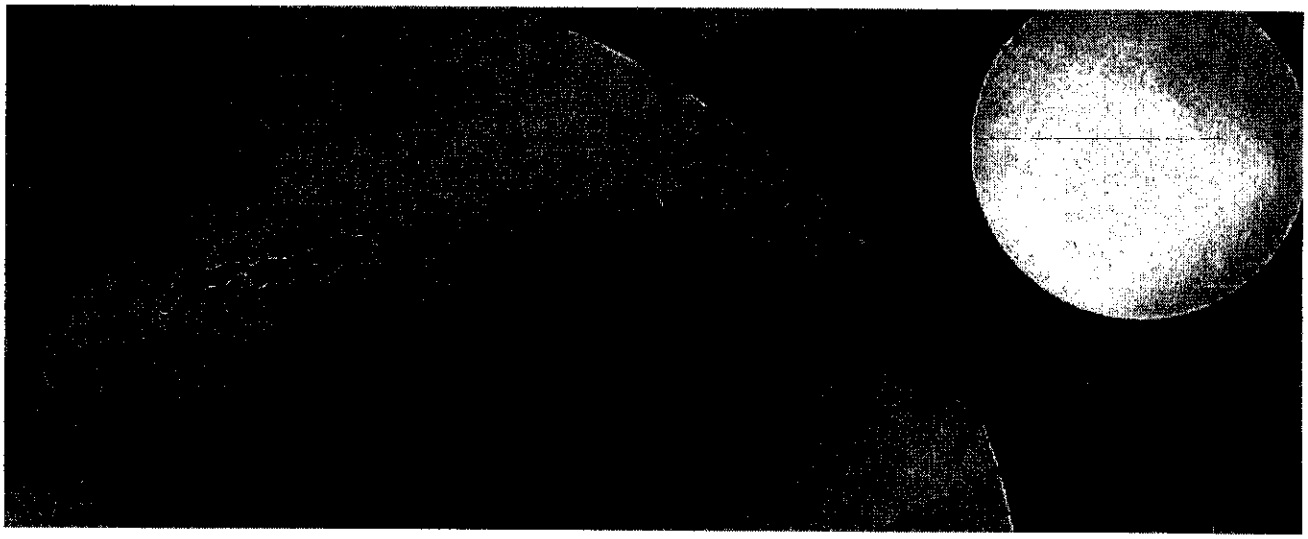
Name: Answer Key Date: _____ Period: _____

# Unit 5:
# Ocean, Atmosphere, and Climate:
# *Cold Years in New Zealand*

## Chapter 1: Air Temperature



**Unit Question:**
What determines the air temperature of a location on Earth?

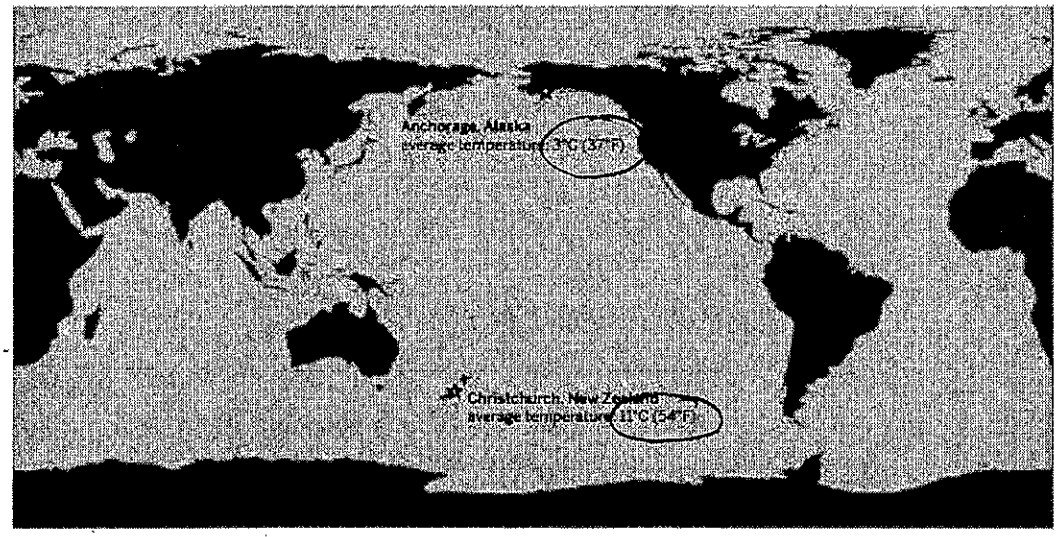
**Chapter 1 Question:**
What determines the air temperature of Christchurch, New Zealand?

## Chapter 1: Air Temperature
## Lesson 1: What Determines the Air Temperature of a Location?

**Learning Target:** I can explain the relationship between temperature and energy.

### Do Now: 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?

Anchorage, Alaska is cooler than Christchurch, New Zealand because Anchorage's temperature is lower than Christchurch's temperature in Celsius and farenheit.

### Introduction

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.

