Met Office

# Leader pack

## Sessions 1-3

What is temperature? What is wind?
What are clouds?
Measuring the weather

VIRTUAL

Science Camp 2021

# Thank you for joining us for the first Virtual Science Camp 2021!

Since 2013 we have welcomed over 1,500 young people to Met Office HQ for our Science Camps. However, due to the pandemic, our plans had to change, so we have chosen to run Science Camp 2021 virtually. This is an exciting opportunity to reach a wider audience with our exciting and interactive content.

To get the most out of this content, we thought we would provide you with a handbook that gives a bit of background to the video sessions, alongside instructions on how to recreate some of the activities or ideas for extension activities.

Every three weeks we will release three videos on topics relating to weather and climate. There will be pauses within these videos for discussion, experiments, activities, and lots of opportunities for the students to engage with the session.

Making our material accessible to all is important to our Education Outreach programme, so we have included suggestions and guidance below to help make sure our sessions are accessible to a wide audience. We have focused on keeping the sessions as interactive as possible and designed activities around equipment that is easy to find around your home or place of study. We have also tried to minimise the use of printed resources to reduce our impact on the planet.

Below you will find everything you need to get started for each session, this will include session aims, resources you might need as well as suggested activities to carry on exploring the topic beyond the sessions. You might want to make sure you have your camera ready to capture this amazing experience that we hope the students will love!

And don't forget, as we go along you can submit your questions to us via Twitter **@metofficelearn** or email us **science.camp@metoffice.gov.uk**. Our final session on 26 November will be LIVE and you will be able to interact with our panel of experts in different roles from around the Met Office.

If you have any further questions, please contact us at **science.camp@metoffice.gov.uk** or look on our dedicated Science Camp 2021 page **Met Office Virtual Science Camp - Met Office**.

Feel free to tag us in any posts you wish to make us aware of on our Twitter feed **@metofficelearn** using the hashtag #MOSciCamp.

### Before you start the sessions

We have provided a link to an "**Introduction to the Met Office**" video to get the students engaged and excited for their learning over the next few weeks. You might want to show this video in your own time before you start Virtual Science Camp 2021.

# Session 1

## What is temperature?
## What is wind?


### Aims of session 1

- Explain the physics behind what temperature is in terms of molecular activity.
- Describe methods of measuring temperature.
- Explain why temperature forecasts are essential using sheep chill example.
- Understand the molecular origins of pressure and why areas of high pressure will move into areas of low pressure.
- Learn how to read a pressure chart.
- Explain how we measure wind speed and make home-made anemometers.
- Describe the effects of the wind.

### What is temperature? – Summary

In this part of the session, we will be discussing temperature and explaining the predicament that Farmer Forth and her sheep found themselves in and how the Met Office can help her keep her sheep safe. This is demonstrated through a hands-on activity you might want to do too with your students (guidance is below). You will also explore 'what is temperature', so be prepared to challenge the answer 'how hot or cold something is' as we want to encourage students to link temperature to how much energy a substance has. We also very briefly touch on how you measure temperature, but you can check out these links for more detailed background information:

- **https://www.metoffice.gov.uk/weather/guides/observations/how-we-measure-temperature**
- **https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/guides/10_0230_fs_17_observations.pdf**

## Word Bank

**Atom** – a single particle of a chemical element, found in the periodic table. It consists of a nucleus surrounded by electrons.

**Molecule** – a group of atoms held together by chemical bonds, this is the smallest unit a pure substance can be divided into while retaining it's chemical properties.

**Infrared radiation** – Invisible radiation with wavelengths just longer than red visible light but shorter than microwaves and radio waves (700-1500 nanometres). Infrared light is used for thermal imaging, but also to change the channel on your TV!

**Satellites** (more on this in session 3) – Anything that orbits the earth! Specifically, earth imaging satellites take pictures of the earth so that we can see cloud/temperature/wind information across a big area. This helps us to check that the forecast is going as expected over the UK, but if lots of satellite "pictures" are put together in a sequence, they can help us track weather systems that are heading our way which may affect us in the coming days.

