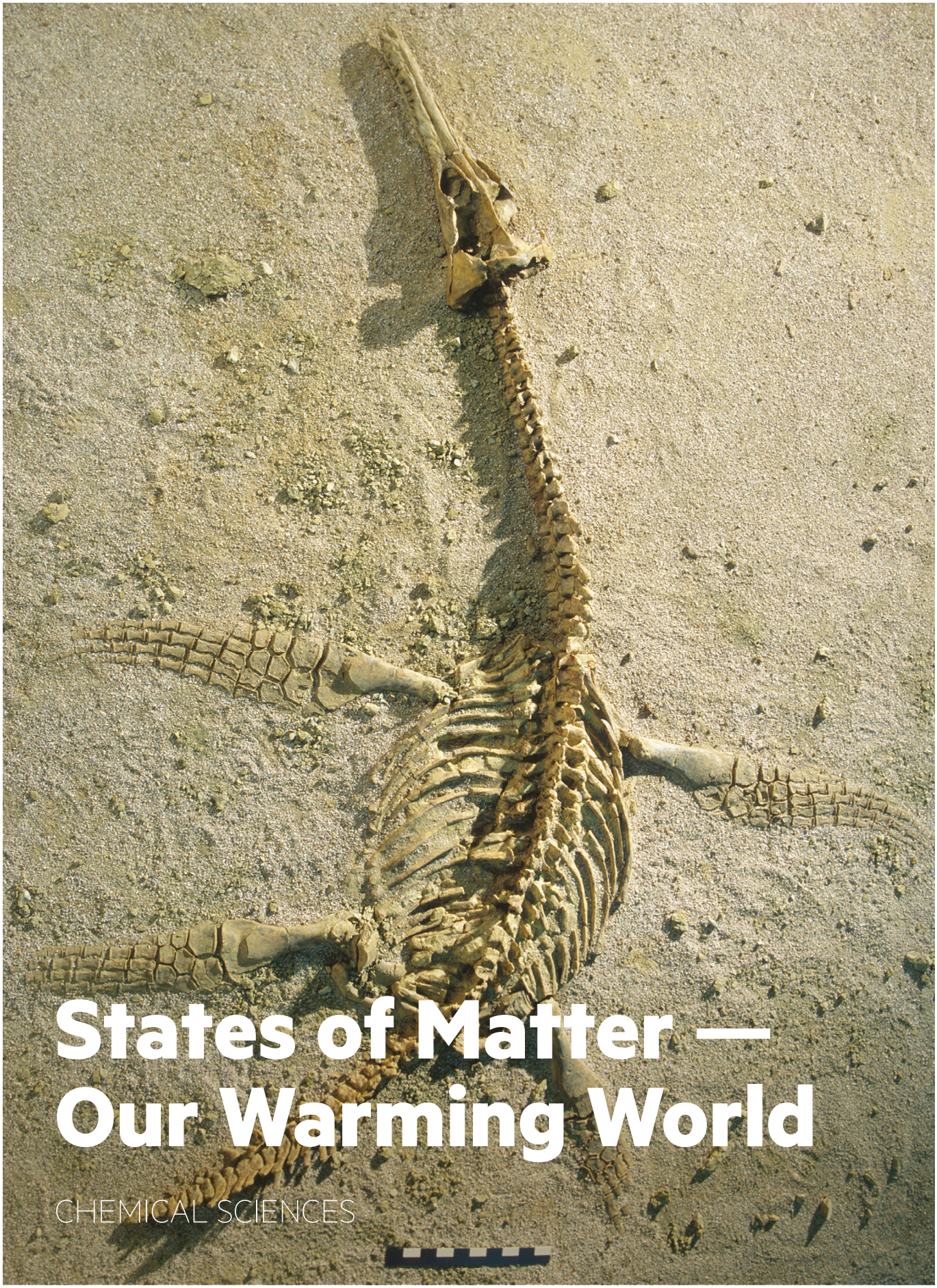


States of Matter — Our Warming World

CHEMICAL SCIENCES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Introduction

A broad range of topics are studied at the Queensland Museum, including geosciences, biodiversity, cultures and histories, and conservation practices. The Queensland Museum has extensive collections of objects to help support this research. For example:

— The Geosciences Collection is one of the largest and most significant Geosciences Collections in the southern hemisphere, consisting of 55,000 geological samples, 27,000 mineral samples, and more than 7 million fossil specimens. This includes nearly 10,000 primary type specimens (reference specimens used to identify, name and classify fossil plant and animal species).

