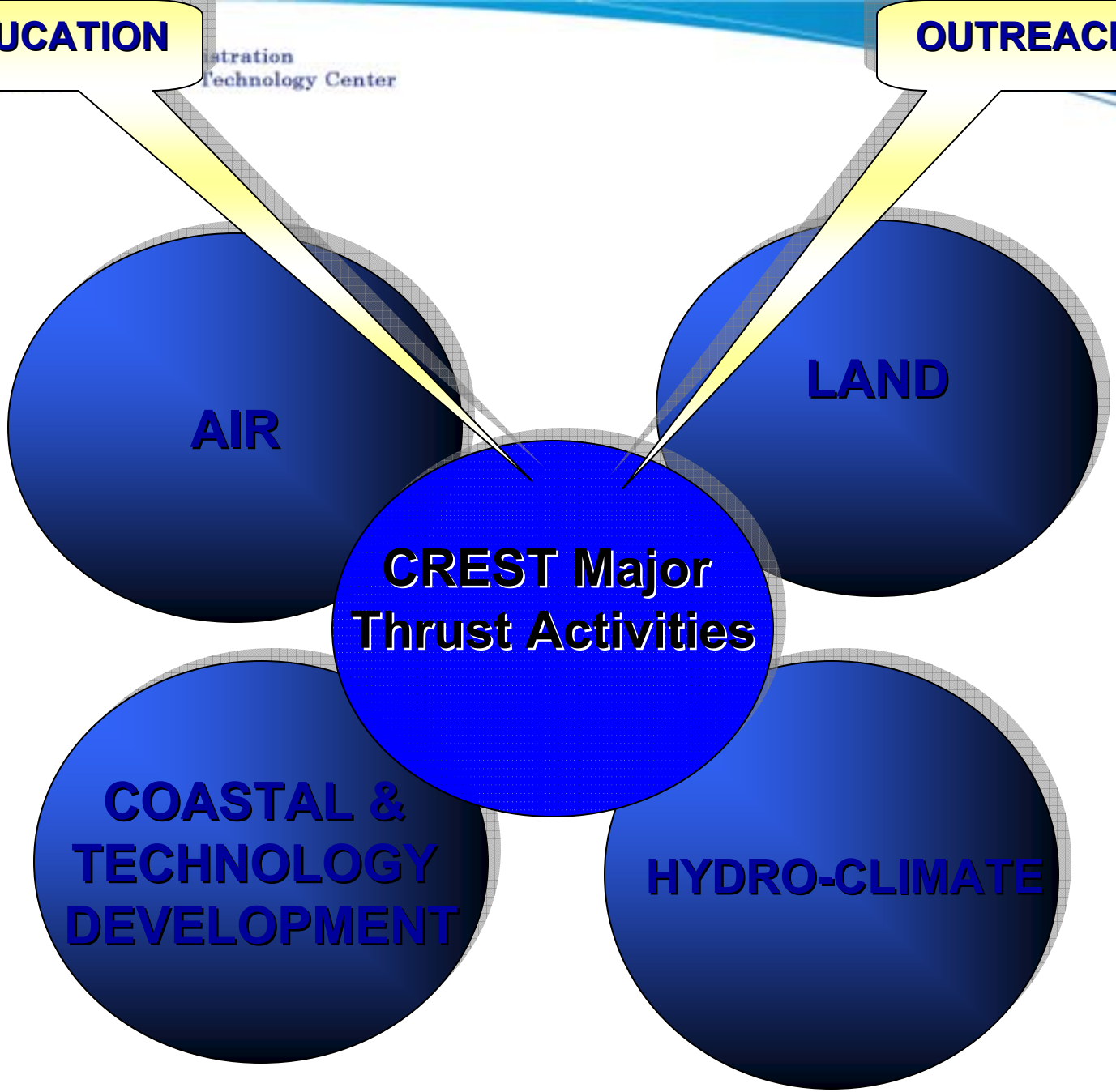
# NOAA-CREST Institutional Members

- CUNY City College
- University of Puerto Rico, Mayaguez
- CUNY Lehman College
- CUNY Bronx Community College
- Columbia University
- University of Maryland - Baltimore County
- Bowie State University-Maryland
- Hampton University-Virginia
- Raytheon, and other Industrial Partners


EDUCATION
OUTREACH
AIR
LAND
CREST Major Thrust Activities
COASTAL & TECHNOLOGY DEVELOPMENT
HYDRO-CLIMATE

## AIR

- Stratosphere
  - Ozone/Aerosols
- Troposphere
  - Air Quality
  - Aerosol Speciation
  - Impacts/Health

## Coastal & Technology Development

- Optical Techniques in Coastal Measurements
- Data Compression
- Satellite Data Mining and Processing Unit

## Land & Hydrology

- Soil Moisture
- Snow-Cover
- Vegetation

## Hydro-Climate

- Precipitation (Snowfall and Rainfall)
- Validation
- Climate Change
- Nowcasting

| NOAA / CREST | NOAA Strategic Missions | | | | |
|---|---|---|---|---|---|
| | Ecosystem | Climate | Weather and Water | Commerce and Transportation | Provide Critical Support to NOAA's Mission |
| **Stratosphere** | | * | | | |
| **Troposphere** | | * | * | | |
| **Land & Hydro-Climate** | * | | * | | |
| **Coastal Waters & Technology Development** | * | | * | | * |

| CREST | NOAA Line Offices Missions | | |
|---|---|---|---|
| | NESDIS | NWS | NOS |
| Stratosphere | 1. Satellite Services Program<br>2. Climate Observation Analysis | 1. To understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond | |
| Troposphere | 1. Weather & Water Science Technology<br>2. Infusion Program through Algorithm Refinement for Current Satellite Instruments & Algorithm Development for future Instruments<br>3. Climate Missions | | |
| Land & Hydro-Climate | 1. Weather & Water Science Technology<br>2. Infusion Program through Algorithm Refinement for Current Satellite Instruments<br>3. Climate Missions | 1. Serve Society's needs for Weather and Water Information | |
| Coastal Research & Technology Development | 1. Integrated Observing and Data Management System | | 1. Manage Coastal Resources to optimize benefits to the Environment, the Economy and Public Safety |

CREST also has active research collaborations with OAR/ETL, NOAA

# CREST TRAQ

## Tropospheric Remote Sensing and Air Quality Monitoring

# *TRAQ GOALS*

1. Establishment of an urban and regional testbed facilitating access to measurements, models, and data archives

2. Demonstration of an integrated multi-sensor, 3D measurement strategy based on CREST's regional facilities (lidar, etc) and bootstrapping on existing/planned meteorological and air sampling networks.

3. Improvement of methods for using current and future satellite measurements in air quality forecasting (MODIS, MISR, CALIPSO, APS, VIIRS, GOES-R , etc.).

## Satellite Algorithm Development and Validation

Application of satellite monitoring to air quality requires estimation of surface concentrations of pollutants from satellite products

## Ground Based Remote Sensing Network

Producing refined urban/regional aerosol products using integrated Satellite/ground-based observations

## Ground Based *In-situ* Measurements, Sampling, and Sample Analysis and Speciation

Relating column and vertical profiles of aerosols, ozone, and other trace gas measurements to surface concentrations

## Modeling and Validation

Regional CMAQ validation-Evaluation of receptor models- Transport modeling

## Health Impacts

Asthma and Air Pollution

***Optical Remote Sensing Group***
***City College of the City University of New York***

## Faculty

***Barry Gross***
***Fred Moshary***
***Sam Ahmed***
***Stanley Gedzelman***
***Reginald Blake***

## Collaborations

***Mike Hardesty*** *ESRL*
***Shobha Kondragunta*** *NESDIS*
***Brian Cairns*** *NASA GISS*
***Pat Lavin*** *DEC*
***Gopal Sistla*** *DEC*

***Postdoc*** *Yunghua Wu*

***Students:*** *Miguel Bustamante*, Yasser Hassebo*, Leona Charles, Ben Herman, Shukie Chaw*, and Viviana Vladutescu*

# Issues with Satellite Derived AOD Product

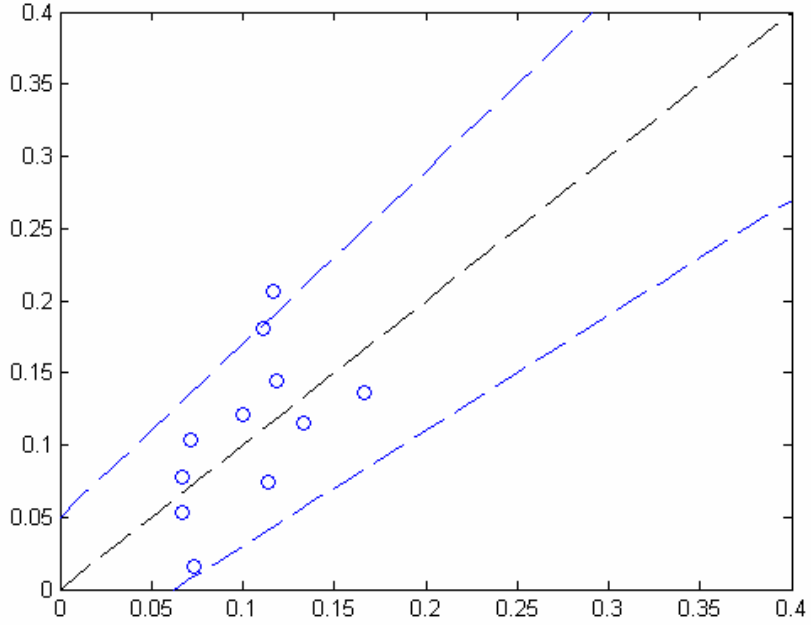
## Inherent Biases

## Need for Multi-sensor Data Fusion

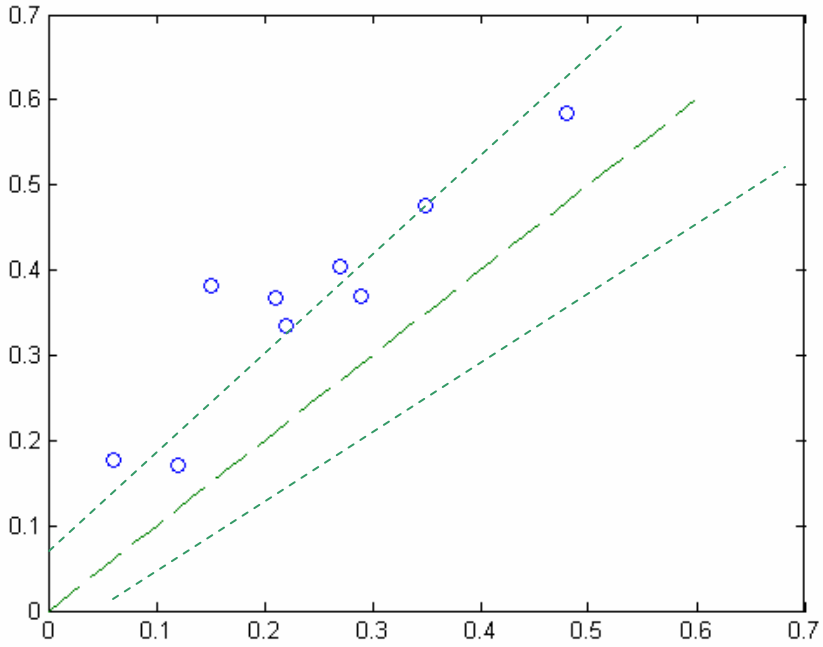
# Intercomparision between Sky radiometer and Satellite AOT

