NOAA National Weather Service (NWS) Products and Services

Hurricanes and Extreme Heat

Ernesto Rodriguez

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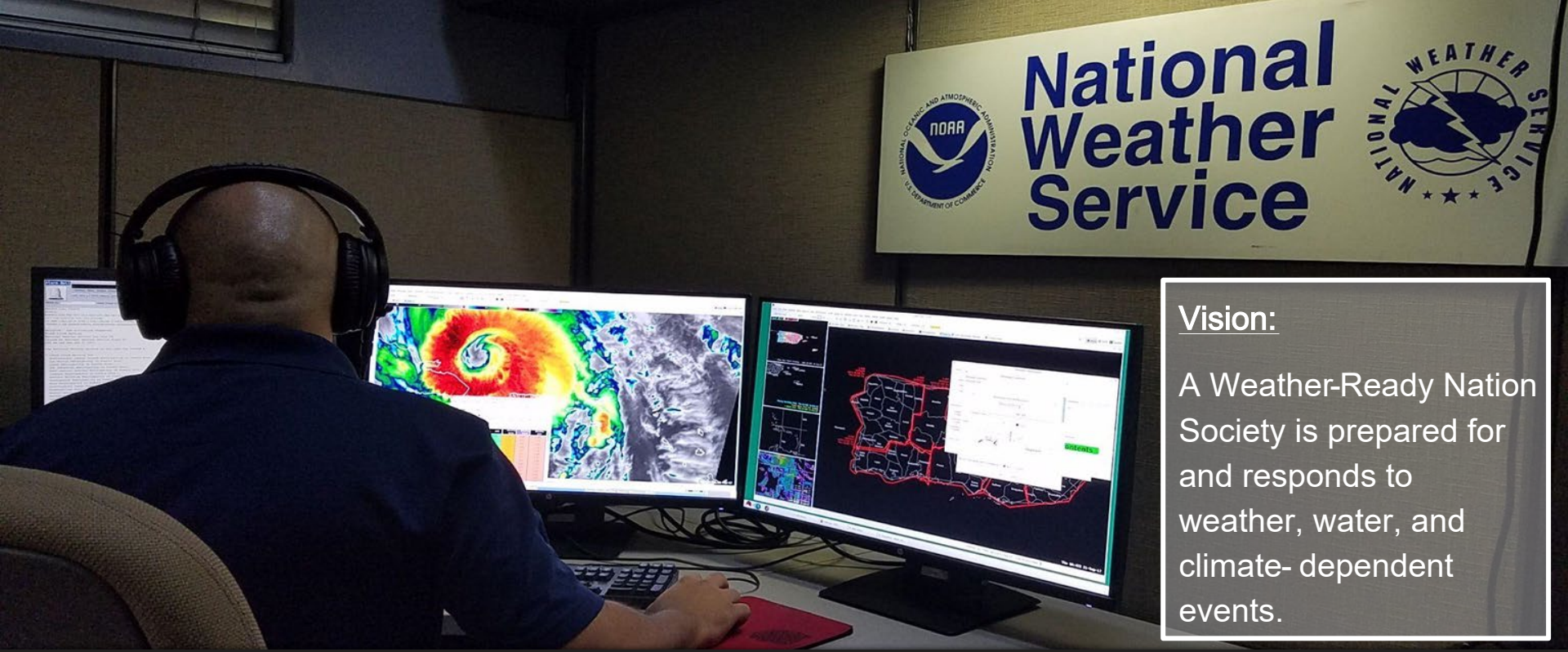
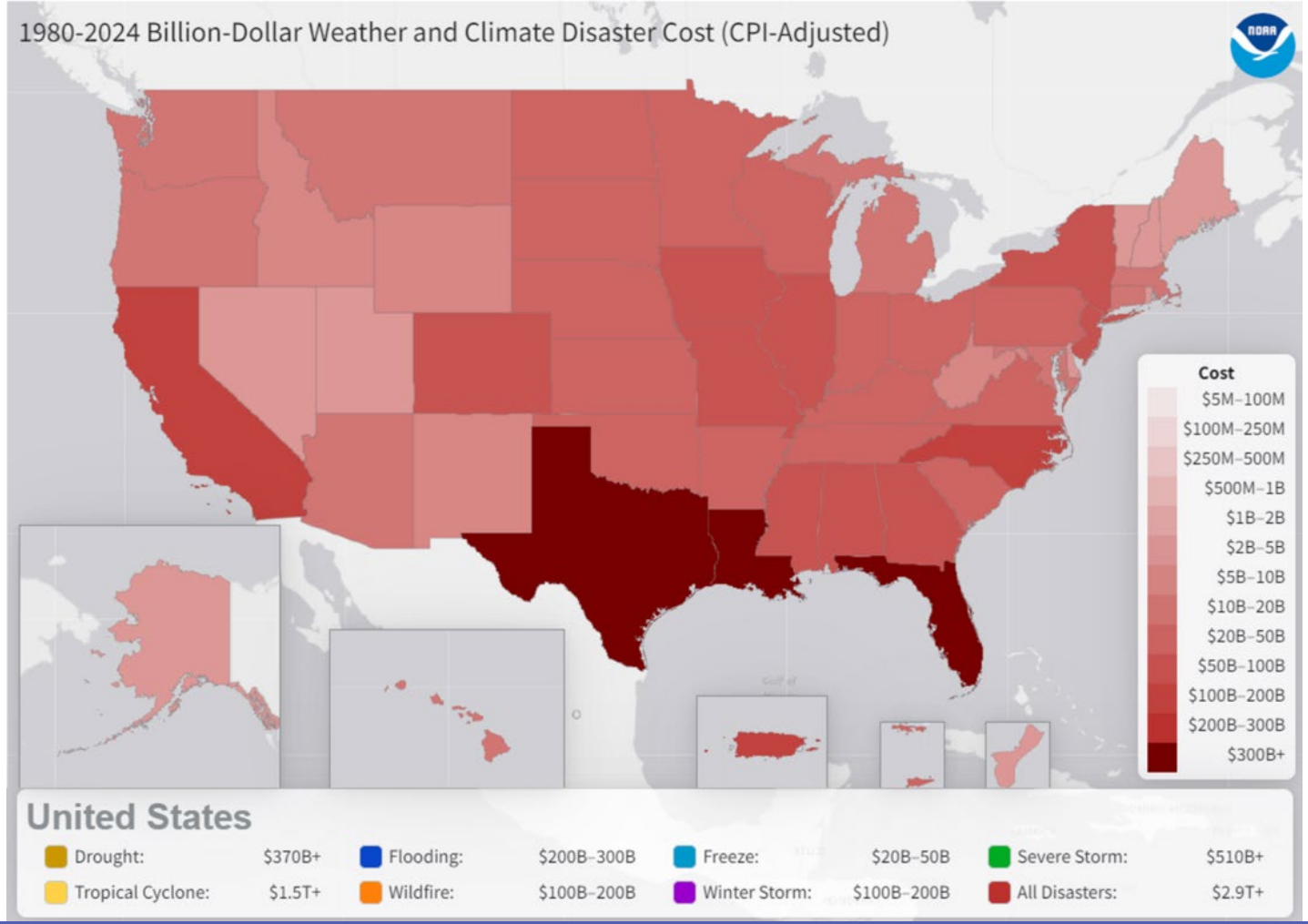


Vision:

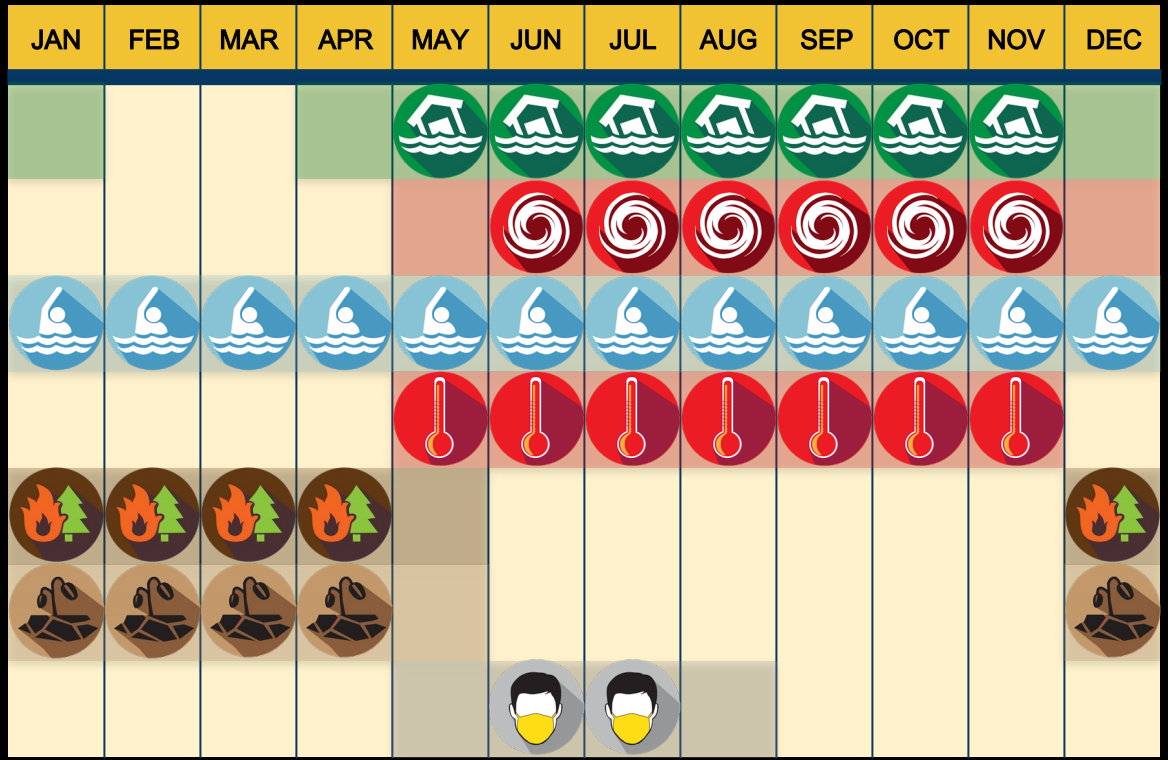
A Weather-Ready Nation Society is prepared for and responds to weather, water, and climate- dependent events.

MISSION: Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.


1980-2024 Billion-Dollar Weather and Climate Disaster Cost (CPI-Adjusted)
Cost
$5M–100M
$100M–250M
$250M–500M
$500M–1B
$1B–2B
$2B–5B
$5B–10B
$10B–20B
$20B–50B
$50B–100B
$100B–200B
$200B–300B
$300B+
United States
Drought: $370B+
Flooding: $200B–300B
Freeze: $20B–50B
Severe Storm: $510B+
Tropical Cyclone: $1.5T+
Wildfire: $100B–200B
Winter Storm: $100B–200B
All Disasters: $2.9T+

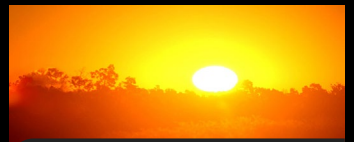
NATIONAL WEATHER SERVICE

Monthly Weather Hazards



Forecasts and Warnings

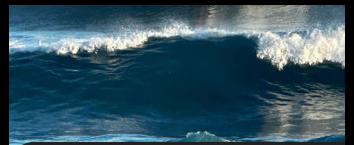

Tropical Weather


Extreme Heat


Floods/Water


Fire


Drought


Marine

US Caribbean (globalchange.gov)

Fuente: Díaz, E., Terando, A., Gould, W., Bowden, J., Chardón, P., Meléndez, M., and Morell, J. (2021). Working Group 1: Geophysical and Chemical Scientific Knowledge. State of the Climate Report. Puerto Rico Climate Change Council. Díaz, E. and Terando, A. [Eds.]

Resumen del informe del Estado del Clima PR Capítulo 1 (pr-ccc.org)

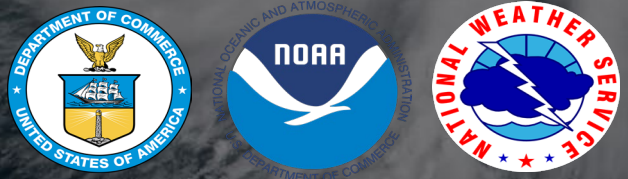
Key Messages

1. **Hurricanes** are a major threat to both Puerto Rico and the U.S. Virgin Islands. **Hurricane extreme winds, rainfall rates, storm surge heights** due to sea level rise, and the number of the strongest (Category 3, 4, and 5) hurricanes are all projected to increase in a warming climate.

2. Future changes in total precipitation are uncertain, but **extreme precipitation is projected to increase**, with associated increases in the intensity and frequency of flooding.

3. **Temperatures in Puerto Rico and the U.S. Virgin Islands have risen almost 2°F since 1950**. Under a higher emissions pathway, historically unprecedented warming is projected during this century, including increases in extreme heat events.

