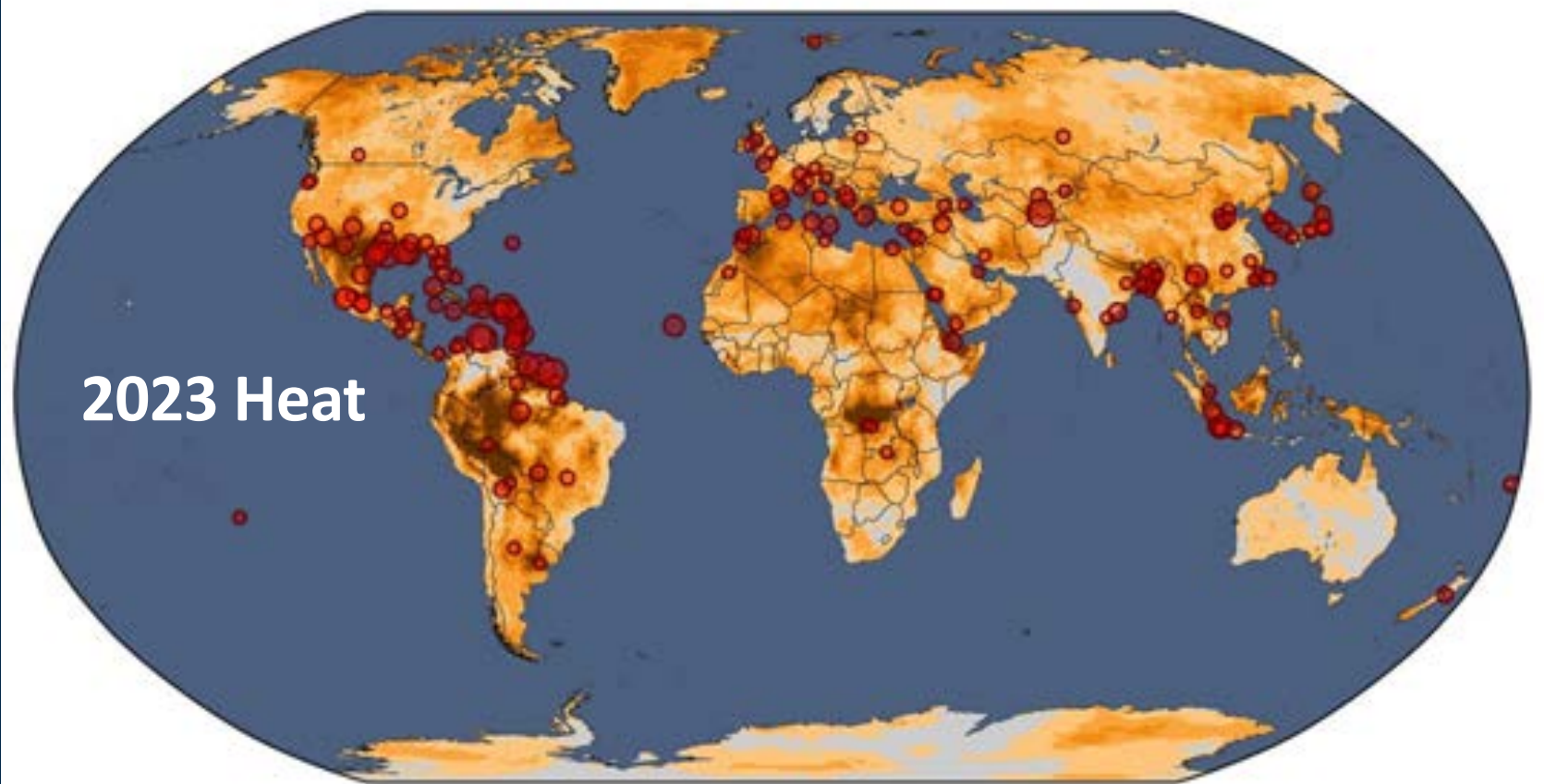


2023 Heat

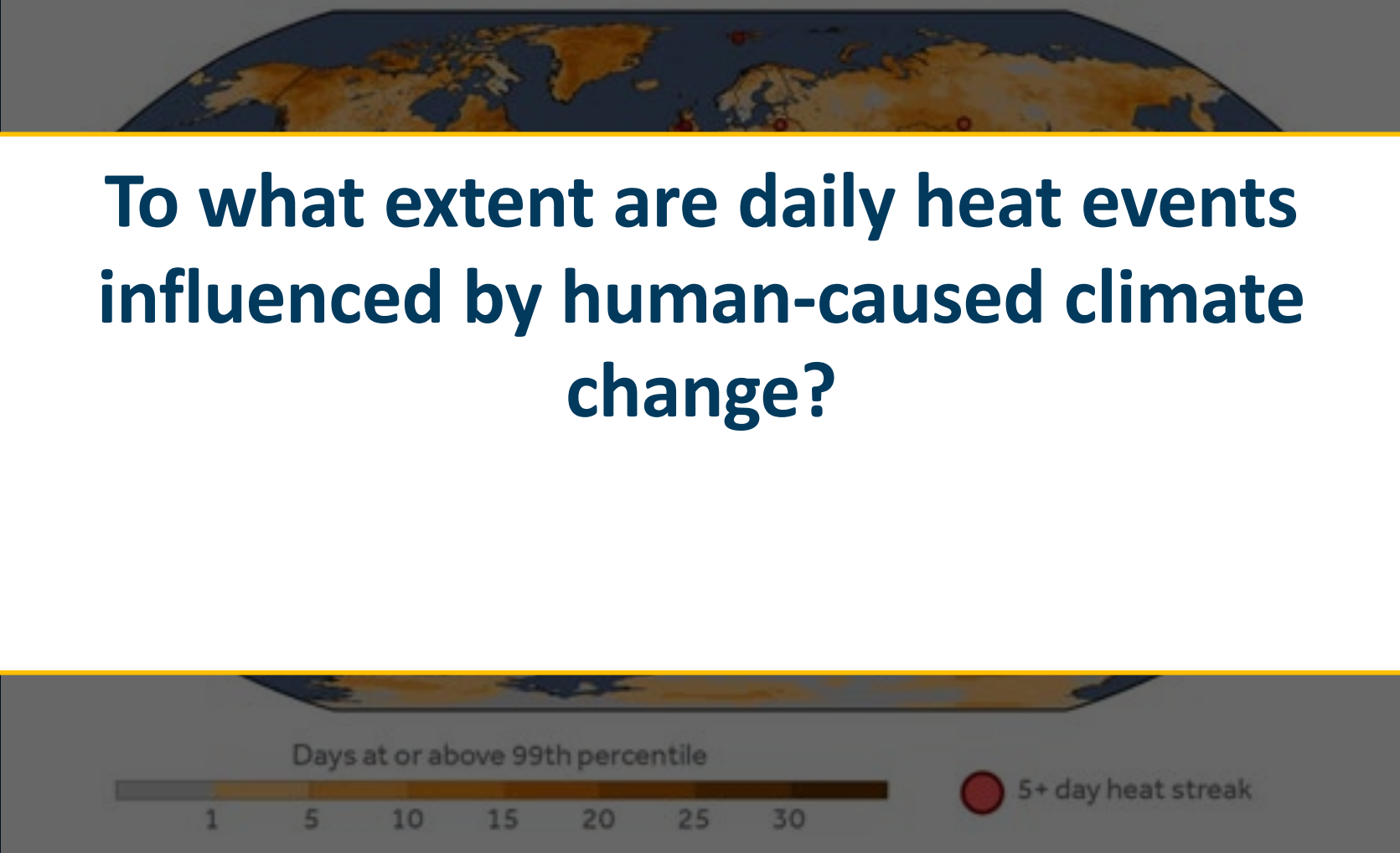


Days at or above 99th percentile



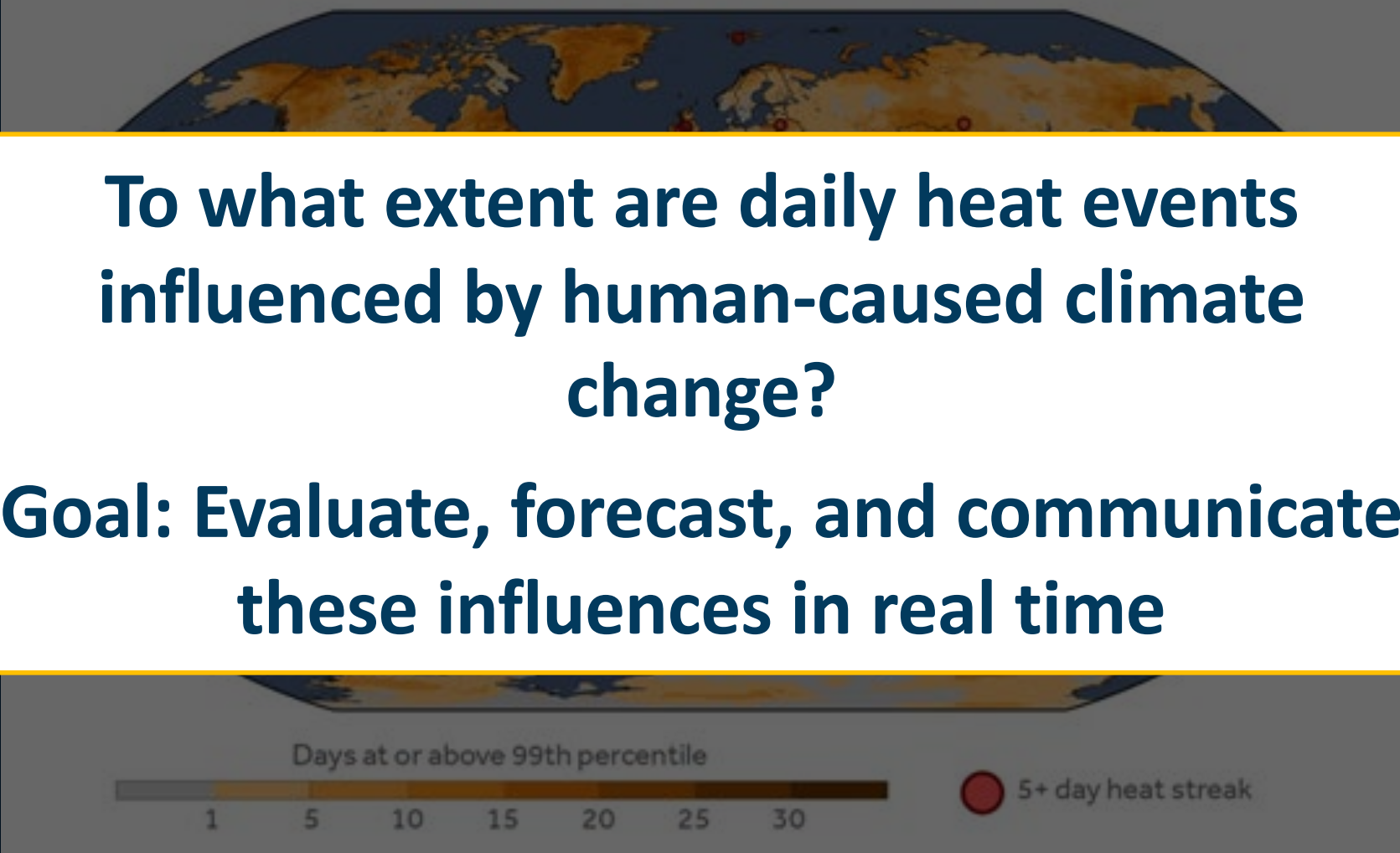
5+ day heat streak





**To what extent are daily heat events
influenced by human-caused climate
change?**

The background features a world map with a color scale indicating the number of days at or above the 99th percentile. The scale ranges from 1 (lightest) to 30 (darkest). A red circle indicates a 5+ day heat streak. The map shows a significant increase in heat events, particularly in the Northern Hemisphere, with the highest concentrations (30+ days) appearing in parts of North America, Europe, and Asia.



