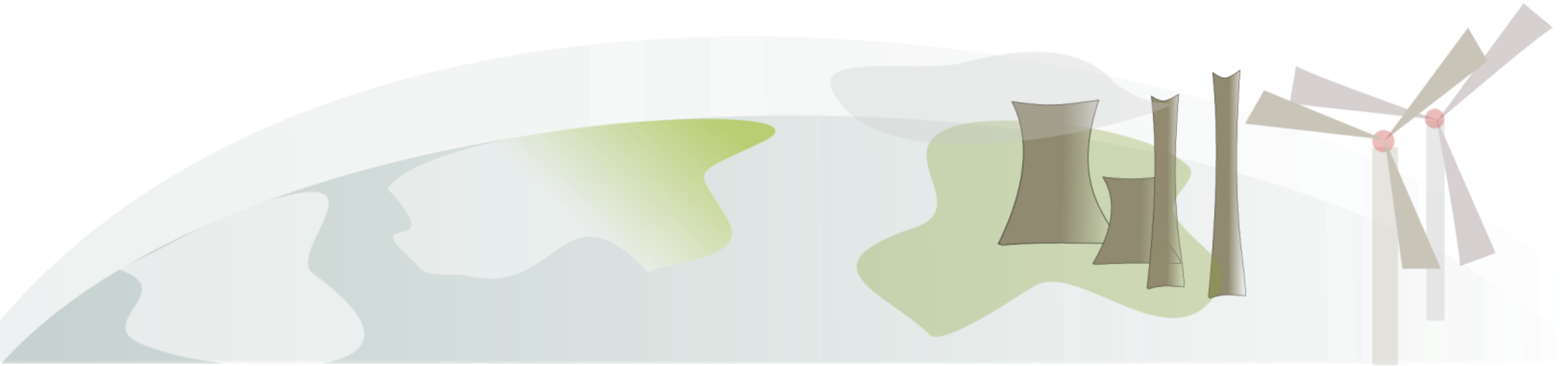

Climate Change – Resources

Thank you for downloading this Climate Change resource from *GeoBus* - https://geobus.st-andrews.ac.uk/

This resource pack was developed in partnership with [Dr James Rae](#) and Dr Rosanna Greenop of the School of Earth & Environmental Sciences, University of St Andrews. Special thanks are also due to Rasa Juras for her involvement.

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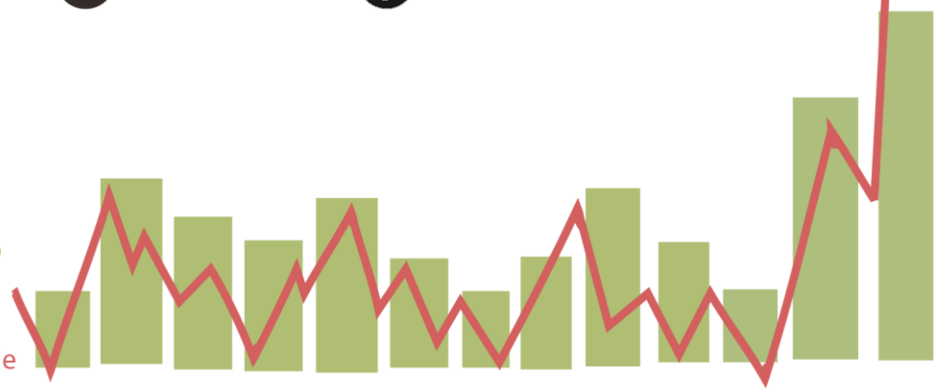
GeoBus

Climate change:
it's happening, it's us, it's serious, it's solvable



The role of the ocean

Overview

Activity Description	A series of experiments and demonstrations looking at role the role of the oceans in global climate systems, and their response to climate change. Demonstrations and experiments can be combined or used independently to suit.
Time	50 - 100 minutes (depending on activities/experiments used)
Learning Outcomes	• Learn how increased levels of CO_2 impact the oceans • Explore the impacts of climate change on ocean circulation • Investigate the relationship between different water masses
Student Organisation	Small groups/pairs (discussion)
Materials Needed	Instruction sheets, worksheets, [depending on experiments being carried out, you will also need; balloons, funnels, water, timers, lighter or candle + matches, spoons, plastic cups or beakers, marker pens, pH indicator, salt, straws]

Background information

In climate change discussions, the importance of Earth's oceans can often be overlooked. In fact, the oceans play a hugely significant role; not least acting as a large store of both heat and carbon.

