy radicals.

In addition to the main set of experiments described above, a second, related project is also being undertaken. Recent work by this group has suggested that dairies may be significant primary sources of carboxylic acids in Central California. Using the same analytical technique used to quantify organic acid production in the smog chamber, solid phase micro-extraction fibers with gas chromatography/mass spectrometry analysis was used to measure carboxylic acid emissions from six California dairies. The measurements confirm that large fluxes of organic acids are emitted from these facilities.

i. Kinetics and Mechanism for the Reaction of Chlorine Atoms with Butanal and Pentanal

In the previous progress report, yields of the acid chloride formed from the reaction between the aldehyde (butanal or pentanal) and chlorine atoms in the absence of oxygen were reported. To better understand the chemistry of this reaction, relative rate measurements have been made using ethene and isopropanol (both in the presence and absence of oxygen) as reference compounds. Relative rate plots for these reactions are shown in Figure 25 below.

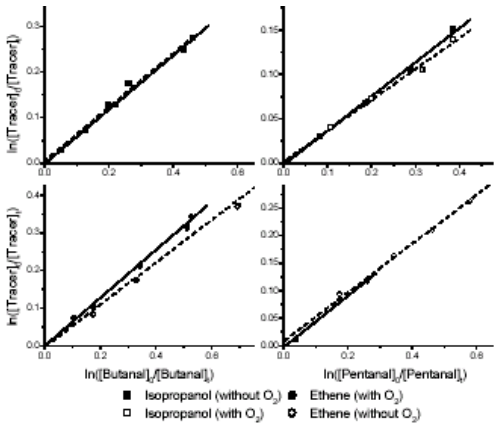


Figure 25. Relative rate plots for the reaction of chlorine atoms with tracers (isopropanol and ethene) with aldehydes (n-butanal and n-pentanal) in the presence and absence of oxygen

Combining these results with literature values for the absolute rate coefficients for the reference compounds gives rate coefficients for Cl + n-butanal and Cl + n-pentanal of $(1.64\pm0.28)\times10^{-10}$ $cm^3.molecule^{-1}.s^{-1}$ and $(2.36\pm0.42)\times10^{-10}$ cm^3 $molecule^{-1}.s^{-1}$, respectively. These values are in better agreement with the trend in Cl + aldehyde rate coefficients than previous measurements (Figure 26).

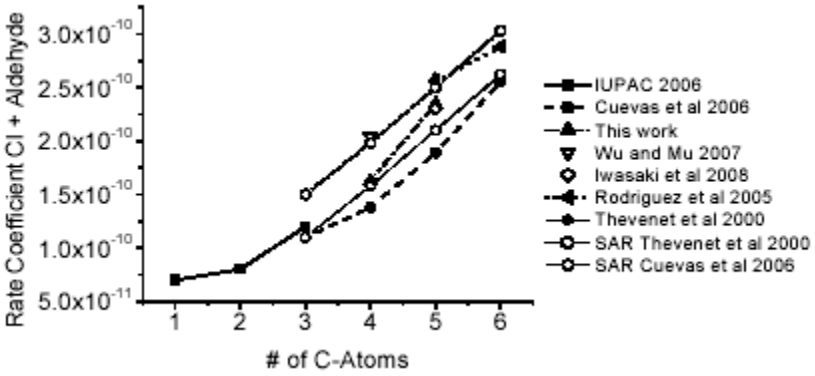


Figure 26 Comparison of rate coefficients for Cl + n-aldehydes containing 1 to 6 carbon atoms.

A manuscript based on the acid chloride yield and relative rate data was submitted to the *International Journal of Chemical Kinetics* in May.

ii. Cl-atom Initiated Oxidation of Butanal in the Presence of NO and NO_2

Chemical modeling of the butionyl peroxy + HO_2 system indicates that the branching ratios for the Cl + butanal reaction (R1a-d) are key parameters in fitting the data (see section iii. below).

$CH_3CH_2CH_2CHO + Cl$	$\rightarrow CH_3CH_2CH_2CO + HCl$	R2a
	$\rightarrow CH_3CH_2CHCHO + HCl$	R2b
	$\rightarrow CH_3CHCH_2CHO + HCl$	R2c
	$\rightarrow CH_2CH_2CH_2CHO + HCl$	R2d

While the branching ratio for R2a was measured in the previous reporting period, the ratios for the remaining channels have not been well established. To address this, the oxidation of butanal was investigated in the presence of NO_2 and NO. Butionyl peroxy radicals (formed from the reaction of the product of reaction R2a with oxygen) react with

NO_2 to form peroxybutyl nitrate (PBN). Since the infra-red absorption cross-section for this species is known, the concentration of PBN can be monitored by FTIR spectroscopy. In the presence of excess NO_2, the yield of PBN is 65% indicates that the branching ratio for R2a is 0.65, an excellent agreement with our previous measurement. In the presence of NO, the organic peroxy radicals (formed from the reaction of the products of R2a-d with oxygen) are converted to alkoxy radicals. R2b reaction products subsequently generate carbon monoxide and propanal while R2c products form carbon monoxide, acetaldehyde and formaldehyde. The yields of CO, acetaldehyde and propanal were monitored from the photolysis of Cl_2/Butanal/NO/Air mixtures using a combination of GC-FID and FTIR spectroscopy. Yields of 25% and 15% were obtained for CO and acetaldehyde, respectively. Since acetaldehyde is produced exclusively from R2c, this indicates that the branching ratio for this channel is 0.15. CO is generated from both R2b and R2c, implying that the branching ratio for R2b is 0.1. The remainder of the Cl + butanal reaction (10%) occurs via R2d. The branching ratios measured here (R2a:R2b:R2c:R2d = 0.1:0.15:0.1:0.65) are different from those reported by Wu and Mu (0.12:0.21:0.25:0.42) using a similar technique. The discrepancies appear to be due to their inability to account correctly for the formation of hydroperoxides and nitrates in their experiments.

iii. Mechanism of the Reaction of Butionyl Peroxy Radicals with HO_2 Radicals

In the last progress report, preliminary experiments to measure branching ratios from the reaction between $CH_3CH_2CH_2C(O)O_2$ and HO_2 were described (R1a-c). Following the submission of the report, several problems became apparent: i. the HPLC system does not quantitatively measure the peroxides formed in this reaction due to decomposition within the column; ii. butanal and propanal (which is a major product from the reaction) have very similar infra-red spectra, making the FTIR data analysis difficult; and iii. carboxylic acids are difficult to measure in the infra-red spectra due to interference from other compounds. To address problem i., several different eluents were tested. While a mixture of dilute sulfuric acid and methanol was found to reduce the decomposition of the peroxides significantly, some loss of these compounds still occurred during the analysis. The column of the instrument was therefore removed, and HPLC was used to measure the total yield of organic peroxides. In the original proposal, HPLC was to be used to monitor the concentration of propyl hydroperoxide; the concentration would then be used to quantify the branching ratio for reaction R1c. IR spectra were therefore used to measure the CO_2 concentration during the reaction, giving a direct measurement of the R1c channel. To circumvent problem ii, butanal and propanal were also measured using gas chromatography with flame ionization detection (GC-FID), with the infra-red spectra being used as a secondary check of the GC measurements. Problem iii was overcome using solid phase micro-extraction (SPME) fibers coupled to gas chromatography-mass spectrometry (GC/MS) to quantify carboxylic acid concentrations in the reactions.

Yields of propanal, acetaldehyde, carbon monoxide, carbon dioxide, total peroxides and butyric acid were measured for the photolysis of butanal/Cl_2/methanol/N_2/O_2 mixtures. The yields of key species measured as a function of the ratio of the concentration of methanol to butanal are shown in Figure 27.

An Acuchem model containing approximately 200 individual chemical reactions was constructed to simulate the chemistry occurring in these experiments. The yields of

the measured species are found to be sensitive to both the branching ratios for reactions R1a-c and R2a-d (Figure 3). Branching ratios for R2a-d were therefore determined as described above. The experimental data were then fitted to the branching ratios for reactions R1a-c (Figure 3). Optimal fits for the data give branching ratios for R2a:R2b:R2c of 0.5:0.2:0.3. There are no literature values for these quantities, but the ratios obtained here are consistent with those obtained for acetyl peroxy and propionyl peroxy radicals.

iv. Mechanism of the Reaction of Pentionyl Peroxy Radicals with HO_2 Radicals

Experimental measurements are currently being carried out on the reaction between $CH_3(CH_2)_3C(O)O_2$ and HO_2. Initially, the yield of butanal from the photolysis of pentanal/methanol/Cl_2/air mixtures was measured by FTIR and GC-FID. The yield was found to be low (8%) due to the isomerization of the 1-butoxy radical (R4) formed from the decomposition of the product of reaction R1c (R3).

$$CH_3(CH_2)_3C(O)O \rightarrow CO_2 + CH_3(CH_2)_3 (+ O_2)$$
$$\rightarrow CH_3CH_2CH_2O_2 (+RO_2) \rightarrow CH_3CH_2CH_2CH_2O + (RO) \quad R3$$
$$CH_3CH_2CH_2CH_2O \rightarrow CH_2CH_2CH_2CH_2OH \quad R4$$
$$CH_3CH_2CH_2CH_2O + O_2 \rightarrow CH_3CH_2CH_2CHO + HO_2 \quad R5$$

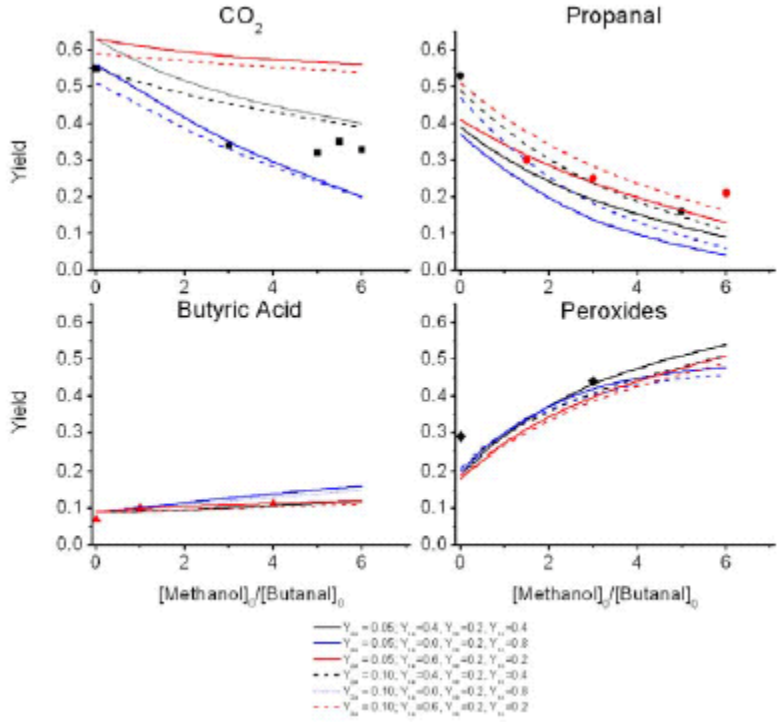


Figure 27 Measured and modeled yields from the photolysis of butanal/methanol/chlorine/air mixtures. Red symbols correspond to measurements made at Fresno State and black symbols to measurements made at NCAR.

Reaction R4 is competitive with the reaction with oxygen to form butanal (R5).

Thus the yield of butanal is expected to increase as the oxygen concentration is increased. A series of experiments were carried out to measure the butanal yield as a function of $[O_2]$. The yield of butanal was found to increase from 8% at 140 Torr O_2 to 16% at 760 Torr O_2.

Yields of pentanoic acid, total peroxides, CO, CO_2, butanal, propanal, and acetaldehyde are currently being measured from the photolysis of pentanal/methanol/Cl_2/air mixtures. Following the completion of these measurements during September, a chemical model will be used to establish the branching ratios for R1a-c.

v. Carboxylic Acid Fluxes from Central California Dairy Facilities

California's Central Valley suffers from some of the highest air pollution levels in the United States. During the summer months, ozone levels regularly exceed the federal and state standards. Current emissions inventories cite dairy operations as the largest single source of VOCs in the region, with short-chain carboxylic acids, phenols and amines constituting the bulk of these emissions. These inventories are controversial, however, because the measurements on which they are based were not taken in (and therefore may not apply to) California.

To address this issue, a method using a flux chamber coupled to solid phase micro-extraction (SPME) fibers followed by analysis using gas chromatography-mass spectrometry was developed to quantify emissions of six VFAs (acetic acid, propanoic acid, butanoic acid, pentanoic acid, hexanoic acid and 3-methyl butanoic acid) from sources at six dairies during Summer 2008. The data show that these facilities may emit as much as 400 $ghour^{-1}$ of organic acids, predominantly as acetic acid. A detailed analysis of the data and additional field measurements will more accurately constrain organic acid fluxes from these sources.

Students: Five students participated in NOAA-ISET research during the reporting period: Sukhdeep Singh, Yesenia Ibarra, Samuel Hernandez, Phillip Alanis (new student), and Sean Campbell (new student). Samuel graduated with a BS in Chemistry in May 2008 and has entered the MS Chemistry program at Fresno State. He is continuing to work on the peroxy radical + HO_2 project. Phillip is a junior BA chemistry major and is measuring carboxylic acid emissions from dairy facilities. Sean Campbell is sophomore BS biology major and is being trained to take over some of the smog chamber experiments when Yesenia and Sukhdeep graduate in the coming months.

Status of collaboration with NOAA scientists

Alam Hasson is currently at the start of a 6 month sabbatical co-hosted by NCAR and NOAA. As a part of this sabbatical, he will participate in a project within the research group of Dr. James Burkholder. Work on a new project to investigate the mechanism of the reaction of isoprene with NO_3 that involves Fresno State, NOAA, and NCAR will also begins in this period. Dr. Burkholder will also be invited to serve on the MS thesis committee of ISET student Samuel Hernandez.

A-9. Methodology for Batch and Continuous CO2 and Other Trace Gases

None reported; PI withdrew from ISET

B. Research Objective II

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

Relevance to NOAA: This project is directly relevant to two NOAA strategic goals **Climate** and **Weather and Water**. This group will produce reference data sets that

provide improved climate information. They will use these data sets to develop integrated historical analyses of the global climate system through integration of multidimensional reference data sets into the application and development of state-of-the science attribution studies. These studies link observed climate changes (including changes in extreme events) to these events. The security of our country and its citizens depends on (i) improving the nation's capability of predicting hurricanes and their damage to the socio-economic fabric; and (ii) the development of the capability for early warning, thus reducing the magnitude of destruction, damage, and loss of life. The expected advances in the capacity to manage geospatial data will complement NOAA's mission in this area by providing technologically appropriate tools for the storage, management, display and analysis of the data. The group works closely with NOAA-ESRL labs, NOAA-NCDC, NOAA-Cooperative Institute for Climate Studies (CICS), the International Research Institute for Climate Prediction (IRI) (which was established by NOAA in 1996), and the Miami Hurricane Center.

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

Section	**Lead ISET CSC researchers**	**Research objectives for year II from the IP**	Comments. Met milestone goals?
B-1: Analysis of Storms and Hurricanes I	Semazzi, Xie; NCSU	Collection, processing, and transformation into gridded forms of data derived from multiple sensors constituents.	YES
B-2: Analysis of Storms and Hurricanes II	Mahani, Khanbilvardi, Brian Vant-Hull, CCNY, CUNY	(a) Compilation and preliminary analysis of data from multiple sensors for aerosol & hydrological-related data; processing & transformation into gridded data; & (b) customization of WRF-CHEM to investigate the relationships between aerosols, microphysics, hydrological variables, and climate.	YES
B-3a: Analysis of Storms and Hurricanes I1I	Ahmidouch, NC A&T	PI resigned from ISET	NO; see main text
B-3b: Hurricane Activity, Magnetic Pole drift, Solar Particles	Danagoulian, NC A&T.	Study the influence of geomagnetic pole drift on the global warming and hurricane genesis.	NO; see main text
B-4: Analysis of Storms and Hurricanes IV	Semazzi, Xie, NCSU	Customization of the RegCM3 model and its application to study the climate anomaly conditions over West Africa during the 2005 extreme hurricane season	YES
B-5: Analysis of Storms and Hurricanes V	Semazzi, Xie, NCSU	Begin initial WRF numerical experiments to quantify the relationships between prescribed exit region coastal SST anomalies associated with upwelling/downwelling.	YES
B-6: Analysis of Storms and Hurricanes VI	Tang, Kyei, NC A&T; Semazzi, Xie, NCSU	Optimization of lateral boundary conditions; formulation, resolution, and the tuning of physical parameters for the WRF-NMM regional climate model for the bifurcation region.	YES
B-7: Analysis of Storms and Hurricanes VII	Liu, Semazzi, Xie, NCSU; Nzewi	(a) Collection, processing & transformation into gridded forms, of data derived from multiple sensors to support the modeling of inland flooding in years 2-5. (b) Risk assessment for weather based accidents	YES NO; see main text

B-8: Analysis of Ground-Based Remote Sensing Measurements of Aerosols and Ozone in Greensboro, NC: Study on the Disturbances in Air Quality and Climate	Ilias, Li, Rastigevey, Schimmel, NCAT	(a) Investigate air quality disturbances such as, high ozone and pollution episodes that occur periodically in Greensboro, and neighboring cities in NC (b) Estimate the mixed layer heights for Greensboro, and neighboring cities from existing meteorological data (c) Examine the relationship between the diurnal evolution of the mixed layer height and ground level ozone concentrations (d) Investigate relationship between vertical mixing and high ground level ozone concentration	YES
B-9: Global Modeling of Large-scale Processes & Regional Modeling of Mesoscale Processes Using NOAA FIM Model & WRF Model	Lin, Tang, Kyei NC A&T; Semazzi NCSU	Investigate the formation of African easterly waves (AEW) and the accompanied mesoscale convective system (MCS) in eastern North Africa, the impacts of AEW and MCS on the formation of hurricanes in eastern Atlantic Ocean, and the landfall of hurricanes on the US coasts.	YES
B-10: Prediction of Atlantic Hurricane Regimes: Joint Thrust Areas II & III	Semazzi, Xie NCSU; Kumar, Said, Homaifar, NC A&T; Steinbach, Minnesota	Application of data mining & data fusion methods in computer science in combination with regional climate modeling on multiple observational data to predict Atlantic hurricane activity	YES

B-1: Analysis of Storms and Hurricanes-1
Faculty: Semazzi, Xie; NCSU

Relevance to NOAA: This research is relevant to NOAA's strategic goal **Weather and Water** that includes analysis, modeling, and prediction of hurricane development (NOAA-ESRL; NOAA/AOML) to provide increase lead time and accuracy for weather warning and forecast, and improve predictability of severe weather.

PROGRESS: A summary of accomplishments in a comparative study of multiple datasets to ascertain the relationship between coastal upwelling and convection in the exit region is discussed below. First, the team compared NOAA Optimum Interpolation Sea Surface Temperature V2 (Reynolds et al., 2002) and NOAA Interpolated Outgoing Long wave Radiation (Liebmann and Smith, 1996), which is a good proxy for convection. Using data for the period, 1982-2007, correlation coefficients between August average SST and August average OLR in a box bounded by 8°N-15°N and 35°W-15°W were calculated and overlaid with SST standard deviation. This box is centered along the typical track of easterly waves which exit the African coast. Negative values indicate that warm SST accompanies enhanced convection and vice versa. Based on 26 years of data, coefficients of 0.388 are significant at the 95th percentile and coefficients of 0.495 are significant at the 99th percentile. In Figure 28 shows the strong correlation between convection and SST anomalies off the African coast, with correlation in excess of -0.50. The position of the SST in the vicinity of the upwelling front is indicated by the maximum in standard deviation between 18°N-20°N. In fact, according to this same

dataset, this region has the largest SST standard deviation in the entire North Atlantic south of 40°N during August.

To examine how upwelling relates to tropical cyclogenesis in the eastern Atlantic, the same SST dataset for August 1982-2007 used above was used and compared to the number of tropical cyclones that formed east of 60°W during July and August. To eliminate the direct effect of underlying SST on tropical cyclogenesis near the upwelling region itself, the tropical cyclones forming both east of 30°W and north of 15°N were eliminated from this count. Figure 28 shows the correlation coefficients between SST and tropical cyclogenesis overlaid with average August SST. Significance levels are the same as those defined for Figure 29. Again, note the high positive correlations (values > 0.55) along the upwelling front well to the north of where tropical cyclogenesis typically occurs.

These two independent analyses based on different gridded sensors produce highly congruent results. Convection off the coast of Africa is related to the position of the upwelling front. These analyses are being used to compliment the modeling tasks in project B-5. Future research activities under this project will expand the collection, processing, and transformation of multiple sensor data into gridded forms to support the empirical and modeling investigations to understand the relationships among the primary phases of hurricane development.

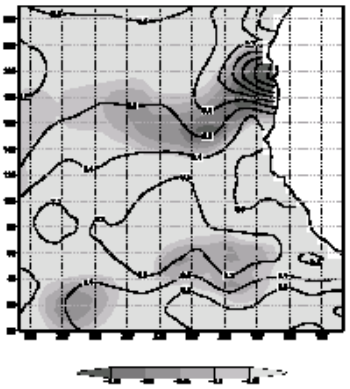


Figure 28 Correlation coefficients between August 1982-2007 OLR and SST (shaded) overlaid with SST standard deviation (°C; contours).

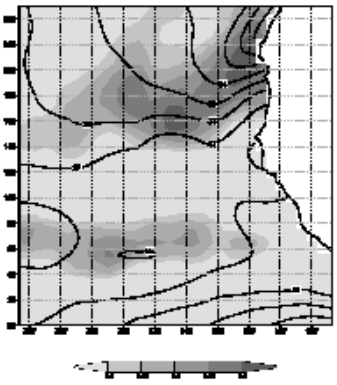


Figure 29 Correlation coefficients between July and August tropical cyclones forming east of 60°W and August SST (°C) from 1982-2007 (shaded). Contour lines show average August SST from 1982-2007.

NOAA collaborators: Gopal, Fairall, Koch, NOAA-ESRL; Marks, Friedman, NOAA/AOML
Students: Michael Diaz (MS)

B-2: Analysis of Storms and Hurricanes-2
Faculty: Mahani, Khanbilvardi, Brian Vant-Hull, CCNY, CUNY
Relevance to NOAA: This work is relevant to NOAA's strategic goal **Weather and Water**, the analysis, modeling, and prediction of hurricane development (NOAA-ESRL; NOAA/AOML) to provide increased lead-time and accuracy for weather warning and forecast, and improve predictability of severe weather. Predicting regional and global climate requires an understanding of the radiative effects of aerosol particles of natural and human origin, their cloud nucleating properties, and their effects on precipitation. The work here contributes to this understanding.
PROGRESS: The satellite study has been expanded from the Canada-Siberia comparison to the U.S. East Coast. Liquid water is calculated to relate aerosol effects to

cloud dynamics. The East Coast study is not as mature as the one in the northern latitudes and does not yet exhibit clear results. To assist in aerosol identification, WRF-CHEM is being installed on the CUNY Staten Island computer cluster. The simpler WRF model is currently used for training.

