# **Another Year of Weather Extremes: Outliers...Or Omens?**

Dr. Jeff Masters Meteorologist for Yale Climate Connections Co-founder, The Weather Underground https://yaleclimateconnections.org/section/eye-on-the-storm/

nerman.masters@gmail.com

71-10

# My Job From 1986 – 1990: Scientist With the NOAA Hurricane Hunters

The story of my near-fatal flight into Cat 5 Hurricane Hugo: https://www.wunderground.com/hurricane/articles/hunting-hugo-part-1

# I co-founded The Weather Underground in 1995...

Weather: Periods of heavy rain. Low 38. Thursday, rain & windy High 48. Details on back page

ANN ARBOR NEV February 26, 1997

**BRIGHT FORECAST** 

Weather Internet site that began as project in U-M lab becomes startup firm

#### THE WEATHER UNDERGROUND

What: One of the most popular weather Web sites.

Where: http://www.wunderground.com.

Key players: Perry Samson, The Weather Underground's director of education and professor of atmospheric, oceanic and space sciences at the University of

Michigan; Jeffrey Ferguson, director of communications; Jeffrey Masters, director of information.

What's with the name? Given the playful nature of The Weather Underground partners, it's not surprising they chose a tongue-in-cheek moniker. Weather Underground was the name of the militant arm of Students for a Democratic Society, a radical movement founded at the U-M in the '60s. 'They were kind of a nasty group,' Ferguson says. 'We're not.'

By MARY MORGAN NEWS STAFF REPORTER

When it rains in reality, it pours at The Weather Underground, a popular Internet site run in large part by a handful of Ann Arbor weather wonks.

And therein lies a business.

What started as a project at the University of Michigan - housed in a delightfully cluttered "Mad Lab" at the College of Engineering's department of atmospheric, oceanic and space sciences - has morphed into a startup firm that's thundering against much mightier rivals

like The Weather Channel. "It's all very new to us, going from the academic world to the real world," says

Jeff Masters, who as a graduate student wrote some of the software that lets The Weather Underground do what it does.

On stormy days, about 1.5 million people worldwide check out http://www.wunderground.com to get the latest weather information. A search feature allows users to see weather conditions in just about any corner of United States.

The site offers in-depth reports for all types of weather watchers, from pilots and farmers to skiers and wind surfers. Colorful maps trace temperature patterns, while a radar map gives a reading of current precipitation.

Now, The Weather Underground is

See WEATHER, Back Page

NEWS PHOTO - ROBERT CHAS

Wednesday

Professor Perry Samson is one of the creators of The Weather Underground, which got its start in a lab on the University of Michigan's North Campus.

...And wrote one of the Internet's most popular extreme weather and climate change blogs from 2005 - 2019, http://www.wunderground.com/cat6



