

Lightning Safety

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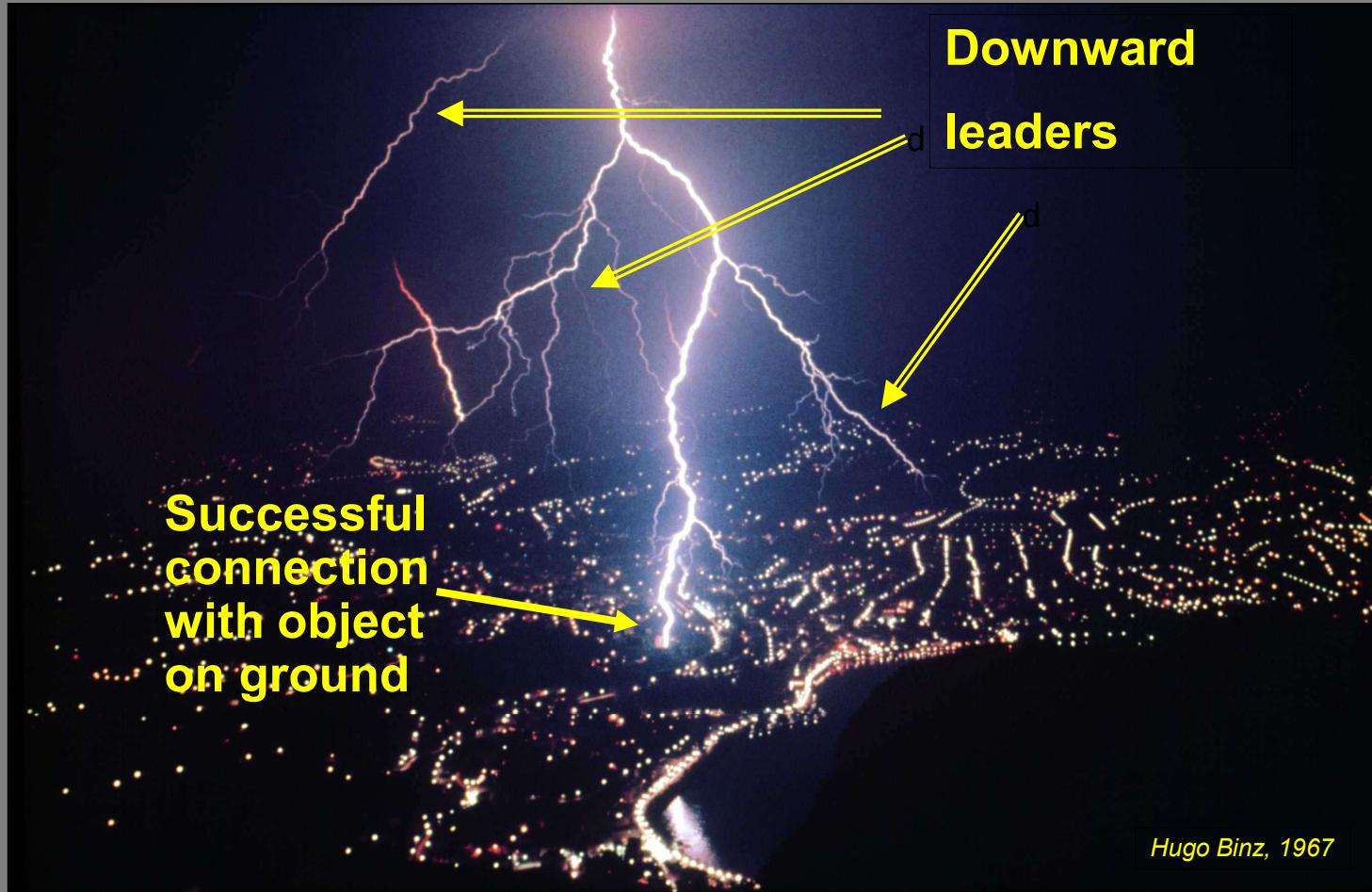
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Cape Town, South Africa

