STAGE 4 GEOGRAPHY

Water Cycle Explored

FOCUS AREA - Water in the World

Outcomes explored

A student:

- Locates and describes the diverse features and characteristics of a range of places and environments GE4-1
- Describes processes and influences that form and transform places and environments GE4-2
- Acquires and processes geographical information by selecting and using geographical tools for inquiry GE4-7
- Communicates geographical information using a variety of strategies GE4-8

Key inquiry question

- Why does the spatial distribution of water resources vary globally and within the countries?
- What effect does the uneven distribution of water resources have on people, places and environments?

Content focus

Students:

- Investigate processes that continue to shape the environment including an atmospheric or hydrological hazard
- Discuss variations in people's perceptions about the value of water and the need for sustainable water management

Content:

- The Water Cycle

Australian Syllabus Links:

- ACHGK038

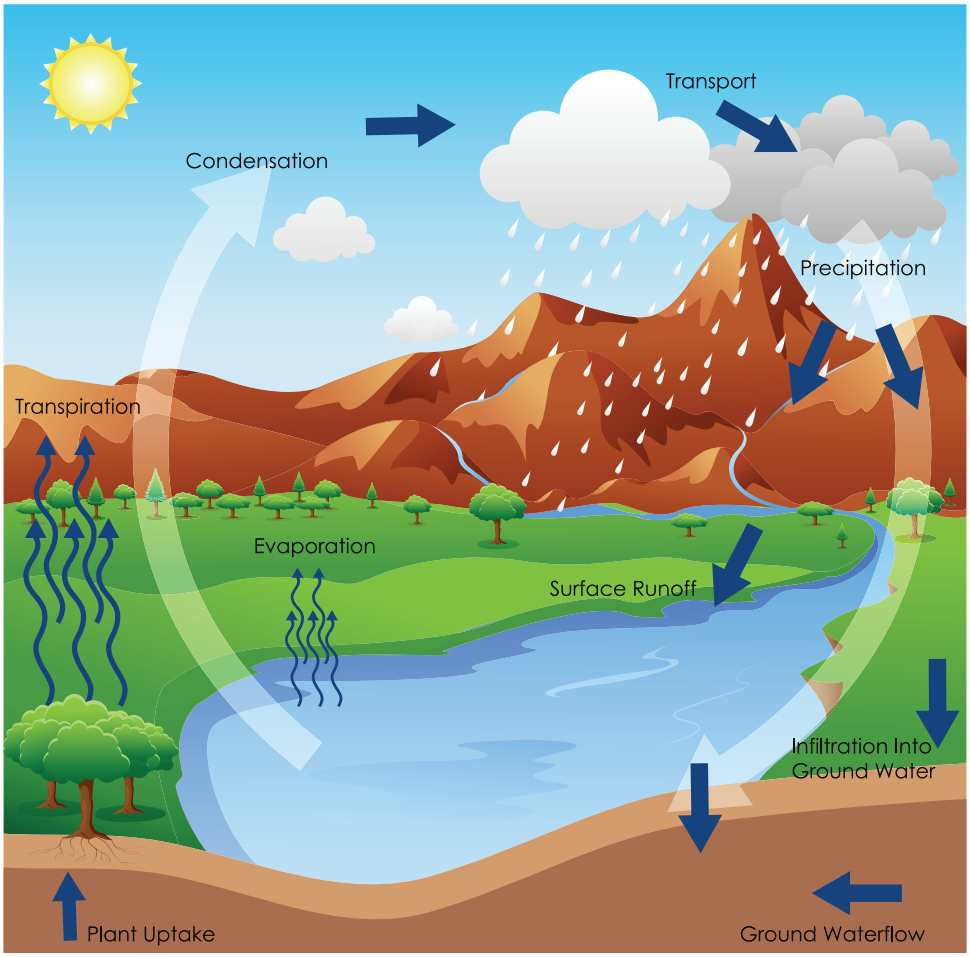
WATER CYCLE EXPLORED

The most important factor in the water cycle is the sun! The sun heats the ocean (just a little bit) and then starts the continuous water cycle.

