

Lightning Safety

Ron Holle

Holle Meteorology & Photography

Oro Valley, Arizona

rholle@earthlink.net



Ronald L. Holle
Holle Meteorology & Photography
11374 N. Cactus Rose Drive
Oro Valley, AZ 85737



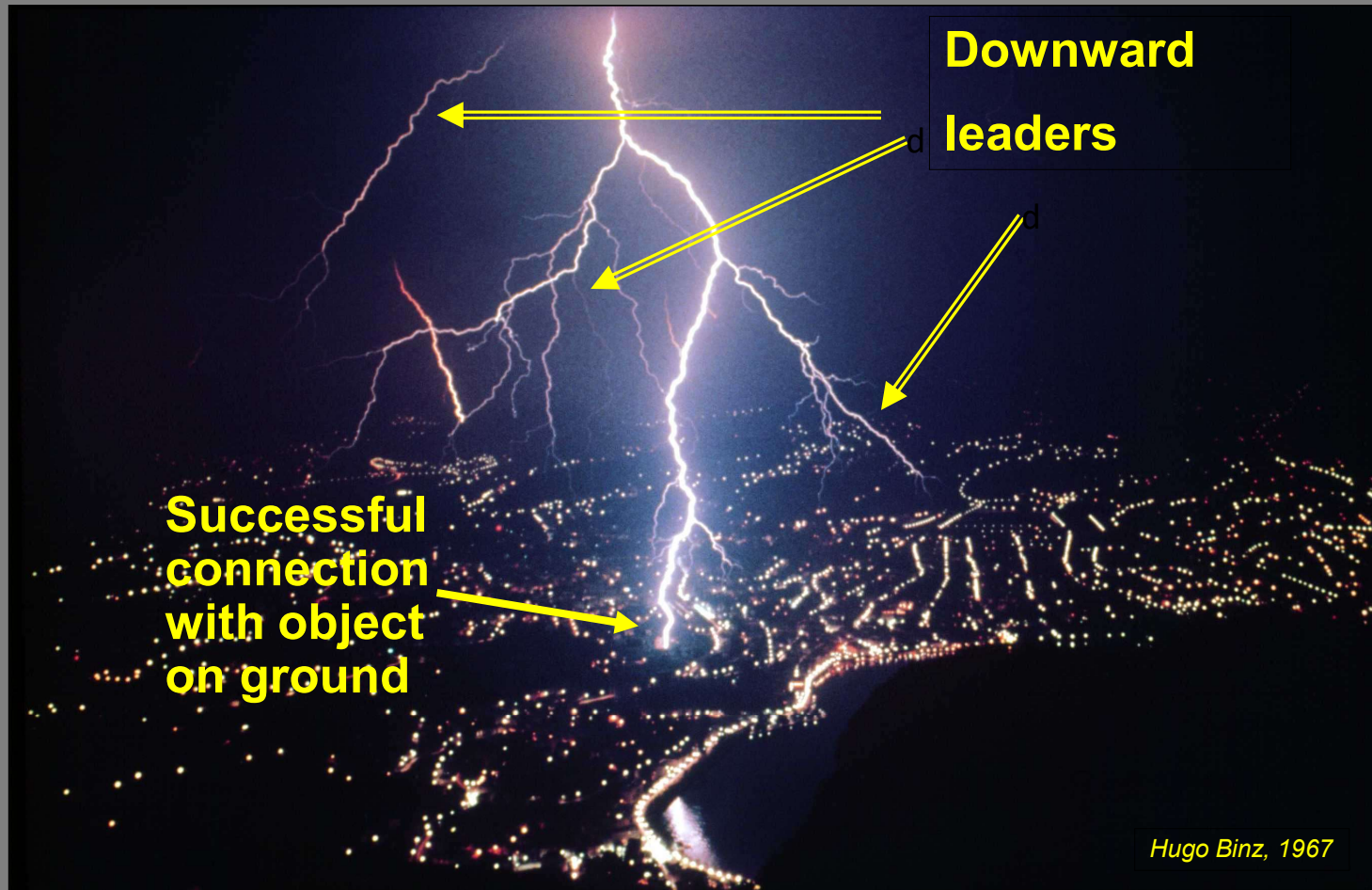
Cape Town, South Africa



ACLENet, 14 December 2023

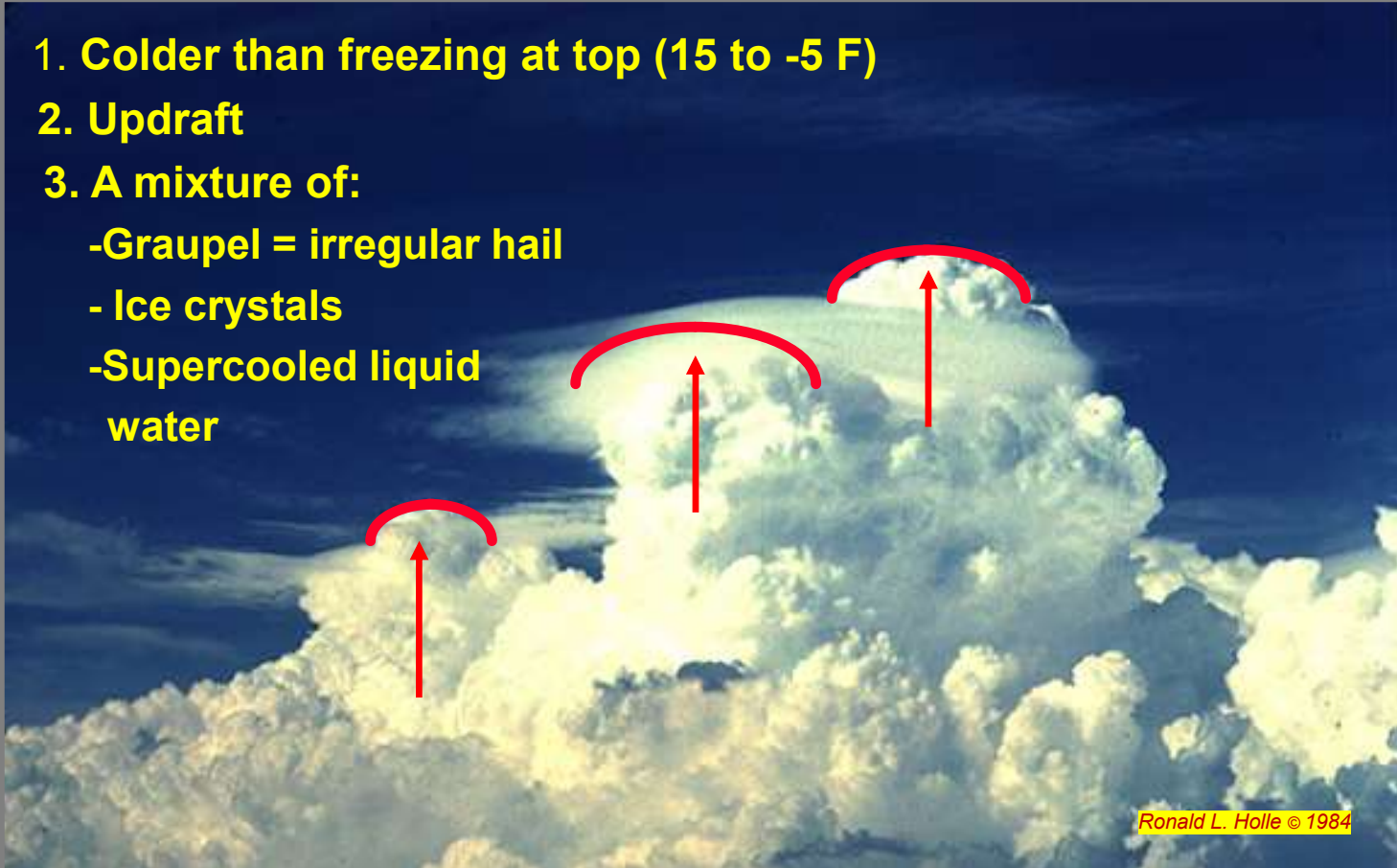
