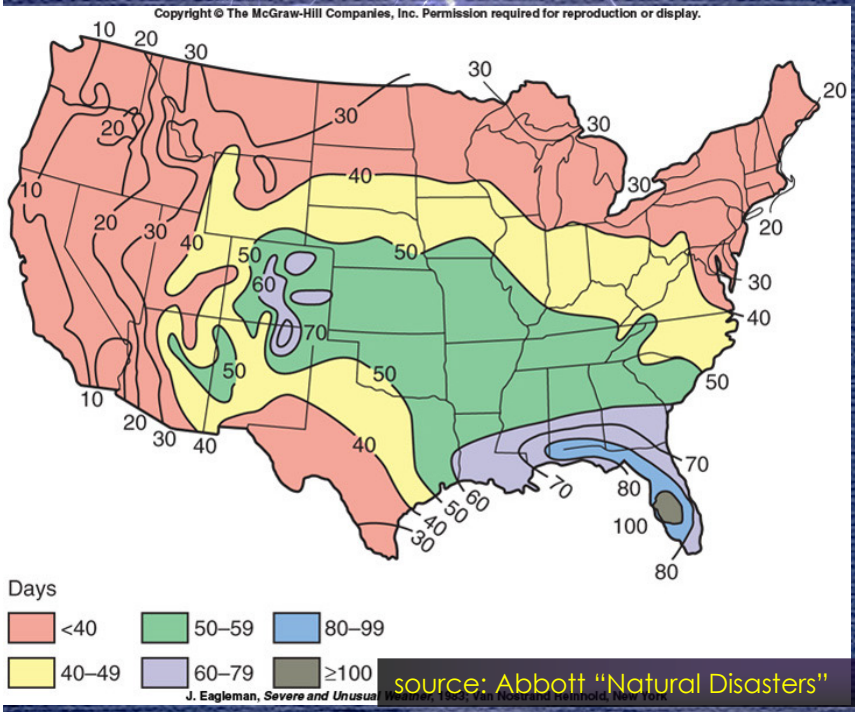
Topic 18a: Thunderstorms

http://geowiki.ucsd.edu/sio15

Thunderstorms - What causes them?

* globally: some 2000 at any given time

Fig. 14.8



source: Abbott "Natural Disasters"

* cold front meets particularly warm moist air mass (e.g. Mid-west)

* convective lifting by solar radiation in moisture rich area (tropics)

Florida

* orographic lifting (mountains)

Rocky Mountains

area with most T-storms: Florida

Thunderstorms – Why dangerous?

Strong winds
Heavy rain
Flash floods
Lightning
Some dry lightning

Some hail
Some tornadoes

source: Daily Express, UK

Thunderstorms - How Do They Form?