## Key Vocabulary

**Climate:** General weather patterns over a long period of time.

## Message from the New Zealand Farm Council...

**Kiri Parata**
To: Student Climatologists
Re: Influences on Christchurch, New Zealand's Air Temperature

New Zealand Farm Council

I am the director of the New Zealand Farm Council. Our organization represents farmers in the area surrounding Christchurch. Every few years, we notice climate changes that affect the crops. During El Niño years, the air temperature is much cooler than usual, and we would like to learn why.

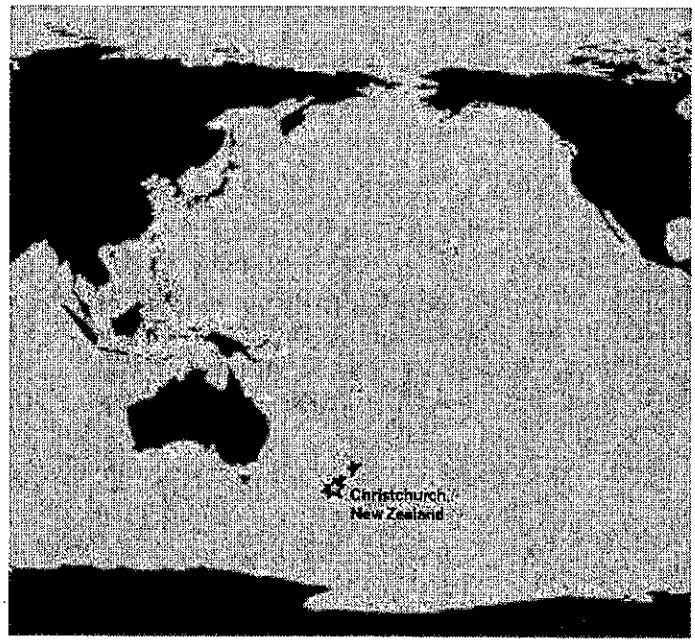
So the farmers are better prepared for these temperature changes, we are asking you—our student climatologists—to conduct some research on what determines Christchurch's air temperature, especially why it decreases during El Niño.

Looking forward to working with you and hearing what you find out!

Kiri

**Kiri Parata, Director**
**New Zealand Farm Council**

## Christchurch During El Niño




**RESEARCH QUESTION:**

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

Discuss your ideas with a partner, then select the claim that is most similar to your ideas.

- ❑ **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.

## Key Vocabulary

| | |
|---|---|
| **Energy:** The ability to make things move or change. | **Temperature:** A measure of how hot or cold something is. |

## Sim Mission: Change the Air Temperature (Teacher Model)

**Part 1:**
**Your teacher will model how to make the air temperature change in the Sim. Go to Energy Test mode.**

- How do you make the air temperature **increase**? (circle one)
  - I (**added / removed**) energy to make the air temperature increase.
- How do you make the air temperature **decrease**? (circle one)
  - I (**added / removed**) energy to make the air temperature decrease.

## Reading: "Effects of El Niño Around the World"

In the article entitled, "Effects of El Niño Around the World," you will learn about the effects of El Niño in specific locations. As you read, annotate the article using the Active Reading strategies that work best for you.

### 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.

## Probability of El Niño:

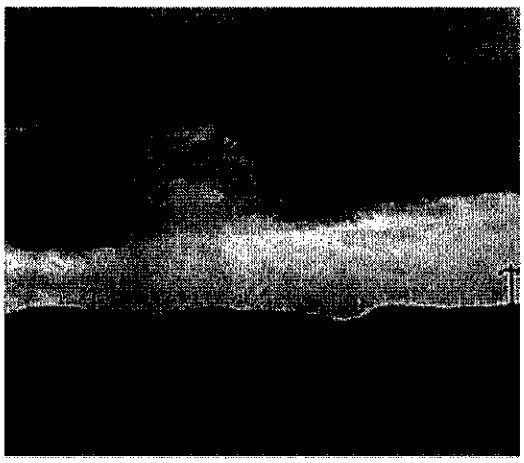
In the reading, you learned about the effects of El Niño and the impact it has on a large part of the world. El Niño is influenced by many causes, from changes in global temperatures, to ocean currents, and even to the direction and speed of winds. Because of the complexity of El Niño, even our best estimates cannot always accurately predict when the next El Niño event will occur. While it is not always certain when El Niño will take place next, scientists can predict from previous years' evidence that the El Niño phenomenon occurs approximately every 2 to 7 years.

**Exit Ticket** (Please complete after you have finished reading the article.)

Based on what you read in the article, why do you think it is important for climate scientists to study El Niño?

It is important to study El Nino because it can help us learn more about where El Nino will affect and how. It will allow us to better prepare for the phenomenon without being surprised by the severity of the weather. It will help us to protect our crops from heavy rain and protect our buildings from potential mud slides and other natural causes.

# Effects of El Niño Around the World



The climate pattern called El Niño causes wet weather in some places and extreme drought in others.

