EOSC114 Homework: Storms *(See footnote for an important copyright notice[1])*

Introduction

Today's **article** is Elsom, Derek M., and Jonathan DC Webb. "*Deaths and Injuries from Lightning in the UK, 1988–2012*" Weather 69, no. 8 (2014): 221–226. This article is essentially a descriptive summary of a database compiled by the authors. See UBC library: http://onlinelibrary.wiley.com/doi/10.1002/wea.2254/pdf. If you cannot access this paper, see https://services.library.ubc.ca/electronic-access/connect/

Also watch the 5-minute **Video clip** https://www.youtube.com/watch?v=7QS9Halhqgg, clipped from a longer documentary. A lucky victim (Michael) is mentioned early in the video without introduction, but his plight is considered near the end.

Learning Goals: After completing this assignment, you should expect to be able to:

1. Relate at least five specific ways of being harmed in a lightning storm to the physical behavior of lighting that is directly responsible for causing that harm.
2. Apply your new knowledge about lightning's physical behaviors to take or recommend actions that will reduce the danger to yourself or others who experience lightning storms.
3. Characterize the article in this assignment in a manner similar to previous reading assignments.

Instructions

1. You should now be familiar with our homework strategies. This one is no different, except there is also a video to watch.
2. This set of questions will have significant differences from questions in previous (and future!) terms. Recall our Code of Conduct, and UBC's academic integrity rules: http://www.calendar.ubc.ca/vancouver/?tree=3,54,111,959
3. **After** completing the worksheet, use the online submission form to transfer your results for automatic grading. REMEMBER – questions you will see are taken directly from this worksheet, and each student sees a different, random subset these questions.
4. Also recall that options to most multiple-choice questions will be RANDOMIZED on Canvas during submission. So, transfer work from the worksheet to submission form online carefully!
5. Hint: Base your answers on only the material presented in the readings and video, not on any other material from class or from the internet.

Step 1: Before reading, consider the title, introduction and a quick skimming of the article and its structure.

☐ What is most likely to be a good reason for reading this article?

- To find out how to reduce the number of lightning strikes from cloud to ground.
- To determine how we might reduce the number of forest fires caused by lightning.
- To learn more about the circumstances under which lightning can be hazardous to people.
- To learn which types of thunderstorms cause the most lightning.

☐ What overarching theme for our eosc114 course is going to be **most clearly** targeted by this paper? This is a judgement, not an opinion. The correct answer can be defended against alternatives as the most acceptable choice.

- Knowledge of underlying **physical processes** is important for understanding and anticipating hazards.
- **Predicting** hazardous events based on knowledge about the history of their timing and severity.
- Characterizing potential **consequences** to individuals, communities or property.
- **Mitigation** entails both preparatory steps aimed at minimizing the impact on people and property and having strategies for dealing with consequences after an event occurs.

☐ What is your first impression of this article and our current homework assignment? (No right answer – all choices receive zero marks, so ignore Canvas if it says "incorrect".)

- The article looks difficult and this assignment probably will be rather difficult.
- The article looks difficult but the assignment probably will be OK.
- The article should be OK but the assignment probably will be rather difficult.
- The article should be OK and the assignment probably will be OK.

Step 2: Now skim questions in this worksheet, then read the **paper** and watch the 5-minute **video** at https://www.youtube.com/watch?v=7QS9Halhqgg. Consider these points (make some notes) while viewing the video.

- In what ways are lab experiments good analogues for reality?
- In what specific ways might reality *differ* from these experiments?
- What ideas are discussed in this video *without* help from lab experiments?
- Why are those situations difficult to synthesise in the lab?
- What lessons are learned about how your risk for harm relates to how and where you stand, relative to the strike (or tree) location?

☐ Match the mechanism of lightning strikes to the type of lightning strike. *(worth 2pts)*.

a) Current flowing from ground upwards rather than from a lightning bolt downwards b) A lightning hazard coming from current flowing in the ground away from a ground-strike. c) Strike occurring not directly but as a "jump" of current from another object taking the original lightning strike. d) Lightning strikes the highest location within 3 metres e) An electrical charge from an object that held the lightning bolt's energy for short time after it was hit f) Shock resulting from touching an electrically conductive object which is carrying the lightning's current.	i. Contact voltage ii. Side flash iii. Direct strike iv. Step voltage or ground current v. Subsequent discharge vi. Upward streamer

☐ Match the lightning phenomenon to the type of injury most likely to be caused by it *(worth 2pts)*.

a) Direct strike b) Step voltage c) Flashover effect d) Direct tree strike e) Touch potential	i. Spasming leg muscles making it hard to walk for several hours. ii. Injury in the form of Lichtenburg figures. iii. Likely fatal due to major burns or damage to internal organs iv. Minor burns to the skin around the point of contact. v. Injury from explosively ejected materials.