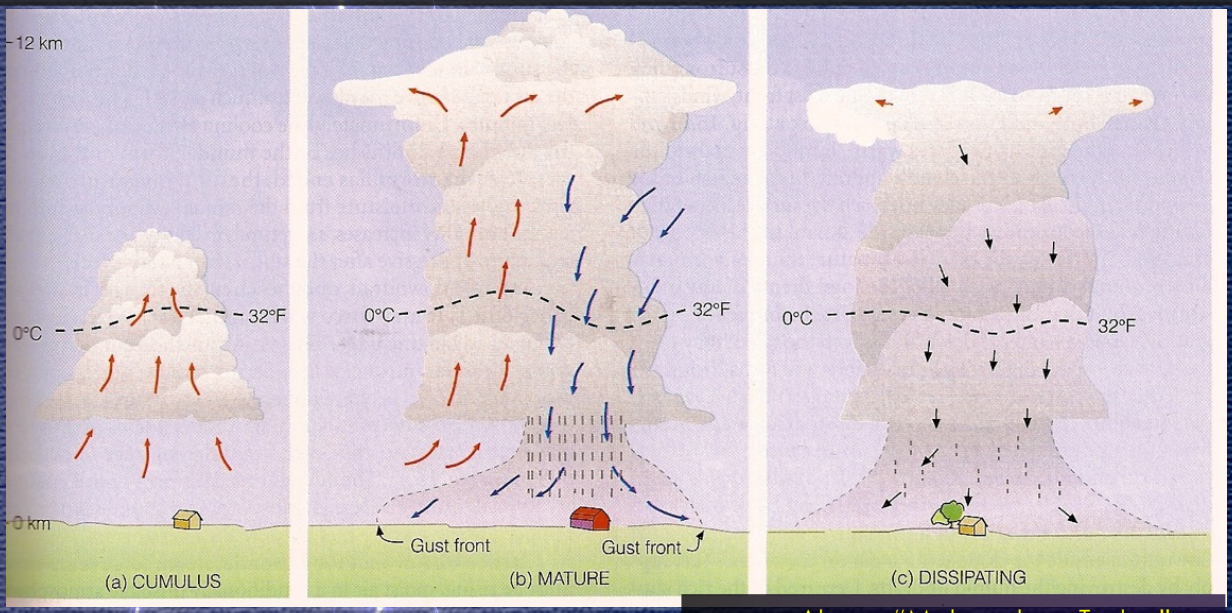


Fig. 14.9

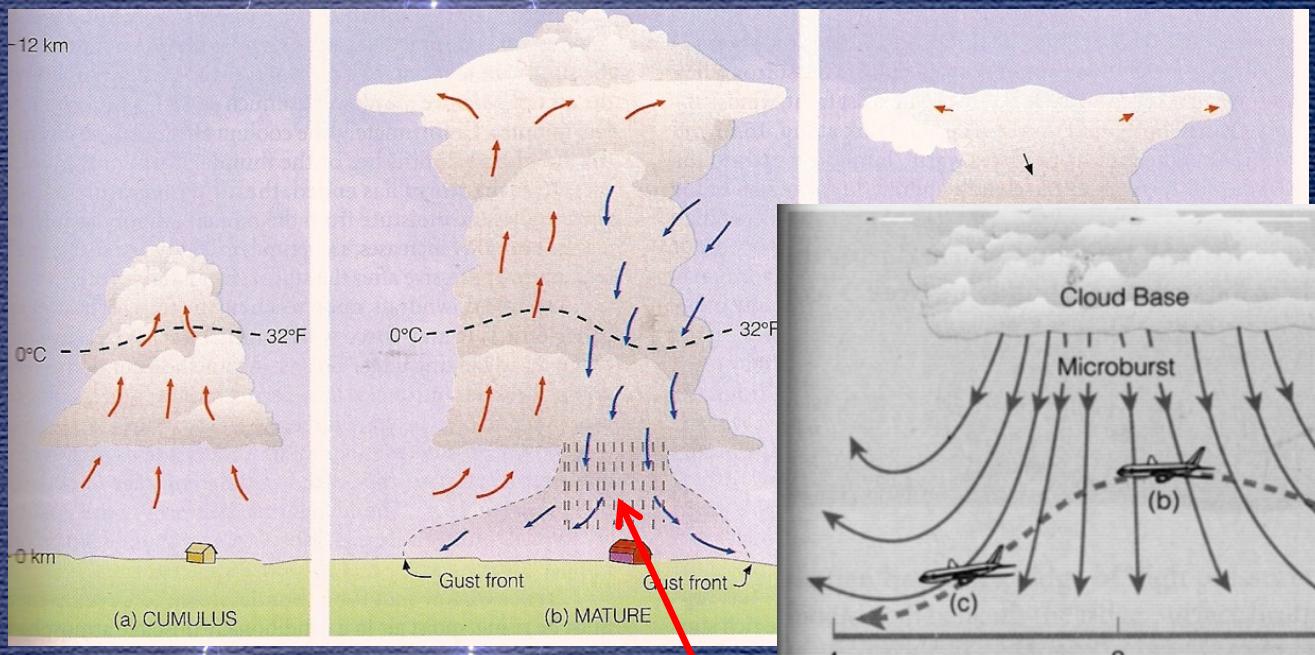
2000-4000 m

source: Ahrens "Meteorology Today"

(Local/small) STORM
- updraft -> condensation
-> release of latent heat
-> feeds more updraft
- mature state:
downdraft by rain/gust fronts
-> dissipation

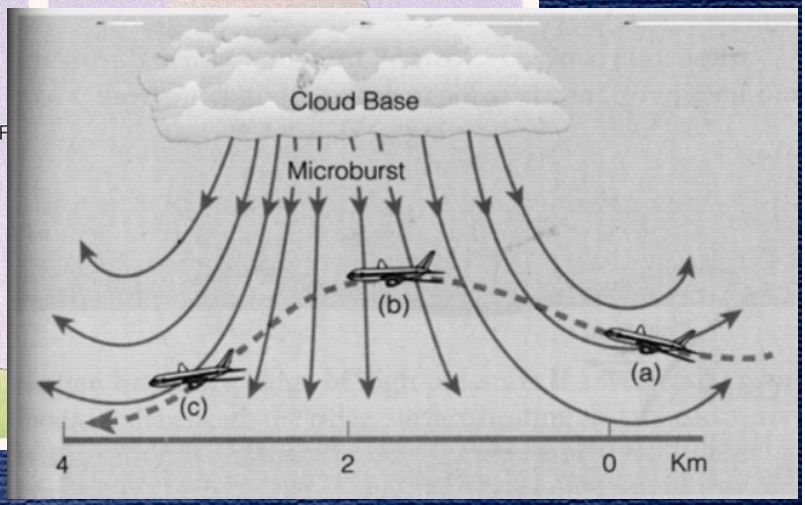
THUNDERSTORM … like storm BUT
- more energy/rapid updraft
- cloud tops reach tropopause
-> anvil
- strong updraft
-> separation of el. charges
-> lightning