## Billion-Dollar Weather Disasters, Jan.-Aug. 2021

Doole	Disselar	LoopHan	Datas	Damana	Deatha
Rank	DISaster		Deres	Deimeige	Deatus
1 sil	Hurricane Ida	Louisiana, NE U.S.	Aug. 23-Sep. 2	\$43-54 billion	77
2	Flooding	Europe	Jul. 12-18	\$30 billion	240
3	Flooding	China	Jun. 1-Jul. 31	\$27 billion	395
4	Winter Weather	U.S.	Feb. 12-20	\$23 billion	215
5	Winter Weather	Europe	Apr. 5-8	\$5.6 billion	AMA .
6	Severe Weather	Europe	Jun. 1 <b>7-25</b>	\$4.8 billion	7
7	Drought	Brazil	Yearlong	noillid 0.8\$	AVA
8	Cyclone Yaas	India	Mary 26	noillid 0.8\$	19
9	Severe Weather	U.S. Plains	Apr. 27-May 2	\$2.5 billion	<u> </u>
10	Drought	Canada	Yearlong	\$2.5 billion	AVA
11	Severe Weather	Europe	Jun. 28-30	\$2.3 billion	1
12	Drought	China	Yearlong	\$2.3 billion	N/A
13	Flooding	SE Australia	Mar. 10-24	\$2.1 billion	2
14	Flooding	India	Jun. 1-Aug. 31	\$2.0 billion	727
15	Drought	Mexico	Yearlong	\$2.0 billion	N/A
16	Winter Weather	Japan	Jan. 7-12	\$2.0 billion	23
17	Winter Storm Filomena	Spain	Jan. 8-12	\$1.9 billion	4
18	Flooding	Western U.S.	Jan. 24-29	\$1.8 billion	2
19	Severe Weather	Central/Eastern U.S.	Mar. 27-28	\$1.7 billion	
20	Severe Weather	Central/Eastern U.S.	Jun. 24-Jul. 1	\$1.6 billion	2
21_	Severe Weather	U.S. Plains	Mar. 24-26	\$1.6 billion	6
22	Winter Weather	Mexico	Feb. 12-20	\$1.5 billion	-20
23	Severe Weather	U.S. Plains, Southeast	May 14-19	\$1.5 billion	5
<u>24</u>	Cyclone Taukiae	India	May 17	\$1.5 billion	198
25	Severe Weather	Central/Eastern U.S.	Jun. 17-21	\$1.4 billion	1
26	Severe Weather	Texas (U.S.)	Apr. 14-15	\$1.4 billion	0
27	Severe Weather	Central/Eastern U.S.	May 3-5	\$1.2 billion	4
28	Tropical Storm Fred	Eastern U.S.	Aug. 10-17	\$1.1 billion	- 7
29	Typhoon In-fa	China	Jul. 20-28	\$1.1 billion	5
30	Drought	U.S.	Yearlong	\$1.0 billion	N/A

Background image: Landslide on Highway 1 near Big Sur, CA on Jan. 27, 2021. Image credit: Heath Johnson, Caltrans)

# Billion-Dollar Weather Disasters Are Increasing, and Set a Record in 2020 (50 Disasters)



## Global Weather Mega-Disasters Costing \$20+ billion, 1980 - 2021

5



# Central Europe staggers toward recovery from catastrophic flooding: more than 200 killed

The worst floods in decades reflect the intensified rainfalls of a warming climate.

![](_page_6_Picture_2.jpeg)

y BOB HENSON and JEFF MASTERS ULY 21, 2021

![](_page_6_Picture_4.jpeg)

![](_page_6_Picture_5.jpeg)

The German state of Rhineland-Palatinate was among the hardest hit by the disastrous floods of mid-July 2021. (Image credit: Landesregierung Rheinland-Pfalz).

## **Europe's Most Expensive Weather Disaster on Record (\$30 Billion) Kills 240**

# Flood disaster in Germany

WorldWeatherAttribution.org: "The likelihood of such an event to occur today compared to a 1.2 °C

Costliest European Weather Disasters, 1980-2021 (EM- DAT)						
Rank	Disasier	Location	Year	Damage	Deaths	
1	Flooding	Germany, Belgium	2021	\$30 billion	240	
2	Extratropical Storm Lothar	Western Europe	1999	\$18.5 billion	133	
3	Flooding	Germany	2002	\$18 billion	27	
4	Heat Wave/Drought	Europe	2003	\$17.9 billion	72160	
5	Flooding		1994	\$17 billion	16	
6	Flooding	Germany	2013	\$15 billion	4	
7	Extratropical Storm Daria	Western Europe	1990	\$14 billion	85	
8	Flooding	Italy	2000	\$12.6 billion	25	
9	Extratropical Storm Kyrill	Western Europe	2007	\$11.7 billion	46	
10	Flooding	Spain	1983	\$10.6 billion	45	

Background image: 2021 Belgium Floods, Régine Fabri, https://commons.wikimedia.org/w/index.php?curid=107637907

# Extreme rainfall in China: over 25 inches falls in 24 hours, leaving 33 dead

Zhengzhou received more than a year's worth of rain on July 20.