Work from the previous reporting period demonstrated that both cloud drop effective radius and optical depth initially increased with aerosol loading, followed by a less rapid decline as aerosol increased. These two variables are affected by cloud development as well as drop size. Total cloud liquid water depends on condensation rates, and should have a much weaker dependence on drop size. These factors focus attention on how aerosol affects cloud dynamics via temperature and water vapor profiles.

Cloud liquid water is calculated by multiplying drop effective radius by optical depth. It exhibits a similar initial increase followed by a decrease as aerosol loading increases (Figure 30). Figure 30 demonstrates the average relationships between cloud liquid water and aerosols optical depth (AOD) for the three levels of precipitable water vapor (WV). There are several possible reasons for this behavior. Extremely low aerosol is probably caused by rainout. Thus, the clouds in the vicinity of low AOD would be dissipated and have low liquid water. As aerosol loading increases, stabilization of the atmospheric column due to direct radiation effects (shading the surface, absorbing and heating higher in the column) could suppress cloud development. It is also likely that thicker clouds are more likely to rain, so aerosol will only be heavy in the vicinity of less developed clouds. By this argument the low aerosol beginning of the plot shows clouds after they have rained; the high aerosol at the end shows clouds before rain has occurred.

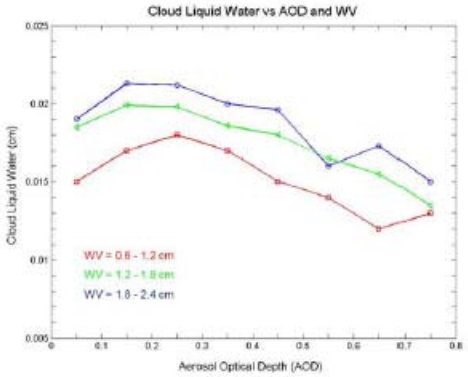


Figure 30: Cloud liquid water as a function of aerosol optical depth, for three levels of total water vapor (WV).

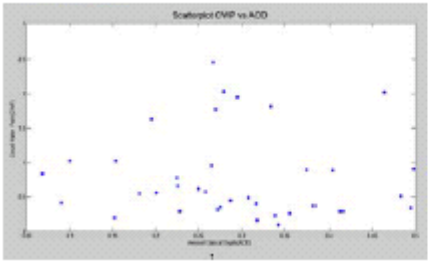
Three different water vapor levels were selected. As expected, higher water vapor results in higher liquid water. The conversion between vapor and liquid could be controlled by atmospheric profiles of temperature and humidity, or by precipitation. A larger rate of conversion of vapor to water would naturally result in larger dispersion between water vapor bins, while a larger rate of precipitation would tend to decrease the dispersion be reducing the number of clouds with high liquid water content. These multiple and sometimes conflicting explanations demonstrate that satellite data alone is insufficient to untangle the relationships between aerosols and clouds. For this reason future work must involve weather radar data as well. This part of the study should use comparisons between the areas with comprehensive radar coverage, such as continental US and Europe.

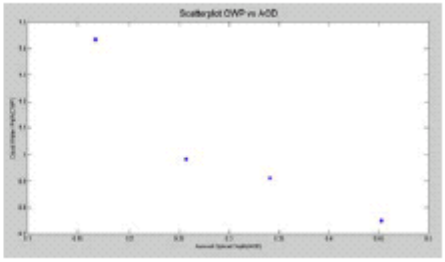
The relationship between cloud liquid water path (CWP) and the AOD for the eastern part of the United States have been investigated using data from Aqua. A study case was selected for July 31st 2007(22:00) to April 1st 2008 (16:00) and an area with latitude from 35° to 45° degrees north and longitude from 70° to 80° degrees west. The temporal and spatial restrictions were aimed to retrieve daytime and land products. Beside the temporal and spatial restrictions, the variables within the data were subject to a series of restrictions, which are:

- Cloud top temperature was maintained above 270° K;
- Water path would only refer to liquid water;
- Cloud fraction was considered less than 0.8;
- Only thin clouds were selected;
- Sensor zenith was fixed between 20° and 35° degrees and solar zenith was fixed between 15° and 30° degrees; and
- The relative azimuth was fixed between 15° and 75° degrees.

Cloud water path was plotted against AOD using the restricted data (Figure 31). Preliminary results for the eastern U.S. do not demonstrate a specific relationship between cloud liquid water to aerosol loading (Figure 31).

A Binning technique applied to data to be able to clarify the relationship between CWP and AOD. Figure 32 represents the CWP against AOD using the data after binning with binning segment of 0.1 for AOD axis. The preliminary results show a decrease in





CWP with aerosol loading (AOD).

Figure 31: Cloud liquid water path as a function of aerosol optical depth (AOD) in the Eastern U.S. Satellite-sun angles are constrained to a range of 60 degrees, with cloud top temperatures warmer than 270 K. Data is averaged into aerosol bins by increments of 0.01.
Figure 32: Cloud liquid water path vs. AOD in the Eastern U.S using data after binning**.**

There is still no evidence of a clear relationship between CWP and AOD. Further screening must be applied before we can state that this null relationship is scientifically valid. Using weather radar to screen out rainfall events should also clarify the aerosol-cloud relationship.

***Student*:** Ousmane Sy Savane
NOAA Collaborator: George Grell (NOAA-ESRL)

B-3a: Analysis of Storms and Hurricanes-3a & b
Faculty: Ahmidouch: NC A&T-PI-Withdrew from ISET
B-3b: Hurricane Activity, Magnetic Pole Drift Solar Particles
Faculty: Danagoulian
Project terminated in response to NAC recommendations; PI in the process of identifying another research focus.
Students: Timothy Lewis (UG) , Brandon Davis (G) will work with Yuh-Lang-Lin

B-4: Analysis of Storms and Hurricanes-4
Faculty: Semazzi, Xie, NCSU
Relevance to NOAA: This research is relevant to NOAA's strategic goal **Weather and Water**. Analysis, modeling, and prediction of hurricane development (NOAA-ESRL; NOAA/AOML) are expected to provide increased lead time and accuracy for weather warning and forecast, and to improve predictability of severe weather. It contributes to NOAA's effort in numeric modeling of climate systems that will help improve the accuracy of climate forecasts.
PROGRESS: Typically, the strongest Atlantic hurricanes originate from tropical easterly waves. The 2005 Atlantic Hurricane Season was the most active season on record with four hurricanes reaching category 5 status on the Saffir-Simpson Hurricane Scale. The working hypothesis in this project is that the African easterly waves in 2005 were fundamentally different and most likely more active than the waves within the other neighbouring years (2001-2004, 2006) of this study. During this reporting period work based on the RegCM3 was terminated because the model is highly deficient over the Atlantic Ocean in the exit region. However the model performs satisfactorily over West Africa before the convective disturbances move over to the ocean. A journal paper is in preparation for that part of the results.
***Student*:** Kurt Korte (MS, graduated)

B-5: Analysis of Storms and Hurricanes-5
Faculty: Semazzi, Xie, NCSU
Relevance to NOAA: This research is relevant to NOAA strategic goal **Weather and Water**. Analysis, modeling, and prediction of hurricane development (NOAA-ESRL; NOAA/AOML) are expected to provide increase lead time and accuracy for weather warning and forecast, and improve predictability of severe weather.
PROGRESS: The ultimate goal in this project is to (1) quantify the relationships between the exit region coastal SST anomalies associated with upwelling/downwelling and (2) investigate the relationship with geographically forced regional teleconnections associated with orographic-dynamic forcing.

In this phase of the project the focus was on using the WRF model to test the hypothesis that the position of the upwelling front off the Mauritanian coast modulates the intensity of the convective systems leaving the west coast of Africa and affects their prospects for becoming tropical cyclones. Figure 33 shows the correlation coefficients between SST and tropical cyclogenesis overlaid with average August SST.

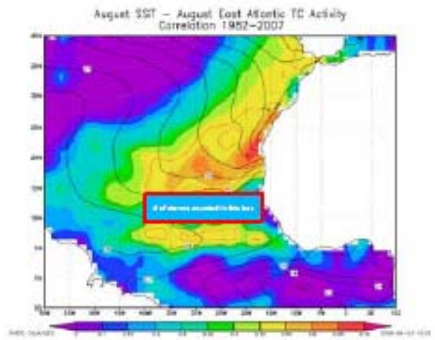


Figure 33 Correlation coefficients between July and August tropical cyclones forming east of 60°W and August SST (°C) from 1982-2007 (shaded). Contour lines show average August SST from 1982-2007.

When the upwelling front is displaced farther southward (northward), a condition which produces anomalously cold water off the coast of Mauritania, the intensity of MCSs entering the eastern Atlantic weakens and eventually produces weaker hurricanes relative to the control experiment (Figure 34). We believe that these SST anomalies (prescribed in the WRF model), which lie to the north of the main MCS trajectory, could be of greater importance than those directly underlying the convection.

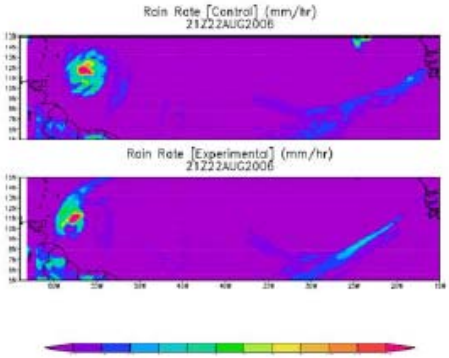


Figure 34 Top: Control experiment; bottom: With colder SSTs off the coast of Mauritania in West Africa. Rainfall in mm/hour

The results of the numerical experiments agree well with our hypothesis. The main finding is that the coastal waters off northwestern Africa north of 15°N are an important moisture source for tropical cyclones developing in the eastern Atlantic. This source tends to offset the detrimental effects associated with the horizontal flux of extremely dry northeastern Atlantic air. The presence of an upwelling front leads to large interannual SST variability in this region; this led to the postulate that the flux of moisture into the monsoon trough along the African coast also experiences large year to year variability. As shown with both our observational and model analyses, a southward displacement of this front favors stronger convection off the African coast and the potential for an increased number of tropical cyclones downwind of this region in the eastern Atlantic Ocean basin. Further investigation of the proposed mechanisms will be the subject of future investigation.

NOAA collaborators: Gopal, Marks, Friedman (NOAA/ AOML), Koch, Fairall (NOAA-ESRL).

Student: Michael Diaz (MS)

B-6: Analysis of Storms and Hurricanes-6
Faculty: Tang, Kyei, NC A&T; Semazzi, Xie, NCSU
Relevance to NOAA: This research is relevant to NOAA's strategic goal **Weather and Water.** Analysis, modeling, and prediction of hurricane development (NOAA-ESRL, NOAA/AOML) provide increased lead time and accuracy for weather warnings and forecasts, and improve predictability of severe weather. This contributes to NOAA's effort in numeric modeling of climate systems that will help improve the accuracy of climate forecasts.
PROGRESS: Research has focused on four fronts (1) numerical investigation of optimization of lateral boundary conditions formulation; (2) customization of relaxation coefficients for the WRF-ARW model; (3) exploration of the effect of winds, sea level pressure, and SST abnormality on hurricane tracks and direction changes; and (4) testing of various idealized cases within WRF-ARW and use of NOAA FIM global model to generate GCM forcing for initial and boundary conditions for WRF models.
Optimization of lateral boundary conditions:

The team is exploring the use of compact volume differencing approach to develop a stable numerical scheme for the associated Navier-Stokes equations and employ local mesh refinements and local defect correction techniques to downscale coarse-resolution GCM data to the resolution level needed for limited area models. This will be used for the numerical investigation of formulations to optimize lateral boundary conditions. Thus this downscaling procedure is guaranteed to have the integrity of the physical dynamics of the flow supporting the idea of radiation boundary conditions. The team is investigating the inclusion of the time domain in determining the control volumes to develop conservative time-stepping schemes for such propagation problems. For large propagation problems in regional climate modeling and numerical weather prediction, explicit time integration methods are preferable. However, the explicit schemes are known to be very diffusive. This has resulted in the preference for operational modeling using time-stepping schemes such as Runge-Kutta methods to improve accuracy. Higher-order accuracy in time requires additional work. A resolution of mixed partial derivatives in the truncation error and additional degrees of freedom provided by additional grid points are needed to improve accuracy and to stabilize the resulting schemes. The time-stepping distances may be adaptively determined based on the spatial discretization and the approximate propagation speed over the local control volume to preserve the integrity of the solution at the next future time step. By considering the control volumes to be the triangular regions of dependence, time stepping points may be considered at points within the triangular control volume to improve accuracy via compact differencing and reduce the diffusive tendencies of the resulting semi-implicit schemes. As a first step of implementation of the ideas, the shallow-water model is being studied. A simple mesoscale model developed by Dr. Yuh-Lang Lin, known as Geophysical Fluid Dynamical Model (GFDM), is being used as a modeling tool for such implementation.

For the customization of relaxation coefficients for the WRF-ARW model (WRF ARW Version 2.2.1), the team explored the use of an exponential function instead of a linear function to generate the relaxation coefficients. This involved the modification of some of the FORTRAN code implementing the relaxation coefficients in the WRF-ARW model and recompilation of the WRF-ARW. The modification was successfully

implemented. They then used WRF-ARW with the modified relaxation coefficients to run a nested model previously run with the linear relaxation coefficients to determine whether there is any improvement with the exponential relaxation coefficients. Figures 35 through 41 illustrate the highlights of this study of numerical experimental sensitivity.

Figure 35: One-way nest for the time period of 08/26-08/28/05, CD 40 km and FD 13 km.

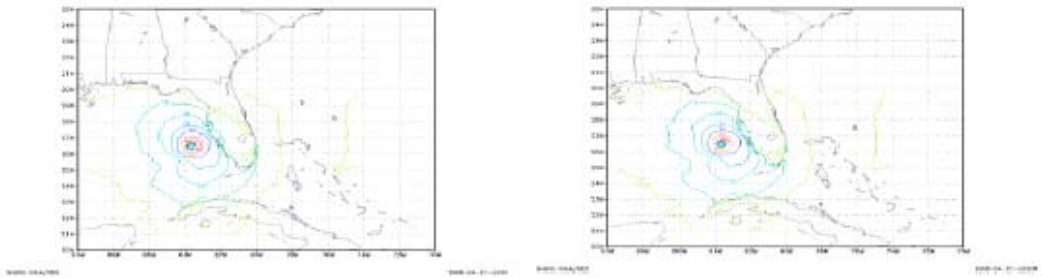


Figure 36: UV-wind profile at 15Z, 08/25/05 with linear relaxation coefficients.
Figure 37: UV-wind profile at 15Z, 08/25/05 with exponential relaxation coefficients.

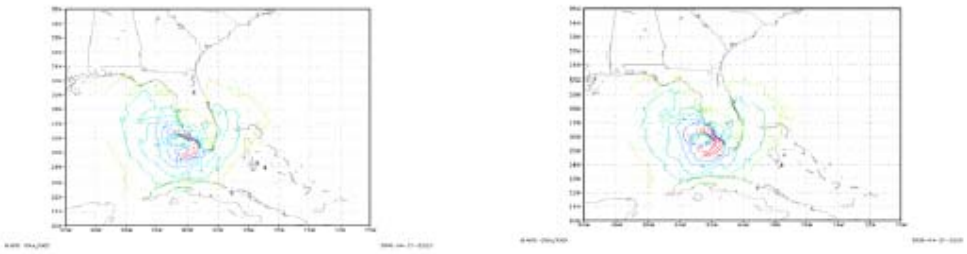


Figure 38: UV-wind profile at 21Z, 08/26/05 with linear relaxation coefficients and buffer zone width of 5 points.
Figure 39: UV-wind profile at 21Z, 08/26/05 with linear relaxation coefficients and buffer zone width of 9 points.

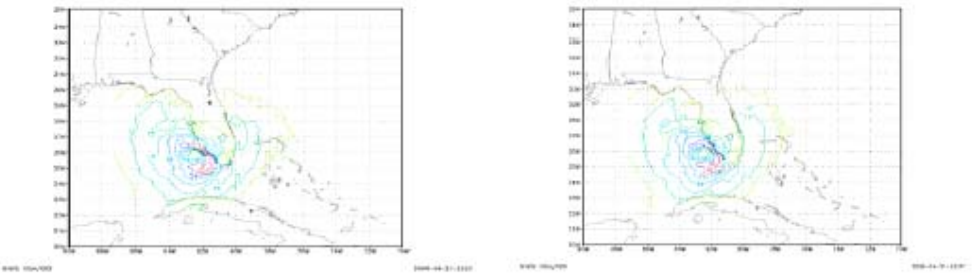


Figure 40: UV-wind profile at 21Z, 08/26/05 with exponential relaxation coefficients and buffer zone width of 5 points.
Figure 41: UV-wind profile at 21Z, 08/26/05 with exponential relaxation coefficients and buffer zone width of 9 points.

The group also tested both linear and exponential relaxation coefficients with different buffer zone widths for a two-way nested model. This preliminary experiment indicated that there is no significant improvement of an exponential relaxation scheme over a linear relaxation scheme for formulation of lateral boundary condition for model runs of short duration. A longer duration of time for the model run will be tested. This study also identified an apparently significant sensitivity on the selection of buffer zone widths. Even though WRF ARW Version 3 offers an option to use either linear or exponential relaxation schemes, this experiment has enabled the team to implement other well-known relaxation schemes within the WRF-ARW model.

Sensitivity simulations on Winds, SST & SLP:

For the exploration of the effect of winds, sea level pressure (SLP), and SST anomalies (SSTA) on hurricane track and direction change, relevant hurricane data have been retrieved. GrADS scripts have been developed to analyze and display meteorological data and several major hurricane tracks running through the Gulf region along with winds, sea level pressure, and SST anomalies, respectively. The variable winds and SLP were run together to show how both pressure and winds act together on the steering behavior of each selected hurricane, revealing that trade winds and prevailing winds play a major role in driving each hurricane. The data analysis also revealed that SLP and SSTA have impact on the hurricane track and direction change. However, additional SSTA data and analysis are needed. Two numerical simulations using WRF ARW were carried out recently. Validation of the findings is underway.

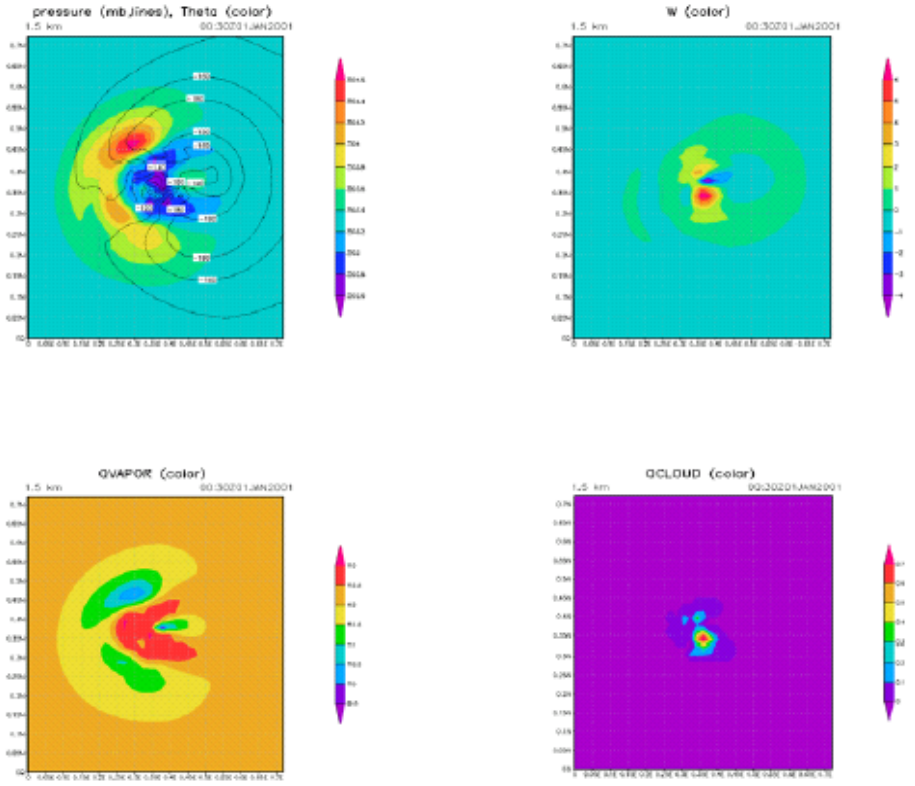


Fig. 42: Idealized cases within the WRF-ARW model in presence of a bell-shaped 3-D mountain for the simulation of the quarter-circle shear supercell case.

Idealized Simulations:
For the fourth part, the team tested several idealized cases within the WRF-ARW model, and explored the possibility of modifying the FORTRAN code to build a bell-shaped 3-D mountain for the simulation of the quarter-circle shear supercell case, as illustrated in Figure 42.

Participation in relevant academic conferences, workshops, and meetings:

Both Dr. Guoqing Tang and Dr. Yaw Kyei travelled to ESRL in Boulder, CO on March 18-22, and worked with Dr. Jin Lee of NOAA/ESRL. They plan to use the FIM model to initialize WRF simulations using data from the FIM global model runs. Being a global model based on accurate finite-volume discretization of horizontal advection, FIM has been shown to be conservative of the various fluxes at the given level of resolution and thus capable of modeling the effective large scale processes and phenomena present in global weather systems. The interactions of these systems (African easterly waves (AEW), accompanied mesoscale convective system (MCS) in eastern North Africa, etc) are multi-scaled. Different physics are required to describe the properties and processes at fluids scales. The effective representations of these processes have been captured at the given levels of resolution by FIM and in running LAM models with WRF,
NOAA collaborators: Jin-Luen Lee, NOAA/ESRL
Students: Two MS graduate students working on this project, Alisha Williams and Danny Fritz graduated in 2008. Alisha was awarded an MS in Applied Mathematics in May while Danny was awarded an MS in Applied Mathematics in August. Two new MS students, James Spinks and Wilson Jones, joined the team in January, 2008. They underwent training on Unix OS and operations, use of WRF-ARW model, and GrADS data analysis and visualization tool in spring 2008. They got involved in mesoscale modeling using WRF ARW and meteorological data analysis using GrADS in summer 2008.

