AmplifyScience

# Ocean, Atmosphere, and Climate:

## Cold Years in New Zealand

**Investigation Notebook**

NYC Edition

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# Safety Guidelines for Science Investigations

1. **Follow instructions.** Listen carefully to your teacher's instructions. Ask questions if you don't know what to do.

2. **Don't taste things.** No tasting anything or putting it near your mouth unless your teacher says it is safe to do so.

3. **Smell substances like a chemist.** When you smell a substance, don't put your nose near it. Instead, gently move the air from above the substance to your nose. This is how chemists smell substances.

4. **Protect your eyes.** Wear safety goggles if something wet could splash into your eyes, if powder or dust might get in your eyes, or if something sharp could fly into your eyes.

5. **Protect your hands.** Wear gloves if you are working with materials or chemicals that could irritate your skin.

6. **Keep your hands away from your face.** Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.

7. **Tell your teacher if you have allergies.** This will keep you safe and comfortable during science class.

8. **Be calm and careful.** Move carefully and slowly around the classroom. Save your outdoor behavior for recess.

9. **Report all spills, accidents, and injuries to your teacher.** Tell your teacher if something spills, if there is an accident, or if someone gets injured.

10. **Avoid anything that could cause a burn.** Allow your teacher to work with hot water or hot equipment.

11. **Wash your hands after class.** Make sure to wash your hands thoroughly with soap and water after handling plants, animals, or science materials.

Name: _____ Date: _____

# *Ocean, Atmosphere, and Climate: Cold Years in New Zealand*
## Unit Overview

Welcome! As a climate science student, you will begin working right away on a research project. The New Zealand Farm Council has hired you as a consultant to help them investigate why the air temperature in Christchurch, New Zealand, is cooler during El Niño years. When the temperature changes, agriculture around Christchurch is affected, and the farmers want to understand and be better prepared for these changes. You'll first need to learn what determines the air temperature of various places on Earth before investigating what could be causing the air temperature to change during El Niño years. Wishing you an interesting and productive investigation . . .

Name: _____ Date: _____

# Chapter 1: Air Temperature
## Chapter Overview

In Chapter 1, you'll investigate the relationship between air temperature and energy at different locations on Earth. Using simulations and hands-on experiments, you and your fellow climate scientists will collect evidence to explain why different locations have different air temperatures.

Name: _____ Date: _____

# Lesson 1.2: What Determines the Air Temperature of a Location?

Welcome to the *Ocean, Atmosphere, and Climate* unit! In this unit, you will be working as student climate scientists, also known as climatologists. Farmers in Christchurch, New Zealand, have noticed that the air temperature is cooler during El Niño years, and these temperature changes affect their crops. As a student climate scientist for the New Zealand Farm Council, you will investigate what is causing these temperature changes. Today you will learn more about El Niño events and air temperature, and use the Sim to begin your research.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 1 Question

- What determines the air temperature of Christchurch, New Zealand?

## Vocabulary

- climate
- energy
- temperature

## Digital Tools

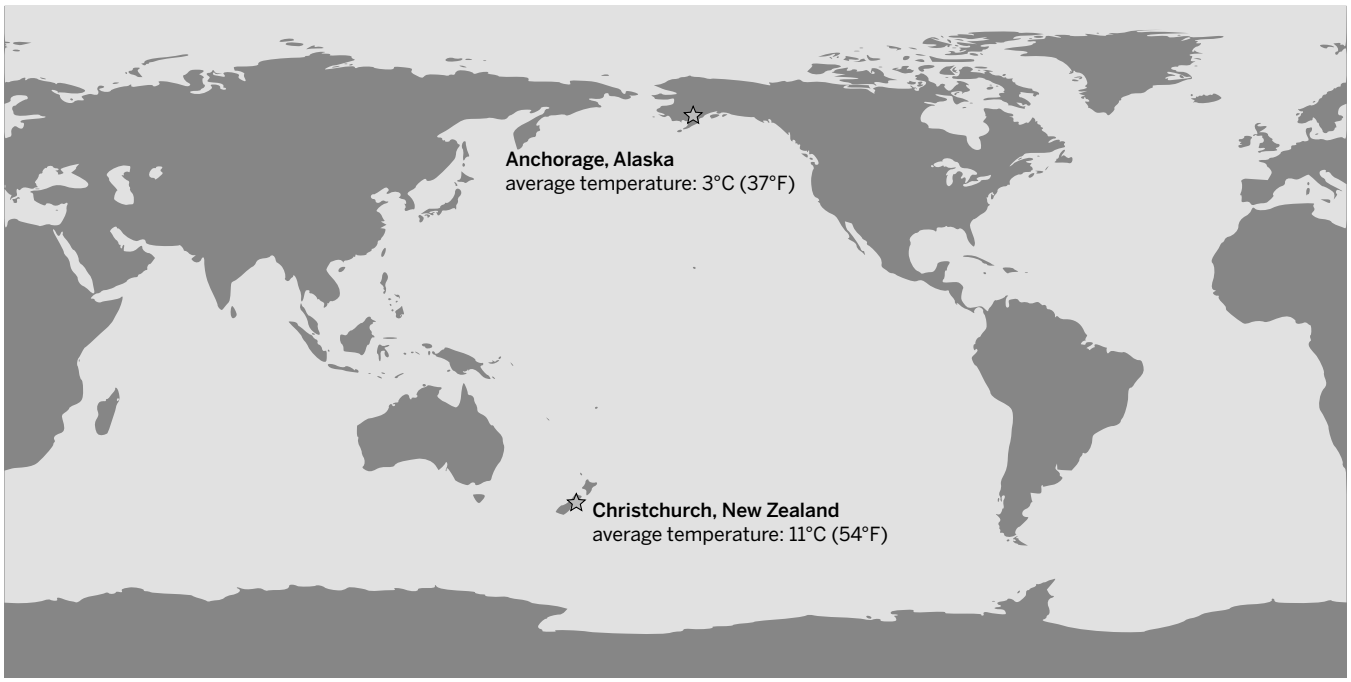
- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Warm-Up

## Comparing Average Temperatures

Compare the average annual temperature for each of the two cities shown on the map. Then, answer the question.




What ideas do you have about what makes Anchorage, Alaska, cooler than Christchurch, New Zealand?

_____

_____

_____

_____

_____

_____

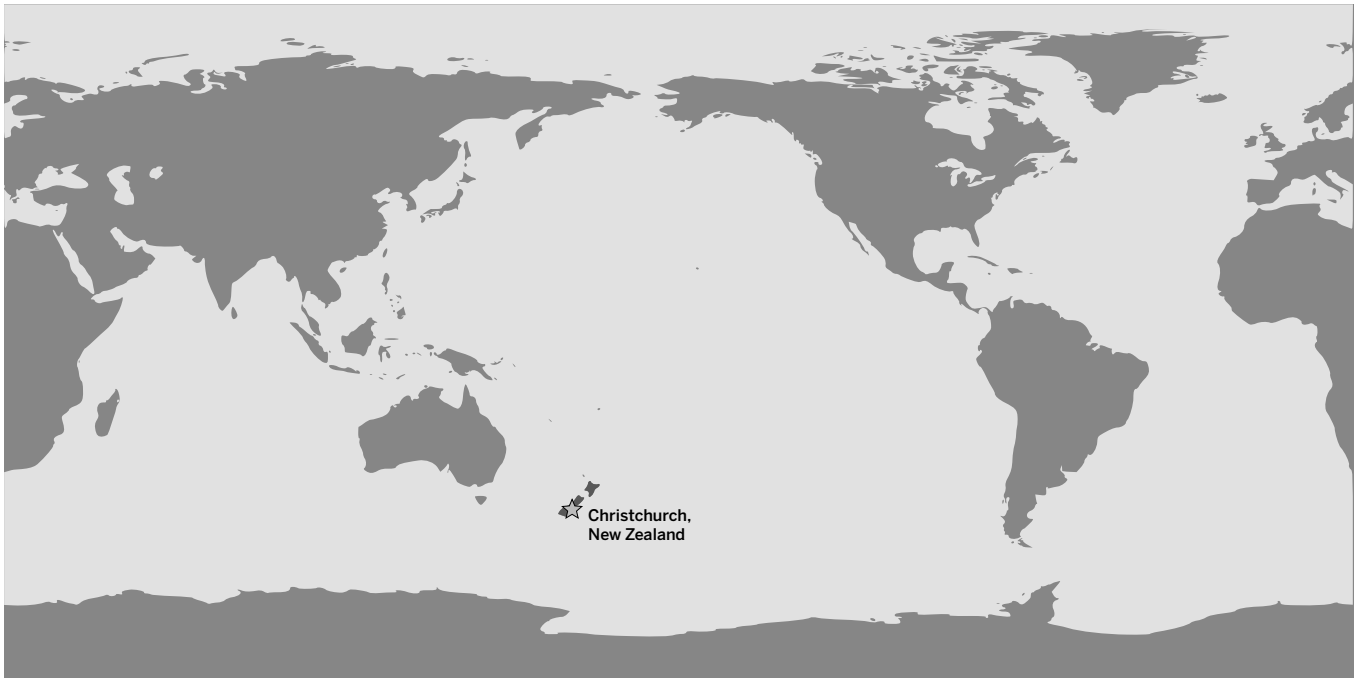
Name: _____ Date: _____

# Christchurch During El Niño

**Partner Discussion: Christchurch During El Niño**

Share your ideas about the research question with your partner.

*During El Niño years, why is Christchurch, New Zealand's air temperature cooler than usual?*




Choose the claim that is most similar to your ideas. Your response does not need to be the same as your partner.

This is why Christchurch, New Zealand's air temperature is cooler than usual during El Niño years: (check one)

- ☐ **Claim 1:** The amount of incoming energy from the sun changes.
- ☐ **Claim 2:** Something about Earth's surface (land or water) changes.
- ☐ **Claim 3:** Something about the air changes.

Name: _____ Date: _____

# Exploring Temperature and Energy in the Sim

## Part 1: Exploring the *Ocean, Atmosphere, and Climate* Simulation

1. Launch the *Ocean, Atmosphere, and Climate* Sim.
2. Work with your partner to become familiar with the features of the Simulation.
3. When you make a discovery about the Simulation, be sure to share it with your partner!

## Part 2: Sim Mission: Change the Air Temperature

1. With your partner, find ways to make the air temperature change in the Sim. Go to Energy Test mode.
   - **Partner 1:** Find a way to make the air temperature **increase.**
   - **Partner 2:** Find a way to make the air temperature **decrease.**
2. Talk to your partner about how you were able to make the temperature change.

How did you make the temperature **increase?** (circle one)

I ( **added** / **removed** ) energy to make the temperature increase.

How did you make the temperature **decrease?** (circle one)

I ( **added** / **removed** ) energy to make the temperature decrease.

Name: _____ Date: _____

# Homework: Reading *Effects of El Niño Around the World*

Read the introduction about El Niño and then choose one of the three articles to learn about the effects of El Niño in a specific location. Annotate the article using the Active Reading strategies that work best for you and then answer the questions.

**Optional challenge:** When you are finished, choose another article to learn about the effects of El Niño in a different location.

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Which article did you read? (circle one)

"Drought in Pakistan"

"Landslide in Los Angeles"

"Malaria in Colombia"

Why do you think it is important for climate scientists to study El Niño?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Lesson 1.3: Energy Transferred to Air

In your first day of research as a student climate scientist, you explored the *Ocean, Atmosphere, and Climate* Sim and observed that more energy in the air makes the temperature warmer, while less energy in the air makes the temperature cooler. You now know that air temperature is determined by the amount of energy in the air, but how does air get energy? Today, you will use evidence from a heating experiment and from the Sim to answer this question.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 1 Question

- What determines the air temperature of Christchurch, New Zealand?

## Vocabulary

- climate
- energy
- temperature
- transfer

## Digital Tools

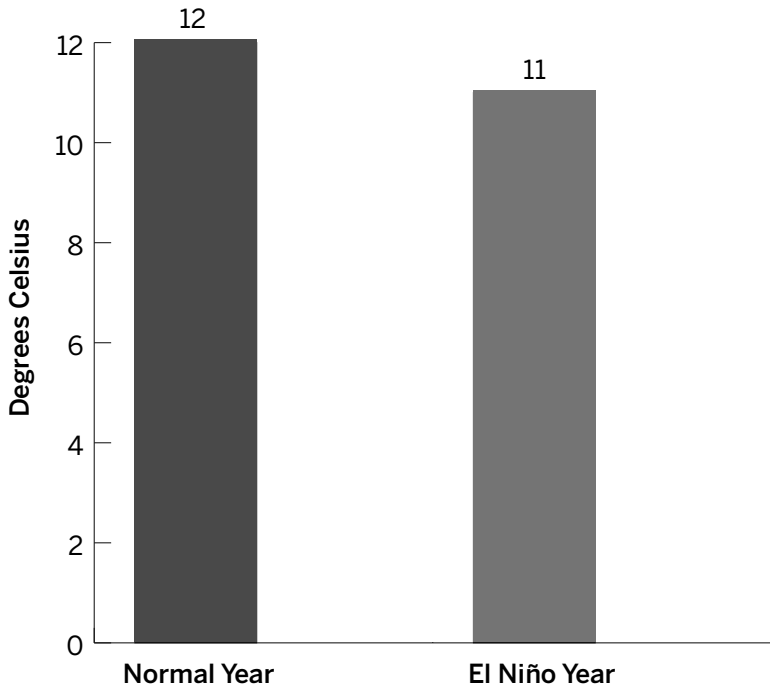
- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Warm-Up

Look at the graph carefully and read all the information to review how the temperature of Christchurch, New Zealand, changes during an El Niño year. Then, answer the question.

**Average Air Temperature: Christchurch, New Zealand**




El Niño events occur every two to seven years. There is a shift in the climate across the tropical Pacific, which causes some areas to become cooler than usual and some areas to become warmer than usual.

Christchurch, New Zealand's air temperature is cooler than usual during El Niño years. This means the air has _____ energy during an El Niño event. (circle one)

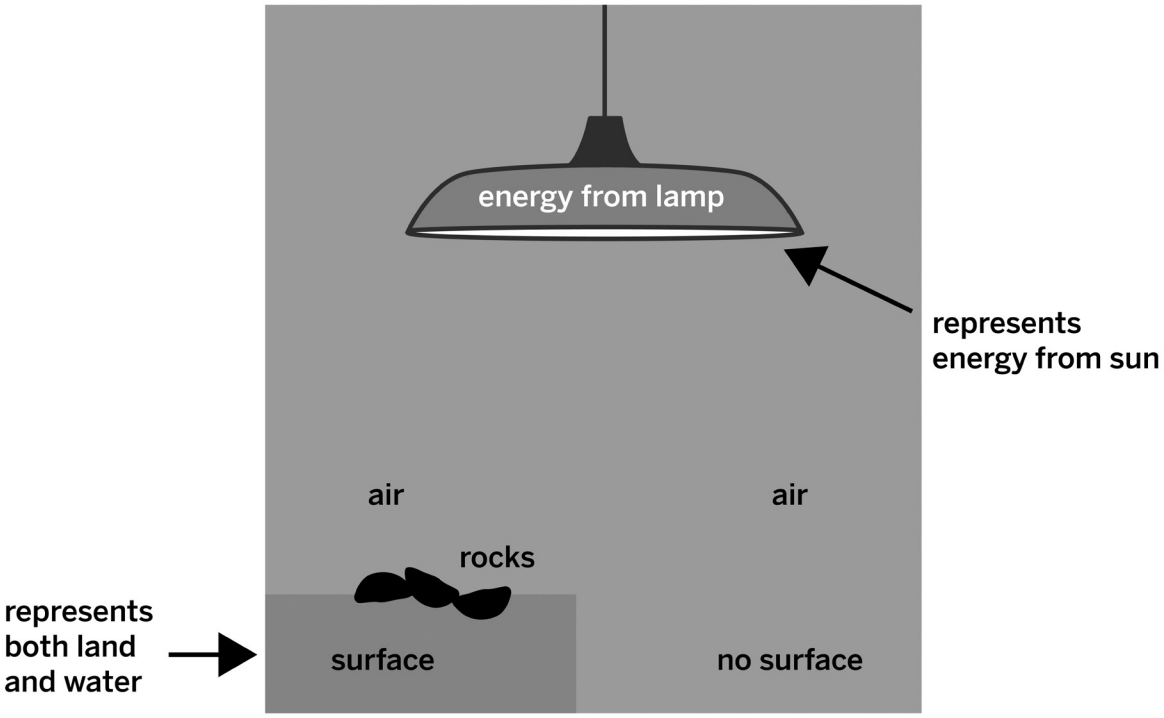
a. more

b. less

Name: _____ Date: _____

# Setting Up the Heating Experiment

Your class is about to conduct an experiment to determine how air gets energy. Talk to your partner about the results you would expect to see if either of these claims were accurate.




**Claim 1:** Energy is transferred from the sun to the air.

- If Claim 1 were true, would you expect the air temperature with no surface underneath to be higher, lower, or the same as the air above the rocks?

**Claim 2:** Energy is transferred from the sun to the surface, and then to the air.

- If Claim 2 were true, would you expect the air temperature with no surface underneath to be higher, lower, or the same as the air above the rocks?

Name: _____ Date: _____

# Setting Up the Heating Experiment (continued)

## Heating Experiment Data Table

Observe as the air temperature of Cup 1 and Cup 2 is measured. Record the temperature data in the table.

| | **Starting air temperature (°C)** (before lamp is turned on) | **Final air temperature (°C)** (20 minutes after lamp is turned on) | **Change in air temperature (°C)** (final temperature minus starting temperature) |
|---|---|---|---|
| **Cup 1** (air above surface) | | | |
| **Cup 2** (air, no surface underneath) | | | |

Name: _____ Date: _____

# Gathering Evidence with the Sim

Gather more evidence about how air gets energy by completing two tests in the Sim. Review the claims, and then follow the numbered steps.

**Investigation Question:** *How does air get energy?*

**Claim 1:** Energy is transferred from the sun to the air.

**Claim 2:** Energy is transferred from the sun to the surface, and then to the air.

1. Predict what will happen to the air temperature when you turn on energy from the sun, for (a) SURFACE and (b) NO SURFACE.

   **a. surface**

   I predict that the air temperature will _____ after 1 minute. (check one)

   - ☐ increase
   - ☐ decrease
   - ☐ stay the same

   **b. no surface**

   I predict that the air temperature will _____ after 1 minute. (check one)

   - ☐ increase
   - ☐ decrease
   - ☐ stay the same

Name: _____ Date: _____

## Gathering Evidence with the Sim (continued)

2. Open the *Ocean, Atmosphere, and Climate* Sim. Go to Surface Test Mode.

**a. surface**

Observe what happens to the air temperature for about 1 minute. Record the results.
The air temperature _____ after 1 minute. (check one)

- ☐ increased
- ☐ decreased
- ☐ stayed the same

**b. no surface**

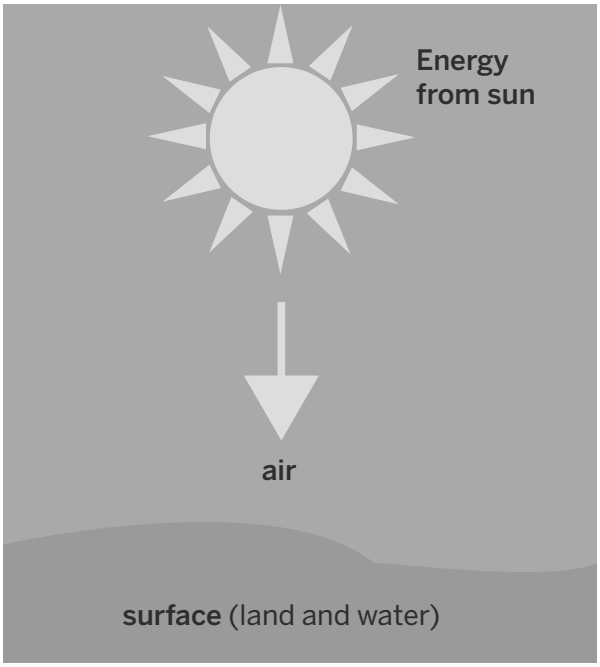
Repeat the test, being sure that Energy from the Sun is set to the same level as the first test.
Record the results. The air temperature _____ after 1 minute. (check one)

- ☐ increased
- ☐ decreased
- ☐ stayed the same

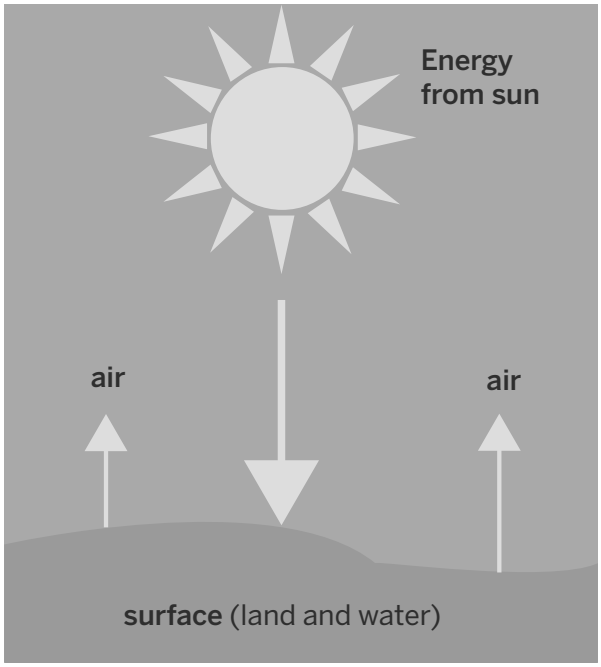
Name: _____ Date: _____

# Revisiting the Claims with New Evidence

**Investigation Question:** *How does air get energy?*




**Claim 1:** Energy is transferred from the sun to the air.




**Claim 2:** Energy is transferred from the sun to the surface, and then to the air.

## Discussing the Heating Experiment Results

Discuss these questions with your partner:

- What happened in the experiment?
- Do the results support Claim 1 or Claim 2?
- What did you learn from the experiment that might help you answer the Investigation Question: *How does air get energy?*

Name: _____ Date: _____

## Revisiting the Claims with New Evidence (continued)

Circle the claim you think is best supported by evidence from the Sim and the heating experiment.

**Claim 1:** Energy is transferred from the sun to the air.

**Claim 2:** Energy is transferred from the sun to the surface, and then to the air.

What evidence supports the claim you chose?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Homework: Considering How Air Gets Energy

Read the statement and determine if you agree or disagree. Use evidence to support your answer.