![](_page_9_Picture_2.jpeg)

00

![](_page_9_Picture_4.jpeg)

Extreme flooding in Zhengzhou, China, on July 20, 2021, after over 25 inches of rain fell in 24 hours. (Image credit: UN Climate Change Twitter feed)

## Scenes from the deadly floods in Zhengzhou, China

200

# Costliest Asian Weather Disasters 1980-2021 (EM-DAT)

Rank	Disaster	Location	Year	Damage	Deaths
	Flooding	China	1998	\$50 billion	3656
2	Flooding	Thailand	2011	\$48 billion	813
3	Flooding	China	2021	\$27 billion	396
4	Flooding	North Korea	1995	\$27 billion	68
5	Winter Weather	China	2008	\$26 billion	145
6	Drought	China	1994	\$25 billion	104
7	Flooding	China	2016	\$24 billion	475
8	Flooding	China	2010	\$23 billion	1691
9	Flooding	China	1996	\$22 billion	2775
10	Typhoon Mireille	Japan	- <u>1991</u>	\$19 billion	66
10	Flooding	India	2014	\$19 billion	298
12	Typhoon Hagibis	Japan	2019	\$18 billion	99
/ 12	Flooding	China	2020	\$18 billion	280
14	Cyclone Amphan	India	2020	\$16 billion	120
14	Flooding	China	2019	\$16 billion	300
16	Typhoon Saomai	Japan	2000	\$14 billion	35
17	Wildfires	Indonesia	1997	\$13.5 billion	240
18	Typhoon Jebi	Japan	2018	\$13.5 billion	17
19	Flooding	India	1993	\$13.2 billion	827
19	Flooding	China	1999	\$13.2 billion	725
21	Typhoon Songda	Japan	2004	\$12.9 billion	41
22	Flooding	China	1995	\$12.0 billion	1437
23	Flooding	China	2003	\$11.7 billion	430
24	Typhoon Haiyan	Philippines	2013	\$11.6 billion	7354
24	Flooding	China	1993	\$11.6 billion	1000
26	Flooding	China	1996	\$11.1 billion	1200
27	Typhoon Lekima	China	2019	\$10.6 billion	72
27	Flooding	India	2019	\$10.6 billion	1900

## Hurricane Ida : a Double Mega-Disaster (\$27-40 Billion in LA/MS/AL, \$16-24 B

![](_page_12_Picture_1.jpeg)

![](_page_12_Picture_2.jpeg)

## U.S. Weather Mega-Disasters Costing \$20+ billion, 1980-2021

Rank	Disaster	Location	Year	Damage	Deaths
1	Hurricane Katrina	LA/MS/AL/FL 2005 \$170 billion		1833	
2	Hurricane Harvey	TX/LA	2017	\$131 billion	89
3	Hurricane Maria	PR/VI	2017	\$94 billion	2981
4	Hurricane Sandy	NY/NJ/CT	2012	\$75 billion	159
5	Hurricane Ida	LA/MS/NJ/NY/CT	LA/MS/NJ/NY/CT 2021 \$43-64 billi		77
6	Hurricane Irma	FL/GA/SC/PR	FL/GA/SC/PR 2017 \$52 billion		97
7	Hurricane Andrew	FL/LA	FL/LA 1992 \$51 billio		62
7	Drought/Heat Wave	Midwest/East	1988	\$45 billion	454
8	Flooding	Mississippi River	1993	\$38 billion	48
9	Hurricane Ike	TX/LA/MS	2008	\$37 billion	112
10	Drought/Heat Wave	Midwest/East	2012	\$34 billion	123
10	Drought/Heat Wave	MIdwest/East	1980	\$34 billion	1260
12	Hurricane Ivan	AL/FL	AL/FL 2004 \$29 bilion		57
13	Hurricane Wilma	FL	2005	\$26 billion	35
13	Hurricane Michael	FL/GA	2018	\$26 billion	49
15	Hurricane Rita	LA/TX	2005	\$25 billion	119
15	Hurricane Florence	NC/SC	2018	\$25 billion	53
15	Wildfires	Western U.S.	2018	\$25 billion	106
10			0004	000 k :!!!	0F

## **Observed Change in Very Heavy Precipitation**, 1958-2012

![](_page_14_Figure_1.jpeg)

Source: https://nca2014.globalchange.gov/report/our-changing-climate/heavy-downpours-increasing