☐ Which one of these aspects was NOT mentioned by authors of this article?

- Whether victims were indoors or outdoors.
- Nature of the injuries.
- Whether victims were harmed in the times before, during or after the peak of the storm.
- Mechanisms that actually caused injury.
- Locations of fatal or potentially fatal incidents (eg near tree, sports ground, mountaintop, etc…)

☐ Which phenomenon does the video suggest may have allowed Michael to survive what appeared to be a direct lightning strike while he was playing golf?

- He was standing in just the right orientation so his feet were at an "equal potential" instead of across the flow of current.
- He may have experienced a "flashover effect" in which current flowed through clothing or the skin's surface rather than through his body.

- His golf club acted as a lightning rod, so the direct strike was attracted to the golf club, which allowed the current to flow directly into the ground without flowing through Michael.
- He may have experienced a "side flash", so the current total current of the lightning bolt had been split into several pathways before he experienced it.
- Current may have flowed from his body into his golf club and then into the ground instead of through is entire body into the ground.

☐ Which one of the following phenomena was described in the article but NOT mentioned in the video? It is an alternative possible explanation for why Michael survived.

- He may have experienced a "flashover effect" in which current flowed through clothing or the skin's surface rather than through his body.
- Current may have flowed from his body into his golf club and then into the ground instead of through is entire body into the ground.
- He was standing in just the right orientation so his feet were at an "equal potential" instead of across the flow of current.
- His golf club acted as a lightning rod, so lightning struck it and flowed into the ground instead of affecting him.
- He may have experienced a "side flash", so the current total current of the lightning bolt had been split into several pathways before he experienced it.

☐ From the article, what reason is suggested for the significantly higher proportion of outside incidents involving males rather than females?

- Young males are more likely to engage in risk-taking activities.
- More men than women were engaged in outdoors work or recreation activities.
- Women are more likely to take appropriate preventative action.
- There was no explanation for this gender imbalance.

☐ What general conclusion can most reasonably be drawn from the decline in incidents for the period 1988-2012 compared to 1865-1980?

- Storms in the UK are generating less and less lightning in recent years
- There are a greater number of "high" objects to act as lightning rods in more recent years.
- Effective public education and the increasing awareness of authorities is resulting in more sensible behaviour and better decisions about sporting, work or leisure activities in the presence of storms.
- Medical treatment practices for dealing with lightning incidents have improved.
- Fewer people live in rural areas.

☐ Which single error in judgement is most likely to result in serious injury when in a lighting-inducing storm?

- Being on a mountain, hilltop or other high point of ground
- Rushing to the nearest building for shelter
- Getting into a car or vehicle for shelter
- Sheltering near or under a tree
- Standing with feet apart facing the storm as it moves towards you.

Step 3: Applying lessons learned to specific situations

For all questions in this section, assume you are under a thunderstorm that has lots of cloud-to-ground lightning, and that you are standing outside.

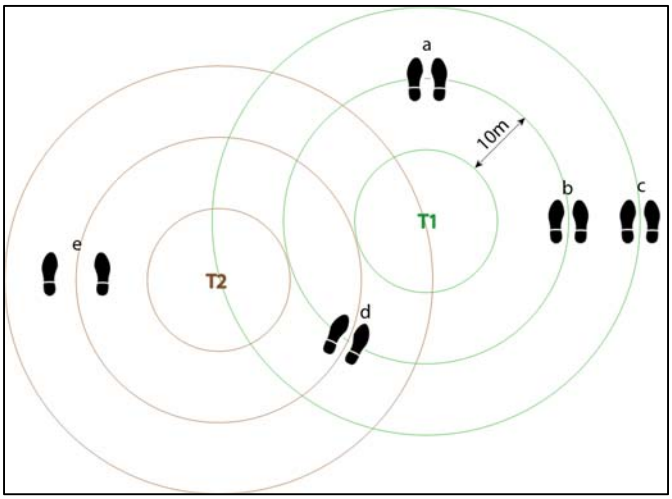
☐ Which of these distances (in meters) from a tree is the **largest that might still result in experiencing** potential effects of currents flowing in the ground?

