When Lightning Strikes!

Tiffany L Brainerd, MD
FAAP, FASA, FAWM, DiMM

High Noon Rotary
Durango, CO
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Disclosures

- No financial disclosures, No conflicts of interest, No product endorsements
- Current affiliations

  American Institute for Avalanche Research and Education (AIARE)

  Wilderness Medical Society (WMS)

  American Society of Anesthesiologists (ASA)

  Society for Pediatric Anesthesiology (SPA)

  Colorado Search and Rescue (CSAR)

  International Society of Mountain Medicine (ISMM)

  Vanderbilt University Medical Center (VUMC)
- Discussions of death, including local case studies

When Lightning Strikes!

Source: NBC News

Source: National Weather Service

Source: Stevens County Emergency Management

Source: Lightning Data Center

Source: NOAA National Severe Storms Laboratory

PHOTO: NEAL HERBERT / NPS

Source: NOAA National Severe Storms Laboratory & NASA

Source: TL Brainerd, MD

Source: Jackson Hole News & Guide

Source: Teton County SAR

Woman killed by lightning in Edgemont subdivision

65-year-old was walking Saturday morning

By Patrick Armijo Herald staff writer

Sunday, Jun 7, 2020 1:05 PM **Updated Sunday, Jun. 7, 2020 6:50 PM**

Source: The Durango Herald

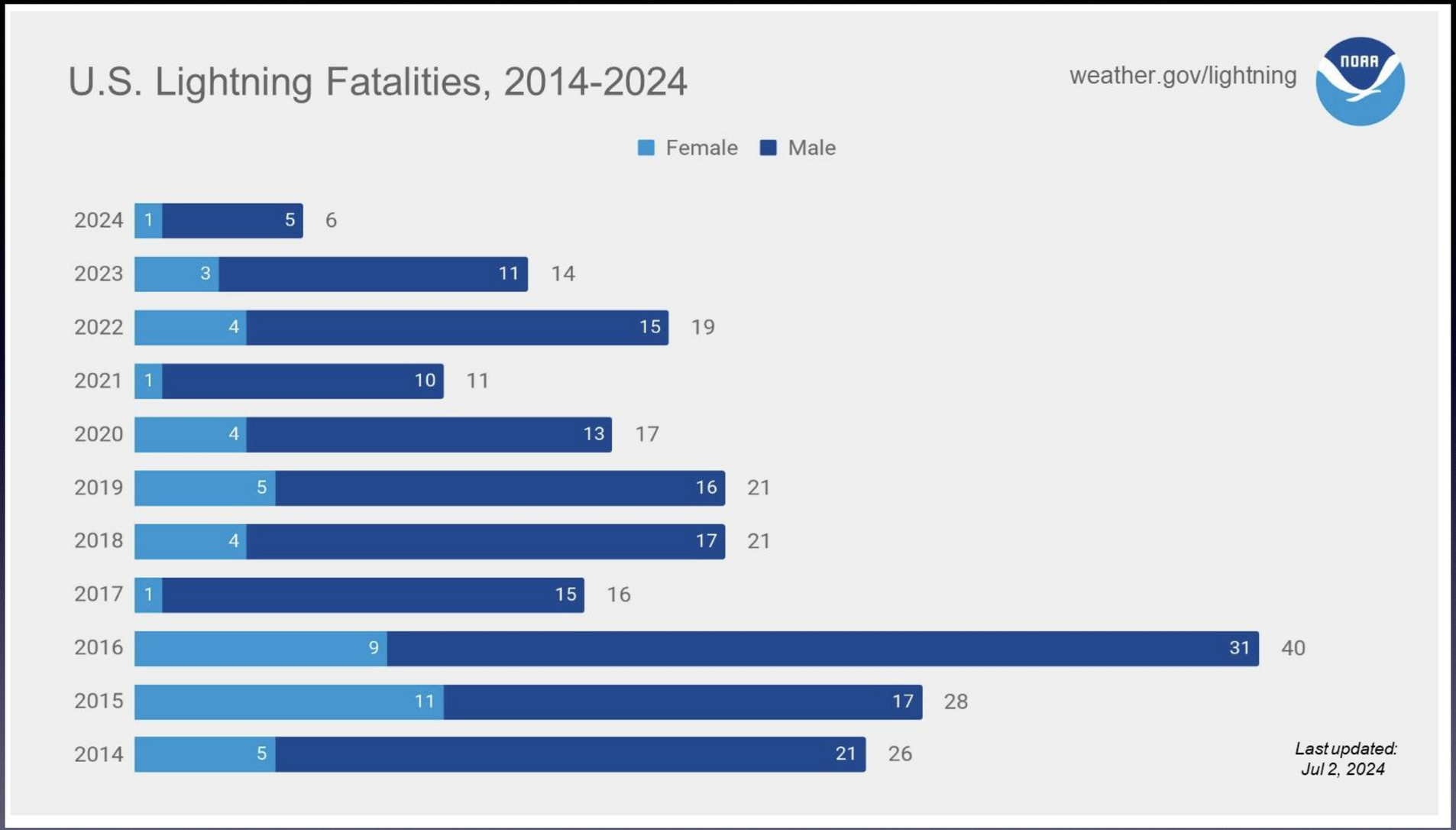
Man struck by lightning recovering in Denver-area hospital

JD Corley was working on a ranch south of Durango when the bolt hit

By Shane Benjamin Herald Staff Writer

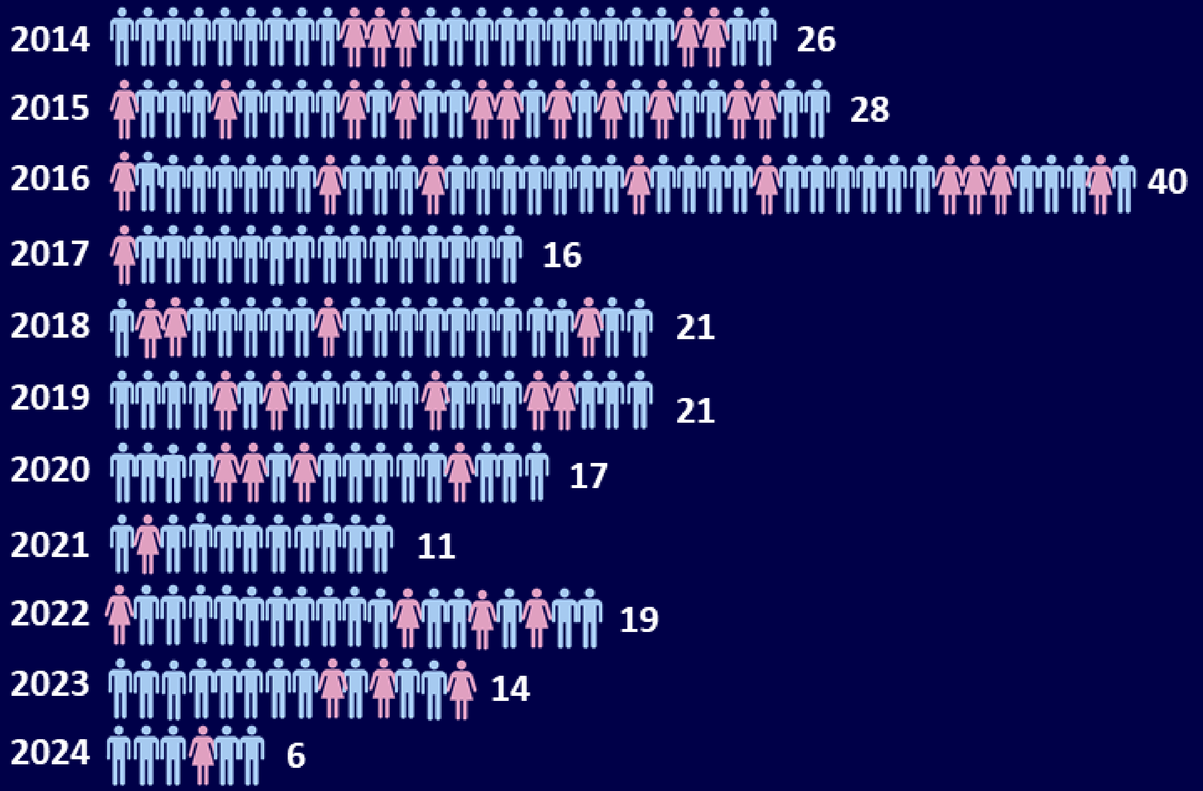
Friday, Sep 20, 2024 9:25 PM **Updated Friday, Sep. 20, 2024 11:15 PM**

Source: The Durango Herald



Source: National Weather Service

U.S. Lightning Fatalities 2014-2024



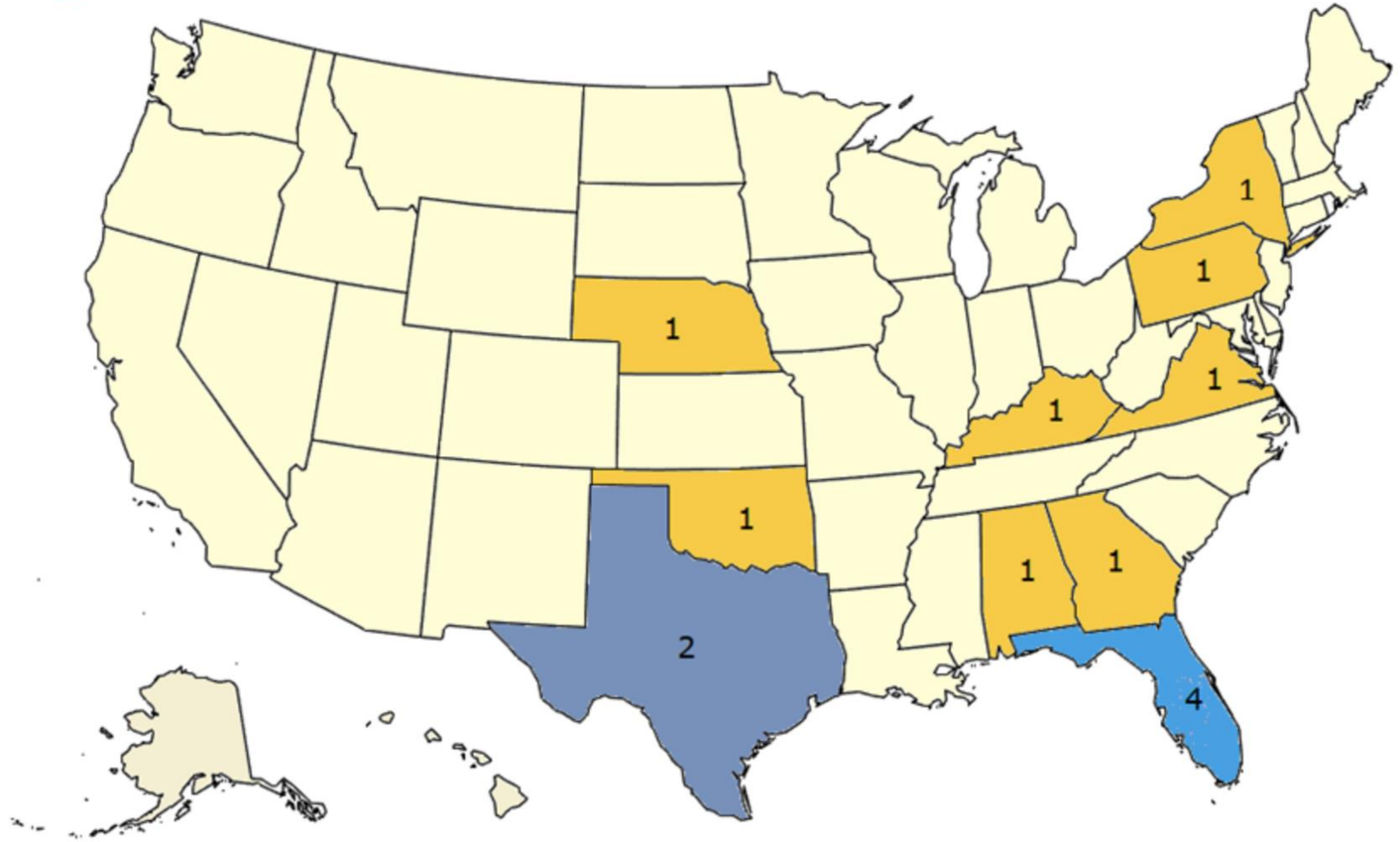
For more information:

lightningsafetycouncil.org/LSC-LightningFatalities.html

Compiled by John Jensenius

Source: National Lightning Safety Council

2023 Lightning Fatalities by State



Source: National Lightning Safety Council

National Weather Service Lightning Fatalities in 2023: 13

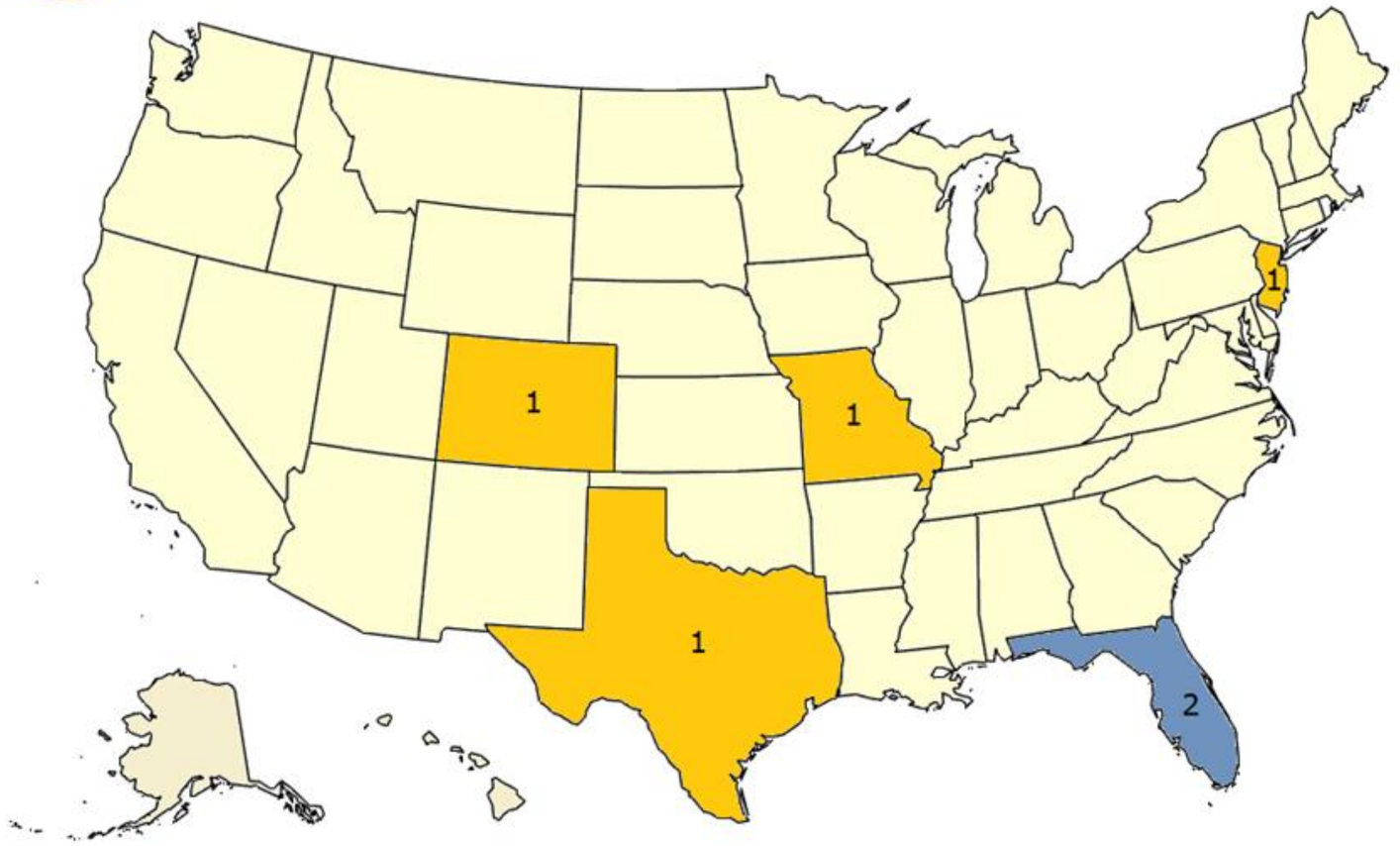
Safety
National Program

Last Updated: 10/5/2023. This page is updated when new information is received and reviewed for completeness.

