ATM S 103

Hurricanes and Thunderstorms

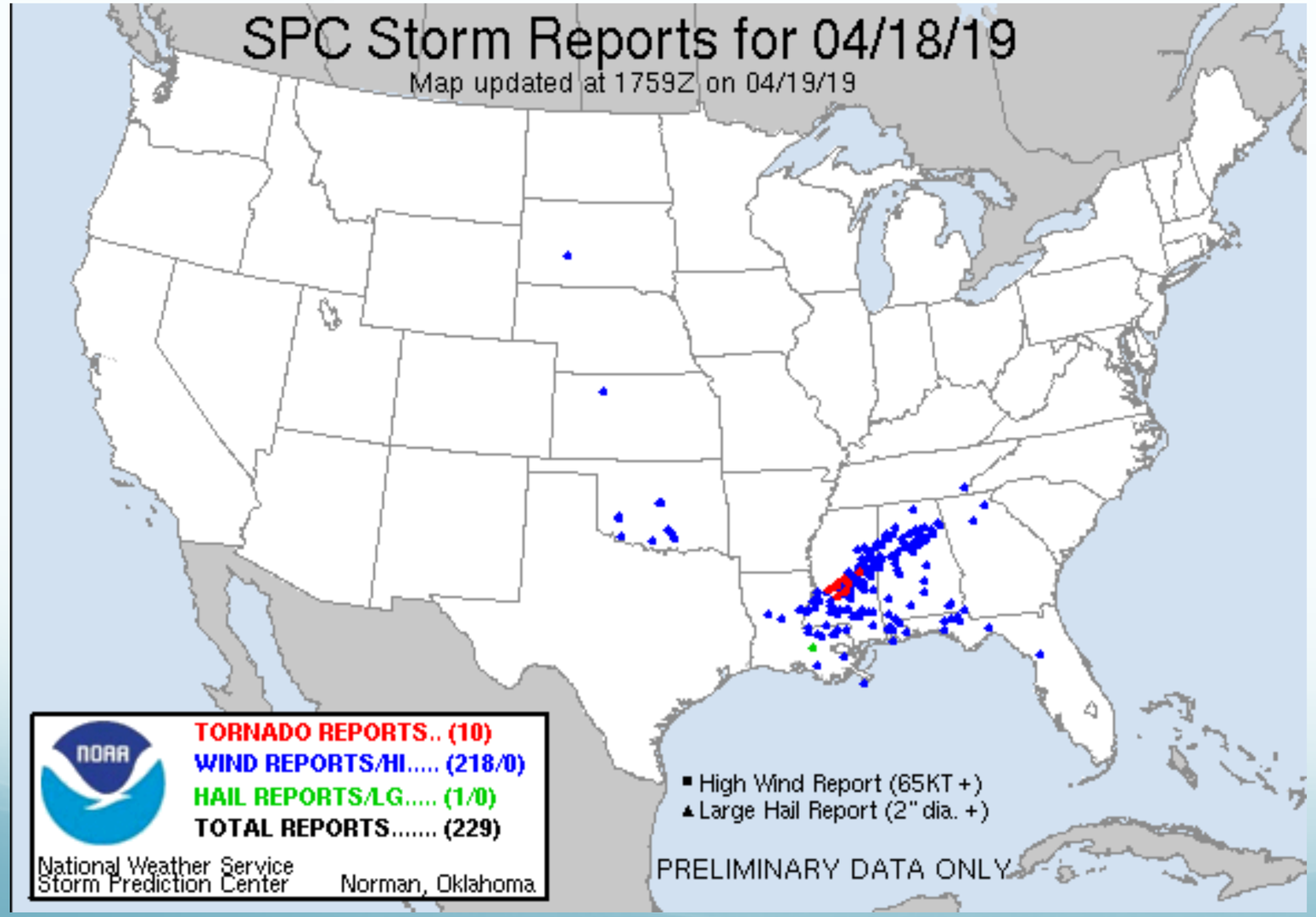
Their Science and Impacts

Dennis Oswald (from http://www.severe-weather.eu)

Announcement

- Homework 2 is due today 6PM
- Homework 3 will be released at 6PM: it covers the lecture and reading material for this past week (April 15-19)

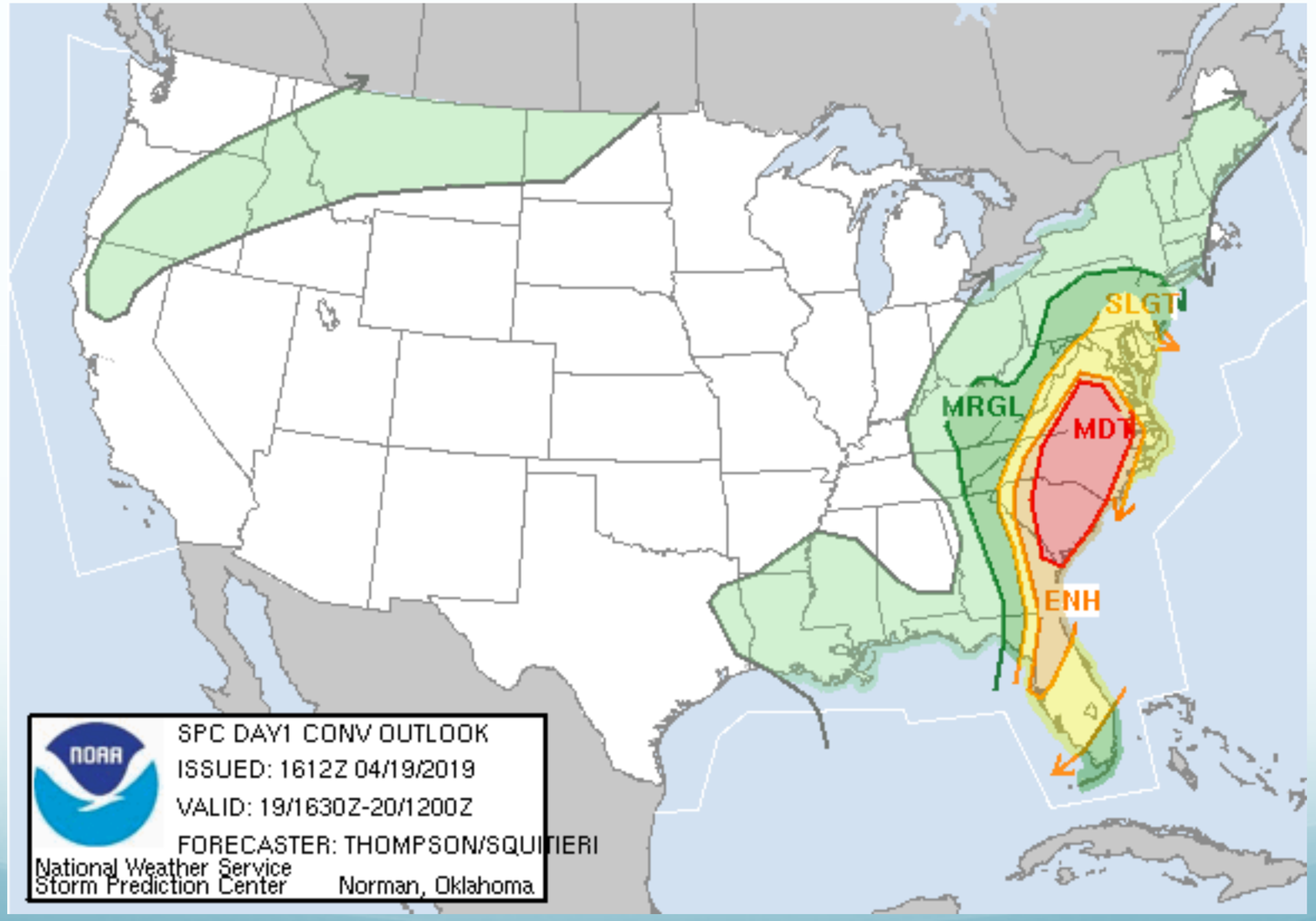
Tornado outbreak in Mississippi yesterday



Damage in Morton, MS

https://www.youtube.com/watch?v=Qncv5PKQiwI&feature=youtu.be&fbclid=IwAR2ybmvyOBPoO3B5gRjJARJALGduI8IBM42sZ6bXrjZom0sgZSm7I9xIdvg

Moderate (second highest) risk this afternoon



Two days ago in Oklahoma

image credit: Paul Smith https://www.facebook.com/SuperCelula/?__tn__=k*F&tn-str=k*F

Exotic lightning: red sprites

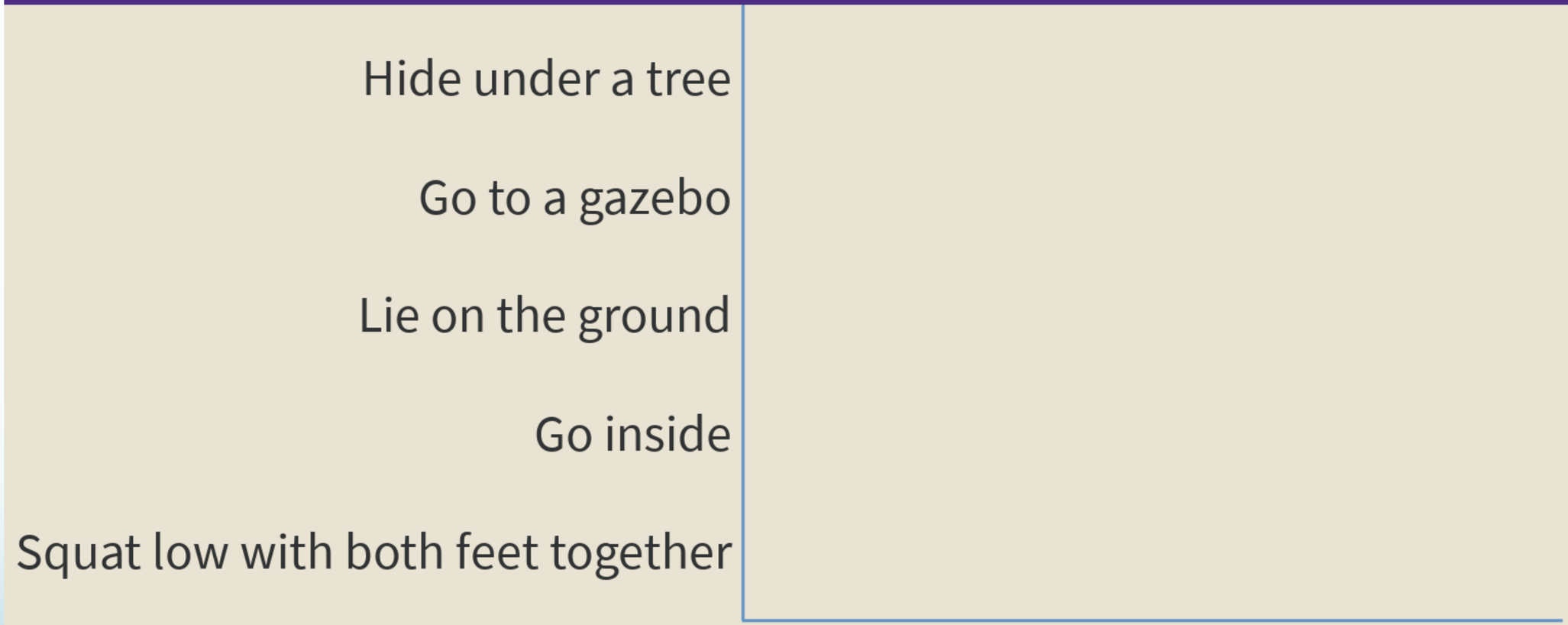
Red sprites

- Occur *way* above active thunderstorms
  - Thunderstorm cloud top typically at 10-15 km
  - Brightest part of sprite typically at 65-70 km
- Hard to see from the ground
  - Thunderstorm is in the way
  - Not bright (note stars in photos)