## Chapter 1: Different Places, Different Effects

Different places on Earth have their own weather patterns that depend on things like local geography and distance from the equator. These weather patterns are known as regional climates, and they don't change very much from year to year . . . ordinarily. However, an El Niño year is anything but ordinary! The climate pattern called El Niño happens every 2 to 7 years, bringing important changes in temperature, precipitation, and more. El Niño affects the whole planet, but it has different effects on different locations. Choose one of the chapters that follow to learn more about the effects of El Niño on the regional climate in a particular place on the globe.

## Chapter 2: Drought in Pakistan

Late summer and early fall are usually wet times in the country of Pakistan. Normally, the monsoon season in August and September brings heavy rainstorms. Monsoon season supplies about half of Pakistan's rain for a typical year—about 25 centimeters (16 inches) in just two months. These storms keep temperatures from getting too hot. However, the climate pattern called El Niño weakens the monsoon season in Pakistan, causing dry, hot weather instead of cool rain. This unusual weather causes a variety of health problems for people there and keeps crops from being watered. Without water to grow food, many people's health problems get worse because they don't get the nutrition they need to get well.

In Pakistan, the El Niño climate pattern causes hot, dry weather instead of monsoon storms.

## Chapter 3: Landslides in Los Angeles

Normally, Southern California is a pretty dry place: the city of Los Angeles only gets about 38 centimeters (15 inches) of rain each year. During El Niño years, however, Los Angeles can get much more rain than usual. For such a dry place, the extra rain brought by El Niño may sound like a good thing—but it can be dangerous. Large amounts of rain falling on dry, hilly ground without many plants to keep the dirt in place can lead to landslides. In Los Angeles, some people build homes at the tops of hills. These hilltop homes can be destroyed when the dirt underneath them gets too wet and slides downhill. Landslides can also block or destroy roads, injuring people in their paths and causing millions of dollars in damage.

**Extra rain in Los Angeles might sound like a good thing, but it can cause landslides that destroy homes and block roads.**

## Chapter 4: Malaria in Colombia

In the South American country of Colombia, El Niño causes serious droughts. These droughts can affect farmers in the area, but they have an even bigger effect on public health there. During El Niño years, Colombia has a 17% increase in cases of a serious disease called malaria. When rivers and streams begin to dry up in a drought, the remaining water forms many shallow pools that are good places for mosquitoes to live and breed. Mosquitoes carry malaria, transmitting it to people by biting them. More places for mosquitoes to breed means there are more mosquitoes around to transmit malaria to nearby humans. Mosquitoes typically breed faster in warm weather, so rising temperatures may also work to increase the rates of malaria in Colombia during El Niño years.

**When rivers and streams begin to dry up, they form pools where mosquitoes live and breed. These mosquitoes can carry malaria and transmit it to people living nearby.**

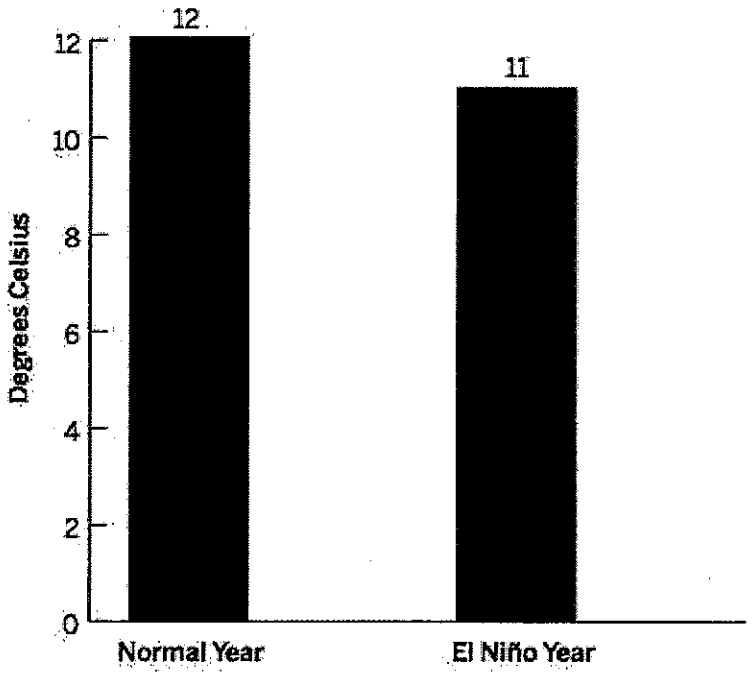
## Chapter 1: Air Temperature
## Lesson 2: Energy Transferred to Air

**Learning Target:** I can explain how the energy from the sun is transferred to the air.

### Do Now

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**



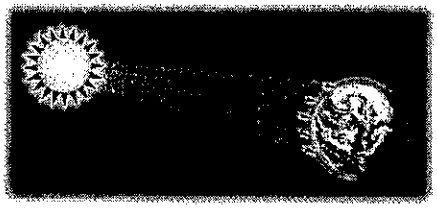

El Niño events occur every two to seven years. There is a shift in the climate across the tropical Pacific, which causes some areas to become cooler than usual and some areas to become warmer than usual.

