



What is Climate?

A Teaching Unit for Years 7 – 10 children

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This workshop and the SEREAD programme are sponsored by:

- The International Oceanographic Institute, University of the South Pacific (IOI)
- UNESCO Office Apia
- Argo Science Team
- Partnership of Observation for the Global Ocean
- National Oceanic and Atmospheric Administration. U.S.A.
- South Pacific Applied Geoscience Commission
- International Oceanographic Commission, Perth Regional Office
- National Institute for Water and Atmosphere, New Zealand.

Is climate change happening?

Our foot is stuck on the accelerator and we are heading for an abyss. (UN Secretary General Ban Ki Moon)



WELCOME TO SEREAD

What is SEREAD?

SEREAD is an educational programme linked to current teaching programmes in Pacific Island schools.

SEREAD stands for Scientific Educational Resources and Experience Associated with the Deployment of Argo. The Argo Project is a series floats that move up and down vertically through the water and the information they provide is used to help understand the changes taking place in today's climate.

The Goal of SEREAD

The goal is to help generate awareness, discussion and an understanding of the ocean's role in the climate system. Climate changes can take place over months or years. The key to understanding change involves the role of the water and energy cycles in the tropical marine climate of the Pacific Islands.

SEREAD's objectives are to:

- Provide teaching resources that complement current teaching curriculum and demonstrate the value of scientific knowledge through realistic and locally relevant applications.
- Teach students about the fundamental measurements that are used to describe and measure changes in climate.
- Help teachers and students to understand how scientists use data.
- Provide opportunities for interaction between scientists and teachers.

In this Workshop the topics will be:

Argo floats: What they are, how they work and the information they provide.

Understanding climate change and the Island Climate Updates.

Introducing the Teaching Programmes.

Unit Studies for Primary Teaching.

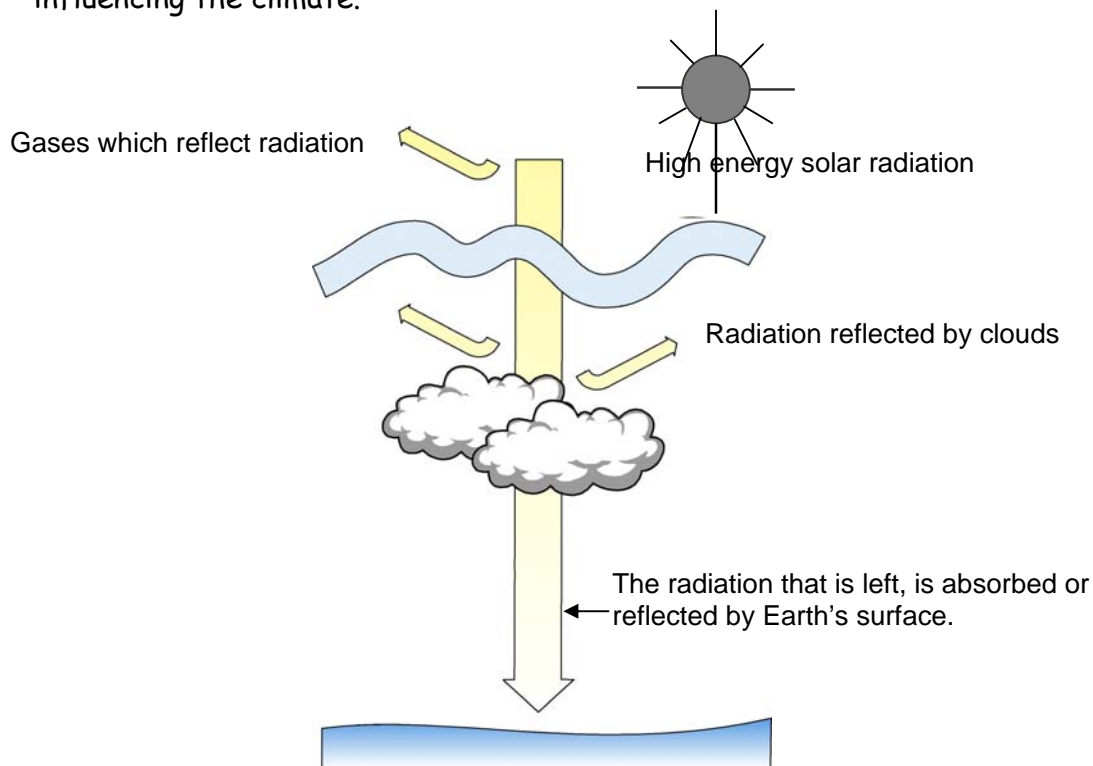
Goals of the SEREAD the workshop:

To provide teachers with practical classroom materials and resources that they can take away with them to use in their classrooms.

Develop teacher's knowledge of climate change and the role of the ocean.

Sun, radiation and atmosphere.

The energy that radiates from the sun is responsible for many things that happen on our planet. Light energy is needed for plant photosynthesis and this is the key to the survival of all living things on the planet. Heat energy warms our planet, enabling life to survive, and creates the weather that we are familiar with. Not all the heat reaches the earth's surface. Some of the radiated heat energy is reflected by, or absorbed by the clouds. This all counts towards influencing the climate.



There is also a lot of harmful radiation that comes from the sun; this radiation would annihilate all life on the planet if it weren't for the atmosphere.

The atmosphere is made of layers that are divided by temperature. Each of these layers influence the radiation that reaches the surface.



The magnetosphere is the top layer. There are no gases, but it still stops some of the harmful particles reaching Earth's surface. This is where we would find weather satellites.

The air in the **exosphere** is very thin. There is very little air here. The top of the layer is 900km above the ground.

The **thermosphere** contains gases, which absorb some of the sun's harmful rays. The top of this layer is 450km above the surface and the temperature here is 2000°C.

The **mesosphere** reaches a height of 80km above the surface of the earth. The temperature at the top is about -100°C. It warms up as you get lower.

The top of the **stratosphere** is about 50km above the ground. The temperature at the top of this layer is 0°C. It cools down as you get lower. This is where we find the ozone layer.

The **troposphere** varies in height from between 10km and 20km. The temperature at the top is about -50°C, but it warms up as you get lower. This is where there is the most air and what we call weather is found.



The Troposphere is the region that concerns most of us! That's where the weather happens.

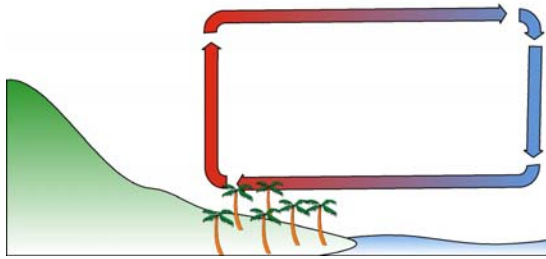
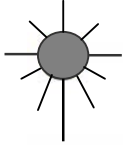
Is climate change happening?

Carbon dioxide acts like a blanket, trapping the sun's heat around the planet.

What happens as the Sun heats the Earth's surface.

One of the most obvious effects we observe from the heating effect of the sun is the air temperature. The surface of our earth is heated by absorbing the sun's radiation. When the air above the surface of the earth is cool, the land beneath it warms it. The warm air rises.

This helps to create localized weather conditions. For instance, sea breezes cool the land near the sea, whereas further inland there is no cooling and it is considerably warmer or the wind is blowing from another direction.

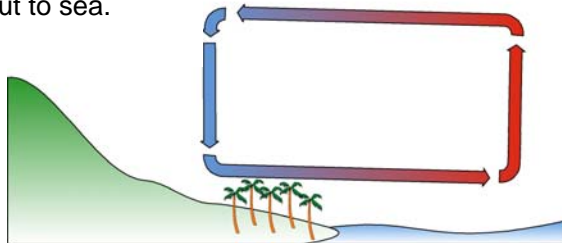


Cool air moves in off the sea to replace warm air rising over the rapidly warming land.

At night the breeze is reversed.

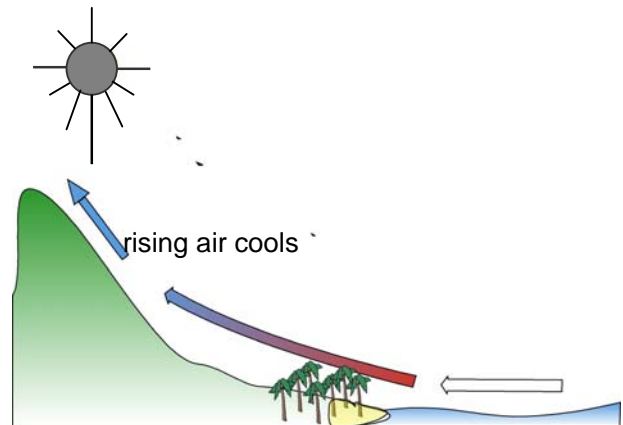


Air sinks, as the land as cools rapidly at night and forces its way out to sea.

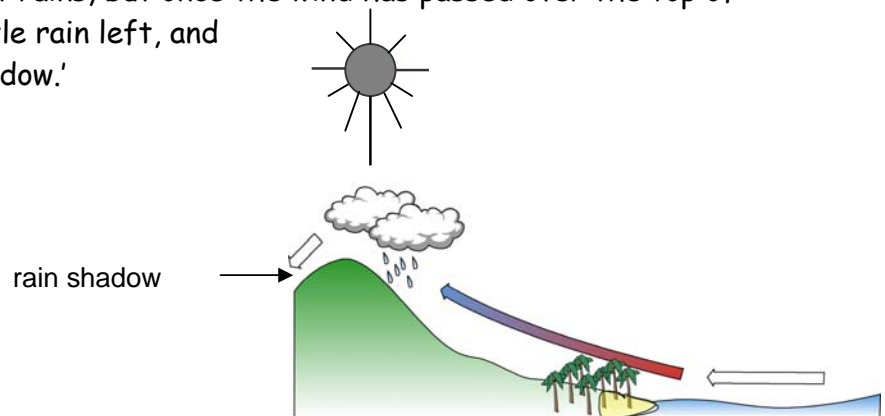


However, if you go round the coast and it is cloudy, there is little radiation to heat up the land. There will be a similar temperature between land and sea and there will be no breeze.

If we move inland and climb the mountain, we also notice the air temperature gets lower the higher we climb.



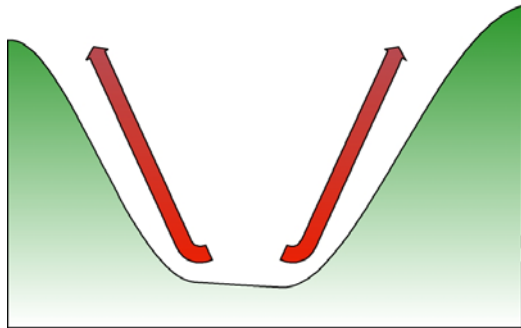
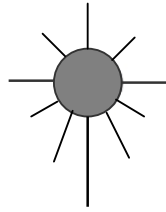
Mountains can also have another effect. Some countries have their winds come mainly from one direction. This is called the prevailing wind and is often associated with different types of weather. Consider what happens when a wind that usually brings rain comes up to a mountain. As the warm air rises the clouds are forced upwards and it rains, but once the wind has passed over the top of the mountain there is little rain left, and the land lies in a 'rain shadow.'



Is climate change happening?

Our climate is changing rapidly, and at a rate faster than what we have experienced in all of human history.

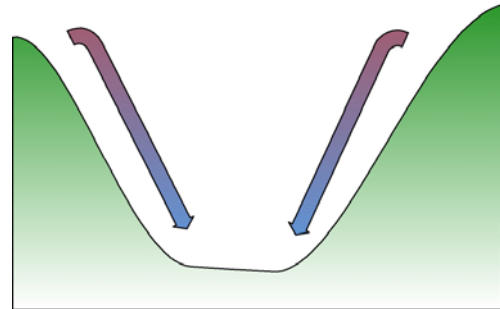
Valleys also have a local effect on climate.



The sun warms up the sides of the valley. This heats up the air in contact with the valley sides and light breezes start to blow up the sides of the valley.



At night the reverse happens in the valleys and the breezes blow down the valley sides cooling the air at the bottom.



Is climate change happening?

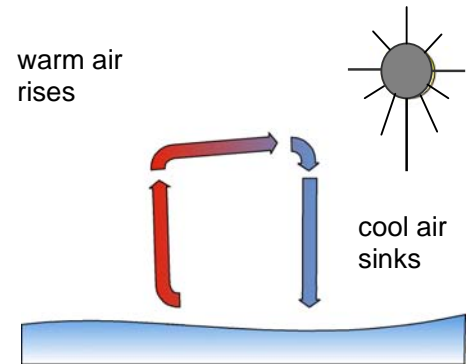
Some experts point out that natural cycles in Earth's orbit can alter the planet's exposure to sunlight, which may explain what is happening now. Earth has experienced warming and cooling cycles roughly every thousand years due to orbital shifts., but these changes have occurred over the span of several centuries.

Today's changes have taken place over the past hundred years or less!