Microbursts



source: Ahrens "Meteorology Today"

Fig. 14.16



- strong local downdrafts near surface
- extremely dangerous to aviation

Fig. 14.24

Lightning – U.S. Fatalities

source: NASA

global ground lightning strike:
8.6 M/day

Deaths due to severe weather in U.S.
(ave. 2012-2021, see Lecture note 1)

Heat	105
Flood	94
Tornado	49
Cold/Winter St.	67
Wind	57
Lightning	23
Hurricane	12

U.S. Lightning Fatalities

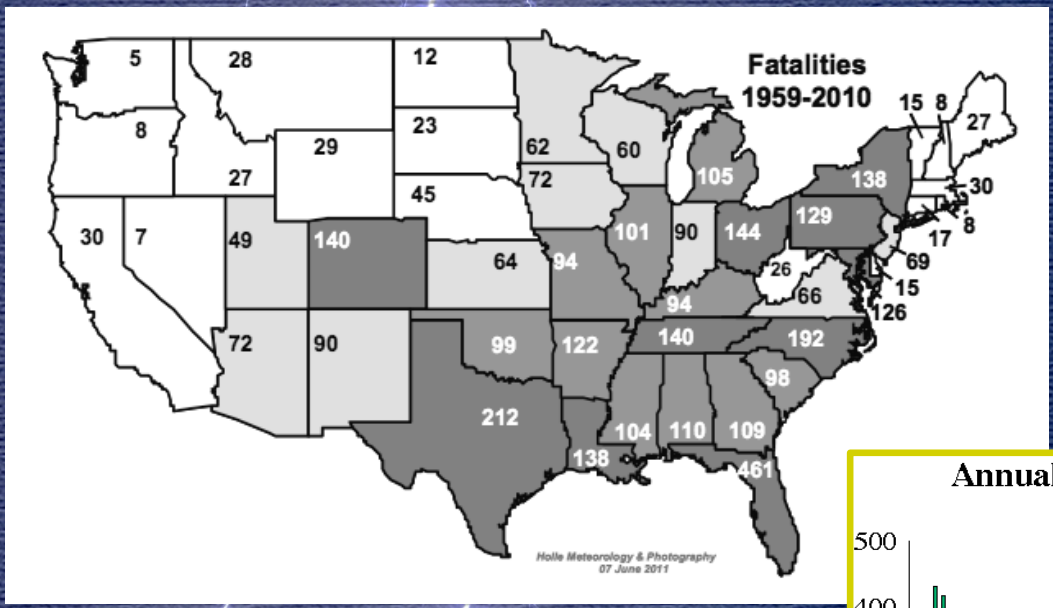
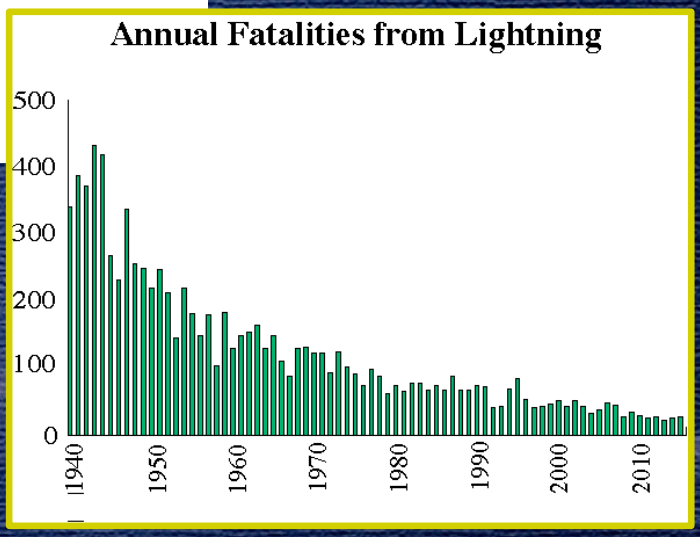