No.	Date	Day	ST	City/County	Age	Sex	Location	Activity
1	4/6	Thu	VA	Louisa County	73	M	Lake	Boating
2	4/15	Sat	PA	Chester County	48	M	Roadway	Driving car
3	4/16	Sun	FL	Brevard County	39	M	On water	Boating
4	5/15	Mon	TX	Valley Mills	34	M	Driveway	Walking home from bus stop
5	5/15	Mon	TX	Valley Mills	6	M	Driveway	Walking home from bus stop
6	5/22	Mon	FL	Deltona	24	M	Rooftop	Construction
7	6/21	Wed	NE	Garden City	24	M	Open area	On horse checking on cattle
8	7/24	Mon	NY	Lincoln	39	M	Under tree	Roofing
9	8/5	Mon	OK	Mayes Cnty	teen	F	Creek	Swimming
10	8/7	Mon	AL	Florence	28	M	Parking lot	Working
11	8/23	Wed	FL	Clearwater	73	F	Sidewalk	Walking
12	8/25	Fri	KY	Sherburne	39	M	Sidewalk	Walking
13	9/26	Tue	FL	Putnam Cnty	16	F	Under tree	Hunting

Source: National Weather Service

2024 Lightning Fatalities by State



Source: National Lightning Safety Council

National Weather Service Lightning Fatalities in 2024: 6

Safety
National Program

Last Updated: 7/2/2024. This page is updated when new information is received and reviewed for completeness.

No.	Date	Day	ST	City/County	Age	Sex	Location	Activity
1	3/3	Sun	FL	Tallahassee	73	M	Field in park	Walking
2	5/25	Sat	CO	Jackson County	51	M	Open field	Branding/feeding cattle
3	6/23	Sun	NJ	Seaside Park	59	M	Beach	Warning children of storm
4	6/27	Thu	TX	Bryan	7	F	Outside home	Unknown
5	6/28	Fri	MO	Holden	53	M	Parking lot	At rodeo
6	6/30	Sun	FL	Davie	19	M	Under tree in park	Running

Source: National Weather Service

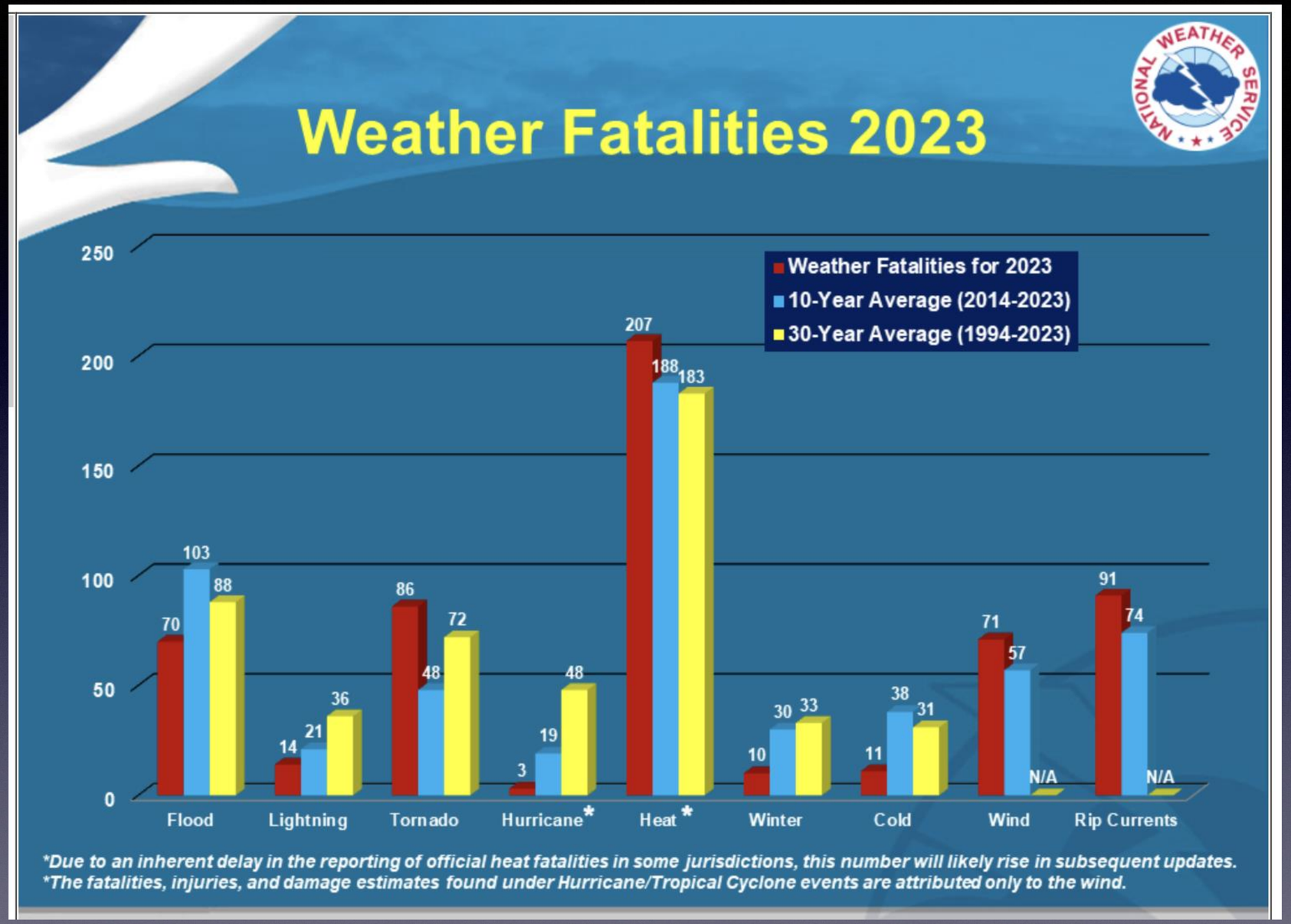
Lightning strike kills Colorado rancher and 34 head of cattle

Incident stunned small, tightknit community where most everybody knows everybody

By By JESSE BEDAYN, Associated Press/Report for America

Monday, May 27, 2024 2:04 PM **Updated Monday, May. 27, 2024 4:00 PM**

Source: The Durango Herald



Source: National Weather Service

US Fatalities Last 15 Seasons/Years
Avalanche vs Lightning

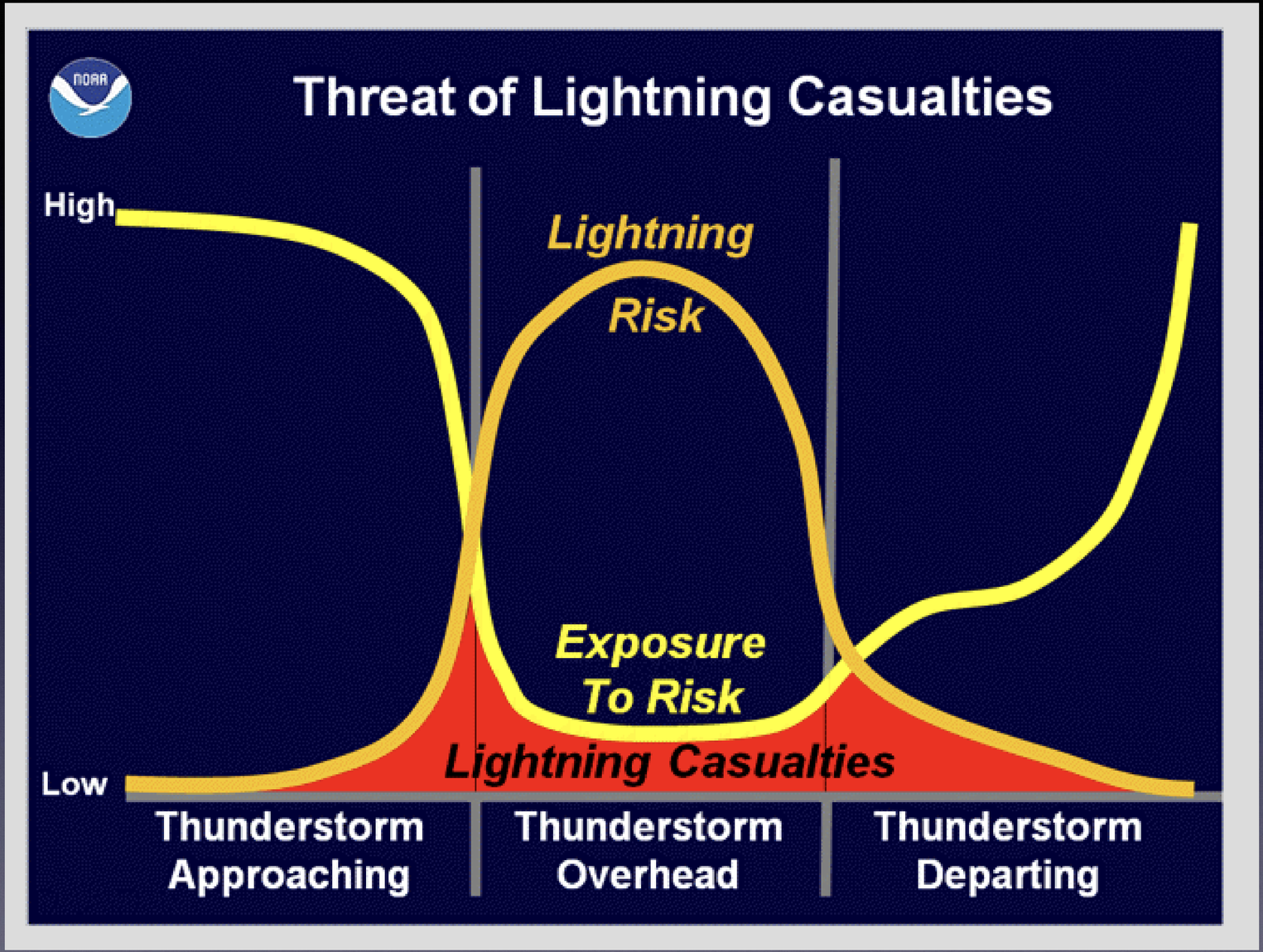
- 2009-2010 36
- 2010-2011 25
- 2011-2012 34
- 2012-2013 24
- 2013-2014 35
- 2014-2015 11
- 2015-2016 30
- 2016-2017 12
- 2017-2018 25
- 2018-2019 25
- 2019-2020 23
- 2020-2021 37
- 2021-2022 17
- 2022-2023 30
- 2023-2024 16

Avalanche
380

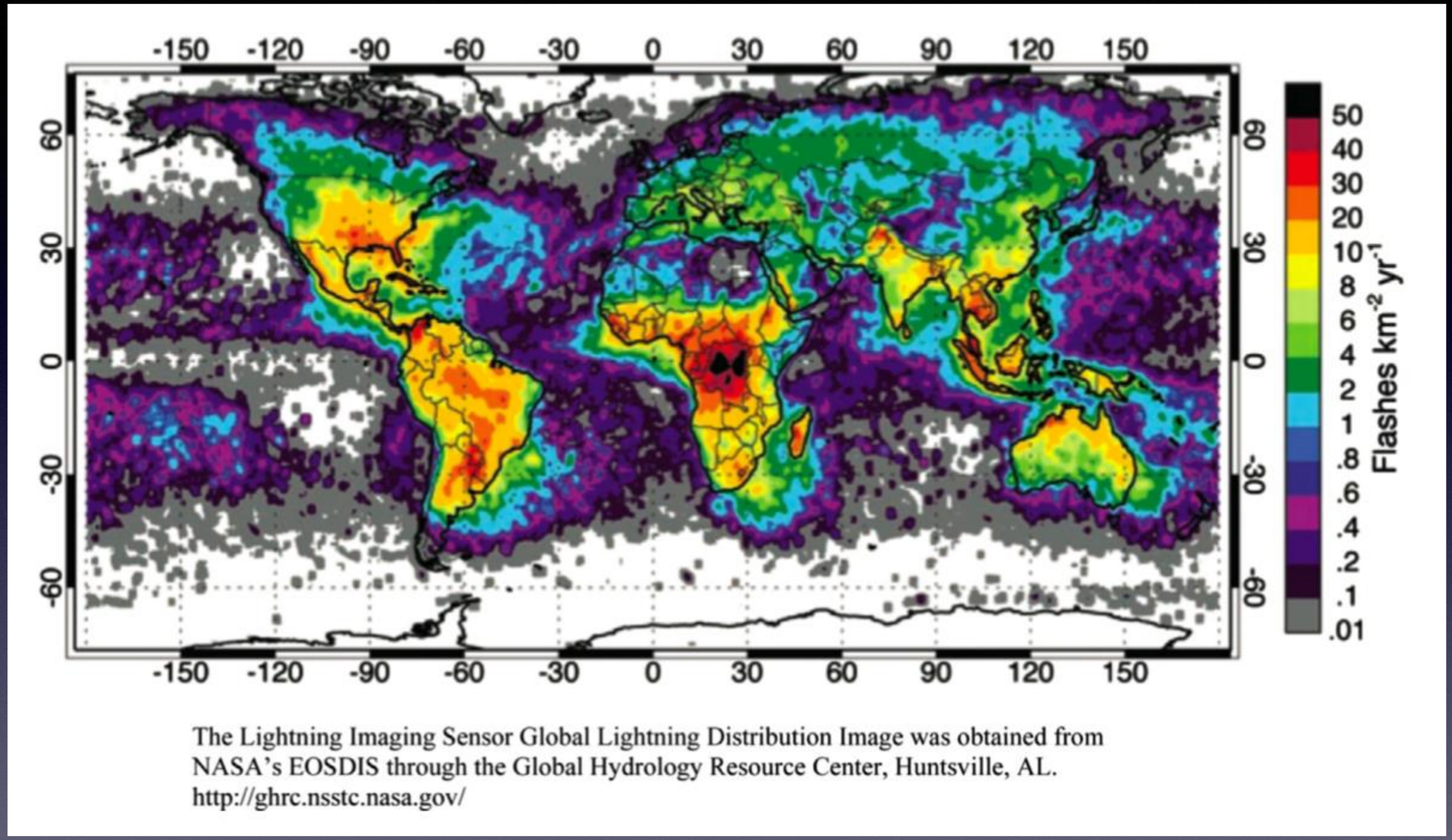
- 2009 35
- 2010 29
- 2011 26
- 2012 29
- 2013 23
- 2014 26
- 2015 28
- 2016 40
- 2017 16
- 2018 21
- 2019 20
- 2020 17
- 2021 11
- 2022 19
- 2023 14

Lightning
354

Source: TL Brainerd, MD – via CAIC & NWS



Source: National Lightning Safety Council



The Lightning Imaging Sensor Global Lightning Distribution Image was obtained from NASA's EOSDIS through the Global Hydrology Resource Center, Huntsville, AL.
http://ghrc.nsstc.nasa.gov/

Source: WMS Practice Guidelines for Lightning Injuries 2014

The Deadly Dozen

The twelve activities that contributed most to U.S. lightning fatalities between 2006 and 2023.