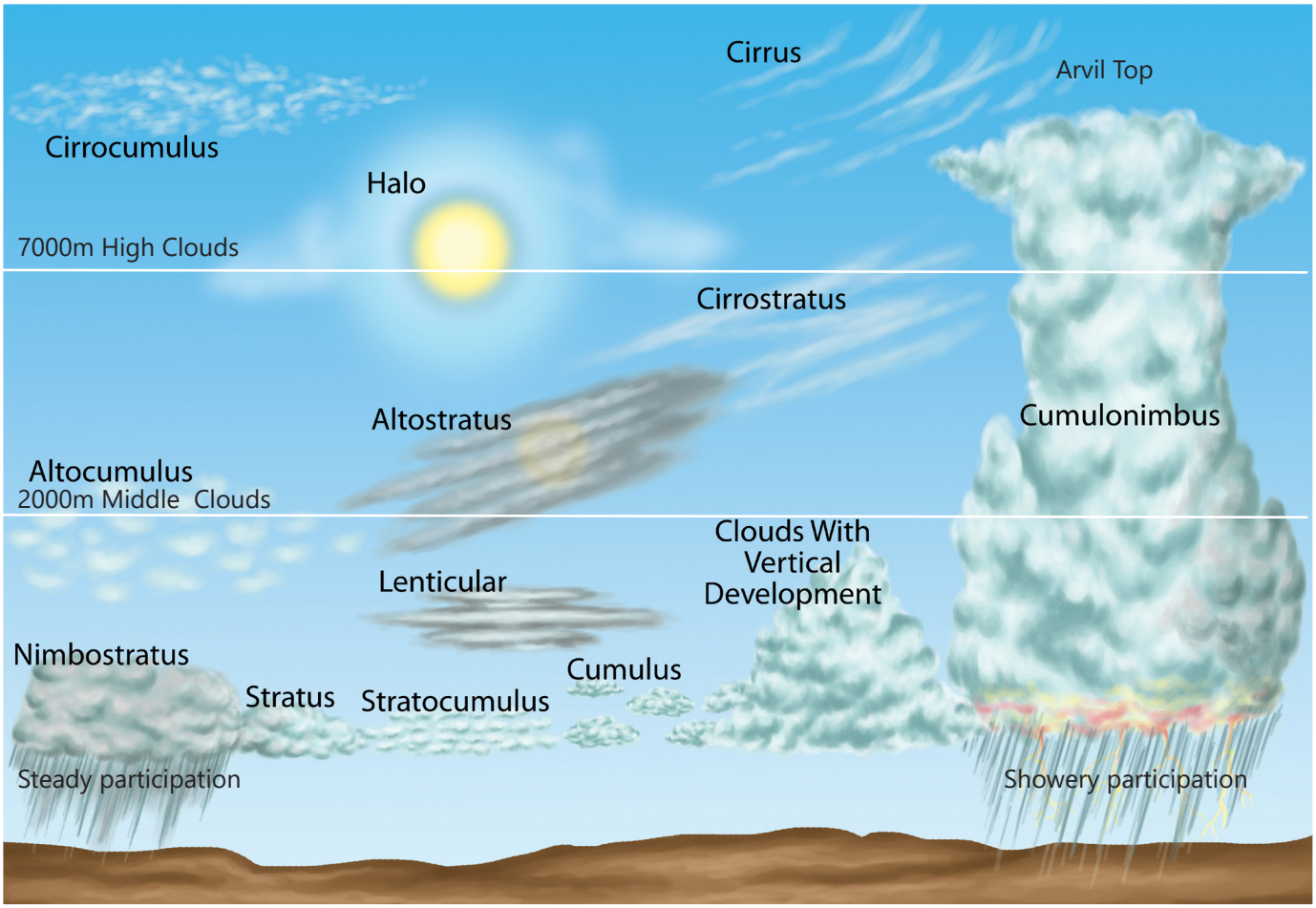
1. Some of the water (a liquid) on the surface of the oceans evaporates. The evaporated water is now a gas and is called water vapour.
2. Wind and air currents help the vapour to rise into the atmosphere. The temperature is cooler high in the atmosphere, so the water vapour condenses and forms clouds.
3. When the weight of the condensed water in the clouds is too heavy the water falls to Earth as rain, snow, sleet or hail. This is called precipitation.
4. The precipitation that falls onto land either soaks into the ground (called groundwater) or it flows downhill into stormwater or surface run off.

