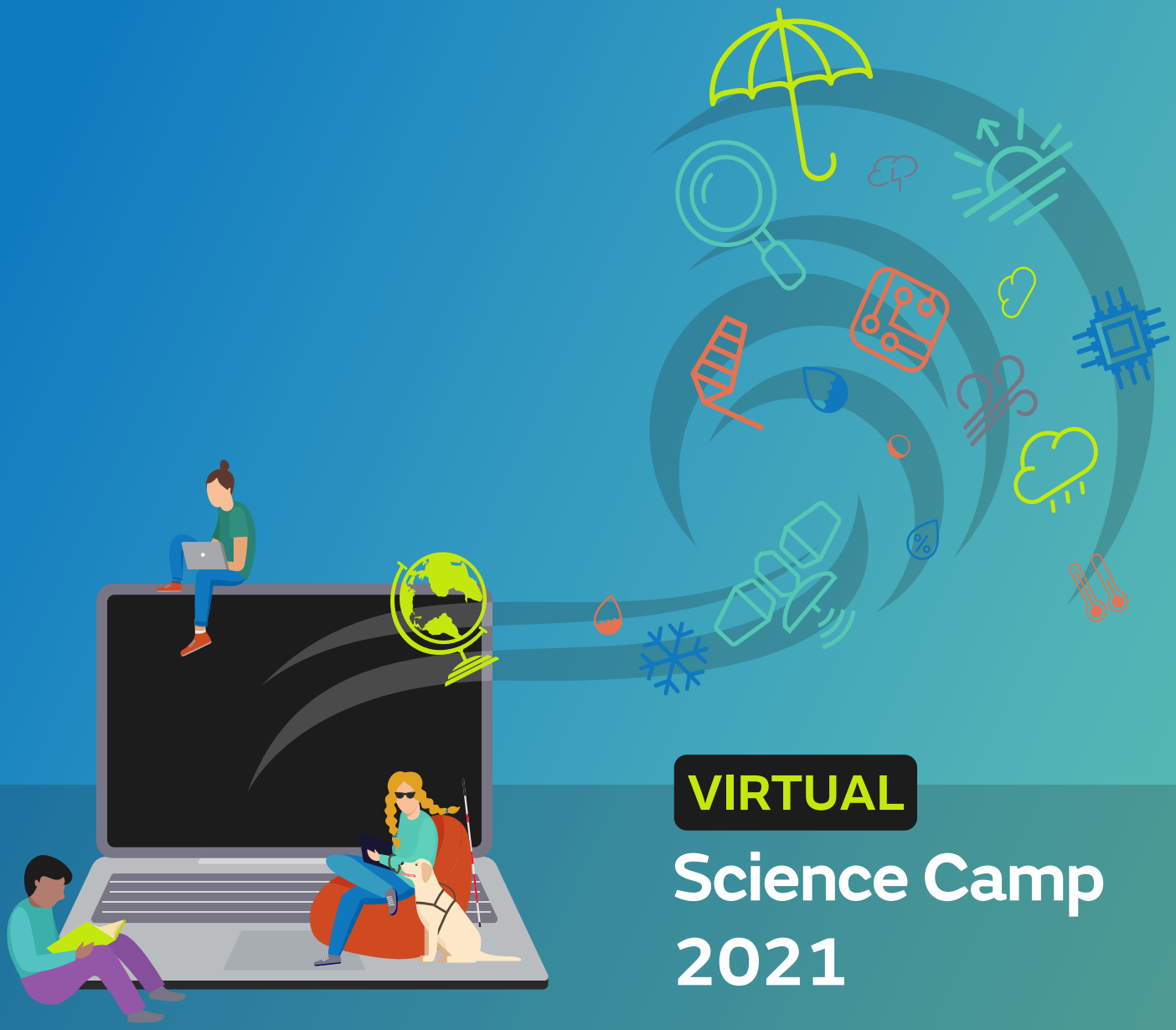
Met Office

Leader pack

Sessions 4-6

Rain or Shine
Forecasting for the World
What makes our computer super?



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 4

Rain or Shine

Aims of session 4

- Students to produce their own weather forecast for The Festival of Flight air show near London on Saturday afternoon (~3pm).
- How do we use observations coupled with our model predictions to make our final forecasts?
- Introduce students to the way a television weather forecast is presented and recorded.
- How our forecasts impact that decisions made by our customers.

Summary

In this session students get the chance to become a meteorologist and present you're their own forecast for The Festival of Flight.

This session will take you through how we produce our forecasts and we have provided detailed notes below as to the structure of the session that you can follow through.
Can you use your knowledge of weather observations to create a forecast for Ian Frost?