**To what extent are daily heat events
influenced by human-caused climate
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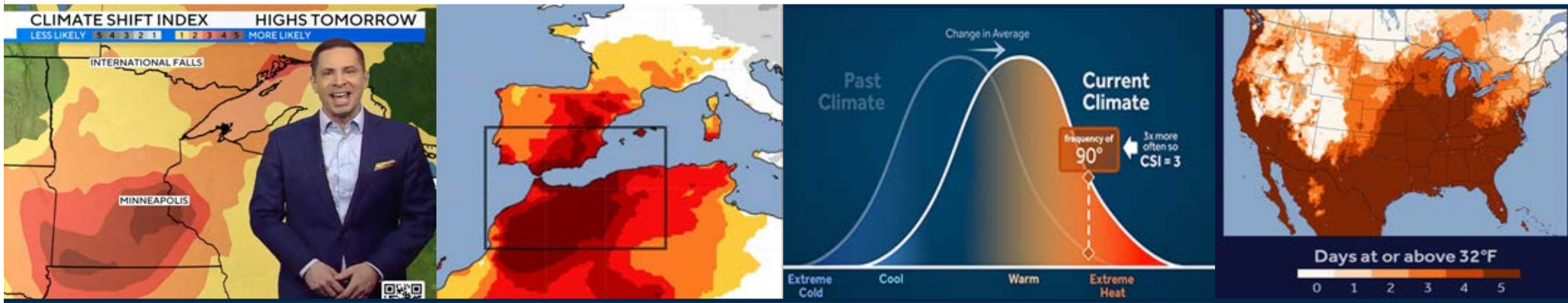
**Goal: Evaluate, forecast, and communicate
these influences in real time**

Days at or above 99th percentile

1 5 10 15 20 25 30

5+ day heat streak

The Heat is On: Forecasting and Communicating Human-Caused Climate Change in Real Time



March 26, 2024

21st Annual Climate Prediction Applications Science Workshop

Daniel Gilford dgilford@climatecentral.org

Andrew Pershing, Joseph Giguere, Friederike Otto, Lauren Casey, Maria Fleury,
Jennifer Brady, Megan Martin, and Arielle Tannenbaum

