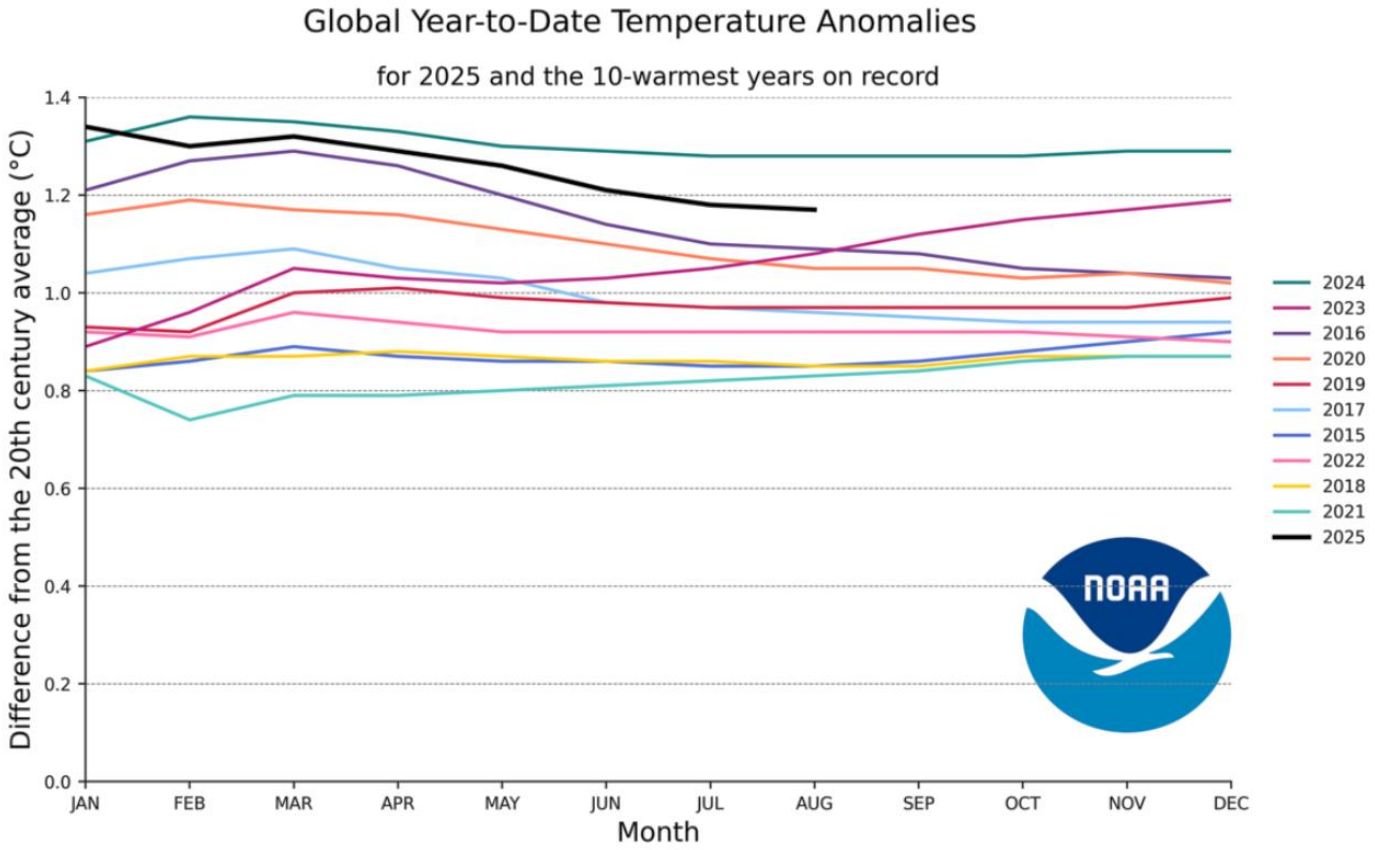
Low and Behold: Barometric Extremes Amplifying Floods

*"The 10 warmest years in the 143-year record have all occurred **since 2015**. The 2024 January–December 2024 global surface temperature ranked warmest in the 175-year record at 1.29°C (2.32°F) above the 20th century average" (NOAA).*



Chief Meteorologist Ms. Sunny Wescott
Critical Infrastructure and Emergency Response Operations

High and Low Pressures: the Carousel of Weather

A **low-pressure system** has lower pressure at its center than the areas around it. Winds blow towards the low pressure, and the air rises in the atmosphere where they meet.

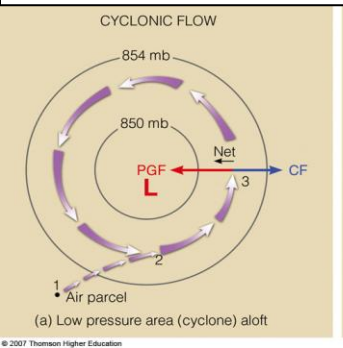
- Because of Earth's spin and the Coriolis effect, winds of a low-pressure system swirl counterclockwise north of the equator.
- As the air rises, the water vapor within it condenses, forming clouds and often precipitation.
- On weather maps, a low-pressure system is labeled with red L.

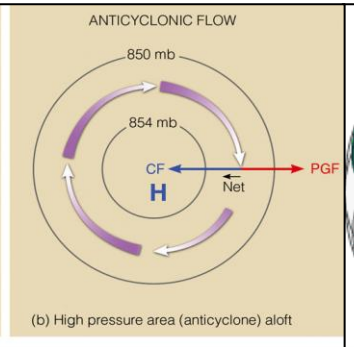
A **high-pressure system** has higher pressure at its center than the areas around it. Winds blow away from high pressure.

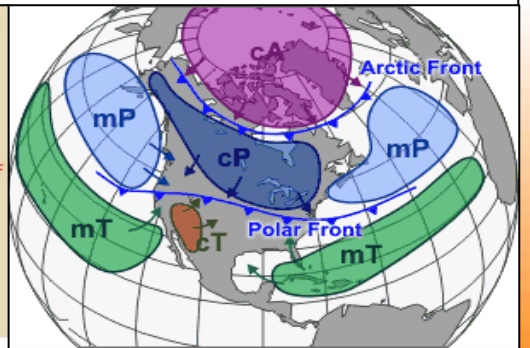
- Swirling in the opposite direction from a low-pressure system, the winds of a high-pressure system rotate clockwise north of the equator (anticyclonic flow).
- Air from higher in the atmosphere sinks down to fill the space left as air is blown outward. On a weather map, you may notice a blue H, denoting the location of a high-pressure system.

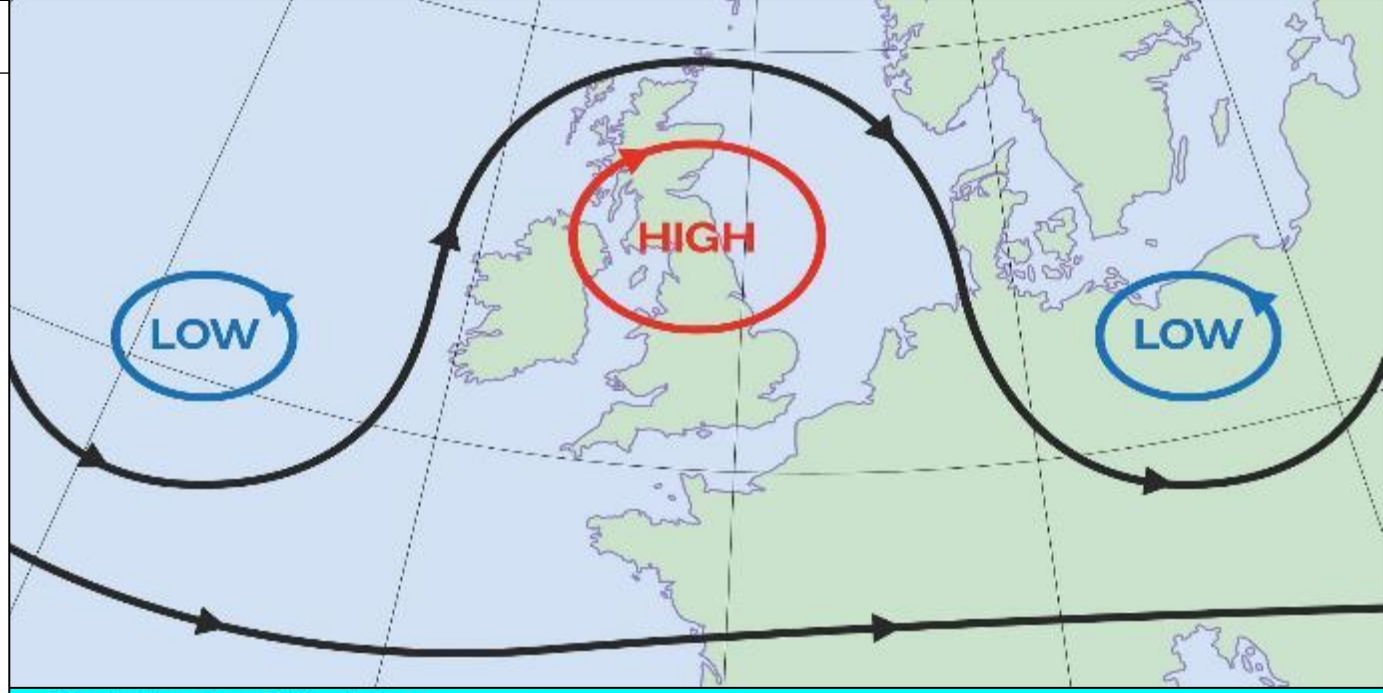
Air pressure depends on the temperature of the air and the density of the air molecules. Air masses differ based off their prevailing fields.

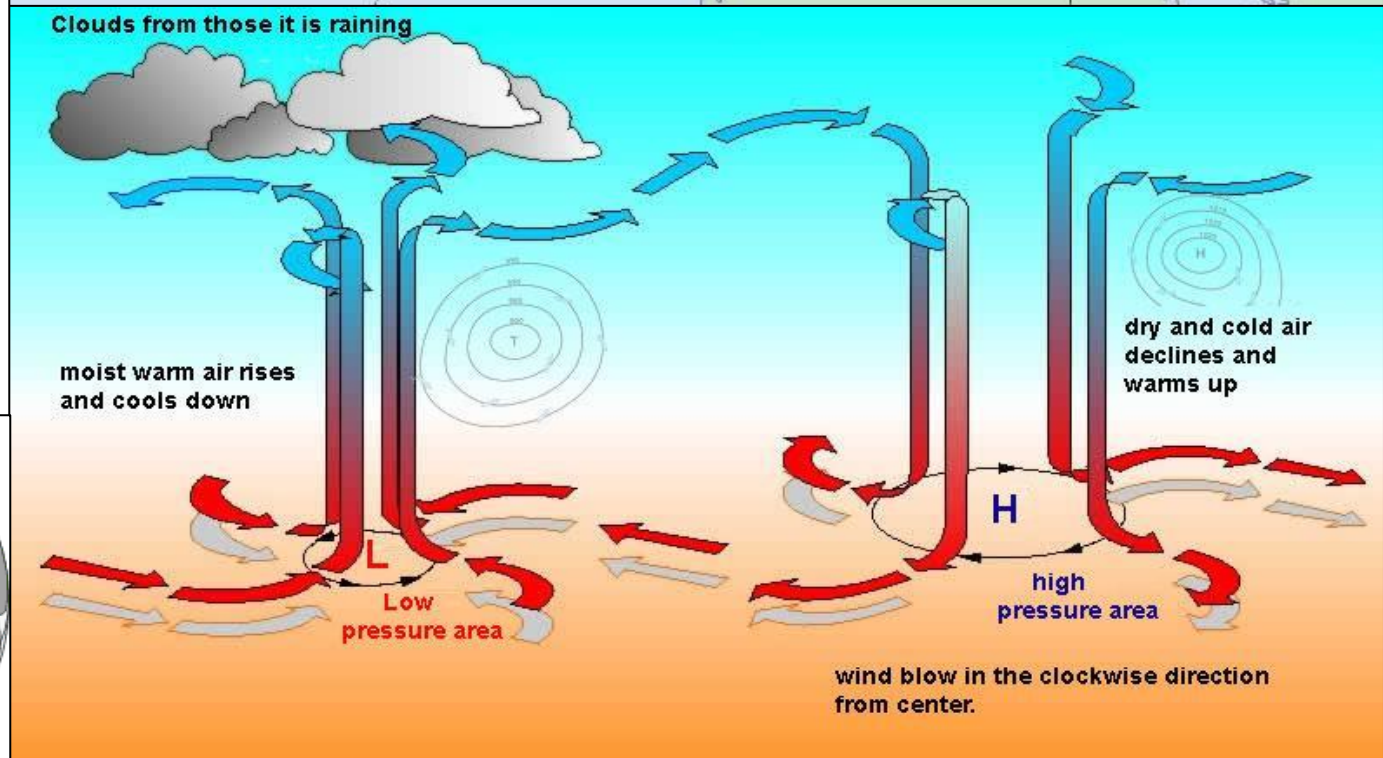
The tighter the gradient between the high and the incoming low, the stronger the winds will be as they mix down from the upper levels.









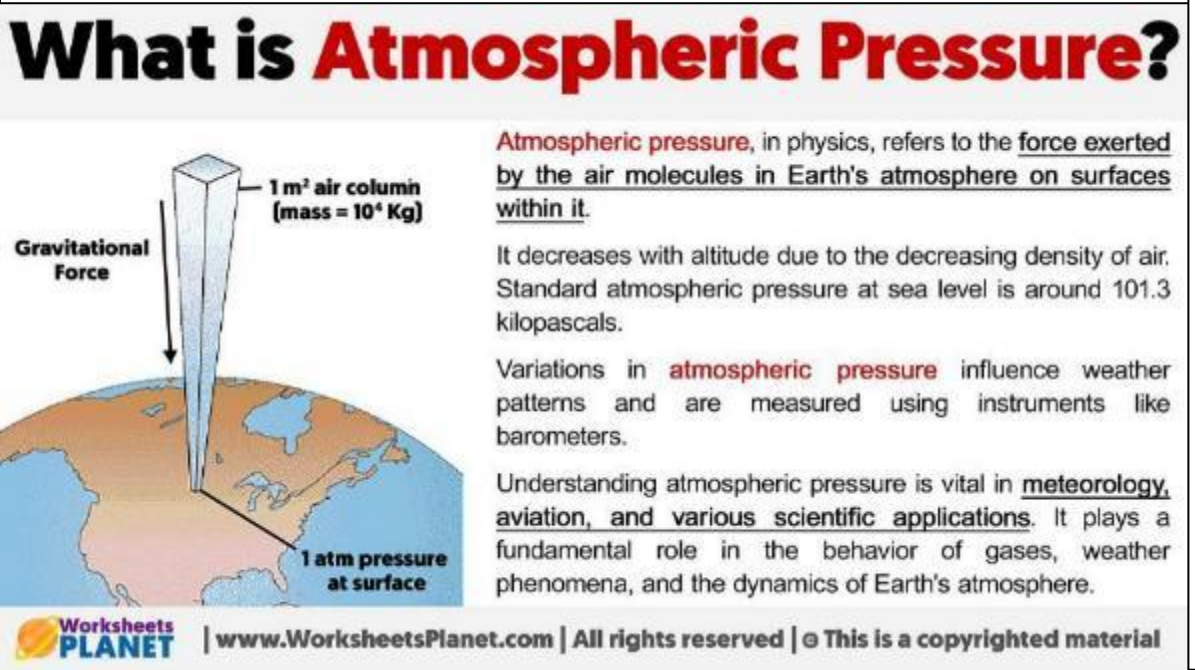


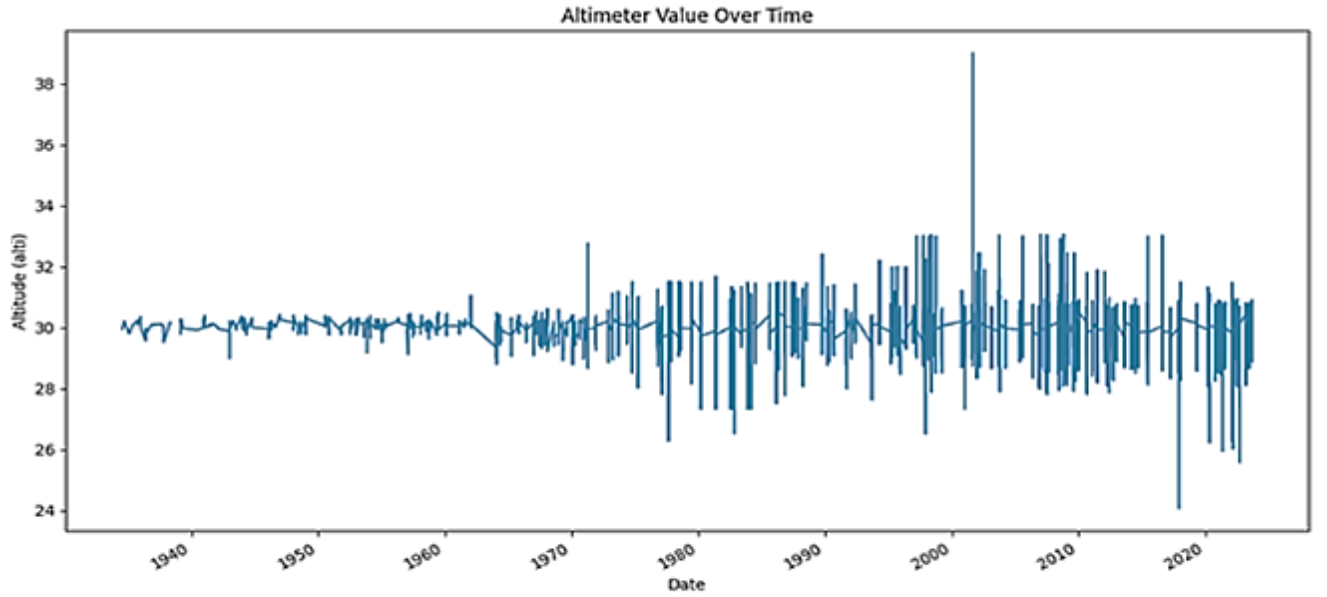
Major Pressure Swings Begin

As low pressures continue to change in depth and intensity, the high-pressure events are left to dominate for longer periods, increase coverage area, and promote significant levels of humidity and water vapor adding to trapped heat.

- The low-pressures drive global cooling winds, bring rainfall and storm events, and are responsible for all notable cloud coverage.
- High-pressures yield clear skies, heat domes, haze, stagnant air, and even the cold air damming periods.

This means a change in either pressure consistency or strength brings immediate consequences for the water cycle.

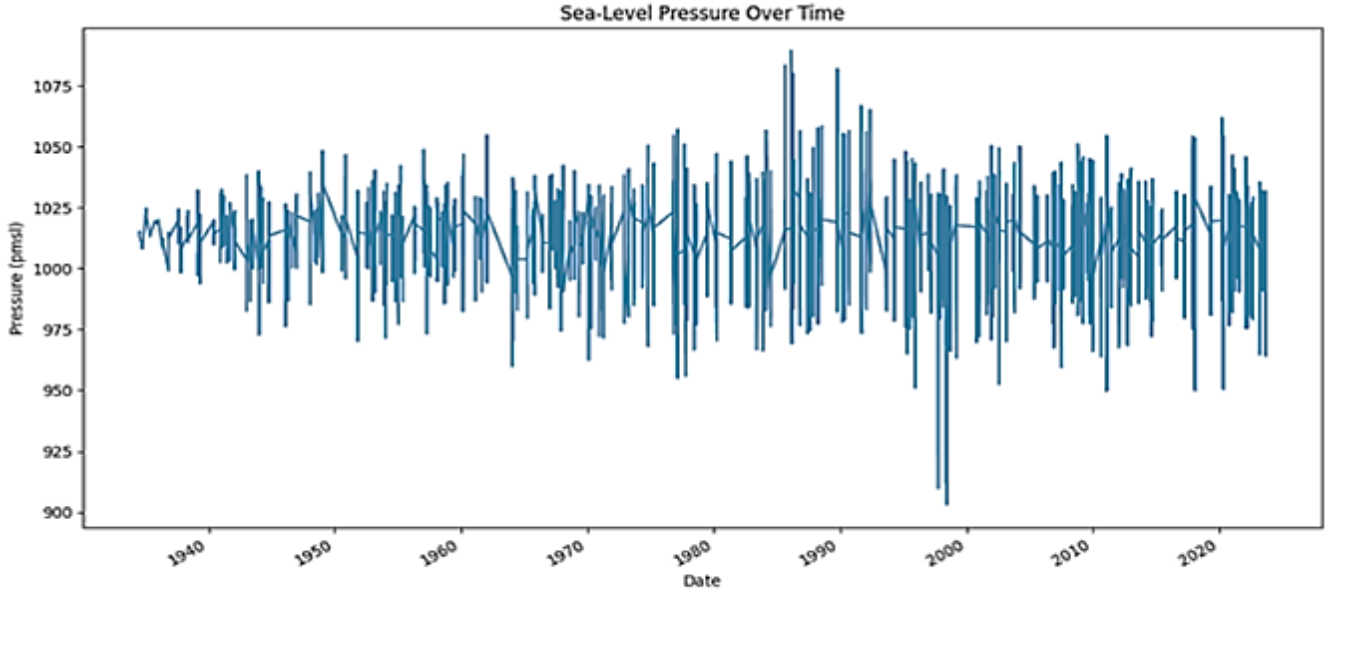




ASOS Raw Data
National Overview

Generated on 2024-11-09 05:48:34.466552

Low- and High-pressure centers are moving into extremes amplifications



Generated on 2024-11-09 05:48:22.662762

Upper-Level Winds

A recent study, in *Nature Climate Change,* suggests that the fastest upper-level jet stream winds will accelerate by about 2% for every degree Celsius (1.8° Fahrenheit) that the world warms.

- Furthermore, the fastest winds will speed up 2.5 times faster than the average wind.

The Intergovernmental Panel on Climate Change (IPCC) states that climate change will affect aggregate global windspeeds with projected average annual wind speeds dropping by 10% by 2100.

- A 2019 study found that in the preceding nine years the global average wind speed increased nearly 6%.

Extreme regional wind events such as the Santa Ana, Diablo, and Chinook, have increased in general over the last 60 years.

- Shifts in winds carrying major seasonal precipitation like Atmospheric Rivers and Monsoons are forecast to amplify while variations in frequency and timeliness.

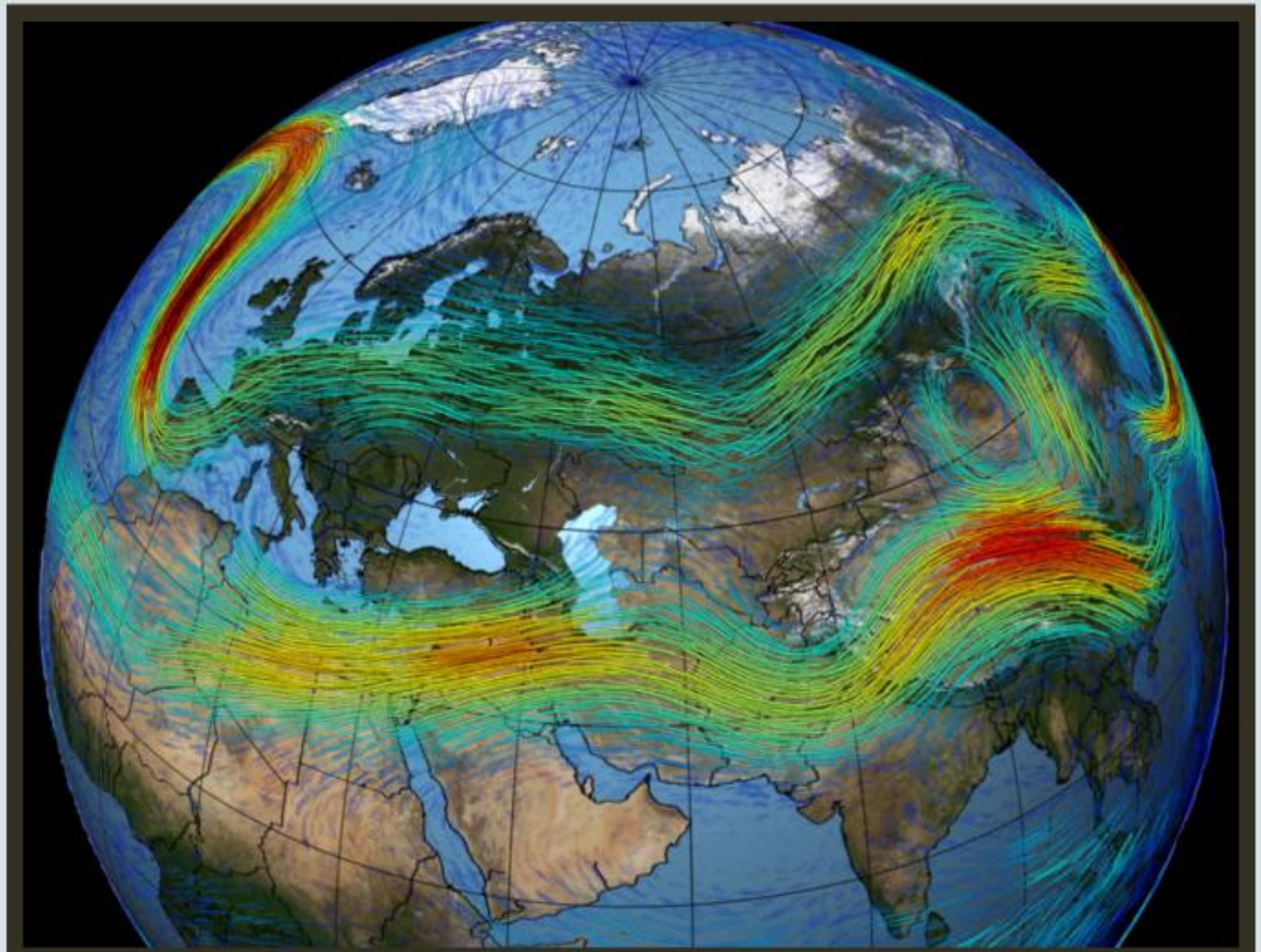
Studies over the past 45 years indicate changes to the tropopause, the top of the troposphere, and the width of the tropical belt may be shrinking, changing the overall storm pattern across the globe.

- The tropopause, has climbed about 50 to 60 meters per decade in the past 20 years.
- The troposphere is the bottom layer of Earth's atmosphere and contains most of the atmosphere's mass, clouds and weather phenomena, and is where the global population and wildlife lives.

JET STREAM WINDS WILL ACCELERATE WITH WARMING CLIMATE

Faster winds likely to cause bumpier flights, more severe weather

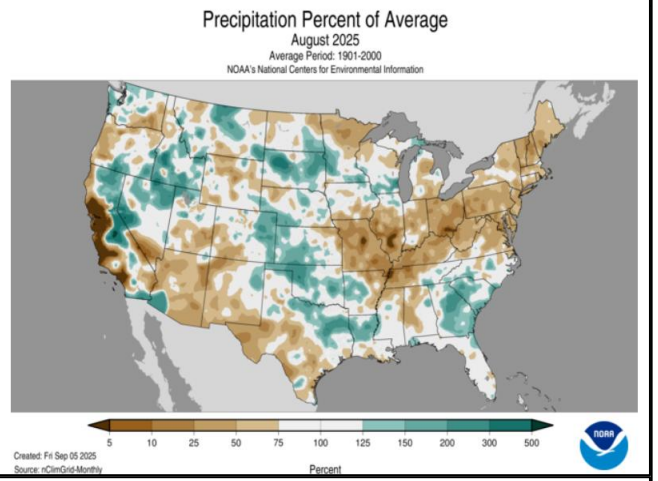
DEC 6, 2023 - BY STAFF

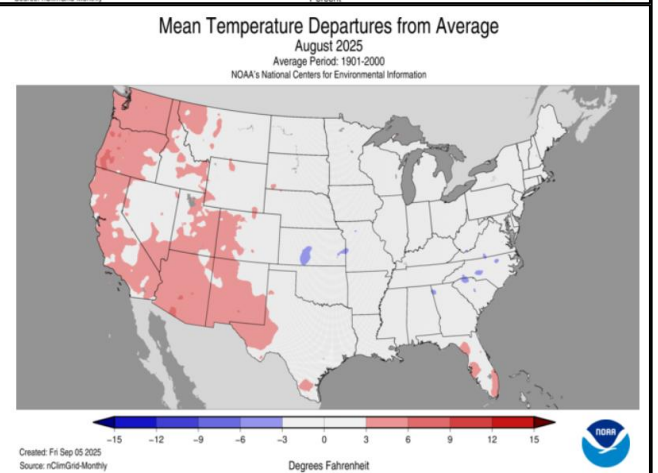


New research shows that the fastest jet stream winds will accelerate with climate change. (Image by NASA/Goddard Space Flight Center Scientific Visualization Studio.)

In July, 1,434 flash flood warning, the second-highest July total in 40 years, and 17 flash flood emergencies were issued nationwide, along with over 2,000 preliminary flood-related storm reports.

Average temperatures in August were above average throughout the West, with Arizona recording its second-warmest August on record at 4.6°F above average, behind only August 2020. Washington and Oregon recorded temperatures over 4°F warmer than long-term monthly average.





Notable Weather and Climate Events: August 2025

On Sep 2, 34.7% of the CONUS was in drought, up 3.7% since the end of Jul. Drought persisted in the West but improved in the northern Plains. Drought developed across parts of the lower Mississippi, Tennessee and Ohio valleys and the Northeast.

Aug 12–13: A glacial dam outburst on the Mendenhall Glacier caused record river crests and major flooding in Juneau.

Aug 7–8: Severe storms swept across ND with 100 mph wind gusts and brief tornadoes, causing widespread tree damage and power outages.

VT had its driest Aug on record, leading to the entire state being covered by drought.

Aug 9–10: Torrential rain triggered deadly flash flooding and marked Milwaukee's second-wettest two-day period on record.

The Gifford Fire became CA's largest wildfire of the year, burning 131,000+ acres and prompting evacuations.

Several counties in the Piedmont region of NC and SC recorded their coolest Aug average temperatures on record.

Aug 7: Phoenix set a new Aug daily high temperature record of 118°F; it was AZ's second-warmest Aug on record.

HI had its driest Aug in at least 35 years, with Honolulu measuring no rainfall for the month.

Four South FL counties—Manatee, Palm Beach, Broward and Miami-Dade—recorded their warmest Aug average daytime high temperatures.

Mid-Aug: Hurricane Erin's outer bands brought heavy rain and strong winds to PR and the USVI.

The average U.S. temperature for Aug was 73.4°F, 1.3°F above average, ranking in the warmest third of the 131-year record.
The U.S. precipitation average for Aug was 2.30 in., 0.32 in. below average, ranking in the driest third of the record.
The average U.S. summer (Jun–Aug) temperature was 73.3°F, 2.0°F above average, ranking in the warmest third of the record.
The U.S. precipitation summer total was 8.69 in., 0.37 in. above average, ranking in the middle third of the record.

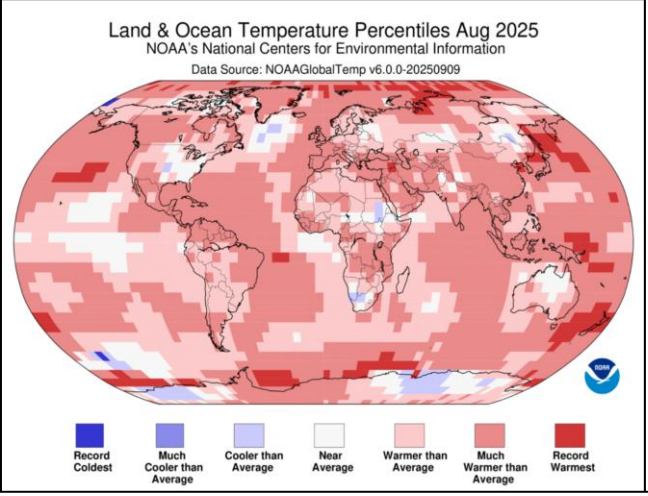
Please Note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: https://www.ncei.noaa.gov/access/monitoring/monthly-report/

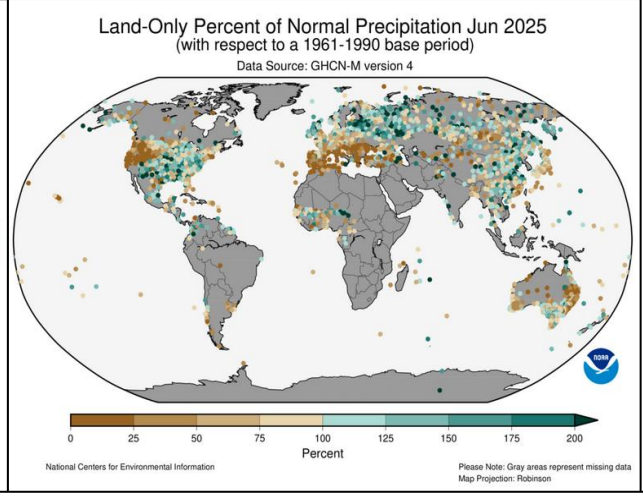
August 2025 was the third-warmest August globally since records began in 1850. The monthly temperature anomaly was +1.07°C (+1.93°F), ranking just below the warmest Augusts of 2023 and 2024 (+1.27°C / +2.29°F).

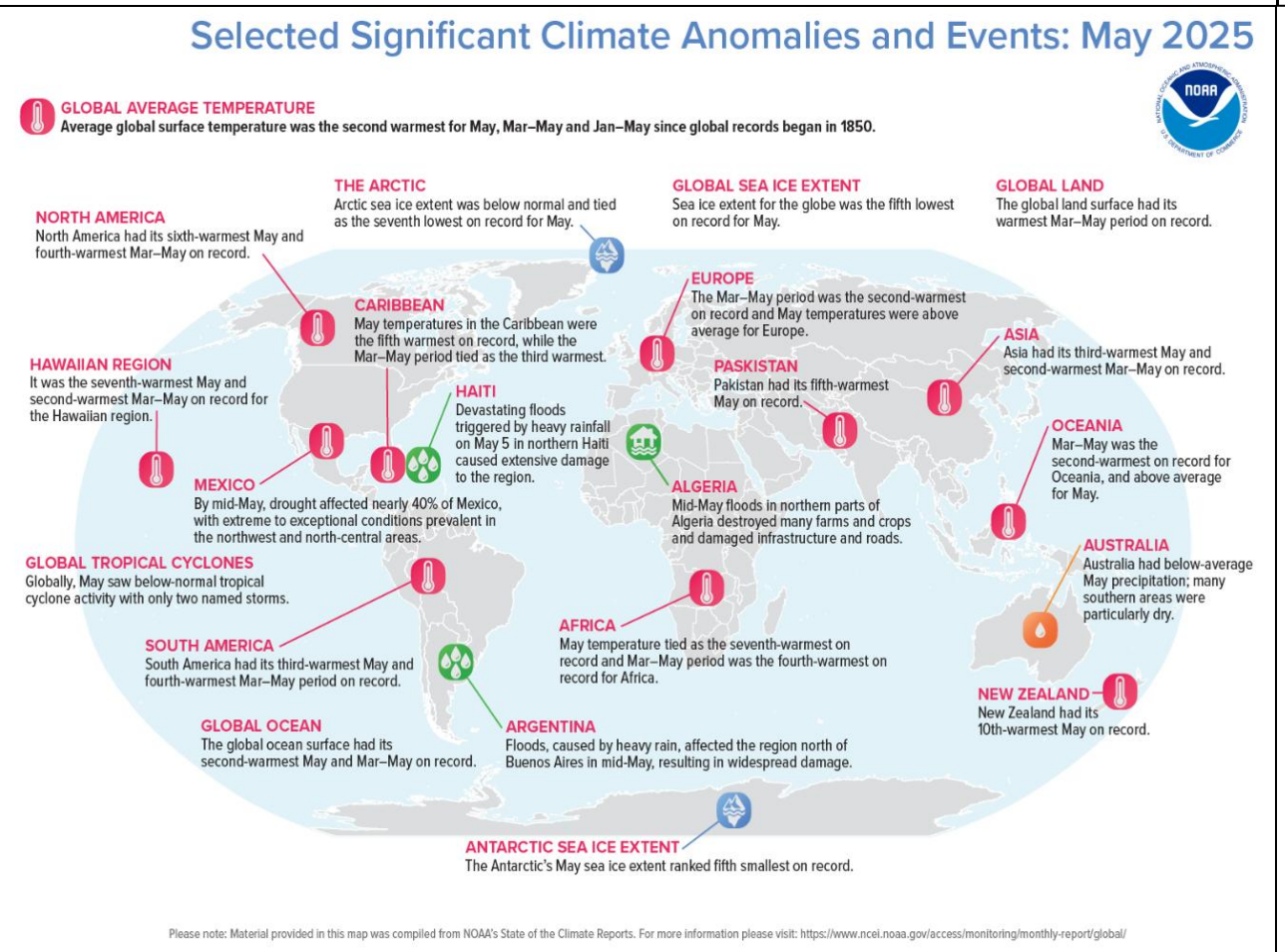
- August 2025 marks the 47th consecutive August with global temperatures at least nominally above average. The ten warmest Augusts have all occurred since 2015.

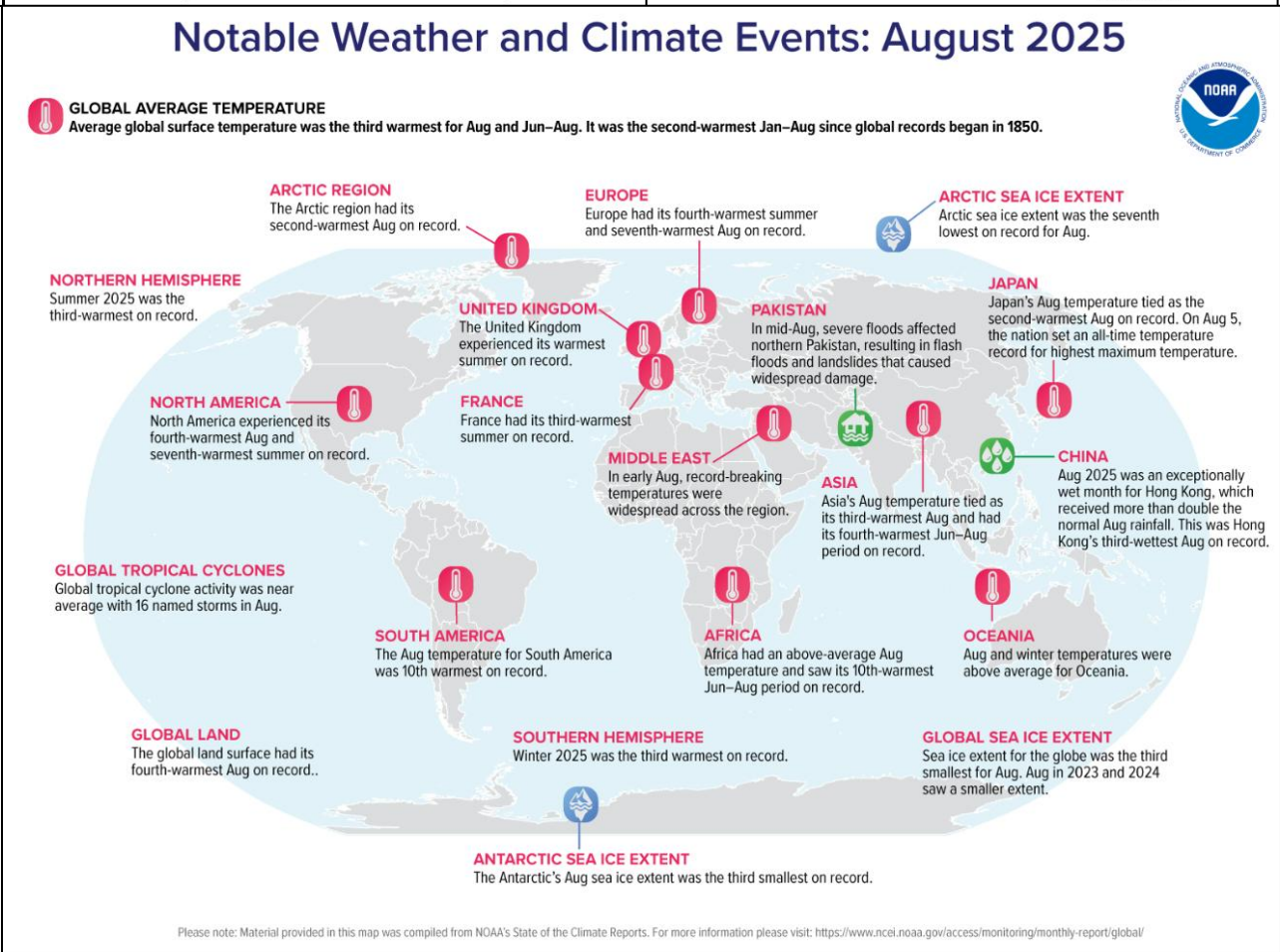
The global ocean-only surface temperature for August 2025 was the third-highest on record for August, with a temperature 0.91°C (1.64°F) higher than the 20th-century average. Only Augusts of 2023 and 2024 were warmer.

