Early Warning of Synoptic Air Quality Events to Improve Health and Well Being in the Greater Caribbean Region

Program Area (Health and Air Quality)

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- **We proposed** to characterize the distribution pattern and variability of dust using synoptic Earth observations from satellites and ground stations, and quantify the impact on public health using detailed time histories of medical records from Caribbean

- The long-term objective is to increase the use of NASA satellite sensors and ground aerosol observations to guide surveillance, early warning, and risk assessment of potential public health issues.

Starting Date Feb 01, 2019

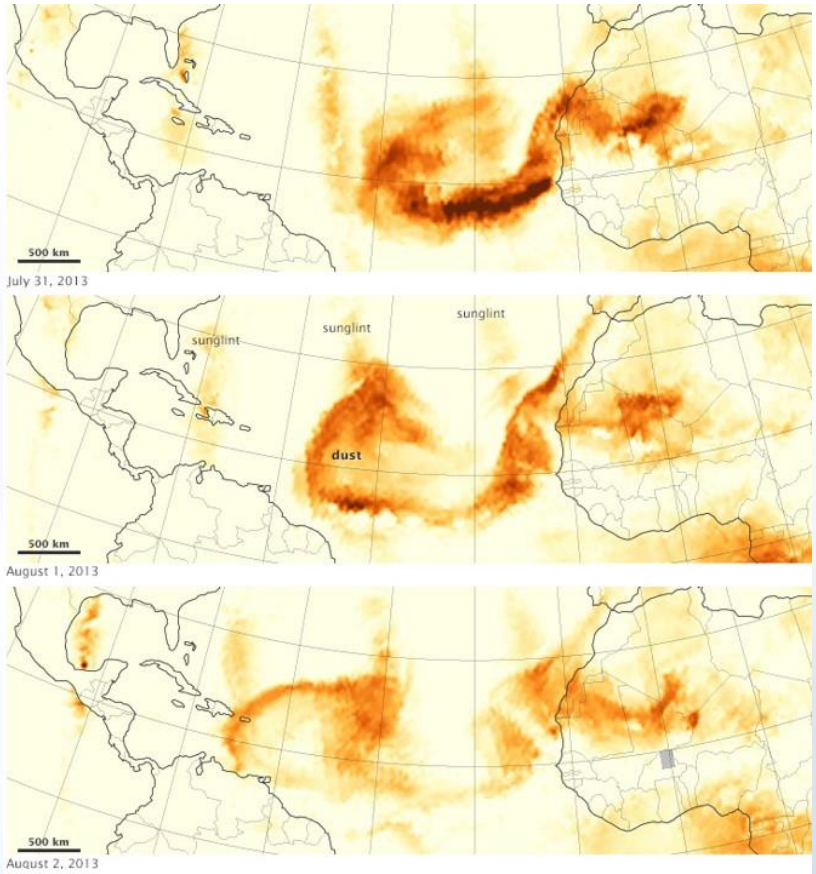

Figure 1. Dust progression over the North Atlantic Ocean. July 31 - August 2, 2013. https://earthobservatory.nasa.gov/IOTD/view.php?id=81864&src=eoa-iotd

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Project Partners-End users-Stakeholders and Practitioners

Organization Type	Participants (38)	Organizations (19)
State Agency-Decision Makers	6	6
Federal Agency-Decision Makers	9	3
Academia Research	10	4
Graduate Students (scholarships, fellowships, research assistant)	7	2
Private Health Clinics	6	4

Puerto Rico Science, Technology & Research Trust

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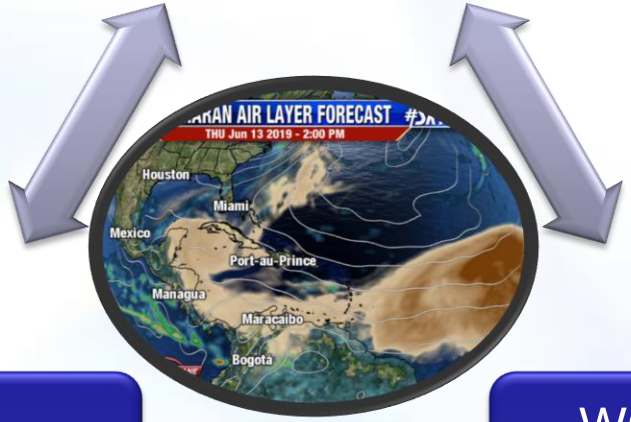
WG1: Resilience, Public Health and Well Being.