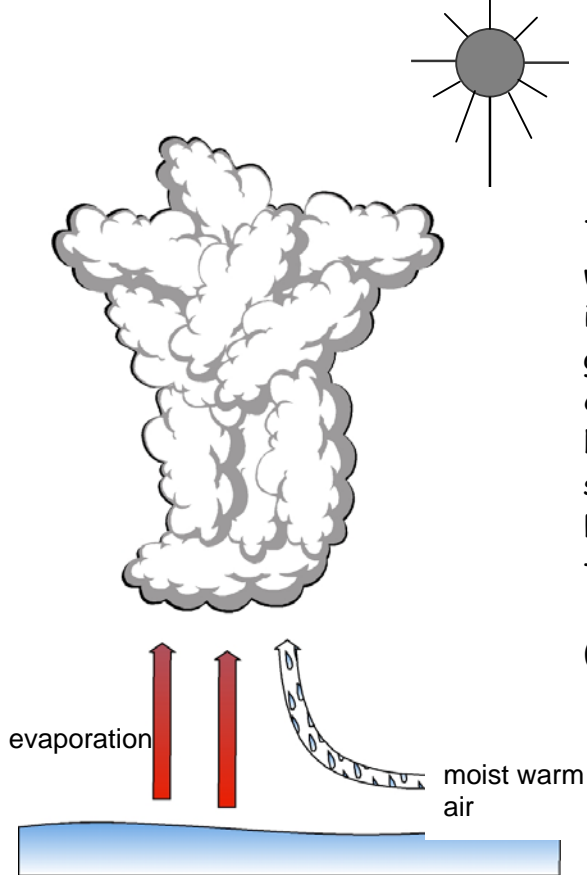
What is driving the Weather?

What appears to drive our weather is air being heated over both land and ocean by the sun. The sun's heat is absorbed by the land and ocean. If air above the land or ocean is cooler, heat energy is transferred to warm this air.

The warm air expands and becomes less dense (heavy), which means it will rise. This rising air has to be replaced, so the surrounding cool air moves in. As the warm air rises, it cools. This causes it to become more dense and stop rising. Eventually it sinks back to the Earth's surface where it becomes warmed up again.



This cycle of moving air can carry water vapour.



Those tropical afternoon showers are formed when the moist warm air above the sea rises into cold air. As the water vapour rises to great heights it condenses to form large clouds. These large tall clouds are pushed higher over the land and heavy tropical showers result. Sometimes water droplets become charged with static electricity and thunderstorms result.

(See the Booklet: What is Weather?)

Is climate change happening?
Cyclones are increasing in severity.

This circulation of warm and cold air is called a Convection Current. Convection currents can cause changes in weather over small distances e.g. the seashore or valleys. These currents also can range over large areas where huge amounts of air are moved. These large movements of air create the weather patterns.

What information do we gather about the weather and why?

The most obvious data we can collect would be:

- Air temperature
- Wind speed and direction
- Rain
- Cloud cover
- Ocean Temperatures

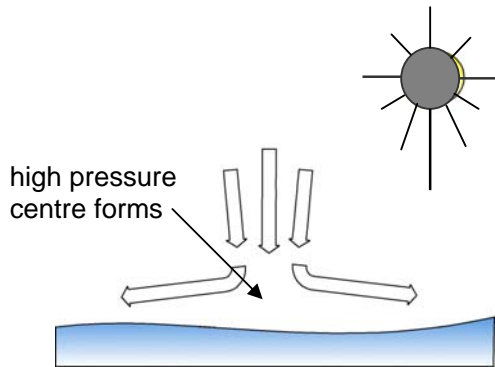
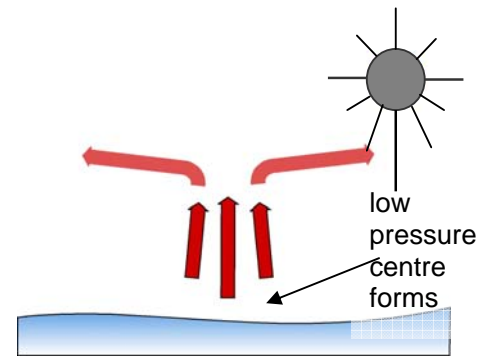
All of these measurements are useful and can be combined, along with other measurements such as air pressure and humidity, to predict weather patterns over a period of time. The historical weather data is combined to give the information that we refer to as climate. It is basically a summary of the patterns of weather data over the long term.

Air Pressure is important in our understanding of weather and climate. Air is all around us and because it is matter, it consists of particles that are bouncing off other objects and us all the time. We don't notice this because we are used to it. However these particles bouncing off us, creates a force. If we take the size of this force over a certain area, this is called pressure. At sea level air pressure is about 1 kilogram per square centimetre. Meteorologists measure air pressure in hectopascals using a barometer. 1016 Hectopascals is normal atmospheric pressure.

Now if air is to move, which we call wind, it has to have energy to flow. Just as the water in a stream or river moves from somewhere high to somewhere low, air has to do the same. Only the difference is, that air moves from areas of high pressure to areas of low pressure.

The areas of high and low pressure are created by the effect of the sun's heating the surface of the planet.

When air is warmed, it rises creating an area of low pressure on Earth's surface. Surrounding air moves in to replace this rising air. This air has come from areas where the pressure is higher.



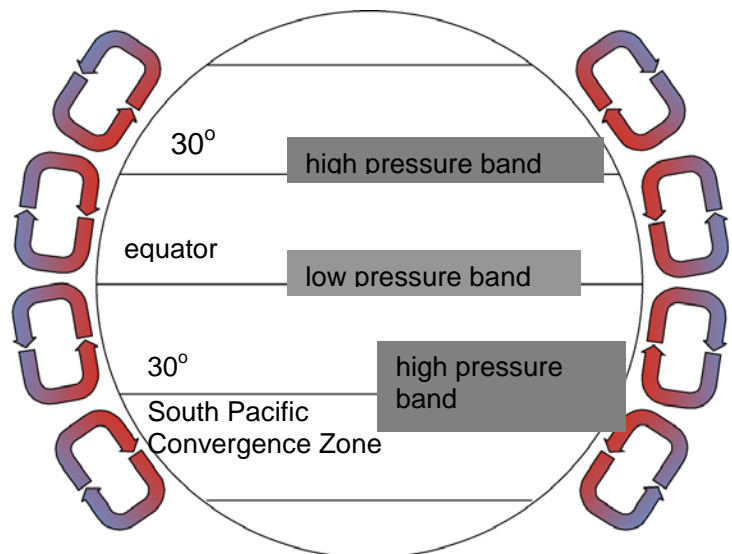
When the air rises sufficiently, it cools and falls back to the earth's surface. This air movement replaces the surface air that has moved away and creates an area of high pressure above the surface.

This also gives us air movement (wind) from areas of high pressure to low pressure.

Where the air rises it creates large areas of low pressure. One of these areas is a low pressure band that exists around the equator.

Over the Pacific Ocean's equatorial regions, warm air rises and gives a large band of low pressure. This air cools and falls at latitudes of around 30 degrees south and north of the equator.

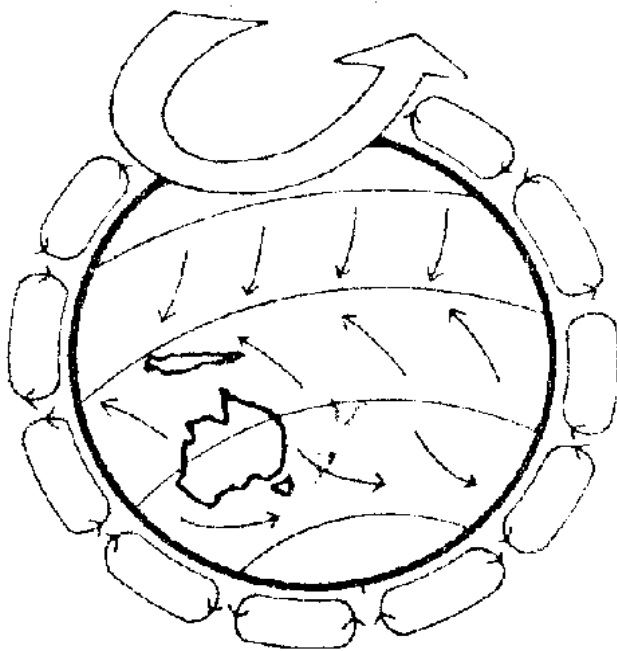
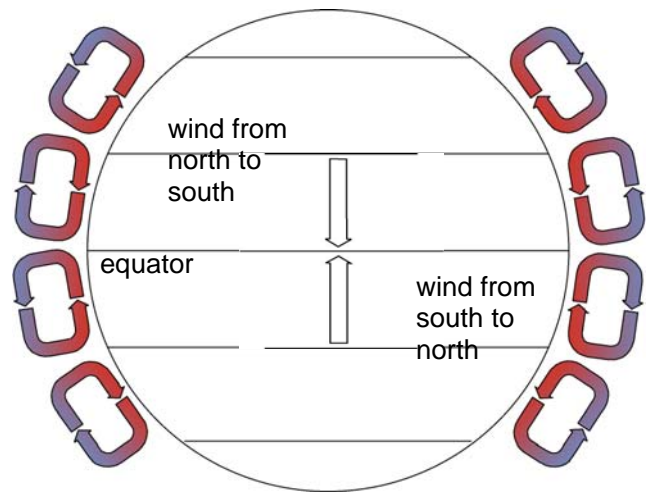
This sinking air gives a band of high pressure in the Pacific, known as the Intertropical Convergence Zone to the north and the South Pacific Convergence zone to the south of the equator. For those of us in tropical regions south of the equator, it provides the means for air movement on the surface from south to north.



Is climate change happening?

Disease carrying insects are moving into new areas as temperature increases. Global warming will expose millions of people to new health risks.

If the earth did not spin, the wind would run directly from south to north in the southern tropical regions.

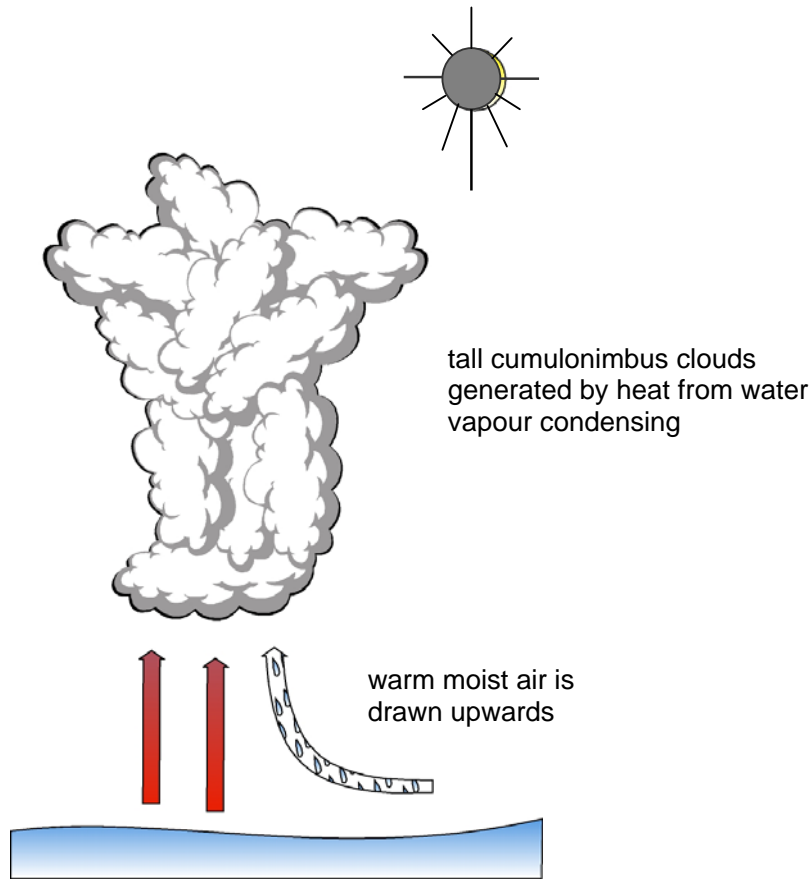


However the spinning of the Earth creates what is known as the Coriolis Effect. The result is the movement of air from the southeast to the northwest. In the South Pacific we recognise this as the South East Trade winds that often provide those tropical downpours.

The southeast trade winds move over the ocean picking up water vapour as it evaporates by virtue of the sun's radiation. The water vapour is carried north and when it reaches land it is forced upward either by high land or rising heat. This cools the moist air and gives rise to condensation and rain. Afternoon sea breezes often increase

the likelihood of rain from these moist trade winds.

Some of the trade winds may encounter areas of the ocean where the surface temperature is quite high. The air in contact with the ocean is warmed and starts to rise. Naturally, as moist air rises the water vapour starts to condense to form droplets of liquid water. The heat energy that is released when water vapour condenses, pushes the air further upward. The result is very tall cumulonimbus clouds that can result in very heavy rainfall.



These can further develop into cyclones .