$\tau_{MODIS}$

CART Site




CCNY Site




$\tau_{CIMEL}$

Non urban sites seem to be well tracked by MODIS within error bars
However, MODIS overestimates optical depth for NYC

# Issues with Satellite Derived AOD Product

## Column vs. Surface Measurements

## Need for vertical profiles

# CCNY Lidar Observaory

**Transmitter:**
Coherent Infinity Nd:YAG
30 Hz Rep rate
1064, 532, and 355 nm Back Scatter
387 Raman
>100 mj/pulse at 3ns pulse length

**Receiver:**
20” Dobsonian, f/# 3.5
Hamamatsu PMTs, EGG APD

**Data Acquisition:**
4 Channel Licel transient digitizer/
Multichannel Scalar
(12 bit A/D+Photon Counting)

**Protection Radar System**

**CIMEL**
**Sky Radiometer**
**AERONET**
**NASA/GSFC**

# Expanding CREST Observation Capabilities

The NOAA-CREST Weather Center at CCNY - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites

Address http://earth.engr.ccny.cuny.edu/noaa/wc/index.html Go Links

# NOAA-CREST Weather Center at City College of New York

WEATHER DATA
Real-Time
Current
Daily Trends
Report Archive
INSTRUMENTS
Lidar & Images
Ceilometer
Shadowband
Water Vapor
Total Sky Imager
Nephelometer
Sun Photometer
DOCUMENTATION
NE Weather Stations
Policies & Errata
Data Definitions
Sensor Specs
LINKS
Instrument Site Maps
Tools and Other Info
Weather Forcast
Magnetic Dec Calc
Solar Calculator

The NOAA-CREST weather station is located on the roof of the Marshak Science Building. It has been gathering data continuously since it began operation on 12 December, 2003. The station's sensor array collects data in one-minute cycles controlled by the program resident in a datalogger at the site. The datalogger is polled and the information downloaded to the host computer in the Steinman Hall Engineering Building via the campus internet.

Archived data is available for research purposes in tabular format both with and without headings, and the same data is published to this NOAA-CREST web site. Data includes wind speed, direction and their vectors; air, dew point, wet bulb, heat index and wind chill temperatures; relative humidity; air pressure; rain; plant trans-evaporation and solar flux. Other instrumentation is located on the roof of the Steinman Engineering Building and the NAC Building (North Academic Center including the Student Center) on the CCNY campus. Several remote sensor sites are additionally located at associated academic campuses. You may click on above image to view the CCNY weather station installation.

The reference global position of the weather station instrument array is Longitude North

Applet Counter started

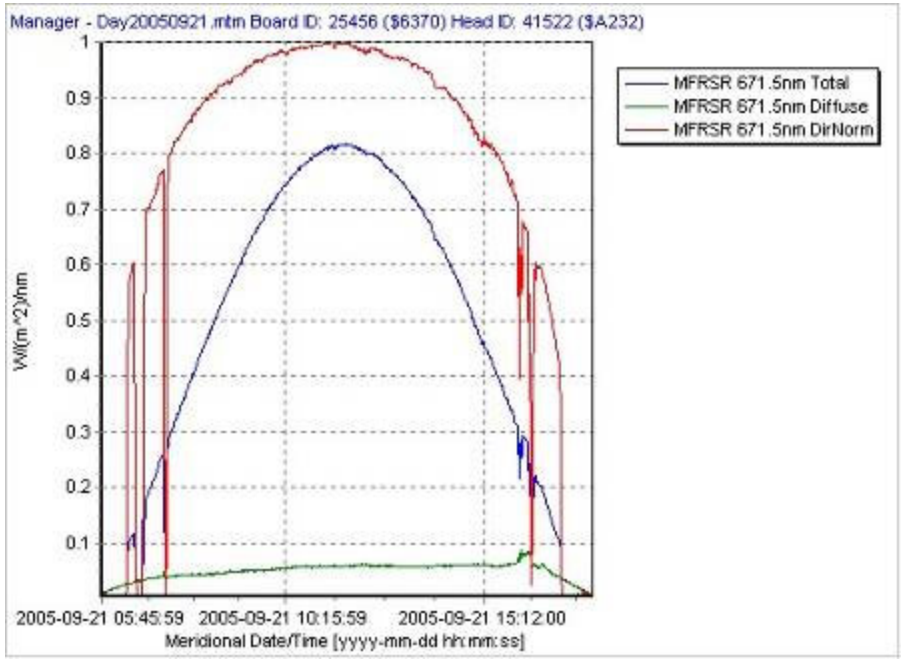
Internet

start NOAA_CREST_EA806 The NOAA-CREST W... 10:47 PM

# Truck Lidar System

## Princeton University, Princeton NJ

Transmitter: Continuum Nd:YAG 10Hz
1064, 532, and 355 nm
Receiver: 14” Caseggarian
Hamamatsu PMTs, EGG APD
Data Acquisition:
3 Channel Licel (12 bit A/D+Photon Counting)
Protection Radar System



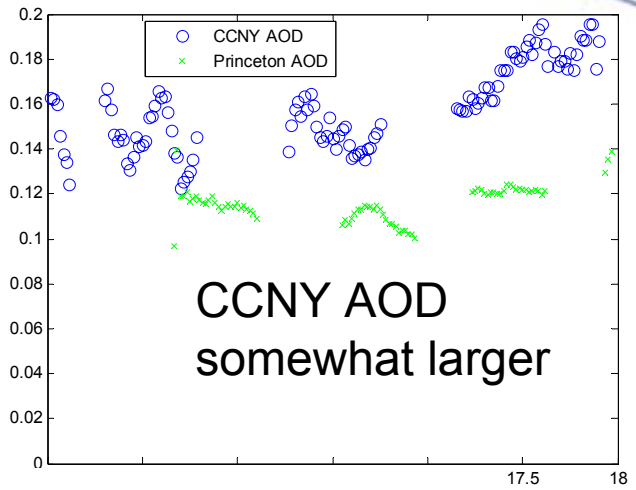

**Multifilter Rotating Shadowband Radiometer**

http://icerd.engr.ccny.cuny.edu/noaa/wc/index.html

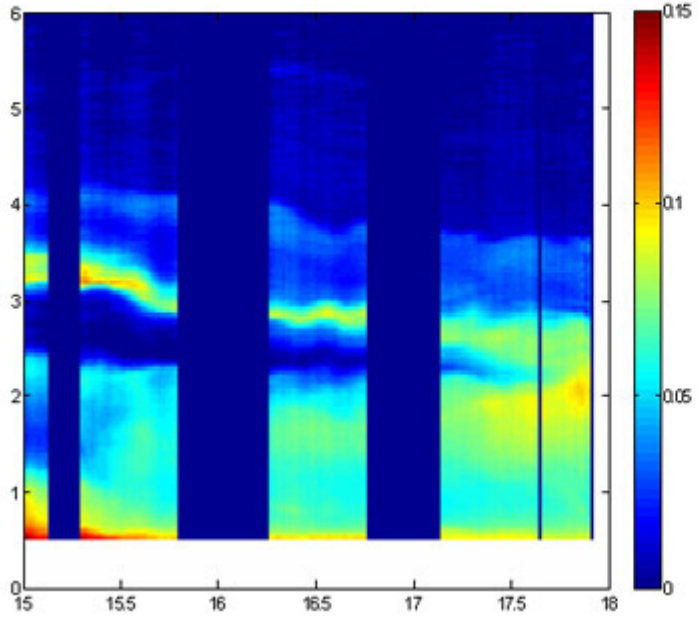
# April 11 Intercomparisons (AOD 532nm)

Much cleaner
Plume structure
over Princeton

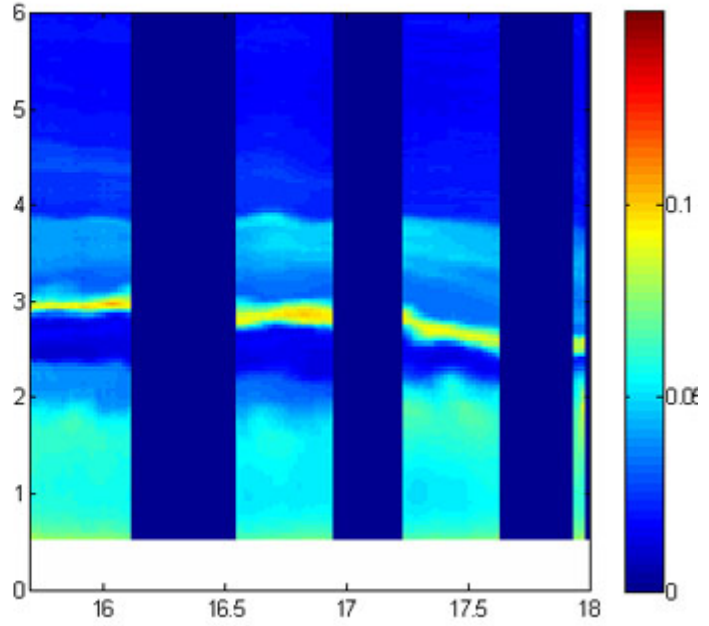
Note the increase in NYC
Extinction in low layer Local sources




CCNY



Princeton



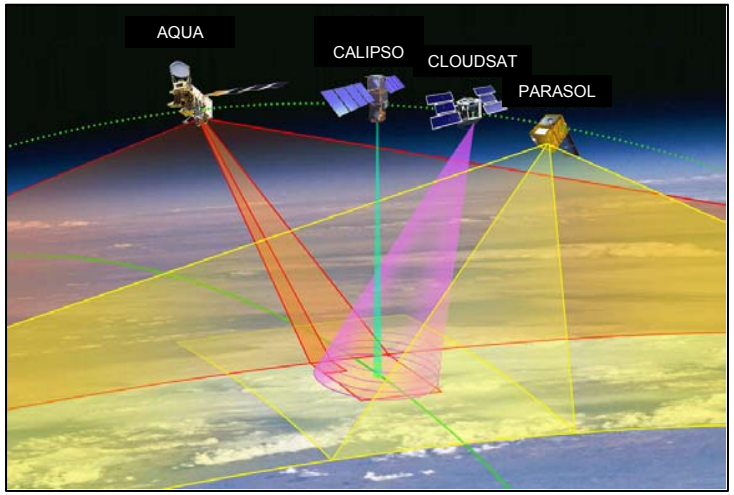
# New Ground Based Network


**MFRSR Network**

# New and Upcoming Opportunities

# CALIPSO Satellite lidar Mission

3 Channel Lidar: 1064 nm,
532 nm both Polarizations




CLIPSO Lidar can provide a snapshot of aerosol profiles along a longitudinal transect. Aerosol transport on the NE US can then be tracked by a few stationary lidars along prevailing winds to the East and North. This will provide a great source of data for validation of aerosol transport and air quality forecasts, and eventual assimilation into such forecast models.