**Weather** – Daily or even hourly variations in temperature, wind, cloud cover and precipitation (rain/snow/hail etc).

## Guidence for experiments and activities in session

**Resources you will need during session:**

- 2 cuddly gloves per group, or cuddly toys as long as no one minds getting them damp
- Spray bottle or glass of water containing room temperature water (not cold water!)
- 1 piece of card (roughly A5) for creating wind
- Paper towels (just in case!)
- A thermometer (like the kind you would point at someone's forehead to read their temperature, optional!)

After pausing the video, give each group two dry "sheep", a spray bottle/glass of water and the wind card. The demonstrators in the video will explain the experiment, but you might want to take a short moment to make sure your students understand what the group is expected to be doing. If you do have any kind of thermometer available, take this around the class and measure some temperatures of the "sheep" in their different states. Emphasise to the class that you need one of the "sheep" to stay dry!

## What is wind? - Summary

In this session we will be discussing the question “what is wind?” and the demonstrator will lead an experiment with ping pong balls as air molecules in a box (air parcel). The participants should clap every time they see the marbles collide with each other or the sides of the tray. This experiment is likely to be noisy!

Feel free to mute and watch the demonstrator with subtitles if you prefer, alternatives to clapping could be a finger tap or standing up/raising a hand for a quieter classroom option.

### Word bank

**Anemometer** – an instrument used to measure wind speed.

**Coriolis (extension)** – The Corolis Effect, or Coriolis Force, is an apparent force which affects an object that is moving over something rotating. As the earth is a spinning sphere, something that is moving through the air just above its surface – like a bird or a plane or even a body of air moving between high and low pressure, is subject to the Coriolis Effect (and the faster it’s moving or the bigger its mass, the stronger the effect). This means that the path the object takes when seen from above, for example, from space, is a curved line rather than a straight line. This line always curves to the right in the northern hemisphere and to the left in the southern hemisphere.

**Wind sock** – Often used at airfields, these can indicate wind direction and speed for pilots.

**Wind vane** – Points to the direction the wind is coming from.

## Additional activities after session

### Temperature around the world

In the session we have already discussed what the weather can be like in the Falkland Islands and why farmers there need our sheep chill forecast. But what about other places around the world? Using the link here (**https://www.ogimet.com/ranking.phtml.en**) you can find out what temperatures are like in some other countries. Have a look and choose a country. The website takes reports from meteorologists and automatic recording stations and ranks them. This means that you are going to find the hottest, coldest, wettest and windiest place within the country that you choose.

**1)** Choose your country - try and choose somewhere with a different climate to the UK. A few countries don't have any data, just pick another one if no values come up.

**2)** Set Items in ranking list to 3.

**3)** Put in todays' date and a time that is in the past (0900 should work if you aren't sure).

**4)** Discuss the max/min/rain/wind for that country as well as the variety in results. Big countries are likely to have a big range in temperatures over different areas. Have google maps at the ready to find out where the exact locations are OR set as homework for students to find out!

### Questions to ask students

Hopefully you have found out about what the temperature, rain and wind were doing today in your country? Were you surprised at what you found out? Was your country hot or cold? What was the difference between the hottest temperature and the coldest temperature? Do you think your country could benefit from a sheep chill (or a "feels like") forecast?

This video that takes you through some of the world's most extreme temperatures **https://www.youtube.com/watch?app=desktop&v=QH7Qqb63fXg&list=PLDpNAhwWNIikc90K9p-WAG_sjXq0TgXjO&index=4&t=0s**

Where are the Falkland Islands?

Could you produce a fact file on the islands?

Think about what information a person would need if visiting.

Are there interesting sights?

What wildlife might you find?

Topography of the island?

Could you possibly draw your own map of the island with the main features on it?