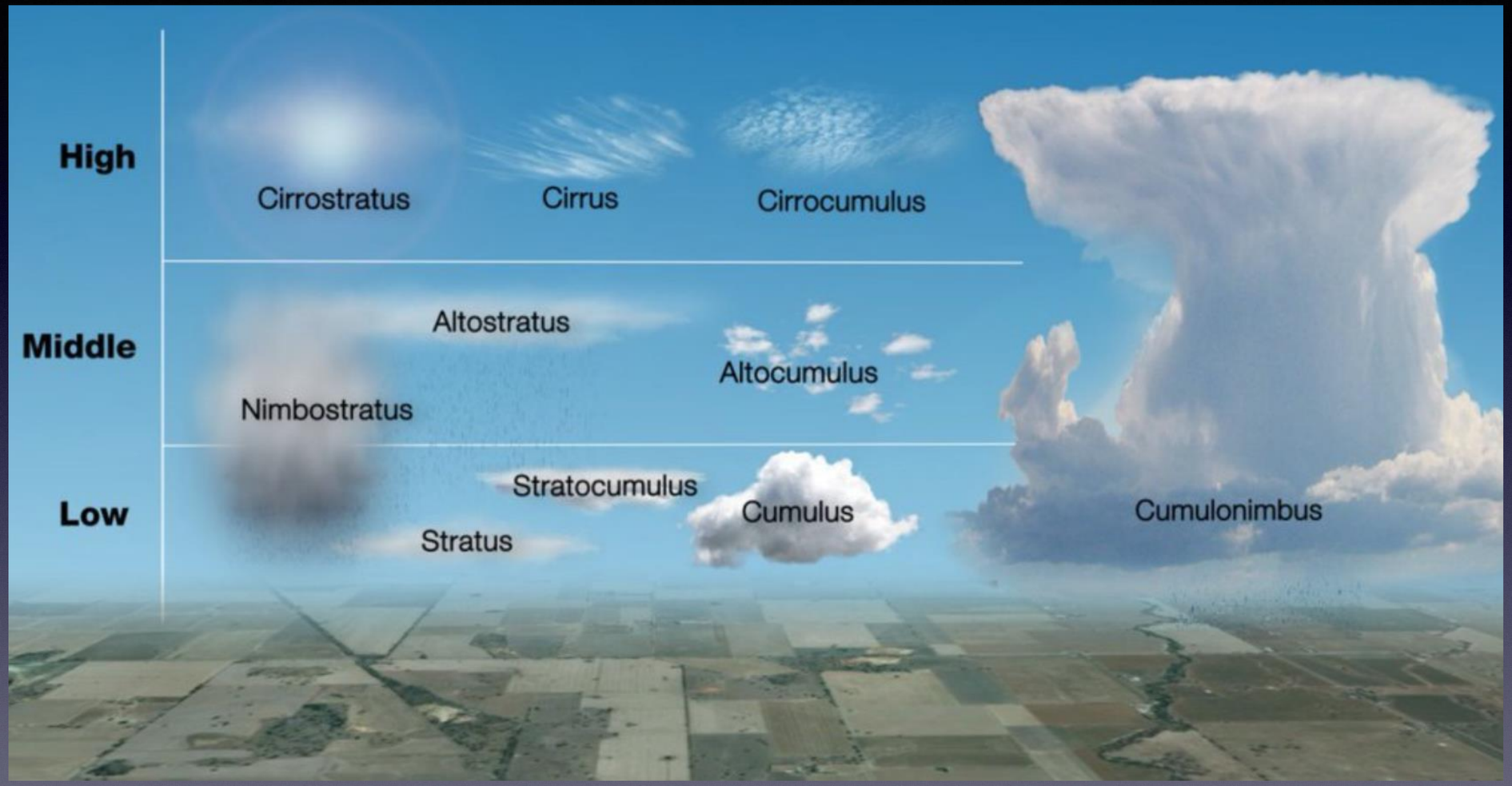
Activity	# of Deaths	(%)
Fishing	41	(9%)
Beach	30	(6%)
Boating	25	(5%)
Camping	23	(5%)
Farming or Ranching	23	(5%)
Roofing	20	(4%)
Riding Bicycle, Motorcycle, or ATV	19	(4%)
Social gathering	17	(4%)
Construction	16	(3%)
Headed to/from or waiting for vehicle	16	(3%)
Yardwork	15	(3%)
Golf	14	(3%)
Total	259	(54%)

Compiled by John Jensenius
National Lightning Safety Council

Source: National Lightning Safety Council

Source: Lightning Data Center

Types of Clouds



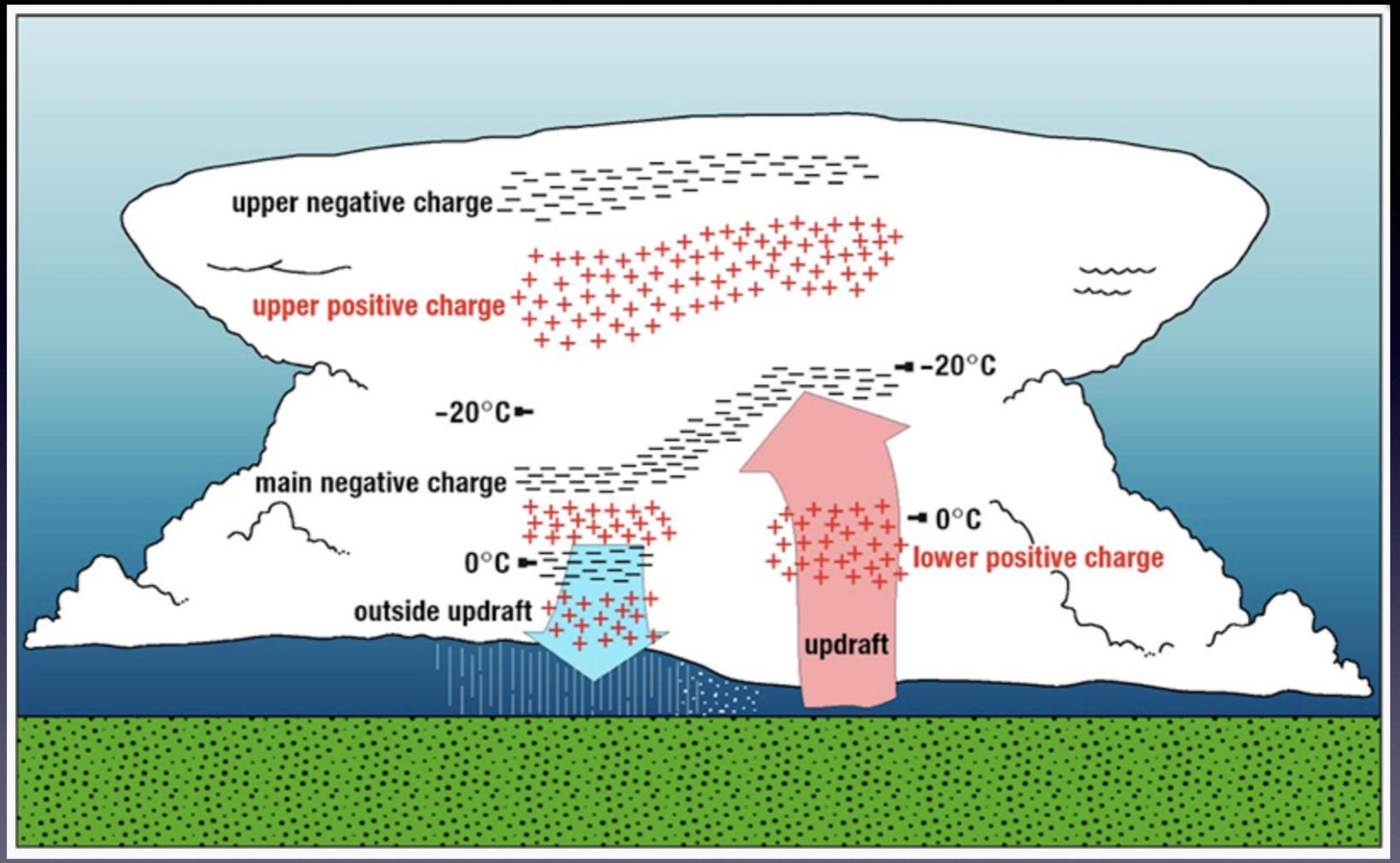
Source: media.bom.gov.au

From 38,000 feet

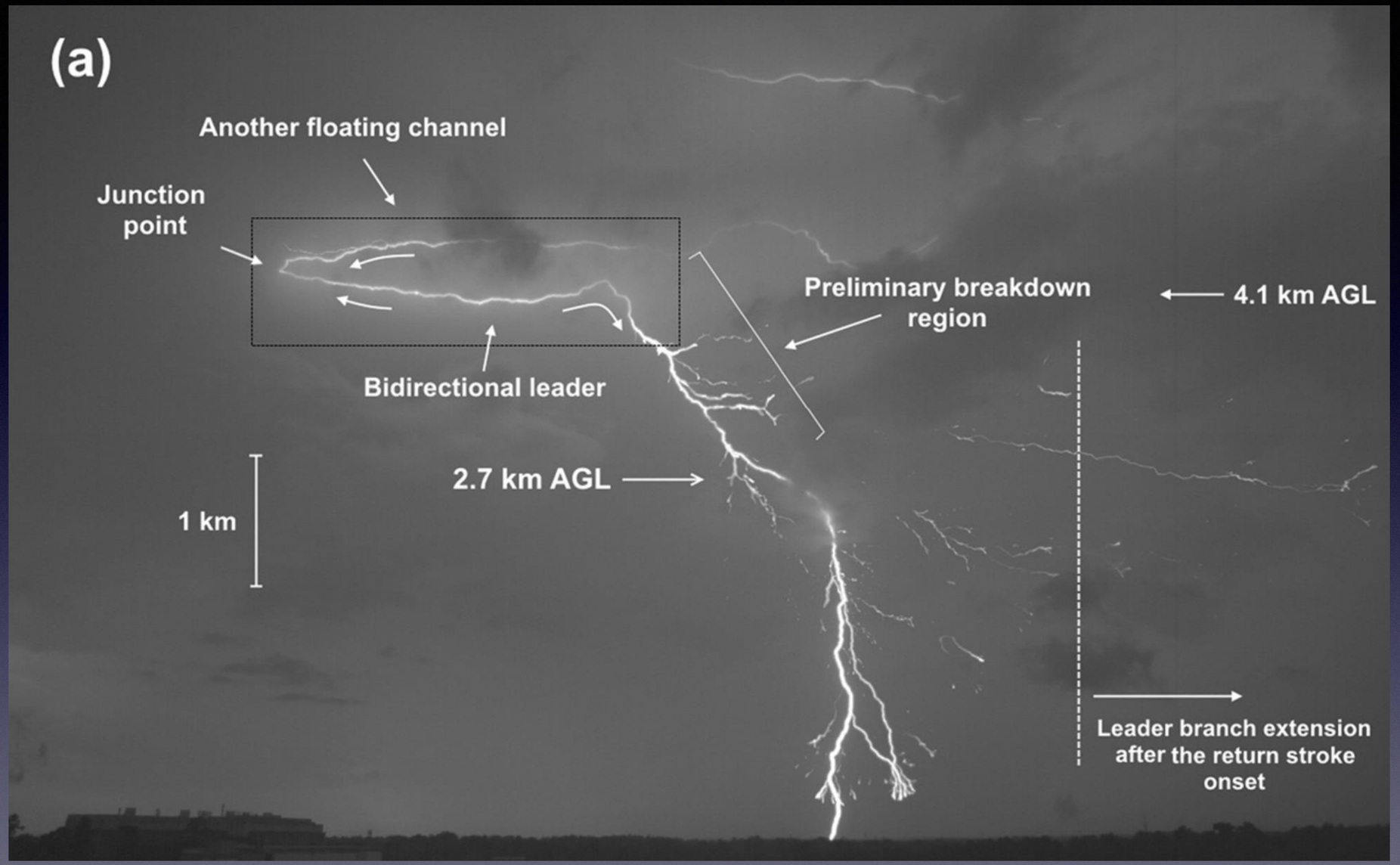
Source: weather.gov

Cumulonimbus Clouds

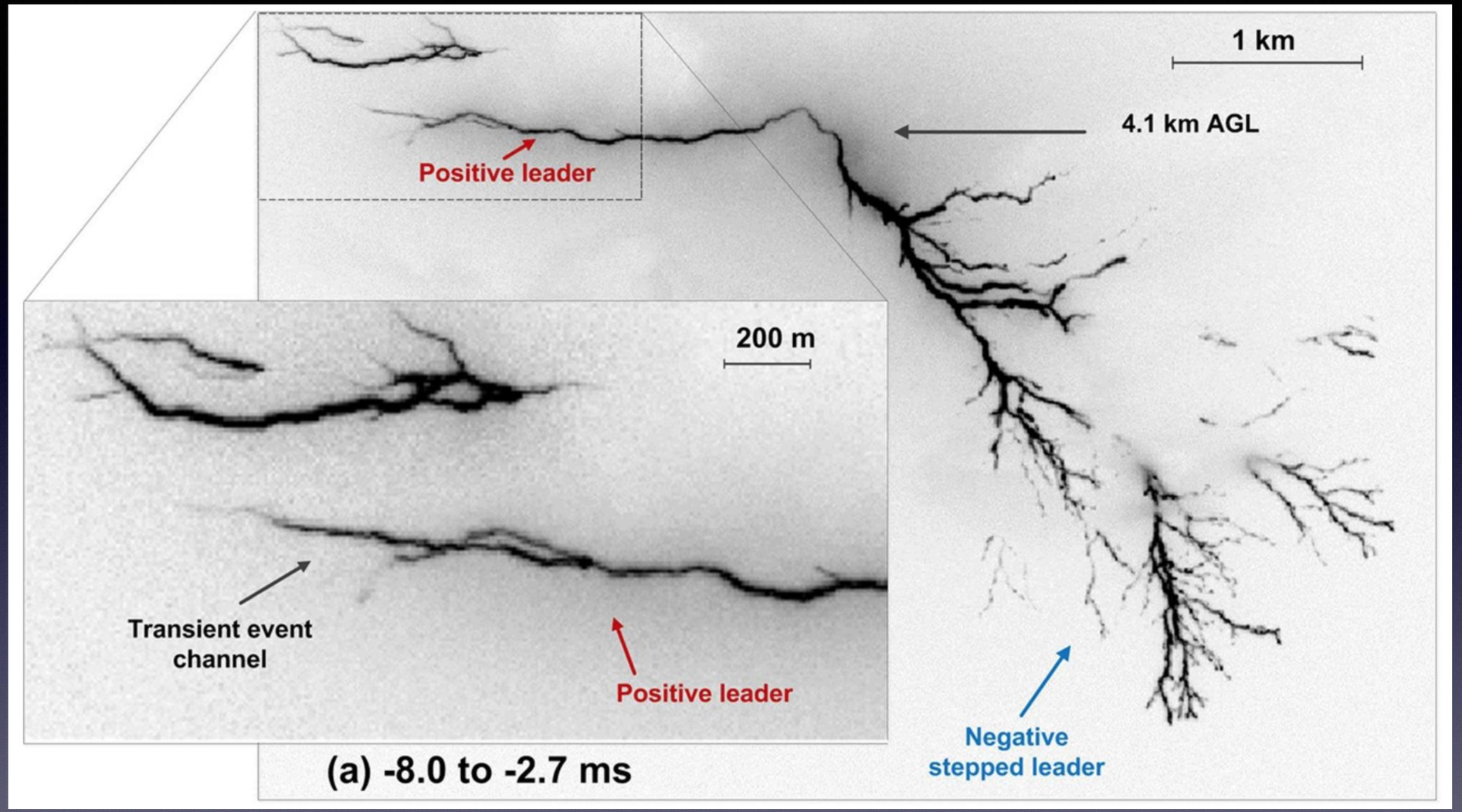
Source: GFDL 1.2, https://commons.wikimedia.org/w/index.php?curid=887553



