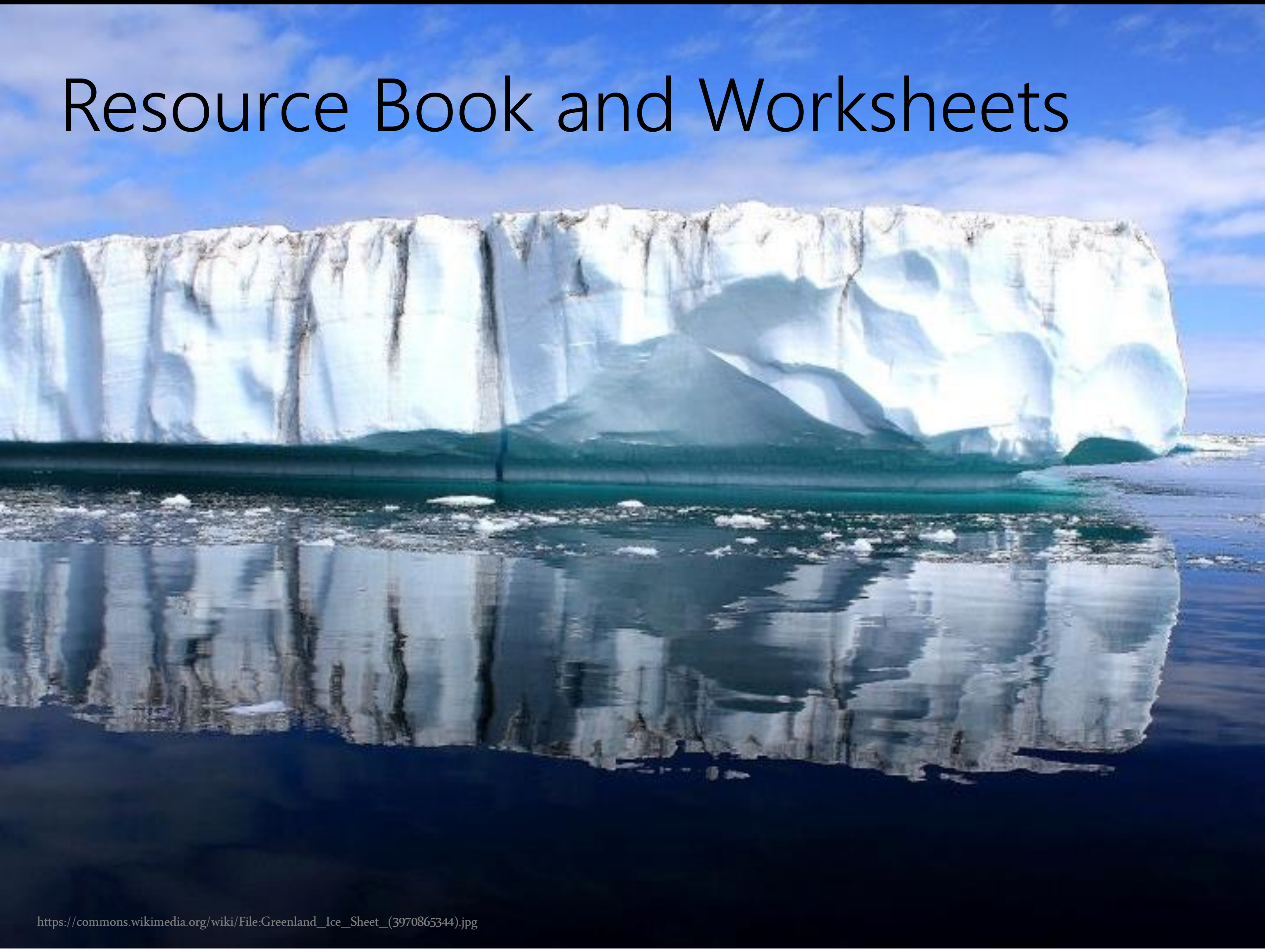
Climate change | Junior Science

Resource Book and Worksheets



https://commons.wikimedia.org/wiki/File:Greenland_Ice_Sheet_(3970865344).jpg

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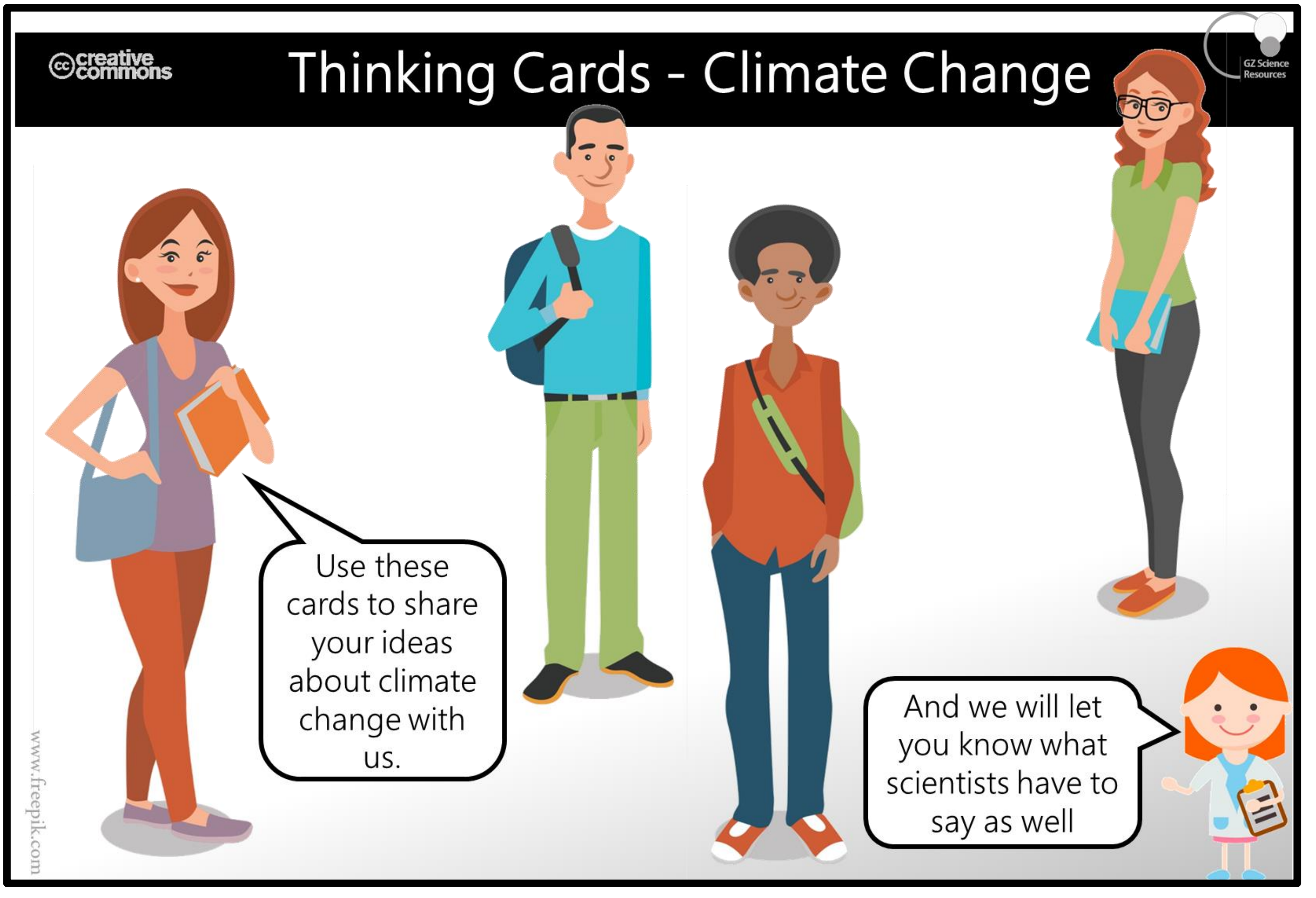
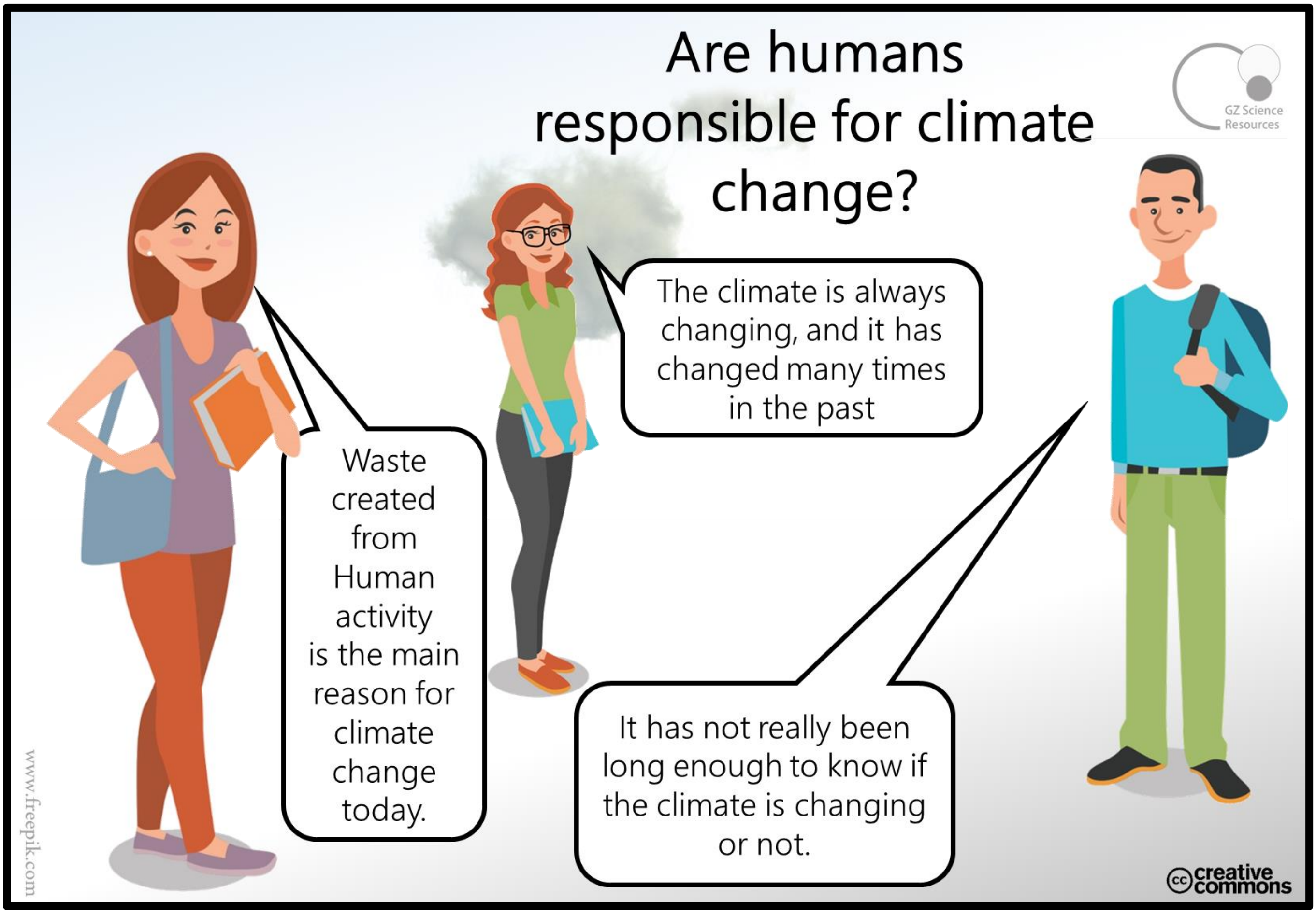
GZ Science Resources



To Use:

1. Students can form small groups of 3-4
2. Students read each card in turn, starting with the key question
3. Each student in the group has a chance to explain which comment they think answers the question best, and give their reasons why.
4. The group comes to a consensus together about which comment they can all agree with, or there may be more than one, and they record it underneath each written question.
5. After all of the groups have finished, the whole class comes together to discuss each question.
6. Each group can get up in turn to present a question each, stating their selected answer. Other students can question from the floor.
7. “Scientist says” slides are available for the teacher to sum up after each card. At this point further questions can be asked.


Are humans responsible for climate change?
GZ Science Resources
The climate is always changing, and it has changed many times in the past
Waste created from Human activity is the main reason for climate change today.
It has not really been long enough to know if the climate is changing or not.
www.freepik.com
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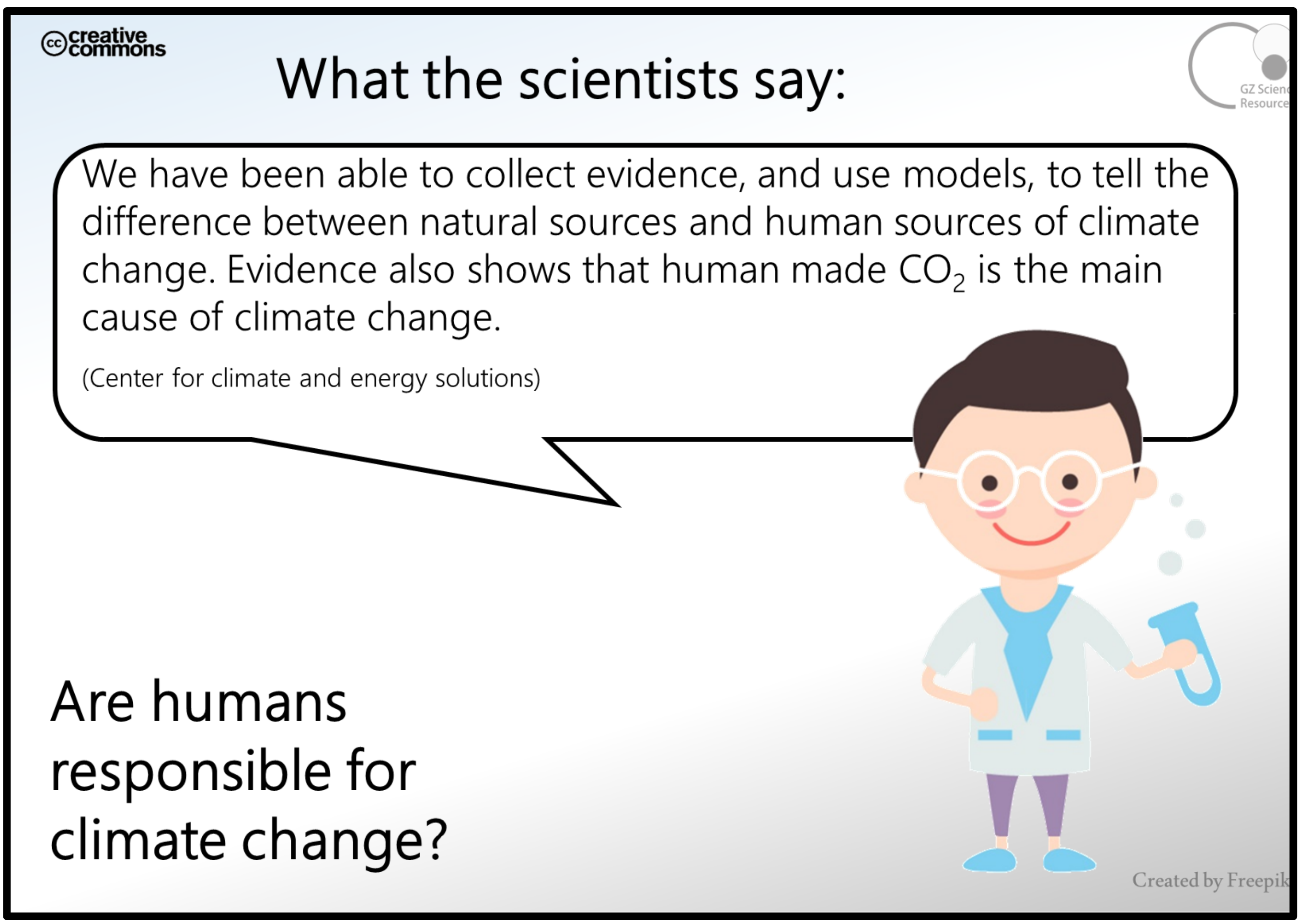
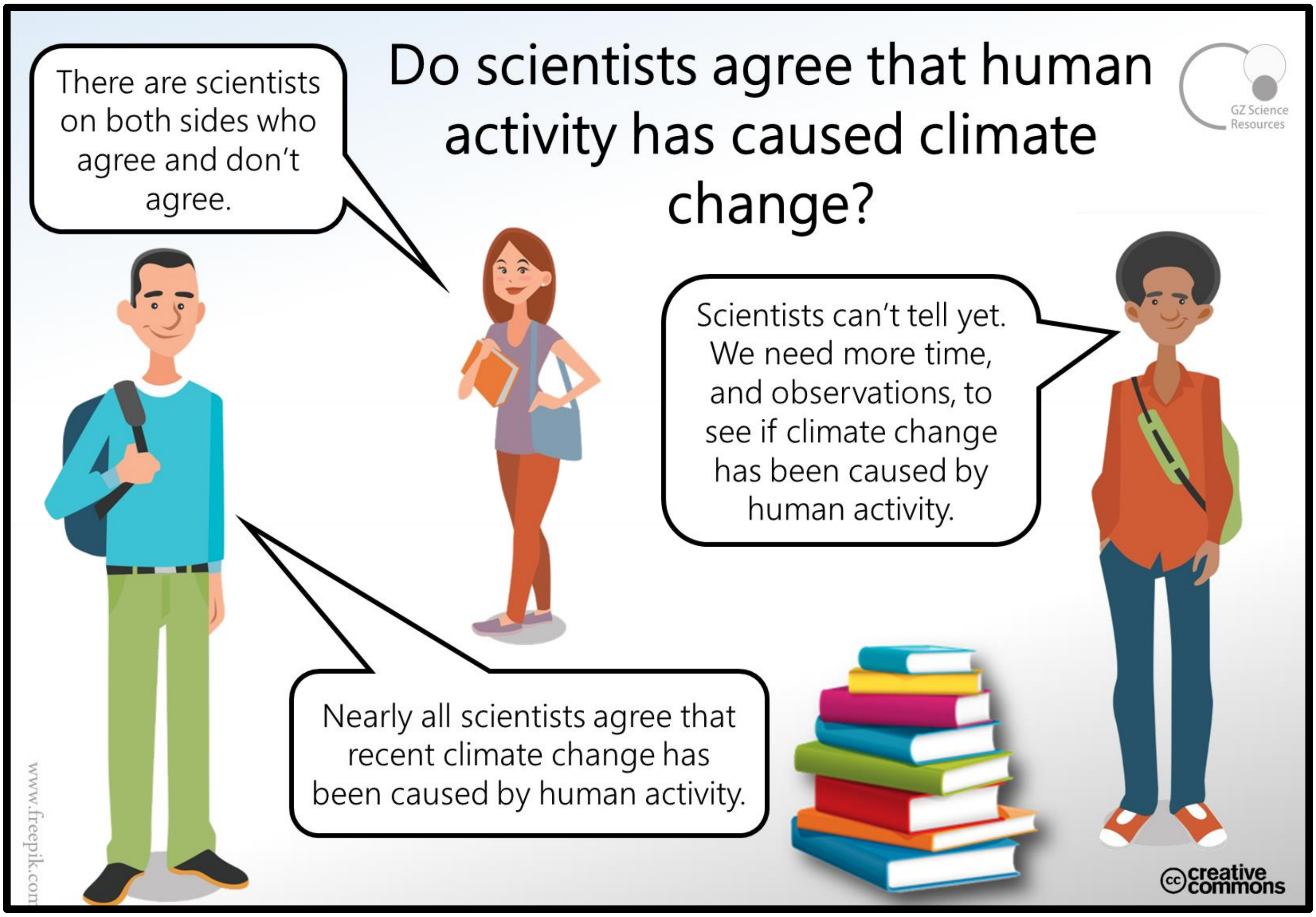

creative commons
What the scientists say:
GZ Science Resources
We have been able to collect evidence, and use models, to tell the difference between natural sources and human sources of climate change. Evidence also shows that human made CO_2 is the main cause of climate change.
(Center for climate and energy solutions)
Are humans responsible for climate change?
Created by Freepik