### Concerning new paper: Satellites observed a 21% global increase in tropical cyclo

#### nature communications

Explore content V About the journal V Publish with us V

nature > nature communications > articles > article

Article Open Access Published: 09 September 2021

#### Global increase in tropical cyclone rain rate

Oscar Guzman & Haiyan Jiang 🖂

Nature Communications 12, Article number: 5344 (2021) | Cite this article 1146 Accesses | 12 Altmetric | Metrics

#### Abstract

Theoretical models of the potential intensity of tropical cyclones (TCs) suggest that TC rainfall rates should increase in a warmer environment but limited observational evidence has been studied to test these hypotheses on a global scale. The present study explores the general trends of TC rainfall rates based on a 19-year (1998–2016) time series of continuous observational data collected by the Tropical Rainfall Measuring Mission and the Global Precipitation Measurement mission. Overall, observations exhibit an increasing trend in the average TC rainfall rate of about 1.3% per year, a fact that is contributed mainly by the combined effect of the reduction in the inner-core rainfall rate with the increase in rainfall rate on the rainband region. We found that the increasing trend is more pronounced in the Northwestern Pacific and North Atlantic than in other global basins, and it is relatively uniform for all TC intensities. Further analysis shows that these trends are associated with increases in sea surface temperature and total precipitable water in the TC environment.

# Western Canada burns and deaths mount after world's most extreme heat wave in modern history

It's not hype or exaggeration to call the past week's heat wave the most extreme in world weather records.

![](_page_16_Picture_2.jpeg)

![](_page_16_Picture_3.jpeg)

![](_page_16_Picture_4.jpeg)

Wildfires exploded in the record-hot air over southern British Columbia on Wednesday, June 30, producing several massive fire-generated thunderstorms. The 'pyrocu' spit out lightning and cast the massive evening shadows seen in this satellite image from 0210Z Thursday, July 1, 2021 (7:10 pm PDT Wednesday). Climate scientist Daniel Swain called the event "a literal firestorm." (Image credit: <u>RAMMB/CIRA/CSU</u>)

Deadliest global weather disaster of 2021, with 1037 deaths (808 in Canada, 229 in the U.S.) WorldWeather

# Death Valley, California, breaks the alltime world heat record for the second year in a row

If verified, the 130 degrees Fahrenheit (54.4°C) reading at the Furnace Creek Visitor's Center on Friday, July 9, 2021, would be Earth's highest reliably measured temperature.

![](_page_17_Picture_2.jpeg)

![](_page_17_Picture_3.jpeg)

![](_page_17_Picture_4.jpeg)

The thermometer enclosure at Death Valley National Park's Furnace Creek Visitor Center as seen August 17, 2020, the day after Earth's second-hottest reliably measured temperature in history, 54.4° C (129.9°F), was recorded. (Image credit: <u>William Reid</u>, who is holding the portable thermometer)

## Summer of 2021 Ties With Dust Bowl Summer of 1936 as Hottest in U.S. History; July 2021 Was Earth's Hottest Month in Recorded History

![](_page_18_Picture_1.jpeg)

Above: Farm machinery lies buried in dust in Dallas, South Dakota, on May 13, 1936, encapsulating the destruction of the 193

![](_page_19_Picture_0.jpeg)

## Wildfires in U.S. and Globally Set All-Time Emission Records in 2021

...

![](_page_20_Picture_1.jpeg)

Ryan Stauffer @ryans\_wx

This one surprised me. Aerosol optical depth, think of it as a measure of smoke thickness, over the US and Canada in July beat even 2018 and 2020 and set a new record high. Terra MODIS data since 2000. We are definitely moving in the wrong direction. giovanni.gsfc.nasa.gov/giovanni/

![](_page_20_Figure_4.jpeg)

Short term (<2 days) exposure to wildfire smoke killed 3,173 people per year in the U.S. from 2000-2016: https://www.thelancei.com/journals/lanplh/article/PIIS2542-5195(21)00200-X/fulltext#sec1

# A Wildly Oscillating Jet Stream Key to Extreme Weather in 2021

Human-caused climate change is making extreme heat waves more probable not just by increasing the bac

# Persistent planetary wave pattern, data centered on 9 June (left) and 15 June (right). Northward air flow is red, southward air flow blue. Further data (not shown) reveal resonance conditions in the atmosphere.