Evaluate the effects of African Dust outbreaks and (DPM) on the environment and public health (including asthma rates, hypertension, cardiovascular diseases) by socioeconomic factor (age, gender, educational level, language, income)

Provide ground-based aerosol data to improve remote sensing estimates of African Dust and Diesel Particulate Matter (DPM) in the Caribbean.



Improve forecasting of arrival of African Dust outbreaks in the Caribbean and public health risk.

WG2: Atmospheric Forcing and Air Quality

WG3: Decision Support Tool: Computation and Visualization

WG1: Mixed Methods

Methods: Qualitative Interviews

Focus Groups are being conducted (September 2019-December 2019) among patients ≥21 years to address air quality stressors and potential impact of African Dust and Diesel Particulate Matter on Public Health.

The composition will be as follow:

- Adults with Cancer (with treatment / without Treatment)
- Adults without Cancer
- Parent's o legal guardians of Kids with chronic conditions

Key Informant Interviews (Adults - Kids / Public Insurance - Private Insurance) in which, topics related to the African Dust and its possible effect on the health of the population will be addressed.

Oncologist: Cardiologists: Pediatric Pulmonologists: Puerto Rico Cancer Registry

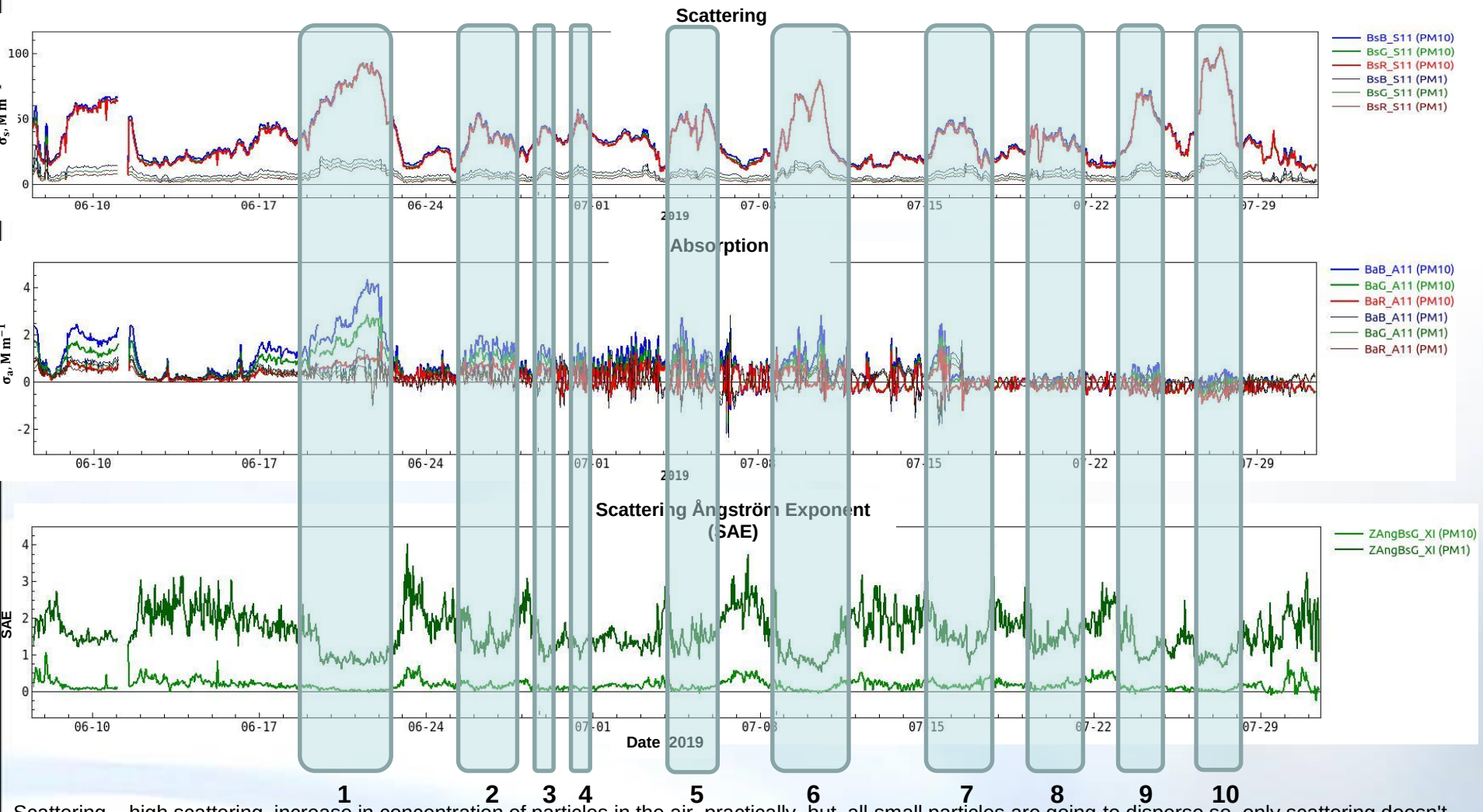
Methods: Quantitative Data

Database	Source	Variables
Mortality	Demographic Registry P.R. Department of Health	Gender, Age, Birth date, Birth place, Residence Place, Marital Status, Death Place, Death Date and time hour, Time spent and facility, Death cause (I-X), Type of Death, Autopsy, Organ donor, Education, Race, Occupation, Pregnancy, Tobacco Related death.
Temperature	National Climatic Data Center (NCDC) NOAA	Air Surface Temperature, Relative Humidity, Date
PM 2.5	EQB,EPA	Date, Daily Mean PM2.5 Concentration, Daily AQI Value,
PM 10	EQB,EPA	Date, Daily Mean PM10 Concentration, Daily AQI Value,
Ozone	EQB,EPA	Date, Daily Mean Ozone Concentration, Daily AQI Value,
Emergency Room visits and Hospital Admissions	Endowed Health Services Research Center School of Medicine Medical Sciences Campus University of Puerto Rico	Demo: STUDY ID DATE OF ADMISSION DATE OF DISCHARGE AGE GENDER Medical Hx: Stroke, Heart Failure, Heart Attack, Cardio, Pulmonary embolus, Atrial Fibrillation, Asthma, Stroke, Congestive heart failure, Pneumonia, Congestive heart failure, Sinus bradycardia Sinus tachycardia, Cardiac Arrhythmia, Renal failure/disease Symptoms Final Validated Diagnosis Complications
Cancer	University of Puerto Rico Comprehensive Cancer Center	Gender, Age, Birth date, Birth place, Residence Place, date of cancer diagnosis, age of cancer diagnosis, cancer type, stage, treatment/date, mortality (vital status/date)

Protocol approved by the IRB. Protocol Number: B1540119

Human-centered design is a problem-solving approach that starts with the people impacted the most by the problem to be solved.

Identification of African Dust Events using Aerosol Optical Properties
Increase in scattering and absorption coefficients and decrease in SAE are indicative of African Dust. Data: O. Mayol UPR-Rio Piedras