Red sprite over Nebraska

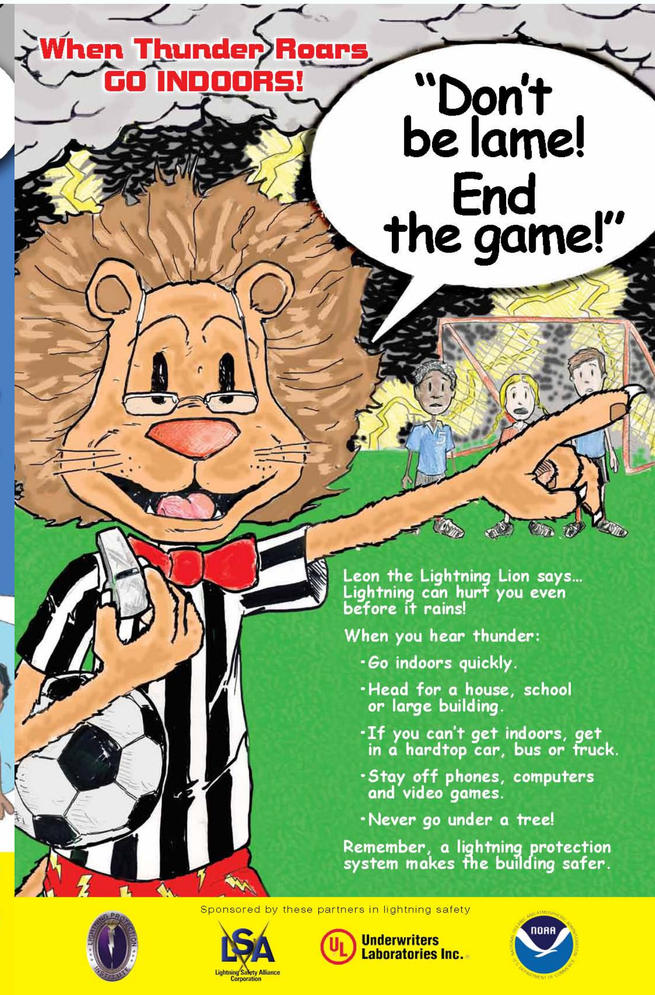
Taken from a research aircraft.

You're outside and hear thunder. Which is the best course of action?



Answer

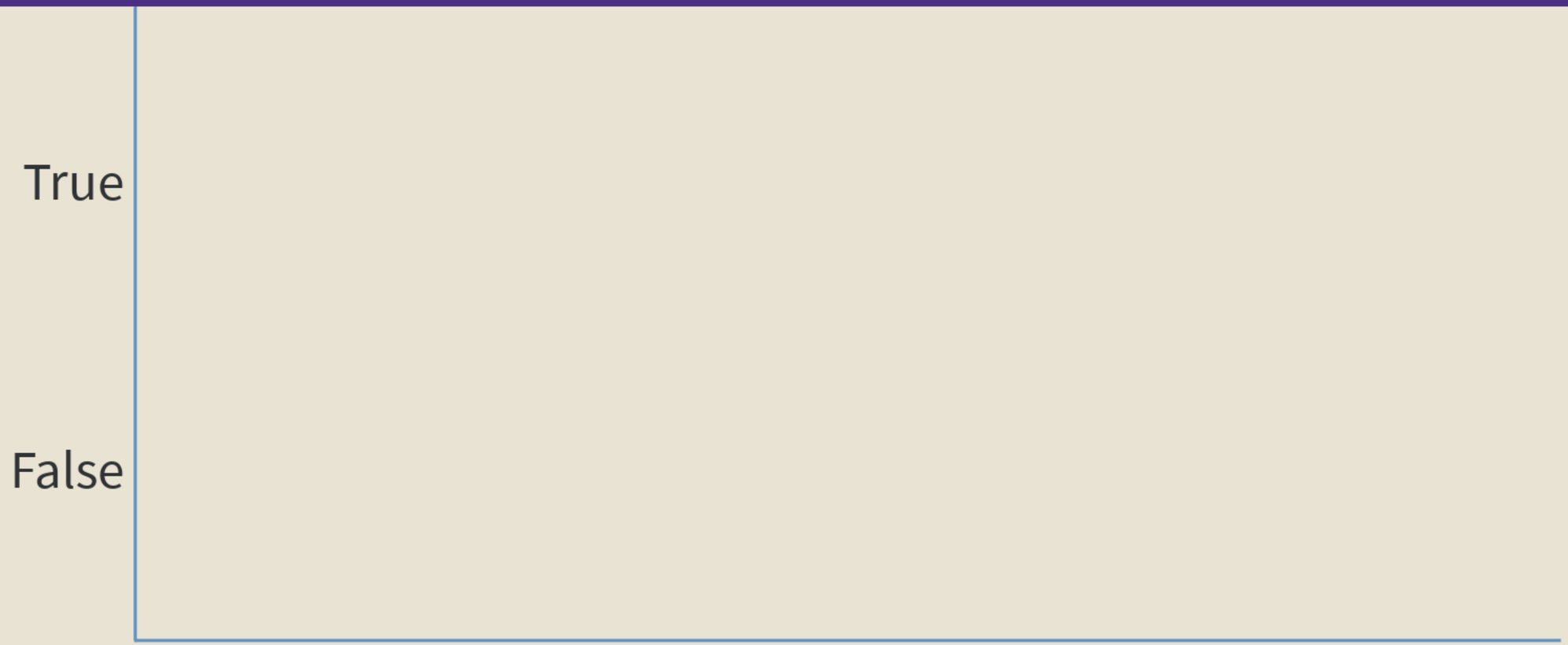
- Go inside if at all possible



NOAA Safety Guidance

- NO PLACE outside is safe when thunderstorms are in the area!!
- If you hear thunder, lightning is close enough to strike you.
- When you hear thunder, immediately move to safe shelter: a substantial building with electricity or plumbing or an enclosed, metal-topped vehicle with windows up.
- Stay in safe shelter at least 30 minutes after you hear the last sound of thunder.

If caught outside during a lightning storm with no shelter around, you should lie flat in the lowest spot available.



Start the presentation to see live content. Still no live content? Install the app or get help at **PollEv.com/app**

Total Results

False, squat low with both feet together.

***What NWS recommends is planing ahead and taking action immediately to get to a safe place as early as possible**

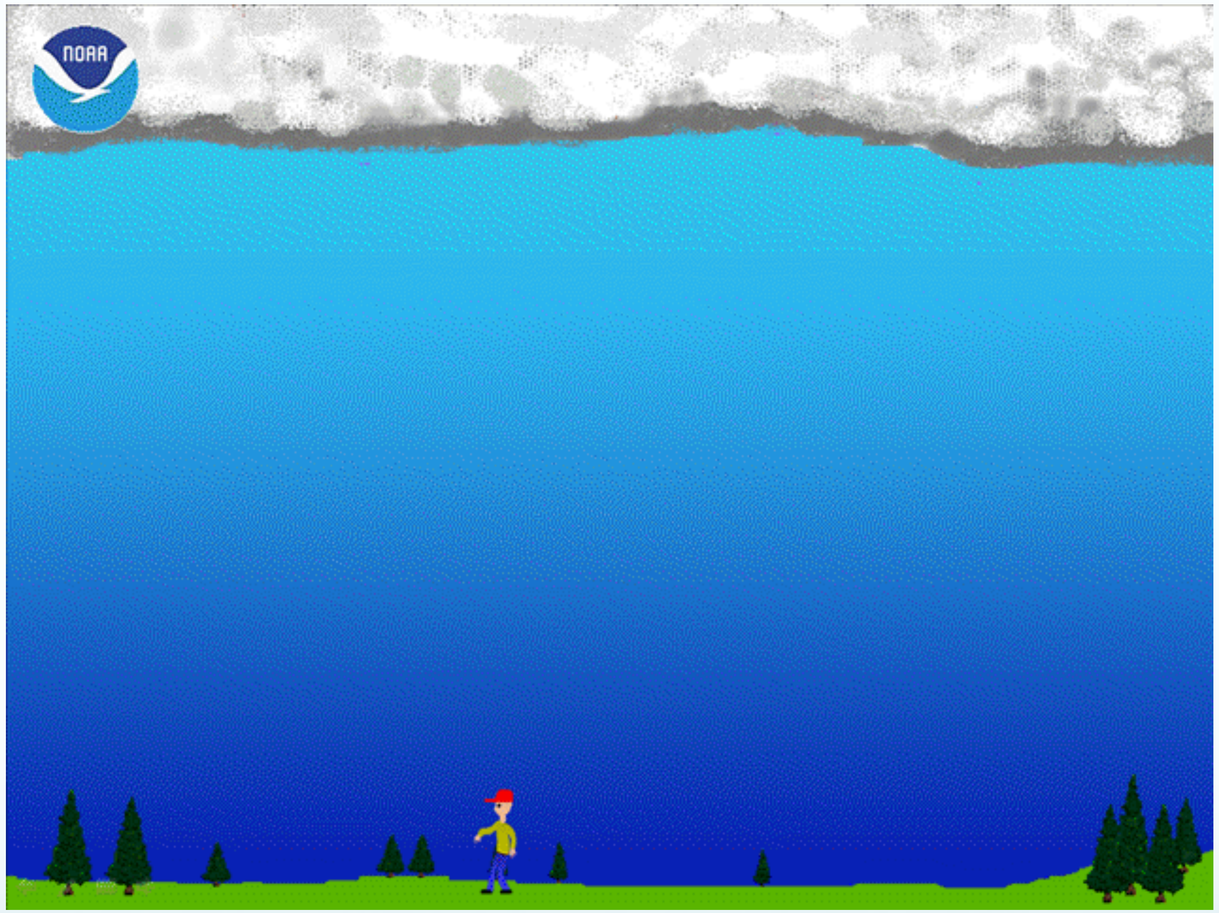
NOAA Guidance – Indoor Safety

- Stay off corded phones, computers and other electrical equipment that put you in direct contact with electricity.
- Avoid plumbing, including sinks, baths and faucets.
- Stay away from windows and doors, and stay off porches.
- Do not lie on concrete floors, and do not lean against concrete walls.

How People Are Struck By Lightning

1. Direct Strike
2. Side Flash
3. Ground Current
4. Conduction
5. Streamer

Direct Strike



Victims struck directly by lightning are usually in open areas. Direct strikes are less common than some of the other ways people are struck, but they are potentially the most deadly.

Side Flash

Victims struck by a side flash are usually standing next to a taller object -- often a tree. On its way to the ground, the lightning jumps from the taller object to the person.