ACLENet, 11 March 2022

Mt. San Salvatore, Lugano, Switzerland



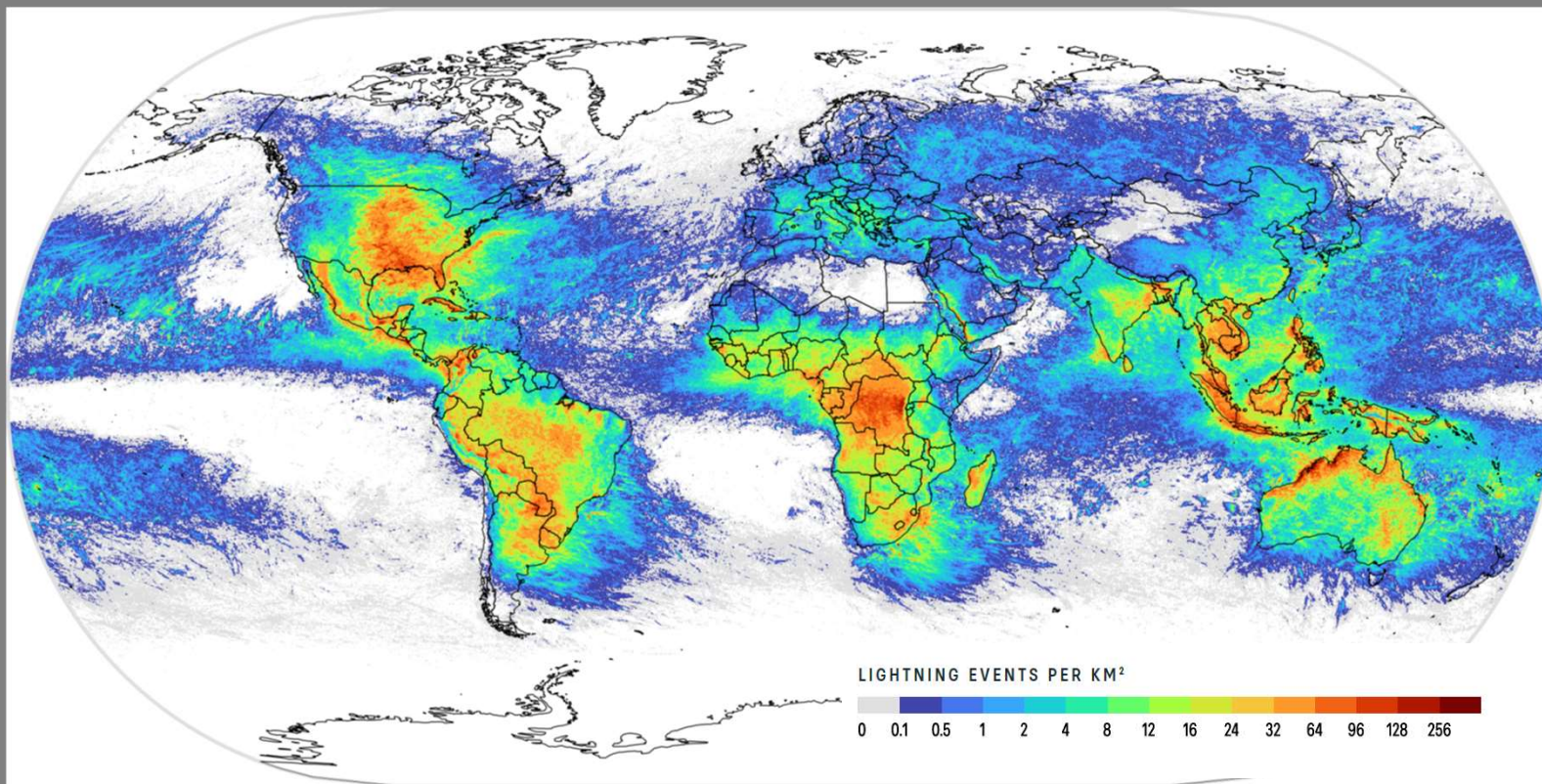
Lightning forms in updrafts in cumulus towers

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

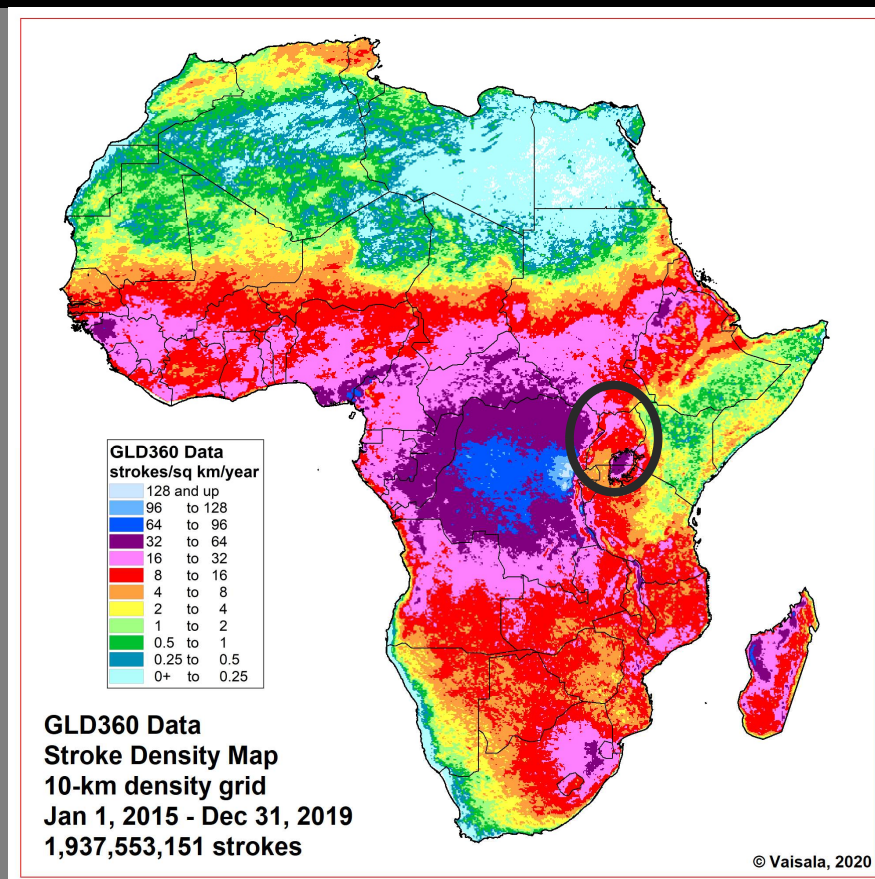
2.2 billion events detected per year...owned and operated by Vaisala



