

Lightning & Severe Weather



Aaron B. Wilson

State Climate Office of Ohio

Byrd Polar and Climate Research Center

OSRT – 3 June, 2016



The Power of Weather



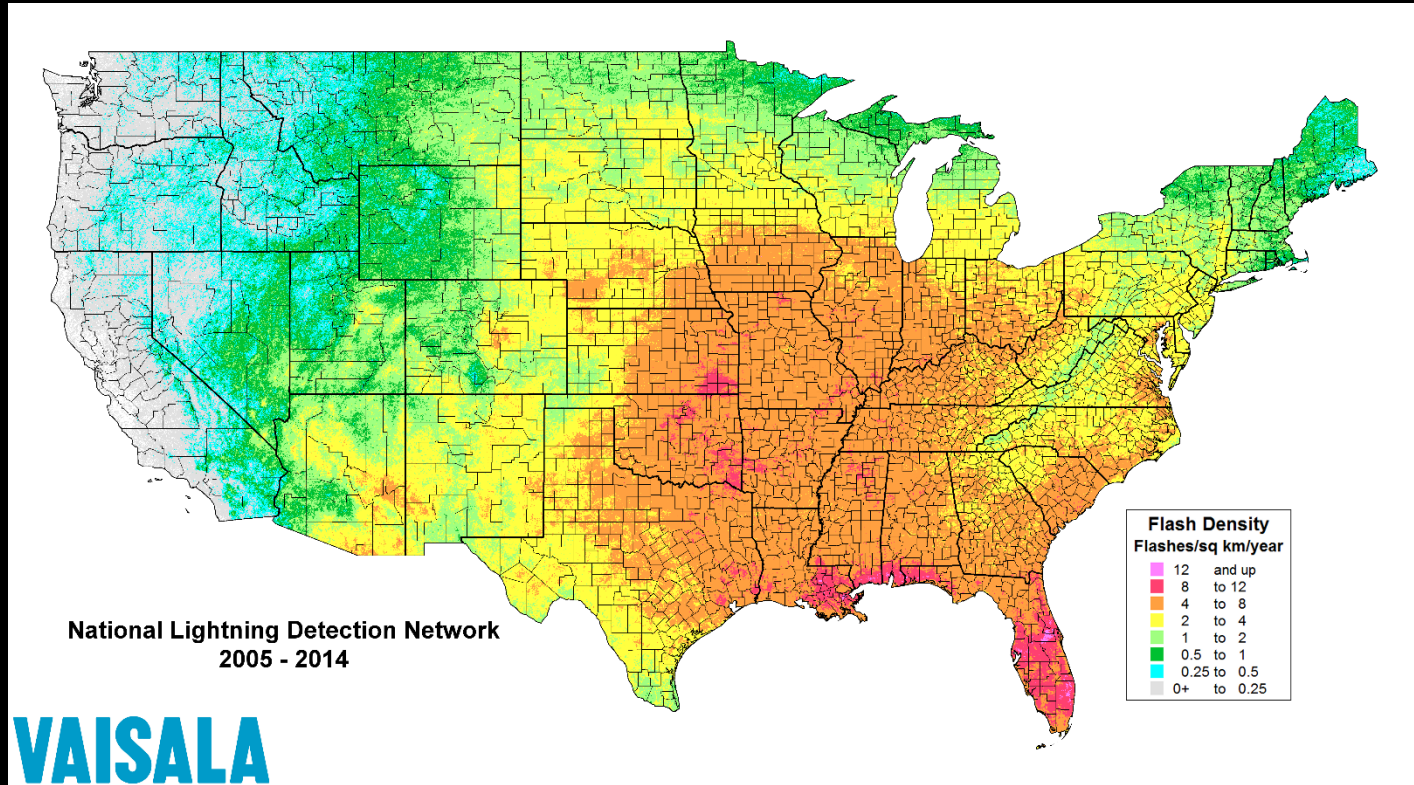
THE F5 TORNADO THAT DEVASTATED XENIA, OHIO, ON APRIL 3, 1974



Lightning Facts

- Lightning strikes the United States about 25 million times a year.
 - In Ohio in 2015: 268,215 on average: 412,702
- Most lightning occurs in the summer, but people can be struck at any time of year.
- Lightning kills an average of 49 people in the United States each year, and hundreds more are severely injured.

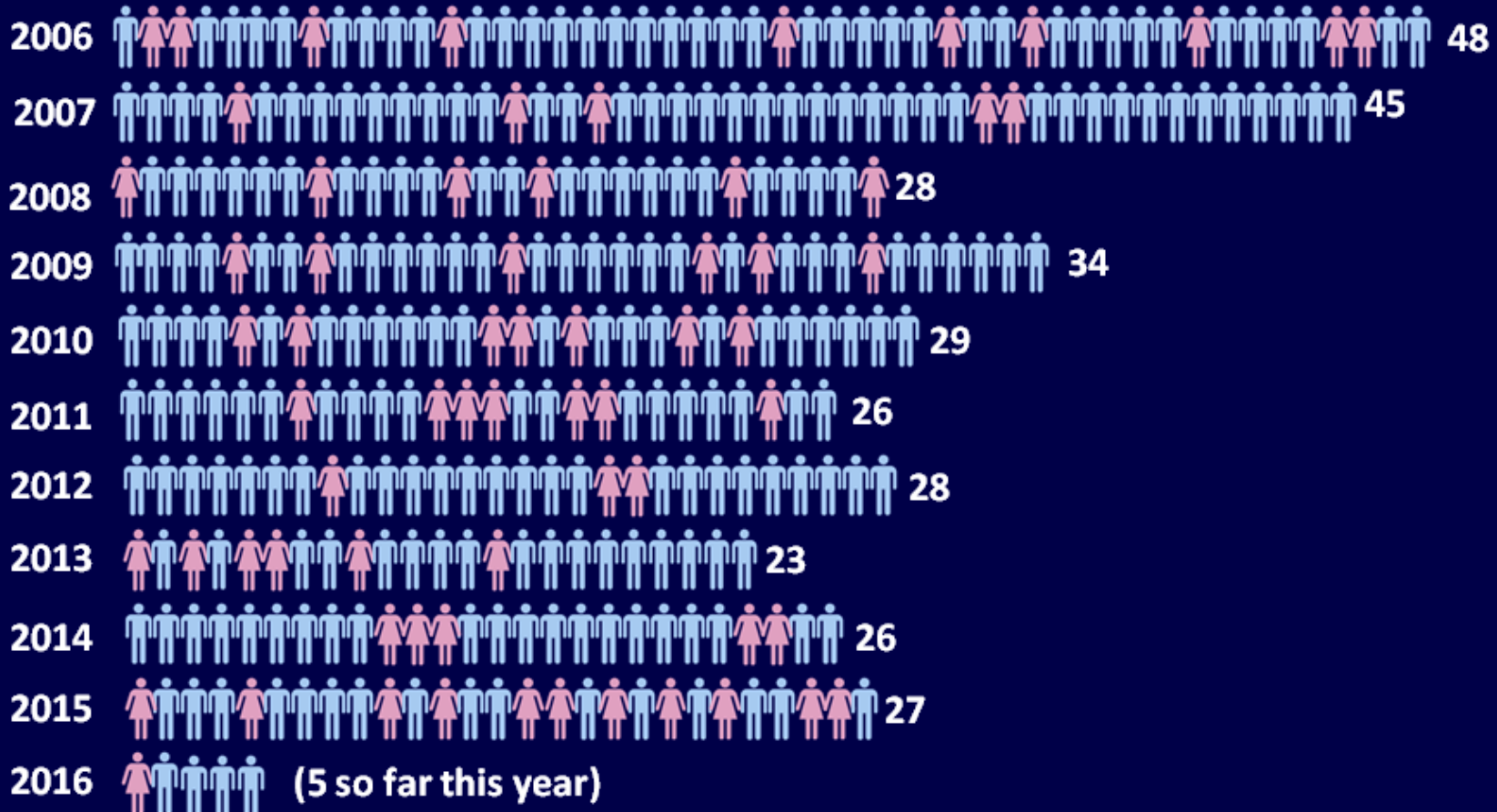
National Lightning Detection Network



A network of antennae are connected to a central processor that records the time, polarity, signal strength, and number of strokes of each cloud-to-ground lightning flash detected over the United States.



U.S. Lightning Fatalities 2006-2016



-252 -67

For more information:

<http://www.lightningsafety.noaa.gov/victims.htm>

Fact or Myth

Lightning never strikes the same place twice.

MYTH

Lightning often strikes the same place repeatedly, e.g. the Empire State Building is hit nearly 100 times a year.

Fact or Myth

If it's not raining or there aren't clouds overhead, you're safe from lightning.

MYTH

Strikes routinely originate from the center of storms 3 miles away. "Bolts from the blue" can come from 10-15 miles away!

Fact or Myth

If trapped outside and lightning is about to strike, I should lie flat on the ground.

MYTH

Lying flat increases your chance of being affected by potentially deadly ground current.

Fact or Myth

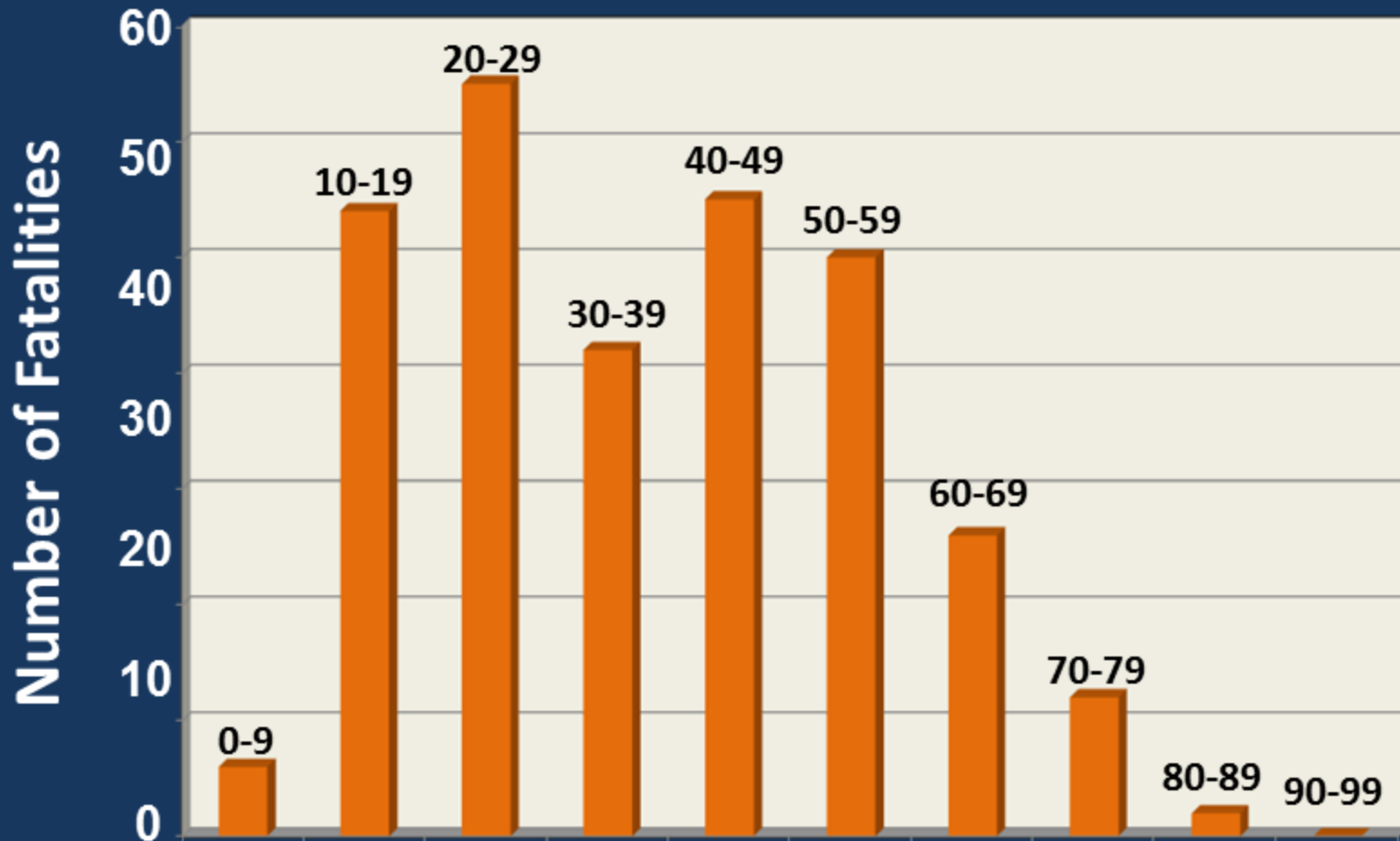
A lightning victim will not be electrified following a strike. You will not be electrocuted if you touch them.

FACT

The human body does not store electricity. Swift medical attention is key to saving lives.