Source: NOAA National Severe Storms Laboratory



Source: nature.com



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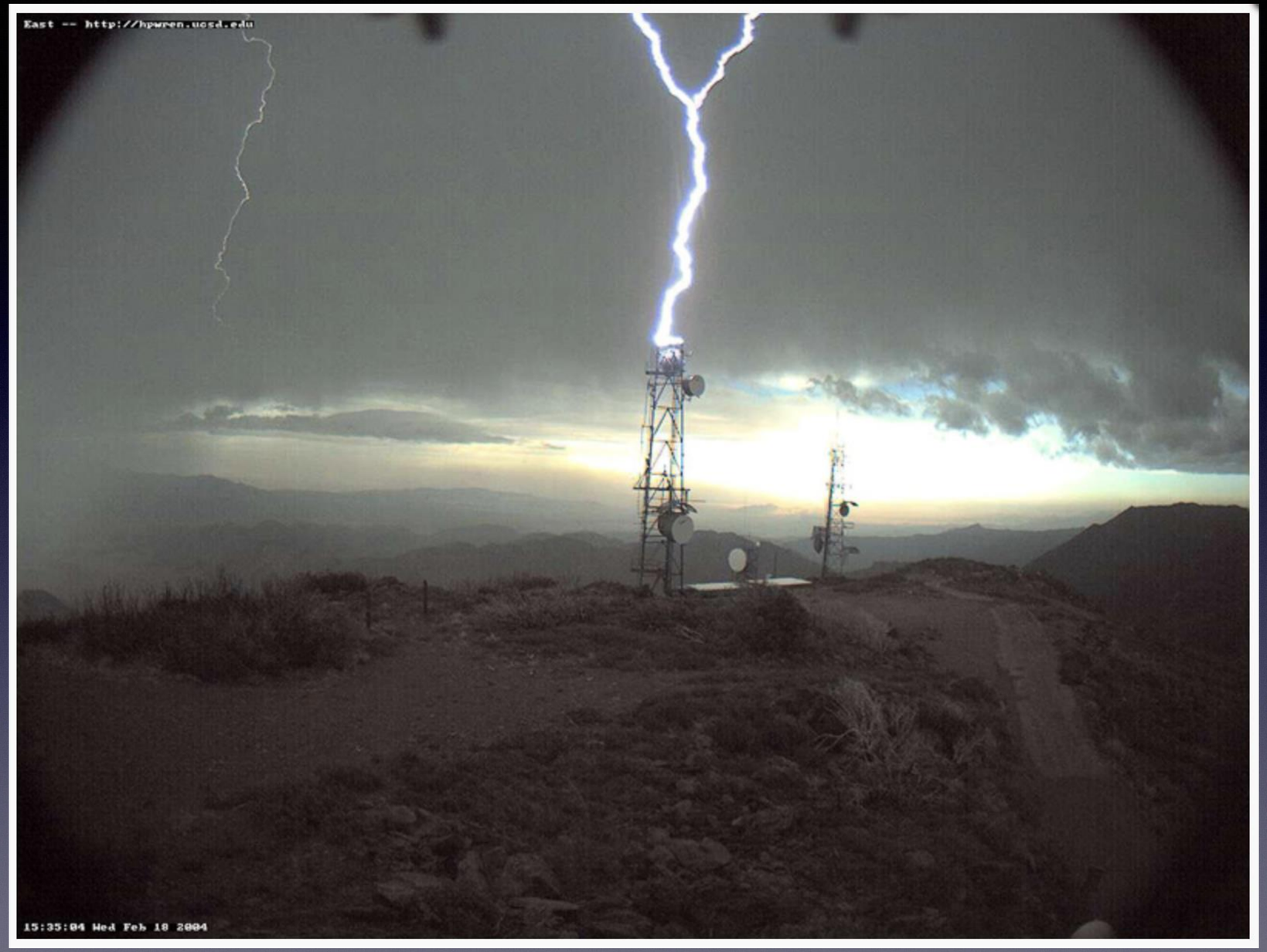

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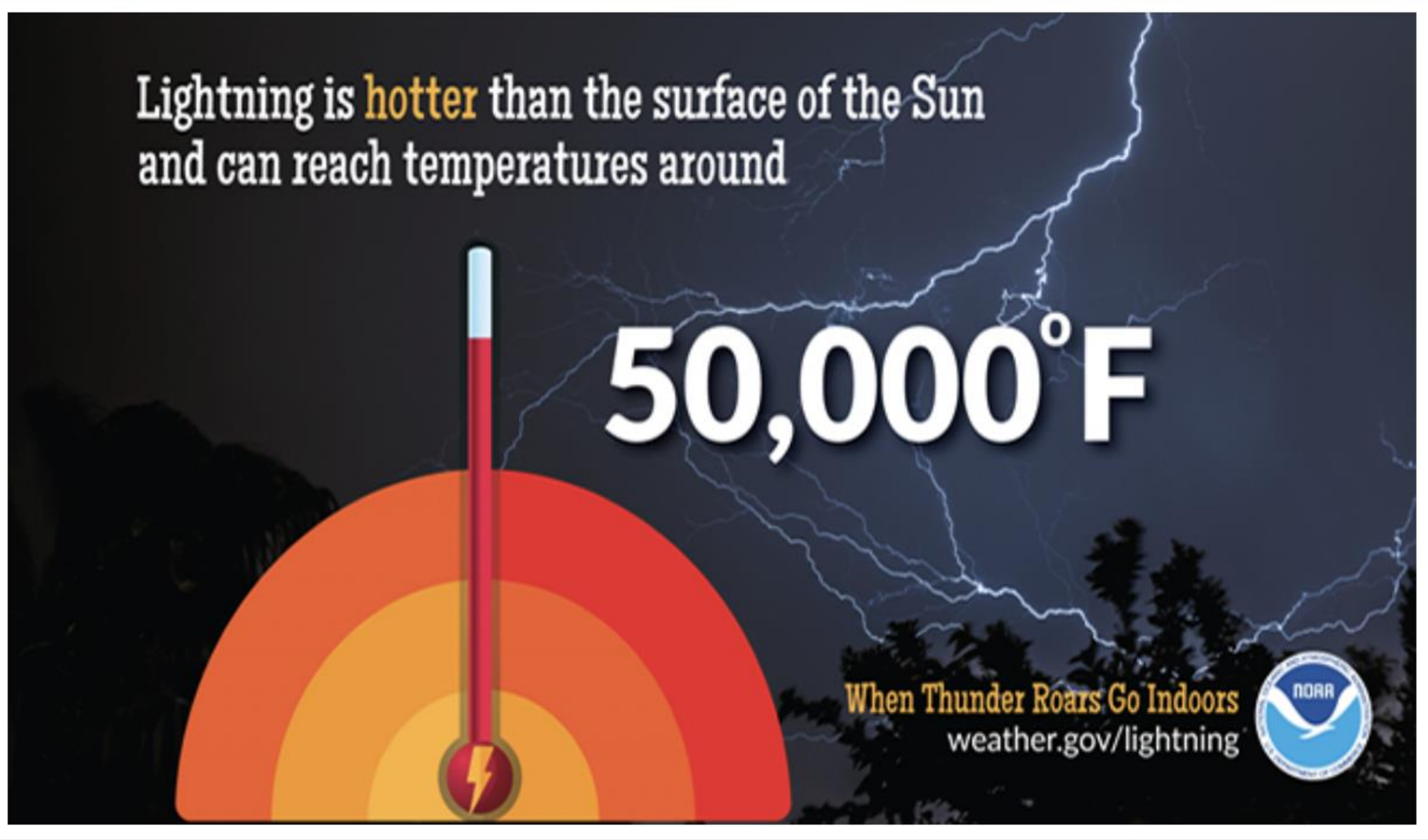
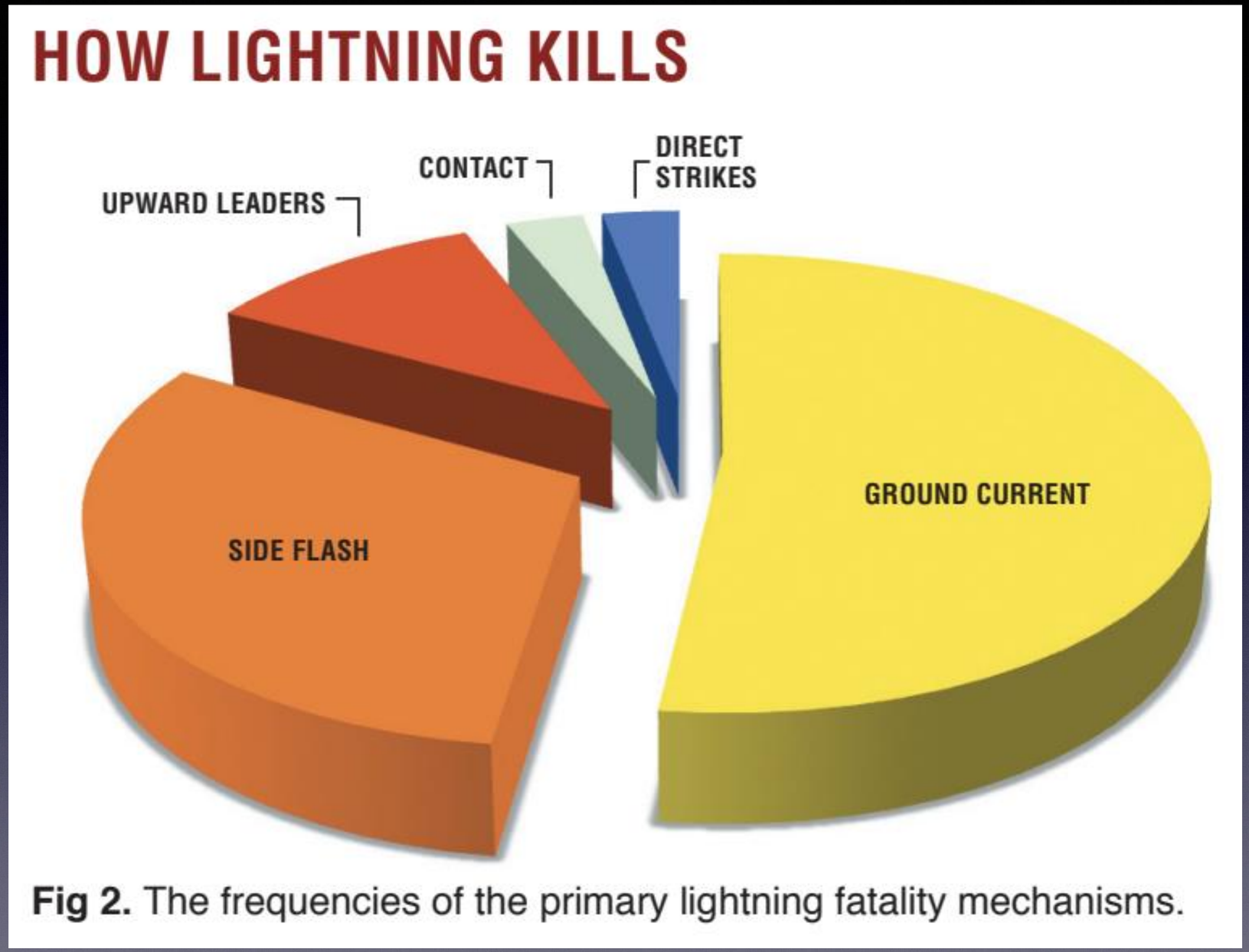


Source: National Weather Service

Source: NOAA National Severe Storms Laboratory

Mechanisms

- Direct Strike: Lightning bolt directly connects with an individual. Relatively rare
- Side Splash: Current from the lightning strike jumps or “splashes” onto the individual following the path of least resistance
- Ground Current: Lightning strikes an object on the ground near a person and travels through the ground to the person. Most common mechanism of injury
- Contact Injury: Lightning strikes an object that the person is touching
- Upward Streamer: This occurs when the electrical current passes up from the ground through the victim



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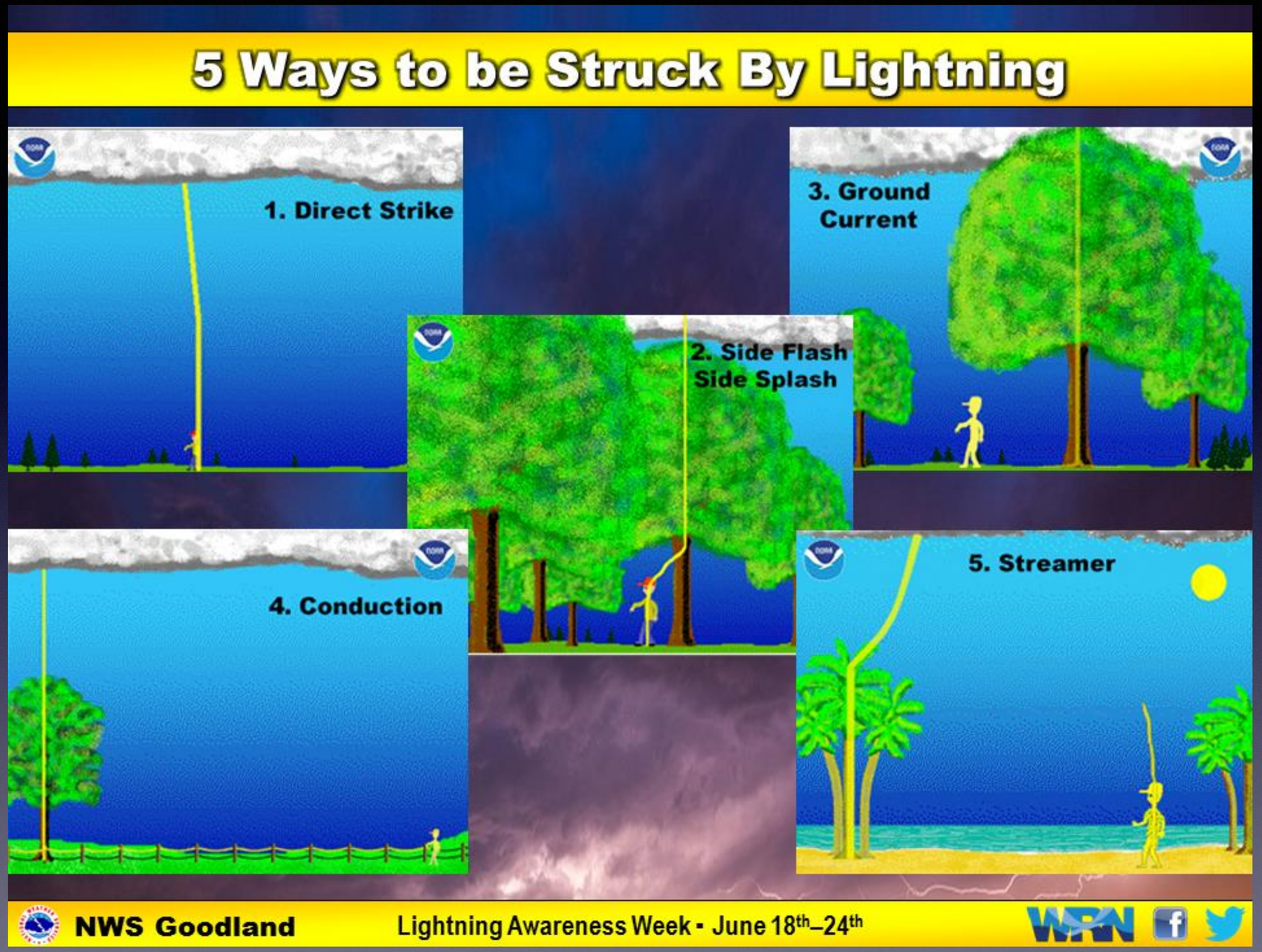

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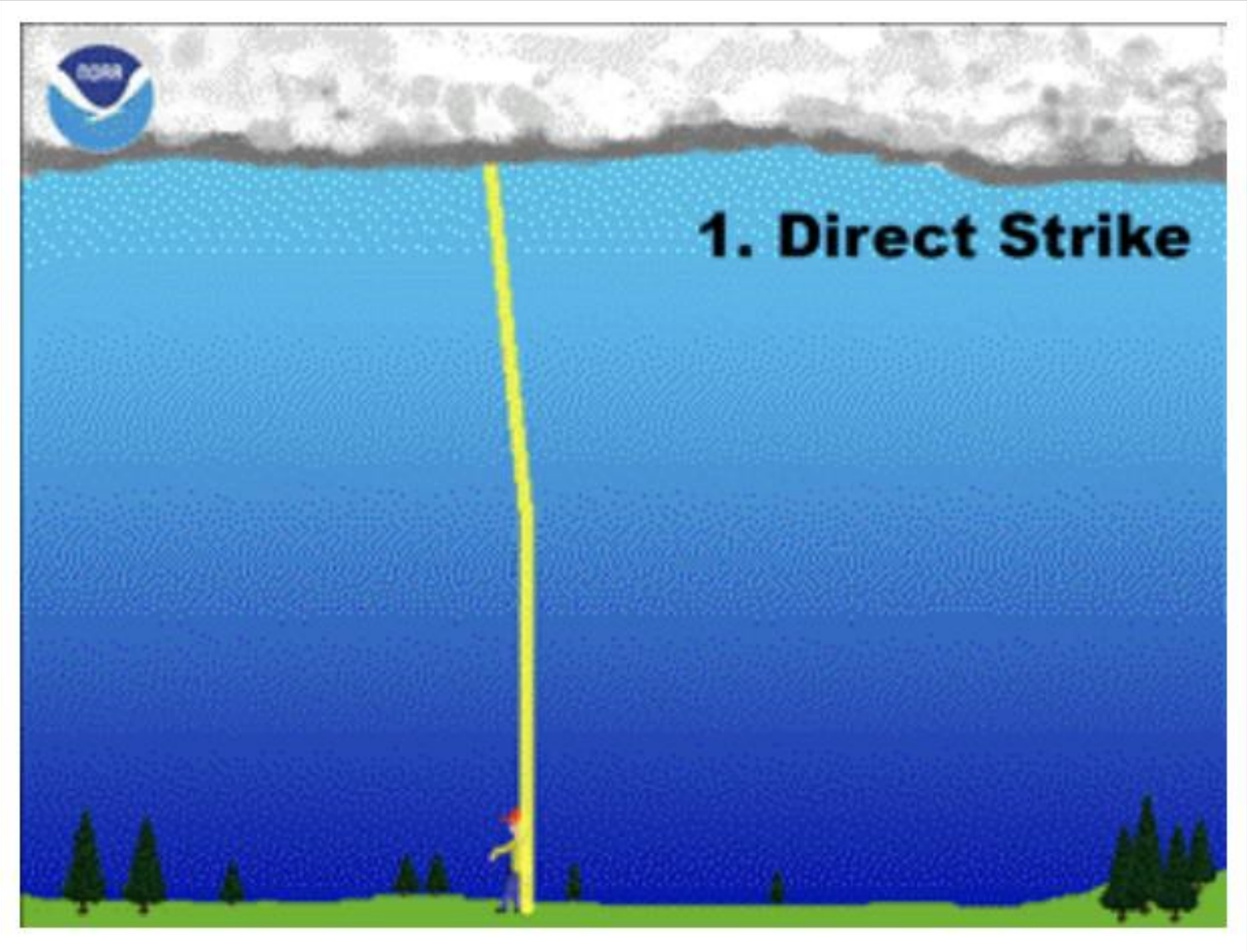

