



**EESI**

Environmental and  
Energy Study Institute

**Materials will be available at:**  
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**CONGRESSIONAL BRIEFING**  
**Innovation as Climate Action:**  
**Advances in Weather Forecasting**  
**How Federal Agencies Partner with the Private**  
**Sector to Tackle Climate Challenges**

Wednesday, January 12, 2022

# About EESI...



## **NON-PROFIT**

Founded in 1984 by a bipartisan Congressional caucus as an independent (i.e., not federally-funded) non-profit organization



## **NON-PARTISAN**

Source of non-partisan information on environmental, energy, and climate policies



## **DIRECT ASSISTANCE**

In addition to a full portfolio of federal policy work, EESI provides direct assistance to utilities to develop “on-bill financing” programs



## **SUSTAINABLE SOCIETIES**

Focused on win-win solutions to make our energy, buildings, and transportation sectors sustainable, resilient, and more equitable

# Polycymaker Education

## Briefings and Webcasts



Live, in-person and online public briefings, archived webcasts, and written summaries

## Climate Change Solutions



Bi-weekly newsletter with everything policymakers and concerned citizens need to know, including a legislation and hearings tracker

## Fact Sheets and Issue Briefs



Timely, objective coverage of environmental, clean energy, and climate change topics

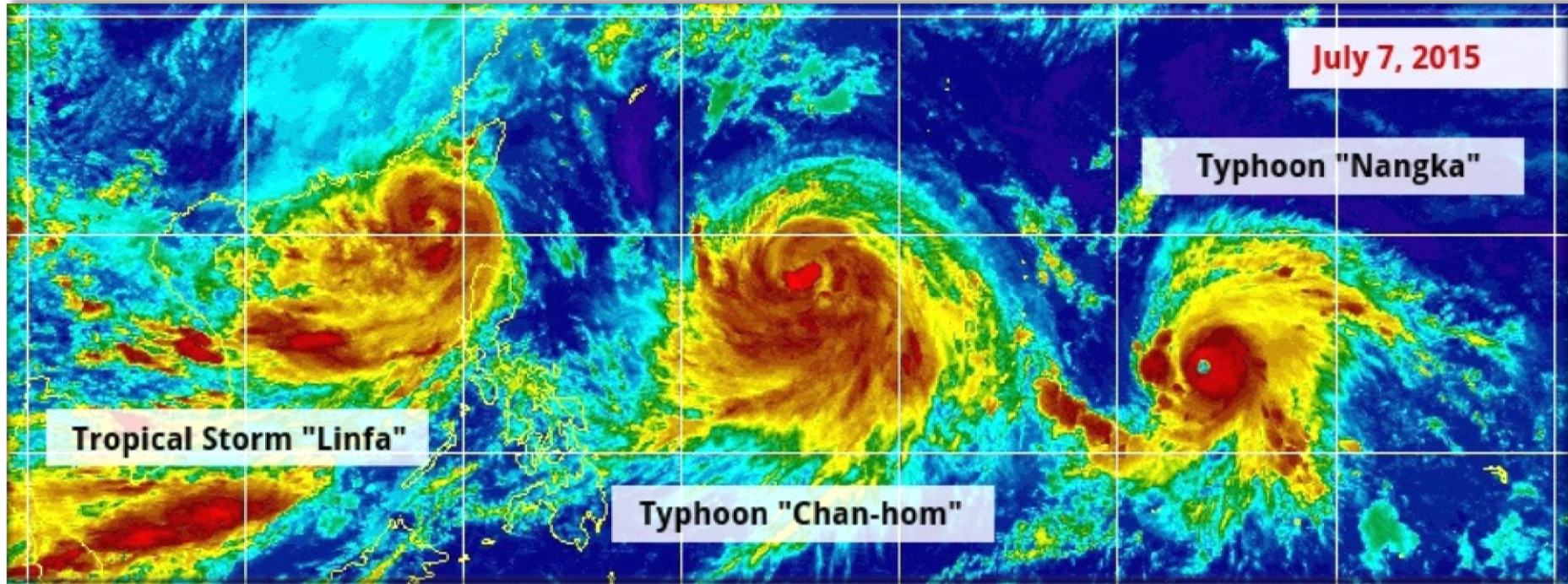
## Social Media (@EESIOnline)



Active engagement on Twitter, Facebook, LinkedIn, and YouTube



# *Weather, Climate, and Ocean Needs for Modern Warfighting*



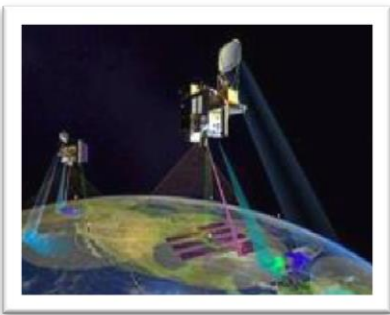
*Rear Admiral Tim Gallaudet, PhD  
US Navy (ret)  
CEO, Ocean STL Consulting*



*Ocean STL Consulting, LLC  
Ocean Science and Technology  
Leadership for the 21st Century*



# *When I Was In the Navy...*



*The Weather Gauge of the 21<sup>st</sup> Century*

# Climate Change Impacts



**Increasing Flooding**



**Water Scarcity**

**Seasonally Ice Free Arctic**



**Fish Stock Movement**



**Extreme Drought Conditions**



**Tropical Cyclone Intensification**



**Impacts to All DOD Missions Worldwide**



# DOD's Climate Plan

Department of Defense  
Climate Adaptation Plan

September 1, 2021

To National Climate Task Force  
and Federal Chief Sustainability Officer

WH.GOV  

BRIEFING ROOM

## FACT SHEET: Biden Administration Releases Agency Climate Adaptation and Resilience Plans from Across Federal Government

OCTOBER 07, 2021

[STATEMENTS AND RELEASES](#)


Today, the Biden-Harris Administration released plans developed by more than 100 federal agencies that outline the steps each agency will take to ensure their facilities