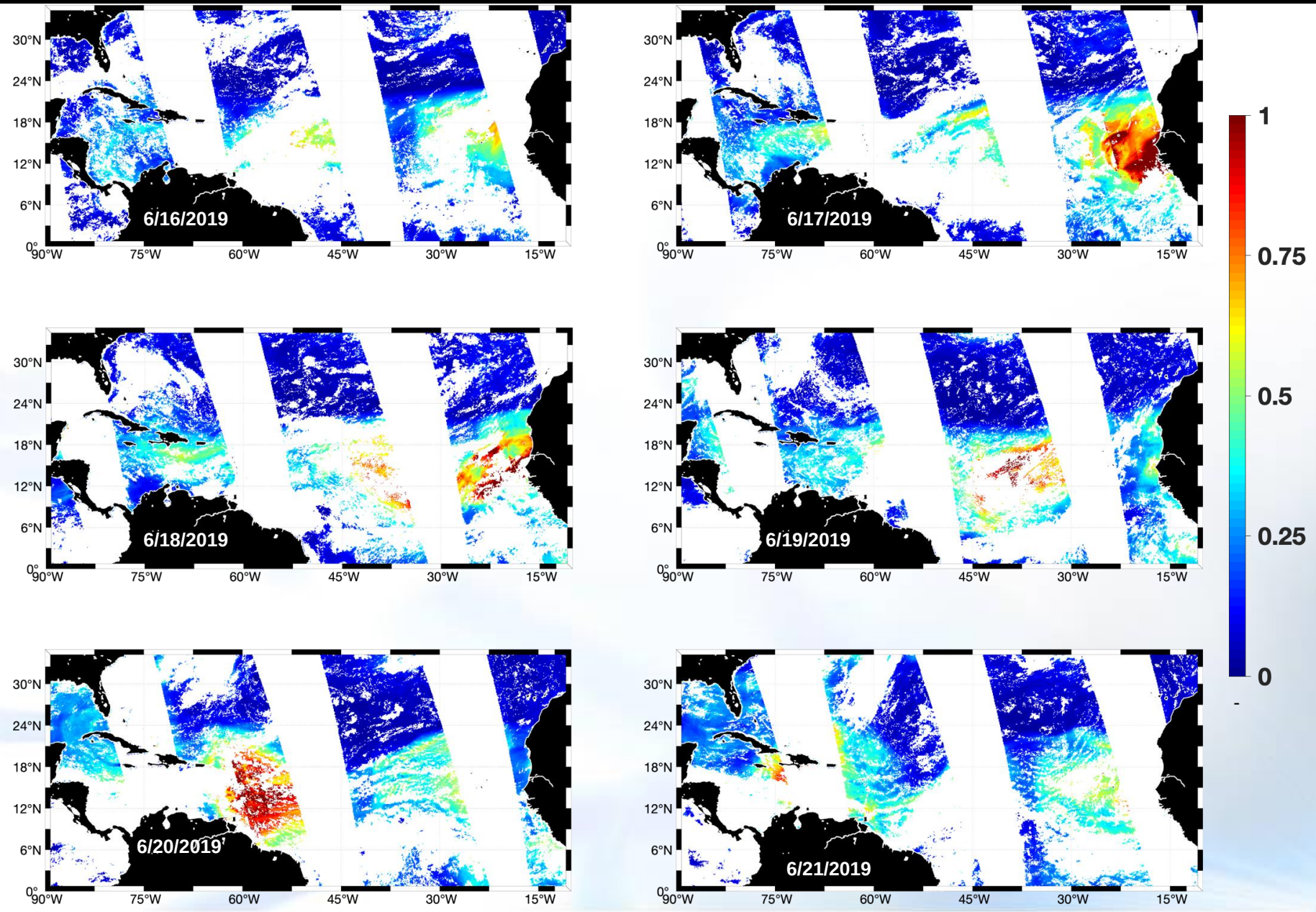


Scattering – high scattering, increase in concentration of particles in the air, practically, but all small particles are going to disperse so, only scattering doesn't tell you that it is dust from Africa.

Absorption - also extensive, but not all particles absorb. But African dust absorbs and when it does you see the separation of the wavelengths (red, green, blue).

SAE (scattering angstrom exponent), relates to the size of the particles, the smaller the SAE, the larger the particle. Dust particles are larger than the background particles, therefore, the decrease observed in the SAE in identified dust events is key to identifying the event. Nephelometer- scattering. Absorption photometer - Absorption coefficient

WG1-2-3:


6/16/2019
6/17/2019
6/18/2019
6/19/2019
6/20/2019
6/21/2019
30°N
24°N
18°N
12°N
6°N
0°
90°W
75°W
60°W
45°W
30°W
15°W
1
0.75
0.5
0.25
0