## Making an anemometer

Resources you will need to make an anemometer (per anemometer):

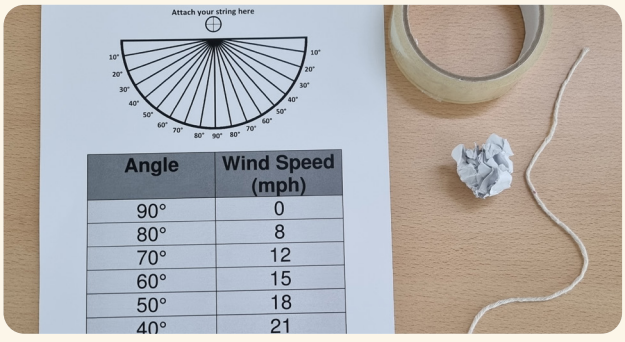
- Anemometer sheet, printed out (end of leader pack)
- Length of string (around 30 cm long, or length of the long side of A4)
- Light object, e.g. recycled plastic bottle lid or ping pong ball.
- Tape

**Step 1:** Tape your recycled object to one end of your piece of string.

**Step 2:** Tape the other end of the string to the marked point on the anemometer sheet.

**Step 3:** Work in pairs or individually to hold up the anemometers OR stick them onto a wall and blow on the object from one side in order to raise the string. Use the chart to see how fast the air is moving in mph based on the height of the string.

**Note** - The speeds that these anemometers will measure will vary slightly depending on the weights of various lids and other re-cycled objects used, but in principle this is exactly how a windsock at an airport works! Windsocks show how strong the wind is based on the angle between the windsock and the pole, so pilots can very quickly get an idea of the wind strength as well as the direction. If blowing at the anemometers in order to test them goes against COVID-19 risk assessments, then encourage students to keep them and test the outside later in the wind.




## Making a wind vane

If you would like to make another instrument to measure the wind, we have provided the instructions to make a wind vane below:

- A ruler
- A pen top/lid
- A plastic fizzy drink bottle
- Card, 2 pieces
- A knitting needle or chopstick
- Matchsticks
- A cork
- Sand/pebbles
- Blu-Tack (or similar)

**Step 1:** Draw an arrow 25 cm long on the card and cut it out. Make another arrow by drawing around the first arrow and cutting it out.

**Step 2:** Place the pen top between the arrows, in the centre facing down, and glue the arrows together around it.

**Step 3:** Push four matchsticks into the long edge of the cork at right angles to each other.

**Step 4:** Cut out four small squares of card and label with the four main points of the compass; N, E, S, W. Attach these to the end of each matchstick with Blu-tack.

**Step 6:** Fill the bottle with sand (or pebbles or something else to weigh it down). Push the knitting needle (or chopstick) into the cork and push the cork in the top of the bottle. Now balance the wind vane arrows on top of the needle/chopstick, using the pen lid.

Choose an open area to test your wind vane. The students can ask an adult or use a compass to point the N label on the bottle towards North. The arrow always shows the direction the wind is blowing from.

# Session 2

## What are clouds?

### Aims of session 2

- There are 3 main types of cloud: cirrus, stratus and cumulus. Discuss the types of weather typically associated with each.
- For clouds to form, the air needs to cool so that the moisture in the air condenses. Discuss mechanisms that cause air to rise and cool.
- Convection: Discuss how warmer air rises upwards while cold air sinks down. Point out resemblance of patterns with cumulus cloud tops.
- Cloud in bottle: Discuss how the rise in temperature causes the moisture to evaporate. Discuss that the sudden drop in pressure causes the temperature to drop and the water vapour condenses, forming a cloud.

### Summary

In this session you will be investigating clouds, how they form and what they're made of. You'll get the opportunity to make your own clouds through taking part in three experiments which will be explained by our demonstrators.

### Word Bank

**Cirrus** – High wispy clouds made of ice.

**Condensation** – The process where water vapour becomes liquid water.

**Convection** – Hot vapour or liquid will rise through cooler vapour or liquid because it is less dense. It then cools and sinks, beginning a circulation.