 MENU

# Tyndall AFB, October 2018





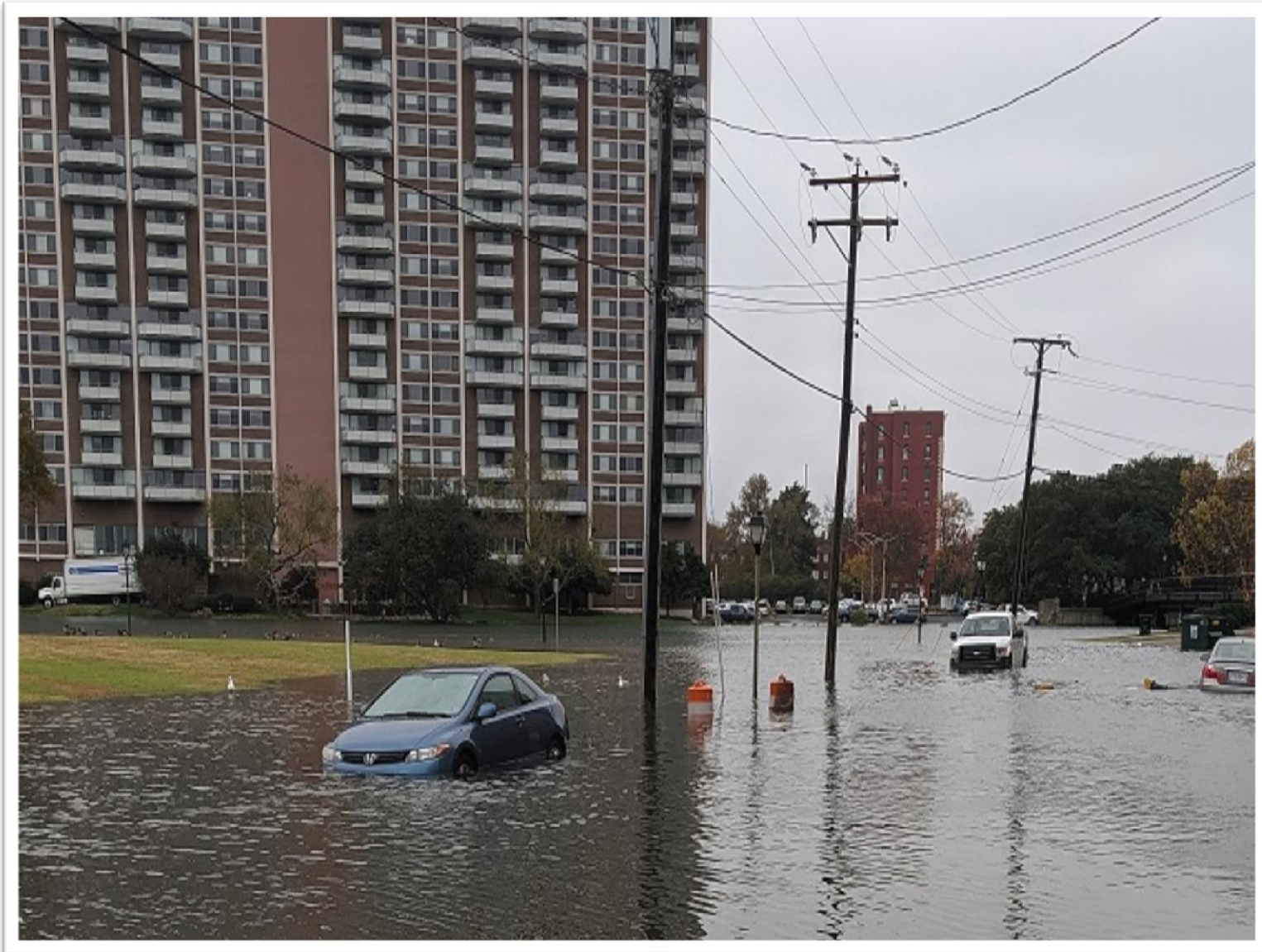
# *Offutt AFB, March 2019*

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# *Norfolk Naval Base, 2020*

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# King's Bay Submarine Base, July 2021



TEAM COVERAGE

4 PEOPLE INJURED AFTER TORNADO TOUCHED DOWN AT NAVAL BASE

KINGS BAY, CAMDEN COUNTY

**FOX30**

ACTION NEWS JAX

75°



# Making the Military Climate Ready



RealClearDefense

Subscribe

## Making the Military Climate-Ready for What Truly Matters – Modern Warfighting

By **Tim Gallaudet**

December 04, 2021



U.S. Navy photo by MC3 Andrew Langholf



# A Recent Wargame

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***“It failed miserably...(they) just ran rings around us...(and) knew just what we were going to do before we did it.”***

***Gen John Hyten  
former Vice CJCS***

# Modern Warfighting Elements

***Distributed Force Dispositions***



***Joint All Domain Operations***



***Technology Proliferation***



***Information Warfare Ascent***



***Need Higher Precision, Longer Lead Times, Larger Areas***

# A Bold New Era



*“In 1957, when the Soviet Union launched the Sputnik satellite, only the federal government could mount a response to that launch. Today, it could easily be a private company or even a startup,”*

*Dr. Kelvin Droegemeier  
former White House Science Advisor*

**DOD Needs Public-Private Partnerships More Than Ever**

# Way Ahead

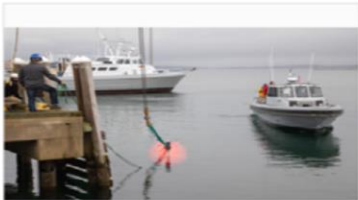
## Sofar and DARPA look to standardize ocean monitoring gadgets with Bristlemouth

Devin Coldewey

@techcrunch / 5:01 am PDT • September 23, 2021



## Dive Technologies Participates in 1st CRADA Event with NUWC - Newport Division



## Tomorrow.io secures US\$20m US Air Force contract to deploy weather satellite constellation



By DAN SYMONDS — October 5, 2021

No Comments



BREAKING  
**DEFENSE**

## Could 'Weather Intelligence' Take The Pentagon By Storm?

A weather "data coverage gap exists in areas that we operate on a regular basis in the military," says Dan Stillman, director of marketing for Tomorrow.io's space and government division.

By THERESA HITCHENS on July 08, 2021 at 7:00 AM



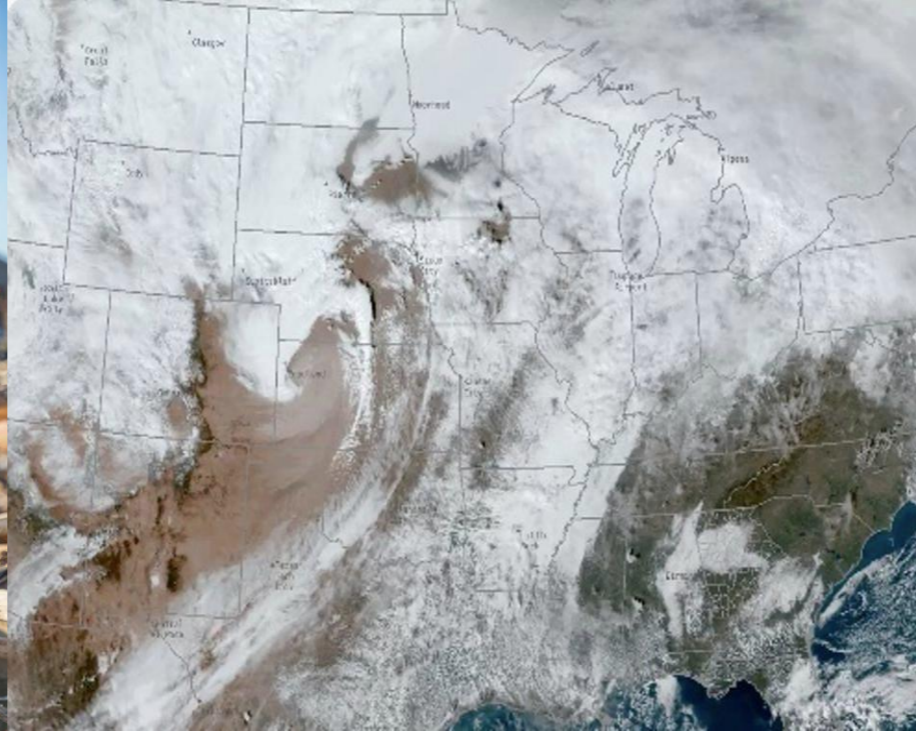
by CBRNE CENTRAL STAFF  
May 8, 2017, 8:52 am