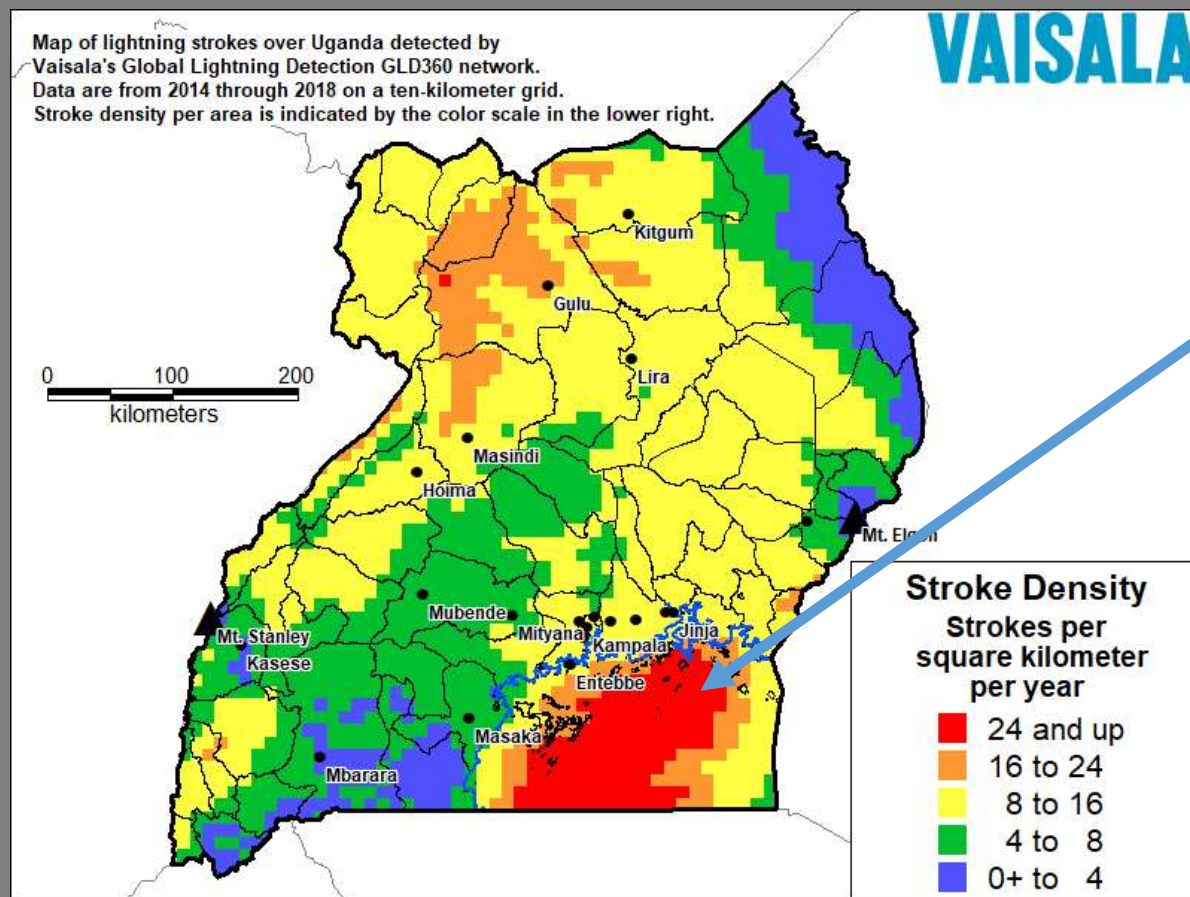
<https://www.xweather.com/annual-lightning-report>

GLD360 over Africa from 2015-2019

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

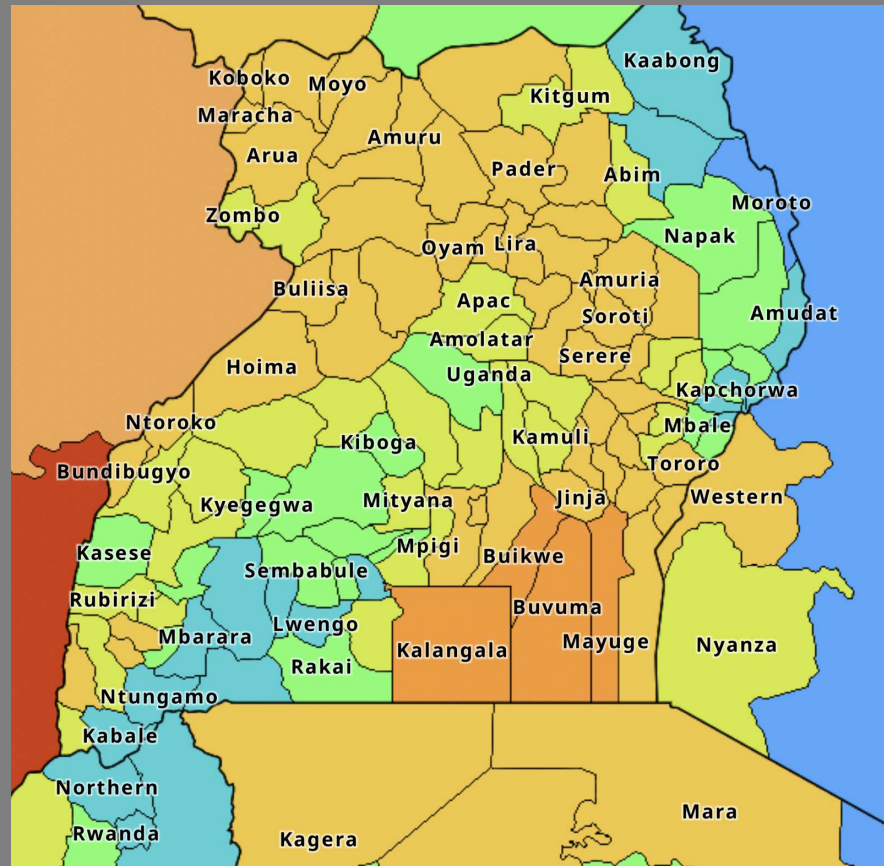


GLD360 over Uganda from 2014-2018



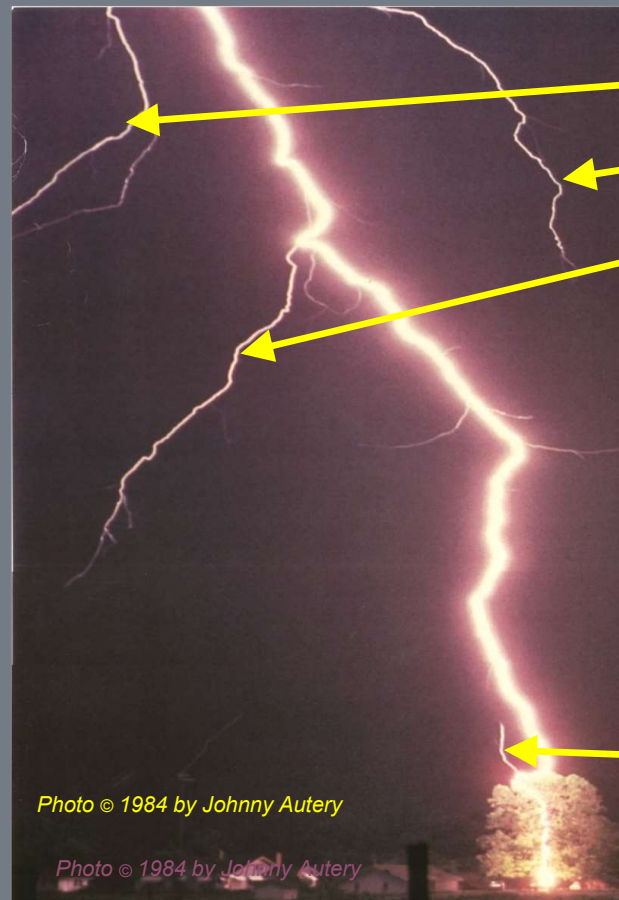
Large lightning maximum over Lake Victoria at night