**The sun warms the air directly.**

Do you agree or disagree with this statement? What evidence supports your ideas?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Lesson 1.4: Air Temperatures Around the World

One of the important jobs of climate scientists is to read and interpret different types of maps that present data about Earth's systems. Today, you will look at two maps that will help you investigate air temperature and why it's different in different places. At the end of class, you will create a model that shows your understanding of why different locations on Earth have different temperatures.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 1 Question

- What determines the air temperature of Christchurch, New Zealand?

## Key Concepts

- Energy from the sun is transferred to Earth's surface. Some of that energy is then transferred to the air above the surface.

## Vocabulary

- climate
- energy
- temperature
- transfer

## Digital Tools

- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Warm-Up

## Predicting the Air Temperature of Different Locations

Open the *Ocean, Atmosphere, and Climate* Sorting Tool activity: 1.4 Warm-Up.

**Goal:** Make predictions about cold, warm, and hot places on Earth.

**Do:**

- Move a green thermometer to one location you think is cold.
- Move a yellow thermometer to one location you think is warm.
- Move red thermometers to two locations you think are hot.
- Move an energy label next to each thermometer so it shows what must be true about energy in that location.

**Tips:**

- Think about how temperature and energy are related.

Explain how your map shows your predictions about cold, warm, and hot places on Earth.

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

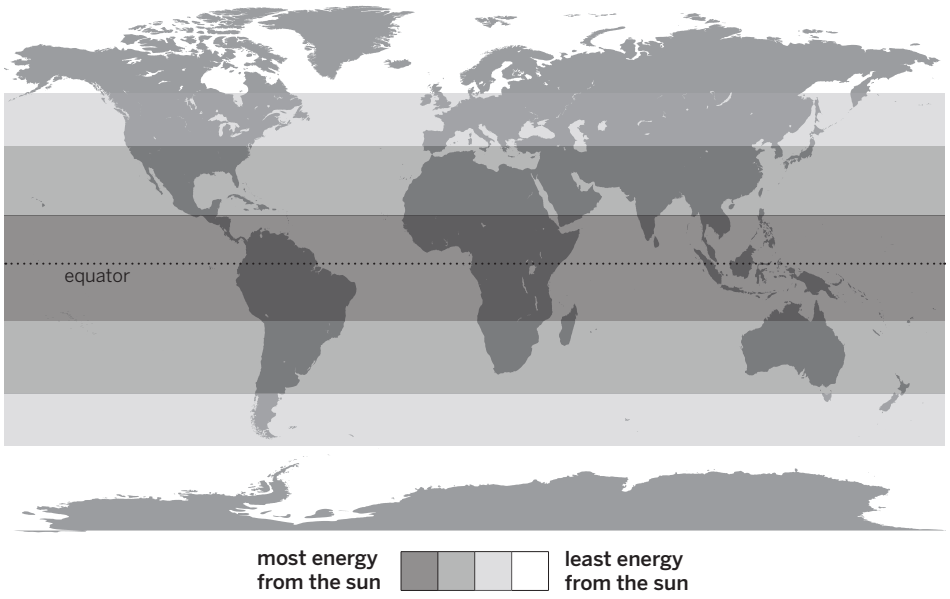
# Investigating Air Temperatures at Different Locations

## Discussing Energy and Temperature Maps

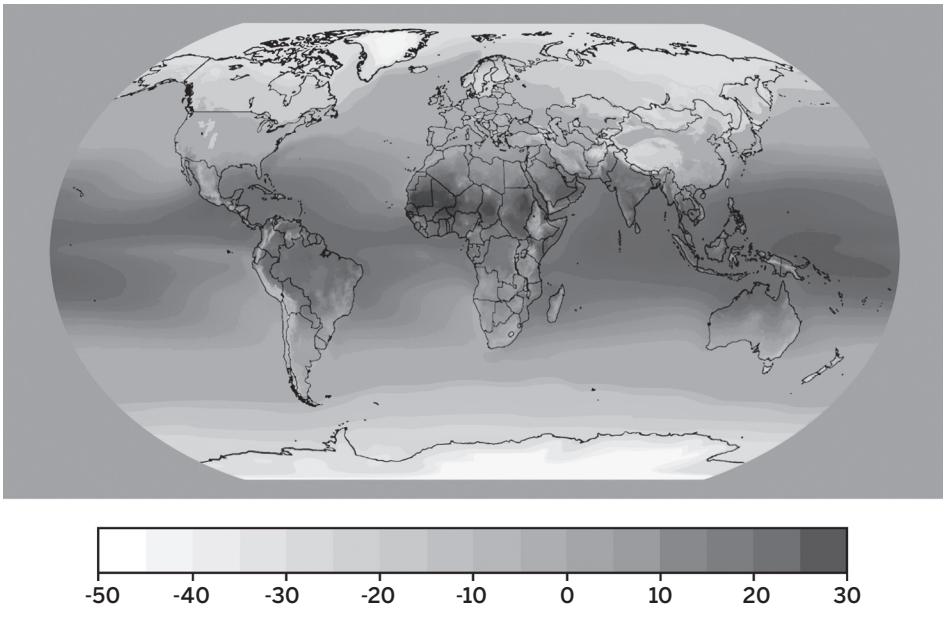
Decide on one map for each partner to focus on. Think about the questions, and then talk to your partner about what you notice. **Note:** Your teacher will project a color version of these maps.

1. What information does your map show?
2. How do the maps go together to provide evidence about the Investigation Question: *Why do different locations have different air temperatures?*

## Incoming Energy from the Sun




## Global Air Temperature



Name: _____ Date: _____

# Investigating Air Temperatures at Different Locations (continued)

3. Use evidence from the maps on the previous page to answer the Investigation Question: *Why do different locations have different air temperatures?*
   - Try to use the following words in your response: *energy, temperature,* and *latitude.*

_____

_____

_____

_____

_____

_____

## Revisiting the Sorting Tool

Return to the *Ocean, Atmosphere, and Climate* Sorting Tool activity: 1.4 Warm-Up. Revise your map, and once you are satisfied, explain the changes you made to your map below.

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Modeling What Determines a Location's Air Temperature

Open the *Ocean, Atmosphere, and Climate* Modeling Tool activity: 1.4 Different Temperatures, and create a model. Press HAND IN when your model is complete.

**Goal:** Model why two locations (Equator and South Pole) have different air temperatures.

**Do:**

- Use Energy Transfer arrows to show how energy from the sun is transferred to the air.
- Select a size for each arrow so it shows the amount of energy being transferred.
- Use thermometers to show the resulting air temperature.

**Tips:**

- Model the air temperature of both locations.
- Press the blue pencil to add information to your model.
- When items are properly connected, choices for size or temperature level will appear.

Explain how your model shows why two locations (Equator and South Pole) have different air temperatures.

_____

_____

_____

_____

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_____

Name: _____ Date: _____

# Homework: Determining Air Temperature at Three Locations

Use the Sim to investigate energy from the sun and temperature at three locations.

Open the *Ocean, Atmosphere, and Climate* Sim. Go to Current Map mode, then select AIR for Temperature View.

1. Place Location Sensors at 1 and 2.
2. Record the level of energy transferred from the sun and the air temperature at both locations.
3. Reset the activity. Place a Location Sensor at 3.
4. Record the level of energy transferred from the sun and the air temperature at the third location.

| Location number | Level of energy from the sun (low, middle, high) | Air temperature (°C) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |

How is the temperature of a location determined by energy from the sun and the location's distance from the equator?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Lesson 1.5: Air Temperature in Christchurch

You have been gathering evidence to explain what determines a location's air temperature. Today, you will begin to use what you have learned to explain why Christchurch's air temperature is cooler during El Niño years. First, you will participate in a Write and Share routine that helps you review the science concepts you have learned so far. Next, you will use what you have learned to analyze real climate data that the New Zealand Farm Council sent to help with your investigation.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 1 Question

- What determines the air temperature of Christchurch, New Zealand?

## Key Concepts

- Energy from the sun is transferred to Earth's surface. Some of that energy is then transferred to the air above the surface.
- The closer a location is to the equator, the more energy it receives from the sun. Therefore, a location's air temperature is affected by its distance from the equator.

## Vocabulary

- climate
- energy
- latitude
- temperature
- transfer

Name: _____ Date: _____

# Warm-Up

*Why is Christchurch, New Zealand's air temperature cooler than usual during El Niño years?*

Review the question and three claims, and then choose the one claim you think is LEAST convincing.

Christchurch's air temperature is cooler than usual during El Niño years because . . . (check one)

- ☐ **Claim 1:** The amount of incoming energy from the sun changes.
- ☐ **Claim 2:** Something about Earth's surface (land or water) changes.
- ☐ **Claim 3:** Something about the air changes.

Explain why you think the claim you selected is the LEAST convincing claim.

_____

_____

_____

_____

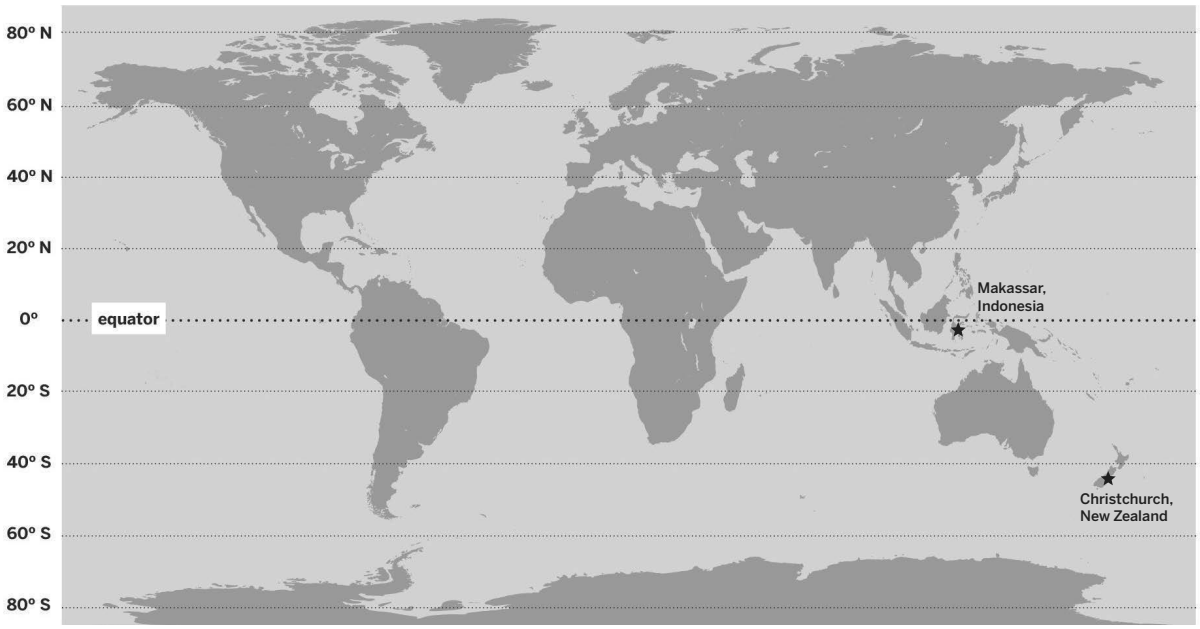
_____

_____

Name: _____ Date: _____

# Write and Share Routine: Student 1

| Location | Average air temperature |
|---|---|
| Christchurch, New Zealand | 11°C (51.8°F) |
| Makassar, Indonesia | 27.5°C (81°F) |




**Prompt:** Why is the average air temperature of Makassar warmer than the average air temperature of Christchurch?

Add annotations to the map that will help you respond to the prompt. Write an explanation, using the evidence from the map and all these words: *energy, temperature, latitude, transfer.*

_____

_____

_____

_____

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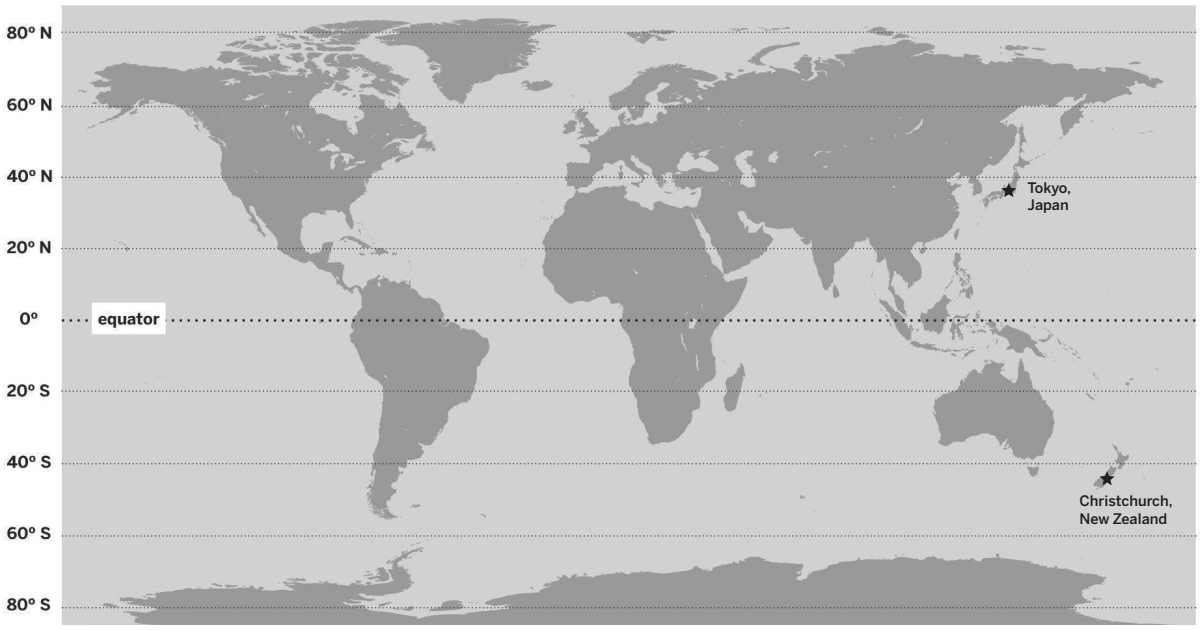
_____

Name: _____ Date: _____

# Write and Share Routine: Student 2

| Location | Average air temperature |
|---|---|
| Christchurch, New Zealand | 11°C (51.8°F) |
| Tokyo, Japan | 15.5°C (60°F) |




**Prompt:** Why is the average air temperature of Tokyo warmer than the average air temperature of Christchurch?

Add annotations to the map that will help you respond to the prompt. Write an explanation, using the evidence from the map and all these words: *energy, temperature, latitude, transfer.*

_____

_____

_____

_____

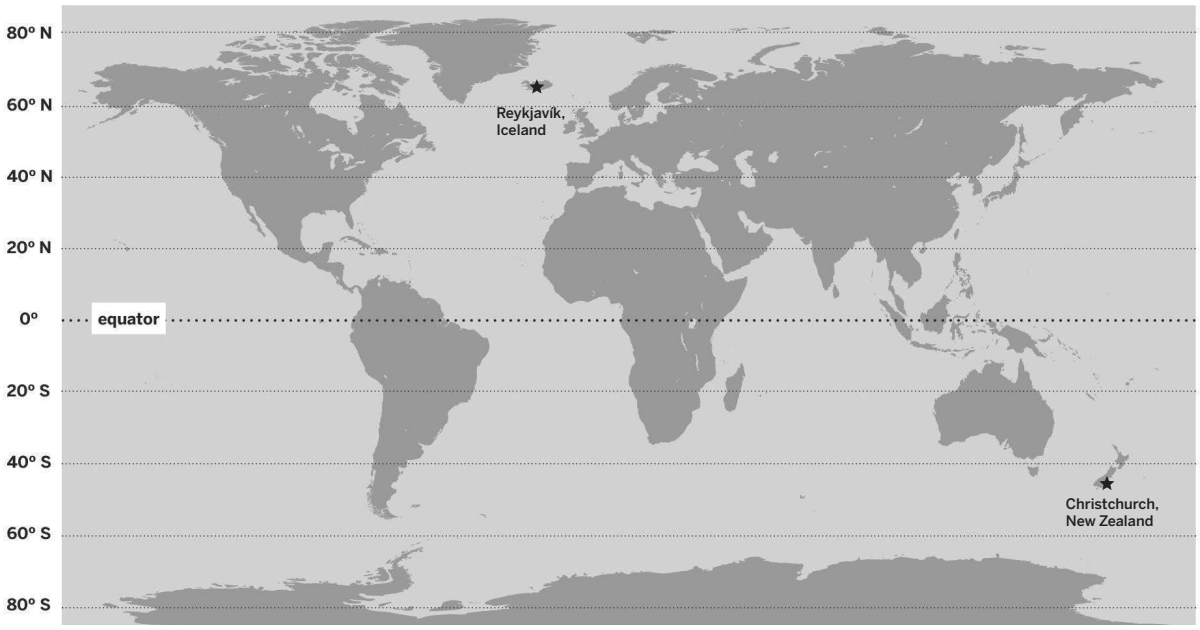
_____

_____

Name: _____ Date: _____

# Write and Share Routine: Student 3

| Location | Average air temperature |
|---|---|
| Christchurch, New Zealand | 11°C (51.8°F) |
| Reykjavik, Iceland | 5.5°C (42°F) |




**Prompt:** Why is the average air temperature of Reykjavik cooler than the average air temperature of Christchurch?

Add annotations to the map that will help you respond to the prompt. Write an explanation, using the evidence from the map and all these words: *energy, temperature, latitude, transfer.*

_____

_____

_____

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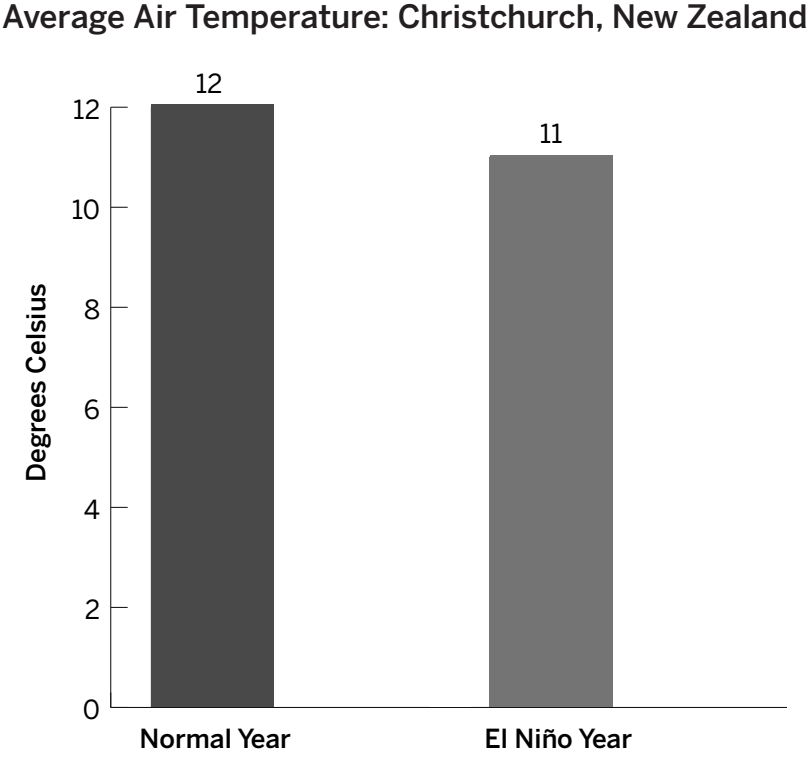
Name: _____ Date: _____

# Evaluating Evidence

## Part 1: Interpreting Climate Data

Participate in the class discussion about this graph.



Name: _____ Date: _____

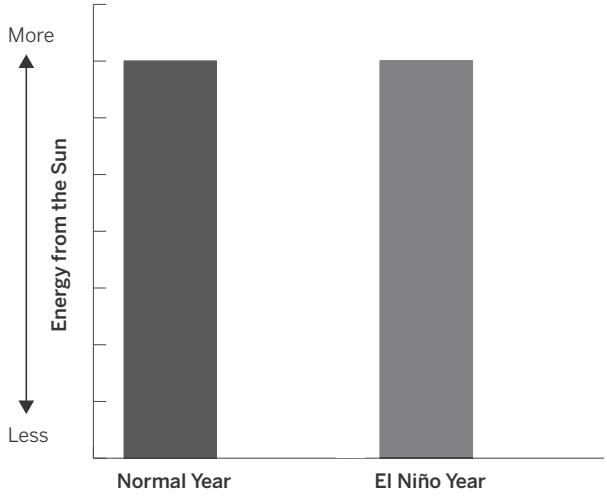
# Evaluating Evidence (continued)

## Part 2: Annotating and Discussing Evidence

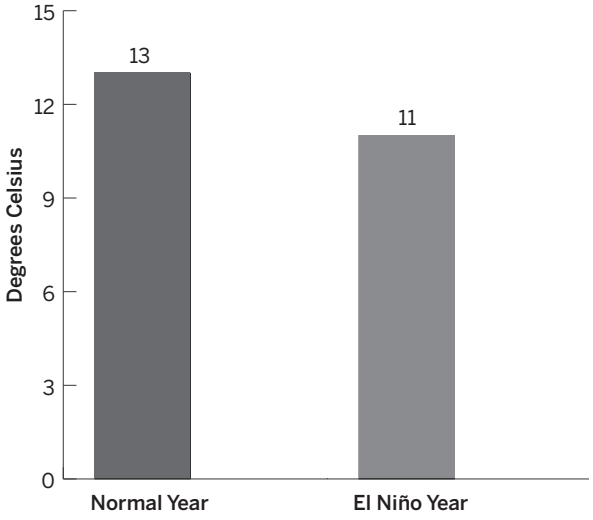
Use the first three questions to guide you as you read and annotate both graphs. When you are finished, discuss your annotations and question 4 with your partner.

1. What does each graph show?
2. What questions do you have about the information in the graphs?
3. How is the evidence connected to what you have been learning about climate, temperature, and energy?

### Energy from the Sun at Christchurch, New Zealand




### Average Ocean Surface Temperature Near Christchurch, New Zealand



Name: _____ Date: _____

# Evaluating Evidence (continued)

4. Do the graphs support or go against the following claims about Christchurch during El Niño years?

Christchurch's air temperature is cooler than usual during El Niño years because . . .

**Claim 1:** The amount of incoming energy from the sun changes.

**Claim 2:** Something about Earth's surface (land or water) changes.

**Claim 3:** Something about the air changes.

Name: _____ Date: _____

# Homework: Check Your Understanding

Scientists investigate in order to figure things out. Are you getting closer to figuring out why the air temperature in Christchurch is cooler in El Niño years?

