**ACTIVITY: Viewing and monitoring lightning**

**Activity idea**

In this activity, students view a short video on lightning phenomena and then answer a set of questions based on the video. They will then log on to WWLLN (which stands for the world wide lightning location network) and view recent lightning activity in the South Pacific region around New Zealand.

By the end of this activity, students should be able to:

* describe in simple terms how an atmospheric cloud-to-ground lightning discharge occurs
* explain the meaning of the terms ‘stepped leader’, ‘streamer’ and ‘sferic’
* give a brief outline of the operation of WWLLN (the world wide lightning location network)
* demonstrate familiarity with safety suggestions for people exposed to thunderstorms.

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**Introduction/background**

Lightning is a large-scale natural spark discharge that occurs within the atmosphere or between the atmosphere and the Earth’s surface. On discharge, a highly electrically conductive plasma channel is created within the air, and when current flows within this channel, it rapidly heats the air up to about 25 000°C. The lightning channel is an example of terrestrial plasma in action.

A worldwide lightning location network (WWLLN pronounced ‘woollen’) was founded in New Zealand in 2003. Working with the collaboration of scientists from around the world, the network plots lightning discharge locations seconds after they occur.

Around the world, there are about 45 lightning flashes per second. Apart from generating the characteristic blue-white light, radio wave pulses known as sferics are also produced. The frequent crackles heard when tuned into an AM radio station during a thunderstorm are sferics from the lightning discharges.

These sferics are registered at the 60 WWLLN receiving stations around the world and provide a near real-time information dataset. This information is made available to scientists via a high-speed internet connection provided by REANNZ (Research and Education Advanced Network New Zealand).

**What you need**

* Copies of the student handout [Looking at lightning](#handout)
* Internet access

**What to do**

1. Hand out copies of the student handout [Looking at lightning](#handout) and have students complete it.
2. Discuss the results.

**Student handout: Looking at lightning**

1. Watch the YouTube video clip ‘Discovery Channel Lightning phenomena’, which is about 5 minutes long. <https://www.youtube.com/watch?v=sKNgqPQIwnU>
2. Answer the following questions:

* 1. What is a favourite target of lightning?
	2. What could one of the consequences be to a person sheltering close to a tree if that tree was struck by lightning?
	3. Describe what is meant by the term ‘stepped leader’.
	4. When a stepped leader is 10–100 m from the ground, describe what can happen next.
	5. During a cloud-to-ground lightning discharge, what is it that moves up from the ground to the cloud? At the same time, what is it that moves down from the cloud to the ground?
	6. In household electrical power outlets, the maximum current available is 10 A. How does this compare with the electric current generated in a typical cloud-to-ground lightning discharge?
	7. At about 3 minutes in, there is an image of a direct lightning strike on a large tree. Describe some of the effects this tree is likely to have suffered as a consequence of this strike.
	8. The highly electrically conductive plasma channel produced develops temperatures in the region of 25 000°C. This causes the air around it to expand explosively. What effect does this rapidly expanding air produce? Is this effect harmful?
1. Log on to <http://wwlln.net/>, click on the far right Google Earth overlay (for the South Pacific-New Zealand region) and use the ‘zoom in’ function on your computer to view the lightning strikes (blue dots) for 1 hour of data ending 6 hours ago. The red dots indicate the location of the WWLLN receivers. New Zealand has one receiver situated in Dunedin. Note the lightning activity in the Tasman Sea and compare this with the activity in the tropical region to the north of Australia.
2. Scroll down the WWLLN webpage and click on the ‘WWLLN Daily Average Density’ map. Apart from the equatorial region, note the Australia/New Zealand regions showing the greatest activity.
3. Focus on the New Zealand region and try to relate activity recorded there to recent weather patterns. For example, if there was a low-pressure system in the Tasman Sea, there could well be lightning activity associated with it.
4. View the video clip [How WWLLN began](https://www.sciencelearn.org.nz/videos/93-how-wwlln-began) that features Associate Professor Craig Rodger talking about the origins of the WWLLN.
5. Answer the following questions:
	1. From the information you have accessed on the <http://wwlln.net/> website, how does the lightning activity in the Tasman Sea compare with that of Northern Australia. If the activity differs markedly, can you suggest a reason why?
	2. On the Google Earth overlay, the red dots indicate the location of the WWLLN receivers. How many receivers are there in the Australia/New Zealand region? How many receivers worldwide?
	3. A lightning strike releases huge amounts of energy. Apart from generating the characteristic blue-white light, radio wave pulses known as sferics are also produced. The frequent crackles heard when tuned in to an AM radio station during a thunderstorm are sferics from the lightning discharges. In order to pinpoint the actual location of the lightning strike, how many WWLLN sensors are needed to pick up the sferic produced?
	4. Who leads the WWLLN management team?
	5. Describe briefly the origins of the WWLLN.

**Looking at lightning – answers**

1. What is a favourite target of lightning?

*Anything that stands high above the ground. Trees are a favourite target.*
2. What could one of the consequences be to a person sheltering close to a tree if that tree was struck by lightning?

*When lightning hits a tree, it runs through the tree sap, instantly vaporising it. A strip of bark can explode outwards at lethal speeds. If a person is sheltering under such a tree, they could be severely injured by the exploding bark as well as being electrocuted by the very large current flowing through the tree to ground.*
3. Describe what is meant by the term ‘stepped leader’.

*When the charge build-up in the cloud reaches a critical level, an initial spurt of electrons moves outward. This stream pools for a very short time period and then moves off in a different direction. Often the stream branches and splits. It is this that is called the ‘stepped leader’.*
4. When a stepped leader is 10–100 m from the ground, describe what can happen next.

*As the stepped leader gets close to the ground, its electric field exerts a pull on the ground. Under this influence, objects on the ground send up weakly luminous plasma streamers.*
5. During a cloud-to-ground lightning discharge, what is it that moves up from the ground to the cloud? At the same time, what is it that moves down from the cloud to the ground?

*The electrons drain to earth in a blinding flash of light. The part of the channel closest to Earth drains first and then the next section and so on until the charge in the cloud drains, so the visible lightning bolt moves up from the ground to the cloud and massive electric currents flow down.*
6. In household electrical power outlets, the maximum current available is 10 A. How does this compare with the electric current generated in a typical cloud-to-ground lightning discharge?

*10 A of household electric current is miniscule compared to the 30 kA of current in a lightning bolt. However, household current can be ‘turned on’ for long time periods, whereas the lightning discharge has an average duration of about 50 microseconds.*
7. At about 3 minutes in, there is an image of a direct lightning strike on a large tree. Describe some of the effects this tree is likely to have suffered as a consequence of this strike.

*See answer to b above.*
8. The highly electrically conductive plasma channel produced develops temperatures in the region of 25 000°C. This causes the air around it to expand explosively. What effect does
this rapidly expanding air produce? Is this effect harmful?

*The rapidly expanding air results in our experience of thunder. Thunder, although frightening to some people, is not damaging provided the observer is a safe distance from the lightning strike.*