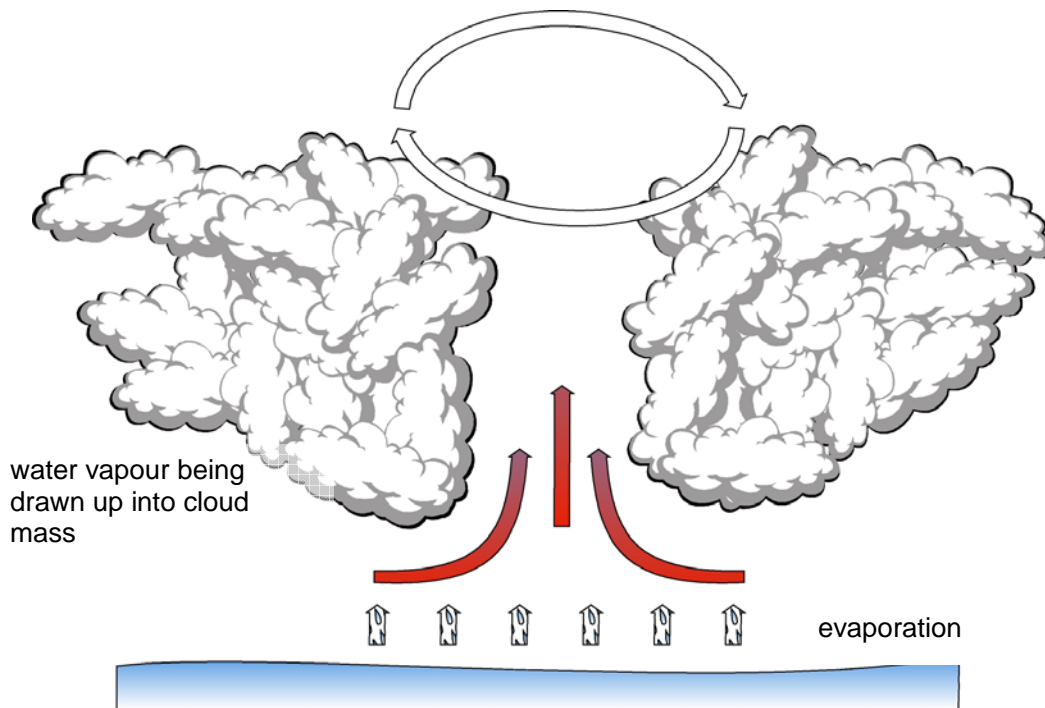
Cyclones.

There are times when the air rising over the warm regions of ocean can form areas of extreme low pressure. This happens when the sea temperatures are above 29°C. The convection currents start spiralling around this low pressure centre, causing rotation. The winds spiral clockwise in towards the centre of the low pressure area picking up more moisture from the sea. At the centre, the air rises upwards, with the water vapour condensing to give high cloud formations and heavy rainfall. As long as the low pressure centre remains over the warm ocean, there will always be energy to continue feeding the system.

The amount of water in the system builds up and wind and rain intensify. The system becomes a tropical cyclone.

Is climate change happening?

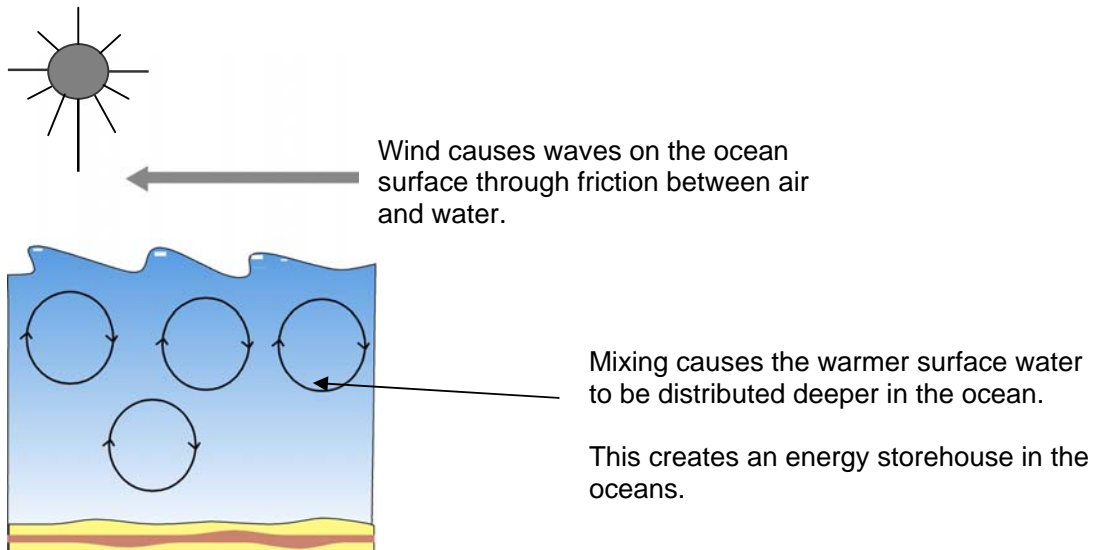
A follow up report released by the IPCC released in April 2007 warned that global warming could lead to large scale food and water shortages and have catastrophic effects on wildlife.



When the tropical cyclone has moved over land or cooler water, there is no energy to feed the system and the cyclone will die away. In the meantime the amount of energy and rain can do a great deal of damage.

Where does Argo fit into this?

Argo floats take on an important role in helping to assess the amount of heat energy being transferred from the ocean to the air. Sea temperatures change more slowly than the air temperature and heat energy is stored through warming of the lower layers of water.

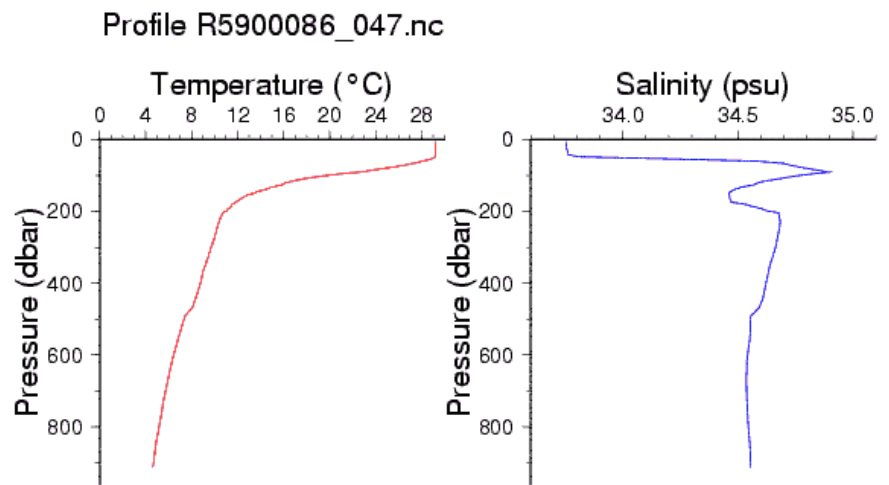


An Argo float is dropped into the ocean, where it sinks up to depths of 2 kilometres. It then travels for a period of 10 days in the ocean currents at these depths, before it rises to the surface. On its way up it measures the temperature and salinity of the water. The temperatures and the temperature depth profile indicate how much heating has been occurring due to the sun, while the salinity measurements also indicate the amount of evaporation that has taken place. High salinity on the surface means salty water due to high rates of evaporation. We would expect to find this over the equatorial regions of the Pacific, and we are familiar with the moist, warm tropical air, which results from this evaporation.

The information helps scientists link the weather we experience on the earth's surface with what is happening in the oceans.



An Argo Float



Temperature and Salinity Profile from Tropical Waters

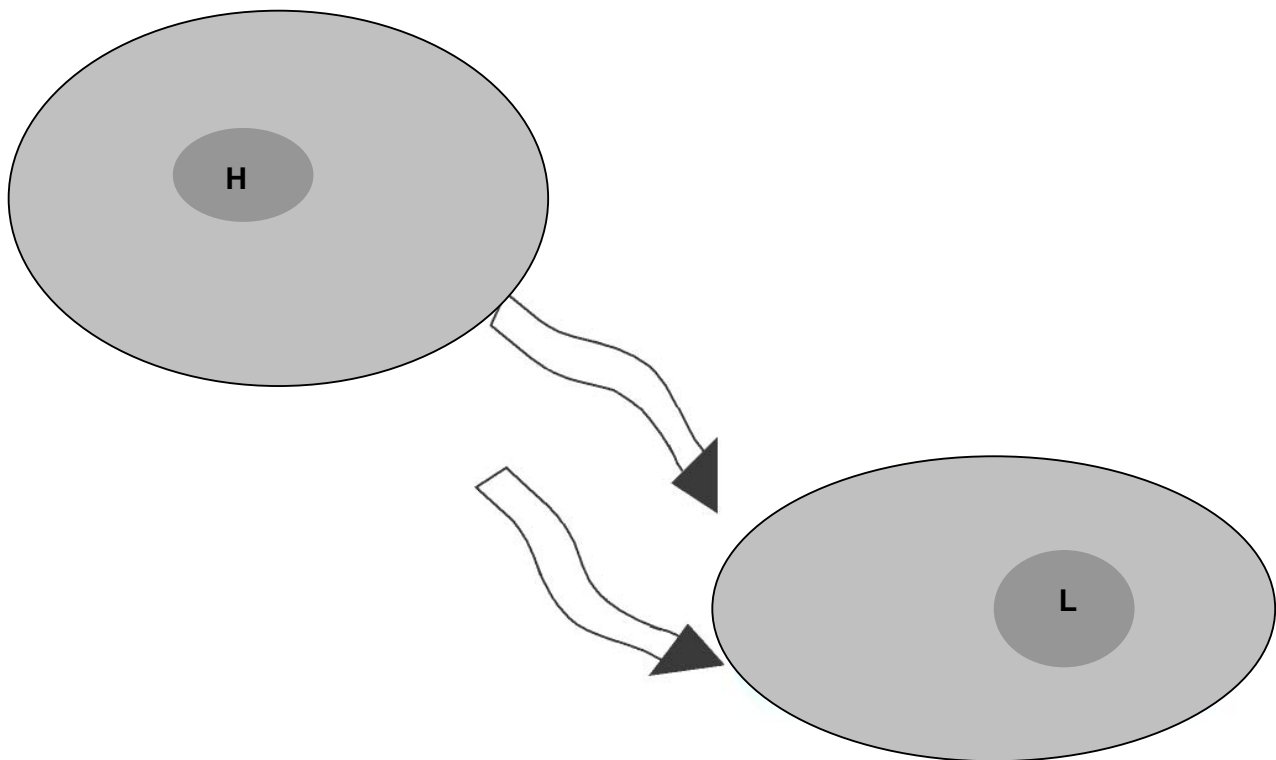
Is climate change happening?

Glaciers around the world could melt, causing sea levels to rise while creating water shortages in regions dependent on runoff for fresh water.

Weather on the move.

Just as water is on the move so are the high pressure centres in the air. Just above earth's surface, air moves from the high pressure areas to the low pressure areas. But very high up in the troposphere there are high level winds that move these pressure centres. These winds are called jetstreams.

As the pressure centres move they will influence one another. If a high pressure centre moves towards a low pressure centre, air will flow from the high pressure centre towards the low pressure centre. If there is a large pressure difference between the two, the air will move faster and give strong surface winds. Conversely when there is little pressure difference we experience only the light breezes as the air moves out slowly from the high pressure centre.

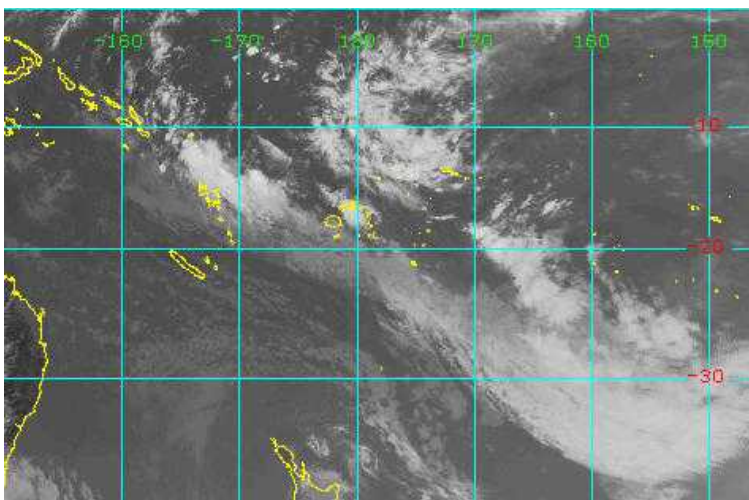
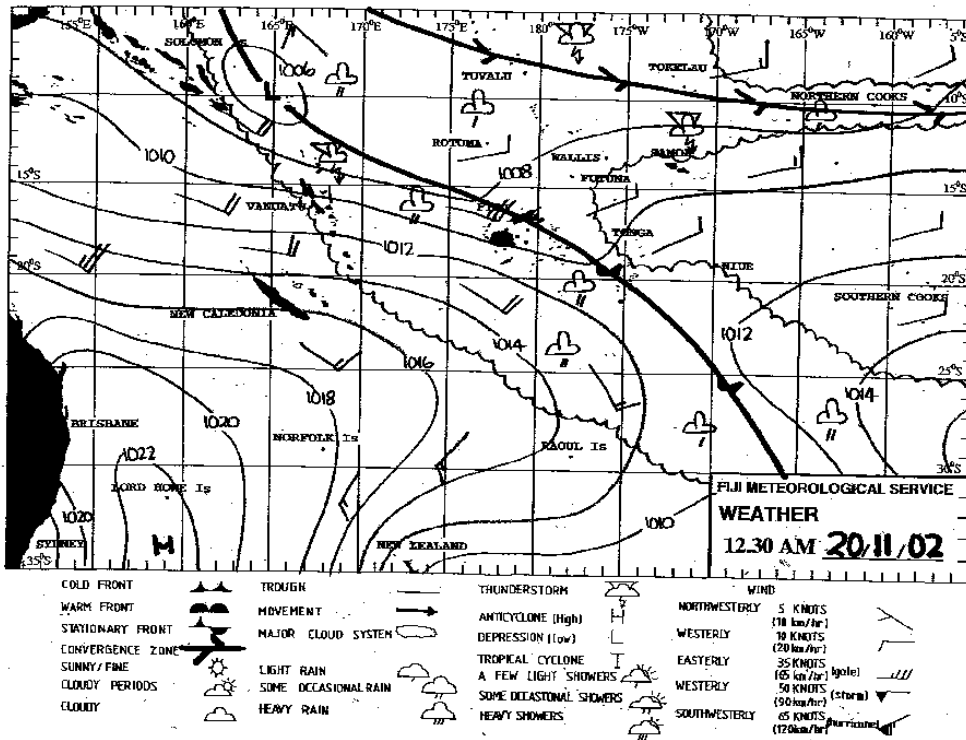


Is climate change happening?