Do scientists agree that human activity has caused climate change?
GZ Science Resources
There are scientists on both sides who agree and don't agree.
Scientists can't tell yet. We need more time, and observations, to see if climate change has been caused by human activity.
Nearly all scientists agree that recent climate change has been caused by human activity.
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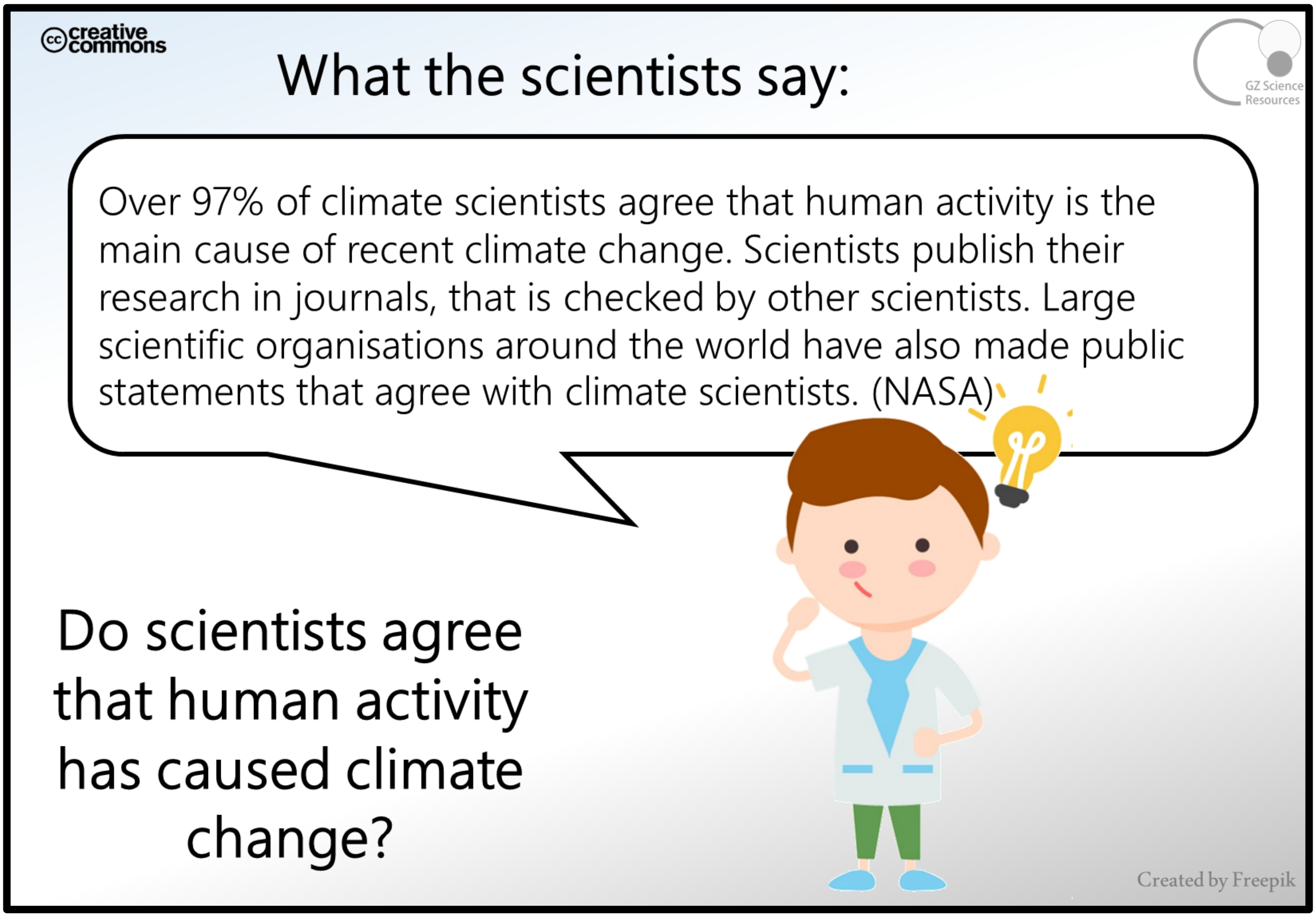
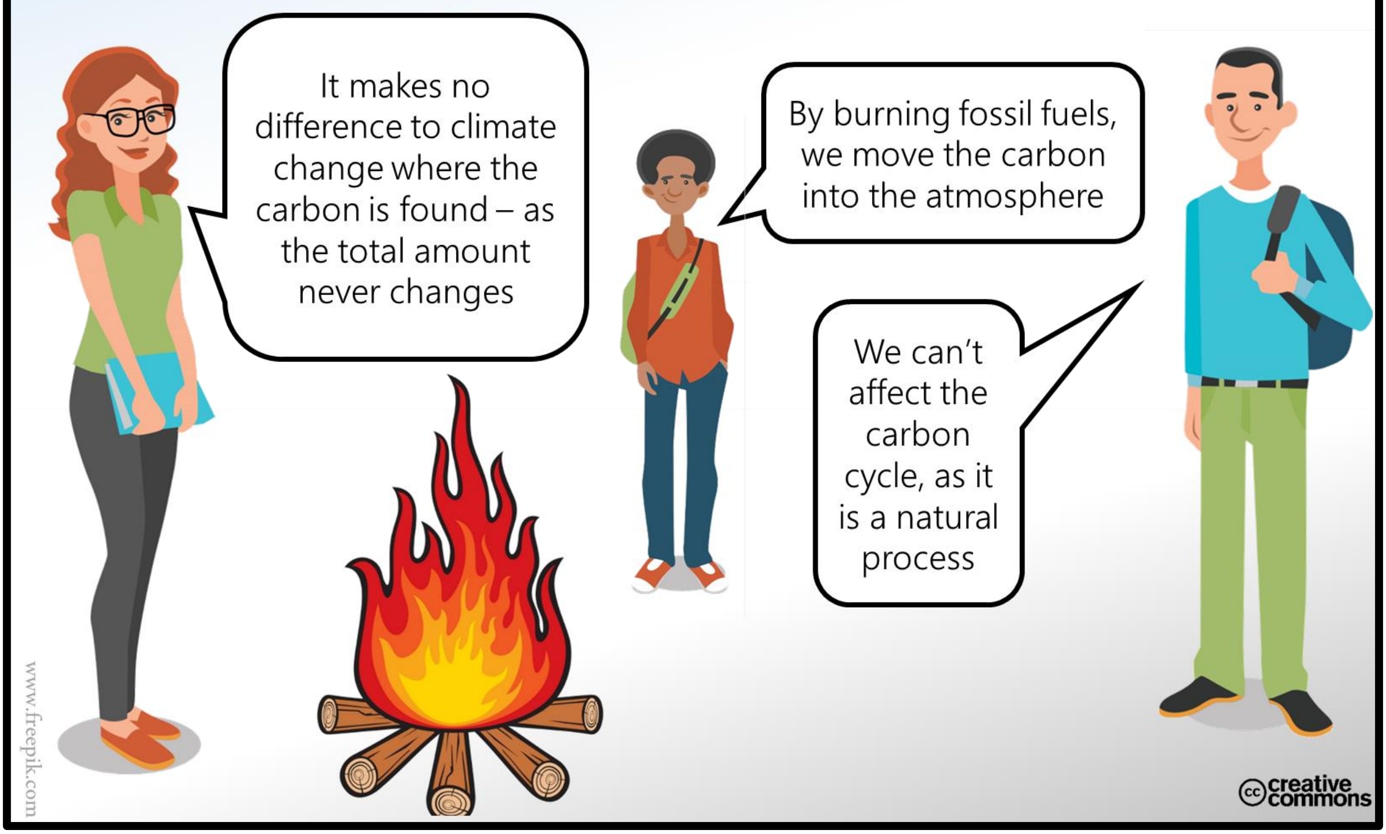

creative commons
What the scientists say:
GZ Science Resources
Over 97% of climate scientists agree that human activity is the main cause of recent climate change. Scientists publish their research in journals, that is checked by other scientists. Large scientific organisations around the world have also made public statements that agree with climate scientists. (NASA)
Do scientists agree that human activity has caused climate change?
Created by Freepik

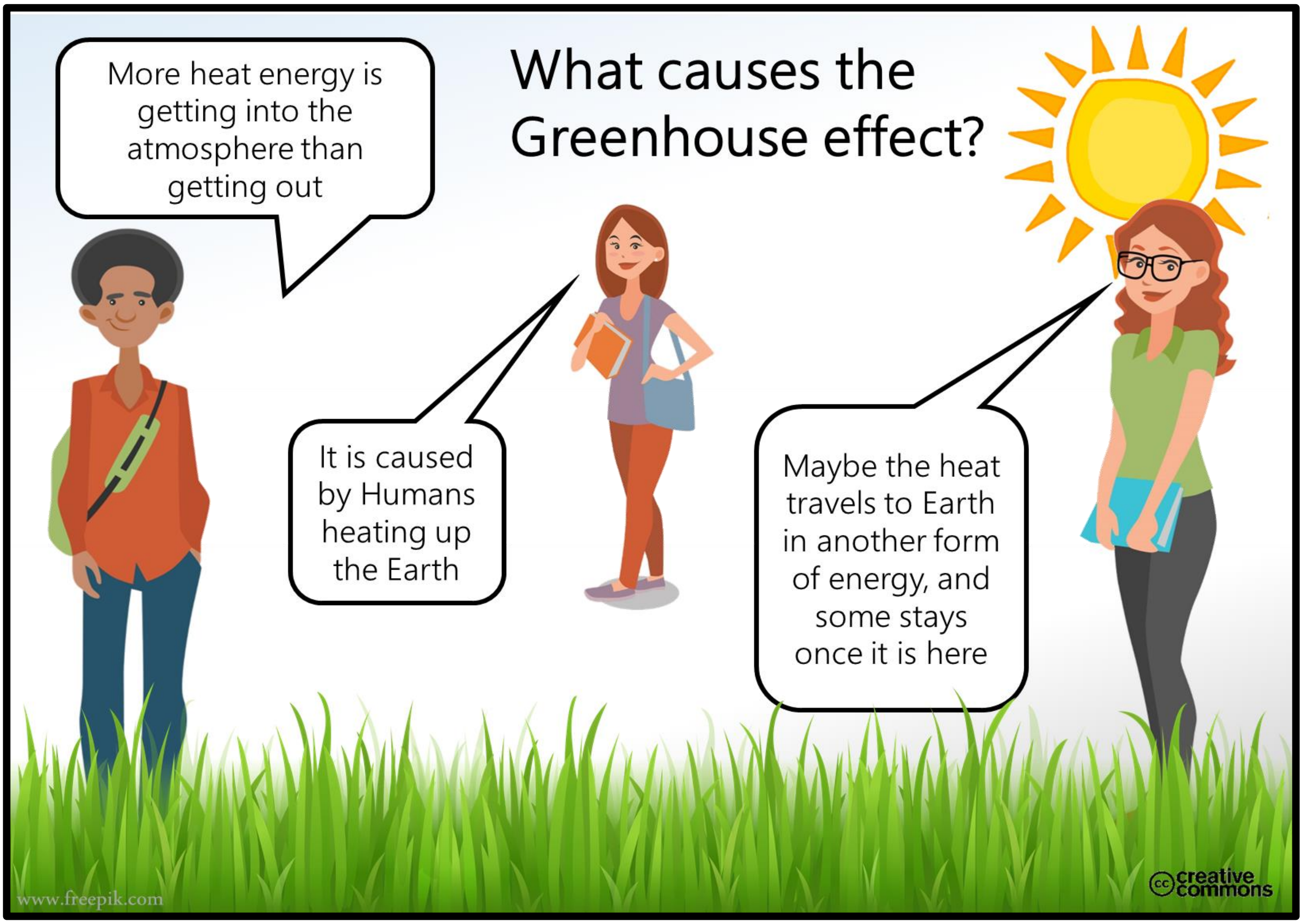
Has human activity affected the carbon cycle?



What the scientists say:

Humans increase the shift of carbon, locked up in fossils fuels, into the atmosphere, by using them as fuels. This also increases the amount of CO_2 moving into the ocean. Due to human activity, the CO_2 levels in the atmosphere are higher than at any time in the last 800,000 years, and the influence on the climate system is clear. (IPCC)

Has human activity affected the carbon cycle?

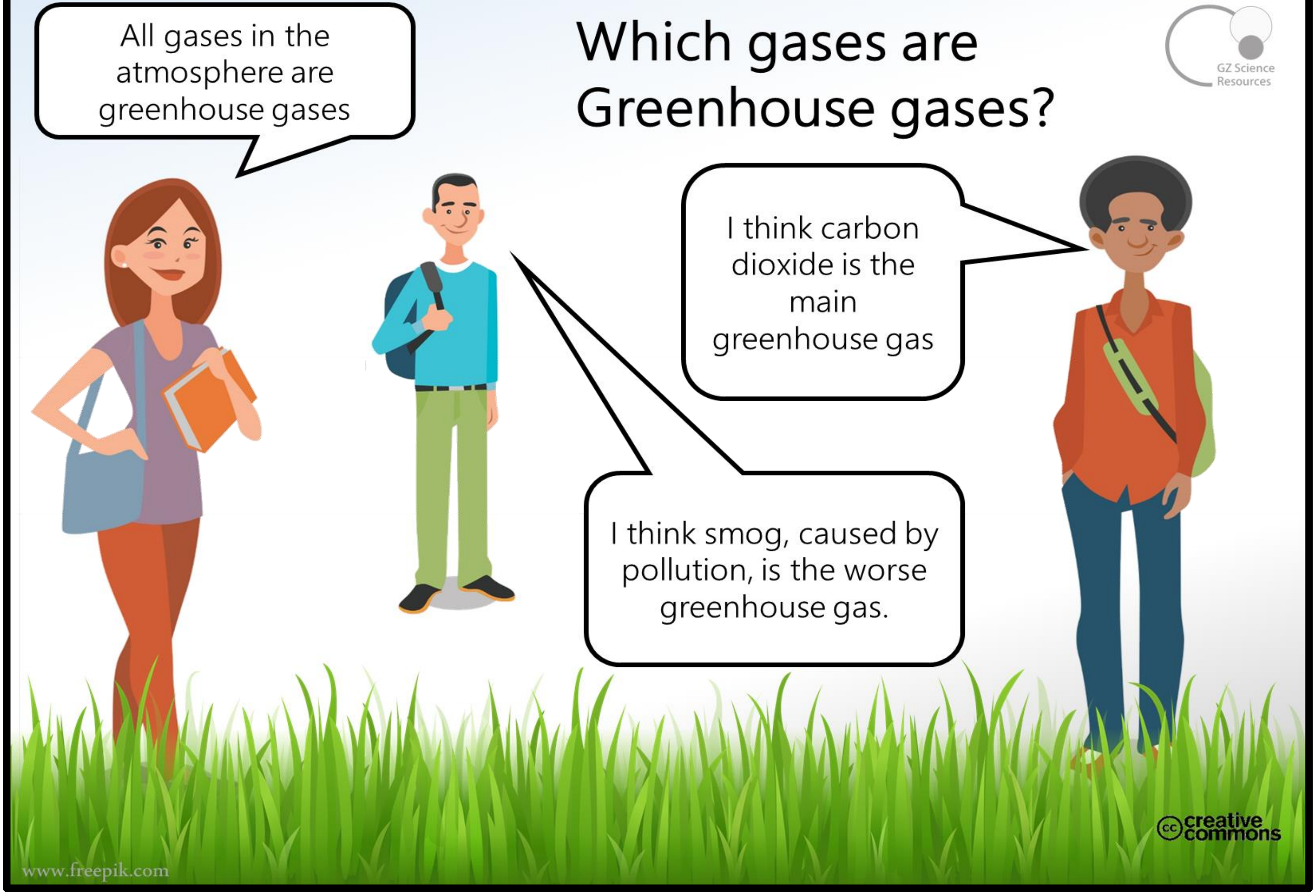


What the scientists say:

The Greenhouse Effect allows heat to remain 'trapped' in the atmosphere around Earth. This is important, so that it is warm enough for life to survive. Energy from the Sun travels to the Earth mostly as light. Light passes through the atmosphere easily to reach the Earth's surface, and then it is absorbed. Energy is then 'emitted' from the cooler earth mostly as heat. Heat energy is absorbed by greenhouse gases such as CO_2, and prevented from escaping from the atmosphere.
This is called the Greenhouse Effect. (IPCC)

What causes the Greenhouse effect?

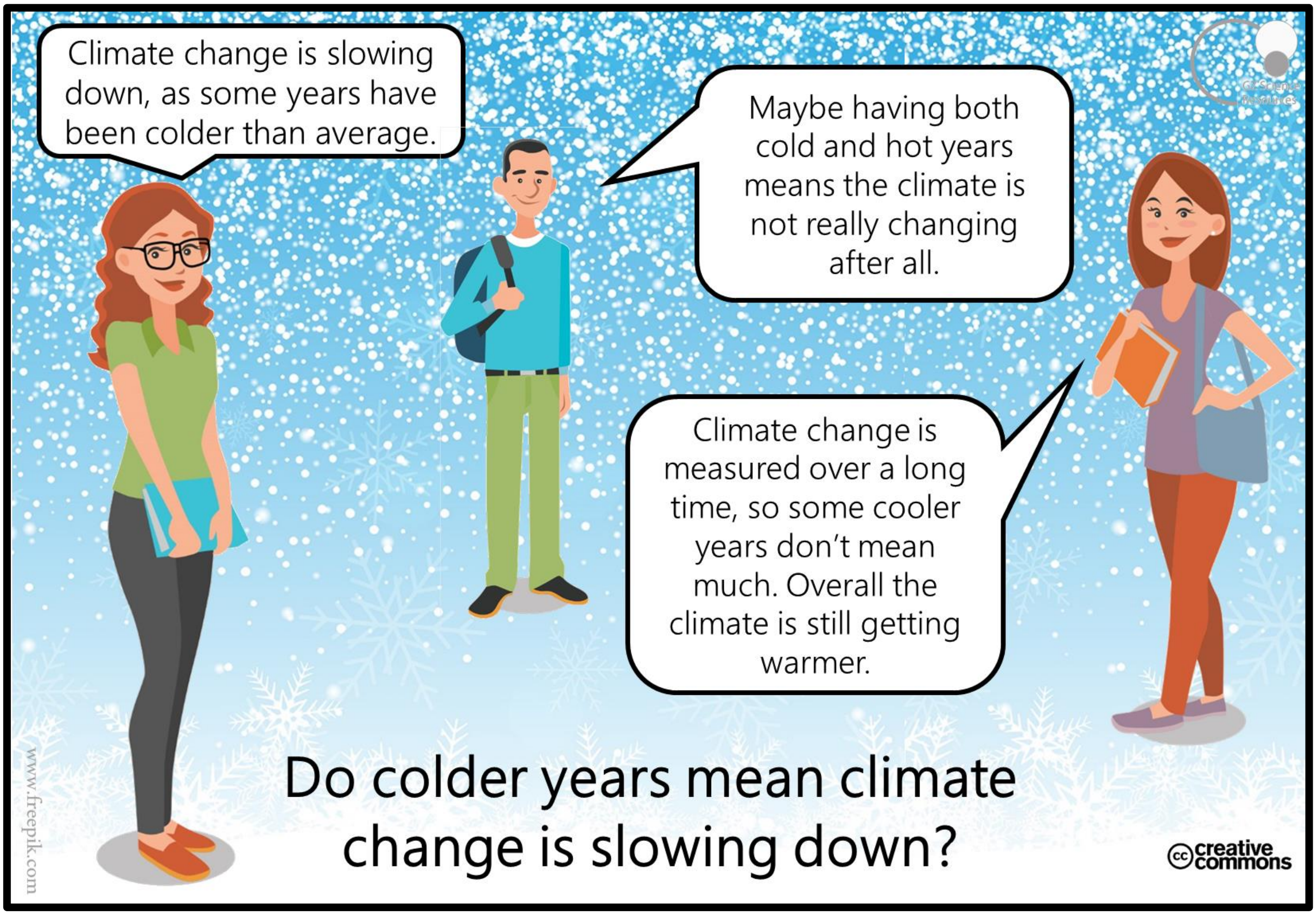
Which gases are Greenhouse gases?



What the scientists say:

Carbon dioxide (CO_2) is naturally found in the atmosphere, and it is able to absorb heat emitted from Earth (transformed from Sun light) to keep the Earth warm, so it is called a Greenhouse gas. Methane and water vapour also act as greenhouse gases, but they disappear from the atmosphere quicker, so have less effect than CO_2. Pollution and smog are not greenhouse gases. Human activity is increasing the amount of greenhouse gases in the atmosphere, especially CO_2, so the Earth is becoming warmer. (IPCC). The more CO_2 in the atmosphere, the more heat is absorbed. The Earth's atmosphere heats up as more energy enters than released, changing the Earth's 'energy budget'.

Which gases are Greenhouse gases?

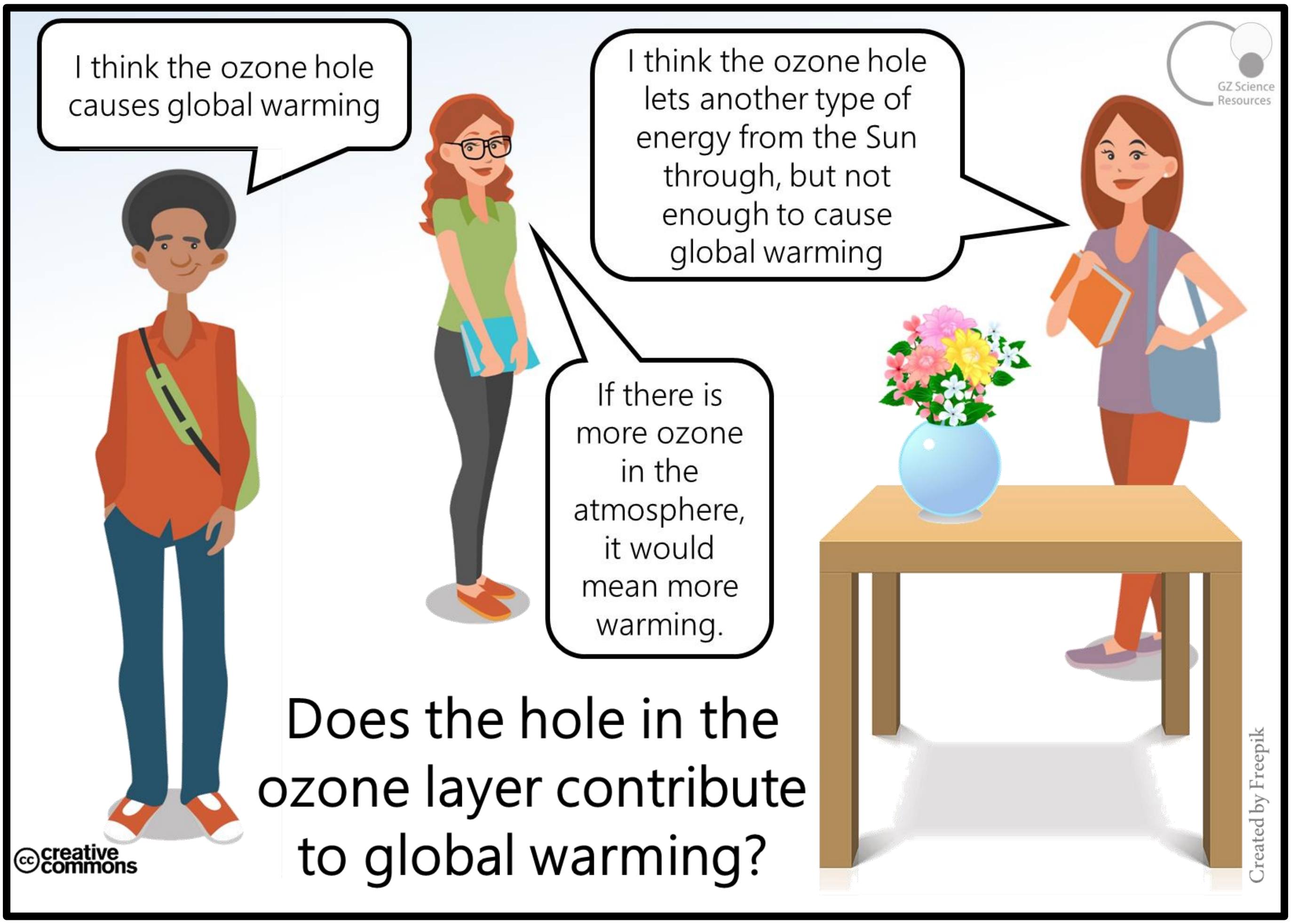


What the scientists say:

Short time periods (less than 10 years), can show some cooling, which lead some people to think climate change is not true. Climate refers to longer term patterns of over 30 years, and this shows that the average surface temperature of the Earth has increased. Powerful computers, based on observations, can help scientists predict, with much confidence, that the Earth will continue to warm, due to human created climate change.

