NOAA-Cooperative Remote Sensing Science and Technology Center (NOAA-CREST)

Reza Khanbilvardi
NOAA-CREST Center
The City College of the City University of New York

11th Annual CoRP Symposium
Cooperative Institute for Climate Studies
University of Maryland, College Park

NOAA-CREST History

- **In existence** since 2001 through major funding by NOAA Educational Partnership Program (EPP)
- **Mission** - to increase number of educated, trained and graduated students especially from underrepresented communities in NOAA related sciences and advance NOAA sciences
- **Overarching Goals –** conduct **research** in NOAA related science in collaboration with NOAA line offices (NESDIS, NWS, NOS) , **recruit , train, educate and graduate** students and **public outreach** to help increase environmental literacy and help increase STEM workforce

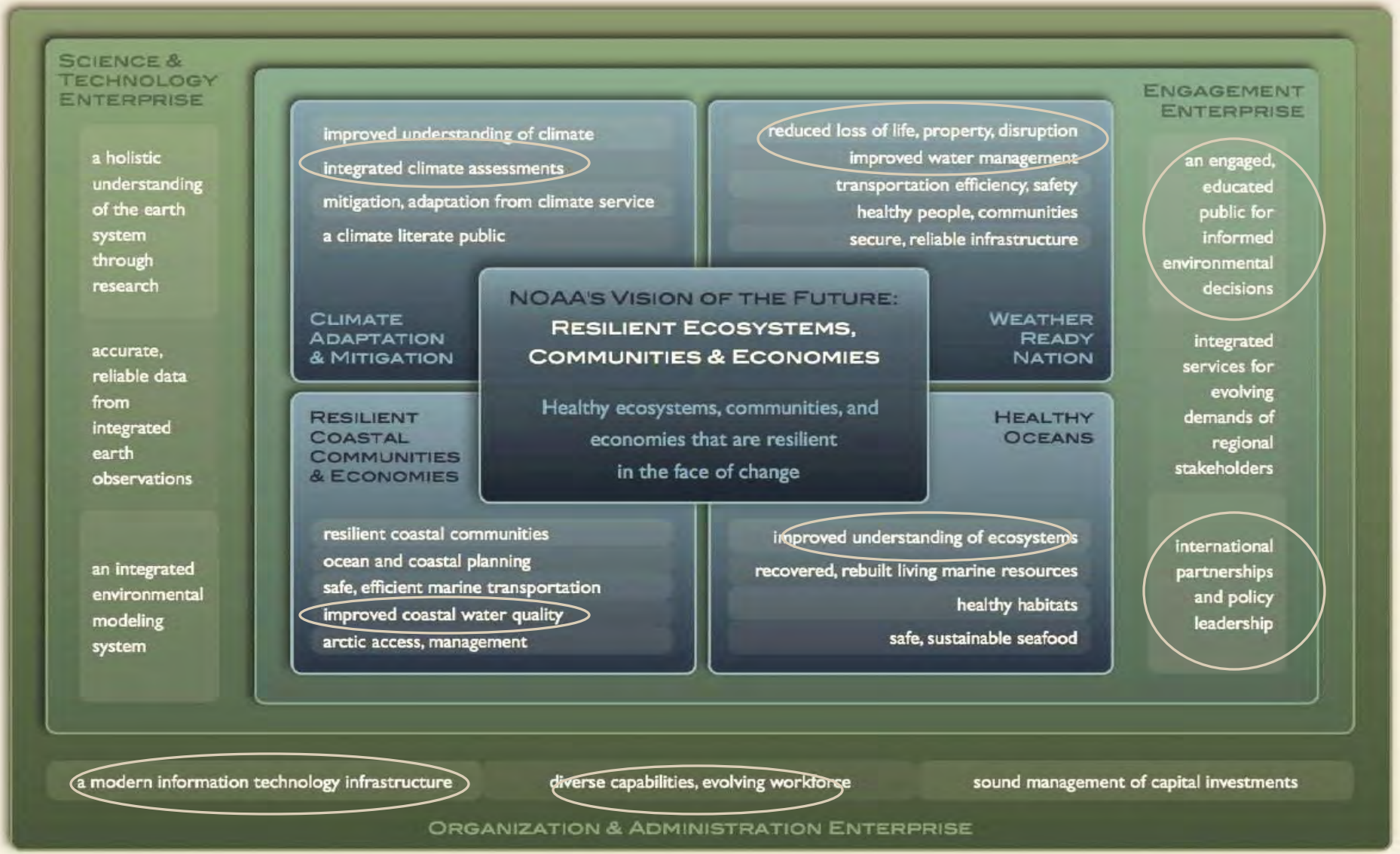

CREST Partner Institution
City University of New York /City College of New York
Lehman College
New York City College of Technology
Bronx Community College
Hostos Community College
LaGuardia Community College
Hunter College
Brooklyn College
Borough of Manhattan Community College
University of Maryland, Baltimore County
University of Puerto Rico, Mayaguez
California State University, Los Angeles
Hampton University
Other Partners
Cooperative Institute for Climate Studies (CICS) , University of Colle Park, MD
Cooperative Institute for Meteorological Satellite Studies, (CIMSS) University of Wisconsin, Madison
Cooperative Institute for Research Atmosphere (CIRA), Colorado Stat University, Fort Collins, CO
NASA-GISS, Columbia University, N
NOAA-Center for Atmospheric Science (NCAS) Howard U.
Environmental Cooperative Scienc Center (ECSC), Florida A&M University
Living Marine Cooperative Sci. Center, (LMRCSC), U. of Maryland, Eastern Shore
CREST Industrial Partners
Northrop Grumman Corporation (NCG)
Raytheon
Earth Research Technology, Inc. (ERT)
Science Systems and Applications, Inc (SSAI)

NOAA-CREST and its four Pillars

- CREST Sciences in line with NOAA's mission
- CREST Education
- CREST recruitment and outreach
- CREST capacity building – faculty, students, infrastructure

NOAA's Mission:
Science, Service & Stewardship

To understand and anticipate changes in climate, weather, oceans, and coasts,
Share that knowledge and information with others, and
To conserve and manage marine resources