Interactive GLD360 map



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

Cloud-to-ground flash



**Unsuccessful
downward
leaders**

Preferred strike points

- Tall
- Isolated
- Pointed

Upward leader

Lightning striking parking lot between poles



ACLENet, 14 December 2023

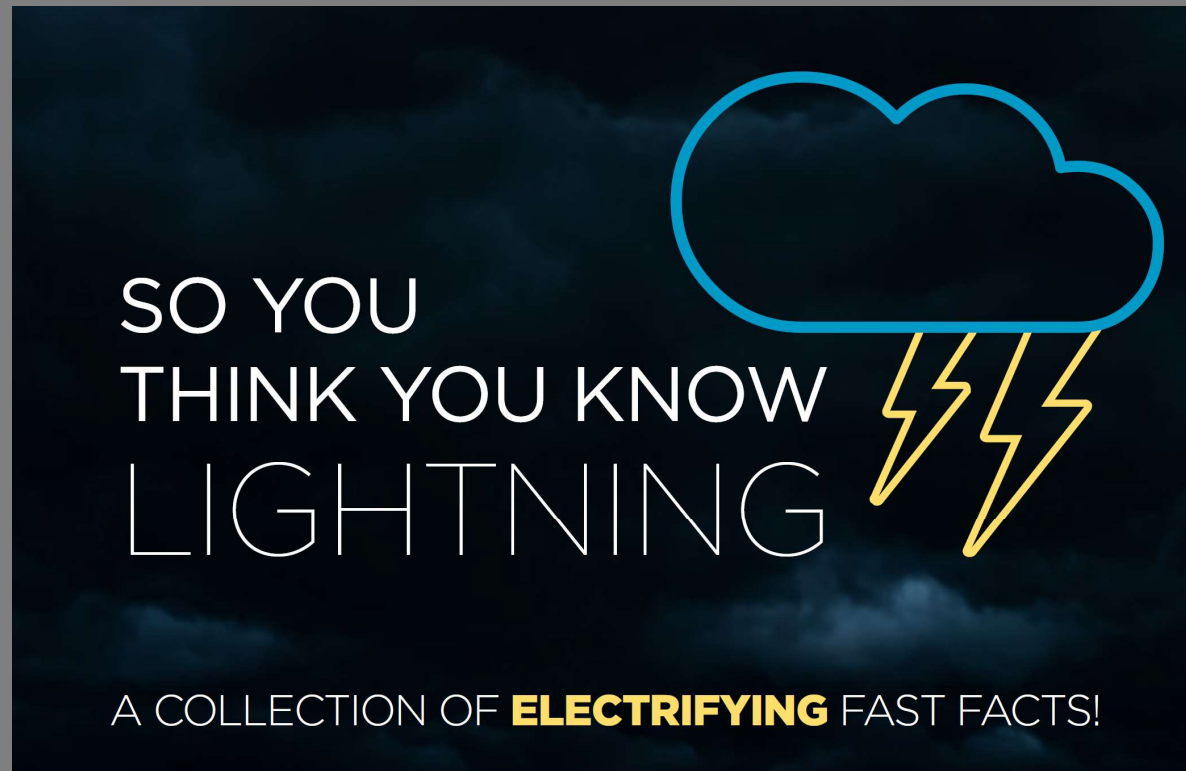
ACLENet, 11 March 2022

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>	<u>55</u>
Under trees	6
Church	4
Tending animals	4
Funeral	3
Playing	3
Soccer	3
Collecting rainwater	2
<u>Inside bar (hut)</u>	<u>2</u>
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>	<u>1</u>
	17

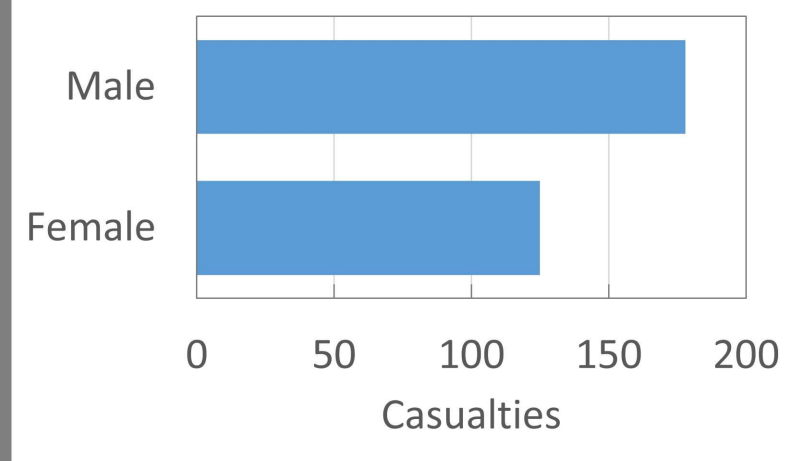
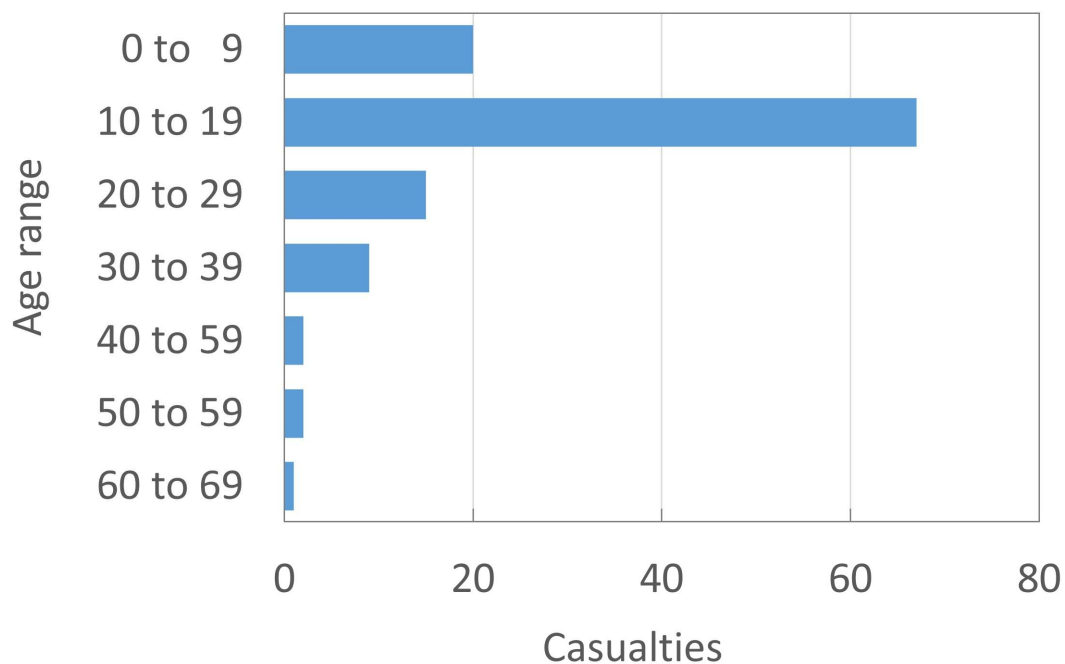
All Uganda lightning casualties, 2007-2020