National Oceanic and Atmospheric Administration
Cooperative Remote Sensing Science and Technology Center

NOAA CREST

THE CITY COLLEGE
OF THE CITY UNIVERSITY OF NEW YORK

# Coastal Remote Sensing


## Sam Ahmed

Herbert Kayser Professor of Electrical Engineering

The City College of the City University of New York


Team: Prof. S. Ahmed, F. Moshary, B. Gross, Dr. A. Gilerson

Students M. Oo, J. Zhou, M. Vargas, A. Mustapha, R. Fortich, R. Amin, I. Ioannou, K. Aran

# The Polarization Properties of Optical Scattering in Sea Water and their Impact on Bio-Optical Retrieval Algorithms

# Introduction

## Goal

Estimate the polarization properties of the water leaving radiance for different water compositions and conditions in the ocean and atmosphere using vector radiative transfer codes and assess their potential in the retrieval algorithms

# Motivation

- Polarization characteristics of the water leaving radiances are important in the retrieval of bio-optical parameters and mineral particles
- The modeling of the polarization signature is necessary to assess the levels of instrument errors
- A sufficiently polarized water leaving signal can be effectively processed to isolate the chlorophyll fluorescence from the elastic signal improving the data used in NIR algorithms

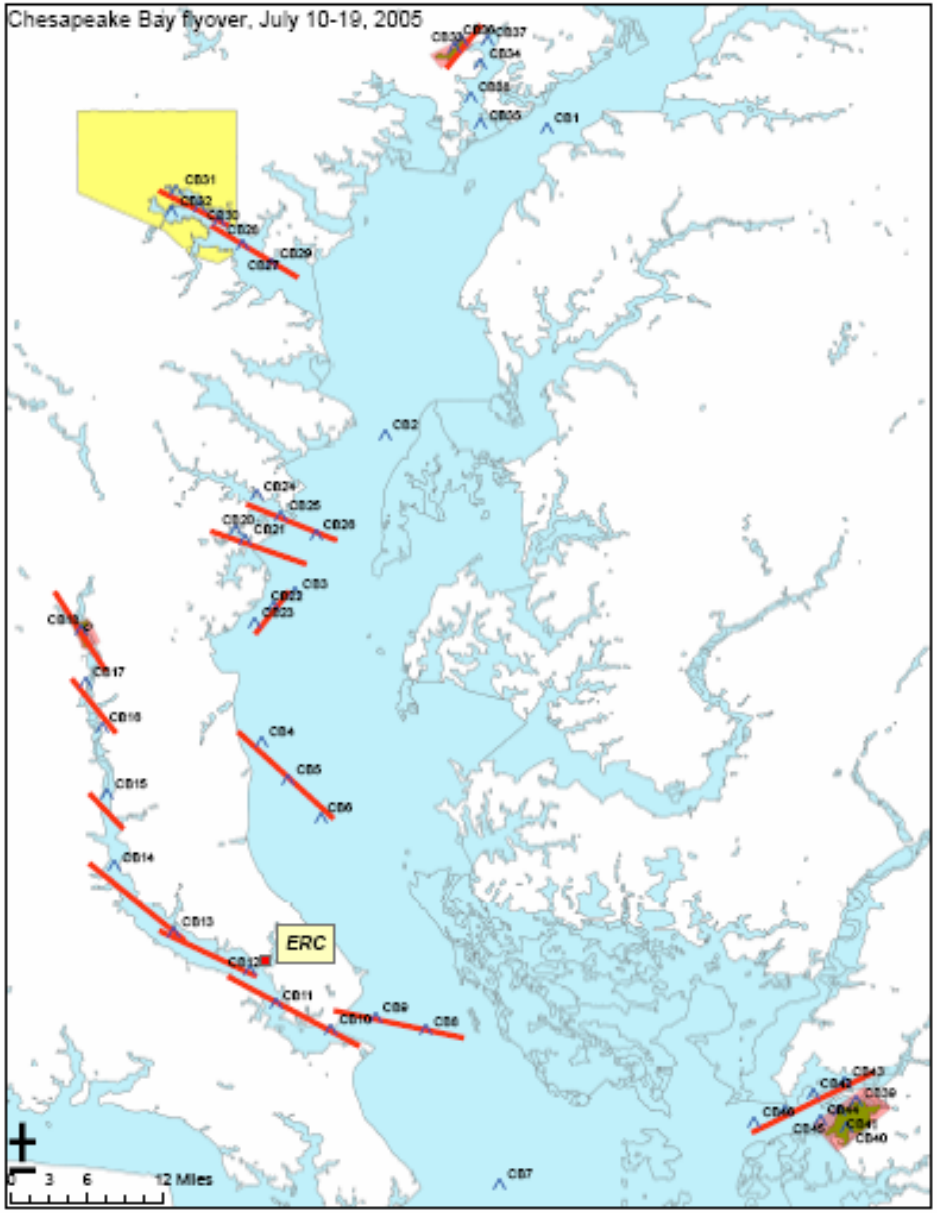
# Field Measurements in Chesapeake Bay

Main goal: set of measurements of biological and optical parameters of the waters in the bay, adjacent rivers and harbors with high variability of water constituents like phytoplankton (including algae blooms), CDOM, suspended solids with parameters measured using different instruments and techniques at the same time and location.

Set of instruments of CCNY team included:

- Wetlabs package for the measurements depths profiles of absorption, attenuation, scattering, backscattering, Chl concentrations, CDOM fluorescence, temperature and salinity.
- GER spectroradiometer for water reflectance measurements above and below water surface with the option of polarization components detection.
- Four channel polarization probe based on the Ocean Optics spectrometer for detection of polarization components of upwelling and downwelling radiances.

# Chesapeake Bay Campaign




Our partners – other teams:
Florida A&M University, Fl;
Creighton University, NE;
University of Nebraska, NE,
Morgan State University, MD

10 days, 46 stations

Measurements:
- Flyover of the Nebraska-Lincoln Piper Saratoga plane with the hyperspectral AISA sensor on board
- Laboratory and HPLC water analyses
- Water turbidity and Secchi disk diagnostics

# Conclusions

- "Fluorescence height" over baseline MODIS algorithm produces significant errors even with high fluorescence values corresponding to the high fluorescence efficiency. For case 2 waters with high mineral concentrations errors can result in more than 100% overestimation.
- Field measurements in Chesapeake Bay showed strong deviations of backscattering spectra from the power law and non – flatness of backscattering ratio spectra, more accurate assumptions are needed for retrieval models from reflectance spectra.
- NIR ratio algorithm for [Chl] retrieval is efficient for both simulated data set and Chesapeake data.
- For the most of the stations a general normalized specific absorption spectrum can be used in the retrieval algorithms

National Oceanic and Atmospheric Administration
Cooperative Remote Sensing Science and Technology Center

NOAA CREST

# Hydro-Climate Projects:

***at the City University of New York (CUNY), Hampton University (HU) and the University of Puerto Rico (UPRM)***

## "Precipitation Forecasting"

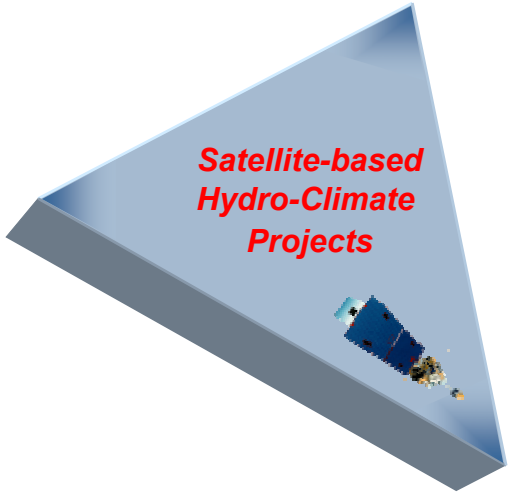
***at CUNY,***
***(NOAA-NESDIS, -NWS, -MDL, & OAR, & CIMMS)***

- ***Satellite-based Precipitation Nowcasting Capability for New York City Metropolitan Area,***

## "Precipitation Estimation"

***at CUNY,***
***(NOAA-NWS & -NESDIS)***

- ***Developing a Satellite-based Rainfall Retrieval Algorithm using Multi-Sensor IR & Lightening Data,***
- ***Developing a Multi-Spectral Remotely-Sensed Rainfall Retrieval Algorithm, using IR & MW Data,***
- ***Snowfall Rate Estimation from Multi-Sensor Satellite-based Data,***
- ***Improving Satellite IR-based Precipitation Estimates,*** **by** ***merging with NEXRAD,***




## "Validation of Rainfall Products"

***(NOAA-NWS & -NESDIS)***

- ***Validation of Satellite-based NESDIS Rainfall Products (CUNY),***
- ***Validation of Remotely Sensed Rainfall Estimates over Tropical Region (CUNY),***
- ***Validation of Satellite-based Rainfall Estimates for Tropical Severe Storms (CUNY),***
- ***Validation of NESDIS-HE over the NAME region (HU),***
- ***Validation of NESDIS Hydro-Estimator Algorithm (UPRM)***

# CREST Hydro-Climate Projects

## *Participants:*

### NOAA-CREST Scientists:

| | |
|---|---|
| *Dr. Shayesteh E. Mahani* | *CCNY- CUNY* |
| *Prof. Reza Khanbilvardi* | *CCNY- CUNY* |
| *Dr. Ismail Yucel* | *HU* |
| *Dr. Eric Harmsen* | *UPRM* |
| *Dr. Ramon Vasquez* | *UPRM* |
| *Dr. Arnold Gruber* | *UMD, CCNY* |

### Other NOAA Scientists:

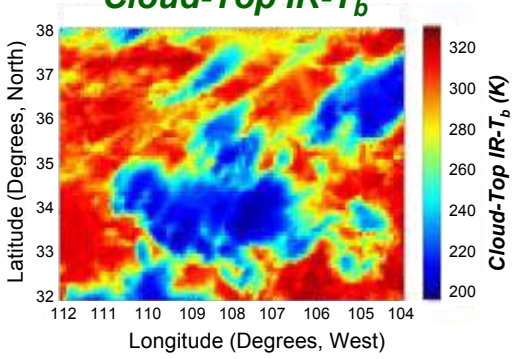
| | |
|---|---|
| *Dr. Bob Kuligowski* | *NESDIS* |
| *Mr. Ralph Ferraro* | *NESDIS* |
| *Dr. David Kitzmiller* | *NWS* |
| *Dr. Pedro Restrepo* | *NWS* |
| *Dr. Chandra Kondragunta* | *NWS* |
| *Dr. Mamoodou Ba* | *NOAA-MLD* |
| *Dr. Robert Rabin* | *NOAA-OAR* |
| *Dr. Vallippa Laksmann* | *CIMMS* |

# Developing a Satellite-based Rainfall Retrieval Algorithm using Multi-Sources IR & Lightening Data

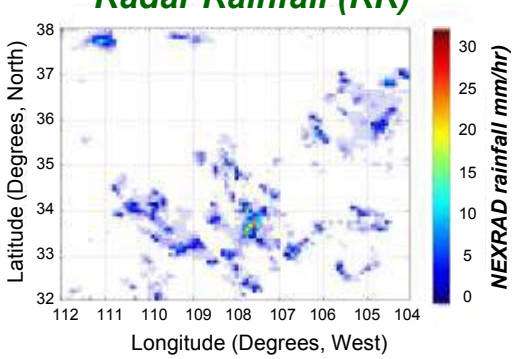
## OBJECTIVE:

**Developing an ANN-based rainfall retrieval algorithm using satellite IR-based cloud-top brightness temperature in conjunction with cloud-to-ground lightening (CGL), to improve high resolution remotely sensed precipitation estimates, particularly for convective and thunder storms.**