1. I understand how energy is transferred to the air of Christchurch, New Zealand. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

2. I understand what happens to the amount of energy in the air of Christchurch in El Niño years. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

3. I understand how Christchurch's distance from the equator affects its air temperature. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

Name: _____ Date: _____

## Homework: Check Your Understanding (continued)

4. I understand why the ocean near Christchurch is a different temperature than we'd expect for its latitude (distance from the equator). (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

5. I understand why the ocean temperature near Christchurch changes in El Niño years and how it affects the air temperature there. (check one)

   ☐ yes

   ☐ not yet

_____

_____

_____

6. What do you still wonder about El Niño and air temperature?

_____

_____

_____

_____

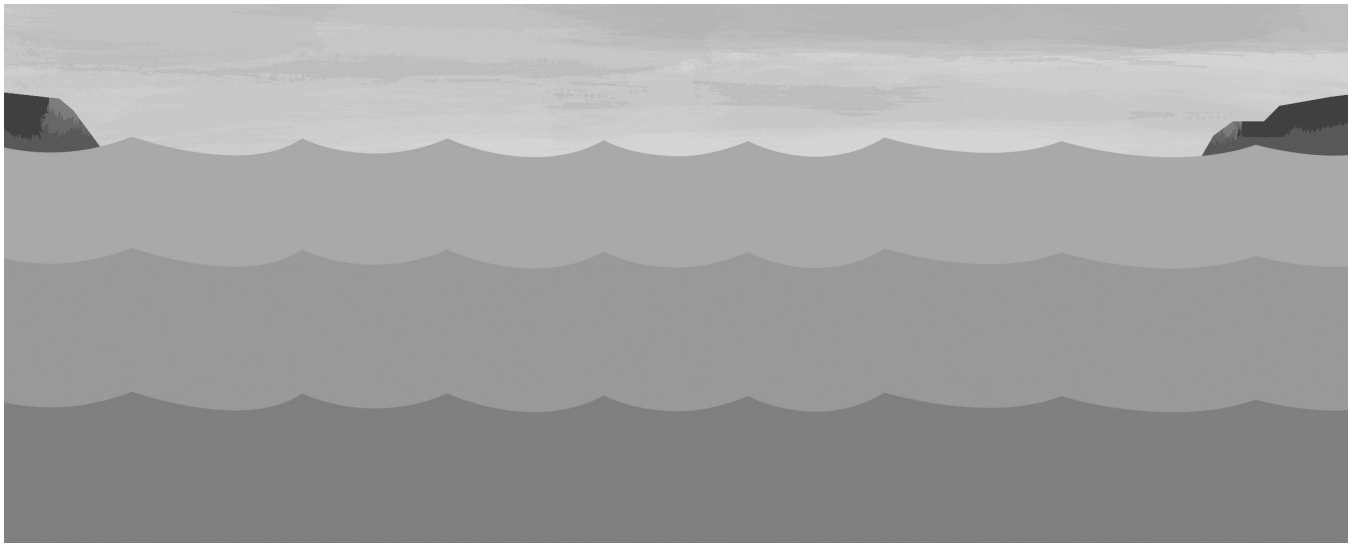
_____

_____

Name: _____ Date: _____

# Chapter 2: Ocean Currents
## Chapter Overview

In Chapter 2, you will discover why the ocean surface varies in temperature at different locations and how this affects the air temperature of places near the ocean. You will use the knowledge you gain in this chapter (which includes an exciting article, a fun board game, and an interesting video) to demonstrate your understanding of all you've learned, using the *Ocean, Atmosphere, and Climate* Modeling Tool.



Name: _____ Date: _____

# Lesson 2.1: "The Ocean in Motion"

As a student climatologist, you determined that a location's latitude affects its air temperature. But Christchurch's air temperature and ocean surface temperature both become cooler during El Niño years. A city's latitude does not change, so, other than latitude, what else might affect a location's air temperature? Dr. Parata, the New Zealand Farm Council director, has sent an article that will help you begin to answer this question.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 2 Question

- Other than latitude, what else affects the air temperature of Christchurch?

## Vocabulary

- climate
- energy
- latitude
- ocean current
- temperature

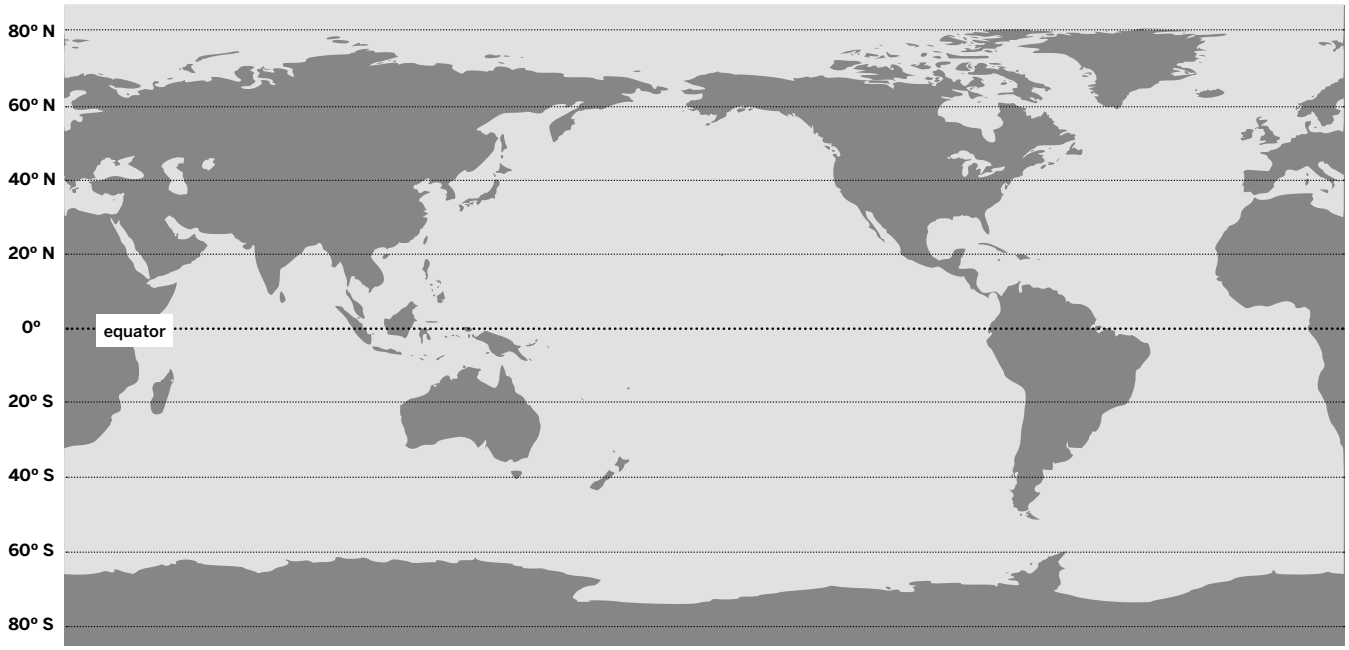
## Digital Tools

- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Warm-Up

Find the place where you live on the world map. Estimate the latitude, and then answer the questions.




Based on the latitude you estimated, predict how much energy is transferred from the sun to the surface, and then to the air in your city.

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Name: _____ Date: _____

## Warm-Up (continued)

Other than latitude, what else do you think might affect the air temperature where you live?

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Name: _____ Date: _____

# Reading "The Ocean in Motion"

1. Read and annotate the article "The Ocean in Motion."
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

**As I read, I paid attention to my own understanding and recorded my thoughts and questions.**

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Homework: Tracking Currents in the Sim

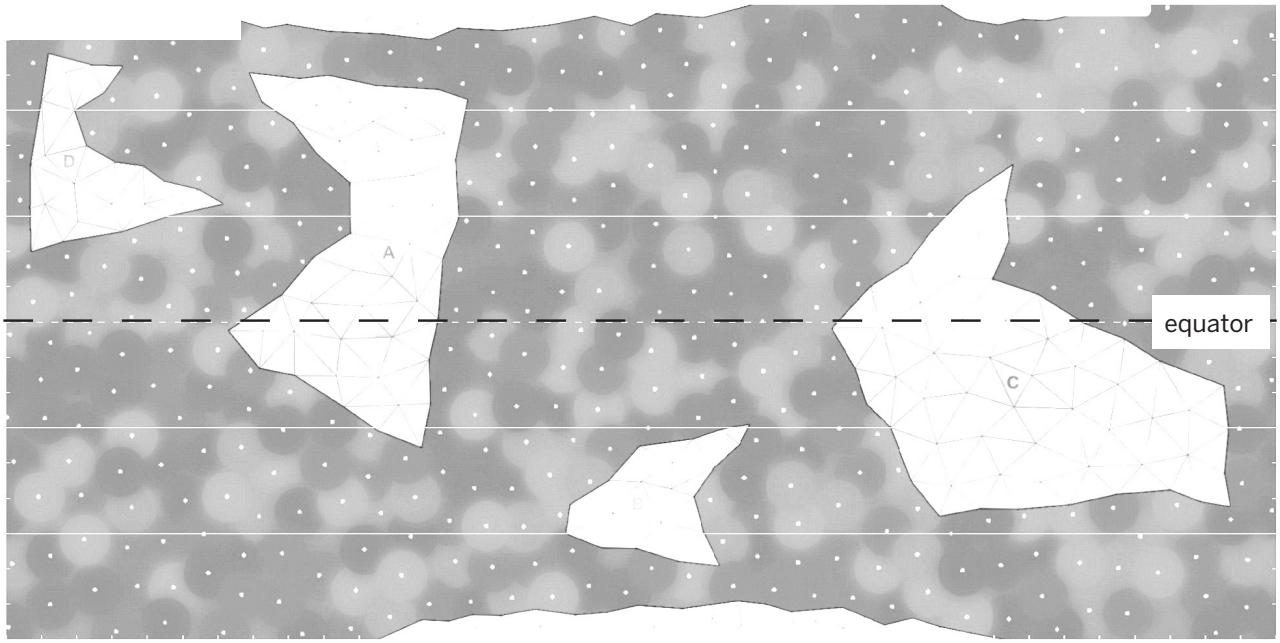
## Tracking a Current

A. Open the *Ocean, Atmosphere, and Climate* Simulation. Select Current Map mode. Be sure NONE is selected in Temperature View.

B. Find a current that could be a part of a gyre. Tap anywhere on the current to activate the tracking system and observe the path of the current.

C. Draw the path of the current that you tracked onto the image.

D. Then, based on your observations, answer the questions below.




1. Describe the shape of the path of the current you tracked.

_____

2. Draw a star on the image to indicate the place where you think the current had the most energy. Why did the current have the most energy in this location?

_____

_____

3. Thinking back to the shoe spill in "The Ocean in Motion," how might those shoes have traveled from the middle of the Pacific Ocean to Oregon, Hawaii, and Japan?

_____

_____

Name: _____ Date: _____

# Lesson 2.2: Ocean Temperatures at Different Locations

Buenos Aires and Cape Town are two coastal locations at the same latitude. Do you think the ocean surface temperature near each of these locations is the same? Do they have different temperatures? Today, you will return to "The Ocean in Motion" and use a map to get evidence that helps you answer this question.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 2 Question

- Other than latitude, what else affects the air temperature of Christchurch?

## Key Concepts

- An effect may have more than one cause; these may be linked into a chain of causes and effects.

## Vocabulary

- climate
- energy
- temperature
- transfer

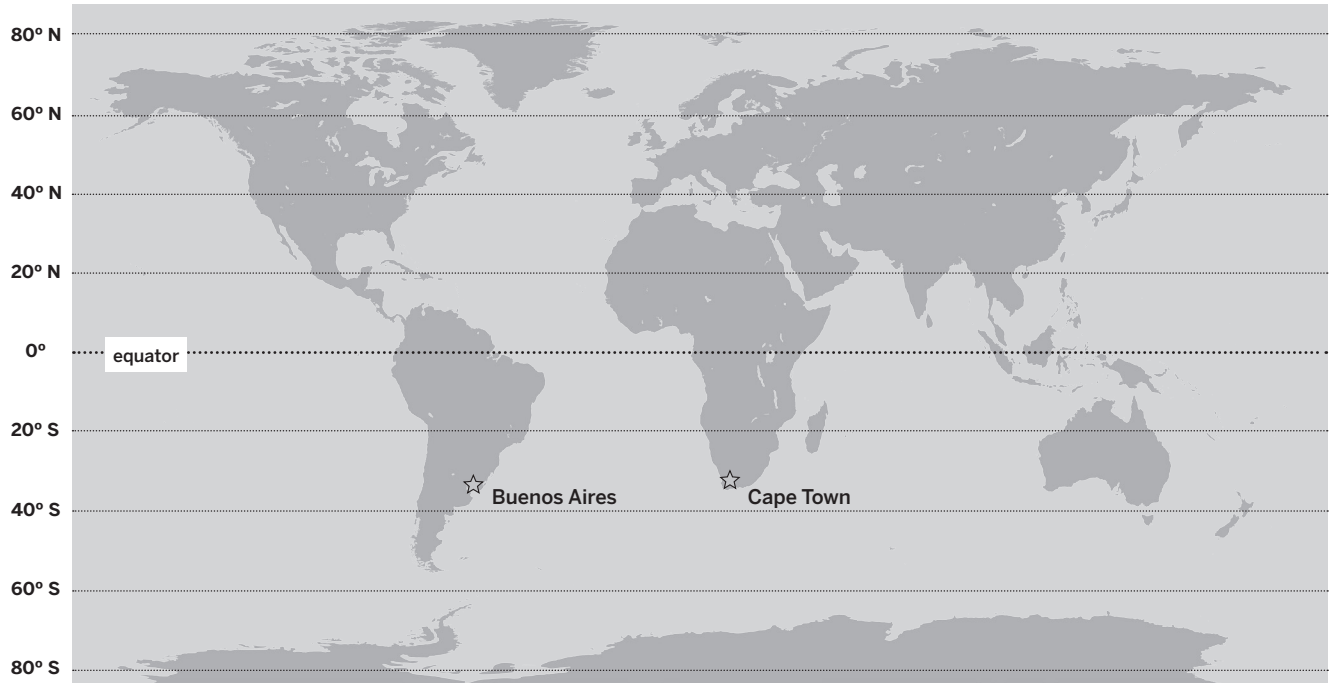
## Digital Tools

- *Ocean, Atmosphere, and Climate* Sorting Tool activity: 2.2 Homework

Name: _____ Date: _____

# Warm-Up

Do you think the ocean surface temperature near Buenos Aires is the same or different from the ocean surface temperature near Cape Town?




Look at the map, and then select and circle Prediction A or Prediction B.

**Prediction A:** Buenos Aires and Cape Town have the **same** ocean surface temperature.

**Prediction B:** Buenos Aires and Cape Town have **different** ocean surface temperatures.

Explain your choice.

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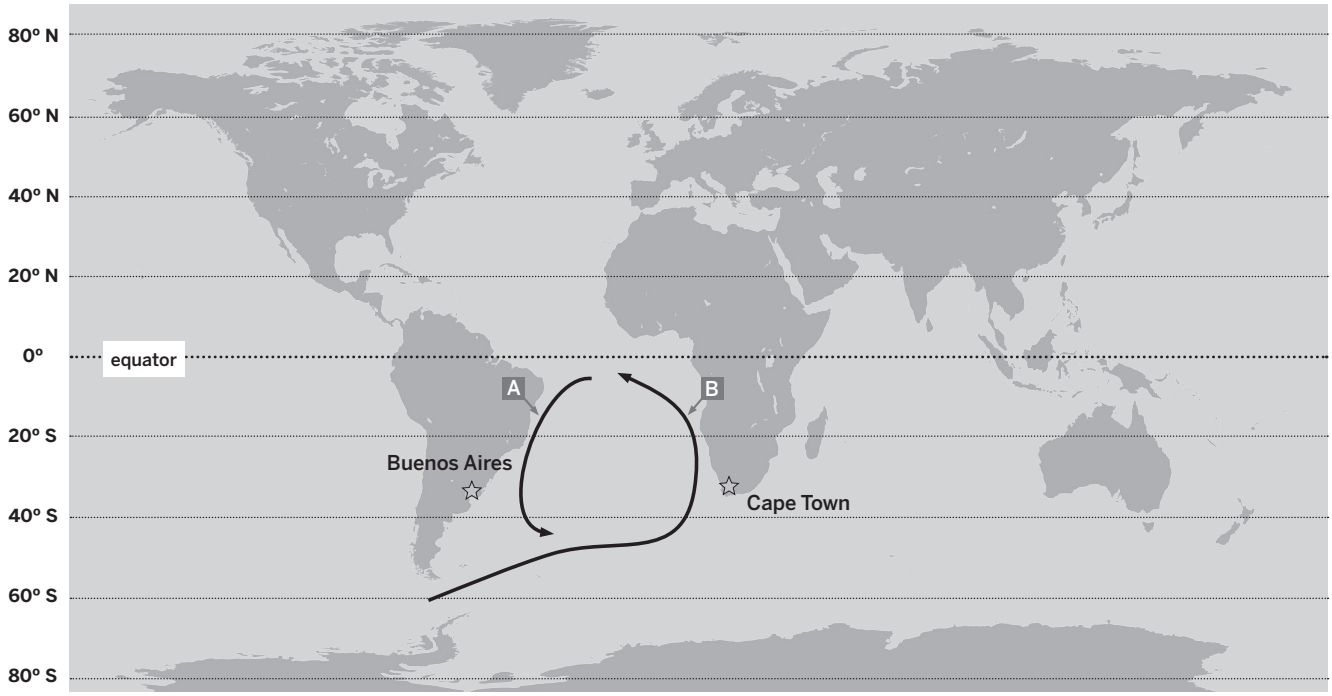
Name: _____ Date: _____

# Investigating Ocean Surface Temperature

## Currents Near Buenos Aires and Cape Town




Compare the two ocean currents (A and B) shown on the map. Match the current with the phrase that best describes it.

Current A (near Buenos Aires) _____. (circle one)

**carries no energy** **carries more energy** **carries the same energy** **carries less energy**

Current B (near Cape Town) _____. (circle one)

**carries no energy** **carries more energy** **carries the same energy** **carries less energy**

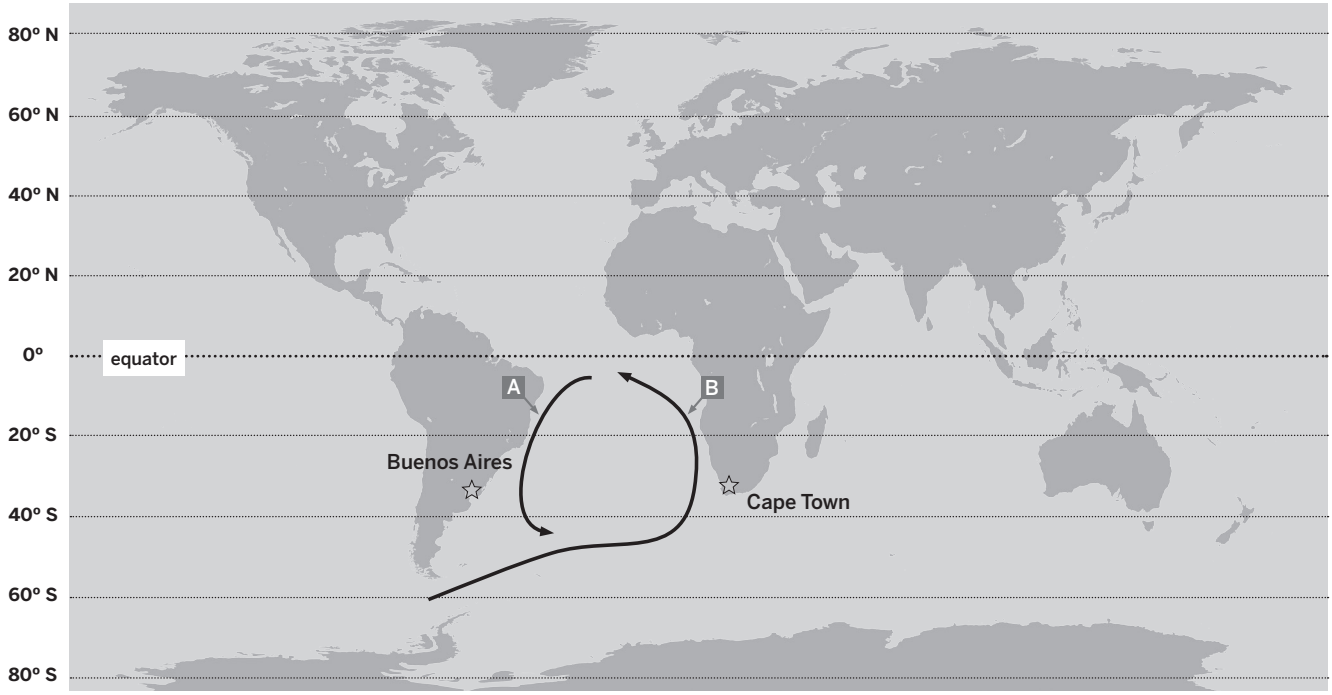
Discuss the following questions with your partner:

- What does the map show?
- Does the map provide evidence that the currents near Buenos Aires and Cape Town cause the ocean surface temperature at each location to be the same or different?

Name: _____ Date: _____

# Investigating Ocean Surface Temperature (continued)

## Explaining Ocean Surface Temperature




1. Which claim is better supported? (circle one)

**Claim 1:** Buenos Aires and Cape Town have the **same** ocean surface temperature.

**Claim 2:** Buenos Aires and Cape Town have **different** ocean surface temperatures.

Name: _____ Date: _____

# Investigating Ocean Surface Temperature (continued)

2. How does the map support the claim you selected? Try to use all these words when you respond.

**Word Bank**

| | | |
|---|---|---|
| equator | energy | current |

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Name: _____ Date: _____

# Homework: Energy and Temperature of Currents in Gyres

Open the *Ocean, Atmosphere, and Climate* Sorting Tool activity: 2.2 Homework and complete the model. Answer the question below.

**Goal:** Show how the starting location of a current affects the amount of energy it carries.

**Do:**

- Use energy labels to show how much energy each current carries. Complete the six remaining ocean currents (three gyres).
- Use thermometers to show how the amount of energy that a current carries affects its temperature.

**Tips:**

- Some currents have already been completed.
- A star indicates the starting location of a current.
- Think about how the latitude of a current's starting location determines how much energy it carries.

How does your model show how the starting location of a current affects the amount of energy it carries?

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Name: _____ Date: _____

# Lesson 2.3: Currents and Air Temperature

You have determined that the surface temperature of the ocean near Cape Town is cooler than the ocean surface temperature near Buenos Aires, but how does this affect the *air* temperature of the two locations? Today, you will conduct an experiment and use the *Ocean, Atmosphere, and Climate* Simulation to gather evidence about how ocean currents affect the air temperature of the two cities. By learning more about how the ocean can affect air temperature, you will be one step closer to figuring out why Christchurch's air temperature is cooler than normal during El Niño years.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 2 Question

- Other than latitude, what else affects the air temperature of Christchurch?