August temperatures were above average across much of the globe's surface, and parts of every continent. The most significant warm temperature departures were in the Northern Hemisphere's northern latitudes, as well as central Antarctica. Record-high August temperatures covered 6.3% of the world's surface.



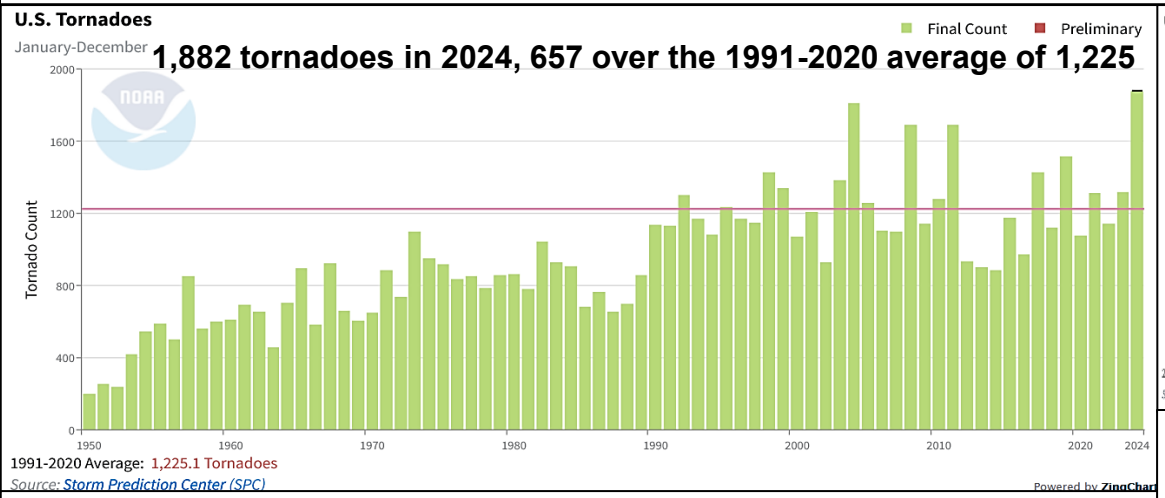


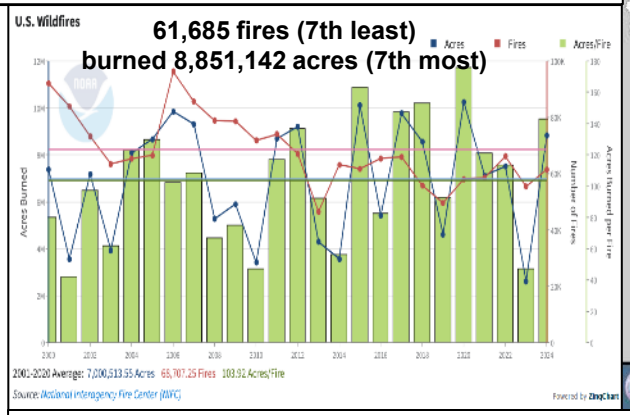


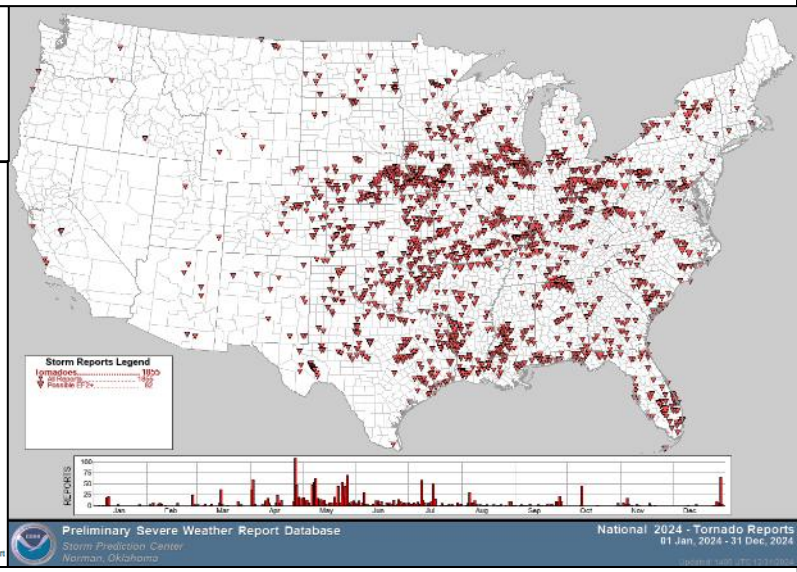


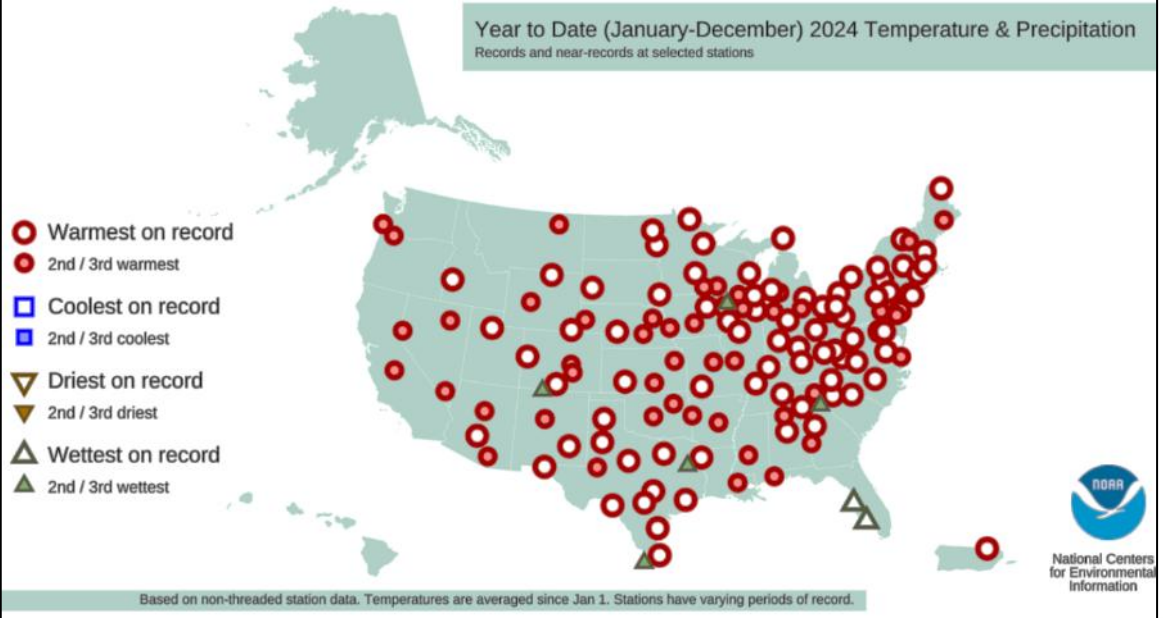
National Temperature Swings Yield Extremes

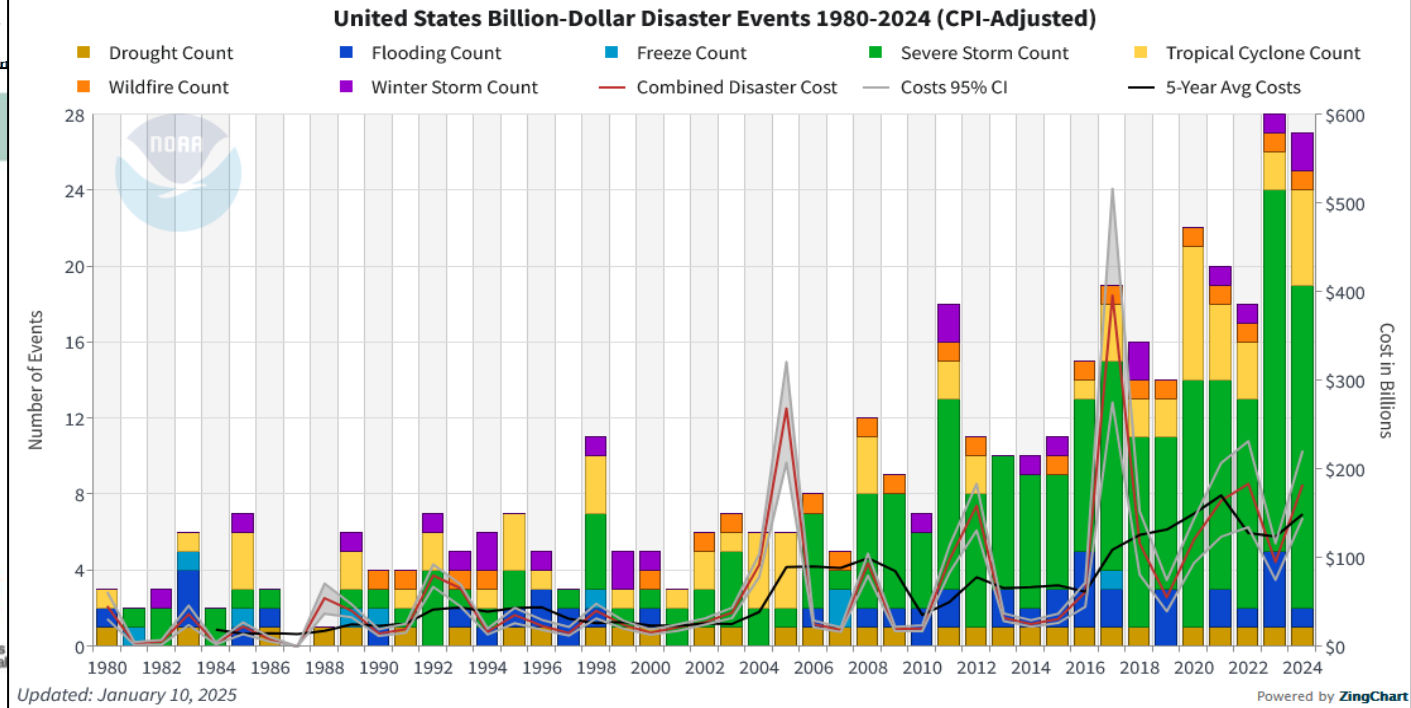
In 2024, there were 27 confirmed weather/climate disaster events with losses exceeding $1 billion each to affect US following the 2023 record 28 billion-dollar events. The total cost from 2024 was $182.7 billion via *17 severe storms, 5 Tropical Cyclones, 1 wildfire, 1 drought/heat event, and 2 winter weather events.*











Changing Spring Conditions

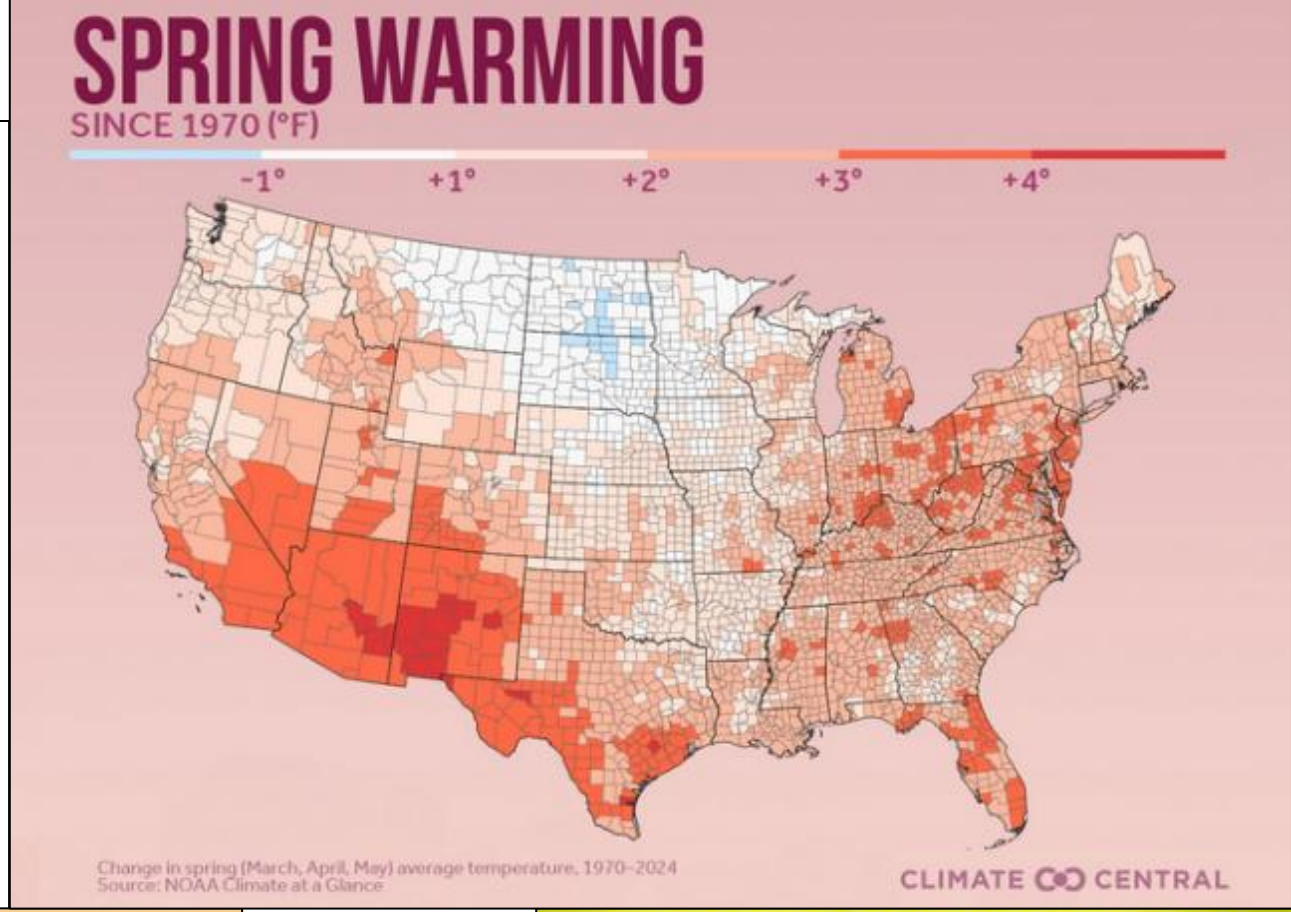
The spring season has warmed in 234 (97%) of the 241 U.S. cities analyzed — by 2.4°F on average.

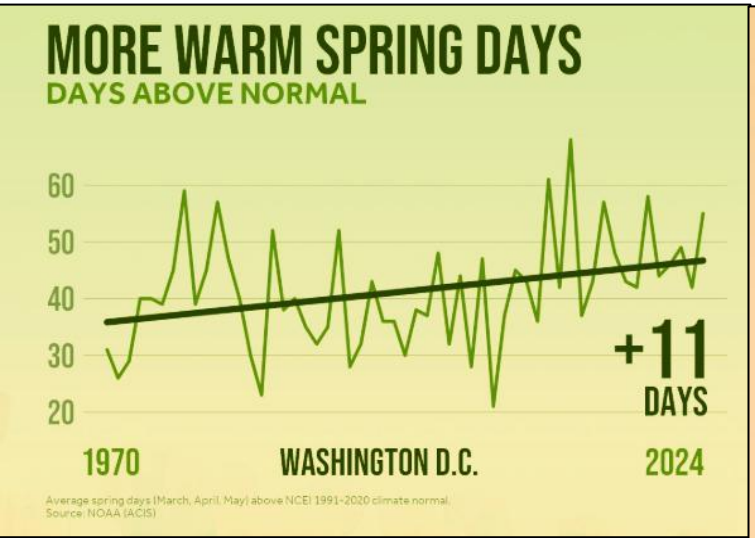
- Unusually warm spring days now happen more often. Four out of every five cities now experience at least one more week of warmer-than-normal spring days than in the 1970s.
- Spring has warmed the most across the southern tier of the country, particularly in the Southwest.
- Spring warming can prolong seasonal allergies, worsen wildfire risk, and limit snow-fed water supplies.

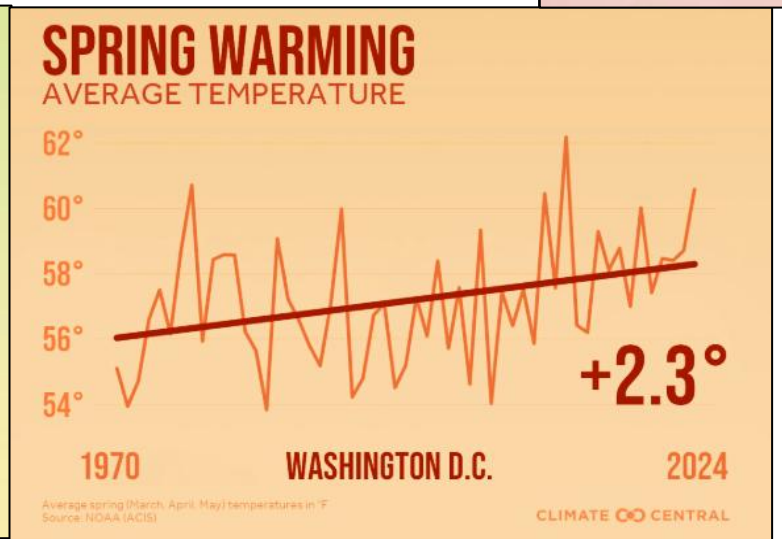
Spring warmed the most, on average, in locations across the southern tier of the country: Southwest (3.4°F), South (2.7°F), Southeast (2.5°F), and Ohio Valley (2.5°F).

- Most locations (80%, or 194) now experience at least seven additional warmer-than-normal spring days than they did in the early 1970s.

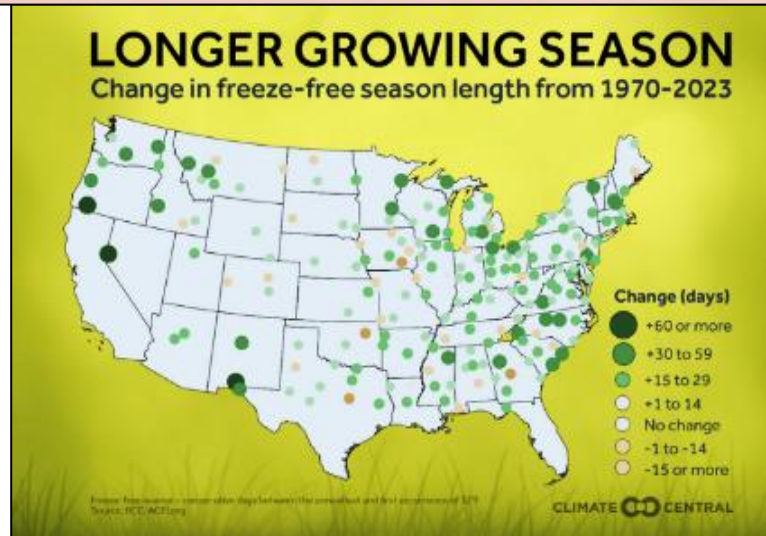
Warmer, shorter winters mean an [earlier spring thaw and later fall freeze](#).







Warmer spring temperatures result in earlier thaws, heavier spring rainfall, longer growing seasons, double blooms, river system changes, marine and wildlife shifts, and changes to energy needs.

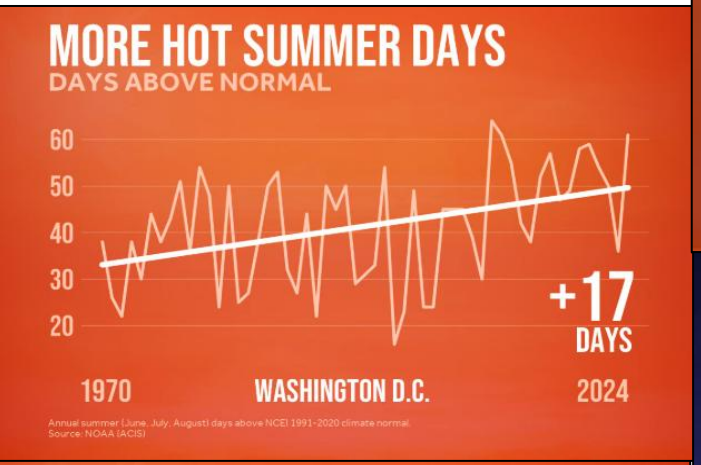


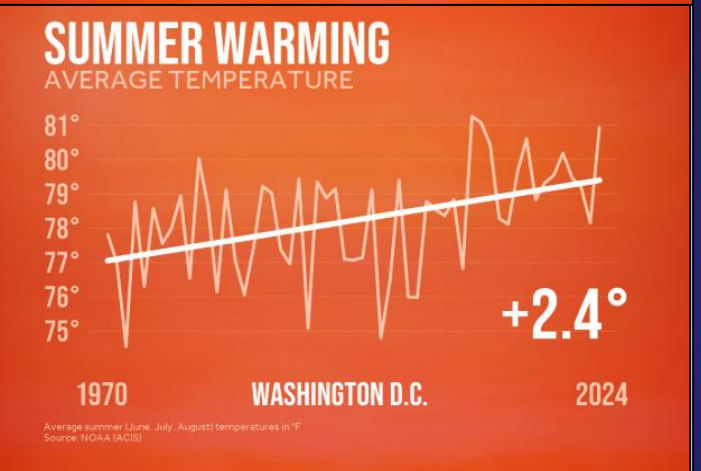
Climate Central's Warming Seasons Graphics

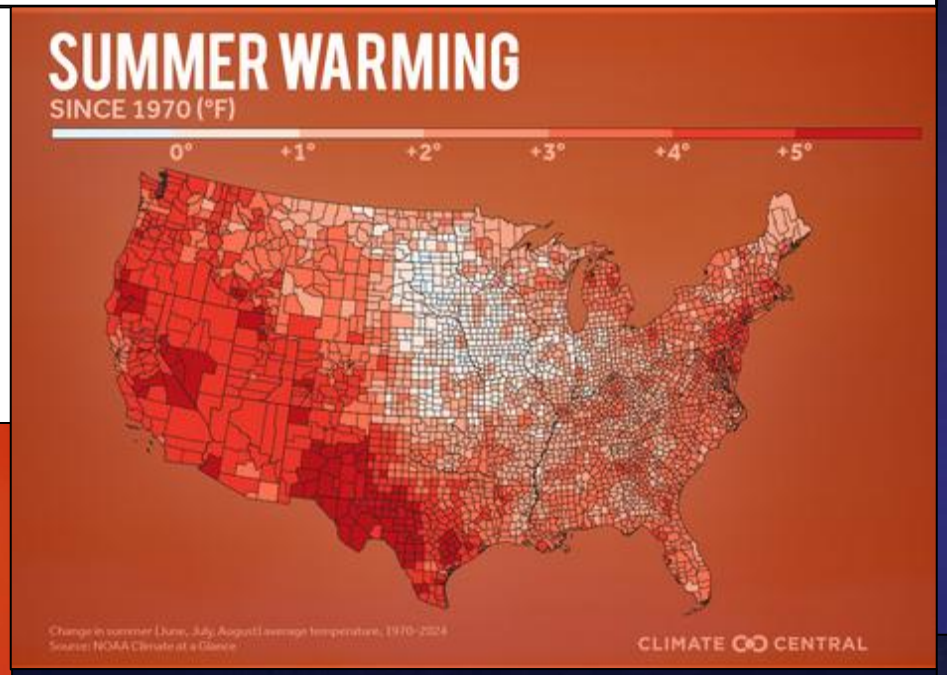
Winters have warmed by 4°F on average across 235 US cities since 1970. Warmer, shorter winters have lingering effects on health, water supplies, and agriculture throughout the year.

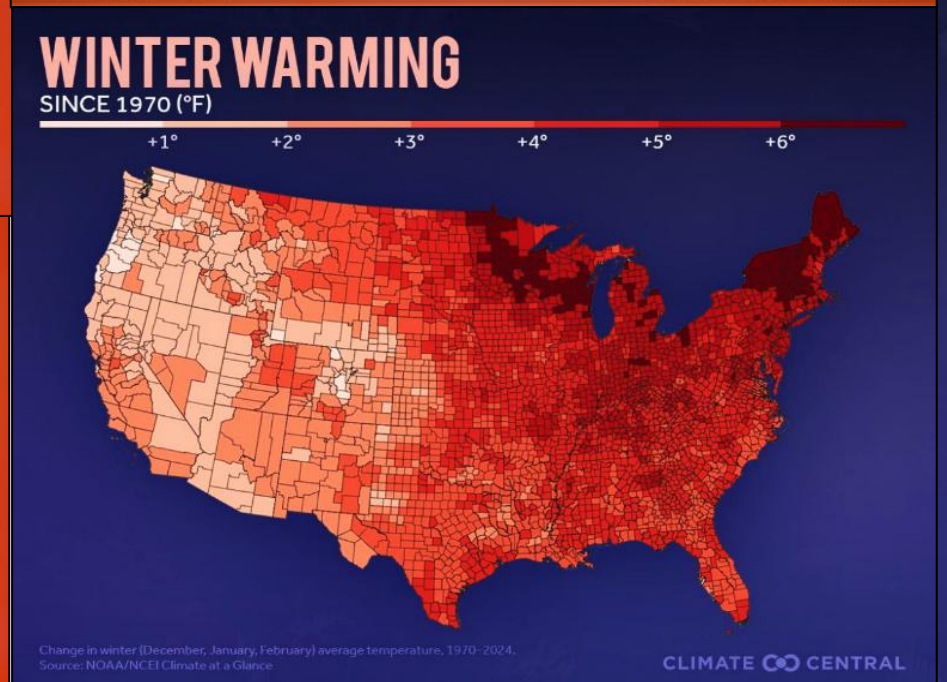
Summers are heating up in 234 of major US cities by an average of 2.6°F since 1970.

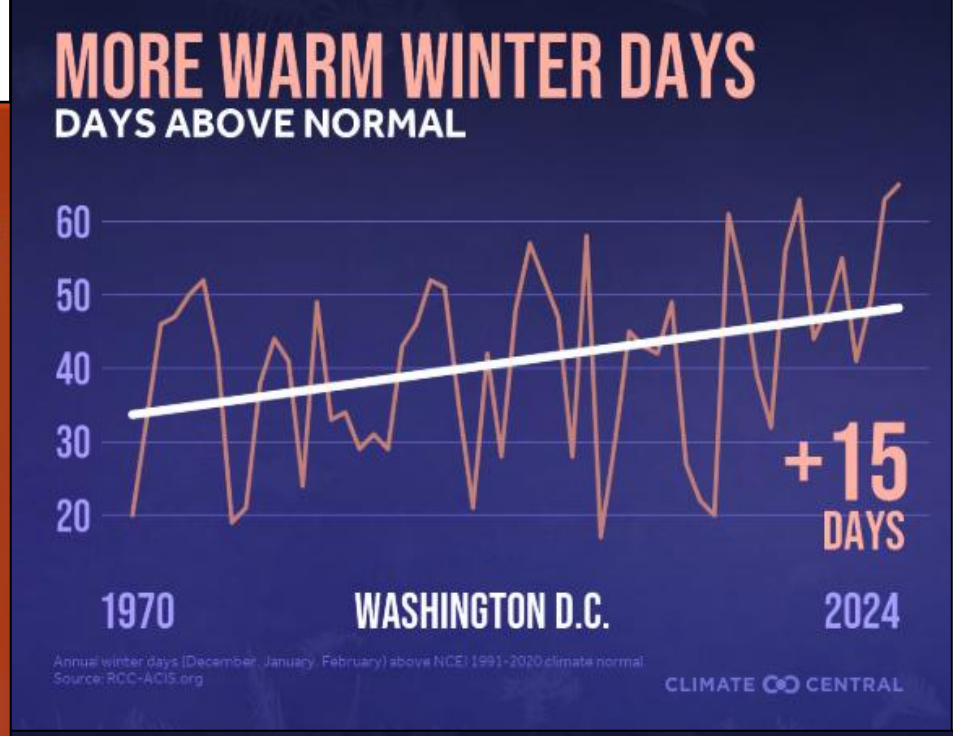
Analysis also shows persisting warmer-than-normal summer nights since 1970 in 246 major US cities.

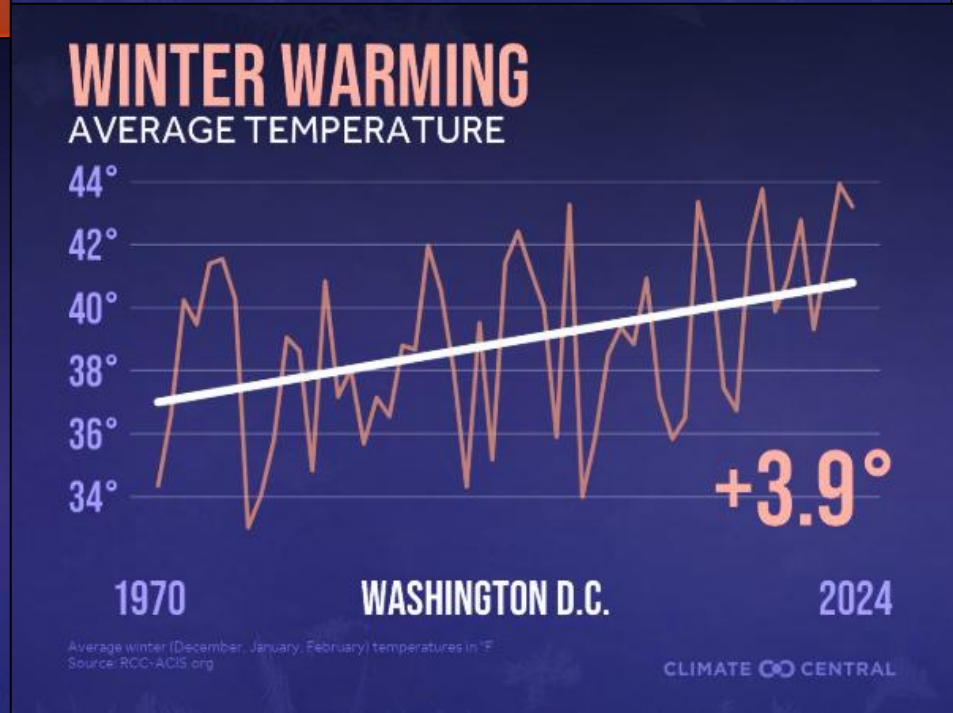












Uneven Snow ~ Avalanche Risk

An uneven snowpack significantly increases the risk of avalanches because different snow densities across a slope can create weak layers, making it more likely for a "slab" of snow to break off and slide down when triggered by weight or movement.

- New and old snow alike can be battered by the wind into ever smaller and smaller pieces, until they look and behave more like tiny grains of sand than the original snowflake that fell from the sky.
- At the larger scale, massive amounts of snow can be moved by the wind, resulting in distribution patterns that vary throughout the landscape.

Atmospheric shifts towards greater rates of warming is linked to the increase in wet snow avalanches in the Western Himalayas.

- Melt/freeze layers form when water molecules transition between solid and liquid. When rain falls on snow, or warm air temperatures and/or strong sun bring the snow surface up to 32oF, the snow will end up with some liquid water present.
- Usually in winter this water will stay near the surface and refreeze to form a melt-freeze crust, or percolate and refreeze deeper in the snowpack.
- Any of these melt-freeze layers are weak when wet but strong when frozen.

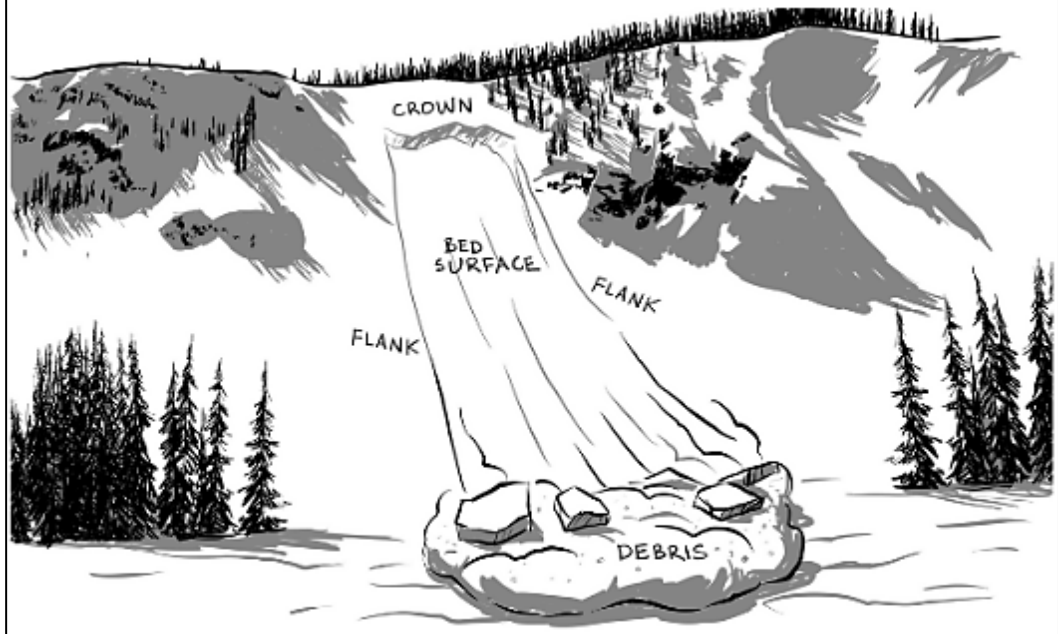
Snow algae blooms are worsening due to warmer winters, and this can lead to more snow and ice melt. now algae can be found in the Sierra Nevada of California, where it can cause snow to appear red, orange, green, or grey.

- Snow algae were prevalent in the early summers of 1993 and 1994. Significant negative correlations were found between snow albedo and algal cell numbers.

Wildfire Smoke: tree loss impacts the landing of snow and evaporative capabilities of the wind/sun but the push of ash into the mountains deposits metals and minerals that can darken the albedo of the region and increase warming trends further amplifying the uneven snowpack and risks of premature losses and avalanche threats.

Avalanche Type is a way to categorize avalanches that display similar characteristics because they result from similar snowpack structures. Different avalanche types behave differently, and deserve different safety margins and group management techniques. Primary avalanche types are Loose Snow and Slab avalanches.

Loose Snow avalanches are the release of weak snow at the surface. They start at a trigger point and entrain more snow as they move downhill, forming a fan-shaped avalanche.



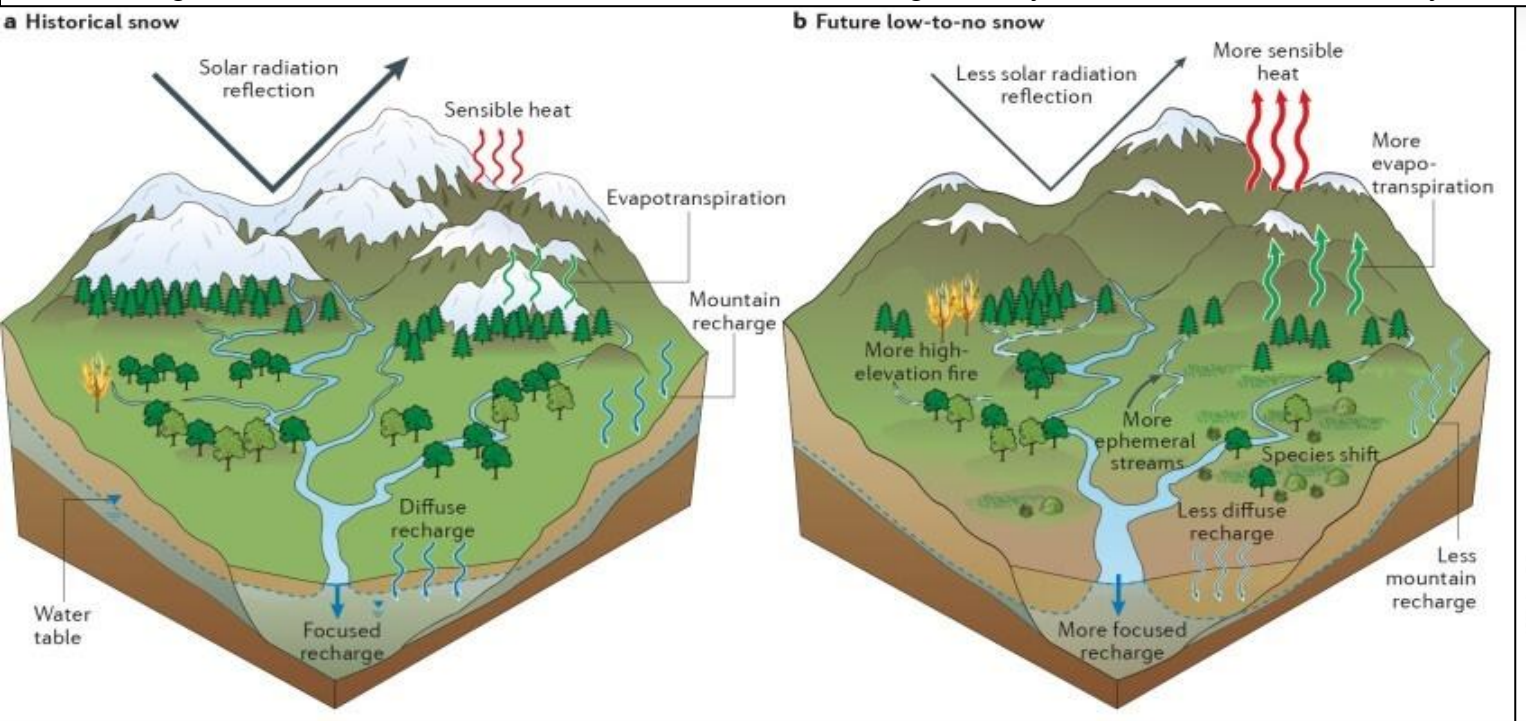
Slab avalanches are the release of a cohesive layer of snow, or slab, with a weak layer below it. The weak layer collapses, which quickly travels, or "propagates," from the initial trigger point.