(Center for climate and energy solutions)

Do colder years mean climate change is slowing down?


I think the ozone hole causes global warming
If there is more ozone in the atmosphere, it would mean more warming.
I think the ozone hole lets another type of energy from the Sun through, but not enough to cause global warming
Does the hole in the ozone layer contribute to global warming?
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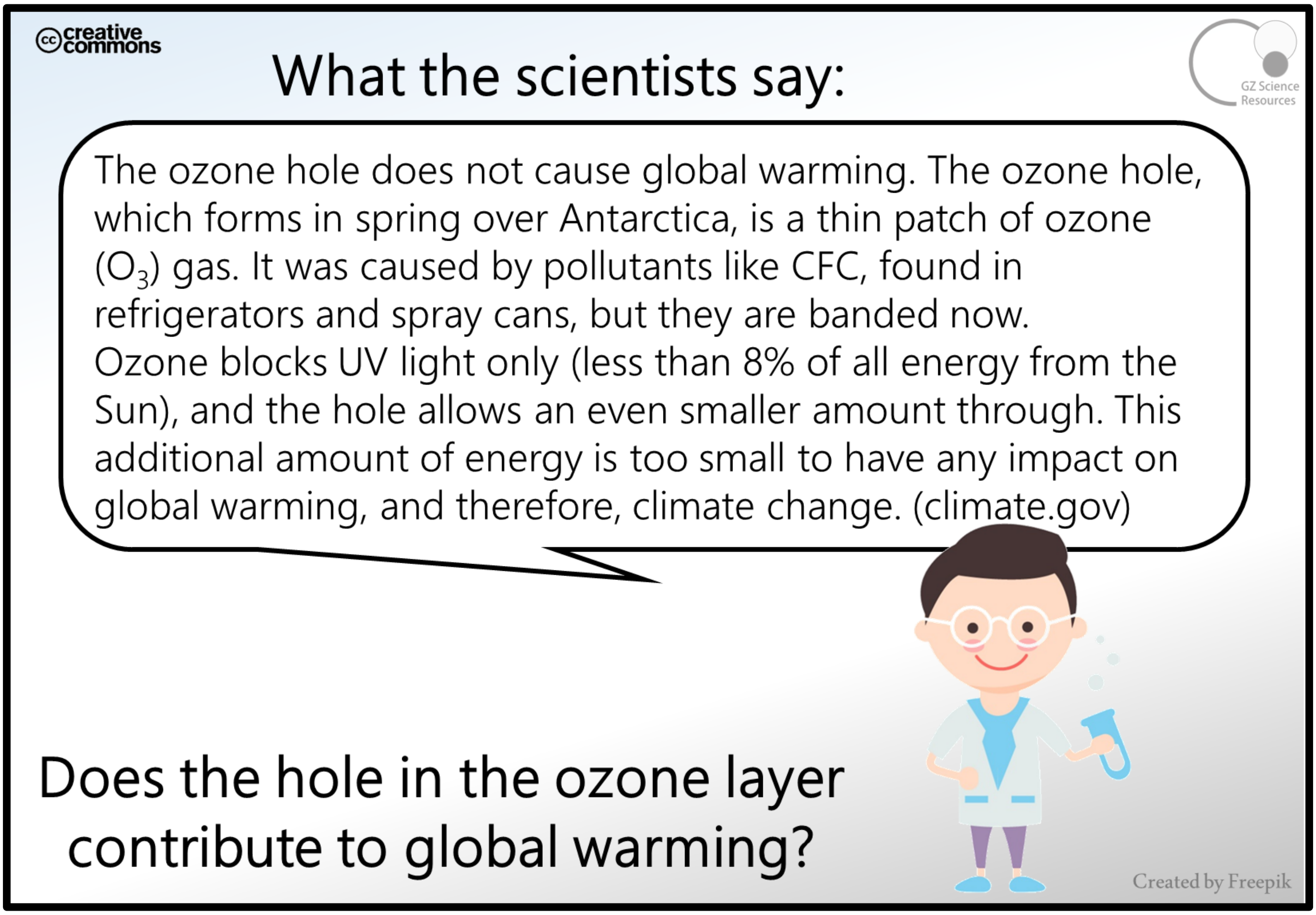
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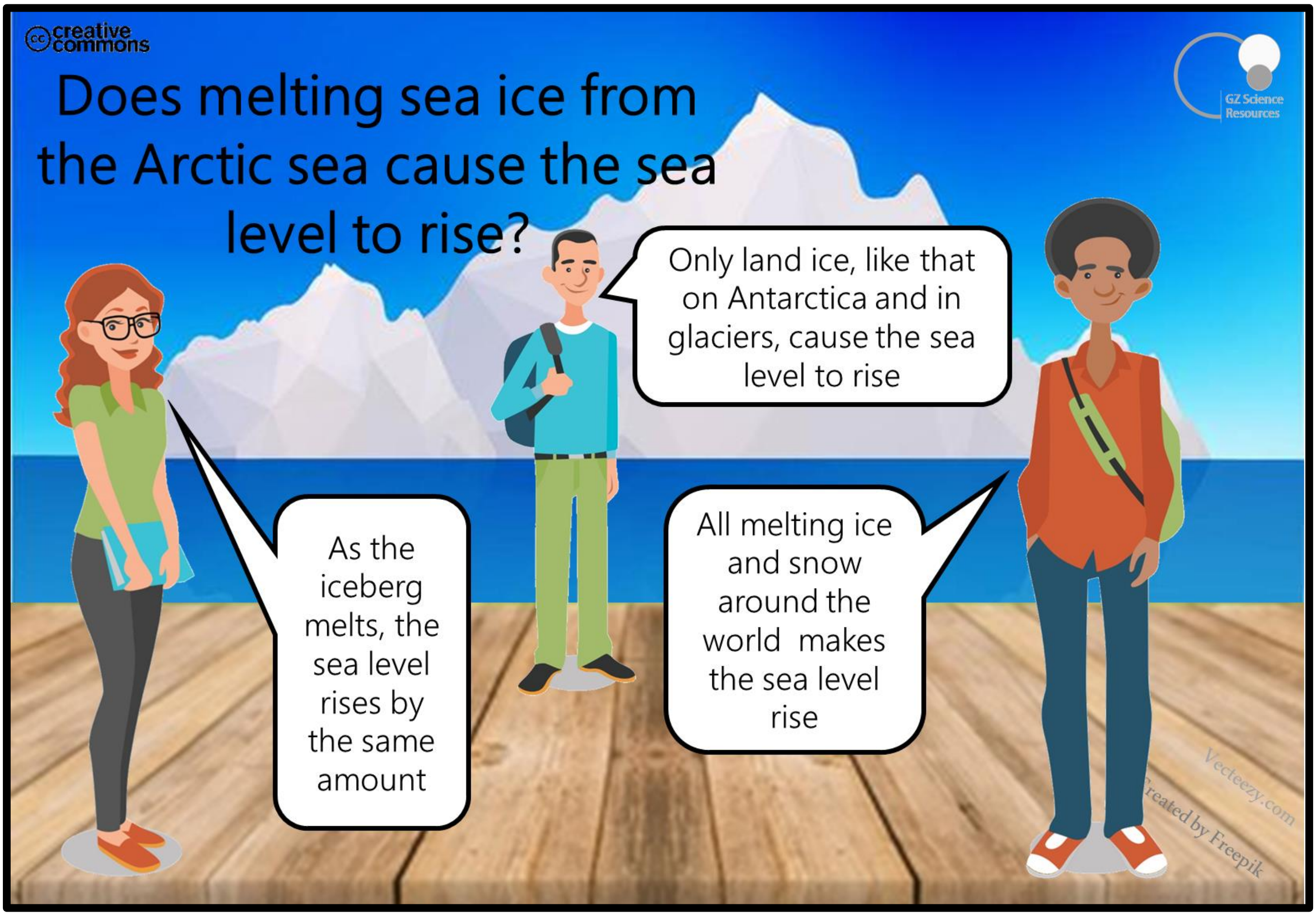
What the scientists say:
The ozone hole does not cause global warming. The ozone hole, which forms in spring over Antarctica, is a thin patch of ozone (O_3) gas. It was caused by pollutants like CFC, found in refrigerators and spray cans, but they are banded now. Ozone blocks UV light only (less than 8% of all energy from the Sun), and the hole allows an even smaller amount through. This additional amount of energy is too small to have any impact on global warming, and therefore, climate change. (climate.gov)
Does the hole in the ozone layer contribute to global warming?
Created by Freepik

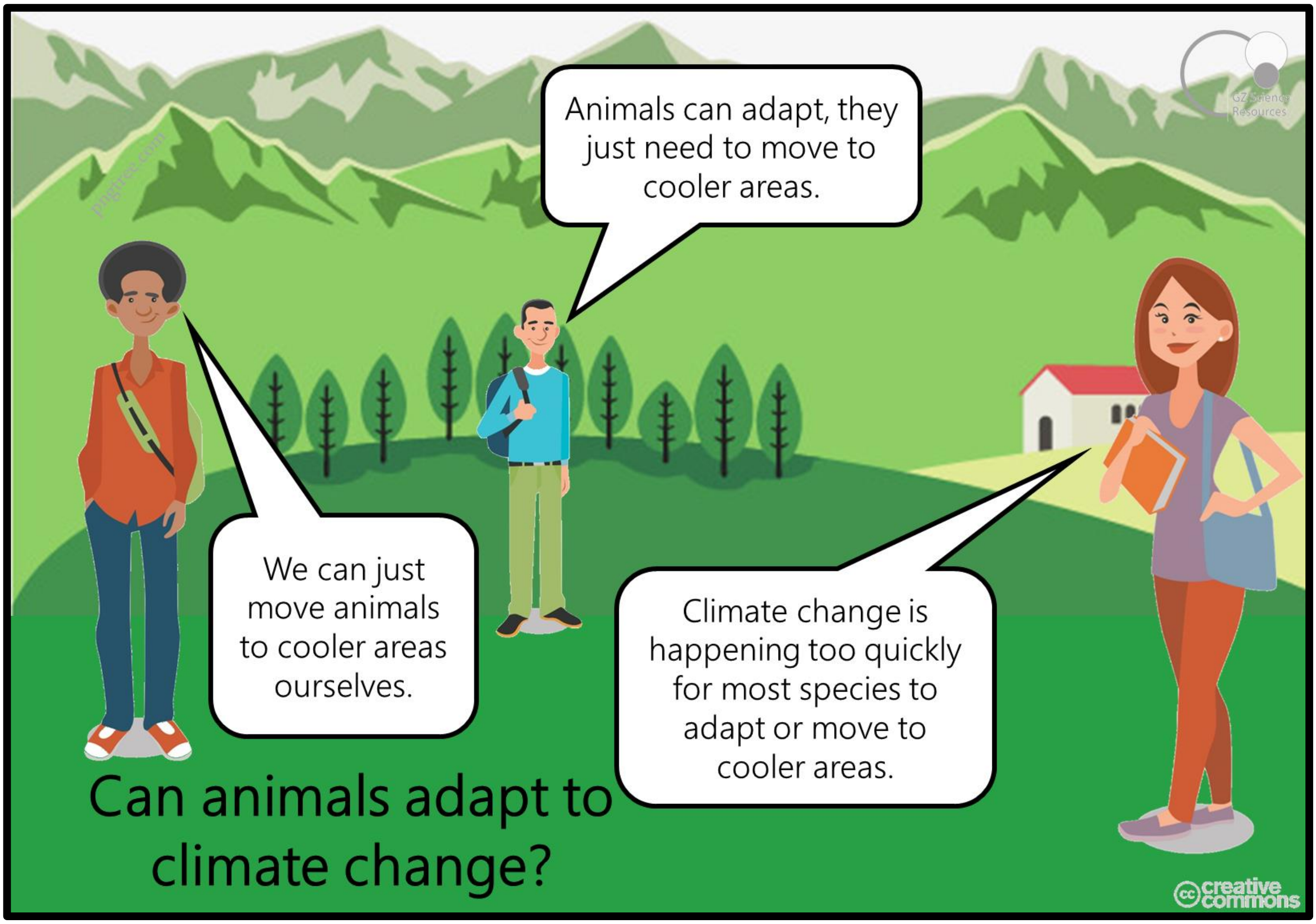


What the scientists say:

GZ Science Resources

Sea level rise is a consequence of climate change. Warming temperatures are causing the melting of the cryosphere (ice and snow on Earth), and much of this is travelling into the oceans as water, causing the sea-level to rise. However, sea ice, such as that floating in the Arctic, is already in the water, and will not change the volume of water added to the ocean.
Climate change also causing the oceans to get warmer, as the water absorbs heat. This causes heat expansion of the water and also adds to sea level rise. (NASA)

Does melting sea ice from the Arctic sea cause the sea level to rise?


Animals can adapt, they just need to move to cooler areas.
We can just move animals to cooler areas ourselves.
Climate change is happening too quickly for most species to adapt or move to cooler areas.
Can animals adapt to climate change?
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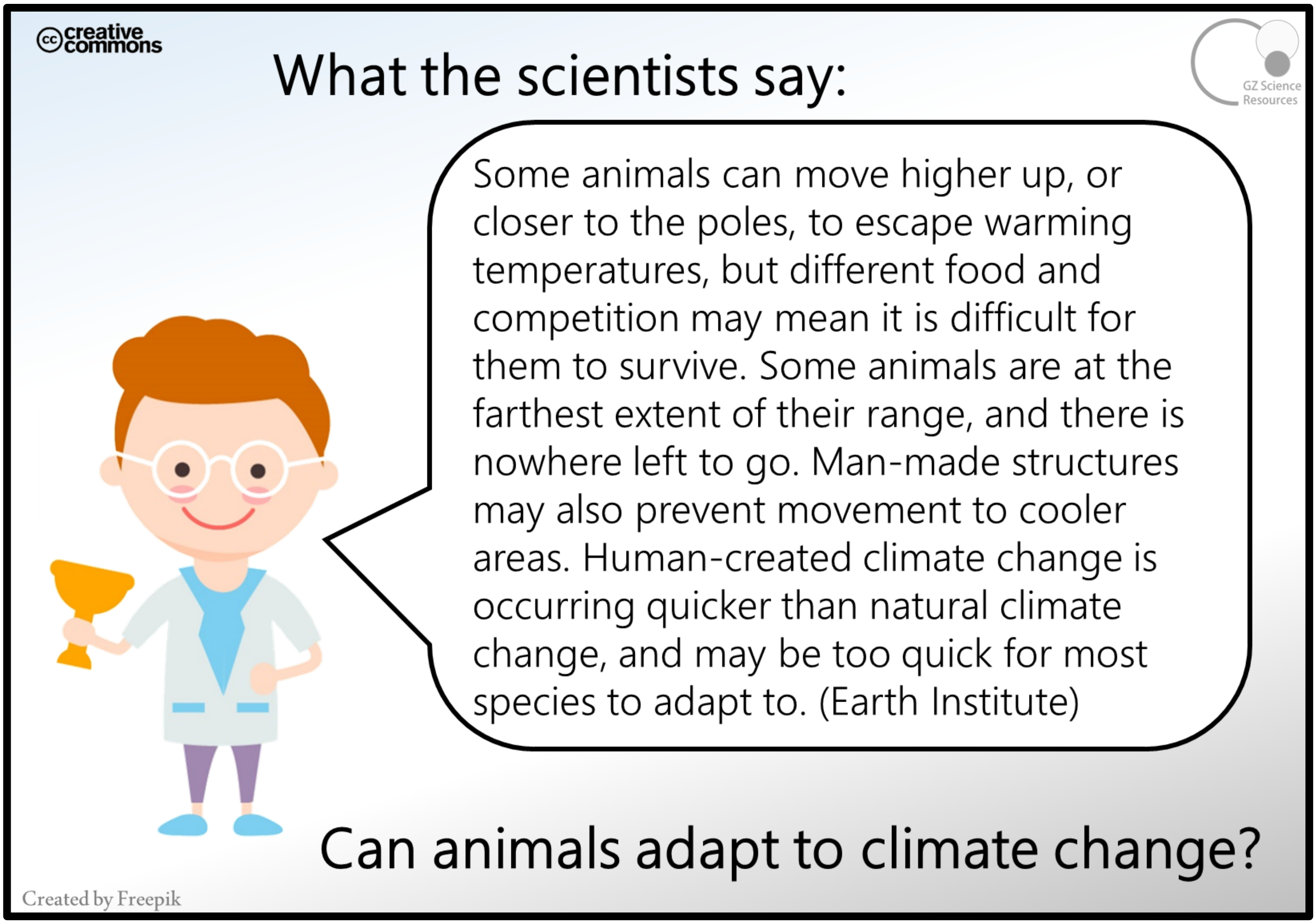
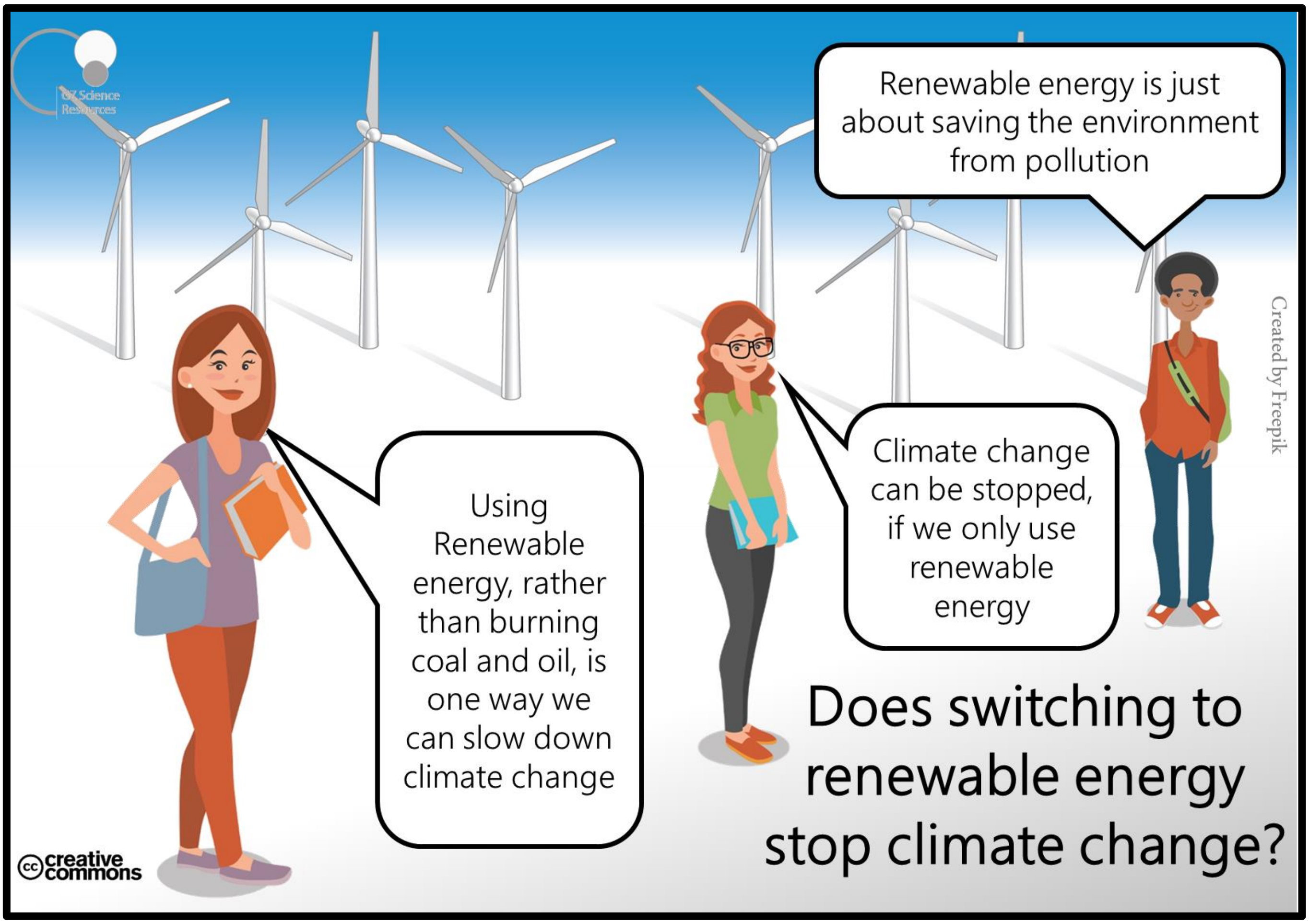

creative commons
What the scientists say:
GZ Science Resources
Some animals can move higher up, or closer to the poles, to escape warming temperatures, but different food and competition may mean it is difficult for them to survive. Some animals are at the farthest extent of their range, and there is nowhere left to go. Man-made structures may also prevent movement to cooler areas. Human-created climate change is occurring quicker than natural climate change, and may be too quick for most species to adapt to. (Earth Institute)
Can animals adapt to climate change?
Created by Freepik



What the scientists say:

Mitigation solutions reduce or remove greenhouse gas emissions of CO2, to slow further climate change. Most CO_2 comes from humans' burning fossil fuels for energy to generate electricity, transport, and industry. Renewable energy does not use fossil fuels. Energy generation produces over two thirds of global greenhouse emissions. Mitigation occurs when we produce electricity using renewable resources, such as hydro, wind or solar energy, instead of burning fossil fuels, and is an important way we can reduce the impact of global warming.