As levels of CO_2 increase, oceans are being subjected to a series of rapid changes resulting in; seasonal shifts, ocean acidification, coral bleaching, sea level rise, coastal erosion, new diseases, loss of marine life, changes in precipitation, fishery declines.

Understanding the role of the oceans in climate change has allowed scientists to more accurately model past conditions and consider future responses to increasing global temperatures.

Classroom Activities

The classroom activities for this resource are described as distinct experiments under two headings – these can be used separately or combined to make a longer lesson investigating the role of the oceans in global climate, and climate change.

1. Heat Capacity (water vs. air – oceans as a heat buffer)
2. Ocean Acidification (fresh water vs. salty water – oceans as a CO_2 buffer)

Classroom Activity 1: Heat Capacity

In this demonstration you will use two balloons to demonstrate the heat capacity of water, and consider the impact this has on the distribution of heat across the surface of planet Earth.

This can either be done as a whole class demonstration (get pupils to hold the balloon!) or in groups, depending on age/class size.

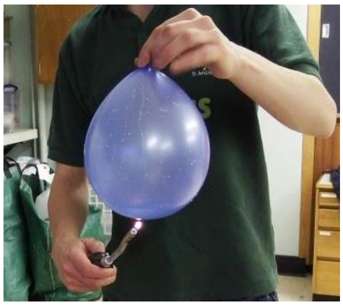
What you need:

- Two balloons
- A funnel
- 150ml cold water
- A timer
- A lighter or candle + matches
- A tray/tub to place under the balloons and catch the water

Method:

1. Blow up one of the balloons, tying it securely
2. Using a funnel, pour 150ml of water into the second balloon
3. Blow up the second balloon and tie the end securely
4. Make a prediction about what you think will happen when a flame is held underneath each balloon. Will both balloons pop? Will one last longer than the other? Estimate how many seconds you think it will take for each balloon to burst.
5. First, hold the balloon containing only air above the tray, and hold either the lighter flame or the candle directly underneath it – time how long it takes to burst
6. Repeat step 5. with the balloon containing some water (make sure you hold the flame directly underneath, so that the heat is being applied to the area with water in it)
7. Discuss the result – which balloon took longer to pop?





Left to right: equipment needed, filling the second balloon with water, experiment in progress!

Talking Points

Water has a high thermal (heat) capacity, which means it can store more heat per unit volume than air can. When the flame is held under the balloon containing only air, the rubber of the balloon quickly heats up and becomes weak, so the balloon pops. In the second balloon, the water absorbs the heat from the flame so the balloon rubber takes longer to heat up enough to become weak.

The oceans acts in a similar way for the earth, absorbing the extra thermal radiation that is being trapped in the atmosphere because of increased CO_2 levels.

Earth's oceans are therefore playing an important role in keeping the planet cooler than we might except from the measured rise in greenhouse gases (particularly CO_2). However, just like the second balloon did eventually pop, the oceans are slowly warming and will reach a point where they can't absorb all of the excess heat.

What influence do you think an increase in ocean temperature might have on these things?

	Impact of increased ocean temperature
Coral reefs	
Sea level	
Tropical storms	
Ice melting	

Check out this article for some more information:

https://www.nationalgeographic.com/environment/oceans/critical-issues-sea-temperature-rise/

Classroom Activity 2: Ocean Acidification

This experiment considers the effect of dissolved CO_2 on both fresh and salt water – considering the impact of rising levels on oceans and sea-life.