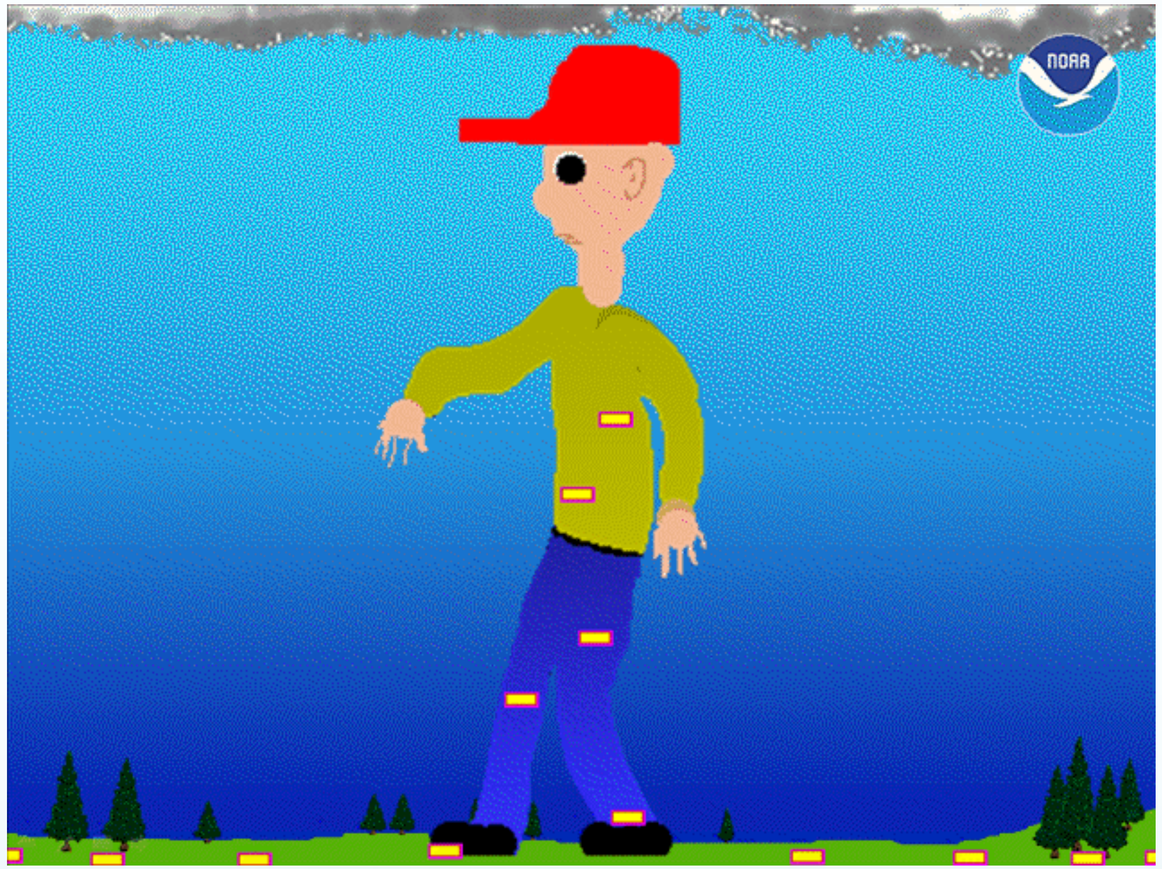
Side Flash

In 2011, a man took shelter under this tall tree. When lightning struck the tree, the man was killed by a side flash.

Ground Current

People struck by ground current are somewhere very near a lightning strike. The lightning might strike a nearby tree or even the ground. Ground current is likely responsible for most lightning fatalities.

Ground Current



Ground current usually passes in one leg and out the other, passing through the body. It is particularly dangerous to anyone lying down. Ground current kills many farm animals every year.

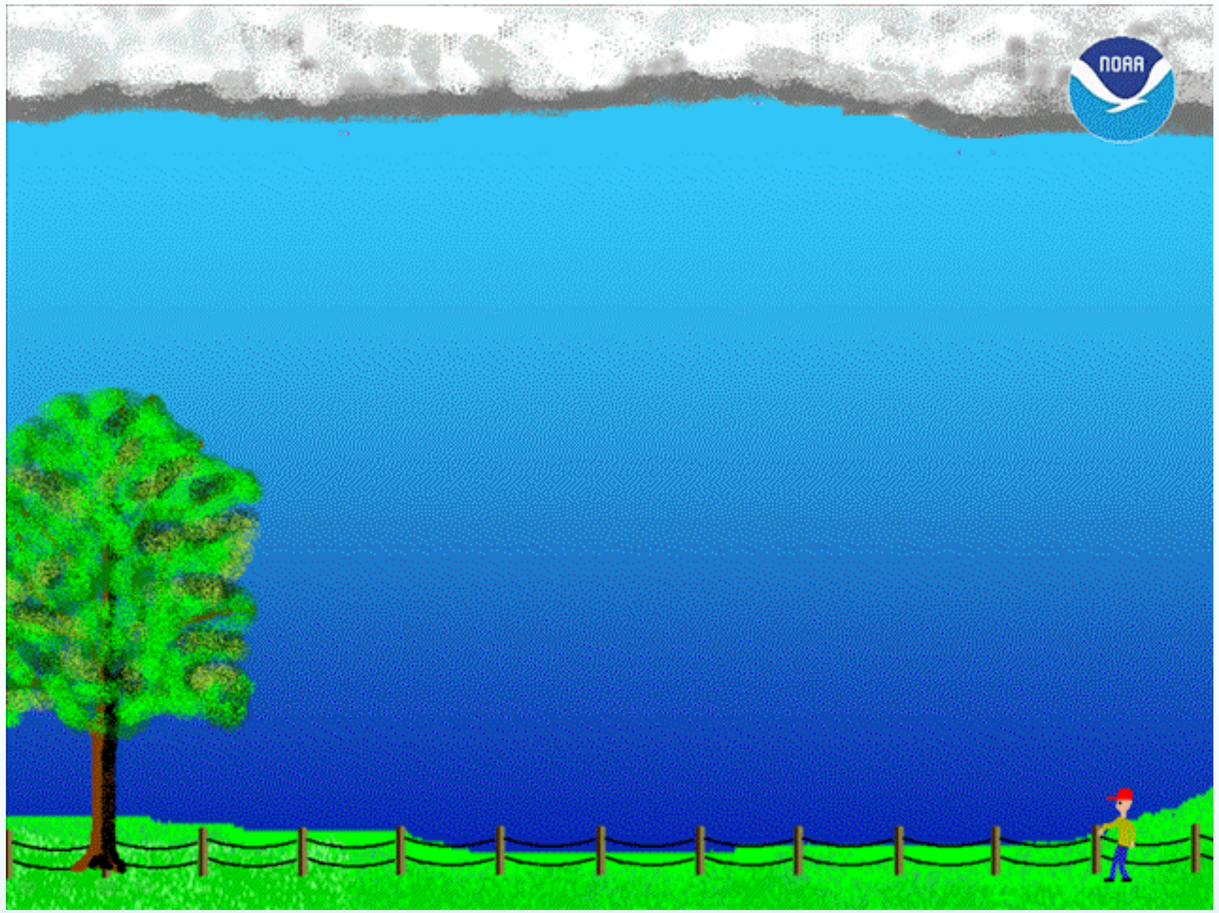
Ground Current

Ground current moves in and along the surface of the ground. In this case, lightning struck the flag and spread out along the ground.

Ground Current

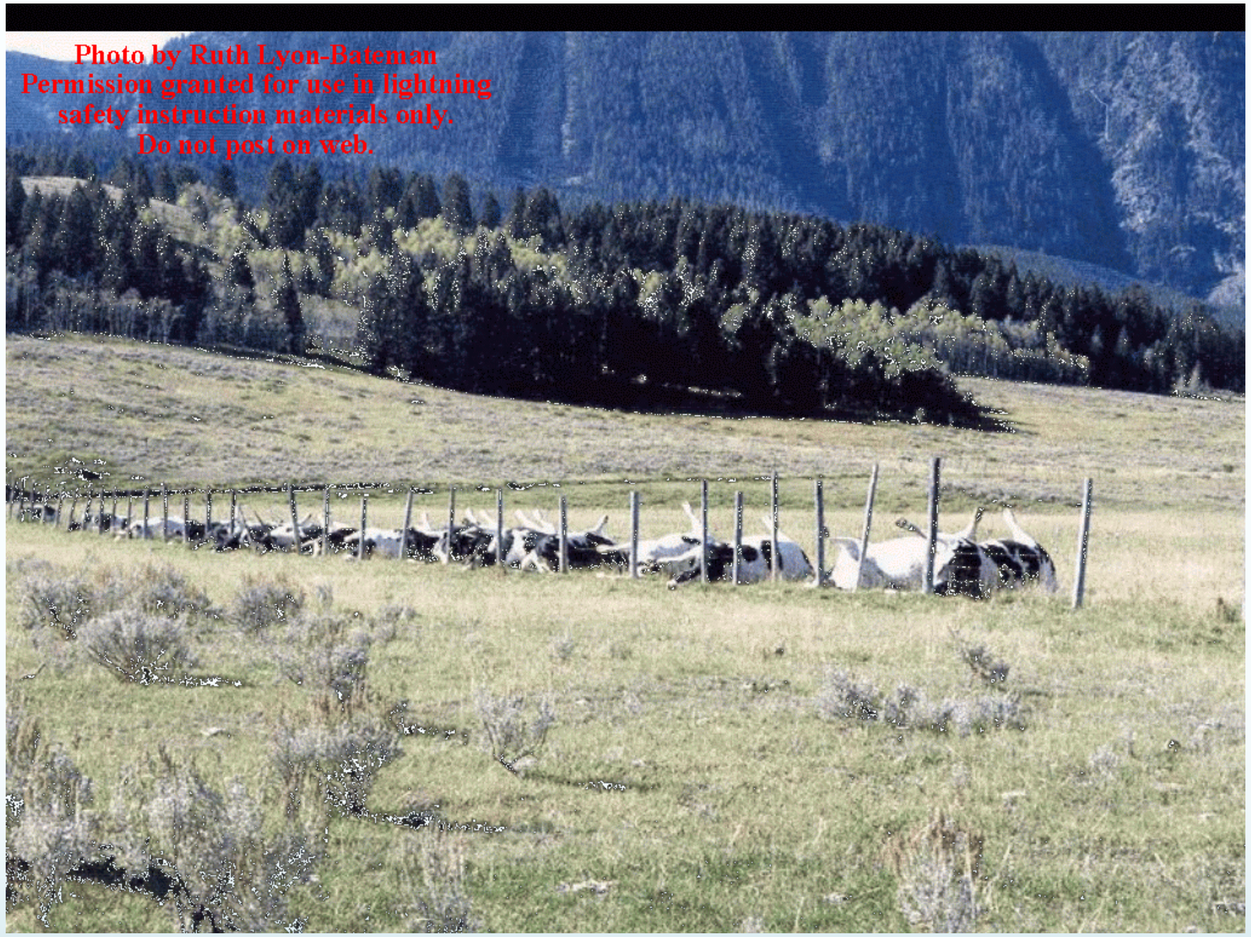
Farm animals are often killed by ground current. In this case, lightning struck the tree and spread out along the ground, killing these cattle.

Conduction



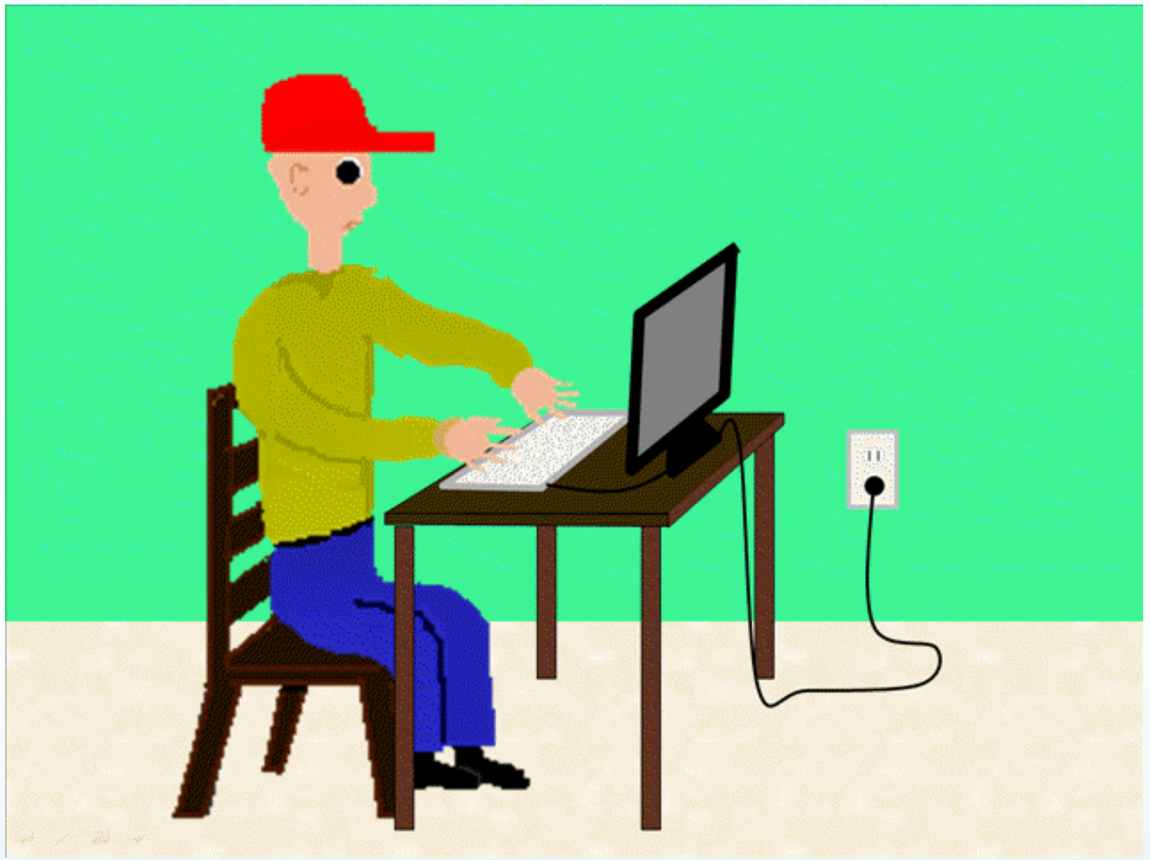
Lightning can travel long distances through wires or metal. Metal does not attract lightning, but it does provide a path for lightning to follow.