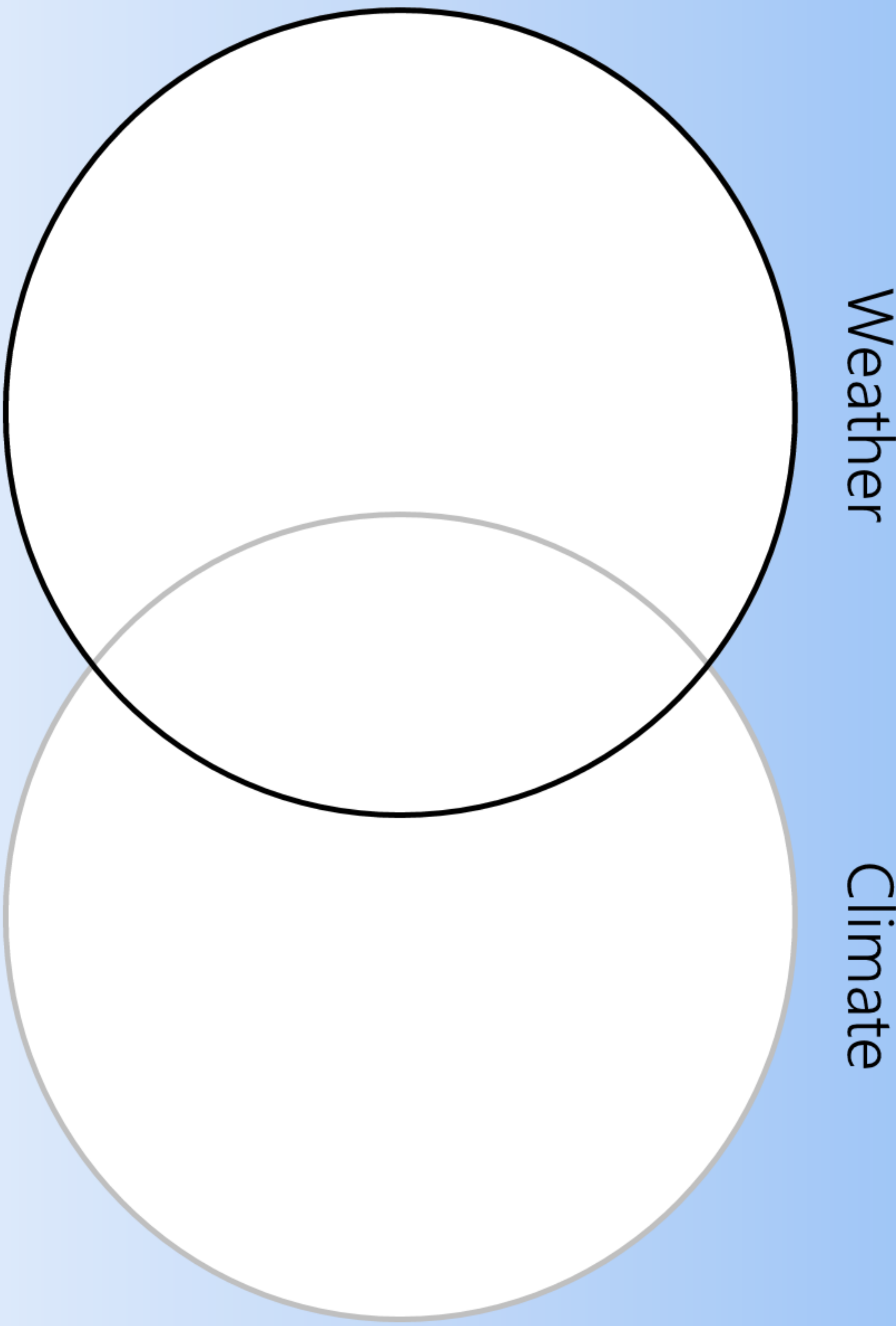
Does switching to renewable energy stop climate change?

Weather or Climate? Junior Science

GZ Science Resources

Directions: Read the following statements and write “weather” or “climate” or “both”

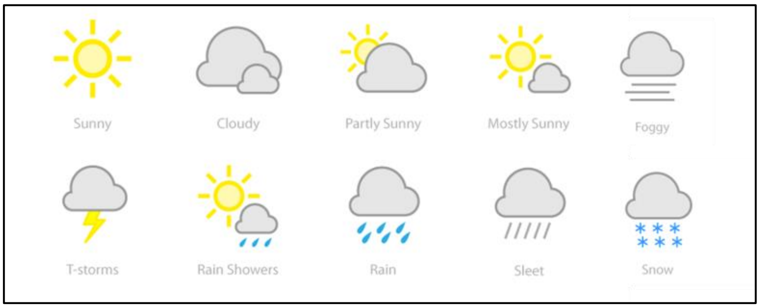
Statement	Weather, or climate?
1. January 2018 (New Zealand mean temperature 20.3°C; 3.1°C higher than the 1981-2010 January average) was New Zealand's hottest month on record, which of course means it was additionally the country's hottest January on record https://www.niwa.co.nz/climate/monthly/climate-summary-for-january-2018	
2. With a mean annual rainfall of 6,412 mm each year, a high level even for the West Coast, Milford Sound is known as the wettest inhabited place in New Zealand and one of the wettest in the world. Rainfall can reach 250 mm (10 in) during a span of 24 hours. https://en.wikipedia.org/wiki/Milford_Sound	
3. On 23rd September, 2018, the temperature in Cambridge reached a high of 16°C https://www.windy.com	
4. Snow is more common inland in both main islands of New Zealand, though snow to sea level does occur on average once or twice per year in the central and southern South Island. https://en.wikipedia.org	
5. On 10 April 1968: Cyclone Giselle caused peak gusts of 145 knots (270 km/h) near Wellington, after colliding with an Antarctic storm moving north. Giselle led to the sinking of the interisland ferry TEV Wahine, and the loss of 53 lives. Total damage caused by the storm was estimated at $14 million. https://en.wikipedia.org	
6. In New Zealand generally there are relatively small variations between summer and winter temperatures, although inland and to the east of the ranges the variation is greater (up to 14°C) https://www.niwa.co.nz	
7. NEW ZEALAND HERALD “Severe rain warnings after flooding overnight” 9 Jul, 2018 https://www.nzherald.co.nz	
8. 25 July and 14 August 2011 New Zealand snowstorms: The first severe winter storm brought the coldest winter snap in fifteen years. During August snow fell consistently down to sea level in Wellington for the first time since 1976, and snowflakes even fell for a brief time in Auckland for the first time in 80 years. https://en.wikipedia.org	
9. Antarctica is the coldest, windiest and driest continent. Scott Base is New Zealand's permanent Antarctic base. Sited on the coast, temperatures, although very low, are higher than those recorded inland. https://www.niwa.co.nz	
10. Future High and low temperature extremes in New Zealand: “Increasing temperatures result in more “hot days” and fewer frosts. New Zealand does not experience the extreme high temperatures that occur in many other parts of the world. A daily maximum temperature threshold of 25°C has therefore been chosen to mark a “hot day” https://www.niwa.co.nz	


Weather
Climate

Reading the Weather

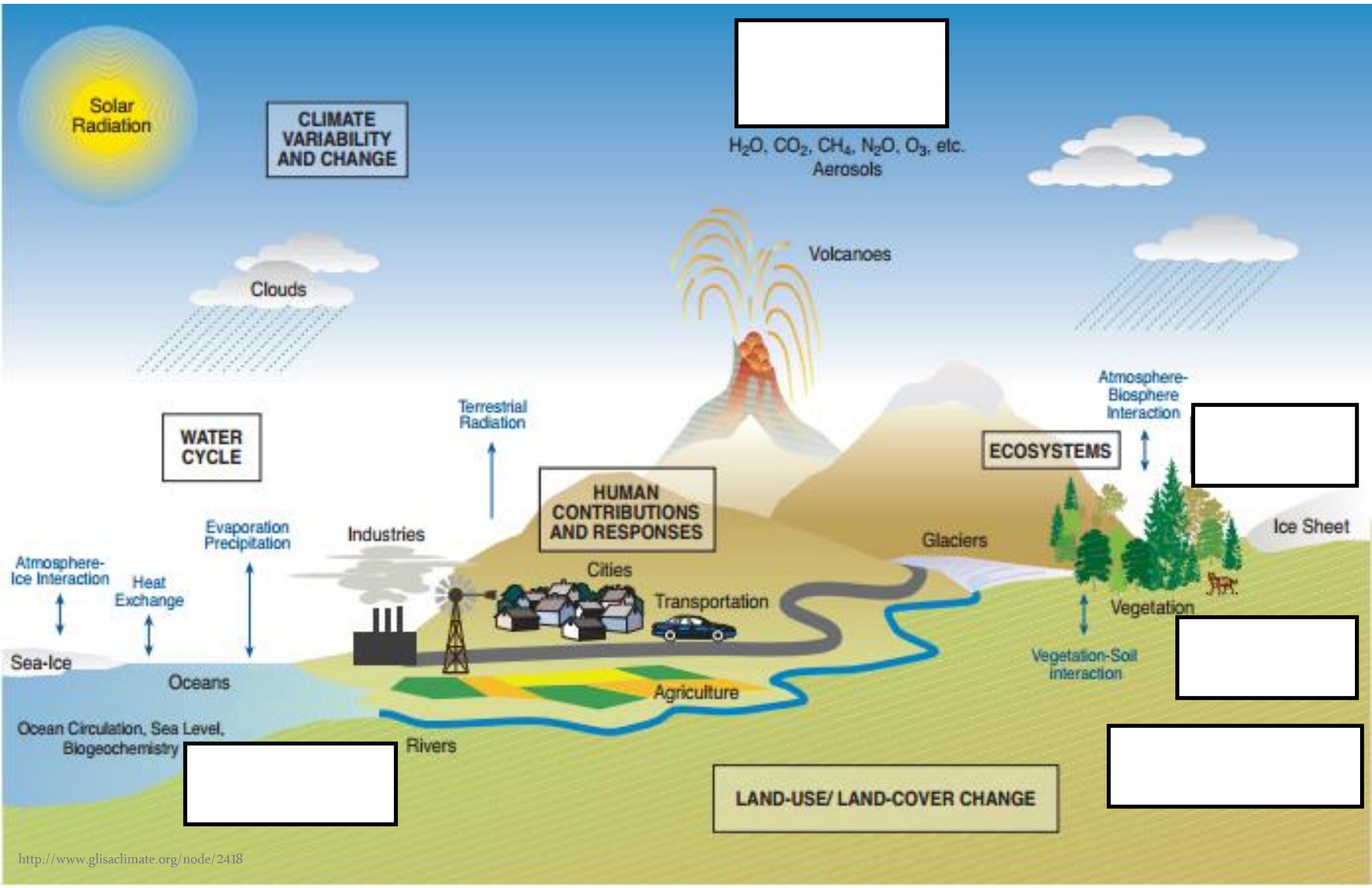
Junior Science

GZ Science Resources



Date	Rain Gauge reading mL	Air Temperature °C at 1.30pm	Weather description (see above)

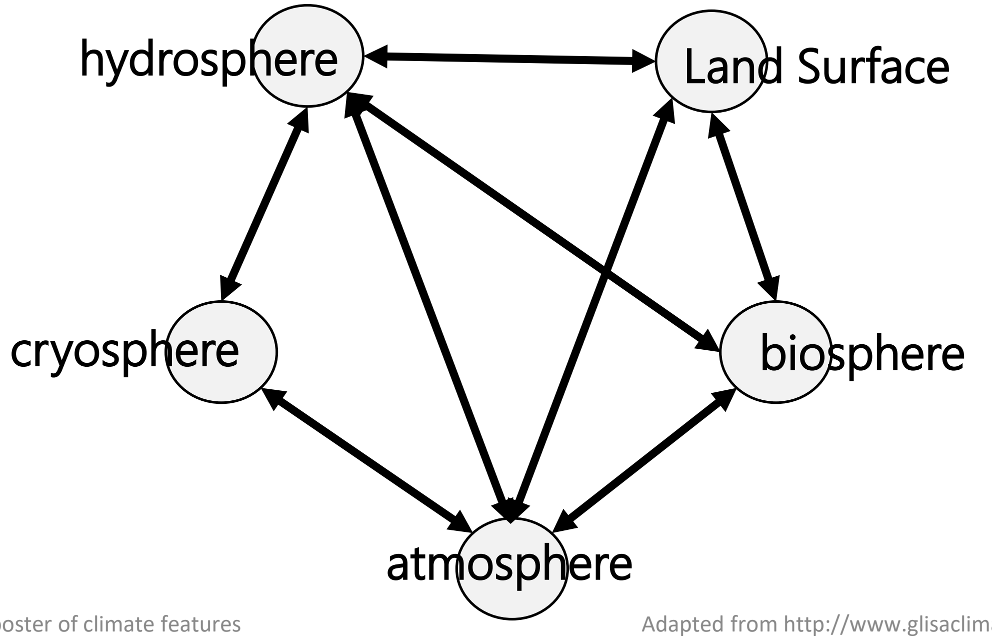
Climate Components Junior Science

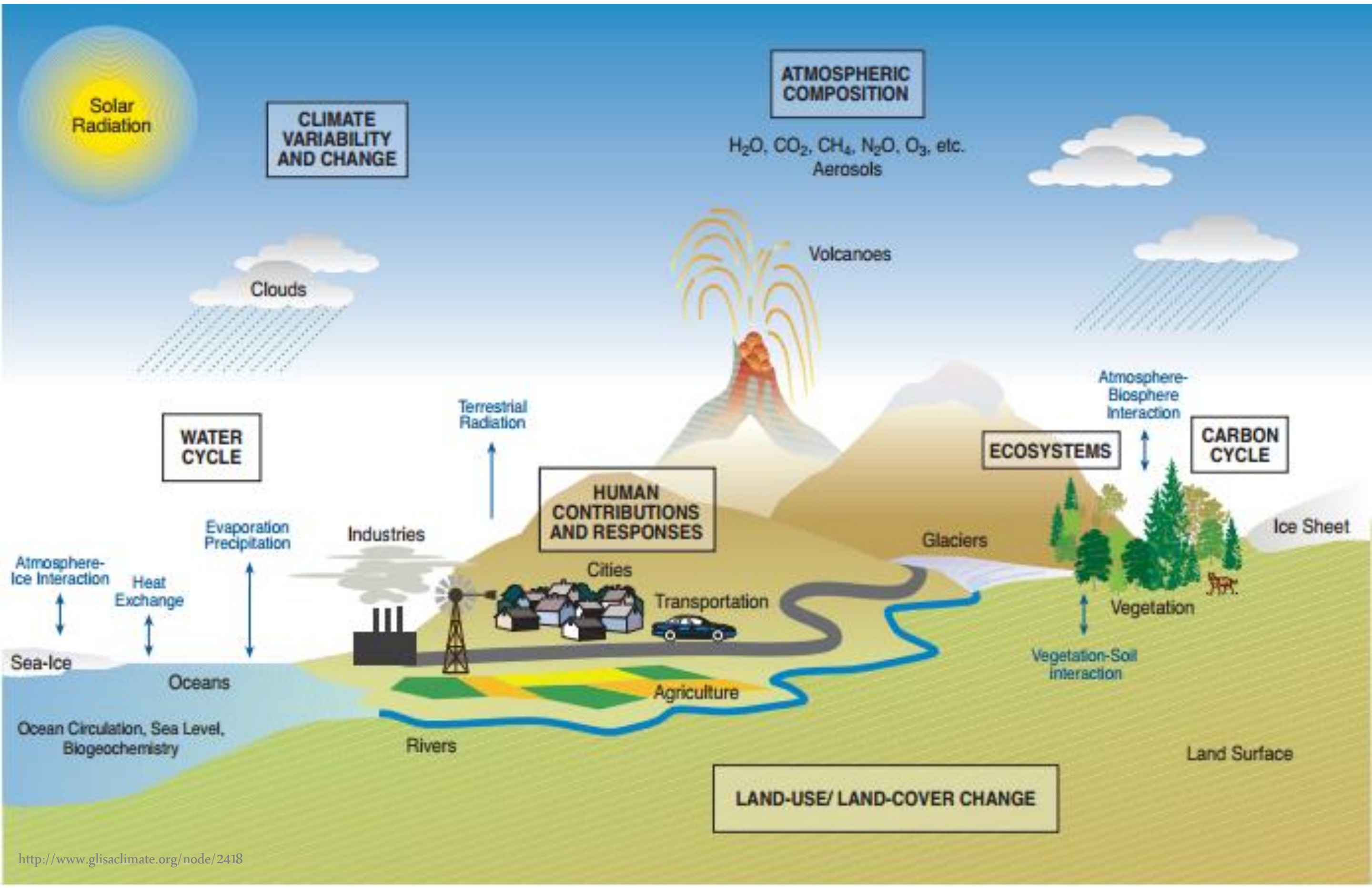


The climate system is an interactive system consisting of <u>five major components</u>: the **atmosphere**, the **hydrosphere**, the **cryosphere**, the **land surface** and the **biosphere**, influenced by various *forcing mechanisms*, the most important of which is the Sun. Any change, whether natural or human caused, in the components of the climate system and their interactions, may result in climate changes. (IPCC)

1. Label the five components above
2. Use information from the diagram, and the word bank, to label some interactions between components

○ *weathering* ○ *evapourating* ○ *freezing* ○ *photosynthesis* ○ *respiration* ○ *plant/leaf litter* ○ *precipitation* ○ *combustion* ○ *melting* ○ *volcanic eruptions* ○ *transpiration* ○ *plant water uptake* ○ *permafrost melting*

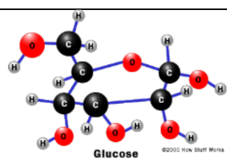
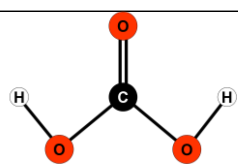


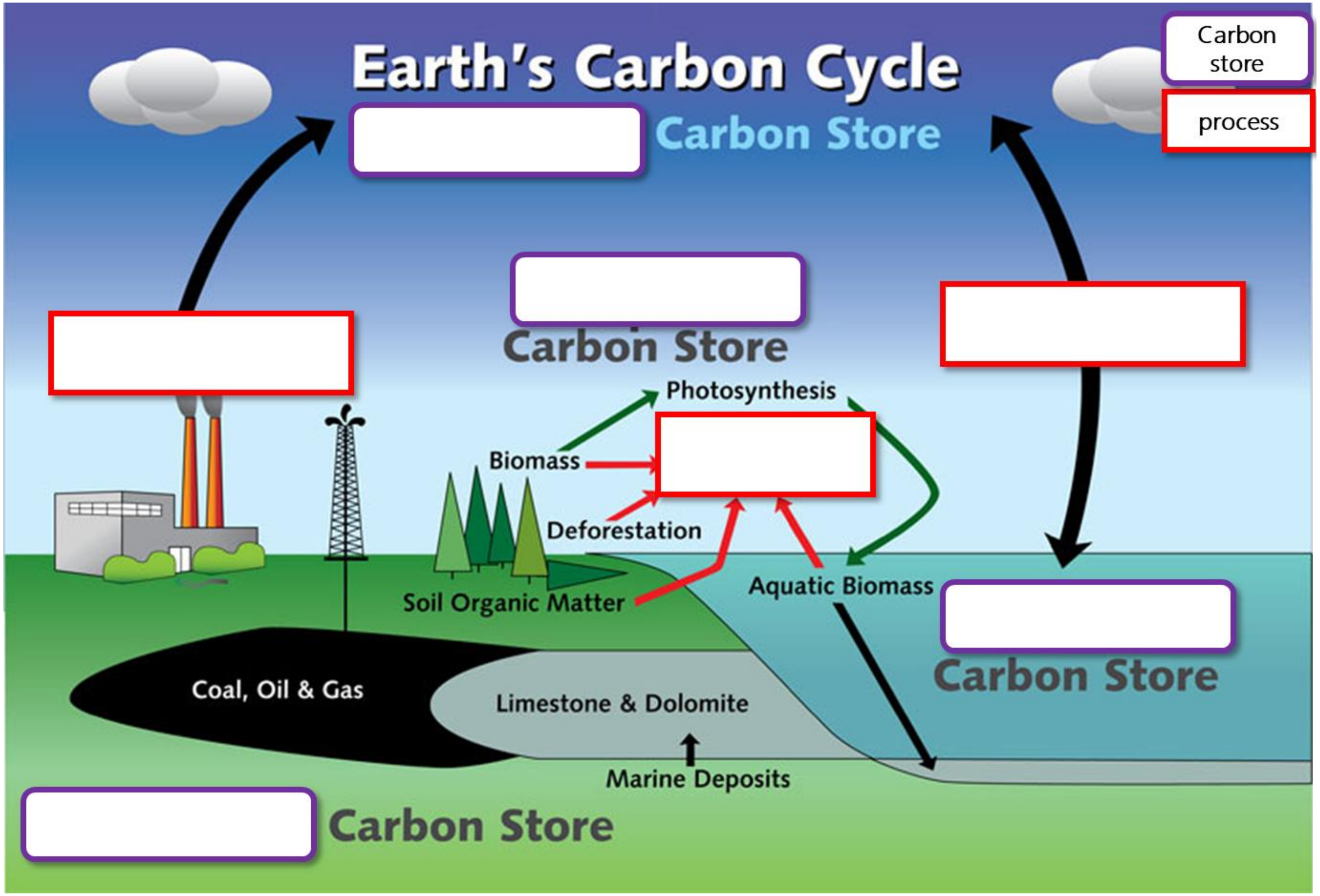


The climate system is an interactive system consisting of <u>five major components</u>: the **atmosphere**, the **hydrosphere**, the **cryosphere**, the **land surface** and the **biosphere**, *forced* or influenced by various *forcing mechanisms*, the most important of which is the Sun. (IPCC). Use information from the diagram to complete chart below:

Component	Comprised of:	How can Human Activity influence this component?
Atmosphere	N_2, O_2, Ar, H_2O, CO_2, CH_4, N_2O, O_3, aerosols	
hydrosphere	Rivers, lakes, oceans	
cryosphere	Sea ice, ice sheets, glaciers, and permafrost	
Land surface	The top layer of the Earth, exposed to the atmosphere	
biosphere	All living organisms found below, above and on the land	

Carbon on Earth

Name	Formula	Model	Where is this found on Earth?	What process creates this?
carbon (graphite / diamond)				
carbon dioxide				
methane				
Calcium carbonate	$CaCO_3$			
glucose	$C_6H_{12}O_6$			
carbonic acid	H_2CO_3			
oil	Carbon and hydrogen molecules			
coal	Mostly carbon			