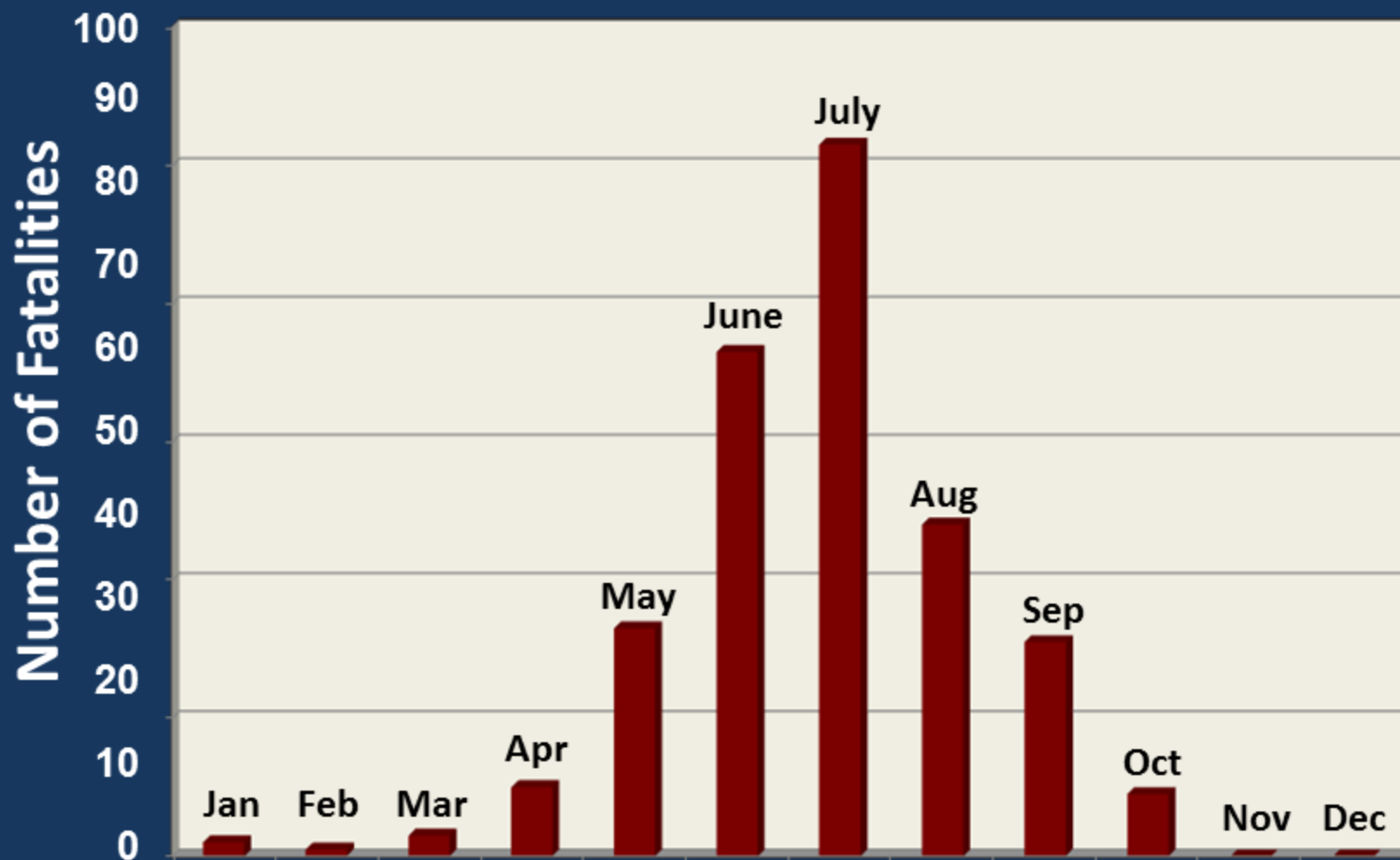
Lightning Fatalities By Age



Based on 312 cases from 2006 through 2015



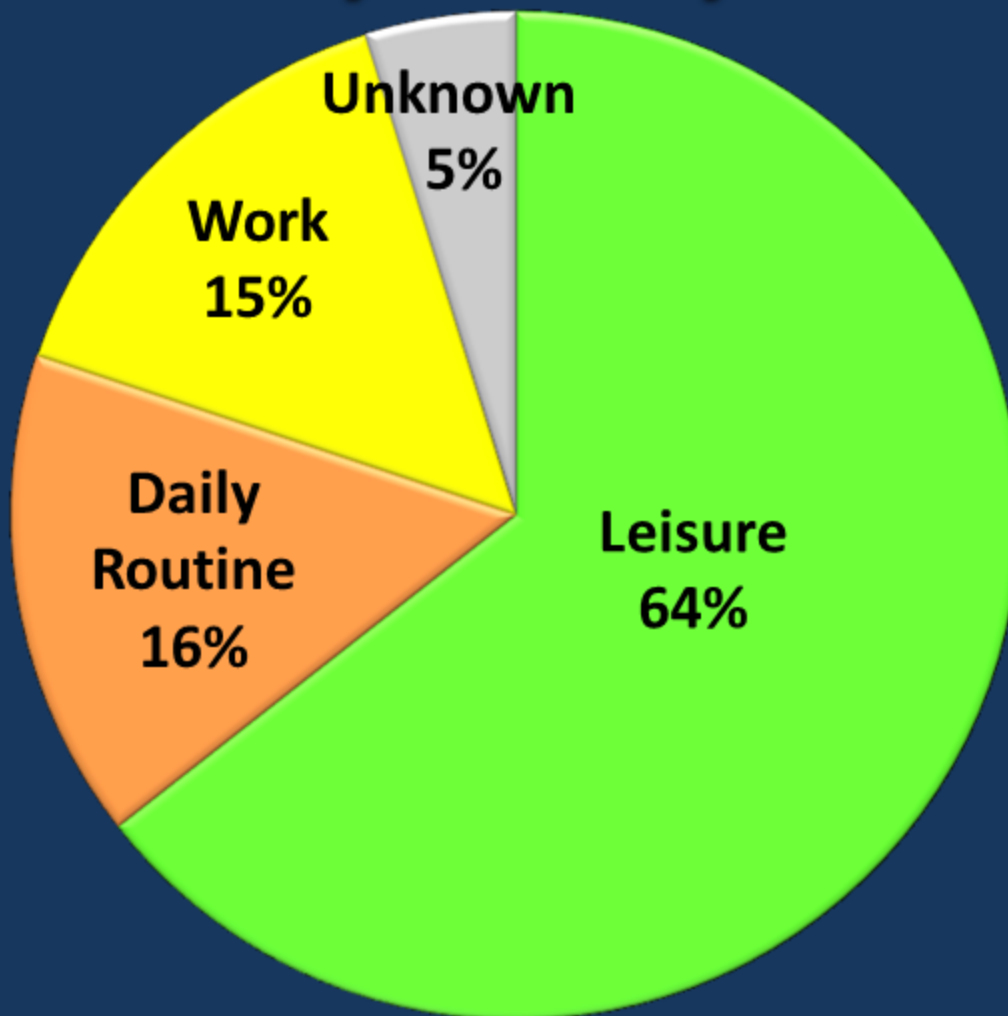
Fatal Lightning Incidents By Month



Based on 313 cases from 2006 through 2015



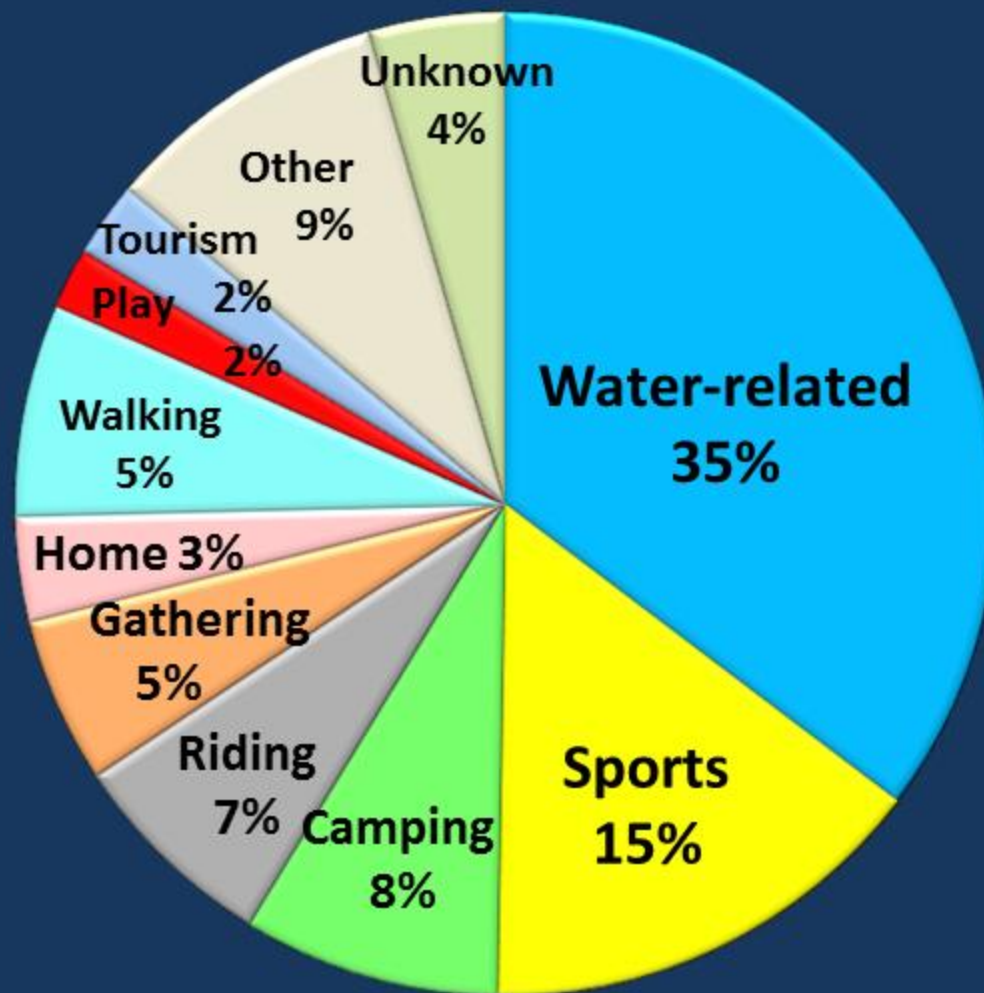
Lightning Fatalities By Activity



Based on 313 cases from 2006 through 2015



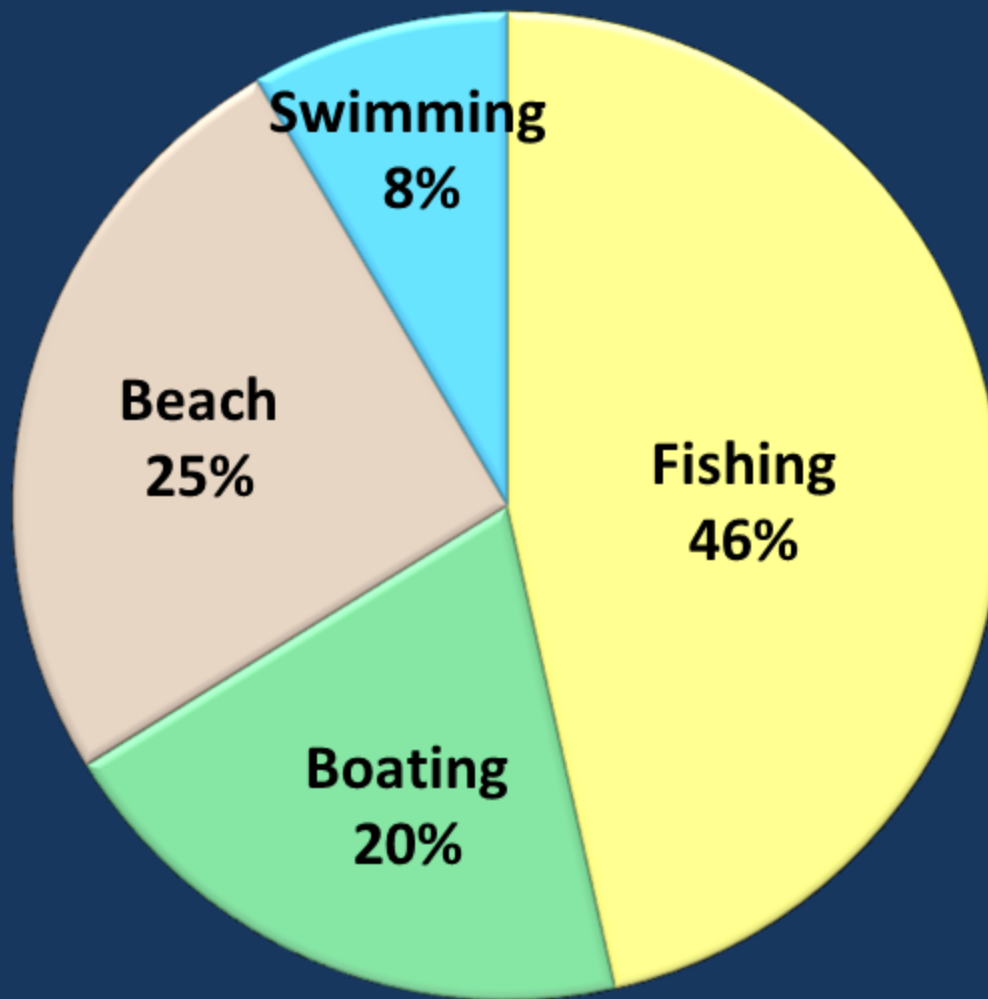
Lightning Fatalities Leisure Activities



Based on 201 cases from 2006 through 2015



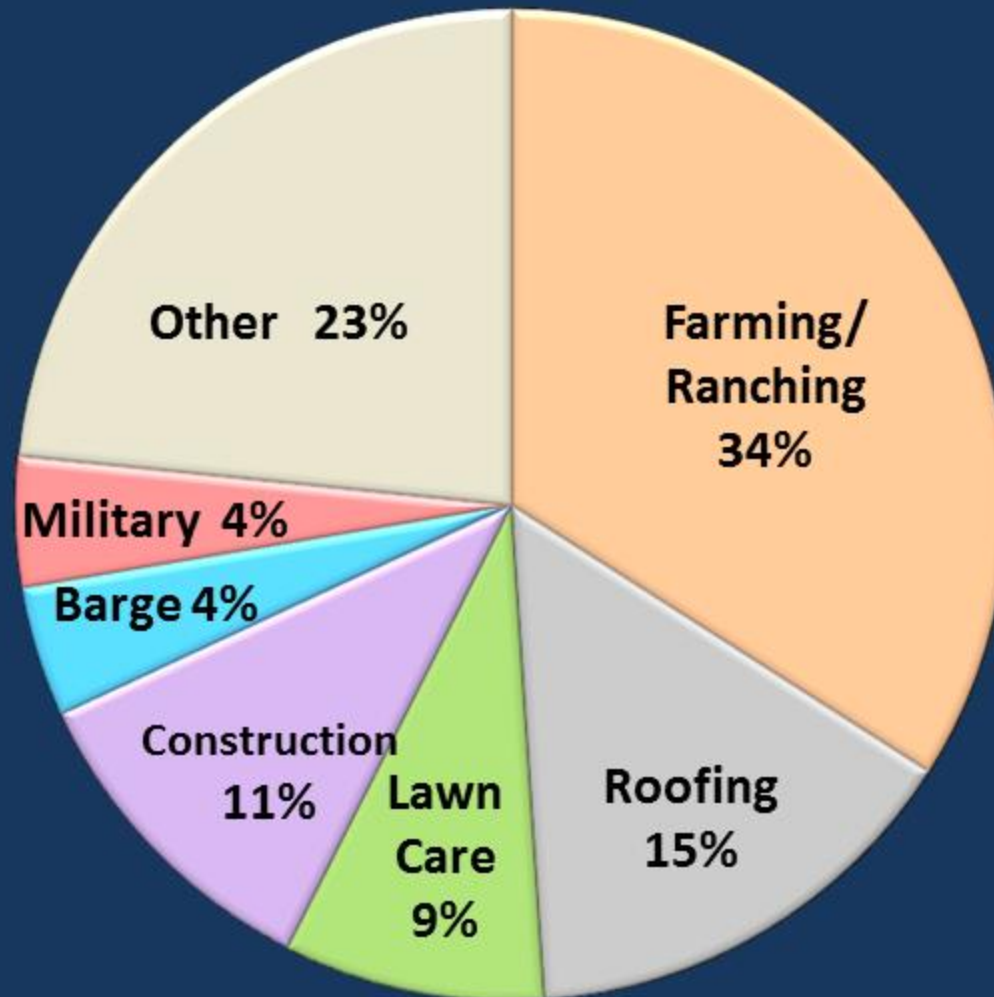
Lightning Fatalities Water-Related Activities



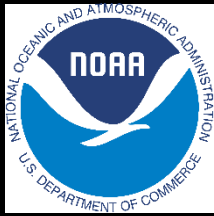
Based on 71 cases from 2006 through 2015



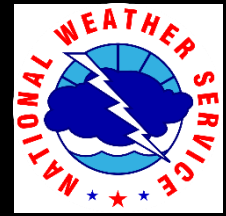
Lightning Fatalities Work-Related Activities



Based on 47 cases from 2006 through 2015



The Science of Lightning

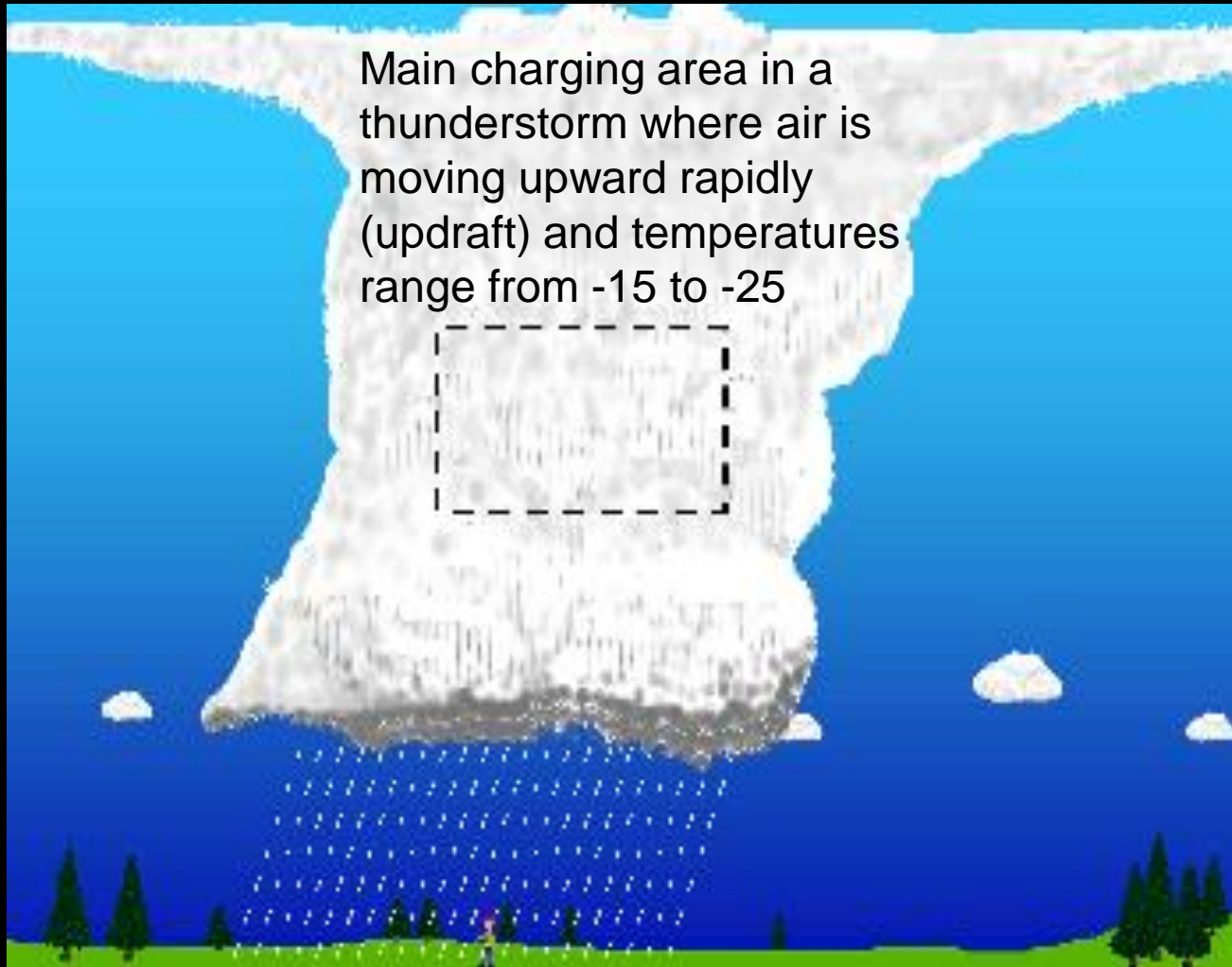


Moisture

Atmospheric
instability
(rising air)