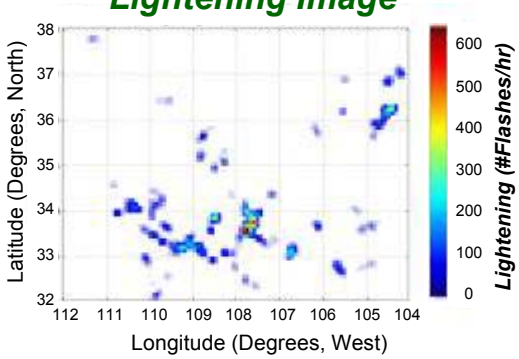
### Cloud-Top IR-$T_b$



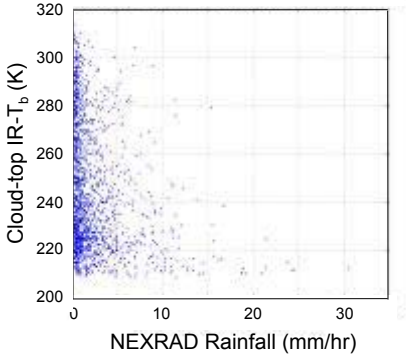

### Radar Rainfall (RR)



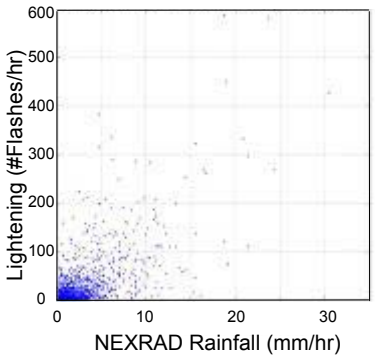

### Lightening Image



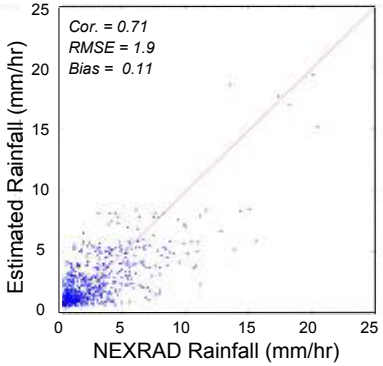

### IR-$T_b$ vs. RR




### Lightening vs. RR




### Model Esti. vs. RR (Input = IR + CGL)




## CONCLUSION:

- *CGL is correlated with RR more than IR,*
- *Using IR+CGL as model input improves rainfall estimates.*

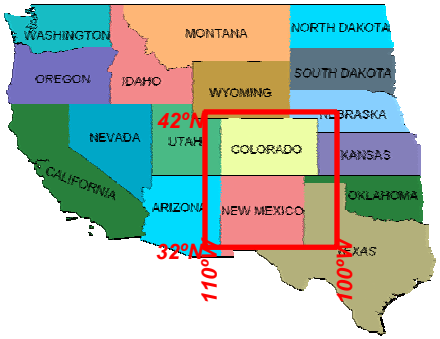
# Multi-Spectral Remotely Sensed Precipitation Estimation

## OBJECTIVE:

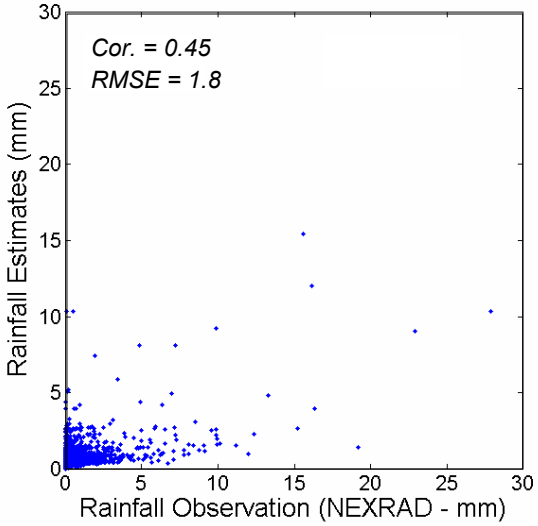
**The main objective of this study is to develop an ANN-based algorithm to improve satellite IR-based rainfall estimates using combination of cloud-top infrared (IR) from GOES and microwave (MW) brightness temperature from AMSU, at 0.25° x 0.25° resolution every few hours.**

**NEXRAD Stage-IV is used for training the model and rain gauge observation used for validation.**

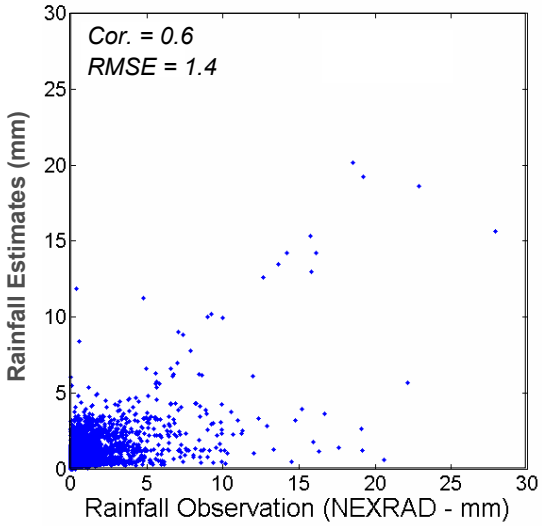
### Study Area




### Using IR (GOES)




### Using IR+MW$_{89\ \&\ 150}$




## CONCLUSION:

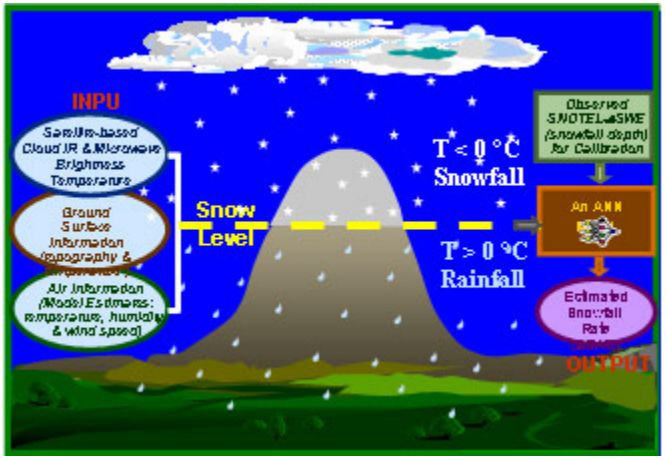
- ***Combining physical accuracy of microwave cloud properties (AMSU 89 & 150 GHz) with sampling and latency of IR cloud-top temperature could improve IR-based rainfall estimates.***
- ***Combination of MW (total column of ice (scattering) or water (emission) in conjunction with cloud-top IR-$T_b$ as model input improves rainfall rate estimates because amount of cloud ice/water strongly related to rain rate .***

# Multi-Sensor Remotely Sensed Snowfall Rate Estimation

## OBJECTIVE:

**Develop an ANN algorithm for estimating snowfall rate using multi spectral, infrared (IR) and microwave (MW), cloud properties in conjunction with ground surface and air information.**

### Snow Detection from Rain




## METHODOLOGY:

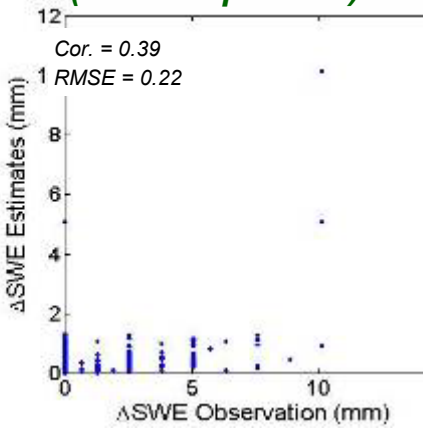
### *1) Snowfall Detection:*

**If max(daily($T_s$)) < 0°C, (Ts = surface temperature)**

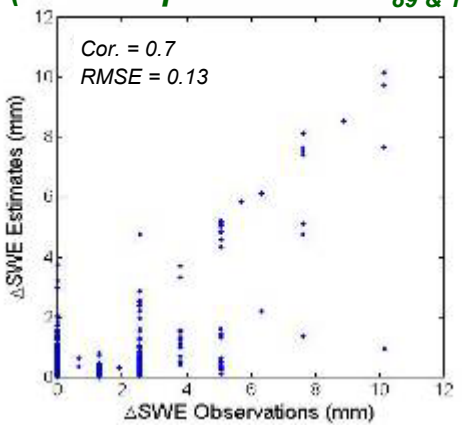
### *2) Snowfall Rate Estimation:*

**Using combination of MW and IR in conjunction with DEM and surface temperature, and some air information as input of an ANN approach.**

### *Model Estimates vs. ΔSWE (Model Input ≈ IR)*




### *Model Estimates vs. ΔSWE (Model Input ≈ IR + $MW_{89\ \&\ 150}$)*




## CONCLUSION:

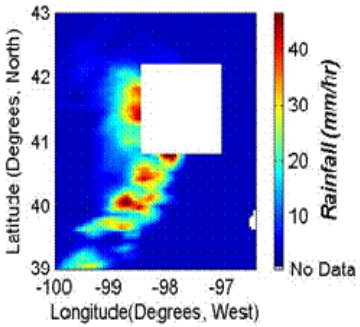
- ***High frequency MW (150.0 GHz) is sensitive to small ice particles and enhances detection of precipitation (rain/snow) over land,***
- ***Using combination of IR and MW (AMSU 89 & 150 GHz) as model input could improve snowfall rate estimates.***

# Improving Satellite-based Precipitation Estimates over the Radar Gap Area by Merging with NEXRAD

## OBJECTIVE:

**To develop an approach for coupling a remotely sensed rainfall retrieval model with a merging algorithm to combine satellite-based precipitation estimates (SPE) with NEXRAD Stage-IV data to generate more accurate rainfall over radar gap coverage. An area with different sizes over radar coverage has been selected as radar gap area to be able to compare generated product with NEXRAD rainfall. NEXRAD rainfall for selected gar area has not used in merging process.**