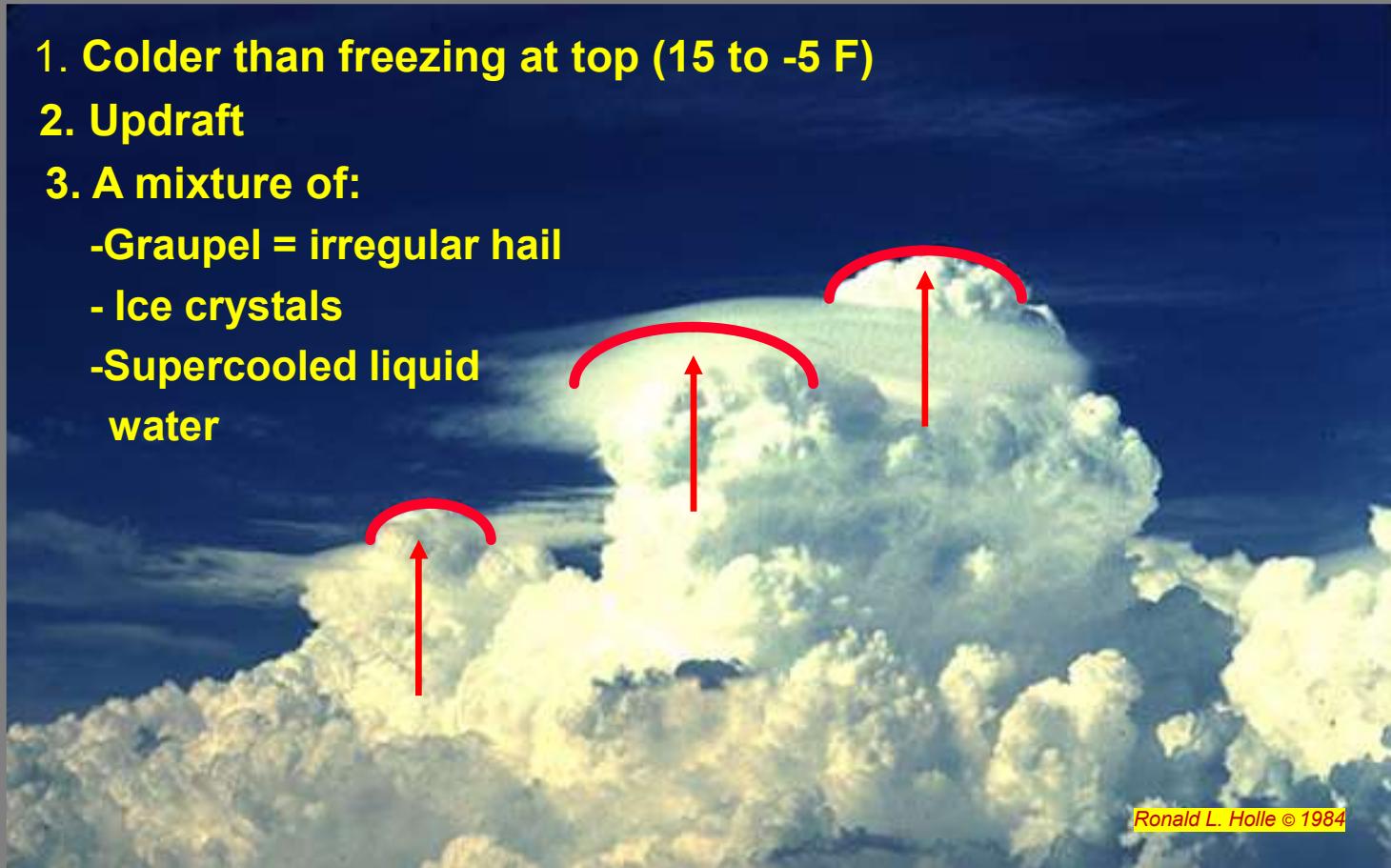


Mt. San Salvatore, Lugano, Switzerland



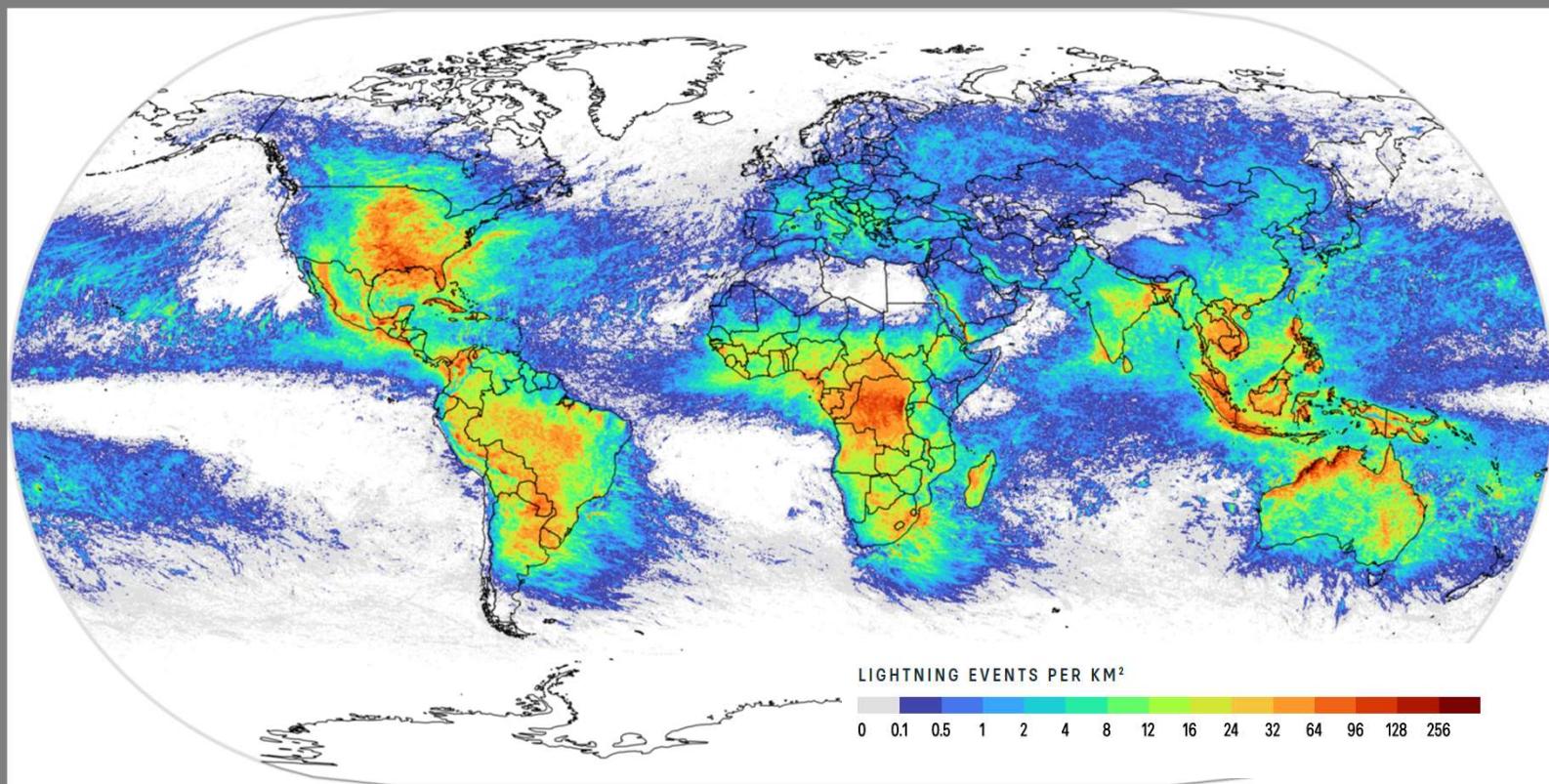
Lightning forms in updrafts in cumulus towers

1. Colder than freezing at top (15 to -5 F)
2. Updraft
3. A mixture of:
 - Graupel = irregular hail
 - Ice crystals
 - Supercooled liquid water



Global Lightning Dataset GLD360

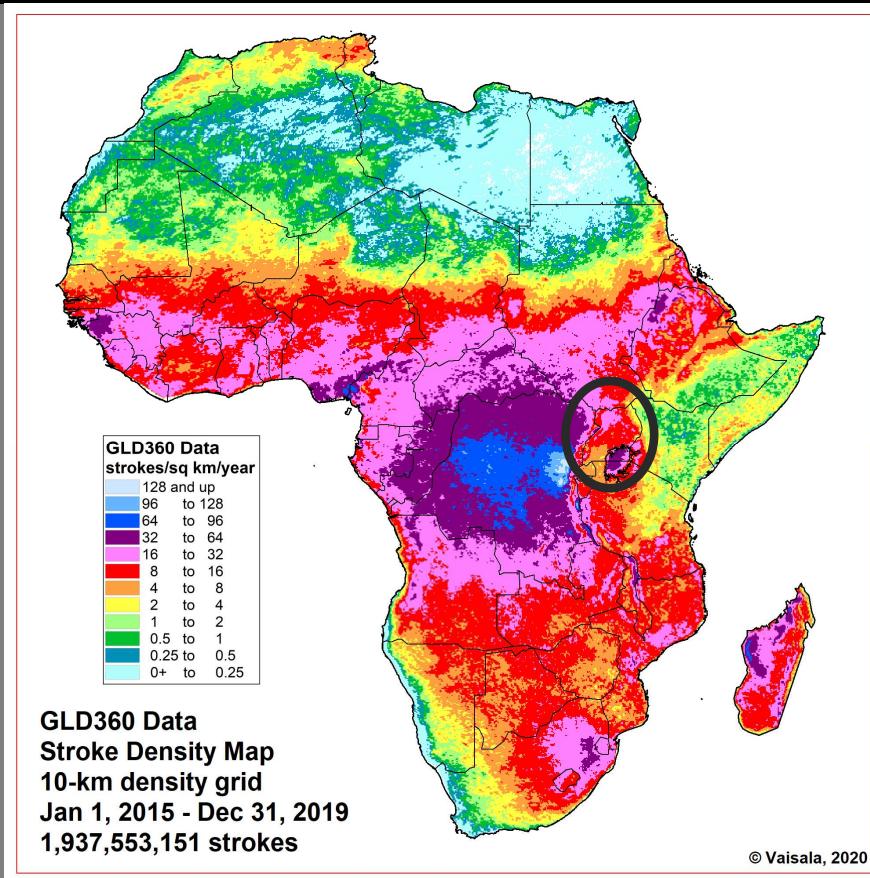
2.2 billion events detected per year...owned and operated by Vaisala