• 4 • 9 • 14 • 19 • 24 • 29 • 34 • 39 • 44

☐ Staying the recommended distance away from an isolated tree is important mainly because …

- It is consistent with the minimum height of a tree that would be a good "lightning rod".
- It will help avoid pieces of exploding tree if its sap is suddenly vaporised
- When a tree gets struck, ground currents flowing away from it will mostly have dissipated by this distance
- That would place you further than the distance a potential side flash could cover
- subsequent discharge effects need to be avoided
- upward streamers may emerge as a result of ground currents.

Now consider this diagram of trees (T1, and T2) where the centers of the circles each represent a tree trunk. For each question, select from options provided to complete the sentence:

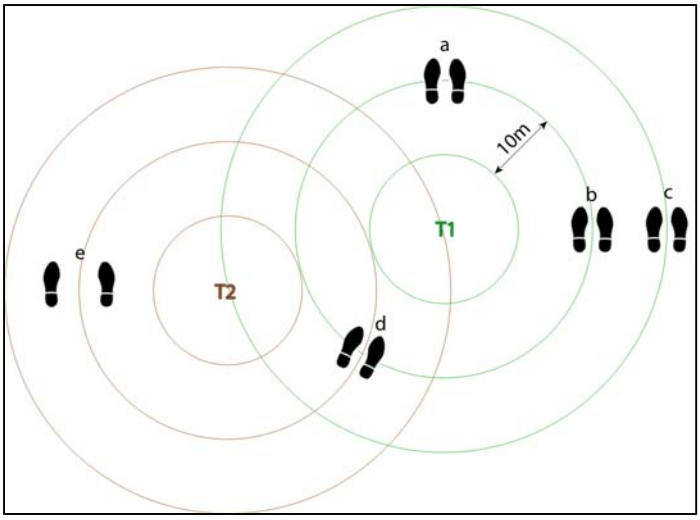


☐ Consider locations "b" and "c". If lightning strikes tree T1, location [b or c] (select one) would be **more** dangerous location because …

- it is further from the tree than the alternative
- it is closer to the tree than the alternative
- feet are oriented so as to result in a higher voltage across them compared to the alternative
- feet are oriented so as to result in a lower voltage across them compared to the alternative
- foot spacing is wider than the alternative
- foot spacing is narrower than the alternative.

☐ If you are standing at location d, lightning striking tree [T1 or T2] (select one) would be **less** dangerous than lightning striking the other tree because …

- it is further from the tree than the alternative
- it is closer to the tree than the alternative
- feet are oriented so as to result in a higher voltage across them compared to the alternative
- feet are oriented so as to result in a lower voltage across them compared to the alternative
- foot spacing is wider than the alternative
- foot spacing is narrower than the alternative.



☐ Consider locations “d” and “e”. If lightning strikes tree T2, location [d or e] (select one) would be **more** dangerous of the two because

- it is further from the tree than the alternative
- it is closer to the tree than the alternative
- feet are oriented so as to result in a higher voltage across them compared to the alternative
- feet are oriented so as to result in a lower voltage across them compared to the alternative
- foot spacing is wider than the alternative
- foot spacing is narrower than the alternative.

☐ This photo shows Main Mall at UBC looking north, with the Beaty Biodiversity Museum (the whale skeleton) on the right, and the Earth Science Building (ESB) behind trees on the left. If there was a thunderstorm overhead, where is the safest location? Rank these locations as 1=LEAST preferable to 4=MOST preferable:

- ____ Where the two people are walking (right side of the image)
- ____ Centre of the grassy middle of the mall
- ____ Inside ESB or the Beaty Museum
- ____ Where the one person is walking (left side)

Step 4: Assumptions and limitations

Assumptions and limitations are an important part of any scientific argument. Also, data available are unavoidably somewhat incomplete. This is not a "problem", especially given the extensive efforts put into gathering the complete database, but it is worth recognizing some assumptions and limitations that could affect conclusions or decisions that may be based on these data.

☐ This database is built from reported incidents. It yields an average of 29 people per year experiencing a lightning incident between 1988 and 2012 in the UK. This is most likely to be …

- roughly the correct average number of all people who actually experienced a lightning incident of any kind each year.
- somewhat MORE than the true average number of all people who actually experienced a lightning incident of any kind each year.
- somewhat LESS than the true average number of all people who actually experienced a lightning incident of any kind each year.
- impossible to say how this value compares to reality.