B-7a: Analysis of Storms and Hurricanes-7
Faculty: Liu, Semazzi, Xie, NCSU
Relevance to NOAA: This research is relevant to NOAA's strategic goal **Weather and Water**. It involves analysis and prediction of inland flooding due to hurricanes (NOAA/South East Forecast Center. AOML/HRD) provides increased lead-time and accuracy for flood warning, and improved predictability of water events.
PROGRESS: This project focuses on the collection, processing, and transformation into gridded forms, of data derived from multiple sensors to support the modeling of inland flooding in years 2-5. In order to perform the watershed modeling, the group has been focusing on the data collection for the Neuse River and Tar River Basins in North Carolina. At this point Keren Cepero (graduate student) has started modeling the upper watershed of an area employing the WMS 7.1 software, the GSSHA model, and HEC-RAS with some examples of radar rainfall data.

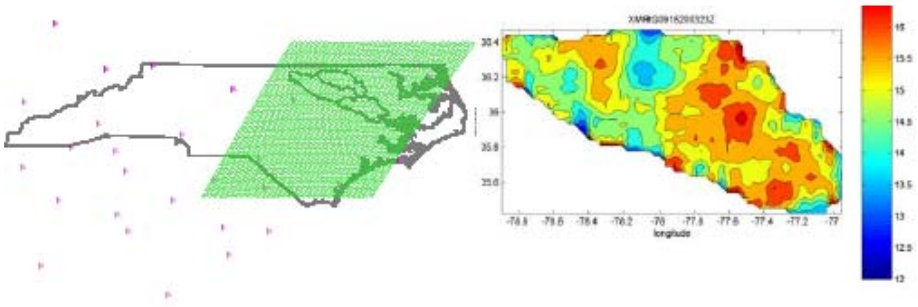


Figure 43: The left image is the grid-distributed rainfall data which covers the whole Tar River basin during the Isabel; the image at the right is a visualization of the runoff (in water depth meters) produced for a radar rainfall data in the same watershed.

The grid rainfall data from a hurricane event (Isabel) has been made compatible with the watershed modeling program by creating a MATLAB code to perform this kind of formatting processes. Paul Liu and Keren Cepero (graduate student) are collecting more watershed data (B-1) and setting up the inland flooding model (Figures 43 & 44).

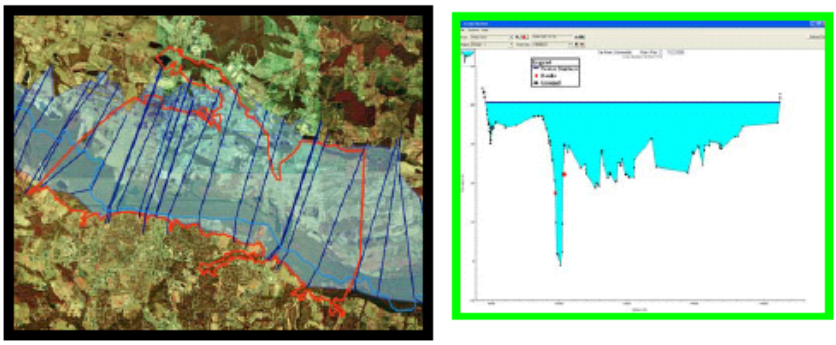


Figure 44: The left image is flood inundation data from Hurricane Floyd overlaid onto an aerial photograph over the Tar River basin; the right image show a cross-section water depth simulated using HEC-RAS.

In addition, they are also trying to incorporate some high-resolution LIDAR–derived elevation data for the watershed DEM setup.
***NOAA collaborators*:** Sean Reed and Dave Kitzmiller, NOAA-National Weather Service, Office of Hydrologic Development, Silver Spring, MD; Kevin Kelleher, National Severe Storms Laboratory, Oklahoma.
Student: Keren Cepero (MS).

B-7b: Research projects Weather-based Intelligent Transportation Systems
Faculty: Nzewi
PROGRESS: Charla Gaskins (PhD Student) continued to work on a dissertation project concerned with weather-based Intelligent Transportation Systems. Ms. Gaskins successfully completed her PhD preliminary exams on May 29, 2008. Drs Karsten Shein (NOAA NCDC) and Jim O'Sullivan (NOAA NWS) are members of Ms. Gaskins' dissertation committee. Another NC A&T committee member [Dr. Yaohang Li (Computer Science)] was added to the committee in August 2008 in response to recommendations made in May 2008.

NOAA Collaborators: Dr. Karsten Shein (NOAA NCDC) has joined the thesis committee of Charla Gaskins. Dr. Jim M. O'Sullivan (NOAA, National Weather Service) also joined the dissertation committee of Ms. Gaskins.

B-8: Analysis of ground-based remote sensing measurements of aerosols and ozone in Greensboro, NC and neighboring cities and study their effects in air quality and climate

Faculty: Ilias, Li, Rastigevey, Schimmel

Relevance to NOAA: This project is directly relevant to NOAA's strategic **Climate**, and **Weather and Water** goals**.** The goals of this research include testing models capabilities and accuracy, recording trends in air quality, providing details on the source, formation mechanisms and transport of ozone in the region, and to also providing NOAA with environmental information that can aid in the better prediction of short-term weather and long-term climate. This will contribute to the overall goal of better understanding the global-scale changes in biosphere processes and patterns.

PROGRESS: There are three major objectives in this project. These are to: (1) investigate air quality disturbances such as high ozone levels and pollution episodes that occur periodically in Greensboro and neighboring cities in NC, (2) estimate the mixed layer heights for Greensboro and neighboring cities from existing meteorological data, (3) examine the relationship between the diurnal evolution of the mixed layer height and ground level ozone concentrations, and (4) investigate relationship between vertical mixing and high ground level ozone concentration. The team is at early phase of this

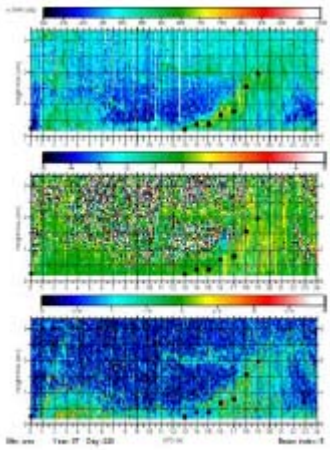


Figure 45
Evolution of typical PBL (generated by ESRL PBS algorithm,

project. The graduate student involved in this project spent about a summer month at ESRL to acquaint himself with the WRF-Chem. Model, Planetary Boundary Layer (PBL) algorithm, wind profilers and data processing. The team obtained the program codes for the PBL algorithm used at ESRL and is currently making modification to the code in an effort to run the PBL algorithm for Greensboro, NC. They plan to acquire SURFER software to process PBL code output. The team identified two wind profilers in this region (one in Raleigh and the one in Charlotte, NC) that will be used to acquire data for this study. Since these profilers are not local, they need to investigate methods of making this data representative of Greensboro.

Using the PBL code, they analyzed wind profiler data. A typical PBL evolution is shown in Figure 45 (Wind Profiler Data from Raleigh, August 8, 2007: Top plot, signal

to noise ratio; middle plot, vertical velocity; and bottom plot, spectral width of turbulence).

The team is currently learning to run the WRF model which is available on campus for hurricane research. This will help them understand the WRF-Chem. version of the model better. In order to use the WRF-Chem. model out-put data for their application, they need to modify the cutdown code (developed by ESRL) to extract only the desired data from WRF-Chem. Model output. This will also minimize any memory concerns.

NOAA collaborators: Wilczak (ESRL)
Student: Katif Peay (EES PhD candidate)

B-9: Analysis of Storms and Hurricanes-10
Global modeling of large-scale processes and regional modeling of mesoscale processes using NOAA's FIM model and WRF model
Faculty: Lin, Tang, Kyei (NC A&T); Semazzi, (NCSU)
Relevance to NOAA: This work is relevant to NOAA's strategic goal: **Weather and Water**. Analysis, modeling, and prediction of hurricane development (NOAA-ESRL; NOAA/AOML) will provide increased lead time and accuracy for weather warning and forecast, and improve predictability of severe weather.
PROGRESS: This study seeks to understand large-scale processes on the formation of African easterly waves (AEWs) and the embedded mesocale convection systems (MCSs), which may serve as precursors for tropical cyclogenesis over eastern Atlantic Ocean (e.g., Lin et al. 2005), over eastern Africa. The group is particularly interested in the formation of AEWs and MCSs in the vicinity and upstream of the Ethiopian Highlands

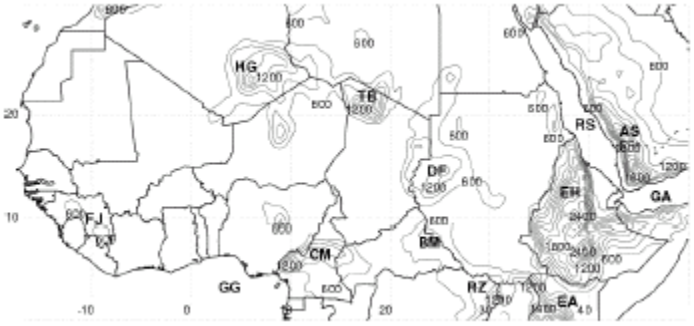


Figure 46: Topography of Africa. AS: Asir Mountains; BM: Bongo Massif; CM: Cameroon Highlands; DF: Darfur Mountains; EA: Eastern Arc Mountains; EH: Ethiopian Highlands; FJ: Futa Jallon Highlands; GA: Gulf of Aden; GG: Gulf of Guinea; HG: Hoggar Mountains; RZ: Ruwenzori Mountains; TB: Tibesti Mountains.

(EH) (Figure 46).

Weather Research and Forecast (WRF) Model Simulations

Figure 47 illustrates the propagation of the pre-Debby (2006) AEW-MCS system across North Africa, as revealed by satellite imagery. In order to investigate the mesoscale processes responsible for the formation of AEWs and MCSs, they have adopted the WRF model to perform numerical simulations of Tropical Storm Debby (2006) with a domain covering the major mountain ranges in Africa, such as EH and Darfur Mountains, and in Arabia Peninsula, such as Asir Mountains (Figure 47), with a grid resolution of 25 km.

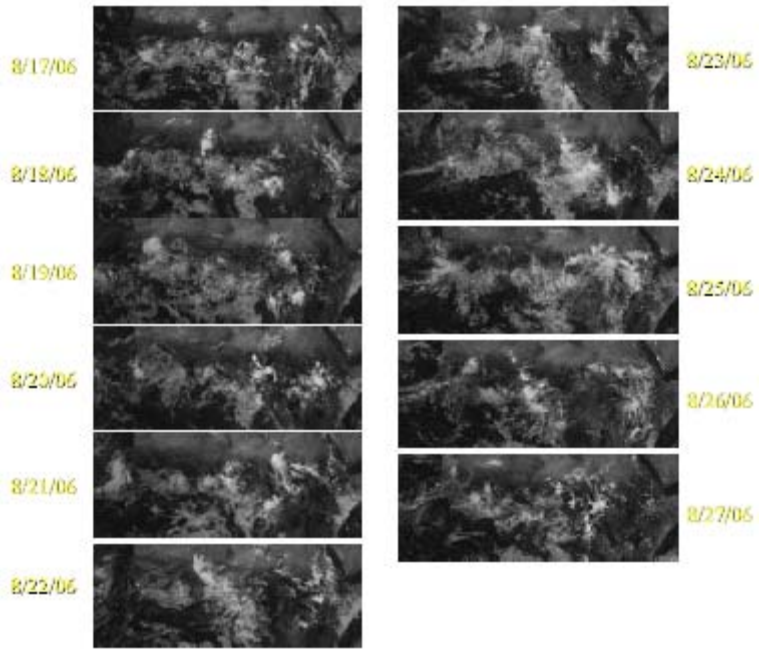


Figure 48 shows the outgoing long wave radiation (OLR) fields simulated by the WRF, which clearly demonstrated that the pre-Debby MCS was formed in the vicinity of the EH. We are making more detailed analysis to indentify more precisely the source of the convection. Figure 49 shows the surface streamline fields simulated by the WRF, which indicate that the AEW was formed in the shear zone with cyclonic vorticity produced by the anticyclonic circulation over the Arabian Peninsula to the northeast of the EH and the cyclonic circulation to the southeast over the Indian Ocean. These two circulations are part of the summer Asian monsoon system. More detailed analysis is in progress to help understand the formation mechanism of the AEW. Overall the WRF simulated fields appear to be consistent with the satellite observations and reanalysis data. The team is making more detailed analysis to understand the dynamics and physics, in particular the source of MCS convection and the mechanism(s) of AEW formation.

Overall the WRF simulated fields appear to be consistent with the satellite observations and reanalysis data. The team is making more detailed analysis to understand the dynamics and physics, in particular the source of MCS convection and the mechanism(s) of AEW formation.

NOAA collaborators: Wilczak (ESRL)

Students: James Spinks (MS student; African American), Wilson Jones (MS student; African American), Van Nguyen (MS student; Asian female). Spinks and Jones joined the team in January, 2008, while Nguyen joined the project in May, 2008. One Research Experience Undergraduate (REU) student from Jackson State University, Patrick Pete, joined the project in summer 2008. Nguyen and Pete were able to learn quickly how to order the METEOSAT satellite imagery from the European Union Meteorological Satellite center (EUMETSAT), and compile this imagery into movies and Hovmoller diagrams.

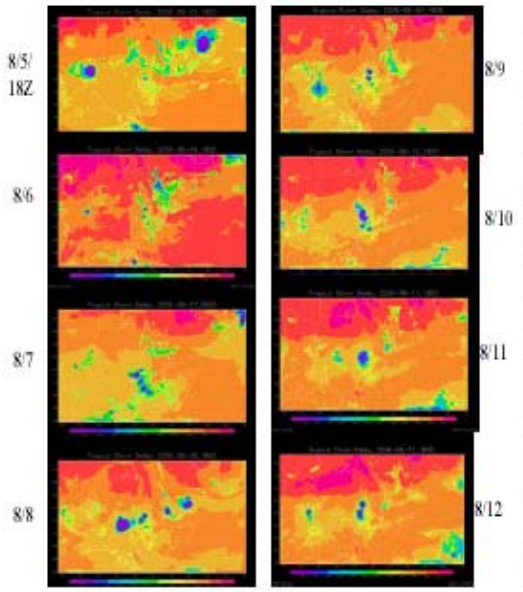


Figure 48: The outgoing long wave radiation fields for pre- simulated by the WRF model.

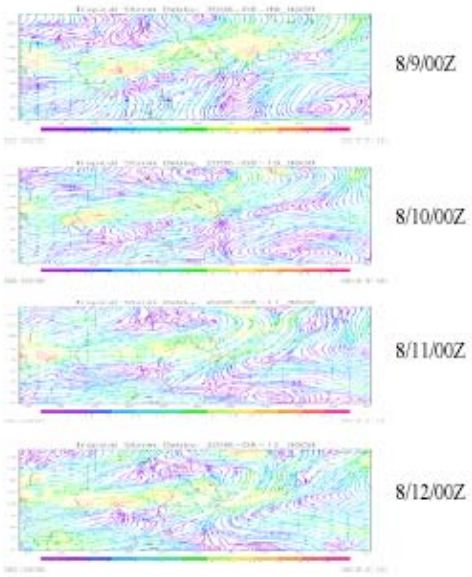


Figure 49: Streamline fields simulated by the WRF Debby (2006) AEW.

B-10: Prediction of Atlantic Hurricane Regimes
Joint Thrust Areas II & III (Semazzi, Xie NCSU; Kumar, Said, Homaifar, NC A&T; Steinbach, Minnesota)

Relevance to NOAA: The projects in this thrust area is directly relevant to NOAA strategic goal **Mission Support**. Data compression and fusion algorithms provide increased quantity, quality, and accuracy of satellite data that are processed and distributed within targeted time.

PROGRESS: This project focuses on the prediction of the level of storm development (cyclongenesis) in the exit region of the eastern Atlantic Ocean using a novel computational approach based on combined application of a weather/climate numerical model and data/mining fusion techniques. Current prediction of cyclongenesis in the Exit Region (Sall et al., 2006; Figure 50) is based on trial and error approach to develop the algorithms.

The proposed methodology will involve the following steps: (i) use numerical model simulation results to deduce important meteorology parameters for use in the application of data mining techniques to derive cyclongenesis indices in the exit region, (ii) find and define new relationships between climate indices (e.g. temperature, surface pressure etc) and events of interest using innovative data fusion and data mining techniques, (iii) predict behavior of climate indices based on short- term predictions of climate variables provided by GCMs and RCMs, and (iv) perform high-level predictions

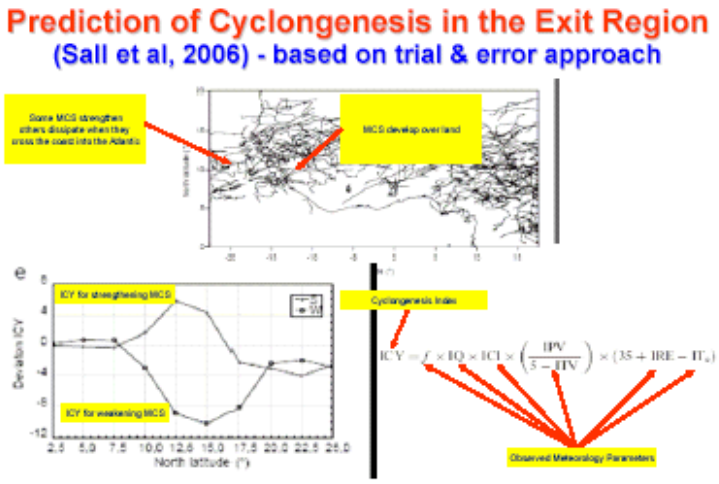


Figure 50 Highlights Sall et al (2006) construction of cyclongenesis and how it relates to the proposed research.

for climate events of interest using relationships found in step (ii). The research team consists of collaborators from NC A&T (Homaifar, Esterline, and Haj Said), UNM (Kumar, Steinbach), and NCSU (Semazzi) to develop a novel computational approach for high-level climate prediction that provides a reliable insight into future climate events, e.g., the severity of the hurricane season or the risk of drought in a particular region. The basic data and modeled data for this work are the time series of chosen climate variables at various points on the Earth and the global National Centers for Environmental Prediction (NCEP) Climate Forecasting System (CFS) respectively. This work is based on innovative computational data analysis techniques (data fusion and data mining). The goals are to: 1) derive climate indices, [time series summarizing climate in a region], 2) find and define new relationships between these climate indices and events of interest, 3) predict the behavior of climate indices based on the short term predictions of climate variables provided by Global Climate Models (GCM) and Regional Climate Models (RCM), and 4) provide high-level predictions for climate events of interest.
NOAA collaborators: Gopal, Fairall, Koch, NOAA/ESRL; Marks, Friedman, NOAA/ AOML.

C. Research Objective III

Conduct information technology research on data fusion and mining for climate studies. The objective of Thrust Area III (Fusion, Data Mining, Distributed Architecture and Geospatial Information Systems) is to conduct research to develop systems using different techniques and algorithms to analyze the changes in the character of the weather, to detect disturbance events, to predict future hurricanes, to analyze historical weather data, and to develop distributed sensor systems. The research activity is closely aligned with NOAA-ESRL, NOAA-NGDC and NOAA/NESDIS. The projects in this thrust area is directly relevant to the NOAA strategic goal of **Mission Support**: "An integrated Earth observation and data management system will enhance NOAA's capabilities to meet mission goals." Increased quantity quality and accuracy of satellite data that are processed and distributed within targeted time is important to NOAA's mission.

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

Relevance to NOAA: Section	**Lead ISETCSC researchers**	**Research objectives and deliverables for year II from the IP**	**Comments. Met Milestone goals?**
C-1: Data Fusion	Michael Grossberg	(a) Development of linear algebraic and information theoretic techniques for characterizing dependence and independence in multi-modal data. (b) Development of a framework for merging physical constraints with data driven probability density estimation in fusion problems	ON TRACK
C-2: Data Fusion-2	Homaifar, Esterline Haj Said, NC A&T	Characterization of fuzzy integrals in relation to the domain. (classical and non-classical techniques) (a) Adaptation of fuzzy integrals to domain-specific requirements. (b) Representation guidelines for multi-objective optimization. (c) Investigate data fusion techniques. (d) Develop virtual sensors algorithm	ON TRACK
C-3: Data Mining	Kumar, Steinbach, University of Minnesota	(a) Determination of the trend in the frequency and intensity of climate disturbances. (b) Detection of disturbance events; Trend analysis of results. (c) Determination of the relationship between land surface precipitation & temperature and ocean surface temperature (d) Analysis of results using cluster analysis, wavelet analysis, and association analysis	ON TRACK
C-4: Image Data Mining	Qian, Caulfield, Fisk University	Exploration of possible pattern recognition algorithms. Find fast and accurate one that will be used for the system. MS (Margin Setting) and PCA (Principal Components Analysis) methods were tested and compared.	ON TRACK
C-5: Distributed Architecture-1	Li, NC A&T; Freeh; NCSU	(a) Development of general sensor grid services. (b) Development of sensor grid service definition language. (c) Development of a sensor grid infra-structure with sensor data integration. (d) Determination of how the large amount of data can be collected and integrated. (e) Development of a sensor grid infrastructure with sensor data integration. (f) Investigation of GEOS issues (g) Data from sensors on telephone towers	ON TRACK
C-6: Distributed Architecture-2	Esterline, NC A&T	(a) Development of prototype multi-agent data-fusion system for restricted data sets. (b) Determination of which architectural issues (regarding multiagent systems) relate to the grid, the Internet infrastructure to be used, and other communication infrastructure (c) Formalization of a model addressing these architectural issues	ON TRACK
C-7: Distributed Architecture-3	Heavner, UAS	(a) Deployment of SEAMONSTER network in Lemon Creek Watershed. (b) Development of data analysis and dissemination framework.	ON TRACK

C-1: Data Fusion-1
Faculty: Grossberg
Relevance to NOAA: The projects in this thrust area are directly relevant to NOAA's strategic goal: **Mission Support**. Data compression and fusion algorithms provide increased quantity quality and accuracy of satellite data that are processed and distributed within targeted time.
PROGRESS: Grossberg (CCNY) along with NCA&T team (Drs. Homaifar and Haj Said) are working on development of virtual sensors using data fusion. The idea of virtual sensing is to create an algorithm which uses data measured by multiple channels, perhaps even multiple instruments, to produce an image that best matches the image that would have been produced by a desired sensor. As a proof of concept, the team have looked at MODIS imager data and predicted a high resolution image in one spectral band using data from multiple images of lower resolution with differing spectral bands. Machine learning techniques have been used to collect statistical information from a limited training set where both high and low resolution data are available. This is then applied to new data where only the low resolution data is used to predict the higher resolution data.

For the preliminary research, a limited number of MODIS granules are used. The team also assembled a database of over 2 tera-bytes of MODIS data, collected and cataloged data for the European Spinning Enhanced Visible and Infrared Imager (SEVERI), and imager data from the NOAA-18 and Meteorological Operational 2 (MetOp 2) platforms. While this data is also being used by compression studies as part of NOAA CREST work, this data will be used to study the effectiveness of our virtual sensor methods to combine data (fusion) using instruments on different satellites.