What you need:

- 2 spoons
- 2 clear plastic cups or beakers
- Marker pen/paper for labels
- pH indicator (liquid or paper)
- Cold water
- Salt
- Straws
- Timer
- Worksheet

Make your own pH indicator:

Add 3-4 pieces of red cabbage to a mug of boiling water and let sit for 5 minutes – carefully remove the cabbage pieces and let the indicator cool before using.

Method:

1. Fill both cups/beakers approximately half full with water (if you live near the coast, you can use real seawater in one cup and miss out the 'adding salt' stage!)
2. Mark one as 'fresh water' and one as 'sea water', and dissolve 3 - 4 heaped teaspoons of salt in to the 'sea water' cup
3. Add 6 drops of pH indicator to each cup, swirling to mix
4. Note the starting pH of the 'fresh water' cup (describe the colour or use the chart)
5. Using a straw, blow in to the 'fresh water' cup for 5 seconds, then record the new pH
6. Continue blowing, recording the change every 5 seconds until 40 seconds has passed
7. Repeat steps 4-6 for the 'sea water' cup

	Initial pH (before CO_2)	pH after CO_2 **5 s**	pH after CO_2 **10 s**	pH after CO_2 **15 s**	pH after CO_2 **20 s**	pH after CO_2 **25 s**	pH after CO_2 **30 s**	pH after CO_2 **35 s**	pH after CO_2 **40 s**
Fresh water									
Seawater									

*If the reaction happens too quickly try reducing the interval to 2 seconds.

Talking Points

During the experiment the water becomes more acidic, because CO_2 – one of the gases that humans breathe out – is dissolving and forming carbonic acid (H_2CO_3) which can release H^+ ions, causing a drop in pH*. There is a difference in the reaction time between fresh water and seawater because the dissolved salt in the seawater acts as a buffer, neutralising some of the acidity – if you use real sea water instead of adding just salt, this effect is even stronger because real sea water has more dissolved salts (not just NaCl – table salt).

Seawater is therefore currently acting as a buffer, absorbing some of the CO_2 from the atmosphere and meaning Earth is not warming up as much as it would be without the oceans. However, the seawater cup/beaker also eventually changed colour, and similarly the oceans are becoming more acidic; over the last 300 million years ocean pH has been ~8.2, but over the last 200 years this has decreased to ~8.1. Because the pH scale is logarithmic, this represents a 25% increase in acidity!

* Higher concentration of H^+ ions in a solution = lower pH, since $pH = -\log_{10}[H^+]$

Extension

This experiment illustrates the effect of ocean acidification on shell creatures, using limestone which is primarily made of calcium carbonate ($CaCO_3$) – the same material as many shells are made from.

What you need:

- Pieces of limestone (if you can't get hold of some pieces of limestone, try this investigation with shells or pieces of chalk – they are forms of $CaCO_3$)
- Vinegar (or other weak acid – follow appropriate safety precautions as appropriate)
- Eye wear & protective gloves
- Shallow container/tray

Method:

Experiment 1: Simply place a couple of drops of vinegar (or acid) on to a piece of limestone and observe what happens – you should see bubbles start to form as the acid reacts with the carbonate and starts to dissolve it.

Experiment 2: Place a small piece of limestone in a container and pour in enough vinegar to just cover it. Leave it undisturbed for around 1 week, and you should see small white crystals growing on top of the rock.

The vinegar is dissolving calcium carbonate from the rock, forming calcium acetate (also an acid). As the liquid starts to evaporate, the concentration of calcium acetate increases and the solution becomes saturated – at which point it starts to crystallise.

Note: take care when using acids, making sure to avoid contact with eyes and to wash hands thoroughly before handling food – it is recommended that eye protection and gloves are worn

Talking Points

Ocean acidification is bad news for sealife! Shells made of calcium carbonate start to dissolve or are weakened and this has a significant effect on the ocean food-chain. Fish, coral and other creatures are also effected by the changing pH – for example more acidic waters is causing a reduction in numbers of cod in the North Atlantic.