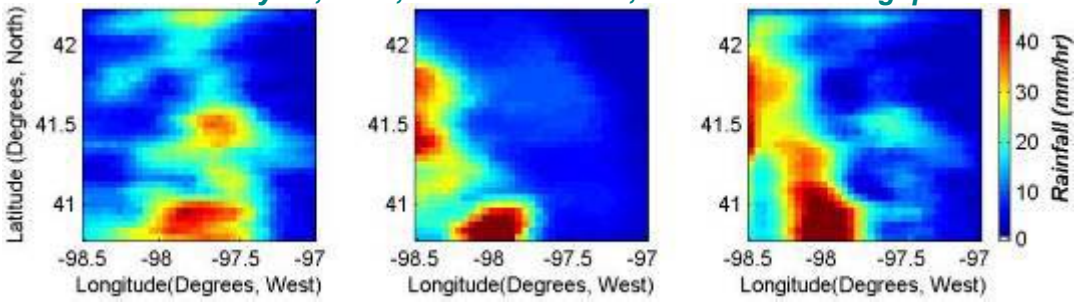
*Selected Radar Gap Area*



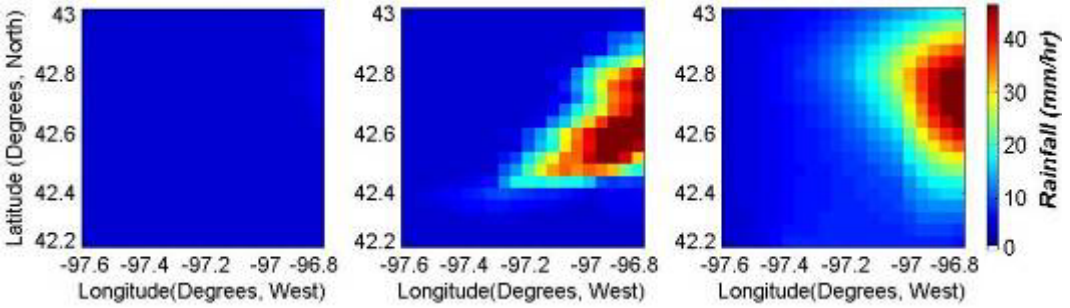

Merging SPE & NEXRAD

*HE Rainfall* *NEXRAD Rainfall* *Generated Rainfall*

*July 14, 2004, hour 03:00 UTC, for a 1.5° x 1.5° gap area*




*August 15, 2004, hour 16:00 UTC, for a 0.8° x 0.8° gap area*




## CONCLUSION:

- *The merging approach is capable of transferring NEXRAD information into the gap area from the neighboring pixels.*
- *NEXRAD rainfall is more correlated with the generated rainfall than satellite-based estimates.*

# Satellite-based Precipitation Nowcasting Capeability for New York City Metropolitan Area

Arnold Gruber, S. Mahani, R. Khanbilvardi, and 2 PhD Students, CUNY
NOAA-Collaborators: Bob Kuligowski (NOAA-NESDIS)
Stephan Smith and Mamoodou Ba, (NOAA-MDL)
Robert Rabin (NOAA-OAR) & Vallippa Laksmann (CIMMS)

## OBJECTIVE:

To develop a satellite based nowcasting capability for the New York City metropolitan area, which is the largest metropolitan area in the Nation. This developmental effort is consistent with the goals of the NOAA National Weather Service Meteorological Development Laboratory (MDL) and the NOAA NESDIS Office of Research and Applications Laboratory. NOAA is interested in utilizing the GOES satellite data in a nowcasting system to help forecasters do a better job in predicting severe or other significant weather events on spatial scales of kilometers and time scales of 1-2 hours. Furthermore, MDL would like to implement a nowcasting model into the AWIPS system for routine use by field meteorologists. and collective goals for a satellite based nowcasting system. Very high resolution GOES-R data will be used in future for improving accuracy and resolution of nowcasting.

## METHODOLOGY:

Existing nowcasting models and operational storm tracking techniques will be examined for the New York City Metropolitan area. The satellite based EUMETSAT-RDT and NESDIS Hydro-Nowcaster models, NSSL-WDSSII multiscale storm identification and forecast algorithm, and the radar-based thunderstorm identification, tracking, analysis, and nowcasting (TITAN) module are selected to be tested, modified, and enhances for using remote sensing data over New York City metropolitan area.

# Land Group: Soil - Snow - Vegetation

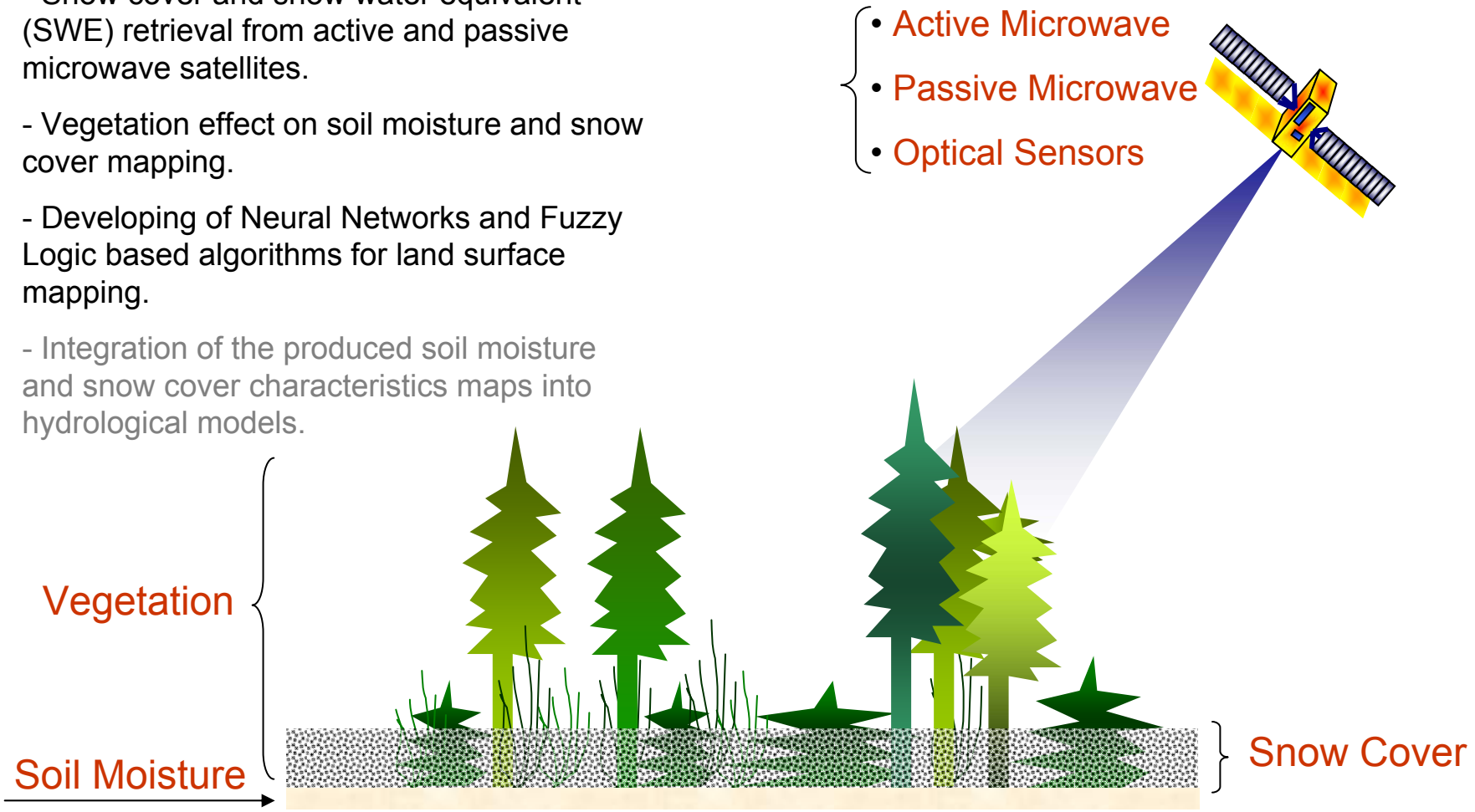
## Projects:

- Snow cover and snow water equivalent (SWE) retrieval from active and passive microwave satellites.

- Vegetation effect on soil moisture and snow cover mapping.

- Developing of Neural Networks and Fuzzy Logic based algorithms for land surface mapping.

- Integration of the produced soil moisture and snow cover characteristics maps into hydrological models.



# Development of better image classification models for snow cover mapping

Snow depth and Snow Water Equivalent (SWE) prediction, accuracy improvement

Research Group:

**Dr. Hosni Ghedira,** Assistant professor (CCNY, CE Dept.)
**Dr. Reza Khanbilvardi,** Professor (CCNY, CE Dept.)
**Dr. Peter Romanov,** Research Scientist (NOAA NESDIS)
**Dr. Norman Grody,** Former Senior Research Scientist (NOAA NESDIS)
**Mr. Amir Azari,** (CUNY Ph.D. Student, Thesis defense scheduled for June 15, 2006)
**Mr. Juan Carlos Arevalo,** (NOAA-CREST M.Sc. student, Graduated in Spring 2005)
**Mr. Adenrele Ibagbeola** (NOAA-CREST M.Sc. Student 2004-2005)
**Ms. Gillian Cain,** (NOAA-CREST undergraduate student, 2005)
**Ms. Nicole Hamilton,** (NOAA-CREST undergraduate student, 2004)

**Collaborator:**

**Dr. Tom Carroll,** Director of the National Operational Hydrologic Remote Sensing Center (NOHRSC)

**Project 1:** Estimation of Snow-Cover Parameters Using a Combination of Microwave and Optical Remote Sensing Data

**Project 2:** The Effect of Vegetation Cover on Snow Cover Mapping from Passive Microwave Data

# Downscaling soil moisture estimates from passive microwave remote sensing using active microwave data.

Algorithm validation and estimation improvement

Research Group:

**Dr. Hosni Ghedira,** Assistant professor (CCNY, CE Dept.)
**Dr. Reza Khanbilvardi,** Professor (CCNY, CE Dept.)
**Dr. Norman Grody,** Former Senior Research Scientist (NOAA NESDIS)
**Mr. Tarendra Lakhankar** (CUNY Ph.D. Student, Thesis defense scheduled for June 8, 2006)
**Ms. Nasim Jahan** (NOAA-CREST M.Sc. student, Graduated in Spring 2005)
**Ms. Mariyam Zachariah** (M.Sc. student, Graduated in Spring 2006)
**Ms. Parmis Arfania** (NOAA-CREST undergraduate student 2005-2006)