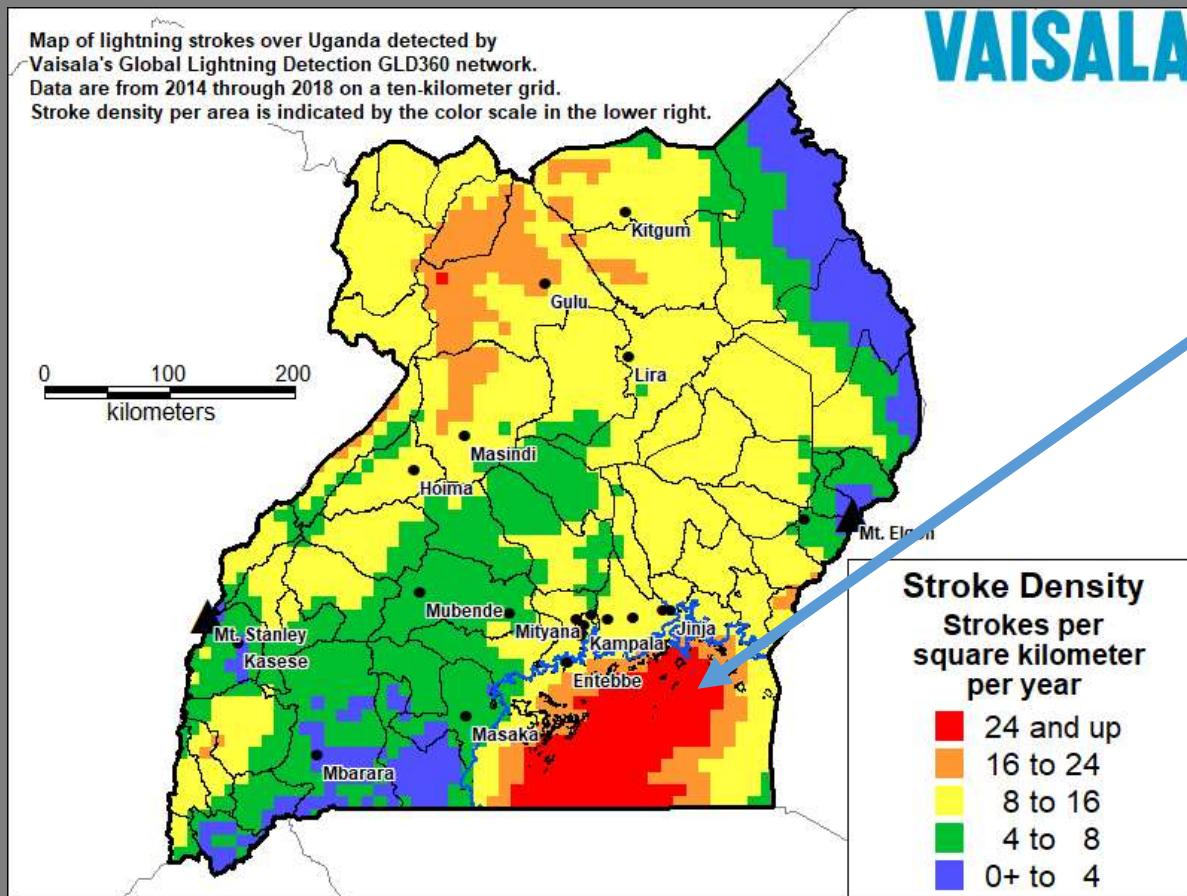
<https://www.xweather.com/annual-lightning-report>

GLD360 over Africa from 2015-2019

1.9 billion events in five years---390 million events per year

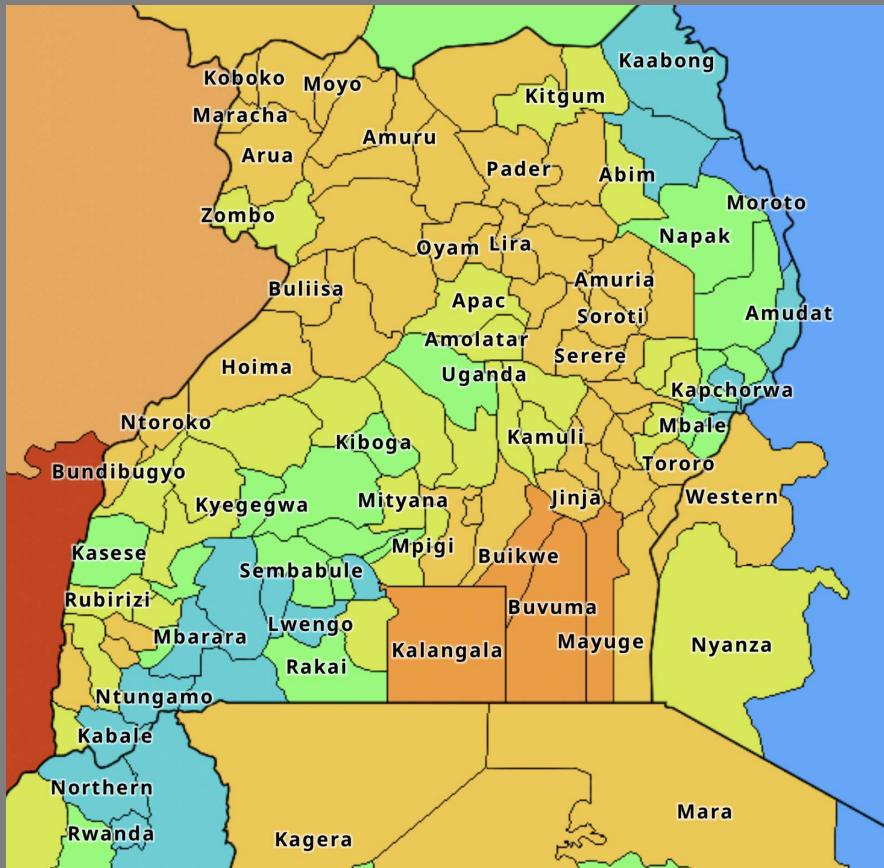


GLD360 over Uganda from 2014-2018



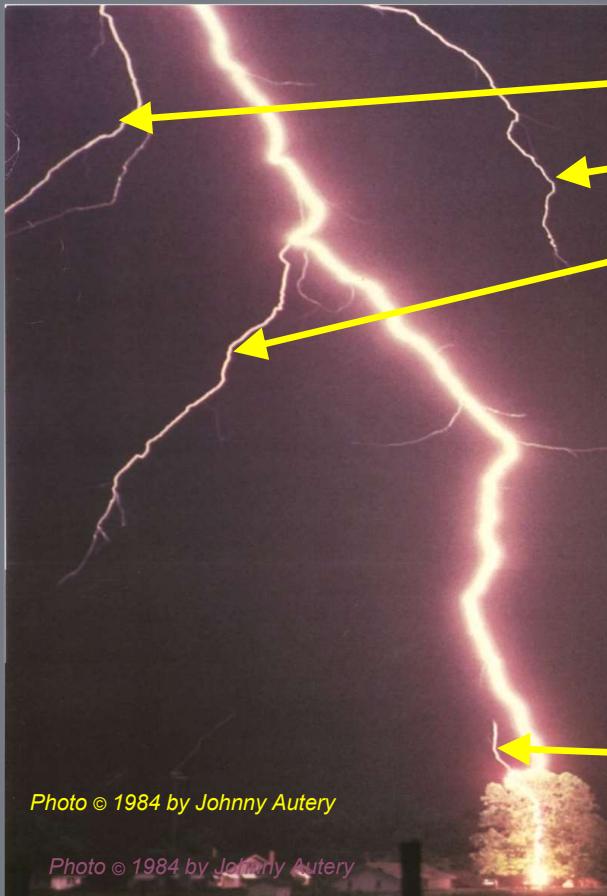
Large lightning maximum over Lake Victoria at night

Interactive GLD360 map



[https://interactive
-lightning-
map.vaisala.com/](https://interactive-lightning-map.vaisala.com/)

Cloud-to-ground flash



**Unsuccessful
downward
leaders**

Preferred strike points

- Tall
- Isolated
- Pointed

Upward leader

Lightning striking parking lot between poles



Two safe places – the **only** places

Two reliably safe places:

- 1. Inside a large substantial frequently-occupied building**
- 2. Inside a fully-enclosed metal-topped vehicle**

Booklet published in 2017



www.vaisala.com/en/system/files/documents/Lightning-Booklet.pdf

Frequently asked lightning safety questions

- Is it safe to use a mobile phone during a thunderstorm?