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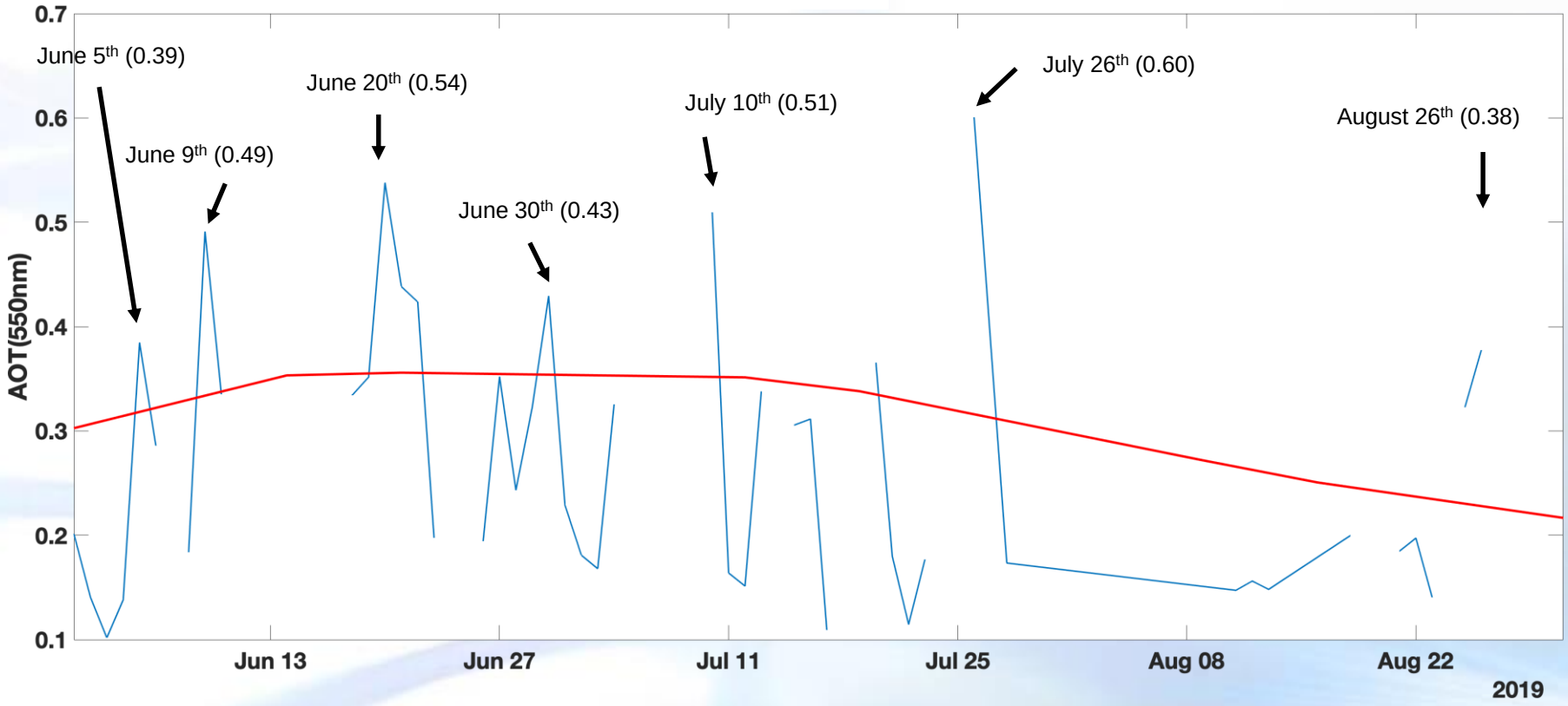
Extracted time-series (D. Otis USF)

VIIRS Total Aerosol Optical Thickness at 550nm with 0.10 degree spatial resolution
Extracted from 0.3 x 0.3 degree box east of Fajardo, PR (center at 18.2855N; -64.4458E)
Quality controlled gridded environmental data record (EDR)
Red line represents climatological values
Obtained from: ftp://ftp.star.nesdis.noaa.gov/pub/smcd/VIIRS_Aerosol/npp.viirs.aerosol.data/edraot550/