CREST RESEARCH

CLIMATE

ATMOSPHERE AND WEATHER

LAND PROCESSES & WATER RESOURCES

COASTAL AND OCEAN WATERS

Recruitment; Education & Outreach

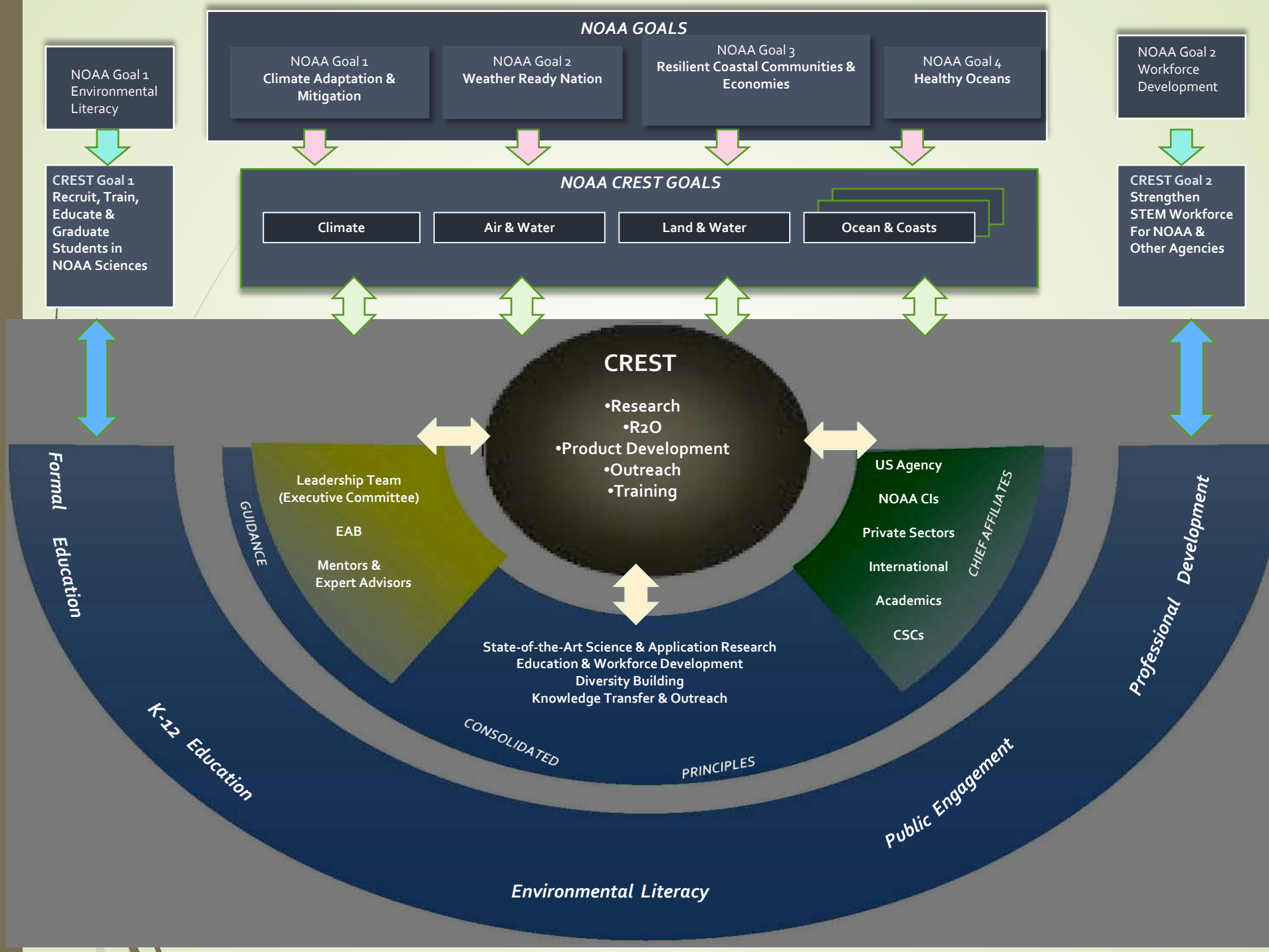
Climate Mitigation and Adaptation

Weather Ready Nation

Healthy Ecosystems

Climate Mitigation and Adaptation

NOAA's Current Goals and Missions


NOAA GOALS
NOAA Goal 1
Climate Adaptation & Mitigation
NOAA Goal 2
Weather Ready Nation
NOAA Goal 3
Resilient Coastal Communities & Economies
NOAA Goal 4
Healthy Oceans
NOAA Goal 1
Environmental Literacy
NOAA Goal 2
Workforce Development
CREST Goal 1
Recruit, Train, Educate & Graduate Students in NOAA Sciences
NOAA CREST GOALS
Climate
Air & Water
Land & Water
Ocean & Coasts
CREST Goal 2
Strengthen STEM Workforce For NOAA & Other Agencies
CREST
•Research
•R2O
•Product Development
•Outreach
•Training
Leadership Team
(Executive Committee)
EAB
Mentors &
Expert Advisors
GUIDANCE
US Agency
NOAA CIs
Private Sectors
International
Academics
CSCs
CHIEF AFFILIATES
State-of-the-Art Science & Application Research
Education & Workforce Development
Diversity Building
Knowledge Transfer & Outreach
CONSOLIDATED
PRINCIPLES
Formal Education
K-12 Education
Professional Development
Public Engagement
Environmental Literacy

NOAA || Climate Mitigation and Adaptation
CREST || Theme
Global Climate Studies
Climate Change Impacts Assessment Technology Development
Analysis of Processes Affecting Climate Variability

NOAA || Weather Ready Nation
CREST|| Theme
Atmosphere and Weather
Improvement of Satellite Products
Aerosol and Planetary Boundary Layer
Stratospheric Studies
Satellite Remote Sensing of Ozone
Urban Coastal Studies

CREST Research
15 Projects 104 Tasks 40 NOAA collaborators >200 Peer Reviewed Publications >414 students trained and graduated

NOAA || Weather Ready Nation and Healthy Ecosystem
CREST || Theme
Water Resources and Land Surfaces
Water Resources Management
Hydrometeorology
Land surface processes
Effects of Climate Change on Water and Water Resources

NOAA|| Health Oceans & Coastal Communities
CREST || Theme
Coastal and Ocean Remote Sensing
Validation of ocean color
Development and improvement of algorithms

- **Developed satellite-based flashflood and thunderstorm forecasting technologies**
- **Developed satellite-based river ice, snow and soil moisture mapping tools**

NOAA || Climate Mitigation and Adaptation

CREST || Theme

Global Climate Studies

Climate Change Impacts Assessment Technology Development

Analysis of Processes Affecting Climate Variability

NOAA || Weather Ready Nation

CREST|| Theme

Atmosphere and Weather

Improvement of Satellite Products

CREST Research

15 Projects

104 Tasks

NOAA || Weather Ready Nation and Healthy Ecosystem

CREST || Theme

Water Resources and Land Surfaces

- **Outreached - > 10000 School (K-12) Students**
- **Increased NOAA and CREST visibility across NE region among schools and research and educational organizations.**
- **Improved Students Professional and Career Development and skills**
- **Recruited, retained, and trained 700* students in last 10 years - 499 graduated of which 75% are Underrepresented Minorities (both CREST funded and its affiliated/leveraged programs) and 262 in pipeline**

***this is cumulative numbers from leveraged EO activities (funded by NOAA, NSF (MIRHTE, REU, OEDG, EaSM), DoEd (ESES, CILES), Navy)**

CREST Capacity Building

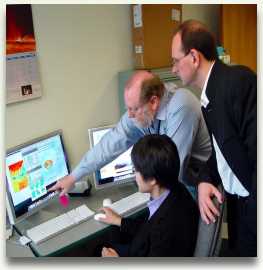
Facilities – Snow, Soil and Coastal observatories

Faculty and scientists from 18 (2002) to 65 (2011) to 75 (present)

Students – from 1 to 650

Research and Publications/Data Products

One CREST - Four Thematic Research Areas

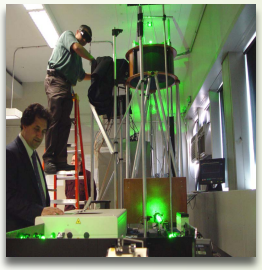


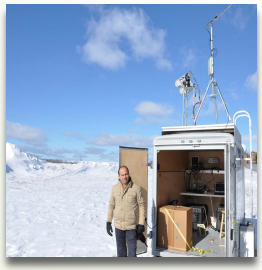
Climate

[NOAA -Climate Mitigation and Adaptation]

Weather and Atmosphere

[NOAA-Weather Ready Nation]



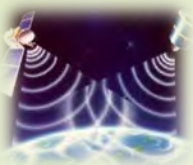


Land Processes and Water

[NOAA-Weather Ready Nation & Resilient Ecosystems]

Coastal and Ocean Waters

[NOAA-Resilient Coastal Communities and Healthy Oceans]



Integrated Data Products

- ISCCP – 2012
- CRIOS - 2012
- Upper Tropospheric Water Vapor (2013)
- Radiative Flux Profiles (2014)
- Land Inundation (2012)
- Snow Cover (2012)
- Cyclone Attributes and Dynamics (2013)
- Tropical Deep Convection (2013)
- Effective cloud emissivity (product of cloud fraction and the cloud emissivity) using CrIS/ATMS and NGAS-CrIMSS radiances
- A climatology of PSCs in the Arctic and Antarctic polar winter stratospheres (2013)
- MODIS AOD Urban Fusion Product (2014)
- In situ datasets for validation of ocean color satellites including JPSS-VIIRS (2012)
- Algal bloom data for West Florida Shelf (2013).

Cal/Val

- ISCCP Radiance Calibrations confirmed to 3% absolute (VIS) and 2% absolute (IR)
- ISCCP Cloud Properties confirmed to better than originally estimated uncertainty
- Microwave Snow Site – CREST SAFE
- Soil Moisture Advanced Radiometric Testbed and In-Site Network
- CREST LIDAR NETWORK (CLN) Assessment of Passive and Active Satellite Aerosol Products
- Long Island Sound Coastal Observatory (LISCO) with reflectance and atmospheric data products, matchups of multi and hyperspectral in-situ and Ocean Color satellite data

R2O

- ISCCP Cloud Product Processing will go operational 2012
- ISCCP Radiative Flux Profile Processing will go operational in summer 2014.
- Assist OMPS LP retrieval algorithms for ozone, aerosol, and NO2 profiles (2014)
- BRDF model for coastal waters (2014)

FLASH FLOODS: WEATHER READY NATION

Research: In the US, flash flooding is the number one killer among all weather-related hazards. The 30 Year Flood Loss **Averages** = $7.82 Billion in damages, 94 deaths per year.

This project integrates **remote sensing satellite based soil moisture data** in current hydrological modeling to improve Gridded Flash Flood Guidance System.

Collaborators:

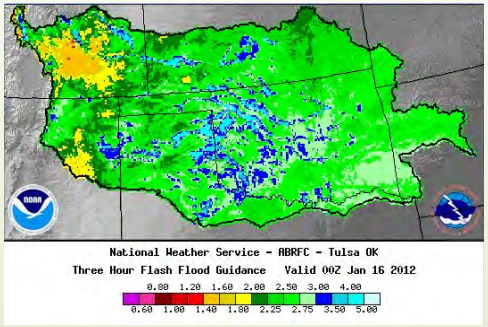
Office of Hydrological Development (OHD/NWS).

Regional Forecasting Center, National Weather Service (NWS), Tulsa OK.

National Environmental Satellite, Data, and Information Service (NESDIS).

End Users:

Weather Forecasting Offices; Local Emergency Management Offices; Federal Emergency Management Agency (FEMA) .



THUNDERSTORM NOWCASTING: WEATHER READY NATION

Research Product: The CREST Thunderstorm Nowcasting project identified and tracks thunderstorms using geostationary satellite data from the CUNY-CREST Satellite Receiving Station. We use the Rapidly Developing Thunderstorm (RDT) algorithm developed at Meteo-France and modified to use NOAA's GOES satellite. It detects towers in the brightness temperature field, tracks them and gathers statistics to determine if the tower might be a convective system. An upgrade that uses water vapor channels and numerical weather data has been installed and is in the process of being tuned against lightning data before being made operational.

End Users: Aviation over ocean or mountains where radar coverage is not available.

RIVER ICE: WEATHER READY NATION

- **Research:** The project introduces an operational new satellite based river ice product to display ice conditions in major rivers in the northern watersheds. Ice maps are updated on a daily basis and the product makes use of images from MODIS acquired in near real time by the CREST satellite receiving station.

- **Product:** Developed ice maps are made available online through a data portal superimposing the Google Earth

- **End-users:** like NOAA NWS River Forecast Centers and Weather Forecast Offices as well as reservoir managers in hydropower plants along the rivers.

SNOW STUDIES : WEATHER READY NATION

CREST-Snow Analysis and Field Experiment (CREST-SAFE)

As per NOAA/NOHRSC report, snowmelt provides over 70% of the water supply in the western USA. Accurate and timely snow forecasts and snowmelt forecasts are critical components in the management of rivers such as the Columbia and the Colorado. Snow also plays a significant role in the United States tourism economy, adds up to more than $7.9 billion dollars a year.

Research:

The CREST-SAFE is being carried out to **develop real time and forecasted gridded snowpack data by objectively merging in-situ** stationed with satellite based VIS/NIR and microwave observation.