Yes, if you are in a lightning-safe place

- Can rubber tires save you from a direct strike to your car? **No**
- Does metal attract lightning? **No**
- Are tents and small shelters safe during a thunderstorm? **No**
- Is it safe to stand under a tree during a thunderstorm? **No**
- Can rubber-soled shoes save you from lightning? **No**
- Are passengers safe if lightning strikes a plane? **Yes**

Lightning safety: Certain and not certain

Certain safety:

- Inside a large substantial frequently-occupied building
- Inside a fully-enclosed metal-topped vehicle

Not certain safety:

- What a person wears or carries
- Where or how a person stands
- On what a person stands
- Anywhere outside

Five lightning safety myths

1. Lightning is attracted to metal **False**
2. Direct strike is the most common method **False**
3. Actions taken outside can always make you safe **False**
4. If it's not raining, I'm safe **False**
5. Rubber tires provide protection **False**

African lightning safety stories

- 1. Wearing red attracts lightning**
- 2. People killed or injured by lightning have done something bad**
- 3. People can call lightning upon their enemy**

Uganda: Lightning casualty activities/locations

All events

<u>Schools</u>	55
Under trees	6
Church	4
Tending animals	4
Funeral	3
Playing	3
Soccer	3
Collecting rainwater	2
<u>Inside bar (hut)</u>	2
Other single events	13

Home events

Grass-thatched house	5
Garden	3
In house	3
Kitchen	2
At home	1
Bedroom	1
Seated outside	1
<u>Under verandah</u>	1
	17

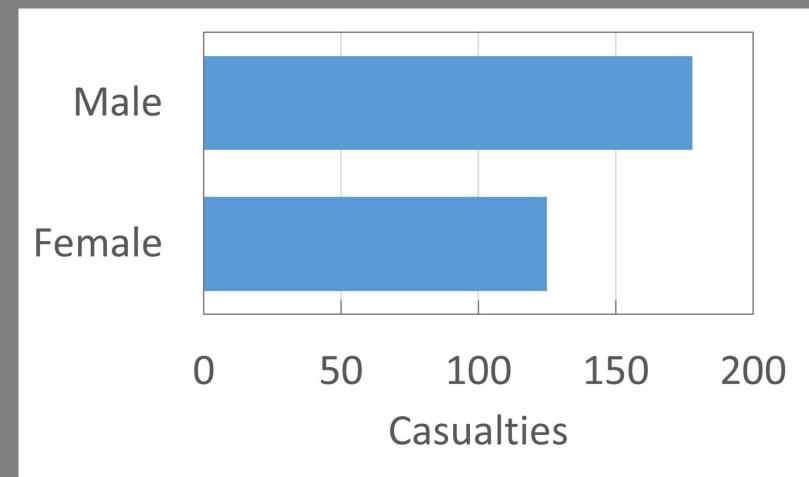
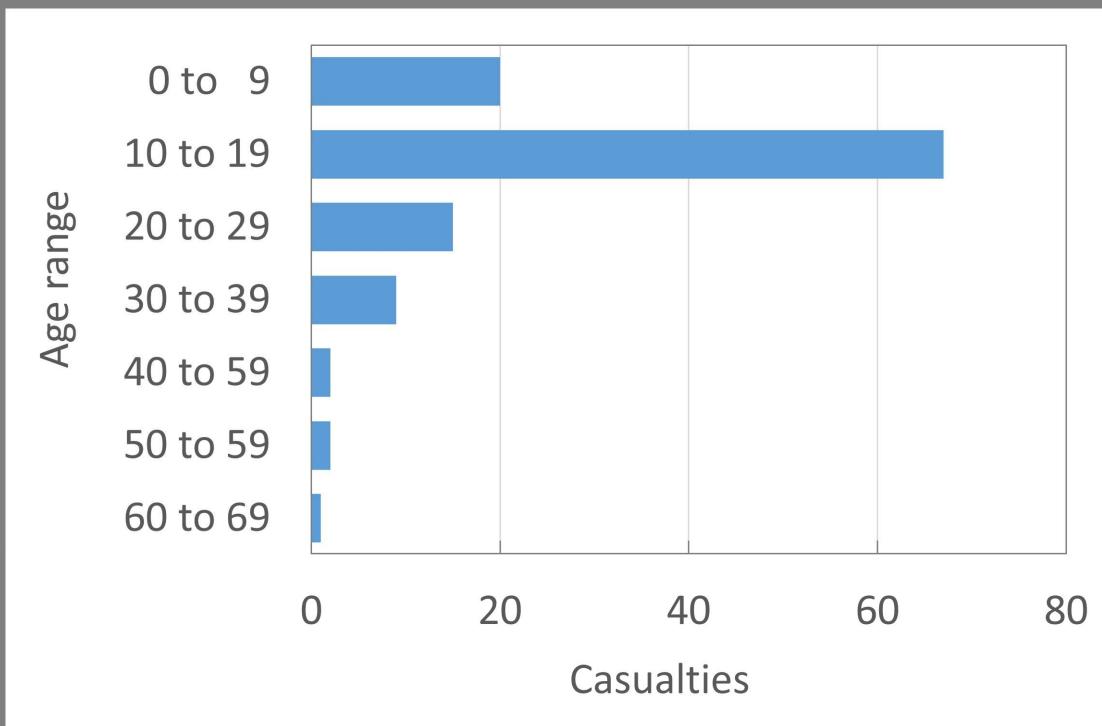
All Uganda lightning casualties, 2007-2020

- 121 events
- 212 deaths
- 824 injuries
- 1,036 deaths and injuries combined
- 2020 population is 47.4 million; 32.4 million in 2010

- 0.4 deaths per million people per year
- Ratio of 3.4 injuries reported per death

Holle, R.L., K.N. Gassert, M.A. Cooper, R. Tushemereirwe, R. Said: Lightning Occurrence and Casualties in Uganda, American Meteorological Society Annual Meeting, 2020.

Uganda: Lightning casualties are usually young



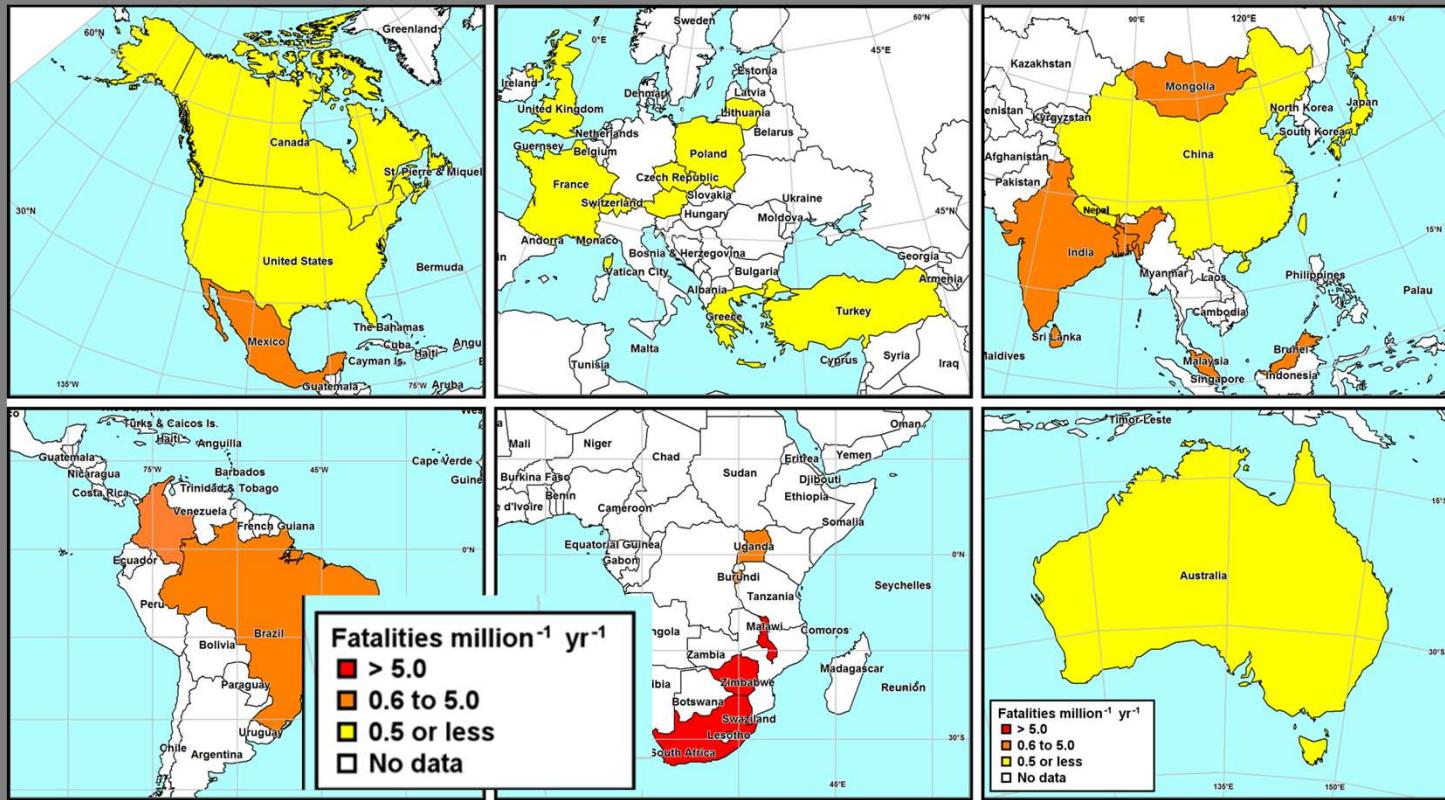
Holle, R.L., K.N. Gassert, M.A. Cooper, R. Tushemereirwe, R. Said: Lightning Occurrence and Casualties in Uganda, American Meteorological Society Annual Meeting, 2020.