Conduction



Lightning struck somewhere along this wire fence. The charge traveled along the fence and killed all these cows.

Conduction



Conduction is responsible for most indoor lightning casualties. Lightning can enter a home through wires or pipes. Anyone that touches plumbing or anything plugged into an electrical outlet is at risk of being struck.

Streamer

Although not as common as other types of fatal incidents, victims caught in "streamers" are at risk of being killed or injured. Streamers discharge when lightning strikes nearby.

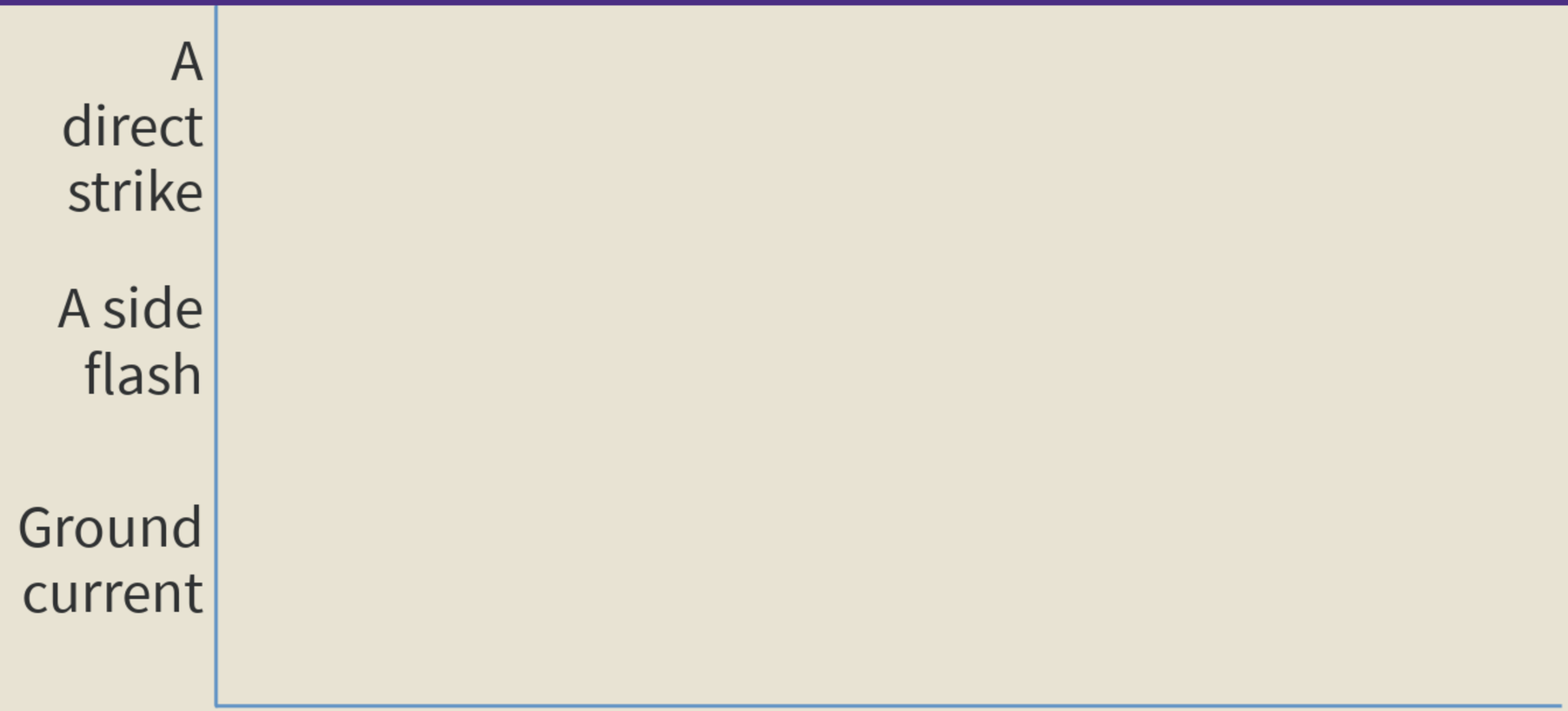
Streamer

This photo shows a nearby flash of lightning. The photographer was lucky that he wasn't killed or seriously injured. In addition to the main flash, there are also "streamers" nearby (see next page).

Streamer

When we zoom in on the picture, you can see two streamers coming from trees in the background.

Why is squatting better than lying flat on the ground during a lightning storm? It reduces the chance of being killed by



Start the presentation to see live content. Still no live content? Install the app or get help at **PollEv.com/app**

Total Results

C: Ground current

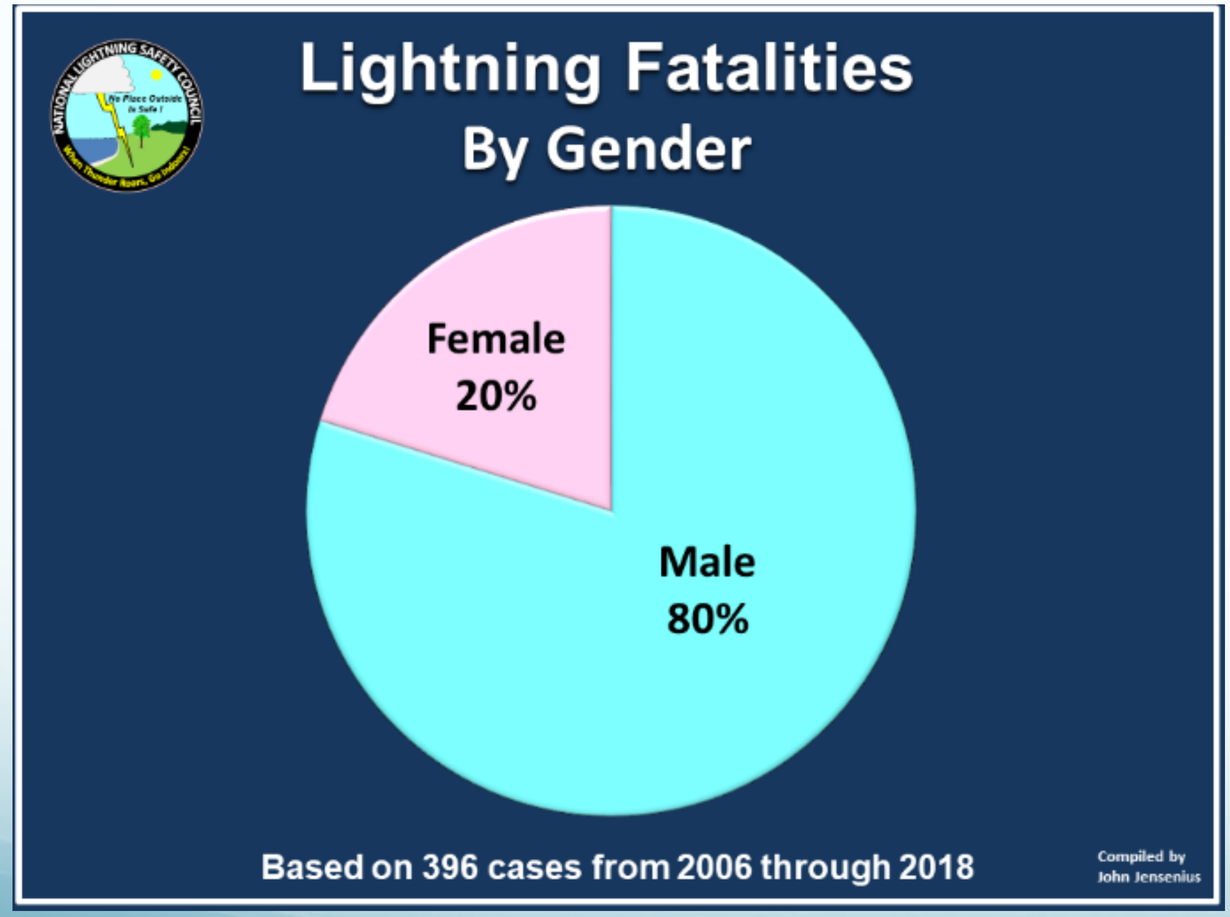
Lightning crouch: squat low with both feet together.

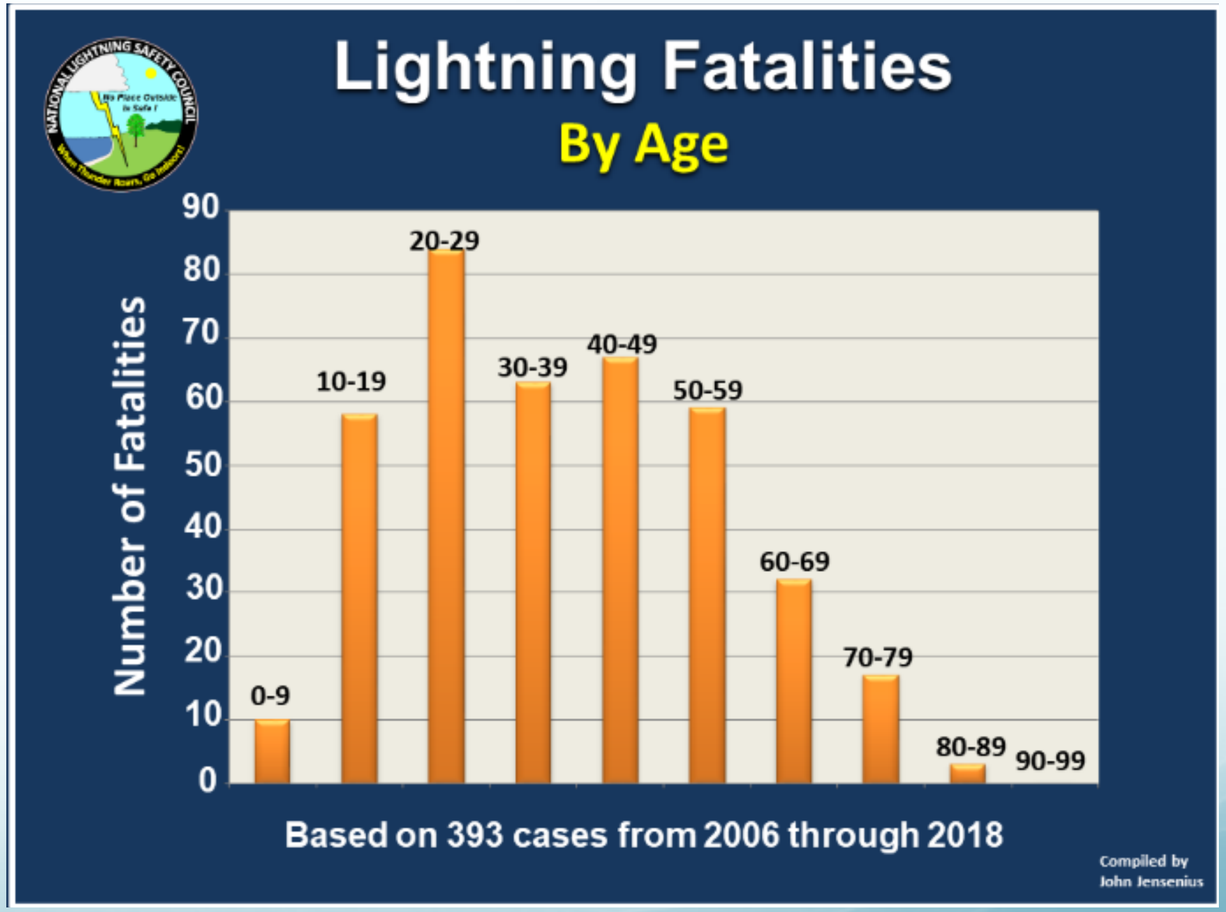
***Again, what NWS recommends is planing ahead and taking action immediately to get to a safe place as early as possible**

More NOAA Guidance when *NO* Shelter Is Nearby

- Immediately get off elevated areas such as hills, mountain ridges or peaks
- Never lie flat on the ground
- Never shelter under an isolated tree
- Never use a cliff or rocky overhang for shelter
- Stay away from objects that conduct electricity (barbed wire fences, power lines, windmills, etc.)