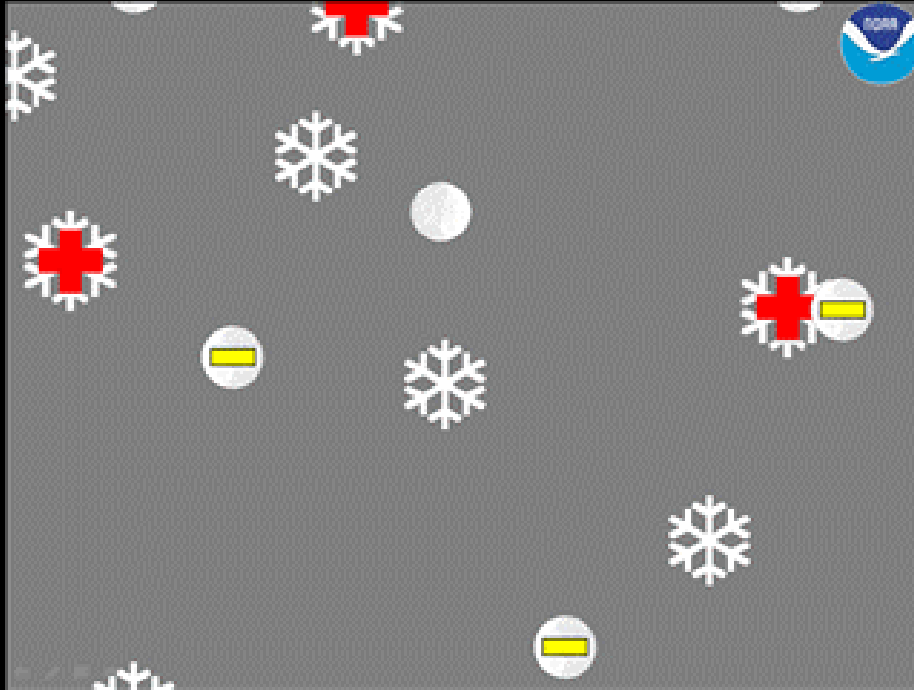
By John S. Jensenius, Jr., NWS Lightning Safety Specialist

The Science of Lightning



By John S. Jensenius, Jr., NWS Lightning Safety Specialist

The Science of Lightning



A mixture of super-cooled cloud droplets (small water droplets below freezing), small ice crystals, and soft hail (graupel).

The updraft carries the super-cooled cloud droplets and very small ice crystals upward while larger, denser graupel fall or suspends.

Collisions lead to positively charged ice crystals and the graupel becomes negatively charged

By John S. Jensenius, Jr., NWS Lightning Safety Specialist

The Science of Lightning

Updraft carries positively charged ice crystals toward the top of the storm cloud.

Denser graupel remains in the middle of the cloud or falls toward the lower part of the storm.

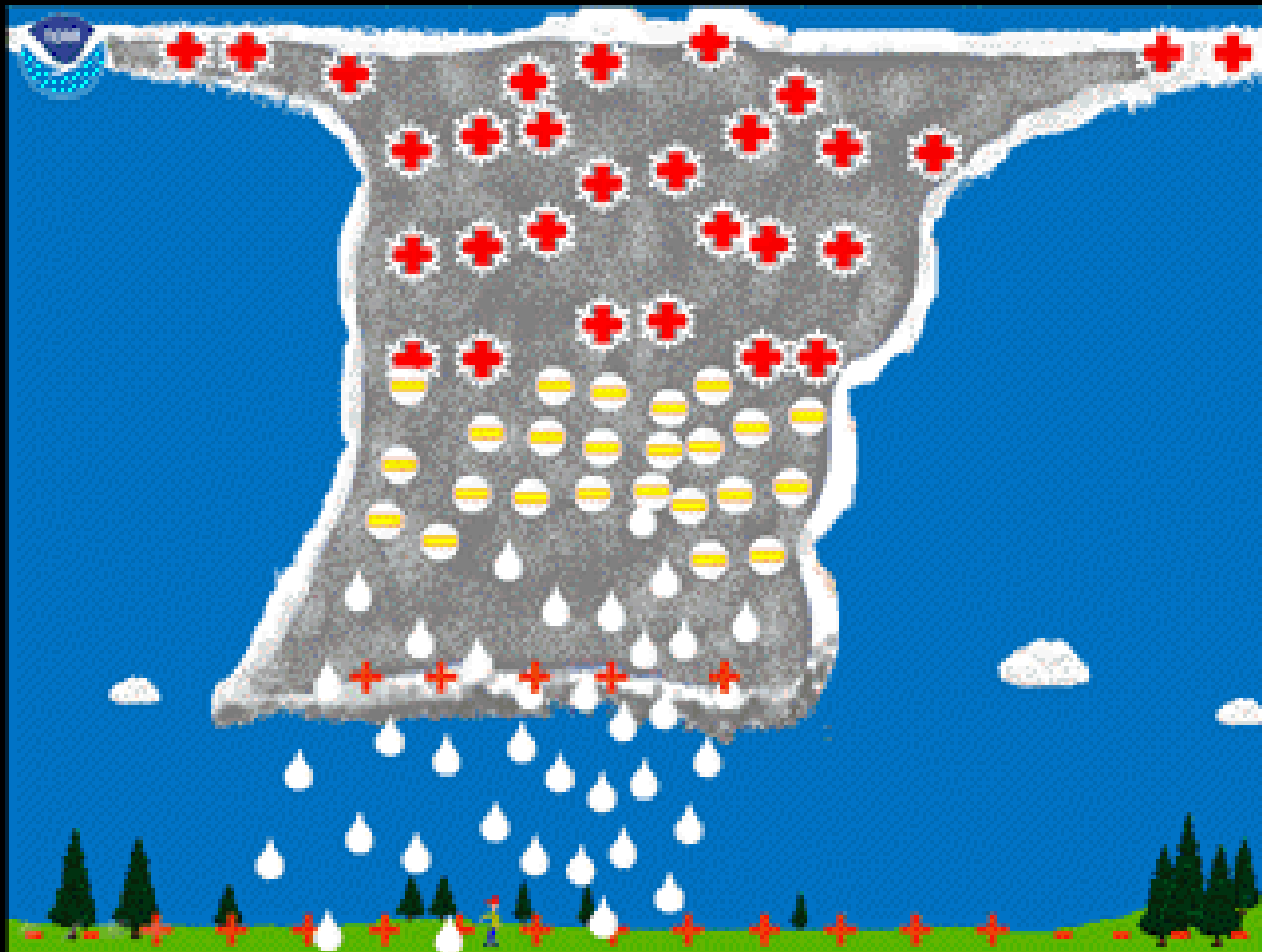
Upper part of the cloud becomes positively charged while the middle to lower part of the thunderstorm cloud becomes negatively charged

Positive charge buildup near the bottom of the thunderstorm cloud due to the precipitation and warmer temperatures.



By John S. Jensenius, Jr., NWS Lightning Safety Specialist

The Science of Lightning



By John S. Jensenius, Jr., NWS Lightning Safety Specialist

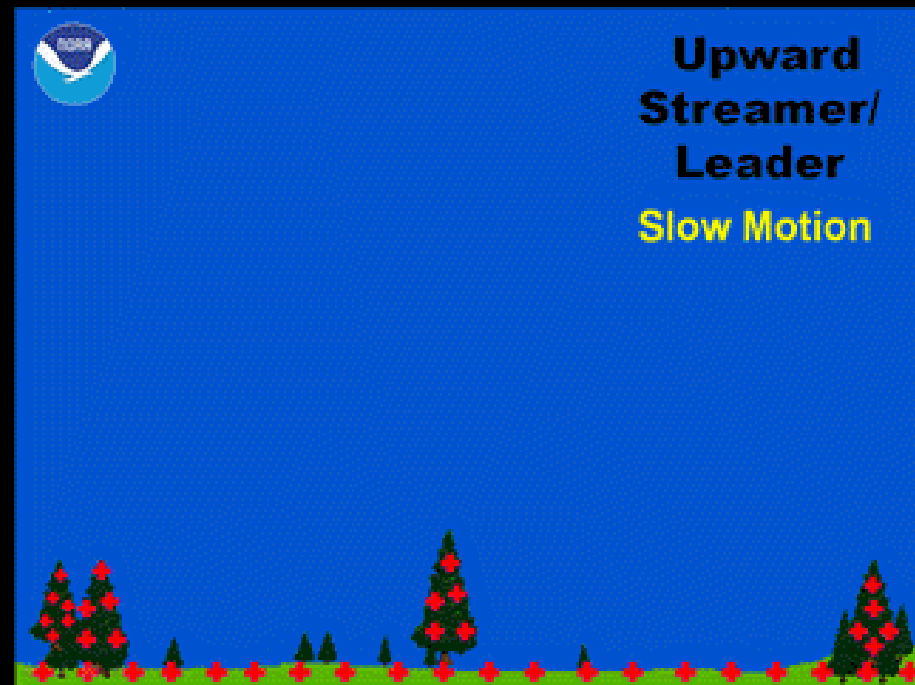
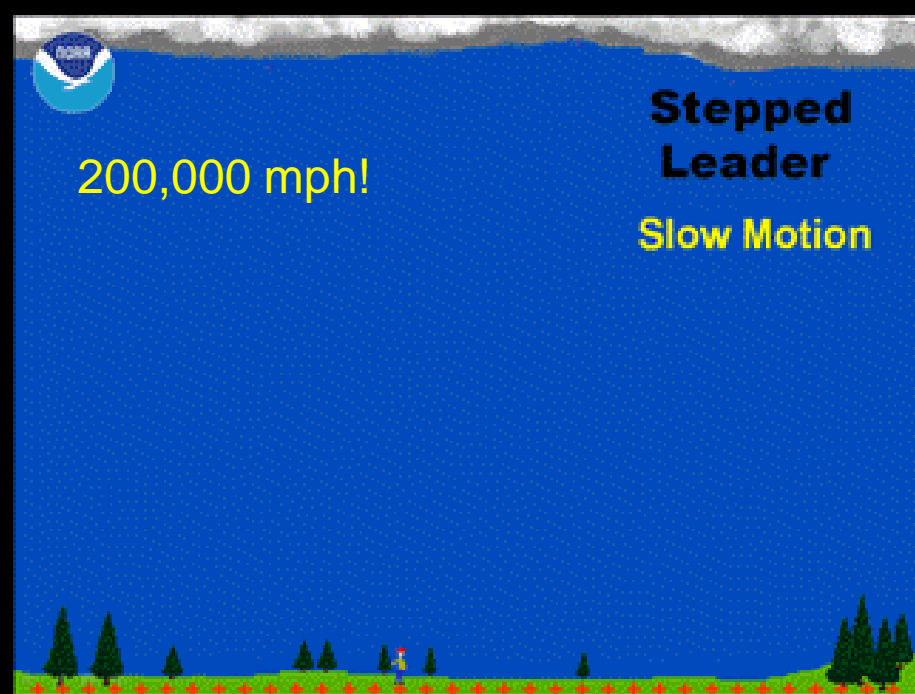
The Science of Lightning

Charge differences in the cloud become too large; negatively charged channel emerges from the bottom of the cloud and continues to move toward the ground

The path of the leader from cloud to ground can be very jagged and indirect as it sense charges in the surrounding air.

Electrical forces between the leader tips and the tops of tall objects on the ground also continues to increase.

By John S. Jensenius, Jr., NWS Lightning Safety Specialist

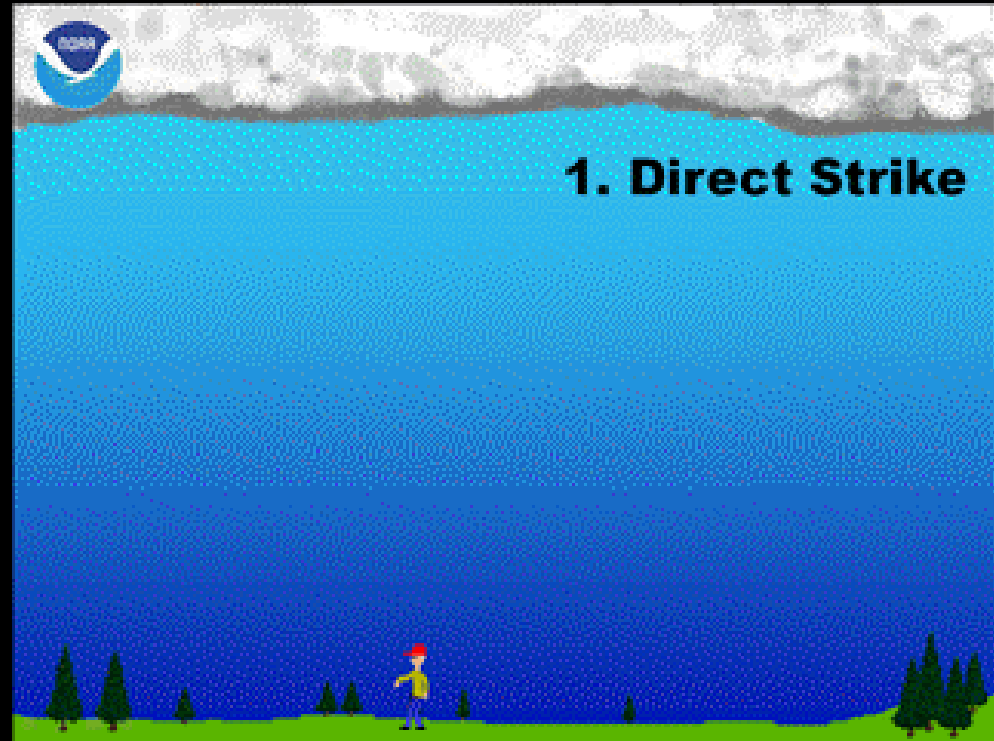


Types of Human Strikes

Usually occur in Open Areas

Potentially the most deadly.

Portion of the current moves along and just over the skin surface (called flashover) and a portion of the current moves through the body-- usually through the cardiovascular and/or nervous systems.



Types of Human Strikes

Lightning strikes a taller object near the victim and a portion of the current jumps from taller object to the victim.

Person acts as a “short circuit”

Occur when the victim is within a foot or two of the object that is struck.

Taken shelter under a tree to avoid rain or hail.