**Solutions for DOD's Needs Are Available Now**



*Thank You!*





# The Extreme Weather - Climate Gap: Implications for Vulnerable and Marginalized Communities

Dr. Marshall Shepherd

Georgia Athletic Association Distinguished Professor, University of Georgia

Host, Weather Channel's Weather Geeks

Senior Contributor, Forbes Magazine

Twitter: @DrShepherd2013

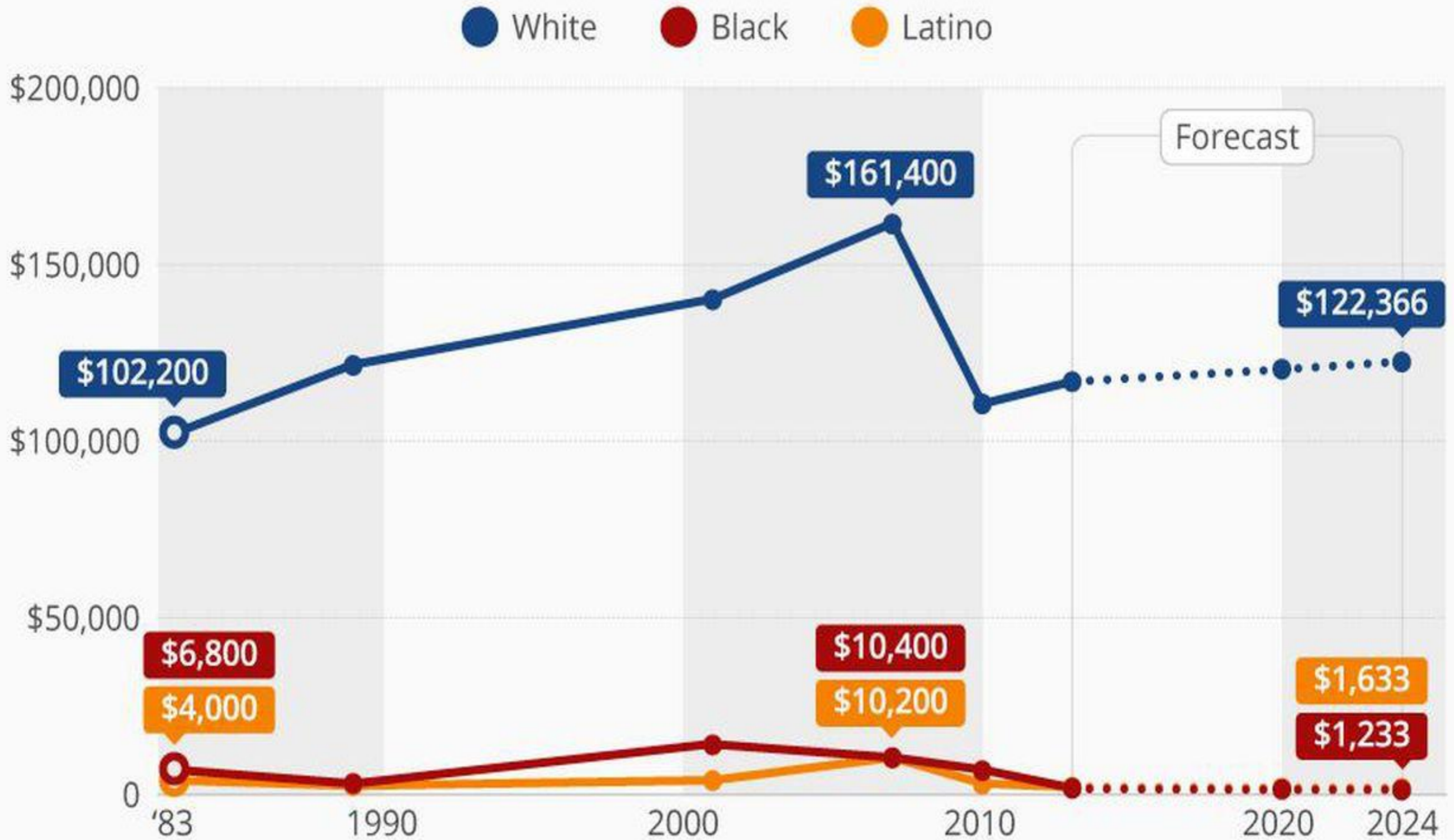
*The gap between the rich and poor is growing among and within most nations.....The global environment shows signs of widespread deterioration. Both natural and social environments are increasingly vulnerable to catastrophic disturbances.*

—*Gilbert F. White*



# Racial Wealth Inequality Is Rampant In The U.S.

Median household wealth by race/ethnicity in the United States (1983-2024)







The Extremes are  
becoming more  
extreme, and people  
feel them far more than  
“averages”

--Dr. Marshall Shepherd

Testifying Before The U.S. House of  
Representatives Science  
Committee in 2019

# 3 Questions About Climate Change That Need To Disappear In 2022



Marshall Shepherd Senior Contributor   
Science

Follow

Are we in a “new normal” climate?

Yes. Yes. Yes. I will even go further. As I recently told reporters, we don’t have to refer to it as a “new normal.”  
It is normal

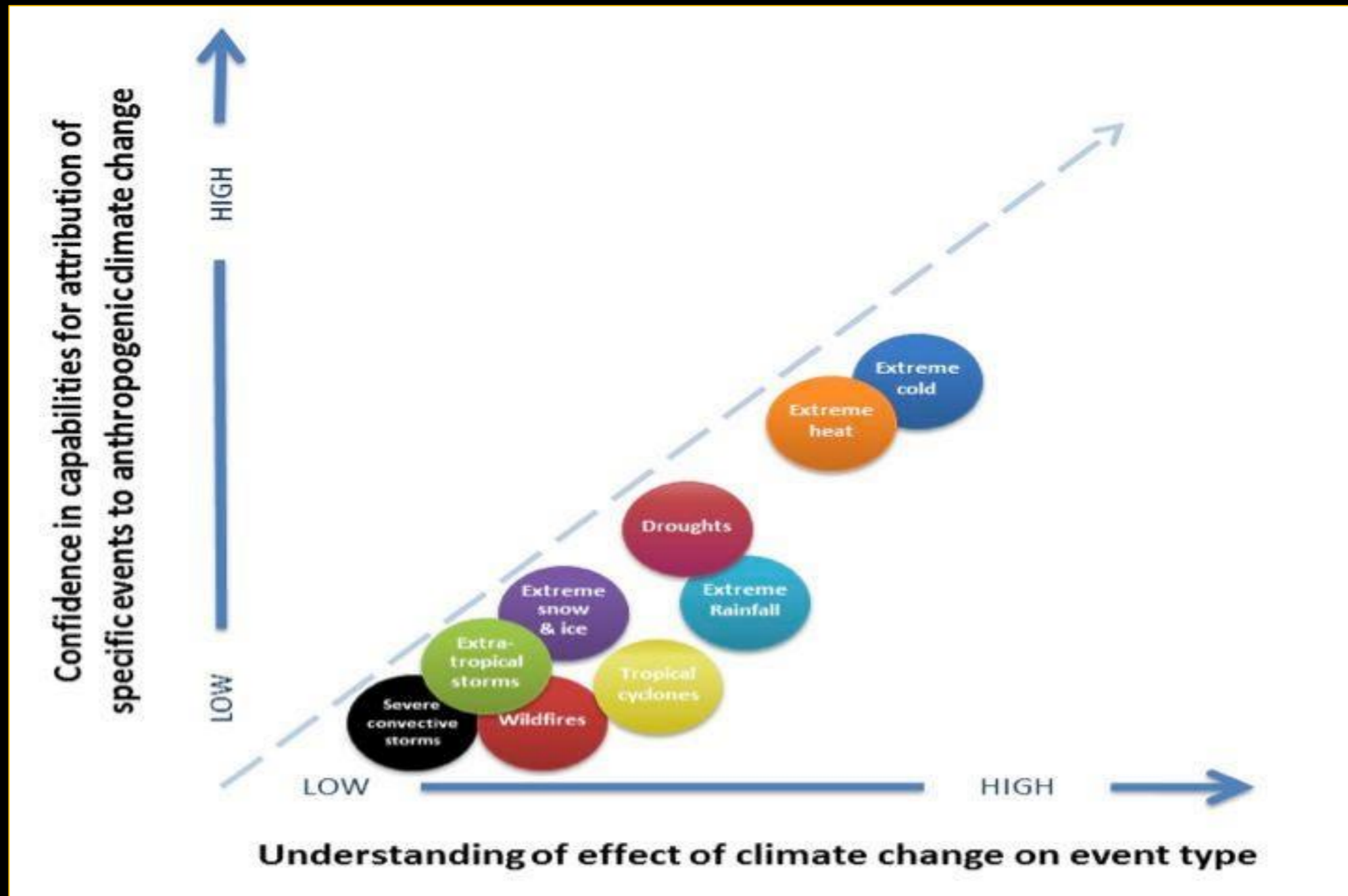
What do think of this being the warmest this or the wettest that?