## Key Concepts

- An effect may have more than one cause; these may be linked into a chain of causes and effects.
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes. When an ocean current comes from a pole, it brings colder-than-expected water to the places it passes.

## Vocabulary

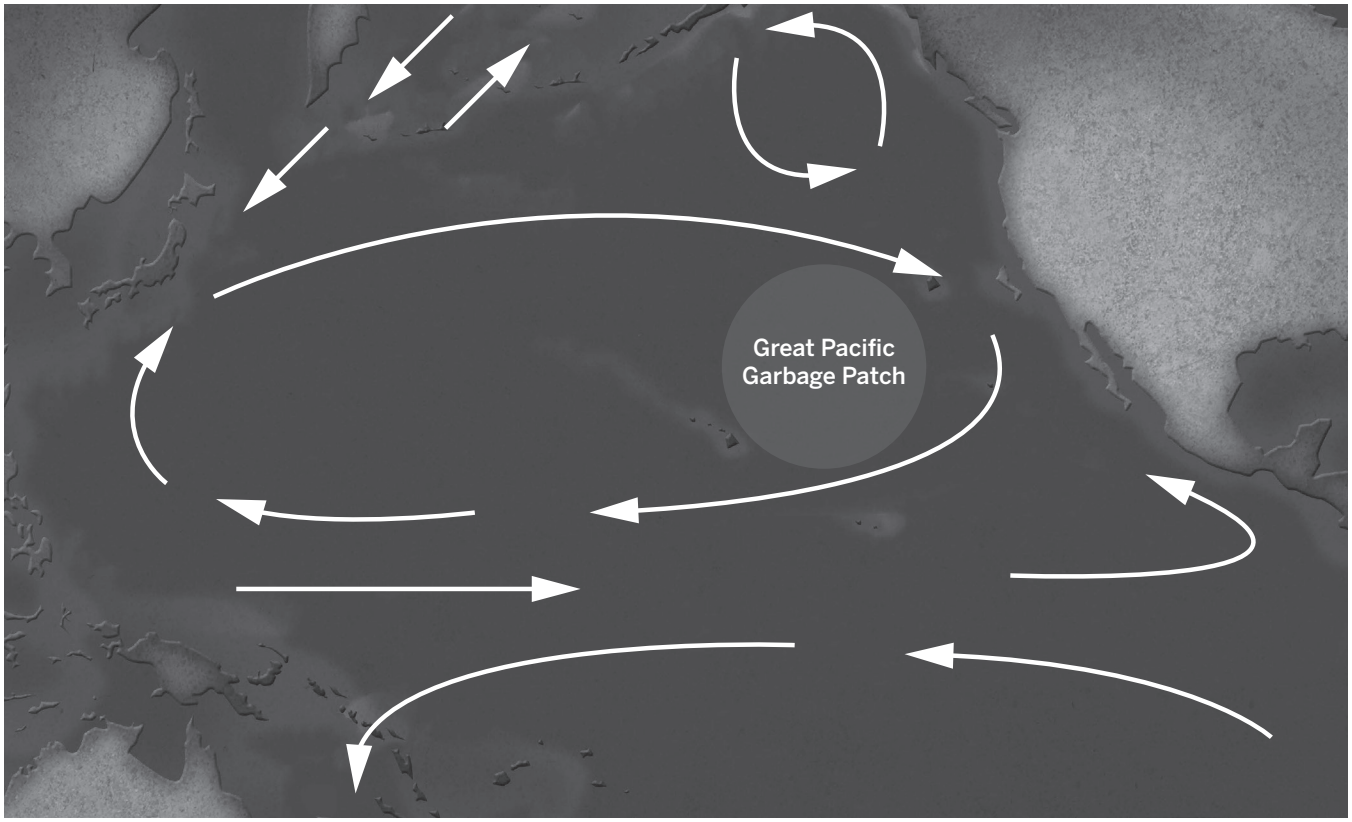
- claim
- climate
- energy
- evidence
- latitude
- ocean current
- temperature
- transfer

## Digital Tools

- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Warm-Up




Trash from all around the world, especially plastics, pollutes the ocean. There are areas in the ocean that have much more trash than other areas. For example, the Great Pacific Garbage Patch is a huge mass of tiny pieces of garbage circulating in the Pacific.

1. Based on what you have learned about currents, how do you think this mass of trash ends up in the Great Pacific Garbage Patch?

Name: _____ Date: _____

## Warm-Up (continued)

2. Looking at the map, what ideas do you have about why the trash is "trapped" in this location?

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Name: _____ Date: _____

# Water and Air Temperature Experiment

**Safety Note: Hot Water**
Handle hot water with care. If spilled, it could burn your skin.

Conduct an experiment to gather evidence about how water temperature affects air temperature. Follow these instructions:

1. Insert one thermometer through the slot of each lid and measure the initial air temperature of Cup 1 and Cup 2. Record your data in the table.
2. Pour hot water into Cup 1 and cold water into Cup 2. The cups should be about half full.
3. Replace the lids and thermometers, making sure the thermometers do NOT touch the water in either cup.
4. Wait 2 minutes and measure the final temperature of the air in Cup 1 and Cup 2. Record this data in the table.

| | **Initial air temperature (°C)** | **Final air temperature (°C)** |
|---|---|---|
| **Cup 1** (hot water) | | |
| **Cup 2** (cold water) | | |

Explain why the air temperature in each cup changed. What must have happened to the energy in the air of each cup?

_____

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Name: _____ Date: _____

# Investigating Ocean Currents and Air Temperature

## Gathering Evidence in the Sim

Open the *Ocean, Atmosphere, and Climate* Sim. Follow the instructions to gather evidence about how ocean currents affect the air temperature of the locations they pass. After you complete the activity, answer the three questions.

1. Select Current Map mode.
2. For Temperature View, select Surface.
3. Place Location Sensors at 4 and 5.
4. Record the air temperature of these two locations.
5. Press play. Observe the motion of the currents and in Side View, observe how energy is being transferred between water and air.
6. After temperatures stabilize (about 2 minutes), record your data.
   - Record the air temperature of both locations.
   - Indicate if the location was near a cold current or a warm current.
7. Then, answer the questions on the next page.

| | **Starting air temperature (°C)** | **Final air temperature (°C)** | **Current: cold or warm?** |
|---|---|---|---|
| **Sensor 4** | | | |
| **Sensor 5** | | | |

Name: _____ Date: _____

# Investigating Ocean Currents and Air Temperature (continued)

1. At which location does energy transfer from water to air? (circle one)

   **Sensor 4** **Sensor 5**

2. At which location does energy transfer from air to water? (circle one)

   **Sensor 4** **Sensor 5**

3. Why is the temperature shown on Sensor 4 different from Sensor 5, even though they are at the same latitude?

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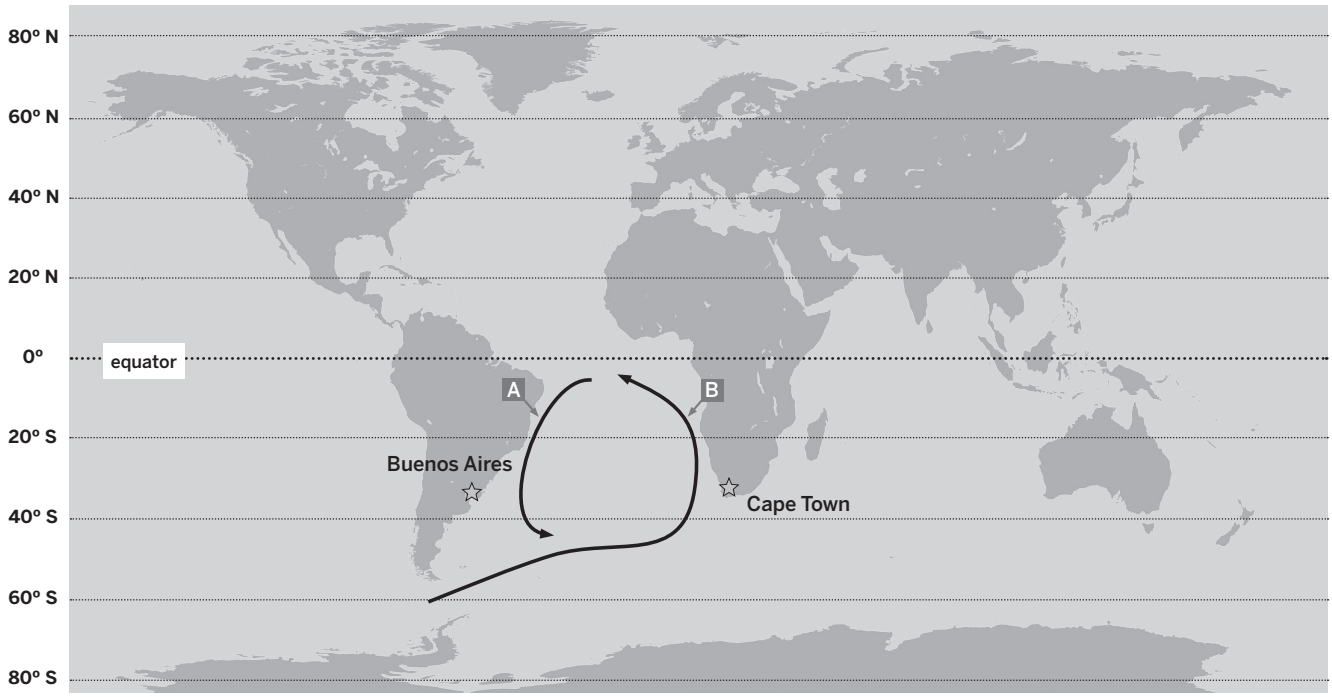
Name: _____ Date: _____

# Air Temperature in Buenos Aires and Cape Town




1. Using what you learned in this lesson, circle the words that will complete the following sentences.

   In Buenos Aires, the ( **ocean** / **air** ) transfers energy to the ( **ocean** / **air** ).

   In Cape Town, the ( **ocean** / **air** ) transfers energy to the ( **ocean** / **air** ).

2. Use evidence from the Sim and the Water and Air Temperature Experiment to make a claim that compares the air temperature of Buenos Aires and the air temperature of Cape Town. Circle the words that will complete your claim. Talk to your partner about the evidence that supports your claim.

**Question:** How do ocean currents affect the air temperature of Buenos Aires and Cape Town?

**Claim:** The ocean currents near these cities cause the air temperature of Buenos Aires to be (**the same as, different from**) the air temperature in Cape Town.

Name: _____ Date: _____

# Homework: Energy Transfer and Air Temperature

Launch the *Ocean, Atmosphere, and Climate* Sim. Select Energy Test mode so you can experiment with adding energy to the air and land. If you have extra time, you can perform the same tests, but select water as the surface.

1. Add energy to the air so the **air becomes warmer than the land.** Observe the energy transfer.
2. Add energy to the land so the **land becomes warmer than the air.** Observe the energy transfer.

When does energy transfer from the **air to the land?**

_____

_____

_____

_____

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_____

When does energy transfer from the **land to the air?**

_____

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Name: _____ Date: _____

# Lesson 2.4: Modeling Ocean Currents and Air Temperature

Today you will reflect on what you have learned about how currents affect the air temperature of the locations they pass. First, you will play a board game to deepen your understanding of how energy is transferred from air to water and water to air. Next, you will model your understanding of how the ocean current moving from the equator affects Christchurch's air temperature during normal years. Finally, you will consider what changes might be causing cooler temperatures in Christchurch during El Niño years.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 2 Question

- Other than latitude, what else affects the air temperature of Christchurch?

## Key Concepts

- An effect may have more than one cause; these may be linked into a chain of causes and effects.
- Energy transfers from warmer substances to colder substances. Warmer currents transfer energy to cooler air, and warmer air transfers energy to cooler currents.
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes, and that water is warmer than the nearby air. When an ocean current comes from a pole, it brings colder-than-expected water to the places it passes, and that water is colder than the nearby air.

## Vocabulary

- cause
- effect
- energy
- latitude
- ocean current
- temperature
- transfer

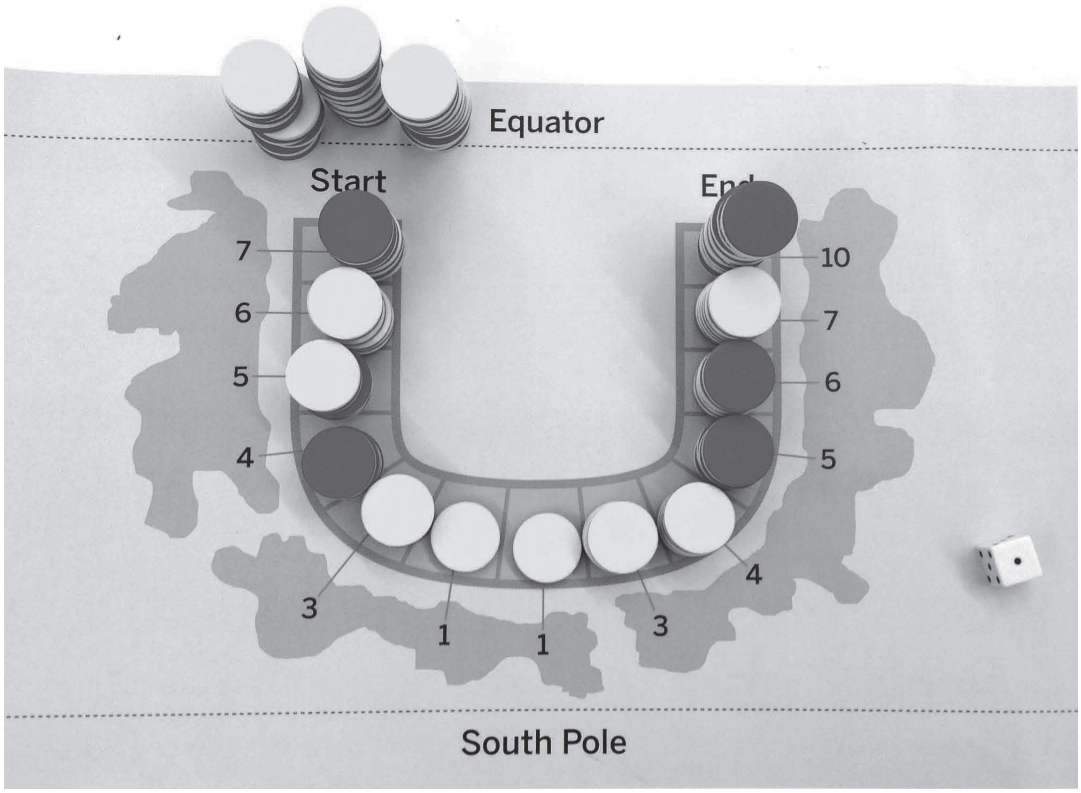
## Digital Tools

- *Ocean, Atmosphere, and Climate* Modeling Tool activity: 2.4 Currents and Temperature

Name: _____ Date: _____

# Warm-Up

Today you will play Ocean Currents, which is a board game. Get prepared by reading the game overview, then answer the three questions on the next page.




## Ocean Currents Game Overview

**Goal:** Equalize energy in the water and energy in the air by transferring energy as you move along the path of an ocean current.

- A player's stack of tokens represents the energy in water as that water moves around the ocean.
- The tokens on the board that are not part of a player's stack represent the energy in the air at those locations.
- Travel with the current by rolling the probability cube and moving your stack of tokens.
- Whenever you stop along the current's path, transfer energy tokens so the amount of energy in the water and energy in the air is the same.
- The player with the most energy tokens at the END wins that round.

Name: _____ Date: _____

## Warm-Up (continued)

1. In general, what do tokens represent?

_____

2. What does a player's stack of tokens represent?

_____

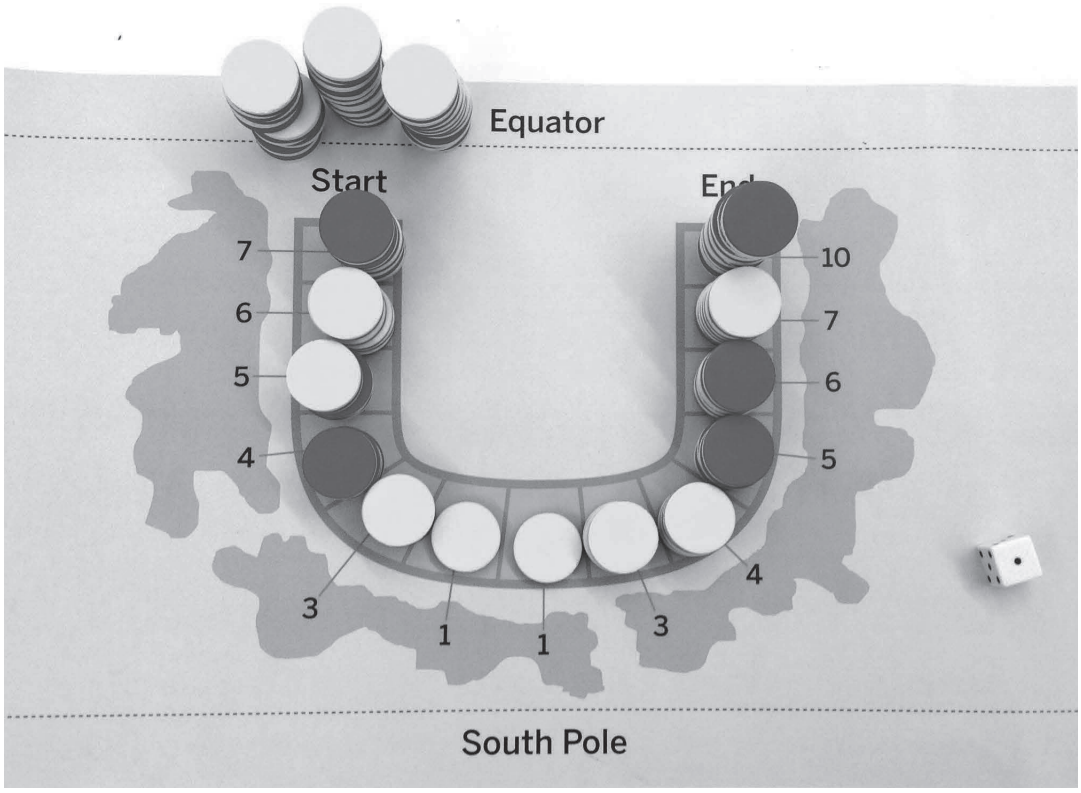
3. What do the tokens on the board (not in a player's stack) represent?

_____

Name: _____ Date: _____

# Playing the Ocean Currents Game

1. With your group, read the Ocean Currents Game Instructions carefully.
2. Set up the board.
3. Play the game.
4. After the game, respond to the questions on the next page.



Name: _____ Date: _____

## Playing the Ocean Currents Game (continued)

Describe how and when energy was transferred, either to the air or the water.

_____

_____

_____

Where was the current coming from when energy was transferred from the water to the air? (circle one)

**from the equator** **from the pole**

Where was the current coming from when energy was transferred from the air to the water? (circle one)

**from the equator** **from the pole**

Name: _____ Date: _____

# Modeling How Currents Affect Air Temperature

1. Open the *Ocean, Atmosphere, and Climate* Modeling Tool activity: 2.4 Currents and Temperature.
2. When your model is complete, answer the first question below.
3. Finally, complete the two sentences that explain your model in terms of cause and effect.

**Goal:** Show how ocean currents affect the air temperature of Christchurch, New Zealand.

**Do:**

- Show where current(s) that affect Christchurch begin and the locations they pass.
- Complete the information in your model with Energy Transfer arrows.
- Add thermometers that show land, water, and air temperature.

**Tips:**

- Drag a current from the bottom of the map. Place it, then adjust its path. The star is the beginning of the current.
- Think about what you learned about energy transfer from the Ocean Currents game.

How does your model show how ocean currents affect the air temperature of Christchurch, New Zealand?

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Complete the two sentences that explain your model in terms of cause and effect.

A cause that is shown in my model is . . .

_____

_____

_____

The effect of that cause is . . .

_____

_____

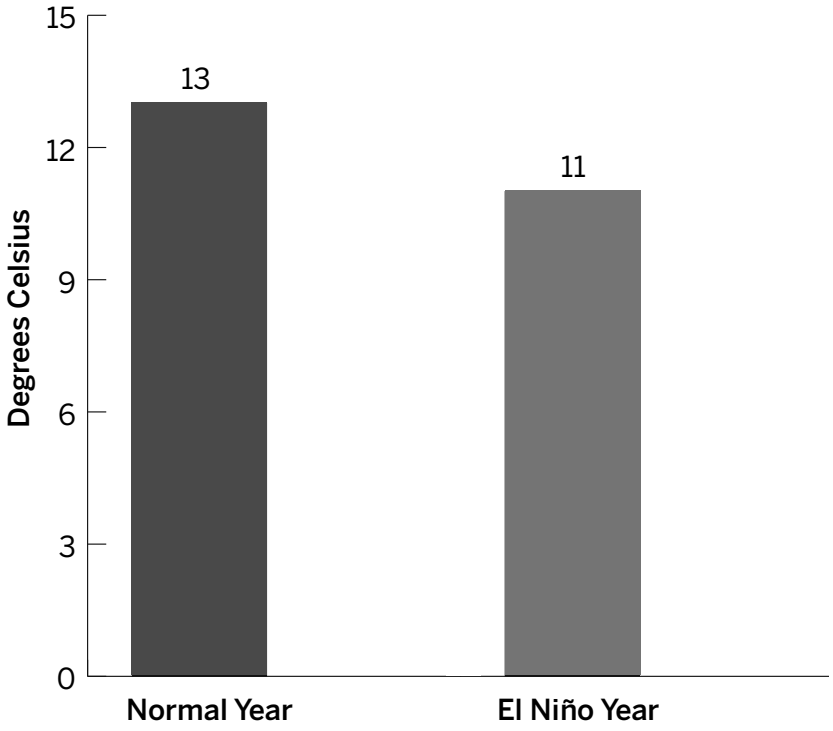
_____

Name: _____ Date: _____

# Considering the El Niño Year

Based on what you have learned, why do you think the ocean surface temperature near Christchurch is cooler during El Niño years?