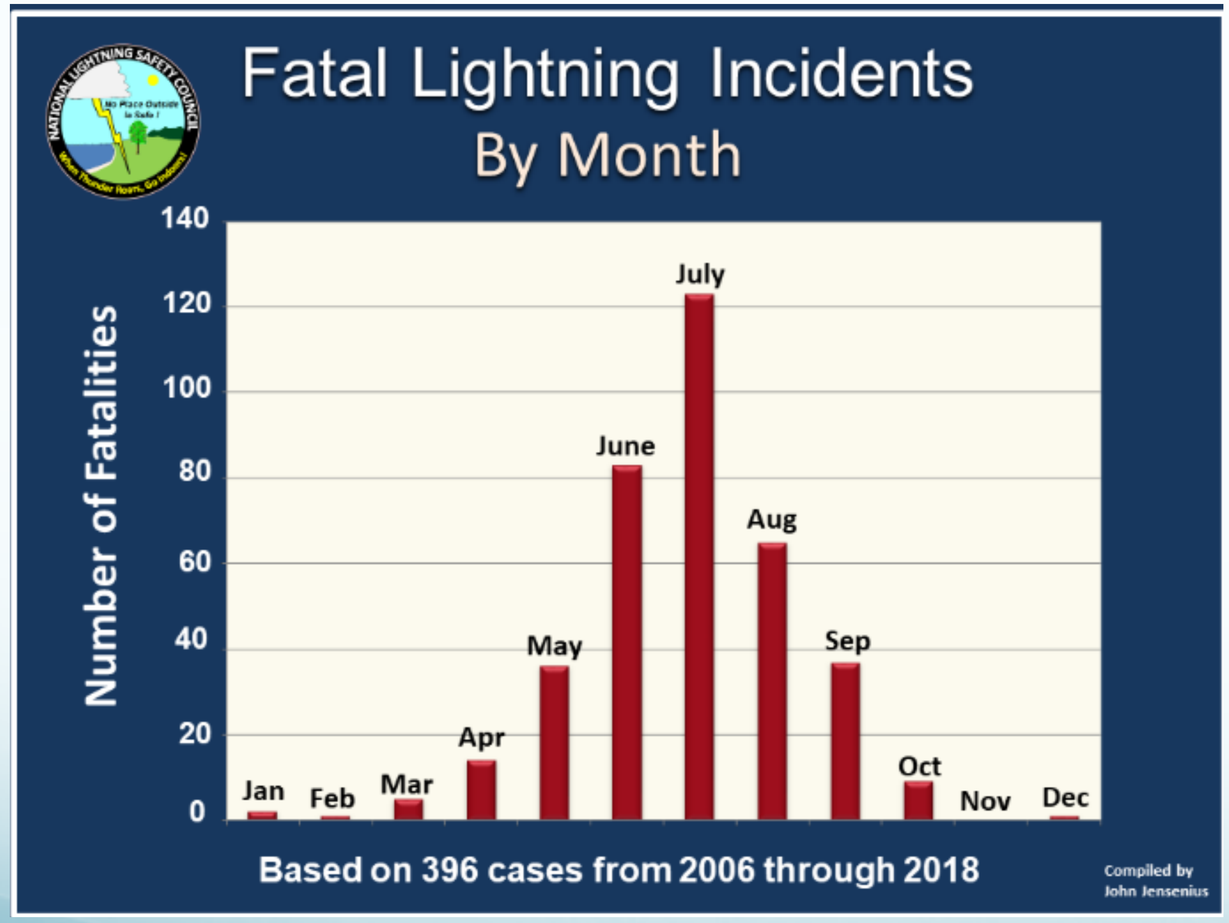
Analysis of Lightning Fatalities in the US

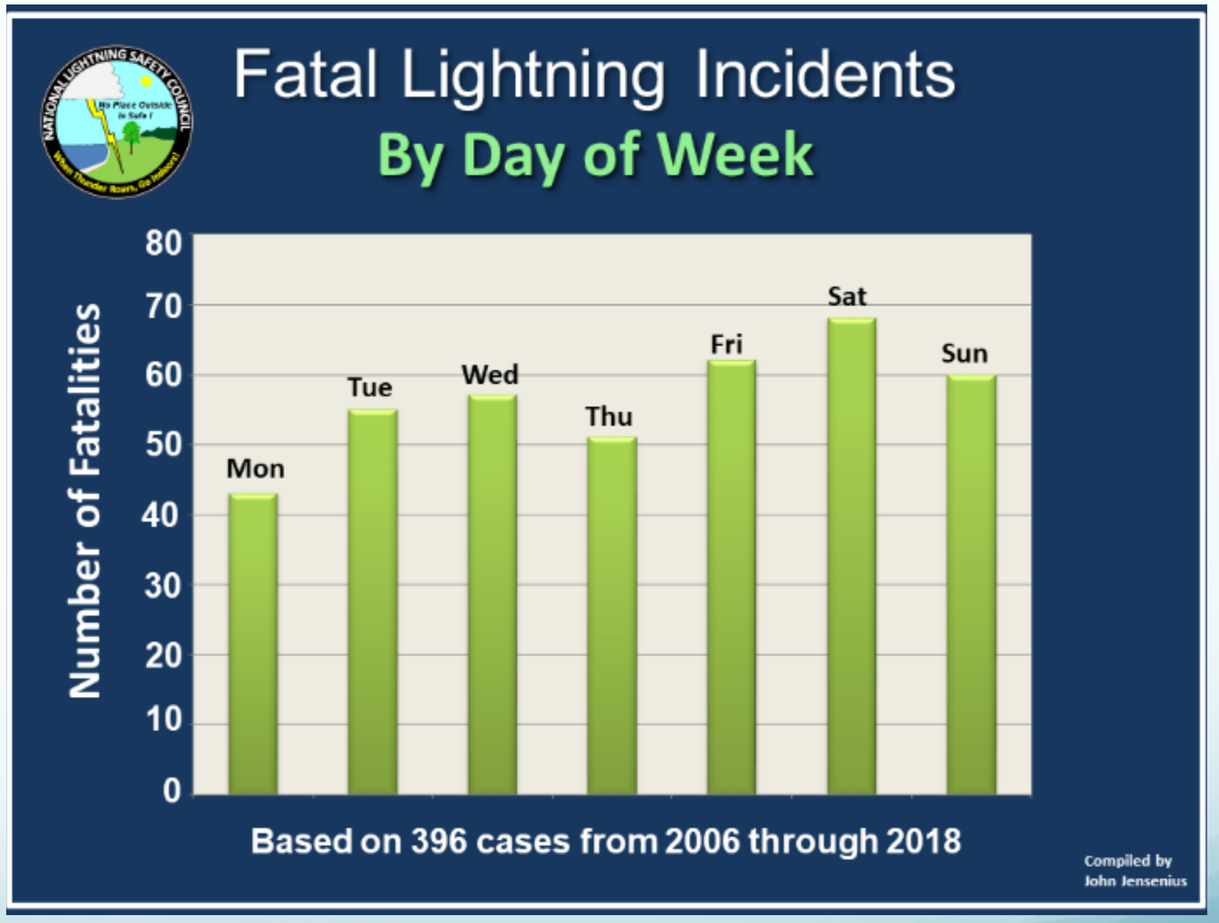




https://www.weather.gov/media/safety/Analysis06-18.pdf

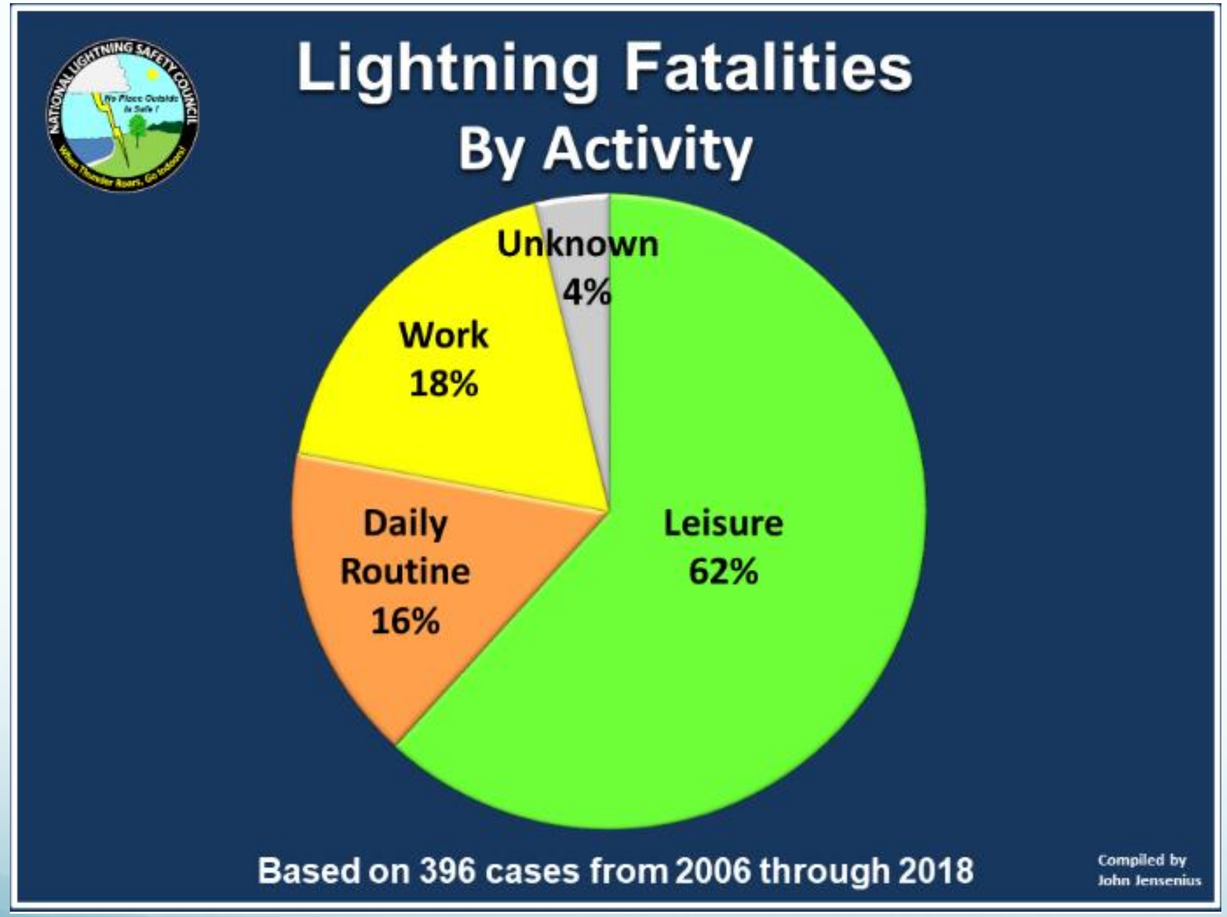
Analysis of Lightning Fatalities in the US