Specifically for fusion, cross band covariance studies have been run on a large collection of data sets to investigate which bands are most correlated. This is important in understanding which bands are best suited for prediction. In addition, an interface is being developed using Python based Django web framework to explore and to compare segmentation methods on multi-spectral data to determine how differences are statistically linked.
Student: Hannah Aizenman (UG) is working on a system that will allow the comparison of several segmentation methods to determine a small number of bands, which allow the segmentation of various cloud types.
***NOAA Collaborators*:** Mark DeMaria, RAMMB; Paul Menzel, NOAA/NESDIS
Valliappa Lakshmanan, at the National Severe Storms Laboratory NSSL
***New collaborations*:** Ingrid Gutch, Walter Wolf, NOAA, Camp Springs,

C-2: Data Fusion-2
Faculty: Homaifar, Staff: Said
Relevance to NOAA: The projects in this thrust area is directly relevant to NOAA strategic goal: **Mission Support**. Data compression and fusion algorithms provide increased quantity quality and accuracy of satellite data that are processed and distributed within targeted time.
PROGRESS: Drs. Homaifar and Haj Said along with Grossberg (CCNY) are working on development of virtual sensors using data fusion. The idea is to synthesize data from several physical source sensors to build a virtual target sensor with different

characteristics than the source sensors. This work can be considered as a proof of concept that shows the ability to predict for example the values of a 500m resolution band 3 data, using 1km resolution images from bands 8, 9, and 10, in Moderate-resolution Imaging Spectroradiometer (MODIS). This application is not limited to determining high resolution images from low resolution ones but also to fusing images measured at several different spectral wavelengths, none of which are at the optimal wavelength for a given application. The approach is based on finding the target sensor data that maximizes the *a-posteriori* (MAP) probability. The MAP problem is solved by using a Bayesian network framework, training data consisting of a set corresponding source, and target data. If the aggregation of all the data available is denoted Y, and the computed virtual image is denoted X, then the goal becomes computing the image X which maximizes the conditional probability P(X|Y). Both X and Y are variables with millions of degrees of freedom (mega-pixel images). The P(X|Y) does not have a simple description, thus the challenge is to make reasonable assumptions on the structure of the data in order to make the computation of X tractable while still accurate. The probabilities are computed using a nearest neighbor search estimator based on the L2 distance on a stack of corresponding patches in the source images. The performance of the algorithm is tested by predicting target sensor data for which ground truth data exists based on criteria of root mean square error and structural similarity information measurement. The results show the effectiveness of this approach.

Drs. Homaifar, Haj Said and Khin (NOAA/NGDC) along with Mohamed Gebril, a PhD student, are working on ECMWF Re-Analysis database (ERA-40) to develop the use of a comprehensive set of global analyses describing the state of the atmosphere, land and ocean-wave conditions during the 45 years from September 1957 to August 2002. Principle Components Analysis (PCA), Independent Components Analysis (ICA), and several clustering techniques such as K-mean clustering and Self Organizing Map (SOM) are used to define indices of climate change.

Students: *(three African American)*: Participating students are **Mohamed Gebril** (PhD, ECE), **Kristopher Blue** (MS, ECE), **Anthony Hagler** (Undergraduate, ECE), and **Eboni Gordon** (Undergraduate, ECE). In particular, Gebril is working on ERA-40 data to define new indices using SOM and other clustering techniques. Haglar is working on ERA-40 data at interested areas of the earth to extract several phases of climate change using PCA and K-mean clustering. Kristopher Blue and Ebony Gordon are collecting data for virtual sensors project.

NOAA Collaborators: The collaboration with Dr. Eric Khin of NOAA/NGDC is progressing very well with teleconferences and frequent communications between students and NOAA researchers via email. Two papers and a proposal for NOAA are in progress as a result of this collaboration.

C-3: Data Mining

Faculty: Kumar, Staff: Steinbach

Relevance to NOAA: The objective is to conduct research to develop data mining techniques to analyze the data provided by NOAA and ISETCSC collaborators to address NOAA's mission goals. Specifically, the objectives are to analyze climate and weather data in order to detect changes in the character of the weather or ecosystem disturbance

events, and to contribute to a greater understanding of the climate indices used to summarize major climate phenomenon and how they might provide important information for predicting hurricane activity. This work is closely aligned with two NOAA goals: to understand climate variability and change to enhance society's ability to plan and respond and to serve society's needs for weather and water information.

PROGRESS: Collaboration is continuing with Fred Semazzi (NCSU), Abdollah Homiafar and Eyad Haj Said (NC A&T) on using climate indices to investigate important weather and climate related events, such as the level of hurricane activity, drought, and lake levels. Together, the group has defined a three-phase approach to provide high level, but more reliable insight into future climate events. A key contribution to this effort will be to extend the work on detecting climate indices, which are timed series that analyze the effect of the oceans and atmosphere on climate. Recent activity related to this has involved investigating alternatives to the Shared Nearest Neighbor (SNN) clustering technique that has been used previously to find climate indices and exploring dynamic cluster indices. These indices are defined over smaller windows of time instead the entire time period as is standard practice.

Collaboration is also continuing with Tracy Hansen, Mary-Sue Schultz, and Tom LeFebvre of NOAA/ESRL. A prototype version of the Earth Information System (EIS) running at Minnesota has been done successfully. Activity related to the EIS includes work on adding access to data in Hierarchical Data Format 5 (HDF5). The data used for this project was the GHCN (Global Historical Climatology Network)-Daily database of daily temperature, precipitation, and snow records over global land areas from the National Climatic Data Center (NCDC). This data provides considerable opportunities to exercise many of the issues surrounding the EIS, including accessing large data sets, visualization, and data analysis. Work is now in progress to cluster this data and visualize the results of the clustering. The long-term goal of this collaboration is to add analytic capabilities to EIS, e.g., data mining capabilities and to provide data and analysis techniques from the collaboration with Semazzi and Homaifar for inclusion in EIS.

***Students*:** Fernando Torre (PhD student, Hispanic) spent most of his time working on tasks related to the collaboration with Semazzi and Homaifar. In particular, Toree has been engaged in research to explore ways to extend the clustering techniques used to find climate indices. A new Ph.D. student, Baylor Wetzel (Ph.D. student, Native American), has also been working on tasks related to this collaboration. A key accomplishment has been the exploration of defining cluster indices by using shorter time windows instead of a single all inclusive time window as is standard practice. Fernando and Baylor have been guided in their research by Steinbach and Kumar. Robert Olabode (undergraduate, African American) has been working on tasks related to the EIS collaboration. Olabode spent this summer at ESRL in Boulder, Colorado working directly with the EIS team to add the ability to access HDF5 data to EIS. In this work, Olabode used the Global Historical Climate Network (GHCN) data set mentioned above. This internship was extremely beneficial both to Robert and the EIS collaboration. Robert is being guided by Steinbach and a senior Ph.D. student with four years of background working on climate data.

***NOAA Collaborators*:** The group is currently collaborating with Tracy Hansen, Mary-Sue Schultz, and Tom LeFebvre of NOAA/ESRL. Biweekly conference calls and communications via email as needed are established.

C-4: Image Data Mining
Faculty: Qian, Caulfield
Relevance to NOAA: This project is directly relevant to two of NOAA's strategic goals: **Climate** and **Weather and Water**. Though developing efficient and accurate image recognition algorithms that can recognize certain weather events (such as hurricanes) in satellite cloud images, scientists can do content-based query from hundreds of thousands of images from their databases. Currently scientists can only query metadata from image databases, which is inefficient and incomprehensive. The new algorithms will help scientists study weather and climate change more efficiently. The image recognition algorithms will be used in the Comprehensive Large Array-data Stewardship System (CLASS) that was developed by NGDC.
PROGRESS: The NOAA-ISETCSC Fisk team is working with Dr. Eric Kihn of NOAA/ NGDC to develop techniques which will lead to the implementation of content-based queries for the CLASS project. Investigators at Fisk are exploring the image recognition algorithms for hurricanes. In this period, the Investigators explored the PCA (Principal Components Analysis) method and the Margin Setting (MS) method, compared them, investigated the correlation target locating algorithm, and improved the traditional algorithm by applying Laplacian filters. The filter improved the accuracy of the traditional algorithm. With the help of Dr. Kihn, about 100 GB DMSP images were downloaded from the CLASS web site and a 1000 image training/testing set was built.
Students: Participating students are Deidre Johnson, Wilsharo Scott, Alok Hota, Anwar Townsend, Nneka Richards, and Taurean Major. All five students (five of six students are African Americans and two are women) participated in the image data mining research, helped to prepare (collect and edit) images, and run the testing programs. NOAA-ISETCSC PIs at Fisk University held seminars for them every other week to teach them image recognition techniques.
NOAA Collaborators: The NOAA-ISETCSC Fisk team is working with Dr. Eric Kihn of NOAA/NGDC to develop techniques, which will lead to the implementation of content-based queries for the CLASS project. Weekly teleconferences with Hansen, Schultz and Hamer of NOAA-ESRL to work on the ISETCSC/DDF pilot project have been established.
C-5: Distributed Architecture-1
Faculty: Li
Relevance to NOAA:
This is directly related to NOAA. This work intends to build a grid-based information framework to integrate and support extremely diverse data sets, from observations to predictive models of the earth, oceans, and atmosphere, for NOAA missions. The investigators are currently working closely with NOAA scientist at ERSL to build pilot projects to demonstrate these ideas.
PROGRESS: The investigators have implemented a pilot project of using Grid workflow system (GridNexus) to integrate and orchestrate the Earth Information System (EIS) services, which intends to provide a state-of-the-art approach to access, integrate, visualize, and analyze geographically distributed heterogeneous sensor data and provide support for data mining and data fusion. Current research efforts are two-fold: 1) extend workflow techniques to support timing requirements in sensor grid services, and 2) develop algorithms to orchestrate distributed sensor services to support multi-sensor

fusion. An EIS pilot project has been implemented. Work on extending the pilot project to support Data Fusion and Data Mining applications is in progress.
***Students*:** Participating students are Kawana Fuller, Tameka Jones, Cheickna Baber, Douglis McClousky.
NOAA Collaborators: **Dr. Li participated in the biweekly teleconference with Albert Esterline (NCAT), Matt Heavner (UAS) as well as the NOAA ESRL scientists Mark Govett, Tracy Hansen, Tom LeFebvre, MarySue Schultz, and Paul Hamer.**
New collaborations: Dr. Li visited Fisk University and presented an REU seminar entitled "Introduction to Grid Computing and Sensor Grid" on Jul. 9, 2008. Dr. Lei at Fisk and Dr. Li plan to collaborate on Grid workflows in distributed sensor services.
Dr. Li, Dr. Esterline, and William Wright visited National Climatic Data Center (NCDC) in Ashville, NC on Aug. 14, 2008 and presented a seminar on "Research in Distributed Architectures for Geospatial Data Management at NOAA-ISET." This activity is a start of future collaboration.

C-6: Distributed Architecture-2
Faculty: Esterline
Relevance to NOAA: The implementation and verified designs of sensor webs will allow more intelligent and robust operation of computation resources in the field that collect and publish weather and climate data. EIS aims at developing an information framework to integrate and support extremely diverse data sets, from observations to predictive models of the earth, oceans, and atmosphere, for NOAA missions. The investigators are currently working closely with NOAA scientists at ERSL to build pilot projects to demonstrate these ideas.
PROGRESS: A sensor web modeled in part on SEAMONSTER at University of Alaska Southeast (UAS) is being implemented. The MS thesis (by William Wright) linked to this effort will be finished this semester. The active, collaborative aspect of the sensor web is being implemented using agent technology, with some agents running on wireless devices. The sensor web also provides and consumes web services in a way that could be extended in the future to implement Open Geospatial Consortium (OGC) standards. The investigators are also producing abstract designs that emphasize the concurrency aspects of a sensor Web and formally verifying them using the Software and Systems Process Improvement Network (SPIN) mode checker. Teleconferences with Heavner at UAS provide design and specification ideas. The investigators are collaborating with Dr. Li on the implementation of the pilot project regarding the Earth Information System (EIS), which was conceived at NOAA ESRL as an information framework to access, integrate, visualize, and analyze geographically distributed heterogeneous sensor data and to provide support for data mining and data fusion. The goal of this pilot project is to provide a proof-of-concept implementation of EIS at North Carolina A&T State University (NC A&T) to demonstrate its effectiveness on distributed sensor data sources. Collaboration has extended recently to Fisk University. Significant progress was made on the NC A&T prototype this summer with a group of research assistants. Several students also had internships at NOAA ESRL where they worked on aspects of EIS with NOAA-ISET interns from other institutions and with ESRL scientists while keeping close contact with their NC A&T colleagues.

A weather station has been installed to provide data, which is being captured in a database and published by a web server. The data is also being copied to an HDF file for efficient access, and a wiki is being maintained to document progress. Analytic software is being developed, a Directory Access Protocol (DAP) server provides online access to the data in the HDF file, and web services are being implemented fro machine-to-machine communication. Implementation since the beginning of the summer has used the Python programming language for consistency with our colleagues at ESRL and other partner institutions.

***Students*:** Participating students are William Wright, Yusef Pogue, Tammy Morrison, Ashley Hall, and Sentel Allen. William Wright was an intern at NOAA ESRL this summer. Tammy Morrison, Ashley Hall, and Sentel Allen worked this summer on the prototype as research assistants at NC A&T.

C-7: Distributed Architecture-3

Faculty: Heavner

Relevance to NOAA: SEAMONSTER increases the understanding of climate variability and change by monitoring atmospheric and aquatic parameters to enhance long term monitoring of the deglaciation process in Southeast Alaska and the resulting impact on terrestrial watersheds. By enabling an understanding of the interactions of retreating glaciers, terrestrial watersheds, and the inputs to ocean environments, SEAMONSTER is improving the knowledge of this tight linkage in Southeast Alaska, an area with an annual fishery of approximately $200M. Through interactions with NOAA Alaska Fisheries Science Center SEAMONSTER is increasing the ability to protect, restore, and manage the use of coastal and ocean resources.

PROGRESS: During the reporting period, the SEAMONSTER project has collaborated with NOAA and ISETCSC personnel to implement and demonstrate the NOAA Earth Information System (EIS) Pilot Project. Database and broad data dissemination tools such as post GIS and the Open Geospatial Consortium (OGC) GeoServer have been implemented and optimized to provide multiple tools for a broad range of users (scientists, technologists, K-12 and undergraduate students, and the general public) to access the SEAMONSTER data and science use case scenario**.**

Students: *(four female students, one African American, two Hispanic)*

Participating students are Logan Berner, Nick Korzen, David Sauer, Josh Jones, Ge-Yanni Polk, Josh Galbraith, Thomas Fayton, Rosemary Luziania, Derek Deraps, Dinorah Chacin, Richard Barnes and Steffi Schreiber. Students participating in the ISETCSC program are mentored in multiple ways including regular group meetings, telecoms with remote NOAA and ISETCSC collaborators, and peer mentoring. Fieldwork aspects of these projects promote strong group building and aid student recruitment and retention efforts. Student presentations during the reporting period are listed below (with students names underlined).

NOAA Collaborators: The collaboration with Dr. Mary Sue Schultz, Dr. Tracy Ann Hansen, and Dr. Tom Lafavre is progressing very well with biweekly teleconferences and frequent communications between UAS students and NOAA researchers via email.

Li, Esterline (NCA&T) and Heavner (UAS) maintain the Web site (http://www.NCA&T.edu/~esterlin/NOAA_ISETCSC_RA_III_C/) for Research Area III-C. This site includes contact information and links for all members, affiliated NOAA

scientists, and other interested parties, as well as links to member's projects and related projects, teleconference minutes, problems and directions, and other information. In the summer, they produced a document "A Survey of Geospatial and Sensor Markup Languages."

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 submitted in year II, by all partners and PI's. (Detailed listing Appendix IV
Note: Some proposals involve multiple partners.

Partner Institution	Proposals submitted	Funded	Pending
NCA&T	22	4	5
CUNY	2	1	1
FRESNO	6	1	4
FISK	-	-	-
MINNESOTA	2 joint with NCAT		
UNCP	-	-	-
NCSU	3	1	2 (one is under negotiations for 1.8 Million)
ALASKA	6	2	2

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

- **Bililign, Semazzi and Ahmed**, "Nile river basin environmental Studies" a planning grant from NSF on a collaborative proposal with Universities in Egypt, Ethiopia, Kenya and Uganda is under review.
- **Semazzi** (NCSU); **Tang, Lin, Kyei** (NC A&T); **Lee, Koch** (NOAA-ESRL) Investigating the formation of African easterly waves and mesoscale convective systems in eastern African using (a) NOAA global FIM model for large-scale processes using the NOAA FIM model, (b) mesoscale processes using the WRF model, and (c) effects of orography, diabatic heating, AEJ and instability on AEW-MCS propagation over central Africa.
- Collaborators from NC A&T (**Homaifar, Esterline, and Haj Said**), UM (**Kumar, Steinbach**), and NCSU (**Semazzi**) are working to develop a novel computational approach for high- level climate prediction that provides a reliable insight into future climate events, e.g., the severity of the hurricane season or the risk of drought in a particular region.
- Collaborators from NC A&T (**Homaifar, Esterline, and Haj Said**), CUNY (**Grossberg**) are working to develop a virtual sensors based on data fusion.
- Collaboration between **Lei Qian** (Fisk) **Dr. Yuh-Lang Lin** (NC A&T) is established to apply pattern recognition techniques for verifying numerical model results of seasonal hurricane forecast.

- Based on feedback from the NOAA Office of Education during a January 2008 meeting, a new collaboration with the NOAA Fisheries Service and Alaska Regional groups is being developed.

SECTION II: EDUCATION AND OUTREACH EFFORTS

Goal 3: Increase the number of underrepresented minorities trained and educated in NOAA sciences. Education and training will be 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: Recruitment Plans/and Activities
(Details APPENDIX -V and IX)
NCA&T:

Developed recruiting and retention strategies following a one day retreat of ISET leadership-See Appendix -IX

CUNY, MINNESOTA, FRESNO, FISK, and NCSU:
See Appendix IX

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, and Conferences Workshops

One of the goals of the Center is to educate the university community about NOAA, its mission NOAA's research activities, and the interdisciplinary nature of NOAA sciences. To facilitate this effort the Center created the ISETCSC Colloquium Series and used available opportunities to deliver talks, workshops, and organize or sponsor conference sessions. The Center's web page was used to advertise and promote its activities.

B-1a: ISETCSC Colloquium Series

Several colloquia were organized in the spring 2008 year at NCA&T and partners involving NOAA scientists in addition to scientists from other partner institutions. Most of them were broadcast live to all partner institutions using a videoconference facility at NC A&T. The talks are posted on ISETCSC web page. The schedule of seminars is in APPENDIX VII

B-1b. Conference sessions and workshops

Creating public awareness about NOAA sciences and NOAA activities is not limited to ISETCSC partner institutions. An invited session on geophysics and atmospheric physics is organized by Bililign at the SESAPS. (Appendix VI)

B-2: Outreach

Several outreach activities are conducted across all partner institutions. Details by partner are listed in Appendix IX

APPENDIX I: Acronyms

ACS	American Chemical Society
AEW	African Easterly Wave
AEJ	African Easterly Jet
AOD	Atmospheric Optical Depth
AOM	Acoustic Optical Modulator
APS	American Physical Society
AVHRR	Advanced Very High Resolution Radiometer
CCN	Cloud Condensation Nuclei
CERN-PAW	European Organization for Nuclear Research-Physics Analysis Workstation
CLASS	Comprehensive Large Array-data Stewardship System
CIMS	Chemical Ionization Mass Spectrometry
CMAP	CPC Merged Analysis of Precipitation
CRD	Cavity Ring down spectroscopy
DAP	Directory Access Protocol
DFB-QCL	Distributed Feedback Quantum Cascade Laser
DMSP	Defense Meteorological Satellites Program
DOAS	Differential Absorption Spectroscopy
DOP	Degree of Polarization
EAR-40	ECMWF Re-analysis Database
ECMWF	European Centre for Medium-range Weather Forecasts
EC-QCL	Electrically Cooled Quantum Cascade Laser
EES	Energy and Environmental Studies
EIS	Earth Information System
ESRL CSD	Earth System Research Laboratory Chemical Sciences Division
ESRL GMD	Earth System Research Laboratory Global Monitoring Division
ESRL/HPCS	Earth System Research Laboratory/High Performance Computing System
ESRL PSD	Earth System Research Laboratory Physical Sciences Division
FDDA	Four-Dimension Data Assimilation
FDNY	Fire Department, New York City
FGDAS	Final Global Data Assimilation System
FIM	Finite-volume Icosahedral Model
FNL	NCEP Final Global Data Assimilation System (FNL)
FTIR	Fourier Transform Infrared
GCM :	Global Circulation Model
GC-M-FID	Gas Chromatography-Methanizer-Flame Ionization Detection
GENSPECT	General Spectroscopic Radiative Transfer Code
GFS	Global Forecasting System
GHCN	Global Historical Climate Network
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GrADS	Grid Analysis and Display System
GSSHA	Gridded Surface Subsurface Hydrologic Analysis

HDF5	Hierarchical Data Format 5
HITRAN	High-resolution Transmission Molecular Absorption Database
HPLC	High Performance Liquid Chromatography
HOBr	Hypobromous acid
HURDAT	Atlantic Basin Hurricane Database
ICA	Independent Components Analysis
ISETCSC	Interdisciplinary Scientific Environmental Technology Cooperative Science Center
ICOA	Institute of Climate Change, Oceans and Atmosphere
IKE	Kinetic Energy Index
JADE	Java Agents Development Environment
LDA	Linear Discrimination Analysis
LBC	Lateral Boundary Conditions
MAP	Maximizes the A-Posteriori
MetOp 2	Meteorological Operational 2
MDR	Major Development Region
MDRST	Major Development Region Surface Temperature
ML	Maximum Likelihood
MODIS	Moderate-resolution Imaging Spectroradiometer
MSC	Meso Scale Convection
MS	Margin Setting
mySQL	Data base management system/Structure Query Language
NCAR	National Center for Atmospheric Research
NCAR-CCM3	National Center for Atmospheric Research Community Climate Mode-version 3 Global Circulation Model
NCDC	National Climatic Data Center
NCEP	National Centers for Environmental Prediction
NGDC	National Geophysical Data Center
NOAA-ESRL	National Oceanic and Atmospheric Administration, Earth System Research Laboratory
NOAA-NCDC	National Climate Data Center
NOAA/AOML	NOAA/Atlantic Oceanographic and Meteorological Laboratory
NMM	Nonhydrostatic Mesoscale Model
NSF-MRI	National Science Foundation-Major Research Instrumentation
NW	North West
NYCDEC	New York City Department of Environmental Conservation
NYCDOHMH	New York City Department of Health and Mental Hygiene
NYCOEM	New York City, Office of Emergency Management
NYPD	New York Police Department
NYSDEC	New York State Department of Environmental Conservation
OAR	Office of Atmospheric Research
OGC	Open Geospatial Consortium
ORL	Outgoing Longwave Radiation
PBL	Planetary Boundary Layer
PCA	Principal Components Analysis
PDI	Power Dissipation Index

POES	Polar Orbiting Environmental Satellites
Python/OPENGL	Programming Language/Open Graphics Library
QCL	Quantum Cascade Laser
RegCM3	Regional Climate Model Version 3
RF	Radio Frequency
RGA	Residual Gas Analyzer
RTOF-MS	Reflectron Time of Flight-Mass Spectrometer
REU	Research Experience for Undergraduates
SEVERI	European Spinning Enhanced Visible and Infrared Imager
SNN	Shared Nearest Neighbor
SNR	Signal to Noise Ratio
SLP	Sea Level Pressure
SOM	Self Organizing Map
SPIN	Software and Systems Process Improvement Network
SST	Sea Surface Temperature
SSTA	Sea Surface Temperature Anomalies
SVM	Support Vector Machine
THW	Temperature Humidity Wind
TRMM	Tropical Rainfall Measuring Mission
TSS	Total Suspended Solid
UDP	Urban Dispersion Program
UV wind	East-West wind component (U); North-South wind component
WHWP	Western Hemisphere Warm Pool
WRF	Weather Research & Forecasting Model
WRF-ARW	Weather Research Forecasting-Advance Research Weather Models
WRF-CHEM	WRF WRF model coupled with Chemistry
WMS	Watershed Modeling System

APPENDIX II: Publications and Presentations

Thrust Area I: Presentations and Publications: (Students Underlined)

PUBLICATIONS (Refereed)

A. Tonizzo, R. Dyer, R. Fortich, J. Zhou, A. Gilerson, J. Chowdhary, B. Gross, F. Moshary, and S. Ahmed, "Multi-angular Multi-spectral Polarized Reflectance from Coastal Waters for the Separation of Water Organic and Inorganic Particulate Components," *Proc. of IEEE 2008 International Geosciences and Remote Sensing Symposium (IGARSS 2008)*, Boston, MA, July 2008.