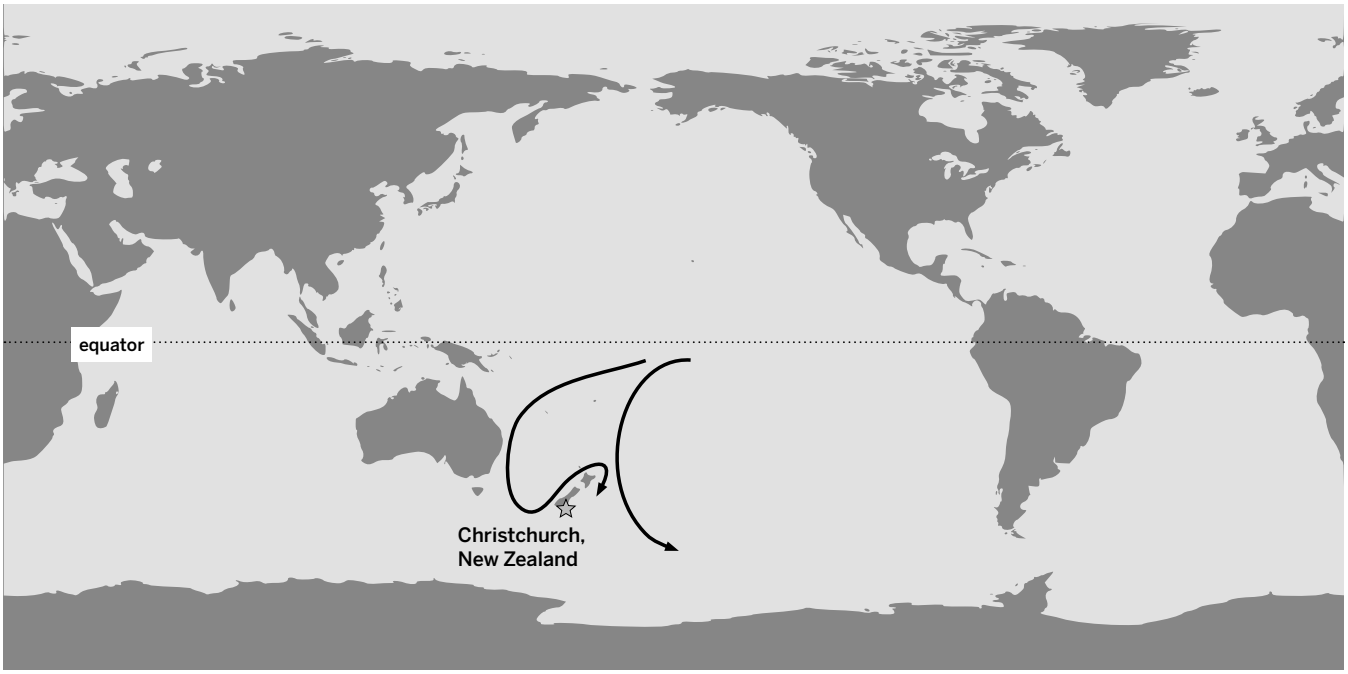
**Average Ocean Surface Temperatures Near Christchurch, New Zealand**



Name: _____ Date: _____

# Homework: Writing a Report to the New Zealand Farm Council

Now that you understand what affects a location's air temperature, you will use the evidence you collected to **(1)** explain what affects Christchurch's air temperature in normal years, and then **(2)** share your ideas about why Christchurch's air temperature might be cooler during El Niño years. Use the words from the Word Bank as you write your responses on the next page.




## Word Bank

| | | | |
|---|---|---|---|
| air | energy | latitude | ocean current |
| surface | temperature | transfer | |

Name: _____ Date: _____

# Homework: Writing a Report to the New Zealand Farm Council
**(continued)**

Explain what determines Christchurch's air temperature during normal years.

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What ideas do you have about why Christchurch's air temperature is cooler during El Niño years?

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Name: _____ Date: _____

# Homework: Reading "How the Ocean Keeps Climates Stable"

You have learned a lot about what determines the temperature of a location. Read and annotate the "How the Ocean Keeps Climates Stable" article, then answer the question below.

Why is the temperature in Seattle more stable than Minneapolis, even though they are at similar latitudes?

_____

_____

_____

_____

_____

_____

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Lesson 2.6: The Climates of Peru

As a student climate scientist, you will use what you have learned so far and apply it to investigating the climate in a region of Peru. You'll read and annotate an article to learn something about your region's climate, and then you'll discuss the annotations with your partner. The Sim will help you investigate your region's climate further. Finally, you'll apply your ideas as you talk to your partner about how your region's air temperature compares to the air temperature of a different region. During these activities, you'll review the concepts you've learned so far and work toward a stronger understanding of what determines a location's air temperature.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 2 Question

- Other than latitude, what else affects the air temperature of Christchurch?

## Key Concepts

- Energy from the sun is transferred to Earth's surface. Some of that energy is then transferred to the air above the surface.
- The closer a location is to the equator, the more energy it receives from the sun. Therefore, a location's air temperature is affected by its distance from the equator.
- An effect may have more than one cause; these may be linked into a chain of causes and effects.
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes, and that water is warmer than the nearby air. When an ocean current comes from a pole, it brings colder-than-expected water to the places it passes, and that water is colder than the nearby air.
- Energy transfers from warmer substances to colder substances. Warmer currents transfer energy to cooler air, and warmer air transfers energy to cooler currents.

## Vocabulary

- cause
- effect
- energy
- latitude
- ocean current
- temperature
- transfer

## Digital Tools

- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Green Group: Warm-Up

Read and annotate the introduction AND "Peru's Warm Rain Forests" from the article set *The Climates of Peru.* You will investigate this region of Peru today. When you are finished, answer the question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

**As I read, I paid attention to my own understanding and recorded my thoughts and questions.**

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Green Group: Investigating Peru's Diverse Climates

## Part 1: Investigating Peru's Rain Forest with Current Map Mode

Launch the *Ocean, Atmosphere, and Climate* Sim, follow the steps, and then answer the questions.

1. Select Current Map mode.
2. For Temperature View, select AIR.
3. Drag a sensor to 7, which represents Peru's rain forest.
4. Observe the Side View for that location.

Using what you learned from your reading in the Warm-Up and what you observed in the Sim, why is the air temperature in the rain forest of Peru so warm?

_____

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With your partner, choose another location in the Sim where you think the air temperature will be the same as or warmer than Sensor 7. Drag a sensor to that new location and test your idea.

Why did you select that particular location?

_____

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Name: _____ Date: _____

# Green Group: Investigating Peru's Diverse Climates (continued)

## Part 2: Modeling Peru's Rain Forests with Surface Test Mode

5. In the Sim, select Surface Test mode from the menu in the upper left-hand corner.
6. Set Solar Output to the level that you think matches the amount of energy from the sun that is transferred to the surface of Peru's rain forest.

Describe how energy gets into the air and what happens to the air temperature.

_____

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_____

_____

_____

_____

What will happen if you decrease Solar Output? The air temperature will _____. (circle one)

**decrease** **increase** **stay the same**

If there is no surface, how will air temperature change when you change Solar Output? The air temperature will _____. (circle one)

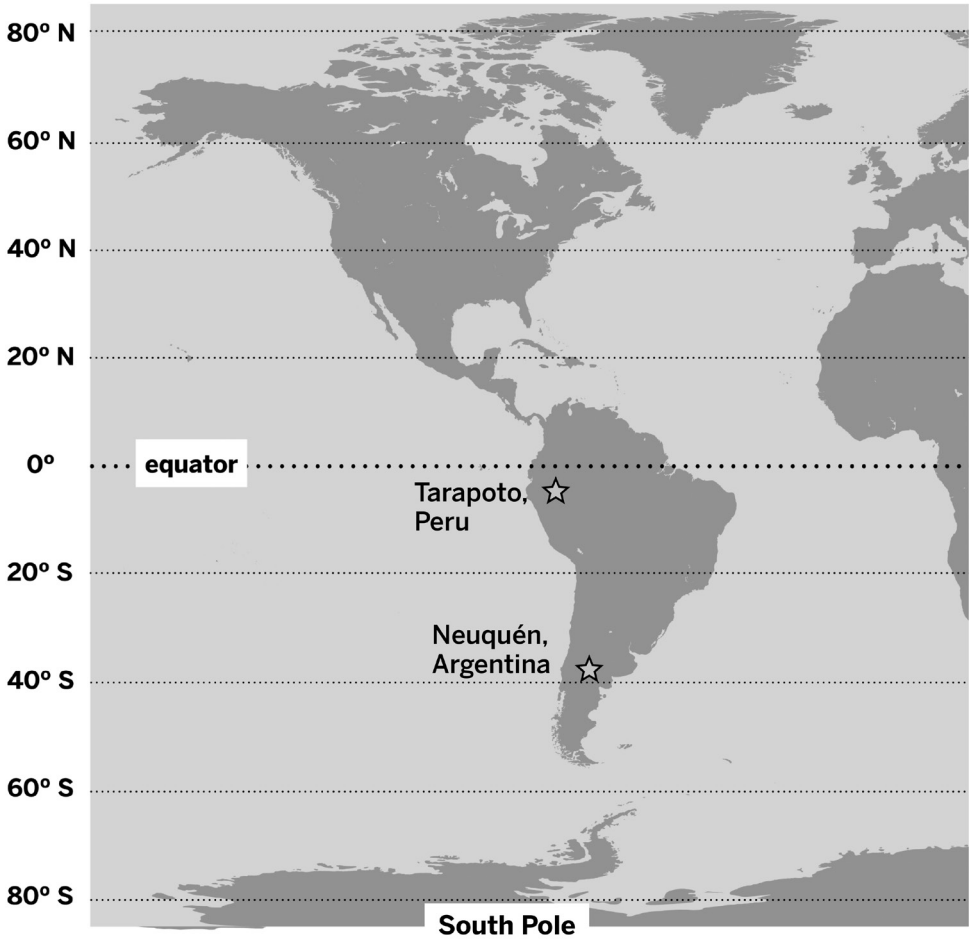
**decrease** **increase** **stay the same**

Name: _____ Date: _____

# Green Group: Investigating Peru's Diverse Climates (continued)

## Part 3: Comparing Air Temperatures in Different Regions

Look at the map and, using the words in the Word Bank below, talk to your partner about this question: *Which location has the warmer air temperature, Tarapoto or Neuquén?*




### Word Bank

| | | |
|---|---|---|
| energy | transfer | equator |

Name: _____ Date: _____

# Purple Group: Warm-Up

Read and annotate the introduction AND "Peru's Cool Coastal Deserts" from the article set *The Climates of Peru.* You will investigate this region of Peru today. When you are finished, answer the question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

**As I read, I paid attention to my own understanding and recorded my thoughts and questions.**

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Purple Group: Investigating Peru's Diverse Climates

## Part 1: Investigating Peru's Coastal Desert and Rain Forest with Current Map Mode

Launch the *Ocean, Atmosphere, and Climate* Sim, follow the steps, and answer the questions.

1. Select Current Map mode.
2. For Temperature View, select AIR.
3. Drag a sensor to 7, which represents Peru's rain forest.
4. Drag another sensor to 6, which represents Peru's coastal desert.
5. Use Side View to observe energy transfer at both locations.

Using what you learned from your reading in the Warm-Up and what you observed in the Sim, why is the air temperature in Peru's coastal desert cooler than in its rain forest?

_____

_____

_____

_____

_____

_____

Predict what would happen to the air temperature at each sensor if the currents stopped.

The air temperature of the coastal desert (Sensor 6) would _____. (circle one)

**get warmer** **get cooler** **stay the same**

The air temperature of the rain forest (Sensor 7) would _____. (circle one)

**get warmer** **get cooler** **stay the same**

Name: _____ Date: _____

## Purple Group: Investigating Peru's Diverse Climates (continued)

Test your predictions by decreasing the speed of the current to 0. Observe the air temperature in both locations.

Explain what happened to the air temperature in these locations. Why?

_____

_____

_____

_____

_____

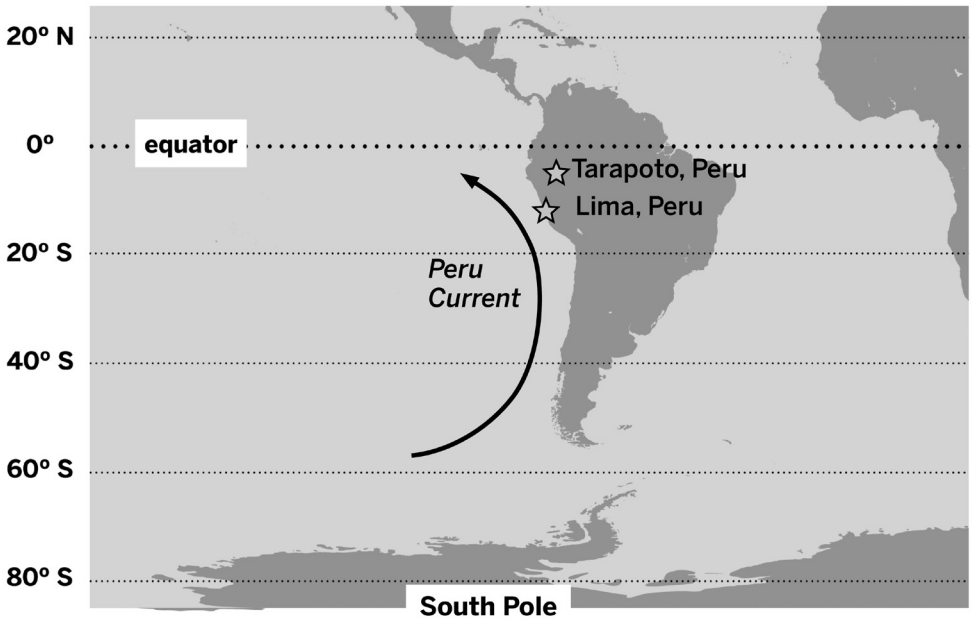
_____

Name: _____ Date: _____

# Purple Group: Investigating Peru's Diverse Climates (continued)

## Part 2: Comparing Air Temperatures in Different Regions

Look at the map and, using the words in the Word Bank below, talk to your partner about this question: *Which location has the warmer air temperature, Tarapoto or Lima?*




### Word Bank

| | | | |
|---|---|---|---|
| energy | equator | ocean current | transfer |

Name: _____ Date: _____

# Blue Group: Warm-Up

Read and annotate the introduction AND "Peru's Bountiful Ocean" from the article set *The Climates of Peru.* You will investigate this region of Peru today. When you are finished, answer the question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

**As I read, I paid attention to my own understanding and recorded my thoughts and questions.**

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Blue Group: Investigating Peru's Diverse Climates

## Part 1: Investigating Upwelling Near Peru with Current Map Mode

Launch the *Ocean, Atmosphere, and Climate* Sim and follow the steps to complete this activity.

1. Select Current Map mode.
2. For Temperature View, select SURFACE.
3. Using what you learned from your reading in the Warm-Up, find two places that have upwelling.
4. Drag sensors to those two locations.
5. Use Side View to observe what is happening with temperature and energy transfer at these locations.

What evidence in the Sim's map let you know that you were selecting areas of upwelling?

_____

_____

_____

_____

_____

_____

What evidence in Side View lets you know that upwelling is happening in these locations?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

## Blue Group: Investigating Peru's Diverse Climates (continued)

Using evidence from your reading during the Warm-Up and the Sim activity, explain how upwelling affects the air temperature of nearby locations.

_____

_____

_____

_____

_____

_____

What would happen to the air temperature of a nearby region if upwelling stopped?

The air temperature would _____. (circle one)

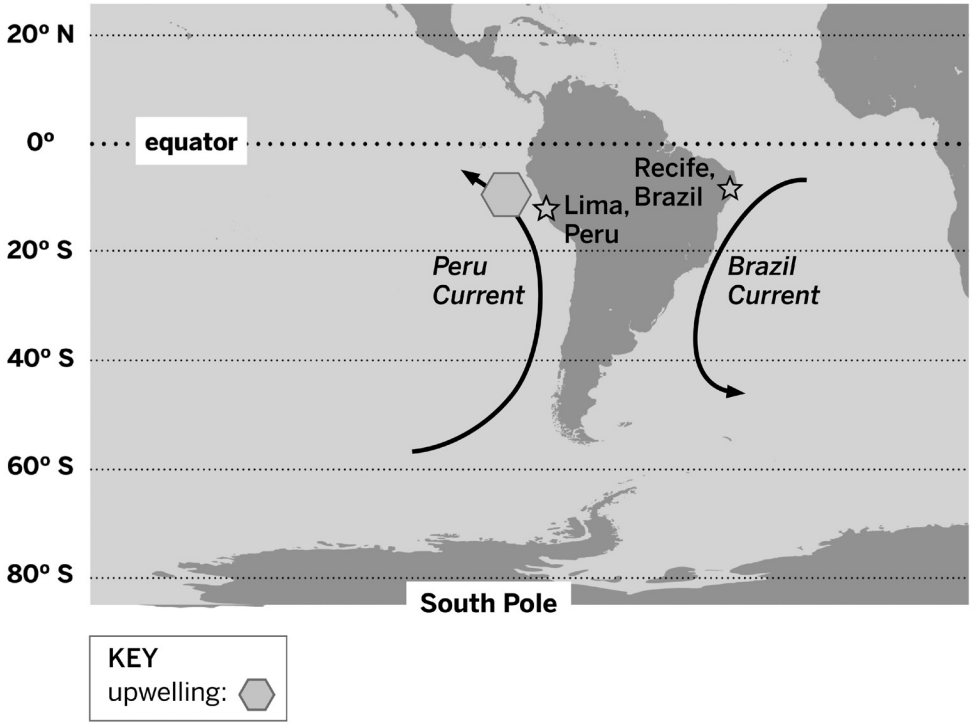
**get warmer** **get cooler** **stay the same**

Name: _____ Date: _____

# Blue Group: Investigating Peru's Diverse Climates (continued)

## Part 2: Comparing Air Temperatures in Different Regions

Look at the map and, using the words in the Word Bank below, talk to your partner about this question: *Which location has the warmer air temperature, Recife or Lima?*




## Word Bank

| | | | | |
|---|---|---|---|---|
| energy | equator | ocean current | transfer | upwelling |

Name: _____ Date: _____

# Homework: Check Your Understanding

Scientists investigate in order to figure things out. Are you getting closer to figuring out why the air temperature in Christchurch is cooler in El Niño years?

1. I understand how energy is transferred to the air of Christchurch, New Zealand. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

2. I understand what happens to the amount of energy in the air of Christchurch in El Niño years. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

3. I understand how Christchurch's distance from the equator affects its air temperature. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

Name: _____ Date: _____

## Homework: Check Your Understanding (continued)

4. I understand why the ocean near Christchurch is a different temperature than we'd expect for its latitude (distance from the equator). (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

5. I understand why the ocean temperature near Christchurch changes in El Niño years and how it affects the air temperature there. (check one)

   ☐ yes

   ☐ not yet

_____

_____

_____

6. What do you still wonder about El Niño and air temperature?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Chapter 3: Ocean Currents and Prevailing Winds
## Chapter Overview

In Chapter 3, you will learn what determines how ocean currents move. By reading about the Gulf Stream and simulating a current in a hands-on tank activity, you and your team of climate scientists will gather information to prepare a report for the New Zealand Farm Council.

Name: _____ Date: _____

# Lesson 3.1: "The Gulf Stream"

So far you have learned about two things that affect Christchurch, New Zealand's air temperature: its latitude and the ocean current that passes its shore. You also know that this ocean current comes from the equator, the location that receives the most energy from the sun. But what determines how ocean currents move? You will begin to investigate this question today. Kiri Parata, the director of the New Zealand Farm Council, has sent an article to help you learn more.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 3 Question

- What determines how the ocean currents near Christchurch move?

## Vocabulary

- cause
- effect
- energy
- latitude
- ocean current
- prevailing wind
- transfer
- temperature

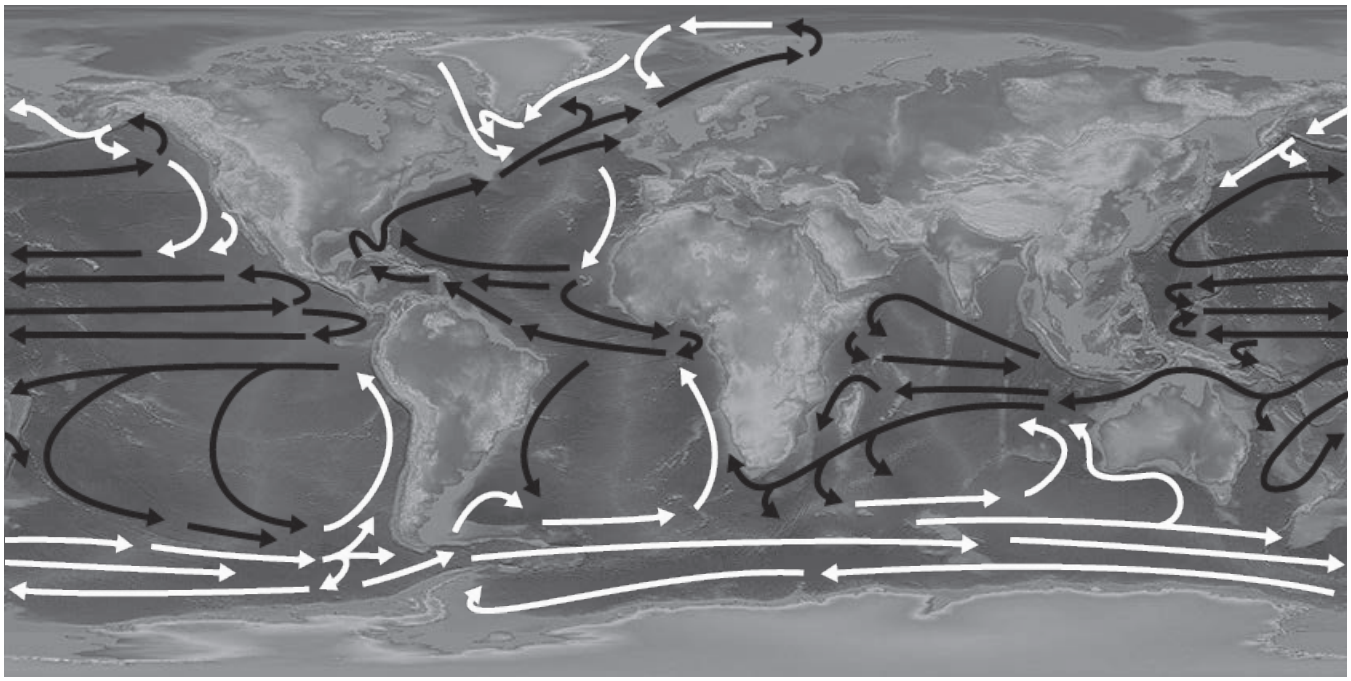
## Digital Tools

- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Warm-Up

## Major Ocean Currents



KEY
warm current: →
cool current: →

The map shows the movement pattern for major ocean currents. What ideas do you have about what might make ocean currents move?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Reading "The Gulf Stream: A Current That Helped Win a War"

1. Read and annotate the article "The Gulf Stream: A Current That Helped Win a War."
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection question below.