**Cumulus** – Lumpy, fluffy clouds that look a bit like cauliflowers. They form quite low in the atmosphere.

**Evaporation** – The process where liquids turn into a gas.

**Stratus** – Very low cloud that forms in grey, shapeless layers and can cover hills (hill fog!)

## Guidence for experiments and activities in session

The experiments below will be demonstrated in the session but if you would like to create them in your own learning environments, we have provided the below instructions:

### Convection experiment


**Resources you will need during session:**

- Large jar/clear container (big enough to fit your small jar inside)
- Small jar (ie. Baby food/pesto jar; works best with a narrow opening). Needs to be glass to ensure it will sink!
- Cold water (to put in large jar)
- Warm water (to put in small jar)
- Sticky tape to attach the string to the jar – if needed)
- String/thread to tie around the small jar
- Food colouring – a strong colour like red or blue is best
- Sheet of white paper/card

Prepare the equipment for the convection and cloud in a glass experiments before starting the session.

1. Have warm and cold water ready in flasks or suitable containers
2. Start by tying string around the small jar(s) rim before adding the water to the jar as this can be fiddly (use tape to secure, if required)
3. Fill the large glass jar with cold water
4. Fill the small glass jar with warm water
5. Put a few drops of blue food colouring into the large glass jar (depending on size, add more to make sure the colour is strong in the water)
6. Put a few drops of red food colouring into the smaller glass jar
7. Place the white piece of card behind the large jar (makes the reaction in the water easier to observe)
8. Using the smaller jar attached with strings, carefully but quickly lower the small jar into the large jar of cold water, try not to let it tip!
9. Make sure the students can see well into the jar throughout this process as the mixing tends to happen very quickly.

## Cloud in a glass experiment

**Resources you will need during session:**

- Large glass, jar or transparent container
- Warm water (hot bath temperature)
- Ice cubes
- Metal or foil dish (you can make one of these out of foil if you don't have one)
- Black piece of paper/card

Leave ice cubes in a freezer/cool area until they are needed so they don't melt. If possible, also place metal tray/foil in the freezer early to cool.

Fill glasses with warm water in order to warm up the entire glass, leave these for a few minutes. Water should be very warm, but not boiling.

**Instructions**

1. Place ice cubes into the metal dish/on the foil lid to cool it down, wait until it is REALLY cold!
   - The best option is to leave the ice and foil in the freezer until needed.
2. Pour warm water out of the glasses, leaving only ~2 cm in the bottom of each glass.
3. One student in each group should hold the black card behind the glass.
4. Place the dish/foil on top of the glass, feel free to leave the ice cubes on top.
5. Watch the top of the glass very carefully to see a cloud begin to form.
   - Cloud wisps are likely to be most obvious in the first minute or two so make sure everyone is ready to watch!

Be prepared to look carefully and don't be disappointed if the cloud doesn't last long. If this is the case, look for condensation around the edges of the glass and discuss how that is the same process as water vapour condensing into cloud droplets. It is easier for water to condense onto a surface than in the air.

## Cloud in a bottle (in video)

**Resources you will need:**

- 2 litre bottle
- Cool water
- Match


**Instructions**

1. Fill the bottle 3 quarters full and shake it.
2. Practice squeezing the bottle and then releasing and discuss how this varies the air pressure in the top of the bottle.
3. Light a match and drop it into the bottle, it will go out, that's fine.
4. Quickly put the lid back on and squeeze the bottle again.
5. When you release, the pressure will drop in the top of the bottle, and the cloud condensation nuclei (tiny particles from the match) help the water vapour to condense so a cloud forms.

## Matching cloud types activity PowerPoint

It's your choice how to run this activity using the presentation provided. You could get the students into teams to discuss their thoughts.

## Additional activities after session

### Video on the different cloud types

**https://www.youtube.com/watch?app=desktop&v=WVZvUI33bDI**
- Re-iterate the key points for each cloud.

If you'd like to make your own cloud-spotting binocular, here's a link to our DIY activity instructions:

**https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/other-content/cloud-spotting-diy-activity**

### Measuring Raindrops experiment

**Aim -** to determine if raindrops are the same size. Rain drops come in many different shapes and sizes. This video helps us understand how droplets begin as tiny cloud droplets and increase in size until they are big raindrops, heavy enough to fall on our heads! Hailstones are even bigger!