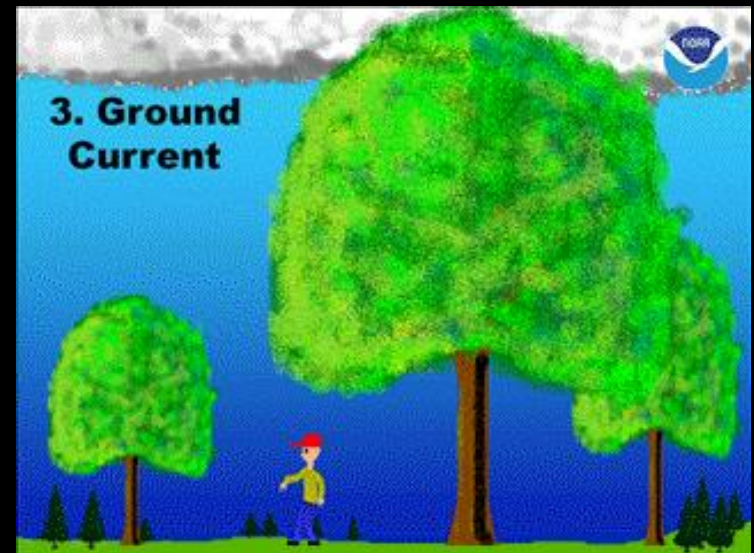
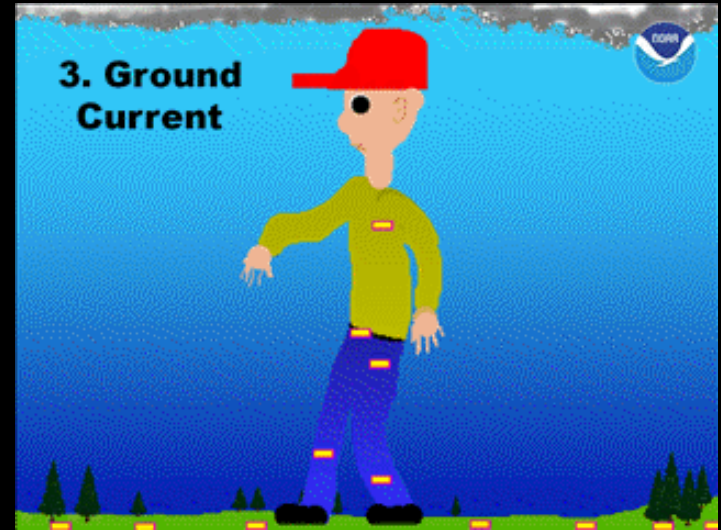


Types of Human Strikes

Ground current: energy travels outward from the strike in and along the ground surface.

Can effect anyone outside near a lightning

Causes the most lightning deaths and injuries, including livestock



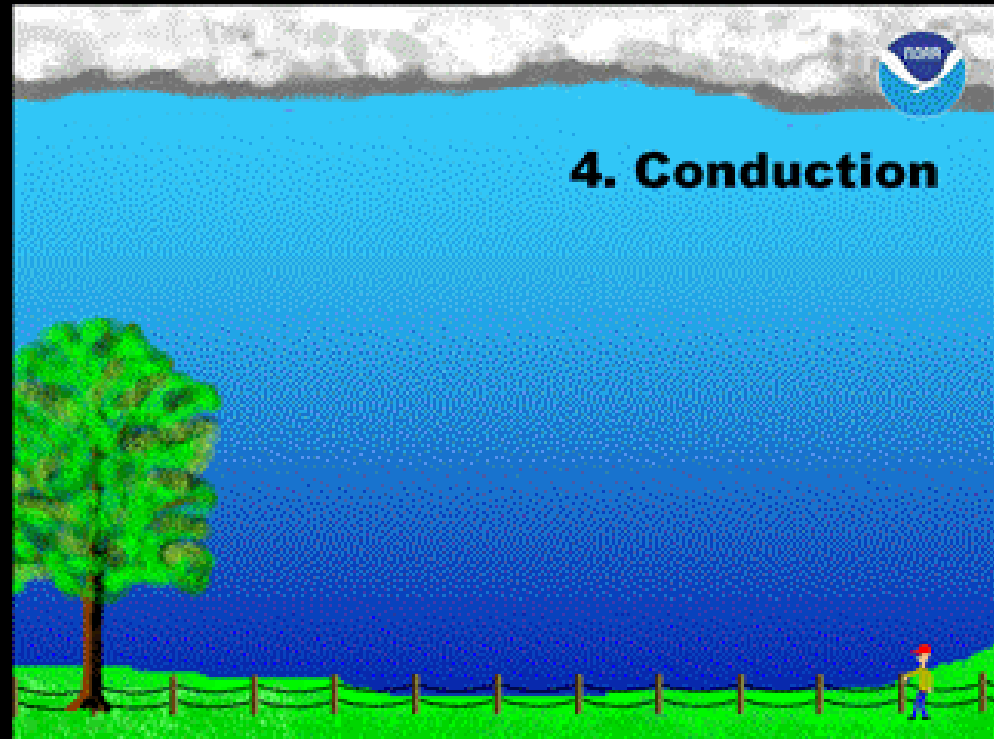
Types of Human Strikes

Lightning can travel long distances in wires/metal

Metal does not attract lightning

Indoor/outdoor casualties

Anyone in contact with anything connected to metal wires, plumbing, or metal surfaces that extend outside is at risk; including plugs in an electrical outlet, water faucets and showers, corded phones, and windows and doors.



Streamers develop as the downward-moving leader approaches the ground.

Typically, only one of the streamers makes contact with the leader as it approaches the ground and provides the path for the bright return stroke; however, when the main channel discharges, so do all the other streamers in the area.

If a person is part of one of these streamers, they could be killed or injured during the streamer discharge even though the lightning channel was not completed between the cloud and the upward streamer.

Types of Human Strikes



Lightning Safety

The ugly truth about lightning:

**There is NO SAFE PLACE outdoors
during a thunderstorm!**

When Thunder Roars, Go Indoors!

NOAA/NWS Recommendations

A dark, stormy night sky with several bright white lightning bolts striking down. The background is a dark, moody scene of a storm, with silhouettes of trees and a street lamp visible in the lower portion of the image.

Plan ahead. (that includes knowing where you'll go for safety)

Listen to the forecast.

Cancel or postpone activities if thunderstorms are in the forecast.

Monitor weather conditions.

Take action early so you have time to get to a safe place.

Get inside a substantial building or hard-topped metal vehicle before threatening weather arrives.

If you hear thunder, get to the safe place immediately.

If Outdoors, Things to Avoid



Avoid open areas.

Don't be or be near the tallest objects in the area.

Don't shelter under tall or isolated trees.

In the woods, put as much distance between you and any tree.

If in a group, spread out so that you increase the chances for survivors who could come to the aid of any victims from a lightning strike.

The Crouch?

- John Jensenius, Lightning Safety Specialist, National Weather Service, NOAA
- During the past few weeks, questions have surfaced about the National Weather Service's recommendations concerning the lightning crouch. The National Weather Service stopped recommending the crouch in 2008. Why? The National Weather Service recommendations are based on providing a significant level of safety. The crouch simply doesn't provide a significant level of protection. Whether you're standing or in the crouch position, if a lightning channel approaches from directly overhead (or very nearly so), you're very likely to be struck and either killed or injured by the lightning strike.
- Rather than "what to do in a dangerous situation" the National Weather Service recommendations focus on "what to do so you don't get into a dangerous situation," and, "if you do find yourself in a dangerous situation, how to get out of the dangerous situation." Our recommendations include:

Indoor Safety

A hand is holding a black electrical outlet cover in front of a wall. The wall has a messy bundle of wires with yellow and red caps, and a light switch. The background is a white wall with a window or door frame on the right.

Stay off corded phones. You can use cellular or cordless phones.

Don't touch electrical equipment such as computers, TVs, or cords. You can remote controls safety.

Avoid plumbing. Do not wash your hands, take a shower or wash dishes.

Stay away from windows and doors that might have small leaks around the sides to let in lightning, and stay off porches.

Do not lie on concrete floors or lean against concrete walls.

Protect your pets: Dog houses are not safe shelters. Dogs that are chained to trees or on metal runners are particularly vulnerable to lightning strikes.

Protect your property: Lightning generates electric surges that can damage electronic equipment some distance from the actual strike. Typical surge protectors will not protect equipment from a lightning strike. **Do not** unplug equipment during a thunderstorm as there is a risk you could be struck.

Medical Symptoms

Immediate Effects

Lightning is primarily an injury to the nervous system, often with brain injury and nerve injury. Serious burns seldom occur. People who do not suffer cardiac arrest at the time of the incident may experience lesser symptoms, which often clear over a few days: Muscle Soreness, Headache, nausea, stomach upset and other post-concussion types of Symptoms, Mild confusion, memory slowness or mental clouding, Dizziness, balance Problems

Longer Term Problems

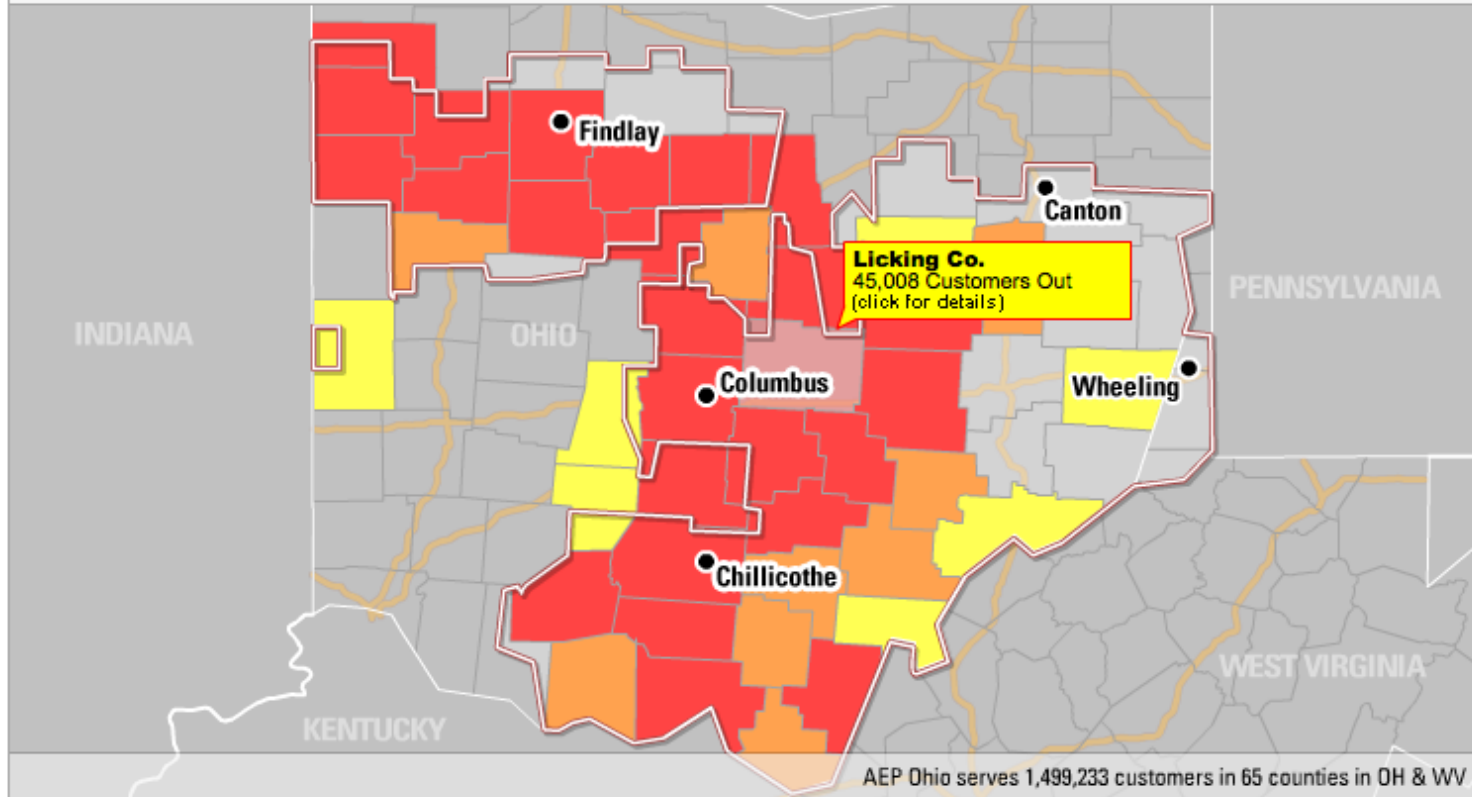
Most survivors experience only some of the symptoms below: Problems coding new Information and accessing old information, Problems multitasking, Slower reaction time, Distractibility, Irritability and personality change, Inattentiveness or forgetfulness, Headaches which do not resolve with usual OTC meds, Chronic pain from nerve injury, Ringing in the Ears and dizziness or balance problems, Difficulty Sleeping, sometimes sleeping Excessively at first and later only two or three hours at a time

Delayed Symptoms

Personality changes/self-isolation, Irritability and embarrassment because they can't remember people, job responsibilities and key Information, Difficulty carrying on a conversation, Depression , Chronic pain and headaches

The Power of Weather

[Click on a colored county to view more detailed information about the area.](#)



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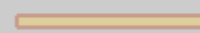
LEGEND