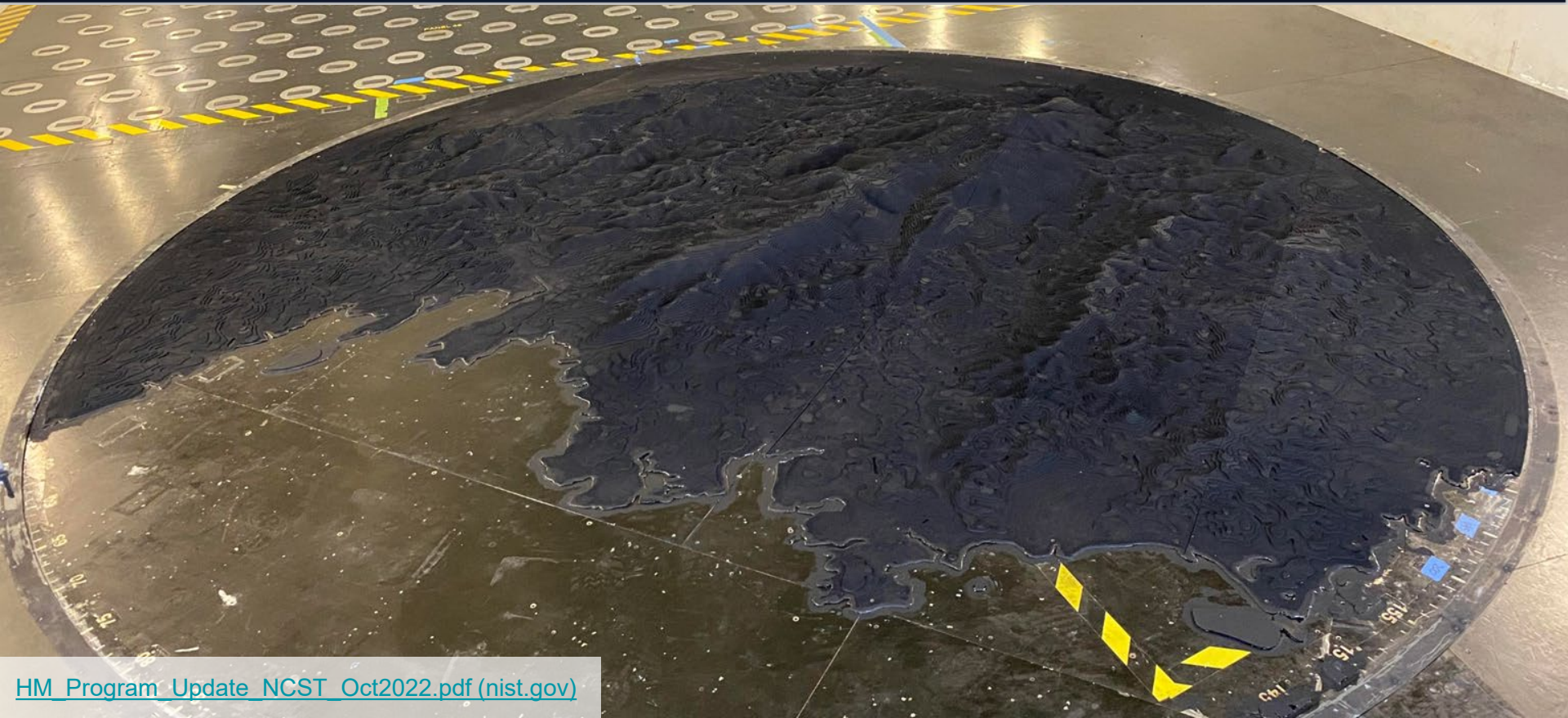
Extreme Winds



NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Joe Main
Team Lead

Maria Dillard
Associate Team Lead



HM_Program_Update_NCST_Oct2022.pdf (nist.gov)

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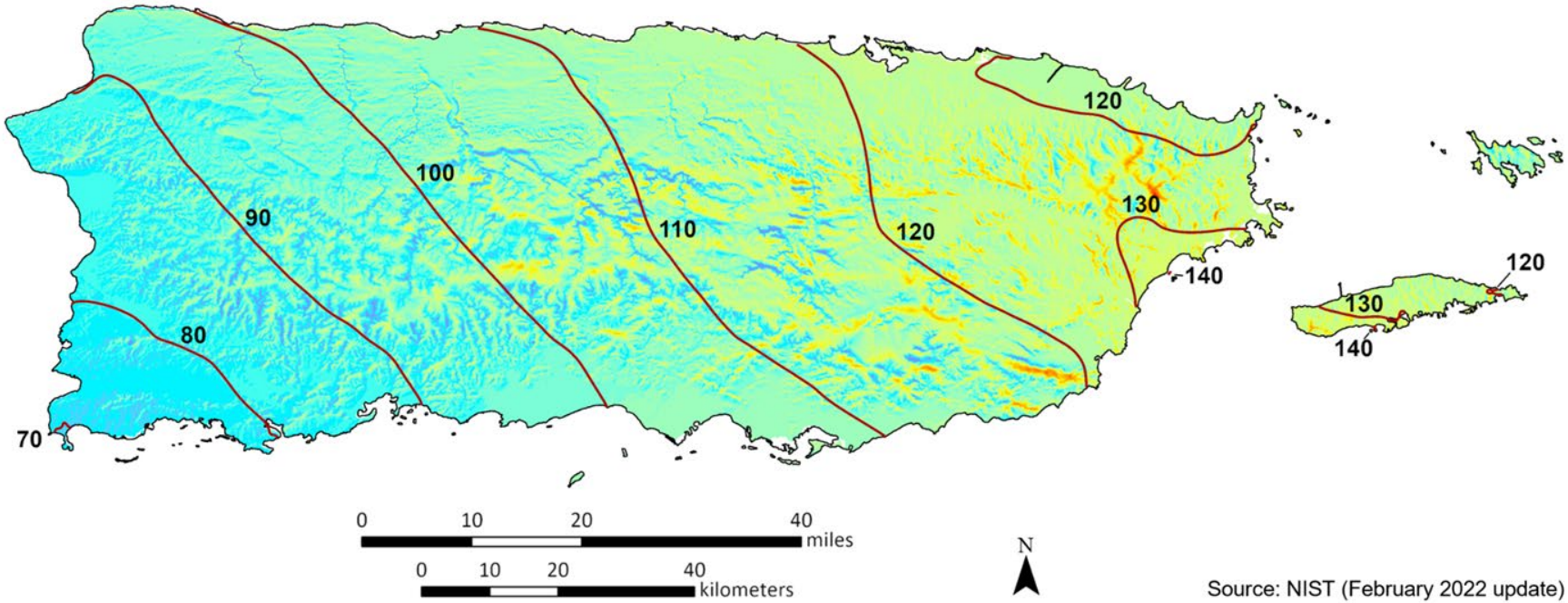
U.S. DEPARTMENT OF COMMERCE

Joe Main — *Team Lead*
Maria Dillard — *Associate Team Lead*

Peak gust wind speed with topographic effects (mph)
(1 mph = 0.447 m/s)

- < 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- 100 - 110
- 110 - 120
- 120 - 130
- 130 - 140
- 140 - 150
- 150 - 160
- 160 - 170
- 170 - 180
- 180 - 190
- 190 - 200
- 200 - 210
- 210 - 220
- 220 - 230

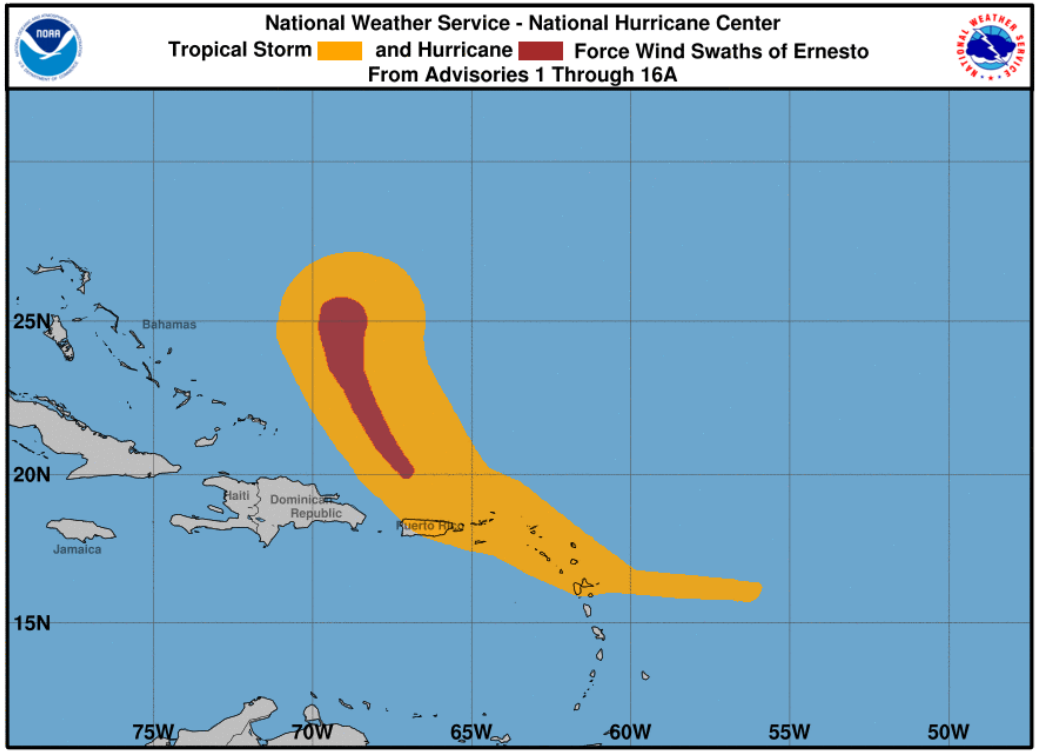
Peak gust wind speeds without topographic effects indicated by red contours (mph)

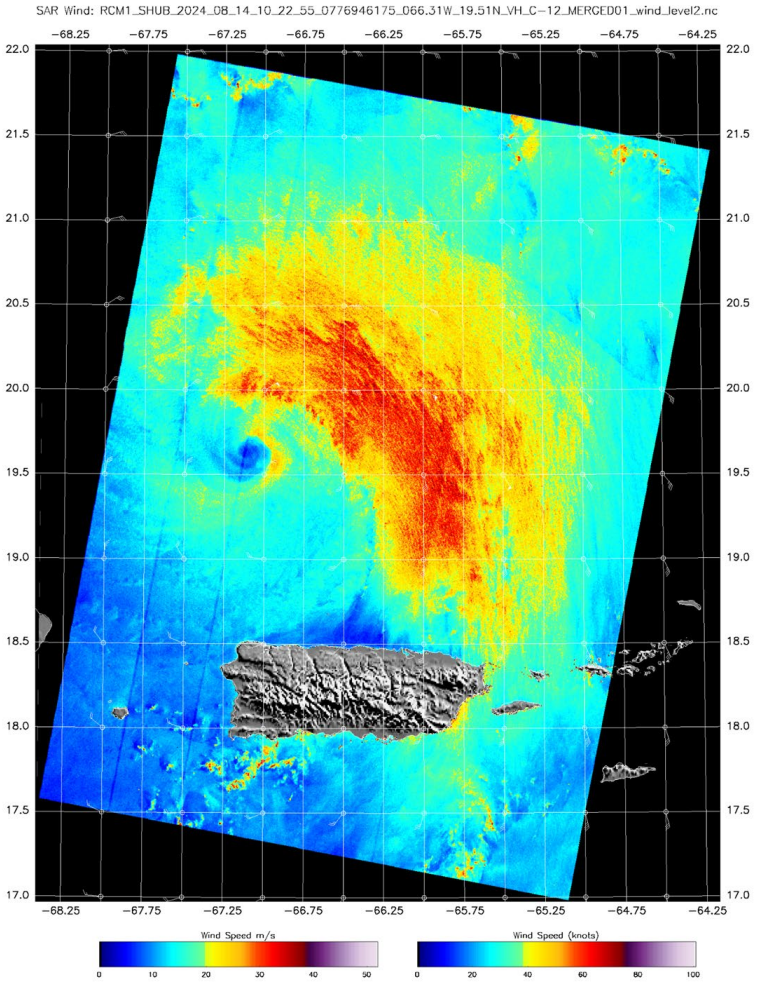


Source: NIST (February 2022 update)

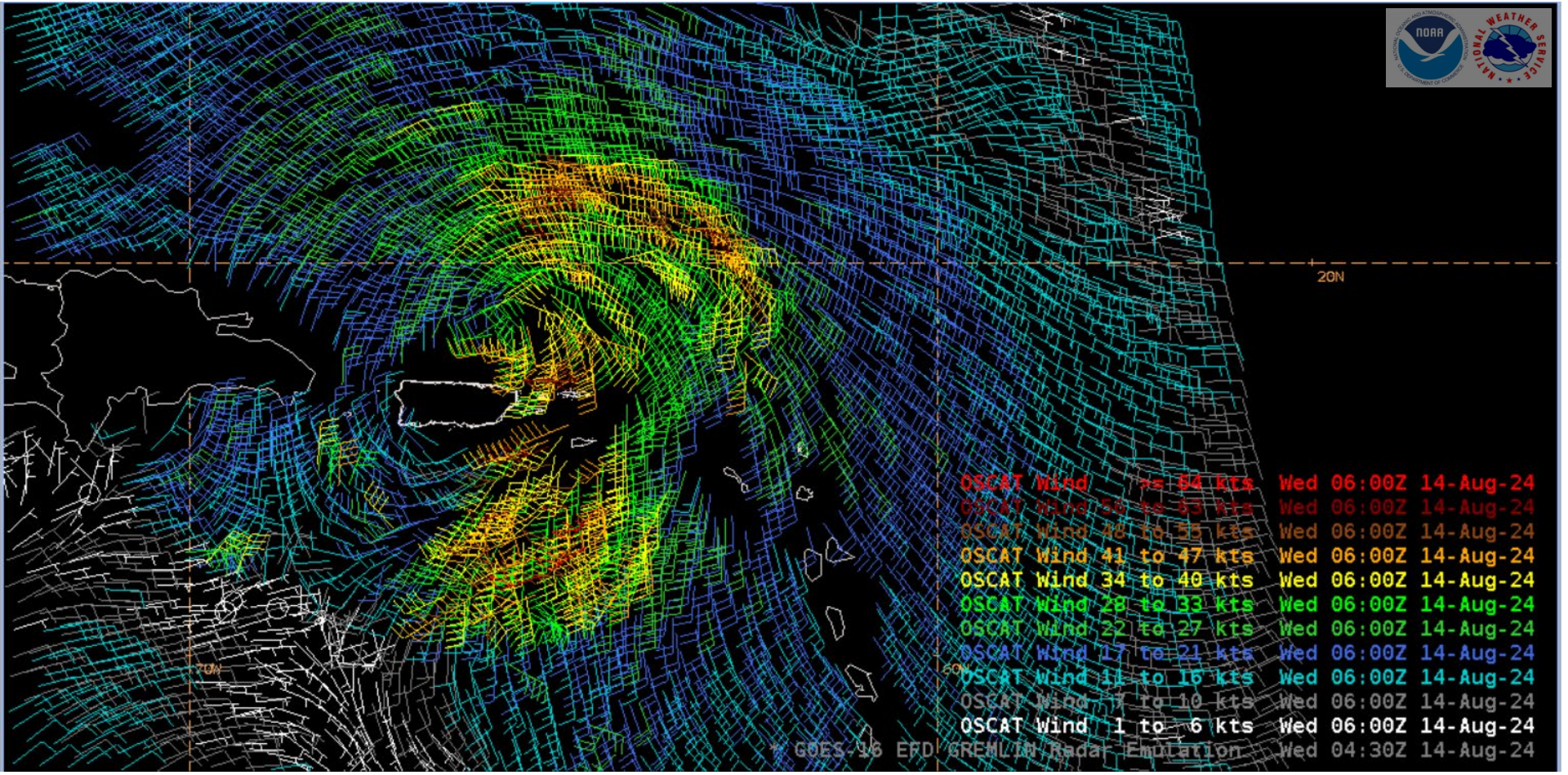
NIST Reports Progress on Hurricane Maria Study | NIST