What's missing in Uganda data? Farming events

- “445 cases were summarized involving 969 fatalities and 597 non-fatal injuries related to agriculture outside the United States since 1993. The most common non-United States agricultural event was in fields, often paddy fields.”
- These types of events are almost certainly happening often in Uganda, but we don't know of them.
- Need better data collection

Holle, R.L., 2016: Lightning-caused deaths and injuries related to agriculture. Preprints, Preprints, 33rd International Conference on Lightning Protection, Estoril, Portugal, 6 pp.

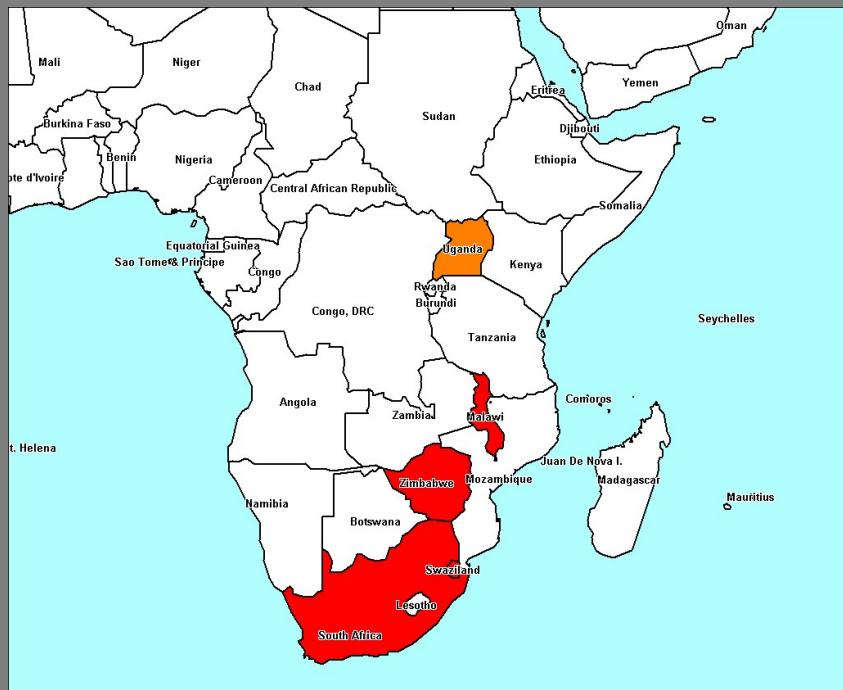
Which countries have the largest lightning death rate per population?



1	Malawi	84.0*
2	Zimbabwe	17.0
3	eSwatini	15.5
4	South Africa	6.3
5	Burundi	5.0
6	México	2.7
7	India	2.0
8	Bangladesh	1.7
9	Colombia	1.7
10	Mongolia	1.5
10	Singapore	1.5

Holle, R.L., 2016: A summary of recent national-scale lightning fatality studies. *Weather, Climate, and Society*, 8, 35-42.

Africa : Largest lightning death rates per population



Red

>5.0 fatalities/million/year

Orange

0.6 to 5.0 fatalities/million/year

Yellow

< 0.5 fatalities/million/year

White

No published national summaries for datasets ending in 1979 or later

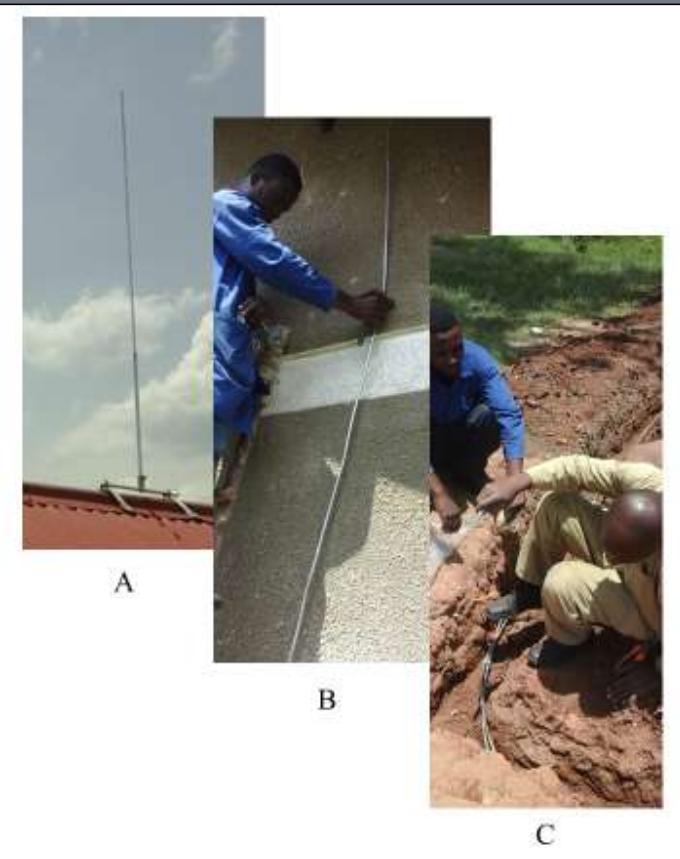
African Centres for Lightning and Electromagnetics Network (ACLENet)



<https://aclenet.org/>

Lightning protection

Franklin rod (A), down conductor (B), grounding (C) [Uganda]



No ACLENet lightning protection

St. Theresa Kisubi Girls' Primary School dormitory in Uganda, October 2023



ACLENet, 14 December 2023

ACLENet, 11 March 2022

ACLENet lightning protection

Mongoyo school – 3 killed, 70 injured in 2018 event [Uganda]



Two safe places – the **only** places

Two reliably safe places:

- 1. Inside a large substantial frequently-occupied building**
- 2. Inside a fully-enclosed metal-topped vehicle**

Safe vehicles



- Fully enclosed
- Metal-topped
- Surround people inside with a Faraday cage-like effect to provide safe path for lightning to follow to ground

Completely unsafe vehicles



- Golf carts
- ATVs
- Motorcycles, scooters
- Bicycles
- Convertibles
- Animal-drawn carts
- Cloth top

Safe structures



- Large substantial buildings
- Where people frequently live or work
- Have grounded wiring and plumbing, and metal structural members
- Follow building codes
- Surround people inside with a Faraday cage-like effect to provide safe path for lightning to follow to ground

Completely unsafe structures - 1



Unsafe: A structure with the word 'shelter' attached – sun, beach, golf, picnic, or rain shelter