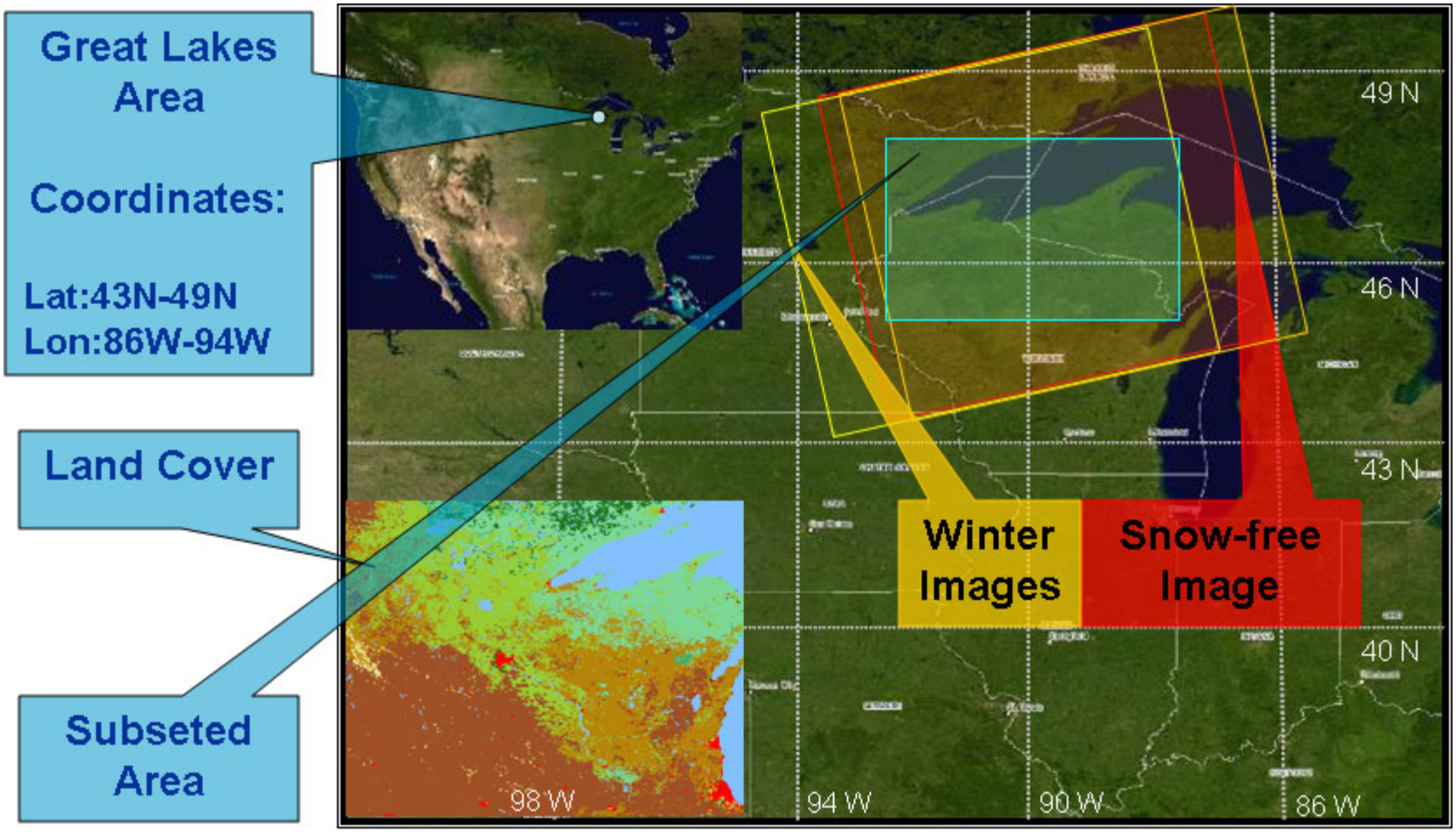
Develop an algorithm to produce spatial estimation of soil moisture using multi-source microwave data (active and passive). The algorithm will be developed using combination of parametric and non-parametric tools such as maximum likelihood, neural networks, fuzzy logic, etc.

**Project 1:** Develop techniques for downscaling soil moisture estimates from passive microwave remote sensing using active microwave data.

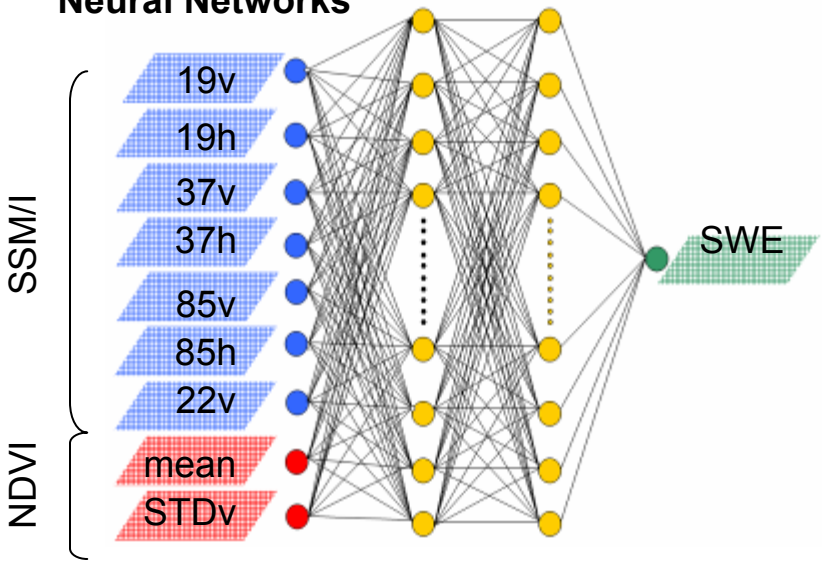
**Project 2:** The Effect of Vegetation Density on Soil Moisture Variation