Strong hurricanes, droughts, heat waves, wildfires and other natural disasters may become common place in many parts of the world.

Weather Map

A weather map shows a series of lines called isobars. Each isobar represents a particular value of air pressure at sea level.



Satellite picture that corresponds to the weather map above

The air spirals around the high and low pressure areas. In the South Pacific the air spirals anticlockwise around the high pressure areas and clockwise around the low pressure regions. The surface winds do not blow directly from the high to low pressure centres, but spiral outwards and flow more or less in a direction parallel to the isobars.

When the lines are widely spaced the winds are gentle, but when the lines are squeezed close together we are looking at big differences in air pressure over small distances and this means strong winds.

Given this information the weather map can be used to predict wind direction and strength. Often this wind direction and strength will give us an indication what weather that may be coming, that's one reason why recording weather conditions can be useful.

If this is weather, what is climate?

Compiling all of this information helps establish long term weather patterns. These patterns we call climate.

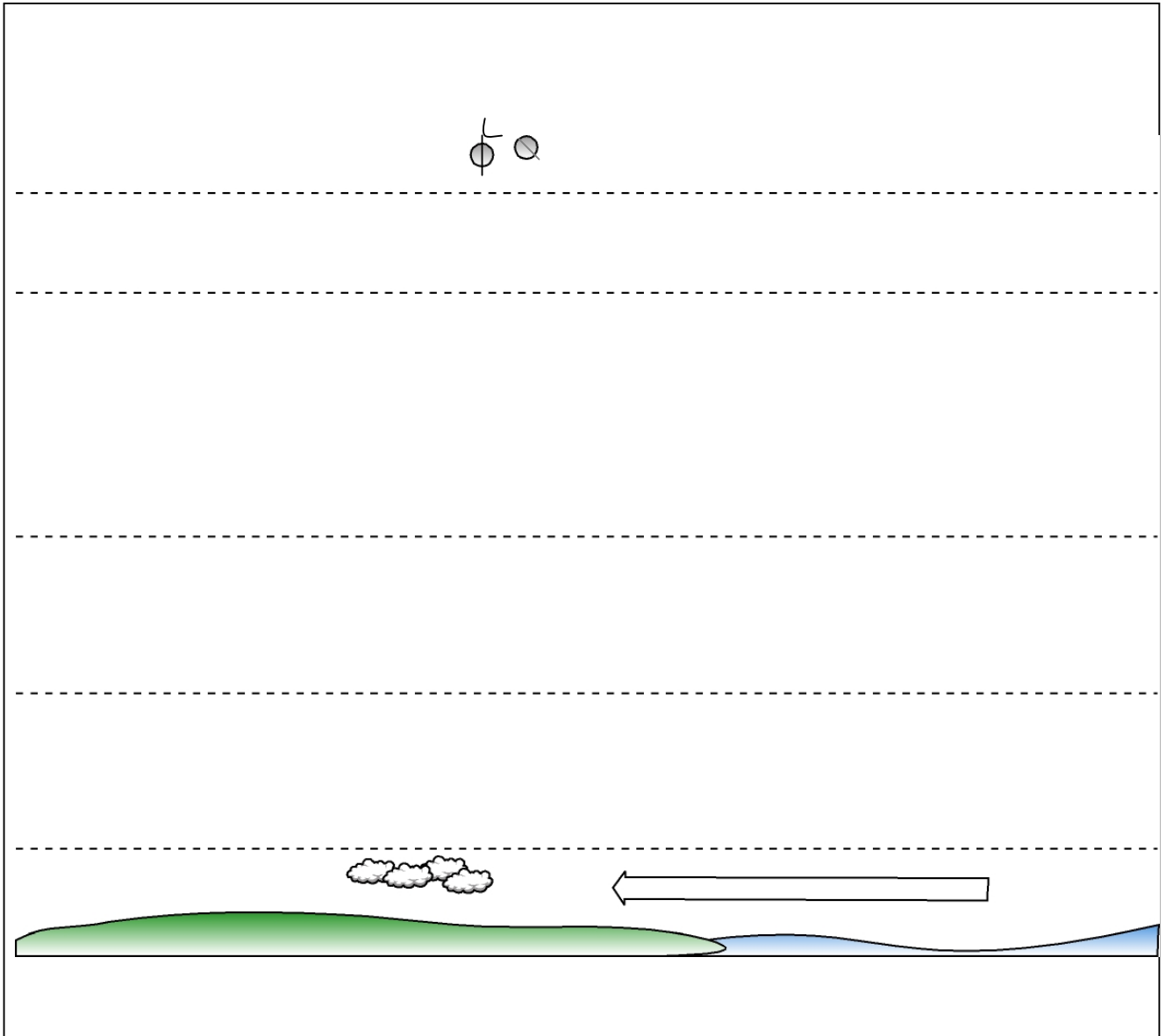
Looking back on these patterns helps to establish whether changes are occurring and what type of change it may be. The scientific data collected by Argo and other sensors as well as human observations helps to make models about possible changes and make predictions on future weather patterns.

Activities:

Activity 1: Layers in the Atmosphere:

The picture shows the atmosphere above the earth's surface.

EARTH'S ATMOSPHERE



The labels are a series of facts that relate to each of the layers. They are not in the correct order.

Cut out each of the labels and put it on the picture where you think it fits.

The air in the **exosphere** is very thin. There is very little air here. The top of the layer is 900km above the ground.

The top of the **stratosphere** is about 50km above the ground. The temperature at the top of this layer is 0°C. It cools down as you get lower. This is where we find the ozone layer.

The **thermosphere** contains gases, which absorb some of the sun's harmful rays. The top of this layer is 450km above the surface and the temperature here is 2000°C.

The **magnetosphere** is the top layer. There are no gases, but it still stops some of the harmful particles reaching earth's surface. This is where we would find weather satellites.

The **troposphere** varies in height from between 10km and 20km. The temperature at the top is about -50°C, but it warms up as you get lower. This is where there is the most air and what we call weather is found.

The **mesosphere** reaches a height of 80km above the surface of the earth. The temperature at the top is about -100°C. It warms up as you get lower.

What we want children to learn:

- The atmosphere is made up different layers. Each layer has its own characteristics.
- Our weather is found in the lowest layer: the troposphere.
- The atmosphere extends 900km above the surface of earth.

Activity 2: The Heating Effect of the Sun on Earth's Surface

This activity is to help you understand the heating effect of the sun on the surface of the earth and why some places are warmer than others.

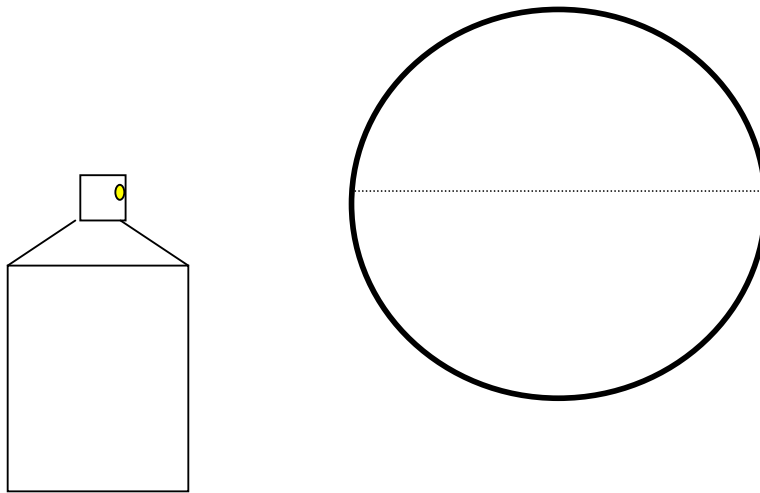
What you will need: A large ball, such as a soccer ball or white balloon. Cover this ball in white paper. (This will represent the surface of the earth.) A tin of yellow spray paint. (alternative: spray bottle from household cleaners or hairspray.)

What to do:

Draw a line around middle of the ball. This represents the equator.

Hold the spray can about 20cm from the ball and point the nozzle at the equator.

Just as the picture shows. Squirt just enough paint to cover an area. (A short burst should do!)

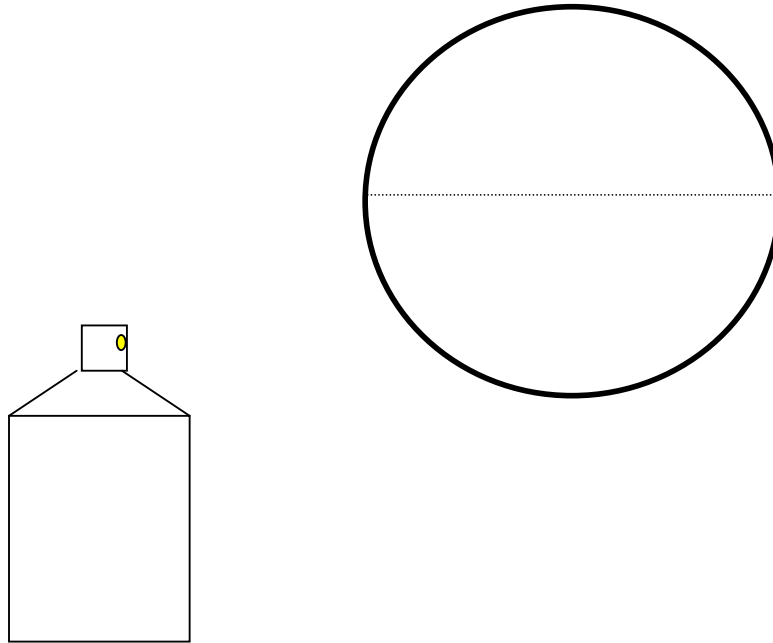


Mark and measure with a pen the area the area the paint covers.

Predict: What do you think will happen to the area of paint if the can is held lower than the equator.

Now hold can of spray lower down the face of the ball. Just as the picture shows.

Spray the area for same length of time and from the same distance as before.



Observe: How much of an area does the paint cover this time.

Explain:

Why is there a difference in the area that the paint covers?

Can you compare the colour to the distribution of heat from the sun?

How do you think this shows how much heat the earth receives from the sun?

Why do you think it is warmer around the equator than further south towards the polar regions?

Which areas of the planet would have the warmest seas?

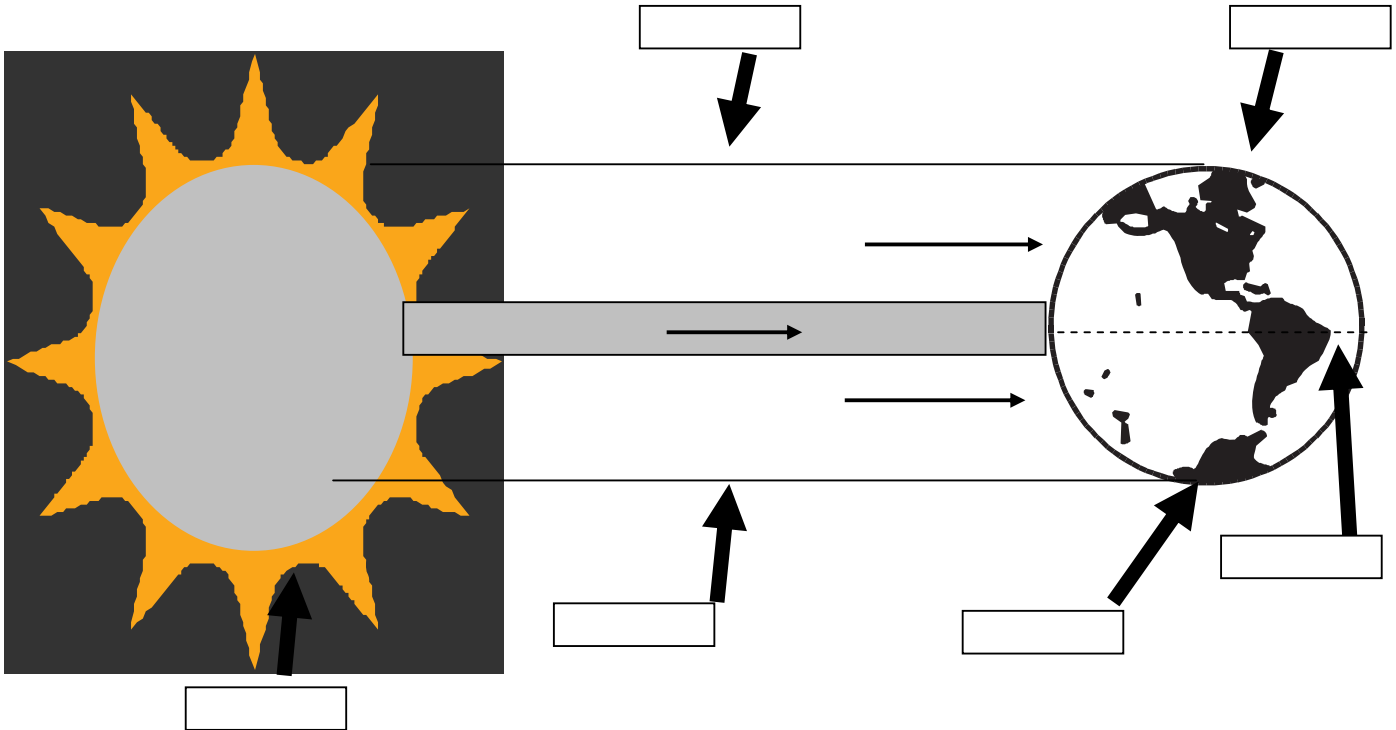
What difference do you think this would make to the amount of water that would be evaporated from the surface of the sea?