Think about why the raindrops change shape as they get bigger and fall?
**https://www.youtube.com/watch?app=desktop&v=TjxEUjk9LLg**

As an extension task you can have a go at measuring the sizes of raindrops next time it rains. Maybe you can share your results with us via Twitter

**Resources you will need:**

- Large tray (baking tray or plastic tray)
- Flour
- A sieve
- Ruler
- Rain!

**Instructions**

1. Wait for the next rainy day or shower
2. Take the empty tray and pour flour onto it, creating an even layer
3. Put the tray outside in the rain for about 10-15 seconds
4. Bring the tray inside and let it sit to dry
5. Once dry, use the sieve to very gently separate the dried raindrops from the flour
6. Spread the raindrops out on a piece of paper and, using the ruler, measure the size of each raindrop

**Results:** Raindrops are small and they vary in size.

# Session 3

## Measuring the weather

### Aims of session 3

- Why are observations important?
- How do we observe all the different parts of the weather at a weather station?
- How does a radar station work and what do we use radar for?
- Why do we need different types of satellite?
- What do we observe using satellites?

### Summary

In this session we will be learning with or demonstrators how observations are important to forecasting and what kinds of instruments we use to observe the weather. You will then get the opportunity to take part in becoming satellites and radars through our interactive games.

### Word Bank

**Observations** – Observations include all information gathered about the state of the atmosphere now (in the present). These can include remote observations from satellites and radar and ground observations by automatic equipment or people.

**Satellite** – Anything that orbits the earth! Specifically, earth imaging satellites take pictures of the earth so that we can see cloud/temperature/wind information across a big area. This helps us to check that the forecast is going as expected over the UK, but if lots of satellite "pictures" are put together in a sequence, they can help us track weather systems that are heading ou0r way which may affect us in the coming days.

**Radar** – Sends out electromagnetic pulses which detect objects in the sky, like raindrops, and can tell how big they are, where they are and how fast they are falling.

**Weather** – Daily or even hourly variations in temperature, wind, cloud cover and precipitation (rain/snow/hail etc.)

**Weather forecast** – A forecast is an estimate of the future state of the atmosphere. It is created by estimating the current state of the atmosphere using observations, and then calculating how this state will evolve in time.

**Weather station** – A weather station is an area where automatic equipment or a team of observers monitor the weather conditions. Play our Observations equipment game to find out what you might find in a weather station!

## Guidance for experiments and activities in session

### Powerpoint "Matching Observations equipment game"

This contains a series of images of observing equipment. Participants need to work out what each image is showing and what it measures.

### Human radar station game

**Equipment:**

- Stopwatch
- As much space as possible

**The roles for each group are as follows:**

**Group 1 =** radar station – send out radar waves and welcome them back.

**Group 2 =** radar waves – students get released by the radar station and walk 10 paces in a straight line.

**Group 3 =** rain shower – located fewer than 10 paces from the radar station.

**Group 4 =** timers, use a stopwatch or phone to time how long it takes the 'radar waves' to hit the shower and return to the station.

**Instructions**

1. Split the class into 4 groups.
2. Firstly, send the group that are acting as "radar stations" to find a space in the room you are using. They can do some rotating and send the waves in all directions if you have space.
3. Get the students that are acting as "rain showers" to stand at a location distance of their choosing (preferably no more than 10 paces away) from the 'radar stations' Rain-like actions can be encouraged, but this group shouldn't move, or only move very slowly.
4. Get the groups that are acting as 'radar waves' to walk 10 paces from the 'radar stations' in a straight line. If they don't hit anything, they simply stop. If they bump (gently) into a rain shower, they reflect and return to the radar station.
5. Ask the students acting as the timers to time how long it takes for the students to walk from the radar station to the rain cloud and back so that we can figure out how far away our rain showers are. One timer for each radar wave, but make sure they stay out of the way!

