

Saharan Dust Early
Warning System:
Protecting public
health in Puerto Rico

NASA Science Mission
Directorate
Earth Science Division
Applied Sciences
Program

Program Area (Health
and Air Quality)

PI: Dr. Pablo A. Mendez-Lazaro

University of Puerto Rico Medical
Sciences Campus

Environmental Health Department

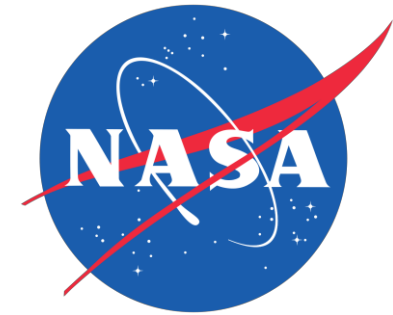
pablo.mendez1@upr.edu

2022 NASA Annual Meeting

September 2022

(No-cost extension)

NASA Grant Number
80NSSC19K0194

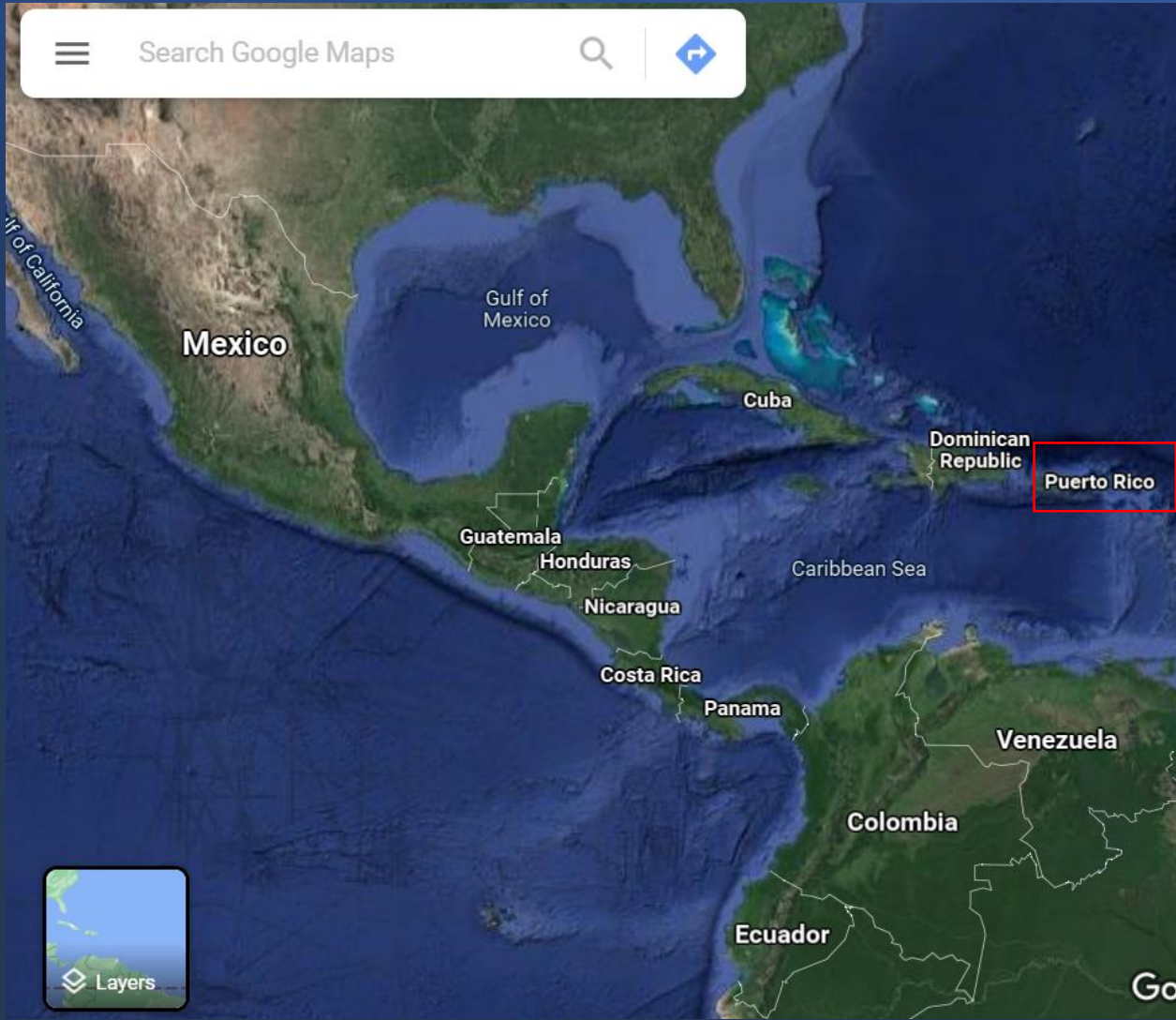


Saharan Dust Early Warning System: Protecting public health in Puerto Rico


- On Nov 2017, we proposed to characterize the distribution pattern and variability of **Saharan Dust** using Earth observations data from satellites and ground stations, and quantify the impact on respiratory diseases in Puerto Rico.
- This research is co-designing a **Public Health Early Warning (Monitoring) System** that integrates data from Earth observing satellites, in situ, and modeled weather information, and public health data.
 - **Working Group 1:** Resilience, Public Health and Well Being.
 - **Working Group 2:** Atmospheric Forcing and Air Quality.
 - **Working Group 3:** Decision Support Tool: Computation and Visualization.

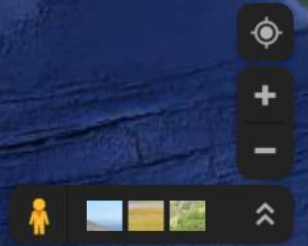


HCD Approach



Search Google Maps

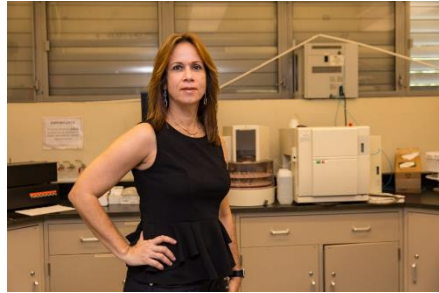
North Atlantic Ocean	Puerto Rico 	Sign in
Population Living Below Poverty Level	43.5% (US 11.4%)	
Main Island(s) Surface Area	3,423.80 (sq. mi)	
Total Population	3,263,584	Western Sahara
Main Language	Spanish	Mauritania
Urban Population	93%	
Rural Population	7%	Senegal
Race and Ethnicity	98.7% Hispanic or Latino (US 18.5% Hispanic or Latino)	The Gambia Guinea-Bissau Guinea Sierra Leone Liberia



Core Team members: Epidemiology, Environmental Health, Remote Sensing, Chemistry, Atmospheric Science, Climatology



Ana Patricia Ortiz, MPH, PhD



Olga L. Mayol-Bracero, Ph.D.



PI: Pablo A. Méndez-Lázaro, Ph.D.



Daniel Otis, PhD



Frank Muller-Karger, Ph.D



Cynthia M. Pérez-Cardona, Ph.D.



Digna Rueda-Roa, Ph.D.

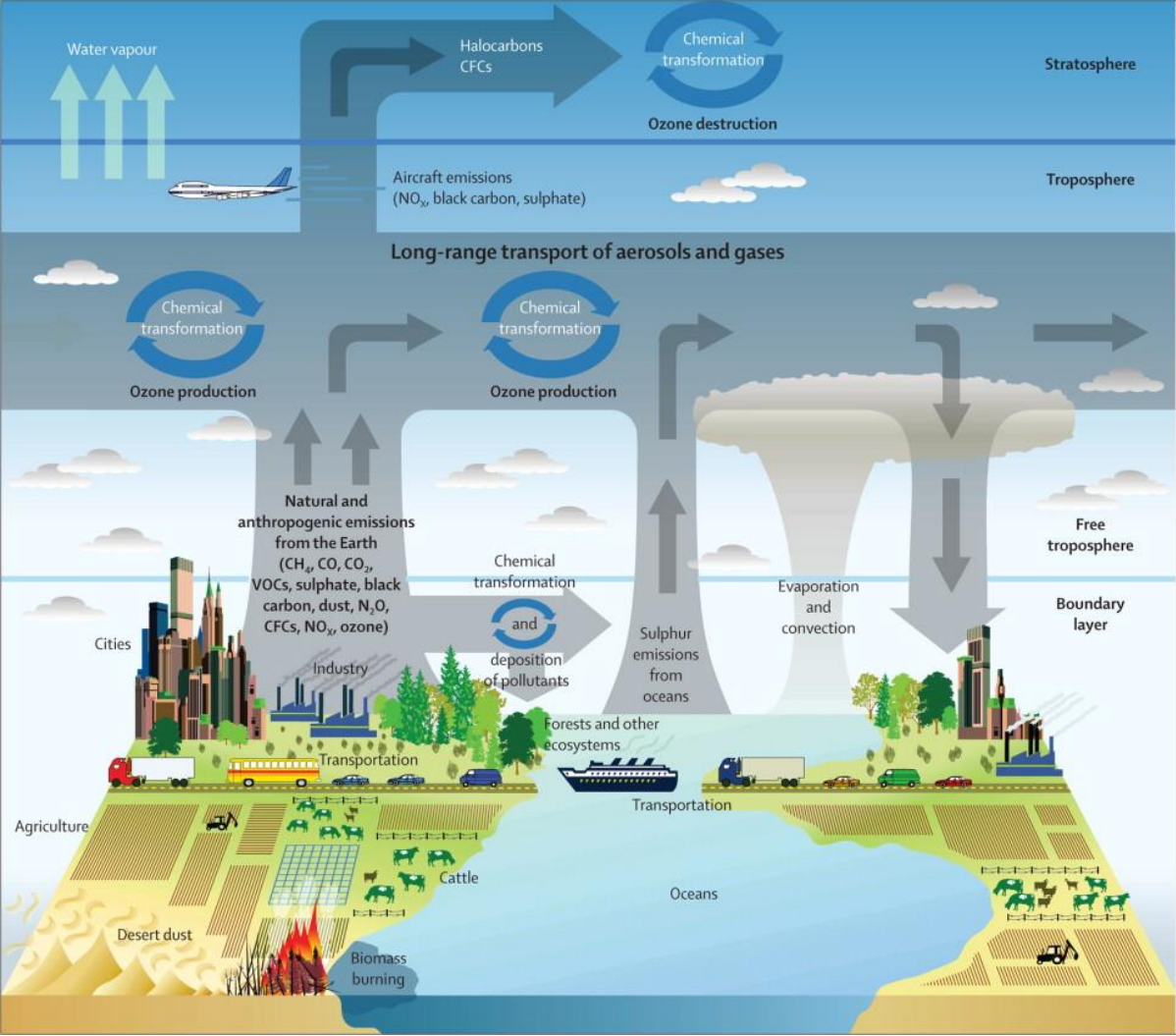
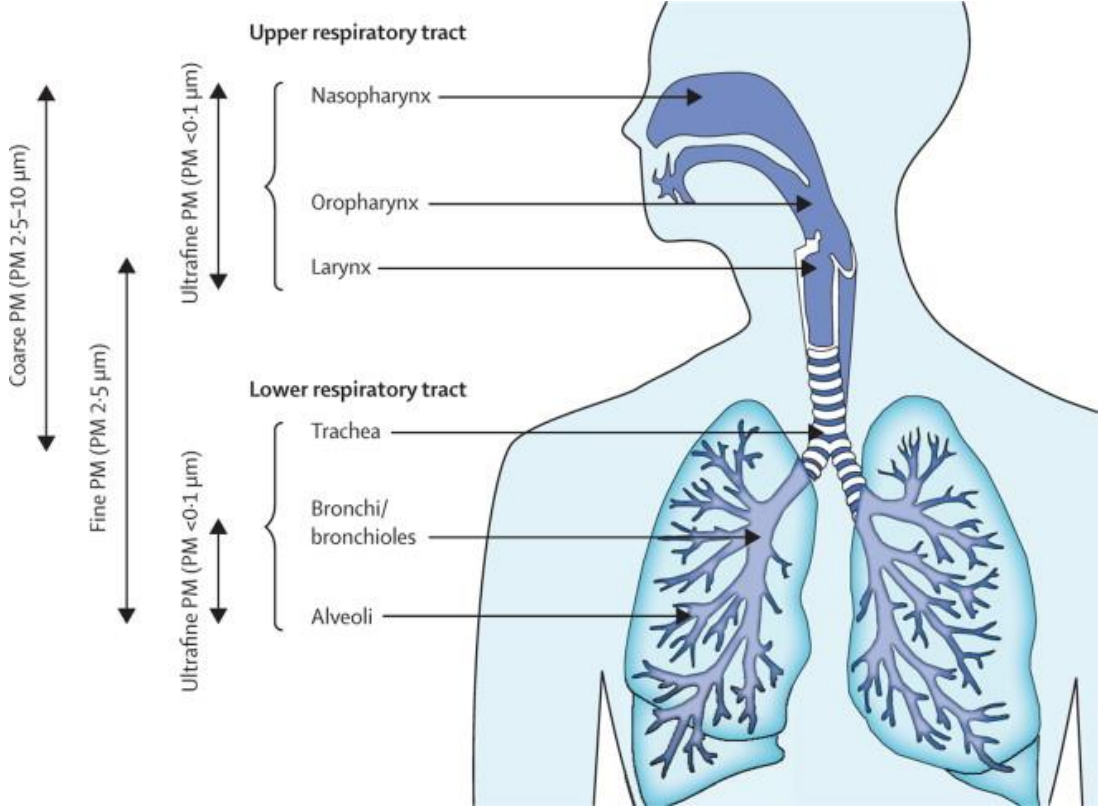


Aluisio Pimenta, PhD, PE

Saharan Dust Early Warning System: Protecting public health in Puerto Rico

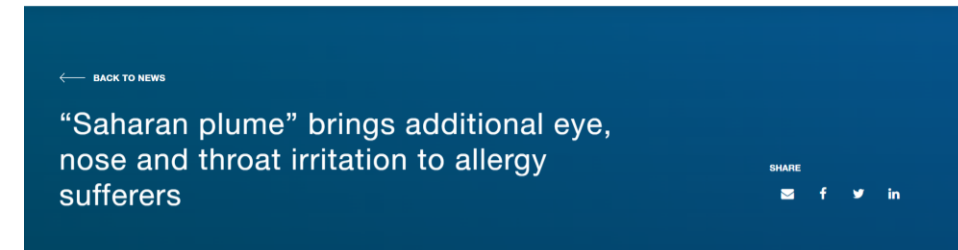
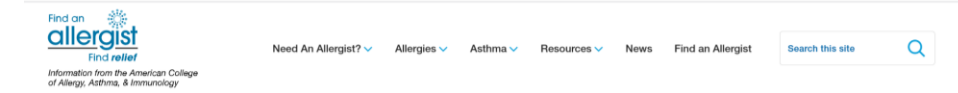
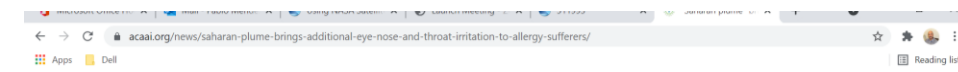
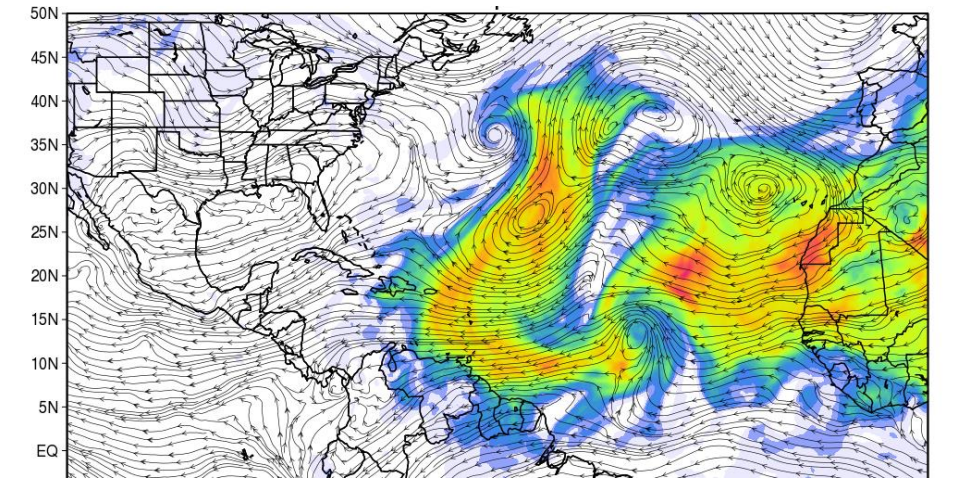
- Over 20 million tons of mineral dust from Africa are transported every year by the Trade Winds over the Atlantic Ocean, reaching South and North America, Caribbean Sea nations, and US territories between May and August every year.
- In the Caribbean islands, dust is associated with increased to excessive risk of emergency room visits and hospitalizations related to respiratory diseases.
- On the other hand, the coronavirus SARS-CoV-2 responsible for the present COVID-19 pandemic increases the risk of mortality due to severe respiratory illness and cardiac injury.
- Our transdisciplinary team proposes to examine these interactions and help understand whether specific African dust transport events lead to higher or lower COVID-19 cases or exacerbate health effects.

