

## THINGS ARE HEATING UP

### Overview:

This lesson provides an overview of climate change indicators in the Arctic and subarctic as well as possible impacts brought about by climate change, including ways climate change may affect students' communities.

### Objectives:

The student will:

- identify indicators of climate change in Alaska;
- write a paragraph that integrates and connects information about climate change in Alaska;
- predict implications of climate change in Alaska for local communities; and
- visually depict a selected aspect of climate change in Alaska.

### Targeted Alaska Reading Performance Standards for the High School Graduation Qualifying Exam

- R4.2 Summarize information or ideas from a text and make connections between summarized information or sets of ideas and related topics or information.
- R4.4 Read and follow multi-step directions to complete complex tasks.
- R4.8 Analyze and evaluate themes across a variety of texts, using textual and experiential evidence.

### Targeted Alaska Writing Performance Standards for the High School Graduation Qualifying Exam

- W4.2 Demonstrate understanding of elements of discourse (purpose, speaker, audience, form) when completing expressive (creative, narrative, descriptive), persuasive, research-based, informational, or analytic writing assignments.
- W4.3 Use the conventions of Standard English independently and consistently including grammar, sentence structure, paragraph structure, punctuation, spelling, and usage.

### Targeted Alaska Grade Level Expectations:

*Science*

- [11] SA1.1 The student develops an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.
- [11] SC3.2 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by analyzing the potential impacts of changes (e.g., climate change, habitat loss/gain, cataclysms, human activities) within an ecosystem.

### Vocabulary:

Vocabulary words are divided into two sections. The first section contains words in general use that may be unfamiliar to students. The second section contains words that are used in the lesson in ways that pertain to science or data collection. Teachers should determine if students need study and practice with one or both sections of vocabulary. Supplementary vocabulary worksheets are included.

#### General Usage Vocabulary

- accelerate** – to cause faster or greater activity, development, progress, advancement, to hasten the occurrence of
- albedo** – reflective power; the ratio of the light reflected by a planet or satellite to that received by it
- anthropogenic** – caused or produced by humans.

## THINGS ARE HEATING UP

**climate** – the composite or generally prevailing weather conditions of a region, as temperature, air pressure, humidity, precipitation, sunshine, cloudiness, and winds throughout the year, averaged over a series of years.

**convection** – the transfer of heat by the circulation or movement of the heated parts of a liquid (like water) or gas (like air).

**current** – a large portion of air, large body of water, etc., moving in a certain direction, a flowing movement

**ecosystem** – a system formed by the interaction of a community of organisms with their environment, an ecological community made up of plants, animals, microorganisms together with their environment

**erosion** – the process by which the surface of the earth is worn away by the action of water, glaciers, winds, waves, etc.

**export** – to ship things to other countries or places for sale, exchange, etc.

**frequency** – rate of occurrence, how often something happens

**harbinger** – anything that foreshadows a future event; omen; sign

**ice core** – a core sample from the accumulation of snow and ice over many years that have recrystallized and have trapped air bubbles from previous time periods. The composition of these ice cores, especially the presence of hydrogen and oxygen isotopes provides a picture of the climate at the time.

**permafrost** – ground that is at 0° Celsius or below for two or more years

### Whole Picture:

Earth's climate is always changing. Historical fluctuations in climate were a result of natural causes and variations. The trends and patterns of change that have emerged in recent decades indicate human influences may be a factor, primarily from increased emissions of carbon dioxide and other greenhouse gases.

Scientists are particularly interested in studying just how the Arctic is responding to climate change. In the past few decades, the average temperature in the Arctic has risen at almost twice the rate as the rest of the world. Widespread melting of glaciers and sea ice and rising permafrost temperatures present additional evidence of strong Arctic warming. These changes in the Arctic provide an early indication of the environmental and societal significance of global climate change. Any changes in the Arctic impact the planet as a whole.