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

## Investigation Question

**How does air get energy?**



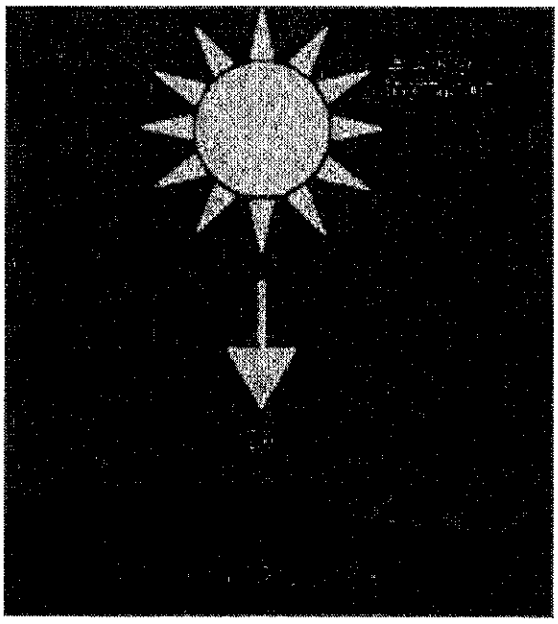
## Key Vocabulary

**Transfer:** To move from one object to another or from one place to another.

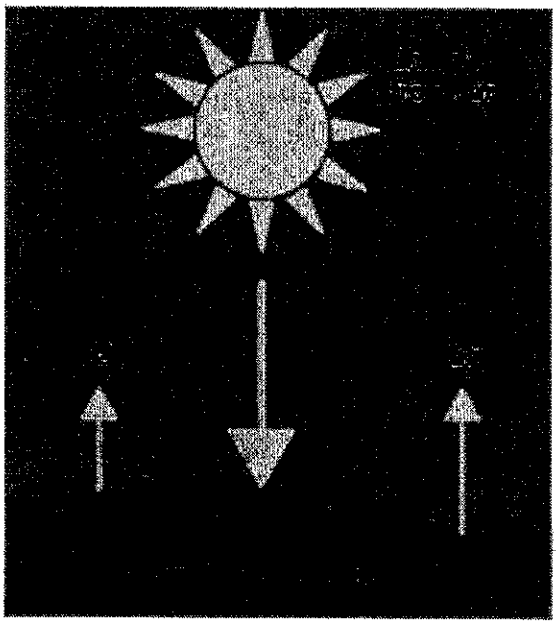
*Energy transfer* happens when energy is moved from one object to another or one place to another.

## Claims

### How does air get energy?



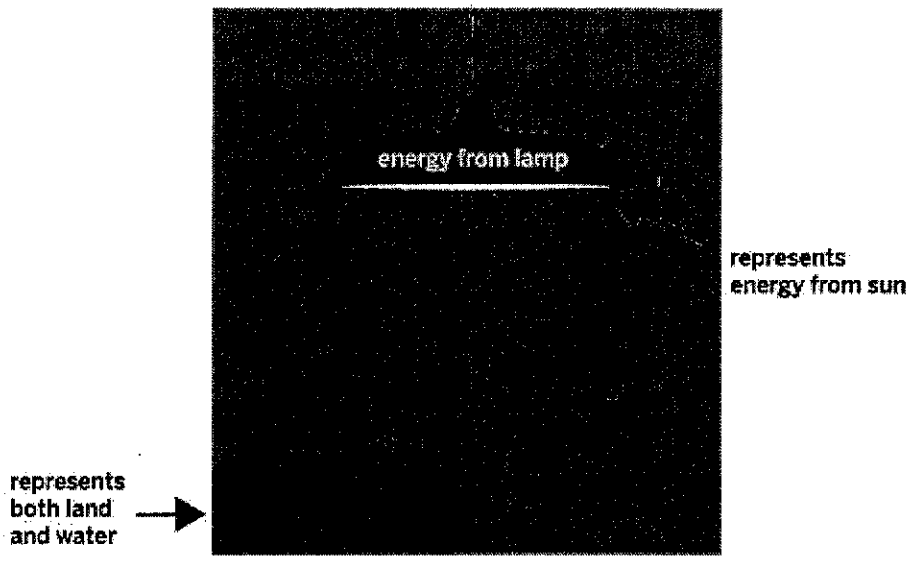
**Claim 1:** Energy is transferred from the sun to the air.



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

## Heating Experiment

Our class will conduct an experiment to determine how air gets energy. Below is a diagram of the setup of the experiment.




With a partner, think 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 / 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 / the same)** as the air above the rocks?

## 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) | | | |

## 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)

   - [x] increase
   - [ ] decrease
   - [ ] stay the same

   **b. no surface**

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

   - [ ] increase
   - [ ] decrease
   - [x] stay the same

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)

   - [x] 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
   - [x] stayed the same

**Heating Experiment Reflection Questions**

1) What happened in the experiment?

In the experiment the air above surface and the air with no surface start at the same temperature. The air above surface increases and the air with no surface stays the same.

2) Do the results support Claim 1 or Claim 2? Explain why.

Supports claim 2 because if claim 2 is correct, the air with no surface would not increase. This is what we observed.