Guarnieri, M., Balmes, J.R. 2014. Outdoor air pollution and asthma. DOI:[https://doi.org/10.1016/S0140-6736\(14\)60617-6](https://doi.org/10.1016/S0140-6736(14)60617-6). Lancet 2014; 383: 1581–92

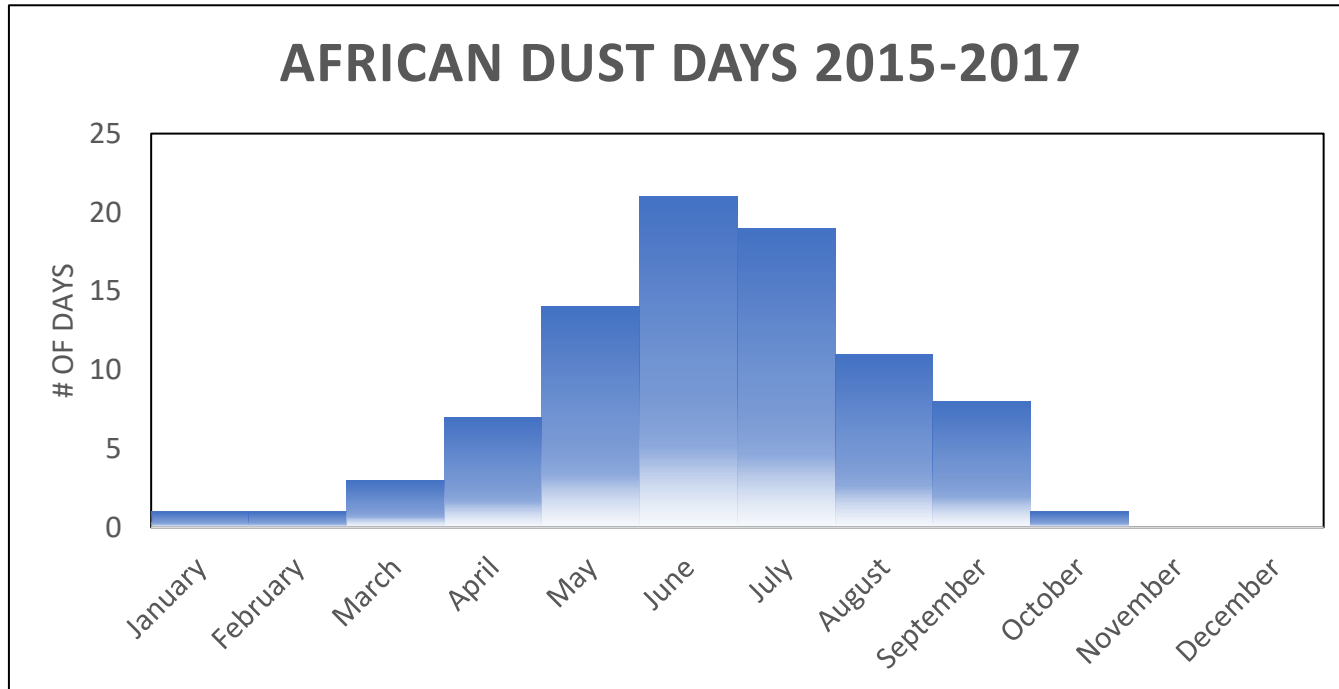


What is Saharan Dust and its seasons in the Caribbean?

- The mineral dust particles that reach us in the Americas from Africa could contain minerals, organic matter, marine salts, viruses and bacteria.
- Dust Clouds are aerosols, small solid and liquid particles suspended in the atmosphere.
- Examples of aerosols include windblown dust, sea salts, volcanic ash, smoke from fires, and factory pollution.
- These particles are important because they can affect the climate, ecosystems and people's health.



Dust “seasons” in the Caribbean

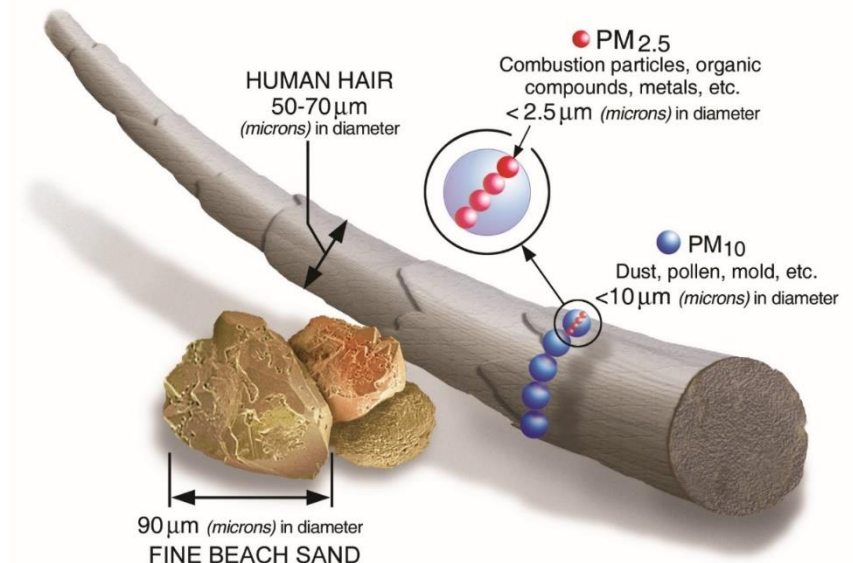
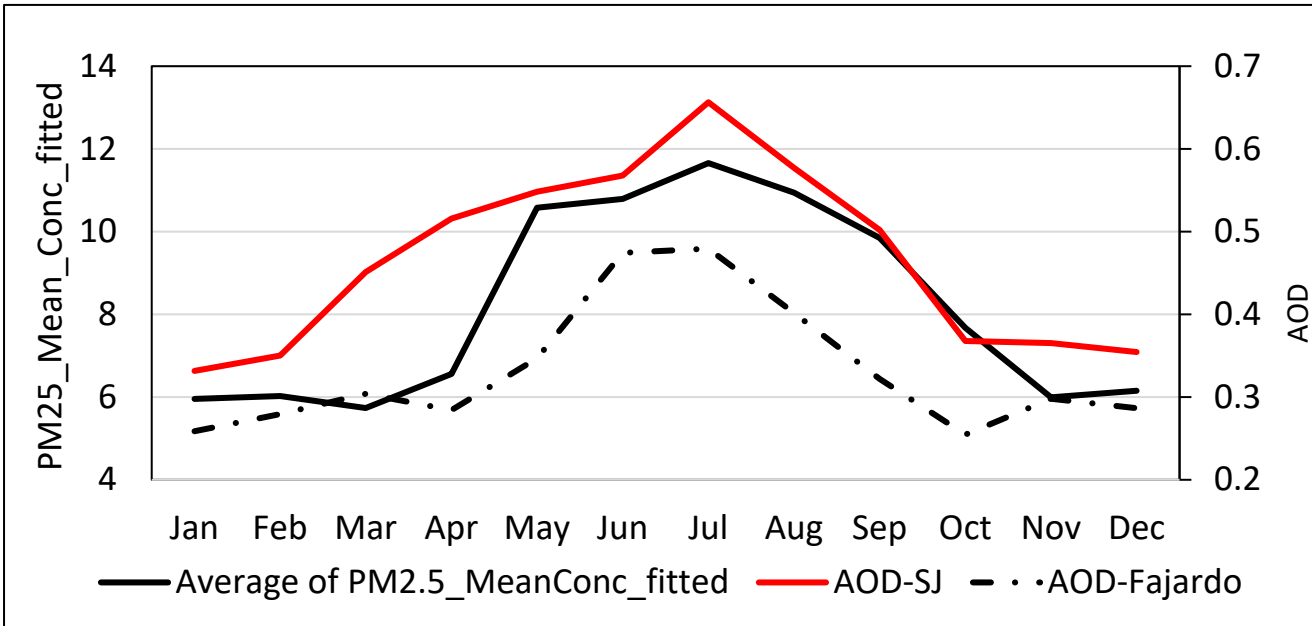


Dust Season in the Caribbean occurs between May and September. (Summer)

The most intense months in Puerto Rico are between the months of June to August.

	#'s of African Dust Events	75th Percentile	90thPercentile	95th Percentile	99.9th Percentile
Autumn	1	5	0	0	0
Spring	10	3	1	0	0
Summer	73	72	32	17	1
Winter	2	1	0	0	0

Aerosol Optical Depth and PM2.5 seasonal patterns



Dust is positively associated with cardiovascular and respiratory conditions in the Caribbean (Lillianne et al. 2019).

Dust outbreaks have also been associated with increased to excessive risk of emergency room visits and hospitalizations related to asthma in children in Trinidad & Tobago (Gyan et al., 2005), Guadeloupe (Cadelis et al., 2015), and Grenada (Akpinar-Elci et al., 2015).

An optical thickness of less than 0.1 indicates a crystal clear sky with maximum visibility, while a value of 1 indicates the presence of aerosols so dense that people would have difficulty seeing the Sun, even at noon.

Journal of the American College of Cardiology Volume 72, Issue 17, October 2018

DOI: 10.1016/j.jacc.2018.07.099

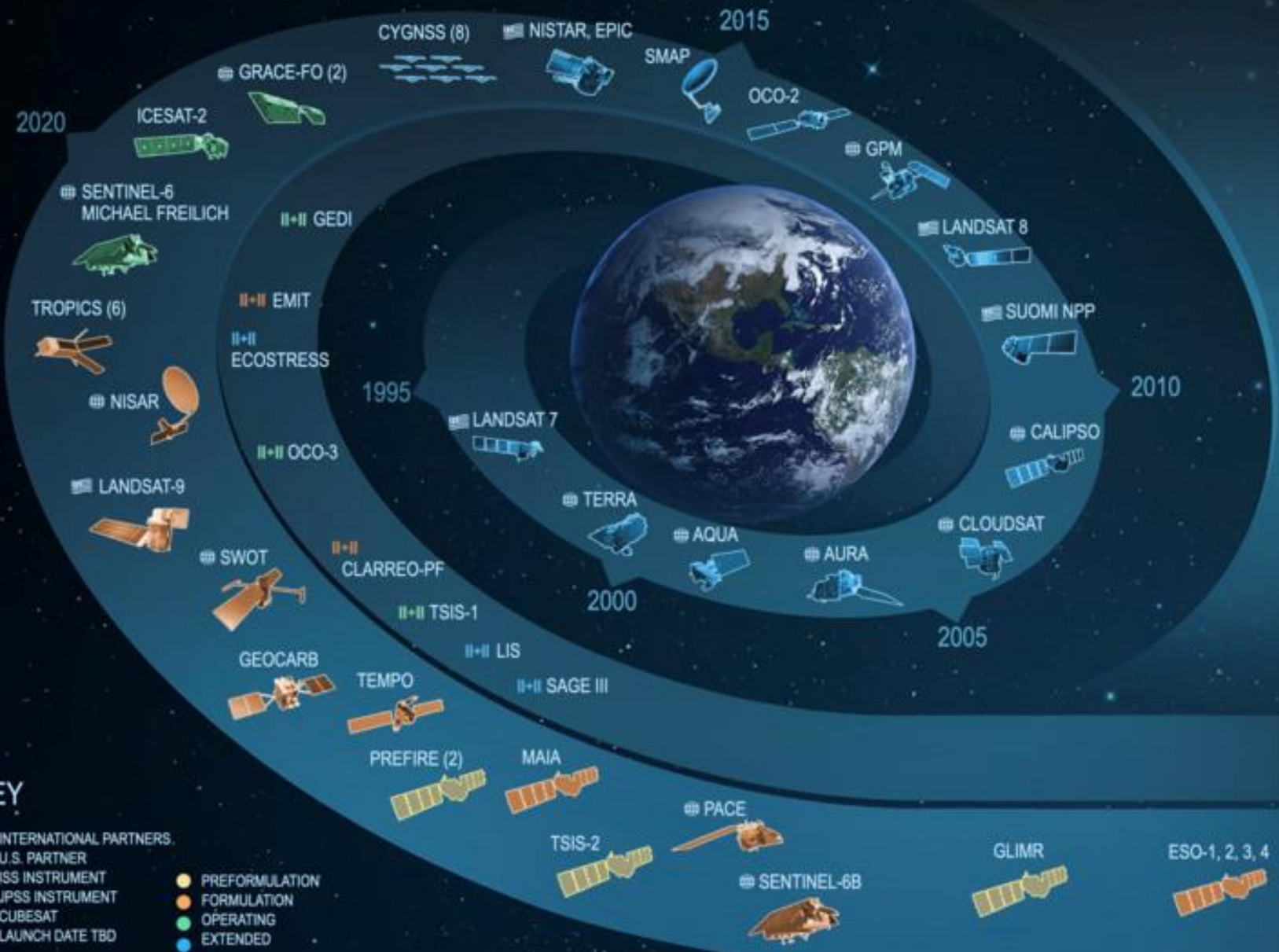
ESO Data

Data Source/Sensor	Variable	Temporal Resolution	Period
Visible Infrared Imaging Radiometer Suite (VIIRS)	AOD (n=1539)	Daily	2012-2020
	SAE (n=1512)		
	MC (n=1368)		
Multi-scale Ultra-high Resolution Sea Surface Temperature	SST (n=1536)	Daily	2012-2020
MODIS-Aqua: Land Surface Temperature	LSTd (n=921)	Daily	2012-2020
	LSTn (n=895)		
ERA5-HEAT (Human thErmAl comforT)	UTCI (n=1539)	Daily	2012-2020
	HI (n=1539)		
	T2M (n=1539)		





EARTH FLEET



INVEST/CUBESATS

- CSIM-FD 2023
- HARP 2022
- CIRIS 2023
- CTIM* 2022
- HYTI* 2022
- SNOOPI* 2022
- NACHOS* 2022
- NACHOS2* 2022

JPSS INSTRUMENTS

- OMPS-LIMB 2022
- LIBERA 2027

ISS INSTRUMENTS


MISSIONS

KEY

- INTERNATIONAL PARTNERS
- U.S. PARTNER
- ISS INSTRUMENT
- JPSS INSTRUMENT
- CUBESAT
- LAUNCH DATE TBD
- PREFORMULATION
- FORMULATION
- OPERATING
- EXTENDED

Earth Observatory (geostationary vs non geostationary)

Geostationary Orbit



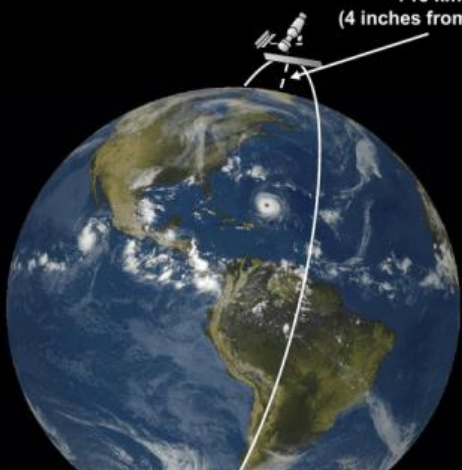
36,000 km (16 feet from SOS)

Geostationary Orbit

Geostationary satellites orbit the Earth's axis as fast as the Earth spins. They hover over a single point above the Earth at an altitude of about 36,000 kilometers (22,300 miles). This orbit allows these satellites to continuously look at the same spot on the earth – important for locating the position of hurricanes and monitoring developing severe storms.