For example, melting of Arctic glaciers is one of the factors contributing to sea-level rise around the globe. The Arctic also provides important natural resources to the rest of the world (such as oil, gas, and fish) that will be affected by climate change. The reduction in sea ice is very likely to have devastating consequences for polar bears, ice-dependent seals, and local people for whom these animals are a primary food source. On the other hand, reduced sea ice is likely to increase marine access to the region's resources, expanding opportunities for shipping and possibly for offshore oil extraction.

Increased areas of tree growth in the Arctic could serve to take up carbon dioxide and supply additional wood products and related employment, providing local and global economic benefits. On the other hand, increased tree growth is likely to add to regional warming and encroach on the habitat for many birds, reindeer/caribou, and other locally beneficial species, thereby adversely affecting local residents. Potential complications include projected increases in forest disturbances such as fires and insect outbreaks that could reduce expected benefits.

Adapted from *Arctic Climate Impact Assessment (2004)*.

### Materials:

- Colored pencils (students can share)
- DVD: Alan Alda in *Scientific American Frontiers: Hot Times in Alaska*
- VISUAL AID: "Climate Change Cartoon"
- STUDENT INFORMATION SHEET: "Social Impacts of Climate Change"
- STUDENT WORKSHEET: "Climate Change Impacts in the Arctic"
- STUDENT WORKSHEET: "Climate Change: Things are Heating Up"

## THINGS ARE HEATING UP

- STUDENT WORKSHEET: "Social Impacts of Climate Change"
- STUDENT WORKSHEET: "There's Something Funny about Climate Change"

### Activity Preparation:

1. Preview the DVD *Scientific American Frontiers: Hot Times in Alaska*.
2. Preview the vocabulary words to determine if pre-teaching is necessary before beginning the lesson.
3. Do an Internet search using the search terms, "climate change cartoons." Gather a few examples of cartoons that illustrate a climate change issue.

### Activity Procedure:

1. Ask students if any of them have heard the terms "climate change" or "global warming." If so, ask students what they think these terms mean. After discussion, explain this lesson will help them understand what scientists mean when they refer to "climate change" and "global warming." Explain that they will also learn how scientists in Alaska have used data to confirm climate changes.
2. Hand out STUDENT WORKSHEET: "Climate Change Impacts in the Arctic." Explain students will be watching a DVD produced by *Scientific American Frontiers* and narrated by Alan Alda. Questions 1 through 13 on the worksheet will be answered in the video. Question 14 will require a thoughtful response. Review the questions so that students will know what to listen for. Show the DVD *Scientific American Frontiers: Hot Times in Alaska*. Allow time for students to finish the worksheet. Students may consult classmates for answers they didn't catch and to check for accuracy through question 13. Answer 14 should be completed independently.
3. Divide students into pairs or small groups. Hand out STUDENT WORKSHEET: "Climate Change: Things are Heating Up." Ask students to take turns reading, then work together to complete questions one through four. At the end of the worksheet, question five asks students to create their own crossword puzzle. Students should work independently to complete the puzzle then trade with a partner or group member. Each student will complete another's puzzle.
4. Hand out STUDENT INFORMATION SHEET: "Social Impacts of Climate Change." Ask for volunteers to read each impact section. Discuss and elaborate. As students about other impacts that could go in each section. Students should add notes during the discussion to be used when completing the worksheet to come. Hand out STUDENT WORKSHEET: "Social Impacts of Climate Change." Ask students to complete.
6. Ask the following review and critical thinking questions:
  - a. How much did the temperature increase during the last decade of the 20th century? Why is such a small increase important?
  - b. What are some natural contributions to global temperature increase?
  - c. How do some scientists think humans may be contributing to a warmer climate?
  - d. What is the difference between weather and climate?
  - e. If you put aluminum foil over a pizza box, what will happen to the box's albedo?
  - f. What happens to the temperature of the land when snow no longer covers it?
  - g. Where on Earth is the convection of air currents the strongest? Why?

