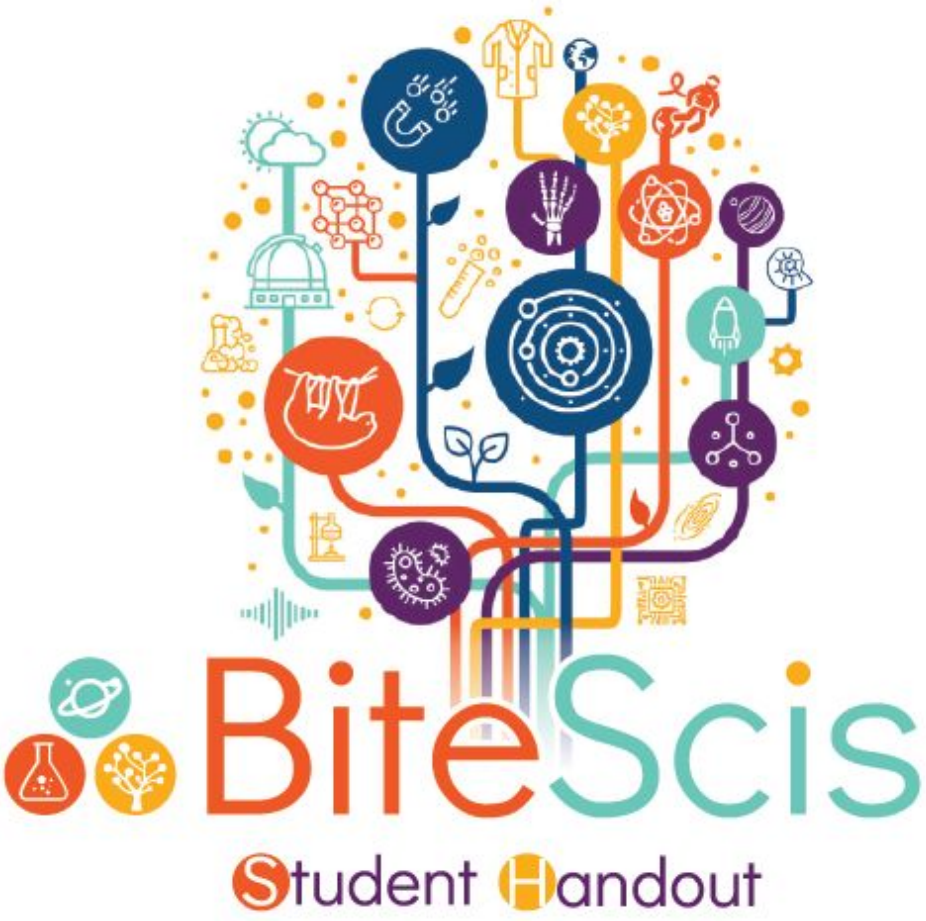

Using Corals to Determine Past Sea Temperatures

BiteScis

Student Handout

Using Corals to Determine Past Sea Temperatures

Introduction

The Galápagos Islands, shown in the red circle in **Figure 1,** are a remote and unique place. Located almost 1,400 km off the coast of Ecuador, they have been a natural laboratory for generations of scientists interested in studying evolution, ecology, and much more.

Due to their location along the equator in the Pacific Ocean, the waters around the Galápagos Islands can experience intense changes during El Niño events. **El Niño** is a cyclical, but irregular climate event that starts in the tropical Pacific Ocean, usually in late December. It tends to occur every two to seven years, and lasts around seven to nine months. During El Niño, ocean surface temperatures warm and rainfall increases in the tropical Pacific Ocean, causing ripple effects on climates around the globe.

Galápagos plants and animals have long withstood the type of short-term climate changes associated with El Niño. However, global climate change has the potential to intensify El Niño events, which could be bad news for one very special part of the Galápagos ecosystem: corals.

Figure 1. The Galápagos Islands. The Galápagos are shown in the red circle off the coast of Ecuador in South America. *Source: Wikimedia Commons.*

Corals, are particularly vulnerable to changing water temperatures. In 1982–83, a strong El Niño caused extreme warming in ocean surface temperatures around the Galápagos Islands. About 95% of the islands' corals died as a result. Many reefs disappeared from the central and southern islands, never to recover. Others recovered, only to be damaged again from large temperature fluctuations in later years. Historical records show that robust coral reefs have existed around the islands for over 500 years, but scientists are unsure if they will survive these more frequent and intense temperature fluctuations associated with climate change.

What To Do

Answer the analysis questions below, reading the Bite when instructed.

Analysis Questions

1. As El Niño develops, does the average molecular kinetic energy of the surface water surrounding the Galápagos Islands tend to increase, decrease, or stay the same? Explain your answer.

2. La Niña is another cyclical climate event that leads to *colder* water around the Galápagos Islands. How is the average molecular kinetic energy of the surface water impacted by La Niña? Explain your answer.