Possible stores (reserviours):
>Atmosphere
>Ocean
>lithosphere
>biosphere

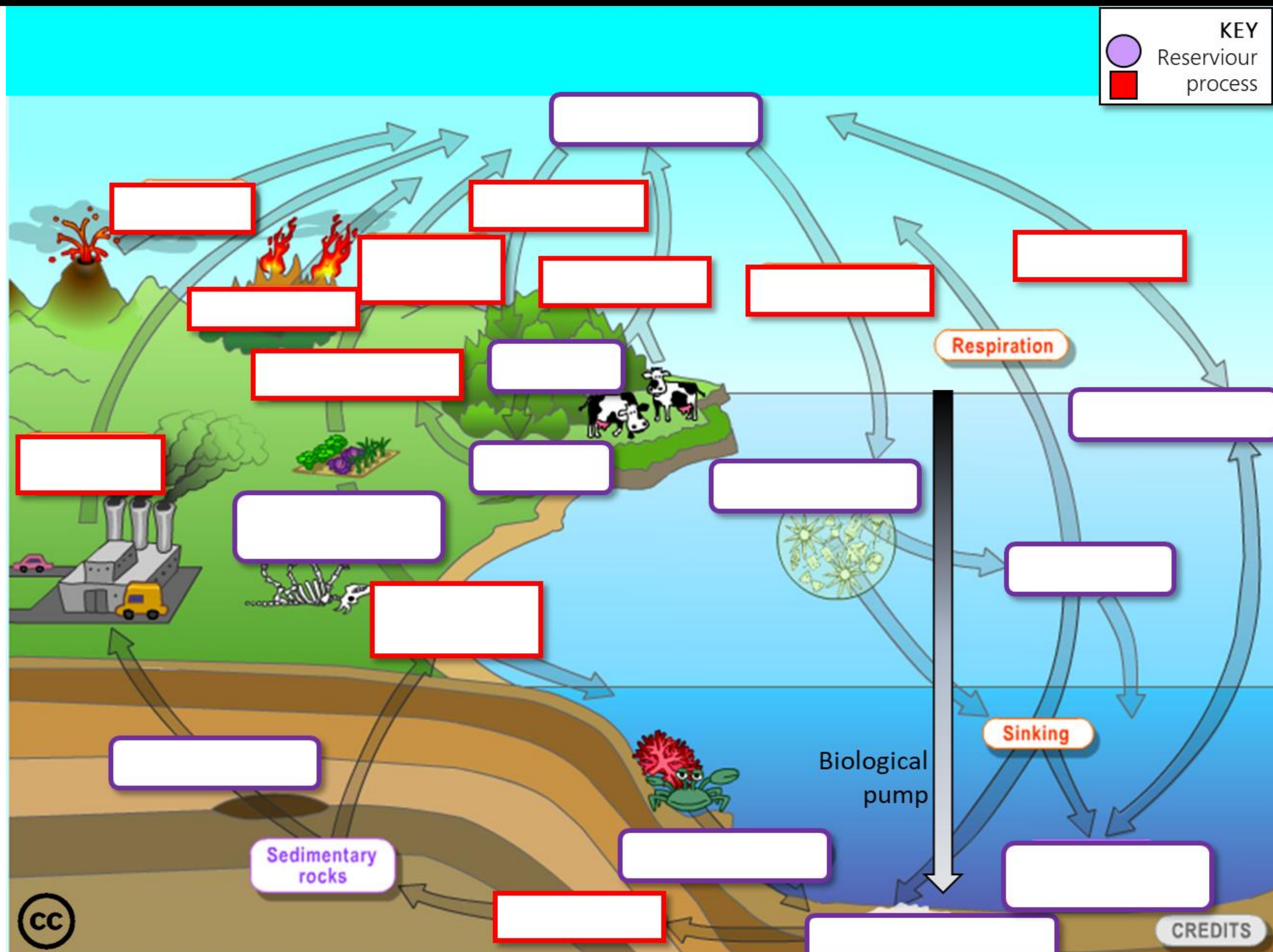
Possible processes:

>fossil fuel emissions,
>respiration & decompositions
>diffusion

1. Write in correct processes and carbon store (reserviour) terms from word bank.
2. Colour in the processes that you think human activity could influence

Carbon Cycle

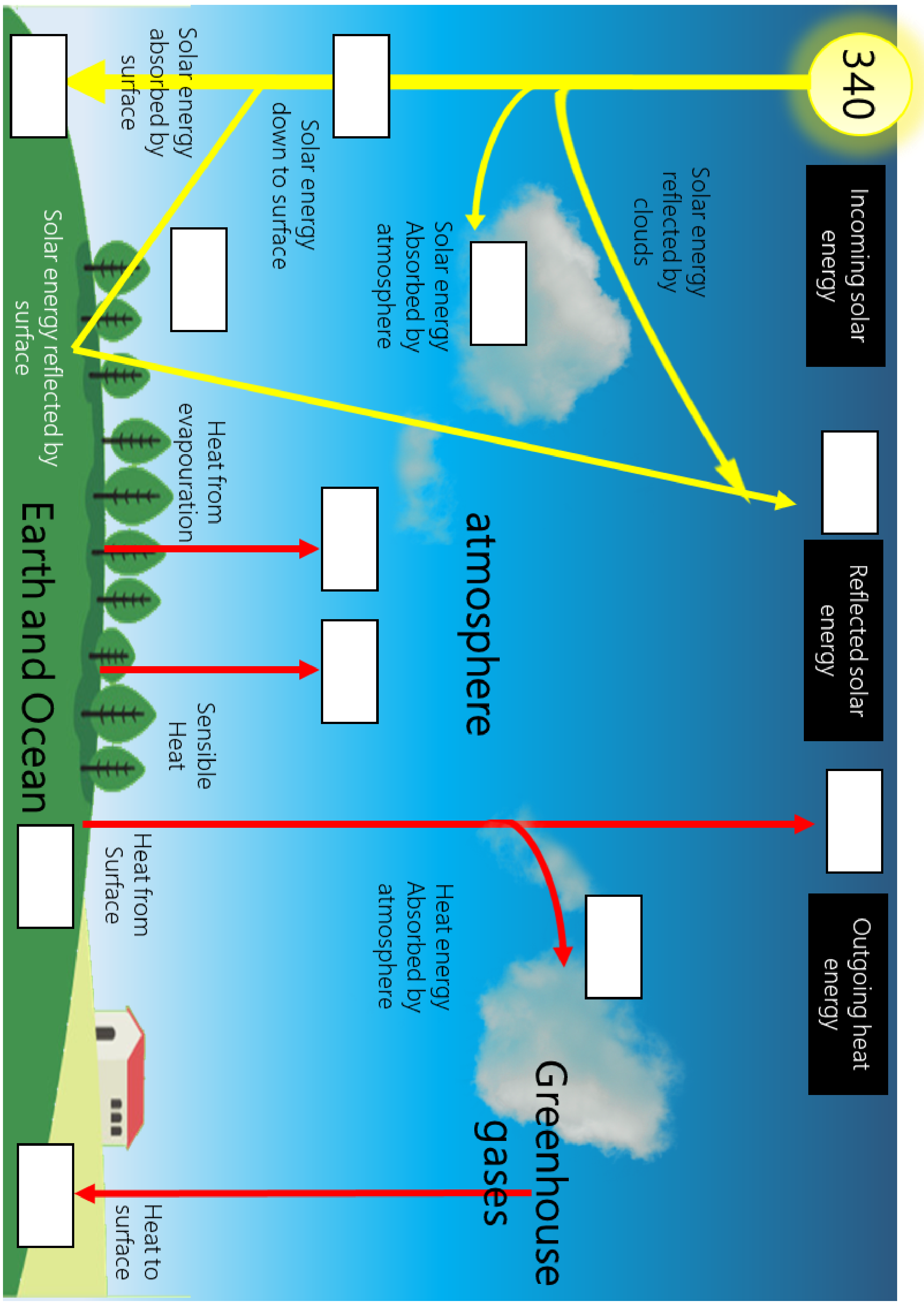
Junior Science



Possible reserviours: Atmosphere, plants, food web, soil carbon, coal, oil and gas, sedimentary rocks, phytoplankton, ocean surface, phytoplankton, food web, shellfish and corals, deep ocean, ocean floor

Possible processes: photosynthesis, respiration, soil respiration, erupting volcano, burning, decomposition, burning fossil fuels, weathering and erosion, diffusion, dissolving, sinking, rock cycle

1. Write in correct processes and carbon reserviour terms from word bank.
2. Colour in the arrows that you think human activity could influence



Energy budget values based on IPCC AR5

Adapted from http://www.ces.fau.edu/nasa/

1. Add the values to the correct labels on the diagram

Contribution	Energy (Watts/m^2)
TOTAL Incoming solar energy	340
TOTAL Reflected Solar energy	100
Solar energy absorbed by atmosphere	79
Solar energy down to surface	185
Solar energy reflected by surface	24
Solar energy absorbed by surface	161
Heat from Evaporation	84
Sensible heat	20
TOTAL Outgoing heat (thermal) energy	239
Heat (Thermal) energy up from surface	398
Heat (Thermal) energy down from surface	342

2. Calculating Earth's Energy Budget

Total of all Solar (light) energy into Earth's atmosphere		Total of all outgoing solar (light) energy from Earth's atmosphere	
		Total of all heat (thermal) energy leaving Earth's atmosphere	
TOTAL of all energy reaching Earth's atmosphere		TOTAL of all energy leaving Earth's surface	

3. Difference in energy IN and energy OUT ________________w/m^2 in the atmosphere

4. What effect will this difference have on Earth's overall energy, and therefore temperature?

5. Discuss what might happen to the Earth's energy budget in these two following scenarios
a. Increase of Carbon dioxide emissions (Greenhouse gas)
b. Decrease of land ice from increasing warming, reducing light reflected by surface (Albedo effect)

Earth's Energy Budget   Junior Science

ADVANCED LEVEL

1. Add the values to the correct labels on the diagram

Contribution	Energy (Watts/m^2)
TOTAL Incoming solar energy	340
TOTAL Reflected Solar energy	100
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Sensible heat	20
TOTAL Outgoing heat (thermal) energy	239
Heat (Thermal) energy up from surface	398
Heat (Thermal) energy down from surface	342

2. Calculating Earth's Energy Budget

Total of all Solar (light) energy down to Earth's surface		Total of all solar (light) energy reflected from Earth	
Total of all heat (thermal) energy to Earth's surface		Total of all heat (thermal) energy leaving Earth	
TOTAL of all energy reaching Earths surface		TOTAL of all energy leaving Earth's surface	

3. Difference in energy IN and energy OUT ___________________w/m^2 onto **Earth's surface**

4. What effect will this difference have on Earth's overall energy, and therefore temperature?

____

____

____

____

5. Discuss what might happen to the Earth's energy budget in these two following scenarios

a. Increase of Carbon dioxide emissions (Greenhouse gas)

b. Decrease of land ice from increasing warming, reducing light reflected by surface (Albedo effect)

____

____

____

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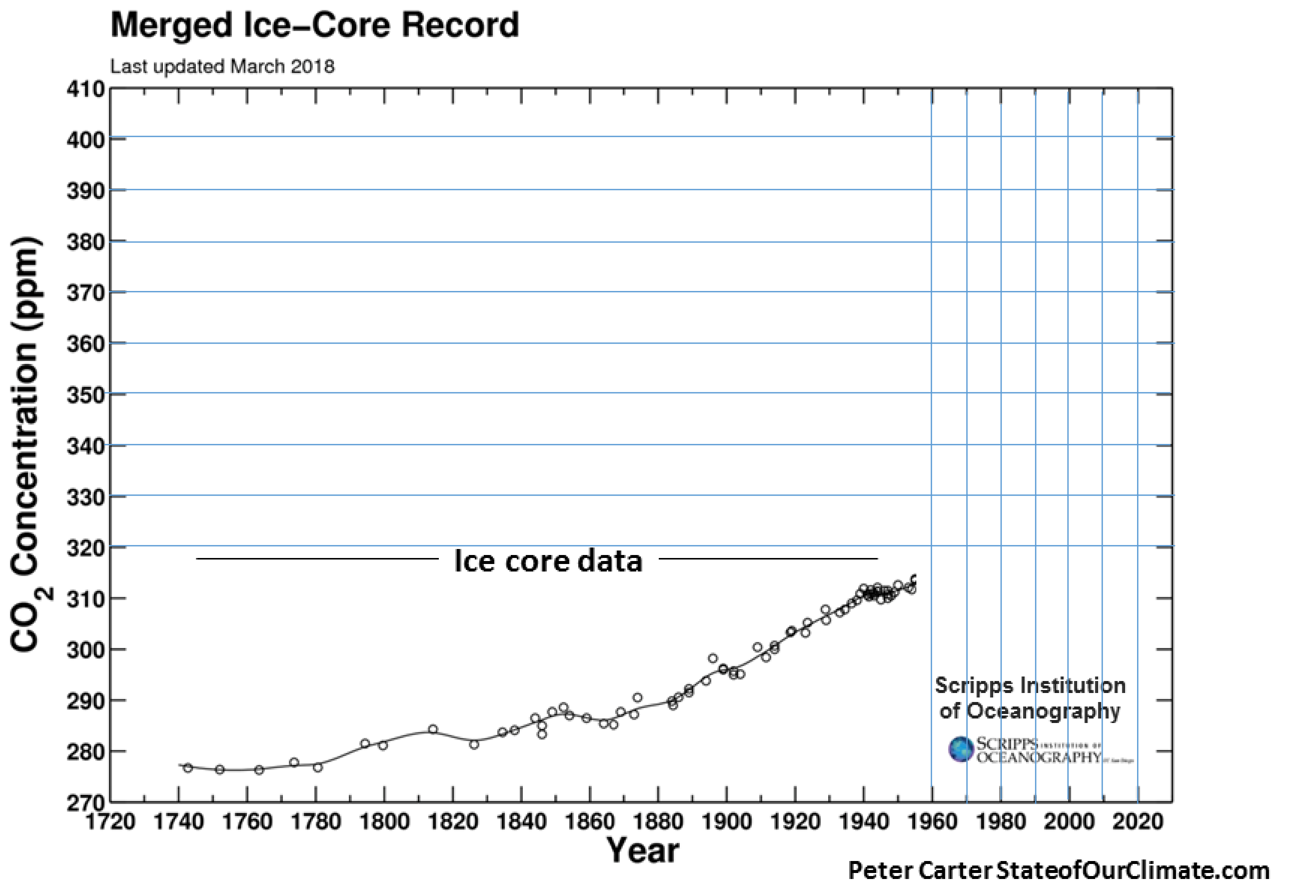
1. Use the following data to continue plotting a line graph of CO_2 concentration in the atmosphere over time. Use a ruler to find correct concentration reading.

Accelerating Atmospheric CO2 Concentration 1720 - March 2018 (Scripps)



Year CO_2 data collected	CO_2 concentration in the atmosphere (ppm)
1960	317
1965	320
1970	325
1975	331
1980	339
1985	346
1990	354
1995	361
2000	370

Year CO_2 data collected	CO_2 concentration in the atmosphere (ppm)
2002	373
2004	377
2006	382
2008	385
2010	389
2012	394
2014	399
2016	403
2018	407 (currently)

data collected from Mauna Loa, Hawaii observatory

For each of the cards

1. As a group, look at each card.
2. Talk about what you think it represents **prior** to looking at the questions for this station.
3. Feel free to ask each other questions about parts of the graph that you don't understand or point out parts of the graph that you think are important. It is helpful to start by identifying what each axis represents.
4. After looking at the graph, read the questions for this station that appear below. Discuss each question as a group.
5. After you are finished discussing the questions, individually answer the questions for each station

Cards

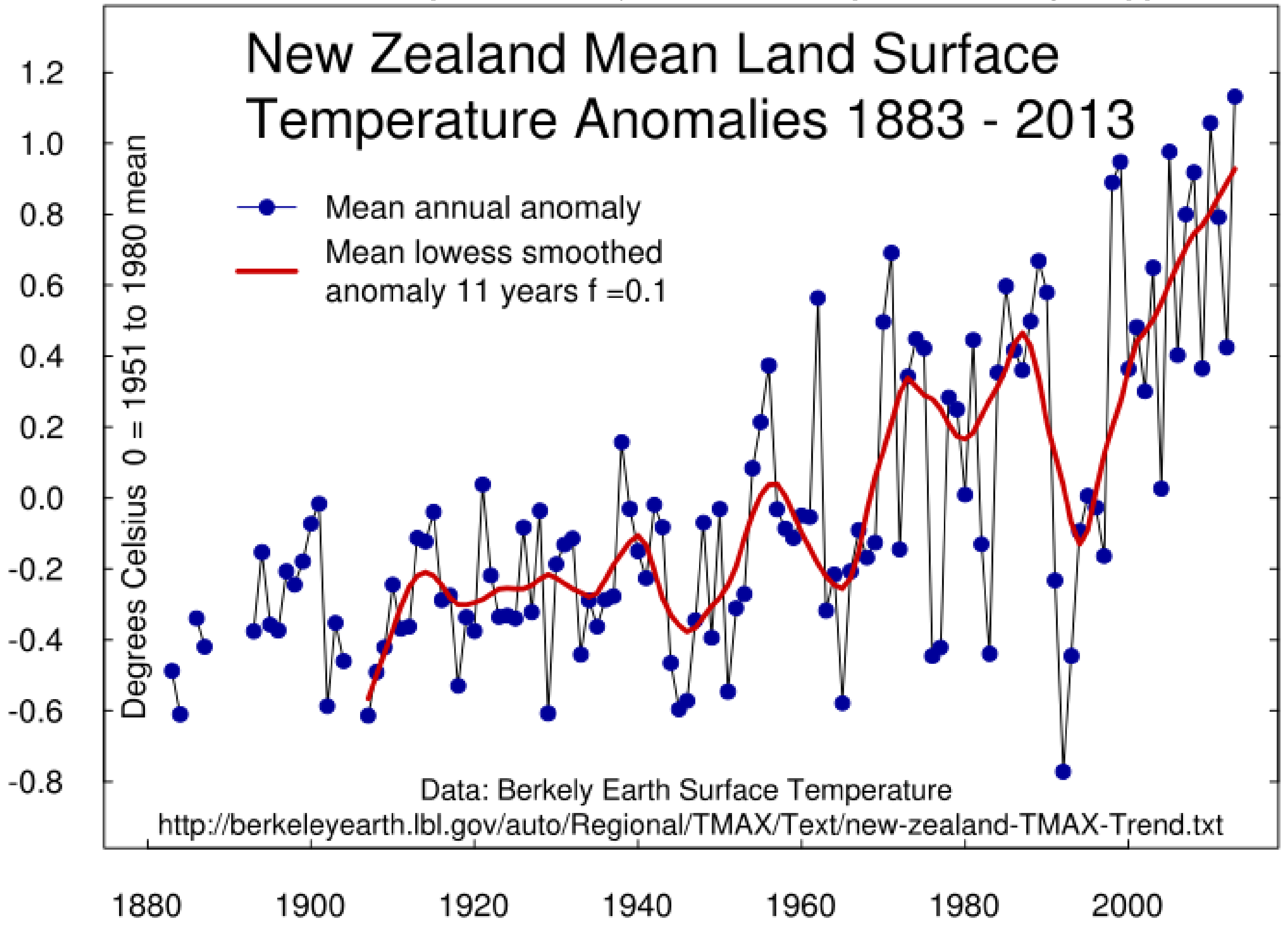
1. Temperature
2. Temperature Predictions
3. Sea Level Rise
4. Sea Level Rise Predictions
5. Rain fall Predictions
6. Extreme Temperatures
7. Melting Glacier
8. Extreme Weather Events

.