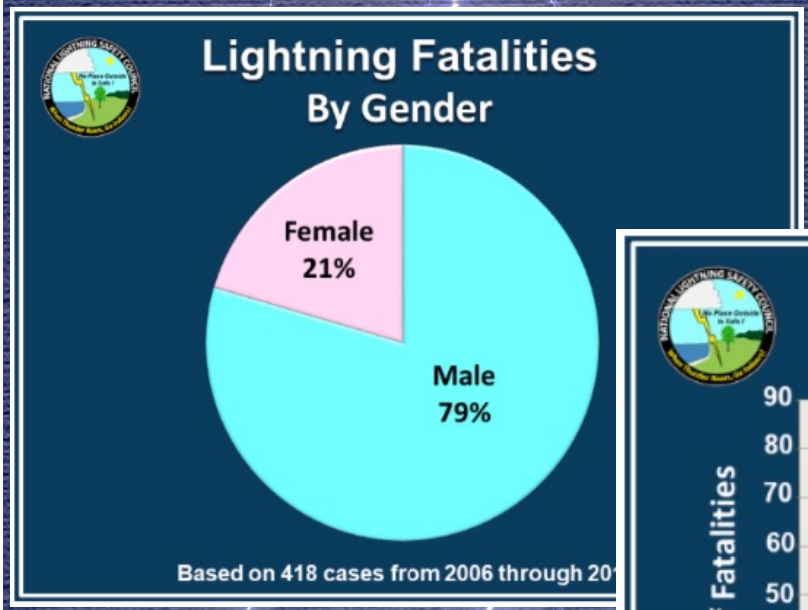
Fig. 14.25

source: NWS

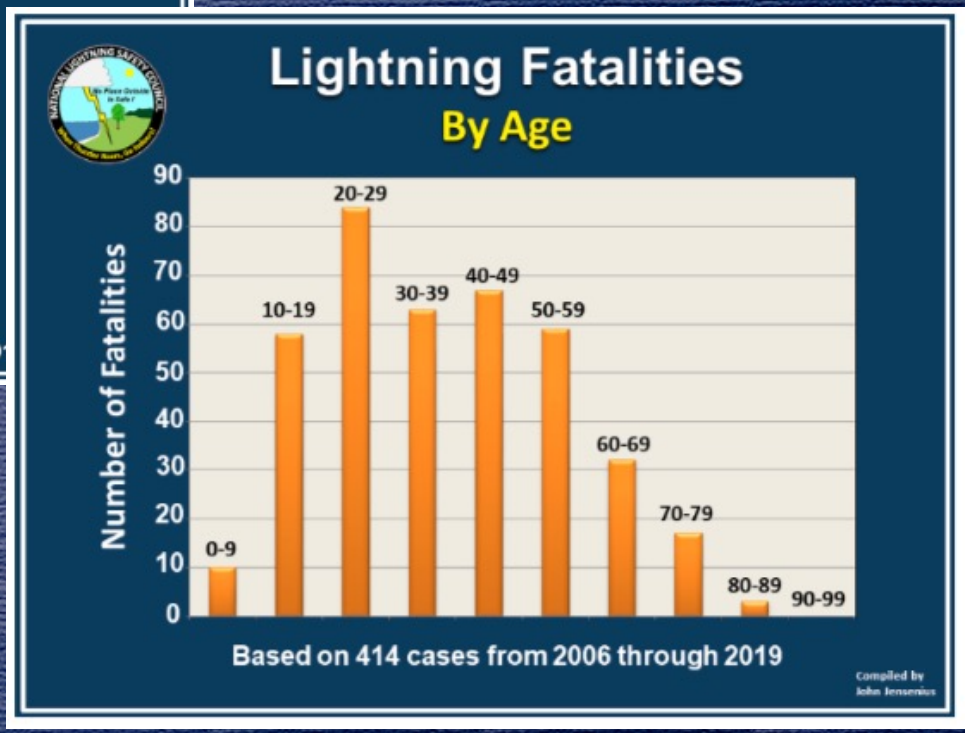


- most lightning deaths: Florida
- lecture notes 1: lightning death have declined exponentially