CREST-SAFE is setup in the backyard of the Weather Forecasting Office at Caribou, ME has equipped with: dual polarized microwave radiometers (37 and 89 GHz), Snow Pillows, ultrasonic snow depth sensor, Infrared Thermometer, Radiation Sensors, snow temperature profiler, snow grain size, density, Humidity/Temperature probe and network camera.

End users:

Modeling community: Improvement in Community Radiative Transfer Model (CRTM) by NOAA/NESDIS

River Forecasting Centers (for Snowmelt and discharge), Water Resources Managers (for Water Supply in spring and summer), Public Safety Managers, Department of Environment Protection (for Snowmelt and flood), Tourism Industry (Snow/Skiing).

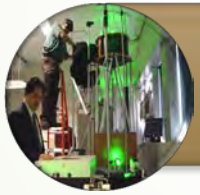
Infrastructure and Facilities

CREST Facilities

CREST Microwave Observation Unit

Coastal Measurement Platform

CREST Earth Observation Unit



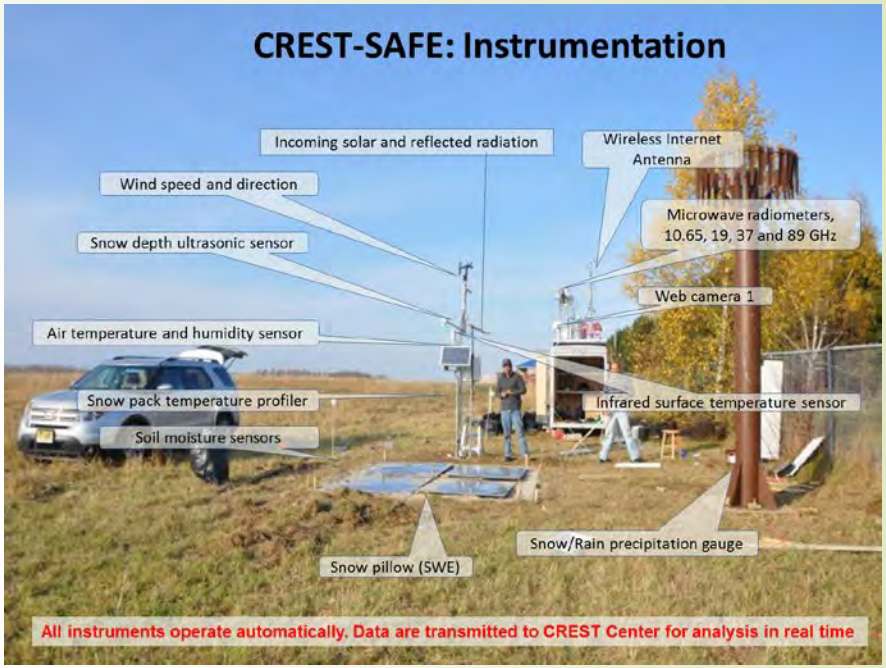
CREST LIDAR Network (CLN)

Computational Labs (GIS, CALIPSO, Earth System Research)

Other Ground Instrumentations and Urban Meteorological Observational Network

Microwave Observation Unit – Snow in the Weather Forecast Office Site, Caribou, Maine

CREST-SAFE Experiment located on the premises of NWS Regional Forecast Office at Caribou Regional Airport, Caribou, ME



http://crest.ccny.cuny.edu/snow/index.htm

37 GHz Radiometer
89 GHz R
Snow Temperature Profiler

Snow Pillow (SWE)
Rain/Snow Gauge
Soil Moisture (2.5, 5, 10cm)
Soil Temp (2.5, 5, 10cm)
Network Cameras (2)

Infrared Thermometer (Skin Temperature)
Snow Depth Sensor
Radiation Sensors
Wind Speed/Direction, Humidity/air temperature

DoD/Navy Funding (2013)
19 and 10.65 GHz Radiometers
CIMEL Sun Photometer

Snow Wetness profiler
GMON3 SWE Sensor

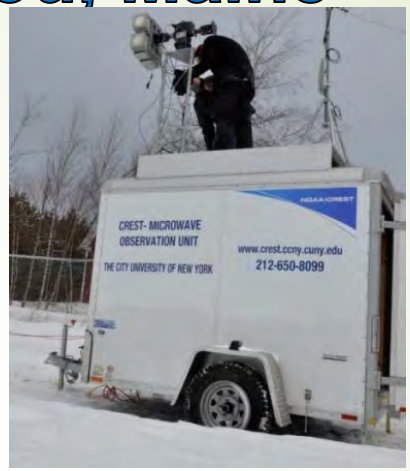
2010 2011 2012 2013 2014

Timeline of Instruments installed at CREST-SAFE Site

Snow Instrument at the Weather Forecast Office Site, Caribou, Maine

Snow Temperature Profiler

Microwave Radiometers



Trailer

Snow Wetness

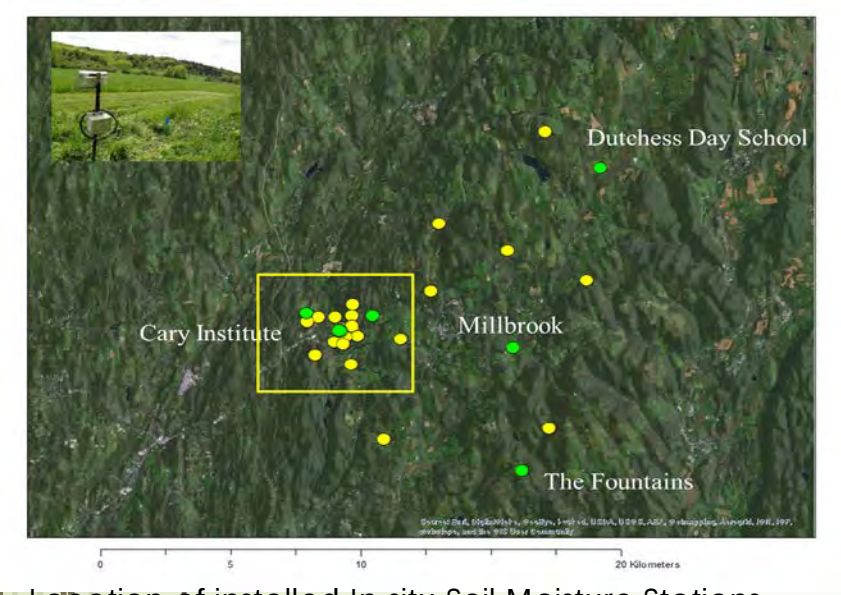
Grain size and Density Instruments

Snow Water Equivalent (SWE) Sensors

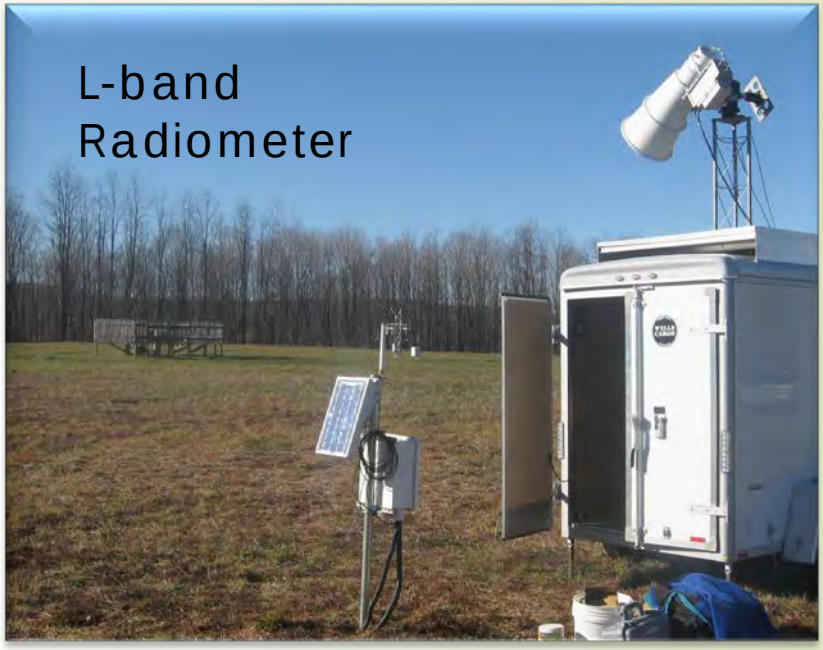
Microwave Observation Unit – Soil, Millbrook, NY

CREST-SMART: Soil Moisture Advanced Radiometric Testbed

The established network was selected by NASA for the Cal/Val of the SMAP



Location of installed In-situ Soil Moisture Stations around Radiometer Site



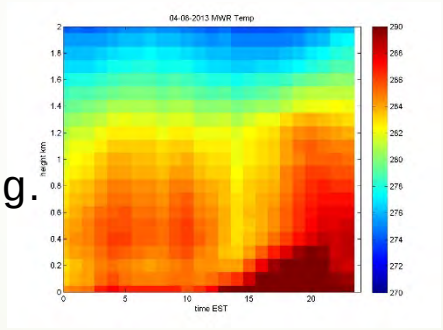
Joint Field Experiment in May 2012

Microwave Observation Unit – Atmosphere

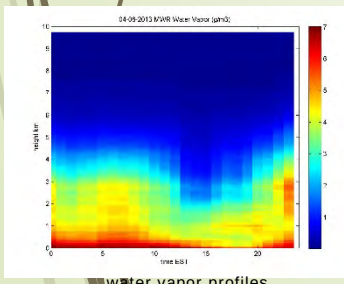
The Radiometrics Profiling Radiometer, model MP-3000A, produces vertical profiles from the surface to 10 km, producing high-resolution 1) temperature, 2) relative humidity and 3) water vapor profiles, and 4) low-resolution liquid profiles.