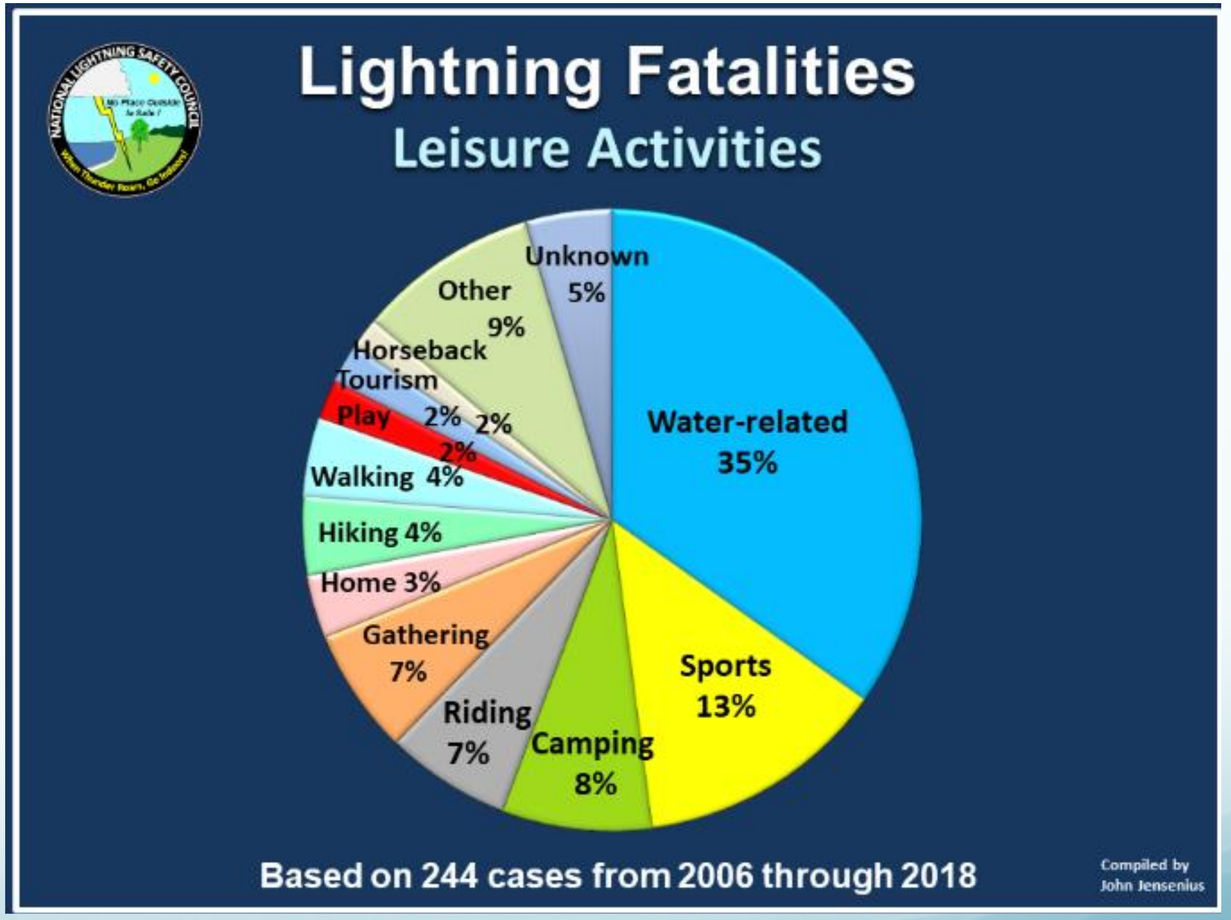




https://www.weather.gov/media/safety/Analysis06-18.pdf

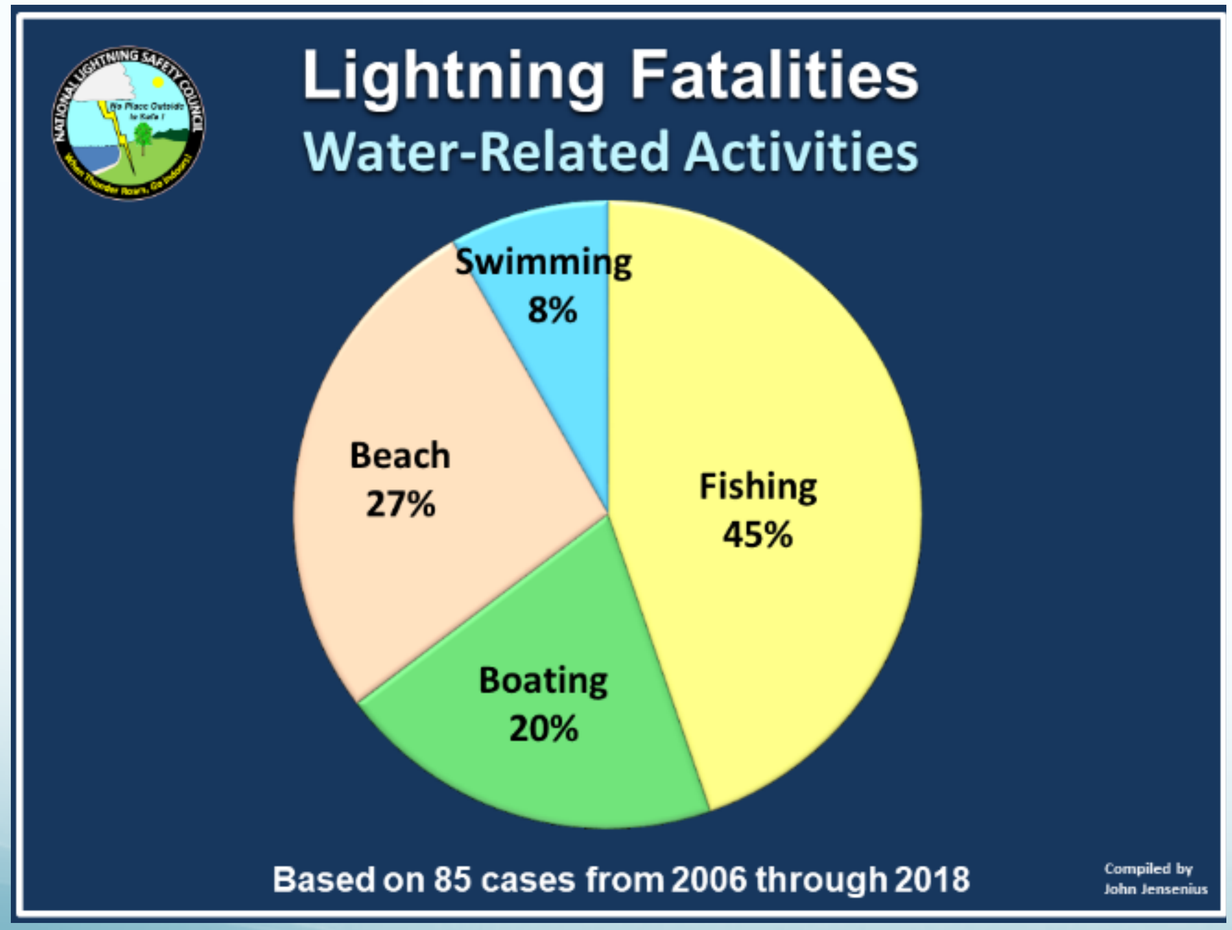
Analysis of Lightning Fatalities in the US