On the Central Coast the surface runoff flows into Wyong River or Ourimbah Creek and then into Tuggerah Lake and eventually into the ocean. Groundwater also flows in a downhill direction due to gravity. Water moving through the ground can also enter into creeks and streams and eventually be returned to the ocean where the cycle starts again.

The water cycle is a relatively simple system that provides fresh water for the Earth. We generally see the result of this process as rain falling to the earth, but rarely do we investigate some of the mechanisms at a global scale. At any time on the earth storms rage producing water, but why do some storms produce more rain? What determines where the rain will fall? How does air temperature, humidity, water temperature, windspeed, etc play a role in this process? Living on the Central Coast we regularly see large storms that come off the ocean or long periods of clear skies with no rain. Understanding how the water cycle works and the driving mechanisms can demonstrate why rain maybe more prevalent in certain areas of Australia while lacking in others and how that can affect our water supply on the Central Coast.



Water Cycle



Types of Clouds

Let's Begin!

This program will have you accessing the website https://earth.nullschool.net/ to analyse various mechanisms that drive the water cycle. The weather data is forecast by super-computers every three hours based on data collected from the Global Forecast System. This data will provide knowledge on where, why and how weather systems begin and how this drives the water cycle here in Australia and around the world.

Some new terms to look at before we start: Understanding these terms will help you develop a story about your location.

- **Sea Surface Temp (SST)** - this is the temperature of the water at the ocean's surface. The warmer the water, the easier water evaporates.
- **Total Cloud Water (TCW)** - is the total amount of water in clouds in a column of air from ground to space. Big storm clouds called cumulonimbus look dark from below due to the density of water inside absorbing sun light or reflecting up into the sky. Conversely, cirrus clouds are white in appearance due to very little water vapor which allows more light through.
- **3hr Precipitation Accumulation (3HPA)** - this is the amount of precipitation (rain/snow) over the next three hours in that location.
- **Relative Humidity (RH) -** the amount of water in the air at that location. If the RH is at 80%, the air in that location is at 80% ability to hold water.
- **Air temp**— is the temperature of the air at that specific height. The closer you are to the Earth's surface the hotter it is.
- **Windspeed**— the speed of the air at that specific height. The windspeed at the outer limits of the atmosphere can be over 300km/hr.

Some helpful hints:

- Hot air is less dense than cold air so when hot and cold air collide, the warmer air is forced to rise over the colder air. When the warm air is forced up, it causes surface air pressure to drop, sort of like having a small vacuum develop at the Earth's surface at the boundary between the two air masses. Cold air rushes in to fill the area of lower air pressure, which causes more warm air to be displaced upward. These extreme differences in air pressure result in a storm.
- Warm air with moisture rising into cooler air higher up will condense to make clouds and rain. Change the "height" of your location using the tool bar. Select 1000hPa, 850hPa and so on to 10hPa. You will notice as you lower your pressure number the temperature will start to drop along with it. Remember to reset your height back to "SFC" for surface temperature.
- Where do you notice most of the biggest storms in the world are coming from?
- The warmer the water the more evaporation. Notice the water temp and where storms are brewing.
- Wind will carry water vapor up into the atmosphere. Where you have a warm air mass and a cool air mass you generally will find strong winds.
- In the tool bar you can select a different date by opening the calendar. Choose the date and click "apply". This will show you the weather at the same time for that date. You can compare that date to the current day to see how much the weather has changed. Make sure you change the date back to the current day to progress in this program.

Pressure	Height(metres)
1000hPa	~100m
850hPa	~1,500m
700hPa	~3,500m
500hPa	~5,000m
250hPa	~10,500m
70hPa	~17,500m
10hPa	~26,500m

WATER CYCLE EXPLORED

Step 1) Opening Program

1. Open up https://earth.nullschool.net/
2. Left click on "earth" on the bottom left corner. This will open your tool bar for choosing any filter you need.
3. Under "Projection" select "E". This is your map view, using this map view you can see the entire earth at once.
4. Under the "Mode" option you will be in either "Air" or "Ocean" for the program
5. To minimize the tool bar click on "earth"

Step 2) Choosing location

1. Open the tool bar, in the "Overlay" option select "3HPA"
2. Using the mouse scroll around until you find an area that shows rain fall. This is indicated by the colour scheme on the scale.
3. You can zoom in to an area by using the wheel on the mouse and holding the left click button allows you to drag the map.
4. A single left click on the map will provide you with a location and details on the bottom left corner.
5. Only choose one location until you collect all your data.