Completely unsafe structures - 2



Hut-Asia

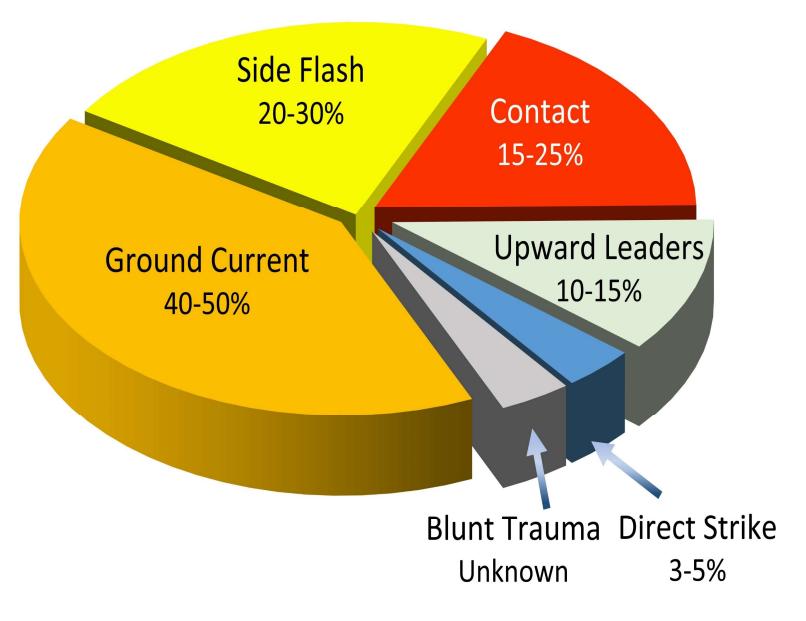


Huts-Africa



Informal Settlement-S. Africa

Mechanisms of lightning injury and death

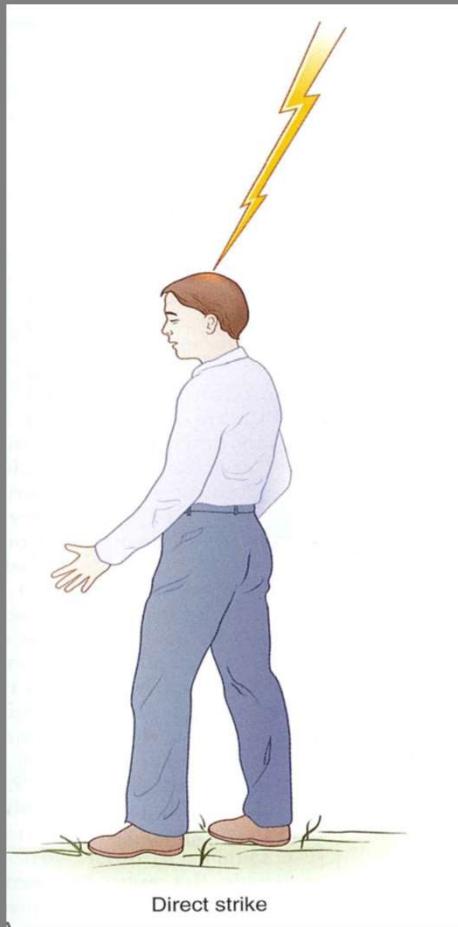


- **Ground current: 40 to 50%**
- **Side flash: 20 to 30%**
- **Contact: 15 to 25%**
- **Direct strike: 3 to 5%**
- **Upward leaders: 10 to 15%**
- ***Blunt injury: Unknown***

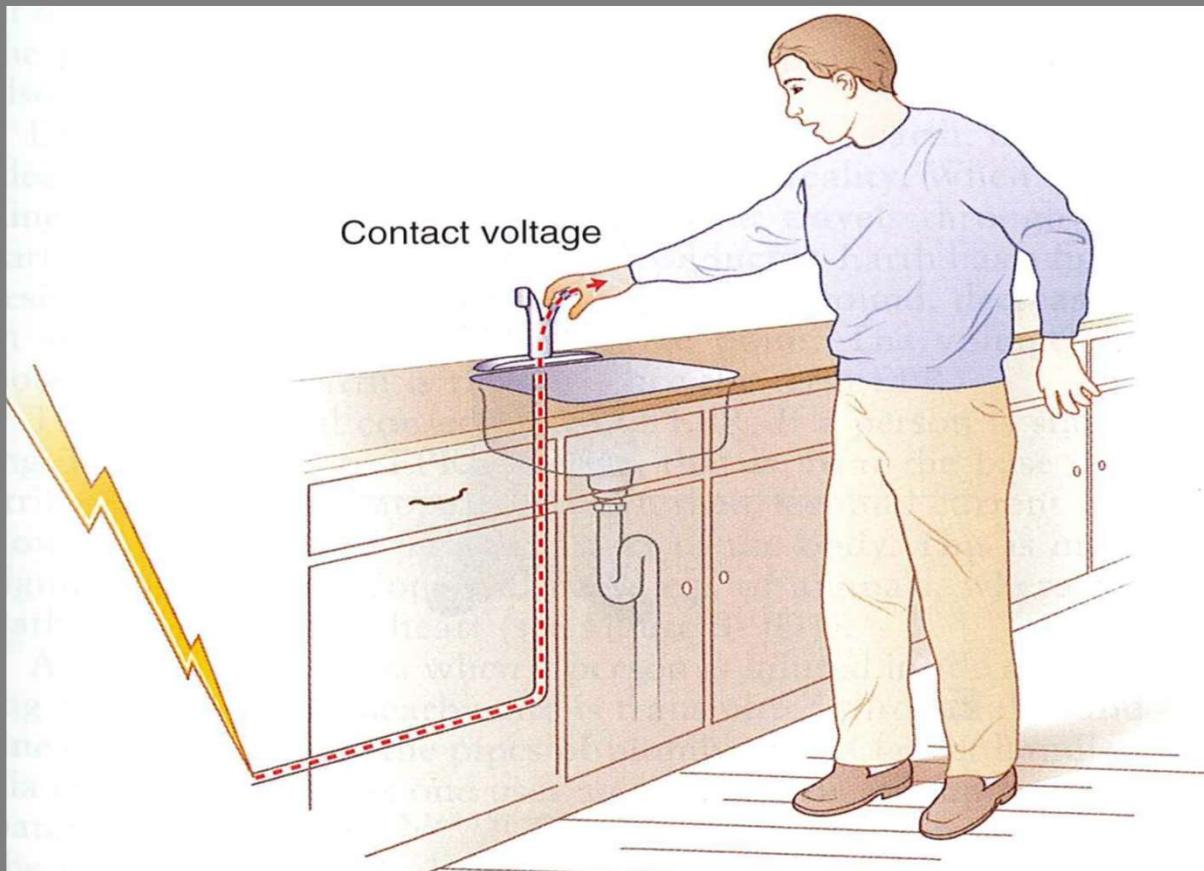
--**Direct strike is a very uncommon mechanism**
--**Lightning safety is not about the direct strike**

Cooper, M.A., and R.L. Holle, 2018: *Reducing lightning injuries worldwide*. Springer Natural Hazards, New York, 233 pp.