Service Territory



County Lines



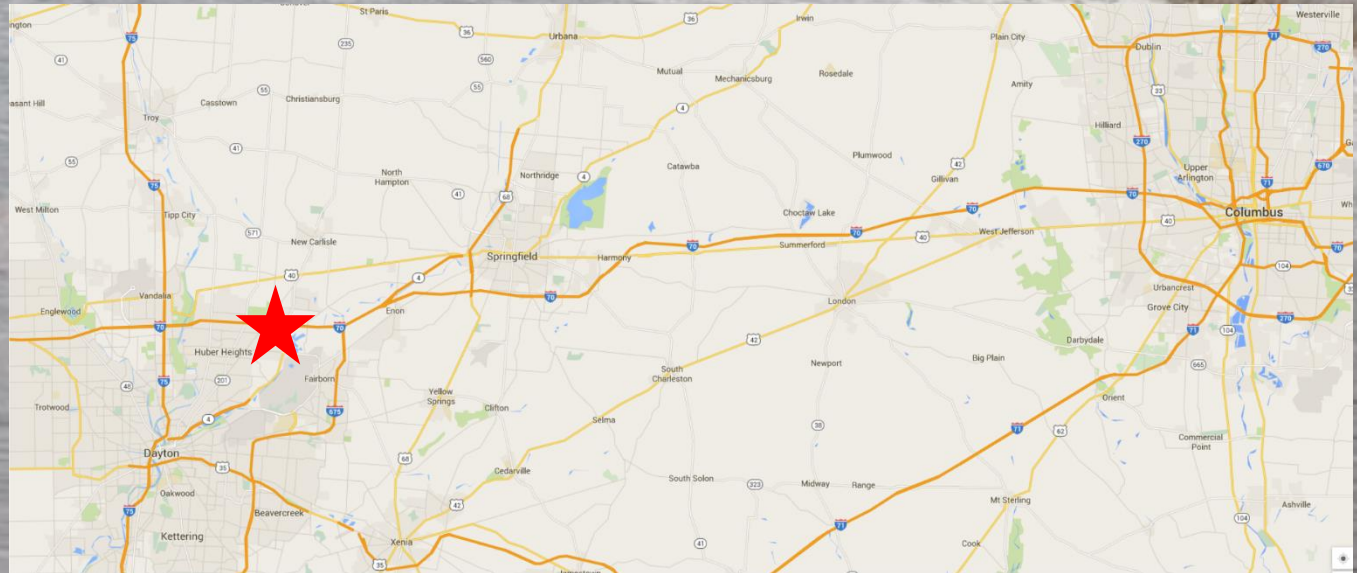
Major Highways

* Wind gusts are preliminary
and at approximate locations



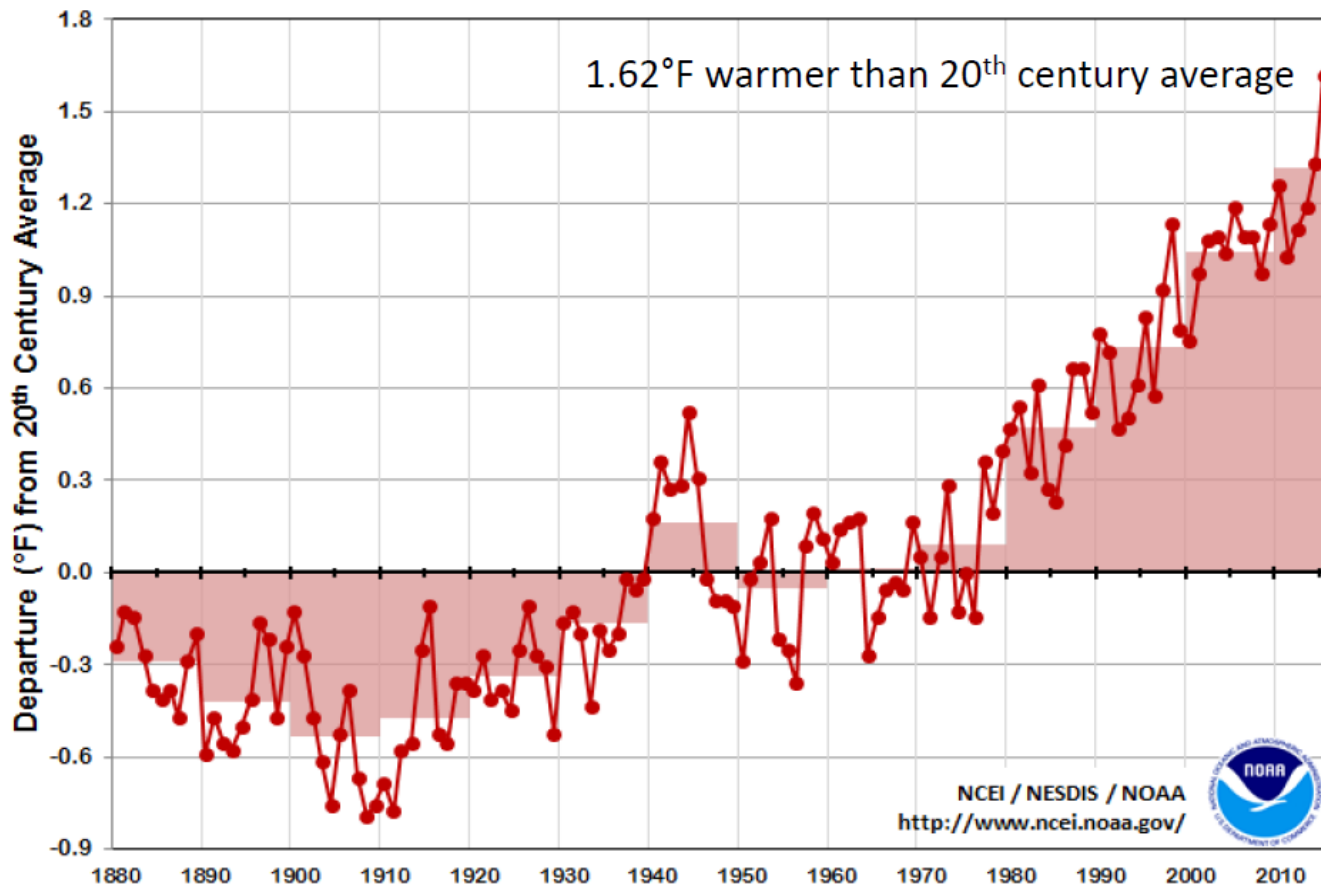


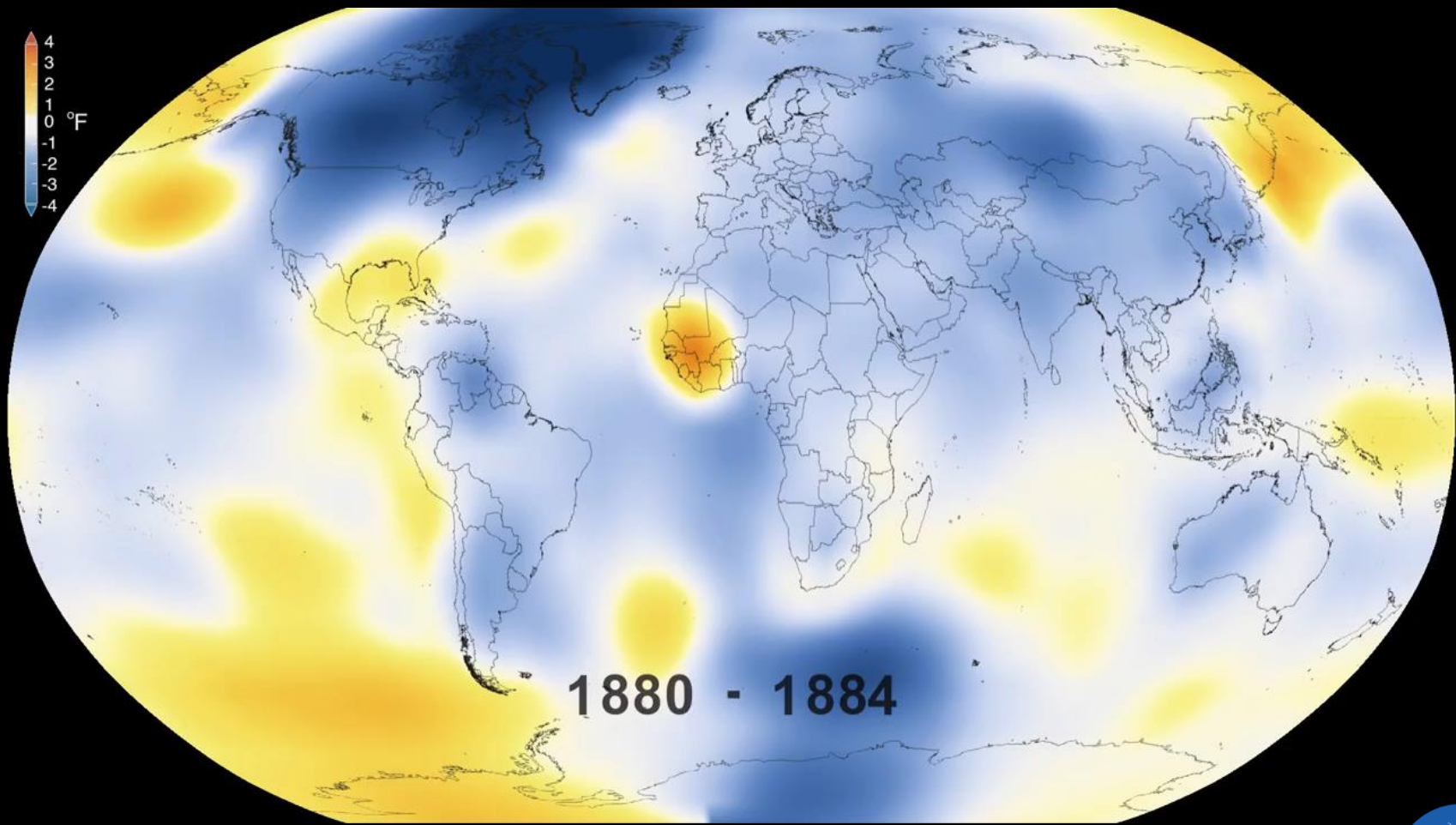
Interstate 70 is closed at Bellefontaine Road due to high water over the road Wednesday, May 21 2014. MARSHALL GORBY / STAFF – Dayton Daily News



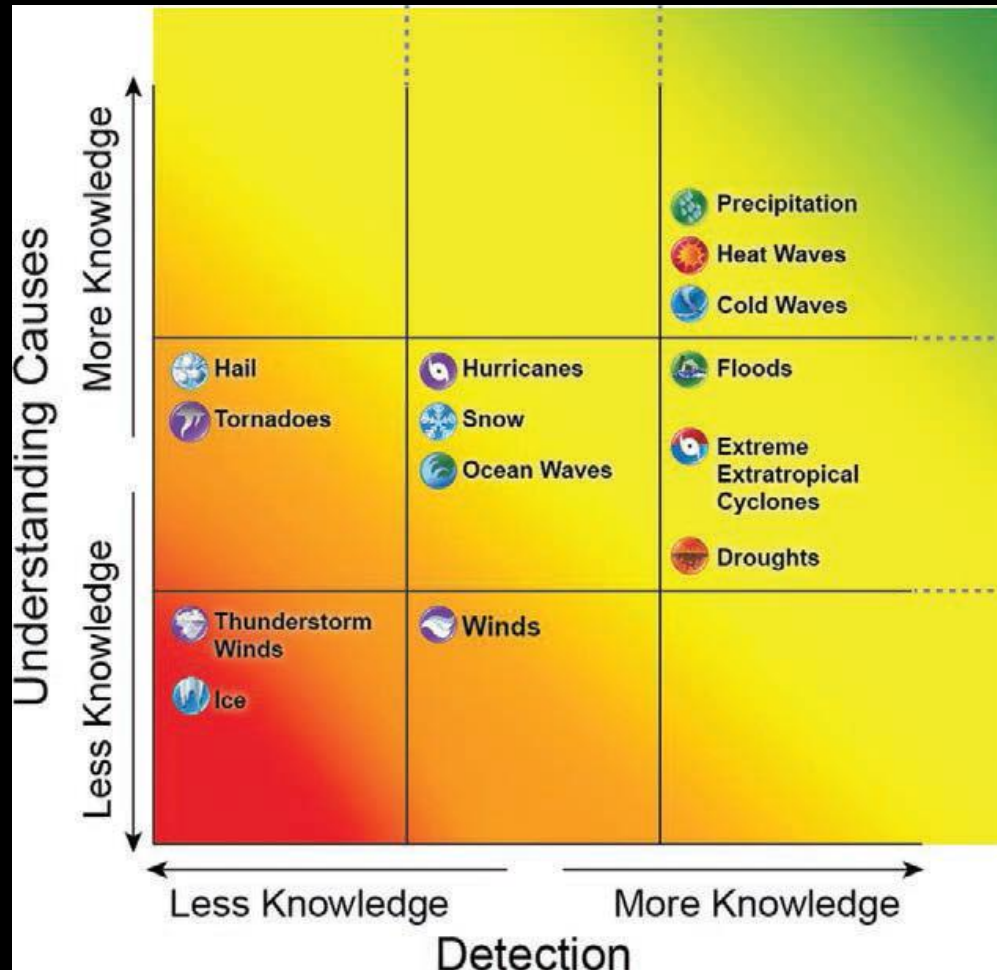
TEMPERATURE

Global Temperature Time Series





DETECTING WEATHER EXTREMES



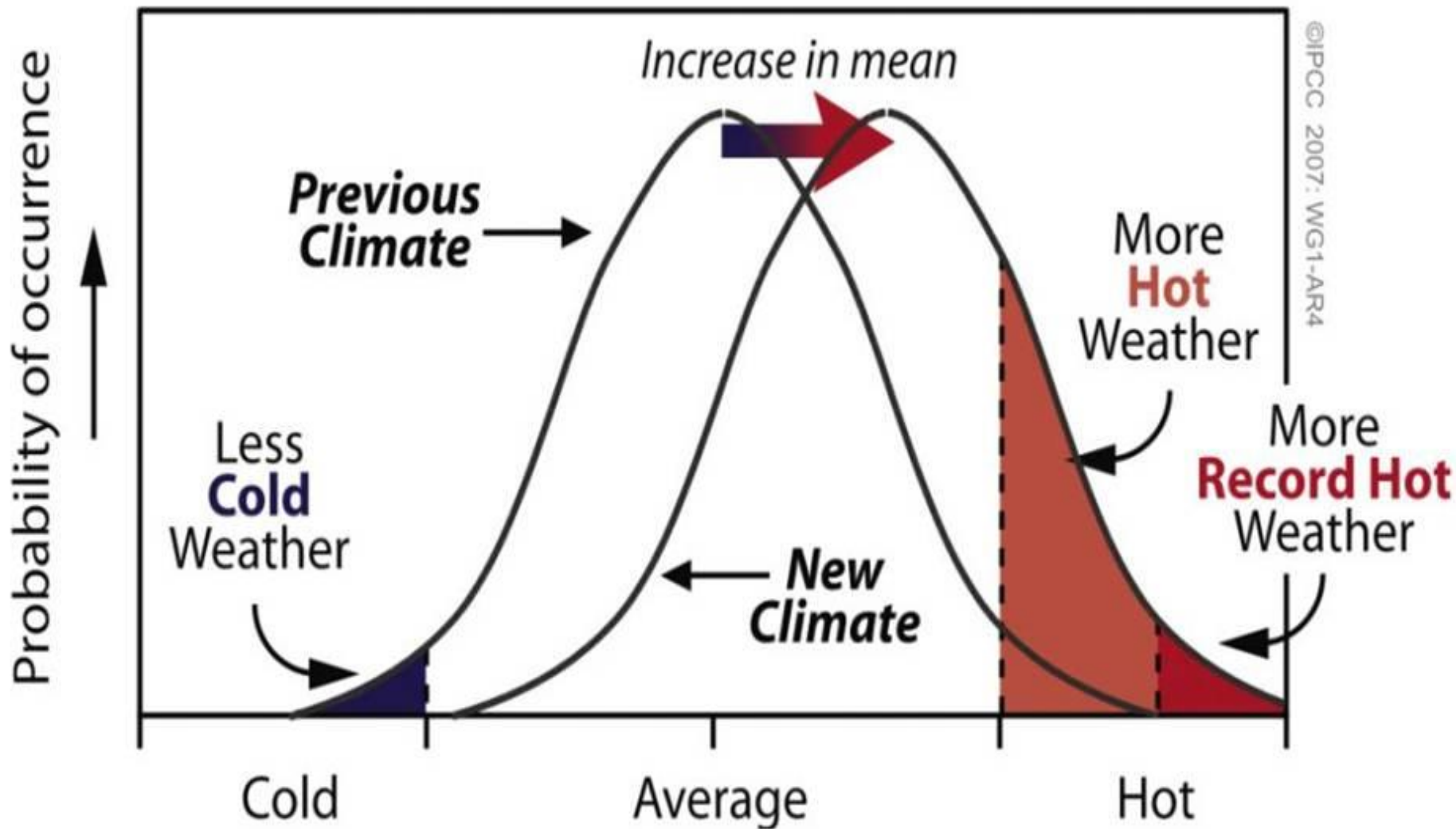
- Assumption that **detection and attribution** of changes in extremes depend on scientists' physical understanding of the **factors that cause a particular extreme**
- **AND** factors that may cause the intensity or frequency of that extreme to change over **time** and the quality and quantity of the data.

D Wuebbles et al. , 2014: CMIP5 Climate Model Analyses: Climate Extremes in the United States. *Bull. Amer. Meteor. Soc.*, **95**, 571–583, doi: 10.1175/BAMS-D-12-00172.1