Rate how successful you were at using Active Reading skills by responding to the following statement:

**As I read, I paid attention to my own understanding and recorded my thoughts and questions.**

- ☐ Never
- ☐ Almost never
- ☐ Sometimes
- ☐ Frequently/often
- ☐ All the time

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Homework: Sim Mission

## Sim Mission: Winds and Warm Currents

You read about a warm current called the Gulf Stream. Investigate a warm current in the Sim, and then answer the questions.

Launch the *Ocean, Atmosphere, and Climate* Sim, select Wind Map mode, and find a warm current (coming from the equator).

1. Focus on the current you selected. Observe the direction of the wind and the direction of the warm current.
   - How do prevailing winds affect the direction of ocean currents?

_____

_____

_____

_____

_____

_____

2. Set the speed of the wind to HIGH, then MEDIUM, and finally LOW. Observe what happens to the current.
   - How does the speed of prevailing winds affect ocean currents?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Lesson 3.2: What Determines the Direction of Ocean Currents?

In the previous lesson, you learned that prevailing winds are strong enough to push ocean currents. Based on what you know so far, do you think prevailing winds push ocean currents in the same direction all over the ocean? Or is it possible for prevailing winds and ocean currents to move in different directions? Today you will return to the Gulf Stream and conduct a hands-on investigation to learn more about what determines how ocean currents move.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 3 Question

- What determines how the ocean currents near Christchurch move?

## Vocabulary

- cause
- effect
- energy
- latitude
- ocean current
- prevailing wind

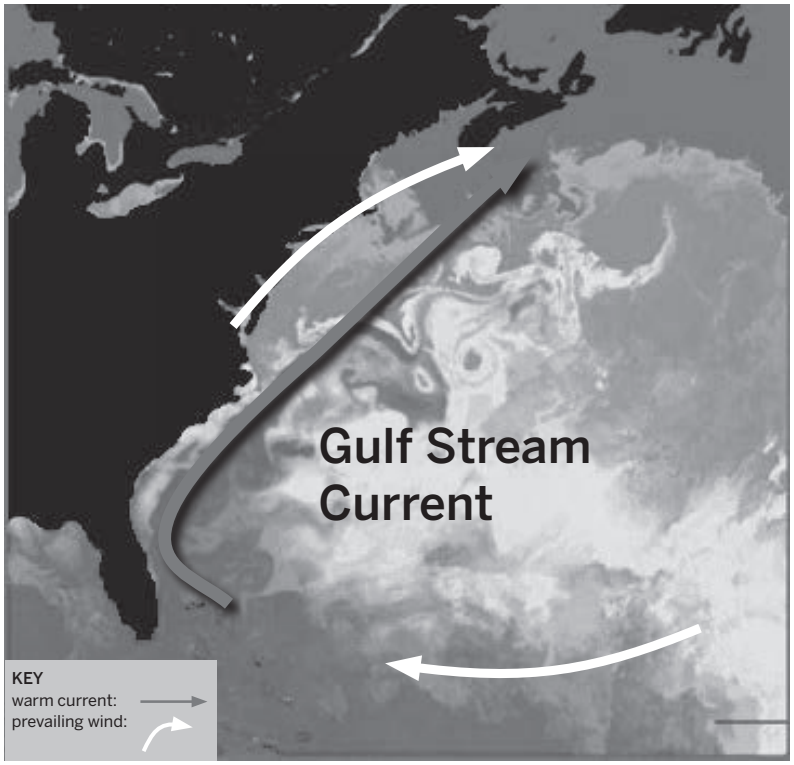
## Digital Tools

- *Ocean, Atmosphere, and Climate* Modeling Tool activity: 3.2 Homework

Name: _____ Date: _____

# Warm-Up

You are about to watch a video animation of this current, the Gulf Stream.




What ideas do you have about what determines how currents like this move?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Rereading "The Gulf Stream: A Current That Helped Win a War"

Reread paragraphs 4 and 5 from the article (beginning with "The Gulf Stream flows from south to north") and highlight evidence that helps you answer the Investigation Question: *What determines how ocean currents move?*

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Investigating with the Currents Tank

**Safety Note: Blowing Through Straws**
When blowing through straws, be careful to avoid hyperventilation. If any students feel dizzy or lightheaded, they should stop blowing and sit down.

To prepare, listen to your teacher's description and complete the sentences below. When you receive your materials, follow the instructions on the next page and conduct the investigation with your group.

*What determines how ocean currents move?*

Describe what each component of the Currents Tank Investigation represents. Use the Word Bank below, if needed.

In the Currents Tank Investigation, . . .

the water represents _____

the sides of the tank represent _____

blowing through the straw represents _____

the moving pepper helps illustrate the movement of _____

**Word Bank**

| | | | |
|---|---|---|---|
| continents | currents | prevailing winds | the ocean |

Name: _____ Date: _____

# Investigating with the Currents Tank (continued)

## Currents Tank Investigation

1. Discuss and record your predictions.
   - Read each mission description carefully.
   - Talk to your group about the direction you plan to direct the wind in order to complete the mission.
   - Make a prediction drawing for each mission: draw one arrow to show how you will direct the wind and another arrow to show how you think the current will move (see example in Mission 1).

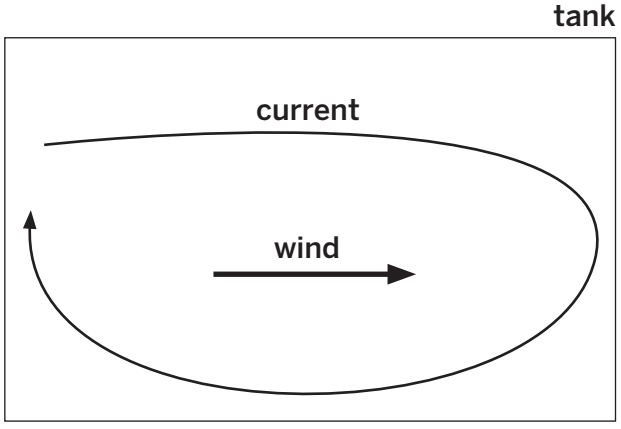
2. Collect materials. (one group member)
   - 1 tank with about 1 inch of water
   - 4 straws, one for each person
     **Do not share the straws!**

3. Complete the missions, one at a time.
   - Blow wind through your straw at an angle to the surface of the water. Blow in only one direction. Do not blow air directly into the water.
   - Have only one person blowing at a time. Take turns, so no one gets dizzy.

4. Record your results after each mission by describing what you observed.

**Mission 1:** Find a way to make the current move in one direction, like a gyre.

**Predictions:**




**Results: Were you able to complete this mission?**

☐ yes ☐ no

If yes, describe how. If no, why not?

_____

_____

_____

_____

_____

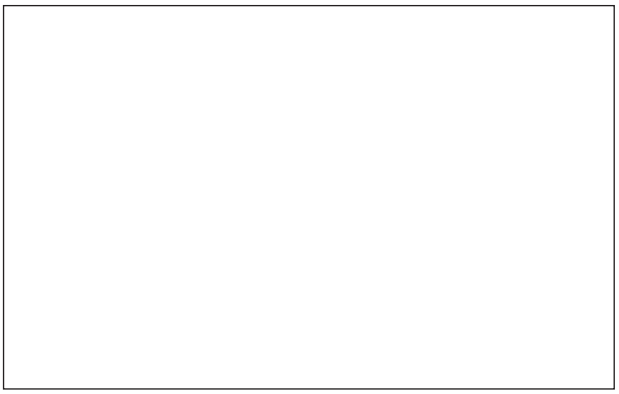
Name: _____ Date: _____

# Investigating with the Currents Tank (continued)

**Mission 2:** Find a way to make the current move in a direction that is different from Mission 1.

**Predictions:**

**tank**



**Results: Were you able to complete this mission?**

☐ yes ☐ no

If yes, describe how. If no, why not?

_____

_____

_____

_____

_____

**Mission 3:** Find a way to make the current move faster than it moved in previous missions.

**Predictions:**

**tank**

**Results: Were you able to complete this mission?**

☐ yes ☐ no

If yes, describe how. If no, why not?

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Investigating with the Currents Tank (continued)

1. Discuss the evidence you gathered from the Gulf Stream article and the Currents Tank Investigation about what determines how ocean currents move.
2. Choose the claim that best answers this question: *How do prevailing winds affect ocean currents?*

Prevailing winds cause ocean currents to move in the same direction as the winds . . . (circle one)

**Claim 1:** in all places in the ocean.

**Claim 2:** in some places in the ocean.

**Claim 3:** nowhere in the ocean.

Describe evidence from the Gulf Stream article and the Currents Tank Investigation that supports the claim you chose.

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Homework: Using the Modeling Tool to Show How Currents Move

Launch the *Ocean, Atmosphere, and Climate* Modeling Tool activity: 3.2 Homework.
Answer the question below when your model is complete.

**Goal:** Show what determines the direction of ocean currents.

**Do:**

- Note the direction of prevailing winds.
- Model some currents that would be affected by the winds and the continents. Show where the currents begin.
- Complete the information about your currents with Energy Transfer arrows.
- Add thermometers that show water and air temperature.

**Tips:**

- Drag currents from the bottom of the map. Place them, then adjust the path. The star is the current beginning.
- Model as many currents as you like.

Explain how your model shows what determines the direction of ocean currents.

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Homework: Reading About Prevailing Winds

Read the description of the two articles below. Then, choose one article to read and annotate. Answer the questions below.

"What Causes Prevailing Winds?"

There's always wind blowing somewhere, whether it's a powerful prevailing wind or a light local breeze. All winds are caused by changes in temperature—warm air rising and cooler air rushing in below to fill in empty space.

"The Coriolis Effect"

For thousands of years, sailors have used prevailing winds blowing in predictable patterns to help them cross the ocean. The path of the prevailing winds is consistent because it's caused in part by something that doesn't change: the spinning of Earth. The resulting Coriolis Effect causes the "bending" of the straight path of air flowing near the equator due to Earth's rotation. The Coriolis Effect shapes the winds that cross Earth's oceans, helps the currents form gyres, and determines the direction that ocean storms rotate.

What are prevailing winds?

_____

_____

In the article you read, what affects the patterns of prevailing winds, and how does it do so?

_____

_____

_____

**Active Reading Guidelines**

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Lesson 3.3: Christchurch: Air Temperature in Normal Years

You are close to completing your investigation into why Christchurch's air temperature is cooler than usual during El Niño years. Today, you will use the Modeling Tool to show what determines Christchurch's temperature during a normal year. Next, you will use the Sim to investigate how changes to prevailing winds can affect the air temperature of a location. This will help you to solve the mystery of the changes in Christchurch's air temperature during El Niño years.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 3 Question

- What determines how the ocean currents near Christchurch move?

## Key Concepts

- Prevailing winds and the position of continents determine the direction of ocean currents.

## Vocabulary

- energy
- latitude
- ocean current
- prevailing wind
- temperature
- transfer

## Digital Tools

- *Ocean, Atmosphere, and Climate* Modeling Tool activity: 3.3 Christchurch Model
- *Ocean, Atmosphere, and Climate* Simulation

Name: _____ Date: _____

# Warm-Up

What affects ocean currents? You may circle more than one answer. **Note:** If you have a device, you can look back at your model in the *Ocean, Atmosphere, and Climate* Modeling Tool activity: 3.2 Homework.

| | |
|---|---|
| **prevailing winds** | **rivers** |
| **continents** | **the Moon** |

Explain your choice.

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Modeling Ocean Currents Near Christchurch

## Modeling the Air Temperature in Christchurch

Launch the *Ocean, Atmosphere, and Climate* Modeling Tool activity: 3.3 Christchurch Model. When your model is complete, answer the question below.

**Goal:** Create a model to explain Christchurch's air temperature during a normal year.

**Do:**

- Model how prevailing winds affect the direction of the current.
- Complete the information about Christchurch with Energy Transfer arrows.
- Add thermometers to show surface and air temperatures.

**Tips:**

- Place as many wind lines as you need in your model.

How does your model explain what determines Christchurch's air temperature during a normal year?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Investigating the Effect of Changing Winds

## What Happens When Prevailing Winds Change?

Use the Sim to learn more about how changes to the prevailing winds can affect the amount of energy in the air.

Launch the *Ocean, Atmosphere, and Climate* Sim, go to Wind Map mode, and select SURFACE for Temperature View. Press PLAY to observe the currents, and then read about the two missions:

**Mission 1:** Find a location that has a **warm ocean current** passing by. Make a change to the wind so the air temperature of the location becomes **cooler.**

**Mission 2:** Find a location that has a **cold ocean current** passing by. Make a change to the wind so the air temperature of the location becomes **warmer.**

## Mission Planning

Each partner will make a plan to complete one of the missions. Tell your partner about the Sim mission you plan to complete:

- Where will you place your sensor?
- What changes will you make to the wind?

I will complete **(Mission 1** / **Mission 2)**. (circle one)

Name: _____ Date: _____

# Investigating the Effect of Changing Winds (continued)

Once you have a plan, complete the mission you agreed on. Follow these steps, record your data, and finally, answer the questions on the next page about your results.

1. Place your sensor on the location you selected. Press PLAY if you paused the Sim.
2. Wait for the air temperature to stabilize.
3. Record the Initial Air Temperature.
4. Make a change to the wind.
5. Wait for the air temperature to stabilize again.
6. Record the Changed Air Temperature.
7. Share your results with your partner.
8. If your mission was not successful, make a new plan and try again.
9. Answer the questions on the next page.

| **Location (latitude/longitude)** | **Initial air temperature (°C) (after it's stable)** | **Changed air temperature (°C)** | **What changes did you make in order to complete this mission?** |
|---|---|---|---|
| | | | |

Name: _____ Date: _____

## Investigating the Effect of Changing Winds (continued)

What change did you finally make that changed the air temperature of your location?

_____

_____

_____

_____

_____

_____

State which mission you completed, and then answer this question:

Why did changing the wind affect the air temperature?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Homework: Reading "Deep Ocean Currents: Driven by Density"

You have learned a lot about how wind and energy affect ocean currents. To learn more about ocean currents, read and annotate the article "Deep Ocean Currents: Driven by Density." Then, answer the questions below.

What causes the movement of deep ocean currents?

_____

_____

_____

_____

_____

_____

How does water sink to the bottom of the ocean and then rise to the surface again?

_____

_____

_____

_____

_____

_____

**Active Reading Guidelines**

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

Name: _____ Date: _____

# Lesson 3.4: Explaining the Change in Air Temperature in Christchurch

Congratulations, student climate scientists! You figured out what determines Christchurch's air temperature during a normal year. Now you are ready to help the New Zealand Farm Council understand why Christchurch's air temperature is cooler than normal during El Niño years. First, you will participate in the Write and Share Routine to think about how changes to prevailing winds can affect the air temperature of a location. Then, you will review evidence about Christchurch and use the Reasoning Tool to prepare a written argument. For homework, you will write to the New Zealand Farm Council and explain why Christchurch's air temperature is cooler than normal during El Ninõ years.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 3 Question

- What determines how the ocean currents near Christchurch move?

## Key Concepts

- Prevailing winds and the position of continents determine the direction of ocean currents.
- Changes to prevailing winds affect ocean currents. Changes to ocean currents affect how much energy is brought to (or taken away from) a location.

## Vocabulary

- climate
- energy
- temperature
- transfer

Name: _____ Date: _____

# Warm-Up

You are trying to determine why Christchurch's air temperature is cooler than usual during El Niño years. Review the evidence card, and then answer the question.

**Evidence Card C: Wind Changes During El Niño Years**

During El Niño years, the normal prevailing winds are disrupted. It is possible for them to slow down or reverse.

What ideas do you have about how changes to prevailing winds could result in Christchurch's cooler air temperature?

_____

_____

_____

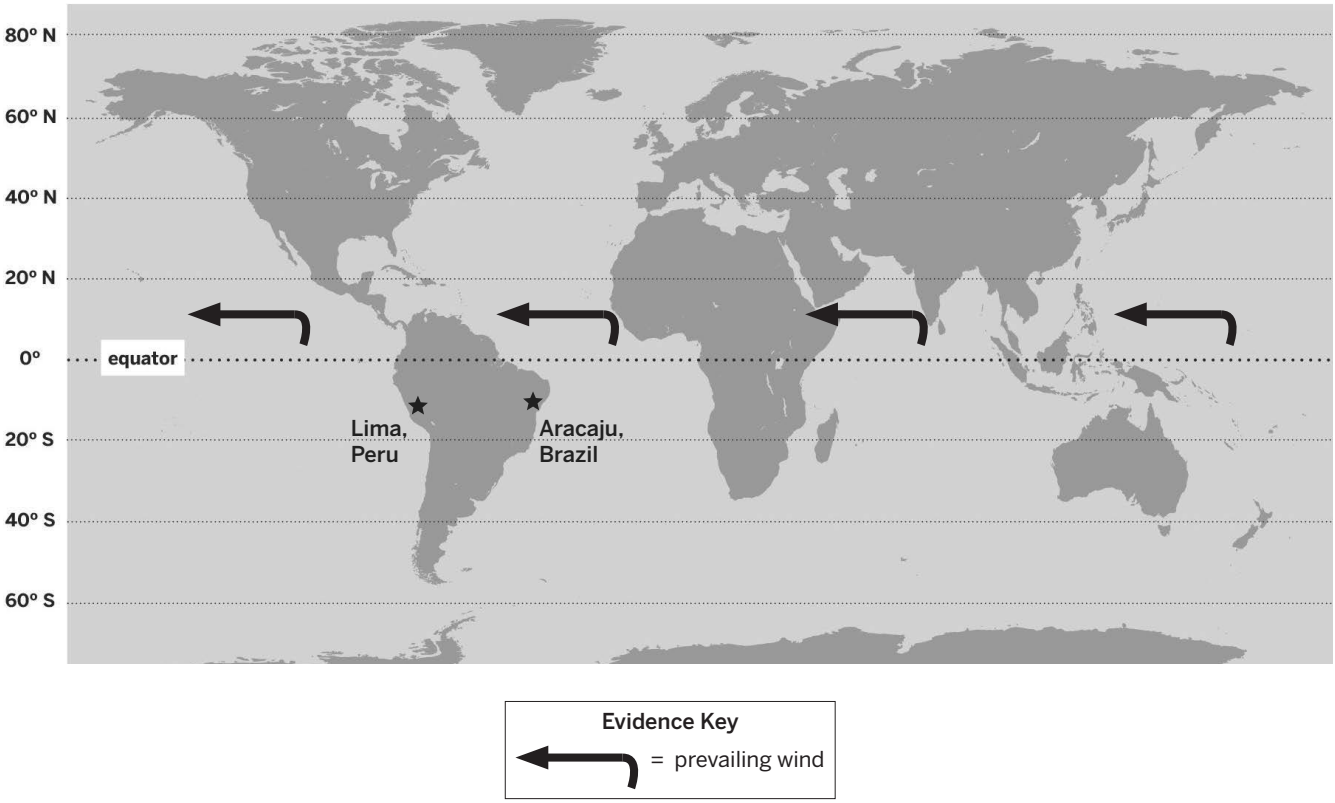
_____

_____

_____

Name: _____ Date: _____

# Write and Share Routine: Student 1




**Prompt:** The average air temperature in Aracaju, Brazil, is warmer than Lima, Peru.
*How do the map and the evidence help explain the temperature difference?*

1. Draw the direction of the ocean currents near Lima and Aracaju.
2. Add any annotation to the map that might help you respond to the prompt.
3. Explain how the evidence shows why Aracaju is warmer than Lima. Use all these words in your written explanation: *ocean current, temperature, prevailing winds, energy.*

_____

_____

_____

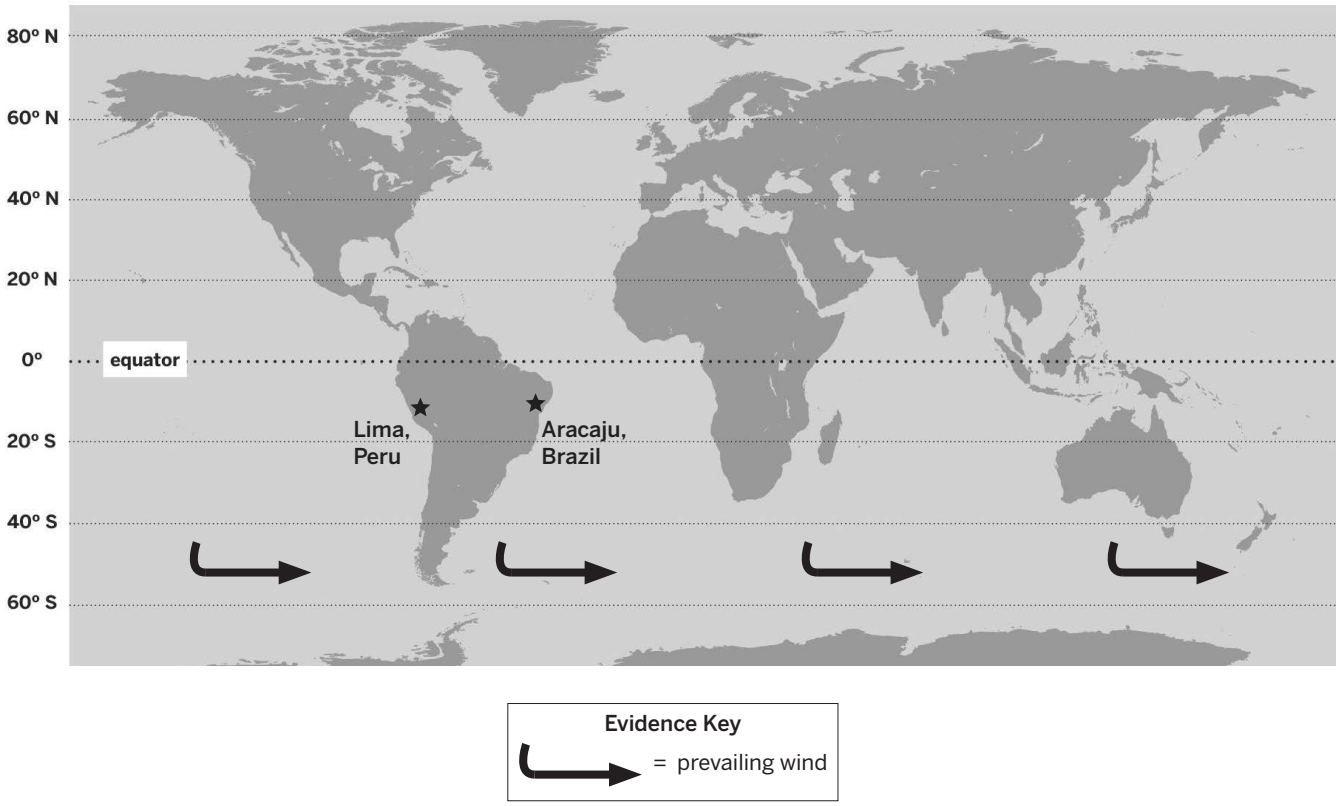
_____

_____

_____

Name: _____ Date: _____

# Write and Share Routine: Student 2

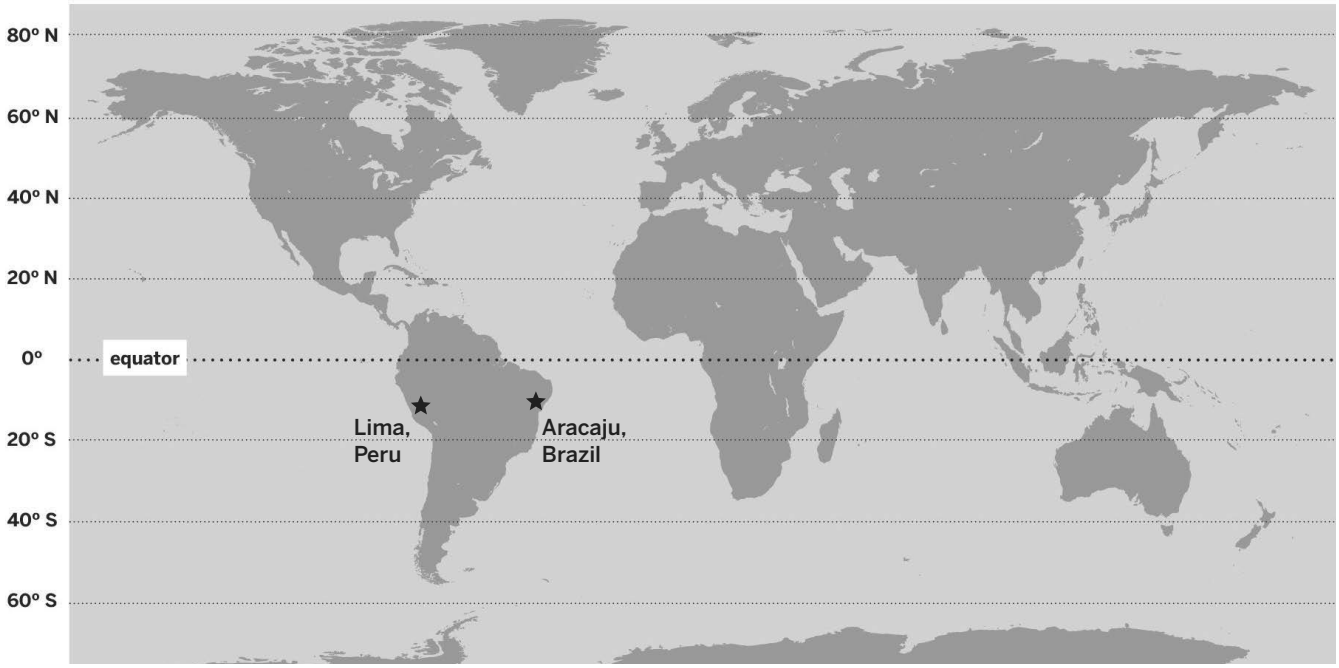



**Prompt:** The average air temperature in Aracaju, Brazil, is warmer than Lima, Peru.
*How do the map and the evidence help explain the temperature difference?*