Tropical Storm Ernesto

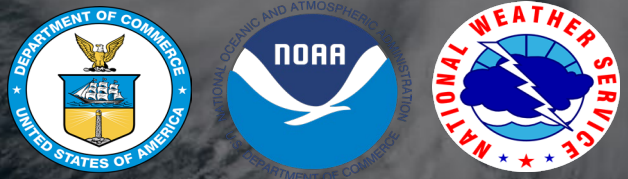




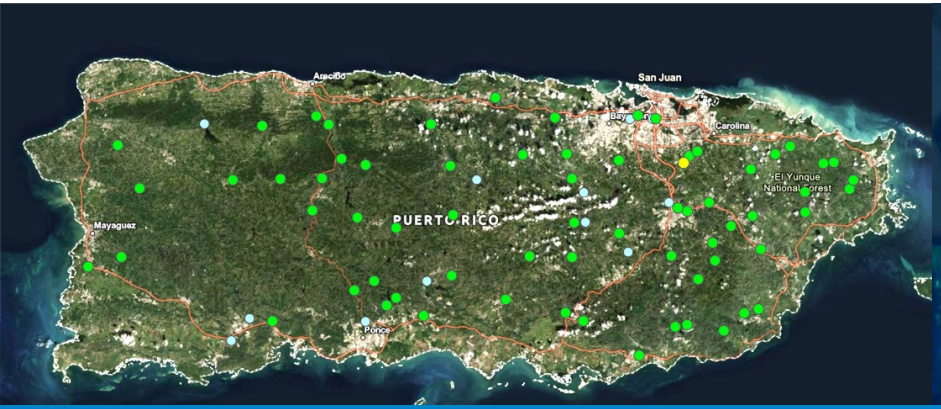
Tropical Storm Ernesto



Flash Flooding



Evolving Water Prediction Capabilities



Service Limited to areas with USGS sensors

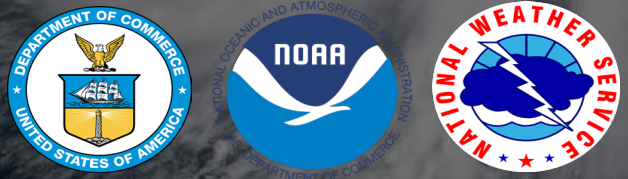
National Water Model has the capacity to represent all rivers and streams in the area.

Putting Water On a Map

22.04 - Carr. 2 flooded - Rio Lajas out of its banksBarrio Chorro de Maguayo flooded

18.53 - Flooding in: Carr 165, in front of Urb Lagos De Plata, Sector El 26Villa Calma, Urb Las Gaviotas, Mansion del Marln Dorado: Flooding in Barrio Mameyal, Sector Costa del Oro

Storm Surge


DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
DEPARTMENT OF COMMERCE
NATIONAL WEATHER SERVICE


Carretera 3
Calle Adriana
Calle La Ola
Calle 1
Calle 2
Calle 3
Muelle Punta Santiago

Puerto Rico/U.S. Virgin Islands Storm Surge & Waves

Project Team

Project Lead: Andre van der Westhuysen, NOAA NCEP

CO-PIs: Joannes Westerink, University of Notre Dame

Collaborators: Juan Gonzalez (CariCOOS/Wood Group PLC), Julio Morell (CariCOOS), Aurelio Mercado (UPRM), Reniel Calzada (UPRM/NOAA CSL), Volker Roeber (University of Hawaii), Dongming Yang (NOAA NCEP), Hugh Cobb (NOAA NCEP NHC), Carlos Anselmi (NOAA NWS San Juan Forecast Office), Ernesto Rodriguez (NOAA NWS San Juan Forecast Office) , Luis Aponte (UPRM)

Federal Partners: Jamie Rhome (NOAA NVEP NHC), Jane Smith (USACE ERDC)

Project Overview and Results

The goal of this COMT project is to extend the present wave/surge operational forecasting capability from mild-sloped coastal areas such as the US East and Gulf of Mexico coasts to steep-sloped areas such as around Caribbean and Pacific islands and transition this capability to NOAA's National Hurricane Center and local WFOs. Broad project objectives are to: (1) compile a data set of observations collected around Puerto Rico and the USVI by the IOOS Caribbean Regional Association; (2) evaluate multiple, coupled wave/surge/inundation models against this data; (3) recommend the most suitable model for transition to operations and (4) assist with the transition. These outcomes will also be applicable to U.S. island regions in the Pacific and may therefore guide future implementations at NOAA's Central Pacific Hurricane Center.

U.S. island regions in the Caribbean and Pacific pose many challenges to the accurate modeling and prediction of hazardous wave-dominated storm surge inundation events. The relative importance of physical processes leading to inundation in steep-sloped, reef-edged island environments differs from those in milder-sloped mainland environments. Relatively little research has been done in these environments, constituting a significant knowledge gap. To compound this uncertainty, little observational data are available in many island environments. As a result, the U.S. National Weather Service (NWS) currently lacks operational surge and inundation guidance for these regions. An exception to this general data scarcity is Puerto Rico and the U.S. Virgin Islands (USVI), which frequently experience strong tropical and extra-tropical storms resulting in high waves, storm surge, and river flooding. A large number of observational instruments have been deployed here, many by IOOS Caribbean Regional Association partners, creating a valuable resource for the evaluation and advancement of operational wave/surge/inundation models of these areas.

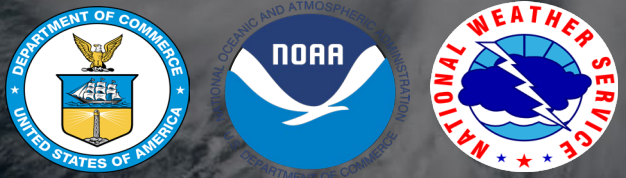
NOAA upgrades storm surge forecasting model

NOAA has upgraded its Probabilistic Storm Surge (P-Surge) model — the primary model for predicting storm surge associated with high-impact weather like hurricanes and tropical storms — to version 3.0. This upgrade advances storm surge modelling and forecasting for the contiguous U.S. (CONUS), Puerto Rico and the U.S. Virgin Islands, and comes just in time for the 2023 hurricane season beginning on June 1 and running through November 30.

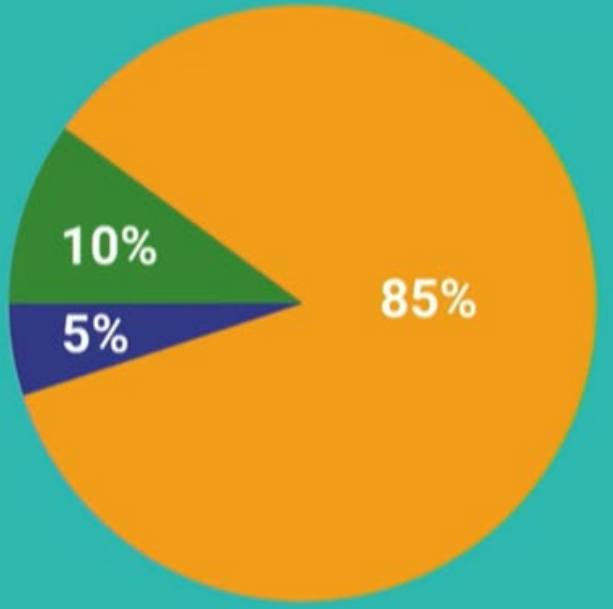
The upgrade includes a number of new capabilities that will help forecasters better understand the risk of storm surge, such as:

- New forecasts for surge, tide and waves for Puerto Rico and the U.S. Virgin Islands.
- The ability to run the model simultaneously for two storms. This capability can help during two landfalling storms impacting the CONUS, or one storm impacting the CONUS and one impacting Puerto Rico and/or the U.S. Virgin Islands.