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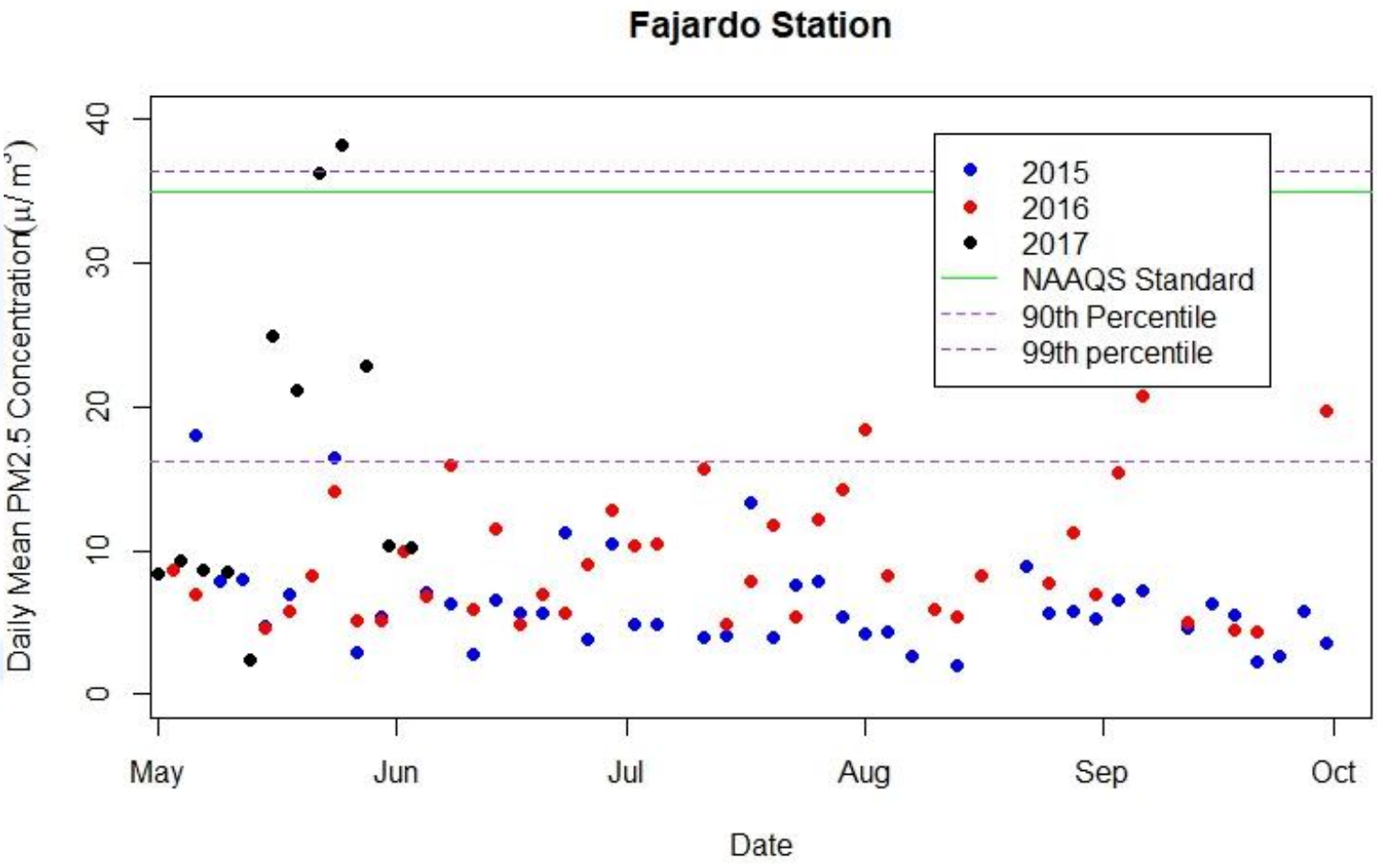