- 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



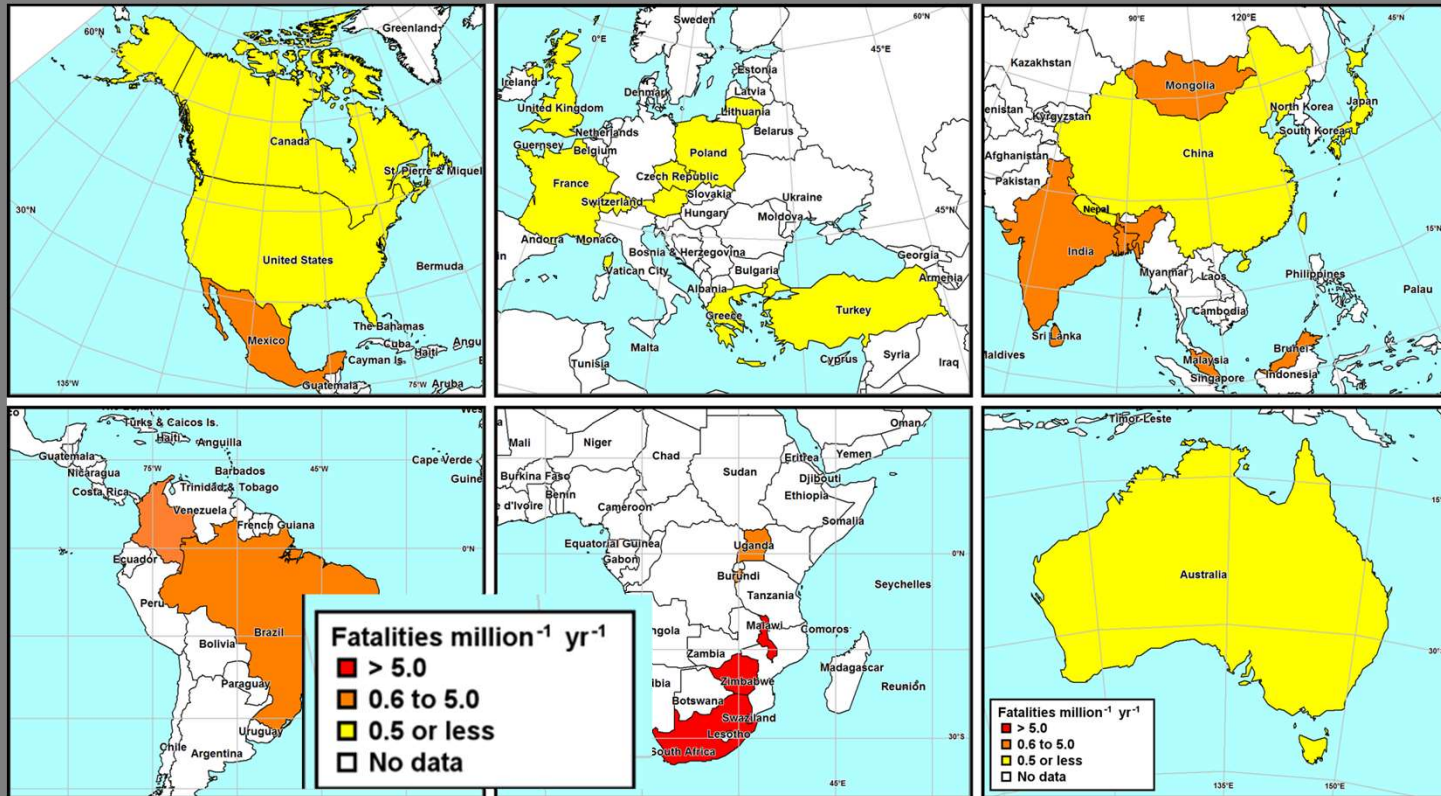
Holle, R.L., K.N. Gassert, M.A. Cooper, R. Tushemereirwe, R. Said: Lightning Occurrence and Casualties in Uganda, American Meteorological Society Annual Meeting, 2020.

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.

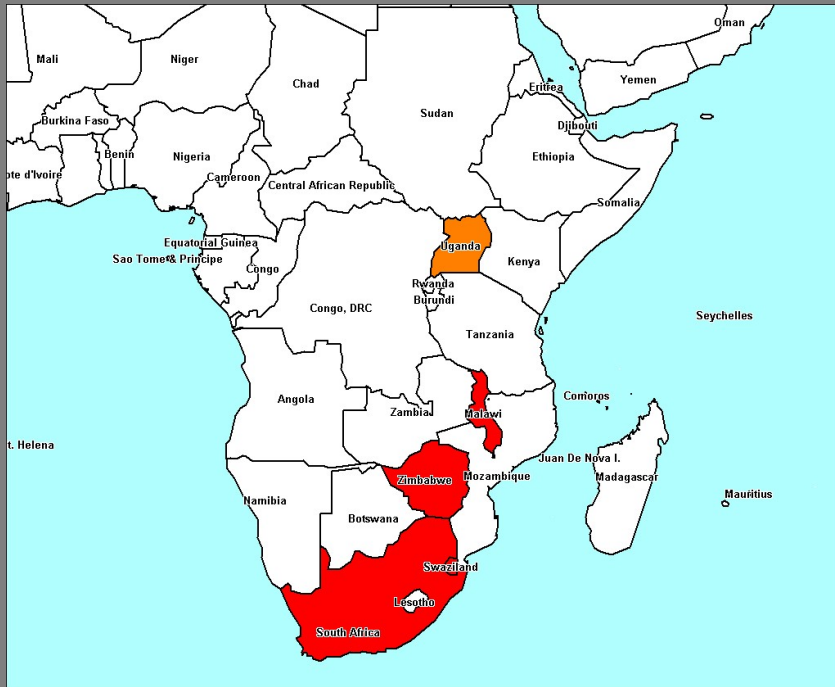
Which countries have the largest lightning death rate per population?