Which parts of the planet do you think would have the highest rainfall and the highest temperatures?

Now complete the questions and diagram below.

Look at the diagram below. Use the words below to label it:

Sun, sun's rays, equator, north pole, south pole.



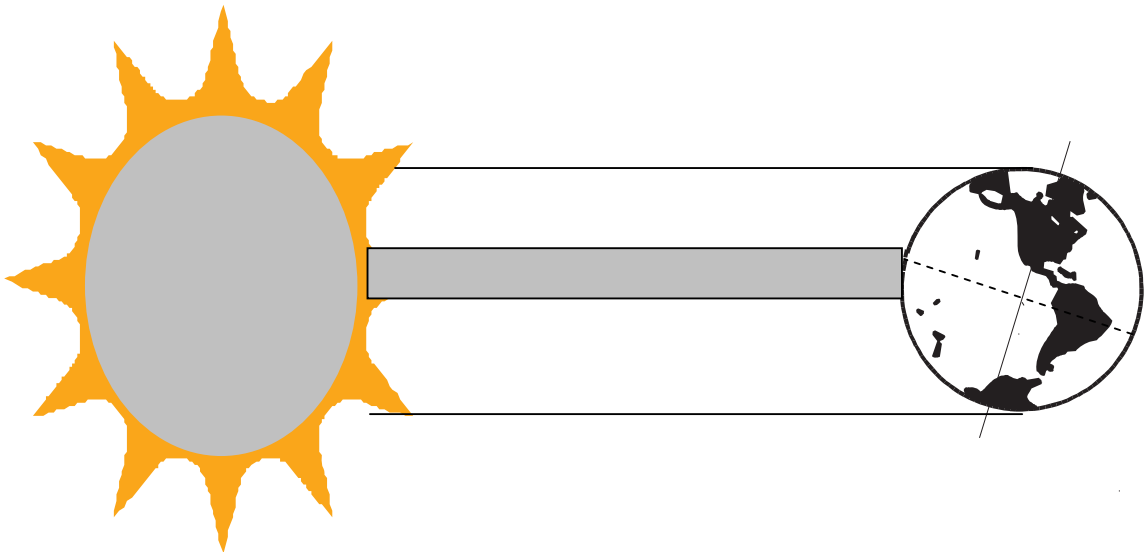
Colour in the areas of the world, which you think are the coldest. Colour these blue.

Colour in the hottest areas red.

A Step further: We recognise that the weather changes at certain times of the year. We call these seasons. Some places have a wet and dry season, others spring summer, winter and autumn.

Why do we have different seasons?

The earth actually goes around (orbits) the sun on a tilt.
Look carefully at the picture below.



Colour in the areas of the world, which you think are the coldest. Colour these blue.

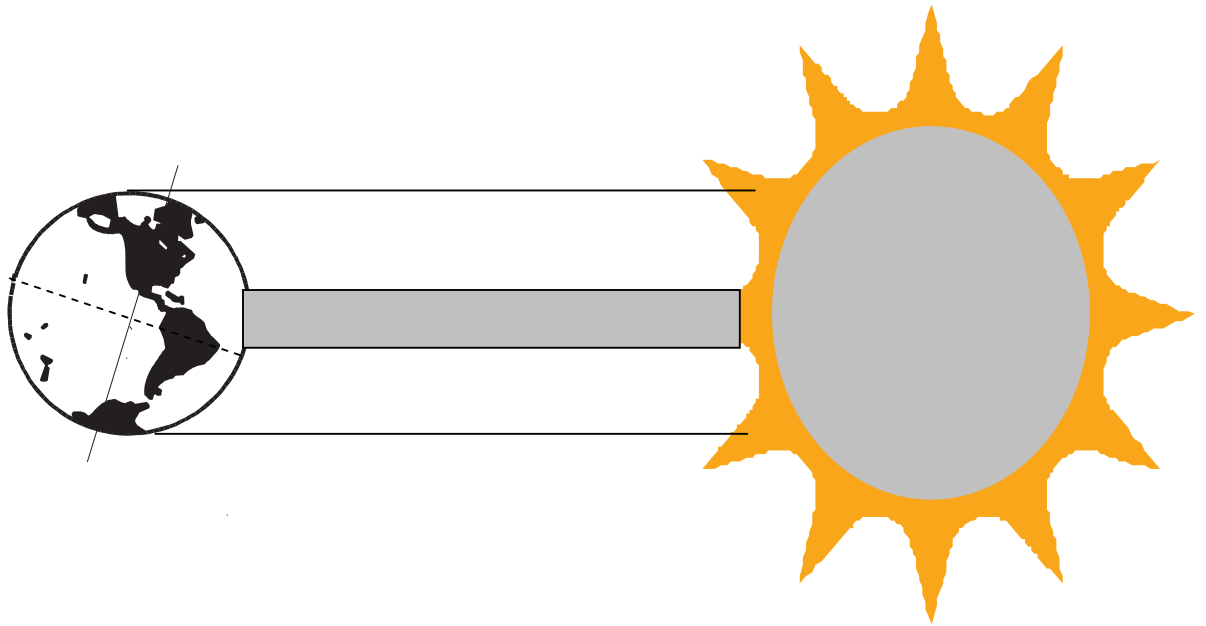
Colour in the hottest areas red.

How different is it from your first picture you coloured in?

Write summer, south of the equator, and write winter, north of the equator,

Now 180 days later the earth is half way around the sun in its orbit. That's half a year.

The picture below shows the earth in its new position as it travels around the sun.



Colour in the areas of the world, which you think are the coldest. Colour these blue.

Colour in the hottest areas red.

How different is it from your first picture you coloured in and the second picture?

Can you explain why there are differences in the hot and cold areas of the earth?

What is the result?

Draw out a large picture of the earth like the one below. Put your country on the map.



Use the pictures you have drawn in the previous exercise.
Colour in the area of the earth that you think will be the hottest part all year round. This area is closest to the sun.
These are known as the 'tropical' regions of the planet.

Colour in the two areas of the earth that you think will be the coldest.

The sun's rays are not so strong here, so they would be coldest.
These are the polar regions.

The area in between the tropics and the polar regions are known as the temperate regions. It is common to experience four seasons in these regions. Colour this area green.

Some more information:

We can look closely at the weather patterns of the world. The climate types you have coloured in earlier can be split up further. There are many climate types and they depend on whether the land is close to the sea or inland.

See if you can find an atlas that has the different climate types shown on the map.

What climate group does the country you live in belong to?

On your world map draw and colour in the different climate types around the world.

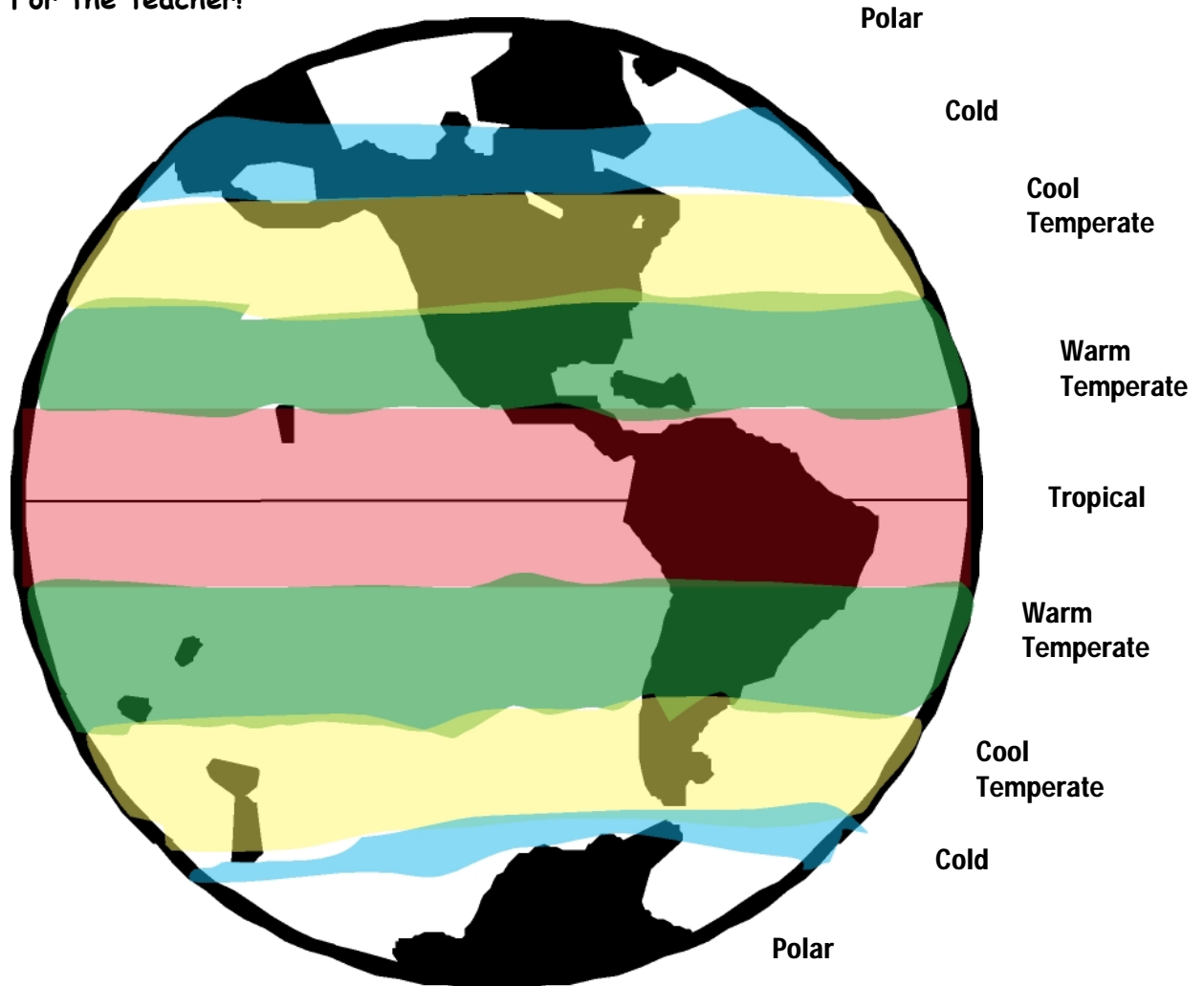
As climate changes and the planet warms, how do you think this map is going to change?

This is what scientists are working on when they talk of climate change.

What we want children to learn:

- The position of the sun over earth's surface changes through the year.
- This change occurs because the earth rotates on a 22.5 degree angle as it orbits around the sun.
- One complete orbit of the sun is equivalent to one year.
- The sun appears to pass over the equator twice a year, March and September.
- The movement of the sun over earth's surface creates seasonal weather patterns and climatic regions on the planet.

For the teacher!



This is a representation of the general climates that exist around the Pacific region.

Activity 3: What is Air Pressure?

These activities will hopefully show you what air pressure is and how weather scientists measure air pressure.

Activity: Does air weigh anything?

What you will need: 2 balloons. A stick or length of bamboo about 45cm long. String. Piece of Sellotape. Measuring cylinder. Tubing

What to do:

Blow up the balloons so they are about the same size.

Suspend the stick from the piece of string.

Put a piece of Sellotape on each balloon.

Tie the balloons onto the stick. Move the balloons so they balance each other.

Prick one of the balloons carefully through the Sellotape.

Observe: What has changed?

Explain: Why has this happened?

What does this tell you about the particles in air?

Extension: Can you use the other gear to work out the volume of air in the balloon?

For the Teacher: as the air moves out of the balloon, it gets lighter so the other balloon goes down, Air particles have mass (weight).

Activity: A simple demonstration of the effect of air pressure.

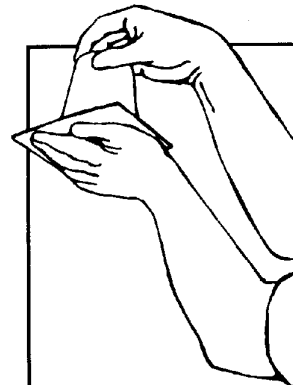
What you will need: a glass or paper cup. A stiff piece of cardboard big enough to completely cover the glass. A jug of Water.

What to do:

Fill up both glasses to the brim with water.

Slide the piece of card over one of the glasses of water.

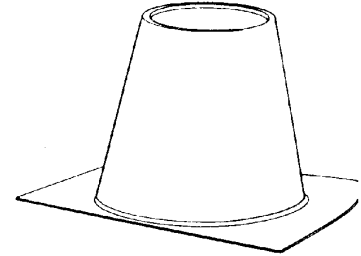
Make sure there is no air between the water and the card.



Gently turn the glass with no card upside down.

Gently turn the glass with the card upside down, whilst holding the card in place.

When the glass is upside down, take your hand off the card.