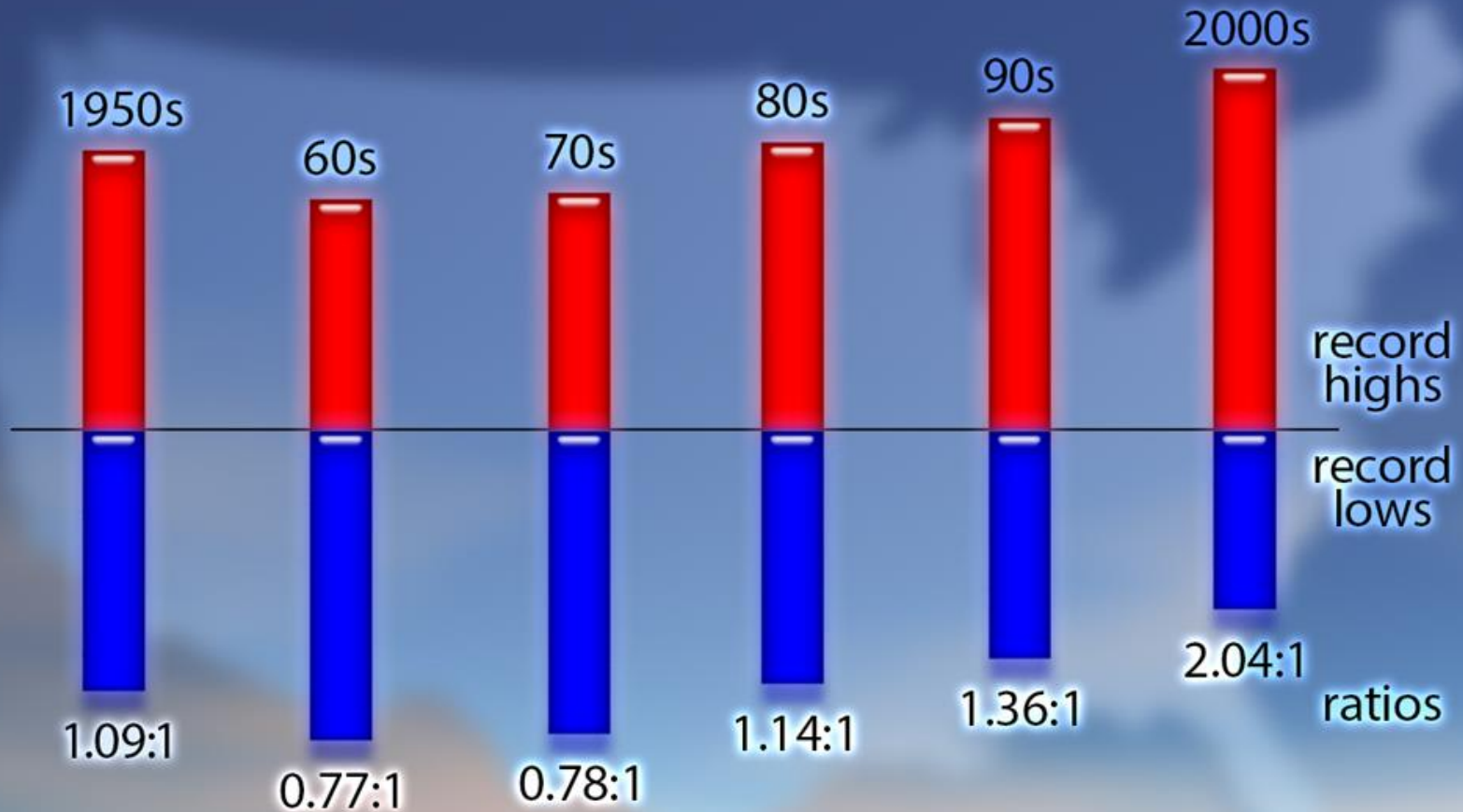
“Weather throws the



Pushing the Extremes: How Changing Climate Changes Weather

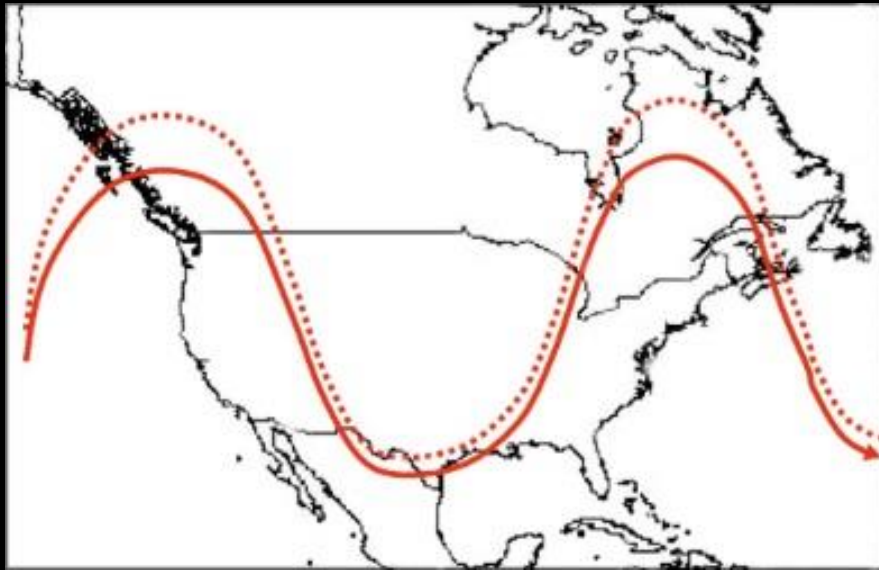


Record Highs Outpacing Record Lows



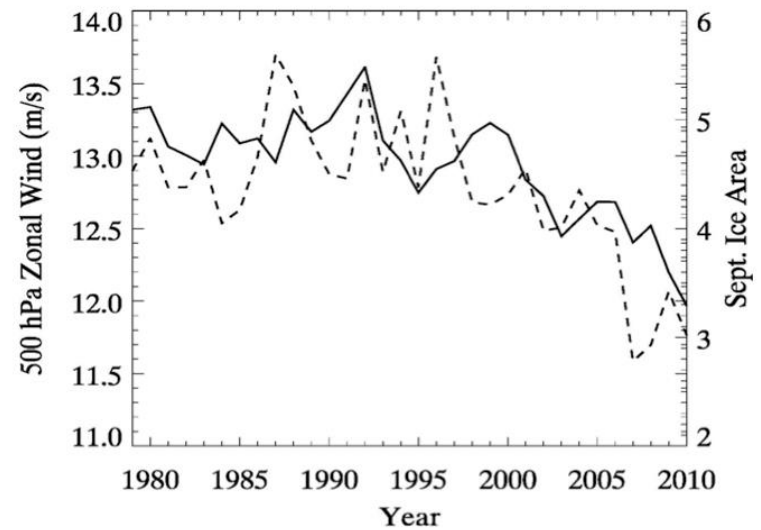
Analysis from Meehl et al. 2009 Geophys. Res. Lett. 36, L23701.

ARE WE SEEING MORE “STUCK” WEATHER?



- Less sea ice & warmer Arctic mean zonal winds decrease
- Systems move slower across the country

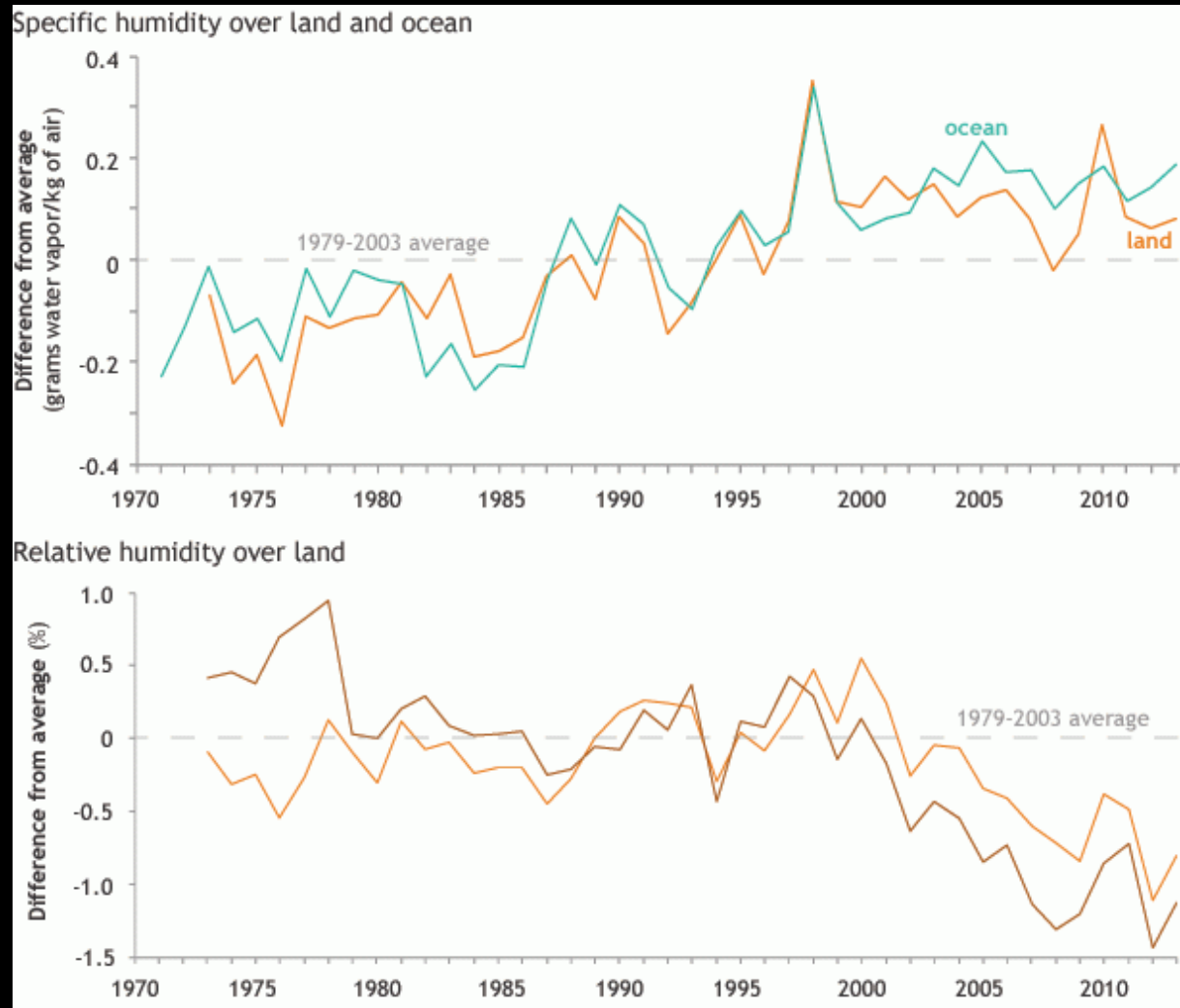
- Jet stream becomes wavier
- Ridges drive warm air northward/cold air southward



Jennifer Francis - research professor at the Institute of Marine and Coastal Sciences at Rutgers University, Co-founder of the Rutgers Climate and Environmental Change Initiative

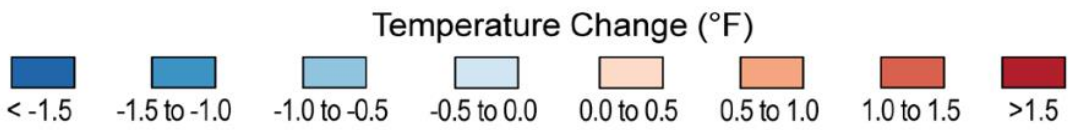
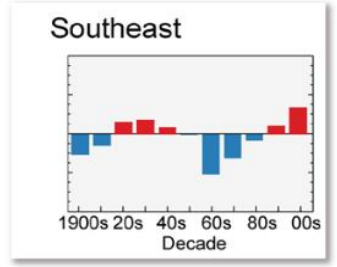
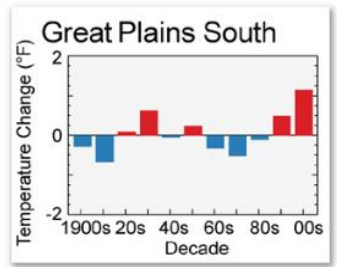
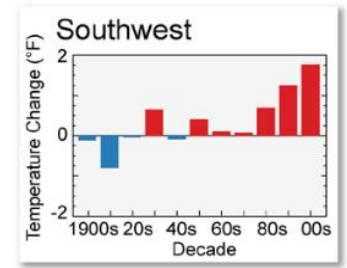
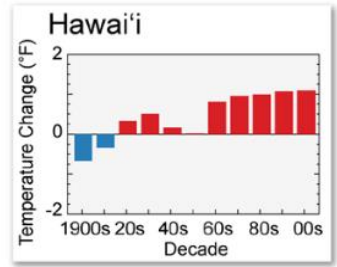
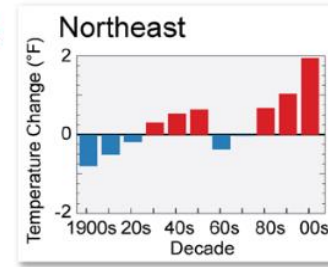
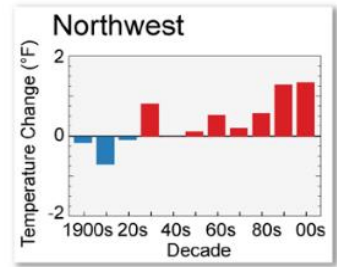
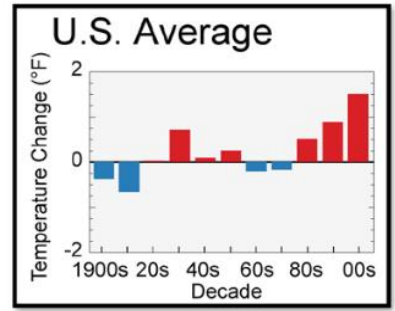
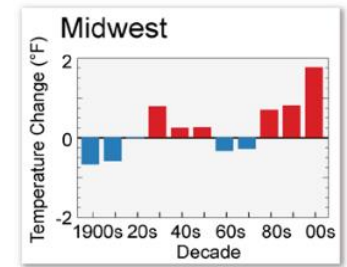
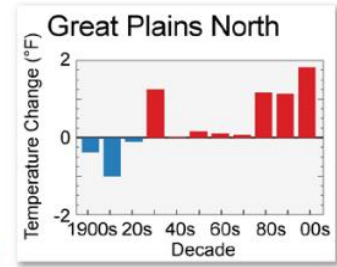
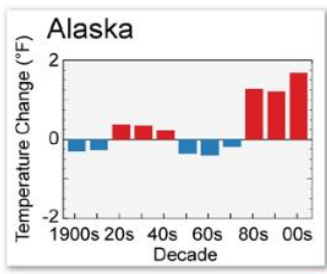
HUMIDITY TOO

On July 30 in Bandar Mahshahr, at 4:30pm, the temperature was 111°F and the dew point 88°F, making the **heat index value a whopping 155°F**, an unfathomably high number. The next day, July 31, at 4:30pm, the **heat index soared to 165°F**, after a temperature of 115°F was reached while the dew point was 90°F.



top) Annual specific humidity over land (orange) and ocean (green) compared to the 1979-2003 average. (bottom) Relative humidity over land areas compared to the 1979-2003 average from two different data sets. While the exact values from the different sources vary from year to year, most show similar trends over time. Graph by NOAA Climate.gov, adapted from Figure 2.12 in State of the Climate in 2013.