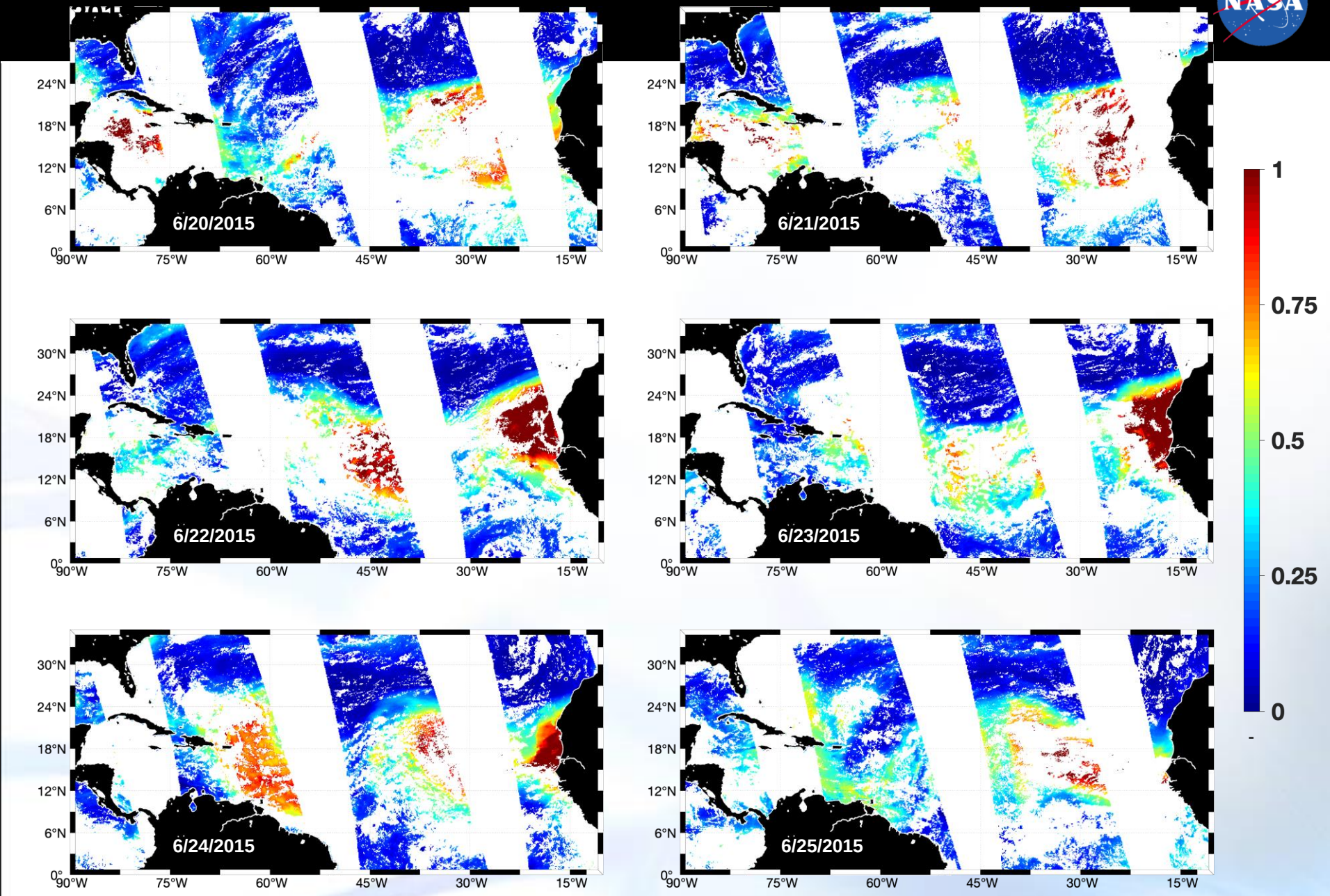
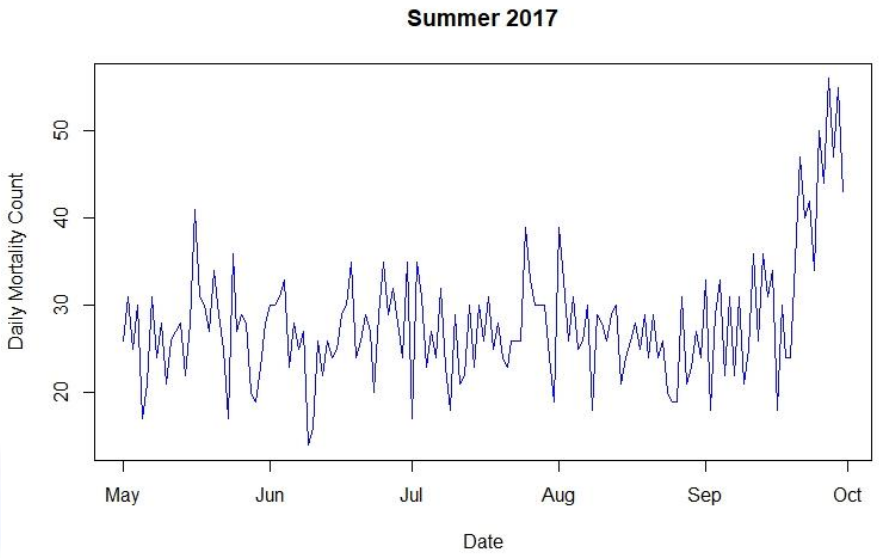
Fajardo 2015:
Values above 90% Percentile for PM2.5