### Extension Idea:

1. Show VISUAL AID: "Cartoon." In addition, show students examples of climate-change-related cartoons collected during activity preparation. Explain climate change is a controversial topic and many artists seize the chance to express their opinions through cartoons. Hand out STUDENT WORKSHEET: "There's Something Funny about Climate Change" and explain students will have the chance to do the same. Consider using the final cartoons to create a classroom display.

**(NOTE:** If time permits, allow students to do an Internet search for cartoons related to climate change to help spur creativity. There are hundreds of them! Suggest they enter the search term, "climate change cartoons.")

## THINGS ARE HEATING UP

### Answers:

#### STUDENT WORKSHEET: Climate Change Impacts in the Arctic

1. B. Arctic cod
2. D. Puffins
3. 4° Celsius
4. Height of glaciers
5. A. Two meters
6. sea/ocean water level
7. carbon dioxide (CO<sub>2</sub>)
8. Climate change rate will increase. CO<sub>2</sub> levels will likely double causing an increase in greenhouse gases that will mean an increase in temperature.
9. C. permafrost is thawing beneath the trees
10. True
11. The implant data loggers in the squirrels in the fall, then read out temperatures the next spring when the squirrel is re-trapped.
12. D. all of the above
13. Climate change will accelerate because of the increase in greenhouse gases and the ensuing increase in temperature.
14. Answers will vary but should indicate an understanding of the nature of change. One example might explain that thawing permafrost will mean that in discontinuous permafrost areas like Minto Flats the trees will eventually disappear. In tundra areas where some, but not all of the permafrost may thaw, more trees will grow as soil warms.

#### STUDENT WORKSHEET: Climate Change: Things are Heating Up

1. Any three of the following: scientists take ice cores to examine layers of volcanic ash, dust and carbon dioxide, take much (sediment cores) out of lakes and riverbeds, look at tree rings, and research records from ancient cultures to learn about climate long ago. Justifications for how those methods translate into climate research will vary, but should indicate that each piece of research indicates a certain condition - i.e. heavy ashfall layers indicate an eruption that could have effected climate.
2. Answers will vary, but students should show an understanding that average temperature growth does not reflect the temperature change that can occur in outlier areas such as the Arctic.
3. Student answers will vary, but should indicate an understanding that weather denotes temporary conditions that are subject to frequent change, while climate denotes a broader, systemic set of conditions. Students should also describe a situation where warming may not have occurred but climate change has happened - most likely an ice age.
4. Each student crossword will be different. Check to see that a classmate could complete.

#### STUDENT WORKSHEET: The Social Impacts of Climate Change

Answers will vary, but students must address two changes and how these changes could impact their community. An example might explain that new marine shipping routes could mean that local residents will see fewer seals and polar bears. Longer growing seasons might mean that local residents can plant gardens, especially root crops like potatoes and carrots.