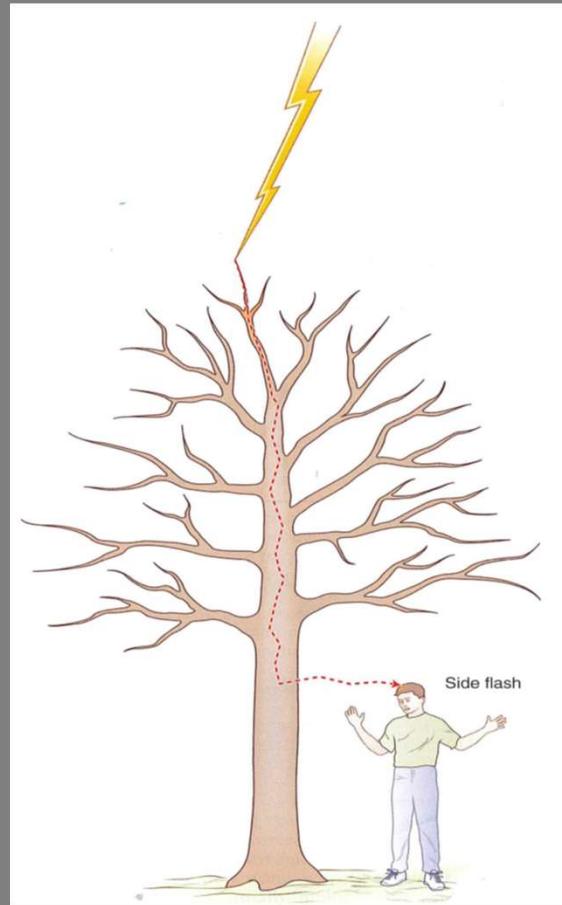
1. Direct strike...3 to 5%



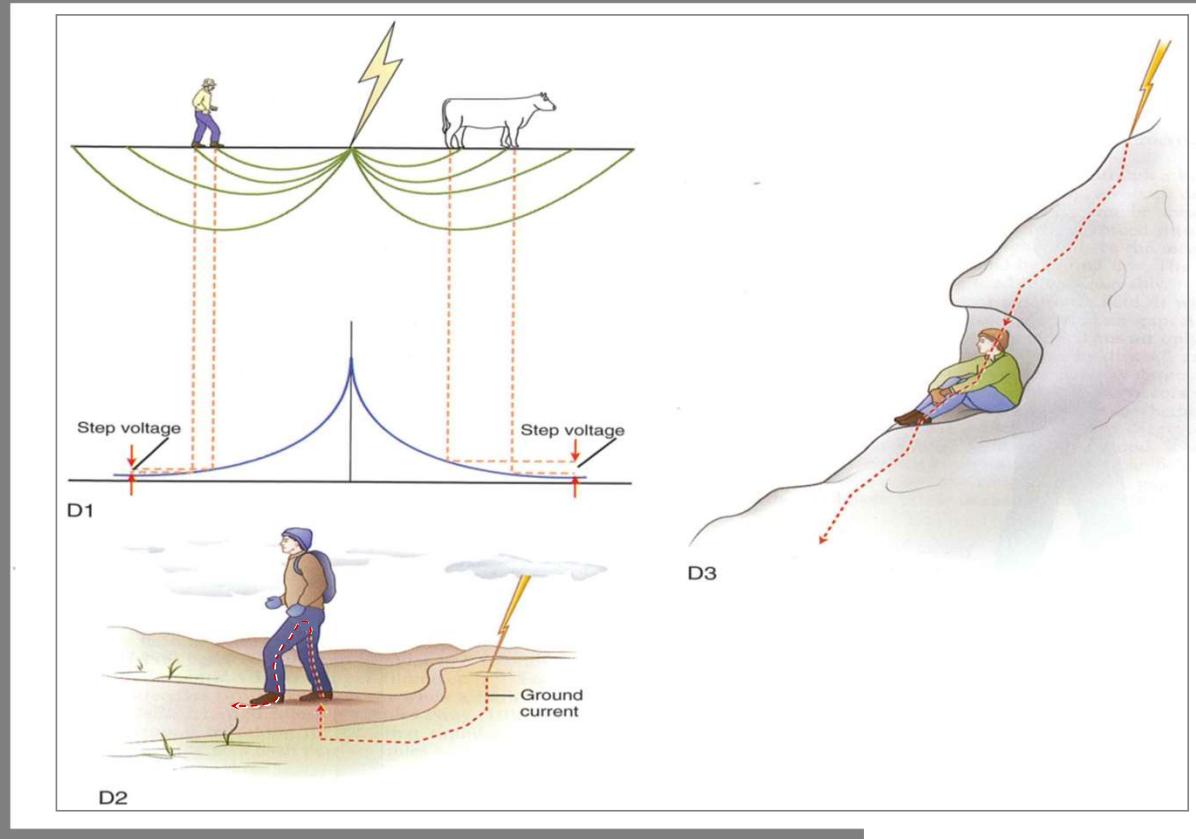
2. Contact voltage...15 to 25%



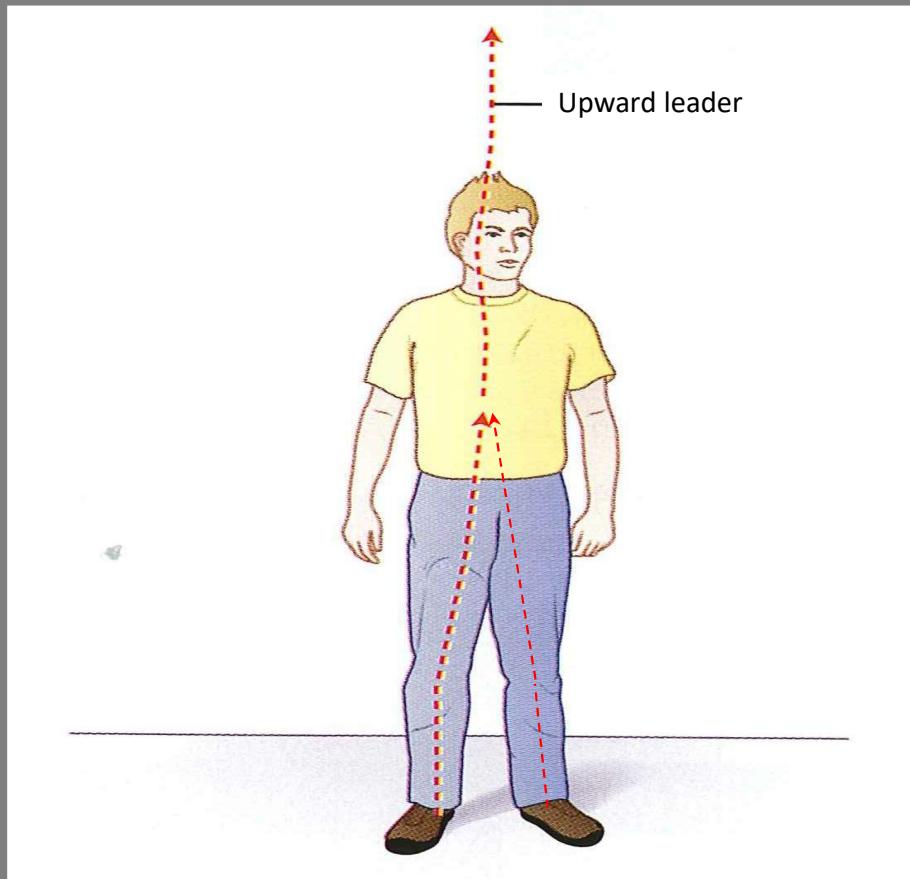
3. Side flash...20 to 30%



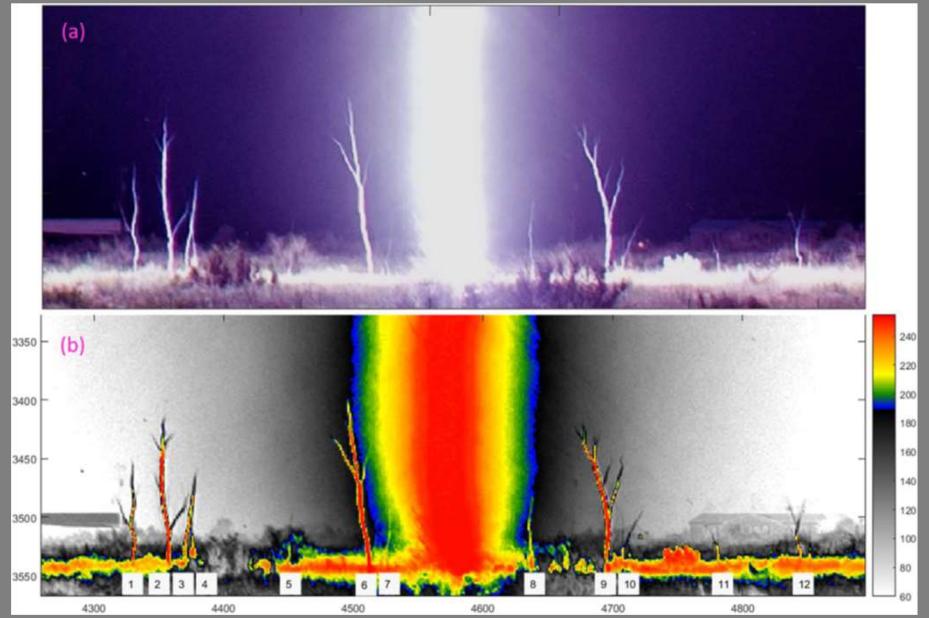
4. Ground current/step voltage...40 to 50%



5. Upward leader...10 to 15%



Upward leaders in an open field



Cummins, K.L., E.P. Krider, M. Olbinski, and R.L. Holle, 2018: A case study of lightning attachment to flat ground showing multiple unconnected upward leaders. *Atmospheric Research*, **202**, 169-174.