NOAA typically operates two geostationary satellites called GOES (Geostationary Operational Environment Satellite). One has a good view

Polar Orbit



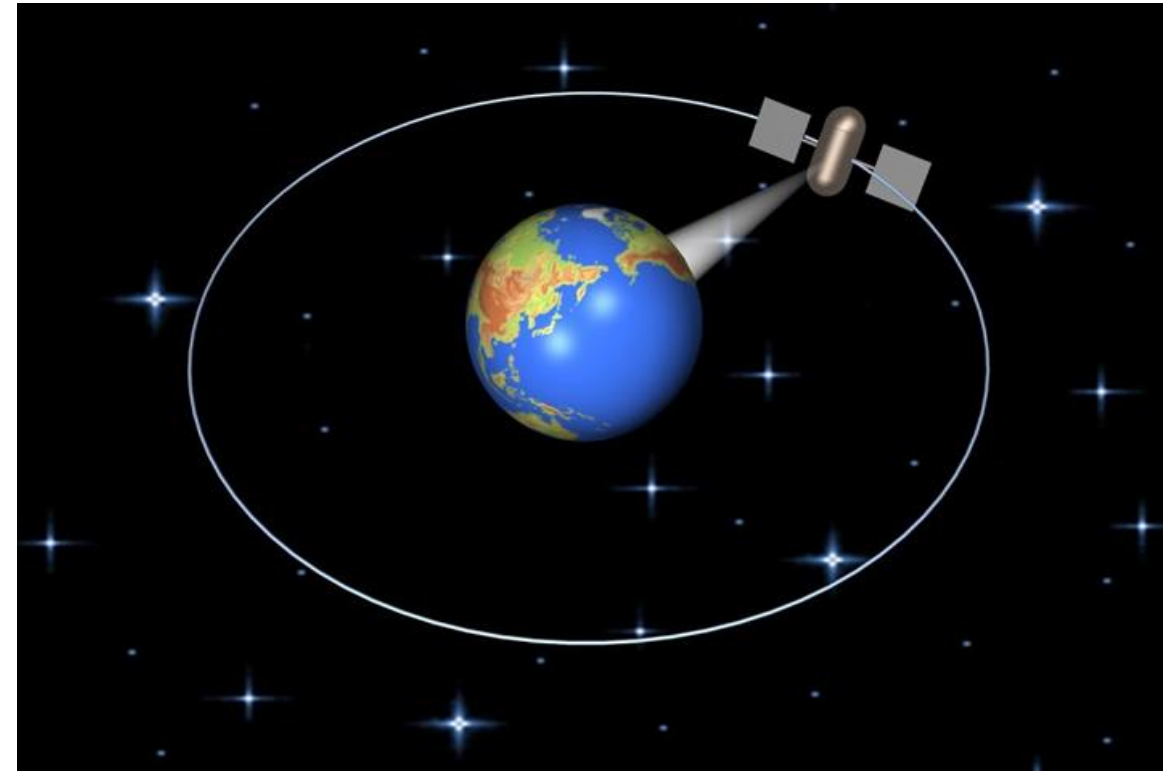
715 km (4 inches from SOS)

Polar Orbit

Polar satellites (also known as sun synchronous satellites) orbit above the Earth at about 715 kilometers (445 miles). Polar satellites monitor strong storms that move across the poles (regions of the Earth that Geostationary satellites cannot view).

NOAA typically operates two polar satellites. One satellite views the afternoon portion of the Earth, while the other views the morning portion of the Earth.

SPACELINE AND ATMOSPHERE 2014



Impacting Decision Making Activities:

Co-design strategies and solutions by engaging scientist and public health officials in all project phases.

Communicating Risks and working with end-users

POLVO DEL SAHARA Y ASMA

El Polvo del Sahara es uno de los factores ambientales asociado a complicaciones respiratorias. Estas nubes pueden contener virus, bacterias, materia orgánica, esporas de hongos, entre otros, que a su vez, se consideran provocadores del asma.

El asma es una enfermedad crónica que se caracteriza por la inflamación y estrechamiento de las vías respiratorias, produciendo un exceso de mucosidad que dificulta el paso del aire.



En Puerto Rico, aproximadamente:



1 de cada 6 niños tiene asma actual



1 de cada 10 adultos tiene asma actual

Ante eventos asociados al polvo del Sahara, es importante que todas las personas tomen precauciones, especialmente aquellas que padecen de enfermedades respiratorias.

- Use sus medicamentos de mantenimiento, y tenga disponible los medicamentos de rescate.
- Limite sus actividades al aire libre. Si necesita salir, haga uso de mascarilla y gafas.
- Manténgase hidratado.



DEPARTAMENTO DE SALUD



October 07, 2021

Mariane Alvarado López, MPHE, CHES®, CGG

Educadora en Salud del Programa de Manejo y Control del Asma

Departamento de Salud de Puerto Rico

División de Prevención y Control de Enfermedades Crónicas

Secretaría Auxiliar para la Promoción de la Salud

mariane.alvarado@salud.pr.gov

www.salud.gov.pr

<http://www.proyectoasmapr.com>

Teléfono: (787) 765-2929 Ext. 4157

Puerto Rico Department of Hazard and Vulnerability Assessment (every 5 years).

AEROSOLS/SAHARAN DUST
LAST UPDATE: APR 13 12:00 PM AST

Share Tweet

GAUGE SAN JUAN, PR ⓘ



GAUGE PONCE, PR ⓘ



GAUGE MAYAGUEZ, PR ⓘ



GAUGE FAJARDO, PR ⓘ



PARTICULATE MATTER AND O...

AirNow

Current Forecast Loops



Higüey

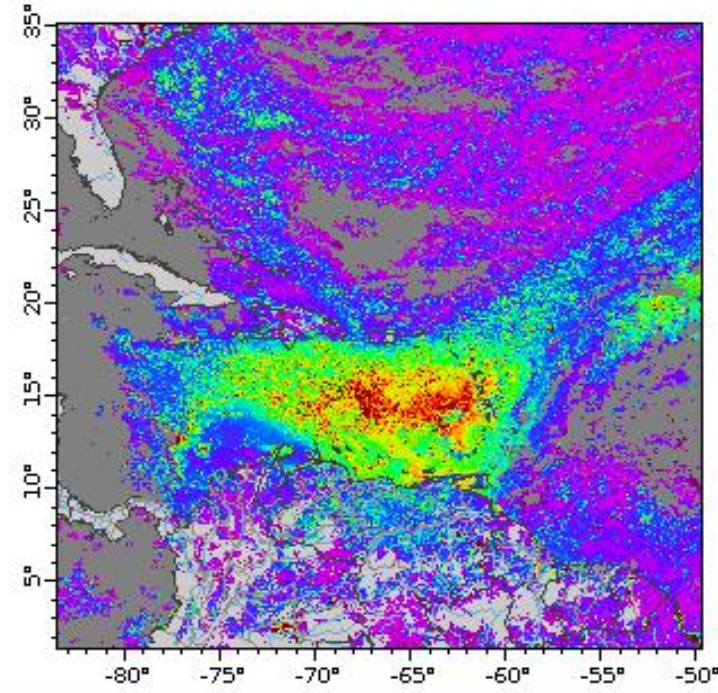
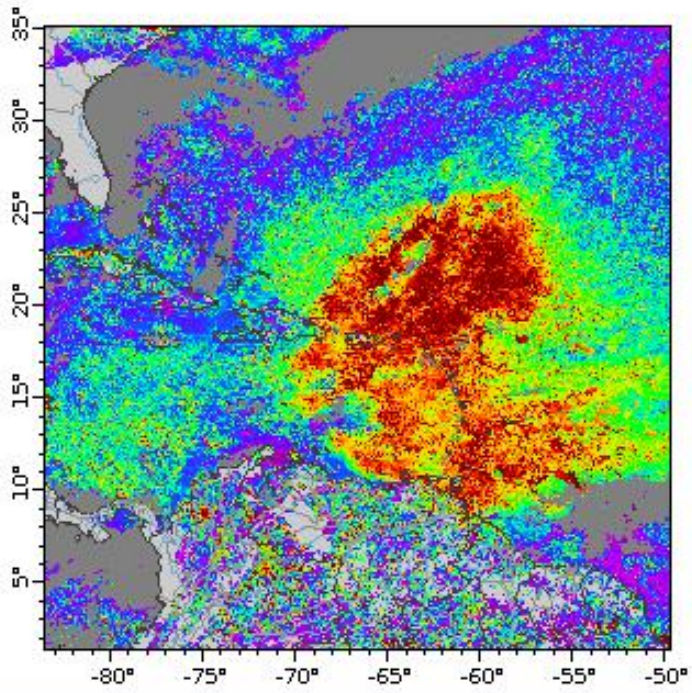


“X-perimental Decision Support Tool “

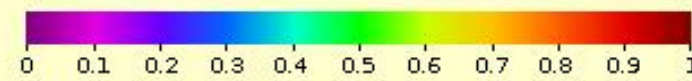
GOES-16: daily datasets: Experimental NRT AOD daily composite created from ABI L2 data from GOES-16. Fields generated by Atlantic OceanWatch node at NOAA/AOML

July 07, 2021

June 29, 2021



ABI L2+ Aerosol Optical Depth at 550 nm (1)
 Experimental NRT AOD daily composite created from ABI L2 data from GOES-16. Fields generated by Atlantic OceanWatch node at NOAA/AOML (2021-07-07T00:00:00Z)
 Data courtesy of USDOC/NOAA/OAR/AOML/PHOD



ABI L2+ Aerosol Optical Depth at 550 nm (1)
 Experimental NRT AOD daily composite created from ABI L2 data from GOES-16. Fields generated by Atlantic OceanWatch node at NOAA/AOML (2021-06-29T00:00:00Z)
 Data courtesy of USDOC/NOAA/OAR/AOML/PHOD



Rico 14m

What is Saharan Dust?
¿Qué es polvo del Sahara?
#prwx #usviwx

SAHARA DUST

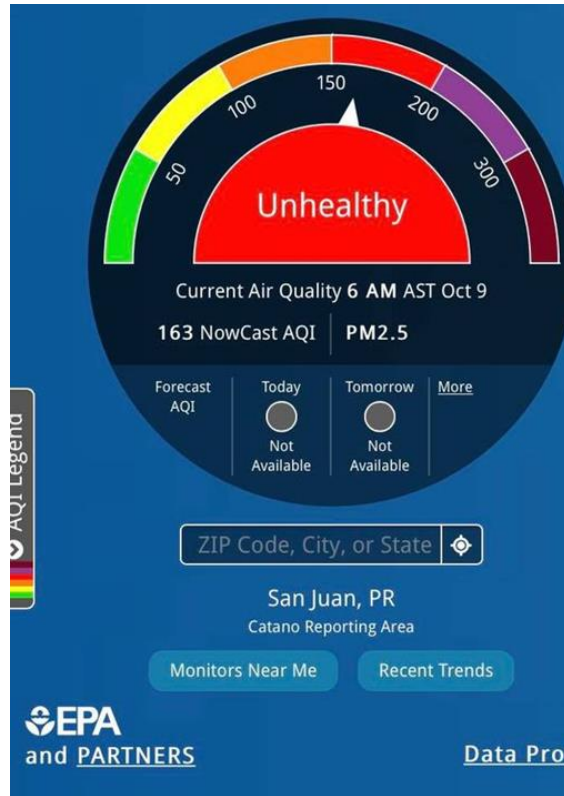
¿Qué es el "Polvo del Sahara"?

¿Qué puede contener el "Polvo del Sahara"?

¿Cuáles son los efectos del "Polvo del Sahara" a la Salud Pública?

Síntomas asociados a la presencia del "Polvo del Sahara"

Prevenición Para Eventos De "Polvo Del Sahara"



Ada Monzon 5m

...a Aerosoles de CARICOOS.org que aunque no distingue...
...partículas, sí establece su concentración general. Vea cómo...
...y. 😊

QUALITY INDEX

AN JUAN, PR PONCE, PR MAYAGUEZ, PR FAJARDO

0.33 0.64 0.33 0.64 0.33 0.64

0.97 N/A N/A 0.85

VERY HIGH

GOOD (0-0.23) MODERATE (0.23-0.33) HIGH (0.33-0.64) VERY HIGH (>0.64)

AEROSOL/ES. CARICOOS.ORG

RICOOOS Latest Conditions and Forecast

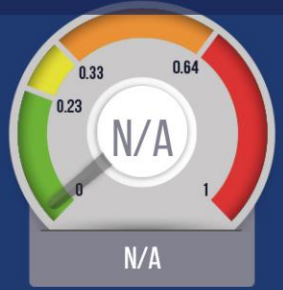
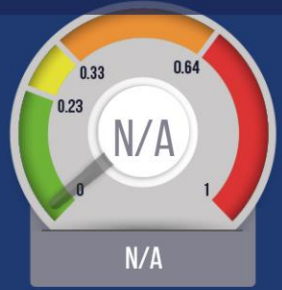
8 5 Comments