This type of information is not breaking news anymore. Expect extreme temperature, rainfall, sea level, Arctic sea ice loss or hurricane intensity records to be broken frequently and with startling magnitudes at times.

Are we acting fast enough?

No. We know the DNA is in climate change because of attribution studies and compound events are a multiplier

# An Important Point on Attribution, Extreme Weather and Climate Change

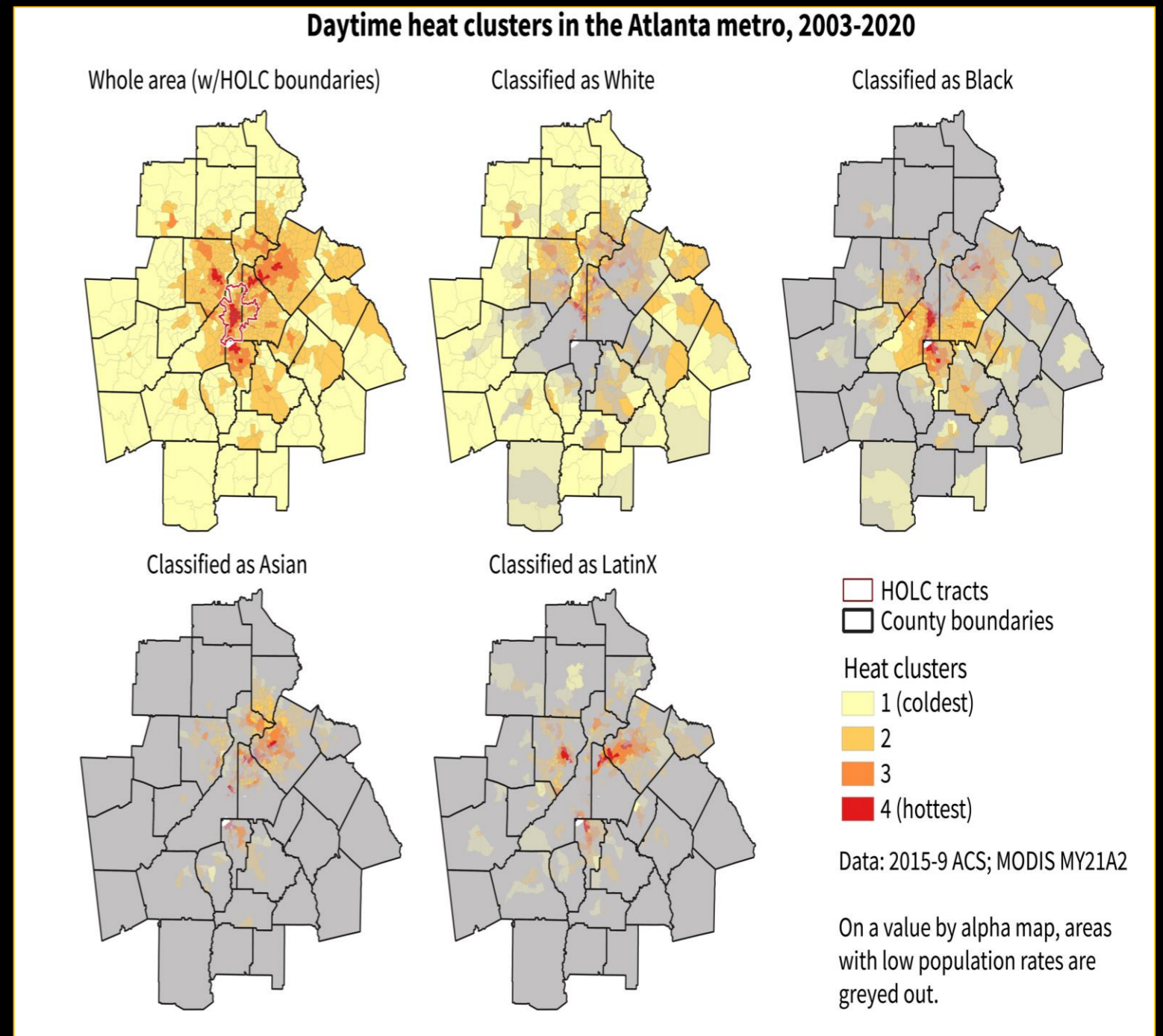




“ Environmental justice embraces the principle that all people and communities have a right to equal protection and equal enforcement of environmental laws and regulations....Today, zip code is still the most potent predictor of an individual’s health and well-being. Individuals who physically live on the “wrong side of the tracks” are subjected to elevated environmental health threats and more than their fair share of preventable diseases....Reducing environmental, health, economic and racial disparities is a major priority of the Environmental Justice Movement.



**What is the Weather-Climate Gap?** - A disproportionate sensitivity to extreme weather-climate events and a delay in the ability to bounce back





## COMMUNITIES OF COLOR

Some communities of color living in risk-prone areas face cumulative exposure to multiple pollutants.

Adaptation plans that consider these communities and improve access to healthcare help address social inequities.



## OLDER ADULTS

Older adults are vulnerable to extreme events that cause power outages or require evacuation.

Checking on elderly neighbors and proper emergency communication can save lives.



## CHILDREN

Children have higher risk of heat stroke and illness than adults.

Adults can lessen risk by monitoring exertion and hydration.