3) What did you learn from the experiment that might help you answer the question, *How does air get energy?*

With no surface, the energy from the sun won't go to the air (it won't increase temperature). Only with surface, can the air get warmer (more energy).

## Revisiting the Claims with New Evidence

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?

Energy is transferred from the Sun to the surface, and then to the air. This is also shown in the Simulation.

## KEY CONCEPT #1

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

## Exit Ticket- 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?

I disagree that the Sun warms the air directly. The evidence that supports this is the energy from the Sun transfers to the surface first. The surface temperature increased before the air temp. did. Only then did the energy transfer to the air from the surface, but the air temperature wasn't as high as the surface.

## Chapter 1: Air Temperature
## Lesson 3: Air Temperatures Around the World

**Learning Target:** I can explain that a location's air temperature is affected by its distance from the equator.

**Do Now**

### Making Predictions about Cold, Warm, and Hot Places on Earth


**Think about how temperature and energy are related:**

- ❑ Mark a **C** on one location on the map you think is **cold.**
  - ❑ What must be true about energy in this location:

    **(Low energy / Medium Energy / High Energy)**
- ❑ Mark a **W** on one location on the map you think is **warm.**
  - ❑ What must be true about energy in this location:

    **(Low energy / Medium Energy / High Energy)**
- ❑ Mark a **H** on two locations on the map you think are **hot.**
  - ❑ What must be true about energy in these locations:

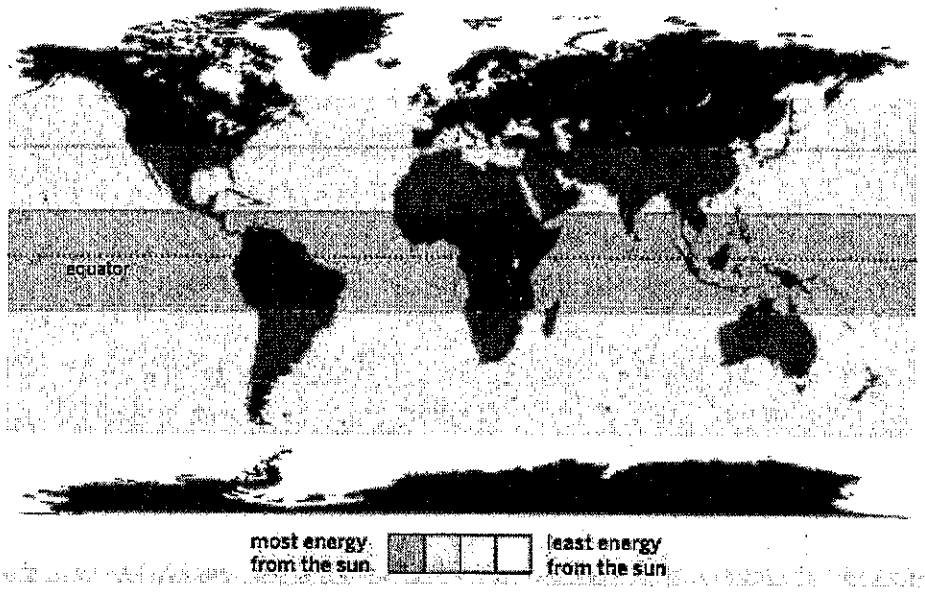
    **(Low energy / Medium Energy / High Energy)**

## Discussing Energy and Temperature Maps

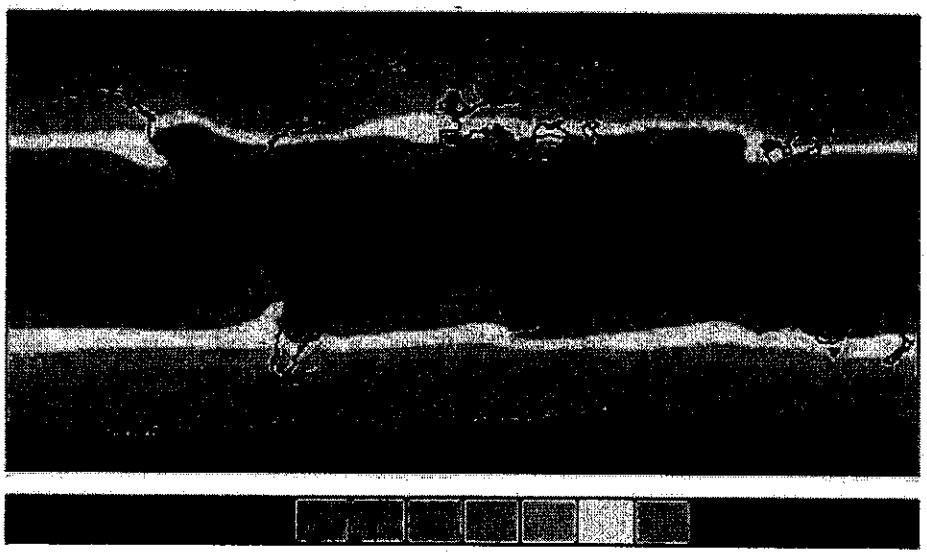
Decide on one map for each partner to focus on. Think about the questions, and then talk to your partner about what you notice. **Note:** Your teacher will project a color version of these maps.