Like Comment Share

October 3rd, 2021

CARICOOS

PONCE, PR



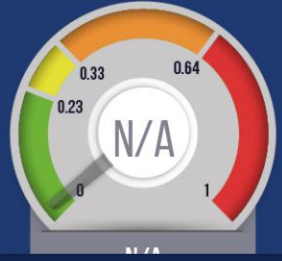
FORECAST

24HS

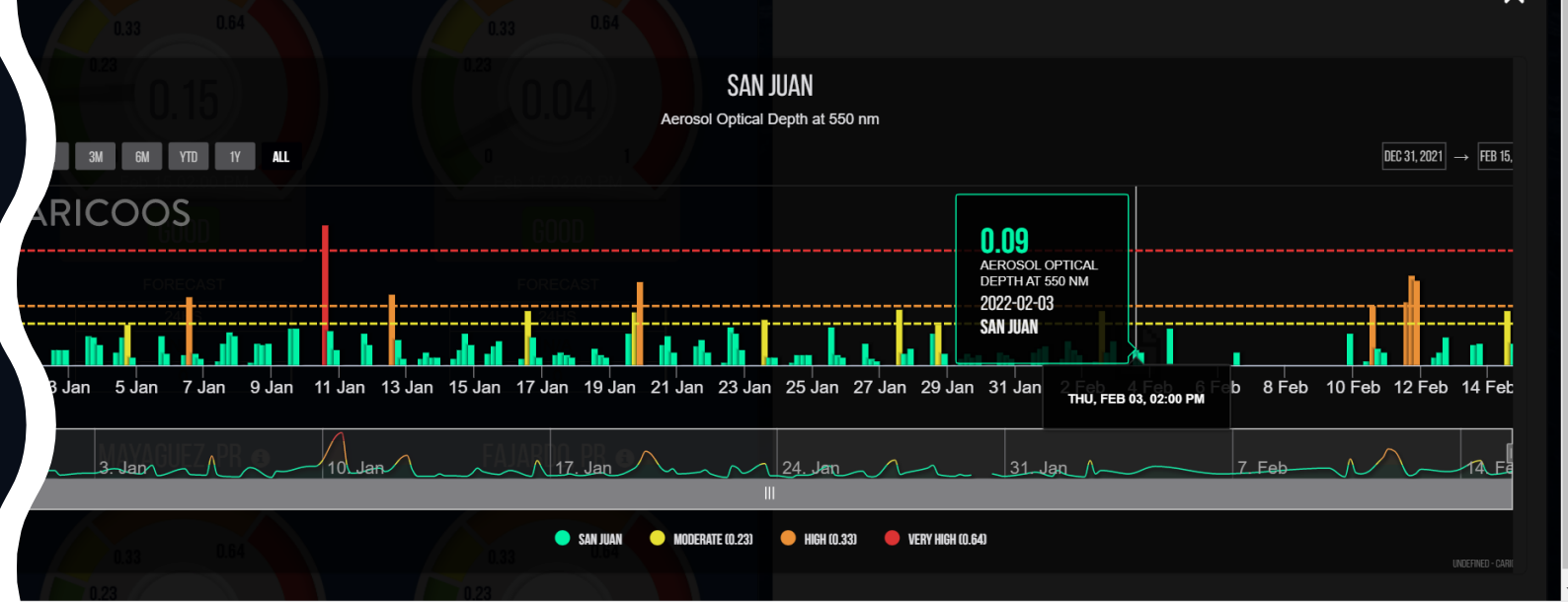
FORECAST

24HS

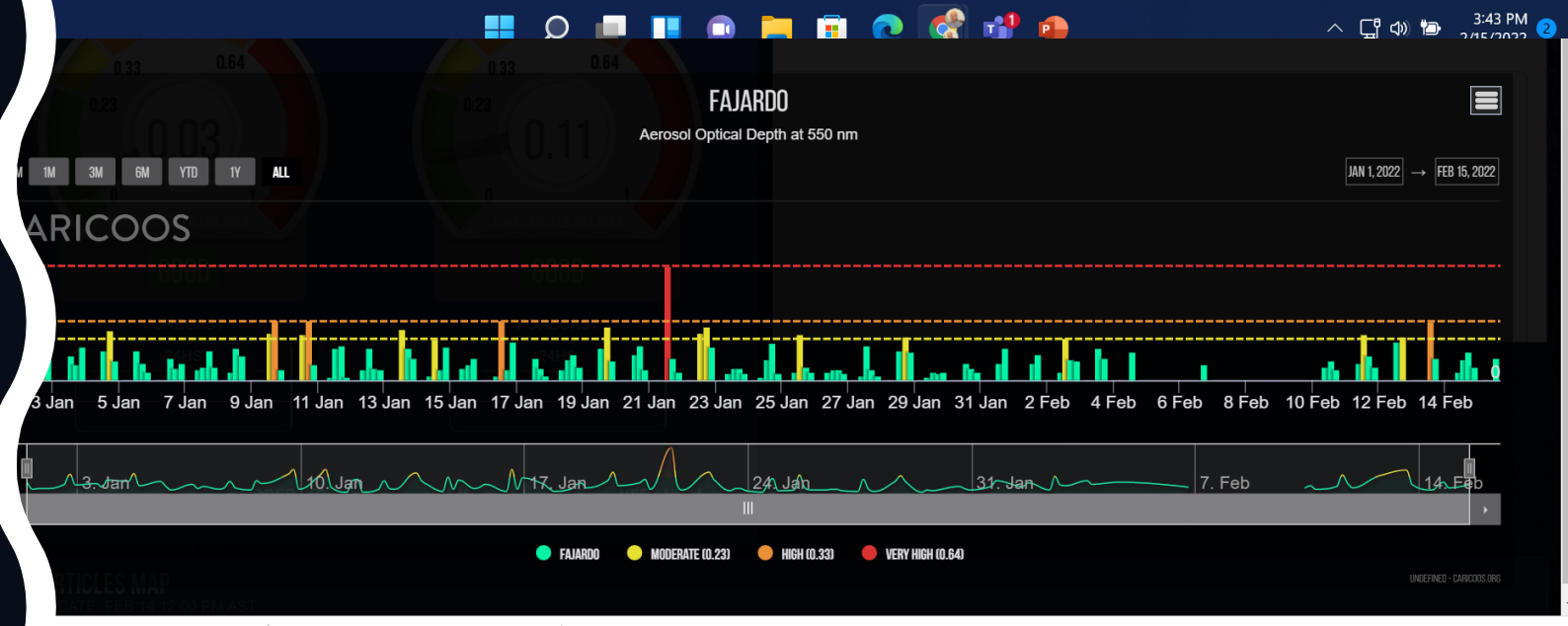
MAYAGUEZ, PR



FAJARDO, PR



noaa-nos-techrpt0...pdf | IQA_Decision_Tree...pdf | Show all



noaa-nos-techrpt0...pdf | IQA_Decision_Tree...pdf | Show all



October 13, 2022

The screenshot shows the website endi.com (EL NUEVO DIA.COM) with the date 'martes, 1 de noviembre de 2022'. The main headline reads: 'Precaución: este jueves es el pico del evento de polvo del Sahara que está sobre Puerto Rico'. Below the headline, it states: 'Tanto el índice de calidad de aire como la cantidad de aerosoles en el aire siguen en niveles moderados'. The website also features a navigation menu with categories like 'ÚLTIMA HORA', 'Noticias', 'Videos', 'Somos PR', 'Negocios', 'Entretenimiento', 'Deportes', 'Opinión', 'EE.UU.', 'Mundo', 'Estilos de vida', and 'PARA SUSCRIBIDORES'. A Liberty Wowfi advertisement is visible at the top.

The screenshot shows a Twitter post from NWS San Juan (@NWSsanJuan) dated 7:08 a. m. · 13 oct. 2022. The tweet text is: 'Today, expect mainly hazy skies. These images contain some information about the Saharan Dust and health suggestions.' and 'Hoy, se espera que el cielo esté mayormente brumoso. Estas imagenes contienen información sobre el polvo del Sahara y algunas sugerencia de salud.' Below the text is a two-panel infographic titled 'SAHARA DUST'. The infographic provides information in both English and Spanish, including: 'What is the Saharan Dust?', 'What does it contain?', 'Impacts to Public Health', and 'Prevention for Saharan Dust event'. The English text includes: 'Saharan dust is a natural fertilizer providing benefits to crops and terrestrial ecosystems. In addition, it can be considered hazardous to public health. It is transported by trade winds over the Atlantic Ocean and travels over 5,000 km to reach the Caribbean including Puerto Rico.' The Spanish text includes: 'El polvo de polvo se mueve como aerosol en la atmósfera y puede contener: metales pesados, minerales orgánicos, sales marinas, cenizas y bacterias. El polvo del Sahara es un fertilizante natural que provee beneficios ecosistémicos marinos y terrestres. Es transportado por los vientos alisios sobre el Océano Atlántico y recorre sobre 5,000 km para alcanzar las costas de Puerto Rico y el Caribe.' The prevention section in English lists: 'Wear your mask outdoors', 'Avoid outdoor activities', 'Keep hydrated', 'Use eye goggles', and 'Use light clothing'. The Spanish section lists: 'Usar mascarilla al salir', 'Evitar actividades al aire libre', 'Mantenerse hidratado', and 'Usar ropa ligera'.



DR. PABLO MÉNDEZ-LÁZARO

Associate Professor, University of Puerto Rico
Medical Sciences Campus
+ NASA-Funded Principal Investigator

at the University of Puerto
Rico Medical Sciences Campus in San Juan,



An Early Warning System Helps Puerto Rico Prepare for Saharan Dust

NASA Video
873K subscribers [Subscribe](#) 122 Share

1.9K views 2 weeks ago
Puerto Ricans can breathe easier thanks to the work of John Haynes, program manager of the NASA Earth Applied Sciences Health and Air Quality program area, and Pablo Méndez-Lázaro, an associate professor at the University of Puerto Rico Medical Sciences Campus in San Juan, and principal investigator for thi ...more



PEOPLE

Tracking Saharan Dust to Safeguard Public Health

PROGRAM AREA: [HEALTH & AIR QUALITY](#)

CARICOOS Facebook

HOW DOES THE SAHARAN DUST AFFECT YOU?

Evidence suggests that high exposure to these aerosols can cause asthma, cardiovascular events, and other serious health problems.

Did you know that our Aerosol Tool can help you monitor it?

CARICOOS MONITOREO DE AEROSÓLES

Check out our tool at **AEROSOLS.CARICOOS.ORG** to get the current measurement and forecasts for your hometown, the Caribbean & the entire North Atlantic

Location	Measurement	Forecast
PONCE, PR	0.25	Moderado
MAYAGUEZ, PR	0.12	Moderado
FAJARDO, PR	0.32	Moderado
ALTO	0.33	Moderado
MUY ALTO	> 0.64	

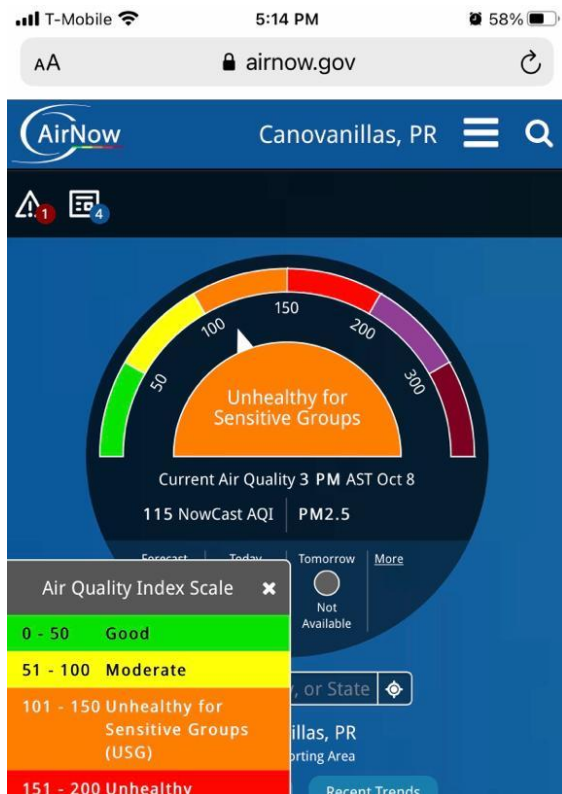


WHAT DOES THE TOOL DO?

The Aerosol Tool monitors air quality by tracking Saharan dust particles as they travel towards the Caribbean.

Want to see what it looks like?





POLVO DEL SAHARA Y ASMA

El Polvo del Sahara es uno de los factores ambientales asociado a complicaciones respiratorias. Estas nubes pueden contener virus, bacterias, materia orgánica, esporas de hongos, entre otros, que a su vez, se consideran provocadores del asma.

El asma es una enfermedad crónica que se caracteriza por la inflamación y estrechamiento de las vías respiratorias, produciendo un exceso de mucosidad que dificulta el paso del aire.

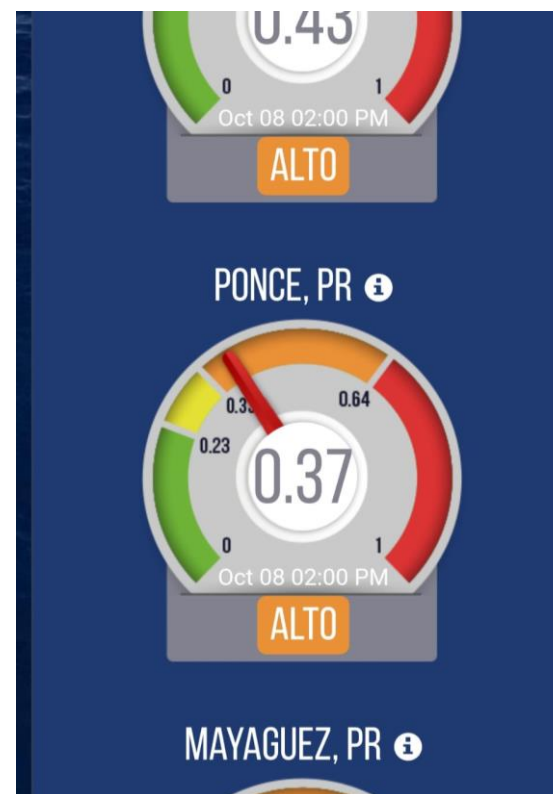
En Puerto Rico, aproximadamente:

- 1 de cada 6 niños tiene asma actual
- 1 de cada 10 adultos tiene asma actual

Ante eventos asociados al polvo del Sahara, es importante que todas las personas tomen precauciones, especialmente aquellas que padecen de enfermedades respiratorias.

- Use sus medicamentos de mantenimiento, y tenga disponible los medicamentos de rescate.
- Limite sus actividades al aire libre. Si necesita salir, haga uso de mascarilla y gafas.
- Manténgase hidratado.

Logos: NASA, PR-CLIMAH, SALUD



Area Forecast Discussion
 Issued by NWS San Juan, PR

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 FXCA62 TJSJ 072012
 AFDSJU

Area Forecast Discussion
 National Weather Service San Juan PR
 412 PM AST Thu Oct 7 2021

.SYNOPSIS...
 Saharan dust will result in hazy skies through at least e the weekend. However, afternoon activity may still develop the northwestern quadrant of Puerto Rico. **Unsettled** weath conditions are expected for the first half of the next wo: **Seas** are gradually improving, but still remaining a littl

&&

.SHORT TERM...Tonight through Saturday...
 A surface high pressure over the central Atlantic will ma moderate east-southeast wind **flow** through the next severa At the mid-levels, a **ridge** holds just west of Puerto Rico at the upper levels, a **trough** lingers north of the island: **infrared satellite imagery** shows small areas of clouds ad toward the region. The high resolution models have some o areas reaching portions of the U.S. Virgin Islands and ea: southeast Puerto Rico, but with **rainfall** accumulation mai one inch.

On Friday, a drier **air mass** east of the **Leeward** Islands a evident in Total **Precipitable Water** from **GOES-16** will rea local islands, with values falling to 1.3 to 1.5 inches. ' mass also contain Saharan dust, that will linger at least early in the weekend, hence hazy skies are expected. Each Friday and Saturday, passing showers may move over portio: eastern Puerto Rico and the U.S. Virgin Islands through t then in the afternoon showers with **isolated** thunderstorms develop over the interior and northwestern Puerto Rico.

October 07, 2021

Media Coverage

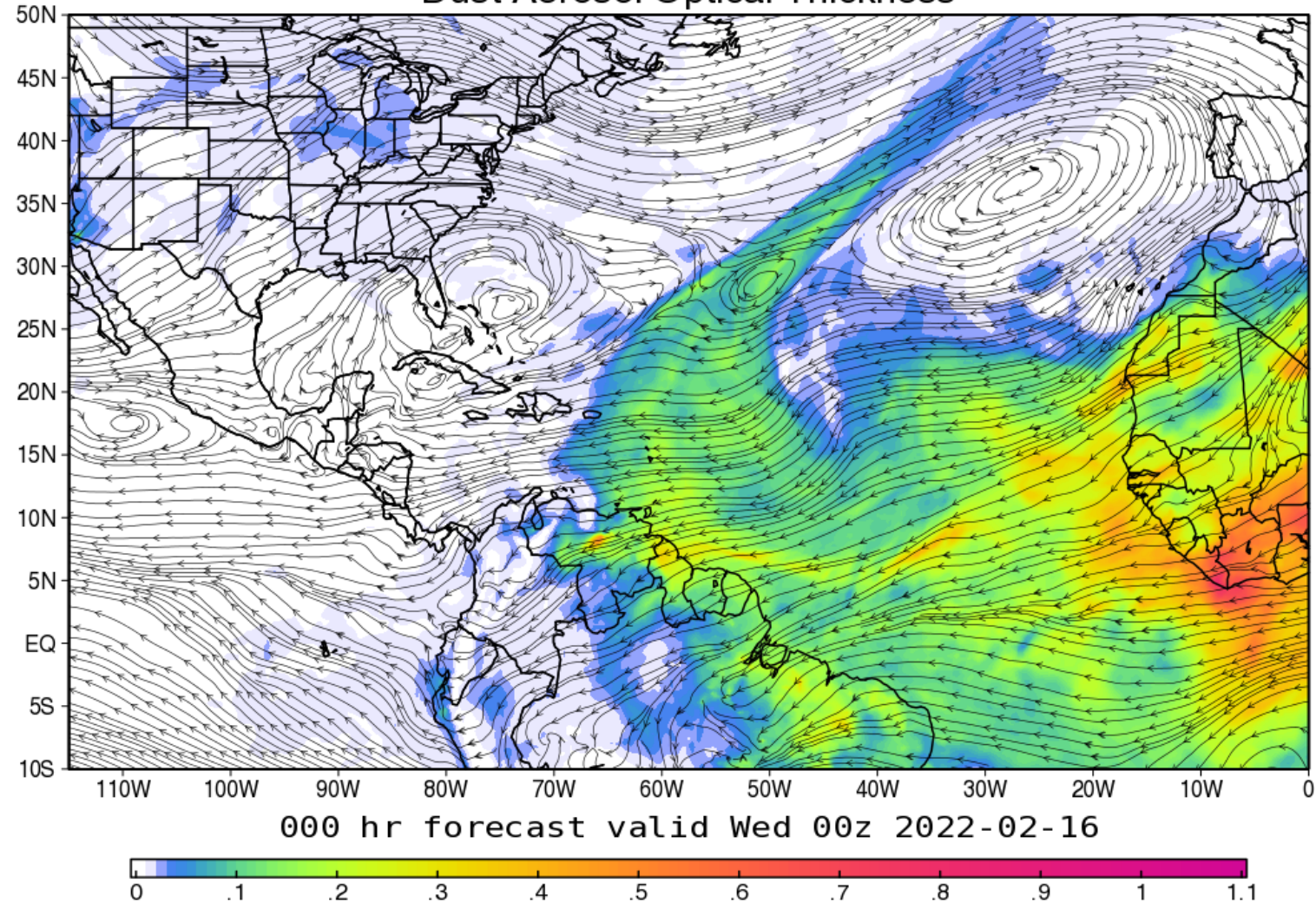
- <https://www.primerahora.com/noticias/puerto-rico/notas/insalubre-la-calidad-del-aire-ante-presencia-de-polvo-del-sahara/>
- <https://www.noticel.com/el-tiempo/20211009/continua-insalubre-el-indice-de-calidad-del-aire/>
- <https://www.elnuevodia.com/noticias/el-tiempo/notas/la-calidad-de-aire-amanece-insalubre-en-varias-partes-de-puerto-rico/>
- <https://www.elnuevodia.com/noticias/locales/notas/densa-bruma-que-afecta-a-puerto-rico-desde-hace-una-semana-deteriora-la-calidad-del-aire/>



October 07, 2021

NASA/GMAO - GEOS Forecast Initialized on 00z 02/16/2022

Dust Aerosol Optical Thickness



February 15-16, 2022



Programa de Asma de Puerto Rico

131 followers

4h

Aquí le compartimos nuevamente información importante sobre el Polvo del Sahara.