Card 1. Temperature

Use the following information to make an **evidence supported** claim

Graph attributed to: Mrfebruary - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=46210465



Card 1

1. What is the difference between the blue dots and the red line?

2. How much has temperature, in degrees Celsius, changed since 1880?

3. Now make an **evidence supported** claim about mean surface temperature in New Zealand.

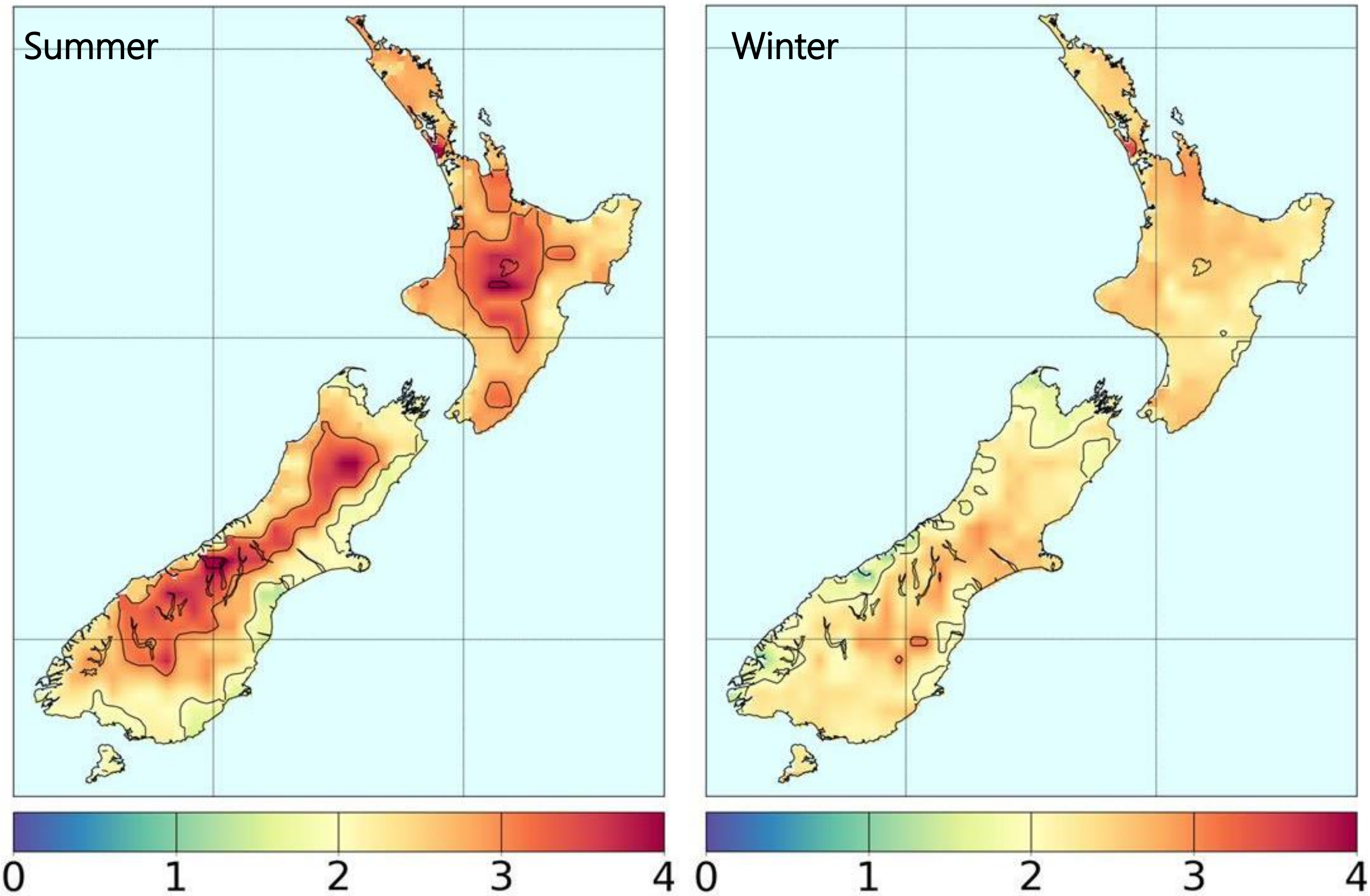
adapted from https://pangea.stanford.edu/programs/outreach/climatechange/curriculum

Card 2. Temperature predictions

Use the following information to make an **evidence supported** claim

Predicted increase in average temperature (°C) by 2090, relative to 1986-2005. (for highest CO_2 emissions prediction)

Graph attributed to: https://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios



°C change from 1986-2005 average time period

Card 2

1. Which season will experience the most impact from the temperature increase, created from climate change?

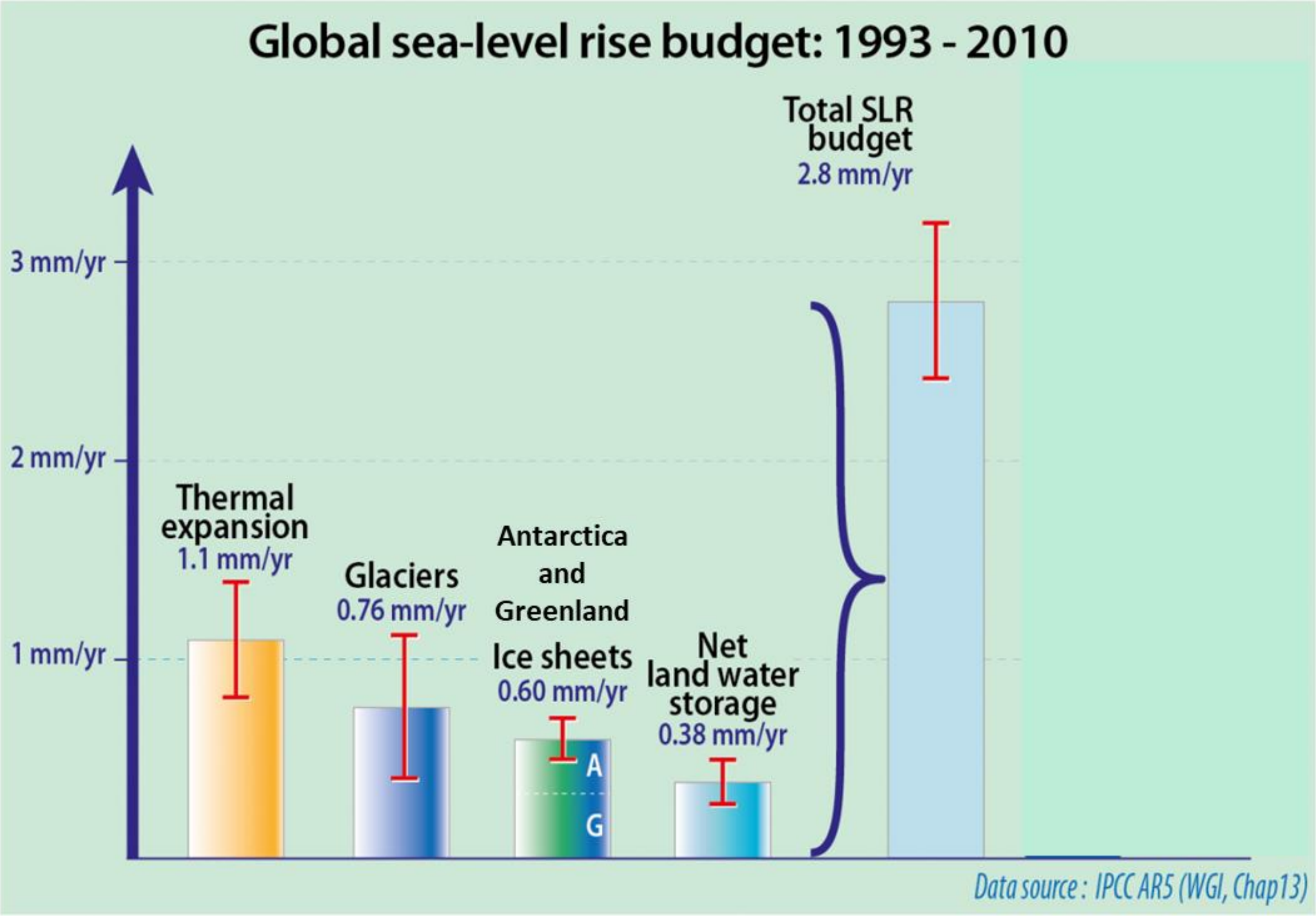
2. Why do you think some areas of New Zealand experience a difference in temperature increase??

3. Now make an **evidence supported** claim about the 2090 **predicted** mean surface temperature in New Zealand.

adapted from https://pangea.stanford.edu/programs/outreach/climatechange/curriculum

Card 3. Sea Level Rise

Use the following information to make an **evidence supported** claim



Sourced from: https://www.niwa.co.nz/natural-hazards/hazards/sea-levels-and-sea-level-rise

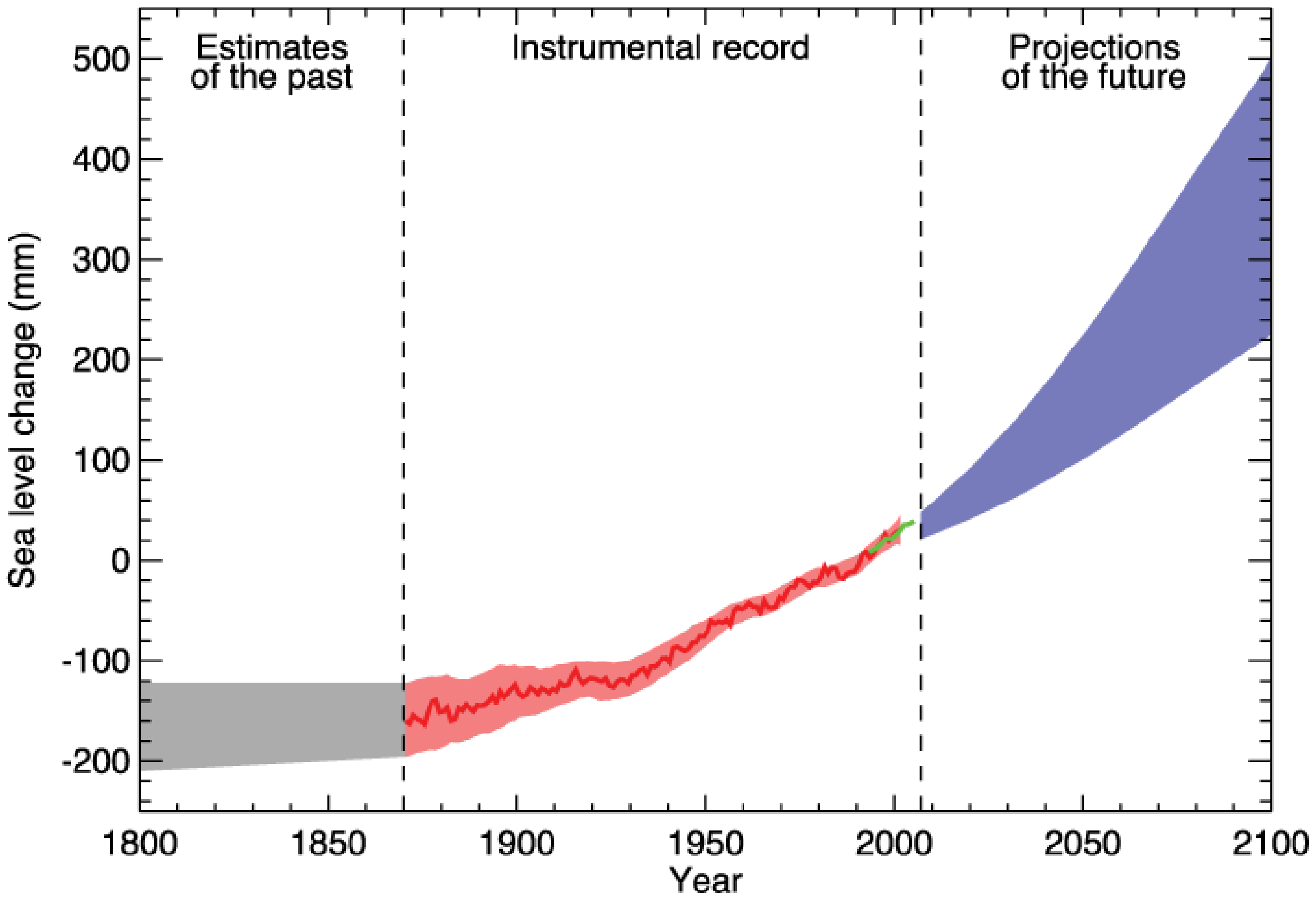
Card 3

1. What are the two main processes that are contributing to sea level rise?
2. What 'melting' does not contribute to sea level rise, and why?
3. What is the total sea level rise from
4. Now make an **evidence supported** claim about the 1993 – 2010 global sea level rise.

Card 4. Sea Level Rise Predictions

Use the following information to make an **evidence supported** claim

Sourced from: http://thebritishgeographer.weebly.com/sea-level-change.html



Card 4

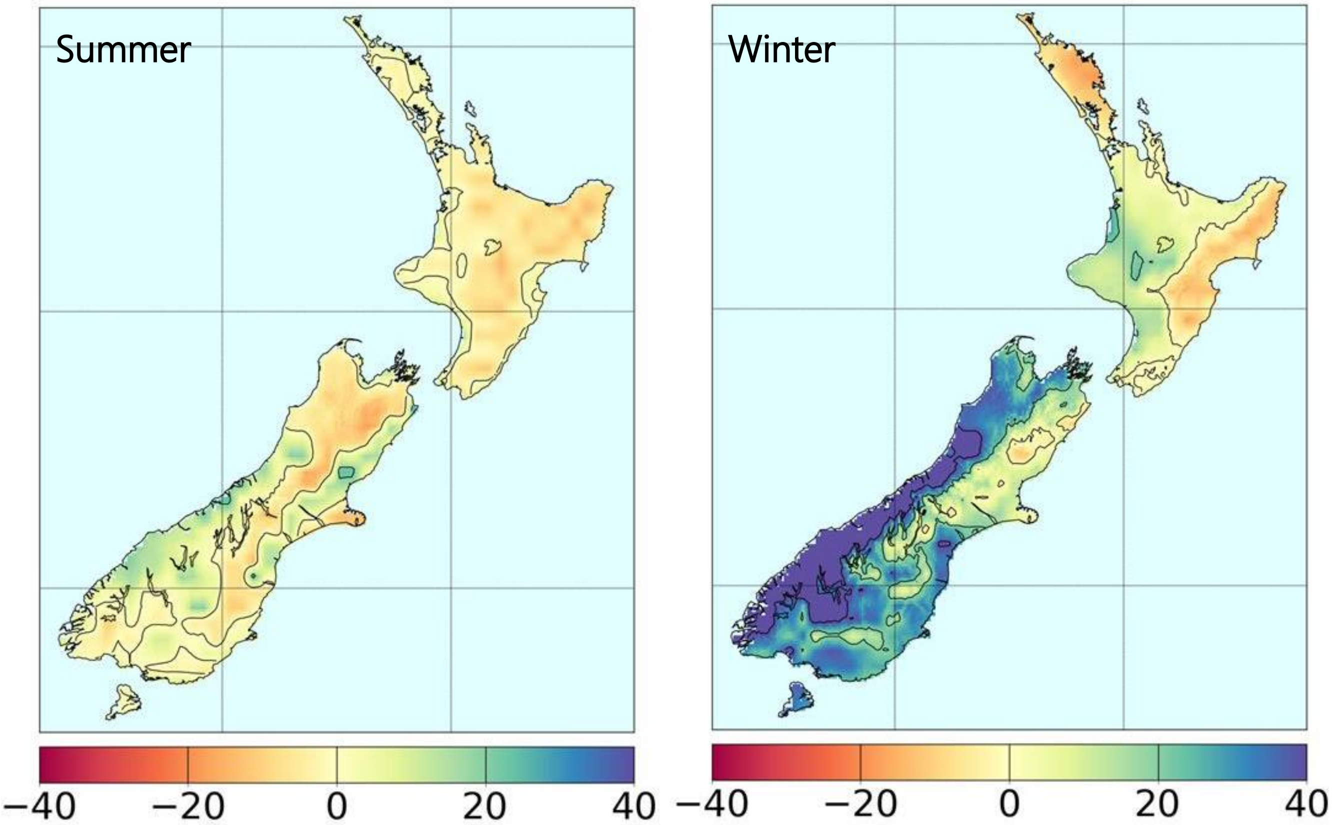
1. Why does the most recent instrumental recording have the narrowest range of sea level rise?
2. Why does the range for the projections of the future sea level rise get larger as time goes by?
3. Now make an **evidence supported** claim about the global sea level rise.

Card 5. Rainfall Predictions

Use the following information to make an **evidence supported** claim

Predicted increase in precipitation (rainfall) (%) by 2090, relative to 1986-2005. (for highest CO_2 emissions prediction)

Sourced from: https://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios



% change from 1986-2005 average time period

Card 5

1. What areas of New Zealand are projected to get drier by 2090, due to Climate change?

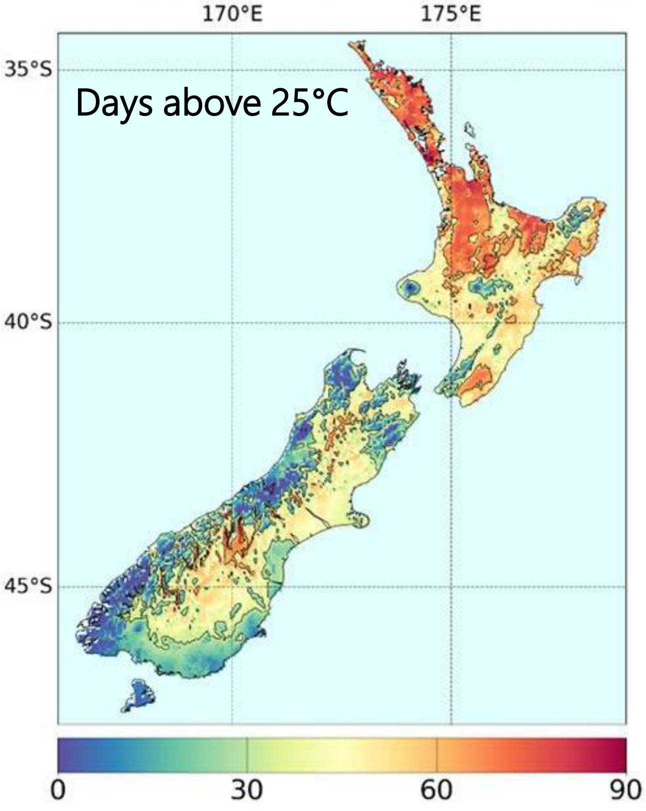
2. What areas of New Zealand are projected to get wetter by 2090, due to Climate change?

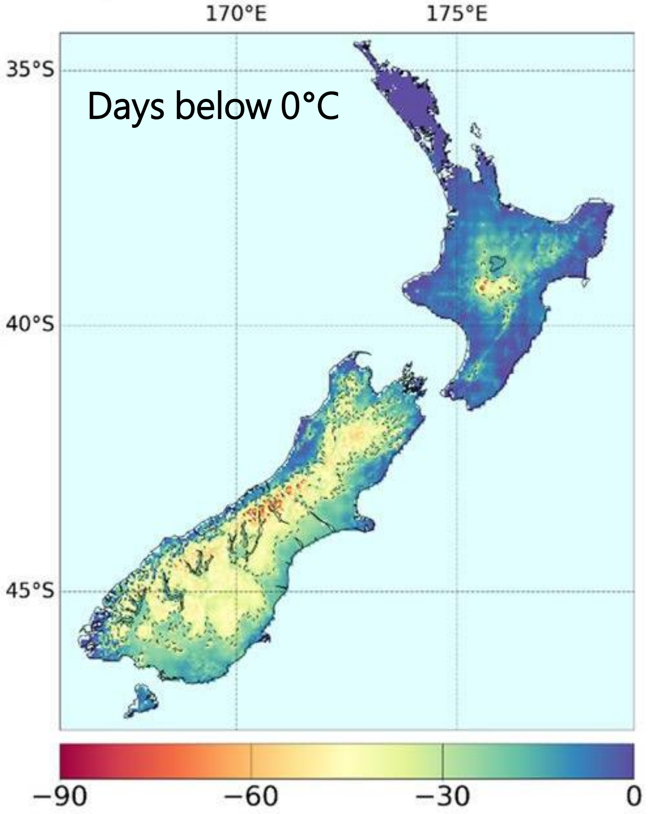
3. Now make an **evidence supported** claim about the predicted changing precipitation rates in New Zealand.

Card 6. Extreme temperatures

Use the following information to make an **evidence supported** claim

Predicted change in number of extreme temperature days by 2090, relative to 1986-2005. (for highest CO_2 emissions prediction)





Number of days change from 1986-2005 average time period

Sourced from: https://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios

Card 6

1. What areas of New Zealand are projected to have more hot days by 2090, due to Climate change?

2. What areas of New Zealand are projected to have fewer frosts by 2090, due to Climate change?

3. Now make an **evidence supported** claim about the predicted changing extreme **hot** AND **cold** days in New Zealand.

Card 7. Melting Glaciers

Use the following information to make an **evidence supported** claim

Change in Fox Glacier, West Coast, New Zealand from 2008 to 2014

Sourced from: http://glacierhub.org/2016/07/26/as-glaciers-melt-tourists-keep-on-coming-in-new-zealand/

Change in Franz Joseph Glacier, West Coast, New Zealand from 2009 to 2013

Sourced from: http://glacierhub.org/2016/07/26/as-glaciers-melt-tourists-keep-on-coming-in-new-zealand/

Card 7

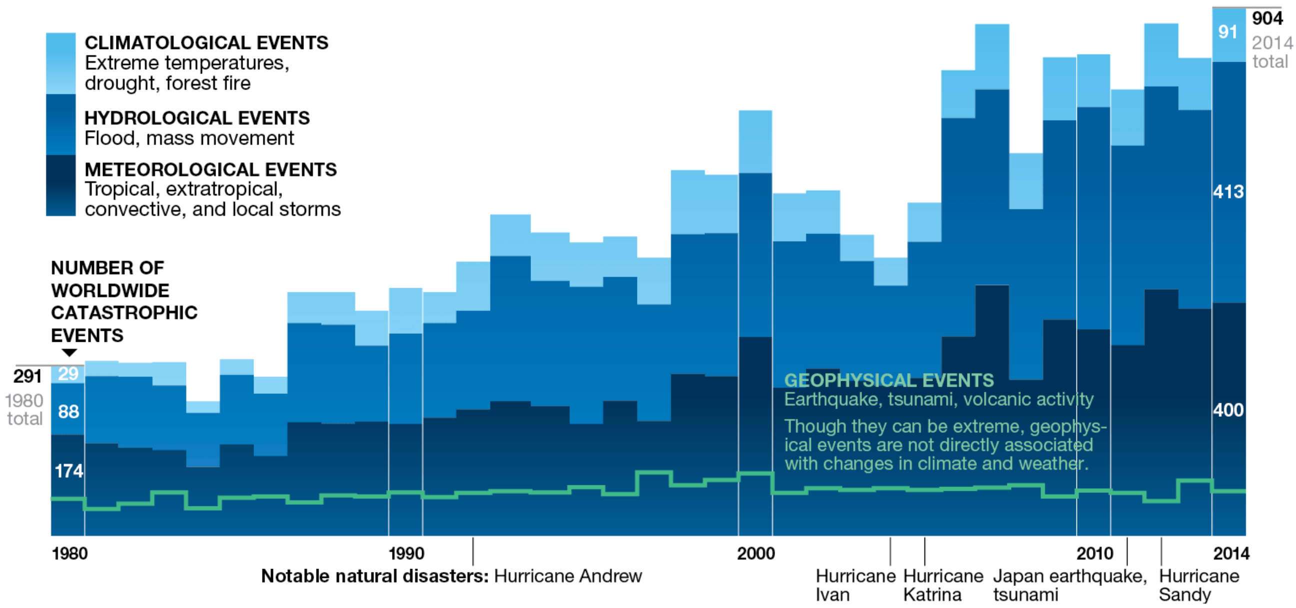
1. Where do you think the ice/snow from the glaciers is going?
2. What do you think is eventually going to happen to the glaciers?
3. Now make an **evidence supported** claim about the change in size of the Glaciers in New Zealand.

 adapted from https://pangea.stanford.edu/programs/outreach/climatechange/curriculum

Card 8. Extreme Weather Events

Use the following information to make an **evidence supported** claim

Numbers of Extreme Weather event from 1980 to 2014



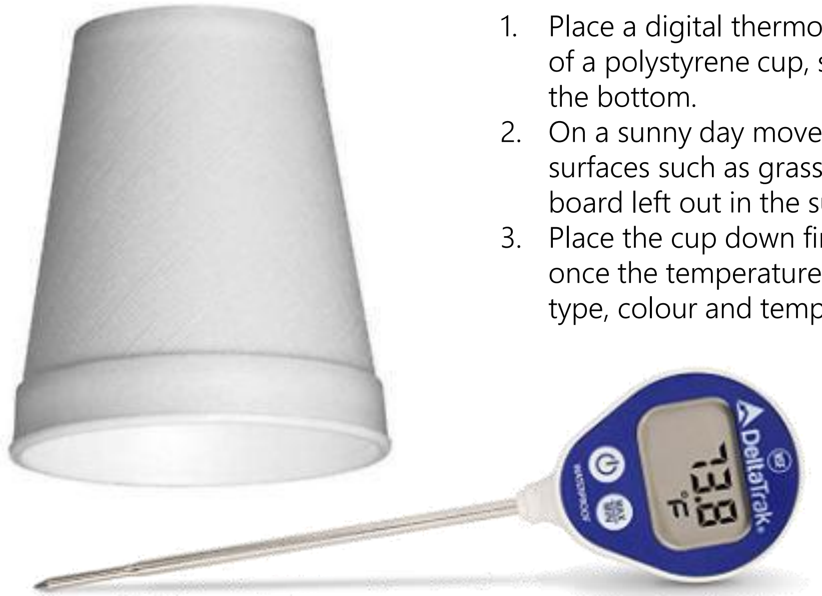
Sourced from: https://www.nationalgeographic.com/climate-change/how-to-live-with-it/weather.html

Card 8

1. What type of events have increased the most from 1980 to 2014?
2. Which events are not attributed to Climate change?
3. Now make an **evidence supported** claim about the change in Extreme weather Events in New Zealand.