2024 Hurricane Season Review & 2025 Hurricane Season Outlook



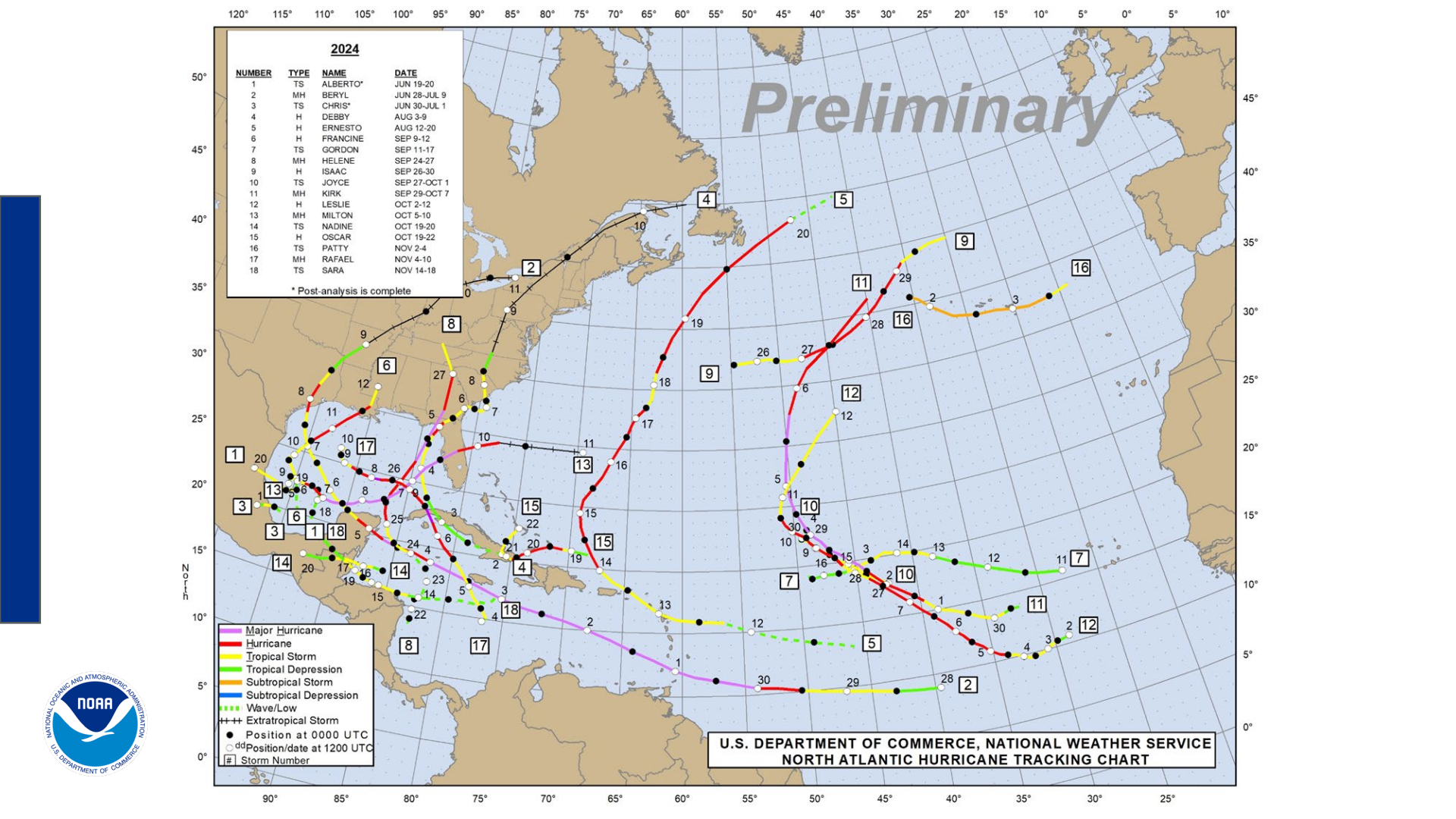
2024 Atlantic Hurricane Season Outlook



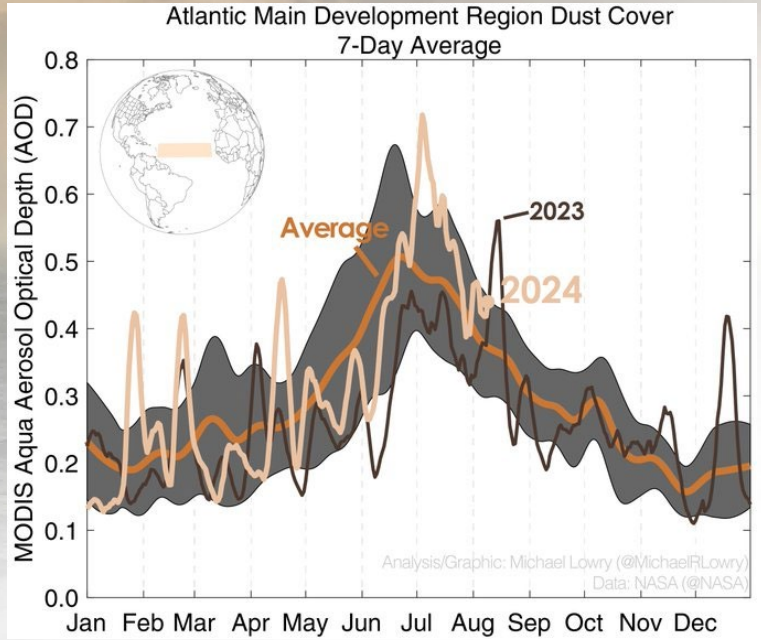
Above normal Near normal Below normal

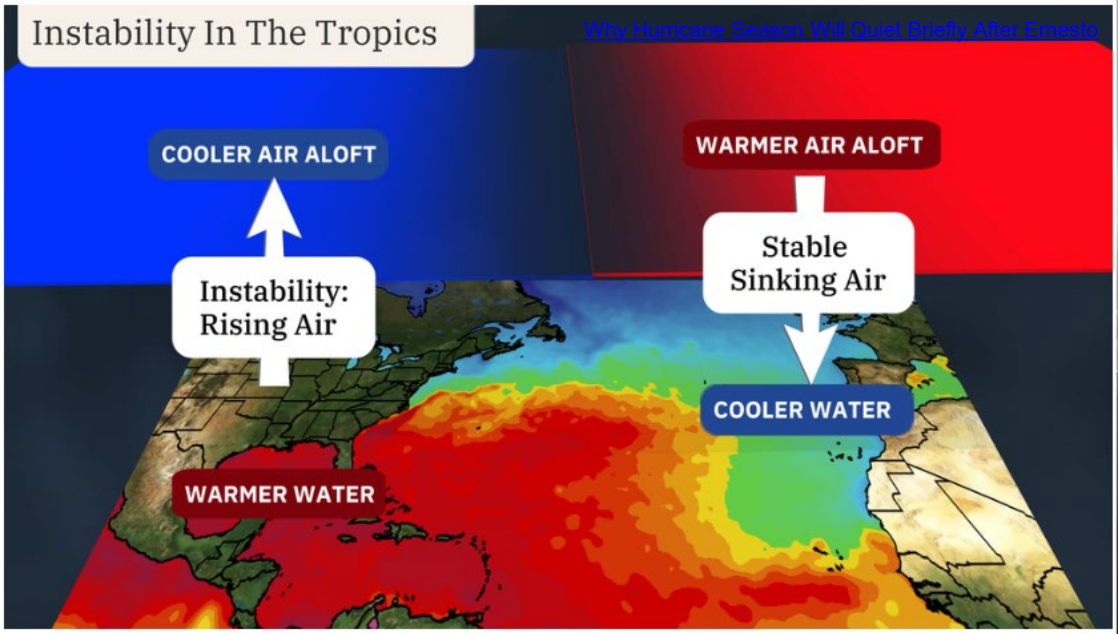
Season probability

Named storms	17 - 25	18
Hurricanes	8 - 13	11
Major hurricanes	4 - 7	5

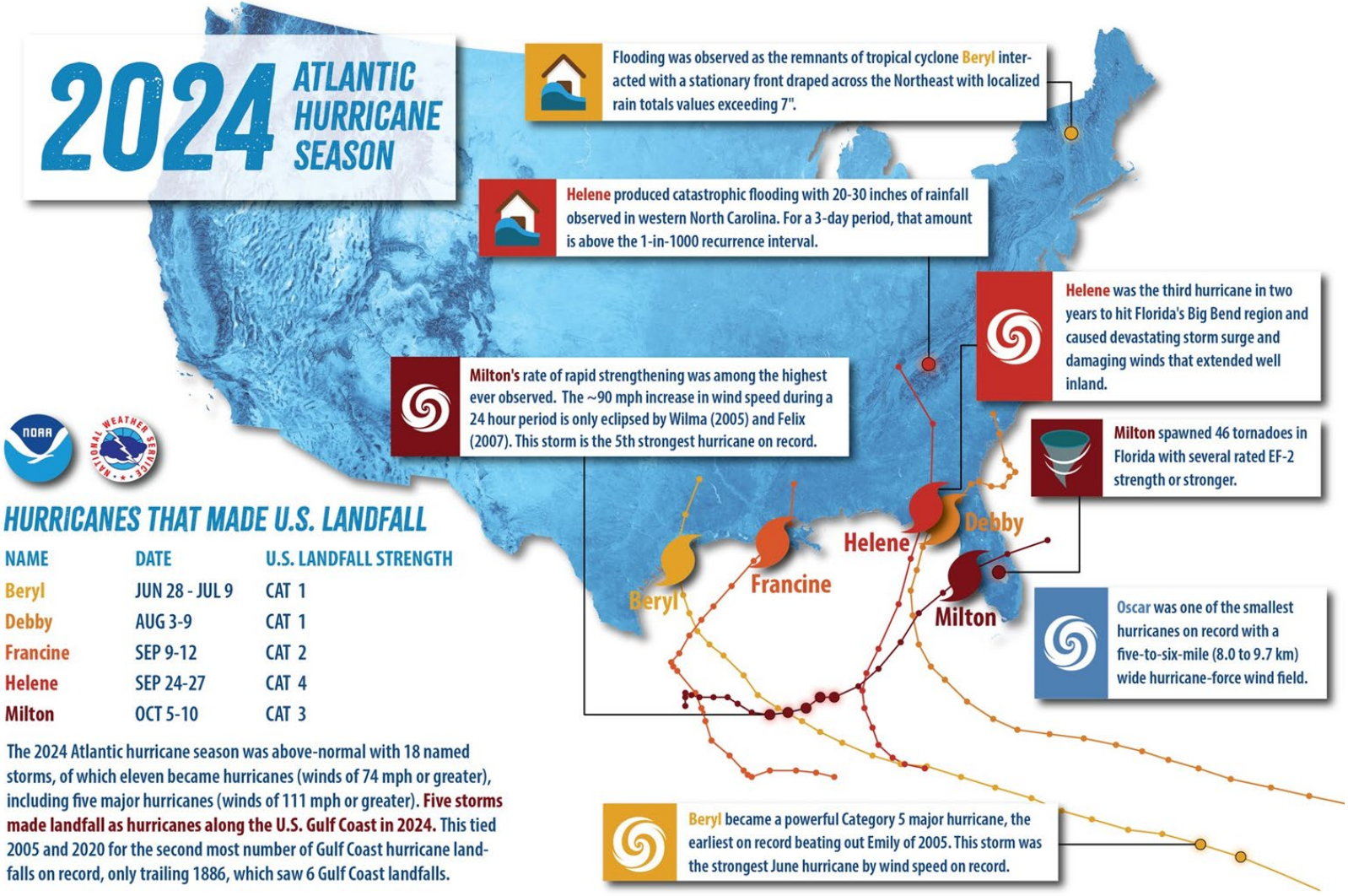

2024
NUMBER TYPE NAME DATE
1 TS ALBERTO* JUN 19-20
2 MH BERYL JUN 28-JUL 9
3 TS CHRIS* JUN 30-JUL 1
4 H DEBBY AUG 3-9
5 H ERNESTO AUG 12-20
6 H FRANCINE SEP 9-12
7 TS GORDON SEP 11-17
8 MH HELENE SEP 24-27
9 H ISAAC SEP 26-30
10 TS JOYCE SEP 27-OCT 1
11 MH KIRK SEP 29-OCT 7
12 H LESLIE OCT 2-12
13 MH MILTON OCT 5-10
14 TS NADINE OCT 19-20
15 H OSCAR OCT 19-22
16 TS PATTY NOV 2-4
17 MH RAFAEL NOV 4-10
18 TS SARA NOV 14-18
* Post-analysis is complete
Preliminary
Major Hurricane
Hurricane
Tropical Storm
Tropical Depression
Subtropical Storm
Subtropical Depression
Wave/Low
Extratropical Storm
Position at 0000 UTC
ddPosition/date at 1200 UTC
Storm Number
North
U.S. DEPARTMENT OF COMMERCE, NATIONAL WEATHER SERVICE
NORTH ATLANTIC HURRICANE TRACKING CHART

The first half of the Hurricane Season Has Been Quiet





2024 ATLANTIC HURRICANE SEASON



Flooding was observed as the remnants of tropical cyclone **Beryl** interacted with a stationary front draped across the Northeast with localized rain totals values exceeding 7".

Helene produced catastrophic flooding with 20-30 inches of rainfall observed in western North Carolina. For a 3-day period, that amount is above the 1-in-1000 recurrence interval.

Helene was the third hurricane in two years to hit Florida's Big Bend region and caused devastating storm surge and damaging winds that extended well inland.

Milton's rate of rapid strengthening was among the highest ever observed. The ~90 mph increase in wind speed during a 24 hour period is only eclipsed by Wilma (2005) and Felix (2007). This storm is the 5th strongest hurricane on record.

Milton spawned 46 tornadoes in Florida with several rated EF-2 strength or stronger.

Oscar was one of the smallest hurricanes on record with a five-to-six-mile (8.0 to 9.7 km) wide hurricane-force wind field.

Beryl became a powerful Category 5 major hurricane, the earliest on record beating out Emily of 2005. This storm was the strongest June hurricane by wind speed on record.

HURRICANES THAT MADE U.S. LANDFALL

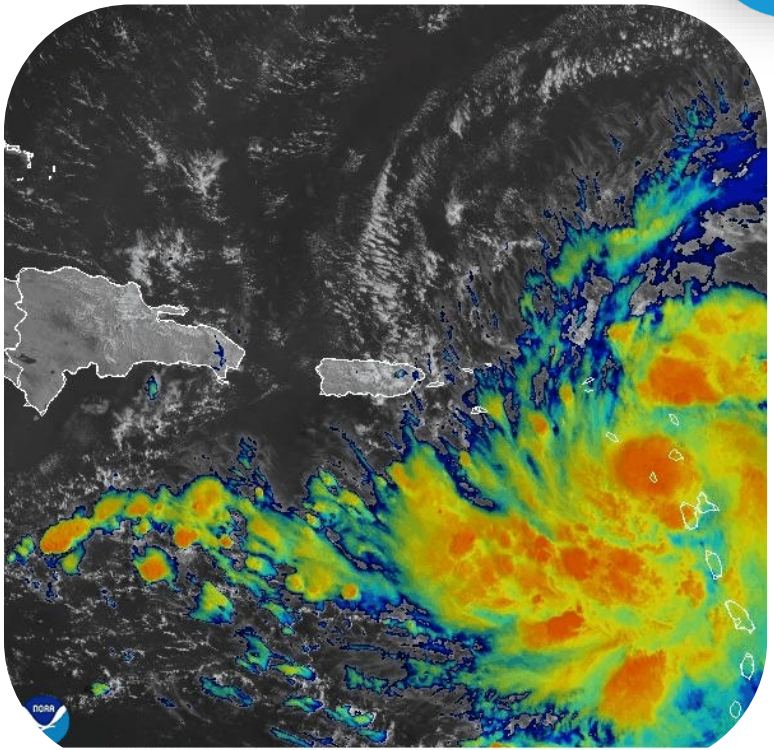
NAME	DATE	U.S. LANDFALL STRENGTH
Beryl	JUN 28 - JUL 9	CAT 1
Debby	AUG 3-9	CAT 1
Francine	SEP 9-12	CAT 2
Helene	SEP 24-27	CAT 4
Milton	OCT 5-10	CAT 3

The 2024 Atlantic hurricane season was above-normal with 18 named storms, of which eleven became hurricanes (winds of 74 mph or greater), including five major hurricanes (winds of 111 mph or greater). **Five storms made landfall as hurricanes along the U.S. Gulf Coast in 2024.** This tied 2005 and 2020 for the second most number of Gulf Coast hurricane landfalls on record, only trailing 1886, which saw 6 Gulf Coast landfalls.