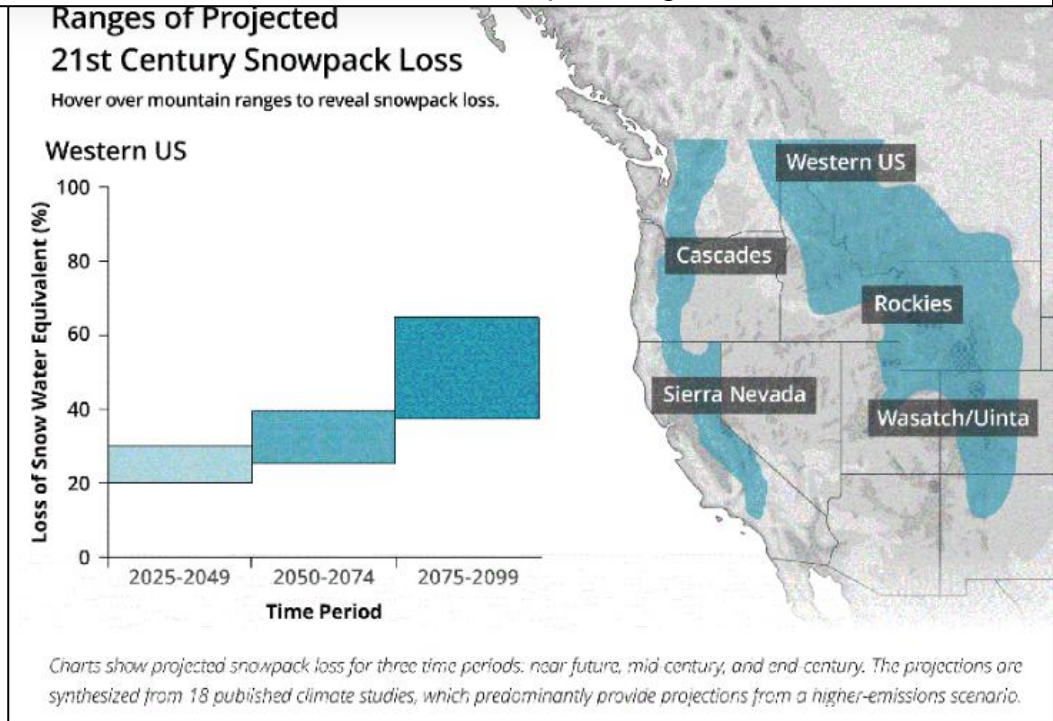
National Snowpack Shifts from Warming

A recent study highlighted that there has been a 21% decline in the April 1st snowpack water storage in the western U.S. since the 1950s – which is equivalent to Lake Mead's storage capacity. Reports of changes across the Western US may provide early notice to the Eastern US mountains and the stability of the snowpacks across the US.

- There have been decreases in peak snowpack volume and earlier occurrences across the West, with the peak occurring approximately 8 days earlier in the year for every 1.8F of warming. There is a correlating shift in premature blooming for plants and double-bloom capabilities in some regions straining soil nutrients and water storage in shallow aquifers.
    - The peak annual *snowpack in the Cascades could decrease by 25% in the next 30-60 years* according to the study.
    - California could experience episodic low-to-no snow beginning in the late 2040s and low-to-no snow in the 2060s.
        - This could cause cascading snow loss into Central US as the storms crossing the West will pick up warmer, drier air from the darker albedo associated with exposed vegetation and landscapes versus what had historical coverage of snow and cold air damming in the valleys.
- For other parts of the western U.S. persistent low-to-no snow emerges in the 2070s which extends across the Rocky Mountains. This will result in more precipitation falling as rain versus snow, changing the way the rivers and reservoirs operate and amplifying concerns of avalanches over the next 45 years as short bursts of precipitation prevail.

Earlier onset snowpack melt can amplify drought and fire threats as runoff throughout the winter can grow short brush which dries out quickly and reduces riverway storage through ahead of agricultural assessments of water levels for distributing industry water needs. Lower river systems can warm at faster rates further compounding the issue.





Charts show projected snowpack loss for three time periods: near future, mid century, and end century. The projections are synthesized from 18 published climate studies, which predominantly provide projections from a higher-emissions scenario.

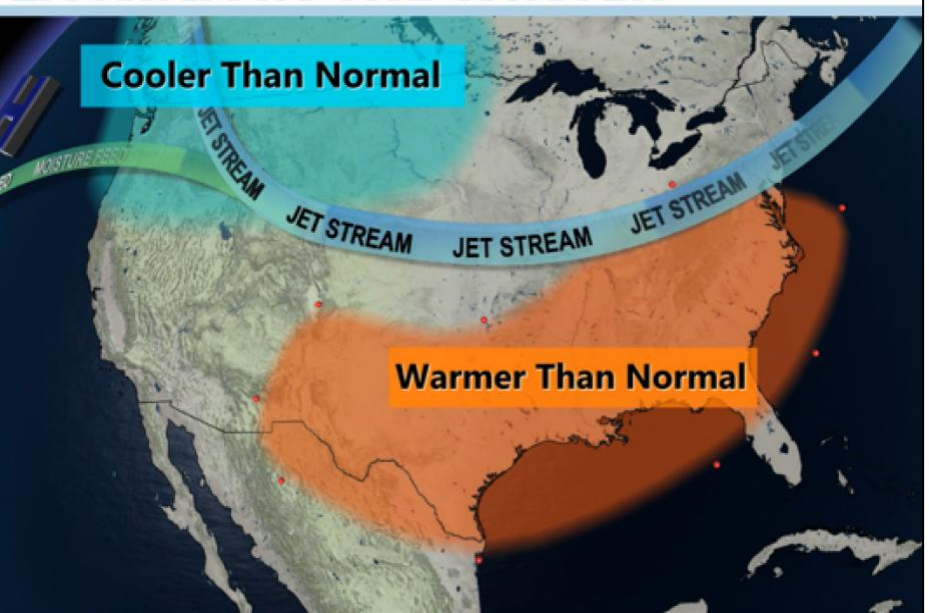
Winter Snowfall Outlooks

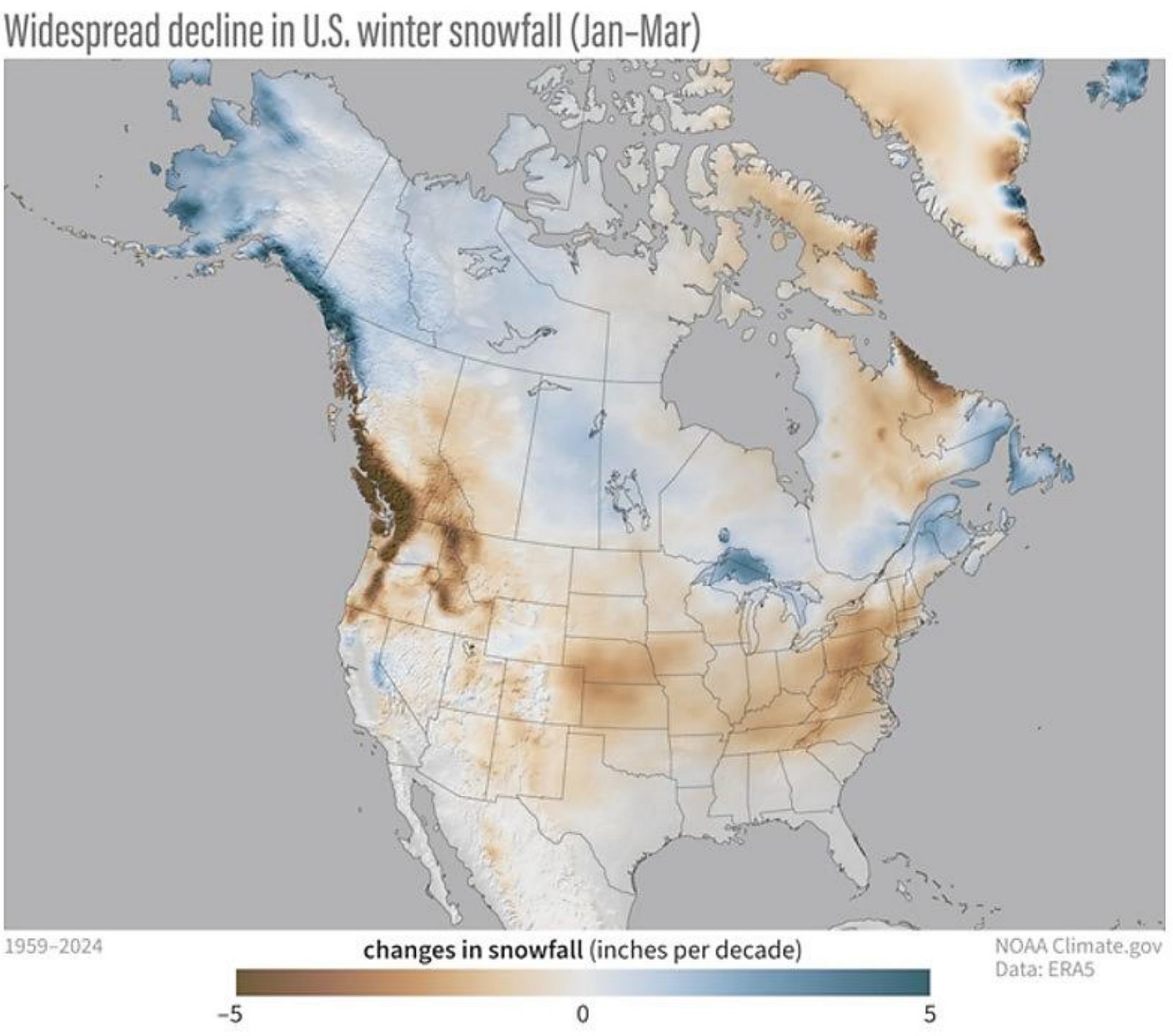
Across many regions, winter is the fastest-warming season.

NOAA's anticipated odds of La Niña peak during a three-month stretch between October and December. Then, the agency predicted, ENSO will return to its neutral phase.

- In terms of ski conditions, La Niña tends to favor the northwestern U.S., where states like Washington, Oregon, and Idaho have, seen higher-than-average snowfall during these years.
- The opposite is true for Southern California, Arizona, and New Mexico.

Snowfall averages by ski resort and last year (La Niña) are provided HERE





Warm Summer Nights

Since 1970, average summer minimum (nighttime) temperatures have warmed in 231 US locations by 3.1°F on average.

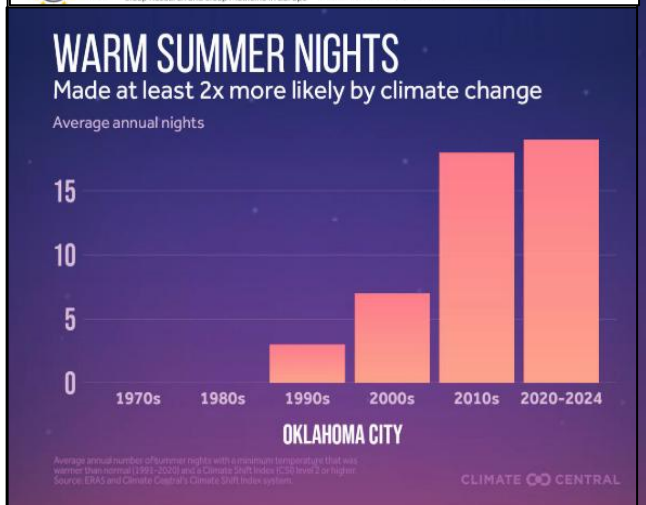
- New analysis shows that climate change is having a growing influence on the frequency of sweltering summer nights since 1970 in all but one of the 247 major U.S. cities analyzed.
- On average, these cities currently experience about 27 warmer-than-normal summer nights with a strong climate change fingerprint each year, compared to one such day annually during the 1970s.
- The top five cities with the largest increases in climate change-fueled warm summer nights are all in Florida.
- Hot summer nights limit our ability to cool off and recover from extremely hot summer days. This can lead to greater heat stress and related health risks.

When nights don't cool off enough relative to peak daytime temperatures, people have a harder time cooling off.

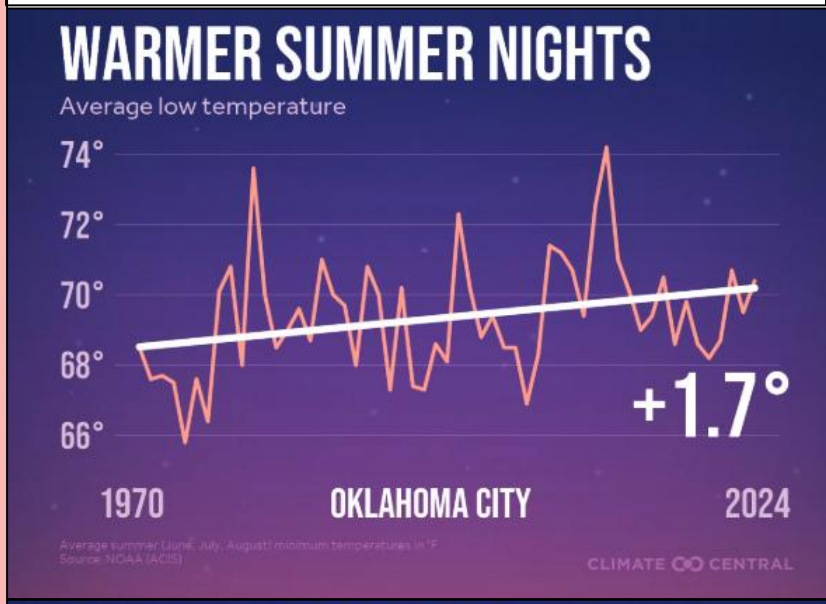
- Heat is the deadliest weather-related hazard in the U.S., and warm nights can worsen heat stress and related health risks during the hottest time of year.
- Summer nights have warmed the most since 1970 in the Southwest, where summer nights have warmed by 4.5°F on average across 11 locations.

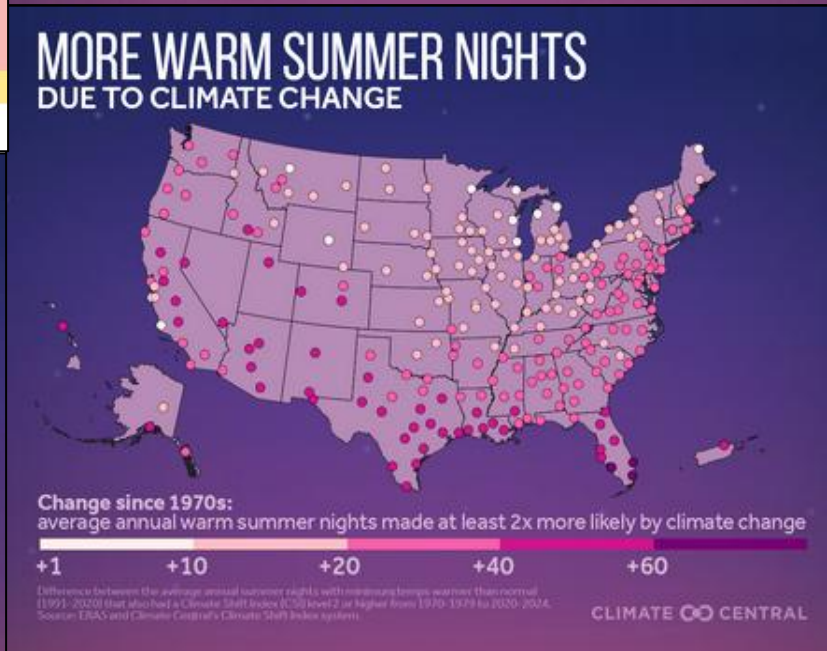
Sleepless Nights, a 2024 report from Climate Central, quantifies the influence of human-caused climate change on the frequency of hot summer nights globally.

More warm nights also mean higher demand for air conditioning.



Abnormally high temperatures overnight present risks of wildfire threats, stressed vegetation, greater rates of evaporative demand, and increased aggression rates.





Warming Surface Water Can Cause

Harmful Algal Blooms (HABs)

E. Coli

Cholera

Amoeba's

Harmful algal blooms release toxins that contaminate drinking water, causing illnesses for animals and humans.

- Natural reservoirs without wastewater treatment can cause mats of HABs and present a threat to anything consuming the water directly. Wildfire smoke can increase the risk of premature birth rates, birth defects, or low birth weight.

Bacteria are common single-celled organisms and are a natural component of lakes, rivers, and streams.

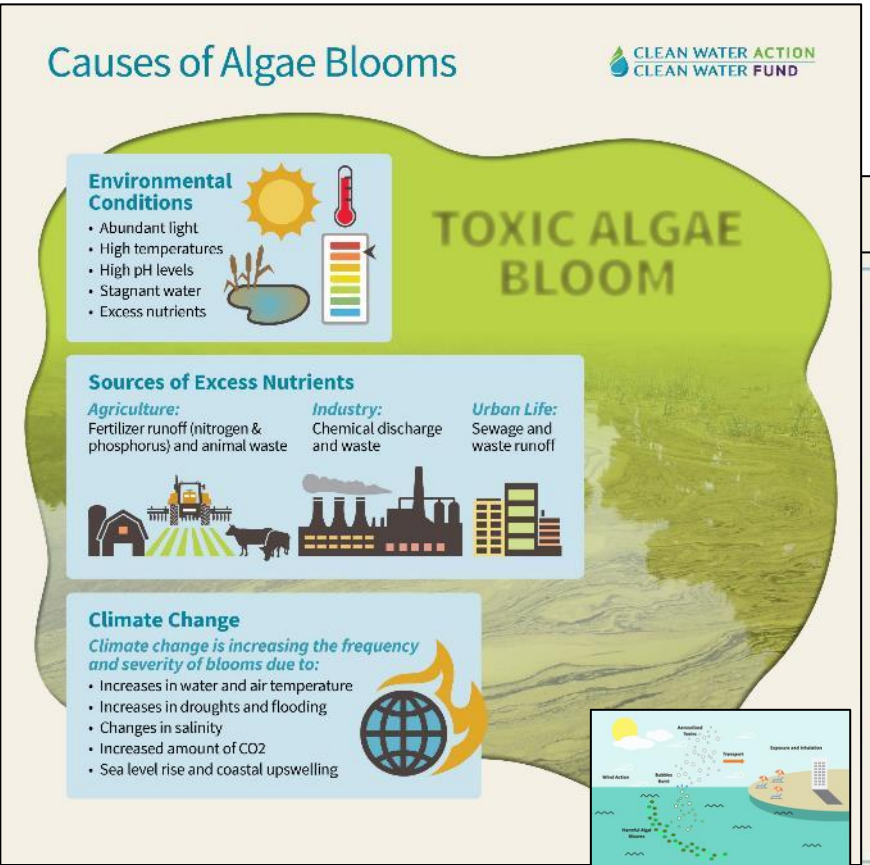
- Escherichia coli (aka E. coli) are bacteria found in the environment, foods, and intestines of people and animals. E. coli are a large and diverse group of bacteria.

Cholera is an acute diarrheal illness caused by infection of the intestine with Vibrio cholerae bacteria.

- People can get sick when they swallow food or water contaminated with cholera bacteria. The infection is often mild or without symptoms but can sometimes be severe and life-threatening.

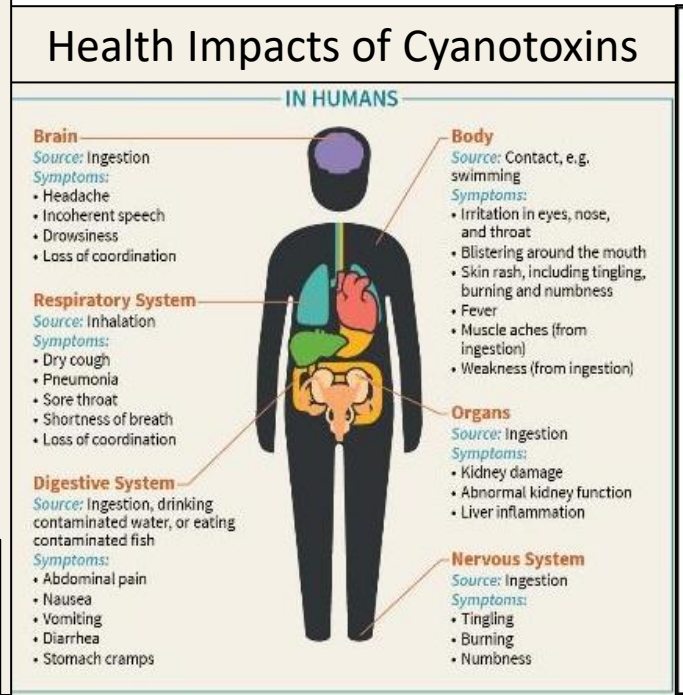
Amoeba named *Naegleria* is a single-celled living organism commonly found in warm freshwater (lakes, rivers, etc.) and soil. Only one type of *Naegleria* infects people: *Naegleria fowleri*.

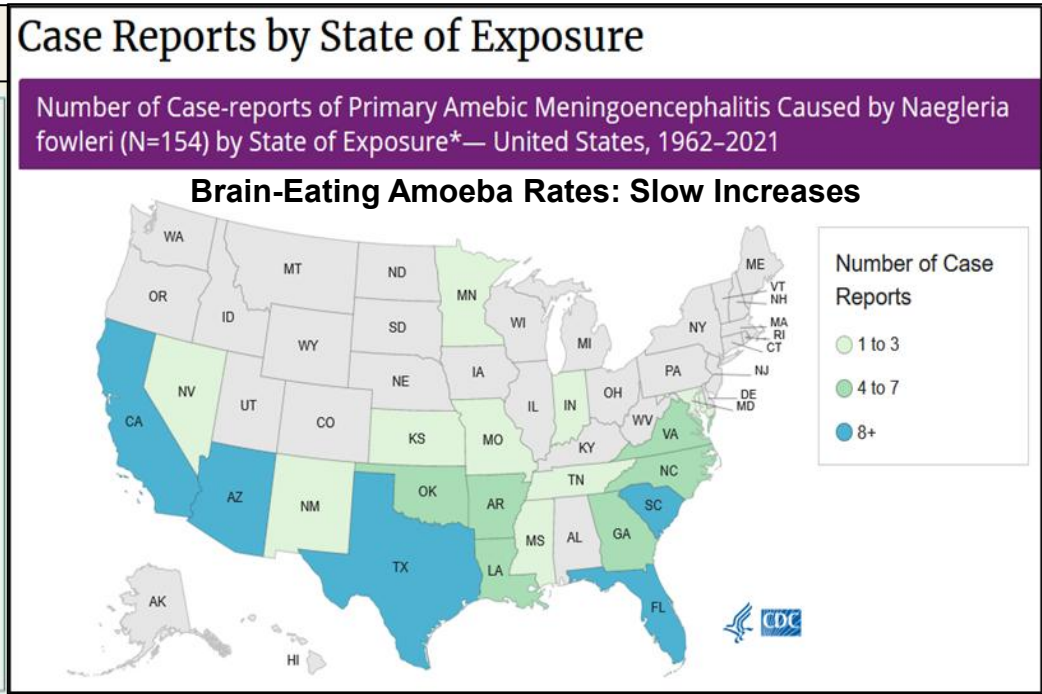
- In the US, most infections have been caused by *this amoeba* come from freshwater located in southern-tier states.



Harmful algal blooms (HABs) occur when algae — simple photosynthetic organisms that live in the sea and freshwater — grow out of control while producing toxic or harmful effects on people, fish, shellfish, marine mammals, and birds.

Warming Waters, Changes in Salinity, Additional Fuels (Carbon Dioxide), Higher Rainfall Rates and Excessive Runoff, Sea Level Rise Increasing Coastal Waters, and Coastal Upwelling can all play a role in HAB movements.





Severe Weather on the Rise

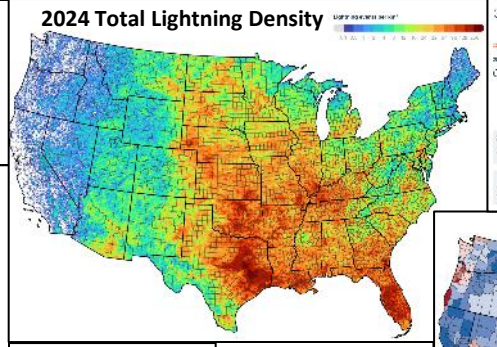
Hail events throughout the US are forecasted to intensify regarding size of the hailstones as warmer seasons across multiple regions can enable stronger updrafts for supercell storms responsible for large hail especially across less hardened areas.

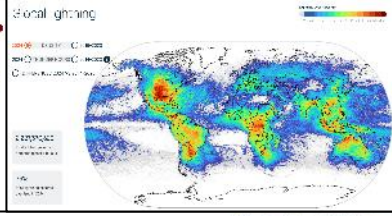
Insured U.S. hail losses average $8 billion - $14 billion per year, or $80-140 billion per decade.

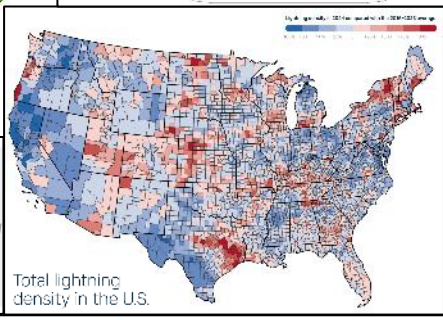
A new study published by the National Center for Atmospheric Research finds there has been "a fivefold increase in the area affected by straight-line winds since the early 1980s" in the central U.S. Straight-line winds are often produced by thunderstorms and can impacts like that of a tornado. These winds have increased at a rate of 13% per degree of warming.

Tornado activity from 2008-2021 in comparison with 1991-2010 indicates the seasonal frequency has remained the same but the location and intensity of tornadic supercells has expanded from "Tornado Alley" to "Dixie Alley" producing larger, longer supercells. Dixie Alley includes Eastern TX, AR, LA, TN, KY, MS, AL, GA, South MO, Southeast OK, and the FL panhandle.

A recent study predicts a nationwide 6.6% increase in supercells and a 25.8% expansion in the area and time supercells remain over land by the year 2100. This may result in areas which do not often see tornadic activity reporting an increase in events too.





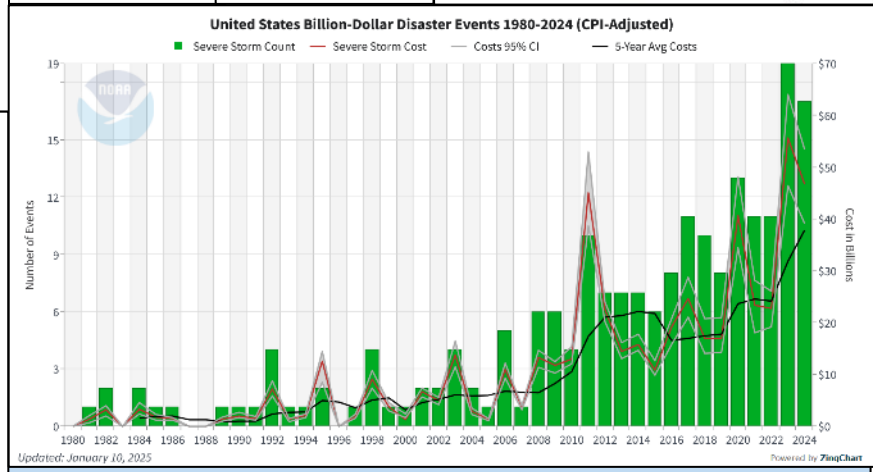


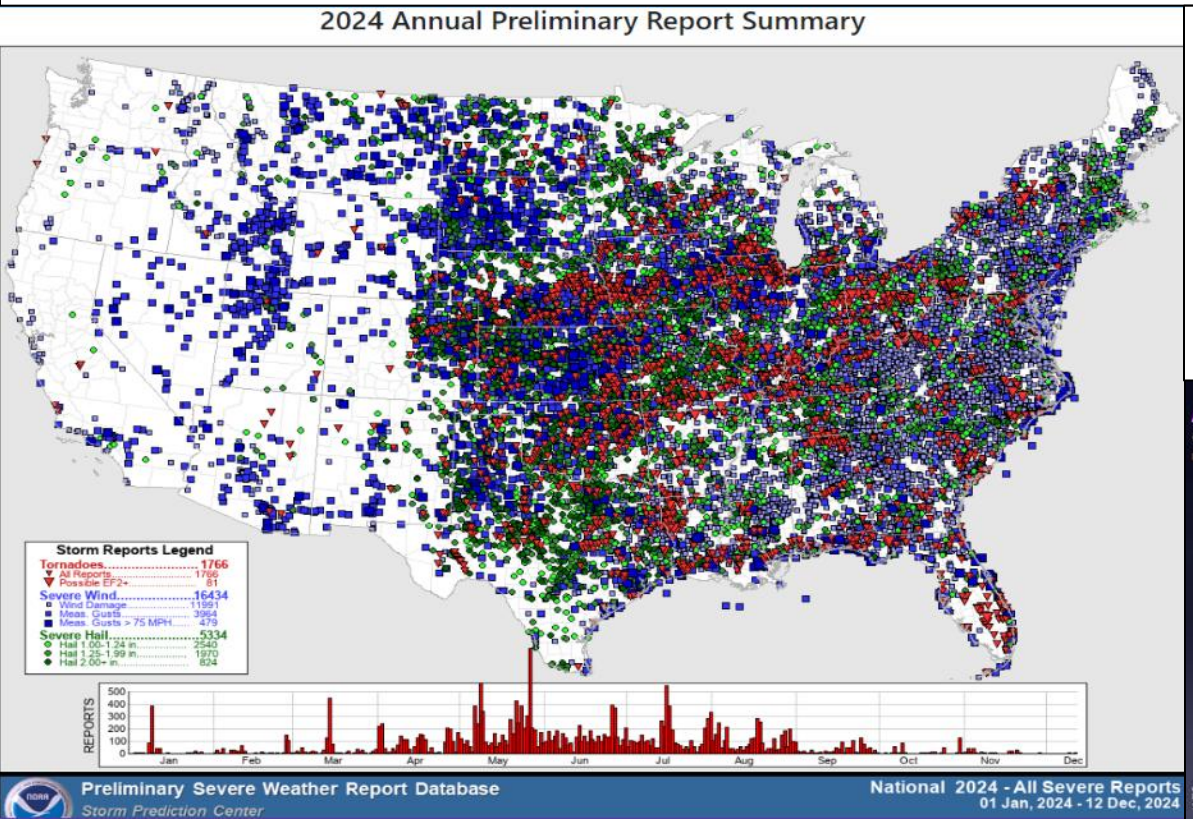
#1 by count

Polk County, Florida, saw 851,938 lightning events in 2024

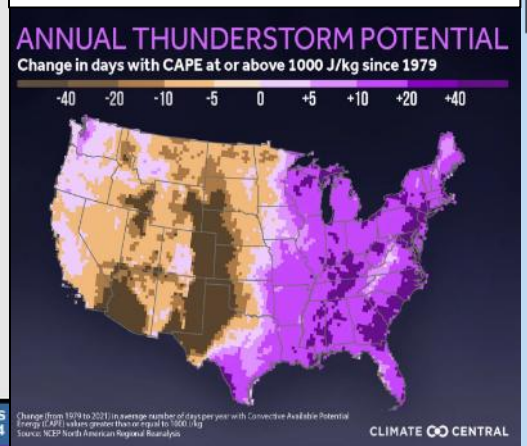
#1 by density

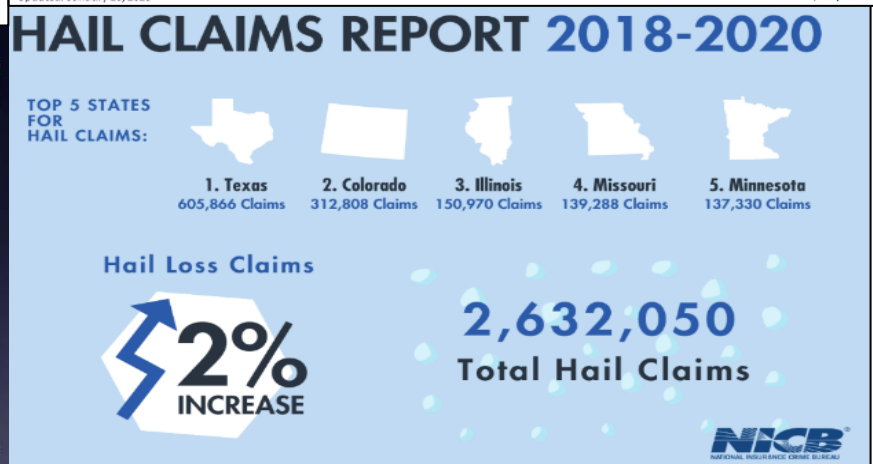
Walker County, Texas, saw 318 lightning events per km² (825 per square mile)





Over the past two years more severe weather has been reported in the way of large, damaging hail and more tornadic activity in the Spring and late Winter months reaching further north than usual. This is amplified in the higher tornado count in 2023 and multiple months in 2024 reporting 2-3x their average tornado counts placing 2024 in line with the annual average for tornado reports within the first six months.





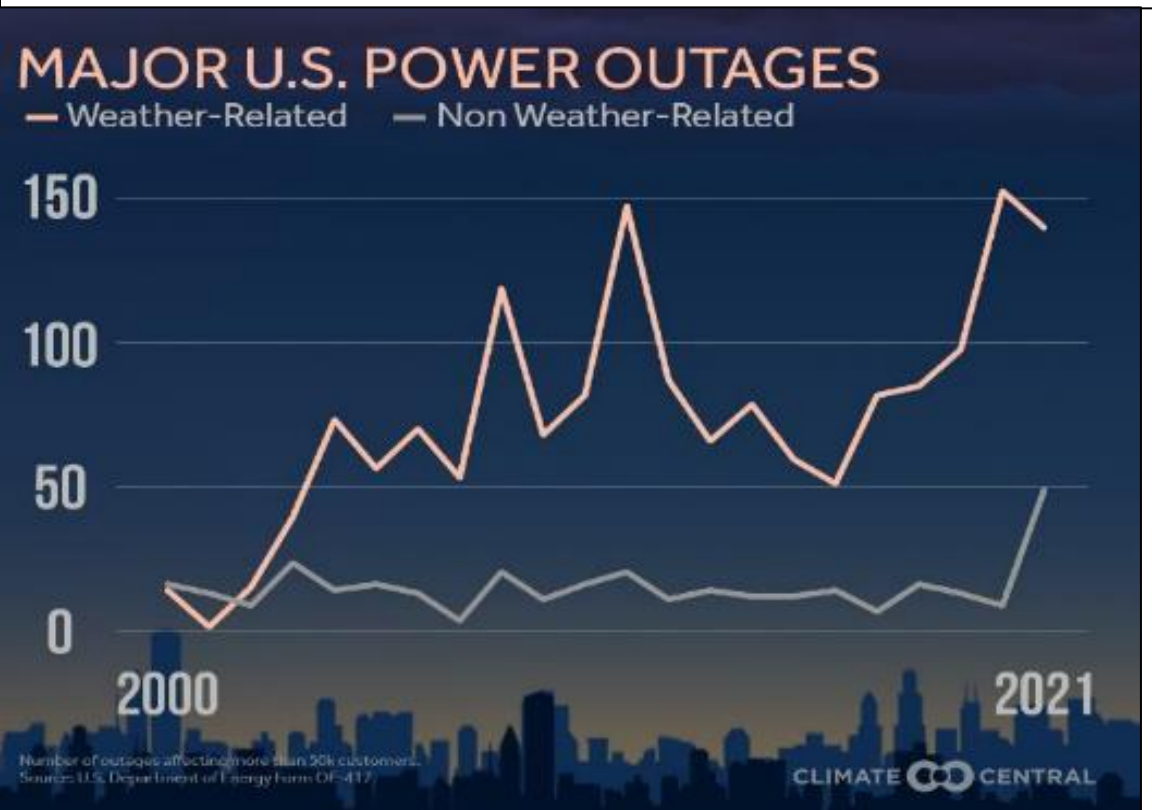
Energy Sector Losses – Ex Wx

Between 2000 and 2023, 80% of reported major outages in the U.S. were due to weather-related events. Severe hailstorms can damage renewables like wind turbines and solar power.

- The average annual number of weather-related power outages increased by roughly 78% during 2011-2021, compared to 2000-2010.
- The U.S. experienced about two times more weather-related outages during the 10 years 2014-2023 versus the first 10 years analyzed of the 2000's (2000-2009).

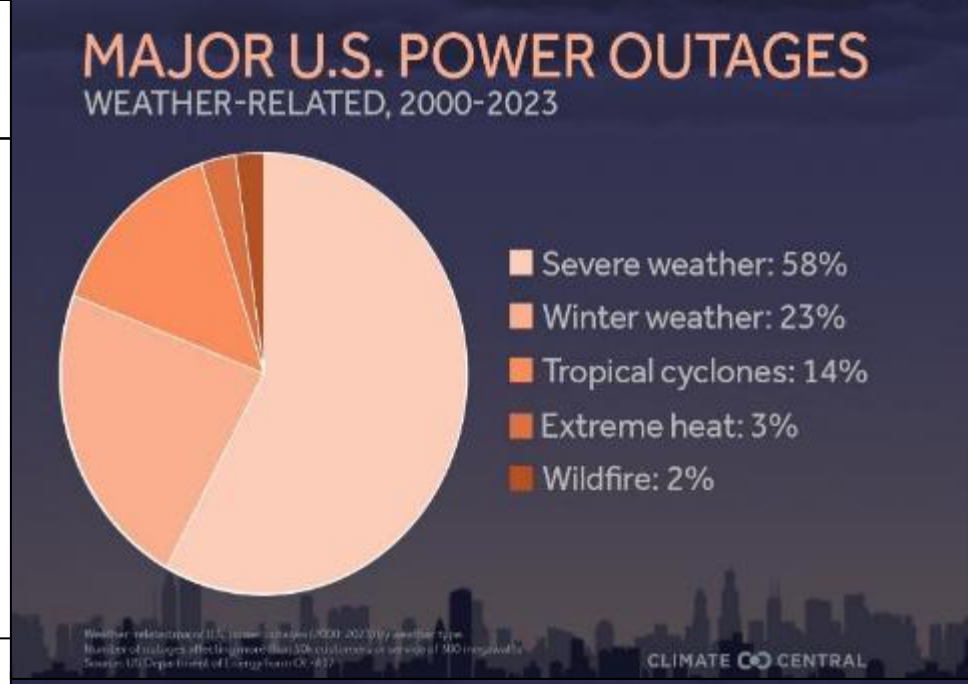
Solar panels and turbines exposed to icing, freezes, or hail may see significant output loss.

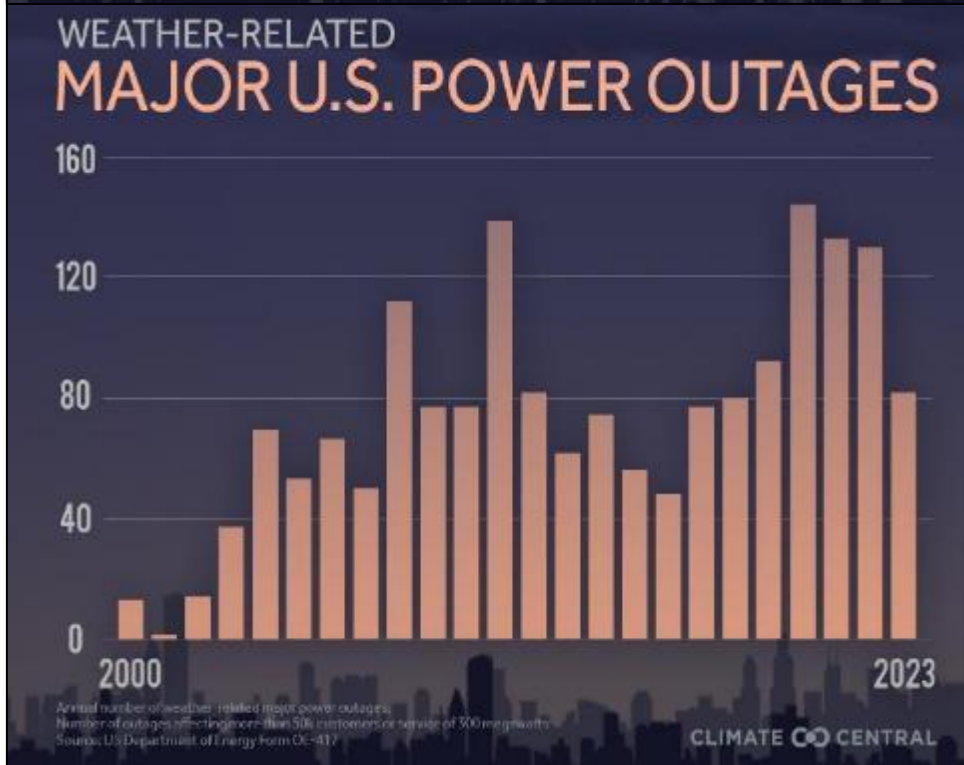
Wind turbines also face significant costs from lightning at +$100 million a year and accounts for about 60% of the blade losses. A turbine in Oklahoma has been struck 111 times in 4 years while a quarter of all sites report at least one strike per turbine per year.