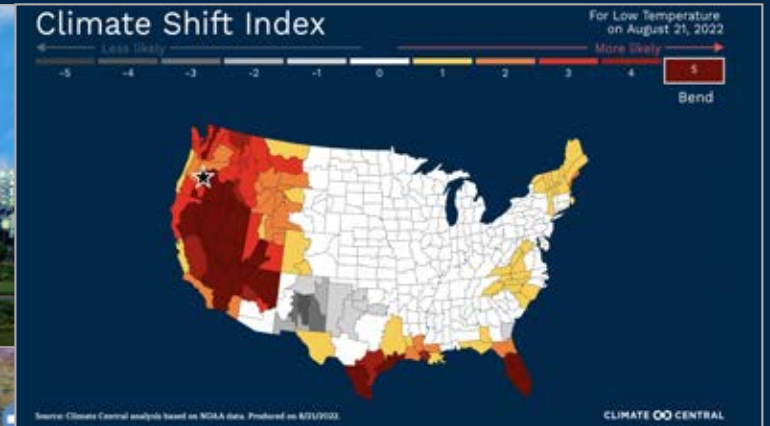


CLIMATE CENTRAL

Climate Matters

Sea Level Rise

Attribution Science



Partnership
Journalism



Realtime
Climate

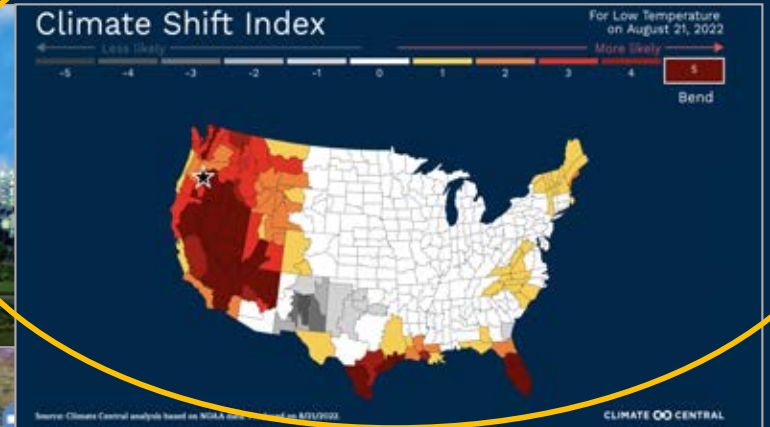
Science Made Clear, Climate Made Local

CLIMATE CENTRAL

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Sea Level Rise

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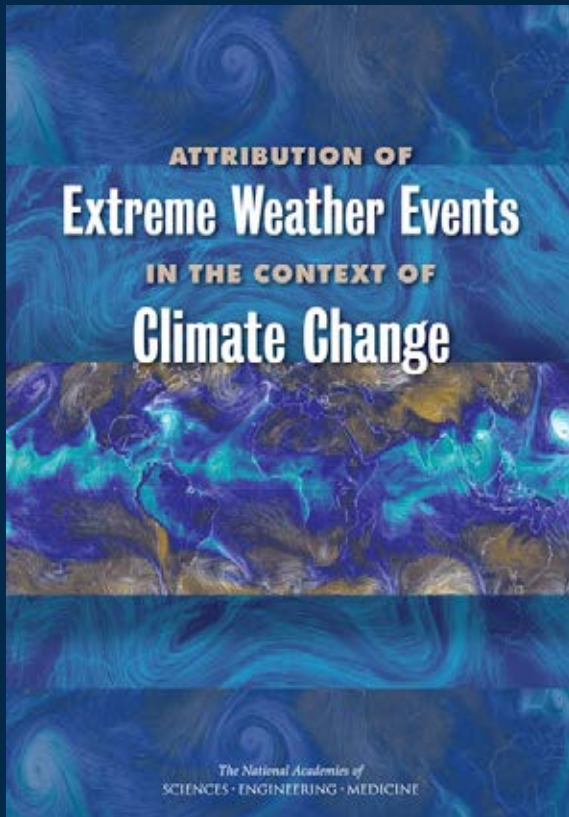
Partnership
Journalism



Realtime
Climate

Science Made Clear, Climate Made Local

Climate attribution science has matured




“It is now often possible to make and defend quantitative statements about the extent to which human-induced climate change... has influenced either the magnitude or the probability of occurrence of specific types of [extreme weather] events...

The science behind such statements has advanced a great deal in recent years and is still evolving rapidly.”

--National Academies Report (2016)

Climate attribution science has matured


 <https://www.worldweatherattribution.org/>
world weather attribution

Home About Analyses News Projects Resources


Climate change made record breaking early season heat in Argentina and Paraguay about 60 times more likely

A large area centred around the central-northern part of Argentina, and also southern Bolivia, central Chile, and most of Paraguay and Uruguay, experienced record-breaking temperatures during two consecutive heatwaves in late November and early December 2022.

Latest analyses




Climate change exacerbated heavy rainfall leading to large scale flooding in highly vulnerable communities in West Africa




Food crisis in Central Sahel in 2022 driven by chronic vulnerability with uncertain role of climate change

The central Sahel is facing a food




Twelve months – WWA without Geert Jan

On 12 of October 2021 – a year ago today – our co-founder, friend and colleague Geert Jan van Oldenborgh




Cold spells

Unusual cold spells can occur even in a warming world, and cause disruption to transport, energy & food supplies.




Drought

Drought affects people in many ways, from reduced water & food supplies to increasing the risk of wildfires.



Extreme rainfall

Rainfall events from a major storm or hurricane, or intense localised downpours can lead to flooding in any type of location.



Heatwave

Extreme poverty rendering Madagascar highly vulnerable to underreported extreme heat that would not have occurred without human-induced climate change



Madagascar, in particular the most populated region around the capital of Antananarivo experienced in 2023 its hottest October ever, breaking many high and low temperature records.

23 November, 2023 | [Heatwave](#) | Africa

Strong influence of climate change in uncharacteristic early spring heat in South America



Large parts of South America suffered from extremely high temperatures for an extended period of time, reaching above 40°C in central and Northern Brazil during mid-September, despite it being the spring season.

10 October, 2023 | [Heatwave](#) | South America

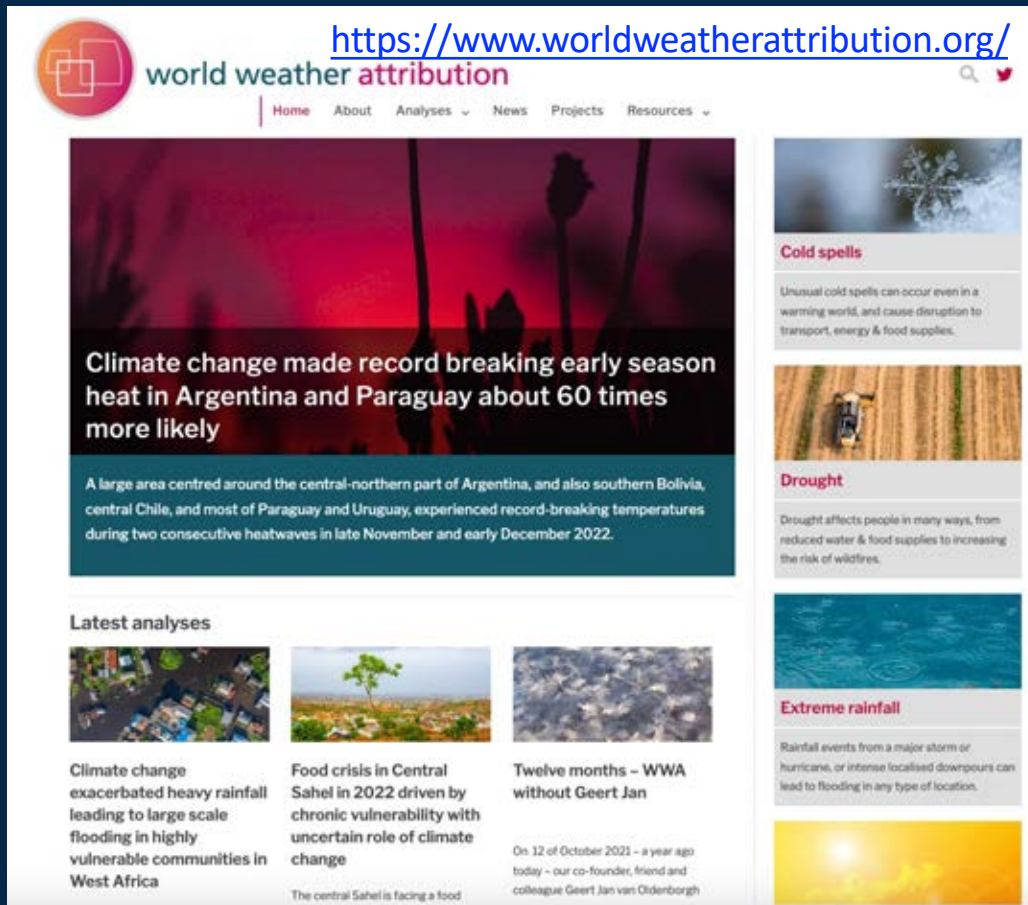
Extreme heat in North America, Europe and China in July 2023 made much more likely by climate change



Following a record hot June, large areas of the US and Mexico, Southern Europe and China experienced extreme heat in July 2023, breaking many local high temperature records.