Branson Maynard, Richard E. Sykora, Kendra Whitehead,* Nuquie Beedoe,** and Zerihun Assefa. "Structural Modulation in Europium Tetracyanoplatinates Incorporating Terpyridine: Synthesis, Structures, and Photoluminescence of Three Distinct Variants" Prepared for submission to *Inorg. Chem.* 2008 (*ISET supported graduate student, **NCAT graduate student)

R. Sykora, P. Khalifah, Z. Assefa, T. Albrecht-Schmitt, and R. G Haire, "Magnetic Interactions in Dimeric Lanthanide Iodates: Structures, Raman Spectroscopy and Magnetism of $Ln(IO_3)_3$ (Ln = Gd, Er) and Magnetism of $Yb(IO_3)_3$," *J. Solid State Chem.,* 181:1867–1875 (2008)

B. Maynard, K. Kalachnikova, Kendra Whitehead,***** Z. Assefa, and R. E. Sykora, "Intramolecular Energy Transfer in a One Dimensional Europium Tetracyanoplatinate," *Inorg. Chem*, 47**:**1895-1897, 2008 (*****ISET supported undergraduate student co-author**).**

M. Mickens, A. Diouf, Z. Assefa, and A. Kebede. Patent, under-filing "Development of UV Detectors from Luminescent Minerals" 2008.

Phillip Alanis, Mark Sorenson, Matt Beene, Charles Krauter, Brian Shamp, and Alam S. Hasson, "Measurement of Non-Enteric Emission Fluxes of Volatile Fatty Acids from a California Dairy by Solid Phase Micro-Extraction with Gas Chromatography / Mass Spectrometry," *Atmos. Environ.*, In Press, 2008.

Sukhdip Singh, Samuel Hernandez, Yesenia Ibarra and Alam S. Hasson, "Kinetics and Mechanism of the Reaction of n-Butanal and n-Pentanal with Chlorine Atoms," *Int. J. Chem. Kinet.*, Accepted, 2008.

CONFERENCE PRESENTATIONS/ABSTRACTS

Shuki Chaw, Yonghua Wu, Barry Gross, Fred Moshary, and Sam Ahmed, "Examination of Calibration Approaches for 1064nm NIR Elastic Lidar," *24th International Laser Radar Conference (ILRC)*, June 2008.

M. Arend, F. Moshary, and S. Ahmed, "Using Environmental Data During Emergencies," New York City Department of Health and Office of Emergency Management 3rd Annual Interagency Workshop, July 15, 2008

Yonghua Wu, Shuki Chaw, Barry Gross, Fred Moshary, and Sam Ahmed, "Low and Optically Thin Cloud Measurements Using a Raman-Mie Lidar," 24th International Laser Radar Conference (ILRC), June 2008

Paul Corrigan, Anna P. Michel, June Yeung, Mary-Lynn Baeck, Maung Lwin, Alexandra Tsekeri, Fred Moshary, James E. Smith, and Barry Gross, "Portable Open-Path Ammonia and Ozone Sensor Using Quantum Cascade Lasers," Proc. 101st AWMA Annual Conference, Portland, 2008.

S. Ahmed, A. Tonizzo, A. Gilerson, J. Zhou, B. Gross, and F. Moshary, "Development of a Hyperspectral Sensor for Multi-angular Measurements of Polarized Reflectance from Coastal Waters," Intern. Symposium on Spectral Sensing Research (ISSSR), Hoboken, NJ, June, 2008.

A. Tonizzo, "Multi-angular Hyper-spectral Polarized Reflectance from Coastal Waters," CoRP Symposium, Corvallis, OR, August 2008.

Z. Assefa, "Tetra- and Dicyano Metallates of Group 10 and 11 Complexes for VOC Detection," presentation at the ACS National meeting, Philadelphia, PA, August 16-21, 2008.

Z. Assefa, "The Design of Luminescent Sensors for Volatile Organic Compound (VOC) detections," ISET students monthly meeting, June 19, 2008

Z. Assefa, "Alternatives to Blaming the Students." Prepared for the ATL Summer Teaching Institute Conference, May 17-18 2007, NCAT.

Israel Begashaw, Anthony Cochran, Christopher Jessamy, and Solomon Bililign, "Cavity Ring Down Spectroscopy for Atmospheric Research," Abstract submitted to the 75th South Eastern Section of the American Physical Society.

Christopher Ware, **"**Verification of Hydrologic Ensemble Forecasts within the Middle Atlantic River Forecast Center," NOAA Office of Education Student Scholarships Presentations, July 28–31, 2008.

Jonathan Jefferies, "Engineers in the NOAA Fleet," NOAA Office of Education Student Scholarships Presentations July 28–31, 2008.

Sukhdip Singh,* Yesenia Ibarra, and Alam Hasson, "Branching Ratios for the Reaction of Hydroperoxy Radicals with Propionyl Peroxy and Butionyl Peroxy Radicals," Spring National Meeting of the National American Chemical Society, New Orleans, LA, April 6th–10th, 2008 and CSU Student Research Competition, CSU East Bay, May 2nd-3rd, 2008.

Phillip Alanis,* Mark Sorenson, Dale Sullivan, Brian Shamp, Koua Cha, and Alam Hasson, "Measurements of Volatile Fatty Acid Emissions from California Dairies," Spring National Meeting of the National American Chemical Society, New Orleans, LA, April 6th–10th, 2008, and CSU Student Research Competition, CSU East Bay, May 2nd-3rd, 2008.

Samuel Hernandez,* Sukhdip Singh, Yesenia Ibarra, and Alam S. Hasson, "Smog Chamber Studies of the Reactions of Butanal and Pentanal with Chlorine Atoms," 29th Annual Central California Research Symposium, California State University Fresno, April 16th, 2008.

Sukhdip Singh,* Yesenia Ibarra, Samuel Hernandez, and Alam Hasson, "Branching Ratios for the Reaction of Hydroperoxy Radicals with Propionyl Peroxy and Butionyl Peroxy Radicals," 29th Annual Central California Research Symposium, California State University Fresno, April 16th, 2008.

Phillip Alanis,* Mark Sorenson, Brian Shamp, and Alam Hasson, "Quantification of Volatile Fatty Acid Emissions from California Dairy Facilities," 29th Annual Central California Research Symposium, California State University Fresno, April 16th, 2008.

***Thrust Area II: Publications and Presentations*:** (Students Underlined*)*

E. Keith and L. Xie. "Predicting Atlantic Tropical Cyclone Activity in April." *Journal of Weather* (in press) 2008.

K. Korte and F. H. M. Semazzi,. "A Regional Climate Modeling Study over West Africa for the 2001-2006 Atlantic Hurricane Seasons," *(*in preparation) 2008.

Conference abstracts and presentations:

K. D. Korte, J. H. Bowden, N. N. Davis, X. Zhang, M. Diaz, L. Xie, and F. H. M. Semazzi, "A Modeling Study of the Extreme 2005 Atlantic Hurricane Season Relative to Recent Years," The 28th Conference on Hurricanes and Tropical Meteorology, 28 April–2 May 2008**.**

Alan Covell and Yuh-Lang Lin, "Effects of Southern Appalachian Mountains on the Rainfall Associated with the Passage of Hurricane Ivan (2004)," Abstract submitted to 75th South Eastern Section of the American Chemical Society, Raleigh, Oct. 2008.

Ian Colon-Pagan, Ying-Hwa Kuo, "Comparison of Water Vapor Measurements from Ground-based and Space-based GPS Atmospheric Remote Sensing Techniques," Abstract submitted to 75th South Eastern Section of the American Chemical Society, Raleigh, Oct. 2008.

James Spinks, Wilson Jones, Yuh-Lang Lin, and Guoqing Tang, "Orographic Effects on the Evolution of African Easterly Wave-Mesoscale Convective Systems Across Africa," Abstract submitted to 75th South Eastern Section of the American Chemical Society, Raleigh, Oct. 2008

Yuh-Lang Lin, "Recent Advances and Future Challenges in Hurricane Prediction," Abstract submitted to 75th South Eastern Section of the American Chemical Society, Raleigh, Oct. 2008

Yuh-Lang Lin, James Spinks, Wilson Jones, and Guoqing Tang, "Formation of African Easterly Waves and Mesoscale Convective Systems over Eastern Africa," Abstract submitted to 75th South Eastern Section of the American Chemical Society, Raleigh, Oct. 2008

Yevgenii Rastigejev and Yuh-Lang Lin, "A Study of Ocean Spray Lubrication Effect on Tropical Cyclone Intensity," Abstract submitted to 75th South Eastern Section of the American Chemical Society, Raleigh, Oct. 2008.

Van Nguyen and Yuh-Lang Lin, "Effects of Orography on the Genesis of Hurricane Javier (2004) in the Eastern Pacific Ocean," Abstract submitted to 75th South Eastern Section of the American Chemical Society, Raleigh, Oct. 2008.

K. Cepero, "Development of a Distributed Flood Model for the Neuse River and Tar River Basins in North Carolina," OPT-ED Alliance Day Conference. September 26, 2008, Greensboro. [http://www.unc.edu/opt-ed/events/alliance_day/]

Charla Gaskins, Nathan Huynh, and Emmanuel U. Nzewi, "Improving Traffic Safety Under Adverse Weather Conditions," 4th National Conference on Surface Transportation Weather, TRB Surface Transportation Weather, and Snow & Ice Conference, June 16 - 19, 2008, Indianapolis, Indiana.

Emmanuel U. Nzewi and Stephanie Luster-Teasley, "Effective Rainwater Harvesting Schemes for Sub-Saharan West Africa," 2008 ASCE EWRI Water Congress, Honolulu, HI, May 12-16, 2008

Emmanuel U. Nzewi and Mahesh Adhikari, "Development of LiDAR-Derived Digital Elevation Models (DEMs) for Watershed Characterization," American Water Resources Association GIS Specialty Conference, March 17–19, 2008, San Mateo, CA.

Thrust Area III: Publications and Presentations (Students Underlined***)***

E. Haj Said, A. Homaifar, and M. Grossberg, "Creating Virtual Sensors using Learning Based Super Resolution and Data Fusion," (Accepted Abstract) IEEE Aerospace Conference.

A. Hagler, E. Haj Said, and A. Homaifar, "Data Reduction Evidence of Climate Change," NC OPT ED Day Conference at Greensboro, NC.

Vipin Kumar, "Discovery of Patterns in the Global Climate System using Data Mining," IEEE Data Mining Forum, Hong Kong, May 28-29, 2008.

Vipin Kumar, "Discovery of Patterns in the Global Climate System using Data Mining," The 2008 International Conference on Computational Science and Applications (ICCSA 2008), June 30 - July 3, 2008, Perugia (Italy).

J. Walls, A. Esterline, and A. Homaifar, "Sensor Fusion Analysis Using Fuzzy Integral and Bayesian Network Techniques," (accepted) 17th IFAC World Conference 2008, Seoul, Korea, 6-11 July 2008.

S. Boriah, V. Kumar, M. Steinbach, P.-N. Tan, C. Potter, and S. Klooster, "Detecting Ecosystem Disturbances and Land Cover Change Using Data Mining," Book chapter: *Next Generation of Data Mining*, forthcoming.

Student's visits, student/faculty presentational and attendances:

D. Kumar, "Discovery of Patterns in the Global Climate System using Data Mining," presentation to the National Science Foundation Symposium on Next Generation of Data Mining and Cyber-Enabled Discovery for Innovation, Baltimore, Oct. 10-12, 2007.

D. Kumar, "High Performance Data Mining - Application for Discovery of Patterns in the Global Climate System," presentation at HiPC 2007, a conference on high performance computing, Bangalore, India, Dec 17-20.

Yaohang Li, Albert Esterline, Kawana Fuller, Michael Burns, Tracy Lee Hanson, Tom LeFebvre, Mary Sue Schultz, Paul Hamer, and Ashvin Mysore, "A Service-Oriented Pilot Project to Access and Visualize Distributed Sensor Data," presented in Sixth Annual NOAA-CREST Symposium, Mayaguez, Feb. 21, 2008.

Kawana Fuller, "Storing Weather Data and Supplying It to the Web" presentation at the 22nd Annual Ronald E. McNair Commemorative Celebration/Symposium on Jan. 27, 2008.

William Wright, "Smart Sensor Webs Using Agents and Web Services" presentation at the 22nd Annual Ronald E. McNair Commemorative Celebration/Symposium on Jan. 27, 2008.

Matt Heavner, Eran Hood, Joshua Jones, Rob Fatland, Regine Hock, "Monitoring Glacier Hydrology and Mass Balance on a Small Temperate Glacier Using a Sensor Web" presentation at NVE Workshop on mass balance measurements and modeling 26-28 March 2008 in Skeikampen, Norway.

Robert Olabode made a presentation about his summer internship work on his data access work for the Earth Information System (EIS) to Steve Koch, a variety of other NOAA scientists, and NOAA ISET PIs on July 2, 2008. Robert will be a contributor to an article summarizing this work which is currently in progress.

Cheickna Baber presented a presentation entitled "A Sensor Information Framework for Integrating and Orchestrating Distributed Sensor Services" in International Conference on Parallel and Distributed Processing Techniques and Applications, Las Vegas, NV. The paper is published in the conference proceedings.

Kawana Fuller and Cheickna Baber participated in the NOAA summer research program at NOAA ESRL in summer, 2008. Together with the other student researchers, they presented in the final student team presentation. Cheickna and Kawana presented talks entitled "EIS Framework" and "EIS Visualization" respectively.

APPENDIX III: ISETCSC Supported Students

Key for Ethnicity: **1** = Asian; **2** = Native Hawaiian or Other Pacific Islander; **3** = American Indian **4** = Alaska Native; **5** = Black, Non-Hispanic; **6** = Hispanic or Latino
7 = White, Non-Hispanic; **8** = Other

ALASKA

Last Name	First Name	Status	Classification	Degree	Graduated (Y/N)	SEX	Ethnicity
JONES	JOSHUA	Senior	Undergraduate	B.S.		M	7
KORZEN	NICHOLAS	Junior	Undergraduate	B.S.		M	7
MILLER	CLIFTON	Junior	Undergraduate	B.S.		M	7
SAUER	DAVID	Junior	Undergraduate	B.S.		M	7
TURNER	JAMIE	Graduated	Undergraduate	B.S.	Y	F	7
WIGFIELD-GORKA	COLLIN	Junior	Undergraduate	B.S.		M	7
BERNER	LOGAN	Graduated	Undergraduate	B.S.	Y	M	7
NELSON	MATTHEW	Graduated	Undergraduate	B.S.		M	7
PONCE	MICAELA	Senior	Undergraduate	B.S.		F	3
TEERLINK	SUZIE	Graduated	Undergraduate	B.S.	Y	F	7
MOELLER	HOLLY	Graduated	Undergraduate	B.S.	Y	F	1
KNUTH	EDWIN	Graduated	Undergraduate	B.S.	Y	M	7
FERNANDEZ	ELENA	Senior	Undergraduate	B.S.		F	6
POLK	GE-YANNI	Junior	Undergraduate	B.S.		F	5
GALBRAITH	JOSH	Graduated	Undergraduate	B.S.	Y	M	7
FAYTON	THOMAS	Senior	Undergraduate	B.S.		M	7
LUZIANIA	ROSEMARY	Junior	Undergraduate	B.S.		F	6
DERAPS	DEREK	Senior	Undergraduate	B.S.		M	7
CHACIN	DINORAH	Junior	Undergraduate	B.S.		F	6
BARNES	RICHARD	Junior	Undergraduate	B.S.		M	7
SCHREIBER	STEFFI	Senior	Undergraduate	B.S.		F	7
SMITH	IVY	Junior	Undergraduate	B.S.		F	8

UNCP

Last Name	First Name	Status	Classification	Degree	Graduated (Y/N)	SEX	Ethnicity
GUTIERREZ	SHANE	Senior	Undergraduate	B.S.		M	6
HOWDEN	EMILY	Senior	Undergraduate	B.S.		F	7
LOCKLEAR	JOSHUA	Graduated	Undergraduate	B.S.	Y	M	3

NCSU

Last Name	First Name	Classification	Degree	Graduated (Y/N)	SEX	Ethnicity
BOWDEN	JARED	Graduate	Ph.D.		M	7
NORMAN	MATTHEW	Graduate	M.S.		M	7
DAVIS	NEIL	Graduate	M.S.	Y	M	7
DIAZ	MICHAEL	Graduate	M.S.		M	6
CEPERO	KEREN	Graduate	M.S.		F	6
WONG	YIYI	Graduate	M.S.	Y	F	5
KEITH	ELINOR	Graduate	M.S.	Y	F	7
KORTE	KURT	Graduate	M.S.	Y	M	5
CATRELL	SHENEK	Graduate	Ph.D.		F	6

FRESNO

Last Name	First Name	Status	Classification	Degree	Graduated (Y/N)	SEX	Ethnicity
SINGH	SUKHDIP	Senior	Undergraduate	B.A.		M	1
IBARRA	YESENIA	Senior	Undergraduate	B.S.		F	6
HALL	ALYSIA	Senior	Undergraduate	B.S.		F	6
HERNANDEZ	SAMUEL	Graduated	Undergraduate	B.S.	Y	M	6
ALANIS	PHILLIP	Senior	Undergraduate	B.A.		M	6
CAMPBELL	SEAN	Junior	Undergraduate	B.S.		M	7

FISK

Last Name	First Name	Status	Classification	Degree	Graduated (Y/N)	Sex	Ethnicity
JACKSON	SHEROD	Junior	Undergraduate	B.S.		M	5
CROWDER	NAUTICA	Graduated	Undergraduate	B.S.	Y	F	5
JOHNSON	DEIDRE	Senior	Undergraduate	B.S.		F	5
ADAMS	JOYLIKA	Senior	Undergraduate	B.S.		F	5
SCOTT	WILSHARO	Junior	Undergraduate	B.S.		M	5
RICHARDS	NNEKA	Sophomore	Undergraduate	B.S.		F	5
HOTA	ALOK	Sophomore	Undergraduate	B.S		M	1
TOWNSAND	ANWAR	Junior	Undergraduate	B.S.		M	5

CUNY

Last Name	First Name	Status	Classification	Degree	Graduated (Y/N)	SEX	Ethnicity
JEREZ	WILLIAM	Senior	Graduate	M.S.		M	6
RICHARDSON	JEROME	Graduated	Undergraduate	B.S.	Y	M	5
SANTORO	DAVID	Senior	Graduate	Ph.D.		M	7
DYER	RUSHANE	Senior	Undergraduate	B.S.		M	5
AIZENMAN	HANNA	Senior	Undergraduate	B.S.		F	7
VLADUTESCU	VIVIANA	Graduated	Graduate	Ph.D.	Y	F	7
GAN	CHUN	Junior	Graduate	Ph.D.		F	1
IOANNOU	IOANNIS	Junior	Graduate	Ph.D.		M	7
SAVANE	OUSMANE	Junior	Graduate	Ph.D.		M	5
LIN	LIN	Junior	Undergraduate	B.S.		F	1
FLORES	JUAN	Graduated	Undergraduate	B.S.	Y	M	6
GAROFALO	ERIKA		Graduate	M.S.	BS (CUNY)	F	6
IRIZARRY	MARIA	Graduated	Undergraduate	B.S.	Y	F	6
ABDELAZIM	SAMEH		Graduate	Ph.D.		M	5
HERNANDEZ	FAUSTO	Senior	Undergraduate	B.S.		M	6
WILMOT-DUNBAR	RUPERT	Senior	Undergraduate	B.S.		M	5
NIU	LIAN	Senior	Undergraduate	B.S.		M	1
BARLEY	RITA	Sophomore	Graduate	Ph.D.		F	5

MINNESOTA

Last Name	First Name	Status	Classification	Degree	Graduated (Y/N)	SEX	Ethnicity
TORRE	FERNANDO		Graduate	Ph.D.		M	6
OLABODE	ROBERT	Senior	Undergraduate	B.S.		M	5
FIELD	BLAYNE	Graduated	Undergraduate	B.S.	Y	M	7
WETZEL	BAYLOR		Graduate	Ph.D.		M	3