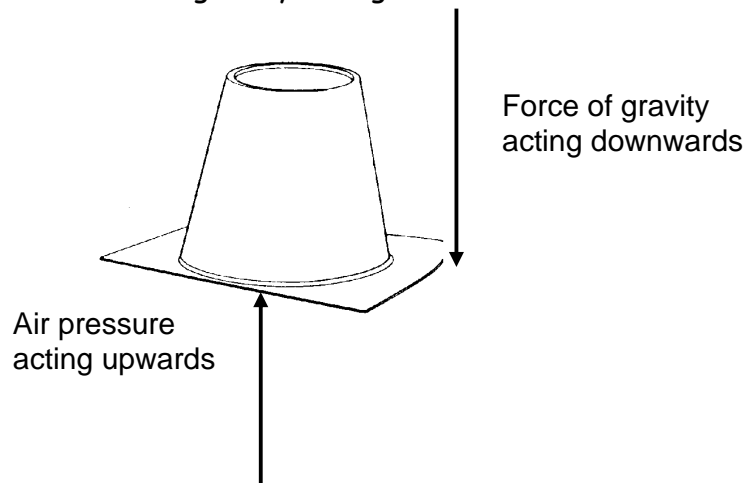


Observe: What happens when the glass are turned upside down?

Explain: Can you explain what has happened? What is holding the card in place?

For the teacher:

The explanation can be put simply as the air pressure on the underside of the cardboard balances the force of gravity acting on the water above the card.



What we want children to learn:

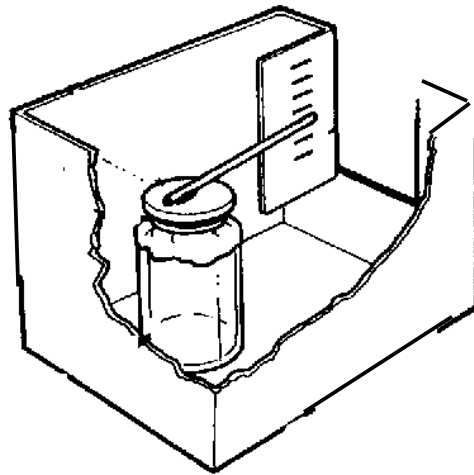
- Air has weight.
- The air exerts a force on us even though we don't realise it.
- The force is spread over the surface of the earth.
- The size of the force is measured as air pressure.

Activity 4: A “do it yourself” barometer

What you will need: Jam jar. Balloon. Elastic Band. Drinking straw. Cardboard Box. (a shoe box will do). Clingfilm. Blu-tack or sticky tape. Fish tank.

What to do:

Warm the jar in hot water.
Cut off the neck of the balloon and stretch it over the jar.
Fasten it with the elastic band to make sure it is airtight.
Glue or tape one end of the straw to the middle of the balloon.
Place the jar in the cardboard box and mark the box behind the straw with a scale marked in centimetres. (Tape a ruler to the box)



To test the barometer.

Put the barometer in an empty fish tank. Cover the fish tank with the cling film. Press down gently on the cling film. What do you notice happen to the end of the straw? Does it move up or down? Is this high or low pressure?

Using the barometer:

At the same time each day record the weather and the pressure on the barometer.

What pattern do you notice between the measurements you made on the barometer and the weather each day?

What do we want children to learn:

- Air pressure changes over of days.
- Changes in air pressure can relate to changes in weather.

Activity 5: Weather Watch

The purpose of this activity is to make up a daily of record of information regarding the weather, and from this possibility work out weather patterns.

This activity will also fit in with various mathematics activities, such as graphing and averages.

The activity requires the students to put together their own measuring instruments for recording weather details. These include rain gauges and wind vanes. A thermometer is the only specialised piece of equipment needed. (It may be possible to obtain a maximum and minimum thermometer.)

To start with: **Introduction to Weather Watch**

Some Questions to think about:

Why is important to study weather?

What are some of things that you would like to know about the weather every day?

What kinds of information is it important to collect?

Is there a better way to study (or monitor) weather than just describing it in words and pictures?

What kinds of instruments could you use to collect information about weather each day?

(Their answers don't have to be specific; They may have responses such as: "something to tell where the wind is coming from".)

What things should these instruments measure?

Some focus questions: (these can be asked after the above introductory questions)

How can we tell which direction the wind is blowing from?

How can we tell how fast the wind is blowing?

What kind of container would be good for collecting rain?

How could rain be measured?

Step One: Choose the site and the time.

The best place for a weather station is out in the open. A garden is a suitable place. Buildings and tall trees can cause problems, so keep away from these. It would help if there was a suitable shady place out of direct sunlight for the thermometer.

The best time to record this information is around midday. It does not have to be exact as an hour either side is fine.

Step Two; Measuring Temperature.

What you will need: Thermometers, a Maximum and Minimum Thermometer.

The thermometer is best placed about 1.2 to 1.5m off the ground. It should be partly in the shade. Hang the thermometer off a fence.

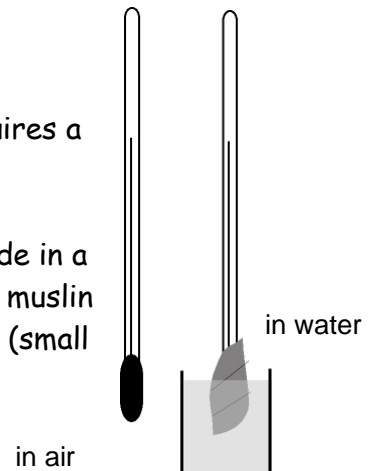
You may be able to use a maximum and minimum thermometer, which is even better. The maximum and minimum temperature for the previous 24 hours as well as the current temperature can be recorded.

Step Three: Measuring Humidity.

Humidity is a measure of the amount of water in the air. It requires a wet and dry bulb thermometer.

A simple version of this is to place two thermometers side by side in a shady place. One of the thermometers has some cotton wool or muslin wrapped around it. The end of the cotton wool is dipped in a tub (small yoghurt pot) of water.

The diagram shows how this is set up.



To find the humidity, read the temperature of the dry thermometer. Work out the temperature difference between the dry and wet thermometers.

The humidity (as a percentage) can be found by reading the temperature difference against the dry temperature on the table below.

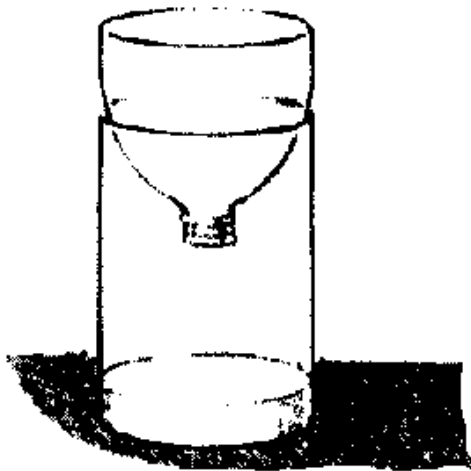
Difference between the wet and dry thermometers

Temperature of the dry thermometer	1oC	2oC	3oC	4oC	5oC	6oC	7oC	8oC	9oC	10oC
10 - 14oC	85	75	60	50	40	30	15	5	0	0
15 -19oC	90	80	65	60	50	40	30	20	10	5
20 -24oC	90	80	70	65	55	45	40	30	25	20
25 -29oC	90	85	75	70	65	55	45	40	30	25
30 -34oC	95	85	80	75	70	60	55	50	45	40
35-40oC	95	90	80	75	70	65	60	55	50	45

Step Four: Measuring Rainfall

What you need: A large plastic drink bottle. Craft knife. Ruler or measuring cylinder.

What you do:



Cut the top off the bottle just below the shoulder. Turn the top upside down to make a funnel. Push this back inside the cut off rim of the bottle.

Find a clear area of ground. Dig a small hole in the ground to fix the rain gauge in position. This will stop it getting moved around. (Sand helps keeps it in place and it is easy to take the bottle out and put it back in place again.)

Use a ruler to mark a scale on the side of the bottle. The scale can be in cm or in mls of water.

At the same time each day: Measure the amount of water in the container by either tipping it out into a measuring cylinder or measuring the height of the water in the bottle.

Remember tip out the water each day.

Step Five: Measuring Wind

Measuring wind direction.

What you need: Craft knife, Shoe box, Card, Protractor, A piece of 5 mm dowel (1m long), Strong tape, marker pen, Book covering plastic (if available). Pen cap or the end of a broken biro. (It needs to be big enough to fit over the dowelling.)

What to do:

Use the plan on the next page to draw out the wind vane.
Cut it out.

Score a line down the centre and fold in half.

Stick the folded halves together.

Cover one side of the wind vane with the protective plastic then fold the plastic over the other side.

Stick the pen cap to the vane.

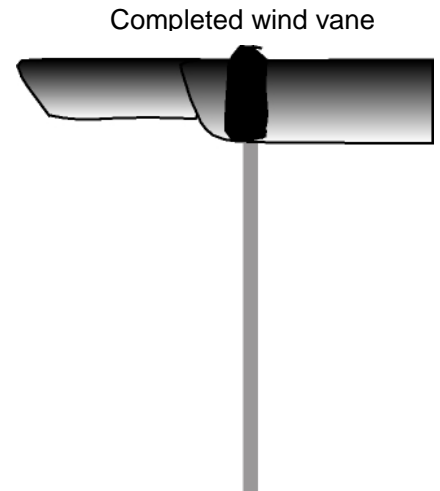
Find a post or fence that is out in the open.

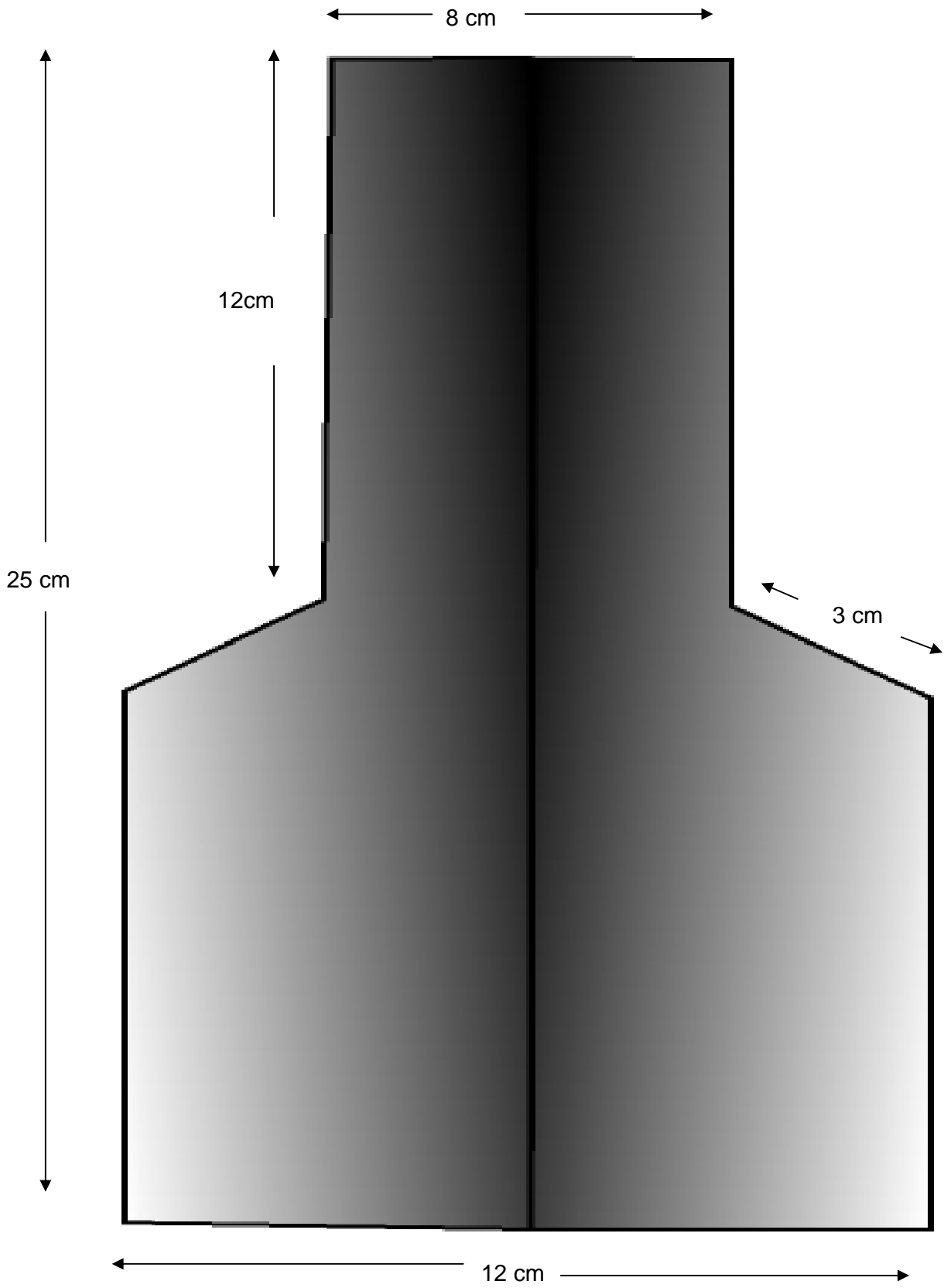
Fix the piece of dowel to the post or fence. (Use clips if possible) Make sure it is vertical and the weather vane spins freely when put on top.

Let the vane spin in the wind. It will spin in the wind and point to the direction the wind is coming from.