The Southeast (360), South (352), Northeast (350), and Ohio Valley (301) experienced the most weather-related outages from 2000 to 2023.

Most outages were caused by severe weather (58%), winter weather (23%), and tropical cyclones (14%). These events are all likely to increase in damages caused and duration of outages to rise.





Hail Records Continue to Rise

2010: A hailstone was discovered in South Dakota measuring 8.0 inches in diameter, 18.625 inches in circumference, and weighing 1.94 pounds.

2016/2022/2024 Colorado reports 2-feet of hail requiring plow trucks to move and triggering flooding as the ice melted quickly at the surface.

2023-2025: Multiple states report melon-size hail (+6-inch diameter).

2025: Texas's new record hailstone reported at 7.25-inch diameter.

Pollution can influence hail formation and potentially lead to larger hailstones.

Pollutants provide cloud condensation nuclei, affecting the size and number of stones.

Hail severity will increase in most regions of the world while Australia and Europe are expected to experience more hailstorms.

Insured U.S. hail losses now average $8 billion to $14 billion per year, or $80-140 billion per decade (as of 2022).

This outpaces the total of $14.1 billion in insured US property loss from tornadoes over the decade from 2010 to 2020.

TEXAS Record MONSTER Hailstone!

Documented 7.25" hailstone 3 miles WNW of Vigo Park, Texas at 7:37pm Sunday set a new state record (pending) shattering the previous record of 6.4" in Hondo, TX in 2021.

Permission: Val and Amy Castor 7:25 PM · Jun 4, 2024

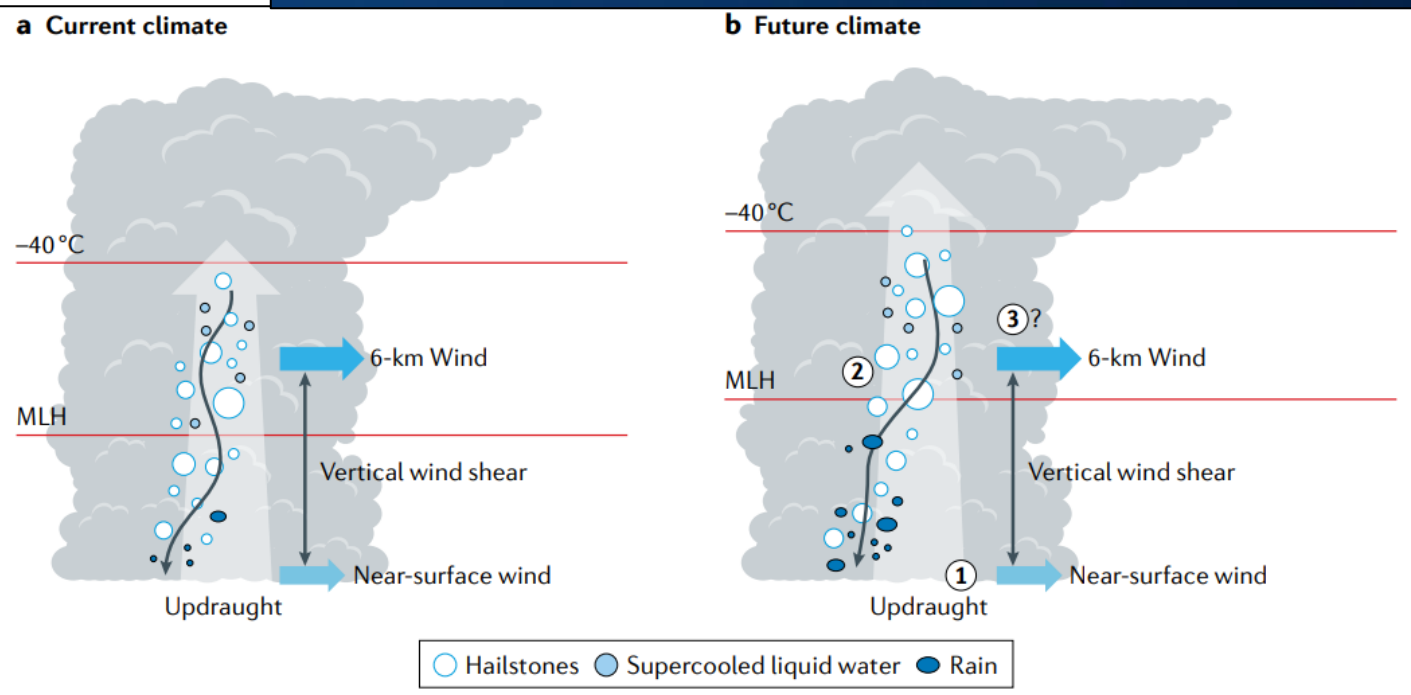


Fig. 1 | **Hail-relevant atmospheric phenomena in current and future climates.** The expected changes in hail-relevant atmospheric phenomena between the current (panel **a**) and future (panel **b**) climates. The numbers in panel **b** correspond to the following changes: (1) increased low-level moisture leads to increased convective instability and updraught strength; (2) an increase in the melting level height (MLH) leads to enhanced melting of hailstones and a shift in the distribution of hailstone sizes towards larger hailstones; and (3) changes in vertical wind shear may affect storm structure and hailstone trajectories, but are generally overshadowed by instability changes.

Concrete: In high heat environments over 80°F, concrete should not be poured, or it will not set effectively. This can increase setting time from 2-3 days up to 7 days in hot weather.

- Thermal cracking is found particularly in thick slabs, or mass concrete, where the temperature differential between different areas of the concrete is too high. (Examples: airport aprons, bridge headsticks, and highways where repaving needs have been increasing.

City Landscapes: Park benches in direct sunlight during summer months can easily reach temperatures of 125°F when ambient air is around 82-83°F.

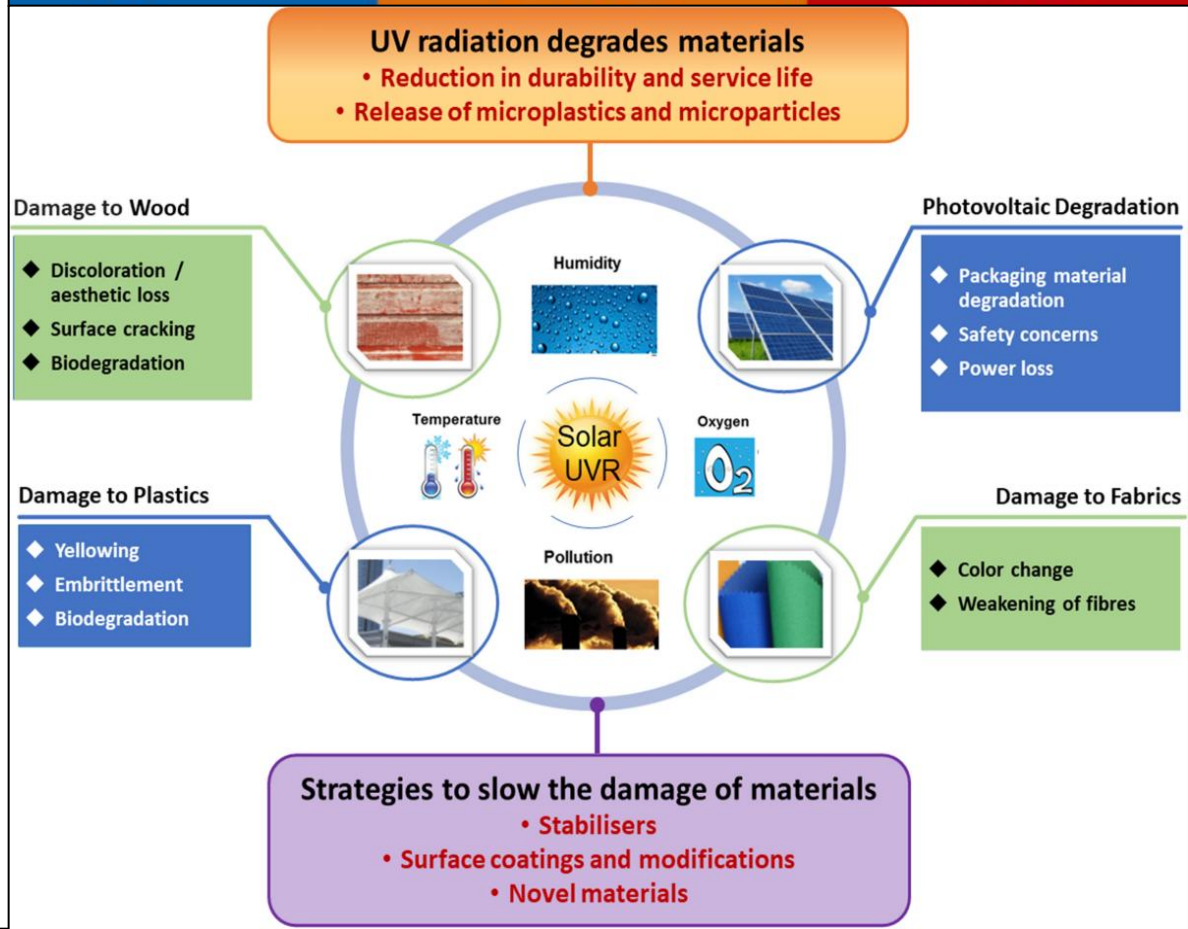
- Metal benches can reach 136°F with coated benches still exceeding 108°F.
- Marble benches comparable can range up to 105°F while limestone can reach 116 degrees in sunlight. Shade often drops these temperature by 16-18°F.
    - Water fountains can reach 95°F, bus stop signs/posts can reach 105°F, bicycles can range to 104°F for seats, 102°F for handles, and crosswalk buttons near 98°F.

Epoxy: Most heat-resistant epoxies need to be cured at temperatures at or beyond the temperature it will need to endure. If temperatures exceed these maximum service temperatures, the material could start to distort. At a temperature of 135°F or higher, the epoxy may begin to exhibit heat damage.

- Epoxy faces the same concerns of needing a few days to cure but in persistent high heat/humidity levels it could take up to two weeks.
    - If Epoxy cures in too high of a temperature it can become too solid, resulting in less give during temperature swings and may crack.

Metals: Extreme heat causes various metals to expand in addition to impacting the structure, electrical resistance, and magnetism. When metal heats, the bonds begin to break.

- Bridges in New York, Sacramento, and London have faced thermal expansion or cracking– 95°F in New York, 103°F in Sacramento, and 65°F in London.



Radiative Heat Threats: Cities + Canals

In the 1980s, concurrent heat waves only occurred for 20-30 days each summer. Recent warming has driven a sixfold increase in the frequency of simultaneous heat waves over the last 40 years. The study also found that concurrent heat waves covered about 46% more space and reached maximum intensities that were 17% higher than 40 years ago.

Concrete is a great material for absorbing and storing heat from the sun, meaning it can warm to higher temperatures then most other materials and releases that heat more slowly as direct heating stops. On a hot summer day, concrete that's in the shade can easily average 70°F, however, concrete that's in direct sunlight can reach 135°F. Due to the higher temperature, these mixtures are at risk of expansion-triggered water incursion, weakening the structural integrity of various sites and foundations.

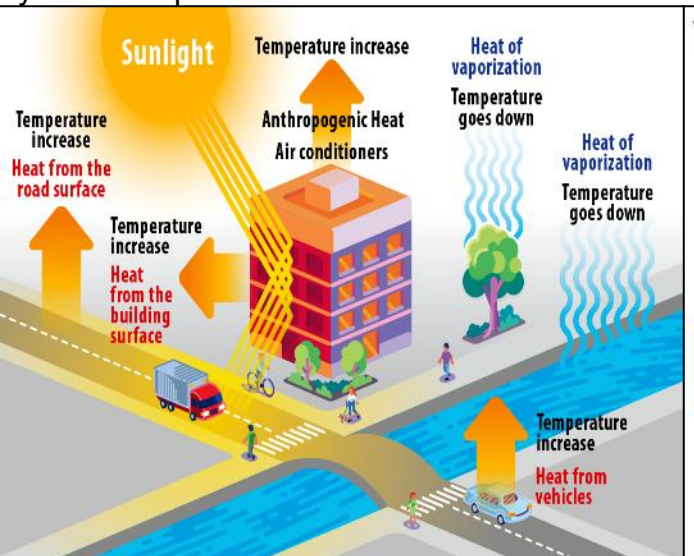
- Grass rarely exceeds 80°F, wood peaks around 90°F, composite decking about 100°F, but concrete can reach a hotter temperature and hold onto that heat longer. In cities, the developed areas of cityscapes may have cooler temperatures due to additions of vegetation and shading, creating significant heat disparities.
- Heat islands form because of reduced natural landscapes in urban areas and increases in heat-retentive materials. Trees, vegetation, and water bodies tend to cool the air by providing shade, transpiring water from plant leaves, and evaporating surface water, respectively.

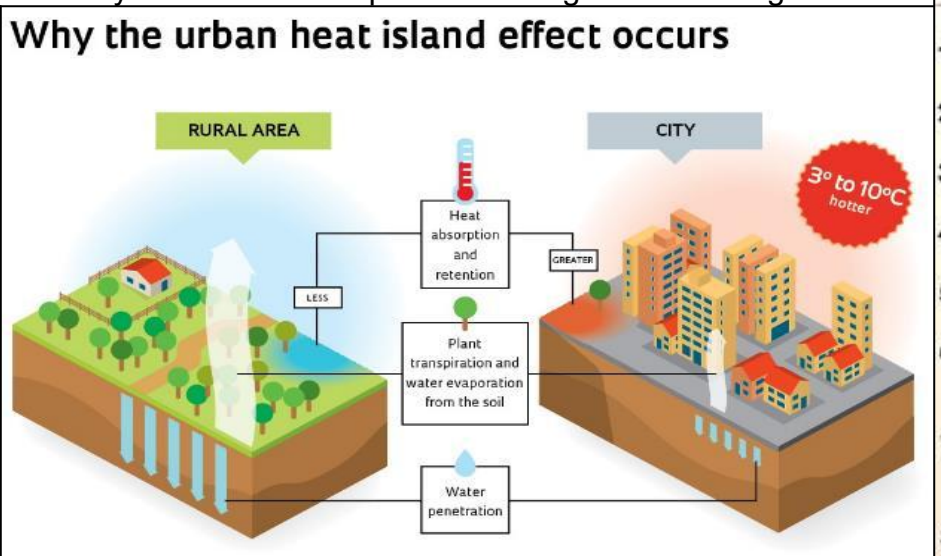
Metal benches, grates, and shopping carts can exceed temperatures of 120°F resulting in burn potential for unhoused populations especially. Without cooling centers staying open overnight, at-risk populations are purged back into an abnormally warm city where pollution concentrations remain high due to the lingering heat.

- The more densely packed a metro car is or a bus is, the greater the ambient temperature will become making it more difficult to cool down between stops.

When asphalt heats it becomes more malleable, making it soft and able to compress under weight and become disformed. High heat also rapidly ages the material, making infrastructure on or near it weaker.

At the current rate of heating, the expansion buffer will not stop the material from buckling more often. This will yield more potholes and lower income communities may not be able to repair at the heightened damage rate.





SURFACE TEMPERATURES

	3/4/22 10:30am	6/21/22 10:30am	6/21/22 3:30pm
AIR TEMPERATURE	52°	84°	104°
1. Concrete (sidewalk)	58°- 61.5°	110°	142°
2. Asphalt (street)	62°- 64°	125°	155°
3. Plants	65°	89°- 91°	105- 115°
4. Turf (grass)	69°- 71°	93.5°	99.5°
5. Bare Dirt	78°	119°	159°
6. Mulch	81°	120°	154°
6a. Soil under mulch		96°	110°
7. Gravel (stones)	82° large 90° small	122° lg. 129° sm.	140° 149°
8. Artificial Turf	90.5°- 93°	143.5°	165°

Flooding Changes: Flashier Flash Floods

Floods are the most common natural disaster in the US and about 41 million U.S. residents are at risk from flooding along rivers and streams.

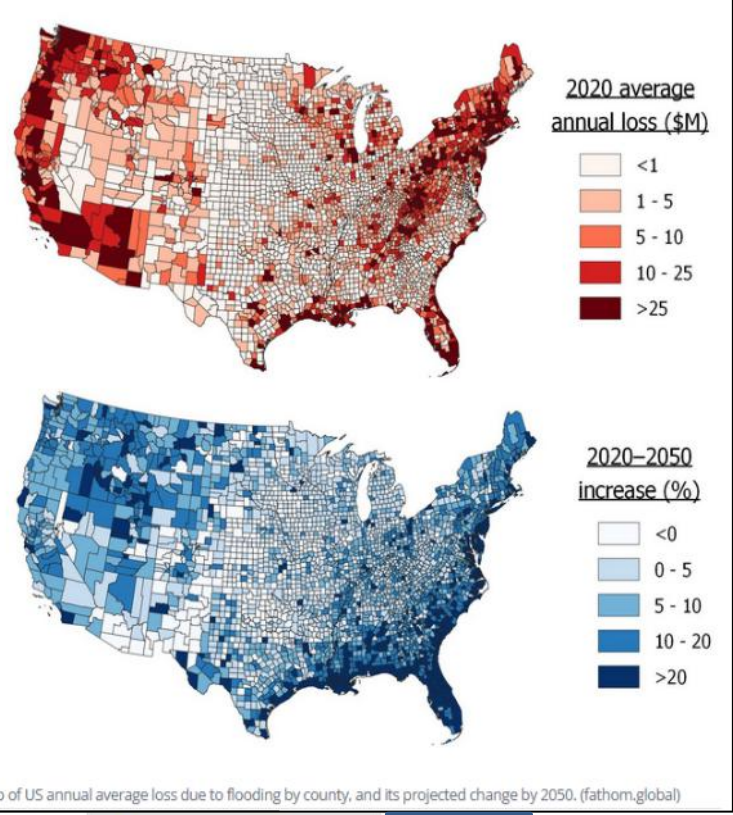
- River flooding can result from heavy rainfall, rapid snow melt, or ice jams thawing resulting in riverbank damages.
- Urban flooding refers to flooding that occurs when rainfall overwhelms the local stormwater drainage capacity of a densely populated area causing water to continue to overflow into communities and infrastructure sites.

Extreme flooding will continue to be concentrated in regions where humans have built on floodplains or low-lying coastal regions. As extreme weather events increase, risks will extend into new areas.

- 1,000-year flood events will occur more often due to increased land use and heavier precipitation. The term "1,000-year flood" means a flood of that magnitude (or greater) has a 1 in 1,000 chance of occurring in any given year. In 2022, the US reported five 1-in-1,000-year flood events in different states causing catastrophic damages.

New research shows as the baseline temperature annually creeps upward due to moderate to high emission rates, flooding events would become 8% "flashier" by the end of the century. This means that heavy rainfall events are likely to occur quickly and in concentrated areas that could lead to torrential flooding.

- A more than 10% increase in flash flooding in the Southwest U.S. which accounts for the greatest increase in "flashiness" among hot spots. Flooding is a factor in over 90% of disaster-related property damage in the US.
- "The 20-year return floods will more likely occur every two to five years, especially alarming for the emerging flashiness hotspots that will be facing unprecedented challenges with aging infrastructure and outdated flood risk measures" Yang Hong.. https://www.un.org/en/climatechange/reports?gclid=Cj0KCQjwjN-SBhCkARIsACsrBz6h_uH-xJnN2929g3CDEV9GZVLFEGh6KWfiNgneXUlf6d78n4Tlk24aAg3fEALw_wcB

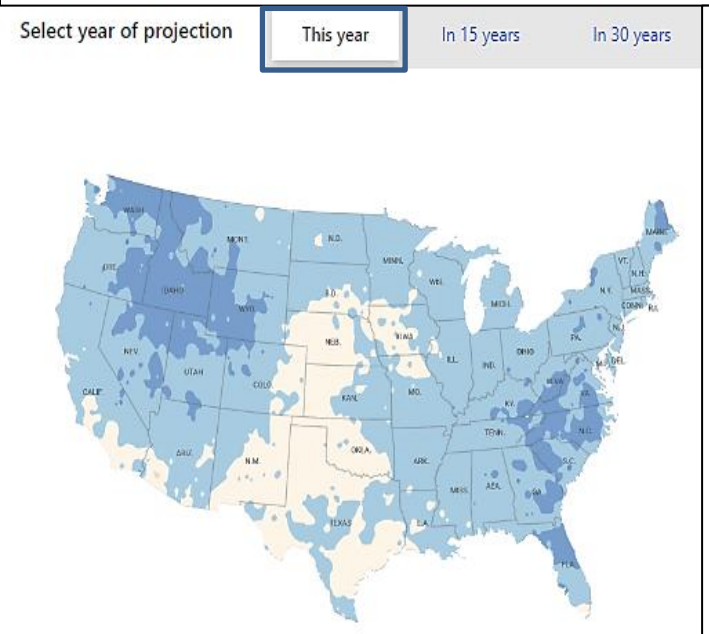


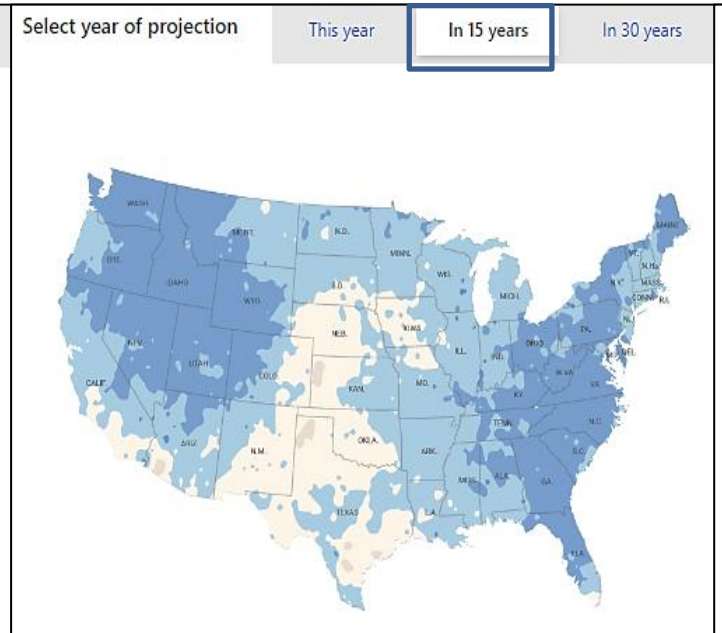
Map of US annual average loss due to flooding by county, and its projected change by 2050. (fathom.global)

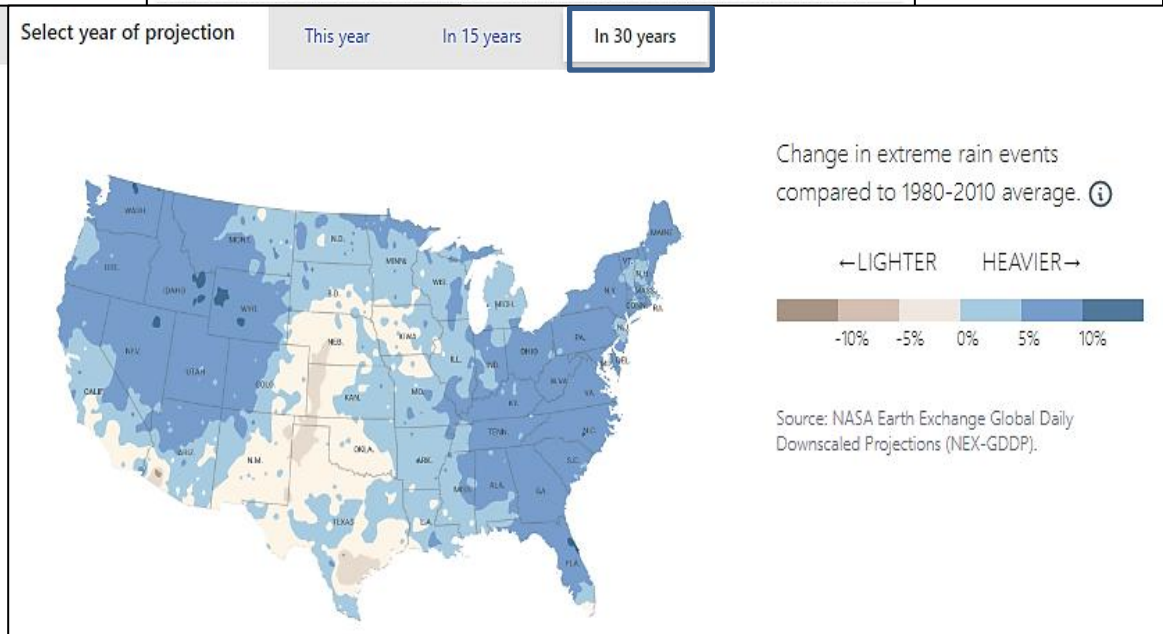
A 2021 study indicated the average annual flood losses are forecast to increase by 26% by 2050, from $32 billion to $40.6 billion, based on 2021-dollar values.

The average annual exposure of the population to floods is expected to rise 97% from current levels by 2050, to over 7 million by 2050.

A flood can impact anyone.



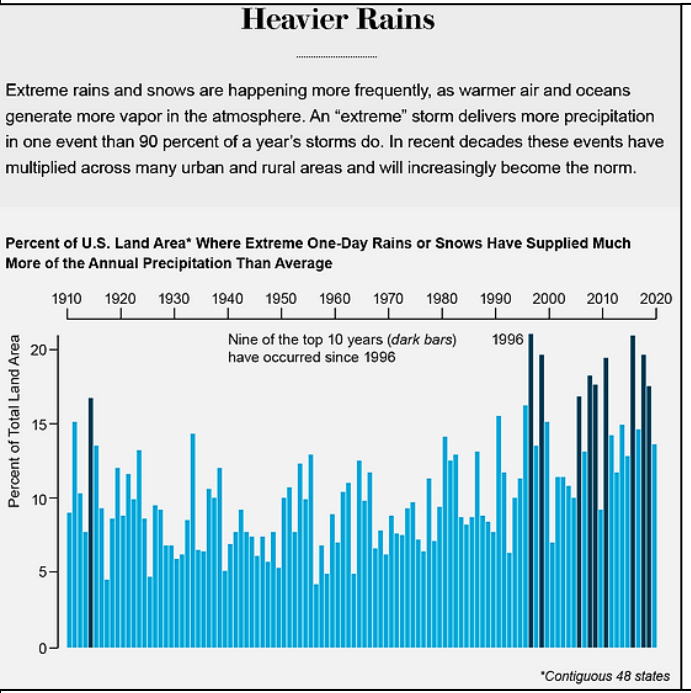




Increases in 1 Hour / 6 Hour / 24 Hour Rainfall Totals

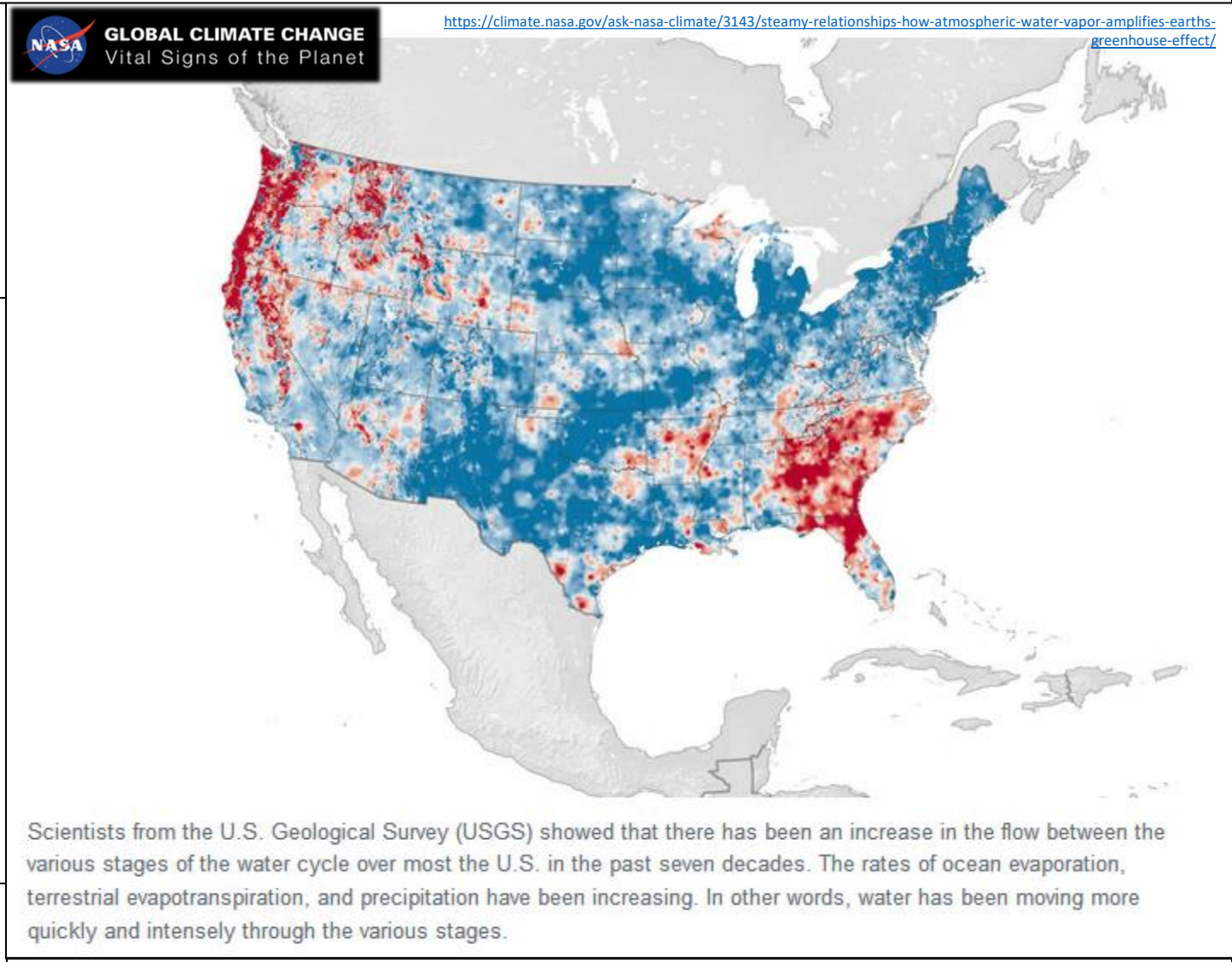
Increases in atmospheric water vapor also amplify the global water cycle. They contribute to making wet regions wetter and dry regions drier. The more water vapor that air contains, the more energy it holds. This energy fuels intense storms, particularly over land. This results in more extreme weather events (NASA).

- More evaporation from the land also dries soils out. When water from intense storms falls on hard, dry ground, it runs off into rivers and streams instead of dampening soils. This increases the risk of drought and floods.



- The average change in hourly rainfall intensity across all 150 stations from 1970 to 2021 was +13%.
- 63% (95/150) of stations had an increase in hourly rainfall intensity of +10% or more (Climate Central).
- 90% of the 150 locations analyzed now experience more average rainfall per hour than in 1970.
- A 2021 report found that one-fourth of critical infrastructure is at risk of failure by flooding.
- Nine of the top 10 years for extreme one-day precipitation events have occurred since 1996 (EPA).

The water-vapor feedback is weakest where vapor is most abundant. In humid areas, the infrared energy absorbed by water vapor is already near its physical limit, so adding some extra moisture has minimal effect. In dry places, however, such as polar regions and deserts, the amount of infrared energy absorbed is well below its potential maximum, so any added vapor will trap more heat and increase temperatures in the lower atmosphere.



This map shows where the water cycle has been intensifying or weakening across the continental U.S. from 1945-1974 to 1985-2014. Areas in blue show where the water cycle has been speeding up—moving through the various stages faster or with more volume. Red areas have seen declines in precipitation and evapotranspiration and experienced less intense or slower cycles. Larger intensity values indicate more water was cycling in that region, primarily due to increased precipitation. Credit: NASA Earth Observatory image by Lauren Dauphin, using data from Huntington, Thomas, et al. (2018).

Atmospheric River Damages

Roughly 80% of levee breaches in California's Central Valley are associated with landfalling Atmospheric rivers (UCSD - Scripps). Atmospheric rivers (or ARs) produce up to 50% of California's precipitation annually and 65% seasonally (AGU).

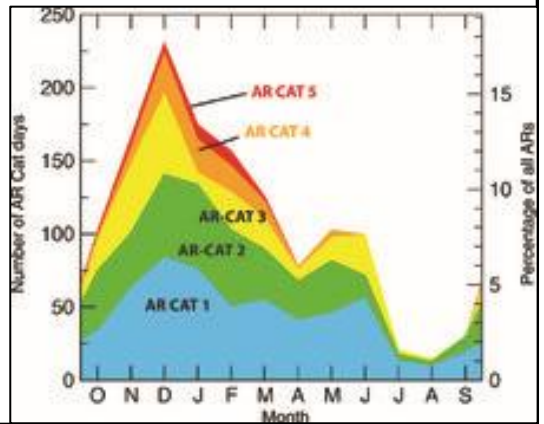
- When an atmospheric river lasts in an area for less than 24 hours, it is demoted by one category, but if it lingers for more than 48 hours, it is promoted.
- Researchers found that models predicted increased low-elevation precipitation, but less high-elevation precipitation.
- In a recent study, researchers found atmospheric heating increased the amount of rainfall from two atmospheric rivers in February 2017. Studies modeling future atmospheric rivers show rainfall will increase up to 40% more, range 15% larger in size, and last six hours longer per degree of warming.
- Previous analysis has shown that on the West Coast, the Oregon coast receives the most atmospheric rivers in the "extreme" range (Atmospheric River Cat 4), averaging about one per year. Washington receives extreme atmospheric rivers about every two years, the Bay Area about every three years and Los Angeles every 10 years.
- The strongest atmospheric river storms hitting the Southern California coast annually, typically fall in the "moderate" to "strong" range (AR Cat 2-3).

Models indicate the atmospheric rivers that are "mostly or primarily hazardous" to water resource management will increase in intensity, occur in closer succession, and drop more rainfall in a season.

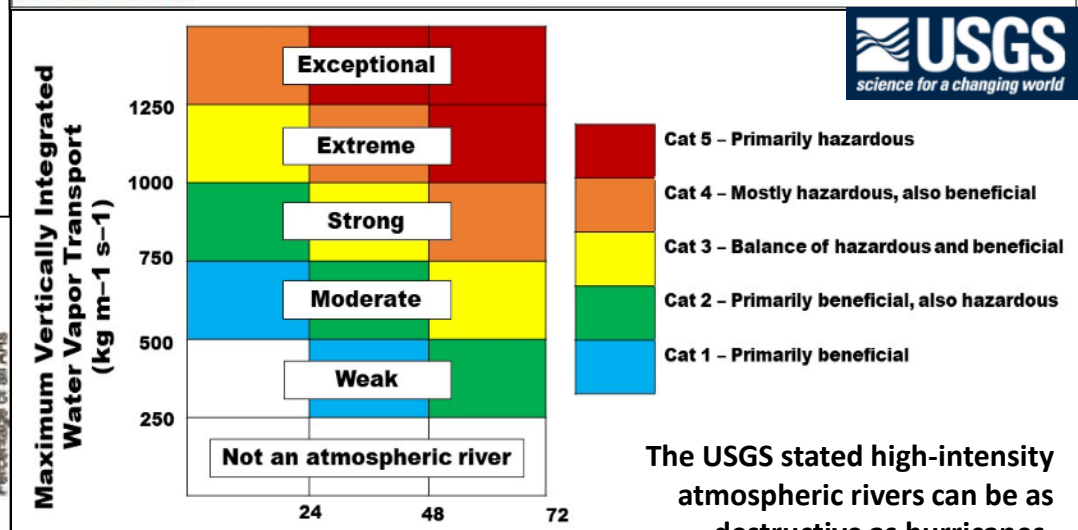
- Scientists state a series of atmospheric rivers caused the Great Flood of 1862, a megaflood that left 6,000 square miles of California's Central Valley under water.
- **Atmospheric rivers cause about $1.1 billion in flood damage annually across the western United States**

The portion of California's annual precipitation that comes from atmospheric rivers is expected to increase as the globe warms.

- A typical atmospheric river can be 300 miles wide, a mile deep and more than 1,000 miles long.
- The term "Pineapple Express" refers to Atmospheric Rivers that form in tropical regions of the Pacific, often around Hawaii.



ARs on the West Coast…	Quantitative finding	References
Cause the heaviest rains	92% of West Coast's heaviest 3-day rain events fed by ARs	Ralph and Dettinger (2012)
Bring warmest storms (less snow, more rain)	Average >50% more precipitation and 2.5°C warmer than other storms in Sierra Nevada	Dettinger (2004); Backes et al. (2015); Guan et al. (2016)
Cause West Coast floods	40%–90% of major floods in West Coast rivers have been fed by ARs	Ralph et al. (2006); Neiman et al. (2011); Konrad and Dettinger (2017)
Cause storm surges in coastal areas	15%–50% of annual sea level maxima are associated with AR-related cyclones	Khouakhi and Villarini (2016)
Yield extreme coastal winds	20%–50% of extreme coastal-wind episodes associated with ARs	Waliser and Guan (2017)
Breach levees	81% of Central Valley levee breaks happened during ARs	Florsheim and Dettinger (2015)
Cause landslides, debris flows, and avalanches	ARs cause 68% of postfire debris flows in Southern California	Oakley et al. (2017); Young et al. (2017); Hatchett et al. (2017)
Bring cycles of wet and dry years	Account for 85% of multiyear precipitation variance in California	Dettinger and Cayan (2014)
Fill reservoirs and provide water supplies	30%–50% of California rain, snow, and streamflow from ARs	Guan et al. (2010); Dettinger et al. (2011)
End West Coast droughts	40%–75% of droughts on West Coast ended by an AR	Dettinger (2013)
Sustain wetlands, floodplains, and fisheries	77% of ecologically significant inundations of Yolo Bypass floodplain, Sacramento River, initiated by ARs	Florsheim and Dettinger (2015)
Water deserts and forests far inland, modulate wildfire risks	Statistically significant relations found between summer normalized difference vegetation index (greenness) and areas burned in parts of interior Southwest	Albano et al. (2017)
Freshen estuaries but sometimes threaten estuarine fauna	Mar 2011 ARs freshened San Francisco Bay by 60%, resulting in wild oyster kill rate of 97%–100%	Cheng et al. (2016)
Modify banks and bottom sediments, modulating aquatic fauna in mountain streams	More invertebrate densities and diversity after major AR flooding; 10 times more in predisturbed settings	Herbst and Cooper (2010)



USGS science for a changing world

The USGS stated high-intensity atmospheric rivers can be as destructive as hurricanes.

https://journals.ametsoc.org/view/journals/bams/100/2/bams-d-18-0023.1.xml

BLUF: Extreme Weather Trends for Stormwater

Extreme rain can cause flooding in low-lying areas that have poor drainage and insufficient stormwater infrastructure systems.

This can cause flooding throughout the city, even for inland neighborhoods. Rain-driven flooding can occur suddenly and intensely, but flood conditions may subside more quickly compared to coastal surge flooding.

Extreme rainfall events will increase in number and severity in the future because of the change in baseline temperatures.

By the end of the century, cities could experience as much as 30% more annual rainfall than today, and 1.5 times as many days with over an inch of rain.