Applications include:

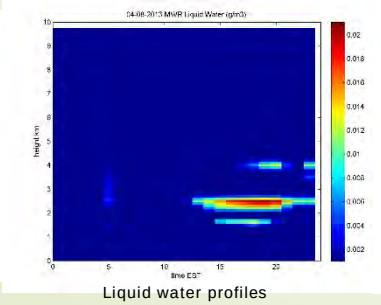
- validation of high resolution meteorological models
- Aerosol – Cloud Interactions
- Hygroscopic Aerosol Modeling.



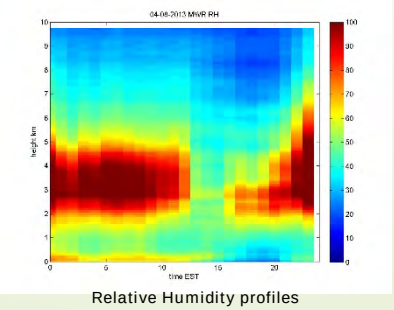
Temperature profiles



water vapor profiles



Liquid water profiles



Relative Humidity profiles

Microwave Radiometer Profile located at Steinman Hall @ CCNY

CREST LIDAR Network (North East Corridor)

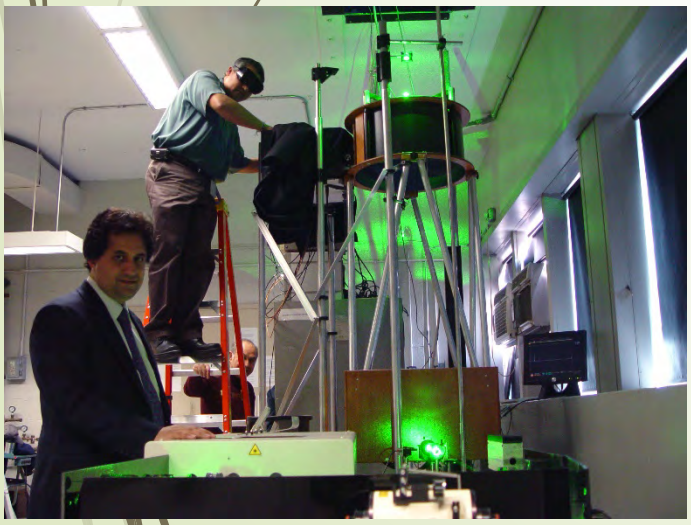
CREST LIDAR Network (NY, VA, MD, PR) studies the vertical profiling along the Atlantic Coast transect from NYC to Caribbean with applications to aerosol transport and air quality. It has been cooperated in founding the International GAW Aerosol LIDAR Observation Network.

@ UMBC

@ Hampton University

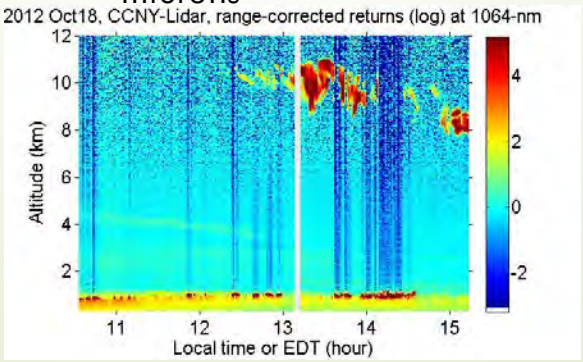
@ UPRM

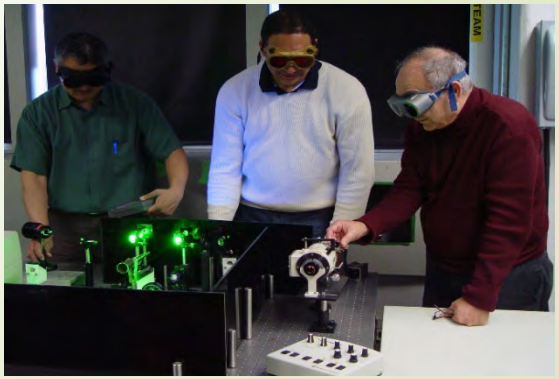
CREST LIDAR Facility at the City College of New York



Mid-IR Lidar at 4.5 microns

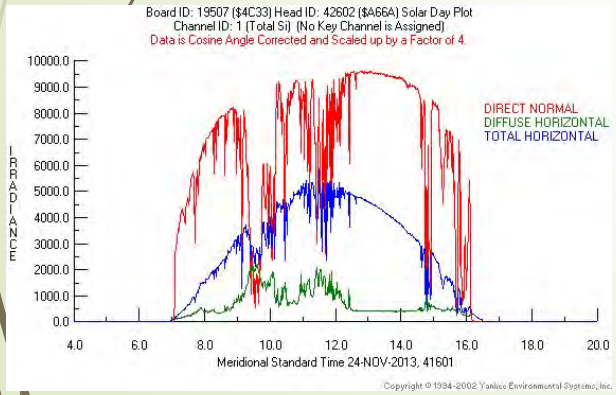
Open-path Laser Measurements at 7.8 microns





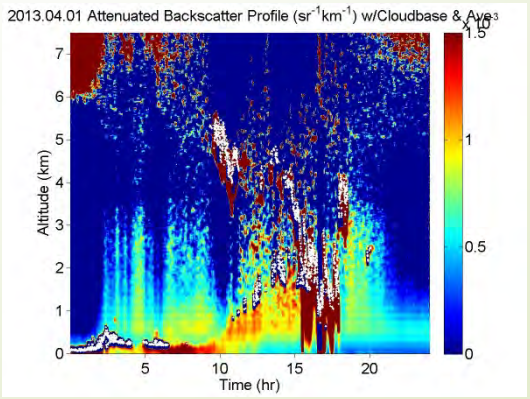
CREST LIDAR Facility at the City College of New York

MFR-7 Shadowband Radiometer



MFRSR measures total, diffuse, and direct irradiance at six wavelengths (415, 500, 615, 673, 870, and 940 nm, each 10 nm FWHM) in the visible/NIR spectrum.

Ceilometer measures backscatter reflection from clouds, aerosols or precipitation is used to measure cloud base height and vertical visibility, and is particularly suited for low altitude measurements.