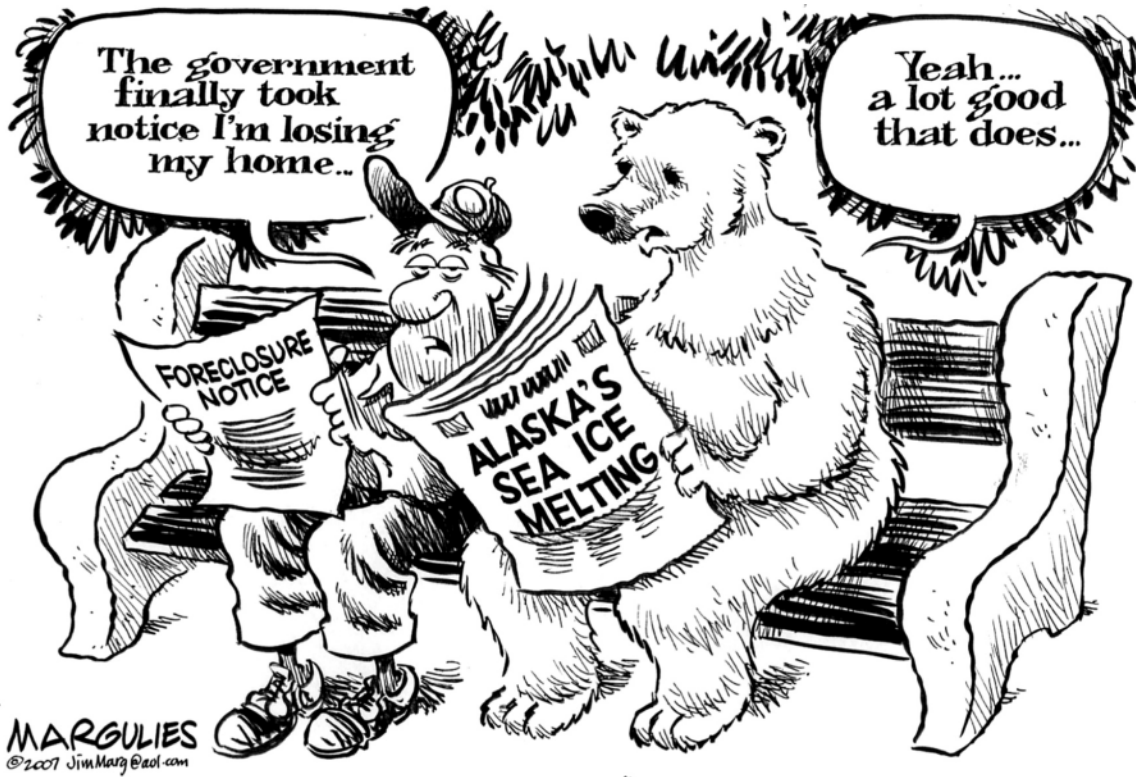
# THINGS ARE HEATING UP

## STUDENT WORKSHEET: There's Something Funny about Climate Change

### Rubric

Criteria	Excellent 5-4	Satisfactory 3-2	Needs Work 1-0
Content	Shows artist's clear understanding of climate change concept	Shows some understanding by the artist of climate change concept	Shows little or no understanding by the artist of climate change concept
Position	The point of view/position of the artist is clearly conveyed	The point of view/position of the artist is discernible with some consideration.	The point of view/position of the artist is marginally or poorly conveyed
Entertainment Value	The artist uses irony or satire. The cartoon is original and funny.	The cartoon is original and funny, but lacks the "bite" of irony or satire.	The cartoon lacks originality and is not very funny.
Visual Presentation	Text and graphics are completely legible and neatly done.	Text and graphics are mostly legible and could be neater.	Text and graphics are mostly illegible.

CLIMATE CHANGE CARTOON



From : Arctic Climate Modeling Program

A changing climate doesn't just mean more hot summer days. The impacts are far reaching. Some changes may be positive, some negative. Consider the brief examples below.

Pros	Cons
<b>Warmer winter temperatures could mean...</b>	
<p>lower heating costs.</p> <p>less wear and tear on vehicles.</p> <p>less risk of frostbite and hypothermia.</p>	<p>thin sea, river and lake ice make travel dangerous.</p> <p>shorter season for ice bridges and roads vital for winter travel.</p>
<b>Warmer summer and longer growing season could mean...</b>	
<p>agriculture has more opportunities.</p> <p>personal gardens do better.</p> <p>tourism opportunities are extended.</p>	<p>ecosystems and animal habitat change.</p> <p>invasive species of plants invade and choke out native species.</p> <p>the seasonal cycle of animals is disrupted.</p>
<b>Permafrost thaw means...</b>	
<p>construction is easier on unfrozen ground.</p> <p>water wells are easier to drill in unfrozen ground.</p>	<p>existing infrastructure is damaged, which is costly to repair.</p> <p>permafrost keeps groundwater out of mining pits. oil and gas well maintenance is affected.</p>
<b>Less sea ice could mean...</b>	
<p>ships may be able to travel farther north, which would reduce transportation costs, allow export of natural resources, and create jobs.</p>	<p>less protection from storms, which leads coastal erosion forcing communities to relocate.</p> <p>the fragile ecosystem of the Arctic land and sea would be at risk.</p>

**Here are a few more things to consider about a changing climate:**

- Changes in the ecosystem impact those inhabitants that rely on subsistence for survival. Animal behavior becomes less predictable as habitat changes.
- Traditional berry-picking areas become less fruitful or disappear.
- Warmer temperatures allow the introduction of new insects, parasites and disease.
- Hot, dry summers lead to more forest fires.