Step 3) Sea Surface Temperature (SST)

1. Open the tool bar and in the "Mode" option and choose "Ocean"
2. In the "Overlay" option select "SST" to get your water temp. This will be displayed in the box above the tool bar.

Step 4) Air Temperature (Temp)

1. Open the tool bar and in the "Mode" option and choose "Air"
2. Make sure the "Height" is set to "Sfc" for the entire time.
3. In the "Overlay" option choose "Temp"
4. This will display the air temp at that location you selected in the box above the tool bar.

Step 5) Total Cloud Water (TCW)

1. Open the tool bar and in the "Mode" option and choose "Air"
2. Make sure the "Height" is set to "Sfc" for the entire time.
3. In the "Overlay" option choose "TCW".
4. This will provide you with the total water in the clouds from earth to space in a column one meter by one meter
5. It will be display as kg/m2 above the tool bar.

Step 6) 3hr Precipitation Accumulation (3HPA)

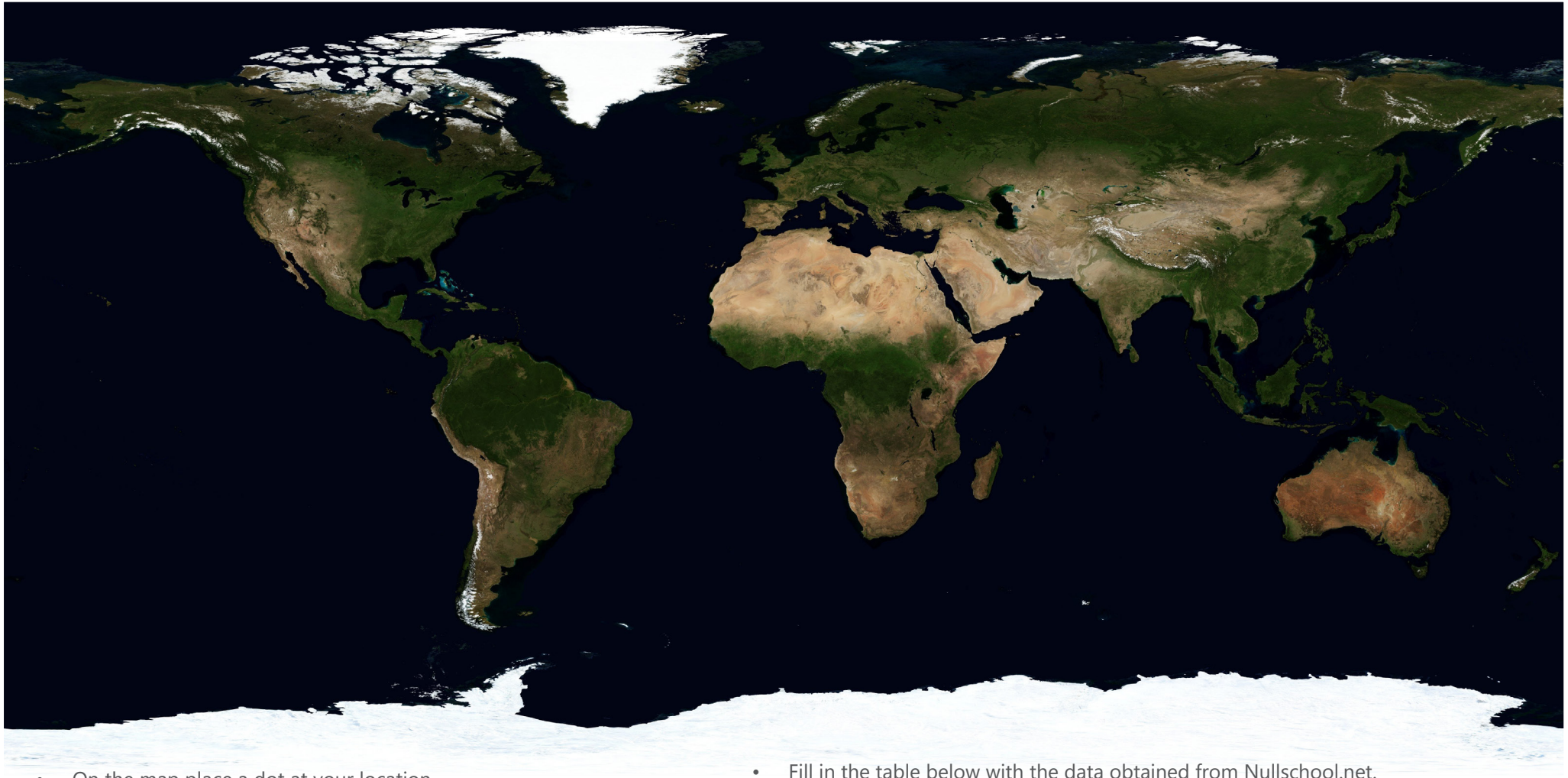
1. Open the tool bar and in the "Mode" option and choose "Air"
2. Make sure the "Height" is set to "Sfc" for the entire time.
3. In the "Overlay" option choose "3HPA".
4. This will provide you with the amount of rain falling every three hours in that location.
5. It will be in the box above the tool bar in mm.