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?*

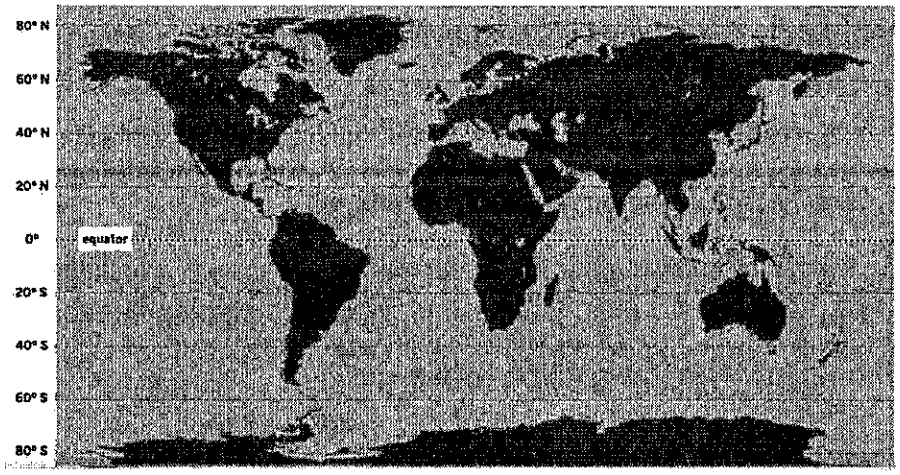
### Incoming Energy from the Sun




### Global Air Temperature



## Key Vocabulary

| | |
|---|---|
| **Latitude:** The distance of a place north or south of Earth's equator. |   |

## Investigating Air Temperatures at Different Locations (continued from previous page)

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*.

Different locations have different air temperatures because the energy from the sun may be different. The distance from the equator is the latitude of a location. It is colder (less energy) the further away you are from the equator.

4. Using what you have learned from these maps, explain why the polar ice caps are found at the north and south pole rather than at the equator.

Since the north and south pole receive the least amount of energy from the sun, thus is where it is the coldest. The further a location is from the equator, the less energy from the sun.

**Revisiting Your Predictions**

Return to your map predictions in today's Do Now activity. Revise your map, and once you are satisfied, explain the changes you made.

* Students will revise their Do Now section.

## KEY CONCEPT #2

**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.**

## Modeling What Determines a Location's Air Temperature

Together as a class, we will open the Ocean, Atmosphere, and Climate Modeling Tool Activity: 1.4 Different Temperatures, and create a model.

**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.

Equator = More energy from sun to surface.

South Pole = Less energy from sun to surface.

## Sim- 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 | | |

## Exit Ticket

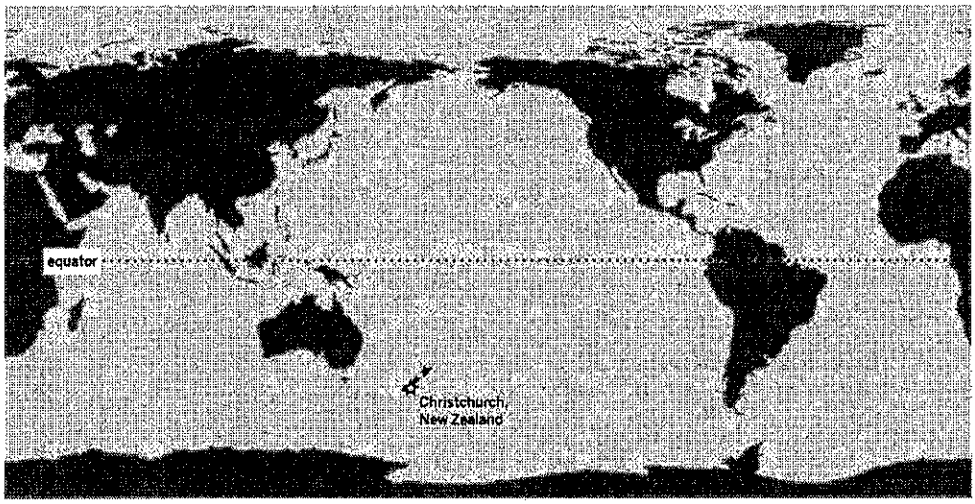
How is the temperature of a location determined by energy from the sun and the location's distance from the equator?

The Sun transfers the most direct sunlight (energy) at the equator. The further north or south you go from the equator, the less energy is transferred to the surface. Therefore, the higher your latitude (distance from equator) is, the colder it will be.

## Chapter 1: Air Temperature
## Lesson 4: Air Temperature in Christchurch

**Learning Target:** I can explain that El Niño changes are not caused by variations in solar energy.

### Do Now- Revisiting the Claims




*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)

- [x] **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.