**NAME:** \_\_\_\_\_  
**CLIMATE CHANGE IMPACTS IN THE ARCTIC**

**Directions:** Watch the video: *Scientific American Frontiers: "Hot Times In Alaska."* To complete the questions below.

1. Guillemot birds depend on what fish to feed their young?
 

A. Salmon hatchlings	C. Arctic char
B. Arctic cod	D. Pike
  
2. What aggressive, subarctic birds are now invading Cooper Island?
 

A. Pigeons	C. Arctic terns
B. Sea gulls	D. Puffins
  
3. On average, how many degrees has Alaska warmed up over the last 50 years? \_\_\_\_\_
  
4. When Paul Claus and Anthony Arendt fly over glaciers, what do they measure? \_\_\_\_\_
  
5. Keith Echelmeyer and By Valentine have found that glaciers lose ice every year. About how much is lost?
 

A. two meters	B. two hundred meters	C. they aren't losing ice
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6. As glaciers melt, what rises? \_\_\_\_\_
  
7. When permafrost, and the organic matter it contains, thaws, what gas will be released in to the atmosphere?  
\_\_\_\_\_
  
8. If the gas is released, how will the rate of climate change likely be affected?  
\_\_\_\_\_
  
9. What causes "drunken forests"?
 

A. Bears push the trees over when they climb.	C. Permafrost is thawing beneath the trees.
B. The trees have reached the end of their life cycle.	D. The tree roots are drawing up toxic chemicals.
  
10. Circle one: True    False  
By comparing aerial photographs from the last 50 years to photos from today, Brian Riordan learned Alaska's lakes are shrinking.
  
11. How do Brian Barnes and Ryan Long keep track of ground squirrels during long periods of hibernation when they can't observe the squirrels?  
\_\_\_\_\_  
\_\_\_\_\_
  
12. What does the shrub photograph study tell scientists about changes in the tundra?
 

A. As the temperature increases, shrub growth moves further north.
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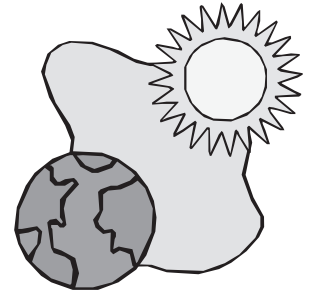
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## CLIMATE CHANGE: THINGS ARE HEATING UP

**Directions:** Read each section then answer the question(s) that follow.

### Climate of the Past

Earth gives many clues to its past climate. From the start the planet has experienced dramatic shifts, from tropical to ice age. Natural forces contributed to past climate change. Shifts in the sun's energy output, changes in ocean currents, even the movement of Earth's continents (plate tectonics) caused long-term climate change. Sometimes large-scale volcanic eruptions spewed ash into the atmosphere and shaded the world from the sun's energy.



There are a number of research methods used to figure out what our climate was like throughout history. Ice, such as glaciers and the Antarctic Ice Sheet store records in their layers. Scientists take ice cores to examine the layers, looking for volcanic ash, dust, carbon dioxide, and other chemical elements—all clues about past climates. They drill into the bottom of lakes and pull out sediment cores to look for clues in the buried layers. The sediment holds pollens, fossilized insects and other materials. Scientists look at tree rings to determine which years were warmer than others. They also interview local inhabitants and research written and oral records from ancient cultures.

Climate records indicate temperatures have been fairly stable since the last major ice age ended about 10,000 years ago. Within the last 100 years a noticeable warming trend began. This time, however, scientists can't trace the cause to the sun or to a volcanic eruption. Scientists are now looking at ways human activity may contribute.