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

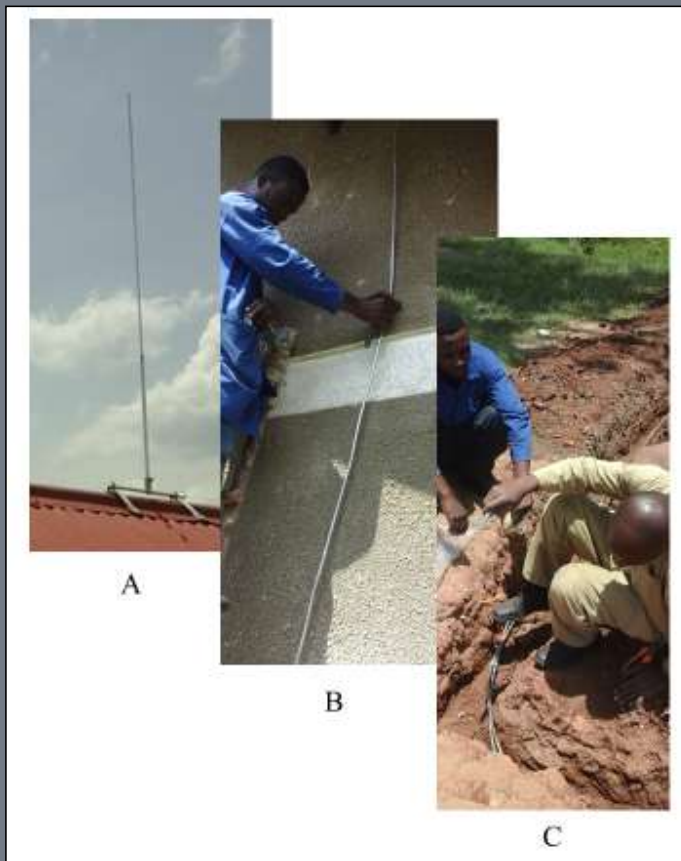
African Centres for Lightning and Electromagnetics Network (ACLENet)



<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

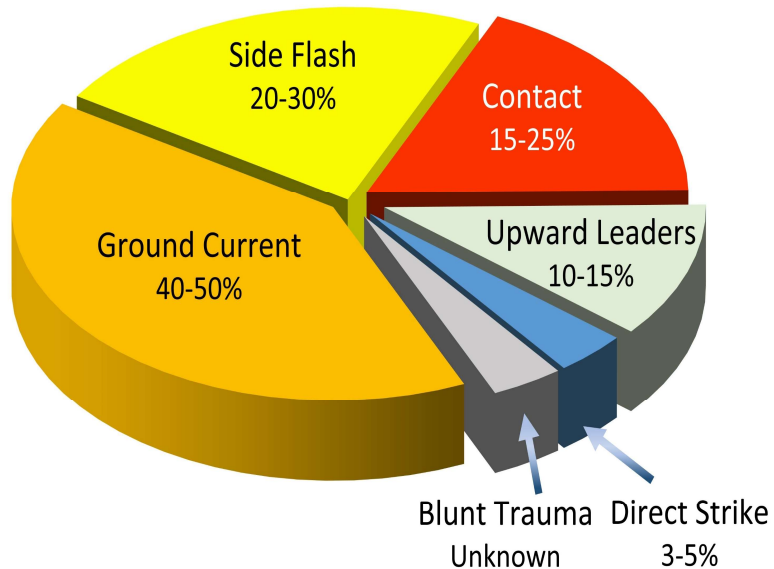


Huts-Africa



Informal Settlement-S. Africa

Mechanisms of lightning injury and death

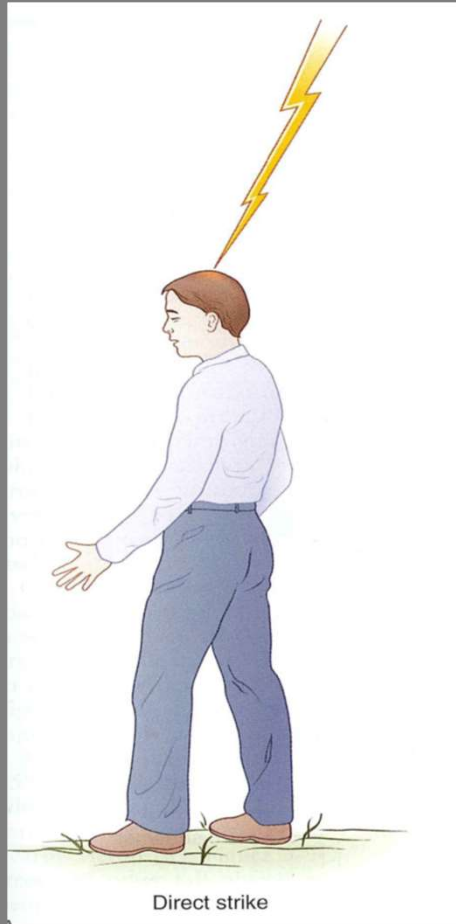


- Ground current: 40 to 50%
- Side flash: 20 to 30%
- Contact: 15 to 25%
- Direct strike: 3 to 5%
- Upward leaders: 10 to 15%
- *Blunt injury: Unknown*

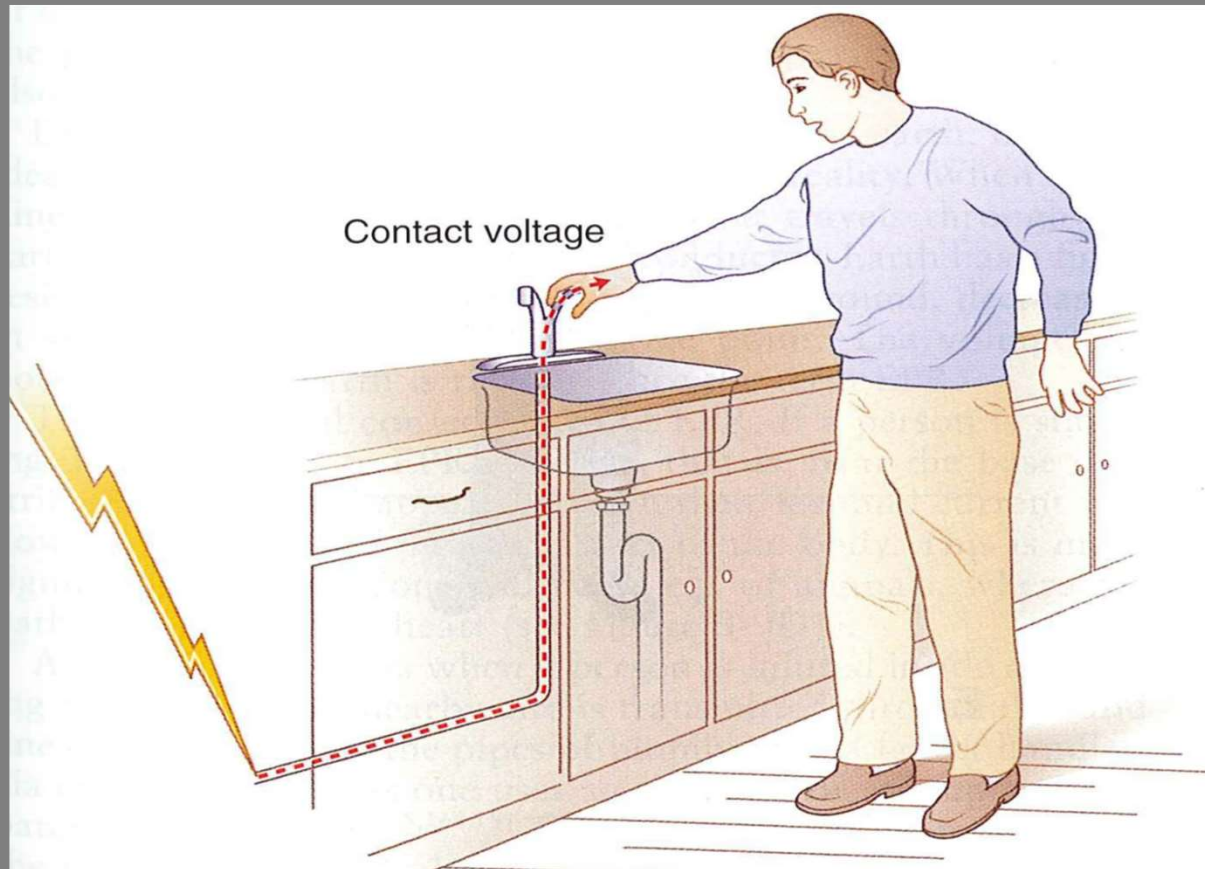
--Direct strike is a very uncommon mechanism
--Lightning safety is not about the direct strike