# Snow Projects:

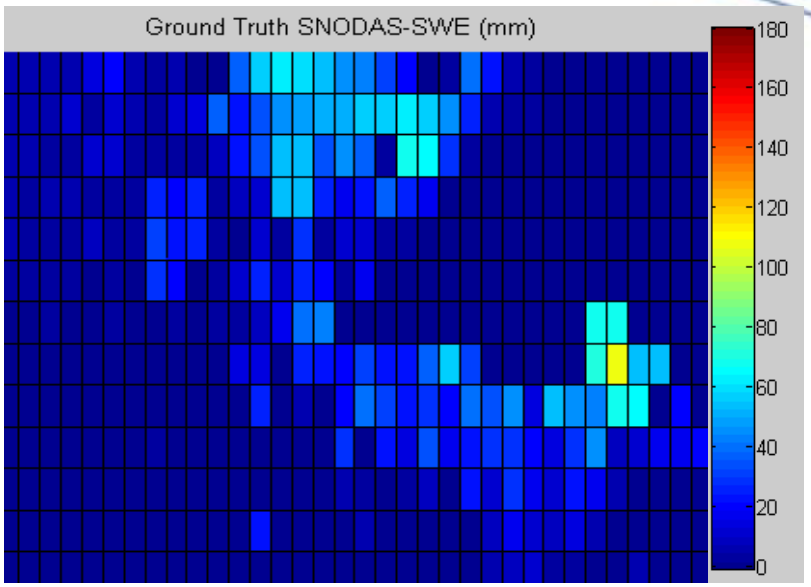
## Study Area and RADARSAT Images



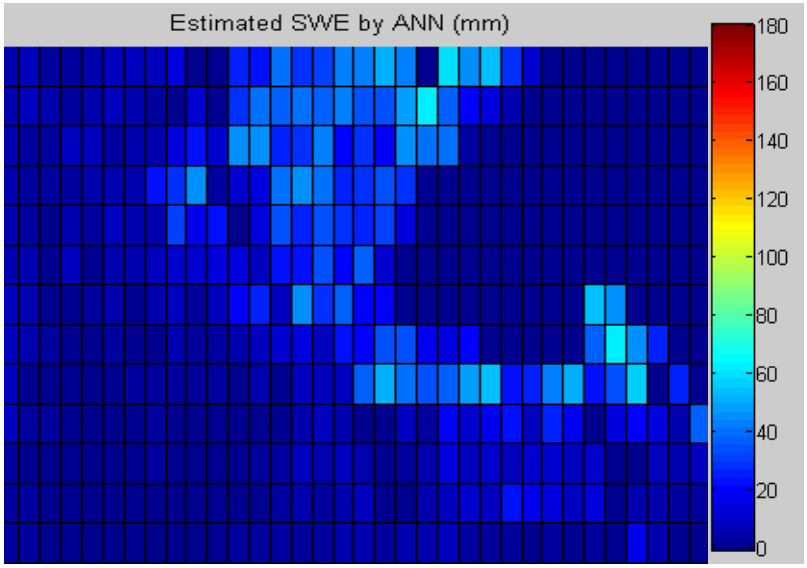
## Neural Networks



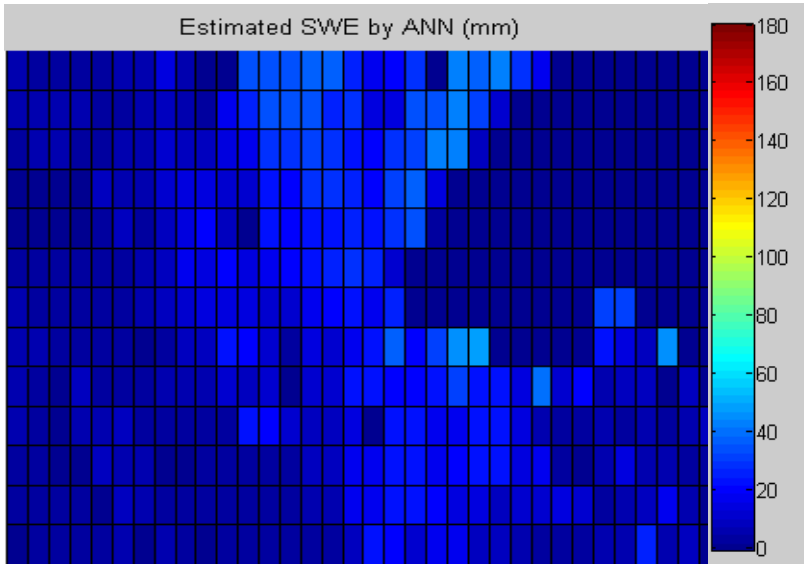

## Ground Truth SWE



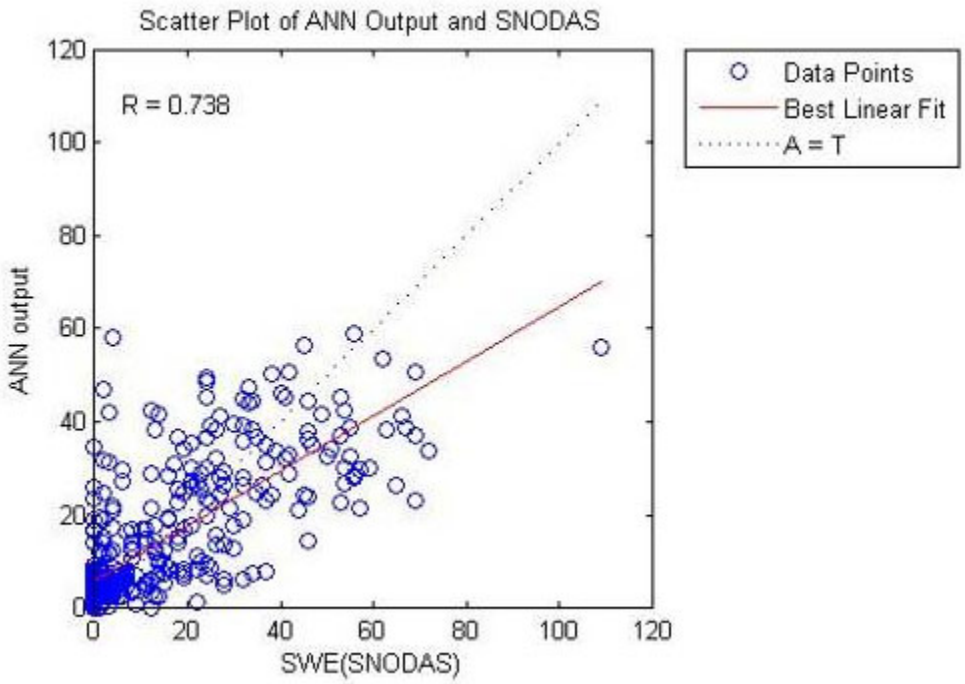

## Input: SSM/I+NDVI



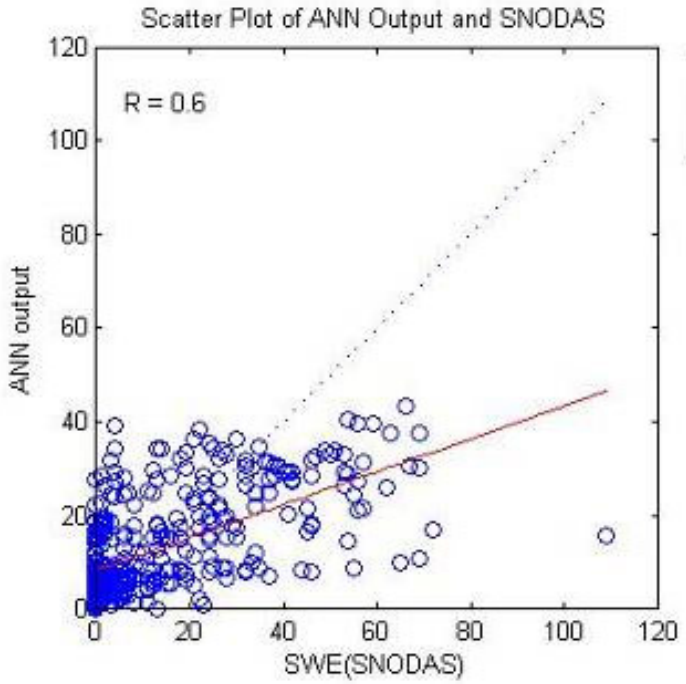

## Input: SSM/I



**Inputs: SSM/I+NDVI**

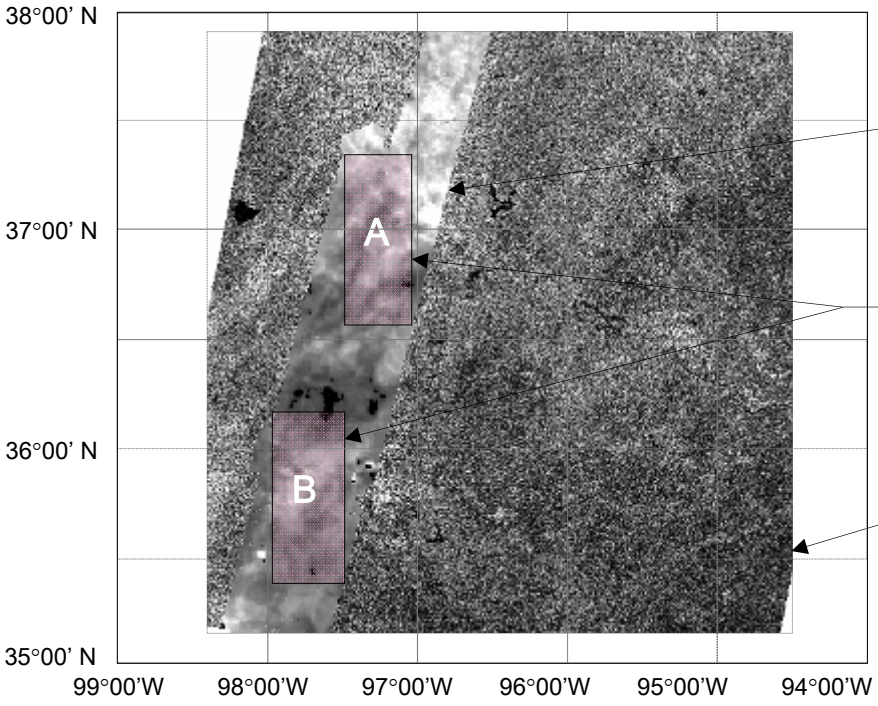



**Input: SSM/I**



# Soil Moisture Project 1: Develop Techniques for Downscaling Soil Moisture Estimates from Passive Microwave Remote Sensing using Active Microwave Data

SGP97: Southern Great Plains 1997 campaign operated by NASA for soil moisture retrieval using passive microwave radiometer.




Soil Moisture Data

*165 km x 495 km*
*(Res. 800 m)*

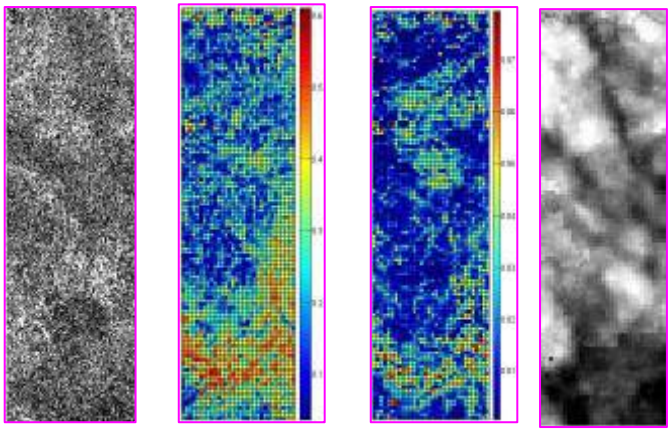
Study Area (A and B)

*A: 26.4 km x 96 km*
*B: 31.2 km x 103.2 km*

SAR Image

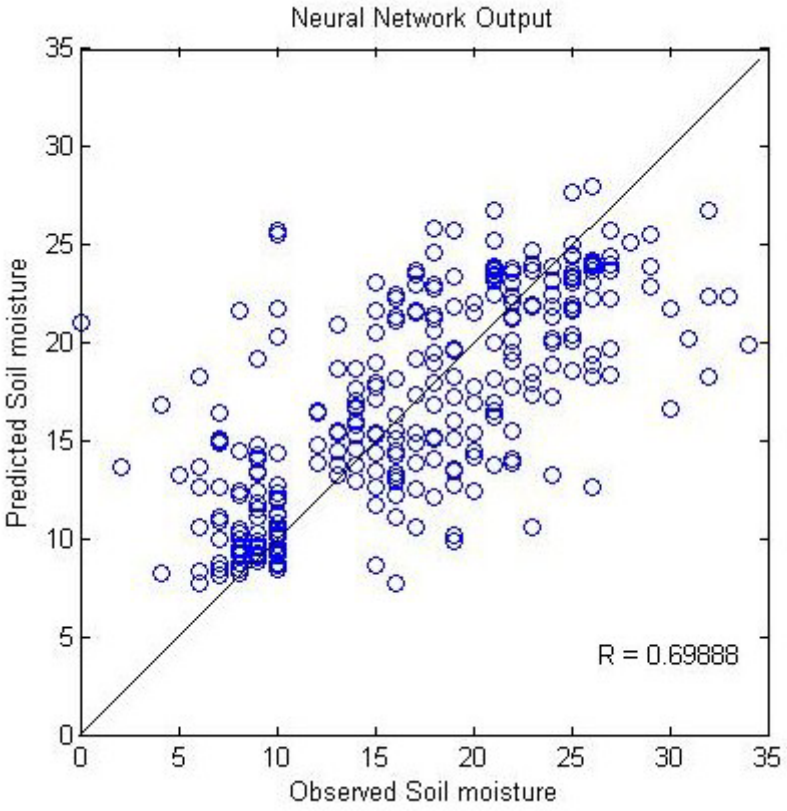
*350 km x 300 km*
*(Res. 25 m)*

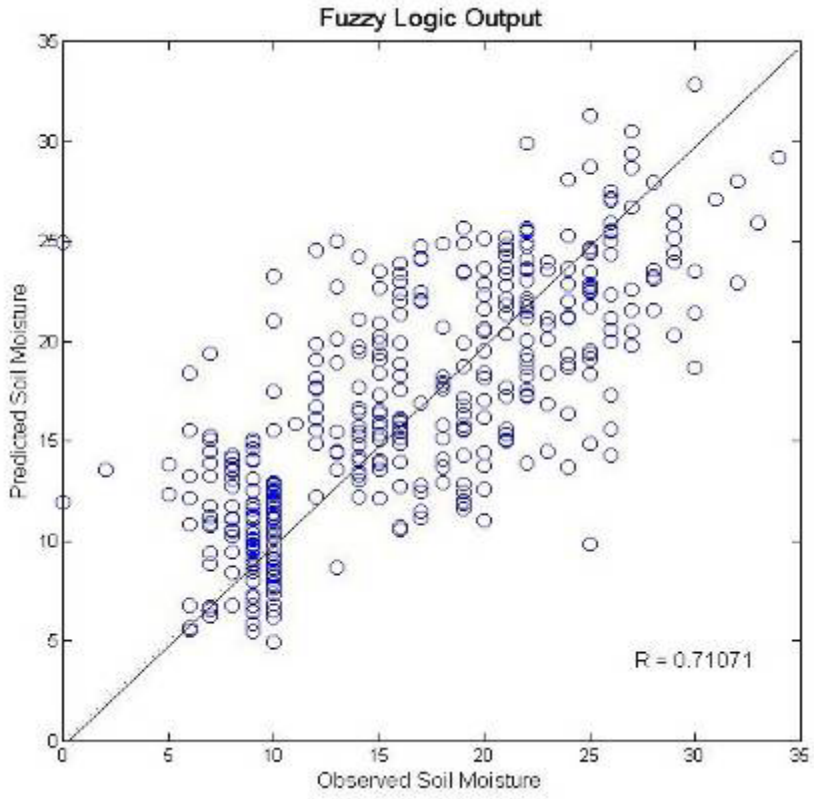
Study area: **Oklahoma** (97d35'W, 36d15'N)
SAR data from RADARSAT in SCANSAR mode
Resolution 25 x 25 m
Frequency: 5.3 GHz = 5.6 cm
(C band range 3.75 – 7.5 cm)
Polarization: HH