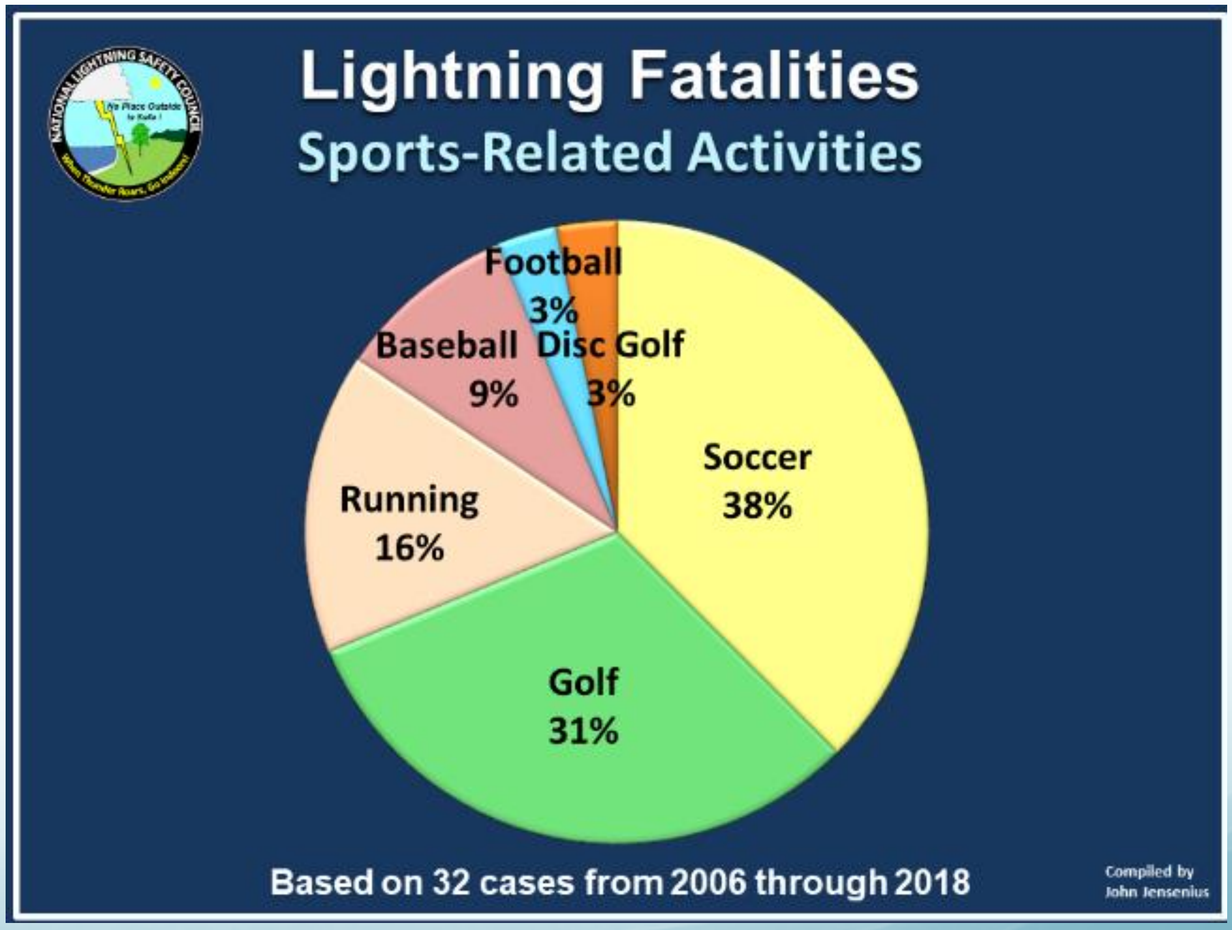




https://www.weather.gov/media/safety/Analysis06-18.pdf

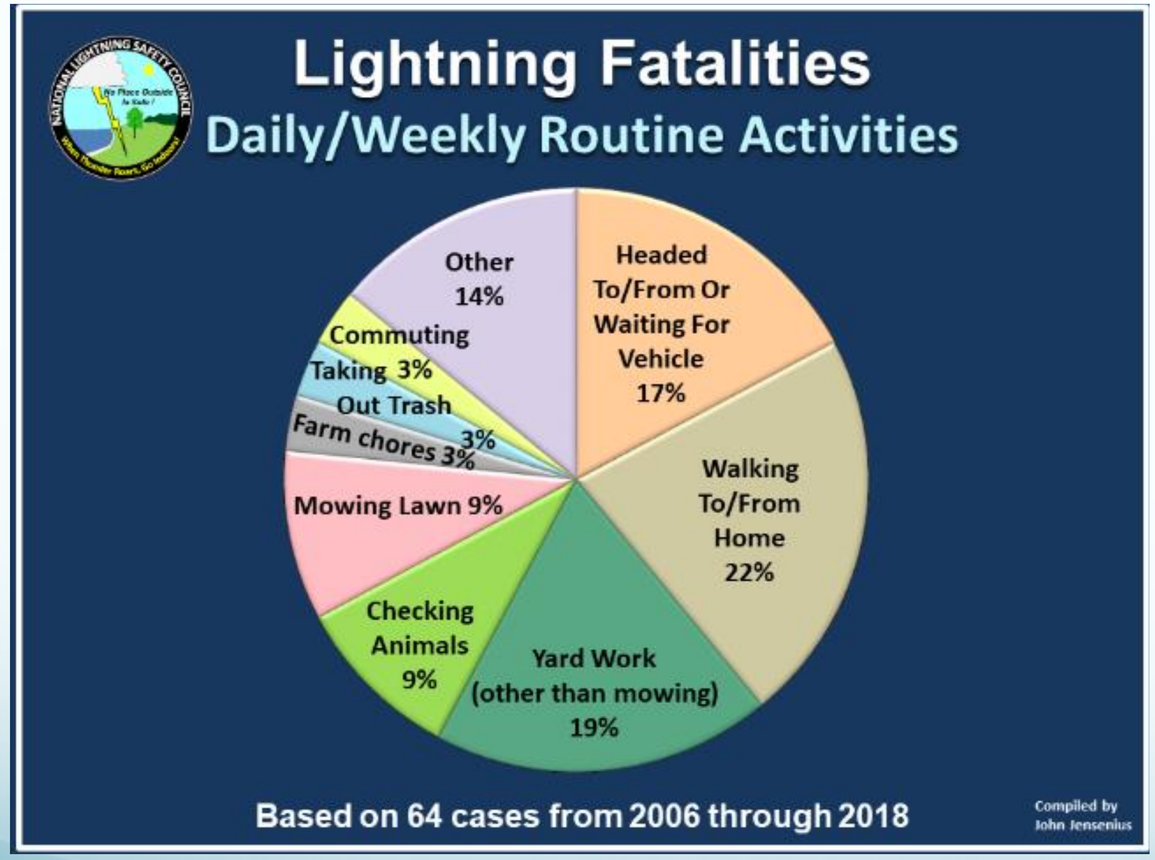
Analysis of Lightning Fatalities in the US

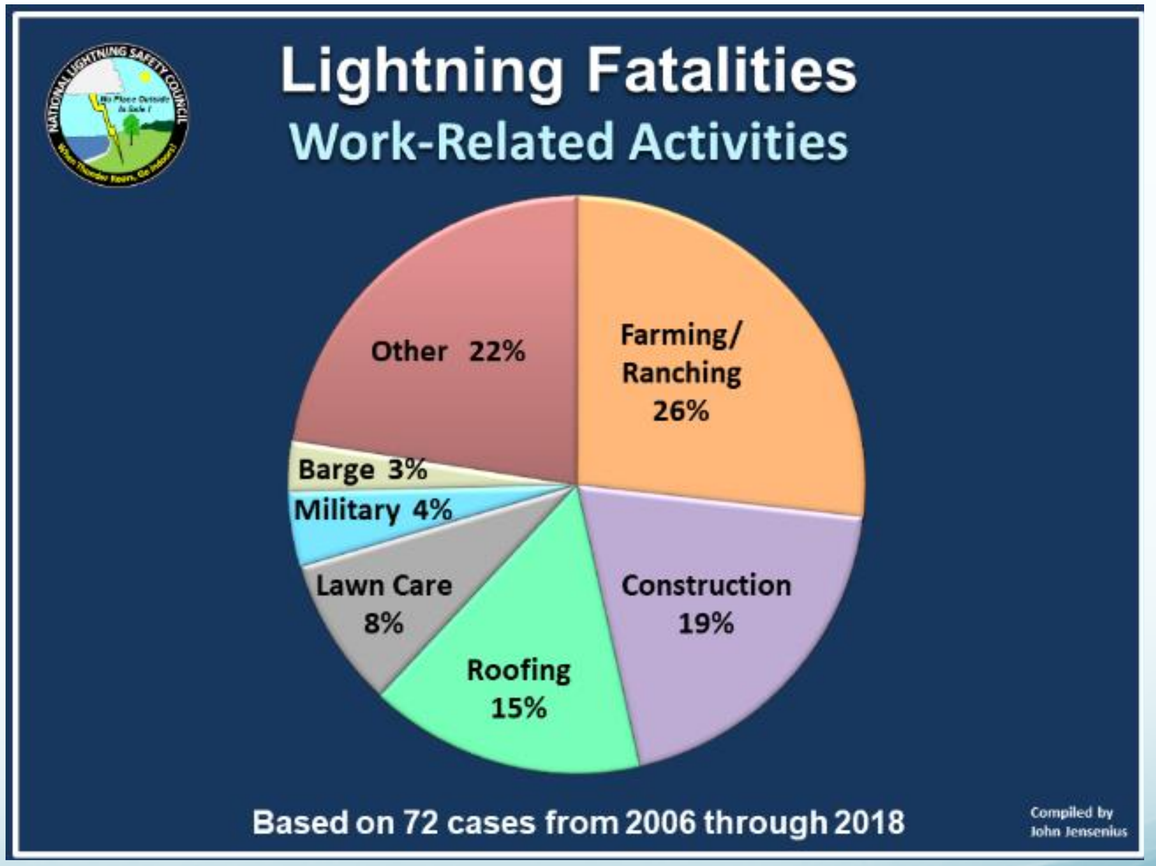




https://www.weather.gov/media/safety/Analysis06-18.pdf

Analysis of Lightning Fatalities in the US



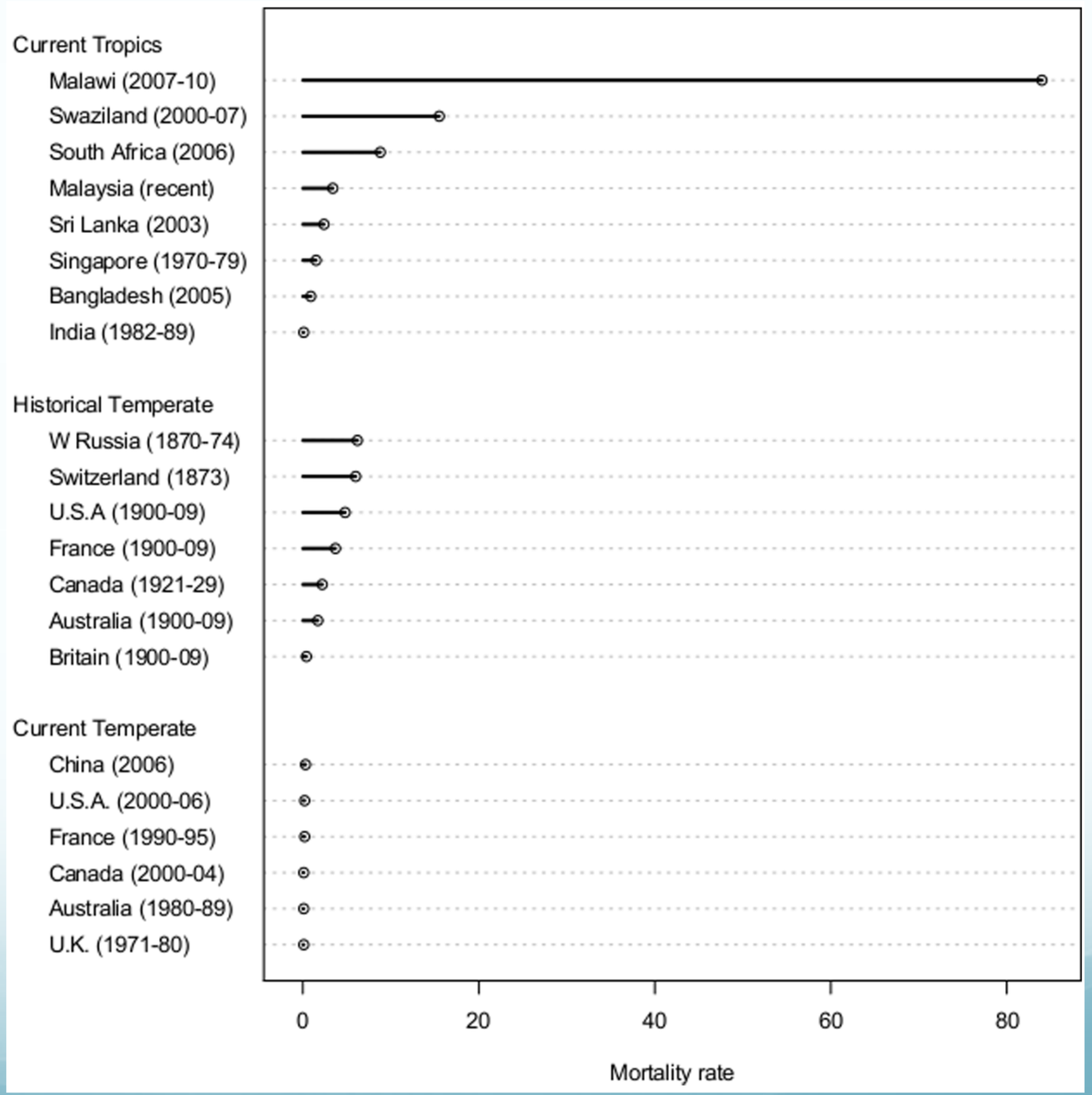


https://www.weather.gov/media/safety/Analysis06-18.pdf

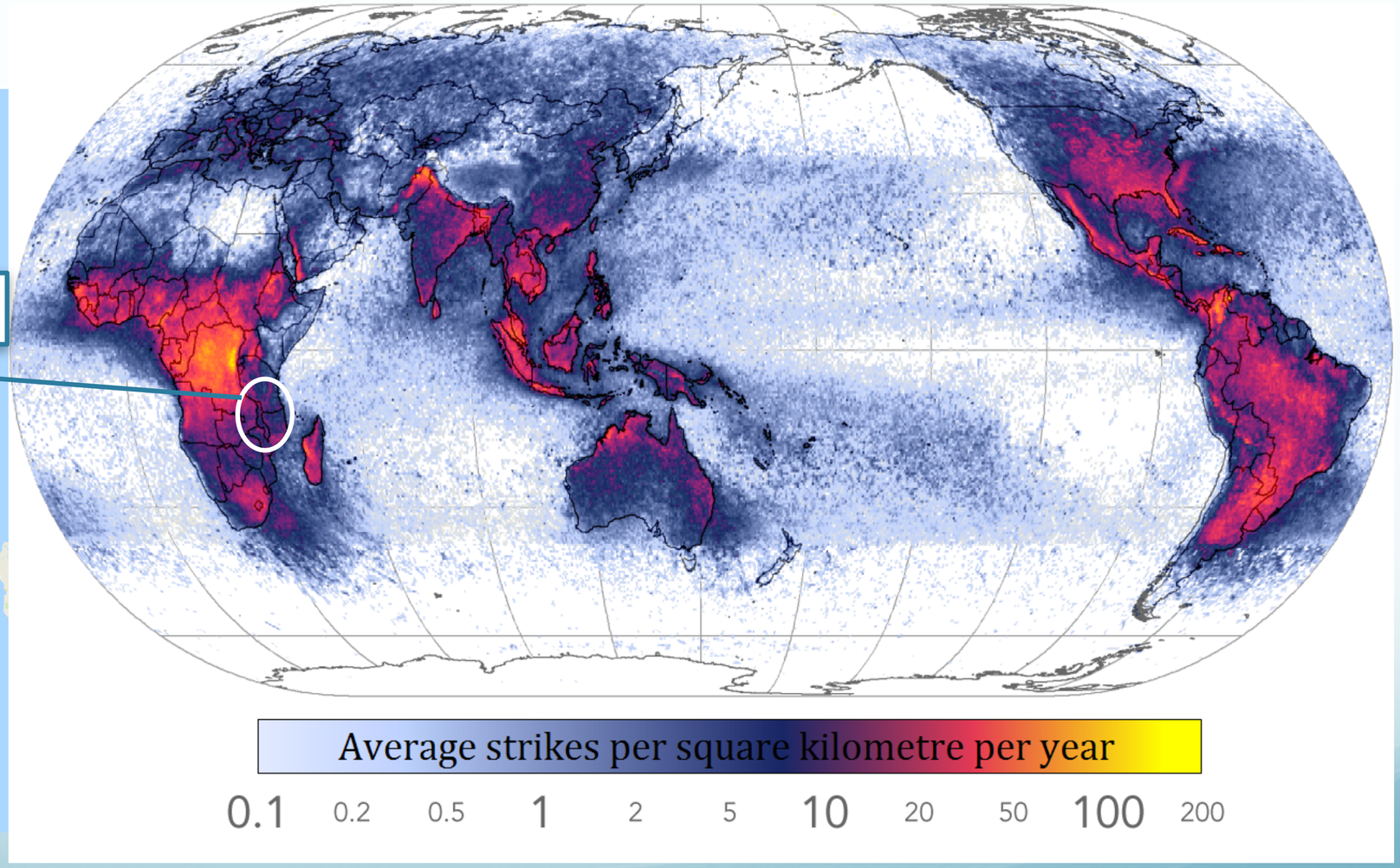
Analysis of Lightning Fatalities in the US