#### For scientific background see:

Mann, M. E., S. Rahmstorf, K. Kornhuber, B. A. Steinman, S. K. Miller and D. Coumou (2017). Influence of Anthropogenic Climate Change on Planetary Wave Resonance and Extreme Weather Events. Sci Rep 7: 45242.

Mann, M. E., S. Rahmstorf, K. Kornhuber, B. A. Steinman, S. K. Miller, S. Petri and D. Coumou (2018). Projected changes in persistent extreme summer weather events: The role of quasiresonant amplification. Sci Adv 4(10): eaat3272.

![](_page_21_Figure_6.jpeg)

Image courtesy of Stefan Rahmstorf, https://twitter.com/rahmstorf/status/1405202170597806081

# Good and Bad News From the Arctic: Lowest Sea Ice Loss Since 2014, But a Big Melt Year in Greenland, With First-Ever Rain at the Summit Station

![](_page_22_Figure_1.jpeg)

![](_page_22_Picture_2.jpeg)

# Atlantic Hurricane Activity Has Gone Berserk! 50 Named Storms in 2020/2021, With 19 U.S. Landfalls

![](_page_23_Figure_1.jpeg)

A Rogues' gallery of the 30 storms of 2020

![](_page_24_Figure_0.jpeg)

![](_page_25_Figure_0.jpeg)

# Ocean Temperatures in the Atlantic Main Development Region for Hurricanes Have Warmed 1°C in Past 100 Years

![](_page_26_Figure_1.jpeg)

Source: https://www.ncdc.noaa.gov/cag/global/time-series/atlanticMdr/

Air pollution particles over the North Atlantic have dropped by nearly a factor of two since the early 1970s, primarily due to more stringent air pollution regulations in the U.S.

![](_page_27_Figure_1.jpeg)

Murakami *et al.*, 2020, <u>"Detected climatic change in global distribution of tropical cyclones"</u>, PNAS May 19, 2020, 117:20, 10706-10714)

![](_page_28_Picture_0.jpeg)

![](_page_29_Picture_0.jpeg)

## **Rapid Intensification of Atlantic Hurricanes is Happening More Often**

![](_page_30_Figure_1.jpeg)

A 2019 paper, "Recent increases in tropical cyclone intensification rates", found that Atlantic hurric

## Strongest Tropical Cyclones Globally Since 1979 (by Advanced Dvorak Technique)

Rank	Storm	Winds	Month/Year	Location	Pressuree e
1	Patricia	209 mph	Oct. 2015	Northeast Pacific	876 mb
2	Haiyan	202 mph	Nov. 2013	Northwest Pacific	878 mb
3	Тір	199 mph	Oct. 1979	Northwest Pacific	873 mb
3	Gay	199 mph	Nov. 1992	Northwest Pacific	883 mb
5	Surigae	196 mph	Apr. 2021	Northwest Pacific	890 mb
5	Gilbert	196 mph	Sep. 1988	Atlantic	887 mb
5	Yuri	196 mph	Nov. 1991	Northwest Pacific	887 mb
5	Nida	196 mph	Nov. 2009	Northwest Pacific	892 mb
9	Halong	192 mph	Nov. 2019	Northwest Pacific	878 mb
9	Linda	192 mph	Sep. 1997	Northeast Pacific	884 mb
9	Allen	192 mph	Aug. 1980	Atlantic	886 mb
9	Wilma	192 mph	Oct. 2005	Atlantic	888 mb
9	Vanessa	192 mph	Oct. 1984	Northwest Pacific	886 mb
9	Angela	a image: Hurricane Pat 192 mph	Nov. 1995	Northwest Pacific	889 mb

![](_page_32_Picture_0.jpeg)

![](_page_33_Figure_0.jpeg)

An Extended Saffir-Simpson Hurricane Scale

![](_page_34_Picture_0.jpeg)