Tropical Storm Ernesto

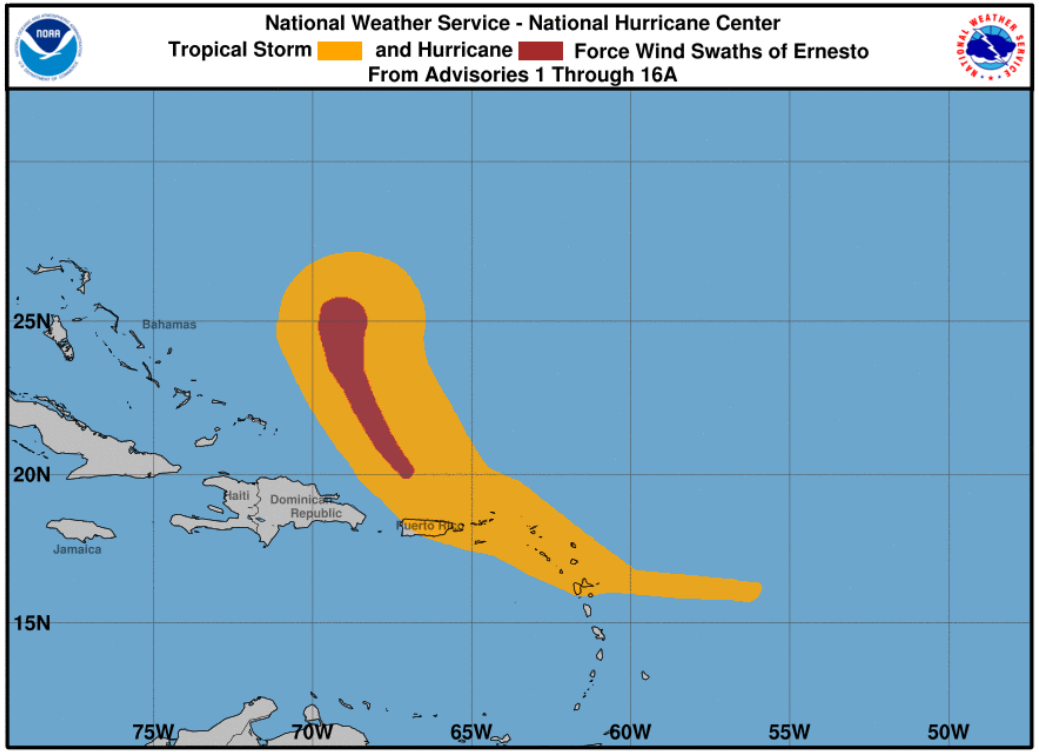
August 13-15, 2024

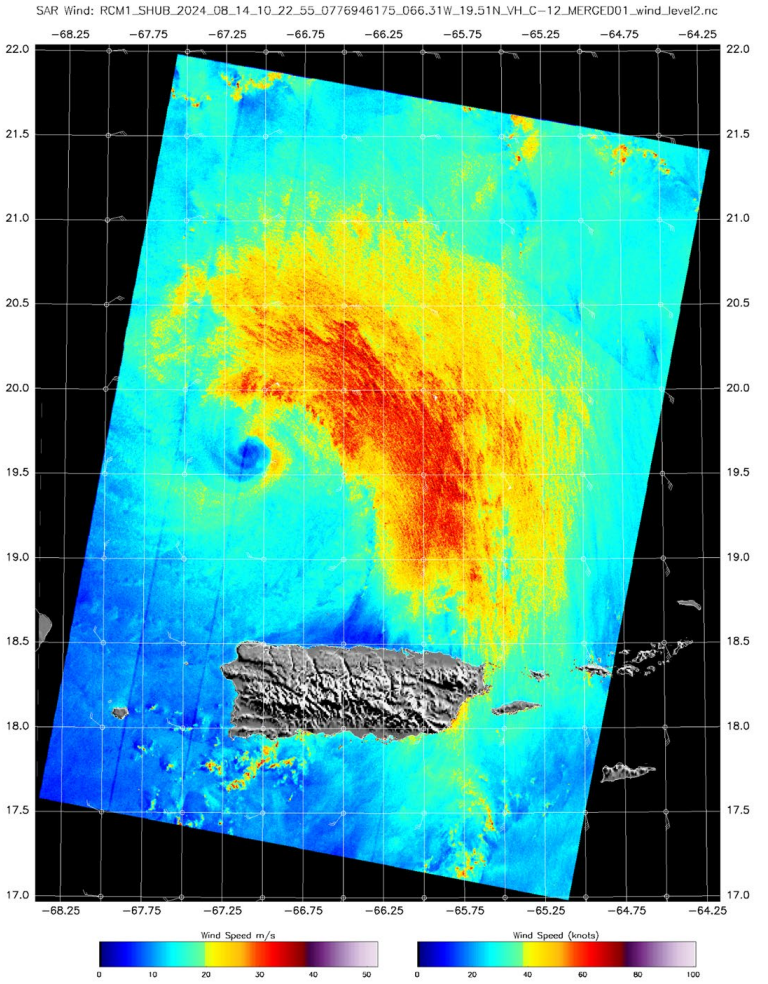
NWS San Juan provided briefings to federal, state and municipal agencies to help them prepare and respond before, during and after the event.



13 Aug 2024 13:30Z - NOAA/NESDIS/STAR - PR - Sandwich Composite

Tropical Storm Ernesto





2025 Atlantic Tropical Cyclone Names

Andrea	Humberto	Olga
Barry	Imelda	Pablo
Chantal	Jerry	Rebekah
Dexter	Karen	Sebastien
Erin	Lorenzo	Tanya
Fernand	Melissa	Van
Gabrielle	Nestor	Wendy

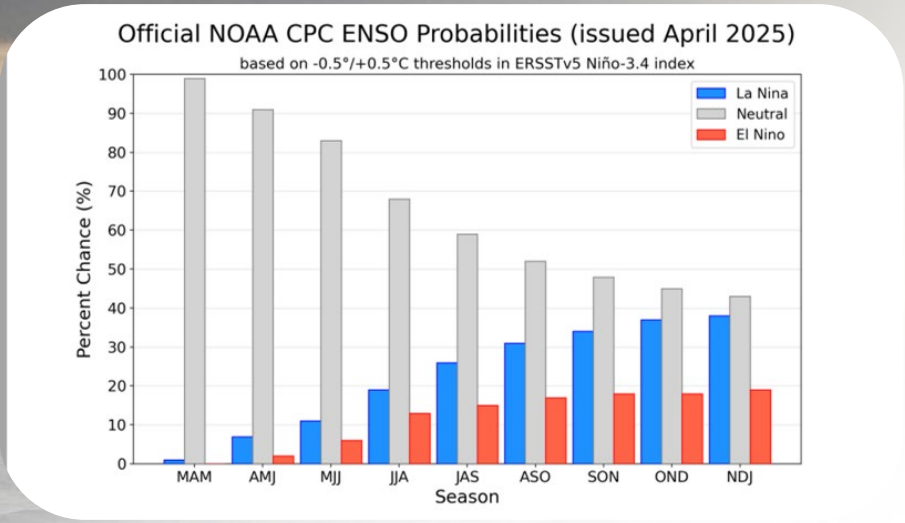
Names provided by the World Meteorological Organization

Be prepared: Visit hurricanes.gov and follow @NWS and @NHC_Atlantic on X.

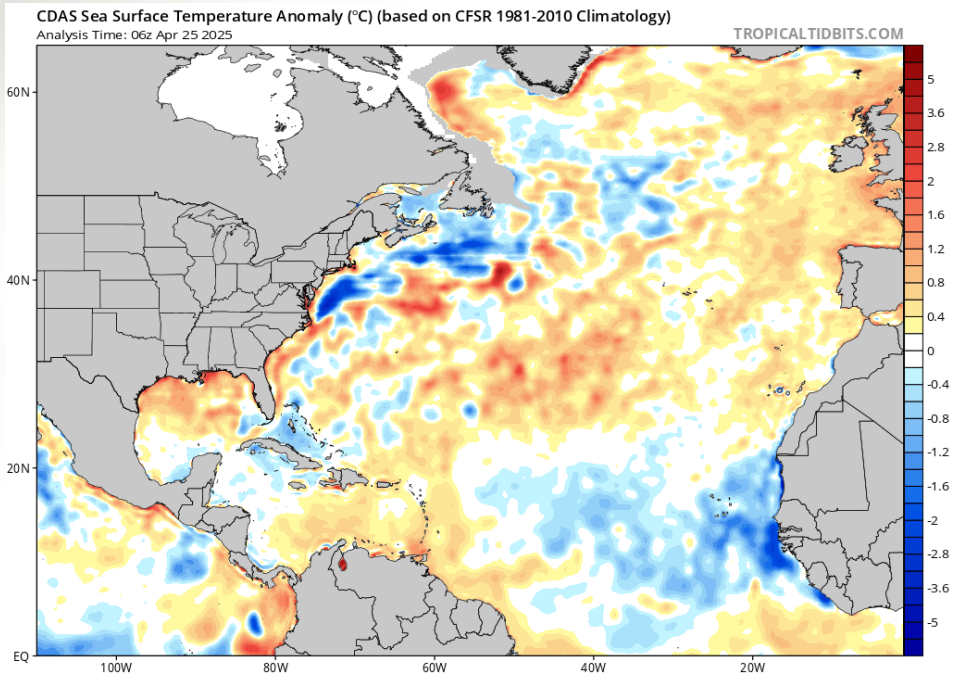
May 2025

2025 Hurricane Season - Current Conditions

NOAA will be issuing this Thursday May 22nd

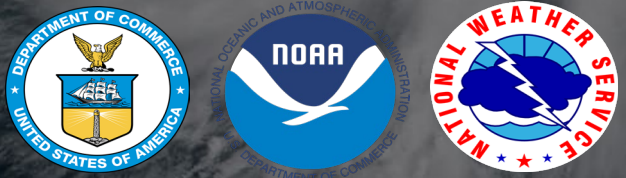


ENSO-**neutral** is favored to persist through the summer 2025, with a greater than 50% chance through the peak of the hurricane season.



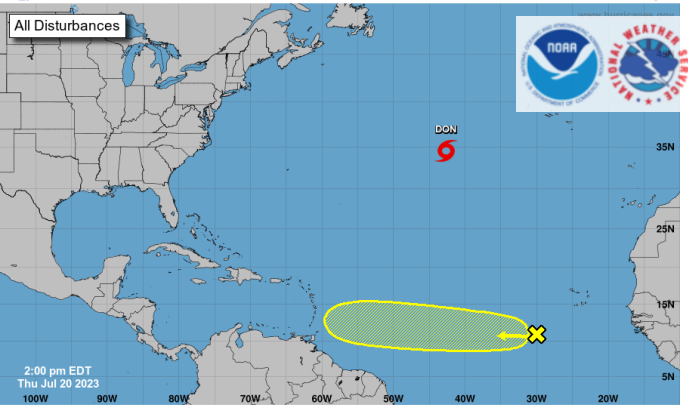
Sea surface temperatures (SSTs) are near-to-below average

Tropical Cyclone Products



Seven-Day Graphical Tropical Weather Outlook

National Hurricane Center Miami, Florida



Current Disturbances and Seven-Day Cyclone Formation Chance: < 40% 40-60% > 60%

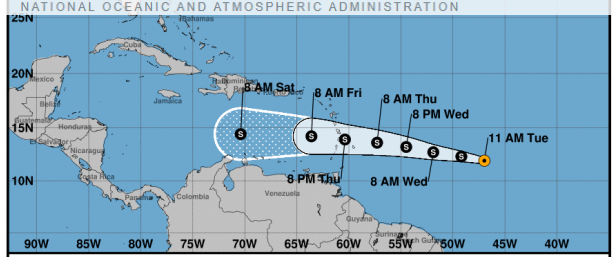
Tropical or Sub-Tropical Cyclone: Depression Storm Hurricane

Post-Tropical Cyclone or Remnants

Note: The cone contains the probable path of the storm center but does not show the size of the storm. Hazardous conditions can occur outside of the cone.

NATIONAL HURRICANE CENTER and CENTRAL PACIFIC HURRICANE CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



Tropical Storm Bret
Tuesday June 20, 2023
11 AM AST Advisory 5
NWS National Hurricane Center

Current information:
Center location 11.9 N 47.0 W
Maximum sustained wind 40 mph
Movement W at 21 mph

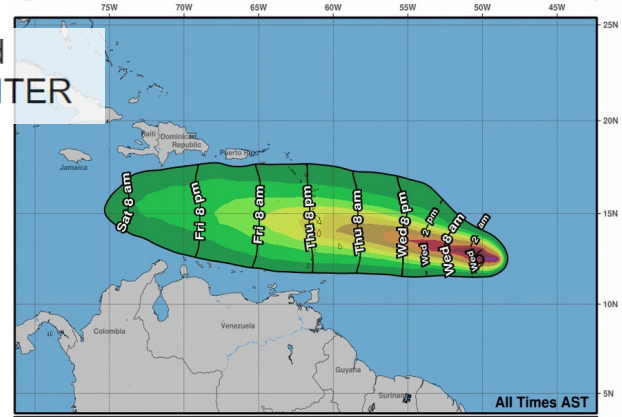
Forecast positions:
Tropical Cyclone Post/Potential TC
Sustained winds: D < 39 mph
S 39-73 mph H 74-110 mph M > 110 mph

Potential track area:
Day 1-3 Day 4-5

Watches: Hurricane Trop Storm

Warnings: Hurricane Trop Storm

Most Likely Arrival Time of Tropical-Storm-Force Winds

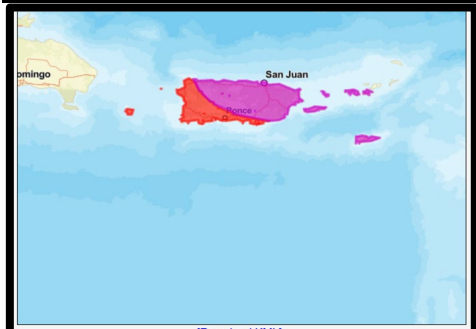


Tropical Storm Bret
Tue. Jun. 20, 2023 11 pm AST
Advisory 7

Storm Location & Wind Speed
< 34 kt (39 mph)
34-63 kt (39-73 mph)
≥ 64 kt (74 mph)

5-day chance of receiving sustained 34+ kt (39+ mph) winds
5 10 20 30 40 50 60 70 80 90 100 %

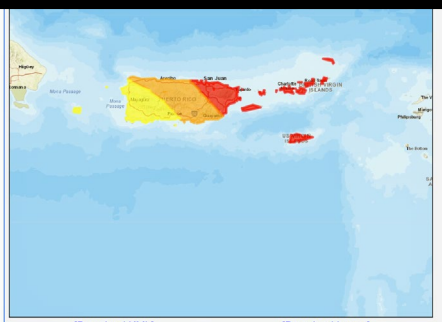
Flooding Threat



[Download KML]

Flooding Rain Threat
Potential for extreme flooding rain
Potential for major flooding rain
Potential for moderate flooding rain
Potential for localized flooding rain
Little to no potential for flooding rain

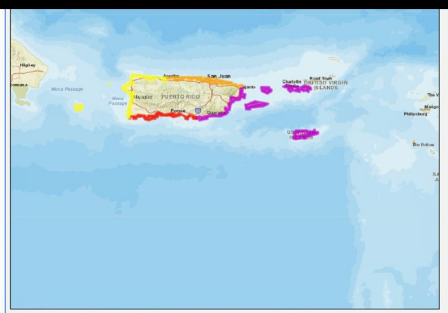
Wind Threat



[Download KML] [Download Image]

Wind Threat
Potential for wind greater than 110 mph
Potential for wind 74 to 110 mph
Potential for wind 58 to 73 mph
Potential for wind 39 to 57 mph
Wind less than 39 mph