Lightning - Fatalities



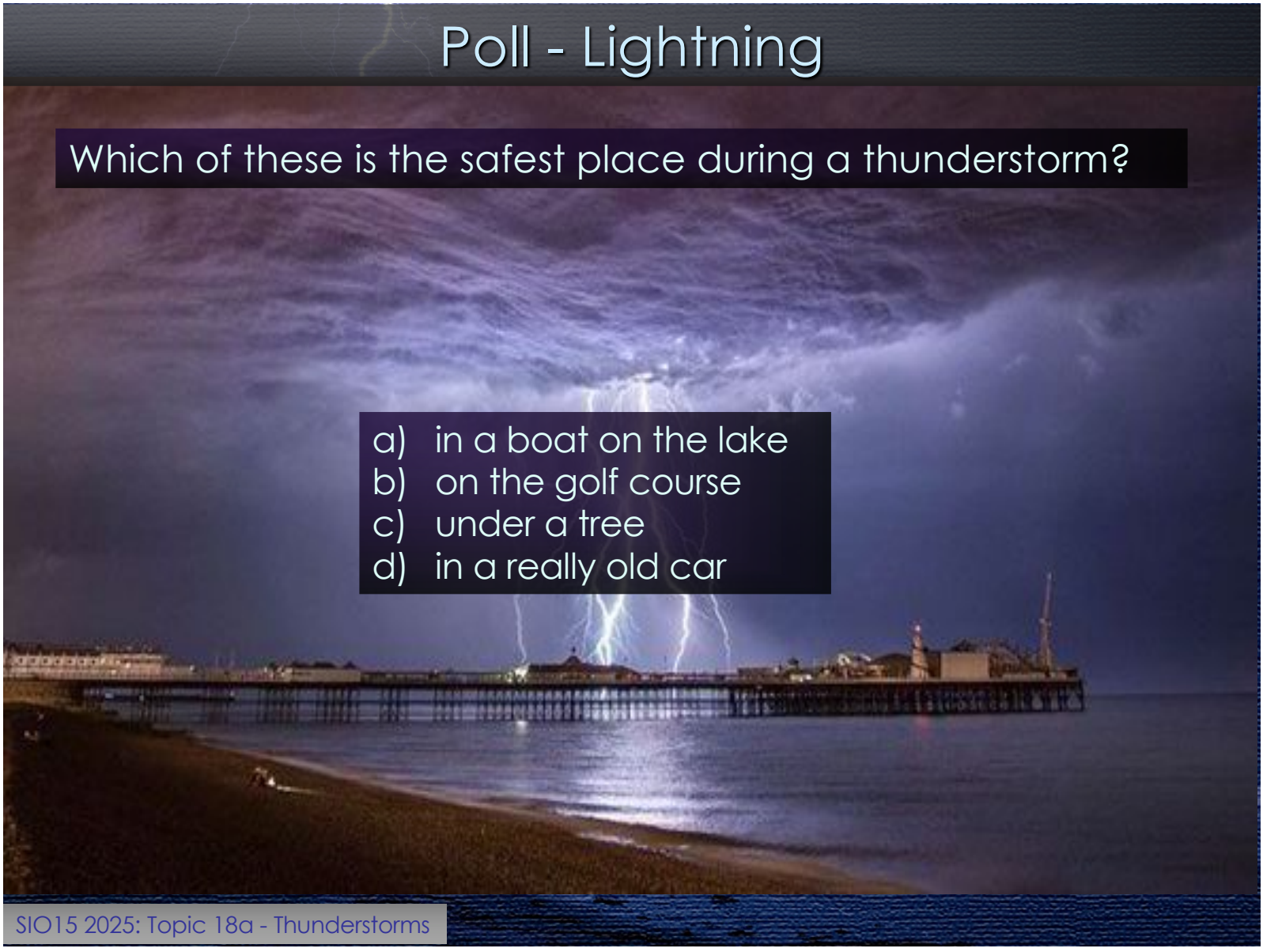
- 2006-2019: 418 in U.S.
- > 3x as many males
- young folks



https://www.weather.gov/media/safety/Analysis06-19.pdf

source: weather.gov

Poll - Lightning



Which of these is the safest place during a thunderstorm?

a) in a boat on the lake
b) on the golf course
c) under a tree
d) in a really old car

DO!