Step 7) Wind Speed (Wind)

1. Open the tool bar and in the "Mode" option and choose "Air"
2. Make sure the "Height" is set to "Sfc" for the entire time.
3. In the "Overlay" option choose "Wind"
4. This will provide you with the wind speed at your location
5. It will be in the box above the tool bar in km/h

Step 8) Relative Humidity (RH)

1. Open the tool bar and in the "Mode" option and choose "Air"
2. Make sure the "Height" is set to "Sfc" for the entire time.
3. In the "Overlay" option choose "RH"
4. This will provide you with how much water is in air as a %
5. It will be in the box above the tool bar in a %



- On the map place a dot at your location
- You can draw on the map to help you remember what have seen
- Fill in the table below with the data obtained from Nullschool.net.
- Think about how the data you're collecting affects each other and the water cycle.

Water body (sea/ocean)	Sea Surface Temp (SST)	Air Temp (Temp)	Total Cloud Water (TCW)	3 hr Precipitation Accumulations (3HPA)	Wind Speed (Wind)	Relative Humidity (RH)	Date

WATER CYCLE EXPLORED

Teacher Debrief Q&A Ideas

1. **When viewing the Nullschool map, where did most of the heavy rain seem to be located? Why do you think those areas had such large storms?**

   A large portion of storms that develop around the world originate near large bodies of water. Oceans provide this needed water in most cases. Large storms do occur inland, but most storms occur around coastal areas where warm and cold air masses meet.

2. **What are some of the reasons why areas inland in Australia are very dry?**

   Having cool air from the ocean mixing with warmer air over the land creates a prime spot for rain to occur. Once the storm system moves inland there is very little water to evaporate compared to the ocean. This lack of water limits evaporation and water vapor to condense to create clouds and rain.

3. **Why is the Central Coast able to experience large storms bringing lots of rain?**

   Coast areas are a prime location for large storms due to warm air temps on the land meeting cooler air from the ocean. Pressure systems spin clockwise for low pressure and anti-clockwise for high pressure systems. This spinning motion can bring the cooler wet air of the ocean towards the coastline where it meets the warmer air on the land. It is this meeting point, between the warm and cold air, that creates the large storms the Central Coast encounters.

4. **When wind speeds increase or becomes gusty what might this be indicating is changing?**

   Wind speeds increasing may indicate a change in pressure systems. These pressure systems often have a change in temperature or bring rain. In general, the weather is going to change with the onset of strong winds.

5. **When looking at warm and cooler surface temps meeting, what seems to occur at those locations?**

   Strong winds, clouds, rain, temperature changes, strong weather systems, pressure changes

6. **Why is it important to have numerous catchments in the Central Coast to collect water?**

   Having numerous catchments is key in water security since storms do not always provide rain to the entire Central Coast. Often it can rain in one area in the Central Coast while other areas see no rain. By having numerous catchments this increases the ability to harvest the water in those areas which provides a more secure water supply to the community.