— The Biodiversity Collection contains over 2.5 million specimens and is used by researchers around the world to document and describe existing species, and discover new species. Scientists from the Queensland Museum have played a role in discovering over 4000 new species since 1862!

— The Cultures and Histories Collections are comprised of objects that document the social and cultural life of people in Queensland throughout time. These collections provide tangible links to human innovation and experience, and help document how people react to changes. At the heart of this collection is the material culture of Aboriginal Peoples and Torres Strait Islanders, connecting the deep history of the continent with contemporary life in Australia today.

Often these research areas overlap; for example, Queensland Museum scientists may explore how the Earth's landscape shapes our biodiversity, and vice versa.

SparkLab, Sciencentre has many interactive exhibits to investigate states of matter. It also has a large 360° data projection globe, *Science On a Sphere (SOS)*, that can display global environmental conditions. School visits to Queensland Museum and *SparkLab, Sciencentre* can be made on our group bookings page.

You can also watch palaeontologist Dr Espen Knutsen explain how evidence is used to learn how the Australian environment has changed over time. Many more hands-on learning resources can be downloaded from Queensland Museum's resources website.

Cover Image: The Richmond Plesiosaur is the name given to an exceptionally well-preserved marine reptile fossil which was found in the desert between the towns of Hughenden and Richmond in 1990. This specimen, one of the best in the world, is the skeleton of an animal that lived in the inland sea covering western Queensland 100 million years ago. The animal's remains are nearly complete and are over four metres long!

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC project aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

Activity Overview
States of Matter — Our Warming World

In this activity you are going to investigate how temperature can affect the motion and arrangement of particles, and how this may impact our world.

TEACHER TIPS

Activity 1

- Arrange students in groups of 3 – 4 to promote collaborative learning and communication.
- If you do not have access to a hot water bath, a bucket filled with warm water can be used to heat the conical flasks. Alternatively, Bunsen burners could be used to heat conical flasks (heating and data recording time will need to be reduced).
- As an extension activity, students could calculate the volume change in the conical flask. This value could then be converted to a percentage, and used to theoretically examine how the volume of the ocean could increase if our oceans were to experience a similar temperature change.
- To further this activity, thermal expansion and contraction can be observed in gasses by heating a balloon using a hair dryer, or cooling a balloon using a freezer or dry ice.
- Thermal expansion and contraction can be observed in solids by using metal ball and ring apparatus.
- This activity could be concluded by watching the video of Dr Espen Knutsen, a palaeontologist at the Queensland Museum who is studying Australia's inland seas.

Activity 2

- Students may work in groups and present their ideas to the class.
- You may wish to compare past climatic and environmental changes experienced in Queensland to the changes in climate occurring today. You could also discuss the similarities and differences between the causes of these climate changes, and the effect of climate change on the Queensland population.
- Aboriginal People were able to explain science and environmental phenomena long before colonialists arrived in Australia. Students may wish to research other scientific phenomenon described in oral history by other Aboriginal language groups.

Activity 3

- The Earth has experienced many changes in climate throughout history. However, the rate of change occurring at present is greater than in past warming events. This activity is designed to illustrate this difference to students. Use this activity to facilitate conversations about what the rapid rate of warming may mean for humans and the environment.
- This activity is designed to show what this rapid rate of warming may look like if it continues into the distant future. We do not suggest or believe that the warming the Earth is experiencing today will continue at this rate over 5000 years.
- It is recommended that you conclude this activity with a discussion about how individuals, the local community, Australia and the international community are reducing their reliance on fossil fuels and combatting climate change. This can demonstrate that we are working together to address climate change, thus mitigating future warming.