The Albedo Effect is the result of different coloured surfaces reflecting, and absorbing different wavelengths (colours) of visible light. White surfaces reflect all wavelengths of visible light, and black surfaces absorb all wavelengths. Different colours have different energy waves, with red at a lower energy than green and violet

1. Place a digital thermometer probe through the top of a polystyrene cup, so the probe nearly touches the bottom.
2. On a sunny day move around to several ground surfaces such as grass, concrete, dirt, and a white board left out in the sun for at least 30mins.
3. Place the cup down firmly on the surface, and once the temperature stabilises, record the surface type, colour and temperature



Surface	Colour of surface	Temperature °C

1. What coloured surface had the highest temperature reading? ______________________________
2. What explanation can you give for this?

____

____

____

3. What coloured surface had the lowest temperature reading?______________________________
4. What explanation can you give for this?

____

____

____

5. If ice and snow melt, caused by raising global temperatures, caused darker rock or earth underneath to be exposed, how do you think this might effect the temperature of the surround area?

____

____

____

Land and Sea Ice   Junior Science

Climate change is causing the world to heat up. All of the frozen ice and snow around the world, together called the cryosphere, is melting because of the temperature increase. Some ice sits on top of land, such as the Antarctica and Greenland ice shelves, as well as the Glaciers around the world. Other ice floats on the sea, such as the Artic ice. Melting ice is causing the Sea level to rise – but what melting ice? This investigation helps us to understand what is causing sea level rise.

Beaker A – Sea ice

Beaker B – Land ice

1. Set up 2 large beakers, with an inverted smaller beaker in each. Place 3 ice cubes around the bottom of Beaker A, and on Beaker B place the 3 ice cubes on top of the inverted beaker.
2. Fill each with the **same volume** of water (but not above the inverted beaker – where the ice cubes sit in Beaker B).
3. Place a heat source (lamp) close to each and record volume in each beaker every 2 minutes until all the ice melts.

Time	Volume of Sea ice (A) in mL	Volume of land ice (B) in mL
Starting time (0)		
2mins		
4mins		
6mins		
Final time (when all of the ice is melted		

What conclusion can you make about the results of this investigation? And how does this relate to whether sea ice or land ice contributes to sea level rise?

___

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___

___

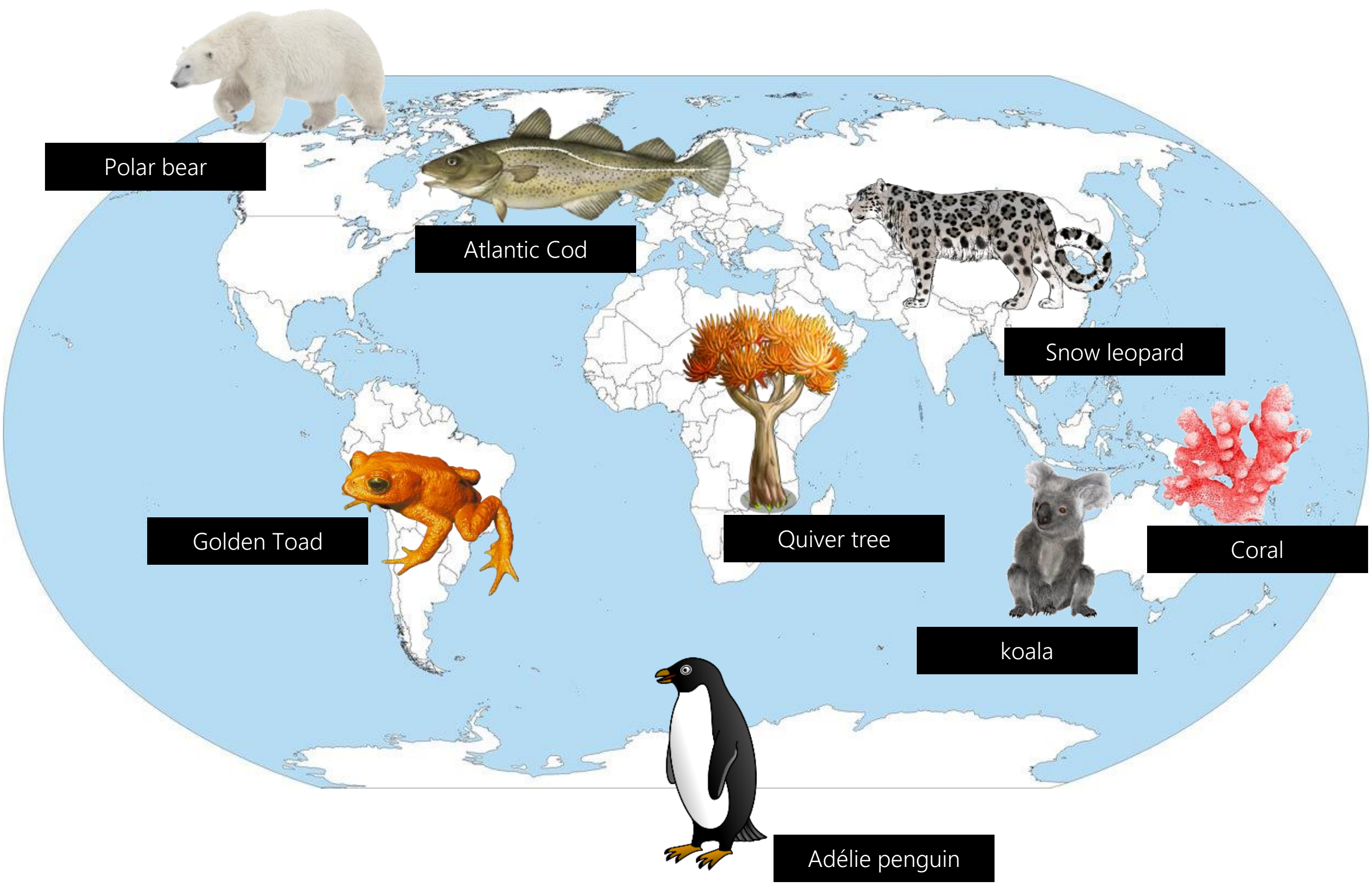
Using your science ideas, why do you think you got the results you did?

___

___

___

Our Homes are changing

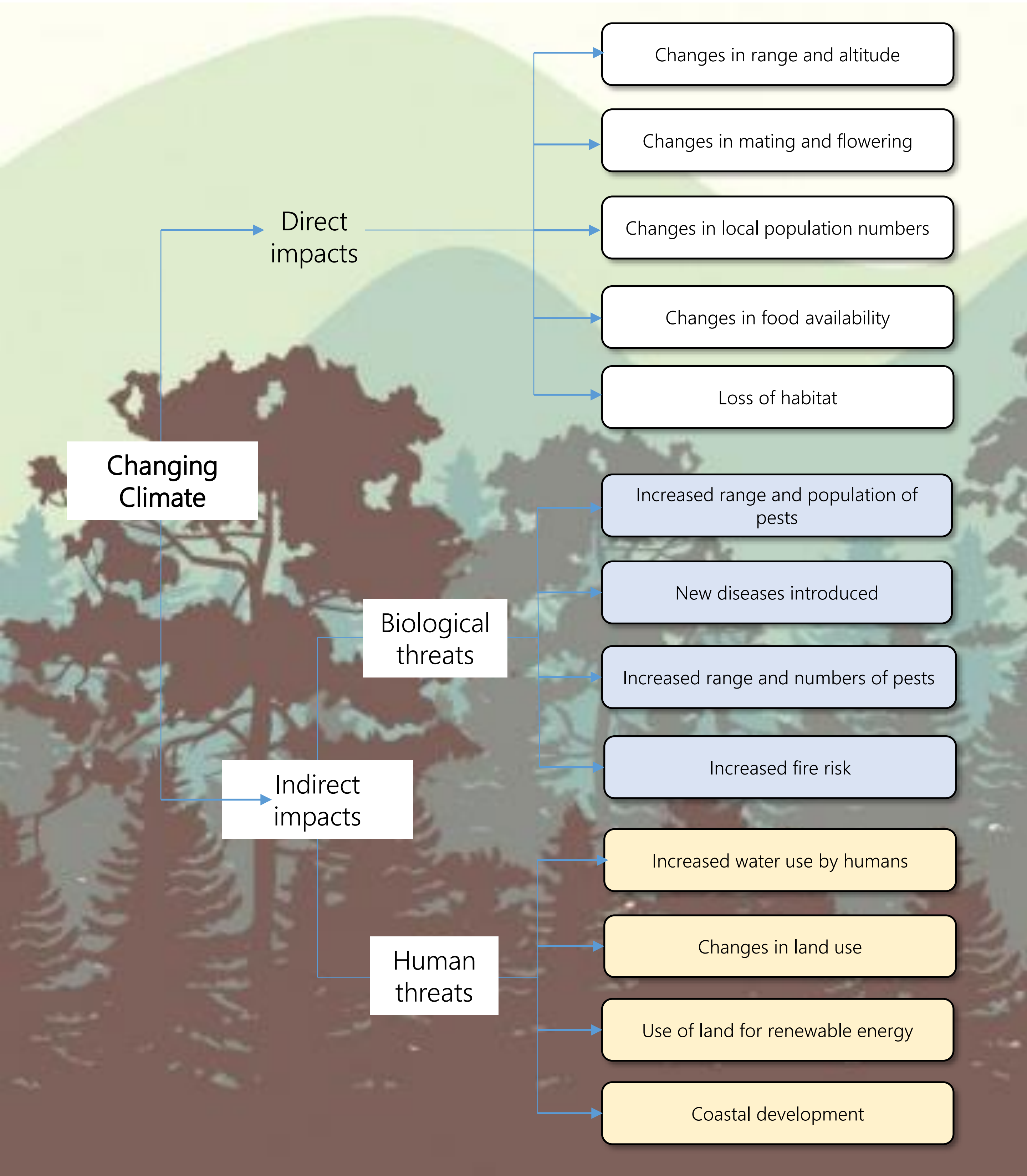


Hear our stories about how Climate change is affecting our homes, and guess who we are

Our stories	Who am I?
I eat tiny crustaceans called krill, which live on the undersides of Antarctic ice sheets. The ice sheets are melting, and I have to go further and further to find food. I now have less energy to raise my young.	
I can grow in dry and hot conditions, but climate change is making my home drier and hotter than I can handle. I can't grow and spread quick enough to keep up with a fast-changing climate.	
I need ice sea, so I can sneak up and hunt for seals in spring and summer, when my young are coming out into the world for the first time. I can't swim fast enough to catch the seals in the water, and I am going hungry.	
I am very important to my ecosystem, and many other species rely on me for homes and protection. The algae, which lives inside me, and gives me a lovely colour, does not like any increase in temperature, so the warmer water is causing the algae to leave me!! I am starting to turn white.	
I have to move to a new place to live, so I can find cooler areas to eat and breed. But when I move the food around me is different to what I like. If all the sea ice disappears, I may not have anywhere else to move to.	
I lived in misty mountaintop cloud forests. Climate change has increased the amount of droughts around my home, making it too dry for me, and I have no where else to live. Nobody has seen me for over 30 years.	
I have a very special diet and only eat one type of food. My food grows in dry places , but if climate change causes my home to be even drier it may not continue to grow here. I will need human help to move around and find more food.	
I am quite rare already, and I have adapted to live in mountain areas away from humans. Climate change is causing humans to spread out into my home area, looking for new places to live. If I am chased away too many times I may have no where else to live.	

Impacts to New Zealand Species due to Climate Change

Select a species card, use the chart to determine what threats a species may face, then discuss what adaptation solutions might help, and how.



Modified from: Adapting to a changing climate. DoC.

New Zealand Species Cards – All photos and information from www.arkive.org

Shore plover

This small, wading bird lives by the coast. It lays its eggs in rocks and grass close to the beach. The birds eat shoreline food found at low tide. Climate change may cause the nesting area to be covered with water due to sea level rise.

Southern rock hopper penguin

The penguin breeds in large colonies, on subantarctic islands to the south of New Zealand. The rockhopper penguin eats krill, squid, octopus, and fish, from the ocean, but climate change may shift where their food can be found, and this will affect survival of their chicks.

Wrybill

The wrybill lives in the 'braided' stony rivers of Otago and Canterbury. It lays camouflaged eggs amongst the stones, on mid river island to avoid pests. Climate change may increase spring flooding, covering the eggs which will then not hatch.

Kakapo

Adult kakapos are camouflaged with mossy green feathers. Breeding is timed with the 'mast fruiting' of the 'rimu' tree, which only occurs every two to five years. Climate change may affect when and how often this mast year occurs.

Modified from: www.arkive.org

New Zealand Species Cards – All cards from www.arkive.org

Shore plover

This small, stocky wader is one of the world's most threatened coastal birds. During the breeding season from November to February, pairs will defend small territories containing their nest. The nests of the shore plover are well hidden amongst vegetation or between boulders, and both the male and female will take part in incubating the two to three eggs that are laid. Outside of the breeding season birds flock together but do not migrate. Their diet is made up of shoreline crustaceans, spiders, molluscs and insects, which are foraged from the sea-shore at low tide. Climate change may cause the nesting area to be covered with water due to sea level rise.

Southern rock hopper penguin

The southern rockhopper penguin breeds in large colonies, which is found on several subantarctic islands to the south of New Zealand, that may comprise over a hundred thousand nests. Breeding pairs are monogamous, and usually return to the same nest every year. The diet of the southern rockhopper penguin is composed of a variety of oceanic species, such as krill and other crustaceans, squid, octopus and fish. Groups of southern rockhopper penguins may often feed together, diving to depths of up to 100 metres in pursuit of prey. Climate change may shift where their food can be found, and this will affect survival of their chicks.

Wrybill

The wrybill is a distinctive wading bird, which possesses a uniquely bent bill. The laying season runs between September and October; a clutch of two eggs is laid into a slight depression amongst the gravel of braided rivers in Otago and Canterbury. Both parents take it in turn to incubate the eggs that are well camouflaged against the shingle, resembling the stones around them. Birds are forced to nest on islands in the middle of braided rivers as a result of predator pressure and river-edge habitat modification. Climate change may increase spring flooding, covering the eggs which will then not hatch.

Kakapo

Adult kakapos have beautiful mossy green plumage mottled with brown and yellow, which provides excellent camouflage against the forest floor. The kakapo is the only parrot to have a lek mating system. Breeding is erratic and slow, occurring every two to five years, and is dictated by the infrequent availability of super-abundant food supplies. One such event is the 'mast fruiting' of the 'rimu' tree (*Dacrydium cupressinum*), which only occurs every two to five years. The kakapo feeds on a variety of fruits, seeds, roots, stems, leaves, nectar and fungi. Climate change may affect when and how often this mast year occurs.

New Zealand Species Cards – All cards from www.arkive.org

Tuatara

The 'living fossil' lives in burrows, where the female tuatara also lays her eggs. The sex of the tuatara is determined by the temperature at which the eggs are incubated, with higher temperatures producing males and lower temperatures producing females. Climate change is causing a temperature increase.

Takahe

This flightless bird prefer alpine tussock grasslands, and feeds mainly on the leaf bases and seeds of tussocks and other grasses. Habitat changes and the introduction of predators, such as stoats, can harm these birds. Climate change can impact survival of this species.

Lesser short-tailed Bat

This bat is more at home on the forest floor than flying through the treetops, and active in winter. Warmer winters, caused by climate change, makes bats need more insects for food when there may not be that many. The bats are important pollinator of the endangered woodrose, a parasitic plant of roots on the forest floor.

Archey's frog

This small frog (3-4 cm) lives in damp forest habitats, in only a few small locations. Archey's frogs make a tasty meal for rats, pigs, stoats, hedgehogs, possums, cats and introduced frogs. These rare frogs are at risk from Climate change effects.

Modified from: www.arkive.org

New Zealand Species Cards – All cards from www.arkive.org

Tuatara

An unusual and unique reptile found only in New Zealand, the tuatara (Sphenodon punctatus) has been dubbed a 'living fossil' as it is the only surviving member of an ancient group of reptiles that flourished during the time of the dinosaurs. The tuatara lives in burrows, either digging one itself or sharing the burrow of a nesting seabird. The female tuatara lays her eggs in spring, covered up by dirt, which do not hatch until 11-16 months later. The sex of the tuatara is determined by the temperature at which the eggs are incubated, with higher temperatures producing males and lower temperatures producing females. Climate change is causing a temperature increase.

Takahe

This unique flightless bird is roughly the size of a hen, making it the world's largest rail. Once thought to be extinct, the birds are still very rare. Mainland populations prefer alpine tussock grasslands although they are also found in forest and sub-alpine shrublands. Island populations are found mainly on modified grassland habitat. The takahe feeds mainly on the leaf bases and seeds of tussocks and other grasses. Habitat changes and the introduction of predators, such as stoats, can harm these birds. Climate change causes an increase in Extreme weather events that can impact survival of young,

Lesser short-tailed Bat

The New Zealand lesser short-tailed bat is remarkable for the fact that it is the most terrestrial bat in the world; more at home on the forest floor than flying through the treetops. New Zealand bats are unusually active in winter compared with other temperate bats, and are therefore sensitive to warmer winters, caused by climate change, becoming more active and thus experiencing an increased demand for insect food at a time when it may be scarce. This species is an important pollinator of the endangered woodrose, a parasitic plant of roots on the forest floor.

Archey's frog

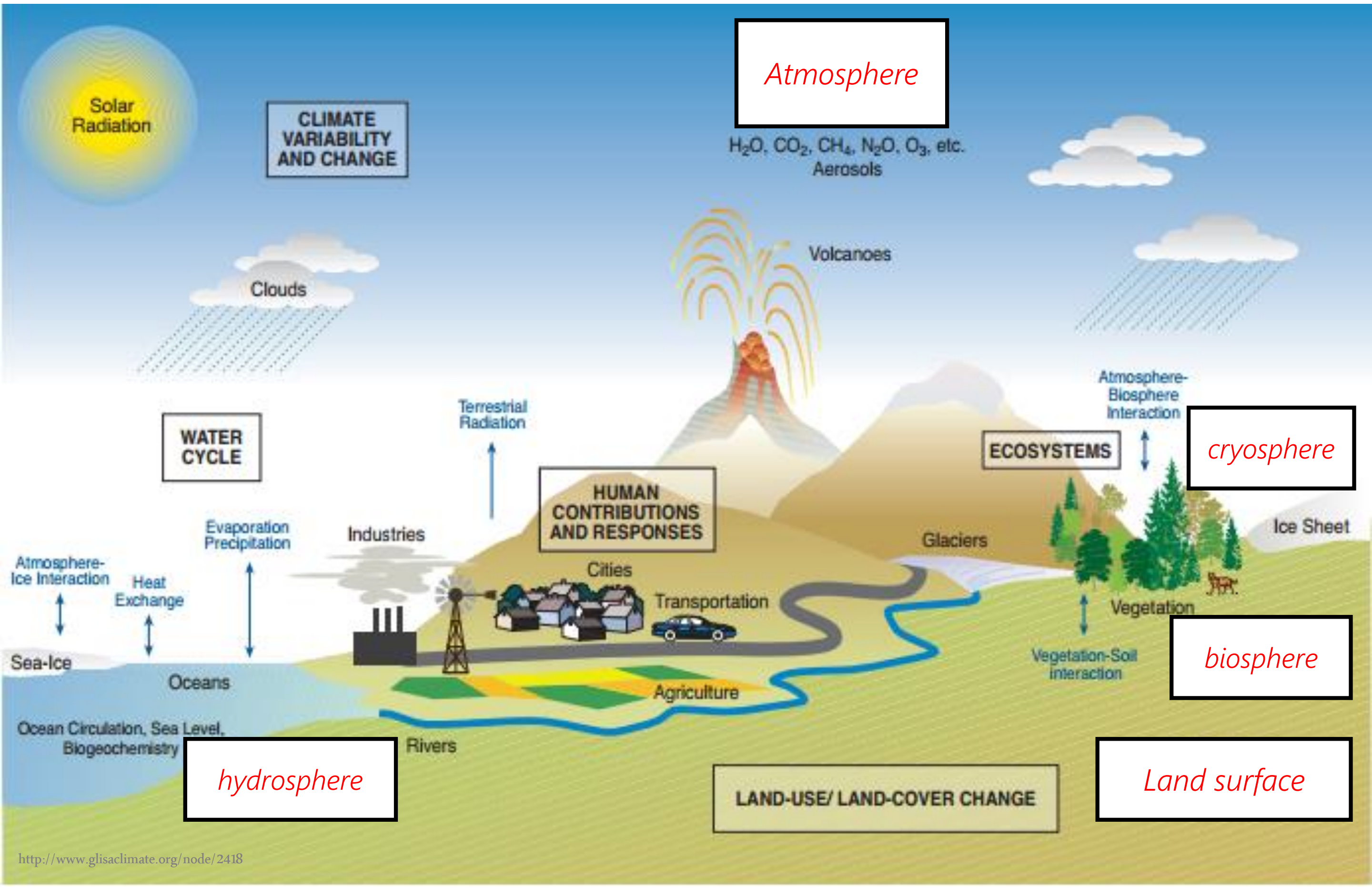
Archey's frog is our smallest native frog, growing up to 37 mm long. It occupies damp forest habitats above 400 m, but has been found as low as 100-200 m above sea level in the Coromandel. Mottled colours of red, green and brown make up the colour of the Archey's skin. Archey's frogs are modern-day dinosaurs. Almost unchanged from their 150 million-year old fossilised relatives, these little battlers are among the world's oldest frogs and in desperate need of help. Archey's frogs make a tasty meal for rats, pigs, stoats, hedgehogs, possums, cats and introduced frogs. These rare frogs are at risk from Climate change effects.