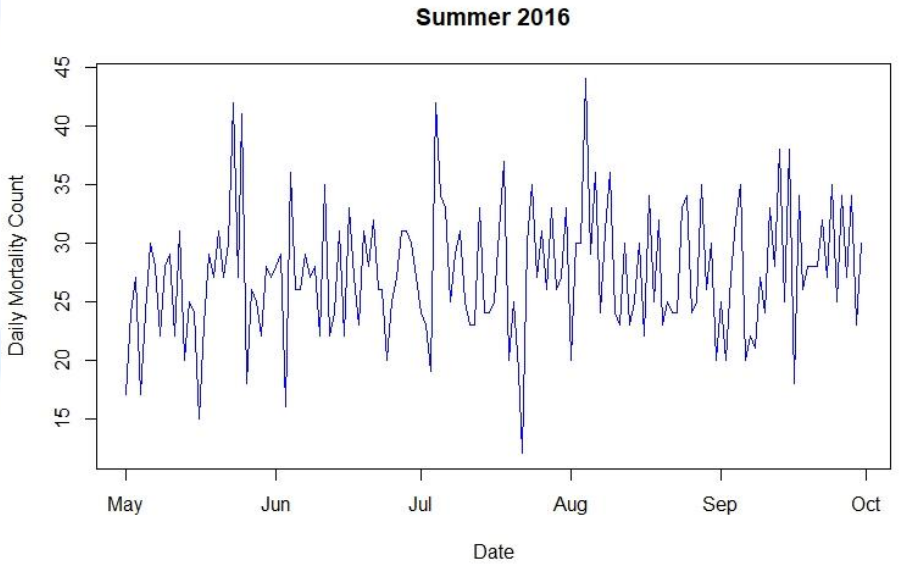
Date	Daily.Mean.PM2.5.Concentration	DAILY_AQI_VALUE
2015-08-22	8.9	37
2015-05-24	16.5	60
2015-06-23	11.2	47