25 July, 2023 | [Heatwave](#) | Asia, Europe, North America

Climate attribution science has matured



<https://www.worldweatherattribution.org/>

world weather attribution

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Extreme heat in Madagascar was made much more likely by climate change

WWA produced five (5) deep-dive reports on heat attribution in 2023

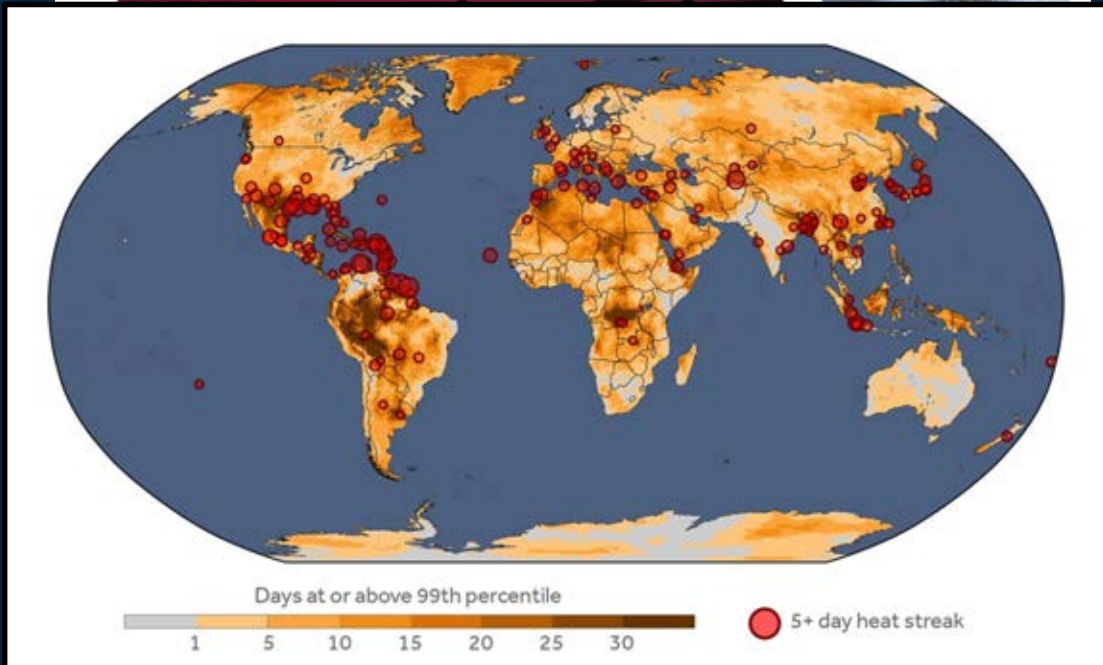
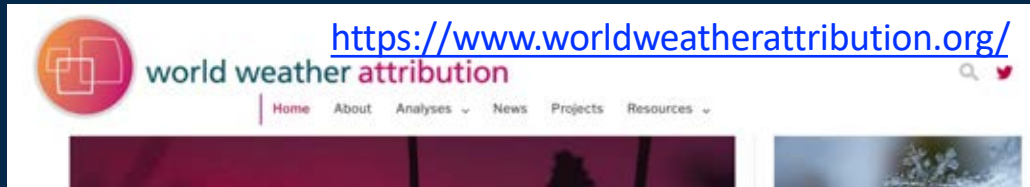
Strong influence of climate change on unusual hot early spring in South America

Extreme heat in North America, Europe and China in July 2023 made much more likely by climate change

Extreme heat in North America, Europe and China in July 2023 made much more likely by climate change

Madagascar, South+North America, South Asia, & Western Europe

Climate attribution science has matured



Heatwave

Extreme heat in Madagascar, Madagascar's capital Antananarivo, was attributed to extreme heat that has been linked to climate change

WWA produced five (5) deep-dive reports on heat attribution in 2023

Extreme heat in Madagascar, Madagascar's capital Antananarivo, was attributed to extreme heat that has been linked to climate change

Strong influence of climate change on unusual hot and dry conditions in South America

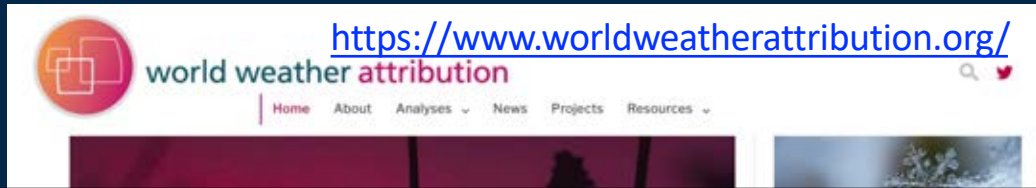
Extreme heat in South America, including temperatures for an extended period in the region, was linked to climate change in Northern Brazil during mid-September, despite it being the spring season.

10 October, 2023 | Heatwaves | South America

Extreme heat in North America, Europe and China in July 2023 made much more likely by climate change

Madagascar, South+North America, South Asia, & Western Europe

Climate attribution science has matured



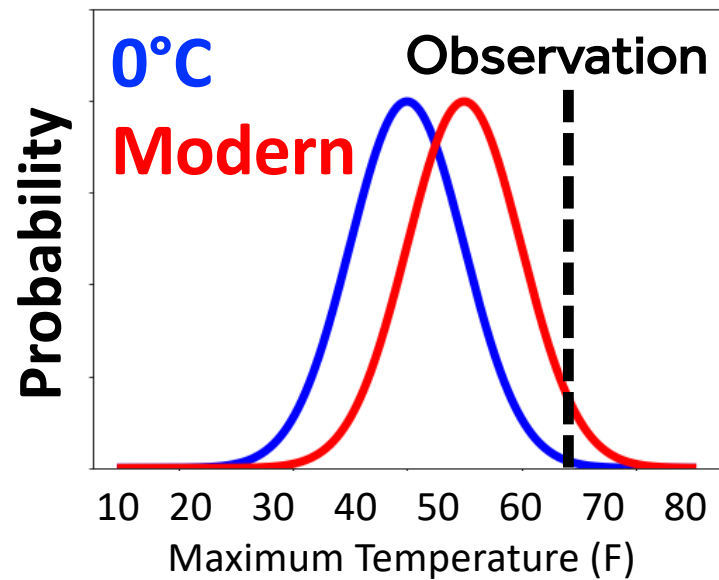
Climate Central developed the Climate Shift Index to analyze+forecast these events in real-time