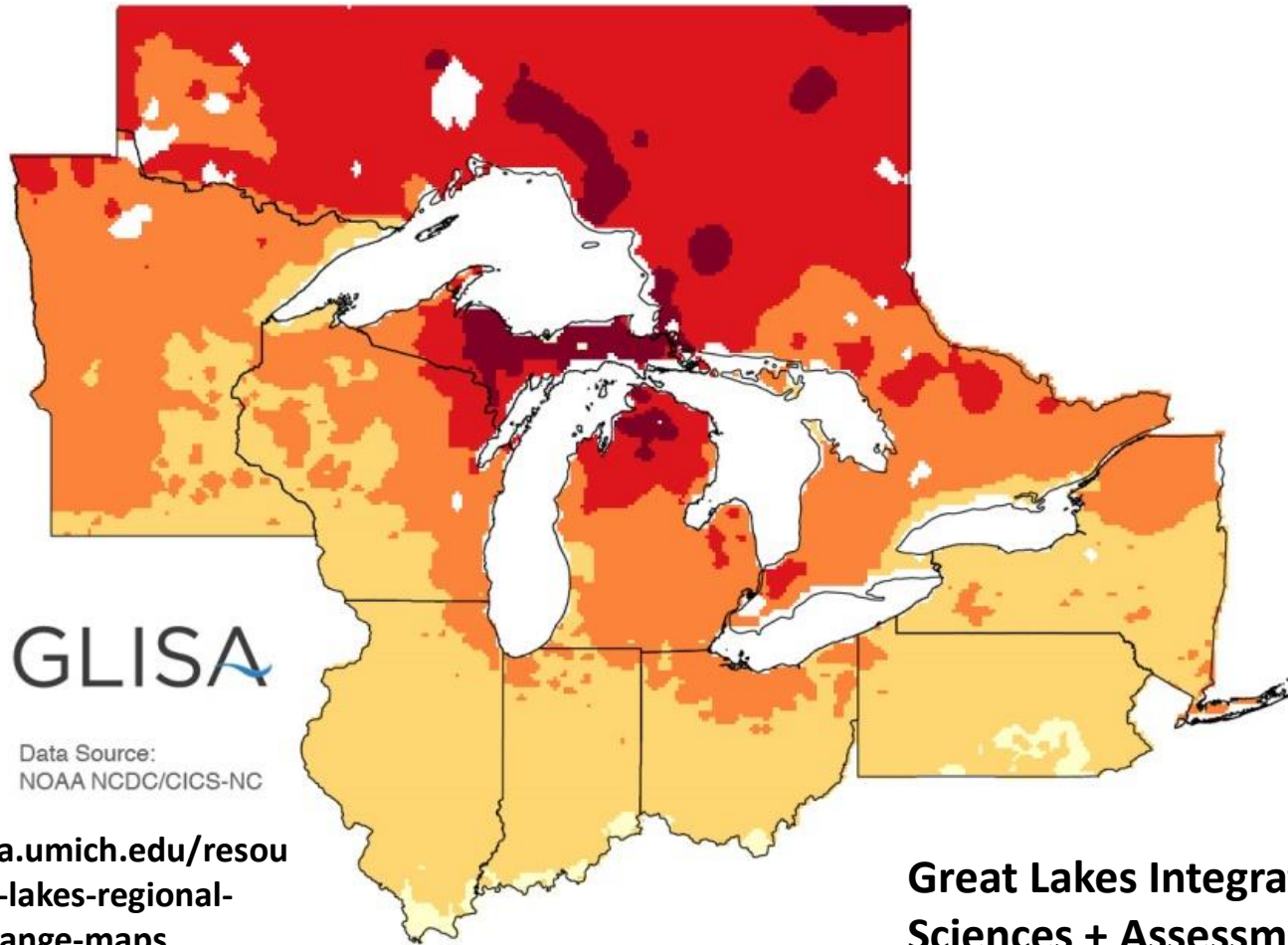
Observed U.S. Temperature Change



**1991-2012
compared
to the
1901-1960
average**

Difference in Average Temperature

Period: 2041-2070 | Emission Scenario: A2

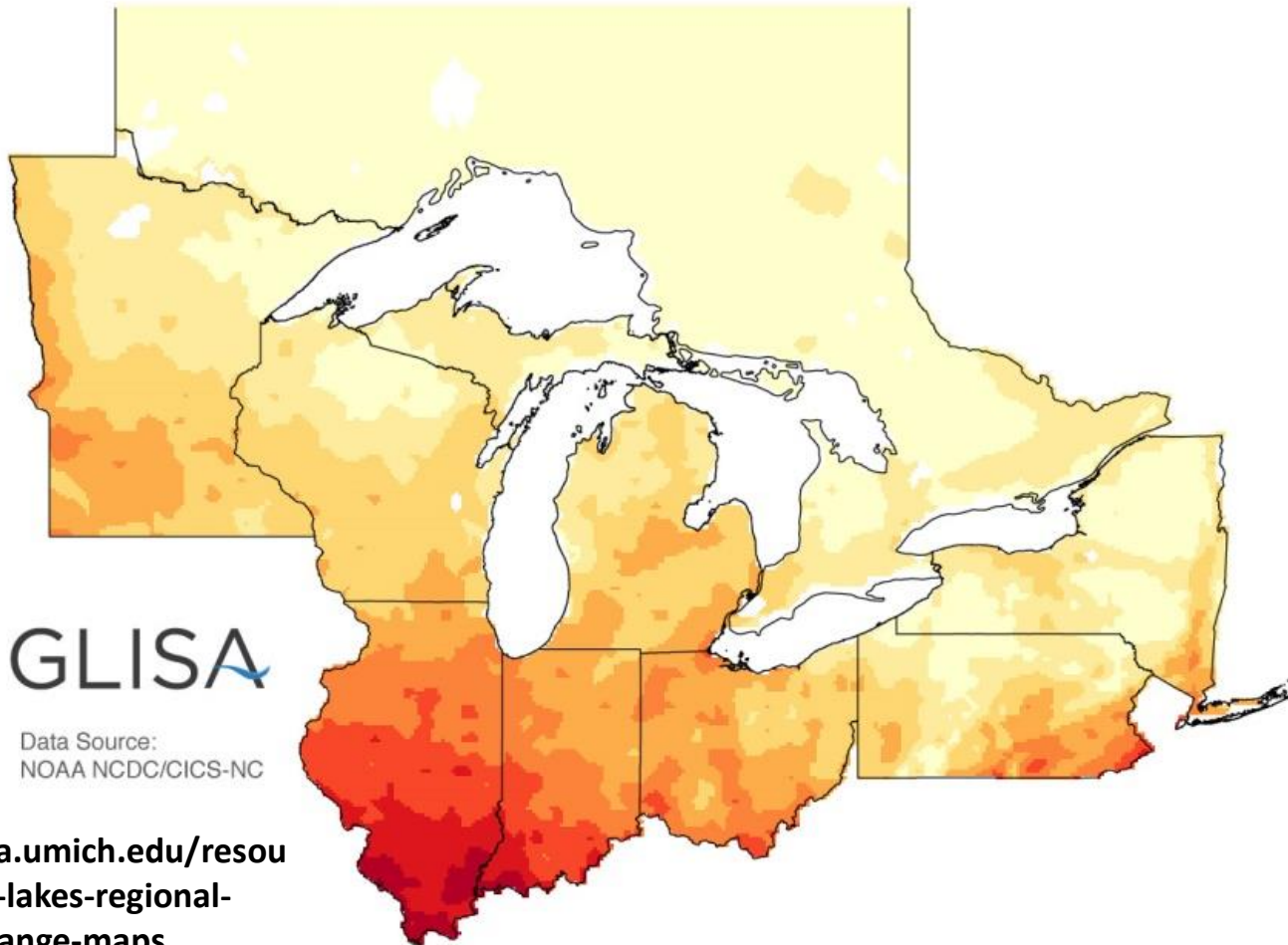


Temperature Difference (°F)

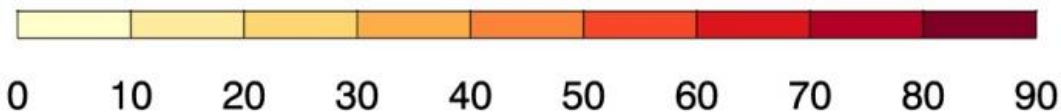


Projected Change in Number of Days Over 90°F

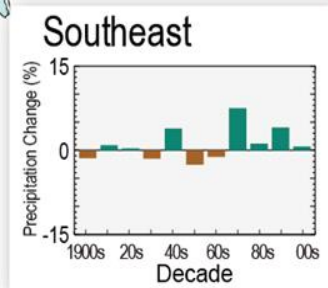
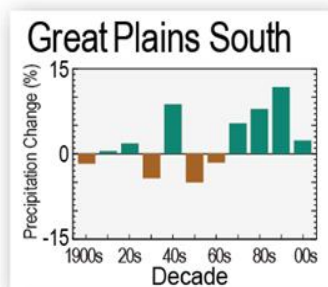
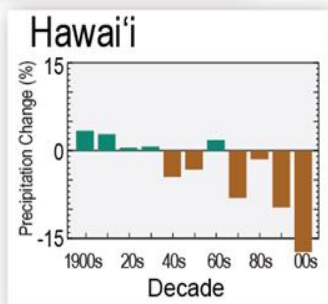
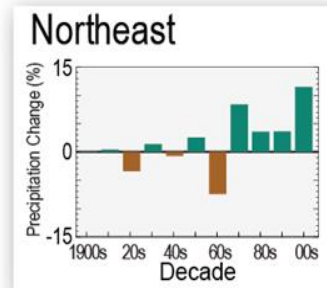
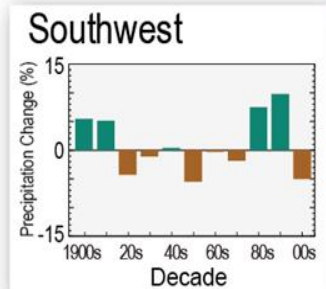
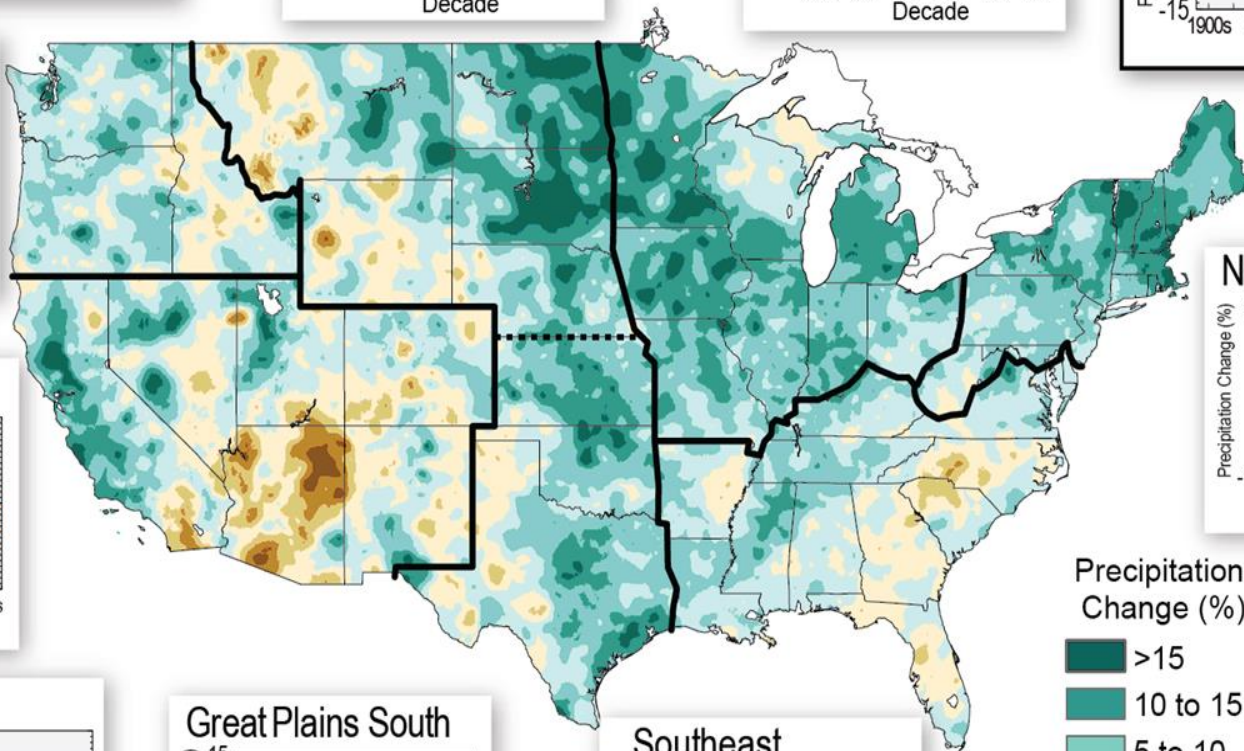
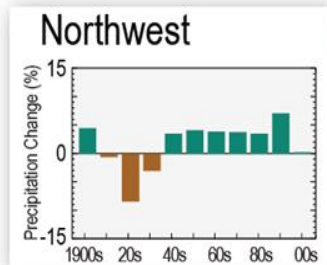
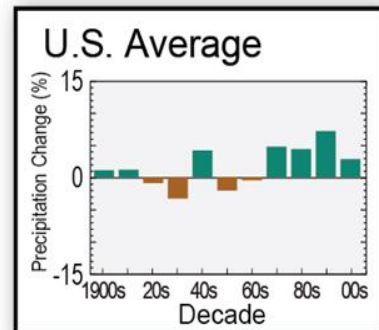
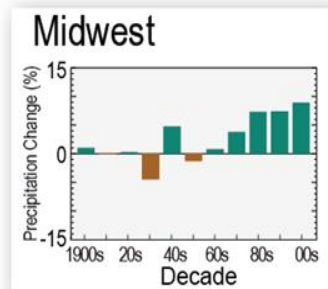
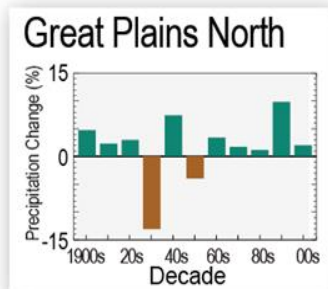
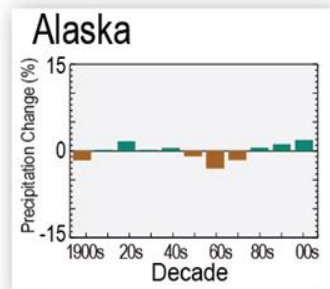
Period: 2041-2070 | Higher Emissions: A2



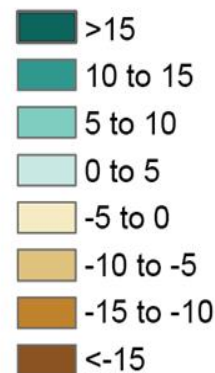
Change In Number of Days Per Year



Observed U.S. Precipitation Change



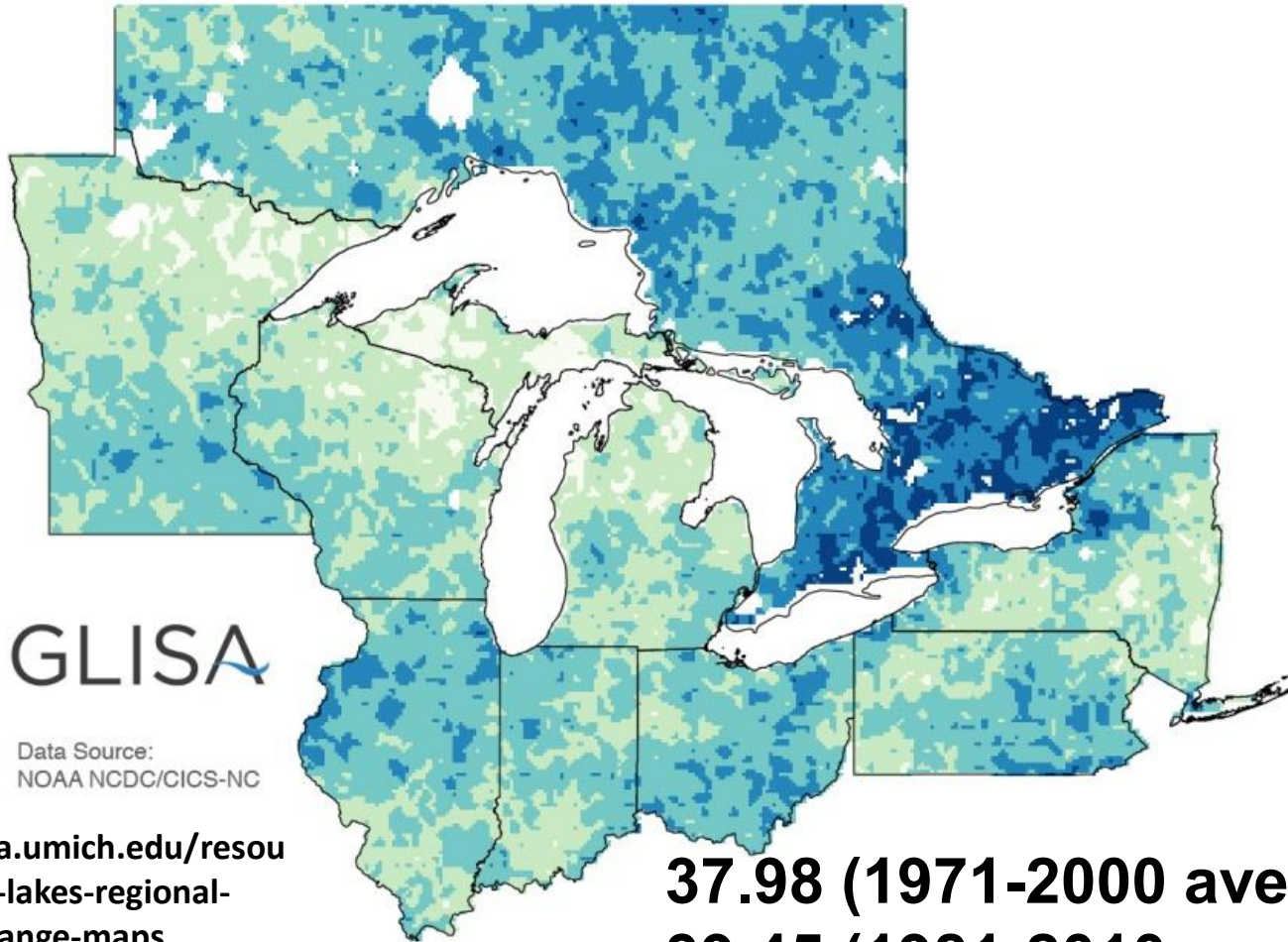
Precipitation Change (%)