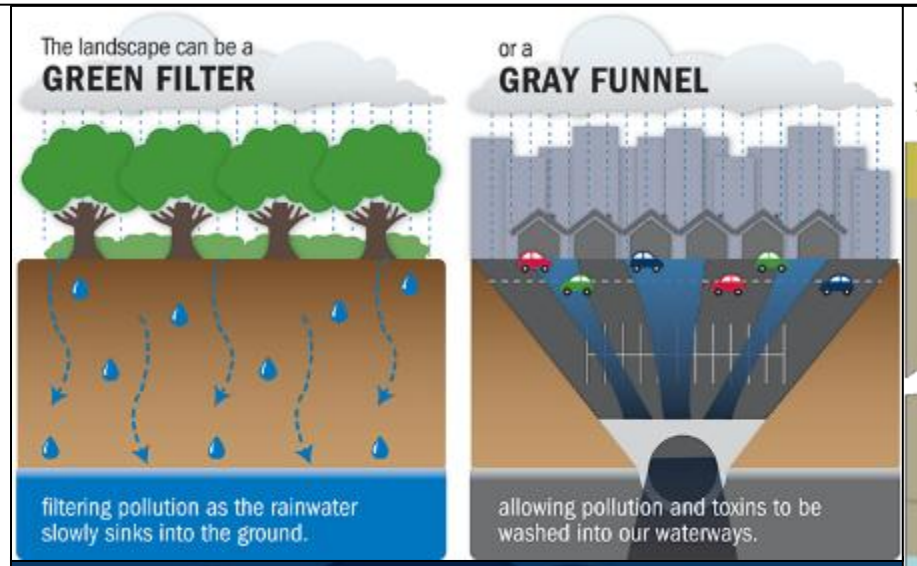
As sea level and groundwater tables rise, stormwater will drain more slowly and contribute to flooding.

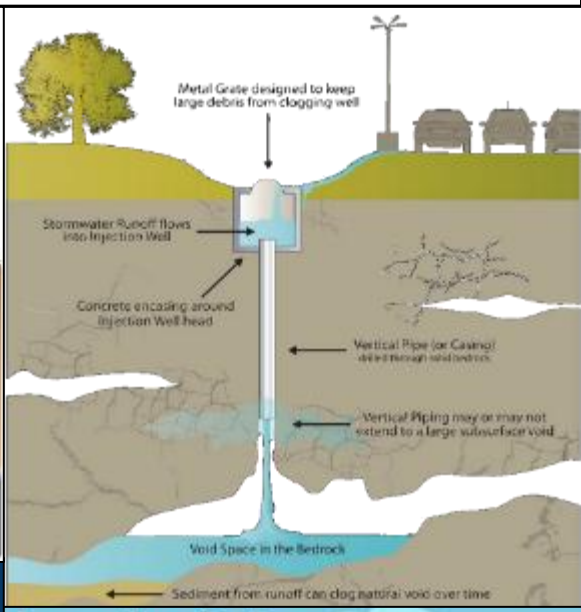
- Record rainfall events in 2019 resulted in more than 100 Minnesota communities releasing partially treated wastewater into area rivers and streams.
- Untreated sewage carries pathogens and other contaminants that pose human health and ecological risks.

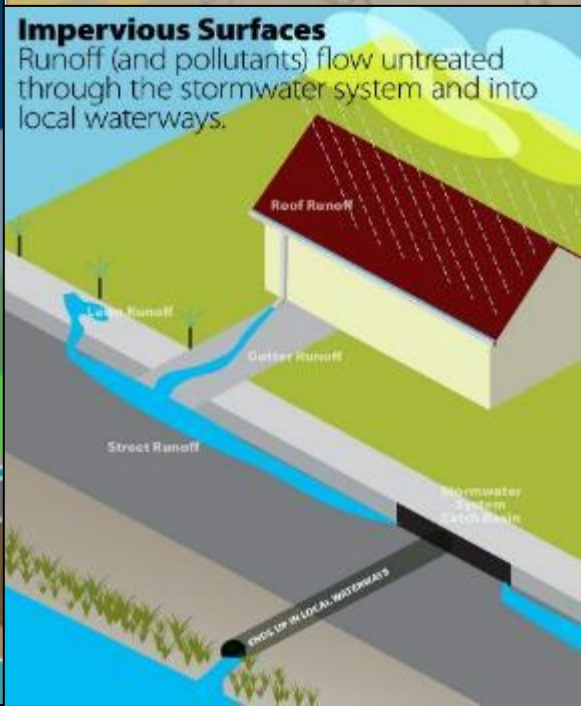
Extreme temperature swings can degrade the quality of materials in addition to the aging process already underway.

- Canals, reservoirs, earthen dams, roadways, sidewalks, and drainage ditches require water to hold the soils together.

Sinkholes are just one of many forms of ground collapse, or subsidence. Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement.







Amplified Runoff: Loss of Trees, Too Dry Soil

Increased rains with fewer trees to block the flow: trees act as natural sponges, intercepting rainwater through their canopy and allowing it to gradually infiltrate the soil, thus reducing the amount of water that flows directly off the surface as runoff; therefore, when trees are removed, more rainwater rapidly runs off, leading to increased storm water volume.

Debris flows can be amplified up to seven years post wildfire due to the lack of vegetation cover and soil stability.

- Healthy trees can slow down the flow of rainwater, absorb rainwater, and reduce the risk of subsidence by holding soils in place through their root systems.
- Trees can also provide wind breaks, reducing the threats of evaporation and providing shade from solar radiation which can aid in soil health and stability.

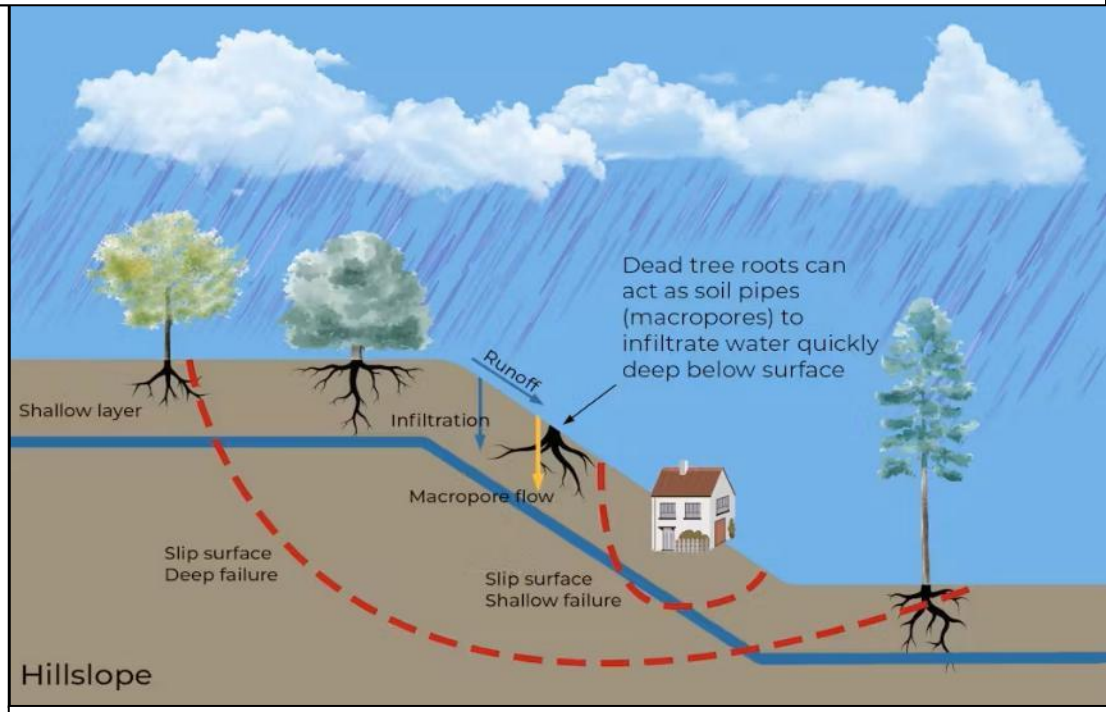
Every 1% increase in organic matter results in as much as 25 thousand gallons of available soil water per acre.

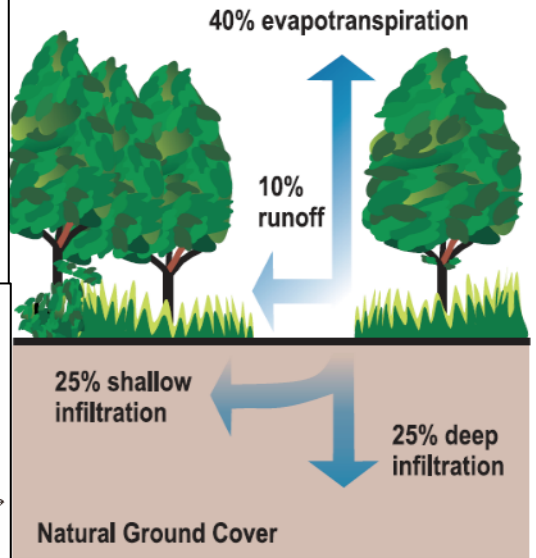
- The optimum level of moisture to maintain soil stability can vary by region but healthy soils can hold more water than overly dry soils.

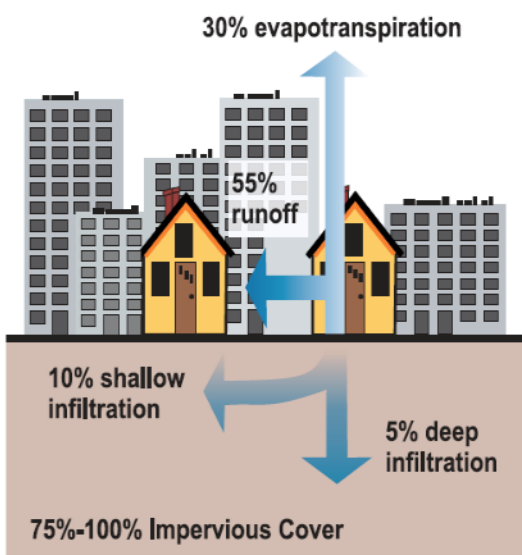
Soil nature directly affects the scale of damage caused by earthquakes. The seismic waves that travel through hard rock move faster than soft soil, and the transition point between the two can yield an increase in amplitude causing stronger shaking.

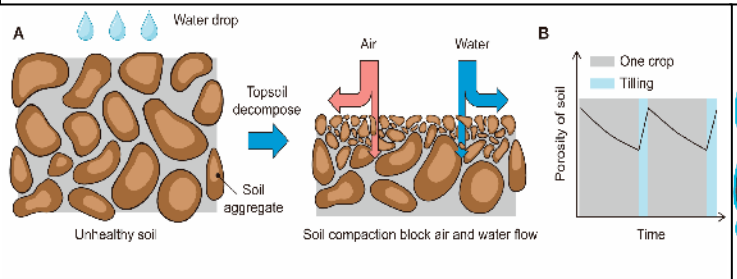
- The deeper the sediment layer above bedrock, the softer soil there is for the seismic waves to travel through. Soft soil means bigger waves and stronger amplification.
    - Soil liquefaction is a leading cause of earthquake damage worldwide.

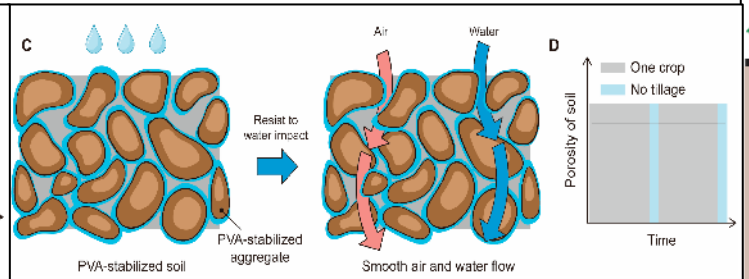
Aeration in compacted soil improves the absorption rate of rainfall and runoff yielding healthier root systems and greater foliage coverage, reducing negative impacts from worsening cyclical atmospheric trends.











Inches Per Hour and Peak Wind Risks Rise

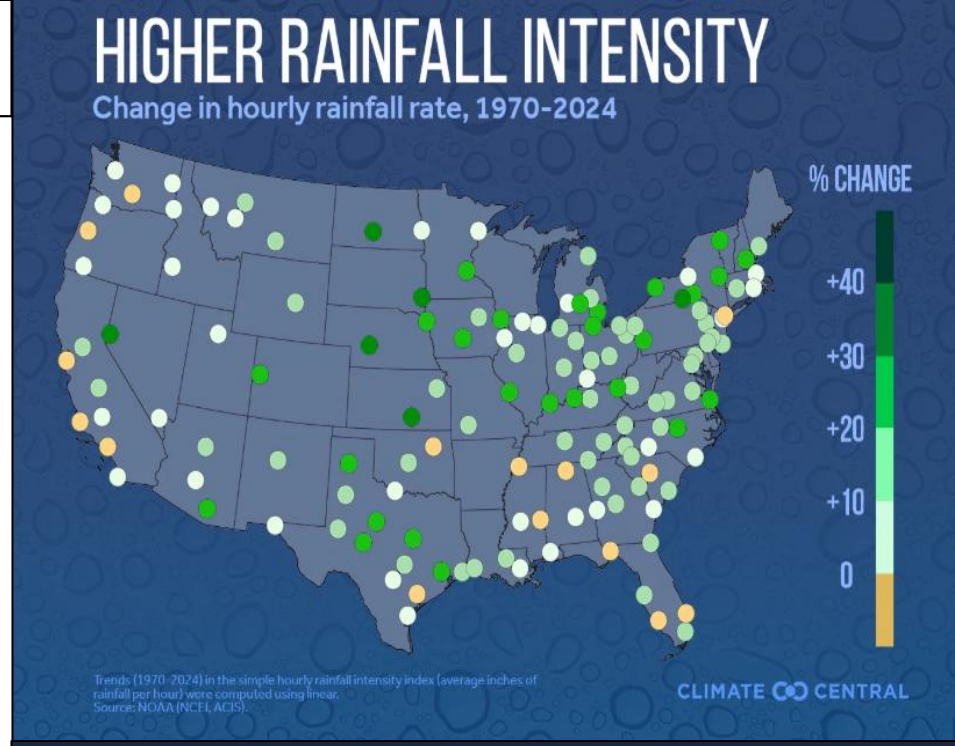
With 2°C (3.6°F) of global warming, the majority (85% or 2,645) of 3,111 total U.S. counties are likely to experience a 10% or higher increase in precipitation falling on the heaviest 1% of days.

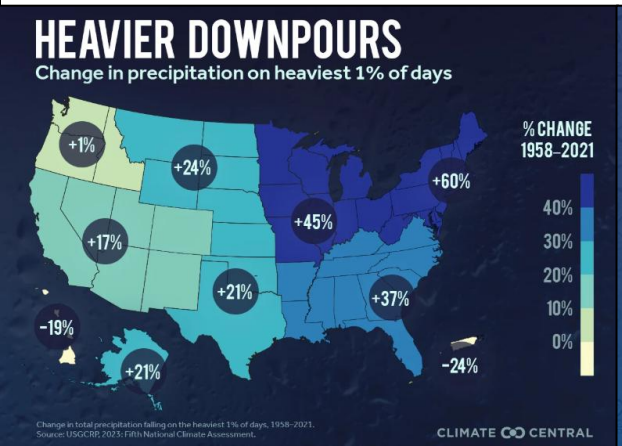
A 2024 study by Climate Central found that 126 of 144 US cities they examined saw an increase in hourly rainfall intensity from 1970 to 2022.

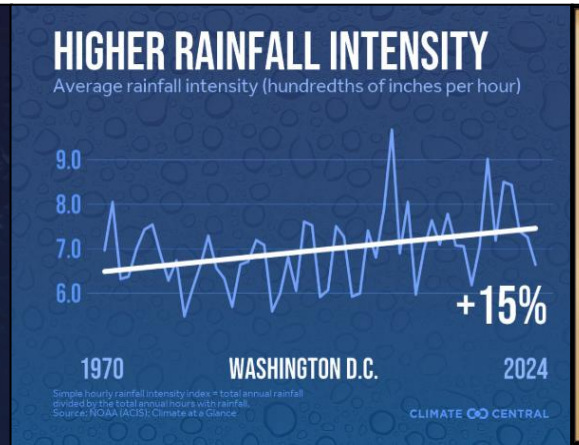
- Rainfall hours became 15% wetter on average across the 126 cities studied with an 88% increase in hourly rainfall rates.
    - The highest known one-hour rainfall total in the US is 12 inches in Holt, Missouri, on June 22, 1947. This rainfall occurred in just 42 minutes.
    - The highest known 1-minute total is also held by the US in Unionville, Maryland at 1.23 inches in 1956.
    - The record 6-hour rainfall was in Smethport, PA at 34.5 inches. A record 42 inches were reported in 24 hours in Alvin, Texas in 1979.

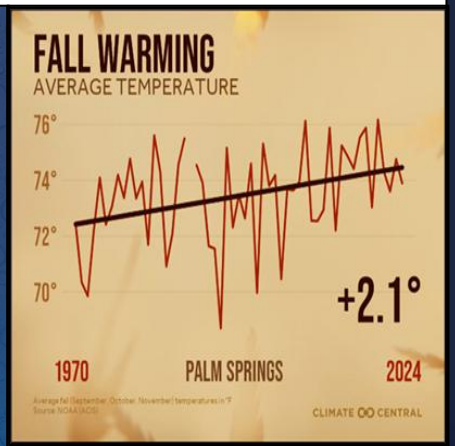
A new study finds the strongest nor'easters have intensified over the last 80 years, with a 6% increase in peak wind speeds resulting in a nearly 20% increase in destruction potential.

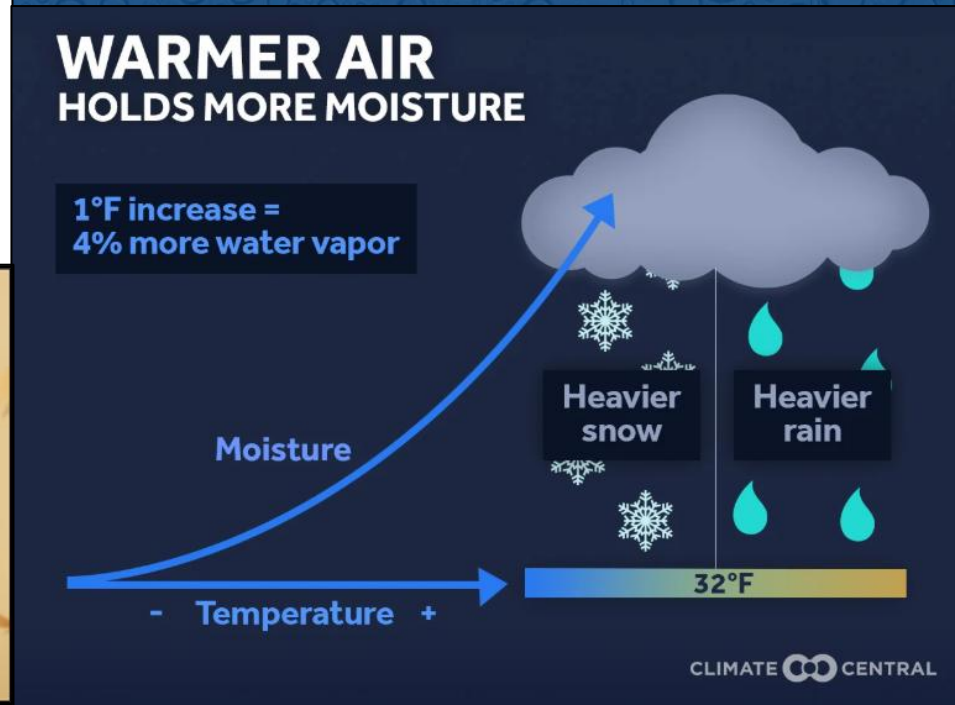
- Previous studies published have predicted an increase in the intensity of extratropical storms close to the northeastern US due to warming during the cool season.
    - The strongest wind gust recorded in the US was 231 mph at Mt. Washington in 1934

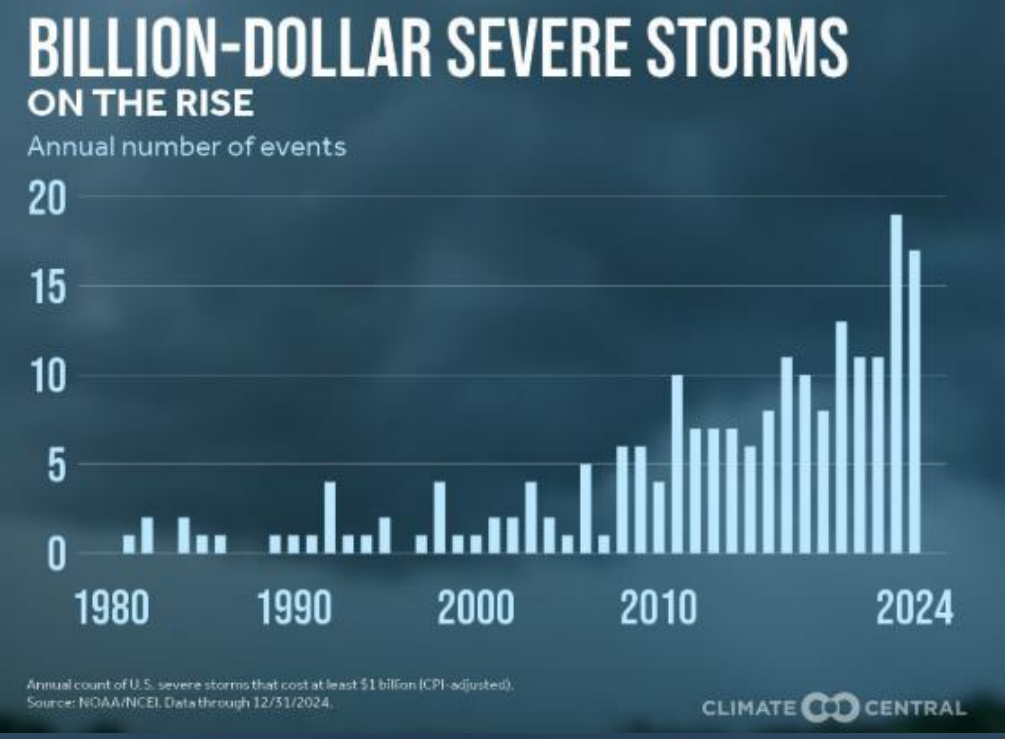


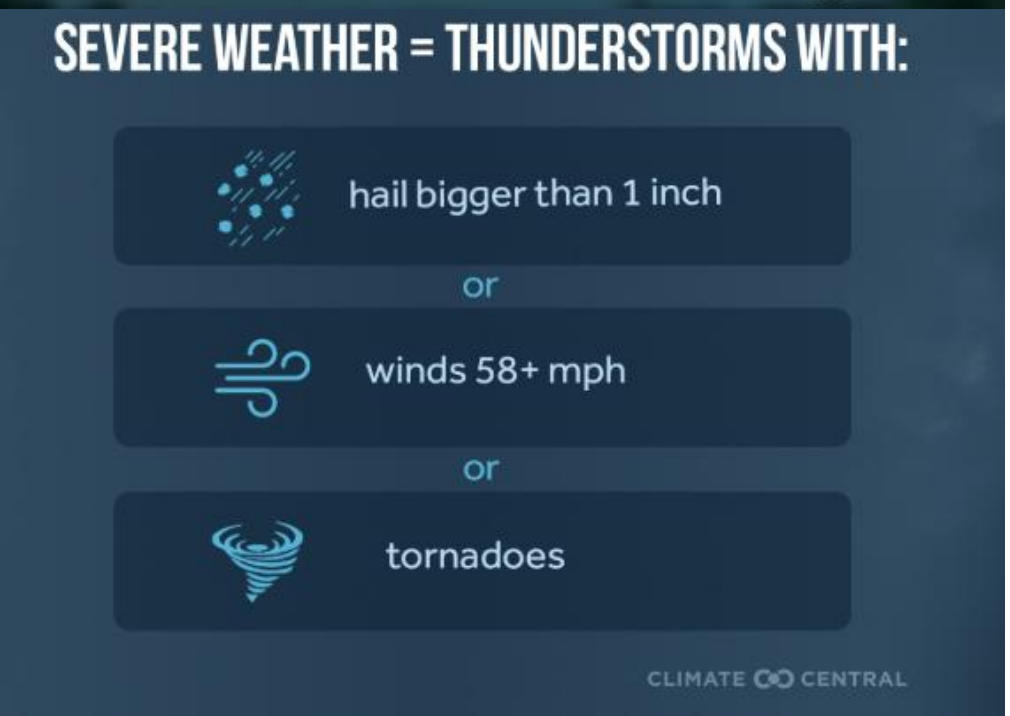












Recent research shows that thunderstorm straight-line wind speeds in the central U.S. have intensified 7% per °F of warming during recent decades (1980-2020).

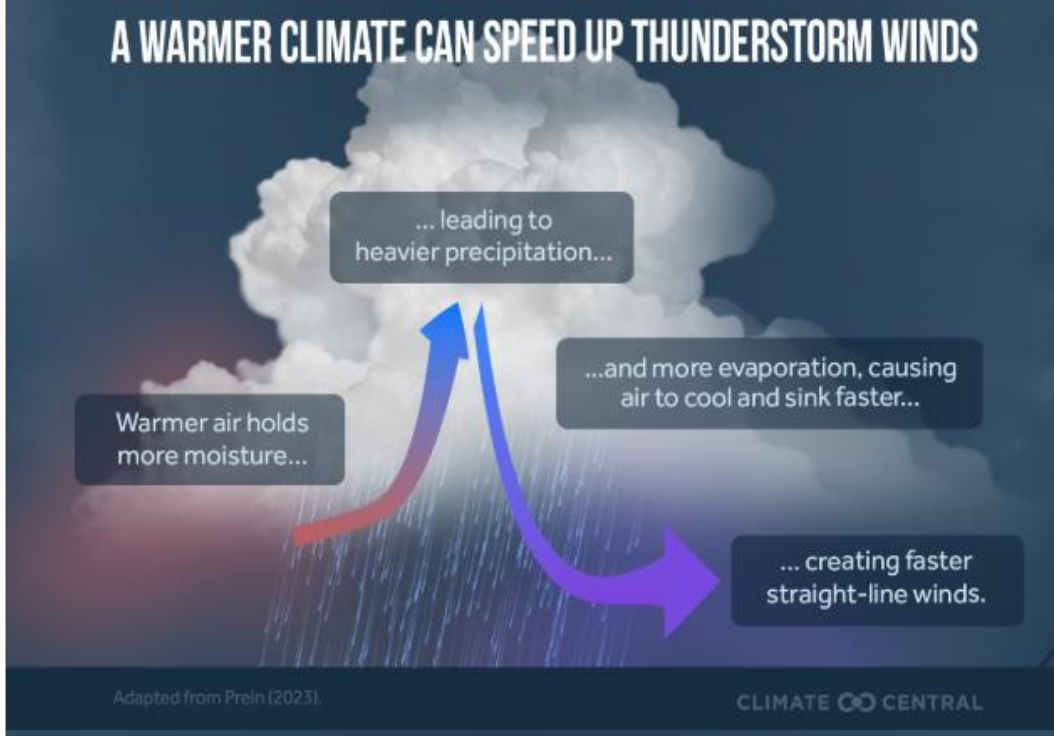
With very high levels of future warming, large straight-line wind systems (derechos) are projected to become more frequent, widespread, and intense in the central and eastern U.S.

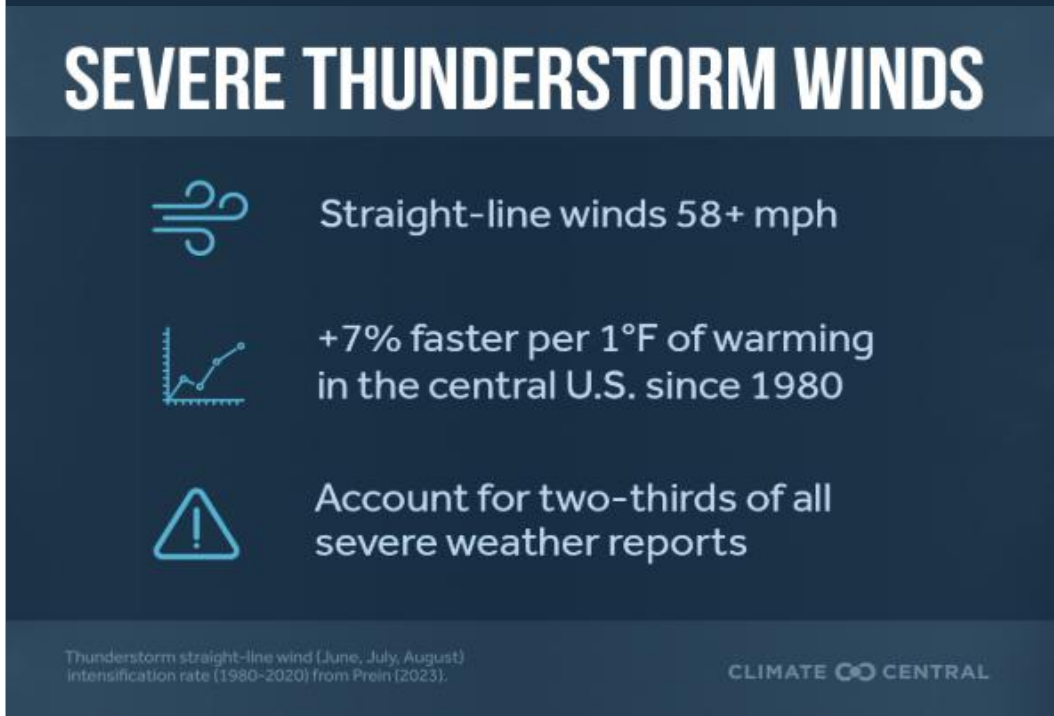
Severe storms — thunderstorms that produce tornadoes, hail at least one inch in diameter, or damaging winds (58 mph or higher) — are destructive and deadly.

They cause an average of 200 deaths annually in the U.S. and account for half of all U.S. billion-dollar weather and climate disasters that have impacted the nation since 1980.

The frequency of billion-dollar severe storms has increased dramatically in recent decades, with 2023 and 2024 ranking as the top two years on record.

Thunderstorm straight-line winds are non-rotating winds originating from thunderstorms. Straight-line winds are different from the rotating winds of tornadoes, and they're classified as "damaging" when their speed exceeds 58 mph.





Changing River Systems and Delivery

Over the last decade, the length of impaired rivers and streams has increased from about 424,000 miles in 2010 to more than 588,000 miles in 2019, and in 2022, more than 703,000 miles.

- Nationally, the EPA's 2022 Clean Watershed Needs Survey (CWNS) estimated the 20-year need for large stormwater systems (Municipal Separate Storm Sewer Systems) had increased from $23.8 billion in 2012 to $115.3 billion a decade later.

Heavy rains after a drought caused nitrates to seep 33 feet under farm fields in as little as 10 days. The study was published in Water Resources Research.

- Previous studies have shown about 40% of nitrogen fertilizer used for vegetables isn't absorbed by the plants but remains in the soil.

The flooding from Hurricane Helene caused significant changes to the Nolichucky River, which flows from North Carolina into Unicoi, Washington and Greene Counties in Tennessee.

- The Nolichucky River is different, even for rescue teams. It'll take time to adjust and learn the new landscape.

New Research: the integration of multiple global geophysical datasets reveals a permanent decline in terrestrial water storage.

- The study provides robust evidence of an irreversible shift in terrestrial water sources under the present changes in climate. More Here

Another new study concluded that changes in the velocity of stormwater runoff into groundwater systems can change the flow deposits and further deteriorate soil systems and vegetation as extreme heat and drought rise.

NOAA's 2023 Flood Inundation Mapping provides actionable information for the extent of flooding hourly and a 5-day flood inundation forecast.

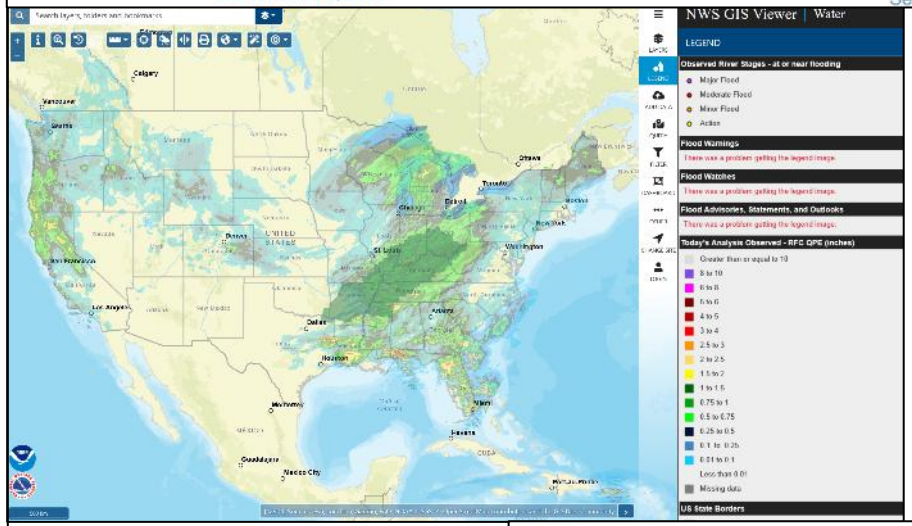
!NEW! - National Water Prediction Service (NWPS) - !NEW!

On March 27, 2024, the National Water Prediction Service (NWPS) website hosted at https://water.noaa.gov was launched replacing the legacy Advanced Hydrologic Prediction Service (AHPS) page previously located at https://water.weather.gov. Resources and more information are listed below.

Public Notification Statement: November 16, 2023
Service Change Notice (SCN):January 12, 2024
SCN: March 6, 2024

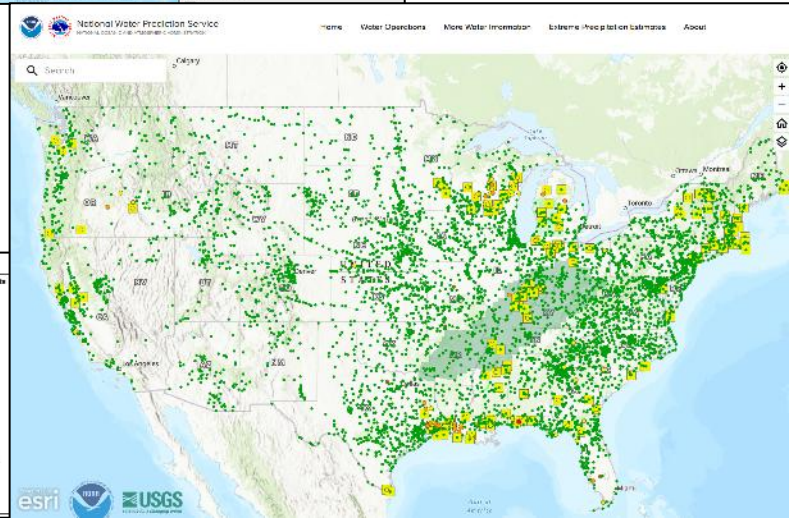
!NEW! - Flood Inundation Mapping (FIM) Services - !NEW!

Experimental FIM services are now available for 30% of the U.S. population including Puerto Rico and the U.S. Virgin Islands. These services will be expanded to nearly 100% of the U.S. population by 2026. Experimental services depict the extent of predicted inundation, as derived from River Forecast Center forecasts and National Water Model analyses and forecasts. Services are available via the National Water Prediction Service, the NWS GIS Viewer, or directly via URLs hosted on the Hydrologic Visualization and Information Services (HydroVIS) cloud system.



River forecasting has expanded to an experimental range up to 10 days on NOAA sites with frequently updated hydrologic and flood discussions posted online for consideration of soil and geological risks in subsidence, aquifer damages, and low-lying flood risks.

NOAA's recent flood focused graphics alert emergency managers to specific regions at risk and narratives. These products can be accessed ahead of hurricanes or storms.



Dams and Reservoirs

The region to the right has 11,037 georeferenced dams listed in the US National Inventory of Dams (NID) with total storage capacity of 7.15×10^{10} m^3 which can store up to 20% of the annual total available water resources in the Northeast.

- 77% of these dams have a capacity smaller than 10^6 m^3 and are essentially considered as 'run of the river' dams that have little effective storage capacity but can have a larger impact on downstream flows in the future.
- There are only eight dams in the region with a capacity larger than 10^9 m^3.

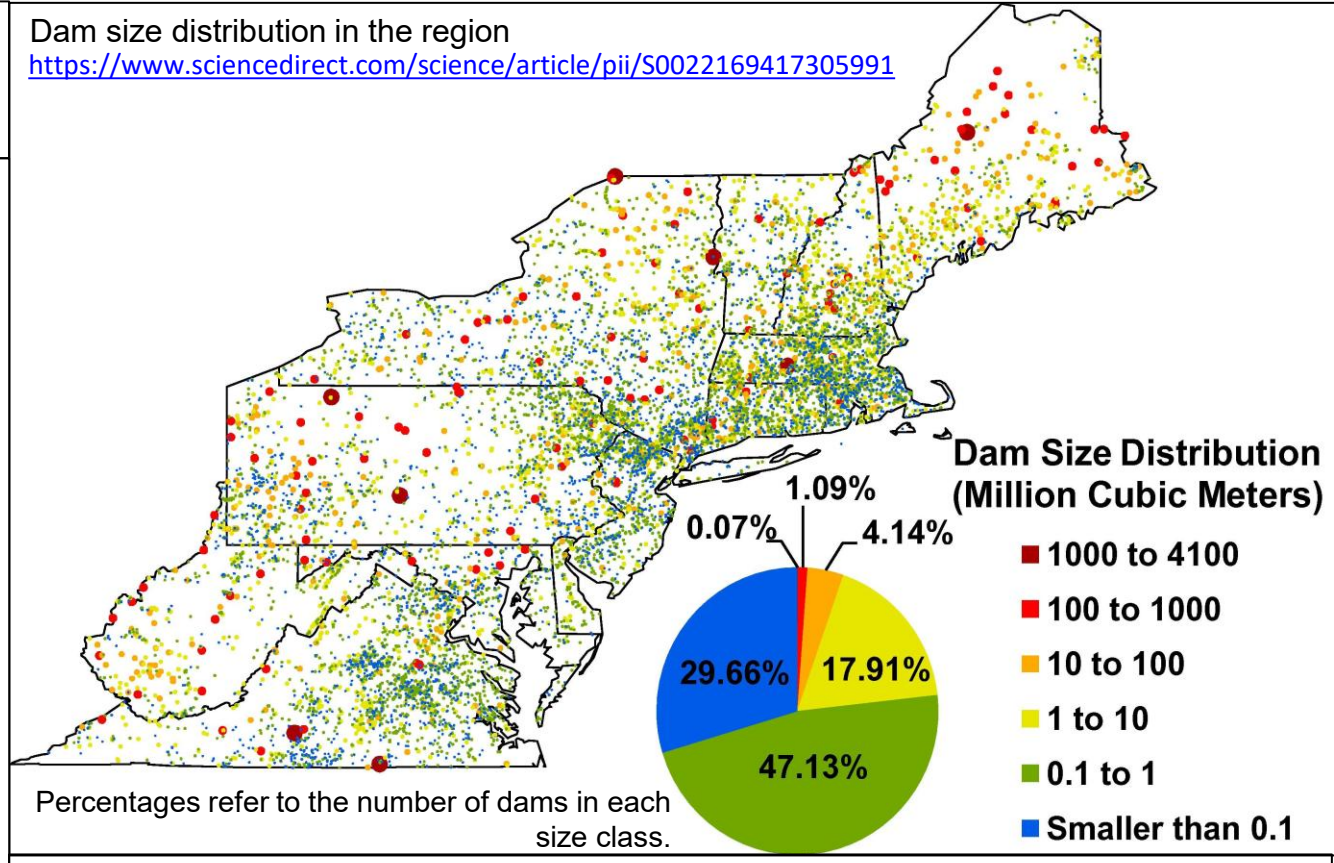
Recent historic flooding events in the region were reported in the Spring, during the April-May period, combining heavy rainfall rates with snowmelt from warm rains.

- 2007 and 2008 produced major springtime flooding in Maine, 2010 in Massachusetts, 2011 and 2023 in Vermont, with additional increases in springtime flooding events possible across the region due to the shift in precipitation type from steady winter snow to warming between snows.