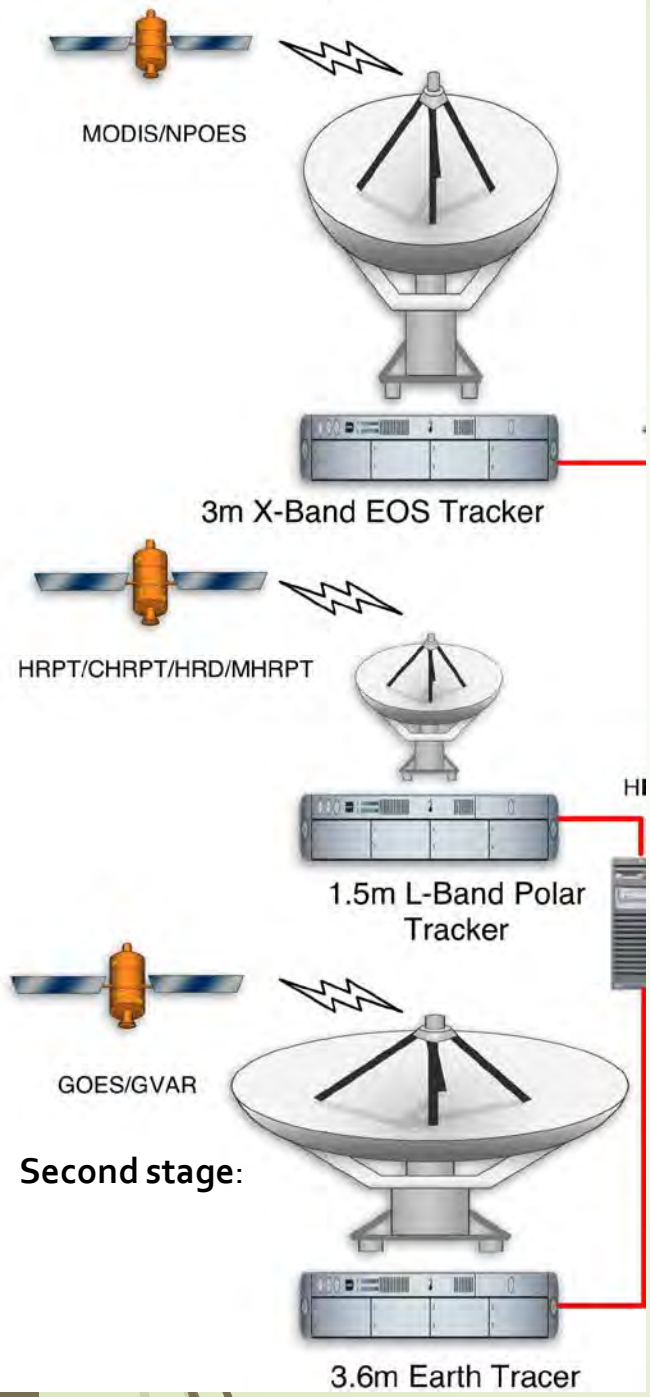


CREST Mobile Doppler LIDAR System

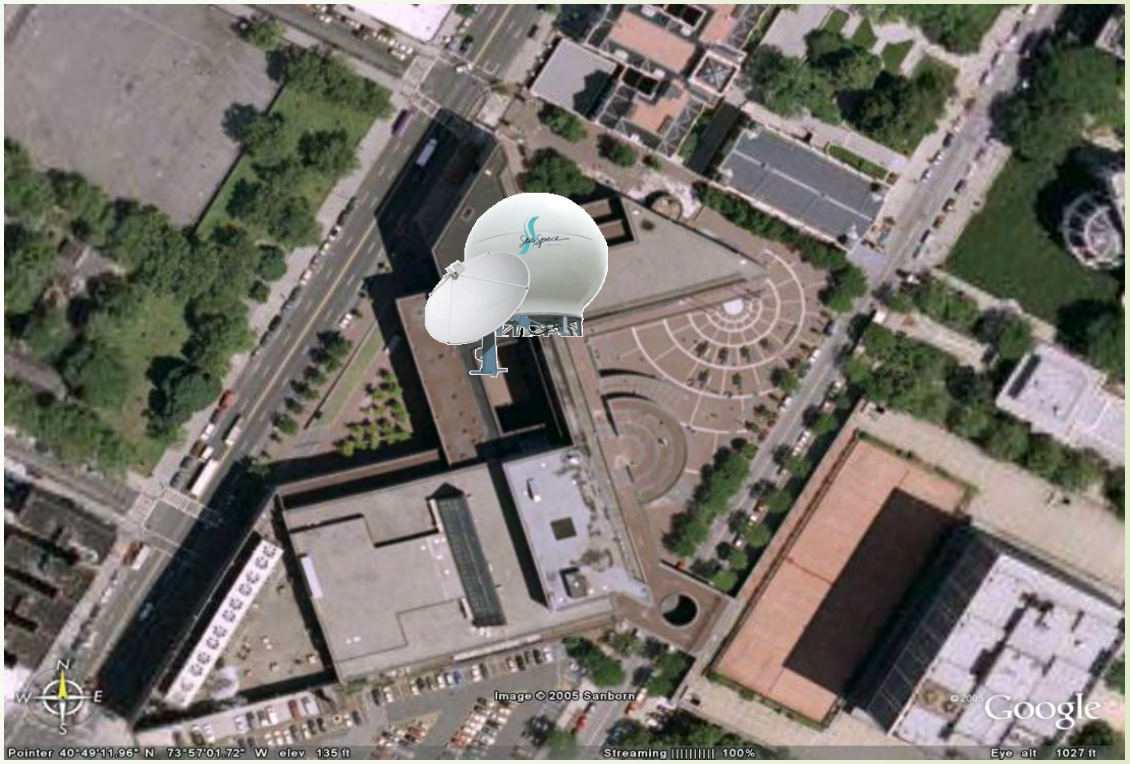
The mobile Doppler Lidar system was installed in MEMLAB (Mobile Environmental Measurements Lab)

Transmitter		Receiver	
Laser	Q-Switched Nd: YAG Continuum Surelite II-10	Telescope Aperture	CM_1400 Schmidt-Cassegrian telescope 14 " (35.56 mm)
Wavelength	1064, 532, 355, 266 nm	Focal length	153.9 " (3910 mm)
Energy/pulse	650 mJ at 1064 nm 300 mJ at 532 nm 100 mJ at 355 nm	Detectors 532 nm 355 nm 1064 nm	Hamamatsu PMT: R758-10 PMT: R758-10 APD
Pulse Duration	7 ns at 1064 nm	Data acquisition	LICEL TR 40-160
Repetition rate	10 Hz	Photon Counter	LICEL TR 40-160
Harmonic Generator	Surelite Double (SLD) Surelite Third Harmonic (SLF)		

New Satellite Data Acquisition Unit



Second stage:



Convent Ave.

NAC building roof

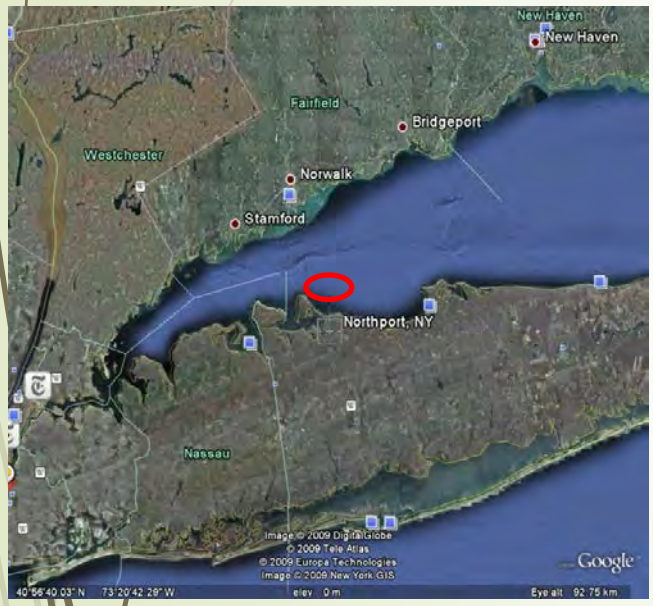
Satellite Earth Observation System

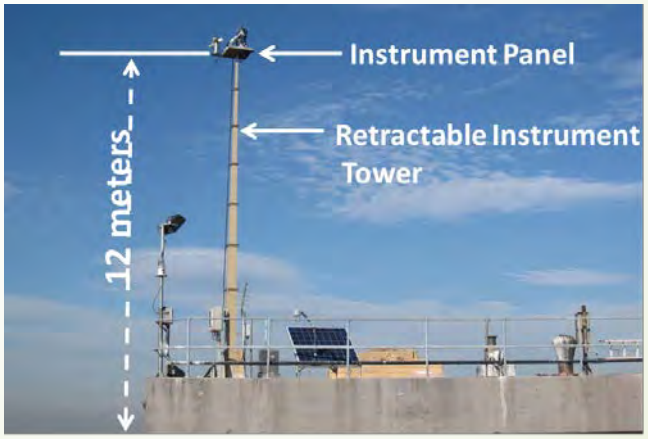
The Satellite Receiving Station is a key component of CREST research . SRS is primarily responsible to acquiring, storing and algorithm processing of all satellite related products.

The Receiving Station currently has 2 antenna and a vast array of data collecting equipment and algorithms for polar and geostationary satellite as well as ground-based field measurement and LIDAR networks.

Long Island Sound Coastal Observatory (LISCO)

Platform: Collocated multispectral **SeaPRISM** hyperspectral **HyperSAS** instrumentations Since October 2009





The platform combines an AERONET SeaPRISM radiometer and CIMEL Electronique as a part of AERONET Ocean Color Network, with a co-located HyperSAS set of radiometers capable of hyperspectral measurements of water-leaving radiance, sky radiance and down-welling irradiance. SeaPRISM data are transferred by the satellite link to NASA.

LISCO Instrumentation

SeaPRISM instrument

- Sea Radiance
- Direct Sun Radiance and Sky Radiance
- Bands: 413, 443, 490, 551, 668, 870 and 1018 nm

HyperSAS Instrument

- Sea Radiance
- Sky Radiance
- Downwelling Irradiance
- Linear Polarization measurements
- Hyperspectral: 180 wavelengths [305,900] nm

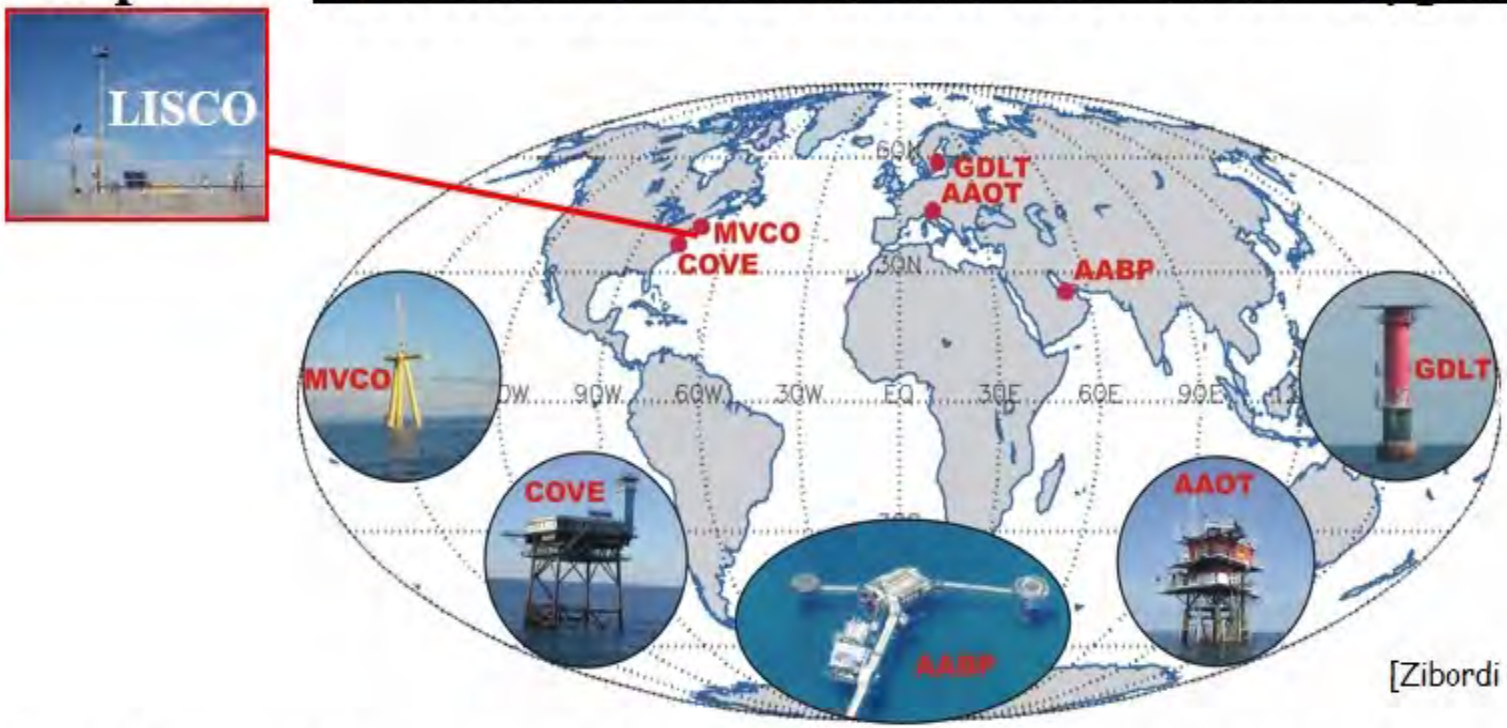
Water Quality Monitor (WQM)

- Measure: temperature, salinity, depth, dissolved oxygen, chlorophyll, turbidity and attenuation data.