Australian Curriculum Links

YEAR 8

Science Understanding

Chemical Sciences

Properties of the different states of matter can be explained in terms of the motion and arrangement of particles *(ACSSU151)*

Science as a Human Endeavour

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available *(ACSHE134)*

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures *(ACSHE226)*

Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge *(ACSIS139)*

Measure and control variables, select equipment appropriate to the task and collect data with accuracy *(ACSIS141)*

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate *(ACSIS144)*

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence *(ACSIS145)*

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements *(ACSIS146)*

Use scientific knowledge and findings from investigations to evaluate claims based on evidence *(ACSIS234)*

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate *(ACSIS148)*

GENERAL CAPABILITIES

Numeracy

Compare, order and use positive and negative numbers to solve everyday problems

Solve complex problems by estimating and calculating using efficient mental, written and digital strategies

Visualise and describe the proportions of percentages, ratios and rates

Solve problems using simple percentages, ratios and rates

Compare, interpret and assess the effectiveness of different data displays of the same information

Convert between common metric units for volume and capacity and use perimeter, area and volume formulas to solve authentic problems

CROSS-CURRICULUM PRIORITIES

Aboriginal and Torres Strait Islander Histories and Cultures

Aboriginal and Torres Strait Islander Peoples have holistic belief systems and are spiritually and intellectually connected to the land, sea, sky and waterways *(OI.3)*

Aboriginal and Torres Strait Islander societies have many Language Groups *(OI.4)*

Aboriginal and Torres Strait Islander Peoples' ways of life are uniquely expressed through ways of being, knowing, thinking and doing *(OI.5)*

The significant contributions of Aboriginal Peoples and Torres Strait Islander Peoples in the present and past are acknowledged locally, nationally and globally *(OI.9)*

Activity 1
Warming Water Molecules

The Richmond Plesiosaur (cover image) is the name given to an exceptionally well-preserved marine reptile fossil which was found in the desert between the towns of Hughenden and Richmond, Queensland in 1990.

The skull is robust and contains many conical teeth, presumably for feeding on fishes and squid, which were abundant in the shallow inland sea. It has four long flippers for propelling and steering through the water. Like all marine reptiles, it spent its time in the sea, but had to regularly surface to breathe. The animal's remains are nearly complete and are over four metres long!

Palaeontologists from the Queensland Museum, along with people using the land, have also found fossils of shells, fishes, turtles, squid, ammonites and other marine reptiles in the desert in the middle of Australia. How did these marine animals end up in the desert?

Objective

To investigate the effect of increased temperature on water molecules.

Materials

- 500 mL conical flask
- Glass tube
- One holed rubber stopper
- Food colouring
- Cold water
- Hot water bath
- Permanent marker
- Stopwatch
- Ruler

Figure 1: Materials

Method

1. Fill the flask with cold water and add a few drops of food colouring.
2. Place the rubber stopper in the top of the flask. Carefully push the glass tube through the hole in the rubber stopper and into the water. Make sure that the flask remains sealed.
3. With the permanent marker, indicate the water level on the glass tubing. Measure and record the results in table 1.
4. Place the flask into the hot water bath. (Be careful not to splash hot water onto yourself.)
5. Measure and record water height every 5 minutes for 30 minutes.

Questions

1. Record the results in the table below.

Table 1: Height of water in glass tube.

Time (min)	Height of water in glass tube (mm)
0	
5	
10	
15	
20	
25	
30	

2. Use a line graph to display your results.

3. Describe what happened. Was there a change in the water level? If so, by how much?

4. Use your knowledge of energy and the particle theory of matter to explain the results.

5. Some scientists predict that the ice caps in the Polar Regions (notably Antarctica, the Arctic and Greenland) could potentially melt due to increased temperatures from climate change. As the ice melts, the water particles are able to move past one another, allowing them to run into the oceans. As a result, sea levels may rise.

   How else may climate change affect sea levels?

6. How could this experiment explain the formation of the inland seas and marine animals found in the middle of ancient Australia?