NCA&T

Last Name	First Name	Status	Classification	Degree	Graduated (Y/N)	SEX	Ethnicity
ABBAS	MOHAMOUD	Senior	Undergraduate	B.S.	REU	M	5
ALLEN	SENTEL	Senior	Undergraduate	B.S.		M	5
BABER	CHEICKNA		Graduate	M.S.		M	5
BAILEY	ALTA	Freshman	Undergraduate	B.S.		F	5
BENNETT	TEQUILLA	Sophomore	Undergraduate	B.S.		F	5
BLUE	KHRISTOPHER		Graduate	M.S.	BS (NCA&T)	M	5
BRADLEY	ASHLEY	Sophomore	Undergraduate	B.S.		F	5
BROWN	LARRY		Graduate	M.S.	Y	M	5
BURNS	MICHAEL		Graduate	M.S.	Y	M	5
CALE	ANDREA	Freshman	Undergraduate	B.S.		F	5
COCHRAN	ANTHONY		Graduate	PhD		M	5
COLON-PAGAN	IAN		Graduate	M.S.		M	6
COVELL	ALLEN		Graduate	M.S.	REU	M	7
CRAWFORD	CARLOS	Sophomore	Undergraduate	B.S.		M	5
DAVIS	BRANDON		Graduate	M.S.	BS (NCA&T)	M	5
DUFF	DELONTE	Freshman	Undergraduate	B.S.		M	5
EMANUEL	MELODI	Senior	Undergraduate	B.S.		F	5
EVANGELIST	RODRICK	Junior	Undergraduate	B.S.		M	5
FRITZ	DANIEL		Graduate	M.S.	Y	M	5
FULLER	KAWANA		Graduate	M.S.	BS(NCA&T)	F	5
GASKINS	CHARLA		Graduate	PhD		F	5
GEBRIL	MOHAMED		Graduate	PhD	MS (NCA&T)	M	7
GODETTE	ADRIENNE	Junior	Undergraduate	B.S.		F	5
GORDON	EBONI	Sophomore	Undergraduate	B.S.		F	5
GREENE	MALIKAH	Sophomore	Undergraduate	B.S.		F	5
HAGLER	ANTHONY	Senior	Undergraduate	B.S.		M	5
HALL	ASHLEY	Senior	Undergraduate	B.S.	REU	F	5
JEFFERIES	JONATHAN	Junior	Undergraduate	B.S.		M	5
JENKINS	DARKUS		Graduate	PhD	MS (NCA&T)	F	5
JOHNSON	DONOVAN	Freshman	Undergraduate	B.S.		M	5
JONES	TAMEKA	Senior	Undergraduate	B.S.		F	5
JONES	WILSON		Graduate	M.S.		M	5
LEWIS	TIMOTHY	Sophomore	Undergraduate	B.S.		M	5
MELVIN	CHARLES	Senior	Undergraduate	B.S.		M	5
MOFFITT	JUSTIN	Freshman	Undergraduate	B.S.		M	5
MORRISON	TAMMY		Graduate	M.S.	BS (NCA&T)	F	5
MUHAMMAD	IBRAHEEM	Graduated	Undergraduate	B.S.	Y	M	5
NGUYEN	VAN		Graduate	M.S.		F	1
PEAY	KATIF		Graduate	PhD		M	5
PETE	PATRICK	Senior	Undergraduate	M.S.	REU	M	5
POGUE	YUSEF		Graduate	M.S.		M	5

RAGLAND	DEBRA	Sophomore	Undergraduate	B.S.		F	5
ROSE	KYLE	Sophomore	Undergraduate	B.S.		M	7
SIMPSON	CHANTEL	Freshman	Undergraduate	B.S.		F	5
SPINKS	JAMES		Graduate	M.S.		M	5
STEWART	FENYANG		Graduate	M.S.	REU	M	5
STROTHER	AMBER	Graduated	Undergraduate	B.S.	Y	F	5
TORAN	KAZMAN	Senior	Undergraduate	B.S.	REU	M	5
WALKER	TARIQ	Sophomore	Undergraduate	B.S.		M	5
WANNAMAKER	JOHNCIA	Senior	Undergraduate	B.S.		F	5
WARDLOW	DAVID	Sophomore	Undergraduate	B.S.		M	5
WARE	CHRISTOPHER	Junior	Undergraduate	B.S.		M	5
WHITEHEAD	KENDRA		Graduate	M.S.	BS (NCA&T)	F	5
WILLIAMS	ALISHIA	Graduated	Graduate	M.S.	Y	F	5
WRIGHT	WILLIAM		Graduate	M.S.		M	5
YISRAEL	YABNE'EL	Freshman	Undergraduate	B.S.		F	5

APPENDIX IV: Administrative and Educational Deliverables
Year II- DELIVERABLES FROM PERFOMANCE REPORT; DELIVERABLES: ADMINISTRATIVE
NCAT
DELIVERABLES: EDUCATION
Second Year

1. Offer an undergraduate outreach course utilizing the AMS Weather Studies curriculum at NCA&T and selected partner universities.

UNST 211 is being taught during fall 2008 with Dr. Schimmel as the instructor utilizing AMS Weather Studies materials with an enrollment of 19 students. Plans are to offer the course in the spring as both a traditional and online course. The online course will be promoted to ISET partner schools. Approval for a new course number/description will be sought during fall 2008.

2. Develop online undergraduate and graduate courses offered to all partners
ON LINE COURSE DEVELOPMENT STATUS

The UNST course will be offered through UNC Online during spring 2009. Plans are underway to have the online course offered to a local community college.

3. Offer biweekly online seminars to all partners.
ON TRACK-Successfully done-Appendix VII

A new web-developer has been hired for the ISET website and the website is being hosted by a third party host instead of A&T. This will allow us to post videotaped seminars on the ISET website now. Equipment and software were purchased during spring 2008 to allow taping and editing of seminars by ISET staff and students.

4. Offer summer camps at NCA&T and most partners for K-12 (aided by Camilla Watkins of National Climatic Data Center).
(**PLANNED FOR THE SECOND TIME IN YEAR II –SUMMER 08)**

Week-long teacher (25 teachers), middle school student (20 students), and high school students (21 students) camps were offered during June and July 2008. NCDC cooperated closely in the offering of the teacher camp providing many of the speakers from NCDC.

5. Provide opportunities for NCA&T and partner faculty members and students to spend time at NOAA labs.

13 STUDENTS TRAVELED TO NOAA ESRL, AND TWO WENT FOR SUMMER OPPORTUNITIES THROUGH EPP

6. Invite NOAA scientists to spend time at NC A&T and partner universities.

Steve Brown spent seven days at NC A&T, lecturing and training students and setting up experiments. Mike Hardesty spent time at CUNY attending graduate thesis

defenses, Jin Lee was on the thesis committee of two ISET students. Have all Center-related M.S. and Ph.D. committees include a NOAA scientist as a member.

Request has been made to A&T's Provost to appoint NOAA scientists Dr. Jin-Luen Lee, Dr. James Roberts, Dr. Steven Koch as adjunct faculty. The approval of this request should be received before the end of the spring semester. Once an appointment is made it remains in effect for a period of three years.

NOAA scientists Dr. Joost deGouw, Dr. James Wilczak, Dr. Jim O'Sullivan, Karsten Shein, Dr. Steve Brown, Dr. Eric Kihn, and Tracy Hanson have been added to this request. Have communicated with the Dean of the School of Graduate Studies to get his approval for the wording of the request to be made to the new A&T Provost. Anticipate that the request will be approved early in the fall 2008 semester.

NCSU: Committees are being set up for Keren Cepero and Michael Diaz. NOAA scientists have been invited to serve on the two committees. Updates on formation of these committees will be provided in our next reporting cycle.

Participate in NOAA field studies**.**

One NC A&T student participated in a NOAA filed study

Ensure that each ISETCSC Center project team produces at least one proposal for additional funding per year to support their research area.

Hire lab manager at NC A&T**.**

(NOT YET)

Hire a research associate for one of the thrust areas at NC A&T**.**

HIRED FOR THRUST AREA III-HAJ SAID AND I-BASOVA), Search for Thrust Area II ongoing

Listing of proposals submitted, funded, pending and declined

NC A&T

- **Z. Assefa** (PI), ACS - Petroleum Research Fund, "Disruption of Metal-Metal Interactions and Extended Linear Chains by Organic Solvent Molecules." Awarded: $ 50,000**.** Duration: August 2008 -2010
- Mereba, T., Callahan, L., Williams, V., **Lin, Y., Schimmel, K**., "Communication Systems and Technologies: Managing Hurricane and Other Natural Disaster Response and Recovery," NSF, $400,000 for three years (2009).-Declined
- Singh, H., **Schimmel, K**., Hamoush, S., Powell, R., "Training University Leaders for Disaster Management Roles," DHS, $477,374 for three years (2009).-Declined
- **Lin, Y-L**, Kelkar, A., **Schimmel, K**., et al., "Center for Planetary Atmospheric and Flight Sciences (CPAFS)," NASA, $5,000,000 for five years (2008)-Declined
- **Lin, Y.-L.,** and S. Chiao (FIT), "Dynamics of Heavy Orographic Rain During the Terrain-influenced Monsoon Rainfall Experiment (TiMREX)." NSF, $620,090, 10/1/08 – 9/30/11. Pending.

- **Lin, Y.-L.,** A. Laing (NCAR), and B.-W. Shen (UMCP), "Tropical Cyclogenesis over Eastern Atlantic Ocean Initiated by African Easterly Waves and Mesoscale Convective Systems Propagating from Eastern Africa." NASA, $573,338, 10/1/08 – 9/30/12. Pending
- **Bililign, J., Talukdar, R**., "Proton-Transfer Reaction Negative Ion Mass Spectrometry for the Measurement of Acids in the Atmosphere." NSF, $330,000 – Awarded.
- **Z. Assefa (PI),** and Co-PI's, **L. P. Kotra, D. Kuila, A. Kebede** and ten other collaborators**, "**NSF-MRI: Acquisition of Smart Apex II Single Crystal X-ray Diffractometer." Requested: $ 350,000. Submitted to NSF, January 2008, Declined and under revision for resubmission.
- **Z. Assefa (PI),** Richard Sykora (Co-PI), "Emission Enhancement through Rationally Designed Cooperative Multiple Donors." NSF- Chemistry, Requested $ 510,000. Status: To be submitted in November.
- **Dr. Li** received a grant of $18,045 from NSF based on the project "Collaborative Research: Enhancing Teaching of Grid Computing to Undergraduate Students by using a Workflow Editor." Awarded
- **Yevgeniy Rastigeyev**, "Multiscale Wavelet-based Numerical Algorithms for Global Atmospheric Chemical Transport Simulation." $845,245. Pending
- **Yevgeniy Rastigeyev**, "Chemical and Physical Processes over Complex Terrain," $575,000. Declined
- Dr. Freeh, **Dr. Li,** et al., "CSR-PSCE, TM: Collaborative Research: Improving Both Power Efficiency and Parallel Efficiency, through Intelligent Consolidation," NSF. Pending
- **A. Homaifar, Haj Said, et al**., "Collaborative Research: Ubiquitous Cyber Analytics Expedition for Transformative Exascale Science," invited to submit full proposal on March 3, 2008 to NSF's Division of Electrical, Communications and Cyber Systems (ECCS). $500,000 for five years. Pending.
- **John Paul Roop, Yaw Kyei and Guoqing Tang**, "Novel Finite Difference Approximation Techniques and Their Applications in Fluid Mechanics and Financial Modeling," submitted to NSF Applied Mathematics Program in November 2007, 8/15/08-08/14/11, $314,774. Declined.
- **Yaw Kyei, Guoqing Tang, and John Paul Roop**, "Higher-Order Compact Volume Differencing Schemes for Elliptic Differential Equations," submitted to NSF Computational Mathematics Program in December 2007, 8/15/08-08/14/11, $353,307. Declined.

CUNY

- "Exploring Techniques for Improving Retrievals of Bio-Optical Properties of Coastal Waters," Office of Naval Research for research collaborations with the Naval Research Laboratory, Stennis Space Center for $900,000 over three years. Part of the work in this proposal leverages ISETCSC efforts. Awarded

UAS

- Matt Heavner (PI), Sensor Directorate Education Partnership with UAS SEAMONSTER, submitted to Wright Patterson Air Force Base and General Dynamics, $10,000. This funding is proposed to provide additional student and research assistant salary support for participation in UAS research projects to increase interest in Science, Technology, Engineering, and Math careers. Secondary goals include closer collaborations between UAS SEAMONSTER and the Air Force Research Labs Sensor Directorate. Awarded
- Elizabeth Mathews (PI) and **Matt Heavner** (co-I), "NSF Research Experience for Undergrads in Marine and Coastal Ecology," National Science Foundation, $425,121. This proposal is a three year renewal for the UAS REU program. Pending
- **Matt Heavner** (PI): "SEAMONSTER Multi-tiered Sensor Web," submitted to NASA, $1,335,141. Pending.
- Proposed continuation and evolution of the SEAMONSTER sensor web into a multi-tiered sensor web by integrating spatially distributed, mote-based sensing into our current sensor web through collaboration with the Johns Hopkins University *Life Under Your Feet* project. Based on the initial three year SEAMONSTER work, this proposed work will directly impact more than 20 UAS undergraduate students through research opportunities, integration with the curriculum, travel, and presentation opportunities at conferences.

FRESNO:

- "Laboratory Studies of Selected Radical Reactions," Faculty Fellowship Proposal, Advanced Study Program, National Center for Atmospheric Research. (3 months sabbatical support). Awarded.
- "Development and Application of Solid Phase Micro-Extraction to Quantify Organic Emissions from Dairy Facilities," USDA NRI-CSREES Program 2008 ($400,000). Principal Investigator. Pending.
- "Henry Dreyfus Teacher-Scholar Award Program," Camille and Henry Dreyfus Foundation ($60,000). Principal Investigator. Pending..
- "Oxidation of Organics at Low Temperatures," NASA ROSES 2008, ($500,000). Collaborator. Pending.
- "Atmospheric Science Scholar-in-Residence at California State University Fresno," Fulbright Scholar-in-Residence Program. In preparation (due date 10/15/08).
- **"**Science on a Sphere at the Downing Planetarium, California State University, Fresno (Fresno State),"NOAA Environmental Literacy 2008 Spherical Display Systems for Earth System Science ($100,000).. Declined. A resubmission is planned

NCSU:

- **Proposals submitted** Using weather and climate information to prevent meningitis in West African; submitted to Google.org; Co-PIs: Fredrick Semazzi (NCSU) & Rajul Pandya (NCAR/UCAR); Amount: $1.8 million/3 years. Final negotiations are underway.

- **Proposals funded** Climate Change Projections of Air Quality Meteorological Indicators over the Southeastern US; Environmental Protection Agency (EPA); Co-PIs: Fredrick Semazzi (NCSU); amount: $37,999/3 months.

DEVELOPMENT OF A CONCENTRATION IN ATMOSPHERIC SCIENCES IN THE EES PHD PROGRAM-ON TRACK

A curriculum changes proposal to allow students to enter the program with a B.S. degree has been prepared for the Energy & Environmental Studies PhD program (currently must have an M.S.) and to add a concentration in atmospheric sciences. The concentration designation will mean that student transcripts and diplomas can include "Concentration in Atmospheric Sciences" along with the program name. A separate proposal has also been prepared to change the name of the Ph.D. program to Energy & Environmental Systems. While new courses proposed can be offered during fall 2008 as special topics courses, the timeline for official adoption of the concentration is as follows:

March – complete revisions based on feedback from A&T ISETCSC faculty
April – get feedback from NOAA on the proposed concentration
May – get approval for changes from EES advisory committee and the Dean of the Graduate School
August – submit to University Curriculum Committee
October – present changes to the University Curriculum Committee, changes presented to the University Senate for adoption

NCSU
Curriculum for the UNC Climate Change and Society Masters Degree Program

The program will be designed to attract to both full-time and part-time students. It is assumed that all entering students will be familiar with the basic concepts of calculus, physics, and statistics. All students will take Fundamentals of Climate Change Science in their first semester. It is a pre-requisite for much of the rest of the program.

The program will consist of 11 course modules. Eight of these will be required courses, one will be an elective, one will be preparation for either a research project or an internship, and the final course will be implementation of that research project or internship.

The required courses are described below. The list of topics for each course is not exhaustive. Other topics will be added during review of this draft and by the faculty teaching the course.

Curriculum for Full-Time Students

Fall Term

1. CCS 501 -Fundamentals of Climate Change Science
   - How does the climate system work?
   - What is the role of greenhouse gases in the climate system?
   - What is the role of the oceans in the climate system?

- How do sea level and the cryosphere respond to climate change?
- What can we learn from study of past climate conditions (paleoclimateology)?
- How can human activities change climate?
- What evidence do we have that humans have changed current climate (temperature, precipitation, and extreme events)?
- Tools for projecting future climate and causes of uncertainty in their projections
- How might humans change future climate (temperature, precipitation, and extreme events)?

2. CCS 502 - Impacts of and Vulnerability and Adaptation to Climate Change
   - What are the observed and projected impacts of climate change (temperature, precipitation, and extreme events) on:
     - Ecosystems, both terrestrial and marine
     - Biodiversity
     - Coastal zones, including coastal zone erosion and similar impacts
     - Agriculture, managed forests, and fisheries
     - Human settlements
   - Interactions between climate change and other environmental problems (air and water quality, protection of biodiversity, prevention of desertification, etc.)
   - How do natural systems respond to climate change?
   - How does human vulnerability to climate change vary with geographic location, level of socio-economic development, and other factors?
   - What options do humans have for adapting to climate change (Costs, barriers to implementations, means for overcoming barriers)?
   - Ethical considerations in evaluating climate change impacts, including gender considerations and intergenerational issues
3. CCS 504 -Tools for Climate Change Information and Decision-making
   - Climate and impacts observational data
   - Climate model outputs
   - Use of GIS information for climate change decision-making
   - Economic analysis
   - Decision-making frameworks, including ethical considerations
4. Introduction to Geographic Information Science (offered online from NCSU) or GIS Management (offered at Appalachian State). This requirement may be replaced with an elective if the student has already taken an equivalent GIS course.

<u>Spring Term</u>

5. CCS 503 - Controlling Human Impacts on the Climate System
   - What factors determine human emissions of greenhouse gases, including population growth, technological choices, economic growth, economic institutions and life style choices?
   - How much control of greenhouse gas emissions and other human impacts on the climate system is required?
   - Options for controlling greenhouse gases including available and projected technology, costs, barriers to application, means for overcoming barriers
     - Energy efficiency and conservation
     - Clean fossil fuel usage, including carbon dioxide capture and storage

- Non-fossil fuel energy (nuclear, wind, solar, biomass, etc.)
- Control of emissions from land use, including biological sequestration of carbon dioxide
- Control technologies for methane and nitrous oxide (particularly from agriculture and landfills) and for fluorinated gases

  Note: The emphasis in the evaluation of these technologies will be on their applicability in North Carolina.

- Ethical issues in the choice of control strategy: e.g., conflicts between development and control of greenhouse gas emissions, implications of biofuel use.

6. CCS 506 - Climate Change Policy and Politics
   - Decision-making under uncertainty
   - History of the international effort to control climate change
   - Current status of the negotiations and issues that require resolution
   - Interaction between climate change and other international issues, especially trade and international aid
   - Positions taken by key national and groups of nations in international negotiations
   - History of the U.S. effort to control climate change
   - Current status of U.S. effort to control climate change and key issues requiring resolution
   - Interaction between climate change and other U.S. issues, e.g. energy security, economic growth, protection of scenic and environmentally sensitive areas
   - State and local government actions on climate change
   - Voluntary activities
   - Ethical issues: Historical responsibility vs. current emissions; equity among nations
7. CCS 510 - Seminar: Critical Issues in Climate Change

   This Seminar will discuss and evaluate:
   - current policy initiatives at the international, national, state and local levels;
   - the relationships between climate change initiatives and broader sustainable development initiatives; and
   - the changes necessary to bring about a low or zero greenhouse gas emission society.

Other topics will be added as appropriate.

8. Elective (See Attachment 1)

<u>Summer Term</u>

9. CCS 505 - Leadership in Responding to Climate Change
   - How climate change is different from other environmental issues
   - Barriers to understanding the potential for climate change and its impacts
   - Effective models for communication of climate change information
   - Achieving organizational change to reduce impact on the climate system
   - Social marketing: achieving behavioral and life style change to reduce impact on the climate system
   - Marketing innovative climate change products and services

10. CCS 590 -Preparation for Research Project or Internship

Fall Term
11. CCS 591 or CCS 599 - Research Project or Internship

Curriculum for Part-Time Students

Fall Term
1. CCS 501 - Fundamentals of Climate Change Science
2. Introduction to Geographic Information Science (offered online from NCSU) or GIS Management (offered at Appalachian State). This requirement may be replaced with an elective if the student has already taken an equivalent GIS course.

Spring Term
3. CCS 503 – Controlling Human Impact on the Climate System
4. CCS 506 - Climate Change Policy and Politics

Summer Term
5. CCS 505 - Leadership in Responding to Climate Change
6. Elective (See Attachment 1)

Fall Term
7. CCS 502 - Impacts of and Vulnerability and Adaptation to Climate Change
8. CCS 504 - Tools for Climate Change Information and Decision-making

Spring Term
9. CCS 510 - Seminar: Critical Issues in Climate Change
10. CCS 590 - Preparation for Research Project or Internship

Summer Term
11. CCS 591 or CCS 599 - Research Project or Internship

APPENDIX V: Recruitment activities

North Carolina A&T State University

ISETCSC High School and College Recruitment Accomplishments for 3/1/08 – 8/31/08

High School	Location	Date	# Students
Smith High School	Greensboro, NC	3/12/2008	44

ISETCSC held recruiting activities at 1 high school for this reporting period. A total of 44 students were impacted.

Other	Location	Date	# Students
Regional Robotic Competition	Greensboro, NC	3/29/2008	4
Academic Fair - Undecided Majors	Greensboro, NC	4/24/2008	6
Annual Summer Enrichment Outreach	Greensboro, NC	4/21/2008	4

Other recruiting activities held in the Greensboro area impacted 14 students.

New incoming freshman scholarship: Offers of scholarships were made to 20 high school seniors who were admitted to the Departments of Chemical Engineering, Chemistry, Computer Science, Computer Engineering, Physics and Energy and Environmental Sciences at NC A&T. Of the 7 that were accepted, 4 are majoring in the new Atmospheric Sciences and Meteorology BS degree program.

High School Recruiting

High school recruiting efforts for the second quarter of 2008 were focused on the Greensboro, North Carolina area. High school visits consist of a PowerPoint presentation that contains information about the ISETCSC research programs, requirements, the Atmospheric Sciences and Meteorology BS program, and NC A&T scholarships. Each student is given a brochure, which contains information about the ISETCSC Center and contact information. Students are also required to fill out a contact card with name, address, e-mail, etc. The contact card is used for statistical purposes, informing potential students of upcoming events, and forwarding thank you letters.

After the presentation the students' information is entered into the Center's database. Each student is sent a thank you letter unless otherwise noted by the student that they do not want to be contacted by the Center.

Goal: The goal for Fall 2008 is to visit a minimum of 3 high schools in the Greensboro, North Carolina area.