1. Choose three ways that scientists learn about Earth's past climate and how that information is used to study climate.

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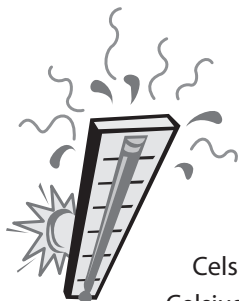


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### Warming Trend



So what's the big deal if it warms up by a couple of degrees? Consider this. During the last ice age Earth was just 4° to 6° Celsius cooler than it is today, but that small difference caused glaciers and ice sheets to cover vast areas of the planet. Sun-loving animals couldn't survive, others adapted and moved rapidly south. While it is true that Earth's climate has always changed, a few degrees can make a big difference.

Scientists' research shows the average temperature of the globe increased by about 0.6° Celsius between 1900 and 2000. Many regions of the Arctic have warmed up by as much as 5° Celsius in the same 100-year period. If the current trend continues, scientists predict the average global temperature is expected to rise by 1.4° to 5.8° Celsius by 2100.

2. While *average* temperature increase over the last 100 years is roughly 0.6°, the increase for many arctic regions is higher. Do *average* temperature increases accurately reflect the actual increases that may eventually be found in many areas? Why or why not?

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NAME: \_\_\_\_\_

## CLIMATE CHANGE: THINGS ARE HEATING UP

### What is Climate Change?

The term *global warming* is often used to describe recent changes in Earth's climate, however the term *climate change* better describes the full range of changes happening worldwide. Climate change is more than just warmer temperatures. Changes occur in precipitation, in wind patterns, and in cloud cover, too. Remember, just a few degrees lower in temperature can lead to an ice age!



Climate is the long-term pattern of a region's weather. It is the composite of 30 years or more of the prevailing weather conditions of a region, including temperature, humidity, precipitation, wind and sun. The two main influences on climate are temperature and precipitation.

Everyone expects the climate in Hawaii, Florida or Mexico to be warmer than Alaska based on historical experience. That is why such places are popular winter vacation spots! However, now and again disappointed vacationers come home complaining about the unusually cold weather that kept them off the beach and in the hotel. Weather is the short-term reality that can make or break our fun outdoors, but climate is the long-term pattern.

Both can change. Weather changes daily and we see it. But climate only changes noticeably over the long-term, over decades, centuries and even longer time periods.

3. Explain the difference between the terms global warming and climate change. What makes them different from one another? Provide one situation where climate change may have occurred but global warming has not.

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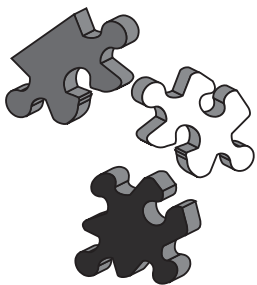
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### Pieces of the Climate Change Puzzle

Scientists believe that several factors work together to influence climate change. These include increased **albedo**, changes in **air and water currents**, increased **moisture** in the air and increased amounts of **greenhouse gases** in the atmosphere.

Land and water absorb the sun's radiant heat. The absorption and reflection of light, heat and radiation is called **albedo**. Heat that is absorbed by the land and water is slowly released back into the air and is an important contributor to climate.

Global patterns of **air currents** are another climate contributor. When warm air rises, cooler air from surrounding areas rushes in to fill the gap, a process called **convection**. The strongest convection occurs near the equator because this part of the world receives more direct sunlight than any other place on Earth. Here in the north the sun hits Earth at a lower angle. The sun's energy has to travel farther before it reaches land or water. A lot of energy is lost before it reaches the surface and the incoming energy is spread over a larger area.





NAME: \_\_\_\_\_

## THERE'S SOMETHING FUNNY ABOUT CLIMATE CHANGE

**Directions:** In the box below draw a cartoon that illustrates a climate change issue. Be prepared to explain your cartoon to your classmates. Your cartoon will be assessed using the rubric provided at the bottom of this page.

### Climate Change Cartoon Rubric

Criteria	Excellent 5-4	Satisfactory 3-2	Needs Work 1-0
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