Word Bank

Meteorologist – a meteorologist uses weather information to forecast the weather

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

Satellite – take pictures of the earth so that we can see what cloud is out there in the sky 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 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.

Guidence for experiments and activities in session

Video Guidance

After watching the first customer video, students are asked about what the customer wants to know. Expected answers/pointers:

Ian Frost wants to know the weather...
- Where? - London area
- When? - Saturday
- Specifically interested in? - if it will be raining at 3pm
- Why? - if it's raining, Ian Frost will move the display for the "Crimson Darts" earlier or later so spectators don't get wet

What is happening with the observations on the slides for 9pm?

- The wind has strengthened everywhere
- It's still clear of cloud in London
- Plymouth is cloudier
- It's raining in Scotland

What is happening with the observations on the slides for 3am?

- Wind is still westerly, pushing the band of rain over the UK
- Getting cloudier and windier over London
- It's pretty windy and wet over Plymouth
- It's clearer again over Scotland but still breezy.
- Discuss whether the observations match the radar? Yes
- Are the isobars (pressure lines) closer together? That means it's windier!
- Which way is the band of rain heading? Towards London and the air show!

Can you help Ian Frost? Can you make a guess at the weather near London at 3pm?
- Hopefully you will get some answers that it might rain. Not completely certain yet.

Comparing models:

- **Model 1** has the rain too far west, so it is predicting the rain will be later in London. Actually, the rain will reach London before the model thinks it will and take everyone by surprise.
- **Model 2** has the rain too far east, so it is predicting the rain will be earlier in London.
- **Model 3** is a much better fit

Using the model, discuss whether the Crimson Darts can do their display:

- The rain won't be over London at 3pm, so we can say it will be dry, but it should also be clear that the rain will be approaching, so will probably arrive later.

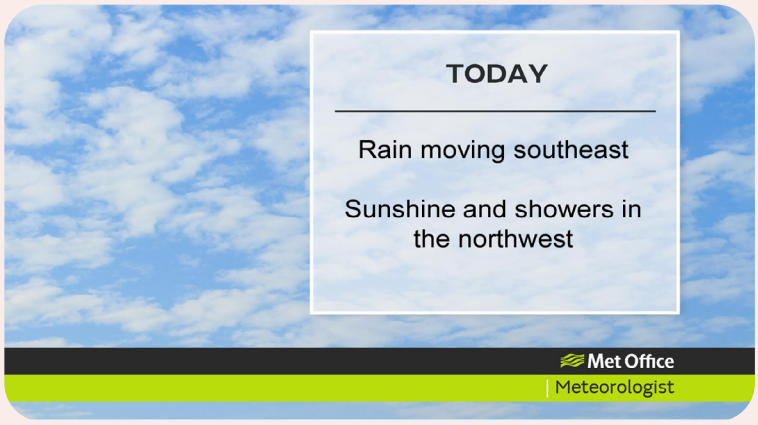
Pilot Briefing

How do we communicate the weather forecast to the public?

- Lots of possible answers including online, newspapers, radio - make sure they give "presenting on the television" as one of the answers.

TV forecast presentation

- Prepare the PowerPoint with the background slides for the TV presentation.
- If you don't have access to a screen/projector then you can print off these slides for the students to use as a prompt and they could be stuck up behind them to aid their presentation.



- Get creative - you could also use a big piece of material with printed out or drawn on weather symbols and an outline map of the UK.

Here are some top tips that might be useful for presenting:

- Think about the words that they will want to use for the different symbols, e.g. sunny/ cloudy/sunny spells and light rain/ heavy rain or windy/breezy/blustery/calm etc.
- Get them to consider how they want to describe different parts of the country e.g. using place names, London, Exeter, Scotland, Cornwall or describe areas using geographical terms e.g. N-E-S-W, near the coast/inland.

  It is up to them how they do their broadcast, but it is good to get them thinking about what they might want to say as it encourages those who are not as confident, it also helps to avoid too many of them doing the same thing! Could they write their scripts down?
- Once everyone has had time to practice, choose as many students as you have time for to present to the rest of the class. Maybe you could get them to film themselves?
- DON'T WORRY if not everyone gets a chance to present their forecast this time. If you're able to join us for session 8 there will be another opportunity to put together and present a weather forecast, but with a slightly different message...
- Once you are finished, return to the video for a few minutes' summary with Ian Frost.

Additional activities after session

Would you like to learn more about how weather is communicated? The lesson below addresses the different ways we can make and communicate predictions about the weather and tell 'weather stories'

7-11 year - **https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-7-11/resources-7-11/forecasting-fact-busters**

11-14 years - **https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-11-14/resources-11-14/forecasting-fact-busters**

Why not write another weather script for your local area or investigate creating your own weather symbols to use in your forecasts?