Impacts of lightning on animals



Canada - July 2022



United States
September 2019

Sound travels six seconds per mile

It takes 30 seconds for sound from a lightning event six miles away to reach you

In-cloud lightning is the same threat as cloud-to-ground

**Treat any lightning as equally dangerous
and as an indicator of the lightning threat
whether
In-cloud or cloud-to-ground**

U.S. National Lightning Safety Council



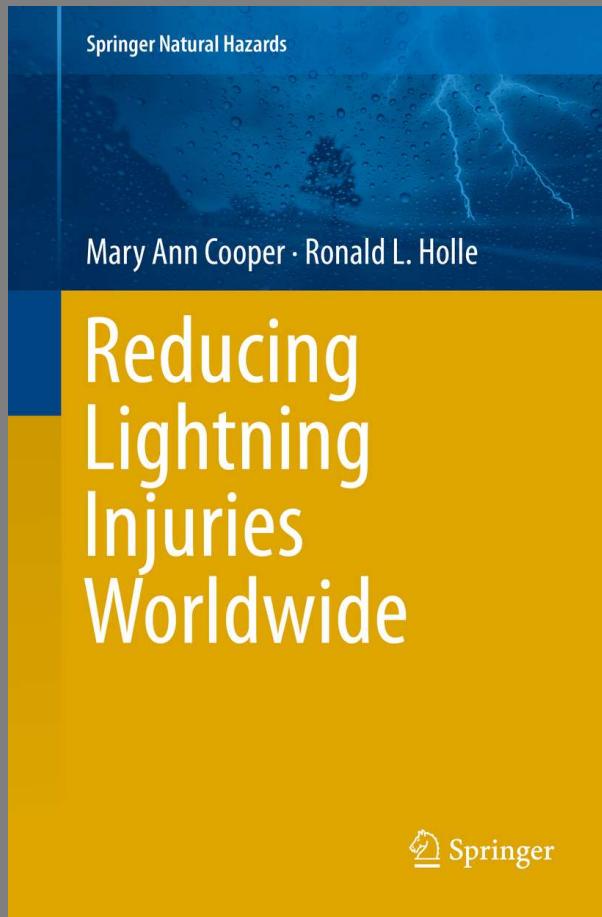
2023 Lightning Fatalities									
Number	Date	D of W	State	City	Age	Gender	Location	Activity	Victim
1	4-6-2023	Thursday	VA	Louisa County	73	M	Lake	Boating	Not released
2	4-15-2023	Saturday	PA	Chester County	48	M	Roadway	Driving car	Not released
3	4-16-2023	Sunday	FL	Brevard County	39	M	On water	Fishing	Peter Strong
4	5-15-2023	Monday	TX	Valley Mills	34	M	Driveway	Walking home from bus stop	Matthew Boggs
5	5-15-2023	Monday	TX	Valley Mills	6	M	Driveway	Walking home from bus stop	Grayson Boggs
6	5-22-2023	Monday	FL	Deltona	24	M	Rooftop	Construction	Edvin Velasquez Cinto
7	6-21-2023	Wednesday	NE	Garden Cnty	27	M	Open area	On horse checking on cattle	Terrel Vineyard
8	7-24-2023	Monday	NY	Lincoln	39	M	Under tree	Roofing	Lauro Zhunaula Saca
9	8-5-2023	Saturday	OK	Mayes Cnty	teen	F	Creek	Swimming	Olivia Richardson
10	8-7-2023	Monday	AL	Florence	28	M	Parking lot	Working	Marquin Russell
11	8-23-2023	Wednesday	FL	Clearwater	73	F	Sidewalk	Walking	Kathleen M. Carrick
12	8-25-2023	Friday	KY	Sherburne	39	M	Field	Putting up hay	Not released
13	9-26-2023	Tuesday	FL	Putnam Cnty	16	F	Under tree	Hunting	Baylee Holbrook

Links to Listings Of Fatalities By Year

- 2006 - 49 fatalities
- 2007 - 47 fatalities
- 2008 - 29 fatalities
- 2009 - 35 fatalities
- 2010 - 29 fatalities
- 2011 - 26 fatalities
- 2012 - 29 fatalities
- 2013 - 23 fatalities
- 2014 - 26 fatalities
- 2015 - 28 fatalities
- 2016 - 40 fatalities
- 2017 - 16 fatalities
- 2018 - 21 fatalities
- 2019 - 21 fatalities
- 2020 - 17 fatalities
- 2021 - 11 fatalities
- 2022 - 19 fatalities
- 2023 - 13 fatalities

<http://lightningsafetycouncil.org/>

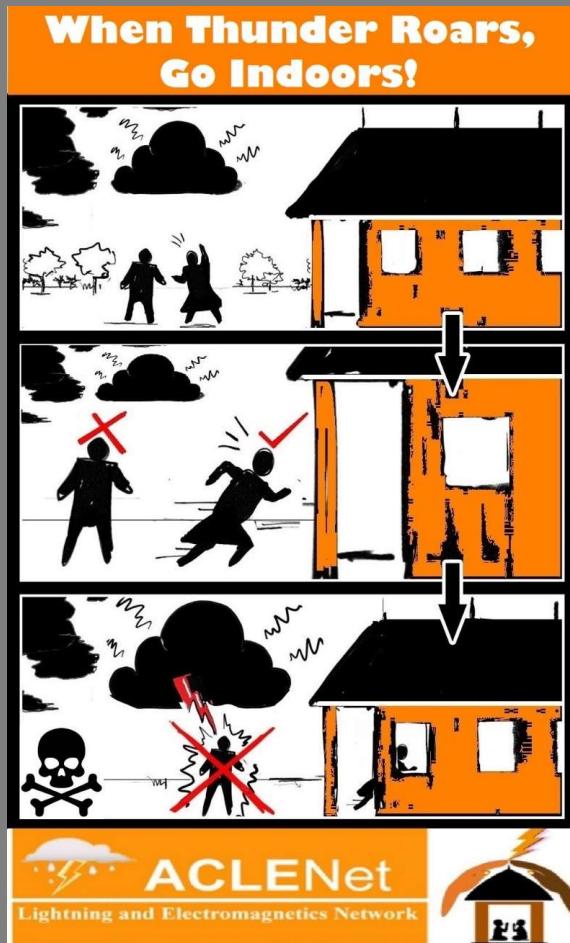
Book on lightning for developing countries



Three more lightning safety ideas

- Lightning never strikes the same place twice False
- Lightning is attracted to metal False
- Cows and horses are more vulnerable to lightning than people True

Safety sign for non-readers



The End



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Ronald L. Holle © 2008

Websites mentioned today

Interactive GLD360 map

<https://interactive-lightning-map.vaisala.com/>

U.S. National Lightning Safety Council

<http://lightningsafetycouncil.org/>

Book by Cooper and Holle

<https://aclenet.org/news-publications/publications/>

Booklet

www.vaisala.com/en/system/files/documents/Lightning-Booklet.pdf

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