STOP & read Science Bite:

Corals Can't Talk, but They Can Tell Us a Lot

The Science Bite describes a study in which researchers measured the ratio of two elements to infer sea surface temperature. A summary of the researchers' findings is in **Figure 2** below.

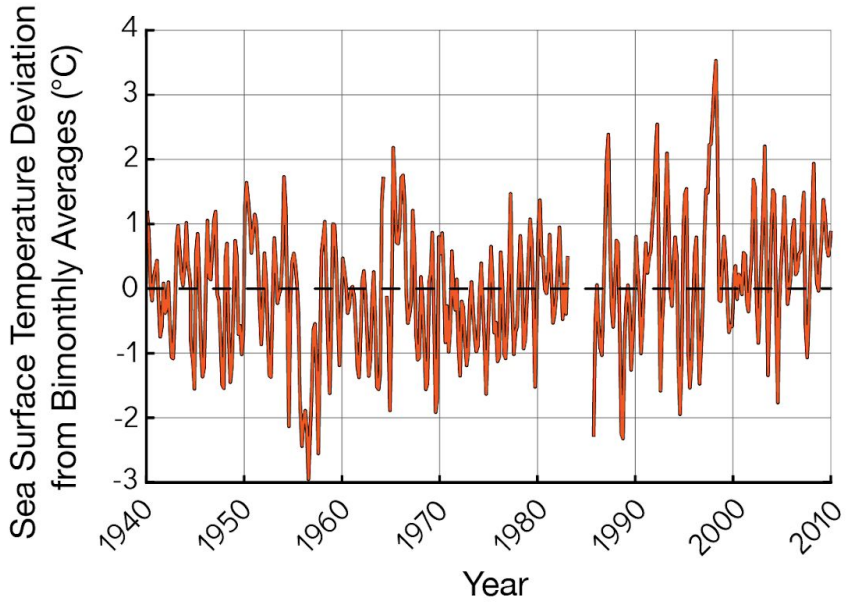

Figure 2. Sea Surface Temperature Deviation from Bimonthly Averages by Year. Scientists used coral core samples to determine how temperatures varied from the average temperature from 1940 to 2010. The y-axis is a measurement of that variation from the average.
Source: Jimenez et. al., 2018.

3. Use **Figure 2** to answer the following questions.

a. Using the graph, identify the two-year period when the corals experienced no growth. How do you know?

b. Based on the introduction and the Bite, why do you think the corals stopped growing during that time?

c. Approximately in which year between 1940 to 2010 was the average molecular kinetic energy of the molecules in the waters around Wolf Island **greatest**? When were they the **lowester**? Explain your answers using evidence from the figure.

In a part of the paper not covered by the Science Bite, the scientists note that their results support the conclusion that radiative forcing is the primary reason that average ocean surface temperatures around the Galápagos Islands and around the world have increased since 1940. **Radiative forcing** is the difference between the amount of energy from the sun that reaches Earth and the amount that is reflected back into space from Earth's surface.

4. Thinking about radiative forcing, consider how heat is transferred from the sun to the ocean surface around the Galápagos Islands (and around the world).

a. In what form does energy from the sun travel to Earth's surface.

b. If it is not reflected, what happens when energy from the sun reaches the Earth? How does that lead to heating of the ocean's surface?

The global increase in greenhouse gases such as carbon dioxide is preventing some light energy from being reflected into space.

5. How is the increase in greenhouse gases impacting radiative forcing? Describe how it is changing the difference in energy hitting Earth's surface and the amount of energy reflected back into space.

6. Why would an imbalance in the amount of energy hitting Earth's surface and the amount reflected from Earth's surface lead to an overall increase in surface temperatures?

In addition to generally increasing ocean surface temperatures, these global temperature changes also make El Niño events more frequent and extreme, which poses a risk to corals and other parts of the Galápagos ecosystem.

7. Given what you read in the Bite and the data in **Figure 2**, what is likely to happen to corals in the Galápagos Islands as El Niño events become more extreme?

8. A student contends that there is friction between water molecules and photons from sunlight. He states that this friction creates thermal energy, and this is the primary cause of ocean warming and more extreme El Niño events. Identify at least two flaws in this student's reasoning.

9. **Connect to the Big Question**. Sometimes scientists can make measurements they are interested in directly. In this study, scientists wanted to know what the temperature of the water around the Galápagos Islands had been over the last several decades, but a record of direct temperature readings was not available. Instead, they used the natural changes in coral skeletons to indirectly measure these temperatures. How do indirect measurements increase scientists' abilities to make observations? Why are indirect methods of measurement important? Can you think of any examples of how you indirectly observe temperature in your everyday life? In other words, without looking at a thermometer or the weather report, or stepping outside yourself, how could you approximate the outside temperature?