Campus Outreach

NC A&T hosts a campus outreach (Academic Fair) to reach undeclared majors. The Center participates in this campus outreach event. In order to attract students to the ISETCSC table/booth, current ISETCSC students volunteer to accompany a faculty member. Students are attracted to their peers and feel more comfortable approaching other students rather than a faculty member. The ISETCSC student is able to give potential students a student's perspective of the program.

Goal: To recruit a minimum of 1 student who hasn't declared a major each year.

Student Referral

ISETCSC students refer a lot of the applicants who apply to the program. The Center also receives several referrals from the Honors Program on campus. There have been a couple of candidates who have seen flyers on campus about the Center and wanted to know more about the research opportunities that are available through NOAA-ISETCSC. There have been 2 students referred by current ISETCSC students.

Last Name	First Name	Status	Classification	Degree
Hagler	Anthony	Senior	Undergraduate	B.S.
Rose	Kyle	Sophomore	Undergraduate	B.S.

Mentoring

Non-freshmen students are required to meet with the Associate Director once a month. During this meeting students discuss their research projects and any problems that might hinder their continued progress. All non-freshmen students are required to submit a report every month on their research project. The Associate Director forwards that report to the PIs for their review. The PIs are able to read the reports to determine if the student is reporting the research activity properly. This is a monitoring tool to ensure that the student is progressing with the research.

Similar to the non-freshmen students, all freshmen student are required to meet with the Associate Director biweekly to also discuss their research projects and any problems that might hinder their continued progress. They are also required to turn in a signed research log biweekly indicating their research commitment has been met. The PI must sign the research log.

The Center strives to make sure that the students are excited about their research projects. If a student is not progressing in the research area, the Associate Director will meet with the PI and the student to try to resolve the issue. The student is constantly assured that his or her success is extremely important to the Center. If at anytime a student loses interest in a research project, the Center will try to find another area of research within the student's major. The Center strives to demonstrate a sense of community and teamwork.

If a student does not meet with the Associate Director as scheduled, an email and/or a phone call is made to the student. The PI is also informed that the student is not meeting the requirements. Students are informed during the initial interview that these meetings are mandatory and if not met, they are in jeopardy of losing all funding from NOAA-ISETCSC.

In addition, students who are seniors and are considering ending their education with a B.S. degree are encouraged to continue their education. A number of exercises are done with the student to weigh the benefits of continuing their education versus entering the job market. For the spring 2008 semester there were 7 undergraduate students who graduated and, out of the 7 students, 5 will continue with the graduate program at NCAT.

The Center holds a mandatory monthly meeting with all of the ISETCSC students. The date and time vary so that as many students as possible can attend the meetings. Students make short presentations on their research projects, enhancing their presentation skills. The Director addresses the students accordingly. Students are able to meet other ISETCSC students that are new to the program. The students form a sense of

community with the meetings. The students volunteer to mentor other students within the ISETCSC program. The monthly meetings also help to assure the students that their research and progress are valued and needed.
Students are required to volunteer for at least one outreach activity per semester. The purpose of this requirement is to give the students an opportunity to share their experience with potential students. It also gives the Associate Director an opportunity to get to bond with the students and able to find out the students' interests, goals, etc. It also helps give students a sense of community.

Graduating Students

The Associate Director performs a series of exercises with students who are graduating that will assist them with interviewing and preparing portfolios for interviews.

GPA Requirements

A student must maintain a cumulative 3.0 or higher GPA in order to remain in the ISETCSC program. At the end of each semester each student's GPA is reviewed to ensure that all requirements are met. If a student's GPA is below 3.0 the following occurs:

- The student is notified that the GPA fell below the ISETCSC requirements and he or she will not receive any funding until the GPA has been raised.
- The student can still continue individual research with the understanding that no funding will be provided until the GPA increases.
- If the student chooses not to continue with the research project, he or she is placed in an inactive file.
- At the end of each semester, the Associate Director will continue to check the student's GPA to see if it has increased to a 3.0 or higher. When it does, the student will be contacted to see if he or she is still interested in participating in ISETCSC research.

Application Process

Candidates apply to the ISETCSC program by completing an application. After the application has been received and reviewed, the candidate is scheduled for an interview. If the student meets all of the ISETCSC requirements and a PI is available, the student will be accepted into the program.

If a PI is not available, the student application and interview status is placed in a pending file. Once a PI becomes available, the student is contacted to see if he or she is still interested in becoming part of the ISETCSC program.

While a student is in pending status, the student is encouraged to meet with the potential PI and find out about the research project. This indicates to the PI that the student is truly interested in research and it also aids the student in understanding what is involved with research. As of June 1, 2008 all students are required to sign a contract with ISETCSC after each semester.

FRESNO

Three recruiting strategies have been used to attract new students:
1. Advertising at regional and national conferences such as AGU.

2. Advertising through on-campus organizations such as the Science Careers Opportunities Program (SCOP). A recruitment flyer is shown below.
3. Direct approaches by ISET faculty to qualified students.

Two new students have been recruited since the last reporting period. Phillip Alanis is a senior BA chemistry major and is measuring carboxylic acid emissions from dairy facilities. Sean Campbell is a junior BS biology major and is being trained to take over some of the smog chamber experiments when other ISET students graduate in the coming months. One of the students, Samuel Hernandez, graduated from Fresno State in May and is entering the chemistry M.S. program at Fresno State. He intends to apply to Ph.D. programs on completion of his Masters degree.

Research Fellowships in Atmospheric Chemistry

Two openings are available to start immediately in Fresno State's Atmospheric Chemistry laboratory. The fellowships are open to students at any level (Freshman – Graduate). The research fellows will be involved in a project investigating the chemistry of pollutants that are important both in the formation of smog and in climate change. The fellowships provide funding to:

- Conduct paid research for up to 20 hours/week.
- Attend and present research at national conferences.
- Visit and conduct research at two of the country's leading research institutes in the atmospheric sciences (the National Oceanic and Atmospheric Administration (NOAA) and the National Center for Atmospheric Research (NCAR)) in Boulder, Colorado during the summer.

The successful candidates must be US citizens and must have a cumulative GPA of 3.0 or higher. Minorities are particularly encouraged to apply. Preference will be given to Chemistry majors with an interest in pursuing graduate level (M.S. or Ph.D.) research.

Please contact Dr. Alam Hasson in the Chemistry department for more information:
ahasson@csufresno.edu

FISK

In this period, Fisk researchers continued their activities to recruit students and enhance their collaboration with other NOAA-ISETCSC participating institutions.

CUNY

COSI sponsorship of LAESA-SHPE's 14th Annual Pre-College Engineering Day (PCED) conference – April 14th 2008

On April 14th 2008, LAESA-SHPE's 14th PCED conference took place. LAESA's PCED started in the mid 1990's to address the alarming drop out rate of Hispanic high school students. The conference seeks to motivate and encourage Hispanic high school students to pursue a higher education, specifically in the fields of science, math, and engineering.

Speakers of the event were Prof. Joseph Barba, Dean of the Grove School of Engineering, Dr Frank Scalzo, Education Liaison – NASA GISS (picture on left), among others.

EPP outreach efforts at CCNY, NOAA ISET co-sponsored and participated in this event.

Participating students had the opportunity to visit various research labs at CCNY. Prof. Sam Ahmed provided special tours of the Remote Sensing Laboratories to the HS students. Standing on the center (picture on the right) is Prof. Sam Ahmed, showing the remote sensing facilities to the participants.

Alaska

Hired new engineering faculty at UAS. Part of the workload includes recruiting at Juneau area high schools, so this will have direct benefit to the UAS NOAA ISET project Working closely with the Juneau high schools and coordinating with the new Engineering faculty, we expect increased recruitment

1. The University of Alaska Southeast partners contributed to the University of Alaska "Alaska Summer Research Academy" for students in grades 8-12. The students were involved in the "Glacier Dynamics and Biological Succession" course in Glacier Bay. This included front page feature articles in the *Juneau Empire* (Friday, July 25, 2008) and the *Fairbanks News-Miner.*
2. Participated in the University of Alaska Southeast "Careers in Environmental Science" fair with a NOAA ISET table.

NCSU

All the four budgeted NCSU graduate students slots have been filled except the one in computer science. Although several potential students have expressed strong interest to fill the slot ISET's budgeted stipend is not highly competitive in computer science and students chose to go to other research projects. Options are being explored to identify ways to supplement the stipend from other sources including application for NOAA graduate scholarships.

APPENDIX VI: ISETCSC Sponsored/Organized Conference

ISETCSC organized a session on atmospheric Sciences and geosciences at the 75 South Eastern Section of the American Physical Society (SESAPS), Oct. 29-31, 2008There will be an invited session, and contributed session. ISETCSC students and faculty contributed thirteen abstracts and the invited session is chaired by Bililign.

75th Annual Meeting of the Southeastern Section of APS

Thursday–Saturday, October 30–November 1 2008; Raleigh, North Carolina

Session EB: Forefront Atmospheric Physics and Geophysics

Chair: Solomon Bililign, North Carolina A&T University
Holiday Inn Brownstone - Washington

Thursday, October 30, 2008 3:45PM - 4:15PM	EB.00001: NOAA Interdisciplinary Scientific Environmental Technology Cooperative Science Center Invited Speaker: Solomon Bililign Preview Abstract
Thursday, October 30, 2008 4:15PM - 4:45PM	EB.00002: Recent Advances and Future Challenges in Hurricane Prediction Invited Speaker: Yuh-Lang Lin Preview Abstract
Thursday, October 30, 2008 4:45PM - 5:15PM	EB.00003: Simulation of the Climate of Africa Based on the Hydrodynamical System of Equations Governing Atmospheric Flow Invited Speaker: Frederick Semazzi Preview Abstract
Thursday, October 30, 2008 5:15PM - 5:45PM	EB.00004: Research and career opportunities in the geophysical sciences for physics students Invited Speaker: Andrew Nyblade

75th Annual Meeting of the Southeastern Section of APS

Thursday–Saturday, October 30–November 1 2008; Raleigh, North Carolina

Session PC: Geophysics and Atmospheric Physics

Holiday Inn Brownstone - Lincoln

Saturday, November 1, 2008 11:09AM - 11:21AM	PC.00003: Orographic Effects on the Evolution of AEW-MCSs Across Northern Africa James Spinks, Wilson Jones, Yuh-Lang Lin, Guoqing Tang Preview Abstract
Saturday, November 1, 2008 11:21AM - 11:33AM	PC.00004: Formation of AEWs and MCSs over Eastern Africa and its Implication to Tropical Cyclogenesis over Eastern Atlantic Ocean Guoqing Tang, Yuh-Lang Lin, James Spinks, Wilson Jones Preview Abstract

Saturday, November 1, 2008 11:33AM - 11:45AM	PC.00005: Orographic Effects on the Evolution of African Easterly Wave-Mesoscale Convective Systems Across Africa James Spinks, Wilson Jones, Yuh-Lang Lin, Guoqing Tang Preview Abstract
Saturday, November 1, 2008 11:45AM - 11:57AM	PC.00006: Formation of African Easterly Waves and Mesoscale Convective Systems over Eastern Africa Guoqing Tang, Yuh-Lang Lin, James Spinks, Wilson Jones Preview Abstract
Saturday, November 1, 2008 11:57AM - 12:09PM	PC.00007: Effects of Southern Appalachian Mountains on the Rainfall Associated with the Passage of Hurricane Iavn (2004) Alan Covell, Yuh-Lang Lin Preview Abstract
Saturday, November 1, 2008 12:09PM - 12:21PM	PC.00008: Comparison of Water Vapor Measurements from Ground-based and Space-based GPS Atmospheric Remote Sensing Techniques Ian Colon-Pagan, Ying-Hwa Kuo Preview Abstract
Saturday, November 1, 2008 12:21PM - 12:33PM	PC.00009: A study of ocean spray lubrication effect on tropical cyclone intensity Yevgenii Rastigejev, Yuh-Lang Lin Preview Abstract
Saturday, November 1, 2008 12:33PM - 12:45PM	PC.00010: Effects of Orography on the Genesis of Hurricane Javier (2004) in the Eastern Pacific Ocean Van Nguyen, Yuh-Lang Lin Preview Abstract
Saturday, November 1, 2008 12:45PM - 12:57PM	PC.00011: Cavity Ring Down Spectroscopy for Atmospheric Research Israel Begashaw, Solomon Bililign, Anthony Cochran, Christopher Jessamy Preview Abstract
Saturday, November 1, 2008 12:57PM - 1:09PM	PC.00012: Wavelet-based adaptive mesh refinement algorithm for atmospheric chemical transport modeling Yevgenii Rastigejev Preview Abstract

APPENDIX VII: Seminars and Colloquia

Seminars and Colloquium Organized/Planned and Student Presentations

North Carolina A&T State University

The following talks were given and planned for the rest of the academic year. A videoconference facility and web meeting capability has been secured to allow live broadcast of the seminars and colloquia to and from partner institutions and NOAA labs.
2008 ISETCSC Colloquium Series Schedule

2008 ISETCSC Colloquium Series			
Date	**Time (EST)**	**Speaker**	**Topic**
Mar. 13	4:00 - 5:00pm	Eric Kihn	Handling a Tidal Wave: Challenges for Scientific Data Archives
Mar. 25	4:00 - 5:00pm	Tracy Hansen	Multipass Processing for Automatic Text Generation
Apr. 15	4:00 - 5:00pm	Mike Hardesty	Lidar Remote Sensing of Planetary Boundary Layer Properties
Apr. 17	4:00 - 5:00pm	Chris Fairall	Air-Sea Interaction in Hurricanes: A Very Nasty Problem
Apr. 22	4:00 - 5:00pm	Jin Lee	FIM: A flow-following, finite-volume icosahedral model

CUNY
NOAA ISET Colloquium
Speaker: Dr. Michael Hardesty; Chief Optical Remote sensing, NOAA-ESRL
Date: Friday April 4, 2008
Room Exhibit Hall,
Time: 12-1 PM
Title: Doppler Lidar Measurements of Wind from Space.

APPENDIX VIII: Summer Student Exchanges

NC A&T students in NOAA labs

Anthony Cochran (EES Ph.D. student, Advisor - Dr. Solomon Bililign) is at ESRL-CSD in Boulder in Jim Roberts's/and Ranajit Talukdar's lab to study the operation of the NI-PTMS. Negative Ion Proton Transfer Mass Spectrometry (NI-PTRMS) represents a conceptually new approach to the gas-phase measurement of acidic gases. Cochran's Ph.D. research will explore the measurement of gas phase acidities and kinetic studies of carboxylic acids.

Katif Peay (EES Ph.D. student, Advisor - Dr. Shamsuddin Ilias; Co-advisor - Dr. Yuh-Lang Lin) is in ESRL - Boulder working with Jim Wilczak. His research is in the analysis of ground-based remote sensing measurements of aerosols and ozone in Greensboro, NC and neighboring cities and to study their effects in air quality and climate

William Wright (NC A&T, Computer Science [G], Advisor - Dr. Albert Esterline), *Kawana Fuller* (NC A&T, Computer Science [UG], Advisor - Dr. Yaohang Li), *Cheickna Baber* (NC A&T, Computer Science [G], Advisor - Dr. Yaohang Li), and *Robert Olabode* (UM Computer Science [UG] Advisor - Dr. Vipin Kumar) are in ESRL-GSD Boulder working with a group of NOAA scientists (Tracy Hansen, Mark Govett, Tom LeFebvre, MarySue Schultz, and Paul Hamer) on The Earth Information System (EIS) project, a proposed end-to-end information system to support end-to-end science.

Besides supporting research applications, the EIS will support time-critical applications.

Mohamed Gebril (NC A&T Electrical Engineering [G], Advisor - Dr. Abdollah Homaifar) is in Boulder working on a data fusion project with Eric Khin

Christopher Ware (Advisor - Dr. Solomon Bililign) and *Jonathan Jefferies* (Advisor - Dr. Solomon Bililign) received the NOAA-EPP (Educational Partnership Program) undergraduate scholarship.

Jonathan Jefferies project was "Jr. Engineering Inspector." As a Jr. Engineering inspector and had a chance to conduct limited inspections of NOAA's ships, write reports on the inspections conducted and learn about a field only known to the maritime industry which is Marine Engineering.

Charles Melvin participated in a summer internship with ExxonMobil in Baton Rouge, LA. He was placed in the refinery's Operation Support Department/ Technical Division (OSD-T) where He primarily worked on two projects to make the distillation towers more energy efficient. According to Mr. Melvin: "Participating in the NOAA-ISET research program has instilled habits in me that helped my summer internship to be more successful. The program instilled the importance of reading literature pertaining to the work I am doing in order to gain a greater understanding of what needs to be done and also minimize redundancy. My summer internship will also help me in being a more productive member of my research team because it helped me to hone my problem-solving, organization and presentation skills. I am very excited to use what I have learned this summer in the lab this year and I plan on being an essential member of the research team this upcoming school year."

Christopher Ware's research at NOAA was Verification of hydrologic ensemble forecasts within the Middle-Atlantic River Forecast Center He worked with the Hydrologic Ensemble Prediction (HEP) Group under the Office of Hydrologic Development (OHD). The purpose of was to determine the accuracy of hydrologic ensemble forecast within the Middle Atlantic Forecast Center, which means to see how good the forecasts are. He learned Atmospheric and Meteorological statistics from his mentor Dr. Demargne. From various metrics, he was able to determine the error of each forecast.

Dr. Samuel Danagoulian, Professor of Physics, led a team of three NC A&T students for an International Research Experience for Students to Ethiopia. This project was funded by NSF in 2007, (PI: Dr. Solomon Bililign, Co-PI: Dr. Samuel Danagoulian). ISET graduate student *Alisha Williams* is one of the students and worked with Dr. Gizaw Mengistu, Professor of Physics at Addis Ababa University, on aerosol retrieval algorithms from satellite data for the long-term monitoring of aerosols and their impact on climate change in the region.

California State University – Fresno

Students visiting NOAA

Sukhdeep Singh (4 weeks). Topic: Chlorine Atom-Initiated Oxidation of Butanal and Pentanal. (Mentors: James Burkholder (NOAA) and Geoffrey Tyndall (NCAR))

Yesenia Ibarra (2 weeks). Topic: Chlorine Atom-Initiated Oxidation of Butanal and Pentanal. (Mentors: James Burkholder (NOAA) and Geoffrey Tyndall (NCAR))

During this period, the students carried out research at NCAR, met with scientists at both NCAR and NOAA, and spent several days observing experiments carried out within the research group of Dr. James Burkholder. The students brought Fresno State's HPLC system and configured it for use with NCAR's 50 L reaction cell. They also set-up a GC-FID instrument for use with the chamber. They then measured product yields from the reaction of butanal and pentanal using GC-FID, HPLC and FTIR spectroscopy.

Minnesota

Robert Olabode spent a month this summer at ESRL in Boulder, Colorado working directly with the Earth Information System (EIS) team (Tracey Hansen, Mary-Sue Schultz, and Tom LeFebvre) to add the ability to access HDF5 data to EIS. The following is his description of the work performed there.

Robert Olabode:

"Since the beginning of summer, I have been working as part of a team to develop the EIS framework. The EIS has specific sections, and mine was data access, and then some preliminary analysis. Our current data is historical data from an NCDC server. It was decided that the HDF5 format is to be our data format standard, and I had to familiarize myself with the format and learn to write to it using java. Since this data changes over time, this included getting the data directly from the NCDC server, before storing it in a local HDF5 file. Since completing that part, I have been working on clustering the data, for climate classification purposes. That is still a work in progress."

CUNY

NCA&T summer exchange ISET student, *Fenyang Stewart* joined CCNY ISET scientists Prof. Barry Gross and Prof. Sam Ahmed. Stewart's summer research was on LIDAR data analysis.

Title: Combining lidar processing with sunphotometer constraints.

Mr. Stewart worked on using the optical depth constraint from the CIMEL sunphotometer to reduce the uncertainty in the Lidar extinction and backscatter profiles. These included the inclusion of uncertainty in the constraints and far end boundary conditions

ALASKA

University of Alaska Southeast ISETCSC partners are working on long-term strategies to increase recruitment (specifically of minority students) through partnerships with the University of Alaska Southeast Research Experience for Undergraduates (REU) program and the University of Alaska Natives Science and Engineering Program (ANSEP). The REU program is in its seventh year at University of Alaska Southeast and has developed successful recruiting strategies. The ANSEP program is primarily at the University of Alaska Anchorage. During the reporting period a "pre-engineering" certificate at the University of Alaska Southeast is being designed to provide an engineering track for students as part of the ANSEP. This project will have the first students during academic year 2008-9. Through ISETCSC and ANSEP synergies, recruitment efforts for both programs are expected to benefit. Our student recruitment goal for the upcoming summer and academic year is three students. Previous students supported by the University of Alaska Southeast ISETCSC funding are working for NOAA, attending graduate school in the Natural Sciences, or continuing their education at the undergraduate level.

NCSU

ISET MS student *Keren Cepero* at NCSU participated in an internship with NOAA NWS/ Office of Hydrological Development (OHD) at Silver Spring, Maryland from June to July 2008. During this period the student worked with the Hydraulic Group in the Inundation Mapping Project guide by the hydraulic group leader, Sean Reed. The student learned how to manage, analyze and develop hydraulic models to produce inundation polygons or flood extent polygons that can be mapped. Currently the student is still working with this project as well with the intensions of comparing the hydraulic model with the hydrologic model performance. Also is trying to see how the digital geographic data quality and resolution affect the models outputs. Finally the student is also interested in comparing the models outputs from a steady-state and unsteady-state approach for both models.

REU at NC A&T:

Mohamoud Abbas, Major, Engineering

Research topic: Luminescent Sensor

Mentor: Dr. Zerihun Assefa

Anthony Hagler, Major, Engineering

Research topic: Data Reduction Evidence of Climate Change.

The intention of the analysis of the ERA-40 data is to examine this vital system and explore its uses in the discovery of new information about weather conditions over the last half century.

Mentor: Dr. Abdollah Homaifar

Ashley Hall, Major: Computer Science

Research topic: Distributed Architecture-2

Mentor, Dr. Albert Esterline

Patrick Pete, Major: Atmospheric Science & Meteorology

Research topic: Compiling the satellite imagery into animation and Hovmoller diagram for verifying numerical model simulated results

Mentor: Dr. Yuh-Lang Lin

Fenyang Stewart (Summer Internship Trail Appointment), Major: Engineering

Research topic – Combining lidar processing with sunphotometer constraints

Mentor: Dr. Samir Ahmed / Dr. B. Gross

Kazman Toran, Major: Engineering

Research topic: Data Fusion-2

Mentor: Dr. Abdollah Homaifar

Allen Covell, Major: Atmospheric Sciences & Meteorology

Research topic: Effects of Appalachians on the track change and orographically induced rainfall during the passage of hurricane Ivan (2004)

Mentor: Dr. Yuh-Lang Lin

Van Nguyen, Major: Computational Sciences and Engineering

Research topic: Tropical cyclogenesis of Hurricane Javier (2004) over eastern Pacific Ocean. Objectives for the summer research was to learn the basics of the WRF model by simulating a hurricane, learn GRADS to visualize the WRF model results, and gather satellite images from an online data archive.