- Factors that contribute to lightning fatalities
  - Willingness to cancel or postpone activities
  - Being aware of approaching or developing storms (use your phone!)
  - Vulnerability of the activity (avoid being in an open field)
  - Ability and willingness to get a safe place quickly

Deaths per 1 million per year



Global Lightning Frequency



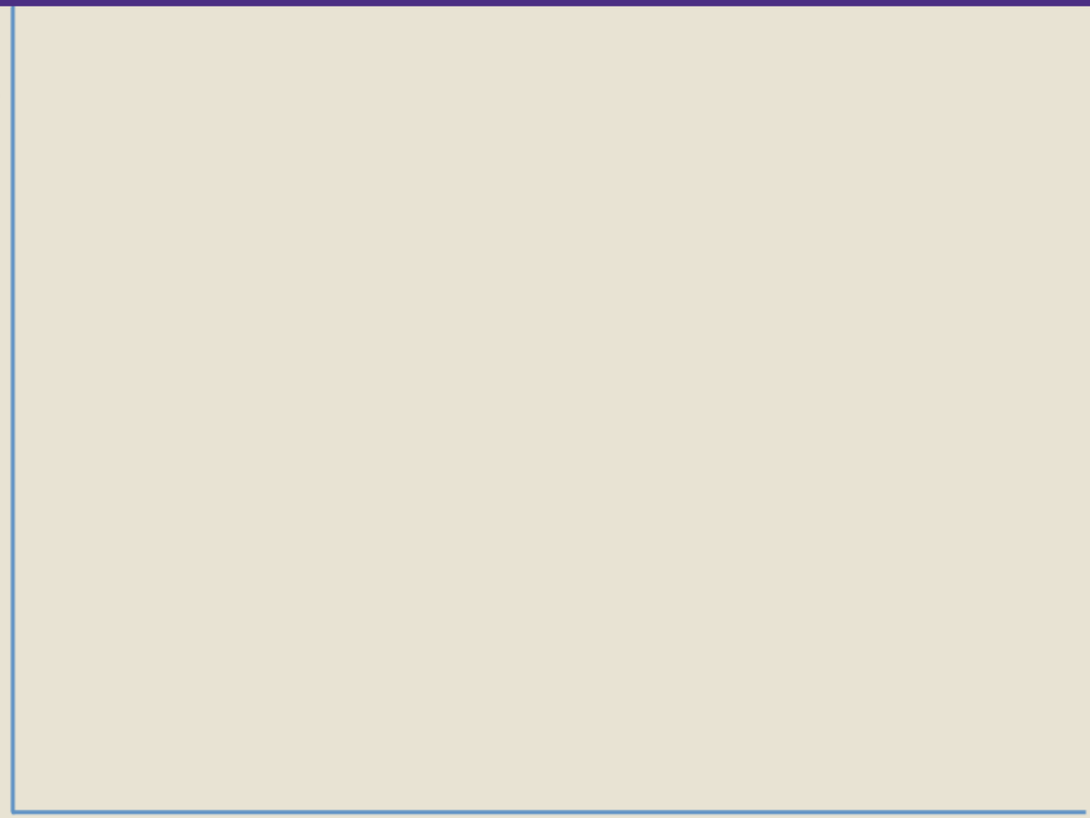
Which is not a reason why lightning death rates in Malawi are so high compared to the US?

Better reporting of all lightning deaths in the US.

Better medical care in the US.

Smaller percentage of the population working outside in the US.

More buildings with plumbing and electrical wiring in the US.

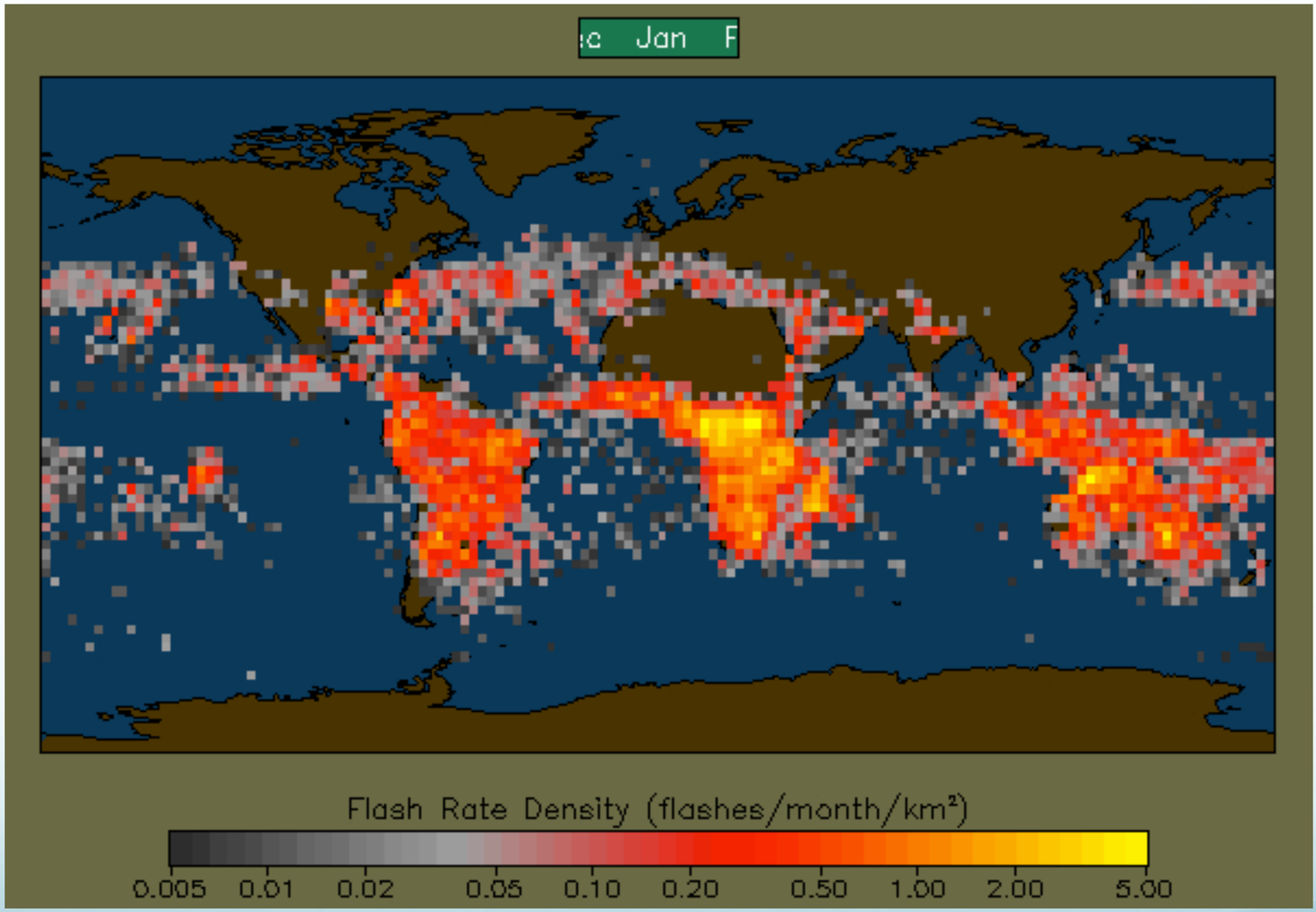


Answer

- Better reporting of lightning deaths in the US would tend to make lightning appear to be more of a hazard, so this is NOT a reason for the higher death rate in Malawi.

Lightning Climatology

Annual Cycle: Worldwide

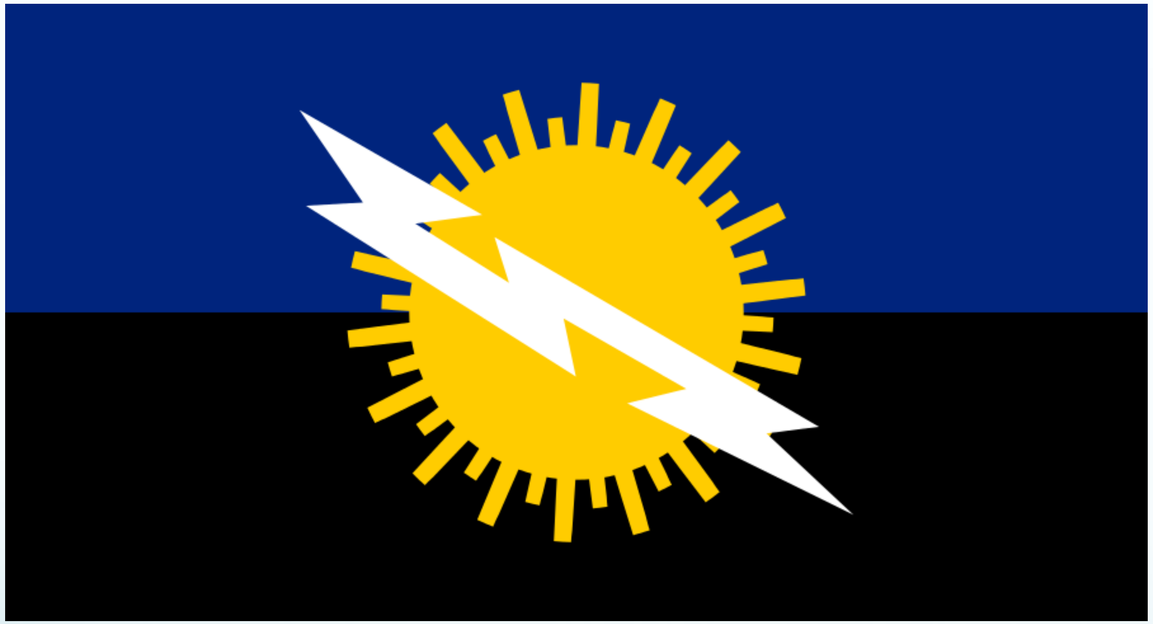


Most Frequent Lightning

- Kifuka, eastern Congo (elevation 3,200 ft)
  - 160 strikes per km^2 per year
- Lake Maracaibo, Venezuela (lots of cloud-to-cloud)
  - Catatumbo lightning
- In US, central Florida
  - 20 strikes per km^2 per year

Zulia State, Venezuela

State flag: Zulia State, Venezuela



- Catatumbo lightning: Mostly cloud-to-cloud
  - 140-160 days per year
  - 10 hours per day
  - Up to 280 times per hour

Ringed by Mountains

Catatumbo Lightning

- Mostly cloud-to-cloud
  - 140-160 days per year
  - 10 hours per day
  - Up to 280 times per hour
- Stopped in 2010 during a drought
- Restarted a few months later
- 2015 edition of Guinness World Records: dethrones Kifuka as having the most lightning bolts
  - 250 per km^2 per year.