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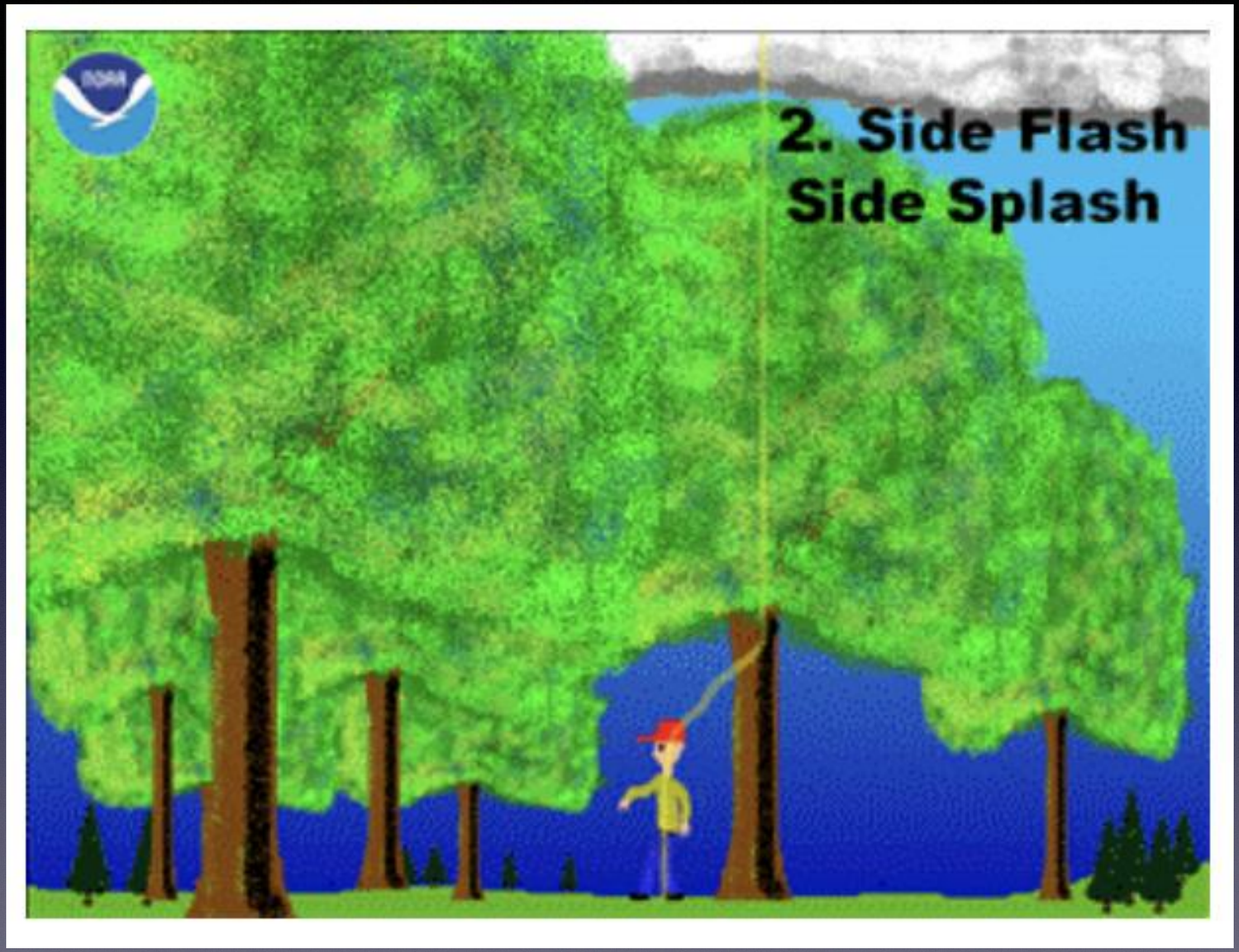

Source: National Weather Service

Source: TL Brainerd, MD

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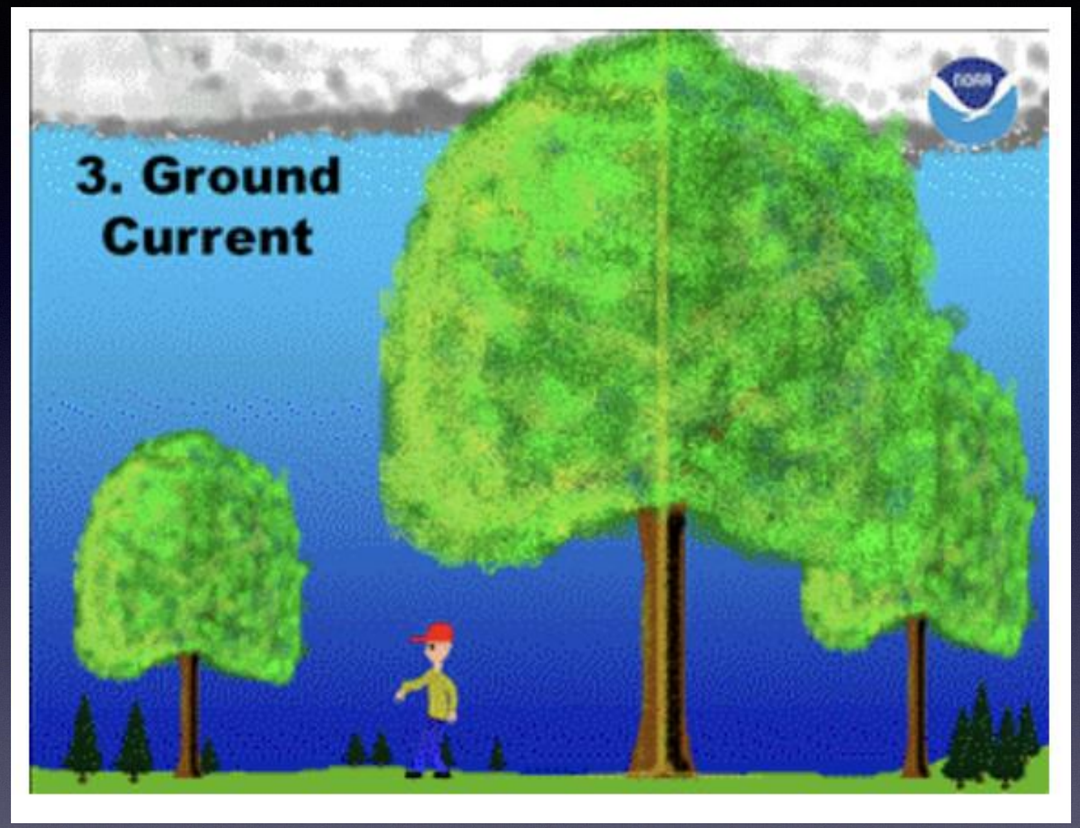

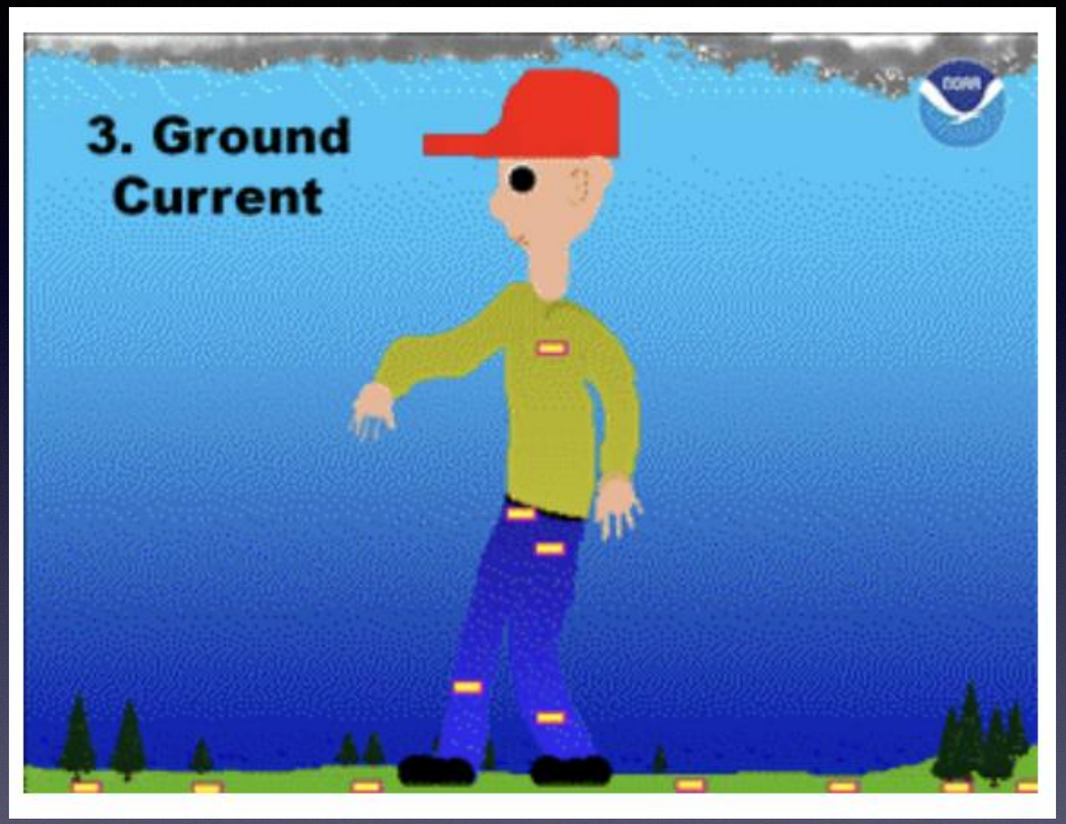

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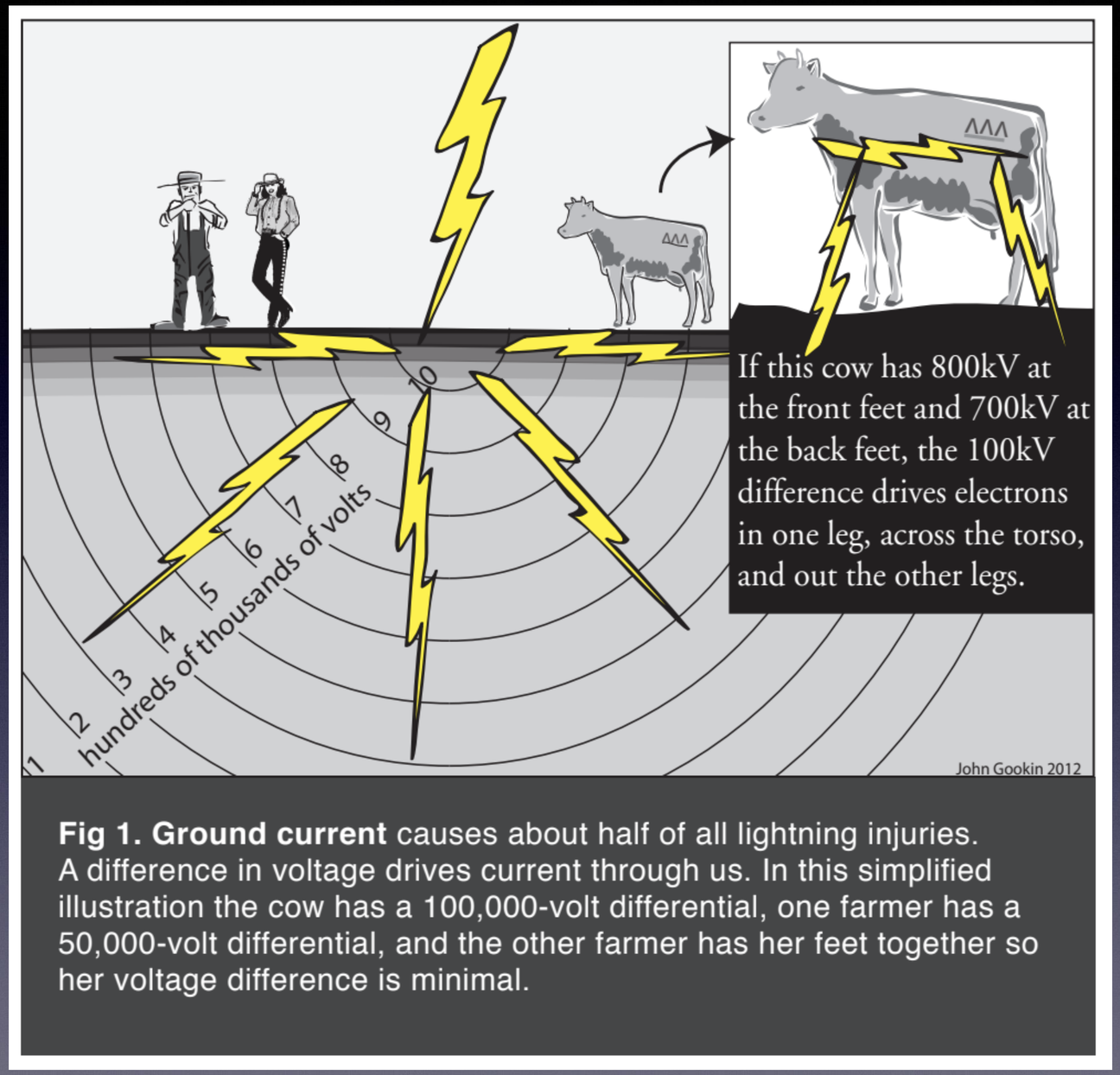

Fig 1. Ground current causes about half of all lightning injuries. A difference in voltage drives current through us. In this simplified illustration the cow has a 100,000-volt differential, one farmer has a 50,000-volt differential, and the other farmer has her feet together so her voltage difference is minimal.