#AsmaPR #DepartamentodeSalud #ProgAsma

SALUD PÚBLICA Y POLVO DEL SAHARA

¿Qué es el "Polvo del Sahara"?

Partículas de polvo mineral provenientes del desierto del Sahara y del desierto del Sahel, al norte del continente africano.

¿Qué puede contener el "Polvo del Sahara"?

- Las nubes de polvo se miden como aerosoles en la atmósfera y podrían contener, pero no se limitan a: minerales, materia orgánica, sales marinas, virus y bacterias.
- El "Polvo del Sahara" es un fertilizante natural y provee beneficios a ecosistemas marinos y terrestres. De igual manera podría ser perjudicial para la salud pública.
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Impactos del "Polvo del Sahara" a la Salud Pública

- Puede exacerbar las condiciones de salud en poblaciones inmunocomprometidas, vulnerables y sensitivas.
- Los médicos y científicos han observado un aumento en el número de exacerbaciones de las condiciones respiratorias entre sus pacientes durante los eventos de "Polvo del Sahara".

Síntomas asociados a la presencia del "Polvo del Sahara"

- Irritación de la nariz
- Sinusitis
- Alergias
- Exacerbación del asma
- Irritación de la garganta
- Irritación de los ojos e irritación de la piel
- Bronquitis aguda
- Riesgo de infecciones respiratorias

Prevención Para Eventos De "Polvo Del Sahara"

- Tener disponible sus medicinas
- Mantenerse hidratado
- Usar ropa ligera
- Evitar actividades al aire libre
- Usar mascarilla y gafas



www.proyectoasmapr.com programa.asma@salud.pr.gov

3:46 [social icons] 23%



Programa de Asma de Puerto Rico

131 followers

8h

El particulado de polvo del Sahara provocará mucho calor y nubosidad toda la semana, y se espera que este patrón se extienda durante el resto de la semana laboral.

Tome medidas de prevención utilizando sus medicamentos de control para evitar crisis asmática y tenga listo su medicamento de rescate. Utilice mascarilla y gafas si planea realizar actividades al aire libre. #AsmaPR #ProgAsma #DepartamentodeSalud

ARENA y POLVO DEL SAHARA Ilega al Caribe

La nube de arena y polvo que llega a América desde el desierto del Sahara puede causar enfermedades al ser humana y daños a algunos ecosistemas. Sin embargo también contribuye al crecimiento de selvas amazónicas.

Recorrido

Las nubes se desplazan desde África por los vientos alisios (dirección oeste) y una parte de estas avanza por las islas Canarias y afecta a varios países Europeos mientras otras van por el Atlántico y llegan al Mar Caribe.

7,500 km
es el recorrido de
nube de polvo y arena



6 días
tarda en llegar
las partículas del polvo
al Mar Caribe.

Sabías que...

La Organización Panamericana de la salud recomendó uso de mascarillas para los personas con males respiratorias crónicas.

Medidas de Prevención contra el "Polvo del Sahara"

- Tener disponible sus medicinas.
- Mantenerse hidratado.
- Usar ropa ligera.
- Evitar actividades al aire libre.

NATIONAL WEATHER SERVICE
SAN JUAN, PUERTO RICO

*Air Quality
Awareness Week*

Moderators:
Ian Colón-Pagán (left)
Fernanda Ramos (right)



Register:


WEBINAR: Saharan Dust & Air Quality.
Thursday, May 6th, 2021 | 11:00 AM - 12:00 PM AST

 **Ernesto Morales:** What is the NWS WFO San Juan?

 **Ernesto Rodríguez:** WFO San Juan & Air Quality Events

 **Dra. Olga L. Mayol-Bracero:** African Dust Measurements in the Caribbean

 **Dra. Odalys Martinez:** African Dust in PR & USVI








 **Dr. Pablo Méndez-Lázaro:** Aerosol Monitoring Support Tool



WEBINARS Edición Polvo del Sahara y Salud Pública


13 al 17 de julio de 2020
3:00 p.m. a 4:00 p.m.

CienciaVirtual

<p>lunes 13</p> <p>Sistemas de alertas temprana de polvo del Sahara para proteger la salud pública</p> <p>Dr. Pablo Méndez Lázaro, Catedrático Asociado, UPR-RCM, Investigador Principal; NASA CALIMA-PH</p> <p>Registro: </p>	<p>miércoles 15</p> <p>Taller: Cocinando en el EcoExploratorio</p> <p>Chef Cely, Chef de Hostelería al Amanteo, Chef de Actividades de la UAGR</p> <p>Registro: </p>
<p>martes 14</p> <p>El polvo del Sahara visto desde el espacio</p> <p>Dra. Digna Rueda-Roa, Biólogo Marino USF College of Marine Science, NASA CALIMA-PH</p> <p>11:00 a.m.</p> <p>Registro: </p> <p>Pronóstico del Tiempo: Aerosoles y Polvo del Sahara en Puerto Rico</p> <p>Ernesto Rodríguez MS y Ernesto Morales MS del Servicio Nacional de Meteorología de San Juan, NOAA</p> <p>3:00 p.m.</p> <p>Registro: </p>	<p>jueves 16</p> <p>Impacto del Polvo del Sahara en la salud: Esfuerzos de investigación en Puerto Rico</p> <p>Dra. Ana P. Ortiz, PhD, MPH, Profesora UPR-RCM, Centro Comprensivo de Cáncer, NASA CALIMA-PH</p> <p>Registro: </p>
<p>viernes 17</p> <p>NASA GEOS Aerosol forecasting system and its application to Saharan dust transport</p> <p>Dr. Peter Colarco, Profesor, University of Miami</p> <p>Registro: </p>	<p>viernes 17</p> <p>Polvo del Sahara en Puerto Rico: ¿Qué es y cómo se mide?</p> <p>Dra. Olga Mayol Bracero, Catedrática, ACAR, UPR-Río Piedras, Co-investigadora Principal; NASA CALIMA-PH</p> <p>Registro: </p>

Registro: www.ecoexploratorio.org/cienciavirtual Capacidad: ZOOM 500 personas Live ilimitada

Un certificado de participación será otorgado a toda persona que complete el webinar a través de la plataforma de ZOOM. Ciertas restricciones aplican. Para más información, favor de escribir a webinar@ecoexploratorio.org



SALUD PÚBLICA Y POLVO DEL SAHARA

¿Qué es el "Polvo del Sahara"?

Partículas de polvo mineral provenientes del desierto del Sahara y del desierto del Sahel, al norte del continente africano.

¿Qué puede contener el "Polvo del Sahara"?

- Las nubes de polvo se miden como aerosoles en la atmósfera y podrían contener, pero no se limitan a: minerales, materia orgánica, sales marinas, virus y bacterias.
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Prevención Para Eventos De "Polvo Del Sahara"

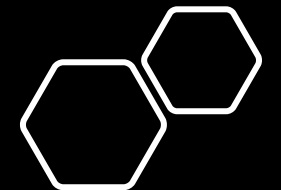
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www.proyectoasmpr.com programa.asma.salud.pr.gov



Co-design strategies and solutions by engaging scientist and public health officials in all project phases.

>400,000 people impacted



Project Title (long version): Study of Imminent Interactions between SARS-CoV-2 (COVID-19), Air Quality due to Saharan Dust and Urban Aerosols, and Social-Environmental Factors in Puerto Rico in summer 2020: Proxies of Health Risks in Small Island States in the Caribbean Region.

NASA Grant Number 80NSSC20K1588

- **Funding Opportunity:** Rapid Response and Novel Research in Earth Science NNH20ZDA001N-RRNES
- **Investigators:** Pablo Méndez-Lázaro (PI), Frank Muller-Karger (Co-I), Ana P. Ortiz-Martínez (Co-I), Cynthia Pérez-Cardona (Co-I), Daniel Otis (Co-I), David De Angel Solá (Co-I), Benjamin Bolaños (Co-I).
- **Institutions:** University of Puerto Rico-Medical Sciences Campus, Graduate School of Public Health, San Juan-Puerto Rico (<http://sp.rcm.upr.edu/>); University of South Florida, College of Marine Science (<http://www.marine.usf.edu/>), St. Petersburg, Florida

Study of Imminent Interactions between SARS-CoV-2 (COVID-19), Air Quality due to Saharan Dust and Urban Aerosols, and Social-environmental Factors in Puerto Rico in summer 2020: Proxies of Health Risks in Small Island States in the Caribbean Region (80NSSC20K1588)

In the Caribbean islands, Saharan dust is associated with increased to excessive risk of emergency room visits and hospitalizations related to respiratory diseases.

On the other hand, the coronavirus SARS-CoV-2 responsible for the present COVID-19 pandemic increases the risk of mortality due to severe respiratory illness and cardiac injury.

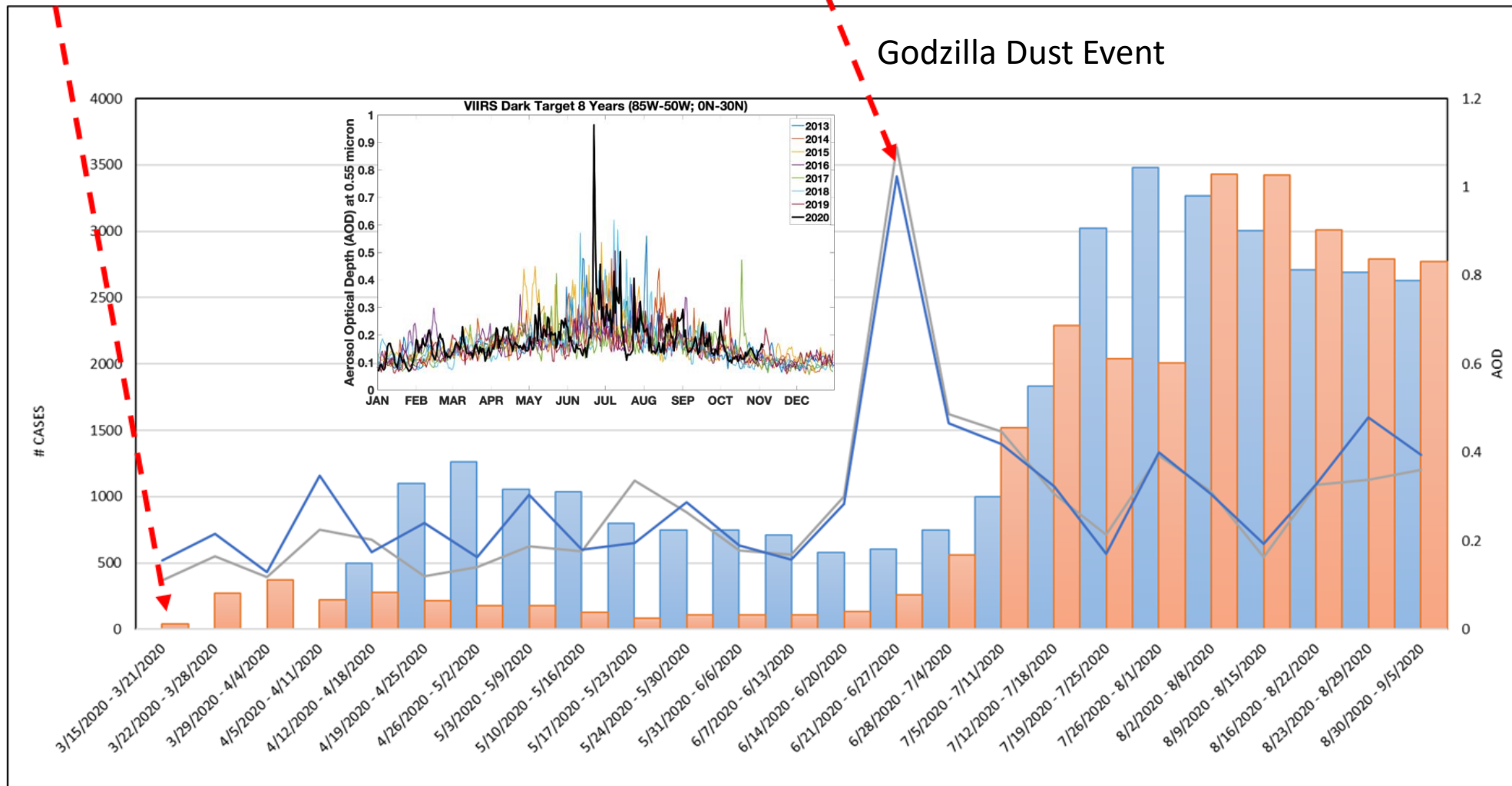
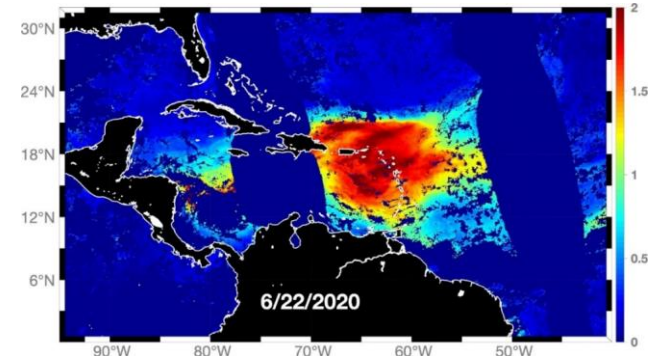
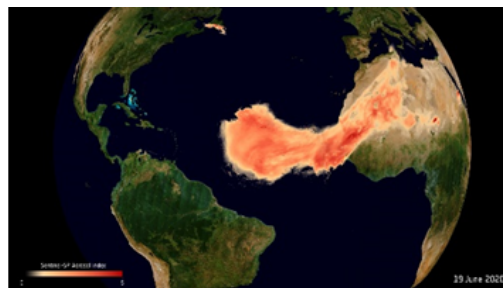
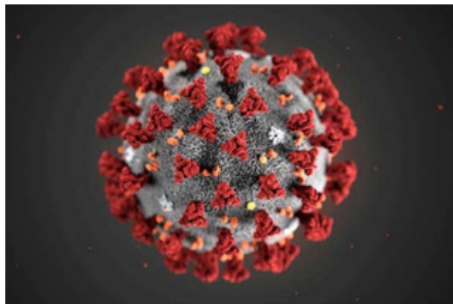
The goal of the proposed work is to expand the scope of a current NASA-sponsored African dust research (80NSSC19K0194) to better understand possible interactions between COVID-19, Saharan dust, and environmental factors (air temperature, sea surface temperature, and precipitation) in Puerto Rico.