Stay in a car

Faraday cage

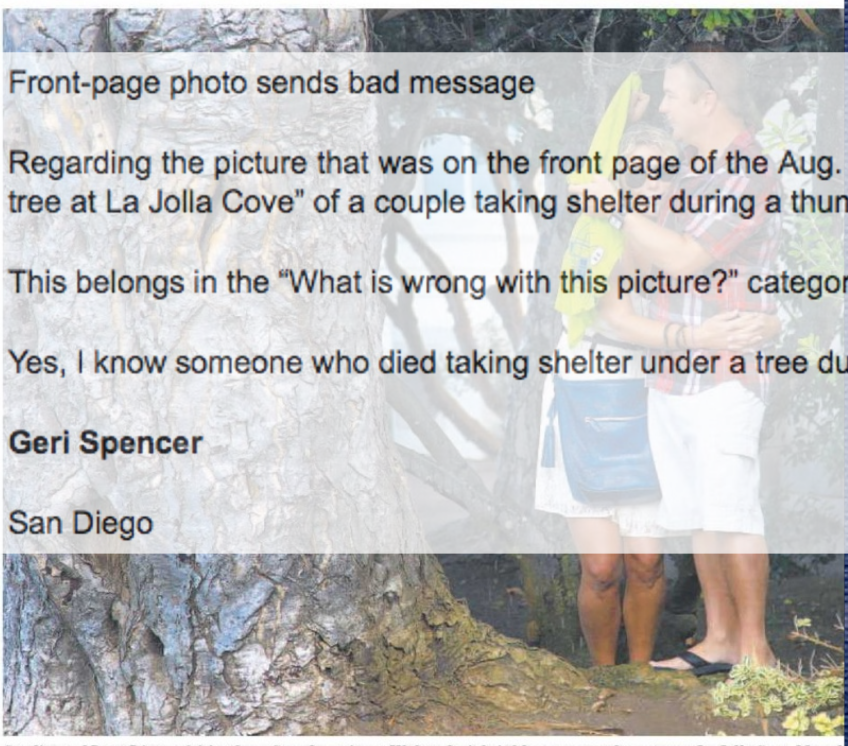
source: Ahrens "Meteorology Today"

from "Meteorology Today" (lightning struck van):
four marks where lightning struck a traveling van
3 tires flattened
slightly damaged radio antenna
driver and 6-year old to hospital, treated for shock/released

DON'T DO! seek a tree

…seriously? …

B1 SHELTER FROM THE T-STORM



Front-page photo sends bad message

Regarding the picture that was on the front page of the Aug. 21 U-T San Diego: This picture was taken "under a tree at La Jolla Cove" of a couple taking shelter during a thunderstorm.

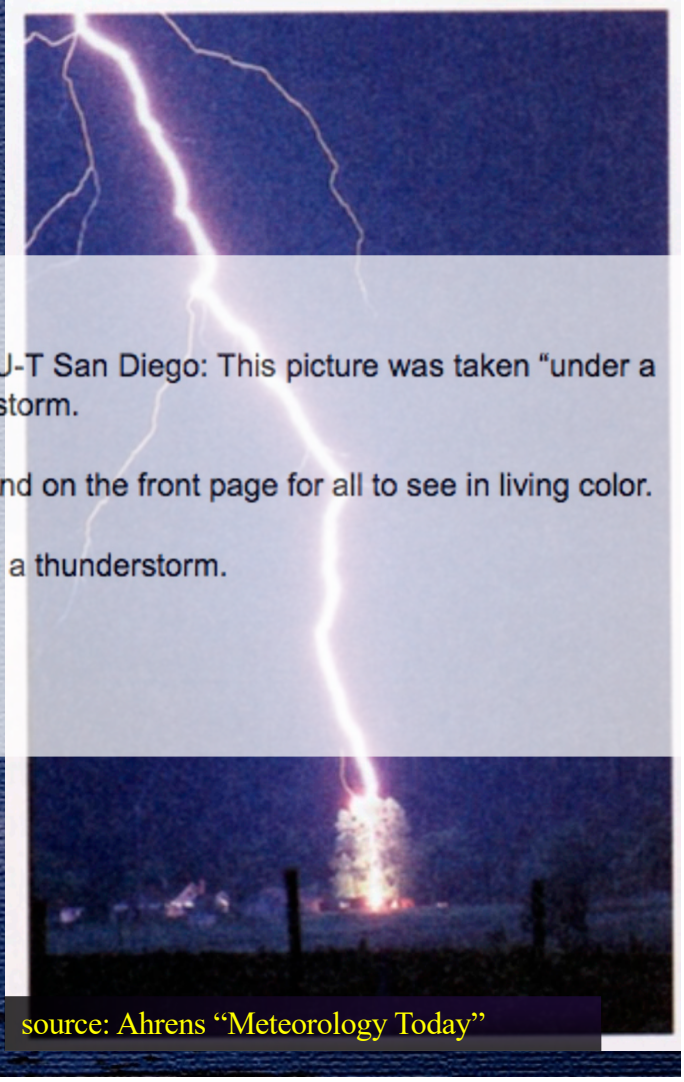
This belongs in the "What is wrong with this picture?" category. And on the front page for all to see in living color.