Source: National Weather Service

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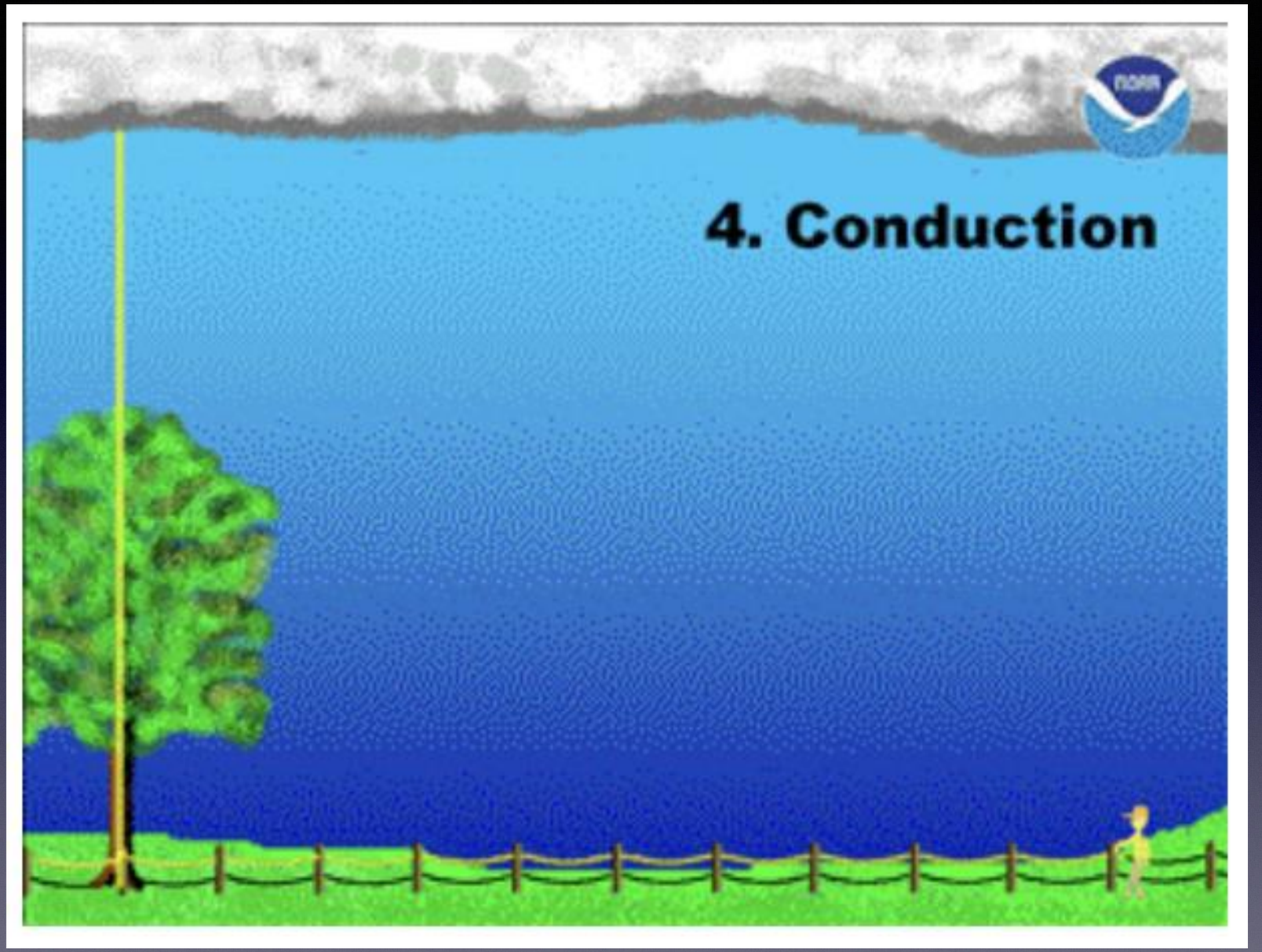

Source: National Weather Service

Source: NOLS

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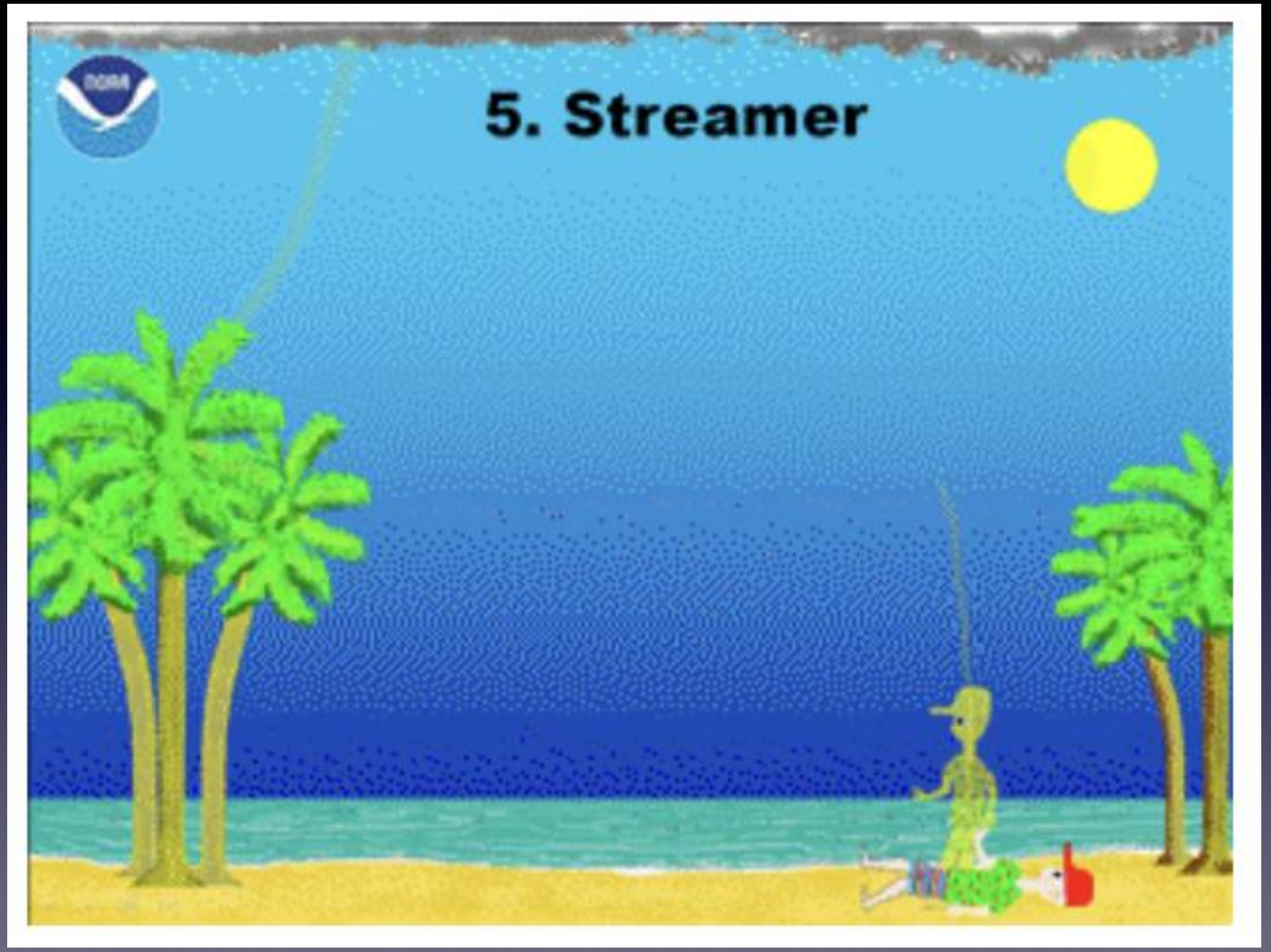

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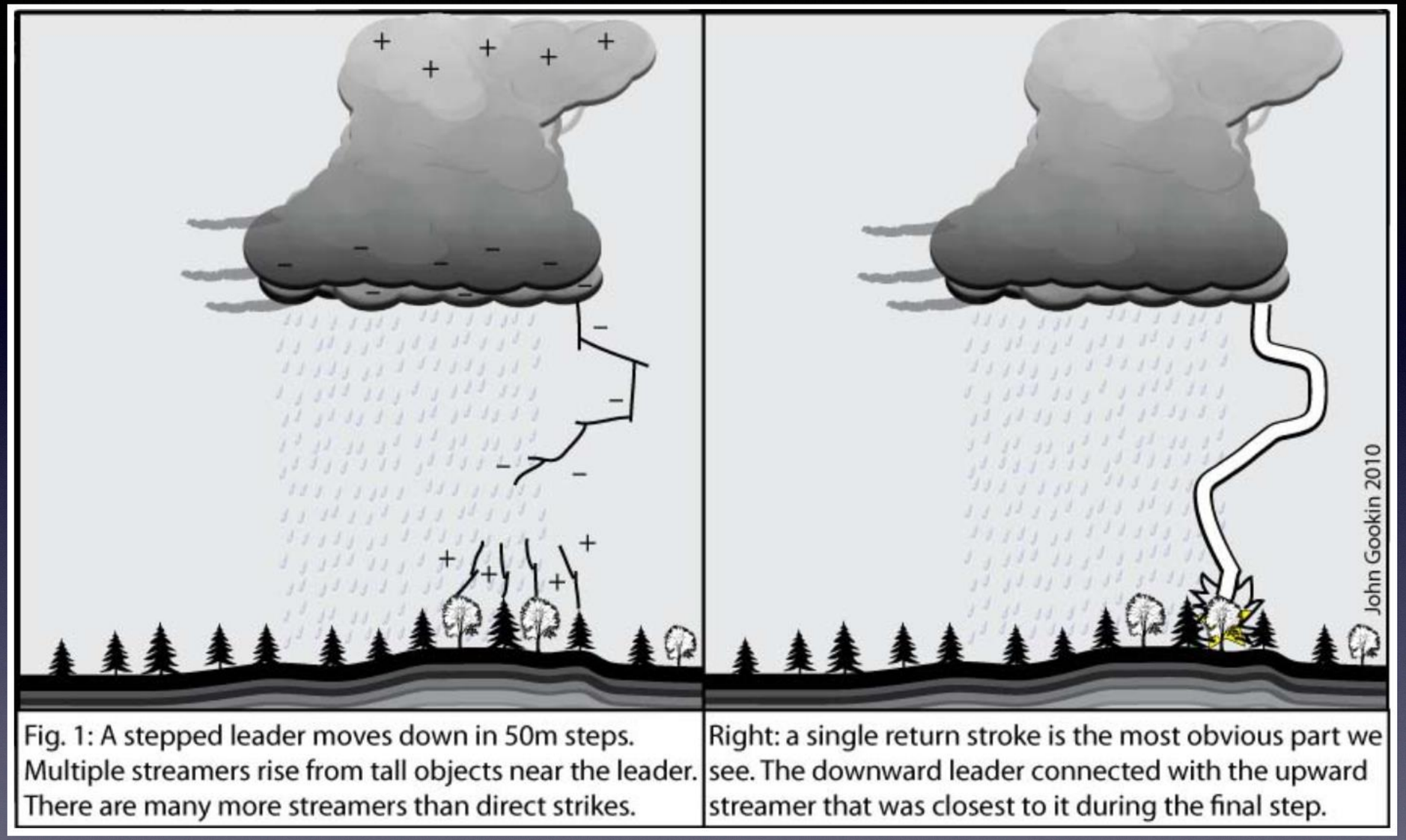


Fig. 1: A stepped leader moves down in 50m steps. Multiple streamers rise from tall objects near the leader. There are many more streamers than direct strikes.

Right: a single return stroke is the most obvious part we see. The downward leader connected with the upward streamer that was closest to it during the final step.

Source: NOLS, John Gookin, Backcountry Lightning Risk Management 2010

Streamers

Moro Rock, Sequoia National Park, CA
August 20, 1975
Sean, 12 yo Michael, 18 yo Mary, 15 yo
Sean died by suicide in 1989.
Not pictured: Jeff, who also died by suicide.

Source: Lightning Data Center

Prevention

- Plan ahead
  - Check specific weather forecasts and be conservative with choices
  - Start early
  - Be prepared to turn around
- Maintain situational awareness
  - Watch, listen, and smell
  - Adapt exit plan as terrain changes
- ”When Thunder Roars, Go Indoors”

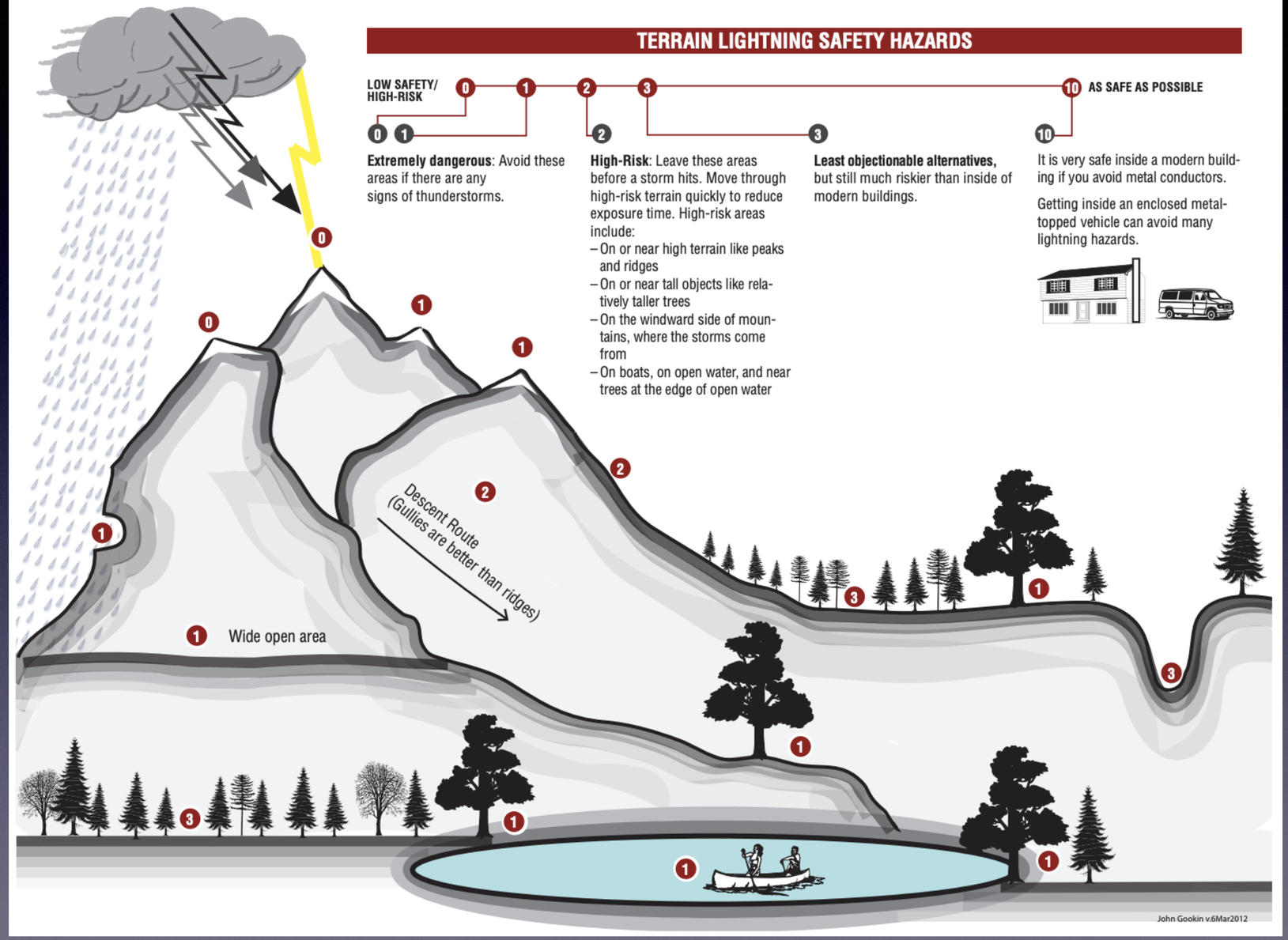
Source: TL Brainerd, MD

Leave High Risk Areas

- Ridgelines and exposed high altitude terrain
- Mountain summits
- High structures such as ski lifts, cell phone towers, and isolated trees
- Avoid open or exposed areas such as a field, golf course, or picnic shelter
- Swimming pools, lakes, and open water
- Move away from the shoreline

BACKCOUNTRY LIGHTNING RISK MANAGEMENT

No place outdoors is safe from lightning. Lightning is an objective hazard. Your behavior can reduce the risk of that hazard harming you.