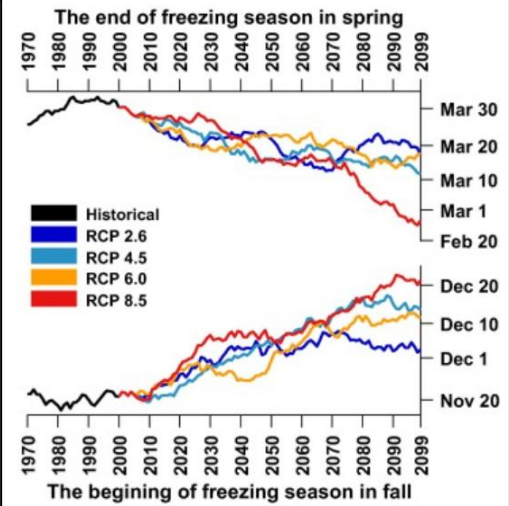
The earliest dam construction documented in the U.S. was in 1640 - the 1.8-m high Old Oaken Bucket Pond Dam that is still active today in Scituate, Massachusetts.

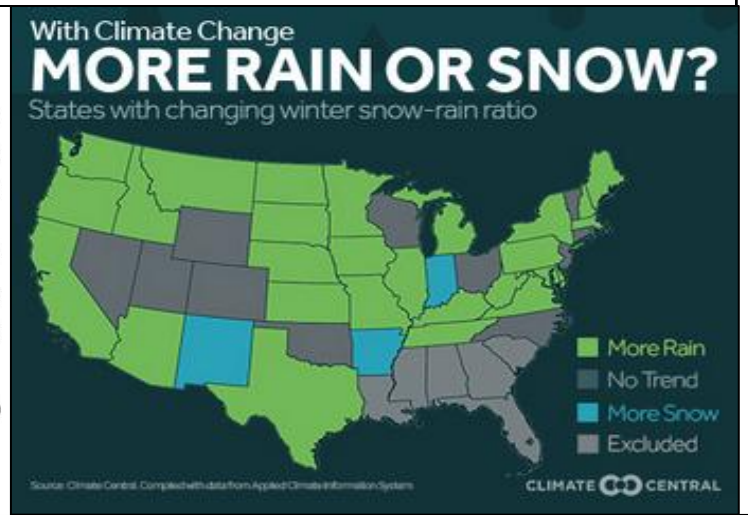
- *Thermal stratification* occurs when the water in a lake forms distinct layers through heating from the sun. Evaporative demand works to lower river levels.

Dam size distribution in the region
https://www.sciencedirect.com/science/article/pii/S0022169417305991



Percentages refer to the number of dams in each size class.





Total count and storage capacity of dams in the Northeast US

State	Connecticut (CT)	Delaware (DE)	Massachusetts (MA)	Maryland (MD)	Maine (ME)	New Hampshire (NH)	New Jersey (NJ)	New York (NY)	Pennsylvania (PA)	Rhode Island (RI)	Virginia (VA)	Vermont (VT)	West Virginia (WV)	Northeast (NE)
Number of Dams	703	83	1426	321	562	634	798	1896	1519	214	2008	356	517	11037
% of Total Number of Dams	6%	1%	13%	3%	5%	6%	7%	17%	14%	2%	18%	3%	5%	100%
Total Storage (10^6 m^3)	2.3	0.1	5	1.8	9.7	3.2	2.4	18.5	11.3	0.4	10.2	1.2	5.4	71.5
% of Total Regional Storage	3%	0%	7%	3%	14%	4%	3%	26%	16%	1%	14%	2%	8%	100%

Impacts from Changing Drought Conditions

The likelihood of extreme multiyear droughts will increase, threatening regional water supplies. Flash droughts start and intensify quickly, over periods of weeks to months, compared to years or decades for conventional droughts. The Environmental Protection Agency (EPA) stated the estimated price tag of fully funding US water infrastructure is *over $3 trillion over the next 20 years*.

- As higher heat and widespread prolonged drought continue to expand in coverage, intensity, and longevity, almost half the world's population will be living in areas of greater water stress by 2030. This can lead to trade shifts, allocation arguments, and infrastructure changes in both material creation and development of regions lacking natural water security.

From 1980-2022, there have been 30 drought events totaling $309.4 billion dollars according to the Billion Dollar Weather and Climate Disasters report NCEI.

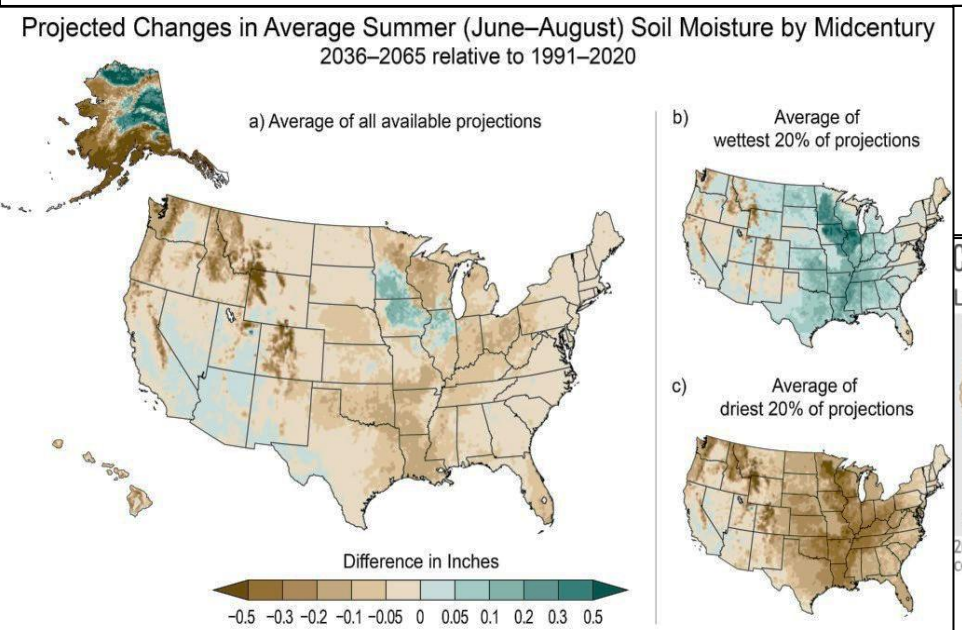
- Surface water is under threat from evaporation, dried soils, increased use for agricultural needs, theft for private consumer use, and a rapidly changing ecology from the drying climate.

If a weather pattern that results in a precipitation deficit lasts for a few weeks or months, it is considered short-term or flash drought. If the pattern and precipitation deficits last for more than six months, it is typically considered long-term or prolonged drought. Increasing the

- Flash droughts, characterized by rapid onset and intensification, are increasingly occurring which can lead to sudden water losses and subsequent cascading allocation restrictions.

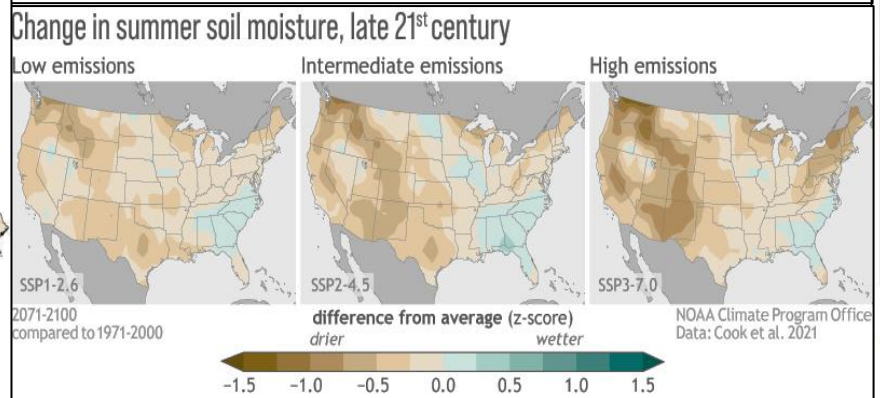
Reductions in water availability can halt developers and certain building repairs, renovations, or retrofitting. Impacts from persisting drought can be mitigated with water recycling such as black or grey water recycling, closed-loop systems, or alternative resources for backup if the primary source becomes threatened such as water trucks or cross basin water sharing infrastructure.

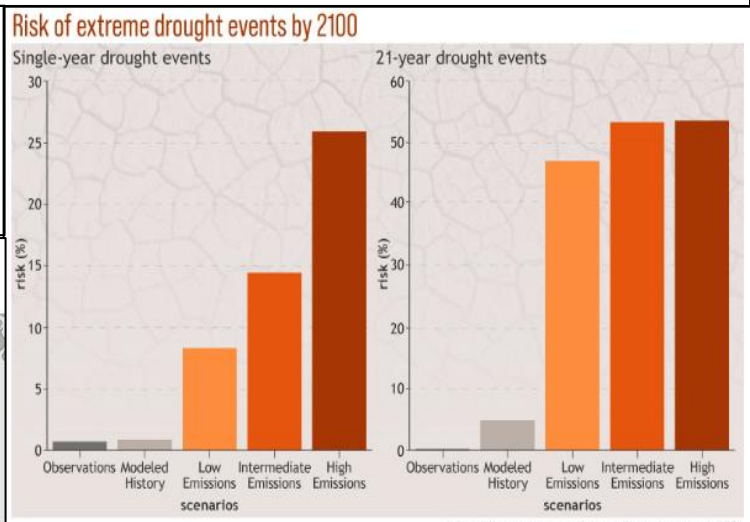
- Clay-based soil types dry and shrink when a drought occurs, resulting in uneven settling that can damage a building's foundation. Low soil moisture causes contraction away from the foundation, compromising the bond. This leads to foundation cracking, damaged pipes, sloping floors, and warped windows and doors.
    - Retaining walls, bridges, sidewalks, pavement, runways, railway platforms, canals, and dams all face the risk of drought-related harm.



Drought can reduce the amount of water available for hydropower and contribute to degraded energy infrastructure critical for the technology sector.

Wildfire, which can be exacerbated by drought, can damage energy generation systems.





As greenhouse gas emissions increase and Earth's temperature rises, new research forecasts the southwestern United States will become drier, with the risk of future soil moisture deficits increasing as emissions increase. From figure 8 of the new study.

Credits: NOAA Climate Program Office / Anna Eshelman

Drought and Seismic Activity

A fault is formed in the Earth's crust as a brittle response to stress. Generally, the movement of the tectonic plates provides the stress, and rocks at the surface break in response to this. Faults form when rock above an inclined fracture plane moves downward, sliding along the rock on the other side of the fracture. Normal faults are often found along divergent plate boundaries, such as under the ocean where new crust is forming. Long, deep valleys can also be the result of normal faulting.

- Collisions zones are where tectonic plates push up, resulting in mountain ranges such as the Himalayas and the Rocky Mountains. The San Andreas Fault in California is the largest in the world at more than 800 miles from the Salton Sea to Cape Mendocino. A devastating earthquake is reportedly 'due' by 2030 along this fault.

The number of earthquakes in the central U.S. has increased dramatically over the past decade. Between the years 1973–2008, there was an average of 25 earthquakes of magnitude three and larger in the central and eastern US. Since 2009, at least 58 earthquakes of this size have occurred each year, and at least 100 earthquakes of this size every year since 2013. The rate peaked in 2015 with 1010 M3+ earthquakes. In 2019, 130 M3+ earthquakes occurred in the same region.

"**The Gravity Recovery and Climate Experiment (GRACE measurements) reveals that major earthquakes (Mw 5 and above) always occur in the dry stage, indicating drought and associated groundwater extraction is an important trigger for major earthquakes**." Earthquakes result from strain build-up and weakening from within faults.

- The loss of an estimated 63 trillion gallons of water in West, most of it groundwater, was reported in a study done by researchers at the Scripps Institution of Oceanography. The loss of the water has caused the ground to rise more than a half-inch in California's mountains in 2017.

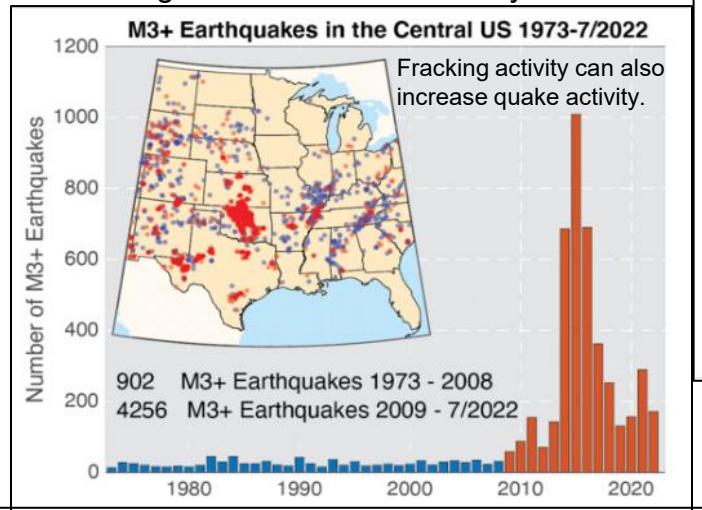
The areas around fault lines have valleys where the plates meet and are at their weakest point. Due to the lower elevations around these topography features, water tends to pool at the lowest elevation and thereby river systems were naturally located in the weaker spots of the fault line.

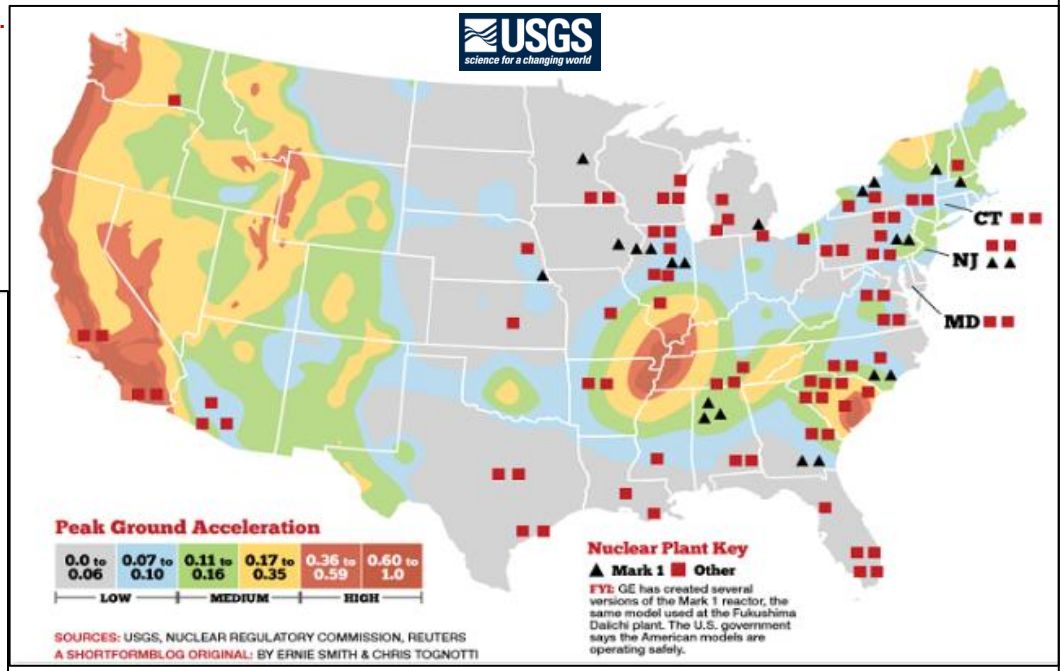
- Damming up the river system resulted in compounding water in different areas than were natural along some faults. As dams were installed, an increase in seismic activity was reported and subsequently as drought has developed, activity has increased again near the river/dam systems.

Water weighs about 8lbs per gallon of water, with more water falling in single events, rapid onsets of pressure on weak pooling points will have downward impacts as will sudden drying from increased evaporation and the drying of soils lifting the pressure on the plate upward.

Recent research has confirmed this correlation of water weight on the crust as a form of water-stress triggering earthquakes during major precipitation shift events.

There are a notable amount of nuclear power plants built along river systems in the US and in areas experiencing increasing drought conditions presenting additional seismic concerns for public safety.





USGS Seismic Hazard Model areas of Risk with Nuclear Power Plants: Comparing these major fault line and tectonic plate boundary areas with persisting surface drought shows the potential instability of quake activity.

Reservoirs, Glaciers, and Groundwater

According to several studies, including a group at Florida State University, there has been an uptick in quakes associated with some hurricanes, but these episodes have generally been weak in magnitude (< 3.5 magnitude).

- There was a magnitude-5.1 earthquake that occurred during the impacts of Tropical Storm Hilary in 2023 in California on the leading end of the low pressure moving into the southern region of the state.

In 2019, a 4.9 magnitude earthquake caused hundreds of houses to partially collapse in the villages of Le Teil and Saint-Thomé in southwest France near a quarry.

- Studies yielded evidence that an influx of groundwater and hydrated soils from intense rains the previous month (flooding events) caused pressure from the extra water weight higher than any time in the past decade near where two fault points met, resulting in pressures 2.5 times above normal and likely responsible.
    - This quake was near the surface and is comparable to the studies done attributing fracking and wastewater injection to earthquake increases in the Central US and abroad.

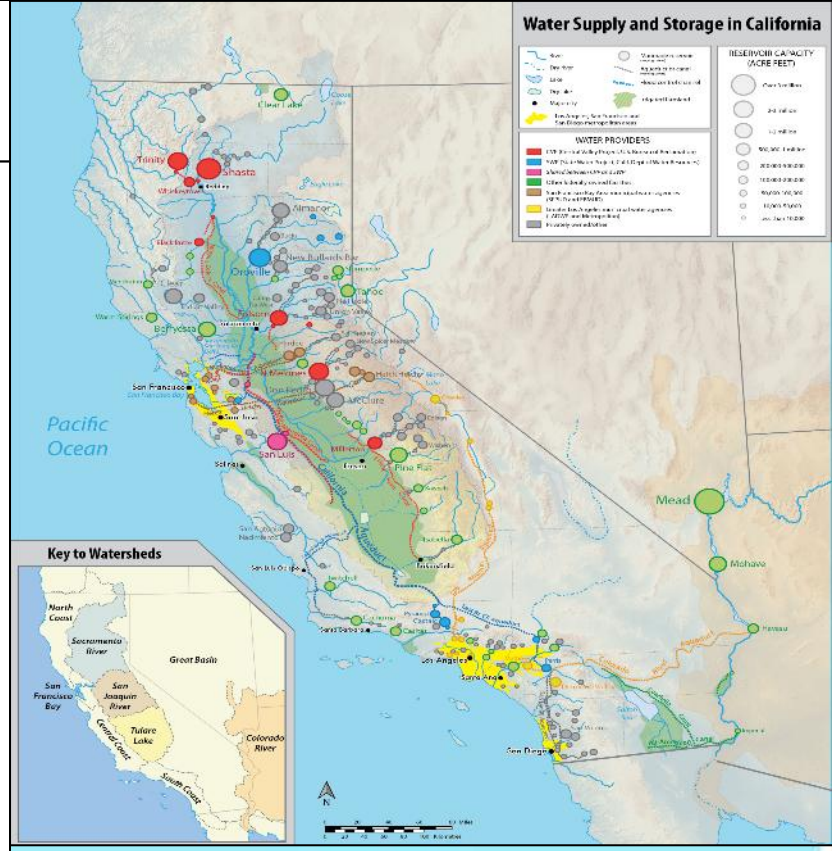
Filling reservoirs could also trigger similar impacts to flood events: In 1975, approximately eight years after Northern California's Lake Oroville, the state's second-largest human-built reservoir, was created behind the Oroville Dam, a series of earthquakes occurred nearby, the largest registering magnitude 5.7.

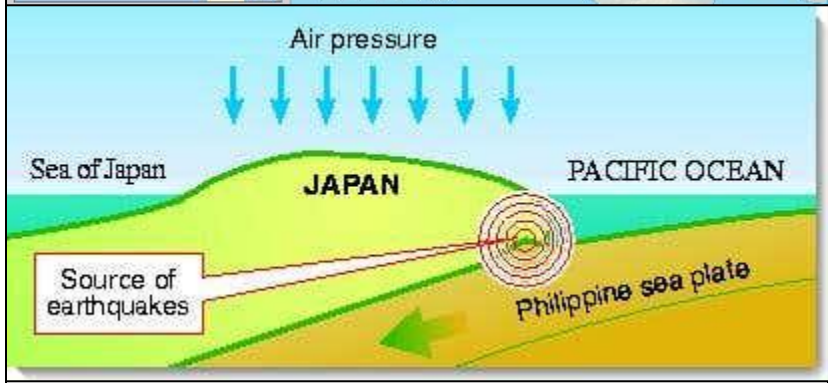
- Recent earthquakes in Northern and Southern California are located closer to the main groundwater basins and fault line clusters.
    - On average by this time of year, California has felt around eight earthquakes with a magnitude of 4 or higher, according to Jones, but so far in 2024, the state has seen 14.
- As of August 2024, was the most seismically active year since 1988 after recent earthquakes in Southern California.

The retreat of a glacier can reduce stress loads on Earth's crust, impacting the movement of subsurface magma.

- A recent study in the journal Geology on volcanic activity in Iceland between 4,500 and 5,500 years ago, when Earth was much cooler than today, found a link between deglaciation and increased volcanic activity.
    - Conversely, when glacial cover increased, eruptions declined.
- The rapid movement of glaciers has also been shown to cause what are known as glacial earthquakes. Glacial earthquakes in Greenland peak in frequency in the summer months and have been steadily increasing over time.

Many studies have been produced interlinking drought and earthquakes as well, stating that in China 82% of drought areas report earthquakes after drought within 1-3 years.





A recent study of meteorological data going back to 1961 found that average monthly atmospheric pressure in the region is around 1000 pascals (10 millibars) higher between August and February than during the rest of the year. The extra force on the Japanese plate is equivalent to placing 100-kilogram weights on each square meter. This pushes down the Eurasian plate, but the extra air pressure has no effect on the Philippine Sea plate, which lies underwater.
The stress differential could be enough to trigger a quake.
https://www.newscientist.com/article/mg14419531-400-earthquake-theory-up-in-the-air/

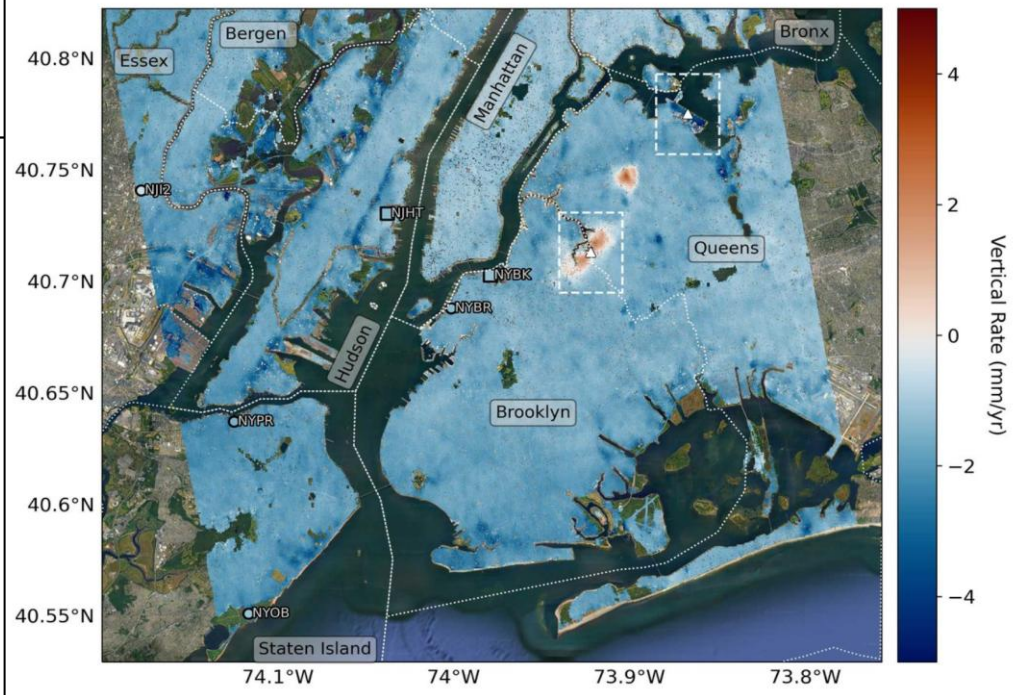
Updated Subsidence Maps

The new study was published Wednesday in Science Advances by a team of researchers from NASA's Jet Propulsion Laboratory in Southern California and Rutgers University in New Jersey.

- The team analyzed upward and downward vertical land motion – also known as uplift and subsidence – across the metropolitan area from 2016 to 2023 using a remote sensing technique called interferometric synthetic aperture radar (InSAR).
- The technique combines two or more 3D observations of the same region to reveal surface motion or topography.

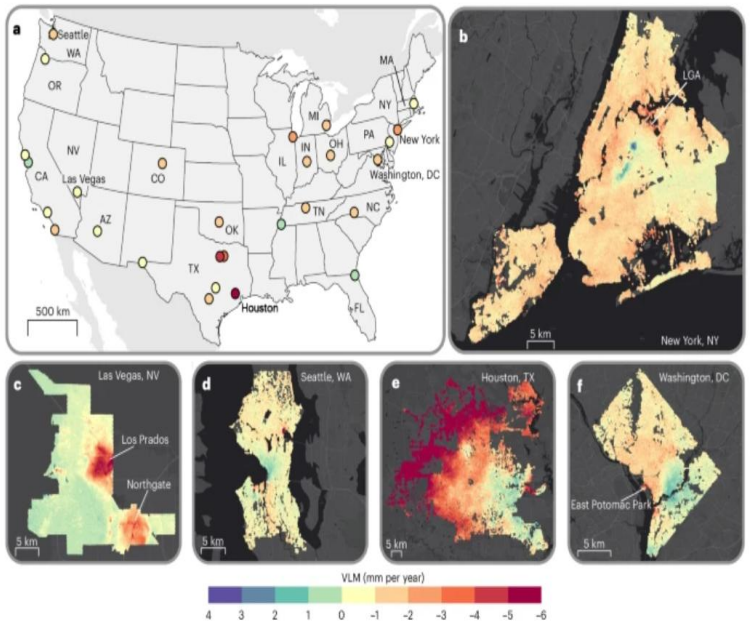
The scientists found that on average the metropolitan area subsided by about 0.06 inches (1.6 millimeters) per year – about the same amount that a toenail grows in a month.

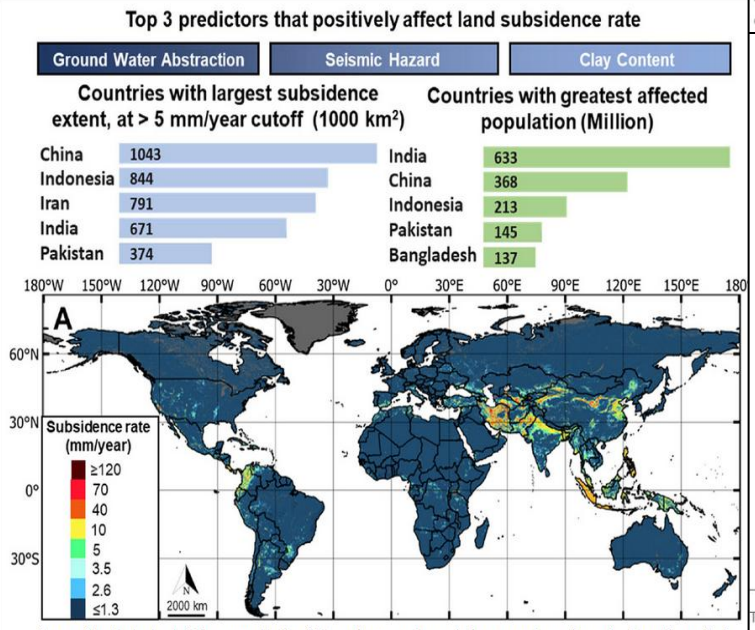
- At least 20% of the urban area is sinking in all cities, mainly due to groundwater extraction, affecting ~34 million people.
- Over 29,000 buildings are in high and very high damage risk areas, indicating a greater likelihood of infrastructure damage.



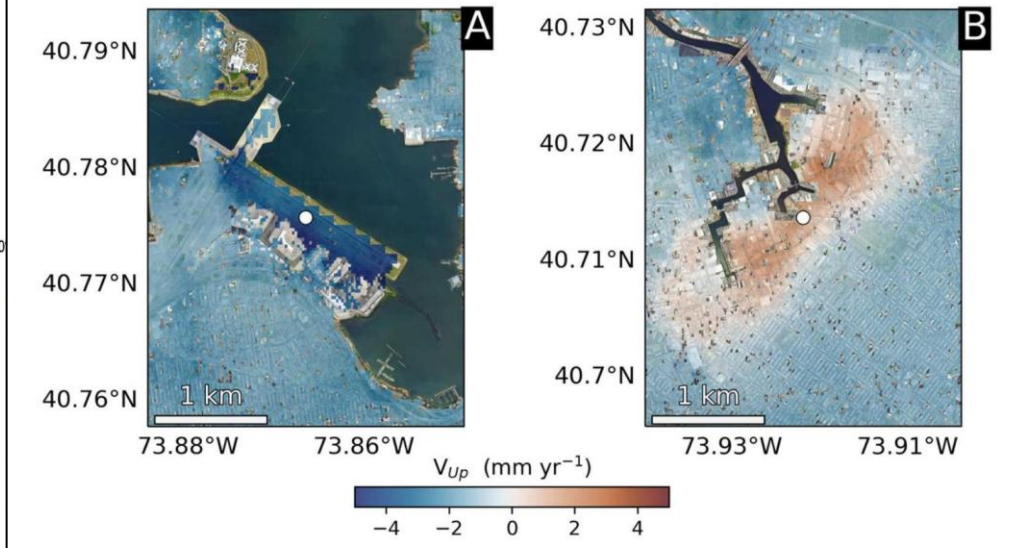
Mapping vertical land motion across the New York City area, researchers found the land sinking (indicated in blue) by about 0.06 inches (1.6 millimeters) per year on average. They also detected modest uplift (shown in red) in Queens and Brooklyn. White dotted lines indicate county/borough borders. Credit: NASA/JPL-Caltech/Rutgers University

Fig. 1: Urban land subsidence in US cities.





Some of the fastest subsiding, or vertically sinking, places are home to large numbers of people. From figure 2 of Davydzenska et al 2024 Geophysical Research Letters https://doi.org/10.1029/2023GL104497



The team pinpointed hot spots: left, runway 13/31 at LaGuardia Airport in Queens, is subsiding at a rate of about 0.15 inches (3.7 millimeters) per year; right, part of Newtown Creek, a Superfund site in East Williamsburg, Brooklyn, is rising unevenly by about 0.06 inches (1.6 millimeters) per year. Credit: NASA/JPL-Caltech/Rutgers University

Changes in Subsidence – Flood Risks

A large area of the East Coast is sinking at least 2 mm per year, with several areas along the mid-Atlantic coast of up to 3,700 square kilometers, or more than 1,400 square miles, sinking more than 5 mm per year, more than the current 4 mm per year global rate of sea level rise.

- Subsidence hazards can be a major concern for specific high-risk infrastructures, such as dams, levees, or airports.
- 2,000 to 74,000 km2 land area, 1.2 to 14 million people, 476,000 to 6.3 million properties, and >50% of infrastructures in major cities such as New York, Baltimore, and Norfolk are exposed to subsidence rates between 1 and 2 mm per year.
- The exposure analysis shows sinking on 81 to 99% of the railway systems (7,452 to 9,221 km out of 9,247 km) and 42% (11 out of 26) of train stations (Fig. S11B), with subsidence rates of >3 mm per year observed along 41 to 846 km stretch of railways on the US east coast.

Subsidence can worsen the effects of flooding by increasing the likelihood and severity of inundation.

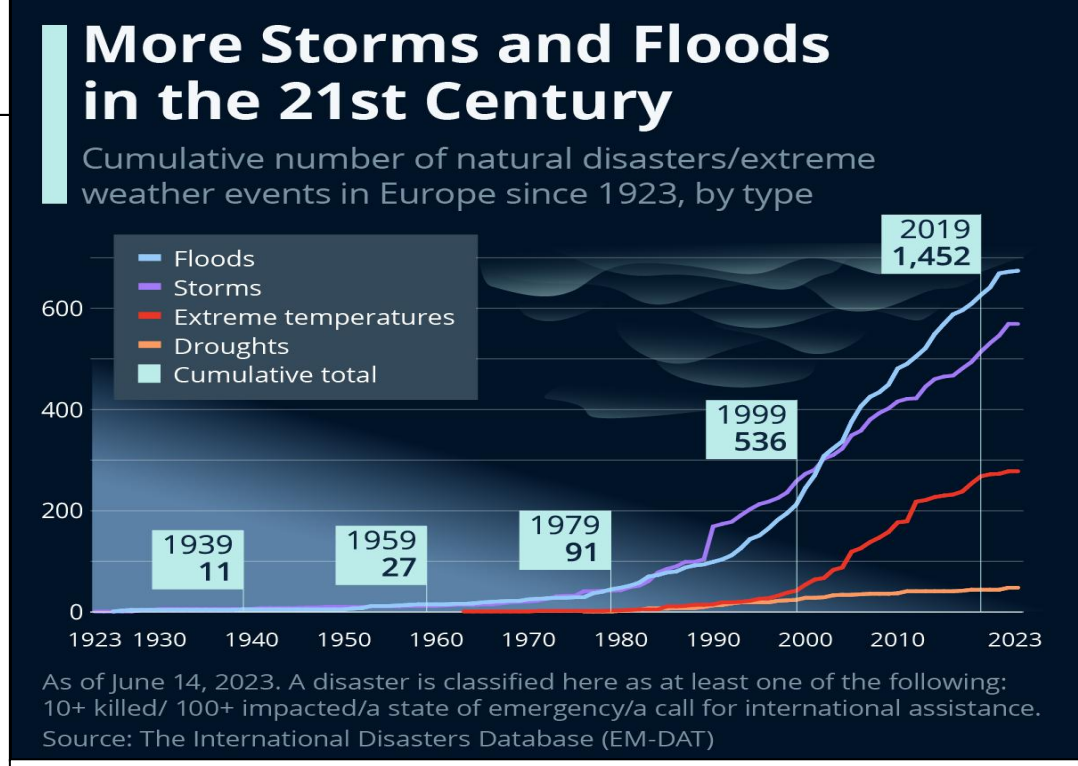
- Subsidence can also disrupt natural drainage systems, leading to localized flooding and changes in water flow patterns in rivers and streams.

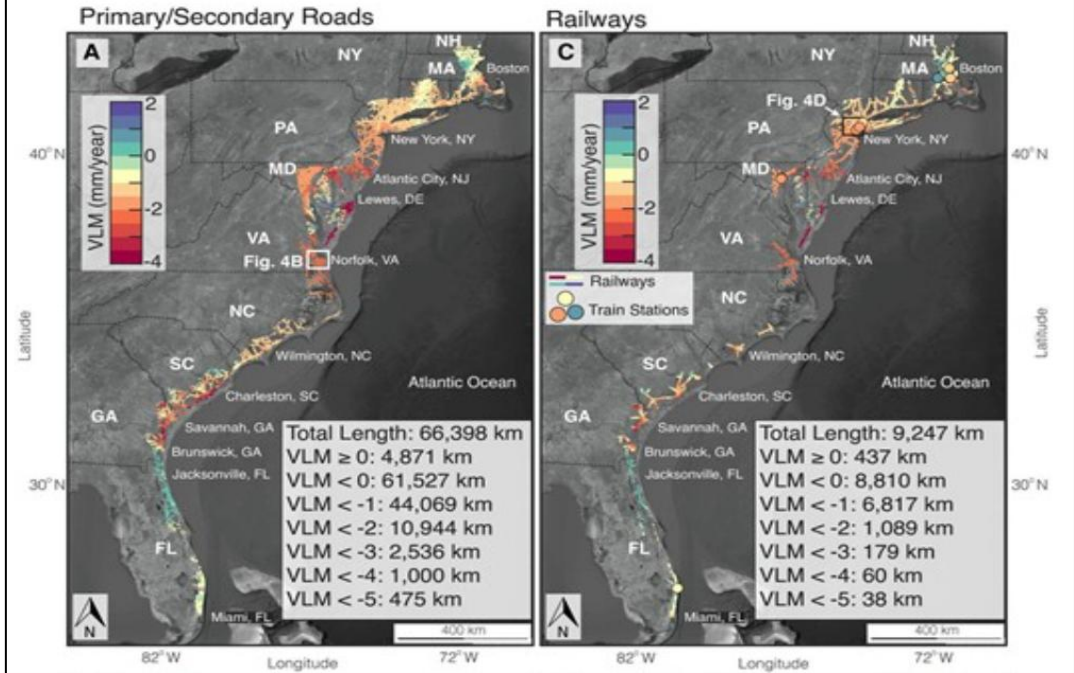
In the two decades between 1990 and 2010, D.C. saw an average of 2.4 tidal flooding events per year. In the last decade, that increased to 7.6 per year.

- That means the average number of flooding events in D.C. more than tripled (3.2x).

The Chesapeake Bay area is the third most vulnerable area of the US to sea level rise (SLR), behind Louisiana and South Florida.

- Tide-gauge records show that sea level in the Chesapeake Bay has been increasing at an average rate of 1.3 to 1.5 inches per decade over the past 100 years, 50% more than the global historical average observed over the same time period.