Data acquisition every 30 minutes for high time resolution time series

LISCO Site Characteristics

LISCO Multispectral SeaPRISM system
as part of AERONET – Ocean Color network +HyperSAS



[Zibordi et al., 2006]

- Identical measuring systems and protocols, calibrated using a single reference source and method, and processed with the same code;

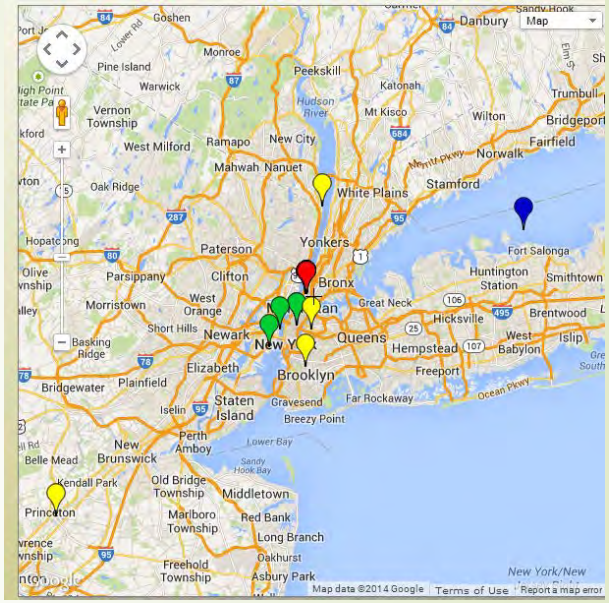
→ **Standardized products of exact normalized water-leaving radiance and aerosol optical thickness**

Chesapeake Bay campaign: Aug 2013

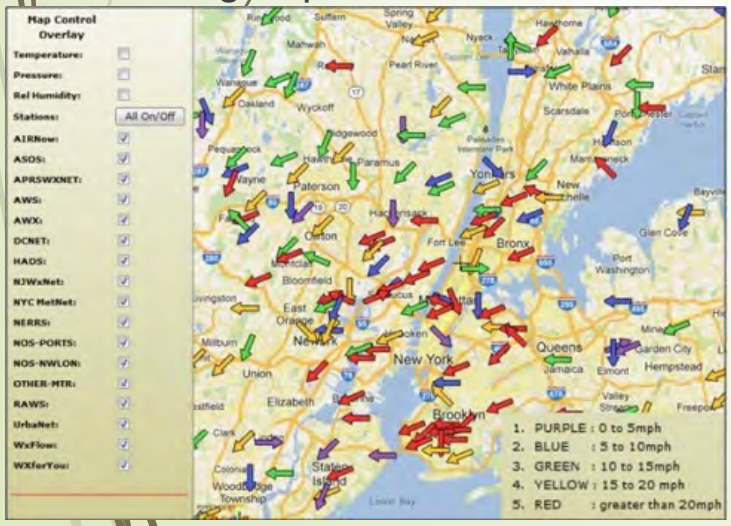
Instrumentation: in-water and above water reflectance, water optical properties, PSD, water samples, ALFA for underway measurements

NYCMetNet, CCNY

- NYCMetNet provides latest meteorological observations in and around The New York metropolitan area (NYC).
- Observations are updated every 15 minutes to better characterize meteorological conditions within the NYC urban environment.
- Surface observations consist, in part, of near real-time atmospheric pressure, relative humidity, temperature, wind direction, wind speed, rain rate, and total rain accumulation measurements at building-top sites.



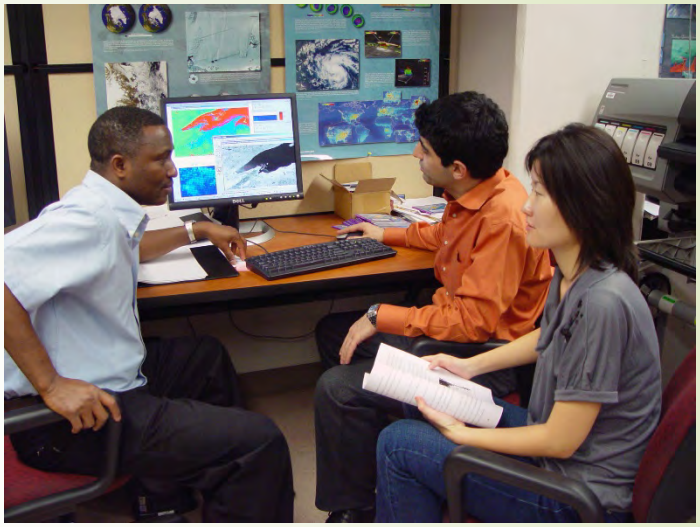
Location of Met Station

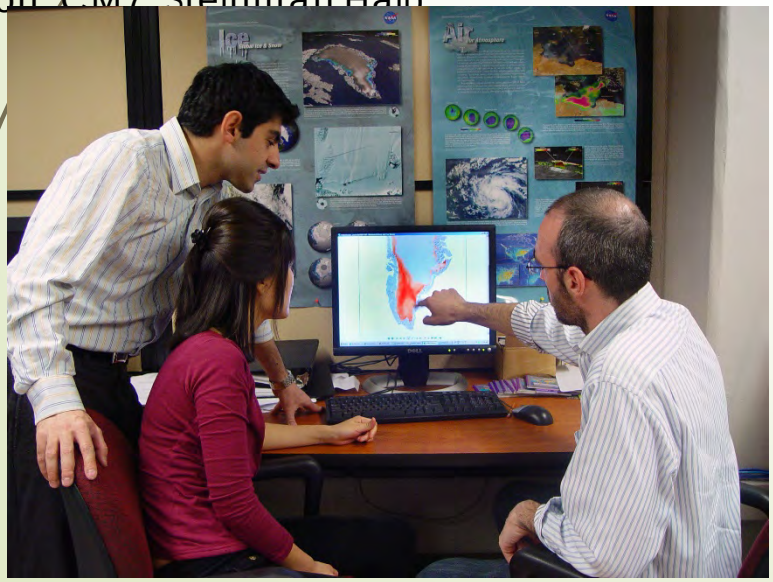


Sustained wind speed and direction

Environmental Remote Sensing and Image Processing Laboratory (ERSL) at The City College of New York

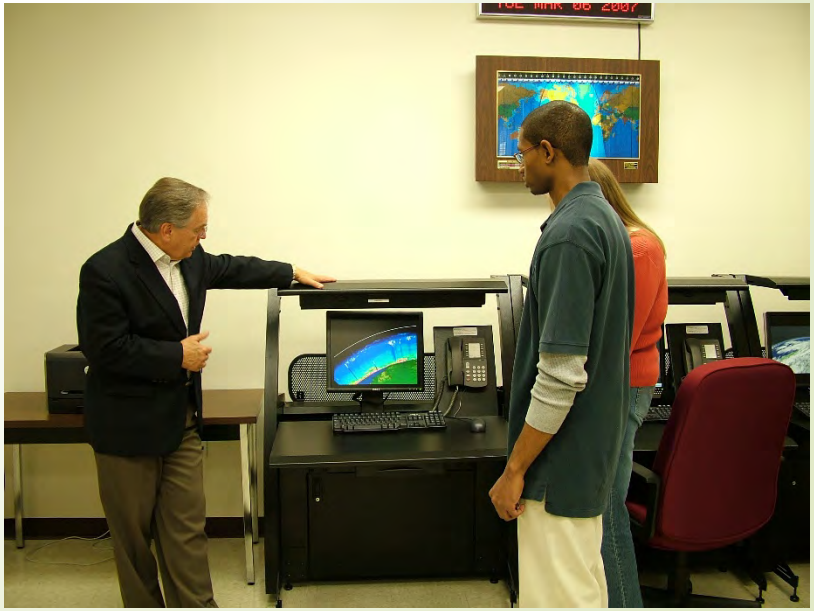
- ERSL provides facilities and resources for instruction and research in the areas of environmental remote sensing and spatial data processing using the state-of-the-art capabilities for image processing, mapping, modeling, statistical analysis, and visualization.
- The ERSL utilizes both PC and UNIX workstation computers that include software for image processing and analysis, as well as a wide array of input-output devices including digitizers, image scanners, and large format color plotters (Lab Location: CM7, Steinman Hall)





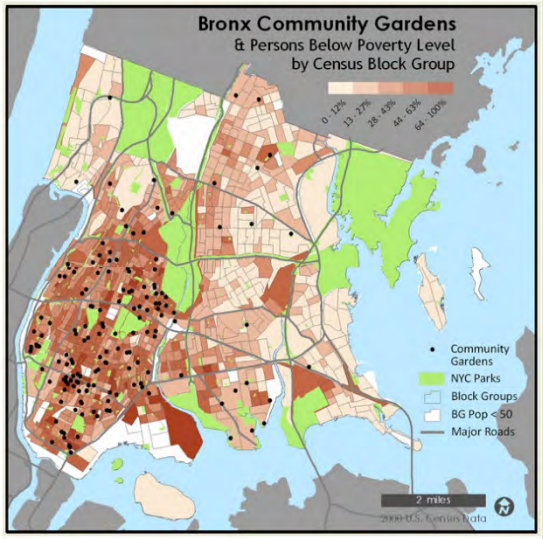
CALIPSO Workstation, Hampton University

- CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) Workstation is located at Hampton University. CALIPSO was developed in part by Hampton University and launched by NASA in 2006.
- The objective of CALIPSO is to improve our understanding of the global climate, hurricanes and temperature changes.
- Prof. Patrick McCormick is co-principal investigator for the satellite experiment CALIPSO.