1. Draw the direction of the ocean currents near Lima and Aracaju.
2. Add any annotation to the map that might help you respond to the prompt.
3. Explain how the evidence shows why Aracaju is warmer than Lima. Use all these words in your written explanation: *ocean current, temperature, prevailing winds, energy.*

Name: _____ Date: _____

# Write and Share Routine: Student 3




**Evidence:** Without prevailing winds, both locations would have the same average air temperature.

**Prompt:** The average air temperature in Aracaju, Brazil, is warmer than Lima, Peru.
*How do the map and the evidence help explain the temperature difference?*

1. Draw the direction of the ocean currents near Lima and Aracaju.
2. Add any annotation to the map that might help you respond to the prompt.
3. Explain how the evidence shows why Aracaju is warmer than Lima. Use all these words in your written explanation: *ocean current, temperature, prevailing winds, energy.*

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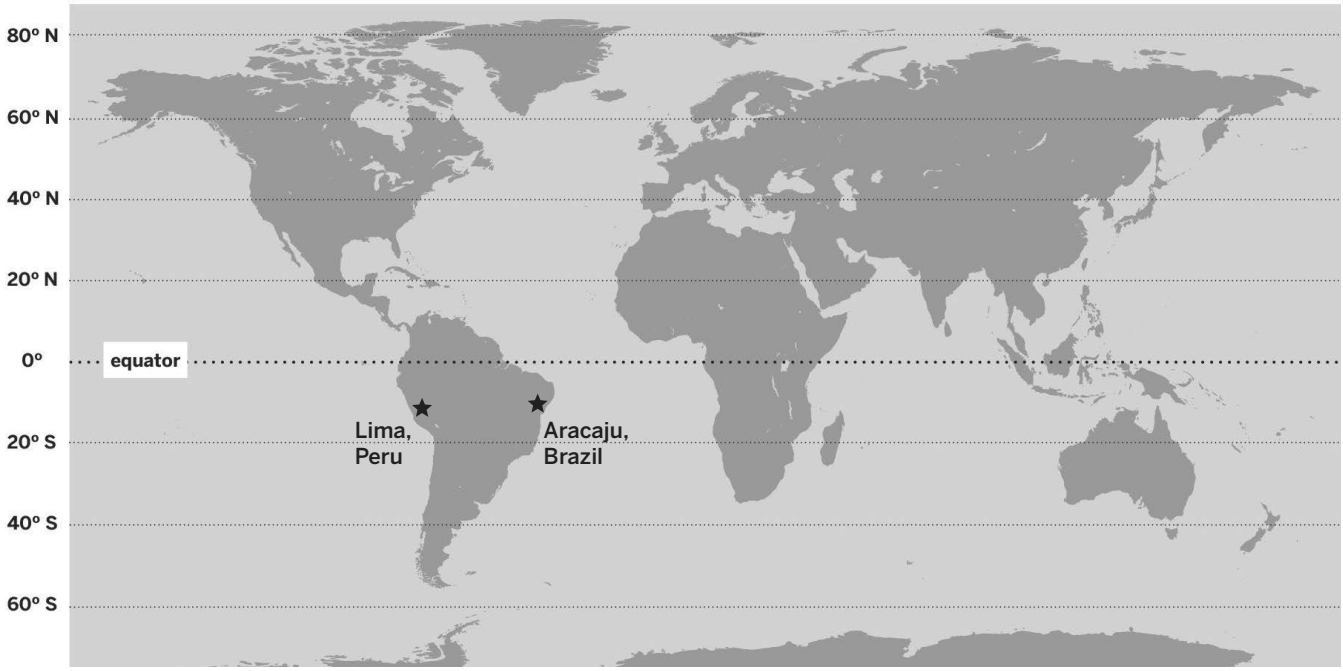
Name: _____ Date: _____

# Write and Share Routine: Student 4




**Evidence:** If the prevailing winds reversed direction, Lima would be warmer than Aracaju.

**Prompt:** The average air temperature in Aracaju, Brazil, is warmer than Lima, Peru.
*How do the map and the evidence help explain the temperature difference?*

1. Draw the direction of the ocean currents near Lima and Aracaju.
2. Add any annotation to the map that might help you respond to the prompt.
3. Explain how the evidence shows why Aracaju is warmer than Lima. Use all these words in your written explanation: *ocean current, temperature, prevailing winds, energy.*

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Name: _____ Date: _____

# The Reasoning Tool

**Question:** *During El Niño years, why is Christchurch, New Zealand's air temperature cooler than usual?*

1. In the right-hand column, write the claim that is best supported by the evidence. You may write the same claim in each cell of that column.
2. In the middle column, explain why your evidence matters or how it supports the claim.

| **Evidence** | **This matters because . . .** (How does this evidence support the claim?) | **Therefore, . . .** (claim) |
|---|---|---|
| **Evidence Card A:** ocean surface temperature is cooler during El Niño years | | |
| **Evidence Card B:** prevailing winds and positions of islands cause warm ocean currents to pass Christchurch in normal years | | |
| **Evidence Card C:** normal prevailing winds slow down or reverse in El Niño years | | |
| **Evidence from the Sim:** when prevailing winds reverse or slow, ocean currents also change | | |

Name: _____ Date: _____

# Homework: Writing a Scientific Argument

During El Niño years, why is Christchurch, New Zealand's air temperature cooler than usual?

Name: _____ Date: _____

# Homework: Writing a Scientific Argument (continued)

Name: _____ Date: _____

# Homework: Check Your Understanding

Scientists investigate in order to figure things out. Are you getting closer to figuring out why the air temperature in Christchurch is cooler in El Niño years?

1. I understand how energy is transferred to the air of Christchurch, New Zealand. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

2. I understand what happens to the amount of energy in the air of Christchurch in El Niño years. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

3. I understand how Christchurch's distance from the equator affects its air temperature. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

Name: _____ Date: _____

## Homework: Check Your Understanding (continued)

4. I understand why the ocean near Christchurch is a different temperature than we'd expect for its latitude (distance from the equator). (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

5. I understand why the ocean temperature near Christchurch changes in El Niño years and how it affects the air temperature there. (check one)

   ☐ yes

   ☐ not yet

_____

_____

_____

6. What do you still wonder about El Niño and air temperature?

_____

_____

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Name: _____ Date: _____

# Chapter 4: Science Seminar
# Chapter Overview

Are you ready to go back in time? We're not just talking way back, but way, way, way back! In the last chapter of this unit, you will use what you've learned about ocean currents and air temperature to engage in scientific argumentation about an ongoing debate in the field of climatology. This seminar will focus on a time period known as the late Carboniferous, which happened about 300 million years ago!

Name: _____ Date: _____

# Lesson 4.1: Comparing Air Temperature: Past and Present

Congratulations on working out why Christchurch's air temperature is cooler during El Niño years! You have helped Dr. Parata and the farmers understand El Niño so they can prepare for future El Niño events. Because of your great work with the New Zealand Farm Council, a paleontologist named Dr. Xi Yang has reached out to you for help with a new question about South China during the late Carboniferous period—about 300 million years ago! By analyzing evidence, you will make an argument to support a claim about the climate of South China during that time.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 4 Question

- In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?

## Key Concepts

- Energy from the sun is transferred to Earth's surface. Some of that energy is then transferred to the air above the surface.
- The closer a location is to the equator, the more energy it receives from the sun. Therefore, a location's air temperature is affected by its distance from the equator.
- An effect may have more than one cause; these may be linked into a chain of causes and effects.
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes, and that water is warmer than the nearby air. When an ocean current comes from a pole, it brings colder-than-expected water to the places it passes, and that water is colder than the nearby air.
- Energy transfers from warmer substances to colder substances. Warmer currents transfer energy to cooler air, and warmer air transfers energy to cooler currents.
- Prevailing winds and the position of continents determine the direction of ocean currents.
- Changes to prevailing winds affect ocean currents. Changes to ocean currents affect how much energy is brought to (or taken away from) a location.

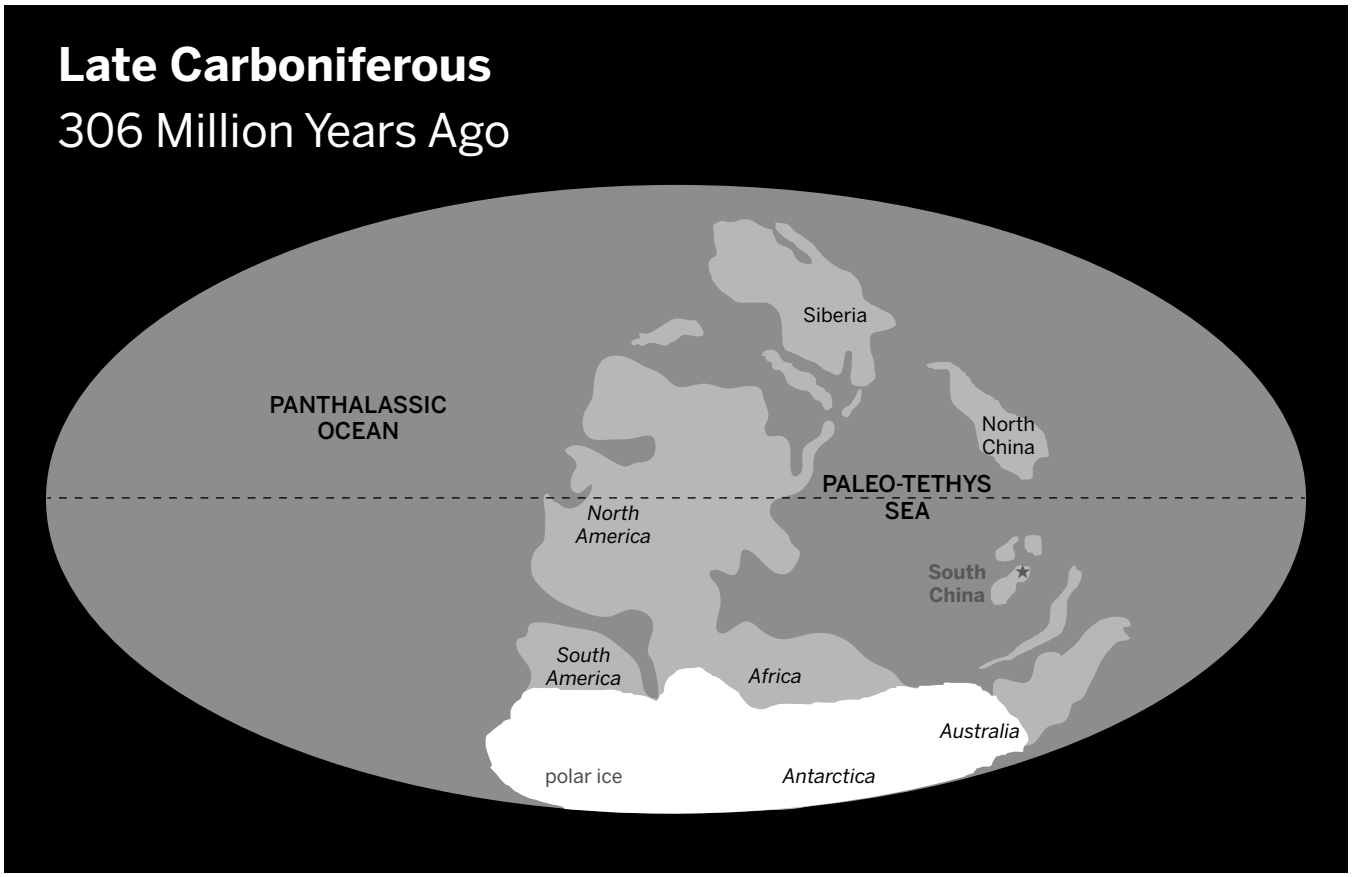
## Vocabulary

- cause
- claim
- effect
- energy
- evidence
- ocean current
- prevailing wind
- temperature
- transfer

Name: _____ Date: _____

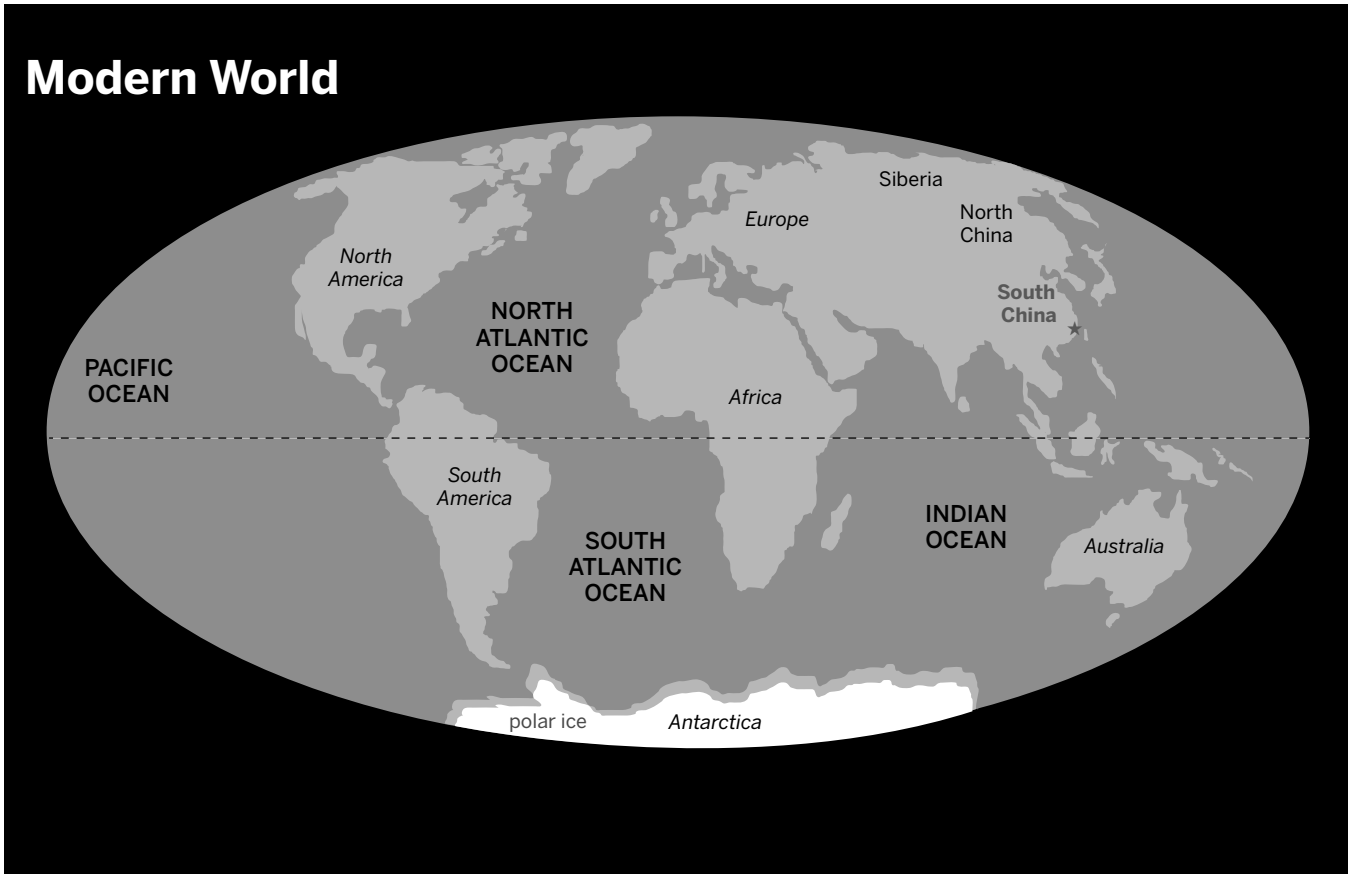
# Warm-Up

Over time, the continents on Earth are moving and changing their positions VERY slowly. This means that millions of years ago the continents were in different locations than they are today. Look closely at the two maps: observe where the region called South China was located 306 million years ago, and compare that to where it is located today. After you've made your observations, answer the question.



Name: _____ Date: _____

## Warm-Up (continued)




Do you think the changing position of South China has affected its air temperature? Why or why not?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Introducing the Science Seminar

**Xi Yang**
To: Student Climatologists
Re: Temperature—Late Carboniferous vs. Present Day

廣西

I am a paleontologist at the South China Institute of Paleontology in Guangxi, China (廣西). I study the late Carboniferous period, which occurred about 300 million years ago. During that time, Earth's continents were in different positions.

We would like your help with analyzing some evidence. We're trying to determine if South China's air temperature during the late Carboniferous period was the same or different (warmer or cooler) than the air temperature in South China today.

I look forward to hearing from you.

**Dr. Xi Yang, Paleoclimatology Department**
**South China Institute of Paleontology**

Name: _____ Date: _____

# Annotating and Discussing Evidence

**Science Seminar Question:** *In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?*

## Individual Work

1. Read each evidence card carefully.
2. Annotate the cards, using these questions as you think about the information on each:
   - What questions do you have about the evidence?
   - How is the evidence connected to what you have been learning about the factors that affect air temperature?
   - How could the evidence help you make an explanation that answers the Science Seminar Question?

## Partner Discussion

1. Talk about your questions about the evidence on the cards; see if you can help each other answer them.
2. Looking at the cards, are there any two pieces of evidence that could work together? How are those two cards connected?

Name: _____ Date: _____

# Sorting the Evidence Cards

## Sorting Evidence Cards by Claim

1. With a partner, discuss whether each piece of evidence supports or goes against a claim. Use the sentence starters to help you talk with your partner.
2. Make annotations on each card:
   - If the evidence supports a claim, write SUPPORTS CLAIM ___ on that card.
   - If the evidence goes against a claim, write GOES AGAINST CLAIM ___ on that card.
   - If the evidence connects with another evidence card, write CONNECTS WITH EVIDENCE CARD ___ on that card.
3. Sort the evidence by placing the cards underneath the claim they support.

## Sentence Starters

I think this piece of information supports this claim because . . .

I don't think this piece of information supports this claim because . . .

I agree because . . .

I disagree because . . .

Why do you think that?

Name: _____ Date: _____

# Lesson 4.2: Science Seminar

In the previous lesson, you analyzed evidence to help you investigate the Chapter 4 Question: *In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?* In today's Science Seminar, you and your classmates will discuss the evidence and work together to arrive at the best answer to this question. By the end of the lesson, you will be ready to write a convincing scientific argument about whether South China's air temperature was warmer, cooler, or the same as it is now.

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 4 Question

- In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?

## Key Concepts

- Energy from the sun is transferred to Earth's surface. Some of that energy is then transferred to the air above the surface.
- The closer a location is to the equator, the more energy it receives from the sun. Therefore, a location's air temperature is affected by its distance from the equator.
- An effect may have more than one cause; these may be linked into a chain of causes and effects.
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes, and that water is warmer than the nearby air. When an ocean current comes from a pole, it brings colder-than-expected water to the places it passes, and that water is colder than the nearby air.
- Energy transfers from warmer substances to colder substances. Warmer currents transfer energy to cooler air, and warmer air transfers energy to cooler currents.
- Prevailing winds and the position of continents determine the direction of ocean currents.
- Changes to prevailing winds affect ocean currents. Changes to ocean currents affect how much energy is brought to (or taken away from) a location.

## Vocabulary

- cause
- claim
- effect
- evidence
- latitude
- ocean current
- prevailing wind
- temperature
- transfer

Name: _____ Date: _____

# Warm-Up

Look back at the evidence cards in your envelope and review the annotations. Use the evidence cards to answer the questions.

*In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?*

Which claim do you think is most convincing? (check one)

- ☐ **Claim 1:** It was warmer than it is today.
- ☐ **Claim 2:** It was cooler than it is today.
- ☐ **Claim 3:** No difference—the air temperature was the same as it is today.