7. Predict how an increase in sea level would affect humans and the environment, including land and marine animals.

Human	Environment

Activity 2
Oral history and sea level change

Natural climatic fluctuations have occurred throughout Earth's history as the planet has moved between glacial (colder) and interglacial (warmer) periods. Cultural history documents the resilience of Aboriginal People in response to changing environmental and climatic conditions. Aboriginal oral history, passed down from one generation to the next, preserves stories of vast hunting grounds that once extended beyond today's coastline, out to the Great Barrier Reef. The oral histories from many different Aboriginal language groups also tell of the sea level rising thousands of years ago.

People belonging to the Yidinji language group around Cairns in far north Queensland tell the creation story of two brothers, Damarri and Guyala. The brothers created all traditional law and social systems, which divided everything into two moieties related to the wet season and the dry season. Mischievous Damarri was associated with the wet season, while his sensible bother Guyala was dry season. The brothers once argued and angered the rainbow serpent, creating a great storm that raised the seawaters.

The Yidinji language group is one of many Aboriginal language groups with preserved oral history of sea level rise. The Gunggandji people also communicated a history in which the Great Barrier Reef was the original coastline of Australia. In earlier times they could walk to nearby Kobahra (Fitzroy Island) across a stretch of connecting land to hunt and gather food, and access Wunyami (Green Island) for ritual ceremony.

Information sourced from *'The Great Barrier Reef – A Queensland Museum Discovery Guide'.*

Research how your local area is predicted to be affected by sea level rise.

What engineering solutions or social changes could your community implement to increase its resilience?

You may want to link this activity with a visit to *Science On a Sphere* at the *SparkLab, Sciencentre*.

Activity 3
Rate of Change

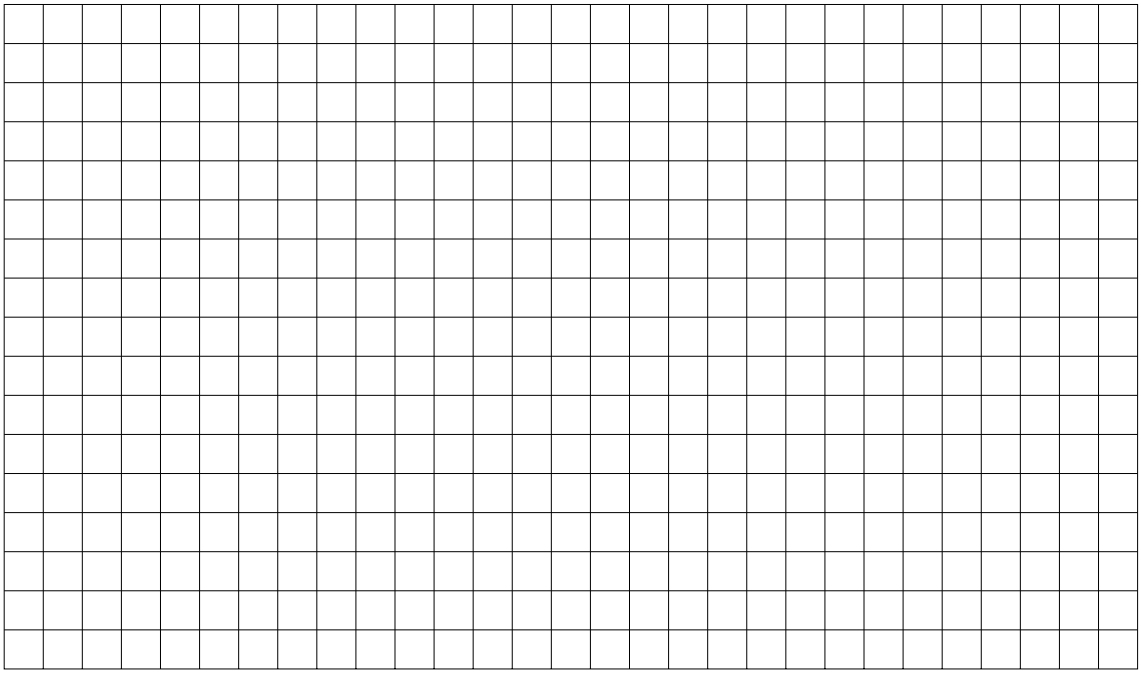
The climate has changed over time and will continue to change. While fossils such as the Richmond Plesiosaur provide evidence of the past, scientists can also gather data by looking at ice cores and sediment cores. Scientists have gathered information about changes in temperature and carbon dioxide (CO_2) levels from sampling ice cores. Bubbles of air in glacial ice trap tiny samples of Earth's atmosphere at the time the ice froze, giving scientists a history of the atmosphere that stretches back more than 800,000 years. The chemical make-up of the ice also provides clues about the average global temperature.