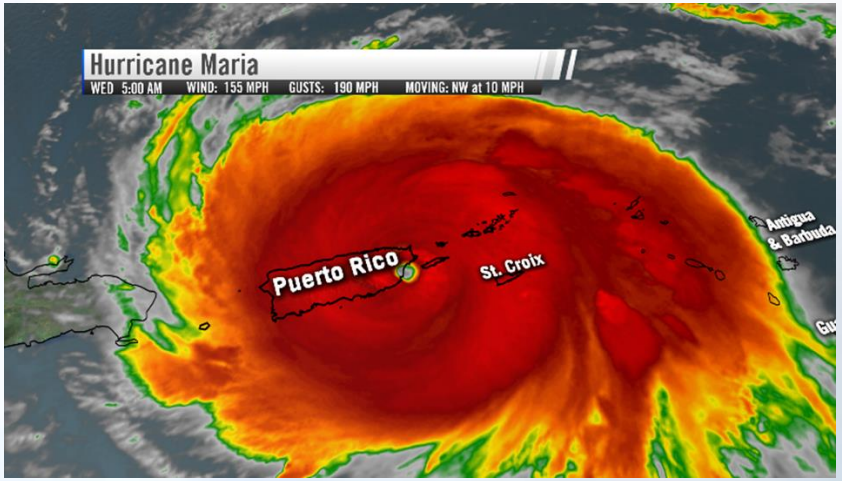

6/20/2015
6/21/2015
6/22/2015
6/23/2015
6/24/2015
6/25/2015
30°N
24°N
18°N
12°N
6°N
0°
90°W
75°W
60°W
45°W
30°W
15°W
1
0.75
0.5
0.25
0

Potential Risks and Pitfalls





- NCI Grant #R21CA239457: All women expressed feeling **environmental stressors** such as heat, mosquitoes, humidity, noise and **air pollution** produced by household electric generators



Application Readiness Level

- Coordinate network sampling activities (ARL 3&4) (H. MARIA)
- Validation of the satellite products are being validated using in-situ observations from the study area, including in-situ dust records from Barbados and the results of aerosol absorption and scattering experiments carried out at a ground station in Fajardo (ARL 3).
- Calibrate, install, test samplers/instruments (ARL 2&3).
- Completion of focus groups and interviews (Plans to better characterize the decision making activity developed: ARL 2-3)
- Determine the frequency of ground-level measurements and the cycles of observation by MISR, MAIA, CALIOP, MODIS, VIIRS, CATS and TES (ARL 2). (*The team has identified several types of satellite data that can be used to assess and quantify dust events that impact islands in the Caribbean. We are currently obtaining these records from NASA and NOAA*)
- Retrieving/collection of ground-level measurements for PM2.5 and PM2.5 speciation (ARL 2)
- Baseline assessment for concentrations of PM2.5 and PM2.5 components measured by the PREQB Bayamon Station (Data source identified: ARL 1&2)
- Baseline morbidity and mortality assessment (Baseline support research identified and documented: ARL 1

Next: Application Readiness Level

- The combination of the satellite data with ground-based observations. (ARL 6&7)
- Integration of products (Application components integrated into a functioning prototype application system with realistic supporting elements: ARL 5)
- Dissemination of materials (Components of eventual application system brought together and technical integration issues worked out: ARL 4)
- Test the GEOS-5 and **WRF-CHEM** models with data provided to see if African Dust forecasts are improved after ingestion with ground-based observations
- Continue Opportunities for training and professional development (ARL 4).
- Use satellite sensors to track and quantify AD plumes. (ARL 3 & 4)
- Intensive Field Phases for African Dust sampling (ARL 3 & 4) (H. MARIA)
- Characterize and quantify African Dust using ground-based instruments. (ARL 3 & 4)
- Revision of materials by practitioners and stakeholders (Components of application tested and validated independently: ARL 3)

- **All Hands Meeting in San Juan, Puerto Rico January 27-31, 2020**
  - Topics
    - African Dust Forecasting and Modelling
    - Diesel Particulate Matter
    - Remote Sensing Techniques
    - Public Health and Air Quality
    - Instrumentations and Labs

Thank you!

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Principal Investigator: NASA--Early Warning of Synoptic Air Quality Events to Improve Health and Well Being in the Greater Caribbean Region (80NSSC19K0194)

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