☐ If you are in a forest or a park with several trees around you during a thunderstorm, you would not know which tree would be struck. Which of the following statements is TRUE:

- You cannot anticipate the best direction (orientation) to face.
- Your safest action is to lie on the ground.
- You can enhance your safety by spreading your feet from each other**.**

Step 5: Characterize the article

☐ Our article's main purpose is to present new previously unpublished methods, knowledge or content, presented directly by those responsible for discovering it: **True / False**

☐ The central message of our paper is constructed mainly by gathering work done from pre-existing literature and/or other sources: **True / False**

☐ Or reading is mainly targeting a general non-scientific audience: **True / False**

☐ The content in our reading is presented in non-technical manner, **without** presenting a complete "chain of evidence" in the form of references and citations: **True / False**

☐ This article is published in a "peer reviewed journal": **True / False** (HINT: if you aren't reasonably sure one way or the other, check "Author Guidelines" at the RMetS Weather website, via https://rmets.onlinelibrary.wiley.com/journal/14778696#pane-01cbe741-499a-4611-874e-1061f1f4679e01

☐ Which one of these options **most** accurately characterizes the **main purpose** of this article?

- A commentary or report aimed at making recommendations about priorities, policy, or decision making
- Social commentary
- Sensationalism to rally the public behind a cause
- Communication to experts in the subject, about new scientific methods, procedures or discoveries
- A report written to address the needs of a client or other third party who may have asked for the report.
- A communication about science written to inform non-specialists and enhance their safety

What **writing strategies** were used in this article? (On Canvas watch carefully to ensure you are answering each question correctly - they may be offered in a different order.)

☐ Assertions and arguments were supported by evidence based on observations, measurements, experiments or data gathered by scientists other than the author(s); **True / False**.

☐ Assertions and arguments were supported by evidence based on scientific observations, measurements, experiments or data gathered by the author(s); **True / False**.

☐ Narrative or personal stories were incorporated into the article; **True / False**.
☐ The author(s) targeted human emotion as part of their writing strategies; **True / False**.
☐ Descriptions of "aesthetic" aspects like scenes, views and impressions were included; **True / False**.
☐ The author(s) identified at least some uncertainties, incomplete aspects or needs for further work; **T / F**.

Next we consider various forms or types of 'claims'.

☐ The claim: *"The average annual number of deaths for the period 1988–2012 in the UK was around half that of the period from the 1960s to 1980s"* could most reasonably be described as … ____

i) an hypothesis or explanation suggesting *'what', 'why*' or '*how*' that should ideally be tested by experiment or observation;
ii) an observation or something measured, recorded or "noticed";
iii) a value based on calculations using parameters and assumptions that could be varied to yield a range of values
iv) an 'understanding', conclusion or theory derived from a variety of observations and/or experiments and logical inferences.

☐ The claim: *"lightning victims can experience long-term health consequences"* could most reasonably be described as … ____

☐ The claim: *"From 1988 to 2012 an average of 29 people were estimated to have experienced an electrical shock due to lightning per annum"* could most reasonably be described as … ____

☐ The claim: *"Intense magnetic fields may induce large, short-lived electric currents in a body causing the heart to stop. "* could most reasonably be described as … ____

☐ This article about lightning has a somewhat different purpose compared to other articles we encounter. It can be most accurately characterized as a piece of writing that …

- … uses scientific understandings to inform and convince readers of a particular perspective on a subject.
- … basically describes and/or explains a set of known or collected facts; there is little being "argued" in the writing.
- … provides rigorous explanations and argumentation in support of a new discovery or understanding.
- … articulates answers to a question posed by authors, clients or some other person or organization.
- … aims to explain some fundamental theoretical concepts to the readers.

Data used as part of any scientific or engineering study can be acquired in several ways. If you are uncertain, consider who provided or obtained the information, how it was obtained, and the "quality" of the data.

☐ What kind of data are dates of events obtained from historical records?

i) measured with instruments of some sort (may include calculations)
ii) observed – i.e. seen or noticed, not measured with instruments.
iii) Simulated or modelled.
iv) gathered – i.e. needing to be collected from people, archives, etc.
v) not really a reliable form of data.

☐ What kind of data are lengths of side-flash arcs obtained from high-speed photographs during lab experiments? ____

☐ What kind of data does this statement represent: "*Tiny, circular, full-thickness burns were evident on the sides of the soles of the feet and tips of the toes on many of the patients"* ____

☐ What kind of data are circles on the ground depicted in the video? ____