## LOW INCOME COMMUNITIES

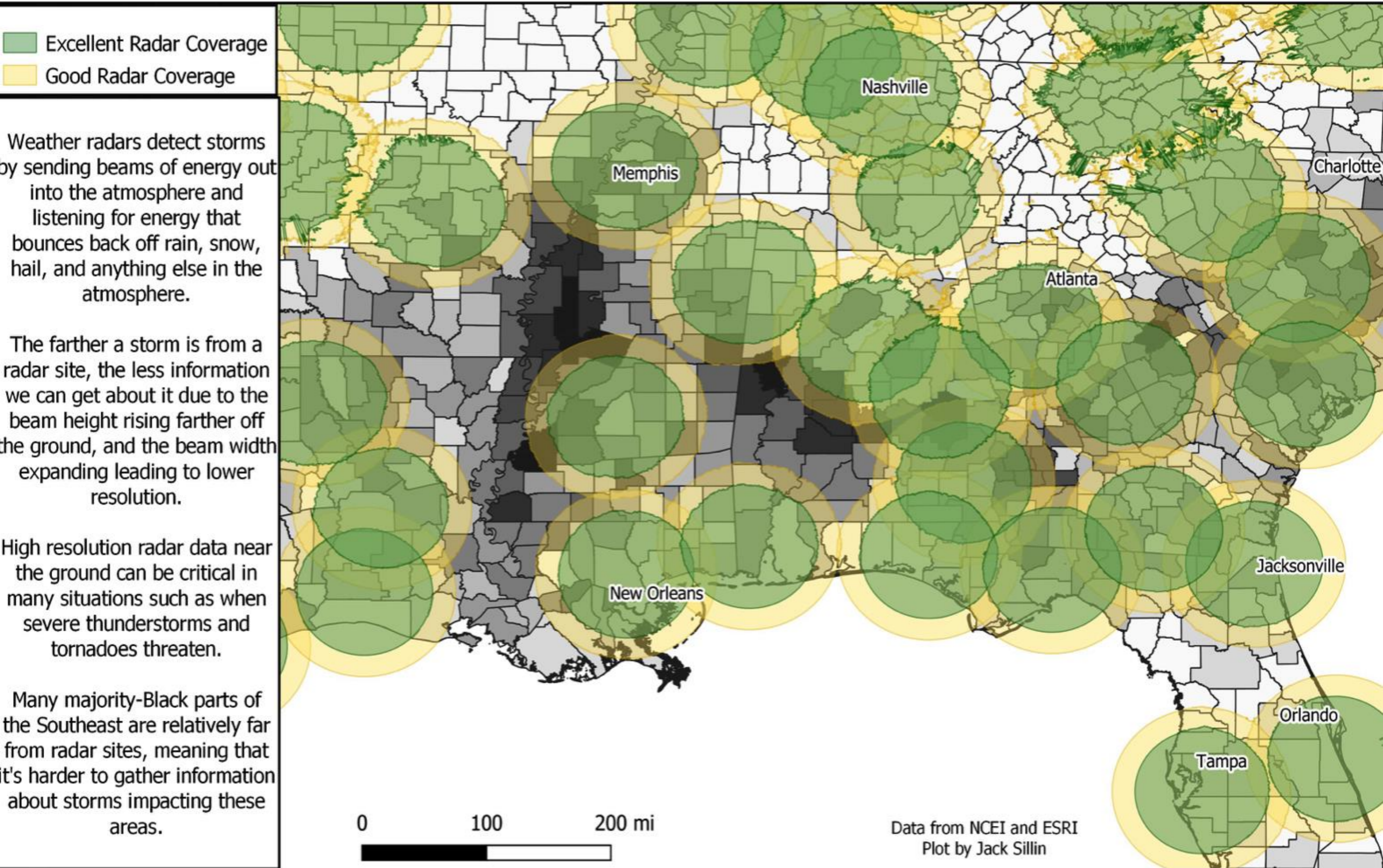
Low income families are at risk of physical and mental illnesses during flooding and in crowded shelter conditions.

Comprehensive disaster management can improve resiliency for people with limited resources.





# Are Black Americans Underserved by the NWS Radar Network?



## Black Population Share





# Our Conundrum - We Land On Mars But People Languish Without Power after a Hurricane or Ice Storm



**Ian Giammanaco** is an expert in the housing resilience and risk mitigation field.



“Being proactive with resilience has shown even a 10 to 1 return on reducing losses from catastrophic events.”

# What we need now....

Increasing resilience across all infrastructure sectors (**engineered and nature based solutions**)

A **"Warp-Speed" or Apollo-Level Effort** Is Required For The Climate Crisis

Marginalized, poor, and people of color **suffer disproportionately** from extreme weather events so close the Weather-Climate Gap

A weather, water, and climate enterprised scale for **21<sup>st</sup> century "normal"**

The **5 P's**



A Year After Hurricane Harvey, Houston's Poorest Neighborhoods Are Slowest to Recover

Texas has made progress recuperating from Hurricane Harvey, but low-income and minority residents have had a much harder time.

## ***How the Storm Turned Basement Apartments Into Death Traps***

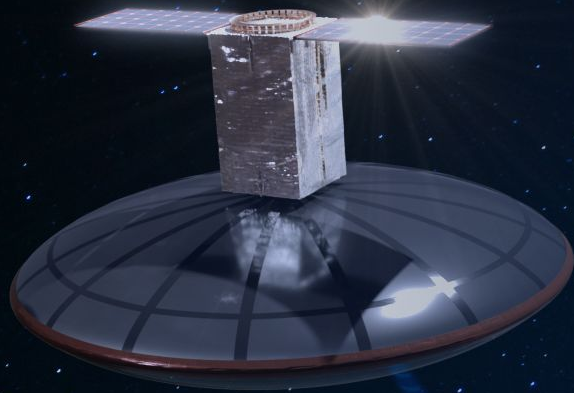
At least 11 people were found dead in basements after torrential rains flooded New York City — nearly as many as those killed by Hurricane Ida in Louisiana, where the storm made landfall.





# A New NOAA “Decadal” Weather Research Report Is a Start

- “Accelerate development of an Earth system modeling approach to improve forecast accuracy and lead time;
- Increase investments in social and human behavioral data collection and sciences to better understand how weather products are used and to support co-development of improved products;
- Prioritize immediate investments in fundamental research on data assimilation to deliver sustained improvements in forecast skill and to train the next generation of experts in this area to fill an existing critical workforce gap;
- Fully implement and expand rapidly the existing plans for improved weather data dissemination, increasing understanding through open-science approaches, and expanding applications through weather industry partnerships;
- Expand high-performance computing capacity by two orders of magnitude over 10 years to support operational forecasts and data dissemination and provide critically lacking capacity in weather research;
- Fill gaps in existing Earth system observing networks with existing, proven or augmenting technologies to expand coverage, especially in underserved regions;
- Support reanalysis and reforecasting vital to Earth system model evaluation and improvement, to characterize extremes, and provide training datasets for artificial intelligence product applications;
- Target the understanding and prediction of high-impact weather to match the urgent need imposed by climate trends, population and infrastructure increases, and disproportionate impacts on vulnerable communities;
- Target water cycle extremes and their cascading impacts to improve flood and drought prediction and to enable forecast-informed reservoir operations; and
- Develop improved and increasingly objective methods to balance investments across the weather information value chain and expand efforts to more precisely target future investments.”