You will need to mark out the directions north, south, east and west. Use a compass or better still a map. (This will give you true north.)

Use landmarks to give you a reference point for the directions.





Measuring Wind Speed;

There are two ways to measure the wind speed. Firstly there is an anemometer.

Activity: Making an anemometer.

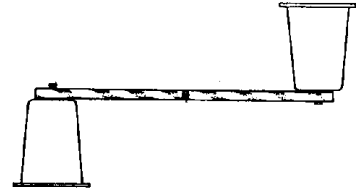
What you will need:

Two yoghurt pots, drinking straw, pins, a post, tape.

What to do:

Fix the pots to the straw using the pins.

Place the wind speed machine on a suitable post so that it spins.



Observe: Record the number of turns in 10 seconds.

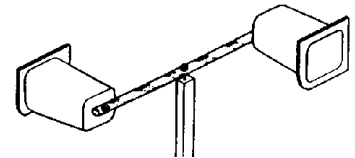
Do this four times and work out the average wind speed.

Other things to try:

Try comparing the wind speed at different heights.

Try making an anemometer with four cups instead of two.

Make up a record of the average number of turns for different wind speeds.



Activity: Wind Speed box.

What you will need: Craft knife, Shoe box, Card, Protractor, A piece of 5 mm dowel (wider than the box.) or metal rod, Clear plastic sheet, Strong tape, Marker pen.

What to do:

On the clear plastic sheet and using the protractor and marker pen, mark off 5 degree intervals between the angles of 0 and 90 degrees.

Cut the ends off the shoe box and lid you have a wind tunnel.

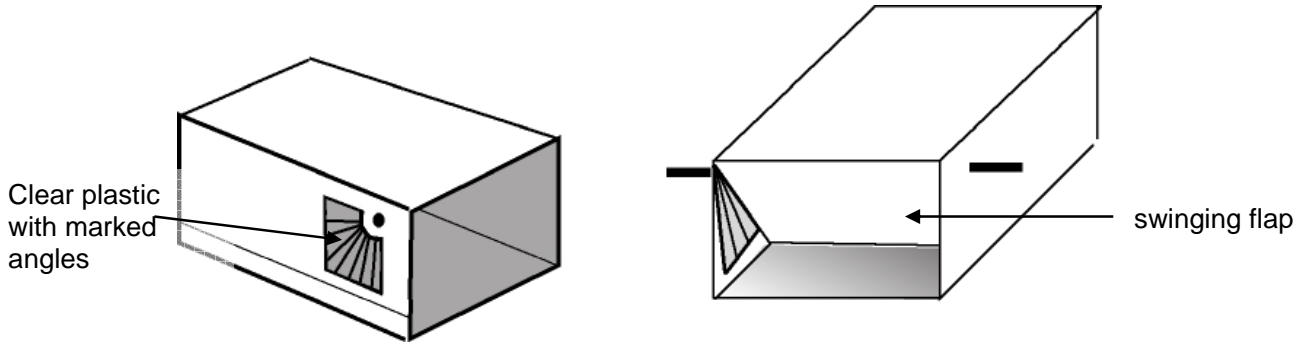
Cut a hole near one end like the one shown in the diagram.

Stick the clear plastic film with the scale on the inside. It should be clearly seen through the hole in the side of the box.

Using the cardboard from one of the end you cut out earlier, cut it so it slightly smaller than the end of the box. Fix it to the rod. Check that the flap you have made swings freely.

Make a hole in the side of the box above the scale and directly on the opposite side.

Push the rod through the holes. Move it around to make sure it can rotate freely.



Observe: Hold the box so it faces into the wind. Measure the angle of the flap. Use the table to work out the wind speed

Angle (degrees)	Speed (km/hr)	Angle (degrees)	Speed (km/hr)
90	0	50	28-30
85	8-11	45	31-33
80	12-14	40	34-36
75	15-17	35	37-39
70	18-20	30	40-43
65	21-23	25	44-48
60	24-25	20	49-54
55	26-27		

Activity: Wind Speed and the Beaufort Scale

Observations of the sea and trees can be used to give an idea of the wind speed. The scale that is used for these is called the Beaufort Scale and is used to represent wind strength.

The table below represents some observations related to wind speed:

Beaufort Wind Force Number	Name	Average Wind Speed (km/hr)	Land observation.	Sea observation.
0	Calm	0	Leaves don't move	Sea like a mirror
1	Light Air	1-5	Smoke drifts slowly Leaves don't move	Sea is slightly rippled
2	Slight Breeze	6-11	Smoke shows direction. Leaves rustle	Small wavelets which don't break
3	Gentle Breeze	12 -19	Twigs and large palm leaves move. Small flags extended.	Large wavelets. The crests just begin to break
4	Moderate Breeze	20 -29	Small branches move Flags flap	Waves with whitecaps
5	Fresh Breeze	30-38	Small trees sway. Flags flap and ripple	Moderate waves with many whitecaps
6	Strong Breeze	39-50	Large branches sway Flags beat and pop	Larger waves with regular whitecaps
7	Moderate Gale	51-61	Whole trees sway.	Large waves Sea heaps up. White foam streaks
8	Fresh Gale	62-75	Twigs break off trees	Moderately high sea with foam blowing off the tops
9	Strong Gale	75-86	Branches break of trees	High crested waves
10	Whole Gale	87-101	Trees blown down. Building damage	High waves. Churning white seas.
11	Storm	102-120	Widespread damage to trees and buildings	Mountainous seas, covered in white foam
12	Cyclone	120+	A lot of damage	Air is filled with spray. Sea is completely white.

A mix and match activity: The boxes are all jumbled up. The wind speeds do not match the descriptions. Cut the sheet up to match the wind speeds to what you think are the correct descriptions. (The boxes in bold are correct!)

Beaufort Wind Force Number	Name	Average Wind Speed (km/hr)	Land observation	Sea observation
0	Calm	0	Branches break of trees	Moderately high sea with foam blowing off the tops
5	Light Air	1-5	Smoke drifts slowly. Leaves don't move	Mountainous seas, covered in white foam
1	Slight Breeze	6-11	Small branches move. Flags flap	Small wavelets which don't break
8	Gentle Breeze	12 -19	A lot of damage	Large wavelets. The crests just begin to break
11	Moderate Breeze	20 -29	Leaves don't move	Sea like a mirror
2	Fresh Breeze	30-38	Small trees sway. Flags flap and ripple	Large waves Sea heaps up. White foam streaks
10	Strong Breeze	39-50	Trees blown down. Building damage	Air is filled with spray. Sea is completely white
9	Moderate Gale	51-61	Whole trees sway	High crested waves
3	Fresh Gale	62-75	Twigs break off trees	Larger waves with regular whitecaps
12	Strong Gale	75-86	Twigs and large palm leaves move. Small flags extended	Moderate waves with many whitecaps
6	Whole Gale	87-101	Widespread damage to trees and buildings	High waves. Churning white seas.
4	Storm	102-120	Smoke shows direction. Leaves rustle	Sea is slightly rippled
7	Cyclone	120+	Large branches sway Flags beat and pop	Waves with whitecaps

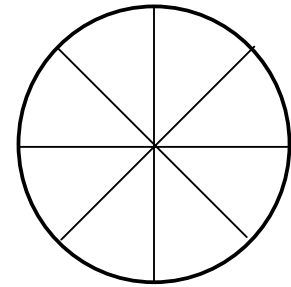
Note for Teacher: the last two activities can be matched together. The wind speed from the wind box can be linked to the Beaufort Scale above.

Step Six: Measuring Cloud Cover

There are two things to look for with clouds. One is the amount of cloud cover; the other is the type of cloud.

Activity: Cloud cover.

What you need: A clear space and open-mindedness.
A piece of clear plastic with a circle on it. The circle is split up in eight segments.



What to do: Lie on the ground or stand and look around you.
Hold the clear piece of plastic in front of you.
Estimate the amount of cloud cover, out of a factor of 8.
Use the chart below.
Check your value out with 3 others. Do you all agree?
Decide amongst yourselves what is the best value. (No answer is wrong!)

Cloud Cover Scale

0 out of 8	no cloud
1 out of 8	very little cloud
2 out of 8	about a quarter of the sky is covered
3 out of 8	
4 out of 8	about half of the sky is covered
5 out of 8	
6 out of 8	about three quarters of the sky is covered
7 out of 8	nearly all the sky is covered. Very few blue patches
8 out of 8	total cloud cover

Step Seven: Cloud Types:

What you need: a clear space

What to do:

Guessing the type of cloud is not easy. There are four main types:

Cumulus: the fluffy cotton wool clouds.

Cirrus: high streaky clouds.

Stratus: sheet or layer cloud.

Nimbus: Rain clouds.

Take a look at the clouds and compare them to the pictures.

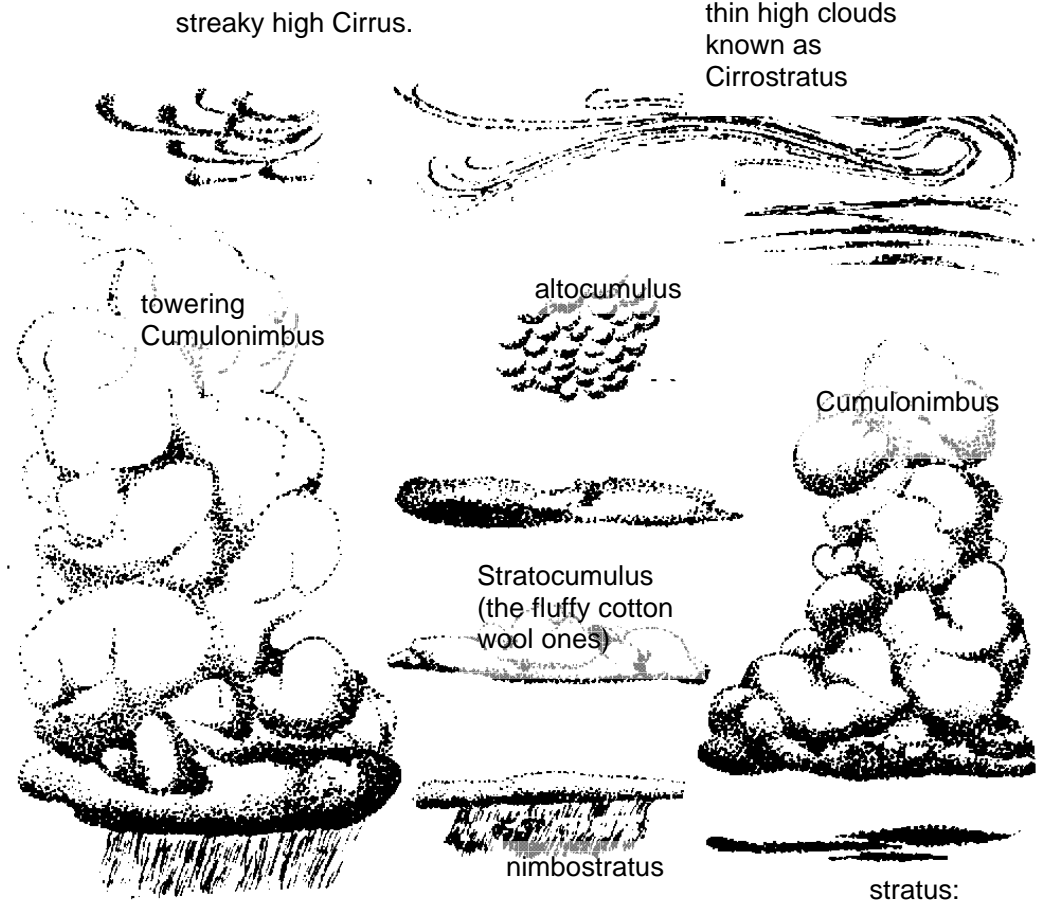
There are nine cloud types shown in the picture. Decide on the type of cloud you see.

Something to think about:

Do all clouds bring rain?

What kind of clouds do you see on sunny days?

Have you ever seen clouds that look like feathers, animals, cotton wool, etc.?




Recording all the information.

The reason for recording all this information is not only to see what is happening now but also to look for patterns and predict future weather patterns from observations.

Recording is important and should be methodical so that anyone can understand what you have done.

Written out is just one idea and it assumes that you have recorded all of the measurements indicated in the activities above. You can even use our forecasts to see how accurate the local weather forecast was.

Don't forget to record the names of the people in your group.

Day and Date	Time	Air Pressure	Wind		Cloud		Temp	Humidity	Rain gauge	General Weather
		Raising Or Falling	Speed	Direction	Cover	Type				
Mon 21 Feb	11.30		4	SE	3/8	Cu	24	65	0	Clear, windy

Suggested follow-up activities

Work with your partners to compose three questions about the data you have collected, for example: What was the coldest day? The day with the most rain? The windiest day?

Swap questions with another group.

Use the charts to compose word problems to practice. (This helps their numeracy skills.) For example: What was the difference between the temperature of the coldest day and the warmest day?

Make bar or circle graphs showing the number of sunny, cloudy and rainy days.

Make line or bar graphs to show the temperature of each day.

Make a chart showing the temperature of each day. Illustrate each day with a picture.

Something extra to do with this information.

Compare your recorded weather with the predicted forecasts.

Contact a school a few kilometres away and see how their weather records compare with yours.

Contact another school on another island or country and see how the weather records compare.

Something to think about:

When does the weather become important? Write down all the times when weather has become important to you or your family. Try and find stories to back up your ideas.