Yes, I know someone who died taking shelter under a tree during a thunderstorm.

Geri Spencer

San Diego

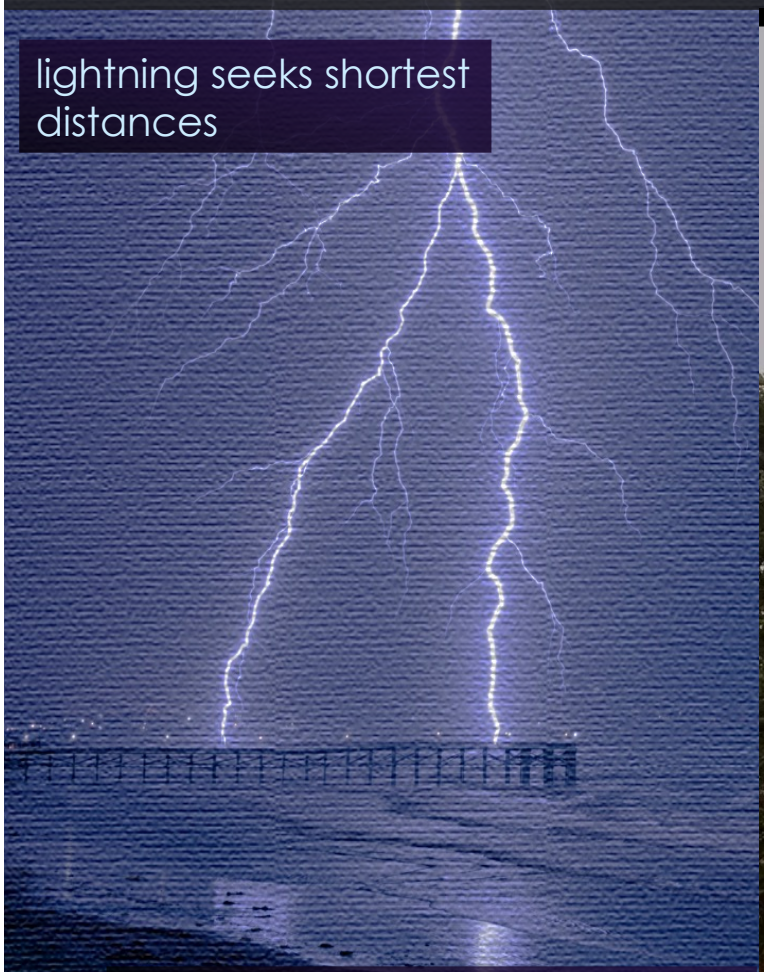
Candice and Doug Dixon, visiting from Canada, wait out Wednesday's brief downpour under a tree at La Jolla Cove. Many l beaches were closed by lightning that struck at or near the coast more than 200 times. Story, B1. HOWARD LIPIN • U-T



source: Ahrens "Meteorology Today"

DON'T DO!

seek a tree



lightning seeks shortest distances

found by SIO15 student Jason Lee 2022

Fig. 14.24

Lightning - Fatalities

source: NASA

Lightning Deaths in U.S. (1959-1994)

open fields	27%
trees	14%
boats; on water	8%
golf course	5%
tractors, road	3%
telephone poles (increasing)	2.5%
radios, transmitters	0.7%
unknown	40%