# How Industry Innovation is Accelerating Advances in Weather Forecasting

Thomas Cavett  
Director of Business Operations for Space

January 2021

# The Global Leader in Weather Technology

Partnering With The Brands People Trust Most



## Fastest Growing Company in the history of the Weather Technology Industry

### Offices

Boston | Bourne | Boulder | Denver  
Tel-Aviv | Singapore | Mumbai | Tokyo | Australia

### Funding

**\$200M+**

First capital \$5M | A \$15M  
B \$60M | C \$23M | D \$77M

### Investors





## Our Work With the Federal Government



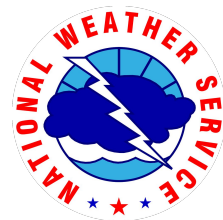
**\$20M contract from U.S. Air Force** to fund development of Tomorrow.io's first four weather radar satellites, with first launches planned for late 2022



Conducting feasibility study for developing an **Urban Air Mobility (UAM) weather testbed** to capture fine-scale phenomena

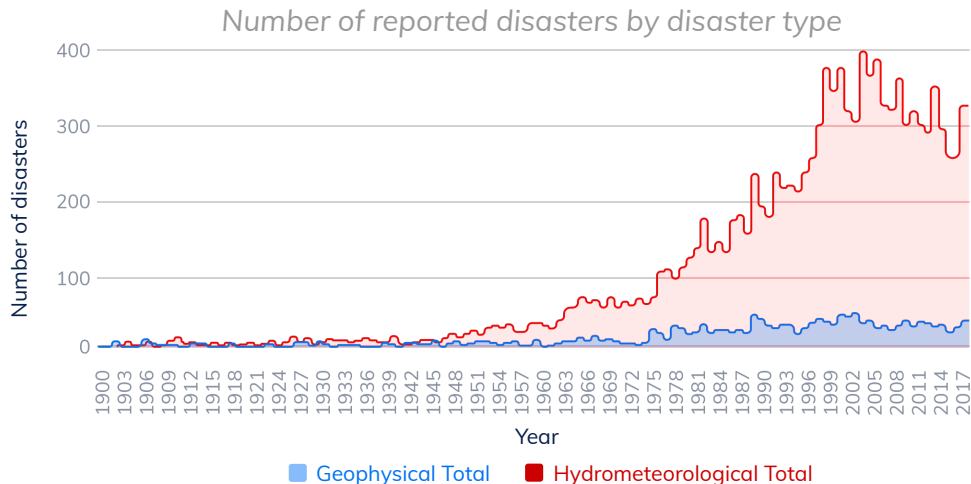


Core teaming partner of Raytheon Technologies, prime contractor for the development of **NOAA's Earth Prediction Innovation Center (EPIC)**



Recognized as **National Weather Service Weather-Ready Nation Ambassador** and trusted partner in delivering life-saving NWS warnings

# Climate Security - Our generation's greatest challenge



- **\$210 Billion** in weather disaster losses worldwide in 2020, a **record year for hurricanes and wildfires** in U.S.
- 2021 **extreme U.S. weather:** Crippling winter storm, catastrophic flooding & fires, deadliest December tornado outbreak
- U.S. businesses could lose **3.1 million days** of operation and over **\$13.5 Billion** from floods in 2022 (source: [First Street Foundation](#))
- **\$4 Trillion** worth of assets at risk of climate change by 2030 (source: [CDP](#))

## Recognition Growing

Climate change is “the single biggest risk that exists to the economy today.”

Former US Treasury Secretary  
**Henry Paulson**

“Climate change is almost invariably the top issue that clients around the world raise with BlackRock. The evidence on climate risk is compelling investors to reassess core assumptions about modern finance.”

CEO of BlackRock  
**Larry Fink**


“215 of world’s largest public companies identified \$970bn in potential losses over 5 years from climate risk.”

2018 CDP report

“Investment from venture capital and private equity is pouring into climate tech, reaching US\$87.5bn over H2 2020 and H1 2021.”

PWC




# The Problem

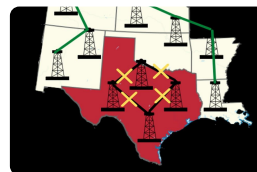
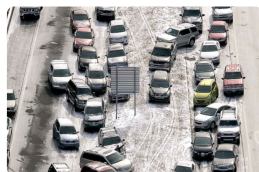
-  Most climate mitigation is focused on future, but **weather impacts are happening now**
-  Much of the world is **blind to weather data**, which hurts forecasts everywhere
-  Weather data and forecasts are often **confusing and not actionable**



Large gaps in weather observations: Over 5 billion people worldwide live outside of terrestrial radar coverage. (WMO)

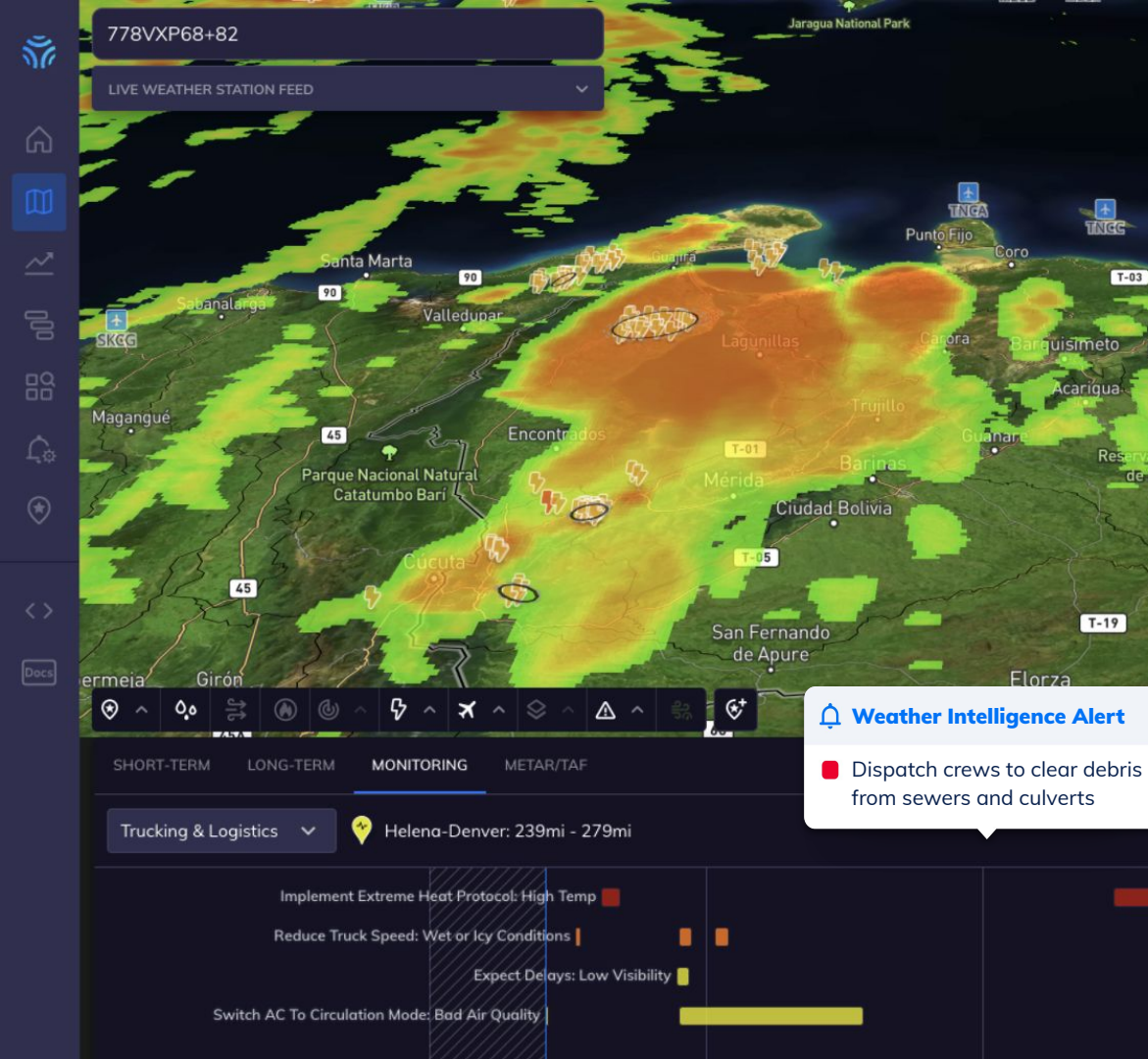
# The Result

-  The **costs of weather are growing** as the number of extreme events increases
-  Businesses and organizations are reactive to weather and **can't link forecasts to expected impact**
-  Existing providers typically provide tailored services, **not systems that scale**