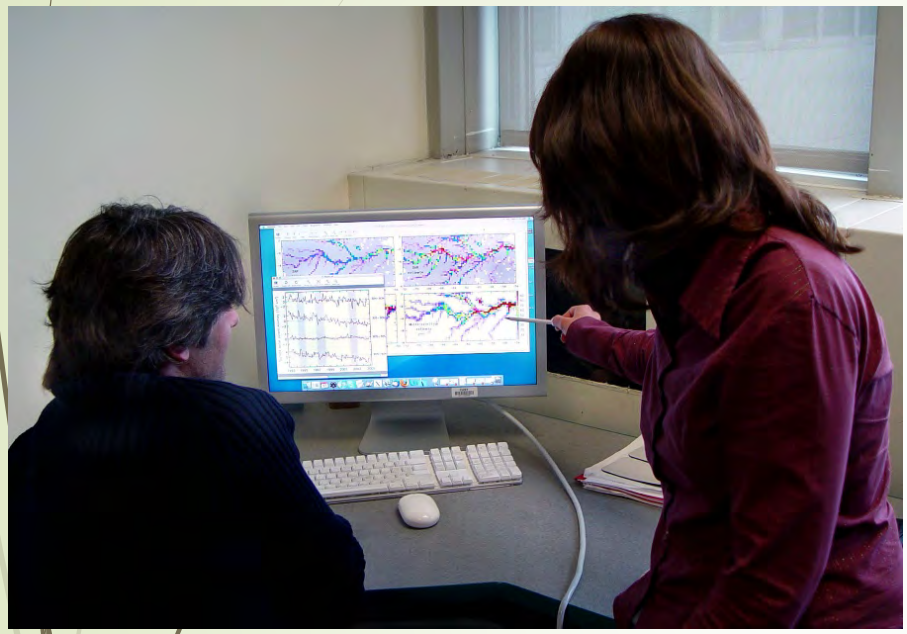


The Urban GISc Lab at Lehman College

- The Urban GISc Lab focuses on exploring the urban environment through Geographic Information Science.
- Current research areas include spatial analyses of urban environmental burdens, environmental justice, health disparities, health and the built environment, urban demographics, hazard and risk assessments, and the connections between social and environmental conditions.

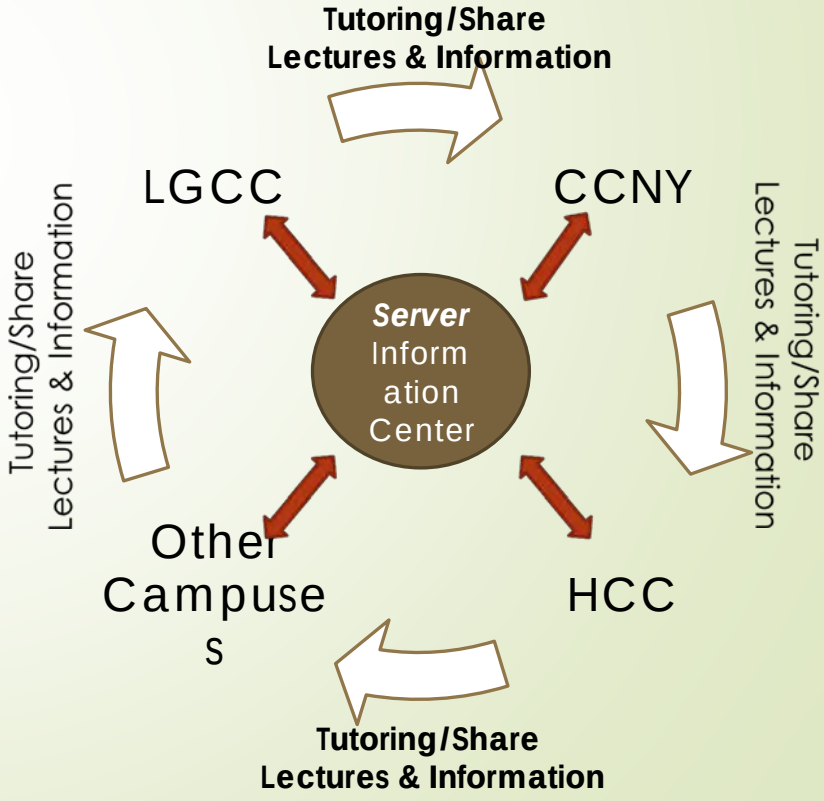


GEWEX ISSCP Global Climate Data Processing Lab



CREST-CILES STEM Labs

These spaces will serve as a common meeting place for students to continue their learning via study groups, or to receive support via multi-campus tutoring. By using the new developed ***Early alert system tool***.

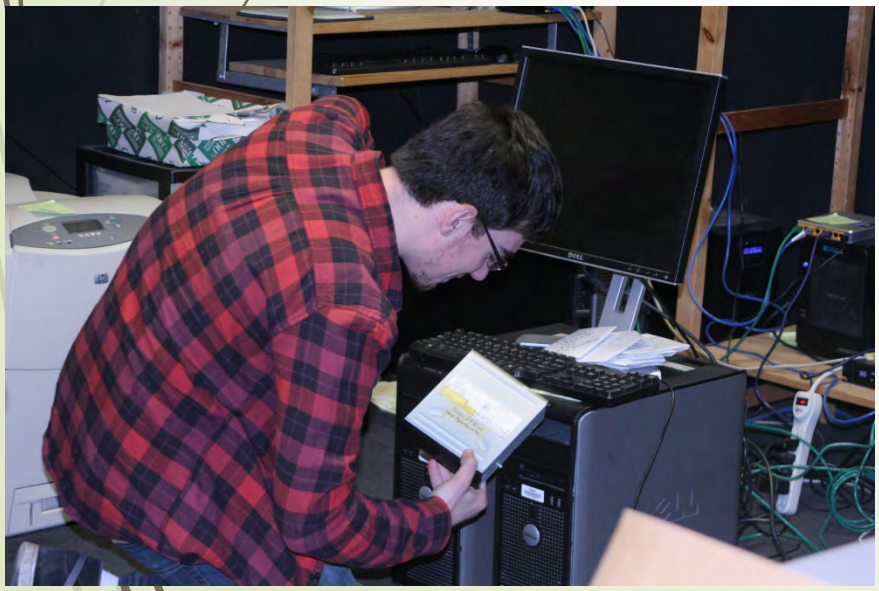


Mid Infrared Diagnostics Lab

- A Mid Infrared Diagnostics Lab for testing sensor characteristics and casings
- Funded by Northrup Grumman
- ISO 10000 clean room facility is used
- Supports Industrial and Military Work to insure systems meet stringent specifications and diagnose imperfections.

The Graphics Learning and Smart Sensing Lab (GLASSlab) and Computational Science of Data-Intensive Remote Sensing (CSDIRS) Labs

- **GLASSlab** and **CSDIRS** provide opportunities for students to get experience with data analysis, and machine learning applied to remote sensing and climate data. Students are creating private computational clouds out of machine clusters.
- Working with the latest data clustering and classification methods and building multidimensional visualizations. NOAA support has funded servers, networking equipment, workstations, and large storage repositories.



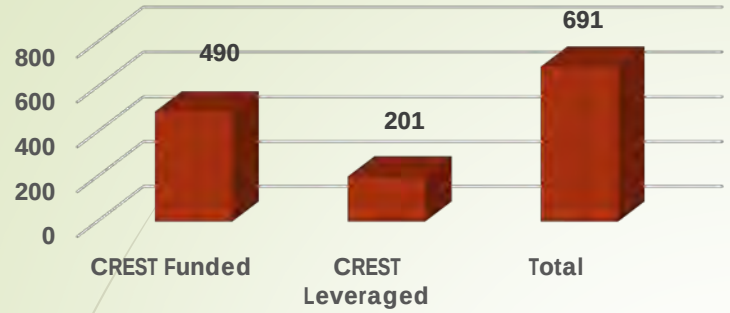
Ecosystem Remote Sensing Laboratory

This new Remote Sensing lab is under development by **Prof. Kyle McDonald, Earth and Atmospheric Science, Science Division** for ground measurements and validation of remote sensing datasets on terrestrial ecosystem dynamics and the carbon and water cycles.

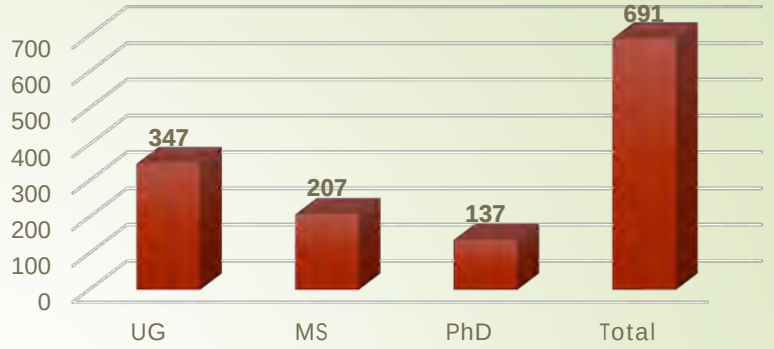
The instruments:

- Field gear supporting ecosystem parameter measurements.
- Dragonfly remotely controlled helicopter, Ocean Optics and ASD Field spec spectrometers
- Valeport Model 106 Current Meter
- Hobo water Level Data Logger
- HP XW9400 Workstation