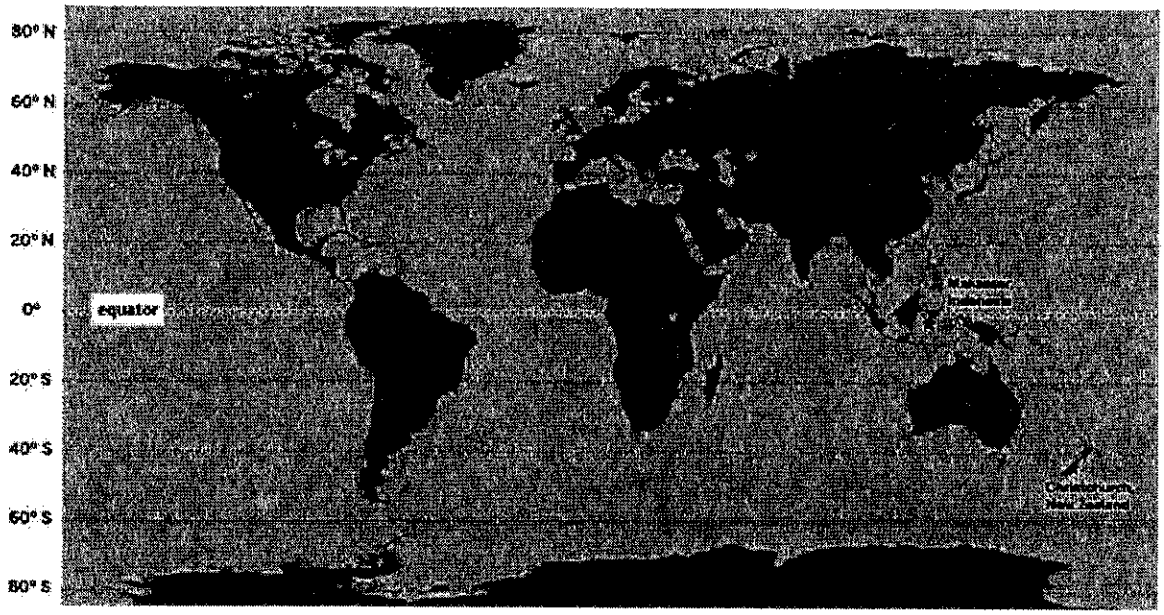
Explain why you think the claim you selected is the LEAST convincing claim.

The sun always releases the same amount of energy to a location.

* Claims and reasons may vary *

**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.*

Makassar is warmer because it is located near the equator, which means it has a low latitude (distance from equator). The sun transfers energy directly to the equator, therefore the temperature will be higher at locations around the equator.

**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) |

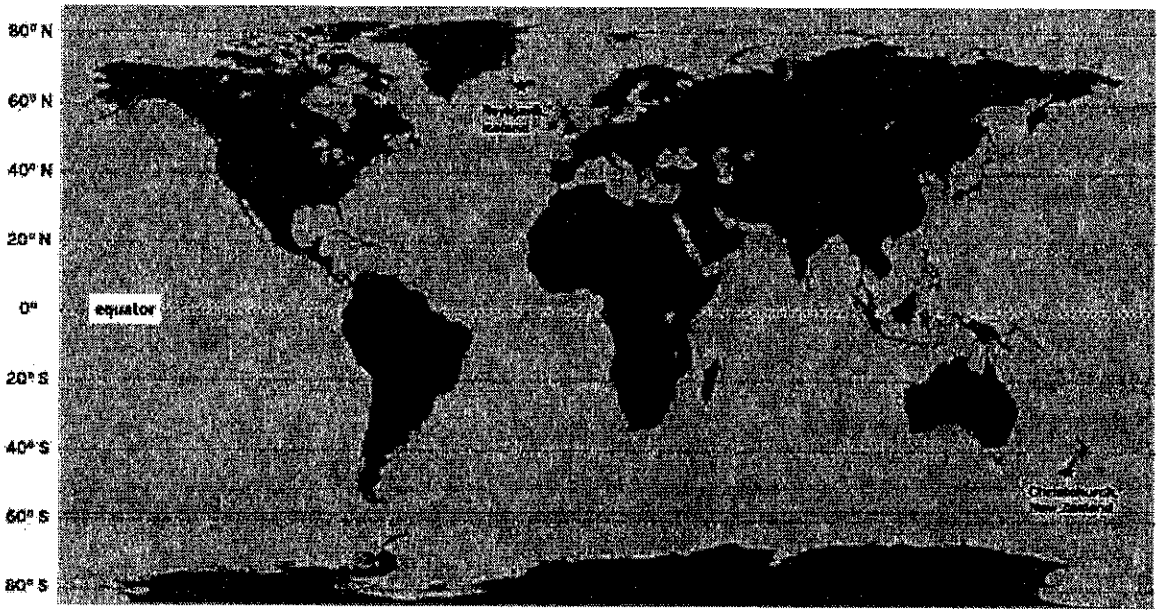

**Prompt:** Why is the average air temperature of Tokyo warmer than the average air temperature of Christchurch?

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.*

Tokyo has a lower latitude. This means Tokyo is closer to the equator than Christchurch. More energy is transferred from the sun to the surface, which then increases the air temperature.

## 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.*

Reykjavik is farther away from the equator than Christchurch, so it has a higher latitude (distance from equator). The higher the latitude, the less energy is transferred to the locations surface, which means less energy for air temperature.