THE JOHN'S HOPKINS NEWS-LETTER (LAKSHAY SOOD)

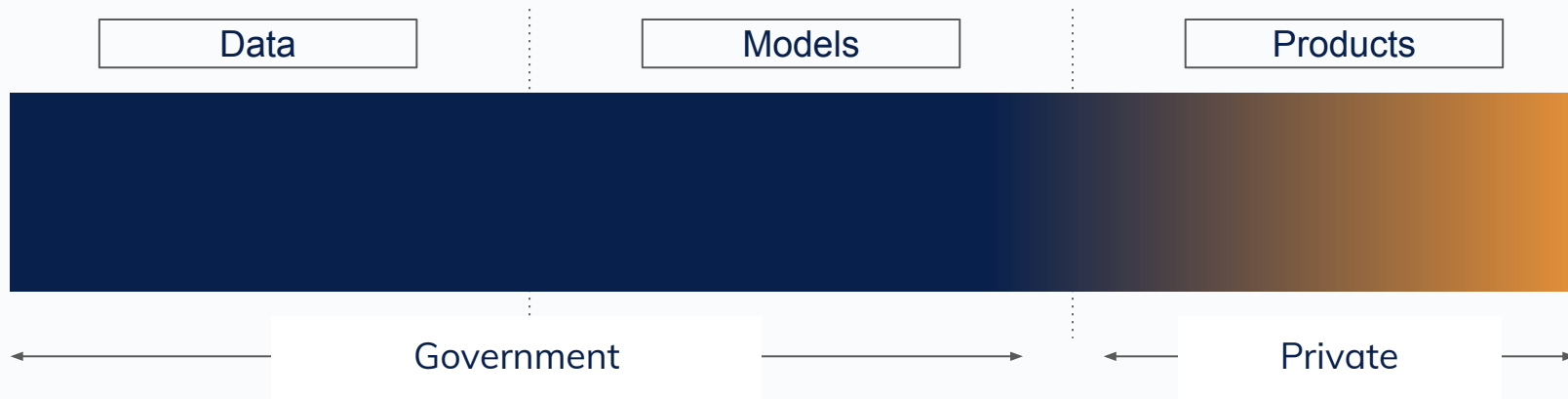




## Automate customized action plans with Tomorrow.io's Weather and Climate Security Platform

- Interactive map and timeline** enables users to visualize and track real-time weather and air quality as well as trends over time
- Predictive insights dashboard** shows how weather will impact your operations or business and recommends specific actions
- Autonomously monitor many locations** at once and automatically send alerts to your team to take action ahead of incoming weather

# The Weather Value Chain – Today



- Most of the work done by government agencies
- Private market focused on repackaging data, few contributions to the backbone
- Many problems result from that, main one is massive inequality in data and forecasts
- Access to reliable and useful weather/climate information - still a dream for most of world



Global distribution of terrestrial radars

Source: [WMO](#)

# Basic Weather Data Still Not Universal



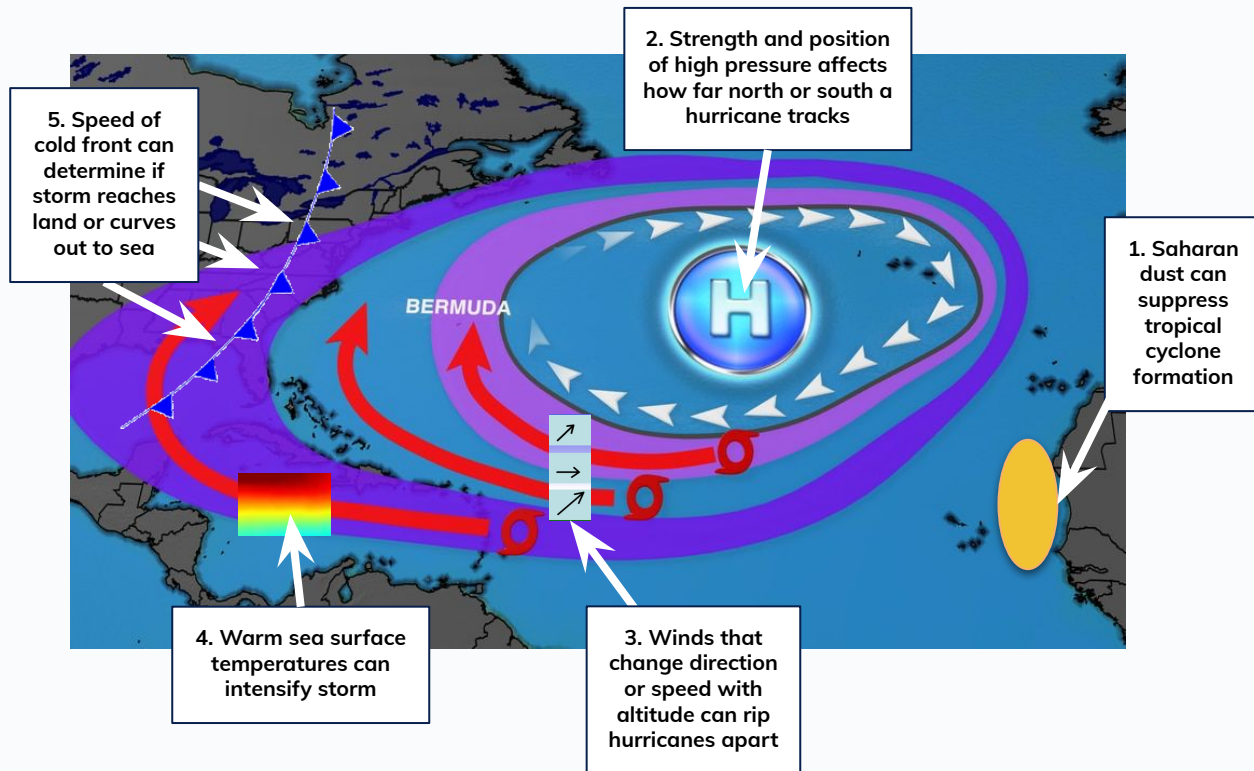
- More than 5 billion people live outside of radar coverage, with almost no coverage of the oceans
- Precipitation is ranked the top priority out of 152 Earth observations by the Group on Earth Observations
- “One of the greatest forecasting challenges ... is the need to improve precipitation forecasts across timescales from weather to climate.” -NOAA
- **The only way to close this gap is with a constellation of radar satellites**



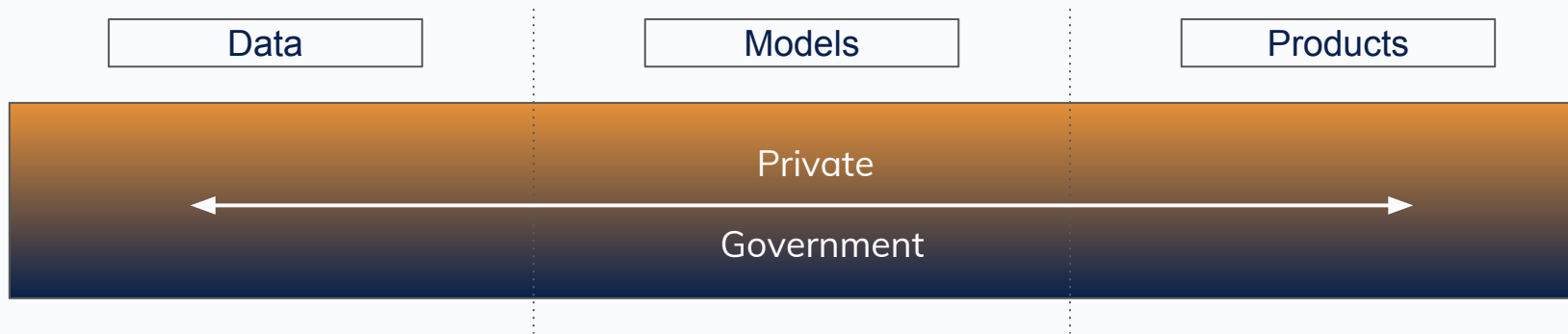
# Why do data gaps elsewhere matter to the United States?