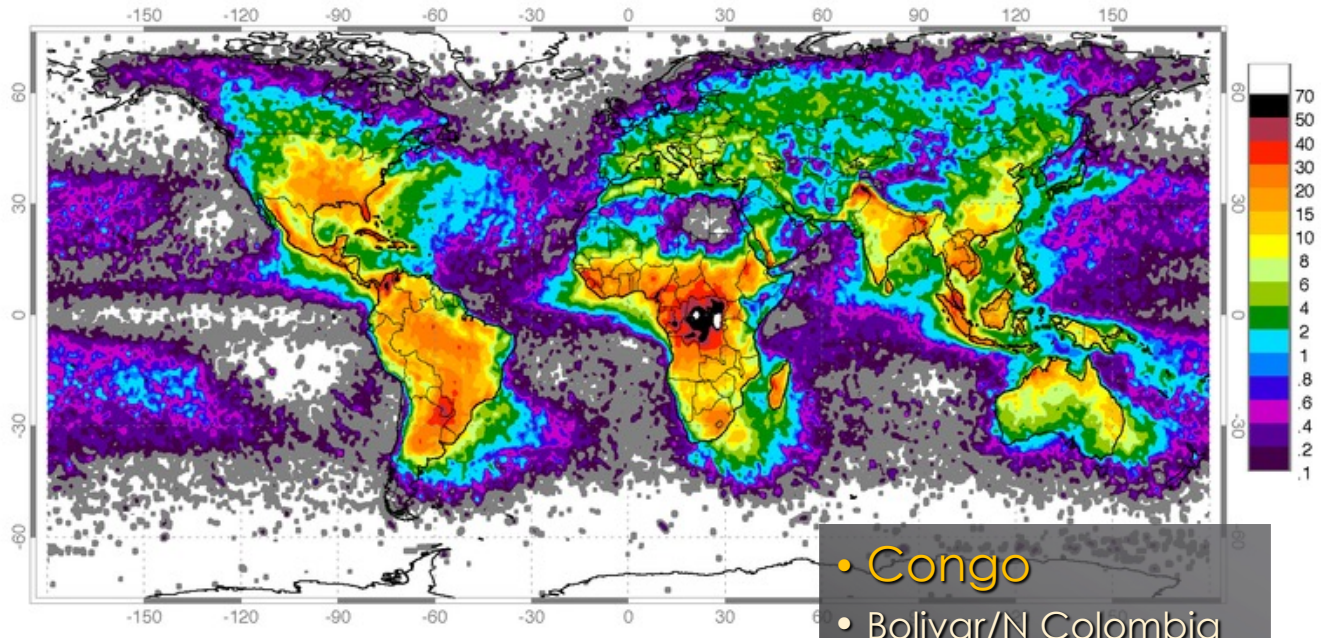
Table 14.2

don't play ball during T.S.!
do not seek a tree for cover!
stay away from water!

Lightning – World Map

find lightning in real time at lightningmaps.org

Annual Lightning Flash rate per km^2

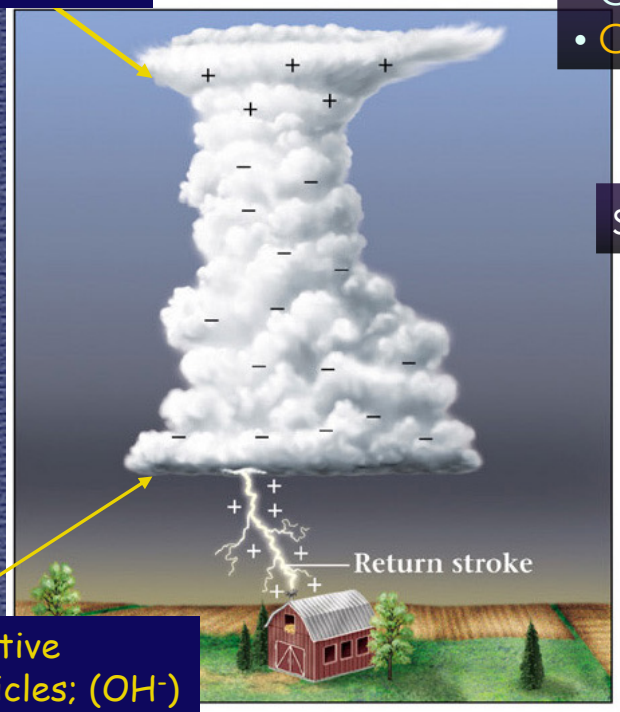


- Congo
- Bolivar/N Colombia
- Zuila/W Venezuela
- Kashmir
- …… Florida

source: wikipedia, NOAA

Lightning

positive particles;(H^+)



negative particles; (OH^-)

source: Marshak "Earth: Portrait of a Planet"

- In-cloud lightning: most frequent; no harm
- Cloud-cloud: relatively rare; no harm
- Cloud-ground: threat to life, property

strong updraft separates charges

lightning seeks shortest distance, i.e. point of highest elevation

Lightning rods: control where lightning hits and how it discharges

Lightning/rain: fires may be extinguished
dry lightning/no rain: fires not extinguished

Lightning - How Does It Work?

Fig. 14.23

positive particles;(H^+)

strong updraft causes electric charge separation

negative particles; (OH^-)

source: Marshak "Earth: Portrait of a Planet"

- separation of charges (by updraft or falling hail?)
- + charges attracted at surface
- air insulates until difference in charge too high
- discharge (lead stroke, then return stroke)
- thunder: lightning heating air around it to 30,000°C; air expands explosively

lightning vs thunder:
3s for each 1 km
(5s for each 1 mi)