![](_page_35_Figure_0.jpeg)

Strongest Tropical Cyclones by Ocean Basin, 1979-2021, Using the Advanced Dvorak Technique

Source: http://tropic.ssec.wisc.edu/misc/adt/info.html

Hurricane Gilbert, Sep. 13, 1988: 185 mph winds, 888 mb central pressure

![](_page_37_Figure_0.jpeg)

Observed Trends in Tropical Cyclone Frequency of Occurence, 1980-2018

## **Climate Change's Biggest Threat: Drought & Food System Shock**

![](_page_38_Figure_1.jpeg)

![](_page_39_Figure_0.jpeg)

## FAO Food Price Index, 1961 - 2021 (Inflation Adjusted)

![](_page_40_Figure_2.jpeg)

"It is estimated that there is now a one-in-twenty chance per decade that heat, drought, and flood events will cause a simultaneous failure of maize production in the world's two main growers, China and the U.S. This would cause widespread famine and hardship." Kent *et al.*, 2017, "Using Climate Model Simulations to Assess the Current Climate Risk to Maize Production"

A <u>"Food System Shock" report issued in 2015</u> by insurance giant Lloyds of London gave a >18% chance in 40 years of an extreme shock to global food production that could cause rioting, terrorist attacks, civil war, mass starvation and severe losses to the global economy.

For an in-depth analysis, see my 2016 post, <u>https://www.wunderground.com/blog/JeffMasters/food-system-shock-climate-changes-greatest-threat-to-civilization.html</u>

# **Global Food Prices are Currently Higher Than in 2011**

![](_page_41_Picture_1.jpeg)

Food riots in Tunisia in 2011 after cut-off of Russian grain exports due to drought

# **Future Drought: We're in Big Trouble if This Forecast Verifies**

Drought Severity Index for 2090 - 2099 from CMIP5 14-Model Ensemble

![](_page_42_Figure_2.jpeg)

Mean drought conditions averaged over 2090–2099 computed using the 14-model ensemble mean climate done for the 2014 IPCC report under a moderate global warming scenario (RCP4.5). The drought index plotted is a modified version of the Palmer drought severity index (PDSI) called the sc\_PDSI\_pm. An sc\_PDSI\_pm of -3.0 corresponds to severe drought in the present climate. However, a 2018 review of climate change drought literature by Cook et al. warned that the relatively simple sc\_PDSI\_pm drought index may overestimate drought in the future climate. Credit: Aiguo Dai, Increasing drought under global warming in observations and models, *Nature Clim Change* **3**, 52–58 (2013) doi:10.1038/nclimate1633

**Global Trade is Vulnerable to Weather-Related Disruptions at Key Chokepoints** 

![](_page_43_Figure_1.jpeg)

Key World Trade Chokepoints

Rodrigue, J.-P., Comtois, C. and Slack, B., 2017, "The Geography of Transport Systems"

# Was There a Climate Change Connection to the Blockage of the Suez Canal by the Ever Given?

![](_page_44_Picture_1.jpeg)

Sentinel-2 satellite image of the Ever Given stuck in the Suez Canal on March 24, 2021. The stern of the ship was lodged aga

Major Food Supply Disruption: Port of South Louisiana, largest bulk cargo port in the world, getting pounded by the strong right front eyewall of category 3 Hurricane Ida

![](_page_45_Picture_1.jpeg)

## Most Concerning Research of 2021: A Collapse of the AMOC May be Imminent

Article Published: 05 August 2021

# Observation-based early-warning signals for a collapse of the Atlantic Meridional Overturning Circulation

Niklas Boers 🖂

Nature Climate Change 11, 680–688 (2021) Cite this article

11k Accesses | 4775 Altmetric | Metrics

(1) A Publisher Correction to this article was published on 17 September 2021

#### Abstract

The Atlantic Meridional Overturning Circulation (AMOC), a major ocean current system transporting warm surface waters toward the northern Atlantic, has been suggested to exhibit two distinct modes of operation. A collapse from the currently attained strong to the weak mode would have severe impacts on the global climate system and further multi-stable Earth system components. Observations and recently suggested fingerprints of AMOC variability indicate a gradual weakening during the last decades, but estimates of the critical transition point remain uncertain. Here, a robust and general early-warning indicator for forthcoming critical transitions is introduced. Significant early-warning signals are found in eight independent AMOC indices, based on observational sea-surface temperature and salinity data from across the Atlantic Ocean basin. These results reveal spatially consistent empirical evidence that, in the course of the last century, the AMOC may have evolved from relatively stable conditions to a point close to a critical transition.