Because all local weather forecasts depend on global data

Hurricanes are a perfect example of how conditions spanning thousands of miles can determine if, when and where a storm makes U.S. landfall, and how strong it is.



# Weather Value Chain 2.0



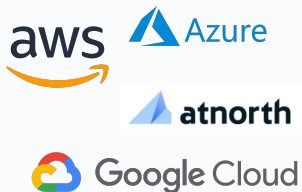
- Urgent need for improvement requires “whole-of-nation” approach
- Private Market can and should take a much more significant role
- Tech enablers (next slide) make it feasible
- Industry is innovating across the value chain

# Technology Enablers



## “Space 2.0”

Remote sensing costs  
down by  $10^2$



## Cloud Computing

Mature enough to host  
large-scale NWP



## IOT

Massive distributed  
sensing networks



## Open Source

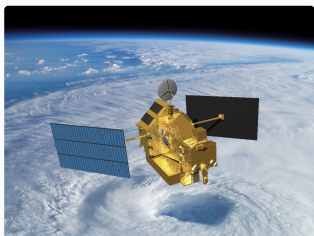
Best models no  
longer hidden behind  
walls



# Building on 25 Years of USG Investment in Spaceborne Radars

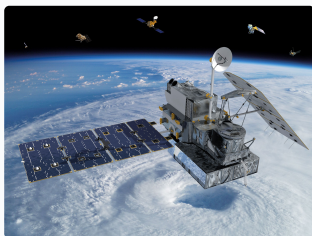
Industry innovation enables transition from research to operations

NASA TRMM  
1997-2015



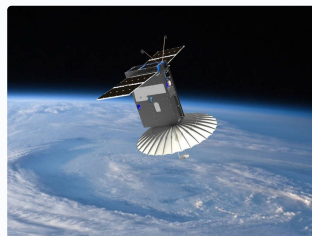
Large Satellites  
\$1B/unit

NASA GPM  
2014- ~2025



Single Satellites, Primarily for Research  
Low Revisit Rate (2-3 days)

NASA RainCube  
2018-2021



Cubesat, Narrow Swath  
<\$5M/unit

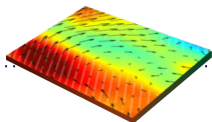
Tomorrow Space  
2022 and beyond

Small Satellites, Wide Swath  
<\$5M/unit

Operational Constellation  
~32 satellites, Hourly Revisit

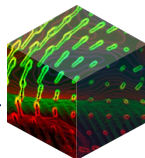
To date, no space-based radar mission has achieved revisit rates suitable for operational applications, with no other solution on the horizon

# Weather Radar From Space: A New Paradigm in Weather and Climate Prediction



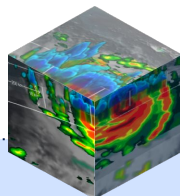
## Ocean Surface Winds

- Detect tropical cyclone formation and measure radius of tropical storm winds
- Resolve hurricane inner-core wind structure and detect hurricane winds over ocean
- Improve marine wind/wave warnings, ship routing, and wind energy forecasts



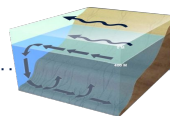
## 3D Wind Profiles (inside clouds and rain)

- One of the highest ranked observation priorities to improve weather models
- Better forecasts of daily weather, hurricane track and intensity, and extreme winds
- Improve prediction of El Niño/La Niña and transport of pollutants and trace gases



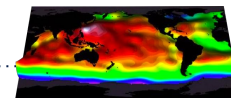
## 3D Precipitation

- Ranked the highest priority out of 152 parameters by Group on Earth Observations
- New level of understanding and prediction of hurricanes
- Improve flood, landslide, wildfire and drought monitoring and prediction
- Enable equal access to radar and reliable weather forecasts worldwide



## Ocean Surface Currents

- Inform planning for military anti-submarine and amphibious operations
- Reduce ship fuel consumption and enable safe and efficient marine navigation
- Improve search and rescue, hazmat cleanup, and marine ecosystem management



## Sea Surface and Wave Height

- Enhanced monitoring and prediction of tides, sea level rise and coastal erosion
- Track ocean heat storage and improve seasonal and individual hurricane forecasts
- Improve ship routing, fisheries management, and coupled ocean-atmosphere models

**All data available globally, at high horizontal and vertical resolution, with hourly (avg) revisit**

# Our Constellation Will Address Numerous Applications

## Flood & Landslide Risk

Accurate early warnings of flooding and landslide risk for developed and developing world

## Hurricanes & Typhoons

Improve intensity and trajectory forecast for every hurricane, typhoon and cyclone on earth

## Wildfire & Drought Risk

Worldwide precipitation data to inform fire danger indices and drought forecasts

## Numerical Weather Prediction

Drive significant improvement in forecast skills for global and regional NWP models

## Aviation

Global en-route storm detection tracking. Weather radar and nowcast for every airport on earth.

## Agriculture

Power farming decisions for every farm on earth using the world's most accurate and comprehensive rainfall data.

## Renewables

Storm prediction for assets outside of terrestrial radar coverage; accurate and timely streamflow forecasts.

## Shipping & Supply Chain

Global en-route storm detection. Ocean wave height and surface winds mapping

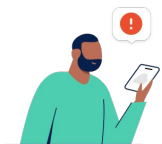




# TomorrowNow.org

We are invested in a future where everyone has access to the innovations needed to act and adapt to a changing climate.

We work with NGOs, Governments and multinational organizations to build capacity and **solve the hardest challenges of Climate Adaptation.**



**Billions still without access to early warnings**

## Partners



Digital Green



## Delivering Hope with Innovation and Partnerships



“ Although desert locusts have been here since biblical times, recent intense outbreaks can be linked to anthropogenic climate change and the increased frequency of extreme weather events ”

[Nature Magazine](#)

# How USG Can Tap Into Industry Innovation To Augment (Not Replace) Government Capabilities

- Traditional contracting (government-owned and operated systems)
- Commercial Data Pilots → Programs of Record
- Other Transaction Authority
- Joint Venture Public-Private Partnerships
- Grand challenges (less prescriptive solicitations, let industry innovate path to solution)





# What did you think of the briefing?

**Please take 2 minutes to let us know at:**  
[www.eesi.org/survey](http://www.eesi.org/survey)

***Materials will be available at:***  
[www.eesi.org/011222weather](http://www.eesi.org/011222weather)

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[#eesitalk](https://twitter.com/eesitalk)   [@eesionline](https://twitter.com/eesionline)

Wednesday, January 12, 2022