Study of Imminent Interactions between SARS-CoV-2 (COVID-19), Air Quality due to Saharan Dust and Urban Aerosols, and Social-environmental Factors in Puerto Rico in summer 2020: Proxies of Health Risks in Small Island States in the Caribbean Region

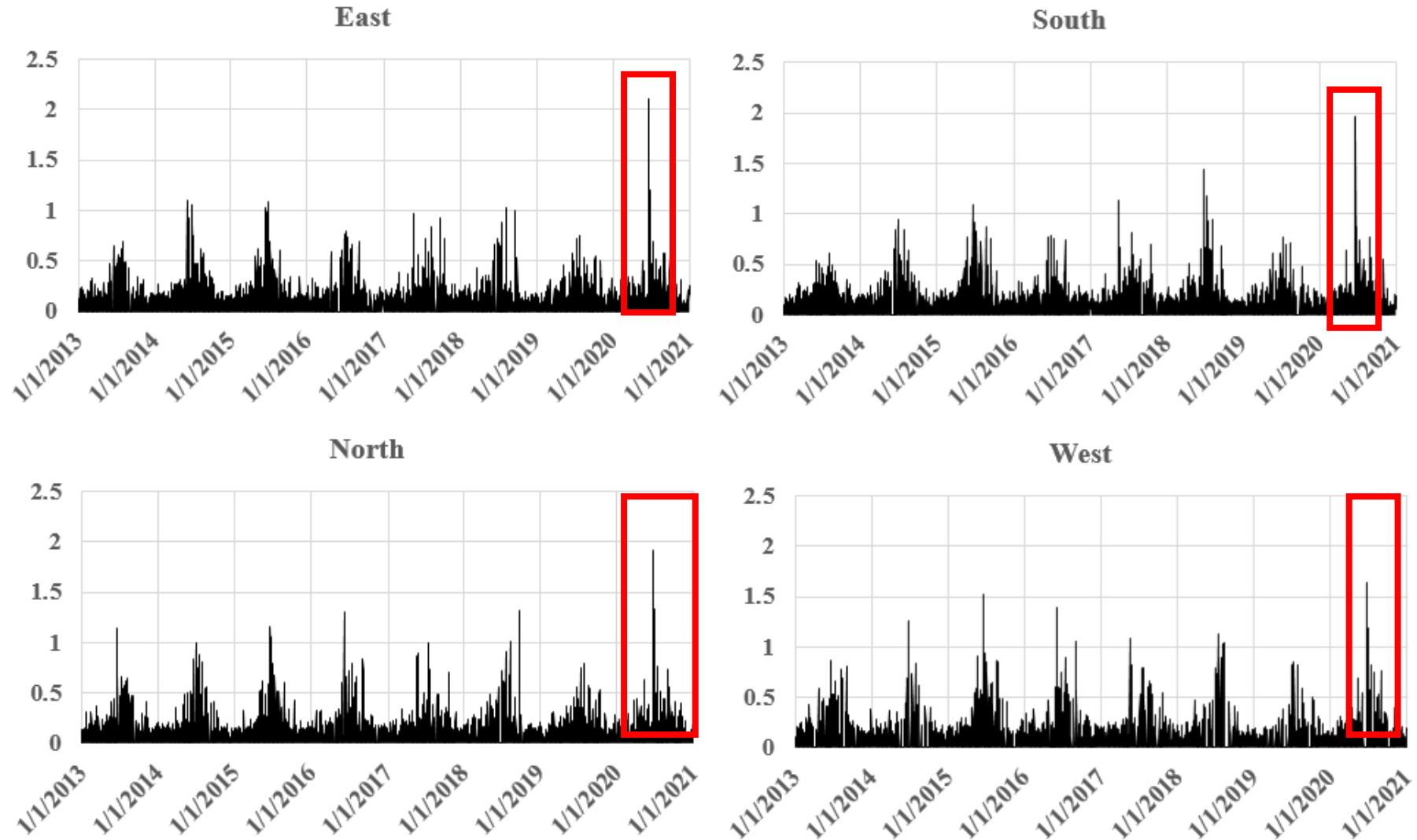
- Designed and implemented (Cross sectional study) qualitative instruments aiming to capture **physicians and patients' risks, barriers, and vulnerabilities.**
 - Physicians N=55
 - Patients COVID-19 confirmed cases N=104
 - IRB-Protocol Number B1540520
- **Emergency Room Visits and Hospitalizations-2020-2021**
 - COVID-19 Weekly 2020-2021
 - Weekly in specific diseases of the respiratory system.

- **All Causes Excess Mortality Analysis Islandwide (weekly 2015-2020) Including COVID-19**
 - Weekly average deaths during 2015-2020: overall and by season
 - Weekly average deaths during 2015-2020: overall by year of death for each season
 - Weekly average during 2015-2020 in specific diseases of the respiratory system.
 - COVID-19 Mortality Analysis (weekly 2020)
 - RR adjusted by environmental data (weekly 2015-2020)

1st COVID-19 Confirmed Case In Puerto Rico



Godzilla Dust Event: Summer 2020



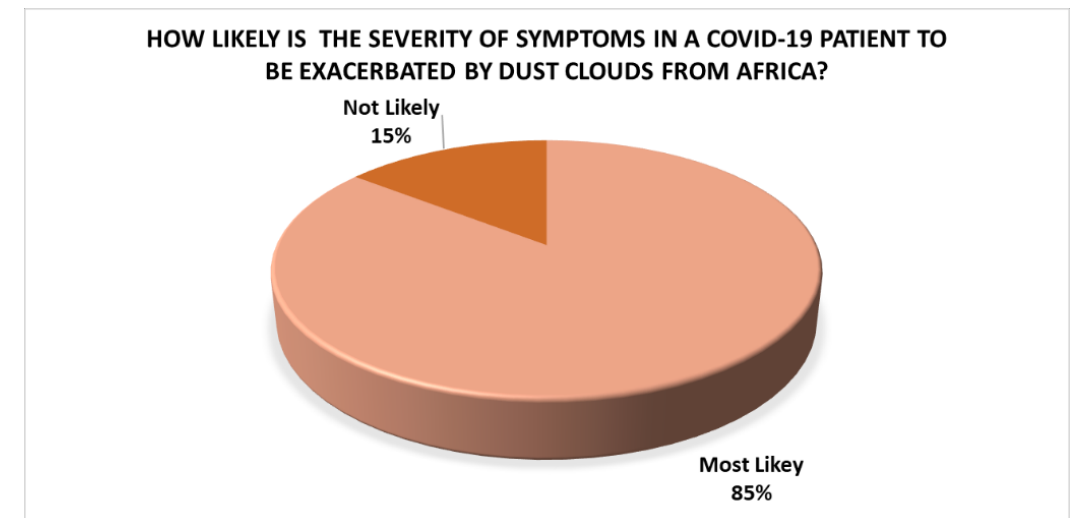
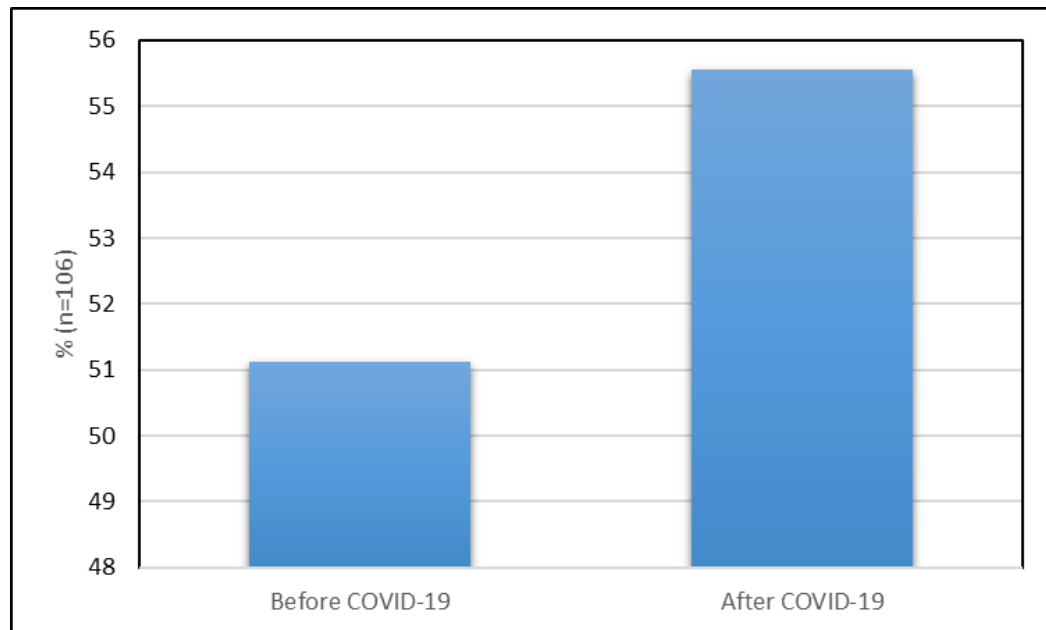
Left: Upper picture June
Tuesday June 23rd, 2020
9:30am (AST)
Lower Image Saturday
June 20th, 2020 9:30am
(AST)



Right: Upper Image:
Morning Saturday June
20th, 2020
Lower Image: Morning
Tuesday June 22nd, 2020



- Females >55 years of age were more likely to be concern about Saharan Dust
- Females were more susceptible to Saharan Dust after being diagnosed with COVID-19.
- Participants positive to COVID-19 and with at least another pre-existing health condition are more likely to be affected by Saharan Dust



Godzilla Dust Event: Summer 2020 (Survey)

- 1500 participants: most respondents were females (82%), **65% had a history of at least one chronic condition.**

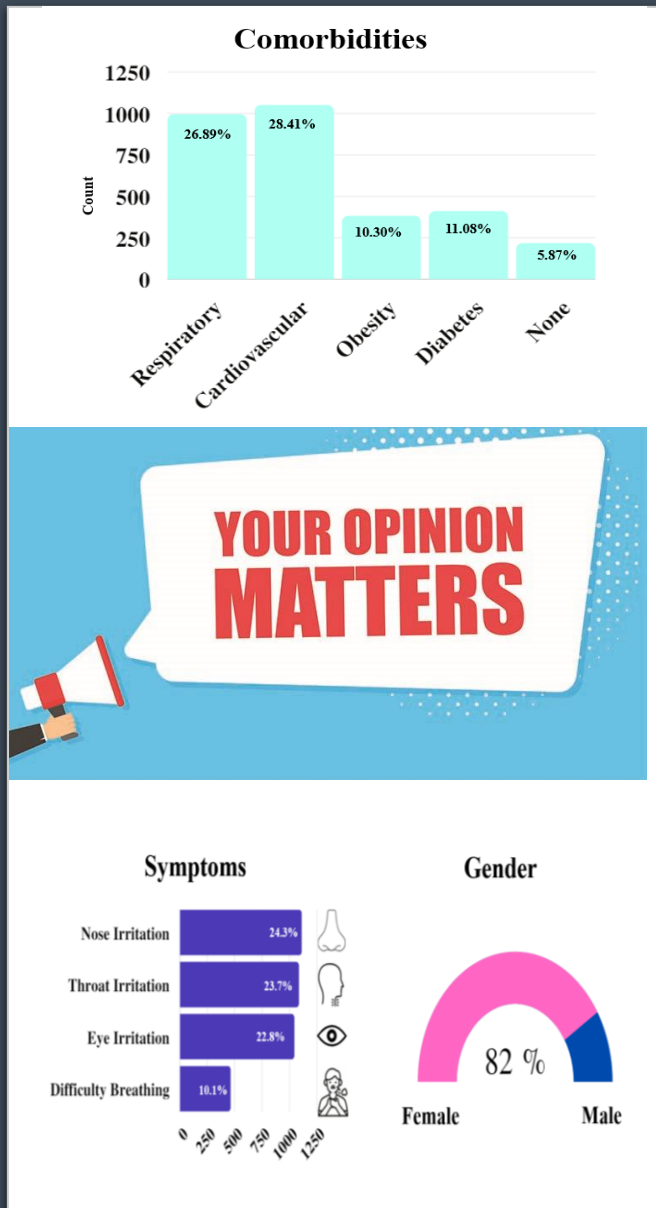
- **Nearly 90%** indicated that Saharan dust affected the health status of both respondents and their family members.

- **Asthma** was the most reported condition (55%).

- However, only 12% reported a physician's visit due to Saharan dust complications. Moreover, nearly two-thirds expressed concern regarding their family's welfare during the Saharan dust events.

- **Individuals with Comorbidities are 14.37% more likely to need medical services in Saharan dust events.**

- Over half (57%) reported that the Saharan dust always or frequently affected their health, causing postnasal drip, cough, red or itchy eyes, shortness of breath, and fatigue.

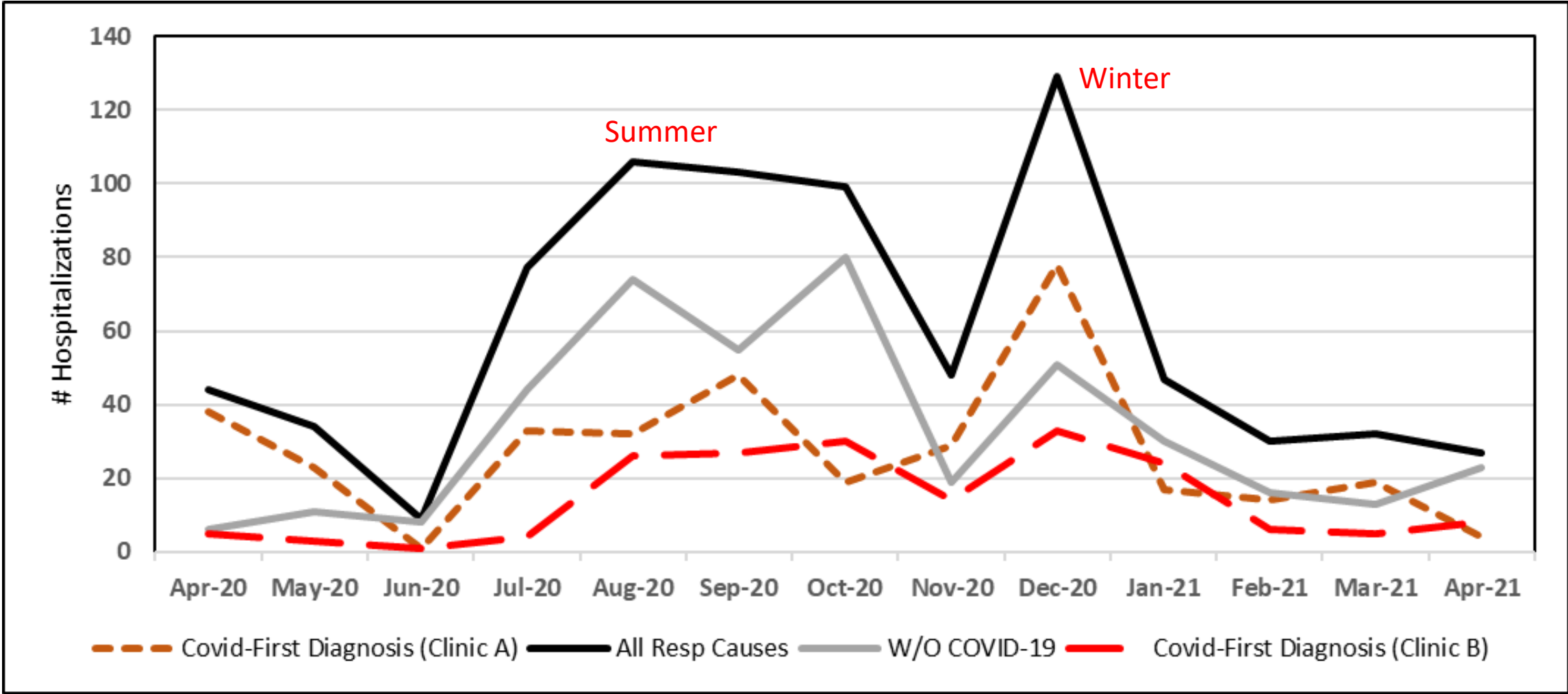


Public Health Data ER & HA

- **March 2020 to March 2021:**
- U07.1 = confirmed COVID-19
- J12.89 = pneumonia due to other viral pathogen
- J12.82 = pneumonia due to SARS-CoV-2
- J12.81 = pneumonia due to SARS-Associated coronavirus
- M35.81 = MIS-C
- Z86.16 = personal history of COVID-19
- Z20.828 = contact and suspected exposure to viral pathogen
- Z20.822 = contact and suspected exposure to SARS-CoV-2
- B97.2 = Coronavirus as the cause of diseases classified elsewhere
- B97.21 = SARS-associated coronavirus as the cause of diseases classified elsewhere
- B97.29 = Other coronavirus as the cause of diseases classified elsewhere
- We additionally requested the list generated include whether these diagnoses had also been added to each patient's problem list, as a means of expediting record review: I25.1, I50, I21 & I25.2, I10 & I15, I60-I69, E10, E12, J45, J41-44, E66, G30-32, F33 & N18.