WWA produced five (5) deep-dive reports on heat attribution in 2023

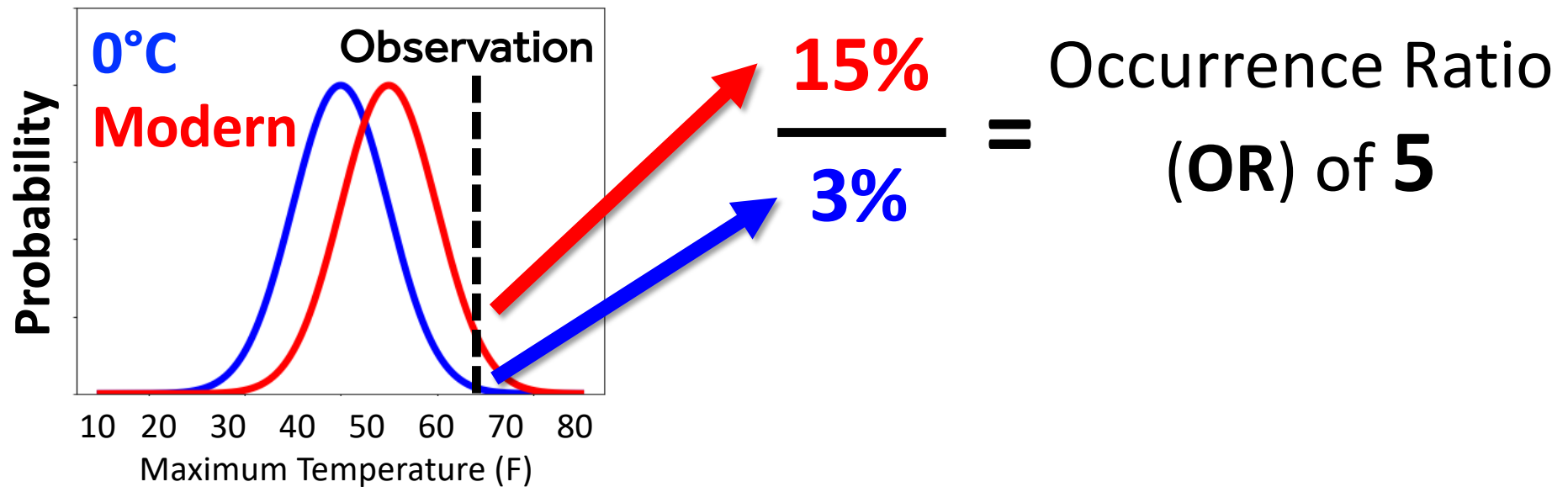
Madagascar, South+North America, South Asia, & Western Europe

A collage of five heatwave attribution reports from World Weather Attribution. The reports are titled: 'Heatwave', 'Extreme heat in Madagascar', 'Strong influence of climate change on unusual hot and dry conditions in South America', 'Extreme heat in South America', and 'Extreme heat in North America, Europe and China in July 2023 made much more likely by climate change'. Each report includes a small image and a date.

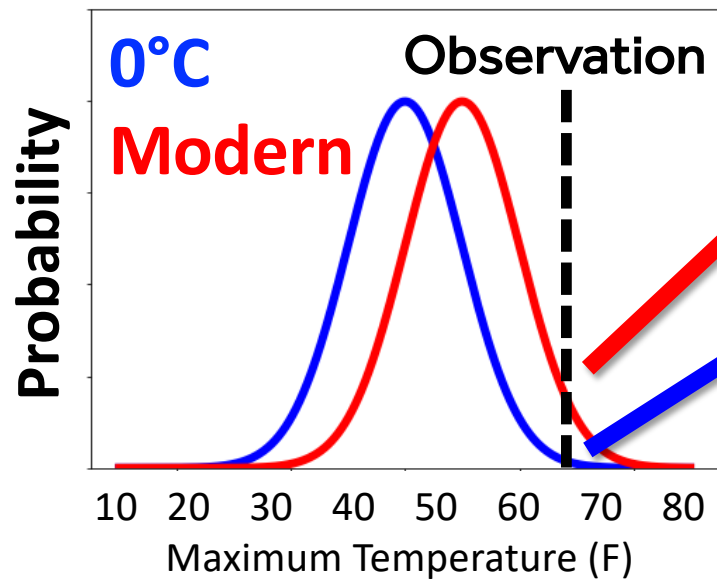
Change in Information due to Perspective (ChIP)



Change in Information due to Perspective (ChIP)



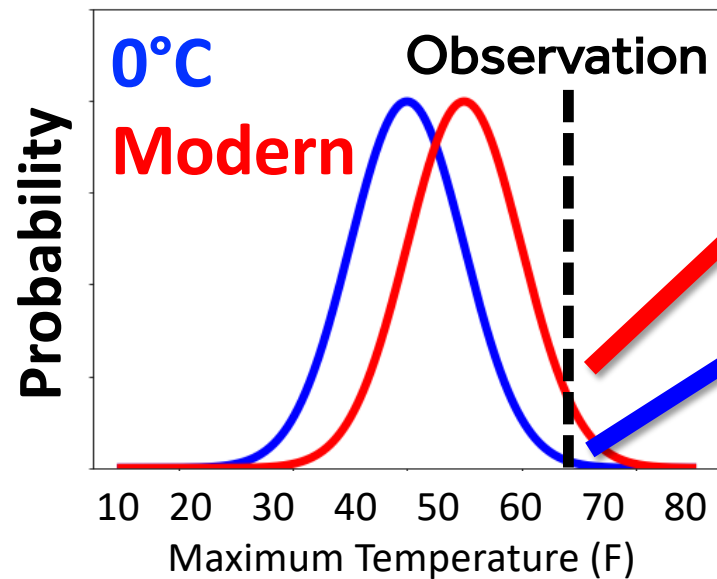
Change in Information due to Perspective (ChIP)



$$\frac{15\%}{3\%} = \text{Occurrence Ratio (OR) of } 5$$

→ These daily temperatures are observed 5x more often in our human-warmed world

Change in Information due to Perspective (ChIP)



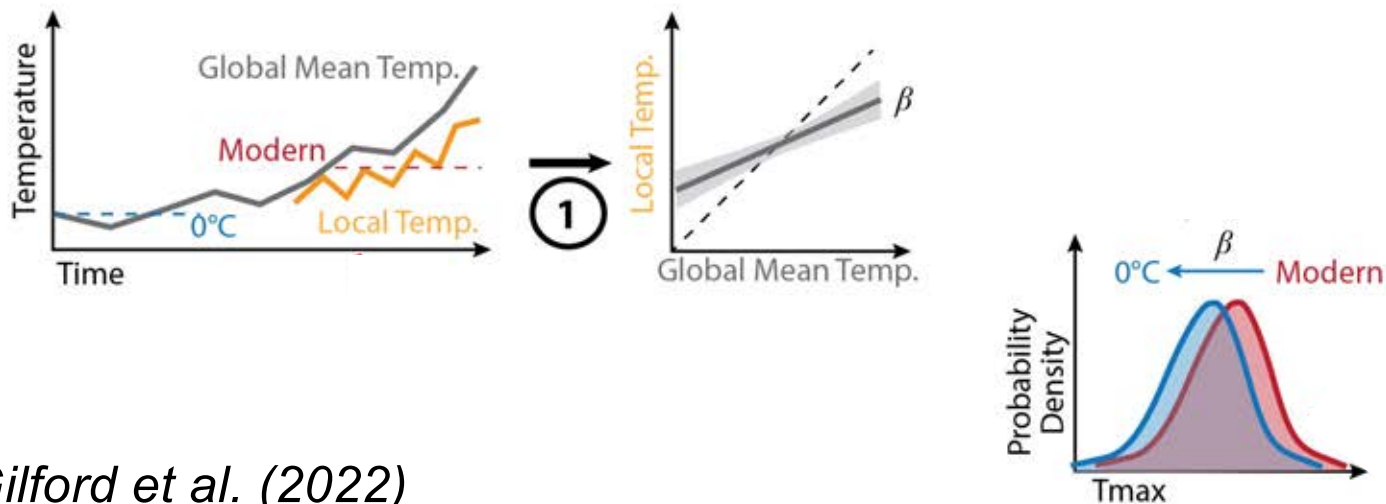
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$$\text{ChIP} = \log_2(\text{OR})$$