**Message From the New Zealand Farm Council...**

**Kiri Parata**
To: Student Climatologists
Re: New Evidence

New Zealand Farm Council

Now that you have learned more about what determines a location's temperature, you are ready to begin helping us determine why Christchurch, New Zealand's air temperature is cooler than usual in El Niño years. I am sending evidence that might help you with this investigation.

Please review the evidence carefully. Remember, your research will help the farmers be better prepared to protect their crops and livestock from temperature changes in the future.

Best regards,

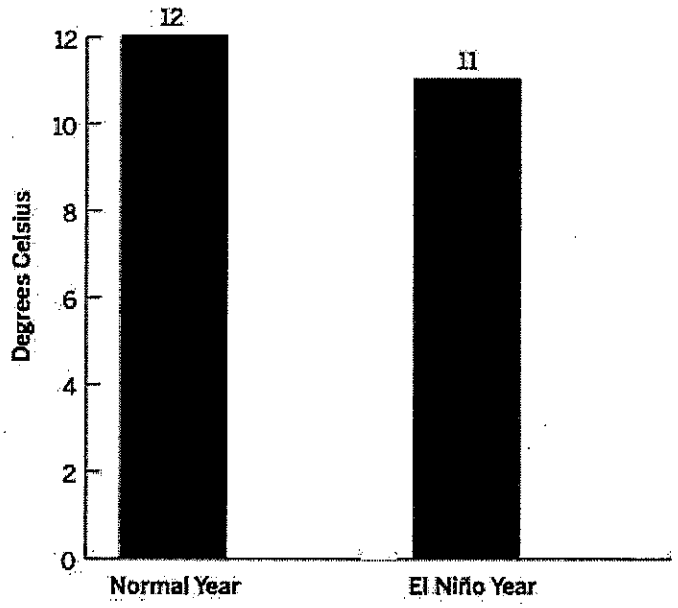
Kiri

**Kiri Parata, Director**
**New Zealand Farm Council**

**Evaluating Evidence- Interpreting Climate Data (Part 1)**

Participate in a class discussion about this graph.

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

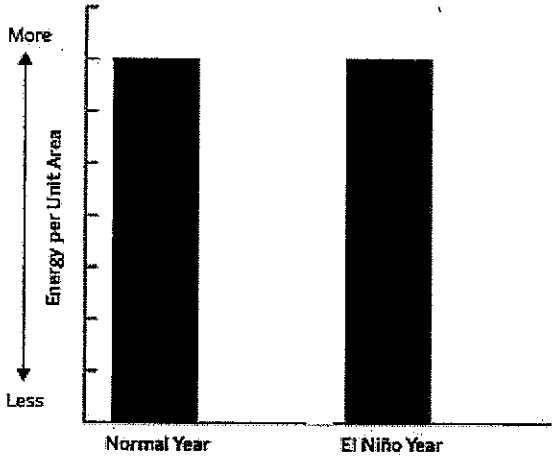


## Evaluating Evidence- Annotating and Discussing Evidence (Part 2)

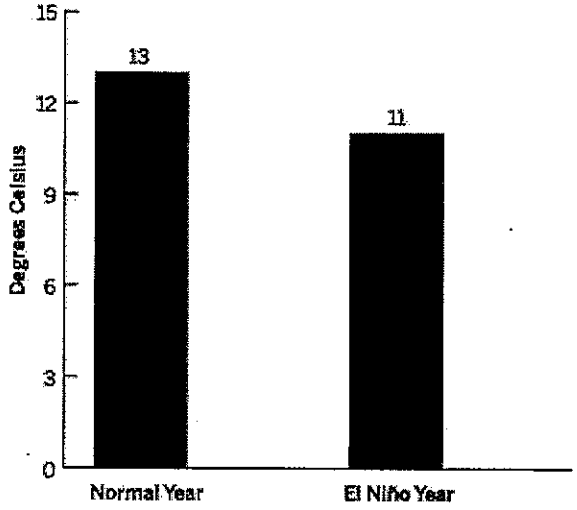
Use the first three questions to guide you as you read and annotate both graphs. When you are finished, discuss your annotations and question 4 with your group.

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**



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.

Claim 1 – graphs do not support
Claim 2 – graphs support
Claim 3 – graphs support

**Exit Ticket- Self Assessment**

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

   Students should know this by the end of Chap. 1

   Explain your answer choice.

* Student explanations will vary *
Sun light (energy) → surface → air

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

   ☐ yes

   ☐ not yet

   Students should know this by the end of Chap. 3

   Explain your answer choice.

* Student explanations will vary *

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

Students should know by end of Chap. 1

☐ yes

☐ not yet

Explain your answer choice.

The further away from the equator a location is, the less sunlight (energy) is transferred to the location's surface, which then transfers to the air.

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)

Students will know this at the end of Chap. 2

☐ yes

☐ not yet

Explain your answer choice.

* Student explanations will vary *

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

Students will know this at the end of Chapter 3

☐ yes

☐ not yet

* Answers will vary *

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