Databases and Sources

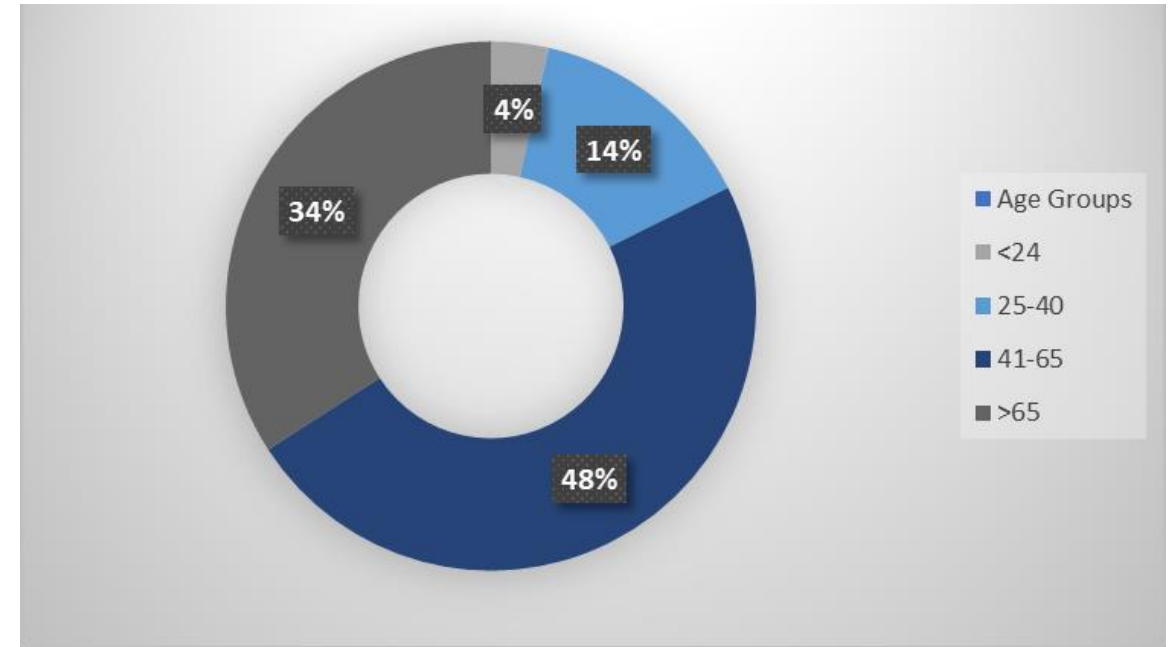
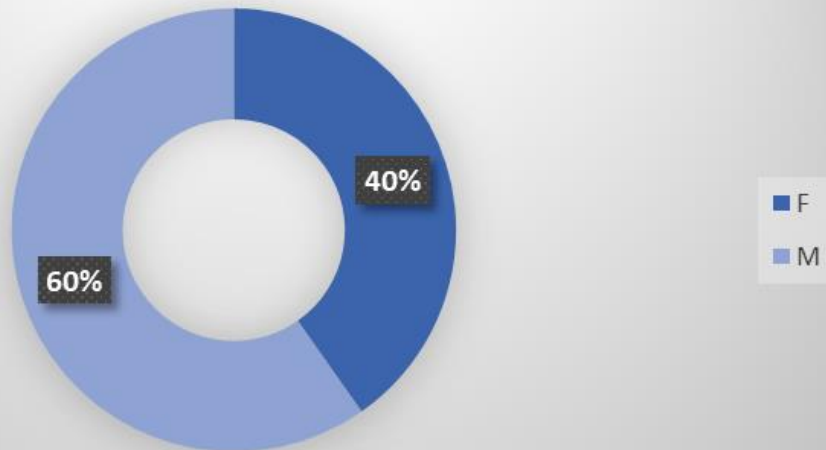
- Non_Acc: Non-Accidental Mortality Accumulated for the day of PM2.5 measurement
- Cardio: Cardiovascular Mortality Accumulated for the day of PM2.5 measurement
- Resp: Respiratory Mortality Accumulated for the day of PM2.5 measurement
- Resp_NoFlu: Respiratory Mortality without Flu cases for the day of PM2.5 measurement
- PM2.5_Mean_Conc_Stations: Mean of the Fajardo, Guaynabo and Bayamon Stations
- Tmax: Associated Maximum Temperature to Date variable
- Sahara: Dichotomous variable that indicates if the corresponding date had a Saharan dust event
- HeatIndex: Associated Maximum Heat Index to Date variable
- Year: Associated year of Date variable
- Population: Population of people 65 years and over in the northeast region of Puerto Rico
- VIIRS data Aerosol Products from Dark Target algorithm, version 1:



Behavioral risk factor

Public Health Data: ER & HA

Sex



Study of Imminent Interactions between SARS-CoV-2 (COVID-19), Air Quality due to Saharan Dust and Urban Aerosols, and Social-environmental Factors in Puerto Rico in summer 2020: Proxies of Health Risks in Small Island States in the Caribbean Region

	San Juan City Hospital (n=134)	Trauma Hospital (n=346)	University District Hospital (n=123)	Outpatient Clinics (n=1729)	Total (n=2332)
	n (%)				
Gender					
Female	66 (49.3)	167 (48.3)	60 (48.8)	994 (57.5)	1287 (55.2)
Male	68 (50.7)	179 (51.7)	63 (51.2)	735 (42.5)	1045 (44.8)
Age Group (years)					
0-17	7 (5.2)	2 (0.6)	6 (4.9)	2 (0.1)	17 (0.7)
18-29	26 (19.4)	38 (11)	15 (12.2)	266 (15.4)	345 (14.8)
30-39	19 (14.2)	53 (15.3)	17 (13.8)	340 (19.7)	429 (18.4)
40-49	21 (15.7)	71 (20.5)	19 (15.4)	540 (31.2)	651 (27.9)
50-64	38 (28.4)	106 (30.6)	27 (22)	502 (29)	673 (28.9)
65-74	17 (12.7)	41 (11.8)	15 (12.2)	75 (4.3)	148 (6.3)
75-84	4 (3)	26 (7.5)	17 (13.8)	3 (0.2)	50 (2.1)
85 and over	2 (1.5)	9 (2.6)	7 (5.7)	1 (0.1)	19 (0.8)
Stay of Length (days)	8.7	0.9	16.8	0	1.5

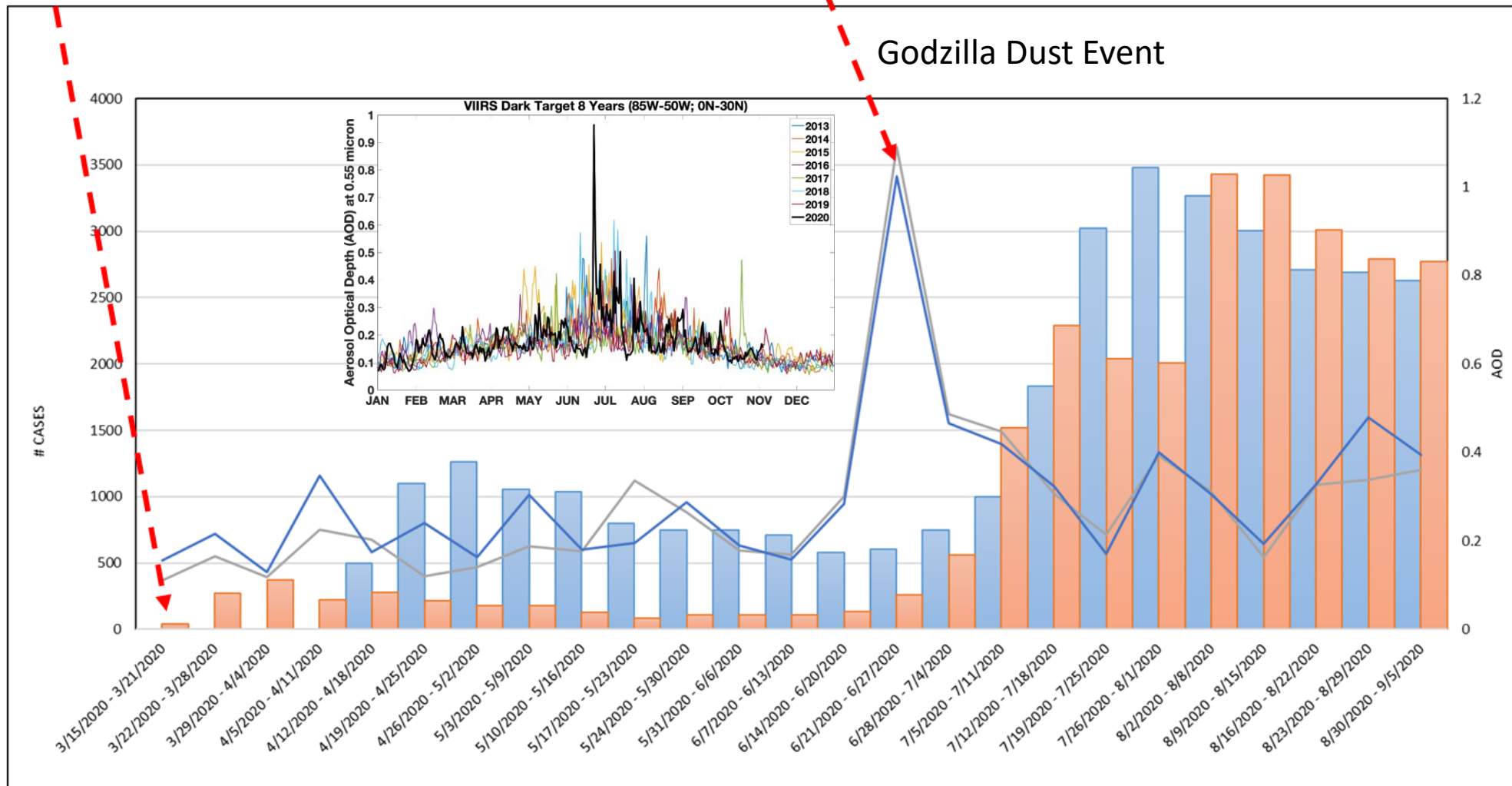
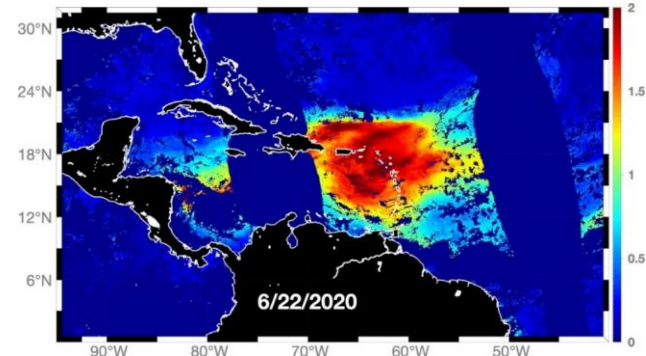
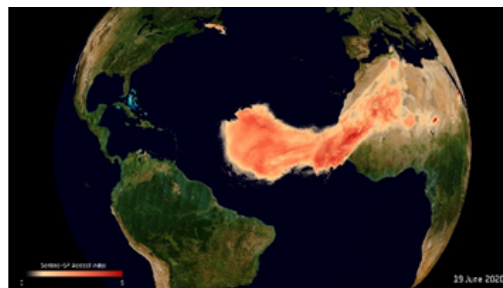
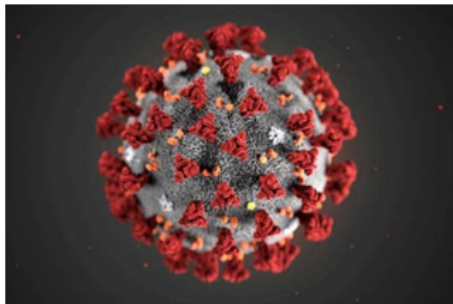
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	External Clinics	Trauma Hospital	University District Hospital	S.J. City Hospital	All Hospitals
Jan	0	0	0	0	0
Feb	0	0	0	0	0
Mar	0	167	4	4	175
Apr	0	20	5	3	28
May	0	14	1	1	16
Jun	0	2	1	4	7
Jul	85	21	17	20	143
Aug	380	22	11	19	432
Sep	353	12	22	27	414
Oct	187	12	11	11	221
Nov	411	24	28	27	490
Dec	313	52	23	18	406

Study of Imminent Interactions between SARS-CoV-2 (COVID-19), Air Quality due to Saharan Dust and Urban Aerosols, and Social-environmental Factors in Puerto Rico in summer 2020: Proxies of Health Risks in Small Island States in the Caribbean Region

ICD-10-CM Group	Description/Category	University District Hospital		Trauma Hospital		Overall	
		n	(%)	n	(%)	N	(%)
A00-B99	Certain infections and parasitic diseases	19	(5.4)	150	(9.0)	169	(8.3)
C00-D49	Neoplasms	14	(4.0)	7	(0.4)	21	(1.0)
D50-D89	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	8	(2.3)	4	(0.2)	12	(0.6)
E00-E89	Endocrine, nutritional and metabolic diseases	17	(4.8)	61	(3.6)	78	(3.8)
F01-F99	Mental, Behavioral and Neurodevelopmental disorders	16	(4.5)	13	(0.8)	29	(1.4)
G00-G99	Diseases of the nervous system	14	(4.0)	11	(0.7)	25	(1.2)
H00-H59	Diseases of the eye and adnexa	5	(1.4)	3	(0.2)	8	(0.4)
H60-H95	Diseases of the ear and mastoid process			1	(0.1)	1	(.05)
I00-I99	Diseases of the circulatory system	27	(7.6)	77	(4.6)	104	(5.1)
J00-J99	Diseases of the respiratory system	25	(7.1)	98	(5.9)	123	(6.1)
K00-K95	Diseases of the digestive system	23	(6.5)	10	(0.6)	33	(1.6)
L00-L99	Diseases of the skin and subcutaneous tissue	6	(1.7)	7	(0.4)	13	(0.6)
M00-M99	Diseases of the musculoskeletal system and connective tissue	13	(3.7)	12	(0.7)	25	(1.2)
N00-N99	Diseases of the genitourinary system	16	(4.5)	14	(0.8)	30	(1.5)
O00- O9A	A Pregnancy, childbirth, and puerperium	44	(12.4)	1	(0.1)	45	(2.2)
P00-P96	Certain conditions originating in the perinatal period	5	(1.4)			5	(0.2)
Q00-Q99	Congenital malformations, deformations and chromosomal abnormalities	3	(0.8)	2	(0.1)	5	(0.2)
R00-R99	Symptoms, signs, and abnormal clinical laboratory findings, not else where classified	17	(4.8)	308	(18.4)	325	(16)
S00-T88	Injury, poisoning, and certain other consequences of external causes	22	(6.2)	73	(4.4)	95	(4.7)
U00-U85	Codes for special purposes	1	(0.3)	248	(14.8)	249	(12.3)
V00-Y99	External causes of morbidity	10	(2.8)	141	(8.4)	151	(7.4)
Z00-Z99	Factors influencing health status and contact with health services	49	(13.8)	434	(25.9)	483	(23.8)

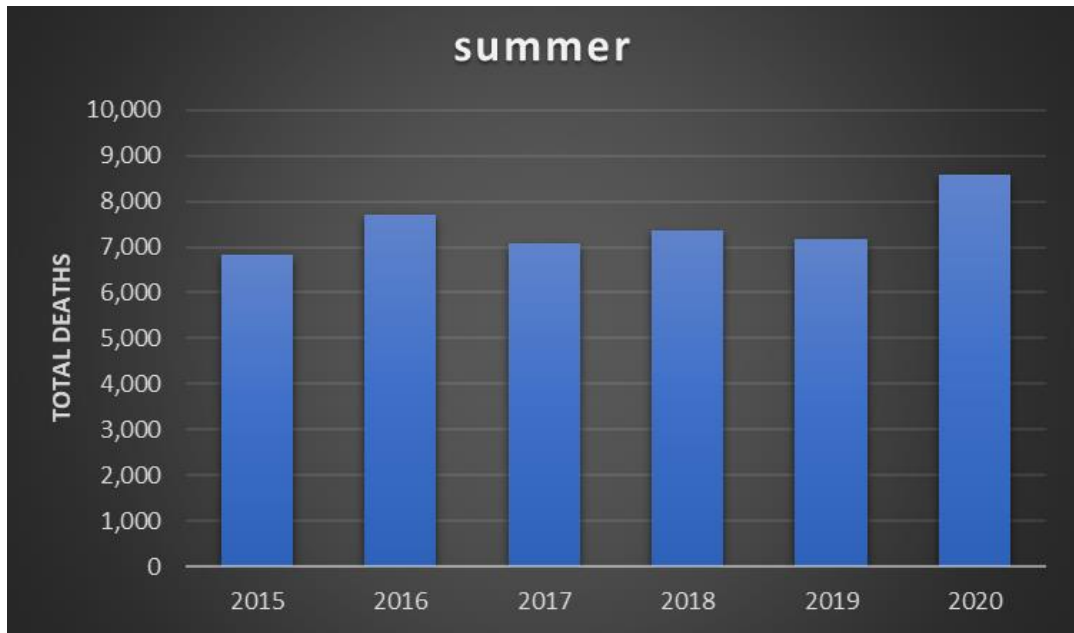
1st COVID-19 Confirmed Case In Puerto Rico