Models+Observations are combined to estimate attribution

Observation-based Methods



Gilford et al. (2022)

Observed data:

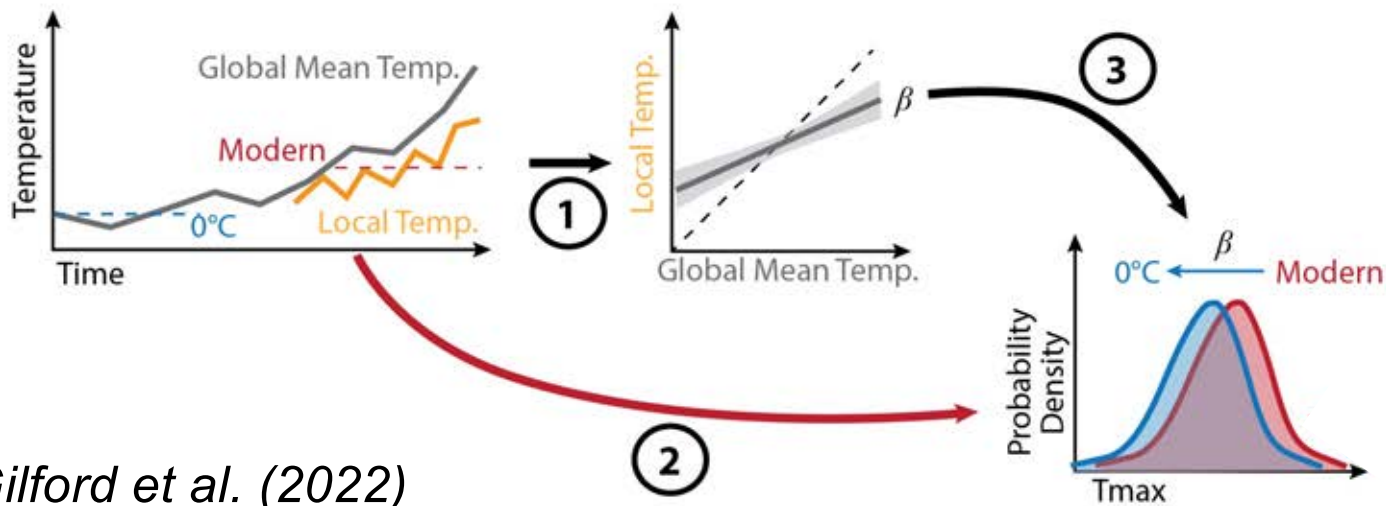
- 5th ECMWF Atmospheric Reanalysis (ERA5)
- HadCRUT5 Global Mean Temperatures

Model data:

- CMIP6 w/ bias adjustment

Models+Observations are combined to estimate attribution

Observation-based Methods



Gilford et al. (2022)

Observed data:

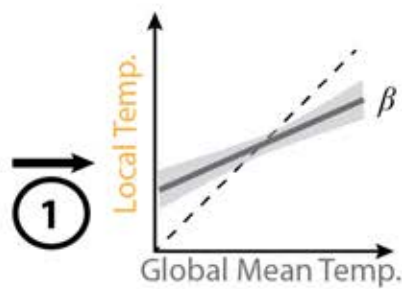
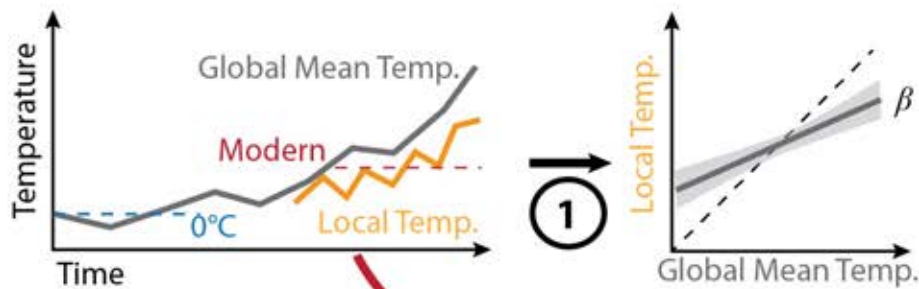
- 5th ECMWF Atmospheric Reanalysis (ERA5)
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Model data:

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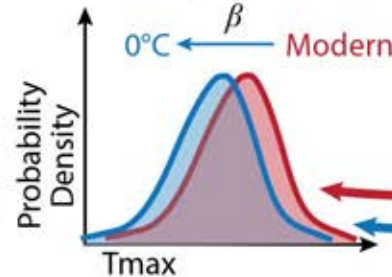
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Observation-based Methods

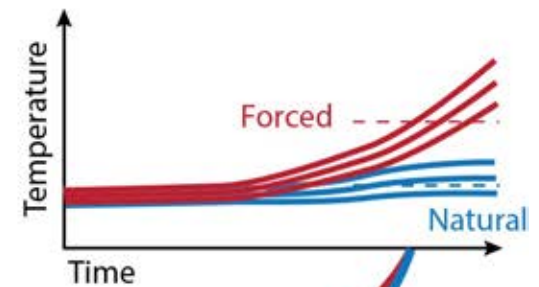


Gilford et al. (2022)

2



Model-based Method



Observed data:

- 5th ECMWF Atmospheric Reanalysis (ERA5)
- HadCRUT5 Global Mean Temperatures

Model data:

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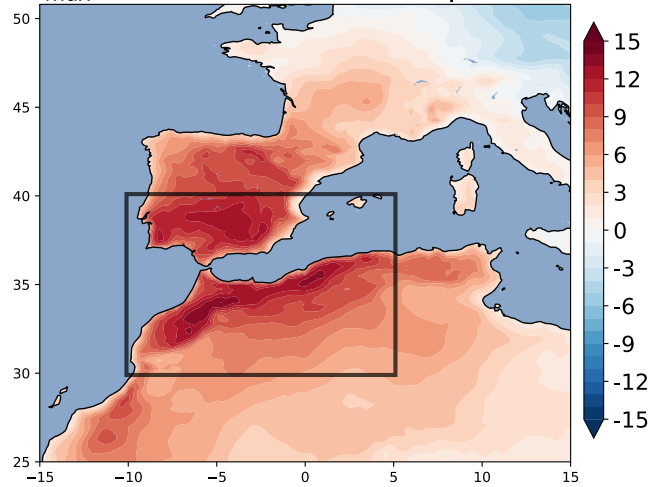
Climate Central's Applications and Attribution Resources

Research

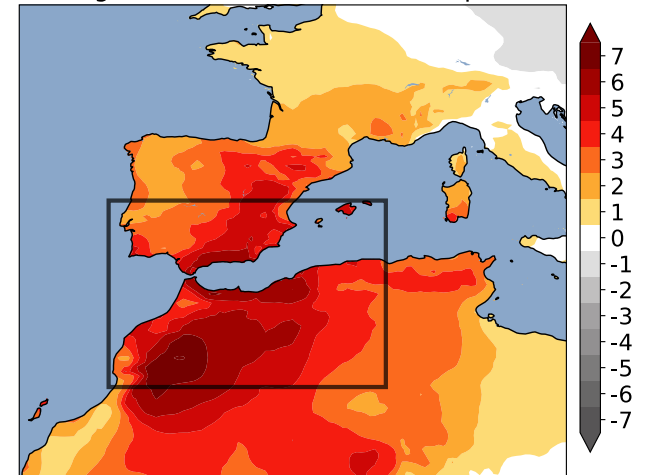
BAMS-EEE
study preprint:



T_{max} anomalies (K), 26-28 April 2023



Change in Information due to Perspective



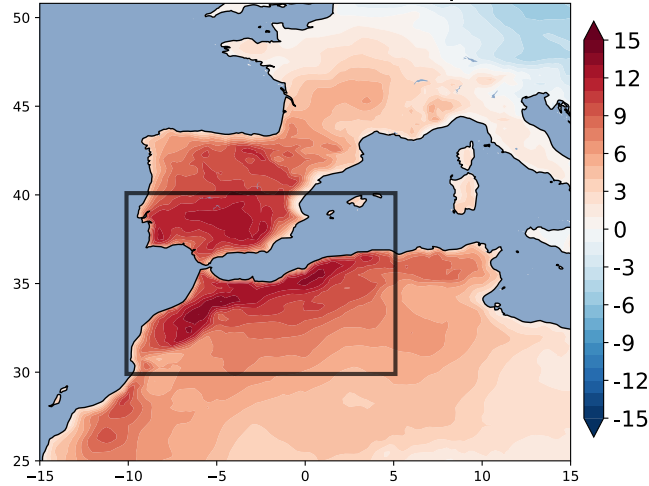
Climate Central's Applications and Attribution Resources

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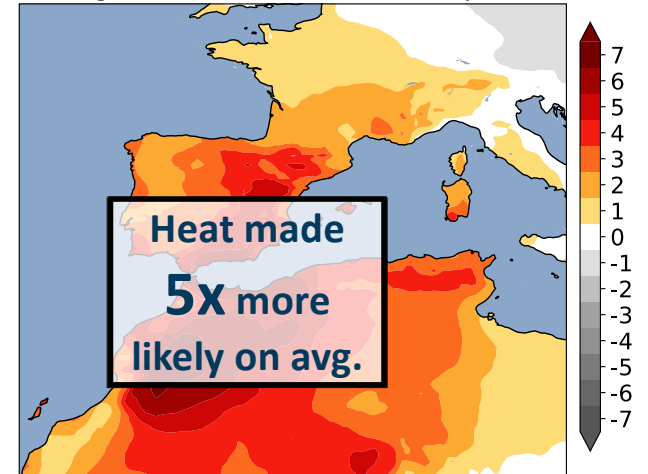
BAMS-EEE
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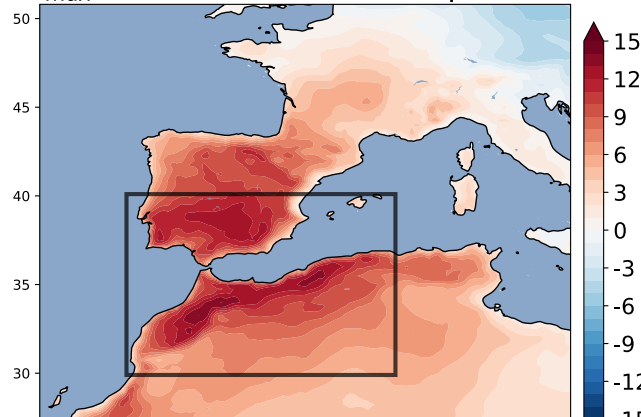
Climate Central's Applications and Attribution Resources

Research

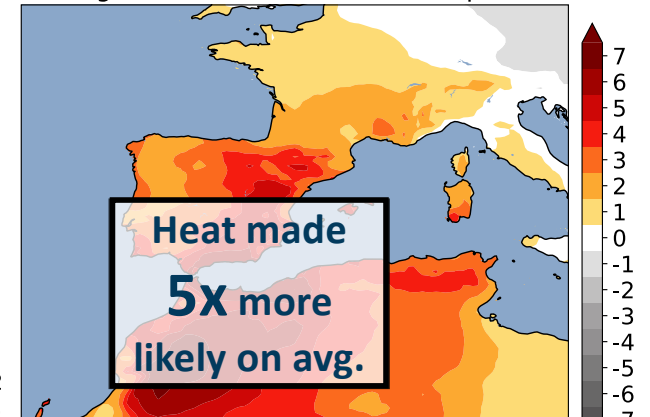
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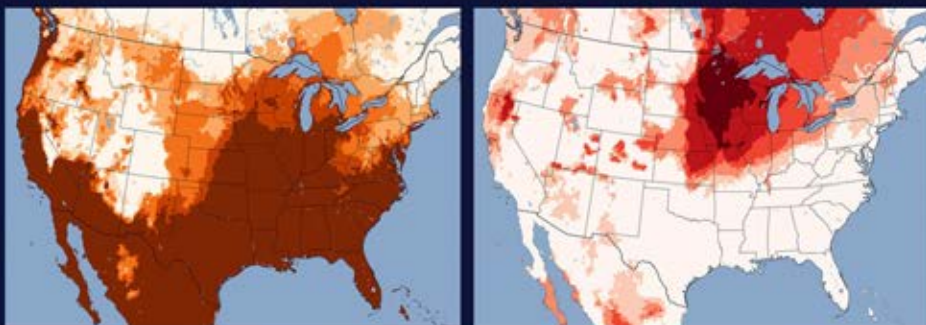