Session 5

Forecasting for the World

Aims of session 5

- To discuss flooding in the context of the most damaging weather types and to give a sense of the damage caused
- To emphasise importance of a good weather forecast to minimise impact
- To explain storm surges and the three contributing aspects (tides, wind, pressure) using a balloon experiment to illustrate effect of pressure on sea level.
- To explain why (inland) floods happen (persistent rain, waterlogged ground, flash floods) and using a flood model to demonstrate.
- To explain extreme weather (especially rainfall) in the UK and globally

Summary

In this session you will be exploring how the Met Office forecast not just for the UK but globally. We'll be starting with a tour of the operations centre (**https://vimeo.com/321683986**) where we provide our 24/7 weather forecasts, IT support and customer service. We delve into extreme weather and explain how much flooding impacts the UK and through our flood model demonstration, you'll be able to see the effects of flooding on the landscape of the UK and how much of an impact it can have when flash flooding occurs. Finally concluding with an Extreme weather quiz, see if you can answer some of the questions posed by our demonstrator!

Guidence for experiments and activities in session

Word Bank

Thermal - This is a type of convection (see session 2: Clouds) The earth's surface is heated by the sun, which in turn heats up the air above the surface. Different surface types and exposure mean that the earth's surface doesn't heat up evenly. Hotter areas of the surface create hotter areas in the air above the surface, which are therefore less dense than the surrounding air so rise faster and to higher levels. Once a thermal has formed, more complex processes act to maintain and increase the heights of thermal columns. Birds, gliders, and hot air balloonists use thermals to fly higher, but they can also be hazardous.

Sea breeze - As we saw in session 1, wind comes from the movement of air from high pressure to low pressure regions. In the summer, the surface of the land is heated by the sun and becomes hotter than the surface of the sea. This causes the air above the land to rise (also convection taking place) creating a low-pressure region over the land. The air over the sea therefore wants to move into this low-pressure region so a sea breeze develops.

Mountain Waves - In certain atmospheric conditions, which we call "stable", air doesn't want to rise. This means that when it is forced upwards over mountains, it rushes down the other side and then follows a wave pattern as it moves away, with each wave getting smaller as distance from the mountains increases. Try demonstrating this by lifting one end of a slinky! These can be hazardous to aircraft due to the fast upwards and downwards movements of air.

Headwind - Wind blowing in the opposite direction to a plane/helicopter. This acts against the aircraft causing it to use more fuel or fly more slowly.

Tailwind - Wind blowing in the same direction that a plane/helicopter is flying in, therefore this can "push" the aircraft along.

Additional activities after session

In the session you will have seen our flood model that we used to explain how flooding occurs. We've put together a list of resources and instructions on how you can make your own.

Resources you will need:

- A plastic tub or tray, it doesn't have to be a huge model
- Objects that represent houses
- Scissors
- Paint and decorations for your model
- Sponges or a cup to pour water over your model with Plasticine, modelling clay or some moulding material to make the floodplain
- Towel to mop up excess water

Instructions

1. Start with your plastic tub/tray - this will be your base to build you floodplain in.

2. Create your riverbed from the modelling clay, have a look at our floodplain model on the video or picture and see if you can model the same flow of the river – it doesn't have to be exact just to flow from one side of the tray to the other. There could be different rivers that you want to emulate from wide bendy rivers or straight narrow ones – the choice is yours!

3. Using objects that represent houses and buildings, place them along your model near to the river, set back. For refence, have a look at our model and where we've placed our houses. If you're feeling ambitious you could make your own houses out of card or other items!

4. Add trees or foliage etc to your model.

5. When complete you can now test what happens when we introduce the rain.

6. Take your sponge/cup and fill with water from a bucket (don't use too much to begin with!)

7. Start to pour your water slowly and evenly on top of your model where the river begins.

8. Observe what happens and discuss with your group:

- Does your model flood straight away?
- Where does the water go?
- Are there any surprises?

Extension

9. Flash flooding – remember in the session how our demonstrator showed you what happens when we experience flash flooding? You can show this through using two sponges or two cups of water and at the same time releasing it into your flood model.

10. Take notice of the difference that having so much water pour into your model has on the local area.

Additional discussion points - think about erosion, what could happen over time to the river and surrounding area if it continually keeps flooding? How could we stop this from happening?

Explore extreme weather further, have a look at our Weather Warriors lesson below. This session brings together community, collaboration, and social action by getting students to understand how weather and climate information can support and benefit their local area. It also includes case studies of real people working in weather and climate to introduce students to the variety of ways we can help communities.