- Stata
- 9 environmental variables
- 18 environmental indices
- Retrieved mostly from NASA (MODIS, VIIRS, Sentinel)

	heatindex~an	heatindex~in	hi_clima_d~x	airtemp_c~an	airtemp_c~in	airtemp_cl~x	utci_clim~in	utci_clima~x	utci_clim~an	angstrom_v~s	mc_viirs	precip~5
heatindex~an	1.0000											
heatindex~in	0.9975	1.0000										
hi_clima_d~x	0.9967	0.9912	1.0000									
airtemp_c~an	0.9901	0.9901	0.9851	1.0000								
airtemp_c~in	0.9871	0.9912	0.9795	0.9946	1.0000							
airtemp_cl~x	0.9788	0.9771	0.9767	0.9929	0.9783	1.0000						
utci_clim~in	0.8614	0.8623	0.8650	0.8390	0.8522	0.8070	1.0000					
utci_clima~x	0.7795	0.7809	0.7844	0.7579	0.7700	0.7282	0.9504	1.0000				
utci_clim~an	0.8665	0.8653	0.8707	0.8416	0.8552	0.8084	0.9896	0.9599	1.0000			
angstrom_v~s	-0.4269	-0.4199	-0.4285	-0.4108	-0.4106	-0.4168	-0.1662	-0.0451	-0.1726	1.0000		
mc_viirs	0.4416	0.4362	0.4396	0.4221	0.4303	0.4173	0.2214	0.1333	0.2435	-0.7891	1.0000	
precip_chr~5	0.2444	0.2386	0.2661	0.2231	0.2051	0.2307	0.3539	0.3163	0.3319	-0.0154	-0.0262	1.0000
precip_chr~3	0.2335	0.2278	0.2552	0.2136	0.1953	0.2223	0.3449	0.3073	0.3215	-0.0112	-0.0315	0.9977
mursst_3x3	0.8788	0.8805	0.8795	0.8947	0.8840	0.8896	0.8772	0.8460	0.8721	-0.1051	0.1146	0.3300
mursst_5x5	0.8790	0.8807	0.8797	0.8949	0.8842	0.8898	0.8773	0.8461	0.8723	-0.1055	0.1151	0.3299
lstn	0.9174	0.9118	0.9199	0.9193	0.9168	0.9053	0.8109	0.7396	0.8163	-0.3662	0.3425	0.2404
lstd	0.4302	0.4125	0.4309	0.3704	0.3846	0.3380	0.3376	0.2841	0.3744	-0.3659	0.3442	-0.0285
aod550_viirs	0.4649	0.4563	0.4654	0.4413	0.4495	0.4314	0.2733	0.1758	0.2928	-0.7417	0.9118	0.0472

Deaths per year of death and season



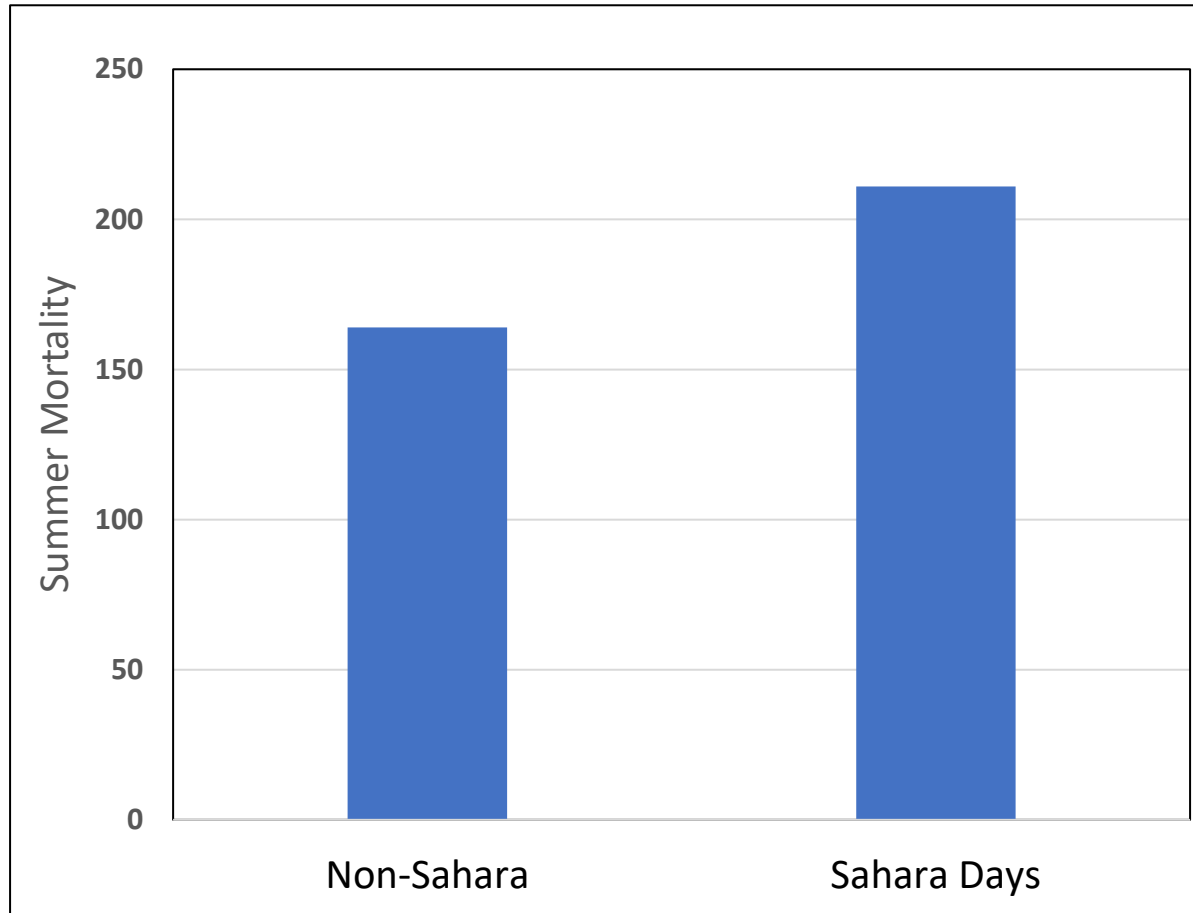
Hurricane Irma & Maria

Deaths per year of death and season

dyr	winter	summer	autumn	spring	Total
2015	6,937	6,828	7,590	6,768	28,123
2016	8,113	7,691	7,478	6,375	29,657
2017	7,410	7,095	9,451	7,164	31,120
2018	8,240	7,356	7,206	6,425	29,227
2019	7,885	7,187	7,236	7,298	29,606
2020	6,463	8,573	8,166	8,077	31,279
Total	45,048	44,730	47,127	42,107	179,012

COVID-19

Respiratory Mortality 2015-2017: Dust Days vs Non Dust Days



- dust concentration increase in the Caribbean between May and September. These plumes are positively associated to respiratory (**without flu causes**) mortality with a relative risk of 1.23 (CI 95%: 1.03, 1.47) when adjusted for PM 2.5 and Air Surface Maximum Temperature.

FINDINGS Poisson model assuming independent observation

- A total of 10,070 deaths occurred in Puerto Rico during the study period. Strong evidence suggests that the heat effect, dust clouds and spores cause an excess risk of non-accidental mortality. Cardiovascular diseases and respiratory conditions were the primary causes of death most associated with elevated temperatures, aerosol optical depth and spores.
- The average number of weekly deaths due to **Covid-19** in decile 5 of **UTCI** is **6 times higher** than the decile 1 of UTCI. This excess was statistically significant ($p < 0.05$).
- The average number of weekly deaths due to **Covid-19** in decile 5 of **FUNGAL SPORES** is **6.47 times higher** than the decile 1 of FUNGAL SPORES. This excess was statistically significant ($p < 0.05$).
- The average number of weekly deaths due to **Covid-19** for values of **UTCI > 27.93** is 97% higher than for values of $UTCI \leq 27.93$, **after adjusting for age**. This excess was statistically significant ($p < 0.05$).

FINDINGS Poisson model assuming independent observation

- The average number of weekly deaths due to **ischemic heart disease** in quintile 5 of **AOD550** is **11%** higher than the quintile 1 of **AOD550**. This excess was statistically significant ($p < 0.05$).
- The average number of weekly deaths due to ischemic heart disease in quintile 5 of **AOD550** is **9% higher than the quintile 1 of AOD550, after adjusting for age and year of death**. This excess was statistically significant ($p < 0.05$).

FINDINGS Poisson model assuming independent observation

- A total of 10,070 deaths occurred in Puerto Rico during the study period. Strong evidence suggests that the heat effect, dust clouds and spores cause an excess risk of non-accidental mortality. Cardiovascular diseases and respiratory conditions were the primary causes of death most associated with elevated temperatures, aerosol optical depth and spores.
- **Pneumonia**
 - The average number of weekly deaths due to pneumonia in quintile 5 of **heat index is 10%** (REadjusted: 1.10, 95% CI: 1.03-1.17) higher than the quintile 1 of heat index, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).
 - The average number of weekly deaths due to pneumonia in quintile 5 of UTCI is 11% (REadjusted: 1.11, 95% CI: 1.05-1.18) higher than the quintile 1 of UTCI, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).
- **Heart Failure**
 - The average number of weekly deaths due to heart failure in quintile 5 of UTCI is 13% (REadjusted: 1.13, 95% CI: 1.08-1.18) higher than the quintile 1 of UTCI, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).

FINDINGS Poisson model assuming independent observation

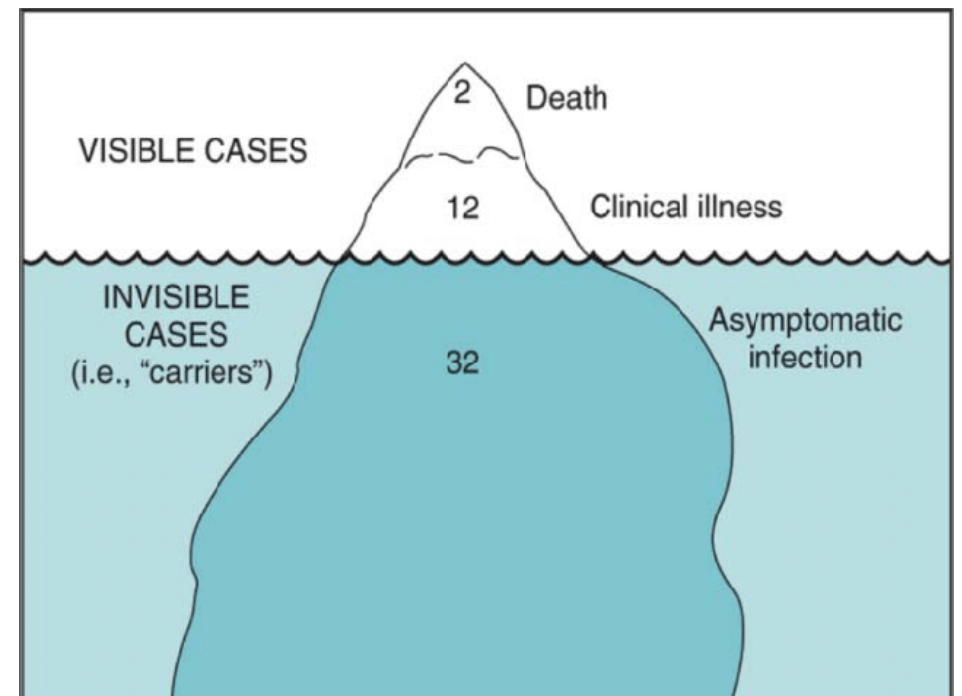
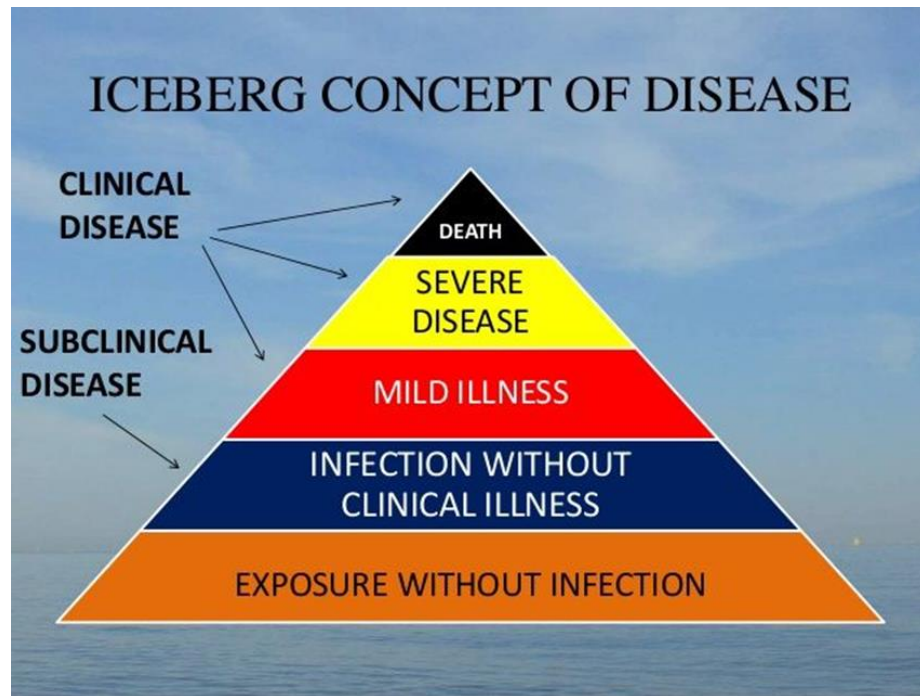
- **Ischemic Heart Disease**

- The average number of weekly deaths due to ischemic heart disease in quintile **5 of aod550** is **10%** (REadjusted: 1.10, 95% CI: 1.02-1.17) higher than the quintile 1 of aod550, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).
- The average number of weekly deaths due to ischemic heart disease in quintile 5 of **UTCI** is 8% (REadjusted: 1.08, 95% CI: 1.01-1.15) higher than the quintile 1 of UTCI, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).
- The average number of weekly deaths due to ischemic heart disease in quintile 5 of **heat index** is 9% (REadjusted: 1.09, 95% CI: 1.02-1.16) higher than the quintile 1 of heat index, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).

- **Myocardial Infarction**

- The average number of weekly deaths due to myocardial infarction in quintile 5 of **aod550** is 9% (REadjusted: 1.09, 95% CI: 1.03-1.15) higher than the quintile 1 of aod550, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).
- The average number of weekly deaths due to myocardial infarction in quintile 5 of **UTCI** is 7% (REadjusted: 1.07, 95% CI: 1.02-1.13) higher than the quintile 1 of UTCI, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).
- The average number of weekly deaths due to myocardial infarction in quintile 5 of **heat index** is 9% (REadjusted: 1.09, 95% CI: 1.03-1.15) higher than the quintile 1 of heat index, after adjusting for age, sex, and year of death. This excess was statistically significant ($p < 0.05$).

Disease/Injury Iceberg Phenomenon



Considerations

- Mortality is always the tip of the iceberg.
- Findings suggest that the arrival from Saharan Dust in Puerto Rico contributes to an increase in cause-specific mortality.
- However, there are remaining questions regarding their effects on vulnerable patient populations, underlying mechanisms of action, and regional variations in both environmental and health effects.
- Better understanding of how these Dust Clouds events affect the health of the population will provide a useful tool for decision makers to address and mitigate the effects on public health.
- The enhanced Dust Early Warning System may be a crucial component in decision making during Watches and Advisories process.



Questions!

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[PR-CLIMAH \(Puerto Rico Climate and Health Research Group\)](#)

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