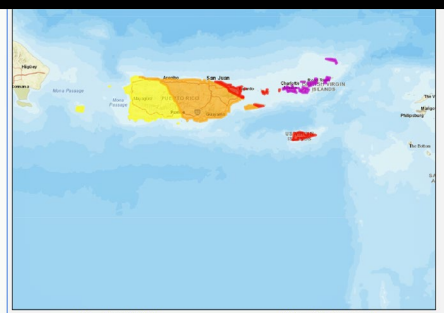
Storm Surge Threat



[Download KML] [Download Image]

Storm Surge Threat
Potential for storm surge flooding greater than 9 ft above ground
Potential for storm surge flooding greater than 6 ft above ground
Potential for storm surge flooding greater than 3 ft above ground
Potential for storm surge flooding greater than 1 ft above ground
Little to no storm surge flooding

Tornado Threat

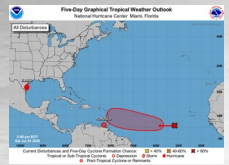


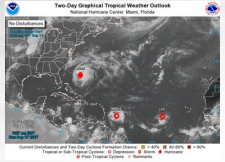
[Download KML] [Download Image]

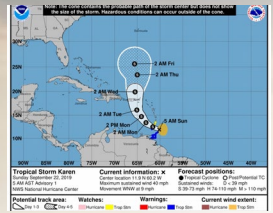
Tornado Threat
Potential for outbreak of tornadoes
Potential for many tornadoes
Potential for several tornadoes
Potential for a few tornadoes
Tornadoes not expected

Official Tropical Products/Graphics

Tropical Weather Outlook

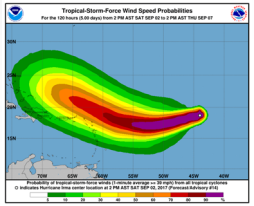


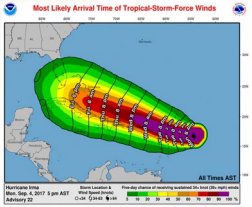




Cone of Uncertainty

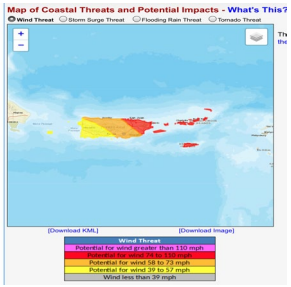
Wind probability



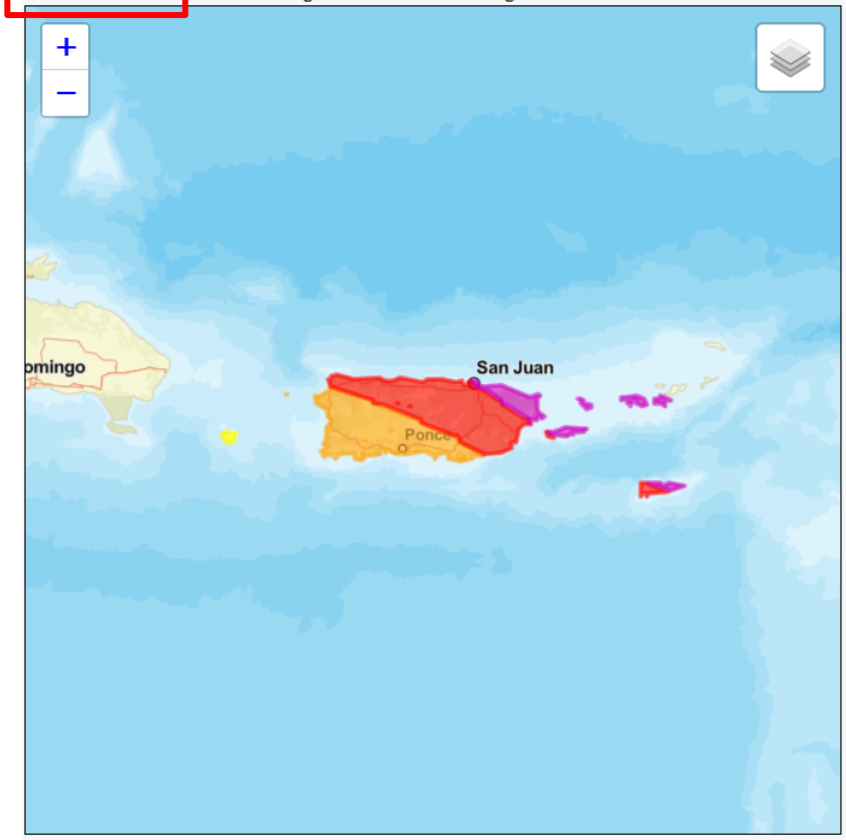


Most Likely and Earliest Reasonable Time Scenarios

Hurricane Local Statement



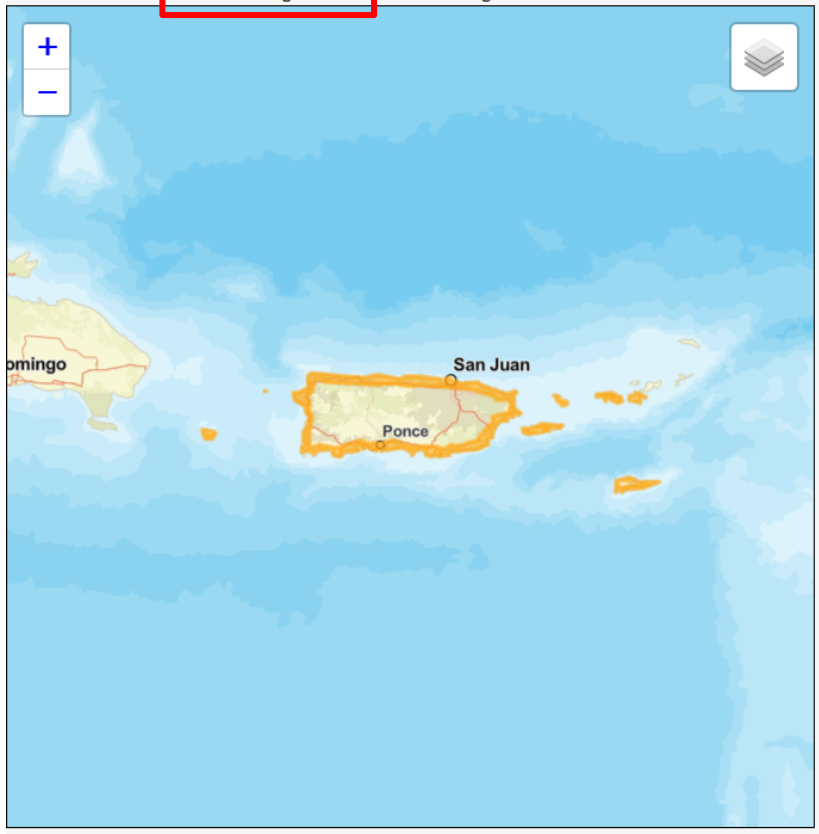
Wind Threat | Storm Surge Threat | Flooding Rain Threat | Tornado Threat



[Download KML]

Wind Threat
Potential for wind greater than 110 mph
Potential for wind 74 to 110 mph
Potential for wind 58 to 73 mph
Potential for wind 39 to 57 mph
Wind less than 39 mph

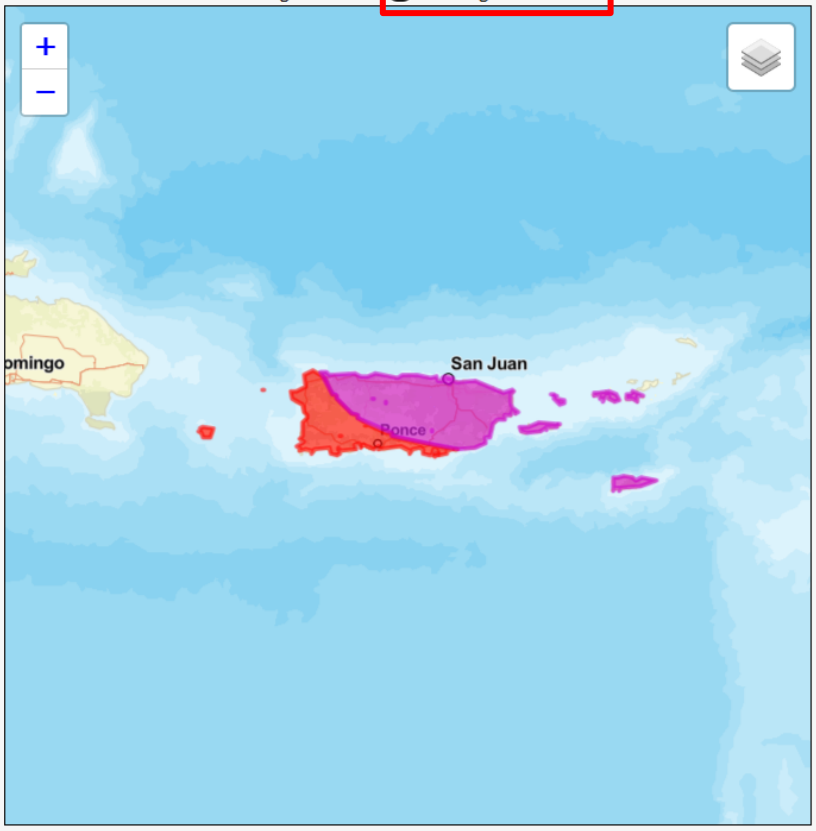
Wind Threat | Storm Surge Threat | Flooding Rain Threat | Tornado Threat



[Download KML]

Storm Surge Threat
Potential for storm surge flooding greater than 9 ft above ground
Potential for storm surge flooding greater than 6 ft above ground
Potential for storm surge flooding greater than 3 ft above ground
Potential for storm surge flooding greater than 1 ft above ground
Little to no storm surge flooding

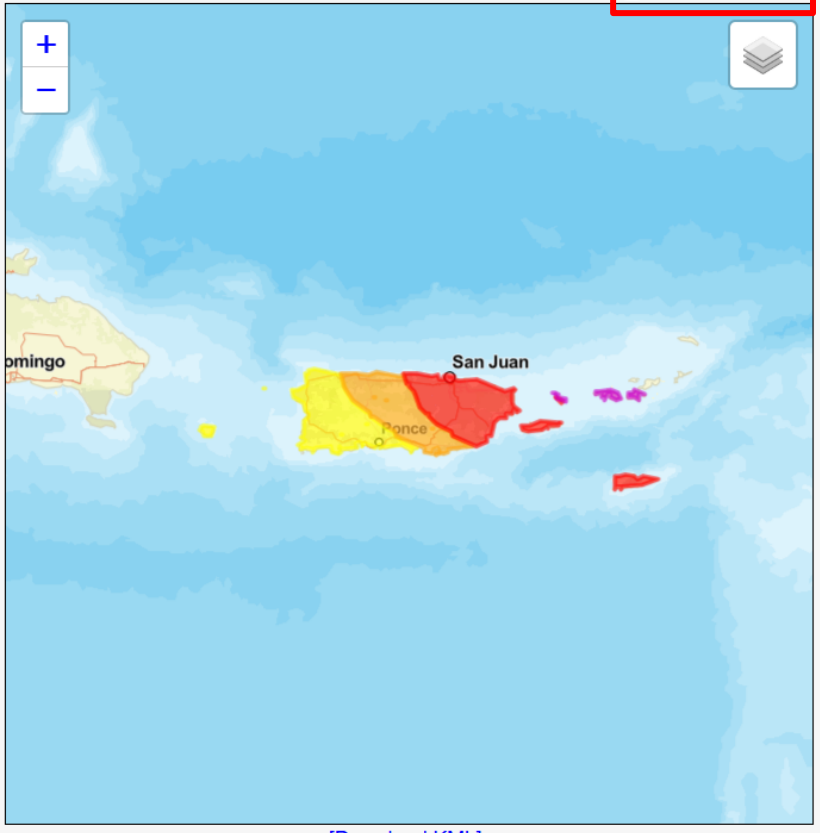
Wind Threat | Storm Surge Threat | Flooding Rain Threat | Tornado Threat



[Download KML]

Flooding Rain Threat
Potential for extreme flooding rain
Potential for major flooding rain
Potential for moderate flooding rain
Potential for localized flooding rain
Little to no potential for flooding rain

Wind Threat | Storm Surge Threat | Flooding Rain Threat | Tornado Threat

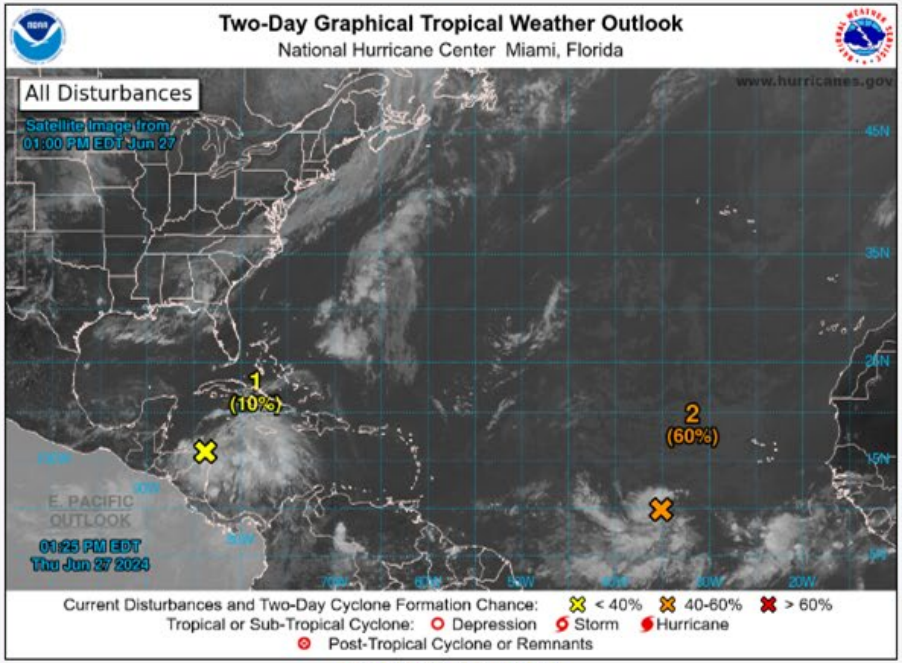


[Download KML]