**SAR** **NDVI** **Opt Depth** **SM**

# Results/Validation

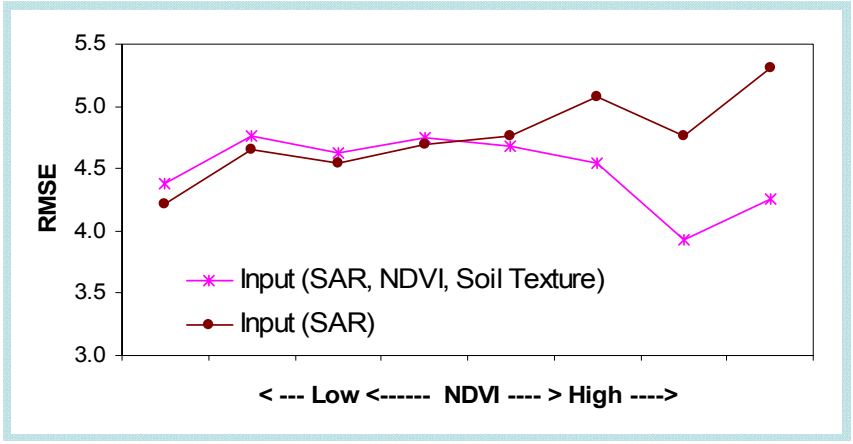


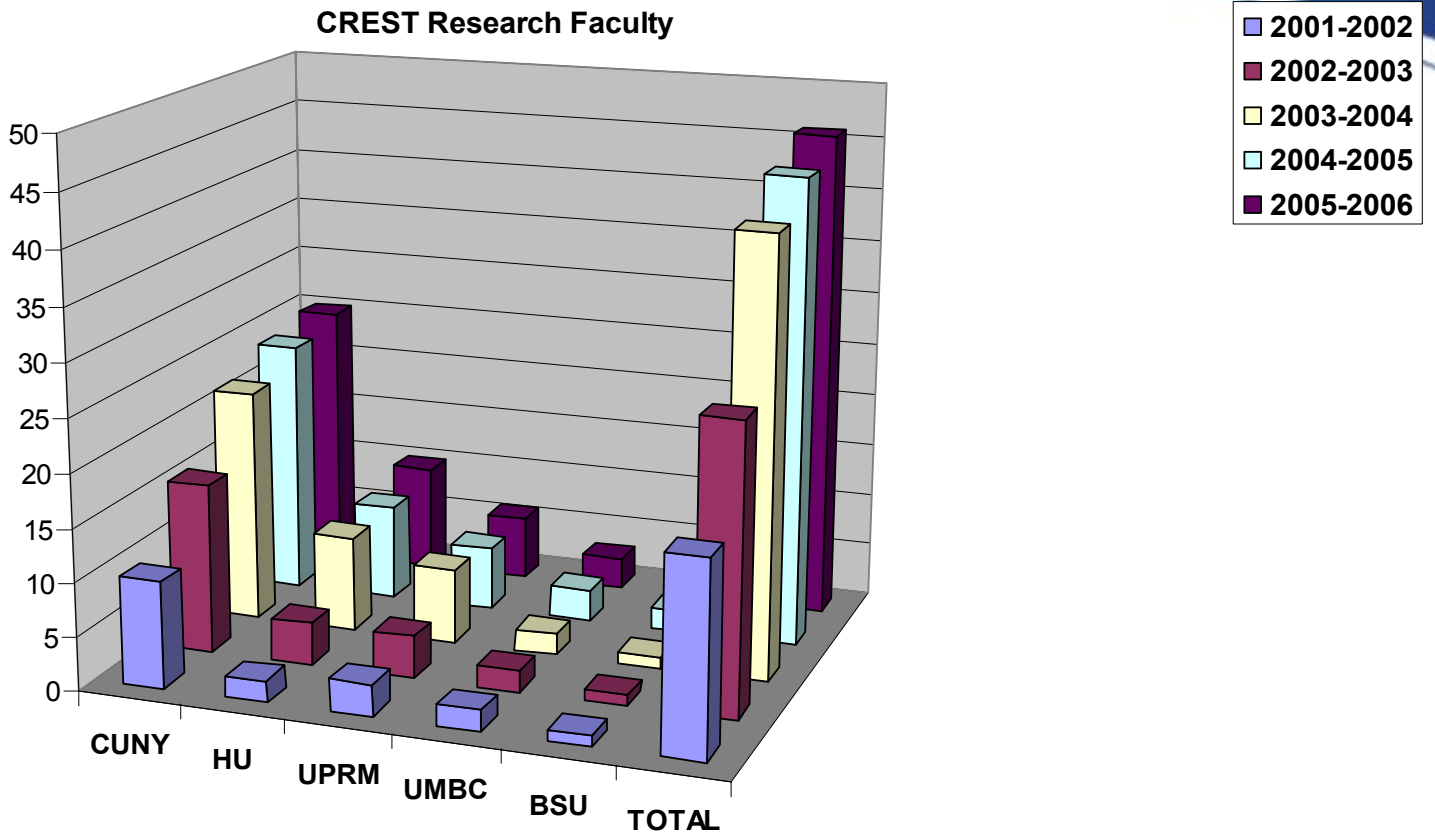




The neural network prediction is underestimated when the soil moisture is higher than 25 % and little overestimated when soil moisture less than 10%.

# Soil Moisture Project 2: The Effect of Vegetation Density on Soil Moisture Variation

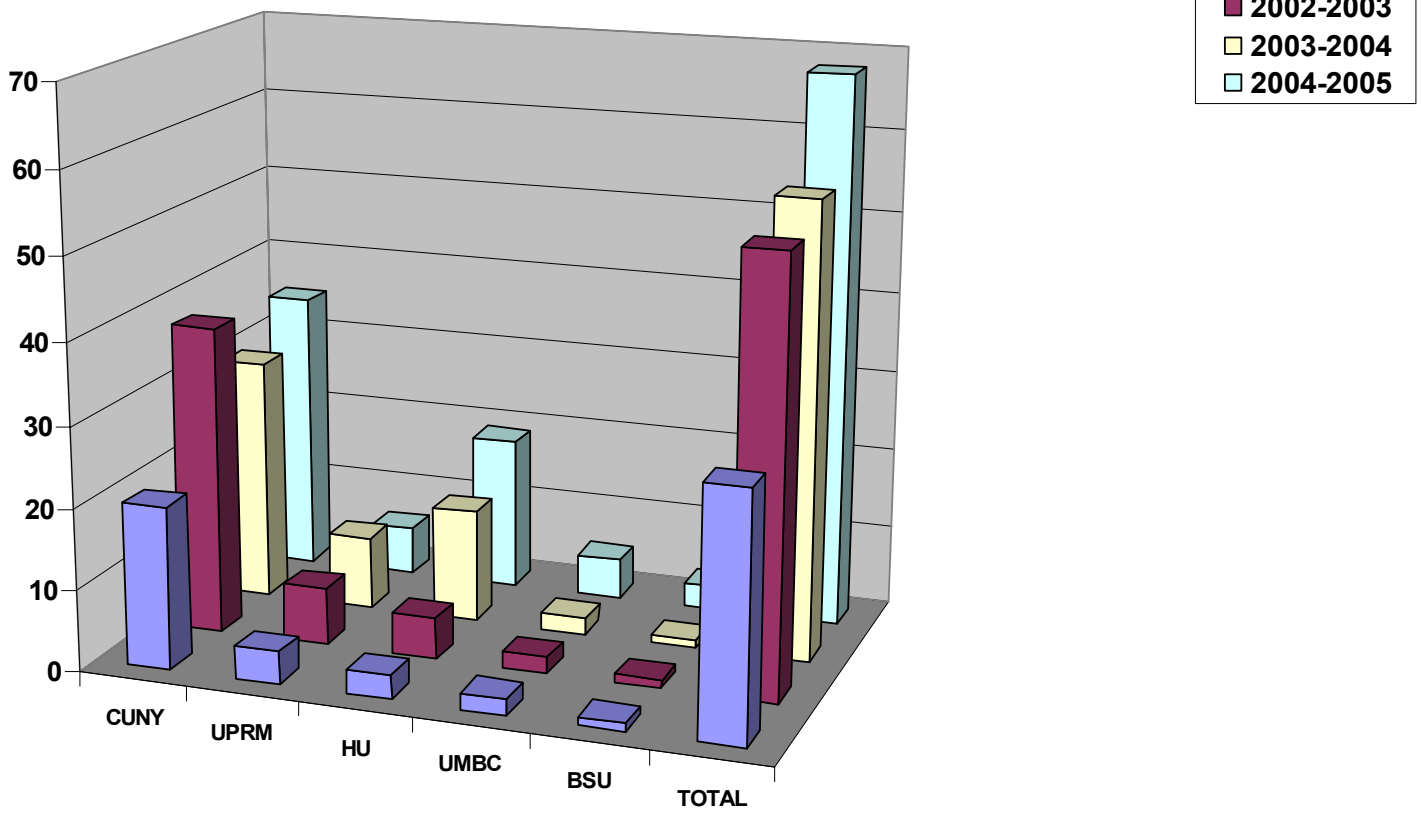
- The additions of NDVI information to NN model have significant effect (increase the accuracy by ~6-10%) on the final soil moisture accuracy.
- The areas with low NDVI showed better classification accuracy






| | CUNY | HU | UPRM | UMBC | BSU | TOTAL |
|---|---|---|---|---|---|---|
| 2001-2002 | 10 | 2 | 3 | 2 | 1 | 18 |
| 2002-2003 | 16 | 4 | 4 | 2 | 1 | 27 |
| 2003-2004 | 22 | 9 | 7 | 2 | 1 | 41 |
| 2004-2005 | 24 | 9 | 6 | 3 | 2 | 44 |
| 2005-2006 | 25 | 10 | 6 | 3 | 2 | 46 |

# CREST Research Projects




| | CUNY | UPRM | HU | UMBC | BSU | TOTAL |
|---|---|---|---|---|---|---|
| 2001-2002 | 20 | 4 | 3 | 2 | 1 | 30 |
| 2002-2003 | 38 | 7 | 5 | 2 | 1 | 53 |
| 2003-2004 | 30 | 9 | 14 | 2 | 1 | 56 |
| 2004-2005 | 35 | 6 | 19 | 5 | 3 | 68 |

# Graduated CREST Students by Ethinicity (Since 2001)

| Students | African American | Hispanics | Other Minority *(Asian/Pacific Islander)* | Others *(White; Caucasian, Other)* | Total |
|---|---|---|---|---|---|
| **Doctorates** | 0 | 0 | 1 | 1 | 2 |
| **Masters** | 8 | 16 | 7 | 5 | 36 |
| **Bachelors** | 33 | 23 | 2 | 2 | 60 |
| **Total** | 41 | 39 | 10 | 8 | 98 |

# Current/ Pipeline CREST Students by Ethnicity (Since 2001)

| Students | African American | Hispanics | Other Minority *(Asian/Pacific Islander)* | Others *(White, Caucasian and Other)* | Total |
|---|---|---|---|---|---|
| Doctorates | 09 | 16 | 4 | 11 | 40 |
| Masters | 12 | 10 | 3 | 3 | 28 |
| Bachelors | 21 | 13 | 0 | 5 | 39 |
| Total | 43 | 39 | 7 | 19 | 107 |

# EDUCATION

- **New Courses/Program**:
  - **CUNY: Graduate Program at CCNY – 3 courses**
  - **GISc 17 credit Certificate Program at Lehman College consisting of 5 courses**
  - **Hampton-CREST Undergraduate Minor Program - SEAS (Space, Earth and Atmospheric Science) – 15 courses out of which 6 are mandatory for CREST scholars**
  - **BSU-CREST: Marine Science Courses – "Oceanus" at BSU. GIS and Remote Sensing with 2 courses each.**
  - **UPRM-CREST: Masters Program in Applied Meteorology/Atmospheric Sciences (Meteo/AS) at UPRM in coordination with NOAA-NWS and JICCS at UPRM**
  - **UMBC-CREST: One Graduate Course (Taught by NESDIS Scientist Chris Brown) and one Introductory course for Professionals (AMS meeting, 2004)**
- **Modifying Existing Courses**
  - **Modified/restarted many courses under science or Engineering**
- **New Curriculum in line with NOAA-CREST Goals**

**- Earth and Environmental Sciences (EES) A BS/BE undergraduate Program at CCNY (*approved by College administration, just got approval from College Board of Trustees, CUNY*) and NY State Board of Education**

# OUTREACH PROGRAMS

- **K-12 Education Initiatives by CREST**
  - ***STARS Program with Mott Hall School – initiated in 2002***
  - ***BCC collaboration with BHSS on the Pollen Grain Allergies and Pediatric Asthma***
  - ***Lectures/seminars by CREST Faculties at BHSS to guide the school students and give future directions to become CREST Scholars and future NOAA Scientists***
  - ***Dr. Ayman Suleiman of Hampton University trained 5 high school students in Summer 2004, under the Geoscience's program at HU.***
- **Mott Hall School –STARS (Students Apprenticeships in Research) Program**
  - ***2 students participated in 2002-03 and 4 students each in 2003-04 and 2004-05***
- **National Ocean Science Bowl Competition : BHSS and Gompers High School**
  - ***1st competition held in Feb 8, 2003***
  - ***2nd Competition on Feb 28 2004 -WON the Regional***
  - ***3rd Competition on February 26 2005 –*** *BHSS stood 5th*
  - ***4th Competition on March 4 2006***
- **NOAA-CREST Annual Day**
  - ***(observed each year since the inception of the program) - Students Recruitments***
- **Interaction with Congressmen in NY and other states**