**1991-2012
compared
to the
1901-1960
average**

Projected Change in Average Precipitation

Period: 2041-2070 | Emission Scenario: A2



GLISA

Data Source:
NOAA NCDC/CICS-NC

<http://glisa.umich.edu/resources/great-lakes-regional-climate-change-maps>

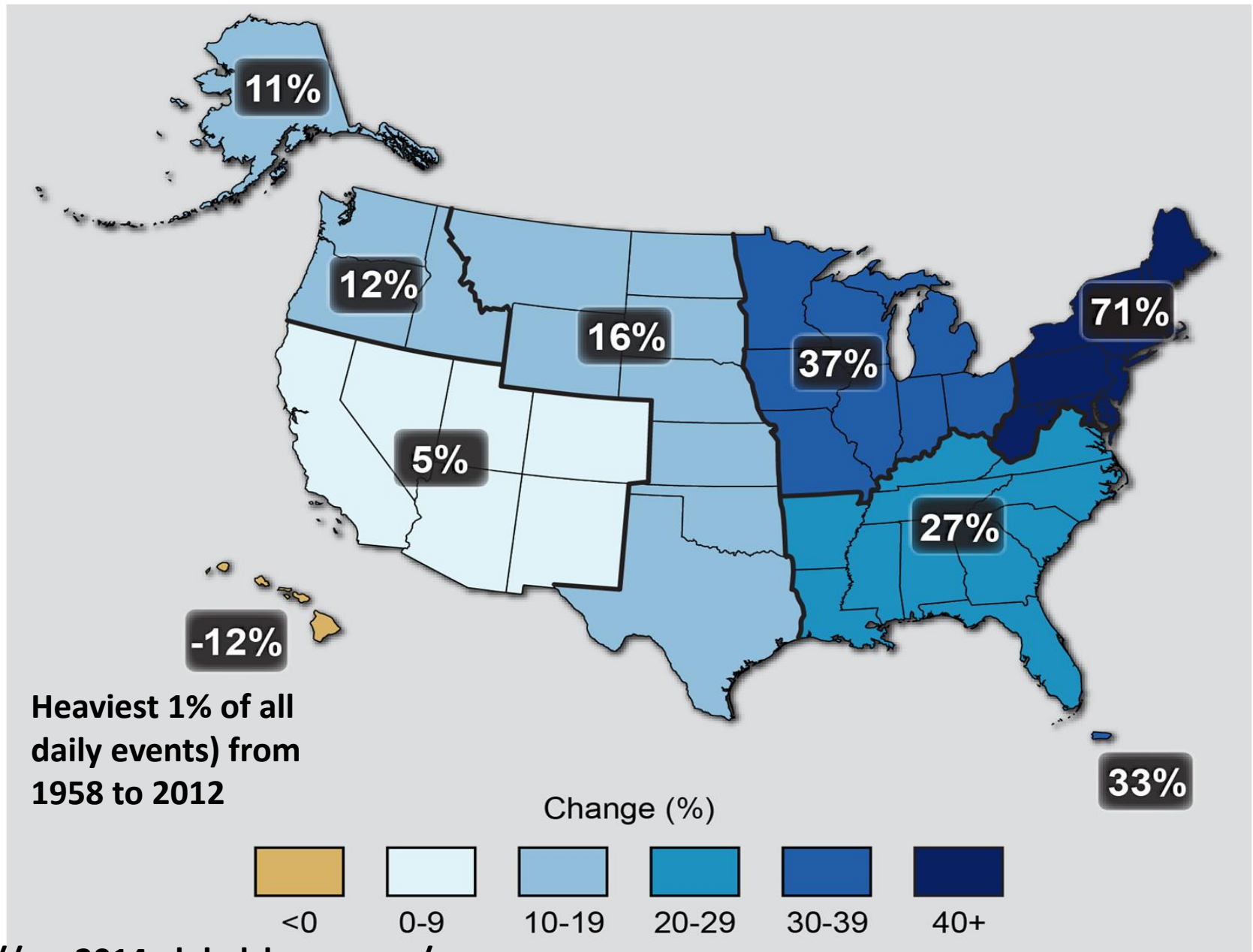
37.98 (1971-2000 average)

39.45 (1981-2010 average)

Precipitation Difference (Inches)

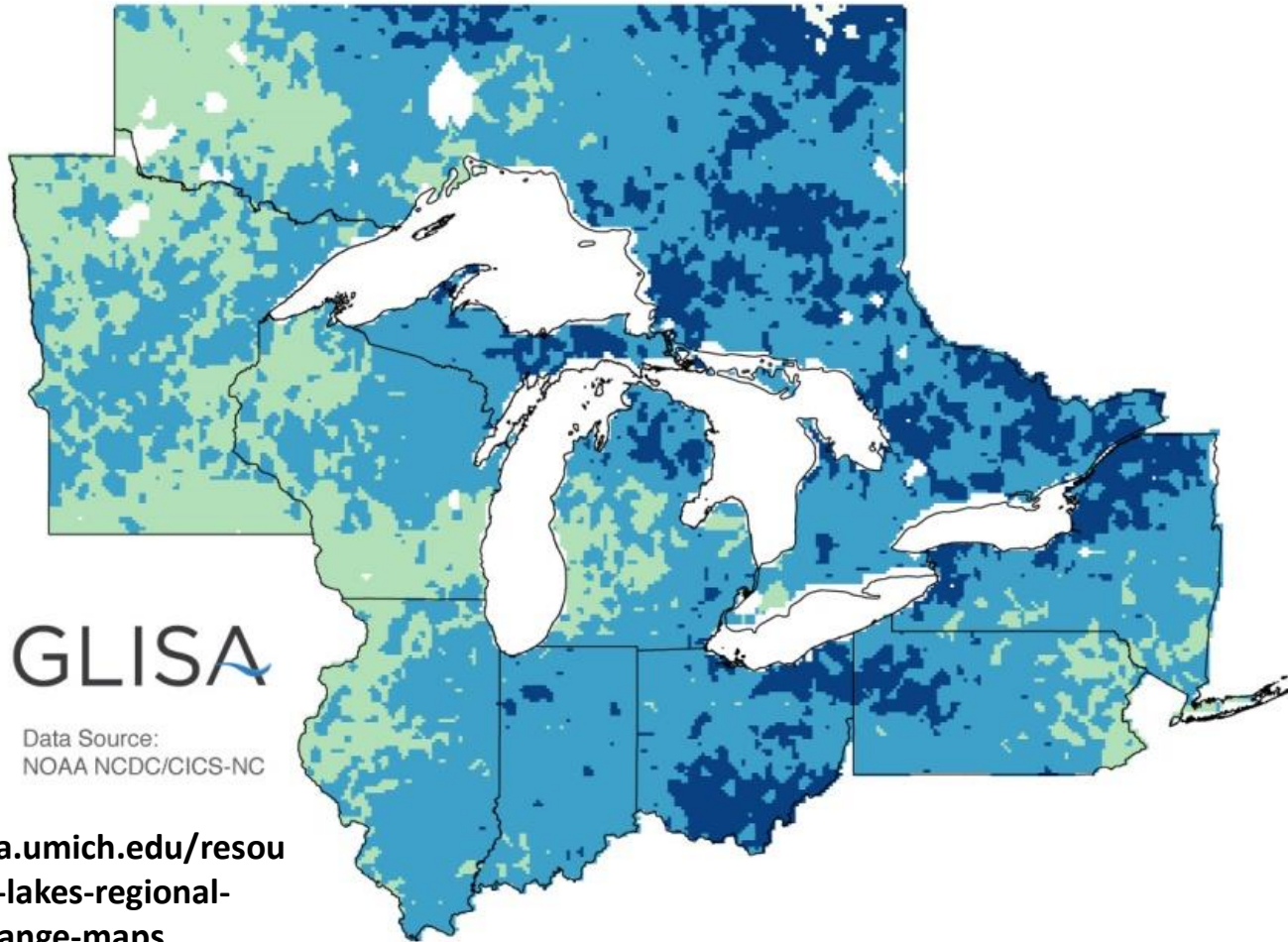


Observed Change in Very Heavy Precipitation



Projected Change in Number of Heavy Precipitation Days

Period: 2041-2070 | Higher Emissions: A2



Change In Number of Days Per Year



THE DETROIT FLOOD 2014

Detroit's wettest day in 89 years flooded at least five freeways 11 Aug 2014



New York suburbs get entire summer's worth of rain in 1 day (13" in Islip) 13 Aug 2014



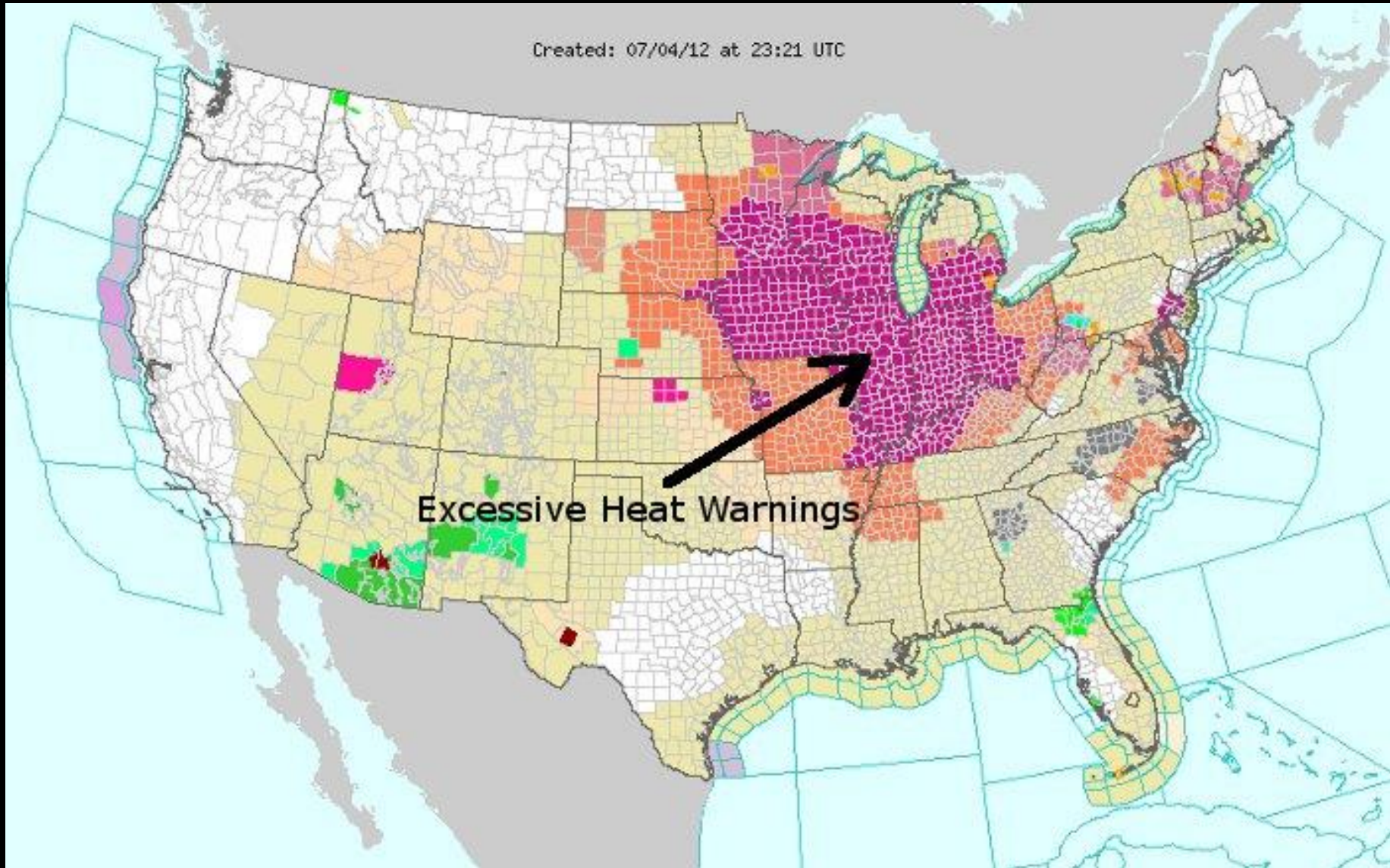
Rainfall that closed I-70 east of Dayton equivalent to '1,000-year flood,' ODOT says 21 May 2014



Floods Hit Phoenix In Area's Wettest Day Ever Recorded 8 September 2014

Heat Products from the NWS

Created: 07/04/12 at 23:21 UTC



Look Before You Lock!

Heat Related Deaths
ARE Preventable
LOOK BEFORE YOU LOCK



The temperature in your car can quickly become deadly!

Outside Temperature 80°



weather.gov/heat

nhtsa.gov

Heat Safety for Outdoor Workers



Drink water often

Rest and cool down in the shade during breaks

Gradually increase workload and allow more frequent breaks for new workers or workers who have been away for a week or more

Know symptoms, prevention, and emergency response to prevent heat-related illness and death

Check weather forecasts ahead of time to be better prepared

Medical Symptoms

Heat Cramps may be the first sign of heat-related illness, and may lead to heat exhaustion or stroke.

Symptoms: Painful muscle cramps and spasms usually in legs and abdomen, Heavy sweating

First Aid: Apply firm pressure on cramping muscles or gently massage to relieve spasm. Give sips of water unless the person complains of nausea, then stop giving water

Medical Symptoms

Heat Exhaustion

Symptoms: Heavy sweating, Weakness, Cool, pale, clammy skin, Fast, weak pulse, Possible muscle cramps, Dizziness, Nausea or vomiting, Fainting

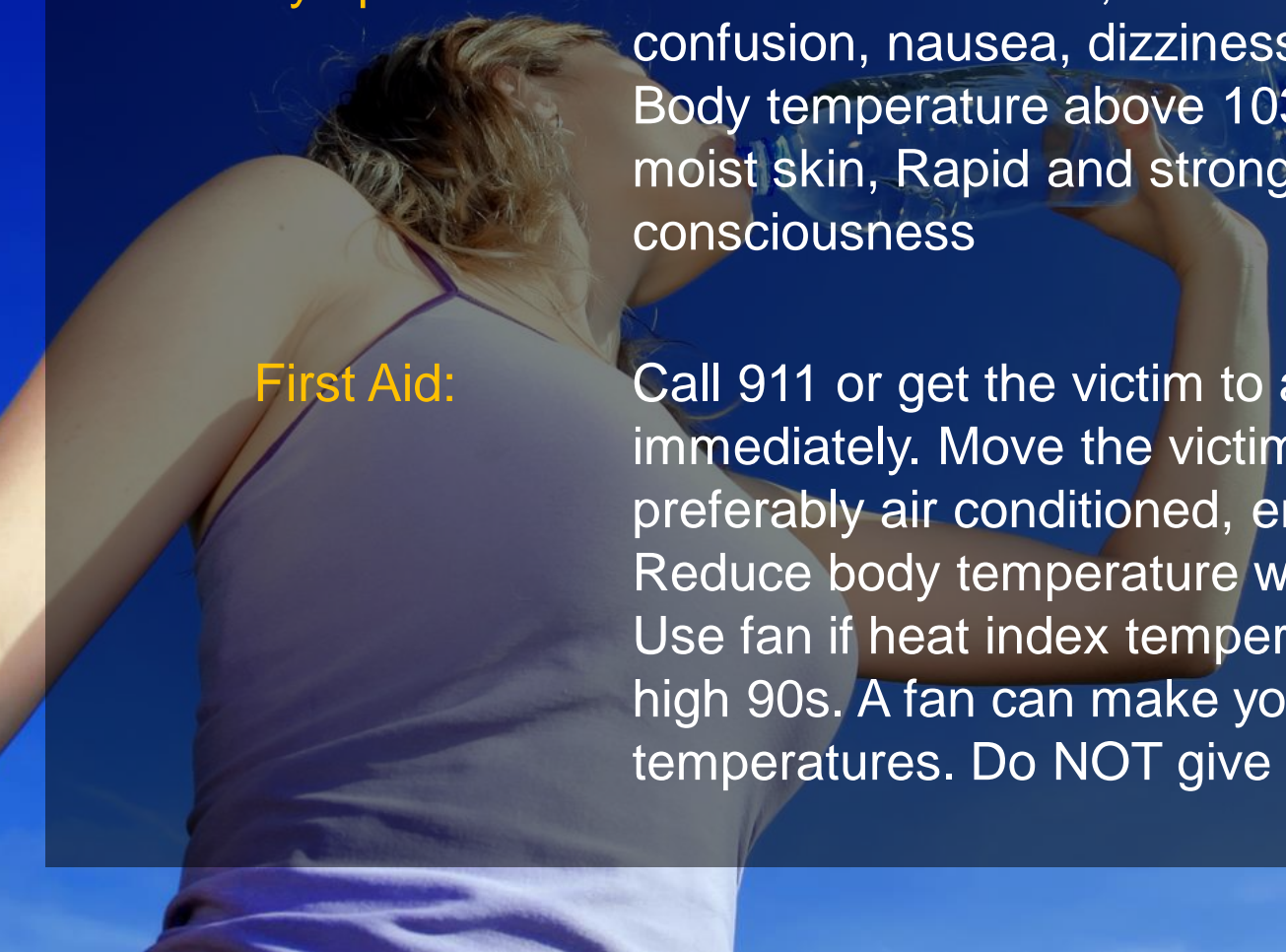
First Aid: Move person to a cooler environment, Lay person down and loosen clothing, Apply cool, wet cloths to as much of the body as possible, Fan or move victim to air conditioned room, Offer sips of water , If person vomits more than once, seek immediate medical attention.

Medical Symptoms



Heat Stroke is a severe medical emergency.

Symptoms: Altered mental state, Throbbing Headache, confusion, nausea, dizziness, shallow breathing, Body temperature above 103°F, Hot, red, dry or moist skin, Rapid and strong pulse, Faints, loses consciousness



First Aid: Call 911 or get the victim to a hospital immediately. Move the victim to a cooler, preferably air conditioned, environment. Reduce body temperature with cool cloths or bath. Use fan if heat index temperatures are below the high 90s. A fan can make you hotter at higher temperatures. Do NOT give fluids.