Change in Information due to Perspective



CLIMATE CHANGE FINGERPRINT ON WINTER WARMTH

T_{min} conditions expected over 12/21-12/25 2023



Days at or above 32°F

0 1 2 3 4 5

Days at or above CSI 2

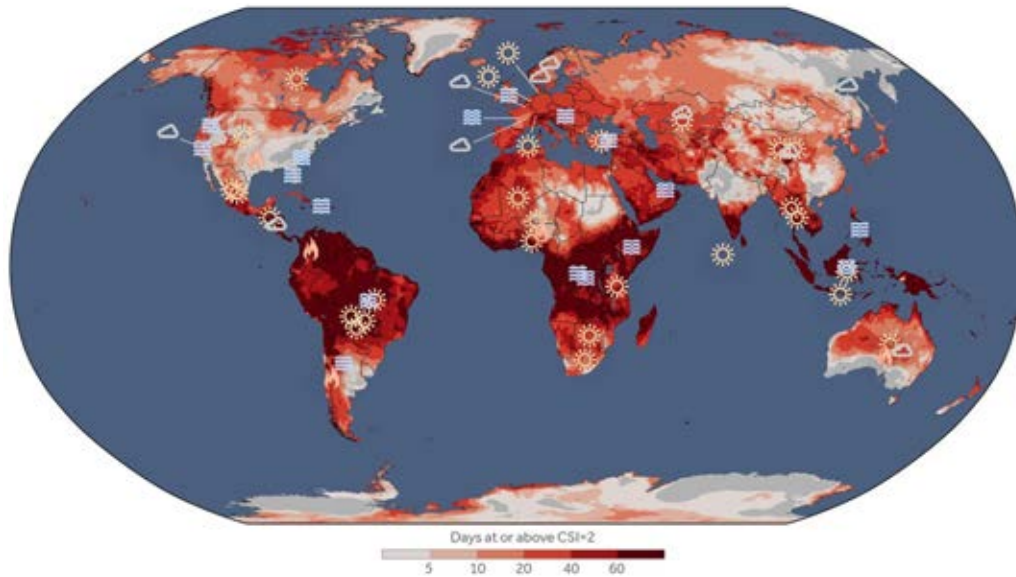
0 1 2 3 4 5

Heat Squad + Real-time alerts

Released on Dec. 21

Climate Central's Applications and Attribution Resources

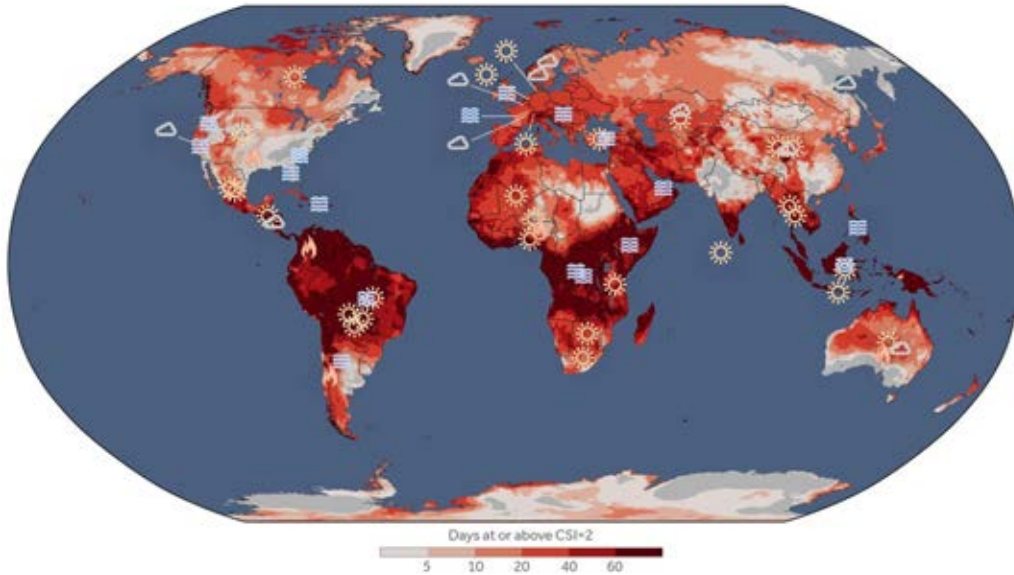
Seasonal Attribution Report -
An analysis of how climate change boosted
temperatures worldwide between December
2023 and February 2024



Reports

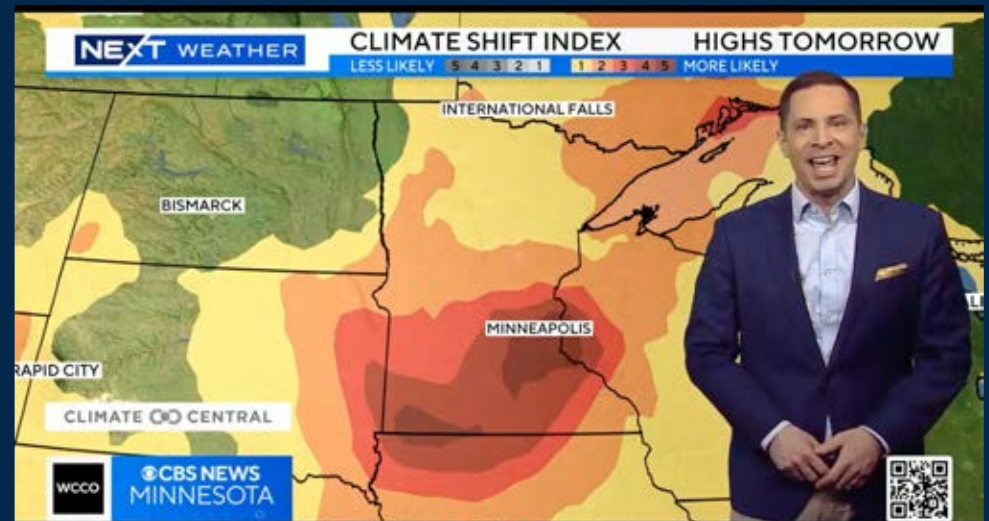
Climate Central's Applications and Attribution Resources

Seasonal Attribution Report -
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2023 and February 2024



Reports

Broadcaster resources + KML files



Courtesy of Mike Augustyniak (WCCO)

Climate Central's Applications and Attribution Resources

CLIMATE CENTRAL

Loaded data for March 17, 2024

Climate Shift Index®

The map shows the [Climate Shift Index \(CSI\)](#) for the daily average temperature. High CSI values mean climate change made the temperatures more likely.

Search Location

Choose A Date

03/17/2024

Advanced Settings

Show Climate Shift Index of

Low Temps

Average Temps

High Temps

Climate Shift Index

for average temperatures, Mar 25, 2024 [Learn more...](#)

Change in likelihood due to climate change

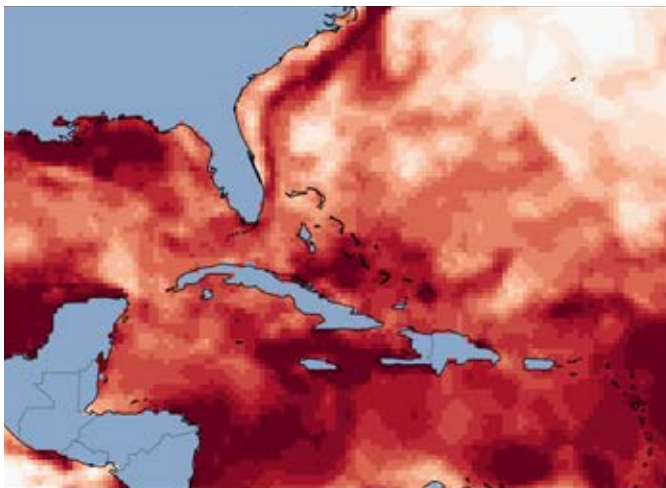


Currently unavailable



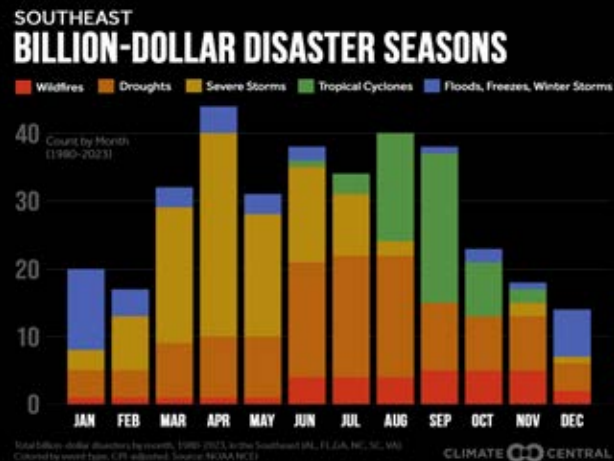
Online Dashboard of Global Attribution

What's next for Climate Central's Attribution research and communication?



SSTs, Marine Heat Waves,
+ Ecosystems Health

Attributable Disasters + Human Impacts



Additional Attributable
Conditions

Summary and Final Thoughts

→ **The Climate Shift Index reliably estimates attributable climate influences on local temperatures with days of lead time**

This lets us (and you!) connect local conditions to the bigger problem of climate change

Daniel Gilford

dgilford@climatecentral.org

*Check out the
Climate Shift Index:
Updated daily!*



Summary and Final Thoughts

→ **The Climate Shift Index reliably estimates attributable climate influences on local temperatures with days of lead time**

This lets us (and you!) connect local conditions to the bigger problem of climate change

→ **We are actively seeking partners + collaborators to use, communicate, and develop real-time attribution resources**

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*Check out the
Climate Shift Index:
Updated daily!*