Evidence from ice cores suggest that during periods of warming in the past, the average global temperature increased at a rate of approximately 4°C to 7°C per 5000 years[1]. In the past 100 years, our climate has warmed by 0.7°C[1] and this is increasing as the concentration of carbon dioxide in the atmosphere increases.

1. If the climate continues to warm at an average of 0.7°C per 100 years (as it has over the last century), calculate the warming that the Earth will experience in 5000 years.

2. Carbon dioxide levels in the atmosphere are increasing exponentially. According to the Intergovernmental Panel on Climate Change (IPCC), if greenhouse gas emissions continue 'business-as-usual', then it is predicted that a warming of 0.3°C per decade will occur[2]. Calculate the warming that the Earth will experience in 5000 years under this scenario.

3. Graph each scenario on the grid paper below.



4. Use the graph above to compare the average rate of warming in the past, to the current rate of warming (Question 1), and the predicted rate of warming if greenhouse gasses in the atmosphere continue to increase (Question 2).

5. How might this affect sea levels?

6. The rate of change today is higher than in the past. Predict how this may affect humans, living things and the environment.

7. If you live for 100 years, how much will the the temperature increase over your lifetime for each scenario? (Mark a line on your graph at 100 years.)

8. You have used current data and future predictions of the climate over 100 years, and extrapolated these over 5000 years to visualise and compare past and present rate of change. In reality, the rate of temperature change will not be consistent over the next 5000 years. Predictions also become less accurate further in the future because there are many unknown variables.

   Why do you think you were asked to compare the change over 5000 years rather than 10 years or 100 years? Use data in your answer.

STEM CAREERS IN REAL LIFE:
Dr John Hooper, Biologist

Dr John Hooper studies sponges and has named and revised over 600 species during his career as a marine biologist.

Sponges are among the most toxic of all animals. They are the "vacuum cleaners" of the sea, filtering toxins and waste products from the marine environment. Some of the chemicals sponges produce have the potential to treat human diseases, and are of great interest to medical and pharmaceutical industries. New compounds that show promising therapeutic benefits are thoroughly tested and trialled. If they are found to be safe and effective, these new drugs will become available for use.

Already some compounds derived from sponges show potential in reducing pain or inflammation, improving circulation, and fighting cancer cells. However, every sponge has different properties, and must be discovered, collected and analysed in the lab before the process of drug discovery starts. Each sponge species produces different chemicals which may target different processes or receptors. This means that many sponges waiting to be discovered could hold the key to curing human diseases.

It is estimated that, at the current rate of habitat destruction and climate change, about half of the world's existing species may become extinct within the next hundred years. In the past, mass extinction events have been the result of natural changes. The current extinction event, however, is the result of one species modifying the planet at the expense of the other 5 – 100 million species. The species at fault is *Homo sapiens* (humans).

It is for this reason that Dr John Hooper is trying to discover, document and communicate information about sponges, so we have this information before it is too late.

Figure 2: Dr Hooper at Lizard Island. His role involves marine surveys, working in the laboratory and caring for museum collections. Image: Queensland Museum

Figure 3: The 'Bob Marley sponge' or Pipestela candelabra (named by Dr Hooper's team for its Rastafarian hair-like growth form) contains compounds that are in preclinical trials for cancer treatment. It is one of the most common sponges on the Great Barrier Reef, yet it was only described in 2008. There are currently 8500 named species of sponges worldwide, and probably the same number awaiting formal identification. Image: QM, John Hooper

9. Scientists make predictions. What do you predict what the future on Earth will look like and why?