Source: NOLS

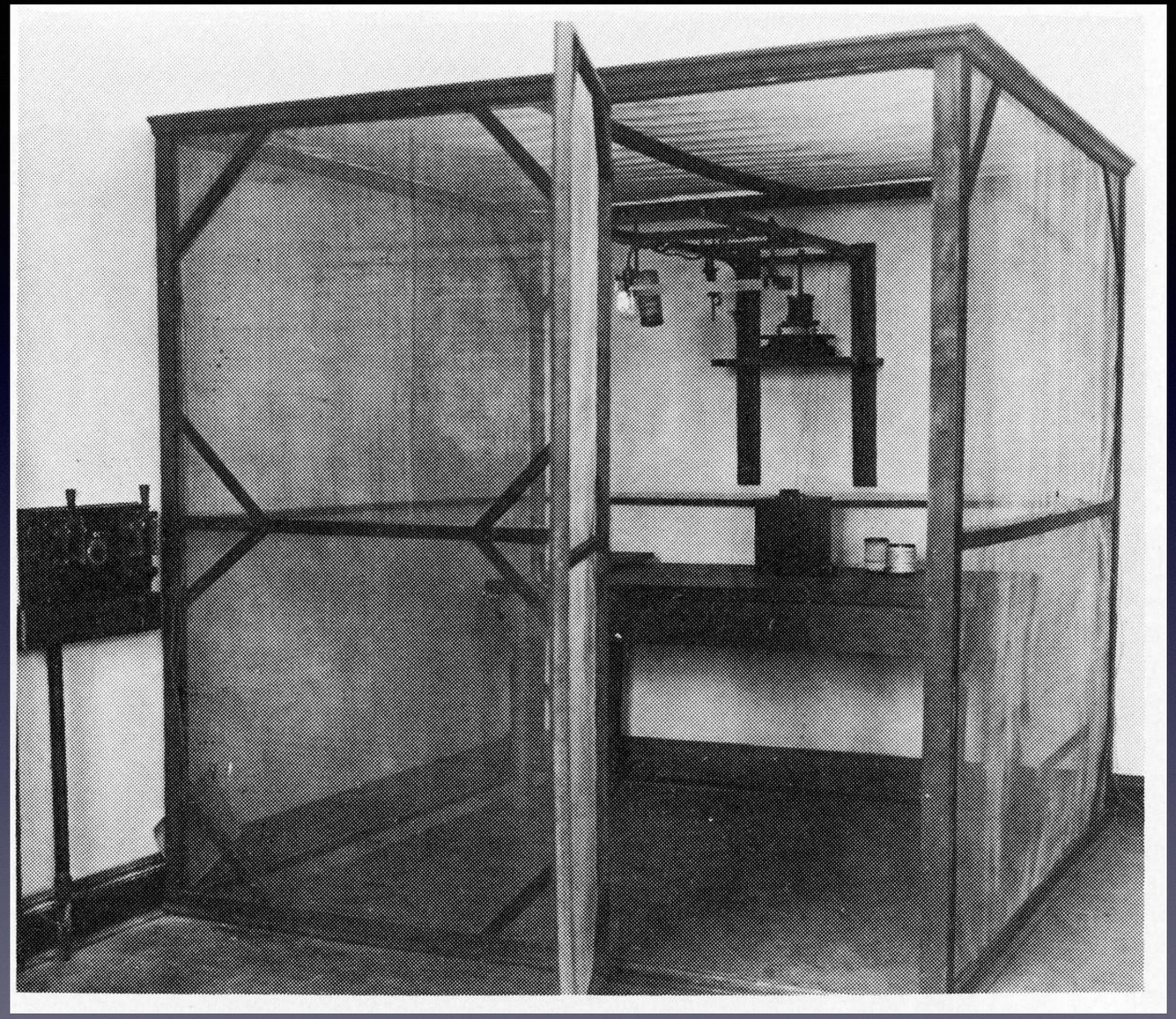
Fig 3. Overhangs, rock shelters, and cave entrances are especially hazardous because lightning travels along vertical surfaces to seek the ground. When lightning jumps a gap, any object bridging that gap can help conduct the current. Standing near the edge of an overhang is extremely dangerous during a thunderstorm. This even includes standing on the porch of a building where you could help conduct current across the open gap at the edge.

Source: National Weather Service

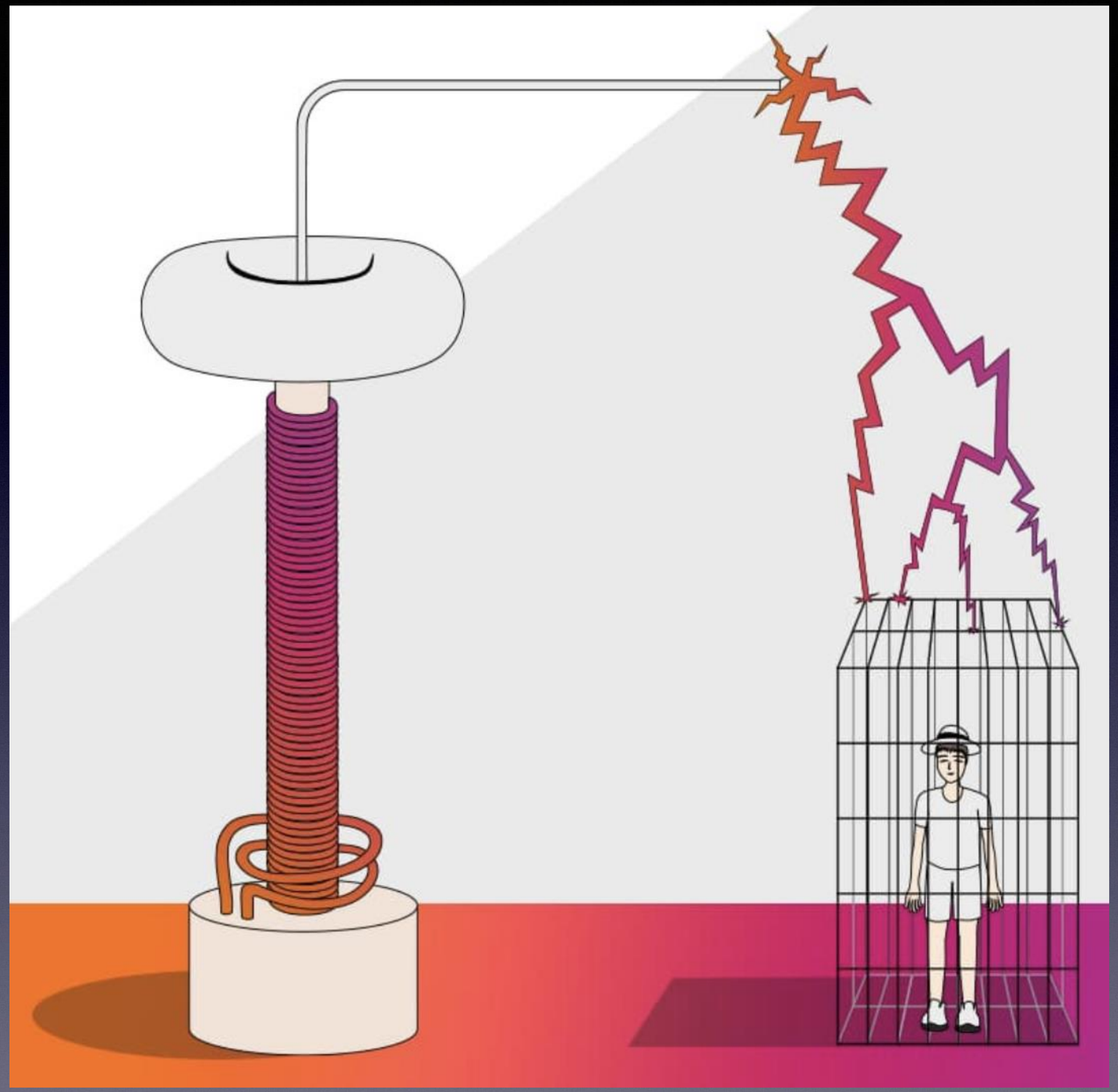
Safer Options

- The largest enclosed building, away from doors or windows
- A hardtop vehicle with doors and windows closed
- A dense forest (avoid isolated trees, trees on the edge of a meadow, or the edge of tree line)
- A deep cave (avoid shallow caves because of the risk of side splash and ground current injuries)

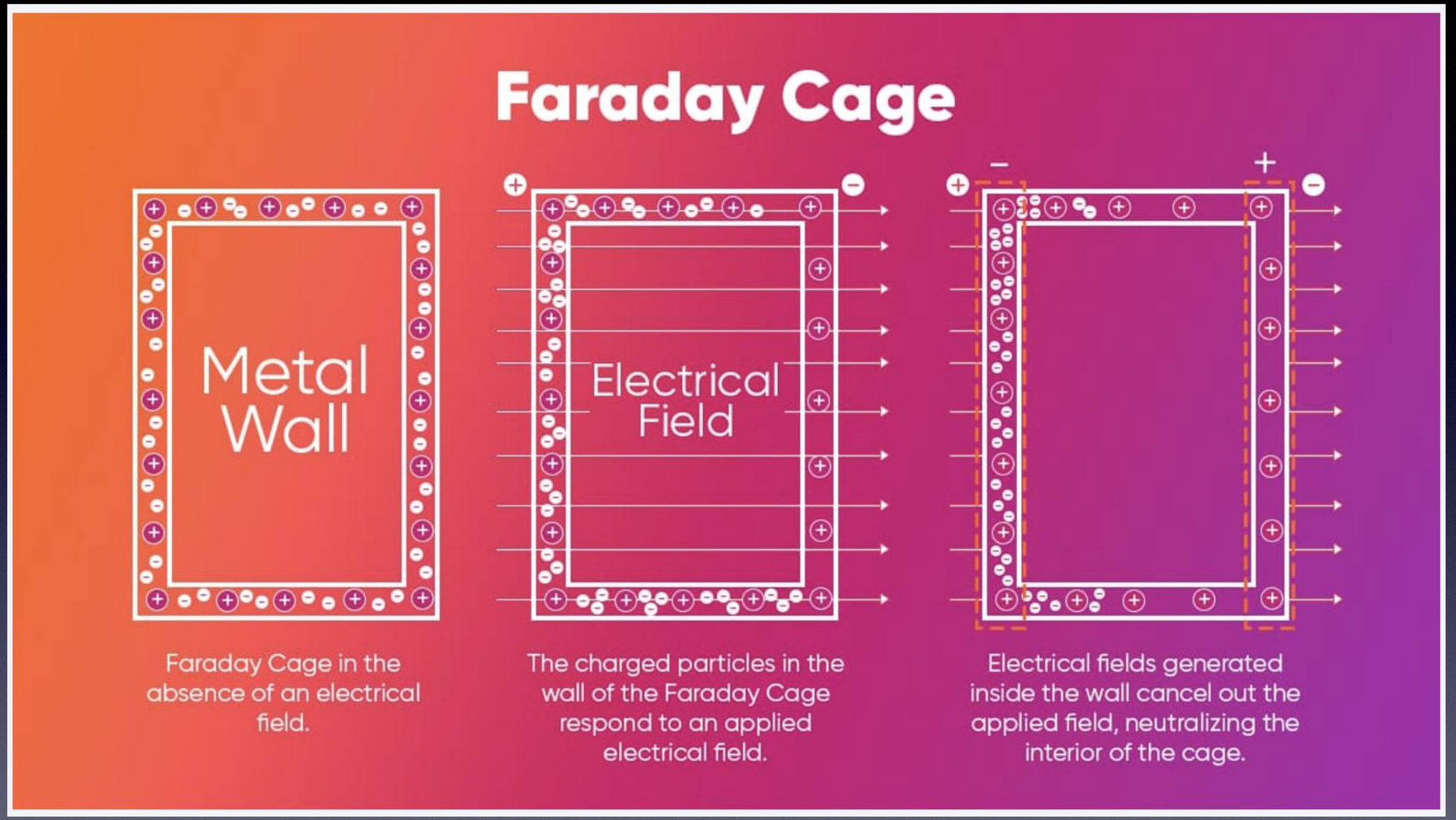
Source: National Weather Service



Source: National Institute of Standards and Technology



Source: aydemperakende.com

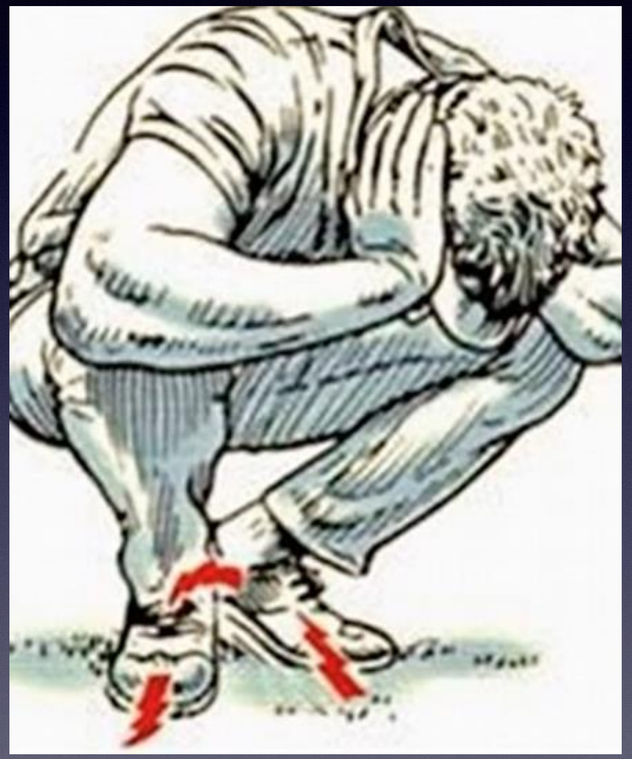


Source: aydemperakende.com

Last Resort

- Remove metal objects
- Lightning position (Last, last resort) This position involves crouching with your feet touching to create only one point of contact with the ground. One may also sit on an insulated pack (no metal), a coil of rope, or sleeping pad. If sitting on an insulated pack or pad, lift feet off the ground to avoid ground current.
- Group safety: Separate group members at least 20 feet apart to avoid side splash to limit the potential for multiple victims.
- Climbers should tie-off individually as lightning is able to conduct over wet climbing ropes, affecting both the climber and belayer.

Lightning Crouch



Source: www.lightningsafety.noaa.gov/crouch.shtml

Source: WMS Practice Guidelines for Lightning Injuries 2014

30 Minute Rule

- After a storm has passed, one should wait a minimum of 30 minutes before resuming outdoor activities in high-risk areas to allow the trailing edge of the storm to fully leave the area.

Source: TL Brainerd, MD

Source: Lightning Data Center

High Risk Indicators

- Suspected Direct Strike
- Loss of Consciousness
- Focal Neurologic Complaint
- Chest Pain or Shortness of Breath
- Major Trauma
- Burns to the Head, Legs, or Burns > 10% Total Surface Area
- Lichtenberg Figures
- Pregnancy

- Evacuation and Medical Evaluation -

Cardiopulmonary

Symptoms

- Cardiac Arrest
- Chest Pain
- Shortness of Breath

Eval and Tx

- ECG
- Echocardiogram
- Any lightning strike victim with a high risk indicator should receive an ECG and Echocardiogram —> If either is abnormal should be monitored for 24 hours

Neurological

Transient Symptoms

- Loss of Consciousness
- Seizure
- Headache
- Paresthesias
- Keraunoparalysis- Transient paralysis. Limb pallor, cyanosis, and pulselessness. Resolves within several hours.