Climate Change Adaptation solutions

Supplementary feeding of species	Changing their environment with plantings and building
Translocation – moving species to another area	Captive breeding programmes
Increased Pest control in their habitat	Design and make new pest proof protected areas
Manage and restore ecosystem areas	keep human roads and buildings away from their habitat

Climate Components   Answer sheet

GZ Science Resources



The climate system is an interactive system consisting of <u>five major components</u>: the **atmosphere**, the **hydrosphere**, the **cryosphere**, the **land surface** and the **biosphere**, *forced* or influenced by various *forcing mechanisms*, the most important of which is the Sun. (IPCC)
Use information from the diagram to complete chart below:

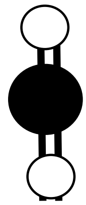
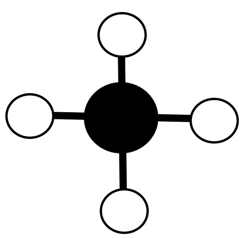
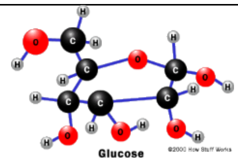
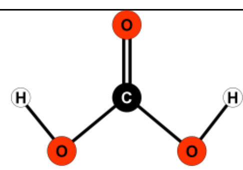
Component	Comprised of:	How can Human Activity influence this component?
Atmosphere	N_2, O_2, Ar, H_2O, CO_2, CH_4, N_2O, O_3, aerosols	*More CO_2 and methane emissions into the atmosphere – increase greenhouse effect Adding aerosols*
hydrosphere	Rivers, lakes, oceans	*Oceans act as heat reserviour. Heating oceans, due to climate change – more evapouration of water into atmosphere, increasing greenhouse effect. Also Sea level rise*
cryosphere	Sea ice, ice sheets, glaciers, and permafrost	*Increasing average temperature is melting cryosphere. Reduced surface ice is decreasing albedo effect (reflecting from ice) so more heat absorbed than reflected. Sea level rise*
Land surface	The top layer of the Earth, exposed to the atmosphere	*Changing land use, like agriculture/building/roads, can increase the amount of heat absorbed.*
biosphere	All living organisms found below, above and on the land	*Cutting down trees (for fuel) can add CO_2 to atmosphere. Trees remove CO2 from atmosphere. Carbon stored in biosphere. Forests retain moisture/water*

Adapted from http://www.glisaclimate.org/node/2418

Carbon on Earth

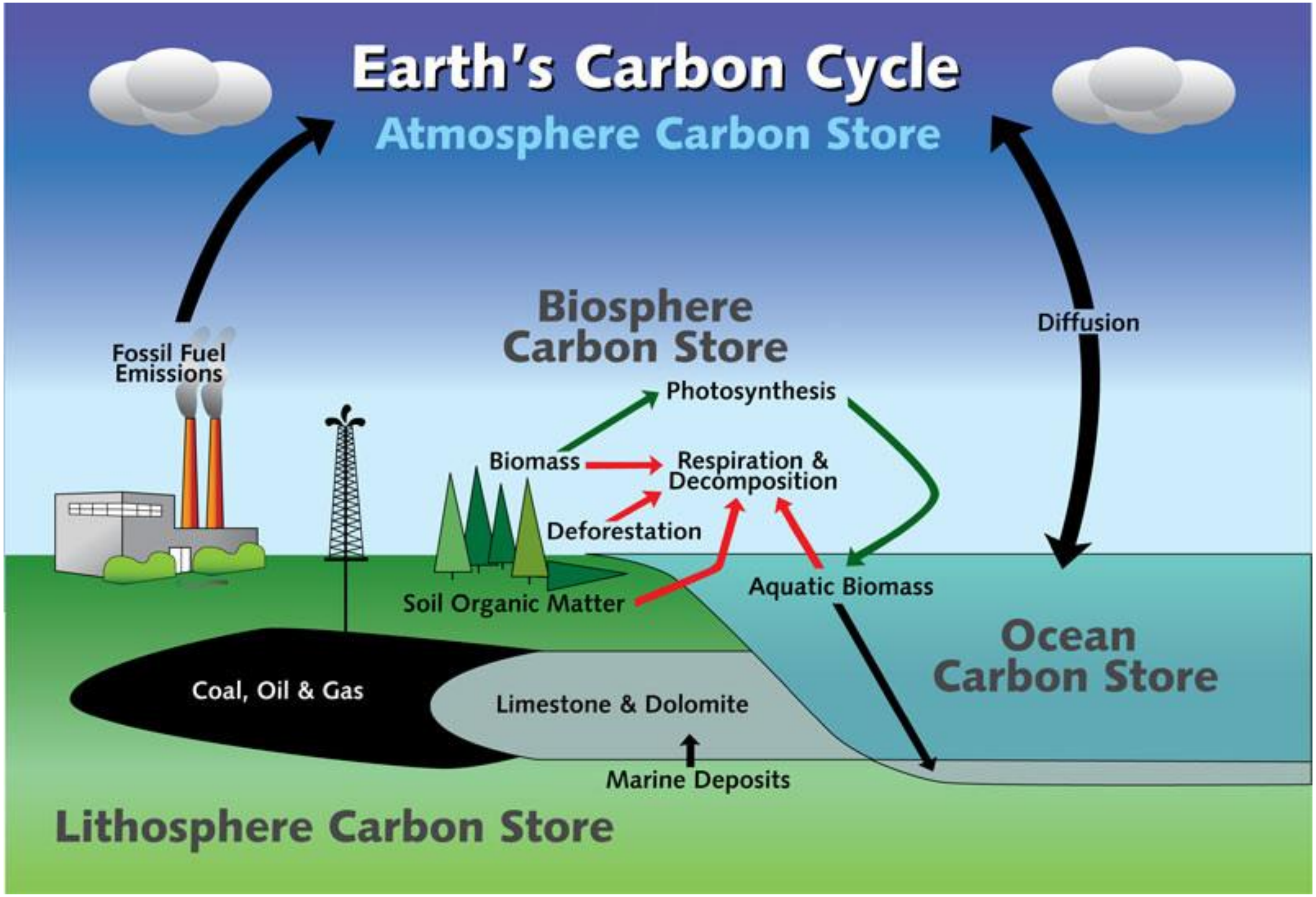
Answers

GZ Science Resources

Name	Formula	Model	Where is this found on Earth?	What process creates this?
Carbon (graphite/ diamond)	C		underground	Heat and pressure from underground
carbon dioxide	CO_2		In the atmosphere	Combustion respiration
Calcium carbonate	$CaCO_3$		In marine/snail shells In rocks like limestone and marble	Biological shell building Pressure and heat on shells underground
methane	CH_4		In the atmosphere In permafrost (frozen ground) Underground	Decomposition dead plants and animals)
glucose	$C_6H_{12}O_6$		In plants In animals	Photosynthesis eating
carbonic acid	H_2CO_3		In oceans In the air/atmosphere	Reacting with water in the oceans Reacting with water in the atmosphere
oil	Carbon and		underground	Fossilised remains of marine animals

Carbon Cycle

Answers



http://www.dec.ny.gov/images/administration_images/carboncycle.jpg

Possible stores (reserviours):
>Atmosphere
>Ocean
>lithosphere
>biosphere

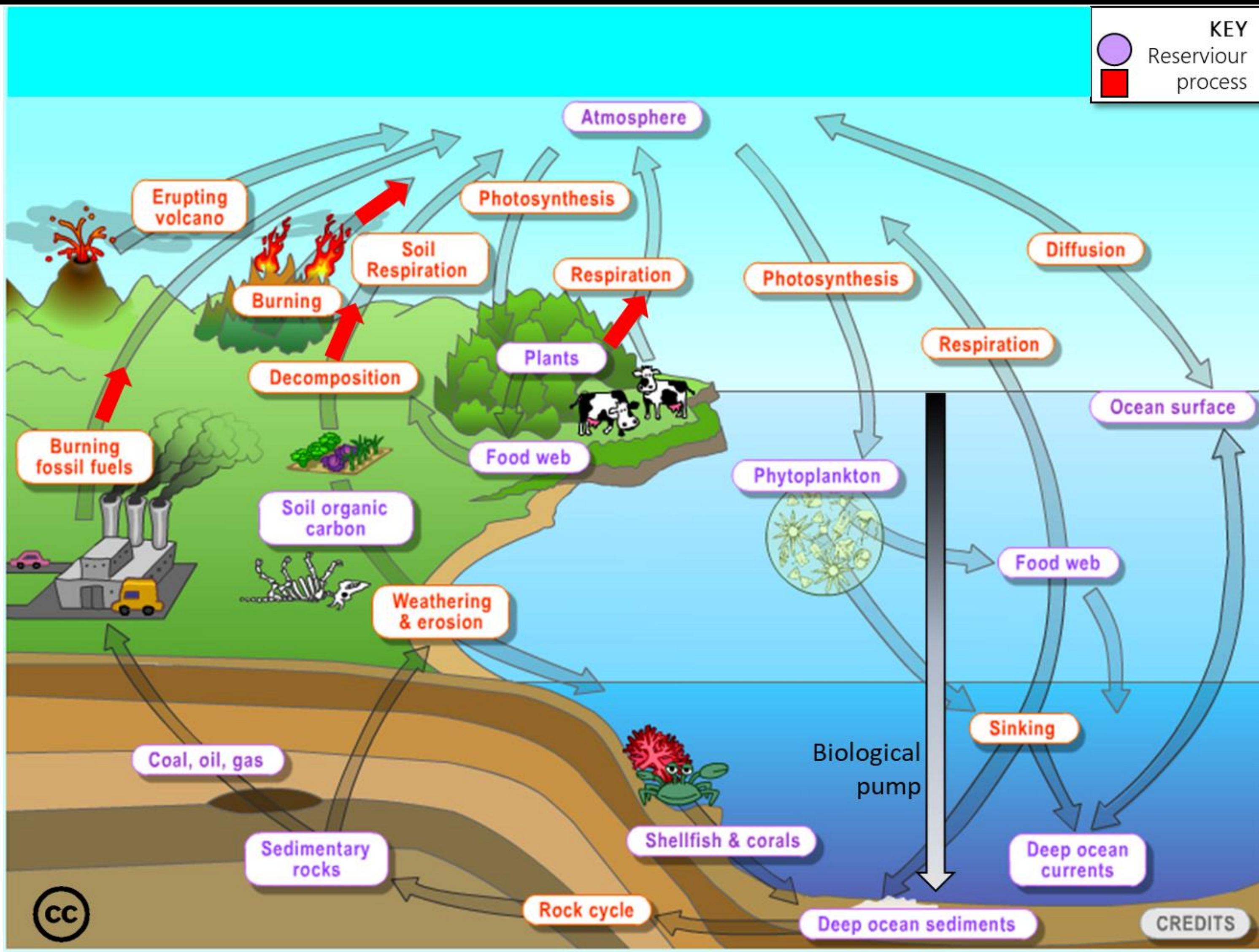
Possible processes:

>fossil fuel emissions,
>respiration & decompositions
>diffusion

1. Write in correct processes and carbon store (reserviour) terms from word bank.
2. Colour in the processes that you think human activity could influence

Carbon Cycle

Answers

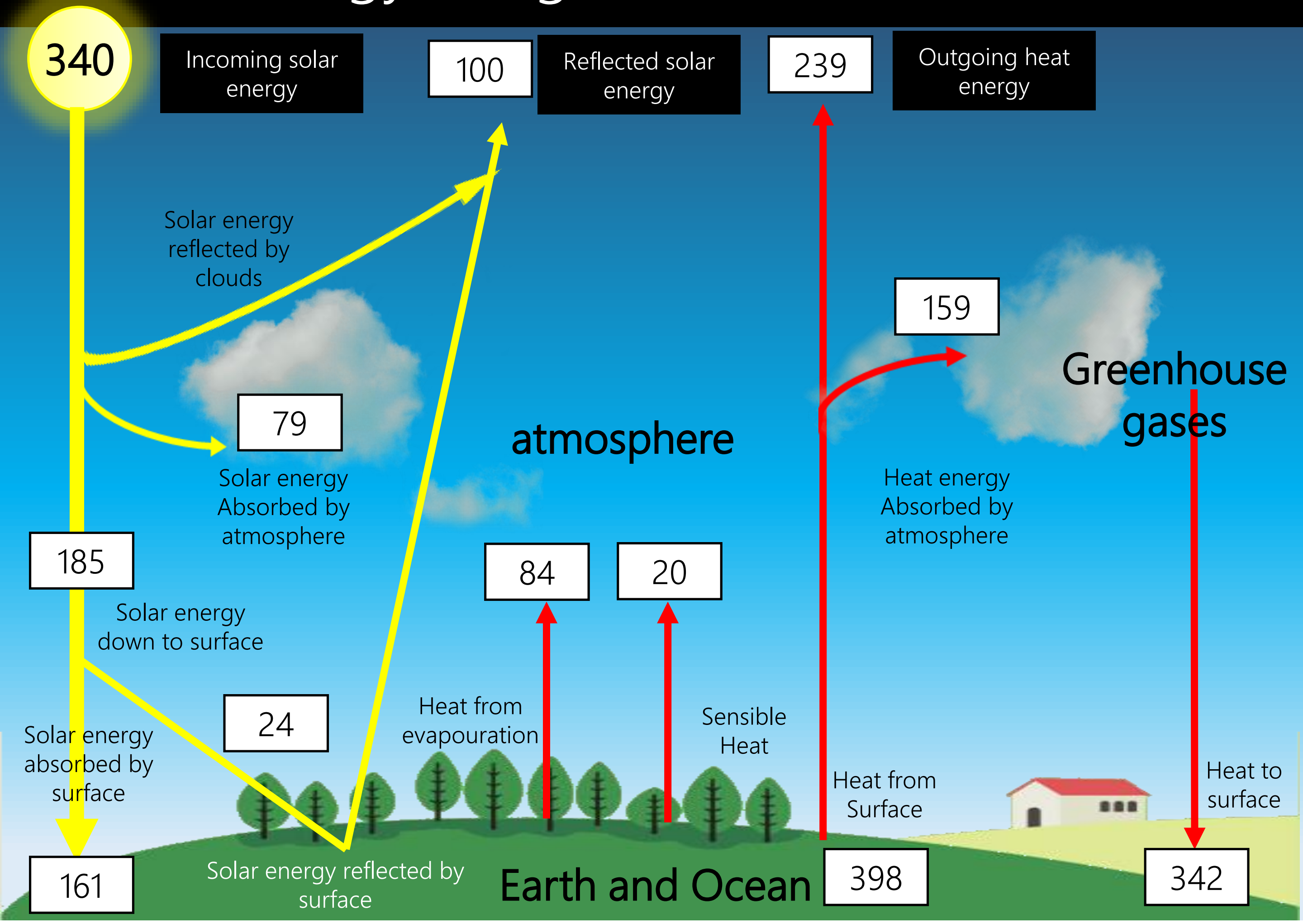


Possible reserviours: Atmosphere, plants, food web, soil carbon, coal, oil and gas, sedimentary rocks, phytoplankton, ocean surface, phytoplankton, food web, shellfish and corals, deep ocean, ocean floor

Possible processes: photosynthesis, respiration, soil respiration, erupting volcano, burning, decomposition, burning fossil fuels, weathering and erosion, diffusion, dissolving, sinking, rock cycle

1. Write in correct processes and carbon reserviour terms from word bank.
2. Colour in the arrows that you think human activity could influence

Earth's Energy Budget Answers



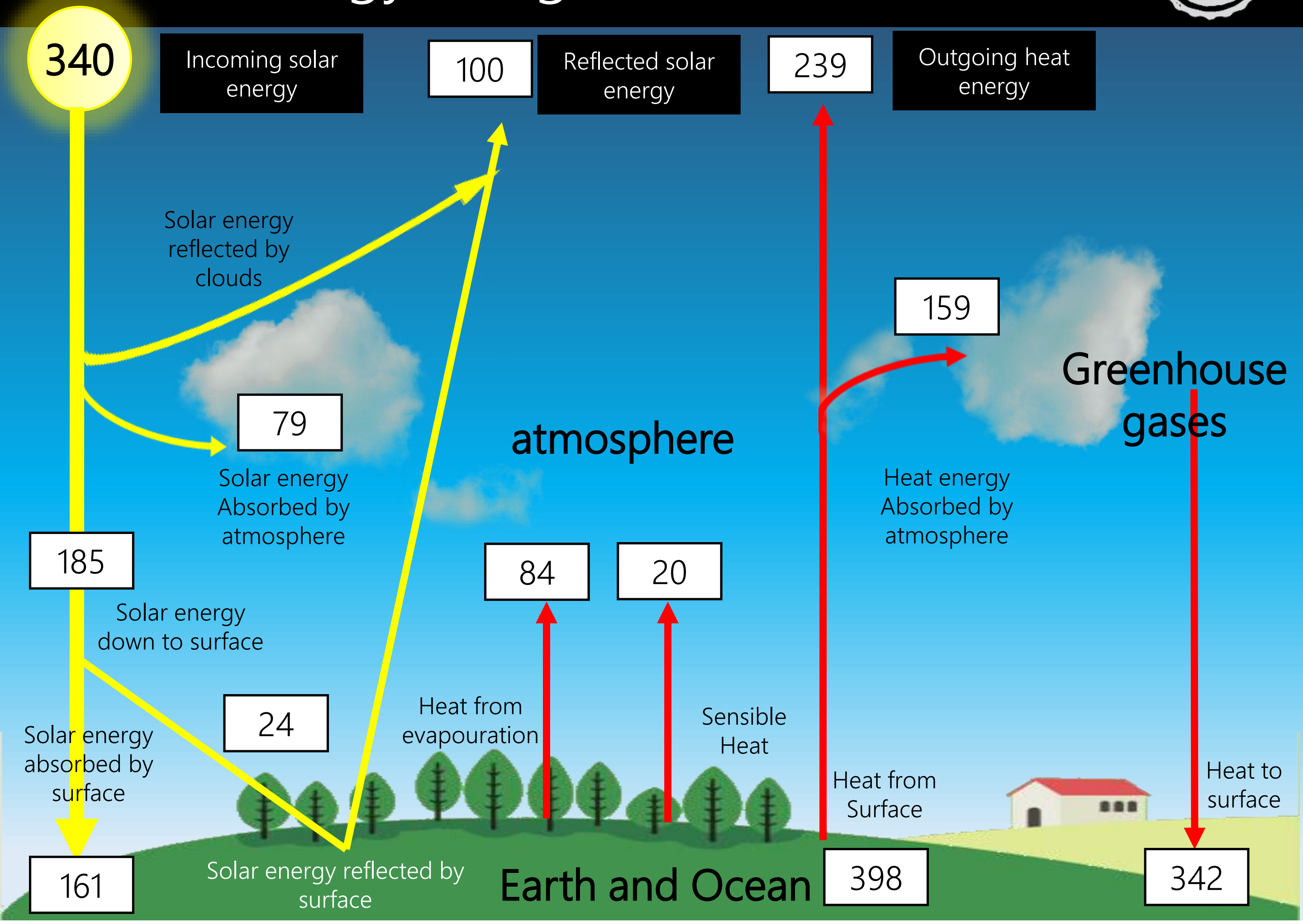
1. Calculating Earth's Energy Budget

Total of all Solar (light) energy into Earth's atmosphere	340	Total of all outgoing solar (light) energy from Earth's atmosphere	100
		Total of all heat (thermal) energy leaving Earth's atmosphere	239
TOTAL of all energy reaching Earth's atmosphere	340	TOTAL of all energy leaving Earth's surface	339

2. Difference in energy IN and energy OUT 1 w/m^2 into Earth's atmosphere

Incoming solar TOA (at the top of the atmosphere) = average solar radiation impinging on top of Earth's atmosphere
Solar reflected TOA = solar radiation reflected by Earth's atmosphere
Solar down surface = solar radiation hitting Earth's surface
Solar absorption surface = solar radiation absorbed by Earth's surface
Solar reflected surface = solar radiation reflected by Earth's surface
Thermal up surface = heat radiated by Earth's surface to atmosphere
Sensible heat = heat exchanged between Earth's surface and atmosphere due to convection
Thermal outgoing TOA = heat radiated from Earth's atmosphere to space
Greenhouse gas effect = back radiation to the surface from heat retained on Earth's surface by greenhouse gases (CO_2, CH_4, N_2O)
Evaporation = heat conveyed from Earth's surface to atmosphere by evaporation of water

Earth's Energy Budget Answers



1. Calculating Earth's Energy Budget

Total of all Solar (light) energy down to Earth's surface	185	Total of all solar (light) energy reflected from Earth	24
Total of all heat (thermal) energy to Earth's surface	342	Total of all heat (thermal) energy leaving Earth	502
TOTAL of all energy reaching Earths surface	527	TOTAL of all energy leaving Earth's surface	526

2. Difference in energy IN and energy OUT 1 w/m^2 into Earth's surface

Incoming solar TOA (at the top of the atmosphere) = average solar radiation impinging on top of Earth's atmosphere
Solar reflected TOA = solar radiation reflected by Earth's atmosphere
Solar down surface = solar radiation hitting Earth's surface
Solar absorption surface = solar radiation absorbed by Earth's surface
Solar reflected surface = solar radiation reflected by Earth's surface
Thermal up surface = heat radiated by Earth's surface to atmosphere
Sensible heat = heat exchanged between Earth's surface and atmosphere due to convection
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Evaporation = heat conveyed from Earth's surface to atmosphere by evaporation of water

 Energy budget values based on IPCC AR5