[Play the game once or twice and keep a note of the times]

Once everyone is sitting down again you can work out the distance to the shower! Radar waves travel at the speed of light (300,000,000m/s)! But our human radar waves were walking at roughly 1.2 m/s (if they were walking slowly and carefully).

Use the equation:

***Distance=Speed x Time***

To figure out how far away the shower is (speed = 1.2, time = the time in seconds recorded on the stopwatches).

## Additional activities after session

### What was the most important forecast in the history of the Met Office?

Some might argue it was our D-Day forecast in 1944. Investigate the role of weather observations and encryption during World War Two with our lesson on Decoding D-Day.

**7-11 years** - **https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-11-14/resources-11-14/decoding-d-day**

**11-14 years** - **https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-11-14/resources-11-14/decoding-d-day**

### Would you like to become satellites?

Here's some instructions below to follow. (Make sure you have a large area to take part in this, maybe on the playground or in your garden or school hall?)

**Equipment**
Continent labels. These could be in the shape of the continents or just labels on paper.

**Instructions**
Choose one student to be the earth, 2 or 3 to be polar orbiting satellites and 4 or 5 geostationary satellites. To get everyone involved, split classes into groups and have multiple "earths".

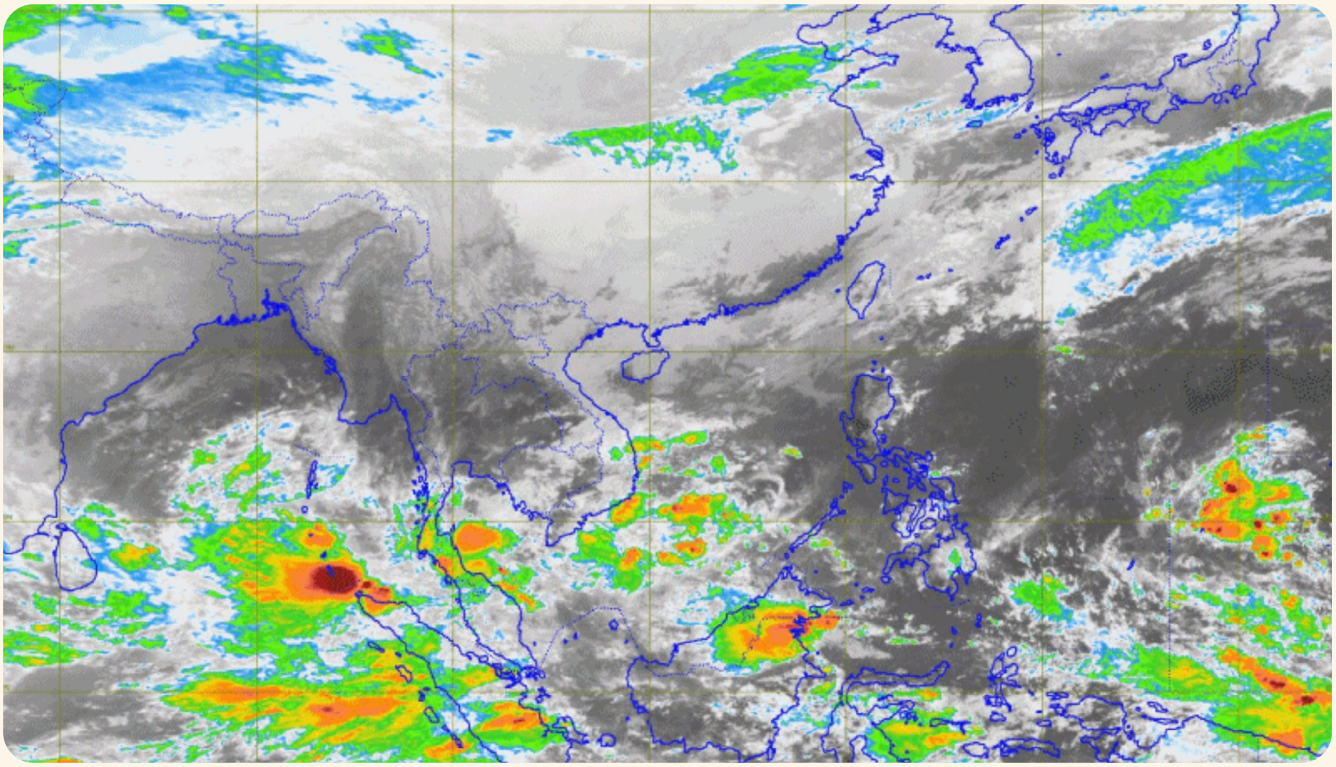
Stick printed continents or pieces of paper with continent labels in roughly the right location on the "earth" student. Eg. Antarctica on their feet, Africa on their stomach, Europe on a shoulder... don't worry about being too accurate.