1. Draw a star on the evidence card that best supports the claim you selected.
2. Why did you choose this piece of evidence?

_____

_____

_____

_____

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_____

Name: _____ Date: _____

# Preparing for the Science Seminar

## Preparing Your Science Seminar Argument

1. Take turns with your partner: Share which claim you think is most convincing.
2. Use your Warm-Up responses and the Argumentation Sentence Starters to help you share ideas.
3. Refer to the annotated claims and evidence cards in your envelope, as needed.

*In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?*

**Claim 1:** It was warmer than it is today.

**Claim 2:** It was cooler than it is today.

**Claim 3:** No difference—the air temperature was the same as it is today.

Name: _____ Date: _____

# Science Seminar Observations

Write a check mark in the right-hand column every time you hear one of your peers say or do something listed in the left-hand column. If you hear an interesting idea, write it in the last row of the table.

| **Observations during the seminar** | **Check marks** |
|---|---|
| I heard a student use evidence to support a claim. | |
| I heard a student respectfully disagree with someone else's thinking. | |
| I heard a student explain how her evidence is connected to her claim. | |
| I heard a student evaluate the quality of evidence. | |
| I heard an idea that makes me better understand one of the claims.<br>That idea is: | |

Name: _____ Date: _____

# Homework: Reflecting on the Science Seminar

Now that the Science Seminar is over, think back to the claim you supported at the beginning. After participating in the discussion, you may have changed your mind about which claim you favor. Show your current thinking by answering the questions.

*In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?*

**Claim 1:** It was warmer than it is today.

**Claim 2:** It was cooler than it is today.

**Claim 3:** No difference—the air temperature was the same as it is today.

Did the Science Seminar cause your thinking about the claims to change? Explain your answer.

_____

_____

_____

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Name: _____ Date: _____

# Lesson 4.3: Writing a Scientific Argument

What was the climate of South China like during the late Carboniferous period? Student climatologists, it's time for you to write your scientific argument. Today, you'll review the evidence and use the Reasoning Tool to organize your thinking. Then, you'll get to make your case to the paleontologist, Dr. Xi Yang, about whether South China was warmer or cooler during the late Carboniferous. How convincing can you make your argument?

## Unit Question

- What determines the air temperature of a location on Earth?

## Chapter 4 Question

- In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?

## Key Concepts

- Energy from the sun is transferred to Earth's surface. Some of that energy is then transferred to the air above the surface.
- The closer a location is to the equator, the more energy it receives from the sun. Therefore, a location's air temperature is affected by its distance from the equator.
- An effect may have more than one cause; these may be linked into a chain of causes and effects.
- When an ocean current comes from the equator, it brings warmer-than-expected water to the places it passes, and that water is warmer than the nearby air. When an ocean current comes from a pole, it brings colder-than-expected water to the places it passes, and that water is colder than the nearby air.
- Energy transfers from warmer substances to colder substances. Warmer currents transfer energy to cooler air, and warmer air transfers energy to cooler currents.
- Prevailing winds and the position of continents determine the direction of ocean currents.
- Changes to prevailing winds affect ocean currents. Changes to ocean currents affect how much energy is brought to (or taken away from) a location.

## Vocabulary

- cause
- effect
- energy
- latitude
- ocean current
- prevailing wind
- temperature
- transfer

Name: _____ Date: _____

# Warm-Up

## Making a Convincing Argument

Guadalupe and Anthony are students studying about ocean, atmosphere, and climate at another school. Below are their arguments about the air temperature in Christchurch during El Niño years. Read and compare the two arguments, and then answer the questions.

### Guadalupe's Argument

Christchurch's air temperature is cooler than usual during El Niño years because the prevailing winds are disrupted and the currents change. Therefore, the change in air temperature is caused by changing winds and currents.

### Anthony's Argument

Christchurch's air temperature is cooler than usual during El Niño years because the prevailing winds are disrupted. This evidence matters because prevailing winds push the warm currents that pass Christchurch. These currents carry energy, and that energy is transferred to the air, which makes the air warmer. When prevailing winds are disrupted, they do not push the currents toward Christchurch, so the energy transfer does not happen. This makes the air temperature cooler. Therefore, the change in air temperature is caused by changing winds and changing currents.

Whose argument is more convincing? (circle one)

**Guadalupe's** **Anthony's**

What makes one argument more convincing than the other?

_____

_____

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Name: _____ Date: _____

# Using the Reasoning Tool

## Reviewing the Evidence and Choosing a Claim

1. Review your Science Seminar cards.
2. With your partner, discuss the claim you plan to support. Remember, it's still okay to change your thinking.

*In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?*

**Claim 1:** It was warmer than it is today.

**Claim 2:** It was cooler than it is today.

**Claim 3:** No difference—the air temperature was the same as it is today.

## Using the Reasoning Tool to Support Your Claim

1. In the right column, record the claim that you think is best supported by the evidence. You may record your own claim if your prefer.
2. In the left column, tape the evidence cards that support your claim. You do not need to use all of the evidence cards, but you should use more than one to support your claim.
3. In the middle column, record how the evidence card in the left column connects to the claim in the right column.

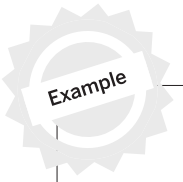
| **Evidence** | **This matters because. . .**<br>(How does this evidence support the claim?) | **Therefore, . . .**<br>(claim) |
|---|---|---|
| | | |
| | | |
| | | |

Name: _____ Date: _____

# Organizing Your Reasoning Tool

Before you write your argument, follow the steps below to organize your Reasoning Tool.

- Draw a circle around your strongest piece of evidence.
- Draw an X over a piece of evidence if you do not plan to use it in your argument.
- Draw an arrow to connect two pieces of evidence if you think that they go together.




| **Evidence** | **This matters because . . .** (How does this evidence support the claim?) | **Therefore, . . .** (claim) |
|---|---|---|
| Example Evidence Card A | Your ideas about how the evidence supports the claim | Your claim |
| Example Evidence Card B | Your ideas about how the evidence supports the claim | |
| Example Evidence Card C | Your ideas about how the evidence supports the claim | |

Name: _____ Date: _____

# Writing Scientific Arguments

## Writing a Scientific Argument About the Air Temperature of South China

1. Review your Reasoning Tool. Include your strongest piece of evidence and connect pieces of evidence that go together.
2. Use the Scientific Argument Sentence Starters to help you explain your thinking in your argument on the next page.

*In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?*

**Claim 1:** It was warmer than it is today.

**Claim 2:** It was cooler than it is today.

**Claim 3:** No difference—the air temperature was the same as it is today.

## Scientific Argument Sentence Starters

| **Describing evidence:** | **Explaining how the evidence supports the claim:** |
|---|---|
| The evidence that supports my claim is . . . | If ___, then . . . |
| My first piece of evidence is . . . | This change caused . . . |
| Another piece of evidence is . . . | This is important because . . . |
| This evidence shows that . . . | Since . . . |
| | Based on the evidence, I conclude that . . . |
| | This claim is stronger because . . . |

Name: _____ Date: _____

# Writing Scientific Arguments (continued)

Write a scientific argument that addresses the question: *In South China during the late Carboniferous period, was the air temperature warmer or cooler than the air temperature in that location today?*

1. State your claim and explain your choice.
2. Use your evidence and explain how each piece supports your claim.

Name: _____ Date: _____

# Writing Scientific Arguments (continued)

Name: _____ Date: _____

# Homework: Revising an Argument

1. Reread your scientific argument.
2. If you need to, finish writing your argument.
3. Look for ways to make your argument clearer or more convincing.
4. Consider reading your argument aloud or having another person read it.
5. Consider these questions as you review your argument:
   - Does your argument clearly explain why you decided that South China's air temperature in the late Carboniferous period was either warmer, cooler, or the same as it is today?
   - Do you describe your supporting evidence?
   - Do you thoroughly explain how the evidence supports your claim?
6. Rewrite any sections that could be clearer or more convincing.

Name: _____ Date: _____

# Homework: Revising an Argument (continued)

Name: _____ Date: _____

# Homework: Check Your Understanding

This is a chance for you to reflect on your learning so far. This is not a test. Be open and truthful when you respond to the questions below.

1. I understand that scientists revise claims as new evidence becomes available. (check one)

   ☐ yes

   ☐ not yet

Explain your answer choice.

_____

_____

_____

2. What are the most important things you have learned in this unit about what determines the air temperature of a location on Earth?

_____

_____

_____

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_____

_____

3. What questions do you still have?

_____

_____

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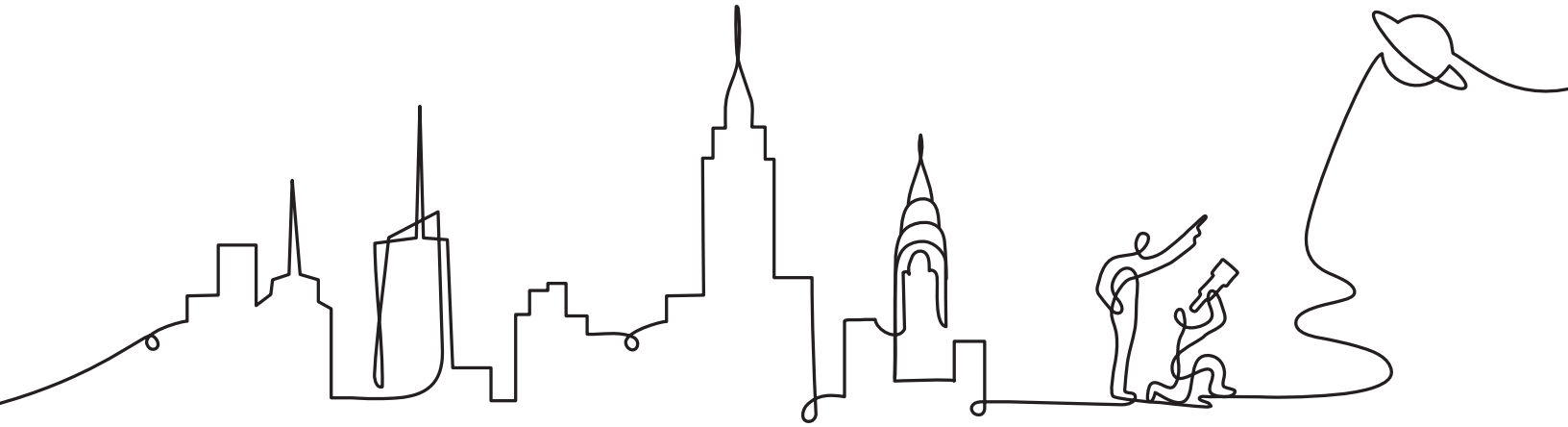


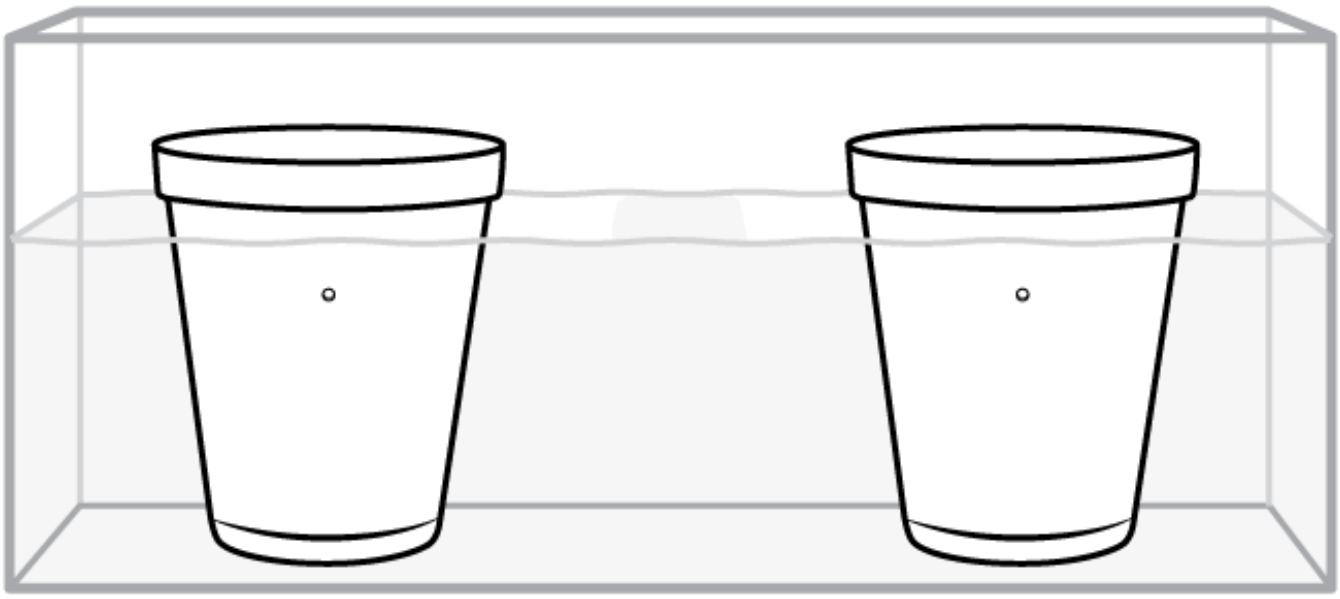
# New York City Companion Lesson

Name: _____ Date: _____

# Investigating Deep Ocean Currents

## Part 1: Deep Ocean Currents Model

In the diagram below, draw and label your observations of the deep ocean currents model.



What are your ideas for why the two types of water moved differently?

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

# Investigating Deep Ocean Currents (continued)

## Part 2: Layering Liquids

**Goal:** Use the four liquids to make as many distinct layers as possible.

Plan each test and explain your reasoning for the plan in the table below. Color the prediction diagram to show what you think the layers will look like. Complete the test and record your results. Use what you learned from the previous test when you plan the next test.

**Color Key:**

Red = Hot-Salty  Blue = Cold-Salty  Yellow = Hot-Fresh  Green = Cold-Fresh

| | | |
|---|---|---|
| **Test 1:**<br>Which liquids will you add and in what order will you add them?<br><br>Reasoning: | **Prediction** | **Result** |
| **Test 2:**<br>Which liquids will you add and in what order will you add them?<br><br>Reasoning: | **Prediction** | **Result** |

Name: _____ Date: _____

# Investigating Deep Ocean Currents (continued)

| | | |
|---|---|---|
| **Test 3:**<br>Which liquids will you add and in what order will you add them?<br><br>Reasoning: | **Prediction** | **Result** |
| **Test 4:**<br>Which liquids will you add and in what order will you add them?<br><br>Reasoning: | **Prediction** | **Result** |
| **Test 5:**<br>Which liquids will you add and in what order will you add them?<br><br>Reasoning: | **Prediction** | **Result** |

Name: _____ Date: _____

# Investigating Deep Ocean Currents (continued)

| | | |
|---|---|---|
| **Test 6:**<br>Which liquids will you add and in what order will you add them?<br><br>Reasoning: | **Prediction** | **Result** |
| **Test 7:**<br>Which liquids will you add and in what order will you add them?<br><br>Reasoning: | **Prediction** | **Result** |

**Color Key:**

Red = Hot-Salty  Blue = Cold-Salty  Yellow = Hot-Fresh  Green = Cold-Fresh

Name: _____ Date: _____

# Investigating Deep Ocean Currents (continued)

## Part 3: Identifying Deep Ocean Currents

1. Why do you think the purple water and the orange water in the deep ocean currents model moved in the ways they did?

_____

_____

_____

_____

_____

2. Scientists are investigating a certain deep ocean current. The scientists have found that the water close to the surface is sinking through the water below it, forming a current close to the bottom of the ocean. Scientists have identified the water below the surface as having a medium level of salt and a temperature of 4°C. Which of the following could be the identity of the water close to the surface (the water that is sinking)? (check one)

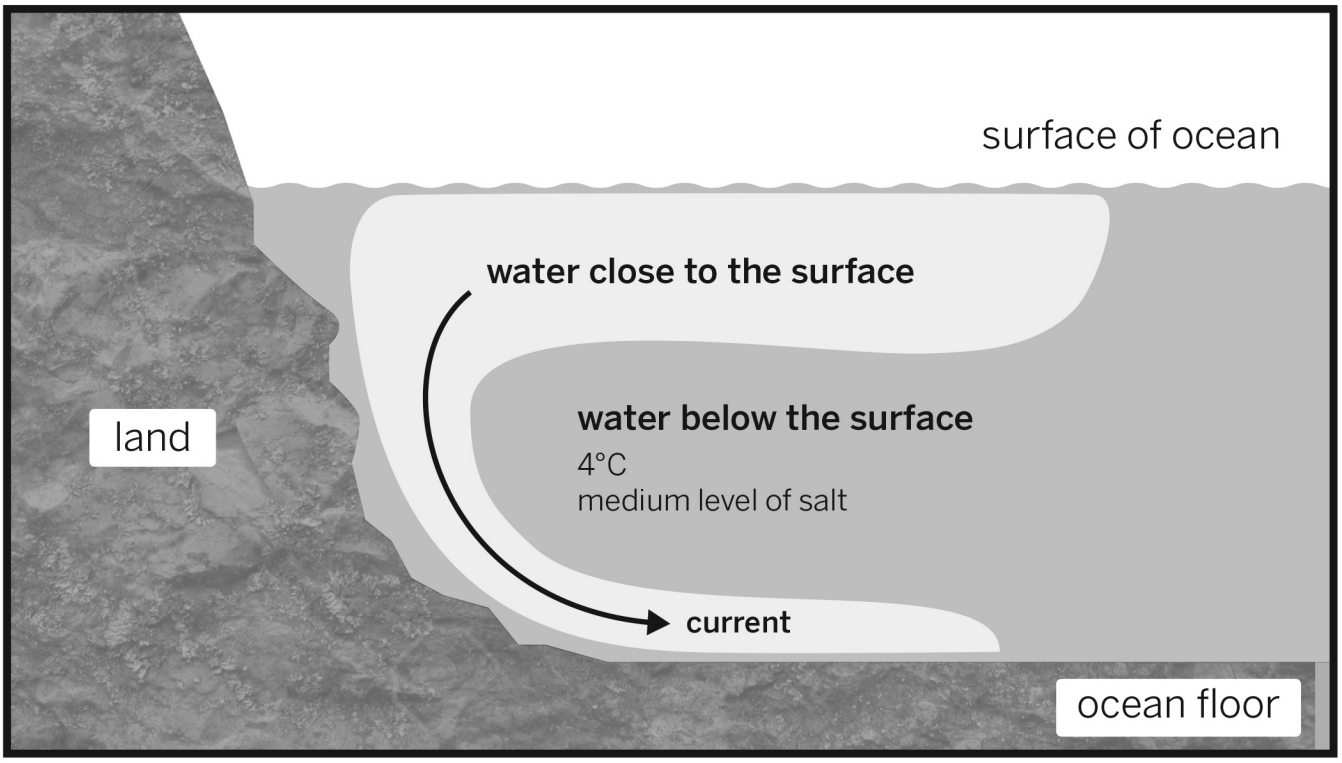
☐ water 2°C with high level of salt

☐ water 20°C with no salt (freshwater)

Explain your choice on the following page.

Name: _____ Date: _____

## Investigating Deep Ocean Currents (continued)




Explain your choice.

_____

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_____

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_____

# *Ocean, Atmosphere, and Climate* Glossary

**cause:** an event or process that leads to a result or change

*causa: un evento o proceso que provoca un resultado o cambio*

**climate:** general weather patterns over a long period of time

*clima: patrones atmosféricos generales que ocurren durante un periodo largo de tiempo*

**climatology:** the study of weather patterns over a long period of time

*climatología: el estudio de patrones del clima durante un periodo largo de tiempo*

**continent:** any of Earth's main continuous areas of land, such as Africa, Asia, and North America

*continente: cualquiera de las principales áreas continuas de terreno de la Tierra, como África, Asia y Norteamérica*

**density:** the amount of matter in a certain amount of space

*densidad: la cantidad de materia en una cierta cantidad de espacio*

**effect:** a result or change that happens because of an event or process

*efecto: un resultado o cambio que ocurre debido a un evento o proceso*

**El Niño:** a climate pattern where water near the equator gets hotter than usual and affects the weather around the world; El Niño happens in the Pacific Ocean

*El Niño: un patrón climático en el cual las aguas cercanas al ecuador se calientan más de lo normal y afectan el clima de todo el mundo; El Niño ocurre en el Océano Pacífico*

**energy:** the ability to make things move or change

*energía: la capacidad de hacer que las cosas se muevan o cambien*

**equator:** the imaginary line that divides Earth into northern and southern hemispheres (halves)

*ecuador: la línea imaginaria que divide a la Tierra en dos hemisferios (mitades): norte y sur*

**gyre:** a giant pattern of moving water that spans whole oceans and moves water from place to place in a circle

*giro: un patrón gigantesco de agua en movimiento que abarca océanos enteros y mueve el agua de un lugar a otro en forma circular*

**latitude:** the distance of a place north or south of Earth's equator

*latitud: la distancia desde el ecuador de la Tierra hasta un lugar al norte o sur*

**longitude:** the distance of a place east or west of Earth's prime meridian
*longitud: la distancia desde el primer meridiano de la Tierra hasta un lugar al este u oeste*

**model:** an object, diagram, or computer program that helps us understand something by making it simpler or easier to see
*modelo: un objeto, diagrama o programa de computadora que nos ayuda a entender algo haciéndolo más simple o fácil de ver*

**observe:** to use any of the five senses to gather information about something
*observar: usar cualquiera de los cinco sentidos para recolectar información acerca de algo*

**ocean current:** ocean water flowing in a continuous path
*corriente oceánica: agua del océano que fluye en una ruta continua*

**prediction:** an idea about what might happen that is based on what you already know
*predicción: una idea acerca de lo que podría suceder que está basada en lo que tú ya conoces*

**prevailing winds:** winds that move in one direction and are strong enough to push ocean currents
*vientos dominantes: vientos que se mueven en una dirección y son lo suficientemente fuertes para empujar corrientes oceánicas*

**scientific community:** scientists around the world who share information and ideas
*comunidad científica: científicos/as alrededor del mundo que comparten información e ideas*

**solar:** related to the sun
*solar: relacionado con el sol*

**surface:** the outside or top layer of something
*superficie: la parte exterior o la capa más externa de algo*

**temperature:** a measure of how hot or cold something is
*temperatura: una medida de qué tan caliente o frío está algo*

**transfer:** to move from one object to another or one place to another
*transferir: mover de un objeto a otro o de un lugar a otro*

**upwelling:** a process in which deep, cold water rises toward the surface of the ocean
*afloramiento: un proceso en el cual las aguas profundas y frías se elevan hacia la superficie del océano*

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# Ocean, Atmosphere, and Climate:
## Cold Years in New Zealand

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