![](_page_47_Figure_0.jpeg)

Jackson et al. (2015) Global and European climate impacts of a slowdown of the AMOC in a high resolution GCM, Climate Dynamics.

![](_page_48_Figure_0.jpeg)

Jackson et al. (2015) Global and European climate impacts of a slowdown of the AMOC in a high resolution GCM, Climate Dynamics.

"We are already observing signs of instability within the climate system. There is no assurance that the rate of greenhouse gas buildup will not force the system to oscillate erratically and yield significant and punishing surprises."

-- Harvard climate scientists Paul Epstein and James McCarthy in "Assessing Climate Instability", Bulletin of the American Meteorological Society, 2004.

Hurricane Sandy, Oct 28, 2012

# My Climate Change Retreat: Property on the Hurricane River in Michigan's Upper Peninsula

![](_page_50_Picture_1.jpeg)

# Solution to the Climate Crisis: 1: Reduce Emissions (Mitigation)! 2: Adapt to a New Climate of Mega-Disasters

![](_page_51_Picture_1.jpeg)

# Good Adaptation News: Major Reforms to the National Flood Insurance Program Went Into Effect Today

# Guardian

# **Mitigating Climate Change Will Reduce Air Pollution**

8.7 million premature air pollution deaths per year occur globally due to burning of fossil fuels, said a 2021 s

# We Must Reduce Emissions (Mitigate)! Reason for Hope: The Renewable Energy Revolution is Here

![](_page_54_Figure_1.jpeg)

#### Source: https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf

When talking about climate change, audience research shows that it is most important to emphasize that based on the evidence,

Earth's climate is warming.
This time, humans are mostly responsible.
97% of climate scientists agree.
The warming climate is already causing significant impacts to people and ecosystems.
There are choices we can make now to reduce the severity of future impacts.

NEWS IN BRIEF

# Climatologists Say Humanity's Best Hope Is Hurricanes Spinning In Different Directions And Canceling Each Other Out

| 9/20/17 6:00AM

**the ONION** 

![](_page_56_Figure_4.jpeg)

SILVER SPRING, MD—Warning that the planet would continue to experience progressively more destructive storms caused by climate change, a group of the nation's leading climatologists said Wednesday that humanity's best hope now is for hurricanes spinning in opposite directions to cancel each other out.

# Good Climate News in 2021 (with caveats):

Global drought losses are near average so far in 2021 (\$11 billion), and drought has not led
It's been a record-long period without an EF5 tornado: over 8 years. Last EF5: Moore, Oklal
No major bad news from Antarctica. (However, the stability of the Thwaites and Pine Island
No evidence that the Arctic "methane bomb" is going off, where melting permafrost causes
No mass coral bleaching events. (However, we've lost 50% of Earth's corals since the 1950
Highest arctic sea ice extent at the September minimum since 2014; Northwest Passage reparts

# **Thanks for Listening!**

# **Resources:**

Good climate scientist Twitter feeds to follow: Michael Mann, https://twitter.com/MichaelEMann (read his 2021 book, *The New Climate War);* Katherine Hayhoe, https://twitter.com/khayhoe (read her 2021 book, *Saving Us)*.

Good website for climate science analysis: Carbon Brief, https://www.carbonbrief.org/

Best website to counter climate science denial arguments: https://www.skepticalscience.com/, https://www.desmog.com/databases/

Dr. Jeff Masters Meteorologist for Yale Climate Connections Co-founder, The Weather Underground https://yaleclimateconnections.org/section/eye-on-the-storm/ weatherman.masters@gmail.com