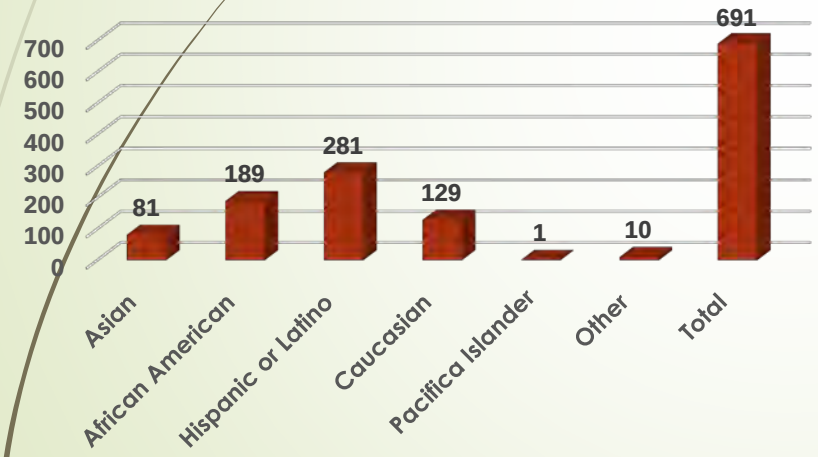
By Funding Status



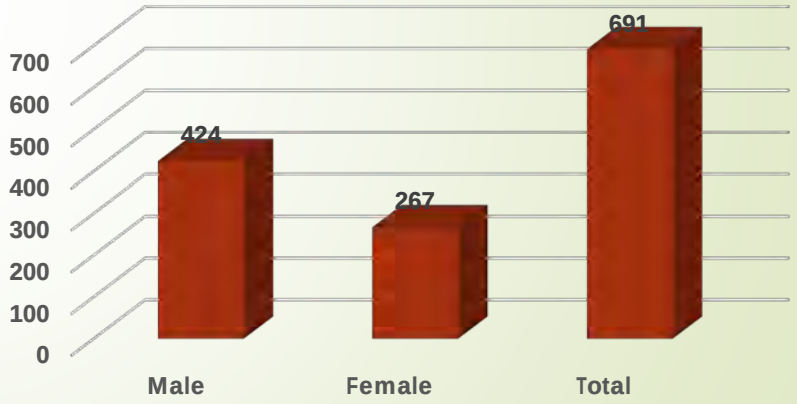
By Degree



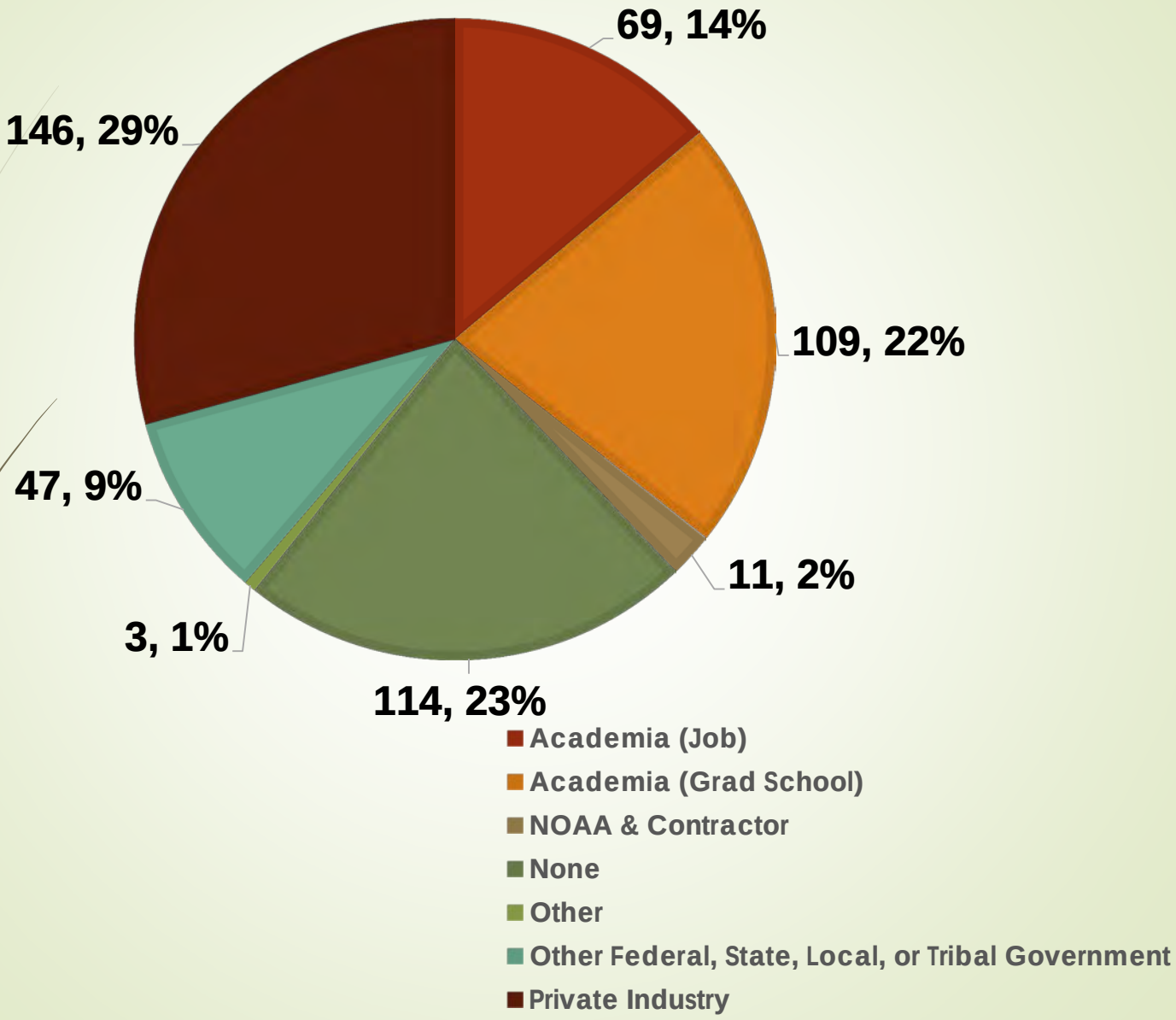
By Ethnicity



By Gender



POST-GRADUATE PROFILE - SINCE 2001



Two-Year Master's Degree Programs

Earth Systems & Environmental Science & Technology

Started in Fall 2013

Enrolled – 9 Students in Spring 2014

Expected to increase to 15 in Fall 2014

With one track on PSM Professional Science Masters Degree

- **Key Courses**
  - Water Resources Engineering Management
  - Climate and Remote Sensing
  - Geo-informatics and GIS

  - Internships with NYSDEC
  - NOAA (past Corp Officer
  - CUNY Building Performance Lab, NY
  - Turner Construction Company, NY

CREST partnership with NESDIS-CIs

Cooperative Institute for Climate Studies

- University of Maryland, College Park, MD

Some of the tasks through CICS

GOES-R3

- *Improving Monitoring of Tropical Forests and their Characterization in NCEP Models Using GOES-R ABI Land Products*
- *Development of Algorithm & Software to Validate Snow Cover Product from VIIRS NPP*
- *Uniform Multi-Sensor Algorithms for Consistent Products: Snow Cover*
- *Development of an Upgraded Southern Hemisphere Automated Snow/Ice Product*
- *Cloud-top Relief Spatial Displacement Adjustments for GOES-R Images*:
- *Development of validation tools and proxy data for GOES-R ABI Air Quality Proving Ground for the Northeast (NY Metro Region)*
- *Quantitative Image Restoration*
- *Convective Storm Forecasting 1-6 Hours Prior to Initiation*

- NOAA Collaborators - Ralph Ferraro (CICS/STAR) Andy Heidinger (NESDIS/CIMSS); Bob Rabin (NOAA/NSSL/CIMSS); Bob Kuligowski (NOAA/NESDIS/STAR); Al Powell (NOAA/NESDIS/STAR); Ingrid Guch (NOAA/NESDIS/STAR); Mitch Goldberg (NOAA/NESDIS/STAR); Jeff Key (NESDIS/CIMSS); Ivan Csiszar (NOAA/NESDIS/STAR and many others....

CREST partnership with NESDIS-CIs

Other Projects:

- *Analysis and Validation of Snowpack Grain Size, Density and Temperature using Snow Physical Model*:
- *CICS Support to the NESDIS Cooperative Research Exchange Program*: River Ice
- *NOAA-CREST Land Emissivity Products from Passive Microwave Observations*
- *Early Career Summer Exchange Program*:

JPSS:

- *Assessment of Assimilating NPP/JPSS ATMS Land Surface Sensitive Observations in the NOAA Data Assimilation System*
- *Coastal Site Data Uncertainties and In situ Validation*
- *Development of Neural Network algorithms for retrieval of chlorophyll-a in the Chesapeake Bay and other coastal waters based on JPSS-VIIRS bands*

Climate- NCDC tasks

Completing the Research-to-Operations Transition of the International Satellite Cloud Climatology Project (ISCCP) **(CICS/NC – NOAA Collaborator - Jeff Privette)**

Best Practices –NESDIS/STAR-CREST engagement (since 2011)

- **Weekly/monthly Brown bags** –
- initiated among all four NOAA/EPP/CSCs (CREST; NCAS; ECSC and LMRCSC)
  - Share the best practices
  - Inter-CSC collaborations
- **Monthly Brown bags between NESDIS/STAR and CREST**
  - Increase research collaborations
  - Joint publications
  - Experiential opportunities – for students mentored by NOAA Scientists – through NOAA-EPP (SSIO – Students Summer Internship Opportunities)
- **Post Doctoral Development Plan**
  - **Daniel Comarazamy** – is now collocated in the NOAA/NESDIS/STAR – NCWCP and a contractor for STAR
  - **Soe Hlaing** –worked with NESDIS/STAR/Menghua Wang now in US Patents Office
- **Experiential Summer Internship Opportunities – Early Career Exchange**

  Equisha Glenn – NESDIS/STAR, MD (**going on to PhD at CCNY/CREST**)

  Nazmi Chowdhary – NESDIS SSIO (2015 with Shobha Kondragunta now job with Nobilis)

  Nazia Shah – NESDIS/STAR SSIO (2015) with Ralph Ferraro

  Andrea Gomex, NESDIS/STAR/ SSIO (2015) with Mark Eakin (Coral Reef Watch)