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

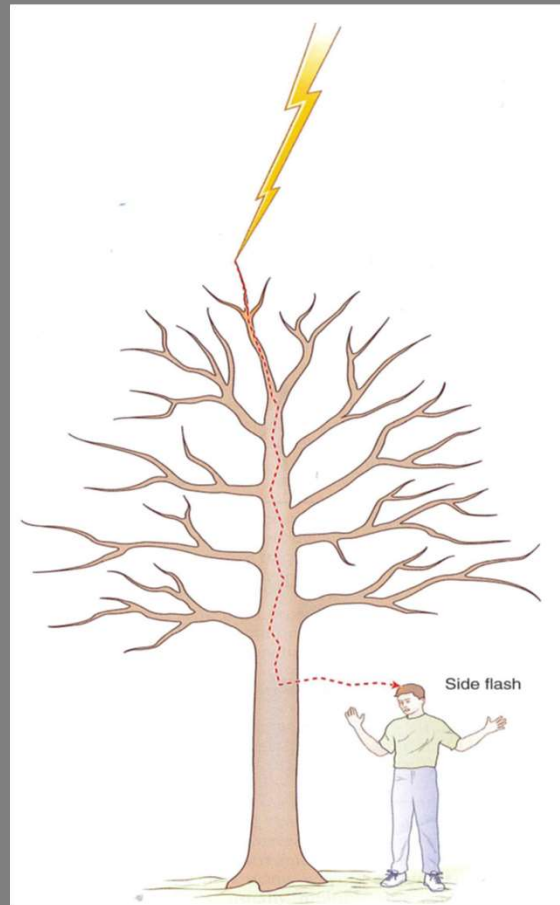
1. Direct strike...3 to 5%



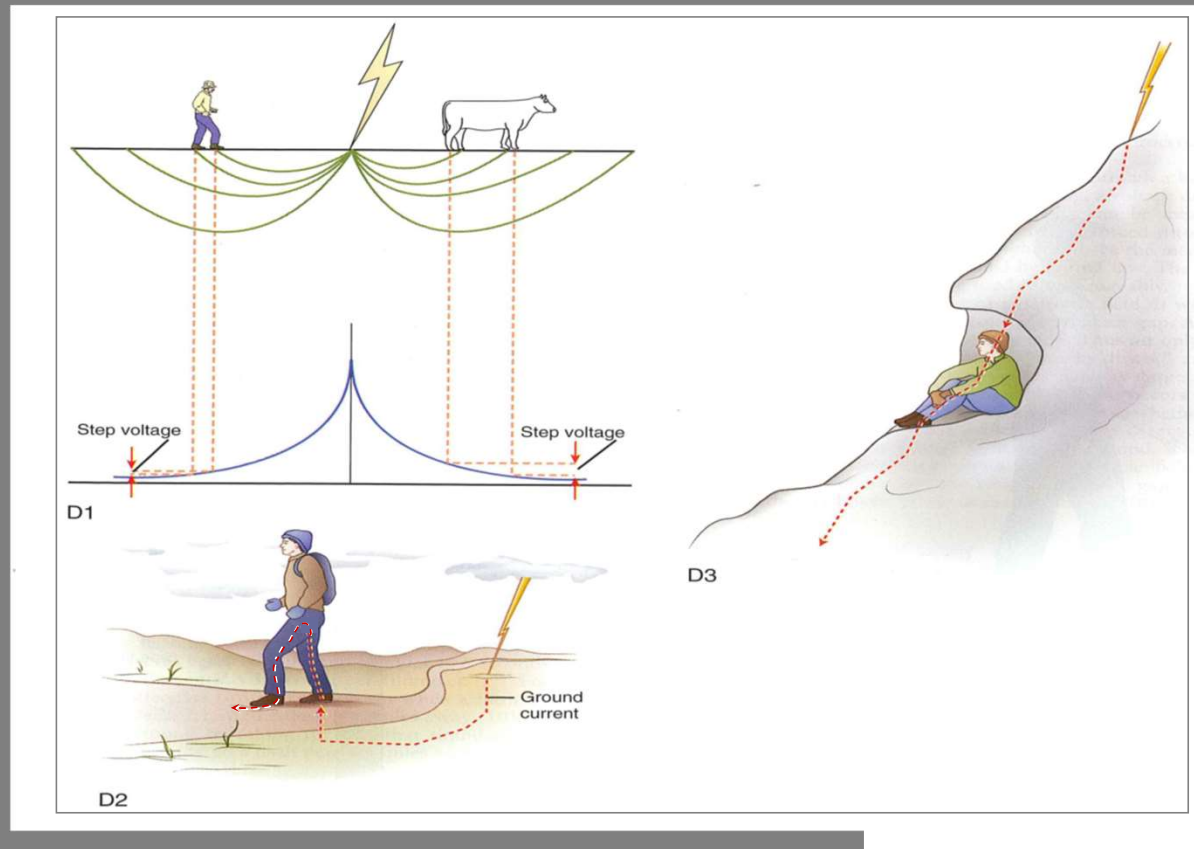
2. Contact voltage...15 to 25%



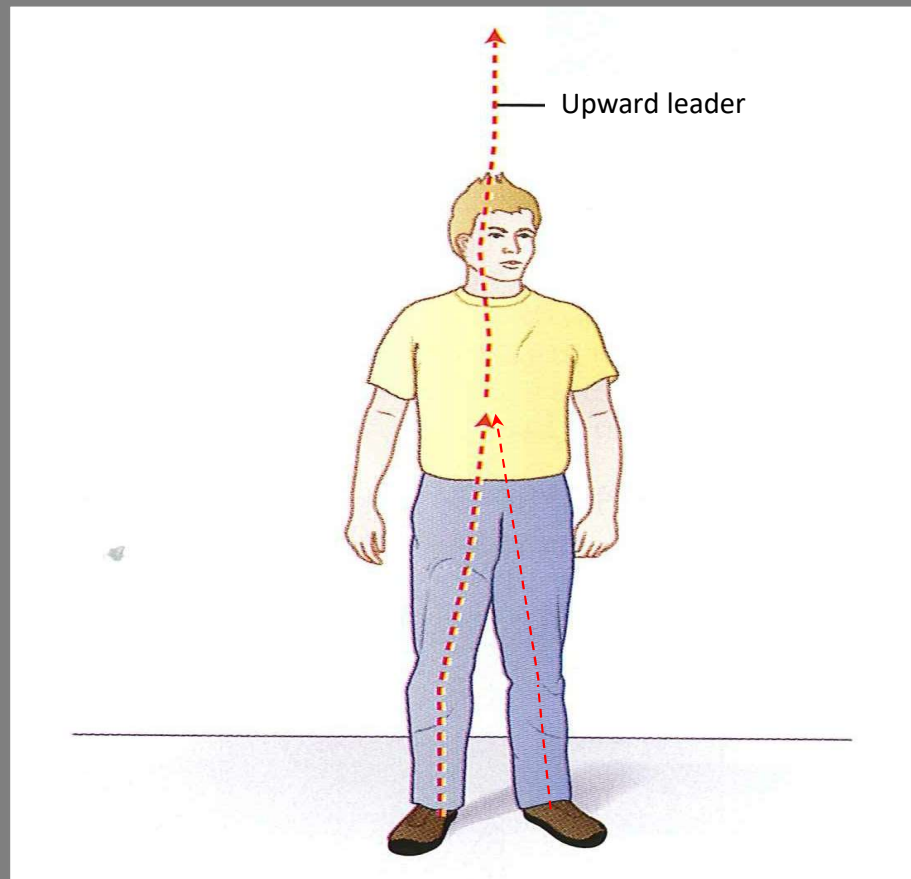
3. Side flash...20 to 30%



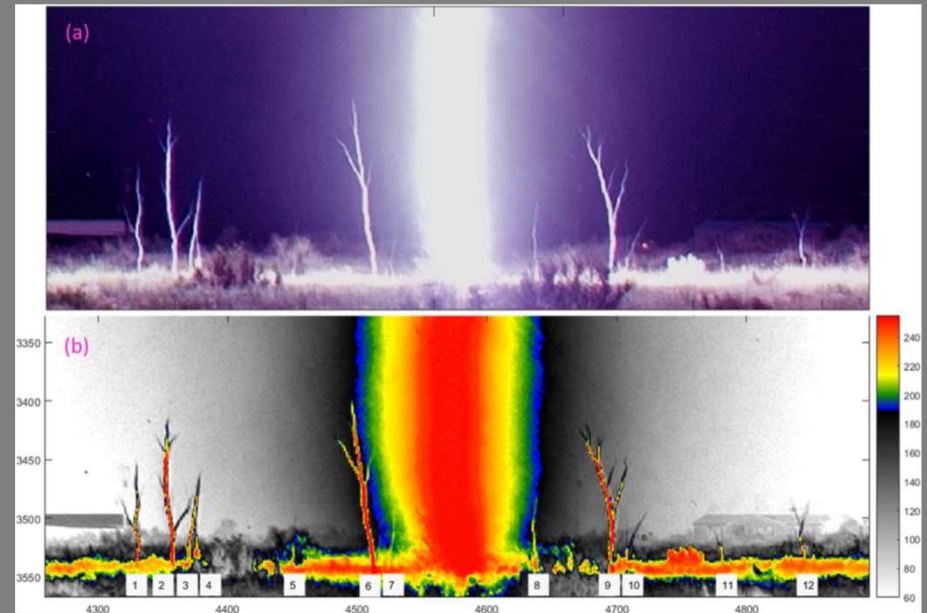
4. Ground current/step voltage...40 to 50%



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

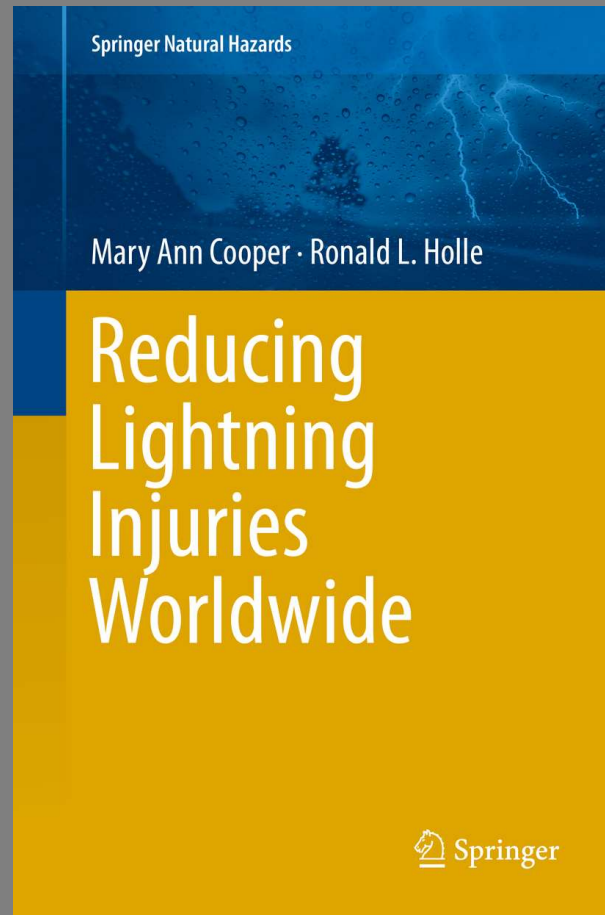
Number	Date	D of W	State	City	Age	Gender	Location	Activity	Victim