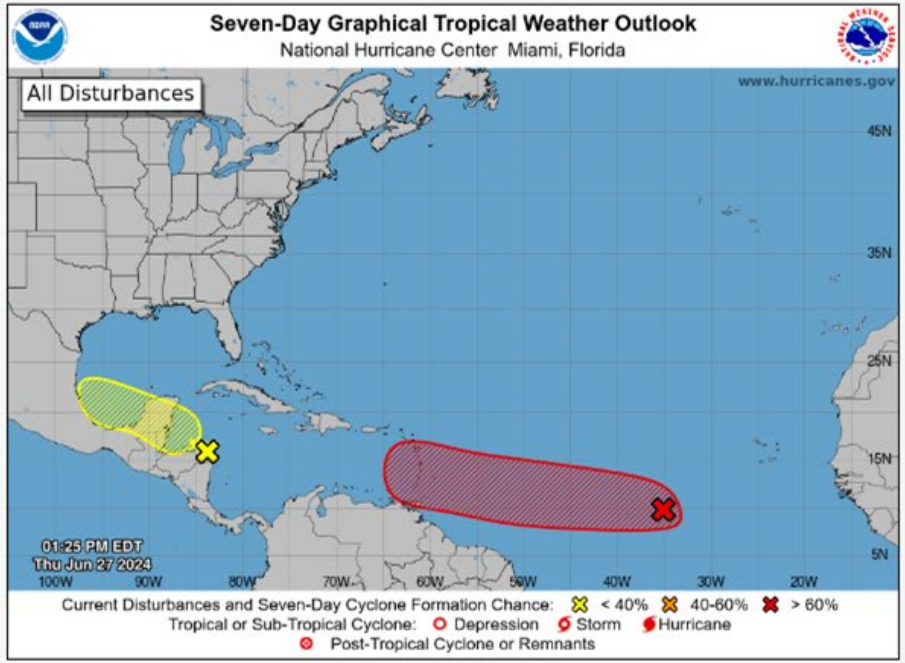
Tornado Threat
Potential for outbreak of tornadoes
Potential for many tornadoes
Potential for several tornadoes
Potential for a few tornadoes
Tornadoes not expected

Outlook | Threats and Impacts | Satellite | Radar | Social Media | Preparedness | Links

There are currently no active storms in the North Atlantic, Caribbean Sea, or Gulf of Mexico.



Product Description

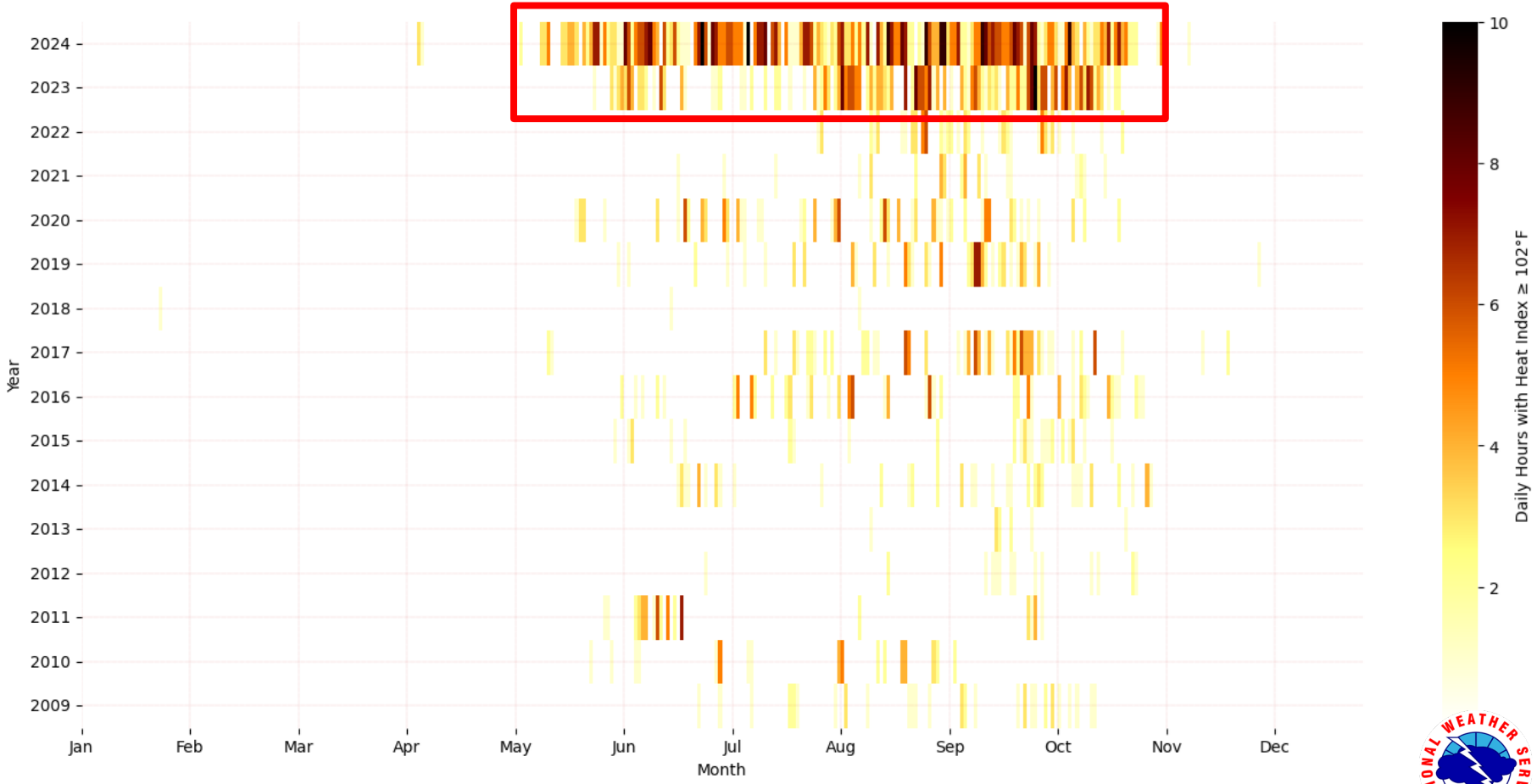


Product Description

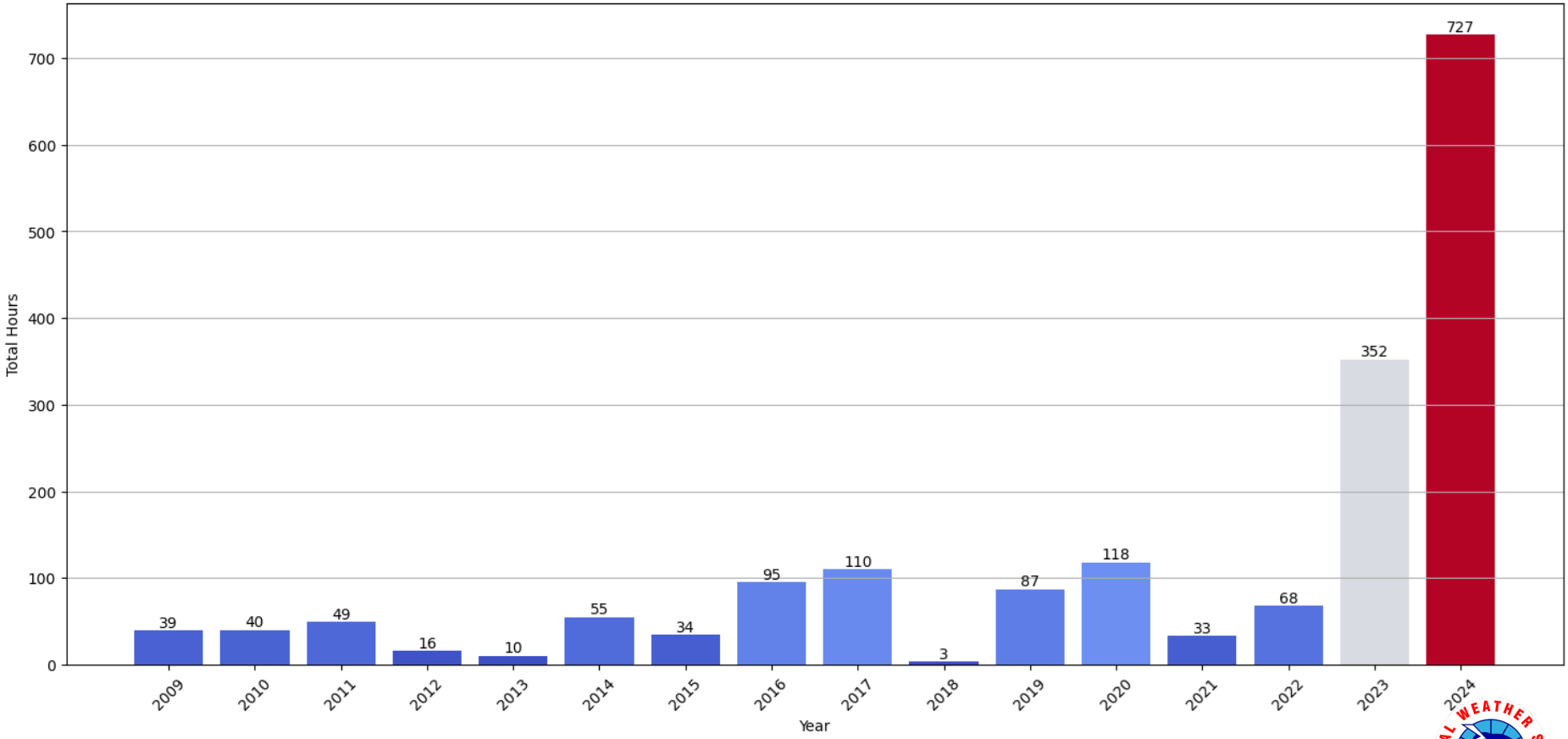
https://www.weather.gov/srh/tropical?office=sju

Excessive Heat

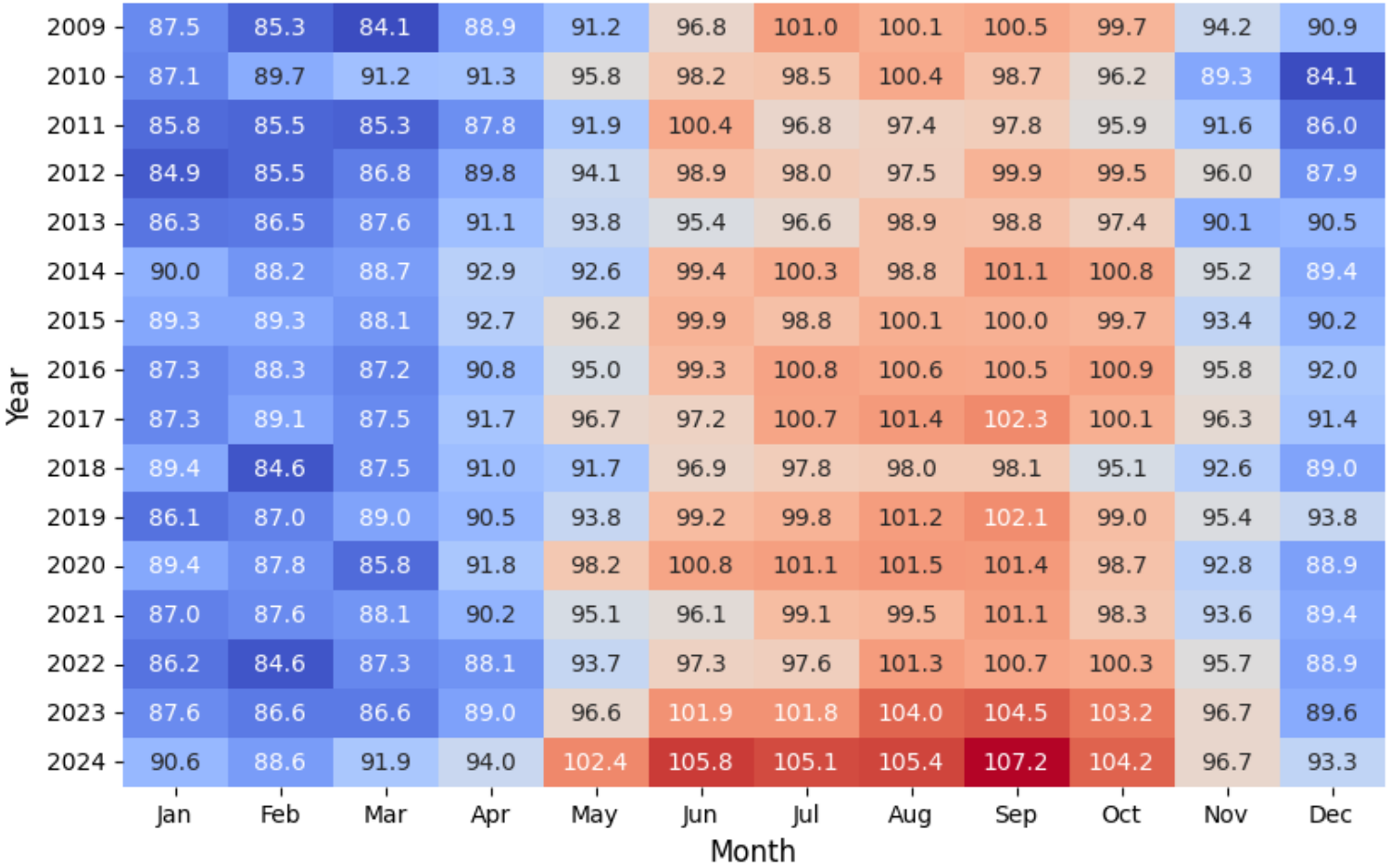
Daily Hours with Heat Index ≥ 102°F in San Juan Airport (TJSJ)