Mentor: Dr. Yuh-Lang Lin

Tammy Morrison, Major: Computer Science

Research topic: Distributed Architecture-I. CherryPy allows developers to build web applications in much the same way they would build any other object-oriented Python program. This usually results in smaller source code developed in less time. Python is an interpreted, object-oriented, high-level programming language with dynamic semantics.

Mentor: Dr. Albert Esterline

Wilson Jones, Major: Mathematics

Research topic: Evolution of Tropical Cyclones over Africa. Research focused on 2006 Hurricane Helene and 2006 Tropical Storm Debby. He analyzed storms, with the use of the WRF model (Weather Research and Forecasting model) and GrADS (Grid Analysis and Display System).

Mentor: Dr. Guqing Tang

James Spinks, Major: Mathematics
Research topic: Genesis of Tropical Cyclones
Mentor: Dr. Guqing Tang
Brandon Davis, Major: Physics
Research topic: Determining Hurricane Intensity
Mentor: Dr. Abdellah Ahmidouch

APPENDIX IX: OUTREACH ACTIVITIES.

ALASKA:

- The University of Alaska Southeast partners contributed to the University of Alaska "Alaska Summer Research Academy" for students in grades 8-12 to be involved in the "Glacier Dynamics and Biological Succession" course in Glacier Bay. This included front page feature articles in the Juneau Empire (Friday, July 25, 2008) and the Fairbanks News-Miner.
- Participated in the University of Alaska Southeast "Careers in Environmental Science" fair with a NOAA ISET table.

CUNY

- **The New York City Louis Stokes Alliance for Minority Participation in Science (NYC LSAMP)** held its 11th Annual Urban University Conference on Friday and Saturday April 11th and 12th, 2008, at the City College. Dr. Zevallos, CCNY-Higher Education Officer, was representing NOAA-ISETCSC, NOAA CREST, NASA-COSI, and NSF programs at CCNY. The conference theme was "Explorations and Discovery."
- **LAESA-SHPE's 14th Annual Pre-College Engineering Day (PCED) conference – April 14th 2008:** The conference was organized by The LAESA-SHPE Chapter at CCNY. Dr. Ahmed,
- NOAA-CREST Day took place on April 17, 2008. The event took place in the Steinman Hall Auditorium located at 140th St @ Convent Avenue. Prof. Sam Ahmed, ISET CCNY-Director hosted a tour to participating students of the Remote Sensing Facilities.
- **ISET's High School Summer Research Program at CCNY** ran from June 27th to August 7. CCNY ISET center took two High School Students under their wings this summer: Jonathan Tien from San Francis Preparatory HS worked with Coastal RS, and Emanuel Arnaud from the Bergen County Tech. HS in New Jersey worked with Mark Arend on METNET – sensor network.

FRESNO:

The Earth and Environmental Sciences Department is planning a series of K-12 outreach activities for Earth Science Week in October. Over 300 K-12 students will come to campus to participate in a series of hands-on activities.

The Department of Chemistry is in the process of developing the "Science in a Suitcase" program. Faculty members have designed several experiments that can be incorporated into school science classes. Undergraduate chemistry majors then visit local schools to carry out the experiments. The goal of this program is four-fold:

- To help raise awareness and interest in college chemistry and chemistry-related careers among school students.
- To provide school teachers with lesson plans incorporating a 'real-world' examples to inspire students to pursue chemistry at the college level.
- To inspire college students (who teach the lessons) to become science teachers.
- Raise community awareness of chemically-related issues such as the origins of air pollution in the region.

An activity based on air quality measurements has been developed and tested at a local high school, with the intention of being used in area high schools in the coming years.

A proposal for a Fulbright Scholar-in-Residence is currently in preparation for submission by October 15, 2008. If funded, the grant would bring a teacher-scholar from overseas to California State University Fresno for 10 months. The scholar would be involved in many education and outreach activities including a) the development of a new General Education course in the area of atmospheric chemistry, b) the development of a new overseas study course in the area of air quality/climate change, c) visits to local community colleges and high schools, and d) talks to university and community clubs and organizations

NC A&T: K-12 Outreach Activity

ISETCSC conducted a very successful middle and high school summer weather camps, and a teachers workshop.

High School Summer Camp

ISETCSC hosted its second high school weather and climate summer camp July 21-25, 2008 on the NCAT campus. As of February 20, 2008, the camp reached the maximum capacity of 10 students, but due to the overwhelming requests from parents, the Center increased the number of participants from 10 to 23 students. Students who successfully complete the five-day weather and climate summer camp received a stipend of $320. In order to recruit the high school students for the summer camp, flyers were printed and distributed to high schools with each recruiting event. The ISETCSC website was updated with the flyers in late October 2007 which allowed for online registration. NC A&T Summer Enrichment Camp also placed the information on its website. The enrollment increased by 16 students from 2007. There were 13 students on the waiting list. Scientists such as Dr. Yuh-Lang Lin (NOAA-ISET Senior Scientist), Dr. Atalay Wondem (Director, Geophysical Observatory, and Addis Ababa University, Ethiopia) and Dr. Solomon Bililign (Director, NOAA-ISET) made presentations during the camp. The students performed a number of weather related experiments and toured the RENCI (Renaissance Computing Institute) located in Raleigh, NC and Morehead Planetarium located in Chapel Hill, NC as part of their week long weather camp experience. The students visited atmospheric chemistry labs and observed real experiments. The facilitators for the high school camp were Dr. Keith Schimmel (Director, Energy and Environmental Studies PhD. Program) and Gayle Scott.

Middle School Summer Camp

ISETCSC hosted its second middle school weather and climate summer camp July 14-18, 2008 on the NC A&T campus. In order to recruit the middle school students for the summer camp, flyers were printed and distributed to middle schools with each recruiting event. The ISETCSC website was updated with the flyers in late October 2007 which allowed for online registration. NC A&T Summer Enrichment Camp also placed the information on its website. The enrollment increased by 4 students from 2007. The students performed numerous weather related experiments which were featured on a live television broadcast (WFMY-TV2) http://www.digtriad.com/news/local/article.aspx?storyid=107337. The students toured RENCI (Renaissance Computing Institute) located in Raleigh, NC and Morehead Planetarium located in Chapel Hill, NC as part of their week long weather camp experience. The facilitators for the middle school camp were Dr. Keith Schimmel (Director, Energy and Environmental Studies PhD Program) and Elizabeth Keele.

K-12 Teachers Summer Workshop

ISETCSC hosted their second K-12 Teachers Summer Workshop June 23-27, 2008 on the NC A&T campus. ISETCSC has partnered with IRIS to conduct the workshop. The participants are eligible to receive up to 4 continuing education units (CEU) credits. In order to recruit the high school teachers for the summer workshop, flyers were printed and distributed to over 400 high schools via email and with each recruiting event. The ISETCSC website was updated with

the flyers in late October 2007 which allowed for online registration. As of February 14, 2008, the workshop was filled to capacity with 20 teachers, but due to overwhelming requests, the Center increased the number of participants from 20 to 25. There were a total of 129 on the waiting list. Each teacher will receive a stipend of $250 per day upon completion of the workshop.

Minnesota Recruiting

We plan to recruit a new undergraduate student. For recruitment, we will likely just consult with faculty who teach lower level computer science classes, since that has worked well in the past.

Our mentoring has consisted of regular meetings between the students and the two PIs (Michael Steinbach and Vipin Kumar). In addition, a senior PhD student provides advice and guidance in some cases. Also, one of the students, *Robert Olabode*, spent a month with the EIS team. This was a very valuable experience for him in terms of what he learned, what he accomplished, and his increased enthusiasm for the project.

Fresno Recruiting

Recruitment strategies are listed in Appendix V. Finding qualified minority students who are interested in NOAA sciences (as opposed to medical school, pharmacy school etc.) has been challenging.

Our students meet with their research advisor at least once per week to discuss progress with their projects. During these meetings career goals and fellowship opportunities are often discussed. Our students are strongly encouraged to attend and participate in conferences that will help them to achieve their career goals. They are also encouraged to visit NOAA and NCAR in Boulder with their research advisor during the summer.

Two of the three recruitment strategies used specifically target minorities. First, ISET is heavily advertised by campus programs that work with under-represented students (such as the Science Careers Opportunities Program). Second, ISET faculty directly approach qualified minority students to inform them about opportunities within ISET.

NCSU Recruiting

Efforts to attract underrepresented minorities include:

- American Meteorological Society (AMS) Central North Carolina; http://www.nc-climate.ncsu.edu/ams (Fredrick Semazzi is scheduled to give a seminar next semester, on April 16th, 2009; 7:00-9:00 pm).
- College of Physical and Mathematical Sciences Open House (handout ISET materials)
- Special webpage to promote access by K-12 teachers and students and their parents [http://www.cgibin.ncsu.edu/sh-bin/k12-directory/visitor.pl].
- NCSU Science House [http://www.science-house.org]. The Science House has 6 offices across the state of North Carolina that we use to reach minorities through out the state [http://www.science-house.org/info/satellite.html].

CUNY Recruiting

CCNY ISET's HS Summer Research Program

This year the NOAA EPP (CREST and ISET) at CCNY joined forces with the City College HS Summer Research Programs to provide HS student participants a more conductive environment and wider range of opportunities, and leverage recruitment and outreach efforts.

The 2008 HS Summer Research Programs was six weeks long and took place on June 27th through August 7th.

CCNY HS Summer Research Program

This year 17 HS students were able to participate in this collaborative HS outreach efforts organized by the NOAA EPP at CCNY (CREST and ISET), NY STEM Institute, the Mid-InfraRed Technologies for Health and the Environment (MIRTHE) center, and the NASA Center for Optical Sensing and Imaging. Selected HS Students had the opportunity to work doing state of the art research in CCNY.

NASA URC, and MIRTHE center's laboratories at CCNY. Students were trained and also taught oral and poster presentation skills and enrolled in a Mathlab computer based college course. Participating students received $1,000 as stipends for their participation at the end of the 6 wk long program.

All students participating in the Research Summer Program had the opportunity to present posters of their research accomplishments in the 5th NASA Student Research Day at CCNY, which took place on July 31st 2008. This single all day event is geared to HS students. It was organized and supported by the NOAA EPP (NOAA CREST and NOAA ISET), MIRTHE, NY STEM Institute, NASA GISS NYCRY and NASA COSI. More than 350 students were in attendance on this day.

The HS Summer Research students' participants this year are presented in the picture above.

ISET supported HS students were:

Jonathan Tien, San Francis Preparatory HS

Emanuel Arnaud, Bergern County Tech. HS

Ms. Galia Spinal (3) and Ms. Charlene Chanlee (4), both HS teacher in NYC were recruited to help run the program. Dr. Manny Zevallos center coordinator was in charge of the HS Summer program.

High School Summer camp attendees

CUNY

Last Name	First Name	Status	Graduated (Y/N)	SEX	Ethnicity
TIEN	JONATHAN	Senior		M	1
ARNAUD	EMMANUEL	Junior		M	

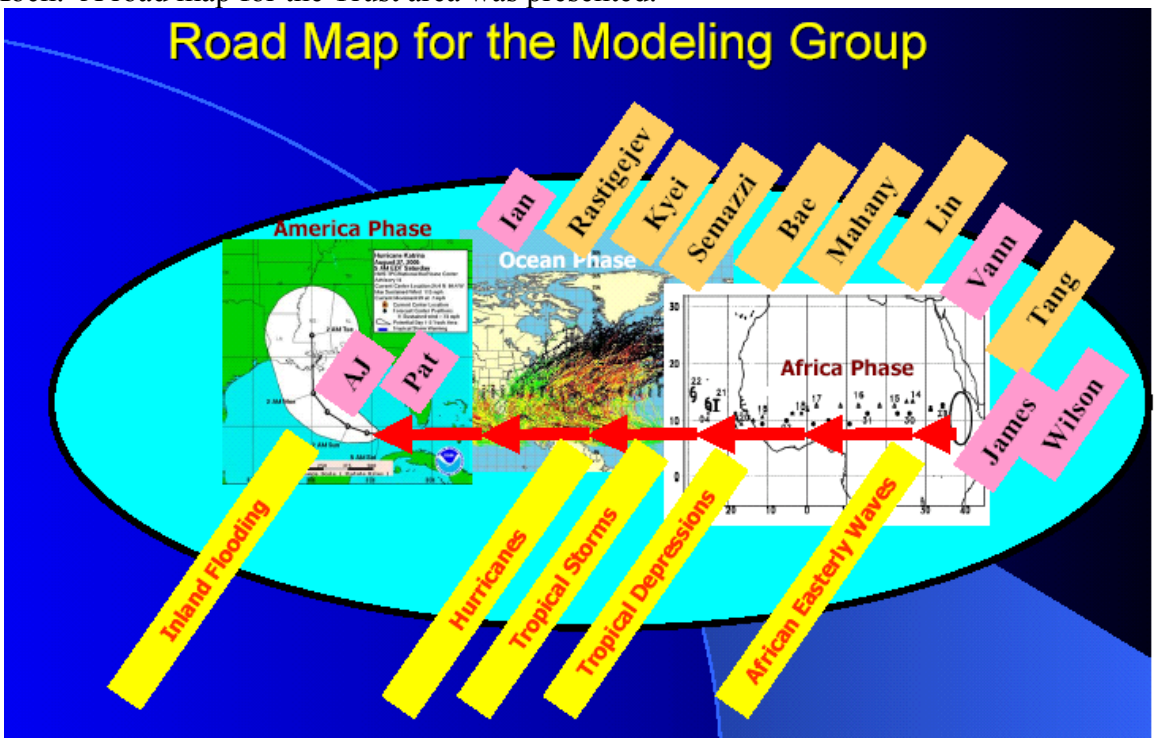
NC A&T

Last Name	First Name	Status	Graduated (Y/N)	SEX	Ethnicity
BORBOR	GAIVOLOR			M	5
BOWDEN	DeANGELO			M	
BOYD	JONATHAN			M	5
BOYLAND	ALEX			M	5
CAMERON	CHEVON			F	5
FISHER	JOSHUA			M	5
FREEMAN	WESLEY			M	5
FULLER	BERNARD			M	5
GLOVER	JORDAN			M	5
HAMPTON	TARA			F	5
HARRIS	ANDRE			M	5
KUILA	PUSHPARGHYA			M	5
McRAE	KRYSTOPHER			M	5
NEWBY	TYLER			M	5
NZEWI	JOSHUA			M	5

ROYSTER	ANDREW			M	5
SAWYER	TERRANCE			M	5
SHEPHERD	LYDIA			F	5
SIMPSON	INDIA			F	5
SMITH	BRITTANY			F	5
SOUTHERN	MERCEDES			F	5
TROWELL	ANDRE			M	5
TROWELL	CHARLES			M	5
WHITE	JAMES			M	5

APPENDIX X: Thrust Area meetings.
A. Thrust Area II Meeting

Thrust area II meeting held on August 8, 2008 in the presence of Technical Monitor Steve Koch. A road map for the Trust area was presented.



Agenda

8:00 – 8:10 Welcome and status of thrust area and NAC comments on TA II (Semazzi)

8:10 – 8:20 Introductions of new members at NCA&T and status of NCA&T group (Bililign/Lin)

Session 1 ***Subareas* II-5b, II-9, II-2, and II-4***

8:20 – 8:35 (II-5b) Ahmidouch:
Conduct in-depth empirical analyses of observational and numerical data to investigate the modulation of hurricane activity by climate change

8:35 – 8:50 (II-9) Ilias/Rastigeyev/Lin:
Analysis of ground-based remote sensing measurements of aerosols and ozone in Greensboro, NC and neighboring cities and study their effects in air quality and climate

8:50 – 9:05 (II-2) Homaifar/Said/Esterline/Semazzi/Xie/Kumar/Steinbach:
Development of Novel Computational Approach for high-level climate prediction

9:05 – 9:25 (II-4) Mahany/Khanbilvardi:
(II-4a) In-depth analysis of data from multiple sensors for aerosol & hydrological-related factors
(II-4b) Application of WRF-CHEM to investigate the relationships between aerosols, microphysics, hydrological variables, and climate

9:25 – 9:40 ***Break***

Session 2 ***Subareas II-1, II-7, II-6, and II-8***

9:40 – 10:15 Semazzi: Analysis and simulations of hurricane development, climatology, and inland flooding:

(II-1a, b) Semazzi/Xie/Liu: Analysis of data for modeling African easterly waves and hurricane development

(II-7) Semazzi/Xie: WRF numerical experiments to quantify the relationships between prescribed exit region coastal SST anomalies associated with upwelling/downwelling

(II-6) Semazzi/Xie: Extension of RegCM3 model study of the 2005 to other extreme hurricane years

(II-8) Liu/Nzewi/Xie/Semazzi: Application of customized watershed model(s) for the investigation of hurricane inland flooding

(Semazzi will make the presentation and emphasize on subareas II-1a, b, and II-7.)

Session 3 ***Subarea II-3***

10:15 – 10:50 Lin: Effects of AEW, MCS, orography, AEJ, African dust, and SST on hurricane formation and evolution

(II-3a) Tang/Lin/Semazzi: Modeling the formation of African easterly waves-mesocale convective system (AEW-MCS) in eastern Africa and TC genesis in eastern Atlantic

(II-3b) Rastigejev/Lin/Semazzi: Investigating the interactions of AEW-MCS with mountains, diabatic heating, and African easterly jet (AEJ) in central N. Africa

(II-3c) Bae/Lin: Analysis and WRF-Chem. modeling of the African dust on TC genesis

(II-3d) Kyei/Semazzi/Tang/Lin: Modeling the SST effects on TC intensification

(Lin will make the presentation and focus on II-3a-c.)

10:50 – 11:25 Opportunities for collaborations with NOAA ESRL (Koch)

11:25 – 11:40 ***Break***

Session 4 ***Group Discussion and Working Lunch***

11:40 – 12:45 Group Discussion (Lead – Lin)
(Will focus on modeling strategy and collaborations with NOAA ESRL scientists)

12:45 – 13:00 Summary of the Workshop

13:00 Adjourn thrust II PIs workshop

Special Modeling Strategy Meeting

13:15 – 15:00 Special afternoon meeting on Thrust Area II modeling strategy & collaboration opportunities (Koch, Lin, Semazzi)

* Subareas are defined in Appendix A.

** Please leave at least 5 minutes for discussion at the end of each presentation.

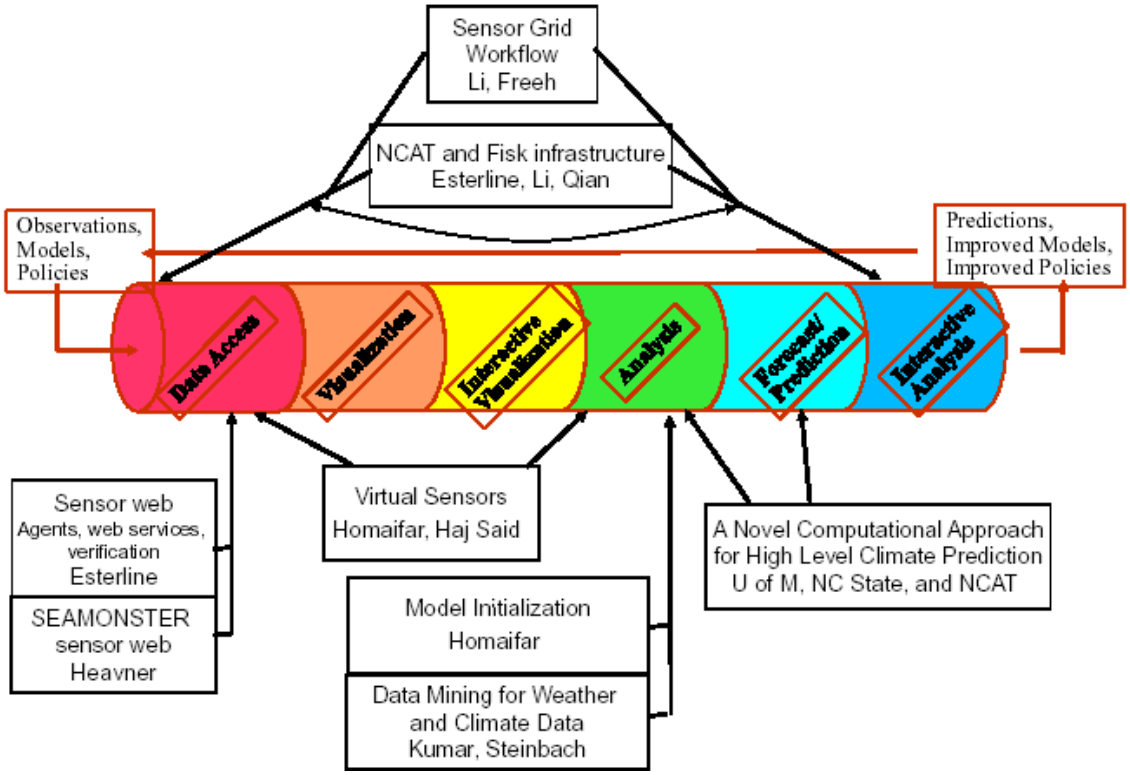
B. Joint Thrust Area II and III Meeting

On August 11, a joint meeting of Thrust area II and III was held at the University of Minnesota, to discuss ways to integrate the research activities between the two thrust areas, evaluate performance and status of the group. August 11, 2008

Agenda

8:00 – 8:05	Welcome - Kumar
8:05 – 8:25	NAC/ISET/EPP key issues - Bililign
8:25 – 8:50	Homaifar/Said/Esterline
8:50 – 9:15	Said/Homaifar/Grossberg
9:15 – 9:40	Steinbach/Kumar
9:40 – 10:05	Qian/Caulfield
10:05 – 10:30	Break
10:30 – 10:55	Esterline/Li/Heavener
10:55 – 11:20	Li/Freeh/Esterline
11:20 – 12:10	Interactions of thrust Area II&III (Lin/Semazzi)
12:10 – 13:10	Working Lunch
13:10 – 13:45	Draft road map for Thrust Area III to be more focused and cohesive
13:45 – 14:20	Topics of collaboration with Thrust Area II
14:20 – 15:20	Group discussions on the following items: Strengthening relation with NOAA scientists Potential student exchange and co-advising Seeking leveraging funds in the time of shrinking funds
15:20	Adjourn

A. Alignment of Thrust area III projects wit NOAA- EIS project
With regards to the EIS the Thrust area III, the research projects are aligned and coherent as depicted in Figure 1 below.



B. Thrust area III and II interactions:
This relationship and integration with Thrust Area II is shown in Figure 2 below.