1	4-6-2023	Thursday	VA	Louisa County	73	M	Lake	Boating	Not released
2	4-15-2023	Saturday	PA	Chester County	48	M	Roadway	Driving car	Not released
3	4-16-2023	Sunday	FL	Brevard County	39	M	On water	Fishing	Peter Strong
4	5-15-2023	Monday	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/>

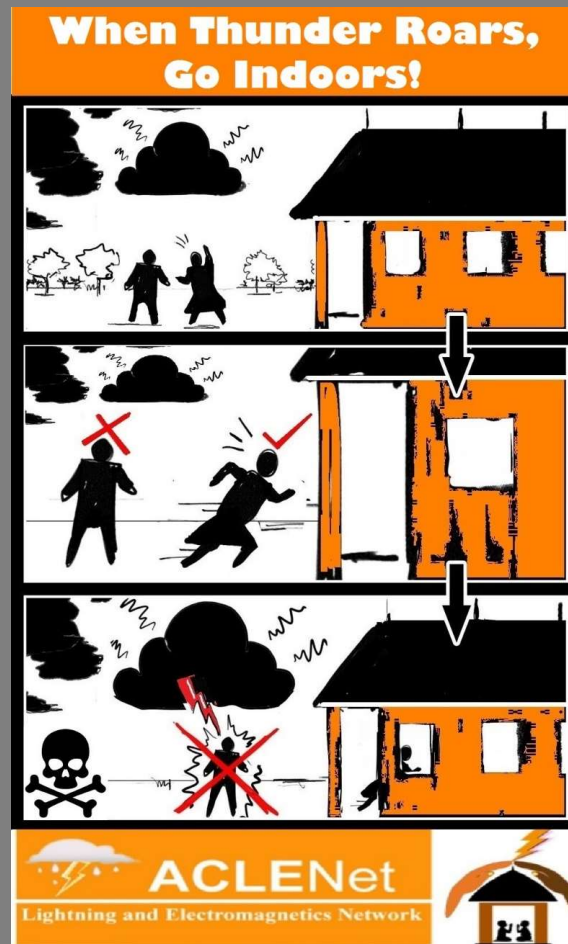
Book on lightning for developing countries



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



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

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