Eval and Tx

- Diagnostic imaging
- May mimic a spinal cord injury: Maintain spinal precautions and obtain imaging to rule out traumatic cause of neurologic deficit
- Any lightning strike victim with loss of consciousness or abnormal neurologic evaluation should receive diagnostic imaging

Neurological

Persistent Symptoms

- Hypoxic Encephalopathy from cardiac arrest
- Lightning-induced intracranial hemorrhage
- Secondary Trauma from Blast Effect

Eval and Tx

- Diagnostic imaging
- May mimic a spinal cord injury: Maintain spinal precautions and obtain imaging to rule out traumatic cause of neurologic deficit

Skin

Symptoms

- Lichtenberg Figures- a feathering pattern that presents following a lightning strike and resolves within 24 hours

Eval and Tx

- High risk indicators
- Burn Tx as indicated

Lichtenberg Figures

Source: researchgate.net

Source: geardiary.net

Lichtenberg Figures

Source: Wilderness & Environmental Medicine

Source: Wilderness & Environmental Medicine

(From "Lightning and Lichtenberg Figures" by Cherington, Olson and Yarnell, Injury, Volume 34, Issue 5, May 2003)

Source: Stoneridge Engineering

Gustavo Miranda Holley / Getty Images

Source: Treehugger.com

Natalia Sokko / Getty Images

Source: Treehugger.com

Catherine MacBride / Getty Images

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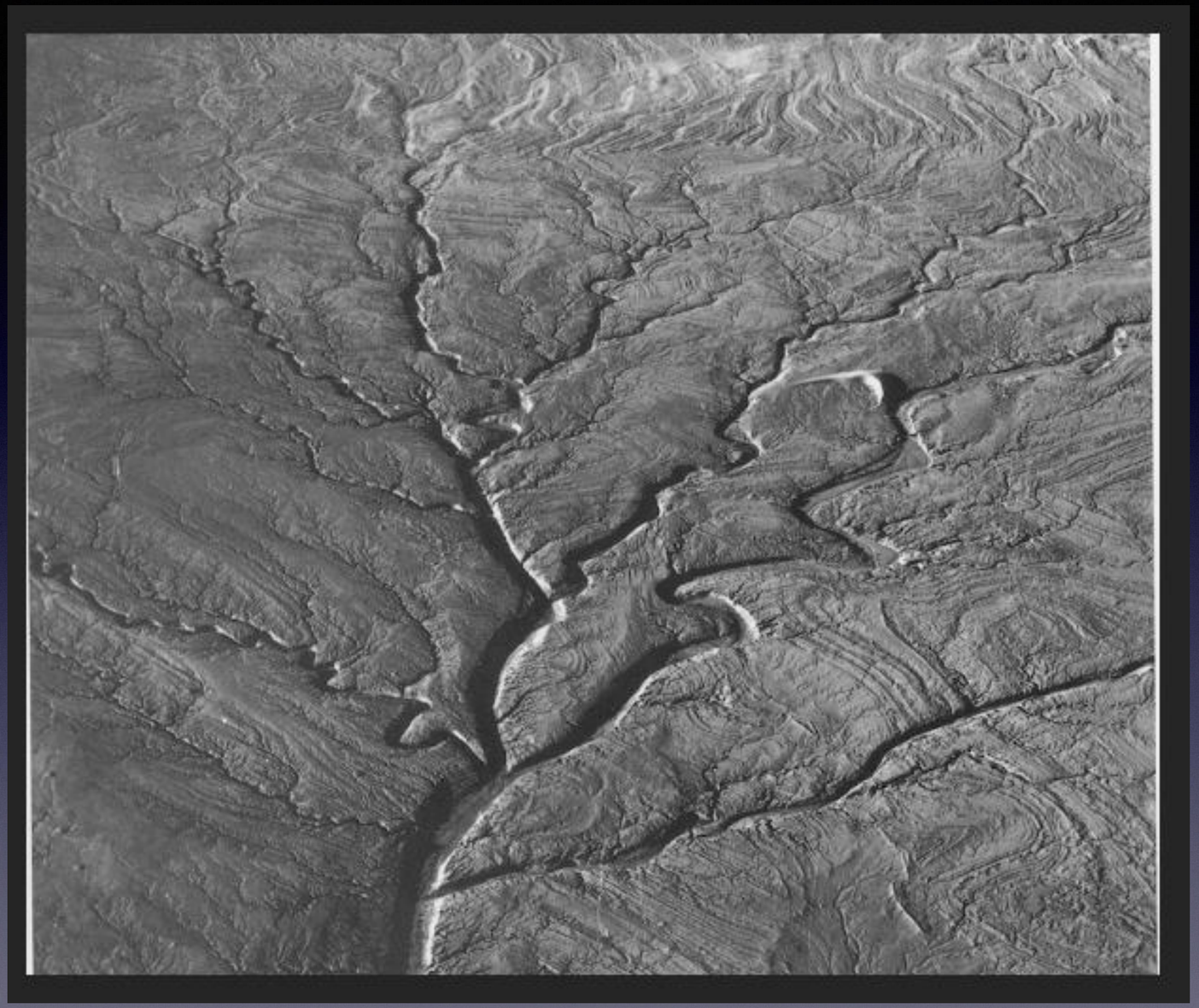
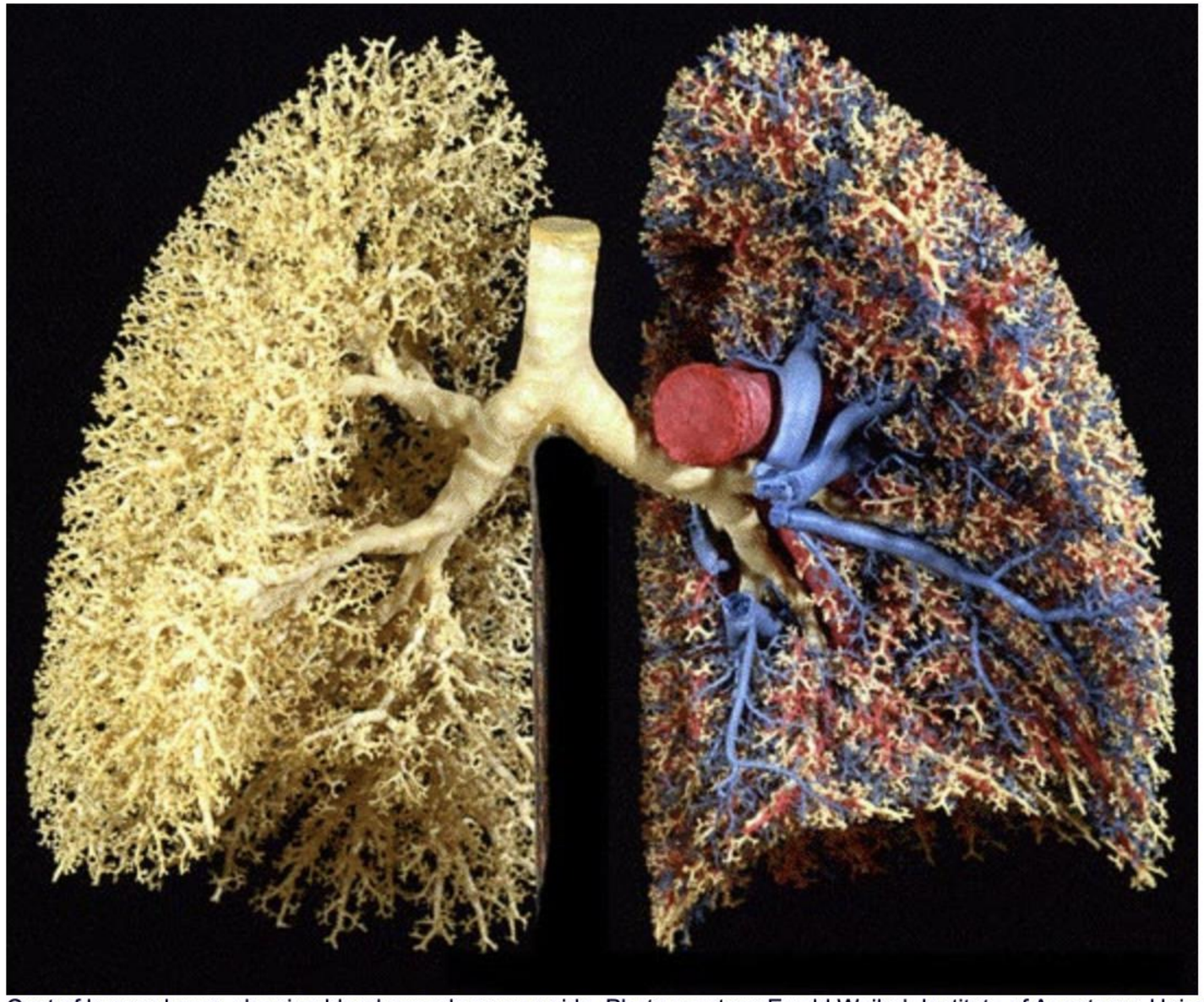


Source: Exploratorium

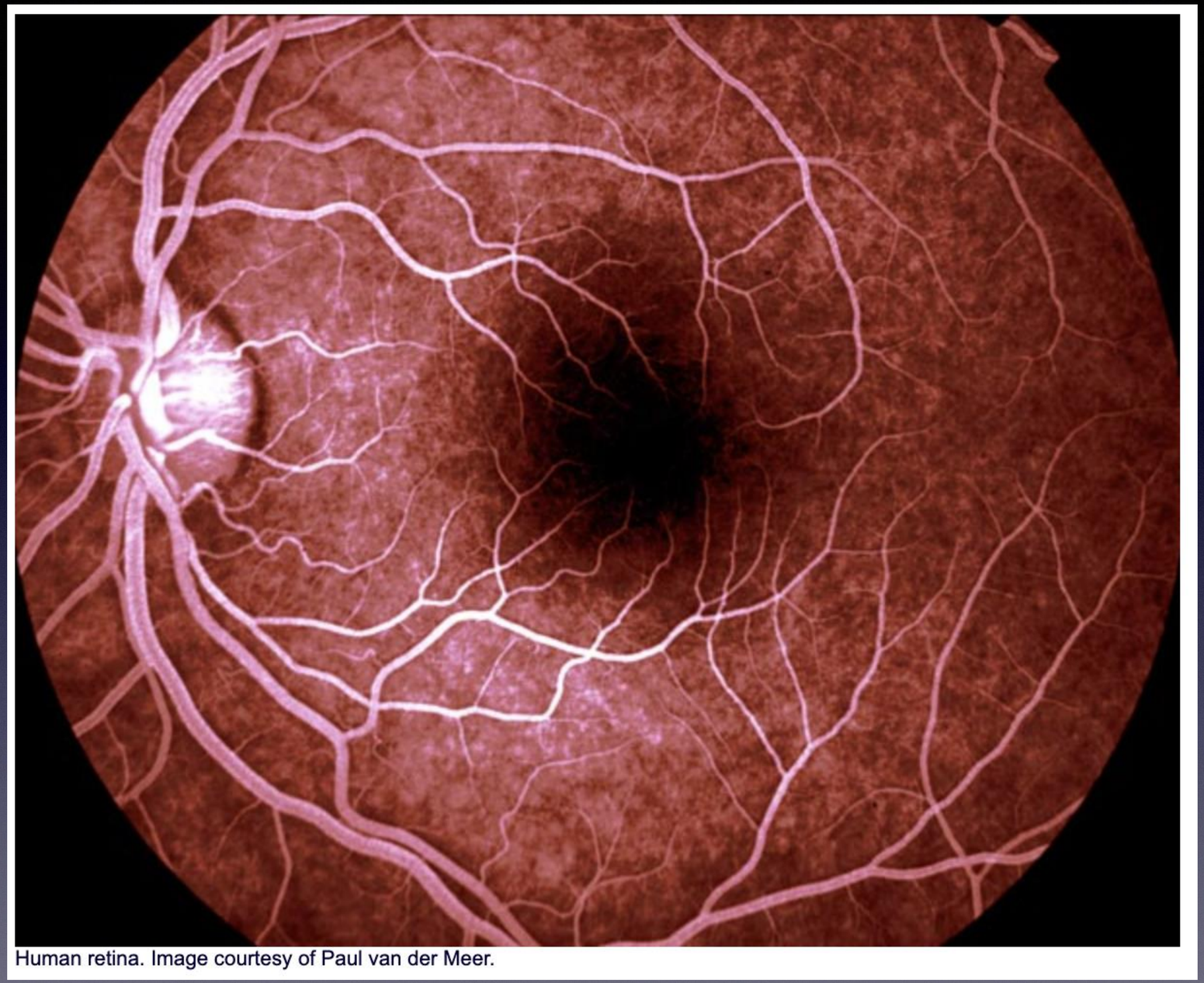
The Grand Canyon in the southwestern US.
Image courtesy of Victor Polyak.

Source: Fractal Foundation



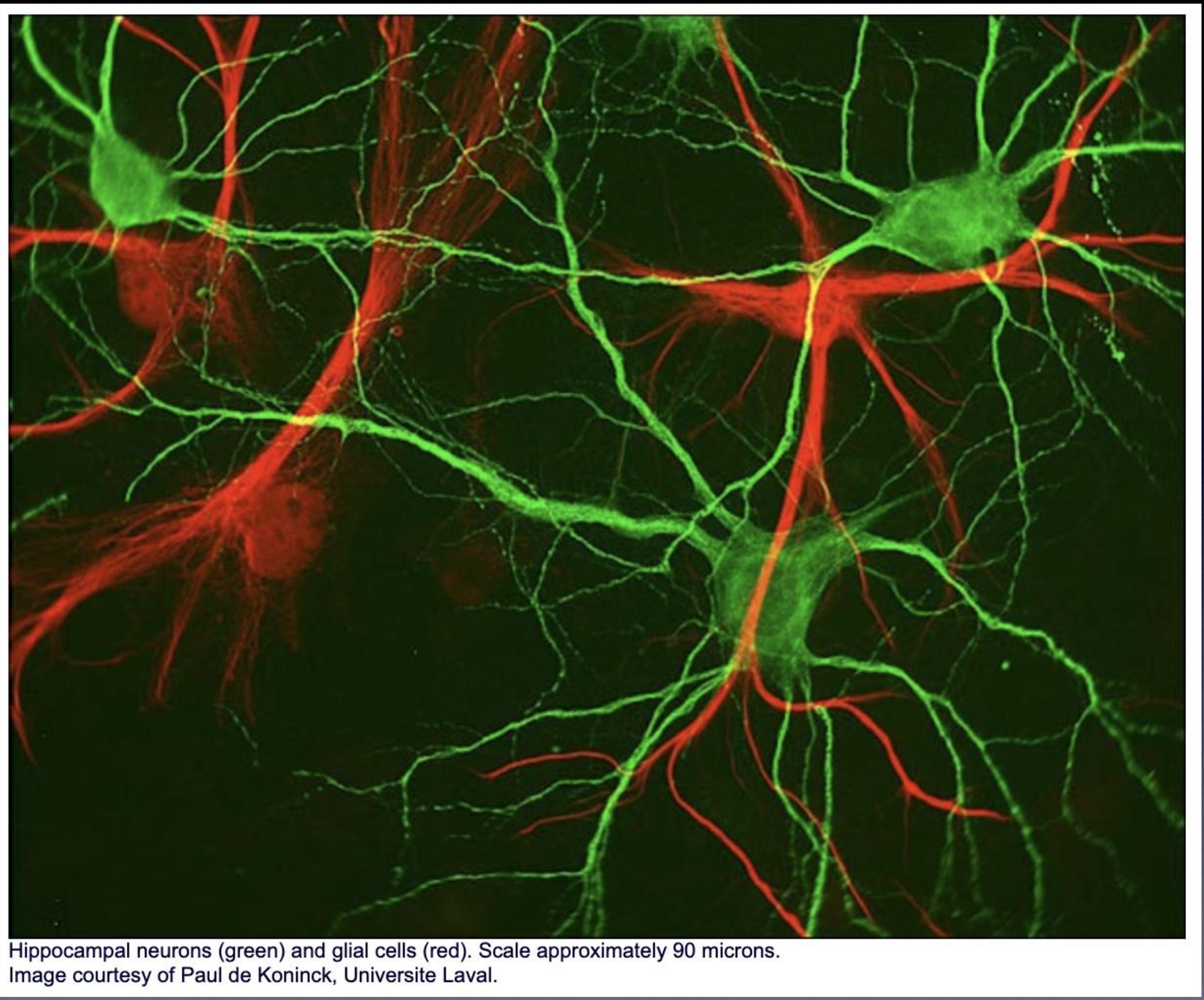
Cast of human lungs, showing blood vessels on one side. Photo courtesy Ewald Weibel, Institute of Anantomy, University of Berne.

Source: Fractal Foundation



Human retina. Image courtesy of Paul van der Meer.

Source: Fractal Foundation



Hippocampal neurons (green) and glial cells (red). Scale approximately 90 microns.
Image courtesy of Paul de Koninck, Universite Laval.

Source: Fractal Foundation

Source: Lightning Data Center

Skin

Symptoms

- Burns
  - Linear: often to areas of high sweat concentration
  - Punctate: a result of the lightning current passing out of tissue, often to the soles of the feet
  - Full thickness: often where skin is in contact with metal or synthetic fabric

Eval and Tx

- High risk indicators
- Burn Tx as indicated

Eye

Symptoms

- Lens Injuries
- Cataracts can form between 2 days and 4 years post incident

Eval and Tx

- Ophthalmologic Evaluation

Ear

Symptoms

- Tempanic Membrane Rupture
- Hearing Loss

Eval and Tx

- Otolaryngologic Evaluation

“Reverse Triage”

- Death by simultaneous depolarization of all myocardial cells —> asystole or ventricular fibrillation
- Pulseless? ALS
- Multiple subjects? Pulseless victims receive priority
- Patients are safe to touch. No residual current. Evaluate scene for ongoing lightning risk.

Lightning over Albuquerque, New Mexico. Photo courtesy of Jef Duncan.

Source: Fractal Foundation

Prevention Reminders

- Plan ahead
  - Check specific weather forecasts and be conservative with choices
  - Start early
  - Be prepared to turn around
- Maintain situational awareness
  - Watch, listen, and smell
  - Adapt exit plan as terrain changes
- ”When Thunder Roars, Go Indoors”

Source: TL Brainerd, MD

Source: Outside Magazine

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Thank you

tbrainerd@gmail.com

Tiffany L Brainerd, MD
FAAP, FASA, FAWM, DiMM