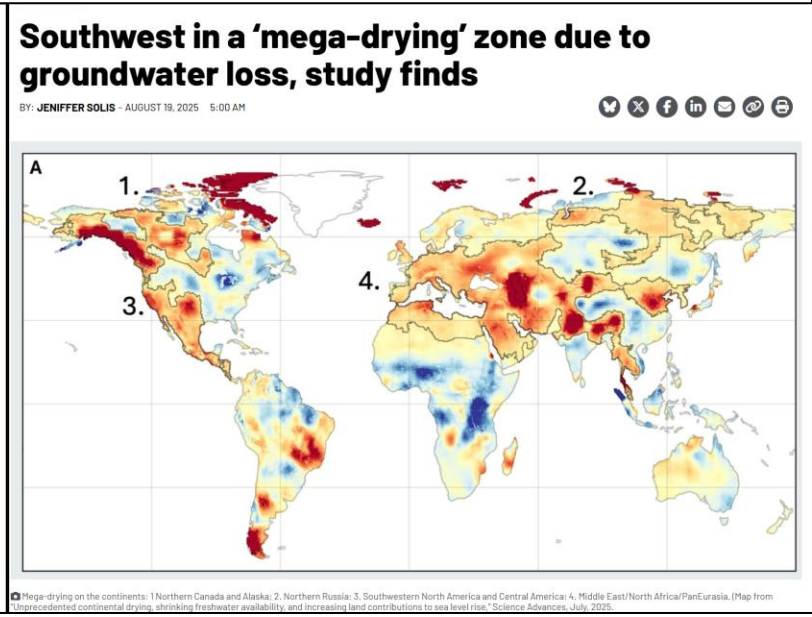


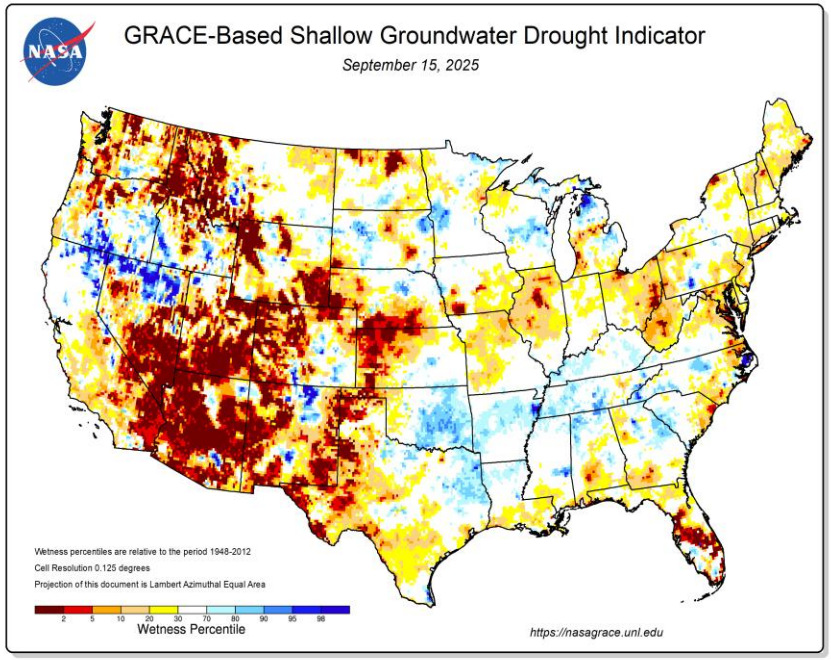
August 2025 Soil, Groundwater, and Root Zone Moisture

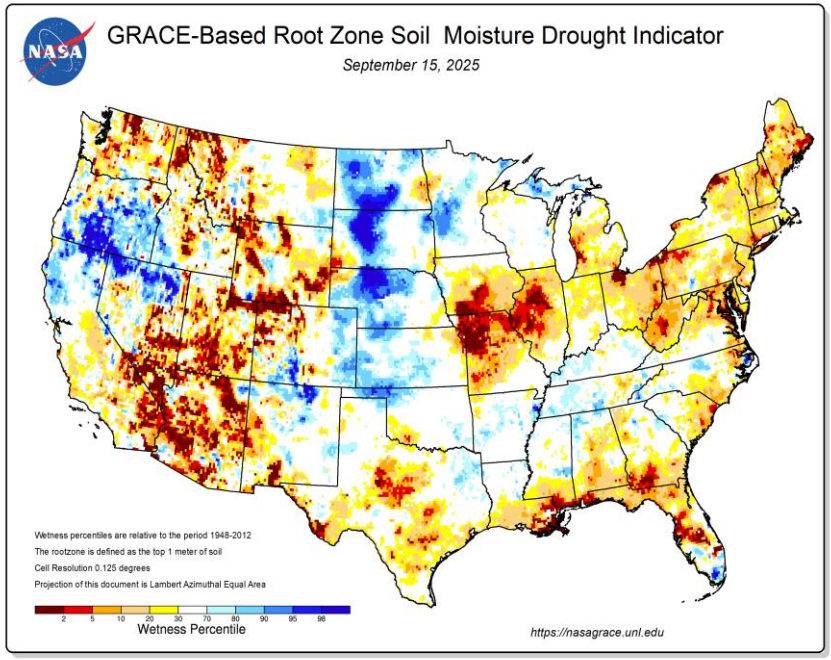
The American Southwest – including Arizona, New Mexico, and portions of Nevada, Colorado, Utah and California – is linked to one of four continental-scale “mega-drying” regions worldwide that have undergone unprecedented rates of drying, according to a recent study in Science Advances.

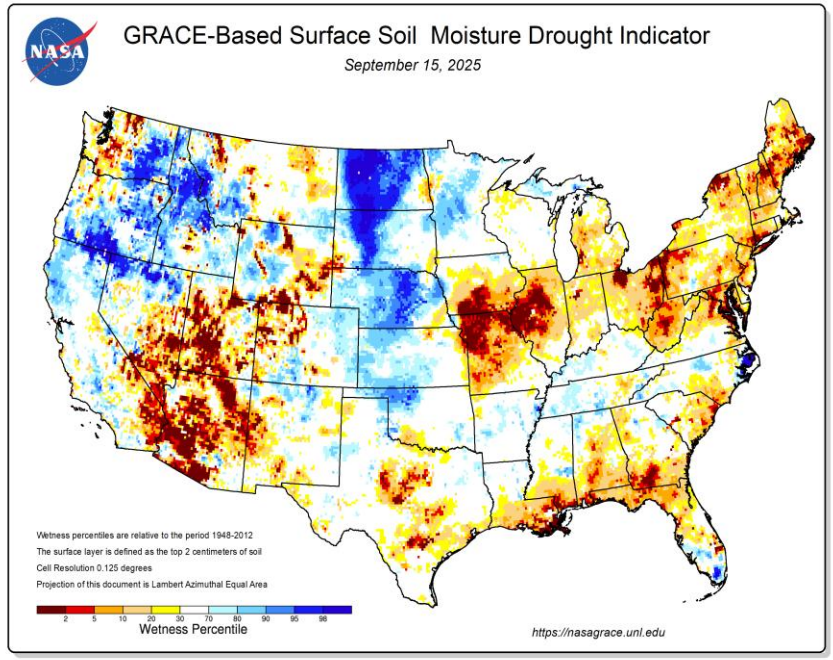
- The loss of freshwater from the regions is the result of two key factors: severe droughts and groundwater overuse.
- Two decades of satellite observations revealed that as the dry areas of the world become drier and surface water in rivers and lakes declines, communities are becoming more reliant on groundwater, leading to rapid depletion of freshwater.

The lower Colorado River Basin – which supplies water for Nevada, Arizona, and California – has lost groundwater equivalent to Lake Mead’s full storage capacity in the last 20 years, or about 28 million acre-feet of water. An acre-foot of water is enough to supply roughly two urban households with indoor and outdoor water needs for a year.









Western Drought: Conditions to Worsen

This summer has been one of the driest on record for the Colorado's critical Colorado River basin, like 2018 and 2021-22, as reported by the Colorado River District.

- Drought in those years made the Colorado River look more like a creek than a river and prompted a 120-mile-long fishing ban on its mainstem.
- Green Mountain Reservoir on the Blue River southeast of Kremmling, did not fill, and the river district will now send water from its upstream Wolford Mountain Reservoir to supplement Green Mountain.
    - High flows from mountain runoff dropped in May, instead of June, and water temperatures started to spike in June, instead of July.

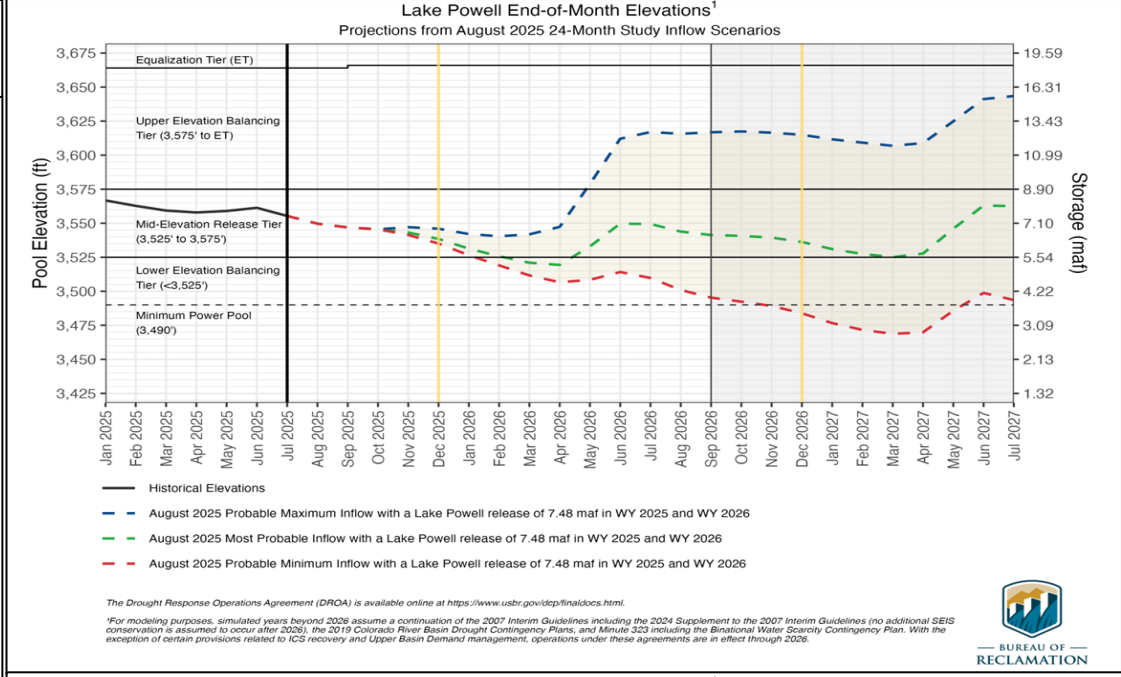
California takes the biggest share of Colorado River water — largely to irrigate half a million acres of alfalfa, winter vegetables and other crops in the Imperial Valley, and also to supply urban Southern California via the Metropolitan Water District. More than half of the power generated at Lake Mead's Hoover Dam goes to California.

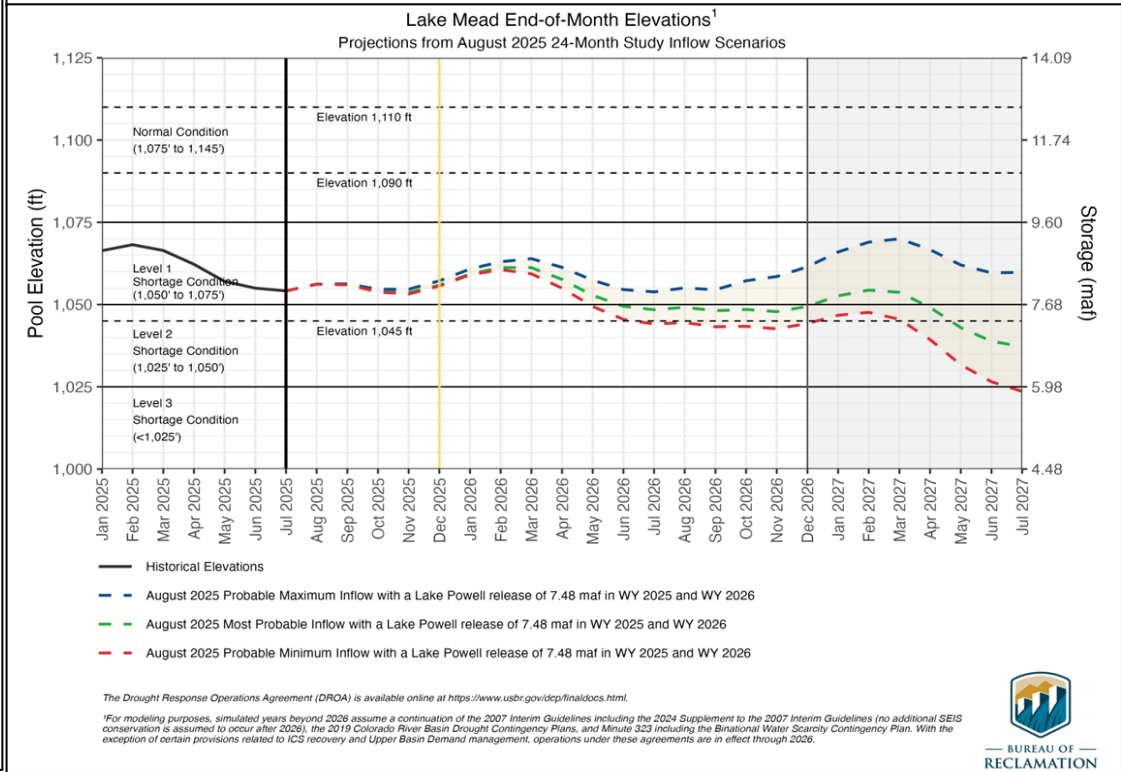
Demand has long outstripped supply, and climate-fueled megadrought and aridification have starved the river in recent decades — drying up the equivalent of Lake Mead by 2021.

By the summer of 2022, the driest 23-year stretch in over a century had sent the river's massive reservoirs plunging to historic lows.

- The reservoirs, each only 31% full, are projected to remain at levels in the coming year that trigger 18% cuts to Arizona's total allotment, 7% to Nevada's, and a 5% reduction for Mexico.

The one that experts say is most likely shows that one more dry year could send Lake Powell plunging below the levels needed to generate power by December 2026. The reservoirs are highly likely to reach *Deadpool* status at least once in the coming decades under current modeling.





Fire Weather

Nationwide, the number of existing properties facing at least a 1% risk will almost quadruple, to 2.5 million by 2050; not accounting for subdivisions to be built in the intervening years.

Over 7 million American homes currently have a "major" risk of wildfire damage, increasing to 13 million over the next 30 years, according to a national wildfire assessment by the First Street Foundation in May 2022.

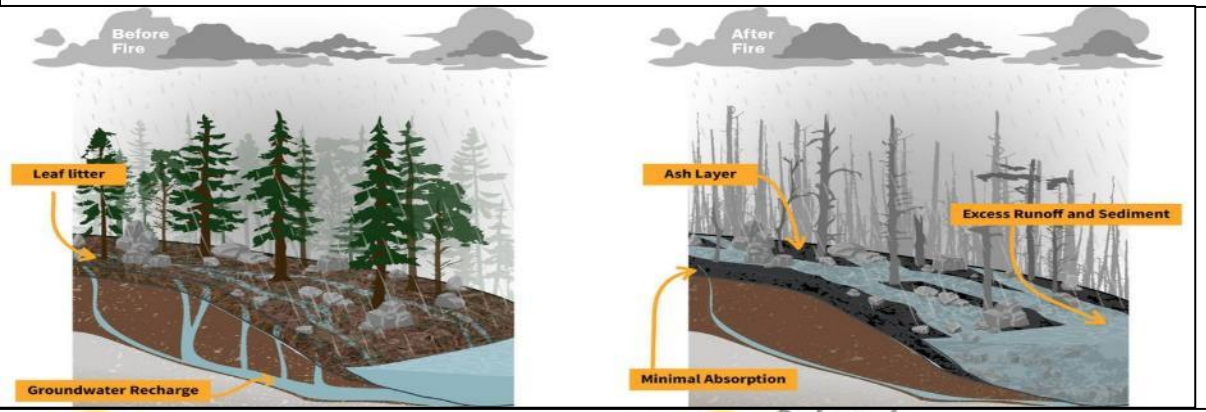
A study from the University of Colorado states wildfires have become larger, more frequent, and more widespread since the year 2000.

Analysis of coincident 1000-hour fuel moistures indicated that as fuels dried out, satellites detected increasingly larger and more intense wildfires with higher probabilities of nighttime burns.

A new study from the University of Montana highlights burn scar impacts to tree regrowth across various regions, indicating new tree seedlings are unable to survive in hotter climates where parent trees remain. The study indicated that if large areas of the forested parts of the Rocky Mountains burned, only 50% would recover.

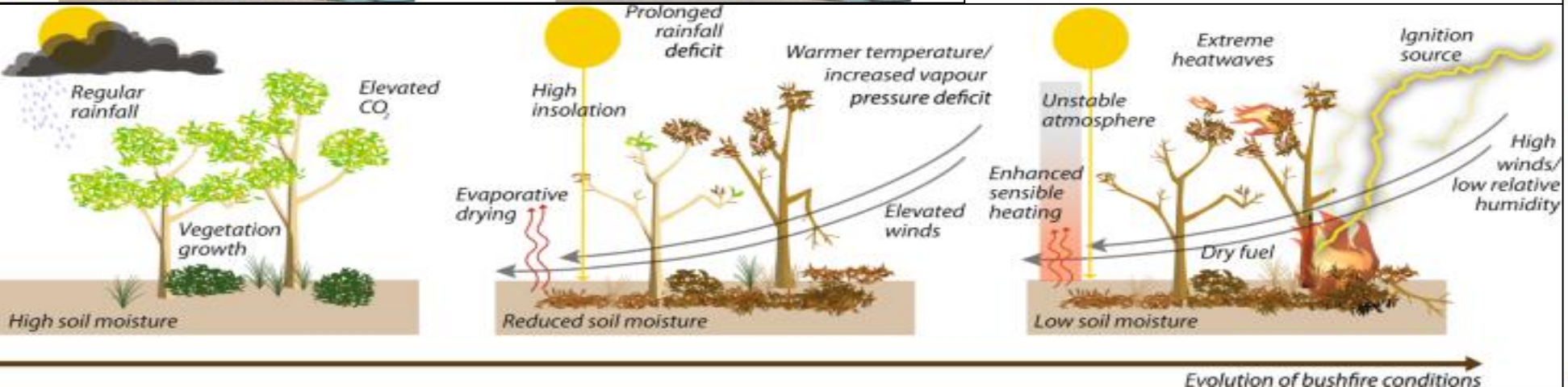
Satellite imagery and state/federal fire history records from 28,000 fires in 1984-2018 showed more fires occurred in the past 13 years than the previous 20 years. On the West and East coasts, fire frequency **doubled**. In the Great Plains, fire frequency **quadrupled**.

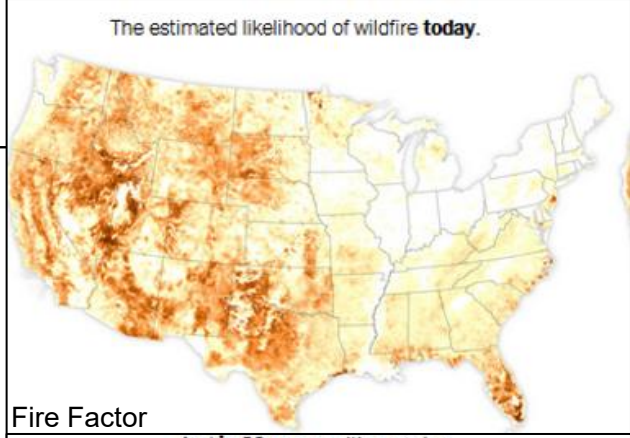
Burned vegetation and charred soil form a water repellent layer which blocks water absorption along with compacted soil from months to years of drought which also inhibits water absorption regionally. These major soil changes cause short rainfall events to be less beneficial for long term



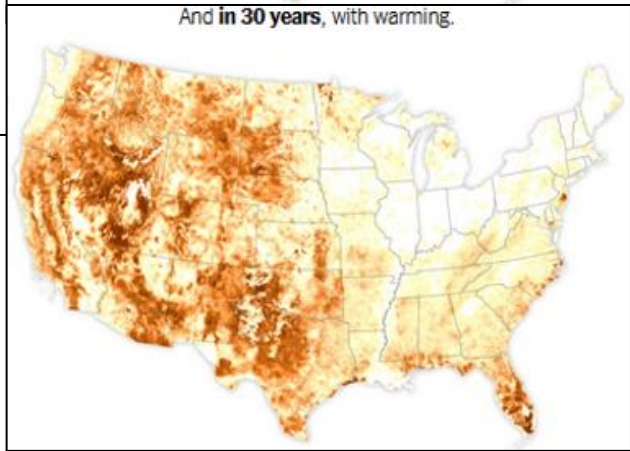
Disasters related to weather, climate, or water hazards happen five times more often now than they did in the 1970s. Droughts that may have occurred only once every decade or so now happen 70% more often.

- The IPCC states heavy rainfall that used to occur once every 10 years now occur 30% more often.
- 61% of western wildfires have occurred since 2000 with a steady increase in the number of wildfires the last 60 years.

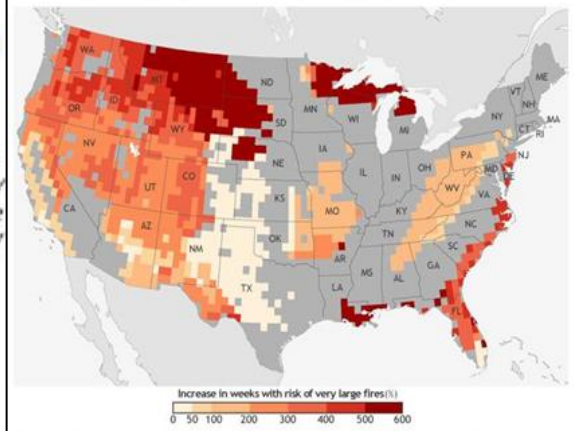




Fire Factor



The map below shows the projected increase in the number of "very large fire weeks"—periods where conditions will be conducive to very large fires—by mid-century (2041-2070) compared to the recent past (1971-2000). The projections are based on scenarios where carbon dioxide emissions continue to increase.



Source: NOAA Climate.gov map, based on data from Barbera et al, 2015.

As fires burn wider areas and into higher elevations topography shifts from tree-creep, soil composition changes, soot deposits, debris flows, burn scars, vegetation/foliage decay, early blooms, flooding post-burn, less wildfire activity, and increased pollution from wildfire smoke, the cycle of heightened wildfire activity will worsen each year.

- Damaged soil from heat transfer result in less fire-resistant plant retention and more scraggly brush growing back between fire weather active periods.

Large wildfires in the right atmospheric conditions can create Pyro-cumulus clouds which can amplify fire growth as they develop severe storm cell traits by causing erratic surface wind gusts, lightning ignitions, downbursts, and even tornadic activity.

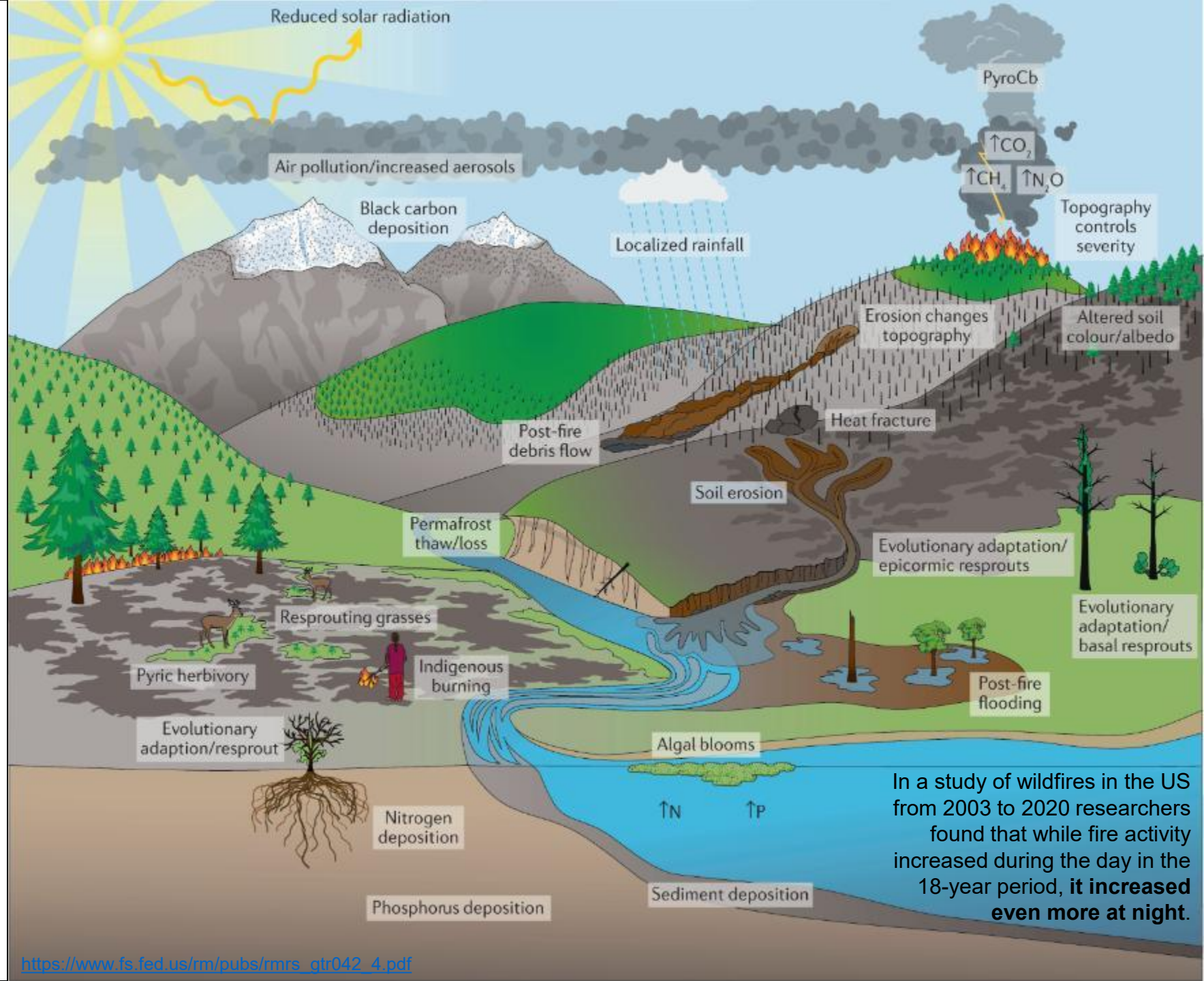
Fires are getting larger and harder to extinguish.

The threats from fewer fires burning more acres can impact the immediate area of the fire by removing the groves/forests and amplifying wind threats and drying while reducing the water retention and force breakup capabilities naturally present historically.

- Without mature trees to hold soils back and slow runoff from storms, sedimentation rates are expected to increase across the rivers and reservoirs system.

- As bodies of water report greater rates of sedimentation there can be an increase in algal blooms or a decrease in retention capacity, causing water safety and ecology concerns.

Deposits of ash/soot into high elevations can provide a dark albedo, feeding snow algae and reducing the stability of snowpacks – yielding avalanche threats.



In a study of wildfires in the US from 2003 to 2020 researchers found that while fire activity increased during the day in the 18-year period, **it increased even more at night**.

https://www.fs.fed.us/rm/pubs/rmrs_gtr042_4.pdf

Tropical Cyclones Strengthening: Wind/Water

Basing emergency response operations off solely a ‘category’ will not prepare regions properly for floods or mudslides

Globally, average sea level has risen over half a foot since 1900 and is expected to rise 1 to 2.5 feet during this century. Coastal regions will experience the worst of these effects.

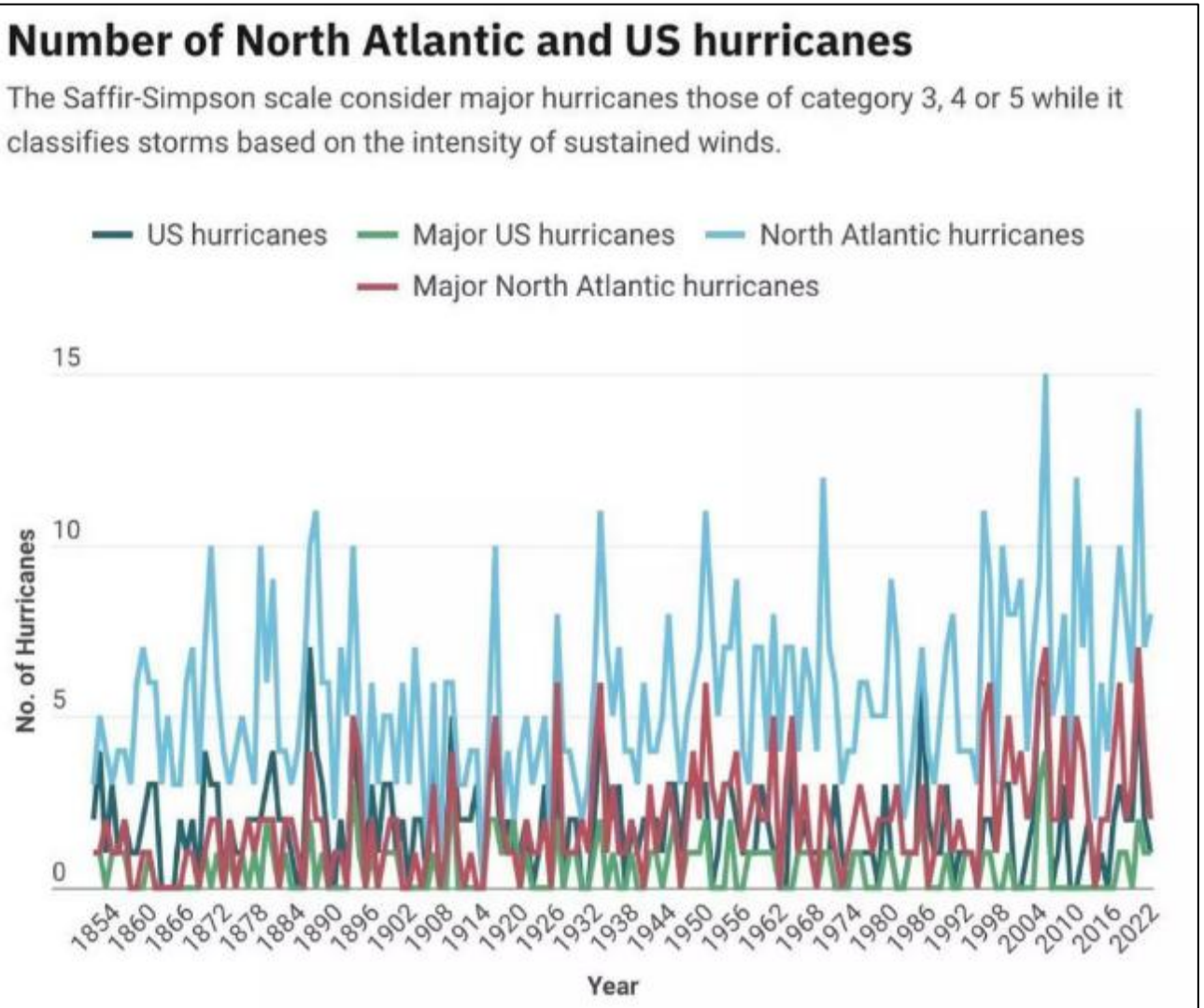
Sea level rise increases the risk of coastal flooding and has intensified the impact of several recent storms.

- A study of Hurricane Katrina estimated that higher sea levels led to flood elevations 15-60 percent higher than climate conditions in 1900.
- A study of Hurricane Sandy estimated that sea levels at the time increased the likely of flooding by three times and that additional rising will make severe flooding four times more likely in the future.

Research reported by Studholme et al in the January 2022 issue of Nature Geoscience suggests northward forming tropical cyclones are consistent with oceanic heating-induced poleward migration of tropical cyclones.

- By 2080, we are likely to see significant tropical cyclone formation and intensification between 30ºN – 40ºN to include New York, Boston, Beijing, Tokyo, etc.

A recent study from China on tropical cyclone landfall producing abnormally heavy rainfall rates, the strongest rains occur when tropical cyclones reach super typhoon (cat 4-5) strength and then weaken to tropical storms after making landfall, meaning cyclones dropping strength before landfall present a larger issue in more flood damage and underestimated event cost/impact.



Tropical Cyclone Changes

Over the recent 2013–2022-decade, rainfall flooding accounted for 57% of all U.S. deaths from tropical cyclones, according to a 2023 report from the NHC.

- From 1980 to 2023, 177 landfalling Atlantic tropical cyclones rapidly intensified.
  - In the North Atlantic, the number of storms that quickly intensified from Category 1 (or weaker) into a major hurricane has more than doubled in 2001-2020 compared to 1971-1990.
  - Most (72%) of the 67 total billion-dollar tropical cyclones in the U.S. since 1980 rapidly intensified.
- Since 1979, warming has increased the global likelihood of a tropical cyclone developing into a major hurricane (+Category 3) by ~8% per decade.
- Warm ocean waters that fueled Hurricane Beryl are up to 400 times more likely.
- The Atlantic hurricane season is expected to be about a month longer by 2100.

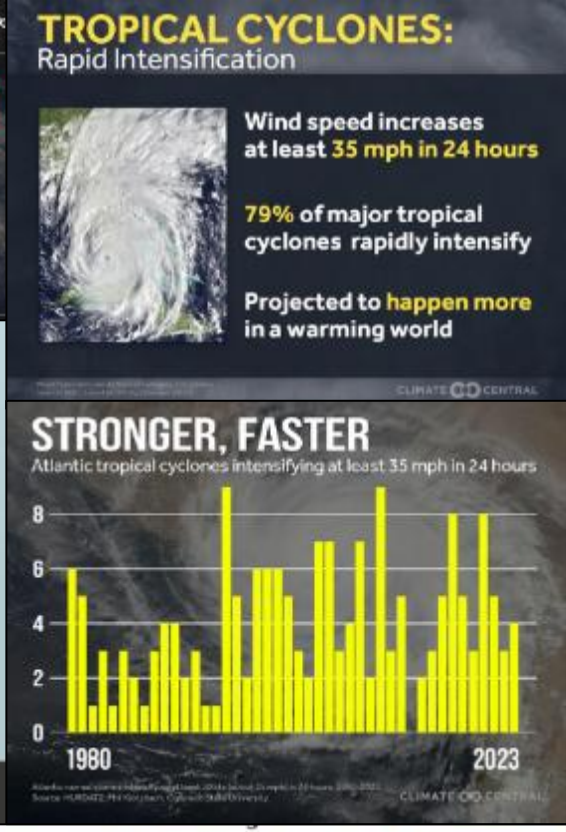
Research shows Atlantic hurricanes are experiencing a reduction of roughly 17% in forward motion speeds than in previous decades, which translates into an increase of about 25% in rainfall.

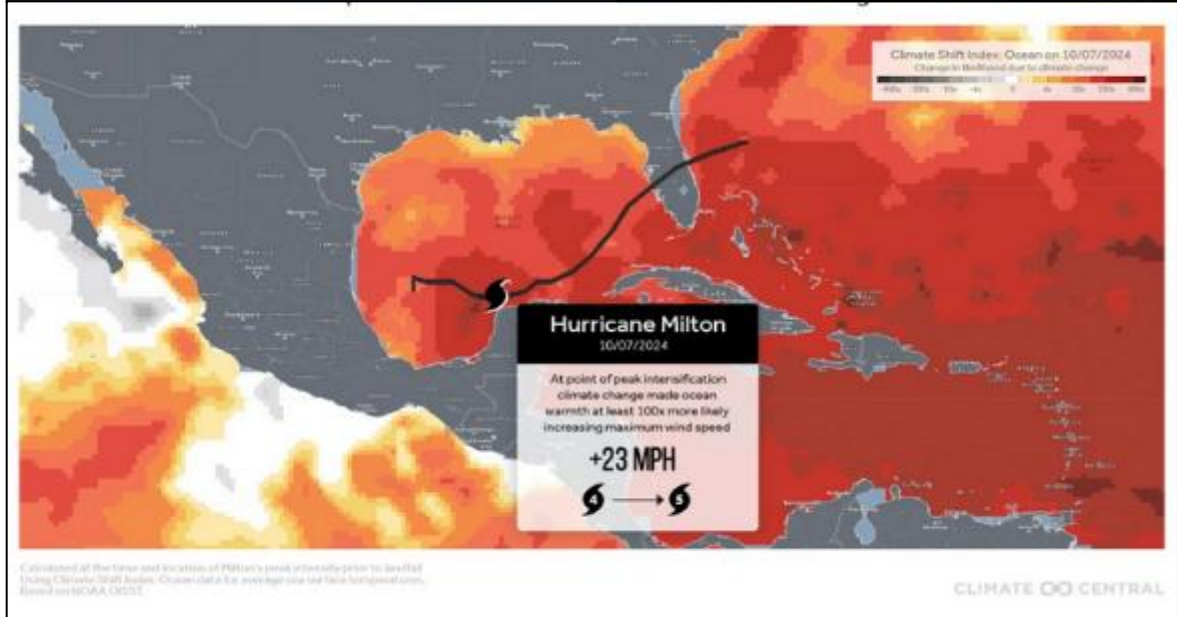
- Extreme rainfall rates (focusing on *hurricane strength only)* saw increases for 3-hourly rainfall rates of 11% and 3-day total accumulated rainfall by 8%.

A recent assessment indicated an increase of global tropical cyclone rainfall rates at 7% per degree of warming with an observational finding of a 1.3% global increase in tropical cyclone rainfall rates per year since the early 1900s.

- A study on the 2020 North Atlantic hurricane season found that hourly hurricane rainfall totals were around 10% higher compared to hurricanes recorded in the pre-industrial (1850s) era.

2025 hurricane season is not forecast to produce a record number of cyclones but could produce more significant damage to US infrastructure via rain and surge.





Sea Level Rise Impacts

The Sea Level Rise Technical Report states flooding is rising toward a nationwide average of 3 to 7 days per year by April 2023 and 45 to 70 days per year by 2050. According to the report, high tides driven by rising seas flooded coastal areas more than 500 times over the past year.

- https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html

Since 1900, global average sea level has risen by about 7–8 inches. Global average sea level is projected to rise another 1–8 feet, with a likely range of 1–4 feet, by 2100.

- Nuisance floods are events in which water levels exceed the local threshold (set by NOAA NWS) for minor impacts.
    - These events can damage infrastructure, cause road closures, and overwhelm storm drains. The additional weight can increase subsidence and erosion effects also.

Higher sea levels will likely increase the probability for major flooding events.

- According to the National Flood Insurance Program (NFIP), “the increase in the expected annual flood damage by the year 2100 for an insured property subject to sea level rise is estimated to increase by 36 to 58% for a one-foot rise” in sea level.
    - Due to local land subsidence, sea level rise along most of the coastal Northeast is expected to exceed the global average rise.

A sea level rise of two feet, without any changes in storms, would more than triple the frequency of dangerous coastal flooding throughout coastal areas of the US.

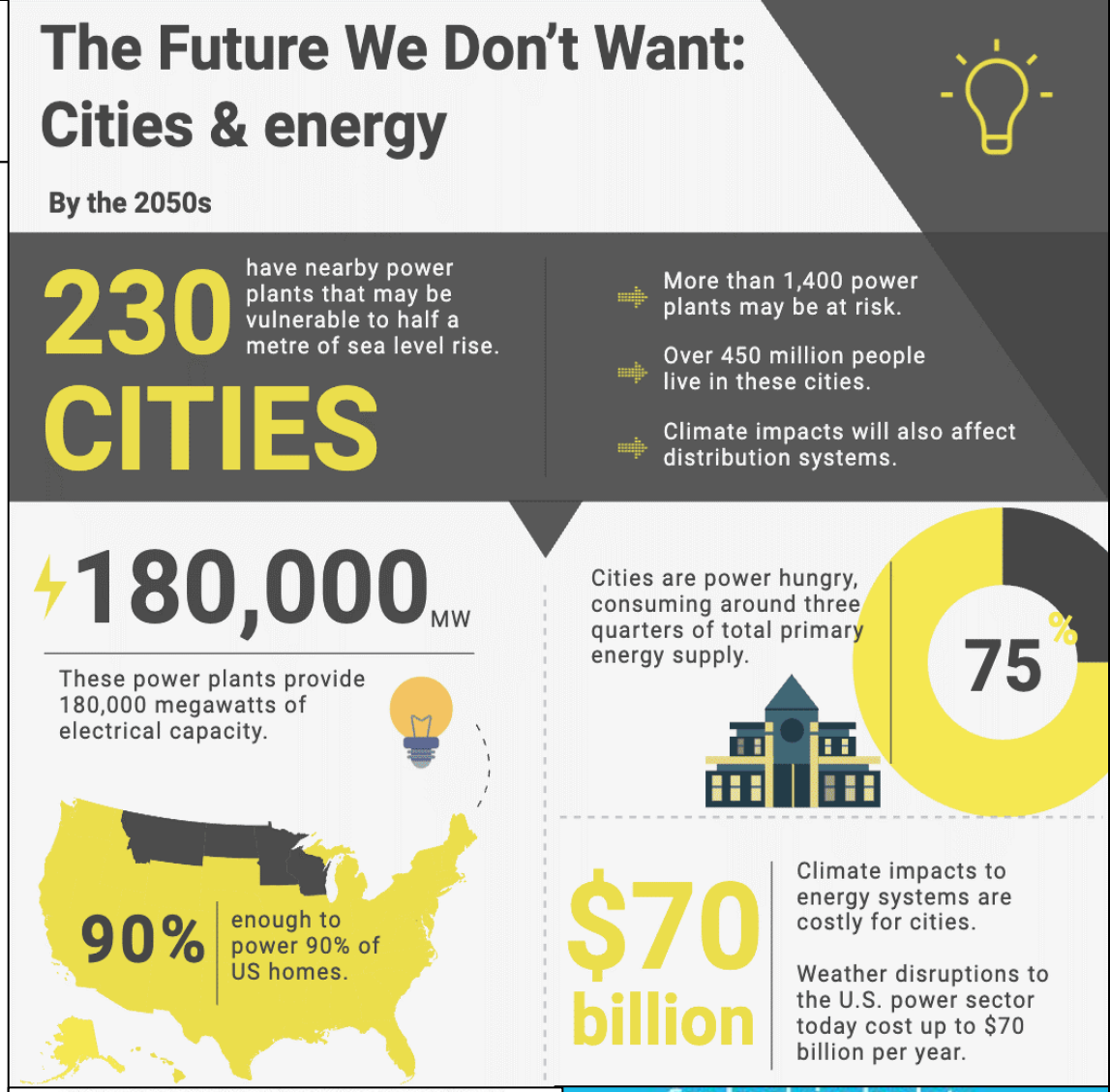
Extreme flooding will continue to be concentrated in regions where humans have built on floodplains or low-lying coastal regions, causing greater risk.