What we want children to learn:

- Collecting weather information takes practice and time.
- Collecting weather information requires us to make careful observations.
- Looking back over the weather information that has been collected over a long period of time tells us if the climate is changing.

Activities looking at heat transfer and heat content.

How well does the Sun heat the Earth?

Activity 6: Which heats up the fastest, land or sea?



What you will need: 2 buckets, sand, water, 2 thermometers.

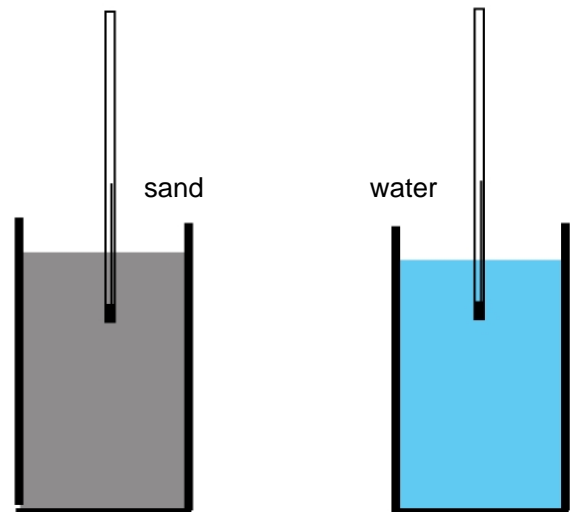
What to do:

Fill up the two jars; one with sand, the other one with water.

Put a thermometer into the jar of sand. The bulb of the thermometer should be about 2cm into the sand.

Put the thermometer into the jar of water. The bulb of the thermometer should be held at about 2cm into the water.

Place the jars in the sun.



Observe:

Record the temperature at the start.

Record the temperature after 10 minutes.

Do this a couple more times so that you end up with the temperature after 30 minutes.

Question: Which one had the greatest increase in temperature?

Prediction: If the buckets are moved in to the shade or somewhere cool, which one will show the greatest drop in temperature?

Observe: Move them to a shady place and record the temperature of the two buckets, and then leave for 10 minutes. Measure the temperature. Do this again a couple more times, so they have been left for 30 minutes.

Explanation: Was your prediction correct?
Can you explain what has happened and why?

What effect do you think this would have on our climate, particularly places by the sea?

What we want children to learn:

- Water can hold more heat energy than sand.
- This is the reason why it heats up more slowly and cools more slowly.
- The oceans hold a lot of heat energy. (In fact the amount of heat energy in the top 3 metres of ocean is roughly equivalent to the same amount of heat energy in the whole of the atmosphere.)

Activity 7: Air on the move.

Mobiles

This activity is designed to show how heat energy travels in air.

What you need: Cotton thread. Candle or heat source such as a light bulb. Aluminium foil. Scissors.

What to do:

To make the mobile, cut a 14cm diameter circle on the foil.

Draw a spiral on it of about 5 turns as shown in the picture.

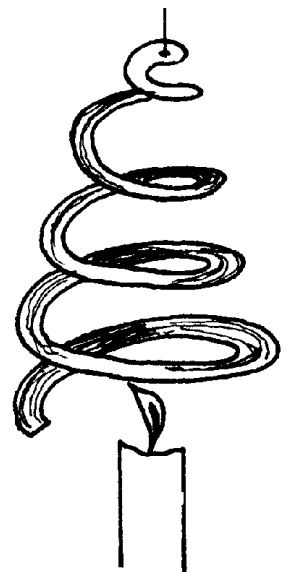
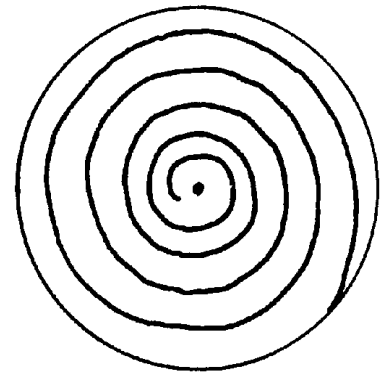
Cut along the line.

Make a small hole in the centre of the spiral and thread the cotton through it.

Light the candle and hold the mobile above the candle.

Observe: What happens?

Explain: Can you explain why the mobile turns. Which direction is warm air moving?



What you need: A large empty soup tin or similar. A candle. A piece of rolled up newspaper.

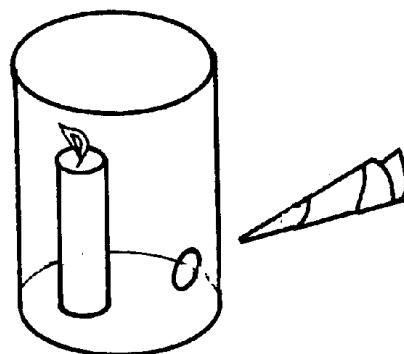
What to do:

Punch a hole in the side of the can, near the base.

Stand the candle in the can.

Light the candle.

Place the smoking piece of paper near the hole in the can.



Observe: What do you see happen?

Explain: Why is the smoke moving through the hole? Can it be explained in terms of air movement?

What happens if you put your finger over the hole in the can?

Can you explain why?

What we want children to learn:

- This activity is designed to show that when warm air rises, cool air moves in to take its place.
- The movement of air is called a **convection current**.

Activity 8: Which way does heat move in water?

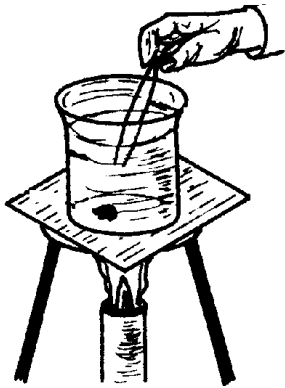
The idea behind this activity is to show how convection currents move in water.

What you will need: Burner or Candle, (Hobby Stove), Lamp, Food Colouring, Dropper.

Experiment 1

What to do: Place the beaker on the stand. Fill the beaker with water. Very carefully using the dropper put a drop of some food colouring in the bottom of the beaker. Sketch what you see.

Now light the burner. Sketch a diagram of what you see now.



Observe: Sketch the beaker before the burner has been lit and after. Use coloured pens to show clearly what you see.

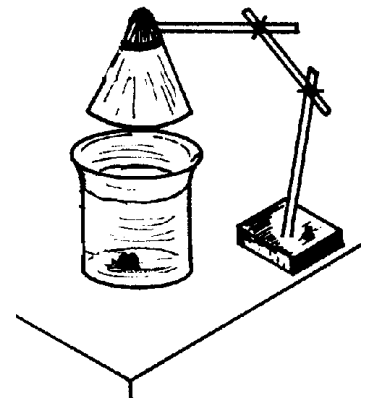
Explain: Describe what you see happening and why you think it is happening.

Experiment 2

Set up the experiment as before but this time put the lamp over the top of the beaker. There should be no heat coming from underneath.

Observe: Sketch the jar before the lamp was placed over the top and after. Use coloured pens to show clearly what you see.

Explain: What has happened this time? Can you explain what you have observed?



What we want children to learn:

- Warm water rises to the surface.
- Cold water sinks.
- The warm water rises because it is less dense and the cold water is more dense.
- The movement of warm water upwards and cold water sinking is a convection current.

What do you think?

Do you think that the oceans will get colder or warmer as you go deeper?

Do you think the sun heats the top of the ocean or all the way down?

Can the heat possibly travel downwards after trying these experiments?

What do you think an Argo float would record as it goes down to 2 kilometres in the ocean?

Argo floats travel in the currents deep in the ocean and then come up again every 15 days or so.

How do you think the temperature will change as they go down and then come up?

Will the temperatures they measure change from place to place?

What sort of temperature range would an Argo float measure in the South Pacific near New Zealand, compared to the Pacific near the Cook Islands?

If the water is warmer near the equator, what do you think will happen to the amount of evaporation of water from the sea in this region?

Would this make the climate wet or dry?

If the sea gets warmer what do you think will happen to the amount of evaporation and the climate in this region of the Earth?



Something to think about?

Why do you think scientists want to know this information?

Activity 9: Argo Floats.

The idea of this activity is to show how an Argo float can work. The principle is based on internal pressure in the buoyancy chamber. In this case the buoyancy chamber is a small tube part filled with air.

What you need: Large plastic lemonade or coke bottle, Small tube that will fit inside, Dropper

What to do:

Set up the bottle as shown in the picture.

Part fill the small tube with water so it floats with air trapped inside it.

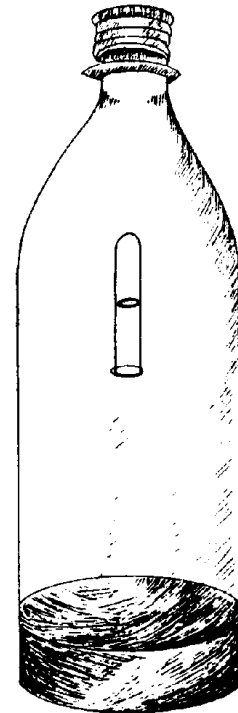
Use the dropper to change the amount of air in the test tube so that it just floats to the top of the bottle.

Screw on the top and gently squeeze the bottle.

Observe: What happens when you squeeze the bottle?

What happens when you stop squeezing?

Draw what you see happening in the diver, when the bottle is squeezed and released.



Explain: How do you think what you have seen might explain the way the diver behaves?

How do you think this might explain how fish can go up and down in the water?

How do you think this works in an Argo float?

Prediction:

What will happen if you were to stand the experiment out in the sun where the water will get warm?

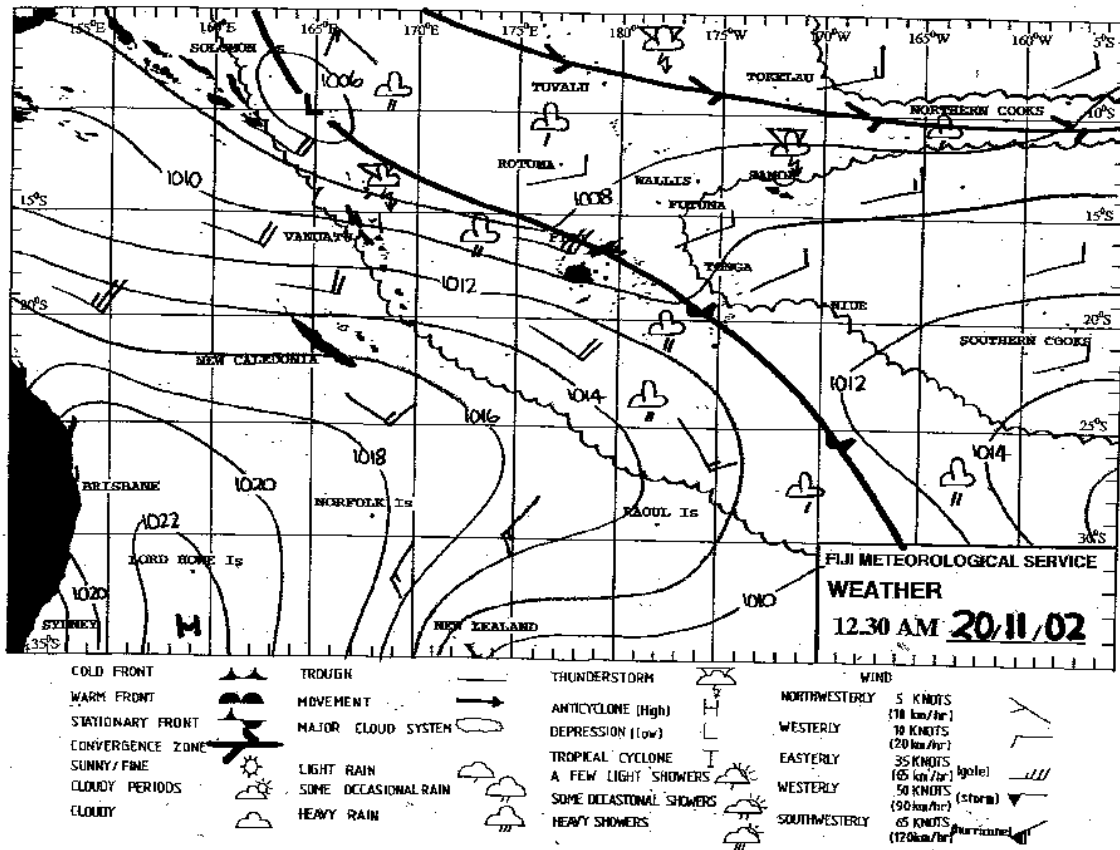
Try it and see.

Activity 10: What's on the weather map?

NOTE: for the Teacher: This exercise could be used as a starter activity before beginning the topic and then at the end as a summative exercise.

What you will need: Weather maps sourced from newspapers or meteorological office.

What to do:



Look at the weather map.

Identify the following if they are on the weather map:

Isobars, Low Pressure centre, High Pressure Centre, Warm Front, Cold Front.

Where do you think the air is rising on the map?

Where do you think the air is sinking on the map?

Where do you think the winds will be strongest?

Draw an arrow to show the direction of the wind.

Where do you think the winds will be lightest?
Draw an arrow to show the direction of the wind.

Extension Activity: Find some weather maps.

Your job is to predict the weather for the TV or radio.

Use the maps to write your forecast from the maps and read it to the class.

What we want children to learn:

- Weather maps provide details for predicting weather in various localities.
- Weather maps show us the movement of weather patterns.
- The lines on a weather map represent air pressure and are called isobars.
(Lines showing equal pressure.)