Weather Warriors 7-11years -

https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-7-11/resources-7-11/weather-warriors

Weather Warriors 11-14years -

https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-11-14/resources-11-14/weather-warriors

Session 6

What makes our computer super?

Aims of session 6

- Nearly all of us own computers and/or use them daily.
- Computers store information.
- Computers process information e.g. make a calculation.
- Information needs to be moved between different parts.
- We need power to operate a computer.
- How we forecast uncertainty using ensembles for the example of storm tracking.

Summary

In this session we will learn about the history of numerical forecasting and all about supercomputers, especially the Met Office supercomputer. We will also introduce the idea of uncertainty in ensemble forecasting and learn why this is a really important to the way we communicate our forecasts.

Word Bank

Atmosphere – is the mass of air that surrounds the Earth. It contains nitrogen (78%) oxygen (21%) and traces of other gases. The atmosphere plays an important part of protecting life on Earth.

Ensemble forecast – instead of running just a single forecast, the computer model is run a number of times from slightly different starting conditions. The complete set of forecasts is referred to as the ensemble, this group of forecasts helps to give a range of possible futures of what might happen in the atmosphere.

Supercomputer – The three Cray XC40 Met Office supercomputers:

- Are capable of over 14,000 trillion arithmetic operations per second – that's more than 2 million calculation per second for every man, woman and child on the planet.
- Contain 2 petabytes of memory enough to hold 200 trillion numbers.

- Contain a total of 460,000 compute cores. These are faster versions of those found in a typical quad-core laptop.
- Contain 24 petabytes of storage for saving data - enough to store over 100 years' worth of HD movies

This power allows the Met Office to take in 215 billion weather observations from all over the world every day, which it then takes as a starting point for running an atmospheric model containing more than a million lines of code.

Guidence for experiments and activities in session

There's a few activities to follow in this session so make sure everyone has a pen and paper to write down some answers!

Processor calculations game - answers

28 ÷ 7 = **4**	235 + 27 = **262**
65 x 2 = **130**	48 ÷ 12 = **4**
12 + 37 = **49**	96 – 42 = **54**
103 – 75 = **28**	144 ÷ 12 = **12**
8 x 7 = **56**	16 x 3 = **48**

Feel free to change these questions to suite the ability of your students

Memory game picture

Answers:

Mug, Cuddly/Soft toy, Thermometer , Glass bottle , Rainbow , Tinsel , Tennis ball , Mouse , Stopwatch , Pen

Additional activities after session

Go and explore our supercomputer further with a virtual tour here: **http://vr-tour.informaticslab.co.uk/** (copy and paste the link in your browser)

What might weather data look like in the future? This lesson will explore this through creating your own vision of how weather data might be communicated in the future.

7-11 years – https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-7-11/technology-and-innovation-in-weather

11-14 years - **https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/themes-for-11-14/resources-11-14/bringing-data-to-life**

Learn more about our new supercomputer from 2022 onwards: **https://www.metoffice.gov.uk/about-us/what/technology/supercomputer** (copy and paste the link in your browser)

Eager to learn more on ensemble forecasting? **https://www.metoffice.gov.uk/research/weather/ensemble-forecasting/what-is-an-ensemble-forecast**

Have a go at creating your own computer codes using Lego. Go to our DIY activity here: **https://www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/other-content/supercomputing-coding-diy-activity**

Glossary

Atmosphere – is the mass of air that surrounds the Earth. It contains nitrogen (78%) oxygen (21%) and traces of other gases. The atmosphere plays an important part of protecting life on Earth.

Coding – creating instructions for a computer using programming language

Ensemble forecast – instead of running just a single forecast, the computer model is run a number of times from slightly different starting conditions. The complete set of forecasts is referred to as the ensemble, this group of forecasts helps to give a range of possible futures of what might happen in the atmosphere.

Headwind - Wind blowing in the opposite direction to a plane/helicopter. This acts against the aircraft causing it to use more fuel or fly more slowly.

Meteorologist – a meteorologist uses weather information to understand and predict/ forecast weather. They also study how weather conditions affect humans and our planet.

Meteorology – the study of the atmosphere

Mountain Waves - In certain atmospheric conditions, which we call "stable", air doesn't want to rise. This means that when it is forced upwards over mountains, it rushes down the other side and then follows a wave pattern as it moves away, with each wave getting smaller as distance from the mountains increases. Try demonstrating this by lifting one end of a slinky! These can be hazardous to aircraft due to the fast upwards and downwards movements of air.

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