First, allocate a continent to each geostationary satellite – they must stand a few metres away and orbit at the correct speed to remain looking at their continent.

Next, introduce the polar satellites, they should stand closer to the earth and "orbit" around the "earth" from their shoulders to ankles, alternate between crouching and standing on their tiptoes. Get them to shout out the different continents that they pass as the earth slowly spins (they must only look straight ahead of them!)

## Why do weather forecasters love satellite images?

1. Satellites allow us to see the sky across a much bigger area than we can from the ground.
2. They allow us to monitor the weather forecast, checking whether everything is going to plan or if we need to update things before anyone is affected.
3. We can see weather systems (which usually bring wet and windy weather) approaching in real time, these will affect us in the next few days. We can also watch how they are growing or weakening on their way.
4. We can spot different cloud types. We can see big cumulonimbus clouds bubbling up in real time (they often appear really bright white because they are so tall and dense) and spot areas of fog, even at night by using infrared imagery (we especially like polar orbiters for this because they show lots of detail). Remember, clouds give us clues about precipitation too!



Find out more about satellite imagery here: **https://www.metoffice.gov.uk/weather/learn-about/how-forecasts-are-made/observations/satellite-pictures**

# Glossary

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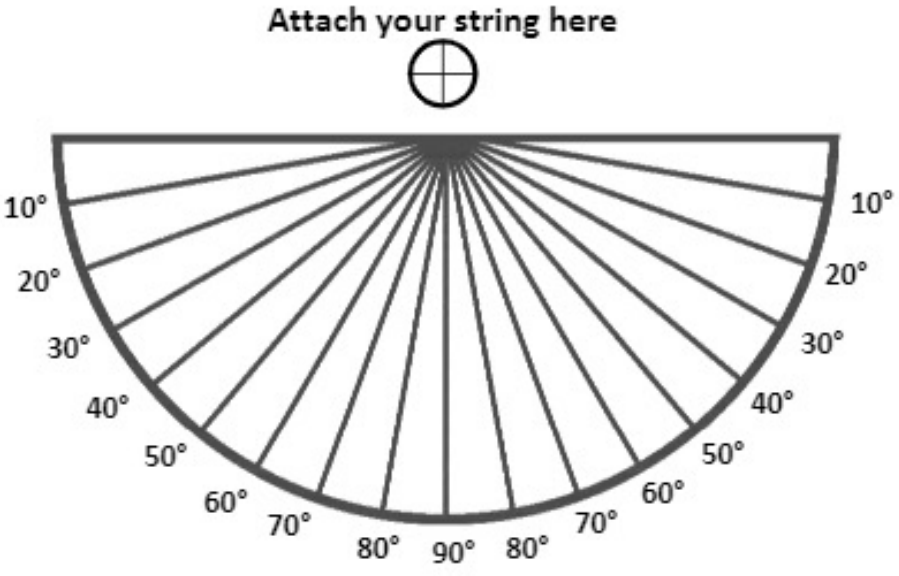
# Appendix

**Anemometer resource –** Session 1 – What is wind? PTO




| Angle | Wind Speed (mph) |
|---|---|
| 90° | 0 |
| 80° | 8 |
| 70° | 12 |
| 60° | 15 |
| 50° | 18 |
| 40° | 21 |
| 30° | 26 |
| 20° | 33 |