Total Hours/Year with Heat Index ≥ 102°F in San Juan Airport (TJSJ)

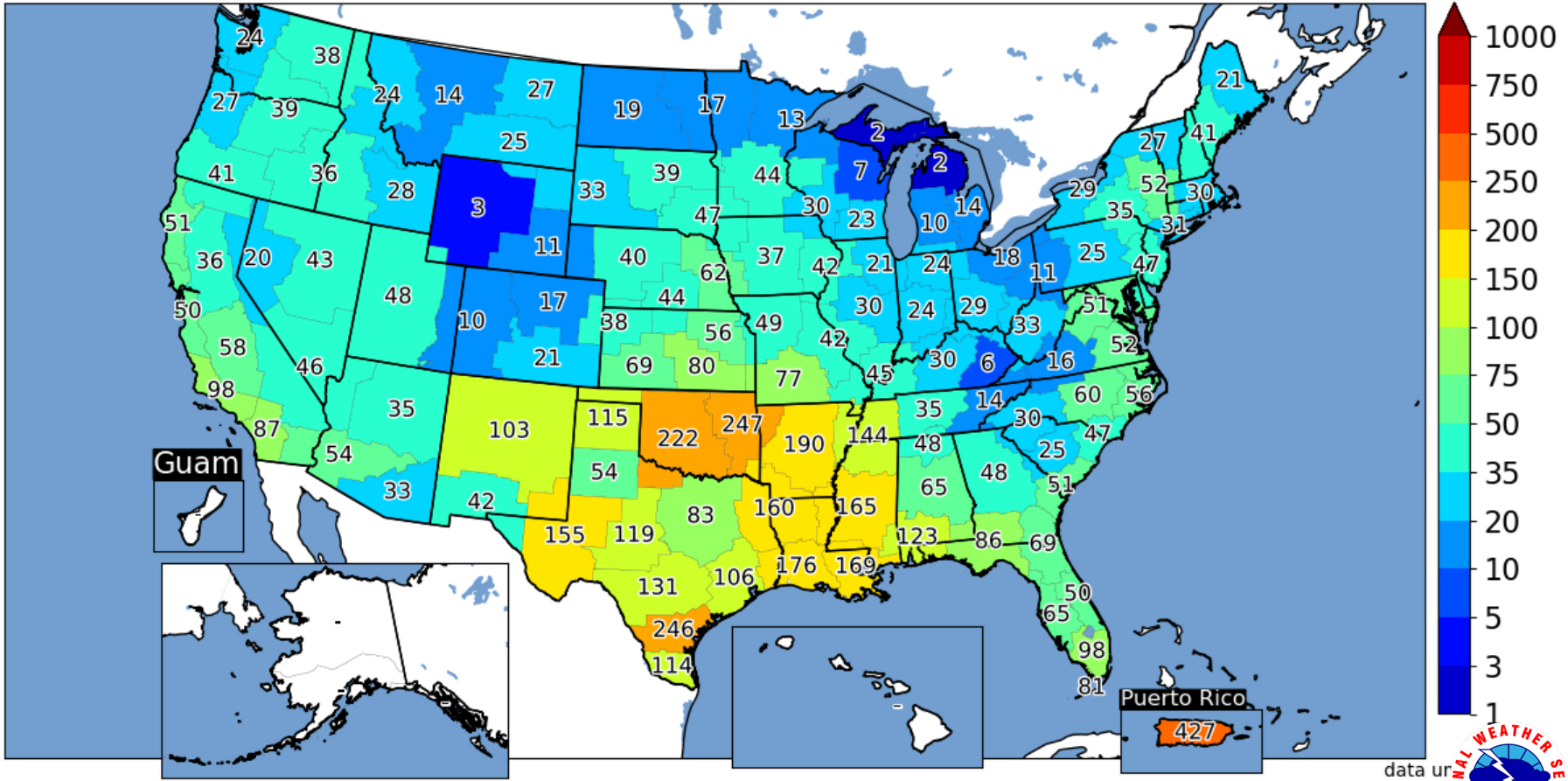


Monthly Average of Daily Maximum Heat Index (°F)



VTEC Unique Event Event Count by WFO

Issued between 01 Jan 2020 00:00 - 19 Jan 2025 23:59 UTC, based on VTEC: EH.W HT.Y 6,927 Events over 117 WFOs



Generated at 19 Jan 2025 8:15 PM CST in 5.03s

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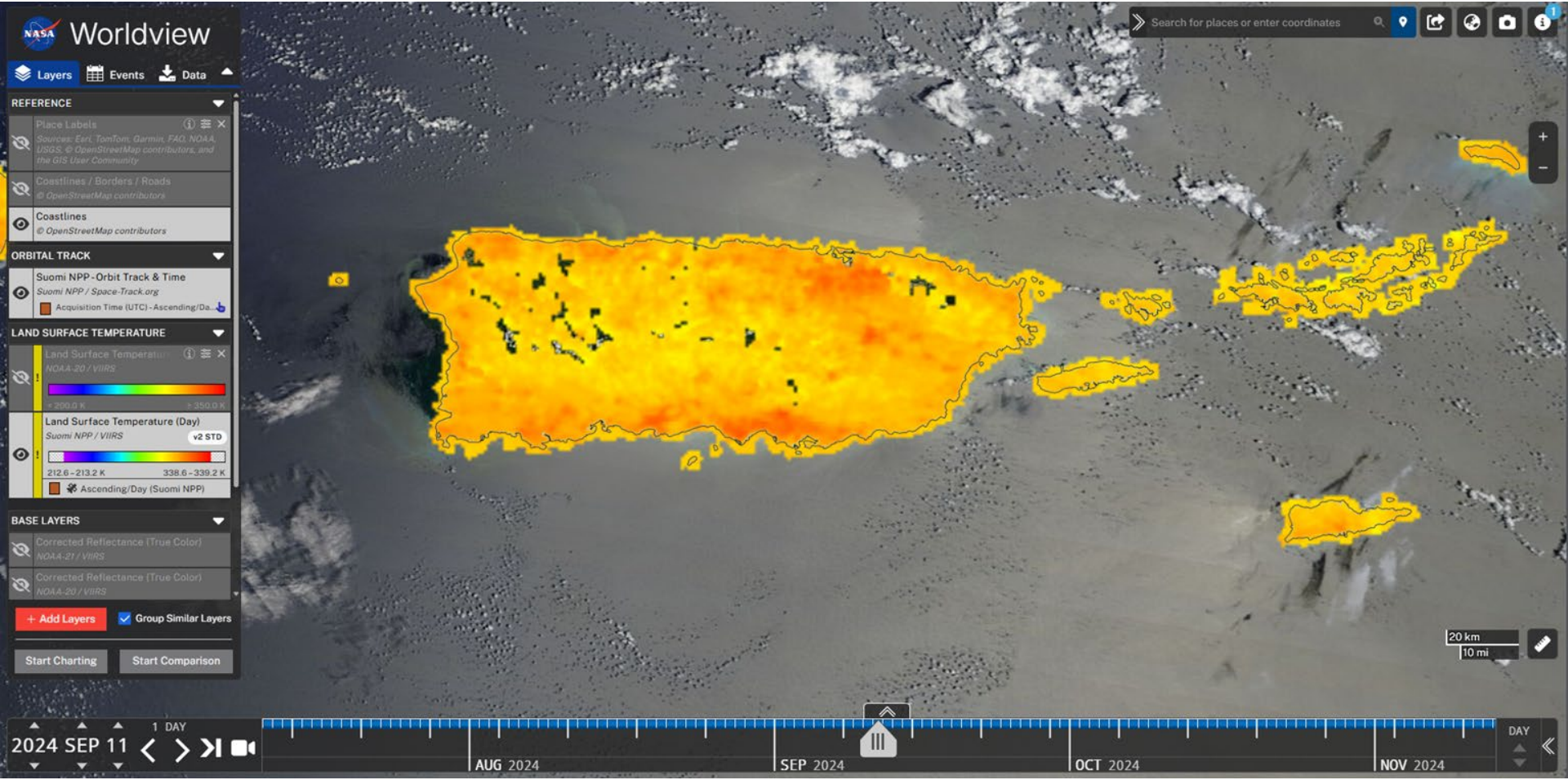
Worldview
Layers
Events
Data
REFERENCE
Place Labels
Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community
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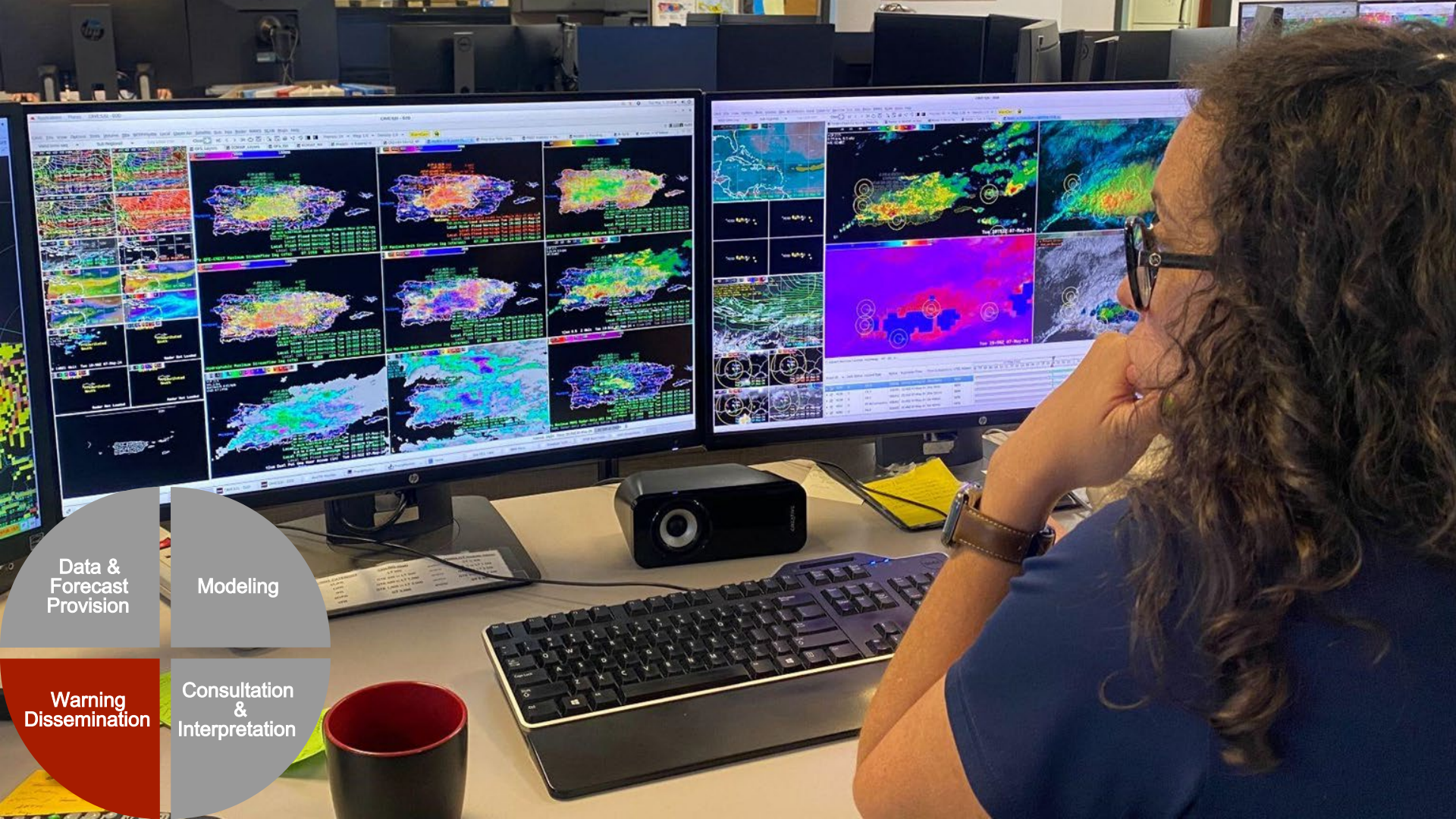
ORBITAL TRACK
Suomi NPP - Orbit Track & Time
Suomi NPP / Space-Track.org
Acquisition Time (UTC) - Ascending/Da...
LAND SURFACE TEMPERATURE
Land Surface Temperature
NOAA-20 / VIIRS
< 200.0 K
> 350.0 K
Land Surface Temperature (Day)
Suomi NPP / VIIRS
v2 STD
212.6 - 213.2 K
338.6 - 339.2 K
Ascending/Day (Suomi NPP)
BASE LAYERS
Corrected Reflectance (True Color)
NOAA-21 / VIIRS
Corrected Reflectance (True Color)
NOAA-20 / VIIRS
+ Add Layers
Group Similar Layers
Start Charting
Start Comparison
Search for places or enter coordinates
20 km
10 mi
1 DAY
2024 SEP 11
AUG 2024
SEP 2024
OCT 2024
NOV 2024
DAY

NATIONAL WEATHER SERVICE

Impact-based Decision Support Services (IDSS)


Data & Forecast Provision
Modeling
Warning Dissemination
Consultation & Interpretation


9:13:43
BOMBEROS
NMRAD


PUERTO RICO EMERGENCY
MANAGEMENT BUREAU
COMMAND UNIT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Modeling
Warning Dissemination
Consultation & Interpretation


NMEAD
Negociado para el Manejo de E rgencias
y dministraci de Des es
DSP
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…And many other local, state, and national agencies!