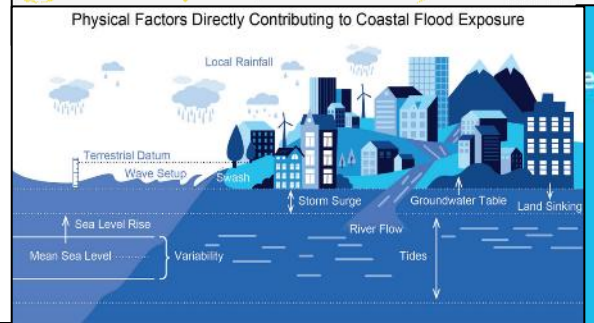
- The rate of rise this past century was greater than any other century in the past 2,000 years.

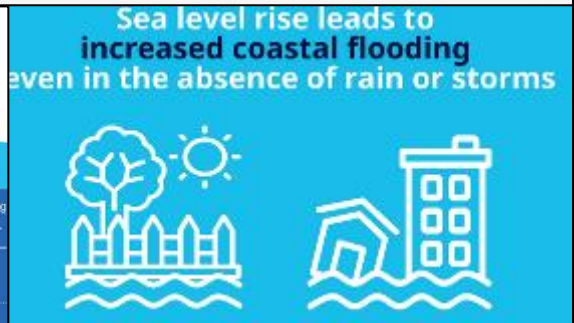
Over 8.6 million Americans live in areas susceptible to coastal flooding, especially from lows such as a hurricane or nor’easter, push a surge of water from the ocean onto land.

Sea level rise is poised to shift the way rivers naturally chart their paths to the shoreline. The nature of that change will depend on both the rate of rise and the sediment load carried by the river, according to 2020 National Science Foundation-funded research.

- If sea levels rise faster than rivers can deposit sediment, the zone of deposition and avulsion will shift upstream, introducing new avulsion hazards to upstream communities.







Stronger Storms = Higher Waves and Sinkholes

A 2019 study shows the global wave power, which is the transport of the energy transferred from the wind into sea-surface motion, has increased globally (0.4% per year) and by ocean basins since 1948. Results indicate the upper-ocean warming, a consequence of anthropogenic global warming, is changing the global wave climate, making waves stronger.

In California, average winter wave heights have increased by as much as a foot since 1970. With more sediment deposit at the mouths of rivers this could result in greater rates of erosion and faster loss of sea floor critical for the coastal ecology.

- Swells at least 13 feet tall (about 4 meters) are also happening a lot more often, occurring at least twice as often between 1996 to 2016 than from 1949 to 1969.

Sedimentation rates can affect earthquake activity by increasing stress on faults, which can lead to shallow earthquakes and large deep earthquakes

- Seawalls also cumulatively increase the intensity of storms because as the beaches disappear, they no longer absorb the impacts of the waves.
- In addition, seawalls increase erosion of neighboring lands that are not protected by seawalls, stimulating more seawall construction.
- Vertical seawalls can also cause a scour hole at the foot of the structure leading to its instability.

Erosion, coastal flooding, damage to coastal infrastructure are listed as threats from the amplified waves and sea level rise.

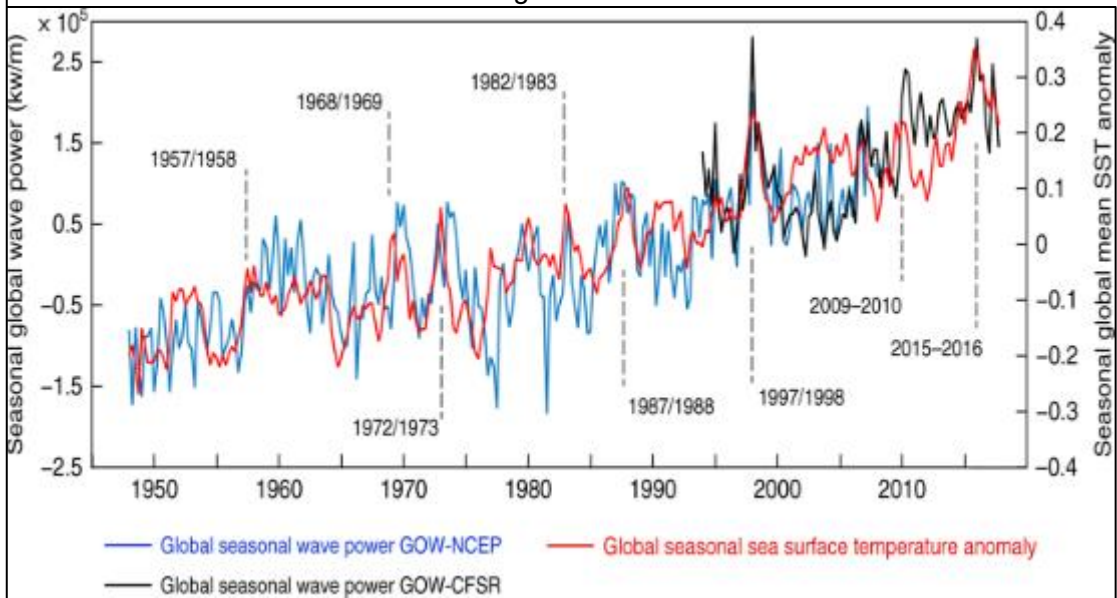
- As sea levels rise and storms intensify, bigger waves will cause more flooding in coastal communities, erode beaches, trigger landslides and destabilize bluffs.

Sinkholes are depressions in the ground caused by erosion, which is the wearing away of soil and rock by water and other forces.

- When heavy rain falls quickly, it doesn't have time to seep into the ground causing the water to pool and weakening the ground over time.
- A series of atmospheric rivers can cause excessive moisture leading to sinkholes.

Subsidence causes water pooling because when land sinks due to subsidence, it creates depressions in the ground surface which can collect rainwater, leading to areas where water accumulates and pools instead of draining properly.

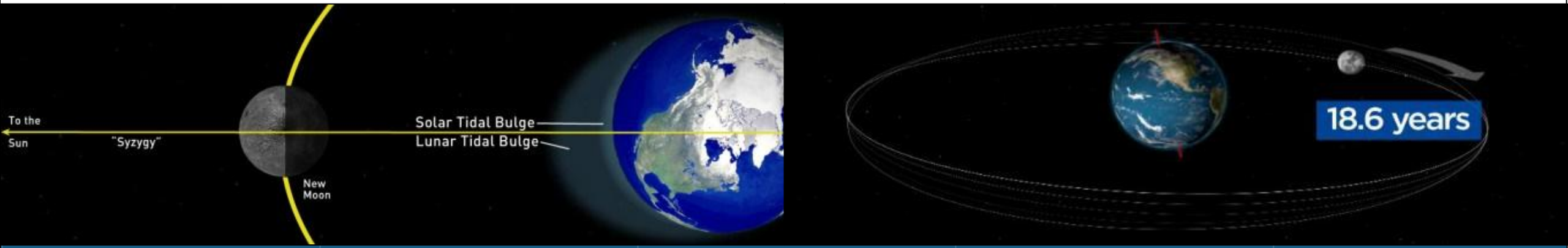
Wind-generated ocean waves drive important coastal processes that determine flooding and erosion.



Moon Wobble Amplifies Sea Level Rise Threat

As part of the 18.6-year lunar nodal cycle, the moon orbits around the Earth on a plane that is tilted about 5 degrees relative to the Earth's orbit around the sun, known as the ecliptic plane. **When the moon intersects with Earth's orbit at the two nodes, it wobbles.** This event was first reported in 1728 and fluctuates the Moon's gravitational pull on the tidal events across the globe.

- The tilt can either suppress or amplify tides. High tides could become lower than normal, and low tides could become higher than normal. Thereby, half of the 18.6-year lunar cycle counteracts the effect of sea level rise on high tides, and the other half increases the effect.
- Nasa has predicted in a new study that the next moon wobble will directly impact American coastlines in the **mid-2030s.**
    - "The higher seas, amplified by the lunar cycle, will cause a leap in flood numbers on almost all U.S. mainland coastlines, Hawaii, and Guam. Only far northern coastlines, including Alaska's, will be spared for another decade or longer because these land areas are rising due to long-term geological processes."
        - Why does this matter to you? Planning: Understanding that all your flooding events are clustered in a particular month, or you might have more severe flooding in the second half of a year than the first – that's useful information. Example: King Tide increases into areas which flood a handful of times a year may see floods a handful of times per season. 'Sunny Day' flooding events are already being amplified by the expanding sea levels from glacier melt and ocean surface heating.
        - Puget Sound saw its lowest tide in more than a decade mid-June 2022, 4 feet lower than the average daily low tide. The wobble in the moon's orbit is nearing its peak, making the tides roll in and out more powerfully than usual in the past 13 years.
    - **NASA says most US coastlines will see a three to four times increase in high tides for at least a decade**, according to the study.
        - https://www.nasa.gov/feature/jpl/study-projects-a-surge-in-coastal-flooding-starting-in-2030s/
    - A hub of resources for climate tools and sea level change, the seal level rise tool can be used for coastal flooding planning: https://sealevel.nasa.gov/
    - The Virtual Earth System Laboratory includes simulations related to glaciers, ice sheets, sea level, and solid earth: https://sealevel.nasa.gov/data_tools/2



GLOBAL MEAN SEA LEVEL	OCEAN MASS	STERIC HEIGHT	GREENLAND ICE MASS CHANGE	ANTARCTICA ICE MASS CHANGE
↑ 3.4 ± 0.4 mm/yr	↑ 2 ± 0.3 mm/yr	↑ 1.2 ± 0.2 mm/yr	↓ 273 ± 21 Gt/yr	↓ 151 ± 39 Gt/yr

High-Pressures and Humans

Hot weather increases body temperature, which in turn increases heart rate and blood pressure. Increased blood pressure and heart rate can lead to discomfort, which can be attributed to the correlation between high heat and increased anger and violence.

- A recent study in India found that a 1C increase in annual mean temperature was associated with a 4.5% increase in intimate partner violence. Other studies noted the increase in sexual violence and heightened workplace violence during heat events.

When the barometric pressure is high, more pressure is pushed against our body, limiting tissue expansion, increasing blood pressure with an increased possibility of heart attacks.

- A 10-millibar decrease <1016 millibar and a 10-millibar increase >1016 mbar were associated with a 12% increase and an 11% increase in myocardial infarction and coronary death events.

Studies have focused on temperatures more than the high-pressure centers enabling persisting heat events over regions for longer periods.

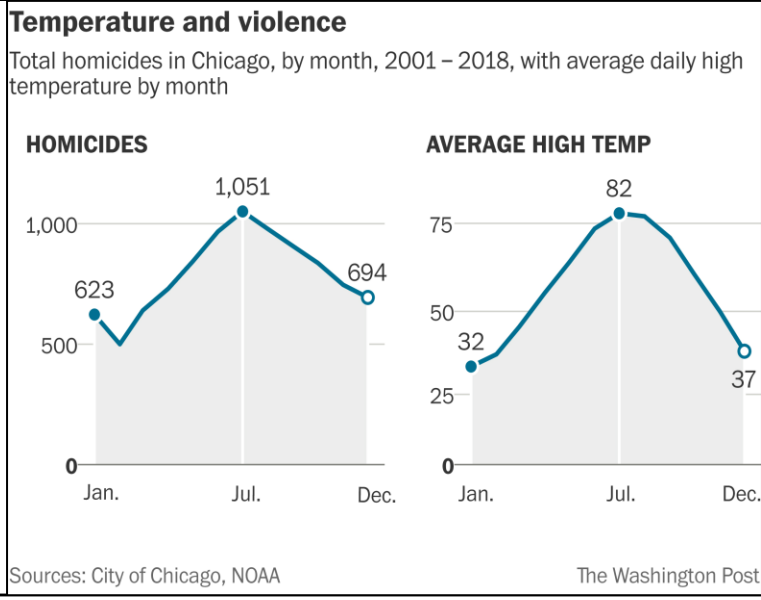
- A 2019 study from Stanford University found weather instability contributed to between 3% to 20% of conflicts over the last century with the potential influence set to increase substantially due to warming temperatures.
- Research from Mexico took 16 years' worth of daily crime records and found an increase in temperature of 1C correlated with an increase across all types of crime by 1.3%.
- There were about a third more accusations of crime per population on days hotter than 32C than on days cooler than 10C.

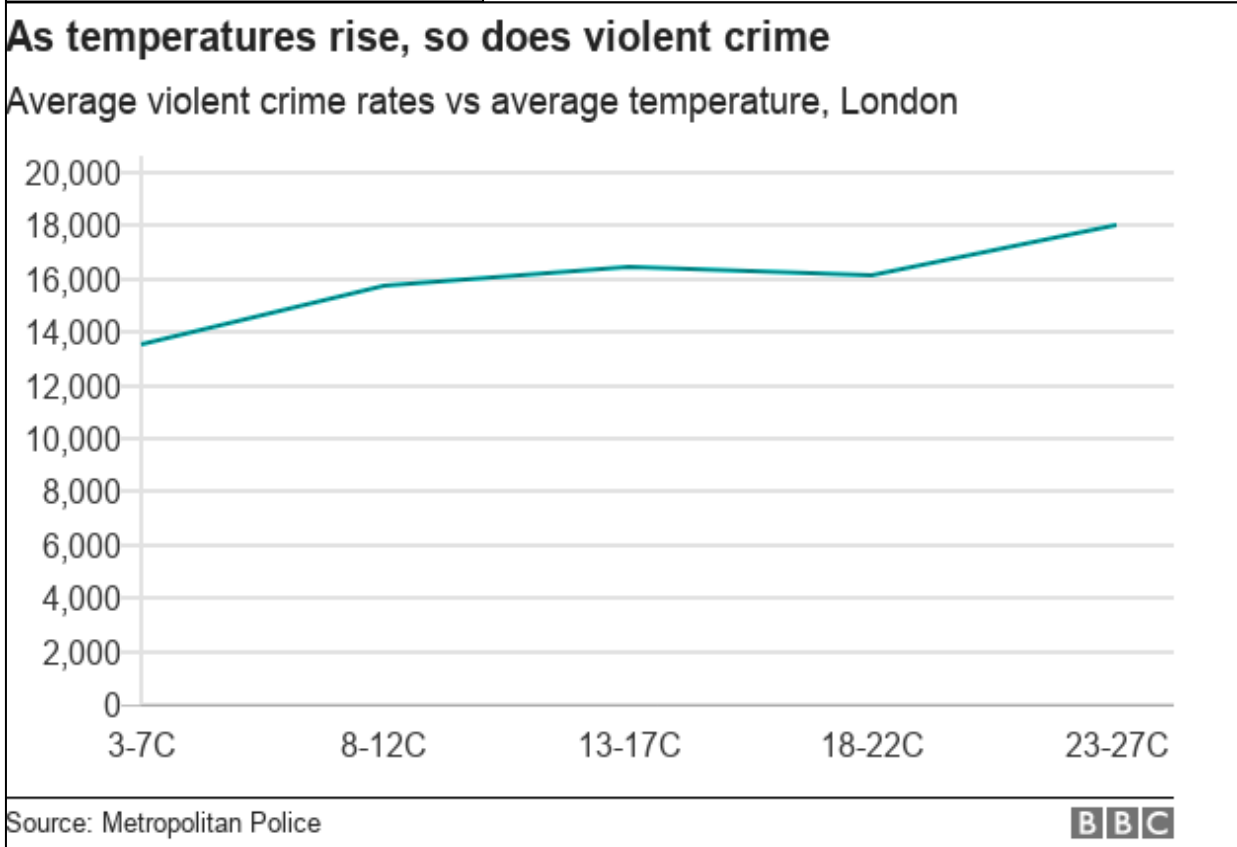
A study of Los Angeles, CA: Overall crime increases by 2.2% and violent crime by 5.7% on days with maximum temperatures above 85F (29.4C).

A 2019 study on terrorist attacks found that not only were terrorist attacks more common on hotter days, but also that the number of fatalities per attack were higher.

Even if the world's countries managed to keep "global temperature rise this century well below 2C above preindustrial levels," global terrorist attacks would increase by 14% solely due to hotter days.

Total terrorism fatalities would rise by 24% to include the increase in populations being outside more and larger events.





According to a 2018 study published in *Nature Climate Change*, a 1.8°F (1°C) increase in average temperature in the U.S. and Mexico correlates to a 1% increase in suicides. Poor quality sleep may be one of the driving factors.

- Heat also plays a role in perceiving an aggressive tone or transgression when interacting with others. Violence in prisons also increases during extreme heat with days ranging over 27C increasing the probability of violence by 18%.

Twitter sees hate tweets and online aggression increase during heatwaves, along with phrasing that researchers have linked to anxiety and depression.

Analysis showed that productivity started dropping when average daily maximum temperatures rose above 20° C. The researchers' calculations suggest that average annual output will decrease by 2.1% if average daily temperatures warm by 1 degree C over current conditions; annual gross domestic product, or the value of goods and services produced in a single year, would drop by 3%.

- Impacts to venue operations could be experienced in decreased productivity, more aggressive crowds, losses in supply chain, site damages, staff burnout, greater damage to operational capabilities, and delays/cancellations of performances/events.

Portland sees spike in gun violence as heat wave blankets metro area

Published: Jul. 8, 2024 at 1:21 AM EDT

A laboratory experiment found that participants demonstrated an increase in the joy of destruction when subject to increasing ambient temperatures.

As the temperature rose across Portland, so has violent crime, with six shootings since July 4. According to a local sociology professor, that is a predictable pattern.

According to the Mississippi Department of Public Safety, the violent crime rate in **Mississippi** increased by 2.4% in 2022 from the previous year.

- The most common violent crimes in Mississippi are aggravated assault, robbery and murder.

Research from Lancet Planetary Health states for every 5°C (9°F) increase in the average daily temperature, there was a 4.5% uptick in sex offenses in the following week across several major U.S. cities.

- On days when the temperature gauge exceeded 85°F (29.4°C), overall crime jumped by 2.2%, and violent offenses surged by 5.7%.

With each 5°C rise in temperature, **Chicago**'s homicide rates shot up by 9.5%, and **New York City** wasn't far behind with an 8.8% increase.

In 1988, during the periods warmest summer on record, the US reported record-breaking violence (1.56 million cases).

- This is a global phenomena and risk.

Atmospheric Changes and Wildlife

Experts theorize air pressure changes affect a fish's swim bladder, which is used to help a fish maintain neutral buoyancy. The bladder is filled with air and is thereby sensitive to pressure changes that occur when moving between different depths, likely to be affected by changing air pressure.

Recent studies found that temperature indeed drives spatial and temporal changes in fish body size. Around 55% of species were smaller in warmer waters (especially among small-bodied species), while 45% were bigger.

Dogs are more likely to attack people on days with higher UV levels, according to Harvard Medical School research.

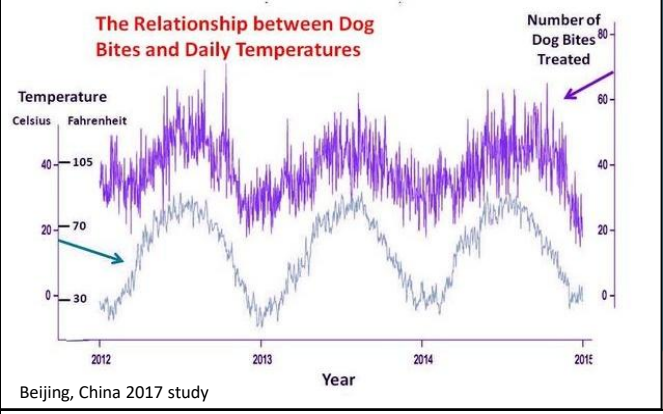
- Dog bites increased by 11% on days with higher UV levels, 4 percent on hotter days, and 3 percent on days with increased ozone levels.

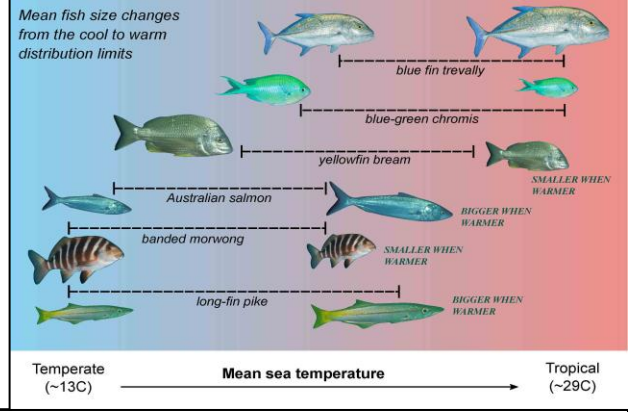
Previous studies have linked high temperatures and air pollution to increased aggression in humans, rats, and monkeys.

As a warm weather loving animal, a hotter environment could allow North Carolina's alligators to expand their limited distribution to areas further inland and away from wet, boggy coastal areas.

- Warmer temperatures could also result in changes to reproductive rates, allowing for earlier sexual maturity and changes in body size for alligators. This could have implications for similar creatures globally.
- Florida has seen a significant rise in alligator attacks, with the Florida Fish and Wildlife Conservation Commission (FWC) reporting an upward trend in the number of alligator bites and fatalities.
- Almost half of the 453 alligator bites reported in Florida between 1948 and 2022, around 47%, occurred in the last 22 years, from (2000-2022).

An uptick in human-shark interactions has been occurring on the shores of Long Island, New York -- closing beaches as surfers, lifeguards and swimmers suffer bites from sharks in search of food.





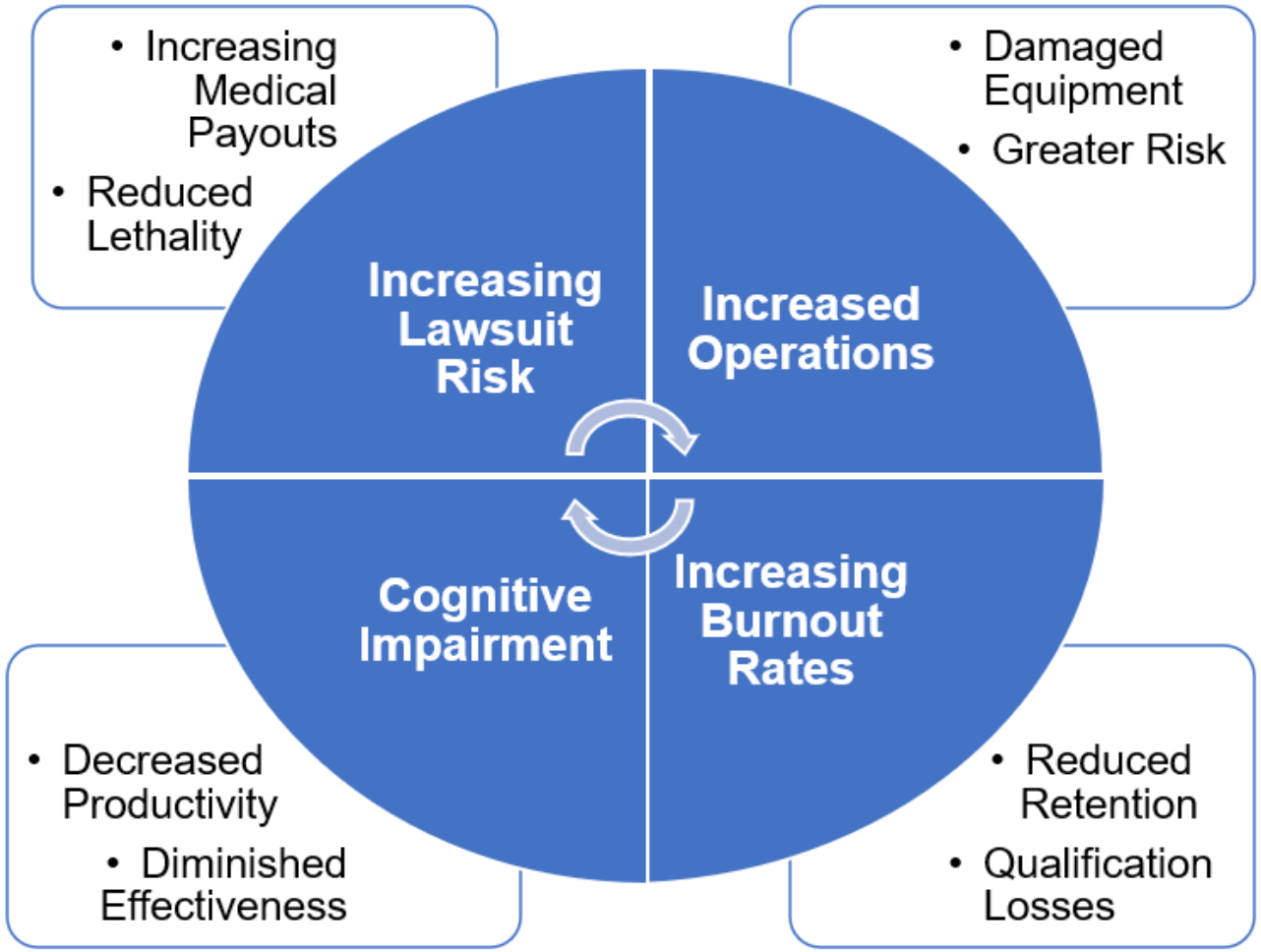
While the onset of overall changes in heat can drive migration threats for animals, the amplification of intensity for storms (both continental and tropical) can trigger bursts of movement and subsequent threats to population centers which normally are not exposed to sudden influxes of insects, rodents, or predators.

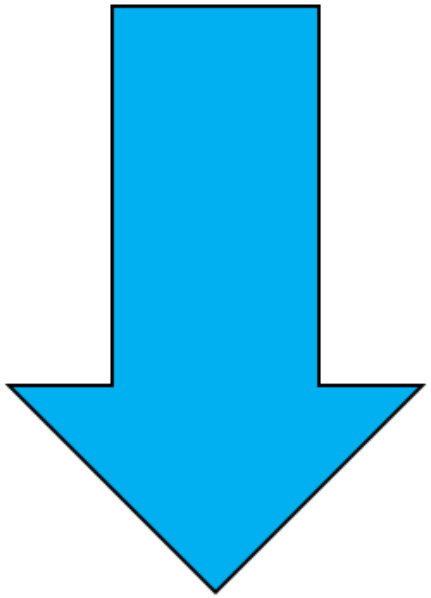
- Sudden floods from a rare storm in Egypt flushed swarms of scorpions and tarantulas from their underground burrows into people's homes resulting in over 500 locals seeking medical attention due to stings.
- Torrential floods in Tanzania led to more lion attacks after their usual prey migrated away from floodplains.
- Higher air temperatures in Australia triggered more aggressive behavior in eastern brown snakes, leading to more incidents of snake bites.
- Wildfires in Sumatra, Indonesia drove Asian elephants and tigers out of reserves and into human-inhabited areas, leading to at least one death.
- Disruption of food webs in the Americas drove black bears in New Mexico and foxes in Chile into human settlements in search of food.
- Warmer air and ocean temperatures in a severe El Nino led to an increase in shark attacks in South Africa.

In India, unstable weather reduced vegetation for blue sheep (bharal), forcing them to feed on human crops, drawing snow leopards into town.

Higher Highs → Lower Lows

Variations outside of the normal for barometric centers present growing operational risks to emergency managers as many struggle to understand the impacts from this invisible threat and are thereby caught off-guard by the symptoms degrading their work performance and destabilizing societal norms.



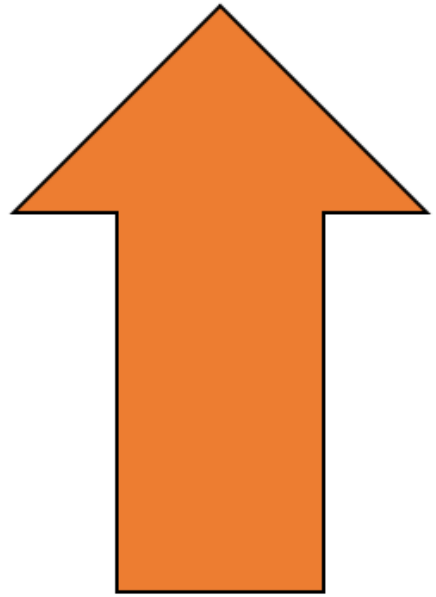


High Pressure Impacts

- Aggression
- Property Damage
- Workplace / Domestic Violence
- Membrane Rupture
- Rising Blood Pressure
- Poor Air Quality
- Heatwaves – Heatstroke
- Paranoia
- Poor Sleep

Low Pressure Impacts

- Suicidal Ideation
- Depression
- Lethargy
- Sinus Issues
- Muscular Pain
- Joint Aches
- Barometric Migraines
- Manic Events
- Digestive Issues



Energy Use: Global Rise

New ICF Study: The global consulting and technology services company predicted that electricity demand could jump at least 25% in the next five years and as much as 78% by 2050 — findings that far outpace historical trends over the past two decades.

- Demand-side management can handle 10% of U.S. load in 2030, but annual generation deployments need to double to keep pace with expected longer-term demand.
- Service territories covering parts of Virginia, Georgia and West Texas could all see 6% growth in overall and peak load through 2035

Threat level: The consumption surge could raise retail rates by 15% to 40%, depending on the market, ICF finds.

- Demand management, efficiency and behind-the-meter tech (think home solar and storage) will be key to mitigate price spikes, ICF said.
- "Broad promotion of these programs could help meet 10% or more of electricity demand by 2030 compared to 8% in 2025."

Stunning stat: On the generation side, new power-producing capacity additions need to rise to roughly 80 gigawatts per year from 2025-2045 — around double the pace of the past five years.

- The report notes that the Energy Information Administration's 2025 annual outlook saw a 12% demand rise in 2030 in their "high" economic growth case and 9% in their "reference" case.

But adding newer data from regional grid planners — including PJM, ERCOT, MISO and parts of SERC — paint a very different picture, ICF said.

- In California, 35% of the increase through 2040 is EVs, building electrification and data centers.
- In Texas, new "large loads" like crypto-mining lead.
- In PJM, the huge mid-Atlantic and Midwest region, it's a combo of new manufacturing (including semiconductors), data centers, building electrification, EVs and more.

Electricity costs are also expected to rise and outpace inflation, with experts predicting a jump of 6% in 2025 — an average of $784 per household for the summer period.

- That would mark a 12-year record, according to a new analysis from the National Energy Assistance Directors Association.

Power Outages in US Metros

Average outage minutes per customer per month, with outliers removed.

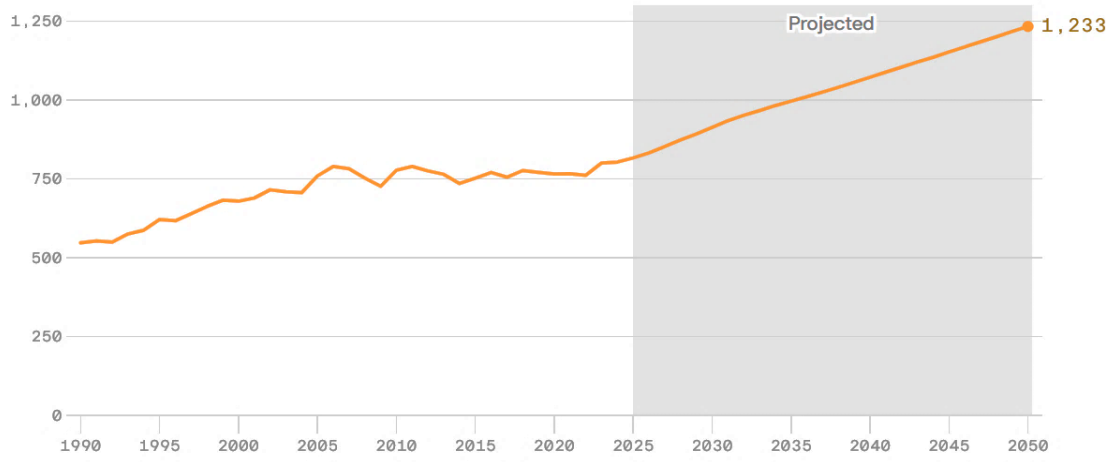
City	2018	2019	2020	2021	2022	2023	2024
Atlanta	9.9	10.9	14.9	11.1	15.3	11.0	17.5
Phoenix	5.1	6.5	6.2	7.2	8.3	6.6	7.1
Bay Area	9.6	17.1	20.2	15.4	17.2	22.2	22.9
Boston	11.4	8.5	19.9	8.7	11.1	13.2	8.5
Philadelphia	12.4	17.9	12.2	14.9	9.4	12.1	18.2
DC	9.6	11.9	10.6	12.8	13.1	9.1	10.8
Miami	9.6	9.4	9.9	9.3	8.7	10.5	9.4
Houston	14.1	23.4	20.4	19.7	21.6	21.6	19.7
Dallas	11.3	13.0	12.9	12.4	17.1	16.0	13.8
Chicago	7.4	8.9	6.3	7.5	7.2	6.3	6.4
LA	12.8	12.6	12.8	14.2	14.1	15.0	12.0
NYC	8.3	9.6	9.6	9.9	9.3	8.5	10.1

Table: Brian Potter • Source: Poweroutage.us

IFP

U.S. peak electricity demand

In gigawatts; Annually, 1990-2024, 2025-2050 projected



Data: ICF; Chart: Axios Visuals

U.S. electricity needs are slated to rise 25% by 2030 and 78% by 2050 compared to 2023, sinus-clearing estimates from the consulting firm ICF seen first by Axios show.

More Than 110 New Flights Cancelled in China as Severe Weather Disrupts Travel for Air China, China Eastern, Shanghai, Shenzhen Airlines, and More, Stranding Passengers

Published on September 16, 2025 By: Rana Pratap

UK weather: Scandinavian ice-dome to send temperatures plunging just days after 26C heat

TN Soybean farmers face 'desperate situation' amid inflation, weather extremes and tariffs

The University of Tennessee in August estimated total losses of nearly $110M for soybeans this year

BY: **CASSANDRA STEPHENSON** - SEPTEMBER 15, 2025 5:00 AM

A New Polar Vortex is Now Emerging over the North Pole and will bring Weather Impacts on Winter 2025/2026

By Andrej Flis

Published: 18/09/2025

Long range / seasonal forecast

Water shutoffs happening earlier than usual for some Yakima Basin irrigators

BY: **QUESTEN INGHRAM** - SEPTEMBER 8, 2025 3:48 PM

A new Polar Vortex is now developing in the Stratosphere over the North Pole as pressure and temperatures are already dropping over the polar regions. With the recent oceanic and atmospheric anomalies having an impact on the Polar Vortex, there are signs emerging for a dynamic Winter 2025/2026.

Syria's worst drought in decades pushes millions to the brink

3 days ago

Samantha Granville

Drought is draining water supplies and driving up food costs where you'd least expect

From Mexico City to the Mekong Delta, increasingly severe droughts caused by climate change are laying waste to ecosystems and economies everywhere.

by Ayurella Horn-Muller, Grist

07/18/2025

SEPTEMBER 18, 2025 The GIST

Europe, Mediterranean coast saw record drought in August: EU data

edited by Andrew Zinin Editors' notes

WEATHER A FACTOR IN EARLY SOUTH AMERICAN PLANTING SEASON

September 18, 2025 By Jared White Filed Under: Ag Weather, Crops, News

Russian-occupied part of Zaporizhzhia Oblast sees lowest harvest since 2003

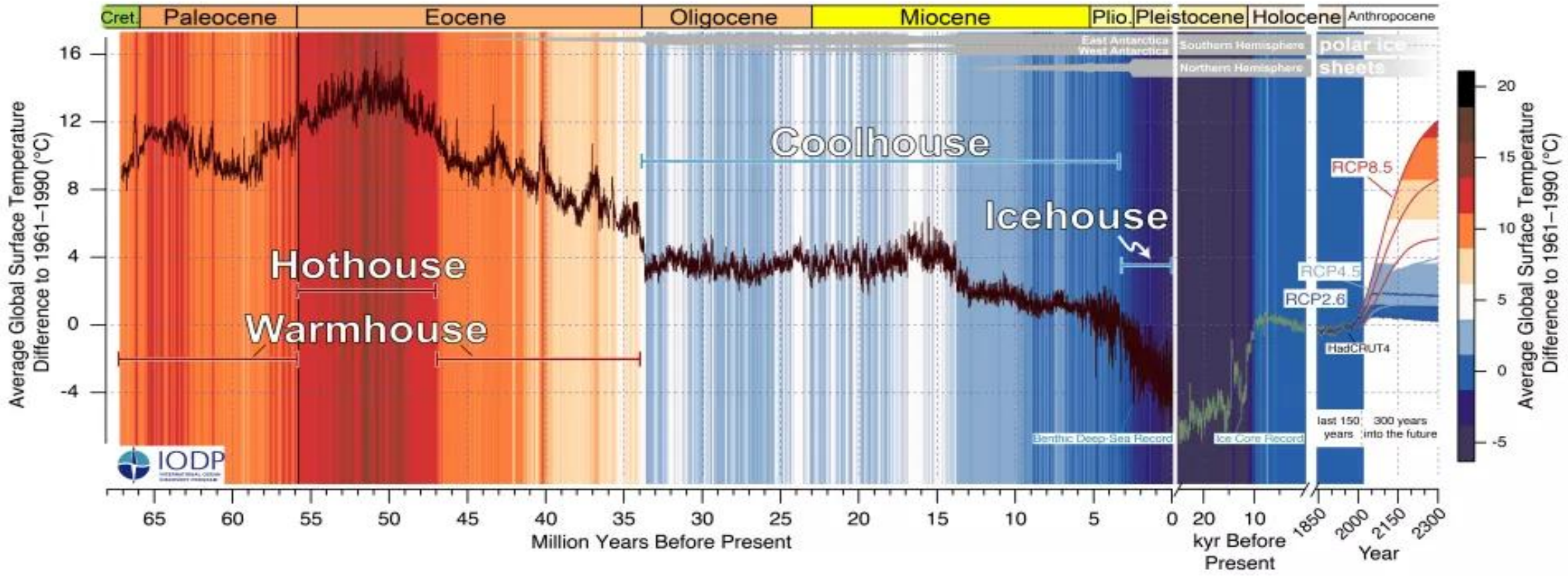
ANDRII MURAVSKYI — FRIDAY, 19 SEPTEMBER 2025, 16:36

Defined Threat: Condensed Period to Adjust

The change in heating is not just that it is baseline creeping upwards, it is that we built to norms from a window of time in stable conditions that we will not be returning to during the next few lifetimes. This means infrastructure was simply not build to withstand.

- The weather hazards defined in previously slides will amplify rapidly in coming decades as the temperature continues to rise.
- Acclimation periods will reduce rapidly as temperatures varying outside of human capacity, materials will face comparable strain.

When comparing the historic warming period, it is critical to annotate which materials shift from rapid heating and may push against or pull away from partnered materials or stress the binding type.



CONTACT

Chief Meteorologist Sunny Wescott

LinkedIn: https://www.linkedin.com/in/sunnywescott/

- Email: Sunny@unlimitedweather.com
- Download: https://linktr.ee/swescott

More Questions?
Reach out instantly
on Aid Arena!

HELPFUL STARTS

- NOAA Repository:

https://www.ncei.noaa.gov/cdo-web/

- Frontal Boundaries:

https://aviationweather.gov/gfa/#progchart

- Infographics:

https://www.climatecentral.org/

- World Meteorological Organization:

https://wmo.int/topics/extreme-weather